WORLD METEOROLOGICAL ORGANIZATION

WWRP POLAR PREDICTION PROJECT (WWRP-PPP)

YEAR OF POLAR PREDICTION IN THE SOUTHERN HEMISPHERE PLANNING MEETING 2 (YOPP-SH2)

28–29 JUNE 2017

NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (NCAR)
NCAR FOOTHILLS LABORATORY
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Group Photo by Kris Marwitz, NCAR
(back row, from left) Naohiko Hirasawa, Kirstin Werner, Lei Han, Kevin Speer, Katsuro Katsumata, Alexander Klepikov, Benjamin Schroeter, Katherine Leonard, Jean-Baptiste Madeleine, Holger Schmithüsen, Karl Newyear, Jordan Powers, Stefano Dolci, Peter Milne, David Mikolajczyk, Deniz Bozkurt, Kyohei Yamada, Eric Bazile, John Fyfe.
(middle row, from left) Joellen Russel, David Bromwich, Qizhen Sun, Alvaro Scardilli, Penny Rowe, Aedin Wright, Julien Beaumet, Diana Francis, Matthew Lazzara, Irina Gorodetskaya, Annick Terpstra, Scott Carpentier.
(front row, from left) Lynne Talley, Jorge Carrasco, Patrick Heimbach, Mathew Mazzloff, Alexandra Jahn, François Massonnet, Robin Robertson, Sharon Stammerjohn, Inga Smith.

1. OPENING

The second planning meeting for the Year of Polar Prediction (YOPP) in the Southern Hemisphere (YOPP-SH) subcommittee was held from 28–29 June 2017 at the National Center for Atmospheric Research in Boulder, Colorado, USA. **David Bromwich**, member of the **Polar Prediction Project Steering Group (PPP-SG),** opened this second meeting (YOPP-SH2). He welcomed participants and explained the two key goals of the meeting. One of these was to compile information on the national activities that will contribute to YOPP-SH (during the June 28th afternoon session). Bromwich pointed out the benefits that all nations will have from a joint effort to improve forecasts in the Southern Hemisphere, in particular with regards to logistics needed to carry out research in and around Antarctica. The Southern Hemisphere Special Observing Period (SOP) will take place from mid-November 2018 to mid-February 2019 which in Antarctic terms is approaching fast. The second goal of the meeting was to assemble and strengthen the connections within the Southern Ocean research community (June 29th morning session) given that the atmosphere and ocean are strongly tied together.

Kirstin Werner from the **International Coordination Office for Polar Prediction (ICO)** then reported on the recent launch of the Year of Polar Prediction. YOPP officially started on May 15th, 2017 with an opening event at WMO headquarters in Geneva, Switzerland. Kirstin provided a brief overview on the organizational structure and timeline of the Polar Prediction Project focused on activities in the Southern Hemisphere. During the YOPP-SH SOP, enhanced routine observations will be accompanied by extra modelling efforts, field campaigns, and satellite snapshots. YOPP endorsement is available for individual projects, programs, initiatives and (soon) institutions, the details of which are listed at http://www.polarprediction.net/yopp-activities/yopp-endorsement/ and the YOPP endorsement website apps3.awi.de/YPP. There is no official deadline for endorsement, however, requests should occur during the core phase. YOPP endorsement enhances both visibility of the activity and coordination efforts within YOPP. Ocean observations and modelling are the least represented by YOPP-SH endorsed projects which is why the joint June 29th session with the CLIVAR/CliC/SCAR Southern Ocean Regional Panel (SORP) was of high relevance. Also, Kirstin invited participants to note their nations' contribution on an Antarctic

map displayed in the poster area (Fig. 1). This map will further help develop a public Google Earth-based interface, which depicts the observations committed by National Antarctic Programs (NAP).

Fig. 1: Map with national contributions as collected during the meeting.

2. NATIONAL CONTRIBUTIONS TO YOPP-SH

2.1. Contributions from the United States to YOPP-SH

The first presentation was given by **David Bromwich** from **Byrd Polar and Climate Research Center)** on U.S. contributions to YOPP. He pointed to the YOPP-SH website to be found at http://polarmet.osu.edu/YOPP-SH/ where results of the

YOPP-SH2 meeting including the presentations will be posted. The Polar Meteorology Group at The Ohio State University provides continued support for the YOPP-SH coordination committee through webpage maintenance and development. Currently, there are about 20 to 25 SH projects endorsed by YOPP.

One of the U.S. efforts that can contribute to YOPP-SH is the Antarctic Mesoscale Prediction System (AMPS). This is a real-time numerical weather prediction (NWP) system for Antarctica built to support the weather forecasters of the United States Antarctic Program (USAP), which forecast, for example, activities at the USAP's main base of McMurdo Station such as heavylift air transport and helicopters and for operations at field camps across the ice. AMPS provides real-time forecasts for the Antarctic using the Weather Research and Forecasting (WRF) Model (primarily) as well as the Model for Prediction Across Scales (MPAS, in development) out to five days. The system's web page, with all forecast products, may be found at http://www2.mmm.ucar.edu/rt/amps. Over the years, AMPS has been developed to incorporate polar physics into its models and to tailor its NWP guidance to USAP forecasters requirements. More on the AMPS project can also be found by Powers et al. (2012)[1]. AMPS forecasts are running twice daily with initializations at 0000 UTC and 1200 UTC, and the model products and output can be used by YOPP-related field campaigns. Various groups evaluate the WRF output from AMPS, and Bromwich presented a recent example. While presentations in the Workshop on Antarctic Meteorology and Climate, which directly preceded the YOPP-SH meeting, had noted that the WRF in AMPS performs well over the continent as a whole, Bromwich's current study using Alexander Tall Tower (Ross Ice Shelf) measurements of the polar boundary layer provided examples of WRF overestimating the strength of the inversion during periods of higher wind speeds.

The ARM West Antarctic Radiation Experiment is endorsed by YOPP. This joint project of the U.S. National Science Foundation (NSF) and the U.S. Department of Energy is directed towards improved observation and prediction of Antarctic clouds

[1] Powers et al. (2012) A decade of Antarctic science support through AMPS. *Bull. Amer. Meteor. Soc.*, 93, 1699-1712

for their characterization and assessment of radiation impacts around the Ross Ice Shelf.

2.2. Météo France and French contribution for YOPP-SH

Eric Bazile from **Météo France** then reported on the contributions to YOPP-SH by France, and in particular by the national forecasting centre Météo France.

French observations within YOPP will cover the Antarctic stations Dumont D'Urville and Dome C. During the YOPP-SH SOP, there will be four daily radiosonde launches (3 up to 20,000 m altitude/1 up to 30,000 m altitude), in contrast to currently only 1 (up to 20,000 m altitude) at Dumont D'Urville station, in addition to other measurements as outlined in Fig. 2. While some of the instruments will not be available after the SOP, there will be several types of observations to measure clouds and precipitation profiles at Dumont D'Urville. Interestingly, already-measured snowfall profiles fit well to modelling data (see YOPP-endorsed APRES3 project, PI: J.B. Madeleine).

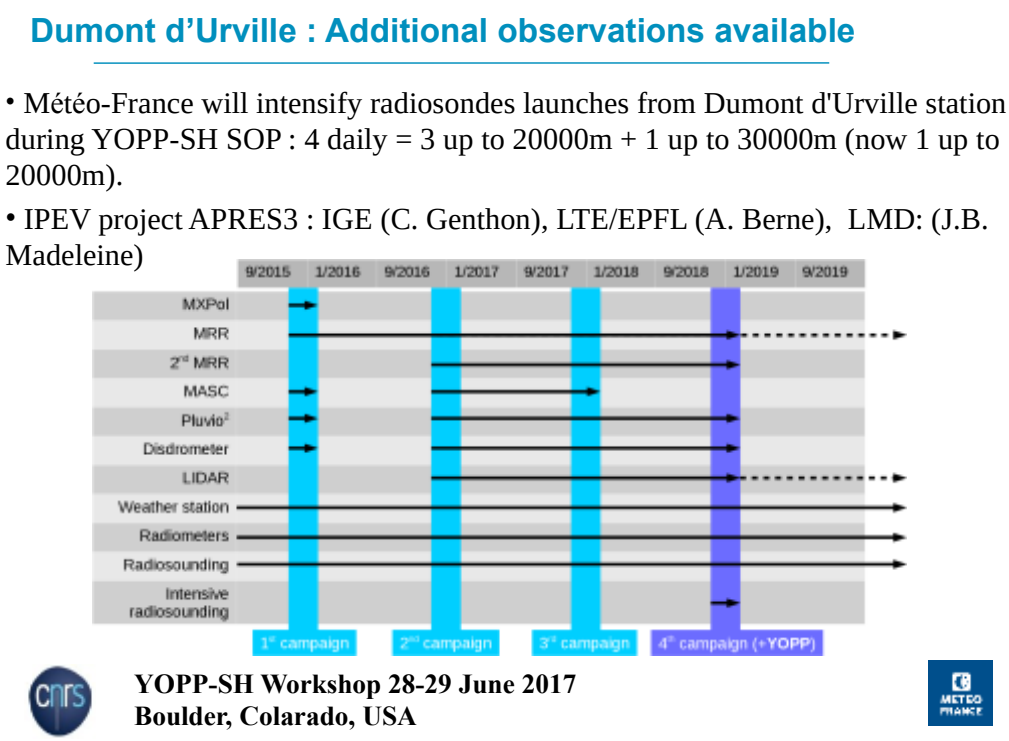

Fig. 2: Ongoing and planned observations at Dumont D'Urville station since September 2015, covering the YOPP core phase with SOP-SH (MRR: micro rain radar, MASC: multi-angle snowflake camera, LIDAR: light detection and ranging).

At Dome C station, the US tower (elevation 40 m) will be used for observations. During the YOPP-SH SOP, temperature and wind profiles will be obtained, however, sonic instruments will not be available so that no measurements of turbulent fluxes can be taken during the period.
ARPEGE model data are in line with measured humidity profiles taken by the radiometer HAMSTRAD (Ricaud et al., 2017[2]), even though the absolute humidity is quite low at Dome C station. While winter stable boundary layer modelling data from ERA-Interim underestimate the stability of stable boundary Layer (SBL) due to an excess of SBL mixing, the ARPEGE-NWP output much better represents the strong winter SBL at Dome C station (Etienne Vignon).

Météo France contributions to YOPP involve forecasts using the global ARPEGE-IFS (Integrated Forecast System) and AROME models with an adjusted domain over Dome C. For ARPEGE, specific configurations for YOPP-SH include a resolution of 5.5 km over Antarctica with 105 vertical levels and the first level being at 10 m above ground layer (AGL). These forecasts can easily be carried out in near real-time forecasts if desired by the community. With the AROME system, a large domain (1500 x 1500 grid points) could be used with a resolution of 5.5 km which would, however, mean not to cover the entire continent and would not have additional benefit. Instead, Bazile recommends rather using AROME with resolutions of 1.3 km at least 5 to 10 smaller domains (300 x 300 grid points) covering the important observations sites in Antarctica such as Dome C, Dumont D'Urville, the Alexander Tall Tower, etc.

The Météo France climate predictions which will be continued over the YOPP period are currently done with System 5 (atmospheric resolution 75 km, ocean/sea ice 1°,

[2] Ricaud et al. (2017) Genesis of diamond dust, ice fog and thick cloud episodes observed and modelled above Dome C, Antarctica. *Atmos. Chem. Phys.*, 17, 5221–5237. https://www.atmos-chem-phys.net/17/5221/2017/acp-17-5221-2017.pdf

initialization data used from ECMWF (atm) and Mercator Ocean (ocean/sea ice), respectively). The weekly predictions contribute to the S2S database.

For the seasonal forecast, Météo France will use the MF-C3S Copernicus system. New physical parameters will be included for the atmosphere and ocean sea ice. Mercator Ocean (Copernicus Marine Global Monitoring and Forecasting Centre) will provide ocean/sea ice analyses and 10-day forecasts in the Southern Ocean. Météo France will contribute their sea ice forecasts to the sea ice outlook in the south (SIPN South) and new configurations are envisioned to be tested within the APPLICATE project.

Eric Bazile emphasized the need to send additional observations to the GTS so they can be used in the operational system ARPEGE-YOPP-SH. The question was raised by Bazile, if ARPEGE-YOPP-SH will be needed in real time or near real time, with the latter meaning that the forecast is available 1 or 2 days later. Eric (eric.bazile@meteo.fr) is happy to receive related comments and opinions.

2.3. Japanese activity and plan for YOPP-SH

Naohiko Hirasawa from the **National Institute of Polar Research** (NIPR) reported on Japanese activities in support of YOPP-SH (pdf). In summer 2012/13, his research group found a high number of ice particles at 1200 m elevation just inland of the Japanese Antarctic station Syowa which indicate surface melting in connection with a historically prominent warming event with maximum summer temperatures of 8.6°C around January 7th, 2013 at Syowa. While since 1966 a general decrease of summer temperatures has been noted at Syowa station, increasing temperatures since 2005 can be related to the ozone hole recovery ongoing from the early 2000s. The latter has been explained by a weakening of the suppression of East Antarctic warming and a positive trend of the Southern Annular Mode (SAM; Jones et al., 2016[3]). In order to capture the climate change in East Antarctica, a long-term field experiment on the East Antarctic ice sheet from Syowa to Dome Fuji station has been designed, and this contributes to YOPP-SH. The field experiment involves

[3] Jones et al. (2016) Assessing recent trends in high-latitude Southern Hemisphere surface climate. Nature Climate Change, 6, 917–926. https://www.nature.com/nclimate/journal/v6/n10/pdf/nclimate3103.pdf

basic meteorological observation as well as measurements of snow depth, temperature, and radiation parameters obtained by an enhanced network of Automatic Weather Stations (AWS) and radiosonde launches at Syowa station and possibly Dome Fuji station, as well as on board the Japanese icebreaking vessel Shirase (Fig. 3). One-month long observation campaigns are envisaged on the ice sheet in summer and winter for at least the next ten years and beyond. At H128 station, additional AWS data has already been collected and sent to the GTS. From Shirase and S17 (near Syowa station), radiosondes were launched in January 2017 and the data sent to the GTS.

During YOPP-SH, Japan will contribute by enhancing radiosonde launches and its AWS network. Extra radiosondes will be launched from Syowa station, the icebreaker Shirase, and likely also for a month from Dome Fuji station.

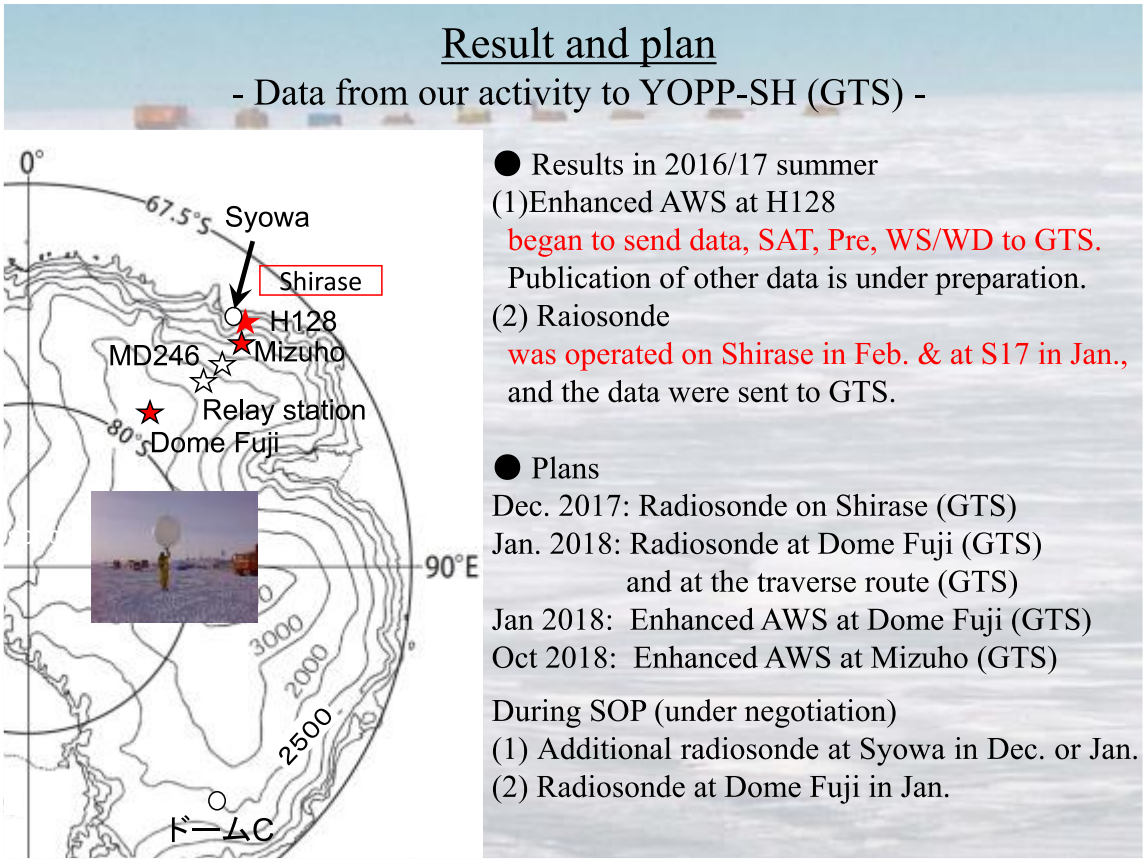

Fig. 3: Japanese plans for YOPP-SH contributions involve the Japanese research stations Syowa and Dome F as well as the icebreaking vessel Shirase.

A question was raised about Japanese contribution to YOPP-SH in terms of modelling. Naohiko pointed to a poster presented by Kyohei Yamada entitled

“Numerical Forecasting for the Entire Antarctic Continent” where he showed details on NIPR numerical prediction for all of Antarctica since June 2016 to support the Japanese Antarctic Research Expedition (JARE). Prediction is executed twice a day by using the Japan Meteorological Agency Non-Hydrostatic Model (JMA-NHM) customized with a Greenland setting.

2.4. German Contribution to YOPP-SH

Holger Schmithüsen from the **Alfred Wegener Institute** reported on the German observational efforts in the Southern Hemisphere during YOPP. These involve contributions from Alfred Wegener Institute in Bremerhaven, the Leibniz Institute for Tropospheric Research in Leipzig (TROPOS), and the University of Trier. The YOPP-endorsed AWImet project in the Southern Hemisphere involves radiosondes from Neumayer station and from the German research icebreaker RV Polarstern. During the YOPP-SH SOP, four daily radiosondes will be launched at Neumayer station at the synoptic hours 00, 06, 12, and 18 UTC. RV Polarstern will leave harbor in Capetown, South Africa on December 15th, 2018 and will be arriving the Neumayer area in January/February 2019 where four radiosondes daily will be launched at the same time. At least two AWSs will operate during YOPP-SH SOP, the Søråsen AWS and the Filchner AWS.

The **AWI sea ice physics group** has been deploying different types of buoys in the Southern Ocean during RV Polarstern cruises. These include drift and snow buoys to measure the thickness of snow pack on the sea ice, as well as ice mass balance buoys and a surface velocity profiler. From the 2015/16 season, four buoy systems are still working and may provide data during the YOPP-SH SOP. In collaboration with BAS (British Antarctic Survey), this group has also deployed three AWSs in the Weddell Sea. Deployments including CTD (Conductivity/Temperature/Depth) measurements of the surface ocean conditions are planned for the coming austral summer season (January/February 2018) on board the RV Polarstern (expedition PS111), and with some luck, these will be providing data also during the YOPP-SH SOP. For the duration of the YOPP-SH SOP (summer 2018/19), buoy deployments still lack funding.

The Swiss-German collaborative project **ACE-SPACE** (PI: Julia Schmale) was carried out during the recent summer period onboard the RV Akademik Tryoshnikov when the Swiss-led Antarctic Circumnavigation Experiment (ACE) was conducted around Antarctica over a three-months period. Silvia Henning from TROPOS was part of the project entitled “Study of Pre-industrial-like Aerosol Climate Effects” (ACE-SPACE) which involved the study of sources of aerosols that serve as cloud condensation nuclei and ice-nucleating particles in the Antarctic pristine atmosphere, considered the closest to one reflecting pre-industrial atmospheric conditions.

Holger also briefly introduced the **Wind LIDAR measurements in the Weddell Sea** that are planned for the RV Polarstern cruise PS111 from January 19th to March, 14th, 2019 (contact: Günther Heinemann). Wind measurements will be compared to modelling results in the area.

In the following discussion, Francois Massonnet pointed to those buoys that did not survive for a long time after deployment. The Sea Ice Drift Forecast Experiment SIDFEx that has recently been initiated by Helge Goessling and colleagues would provide sea ice drift forecasts which could be useful for finding the right location for future buoy deployment.

2.5. KOPRI'S contribution for YOPP-SH

Sang-Jong Park from the **Korea Polar Research Institute (KOPRI)** reported on South-Korean contributions to YOPP-SH. KOPRI will focus its effort to enhance observations at their stations King Sejong (King George Island) and Jang Bogo (Terra Nova Bay) while there will be almost no modelling activities going on during YOPP-SH SOP.

At **King Sejong station**, one radiosonde per day will be launched at 12 UTC in agreement with operators of the Chilean Base Presidente Eduardo Frei Montalva where a radiosonde will be launched at 00 UTC. The contact for King Sejong station is Sang-Jong Park sangjong@kopri.re.kr.

At **Jang Bogo station**, there will be a daily radiosonde at 18 UTC, in combination with three launches at the adjacent Italian Mario Zucchelli station at 00, 06, and 12

UTC. Thus, in total there will be four daily radiosonde launches from Terra Nova Bay. In addition, at Jang Bogo station, a ceilometer will measure cloud conditions. Contact for Jang Bogo station is Tae-Jin Choi ctjin@kopri.re.kr.

Regarding the icebreaking **RV ARAON**, plans for YOPP-SH SOP are not as concrete as for the stations. Final agreement is pending until end of 2017, but most likely there will be a cruise will be in the Ross Sea region. Surface meteorological observations will be carried out during the cruise and a mini-Micropulse LIDAR (mini-MPL) will be measuring aerosols and cloud conditions.

For general questions on Korea's contribution to YOPP-SH, Seong-Joong Kim can be contacted at seongjkim@kopri.re.kr.

2.6. Australian planned contributions to YOPP-SH

Scott Carpentier from the **Australian Bureau of Meteorology (BOM)** presented ongoing Australian observational activities and those under consideration. Australia operates four permanently-occupied stations in the Antarctic: Mawson, Davis, Macquarie Island, and Casey station. In addition, Australia sends the icebreaking vessel Aurora Australis and an Airbus A319 airplane for supply between Hobart, Tasmania and the stations.

The **Aurora Australis** goes back and forth in summer about five times between the four stations for supply and sometimes also conducts scientific cruises. Underway is the synoptic observational program from the vessel from which data is routinely fed into the GTS.

The **A319 plane** is equipped with an Aircraft Meteorology Data Relay (AMDAR) system that automatically transfers temperature and wind data to the GTS. Last year, A319 had eleven return flights between Hobart and the stations.

Also fed into the GTS are wind data from throughout the troposphere (up to 8 km height) every 15 minutes from measurements taken by an Australian Antarctic Division-operated VHF wind profiler at **Davis station**, and from this vertical variation of wind velocities can be deduced.

All four Australian Antarctic stations are part of the WMO Global Climate Observing System (GCOS) program. Eight AWSs that are remote from the stations are sending their data to the GTS.

BOM is already running a fairly big radiosonde program involving Casey, Davis and Macquarie Island stations with 2 launches per day at 00 and 12 UTC as part of the Global Upper Air Network (GUAN). At Mawson station, 1 radiosonde per day is currently launched at 12 UTC while the 00 UTC time period appears too windy for deployment.

In addition, at Macquarie Island weekly ozone sondes are launched during the ozone depletion season (winter/spring); weekly ozone sondes are also deployed at Davis station in partnership with the Chinese program.

Scott also mentioned the following additional projects with Australian participation (mainly projects with US and New Zealand involvement).

- The MARCUS project where an Atmospheric Radiation Measurement (ARM) instrument from the US Department of Energy (DOE) will be deployed to Aurora Australis in summer 2017/2018.
- The SOCRATES project where an NSF/NCAR Gulfstream-V High-performance Instrumented Airborne Platform for Environmental Research will be deployed from mid-January to end-February 2018 to characterize clouds, radiation, aerosols, and precipitation. The aircraft, in combination with the Australian RV Investigator will do transects to the Antarctic coast line and back to Hobart to observe and capture Southern Ocean clouds with a focus on supercooled droplets in the cold sectors of cyclones.
- After the MARCUS time period, the ARM facility will be transferred to Macquarie Island station to do cloud radiation experiments for the Macquarie Island Cloud Radiation Experiment (MICRE) and to Davis station for the Antarctic Cloud and Radiation Experiment (ACRE)
- ACCESS, the Australian numerical weather prediction model provides seasonal forecast. Postdoc Laura Davies is currently working on sea ice aspects of ACCESS S, and PhD student Ben Schroeter working on high-latitude verification of ACCESS G).

The sea ice evaluation by means of ACCESS S goes along with observations during February to September, the months of sea ice maximum. However, it does not well reflect the end of summer season when sea ice loss is high, but models indicate lesser sea ice extent than actual observations. The sea ice outlook resulting from ACCESS S will be going into SIPN South efforts (see part 4.3.).

Experiments by Ben Schroeter involving ACCESS G have been already

presented in a poster and during the Workshop on Antarctic Meteorology and Climate. Essentially, experiments show that forecast error growth is maximized in the polar regions. Work by Phil Reid aims at studying Antarctic sea ice extent over the full longitudinal range across the continent over time by means of Hovmöller diagrams. Fast changes in the anomalies (sea ice decrease and growth) could be identified when looking at the impact of transient cyclonic systems on the sea ice.

Under consideration for YOPP are to:
(1) Transfer Davis station from the GCOS Upper Air Network (GUAN) to the GCOS Reference Upper-Air Network (GRUAN) which essentially means that Davis would become a reference site with tighter quality control and more testing before radiosondes are deployed.
(2) Routinely install C & V (ceilometer and visibility) sensors at some or all Australian Antarctic stations. Here, Scott also mentioned that these are generally deployed to support aviation operations but that resulting backscatter data are not saved. The real-time use of those data could, however, be very interesting for information on cloud phase, waves in clouds, or aerosol content. While he has no information how other nations deal with these data (provided to science or just deleted), it might be interesting for the YOPP community to encourage nations to save more of this data.
(3) The evaluation of manual forecast performance skills is envisaged to improve terminal and public weather forecasts for the stations and for the Wilkins Aerodrome (a single-runway aerodrome approximately 65 km/40 mi from Casey Station).
(4) Enhancing radiosonde launches to 4 times per day from the stations is currently being looked at. Extra launches from Casey and Davis stations might be realistic but need to be discussed further.
(5) As well, radiosonde launches beyond the MARCUS project (during the YOPP-SH SOP) to be launched from RV Aurora Australis and possibly from the RV Investigator are being discussed.
(6) Further activities under consideration involve some marine and sea ice aspects not presented here (but to be made publicly available by Scott later on).

Model sensitivity tests by ACCESS G could be carried out by using the 4D-Var system for observational simulations.

Concluding his presentation, Scott highlighted the need to transfer research into use which does have an important value to the society. This was also pointed out at the recent EC-PHORS meeting in Ushuaia with the services task team. That team plans to put together a summary paper on the global influence of Antarctica, but also addressing teleconnections and sea level rise.

A question was raised by someone in the auditorium about the number of radiosondes during the MARCUS project. There will be 4 to 8 radiosondes per day during MARCUS launched from Aurora Australis which is coordinated with the SOCRATES aircraft campaign.

2.7. Italian contribution to YOPP-SH

Stefano Dolci from the **Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA)** coordinates the operational meteorological activities at the Italian base Mario Zucchelli (MZ) and at the Italian-French station Concordia (Dome C). On behalf of his colleagues Paolo Grigioni (ENEA) and Vito Vitale (ISAC-CNR) who are point of contacts for YOPP-SH, Stefano reported on the status of the Italian projects contributing to YOPP-SH.

Before introducing the projects, Stefano raised three important points for the later discussion:

1) Is the concept of Intensive Observing Periods within Special Observing Periods as outlined in earlier YOPP documents still valid?
2) Regarding projects which do not feed their data into the GTS: How does the data needs to be formatted and deployed in order to be useful for YOPP?
3) Also, it will be important to agree on the timing for radiosonde launches in Antarctica as logistical efforts by personnel needs to be kept into account.

There are essentially ten Italian-led projects that contribute to the Southern Hemisphere parts of YOPP. Seven of these projects have already been funded while three are still pending support. For these three projects, a deadline needs to be set since instrument acquisition, arrangement of research activities and transfer of

instruments to Antarctica require time so that efforts will not be too late in the YOPP period.

The YOPP-endorsed **Italian Antarctic Meteo-Climatological Observatory** (IAMCO) involves a large meteorological network of 15 AWSs at MZ and Dome C operating more than thirty years, plus a snow drift station, two radiosounding stations (one at each station), and twelve airstrip weather stations. In cooperation with the adjacent Korean Jang Bogo station, IAMCO will be contributing to YOPP by doubling the radiosounding activities during the YOPP-SH SOP, providing 4 radiosondes per day. At Concordia station, radiosondes will be increased from 1 to 2 launches per day. If there is interest among the YOPP community, the production of synoptic messages sent from the AWS network could be increased during the SOP via the weather forecasters working at MZS. Additionally, snowfall estimation will improve; cloud observations will be enhanced from new ceilometers being installed at MZS and Dome C.

ISAC-CNR Radiometric Observation activities in polar regions are carried out in the frame of the BSRN observatory at Concordia. They are focussing on both long- and short-wave radiation, spectral UV fluxes at surface, as well as to investigate surface albedo and cloud radiation effects. These measurements could be carried out along the coast of the Ross Sea in cooperation with the SAMEECA project (see below, just funded and in cooperation with KOPRI). The goal of the activities is to obtain accurate measurements of solar and terrestrial radiation at the surface level. Similar activities are also performed at the Dirigibile Italia station in Ny Alesund in the Arctic. Radiation data such as on cloud effects and the dynamics of the ozone column at Concordia station will be contributing to YOPP. The data will be submitted to the BSRN network no more than one month after collection.

The project entitled **"Antarctic Precipitation Properties from ground-based instruments"** (APP) aims to set up a precipitation observatory consisting of ground-based instruments installed at MZ, including specific instruments such as a Metek Micro Rain Radar and an OTT Parsivel laser disdrometer. Ad hoc post-processing for precipitation will be developed to provide a data set for precipitation events to the YOPP community.

The **Lidar Observatory at Dome C** aims to compare and validate satellite based lidar observations, as well as comparing ground and satellite based lidar observations with a chemistry climate model. Contributions to YOPP encompass the observations of cirrus clouds and their correlation with Polar Stratospheric Cloud (PSC) occurrences, improvements of PSC measurements between 20 and 30 km, and routine temperature measurements.

Funded by PRNA are the activities on Italian moorings in the Ross Sea. The focus of the project is to manage the **"Marine observatory in the Ross Sea"** (MORSea) which has been in operation since 1994, mainly through earlier projects Clima and Abioclear. While these projects were completed in 2010, measurements at MORSea are continuously carried out providing data on oceanographic parameters such as sea surface temperature and salinity, conductivity, turbidity, sediment trap data, etc.

Surface-Atmosphere Mass and Energy Exchanges at a Coastal Antarctic site (SAMEECA) aims to better understand atmospheric surface mass and energy exchanges on an Antarctic coastal site in Ross Sea including a multiscale modelling approach. Therefore, it is envisaged to collect data year-round at the Korean Jang Bogo station which will provide the base for the evaluations of the models' performances. These data will include (micro-)meteorological parameters of the ground and atmospheric column including radiation components and atmospheric characteristics.

Pending funding are the projects RADIANCE, TRIMMER, and PIRANhA.

Radiative Impact of Antarctic Clouds Experiment (RADIANCE) aims to investigate the optical and physical characteristics of cloud effects on the surface and atmospheric radiative budget, focusing on liquid clouds. Therefore, it is envisaged to enhance cloud observations at MZ and to set up a database of atmospheric parameters for Antarctic research.

The project **TRaceability and Improvement of Meteorological Measurements during YOPP intEnsive peRiods, to better investigate ABL characteristics and coupling processes in coastal Antarctica** (TRIMMER) involves boundary layer meteorology along Victoria Land. Envisaged is to measure vertical profiles at the 30 m Alexander Tall Tower on the Ross Ice Shelf in comparison with tall tower and sodar data at MZS and Jang Bogo Station.
Precipitation Impact on the Regional ANtarctic Accumulation (PIRANhA) plans to quantify snow precipitation over the coastal areas of Antarctica.

2.8. Russian contribution to YOPP-SH

Alexander Klepikov from the Arctic and Antarctic Research Institute (AARI) reported on the status of YOPP planning for Antarctica from the Russian side. While the situation for the Arctic is much clearer, activities in the Southern Hemisphere will only be decided this fall, so any input and recommendations from the community are most welcome for ongoing discussions.

Russia runs five overwintering stations in Antarctica, these are Bellingshausen, Novolazarevskaya, Progress, Mirny, and Vostok. Routinely, radio soundings are launched at 00 UTC from Novolazarevskaya and Mirny stations once a day. Under discussion is to increase radiosonde deployments for either both or one of these stations during YOPP-SH SOP. Alexander mentioned that any recommendation will be helpful in case funds are restricted to only run 2/day radiosondes at one of these two stations.

In addition, Russia operates seasonal stations where AWSs are installed. These are: Molodezhnaya, Soyuz Druzghnaya-4, Russkaya, and Leningradskaya.

At the coastal stations (Mirny, Progress, and Bellingshausen), ice studies including fast ice, and ice and snow thickness are routinely carried out. From Mirny, there exists a fast ice record since 1956.

Oceanographic work is done and will be continued over YOPP-SH from Prydz Bay and in the Davis Sea which is close to Mirny station. In addition, three different Russian vessels are operating in the Southern Ocean, these are Akademik Federov

and Akademik Tryoshnikov which both are belonging to AARI obtaining meteorological data to be sent to the GTS; and Aleksandr Karpinksi, a marine geology vessel. All three vessels could be used to deploy buoys in the Southern Ocean. While the vessels are mainly operating in the Indian Ocean sector, they also go to the Atlantic Ocean sector to supply Bellingshausen station. No radiosoundings are carried out on the vessels. However, all meteorological data from vessels feed into the GTS. Alexander once more emphasized the need for recommendations on which of the two stations Novolazarevskaya and Mirny are preferred for a second daily radiosonde.

2.9. UK contribution to YOPP-SH

Steve Colwell from the **British Antarctic Survey (BAS)** briefly reported on the status of BAS planning for YOPP-SH SOP. These are essentially are radiosonde launches at the BAS stations Rothera and Halley. At Rothera, the current 4 launches per week will be increased to daily radiosondes at 12 UTC. Depending on the situation in early to mid-November 2018, radiosonde launches will be increased to twice daily deployments with additional acensat at 00 UTC at Halley station, (currently one radiosonde launched at 12 UTC).

Steve also offered to set up an archive with YOPP-SH high-resolution meteorological data obtained during YOPP-SH SOP from AWS, radiosondes and additional electronic instruments, all of which can be of valuable use for guidance in the consolidation phase of YOPP.
Some additional projects such as a Southern Ocean Aerosol Clouds Experiments (SEASCAPE; University of Leeds) are still under consideration for funding. Also, the Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports (ORCHESTRA) project led by BAS might be a good candidate for YOPP endorsement.

2.10. Argentine Naval Hydrographic Service's contribution to YOPP-SH

In his presentation on Argentine Naval Hydrographic Service's contribution to YOPP-SH, **Alvaro Scardili** from **Argentina's Naval Hydrographic Service (NHS)** pointed out that this meeting would be the first YOPP meeting with NHS contribution, and NHS is keen on sharing their various activities to contribute to YOPP. Argentina is

active in Antarctica since the end of the 19th century and installed the first permanent meteorological station in South Orkney Island in 1904. Nowadays, Argentina runs 13 stations in Antarctica, six of them (Belgrano II, San Martin, Carlini, Esperanza, Marambio, Orcadas) being permanent, while the rest are open depending on researchers' needs. However, only a small number of stations are currently contributing to the GTS.

Argentina is also responsible (including Search and Rescue) for NAVAREA VI (http://weather.gmdss.org/navareas.html) and provide services to the public and the navy. Particularly important is the increasing number of tourists (35,000 per year) which are focus on the northern Antarctic Peninsula. Thus, as being truly users of forecast products, and also producing their own, information generated during YOPP is a very important issue for Argentina.

The NHS Department for Meteorology, which also is head of the Navy Weather Service, has separate research and operational sections which, however, work in close collaboration in order to provide better support for operations in Antarctica.

All of the above-mentioned stations provide meteorological records, however, only a few feed their data into the GTS, and Marambio is the only station with radiosonde launches. Thus, one of the goals of the Argentine Antarctic stations will be to get meteorological data into the GTS during YOPP. Also, Alvaro noted an interest to feed data from these stations into the data assimilation of AMPS.

Argentina also runs four classes of vessels in Antarctica which all carry out meteorological observations every six hours (hourly records of observations available at the ships). Yet, data transmission is only provided to the Navy Weather Service. NHS, however, is working on getting the data also onto the GTS.

NHS does provide training on ice and meteorological observations for Navy ships and station personnel. SYNOP data from most of the stations is not yet going onto the GTS.

Regarding the ice observations, NHS is using their own system which is probably quite similar to, but may have a different structure compared to WMO codes. In order to feed ice data onto the GTS, it is unclear if the NHS system can be used. Many of the ice data, as well as meteorological data that have been obtained since the 1950s can be made available for climatological study. First, however, they have to be digitized in order to be used by ships and stations.

New AWS are going to be installed over the coming seasons at Deception Island and Melchior Base. Probably, there will be satellite (ARSAT, Argentinian satellite) connections available in order to send data to the GTS.

Modelling activities such as for sea ice and meteorological forecasts have been in operation since 2015 with monthly updates based on the Principal Components Analysis and Artificial Neural Network approach. The contact for them is Sandra Barreira (barreira.sandra@gmail.com), and sea ice forecasts using a statistical model to plan logistics are likely very useful also for the deployment of buoys, as they are already for the planning of stations' replenishment in the austral summer season.

Alvaro concluded that NHS will be keen on getting more involved with YOPP (one way would be to request institutional YOPP endorsement for NHS) providing Argentine Sea Ice products to the community such as ice charts, sea ice edge charts, iceberg charts, ice observation coding, and analysis for navigating ships to the community.

2.11. Chilean contribution to YOPP-SH

Penny Rowe and Jorge Carrasco from the **University of Santiago** presented activities carried out by the university's Antarctic Research Group. Only one project is yet YOPP endorsed, but all presented projects are funded, and Penny and Jorge are working on them to request YOPP endorsement.

Penny Rowe then reported on the YOPP-endorsed project **Characterizing the Antarctic Atmosphere and Low Clouds** (CAALC) which focuses on King George

Island activities, but an extension to Union Glacier is envisaged. The CAALC radiosounding program will be in collaboration with the Korean station King Sejong. And, if anyone from the Russian or Chinese station is interested to add radiosondes they should contact Penny Rowe (penny@nwra.com). As mentioned earlier by Sang-Jong Park, there will be one radiosonde launched daily from King Sejong station during the YOPP-SH SOP (at 12 UTC). This will be complemented by one radiosonde launch daily from Escudero Station, as part of the CAALC project (at 00 UTC). In addition, as part of the CAALC project, radiosonde deployments are planned for 4 to 5 times per week during the coming austral summer (2017/2018). Furthermore, King Sejong Station will launch one radiosonde per week from November 2017 until the start of the YOPP-SH SOP in mid-November 2018. Also, broadband measurements are part of the experiment. All instruments for CAALC, including a mini Micropulse Lidar (which will be made available for the YOPP period by Raul Cordero, and which is believed will be the only cloud Lidar on the Antarctic Peninsula) will be housed at the newly built Transportable Antarctic Research Platform (TARP). Led by Raul Cordero, TARP became operational on King George Island in early 2015. TARP housed instrumentation, including broadband instruments and radiosondes, that was successfully operated during Austral summer 2016/2017.

Another project by the Antarctic Research Group looks at black carbon in Antarctic snow. Near-surface temperature effects on reflectivity of snow-covered surfaces are going to be investigated. It is a collaboration, amongst others, with BAS who provide aircraft support and cloud sensors during the coming summer. Also, Matthias Braun from University of Erlangen will be launching radiosondes from the German Antarctic Receiving Station *(*GARS) at O'Higgins station on King George Island.

Jorge Carrasco then reported on a project entitled **Reflectivity in Antarctic** which is in its third and final year setting up radiation instruments on Union Glacier. Also, he mentioned that the newly-built Antarctic Research Platform would be open to anyone with interest using the instruments there (see list with available instruments in presentation file).

The **Southern Hemisphere Climate System Response to Stratospheric Ozone Depletion** project investigates the Antarctic ozone hole's impact on the Southern

Hemisphere Climate as well as the assessment of weather driven variability of surface UV.

Commitment by the Chilean Weather Service DMC is to use the Polar WRF model in Antarctica in the coming austral summer and during YOPP. At the moment, WRF is run over Chile with different resolutions (up to 4 km). In the future, Polar WRF will be run twice a day out to 120 hours ahead. Model output will probably be hard to archive, but hopefully they will find a way to have the data daily online for download.

The project **Calving and mass balance studied by remote sensing, in-situ methods and modelling at King George Island** is a glaciological study in King George Island which plans to get YOPP endorsement.

Also, the **IDEAL Research Center Dynamics of High Latitude Marine Ecosystems** is a 5-year project with the option to apply for another 5 years. It will build the oceanic branch of Chilean contributions to YOPP.

2.12. Belgian contribution to YOPP-SH

Francois Massonnet then briefly presented the YOPP-endorsed project **Regional coupled model in Adelie Land, impacts of small scale processes** (AdelieHRM) on behalf of his colleagues Pierre-Vincent Huot and Thierry Fichefet from the Université Catholique de Louvain. Its main goal is to increase the understanding of the role of small-scale processes in the ice, ocean, and cryosphere in the Southern Hemisphere, such as interactions between ocean and sea ice, and ice and atmosphere, as well as sea ice rheology, land fast ice, and ice shelves. These are typically missing in large-scale general circulation models as they are too small-scale. The set up for the project will be rather simple, as it will be looking into shorter time scales, of a few seasons by different simulations: atmospheric simulations forced by ocean boundary conditions, ocean conditions driven by known atmospheric conditions, and a coupled configuration to learn about the coupled processes. While this project does not directly provide data for YOPP campaigns (the simulations are hindcasts, i.e., conducted retrospectively), it will contribute by enhancing the process understanding. Adelie Land has been specifically picked for

this project, as on the one hand there are many observations available due to the presence of the station Dumont D'Urville. On the other hand, it is a quite complicated area in terms of bathymetry and topography, characterized by strong katabatic winds. The model NEMO will be coupled to the LIM3 sea ice model and the MAR model.

In the discussion, Dave Bromwich suggested to extend the area a bit more to the east and south as it may better capture atmospheric processes.

2.13. Update on Planned Observational Campaigns over the Southern Ocean: SOCRATES and MARCUS

On behalf of Greg McFarquhar (University of Illinois), Dave Bromwich briefly provided an update on the "Planned Observational Campaigns over the Southern Oceans for Determining the Roles of Clouds Aerosols and Radiation in the Climate System: MARCUS and SOCRATES". Both YOPP-endorsed programs are funded with the motivation to study clouds in the Southern Ocean, one of the cloudiest regions on Earth. At the same time, the Southern Ocean is a unique testbed for understanding cloud-aerosol interaction due to its remoteness from anthropogenic and natural continental aerosol sources. In CMIP5 models, clouds are not well represented over the Southern Ocean. There is a need for more in-situ observations due to the high presence of supercooled liquid water in clouds over the Southern Ocean. Also, large seasonal cycles of cloud droplet and CCN concentrations exist which are not yet well-studied.

The goals of the two programs are to:

- characterize physical properties of lower-tropospheric cloud systems around mid-latitude cyclones over complete seasonal cycle;
- characterize microphysical and chemical properties of aerosols;
- assess the quality of satellite cloud, aerosol, precipitation, and upper ocean products; and
- to evaluate and improve skill of models at different scales to reproduce observed properties of SO clouds.

Funded are the following activities for the next austral summer.

- Australian R/V Investigator for 2016 & 2018
- DOE-funded instruments on Macquarie Island plus Australian instruments and installation of AMF-2 on Aurora Australis for Antarctic resupply voyages (MICRE and MARCUS)
- IMOS Buoy in SOCRATES domain
- R/V Tangaro in Ross Sea
- NSF GV deployment
- Integrated Sound System on R/V Investigator

Measurements of Aerosols Radiation and CloUds over the Southern Oceans (MARCUS) targets observations of clouds, aerosols, precipitation and radiation over the Southern Ocean onboard the supply vessel Aurora Australis (AA) that will make routine transits between the Australian stations. During these voyages, AA will measure various parameter with an AMF-2 that will be installed on board the vessel between October 21st, 2017 and March 23rd, 2018. More on MARCUS can be found at https://www.arm.gov/campaigns/amf2017marcus/ and on the AA shipping schedule, at https://secure3.aad.gov.au/public/schedules/voyage.cfm?season=1718.

The **Southern Ocean Clouds Radiation Aerosol Transport Experimental Study** (SOCRATES) campaign characterizes clouds, radiation, aerosols and precipitation along a north-south transect, roughly Tasmania to Antarctica, using both cloud remote sensing and in-situ instrumentation on both NSF/NCAR GV aircraft and R/V Investigator.

The meeting included a poster session with the following being offered

Gorodetskaya	Irina	Atmospheric Rivers over the Southern Ocean and Antarctic ice sheet as part of the global water cycle
Heinemann	Günther	Wind LIDAR measurements on an icebreaker in the Antarctic
Madeleine	Jean-Baptiste	The APRES3 project and its insights into clouds and snowfall in Antarctica

Schroeter	Benjamin	Antarctic verification of the Australian weather forecast model
Wright	Aedin	Integrating Polar Research in Undergraduate Curricular
Yamada	Kyohei	Numerical forecasting for the entire Antarctic continent

2.14. Chinese Contributions

Qizhen Sun from the **Chinese National Marine Environmental Forecasting Center (NMEFC)** reported on the Antarctic Observations by China and its Contribution to YOPP-SH. NMEFC is part of the Chinese State Oceanic Administration (SOA) under which umbrella China has carried out expeditions since 1984 in collaboration with numerous universities and institutes. China currently runs two year-round stations, Great Wall and Zhongshan. A new station is planned to be installed in the Ross Sea/Terra Nova Bay area which will be operated year-round with permanent meteorological observations. From Great Wall and Zhongshan, routine meteorological observations are transferred into the GTS four times daily. In addition, China has the icebreaking vessel Xuelong which goes to Antarctica every year. From the icebreaker, while boundary layer soundings are deployed, the data are not shared with the GTS. A second icebreaker is currently under construction and will be available in two years (not during the YOPP-SH SOP).

Sea ice observations have been continuously carried out since 2010 from Zhongshan with a focus on measurements of the albedo and the sea ice surface temperature.

Planned contributions to YOPP involve the weather and atmospheric observing system that will be installed at the new station in the Ross Sea, and 13 AWSs which will be installed on a 100 km transect from Zhongshan station to Dome A/Kunlun station. This data will hopefully be available in two years. In addition, sounding observations by UAVs (small unmanned meteorological observers – SUMO) are planned both during the icebreaker cruises and at the stations. In summary, China will contribute to YOPP-SH by:

- adding weather and sea ice observations, including atmospheric soundings on cruises;
- providing a fieldwork and research infrastructure available for long-term research; and
- sharing data in agreement with YOPP and international collaborations.

The 35th CHINARE expedition onboard the Chinese icebreaker 'Xuelong' will be happening during the Antarctic YOPP SOP.

David Bromwich asked if there will be soundings deployed from Great Wall, but there are not yet any plans for these. The new Chinese station will be installed at Terra Nova Bay in the Ross Sea, however, a precise location has not yet been found. In total, there will then be three stations at Terra Nova Bay.

2.15. Finland's YOPP contributions

On behalf of Timo Vihma from the **Finnish Meteorological Institute,** Qizhen Sun also reported on Finnish Meteorological Institute plans for Southern Hemisphere YOPP (see second part of the presentation). These are essentially contributions by the YOPP-endorsed project "Antarctic Meteorology and Snow Research: from Process Understanding to Improved Predictions" (ASPIRE) led by Timo Vihma. The project has three different work packages (Snow and Albedo, Antarctic Boundary Layer and Clouds, Large-scale circulation and transport) which feed into the fourth work package (Improved Weather and Climate Predictions). The latter consists of two subtasks, these are A) Model evaluation and B) Physical Parameterizations.

3. General Discussion

3.1. Coordination of Radiosonde Launches

The following discussion was led by David Bromwich. The first part was about the coordination of radiosonde launches in Antarctica during the Special Observing Period in the Southern Hemisphere. With regards to the question raised earlier by Stefano Dolci, David Bromwich and Kirstin Werner explained the idea of the Special Observing Period (SOP), which is a three month-period during which enhanced routine observations during YOPP should be preferably happening. The earlier

concept of Intensive Observing Periods (IOPs) as stated in previous YOPP documents no longer exists. However, PIs are not expected to carry out their measurements for the entire duration of the period, but should cover the period as best as possible according to financial allowances. Questions arose regarding whether certain weeks or synoptic events in the SOP be prioritized for National Antarctic Programs who can't afford the whole SOP. Therefore, it was discussed if radiosonde launches should be carried out four times a day over a certain period, or two times per day over a longer period. Expressed was a request to the PPP Steering Group to formulate recommendations by, for example, ranking the different activity frequencies. Changing frequency or length (2/day for a month or 4/day) for a limited period was proposed as an option to address budget constraints, and there was a question whether it is better to have length or resolution. From the modelling point of view, Dave Bromwich preferred to plan for an extended period with two measurements per day, as it would be better to have coverage throughout the three months rather than frequency. Also, it was noted that deploying four times per day is expensive in terms of staff, as additional staff for the night shift needs to be put down the field.

3.1.1. Timing of Radiosonde Launches

This prompted questions of prioritization of times and whether alternate launches should be conducted based on the distribution of sites. 00 UTC and 12 UTC are seen as priority hours for radiosonde launches. At Neumayer station, sondes are routinely deployed 75 min before UTC time so that the sonde is at 100 hPa at UTC time, Holger Schmithüsen reported. David Bromwich emphasized the importance for YOPP to have twice as many radiosondes for at least two months (for statistical significance of results) to demonstrate the positive impact on predictive skill. As pointed out in the previous discussions, from a modelling perspective, it would be more important to have a longer period covered by extra radiosondes (two per day should be sufficient for many operational centers; e.g., ECMWF does two initializations a day) rather than increased temporal resolution of up to four soundings per day. Spatial coverage of radiosonde data points south of 40°S is 15 times as less as north of 40°N. So, there is a need to improve spatial coverage at the expense of diurnal coverage.

The question of “sharing” of sondes was raised, with possible solutions tying such exchanges to the funding of committed research projects. Irina Gorodetskaya asked if there is an option to get in touch with launchers to ask about their particular requirements, in particular their flexibility to launch additional sondes for events that occur (e.g., atmospheric rivers). The lead time for “on demand” launches is at least 24 hrs to capture events, but communications and logistics could be as much as 2-3 days. Penny Rowe offered to be contacted via skype whenever such an event can be anticipated. Holger Schmithüsen suggested establishing an effective communication channel with relevant stations prior to the field season, as has been done previously. In this case, also, compensation arrangements for the sharing of equipment need to be considered.

The cost of sondes was discussed, with Vaisala commanding market share in the region. The group suggested aligning efforts with YOPP-NH (Russia) and/or investigating a discount price for the YOPP SOPs. However, it is unclear how this would work with some NAPs not using Vaisala.

David Bromwich suggests that the coordination committee that has representatives with decision-making authority (i.e. who can authorise purchase/launch) must come up with the recommendations for radiosonde launches, including priorization and target periods, and then to contact the responsible person for each country.

3.2. **Collection of Southern Hemisphere YOPP Data**

The need for consolidated data storage and archiving was discussed, as currently NAP operators must be approached to acquire data. Radiosonde observations and synoptic data from the SH community should go to a centralized data repository (after they have been quality-controlled). Steve Colwell (UK) volunteered to investigate a centralized database and offered to coordinate such a data archive hosted at BAS where at least the high-resolution meteorological data that will be generated during the SOP will be stored (but possibly earlier data, too). The question was how will be dealt with mast, flux, and turbulence data. Kirstin Werner mentioned the YOPP data portal that will hold a metadata base since many groups will store data on other data archives routinely. So, the YOPP data portal is planned to link all

of these datasets. The "meta-data" approach (one link pointing to all data) might have some advantages since many models host tendencies. ECMWF and AMPS are already storing information. An early version of the portal can be found at https://yopp.met.no/. Holger Schmithüsen explained that many of the data goes to PANGAEA, and possibly, PANGAEA could also host data generated during YOPP (Holger and Kirstin will investigate).

The topic of data formats was raised, with both raw and processed data (adhering to some standard) required by various groups. There should be limitations on the type of data in the database, with satellite and model output considered too voluminous to store. Parameters stored should align with YOPP-NH.

The possibility of developing a Poor Man's Ensemble (PME) was discussed, including the models of all NAPs. However, the solution to storing large datasets is still unclear. Storing model output on NCAR/UCAR servers is being investigated.

3.3. Modelling

It was requested by participants to make sure the community knows where which modelling data sets are available at what location. This could be done, for instance, via the YOPP website.

Discussion was around an Antarctic or joint polar CORDEX which, however, involve climatology rather than weather aspects. Antarctic CORDEX is just forming; their first meeting will be in October which is something to keep an eye on as it is important to define if only forecast, or also hindcasts are important. Hindcasts can eventually serve for the improvement of forecasts. But is it necessary to deliver real-time forecasts? These might be needed to have something like AMPS for organizing stuff in one of the most hostile regions on Earth.

3.4. Remaining points (not thoroughly discussed)

- There are limited funds for the Antarctic Polar Boundary Layer (PBL) research in the USA
- Should there be an additional SOP for the ocean?
- SOOS biology group may be able to contribute to data strategies
- Should ocean/atmosphere be considered together?
- What ocean outputs are needed for atmospheric objectives, and vice-versa?
- What is being done with drift/icebergs?

- Is it possible to enhance the ARGO array for use during YOPP-SH SOP?
- YOPP should leverage existing projects in the area.
- Need to articulate the relevance of the work to the global community and policy-makers, with a strong connection to societal implications.
- How can we do this DURING the SOPs?

4. JOINT YOPP-SORP SESSION (by Lei Han/CLIVAR)

4.1. Welcome and Introduction

YOPP-SH and SORP had a joint half-day session in the morning of 29 June. Inga Smith, one of the co-chairs of SORP, first welcomed the participants to the joint session and then gave an introduction on SORP's terms of references: to serve as a forum for the discussion and communication of scientific advances in the understanding of climate variability and change in the Southern Ocean; to advise CLIVAR, CliC, and SCAR on progress, achievements, new opportunities and impediments in internationally-coordinated Southern Ocean research, with specific activities:

Specific Activities:

1. Facilitate progress in the development of tools and methods required to assess climate variability, climate change and climate predictability of the ocean-atmosphere-ice system in the Southern Ocean.
2. Identify opportunities and coordinated strategies to implement these methods, spanning observations, models, experiments, and process studies.
3. Provide scientific and technical input into international research coordination, collaborating as required with other relevant programs, including SOOS.
4. Monitor and evaluate progress in Southern Ocean research, and identify gaps.
5. Enhance interaction between the meteorology, oceanography, cryosphere, geology, biogeochemistry and paleoclimate communities with an interest in the climate of the Southern Ocean.
6. Work with relevant agencies on the standardization, distribution and archiving of Southern Ocean observations.

Inga also expressed the intention of SORP to get coordination with YOPP-SH, and pointed out that SORP members were mainly observationalists and climate modellers, but not familiar with NWP (Numerical Weather Prediction). Thus, it is a good opportunity to learn for them via the cooperation with YOPP-SH.

The YOPP-SH subcommittee leader, also the new member of SORP from this year, David Bromwich, introduced the 10 years' project of YOPP since 2013: a preparation phase (2013-2017), YOPP Core Period (mid-2017 - mid-2019), and a consolidation phase (2019-2022). Unlike SORP which belongs to World Climate Research Programme (WCRP), YOPP is one of the key elements of the Polar Prediction Project (PPP), which is under the auspices of World Weather Research Programme (WWRP). For YOPP's mission of achieving a significant improvement in environmental prediction capabilities for the polar regions and beyond, David deemed the link with ocean was critical because ocean predictability is vital for two-month atmospheric prediction. Thus, SORP is central to YOPP goals. Joellen Russell supported David's point by mentioning that the ice prediction around Alaska cannot be done with only atmosphere, but has better include the sea ice. John Fyfe also pointed out that the subsurface observations need to be assimilated for sea ice prediction over six months. David suggested that the fully coupled reanalysis is central to all applications but the current ones include atmosphere only.

Wintertime observations in Southern Ocean and Antarctic were discussed. Lynne Talley mentioned the wintertime observations have never been obtained before and would be better to be included in the YOPP-SH's field campaign. Joellen Russell added that the wintertime storm track observations are crucial but still quite unknown. But David Bromwich thought the storm track regions are far offshore, how to make the observation still remains a question.

Regarding the efforts YOPP-SH would focus, David Bromwich preferred that it should be towards scientific questions, such as the downstream impacts. While Inga Smith thought that it had better entrain the existing projects instead of creating new ones since it is driven by research funding. David Bromwich expressed that YOPP-SH will do the best on the upcoming observation phase, and will have more on oceanography in future.

The ENSO's impacts on the Antarctic and Southern Ocean were brought up by John Fyfe. David Bromwich agreed that ENSO (El Niño Southern Oscillation) has impacts on the blocking high in the higher latitudes of Southern Hemisphere, and

believed that the different impacts of 97/98 and 15/16 ENSO events on the Antarctic are related with SAM (Southern Annular Mode). ENSO's impacts will be considered in YOPP-SH project.

As the biological aspects and how they can be embraced in YOPP-SH, Joellen Russel reminded that SOOS has great biological groups that focus on those aspects in the Southern Ocean.

4.2. SOOS field and modelling capabilities of relevance to YOPP

Matthew Mazloff reported on behalf of SOOS its goals, working groups, achievements, and plans. SOOS coordinates and facilitates incorporating ocean observations and data management in the Southern Ocean. The predictive skill for two-month atmospheric prediction lies in the ocean preconditioning. One major outcome of SOOS is DueSouth (Database of Upcoming Expeditions in the Southern Ocean) which compiles and indexes user-provided information on voyages, leadership, and onboard projects in the Southern Ocean, and is proposed to connect with YOPP Explorer. Another outcome to be launched by the end of 2017 is SOOS Map, which is collaborated with EMODnet (European Marine Observations and Data Network). SOOS map tries to incorporate in layers of all the major observation endeavours in the Southern Ocean, such as Argo, SOCCOM, GO-SHIP, DueSouth, tide gauges, AWS, XCTD/XBTs, OceanSITES, moorings, gliders and so on. SOOS has 5 regional working groups surrounding the Antarctic continent and 4 capability working groups covering animals, ecosystem, observation under sea ice, and air-sea fluxes. Matthew also briefly introduced the Southern Ocean State Estimation (SOSE) that is a biogeochemical-sea ice-ocean model using 4D-Var with multi-year assimilation windows to solve for the atmospheric fluxes necessary to bring the solution into consistency with observations. A targeted YOPP-SH ocean reanalysis was proposed to be produced out of SOSE.

The question was raised if there is an additional mechanism to liaise with YOPP other than project endorsement. Kirstin Werner replied that there is be an institutional YOPP endorsement added where institutions such as operational forecasting centers and research institutes can partner with YOPP. (The institutional endorsement is now underway and can be requested via the YOPP endorsement website http://www.polarprediction.net/yopp-activities/yopp-endorsement/ and the link placed here).

Regarding the moorings, OceanSITES only covers half of the Southern Ocean moorings, while SOOS will include all. David Bromwich suggested to get SOFLUX (SOOS's Working Group on Southern Ocean Air-Sea Fluxes) moorings onto GTS (Global Telecommunication System) of WMO for bigger impacts of SOOS.

For the question of the criteria of defining the 5 regional working groups of SOOS, Inga Smith pointed out that it is more logistical instead of scientific. And Joellen Russel also thought that the 5 regional working groups are quite set thus hard to redefine them.

4.3. Designing an Antarctic sea ice prediction coordinated experiment

François Massonnet introduced a sea ice prediction project in the Southern Ocean, SIPN-South (http://apps3.awi.de/YPP/pdf/stream/106). SIPN (Sea Ice Predication Network, https://www.arcus.org/sipn) was launched in 2013 aiming at developing a collaborative network of scientists and stakeholders to advance research on sea ice prediction and communicate sea ice knowledge and tools. Talking about the two polar regions, the studies on Arctic sea ice prediction are overwhelmingly more than those on Antarctic. And both the sources of sea ice predictability and skills of sub-seasonal to seasonal predictions between the two polar regions have significant distinctions. The Antarctic sea ice prediction remains as an opening area of research. The SIPN-South was thus formed with a first attempt to address the sea ice prediction. François also demonstrated the roadmap of SIPN-South during the period 2017-2019 with one of the objectives of coordinating a realistic prediction exercise in conjunction with YOPP-SH SOP in February 2019.

During the discussion, Alvaro Scardili from the Argentina National Hydrological Service NHS was interested to engaging in SIPN-South with its sea ice model. François will include him into the mailing list of contributors. John Fyfe mentioned there are large spread among different products on the Antarctic sea ice extent of February. David Bromwich replied the sea ice extent would be one part of the campaign of YOPP-SH. Joellen Russell found the processes driving and changing melting play important roles in prediction of seasonality. François deemed that probability forecast is the only feasible way for seasonal time scales. The participation to SIPN-South is voluntary.

People proposed that supports are needed from users like modellers to prove useful for the WMO buoys in the Antarctic. It was replied that it should be two-way

communications. As for the needs for the Antarctic than the Arctic, Inga Smith thought fishing, tourism, and vessels are all practical needs for the Antarctic region aside from many scientific questions useful for climate predictability. Scott Carpentier pointed out the primary clients in the Antarctic are with resupply. He also mentioned that WMO begun to make the global seasonal forecasts by designating some national climate centres as WMO Global Producing Centres for Long-Range Forecasts.

5. Discussion

As a reply to the question what it is needed from ocean to optimize the atmospheric predictability, David Bromwich thought it inappropriate to separate ocean and atmosphere predictability because they are a coupled problem.

Icebergs were also needed to be modelled. The Canadian model developed for the Arctic will do a test for the Antarctic next summer. Mixing layer and mixing estimates were suggested necessary to examine, but the models are unable to produce mixing estimates to compare with the observations.

Big push for YOPP is to move predictions into the weather timescales, to do the coupled assimilations so it will be a balanced atmosphere-ocean-sea ice system. The variables to be assimilated include temperature, salinity, height, and passive microwave sea-ice concentrations.

There are increasing gaps of float coverage due to decreases in funding. Maintaining floats like Argo needs to be considered. Maintaining Argo floats in south of 60^{o}S is no longer priority for US. We need floats that are closer into the Antarctic and can sample areas with polynyas. WMO doesn't see Argo as valuable data points because they are not permanent.

There is a shift towards temporary measurements because technology is becoming cheaper. Ships or planes of opportunity, buoys that can be frozen in and then out, AWS buoys, ice mass balance buoys are all critical and needed for forecast modelling community as discussed at COMNAP (Council of Managers of National Antarctic Program). The regions to focus is the South Pacific, which has big changes and climate sensitivity. It would be a good idea to leverage other projects targeting those regions, such as the Ross Sea, and the Antarctic Peninsula. Lynne has just put some sea ice surface buoys into the Southern Ocean, so there is already a contribution. The YOPP-SH SOP is in summer, but for sea ice predictability, the crucial season is winter. One option is to deploy the buoy in summer in the open water and then they'll freeze

in winter. Anything is helpful because we really lack validation data from satellites. According to David Bromwich, there is a pending cluster proposals for Thwaites studies. It is worth coordinating with what they are planning to put in drifting buoys once the proposals are selected and funded.

For sea ice one needs to focus on various regions and regional analysis rather than circumpolar analysis. SIPN-South will focus on Ross Sea and Weddell Sea which are highly variable and Amundsen Sea which suffers from sharp decline in sea ice extent.

Regarding the numerical modelling parts, ECMWF will have all the global predictions for 2 years of YOPP (mid-2017~mid-2019), which are 3-hour output frequency, 0.125 degrees or 12 km resolution, 14 days' atmosphere only forecast and are already online and easily accessible. Scott Carpentier pointed out that manual charting provides 40-70 % enhancement of delineation of sea ice edge relative to satellites. Also, there are some operational sea ice forecasting models. The Canadian model will be tested and made operational if it works. In terms of modelling efforts of YOPP, Matthew Mazloff suggested it should focus on improving bulk formula and coupling. A lot of tasks need to be done before getting into a full coupled system that will really help us understand where the problems lie and we can use the observations to improve. For example, if the bulk formula are terrible, we aren't going to improve the atmospheric modelling. We need to decide who can focus on the modelling and who can do ocean observations and do what. The atmospheric modelling part has been challenging in YOPP. Regarding model improvement, there is an issue that making improvement in one model doesn't necessarily lead to improvement for the others, for example, WRF improvements have no bearing on ECMWF. There are various problems in the wide range of models with evolving appreciation of physical parameterization strengths and weaknesses, including that clouds have too much short-wave radiation at the surface, which could be a big part of sea ice prediction and fluctuation problems; water/ice, how it interacts with short- and long-wave radiations; and mixed phase clouds not well enough understood (motivation for SOCRATES and MARCUS – study CCN (Cloud Condensation Nuclei) and ice-nucleating particles (INP) that seed liquid and ice clouds). These stretches across all time scales.

As for the who-cares question on the Antarctic atmosphere and ocean studies, more motivation reasons are needed to convince taxpayers. Sea level, carbon budget, ocean heat uptake, ozone assessment, and melting of West Antarctica are all

motivations. The greater the relevance for Washington DC, the more impacts there will be.

Regarding the data archiving, YOPP data portal has metadata and links to actual data. For contributed high-resolution meteorological data like radiosondes generated during YOPP-SH SOP, Steve Colwell could host that at BAS (British Antarctic Survey). For other oceanographic data etc., people could use PANGAEA (https://www.pangaea.de/), which is hosted by AWI (Alfred Wegener Institute) in Germany. Further discussion with AWI on hosting the YOPP datasets in PANGAEA will be conducted.

Lynne Talley proposed the idea of an implementation plan for YOPP-SH, in order to formalize and determine what can be actually implemented, and the best strategy to get maximum return for investment. It could appear as a succinct statement that could be publicized onto the website. We need a Southern Hemisphere subset for the Southern Ocean. What we could do is to mirror what they did for Arctic YOPP with YOPP-SH. Online discussions will be done for the drafting of the implementation plan. SORP members were invited to contribute to the drafting of the YOPP-SH implementation plan.

ACRONYMS

4D-Var	four-dimensional variational assimilation techniques
AA	Aurora Australis
AARI	Arctic and Antarctic Research Institute
ACCESS	Arctic Climate Change Economy and Society
ACE-SPACE	Antarctic Circumnavigation Expedition: Study of Pre-industrial-like Aerosol Climate Effects
ACRE	Antarctic Cloud and Radiation Experiment
AdelieHRM	Influence of small-scale processes on the dynamics of the coupled atmosphere-cryosphere-ocean system on daily to seasonal timescales in the region of Adélie Land, Antarctica
AMDAR	Aircraft Meteorology Data Relay
AMPS	Antarctic Mesoscale Prediction System
APP	Antarctic Precipitation Properties from ground-based instruments
ARM	Atmospheric Radiation Monitoring
AROME	Applications de la Recherche à l'Opérationnel à Méso-Echelle (Météo France model)
ARPEGE	Action de Recherche Petite Echelle Grande Echelle
ARSAT	Argentinian satellite
ASPIRE	Antarctic Meteorology and Snow Research: from Process Understanding to Improved Predictions
AWI	Alfred Wegener Institute (Germany)
AWS	Automated Weather Station
BAS	British Antarctic Survey
BOM	Australian Bureau of Meteorology
BSRN	Baseline Surface Radiation Network
C3S	Copernicus Climate Change Service
CAALC	Characterizing the Antarctic Atmosphere and Low Clouds
CCN	Cloud Condensation Nuclei
CLiC	Climate and Cryosphere (core project of the WMO WCRP)
CLIVAR	Climate and Ocean: Variability, Predictability and Change (a core project of the World Climate Research Programme)
CNR	National Research Council of Italy

COMNAP	Council of Managers of National Antarctic Program
CORDEX	Coordinated Regional Downscaling Experiment
CTD	Conductivity/Temperature/Depth
DOE	Department of Energy (U.S.)
DueSouth	Database of Upcoming Expeditions in the Southern Ocean
EC-PHORS	Executive Council Panel of Experts on Polar and High Mountain Observations, Research and Services
ECMWF	European Centre for Medium-range Weather Forecasts (U.K.)
EMODnet	European Marine Observations and Data Network
ENEA	Italian National Agency for New Technologies, Energy and Sustainable Economic Development
ENSO	El Niño Southern Oscillation
GV aircraft	Gulfstream V aircraft
GARS	German Antarctic Receiving Station
GCOS	Global Climate Observing System
GRUAN	GCOS Reference Upper-Air Network
GTS	Global Telecommunication System of WMO
GUAN	Global Upper Air Network
HAMSTRAD	H_2O Antarctica Microwave Stratospheric and Tropospheric Radiometers
IAMCO	Italian Antarctic Meteo-Climatological Observatory
ICO	International Coordination Office (PPP)
IFS	Integrated Forecast System
INP	ice-nucleating particles
IOP	Intensive Observing Periods
IPEV	Institut Polaire Français Paul-Emile Victor (France)
ISAC	Institute of Atmospheric Sciences and Climate (CNR)
ISS	Integrated Sound System
JARE	Japanese Antarctic Research Expedition
JMA-NHM	Japan Meteorological Agency Non-Hydrostatic Model
KOPRI	Korea Polar Research Institute
LIDAR	LIght Detection And Ranging
LIM3	Louvain-la-Neuve Sea Ice Model (current version)
MAPS	Model for Prediction Across Scales

MAR	Modele Atmospherique Regional
MARCUS	Measurements of Aerosols Radiation and CloUds over the Southern Oceans
MASC	Multi-Angle Snowflake Camera
MF	Meteo France
MICRE	Macquarie Island Cloud Radiation Experiment
mini-MPL	mini-Micropulse LIDAR
MORSea	Marine observatory in the Ross Sea
MRR	Micro Rain Radar
MZ	Mario Zucchelli station
NAP	National Antarctic Programs
NCAR	U.S. National Center for Atmospheric Research
NEMO	Nucleus for European Modelling of the Ocean (state-of-the-art modelling framework of ocean related engines)
NHS	Argentina's Naval Hydrographic Service
NIPR	National Institute of Polar Research (Japan)
NMEFC	Chinese National Marine Environmental Forecasting Center
NSF	National Science Foundation (U.S.)
NWP	Numerical Weather Prediction
ORCHESTRA	Ocean Regulation of Climate by Heat and Carbon Sequestration and Transports
PBL	Polar Boundary Layer
PI	Principal Investigator
PIRANhA	Precipitation Impact on the Regional ANtarctic Accumulation
PME	Poor Man's Ensemble
PPP	Polar Prediction Project
PSC	Polar Stratospheric Cloud
RADIANCE	Radiative Impact of Antarctic Clouds Experiment
RV	Research Vessel
S2S	Subseasonal-to-Seasonal Prediction Project (WWRP)
SAM	Southern Annular Mode
SAM	Southern Annular Mode
SAMEECA	Surface-Atmosphere Mass and Energy Exchanges at a Coastal Antarctic site

SBL	Stable Boundary Layer
SCAR	Scientific Committee on Antarctic Research
SEASCAPE	Southern Ocean Aerosol Clouds Experiments
SG	Steering Group
SH	Southern Hemisphere
SIDFEx	Sea Ice Drift Forecast Experiment
SIPN	Sea Ice Prediction Network
SO	Southern Ocean
SOA	Chinese State Oceanic Administration
SOCRATES	Southern Ocean Clouds, Radiation and Aerosol Transport Experimental Studies
SOFLUX	SOOS's Working Group on Southern Ocean Air-Sea Fluxes
SOOS	Southern Ocean Observation System
SOP	Special Observing Period
SORP	Southern Ocean Regional Panel
SOSE	Southern Ocean State Estimation
SUMO	Small Unmanned Meteorological Observers
TRIMMER	TRaceability and Improvement of Meteorological Measurements during YOPP intEnsive peRiods
TROPOS	Leibniz Institute for Tropospheric Research in Leipzig
UCAR	University Cooperation for Atmospheric Research
USAP	United States Antarctic Program
WCRP	World Climate Research Program
WMO	World Meteorological Organization
WRF	Weather Research and Forecasting
WWRP	World Weather Research Programme (WMO)
WCRP	World Climate Research Programme (WMO)
YOPP	Year of Polar Prediction (PPP/WMO)

ANNEX 1: AGENDA

Wednesday 28 June		
13:00-13:05	***Welcome and Introduction***	David Bromwich
13:05-13:20	***Launch of the Year of Polar Prediction in the Southern Hemisphere***	Kirstin Werner
Session I – National Contributions to YOPP-SH		(chair: David Bromwich)
13:20-13:30	*Contributions from the US to YOPP-SH*	David Bromwich
13:30-13:40	*Météo France contribution for the YOPP-SH*	Eric Bazile
13:40-13:50	*Japanese activity and plan for YOPP-SH*	Naohiko Hirasawa
13:50-14:00	*German contribution to YOPP-SH*	Holger Schmithüsen
14:00-14:10	*KOPRI's contribution for YOPP-SH*	Sang-Jong Park
14:10-14:20	*Australian planned contributions to YOPP-SH*	Scott Carpentier
14:20-14:30	*Italian contribution to YOPP-SH*	Stefano Dolci
14:30-14:40	*Russia contribution to YOPP-SH*	Alexander Klepikov
14:40-14:50	*UK contribution to YOPP-SH*	Steve Colwell
14:50-15:00	*Argentine Naval Hydrographic Service's contribution to YOPP-SH*	Alvaro Scardili
15:00-15:10	*Chilean contribution to YOPP-SH & Characterization of the Antarctic Atmosphere and Low Clouds (CAALC)*	Jorge Carrasco/ Penny Rowe
15:10-15:20	*Belgian contribution to YOPP-SH*	François Massonnet
15:20-15:30	*Update on Planned Observational Campaigns over the Southern: SOCRATES and MARCUS*	Greg McFarquhar (presented by D. Bromwich)
15:30-15:40	*1-minute announcement of posters*	*Poster Presenters*
15:40-16:10	***Coffee break & poster session***	
16:10-16:20	*Chinese contribution to YOPP-SH*	Qizhen Sun
16:20-18:20	***Discussion***	chair: Dave Bromwich
Thursday 29 June		
Session II – Joint session with CLIVAR/CliC/SCAR Southern Ocean Regional Panel		(chair: Lynne Talley)
08:30-08:45	***Welcome and Introduction***	Bromwich/Fyfe/Smith/ Han/Werner
08:45-09:00	***Meeting goals***	Bromwich/Fyfe/Smith/ Han/Werner
09:00-09:15	*SOOS field and modelling capabilities of relevance to YOPP*	Matthew Mazloff
09:15-09:30	*Designing an Antarctic sea ice prediction coordinated experiment*	François Massonnet
09:30-09:35	***Group photo***	

09:35-10:05	***Coffee break & poster session***	
10:05-12:00	***Discussion***	chairs: L. Talley/D. Bromwich
	1. *Define the Southern Ocean oceanographic observations needed during the YOPP-SH special observing period, 16 November 2018 – 15 February 2019. (SOOS representative expected to be present for this).*	
	2. *Make progress on the issue of how the predictable ocean behaviour out to 2 months projects onto the behaviour of the atmosphere, i.e., how coupled numerical weather prediction over the Southern Ocean would be enhanced over that using specified ocean conditions.*	
12:00-13:00	***Lunch break***	

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