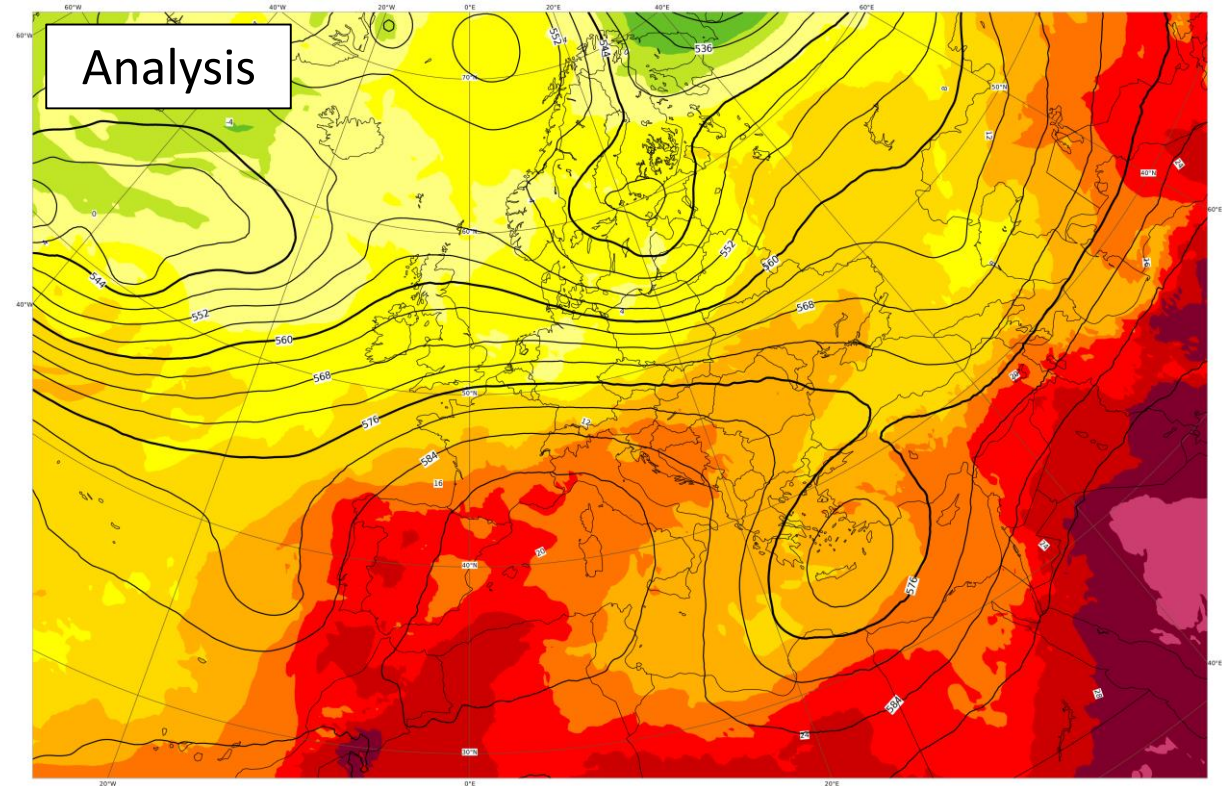
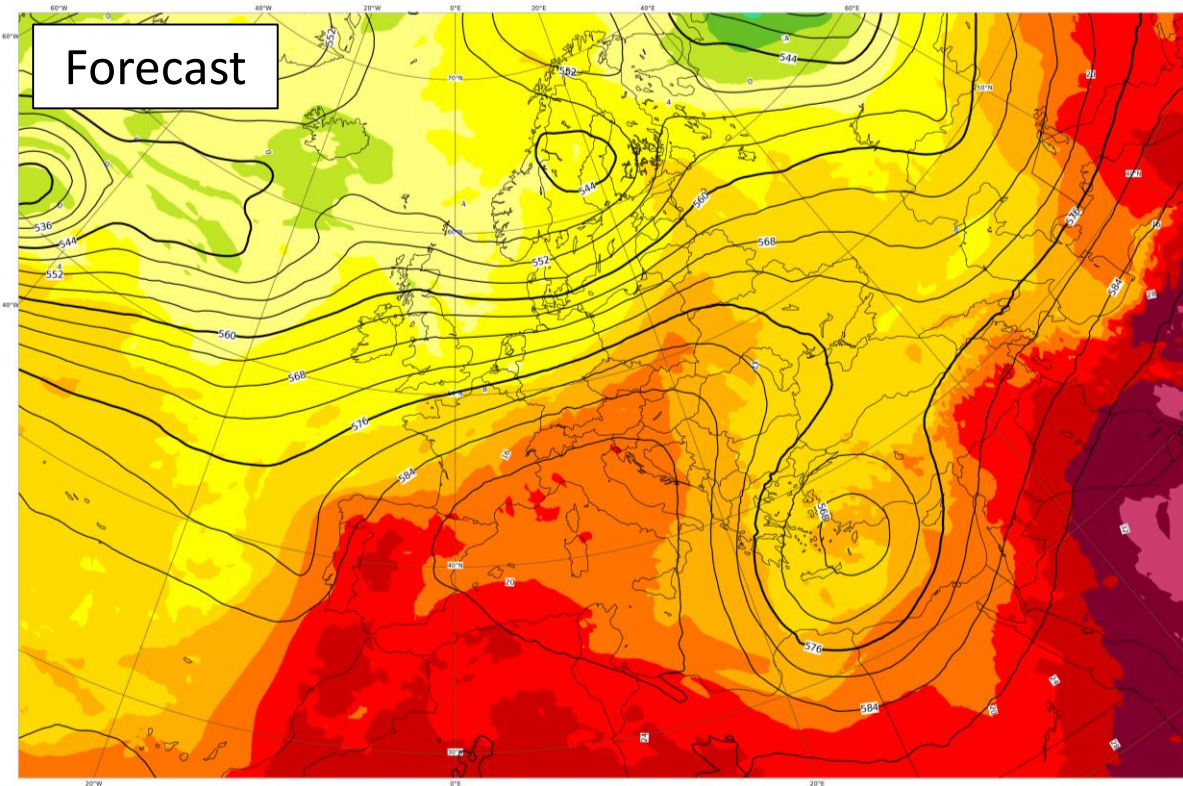


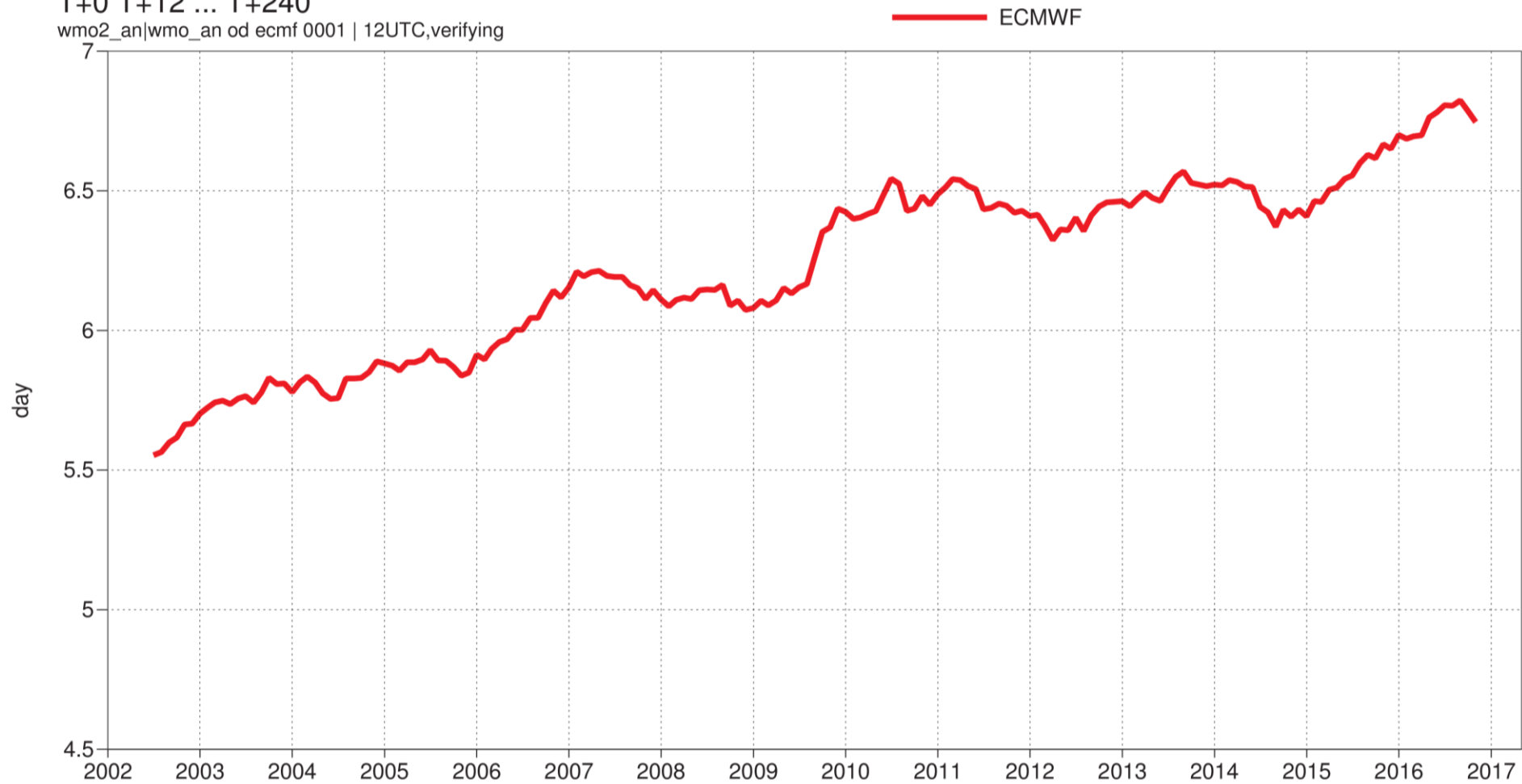
# Verification at ECMWF

Thomas Haiden and Martin Janousek  
*European Centre for Medium-Range Weather Forecasts*



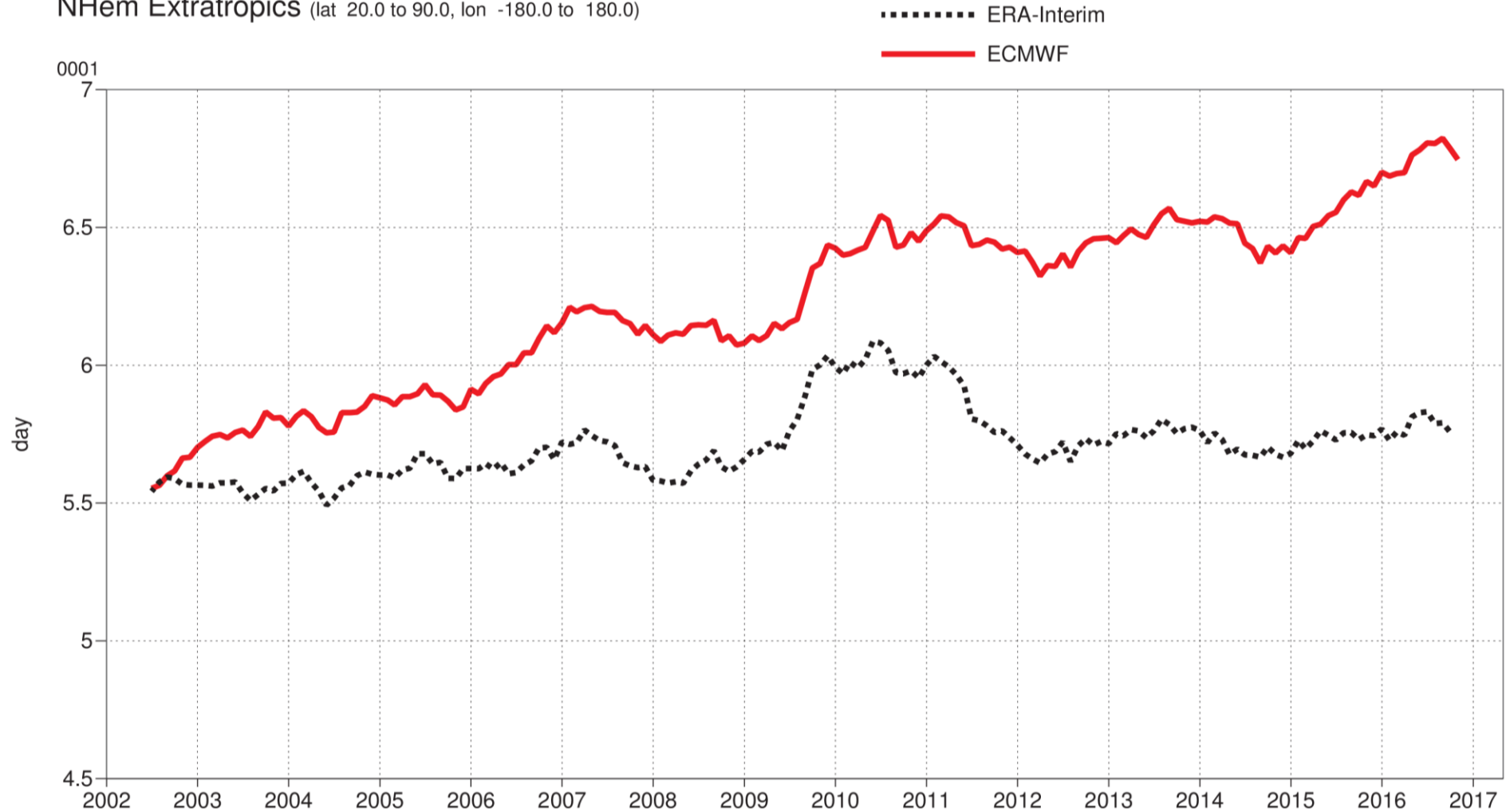
# Anomaly correlation of 500 hPa geopotential

500hPa geopotential  
Anomaly correlation  
NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)  
T+0 T+12 ... T+240  
wmo2\_an|wmo\_an od ecmf 0001 | 12UTC,verifying



# Anomaly correlation of 500 hPa geopotential

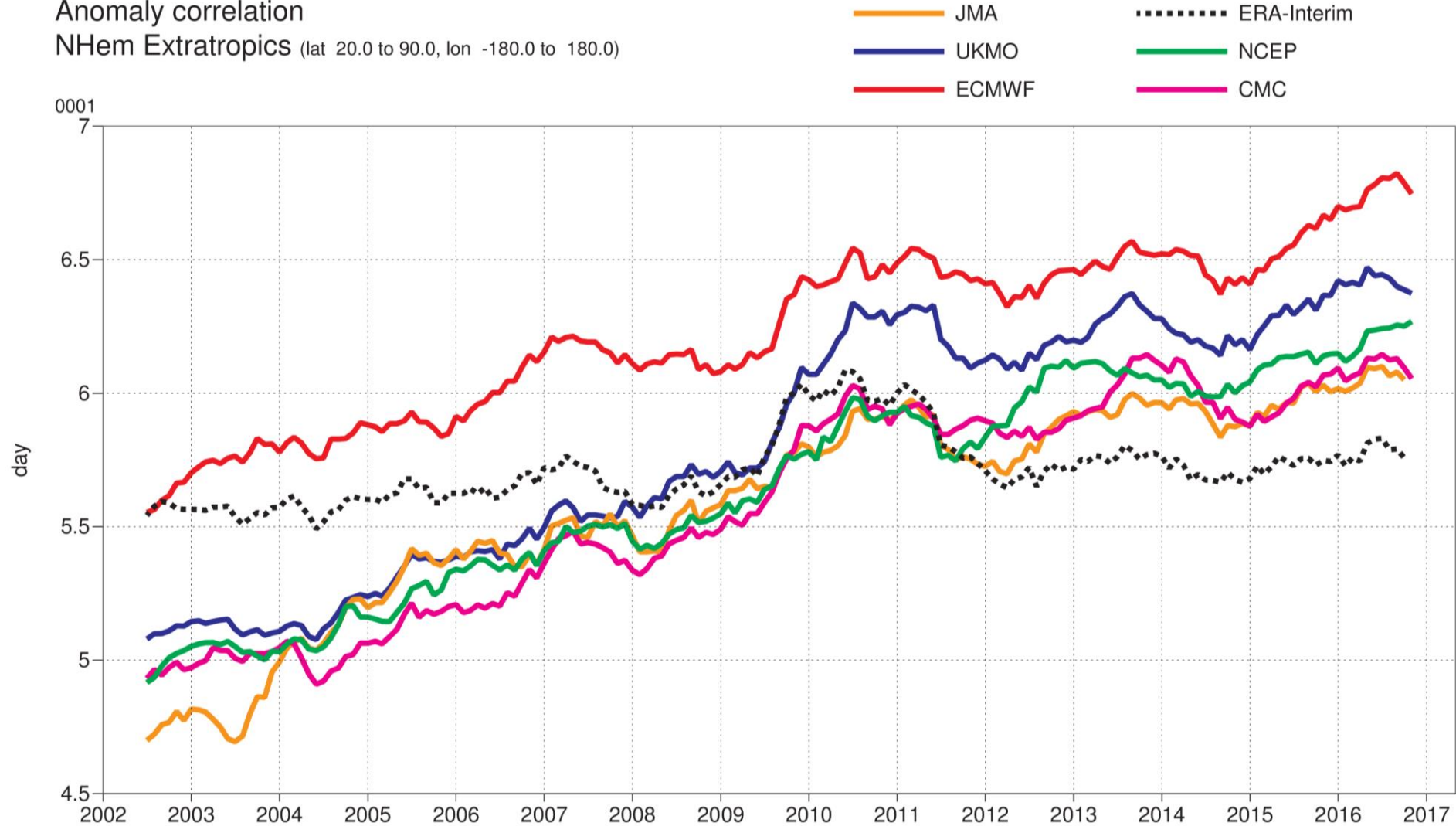
500hPa geopotential  
Anomaly correlation  
NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)





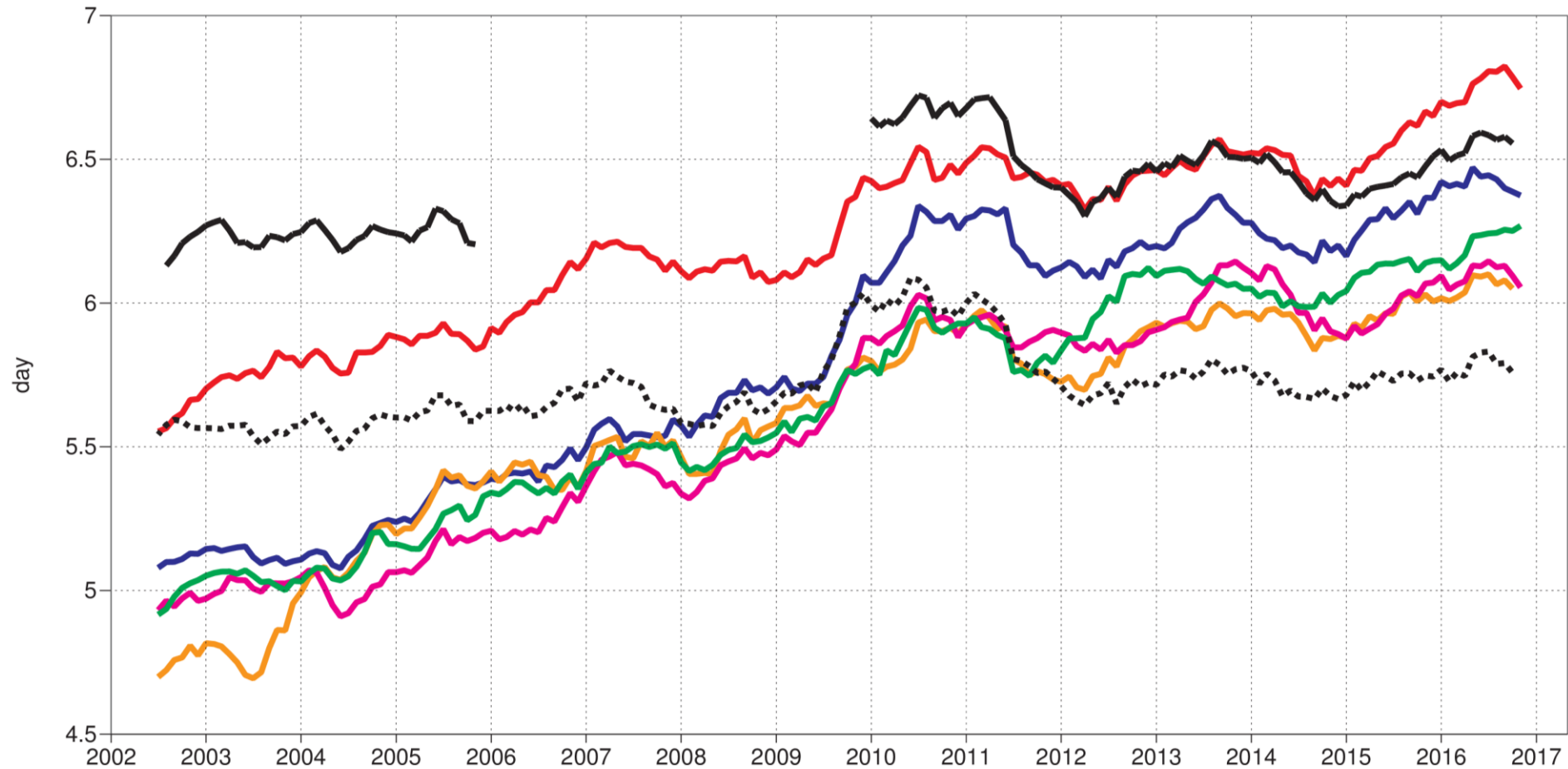
# Anomaly correlation of 500 hPa geopotential

500hPa geopotential  
Anomaly correlation  
NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)

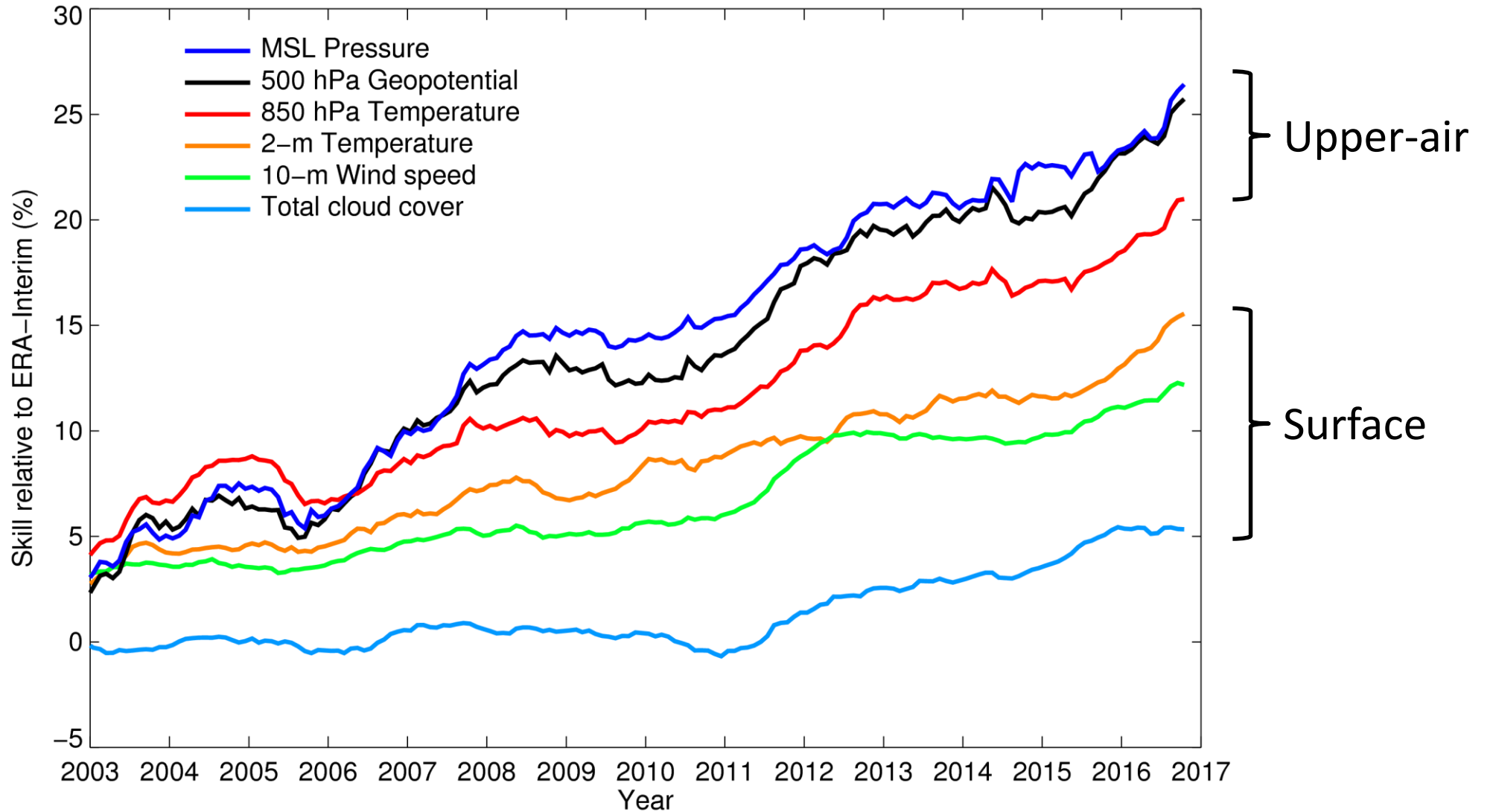


# Anomaly correlation of 500 hPa geopotential

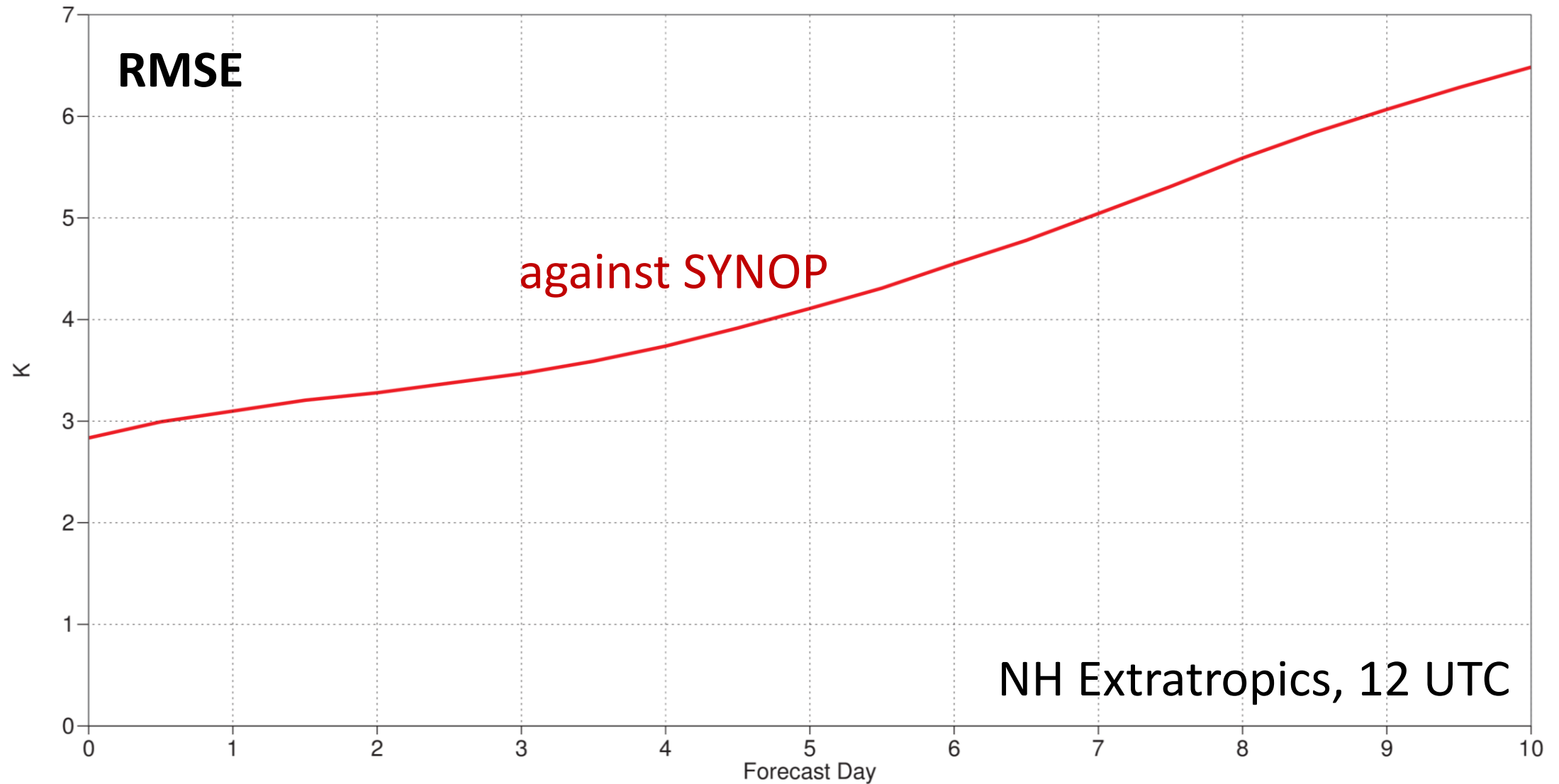
500hPa geopotential  
Anomaly correlation  
NHem Extratropics (lat 20.0 to 90.0, lon -180.0 to 180.0)



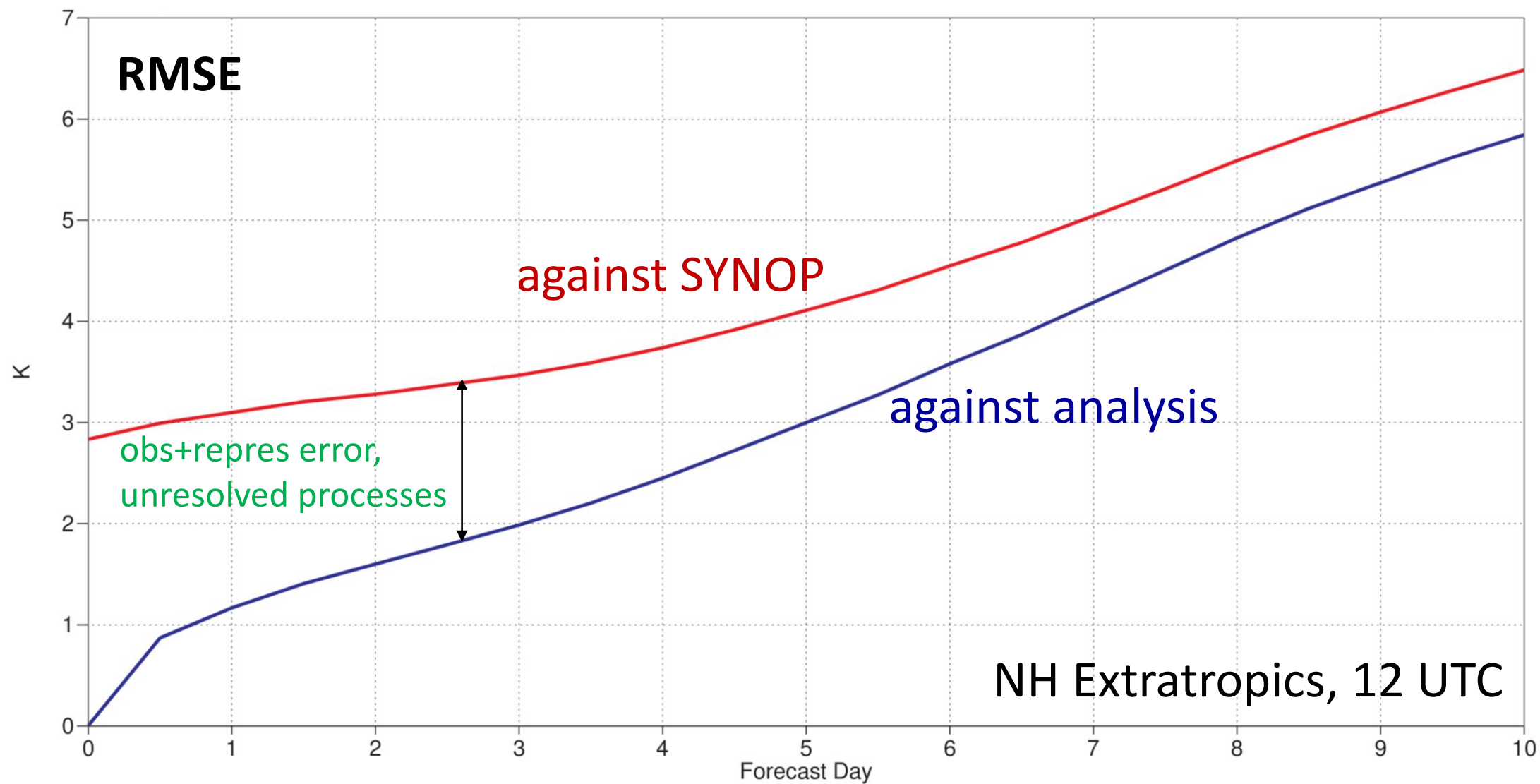
# Improvement relative to ERA-Interim



# 2-m temperature error growth: DJF 2016-17

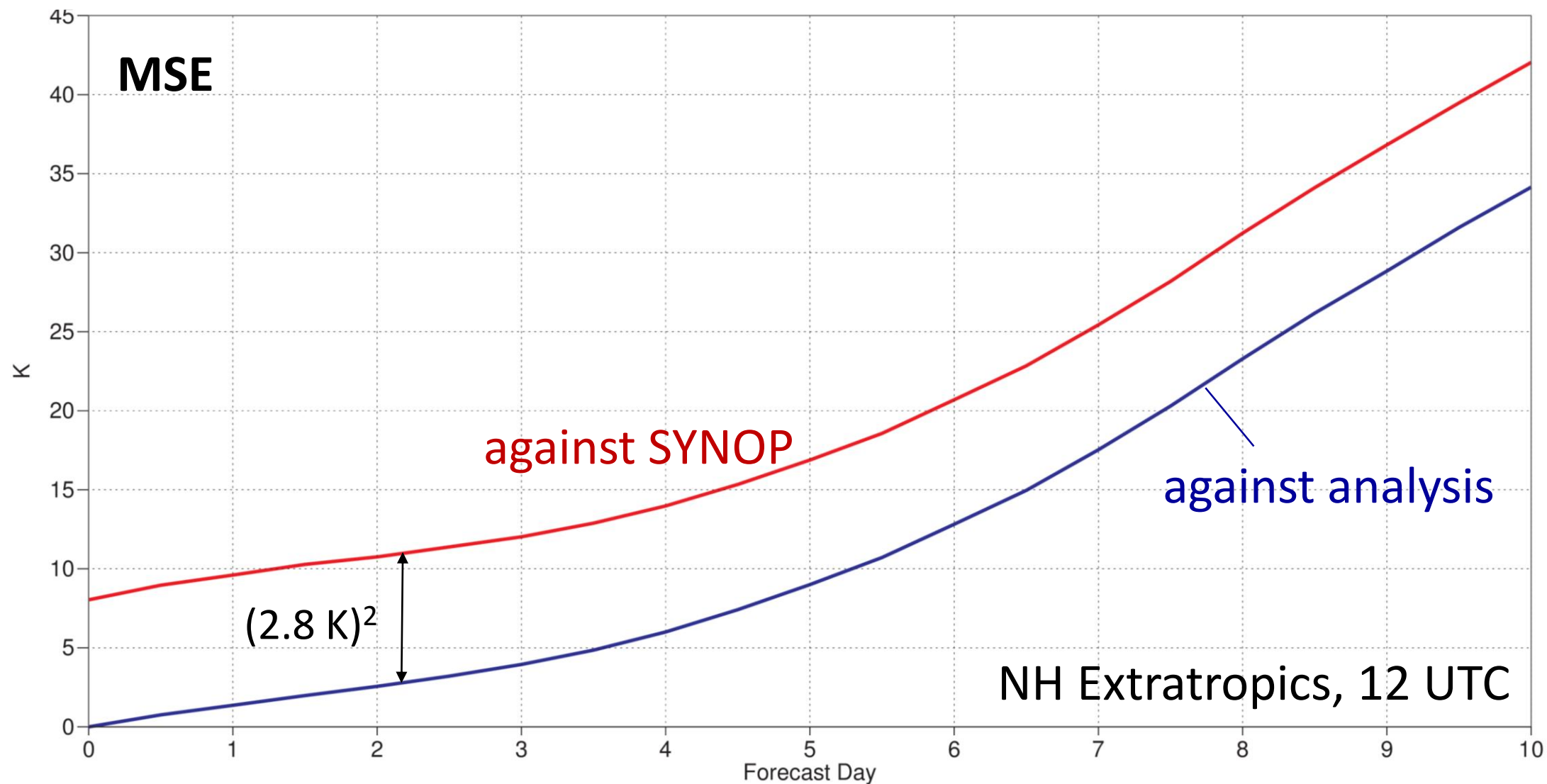


# 2-m temperature error growth: DJF 2016-17

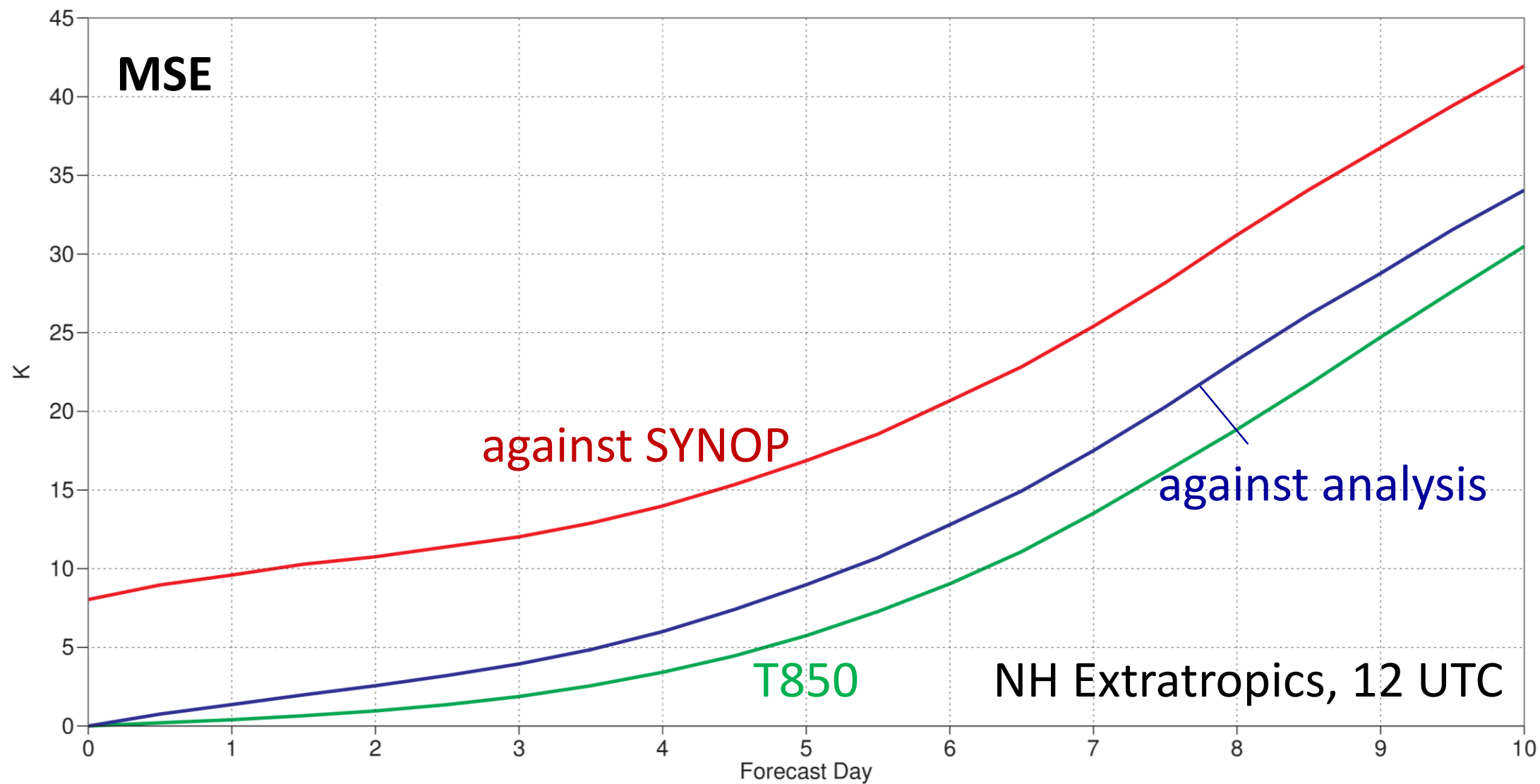




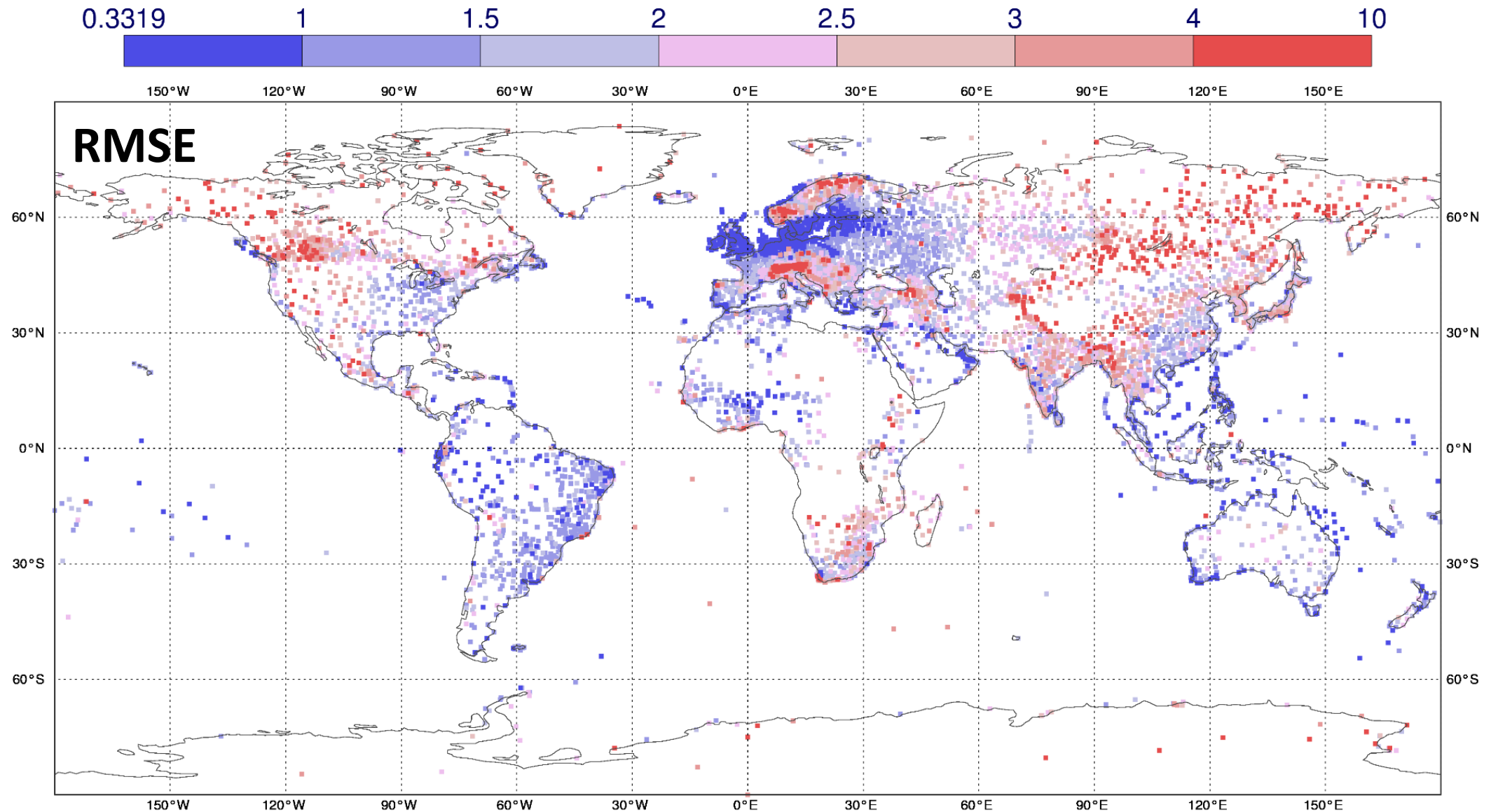
# 2-m temperature error growth: DJF 2016-17



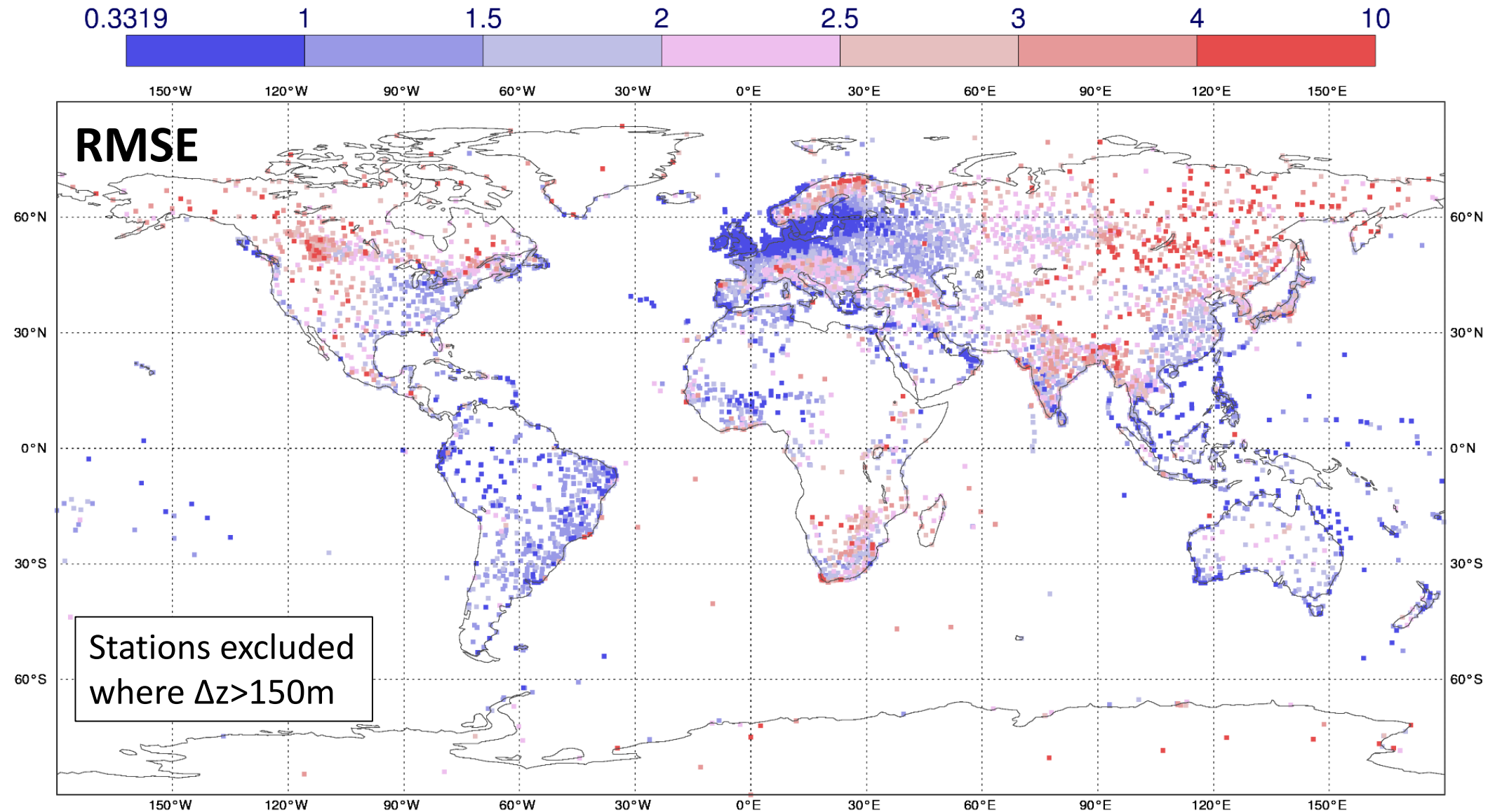
# 2-m temperature error growth: DJF 2016-17



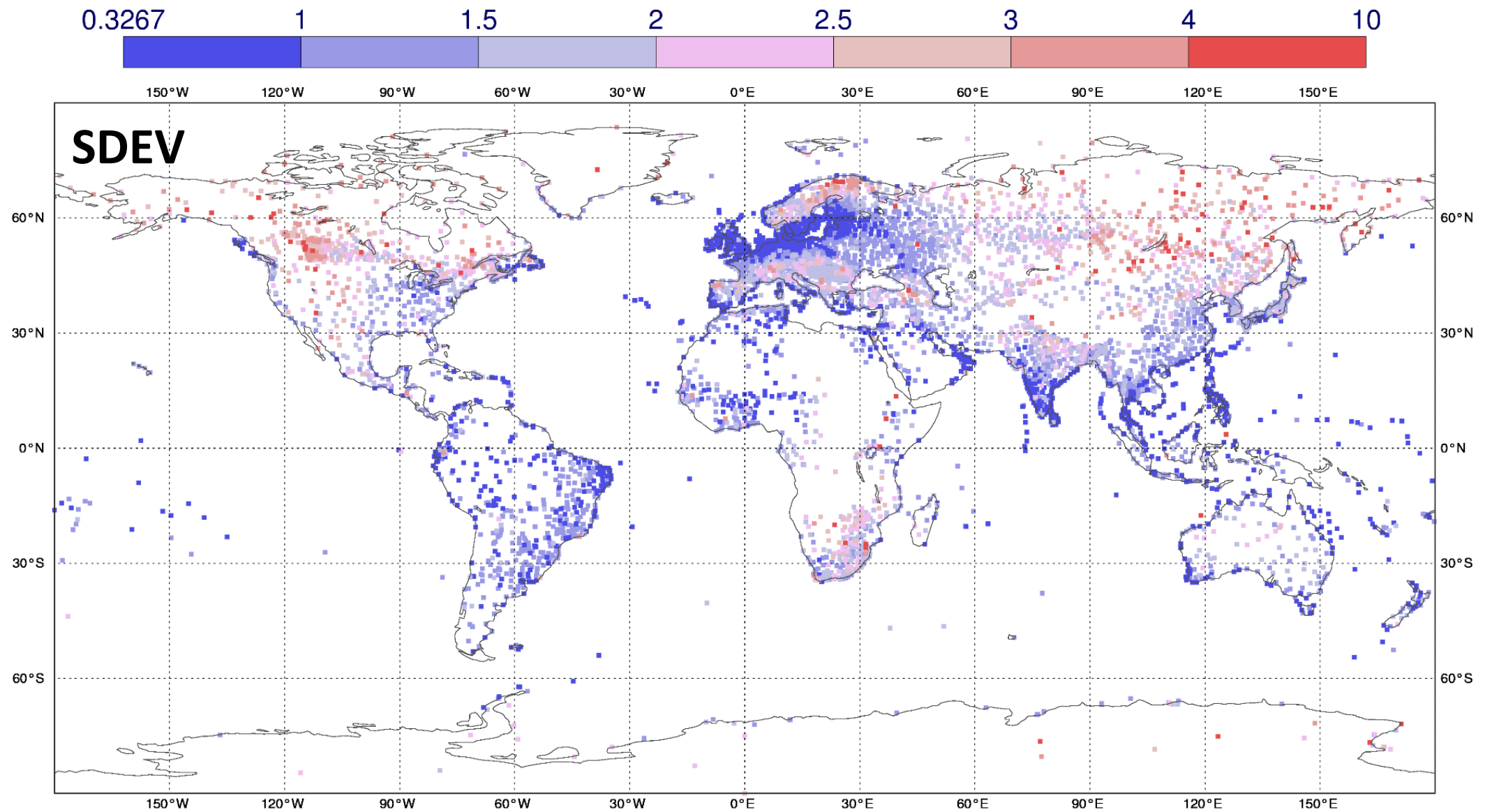
# Regional variations



# Regional variations

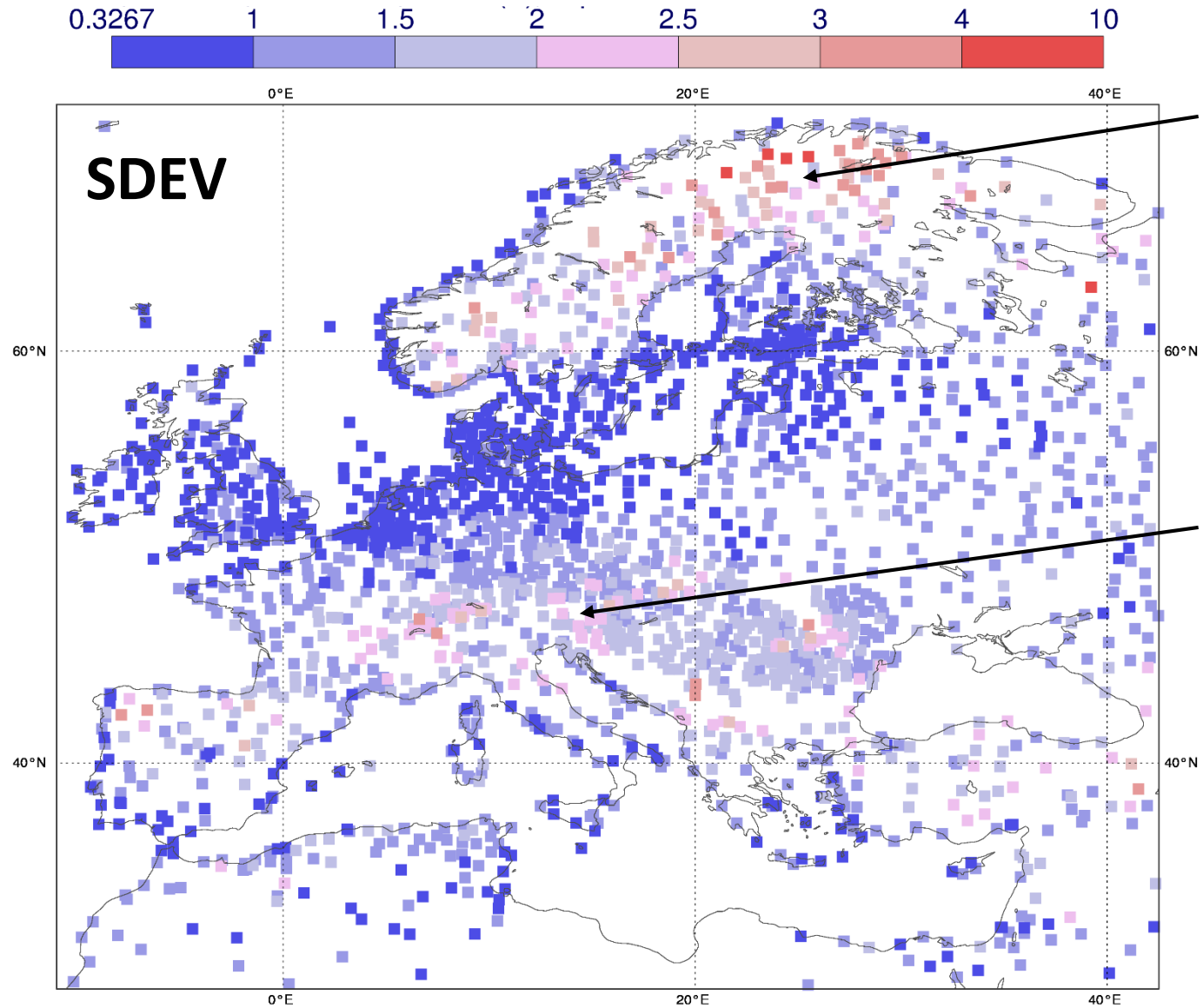


# Regional variations





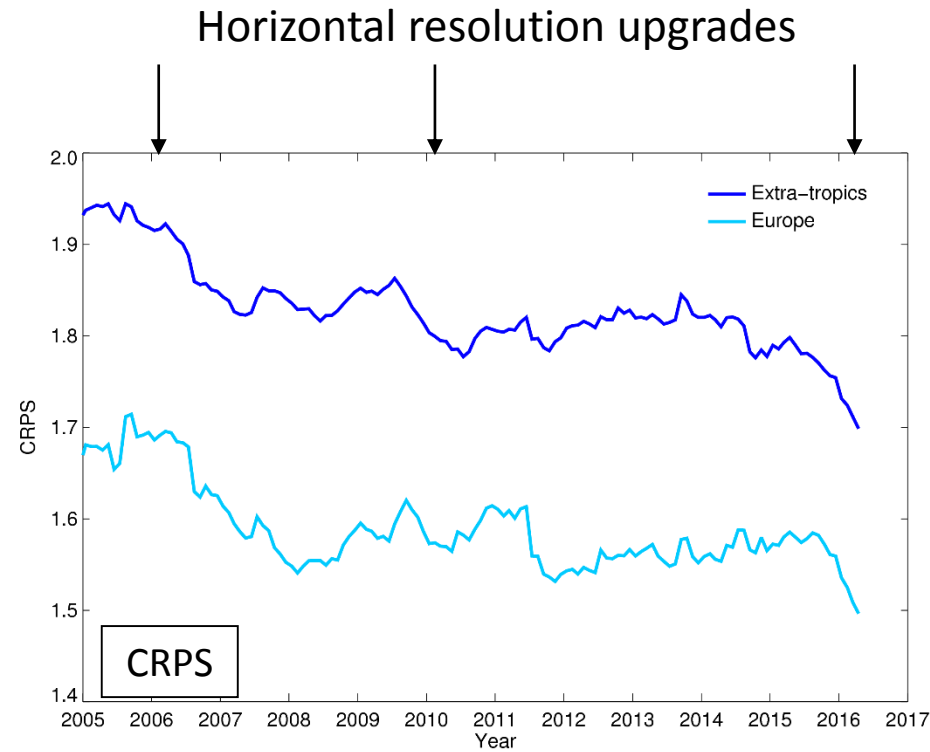
# Europe



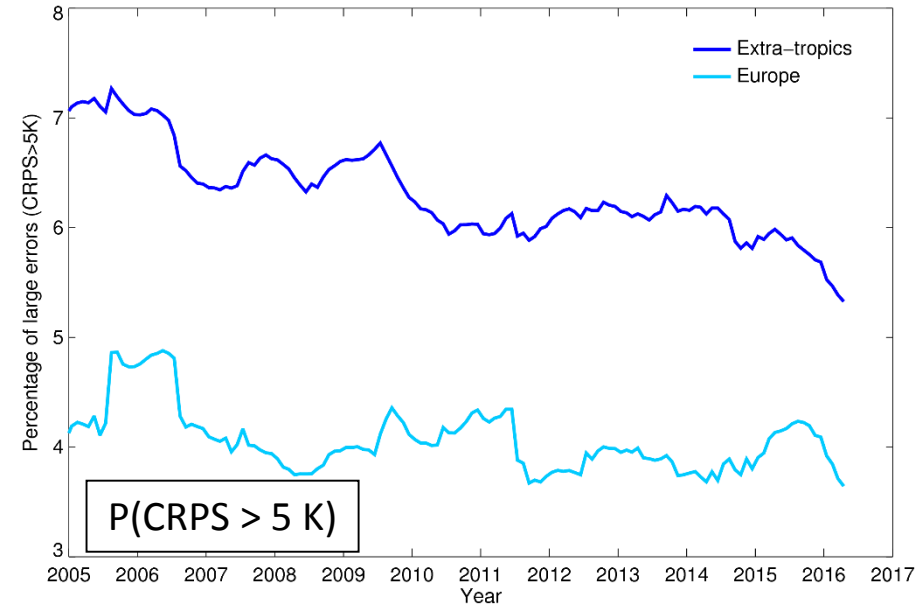
Problem: strong surface inversions over snow

Problem: low stratus boundaries and persistence

# T2m forecast skill evolution (ENS) – Day 5



All errors

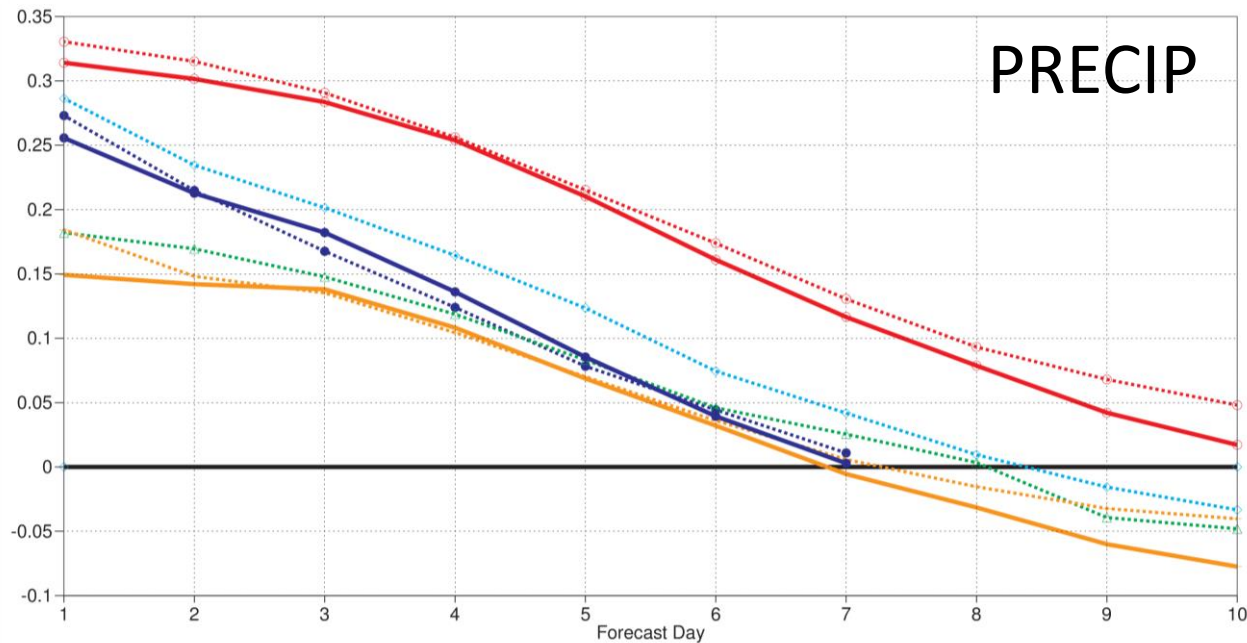
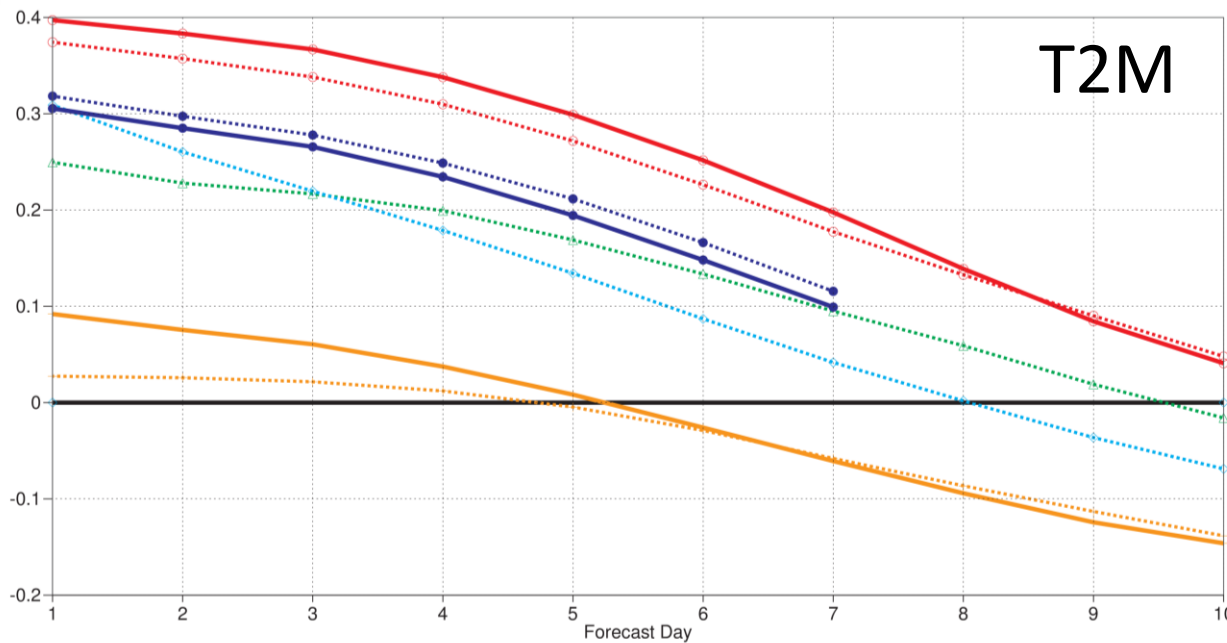
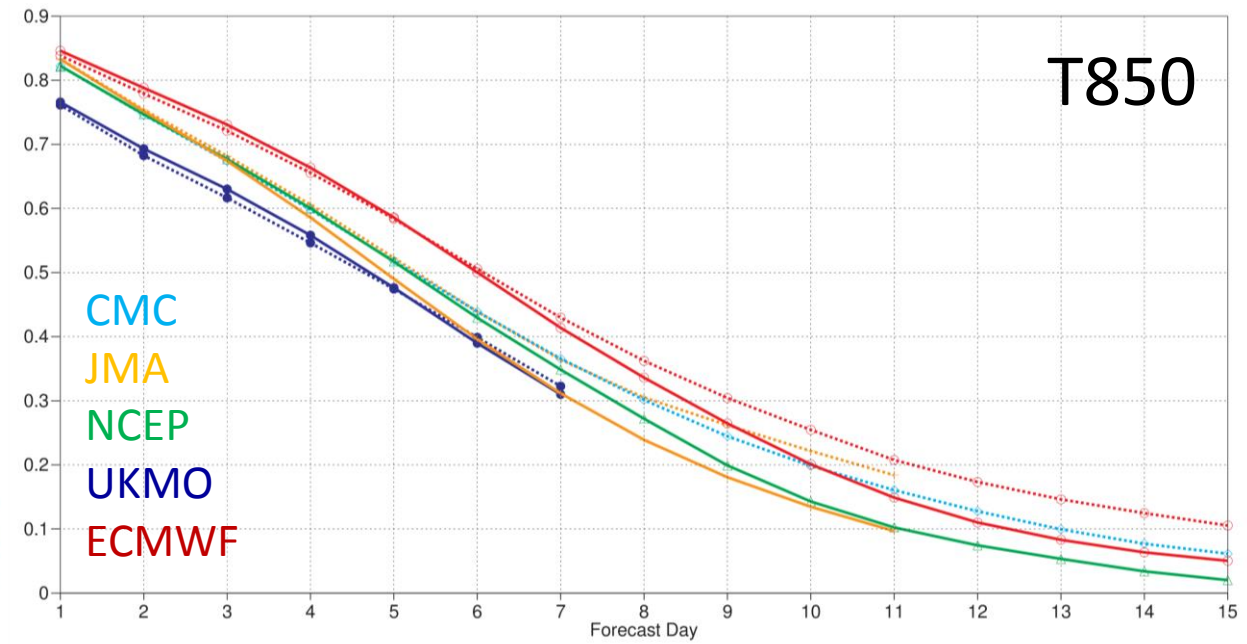
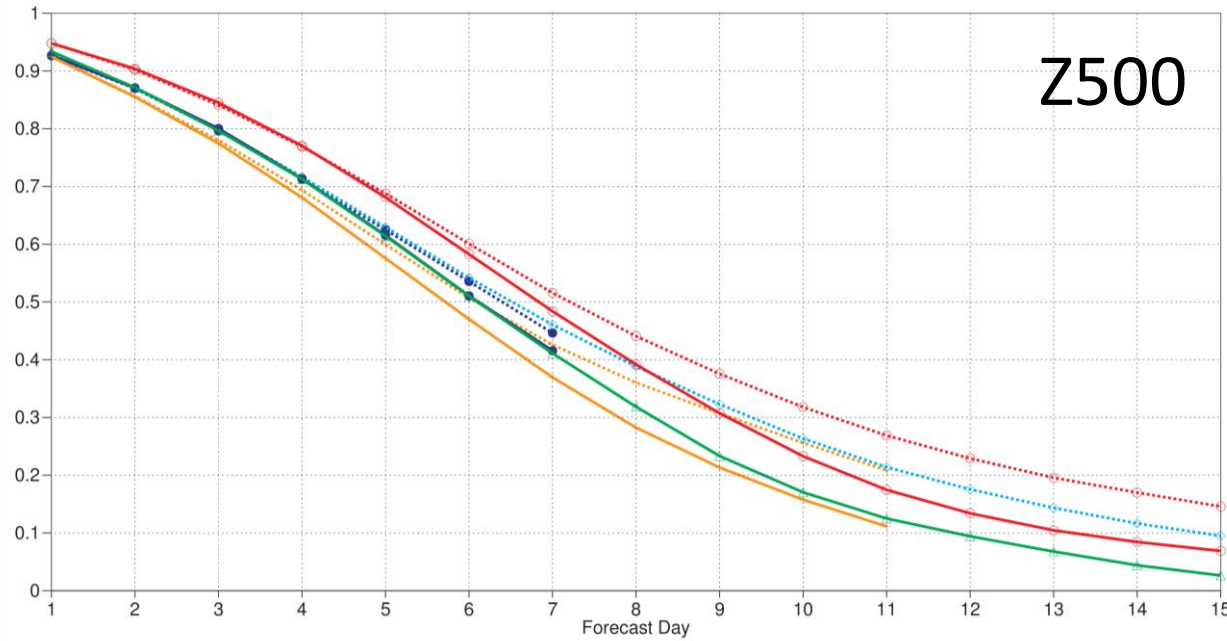


Percentage of large errors

CRPS decreased by ~10%

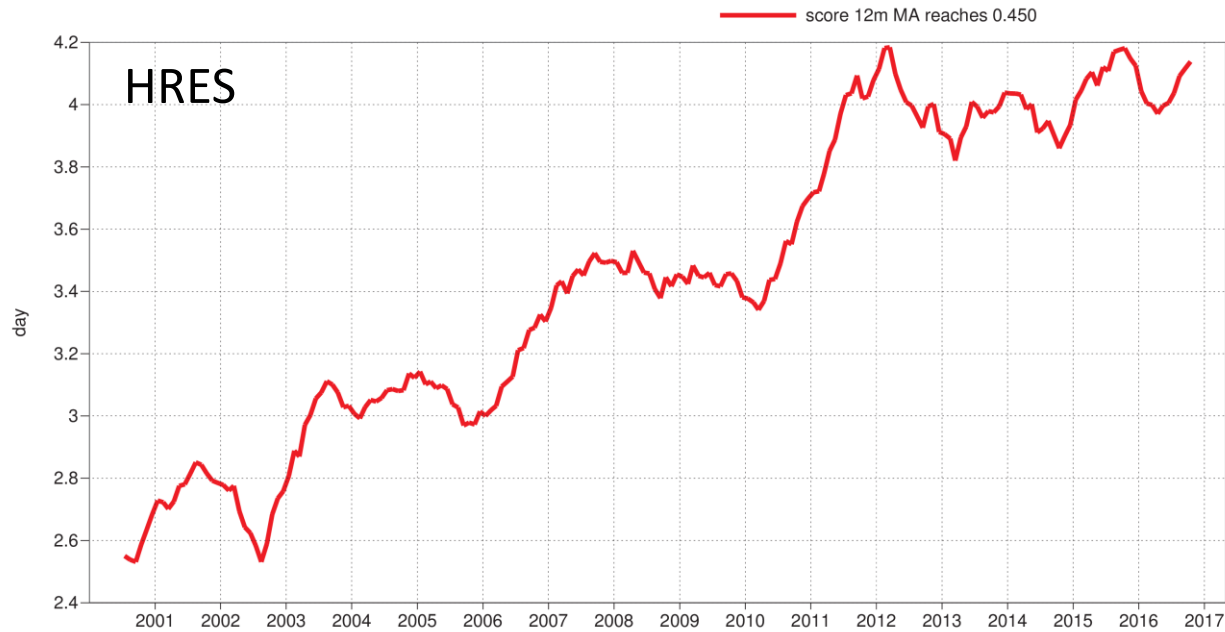
Frequency of large errors decreased by ~20%

# TIGGE scores (CRPSS) – DJF 2016 and 2017

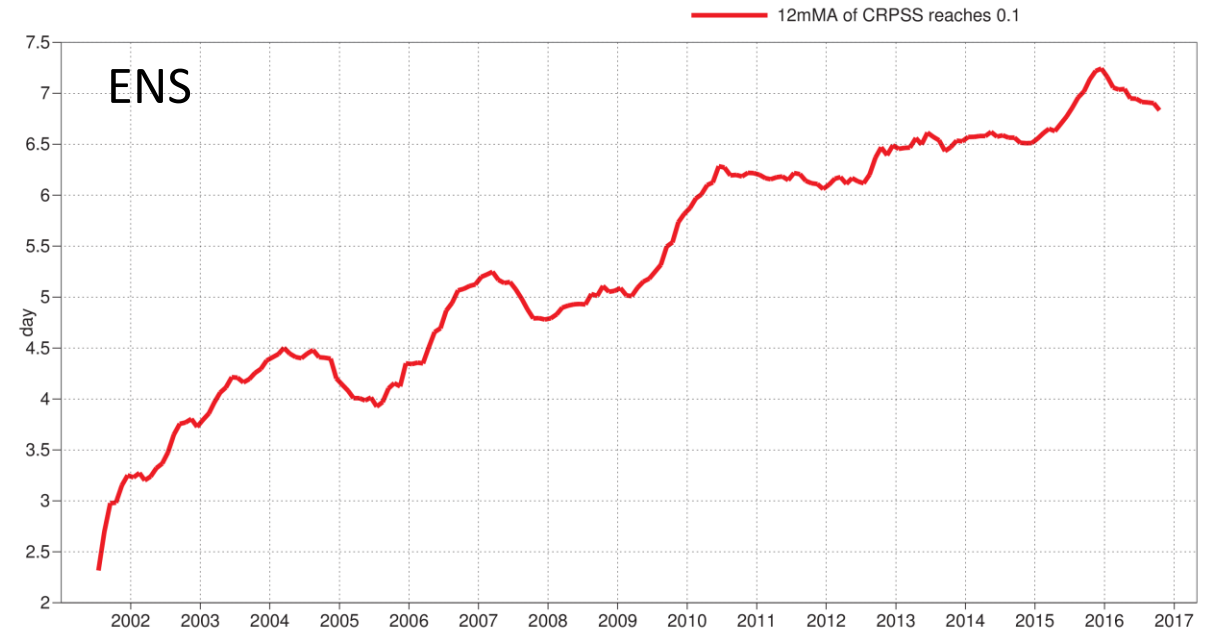


# Precipitation forecast skill

total precipitation  
1-SEEPS  
Extratropics (lat -90 to -30.0 and 30.0 to 90, lon -180.0 to 180.0)

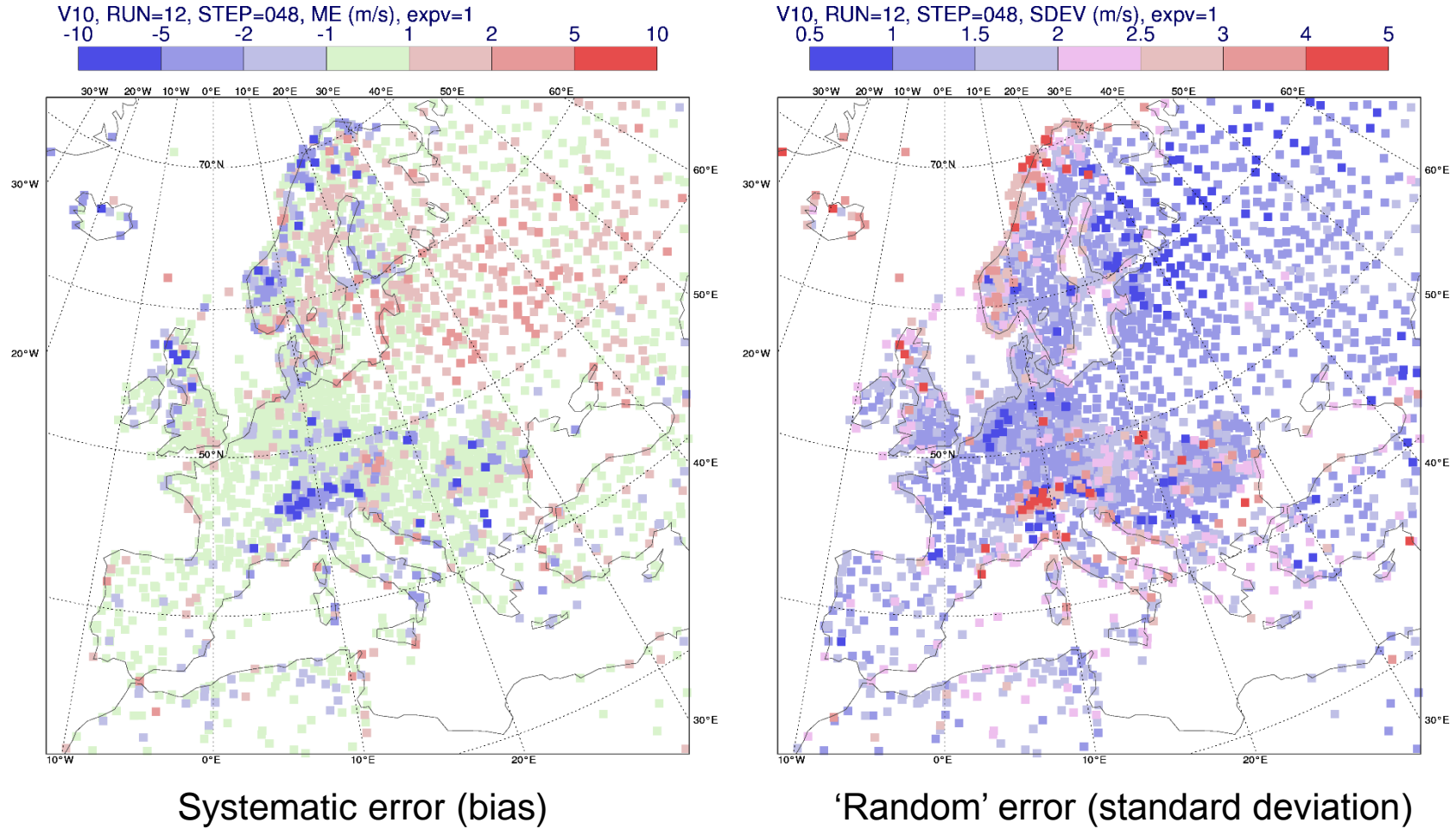


total precipitation  
Continuous ranked probability skill score  
Extratropics (lat -90 to -30.0 and 30.0 to 90, lon -180.0 to 180.0)



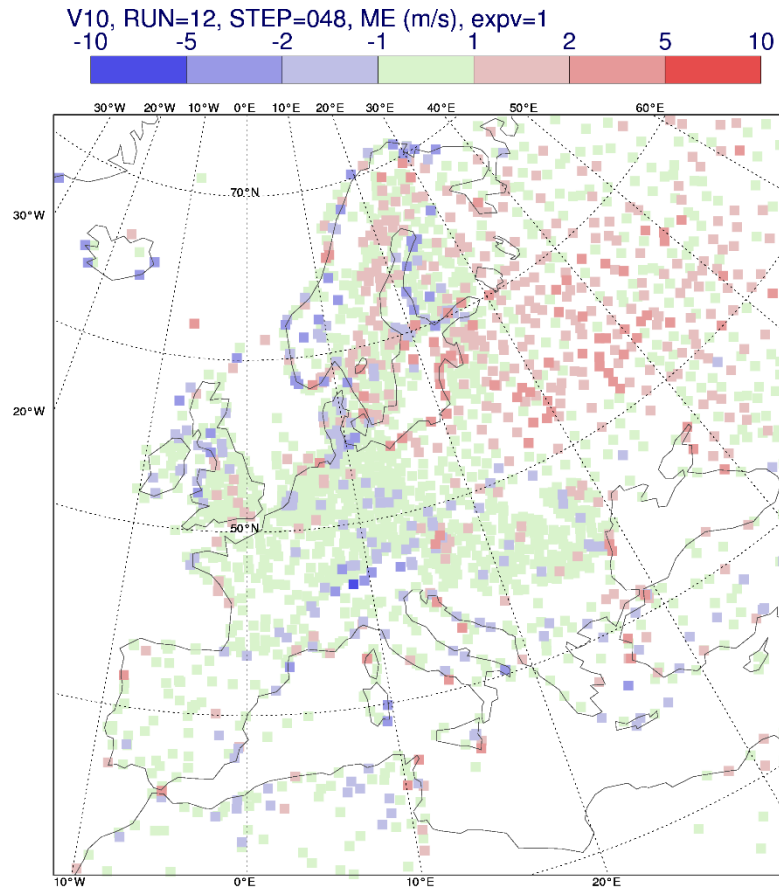
Overestimation of frequency of light precipitation still an issue, especially in summer (convection)

# 10 m wind speed verification

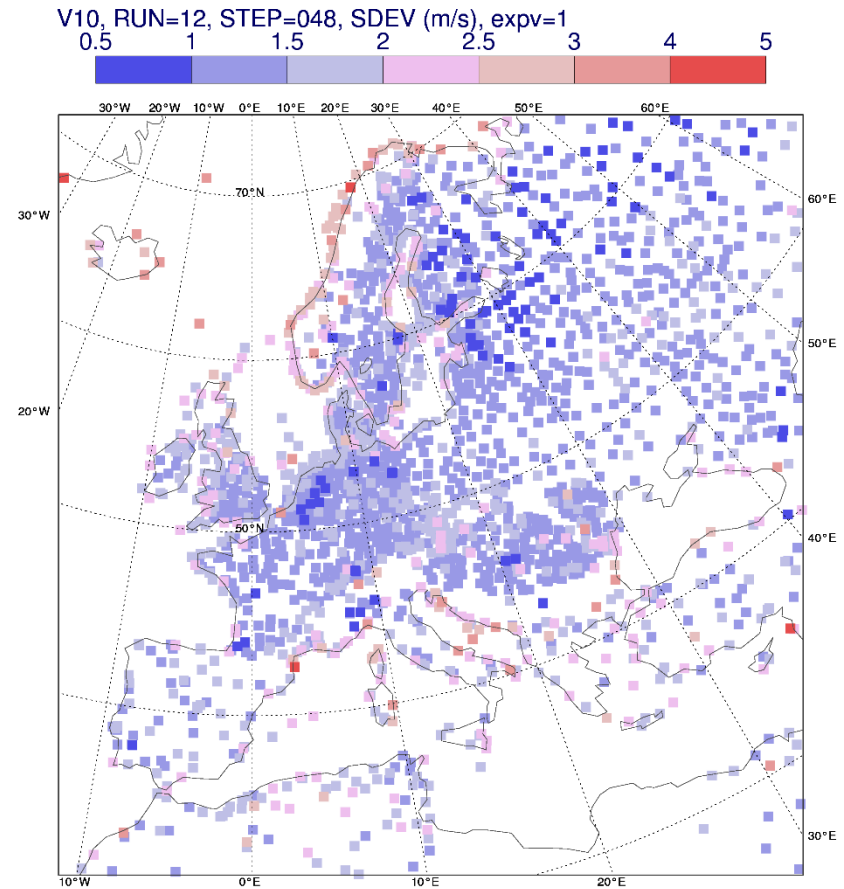




# 10 m wind speed verification



Systematic error (bias)

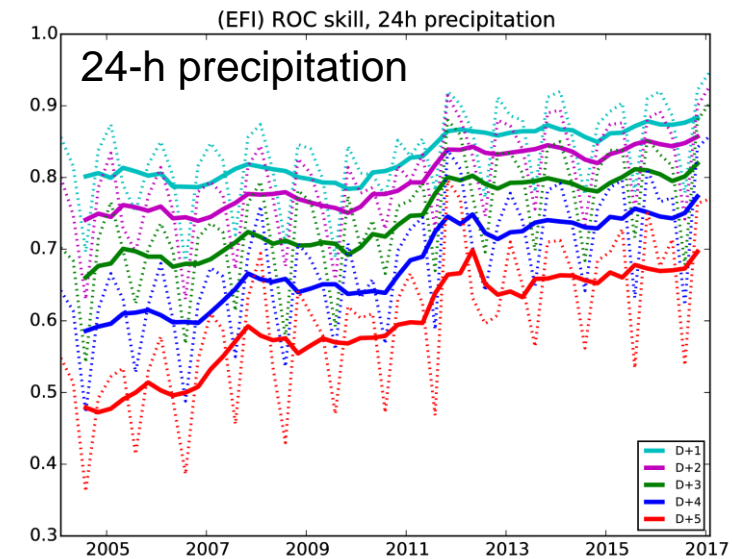
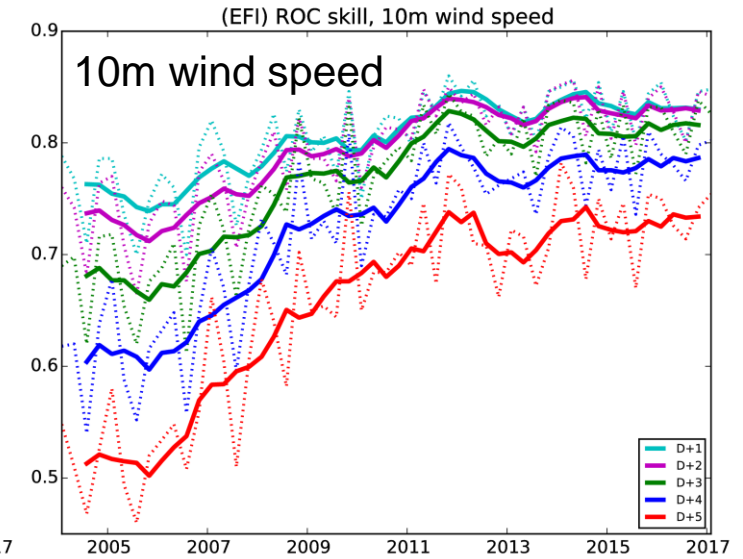
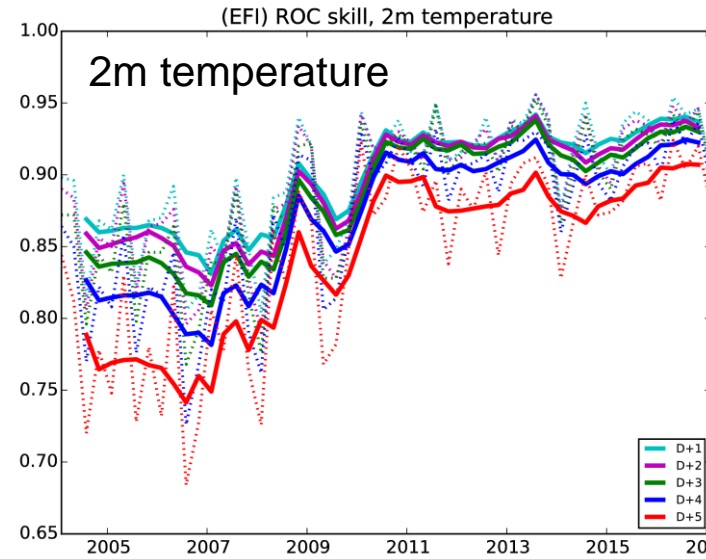
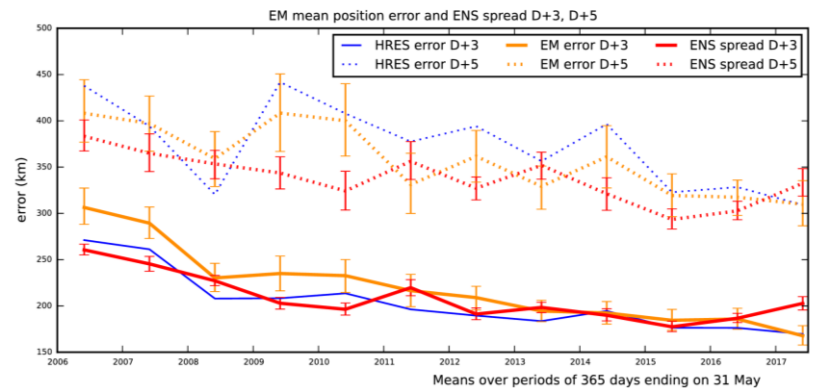
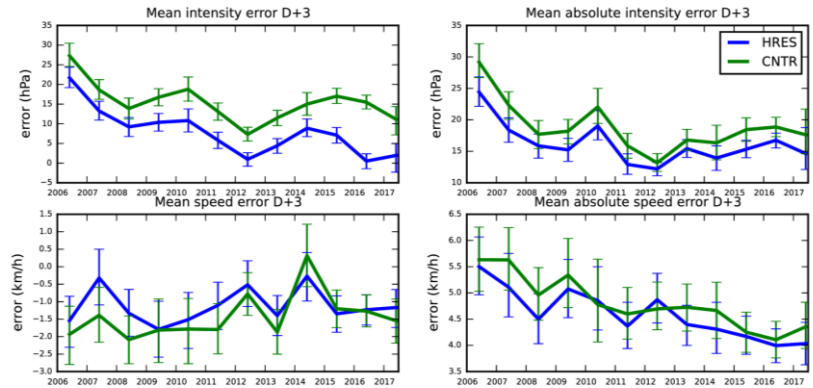
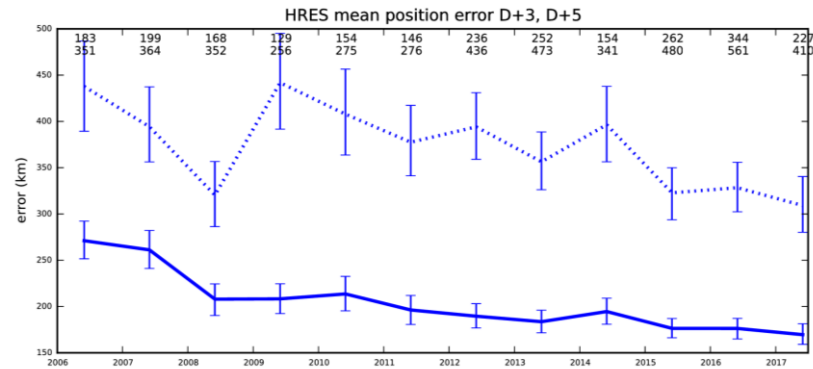


'Random' error (standard deviation)


# High-impact weather

## Tropical cyclones

## Extreme forecast index (EFI)



# Verification on the ECMWF webpage

Show All 

**Range**

- Extended (30 days) (9/24)
- Medium (15 days) (28/214)

[show 1 more](#)

**Type**

- Verification (37)

[show 1 more](#)

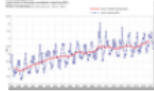



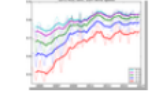

**Parameters**

- Geopotential height (9)
- Mean sea level pressure (7)
- Ocean waves (5)
- Precipitation (12)
- Temperature (14)
- Tropical cyclones (1)
- Wind (11)

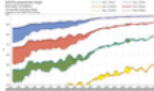
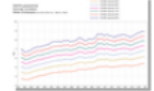
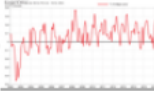
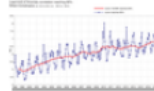

[show 3 more](#)

---


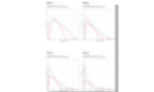


**Headline scores**

-  Lead time of ACC reaching a
-  Lead time of CRPSS of T850 reaching a
-  Lead time of CRPSS of 24h precipitation
-  Lead time of 1-SEEPS of 24-h
-  ROC skill score of Extreme Forecast
-  Errors of tropical cyclone forecasts






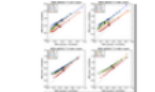


**Verification of high-resolution forecasts**

-  Anomaly correlation of ECMWF 500hPa
-  Lead time of ACC reaching multiple
-  Verification of the high-resolution
-  Lead time of ACC reaching a
-  Lead time of 1-SEEPS of 24-h


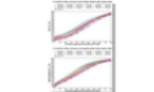
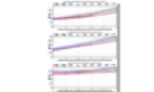

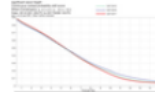
**Verification of ensemble forecasts**

-  Brier skill score of weather parameters
-  Cost loss ratio diagrams for
-  ROC skill score of EFI
-  Reliability diagrams for weather

**Comparison of verification scores to other centres**

-  Monthly WMO scores over Europe
-  Monthly WMO scores over Extra-
-  Monthly WMO scores over Tropics
-  Verification of other centres (MSL
-  Verification of other centres (upper air
-  Spread reliability diagram for ENS
-  Skill scores of forecasts of
-  Skill scores of forecasts of weather

**Wave products comparison against in-situ data and analysis**

-  Ocean waves and 10m wind
-  Annual scores for waves and wind
-  Comparison with other operational
-  Timeseries of statistics for wave
-  Skill scores of ENS forecasts of ocean





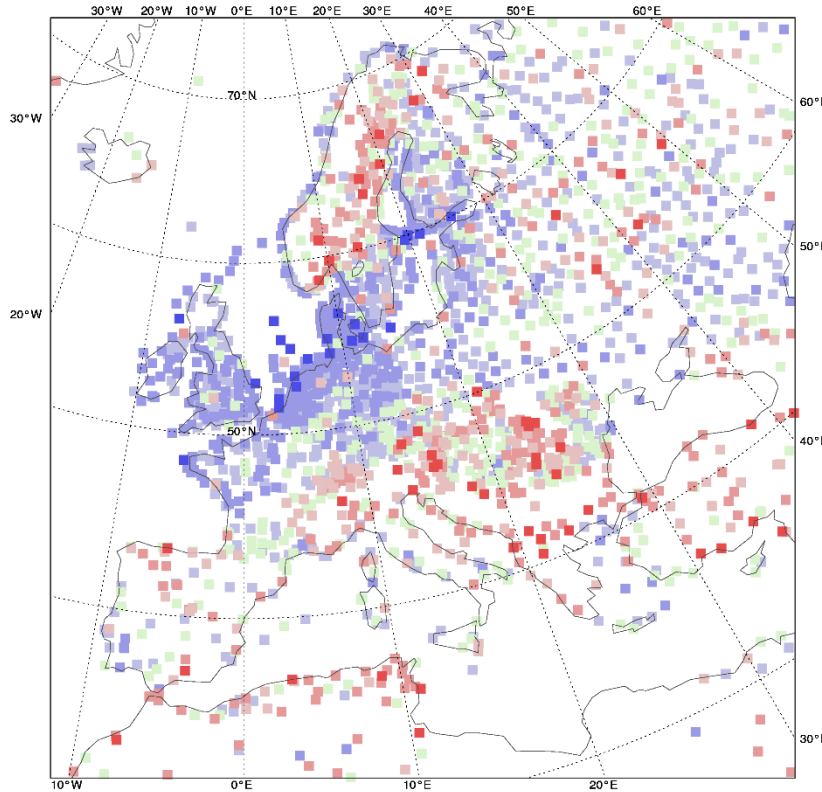


# Conclusions

- Medium-range NWP further improving – ECMWF leading the way
- Regional-scale systematic errors in surface parameters, need to be addressed
- Frequency of large errors in ENS 2-m temperature: additional headline score
- Promising developments for future cycles (e.g. ocean coupling, cloud physics)

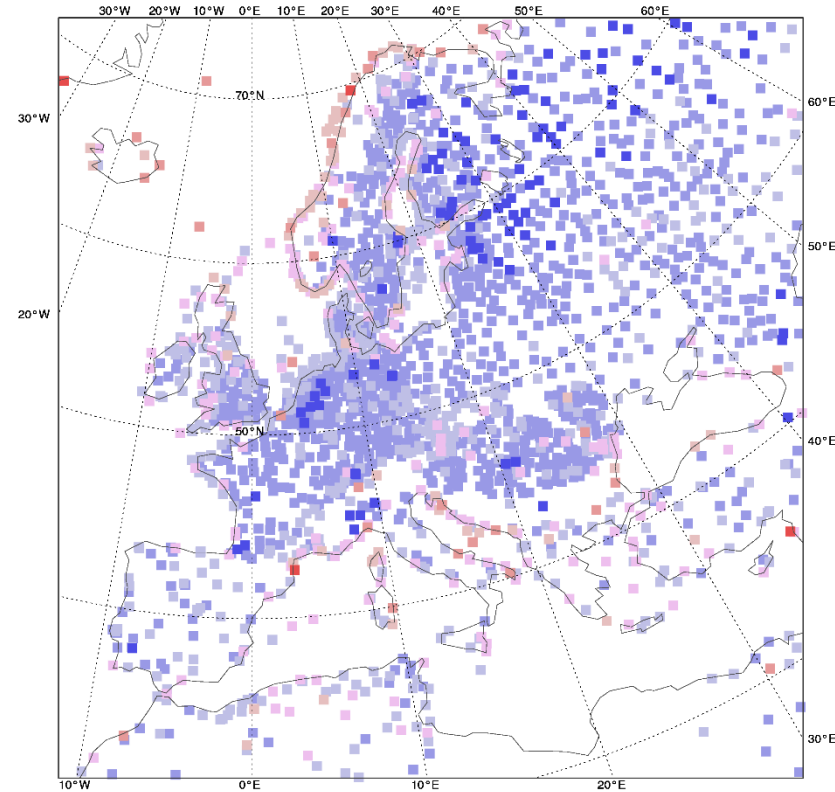
# 10 m wind speed verification

V10, RUN=12, STEP=048, SDEV\_REL (m/s), expv=1  
0.1 0.2 0.3 0.4 0.5 0.6 0.8 1



Random error,  
normalized

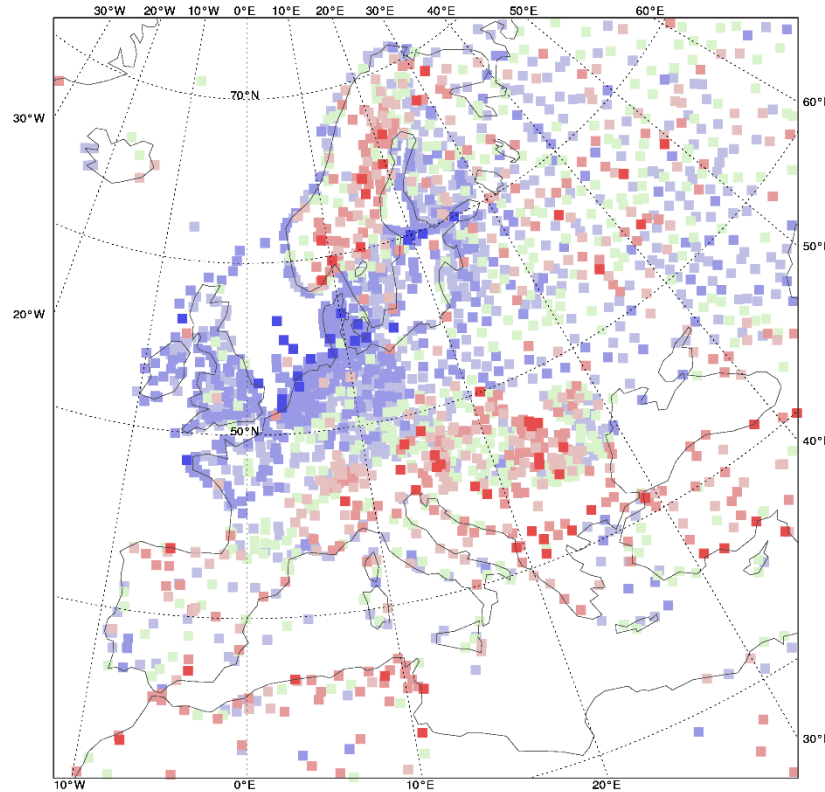
V10, RUN=12, STEP=048, SDEV (m/s), expv=1  
0.5 1 1.5 2 2.5 3 4 5



Random error

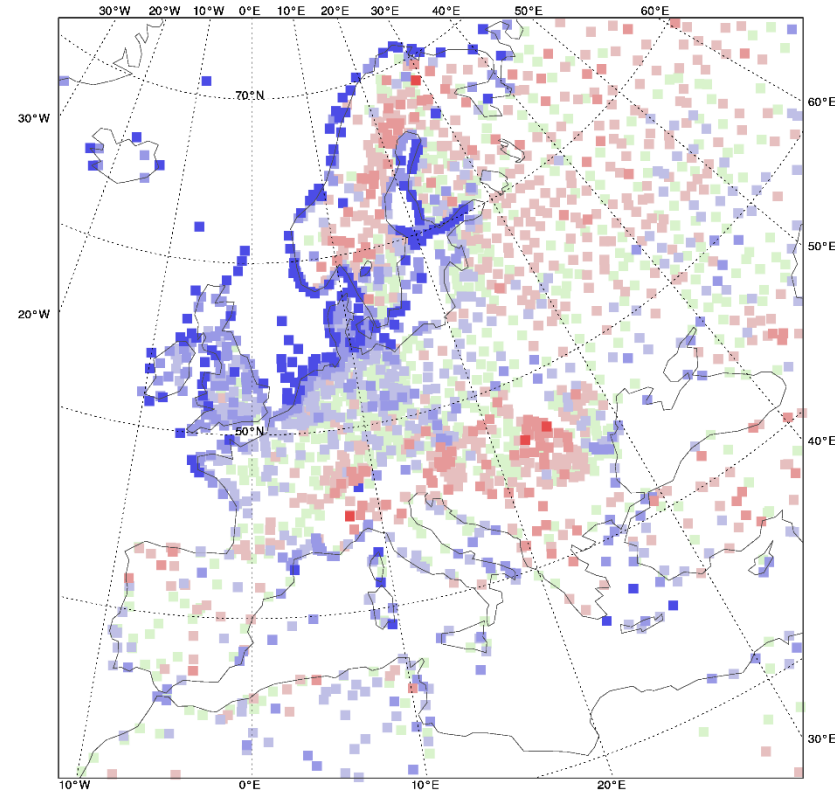
# 10 m wind speed verification

V10, RUN=12, STEP=048, SDEV\_REL (m/s), expv=1  
0.1 0.2 0.3 0.4 0.5 0.6 0.8 1



Random error,  
normalized

V10, RUN=12, STEP=048, OBS (m/s), expv=1  
0 1 2 3 4 5 7 10



Mean wind speed (observed)