

Assimilation of OPERA radar data in HARMONIE

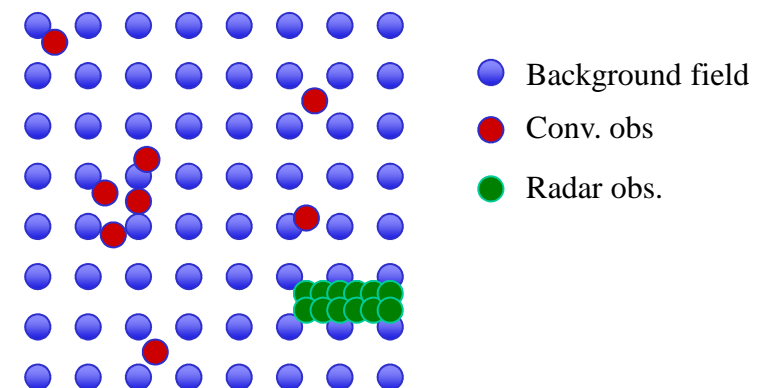
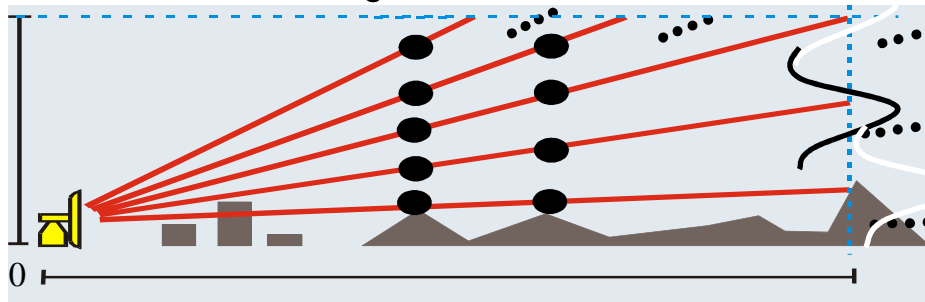
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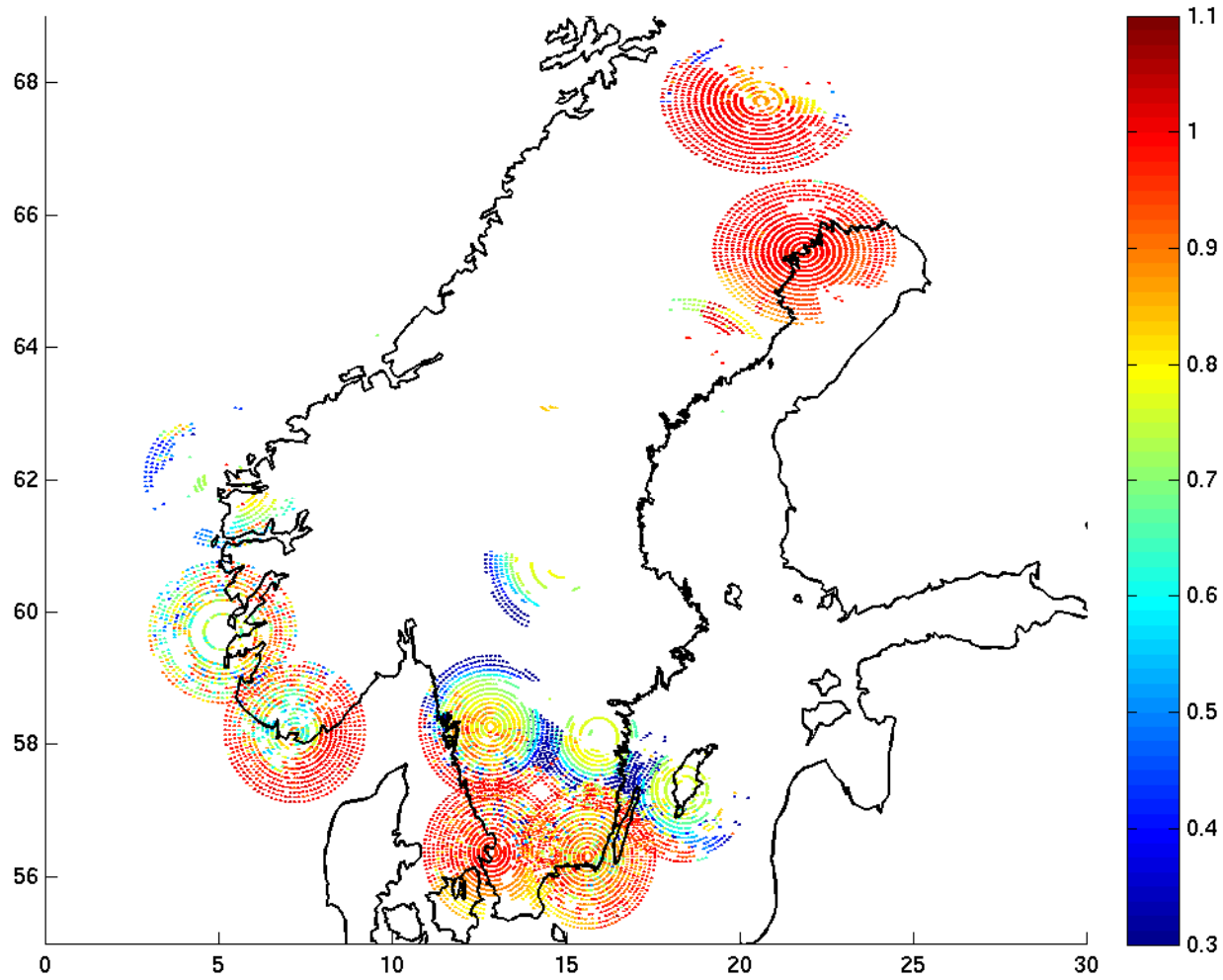


Radar assimilation

- 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

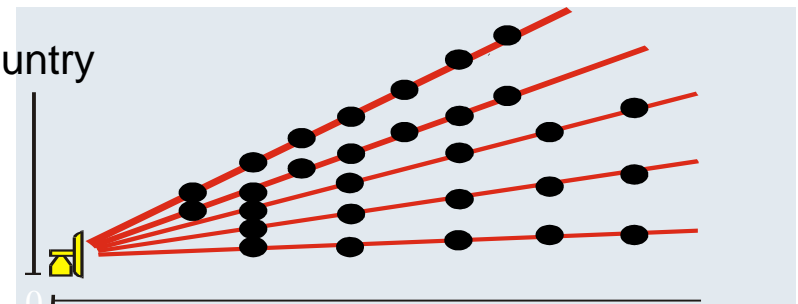


Pseudo observation of humidity



HARMONIE assimilation: Challenges

- Different data formats
 - HDF5, BUFR, internal formats...
 - Many countries are aiming for the OPERA Data Information 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



CONRAD

- Conversion of radar data
 - Converts local formats to MF-BUFR
 - Users need to write their own reader
 - Output is MF-BUFR in polar or Cartesian coordinates

- Disadvantages
 - The person who developed CONRAD at MET-Norway has left
 - Originally an intermediate solution
 - Several dirty tricks to solve some of the challenges
 - Several versions of CONRAD

- Future
 - No further development
 - Currently two versions of polar bator exits – merging will lead to CONRAD changes

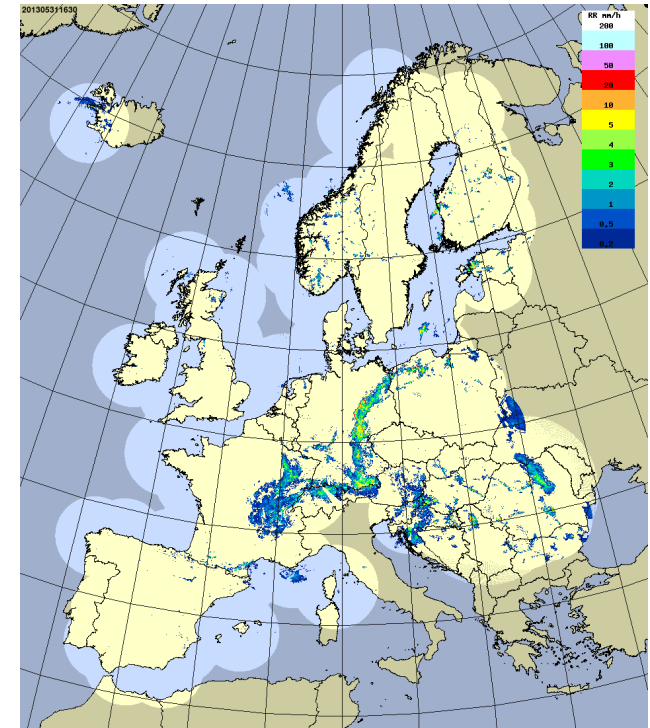
ODIM HDF5

- OPERA
 - Eumetnet programme to collect radar data
 - Produces 2D radar composites
 - No distribution of volume data and no demand of winds
 - NWP usage put new, high demands on the data

- Advantages of ODIM_H5
 - Well defined
 - Well documented
 - Most countries deliver data in ODIM_H5 to OPERA
 - The output format from the BALTRAD toolbox (QC)

- Local differences (errors)
 - Wrong naming, unit errors, missing parameters...
 - Not detected since there has been no such advanced usage earlier
 - The use of “undetected” and “nodata”

- Delivery of volumes or scans
 - The model expects volumes
 - Can cause differences when the scans are put together to a volume



HARMONIE assimilation: Where are we?

- Input data format
 - A conversion tool is available (local format → MF-BUFR)
 - A reader for ODIM_H5 is available
 - We can handle (most?) local differences regarding volume sizes, scan strategies...

- Assimilation experiments
 - Impact experiments performed at SMHI, MET-Norway, KNMI
 - Technical experiments performed at DMI including data from several countries (Denmark, Sweden, Norway, Finland and Poland)
 - A working version at ECMWF
 - Work started to include radar data in HARMONIE 4D-Var

- Radar data exchange
 - An operational data exchange between HIRLAM countries is established
 - Uses the BALTRAD servers with data sent in to OPERA
 - Quality controlled with the BALTRAD toolbox before made available

Assimilation experiments at SMHI: Input data

- Swedish radar data
 - 12 radars
 - Wind and reflectivity in the same HDF5 file
 - Quality controlled using BALTRAD toolbox, including de-aliasing
 - Quality information translated into MF-flag values (used by the model)

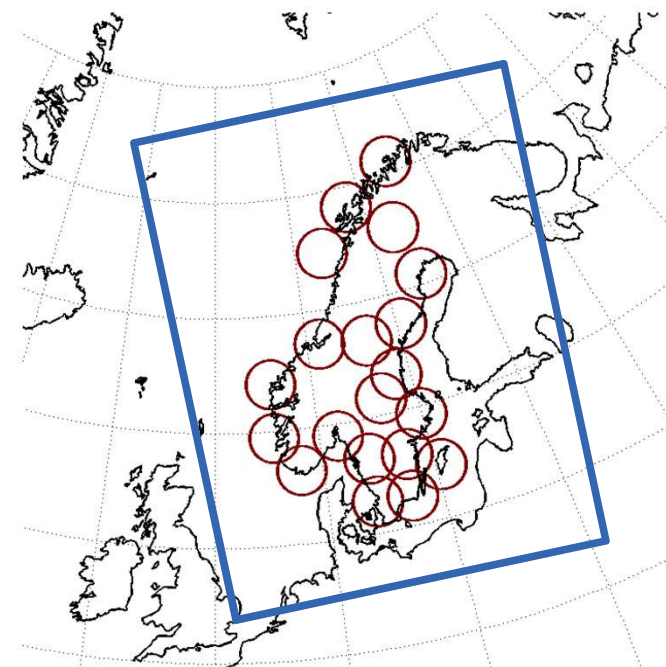
- Norwegian radar data
 - 8 radars, 3 with fewer scans (currently 9 and one more coming)
 - Wind and reflectivity in different files (different measurement configuration)
 - Data files are converted to MF-BUFR using CONRAD
 - Quality controlled using the PRORAD library
 - QC-flags are translated into 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

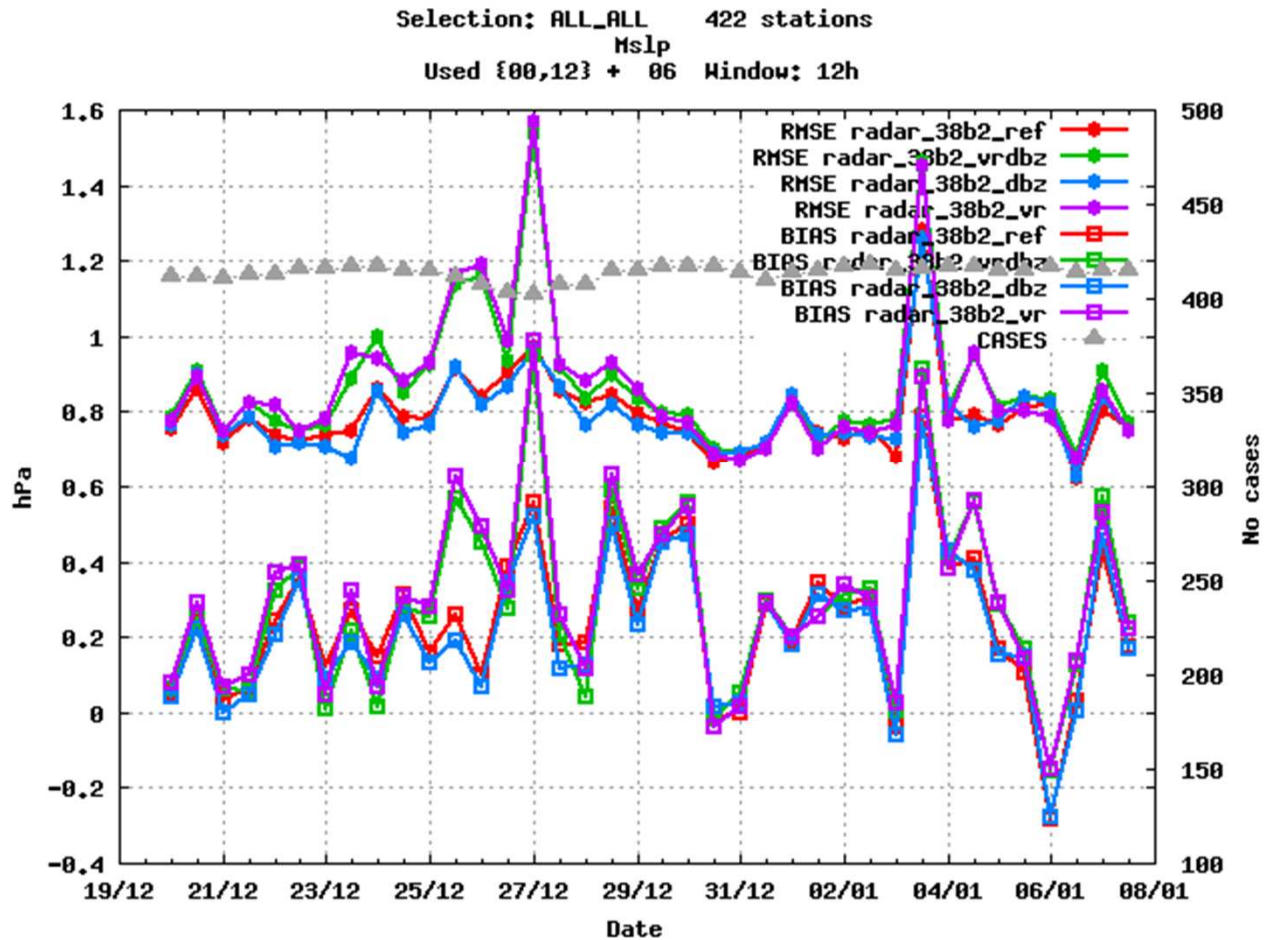
- Experiment setup
 - Run over the MetCoOp-area, 2.5 km resolution, 65 vertical levels
 - Two week period in August 2011 and three week period in December/January 2011/2012
 - 3 hour cycling
 - 30 hour forecasts at 00, 06, 12 and 18
 - Conventional observations included in all runs, no satellite data
 - The lowest elevation excluded for all radar data

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

750x960 grid-points

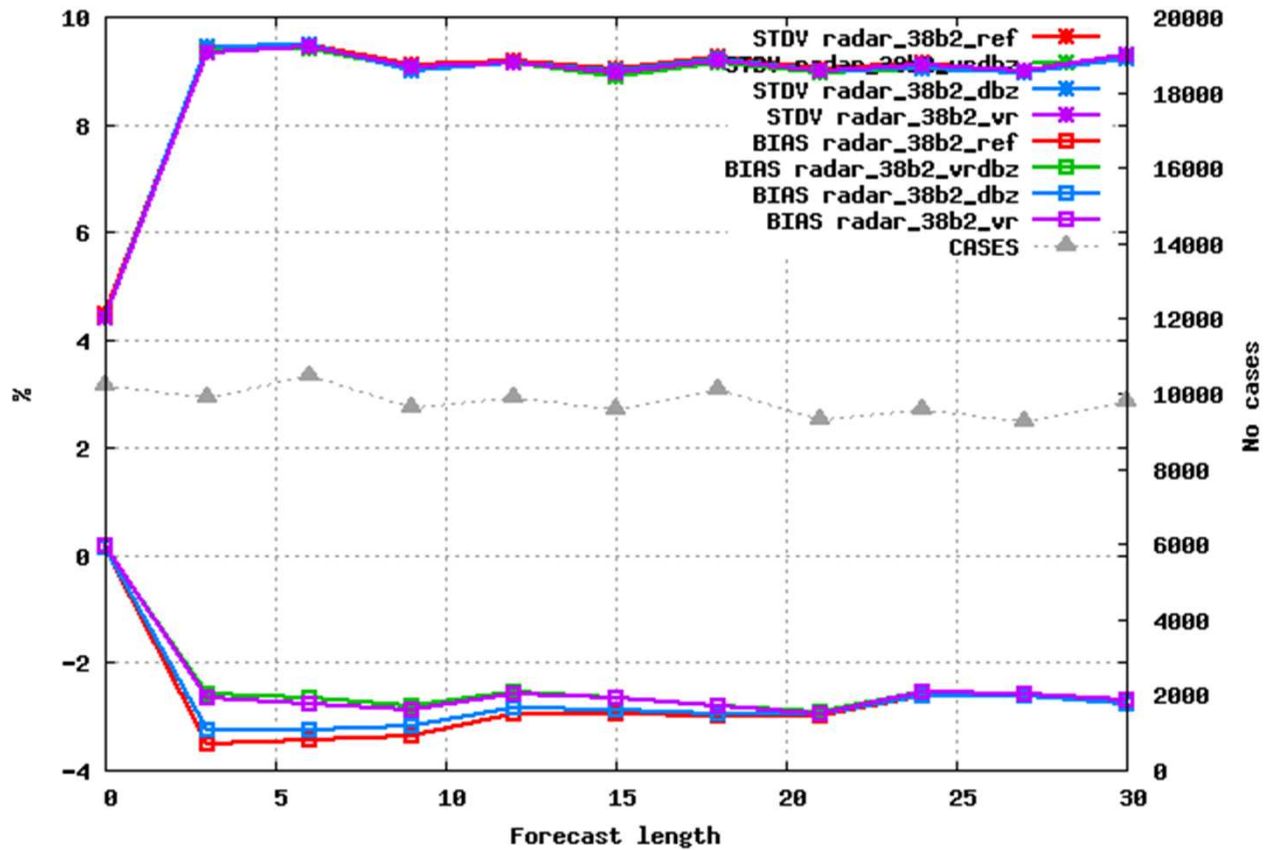


Time series of surface pressure

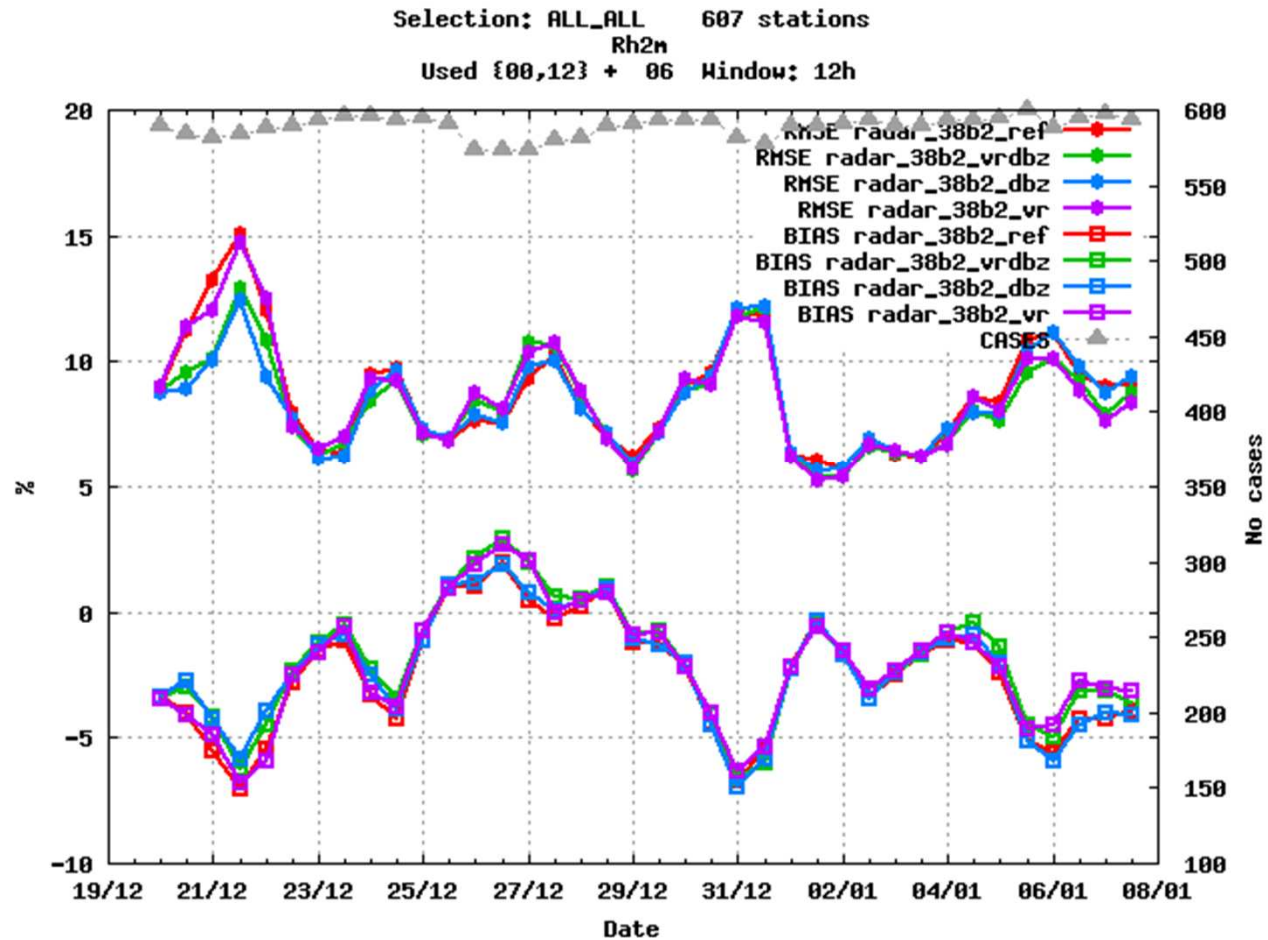


Relative humidity

Selection: METCOOP_ALL using 341 stations
Period: 20111223-20120107
Rh2m Hours: {00,12}



Time series RH



Significans test, RH

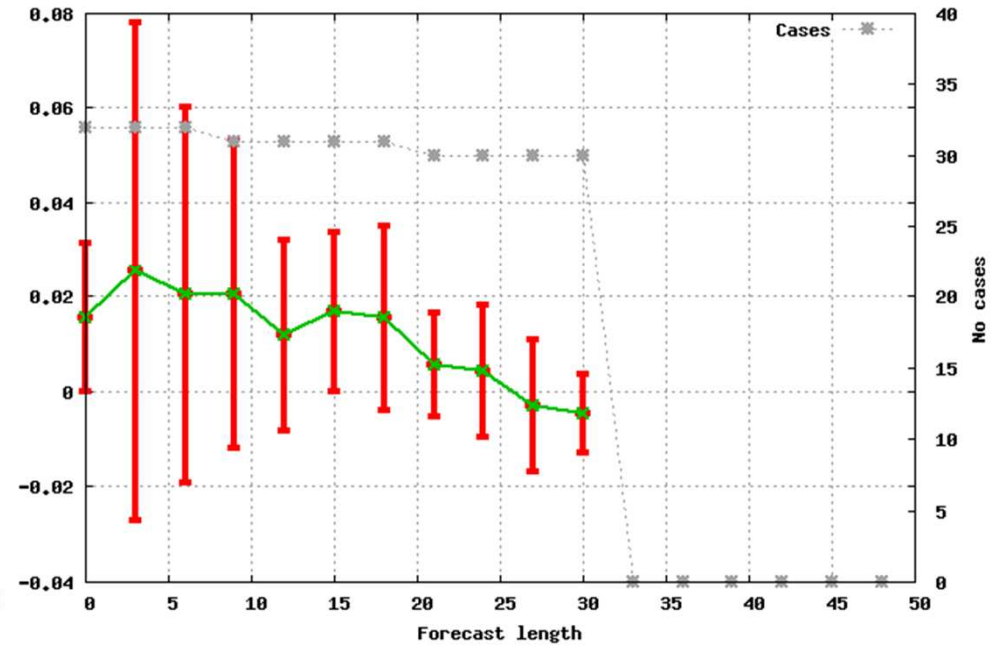
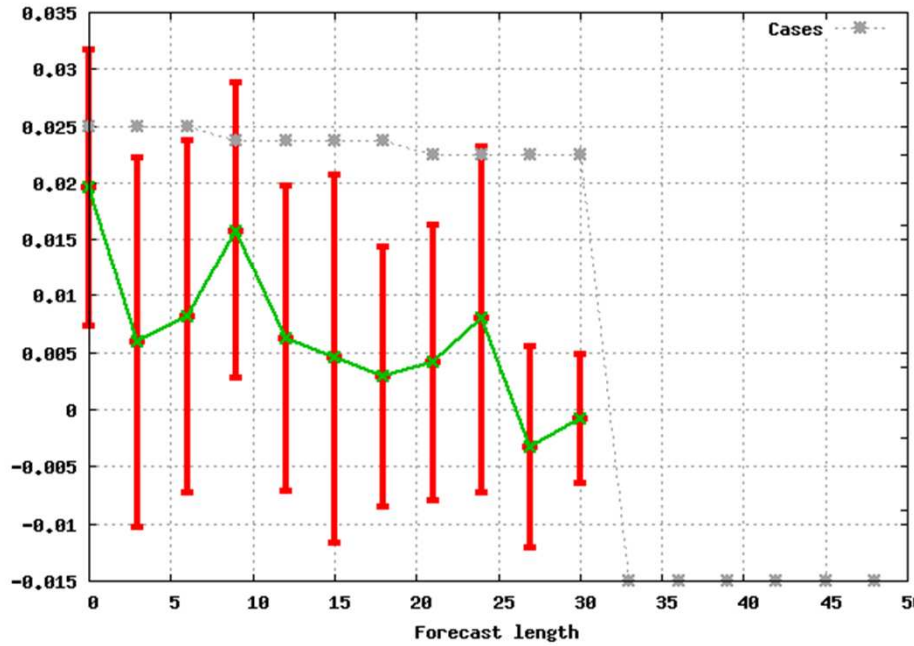


Ref-dbz

Ref-vr

Normalized mean RMSE diff (90% conf) radar_38b2_ref - radar_38b2_dbz
Selection: METCOOP_ALL using 341 stations
Period: 20111223-20120107
Rh2m Hours: {00,12}

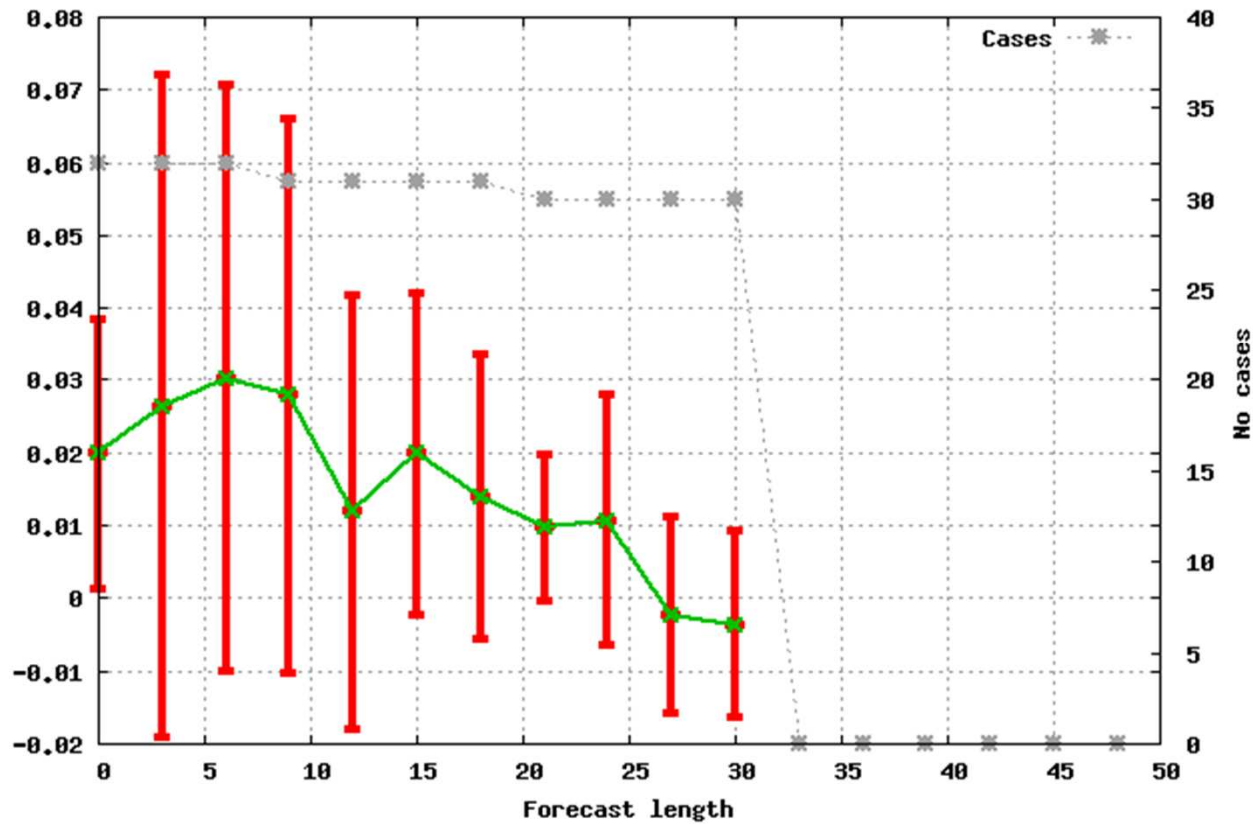
Normalized mean RMSE diff (90% conf) radar_38b2_ref - radar_38b2_vr
Selection: METCOOP_ALL using 341 stations
Period: 20111223-20120107
Rh2m Hours: {00,12}



Significans test, RH

Ref-vrdbz

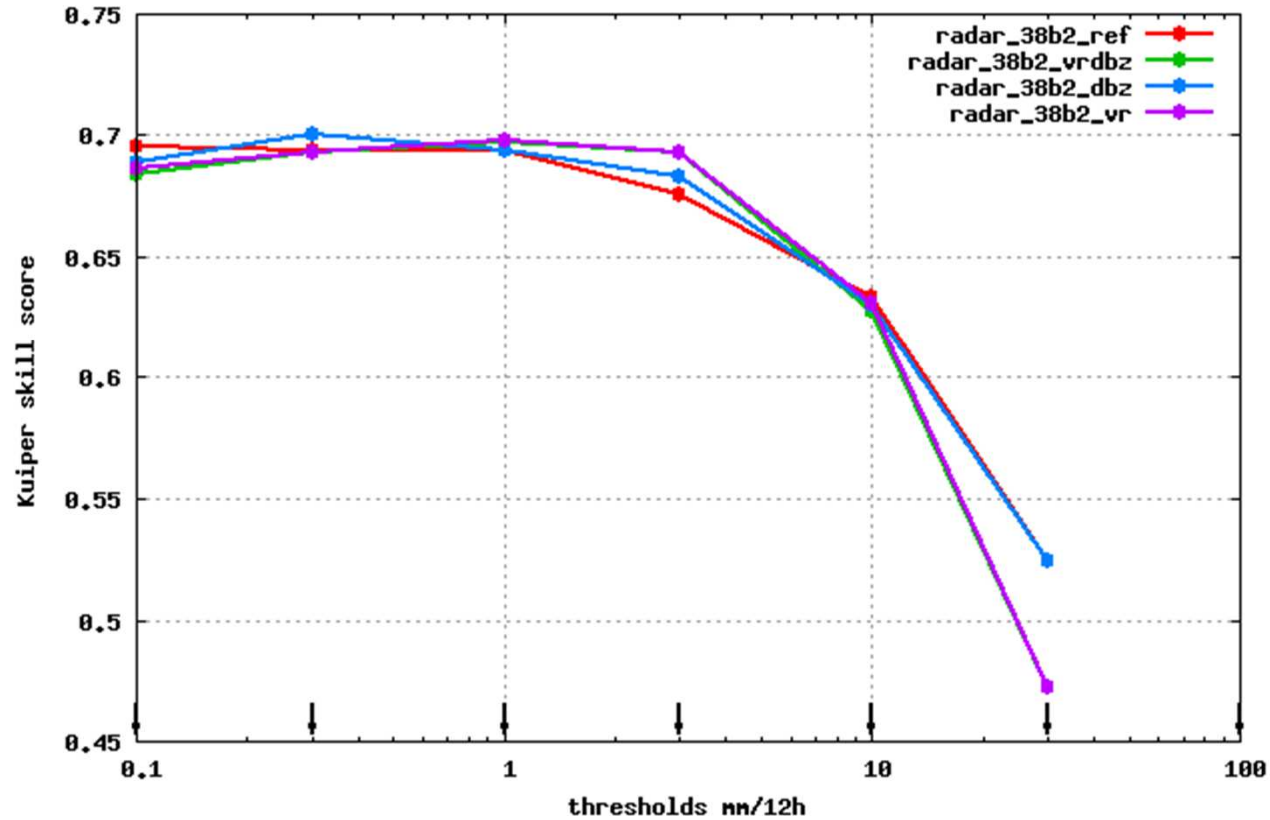
Normalized mean RMSE diff (90% conf) radar_38b2_ref - radar_38b2_vrdbz
Selection: METCOOP_ALL using 341 stations
Period: 20111223-20120107
Rh2m Hours: {00,12}



Kuiper Skill Score, precipitation

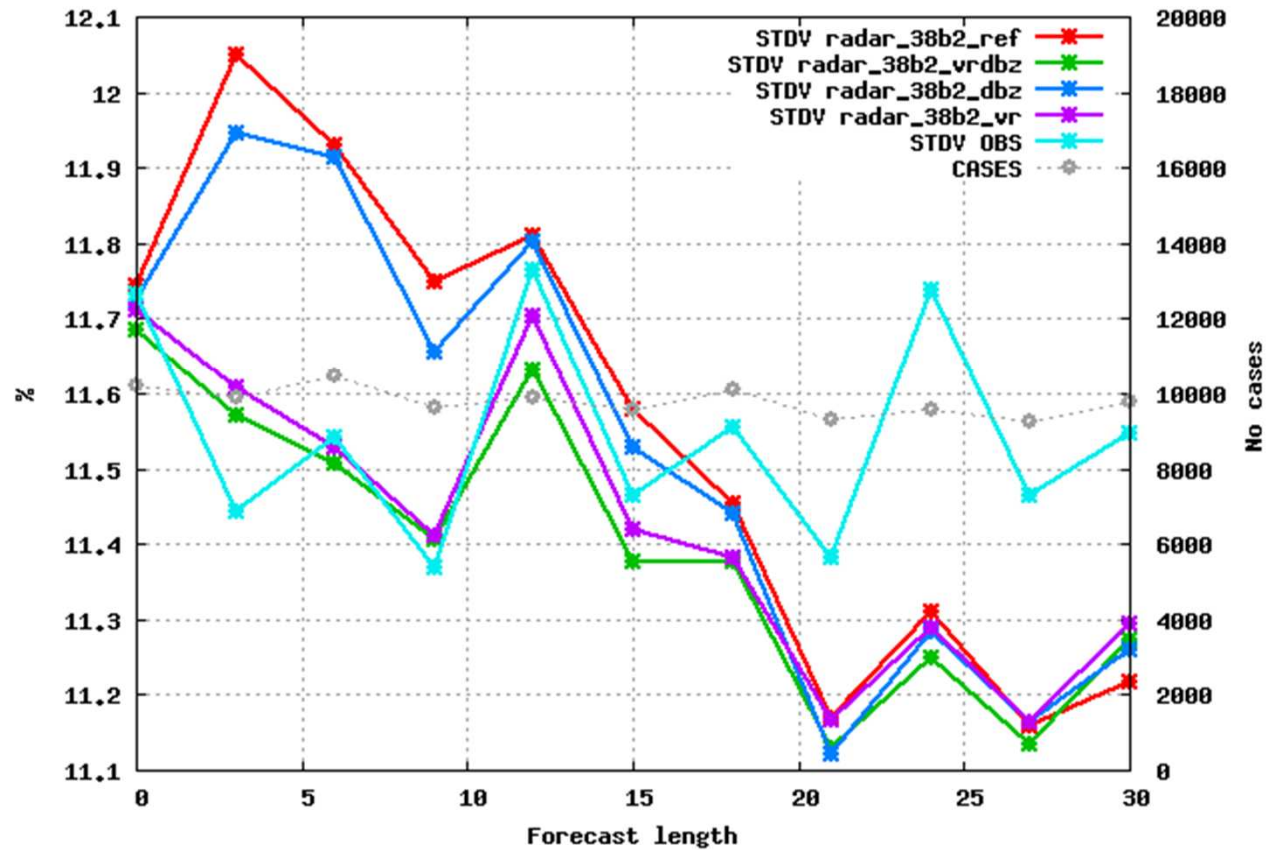
SMHI

Kuiper skill score for Precipitation (mm/12h)
Selection: METCOOP_ALL 260 stations
Period: 20111223-20120107
Used {00,12} + 18- 06 30- 18



Variability, RH

Selection: METCOOP_ALL using 341 stations
Period: 20111223-20120107
Rh2m Hours: {00,12}



Summary and conclusions

- Using data from many countries is a challenge
 - Format issues
 - Meta data can differ
 - Operational data exchange

- OPERA data
 - All countries deliver the same set of parameters in the same format
 - A real time data exchange has been set up through BALTRAD
 - The model can read ODIM_H5 data in parallel to MF-BUFR

- 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

- Radar observations adds, in most cases, positive impact
 - Some problems with the wind data
 - Could be due to small observation error combined with broad structure functions
 - Requires frequent updating

MetCoOp

- Cooperation between Sweden and Norway to deliver operational forecasts
 - Common domain and model
 - Share computer resources
 - Operational 18 March 2014

- Radar data
 - Radar data will be included in passive mode ASAP
 - Swedish and Norwegian data (to start with)
 - Monitoring
 - Fully operational before the summer (hopefully!)