Koninklijk Nederlands
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Operational use of high resolution observations for very short term numerical weather forecasting

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Sibbo vd Veen (KNMI)
Magnus Lindskog (SMHI)
Martin Stengel (DWD)

Very short term numerical weather forecasting

Project initiated by:

Amsterdam Schiphol Airport and Air Traffic Control, The Netherlands

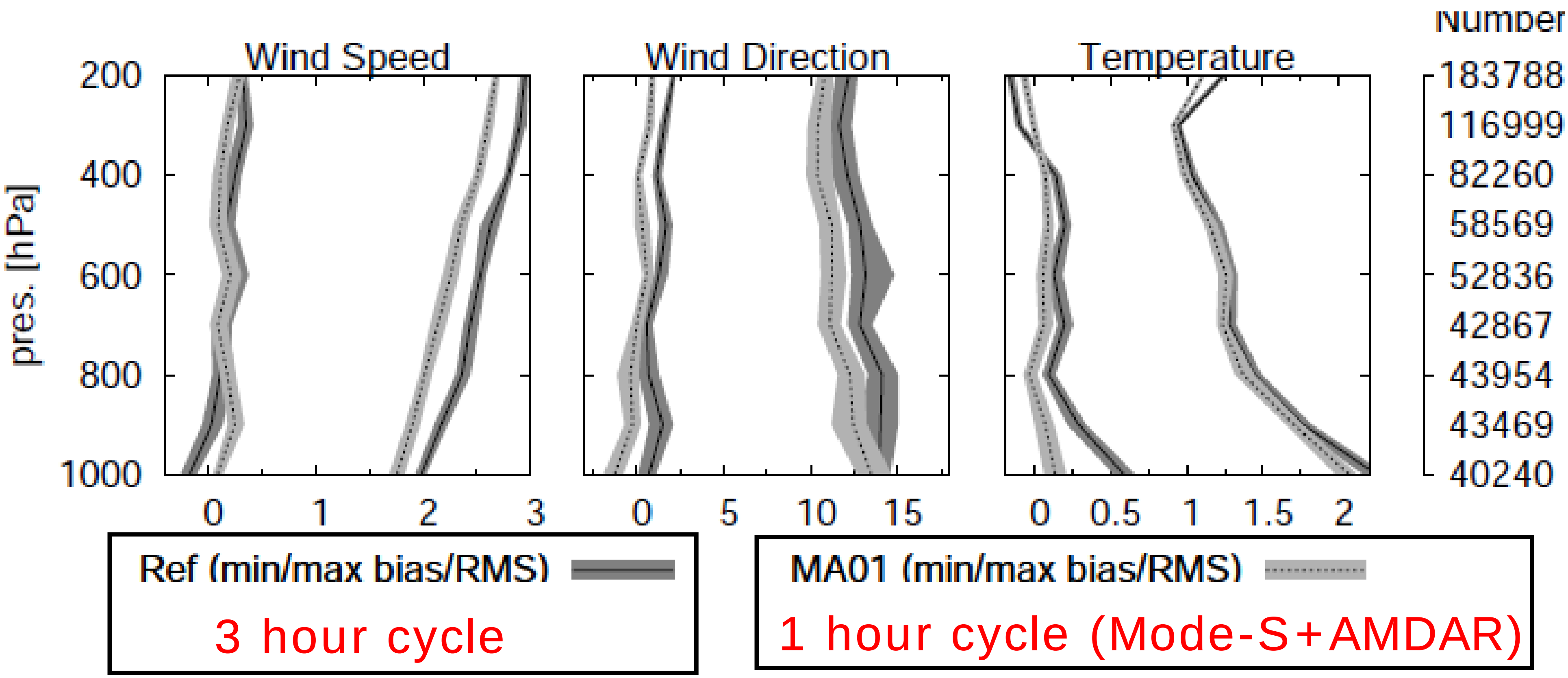
Research to support Continuous Descent Approach

- Environment (fuel/noise)
- Efficiency Amsterdam Schiphol Airport
- Prototype “Expected touchdown time”
  - Meteorological Input
    - Mode-S
    - NWP Model
  - Improved prediction
    - Landing time estimates
    - Wind forecast

Real-time Forecast skill

At observation time compared with available forecast

5% reduction in wind speed RMS



DeHaan/Stoffelen, WAF, 2012 (almost in print)

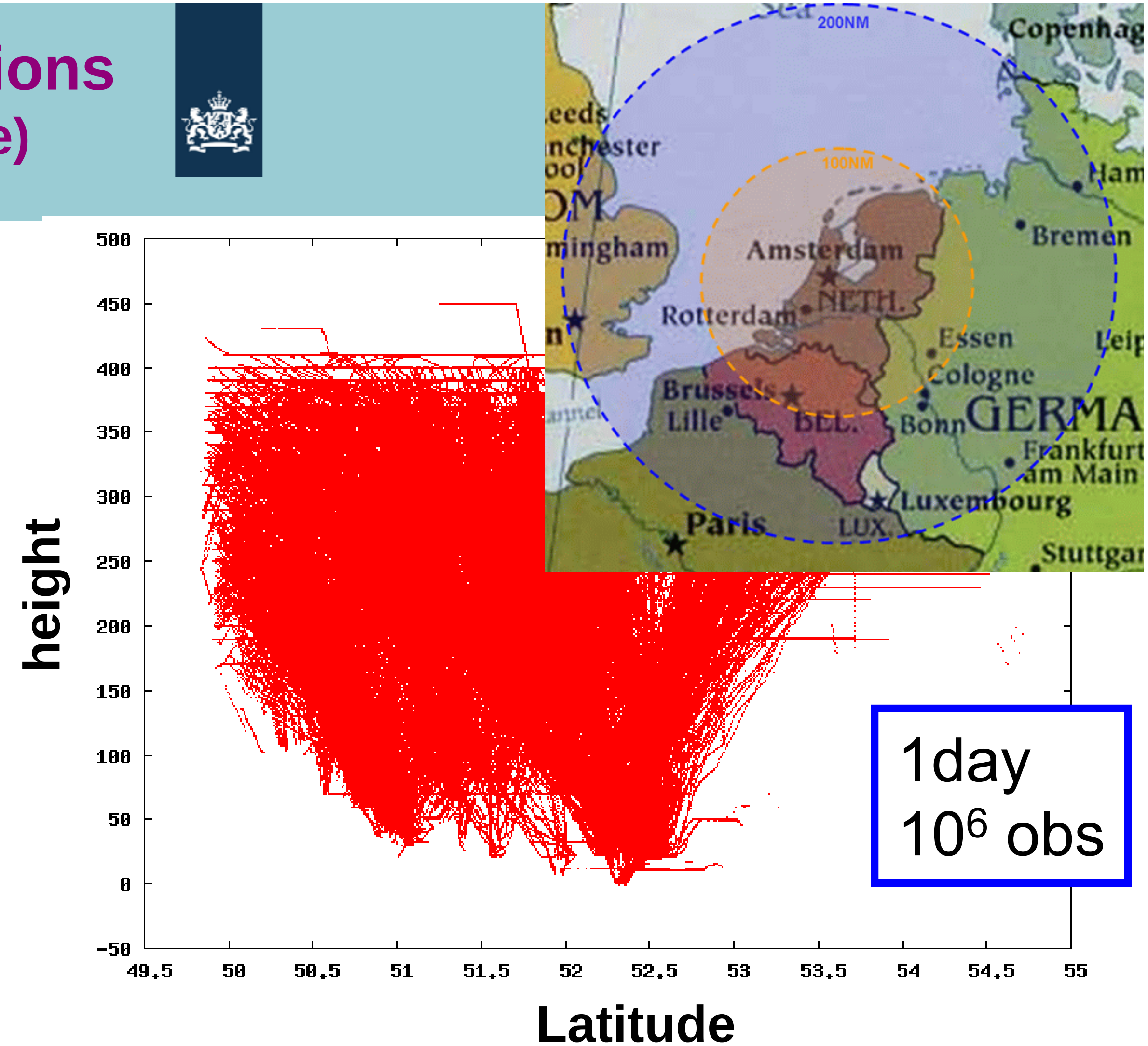
Mode-S EHS observations
(Enhanced Surveillance)

ATC-Radar interrogates all aircraft

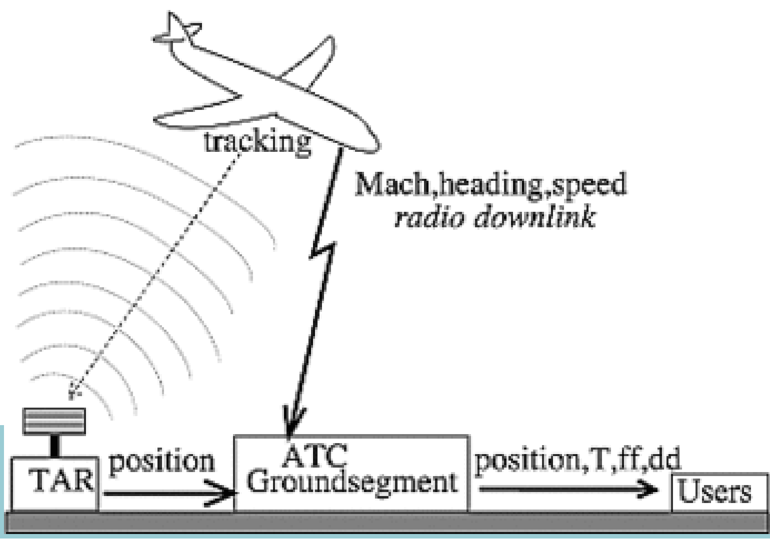
Aircraft replies with:

- Identity
- Flightlevel
- Airspeed/direction
- Mach number

All aircraft/every 4.2 seconds



1day
10^6 obs



Wind observation similar to AMDAR
Temperature slightly worse.
After calibration and correction

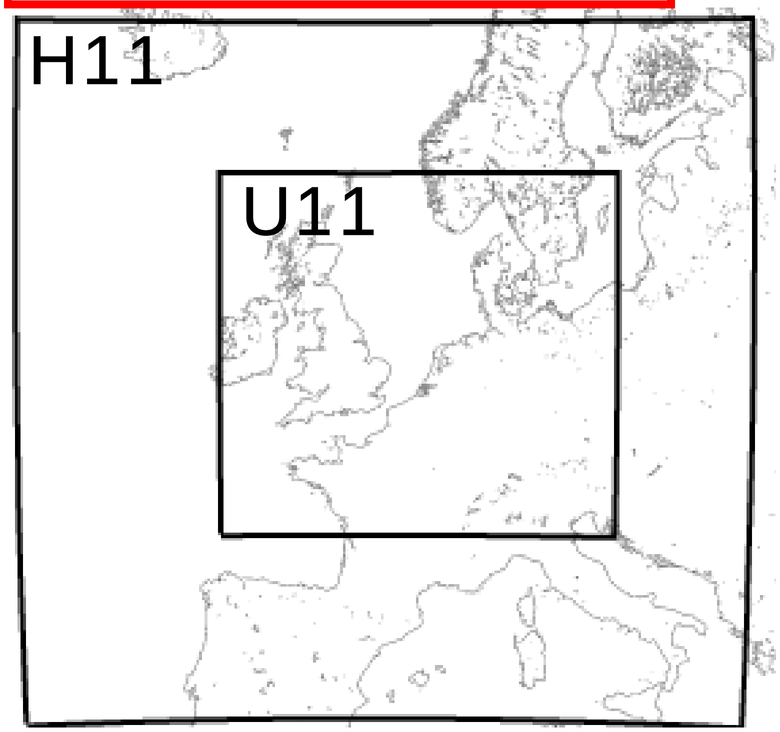
DeHaan, JGR, 2011

Numerical Weather Prediction Models

HIRLAM

- 11 km Resolution (U11)
- Observation cut-off time : 10 minutes
- 9 hours forecast
- Hourly 3DVAR Assimilation: **p,u,v,T,q**
- Operational (U11)
  - Synoptic (land, ship, buoy) — p
  - AMDAR/Mode-S — u,v,T
  - Groundbased GNSS — ≈ q
  - Radar radial winds (NL) — ≈ u/v
- Simultaneous test (pre-operational)
  - MSG clouds/ceilometer (initialization) — ≈ q,T
  - MSG Seviri (ch 6.2,7.3,13.4) — ≈ q,T
  - AMSU-A — ≈ q,T

Operational (H11)
3 hour 3DVAR
cycle: Synoptic
(land, ship,buoy)
radiosonde AMDAR



Assimilation of GNSS and radar radial winds

Radar radial winds

Lowest elevations have an unambiguous velocity of 24 m/s

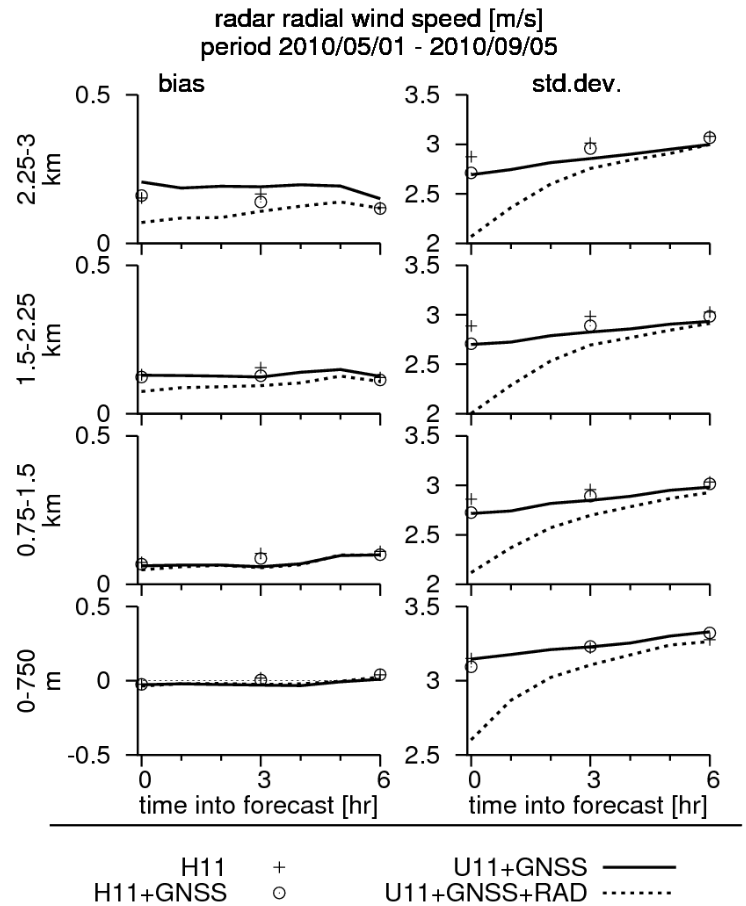
Dealiasing using higher elevations

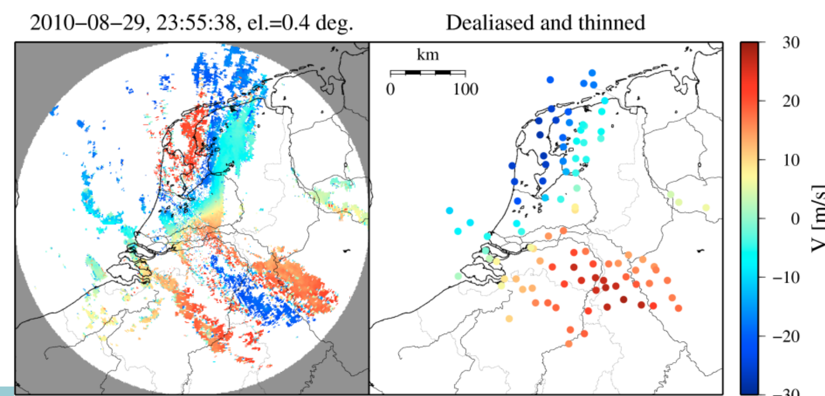
Thinning to 20x20 km boxes

QC checks

GNSS ZTD observations

Processing of within 5 minutes after observation time

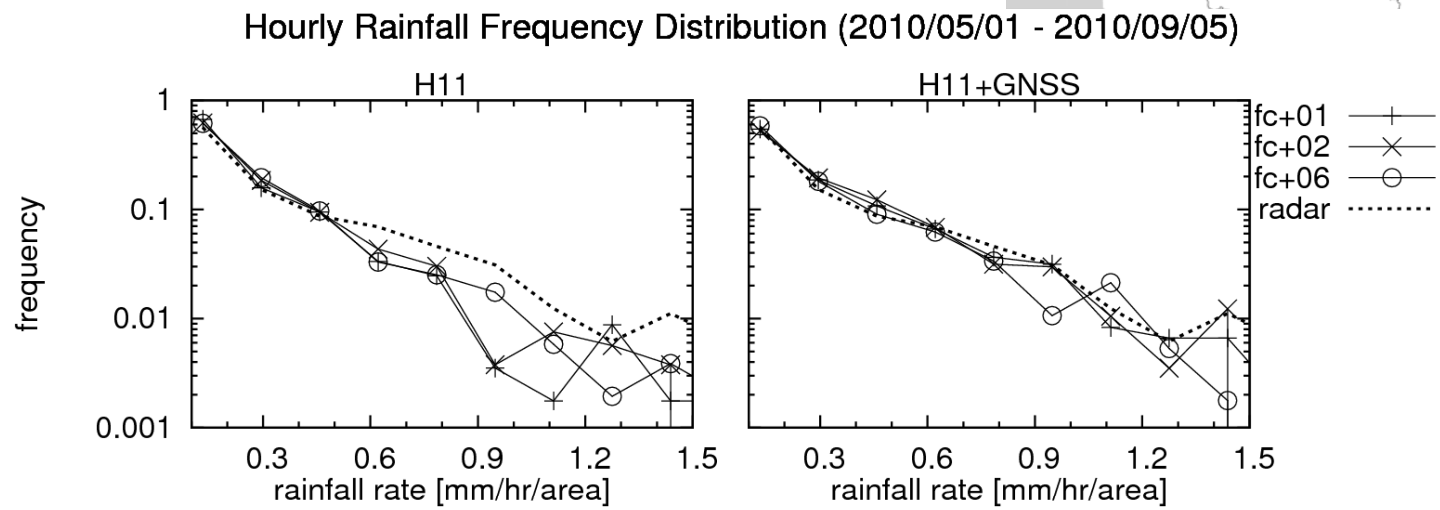




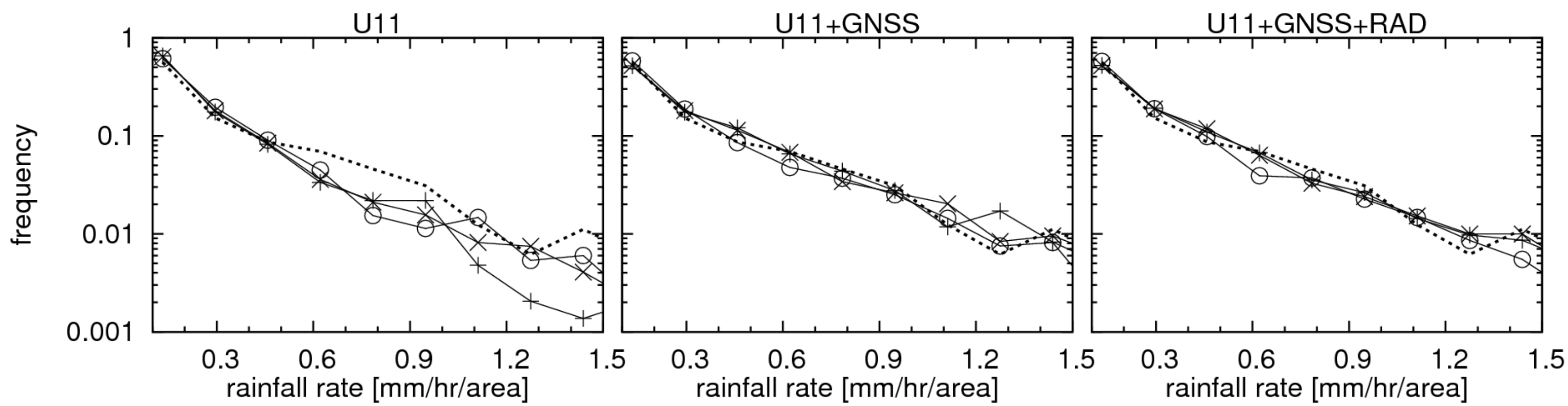
DeHaan, QJRMS, 2012 revised

Assimilation of GNSS and radar radial winds

3 hour cycle



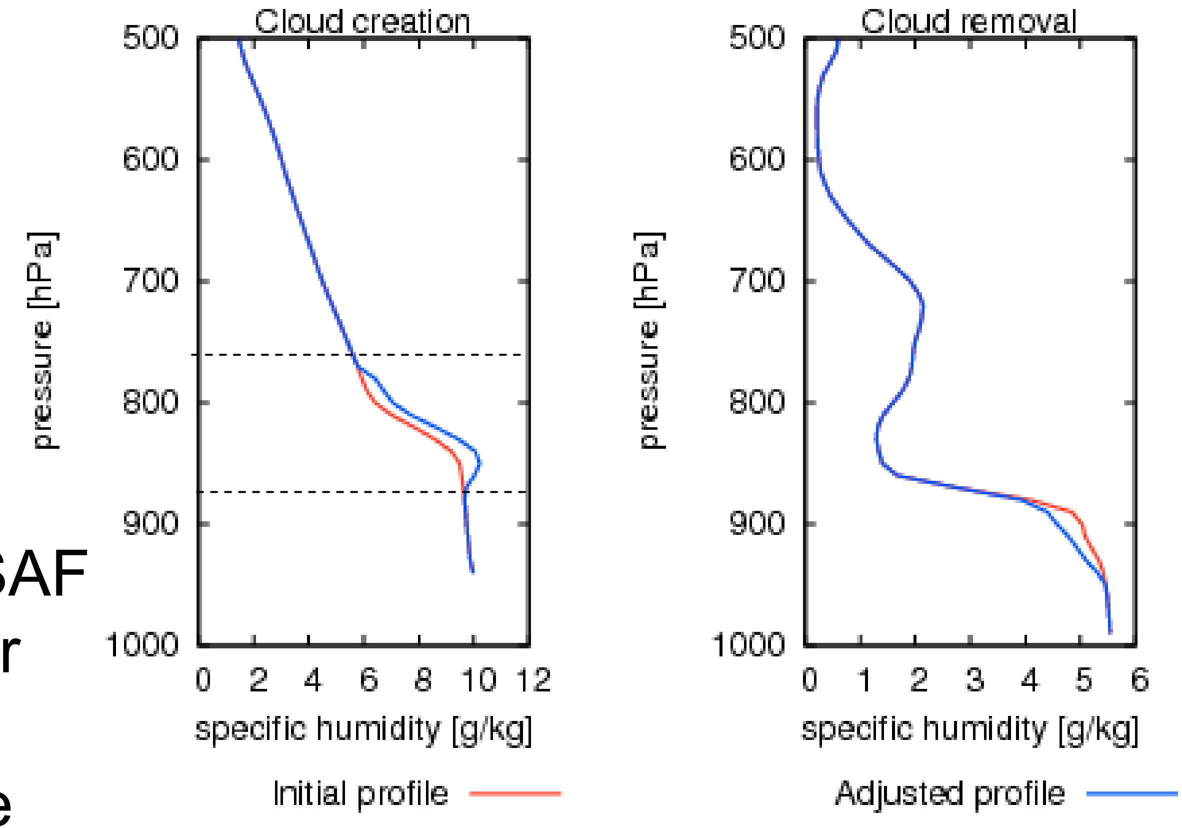
1 hour cycle



DeHaan, QJRMS, 2012 revised

Mixing cloud information in hourly update

Temperature and specific humidity adjustment after digital filtering step



Input:

From the NWPSAF

- Cloud Cover
- Cloud Top Temperature

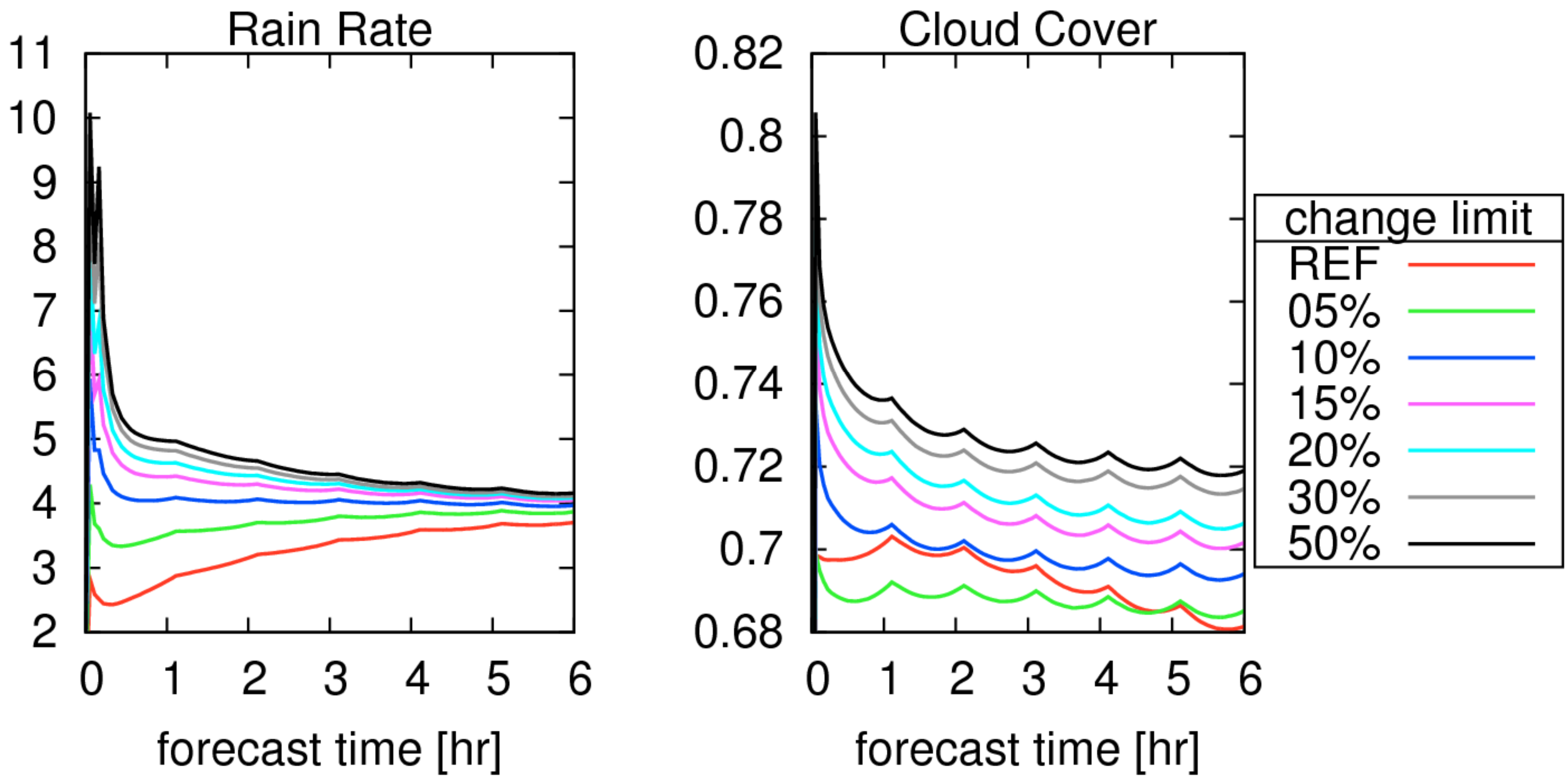
SYNOP Cloud base height

vdVeen, MWR, submitted

Effect of initialization on spinup

Tests with different change limits in change of q

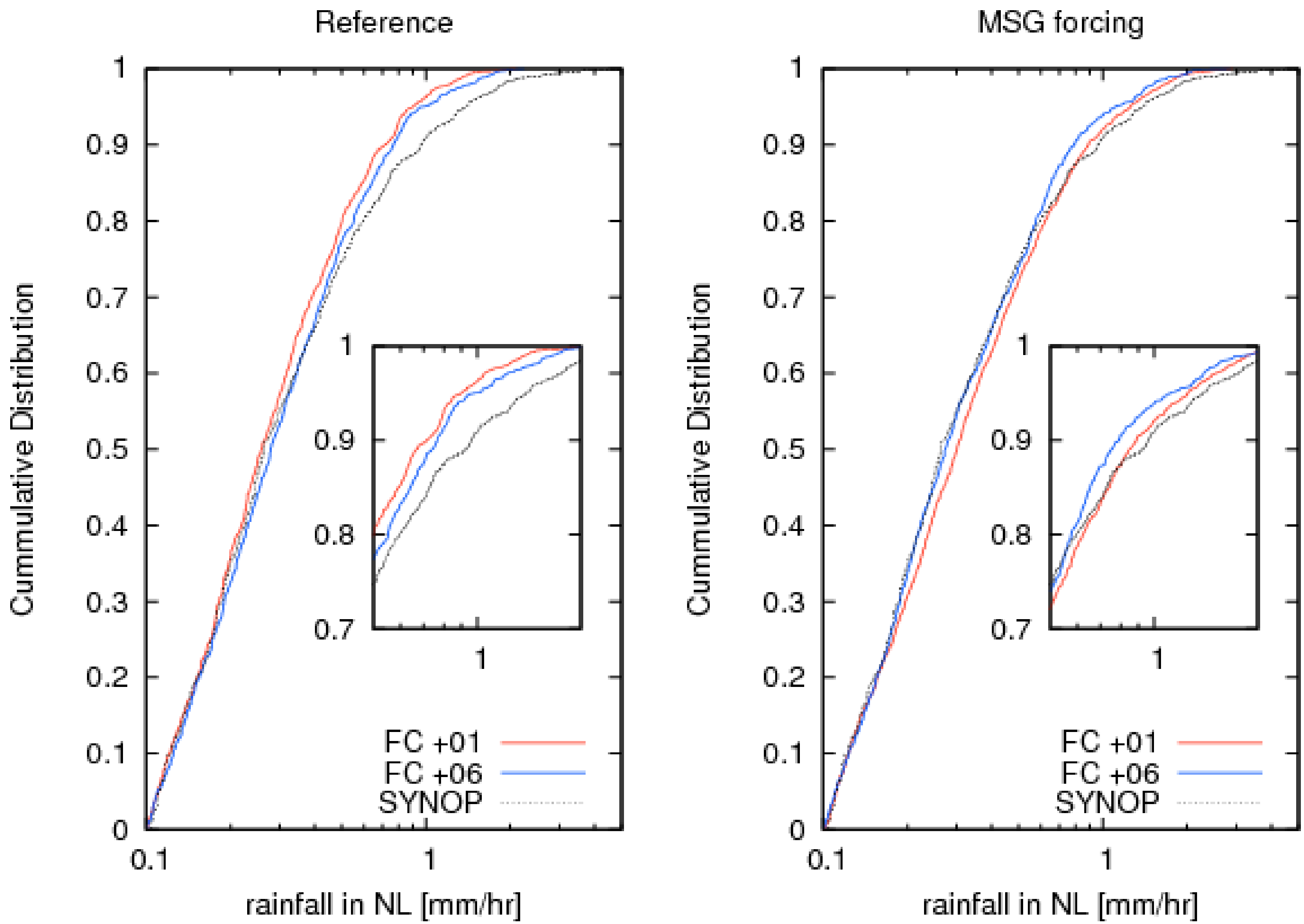
6 days: 144 runs



deHaan and vdVeen, in preparation

Maximum change in q is set to 10%

Impact on rainfall rate
May 2011 – December 2011



MSG/Seviri/ATOVS assimilation

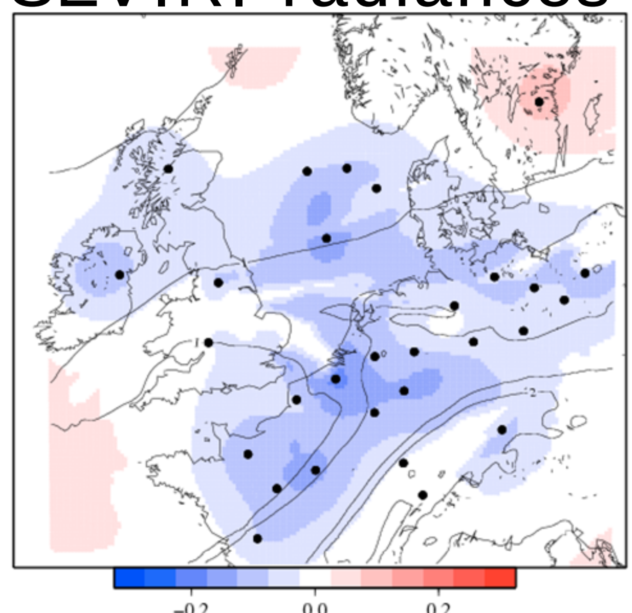
Period : 13 April 2012 – 12 May 2012

Pre-operational

- Use late/delayed observation
  - Obs-cutoff time : 1h05m
  - Radiosondes
  - AMSU-A
- Real-time assimilation of
  - Mode-S/AMDAR
  - SYNOP pressure
  - Radar radial velocities
  - MSG initialization
  - SEVIRI radiances (Stengel,QJRMS,2009)

AMSU-A

SEVIRI radiances



Impact results

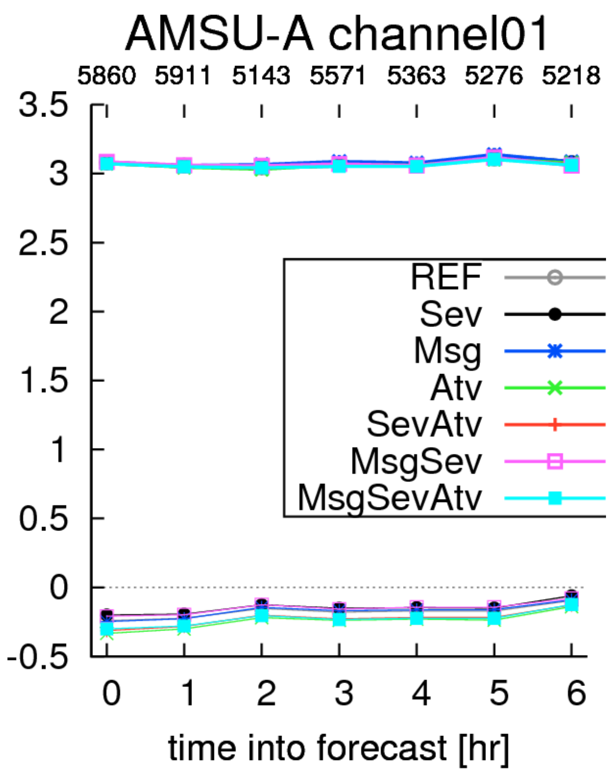
Comparing the AMSU-A observations against forecasts. (Polar orbit = irregular)

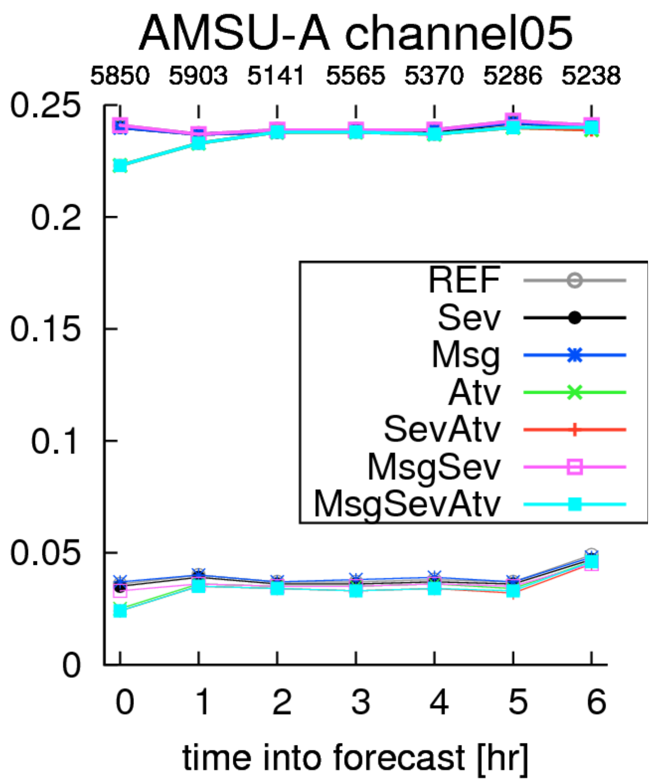
Standard bias corrections as derived for operational HIRLAM

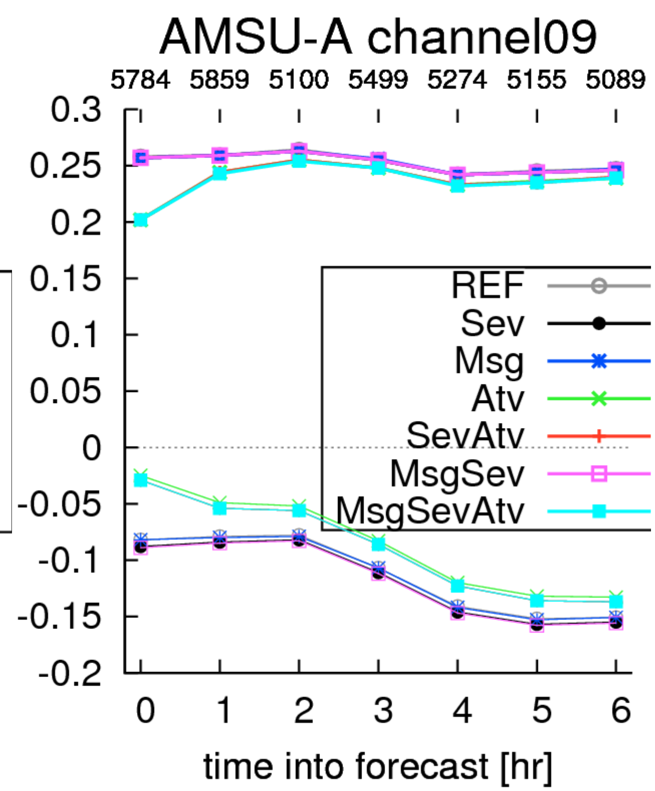
Channels 01-04 show no signal

Channels 05-10 show better scores:

- Reduction in standard deviation in the first hour of the forecast
- Bias is present and may change with forecast time!







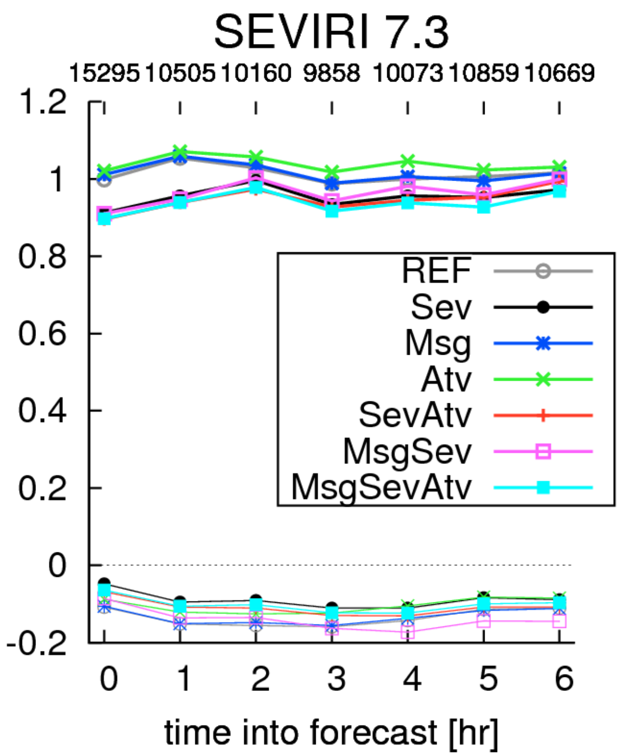
Impact results

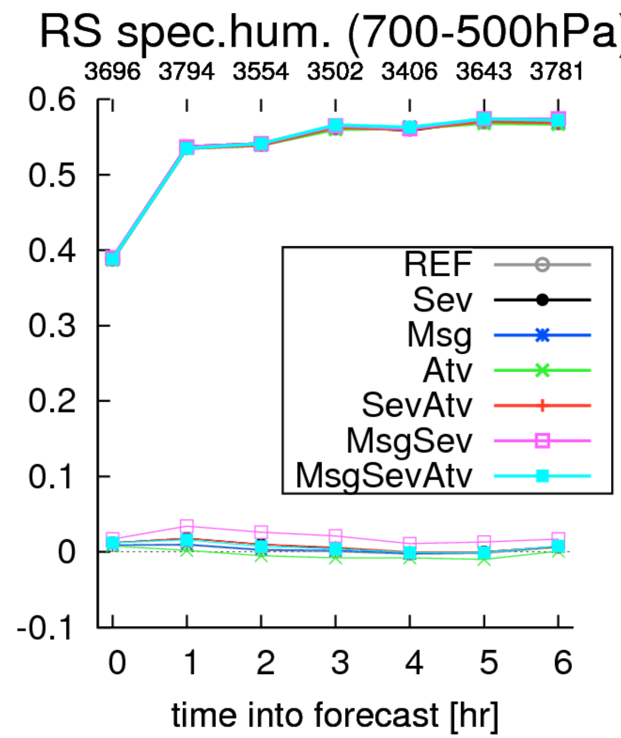
Positive impact of SEVIRI data over the whole forecast range

Bias correction is probably needed

Run with MSG and SEVIRI (**MsgSev**) shows a small negative impact in bias on radiosonde specific humidity.

Other runs show neutral impact.





Summary

- Hourly HIRLAM beneficial for ATC/CDA
  - Improved wind forecasts for real-time usage
- Use of GNSS observations essential for humidity/rainfall forecast
- Use of radar radial winds improves the wind forecast (locally)
- MSG initialization
  - improves cloud cover forecast even up to 6 hour
  - Positive effects observed for rainfall rate
- Recycle of HIRLAM to use “delayed” observations
  - Radiosondes
  - AMSU-A
  - Bias corrections for AMSU-A and SEVIRI seems necessary

- More observations from surrounding countries:
  - radars (BEL/FRA/GER/UK)
  - Mode-S observations

Assimilation of radar radial winds

- Data in HDF5 format
- Using dealiasing from high elevation
  - large ambiguity (48m/s and 25m/s)
- Thinning to 20x20km boxes
  - median
  - number + standard deviation check