WORLD METEOROLOGICAL ORGANIZATION WWRP POLAR PREDICTION PROJECT (WWRP-PPP)

SIXTH YOPP-SH MEETING (VIRTUAL)
June 24 -25, 2021

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Hosted by Polar Meteorology Group and
Byrd Polar and Climate Research Center,
The Ohio State University
Publication Date: August 20, 2021

YOPP-SH Meeting Agenda

Day 1: Thursday June 24 Day Session
11:00 – 1:40 pm (EDT) / 1500 – 1540 UTC

Chair: David Bromwich
Topic: Summer YOPP-SH SOP

11:00 – 11:10 **Welcome and Introduction**
David Bromwich

11:10 – 11:25 **Update from the YOPP International Coordination Office for Polar Prediction**
Kirstin Werner
Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany

11:25 – 11:40 **Four seasons of forecasting summer Antarctic sea ice: lessons learned from the SIPN South project.**
François Massonnet
Université catholique de Louvain (UCLouvain)

11: 40 – 11:55 **Seasonality of sea ice and snow properties from autonomous ice-tethered platforms in the Weddell Sea, Antarctica**
Presenter: Stefanie Arndt
Affiliation: Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany

11:55 – 12:10 **OSE with ARPEGE-SH during the YOPP-SH SOP.**
Eric Bazile
Météo-France/CNRS, France

12:10 – 12:25 **Data denial experiments for the YOPP-SH summer SOP using AMPS-Polar WRF**
David Bromwich
Byrd Polar and Climate Research Center, The Ohio State University, USA

12:25 – 12:30 **Break**

12:30 – 12:45 **Targeted measurements and numerical modelling of atmospheric rivers at the Antarctic Peninsula during the summer YOPP-SH special observing period: impacts on clouds and precipitation**
Irina Gorodetskaya
University of Aveiro, Portugal

12:45 – 13:00 **Analysis of the 16 Feb 2016 windstorm on South Shetland Islands and assessment of the short-range predictability of the event**
Sergi González
AEMET, Spain

13:00 – 13:15 **Supercooled Liquid Water Cloud remotely observed and analyzed above Dome C, Antarctica and future in situ observations**
Ricaud Philippe
CNRM, France

13:15 – 13:30 **Evaluation of the Present Antarctic Weather Station Network in Monitoring the Intra-seasonal to Decadal Climate Variability**
Xichen Li
Institute of Atmospheric Physics, Chinese Academy of Sciences, China

Winter SOP

13:30 – 13:40 **South African plans for the winter SOP in 2022**
Tamaryn Morris
South African Weather Service

End of the Day Session

Day 1: Thursday June 24 Evening Session
17:00 – 19:00 (EDT) / 2100 – 2300 UTC

Chair: Jordan Powers

17:00 – 17:15 **What we have learned so far: Stakeholder interactions and needs**
Daniela Liggett
University of Canterbury, New Zealand

Winter SOP (continued)

17:15 – 17:25 **Australian plans for the winter SOP in 2022**
Phillip Reid
Australian Bureau of Meteorology

17:25 – 17:35 **Japanese plan of observation and research for the TOPs of YOPP-SH in 2022**
Naohiko Hirasawa
National Institute of Polar Research, Japan

17:35 – 17:45 **New Zealand plans for the winter SOP in 2022**
Adrian McDonald
Director Gateway Antarctica/ Professor School of Physical and Chemical Sciences University of Canterbury, New Zealand.

17:45 – 17:55 **Korean Contribution to YOPP-SH Winter TOP**
Sang-Jong Park
Korea Polar Research Institute

17:55 – 18:10 **US plans for the winter SOP in 2022**
Jordan Powers, Matthew Lazzara, Art Cayette, David Bromwich

National Center for Atmospheric Research; Madison Area Technical College and University of Wisconsin-Madison; Naval Information Warfare Center (NIWC); Byrd Polar and Climate Research Center, The Ohio State University.

18:10 – 18:20 **Weather Decisions: Social Science Weather Decisions Project for YOPP-SH Winter TOP-1**
Victoria Heinrich
University of Tasmania, Australia

18:25 – 18:30 **Break**

Discussion of Forecasting Team for Greater Ross Sea and East Antarctica
Host: David Bromwich
18:30 – 19:00

End of Day 1

Day 2: Friday June 25 Day Session
11:00 – 13:35 (EDT) / 1500 – 1735 UTC

Chair: Kirstin Werner

Winter SOP (continued)

11:00 – 11:10 **Introduction**
David Bromwich

11:10 – 11:20 **Atmospheric rivers and their impacts on clouds, precipitation and melt: the Portuguese contribution to YOPP targeted observing periods during austral winter 2022 with radiosonde profiling and precipitation radar**
Irina Gorodetskaya
University of Aveiro, Portugal

11:20 – 11:30 **Atmospheric Profiling, Ground-Based Measurements and Forecasting Modeling: the Chilean Contribution to YOPP Special Observing Period (SOP) during Austral Winter 2022**
Raul Cordero
Universidad de Santiago, Chile

11:30 – 11:40 **British Antarctic Survey Activities during the SH winter SOP**
Tom Lachlan-Cope
British Antarctic Survey, UK

11:40 – 11:55 **Italian contribution to YOPP-SH winter 2022 special observing period**
Vito Vitale

CNRM, Italy

11:55 – 12:05 **French Contributions to Winter-SOP**
Eric Bazile
Meteo France, France

12:05 – 12:10 **Break**

Discussion of Forecast Sensitivity to Observations Experiments for Winter TOPs
Host: David Bromwich and Eric Bazile
12:10 – 12:40

12:10 – 12:40 **Open Discussion**

12:40 – 12:50 **Planned activity for YOPP-SH winter SOP on the Ukrainian Antarctic Station Akademik Vernadsky**
Svitlana Krakovska
NASC, Ukraine

Poster Session

12:50 – 12:55 **Study of the variability of temperature and ozone in the lower-middle stratosphere of the Antarctic Peninsula in disturbed Dst periods**
Adriana Maria Gulisano
IAA/DNA, IAFE (UBA-CONICET), DF FCEyN UBA, Argentina

Discussion of Forecasting Team for the Greater Antarctic Peninsula
Host: Irina Gorodetskaya
12:55 – 13:35

12:55 – 13:05 **Forecasting team and measurement planning of targeted observing periods at the Greater Antarctic Peninsula region during the winter YOPP-SH 2022**
Irina Gorodetskaya
University of Aveiro, Portugal

13:05 – 13:35 **Open Discussions on the Greater Antarctic Peninsula Forecasting**

End of the Conference

1. Welcome and Introduction

The sixth Year of Polar Prediction – Southern Hemisphere (YOPP-SH) meeting was held online from 24 – 25 June 2021. **David Bromwich**, member of the Polar Prediction Project Steering Group (PPP-SG), opened the first day session. He welcomed everyone who joined the online conference and gave a brief overview concerning the rules during the meeting and about its schedule. Then, **Bromwich** explained the two main goals of the meeting. One of these was to give the project investigators and representatives of national agencies that are active in Antarctica the opportunity to provide updates on their research resulting from the YOPP summer Special Observing Period (SOP) in the Southern Hemisphere (Nov. 16, 2018 to Feb. 15, 2019). The second goal of the meeting was to highlight advanced planning for the upcoming winter SOP in 2022 (mid-April to mid-July) with its focused activities during the Targeted Observing Periods (TOPs). **Bromwich** informed the attendees about the number of people that signed up for the YOPP-SH meeting (110) and the scientists from over 15 countries being present.

2. YOPP Update

Kirstin Werner from the **International Coordination Office for Polar Prediction (ICO)** gave a YOPP Update in which she talked about the Polar Prediction Project having moved into its Consolidation Phase (2019-2022), while the YOPP in the Southern Hemisphere community continues to be active until 2024. There are several activities currently ongoing in view of finalizing the ten-year project by the end of December 2022, including the planning and organization of the YOPP Final Summit (1 – 4 May 2022, Montreal, Canada), the YOPP Final Summit School, the Fellowship program (aligned with YOPP Final Summit), and the evaluation of the project's success. She urged everyone to contact the ICO about working together to develop YOPPSiteMIP in the Southern Hemisphere and to join the YOPP-SH Mailing list (yopp-sh-taskteam@listserv.dfn.de, to be added email a request to office@polarprediction.net). A brief discussion followed about the organization of the data files in an online portal (using NetCDF-Format). A proposal was made, to have a "Green Summit" by combining the WAMC and the YOPP Final Summit. The YOPP Final Summer School will take place from 27 April until 1 May 2022 near Montreal. Around 30 early career scientists will have the opportunity to establish connections and build a network. The Fellowship Program will have a competitive element. **Werner** closed her brief update by talking about the YOPP Evaluation & Legacy work. For the Final Summit, "success stories" could be presented to highlight the advancements in the Polar Prediction Community.

3. Scientific Achievements from Summer SOP

François Massonnet from **Université catholique de Louvain, Belgium** then delivered an update on the Sea Ice Prediction Network South project (SIPN South project). The project was originally planned to end but because of the success, it was extended. The number of groups contributing to the SIPN South project is stable for the last four years (ca. 13), but the total number of forecasts received has increased with some groups contributing up to 60 forecasts. The Antarctic sea ice conditions for 2020 – 2021 are "pretty normal, close to average", even with a look at the spatial distribution of anomalies. There is evidence from literature that sea ice is predictable at annual and interannual time scales. They think there is some predictability in the system. They combine the results from statistical model and coupled dynamical models. With these, an extrapolation is possible for what the sea ice will be like in the future. The statistical contributions seem to have a lower error than the dynamical models which have a bias at the regional scale. Sometimes the statistical models may be "too sharp" and miss areas where there is ice reported by observations. The winter

YOPP SOP will be highly beneficial for SIPN South and their extra coordinated sea ice prediction experiment. It aims to see how models capture the variability.

Stefanie Arndt from the **Alfred Wegener Institute Helmholtz Center for Polar and Marine Research, Bremerhaven, Germany** gave a presentation on seasonality of sea ice and snow properties from autonomous ice tethered platforms in the Weddell Sea, Antarctica. It is important to conduct research about snow on Antarctic sea ice. Snow on top hampers sea ice growth but also causes flooding when the sea ice snow interface gets pushed below the ocean surface. After the water freezes, it adds to the mass balance. This mechanism adds a lot of uncertainties when looking at satellite data. To tackle this lack of knowledge, special observations are needed:
For the past eight years: about 33 Snow Buoys (4 sonar sensors for snow accumulation measurements, air temperature and pressure that go into the GTS) have been deployed in the Weddell Sea. Other measuring devices are Ice Mass Balance Buoys (Thermistor string, Temperature and heat conductivity every 2 cm) and Surface Velocity Profiler (SVP). Two pairs of Snow Buoys are still active, as well as one Ice Mass Balance Buoy and 9 SVPs. For the Winter SOP-SH the measurement program is not going to be extended, but the normal seasonal activities remain. In June/July two Ice Mass Balance Buoys and two Snow Buoys will get deployed in Atka Bay and sea ice, snow and atmospheric measurements will take place there as well. Thirty additional radio soundings (depending on staff capacity) will take place up to 4 times per day, for a few days in a row. The normal data release cycle for full timeseries data is once per year. If data are needed sooner, this can be arranged upon request.

Eric Bazile from **Météo-France/CNRS, France** delivered a presentation on Observing System Experiments (OSE) with ARPEGE-SH during the YOPP-SH SOP. Within YOPP-SH SOP (15/11/2018-15/02/2019), additional observations (such as radiosondes) have been performed in Antarctica and used in real time by global operational numerical weather prediction (NWP) models. However, afterwards, it was difficult to see the impact of this effort in terms of forecast quality especially by comparing with previous same periods. An objective evaluation is necessary at least to provide a feed-back for the "observation's providers" but also for the NWP community. Therefore, an OSE was performed with the YOPP-SH version of the global model ARPEGE: ARPEGE-SH and a 4DVAR assimilation. The purpose of this OSE was to remove all the YOPP extra radiosondes in order to retrieve the number of sounding data used during "normal" year (not YOPP). Unfortunately, all the extra radiosondes have been localized at the existing sites, so it was "only" an increase of the frequency, not a real change in terms of spatial coverage. The presentation briefly described the ARPEGE-SH configuration and then showed some impact in the assimilation cycle with some focus on supersite and specific events. The impact on the forecast quality against observations and ECMWF analysis was discussed.
The added radiosondes during YOPP improved the assimilation cycle with a better observational guess. The improvement on the forecast skill is significant on the temperature and wind against radiosondes, however and unfortunately only up to 12 hours lead time. Nevertheless, against ECMWF IFS (Integrated Forecasting System) analysis, the positive impact is smaller but still statistically significant.

David Bromwich from **Byrd Polar and Climate Research Center, The Ohio State University, USA** presented the results of data denial experiments for the YOPP-SH summer SOP using AMPS-Polar WRF. Working with the Antarctic Mesoscale Prediction System (AMPS), observing system experiments (also known as data denial experiments) have been conducted for the summer SOP of the YOPP-SH. The focus has been on three periods:

November 16 to December 7, 2018; January 1-17 and February 1-15, 2019. For each period, three days of regional cycling assimilation in steps of 6 hours are followed by a three-day forecast for each 0000 UTC. Two runs have been completed: SOP (targeted simulation with extra radiosondes) considers all conventional and satellite radiance data while NoSOP (targeted simulation without extra radiosondes) denies the extra radiosonde ascents obtained during the SOP but retains all other meteorological information. SOP and NoSOP forecasts are compared with surface and upper air observations to determine the additional forecast skill imparted by the additional SOP radiosonde ascents. Temperature forecasts are most improved followed by wind speed forecasts. Relative humidity forecasts are not consistently impacted. Next SOP and NoSOP forecasts are compared with ERA5 global reanalysis fields, taken to be an approximation to reality. This comparison provides a much broader view of the forecast performance than just at the observation sites and demonstrates that the additional forecast skill for temperature and wind speed tends to be confined to Antarctica but persists throughout the 72-hour forecast period. The impact on the relative humidity forecasts extends well north of Antarctica. Implications of these results for planning the winter Targeted Observing Periods in 2022 were also discussed (Fig. 1).

The data denial experiment showed the impact the extra radiosondes have on the forecast. At almost every level on average, the SOP forecast was better in terms of mean absolute errors than NoSOP. Furthermore, the additional radiosondes south of 60°S had a much stronger forecast improvement compared to the effect north of 60°S. Therefore, more radiosondes are needed at lower altitudes to better constrain the forecast. Unfortunately, there are not many sites in that region. A possible solution of having autonomous sailboats equipped with meteorological sensors was entertained.

Irina Gorodetskaya from the **University of Aveiro, Portugal** delivered a presentation on Atmospheric Rivers (ARs) at the Antarctic Peninsula during the summer YOPP-SH special observing period, as well as their impacts on clouds and precipitation. The ARs are elongated narrow corridors of intense moisture transport forming in subtropical and mid-latitude regions and associated with extra-tropical cyclones. Poleward-directed ARs reaching Antarctica can cause both extreme precipitation and major melt events. This presentation demonstrated the added value of assimilating more frequent radiosonde observations in improving weather forecasts during ARs, using the Polar-WRF model.

The study focuses on the Antarctic Peninsula, because significant ice mass loss / stronger increase in ice discharge has been observed there. In order to reach a better understanding, additional radiosondes at Punta Arenas and King George Island were released during Atmospheric River events. One of the key conclusions of the study was that the surface mass balance of the Antarctic Peninsula can be especially sensitive to Atmospheric River events during summer, when the surface temperatures vary around zero and frequent transitions occur between snow and rainfall.

Sergi Gonzales from **AEMET, Spain** presented an analysis of the 16 February 2016 windstorm on South Shetland Islands and assessment of the short-range predictability of the event. Despite the improvement of atmospheric models, weather forecasting in the Antarctic Peninsula is still a scientific and technological challenge. Therefore, it is important to assess the ability to forecast high impact events. This study conducted a prospecting analysis of the short-range predictability of this windstorm using a subset of the convection-permitting ensemble prediction system AEMET-γSREPS with four different regional mesoscale models. As main result related to the predictability it has been found that the four models grouped into two different cyclone paths with different consequences on Juan Carlos I station. This implies low short-range predictability for this high-impact event.

Ricaud Philipe from the **CNRM, France** gave a presentation on supercooled liquid water (SLW) clouds, remotely observed and analyzed above Dome C, Antarctica and future in situ observations. A comprehensive analysis of the water budget over the Dome C (Concordia, Antarctica) station has been performed during the summer 2018-2019 as part of the YOPP international campaign. Thin (~100-m deep) SLW clouds have been detected and analyzed using remotely sensed observations, at the station (LIDAR, microwave radiometer HAMSTRAD, net surface radiation from BSRN, radiosondes) and on satellite (CALIOP LIDAR) combined with a specific configuration of the NWP model ARPEGE-SH. Two case studies were presented. On 24 December 2018, the atmospheric planetary boundary layer (PBL) evolved following a typical diurnal variation, with the SLW clouds observed at the top of the PBL. The second case study took place on 20 December 2018, when a warm and wet episode impacted the PBL with no clear diurnal cycle of the PBL top. The amount of liquid water measured by HAMSTRAD was ~20 times greater in this perturbed PBL than in the typical PBL. In both cases, ARPEGE-SH was not able to accurately reproduce these SLW clouds. The discrepancy between the observed and calculated net surface radiation reached +50 W m^{-2}. The model was then run with a new liquid water partition function and was able to generate SLW clouds on 24 December 2018. In the near future, in situ observations of SLW clouds will be performed by means of SLW probes attached to meteorological radiosondes (summer 2021-2022) and aboard a light remotely-piloted aircraft system (summer 2022-2023).

This presentation also discussed the future plans:
1. December 2021 to January 2022: 20x SLW/UWC sondes attached to regular sondes on balloons.
2. December 2022 to January 2023: SLW/UWC sondes on board light remotely piloted aircraft (Drones); 10x SLW/UWC sondes attached to regular sondes on balloons.
The project demonstrated that supercooled liquid water clouds can be detected by combining observations from HAMSTRAD (IWV, LWP) and the LIDAR. In-situ observations of supercooled liquid water clouds are planned for the near future.

Xichen Li from **Institute of Atmospheric Physics, Chinese Academy of Sciences, China** gave a presentation on the evaluation of the present Antarctic Weather Station Network for monitoring the intra-seasonal to decadal climate variability. In recent decades, hundreds of weather stations and automatic weather stations have been set up over the Antarctic, which provides great potential in improving the quality of the observations of climate variability on intra-seasonal to decadal time scales, and may largely improve the weather prediction skill around Antarctica. However, it is seen that the present Antarctic atmospheric reanalysis and observational datasets still suffer from large uncertainty, partially due to the limited usage of the weather station observations in producing these reanalysis datasets. On the other hand, the site selection of the present weather stations network highly depends on the logistic issues. It is thus very necessary to evaluate the present Antarctic observational network. In this study, an Ensemble Kalman Filter-based method is used to evaluate the present weather station and automatic station network in monitoring the intra-seasonal to decadal variabilities around Antarctica. In particular, we focus on the ability of the present network in observing the surface temperature and sea level pressure around Antarctica on different time scales. Results show that a sub-set of present networks with about 100 stations will be good in constraining the uncertainties in the observational dataset, while several new stations over Central Eastern

Antarctica and the coastal region of the West Antarctic will help to further improve the quality of the observations.

The evaluation of the present Antarctic Weather Station Network was mainly motivated by the uncertainty in satellite observations. The greatest uncertainties are around the coastal regions and the Southern Ocean. In-situ observations may well constrain the uncertainties over inland Antarctica.

Daniela Liggett from **University of Canterbury, New Zealand** summarized the Polar Prediction Project on Societal and Economic Research Applications (PPP-SERA) achievements, including the special issue of Polar Geography and a synthesis paper that is being prepared. Daniela's conclusions were:

- Need to establish connections and trust between providers and consumers of WWIC (Weather, Water, Ice and Climate) information.
- Need to align the space and time scales of WWIC services with user needs.
- Service means relevant content in a transferable format.
- Emphasis of user services is on risk reduction. Uncertainty is a key aspect.
- Further research is needed across disciplines and regions as actors change.

Daniela was asked whether better bandwidth would help. Answer: Yes. More timely. Less costly. Higher resolution information could be provided.

4. National Contributions to Winter SOP.

Tamaryn Morris from **South African Weather Service** talked about the South African plans for the winter SOP in 2022. The South African Weather Service (SAWS) maintains upper-air stations on two sub-Antarctic bases; Marion and Gough Island, the latter of which is leased from the United Kingdom. In addition, SAWS undertakes upper air ascents from its state-of-the-art ice-breaker, the S.A. Agulhas II. Provisional plans for the Year of Polar Prediction (YOPP) work for South Africa will focus primarily on upper air ascents from the vessel, given the location further north of the sub-Antarctic bases to be of relevance. The vessel does change-over voyages to Antarctica from December to January each year, and when possible, research cruises to the sea-ice edge during winter months, given the current global pandemic.

At Gough Island and Marion Island they do two ascents per day (noon and midnight UTC). As part of their research program, they operate a research icebreaker which is equipped with a balloon room (Ozone sondes and upper air). The accepted SAPRI (South African Polar Research Infrastructure) for 2022 to 2023 includes measurements from Marion Island (April-May), Gough Island (September-October), SANAE IV (December-February), the SEAmester Training Cruise (a training cruise for students in July) and the Winter Cruise to the marginal ice zone where they will be able to do additional upper air sondes and synoptic observations (July-August). If the additional sondes and balloons can be sourced, there may be four ascents per day on the island bases for dedicated periods of time. Another option would be to decrease or cease the upper air ascents to conduct data starvation studies. Both variants are possible on the research and take-over voyages as well.

Phillip Reid from the **Australian Bureau of Meteorology** talked about an anticipated regional coupled model that is centered on Antarctica and nested within the global coupled model. It will be available as a research version in mid-2023, data assimilation is not anticipated initially. An atmosphere-only version will probably be available for the YOPP-SH winter SOP. There will be extensive measurements with the emphasis on clouds and precipitation, with a profiling VHR radar operating at Davis Station. All stations will launch an additional radiosonde each day during the TOPs with a preference for atmospheric river events. The normal schedules for Casey, Davis and Macquarie Island are two times per day, while Mawson is once per day. Their forecasting team will help identify TOPs and perform case studies. Operational aspects will be investigated. Extensive measurements, such as a profiling VHR radar, will be operating at Davis. Emphasis is on clouds and precipitation.

Naohiko Hirasawa from **National Institute of Polar Research, Japan** presented the Japanese plans for observation and research during the YOPP-SH TOPs in 2022: Syowa launches two radiosondes per day (00 and 12 UTC) and additional ones at 06 and/or 18 UTC during TOPs. 40-60 sondes were allocated for this purpose. The AWS measurements every 3 hours continue as normal. For the TOPs they will conduct modeling experiments that look at the impact on precipitation forecasts when there is an increase in radiosondes. Their research interests are snowfall estimation and examining the synoptic and local impacts. At Syowa station a X-band radar, a Disdrometer and a Ceilometer will take measurements. On a transect from the coast to Dome Fuji, AWSs with acoustic depth gauges will be installed.

Adrian McDonald from **University of Canterbury, New Zealand** presented the New Zealand plans for the winter SOP in 2022: Their focus of interest will lie on clouds and aerosols. At Scott Base they operate a Microrain radar and a ceilometer. There will be a lot of measurements at Invercargill as well, including a Micropulse Lidar, additional radiosonde launches during TOPs (added launches at 06 and 18 UTC, making it four times per day with the already scheduled launches at 00 and 12 UTC; 60 sondes are available) and Lidar backscatter profiles that can be made available in near-real time. Sea ice mass balance studies will take place at Scott Base. There will be a resupply voyage in mid-January-February to the vicinity of Scott Base with the return in early March. During the resupply there is the possibility to do radiosonde launches. Unfortunately, the set-up of the equipment may be delayed beyond the start of the SOP to June 2022.

Sang-Jong Park from **Korea Polar Research Institute** presented the Korean contribution to the YOPP-SH winter TOP. On the King George Island, there will be one additional radiosonde launch per day from the King Sejong station during TOPs. There are 70 available radiosondes, and they are planned to release for 18 UTC. At the Jang Bogo station, there are 25 radiosondes available, and the plan is to make one launch per day at 00 UTC in March 2022. If necessary, more radiosondes can be provided. At King Sejong station surface meteorology measurements will contribute to the GTS three times per day, a visibility sensor will be added around February 2022. If Chile blocks entry in the summer 21/22 due to COVID-19, there will only be a deployment of an overwintering team by IBRV and ARAON without summer visitors, so on-site training might be compromised. **Sang-Jong Park** will visit both stations.

Jordan Powers from NCAR, **Matthew Lazzara** from **the University of Wisconsin Madison & Madison College Department of Physical Sciences, Arthur Cayette** from **Naval Information Warfare Center** and **David Bromwich** from **Byrd Polar and Climate Research Center** introduced the US contributions and plans for the YOPP project.

- **David Bromwich** told everyone that after YOPP and the International Coordination Office complete their work in December 2022, the coordination until the end of YOPP-SH in December 2024 will be supported out of the Byrd Polar and Climate Research Center. The plan is to hire one or more part time staff to facilitate the coordination. There will be regular virtual meetings with the emphasis on facilitating research through special journal issues and special sessions at major scientific meetings like AGU, EGU. The plan is to track publications and maybe continue YOPP endorsement.

- **Matthew Lazzara** talked about running the AMRDC (Antarctic Meteorological Research and Data Center) and the Antarctic Automatic Weather Station (AWS) network. He mentioned some highlights, which were that a new website will be operational soon, the data collection and archiving has resumed and has formed a formal data repository which focuses on Antarctic weather and climate. Real-time data distribution via the Antarctic-IDD is underway as well. The AWS program will have limited personnel in the field in 2021-2022 because of the pandemic restrictions and site visits will concentrate around McMurdo and in West Antarctica. A new data server will be installed at McMurdo via AMRDC funding.
- **Arthur Cayette** followed up on operational aspects. There are 45 radiosondes planned to be launched from the McMurdo station in support of the YOPP-SH winter TOPs. An alert system for significant weather events expected to affect McMurdo station may be established under the direction of Chief Meteorologist **Joey Snarski**. Staffing challenges will be experienced for the 2021-2022 austral summer because of pandemic travel restrictions through New Zealand. Automation will be stepped up as a result especially for the main observation location (Building 165), and hourly METARs will be produced.
- **Jordan Powers** informed about the Antarctic Mesoscale Prediction System (AMPS), which stands ready to provide forecast products and perhaps tailored prediction windows as requested for YOPP-SH TOPs. The AMPS personnel will also take part in the forecast team for the greater Ross Sea.

Victoria Heinrich from **University of Tasmania, Australia** talked about the Social Science Weather Decision Project for YOPP-SH Winter TOPs. This is a unique opportunity to examine weather decision-making, information use, and outcomes across an international research program and multiple stakeholders. She aims to examine the forecast and research teams' go/no go decisions to release additional radiosondes, or not, for each TOP weather event.

Open Discussion of the Forecasting Team for Greater Ross Sea and East Antarctica
First the members of the team were revisited. **Michele Hollister** and **Scott Carpentier** from Australia and perhaps others were identified. Their interest will have a preference for the Australian Antarctic stations, but the entire forecast domain will be considered. A sea ice analysis can be provided by Australia and how the sea ice cover is affected by the major synoptic events. NIWC personnel will focus on the Ross Sea region and a formal alert system for imminent significant weather events will be established. **Matthew Lazzara, Jordan Powers**, and **David Bromwich** will participate. Italy expects to participate, with details to be confirmed.

Next discussion turned to how the team might operate and the need to lay out the structure. A plan is needed, and **David Bromwich** agreed to prepare this. This will define the events to be targeted, the forecast products needed, the division of responsibilities, the lead time to call a TOP, and have a process-oriented approach. It was pointed out that past atmospheric experimental campaigns (e.g., THORPEX) can provide valuable guidance for executing the TOPs. The team will be an online discussion group perhaps meeting twice a week. At least one dry run was agreed as a useful planning exercise. One possibility is Winfly that takes place in early August and executes five C-17 flights into McMurdo Station. Depending on the weather, this can take one to several weeks. Winfly wants good weather conditions to land the planes safely and efficiently whereas we are targeting inclement weather.

End of Evening Session of Day 1

Day 2, Day session

Irina Gorodetskaya from **University of Aveiro, Portugal** talked about the Portuguese Polar Program, which links Punta Arenas (Chile) and King George Island in Antarctica with flights. The PROPOLAR flights are a contribution to the international logistics in the Antarctic Peninsula, supported by 62 scientists and technicians from PROPOLAR and six other partner programs. The project APMAR – Antarctic Peninsula precipitation and surface Mass balance is trying to figure out the role of Atmospheric Rivers and the project TULIP (Towards a better Understanding of the link between cloud microphysics and precipitation during warm air intrusions north of the Antarctic Peninsula) are both PROPOLAR projects. Project APMAR (PROPOLAR) includes a Micro-rain radar MRR2 (Installation Jan-Feb 2022) and 15 radiosondes during ARs in the summer. Project TULIP (PROPOLAR) includes 30 radiosondes during winter TOPs (20 via the French ARCA project, 10 via the Portuguese project), 10 Anasphere cloud SLWC (possible additional LWC-NSF project pending) and precipitation sampling for isotopic and chemistry/biological tracers analysis (pollen, diatoms and Sr-Nd isotopes in dust). Project ATLACE (funded by portug. FCT) will analyze atmospheric rivers with a focus on aerosol-cloud-precipitation interactions. Measurements by other countries (existing collaborations) will be used in the analysis (Instruments at Escudero by USACH Chile, Radiosondes and surface meteorology at King Sejong S. Korea, Precipitation measurements and meteorology at Vernadsky Ukraine).

Raul Cordero from **Universidad de Santiago, Chile** gave a talk on the Chilean Contribution to YOPP Special Observing Period (SOP) during Austral Winter 2022. Given the strong interest in conducting Antarctic fieldwork outside austral summer, Chile will contribute to the YOPP-SH Special Observing Period (SOP) by launching radiosondes for atmospheric profiling and conducting atmospheric radiation measurements on King George Island (at the northern tip of the Antarctic Peninsula), as well as by running the Polar Weather Research and Forecasting model (PWRF) over the Antarctic Peninsula region. The field experiments will begin in early 2022 or late 2021 and will extend until the end of the YOPP-SH SOP-2022 (in the late fall and early winter in 2022) allowing us to monitor and provide insights on atmospheric river events that often touchdown on the Antarctic Peninsula, and on major Southern Ocean cyclones that frequently impact the Antarctic regions. Through the measurements and analysis, Chile will support explorations of Antarctic atmospheric predictability at the beginning of the austral cold season when the southern sea ice cover is rapidly expanding. This study will build a better understanding of the interplay between the atmosphere, clouds and the surface radiation budget over the Antarctic Peninsula and the Southern Ocean.

Precipitation has surged at King George Island. There is a Lidar to track for example super cooled droplets. The station is sometimes in the Ozone Hole, sometimes outside of it. They are normally launching radiosondes for the GTS already and will add an extra 100. They will provide forecast modelling during the campaign by Chilean weather forecast Meteo Chile. Staff capacity at the station is not the problem, but funding is. They try to extend to mid-July that is end of SOP. There will be 30 radiosondes from Irina, ~100 at Escudero, and some additional contribution from Korea. Nothing is planned for Punta Arenas yet. Korea will have launches at noon UTC, and Escudero will have launches at midnight from March to Mid-July (100 Days)

Tom Lachlan-Cope from **British Antarctic Survey, UK** delivered a presentation on British Antarctic Survey activities during the SH winter SOP. During the 2021/22 Antarctic season the British Antarctic Survey will deploy new instruments to observe aerosol and cloud at Rothera Station on the Antarctic Peninsula. The new observations made at this site will include the physical and chemical properties of aerosols (including whether they will act as cloud nuclei) and LiDAR measurements of clouds. These measurements will largely be continuous, but it is planned that extra filters will be collected during atmospheric river events. As well as these additional measurements the existing series of surface-based observations and radiosondes will continue with extra radiosondes being flown when requested. As well as the aerosol observations made at Rothera some limited aerosol measurements will be taken at Bird Island during the 2022 winter.

In detail, extra radiosondes will be launched during TOP's, particularly during the occurrence of atmospheric rivers. Micropulse lidar for cloud observations. Next season is the first one of the full 3 Year Project. Long term measurements in next 3 Years. Instruments will be moved around. Extra observations as part of Southern Ocean cloud project. **Steve Colwell** mentions constraints are staff capacity.

Vito Vitale from **CNR Institute of Polar Sciences (ISP), Italy** gave a talk on Italian contribution to YOPP-SH winter 2022 special observing period. The plan discussed at Italian level was presented. Considering that a better representation of cloudiness conditions and precipitation events (in particular Atmospheric Rivers) are key targets of the science plan for YOPP-SH Special Observing Period (SOP) in winter 2022, Italian contribution will focus on improving knowledge of the atmospheric water budget over Antarctica, its seasonal behavior and vertical distribution, and its accurate representation in models. For this purpose, we will connect extra activities during the winter SOP period to a coordinated plan extending from summer 2021 to summer 2022. Our attention will concentrate, in particular, on the role of supercooled liquid water (SLW) clouds, and their effects on the radiation budget, and precipitation events. Extra soundings with standard as well as LWC sondes and connection/upgrade of ongoing and planned ground-based observations related to these topics at the two sites of Dome C and Terra Nova Bay (TNB) will provide new and more integrated datasets (up to 30 launches), with a focus on SLW clouds. The possibility to collect observations at a coastal site and an interior site 1000 km away from each other, and should allow evaluation of the accuracy of current models at the synoptic scale. At the same time, the plan to improve winter observations and better connect them with already planned summer activities should provide a unique opportunity to better understand the water budget behavior during the entire year.

Eric Bazile from **Meteo-France and IPEV** delivered a presentation on Meteo France and IPEV contributions for the YOPP-SH winter of 2022. Additional observations will be launched at Kerguelen at 12UTC, which has up to 20 additional radiosondes. Dumont D'Urville currently has a radiosonde launch only at 00UTC. For TOP period, two additional radiosondes will be launched at 06 and 12UTC. Also, the new AROME-Arctic model will update the forecast from 5km horizonal resolution to 1.5km.

Open Discussion of Forecast Sensitivity to Observations (FSO) Experiments for Winter TOPs

Discussion led by **David Bromwich** and **Eric Bazile**. A robust discussion of FSO and the challenges of implementing in the WRF framework by Ohio State took place with the test case being passed but some current computer issues remain to be solved for practical applications. The relationship between FSO and data denial experiments was discussed with the former being recognized as providing a quantitative impact of different observation types versus a forecast metric whereas data denial looks directly at the forecast impact of the denied observations but is less quantitative. Identification of regions of fastest growth of forecast errors was discussed by Eric Bazile for the Arpege global forecast system. It was concluded that quite some effort is needed to fully implement these forecast tools for the YOPP-SH winter SOP.

Svitlana Krakovsk from **NASC, Ukraine** gave a talk on planned activity for YOPP-SH winter SOP at the Ukrainian Antarctic Station Akademik Vernadsky. Ukrainian Antarctic station Akademik Vernadsky (UASAV) is situated at the western side of the Antarctic Peninsula and has a good location for study, such as orographic enhancement of precipitation, katabatic winds from the continent, sea-ice formation and movement with ocean currents, atmospheric aerosols in pristine environment, etc. In the last few years, meteorological measurements at UASAV were extended and new equipment was installed, such as automatic weather station Vaisala PWD-22, radar precipitation sensor Luft WS-100, and Micro Rain Radar Pro (MRR-Pro). We plan to start regular radiosounding in early 2022 once per day and will contribute to the YOPP-SH winter Special Observing Period (SOP) by more frequent launching of radiosondes. We consider the possibility to launch ozone layer sondes once per month when regular Dobson spectrophotometer measurements are stopped due to low sun in winter. We will coordinate our measurements with the international community and freely exchange all data with consortium participants. Our special interest is precipitation phase transition in and under clouds particularly during extreme weather events such as atmospheric rivers. Numerical simulation with Polar WRF and other models suitable for cloud and precipitation formation study are planned to implement as well.

Adriana Maria Gulisano from **IAA/DNA, IAFE (UBA-CONICET), DF FCEyN UBA**, **Argentina** gave a talk on study of the variability of temperature and ozone in the lower-middle stratosphere of the Antarctic Peninsula during disturbed Dst periods. Geomagnetic storms are caused by solar and interplanetary events that generate disturbances in various regions of the terrestrial space environment; these events can last hours or days. Magnetospheric substorms are episodes of transport and dissipation of energy in the ionosphere and the magnetosphere, with duration of 10 minutes to 3 hours, and are much more frequent than geomagnetic storms. The aim of this work is to study the variability of temperature and ozone profiles in the lower-middle stratosphere of the Antarctic region during severe weather events. Vertical profiles of these atmospheric parameters are analyzed at the Marambio station, among solar cycles 23 (1998-2008) and 24 (2009-2018). The data are obtained by ozone-radio soundings, which are provided by the National Meteorological Service of Argentina and the Meteorological Institute of Finland. **Adriana Maria Gulisano** suggested more soundings are needed to understand the link between space weather and high layers of the atmosphere.

Forecasting team and measurement planning of targeted observing periods at the Greater Antarctic Peninsula region during the winter YOPP-SH 2022

Irina Gorodetskaya from **University of Aveiro, Portugal** talked about forecasting team and measurement planning of targeted observing periods for the Greater Antarctic Peninsula region during the winter YOPP-SH 2022. The Antarctic Peninsula (AP) region is a hotspot of climate change showing air temperature warming greater than the global average and a significant increase in precipitation. However, there is a significant discrepancy between observations and models in capturing these trends. Operational forecasts also show a rather low predictability skill for the AP and entire Antarctica. Winter YOPP-SH is an international initiative that aims to consolidate efforts of many countries at conducting enhanced observations during several Targeted Observing Periods (TOPs) focusing on key atmospheric and oceanic phenomena, including extreme events, in a regional approach. Winter YOPP-SH initiative is challenging and unique as it encompasses a range of scientific interests, while relying on limited resources and personnel during winter. Thus, it requires developing a specific strategy and forecast-measurement protocols, which we propose to establish and test during a dry run in July 2021 to be used during the YOPP-SH winter TOPs in 2022. During the workshop, organization of a dry run for the AP (and in connection with other regions) was discussed and planned with all interested parties, with a purpose of identifying existing forecasting capabilities aiming at the various phenomena of interest, combining information about measurements (including long-term monitoring and extra radiosondes and other enhanced measurements during TOPs from stations and ships), and ways of communication between the forecast and measurement teams and with other regions. During the discussion, **Irina Gorodetskaya** raised the questions: 1) What do we want to measure together? 2) how do we maximize understanding of processes and improving forecasts with limited resources? A Dry Run was also discussed at the end of this talk. **Raul Cordero** mentioned that students are willing to do additional launching at Escudero for the Dry Run.

Open Discussion of the Forecasting Team for the greater Antarctic Peninsula and the Weddell Sea

Irina Gorodetskaya from the **University of Aveiro, Portugal presented an overview of the issues. Following are some key points:**

Forecast Resources Available

- Global model output that is freely available like from ECMWF and NCEP.
- **Sergi Gonzalez** can request dashboard capability from ECMWF that provides meteograms and forecast uncertainty from their ensemble prediction system.
- Regional high-resolution ensemble for the Antarctic Peninsula from Sergi Gonzalez. Question about free access.
- Antarctic Mesoscale Prediction System (AMPS) 2.7 km grid predictions covering the Antarctic Peninsula. Open access.
- Local station forecasts like from the Chilean Weather Service.

Science targets

- Cyclonic activity, atmospheric rivers, precipitation, fog and low cloud, gravity waves, sea ice prediction (SIPN-South).
- Most or all are linked together, so multiple aspects can be covered during one event.

Some questions:

- How should these be organized? One per month during March-July?
- Have two groups with different interests with the first group focusing on the early SOP and the second the later SOP?
- An atmospheric river event was presented as an example. ARs have widespread major impacts (melting, rainfall, and high winds) so could be sampled by many stations.
- What should be measured together to maximize the understanding of the processes and to improve the forecast models?
- Could focus on those forecast events that have the greatest uncertainty?

Dry run soon to focus on the tasks to be undertaken

- Simulate the measurement campaign. Identify who is available to participate. Routine forecasting to be undertaken. Set up an online discussion group for the Antarctic Peninsula.
- *Comments from **Vito Vitale**:* Need to identify which scientific and operational aspects are of most interest. Planning can only help to a certain extent given how different periods can be. Be adaptive.
- *Comments from **Sergi Gonzalez***: Best to have TOPs throughout the SOP, April-July. Who makes the final decision for calling a TOP?

General Discussion

- Best if a group decision with consensus to call a TOP.
- Decide the roles of involved individuals.
- Standard protocol is desirable to initiate the TOPs with decision points.
- It is recognized that this is a challenging undertaking.
- Possibility that not all radiosondes will be used.
- Need to rank the topics to ensure the most interesting get sampled.

How will radiosondes be released?

- Constraints: Personnel and number of radiosondes are limited. Further there are wind speed limits for launches for safety reasons, and there are limits to the work hours for some stations.
- Most stations can release 1-2 soundings per day.
- King George Island with Escudero (Chile) and King Sejong (Korea) stations offers the possibility of say every 6 hours. Uncertain whether the radiosondes available will be routinely released with some enhancement during TOPs or a big push during the TOPs. Also uncertain is the mix between regular radiosondes and those measuring supercooled liquid water amounts.

***Summary*:**

- The greater Ross Sea group will use the upcoming early August Winfly (4 C-17 jets into McMurdo to start the field season) to practice and understand the forecast team effort needed for that region. Another effort for East Antarctica will likely be organized for a later date when all key personnel are available.
- The greater Antarctic Peninsula and Weddell Sea will undertake a dry run in the near future with the "when", "how", and "targets" to be decided soon.

5. Summary

The 6th Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) Meeting was held online, hosted by Polar Meteorology Group at Byrd Polar and Climate Research Center, The Ohio State University. This meeting provided scientists great opportunities to update their research achievements from YOPP summer Special Observing Period (SOP) in the Southern Hemisphere (November 16, 2018 to February 15, 2019). Also, the plans for the upcoming winter SOP in 2022 were highlighted. Figure 1 shows all extra radiosondes that are now scheduled for the winter SOP, and more might be added later this year. Compared to the summer SOP, more sites from lower latitude are included to provide better coverage over Antarctica, especially upstream of extreme weather events.

End of Conference

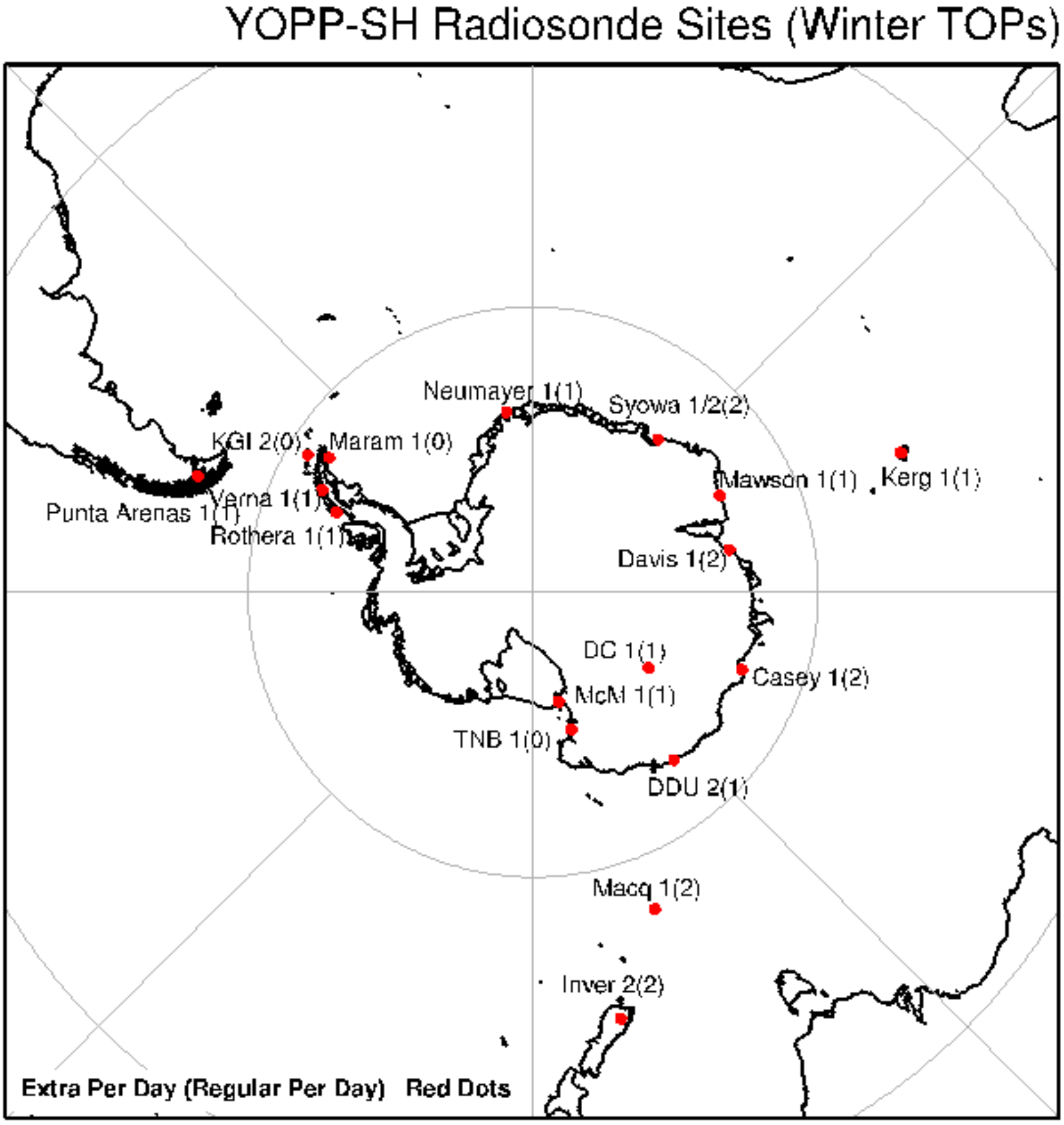

Figure 1. Plans for Winter TOP launches as of August 15, 2021.

Table 1. YOPP-SH, List of attendees

NO.	Last name	First name	Country
1	Alexander	Simon	Australia
2	Almeida da Silva Ferreira	Larissa	Brazil
3	Andersson	Tom	UK
4	Arndt	Stefanie	Germany
5	Bai	Lesheng	USA
6	Baldini	Luca	Italy
7	Bazile	Eric	France
8	Bozkurt	Deniz	Chile
9	Bracci	Alessandro	Italy
10	Bracegirdle	Tom	UK
11	Bromwich	David	USA
12	Carpentier	Scott	Australia
13	Cayette	Arthur	USA
14	Chen	Thomas	USA
15	Chenoli	Sheeba	Malaysia
16	Choi	Yonghan	South Korea
17	Colwell	Steve	UK
18	Cordero	Raul	Chile
19	Dare	Richard	Australia
20	Dattore	Bob	USA
21	Di Natale	Gianluca	Italy
22	Dick	Kirsty	Scotland
23	Ekrami	Negar	Portugal
24	Essary	Falon	USA
25	Favier	Vincent	France
26	González	Sergi	Spain
27	Gorodetskaya	Irina	Portugal
28	Gossart	Alexandra	New Zealand
29	Grazioli	Jacopo	Switzerland
30	Grumbine	Robert	USA
31	Gulisano	Adriana Maria	Argentina
32	Gulli	Paul	USA
33	Guyot	Adrien	Australia
34	Hafner	Jakob	Germany
35	Heil	Petra	Australia
36	Heinemann	Günther	Germany
37	Heinrich	Victoria	Australia
38	Hines	Keith	USA
39	Hirasawa	Naohiko	Japan
40	Hollister	Michelle	Australia
41	Hwang	Hyewon	South Korea
42	Inoue	Jun	Japan

43	Johnson	Cassidy	USA
44	Johnson	Michael	USA
45	Keller	Linda	USA
46	Kim	Seong-Joong	South Korea
47	Kirchgaessner	Amelie	UK
48	Koppanyi	Harry	USA
49	Koudelka	Ethan	USA
50	Krakovska	Svitlana	Ukraine
51	Kristiansen	Jørn	Norway
52	Kuye	Akin	UK
53	Lachlan-Cope	Tom	UK
54	Lazzara	Matthew	USA
55	Li	Xichen	China
56	Liggett	Daniela	New Zealand
57	Liu	Zhengyu	USA
58	Luís	Diogo	Portugal
59	Lynds	Jamie	New Zealand
60	Manning	Kevin	USA
61	Mansilla	Gonzalo	Chile
62	Marin	Julio	Chile
63	Marincovich	Giselle Lujan	USA
64	Massonnet	François	Belgium
65	McDonald	Adrian	New Zealand
66	McFarquhar	Greg	USA
67	Meyer	John	USA
68	Michael	Bob	USA
69	Milne	Peter	USA
70	Mikolajczyk	David	USA
71	Moffat-Griffin	Tracy	UK
72	Morris	Tamaryn	South African
73	Motoyama	Hideaki	Japan
74	Mounier-Vehier	Alice	Portugal
75	Mullenax	Robert	USA
76	Nasar-u-Minallah	Muhammad	Pakistan
77	Nicholson	Ruanui	New Zealand
78	Nie	Yafei	Finland
79	Norton	Taylor	USA
80	Onsi	Bella	USA
81	Rodriguez Imazio	Paola	Argentina
82	Park	Sang-Jong	South Korea
83	Philippe	Ricaud	France
84	Pilson	Gaby	N/A
85	Pishniak	Denys	Ukraine
86	Pletzer	Tamara	New Zealand
87	Powers	Jordan	USA

88	Radenz	Martin	Germany
89	Ramugondo	Ntanganedzeni	South Africa
90	Reid	Phil	Australia
91	Reusch	David	USA
92	Richter	Maren Elisabeth	New Zealand
93	Rodriguez Imazio	Paola	Argentina
94	Roff	Greg	Australia
95	Rowe	Penny	USA
96	Scardilli	Alvaro	Argentina
97	Seo	Wonseok	South Korea
98	Smith	Patrick	USA
99	Snyder	Hannah	USA
100	Spago	Sofia	Argentina
101	Sutherland	Dave	USA
102	Swart	Sebastiaan	Sweden
103	Torres	Christian	Brazil
104	Uotila	Petteri	Finland
105	Vichi	Marcello	South Africa
106	Vitale	Vito	Italy
107	Wang	Sheng-Hung	USA
108	Welhouse	Lee	USA
109	Werner	Kirstin	Germany
110	Wille	Jonathan	France
111	Zou	Xun	USA