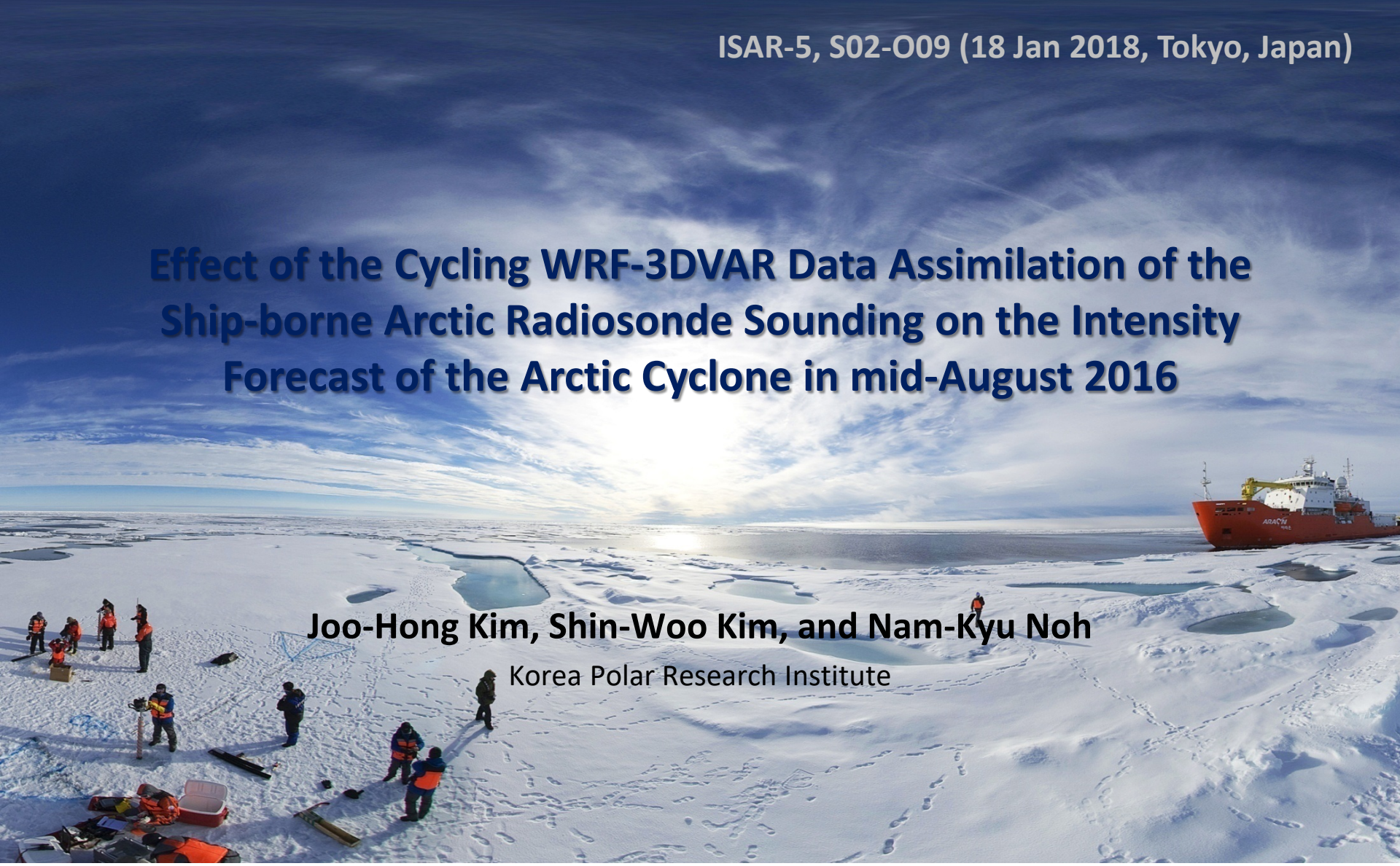
ISAR-5, S02-O09 (18 Jan 2018, Tokyo, Japan)

Effect of the Cycling WRF-3DVAR Data Assimilation of the Ship-borne Arctic Radiosonde Sounding on the Intensity Forecast of the Arctic Cyclone in mid-August 2016



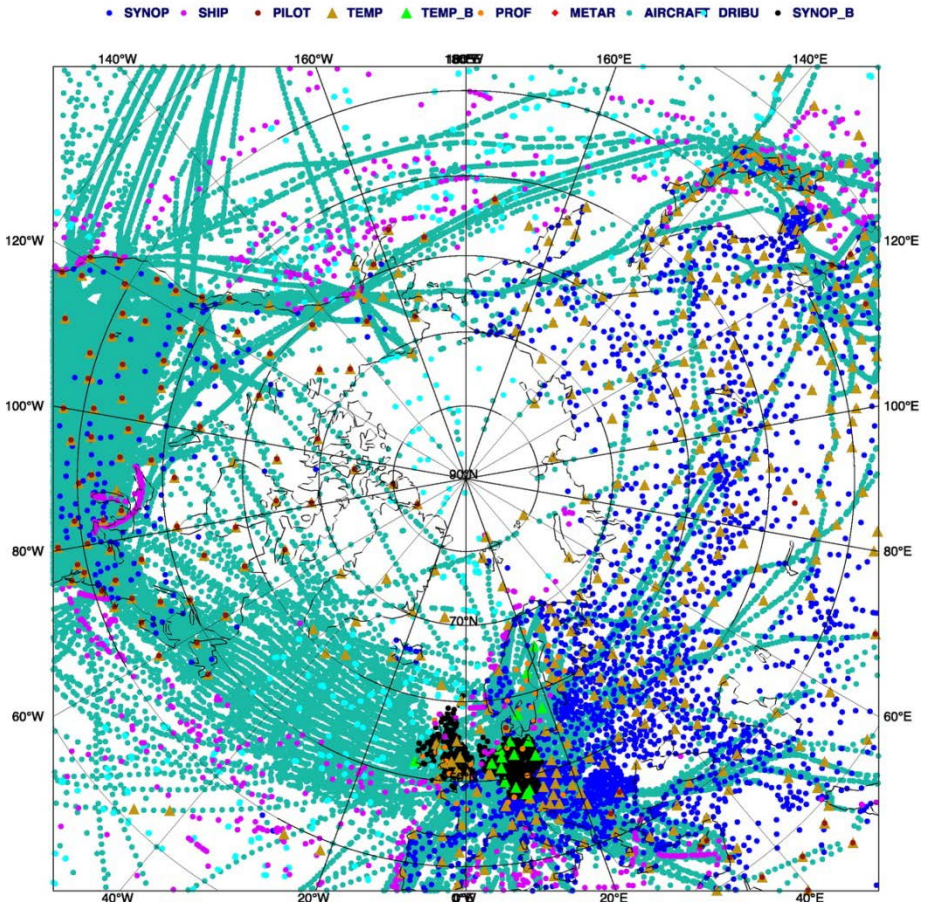
Joo-Hong Kim, Shin-Woo Kim, and Nam-Kyu Noh

Korea Polar Research Institute

Special Thanks to Liran Peng, Xiangdong Zhang, Zhaomin Wang, Zelin Xie, Chang-Kyu Lim and Yizhi Li for their observation support

Gaps in the Arctic observations

- Conventional observations of different types (assimilated by ECMWF on 15 April 2015)



Jung et al. (2016, BAMS)

"The polar regions are among the most sparsely observed parts of the globe by conventional observing systems."

Year Of Polar Prediction (YOPP)

- **An extended period of coordinated intensive observational and modelling activities**, in order to improve prediction capabilities for the polar regions and beyond, on a wide range of time scales from hours to seasons

- A key element of the WWRP-PPP

Preparation Phase 2013 to mid-2017	YOPP mid-2017 to mid-2019	Consolidation Phase mid-2019 to 2022
Community engagement	Intensive observing periods & satellite snapshot	Data denial experiments
Alignment with other planned activities	Dedicated model experiments	Model developments
Development of Implementation Plan	Research into use & value of forecasts	Dedicated reanalyses
Preparatory research	Intensive verification effort	Operational implementation
Summer school Workshops	Summer school	YOPP publications
Fundraising & Resource mobilization		YOPP conference

Making our data online

ECMWF

ECMWF
Global Data Monitoring
Report

August 2017

IBRV Araon

DSQL7	12	Z	100	18	11.3	-10.3
DSQL7	00	Z	100	27	8.4	-5.8

YOPP endorsement

YOPP YEAR OF POLAR PREDICTION

Newsletter #03 // Aug. 2017

International Coordination Office (ICO) of the Polar Prediction Project

PPP WORLD METEOROLOGICAL ORGANIZATION

Find more information at www.polarprediction.net

AWI ALFRED-WEGENER-INSTITUT HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Dr Baek-Min Kim and Dr Joo-Hong Kim
Korea Polar Research Institute
Get-pearl Tower
12 Gaetbeol-ro, Yeonsu-gu
Incheon 406-408
Korea

Via E-Mail: bmkim@kopri.re.kr and joo-hong.kim@kopri.re.kr

08.05.17

YOPP Endorsement for ***The Korea Polar Prediction System for Climate Change and Weather Disaster (KPOPS)***

Dear Dr Baek-Min Kim and Dr Joo-Hong Kim,

Following your application for YOPP endorsement, the PPP steering group has reviewed your request taking into account the following criteria:

- The project addresses or contributes to the general YOPP objectives as outlined in the YOPP Implementation Plan.
- The project acknowledges the importance of close coordination of all planned YOPP activities.
- There is agreement that a summary of the planned activities of the endorsed projects/programmes/initiatives (including their logos, if applicable) will be made public through the website of the International Coordination Office (ICO) and other appropriate means.
- Open data sharing is an important element of the project and the project data relevant to YOPP will be made available in alignment with the YOPP data strategy as outlined in the YOPP Summit report (see http://www.polarprediction.net/yopp/yopp-summit/).
- The project researchers agree to support the work of the PPP Societal and Economic Research Applications (SERA) subcommittee, e.g., by interviews, discussions, surveys or other means of communication should they be contacted by PPP-SERA.
- There is agreement that points of contact have the obligation to inform the ICO about possible changes to the project.

It is my pleasure to let you know that the PPP steering group unanimously agreed to endorse *KPOPS*. The activities make substantial contributions to YOPP.

Please note that the endorsement will be made public through the website of the International Coordination Office (http://www.polarpredicton.net).

Yours sincerely,

(Thomas Jung, Chair of the Polar Prediction Project)

...of clouds in Arctic Amplification." Read about the campaigns here and in an Eos article. **Contact**: Manfred Wendisch m.wendisch@uni-leipzig.de

The icebreaker RV Araon operated by the Korea Polar Research Institute (KOPRI) started her travels to the Chukchi, East Siberian and Beaufort Seas on 5 August. One of the several projects involved in the Arctic expedition is the YOPP-endorsed project "The Korea Polar Prediction System for Climate Change and Weather Disaster" (**KPOPS**). **KPOPS** Co-PI Joo-Hong Kim from KOPRI (joohong.kim@kopri.re.kr) leads the expedition's Arctic meteorological observations of surface and upper-air meteorological variables (including radiosondes). **KPOPS** in particular aims at improving „predictability of Arctic-mid-latitude climate change and weather disasters by enhancing Arctic atmospheric observations and climate and weather forecast models". More on the project can be found in the YOPP Explorer and here. **Contact**: Joo-Hong Kim joohong.kim@kopri.re.kr

Radiosonde launched at RV ARAON (Photo: Joo-Hong Kim)

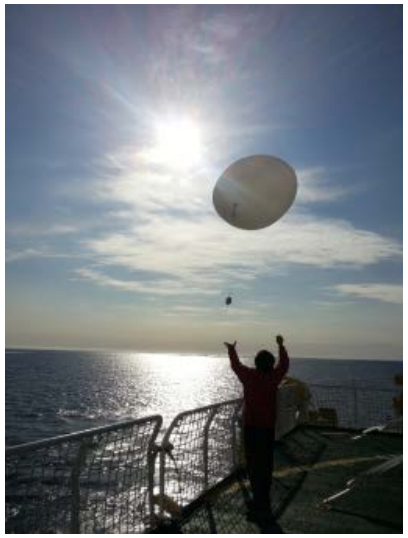
12 Horizon2020 Kick-Off Meetings | The projects APPLICATE, Blue-Action, INTAROS, ICE-ARC, INTERACT, EU-PolarNet and the newly funded Nunataryuk are all part of a cluster of EU-funded projects with a focus in the Arctic. The new EU-Arctic Cluster (Horizon2020 programme) covers a wide spectrum of topics from both natural and social sciences perspectives to improve our understanding of how the Arctic is changing and what are the expected impacts on the environment and communities living in the region. APPLICATE and Blue-Action are two of the projects in the EU-Arctic cluster that specifically contribute to YOPP.

07 / 11

Radiosonde upper air observations on IBRV Araon

(2015) August 2 ~ August 20 (Only for the leg-1 period of Arctic cruise)

- Frequency
  - Twice daily (00, 12 UTC)
  - 4-times daily (00, 06, 12, 18 UTC) around the ice camp period (18 UTC 11 Aug. ~ 12 UTC 14 Aug.)
- Total number of launch: 50



(2016) August 5 ~ September 9

- Frequency
  - Leg 1 (5 Aug ~ 21 Aug): Twice daily (00, 12 UTC) – regular, 4-times daily (00, 06, 12, 18 UTC) around the ice camp period, and 8-times daily during the ice camp period (00 UTC 14 Aug. ~ 06 UTC 15 Aug.)
  - Leg 2 (26 Aug ~ 9 Sep): Twice daily in August, 4-times daily in September with two days of 3-hourly obs (4-5 Sep)
- Total number of launch: 89

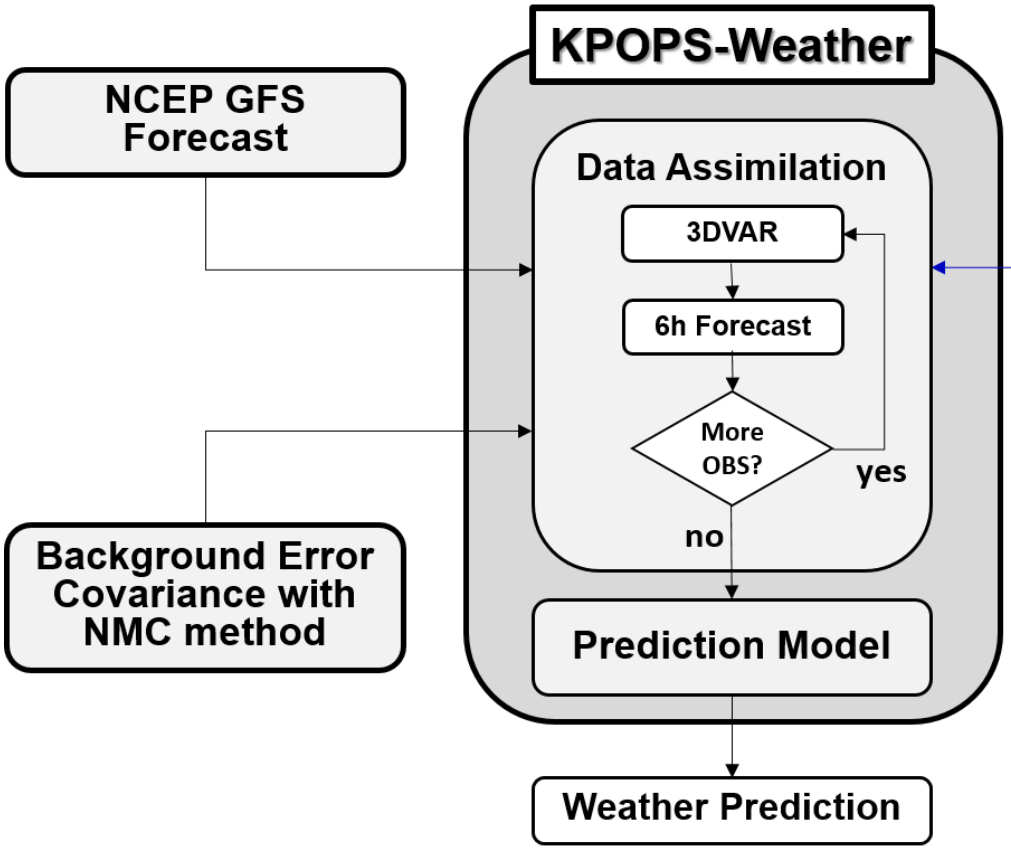
(2017) August 7 ~ September 13

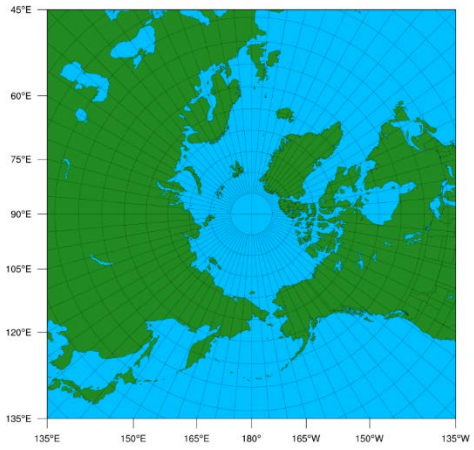
- Frequency
  - Mostly keep 4-times daily (00, 06, 12, 18 UTC)
- Total number of launch: 136
- GTS broadcasting

(2018) Early August ~ Mid-September (Special Observing Period, SOP)

Weather prediction

KPOPS(**K**OPRI **PO**lar **P**rediction **S**ystem)





< KPOPS-Weather >

- Arctic prediction system based on Polar WRF (v3.7.1)
- Arctic-Eurasia regional prediction and forecasts during ARAON cruise

Intense Arctic cyclone in mid-August 2016

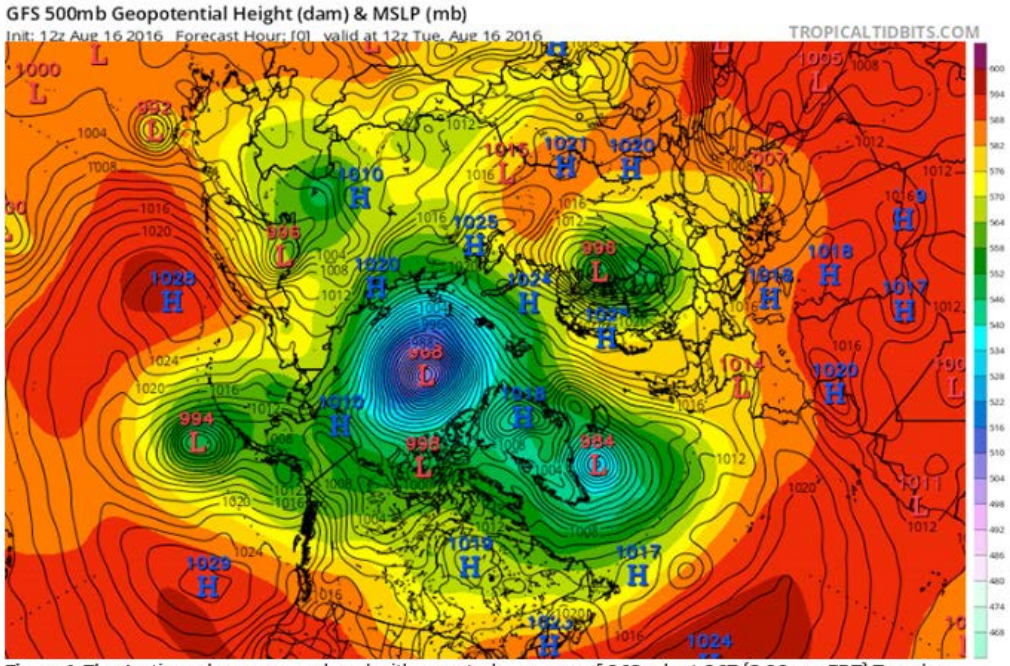


Figure 1. The Arctic cyclone was analyzed with a central pressure of 968 mb at 06Z (2:00 am EDT) Tuesday, August 16, 2016. The central pressure had risen to 971 mb by 12Z (8:00 am EDT). Image credit: tropicaltidbits.com.

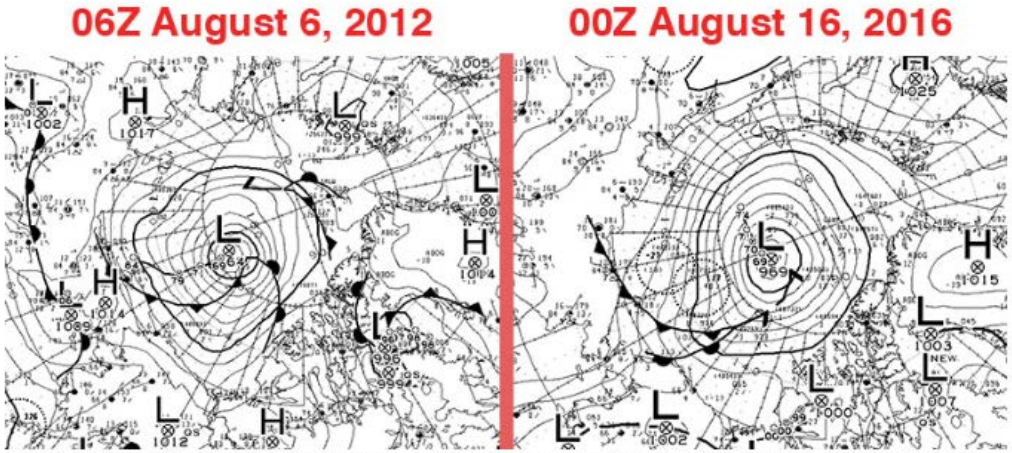
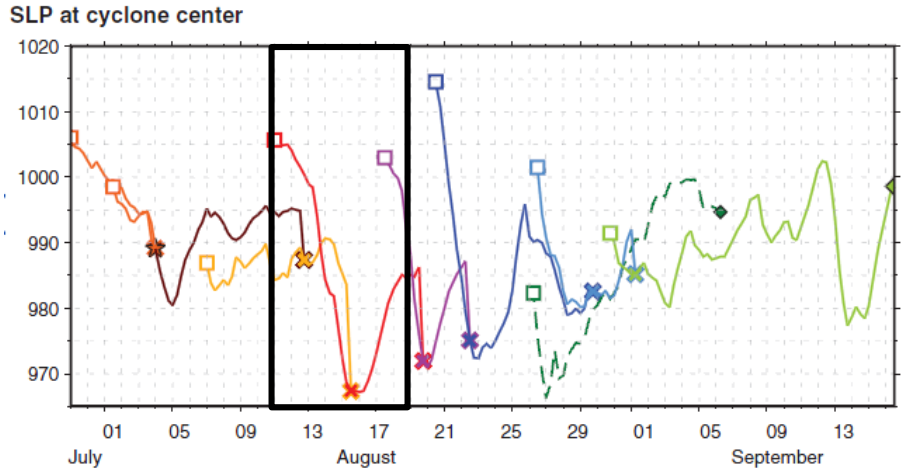


Figure 2. Surface analyses over the Arctic Ocean show the Great Arctic Cyclone of 2012 at its deepest (left, at 06Z August 6, 2012) juxtaposed with the current cyclone (right, as of 00Z Tuesday, August 16, 2016). The initial Image credit: Environment Canada.

Intense Arctic cyclone in mid-August 2016

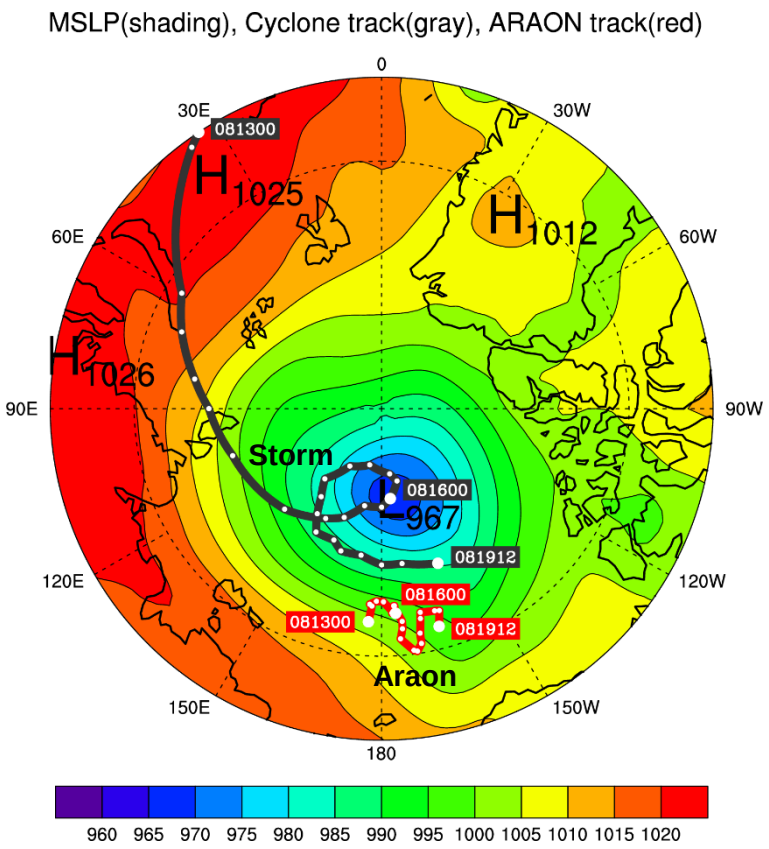
Yamagami et al. (2017): Extreme Arctic cyclone in August 2016

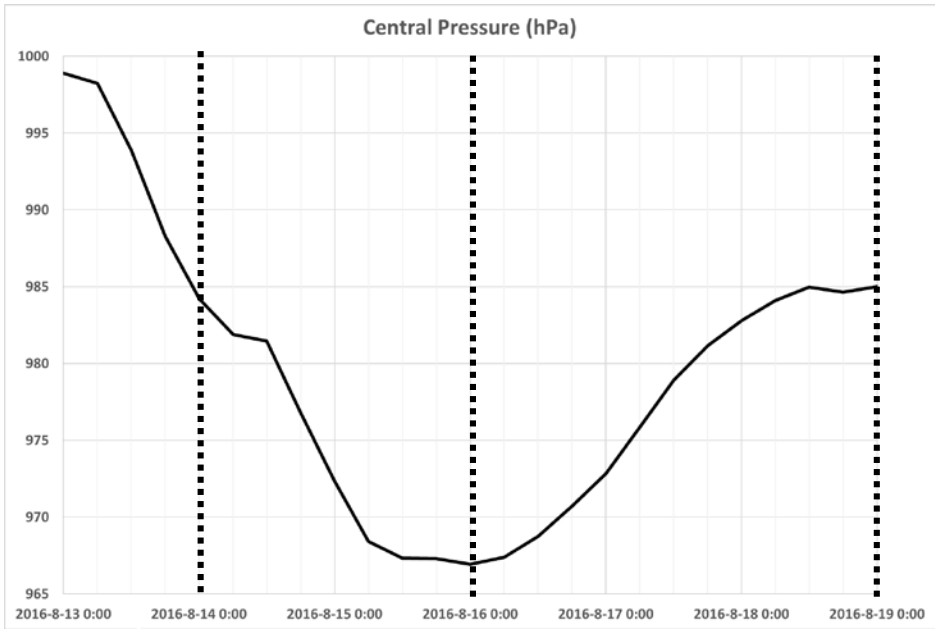
The cyclonic Arctic was maintained for more than 1 month. Baroclinic instability and mergings with cyclones are suggested as the main cause.



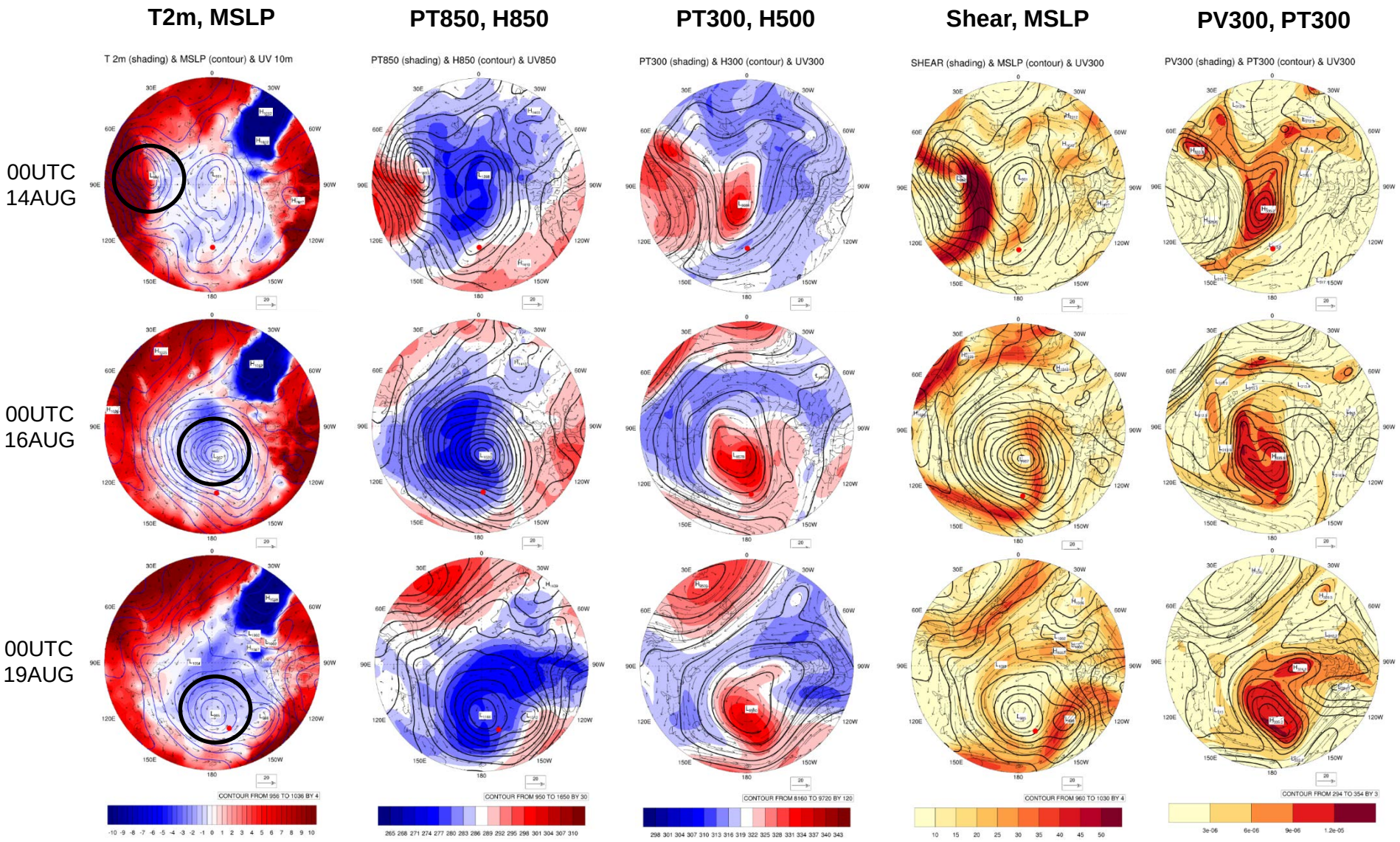
Time series of cyclone center SLP in summer Arctic 2016. Color means the each cyclone developed in Arctic area.

Intense Arctic cyclone in mid-August 2016





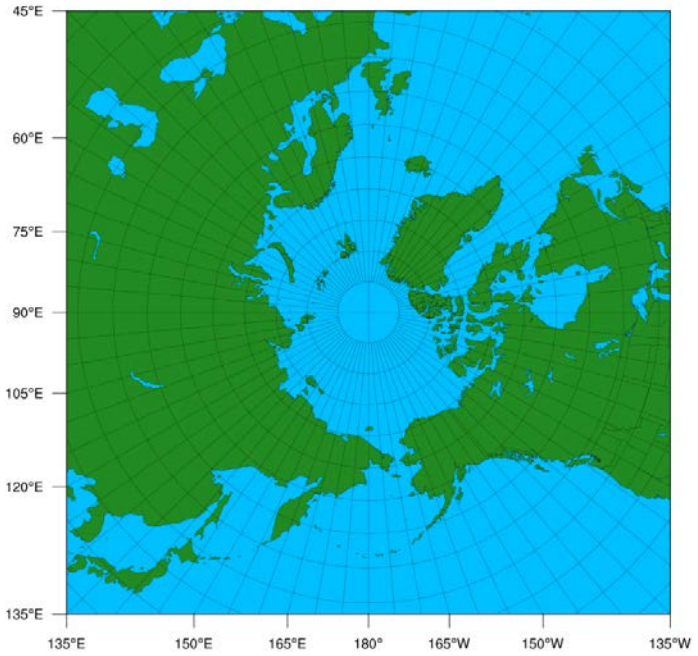
Representation in the ERA-Interim reanalysis

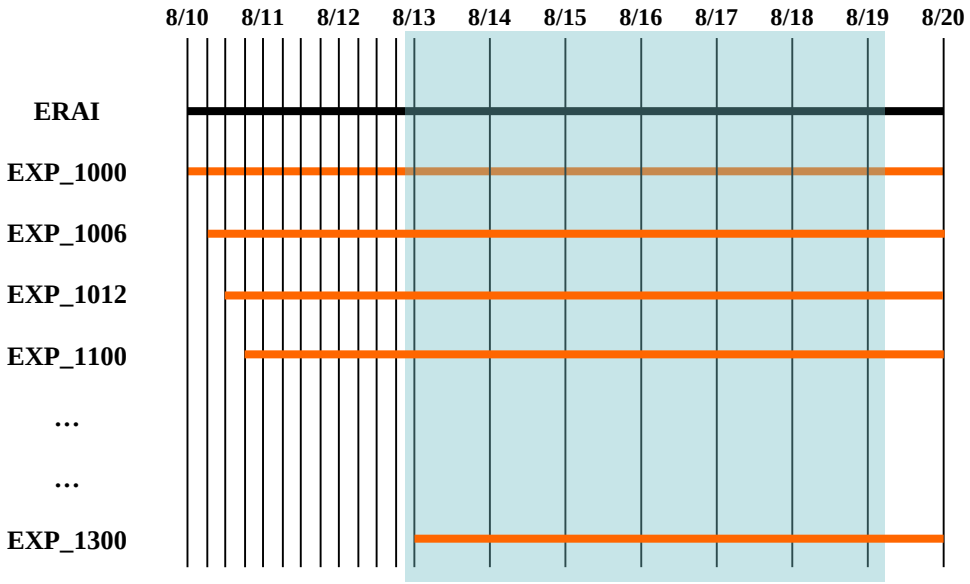


Polar WRF simulation

Model
- Polar WRF (PWRFV3.7.1)
- Spatial resolution: 27 km
- Initial data: NCEP GFS forecasts (0.5^{o})

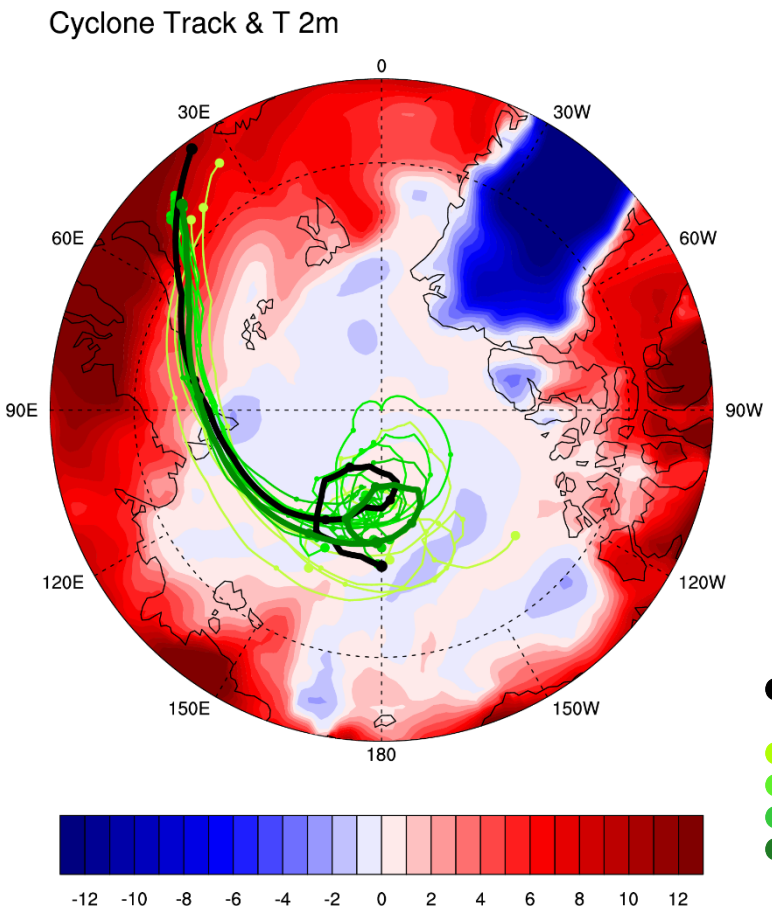
Physics Options (ASR Physics, Bromwich et al., 2016)
- Goddard scheme
- RRTMG shortwave and longwave radiation
- MYNN surface-layer
- Noah LSM
- MYNN 2.5 level TKE PBL scheme
- Kain-Fritsch cumulus

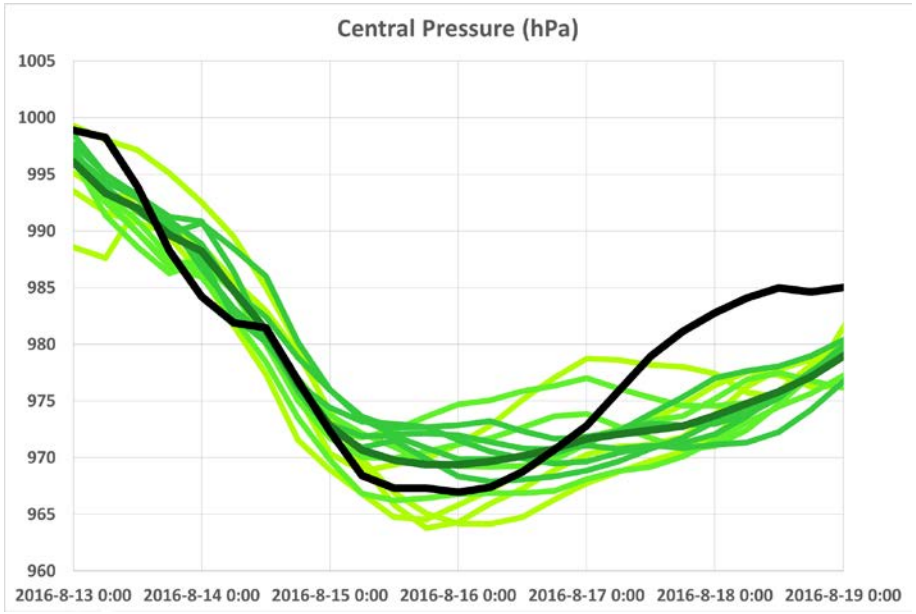




Initial condition ensemble simulations

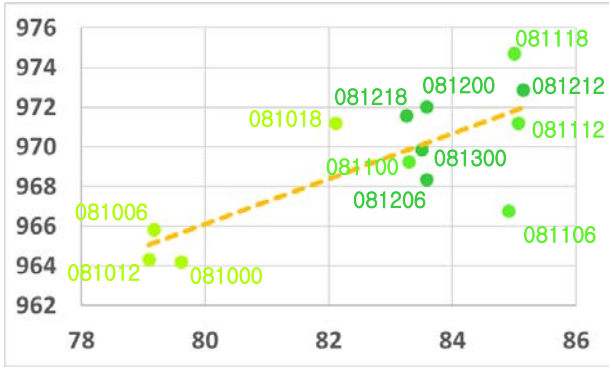
Figure: Track & Intensity





● : ERA INTERIM

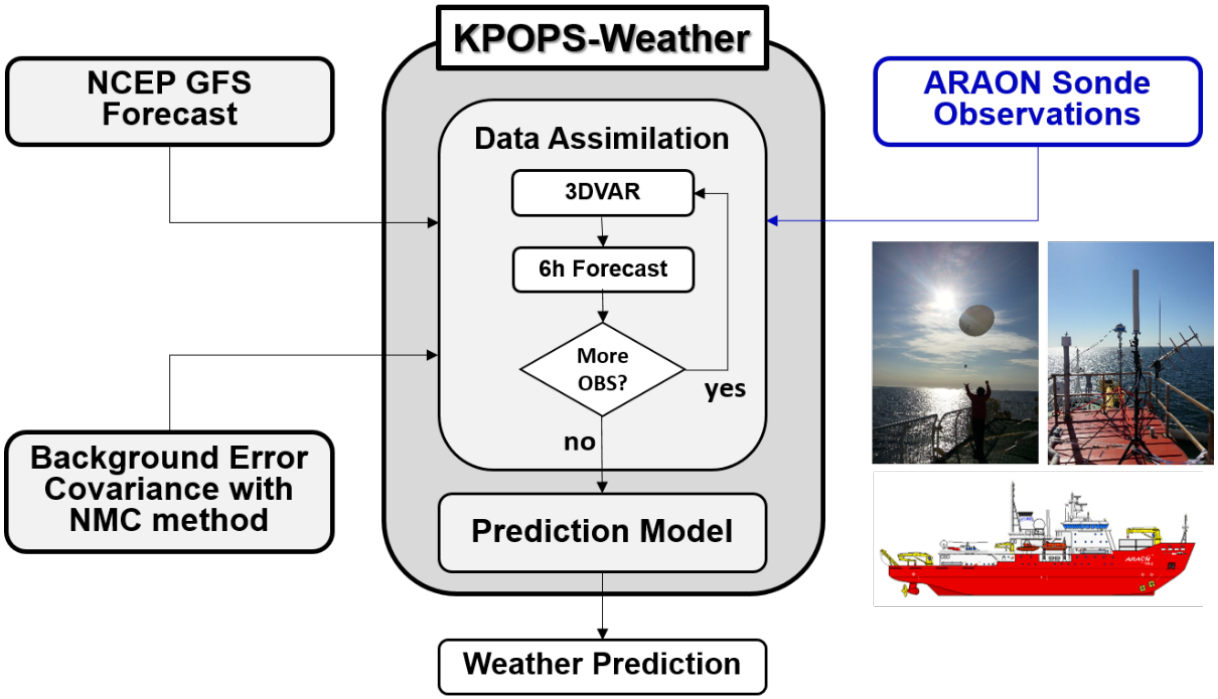
● : 081000~081018
● : 081100~081118
● : 081200~081300
● : Mean

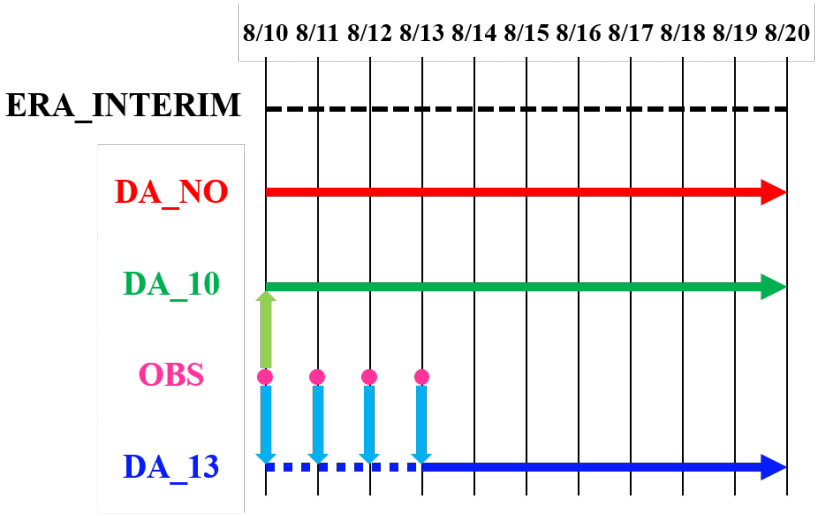


ERAI (Black), Forecasts mean (Thick green), Forecasts members (Thin green)

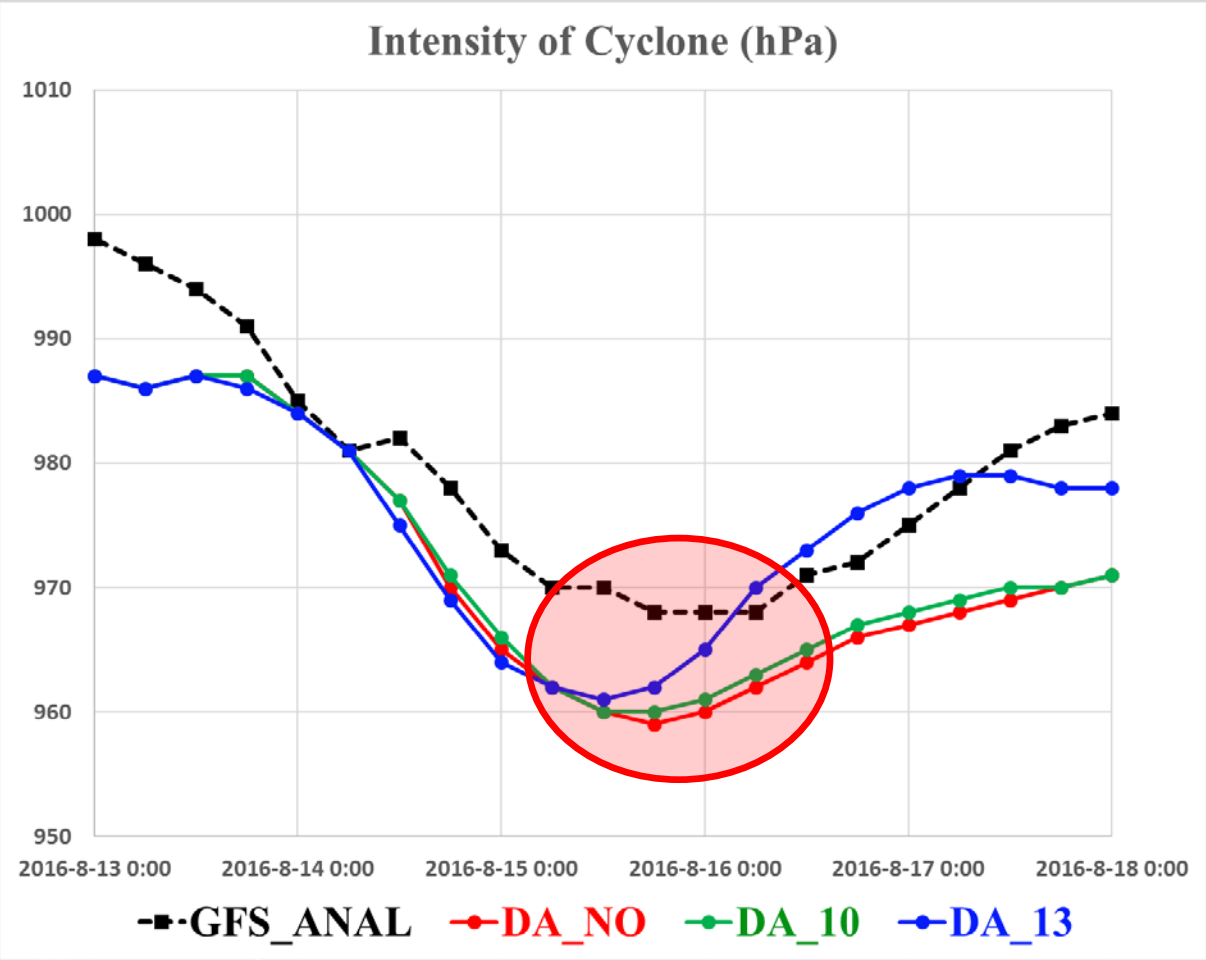
PWRF forecasts (Initial time : 8/10 00 UTC ~ 8/13 00 UTC, 6 hourly, 13 members)

Data Assimilation of Arctic Radiosonde Sounding





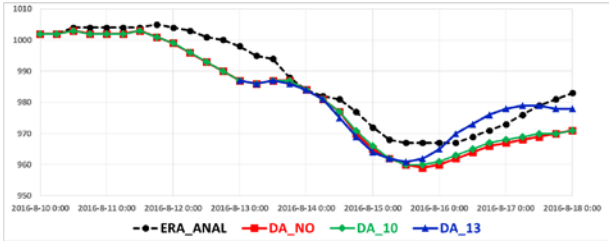
Results: Central Pressure

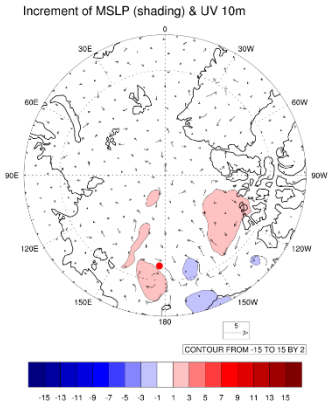


GFS analysis (black), control forecast (red), forecast by 1-profile assimilation at 00UTC 10 August (green), and forecast with 3-day cycling assimilation windows from 10 to 13 August (blue).

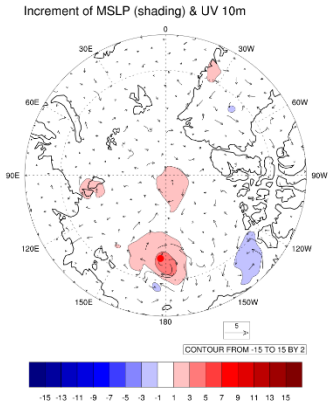
Results: Forecast Increments of MSLP

Increments (DA_13 – DA_NO)

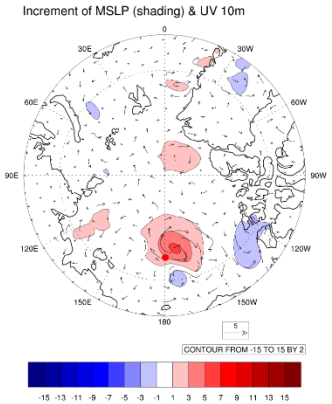




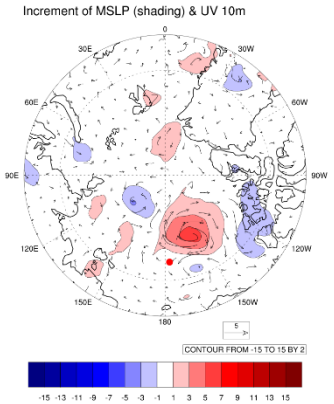
08/13 00 UTC



08/13 12 UTC



08/14 00 UTC



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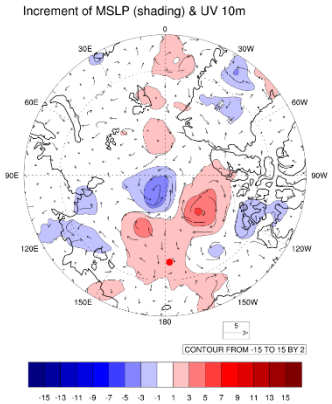

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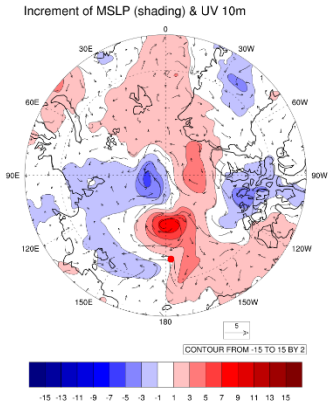

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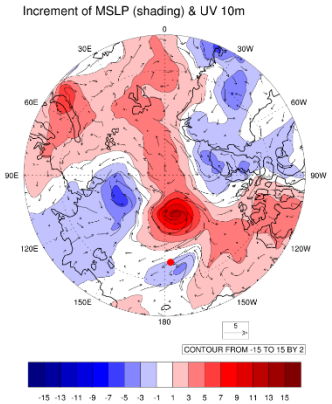

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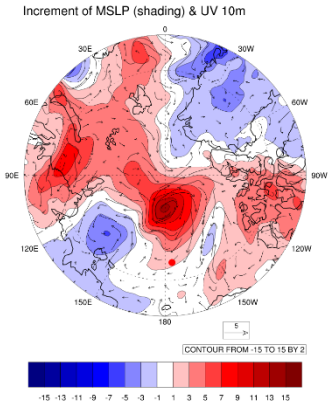
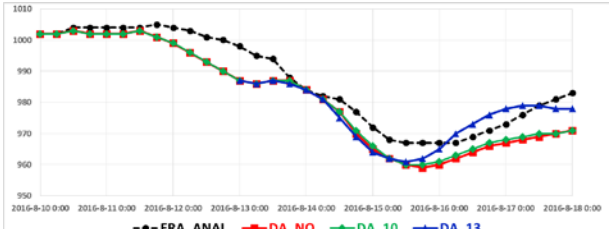
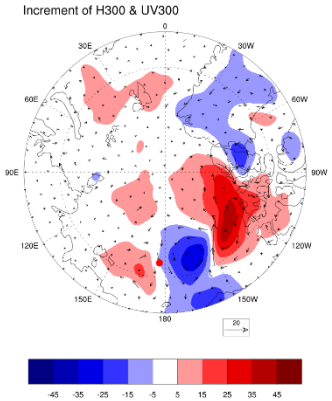


08/16 12 UTC

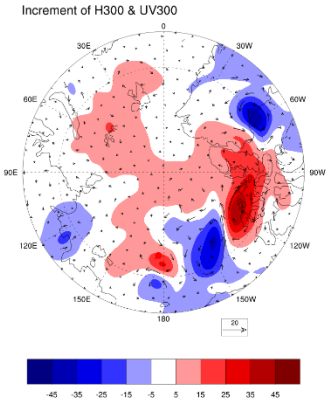
Results: Forecast Increments of GPH300

Increments (DA_13 – DA_NO)





08/13 00 UTC



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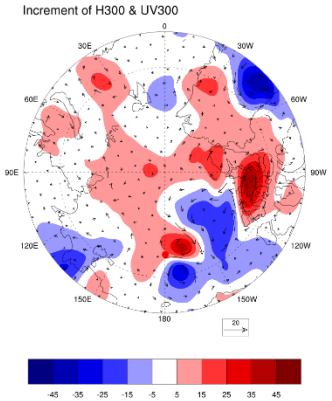
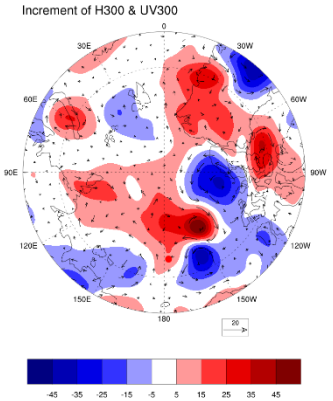


08/14 00 UTC



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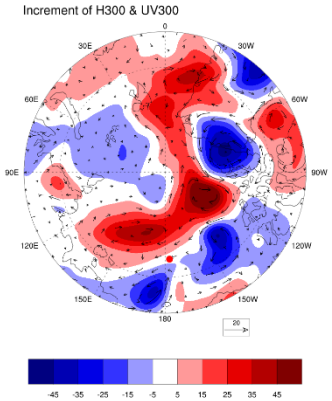

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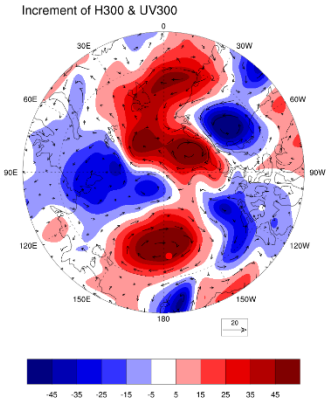

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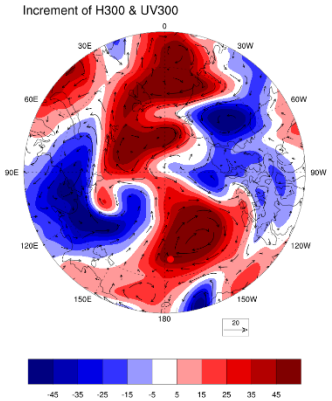
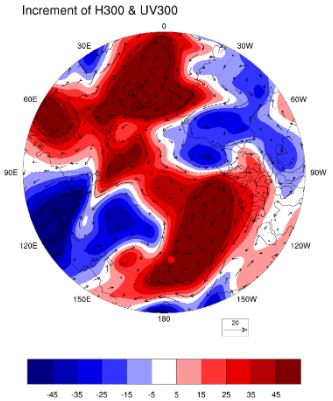
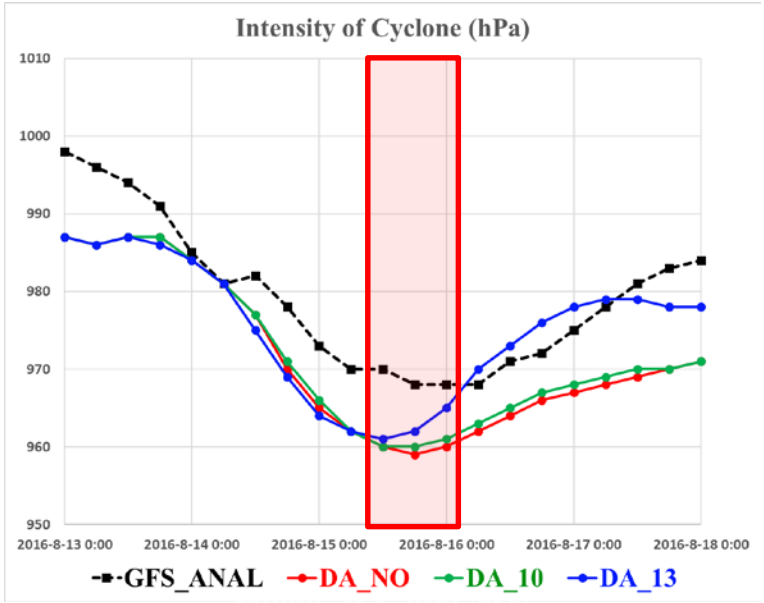


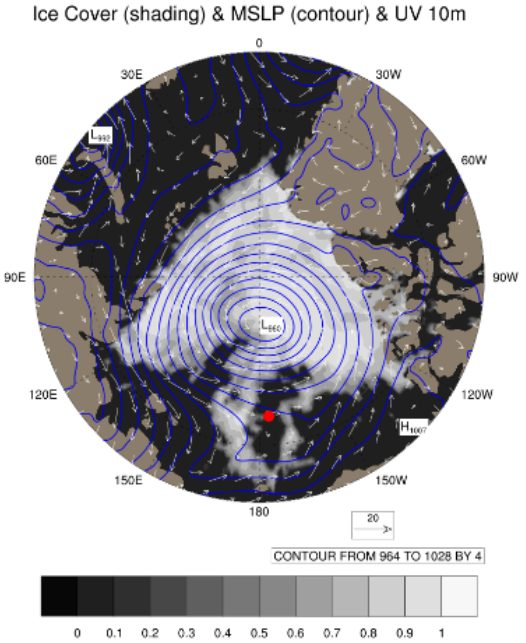
08/16 00 UTC

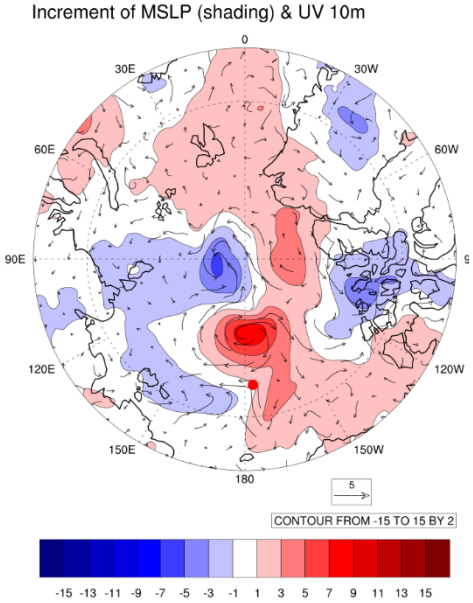


08/16 12 UTC

Results: Forecast Increments of MSLP







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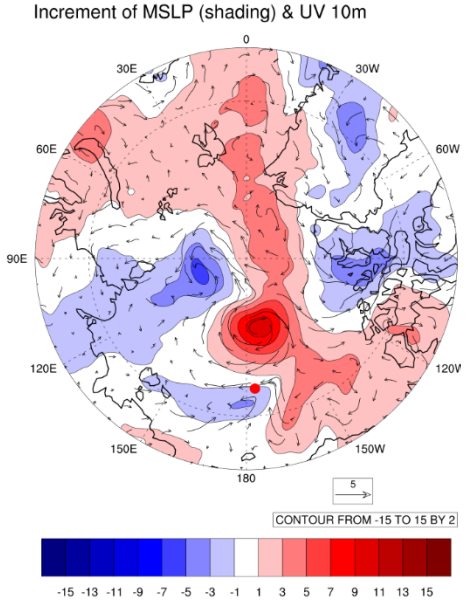
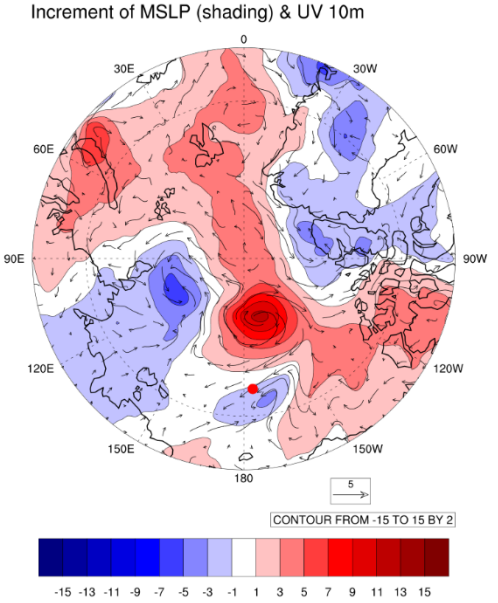
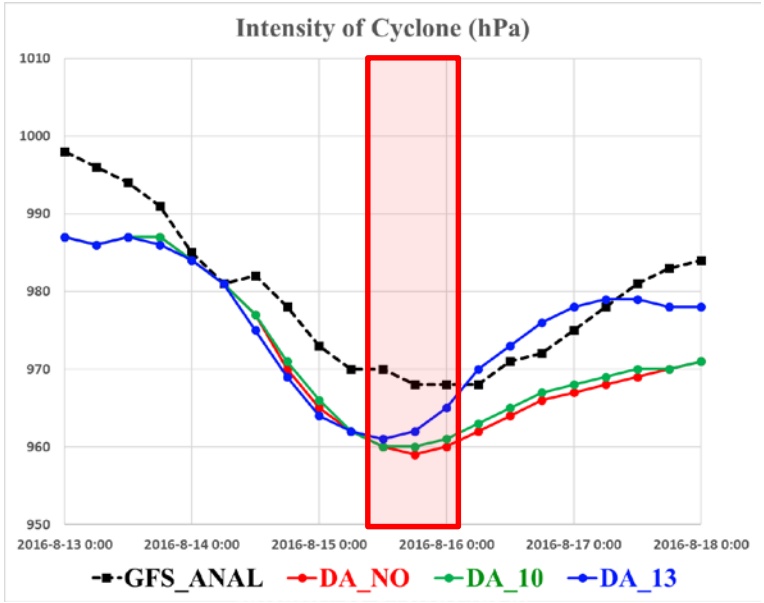


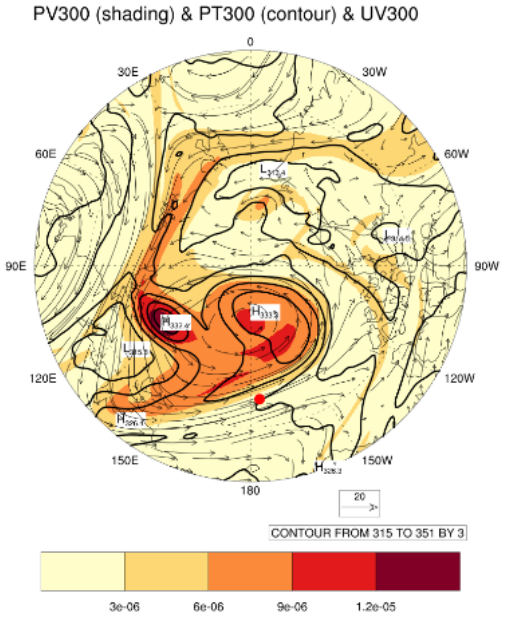
08/15 18 UTC

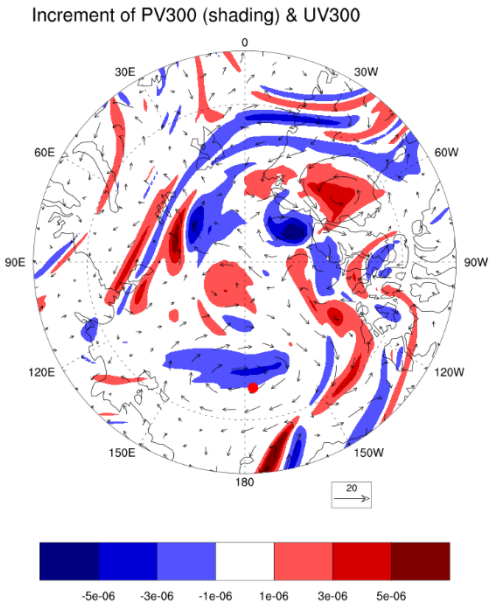


08/16 00 UTC

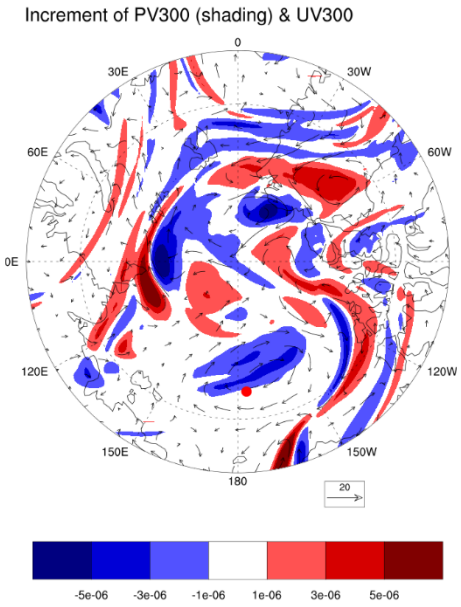
Results: Forecast Increments of PV300







08/15 12 UTC



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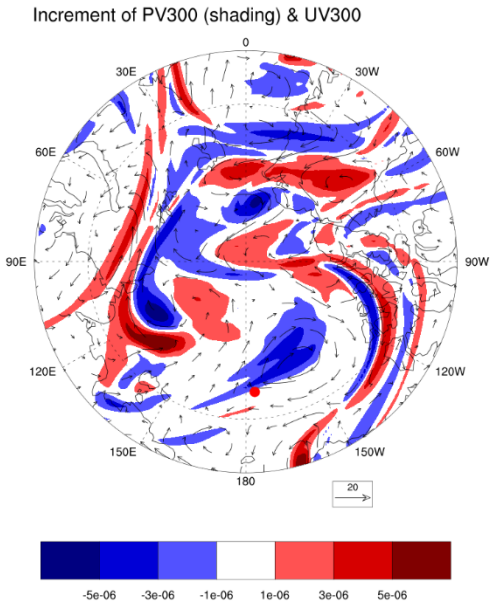


08/16 00 UTC

Conclusions

- We perform WRF forecasts of the mid-August intense cyclone's life cycle with the initial and boundary conditions from the NCEP GFS forecast fields.
  - The intensification phase is simulated in all experiments

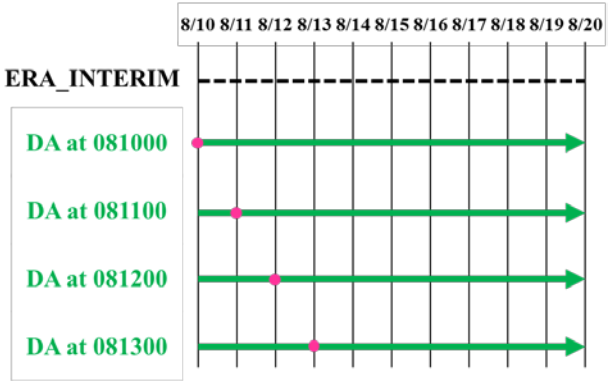
- For an experimental purpose, we test the assimilation impact of the extra Araon sounding data using the WRF-3DVAR.
  - Three model experiments: DA_NO, DA_10 (Single_DA), DA_13 (Cycling_DA).
  - DA_NO and Single_DA simulated the cyclone's life cycle in a very similar way, whereas Cycling_DA shows a notable discrepancy on the simulation of the weakening phase from 16 August. In Cycling_DA, the weakening rate is even more rapid, compared with the reanalysis data.
  - An anticylonic increment generated by the cycling sounding data assimilation grows and spreads to the central Arctic Ocean and excessively affects the cyclone weakening while it passes around the International Dateline, located at the closest distance from the Araon.

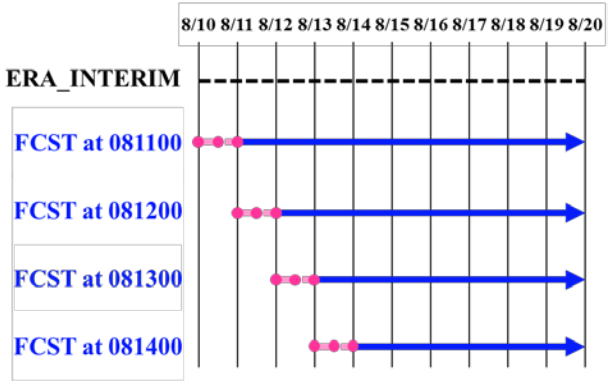
Ongoing works

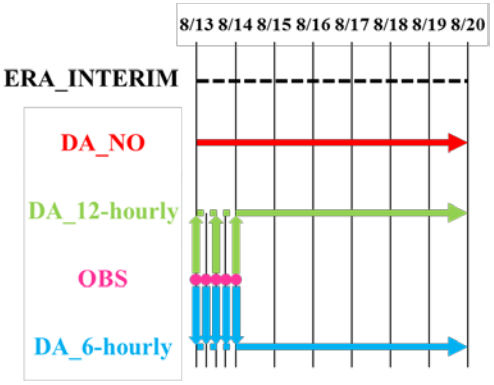
More data assimilation experiments…

- Effect of an individual observation under the same initial condition

- Sensitivity experiments: initial condition & assimilation intervals

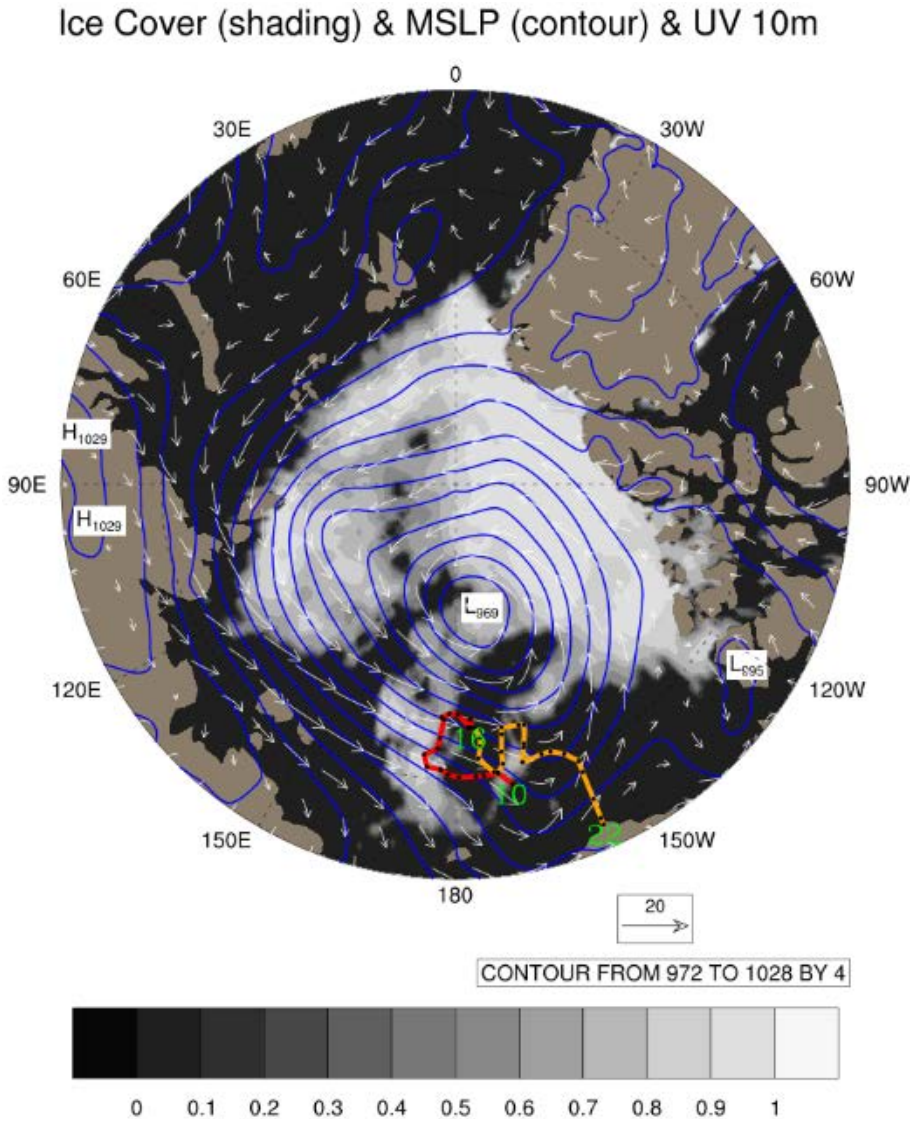






Supplementary Materials

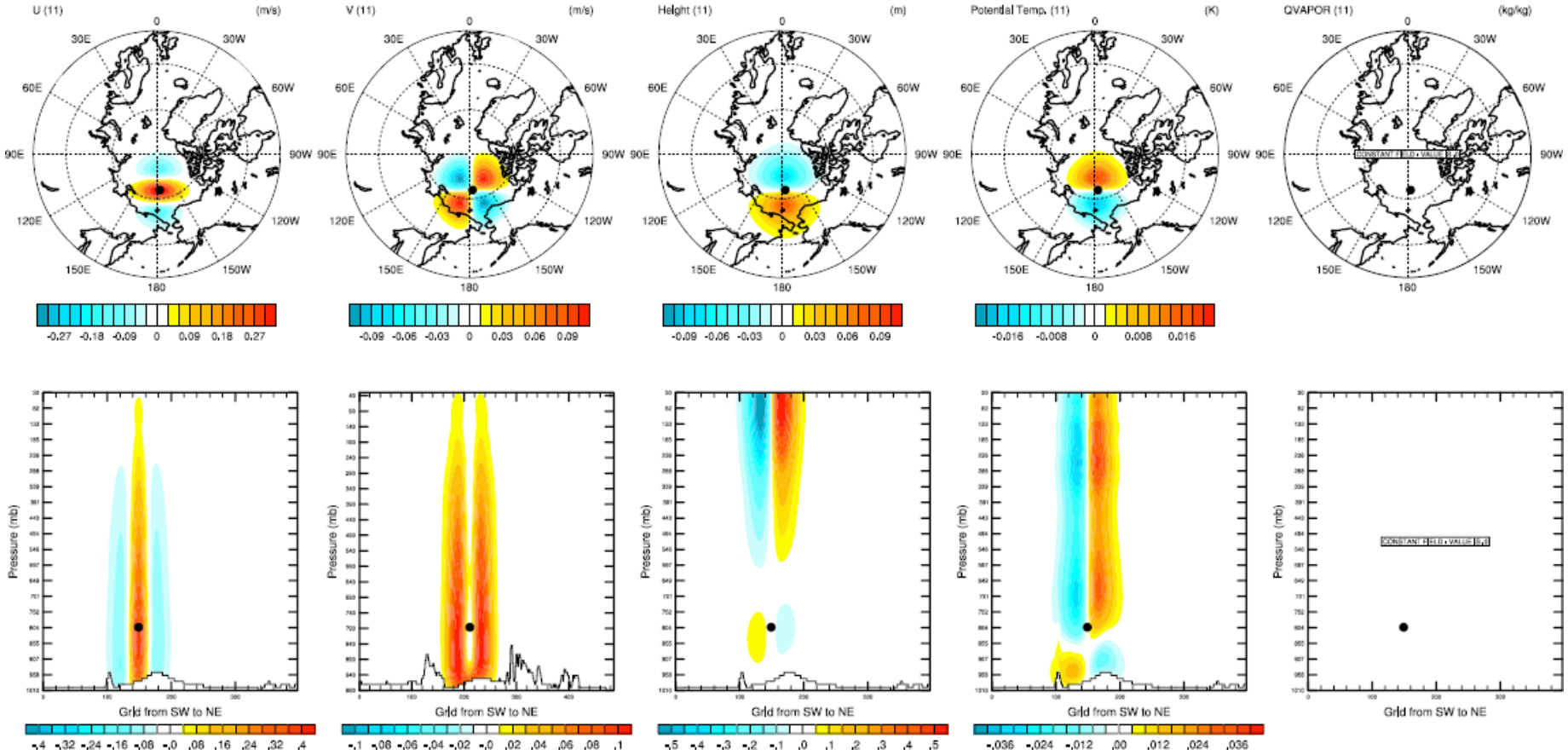
Araon cruise track



Simulated arctic cyclone at 00UTC 16 August and the location of Araon radiosonde

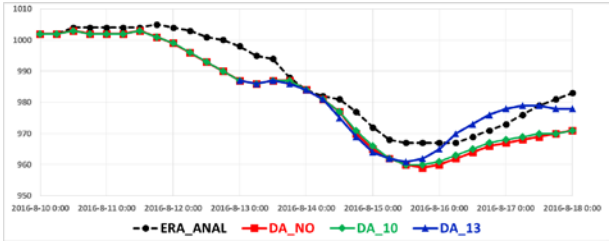
Analysis Increments with pseudo single observation test

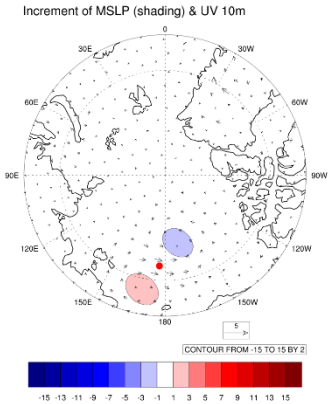
- **Analysis increments with pseudo single observation test (U at eta level 11)**



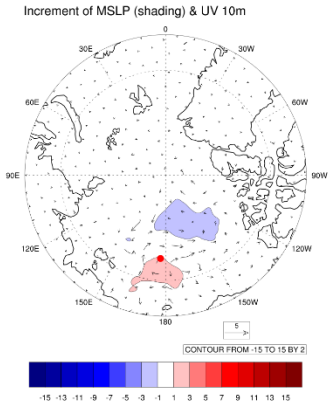
Results: Forecast Increments of MSLP

Increments (DA_13 – DA_12)

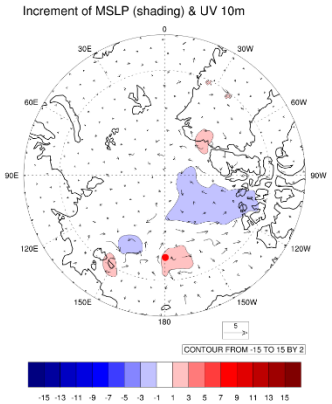




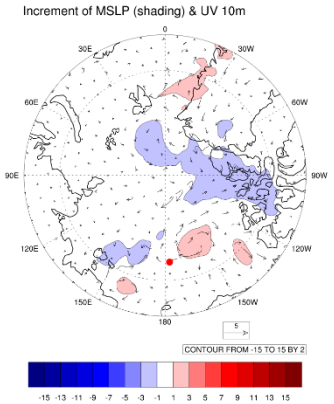
08/13 00 UTC



08/13 12 UTC



08/14 00 UTC



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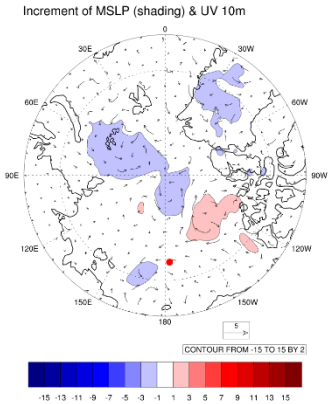

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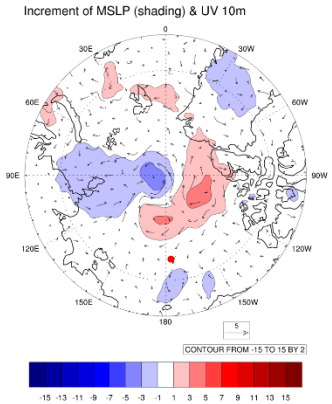

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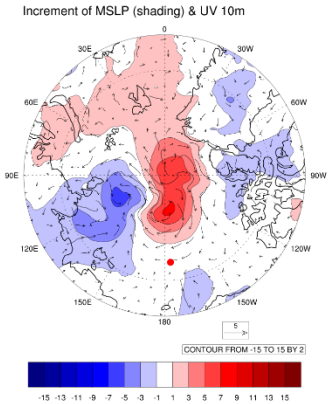

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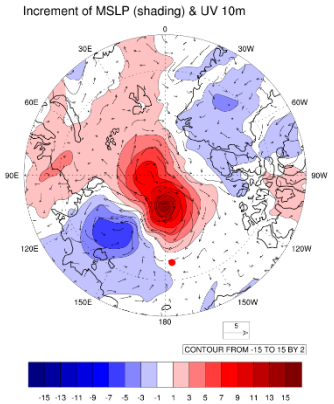
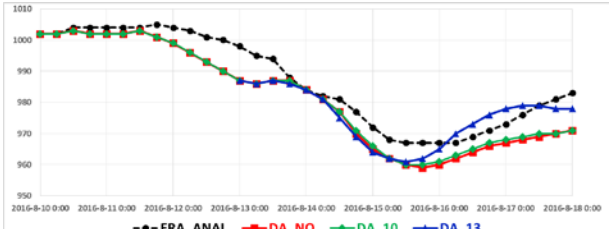
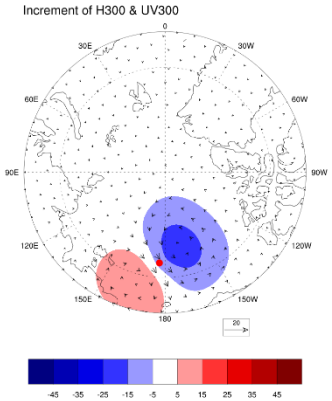


08/16 12 UTC

Results: Forecast Increments of GPH300

Increments (DA_13 – DA_12)





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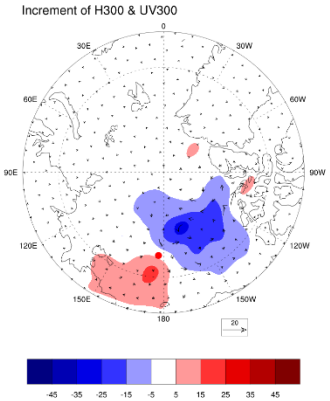

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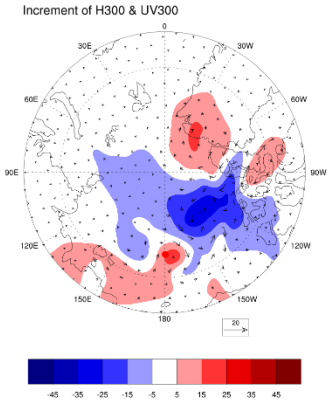

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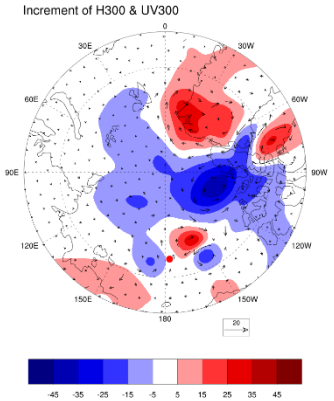

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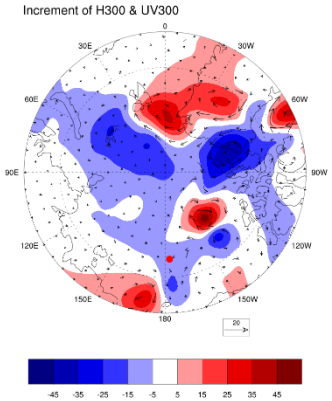

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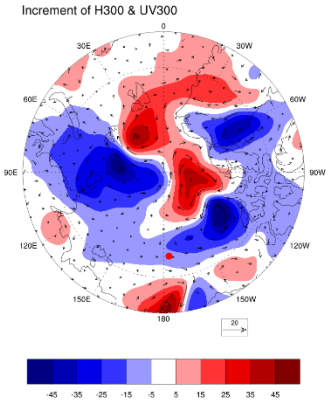

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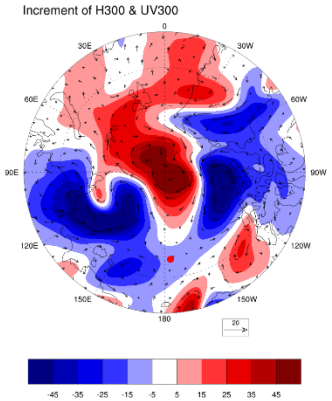

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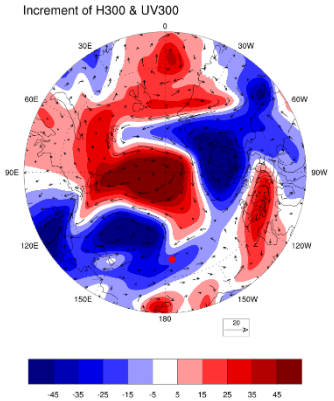

08/16 12 UTC

Effect of sea ice update

Physics Configuration

P1 : CBHAR set
P2 : ASR set
P3 : Antarctic set
P4 : WRF default set