Regional Cooperation for Limited Area Modeling in Central Europe

Data assimilation of Mode-S EHS observations

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Outline

- Introduction
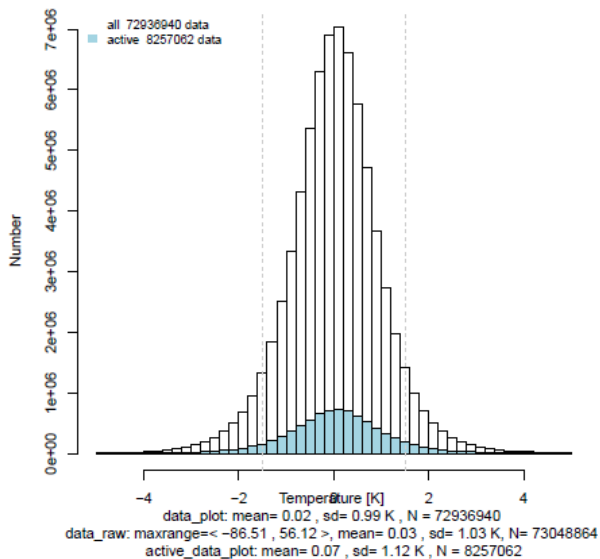- Quality of EHS
- Thinning
- Impact experiments
- Conclusions

Introduction

▸ Mode-S EHS are high-density aircraft observations

▸ Wind almost directly observed, temperature calculated from using the speed of sound equation

▸ Extensive preprocessing and calibration at KNMI

▸ Added to OPLACE this year

▸ First used by Hirlam with encouraging results
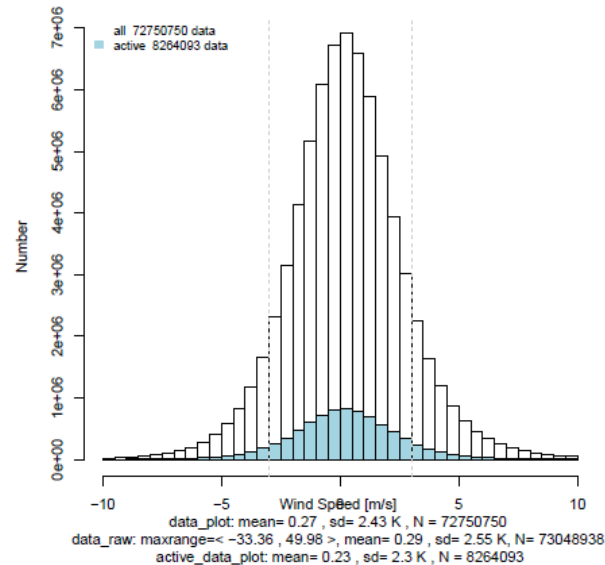
▸ Stay in Prague to test the data in ALADIN BlendVar

Data quality

▸ Estimated on a set of OMG departures over 10 moths

▸ Short-range operational forecast used as a reference

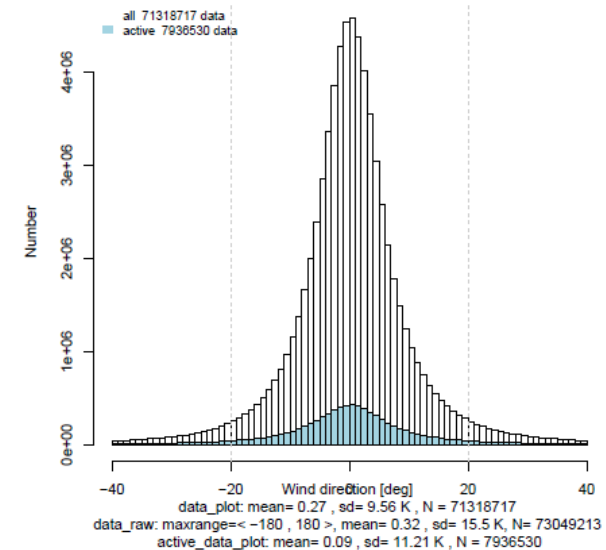▸ Departures normally distributed with a few outliers – removed prior to further analysis

Whitelisting based on aircraft type

▸ Based on standard deviation and bias of complete OMG data set

▸ Several reasonable threshold checked and N>10.000

▸ Statistics on 10% of randomly sampled data

var.	gross	mean	sd	N_{data}	$N_{aircraft}$
T	15	0.3	1	53,763,057	3181
T	15	0.5	1.5	70,661,437	4618
T	15	1	2	71,787,439	4728
wsp	50	0.3	2	26,691	16
wsp	50	0.5	3	68,986,593	4038
wsp	50	1	5	72,267,829	4746
v	360	3	20	68,459,623	4494
v	360	5	20	68,480,174	4506
v	360	5	30	72,313,569	4761

Data quality – profiles of OMG

- Profiles of OMG compared to AMDAR and Slovenian Mode-S MRAR
- Impact of whitelisting also tested
- Profiles of active data (i.e. selected by screening also checked)

Temperature

Profile of T aircraft OMG departures
Aircraft number EHS all:7012 whitelisted:4618 active:6880 AMDAR:1094 SI_MRAR:208
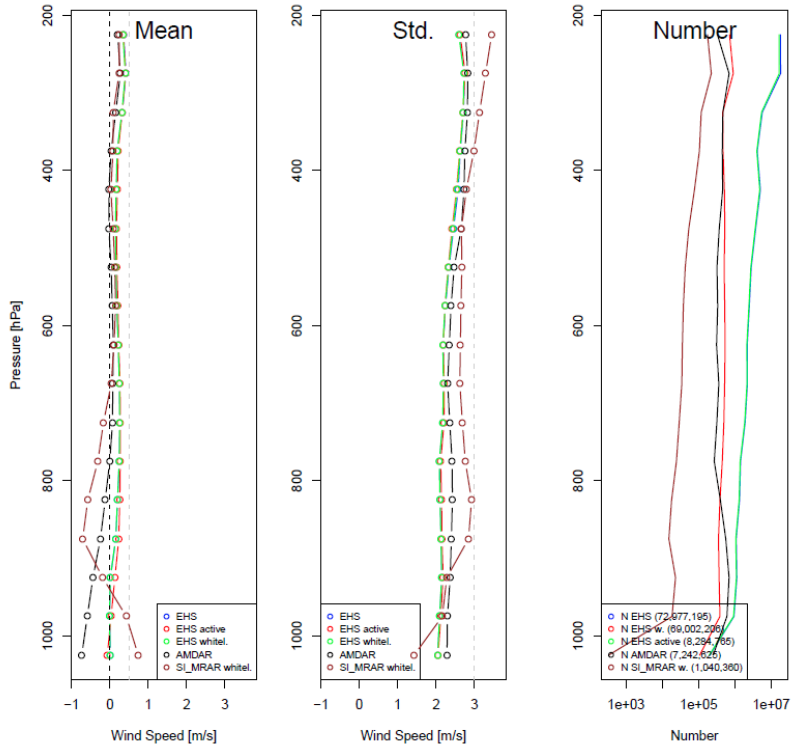Size of EHS dataset reduced to 10%
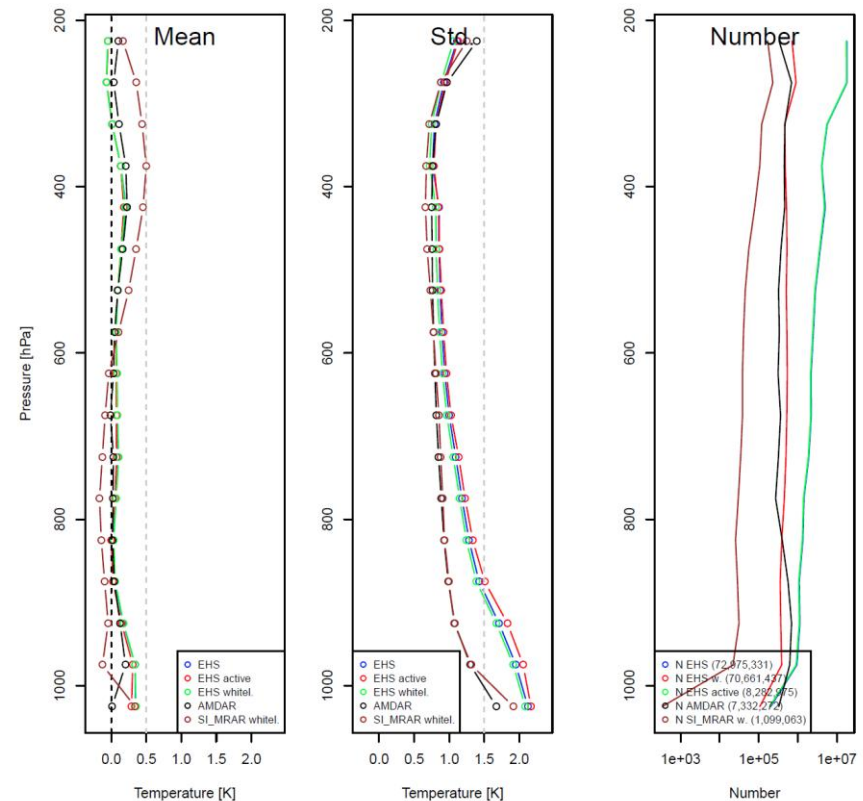
# Data quality – profiles of OMG

Wind speed

Profile of WSP aircraft OMG departures
Aircraft number EHS all:7017 whitelisted:4039 active:6906 AMDAR:1094 SI_MRAR:205
Size of EHS dataset reduced to 10%

Wind direction

Profile of WDIR aircraft OMG departures
Aircraft number EHS all:7019 whitelisted:4498 active:6906 AMDAR:1094 SI_MRAR:205
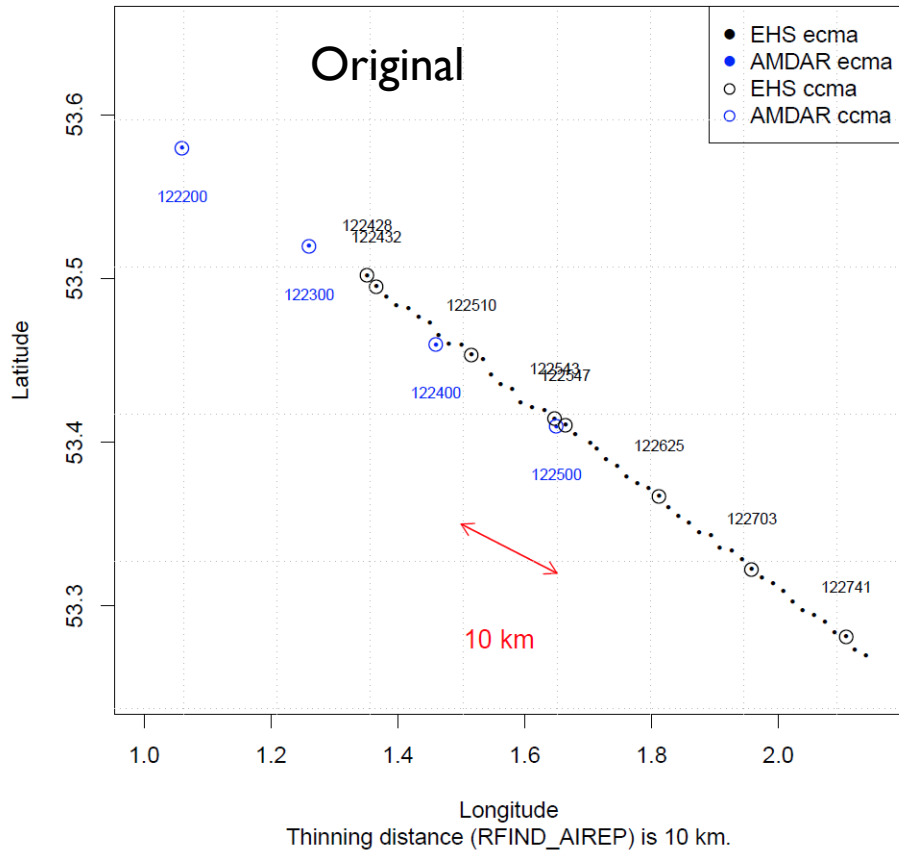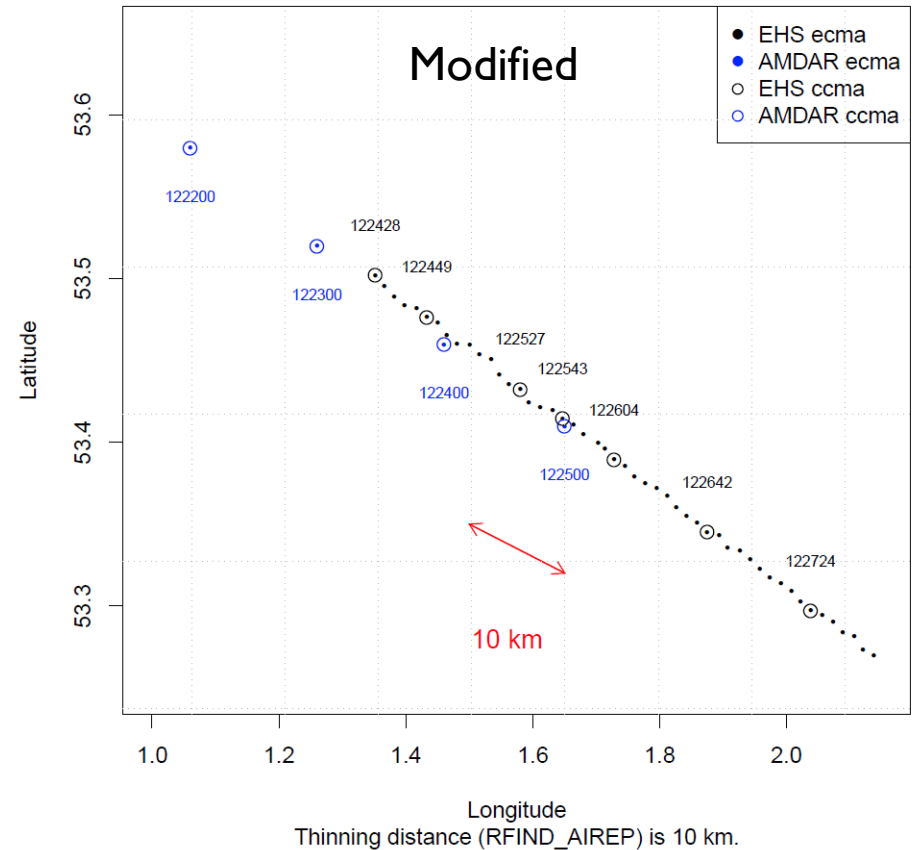Size of EHS dataset reduced to 10%
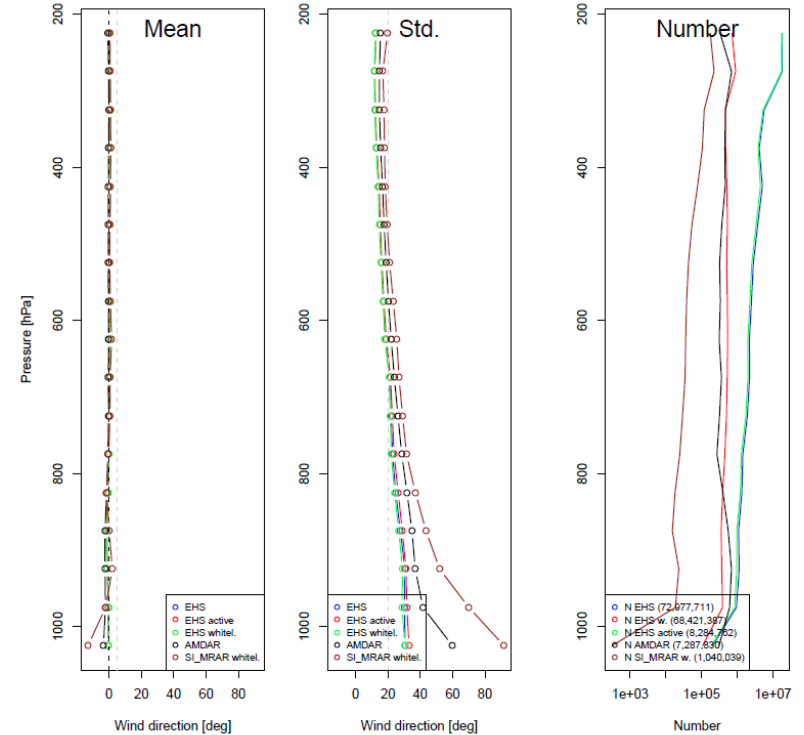
Thinning

- Typical distance between Mode-S observations ~1 km
- BlendVar uses 25 km thinning for AMDAR and CZ MRAR (tunning based on Desroziers diagnostics and using decreased obs. error std., applied in the oper. setup after retuning obs.error std.)
- What value to use? A passive assimilation experiment using 5 km thinning distance used to estimate optimal thinning distance
- Correlation for temperature should fall below 0.2 (Liu and Rabier)
- ObsTool (developed in CZ)

Thinning – data selection in thiair.F90

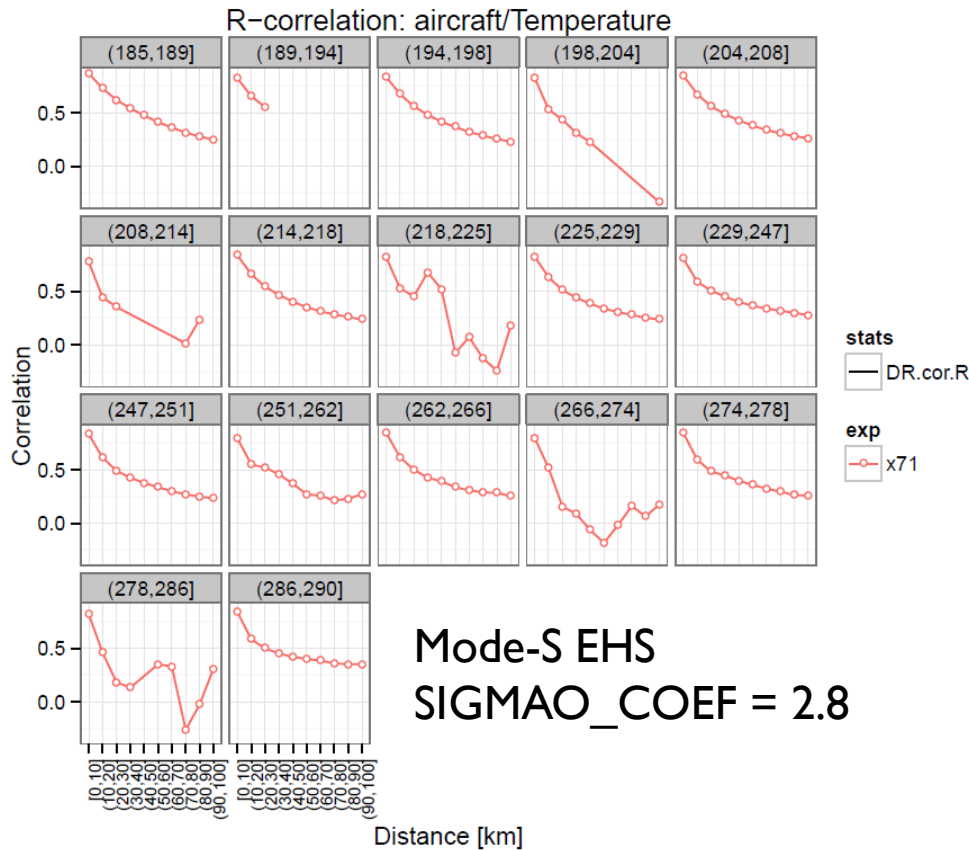**Mode−S EHS and AMDAR data selection in screening single aircraft (AMDAR EU6638, Mode−S M75d1c6)**

Original

Legend:
- EHS ecma
- AMDAR ecma
- EHS ccma
- AMDAR ccma

Latitude / Longitude

Thinning distance (RFIND_AIREP) is 10 km.

Mode−S EHS and AMDAR data selection in screening single aircraft (AMDAR EU6638, Mode−S M75d1c6)

Modified

Legend:
- EHS ecma
- AMDAR ecma
- EHS ccma
- AMDAR ccma

Latitude / Longitude

Thinning distance (RFIND_AIREP) is 10 km.

Thinning -results

- ► Suggested thinning of 50 - 100 km

R−correlation: aircraft/Temperature

Mode-S EHS
SIGMAO_COEF = 2.8

Results using Mode-S MRAR for SIGMAO_COEF = 0.67 and 2.7
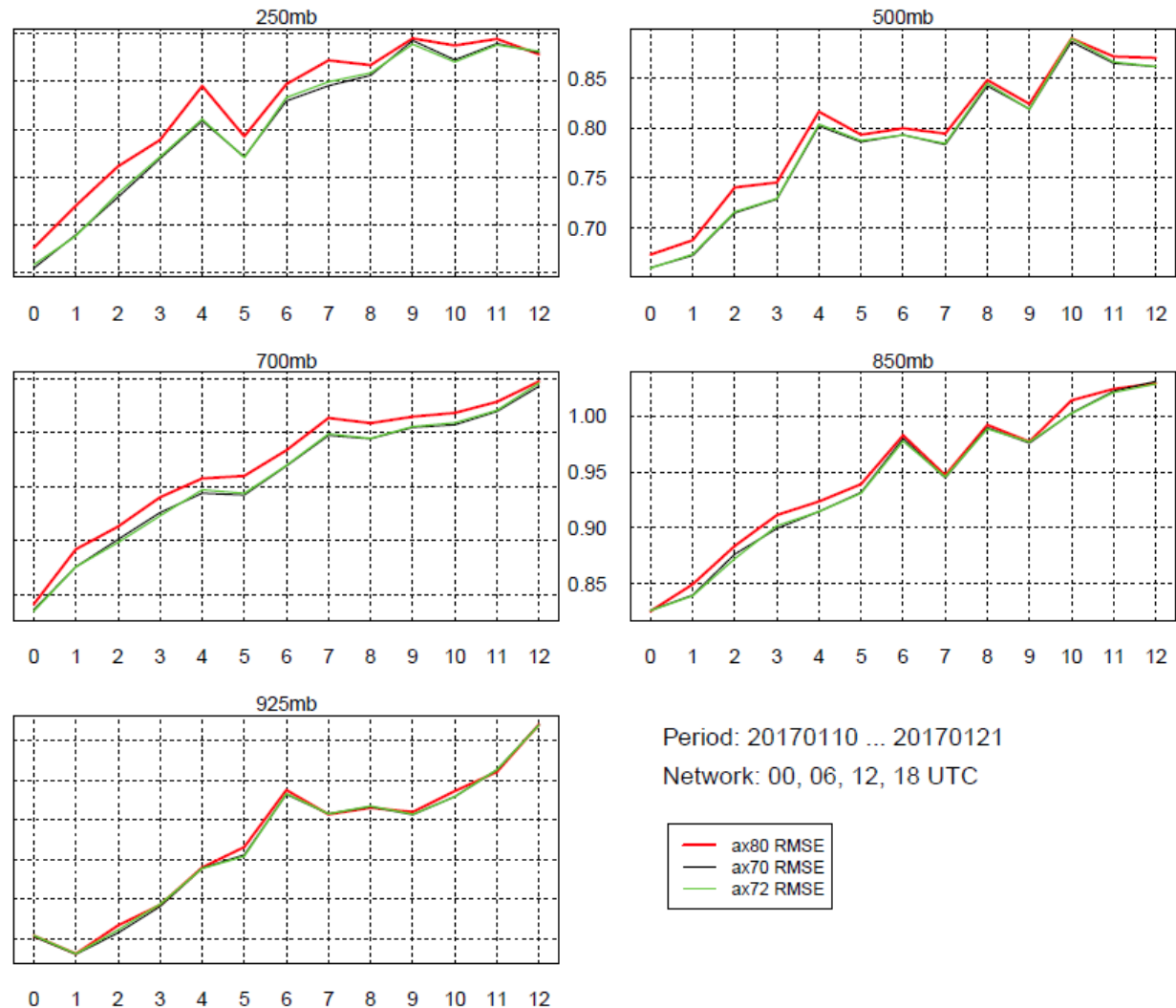

Observation error correlations for mrar/Temperature
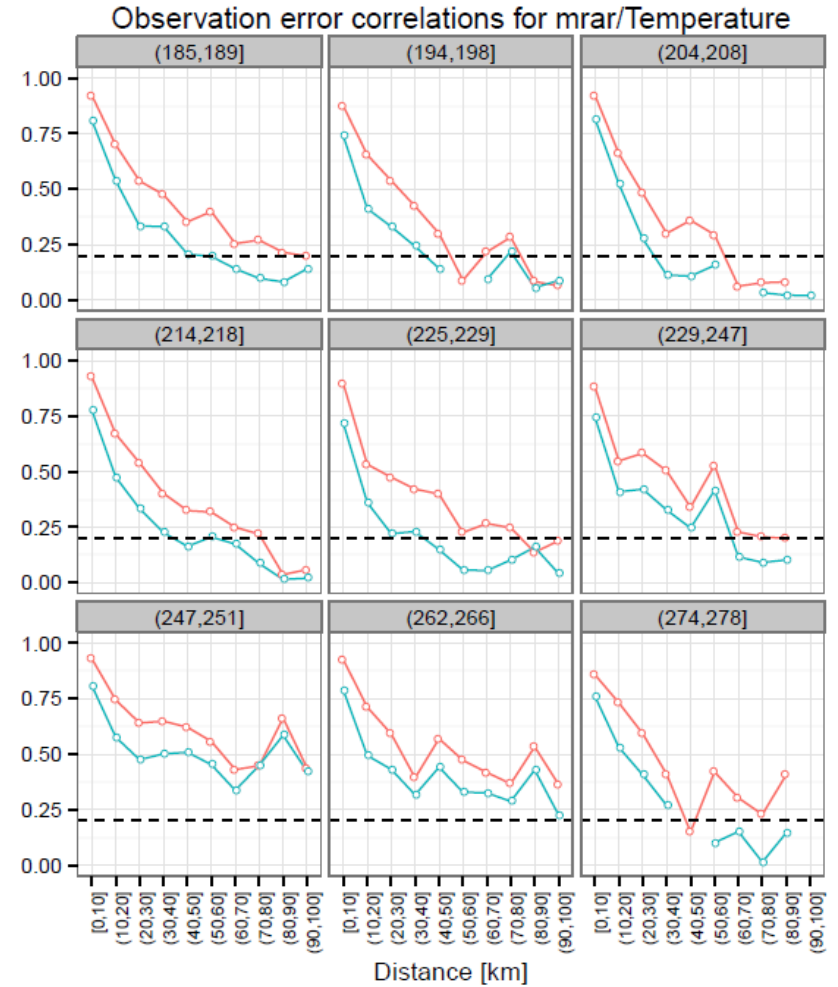
Impact on forecasts

- Investigation period 10 Jan 2017 – 10 Feb 2017
- 6-hourly cycling (BlendVar) and 12h forecasts from each analysis time
- Experiments:
  - Reference
  - Full Mode-S EHS data set
  - Whitelisted Mode-S EHS data
  - Only Mode-S wind assimilated
  - Reduced thinning (50 km) and modified data selection

Impact on forecast – full vs. whitelisted
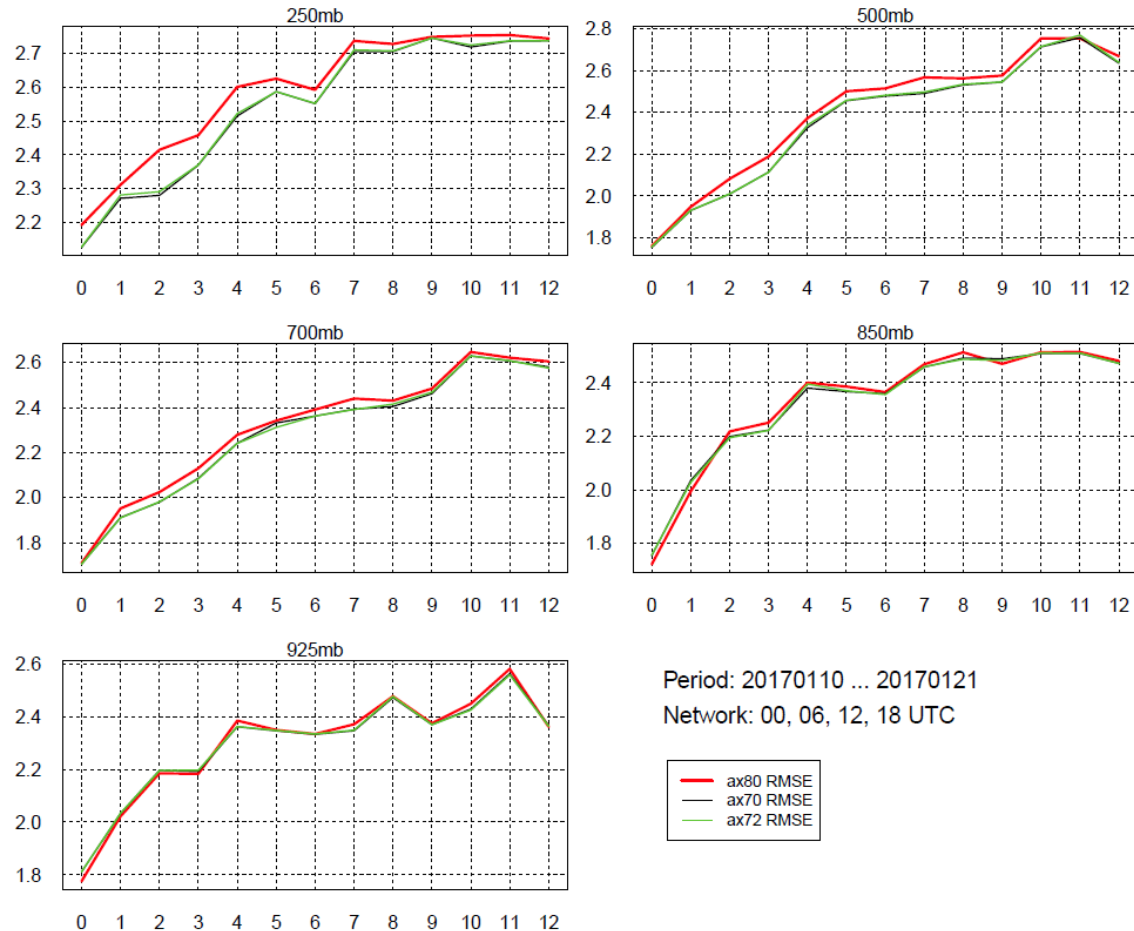
- Veral (Canari)
- Hourly verification against AMDAR

Temperature

- Reference
- EHS full
- EHS whitelisted

Period: 20170110 ... 20170121
Network: 00, 06, 12, 18 UTC

ax80 RMSE
ax70 RMSE
ax72 RMSE

Impact on forecast – full vs. whitelisted

Wind speed

- Reference
- EHS full
- EHS whitelisted

Period: 20170110 ... 20170121
Network: 00, 06, 12, 18 UTC

ax80 RMSE
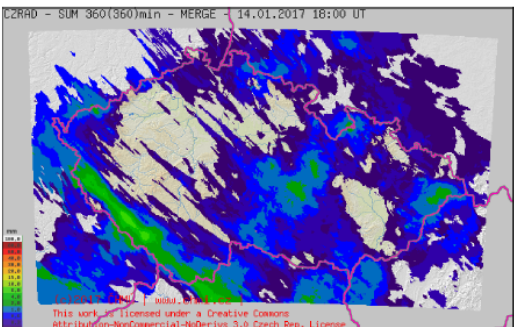ax70 RMSE
ax72 RMSE

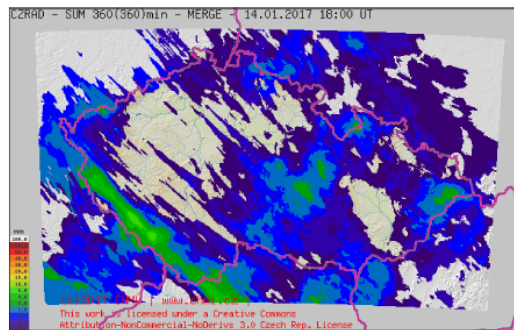# Impact – daily evolution at 250 hPa
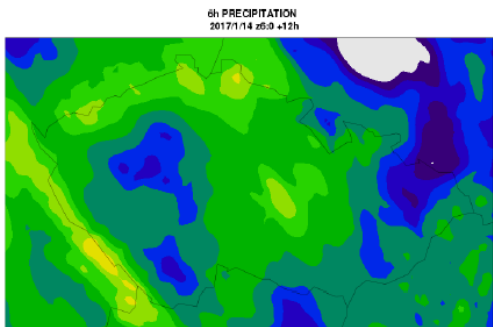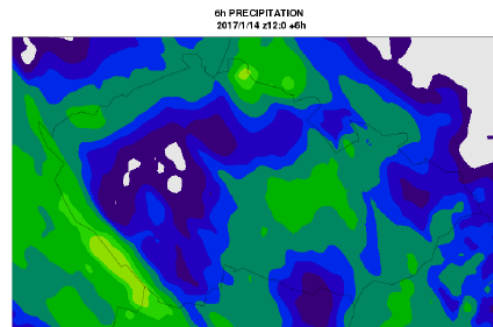

- Reference
- EHS full
- EHS whitelisted
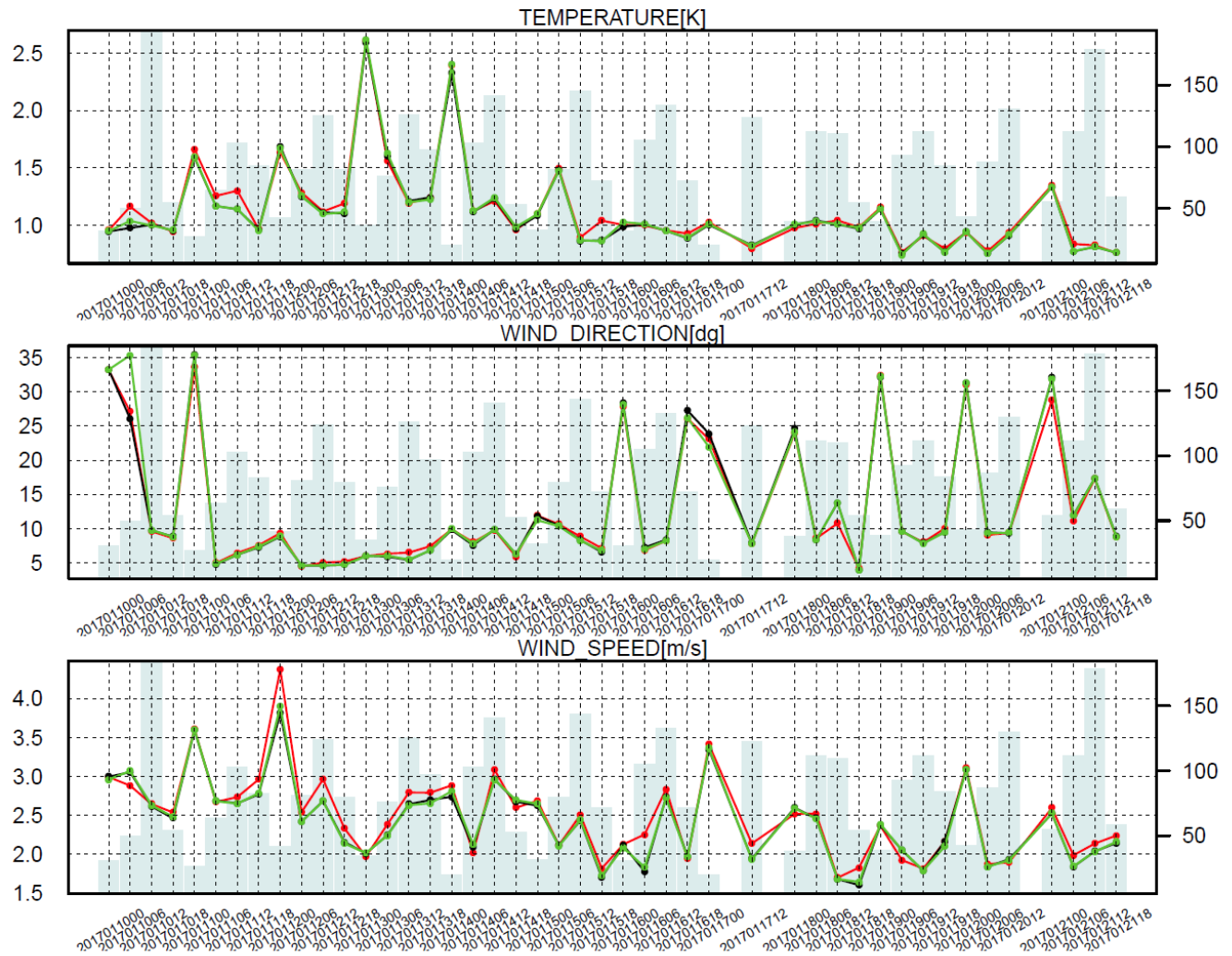
Impact on precipitation

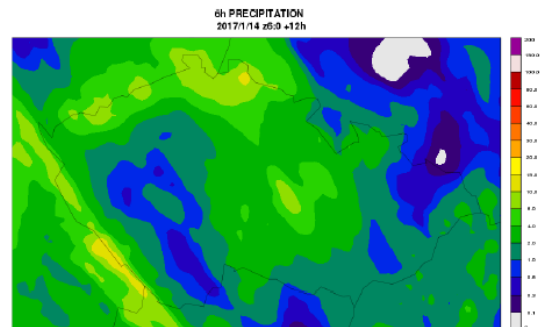▸ Verified only subjectively through a comparison with analysed 6h precipitation

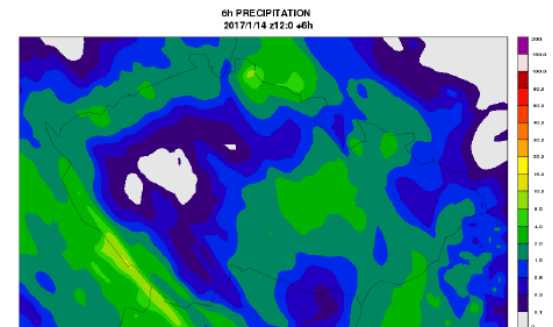analysis   reference   Mode-S EHS
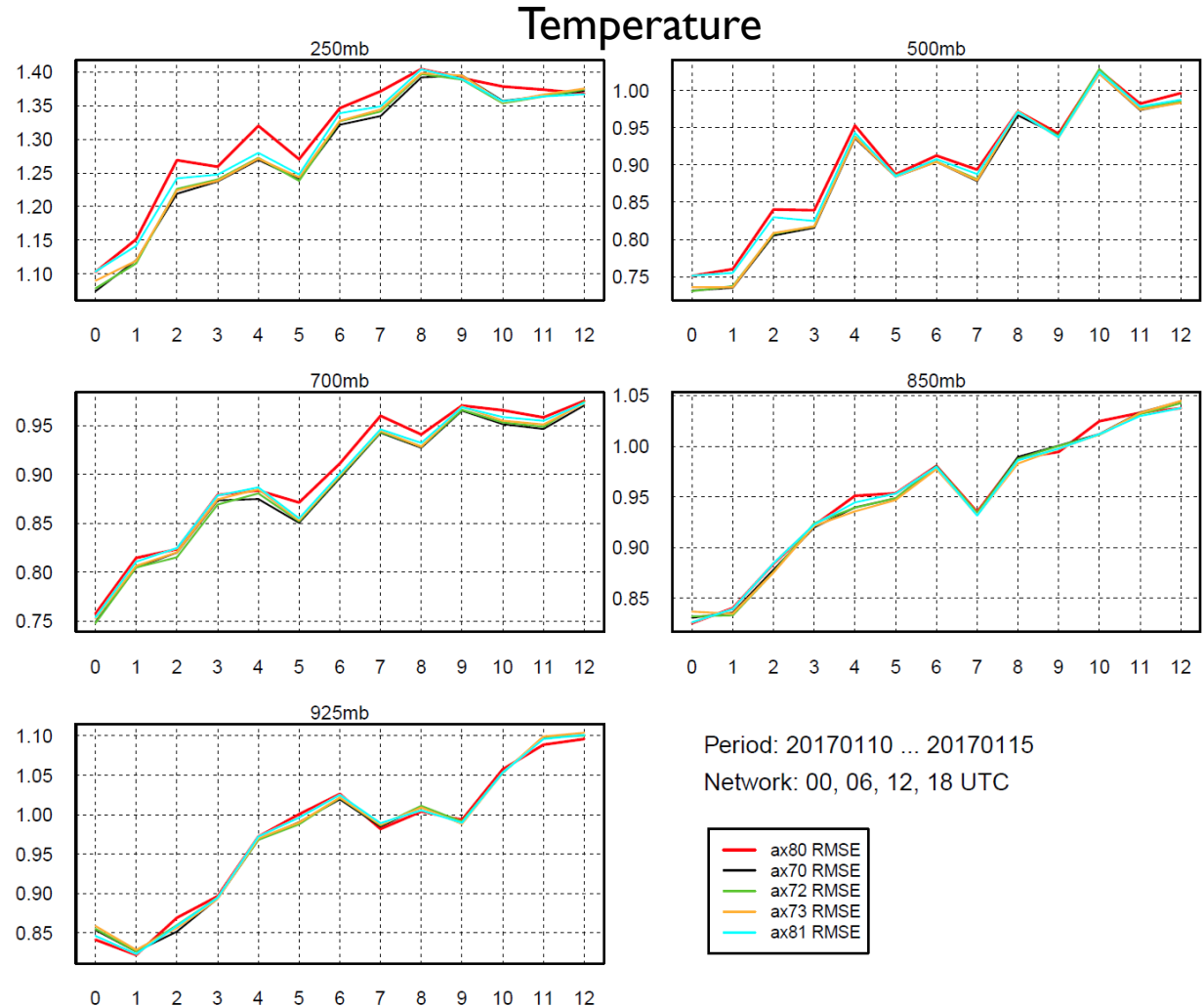
Impact – wind only, thinning

▸ Shorter period – to be continued

- Reference
- EHS full
- EHS whitelisted
- EHS wind
- EHS thinning

Temperature

Period: 20170110 ... 20170115
Network: 00, 06, 12, 18 UTC

ax80 RMSE	
ax70 RMSE	
ax72 RMSE	
ax73 RMSE	
ax81 RMSE	

Impact – wind only, thinning

Wind speed

Period: 20170110 ... 20170115
Network: 00, 06, 12, 18 UTC

Legend:
- Reference
- EHS full
- EHS whitelisted
- EHS wind
- EHS thinning

- ax80 RMSE
- ax70 RMSE
- ax72 RMSE
- ax73 RMSE
- ax81 RMSE

Conclusions

- Mode-S EHS of high quality and useful as is
  - Whitelisting had neutral or slighlty degrading impact
  - OMG departures show good bias and std. for wind speed
  - Temperature also improves analysis and forecast, despite lesser quality

- Thinning is so far understood
  - Diagnostics by Desroziers depend on obs. error std.
  - Imapct on forecast is almost negligible (25 vs. 50 km thinning)
  - Data selection by RFIND boxes provides smaller effective thinning distances
  - Distinction by aircraft address means that EHS and AMDAR are thinned independently – possible duplications

Perspective

- Operational assimilation of EHS

- Investigate/check for possible solution for EHS/AMDAR duplications and close observations