ASSIMILATION
OF
GNSS ZTD FROM THE NGAA PROCESSING CENTER
IN
METCOOP

Martin Ridal, Magnus Lindskog, Sigurdur Thorsteinsson and Tong Ning

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GNSS from NGAA processing centre

- Due to quality issues MetCoOp did not assimilate NGAA data but rather the few stations over the MetCoOp domain processed by METO and ROBH processing centres. ~25 stations.

- In June, 2015, Lantmäteriet (the Swedish mapping, cadastral and land registration authority) took over the NGAA data processing which includes two parts of work:

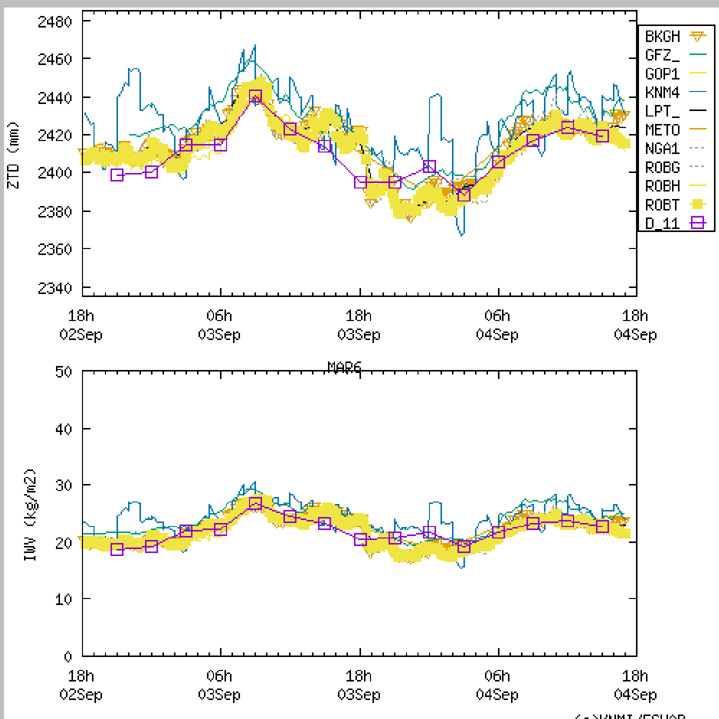
  1. Move and modify GIPSY solution to Lantmäteriet servers.
  2. Prepare a new Bernese solution.

- Since the beginning of 2016, Lantmäteriet transfer data to SMHI:
  - Sweden – 383 sites
  - Finland – 88
  - Denmark – 10
  - Norway – 192
  - IGS – 10 In total 683 sites

- Both Bernese (v 5.2) solution (NGA1) and GIPSY (v 6.2) solution (NGA2) are uploaded to SMHI. Only Bernese solution are further uploaded to E-GVAP due to longer time delay (more than 1.5 hour) of the GIPSY solution caused by long waiting time of JPL ultra rapid orbit and clock product.

NGA1 at E-GVAP (egvap.dmi.dk)

Mårtsbo (MAR6)



HIRLAM(KNMI) AN - GPS ZTD

7day stat. 2016/08/28 - 2016/09/05

AC	num	bias	RMS	stddev
GFZ	53	17.5	19.9	9.6
GOP1	55	6.6	11.4	9.3
KNM4	56	27.1	30.6	14.0
LPT	56	8.2	12.1	8.9
METO	56	5.5	11.8	10.5
ROBG	52	6.7	12.2	10.2
ROBH	52	4.7	11.0	9.9
TEST				
BKGH	56	7.0	11.6	9.3
NGA1	56	8.1	12.0	8.8
ROBT	52	6.3	11.5	9.6

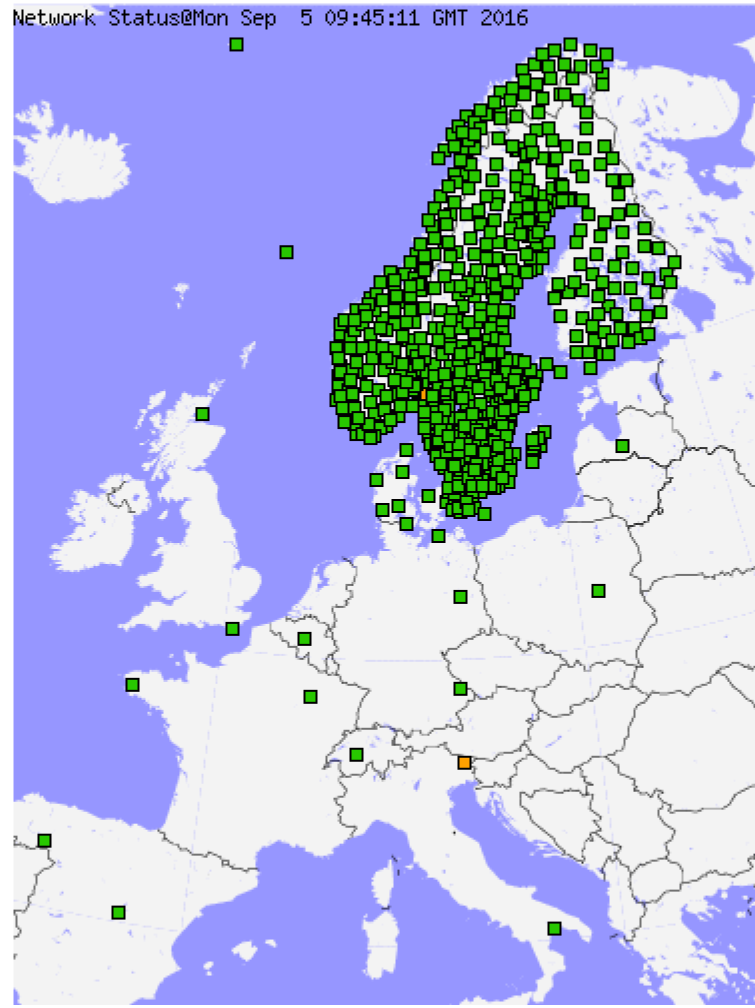
Notes

- Statistics are updated daily
- GPS ZTD are interpolated to NWP analysis time

Graphical location of the site

latitude	60.59510
longitude	17.25850
altitude	108.77

Map showing the NGA1 data are sent to E-GVAP



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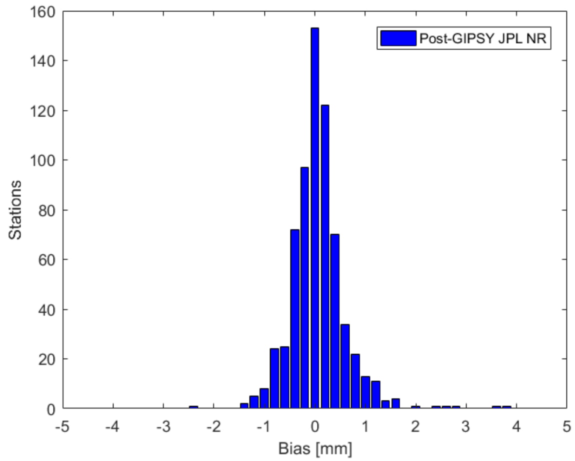
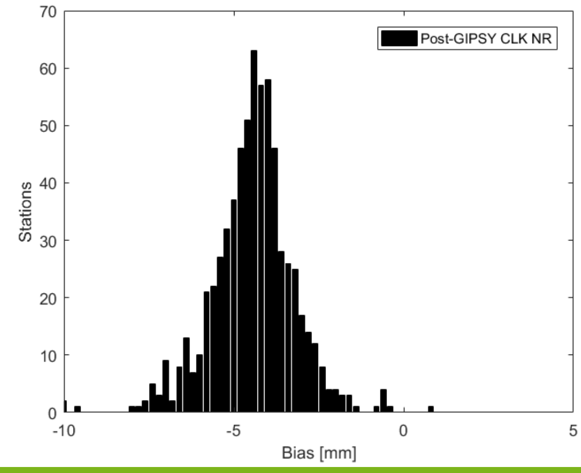
Tests on NGA2 products

The PPP solutions running by the GIPSY-OASIS software (V6.2) is used for NGA2 products under a test stage. We tested the ZTD products using two different satellite orbits and clock products. One is using the IGS real-time products and the CNES clock corrections (CLK90) are utilized. The other is using the JPL ultra-rapid products which however has a longer latency (over one hour).





The NGA2 ZTD were compared to the ones estimated by a post-processing using the IGS final satellite orbits and clock products. A significant bias (~4 mm) is seen from the results given by the GIPSY PPP solutions using the IGS real-time products and the CLK90 clock corrections (Black) while no significant bias is observed from the solution using the JPL ultra-rapid products (Blue).

LANTMÄTERIET

Next step

- Due to the fact that the JPL ultra-rapid satellite orbits and clock products have a longer latency (over one hour), the resulting near real-time ZTD cannot be used for operational meteorology in near real-time. We are now working on producing our own satellite clock corrections in near real-time for the GIPSY PPP solution.

- The data acquired from the newly installed stations for the Swedish national GPS network (SWEPOS) will be included in the E-GVAP data processing.

LANTMÄTERIET

Data assimilation experiments

- One month parallel experiment with copy of preop and starting files (first guess and varbc files) from preop. Operational observations and lateral boundaries.

- Three parallel experiments:

CRL – Observation usage as in operational MetCoOp. GNSS from METO and ROBH.
NGA1 – Like CRL with additional NGA1 GNSS data.
NGA2 – Like CRL with additional NGA2 GNSS data.

No time-constraints on data for NGAA data in this experiment, the closest to analysis time taken. For operations cut-off: NGA1: 1h 45 min NGA2: at present 3h 45 min.

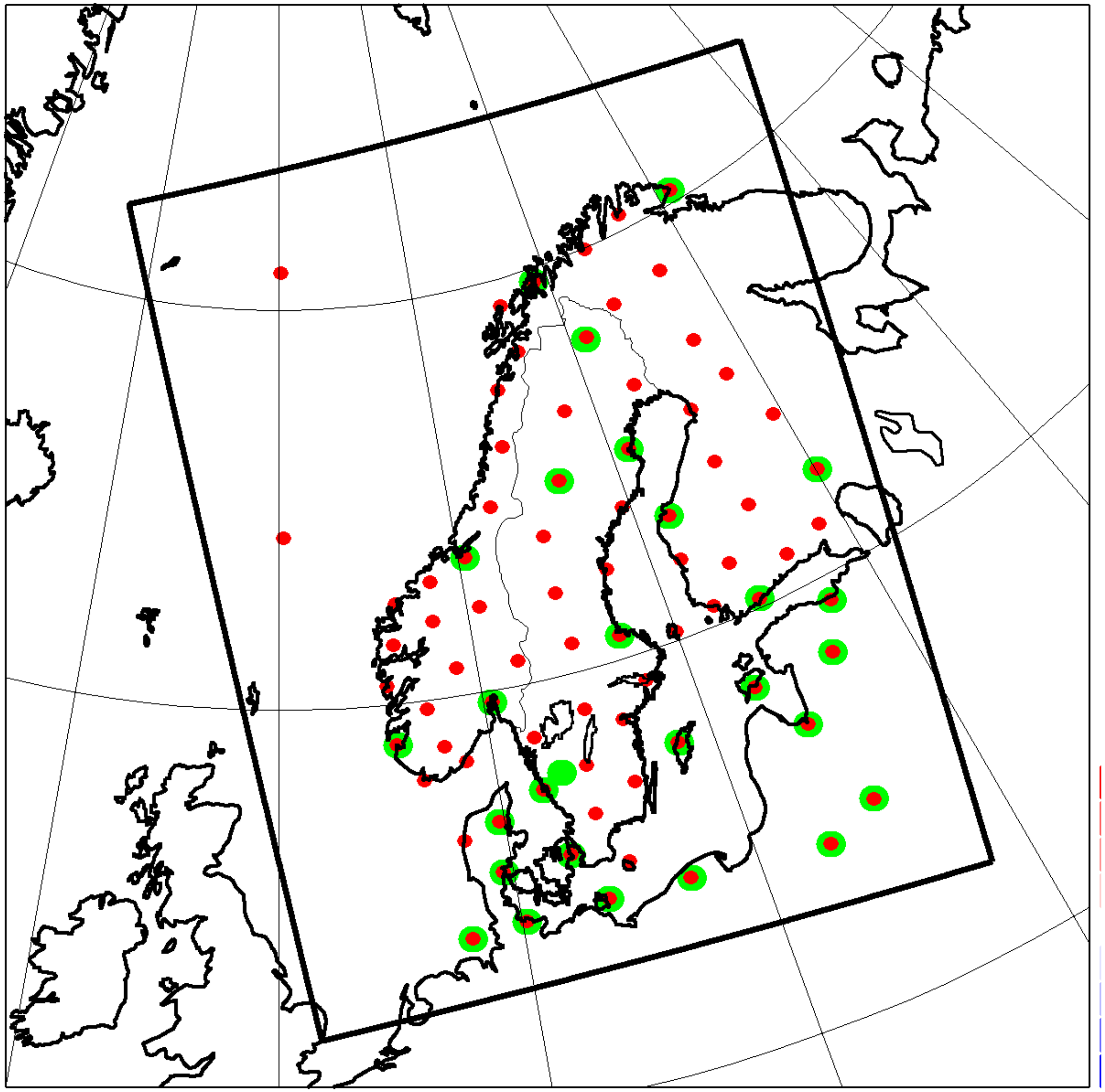
- Spin-up of VARBC coefficients for NGA1 and NGA2 during 15 days cycling with GNSS assimilated in passive mode during 20160215-20160229.

- Three parallel experiment with GNSS assimilated actively during 20160301-20160331. Three-hour DA cycle with forecasts up to 36 h at 00 and 12.

MetCoOp GNSS stations

Operational use:
METO and ROBH

Experimental use
NGAA, METO and ROBH
Spatial thinning of ~100km



MetCoOp area

2.5 km (750x960 gridpoints)
65 vertical levels

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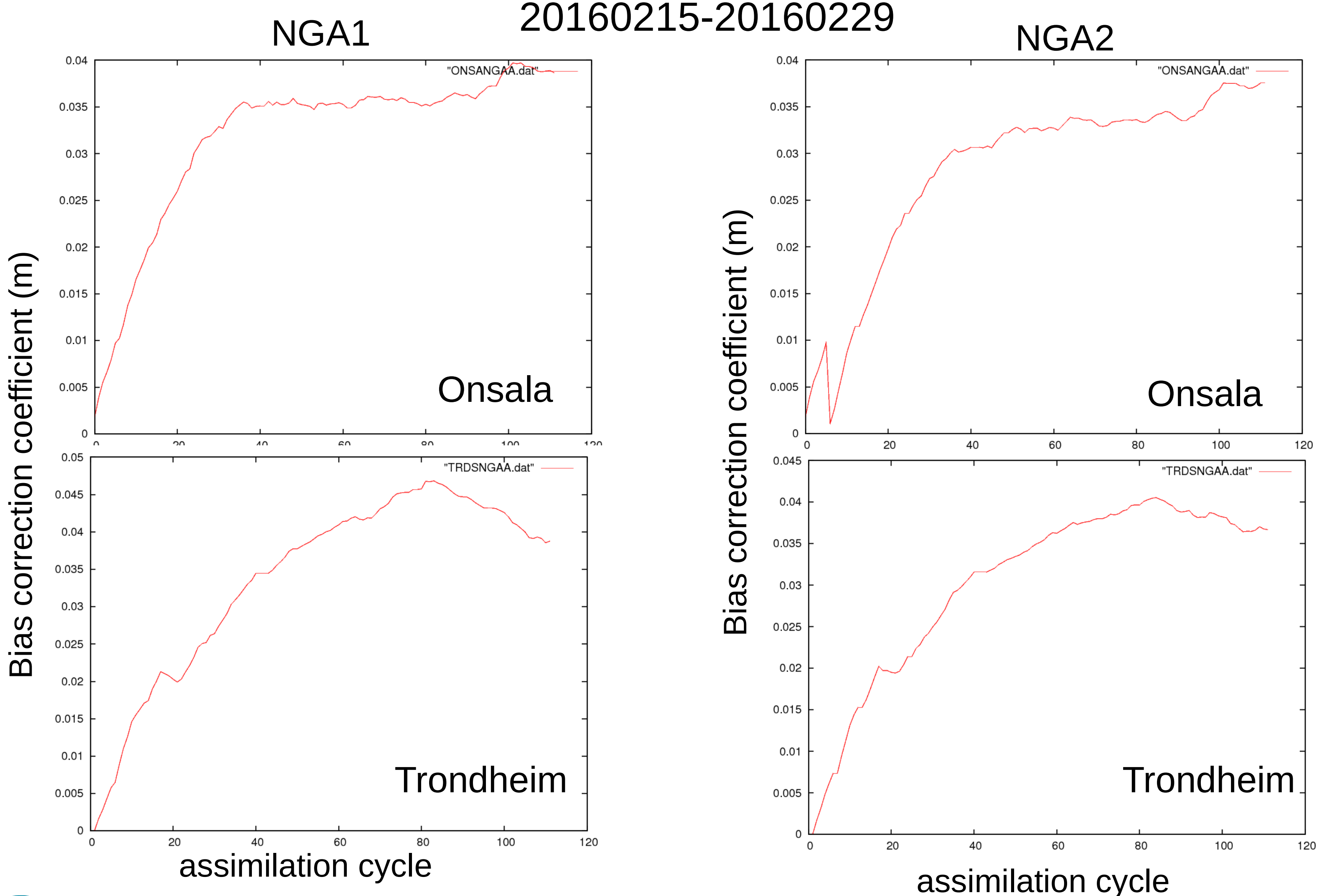
Spin-up of NGAA GNSS VARBC-coefficients 20160215-20160229



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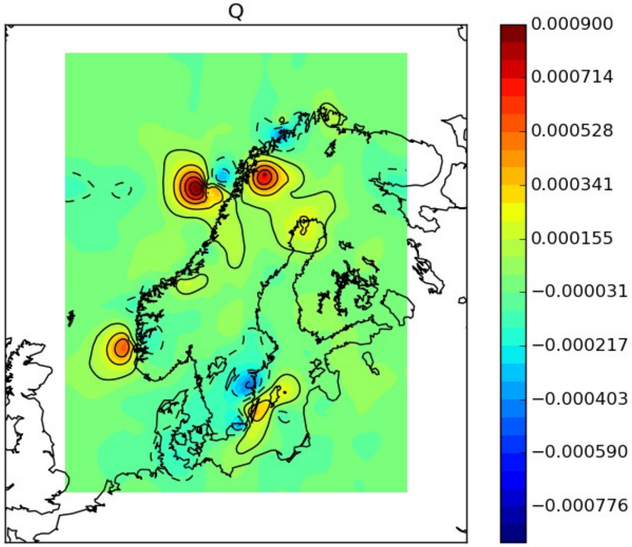
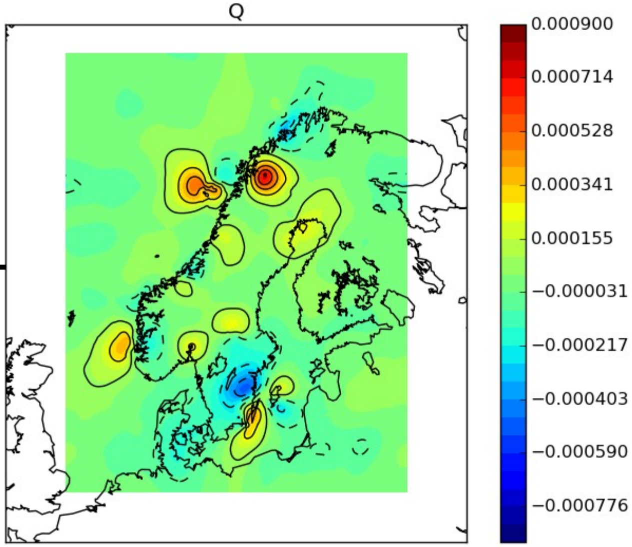
Impact of GNSS on analysis
20160310 03 UTC
800-850 hPa
Specific humidity
analysis increments

CRL



NGA1



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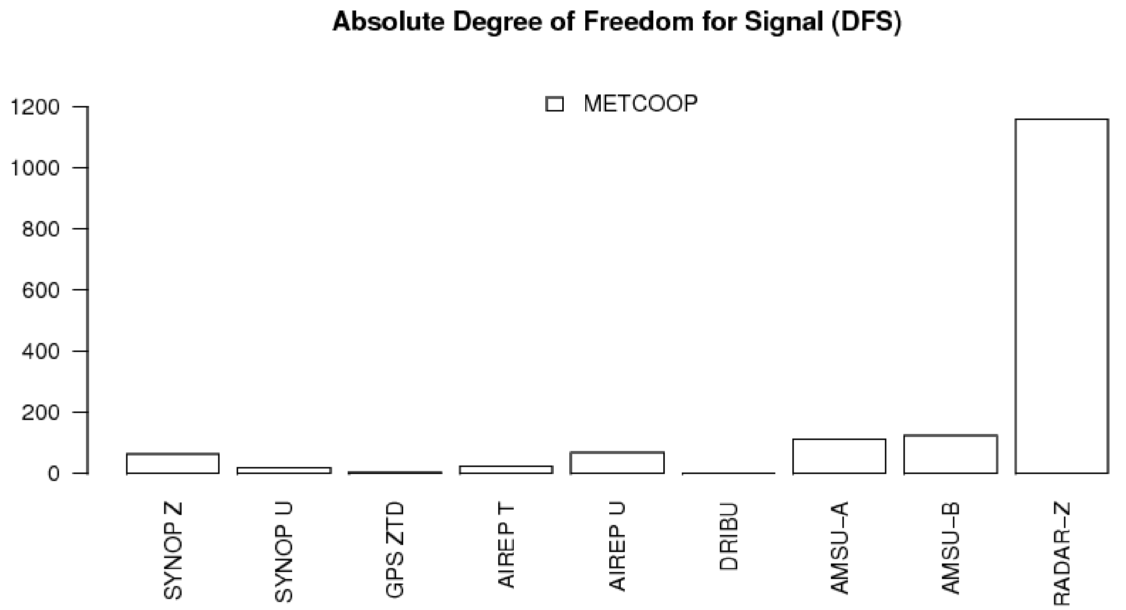
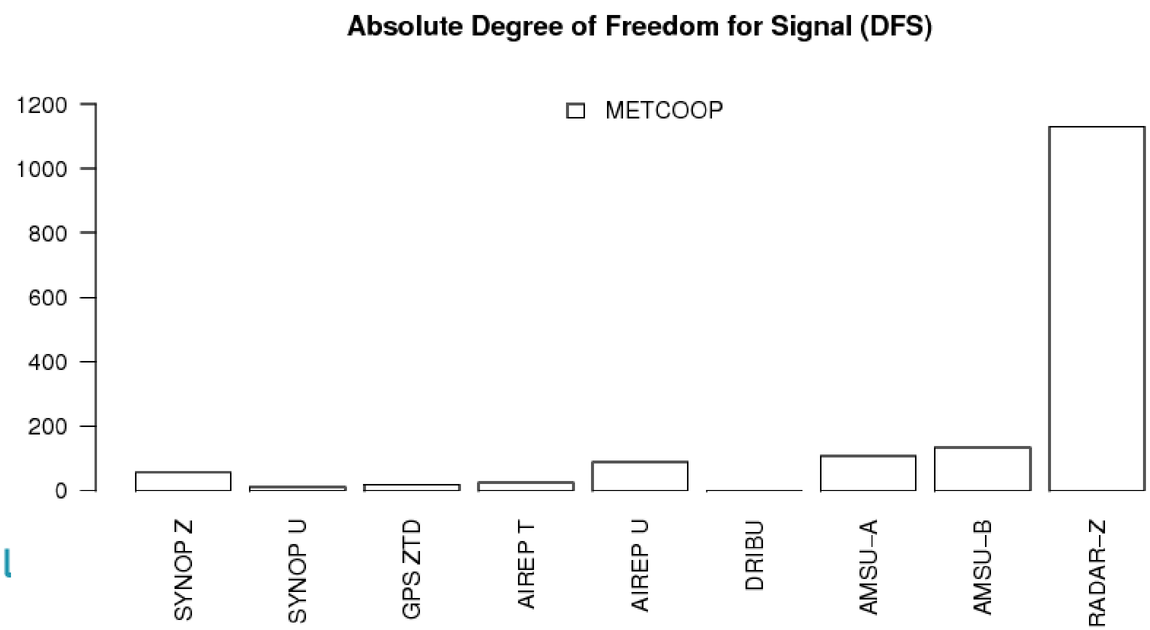
Impact of GNSS (all) on analysis 20160310 03

CRL



NGA1



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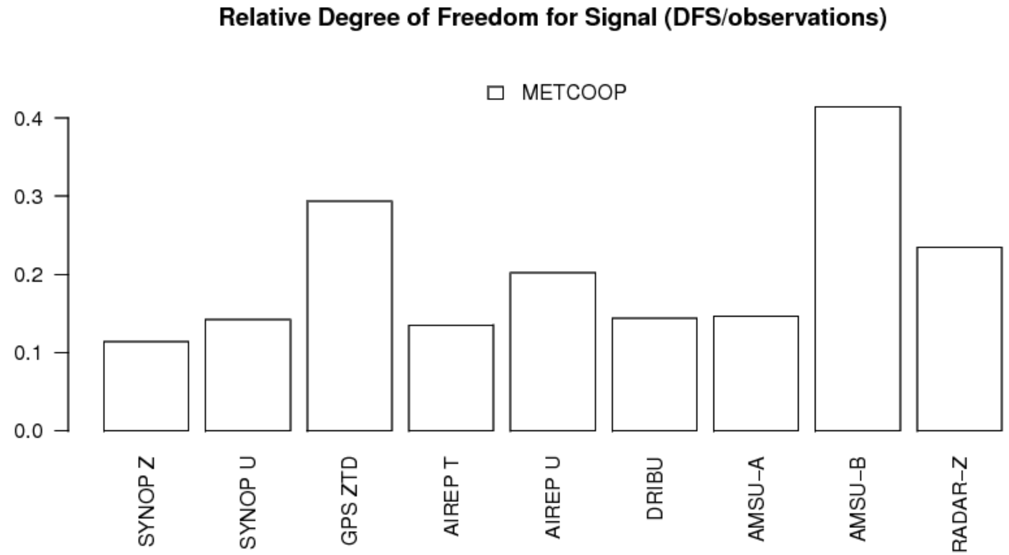
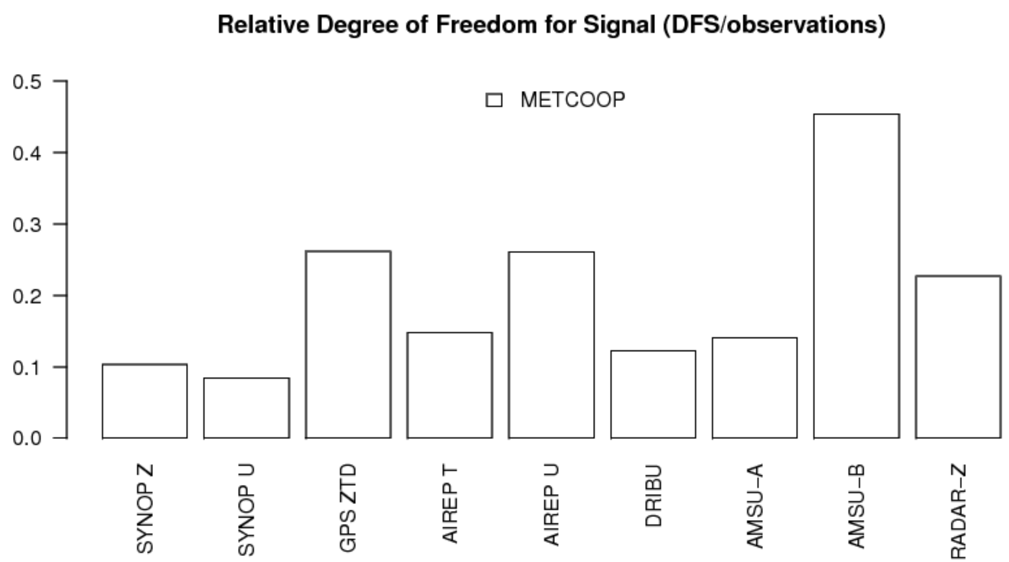
Impact of GNSS (per observation) on analysis 20160310 03 UTC

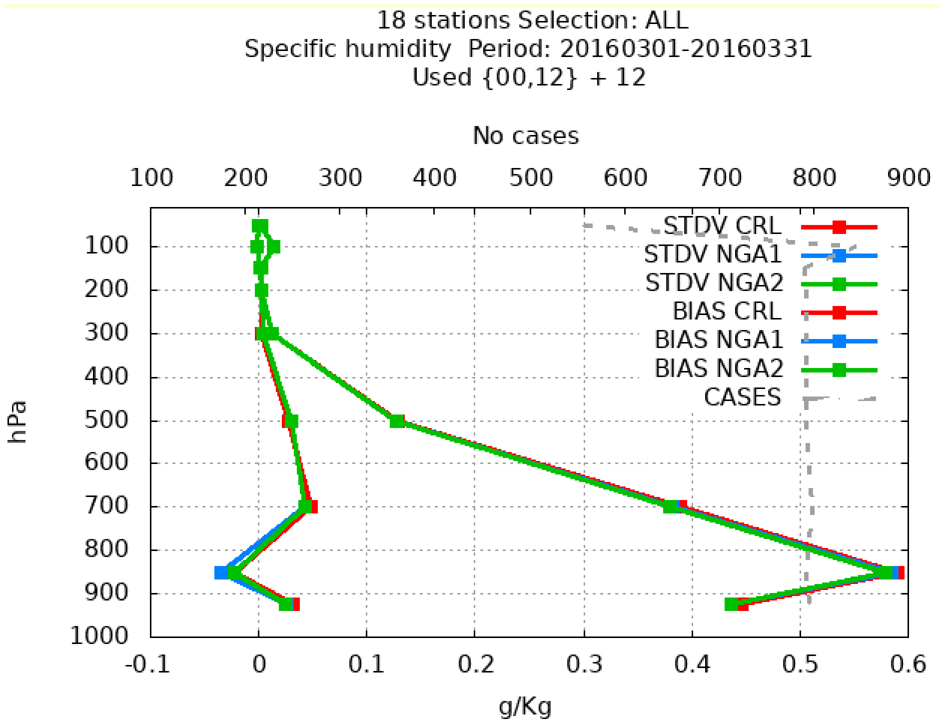
CRL

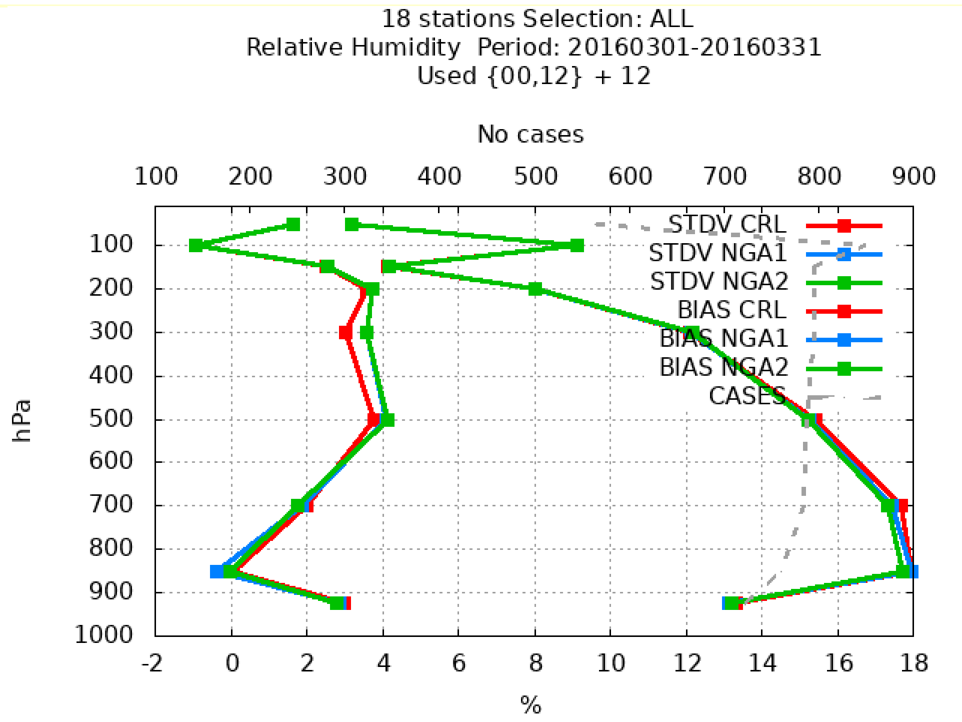


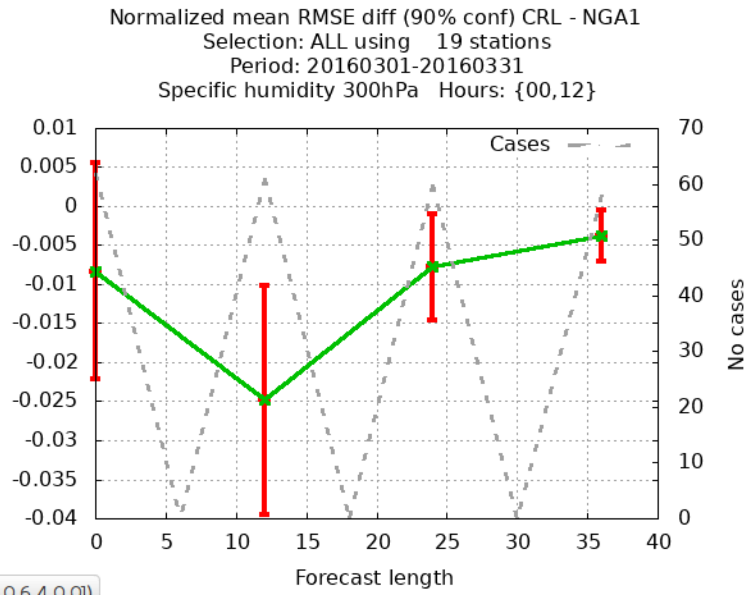
NGA1



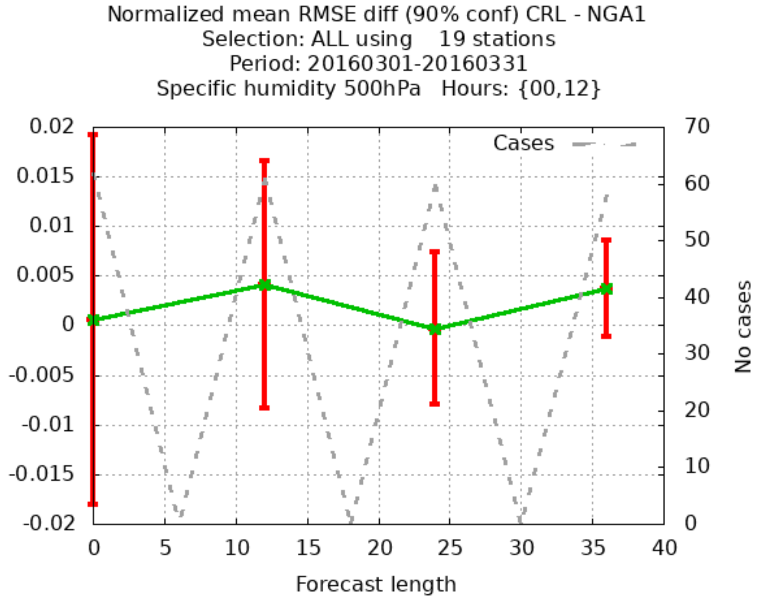
Verification Scores for Humidity

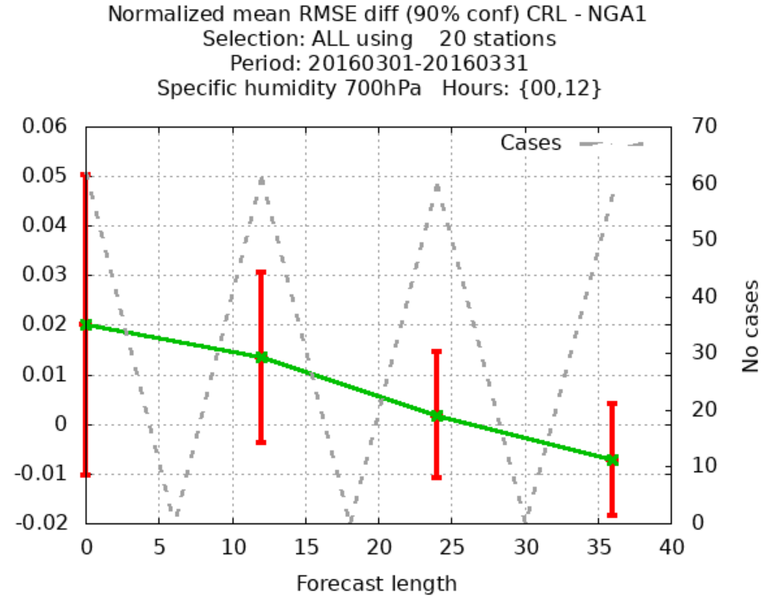






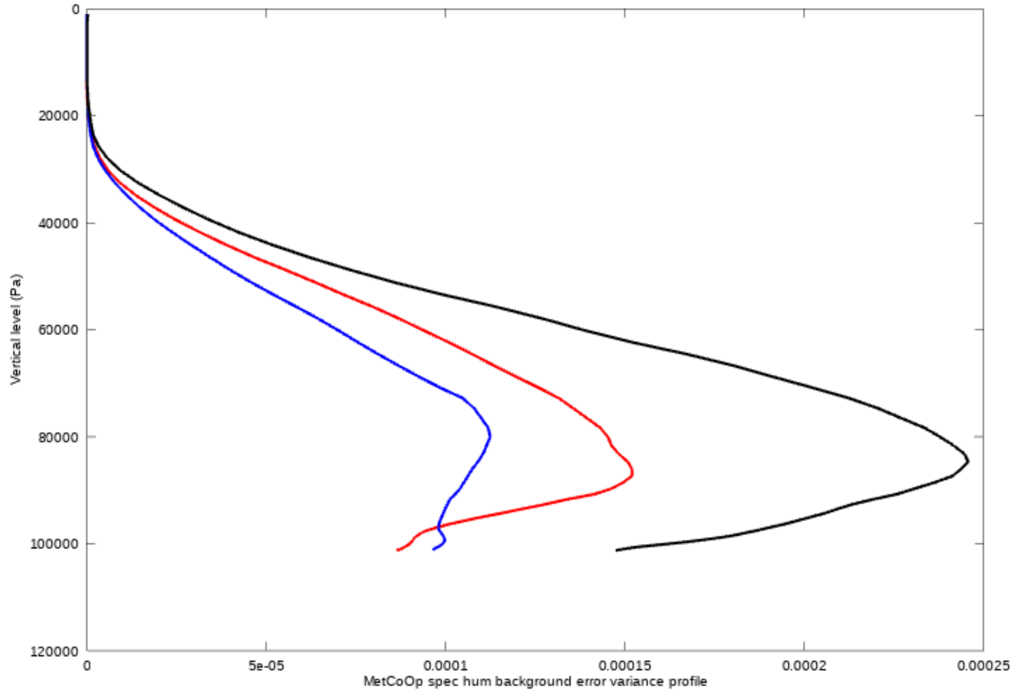
Difference of q RMSE as function of forecast length and significance in results





Seasonal variation of background error standard deviation profiles

Summer-DKCO times 0.3 Winter-DKCO Winter+Summer-MetCoop

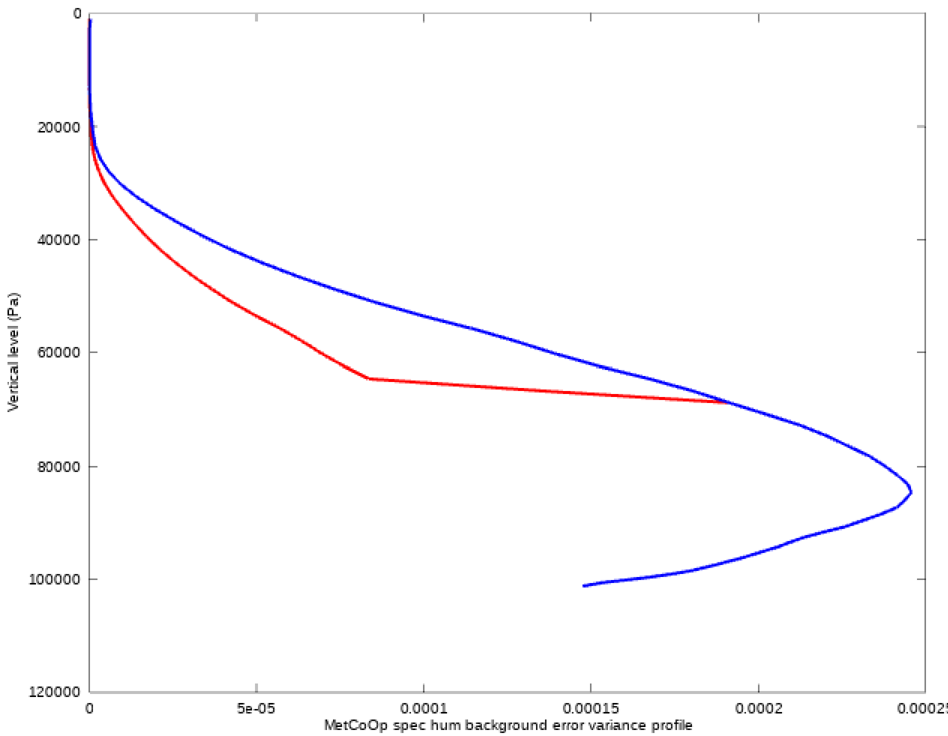


The q sigmab-profile influence how the total columnar water information from the GNSS observation is vertically distributed.
More distributed on higher vertical levels during summer than during winter.

The MetCoOp sigmab values are averaged over summer and winter statistics. For this March period, is to much of the GNSS information distributed to higher altitudes?

Modified q-sigmab vertical profile in MetCoOp Experiment

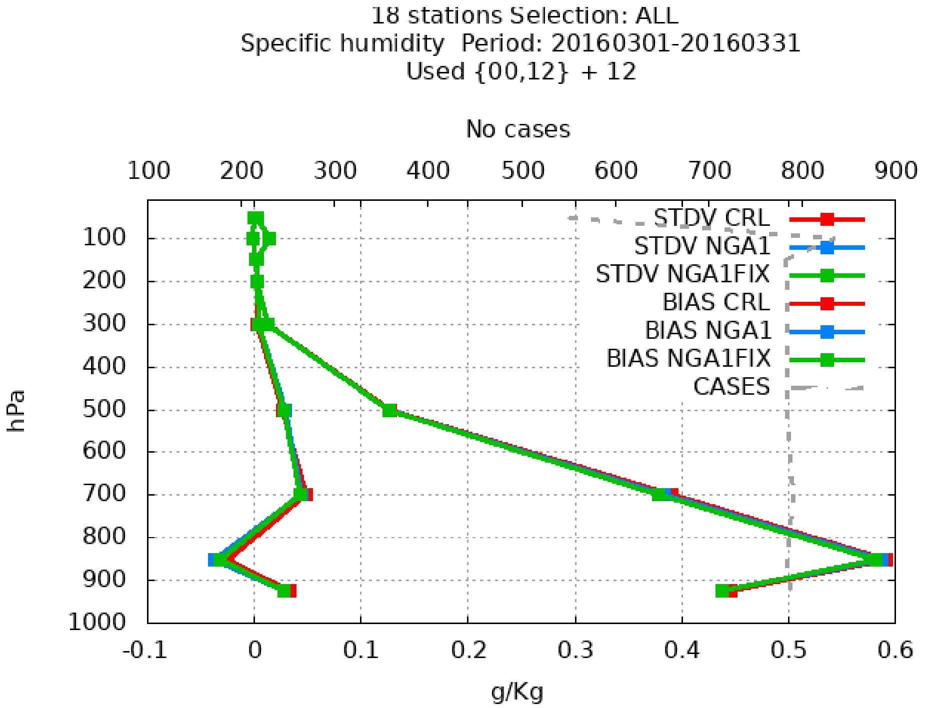
Original (NGA1)   Modified (NGA1fix)

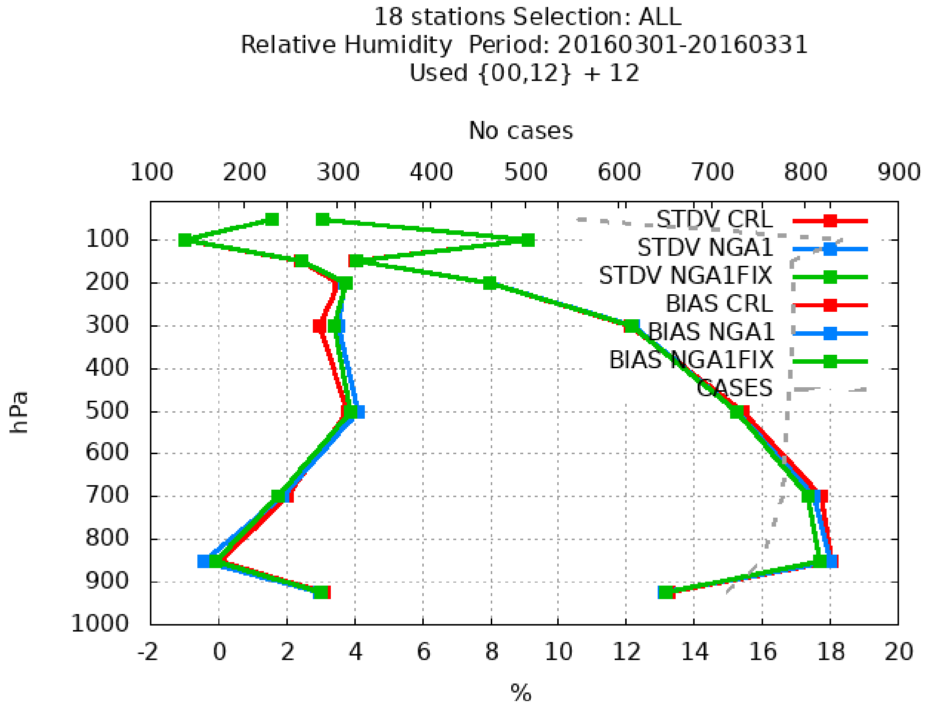


The purpose is the investigate the sensitivity to the vertical sigmab-profile and the potential benefit from introducing seasonally varying sigmab-profiles.

NGA1 exp. was re-run for entire month with the modified sigmab-profile.

Verification Scores for Humidity





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New assimialtion experiments

- One month parallel experiment during summer (June 2016)
- Same setup as the previous experiment.

- Five parallel experiments:

1. Control – Observation usage as in operational MetCoOp. GNSS from METO and ROBH.
2. Like CRL with additional NGA1 GNSS data, thinning distance 100 km.
3. Like CRL with additional NGA2 GNSS data, thinning distance 100 km.
4. Like 2 with thinning distance 40 km.
5. Like 2 with two predictors for the VARBC.

If 2 and 3 are very different 3 and 4 will also be run with NGA2 data.

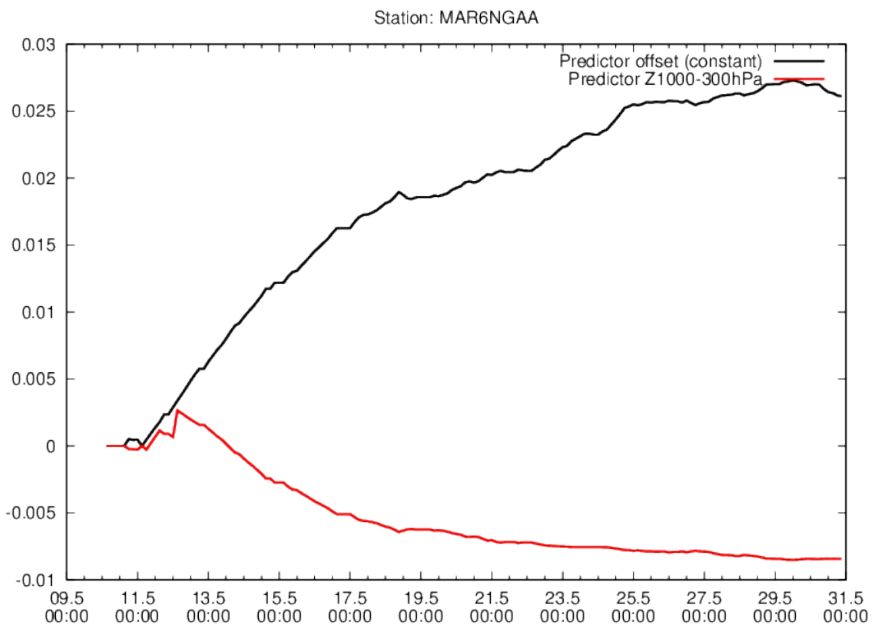
- Spin-up of VARBC coefficients for NGA1 and NGA2 during 20 days cycling with GNSS assimilated in passive mode during 20160510-20160531.

- Experiments with GNSS assimilated actively during 20160601-20160630. Three-hour DA cycle with forecasts up to 36 h at 00 and 12.

Spin-up of NGAA GNSS VARBC-coefficients 20160510-20160531

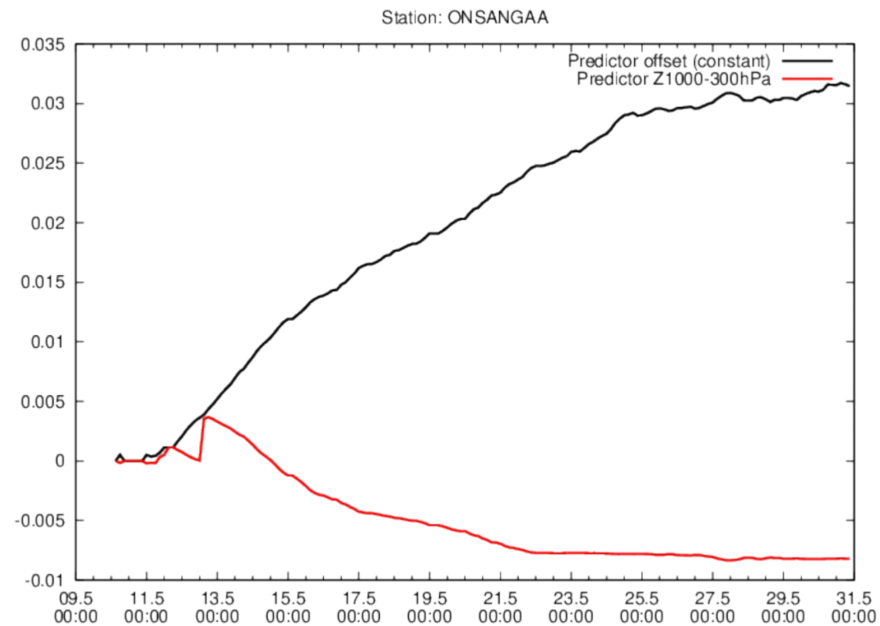
Mårtsbo (MAR6)

Bias correction coefficient (m)



assimilation cycle

Onsala (ONSA)



assimilation cycle

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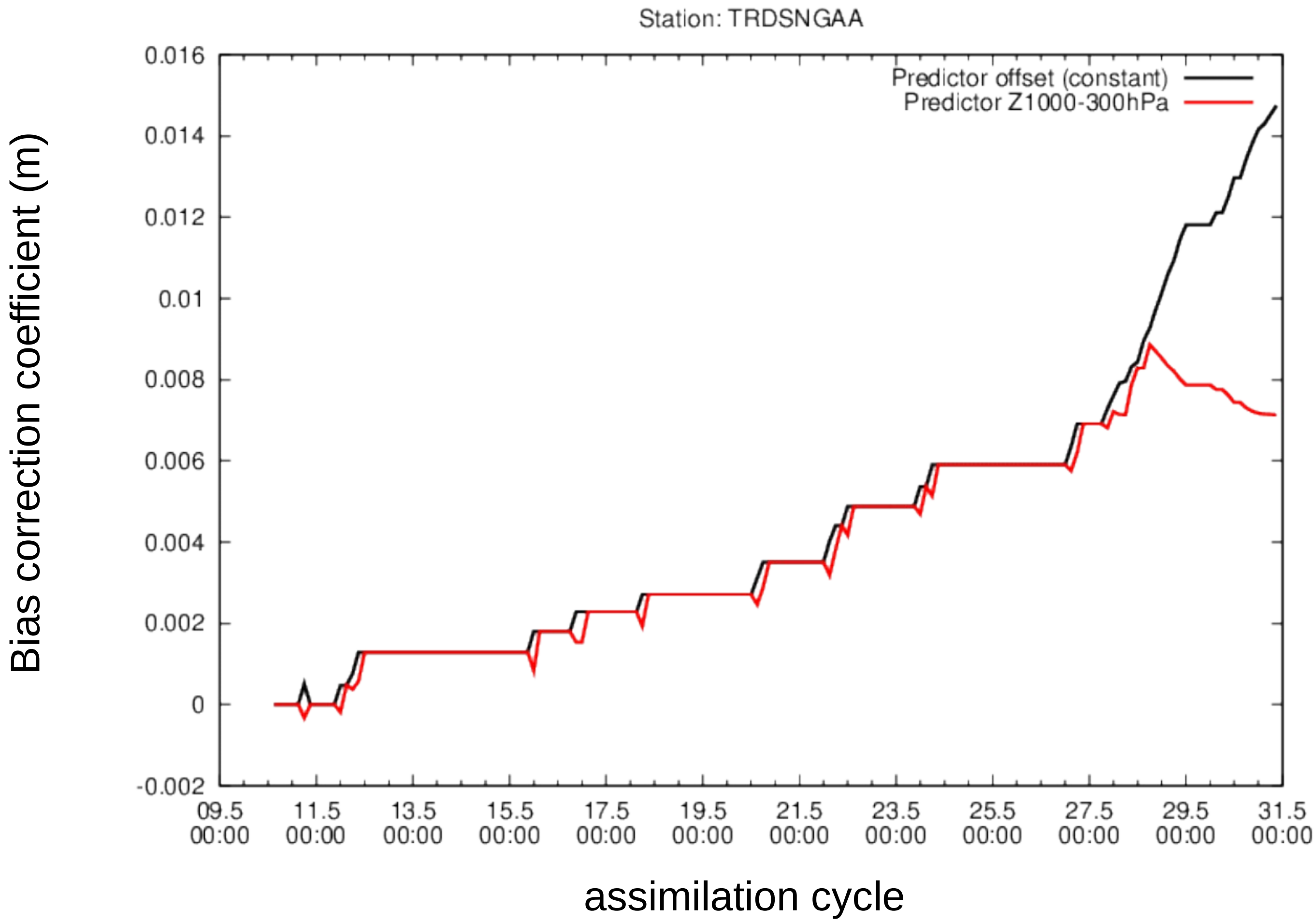
Spin-up of NGAA GNSS VARBC-coefficients
20160510-20160531

Trondheim (TRDS)



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Conclusions

- Lantmäteriet deliver two ZTD solutions of good quality from the Nordic ground based networks. Work is underway to create own orbit and clock estimates.

- GNSS observations from the NGAA processing site as been assimilated within the MetCoOp modelling system.

- More impact of GNSS on analysis when also GNSS from NGAA are used.

- Lower tropospheric humidity verification scores are improved by introduction of GNSS from NGAA. Increased bias in upper troposphere humidity forecasts with introduction of GNSS. Relatively small impact of whether NGA1 or NGA2 is used.

- Verification scores sensitive to humidity background error standard deviation profiles, so in future worthwhile to explore seasonally dependent background error standard deviations.

- New experiments are run with different thinning distances, VARBC predictors...