

# The impact of Arctic Observations on ECMWF NWP forecasts

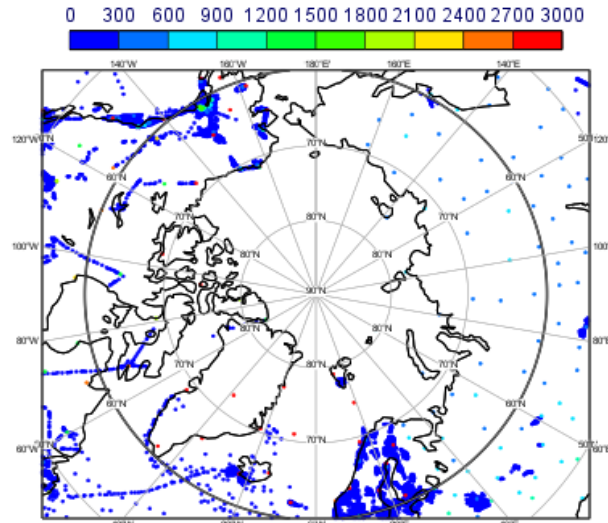
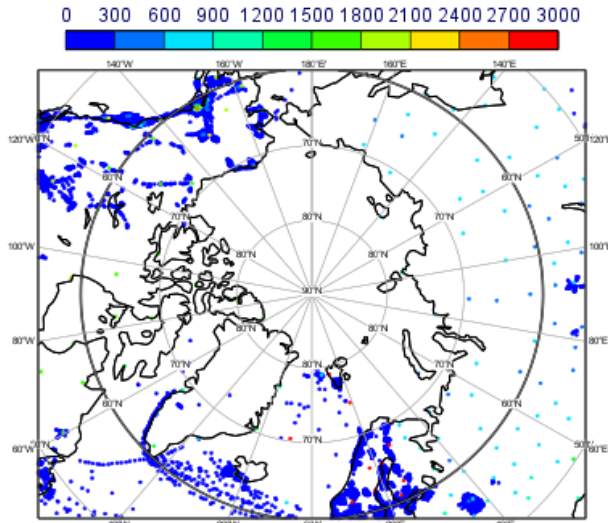
Heather Lawrence, Niels Bormann, Irina Sandu, Jonny Day, Jacky Farnan, Peter Bauer

# Conventional observations

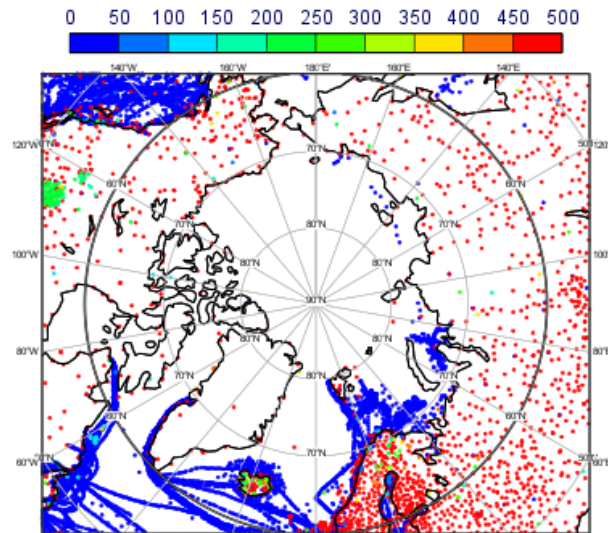
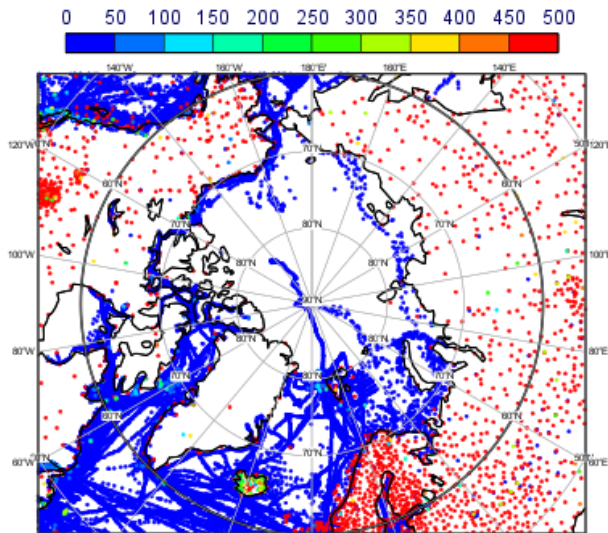
Summer 2016

Winter 2017/2018

Nb radiosondes



Nb surface pressure



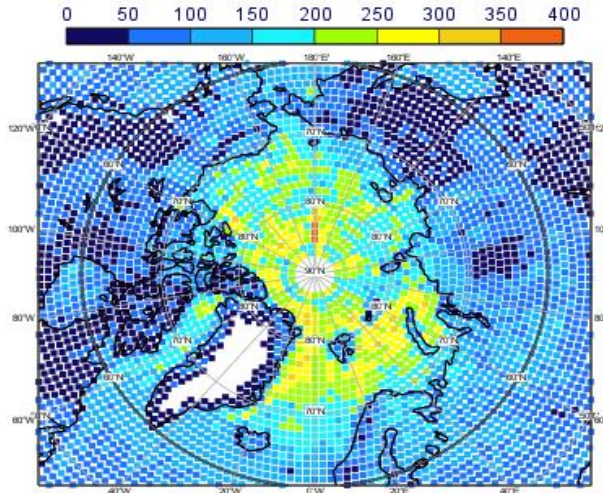
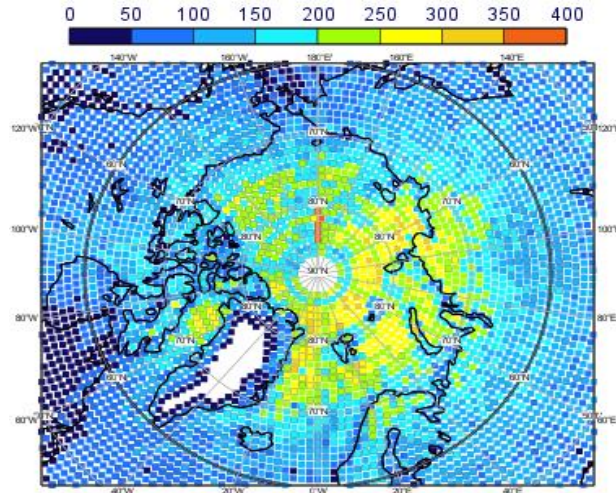
Less conventional data  
north of 70N than at  
Northern mid-latitudes

Also more expensive and  
difficult to obtain

# Satellite observations

Summer 2016

Winter 2017/2018

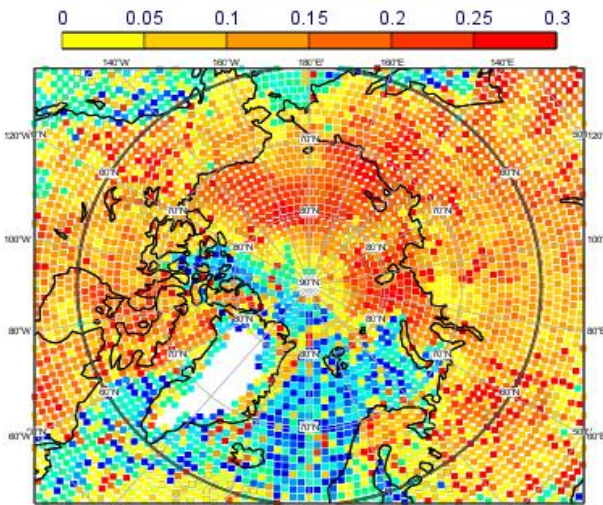
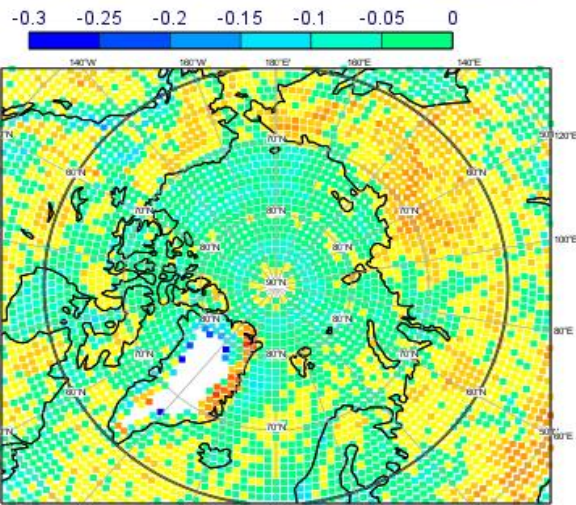


Nb obs

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

a) AMSU-A channel 5 mean O - B summer

b) AMSU-A channel 5 mean O - B winter



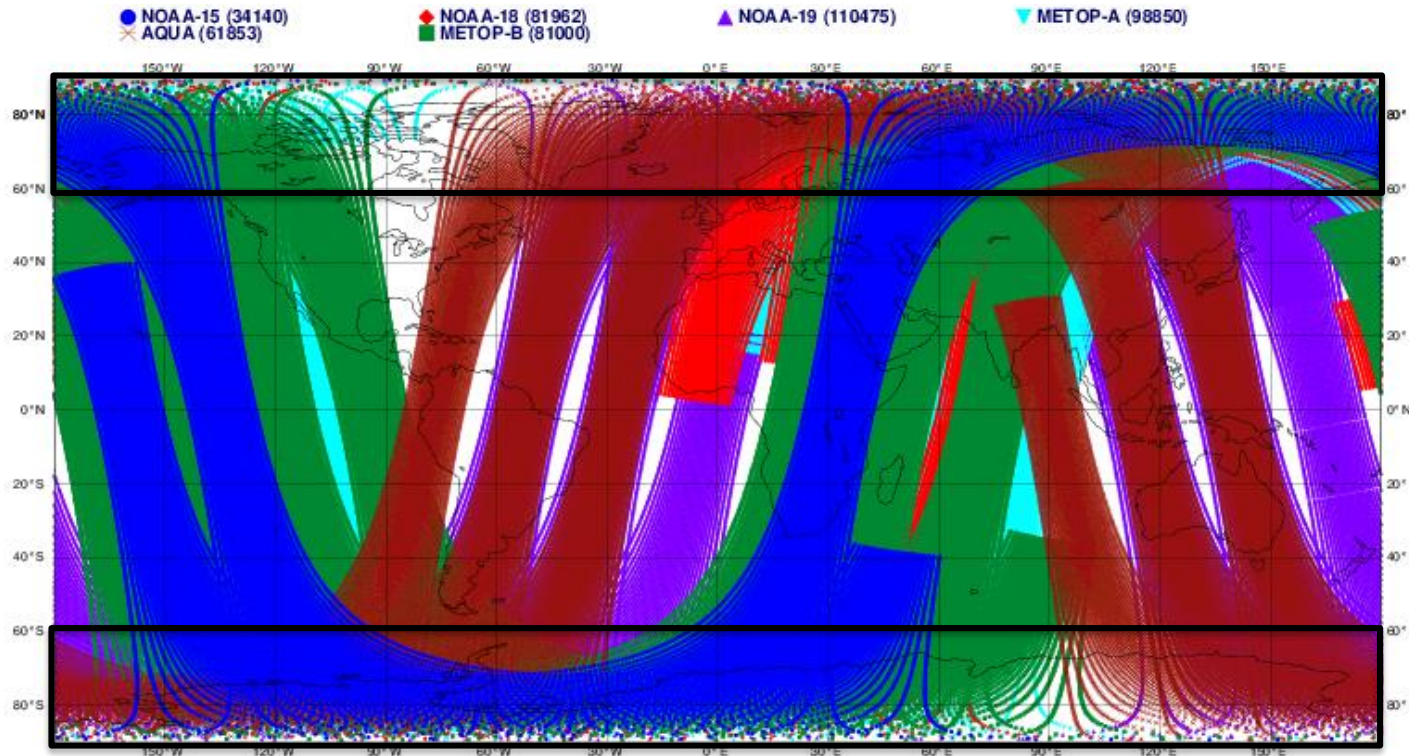
Obs - fc

- 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



# Observing System Experiments (OSEs)

Remove observations at lat>60N and lat<-60S:



Analyse the increase in forecast error when observations are removed from the Arctic

# Summary of OSE experiments


	ECMWF (25km)	Env. Canada (39km)	DWD (13km)	MetNo (AROME Arctic)
Period	JJA 16 + DFJM 17/18	DJFM17/18 + JJAS 18	FM18 JJ18 TBD	FM18
CTL (all obs, including YOPPobs)	✓	✓	✓	✓
Microwave (MW)	✓	✓	✓	✓
Infrared (IR)	✓	✓		✓
Conventional (Conv)	✓	✓		✓
GPSRO	✓	✓		
AMVs	✓	✓	✓	✓
Radiosondes	✓	✓	✓	✓
Buoys	✓			
Synop	✓			
Surface pressure	✓	✓	✓	✓
YOPP obs	✓	✓	✓	✓
MW temperature	✓	✓		
MW humidity	✓	✓		

**Main**

**Conv  
split**

**MW  
split**

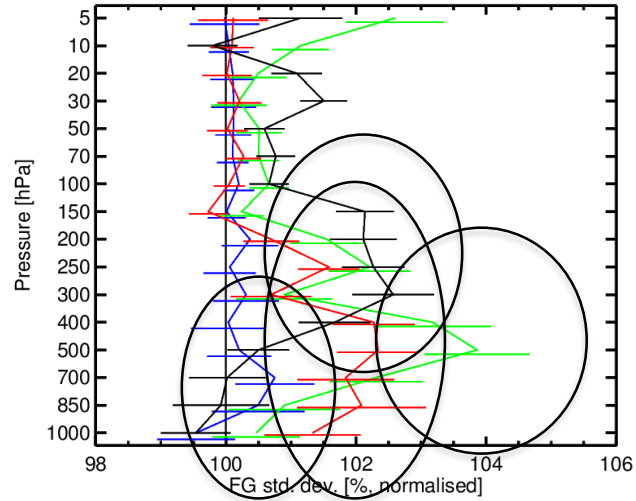
impact of obs  
through DA and LBC



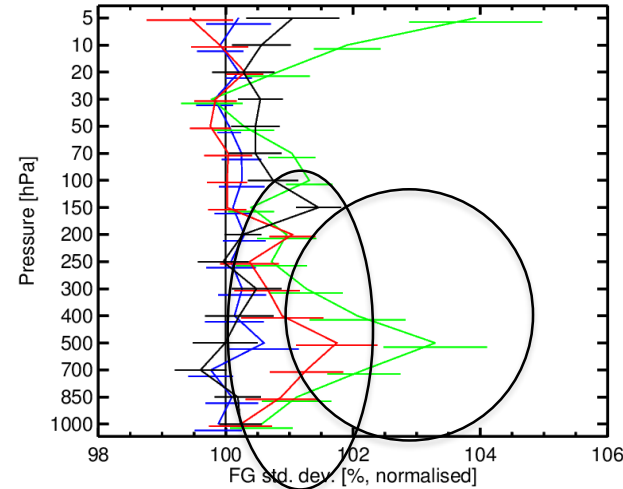
# Short-range forecast fits to polar radiosondes

Temp-T  
60 – 90 N

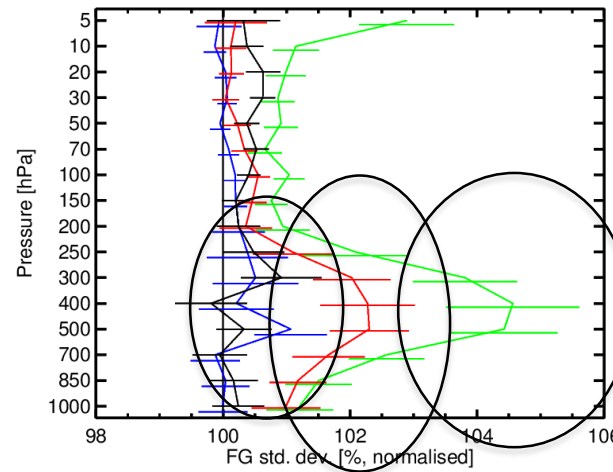
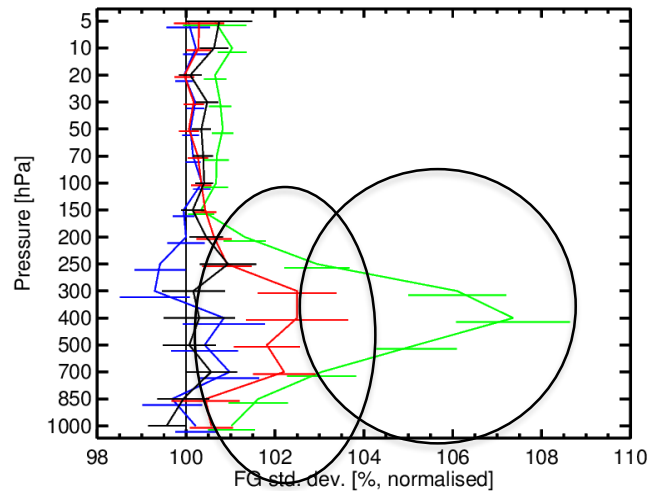
**SUMMER**



**WINTER**



wind2  
60 – 90 N



Microwave:

- Temperature 500 hPa
- Wind 300 – 500 hPa

Infrared:

- Temperature 1000 - 300 hPa
- Wind 700 – 300 hPa

GPSRO

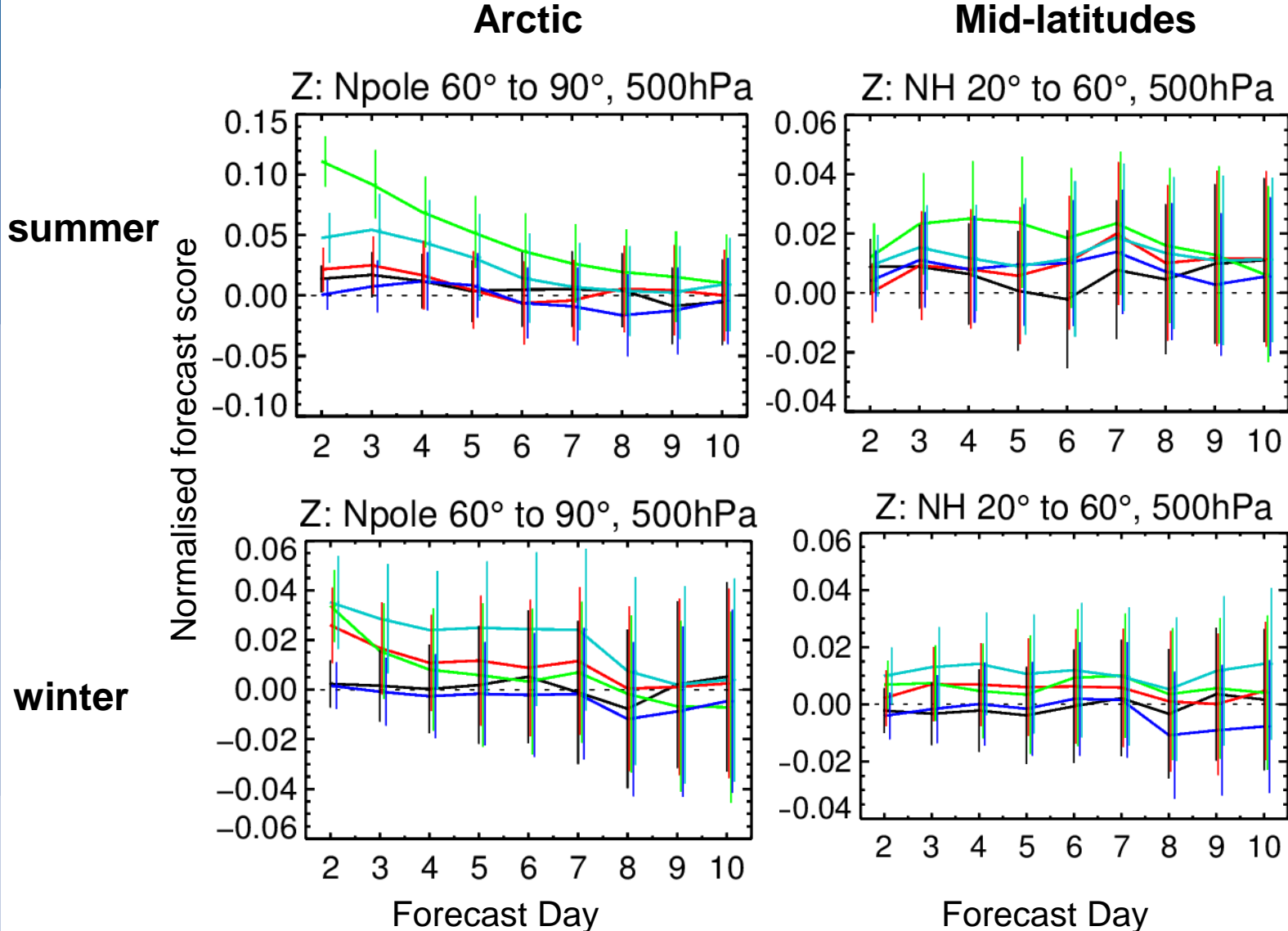
- Summer temperature 300 – 150 hPa

AMVs

- Wind, temperature 850 – 500 hPa

- GPSRO – Ctrl
- IR – Ctrl
- MW – Ctrl
- AMVs – Ctrl

# Medium-Range Forecast Scores: Z500 Arctic and N. Midlat



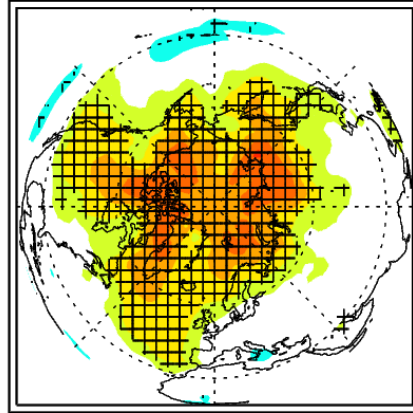
- Summer:**
- Microwave
  - Conventional
  - Infrared
  - GPSRO, AMVs
- Winter:**
- Conventional
  - Infrared/Microwave

- GPSRO – Ctrl
- IR – Ctrl
- MW – Ctrl
- AMVs – Ctrl
- Conv – Ctrl

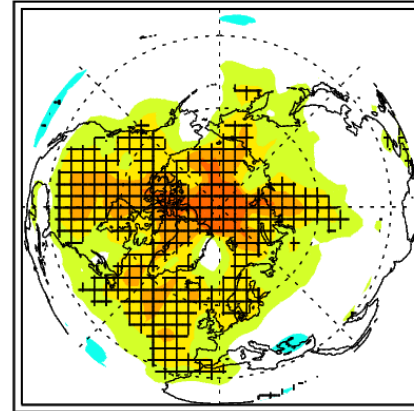
# Polar OSEs: Arctic to mid-latitude impact

Microwave Summer  
Z500 scores

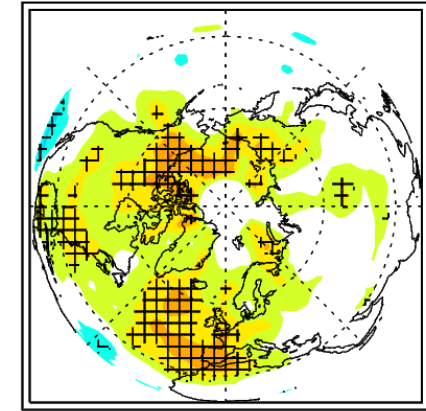
Day 3



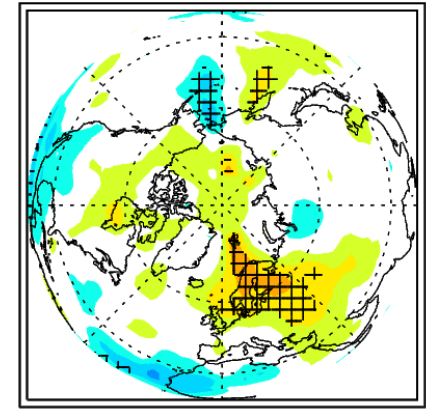
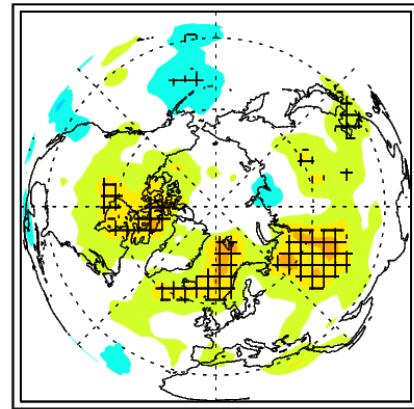
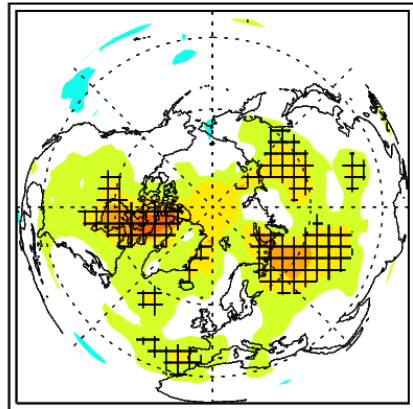
Day 4



Day 5



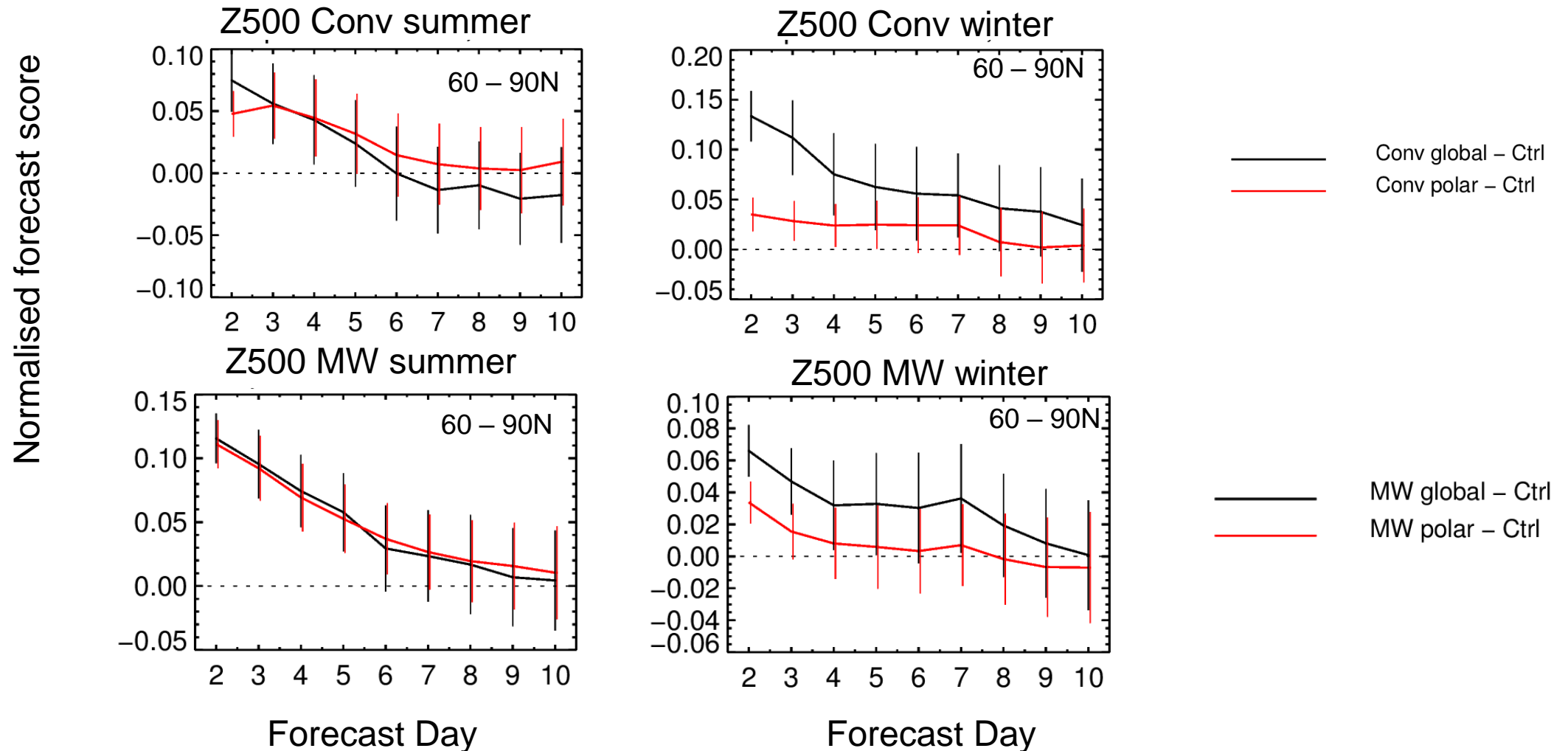
Conventional winter  
Z500 scores





# Polar vs Global OSEs: Mid-latitude to Arctic impact

Mid-latitude observations influence Arctic weather forecasts in winter:



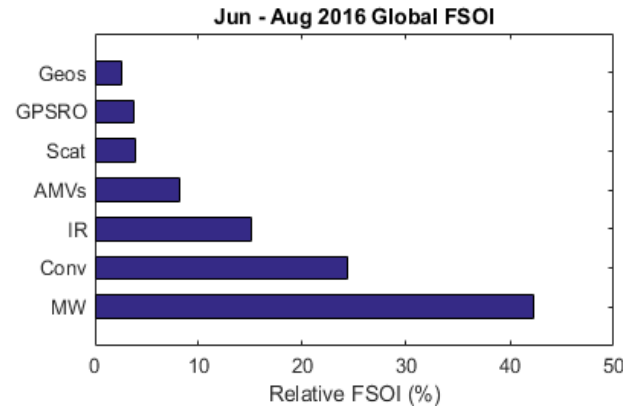
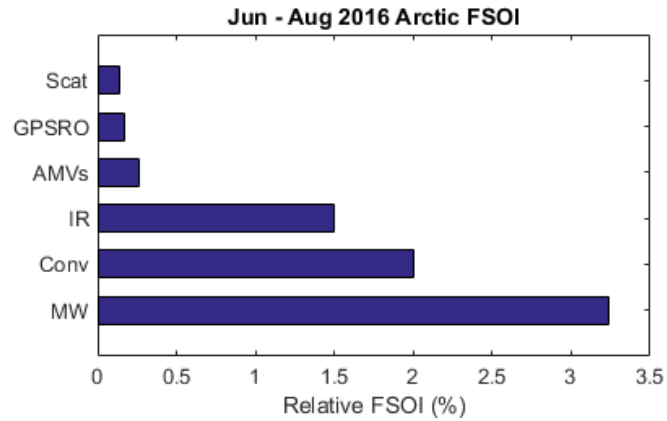
# FSOI: Forecast Sensitivity to Observation Impact

*Adjoint-based method of measuring observation impact (Cardinali, 2009)*

## Arctic:

## Global:

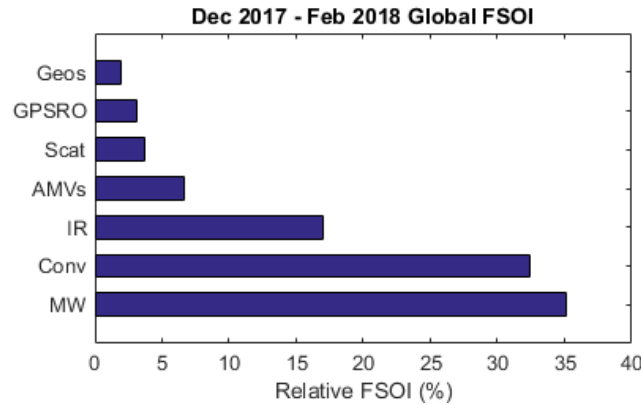
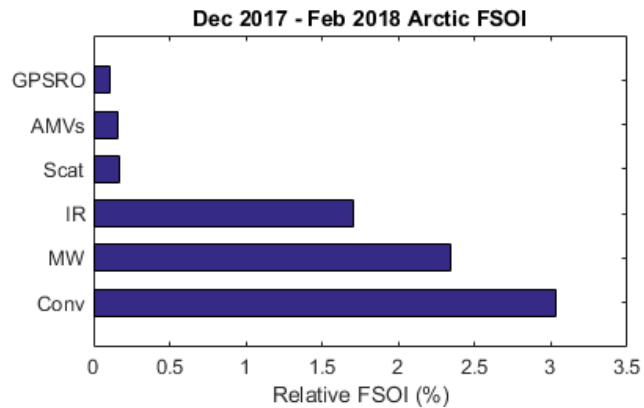
summer



## Globally:

1. Microwave
2. Conventional
3. IR

winter



## Arctic summer:

1. Microwave
2. Conventional
3. IR

## Arctic winter:

1. Conventional
2. Microwave
3. IR

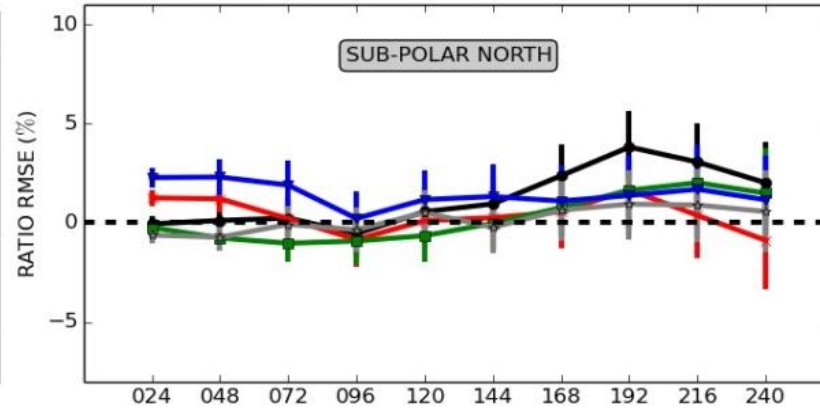
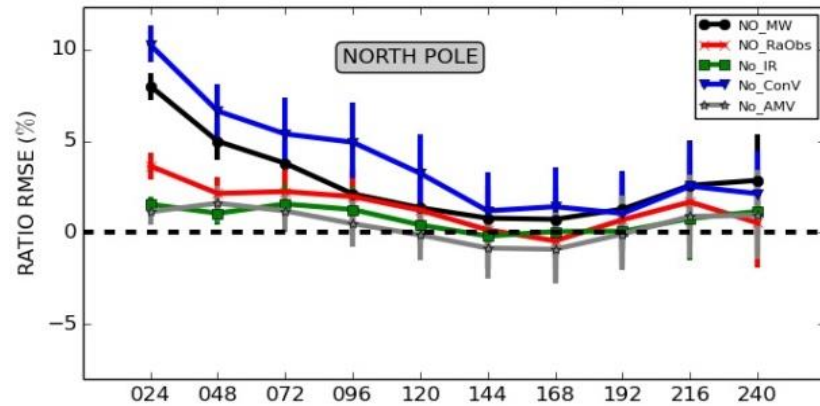


## Degraded forecast skill in the Arctic and Northern Mid-latitudes

60 – 90 N

47 – 60 N

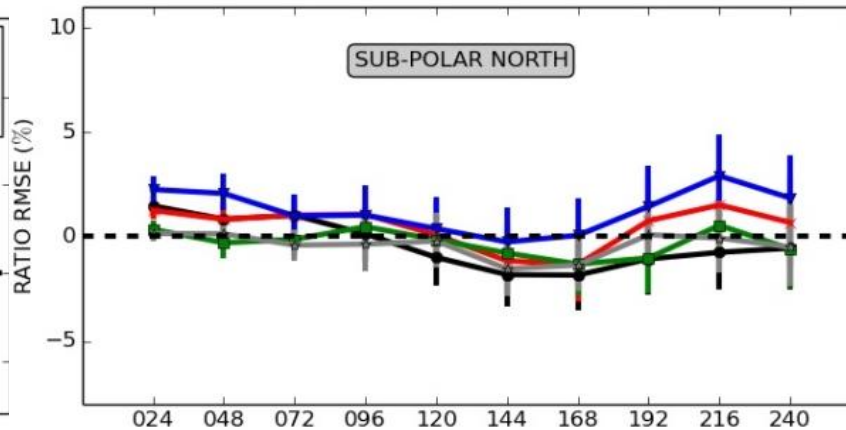
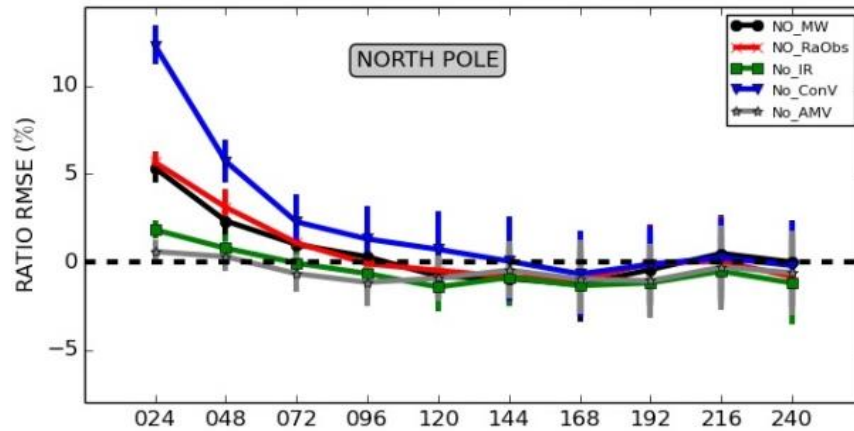
Summer  
2018



Summer:

- Conventional
- MW/Radiosondes

Winter  
2018



Winter:

- Conventional
- Radiosondes
- MW

FSOI analysis to follow

Normalized RMSE difference (%) for Z500



# Conclusions

- Microwave, conventional and infrared data are key observing systems in the Arctic, as elsewhere
- We make good use of satellite data in the Arctic summer – similar to SHERA
- Microwave impact is lower in winter....

Improve data use over snow e.g. with:

- Modelling of snow emission/reflection using snow model developed in APPLICATE
  - Lambertian reflection
  - Improved skin temperature estimates?
- Results at different NWP centres depend on the (use of observations in the respective) NWP system
  - Impacts are always subject to the sophistication/maturity of the data use. Investment in the data use may be at least as important as investment in further observations

*H. Lawrence et al, 'Evaluation of Arctic Observation Forecast impact in the ECMWF Numerical Weather Prediction System,' in preparation*



# Extra slides

## Degraded forecast skill in the Arctic and Northern Mid-latitudes

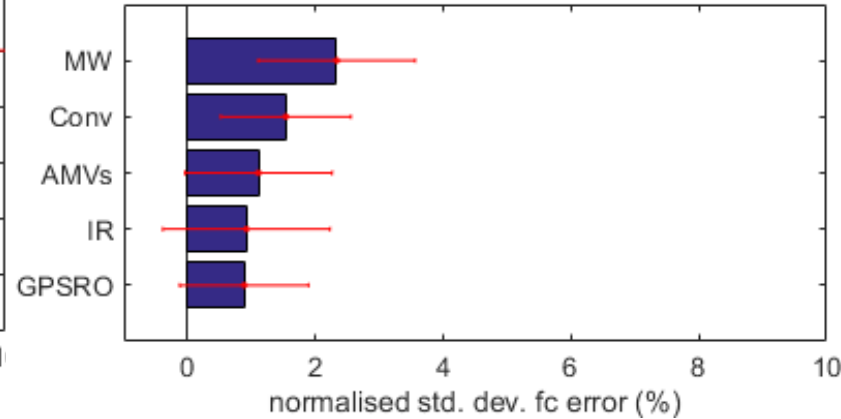
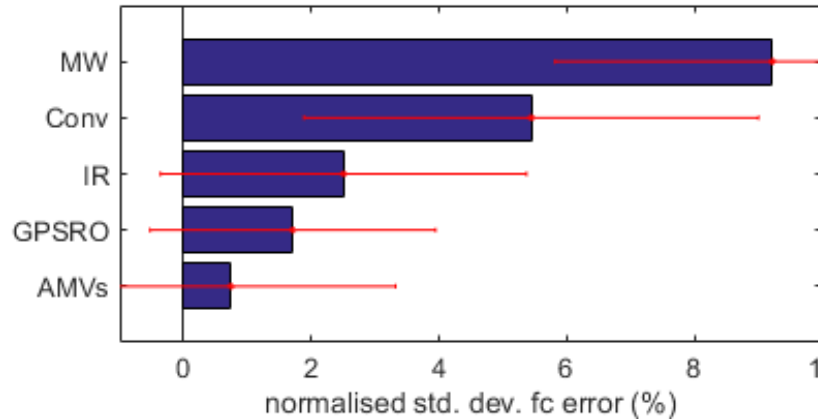
**60 – 90 N**

**20 – 60 N**

summer OSE Z500 day 3 Npole

summer OSE Z500 day 3 NH

summer



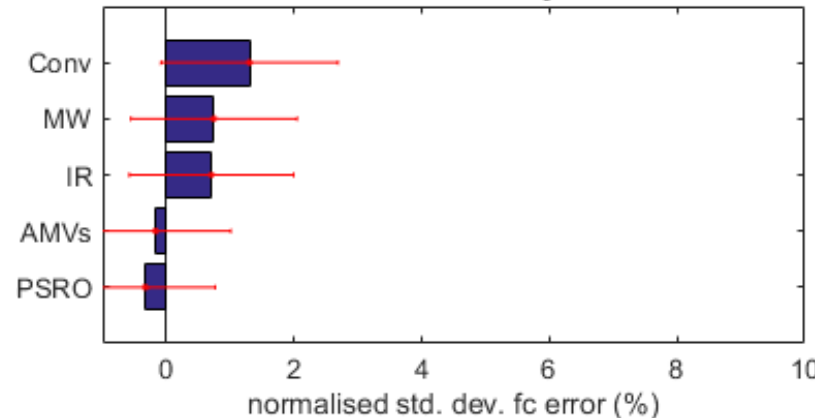
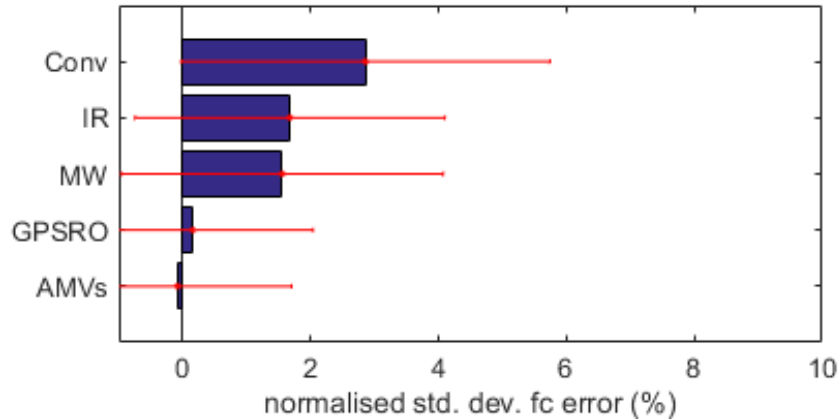
**Summer:**

- Microwave
- Conventional
- Infrared
- GPSRO, AMVs

winter OSE Z500 day 3 Npole

winter OSE Z500 day 3 NH

winter



**Winter:**

- Conventional
- Less impact overall from each observation type

# Medium-Range Forecast Scores: Z500 Arctic and N. Midlat

