Assimilation of radar data in HARMONIE Activities and plans

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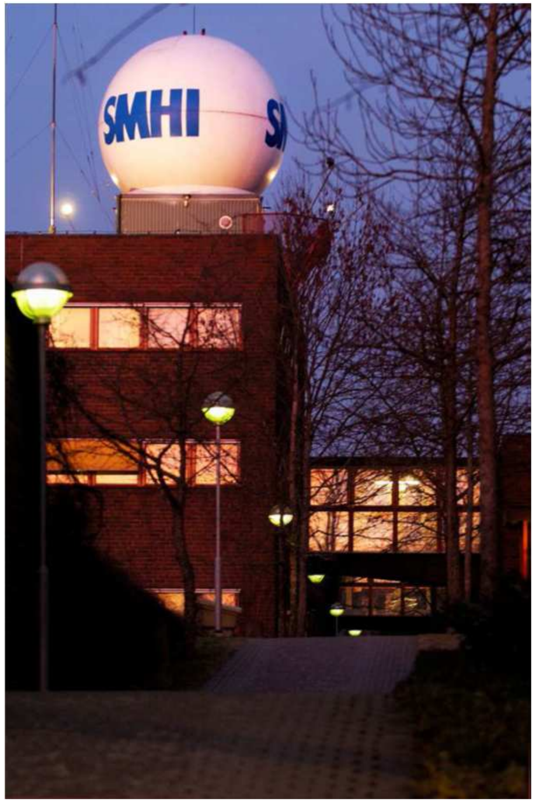
Outline

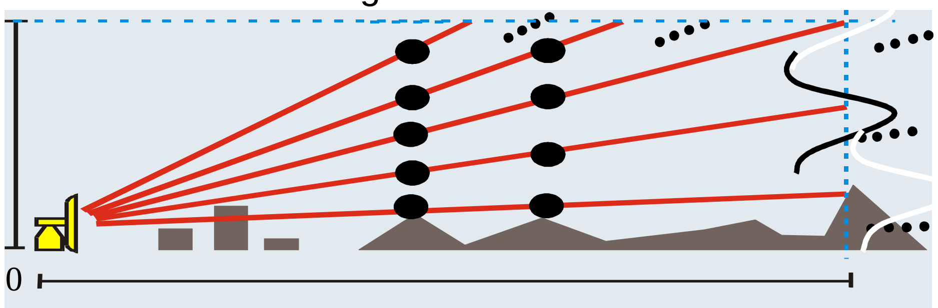
- Radar data assimilation in general
  - What and how
  - The “dry pixel problem”
  - Data reduction
- Radar data assimilation in HARMONIE
  - Challenges of building a general system
  - Data exchange
- Assimilation results
  - Impact experiments
  - Verification of a longer run
- Summary and future highlights

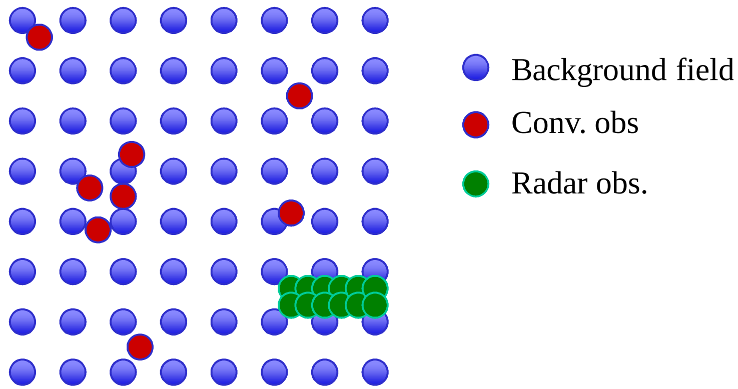


SMHI

Radar assimilation

- Radar data
  - Volume scans from each radar
  - Very large data amounts
- Reflectivities
  - Difficult to do direct assimilation (complicated relation between control variables and reflectivity, including microphysics)
  - 1D + 3DVar
  - Assimilation of a humidity pseudo observation
  - Assimilation of “no humidity” to dry the model
- Radial velocities
  - Easier and more straight forward
  - Dealiasing is needed





HARMONIE radar assimilation: Reflectivity

- Combination of 1D Bayesian and 3DVAR schemes
  – Developed by MeteoFrance (Caumont et. al, 2007)

- 1D humidity profiles are retrieved utilizing reflectivity measurements
  – Comparing radar reflectivity with simulated reflectivity to obtain weights for interpolation
  – Pseudo-observations of relative humidity using the weights model humidity to observation point
  – If there is no precipitation in the model, but in observations, humidity is set to 100%
  – If there is precipitation in the model but not in observations, surrounding dry pixels are used

- Pseudo-observations assimilated using 3DVAR

- Areas of no precipitation
  – It is also important to assimilate pixels with no reflectivity to dry the model
  – “nodata” or “undetected” ?!

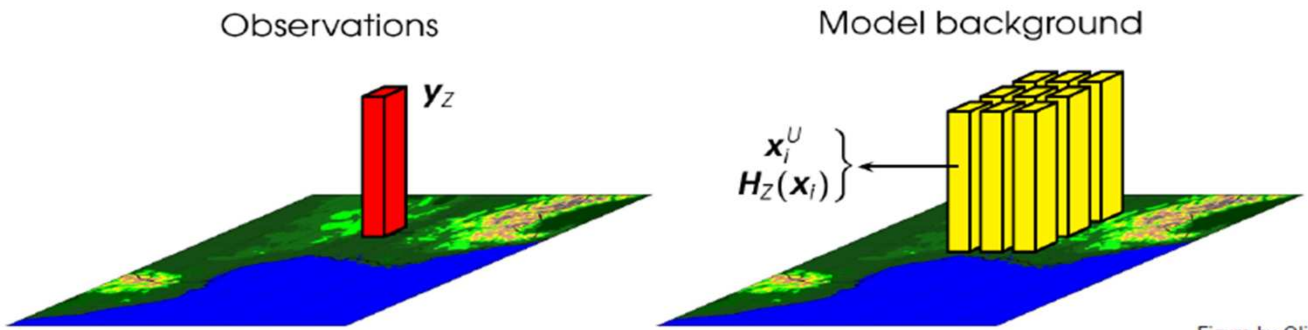
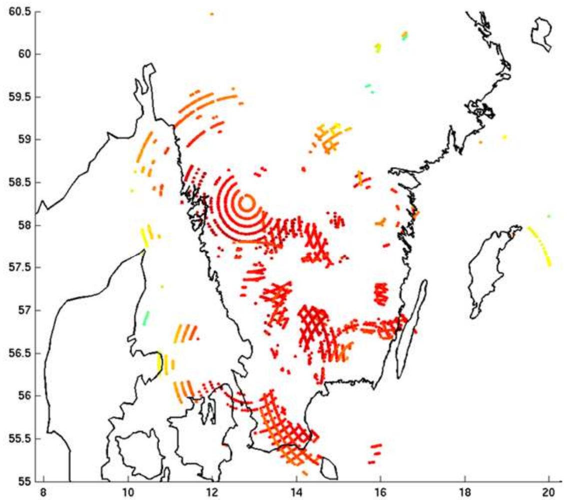


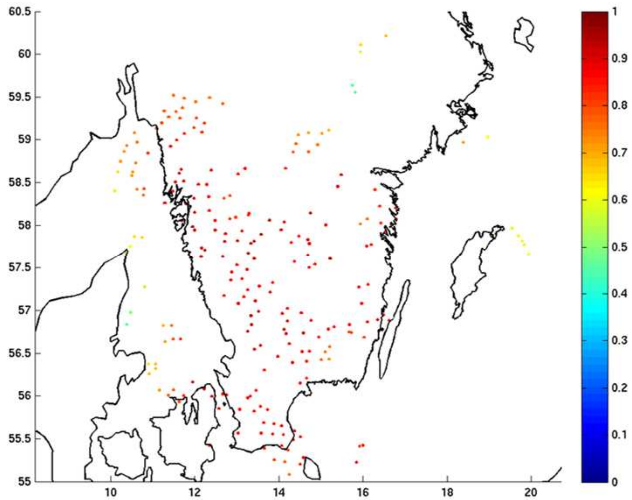
Figure by Olivie

Data reduction: Thinning or superobbing

- Thinning
  - Use the raw data with coarser resolution
  - Possibility to avoid noisy pixels
  - Used today in HARMONIE

- Super observations
  - Calculate spatial averages of the raw data
  - Needs to be made carefully, e.g. use precipitating or non-precipitating pixels





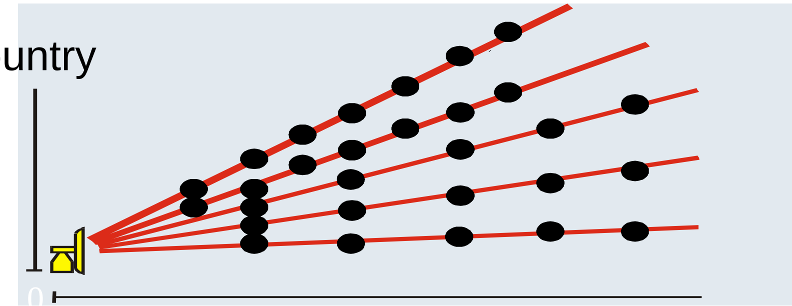
HARMONIE assimilation: Challenges

- Different data formats
  - HDF5, BUFR, internal formats…
  - Many countries are aiming for the OPERA Information Data Model (ODIM) in HDF5 or BUFR file format

- Different grid types
  - Most countries use polar coordinates (azimuth angle and range)
  - Different volume sizes

- Different scan strategies
  - Different for different elevations
  - Different for reflectivity and radial velocity

- Different quality of the data
  - Different levels of quality control in each country



HARMONIE assimilation: Where are we?

- Input data format
  - A conversion tool is available (local format → MF-BUFR)
  - A reader for ODIMH5 is available
  - We can handle (most?) local differences regarding volume sizes, scan strategies…
- Radar data exchange
  - Plans are to exchange data operationally between HIRLAM countries
  - BALTRAD servers?
- Quality control
  - BALTRAD toolbox will be the preference
- Assimilation experiments
  - First reflectivity experiments performed at MET-Norway
  - Impact experiments performed at SMHI
  - Technical experiments performed at DMI including data from several countries (Denmark, Sweden, Norway, Finland and Poland)

Assimilation experiments at SMHI: Input data

- Radar experiments
  - Reflectivity and wind combined
  - Reflectivity only
  - The lowest elevation is excluded for all radar data

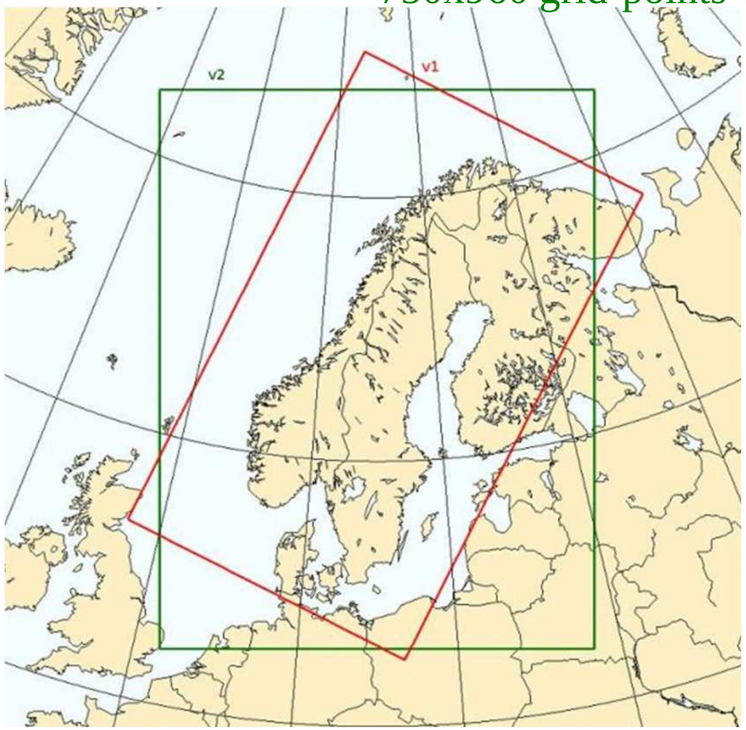
- Swedish radar data
  - Wind and reflectivity from all radars
  - Quality controlled using BALTRAD toolbox
  - Quality information translated into MF-flag values (used by the model)

- Norwegian radar data
  - Wind and reflectivity from most radars. Not all
  - Quality controlled using the PRORAD library
  - QC-flags are translated into MF-flag values (used by the model)
  - Data is thinned to the same resolution as the Swedish data before reading – further thinning is done in the model

Assimilation experiments at SMHI: Results

- Experiment setup
  - Run over the MetCoOp-area, 2.5 km resolution, 65 vertical levels
  - A two week period in August 2011
  - 3 hour cycling (RUC)
  - 30 hour forecasts at 00, 06, 12 and 18
  - Conventional observations included in all runs, no satellite data

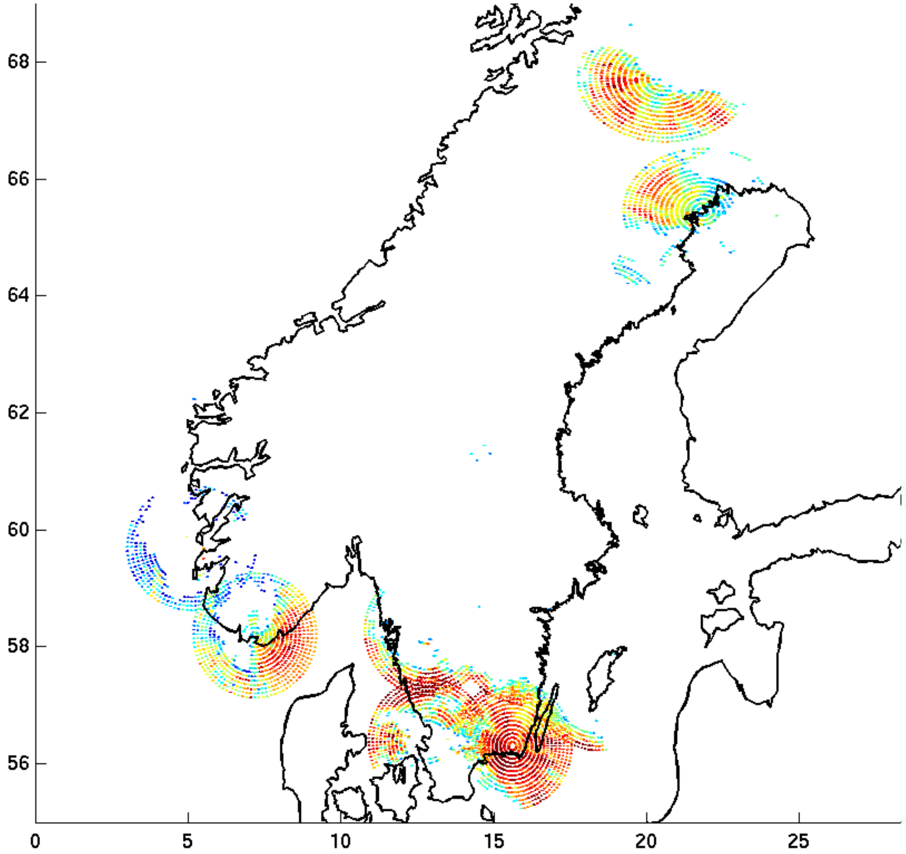
750x960 grid-points



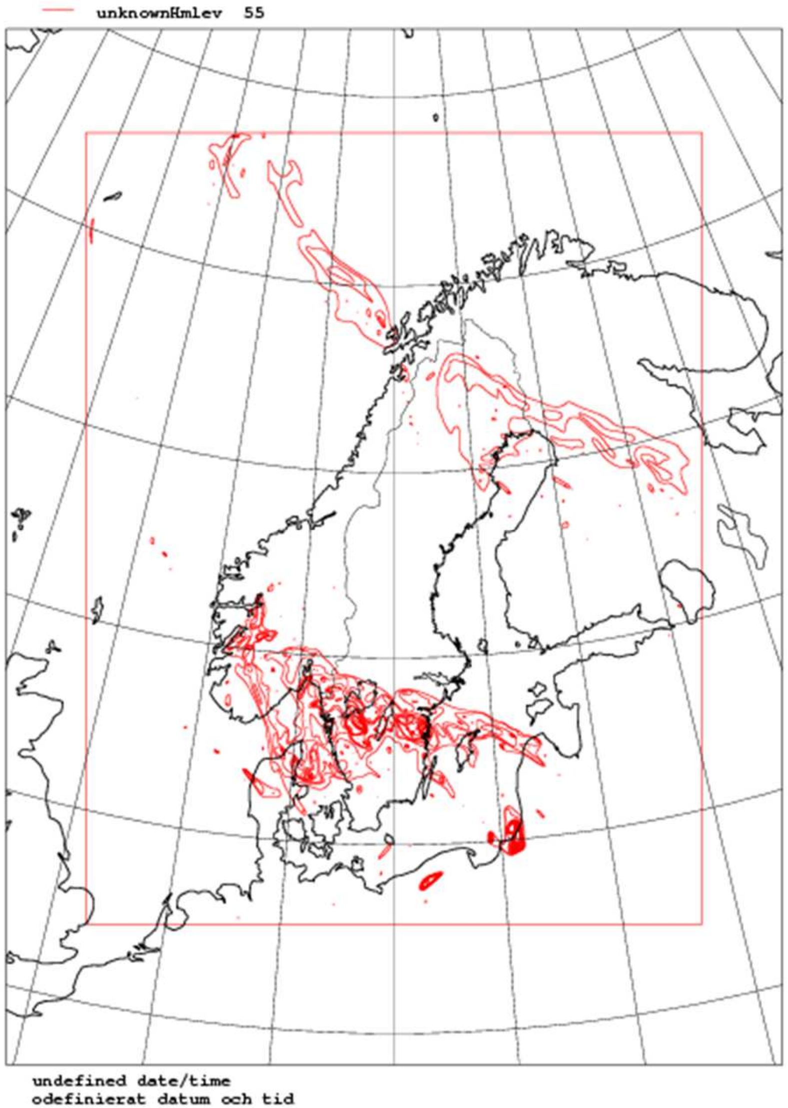
- Verification
  - Using the verification package in HARMONIE
  - Only for the “reflectivity only” runs

- Example from 20110819_06

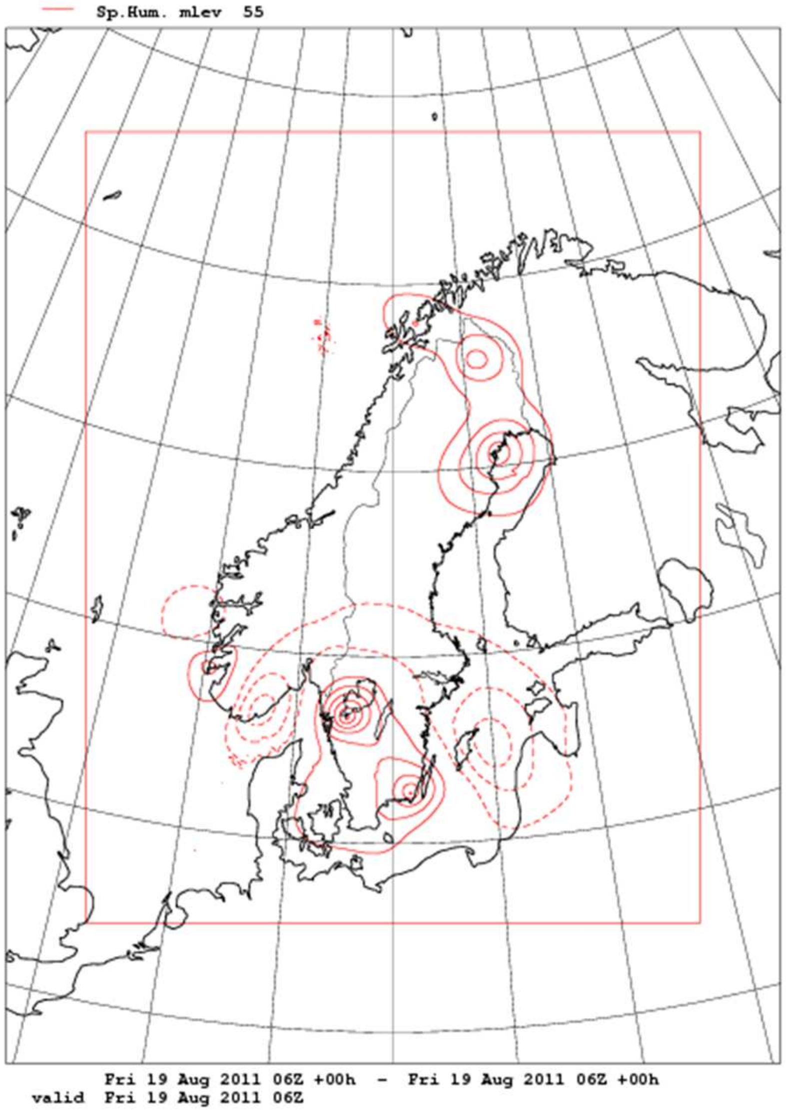
Observed reflectivity



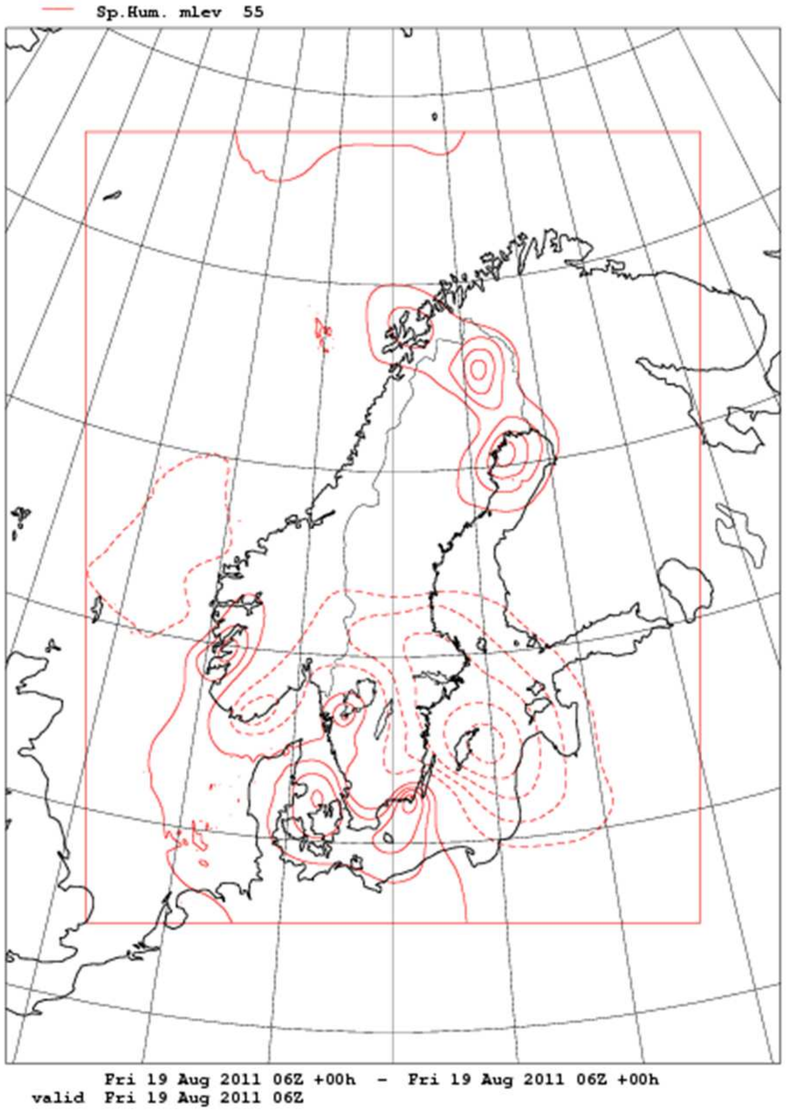
Model precipitation

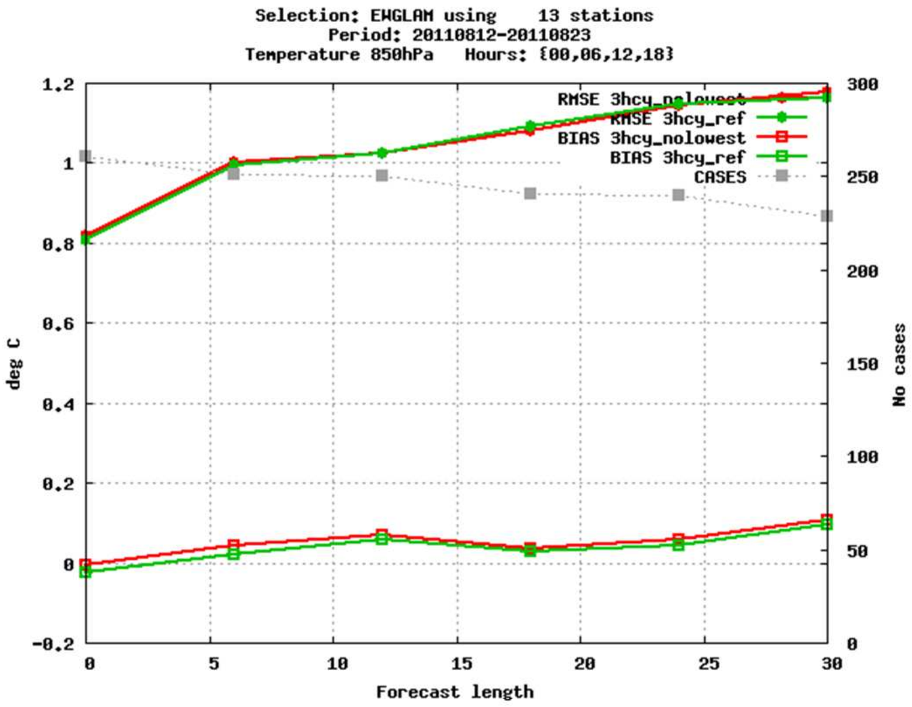


Impact on the analysis: An(dbz)-An(ref)



Impact on the analysis: An(vr&dbz)-An(ref)

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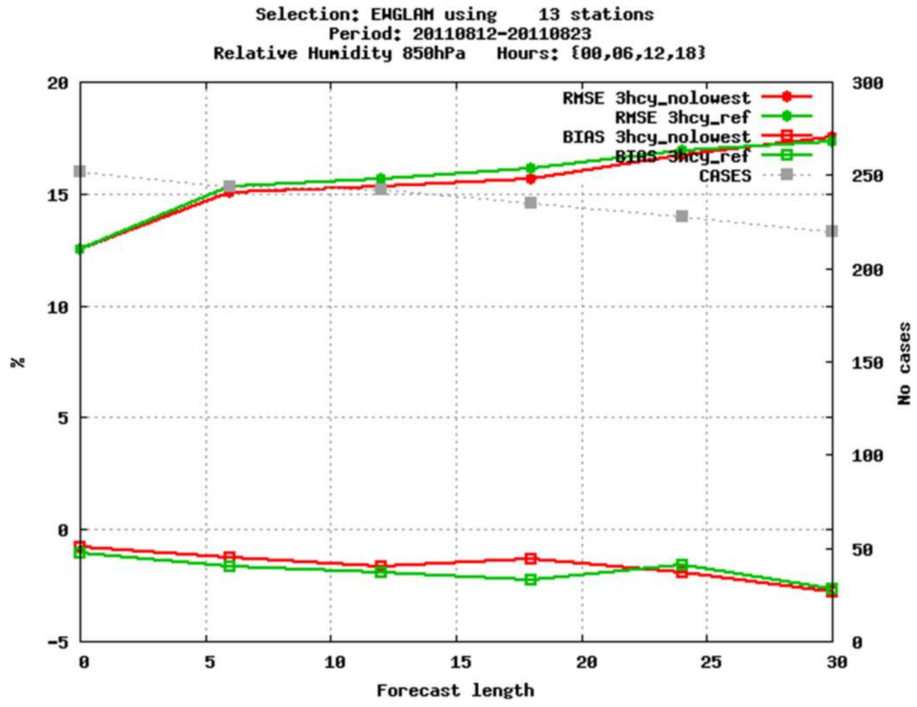
Period: 20110812-20110823
Temperature 850hPa Hours: {00,06,12,18}
RMSE 3hcy_nolowest
RMSE 3hcy_ref
BIAS 3hcy_nolowest
BIAS 3hcy_ref
CASES
deg C
No cases
Forecast length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Relative Humidity 850hPa Hours: {00,06,12,18}
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CASES
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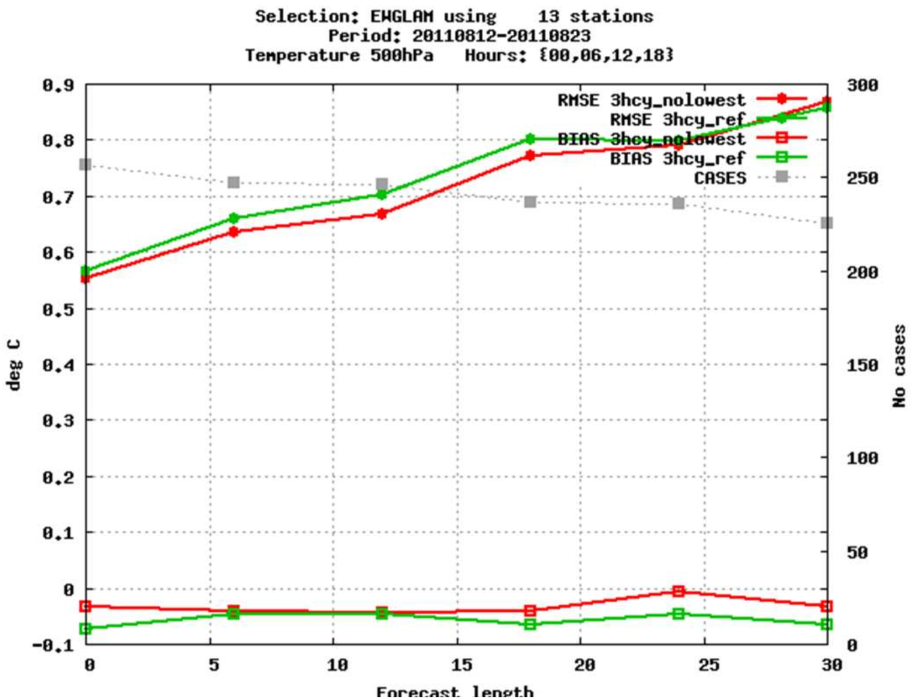
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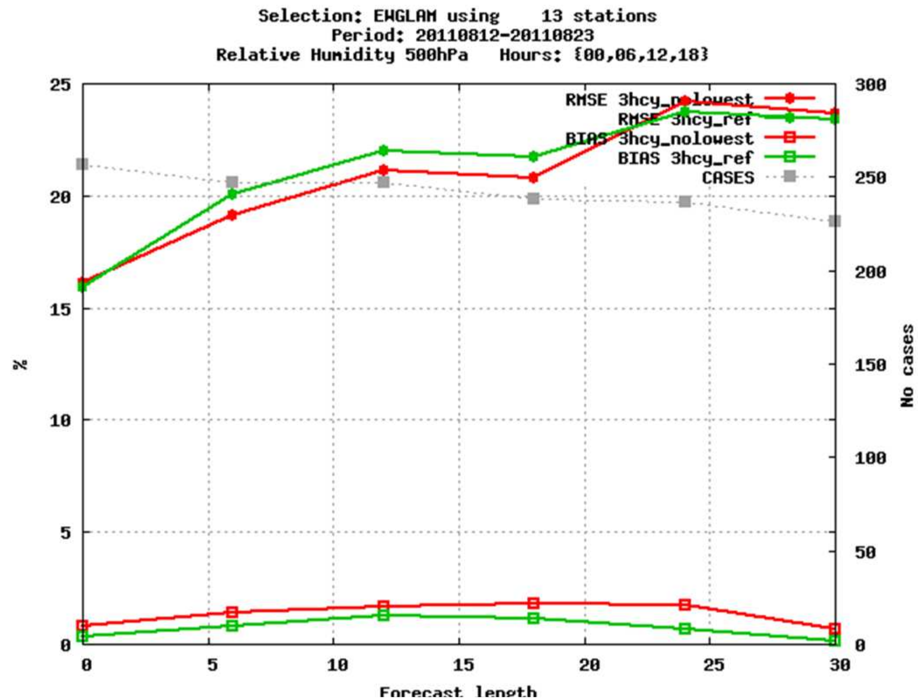
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%
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Summary and conclusions

- Radar observations adds, in most cases, positive impact
  - Requires frequent updating
- We want to assimilate both “wet” and “dry” observations
- Quality control is very important – we need to know what we assimilate
  - Which observation is corrected and which is not
  - Better to loose some good data than to assimilate bad data
- Using data from many countries is a challenge
  - Format issues
  - Meta data can differ
  - Operational data exchange