Arctic OSSE

Evaluate and Improve the Usage of Arctic Observation for Weather and Extended Range Forecasts using OSEs and OSSEs with NGGPS. Preparation for YOPP and beyond.

Principal investigator

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Areas of contribution

Modelling and forecasting

Observations

Data assimilation

Economic aspects

Summary

Arctic ice has declined during the last decade, and possibly related unprecedented abnormal midlatitude weather has been reported. There is evidence that a more complete Arctic observing system will improve tropical cyclone track forecast in the mid latitudes. Arctic observations require urgent research efforts for effective planning to prevent or mitigate potentially large societal and economic losses.

In this project, effective observation system in the Arctic region to improve Arctic and mid-latitude extended-

range forecasts will be investigated using Observing System Simulation Experiments (OSSEs). Global and Regional OSSEs and theoretical prediction can provide complementary information about requirements for future Arctic observing systems. First, OSSEs with global coverage will be conducted at relatively low resolution, and resolution will then be varied to evaluate how the observation impact depends on the model resolution and various configurations. The impact of higher resolution will be investigated with regional OSSEs with advanced physics over the Arctic.

Simulated experiments with idealized observations will be conducted in the initial stage. Idealized observations are designed based on the distribution of planned potential observing systems without current technical limitations.

The task will be accomplished by making the best use of the recently developed US operational weather forecast system including the Next Generation Global Prediction System (NGGPS). The Nature Run (NR), simulated 'truth' for the OSSEs, which is most suitable for this project, is being prepared.

Description

Arctic ice has been reduced during the last decade, unprecedented abnormal midlatitude weather has been reported. Although the impact of Arctic weather to midlatitude extended-range forecast has been discussed, the quality of existing observing systems, forecast systems, verification systems over the Arctic are not sufficiently developed to evaluate effective future Arctic observing systems. As we enter the Year of Polar Prediction (YOPP) in 2019, forecast and verification systems in the Arctic need to be improved in order to evaluate observing systems effectively. Arctic observations require urgent research efforts for effective planning to prevent potentially large societal and economic losses.

In this project effective observation system in the Arctic region to improve Arctic and midlatitude extended-range forecasts will be investigated using Observing System Simulation Experiments (OSSE Masutani et al 2010, Masutani et al 2013). Global and Regional OSSE, and theoretical prediction can provide complementary information about requirements for future Arctic observing systems.

There is evidence that Arctic observing system will improve tropical cyclone track forecast in midlatitude. Inoue (2017) presented a results which showed this. Since these results are limited case studies, the results could be affected by sampling. Number of Arctic observation is limited and quality is poor. In this project, simulated experiments with idealized observations will be conducted in the initial stage. Impact of Arctic observation will be tested with idealized observations to design the future observing system with better technology.

Recently extra Radiosonde were launched on 23 February 2018 at the Finnish Meteorological Institute's Sodankylä site as part of the YOPP special observing period. ECMWF planned to evaluate the forecast impact of these extra observations. Evaluation using NGGPS is a potential task in this project.

An OSSE with idealized observation was conducted in the past (Woollen et al 2008), then the focus was moved to simulate more realistic observation and realistic observational (Boucabara et al 2017) errors (Errico and Privé 2014). Simulation of realistic observation takes up significant resources for high density observations such as observations from GOES-R and Himawari. Realistic error depends on development of technology and forecast systems. Emissivity models over ice and snow require much more development and are introducing serious uncertainty in both satellite observation and assimilation for weather forecasts over the Arctic. We need to avoid

valuable Arctic observing system from being eliminated from future plans due to the limitations of current technology.

Idealized observations are designed based on distribution of planned potential observations. Ground-based profilers, ship observations from the newly opened Arctic Oceans, and space-based observations such as GPSRO, DWL, sounders, will be evaluated. The international community will be invited to propose future possible observing systems. When CSEM and CRTM are developed further more realistic observations will be able to be simulated and assimilated.

First, OSSE with global coverage will be conducted at relatively low resolution and resolution will then be varied to evaluate how the observation impact depends on the model resolution and various configurations. In OSSEs, often only high resolution experiments are conducted. As results, all resource has are consumed by only few experiments. However, reliable OSSEs require many experiments with various conditions. The impact of higher resolution will be investigated with regional OSSEs with advanced physics over the Arctic by OSU. OSU has conducted regional reanalysis over the Arctic and has very extensive experience in analysis there.

The task will be accomplished by making the best use of the recently developed NGGPS including NCEP data assimilation system. The first version of NGGPS forecast model, FV3GFS was released in April 2018. An early version of NGGPS has already been implemented at one of the NSF computers and is being tested by DTC. A new forecast verification systems, Met+, over Arctic will be implemented in 2019. Ohio State University (OSU) will conduct regional OSSEs in coordination with the development of operational weather forecasts and future forecast systems. Through this project new NGGPS system will be tested and evaluated using ideal data sets.

Numerical Weather Prediction (NWP) over the Arctic region is one of the new frontiers in weather forecasting. The Arctic region is difficult and has received limited attention from the NWP community, and forecast performance there has not been well evaluated. The forecast verification packages for the Arctic region in operational centers are still limited and require further development. Due to increasing activities in the Arctic region the economic impact of the region has increased, as has the economic damage of unreliable forecasts.

In order to evaluate impact of Arctic observation on the global weather forecast in this project. A diagnostic evaluation of this connection needs to be completed with new CSFR reanalysis at NCEP. The Met+ over Arctic region will be evaluated in this project with idealized OSSE. Some development for the treatment of ice in the radiative transfer model and emissivity model at JCSDA is required to improve data assimilation. Through this project NWP system will be evaluated by OSSEs.

The Nature Run (NR) with O1280 (Dando 2016), Octahedral 1280, with horizontal resolution 9km and with 137 levels, which has demonstrated extended range forecast skill, will be produced by ECMWF. The NR will be acquired by NOAA and shared with the scientific community. Various software to simulate observations were developed at JCSDA and released to the scientific community and are useful to this project.

Timeline

2019-01-01 - 2021-12-31

User relevant aspects

USER (International Academic community and operational community)
Observing System Simulation Experiments for International collaborative Joint OSSE.
Simulate basic observation from Nature Run will be shared with Joint OSSE community.
Help implementation of FV3 NGGPS to academic community

Provider relevant aspects

Provider (US Academic and operational community)
Evaluation of Arctic observation in real data.
Testing new FV3 NGGPS in US in idealized environment.
Help implementation of FV3 NGGPS to academic community (O2R) and feedback from academic to operation (R2O)
Enhance awareness of Arctic in US operational forecast.

Regional emphasis

Northern hemisphere: Yes

Southern hemisphere: No

Further specification

The impact of Arctic weather to midlatitude extended-range forecast including improving tropical cyclone track forecast in midlatitude.
Plan for future observing system over Arctic.
Evaluate YOPP observation data using OSSE
Arctic observations require urgent research efforts for effective planning to prevent potentially large societal and economic losses.

Key project deliverables

In this project, simulated experiments with idealized observations will be conducted in the initial stage. Impact of Arctic observation will be tested with idealized observations to design the future observing system with better technology.
Global OSSE system and regional OSSE over Arctic with the new Nature Run.
Recommendation for YOPP observation

Data management

NSF supercomputerss
NCAR Archive
Ohio Stata University
University of Maryland

Potential archive
NOAA R&D computer
NASA portal

Is data provided to WMO Global Telecommunication System

No

Real-time provision

not relevant

Other information

We will submit a proposal to NSF after we receive endorsement from YOPP. Then submit proposal to NOAA and NASA.
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Timelines

Location	Latitude	Longitude	Start date	End date	Activity
Maryland, Colorado, in United States of America	39N	77W	2019-01-01	2021-12-31	Global Observing System Simulation Experiments
Ohio United States of America	40N	83W	2019-01-01	2021-12-31	Diagnostics of the Nature run and Regional OSSE
National center for Atmospheric research, Bolder Colorado	37N	95W	2019-01-01	2021-12-31	Observing System Simulation Experiments, theoretical research
National Centers for Environmental Prediction, College Park, Maryland, USA	39N	77W	2019-01-01	2021-12-31	Support development of OSSE system