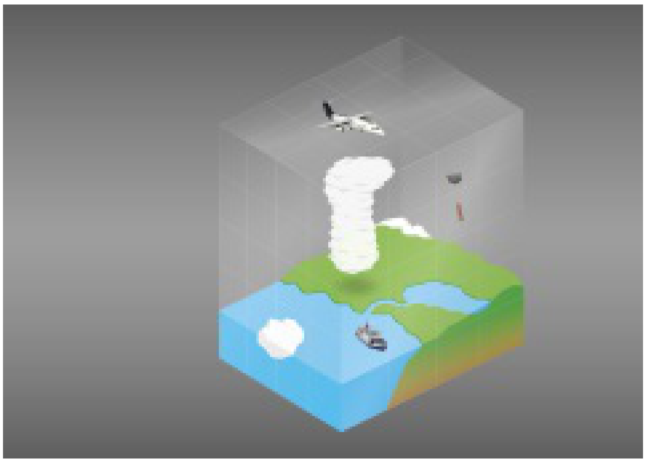
Workshop: Observational campaigns for better weather forecasts



Report of Contributions

Contribution ID: **1** Type: **Oral presentation**

Improving NWP models with observations from the Iceland Greenland Seas Project

Wednesday, 12 June 2019 14:00 (30 minutes)

The Iceland Greenland Seas Project (IGP) is a coordinated atmosphere-ocean research program investigating climate processes in the source region of the densest waters of the Atlantic Meridional Overturning Circulation. During February and March 2018, a field campaign was executed over the Iceland and southern Greenland Seas that utilized a range of observing platforms to investigate critical processes in the region –including a research vessel, a research aircraft, moorings, sea gliders, floats and a meteorological buoy. A remarkable feature of the field campaign was the highly-coordinated deployment of the observing platforms; the research vessel and aircraft tracks were planned in concert to allow simultaneous sampling of the atmosphere, the ocean and their interactions. Here we use some of these observations to evaluate the quality of a number of numerical weather prediction forecasts, analyses and reanalyses. In particular we make use of low-level aircraft observations where bulk and turbulent atmospheric variables are available. A coupled evaluation, using boundary-layer observations from both the atmosphere and ocean is underway.

Primary authors: RENFREW, Ian (University of East Anglia); Dr ELVIDGE, Andy (UEA)

Presenter: RENFREW, Ian (University of East Anglia)

Session Classification: Polar processes - Chair: Jonathan Day

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **2** Type: **Oral presentation**

FESSTVaL: Field Experiment on sub-mesoscale spatio-temporal variability in Lindenberg

Tuesday, 11 June 2019 12:20 (20 minutes)

Numerical weather prediction (NWP) models applied on regional scales use a typical grid spacing of O(1 km). While such a grid spacing allows to start explicitly resolving convection - at least deep convection - several features of the flow remain of subgrid-scale nature, e.g. turbulence, shallow convection, or may be distorted by the coarse grid spacing. Large-eddy simulations (LES) with grid spacing of at least O(100 m) can be used to get more information on smaller-scale, generally under-resolved, phenomena. But such simulations also rely on parameterizations, most notably turbulence and microphysics. Getting information on the atmospheric flow on scales O(500 m) from observations remains challenging as the measurement network lacks the spatial resolution. For instance automatic measurement stations of the German Weather Service (DWD) have a typical horizontal distance of O(25 km). This makes the validation of NWP models and LES difficult.

We present the plan for the field campaign FESSTVaL, which deploys a high-density measurement network that will allow us to observe features of the atmospheric flow occurring on scales between 500 m and 5 km. The measurements will be used to (i) improve our process understanding, (ii) validate aspects of convection permitting NWP simulations and (iii) compare different measurement strategies and instrument types, including a citizen science approach and newly available satellite observations, in view of designing appropriate measurement networks of the future. Finally, in addition to the measurements, various simulations will be performed in support of the field campaign and for validation purposes.

With respect to the source of submesoscale variability, the measurement campaign focuses on three different topics: boundary layer patterns, cold pools, and wind gusts. The four topics are inter-connected via cold pools, which both generate boundary layer patterns and wind gusts. Furthermore, usability of citizen-science-based measurements will be investigated. Finally, FESSTVaL will provide a first opportunity to evaluate quality and representativeness of ESA Aeolus products.

The measurement campaign will take place in Lindenberg (east Germany) for an extended summer season in 2020 in the context of HErZ (Hans Ertel Centre for Weather Research). Lindenberg is chosen given the already existing instruments, the support by DWD available on site as well as the relatively flat topography. Moreover Lindenberg experiences more frequent convective activity than many other flat regions in Germany. One particular feature of the planned field experiment is the use of about 100 ground base stations, spread over a domain with a radius of 20km around the Lindenberg observtory.

Primary author: KLOCKE, Daniel (Hans Ertel Centre for Weather Research, DWD)

Co-authors: BEYRICH, Frank; KIRSCH, Bastian; AMENT, Felix; LÖHNERT, Ulrich; BASTAK--DURAN, Ivan; RUST, Henning; WEISSMANN, Martin; GOEBER, Martin; SCHMIDLI, Juerg; WAHL, Sabrina; ANNIKA, Schomburg; SCHLEMMER, Linda; HOHENEGGER, Cathy

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Session Classification: Clouds - Chair: Irina Sandu

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **3** Type: **Oral presentation**

Application of Ensemble-based Sensitivity to ECMWF Ensemble Forecasts in Field Campaigns

Monday, 10 June 2019 16:00 (30 minutes)

Although the most popular application of ensemble forecasts is the mean and forecast standard deviation, there is substantial information within the higher moment statistics of these datasets that can be used to evaluate the dynamics and predictability of dynamical systems. In addition, these ensemble-based sensitivity methods can be used to identify locations where additional observations could change and/or reduce the variance in a forecast metric of interest, such as tropical cyclone (TC) position or rainfall. One of the advantages of this approach is that it is a computationally inexpensive post-processing application that can be quickly produced given ensemble forecast output. The goal of this talk is to provide examples of how ensemble-based sensitivity applied to ECMWF ensemble forecasts has been used in past field programs. During 2017 and 2018, experimental ensemble-based sensitivity has been used to guide where to deploy aircraft dropwindsonde locations that are meant to improve TC track forecasts. In 2019, this technique will be used to evaluate the forecast uncertainty and target locations for landfalling atmospheric rivers along the west coast of North America.

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Presenter: TORN, Ryan (University at Albany, SUNY)

Session Classification: From models to observations and back - Chair: Mohamed Dahoui

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **4** Type: **Oral presentation**

The impact of dropsonde and extra radiosonde observations from the field campaigns NAWDEX and SHOUT in 2016

Wednesday, 12 June 2019 09:00 (30 minutes)

Dropsonde observations from three research aircrafts in the north-Atlantic region as well as several hundred additionally launched radiosondes over Canada and Europe were collected during the transatlantic field campaign NAWDEX in autumn 2016. In addition, over 500 dropsondes were deployed during NOAA's SHOUT and Reconnaissance missions in the west-Atlantic basin, complementing the conventional observing network for a total of 13 intensive observation periods. This unique dataset was assimilated within the framework of cycled data denial experiments performed with the global model of ECMWF.
On average, these additional observations led to a reduction in forecast error of a few percent in a large area covering the North Atlantic and Europe. The error reduction mainly seems to be related to three particular sensitive episodes that are associated to the extratropical transitions of tropical storm Karl and hurricanes Matthew and Nicole. The forecast sensitivity to observations impact (FSOI) also exhibits largest beneficial impacts for dropsondes near tropical cyclones, followed by dropsondes over the North Atlantic and additional Canadian radiosondes.

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Presenter: WEISSMANN, Martin (DWD/LMU)

Session Classification: Tropical and extra-tropical dynamics - Chair: Andreas Schäfler

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **5** Type: **Oral presentation**

Diagnosing Forecast Sensitivity for Field Campaigns using Adjoints

Tuesday, 11 June 2019 09:30 (30 minutes)

Adjoint models can provide valuable insight into the practical limitations of our ability to predict weather systems, such as extratropical and tropical cyclones, and their associated high-impact weather. An adjoint model can be used for the efficient and rigorous computation of numerical weather prediction forecast sensitivity to changes in the initial state or an earlier point in the forecast. The sensitivity calculations can help to unravel complex instabilities and influences on extratropical and tropical cyclone evolution that occur over a wide range of scales. Adjoints also can be used to explore the rapid growth of small perturbations that lead to large errors on multiple scales and limit the forecast accuracy of high-impact weather events.

In this presentation, we provide highlights from a number of field programs to illustrate the utility of adjoints to: i) inform field program observing strategies; ii) highlight key mesoscale moist instabilities and processes; and iii) diagnose initial condition sensitivities and processes that contribute to forecast errors. We will discuss examples from several fields programs in which we apply NRL's Coupled Ocean-Atmosphere Mesoscale Prediction System (COAMPS) moist adjoint to diagnose forecast sensitivity including: i) tropical cyclone programs: NASA Hurricane and Severe Storm Sentinel (HS3), NOAA/NASA Sensing Hazards with Operational Unmanned Technology (SHOUT), Office of Naval Research (ONR) Tropical Cyclone Intensity (TCI) and ii) extratropical cyclone programs: North Atlantic Waveguide and Downstream Impact Experiment (NAWDEX) and Atmospheric Rivers Reconnaissance (ARRECON).

The adjoint, tangent linear, and nonlinear models for the nonhydrostatic COAMPS are applied with high-horizontal resolution (5 to 45 km). We show that the initial state sensitivity and forecast errors are well correlated based on results from several different field programs. We compare and contrast results from tropical and extratropical campaigns using several different response functions to explore various aspects of sensitivity and predictability including: i) kinetic energy, ii) accumulated rainfall, iii) integrated vapor transport, and iv) potential vorticity. The adjoint sensitivity results for the extratropical and tropical cyclones underscore the importance of the low- and mid-level moisture distribution and multi-scale interactions. We demonstrate that small perturbations of moisture, winds, and temperature in sensitive regions rapidly evolve into disturbances that impact the predictability of downstream high-impact weather. The forecast sensitivity to diabatic heating is also explored using the adjoint to provide insight into the implications of model error associated with microphysical parameterizations.

The results underscore the need for accurate moisture observations and data assimilation systems that can adequately assimilate these observations in order to reduce the forecast uncertainties for these high-impact events. However, given the nature of the sensitivities and the potential for rapid error growth, the intrinsic predictability for high-impact weather appear to be limited.

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Session Classification: Diagnostics or making use of the data - Chair: Mark Rodwell

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **6** Type: **Oral presentation**

Is it time for interactivity and 3D? New approaches to analysing NWP data for observational campaigns using 3D and ensemble visualization

Tuesday, 11 June 2019 09:00 (30 minutes)

Visualization is an important and ubiquitous tool in the daily work of atmospheric researchers to analyse data from simulations and observations, and field campaigns are no exception. Visualization techniques are applied during flight planning to analyse Numerical Weather Prediction (NWP) output to perform weather forecasting under campaign-specific requirements, for example, to predict the occurrence of warm conveyor belts or specific chemical species. Also, after a campaign has been conducted, analysis of collected cases heavily relies on visualization.

Visualization research has made much progress in recent years, in particular with respect to techniques for ensemble data, interactivity, 3D depiction, and feature-detection. Transfer of new techniques into the atmospheric sciences, however, is slow. This talk will present recent developments of interest to flight planning and case analysis, in particular focusing on the "Met.3D" project (https://met3d.wavestoweather.de), our effort to make novel 3D ensemble visualization techniques accessible to atmospheric researchers. We will discuss experiences gained during the 2016 North Atlantic Waveguide and Downstream Impact Experiment (NAWDEX), during which interactive 3D ensemble visualization was applied to analyse ECMWF forecasts for flight planning. The NAWDEX cases also subsequently received strong focus of research conducted on facilitating visual analysis of synoptic-scale atmospheric features including jet-stream core lines and fronts in midlatitude cyclones, and on interactive visual analysis of similarity and sensitivity within ensemble predictions. We will discuss the benefit of these new techniques for analysing campaign cases, and point out the potential of 3D interactive visual analysis as a diagnostic tool to link observational data to model data. We will show how future campaigns can make use of the new techniques.

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Presenter: RAUTENHAUS, Marc (Universität Hamburg)

Session Classification: Diagnostics or making use of the data - Chair: Mark Rodwell

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **7** Type: **Oral presentation**

Airborne active remote-sensing observations of the extratropical troposphere and lower stratosphere with a special focus on the NAWDEX field experiment

Monday, 10 June 2019 14:00 (30 minutes)

In the past decade, the German Aerospace Center was involved in a series of observational campaigns with various objectives, e.g. on atmospheric dynamics, cloud microphysics or atmospheric chemistry. This presentation gives an overview of active remote-sensing lidar and radar profile observations of winds, humidity, ozone, aerosols and clouds; i.e. parameters of potential relevance for numerical weather prediction (NWP).

The focus of the talk will be set on the North Atlantic Waveguide and Downstream impact EXperiment (NAWDEX), a multi-aircraft field campaign that was conducted over the North Atlantic Ocean in autumn 2016. NAWDEX was the first field experiment with synergistic airborne and ground-based observations from the entrance region to the exit region of the storm track, and was undertaken to investigate the role of diabatic processes in altering jet stream disturbances, their development, and their effects on high impact weather (HIW) downstream. We will illustrate how ECMWF deterministic and ensemble forecasting products were used to define the scientific goals, the experimental design and flight planning.

NAWDEX provides an excellent opportunity to study forecast errors as the campaign period contained episodes of reduced predictability, indicating that uncertainties originating in the estimated atmospheric state and model formulation grew rapidly. Weather features expected to be associated with forecast errors were extensively probed by accurate high resolution cross sections. As an example of systematic meteorological analysis errors, a study of the representation of jet stream winds during the NAWDEX period will be presented. A comprehensive set of wind profile observations across the tropopause from airborne lidar, dropsondes and a ground-based wind profiler was compared with analyses of ECMWF's IFS and MetOffice's Unified Model. The results look pretty similar for both models and revealed increased uncertainty of winds and wind speed gradients at and directly above the tropopause, especially in situations of elevated tropopauses downstream of mid-latitude cyclones. Short-term forecasts showed radidly growing errors in this region with an underestimation of wind speeds.

Additional to this study on winds, we will discuss previous results on the representation of lower tropospheric humidity together with plans for future work on validation of NWP models. Based on the described airborne observations, we aim to identify areas with potential for improved collaboration between the NAWDEX community and ECMWF.

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Session Classification: From models to observations and back - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **8** Type: **Oral presentation**

Forecast products for flight planning from a researchers' perspective

Wednesday, 12 June 2019 11:00 (30 minutes)

The scientific aim of the North Atlantic Waveguide and Downstream Impact Experiment (NAWDEX; Schaefler et al. 2018) was to increase the physical understanding and to quantify the effects of diabatic processes on disturbances of the jet stream and their influence on downstream high-impact weather. The field campaign in September/October 2016 involved four research aircraft which performed in total 49 research flights. In preparation of NAWDEX and previous related field campaigns such as T-NAWDEX Falcon (Schaefler et al. 2014) and ML-Cirrus (Voigt et al. 2017), researchers at ETH Zurich developed web-based forecasting tools using output of ECMWF's high-resolution and ensemble forecasting system. These tools allowed to identify regions where diabatic processes were at work and where they interacted with the jet stream. For example, the computation of warm conveyor belt trajectories from the ensemble forecasting system helped to assess the probabilities of these rapidly ascending air streams and to design preliminary flight plans a few days in advance. The flight plans were then refined using the high resolution deterministic forecast. The use of web-based vertical cross-section tools as well as the computation of trajectories starting from the envisaged flight path were particularly helpful. Accordingly, this talk will demonstrate the variety of forecasting products and will provide examples on how they were used during NAWDEX and related campaigns.

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Presenter: QUINTING, Julian (Karlsruhe Institute of Technology)

Session Classification: Tropical and extra-tropical dynamics - Chair: David Lavers

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **9** Type: **Oral presentation**

Global forecasts of atmospheric gravity waves for observational campaigns

Thursday, 13 June 2019 09:30 (20 minutes)

The Institute of Atmospheric Physics of the German Aerospace Center (DLR) organized and participated in three observational campaigns on atmospheric gravity waves (GWs) in the past 7 years: GW-LCYCLE I (Kiruna, Sweden, 2013), DEEPWAVE (Christchurch, New Zealand, 2014) and GW-LCYCLE II (Kiruna, Sweden, 2016). The overreaching goal of all the campaigns with combined airborne and ground-based measurements was a better understanding of the GW sources in the troposphere and lower stratosphere and the wave propagation to the middle and upper atmosphere. The Scandinavian mountain range and the Southern Alps of New Zealand are hotspots of stratospheric mountain wave activity. However, the region of the Andes and the Antarctic Peninsula is the global hotspot in terms of stratospheric GW activity and momentum fluxes. Hence, the investigation of GWs in this region is part of the upcoming SOUTHTRAC campaign in September 2019.

High-resolution operational IFS forecasts (HRES) of the ECMWF have been used for mission and flight planning. Hereby, standardised products on a mission web site as well as an optimized representation in the mission support system (Rautenhaus et al., 2012) were employed. Additionally, HRES forecasts serve as valuable information for controlling autonomous ground-based measurements.

Because of their high fidelity, operational IFS analyses have been often used for post-campaign investigations, e.g., as an overview of the meteorological background conditions, see Gisinger et al., 2017. IFS data were used for the direct comparison or combination of model and observational data (e.g., Ehard et al., 2018) and for interpretation of the results. We found a remarkable agreement of the simulated wave structure in the IFS short-term forecast and space-borne lidar observations (Dörnbrack et al. , 2017). This indicates that the finer resolution and increasing realism of operational NWP model outputs offers a valuable quantitative source for mesoscale flow components which were hitherto not accessible globally.

At the workshop, we want to show briefly how we make use of ECMWF forecasts during a gravity wave campaign. We want to present some selected results of the past campaigns. This will include not only case studies of individual GW events but also long-term (1 year) comparison between model and lidar temperature data
of the middle atmosphere at Rio Grande (Argentina).

Dörnbrack, A., S. Gisinger, M. C. Pitts, L. R. Poole, and M. Maturilli, 2017: Multilevel Cloud Structures over Svalbard. Mon. Weath. Rev., 145 (4), 1149-1159, doi:10.1175/MWR-D-16-0214.1

Ehard, B., S. Malardel, A. Dörnbrack, B. Kaifler, N. Kaifler, and N. Wedi, 2018: Comparing ECMWF high resolution analyses to lidar temperature measurements in the middle atmosphere. Q. J. R. Met. Soc. 144, 633-640. doi:10.1002/qj.3206

Gisinger, S., A. Dörnbrack, V. Matthias, J. D. Doyle, S. D. Eckermann, B. Ehard, L. Hoffmann, B. Kaifler, C. G. Kruse, and M. Rapp, 2017: Atmospheric Conditions during the Deep Propagating Gravity Wave Experiment (DEEPWAVE), Mon. Wea. Rev., 145, 4249-4275, doi:10.1175/MWR-D-16-0435.1

Rautenhaus, M., Bauer, G., and Dörnbrack, A., 2012: A web service based tool to plan atmospheric research flights, Geosci. Model Dev., 5, 55-71, doi:10.5194/gmd-5-55-2012

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Session Classification: Stratosphere, mountains and wind - Chair: James Doyle

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **11** Type: **Oral presentation**

Field Experiments for NWP: The LITFASS Experience

Tuesday, 11 June 2019 12:00 (20 minutes)

Numerical weather prediction (NWP) essentially relies on measurements of atmospheric variables for data assimilation, parameterization development and validation. Observatories and supersites nowadays provide comprehensive data sets from operational measurement programs which might be considered as a long-lasting field experiment taking into account the size and variety of measurements. These data are of special relevance for model development as they cover the full spectrum of weather situations and phenomena occurring at a given site over longer periods.
However, additional challenges to the observational capabilities are associated with the increasingly higher spatial resolution of the models and with the parameterization of increasingly complex small-scale physical processes and interactions. These call for data sets which can only be collected within the frame of field campaigns.
Deutscher Wetterdienst (DWD) at its Meteorological Observatory Lindenberg (MOL) in 1995 started the LITFASS (Lindenberg Inhomogeneous Terrain –Fluxes between Atmosphere and Surface: a longterm Study) project, a program to test and to establish a strategy for the determination of soil-vegetation-atmosphere interaction processes over a heterogeneous land surface at the scale of a grid cell of a NWP model. Three major field experiments have been organized within LITFASS around Lindenberg: LITFASS-98, LITFASS-2003, and LITFASS-2009. The basic focus of these experiments was the determination and description of momentum, sensible heat and water vapour fluxes as an area-average at the meso-� scale.
The presentation will give an overview on the goals and major results of the three LITFASS field experiments with a special focus on the lessons learned from these campaigns. Another aspect to be mentioned does concern the role of field experiments to test new instruments and measurement strategies which might become operational in future years thus improving the data base for NWP. Ground-based remote sensing systems or unmanned aerial vehicles are prominent examples for such a development.

Primary author: BEYRICH, Frank (Deutscher Wetterdienst)

Presenter: BEYRICH, Frank (Deutscher Wetterdienst)

Session Classification: Clouds - Chair: Irina Sandu

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **12** Type: **Oral presentation**

The CNES stratospheric balloon activities: capabilities, mission and operations

Thursday, 13 June 2019 10:40 (20 minutes)

For more than 50 years of experience, the Centre National d'Etudes Spatiales (CNES) has been supporting scientific ballooning, which remains the most cost effective means to access to near space science.
This paper will give a quick overview of the CNES capabilities and services for operational balloon activities: Zero Pressure Balloon, Super Pressure Balloon and Sounding balloons. It will focus on the on-going development to improve them. The most recent balloon campaigns will be presented, as well as the future campaigns.

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Session Classification: New observational capabilities - Chair: Emma Pidduck

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **13** Type: **Oral presentation**

Synergetic use of field campaign observations and detailed simulations to improve NWP models at Météo-France

Monday, 10 June 2019 15:00 (30 minutes)

Météo-France/CNRM has a long experience and know-how in designing field experiments for developing and improving physical parameterizations for atmosphere, continental surfaces and ocean coupled models. The most outstanding field campaigns of the last decades include those coordinating in CAPITOUL on urban boundary layer in 2004-2005 (Masson et al, 2008), in AMMA on African Monsoon in 2006 (Redelsperger et al, 2006), in HyMeX on Mediterranean heavy precipitation and flash-floods in 2012 (Ducrocq et al, 2014) and on dense water formation induced by strong regional winds in 2013 (Estournel et al, 2016) and, for the near future ones, SOFOG3D on fog in winter 2019-2020 and HyMeX-LIAISE on the human imprint on atmosphere-land surface Interactions over semiarid regions in spring and summer 2020.
The aims of the presentation is to describe the methodologies that are developed to make use of these field campaign observations for improving the physical parameterizations (e.g. microphysics, turbulence, land surface schemes, urban surface models, air-sea fluxes,⋯) of numerical models. The methodologies often include a combine use of field campaign observations and of detailed model simulations, such as Large Eddy Simulations.

Ducrocq, V., et al, 2014: HyMeX-SOP1, the field campaign dedicated to heavy precipitation and flash flooding in the northwestern Mediterranean. *Bulletin of the American Meteorological Society*, **95**, 1083-1100.

Estournel, C., et al., 2016: HyMeX-SOP2: the field campaign dedicated to dense water formation in the northwestern Mediterranean. *Oceanography*, **29**, 196-206.

Masson, V., et al.,2008: The Canopy and Aerosol Particles Interactions in TOulouse Urban Layer (CAPITOUL) experiment, *Meteorol. Atmos. Phys.*, **102**, 135–157.

Redelsperger, J., C.D. Thorncroft, A. Diedhiou, T. Lebel, D.J. Parker, and J. Polcher, 2006: African Monsoon Multidisciplinary Analysis: An International Research Project and Field Campaign. *Bull. Amer. Meteor. Soc.*, **87**, 1739–1746.

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Session Classification: From models to observations and back - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **14** Type: **Poster presentation**

Developing field campaign science plans using research models and operational forecasters

TerraMaris is a future airborne field campaign based between Java, Indonesia and Christmas Island (Aus.) and will be supported by two instrumented ground sites, and oceanographic measurements.

In advance of the airborne Intensive Operating Period (IOP) in January 2020 we have begun to undertake a number of planning "Dry-Runs" in order to simulate the day-to-day field campaign operations. We use existing model products and research NWP models, along with guidance from operational forecasters to asses the science planning and the likelihood of success of proposed airborne research missions. Success in this case can be either a good science flight in the expected conditions, or an aircraft down-day to avoid unsuitable conditions.

Events have taken place in the same season as the IOP at 2 years and 1 year lead time and have involved Met Office teams and UK University collaborators along with the Indonesian Met. Service BMKG, and aeronautical agency LAPAN . Findings have helped develop and refine the available model products, and understand model biases compared to satellite and land based observations. This has lead to the development of new science hypotheses and the generation of new sortie plans to explore these.

Here we present an overview of the process and successes to date and invite broader collaboration from interested scientists and operational centres.

Primary author: BARRETT, Paul (Met Office)

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Presenter: BARRETT, Paul (Met Office)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **15** Type: **Poster presentation**

SAFIRE : research aircraft to study phenomena

Since more than 10 years, the French fleet for airborne research in environment "SAFIRE" has been used by more than 500 researchers for various experiments. The poster will give examples of recent campaigns that have used various instrumental techniques to improve the knowledge about phenomena and their prediction.

Primary author: CANONICI, Jean-Christophe (SAFIRE : Météo-France/CNRS/Cnes)

Presenter: CANONICI, Jean-Christophe (SAFIRE : Météo-France/CNRS/Cnes)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **16** Type: **Poster presentation**

Key Lessons from the DACCIWA (Dynamics-Aerosol-Chemistry-Cloud Interactions in West Africa) Project for Operational Meteorological Services

The DACCIWA project addressed weather, climate and air pollution problems in southern West Africa. The main field campaign in June-July 2016 produced the most comprehensive atmospheric dataset over this region to date. Operational products from ECMWF and other centres were used for a better planning of the field observations. The following conclusions from DACCIWA are highlighted as directly relevant to operational meteorological services.

The operational meteorological station network in West Africa is sparse and existing data are not always available for research, limiting evaluation of model and satellite products. Standard satellite cloud retrievals underestimate the frequency of low clouds during boreal summer by 20–30%, leading to errors in surface short-wave radiation. Inconsistent retrievals of short-wave absorption lead to uncertainty in estimating the total aerosol radiative effect. Satellite-based rainfall datasets tend to underestimate precipitation in the coastal zone (up to ˜8°N) with error compensations between different types of rainfall.

A new observations-based conceptual model for the low cloud decks of southern West Africa is now available as a benchmark for models. Warm rain and drizzle are frequent, impacting on cloud lifetime and the vertical distribution of moisture. Convective organisation is a key element of the local meteorology, creating large sensitivities to model resolution.

Skill of operational forecasts (ECMWF, MetOffice, DWD) of rainfall and cloud prediction is very low overall, with some skill evident on the regional scale when synoptic-scale vortices are present. Forecasts tend to be too cold and dry at the immediate Guinea Coast during the summer monsoon. Low clouds tend to be underestimated, leading to too much surface solar radiation. Explicit convection improves forecasts over Africa, but also medium-range forecasts elsewhere. Forecast improvements due to assimilating better observations into the operational ECMWF system are moderate at best, pointing to model errors being a substantial obstacle to better forecasts.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **17** Type: **Oral presentation**

Analysis and forecast using dropsonde data from inner-core region of tropical cyclones obtained during the aircraft missions of T-PARCII

Tuesday, 11 June 2019 17:30 (30 minutes)

The inner core of tropical cyclone (TC) Lan was observed on 21-22 October 2017 by newly developed GPS dropsondes during the aircraft missions of the Tropical Cyclones-Pacific Asian Research Campaign for the Improvement of Intensity Estimations/Forecasts (T-PARCII). On 25-28 September 2018, the inner core of TC Trami was also observed by T-PARCII team with the support of Science and Technology Research Partnership for Sustainable Development (SATREPS). So far, the eyewalls were penetrated nine times with a Gulfstream II jet and 90 dropsondes were dropped from 43,000 ft. The estimated minimum sea-level pressure was 925 hPa in the aircraft missions for TC Lan, while it was 920 hPa for TC Trami. From 2018, we started to transmit the BUFR data on GTS through Japan Meteorological Agency (JMA). To evaluate the impact of dropsondes on forecast skill, the forecast experiments were conducted using a JMA non-hydrostatic model (JMA-NHM) with a JMANHM-based mesoscale four-dimensional data assimilation system with a grid-spacing of 5 km for TC Lan. Then, we evaluated the forecast skill against the best track data published by the Regional Specialized Meteorological Center (RSMC) Tokyo. Track and heavy rainfall forecast skills generally improved by about 10 % with the assimilation of the dropsonde data, while the intensity forecasts were generally degraded. The degeneration of the intensity forecast skill is, however, potentially due to uncertainties in the best track data as the best track data set usually relies on the Dvorak technique involving the error of the order of 10 hPa. The benefits of inner-core observations described are encouraging, yet at the same time they remind us of the importance of the ground truth in the researches of TC forecasting. Other relevant researches including the assimilation with a JMA global data assimilation system and sensitivity analysis will be also presented.

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Session Classification: Tropical cyclones - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **18** Type: **Poster presentation**

Short-term sea ice forecast over the Arctic region during 2018 expedition of the Japanese research vessel MIRAI

To observe ocean and sea ice conditions in the Chukchi Sea of the Arctic Ocean, a Japanese research vessel (RV) MIRAI entered the Arctic water from 4 to 25 November 2018 through the Bearing Strait. The Arctic sea ice conditions can change over short timescales due to dynamics and thermodynamics. Leads may open and close in a very short time, and heavy pressure may build up in the compression of compact ice. These short timescale processes have a strong influence on shipping on the ice infested water. Therefore, precise ice distribution prediction in the short-term (10–days scale) is one of the key issues to realize safe and efficient navigation. A high-resolution (about 2.5 km) ice-ocean coupled model is developed for forecasting the short-term sea ice distribution in the Chukchi Sea. European Center for Medium-Range Weather Forecast atmospheric high-resolution 10-days forecasted forcing data is used for the sea ice prediction simulations. Since RV MIRAI navigates to avoid the sea ice as much as possible, a factor to score the forecast skill is considered to be ice edge error which is an averaged distance between forecasted and observed ice edges. The maximum forecasted ice edge error in the ice-ocean coupled model is 16.01 km in the Chukchi Sea with the threshold of 15% ice concentration for the ice edge. It can be said that the present model of 2.5 km grids satisfies the ship crew requirement of ice edge error for 10-days forecast.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **19** Type: **Oral presentation**

Arctic Clouds - Evaluating Modelled Cloud with Field Observations

Wednesday, 12 June 2019 15:00 (30 minutes)

Extensive surface based remote sensing observations of Arctic clouds have been made during two recent research cruises: Arctic Cloud in Summer Experiment (ACSE, 2014) and the Microbiology-Ocean-Cloud Coupling in the High Arctic (MOCCHA, 2018). The cloud properties were retrieved using Cloudnet from measurements by Doppler cloud radar, lidar, scanning microwave radiometer, and 6-hourly radiosondes. Here we present details of the observations and a preliminary evaluation of model output from the IFS.

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Session Classification: Polar processes - Chair: Jonathan Day

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **20** Type: **Poster presentation**

Modelling and observing the atmospheric boundary layer over mountains

The exchange of heat, momentum, and mass in the atmosphere over mountainous terrain is controlled by synoptic-scale dynamics, thermally-driven mesoscale circulations and turbulence.

Exchange processes at the land surface and within the atmospheric boundary layer are represented in numerical weather prediction and climate simulation models by empirically tuned and inherently uncertain parameterization schemes. The effects of sub-grid-scale turbulent processes are represented using concepts from boundary-layer meteorology (e.g., scaling based on dimensional analysis), which work reasonably well over flat and homogeneous terrain but often prove too simplistic over mountainous terrain. Because about 30% of land is occupied by complex orography, the implications of suboptimal modelling are likely to be large.

The mountain boundary layer (MBL) is persistently subject to processes other than turbulence, e.g., breeze systems. These produce complex patterns of variability in three dimensions, which are hard to observe and model, and have a direct impact on surface exchange. The present contribution briefly outlines a few key aspects of recent MBL research that are relevant to parameterization development: limitations of Monin-Obukhov surface-layer scaling, importance of horizontal boundary-layer exchange and spatial heterogeneity in exchange processes, challenges in determining the mixing height.

Much of the recent knowledge on MBL processes stems from high-resolution idealized numerical simulations, and there is a critical need for novel observational data to support theory and model development. Examples of usage of long-term observations from the "Innsbruck Box"(i-Box) for model evaluation are presented. Preliminary plans for a larger-scale observation campaign are also sketched.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **21** Type: **Oral presentation**

Experiences from Arctic field campaigns: Weather forecasting and evaluations, and model comparisons

Monday, 10 June 2019 14:30 (30 minutes)

Over the last decades the Swedish icebreaker Oden has had atmospheric research mission to the central Arctic four summers; 2001, 2008, 2014 & 2018. The data brought back from these expeditions provides invaluable detail on conditions and processes that can be used to test models and model formulations. But the field campaigns also rely on weather forecasts for the operations. One very special aspect of weather forecasting for central Arctic expeditions is the very limited bandwidth. The forecast material available to the ship's meteorologist is typically very limited, a few forecast maps, some of the expeditions own observations and real-time satellite imagery from polar orbiters.

In this presentations we will explore the data gathered during such expeditions and how it has been used for model testing. We will also review what forecast material that has been available, with a focus on the latest endeavor: Arctic Ocean 2018 expedition (AO18). This expedition took place during August and September 2018, during the tail end of the Year of Polar Prediction (YOPP) Arctic Summer Special Observing Period (SOP). For AO18, YOPP in collaboration with the EU HORIZON2020 project APPLICATE provided a set of specialized forecast for AO18 based on the ECMWF IFS model; forecast were also evaluated in near-real time and some of the results will reviewed.

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Session Classification: From models to observations and back - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **22** Type: **Oral presentation**

The Strateole-2 long-duration balloon project in the deep tropics: benefiting from and improving weather forecasts?

Thursday, 13 June 2019 09:50 (20 minutes)

Three long-duration stratospheric balloons were released in February 2010 from Seychelles Island (5°S) by the French space agency (CNES), within the pre-Concordiasi campaign. Once at their float altitude at $\sim$20 km, these balloons drift on constant-density surfaces, and are simply advected by the wind. The pre-Concordiasi flights lasted for 3 months each. In-situ meteorological measurements (temperature, pressure, and wind deduced from successive balloon positions) were performed every 30 s during the flights, and have revealed large discrepancies between observed winds and those in analyses issued by various operational centers for time periods as long as 1˜month (Podglajen et al., 2014). The errors in modeled winds have been primarily associated with Kelvin and Rossby-gravity wave packets that were not captured in the analyses, despite their planetary-scale structure. The largest errors occurred over the Indian and Eastern Pacific oceans, where in-situ wind observations are very scarce.

These results contributed to the motivation of the forthcoming Strateole-2 balloon campaigns, which will release $\sim$ 50 similar long-duration balloons in the deep tropics in the 2019-2024 time frame. Strateole-2 balloons will circum-navigate
the Earth around the equator in the lower stratosphere, and provide observations over both continents and oceans. Meteorogical measurements performed during the flights will be sent on the GTS so as to be assimilated by numerical weather
prediction (NWP) systems. The wind observations should particularly contribute to improve NWP wind analyses and forecasts in the tropics. On the other hand, better operational wind products are also very useful for the campaign management. They
for instance provide (i) better guidance on future balloon trajectories, which are monitored for safety reasons, and (ii) opportunities to manage coordinated measurements with instrumented sites at ground.

The presentation will briefly review the past pre-Concordiasi experience, and provide a detailed view of Strateole-2 and its potential interactions with the operational weather forecast community.

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Session Classification: Stratosphere, mountains and wind - Chair: James Doyle

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **23** Type: **Oral presentation**

YOPP supports the Japanese Arctic research cruise in 2018

Wednesday, 12 June 2019 15:30 (30 minutes)

Unusual states of the Arctic regions, for example, less sea-ice extent, high temperatures in the atmosphere and ocean, much snowfall, and extreme weather events in the Arctic and beyond, have been prominent in recent years in particular during winter time. Those phenomena are scientifically important for understanding the air-ice-sea coupled physical processes and improving skills of numerical models. Skillful forecasts of weather, sea ice and ocean are useful for ship navigation as well as activities of indigenous people. The Year of Polar Prediction (YOPP) proposed by the World Meteorological Organization (WMO) Polar Prediction Project (PPP) provides a great opportunity to collaborate with observing and modeling platforms. In November 2018, the Japanese research vessel Mirai went to the southern Chukchi Sea to observe the unusual conditions of the atmosphere, sea ice, and ocean during the beginning of the freezing. To succeed this unique cruise, skillful forecasts were vital for this ice-strengthen ship. This presentation gives an overview of this cruise from the viewpoint of polar predictions.

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Session Classification: Polar processes - Chair: Jonathan Day

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **24** Type: **Oral presentation**

RALI: the French radar-lidar airborne platform for cloud dynamics and microphysics studies

Tuesday, 11 June 2019 12:40 (20 minutes)

Mobile Radar-Lidar facilities are unique tools for cloud process analyses and case studies. The radar-lidar airborne platform (RALI) can be deployed on board the French SAFIRE aircraft (Falcon 20 or the ATR42 depending on the targeted areas). RALI consists of a combination of the multi beam 95 GHz Doppler radar RASTA (RAdar SysTem Airborne) and the Doppler high spectral resolution (D-HRS) lidar LNG (Leandre New Generation). Both instruments were developed at LATMOS and DT-INSU (http://rali.projet.latmos.ipsl.fr). LNG operates at three wavelengths (355 nm, 532 nm, 1064 nm), including depolarization and D-HRS at 355 nm. This synergistic platform has been deployed in many field campaigns on SAFIRE aircraft since 2006 combined with radiometry for SW and LW flux measurements (for example AMMA, HYMEX, CHARMEX, HAIC, NAWDEX and EXAEDRE). The unique configuration of the RASTA radar allows for the retrieval of the three-dimensional cloud/precipitation wind above and below the aircraft (data collected during HYMEX data have been recently assimilated in AROME). Ice clouds, water cloud top and aerosol properties (local scale dynamics and radiative parameters) can also be retrieved thanks to the D-HRS lidar. Combination of both instruments give access to an unprecedented set of parameters over the whole atmospheric column. We will present the platform and its capability in terms of microphysical and dynamical processes studies and some applications.

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Session Classification: Clouds - Chair: Irina Sandu

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **25** Type: **Poster presentation**

The implication of the X-band rain radar ROXI in the EXAEDRE project

ROXI (Rain Observation with an X-band Instrument), is a X-band Doppler ground-based radar (9.4 GHz) for rain observations. It was designed at LATMOS, for the study of the microphysical properties of precipitating systems, the vertical structure of clouds and precipitations by measuring the vertical reflectivity and Doppler velocity profile. The measurements extend from 100m to 12.8 km.
The EXAEDRE (EXploiting new Atmospheric Electricity Data for Research and the Environment) project took place this summer in Corsica. It aims at consolidating the HyMex (HYdrological cycle in the Mediterrenean EXperiment) activities collected during the field campaign in relation with atmospheric electricity.
During the campaign, a suite of data was acquired simultaneously from the zenith pointing radars ROXI and BASTA. In situ measurements were also collected from airborne microphysics probes and the 95 GHz Doppler radar RASTA onboard the SAFIRE French Falcon20 aircraft.
Thanks to ROXI, we can retrieve the mean duration of the precipitating events, the characteristics of the bright band in relation the ice properties, the precipitating rate, the particles Doppler velocity, and the work on the Z-R relation.
In addition, and thanks to the joint airborne measurements, we can extract information on the microphysics of the particles in the precipitating clouds.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **26** Type: **Oral presentation**

ASKOS-WIND –A Contribution to the Aeolus CAL/VAL Campaign in Cape Verde in June-July 2020

Wednesday, 12 June 2019 11:50 (20 minutes)

In August 2018, the Aeolus satellite carrying the first UV Doppler lidar in space (ALADIN) was successfully launched. The particular gap that Aeolus is closing in the global observing system is measurements of winds in cloud free regions and thus we expect Aeolus to substantially improve analysis fields and subsequently predictions of synoptic- to planetary-scale wave phenomena in the Tropics. As part of the Aeolus CAL/VAL activities, an experimental campaign named ASKOS will be organized in June-July 2020 in Cape Verde. ASKOS will deploy advanced instrumentation over Cape Verde to provide unprecedented observations of high quality and accuracy for the wind and aerosol component of Aeolus.

Cape Verde during boreal summer is ideal for this study. The generally high aerosol loading is interesting because it will allow the measurement of both aerosol optical properties and wind, thus opening the way to the study of the interaction between the two. The midlevel African easterly jet allows for the formation of synoptic-scale African easterly waves (AEWs) that typically reach their maximum intensity close to the coast of West Africa. AEWs interact with convection and its mesoscale organisation through modifications in wind, temperature and vertical wind shear, and often serve as initial disturbances for tropical cyclogenesis. In addition, the tropical atmosphere sustains different types of planetary waves that frequently interact with the monsoon and AEWs.

Science questions to be addressed in ASKOS-WIND include: (A) How well does Aeolus monitor winds at different vertical levels in comparison with aircraft measurements and what limits the quality of the retrievals? (B) How well are characteristics of wave disturbances represented in analysis and forecast data relative to the satellite measurements ? (C) How much deterioration do we get if we deny the satellite / aircraft measurements to the data assimilation system? (D) Does a better analysis lead to better forecasts of waves rainfall, dust emission and tropical cyclogenesis?

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Session Classification: Tropical and extra-tropical dynamics - Chair: David Lavers

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **27** Type: **Oral presentation**

Comparison between airborne remote sensing observations of an extratropical cyclone and short-term forecasts using a hierarchy of models.

Wednesday, 12 June 2019 11:30 (20 minutes)

The main goal of the study is to analyze the representation of the Stalactite Cyclone (29 September-2 October 2016) in a hierarchy of models (mesoscale NWP model, global NWP model, climate models). The Stalactite Cyclone is an extratropical cyclone that has been intensively observed during the international field campaign NAWDEX. Its later stage of development is associated with the onset of a low-predictable European block event. Short-term forecasts of all the models are compared with observations made with the RALI platform on board the SAFIRE Falcon. The RALI platform is composed of a Doppler radar RASTA and a three-wavelength backscatter lidar LNG. Two flights of the SAFIRE Falcon have been performed in the ascending and outflow regions of the warm conveyor belt of the cyclone. The comparison between the observations and the model outputs mainly relies on the horizontal wind speed derived from the Doppler radar RASTA, the radar reflectivity and the ice water content retrieved from the RALI observations. The aim of all these observations is to provide indirect information about the diabatic heating rates along the warm conveyor belt and their impact on the dynamics through modification of potential vorticity. The ability of the models to accurately represent the diabatic heating rates, the potential vorticity and the wind within the Stalactite Cyclone and its downstream influence on the blocking formation is assessed.

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Session Classification: Tropical and extra-tropical dynamics - Chair: David Lavers

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **28** Type: **Poster presentation**

Two-dimensional water vapour and temperature measurements from the airborne infra-red limb sounder GLORIA compared to atmospheric simulations

We will present measurements of water vapour, temperature and cloud tops obtained by the GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere) instrument that has been operated on the HALO (High Altitude and Long range) research aircraft during the PGS (POLSTRACC / GW-LCYCLE II / GWEX / SALSA) campaign in the Arctic during winter 2015/16.
We will show retrievals of two-dimensional water vapour and temperature distributions derived from GLORIA observations performed with high spectral resolution. In total, 16 HALO research flights with each up to 10 hour duration (10,000 km distance) have been performed during this aircraft campaign. The focus of these measurements is the UTLS (Upper Troposphere Lower Stratosphere) region. Within these flights, complex tropopause patterns, such as tropopause folds and gravity wave induced trace gas modulations, have been observed. These detailed cross sections allow for comparisons with ECMWF forecasts and reanalysis products.
In our contribution, we discuss agreements and differences between GLORIA observations and model data at the geolocations of the measurement, and we help to identify regions of the UTLS, which need to be improved in atmospheric models.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **29** Type: **Poster presentation**

The EXAEDRE campaign for a better understanding of the microphysical, dynamical and electrical processes in thunderstorms

The 4-year ANR-16-CE04-005 EXAEDRE (EXploiting new Atmospheric Electricity Data for Research and the Environment) project aims at providing a comprehensive description of the electrical activity in thunderstorms in the north-western Mediterranean region through innovative multi-disciplinary and state-of-the-art instrumentation and modeling tools.

The EXAEDRE airborne campaign, supported by ANR, CNES and the MISTRALS/HyMeX program, was conducted between mid-September and mid-October 2018 in the Corsica region. The French Falcon research aircraft was equipped with four microphysics probes, a cloud radar, eight electric field mills and a series of high-energy particle detectors. Eight research flights sampling different types of convective and precipitating systems at different stages of their lifecycle were conducted from only few kilometers away from the electrical cores to farther in the stratiform region. Lightning activity was documented by the research Lightning Mapping Array SAETTA network and the operational Météorage lightning locating system. Additional ground-based remote sensing and in situ observations were collected at a super site equipped with research instruments from end of June 2018 to beginning of November 2018.

A summary of the scientific and technical objectives of the EXAEDRE campaign will be given first. Second a short description of the daily operations including forecasts, flight preparation, flight decision and guidance will be presented. Then an overview of the eight EXAEDRE flights will be presented with examples of microphysical, dynamical and electrical features based on concurrent airborne and ground-based in situ/remote sensing observations.

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Presenter: Dr DEFER, Eric (LA)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **30** Type: **Poster presentation**

Verification of ECMWF deterministic forecast against surface and radiosonde observations around the marginal ice zone in the Chukchi Sea during an Arctic cruise of the R/V Mirai

The R/V Mirai conducted an Arctic cruise of the Chukchi and Beaufort Seas from 25 October to 7 December 2018. During this cruise, intensive meteorological observations around the marginal ice zone (MIZ) were made in the period of 6 to 22 November 2018. This study verified the ECMWF deterministic and ensemble forecasts against surface and radiosonde observations around the MIZ during this period.
Predicted 2m temperature showed an apparent positive bias at the nearest grid point to the location of the R/V Mirai on 9–13 November, even in a 24-hour forecast. The warm biases were also seen at 1000 to 925 hPa levels in this period. In particular, the biases reached up to 700 hPa and were largest (≥2 K) at 925 hPa and on 12 November.
Regarding synoptic fields on 12 November, analyzed northerly wind was dominant around the location of the R/V Mirai. Predicted northerly wind in 24- to 72-hour forecasts was, however, weaker than the analyzed wind. The warm biases were attributed to the weaker northerly wind. The weaker northerly wind was related to the negative sea level pressure (SLP) error along over the MIZ at lead times up to 72 hours. Around the MIZ, predicted sea-ice concentration (SIC) was much lower than the observed SIC by AMSR2. The negative SLP error was generated by excessive surface heat flux due to the lower SIC in the model.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **31** Type: **Poster presentation**

Analysis of observations and ERA5 comparison in the data sparse Arctic Ocean

Analysis of observations and ERA5 comparison in the data sparse Arctic Ocean

Takehiko Nose1, Takuji Waseda1, Kodaira Tsubasa1, and Jun Inoue2.

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R/V Mirai conducts observational campaigns to the Arctic Ocean annually. Observations in the data sparse ocean often provides new insights into the atmosphere and oceanic physics, and can help identify possible problems in numerical models. During the summer of 2016, R/V Mirai deployed drifting wave buoys for 2 months in ice-free waters, which recorded two large storms. The wave data were compared against ECMWF ERA5 wave reanalysis, which compared well in general; however, during one of the storms, a conspicuous model underestimation bias was found, which was possibly caused by wind accuracy due to reduced barometric pressure observations. This identified the significance of observations in the data sparse Arctic Ocean for wave models. In the late autumn of 2018, R/V Mirai sailed the Chukchi Sea and collected shipboard data in the refreezing waters. Repeat marginal ice zone (MIZ) transects were conducted between the 9th and the 20th of November with a view to better understand how the warming sea surface temperatures of the Arctic Ocean may affect the sea ice refreezing processes. The ECMWF forecast was extensively used for this voyage, which enabled the vessel to remain near the MIZ and provided an opportunity to ground-truth ECMWF predicted sea ice cover with the shipboard observations. During the last two days, very cold off-ice winds led to air temperatures below -10 degrees C. Despite the cold air mass, measured sea surface temperatures (SST) elevated to positive degrees C. The ERA5 reanalysis data suggest the model was unable to reproduce these elevated SSTs. We are currently analysing this phenomenon with a view of identifying possible missing physics or model errors and how SST accuracy may affect the forecast and reanalysis of sea ice cover.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **32** Type: **Poster presentation**

Ensemble Forecast Sensitivity to Observations (EFSO) technique for global observing system experiments (OSEs)

A global atmospheric data assimilation system called ALEDAS comprised of AFES (Atmospheric GCM) and the LETKF has been developed in our research team to generate an experimental global ensemble reanalysis called ALERA2. The ALERA2 and ALEDAS have been used to conduct several OSE studies to assess impacts of special observations obtained during some observational campaigns, especially on the Arctic and subtropical oceans. We have also performed some predictability studies by using the ensemble reanalysis and/or the OSE reanalyses as initial values for AFES. Recently, a diagnostic technique called Ensemble Forecast Sensitivity to Observations (EFSO) which can quantify how much each observation has improved or degraded the forecast without a data denial OSE experiment (in offline) has been implemented into ALEDAS. In our presentation, we will discuss that estimation by EFSO is compared with actual data denial experiments and can be useful for global OSE researches.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **33** Type: **Oral presentation**

TEAMx: A coordinated effort to investigate transport and exchange processes in the atmosphere over mountains

Thursday, 13 June 2019 09:00 (30 minutes)

Mountains have a profound impact on synoptic- and meso-scale atmospheric processes. They also shape the transfer of heat, momentum and mass (water or trace gases) between the ground, planetary boundary layer and the free atmosphere. An integral part of past international research programmes that focused on the impact of mountains on the atmosphere (e.g., ALPEX, PYREX and MAP) was a deployment of special observing facilities in large-scale field campaigns. Significant progress in understanding and prediction of processes in and around complex terrain ensued, for instance in relation to gravity-wave-induced phenomena and orographic precipitation. In the two decades since MAP, technological and scientific progress has extended the range of phenomena that can be accurately observed and modelled towards smaller spatial scales. This forms the basis for an internationally coordinated program to study exchange processes over mountains, their interaction with mesoscale processes and their role in the climate system.

From the experimental perspective, terrain heterogeneity creates challenges in practical use and interpretation of observations. Among others, these include limited representativeness of point measurements, special requirements for data post-processing (e.g., for turbulence measurements), and limited validation of satellite remote-sensing retrieval algorithms over regions of complex terrain. From the modelling perspective, sub-grid-scale orographically-induced processes are typically not accounted for in parameterizations of land-surface exchange, planetary-boundary-layer turbulence and convection. Both numerical weather prediction and climate change simulations suffer from model errors caused by imperfect representation of the flow over mountains. These errors remain one of the major sources of uncertainty for the Earth System models despite the ever-increasing model resolution.

This contribution offers an overview of TEAMx (Multi-scale Transport and Exchange Processes in the Atmosphere over Mountains –programme and experiment), a recently initiated programme focusing on the investigation, field observations, and numerical modelling of exchange processes between mountainous terrain and the free atmosphere.

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Session Classification: Stratosphere, mountains and wind - Chair: James Doyle

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **34** Type: **Poster presentation**

Target observations for improving NAO event onset prediction

Based on the viewpoint that North Atlantic Oscillation (NAO) event has an intrinsic time scale about 2 weeks and can be treated as an initial-value problem, target observations for improving NAO event onset prediction are investigated by conditional nonlinear optimal perturbations method with a quasi-geostrophic model. The results show that the sensitive areas are flow-dependent, which are mainly located in the North Atlantic and its upstream regions. Target observations over main sensitive areas could improve NAO onset forecast in most cases (approximate 75%) due to reduced anomalous eddy vorticity forcing (EVF) projection errors on the typical NAO mode. Moreover, a fixed sensitive area is determined based on the winter climatological flow, and NAO onset forecast can also be improved by target observations over North American Continent and its adjacent Ocean, but somewhat lower than those in flow-dependent sensitive area. The above results indicate that target observations over sensitive area identified by CNOP method are helpful to improve the NAO onset forecast.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **35** Type: **Oral presentation**

Observations to operations in the Met Office Unified Model

Monday, 10 June 2019 16:30 (30 minutes)

Observation-model difference drive the development of parametrizations. Here we will show how the combination of aircraft, satellite and ground based observations as well as theoretical and seamless modelling has led to model improvements in the Met Office Unified Model. Examples to be discussed will include i) the Southern Ocean sea surface temperature bias that draws on a rich combination of field work, case studies and theoretical underpinning, ii) the global model representation of light rain that tries to capture the broad range of the rain drop distribution for an operational single moment representation based on extensive aircraft observations, iii) a multi modal pdf approach for cloud fraction tested against ARM site data and iv) the impact of an improved land surface representation from airborne operations.

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Session Classification: From models to observations and back - Chair: Mohamed Dahoui

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **36** Type: **Poster presentation**

In situ observations from Unmanned Surface Vehicles (USVs) on the GTS: an emerging data set.

The oceans affect the fundamental processes that drive our weather and climate. Saildrone designs and manufactures wind and solar powered unmanned surface vehicles (USVs) which make cost-effective ocean data collection possible at scale. Saildrones are instrumented with a full suite of ocean, meteorological, and fisheries acoustic instruments and have been successfully deployed over the past 5 years in challenging regions of the global oceans.

In situ platforms like ships, buoys, and drifters provide observational data such as mean sea level pressure and sea surface temperature that is assimilated into operational weather forecasts. However, there are gaps in spatial coverage and not all of those platforms are deployed with pressure sensors or other instruments relevant to observational data assimilation. Since July 2017, a subset of data collected from Saildrone USVs has been ingested into the World Meteorological Organization's Global Telecommunication System (WMO GTS) through the US National Oceanic and Atmospheric Administration's (NOAA) data management system, ERDDAP in near realtime.

Capable of missions lasting up to 12 months, Saildrone USVs can maintain a permanent presence, enabling immediate response in an area that needs constant monitoring, or follow a set trajectory designed to measure specific processes or regions, with strict data quality control provided by NOAA and others. This presents a novel opportunity to compliment existing observational data platforms with coverage in remote oceanic areas that contribute to global weather and climate patterns.

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Presenter: DE HALLEUX, Sebastien (Saildrone, Inc.)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **37** Type: **Oral presentation**

New observational strategies for operational global and hurricane model improvements using airborne Tropical Cyclone and Winter Storm surveillance flights

Tuesday, 11 June 2019 17:00 (30 minutes)

A new aircraft observing strategy is proposed for obtaining much-needed atmospheric dropsonde observations throughout the entire depth of the troposphere within the inner core of Tropical Cyclones (TCs) and their environment during TC season, as well as over developing winter storm systems in the Central and Eastern Pacific (CPAC and EPAC) upstream from the U.S. West Coast Atmospheric River (AR) landfalls, Central Plains severe weather and rapidly developing East Coast winter storms. The observing strategy involves new and improved dropsonde instruments deployed utilizing new and improved dropsonde targeting strategies which define regions of model uncertainty using operational global ensemble forecast models. Data from these flights would be for the purpose of reducing model uncertainty in the prediction of TC track and intensity as well as location and intensity of winter storm systems. Secondarily, initial analyses suggest that data from these flights would play a role in improving longer-range, down-stream forecasting of TC's such as Extratropical Transition (ET) and storms in other global basins as well as severe weather impacts over the CONUS region during the winter season. The use of emerging new dropsonde targeting techniques defining regions of operational model uncertainty is critical to the successful implementation of this new plan. Initial experimentation suggest that use of multiple global models (and their ensembles) with different uncertainty estimation methods helps to further reduce targeting uncertainty and maximize the use of dropsonde observations in the operational data assimilation system.

Preliminary results from targeting strategies implemented with the recent hurricane seasons using Global Hawk and G-IV aircraft will be discussed with respect to impacts on the new NCEP operational Global Forecast System (GFS) based on the Finite Volume Cubed Sphere (FV3) dynamic core, and operational Hurricane Weather Research and Forecast (HWRF) models. These strategies were further exploited during the Atmospheric Rivers Reconnaissance campaign in February 2019 using dual WC-130J aircraft. NWS has partnered with CW3E, Navy, NCAR and SUNY Albany in providing ensemble model based targeting strategies for dropsonde deployments for the ARR-2019 as a pilot project. Preliminary results from this campaign will be presented. Impact on numerical model guidance, local forecasts and downstream impacts will await further in-depth study.

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Session Classification: Tropical cyclones - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **38** Type: **Oral presentation**

Examples of targeted high-altitude airborne dropsonde deployment strategies for improved tropical cyclone and winter storm prediction

Tuesday, 11 June 2019 16:00 (30 minutes)

Two recent Tropical Cyclone (TC) Forecast Demonstration Projects (TCFDP) have utilized new and innovative technologies and targeted observing strategies for improving TC track and intensity forecasting: 1) Sensing Hazards with Operational Unmanned Technologies (SHOUT, 2015-16) and 2) East Pacific Origins and Characteristics of Hurricanes (EPOCH, 2017). Both of these projects share the objective of complementing legacy G-IVSP RD-94 dropsonde observational capability of the mid- and upper troposphere with improved NRD-94 mini-dropsonde observing strategy deployed from Global Hawk UAV vehicles in the lower stratosphere.

During the 2018 hurricane season and planned for the 2019 hurricane season is the use of improved versions of the ensemble targeting strategies developed at U. Albany in concert with the U.S. National Hurricane Center and Environmental Modeling center using ECMWF global model together with new instrument design in high-altitude dropsonde deployments from the NOAA GIVSP aircraft. The new targeting strategy and a third generation dropsonde design were implement mid-way through the 2018 hurricane season. Adding to these developments is a second ensemble targeting system utilizing the GFS global model that was developed for use in hurricanes and which was first implemented in the recently completed 2019 Atmospheric Rivers Reconnaissance program for winter storm event forecasting improvement along the U.S. West Coast. This program was directed by the Scripps Center for Western Weather and Water Extremes (C3WE) and conducted jointly with the Air Force Reserve Command (AFRC), NOAA/ Environmental Modeling Center (EMC), National Center for Atmospheric Research (NCAR) and the ONR/Naval Research Lab (NRL). The AFRC/ 53rd Weather Reconnaissance Squadron flew two WC-130J aircraft at maximum altitude, deploying new third generation NCAR/EOL designed, Vaisala produced RD-41 dropsondes.

A new dropsonde targeting strategy was developed at U. Albany using ECMWF ensemble forecasts in the 48-72 hour period to estimate regions of high observational uncertainty for prediction of track and intensity. Midway through the ARR-2019 program a similar product was introduced by EMC using GEFS ensemble global model, allowing consensus uncertainty regions to be identified. The Global Hawk patterns flown in both of these projects used the U. Albany strategy in developing dropsonde deployment locations for each flight. This paper describes how the resulting dropsonde locations compared with these regions of maximum uncertainty. In addition, the locations of these high uncertainty regions relative to key environmental and storm relative features is described and depicted using GOES visible and IR imagery, microwave imagery and concurrent airborne and land-based radar imagery.

Primary authors: BLACK, Peter (I.M. Systems Group); Dr TALLAPRAGADA, Vijay (NOAA/NWS/NCEP/Environmental Modeling Center); Prof. TORN, Ryan (University at Albany); Dr WU, Xingren (I.M. Systems Group); Dr ELLESS, Travis (I.M. Systems Group); Dr MEHRA, Avichal (NOAA/NWS/NCEP/Environmental Modelling Center); Dr DUNION, Jason (NOAA/AOML/Hurricane Research Division (CIMAS))

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Session Classification: Tropical cyclones - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **39** Type: **Oral presentation**

Atmospheric River Reconnaissance to Improve Forecasts: Needs, Approach and Underlying Science

Wednesday, 12 June 2019 09:30 (30 minutes)

The Atmospheric River Reconnaissance project "AR Recon"formulated a targeting method focused on AR landfall prediction on the U.S. West Coast, where AR landfall position forecast errors at 1-4 days lead time range from 200-400 km on average (Wick et al. 2013, DeFlorio et al. 2018), and can contribute to significant errors in extreme precipitation forecasts (e.g., Ralph et al. 2010, 2011). The recent addition of moist processes in an adjoint method concluded that errors in the location and characteristics of ARs offshore as the leading source of initial condition error for landfalling storm forecasts on the west coast (Doyle et al. 2014; Lavers et al. 2018; Reynolds et al. 2019). These forecast errors impact water decisions in the West, including those associated with mitigating flood risk and drought (http://cw3e-web.ucsd.edu/firo/).
The AR Recon project is a multi-year, interagency, cooperative effort to collect unique dropsonde observations in and around ARs off the U.S. West Coast to improve AR-landfall-associated weather forecasts during the cool season. It has collected data with multiple aircraft in 3 ARs in February 2016 (two Air Force C-130s), 6 ARs in January-February 2018 (involving a mix of two Air Force C-130s, and NOAA's G-IV), and 6 ARs in February 2019 (used two Air Force C-130s). In 2019, AR Recon also supported the deployment of additional drifting buopys, with surface pressure sensors, in the northeast Pacific. Additionally, airborne GPS met observations have been made in some cases (Haase).
Global modeling centers (NCEP, US Navy, ECMWF), and regional modelling efforts (COAMPS; West-WRF) have teamed up to collaborate. An AR Data Assimilation and Modeling Steering Committee (the co-authors of this abstract) has brought together diverse expertise and substantial institutional capacity to carry out the collaboration.
This presentation will present a status report on data collection and analysis.

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Session Classification: Tropical and extra-tropical dynamics - Chair: Andreas Schäfler

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **40** Type: **Oral presentation**

Upper Ocean Data Collection during Operational Hurricane Reconnaissance Missions

Tuesday, 11 June 2019 16:30 (30 minutes)

In 2011 the U.S. Working Group for Hurricane and Winter Storms Operations and Research approved a multi-year AXBT Demonstration Project to assess whether the collection of upper-ocean temperature observations during operational tropical cyclone (TC) reconnaissance missions could improve coupled numerical model forecasts of TC track and intensity. In 2017, the program was expanded to include salinity observations and was incorporated as a Navy-Air Force partnership in the U.S. National Hurricane Operations Plan. Over the past eight years, with support from the Office of Naval Research, we have collaborated with the U.S. Air Force 53rd Weather Reconnaissance Squadron in the deployment of more than 1000 AXBTs and 80 ALAMO floats in 29 named storms, and with the Naval Oceanographic Office, National Data Buoy Center, and Naval Research Laboratory –Monterey in the transmission, assimilation, and analysis of the observations and impact. We have also begun research collaborations with scientists from ECMWF and the UKMET Office.

Achievements and results to date include near-real-time assimilation of upper-ocean temperature and salinity observations, increased accuracy of ocean model forecasts, improved track and intensity forecasts in coupled dynamical models, and development of a targeting system to identify critical ocean observation areas ahead of tasked tropical cyclone missions. Challenges include understanding when and where the observations are most impactful, and identifying an optimal sampling strategy to facilitate transition to an operational program. Topics in focus here will include the operational construct of the research program, an overview of the observations collected to date, a discussion of current objectives and future plans, and an invitation to collaborate with workshop participants to maximize the effectiveness of future observations.

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Session Classification: Tropical cyclones - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **41** Type: **Poster presentation**

A new criterion to detect drizzle from ground-based: a potential new tool for model evaluation.

Authors: Claudia Acquistapace, Maximilian Maahn, Ulrich Löhnert, Pavlos Kollias

Liquid clouds substantially contribute to Earth's radiation budget but are still poorly represented in global circulation models (GCMs), i.e. due to uncertainties in the description of the cloud-scale microphysical processes such as drizzle production. Drizzle production in pure liquid clouds is the main mechanism of liquid water removal and it affects the dynamics and lifetime of clouds as well as the boundary layer dynamics and thermodynamics. In models like The high-resolution (150 - 300 m) Icosahedral non-hydrostatic model (ICON-LEM), developed by the Max Planck Institute for Meteorology (MPI-M) and the German Weather Service (DWD), this process is described by the autoconversion parametrization, that characterizes the mass transfer rate from cloud droplets to embryonic drizzle particles. Various parametrizations of autoconversion have been proposed in recent years for numerical models but their evaluation is still controversial because direct observations of drizzle development in the cloud are missing.
In this work, the new criteria "CLAssification of Drizzle Status"(CLADS) to detect drizzle development in the cloud is presented. We base the new criteria on the skewness of the Doppler spectra obtained from the Ka-band radars operating at JOYCE (Juelich Observatory for Cloud Evolution) and at the Barbados Cloud Observatory. CLADS has been tested on a statistical ensemble of liquid cloud case studies collected at JOYCE as well as on a number of shallow cumulus cloud cases observed at the Barbados Cloud Observatory. After algorithm application, the different drizzle classes are characterized in terms of standard Doppler spectra moments reflectivity, mean Doppler velocity, spectral width and microwave-radiometer-derived LWP. These are compared to the different categories identifying drizzle in the common Cloudnet target classification. The new criterion improves compared to Cloudnet the possibilities of detecting drizzle from the ground and is currently being implemented as an extension to the Cloudnet target categorization algorithm.
ICON-LEM is an LES model with characteristics that makes is especially interesting to be compared to ground-based observations. We used the radar forward simulator PAMTRA to evaluate the process of drizzle formation in the measurement space by deriving radar Doppler moments: we apply CLADS to ICON-LEM output as well as to observations and we develop an analysis of clouds in a multivariable space including liquid water path, center of gravity and radar Doppler moments aimed at providing constraints for autoconversion parametrizations.

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Presenter: ACQUISTAPACE, Claudia (University of Cologne)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **42** Type: **Oral presentation**

Saildrone: A global class Unmanned Surface Sailing Vehicle for air-sea interaction observation and its potential as a reliable data source for NWP models

Thursday, 13 June 2019 11:00 (20 minutes)

Over the past decade, significant progress has been made in the global ocean observing system (GOOS), which is monitoring much of the upper ocean on a global scale in real time with multiple observing platforms. But observation of air-sea fluxes has been relying on fixed surface moored buoys and research and voluntary ships with limited spatial coverage. As a result, the current GOOS is not able to adequately observe the air-sea interaction processes across fronts and eddies. A recent technology development, the Saildrone, is an Unmanned Surface Vehicle (USV) powered by wind and solar energy with a range of more than 6,000 nautical miles, making it a potential platform to sample across fronts and weather systems over the global ocean. To make the Saildrones capable of observing air-sea interaction processes, we have installed sensors with equivalent or better quality than those currently used on Tropical Atmosphere and Ocean (TAO) buoys for air-sea flux measurements, and a 300-kHz Acoustic Doppler Current Profiler for upper ocean current measurements. So far, two pilot Saildrone missions have been completed in the tropical Pacific, as part of the Tropical Pacific Observing System (TPOS)-2020 project: one mission with two Saildrones deployed and recovered at San Francisco, California; the other one with four Saildrones deployed and recovered at Honolulu, Hawaii. Both missions reached the equator and sampled across the tropical Pacific cold tongue fronts and oceanic vortices. We will present the Saildrone data from these TPOS missions and use these results as an example to demonstrate the potential of Saildrones for air-sea interaction studies over the global ocean. While the Saildrone observations can provide the needed data to the Numerical Weather Prediction (NWP) models, the NWP forecasts are essential for the planning and execution of Saildrone missions for navigation and better sampling strategies. Through this presentation, we hope to open the dialogue between the USV observation and NWP modelling communities to facilitate future collaborations in better collection and use of the air-sea interaction data collected by these new platforms.

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Session Classification: New observational capabilities - Chair: Emma Pidduck

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **43** Type: **Oral presentation**

What will happen during YOPP SOP3?

Wednesday, 12 June 2019 14:30 (30 minutes)

The Special Observing Periods (SOPs) within the Year of Polar Prediction aim to provide enhanced observations for the benefit of model improvement for NWP. SOP1 and SOP2 provide additional radiosoundings for a winter and summer period during 2018. For the third one, the SOP3, it is the ambition to coordinate additional observations complementary to the MOSAiC effort. The aim is to target warm airmasses that are heading to the Arctic and the MOSAiC site and cold airmasses advected southward. For the SOP3 to be successful, NWP support is needed for planning. The presentation will present the planning and how NWP centers can be of support and what the additional data can provide to the model development.

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Presenter: SVENSSON, Gunilla (Stockholm University)

Session Classification: Polar processes - Chair: Jonathan Day

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **44** Type: **Poster presentation**

Targeted observations using dropsondes

Dropsondes are small sensor packages, which are released from aircraft to provide targeted observations for pressure, temperature, humidity, and winds, for operational forecasting and research. The vast majority of dropsondes are launched into severe storms, where they provide essential observations about the state and development of the storm. These observations have a significant impact on the forecast quality of these systems, since a number of other remote sensing instruments do not provide adequate observations and models are poorly constrained in these extreme situations.

Due to data formats and metadata restrictions, some information content is lost and may affect the use of the observations in models, which is a problem shared with radiosondes and some other in situ sensing instruments. The transition to the BUFR format is a significant improvement, but some limitations remain.

The development of dropsondes is heavily driven by forecasting needs, yet little information is available about these needs. The development of instrumental uncertainties as part of the data products has been pioneered by the GCOS Reference Upper Air Network for radiosondes and is an essential tool to characterize the quality of observations. Developing these uncertainties is very resource intensive and may, in parts, be justified by the added value for models and forecasting. Systematic biases such as dry bias issues seen in the past on radiosondes and dropsondes may negatively affect models. Closer cooperation between models and instrument developers may reduce the occurrence of instrumental issues.

Primary authors: VÖMEL, Holger (NCAR); HOCK, Terry (NCAR); GOODSTEIN, Mack (NCAR); ARENDT, Clayton (NCAR); TUDOR, Laura (NCAR); SUHR, Isabel (NCAR)

Presenter: VÖMEL, Holger (NCAR)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **45** Type: **Poster presentation**

Field Campaign Support by the NCAR Earth Observing Laboratory

The mission of the Earth Observing Laboratory (EOL) of the National Center for Atmospheric Research (NCAR) is to insure progress in the atmospheric sciences by providing end-to-end support for observational field campaigns, nationally and internationally. EOL offers scientific, technical, operational, data and logistics support in an effort to continually drive progress in atmospheric research. Facilities available for deployment include aircraft, radars, lidars, surface and sounding systems, and a range of other in-situ and remote sensing instrumentation. EOL has been serving the global atmospheric research community for more than 40 years with experience in coordinating and supporting field campaigns taking place all over the globe. Just in the last 10 years, we have supported more than 70 campaigns, 23 of which took place outside of the continental US and 17 were complex undertakings, involving multiple observing systems and investigators teams and requiring advanced planning and logistics.

Forecasts provided by numerical weather prediction models, including the ECMWF model, have a regular presence in field campaigns and are used to plan missions and guide field operations. Within the past year, EOL has been using high-resolution ECMWF model output to support SOCRATES and RELAMPAGO, two large international field campaigns. Working with ECMWF, EOL has provided specific analyses and forecast fields that were requested by the project principal investigators. The ECMWF model analyses have been also used to initialize research model runs by the investigator teams. All analysis and forecast products in EOL-supported campaigns are saved in the Field Catalog –a web-based tool intended for collecting, organizing, and presenting reports; viewing quick-look data products from operational, research, and model generated sources; and finding and updating status information during the field phases of observational experiments.

Primary authors: GRUBIŠIĆ, Vanda (National Center for Atmospheric Research); Ms BAEUERLE, Brigitte (National Center for Atmospheric Research); HOCK, Terry (NCAR); Dr LEE, Wen-Chau (National Center for Atmospheric Resaerch); Dr STITH, Jeff (National Center for Atmospheric Research); Mr STOSSMEISTER, Greg (National Center for Atmospheric Research)

Presenter: GRUBIŠIĆ, Vanda (National Center for Atmospheric Research)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **46** Type: **Poster presentation**

Modeling Efforts for PRECIP2020: Prediction of Rainfall Extremes Campaign in the Pacific 2020

High-impact weather events are often accompanied by heavy precipitation over prolonged periods of time; yet, our understanding and ability to predict heavy precipitation remains deficient. This issue is of utmost importance for forecasting and scientific communities alike because heavy precipitation events can impact communities all around the world. Motivated by these issues and implications, an international field campaign will take place in the western North Pacific during the warm season (May–August) of 2020. The U.S. component of the project—Prediction of Rainfall Extremes Campaign in the Pacific (PRECIP)—will seek to identify the basic kinematic, thermodynamic, and microphysical ingredients that differentiate heavy precipitation from ordinary precipitation events with a special focus on the MeiYu front, mesoscale convective systems, and tropical cyclones. **One of the core hypotheses for PRECIP is that forecast improvements of heavy precipitation can only be achieved through the accurate representation of those basic ingredients responsible for heavy precipitation.** We plan to test this hypothesis through a comprehensive modeling effort that will inform observational strategies before the campaign and through extensive process-based analysis that will identify model deficiencies during and after the campaign.

In this presentation, I will discuss our modeling efforts which range from global to mesoscale to large-eddy simulations. I will also discuss opportunities for modeling centers, such as ECMWF, to benefit and contribute to our common goal of improving high-impact, heavy precipitation events.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **47** Type: **Poster presentation**

Impacts of Dropsonde Observations on the Predictability of Landfalling Atmospheric Rivers

Landfalling Atmospheric Rivers (ARs) provide between 30-50% of precipitation but can also cause major flooding events in the western U.S. Accurate forecasts of a landfalling AR can improve water management decisions. Sparse observations over the Pacific have limited the improvement of forecast skills for the western U.S. due to the poor upstream initial conditions. While the numerical weather prediction reaps the benefits of satellite data over the oceans, those data poorly represent the low-level circulation and the vertical structure of water vapor in ARs. E.g., the landfall position error in the National Centers for Environmental Prediction Global Forecast System is about 400 km at 3-day lead time.

In the winters of 2016 and 2018, nine aircraft reconnaissance missions were carried out targeting AR conditions on the eastern Pacific. More than 600 dropsondes measured vertical profiles of wind, water vapor, temperature, and pressure. The impact on the forecast accuracy of ARs by assimilating these dropsonde data is evaluated. Four experiments are conducted using the Weather Research and Forecasting (WRF) model with the Community Gridpoint Statistical Interpolation (GSI) system: no data assimilation (CONTROL), with the dropsonde data assimilated (DROP), with conventional data assimilated (REGULAR), and with both conventional and dropsonde data assimilated (ALLDATA). Comparisons between DROP and CONTROL show that the 1-3 day precipitation forecast error it is reduced by 5-25% when assimilating dropsondes with GSI-WRF. With the dropsonde data assimilated, WRF better simulates small features of the integrated water vapor transport and the finer structures of the precipitation and its coverage area. The value of dropsondes in addition to the conventional observations is assessed by comparing the REGULAR and ALLDATA runs. This work will also investigate the impacts of employing different error-covariance matrix on the ensemble generations used for GSI hybrid data assimilation.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **48** Type: **Poster presentation**

Potential Contributions of Airborne Radio Occultation Observations in Field Campaigns to Forecast Improvement of Hurricanes and Atmospheric Rivers

Because of its high vertical resolution and global sampling, spaceborne GNSS radio occultation has had a large impact on operational numerical weather prediction. Implementation of this technology on aircraft greatly increases the density of this type of observations for use in field campaigns and provides the capability to target observations in sensitive regions where the forecast can potentially be improved. Airborne radio occultation (ARO) measures signal propagation delay from rising and setting GNSS satellites below the local horizon that sample the atmosphere in the region up to 600 km to the sides of the aircraft. The derived profiles are thus complementary to dropsondes released directly below the aircraft. The benefits of this strategy were demonstrated during research flights which were forced to avoid convective towers in the genesis region of hurricane Karl. ARO observations were made through these regions that were impossible to fly over, thus expanding greatly the capabilities of the aircraft during the field campaign. The observations helped to show in data assimilation experiments that the flow of mid-level dry or moist air affected the hurricane development. Several variations of the original GNSS Instrument System for Multistatic and Occultation Sensing (GISMOS) have flown subsequently in field campaigns targeting atmospheric rivers, where both ensemble and adjoint methods were used to determine sensitive areas for potential rapid uncertainty/error growth. With multiple measurement objectives, ie quantifying integrated vapor transport in the pre-frontal low-level jet as well as reducing uncertainties in the dynamics of the system, we show how ARO contributes to realizing these multiple objectives by easily expanding the region of the atmosphere sampled during each flight. We also show how using true GNSS (GPS plus Galileo) expands that area still further, and increases confidence in observation errors assigned to the data type in data assimilation.

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Presenter: Dr HAASE, Jennifer S. (Scripps Institution of Oceanography, UCSD)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **49**   Type: **Poster presentation**

Assessing the predictability of mesoscale precipitation processes in landfalling atmospheric rivers using AR Recon dropsonde observations

Atmospheric River Reconnaissance (AR Recon) is an airborne meteorology field campaign designed to improve the observation of impactful weather events ahead of landfall on the U.S. West Coast. Observations of the full profile of moisture, winds and temperature within atmospheric rivers (AR) during their evolution and propagation over the northeastern Pacific Ocean provides useful information for numerical weather prediction, which is an initial value problem. While AR Recon observations were assimilated in near real-time by global forecast models, the collected data are also key to better understanding the dynamical processes that define AR characteristics, such as their intensity, propagation, duration and precipitation production. This presentation utilizes AR Recon observations from 2018 and 2019 to evaluate the ability of a near real-time version of WRF in representing the evolution of mesoscale precipitation processes, such as narrow cold-frontal rainbands and mesoscale frontal waves, which strongly modulate AR characteristics. The representation of these processes in numerical weather prediction is an important challenge for forecasting precipitation impacts in the Western U.S.. Specific predictability challenges and opportunities for advancement are detailed through the example of a well-observed case study during the 2019 field campaign in which dropsonde data was collected along transects of an AR and its attendant cyclone as it underwent rapid cyclogenesis offshore of Southern California. Through dropsonde observations in the offshore environment, and radiosonde observations of the same features 24 hours later during landfall, it is shown that WRF skillfully represents the physical processes responsible for the development and maintenance of an impactful narrow cold-frontal rainband, for example. However, uncertainty in the timing, orientation, propagation and inland extent of this feature limits the extent to which the model can be used to predict associated hazards at small scales. This analysis and a range of additional examples lend confidence to the utility of WRF as a situational awareness tool for short-to-medium range forecasting of mesoscale precipitation processes in landfalling ARs. Importantly, the continued development methodologies to assess the representation of physical processes in global and mesoscale models using AR Recon observations will provide advanced insight into precipitation forecast uncertainty in landfalling ARs.

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Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **50** Type: **Poster presentation**

Forecast Informed Reservoir Operations (FIRO): Supporting Forecast Improvements through Targeted Data Collection

Forecast Informed Reservoir Operations (FIRO) is a proposed alternative management strategy that aims to use data from watershed monitoring and state of the art weather and streamflow forecasting to improve water supply reliability without impairing flood protection. Lake Mendocino, located in northern California, US, is a current testbed for this strategy. This project was guided by the Lake Mendocino FIRO Steering Committee (SC), which consists of water managers and scientists from several federal, state, and local agencies, and universities. The SC shares a vision that operational efficiency can be improved by using monitoring and forecasts to inform decisions about releasing or storing water. Assessment is underway that will consider and recommend FIRO strategies that could be implemented in the near term using current technology and scientific understanding. This effort will also identify and develop new science and technologies to ensure the successful implementation of FIRO and increased benefits in the long term.
An extensive data collection campaign has been underway since January 2017, with the objective to improve precipitation forecast skill through improved understanding of atmospheric rivers (ARs), the storms that bring the most precipitation to this watershed. The goal is understanding AR evolution as the AR makes landfall and interacts with terrain, understanding the effect of ARs on watershed management and hydrology, and to form a unique database for model verification. Coastal and inland field sites equipped with multiple ground-based sensors as well as Vaisala radiosonde systems and profiling radars support these objectives. This network provides a high resolution look at how low level water vapor flux brought by ARs moves through the watershed. This presentation will provide an overview of the FIRO project, with an emphasis on the field data collection program and its role in helping to achieve major FIRO science and management goals.

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Presenter: WILSON, Anna (University of California San Diego)

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **51** Type: **Oral presentation**

Cloudy boundary layers over the Northeast Pacific and Southern Ocean: Field observations and ERA5

Tuesday, 11 June 2019 11:30 (30 minutes)

In recent years, field campaigns have deployed modern in-situ and remote-sensing instrumentation in diverse marine cloudy boundary layer regimes. For example, the CSET (2015) airborne campaign sampled across the NE Pacific stratocumulus-cumulus transition between California to Hawaii. The Southern Ocean Atmospheric Research program (2016-8) comprised four observational campaigns (SOCRATES, CAPRICORN, MICRE and MARCUS) sampling between Tasmania and Antarctica, including airborne, ship and island measurements of cloud microphysics, precipitation, turbulence, thermodynamic profiles, and aerosols.
This talk will summarize observations taken during these campaigns and compare them with ERA5. In general, ERA5 is remarkably consistent with in-situ wind and temperature measurements, locates high relative-humidity layers accurately, boundary-layer vertical structure moderately accurately, and the vertical structure of cloud, precipitation and ozone somewhat less accurately. It slightly outperforms MERRA-2 in almost all respects.

Primary authors: BRETHERTON, Chris (University of Washington); MCCOY, Isabel (University of Washington)

Presenter: BRETHERTON, Chris (University of Washington)

Session Classification: Clouds - Chair: Irina Sandu

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **52** Type: **Oral presentation**

Learning about clouds and circulation during EUREC4A

Tuesday, 11 June 2019 11:00 (30 minutes)

To follow

Primary author: BONY, Sandrine (CNRS, LMD/IPSL, Sorbonne University)

Presenter: BONY, Sandrine (CNRS, LMD/IPSL, Sorbonne University)

Session Classification: Clouds - Chair: Irina Sandu

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **54** Type: **not specified**

Opening and welcome

Monday, 10 June 2019 13:00 (15 minutes)

Presenter: PAPPENBERGER, Florian (ECMWF)

Session Classification: From models to observations and back - Chair: Linus Magnusson

Contribution ID: **55** Type: **Oral presentation**

How ECMWF supports field campaigns

Monday, 10 June 2019 13:15 (15 minutes)

Presenter: PIDDUCK, Emma (ECMWF)

Session Classification: From models to observations and back - Chair: Linus Magnusson

Contribution ID: **56** Type: **Oral presentation**

From Models to Data

Monday, 10 June 2019 13:30 (30 minutes)

Often it is thought that observations exist to serve models. A commonplace idea in the atmospheric and climate sciences is that observations exist to 'verify', 'evaluate' or 'improve' models. In this talk I instead focus on how models can be used to guide observations. By identifying specific processes underlying a particular type of modeled behavior, models can instead be used to craft hypotheses that observations can be used to test. This is an old-fashioned an familiar idea for much of the physical sciences, but poorly practiced in atmospheric and climate science. Examples will be provided of where this has been successful, and why it might be useful to think of models as tools for guiding and sharpening observations, rather than the other way around.

Primary author: STEVENS, Bjorn (Max Planck Institute for Meteorology)

Presenter: STEVENS, Bjorn (Max Planck Institute for Meteorology)

Session Classification: From models to observations and back - Chair: Linus Magnusson

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **58** Type: **Oral presentation**

The gauging and modelling of rivers in the sky

Wednesday, 12 June 2019 10:00 (30 minutes)

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Primary author: LAVERS, David (ECMWF)

Presenter: LAVERS, David (ECMWF)

Session Classification: Tropical and extra-tropical dynamics - Chair: Andreas Schäfler

Track Classification: Workshop: Observational campaigns for better weather forecasts

Contribution ID: **60** Type: **Oral presentation**

How ARM/ASR observations have contributed to ECMWF model development

Monday, 10 June 2019 17:00 (30 minutes)

Presenter: SANDU, Irina (ECMWF)

Session Classification: From models to observations and back - Chair: Mohamed Dahoui

Contribution ID: **61** Type: **Oral presentation**

Impact assessment approaches for field campaign data

Tuesday, 11 June 2019 10:00 (30 minutes)

Presenter: DAHOUI, Mohamed (ECMWF)

Session Classification: Diagnostics or making use of the data - Chair: Mark Rodwell

Contribution ID: **62** Type: **Oral presentation**

Operational briefing

Monday, 10 June 2019 17:30 (30 minutes)

Presenters: DEHART, Jeremy (USAF Reserve Hurricane Hunters); RICKERT, Ryan (53 WRS Hurricane Hunters)