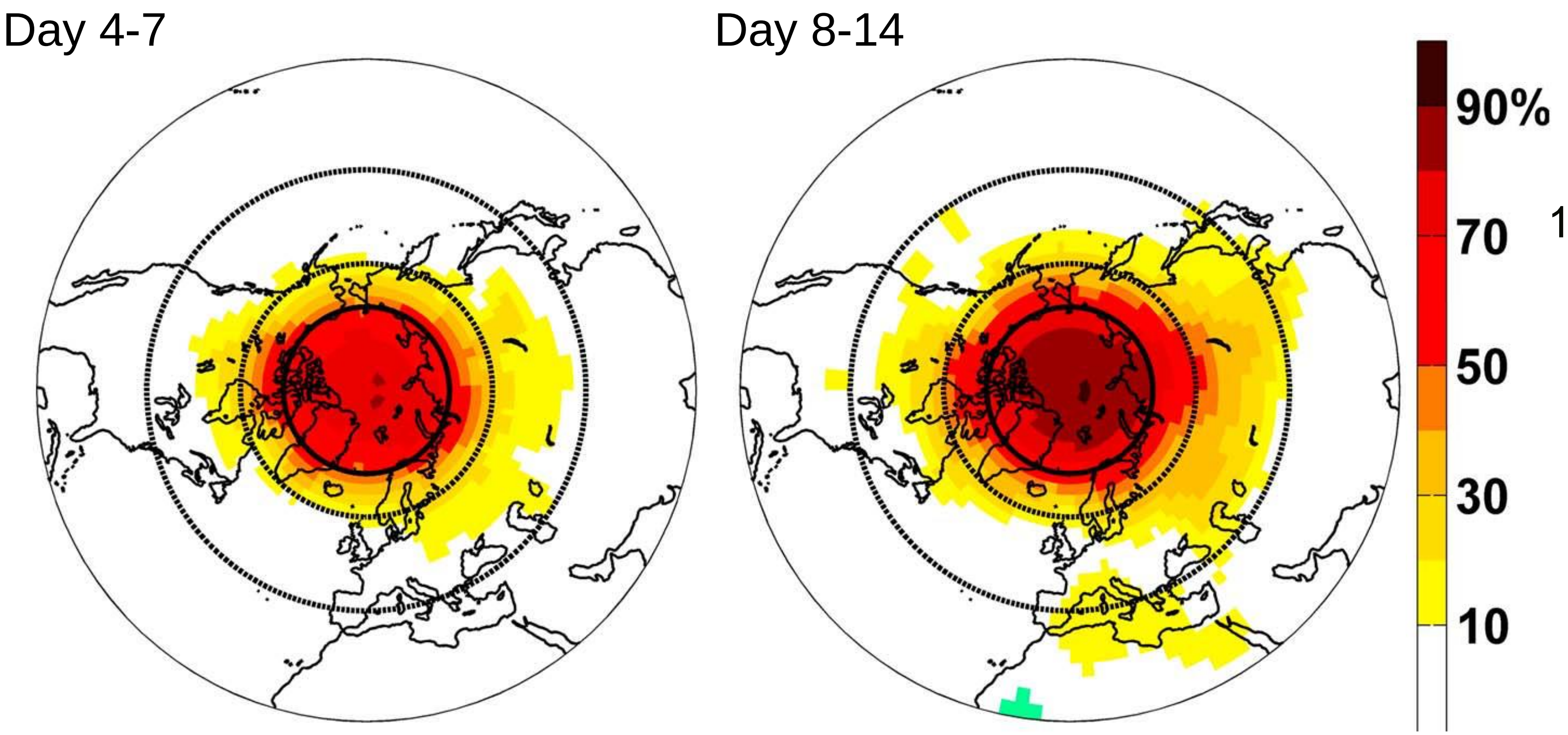
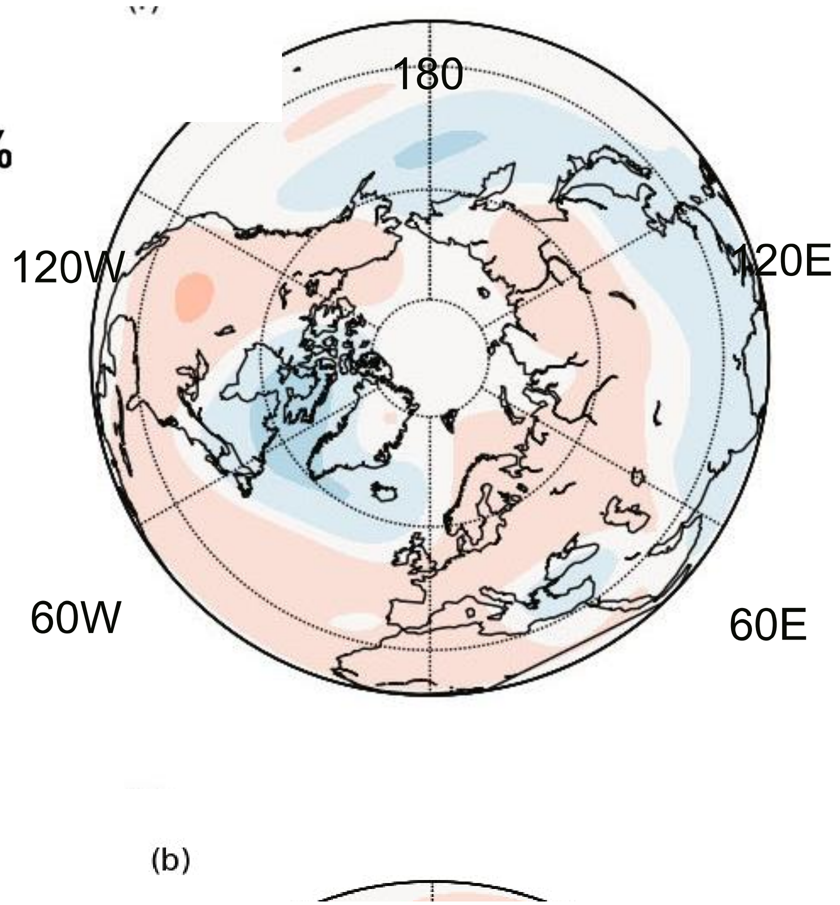
Increased impact of Arctic observations during Scandinavian Blocking episodes

Jonathan Day, Heather Lawrence, Irina Sandu, Linus Magnusson, Niels Bormann, Mark Rodwell and Thomas Jung (AWI)

j.day@ecmwf.int

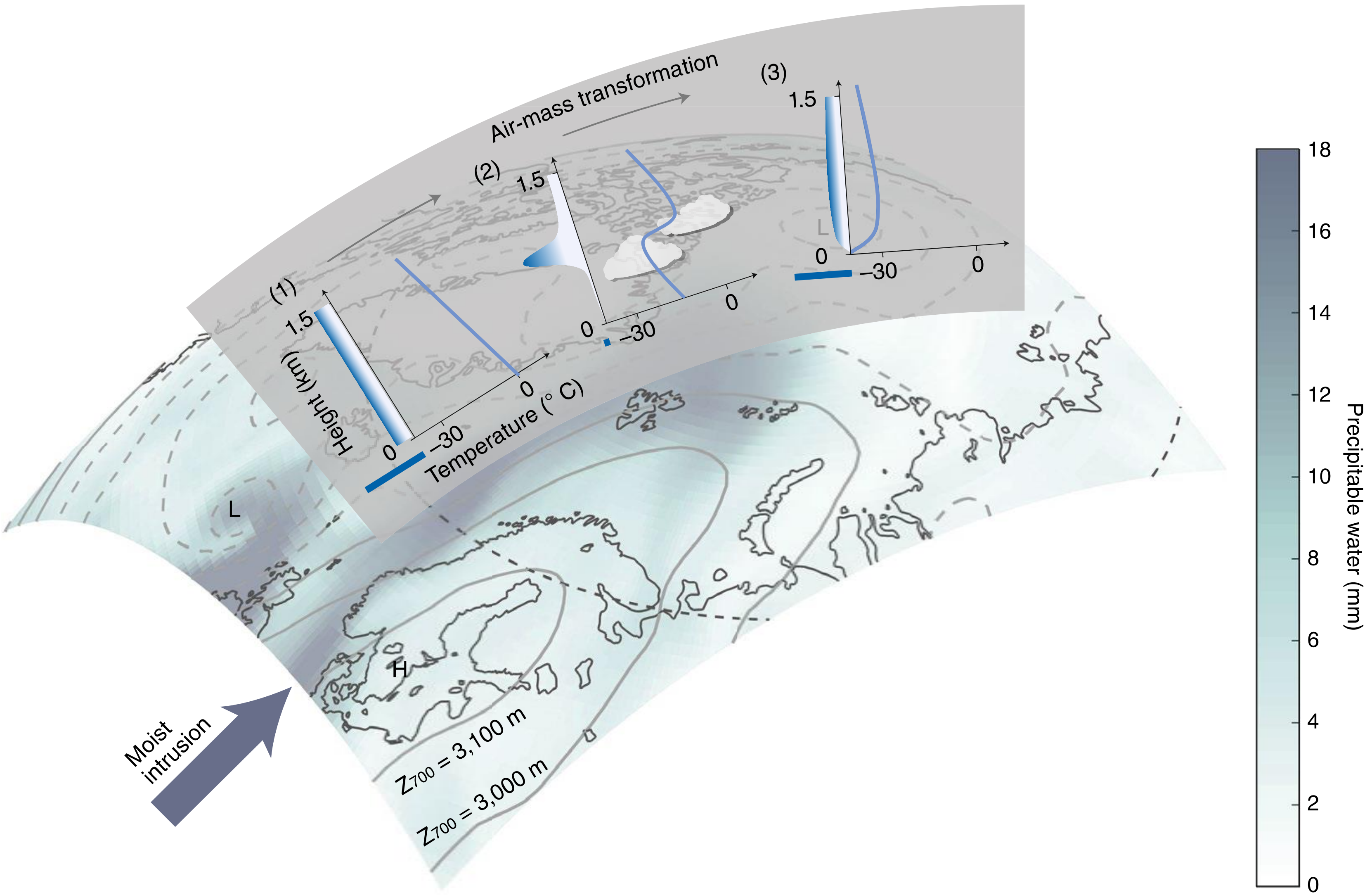
Linkages to mid-latitudes: what if our forecasts were perfect in the Arctic?





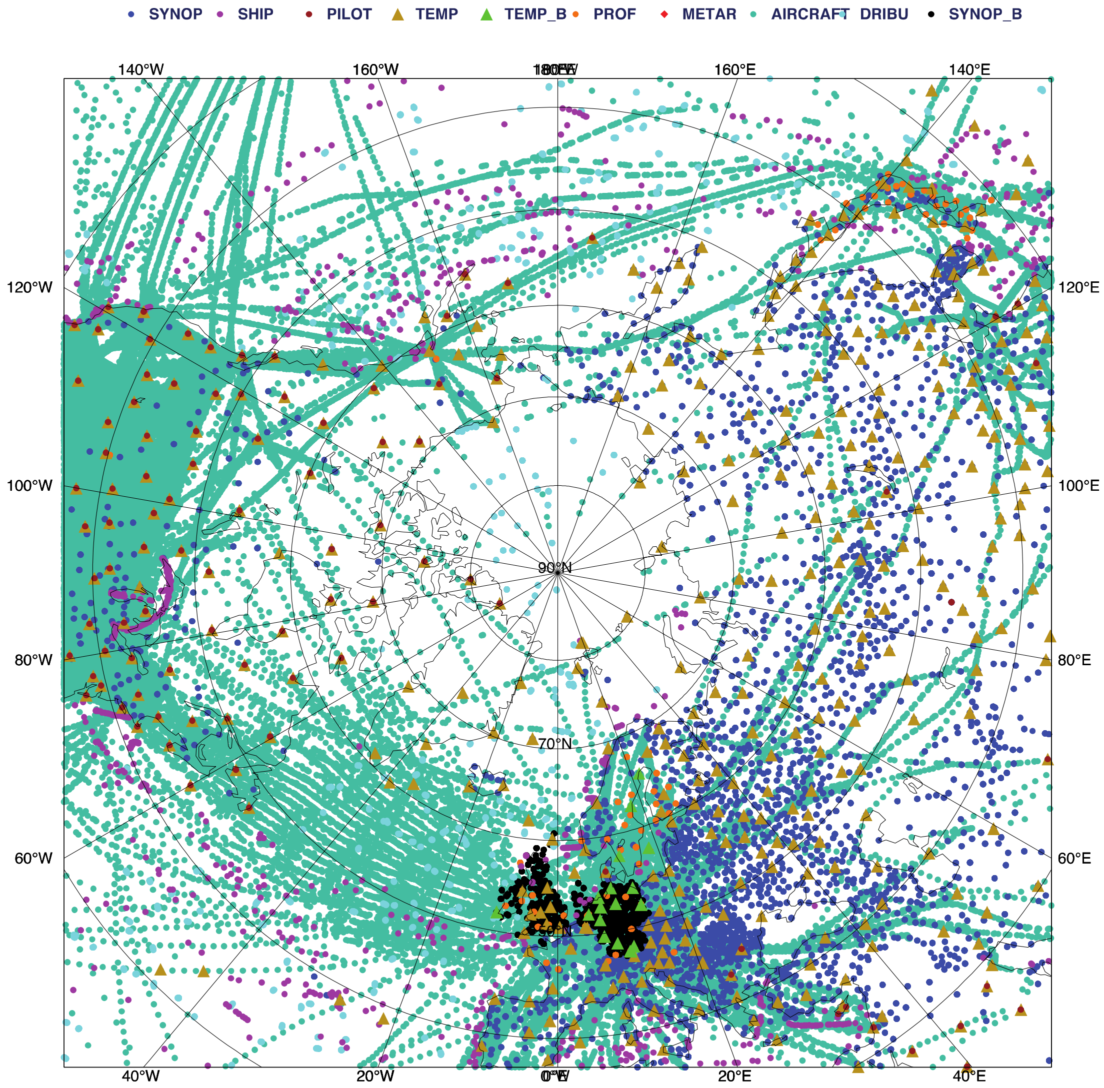
Jung et al. (2014) and Semmler et al. (2018)

Challenge 1: simulating Arctic processes



Pithan et al. (2018)

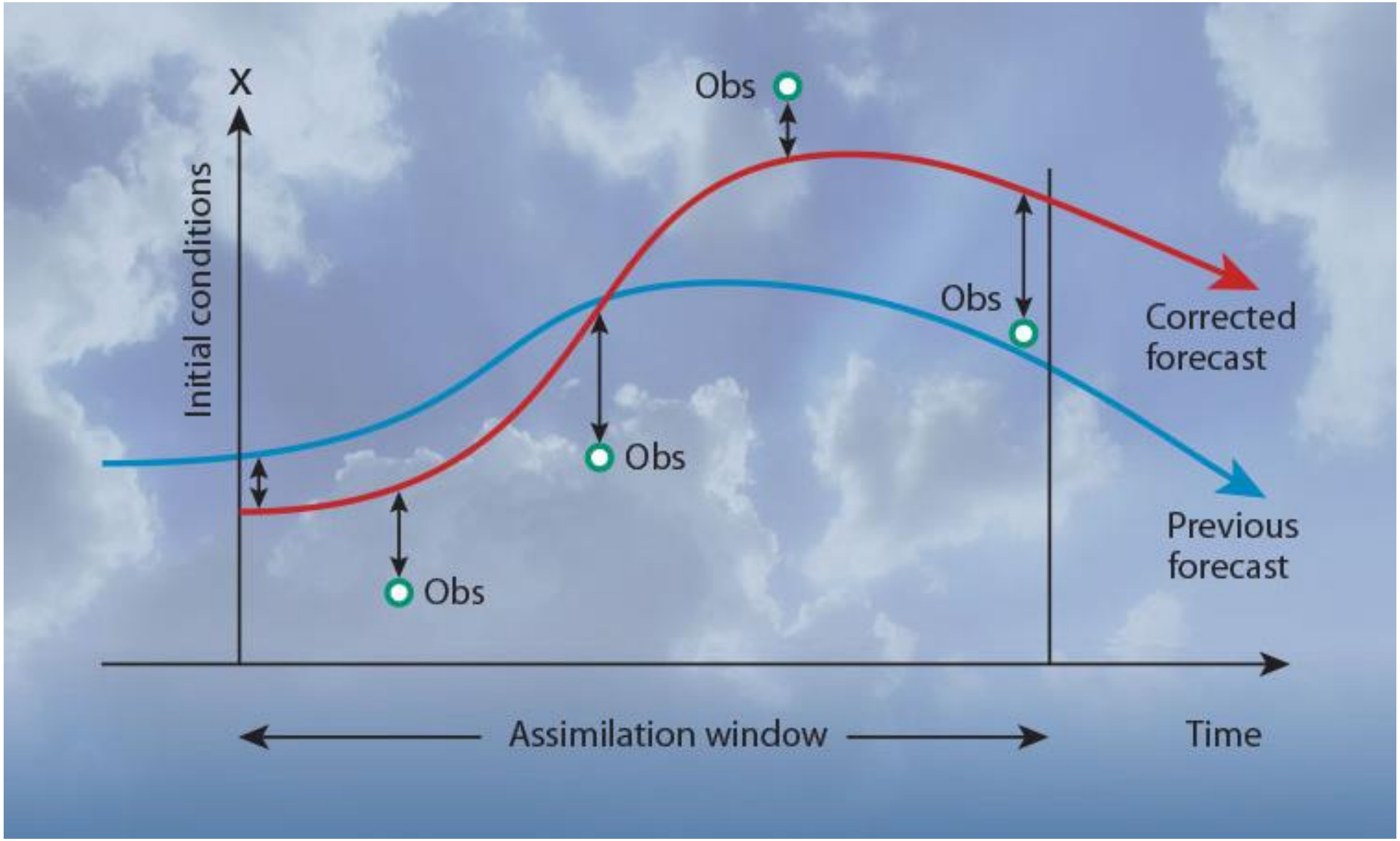
Challenge 2: observing



- SYNOP
- SHIP
- TEMP
- AIRCRAFT

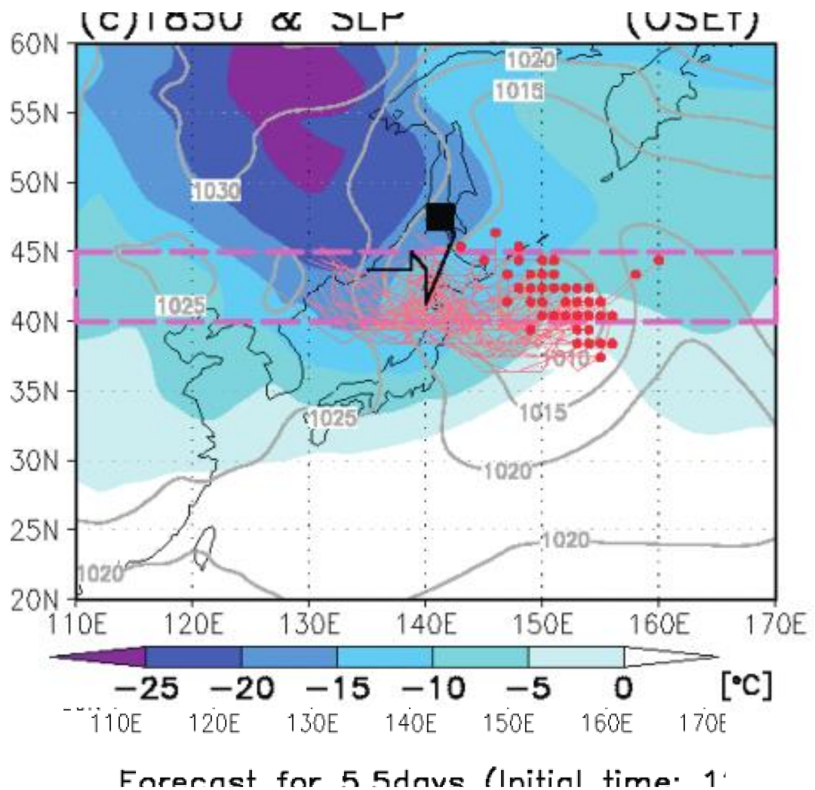
Jung et al. (2016)

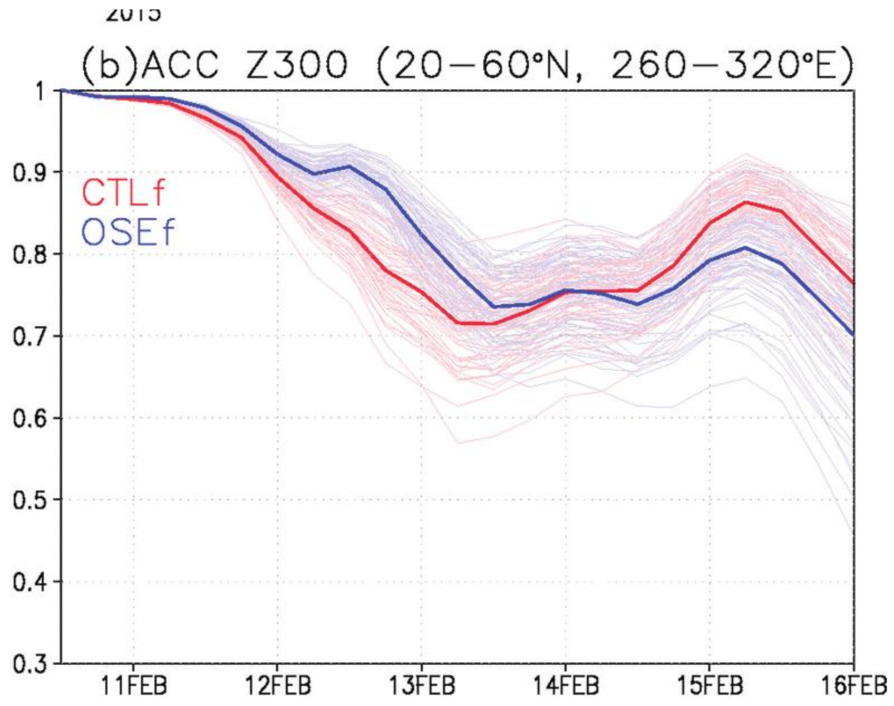
Challenge 3: Initialisation



Observing System Experiments (OSEs)

- OSEs have been used to determine the importance of extra observations for improving the skill of case studies in mid-latitudes





- Not been done in operational systems with a "full" observing system.
- Hard to know if extra observations will really improve skill in mid-latitudes.

Sato et al. (2016)

Observing System Experiments (OSEs)

OSE’s removing polar observations for:

- Microwave (MW)
- Infrared (IR)
- Conventional (Conv)
- GPSRO (bending angles)
- Polar AMVs
- **Extra observations during SOPs**

Experimental set-up:

2 x 4 months, 2 seasons, TCo399 (25 km)

June – September 2016

December – March 2017/2018 (includes SOP1)

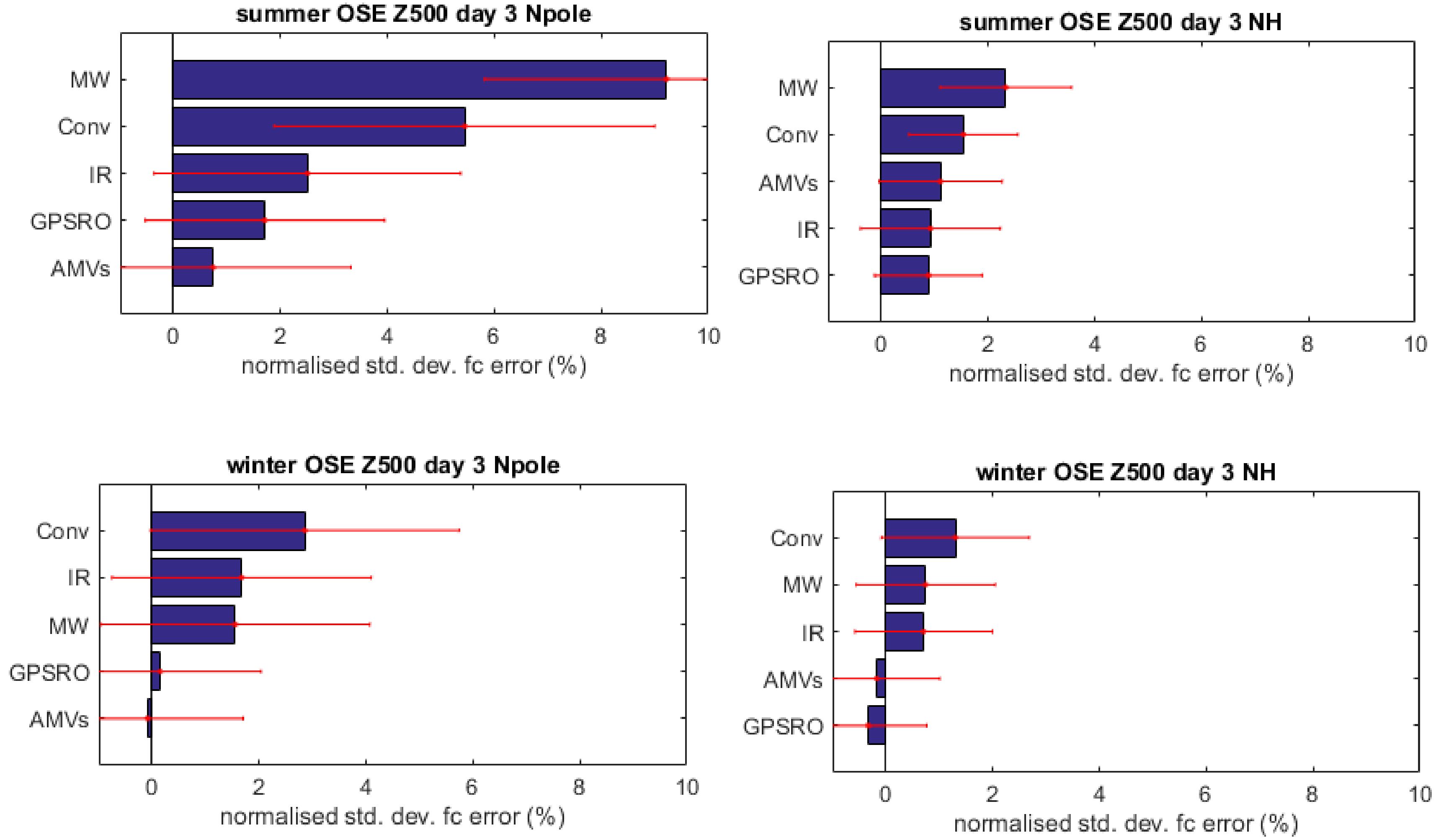
Degraded forecast skill in the North Pole and Northern Mid-latitudes

APPLICATE.eu
Advanced prediction in polar regions and beyond

60 – 90 N **20 – 60 N**

summer

winter



Summer:
- Microwave
- Conventional
- Infrared
- GPSRO, AMVs

Winter:
- Conventional
- Less impact overall from each observation type

ECMWF

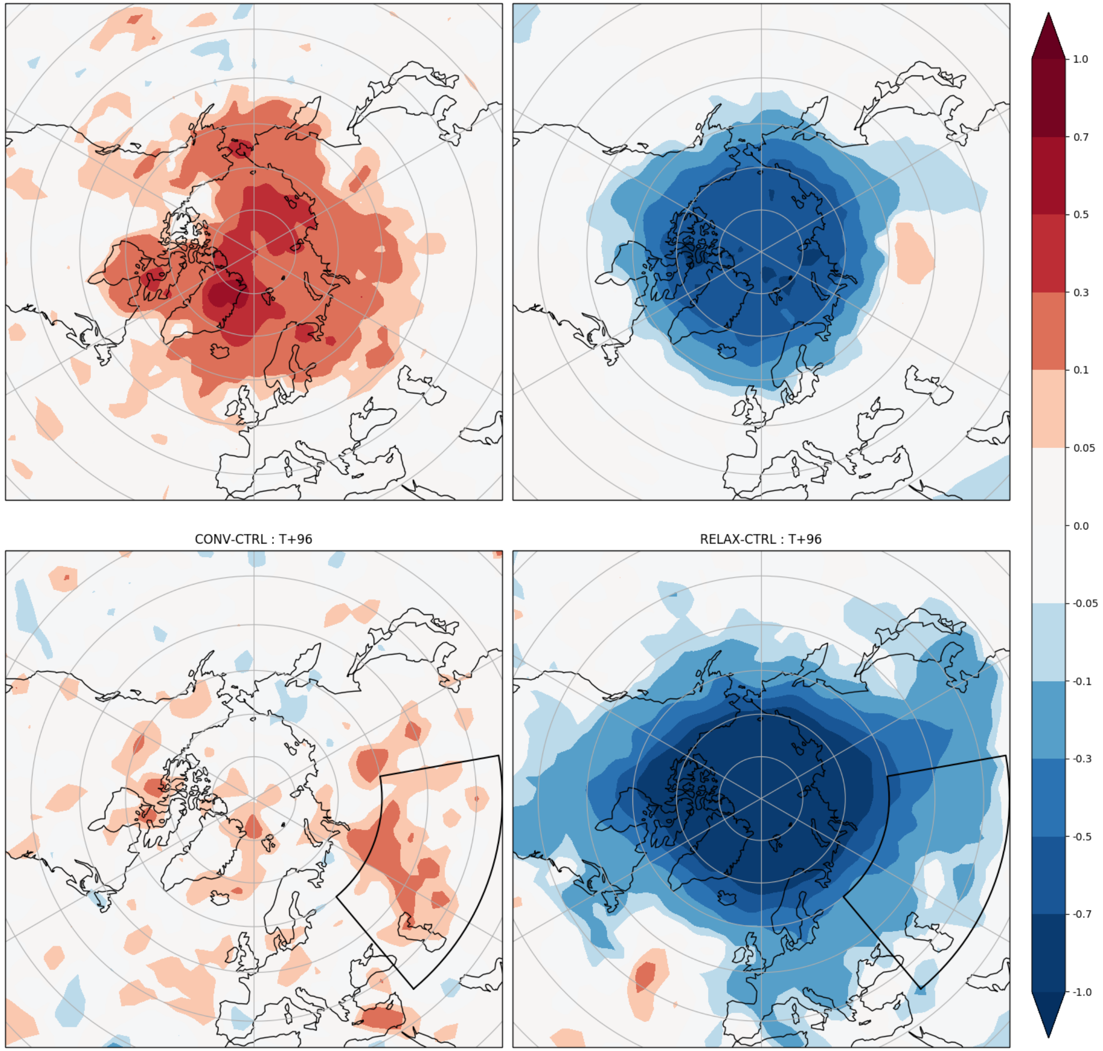
H. Lawrence et al., in preparation

Spatial extent of errors

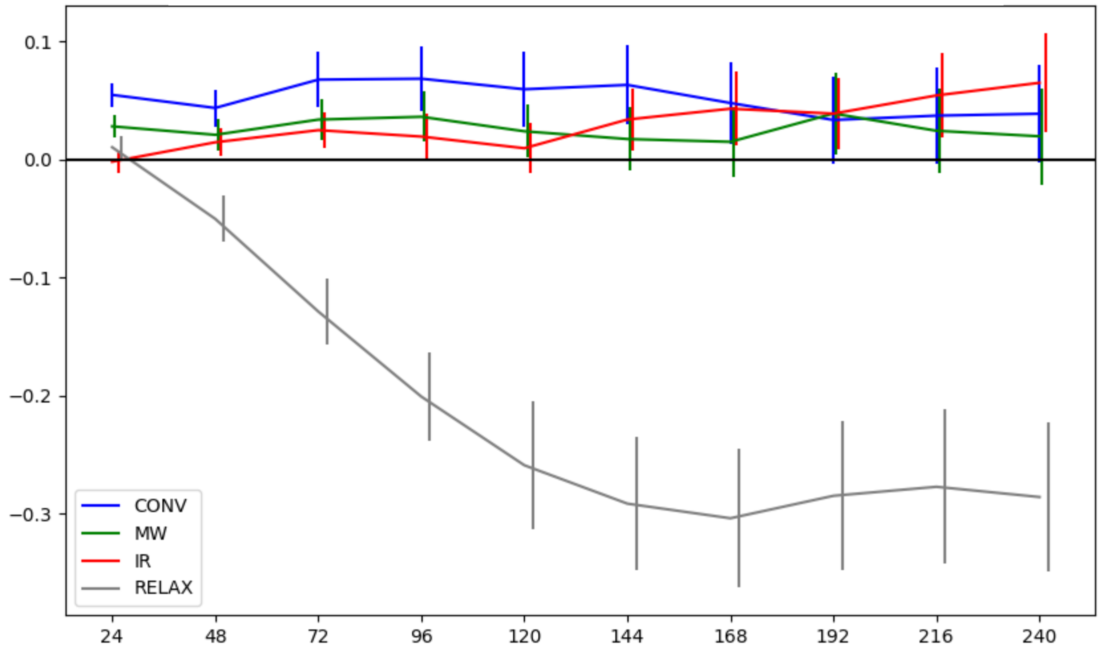
Conventional OSE | Relaxation

Day 1

Day 4

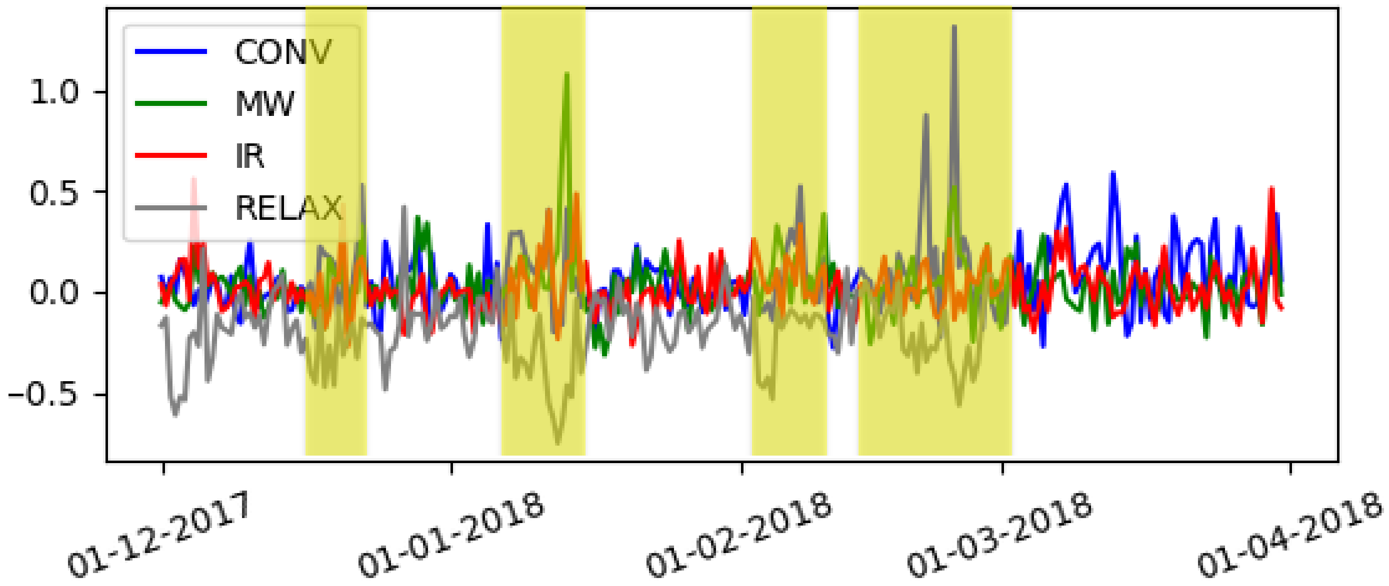


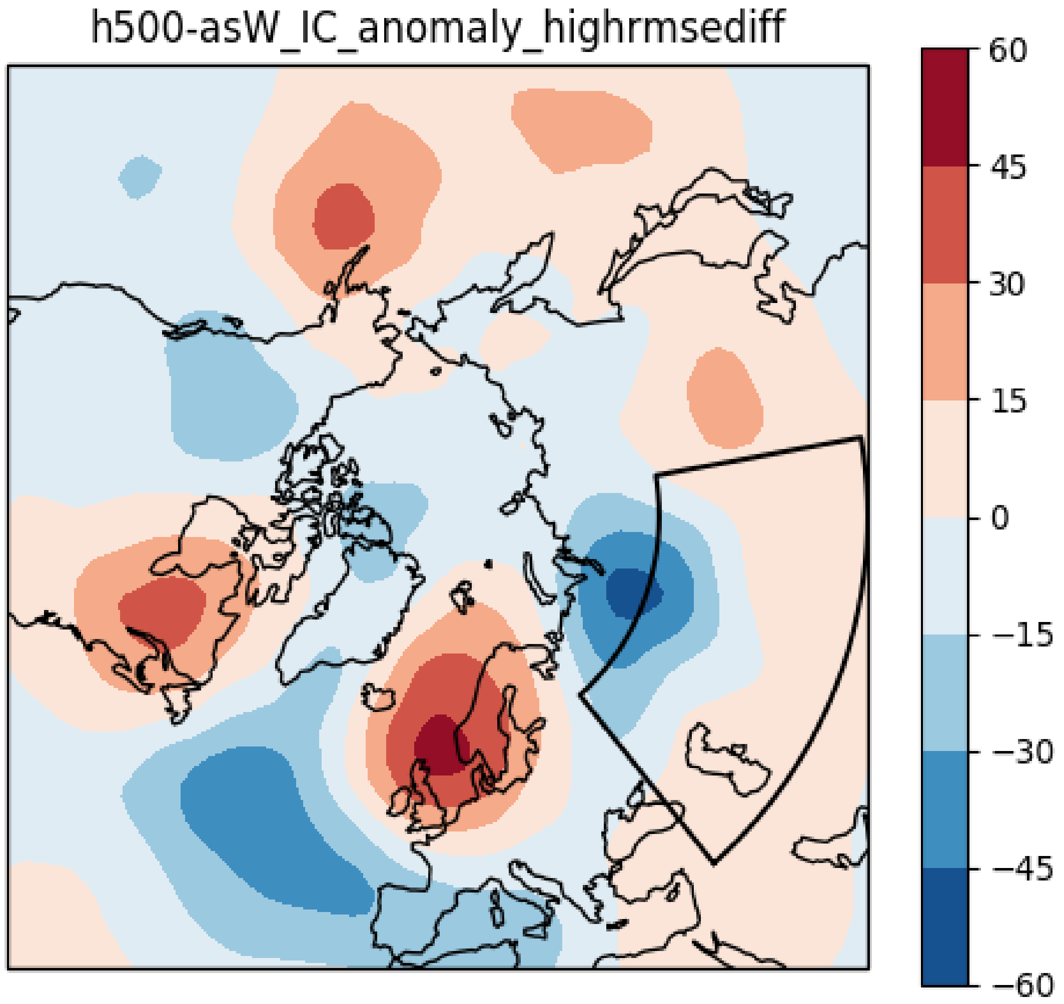
Normalised error difference – N. Asia



$$\frac{RMSE_{OSE} - RMSE_{CTRL}}{RMSE_{CTRL}}$$

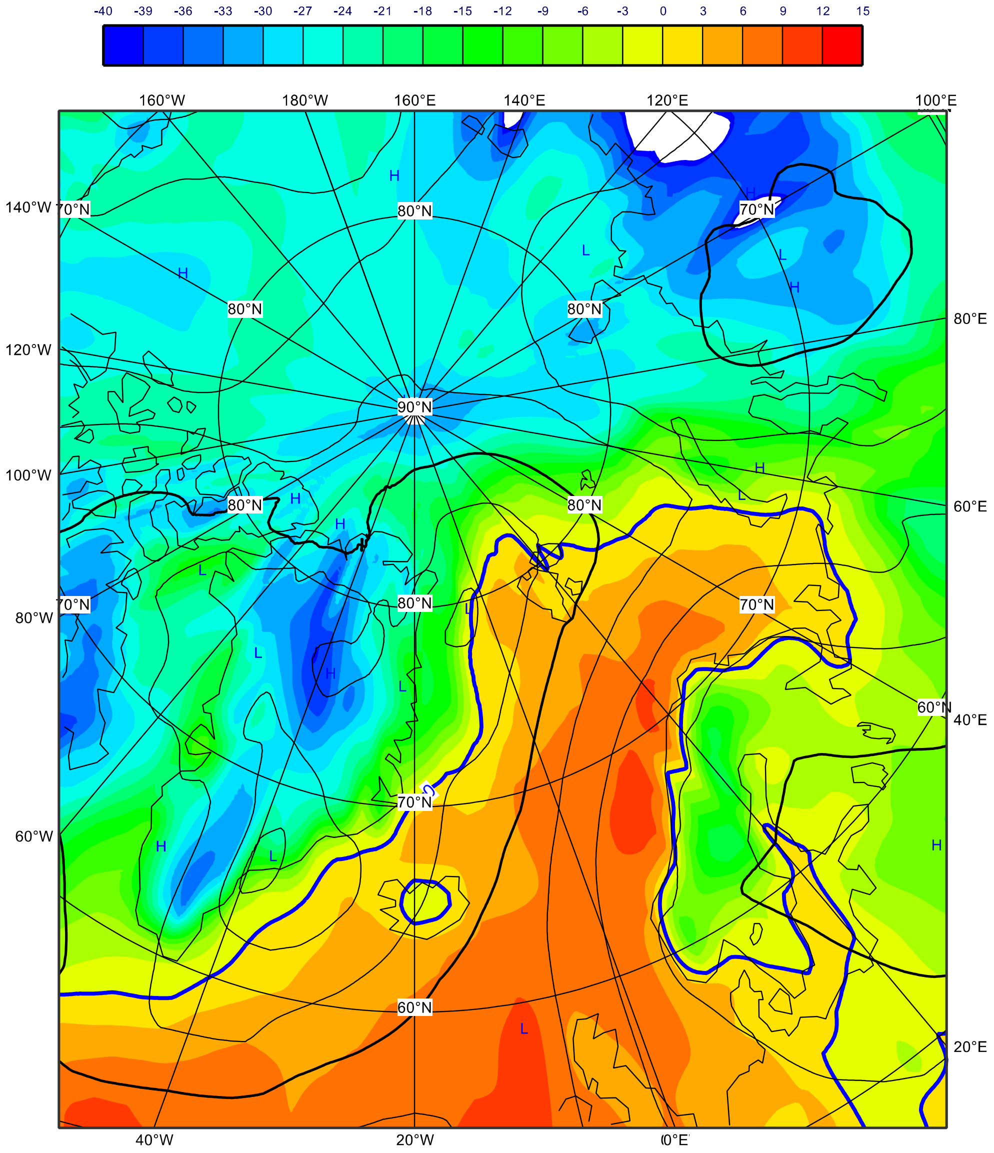
Episodic impacts over North-West Asia



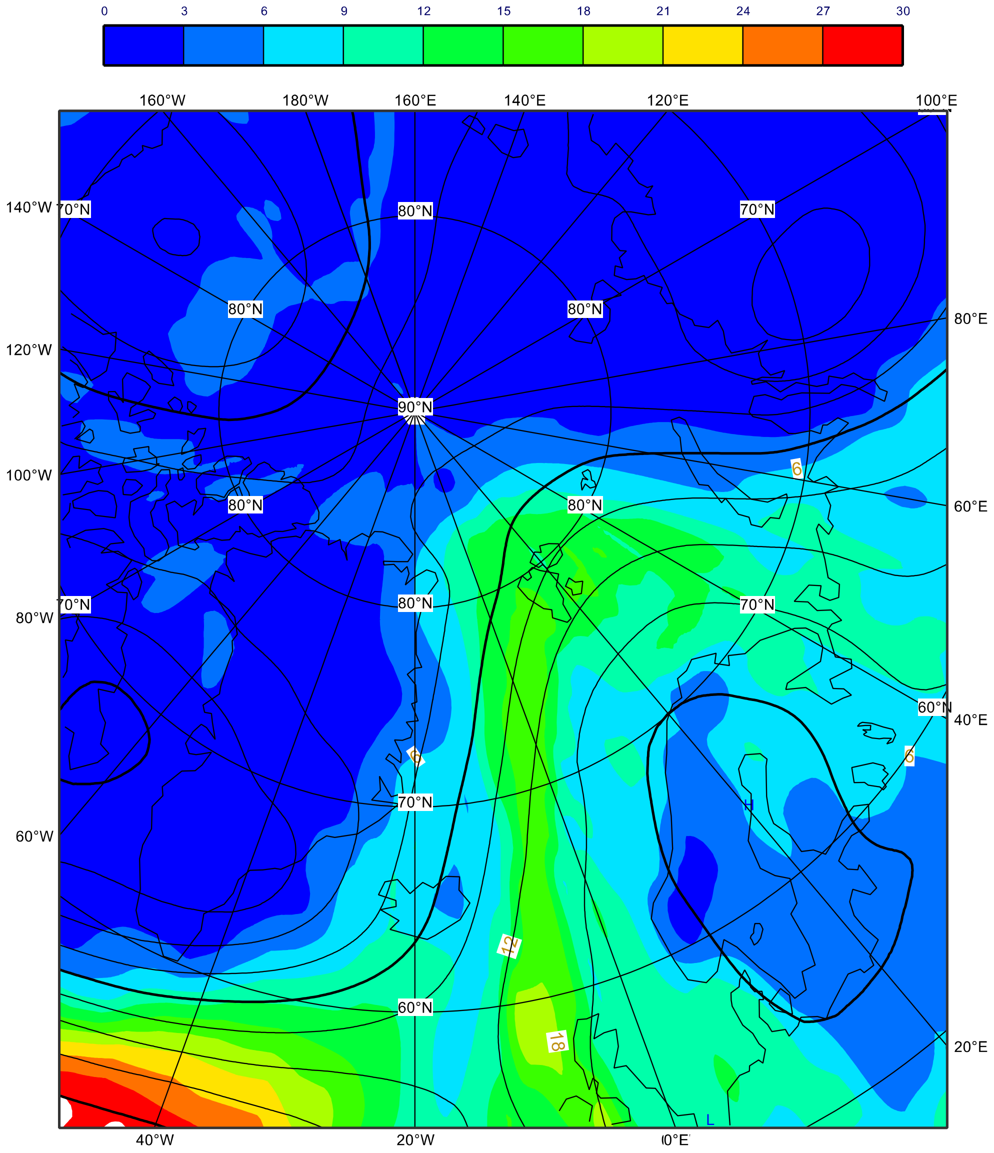


Case Study: initial conditions

2m temperature & MSLP

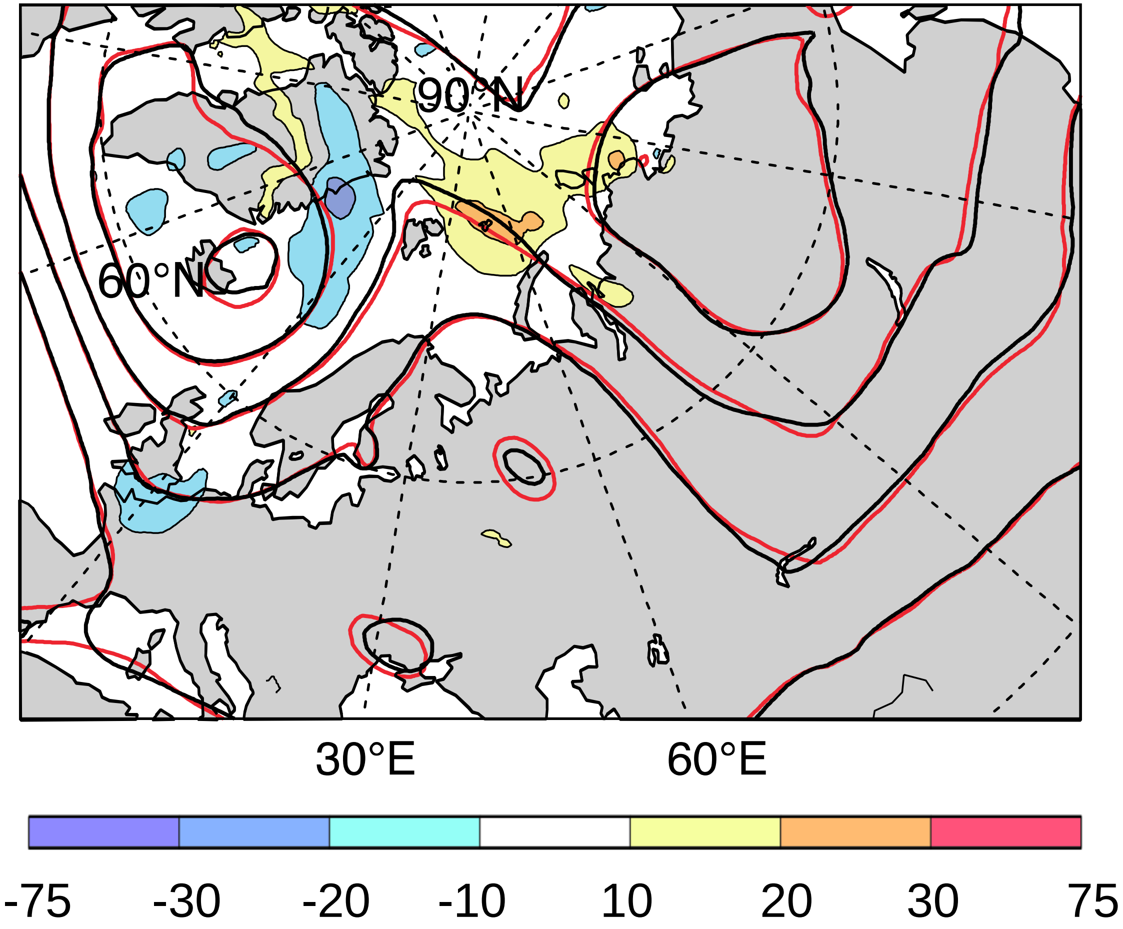


Total Column Water & Z500

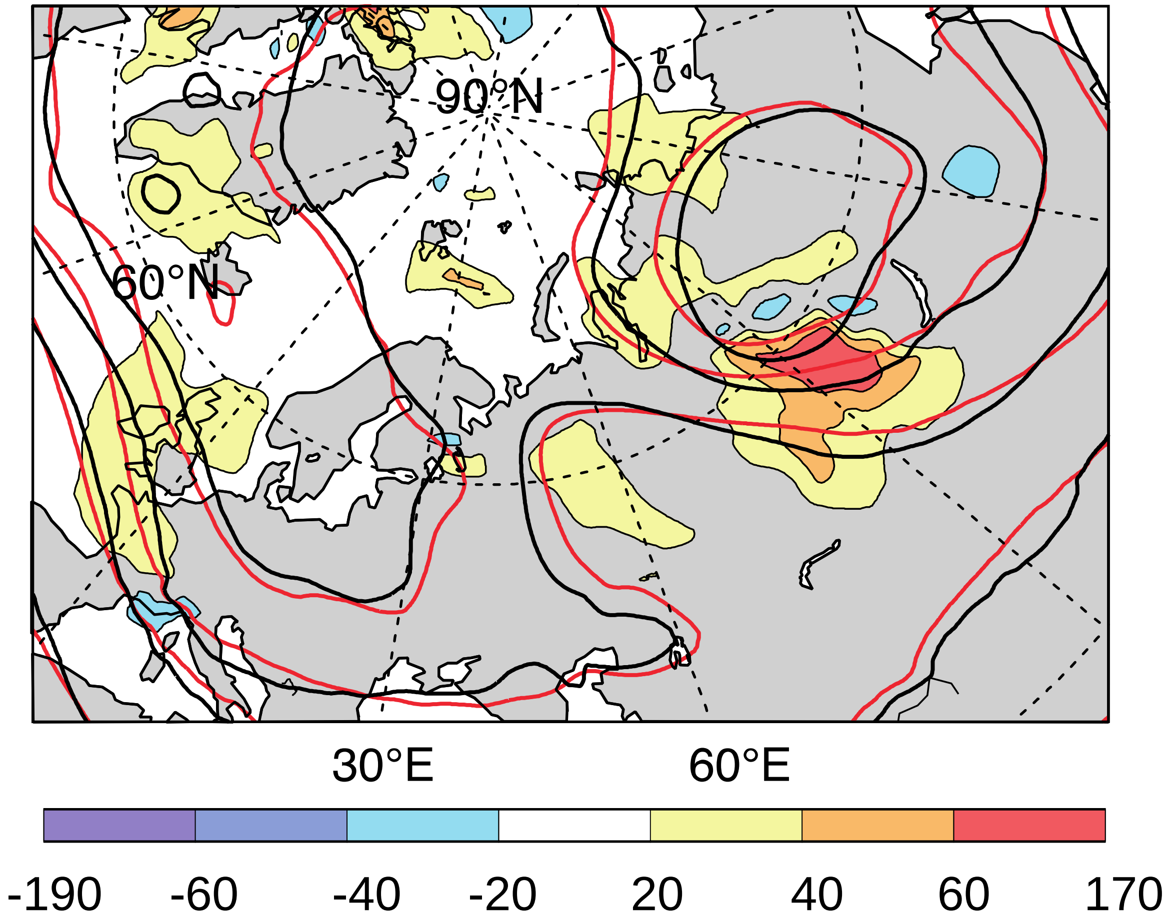


Case Study: error growth

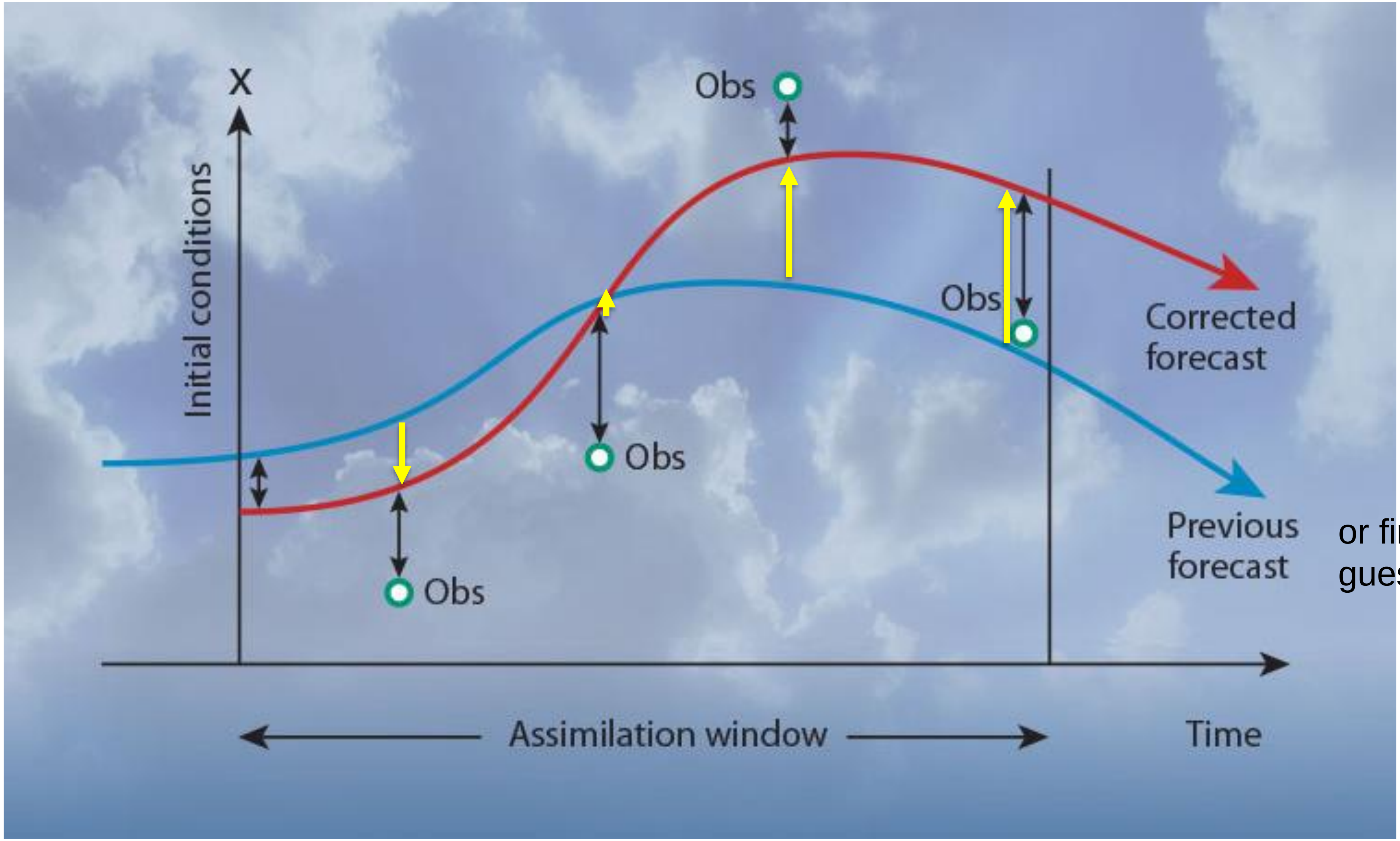
Increase in absolute error (OSE-CTRL): Day 2



Increase in absolute error (OSE-CTRL): Day 4

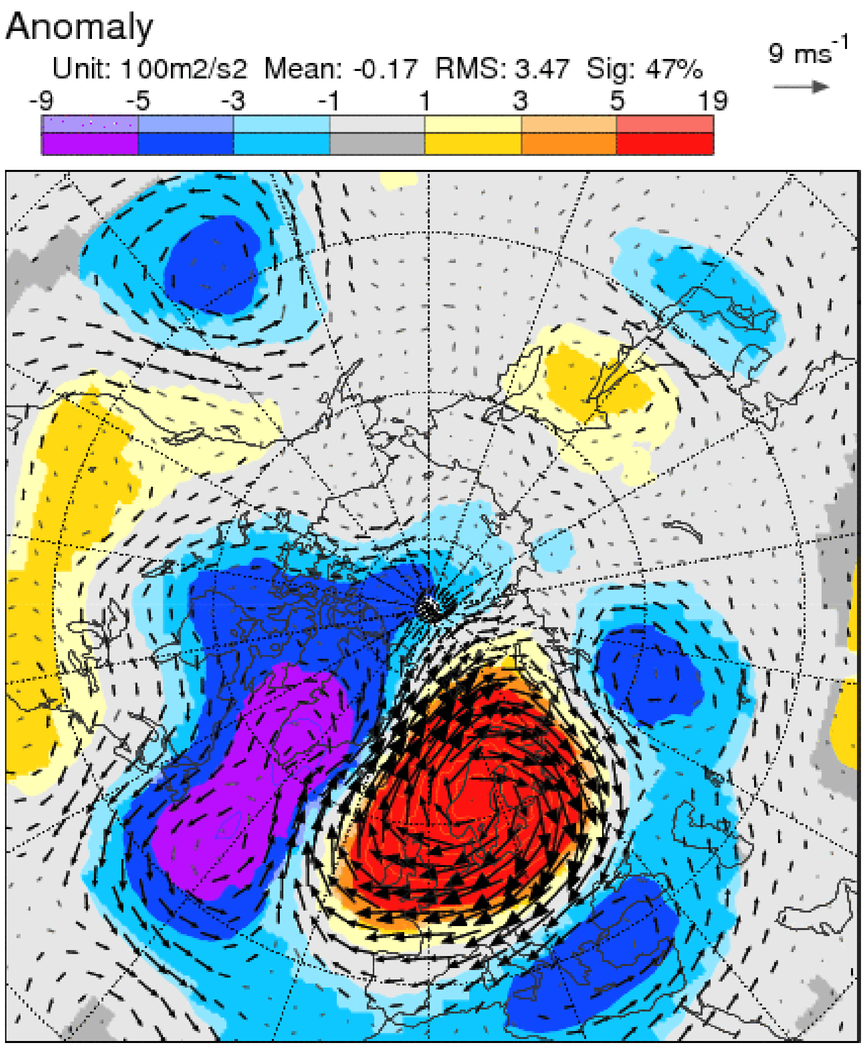


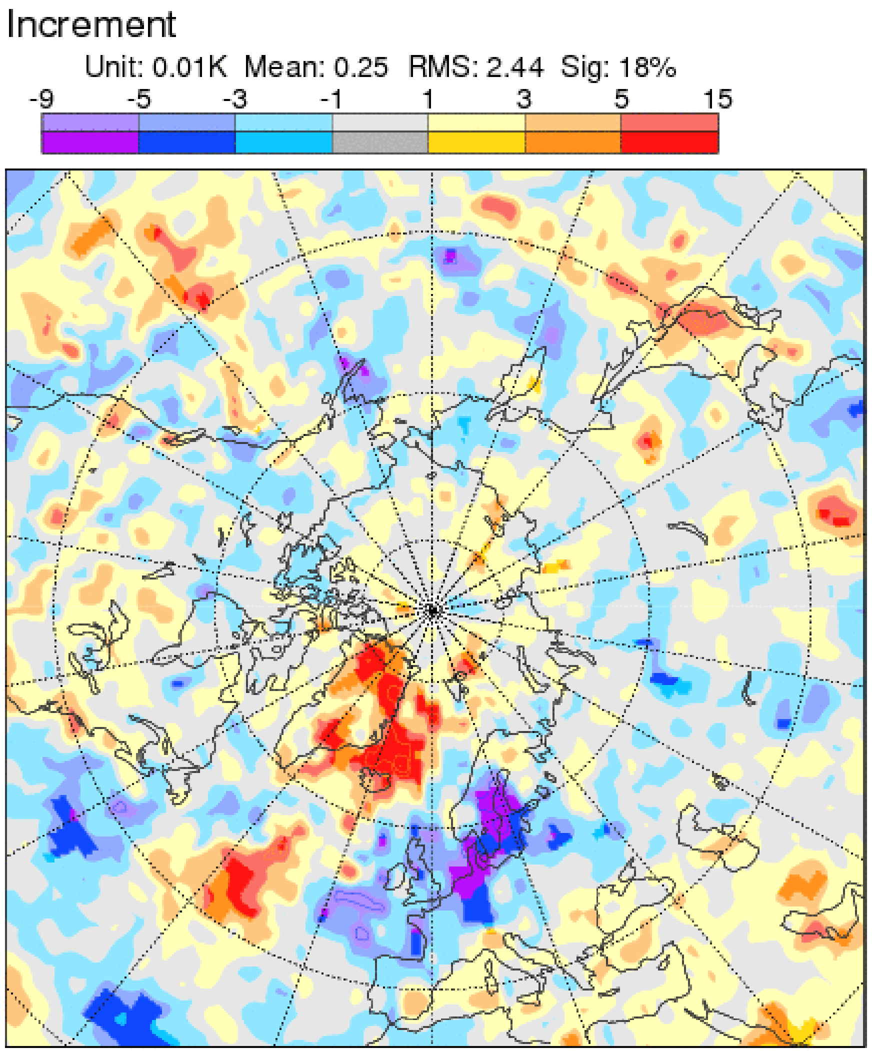
Is the impact of the observations also regime dependent?



or first
guess

Do periods of blocking lead to faster error growth?

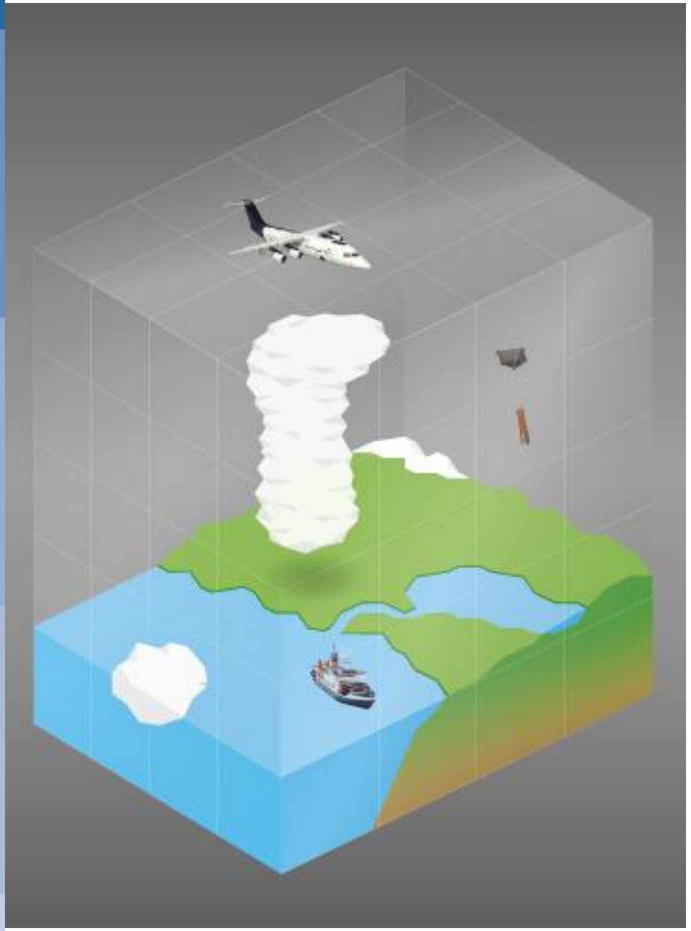




Conclusions

- Forecast errors associated with denial of Arctic observations during winter significantly impact skill over Northern Asia.
- The impact of Arctic data denial and relaxation on N. Asia is largest during periods of Scandinavian Blocking, when high amplitude waves allow errors to propagate out of the Arctic.
- Arctic observations also play a more important role in constraining the initial state during periods characterised by Scandinavian Blocking, where warm-moist intrusions lead to higher baroclinicity and error growth within the Arctic.
- Could increasing Arctic observation density during blocking episodes improve skill? → Possible idea for SOP3.

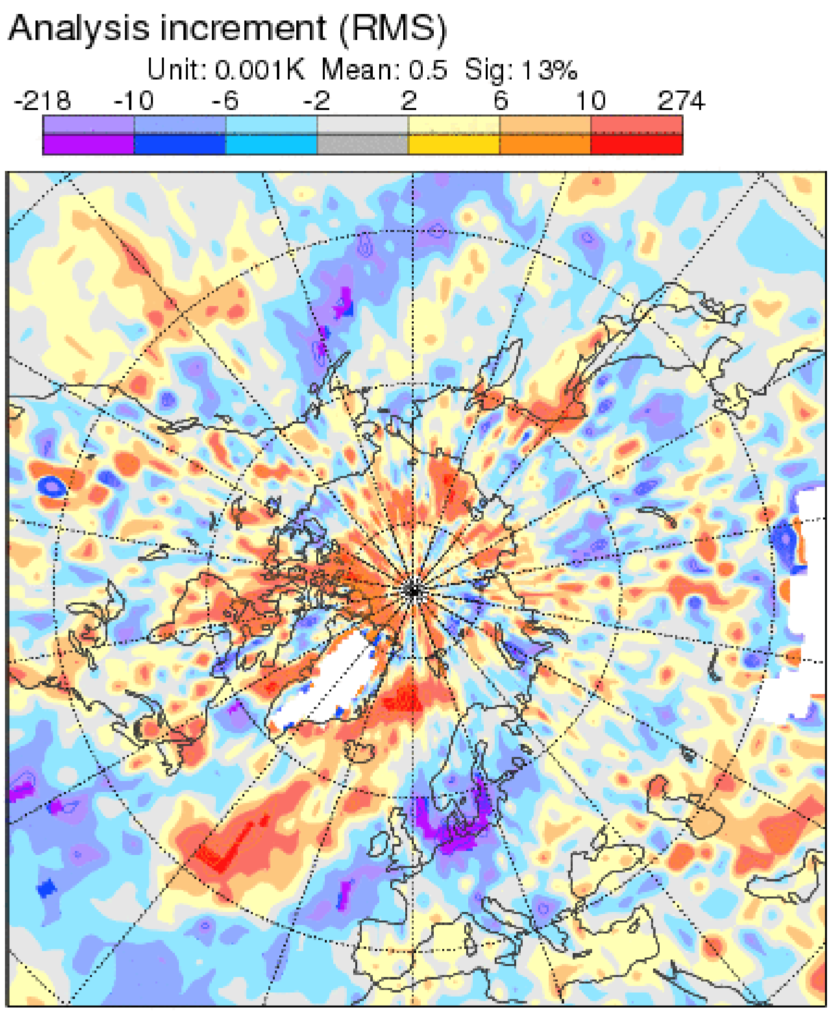
Upcoming ECMWF workshop:
Observational campaigns for better weather forecasts 10-14 June 2019

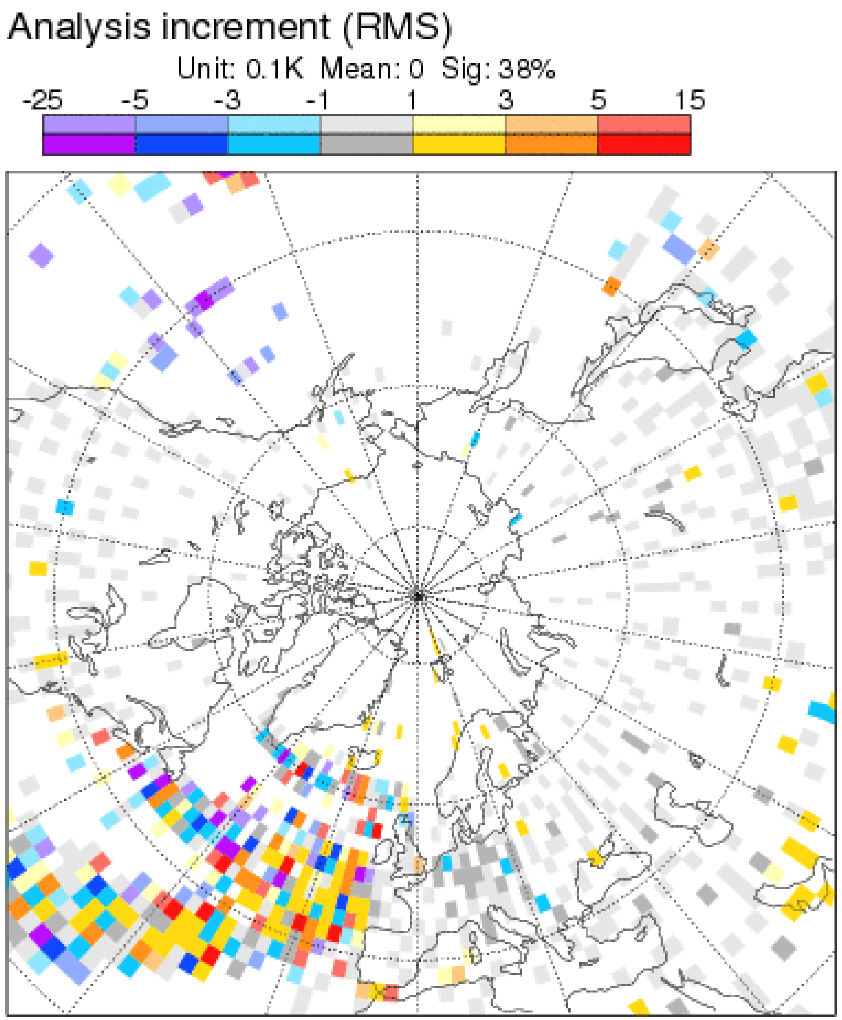


Key questions:

- How are field campaigns making use of ECMWF data? Are there any obstacles to the use of this data?
- How can observational campaigns help to identify and diagnose problems in models, observation operators, etc.?
- How can knowledge and diagnosis of NWP problems help define future field campaigns?
- How can observational campaigns learn from each other in terms of their usage and diagnosis of ECMWF forecasts?

Deadline for registration and Abstracts: 1 March
https://www.ecmwf.int/en/learning/workshops/workshop-observational-campaigns-better-weather-forecasts


Analysis increment (RMS)
Unit: 0.001K Mean: 0.5 Sig: 13%
-218 -10 -6 -2 2 6 10 274


Analysis increment (RMS)
Unit: 0.1K Mean: 0 Sig: 38%
-25 -5 -3 -1 1 3 5 15

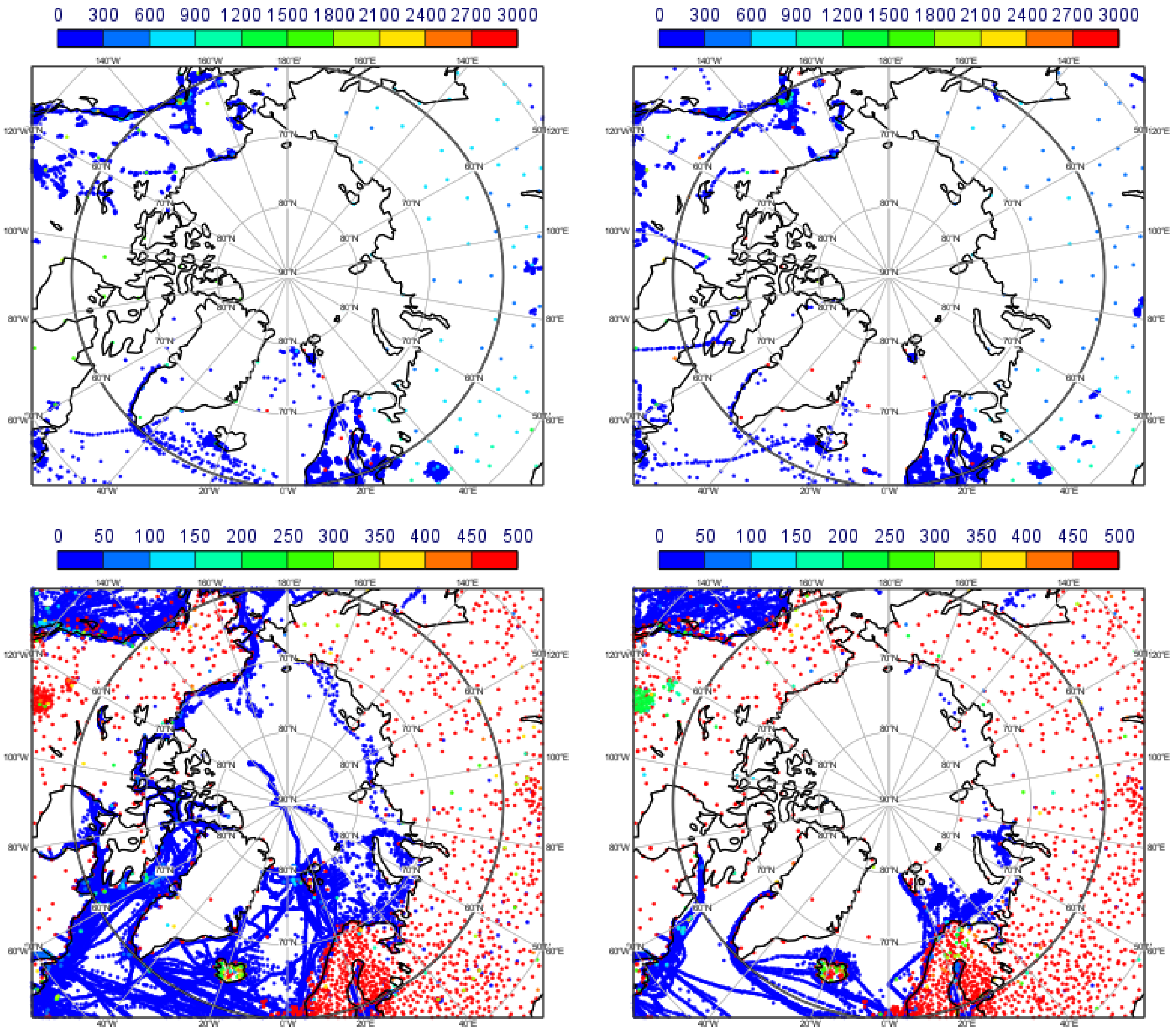
Challenges in the use of observations

APPLICATE.eu
Advanced prediction in polar regions and beyond

Summer 2016 | Winter 2017/2018

Nb radiosondes

Nb surface pressure



Less conventional data above 70N than Northern mid-latitudes

Also larger model errors & too much confidence in the model in the lower-troposphere

ECMWF

H. Lawrence

Challenges in the use of observations

APPLICATE.eu
Advanced prediction in polar regions and beyond

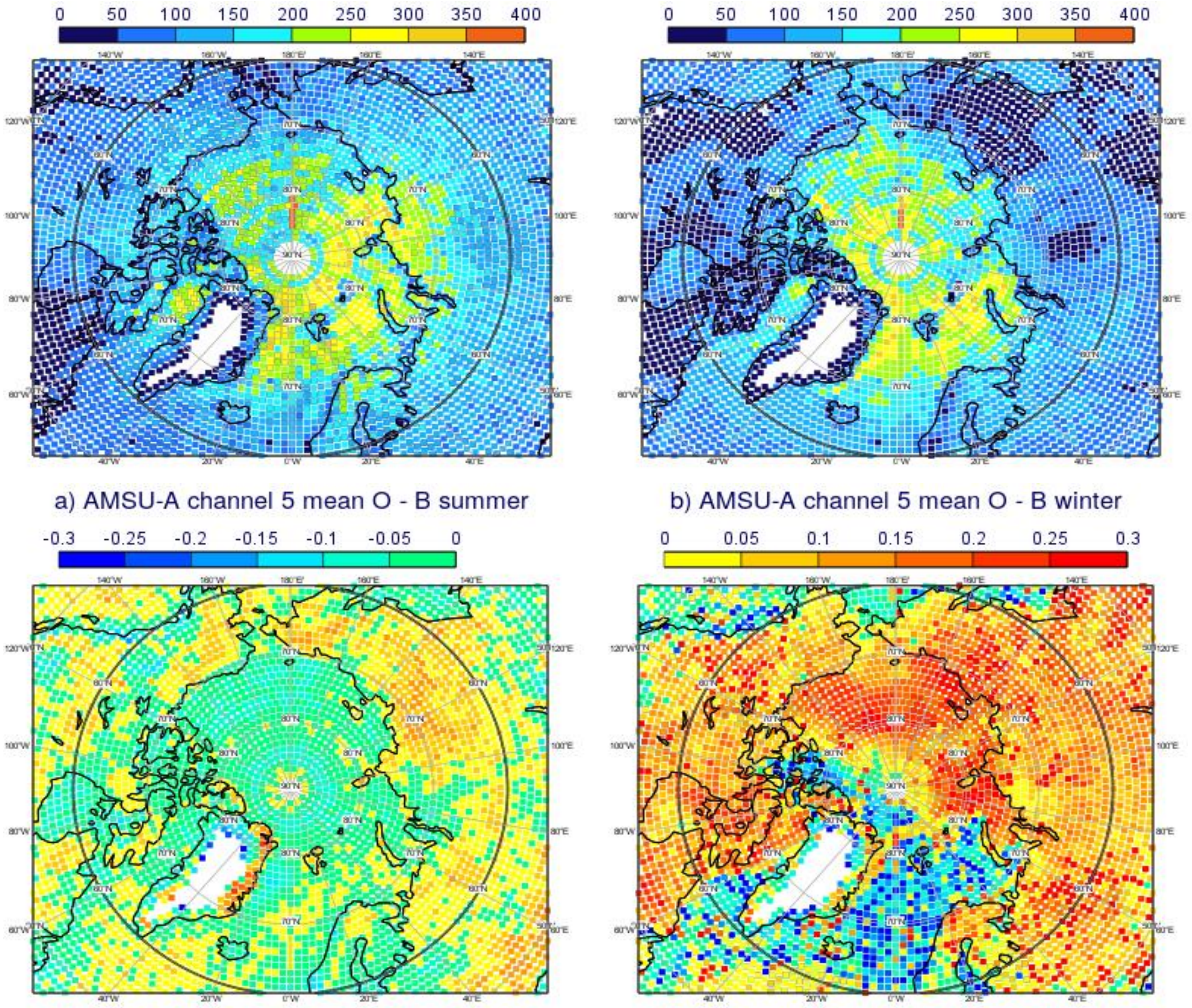
Summer 2016

Winter 2017/2018

Nb obs

NOAA-15
AMSU-A channel 5
(peaks 500-700hPa)

Obs - fc



- better coverage from polar orbiting satellites than anywhere else
- more challenges with their use (model errors, radiative transfer modelling)
- more data rejected for tropospheric channels in winter

ECMWF

H. Lawrence

Impact of denial and relaxation