ABSTRACTS BY THEME

Abstracts are presented by the first author except where indicated with an asterisk (*)

EARTH SYSTEMS - A1. A WINDOW INTO GEOSPACE

INVESTIGATION OF PC5 PULSATIONS DURING A TRINNI EVENT

J.A.E. STEPHENSON[1], B. MMAME[1] AND A.D.M. WALKER[1]

1. School of Chemistry and Physics, University of KwaZulu-Natal, Durban, 4041; stephens@ukzn.ac.za

UKZN and SANSA operate a HF (High Frequency) radar at SANAE, Antarctica. It, and 35 similar HF radars, form an international network called SuperDARN which routinely measures ionospheric convection. A “map potential” technique is used to produce a global convection map every 2 minutes for each hemisphere which utilizes all existing radars ionospheric measurements of velocity with a spherical harmonic representation of the ionospheric electrostatic potential. High speed ionospheric plasma flows in the night side sector, map to the magnetospheric tail, during periods which are magnetically quiet. They may be interpreted to be associated with the release of energy from a rapid reconfiguration of tail magnetic field lines due to reconnection. Such events are now known as ‘TRINNIs’ or ‘tail reconnection during IMF northward, non-substorm intervals’. Changes in the cross-polar cap potential, determined during the production of these maps, will be used as proxy for TRINNI events in this analysis. During a TRINNI event, we propose here that a portion of released energy may manifest as Pc5 (1-5 mHz) pulsations. Their presence will be sought by Fourier analysis of the radar’s Doppler velocity data. SuperDARN has the unique ability (due to its insitu ionospheric measurements over a very large area) to determine spectral information, azimuthal wave number, phase and group velocity and polarization properties of the Pc5 resonance. These parameters are essential clues to determine the generation mechanism. In particular, a sunward phase velocity would effectively rule out a number of popular candidates for the generation mechanism such as Kelvin-Helmholtz, solar wind coherent pulsations and solar wind pressure perturbations. Identifying the energy sources of Pc5 pulsations is an important and open question in space physics. The nature of the magnetosphere makes it a complex problem. For the first time, a different perturbation source may be proposed of magnetic reconnection in the magnetotail, such as during a TRINNI event.

A1O2 | **Radar observations of the thermosphere**

M.J. KOSCH[1]

1. SANSA, Hospital Street, Hermanus, 7200; mkosch@sansa.org.za

Radar systems rely on backscatter echoes to determine range and Doppler shift of a target. In the upper-atmosphere, the target is charged particles, generally electrons, but these are strictly in the minority. In order to use a radar to observe the majority neutral atmosphere a new technique is developed. Using the ion-momentum equation in the ionosphere, simplified for magnetic field perpendicular (or parallel) ion motion only, we derive an expression for the ion-neutral collision frequency that depends primarily on the temporal and spatial variability of the ion velocity. Experiments performed by the EISCAT ionospheric modification facility (located in Norway) in 2015, 2016 and 2017, using the CUTLASS-Hankasalmi SuperDARN radar for observations, show that realistic estimates of thermospheric neutral density compared to the MSIS model can be obtained from the ion-neutral collision frequency in the thermosphere with an hourly cadence. Since HF radio wave propagation refracts in the upper-ionosphere (150-300 km altitude), a functional comparison is only possible with ray tracing. The new technique works well, at least for low geomagnetic activity. The purpose for developing this new technique is to monitor and study the thermospheric density variations, which may be as much as an order of magnitude, due to solar and geomagnetic storms. This affects, for example, satellite drag and therefore satellite lifetime with obvious economic impact.

A1O3 | **Status and future of the SANAE neutron monitor**

R.D. STRAUSS[1], H. KRÜGER[1], C. DIEDERICKS[1]

1. Centre for Space Research, North-West University, South Africa; dutoit.strauss@nwu.ac.za

The South African neutron monitor in Antarctica has been observing the intensity of cosmic rays since the 1960's. Such long-term records are invaluable to the scientific community and represent an almost continuous record of solar activity variations over more than half a century. We will discuss some of the most notable observations of this instrument, but focus on the recent hardware developments that are currently retro-fitted to the neutron monitor which will enable the instrument to operate semi-autonomously from 2019 onwards. This is especially relevant as 2018 will be the last year that a "cosmic ray engineer" will be able to over-winter at SANAE.

A1O4 | **Tracking the evolution of rotating plasma features in Saturn's magnetosphere using auroral imagery from Cassini**

J. KINRADE[1]

1. Physics Department, Lancaster University, Bailrigg, Lancashire, UK; j.kinrade@lancaster.ac.uk

While Earth's magnetosphere is largely influenced by the solar wind, Saturn's magnetosphere is internally loaded with plasma originating mainly from the volcanic moon Enceladus and other icy satellites. A major driver of plasma circulation within Saturn's magnetosphere is hot plasma injection following magnetic reconnection events in the tail. The point at which this injected plasma meets Saturn's inner cold plasma torus is the subject of current research. The triggering of instabilities and resulting interchange processes that occur here are thought to dominate radial plasma transport, although these are not fully understood. It is difficult with in-situ measurements to pin down the timescale and spatial regions over which these processes operate. Global observations are required to capture the large radial distances traversed by hot plasma packets during injection events, and the observations must ideally span several planetary rotation periods. This study presents imagery from two instruments onboard the Cassini satellite that provide a picture of global magnetospheric dynamics. Firstly, the Cassini Ultraviolet Imaging Spectrograph (UVIS) captures Saturn's most intense UV auroral emissions, which are the optical, ionospheric fingerprint of hot plasma in the magnetosphere. Secondly, a picture of the magnetosphere's hot plasma population is possible through imaging of Energetic Neutral Atoms (ENAs) using the Cassini Ion-Neutral Camera (INCA).

The ultimate fate of the injected hot plasma is currently unknown, and the long lifetimes of rotating ENA flux regions once they reach the inner magnetosphere remains puzzling. By tracking the auroral features and hot plasma in the magnetosphere together following injection events, we profile the magnetospheric dynamics from 'source to sink' during opportune periods of dual observation, and try to answer some of these open questions. Early results indicate that it may be possible to locate Saturn's 'plasmapause' by tracking transient auroral features via magnetospheric mapping.

A1O5 | **Analysis of the space weather events of 6-10 September 2017 and its impact on aviation**

R. NNDANGANENI[1]

1. South African National Space Agency (SANSA), PO Box 32, Hermanus, 7200; rnndanganeni@sansa.org.za

Solar flares and solar proton events are some of the space weather events that have an impact on HF communications, navigation and can contribute in enhancing the radiation exposure at aviation altitude. Space weather refers to conditions on the Sun, in the solar wind, magnetosphere, ionosphere, and thermosphere that can influence the performance and reliability of space borne and ground-based technological systems. During adverse space weather conditions, communications and navigations can be interrupted and this is become problematic since the space-based position and navigation enables position determination for all phases of flight from departure, en-route and arrival. The impact of solar flares and the solar energetic particles on the aviation sector is investigated.

A1O6 | **Progress in the Gondwana Amalgamation and Correlation Project**

G.H. GRANTHAM[1], M.W. KNOPER[1], H. VAN NIEKERK[1], M. MORAKE[1], J. O'KENNEDY[1], C. GROENEWALD[1], R. BOTHMA[1], E. BURGER[2]

1. Department of Geology, University of Johannesburg; ghgrantham@uj.ac.za

2. Department of Geology, University of Pretoria, Pretoria, South Africa

The focus of the project has been two fold namely comprising a study of the Jurassic dykes related to the breakup of Gondwana and a study of rocks and structured related to the amalgamation of Gondwana. The dyke study has provided detail on the varying orientation of dykes intruded and has also shown that the age of dyke emplacement occurred over a far wider range in time than previously thought extending from ~170Ma to 216Ma. The age range has implications for the inferred mechanism of Gondwana breakup whether tectonically driven or plume-magmatism driven. Studies of the paleomagnetic poles are also in progress. In addition to the Jurassic dykes, an older new dyke swarm of age ~720Ma has been identified in the Borgmassivet area. This dyke swarm has equivalents in Zimbabwe. The Gondwana amalgamation study has recognised a wide variation of magmatic activity of ages between ~520Ma to 480M with dominantly acidic compositions but including volumetrically limited basic compositions. Early magmatism around ~520Ma is extensional in nature with juvenile isotopic characteristics. In contrast granitic veins emplaced ~480-490Ma show syntectonic emplacement in a top to S and SE direction with the veins having evolved isotopic characteristics implying melt genesis from an older source at depth. Basement isotopic studies combined with published and new geochronology define at least two, potentially three distinct terranes, probably separated by tectonic boundaries. These boundaries can locally be correlated to aeromagnetic domains. An Ar-Ar study on the age of mica and amphibole focussing on the uplift history show that uplift and erosion up to ~530Ma was limited to Sverdrupfjella and Kirwanveggan and places limits on the areal extent Kuunga Orogeny. The various chemical and structural data collected are consistent with a tectonic nappe collisional model proposed in 2008 with collision between N. and S. Gondwana.

A1S1 | **Novel radar and optical observations of black auroras in the upper atmosphere**

A. NEL[1]

1. South-African National Space Agency, Hospital Road, Hermanus, 7200; anel@sansa.org.za

Black auroras are recognised as spatially well-defined regions of reduced optical emissions within a much brighter, quasi-uniform diffuse auroral background. The energy of the precipitating electrons is reduced within the black aurora compared to the surrounding diffuse aurora. They are usually seen drifting eastward during the substorm recovery phase. Several theories have been proposed to explain the decrease in electron energy and flux in this region, but the underlying mechanism is as yet unknown.

The black aurora phenomenon has been studied by both optical and radar methods, using the EISCAT incoherent scattar radar in Tromso, Norway in conjunction with multi-wavelength cameras.

Results derived from optical and radar methods are presented here, which shows characteristic energies, as well as precipitating particle energy spectra, for both inside and outside the black aurora.

A1S2 | **Space borne and ground based lidars**

L. SHIKWAMBANA[1, 2]

1. Space science division, South African National Space Agency, Hermanus, 7200, South Africa

2School of Chemistry and Physics, University of KwaZulu-Natal, Durban, 4000, South Africa; lshikwambana@gmail.com or lshikwambana@sansa.org.za

Lidar is an acronym for light detection and ranging. It is analogous to radar (radio detection and ranging), except that it is based on discrete light pulses and measured travel times. The advancement in both laser and detector technology along with improvements in data-acquisition and analysis techniques have made lidar a very reliable tool for active atmospheric remote sensing. With this advancement a lidar system can be employed to measure: (1) temperature (structure from ground to the thermosphere; diurnal/seasonal/interannual variations, etc.), (2) Wind (structure from ground to upper atmosphere; its variations, etc.), (3) Aerosols and clouds (distribution, extinction, composition, size, shape, and variations spatially and temporally) and (4) Constituents (O3, CO2, H2O, O2, N2+, He, metal atoms like Na, Fe, K, Ca, pollution, etc). In this presentation we discuss the principles and applications of lidar. We further discuss some results we obtained from both ground based and space borne lidars.

A1S3 | **Investigate ionizing radiation in the troposphere using ground-based Neutron Monitor, ACE satellite and RBSP satellite data for aviation radiation forecasting**

G. THAGANYANA[1, 2]

1. South African National Space Agency (SANSA), PO Box 32, Hermanus, 7200

2. University of Western Cape (UWC), Private Bag X17, Bellville, 7535; cthaganyana@sansa.org.za

The aviation altitude is continuously bombarded with high-energy ionizing cosmic radiation. The high-energy ionizing cosmic radiation is believed to be produced by the remnants of supernovae, black holes, neutron stars, and also from the more exotic objects from the Sun and stars. The passengers and aircraft crew are exposed to high-energy ionizing cosmic radiation during the flight. In this context, we will investigate the correlation between Neutron Monitor counts rates and solar wind speed and proton density from the Advanced Composition Explorer (ACE) satellite, as well as Neutron Monitor count rates and radiation belt density from the Radiation Belt Storm Probes (RBSP) satellites, during the coronal mass ejection (CME) events. If the correlation exists, then it may be possible to use Neutron Monitor data in the future for the forecast the timing and level of ionizing radiation in the troposphere.

A1S4 | **Mesoscale neutral wind variability near auroral arcs measured using Fabry-Perot Interferometers**

N. NGWANE[1, 2]

1. SANSA, P.O. Box 32, Hermanus, 7200

2. UKZN, Westville Campus, Durban, 4000; nngwane@sansa.org.za

Central to this study is the investigation of the mesoscale neutral wind behaviour near auroral arcs in the E region upper atmosphere using Fabry-Perot Interferometers (FPIs). FPIs measure the Doppler shift and broadening of the green-line emission from which neutral velocities and temperatures can be derived respectively. The Scanning Doppler Imager (SDI) which is an enhanced FPI provides an all sky image of the neutral winds. SDIs are currently located in Alaska, Antarctica and Svalbard island. The study seeks to understand the E region neutral wind response to the driving force caused by the enhanced electric field upon the occurrence of an aurora. Subsequently, it is intended to study the ion-neutral coupling in the E layer focussing on energy dissipation in the form of Joule heating. This work expands from an initial single publication (Kosch et al., 2010) where Scanning Doppler Imager (SDI) data from Mawson, Antarctica, was used. The Super Dual Auroral Radar Network (SuperDARN) data set is used as a source of ion velocities to estimate the electric field.

A1S5 | **Optically observations of sprites over southern Africa: The journey so far**

S. NNADIH[1], M.J. KOSCH[2], D. MASHAO[2]

1. SpaceLab, University of Cape Town, South Africa

2Science Centre, South African National Space Agency; Nndsta001@myuct.ac.za

Sprites are the optical signatures of an electrical discharge in the mesosphere that are triggered by large lightning strikes associated with active convective thunderstorms. Since their discovery in the late 1980s, Sprite has been observed extensively around the world but much so less in Africa. This paper presents the results of the series of ground-based observations of sprites during the summer of 2015/2016, 2016/2017 and 2017/2018 in South Africa. The occurrence these events were compared to the lightning location and peak amplitudes determined from the lightning detection network operated by the South African Weather Service (SAWS). The results show that the charge moment change associated with most of the events agree with the dialectic breakdown of the mesosphere.

A1S6 | **Sprite over South Africa**

D.C. MASHAO[1]

1. South African National Space Agency, Hospital Street, Hermanus, 7200; dmashao@sansa.org.za

Sprites are a middle atmosphere gas discharge phenomenon powered by large positive cloud-to-ground lightning strikes which have an average peak value of ~74 kA. Sprites appear in different forms, such as carrot, jellyfish, column or disk-shaped, typically in the height range ~40-90 km. Sprites are part of the global electric circuit. Lightning strikes and sprites produce unique Very Low Frequency (VLF) and Extremely Low Frequency (ELF) radio wave signatures that can be detected remotely on the ground. South Africa has large convective thunderstorms typically in January and February of every year. Sprites were recorded for the first time in January 2016 from Sutherland using a night-vision TV camera from SANSA's Optical Space Research laboratory. Lightning strength, time and position data is obtained from the SA Weather Service and may also be tracked in real time using the World Wide Lightning Locating Network (WWLLN). The aim of this research is to characterize the maximum altitude of sprites as a function of the lightning magnitude. Dual-camera observations, for example from Sutherland and Carnarvon in the Northern Cape, using night-vision TV cameras will be used to simultaneously record the sprites from two separated locations. The cameras' spatial pointing geometry was calibrated using stars. The algorithm for distance and height triangulation in spherical coordinates (latitude, longitude, altitude) was developed. The data from 2016 Sprites campaign was processed and we found that the average maximum altitude, and altitude of maximum brightness, of sprites is approximately 85 and 69 km, respectively.

A1S7 | **Dosimetry at commercial airline altitudes**

M.G. MOSOTHO[1], H. KRÜGER[1], R.D. STRAUSS[1], M.J. KOSCH[2]

1. North-West University; godfrey.mosotho@nwu.ac.za

2. South African National Space Agency, Hospital Street, Hermanus, 7200

Scientists have been assessing the exposure of crewmembers and passengers of commercial airlines to ionizing radiation ever since it was identified as a health risk in the early 1960s. Progress has been made over the years in measuring and monitoring radiation at flight altitudes. The interaction of ionizing radiation with cellular DNA might lead to harmful effects such as cancer. To monitor and measure the radiation exposure of commercial airline crewmembers and passengers, a very small and lightweight active dosimeter known as HARM, an acronym for High Altitude Radiation Monitor, was developed and built. This instrument uses a silicon semiconductor sensor capable of measuring neutral and charged particles during a flight. Measurements obtained during a flight have been shown to exceed the limits of ground level workplaces and consequently, radiation exposure could be harmful to crewmembers and passengers. Therefore, monitoring changing radiation parameters in space and time is essential. In this presentation, I will talk about HARM observations and discuss current approaches to radiation risk estimation used by radiation agencies.

A1S8 | **The Ionospheric response to CME and CIR-driven storms**

T.M. MATAMBA[1, 2], J.B. HABARULEMA[1, 2]

1. South African National Space Agency Space Science, Hermanus, South Africa

2. Department of Physics and Electronics, Rhodes University, Grahamstown, South Africa; mtshimangadzo@sansa.org.za

The response of the ionosphere to Coronal Mass Ejection (CME)- and Corotating Interaction Region (CIR)-driven storms that occurred during the solar cycle 24 (2008-2017) will be presented. Global Navigation Satellite System (GNSS) Total Electron Content (TEC) and critical frequency of F2 layer from the ionosonde were used to study ionospheric responses. Analysis has shown that ionospheric changes during disturbed conditions could be due to a number of dynamic and electrodynamic processes. Some physical mechanisms responsible for ionospheric storm effects will be discussed.

A1S9 | **Highlights about the performances of different storm-time TEC modelling techniques**

J.C. UWAMAHORO[1, 2], J.B. HABARULEMA[1, 2]

1. South African National Space Agency (SANSA), Space Science, 7200, Hermanus, South Africa

2. Department of Physics and Electronics, Rhodes University, 6140, Grahamstown, South Africa; juwamahoro@sansa.org.za

A statistical evaluation of storm-time total electron content (TEC) modelling techniques over various latitudes of the African sector and surrounding areas is presented. For each selected global positioning satellite (GPS) receiver station, three different storm-time models based on empirical orthogonal functions (EOF) analysis, non-linear regression analysis (NLRA) and Artificial neural networks (ANN), were implemented. Storm-time TEC derived from GPS measurements over selected receiver stations were used to develop and validate the models. The models' estimates were compared with TEC provided by the International Reference Ionosphere (IRI - 2016) and statistics are presented. A statistical analysis revealed that ANN provides more accurate predictions than other modelling techniques. However, strengths and weaknesses of each model are provided.

A1S10 | **Investigation of TIDs using SANAE SuperDARN radar**

T. ATILAW[1, 2]

1. Rhodes University, South Africa

2. SANSA Space Science, South Africa; tatilaw@sansa.org.za

Traveling ionospheric disturbances are an ionospheric manifestation of atmospheric gravity waves that occur in the neutral atmosphere. There are different Source of mechanisms for TIDs, such as auroral electrojet (Joule heating and Lorentz force), solar terminators (sunrise and sunset solar terminators), energetic particle precipitation, magnetic storms, tropospheric weather and mountain turbulence. TIDs appear in power spectra of SuperDARN radars as spatially localized enhancements and as quasi-periodic fluctuations in Doppler velocities and reflection heights. SuperDARN is a network of HF radars designed to study plasma convection and plasma density irregularities in the E and F-regions of the ionosphere at high and mid-latitudes. The network consists of 35 low-power HF radars, 23 radars in the Northern hemisphere and 12 in the Southern hemisphere, with a collaboration of 10 countries. South Africa is one of the collaborating countries with HF radar installed at the SANAE IV station in Antarctica. There haven't been many studies done on TIDs observed in the southern polar hemisphere, in particular, by the SANAE HF radar. This paper aims to investigate TIDs events observed by SANAE SuperDARN radar in more details. The investigation includes propagation direction, frequency and wavelength of the TIDs events and also possible source of mechanisms of the TIDs events. For this study we will use data from SANAE radar and other radars which have field of view that overlap with SANAE radar.

EARTH SYSTEMS - A2. SOUTHERN OCEAN IN THE COUPLED OCEAN

A2O1 | **Seasonal depletion of the sub-surface iron reservoir in the sub-Antarctic zone of the Southern Ocean**

T.N. MTSHALI[1], N.R. VAN HORSTEN[1, 2], S.J. THOMALLA[1, 3], T.J. RYAN-KEOGH[1, 3], S-A. NICHOLSON[1], A. ROYCHOUDHURY[2], E. BUCCIARELLI[4], G. SARTHOU[4], P.M.S. MONTEIRO[1]

1. Southern Ocean Carbon and Climate Observatory, Natural Resources and Environment, SIR, Rosebank, Cape Town, 7700, South Africa; tmtshali@csir.co.za

2. Department of Earth Sciences, Stellenbosch University, Stellenbosch, 7600, South Africa

3. Department of Oceanography, University of Cape Town, Rondebosch, Cape Town, 7701, South Africa

4LEMAR/ IUEM, UMR, 6539, CNRS-UBO-IRD-IFREMER, Place Nicolas Copernic, Technopôle Brest Iroise, 29280, Plouzané, France

Iron availability in the Southern Ocean limits primary productivity with implications for the overall extent and efficiency of the biological carbon pump. Diagnosing the climate sensitivity of dissolved iron supply requires an improved understanding of the relative role of various input pathways (e.g. winter mixing, diapycnal diffusion, transient mixed layer entrainment and surface water iron recycling). This study utilises multiple occupations of a station in the sub-Antarctic Southern Ocean, spanning winter (July) to late summer (February), to address the seasonal evolution of dissolved iron profiles, providing insight into the dominant supply mechanisms of dissolved iron to surface water production. Results highlight the seasonal decrease observed in the subsurface dissolved iron reservoir (mean euphotic depth (82 m) to maximum winter mixed layer depth (200 m), which is in excess of that which is required to support estimated surface water production. Results suggest an important vertical physical supply of dissolved iron to surface waters, over and above mixed layer remineralisation to sustain productivity through to late summer. A wind induced mixed layer deepening event in February that coincides with an increase in phytoplankton biomass is indicative of the important role of storms in supporting sub-Antarctic blooms.

A2O2 | **Landscape and climate interaction on Marion Island**

W. NEL[1], D.W. HEDDING[2]

1. Department of Geography and Environmental Science, University of Fort Hare, Alice, South Africa; wnel@ufh.ac.za

2. Department of Geography, University of South Africa, Florida, South Africa

Marion Island in the southern ocean has a hyper-maritime climate and an environment where diurnal processes dominate the landscape. Results from automated and manual experiments on a variety of landscape elements show that the landscape on Marion Island is dominated by the passage of synoptic scale weather systems. These systems influences the thermal characteristics of soil, river dynamics, intensity of rainfall, snowfall, soil frost dynamics, needle ice development, aeolian erosion and a host of other abiotic processes and its direct and indirect interactions with the ecosystem. The sub-Antarctic is a unique environment since the impact of climate change on the landscape occurs at a higher resolution than for seasonal and permafrost environments and our research are therefore focused on interaction at the synoptic time scale. This presentation reviews the current knowledge on the interaction between climate and the landscape, the current methodologies employed to investigate these interactions and specifically addresses the possible landscape responses under a future climate.

A2O3 | **Surfing white waves: impacts of a severe storm on the winter marginal ice zone in the Southern Ocean**

M. VICHI[1], S. SKATULLA[2], K. MACHUTCHON[2], E. DE JONG[3], C. EAYRS[4], J.M. MONCADA[4], D. HOLLAND[5],

A. TOFFOLI[6], A. ALBERELLO[6], M. ONORATO[7], C. SAUNDERS[8], A. BEKKER[8], W. JOUBERT[9]

1. University of Cape Town, Marine Research Institute, Cape Town, South Africa; marcello.vichi@uct.ac.za

2. University of Cape Town, Civil Engineering, Cape Town, South Africa

3. University of Cape Town, Department of Oceanography, Cape Town, South Africa

4. New York University, Abu Dhabi, Center for global sea level change, Abu Dhabi, United Arab Emirates

5. New York University, Courant Institute, New York, United States

6. The University of Melbourne, Department of Infrastructure Engineering, Melbourne, Australia

7. University of Turin, Department of Physics, Turin, Italy

8. Stellenbosch University, Department of Mechanical and Mechatronic Engineering, Stellenbosch, South Africa

9. South African Weather Service, Cape Town, South Africa

The winter marginal ice zone (MIZ) in the Southern Ocean is one of the least explored regions of the world ocean, where synoptic weather, sea-ice and oceanic processes are more tightly interlinked. Remote sensing observations have revealed the large variability of the Southern Ocean sea ice over the past 20 years, and the increased spatial resolution of sensors now allow to capture synoptic patterns in the ice edge. The actual reliability of these data is however not known because of the very few in situ observations particularly during the winter period. This contribution reports on a process study conducted in July 2017 in the Indian Ocean sector, aimed at studying the winter MIZ, the relation with met-ocean conditions and how they impact navigation performances. The response of the MIZ to a large-scale storm was documented by means of sea-ice observations, ice-drift buoys, wave cameras and the ship-response to vibrations. The sea ice was composed of pancakes of varying dimensions that did not show compaction for more than 150 km into the MIZ. The preliminary results hint at a coherent large-scale response of the pancake ice field to wind and swell, with 7 m significant wave height and drifts of up to 0.8 m/s, more typical to brash ice conditions rather than the observed semi-consolidated surface. The results are analysed in conjunction with atmospheric reanalyses data and ocean forecasting models to provide insights on the process dynamics and improve future polar predictions in the southern hemisphere.

A2O4 | **Using the nitrogen isotopes to understand the past and present polar ocean and atmosphere: a plan for research capacity development and student training**

S.E. FAWCETT[1], K.E. ALTIERI[1]

1. Department of Oceanography, University of Cape Town; sarah.fawcett@uct.ac.za

Studies of the nitrogen (N) cycle are essential for understanding the coupled ocean-atmosphere system. While not the primary limiting nutrient in much of the Southern Ocean, N nonetheless exerts a dominant control on Antarctic productivity and CO2 drawdown as it is required universally by phytoplankton. Additionally, N emissions from the surface ocean to the atmosphere impact climate through new particle formation and by neutralizing atmospheric acidity. N has two stable isotopes, the natural abundance distributions of which provide an integrated view of biogeochemical and physical processes that are highly variable in time and space. The denitrifier-isotope ratio mass spectrometry (IRMS) method can be used to measure the N isotopes of almost all N species, revolutionising N cycle studies since its development in 2001. It is now the global standard for N isotope research, facilitating the analysis of samples 100-1000 times smaller than conventional techniques allow and permitting the simultaneous analysis of the oxygen (O) isotopes of nitrate. Despite international expectations that most N cycle questions will be addressed using the denitrifier-IRMS method, it has yet to be implemented in any African laboratory. Here, we describe our efforts to develop it in South Africa and discuss its utility for Antarctic science. For example, nitrate N and O isotopes can be used to quantify seasonal nitrate drawdown (i.e., net community production) and disentangle overlapping N cycle processes that complicate estimates of CO2 removal; nutritional preferences of important phytoplankton taxa can be deduced from the N isotopes of organic biomass; the hypothesis that more complete Southern Ocean macronutrient consumption drove the ice-age atmospheric CO2 decline can be tested using the N isotopes of sedimentary microfossils; the N and O isotopes of atmospheric nitrate can be used to distinguish NOx sources and preindustrial oxidant chemistry, while atmospheric ammonium isotopes can be used to trace marine ammonia emissions and their impact on new particle formation.

A2O5 | **Storm driven mixing in the Sub-Antarctic Zone and implications for phytoplankton biomass and CO2 fluxes**

S-A. NICHOLSON[1], P.M.S. MONTEIRO[1, 2], S. SWART[3], D.B. WHITT[4], A. BOSSE[5], I. FER[5]

1. Southern Ocean Carbon - Climate Observatory, CSIR; snicholson@csir.co.za

2. Department of Oceanography, University of Cape Town

3. Department of Marine Sciences, University of Gothenburg, Gothenburg, Sweden

4. National Center for Atmospheric Research (NCAR), Boulder, CO

5. University of Bergen, Norway

The Southern Ocean is one of the stormiest places on earth; here strong mid-latitude storms frequently traverse large distances of this ocean. Beneath these passing storms, this ocean is characterized high eddy kinetic energy (eddies and fronts occupying the meso to sub-mesoscale). Storms drive significant changes in upper-ocean stratification and turbulence. In addition, storm-driven ocean mixing drives a vertical flux of nutrient that fuels phytoplankton growth in nutrient limited oceans. Yet, the modifying effects of mesoscale (10-100 km) motions on mixing, upward nutrient fluxes and phytoplankton dynamics during and after a storm are not well understood. Idealised simulations with synoptic forcing show that storms intensify vertical nutrient transport pathways associated with mesoscale dynamics resulting in increased phytoplankton production. However, it is unknown where and when these results are relevant in reality in the Southern Ocean. The SOSCEx-STORM experiment aims for the first time to address this important climate knowledge gap by simultaneously measuring how these intense storms impact upper ocean physics and biogeochemistry within meso to submesoscale fronts. Novel twinned autonomous ocean robots (Wave Glider coupled to a Slocum with a MicroRider turbulence package) experiments have been designed to directly observe scale sensitivities and links between storm-driven wind forcing, upper-ocean mixing, phytoplankton biomass and CO2 fluxes. The preliminary results from the first SOSCEx-STORM experiment carried out in the Sub-Antarctic Zone during SANAE57 (December 2017 – February 2018) are presented here. Given that the SO is arguably the main source of medium-term uncertainty in global CO2 fluxes, understanding such climate sensitivities is of critical importance.

A2O6 | **Where is the Southern Ocean Carbon Cycle going in the 21st Century? Seven years of learning from SOCCO and international research**

[1]Pedro M.S. Monteiro, [1]Sandy Thomalla, [1,3]Precious Mongwe, [1,3]Luke Gregor, [1]Nicolette Chang, [1]Sarah Nicholson, [1]Thato Mtshali, [2]Francois Engelbrecht, [3]Marcello Vichi, [4]Schalk Kok, [5]Warren Joubert

1. Southern Ocean Carbon – Climate Observatory (SOCCO), CSIR

2. Climate Modelling and Environmental Health, CSIR

3. MaRe Institute, UCT

4. Department of Mechanical Engineering, University of Pretoria

5. South African Weather Services, Cape Point-GAW, SAWS

One of scientific grand challenges to global climate for the balance of the 21st century are the projected changes to the feedbacks between ocean and terrestrial carbon reservoirs and climate (WCRP, 2017). The Southern Ocean is a major contributor to this challenge. It already accounts for 50% of the CO_2 uptake and 75% of the heat uptake by the ocean and accounts for most of the uncertainty in global estimates of air-sea fluxes. The scientific challenge is how will this main driver of global carbon budgets change in the coming decades and what does our learning of its contemporary dynamics help us anticipate the 21st century trajectory of carbon fluxes and storage in the Southern Ocean? The major insight of the past 7 years from global ocean carbon science was that the carbon uptake by the SO has a decadal mode with very large amplitude of 0.6 -1Pgy-1. This is large enough to influence the long-term trend and the impact of mitigation measures. However, presently we neither understand the drivers nor do earth system models have ability to simulate the interannual – decadal variability of CO2 fluxes in the SO. Although global models agree on the mean annual fluxes they diverge on the seasonal cycle of the fluxes of CO_2. This points to mechanistic differences that can influence the climate forcing sensitivity of the internal variability and trends. Here we examine how SOCCO research is contributing to these problems in three main ways: firstly, by taking a high-resolution approach to develop new observational product constraints to the interannual variability of the seasonal cycle of CO2 fluxes; secondly, by using the seasonal mode to advance the understanding for the mechanisms behind carbon biases in CMIP5 models and thirdly, by examining the role of fine scale dynamics in understanding the climate sensitivity of CO2 fluxes as well as the biological carbon export fluxes. We then propose how this learning will help us contribute to the global challenge of improving the understanding and projections of the role of the Southern Ocean in global climate in the future.

A2O7 | **What We Have Learned From SOSCEx: A High-Resolution Glider Experiment In The Sub-Antarctic Southern Ocean**

S.J. THOMALLA[1, 2], I.J. ANSORGE[2], M. DU PLESSIS[1, 2], L. GREGOR[1, 2], M. LEVY[3], H. LITTLE[1, 2], S. MAENNER[4], A. MAHADEVAN[5], G. OGUNKOYA[2], +, M-F. RACAULT[6], C. SABINE[4], S. SWART[1, 2], #, M. VICHI[2], P.M.S. MONTEIRO[1, 2]

1. Southern Ocean Carbon - Climate Observatory, CSIR, Rosebank, South Africa, and Department of Oceanography, University of Cape Town, Rondebosch, South Africa; sandy.thomalla@gmail.com

2. Department of Oceanography, University of Cape Town, Rondebosch, South Africa

3. Sorbonne Université (UPMC, Paris 6)/ CNRS/IRD/MNHN, Laboratoire d'Océanographie et du Climat, Institut Pierre, Simon Laplace, Paris, France

4. NOAA/PMEL, Seattle, Washington, USA

5. Woods Hole Oceanographic Institution, 266 Woods Hole Road, MS #29, Woods Hole, MA, 02543, USA

6. Plymouth Marine Laboratory, Prospect Place, The Hoe, Plymouth PL1 3DH, UK

+Now at: Department of Ecology, Montana State University, Bozeman, MT, USA

#Now at: Department of Marine Sciences, University of Gothenburg, Box 460, 40530, Gothenburg, Sweden

In the Southern Ocean there is increasing evidence that seasonal to sub-seasonal temporal scales, and meso- to submeso- spatial scales play an important role in understanding the sensitivity of ocean primary productivity to climate change. In addition, there appear to be important regional and basin scale differences in the way that ocean productivity responds to the otherwise regular seasonal forcing, which is not well understood (Thomalla et al., 2011). These knowledge gaps in this globally important region provide the stimulus for a high-resolution approach to characterizing the drivers of variability of the seasonal cycle of phytoplankton distribution and primary production. Here we summarise the key insights from a series of glider deployments in the Sub-Antarctic Zone (SAZ) that form part of the Southern Ocean Seasonal Cycle Experiment (SOSCEx), which highlight: 1) the important role of small scale variability in driving vertical stratification and early blooms in spring and mixed layer variability and sustained blooms in summer (Swart et al., 2015, du Plessis et al., 2017); 2) The seasonal progression of net community production and sensitivity to fine-scale dynamics (Thomalla et al., 2015); 3) Seasonal trends and sub-seasonal variability in chlorophyll to carbon ratios (Thomalla et al., 2017) and 4) The requirement to subsample the SAZ frequencies of less than 10 and 2 days days to adequately characterise the seasonal scales of variability in chlorophyll and CO2 flux respectively (Monteiro et al., 2015; Little et al., in prep). These results highlight the need for climate models to resolve both the meso- to submesoscale and subseasonal processes in order to accurately reflect the phenology of the phytoplankton community and understand the sensitivity of ocean primary productivity to climate change.

A2O8 | **The temperature, bulk salinity and brine characteristics of pancake ice at two single locations on the outer and inner edges of the marginal ice zone in the Atlantic-Indian Ocean sector of the Antarctic Ocean**

K.R. MACHUTCHON[1]

1. Department of Civil Engineering, University of Cape Town; keith.machutchon@uct.ac.za

Sea ice is a multiphase material comprised of a pure ice matrix containing liquid brine, solid salts, microalgae, gases and other impurities which exist together in inclusions and pores within the matrix. Pure ice crystals are comprised of a tight, hydrogen bound, hexagonal network of dipolar H2O molecules formed by the relatively strong covalent bonding of the hydrogen and oxygen atoms. The strength of the hydrogen bonds increase as the distance between the water molecules reduce due to lower thermal motions in a cooling environment.

Sodium chloride ions that are highly soluble in water, are insoluble in ice with the result that brine is rejected or displaced by the ice during the formation of sea ice systems such as pancake and pack ice elements. This brine either (i) drains out of the ice matrix through channels, or (ii) it remains trapped in pockets between pure ice crystals, depending of the permeability of the matrix.

The characteristics of sea ice are typically most dependant on temperature, bulk salinity and liquid brine content parameters. These parameters are all closely related and, in idealised gas-free ice, any two can be used to calculate the third [Hunke et al, 2011]. Temperature and bulk salinity values can most easily be directly measured from in-situ ice samples.

The presentation will focus on the testing and analysis of pancake ice samples collected at two single locations on the outer and inner edges of the Antarctic marginal ice zone (MIZ) during research cruises in the winters of 2017 and 2018. We shall show how the parameters vary with their distance from the open sea at the outer edge of the MIZ.

A2S1 | **Marginal Ice Zone Phytoplankton Phenology in CMIP5 Models**

M.C. HAGUE[1], M. VICHI[1, 2]

1. Department of Oceanography, University of Cape Town; markhg77@gmail.com

2. Marine Research Institute, University of Cape Town

The presentation will focus on the role sea-ice plays in seasonal cycle of phytoplankton growth in the Southern Ocean. In particular, it will summarize a detailed study of 11 CMIP5 Earth System Models and their representation of phytoplankton phenology in the Marginal Ice Zone (MIZ) of the Atlantic Southern Ocean. The study revealed that models could be grouped according to two dominant controls on their simulated phenology, namely the location of the ice edge and degree of stratification present in the water column. This grouping allows us to investigate not only the mechanisms responsible for the major model biases, but also the response of phytoplankton, now and in the future, to a complex physical environment characterized by strong ice-ocean-atmosphere coupling. This work was sponsored by the SANAP grant TRAIN-SOPP: Southern Ocean Primary Production in the Earth System (2015-18).

A2S2 | **Assessment of the synoptic variability of the Antarctic marginal ice zone with in situ observations**

E. DE JONG[1], M. VICHI[1], M. SUOMINEN[4], K.I. SOAL[2], C.F.W. SAUNDERS[2], A. BEKKER[2], T. ROBERTSEN[3], P. KUJALA[4], M. LENSU[5], C. MEHLMANN[6], P. MINAKOWSKI[6], T. RICHTER[6]

1. Department of Oceanography and Marine Research Institute, University of Cape Town, Private Bag, Rondebosch, Cape Town, 7701, South Africa; djnehl001@myuct.ac.za

2. Department of Mechanical and Mechatronic Engineering, University of Stellenbosch, Cnr. Of Banghoek & Joubert Street, Stellenbosch, 7602, South Africa

3. The Norwegian Ice Service; a part of the Norwegian Meteorological Institute, Tromsø, Norway

4. Department of Mechanical Engineering, Marine Technology, Aalto University, Espoo, Finland

5. The Finnish Meteorological Institute, Helsinki, Finland

6. Institute of Analysis and Numerics, University of Magdeburg, Germany

Our knowledge of sea ice variability, which contributes to the detection of climate change trends, stems primarily from remotely sensed information. However, sea ice in the Southern Ocean is characterised by large variability that remains unresolved and limits our confidence on the remotely sensed products. Although one of the biggest seasonal changes on Earth is the annual advance and retreat of the Antarctic sea-ice cover, relatively little attention has been given to the processes by which the marginal ice zone (MIZ) edge forms and responds to synoptic events. The objective of this study was to compare sea-ice observations from the SA Agulhas II to high resolution satellite imagery when transecting the MIZ. Therefore, enhancing our understanding of the relationship between the MIZ and synoptic events. The location of the ship was tracked, allowing a more quantitative description of spatial sea-ice characteristics, specifically focusing on the MIZ edge. High resolution remotely sensed data were used to retrieve sea-ice properties. The Antarctic sea ice conditions were investigated to evaluate the quality of satellite retrievals with respect to on-board observational estimates, based on the Antarctic Sea Ice Processes and Climate (ASPeCt) protocol. To maximize the retrieval of information from previous cruises not specifically dedicated to sea-ice observations, an algorithm was developed to automatically retrieve sea ice concentration from still images and videos. This method can be used to obtain quantitative sea-ice data from vessels of opportunity without the need to have trained personnel on-board.

A2S3 | **A novel approach to investigating fluorescence quantum yield variability in the Southern Ocean**

E.L. BONE[1, 2, 3], D.J. GRIFFITH[4], S.J. THOMALLA[1, 3], S. BERNARD[1, 5]

1. Department of Oceanography, University of Cape Town, Rondebosch, Cape Town, 7700, South Africa

2. Nansen-Tutu Centre for Marine Environmental Research, Marine Research Institute, University of Cape Town

3. Southern Ocean Carbon and Climate Observatory, Natural Resources and Environment, CSIR, Rosebank, Cape Town, 7700, South Africa; emmalewisbone@gmail.com

4. Defence, Peace, Safety and Security, CSIR, Brummeria, Pretoria, 0001, Gauteng, South Africa

5. Earth Observation, Natural Resources and Environment, CSIR, Rosebank, Cape Town, 7700, South Africa

The fluorescence quantum yield (FQY) of marine phytoplankton refers to the ratio of photons emitted as fluorescence to those absorbed by individual cells, which serves as a first order estimate of photosynthetic efficiency. Dedicated instrumentation to measure this optical indicator is currently limited. In this study, a JFE Advantech Multi-Exciter Fluorometer (MFL), originally designed to discriminate phytoplankton species in a population based on accessory pigment composition, was selected as a low-cost option to derive FQY. Two different approaches were employed to optically characterise the fluorometer, providing a robust calibration that has yielded quantitative in situ measurements. The nine different excitation wavelengths of the MFL allows for both a spectral and total FQY derivation. This has both in situ and remote sensing application, allowing for the determination of the potential species composition influence on FQY variability, alongside comparable measurements to investigate current remote sensing limitations. The MFL was deployed in the Atlantic sector of the Southern Ocean during the austral winter of 2012 and summer of 2013/2014, where the FQY was determined at various stations. Fluorescence quantum yield in the Southern Ocean is influenced by light history, taxonomy and micronutrient availability. Our initial results indicate the fine scale resolution of community structure into smaller phytoplankton groups contains a wealth of physiological information. This new insight may be used to expand current remote sensing algorithms of the region. Improving our understanding of the physical and biological drivers of photosynthetic variability, particularly in the ecologically important Southern Ocean, is imperative to improving our predictive capabilities of a changing climate.

A2S4 | **Characterising the seasonal response of the mixed-layer and the transitional-layer to the passage of storms in the Sub-Antarctic Zone**

A. Mpalweni. [1]

1. University of Cape Town, Rondebosch, 7700; MPLAYA001@myuct.ac.za

Mid-latitude storms occur over large distances in Southern Ocean (SO) and have been shown to drive substantial vertical mixing leaving behind enormous wakes of perturbed upper ocean. The vertical extent and duration of the impact of these storms on the upper ocean remains unknown in this region, partly due to lack of observations in this remote part of the world. The mixed-layer depth (MLD) is used widely as proxy for vertical extent of upper-ocean mixing with the assumption that it reflects the integrated variability of atmospheric forcing. However, the responses of the vertical extent of the MLD and the transitional layer depth (TLD) where sub-MLD mixing may occur has been shown to vary substantially between storm events at similar locations. In this study, these two-physical metrics, the MLD and TLD, have been used to better characterise the response of the upper ocean mixing to storms in the Sub-Antarctic Zone (SAZ) and to further interrogate the relevance of the MLD as a proxy for mixing extent at these temporal scales. This is explored under different seasonal conditions using data collected from high-resolution autonomous robotic platforms (gliders), which remotely sampled the SAZ from spring to summer documenting the passage of several strong storm events. Two types of gliders are used in pseudo-mooring mode: a deep-profiling Sea-glider collecting the density structure from the surface ocean to 1000 m and circling this glider is a Wave-glider, which is at the surface measuring wind intensities and changes in atmospheric pressure. The findings of this work are important because storms on MLD regulate iron to the upper ocean vertical structure, and iron contributes towards phytoplankton growth required for the ocean productivity. We are also hoping to see how reliable MLD is as a metric for turbulence in the SO.

A2S5 | **Steady-state box modelling of ammonia/um across the air-sea interface during winter in the Atlantic sector of the Southern Ocean**

S.M. SMITH[1], K.A. SPENCE[1], S.E. FAWCETT[1], K.E. ALTIERI[1]

1. Department of Oceanography, University of Cape Town; smtsha023@myuct.ac.za

Ammonia gas emissions have increased substantially since the preindustrial era due to agricultural activities and fossil fuel burning. The subsequent increases in deposition, even in remote regions, have led to multiple environmental consequences known as the 'nitrogen cascade'. Investigating the anthropogenic effect on the nitrogen cycle requires quantification of natural sources. However, marine ammonia emissions, the largest natural source of ammonia, are difficult to quantify due to the dominance of continental sources and inaccessibility of remote regions. Previous work in coastal regions suggests that the marine ammonia source may have a unique isotopic signature as compared to anthropogenic/continental sources, but this has never been tested in a truly remote marine region. Here, we use a steady-state isotope box model and surface ocean measurements to investigate ammonia/um (NHx) cycling in the remote atmosphere of the Southern Ocean in order to characterize the isotopic composition of marine ammonia emissions. The model calculates the concentrations and isotopic compositions of NHx species in the ocean and atmosphere (seawater NHx, ammonia gas, and ammonium aerosols), and was initialised using measurements from a cruise to the marginal ice zone south of Africa during austral winter of 2017 onboard the R/V SA Agulhas II. Atmospheric NHx concentrations and isotopic compositions varied between the Sub-Antarctic, Polar Frontal, and Antarctic Zones. These differences were driven by seawater NHx concentrations and isotopic compositions, sea surface temperature, and wind speed. The correlation between the isotopic composition of seawater and atmospheric NHx demonstrates the predominance of the marine ammonia source in remote marine regions and suggests that isotopes can be used as a tracer for the marine ammonia source. Future work, including additional measurements of NHx and dimethyl sulphide and model validation, will improve our understanding of the surface ocean-lower atmosphere nitrogen cycle and its impact on marine aerosols and climate.

A2S6 | **Observing the seasonal cycle of pCO2 in the SAZ using pH**

M. RAWATLAL[1, 2], P.M.S. MONTEIRO[1, 2], K. ALTIERI[1, 2]

1. University of Cape Town, Department of Oceanography

2. Southern Ocean Carbon – Climate Observatory, CSIR; mishka.rawatlal@gmail.com

The Southern Ocean (SO) is responsible for more than half of the oceanic uptake of atmospheric CO2, data in this region is limited and subject to temporal, spatial and seasonal bias due to the inaccessibility of the SO as a result of high risk weather conditions and ice coverage experienced in winter. To resolve this bias, we have begun to use autonomous ocean robotic systems to collect high resolution seasonal data. The first aim of my study is to determine the accuracy of pCO2 derived from autonomous measurements of pH. The second aim is to investigate the applicability of the Lee et al. 2006 algorithm used to estimate total alkalinity (TA) from sea surface salinity and temperature to the SO in winter. My study utilizes data collected from Wave Glider deployments (pCO2, pH) at a reference station (43 °S; 8.5 °E), shipboard underway sampling (DIC, TA) and continuous in situ analysis (pCO2). The ultimate goal is to quantify high-resolution ocean fluxes of CO2 in the sub-Antarctic zone of Southern Africa from the summer 2013 - winter 2017 and to investigate the strength of the pCO2 sink in winter in comparison to data obtained by the SOCCOM project (Williams et al. 2017).

A2S7 | I**nterannual drivers of the seasonal cycle of CO2 in the Southern Ocean**

L. GREGOR[1, 2], S. KOK[3], P.MS. MONTEIRO[1, 2], M. VICHI[1]

1. University of Cape Town, Department of Oceanography

2. Southern Ocean Carbon – Climate Observatory, CSIR; luke.gregor@uct.ac.za

3. University of Pretoria, Department of Mechanical and Aeronautical Engineering

Machine learning has become a useful tool to interpolate ship measurements of pCO2 to a gridded map using satellite data. In this study we use an ensemble of three machine learning methods: Support Vector Regression (SVR) and Random Forest Regression (RFR) from Gregor et al. (2017); and the SOM-FFN method from Landschützer et al. (2016). The interpolated data were separated into nine regions defined by basin (Indian, Pacific and Atlantic) and functional biomes. The regional approach showed a seasonal decoupling of the modes for summer and winter interannual variability. Winter interannual variability had a longer mode of variability compared to summer, which varied on a 4–6-year time scale. To understand this variability of ΔpCO2, we investigated changes in summer and winter ΔpCO2 and the drivers thereof. The dominant winter changes are driven by wind stress variability. This is consistent with the temporal and spatial characteristics of the Southern Annular Mode (SAM), which has a decadal mode of variability (Lovenduski et al., 2008; Landschützer et al., 2016). Interannual trends in summer variability of ΔpCO2 are consistent with chlorophyll-a variability where the latter had high mean seasonal concentrations. In regions of low chlorophyll-a concentrations, wind stress and sea surface temperature emerged as stronger drivers of ΔpCO2. In summary we propose that sub-decadal variability is explained by summer drivers, while winter variability contributes to the long-term changes associated with the SAM. These findings reemphasise the importance of the long-term changes in wind stress over the Southern Ocean. We propose that more work is required in understanding the variability of long term wind stress.

A2S8 | **Decadal shifts in the diet of four penguin species at Marion Island**

M. SIGQALA[1], M. CONNAN[1], T. CARPENTER-KLING[1], P.A. PISTORIUS[1, 2]

1. Department of Zoology, Nelson Mandela University, South Campus, Port Elizabeth, 6031, PO Box 77000, South Africa; makabongwe.sigqala@gmail.com

2. DST/NRF Centre of Excellence, Percy FitzPatrick Institute for African Ornithology, University of Cape Town

To ensure co-existence, sympatric species have to share the resources whether it is habitat, foraging areas or else, food. At Marion Island, four species of penguins breed in sympatry, namely king (Aptenodytes patagonicus), gentoo (Pygoscelis papua), macaroni (Eudyptes chrysolophus) and eastern rockhopper (Eudyptes chrysocome filholi) penguins. These four species have been found to spatially segregate in their foraging habitats. King penguins typically forage offshore, up to 900 km from their breeding colonies, while gentoo penguins remain inshore, reaching no further than 15 km from the shore. In between, the macaroni and rockhopper penguins forage both inshore and offshore depending on life stages. These different behaviours are expected to drive varying degrees of dietary overlap and segregation. Twenty stomach content samples were collected concurrently for the four penguin species on the south-east coast of the island in 2016 and 2017. The stomach contents from the penguins were sorted into their three prey item groups; fish, cephalopod and crustaceans. These groups were then identified to their lowest taxonomic level. Preliminary results show that king and gentoo penguins mainly foraged on fish species with Myctophidae and Nototheniidae remains dominating the king and gentoo stomach content samples, respectively. Macaroni and rockhopper penguins showed a crustacean dominated diet with Euphausiid species representing the bulk of the species in both penguin species. Macaroni penguins consumed quantitatively more fish than rockhopper penguins, as well as a larger size class of the fish prey component. Our study shows how sympatric penguin species at Marion Island ensure co-existence by coupling different foraging areas and dietary segregation. Species preferences in food and foraging areas are likely to be instrumental to explain the population dynamics of the four species at Marion Island in the context of environmental change.

A2S9 | **King penguins at Marion Island: inter-annual spatial variability in foraging and trophic ecology**

L. RUITERS[1]

1. Nelson Mandela University; s21999732@mandela.ac.za

Gaining a clear understanding of how ecological communities will respond to global climate change in the future is of paramount importance. Marine predators can serve as an indicator of ecosystem health as their behaviour, specifically foraging, reflect lower down changes in the food chain. King penguins, Aptenodytes patagonicus, are one of the key predatory consumers in the Southern Ocean and the species also makes up a significant portion of the total seabird mass at the Prince Edward Islands. Much work has been done on King penguins at other islands in the Southern Ocean, however, very little is known about their foraging behaviour during the breeding season at the Prince Edward Islands. Marine top predators often feed at the highly productive Antarctic Polar Front and climate change projections suggest that this front is and will continue to move southwards due to rising sea temperatures. As a result, marine predators are having to travel increasing distances from breeding islands for foraging and feeding their offspring, which potentially results in lower breeding success. This study investigates the spatial foraging patterns of King penguins using tracking data collected at Marion Island over a three year period. It furthermore investigates trophic segregation between King penguins and other myctophid specialists, particularly sympatric sub-Antarctic and Antarctic fur seals. It is important to understand the foraging ecology of king penguins so that we are able to more accurately predict what future impacts climate change may have on the species.

A2S10 | **Phytoplankton group-specific contributions to the Subantarctic biological pump**

H.J. FORRER[1], T.G. BORNMAN[2], S.C. WATERWORTH[3], A.N. KNAPP[4], R.K. THOMAS[4], R.A. DORRINGTON[3], S.E. FAWCETT[1, 5]

1. Department of Oceanography, University of Cape Town; hjforrer@gmail.com

2. Elwandle Coastal Node, South African Environmental Observation Network

3. Department of Biochemistry and Microbiology, Rhodes University

4. Earth, Ocean and Atmospheric Science Department, Florida State University

5. Marine Research Institute, University of Cape Town

Summer Subantarctic surface waters are characterized by high concentrations of unconsumed nitrate (NO_3^-), likely due to combined iron, light and silica limitation of phytoplankton growth. The response of phytoplankton diversity and community structure to these nutrient limitations is not well understood despite the implications of such dynamics for organic carbon (C) export. The degree to which phytoplankton consume NO_3^- supplied by upward vertical mixing ("new production") is proportionate to net C removal to the deep ocean, while growth fueled by recycled ammonium (NH_4^+) yields no net C flux. The N isotopic composition ($\delta^{15}N$) of upper ocean biomass can be used as an integrative tracer of NO_3^- vs. NH_4^+ uptake. However, surface particles include heterotrophs and detritus in addition to phytoplankton, complicating the use of bulk particle $\delta^{15}N$ as a measure of new vs. recycled N uptake. This is overcome by coupling cytometric cell sorting (FACS) – isolating important populations (e.g., cyanobacteria, picoeukaryotes, diatoms) – with group-specific $\delta^{15}N$ analysis. During the summer 2016/2017 Antarctic Circumnavigation Expedition cruise across the Indian sector of the Subantarctic Ocean, we collected particles for FACS-$\delta^{15}N$ analysis and seawater samples for nutrients and NO_3^- $\delta^{15}N$. Four phytoplankton groups (Synechococcus, and three different types of eukaryotes) appear to be dominant across the basin. Their contribution to new production and C export will be discussed, as will that of Subantarctic island populations occupying waters where iron and possibly silica are no longer limiting due to mesoscale upwelling and island runoff. Indeed, results indicate that surface NH_4^+ and silica concentrations are higher near and downstream of the islands relative to open Subantarctic waters, indicating terrestrial inputs. Particulate organic N biomass is also higher, as is its $\delta^{15}N$, which can be explained by enhanced NO_3^- drawdown in near-island waters due to the alleviation of iron limitation of phytoplankton.

A2S11 | **CO2 as a driving factor of Carbon isotopic signature in the Southern Ocean**

Z. JORDAAN[1]

1. Stellenbosch University, Department of Earth Sciences; zandriaj94@gmail.com

The carbon cycle in the Southern Ocean changed dramatically over the past few years (Arrigo et al., 1999), as a result of the rising atmospheric CO2. The high rising partial pressure of CO2 in the atmosphere results in an increase in dissolved CO2 concentrations, which almost immediately effects marine plankton (Arrigo et al., 1999; Bousquet et al., 2000). Reconstructions of CO2 changes in the past help understanding the extent and impact of current changes. However, since pCO2 can't be measured directly in historic archives, such as oceanic sediment cores, a proxy needs to be established to assess those pCO2 changes of the past. Atmospheric CO2 is made up by the two stable isotopes of carbon, 1.1% of the non-radioactive isotope Carbon 13 and 98.9% of carbon 12 (O'Leary, 1988). It is possible to measure the isotopic signature of particulate organic carbon (δ13CPOC), and it has been used widely in paleo-reconstruction studies as a proxy for pCO2, but it is important to study the relationship between pCO2 and δ13CPOC. If there is a proportional ratio between the isotope and carbon dioxide, δ13CPOC can be used to measure the pCO2 in core sediments. We hypothesise that other factors might bias such proportional ratio in the Southern Ocean. In this study data on POC, δ13CPOC, and phytoplankton abundance (chl-a), community composition, macronutrients such as nitrate, ammonium, phosphate and silicate, micronutrients such as iron, as well as data on temperature and salinity will be analysed. The relationship of all those parameters with changes in δ13CPOC will be tested to determine their potential influence on the phytoplankton δ13CPOC. In addition, available pCO2 data will be used to determine the effect of pCO2 on the δ13CPOC in the upper layer of the Southern Ocean.

A2S12 | **Aeolian processes and landforms on sub-Antarctic Marion Island**

D.W. HEDDING[1], A. NGUNA[2], W. NEL[2]

1. Department of Geography, University of South Africa, Florida, 1710; heddidw@unisa.ac.za

2. Department of Geography and Environmental Science, University of Fort Hare, Alice, 5700

Sub-Antarctic Marion Island has a hyperoceanic climate characterised by cold and wet conditions with consistently strong wind velocities throughout the year. Recent observations have recognised the increasing role of aeolian processes as a geomorphic agent on this sub-Antarctic island. The first data on intra-annual variations in aeolian sediment flux at the study site near Mesrug (46° 56' 41"S; 37° 49' 59"E) are presented. An intensive and high resolution environmental monitoring campaign was conducted between May 2015 and April 2016 at the study site. Aeolian transported sediments were collected using Big Spring Number Eight (BSNE) sediment traps at four different heights above the ground (i.e. 0.05, 0.25, 0.45, 0.65 m) on a monthly basis. Local meteorological condition, namely air temperature, soil moisture, wind speed, wind direction and rainfall were also monitored at five-minute intervals using Pace Scientific sensors and recorded on Pace Scientific XR5 data loggers. An annual sediment flux of 1.37 kg cm-2 y-1 has been calculated. This value is lower than the initial annual sediment flux of 3.85 kg cm-2 y-1 for the same site, based on preliminary data, presented by Hedding et al. (2015). Modelled aeolian sediment movement appears to cease from 0.93 m above the ground. A notable limitation of the research is the incomplete dataset of monitored environmental parameters. As such, no single environmental parameter can be correlated with aeolian sediment flux. This study advocates further long-term monitoring of aeolian processes on Marion Island and that the link between aeolian processes and synoptic climate should be investigated.

A2S13 | **Plastics in Antarctica – preliminary findings from the Antarctic Circumnavigation Expedition (ACE)**

P.G. RYAN[1]

1. FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Rondebosch, 7701, South Africa; pryan31@gmail.com

The Antarctic Circumnavigation Expedition (ACE) sampled micro, meso and macroplastic litter around Antarctica from December 2016 to March 2017. Only 22 floating macrolitter items were observed south of the Subtropical Front in almost 15,000 km of transect counts, confirming that the Southern Ocean is the ocean least polluted by plastics globally. However, macro debris was found in two of the small number of seabed trawls, probably arising from fisheries operating in the region. Surface tows with a 200 micron neuston net captured no obvious mesoplastic items, but microfibres were found in most bulk water samples collected at sea and some beach sediments from sub-Antarctic and Antarctic sites. Surprisingly, there was no marked gradient in these fibres as we approached continental source areas. However, initial tests with micro-FTIR spectroscopy indicates that few fibres were synthetic, highlighting the need to confirm that microfibres in particular are made from persistent, synthetic polymers.

A2S14 | **Towards an improved Southern Ocean in the Earth System Model, CSIR VR-ESM**

N. CHANG[1]

1. CSIR, Southern Ocean Carbon and Climate Observation, 11 Jan Celliers Street, Stellenbosch, 7600; nchang@csir.co.za

The Southern Ocean is a key region for global carbon exchange, in which both physical and biological mechanisms drive carbon between the atmosphere and the surface ocean and ocean interior. Our research shows that the spatial scales of the surface ocean dynamics in the Southern Ocean are important in driving these exchanges, scales from mesoscale O (10-100km) down to submesoscale O (1km). We consider the representation of these processes in our configuration of an Earth System Model (ESM), the CSIR Variable Resolution Earth System Model (VR-ESM).

ESMs consist of multiple individual, interacting numerical models each representing different system components such as the atmosphere, land and ocean, all simulating hundreds of years of earth/climate evolution. We thus have to balance out model complexity with available computational power (CPUs and wall time) which is provided by the CHPC, Centre for High Performance Computing. Mesoscale and submesoscale processes therefore can either be explicitly resolved by the model grid resolution or represented by a parametrization. Typically, the ocean component of ESMs run at mesoscale-permitting to mesoscale-resolving grid resolutions, resolving the submesoscale is still only possible for localised regional runs.

We use the numerical model NEMO in a regional South Atlantic-Southern Ocean configuration as an experimental platform to inform ESM design choices for a better representation of the Southern Ocean. Through model sensitivity studies with NEMO's ocean, ice and biogeochemistry components and understanding the surface ocean-biogeochemistry dynamics, the model solution is improved while also optimizing the model with consideration to computational power.

A2S15 | **An investigation into the porosity of sea ice from the Atlantic-Indian marginal ice zones and its link to temperature and salinity using imaging analysis**

A. COOK[1]

1. Department of Civil Engineering, University of Cape Town, Rondebosch, Cape Town, 7735; ckxand008@myuct.ac.za

The purpose of this study is to explore the porosity of sea ice from the Antarctic-Indian marginal ice zone and its link to temperature and salinity variations using imaging analysis. Samples of laboratory grown ice made from saline water as well as a sea ice core extracted from the Antarctic Indian marginal ice zone were under investigation in this study.

The ice samples were all subjected to an imaging analysis using a 3T Siemens Skyra magnetic resonance scanner. The images generated by this device were qualitatively analysed to answer the research questions asked in my study. The data was analysed by comparing the images generated in the study to the temperature and salinity properties of each ice sample. Furthermore, similarities and differences between laboratory grown ice samples and the sea ice core extracted from the Antarctic-Indian marginal ice zone were recorded.

The data obtained verifies the link between temperature, salinity and the porous nature of ice samples. The findings furthermore confirm that higher temperatures and higher salinities yield more porous ice samples. It was also observed that temperature and salinity differences are not the only variables that influence the distribution of brine inclusions, as the methods used in forming ice also influence this distribution.

A2S16 | **Submesoscale instabilities drive enhanced variability of the Southern Ocean mixed layer: a four-year Seaglider experiment**

M.D. DU PLESSIS[1, 2], S. SWART[2, 3], I.J. ANSORGE[1]

1. Department of Oceanography, University of Cape Town, Rondebosch, South Africa, and Southern Ocean Carbon and Climate Observatory, CSIR, Stellenbosch, South Africa; marceldpl10@gmail.com

2. Southern Ocean Carbon and Climate Observatory, CSIR, Stellenbosch, South Africa

3. Department of Marine Sciences, University of Gothenburg, Gothenburg, Sweden

The ocean influences climate by storing and transporting large amounts of heat and carbon, and exchanging these properties at the air-sea interface. The subduction of these properties from the ocean mixed layer to the interior is a key process for the regulation of the global climate. One way the ocean transports properties vertically and horizontally is through submesoscale (1-10 km) instabilities, which manifest in regions of large horizontal density gradients, of which the Southern Ocean is ubiquitous. This study investigates the impacts of submesoscale instabilities in the Subantarctic Zone using high-resolution (1-2 km, 2 hourly) autonomous glider observations collected over four full seasonal cycles (winter to summer). Results indicate submesoscale instabilities propagate in winter and spring where Ertel potential vorticity suggests unstable flow. We show that winds orientated along the flow of fronts induce a destabilising flux via a horizontal Ekman buoyancy flux (EBF) towards the less dense domain of the front. EBF erodes the upper ocean stratification, deepens the mixed layer depth and reverses the sign of the potential vorticity, making the flow susceptible to submesoscale instabilities. Wind relaxation and when the wind orientation reversed against the frontal current restratified the mixed layer, enhancing the stratification and stabilising the flow. This restratifying flux is driven by the strength of the horizontal density gradients and the strength of the wind stress. When implemented into the 1-D PWP mixed layer model, EBF fluxes show upper ocean stratification to resemble our glider data, while 1-D air-sea fluxes over-estimate stratification. Previous work shows EBF is associated with turbulent fluxes, which may have key implications for mixing and vertical transport in the Southern Ocean. Therefore, this study shows the need to incorporate submesoscale processes into global climate models.

EARTH SYSTEMS - A4. CARBON-CLIMATE LINKS AND GEOTRACES

A4O1 | **GEOTRACES Program in South Africa, latest developments, achievements and future plans**

A.N. ROYCHOUDHURY[1], GEOTRACES TEAM

1. Department of Earth Sciences, Stellenbosch University, Stellenbosch; roy@sun.ac.za

With continued development and increasing capacity, GEOTRACES program within South Africa is now well established. This presentation will provide an overview of the infrastructure development, cutting edge analytical capabilities which puts South Africa among the best in the world and results from past few cruises to highlight the contribution of this program for a better understanding of the workings of the Southern Ocean. Given the high level skills required to conduct GEOTRACES related work, a lack of focused chemical oceanography curriculum in major marine related programs at South African universities needs a concerted discussion that would allow the growth of this program and participation/capacity development beyond the Western Cape.

A4S1 | **Southern African aerosol trace metal concentration and dissolution kinetics characteristics Aerosol trace metal concentration and dissolution from known dust sources in Southern Africa**

K.I. KANGUEEHI[1], S. FIETZ[1], A.N. ROYCHOUDHURY[1], F.D. ECKARDT[2], J. VON HOLDT[2]

1. Earth Science Department, University of Stellenbosch, South Africa; 16880501@sun.ac.za

2. Environmental and Geographical Science Department, University of Cape Town, South Africa

Dust can be a source of micronutrients to surrounding areas such as oceans and terrestrial regions. The deposition of dust can provide trace elements to the open oceans, which can increase primary production and ultimately remove carbon dioxide from the atmosphere, therefore reducing global warming. Previous remote sensing studies have shown that southern African is a prominent dust emitting region and can potentially provide micronutrients to oceanic regions which might be depleted in some bioactive trace elements. Hysplit modeling software was used to estimate the long distance transport of dust emissions observed in southern Africa between January 2005 and December 2008. The observations revealed that most of the dust emissions occur during spring and winter seasons, with very little emissions in autumn. Most of the dust emissions tend to travel off the Namibian coastline towards the north-west Africa regions and are mainly influenced by strong south easterly trade winds. A strong air mass migrates towards the Indian Ocean and as far as the Australian continent due to the effects of the westerlies. Fewer air masses travel towards the nutrient-limited regions of the Atlantic Southern Ocean and central eastern Indian Ocean. The locations further north of the southern Africa preferentially travel towards the north west Atlantic Ocean, because the westerlies are not strong enough to transport air-masses towards the southern oceanic regions. This study also revealed that the prominent dust emitting sites in southern Africa are two ephemeral rivers, Kuiseb and Omaruru River as well as two ephemeral pans, the Etosha Pan in Namibia and Makgadikgadi Pan in Botswana. Emissions from these sources tend to travel towards north west Atlantic Ocean and south east Indian Ocean, with the exception of the Etosha Pan, which has emissions that travel towards the northern regions. These emitters were investigated for particle size distribution, mineralogical characteristics and trace elemental concentrations. The role of ephemeral rivers in southern Africa as potential sources of micronutrients to marine environments has not been previously investigated extensively. Most previous studies focussed on the ephemeral pans. Etosha Pan has the finest grain sizes, while the Makgadikgadi had the coarsest grain size. Omaruru and Kuiseb River showed medium grain size variation. Our dissolution experiments showed, however, that the dissolution of the sediments is mostly influenced by the mineralogy rather than the particle sizes. The two pans appeared to be enriched in calcite, silica oxide and quartz, while the two rivers were more enriched in kaolinite, quartz, illite and muscovite. High trace element solubility in the Etosha Pan is most probably attributed to the high calcite content, which is highly soluble. This study is one of the few in southern Africa which aimed at modelling the air mass pathways from dust emissions that have been observed instead of just creating simulations. Our findings highlight the importance of additional studies to prove the dissolution and quality of dust in dry regions as potential contributors to marine primary production.

A4S2 | **Ground-truthing the Foraminifera-bound Nitrogen Isotope Paleo-proxy in the Modern Southern Ocean**

S.M. SMART[1], S.E. FAWCETT[2], H. REN[3], R. SCHIEBEL[4], A. MARTÍNEZ-GARCÍA[4], A.N. ROYCHOUDHURY[1], G.H. HAUG[4], D.M. SIGMAN[5]

1. Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa; sandi.smart@alumni.uct.ac.za

2. Department of Oceanography, University of Cape Town, Rondebosch, 7700, South Africa

3. Department of Geosciences, National Taiwan University, Taipei 106, Taiwan

4. Climate Geochemistry Department, Max Planck Institute for Chemistry, 55128 Mainz, Germany

5. Department of Geosciences, Princeton University, Princeton, New Jersey 08544, USA

We present the first nitrogen isotope (δ15N) measurements of living planktic foraminifera, paleoceanographically important zooplankton, from the Southern Ocean. This study builds on previous work in the subtropical ocean (near Bermuda) where, under conditions of complete nitrate consumption, foraminifera record the annual average δ15N of nitrate supplied to the euphotic zone. Time-series measurements from the Bermuda region demonstrate that foraminifera δ15N can likely also record seasonal changes in upper ocean ammonium recycling. In the polar ocean, we expect regional and seasonal variations in the degree of nitrate consumption to be an additional influence on foraminifera δ15N. Here, our focus is on investigating the regionally- and species-specific signals captured by foraminifera in Subantarctic waters. Nine foraminifera species were collected from upper ocean net tows in winter 2015 (between Cape Town and the Antarctic sea-ice edge at 56.4°S, 0.3°E) and late summer 2016 (between Cape Town and Marion Island at 46.9°S, 37.7°E). Consistent with expectations from the progressive, northward drawdown of nitrate by phytoplankton (and their preferential removal of the lighter isotope, δ14N) across the Southern Ocean, the bulk tissue δ15N of most foraminifera species mirrors the northward rise in nitrate and suspended particulate organic N δ15N in late summer. In winter, however, tissue δ15N exhibits no clear north-south trend, and is significantly higher than in late summer (by 3-4‰). Here, we explore the roles of nutrient dynamics (nitrate supply, the degree of nitrate consumption, and ammonium cycling) as well as food availability and species-specific characteristics (e.g., depth habitat, feeding preferences, and symbiotic activity) in explaining these observations. These enquiries are essential for the reliable interpretation of fossil foraminifera-bound δ15N from sedimentary archives, and for our understanding of the biological effect on global carbon and climate cycles.

A4S3 | **Seasonal comparisons between dissolved trace metals (Copper, Zinc and Nickel) in the Southern Ocean. Insights into deep winter mixing**

R. CLOETE[1], J.C. LOOCK[1], T.M. MTSHALI[2], A.N. ROYCHOUDHURY[1]

1. Department of Earth Sciences, Stellenbosch University, Stellenbosch, 7600, South Africa; 15994619@sun.ac.za

2. Southern Ocean Carbon and Climate Observatory, Natural Resources and Environment. CSIR, Rosebank, Cape Town 7700, South Africa

The re-occupation of 3 stations (46°S, 50°S, 54°S) along the Bonus Goodhope Line, Southern Ocean, during a consecutive summer-winter cycle allowed us to investigate the biogeochemical cycling of three bio-active elements, copper (Cu), zinc (Zn) and nickel (Ni), in summer, when conditions favoured algal growth (e.g. high light levels and a stable, shallow mixed layer), and in winter, when conditions limit algal growth (e.g. low light levels and a deep mixed layer). Results have implications in constraining the importance of winter deep mixing (entrainment) in supplying essential trace metals to depleted surface waters which then sustains phytoplankton productivity over the subsequent spring and summer seasons. Profiles of dissolved copper (dCu), zinc (dZn) and nickel (dNi) showed a general nutrient type behaviour throughout the study. In summer, dZn observed the greatest concentration range with sub-nanomolar surface concentrations increasing to 8 nmol kg-1 in bottom waters. dCu was typically 1 nmol kg-1 in surface waters and increased to 3 nmol kg-1 at depth. dNi showed a comparatively conservative profile throughout the water column with measured values between 5 and 7 nmol kg-1. Trace metal seasonality was most apparent in the mixed layer where average winter concentrations exceeded summer average concentrations by 0.2 nM for dCu, 0.9 nM for dZn and 0.5 nM for dNi. Summer-winter profiles in the intermediate and deepwaters (>500m), were tightly correlated for each metal indicating a loss of seasonal signal in the deeper waters. Subsurface trace metal reservoirs were calculated by depth integrating the metal profiles between surface and mixed layer depth. Results show that the subsurface reservoir, that portion of the water column between the summer and winter mixed layers, contained between 59.18 – 139.64 nmol m-2 dCu, 56.77 – 344.21 nmol m-2 dZn and 243.74 – 675.70 nmol m-2 dNi, which represents an important source of micronutrients, at times larger than the summer mixed layer inventory, during the onset of the growth season.

A4S4 | **Microbe-nutrient interactions in the Agulhas System Climate Array marine system**

K.Y. SINYANYA[1], R.G. PARROTT[1], D.R. WALKER[2], S.E. FAWCETT[1]

1. Department of Oceanography, University of Cape Town; ksinyanya@gmail.com

2. Department of Conservation and Marine Sciences, Cape Peninsula University of Technology

Phytoplankton growth and diversity are highly dependent on nutrient availability and can be hindered by an inadequate supply of biologically-available forms of nitrogen (N) such as nitrate and ammonium. The Agulhas System Climate Array (ASCA) transect in the Indian Ocean was developed to provide long-term observations of the hydrography of the greater Agulhas Current system, including volume, heat and salt transport. However, little is known of the biogeochemistry of this region, particularly the role of different phytoplankton in carbon production and export. In these subtropical waters, upper ocean density stratification obstructs the upward flux of nitrate into the euphotic zone so that phytoplankton presumably rely mostly on ammonium recycled in surface waters. Over an appropriate timescale, this ammonium-fuelled production yields no net carbon export to deep waters, in contrast to growth supported by upwelled nitrate, which is quantitatively linked to carbon removal. Here, we use fluorescence-activated cell sorting to separate prokaryotic and eukaryotic phytoplankton from bulk particle samples collected along the ASCA transect during winter 2016. Subsequent measurements of the organic N isotopes of these populations can be used to deduce the dominant N source supporting their growth, with the expectation that eukaryotic phytoplankton will be the primary consumers of nitrate. Preliminary results show that on average, eukaryotic phytoplankton abundance decreases with distance from the coast along with a decline in the nitrate concentration, while the prokaryotic genus, *Synechococcus*, becomes more dominant as conditions become more oligotrophic. Both populations are most abundant at the southern edge of the Agulhas Current, likely due a higher upward supply of nutrients driven by boundary shear. This is supported by depth profiles of chlorophyll and the concentration and N isotopes of nitrate that indicate higher biomass accumulation and a higher degree of nitrate consumption in current-edge waters.

A4S5 | **The kinetics and implications of nitrification in the Southern Ocean mixed layer**

M. MDUTYANA[1, 2], J. BURGER[1], S.J. THOMALLA[1, 2], B.B. WARD[3], S.E. FAWCETT[1]

1. Department of Oceanography, University of Cape Town, Private Bag, Rondebosch, Cape Town 7701, South Africa

2. Ocean Systems and Climate Group, CSIR, P.O. Box 320 Stellenbosch, 7599, South Africa; mdtmhl001@myuct.ac.za

3. Department of Geosciences, Princeton University, Princeton, New Jersey, USA

The Southern Ocean (SO) is an important sink for anthropogenic carbon dioxide, which depends in part on phytoplankton and bacterial cycling of nutrients in the surface mixed layer (ML). Nitrogen (N) limits primary production in much of the ocean, yet SO surface waters are perennially high in nitrate (NO_3^-) due to combined iron and light limitation of phytoplankton. Nonetheless, the seasonal drawdown of NO_3^-, supplied to ML waters largely through winter mixing, can be quantitatively related to carbon export provided that nitrification, the oxidation of ammonium (NH_4^+) to nitrite (NO_2^-) and NO_3^-, occurs in the ML at a rate that is insignificant relative to autotrophic NO_3^- uptake. Our work in the Atlantic SO has shown strong seasonality in ML nitrification, with wintertime rates that are 30-70 times higher than those measured in summer when nitrification accounts for <5% of the NO_3^- consumed by phytoplankton. This suggests that summertime NO_3^- drawdown from surface waters is a reasonable proxy for SO carbon export. However, high winter ML nitrification rates affect the NO_3^- pool available for consumption in the following spring/summer season because the winter ML evolves into both the spring/summer ML and the subsurface “winter water” layer that underlies and exchanges with the spring/summer ML. The implications of this for SO carbon export are not yet clear. To address this uncertainty, we conducted a series of high depth-resolution nitrification experiments across the Indian sector of the SO in winter 2017. In addition, we investigated the physiological capabilities of NH_4^+ and NO_2^- oxidizing bacteria through kinetic (i.e., Michaelis-Menten) experiments that deduce the theoretical maximum oxidation rate (V_{max}) and half saturation constant (K_s; an indicator of substrate affinity) parameters. These results will yield insights into the controls on nitrification under varying conditions. For example, our work-to-date suggests that NH_4^+ oxidation is the rate-limiting step for nitrification, but the controls on this remain unknown.

A4S7 | **A winter GEOTRACES study characterizing Fe-binding ligands and the physical speciation of Fe in the Southern Indian Ocean**

N. VAN HORSTEN[1]

1. The Council for Scientific and Industrial Research/Stellenbosch University, Stellenbosch, 7600; Nvhorsten1805@gmail.com

The Southern Ocean is of global significance to ocean biogeochemical cycling of nutrients and climate change. The trace metal Fe has been identified as a limiting nutrient to primary productivity in the Southern Ocean, thereby being classified as a High-Nutrient Low-Chlorophyll region. The cycling of Fe has been studied extensively, globally but lacking in the Southern Ocean, to determine the inputs and cycling of this crucial micronutrient. Climate change is predicted to affect the bioavailability of Fe and therefore a clearer understanding of the current Fe cycle is required to better predict future changes. Physical speciation is a major control on bioavailability of Fe to phytoplankton. The speciation of Fe in the marine environment has various controls, one dominant control is the presence of organic Fe-binding ligands. A large gap in understanding Fe cycling in the Southern Ocean lies within the lack of Fe physical speciation and seasonality data within this region. During July 2017 the IO6 Transect (30°E) was sampled, between 42°S and 58°S, for particulate and dissolved trace metals, on-board the SA Agulhas 2. Seven deep profiles were sampled along this transect. This is the first time particulate trace metal samples have been collected in the Southern Ocean during austral winter. Along with dissolved trace metal data we can start to close the gap in understanding the seasonality of Fe physical speciation. Organic Fe-binding ligand samples were also collected and the speciation of Fe can be further discussed with available organic data. Ultimately, this study aims to improve the understanding of the interactions between the size fractions of Fe and how Fe-binding ligands and seasonality affect these interactions, throughout the water column. Analysis of samples collected during the IO6 transect is currently underway.

LIVING SYSTEMS - B1. ECOSYSTEM FUNCTIONING AND THE RESPONSE TO GLOBAL CHANGE

B1O1 | **Songs of humpback whales (Megaptera novaeangliae) off Antarctica and South Africa**

F.W. SHABANGU[1, 2], K.P. FINDLAY[2, 3]

1. Fisheries Management, Department of Agriculture, Forestry and Fisheries, Foreshore, Cape Town, South Africa

2. Mammal Research Institute Whale Unit, University of Pretoria, c/o 16 Ebor Road, Wynberg, 7800, South Africa; fannie.shabangu@yahoo.com

3. Cape Peninsula University of Technology, PO Box 652, Cape Town, 8000, South Africa

Seasonal acoustic occurrences and diel singing patterns of humpback whale (*Megaptera novaeangliae*) songs are described using acoustic recordings from the west coast of South Africa and Maud Rise, Antarctica. Acoustic data were recorded using autonomous acoustic recorders deployed on oceanographic moorings from early 2014 to early 2017. Acoustic occurrences (i.e. presences) of humpback whale songs were identified through visual scrutiny of spectrograms of recorded data. Environmental parameters associated with humpback whale song occurrences were identified and ranked according to their model-predicted relative importance. In South Africa, humpback whale songs were detected from June to December with peaks in the occurrence of song in September. In Antarctica, humpback whale songs were detected from March to May (singing peaked in April) with few songs detected in July and September. Humpback whales were more vocally active at night in all recording sites. Peaks of acoustic occurrence of humpback whale songs in spring and autumn for South Africa and Antarctica respectively, suggest the west coast of South Africa is potentially used as an overwintering ground and migratory route whereas the Maud Rise is possibly used as a feeding ground. This study improves our knowledge about the diel singing pattern and seasonal occurrence of humpback whale songs off the west coast of South Africa and the Maud Rise, Antarctica. Such knowledge could be essential for the conservation and management of the species in South Africa and Antarctica.

B1O2 | **Invasive sub-Antarctic grasses respond to increasing temperatures at the expense of chilling tolerance**

B.S. RIPLEY[1], E. EDWARDES[2], M. ROSSOUW[2], V.R. SMITH[2], G.F. MIDGLEY[2]

1. Botany Department, Rhodes University, PO Box 94, Grahamstown, 6140, South Africa; b.ripley@ru.ac.za

2. Department of Botany & Zoology, Stellenbosch University, Private Bag Xl, Matieland, 7602, South Africa

Climate change and global warming has large effects on the performance and spatial distribution of plants and is considered one of the underlying causes for the spread of invasive species. Particularly vulnerable is the vegetation in cold environments where plants selected for tolerance traits have reduced phenotypic plasticity and capacity to respond to warming temperatures. In contrast, invasive species are phenotypically plastic and respond positively to climate change at the expense of stress tolerance. We investigate this trade-off in traits measuring the photosynthetic response to warming, chilling tolerance and specific leaf area (SLA) of a phylogenetically constrained group of Pooid grasses. We correlate this to the extent to which their ranges have expanded on a cold Sub-Antarctic Island in the southern ocean. The invasive species responded strongly to warming, increasing photosynthetic rates by up to two-fold, while non-invasive species did not respond. The response was associated with increased stomatal conductance and not to modifications of the photosynthetic metabolism. In contrast, electrolyte leakage, a measure of chilling sensitivity, was higher in invasive than non-invasive species, and SLA followed a similar pattern. All three traits scaled linearly with the rates of range expansion and demonstrate that on a historically cold island, unprecedented warming over the last 50 years has favoured grass species that can respond to warming at the detriment of those that cannot, and negated the advantage that chilling tolerance must have conferred in the past. This shows that cold ecosystems are particularly vulnerable to warming as species selection for stress tolerance has limited their responsiveness to environmental change, while introduced invasive have no such limitations. We show clear mechanistic evidence of the physiology that underpins these warming and chilling tolerance traits.

B1O3 | **Shifts in phytoplankton and microbial community composition in function of trace metal cycling in the Southern Ocean**

S. FIETZ[1], TRACEEX TEAM[1]

1. Department of Earth Sciences, Stellenbosch University; sfietz@sun.ac.za

The oceans are changing under pressure of global changes, such as increase in temperature, sea-ice melt, stratification, acidification or pollutants. The microorganisms will mostly adapt to it. However, environmental pressure will result in shifts in community composition and thus in biogeochemical fluxes, including the export of carbon, essential for an efficient drawdown of atmospheric CO2. We investigate the key role of metal bioavailability in the control of microorganisms in the Southern Ocean, one of the world's most important potential sinks for anthropogenic CO2. In turn, we support interpretation of the striking patterns in the regional, vertical, and temporal distribution of essential micronutrients, including, but not limited to iron. This presentation will show the outcome of the team's effort of the past 5 years and highlight the plans for the coming years.

B1O4 | **Marion Island Marine Mammals: individual variation and population processes**

P.J.N. DE BRUYN[1]

1. Mammal Research Institute, Department of Zoology & Entomology, University of Pretoria, Pretoria, South Africa; pjndebruyn@zoology.up.ac.za

Understanding predator responses to extrinsic drivers requires knowledge of their life history parameters and the nature of interactions amongst them. Linking variation in vital rates to particular environmental factors requires a thorough understanding of the mechanisms, adaptive responses, and possible population change associated with such linkage. In particular, how environmental variation may interact with individual heterogeneity. Assessing cause and consequence of individual variation and its impact on population processes is the focus; as a population's stability can be strongly affected by between-individual variation in frequency-dependent interactions. Annual climatic variation likely causes changes in resource accessibility and availability, influencing top predator vital rates. Current long term studies of top predator southern elephant seal *Mirounga leonina* (SES), Subantarctic fur seal *Arctocephalus tropicalis* (SAFS), Antarctic fur seal *A. gazella* (AFS) and killer whales *Orcinus orca* (KW), that variously breed, moult and feed at Marion Island (MI), facilitate observation of climate impacts. Mark-recapture in capital breeding SES investigates individual life-history. Body composition changes of SES individuals, a proxy for foraging success, are measured through photogrammetry, whilst satellite tracking of individuals identifies foraging variability. Dietary, hormonal and genetic profiles inform differential individual breeding and foraging identified in SES females. These investigations collectively aid in disentangling intrinsic and extrinsic drivers of individual heterogeneity. Income breeding sympatric populations of SAFS and AFS are assessed for a different scale of responses to environmental change through long-term dietary composition, individual foraging behaviour and breeding success. Potential top-down pressure on seal prey is investigated by intensive photographic mark-resight observation and foraging assessment of the local KW population. Here I report on the current status of populations and latest research findings within the context of the 35-year old Marion Island Marine Mammal Programme dataset, specifically related to our current objectives

B1O5 | **Novel insights into Marion Island plant function through sensing of the Photochemical Reflectance Index (PRI)**

G.F. MIDGLEY[1], A. ZIETSMAN[1]

1. University of Stellenbosch, Department of Botany and Zoology, Merriman Avenue, Stellenbosch, 7600; gfmidgley@sun.ac.za

Spectral reflectance methods allow the investigator to detect plant physiological status remotely, i.e., without disturbing the plant part being observed. A recent addition to the tool set designed for such purposes is the Photochemical Reflectance sensor (PRI-sensor), which measures wavelengths of light emitted by xanthophyll cycle activity in the leaf. When coupled to a data logger measuring pertinent driving variables (light, wind speed, air temperature, humidity, canopy temperature, soil moisture) and monitoring at relatively high frequency (minute time scale), this system can provide insights into the levels of stress being experienced by the observed tissue. From this, it is possible to characterise the conditions under which plants are performing closer or further away from a potential optimum. Such studies can form a powerful baseline for long term monitoring for example of climate change impacts. We set up such a system on Marion Island, to quantify the drivers of plant stress in three main plant functional types (PFTs); lower plants, cushion plants, and grasses. The system operated almost faultlessly for a year in 2016 (now extended for a further year in 2017). The three PFTs had distinct diurnal and seasonal patterns of PRI, and the environmental drivers of PRI response varied significantly between them. Lower plants were adversely affected by higher light levels diurnally, and seasonally by decreased habitat moisture levels. Cushion plants experienced less stress when cold, and to decreased canopy temperatures induced by wind. Grasses showed lower stress during the growing season, while cushion plants experienced significantly more stress. Lower plant species did not show seasonality in PRI response. This suggests that different PFTs respond differentially to environmental drivers, providing an important monitoring tool. The in situ approach described may be valuable for providing a detailed picture of how this ecosystem is responding to climate change.

B1O6 | **Spatial and temporal variations of the Southern Ocean ecosystem: Information from fur seals**

M. CONNAN[1], M.N. BESTER[2], LE. PRETORIUS[2], P. RICHARD[3], F. FERRATON[4], G.J.G. HOFMEYR[1, 5]

1. Coastal and Marine Research Institute, MAPRU, Department of Zoology, Nelson Mandela University, Port Elizabeth, South Africa; maelle.connan@gmail.com

2. Mammal Research Institute, Dept. of Zoology & Entomology, University of Pretoria, South Africa

3. Littoral Environnement et Sociétés – Université de La Rochelle, France

4. Marine Biodiversité Exploitation et Conservation, Université de Montpellier, France

5. Port Elizabeth Museum at Bayworld, Port Elizabeth, South Africa

Marine ecosystems are experiencing important changes worldwide and the Southern Ocean is no exception. Assessing the impact of these changes is difficult when relatively few current, let alone historical data, are available. One source of historical data, however, are samples housed in museums, which can be compared to contemporary samples. We used two widely distributed top predator species within the Southern Ocean as bio-indicators: the Antarctic *Arctocephalus gazella* (AFS) and Subantarctic *A. tropicalis* (SAFS) fur seals. Pinnipeds exhibit incremental tooth growth, with each growth layer reflecting the chemical elements deposited during a specific period during the animal's life. Fine-scale longitudinal sampling can therefore provide information for the 10 to 15 years prior to the animal's death. Samples collected at three locations (Bouvet Island [AFS], Gough Island [SAFS], Marion Island [AFS and SAFS]) from 1978 to 2016 are compared. Making use of the well-known δ13C isoscapes in the Southern Ocean, bulk carbon stable isotopes of tooth dentine provide information on the geographic locations at which the animal foraged during their lives, while nitrogen stable isotopes indicate the trophic level at which the animal was feeding. Bulk stable isotope analyses are complemented by stable isotope analyses of particular amino-acids to further examine spatial and/or temporal changes in ecosystem stable isotope baselines. Three main questions will be addressed: (1) Do the two fur seal species exhibit differences in trophic ecology depending on their breeding location? (2) Do changes in the fur seal trophic ecology reflect global changes in the marine ecosystem over the last fifty years? (3) If changes are detected, do female and male fur seals react similarly? The answers to these questions will bring new insights for the implementation of management plans in the context of climate change and sustainable exploitation of Antarctic resources.

B1O7 | **Influence of ontogeny and sex on the trophic ecology of Southern Ocean fur seals: Information from dentine**

L.E. PRETORIUS[1], M.A. CONNAN[2], M.N. BESTER[1], I. BENTALEB[3], F. FERRATON[4], *G.J.G. HOFMEYR[2, 5]

1. Mammal Research Institute, Dept. Zoology & Entomology, University of Pretoria, South Africa

2. Coastal & Marine Research Institute, MAPRU, Dept. Zoology, Nelson Mandela University, Port Elizabeth, South Africa

3. Institut des Sciences de l'Evolution de Montpellier- UMR 5554, Université de Montpellier, France

4. Marine Biodiversité, Exploitation et Conservation, Université de Montpellier, France

5. Port Elizabeth Museum at Bayworld, Port Elizabeth, South Africa; *greghofmeyr@gmail.com

The Southern Ocean is inhabited by both the Antarctic fur seal *Arctocephalus gazella* (AFS) and the Subantarctic fur seal *A. tropicalis* (SAFS). While they are closely related and show a similar degree of sexual dimorphism, they exhibit differences in life history, with AFS weaning at a considerably earlier age. Although the foraging ecology of adult females of both species is well known, the influence of ontogeny and sex is still poorly understood. The teeth of pinnipeds grow incrementally, with each dentine layer reflecting chemical elements deposited during a specific period of the animal's life. By serially micro-sampling and analysing carbon and nitrogen stable isotopes from each layer, we obtained retrospective information on the foraging environment and trophic level of the individuals at the time when dentine was deposited. Our data emphasized the influence of life history on stable isotope dentine values when comparing juveniles of both species. Immediately following weaning, AFS experienced a dramatic change in trophic level that is not evident in SAFS, suggesting a steeper period of adaptation to nutritional independence. This phase in AFS is characterized by a diet of a lower trophic level than that of older individuals. Sex influenced foraging location in both species with adult females targeting more southerly waters on average. A more striking sex difference was found in the nitrogen stable isotope data in SAFS pups. Since the pups are still suckling, the higher δ15N of female pups is unlikely to be due to their mother's foraging behaviour, but would more likely have originated from the differing physiology of male and female pups. These longitudinal data show specialization in fur seals, including of closely related and sympatric species. Traditional assessments of trophic level based on one component of the population will need to be reassessed in this light.

B1O8 | **Ocean utilization of marine top predators at Marion Island: Recent highlights and future perspectives**

P.A. PISTORIUS[1, 2]

1. Marine Apex Predator Research Unit (MAPRU), Coastal and Marine Research Institute, Nelson Mandela University, Port Elizabeth, South Africa

2. DST/NRF Centre of Excellence at the Percy FitzPatrick Institute for African Ornithology, Department of Zoology, Nelson Mandela University, Port Elizabeth, South Africa; pierre.pistorius@mandela.ac.za

Marine top predators have been studied extensively at Marion Island over the past few decades, largely driven by conservation needs of specific species. The majority of this research has been conducted on a species by species basis, and large amounts of data have been collected on diet and foraging distributions over varying time periods. There is a growing recognition of the importance of studying multiple marine top predator species at the ecosystem-level to gain insights into large scale environmental changes. As these top predators generally target areas of high productivity, they have also increasingly been used to identify ecologically important areas for conservation-based spatial planning. The SANAP funded project I report upon here involve distributional and dietary investigations on a suite of marine top predator species breeding at Marion Island (four penguin, albatross and petrel species and two fur seal species), as well as a subset of species breeding at the neighbouring Crozet archipelago within the new funding cycle. An overarching objective has been to identify areas of importance and high productivity relevant for spatial planning around the Prince Edward Islands using tracking data. All historical tracking data from the Prince Edward Islands were accordingly collated into a single database and through recent advances in habitat modelling this data was used to identify important habitat. In this presentation I highlight these areas and report on some of the recent research highlights within the overall project. I conclude by giving an overview of our future project priorities within the current SANAP funding cycle.

B1O9 | **Genetic information at different spatial scales**

B. VAN VUUREN[1]

1. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg; bettinevv@uj.ac.za

Biocomplexity can loosely be defined as the study of complex biological patterns that arise from interactions within the physical and biological arena. The overall aim of our project is to understand biological complexity in space and time. For this, we focus on a diversity of organism from microorganisms, arthropods, to plants; from the scale of the Southern Ocean (biogeography and colonization), individual island (phylogeography driven by adaptation, geology and climate), to patterns across tens of meters (population ecology linked to ongoing dispersal). Understanding spatial and temporal patterns and processes of biotic diversity across hierarchical spatial scales has become particularly critical in the face of rapid environmental change and increased numbers of alien invasive species driving biodiversity loss. The combination of spatial genetic structure with historical information on climate and geology linked to ecological information on species abundances and distributions provides a powerful approach to achieving this goal. Southern Ocean islands have simple yet well-developed terrestrial ecosystems that represent a continuum of increasing complexity from the low diversity found in the Antarctic to the species rich and complex continents to the north. The Southern Ocean islands were also markedly affected by past climate change, with a notable range of geological and glacial histories characterizing the various islands. Therefore, the Southern Ocean islands represent ideal model terrestrial ecosystems to investigate the history and evolution of biodiversity by being comparatively bounded systems with lower complexity than that characteristic of continental biotas.

B1O10 | **Metagenomic derived insights of microbial communities in the Southern Indian Ocean**

S. VIKRAM , S. PHOMA, D.A. COWAN, T.P. MAKHALANYANE

Centre for Microbial Ecology and Genomics (CMEG), Department of Biochemistry, Genetics and Microbiology (BGM), University of Pretoria, Pretoria, South Africa; surendravikram1@gmail.com

To understand the oceanographic features, how they shape marine microbial ecosystems and their implications on biogeochemical cycling remains a major ecological endeavor. Recently, several studies have assessed the contribution of photoautotrophs in surface waters and related factors which shape them. However, in contrast very little is known regarding chemolithoautotrophs in the marine ecosystems generally and waters south of 40o. Here, we assess microbial diversity, and functional capacity along the Agulhas current system and the Subtropical convergence in the South Indian Ocean. Samples collected from three water columns, epipelagic zone, oxygen minimum zone (OMZ) and bathypelagic zone, were analysed using shotgun metagenomics. We found high taxonomic richness in surface and deep water sample, with generally low numbers for middle samples, corresponding to the oxygen minimum zones, in contrast to other marine environments. Community analysis revealed significant dissimilarity between the three water depths; dominated by marine Proteobacteria, followed by Bacteroidetes, Actinobacteria, and Firmicutes with strikingly low relative abundance of Cyanobacteria. Our data showed evidence of extensive carbon, nitrogen and sulfur biogeochemical cycling genetic capacity with a large proportion of functional genes belonging to Alphaproteobacteria (Rhizobiales), Gammaproteobacteria (genus Pseudoalteromonas) and Cyanobacteria (genus Synechococcus). We have reconstructed the bacterial genome bins using bioinformatics tools. The most completed genome bin shows highest similarity to the genus Psychrobacter, having genes for the sulfur and iron metabolism, suitable for the South Indian Ocean marine environment. Taken together, our results suggest differential microbial community structure along with the water columns. Functional analysis revealed a variety of traits driven by these taxa together with Proteobacteria, suggesting high functional redundancy.

B1O11 | **Food is in the air: Alternative pathways of primary production in Antarctic soils.**

M. ORTIZ, M. VAN GOETHEM, T. MAKHALANYANE, D. COWAN

Centre for Microbial Ecology and Genomics, Department of Biochemistry, Genetics and Microbiology, University of Pretoria, Pretoria, South Africa 0002; emaxortiz@gmail.com

Terrestrial Antarctica is one of the most extreme environments on the planet Earth. Despite the harsh conditions, the continent is able to host a surprisly high diversity of microorganisms comparable to temperate environments, even in areas with total absent of phototrophs organisms. A recent study demonstrates how high-affinity hydrogenases, carbon monoxide dehydrogenases and a RuBisCo lineage are capable to scavenge atmospheric trace gases to support chemosynthetic carbon fixation. Notwithstanding this insightful approach, only two sites in Antarctica have been used to support this discovery, leading to the necessity of increasing the sampling depth and the potential of other kind of enzymes involved in the gas scavenging process. Here we analyzed 19 soil metagenomes from a region north of McMurdo Dry Valleys, Eastern Antarctica. We identified the main groups of genes encoding enzymes implicated in the scavenging of atmospheric hydrogen and carbon monoxide to produce carbon biomass. We also propose additional gene groups involved in the uptake of different atmospheric gases including methane and ammonia as alternative chemosynthetic pathways of primary production. In our metagenomes we identified 25 complete genes (and 1224 partial sequences) belonging to high-affinity NiFe-hydrogenases (group 1h) and 6 complete genes (and 277 partial sequences) with sequence homology to carbon monoxide dehydrogenases (Mo-Cu CoxL), responsible for the scavenging of the molecular H2 and CO from the atmosphere, respectively. Moreover, we identified 45 complete genes (and 736 partial sequences) for non-classical methane oxygenases, potentially involved in the aerobic oxidation of methane. With respect to the ammonia scavenge we found a wide distribution for high-affinity ammonium/ammonia transporters able to introduce atmospheric ammonia into the bacterial cell that, in conjuntion with glutamine synthetase (54 complete genes and 948 partial sequence), are responsible for the conversion of this metabolite into glutamate. Evolutionary relationships confirmed their phylogenetic assignment into every single family of enzymes. This work gives a comprehensive overview of how non-photosynthetic communities from Antarctica are able to use trace gases from the atmosphere as alternative pathways to support primary production in an ubiquitous way.

B1S1 | **The microbial composition of algal mats in meltwater ponds in nunataks of the Western Dronning Maud Land**

S. VAN ASWEGEN[1], G. MATCHER[1]

1. Department of Biochemistry and Microbiology, Biological Sciences building, Rhodes University, Grahamstown, 6140; sunet.vanaswegen@gmail.com or g15v3890@campus.ru.ac.za

There is still a major gap in Antarctic microbial research, which limits our understanding of the microbial populations and interactions in the Western Dronning Maud Land. Algal mats in meltwater ponds host a variety of microbial species, which increases the activity that take place in aquatic habitats. Studying the species present gives an indication of the microbial food web and the mechanisms they use to survive these extreme environments. Algal mats were collected from meltwater ponds in several nunataks, namely Roberskollen, Valterkulten, Vasdallen, Sessegen, Grjotøyra, and Svartgryta. The algal samples were examined microscopically to assess the morphology and composition. The majority comprised of Cyanobacteria and green algae. Tardigrades and rotifers were detected in the Sessegen sample and only rotifers were present in the Robertskollen sample. DNA was extracted from the algal samples followed by 18S, 16S, and ITS1-ITS4 gene amplification. Illumina sequencing was performed on the 18S amplified fragments and the 16S and ITS1-ITS4 amplified fragments were Sanger sequenced. The 18S sequences results showed that Chlorophyceae was the dominant phylum for all the sites. The tardigrades and rotifers were identified as *Acutuncus antarcticus* and *Adineta vaga*, respectively. The forward and reverse strands of the 16S and ITS1-ITS4 fragments were sequenced and aligned for identification. The green algae, *Pleurastrum* sp., was the dominant species identified in the ITS1-ITS4 fragments. A few protozoan species were also identified. The 16S forward and reverse strands could not be aligned due to a 100-300 bp gap. Thus, current work is to identify primers which span this gap to enable alignment and identification. Future work will be to compare this season's (2017-2018) algal mat microbiomes with previous collections (2016-2017) and identify any potential environmental factors affecting the microbial populations in the meltwater ponds.

B1S2 | **Characterisation of hypolith communities in Dronning Maud Land, Antarctica**

R.L. MIKHARI1

1. Department of Biochemistry and Microbiology, Rhodes University, Grahamstown, 6140, ritoleanah@gmail.com or g14m0302@campus.ru.ac.za

Antarctica is an extremely cold, dry and windy environment covered mostly in ice and permafrost soil. Despite the harsh environment, Antarctica harbors diverse and thriving microbial communities in a variety of micro-niches, one of which is hypoliths. Hypoliths are a heterogenous community of microorganisms that develop at the ventral side of mostly translucent rocks in extremely hot or cold desert environments. The Dry Valley Deserts in western Antarctica, are known to harbor hypolith communities. However, no information thus far has been published on hypoliths from the Dronning Maud Land (eastern Antarctica). In this study, high-throughput targeted amplicon sequencing of the 16S rRNA genes was used to characterize the microbial diversity within hypolith communities in the Dronning Maud Land. Hypolith communities were found to be dominated by Proteobacteria and Bacteroidetes, followed by Actinobacteria, and were also found to be distinctly different from those isolated from Dry Valley Desert hypoliths. Abiotic factors, such as location, slope aspect, elevation and type of rock under which the hypolith was found, were taken into consideration during this analysis. None of these factors, however, appeared to play a role in the diversity and distribution profiles of the hypolithic microbial communities in this study. Nevertheless, during statistical analysis, microbial communities were observed to group into four distinct clusters and it is proposed that these groupings are representative of developmental succession. In conjunction with this study, the potential for involvement in nitrogen cycling within these communities was assessed, since Antarctica is characterized by a low nitrogen input.

B1S3 | **An aggressive invasive, *Sagina procumbens*, causes a partial invasional-meltdown on sub-Antarctic Marion Island**

M. TWALA[1], C. JANION-SCHEEPERS[2], P.C. LE ROUX[1], M. GREVE[1]

1. Department of Plant and Soil Sciences, University of Pretoria, South Africa; Mthokozisi.thwala@gmail.com

2. Division of Natural History, Iziko South African Museum, Cape Town, South Africa

'Invasional meltdown' occurs when one invasive species facilitates other invasives' establishment, spread and abundance, and subsequently increases their impacts. Most studies on invasional meltdown have assessed facilitation of one invasive species by another invader, or of one invader on other invaders on one taxon, but few have assessed meltdowns in different taxa. Therefore, the aim of this study was to assess whether an invader causes invasional meltdowns in two very different taxa. *Sagina procumbens* (Caryophyllaceae) is an invasive cushion- or mat-forming vascular plant that has spread extensively on sub-Antarctic Marion Island. Little is known about its impacts, though observations suggest that it could be negatively impacting biodiversity and ecosystem functioning on the island. Therefore, we assessed whether S. procumbens is facilitating invasional meltdown of plant and collembolan communities on Marion Island. The abundance, richness, and species composition of native and invasive vascular plants growing on, and of native and invasive collembolans living in, S. procumbens were compared to those of two indigenous plant species (*Azorella selago* and *Clasmatocolea humilus*) which are being locally outcompeted by *S. procumbens*. Neither native nor invasive richness nor composition of the plants growing on *S. procumbens* differed significantly to that of plants growing on the two native control species. The richness of invasive collembolans was significantly higher in *S. procumbens* compared to the native control species; however, the richness of native collembolans in S. procumbens were not significantly different to that in *A. selago* and *C. humilis.* The abundance of invasive collembolans was significantly higher in *S. procumbens* compared to the native control species; a similar trend was found for native collembolans. The composition of invasive and native collembolans was significantly different between the three focal plant species. Therefore, we show evidence of an invasional-meltdown in collembolans, but not vascular plants, facilitated by *S. procumbens*.

B1S4 | **Differences in trait variation between native and invasive plant species, an implication for climate change**

R. MATHAKUTHA[1], C. STEYN[1], P.C. LE ROUX[1], I.J. BLOM[1], M. GREVE[1]

1. Department of Plant and Soil Sciences, University of Pretoria, Pretoria, South Africa; mathakutha.rabia03@gmail.com

Whether species withstand climate change, may depend on their ability to respond to rapidly environmental changes. Quantifying intraspecific trait variation within a population is one manner to assess the ability of species to respond to environmental changes. Species that are able to vary their traits more, generally have a higher capacity to respond to environmental changes, making trait variation an important indicator of species' ability to survive changes in the environment. It remains to be understood whether invasive species will be able to better respond to climatic changes than native species. Therefore, this study examined how trait variation differs between invasive and native species to understand how these groups of species cope with variable environments, and what their capacity to respond to future environmental changes might be. This was achieved by quantifying the intraspecific variation of five ecologically important traits related to growth, resource acquisition, photosynthetic capacity and environmental stress tolerance of five native and five invasive plant species of sub-Antarctic Marion Island, and comparing the amount of trait variation between invasive and native species. Differences in trait variation were evaluated across two contrasting altitudes, at different habitat types, and across the entire island. The results show that invasive species had higher trait variation than native species across altitude. However, there was no consistent pattern in terms of whether native or invasive species showed higher trait variation between different habitat types, or when overall trait variation was assessed. Overall, it thus remains unclear whether native or invasive species would be better at dealing with climate changes. However, invasive species showed consistently higher variation in specific leaf area, suggesting an ability to better adjust resource acquisition in response to environmental variation than native species.

B1S5 | **Risk assessment of alien plants in the Southern Ocean - Using distribution modelling approaches to predict potential future invaders**

C. STEYN[1], P.C. LE ROUX[1], S.L. CHOWN[2], M. VAN KLEUNEN[3, 4], W. DAWSON[5], M. WINTER[6], F. ESSL[7, 8], J. PERGL[9], P. PYSEK[8, 9, 10], P. WEIGELT[11], H. KREFT[11], M. GREVE[1]

1. Department of Plant and Soil Sciences, University of Pretoria, Private Bag X20, Pretoria, 0002, South Africa; steyn.christien@yahoo.co.za
2. School of Biological Sciences, Monash University, Victoria, 3800, Australia
3. Ecology, Department of Biology, University of Konstanz, Universitätsstrasse 10, D-78464 Konstanz, Germany
4. Zhejiang Provincial Key Laboratory of Plant Evolutionary Ecology and Conservation, Taizhou University, Taizhou 318000, China
5. Department of Biosciences, Durham University, South Road, Durham, DH1 2LF, United Kingdom
6. German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, 04103, Leipzig, Germany
7. Division of Conservation Biology, Vegetation and Landscape Ecology, University of Vienna, 1030, Wien, Austria
8. Centre for Invasion Biology, Department of Botany & Zoology, Stellenbosch University, Matieland, 7602, South Africa
9. Institute of Botany, Department of Invasion Ecology, The Czech Academy of Sciences, CZ-252 43 Průhonice, Czech Republic
10. Department of Ecology, Faculty of Science, Charles University, CZ-128 44 Viničná 7, Prague 2, Czech Republic
11. Biodiversity, Macroecology & Biogeography, University of Goettingen, Büsgenweg 1, D-37077 Göttingen, Germany

As invasive species continue to spread, they increasingly threaten indigenous biodiversity. In isolated island systems, alien invasions particularly pose a risk to native species. The remote Southern Ocean Islands (SOIs) are minimally influenced by human development and disturbance; nevertheless, substantial numbers of alien species have reached the SOIs. To mitigate future invasions, predicting the potential for new invasions to the SOIs is thus essential. Since prevention of introductions of new species is widely recognised as the most cost-effective measure in combatting the threats posed by new and emerging invasive species, we performed a risk assessment of global invaders to the SOIs. Because people travel to the SOIs from across the world, a potentially wide-ranging pool of propagules could be introduced to the region. However, this large potential source pool can be narrowed by only considering species that are climatically suited to survive on SOIs. For this purpose, climate-matching provides a useful first prediction of potential invaders to a region. Therefore, we used a climate-matching approach to predict which global plant invaders have the potential to establish on the SOIs if introduced, and which islands are most prone to invasions. A list of over 13000 global plant invaders, i.e. species with a known history of invasion, was compiled, and occurrence data for these species assembled. Species distribution models were then run for 8564 of these species to establish whether the climate envelopes of the global invaders overlap with the climate conditions of the SOIs. We also examined how invasion risk is expected to change under a climate change scenario. Despite their isolation and relatively cold climates, SOIs are vulnerable to invasive species establishment, and this risk will be worsened under future climate change. It is imperative that biosecurity measures for the region remain strict.

B1S6 | **Characterising soil microbiomes associated with cushion plant species *Azorella selago* and *Sagina procumbens* on Marion Island**

R.D. PIENAAR[1], R.A. DORRINGTON[1], G.F. MATCHER[1], S. VENKATACHALAM[1], S. SEKAR[2]

1. Department of Biochemistry and Microbiology, Rhodes University, Grahamstown, 6140, RSA; g13P1360@campus.ru.ac.za or robertdanpie@gmail.com

2. Department of Zoology, University of Johannesburg, PO Box 524, Auckland Park, 2006, South Africa

The development of an ecosystem is dependent on several organisms, with the focus of research falling primarily upon pioneering plants and subsequent plant succession during the early phases of development. Currently, little research has been published using targeted metagenomic approaches to investigate the effects of the soil microbiomes on alien invasion within plant driven ecosystem development, particularly in sub-Antarctic terrestrial ecosystems. There is evidence suggesting that cushion plants act as ecosystem engineers, with *Azorella* spp. fulfilling this role in the Chilean Andes and *Sagina procumbens* colonizing baron lava fields on the geologically young island of Surtsey. Marion Island is host to an indigenous cushion plant species, *Azorella selago*. The presence of invasive cushion species, *Sagina procumbens*, was first reported in 1965 and is presently established in 21 different habitats and dominates the plant community at 7 of these sites. The research described here aimed to characterise the soil microbiomes associated with *A. selago* and *S. procumbens* through analysis of 16S rRNA and 18S rRNA amplicon sequence data. Statistical analysis of the data suggests that geographic location of the plant most greatly impacts the community composition of the plant-associated microbiota relative to factors such as plant size or aspect. Furthermore, differences were observed in microbial communities in soil sampled from directly beneath the plant specimens relative to the surrounding open soil.

B1S7 | **Do positive interactions expand the upper distributional limits of vascular plant species on Marion Island?**

M.J. RAATH[1], P.C. LE ROUX[1]

1. Department of Plant and Soil Sciences, University of Pretoria, Private Bag X20, Pretoria, 0002, South Africa; morganj.r@hotmail.com

Biotic interactions may strongly shape species' distributions as they contribute to determining species' realized niches, potentially either constraining or expanding the range of conditions under which species occur. This study examined whether fine-scale plant-plant interactions scale up to shape plant species distributions using *Azorella selago* Hook, a widespread cushion plant (compact, hemispherical plants that create favourable microhabitats by ameliorating stresses) and the rest of the vascular flora from the sub-Antarctic Marion Island as a model system. We assessed the elevational distribution of vascular plant species when growing in association or away from *A. selago* to test how the interaction with this cushion plant species affect species' ranges along: 1) twenty island-scale altitudinal transects, and 2) twenty-one landform-scale altitudinal transects. The upper distributional limits of most species did not differ significantly in the presence and absence of *A. selago* at either spatial scale. However, at the island-scale, *A. selago* had a positive effect on the upper range limit of one species, *Aceana magellanica* (mean difference = + 26 m), and had a strong positive effect on another species, *Colobanthus kerguelensis* (+ 104 m) in transects located on the south slope aspect of the island. Therefore, although *A. selago* strongly impacts some fine-scale species patterns, these local impacts could only scale up to shape the distribution of certain vascular plant species on Marion Island. Thus, plant-plant interactions have the potential to mediate range shifts by expanding species' upper distributional limits, although the influence of these interactions may be species-specific.

B1S8 | **Do cushion plants act as nurse plants due to wind-driven seed trapping?**

C.A. GOUWS[1], P.C. LE ROUX[1]

1. Department of Plant and Soil Sciences, University of Pretoria; gouwscharne@gmail.com

Facilitation between plants is most commonly found in abiotically-stressful areas. The nurse plant effect is a form of facilitation, where an adult plant of one species improves the germination and/or establishment of other species. While the nurse plant effect is generally attributed to amelioration of abiotic conditions (including higher soil moisture and buffered thermal conditions), seed trapping is a potential mechanism driving higher abundances of seedlings in association with nurse plants. Nurse effects have been observed on Marion Island between the cushion plant, *Azorella selago* and its dominant epiphyte, the grass *Agrostis magellanica*. The compact, prostrate form of cushion plants may make these species efficient at trapping seeds, and the very windy conditions on Marion Island likely cause a large proportion of seeds wind-transports, at least for short distances. We investigated spatial patterns of seed accumulation on Marion Island, comparing seed densities between *A. selago* cushion plants, similarly sized rocks and open control sites. Multiple sides of cushion plants and rocks were sampled to account for potential difference due to the dominance of westerly and north-westly winds. Results from Marion Island will be discussed, and will be contrasted with findings from previous research on the island that used spatial variation in seedling abundance as a proxy for seed density.

B1S9 | **Do plant-plant interactions affect functional traits?**

S. VAN DER MERWE[1], M. GREVE[1], P.C. LE ROUX[1]

1. Department of Plant and Soil Sciences, University of Pretoria, Pretoria, South Africa; stephni.vdm@gmail.com

The causes of variation in the expression of functional traits are relatively poorly understood. While functional traits may be affected by abiotic conditions, traits could potentially also be influenced by plant-plant interactions. Indeed, functional traits have been found to respond to biotic interactions in some systems. Nurse plants, in particular, may influence the expression of functional traits by the other plants, as they strongly modify microhabitat conditions, changing the fine-scale environmental conditions experienced by interacting individuals. I investigated whether functional trait values are influenced by facilitative interactions on Marion Island, using the interactions between cushion plants (known to facilitate species in harsh environments) and beneficiary species as a model system. Contrary to expectation, I found a limited response of seven leaf traits of a perennial grass (*Agrostis magellanica*) to the interaction with a cushion plant (*Azorella selago*), despite *A. selago* having a strong impact on the biomass, abundance and population structure of *A. magellanica*. Functional traits also showed limited responses to elevation, and the influence of microhabitat type (i.e. growing in cushion plants or in adjacent substrate) did not vary with elevation, despite the net outcome of the interaction between *A. selago* and *A. magellanica* being related to elevation. These results show that plant performance, as assessed by functional traits, has a limited response to the interaction with nurse species. This research demonstrates that the process through which facilitation occurs is not through shifting beneficiary species' expression of functional traits towards more resource-acquisitive states. Therefore, other processes must be responsible for translating beneficial microhabitat modification by benefactor species into positive impacts on beneficiary species.

B1S10 | **The influence of biotic interactions and abiotic factors on fine-scale variation in plant species richness and performance on sub-Antarctic Marion Island**

N.F.P. MHLONGO[1]

1. University of Pretoria, PO Box 1266, Pretoria, 0001, South Africa; nfpmhlongo@gmail.com

Traditionally studies examining the determinants of species ranges have focused on abiotic variables (specifically climatic conditions). The recent explicit consideration of biotic interactions in these studies represents an important advance in the field. However, while these studies support the importance of biotic interactions for species distributions, only the influence of a single species and/or a single interaction is examined by most studies (despite species distributions potentially being affected by multiple biotic interactions). Moreover, the impact of biotic interactions on community composition and richness may vary through space and time, suggesting that the influences of interactions on species distributions and diversity may be environmentally contingent (as predicted by the stress-gradient hypothesis). Therefore, the aim of this study was to examine the influence of biotic interactions, after accounting for the influence of abiotic factors, on plant community richness along fine-scale environmental gradients. Specifically, we tested whether incorporating biotic interactions into high-resolution models improved predictions of species richness and diversity, allowing the influence of specific interactions to vary based on abiotic conditions. This was achieved by including the cover of dominant plant species (as a proxy for the intensity and frequency of their interaction with other plant species) into two methodologically-divergent species richness modelling frameworks – stacked species distribution models (SSDM) and macroecological models (MEM) – for two evolutionary- and ecologically-distinct taxonomic groups (vascular plants and bryophytes). Predictions from models including biotic interactions were compared to the predictions of models based on abiotic data only. The results from these analyses will be discussed.

B1S11 | **A winter foraging hotspot for king penguins from the Prince Edward Islands and the Crozet Archipelago**

F. ORGERET[1], R. REISINGER[1], C-A. BOST[1], P.A. PISTORIUS[1]

1. Department of Zoology, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa; florian.orgeret@gmail.com

Half of the world population of king penguins breed at the sub-Antarctic Crozet Archipelago and Prince Edward Islands. Because of their large biomass and high energy requirements, and thus their large functional effects on marine ecosystems they are considered sentinels of ocean health. Determining the influence of their foraging behaviour on their population responses is thus critical for understanding the impact of climate variability on the marine ecosystem. Two recent studies revealed a hitherto unknown foraging area for king penguin breeding adults from Marion Island (Prince Edward Islands) and juveniles from Possession Island (Crozet Archipelago) during winter (the least known part of their life cycle). This area is situated around 800km southwest of Marion Island along the Southwestern Indian Ridge and almost 2000km off the Crozet archipelago. Combining for the first time tracking and diving datasets from the two island groups allowed a refined examination of the use of this area by two populations of top predators potentially in competition for the same food. The productivity of this area is likely due to interactions between the bathymetry and currents. Habitat selection models including oceanographic covariates such as sea level anomalies, currents, eddies and mixed layer depth allowed the identification of important, dynamic foraging habitat common to both populations, at a fine spatial scale. We discuss the importance of this zone with respect to the closer Polar Front, especially used by the breeding birds during summer. The area may be particularly important for king penguins in winter - the period of scarcity of their main prey resources. The area is also used by many others marine predators such as penguins, seals, whales and albatrosses. Understanding the area's significance for these two important king penguin populations is thus critical, especially given projected poleward shift of the Antarctic Polar Front.

B1S12 | **Plankton production and trophic dynamics in the waters surrounding the Subantarctic Prince Edward Islands archipelago**

L. STIRNIMANN[1], T.G. BORNMAN[2, 3], H.M. VERHEYE[4], K.Y. SINYANYA[1], S.E. FAWCETT[1]

1. Department of Oceanography, University of Cape Town, Cape Town, Rondebosch, 7700, RSA; luca.stirnimann3@gmail.com

2. Department of Botany, Nelson Mandela University, Port Elizabeth, 6001, RSA

3. South African Environmental Observation Network, Port Elizabeth, 6001, RSA

4. Biological Oceanography, Oceans and Coastal Research, department of environmental affairs, Cape Town, 8001, RSA

The Southern Ocean is defined as a High Nutrient-Low Chlorophyll (HNLC) region owing to the combined iron and light limitation of phytoplankton that leaves major nutrients unconsumed in surface waters. Nonetheless, the region supports a complex food web shaped by the many interactions that occur between the plankton system and the physico-chemical conditions of the marine environment. An essential source of energy for marine ecosystems is plankton production (a combination of primary and secondary production), which may be particularly important in the vicinity of islands where it can be high due to terrestrial inputs of fundamental nutrients – the so-called Island Mass Effect (IME). Marine ecosystems are currently experiencing rapid change, particularly at high latitudes, yet little is known about the 'baseline' state of trophic carbon fluxes in these systems, which is key to understanding their potential response(s) to ongoing and future perturbations. We investigated plankton production and trophic dynamics in the waters surrounding the Subantarctic Prince Edward Islands archipelago during two expeditions to the Southern Ocean – the Antarctic Circumnavigation Expedition in December 2016 (summer) and the South African National Antarctic Programme (SANAP) cruise to Marion Island in April/May 2017 (autumn). We collected biological (e.g., phyto- and zooplankton abundance, biomass, diversity) and chemical (e.g., dissolved organic carbon, nutrients, carbon and nitrogen isotopes) samples, and conducted experiments to determine important biogeochemical rates (e.g., primary and secondary production, nutrient regeneration) in the open Subantarctic Ocean and in the vicinity of the islands. Our results on planktonic trophic structure, rates of production, nutrient biogeochemistry and their interactions will be discussed in the context of Subantarctic ecosystem carbon cycling and the IME.

B1S13 | **Southern Ocean phytoplankton silica uptake: implications for leakage and carbon export**

I. WEIR[1]

1. University of Stellenbosch, Stellenbosch, 7600; 16634616@sun.ac.za

The silicic acid cycle is closely linked to the carbon cycle in oceans as diatoms, a dominant, siliceous phytoplankton in the Southern Ocean (SO), are estimated to be responsible for the removal of approximately 55% of the total organic carbon in modern oceans. The incorporation of silicic acid into the diatom cell wall structure, carbon export, productivity and biogenic silica distribution are reported in this paper through incubation experiments and transect data addressing pitfalls of the Silicic Acid Leakage Hypothesis. Upon iron (Fe) fertilization, the potential for the community to utilize less silicic acid from the water column is evaluated. The study spans a winter and three summer cruises, including the Atlantic and Indian Sectors of the SO. Biogenic silica is coupled with ancillary trace metal, macronutrient, particulate organic carbon (POC), Chlorophyll a and community composition data. Incubation experiments within the community illustrate a noticeable increase in biogenic silica under high iron and light regimes, whilst transect data reiterate these limitations. Results suggest an increase in productivity across all oceanic zones. Scanning Electron Microscopy imaging indicates that upon Fe fertilization, changes in the thickness of the diatom cell wall are species-specific. To conclude, Fe addition drastically increases diatom production with certain species displaying a thinning of the cell wall marking potential for excess silicic acid in the water column.

B1S14 | **Southern-Atlantic phytoplankton community composition, distribution and response to relief of light and iron limitation**

J.J. VILJOEN[1], S. FIETZ[1]

1. Department of Earth Sciences, Stellenbosch University, 7600, Stellenbosch, South Africa; 16487338@sun.ac.za

Understanding the response of phytoplankton communities to specific environmental drivers in different Southern Ocean water masses is critical to improve projections under current threats of global change. We show the importance of understanding of the role the biological pump play in the future global climate and more specifically the effect of different phytoplankton communities. Different phytoplankton play different roles in the ocean biogeochemical cycles, especially carbon export, and thus on climate feedback processes. This study presents changes in the community composition across a South-Africa to Antarctic transect along with an assessment of the effects of increased micronutrients using a series of on-board iron/light bulk incubation experiments. Phytoplankton functional group compositions and distribution was assessed using their photosynthetic pigments. The smaller groups like Cyanobacteria and Chlorophytes were most abundant in the Sub-Tropical zone. Diatoms were dominant in the Sub-Antarctic, Polar Frontal, and - along with Phaeocystis antarctica - the Antarctic zone. This was re-enforced when cultivated under increased light/iron conditions and the new bulk community was diatom dominated. Incubations also revealed that Phaeocystis antarctica acclimated its pigment ratios to function more efficiently within different light and iron conditions and that community compositions in the Antarctic zone depend more on iron availability than that of the Polar Frontal zone. We conclude that both light and iron are significant controls on the phytoplankton community and that their effects varies regionally.

B1S15 | **Insights into tundra fern physiology from close-distance remote sensing and leaf level gas exchange**

M.W. ROSSOUW[1], G.F. MIDGLEY[1]

1. Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa; marius.w.rossouw@gmail.com

We have deployed, for the first time, a close-distance remote sensing system to study leaf level physiological processes of Blechnum penna-marina at fine time scales (minute x minute) on Marion Island, over an annual cycle. Combined with this, standard leaf gas exchange approaches were also employed. We placed the remote sensing stations at a range of elevations, and these collected micrometeorological data, as well as an index which indicates levels of plant stress. Experiments using a LICOR 6400xt gas exchange system were performed on low altitude plants, which were acclimated for 3 days at different treatment temperatures. Field data suggested that plants experienced stress above 11°C, and leaf gas exchange information allowed us to explore this relationship in more detail. We used structural equation modelling, to identify the major meteorological factors that influence plant stress response. Machine learning was used to characterize the archetypical diurnal conditions, which in turn allowed us to further understand how plant physiology reacts to the abiotic environment. We argue that this mix of techniques allows the exploration of crucial aspects of how the abiotic environment affects plant function. In conclusion, a multi-tiered approach using both remote sensing and gas exchange will be valuable in future to understand the complex interaction climate has with organisms.

B1S16 | **Variation in the outcome of plant-plant interactions is not related to abiotic gradients across fine scales in four different taxa**

I.P.R. BUYENS1, *P.C. LE ROUX1

1. Department of Plant and Soil Sciences, University of Pretoria; *peter.leroux@up.ac.za

Biotic interactions are key drivers of community composition, with the outcome of plant-plant interactions varying from positive (e.g. facilitative) to negative (e.g. competitive), even across short distances and/or time periods. Such variation in the outcomes of interactions may be explained by the stress gradient hypothesis (SGH) which posits that there is a shift from more negative to increasingly positive interactions with increasing environmental stress.

Examining the interaction between the cushion plant Azorella selago and species from four co-occurring taxonomic groups on a single scoria cone on sub-Antarctic Marion Island revealed that, as observed in other studies, vascular plant richness was higher in association with the cushion plant. However, in contrast to the predictions of the SGH, the cushion plant had a negative impact on the richness non-vascular taxa, and the outcome of A. selago's interaction with all of the taxa was not related to any measures of abiotic stress. These results suggest that the SGH, at least in its current form, may not be useful for predicting the impact of plant-plant interactions on non-vascular taxa or across very short spatial extents.

B1S17 | Invasions in the changing sub-Antarctic: a project overview

M. GREVE[1]

1. Department of Plant and Soil Sciences, University of Pretoria, Hatfield, 0028, South Africa; Michelle.greve@up.ac.za

Non-indigenous species are a major conservation threat in the sub-Antarctic. However, what allows aliens to become successful, and what their impacts are, has been little explored for the region. In addition, while there has been some speculation about how climate change may impact sub-Antarctic species and ecosystems into the future, there have been few tests of these theories and little exploration of the mechanisms of response to climate change in plants. I will here be giving a brief overview of our newly funded SANAP project which will address the factors that mediate the success of alien species with respect native species, the impacts of aliens on natives, and how climate change may affect both alien to native species. The project will have a specific focus on plant and vegetation responses from a mechanistic to an ecosystem scale.

B1S18 | **Biological characteristics of the drifting bivalve *Gaimardia trapesina* in the Southern Ocean**

E. PUCCINELLI[1], C.E.O. VON DER MEDEN[2], C.D. MCQUAID[3], I.J. ANSORGE[1]

1. Department of Oceanography, Marine Research Institute, University of Cape Town, Rondebosch, 7701, Cape Town, South Africa; eleonorapuccinelli@gmail.com

2. Environmental Observation Network (SAEON), Egagasini Node, Foretrust Building, Martin Hammerschlag Way, Roggebaai, 8012, Cape Town, South Africa

3. Department of Zoology and Entomology, Rhodes University, PO Box 94, Grahamstown, 6140, South Africa

Drifting invertebrate species represent an important link for the dispersal of benthic marine species that colonise islands. Shifts in water masses (i.e. speed, direction), play a fundamental role in determining food availability for suspension feeders that often form the base of the trophic chain. This study investigates the population structure, diet and distribution of the kelp-associated, drifting bivalve *Gaimardia trapesina* around the Southern Ocean Prince Edward Islands (PEI). Samples of *G. trapesina* and its potential food sources were collected in April 2015 and 2016 and analysed using stable isotope and fatty acid analyses. Size-structure and attachment strength of *G. trapesina* were also tested. The PEI lie in the path of the west-east flowing Antarctic Circumpolar Current and the highest abundances and largest individuals of *G. trapesina* were found on the north-east sides (downstream) of both islands, while the species was not present from the upstream side of either island. Diet analyses and SIAR mixing model indicated that *G. trapesina* feeds on suspended particulate matter, predominantly comprising a mixture of micro, nano and picoplankton. Long-term temporal variability was seen in δ13C signatures of *G. trapesina* when these were compared to samples collected in the 1990s and this variability is aligned with a southward shift of the Sub Antarctic Front. Here, we highlight the functional role of *G. trapesina* at the PEI and the implications of climate change effects on the biology of this species and the related marine community.

B1S19 | **Habitat and pressures mapping at the Prince Edward Islands: Towards South Africa's National Biodiversity Assessment 2018**

C.E.O. VON DER MEDEN[1], K. SINK[1], A. LOMBARD[2], A. BOSMAN[3], M. DOPOLO[4], F. FOURIE[5], L. HARRIS[2], S. HOLNESS[2], P. MADJIT[1], A. MAKHADO[4], R. MEYER[6], P.A. PISTORIUS[2], R. RIESINGER[7], S. SOMHLABA[8], S. SWART[9], M. SMITH[10]

1. South African National Biodiversity Institute; Charlie@saeon.ac.za

2. Nelson Mandela University

3. IZiko South African Museum

4. Department of Environmental Affairs

5. Sea Technology Services

6. Centre for Scientific and Industrial Research

7. French National Centre for Scientific Research

8. Department of Agriculture Forestry and Fisheries

9. University of Gothenburg, Sweden

10. Capricorn Marine Environmental

The Prince Edward Islands (PEI) have for the first time been included in South Africa's National Biodiversity Assessment (NBA). We build on marine spatial planning work completed for the country's first offshore Marine Protected Area, proclaimed at the islands in 2013. Habitat and biodiversity data for the islands were updated and collated together with entirely new datasets to produce a marine ecosystem classification and habitat map. The new data have allowed identification of Vulnerable Marine Ecosystems, modelling of top predator forage areas, detailed mapping of kelp habitats and refined bathymetry and substrate classification for the island shelf. Under the National Biodiversity Assessment process the updated spatial information was used to assess pressures and protection status within the island's EEZ. The main pressure identified was the long-line toothfish fishing which overlapped with several habitats types. Representation of these habitats within the design of the PEI Marine Protected area was assessed.

B1S20 | **Spatial population structure of selected species on Southern Ocean Islands**

J.H. CHAU[1], B. VAN VUUREN[1]

1. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg; chaujohnh@gmail.com

Southern Ocean Islands feature unique environments with distinct assemblages of species that are expected to be highly impacted by rapid environmental change, including global climate change and spread of alien invasive species. These islands also represent ideal model systems for the study of evolutionary and ecological processes because of their bounded and simple yet well-developed terrestrial ecosystems and the presence of a continuum of structural complexities on different islands. A major goal in the biodiversity sciences is to understand spatial patterns of biotic diversity across hierarchical levels, which has become especially critical in the face of rapid environmental change and biodiversity loss. Species on Southern Ocean Islands are especially at risk from environmental change, since oceanic islands often experience more dramatic climatic shifts than continental ecosystems. The genetic structure of the vast majority of species on Southern Ocean Islands is unknown, and therefore what the effects of geology and climate are on these populations remains an unanswered question. Among the taxa awaiting more in-depth study is the plant *Azorella selago* (Apiaceae) and arthropod species such as *Cryptopygus antarcticus travei. Azorella*, a keystone species on many Southern Ocean Islands that forms dense cushions providing ameliorated microenvironments for other organisms. *Cryptopygus antarcticus* is one of the main detritivore species with a very high abundance. We characterize the phylogeographic structure for selected species on Southern Ocean Islands with unique climate, geological histories, and landscape topography, allowing for a comparative study of the effect of these features on spatial genetic structure.

B1S21 | **Genetic patterns at fine spatial scales - complex findings in a complex landscape**

D.M. MONSANTO[1], A. EMAMI-KHOYI[1], P. TESKE[1], B. VAN VUUREN[1]

1. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg; dmonsanto119@gmail.com

Landscape genetics describes spatial genetic patterns, and overlays these onto a habitat matrix. Observed patterns are then interpreted from the viewpoint of the individual organism and how different organisms move and interact within their habitat. Previous phylogeographic studies performed on Marion Island taxa placed great emphasis on the role that heterogeneous environments play in shaping island-wide patterns. However, the investigation of genetic diversity at fine spatial scales may be a better approach for conservation biology. Using the springtail, *Cryptopygus antarcticus travei* from Marion Island, we explored genetic structure across a 350 m transect and interpreted our results in light of the factors driving small-scale spatial evolution in this model organism. Our results for 390 individuals from 22 sampling sites revealed the presence of two genetic lineages whose contact zone coincides with a landscape ridge. This contact zone does not manifest as a clean break, but rather a complex pattern of clustering, with sampling sites on either side of the ridge showing alternating lineage membership. Individuals within each site were not admixed but, uniformly belonged to the same lineage, and the level of inbreeding was consistent with what is expected for sexually reproducing organisms. High genetic diversity reflects a large effective population size, consistent with the high census population size reported for the species. An explanation for the complex lineage patterns observed could be micro-habitat preferences and/or a fitness funnel driven by local adaptations. The complexity of our genetic structure at a fine scale indicates that this species may be influenced by climatic change, evident from proposed local adaptations. This complexity may bring about far-reaching implications to evaluate their response to environmental change, specifically with regards to climate. Hence, springtails may serve as proxies for monitoring global climate change due to their unique role as major herbivores on a sea-locked landscape.

B1S22 | **Comparing genetic patterns in species *Tullbergia bisetosa* (indigenous) and *Isotomurus maculatus* (invasive) on sub-Antarctic Marion Island**

H. JAGATAP[1], R. DORRINGTON[2], B. VAN VUUREN[1]

1. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg; harinij@uj.ac.za

2. Department of Biochemistry and Microbiology, Rhodes University

Many sub-Antarctic islands experienced major glaciation and volcanic activity. It might be predicted that substantial population substructure and little genetic isolation-by-distance should characterize indigenous species. By contrast, substantially less population structure might be expected for introduced species. Here we examine these predictions and their consequences for the conservation of diversity in the region. We do so by examining haplotype diversity based on mitochondrial cytochrome c oxidase subunit I (COI) sequence data, from one indigenous (*Tullbergia bisetosa*) and one introduced (*Isotomurus maculatus*) species from Marion Island. It has widely been suggested that warming climates would favour invasive species, with endemic species moving to high latitudes/altitudes. Microsatellites (or SSRs: simple sequence repeats) are among the most frequently used DNA markers in many areas of research. They have a higher mutation rate than other areas of DNA leading to high genetic diversity. Microsatellites are also used in population genetics to measure levels of relatedness between subspecies, groups and individuals. The high variability, ease, and accuracy of assaying microsatellites make them the marker of choice for high-resolution population analysis. Microsatellites with only a few alleles are well suited for population genetic studies, while the more variable loci are ideal for genome mapping and pedigree analysis and the fixed or less polymorphic microsatellite loci are used to resolve taxonomic ambiguity in different taxa.

B1S23 | **The origin of recent biological invasions in sub-Antarctic islands: the case of *Poa annua***

M. MAIRAL[1], B. VAN VUUREN[2], J. LE ROUX[1]

1. Department of Botany and Zoology, Stellenbosch University; mariomairal@gmail.com

2. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg

The Southern Ocean presents one of the most interesting arenas in which to study phylogeographic patterns linked to dispersal and the drivers of propagules. This area stands in stark contrast to the Arctic circle in the northern hemisphere, given the very different land to water ratios present in these two polar regions, highlighting the huge distances and small areas between the sub-Antarctic islands. The remoteness of these areas has allowed them to remain as one of the most pristine areas of the planet, only disturbed by first explorers and scientific expeditions. However, increase in visits together with climate change, has increased the probability of biological invasions, making the region an ideal scenario to study their recent impact. A prime example of successful coloniser has been Poa annua. This herb is arguably the most successful invasive plant in the Southern Ocean, having colonized recently several sub-Antarctic islands. We have developed microsatellite markers with the intention of unravelling its phylogeographic structure and spatial dynamics. This will give new insights about the patterns of connectivity-isolation between islands, as well as introduction routes, the sources of new invasions, and how to reduce the risk of human introductions.

B1S24 | **Ontogeny of foraging site fidelity in two sympatric marine predators: a mother and pup perspective**

M. WEGE[1], P.J.N. DE BRUYN[1], M.N. BESTER[1]

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield, Pretoria, 0028, South Africa; mia.wege@gmail.com or mwege@awi-polarstern.de

Foraging experience of juveniles is less diverse and inferior to that of adults. The knowledge gained during their first foraging phase after gaining independence is important to not only individual survival but also population subsistence. However, the ontogeny of naïve individuals' foraging behaviour is poorly understood. The Marion Island sympatric fur seal population, consisting of Subantarctic (*Arctocephalus tropicalis*; SAFS) and Antarctic (*Arctocephalus gazella*; AFS) fur seals have colony-specific foraging areas and maintain minimal overlap with foragers from neighbouring colonies situated around the coastline of Marion Island, despite being well within the travelling range of each other. How these segregated foraging areas of breeding colonies develop is currently unknown. Mother-pup pairs of two SAFS colonies on the west and north-east respectively and one AFS breeding colony on the south coast of Marion Island were satellite tracked. These locations coincide with previously satellite tracked study colonies. The aims were: 1) to determine whether pups forage with their mothers in the same areas after weaning; and 2) to determine whether pups forage in the same general broad colony-preferred foraging areas than their adult colony-counterparts. Unsurprisingly, pups from all 3 study colonies did not forage with their mother post-weaning. However, AFS pups on the south coast, SAFS pups from the west and north-east coast of Marion Island all foraged in the same general south, west and north-east directions as their respective adult colony-counterparts. This suggests that colony-preferred foraging areas, and subsequent foraging site fidelity, is not a learned behaviour as previously thought; but could either be 1) innate or 2) some form of information transfer exists between individuals within the colony. This is the first ever data where mothers and pups were tracked concomitantly and provide novel insights into the development of foraging memory.

B1S25 | **Making use of multiple surveys: estimating breeding probability using a multievent-robust design capture-recapture model**

W.C. OOSTHUIZEN[1, 2], R. PRADEL[2], M.N. BESTER[1], P.J.N. DE BRUYN[1]

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa; wcoosthuizen@zoology.up.ac.za

2. Biostatistics and Population Biology Group, Centre d'Ecologie Fonctionnelle et Evolutive, Centre National de la Recherche Scientifique, Montpellier, France

Increased environmental stochasticity due to climate change will intensify temporal variance in the life-history traits, and especially breeding probabilities, of long-lived iteroparous species. These changes may decrease individual fitness and population viability and are therefore important to monitor. In wild animal populations with imperfect individual detection, breeding probabilities are best estimated using capture-recapture methods. However, in many vertebrate species (e.g., amphibians, turtles, seabirds), non-breeders are unobservable because they are temporarily absent from breeding colonies. Although unobservable states can be used to model temporary emigration of non-breeders, there are disadvantages to having unobservable states in capture-recapture models. The best solution to deal with unobservable life-history states is therefore to eliminate them altogether. Here, we achieve this objective by fitting novel multi-event-robust design models which utilize information obtained from multiple surveys conducted throughout the year. We use this approach to estimate annual breeding probabilities of capital breeding female southern elephant seals (*Mirounga leonina*). Conceptually, our approach parallels a multistate version of the Barker/robust design in that it combines robust design capture data collected during discrete breeding seasons with observations made at other times of the year. A substantial advantage of our approach is that the non-breeder state became "observable" when multiple data sources were analyzed together. This allowed us to test for the existence of state-dependent survival, and to estimate annual breeding transitions to and from the non-breeder state with greater precision compared to a multistate open robust design model. We used program E-SURGE (2.1.2) to fit the multi-event-robust design models, with uncertainty in breeding state assignment (breeder, non-breeder) being incorporated via a hidden Markov process. This flexible modelling approach can easily be adapted to suit sampling designs from numerous species which may be encountered during and outside of discrete breeding seasons.

B1S26 | **The life history of male southern elephant seals: trade-offs at the population and individual level**

K.J. LLOYD[1], W.C. OOSTHUIZEN[1], P.J.N. DE BRUYN[1]

1. Department of Zoology & Entomology, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa; kyle.john.lloyd@gmail.com

The central goal of ecology is understanding and predicting the spatio-temporal dynamics of populations. Population ecology thus deals specifically with the factors that control the growth rates, abundances and distributions of populations. This is especially true for marine predators that are wide-ranging and come into contact with a number of ocean habitats throughout their life cycle. Changes in their population dynamics may reflect large-scale changes in ecosystem structure and function. The survival and recruitment probabilities of a population are bound and limited by trade-offs. Trade-offs exist between two or more life history traits when an increase in one trait that improves fitness results in a decrease in another trait that reduces fitness. We investigate these trade-offs in the life history of an extreme polygamous and capitalist breeder, the male southern elephant seal (SES), using mark-recapture data from a long term (34 years) study at Marion Island. Specifically, to initiate these investigations we ask: What are the recruitment and survival probabilities of male SES at Marion Island using multi-event population models? In addition, how do trade-offs between current reproduction and survival influence future recruitment? We predict that mortality rates are greatest for sub-adult males as only a few percentage of the adult males in the population end up breeding. These few breeding males are likely to be of greater individual quality than bachelor males as preliminary data shows that they maintain their breeding status for several years. Ages 8 & 9 are likely to be responsible for the highest breeding probability in the population given their years of experience and substantial investment in reproduction.

B1S27 | **Environmental drivers of at-sea foraging behaviour in southern elephant seals**

T.L. MAJELANTLE[1], T. MCINTYRE[1], P.J.N. DE BRUYN[1]

1. Mammal Research Institute (MRI), Department of Zoology and Entomology, University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa; tshepiso.majelantle@zoology.up.ac.za

Southern elephant seals (*Mirounga leonina*) are important predators in Southern Ocean food webs and are known to exhibit high levels of foraging site fidelity with occasional deviations. The relationship between environmental variables and the at-sea behaviour of southern elephant seals (SES) and the possible correlates of environmental cues with SES foraging fidelity remains poorly understood. This study aimed to assess the environmental drivers of changes in behaviour for individuals tracked over multiple foraging migrations and to analyse the relationship between a series of environmental variables and SES at-sea behaviour using linear mixed effects models. We report on behavioural data from 95 satellite relay data loggers (SRDLs) deployed on SES at Marion Island between April 2004 and September 2013. Individual-level variance accounted for substantial variance within the models, and few environmental variables were identified as strong predictors of behaviour. Male SES two-dimensional (2D) home range sizes were significantly correlated with seal age, encountered chlorophyll–a (chl-a) concentration and temperature at depth, possibly resulting from age-related diet differences in male SES. Seals travelling greater distances tended to target deeper waters, seals travelling shorter distances tended to target shallower areas during their migrations. Bathymetry was further significantly correlated with female SES direction and 2D home range size. Female SES tended to perform deeper, but shorter, dives if the previous year had high chl-a. Females also adjusted their 3-dimensional home range overlap according to the sea surface temperature (SST) from the current and previous year. The results show the potential usefulness of including time lags in the use of remotely sensed predictors (e.g. chlorophyll) to account for the time required for energy transfer through trophic levels. Many of the environmental variables did not consistently explain behaviour between sexes and repeated tracks, suggesting complexity in the physical drivers of SES at sea behaviour.

B1S28 | **Stable isotope ecology of two sympatric fur seal species from Marion Island, Southern Indian Ocean**

I. MUKUTYU[1], M. WEGE[1], N. LÜBCKER[1], P.J.N. DE BRUYN[1]

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Hatfield, 0028, Pretoria, South Africa; mukutyuitai@gmail.com

Stable isotope analysis is a useful method to assess the spatial and temporal parameters integral to the niche ecology of marine mammals. Here, we implemented stable isotope values of sub-sampled regrowth whiskers and telemetry data from GPS/TDR loggers to investigate interspecific variation in the foraging ecology and of two congeneric fur seal species. Combining these methods enabled us to (1) deduce interspecific variation in isotopic niche widths (proxy for dietary niche width), and (2) establish interspecific variation in spatial niche utilization between Antarctic (*Arctocephalus gazella*) and Subantarctic (*A. tropicalis*) fur seals at three rookeries of different densities, with seasonal comparisons. We used 10 individuals from each of the three rookeries, with at least ten, ≥12 mm whisker subsamples per individual. Isotopic values were calculated via the Standard Ellipse Area hence providing a measure of the isotopic niche utilized by each individual. We adapt an existing methodology, but this study will integrate temporal comparisons. Both fur seal species are income breeding marine mammals from Marion Island, in the southern Indian Ocean, although they invest differently in their annual breeding biology. Fur seals from high density rookeries exhibited broader isotopic niche widths due to competition. Variation of isotopic niche widths with respect to season was low. Variation in spatial and temporal niche utilisation persisted between rookeries of high and low densities which could be a sign of resource partitioning or other factors, hence requiring further analysis.

B1S30 | **The year-round distribution and foraging behaviour of grey-headed albatross at Subantarctic Marion Island**

K.L. STEVENS[1]

1. FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Cape Town, South Africa; stevenskim18@gmail.com

Grey-headed albatrosses *Thalassarche chrysostoma* are listed as endangered on the IUCN Red List. Key threats include incidental bycatch in fisheries, climate change and predation at their breeding colonies. Globally their numbers are declining, but the population at sub-Antarctic Marion Island, the larger of the Prince Edward Islands, comprising 7 % of the global population, is currently considered stable. Though most of their life is spent at sea, little is known about where they go. At Marion Island, I investigated their year-round foraging during the breeding and non-breeding seasons in relation to environmental variables, marine protected areas and longline fishing effort. I tracked foraging trips of breeding greyheaded albatrosses during four years between 2012 and 2017 using GPS loggers, and recorded their year-round distribution from 2002 to 2005 and 2012 to 2016, using light-level Geolocation Sensors (GLSs). I found that during the breeding season adults take much shorter trips (both in distance and duration) to waters over the South West Indian Ridge, an area of high productivity due to upwelling, whereas trips during incubation are much more wide-ranging and longer in duration, extending east and west of the island. During the non-breeding season, several migration strategies are observed – either remaining near the island; going east or west; or circumnavigating the Southern Ocean. Several core use areas were also identified. More wide-ranging trips, during both seasons, also mean that birds spend most of their time outside of Marine Protected Areas and in the high seas where they are more at risk to incidental bycatch in fisheries. As long-lived and wide-ranging predators, they are indicators of global ocean health and shifts in climate. Thus obtaining accurate descriptions of their distribution and at-sea habitat selection are essential in both contributing to their conservation as well as giving insight into global climate change.

B1S31 | **The finches of Nightingale Island, Tristan da Cunha archipelago**

B. DILLEY[1], D. DAVIES[1]

1. FitzPatrick Institute of African Ornithology, University of Cape Town; dilleyben@gmail.com

Island finches have been especially influential in the development of evolutionary theory, the most famous example being Lack's classic study of speciation among Darwin's finches on the Galapagos islands. The volcanic islands in the Tristan da Cunha archipelago in the south Atlantic are home to an equally exciting story of parallel ecological speciation of *Nesospiza* finches on the two smaller islands: Inaccessible (14 km2) and Nightingale (4 km2). Like Darwin's finches, *Nesospiza* finches (or buntings as they are often called) evolved from finch-tangers which were carried on the prevailing westerly winds across 3000 km of ocean from South America. Today, two species are recognised on Nightingale Island: an abundant small-billed dietary generalist (*N. questi*) and a scarce large-billed specialist (*N. wilkinsi*) which specialise on the fruits of the island tree *Phylica arborea*. Small- and large-billed forms also occur on Inaccessible Island, but with considerable hybridisation in one habitat type, resulting in only a single species being recognised at this island (*N. acunhae*). Peter Ryan's work on the evolution of these buntings showed the small- and large-billed forms were likely to have evolved independently on each island – quite remarkable, considering the islands are only 20 km apart! We present our recent research from Nightingale Island where we closely followed these two sympatric species over two summer breeding seasons. Despite being each other's closest relatives, the two species differ ecologically, with lower reproductive output by the large-billed *N. wilkinsi*. We test whether this reduced chick production is offset by higher first winter survival, and also assess other threats to the tiny population of *N. wilkinsi* (roughly 100 pairs). Most worrying is the recent finding of an invasive scale insect and associated sooty mould that could is likely to reduce fruit production by island trees.

B1S32 | **Ross Seals: Pack Ice and Open Ocean Commuters**

M.N. BESTER[1] BESTER, M., WEGE M[1], BORNEMANN H[2],

1 Mammal Research Institute, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

2Alfred Wegener Institute Helmholtz Centre for Polar and Marine Research, Biosciences, PO Box 120161, 27515 Bremerhaven, Germany; mnbester@zoology.up.ac.za

The relative abundance and ranging behaviour of Ross seals (*Ommatophoca rossii*) were investigated to determine the way oceanographic conditions affect the rarest true Antarctic species of seal breeding off Dronning Maud Land, Antarctica, with a view to using these as bioindicators of environmental change. Shipboard summer surveys were conducted from the bridge of the ice breakers *SA Agulhas II* (2015/2016) and *RV Polarstern* (2018). Satellite-linked dataloggers were deployed on moulted adults in January 2016 (n = 8 females; n = 3 males) and 2018 (n = 2, one per sex). Four devices failed prematurely, and two devices lasted for a full year until the next moult. Despite the low survey effort, Ross seals were relatively (compared to all other shipboard surveys around Antarctica) abundant in the pack ice of the eastern Weddell Sea in mid-January 2016, seemingly similar to the situation here in the 1970s. Although adult Ross seals give birth, mate and moult in the pack ice, they foraged in open water far north of the seasonal pack ice after breeding, and again after moulting. During their two annual commutes between the pack ice and the open ocean, their distribution overlaps with that of three other phocids within the pack ice (crabeater, leopard and Weddell seals), and with another (southern elephant seal) in the open ocean. With Ross seals predictably found within the eastern Weddell Sea during relief cruises to service SANAE IV and Neumayer III, the commuting of the Ross seals between pack ice and open ocean makes them ideal candidates to carry satellite-linked dataloggers. Such instruments can sample, amongst others, in situ physical and biological oceanographic characteristics at times when oceanographic recordings by other means are difficult or impossible.

B1S33 | **USING METAGENOME BASED GENOME RECONSTRUCTION TO UNDERSTAND BACTERIAL AND ARCHAEAL ASSEMBLAGES IN THE SOUTHERN OCEAN**

M. CLAYTON[1], S. VIKRAM, T.P. MAKHALANYANE

1. Center for Microbial Ecology and Genomics, Department of Genetics, University of Pretoria, Pretoria, South Africa; matthew@claytons.co.za

Microbial communities (bacteria and archaea) are ubiquitous in nature and have been identified as key regulators of biogeochemical cycles. Due, in part, to challenges in cultivation of 99% of microorganisms, little is known regarding the precise mechanisms which allow microbial guilds to perform their ecological roles. To bypass such 'cultivation bottle-neck', alternative culture independent approaches are used to generate immense datasets, which offer crucial insights into microbial metabolic potential. The Southern Ocean (SO) regulates the Earth's climate and accounts for 40% of all oceanic carbon cycling. Evidence suggests that microbes are significant mediators in cycling of carbon, nitrogen and sulphur in abyssopelagic ocean through chemo(litho)autotrophic pathways. To investigate this, shotgun metagenome sequences were generated from samples recovered from the abyssopelagic SO. These sequences were assembled and BLASTp performed on translated contigs to assess functional potential and diversity within the metagenomes. Contigs were binned using composition (in)dependent binning approaches and near-complete draft genomes were annotated to assess functional potential. The assembly of 6 datasets produced approximately 39, 000 contigs (≥500 bp) per sample. Assemblages were binned to produce 17 bacterial and 14 archaeal genomes. Of these, 13 showed above 40% completeness. BLAST analyses revealed functional dominance of *Proteobacteria* in all datasets with a high relative abundance (%) of *Halobacteria*. Further investigation suggests *Gamma*- and *Alphaproteobacteria* dominate functional guilds. This contrasts photic ocean zones where *Cyanobacteria* drive key ecosystem processes. Functional analysis of near-complete draft genomes demonstrated that abyssopelagic microbes have to functional potential for cycling carbon, nitrogen and sulphur through mainly chemoautotrophic pathways. Taken together our results suggest that despite severe micronutrient limitation, high hydrostatic pressure and low mean temperatures of deep-sea environments harbour microbes with surprisingly high metabolic diversity.

LIVING SYSTEMS - B2. BIODISCOVERY AND BIOTECHNOLOGY

B2O1 | **Mining the Southern Ocean microbiome**

J.R. LLOYD1, S. FIETZ2

1. Department of Genetics, Stellenbosch University; lloyd@sun.ac.za

2. Department Earth Science, Stellenbosch University

Microbes growing in extreme environments can be a useful source of genetic material for biodiscovery projects. Over the past two years we have both collected metagenomic DNA and isolated bacteria from sample points between 41 and 56° S during both summer and winter cruises of the SA Agulhas II. The metagenomic samples have been used to analyse species diversity using next generation sequencing from 16S RNA gene amplicons. In addition, we have identified the species of the bacterial isolates also using 16S RNA gene analysis. In the future we plan to create metagenomic libraries and use them to screen for a number of activities, including hydrocarbon degradation and biopolymer formation. We will also functionally analyse the isolates using Biolog nutrient utilisation plates to examine their potential roles in nutrient cycling within the Southern Ocean. Finally, we will examine the isolates to identify if they can degrade hydrocarbons to identify species that can be used for pollution alleviation.

B2S1 | **Keratinous tissue as matrix for obtaining time-based biochemical data**

N. LÜBCKER[1], P.J.N. DE BRUYN[1], R. MILLAR[2], M.N. BESTER[1], P. SWART[3], S.D. NEWSOME[4]

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa; nlubcker@zoology.up.ac.za

2. Centre for Neuroendocrinology, University of Pretoria, Pretoria, South Africa

3. Department of Biochemistry, University of Stellenbosch, Matieland, 7602, South Africa

4. Biology Department, Center for Stable Isotopes, University of New Mexico, Albuquerque, New Mexico, United States of America

Sequentially sampled keratinous tissue provides a chronology of biochemical data. Herein, we used whiskers (vibrissae) of southern elephant seals (SES) *Mirounga leonina*, sampled at Marion Island in the Southern Ocean, as example, to demonstrate how time-based interpretations of the steroid and isotopic data captured along the length of the whiskers are obtainable. Bulk stable isotope dietary reconstructions are based on the principle, "you are what you eat", and provides a powerful, indirect approach to assess the trophic ecology of an individual. However, our data suggest that pregnant females might not be "what they eat" during gestation, which contrasts with the theoretical basis of the use of stable isotope dietary reconstructions. I also aim to present our results regarding the first, successful chronologically extractions of hormones captured along the length of SES whiskers and discuss the potential of using the whisker hormone profile as "pregnancy test" in seals. Our novel, multidisciplinary combination of hormones, bulk stable isotopes, and compound-specific stable isotopes, should permit conclusions about the trophic ecology and nutritional status of the individual that can be linked to an individual's fecundity. Information regarding the trophic ecology and physiology of SES aids our understanding of their role in the marine ecosystem, pivotal to their future utility as sentinels to gauge ocean health.

B2S2 | **Molecular characterization of the worm *Diomedenema diomedeae* from the air sacs of grey-headed albatrosses on Marion Island**

R.E.T. VANSTREELS[1, 2], M.J. YABSLEY[3, 4], L. SWANEPOEL[4], K.L. STEVENS[5], T. CARPENTER-KLING[1, 2], P.G. RYAN[5], P.A. PISTORIUS[1, 2]

1. Marine Apex Predator Research Unit (MAPRU), Institute for Coastal and Marine Research, Nelson Mandela University, Port Elizabeth, South Africa

2. DST/NRF Centre of Excellence at the Percy FitzPatrick Institute for African Ornithology, Department of Zoology, Nelson Mandela University, Port Elizabeth, South Africa; ralph_vanstreels@yahoo.com.br

3. Warnell School of Forestry and Natural Resources, The University of Georgia, Athens GA, USA

4. Southeastern Cooperative Wildlife Disease Study, Department of Population Health, College of Veterinary Medicine, The University of Georgia, Athens GA, USA

5. Percy FitzPatrick Institute of African Ornithology, University of Cape Town, Cape Town, South Africa

Albatrosses are the world's most endangered family of seabirds, and Marion Island and Prince Edward Island are Subantarctic nesting sites of global importance for seabird conservation, including five species of albatrosses. In March-April 2016 a number of grey-headed albatross (*Thalassarche chrysostoma*) chicks was found dead along the southern coast of Marion Island (46°57'S 37°42'E). Affected chicks were weak, prostrated, apathetic, had drooping wings, and eventually died while sitting on the nest. Five carcasses were necropsied, and samples were obtained for pathological and parasitological analysis. Four chicks appear to have died from starvation in association with tick infestation and predator harassment, and one died due to air-sac helminthiasis, with extensive haemorrhage in the air sacs and multifocal pyogranulomatous air-sacculitis. The air sac parasites were identified as *Diomedenema diomedeae*, a nematode worm of the family Desmidocercidae, superfamily Aproctoidea. *D. diomedeae* had been described in 1952 from the body cavity of a grey-headed albatross that had washed ashore in South Australia, and was never recorded since its original description. We produced sequences for the nuclear 18S rRNA gene and the mitochondrial cytochrome c oxidase subunit I gene, which are the first DNA sequences for a species of the superfamily Aproctoidea. Phylogenetic analyses of the gene sequences corroborate that the superfamily Aproctoidea belongs to the suborder Spirurina, as had been previously speculated on the basis of morphology. Furthermore, the phylogenetic analyses suggest that Aproctoidea is closely related to Diplotiraenoidea, a superfamily of worms that infect the air sacs and subcutaneous tissues of a variety of bird species. These results demonstrate how research at remote sites such as the Prince Edward Islands can provide valuable insight into the evolution and genetics of parasites that are otherwise poorly represented in the literature.

B2S3 | **Metagenomic Analysis of the Soil Microbial Community in Marion Island, South Africa**

S. SEKAR[1], R. DORRINGTON[2], G. MATCHER[2], V. SIDDARTHAN[2], B. VAN VUUREN[1]

1. Centre for Ecological Genomics and Wildlife Conservation, Department of Zoology, University of Johannesburg; sudharshans@uj.ac.za

2. Marine Natural Products Research Lab, Department of Biochemistry and Microbiology, Rhodes University

Metagenomics is used in microbial ecology to study microbial communities in more detail, including many strains that cannot be cultivated in the laboratory. Bio-informatic analyses make it possible to mine huge metagenomics datasets and discover general patterns that direct microbial ecosystems. The discipline of metagenomics can be defined as the culture-independent genomic analysis of all the microorganisms in a particular environmental niche. High throughput sequencing of an entire array of genomes present in environmental samples enables us to not only enumerate but also classify microorganisms with their phylogenetic relationship among themselves. Soil is probably the most challenging of all natural environments for microbial ecologists with respect to the microbial community size and the diversity of species present. Here we focus on the microbial community in Rhizhosphere soil around Marion Island from different habitats, addressed from a direction and altitudinal perspective. Here we use phylogenetic, operational taxonomic units, and non-metric multidimensional scaling methods for measuring community dissimilarities.

COMBINATION OF THEMES A & B. EARTH SYSTEMS AND/OR LIVING SYSTEMS

AB1O1 | **Active layer and permafrost monitoring in Western Dronning Maud Land, Antarctica**

K.I. MEIKLEJOHN[1]

1. Department of Geography, Rhodes University, Grahamstown, South Africa; i.meiklejohn@ru.ac.za

Since the International Polar Year in 2007 and 2008, the active-layer and permafrost thermal regimes in accessible parts of Western Dronning Maud Land have been monitored as part of the international efforts in the northern and southern Polar Regions. Data recorded has contributed to the Antarctic Permafrost and Soils group of SCAR and the International Permafrost Association (IPA), as well as the Global Terrestrial Network for Permafrost (GTN-P). An initial evaluation of temperatures was conducted in 2010 by Vieira et al., followed by an active-layer synopsis (Hrbáček et al. 2018) and an evaluation of permafrost temperature trends over the last decade (Biskaborn et al. Subm.). While measurements from Antarctica are sparse, the relatively short period of monitoring in the Ahlmannryggen and Jutulsessen show that permafrost temperatures are increasing and that the active-layer is thickening. The results of this study are in line with a global analysis that shows Antarctic Permafrost warming at 0.37±0.1°C.dec-1 and global Permafrost at 0.31±0.1°C.dec-1 (Biskabon et al. subm). It is not immediately clear if the observed trends represent short-term variations, or if they signify long-term warming. However, when considered together with ice-mass balance studies and sea-ice trends, it is most likely that the trends observed from borehole data in Western Dronning Maud Land are part of a content-wide warming that represents a global warning system.

AB1O2 | **Southern Ocean estimates of phytoplankton primary production through coupled observations and experiments**

T.J. RYAN-KEOGH[1, 2], S.J. THOMALLA[1, 2]

1. Southern Ocean Carbon and Climate Observatory, NRE, CSIR, Rosebank, Cape Town

2. Department of Oceanography, University of Cape Town, Rosebank, Cape Town; tryankeogh@csir.co.za

Phytoplankton primary production (PP) in the Southern Ocean (SO) is a key contributor to global atmospheric CO2 drawdown, responsible for 30-40% of global anthropogenic carbon uptake. Addressing the potential extent and magnitude of PP in the SO, under current and future climate change scenarios, is constrained ultimately by chronic under sampling, thereby limiting our understanding of the direction, magnitude and rates of change. Active chlorophyll fluorescence measurements can provide rapid, non-intrusive measurements of phytoplankton PP at high temporal and spatial resolution, addressing the space-time gaps, in comparison to in vitro photosynthetic-irradiance assays. Despite the strength of active fluorescence measurements to better resolve the nature and drivers of PP and the significant progress in fluorescence-based productivity algorithms, they are not routinely applied to determine PP in part due to the conversion from fluorescence units to ecologically relevant rates of carbon fixation. Earth systems models often require the photosynthetic currency of fixed carbon, to improve upon current PP estimates and to constrain the model limits. To this end, a series of active chlorophyll fluorescence measurements were performed on 2 cruises during winter and summer, with co-located photosynthetic-irradiance assays to derive a regionally and seasonally constrained conversion factor from fluorescence to carbon. Significant differences were found both spatially and temporally in the rates of PP, when measured using either fluorescence or in vitro assays. Multivariate analyses of the PP estimates and in situ biogeochemical parameters revealed novel empirical relationships that can be used to improve upon existing fluorescence-based production algorithms and biogeochemical coupling to earth systems models.

AB1S1 | **Temperature dynamics in mire ecosystems on Marion Island**

S.S. SINUKA[1]

1. University of Fort Hare, Alice, 5700, Eastern Cape; sinukass@gmail.com

The sub-Antarctic tundra is sensitive to disturbance due to its composition and scarcity of species. The Mire Complex on Marion Island which constitutes half of the area below 300m.a.s. l is a very important habitat for temperature dependant graminoids, mire bryophytes and moss species. Preliminary temperature measurements at depth in five separate mesic mires at different locations on Marion Island indicate that mires on the western side of the island are warmer in both winter and summer and mire temperatures in the east are colder and more variable. Temperature records show that it is the top layer of the mire that are the most thermal variable and that a seasonal reversal in temperature gradient with depth exist. It is suggested that this reversal is due to the seasonal changes in solar radiation inputs into the mire and that the passages of synoptic scale weather systems influence the diurnal radiative and sensible heat exchanges in the top layers. This diurnal radiative and sensible heat fluxes are, therefore, superimposed on the seasonal changes in the energy budget. Climate change implications for sub-surface mire dynamics on Marion Island show that if a continuous warming trajectory remains and the current changes in synoptic scale weather patterns persist, a further warming trend in mire temperatures must be expected. This in turn will influence the respiration rates of mire soils and soil decomposition potentials, ultimately threatening the variation of biotic communities within mire ecosystems.

AB1S2 | **Comparing the frost environment of three disparate locations: Western Dronning Maud Land of Antarctica, sub-Antarctic Marion Island and the High Drakensberg of South Africa**

C.D. HANSEN[1, 2], K.I. MEIKLEJOHN[1], W. NEL[3]

1. Department of Geography, Rhodes University, Grahamstown, South Africa

2. Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa; u04403363@up.ac.za

3. University of Fort Hare: Department of Geography and Environmental Science, University of Fort Hare, East London, South Africa

Frost processes occur across climatic zones and warming temperatures affect regions where climatic thresholds are narrow. This paper explores the annual, seasonal and diurnal frost environments of three locations: western Dronning Maud Land (WDML) of Antarctica, sub-Antarctic Marion Island, and the High Drakensberg of the Eastern Cape of South Africa. WDML is characterised by continuous permafrost and a paucity of diurnal thawing and a shallow active layer. Permafrost is absent on both sub-Antarctic Marion Island and in continental South Africa. Marion Island is, however, characterised by a dynamic diurnal frost environment, with shallow and high-frequency cycles. The High Drakensberg of the Eastern Cape of South Africa exhibit seasonal freezing at higher altitudes with frozen ground occurring for periods of up two months at ~ 3 000 m.a.s.l. Global warming scenarios (1°C, 2°C and 5°C increases) and how these affect freezing cycles are explored, as are environmental and locational forcings on freezing cycles observed. The results from WDML contribute towards scientific output and research of ANTPAS (Antarctic Permafrost and Soils) and the Global Terrestrial Network for Permafrost (GTN-P). Higher altitudes show an increase in frost cycles; vegetation cover dampens such cycles. Furthermore, snow cover reduces diurnal frost in WDML, whereas it increases the depth of freezing on Marion Island. Finally, diurnal frost cycles are highly sensitive to temperature changes and associated thresholds and that such cycles can be used as indicators for warming conditions.

AB1S3 | **Rock hardness as a relative-age indicator of glacially striated surfaces on Marion Island**

E.M. RUDOLPH[1], D.W. HEDDING[2], W. NEL[3]

1. Department of Geography, University of the Free State, Bloemfontein, 9301; rudolphem@ufs.ac.za

2. Department of Geography, University of South Africa, Florida

3. Department of Geography, University of Fort Hare, Alice

Rock hardness is an accepted measure for the degree of weathering of a rock surface. Over time, gradual exposure to the elements causes disintegration of the rock surface, weakening the rock to produce lower values of rock hardness. For decades the Schmidt hammer has been the preferred instrument to obtain rock hardness values, but the Equotip, manufactured by the same company, has, in recent years, been used in an increasing number of relative-age dating studies. Due to its light weight, internal electronic memory and ability to correct for certain errors, the Equotip is considered superior to the Schmidt hammer by some geomorphologists, but is still not used nearly as often as the Schmidt hammer. On Marion Island, the deglaciation timeline is not well established, and an improved knowledge of this will have implications on the interpretation of the island's landscape development since the Last Glacial Maximum (i.e. 10-30 kya). Assuming rock weathering is reset by a glacial period, rock hardness can serve as a relative-age indicator of striated surfaces and shed light on the rate of geomorphic change and ecological succession, for example. In this study, Equotip rock hardness values, collected in 2017, are presented as a relative age indicator of previously glaciated surfaces. These new values are compared to research findings and Schmidt hammer values collected by geomorphologists in the last 20 years. Further, comments are made in the light of expected age of sampled surfaces and new directions are suggested for future studies using the Equotip for rock hardness measurements.

AB1S4 | **Understanding Southern Ocean-specific phytoplankton ecophysiological response to iron availability**

A. SINGH[1, 2], T.J. RYAN-KEOGH[1], S.J. THOMALLA1, S. FIETZ[2]

1. Southern Ocean Carbon and Climate Observatory, Natural Resources and Environment, CSIR, Cape Town, South Africa

2. Department of Earth Sciences, Stellenbosch University, Private Bag X1, Matieland, 7602, South Africa; NaaginMitha@gmail.com or asingh5@csir.co.za

The efficiency of the biological carbon pump in the Southern Ocean (SO) is constrained by the availability of light and the micronutrient iron (Fe), which plays a critical role in the functioning of photosynthesis. The low Fe concentrations (<0.1 nM) in the SO surface waters, limits phytoplankton biomass, primary production, and influences the community composition. A greater understanding of the Fe biogeochemical cycle and its effects on SO phytoplankton species is required to make more accurate assessments and predictions on the impact of future climate change. Climate change is predicted to alter the physical (i.e., temperature, light, salinity) and chemical (i.e., nutrient concentrations, pH) environment of the SO, which in turn is expected to modify the physiological and metabolic functions of phytoplankton. Our current understanding of the interacting effects of these parameters on SO phytoplankton species is poorly understood. Furthermore, the potential evolutionary adaptation of phytoplankton to future predicted changes in these parameters is unknown. The goal of this study will allow us to better understand the SO, by contributing to our current knowledge of the Fe biogeochemical cycling and its effect on SO phytoplankton biomass, primary production and community composition through in situ SO experiments. Moreover, laboratory based culture experiments will assist in the understanding of whether climate change will have a positive, negative or zero-sum effect on the phytoplankton, and hence the biological uptake of CO2 by the oceans. The relationships between phytoplankton and the drivers of their primary production (light, temp, nutrients, etc.) will inform and constrain on existing biogeochemical parameters within Earth Systems models.

AB1S5 | **Marine mammals exploring the oceans pole to pole: a review of the MEOP Consortium**

A.M. TREASURE[1, 2], I.J. ANSORGE[2], M.N. BESTER[1], T. MCINTYRE[1], P.J.N. DE BRUYN[1], MEOP CONSORTIUM

1. Mammal Research Institute, Department of Zoology and Entomology, University of Pretoria, Pretoria, South Africa

2. Department of Oceanography and Marine Research Institute (Ma-Re), University of Cape Town, Cape Town, South Africa; anne.m.treasure@gmail.com

Polar oceans are poorly monitored despite the important role they play in regulating Earth's climate system. Marine mammals equipped with bio-logging devices are now being used to fill the data gaps in these logistically difficult to sample regions. Since 2002, instrumented animals have been generating exceptionally large data sets of oceanographic CTD casts (>500,000 profiles), which are now freely available to the scientific community through the MEOP data portal (http://meop.net). MEOP (Marine Mammals Exploring the Oceans Pole to Pole) is a consortium of international researchers dedicated to sharing animal-derived data and knowledge about the polar oceans. Collectively, MEOP demonstrates the power and cost-effectiveness of using marine mammals as data-collection platforms that can dramatically improve the ocean observing system for biological and physical oceanographers. We recently reviewed the MEOP consortium in a paper to bring the program and database to the attention of the international community.

HUMAN ENTERPRISE – THEME C.

CO1 | **SEAmester continues to grow!**

I. ANSORGE[1] , T. HENRY[1]

Oceanography Department University of Cape Town

"It seems almost yesterday that I approached DST and the NRF to consider funding a Floating University that would be open to all University and Technikon postgraduate students" says A/Prof and Head of Oceanography Isabelle Ansorge "and here we are planning our third year"! SEAmester aims to introduce marine science as an applied and cross-disciplinary field to students who have shown an affinity for these core science disciplines. It combines traditional class-room lectures with hands-on ship-based deck activities for the students, while providing them with opportunities to network with and support specialist scientists in recognised marine research activities. The programme strives to gain greater awareness of the oceans' physical and ecological response to climate change. To date, since the first cruise in 2016 over 120 students from 23 universities and technikons around South Africa as well as over 54 lecturers have participated in SEAmester. As an example - the lectures range from space weather to ocean plastics to marine microbiology to ocean instrumentation. Going hand-in-hand with the lectures are specially designed experiments which are linked to the mornings classroom lecture – so for plastics the students then spend a few hours towing a net over the side, after a lecture on the seafloor we tow a dredge to see what comes up from over 400 m deep, students learn to count seabirds, study and forecast weather patterns and get to grips with calibrating oceanographic data. What makes SEAmester so unique is that its open to any national postgraduate student. In the past access to the SA Agulhas II was only possible if your supervisor had a grant through the South African National Antarctic Programme – Naturally this was limited to only a few Universities who undertook polar research – so this meant that students studying mangrove swamps at the University of Zululand for instance would never have a chance to go onboard the SA Agulhas II – SEAmester removes those restrictions!. The participating students come from a range of backgrounds and for majority of these students it is their first time out at sea - a truly life changing event! SEAmester is funded until 2020 but its hoped to become a flagship DST project in marine education.

HUMAN ENTERPRISE –PALAEOSCIENCES AND HUMAN HISTORY THEME C2.

C2O1 | **A New SANAP Portal**

A. LOUW[1], M.P. OLIVIER[1]

1. Antarctic Legacy of South Africa, Stellenbosch University, Department of Botany and Zoology, Private Bag X1, Matieland, Stellenbosch, 7602; antarcticlegacy@sun.ac.za

The Antarctic Legacy of South Africa (ALSA) fulfil various aims within the South African National Antarctic Programme (SANAP), one aim being to promote the human involvement in the South African sector of the Antarctic region. This aim is achieved mainly through attracting post graduate students to the different research disciplines part of SANAP through the World Wide Web, social media and awareness activities e.g. museum exhibitions.

Our website and the success it has within the reach of South Africa did not go unnoticed by partners in the SANAP environment. This resulted into the design of a new and improved SANAP- portal, in the form of a new website by the Antarctic Legacy of South Africa. This portal will present, amongst other things, information on the logistics and research efforts of South Africa in the Antarctic region. The research efforts will cover the four themes as stipulated by SANAP, namely Earth Systems, Living Systems, Human Enterprise and Innovation: technology and engineering. The portal will furthermore serve as a contact point nationally and internationally.

This presentation will thus focus on ALSA's role in promoting South Africa's involvement in the Antarctic, through the new SANAP portal.

INNOVATION, TEHCNOLOGY AND ENGINEERING – THEME D

D1O1 | **Utilising computational simulations and data measurements to quantify and assess the ecological impacts of wind flow across Marion Island**

J. SCHOOMBIE[1]

1. Council for Scientific and Industrial Research; Jschoombie@csir.co.za

Although it is commonly assumed that the presence of high wind velocities has a significant impact on the biotic and abiotic systems on Marion Island, there is very little quantitative data available on the within-island variation in wind speed and direction. It has also been suggested that the forecast changes in regional climate patterns will affect the local climate around the Prince Edward Islands. Therefore, to predict the effects of a potential change in wind characteristics in and around the islands, it is necessary to understand the influence of contemporary dominant wind patterns on the current distribution of biotic communities and abiotic processes.

By using modern computational simulations together with field quantified wind data, this project aims to model within-island wind flow and its ecological impacts. Since computational simulations, although generally dependable, are based on theoretical knowledge of fluid flow, it is necessary to validate a computational model experimentally or with full-scale measured data. In the present case, the validation method employed consists of deploying a series of wind speed and direction sensors strategically placed across the island. The sensors will be deployed in the take-over period in 2018 and will log wind data for a period of two years. The locations in which the wind sensors are deployed are critical in ensuring effective validation of the computational model and are the focus of this talk. A comparison of measured and simulated absolute values and flow trends aims to verify the computational model, after which the simulated flow patterns may be used to analyse additional flow features and how they may change according to a change in dominant wind direction and speed.

D1O2 | **SAA II – Big brother & her digital twin**

A. BEKKER1

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; annieb@sun.ac.za

The *SA Agulhas II* is a South African polar supply and research vessel, which offers crucial research access to the Antarctic and Southern Ocean. In order to advance the scientific basis for ice-going vessels and ship-based ergonomics this vessel has been the subject of full-scale engineering measurements since 2012. The sensor infrastructure and advanced data analytics that have resulted position this ship as an ideal platform from which to explore definitive trends in the future marine industry and science, namely digital twin technology. Digital twins are a digital, real-time, in-context, operational mime of an asset, which connects the digital and real word representations towards actionable insights. The technology readiness of the SA Agulhas II platform, is considered against the conceptual architecture required to implement digital twin technology. The advantages of digital twin technology are explored for stakeholders including the marine industry, the vessel owner and applications in Antarctic science. It is emphasized that the mastery and application of such technology trends will result in inter-disciplinary benefits and the facilitation of research through state-of-the-art engineering technology.

D1O3 | **Identification of wave slamming incidence from full-scale acceleration measurements**

C.F.W. SAUNDERS[1], A. BEKKER[1], *J. MUIYSER[1]

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; *jmuiyser@sun.ac.za

The *S.A. Agulhas II* is South Africa's premier polar resupply and research vessel. She operates in harsh environments including Antarctic ice and adverse weather conditions, including swells in excess of 10 m. As a result of her flat, extended transom design, wave slamming has proven to be a persistent problem. Several full-scale measurement campaigns have been directed at the measurement of the dynamic response of the vessel to wave slamming. Previous research concluded that vibration has reached levels where damage is possible in the stern and is probable in the bow during open water navigation. A vessel at sea experiences a slamming event when a wave impacts the bow, stern or bottom of the vessel, causing an impulsive force exerted over a short period of time. This impulsive event is characterized by a broadband excitation in the frequency domain, as well as the post impulse transient response, known as whipping. Wave slamming on seaborne vessels initiates in the bow or stern depending on the ship's speed and orientation relative to the swell. The purpose of this work is to evaluate methods for the automatic detection of slamming incidents from long-term full-scale measurements. This will allow the automatic detection and classification of slamming into bow slamming, which is expected for ice-going hulls stern slamming which is an un-desirable result of a vessel design decision. Identification algorithms are evaluated on example case studies including short durations of data. The performance of conceptual algorithms is compared to identify the most reliable method for automatic slamming detection.

D1O4 | **Engineering for Space Science**

J. WARD[1]

1. SANSA Space Science, Engineering & Data Acquisition Unit; jward@sansa.org.za

The South African National Space Agency's Space Science Directorate, previously the Hermanus Magnetic Observatory (HMO), has been participating in the South African National Antarctic Programme for a number of years. SANSA's permanent observatories at the SANAE IV, Marion Island and Gough Island bases collect data year round, for both near real time and long-term data sets, and make an important contribution towards SANSA's mandate to provide Space Weather Services and cutting-edge research in the Space Science and Physics disciplines. This presentation outlines the contribution of the Engineering and Data Acquisition Unit (EDA), which is responsible for Science Support Engineering - managing and performing installations, commissioning, maintenance, calibrations and modifications on electronic instruments and systems for the collection, reduction and analysis of scientific data. The presentation also focuses on the engineering challenges with working in remote locations and in extreme environments as well as the SANSA's contribution to Human Capital Development with highlights on some of our achievements to date.

D1S1 | **HF Antenna Array Characterisation Using a Multi-Copter Platform**

C.P. GRAY[1]

1. Engineering Faculty, Stellenbosch University, Banghoek Road, Stellenbosch Central, Stellenbosch, 7600; info@sun.ac.za

The Super Dual Auroral Radar Network (SuperDARN) is an international collaboration of researchers interested in Earth's near-space plasma environment. This group uses 35 high frequency (HF) radars and backscatter from magnetic field-aligned plasma irregularities to measure the Doppler Velocity of the ionosphere in order to study Space Weather manifested in the Earth's magnetic field (magnetosphere) and ionosphere. The movements of these irregularities are tied to the magnetic reconnection of the Earth's magnetic field with the solar wind of the interplanetary medium. The SuperDARN radar uses a 16-element Twin Terminated Folded Dipole (TTFD) phased array to transmit and receive 300us/100us pulses at up to 2.4 kW per antenna over a frequency range between 8 MHz and 20 MHz. One of the challenges of such a physically large array is that it is very difficult to characterize the beam shape and pointing direction using traditional, far-field techniques. The approach is expensive, logistically demanding and in most cases results in inaccurate and sparse data. Advances in multi-copters have unlocked many new and exciting applications for scientific research. One such application is the possibility of characterising large arrays such as the SuperDARN radar. This project proposes that a near-field measurement of a SuperDARN array, using a multi-copter platform, and a near-to-far-field transformation can be used to characterize the far-field beam patterns. A near-field scan on the SuperDARN would involve the multi-copter flying in a vertical plane around 30 m, or farther, in front of the array. Additionally a second vertical plane scan would be needed around 30 m farther than the first plane. This allows for much simpler, phase-less measurements, where the phase can be de-embedded by a plane-to-plane transform.

D1S2 | **Full scale shaft-line responses in open water and ice**

B.M. NICKERSON[1], A. BEKKER1

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; annieb@sun.ac.za

The shaft-line of the SA Agulhas II is instrumented with strain gauges for full-scale measurements of shaft torque and thrust. These measurements serve to quantify the ranges of operational loading, which are encountered by the ship through her service life. Thrust measurements provide an indication of the resistance experienced by the vessel in different operating environments. The most efficient strategies to operate the vessel, are highlighted by conditions that exhibit minimal resistance. Tailored insights into vessel navigation for minimal resistance could result in fuel savings, especially for applications in ice.

D1S3 | **Open water resistance of the SAA II**

J. MOUTON[1], A. BEKKER[1], C.J. MEYER[1]

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; annieb@sun.ac.za

The full-scale hull geometry of the SA Agulhas II is used to extract the hull contours required to create a scale model of her displacement hull. Special focus will firstly be afforded to ship resistance, whereby theoretical resistance curves are generated through simulation in computational fluid dynamics. The hull geometry is further used to create a 2 m scale model of the vessel for testing I the Stellenbosch towing tank. These results will finally be correlated with ship resistance as determined from full-scale measurements (shaft thrust) of the SA Agulhas II in open water. These combined methods lay the groundwork for operational insights to improve vessel management and handling as well as more advanced studies relating to problematic wave slamming and ship resistance during ice passage.

D1S4 | **Human responses to vibration on a vessel during a storm in the marginal ice zone**

C.M. VAN ZIJL[1], A. BEKKER[1]

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; annieb@sun.ac.za

Dynamic inputs through interactions with waves and sea-ice result in significant noise and mechanical vibration on-board polar vessels, which creates challenging conditions to live and work in. Whole-body vibration that occurs in these environments may be debilitating to the health and comfort of occupants. Full-scale vibration measurements were conducted on the SA Agulhas II (SAAII), a modern polar research and supply vessel, during an oceanographic research expedition in the Southern Ocean. Measurements on Deck 4, Deck 7 and the Bridge were processed to evaluate the health and comfort of occupants on-board the vessel according to a standard methodology presented in ISO 2631-1. According to limits specified in ISO 2631- 1, vibration levels were classified as “a little uncomfortable” and sometimes “fairly uncomfortable” on the Bridge. During an open water storm the daily vibration exposure on the Bridge was only marginally lower than limits for occupational health risk specified in EU Directive 44/2002/EC. Metrics defined in ISO 2631-1 were further statistically correlated with human responses to slamming vibrations captured in passenger surveys. The metrics correlated strongly with daily subjective ratings of wave slamming events and with human complaints of interference with sleep and motor tasks.

D1S5 | **Towards integrated engineering data platform for vessel monitoring**

P.G. DURANDT[1], A. BEKKER[1]

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; annieb@sun.ac.za

Presently full-scale engineering measurements on the SA Agulhas II include almost 200 channels of continuously recorded data. Engineering data is captured using a variety of sensors and data acquisition platforms at different rates of acquisition. The data is also received in a variety of formats such as time series or video formats. The present work proposes an engineering data platform which adds value to real-time recordings. It is envisioned that data can be aggregated, visualized and analysed during an almost real-time process through a central user interface and appropriate data architecture on the vessel. This work paves the way towards in-situ ship monitoring whereby engineering calculations provide parameters, which are assessed in semi-real time in relation to ship design limits.

D1S6 | **Measurement and analysis of sleep disturbance aboard the *SA Agulhas II***

M.E.C. ENGELBRECHT[1], J. MUIYSER[1], A. BEKKER[1]

1. Sound and Vibration Research Group, Department of Mechanical and Mechatronic Engineering, Stellenbosch University; jmuiyser@sun.ac.za

Passenger comfort aboard the *SA Agulhas II* Polar Supply and Research Vessel has been studied by the Sound and Vibration Research Group of Stellenbosch University's Department of Mechanical and Mechatronic Engineering since 2014. For this purpose whole-body vibration has been measured and analysed in accordance with ISO 2631-1. These measurements were recorded using an array of accelerometers installed at various locations in the vessel. In conjunction with these vibration measurements passenger questionnaires have been used to record the crew's subjective response to wave slamming. A recent study has shown that high levels of reported passenger discomfort may be due to sleep disturbance caused by slamming events. The current study adds to the present level of understanding into the effect of slamming on passenger comfort by including noise measurements in sleeping quarters and work areas also for recumbent passengers. Passenger discomfort, vibration measurements and noise measurements were analysed statistically to determine the effect of noise on passenger comfort in relation to the previously studied vibration metrics.

D1S7 | **Intelligent determination of the ice concentration and floe size**

A. SANDRU1

1Aalto University, Espoo, Finland; andrei.sandru@aalto.fi

Ice induces additional difficulty for maritime transportation. The important parameters from the ship's performance point of view are ice thickness, ice concentration and floe size. These parameters have been traditionally observed visually and the development of remote sensing has enabled more advanced techniques to estimate these parameters. However, these methods have their own hindrances. Visual observations are subjective and satellite are not frequently passing the area and the footprint of the data might be too large for tactical navigation. Thus, new additional technologies are needed for the determination of concentration and floe size. Machinery vision offers a possibility to provide the additional information from these conditions. For these reason, the stereo camera system that has been used in previous SANAE voyages for ice thickness measurements was tuned for concentration and floe size measurements. The distance between cameras were increased to improve the long distance resolution and the system was mounted to the crow's nest of S.A. Agulhas II for the SANAE voyage 2017-18. The system recorded images and the in-house MATLAB code calculated the floe size and concentration of the field in real time.

D1S8 | **Simulating wind patterns across Marion Island using computational fluid dynamics**

K.A. GODDARD[1], K.J. CRAIG[1], J. SCHOOMBIE[2]

1. University of Pretoria, Private Bag X20, Hatfield, 0028, South Africa; kyle.goddard@outlook.com

2. Council for Scientific and Industrial Research (CSIR), South Africa

Marion Island is a sub-Antarctic island located between 40 and 50 °S, in a region known as the roaring forties. It is generally assumed that wind has a significant impact on both the biotic and abiotic systems on the island, but there is a lack of quantitative data on detailed in-island wind patterns produced by the dominant wind direction and speed ranges. The aim of the present study is to simulate air flow across Marion Island's topography using computational fluid dynamics (CFD). CFD is an engineering tool commonly used in the field of fluid dynamics and has been used to simulate flow over complex landscapes, although not typically at this spatial scale. A baseline CFD model will be produced for a range of wind directions and speeds that are presently dominant around Marion Island. The computational simulations will be validated by comparing the simulation model to existing validation cases as well as comparing the computational data to a series of measurements taken on Marion Island over a period of two years. Once a baseline simulation model has been created, the wind patterns may be used to assess the relationship between the wind patterns and the ecological systems in the current climate. It is then possible to computationally simulate wind flows at additional wind directions, thereby assessing the impact of a change in dominant wind direction on ecological systems on Marion Island.

D1S9 | **Fine-scale flight: Using high frequency data loggers to study the at-sea behaviour of wandering albatrosses**

S. SCHOOMBIE[1], R.P. WILSON[2], P.G. RYAN[1]

1. FitzPatrick Institute of African Ornithology, DST-NRF Centre of Excellence, University of Cape Town, Rondebosch, 7701, South Africa; schoombie@gmail.com

2. Department of Biosciences, College of Science, Swansea University, Swansea SA2 8PP, UK

Albatrosses are large seabirds that function as top predators within the Southern Ocean. Studying their behaviour provides us with valuable ecological information with the potential of indicating changes in marine conditions. Like all seabirds, albatrosses are central place foragers while breeding, returning to their colonies at regular intervals. Consequently, the on-land behaviour of these birds is well studied. However, they are more difficult to study while foraging at sea. Technological advances during the last few decades have seen the development of miniaturised data loggers with long battery life, allowing the recording of fine scale data from several seabird species. We deployed Daily Diary loggers (acceleration data at 16-40 Hz) in conjunction with GPS loggers and miniature cameras on wandering albatrosses (*Diomedea exulans*) breeding on Marion Island. These data were used to derive the body posture of the birds from the acceleration data and magnetic heading. Daily Diary loggers were calibrated with visual observations from the bird-borne cameras to identify flying behaviour. Bank angles during flight were extracted from video footage using custom-written Python code. Behavioural data were compared to local wind patterns to assess the effect of wind on the flying behaviour of the albatrosses.

While commuting albatrosses mainly flew with tail or cross winds, following the predominant wind direction. They were able to deviate from the wind direction by banking more to the relevant side. On average, individual flights lasted 1.25 hours with flapping every ~30s. However some flights lasted > 4 hours with extended periods without flapping (over 20 mins). Birds flying into headwinds performed shorter flights with more frequent flapping behaviour.

Our results give a glimpse into the fine-scale flight behaviour of albatrosses and show the effect of wind strength and direction on their flight patterns. They highlight the value of high frequency loggers to study seabird behaviour.