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Assimilation of OPERA radar data in HARMONIE: A new pre-processing and data reduction

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Outline

Background – why do we do this?

New data reduction – better thinning and super observation construction

Elevation separation check

First results with the new preprocessing

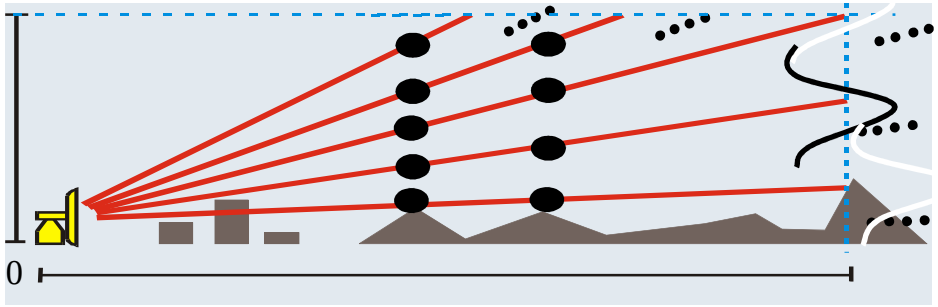
Summary/conclusions

Background – pre-processing

- The OPERA data sets
  - Several data producers
  - Not completely the same contents
  - Missing fields, unit errors, wrong naming of fields…

- Elevation overlap
  - Strong probability of hitting the ground
  - Correlated observations

- New solution
  - Elevation check
  - Removal of overlapping and very low elevations
  - Correct identified units, namings and fill in standard (or known) values if missing

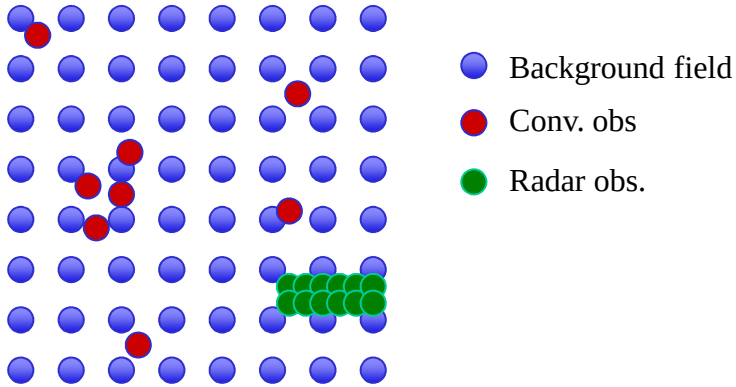


Background – data reduction

- A high resolution dataset
  - Model can't resolve the full resolution
  - The computers can't handle the full amount of data

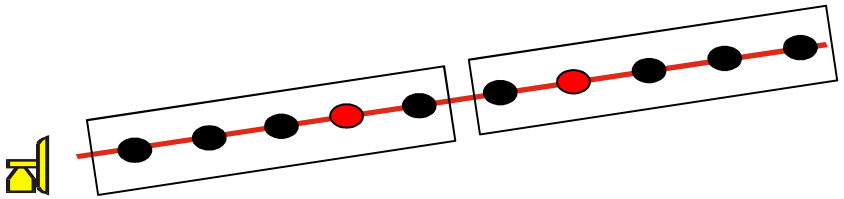
- Current solution
  - Thinning is made in three places in the code
  - A "blind" pixel hopping in the first two
  - Not optimal for polar coordinates

- New solution to replace the first two thinning steps
  - Super observation
  - Intelligent thinning



”Intelligent” thinning

- Separation boxes are defined
  - For each elevation
  - Could also be done in azimuth direction
- Choice of observation point
  - Lowest probability of anomaly, i.e. best quality (from QC)
  - Strongest reflectivity value
- Pros and cons
  - We know that we get a good observation (the selection is not “blind”)
  - The chosen observations can end up very close to eachother

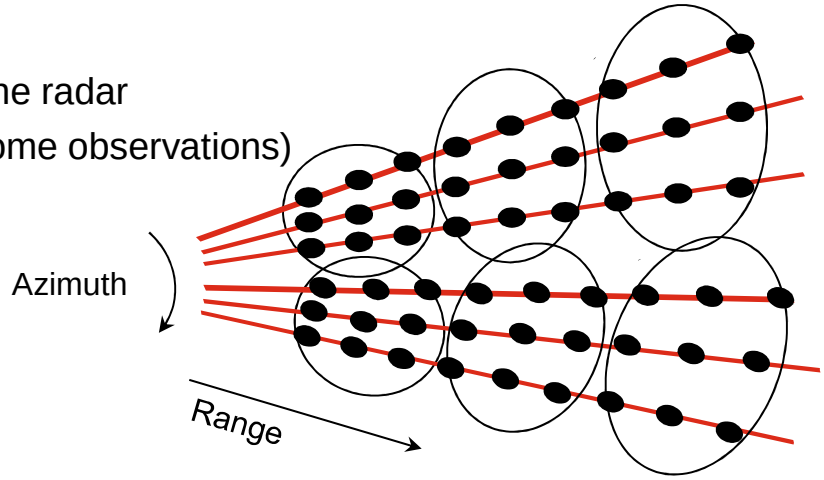


Super observations

- Separation boxes are defined
  - For each elevation
  - Both in azimuth (degrees) and range direction (metres)

- Choice of observation points to include
  - Observations of good quality and above noise threshold
  - At least 30% (more or less?) precipitation in order to be classified as rainy
  - If not it is regarded as clear unless all observations are of poor quality

- Pros and cons
  - We use all the information in the observations
  - The size of the SO increases with distance from the radar
  - It can easily be limited in size (but then we lose some observations)



Example, 20140829_18, Copenhagen (Stevns)

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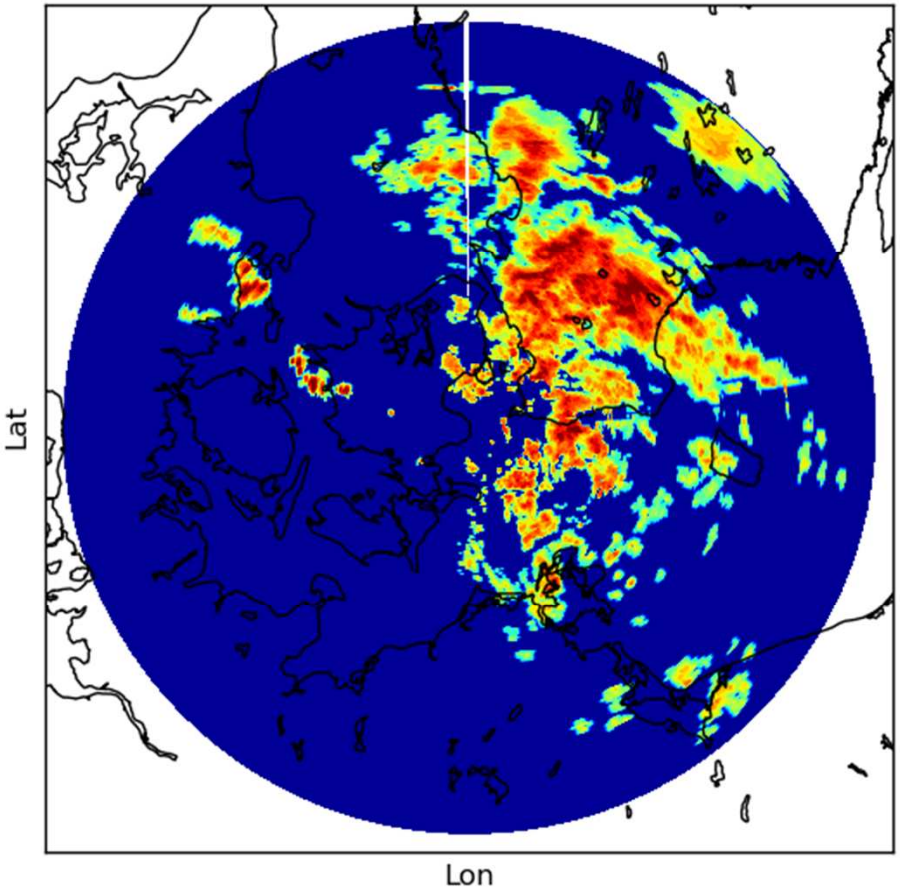
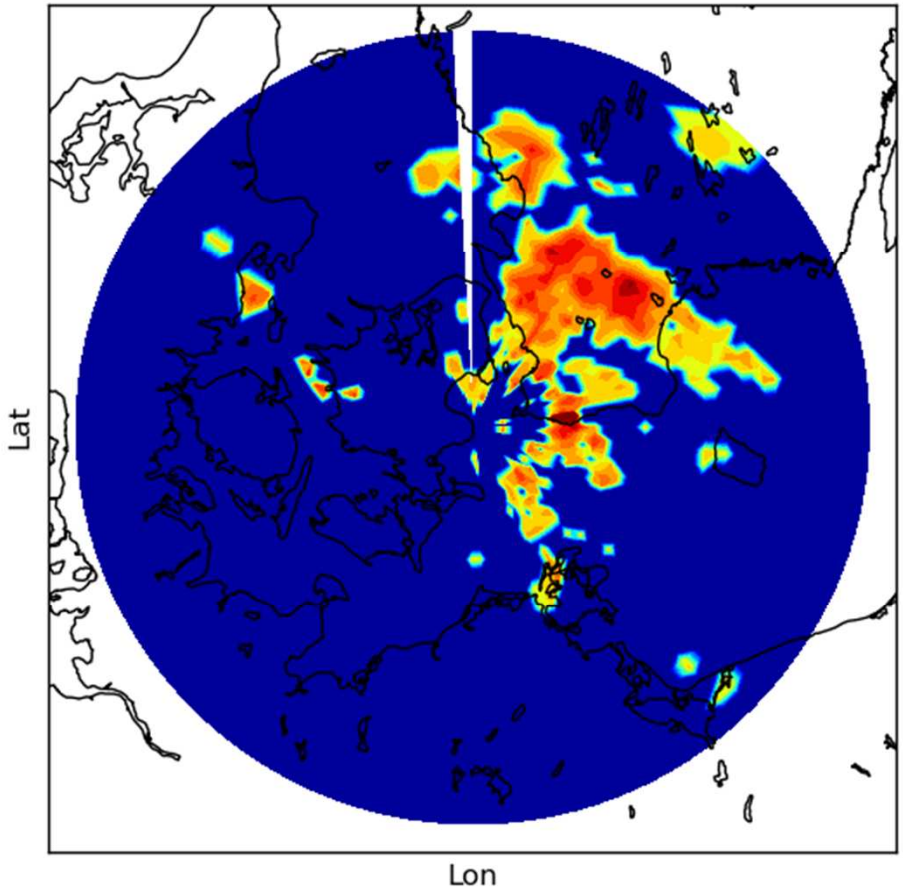
Original data



Super observations



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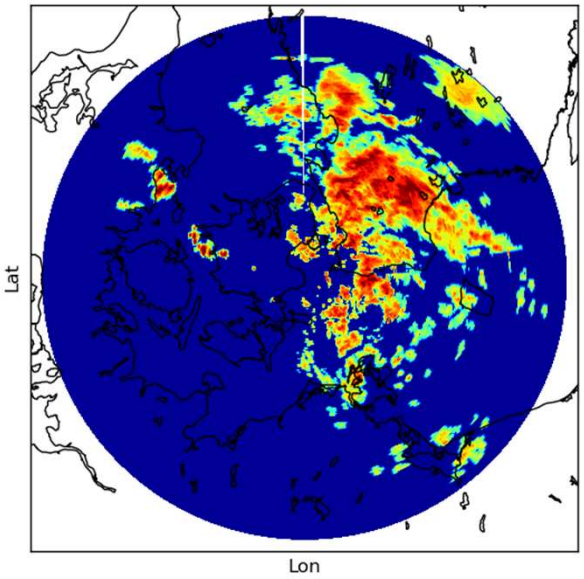
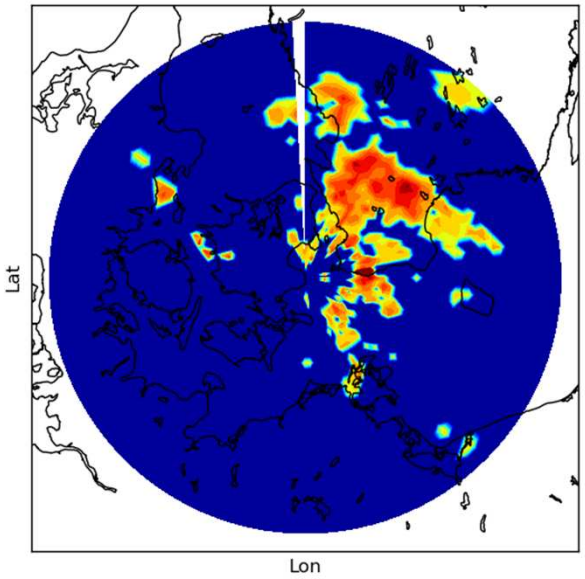
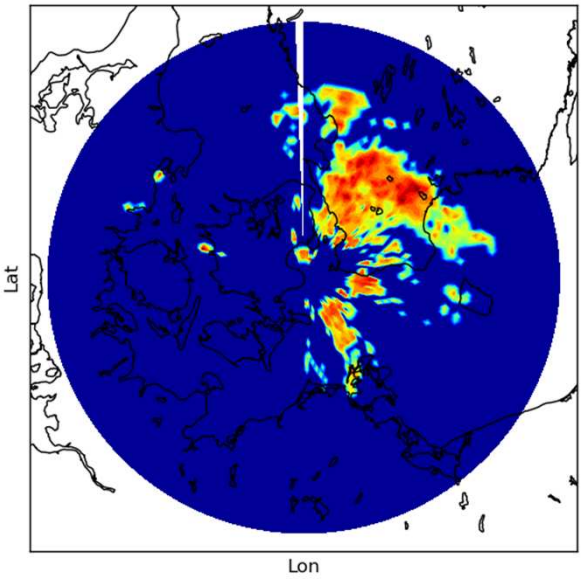


Super observations



Intelligent thinning



The quality information

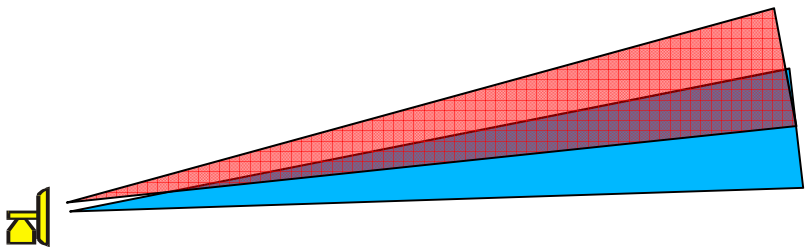
- The model only uses three indicators
  - Rain (precipitation)
  - Clear sky
  - Don’t use

- Thinning
  - Observed values and quality indicators are kept

- Super observations
  - Already quality checked in the construction
  - Rainy SO: Arbitrary value below acceptance threshold
  - Clear SO: Arbitrary value below acceptance threshold
  - SO with only bad quality observations: Arbitrary value above acceptance threshold

Elevation overlap check

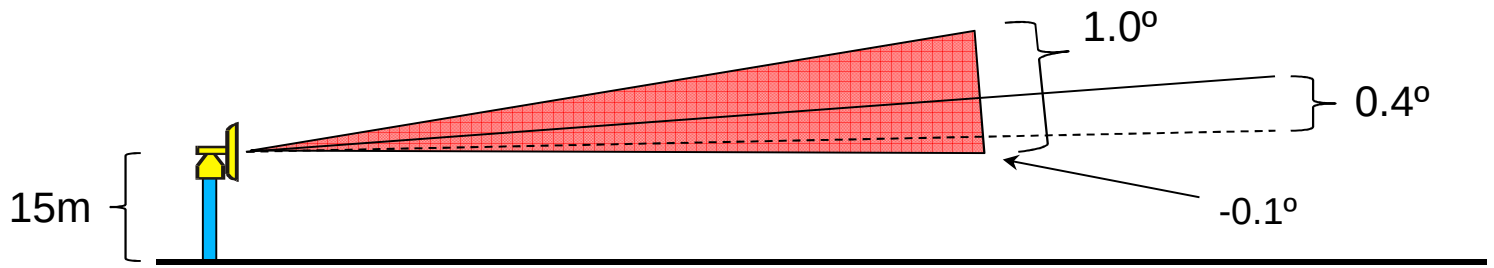
- Elevation separation
  - Elevation scan angles must be separated with at least half of the beamwidth
  - We do not want to use observations from the same air volume twice
- Lowest elevation
  - If it, most probably, will hit the ground it is removed
- Upper elevations
  - If the elevations, most probably, will overlap the lowest is removed



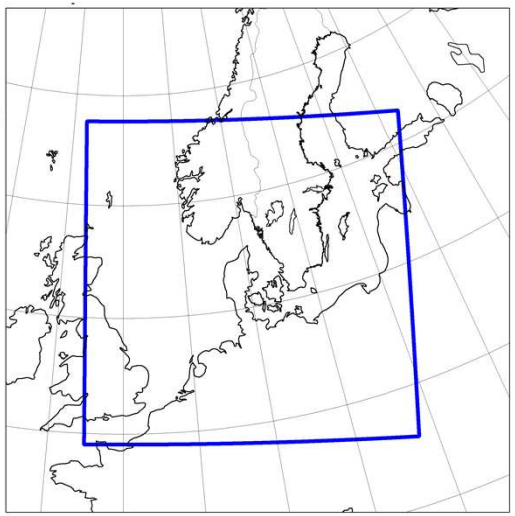
Example

Elevation angle = 0.4º
Beamwidth = 1.0º
Antenna height = 15 m

Will hit the ground after 0.015/tan(0.1*pi/180) = 8.6 km



Experiments



- Domain: DKCOEXP
  - Covers many countries
  - 648x648 grid points, 65 levels, 2.5 km grid space
- Radar data
  - Radar data from 9 countries: Belgium, Germany, Denmark, Estonia, Finland, France, The Netherlands, Norway and Sweden
  - The same data as is sent to OPERA
  - Reflectivity only
  - Quality controlled using the BALTRAD toolbox
- Period: 20140824-31
  - During this period a strong precipitation event hit Copenhagen and Malmö (southern Sweden)
- Three experiments in the examples
  - Baseline – contains no radar data
  - Old thinning – made with the blind pixel hopping method (two times)
  - Superobservations – super observations are created and the elevation check perfomed

Verification examples

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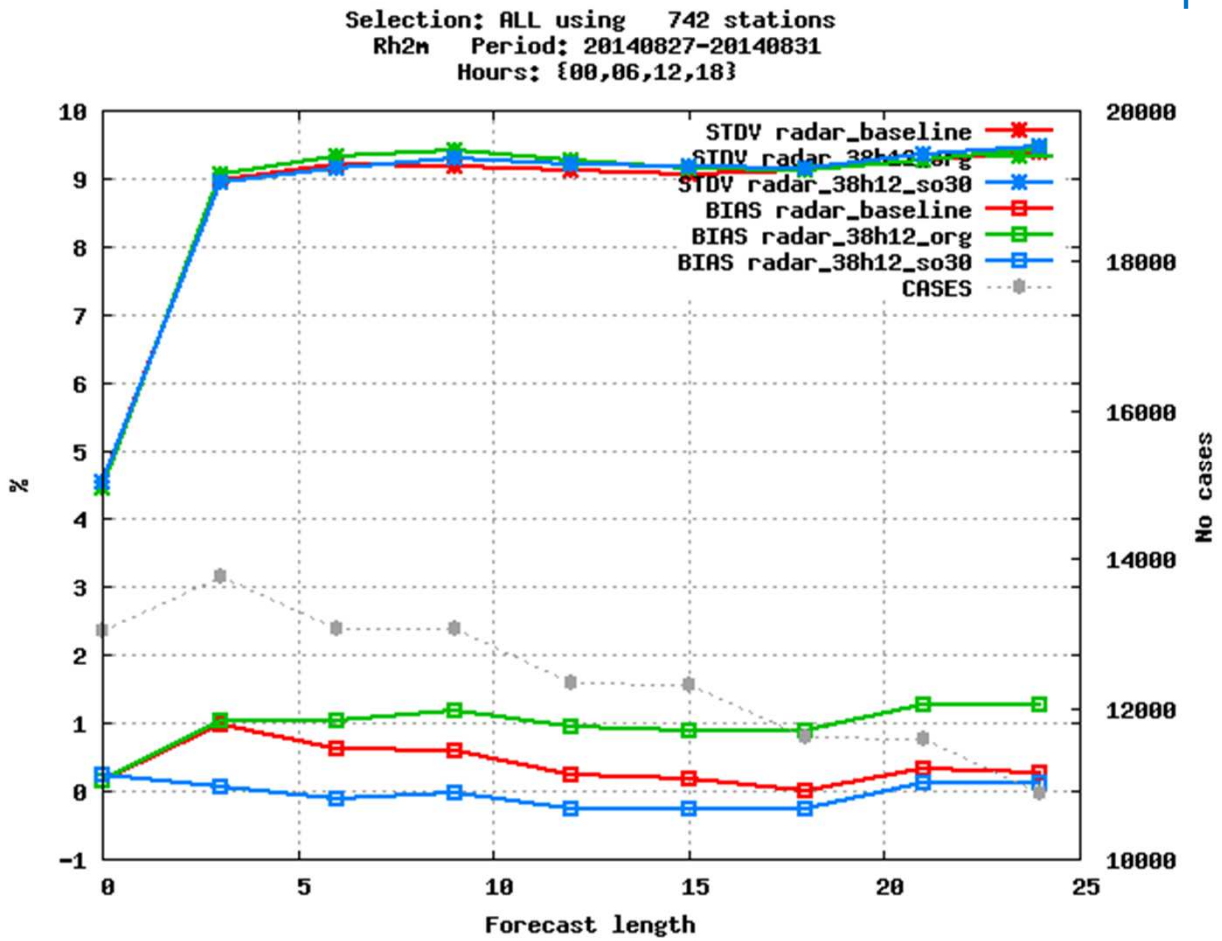
2 m relative humidity

Baseline
Old thinning (blind)
Superobservations



Verification examples

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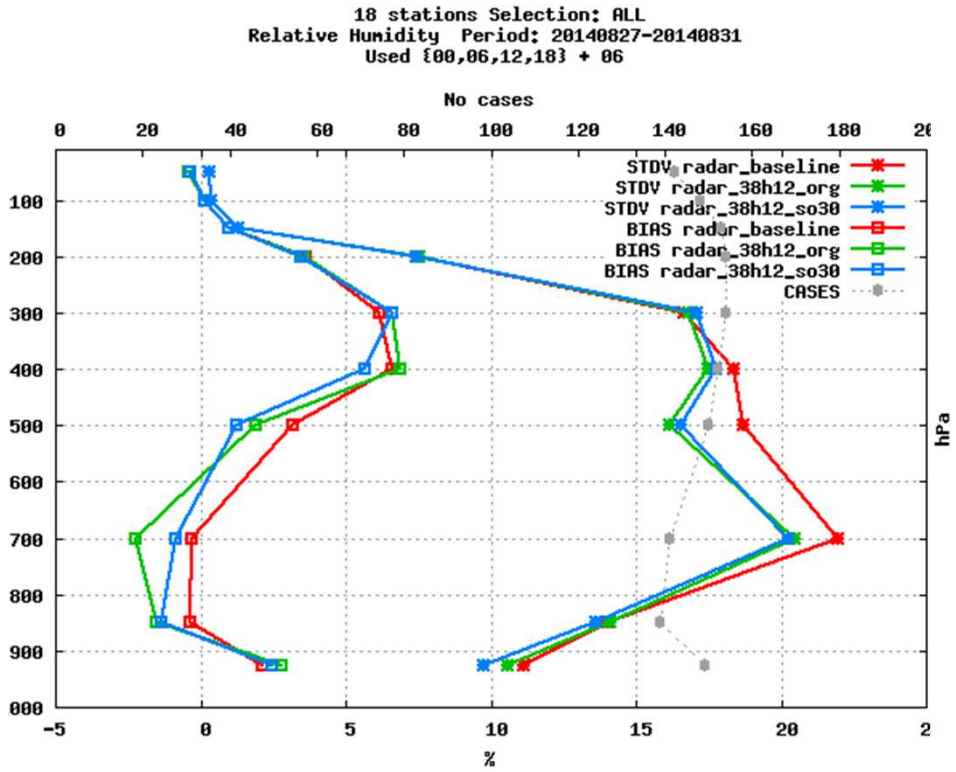
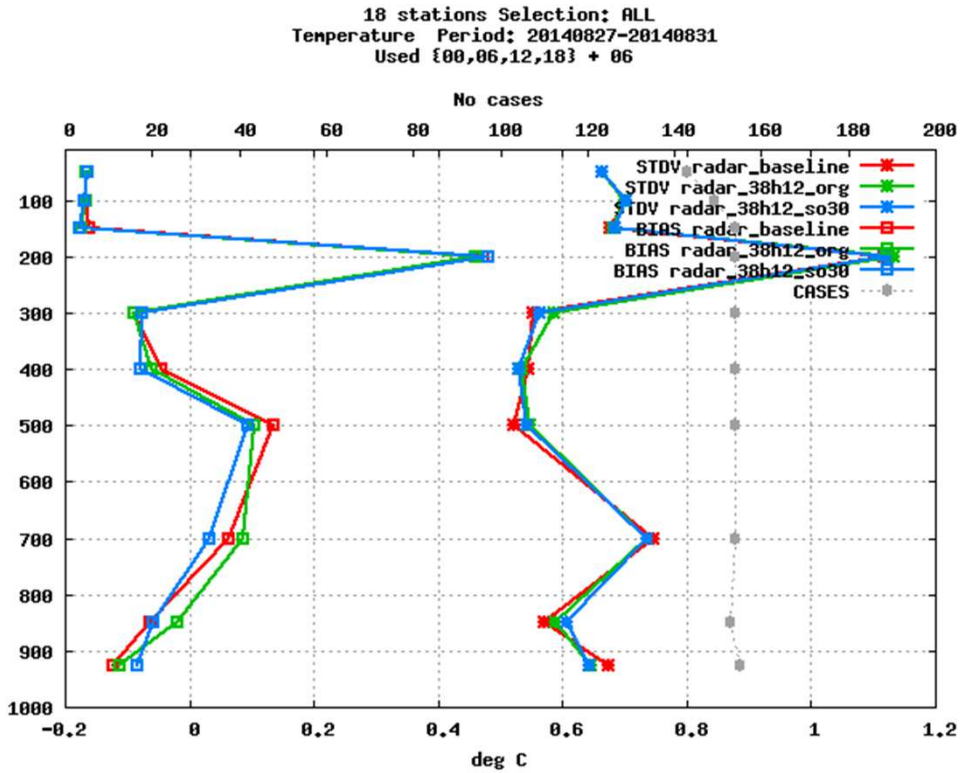
Relative humidity profiles



Temperature profiles



Baseline
Old thinning (blind)
Superobservations

Verification examples

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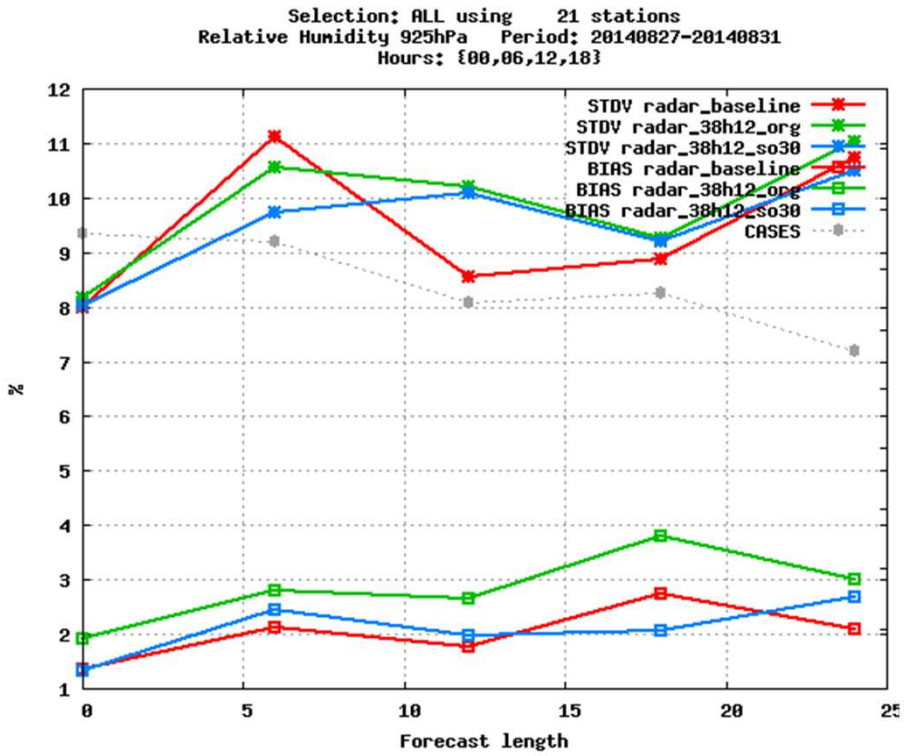
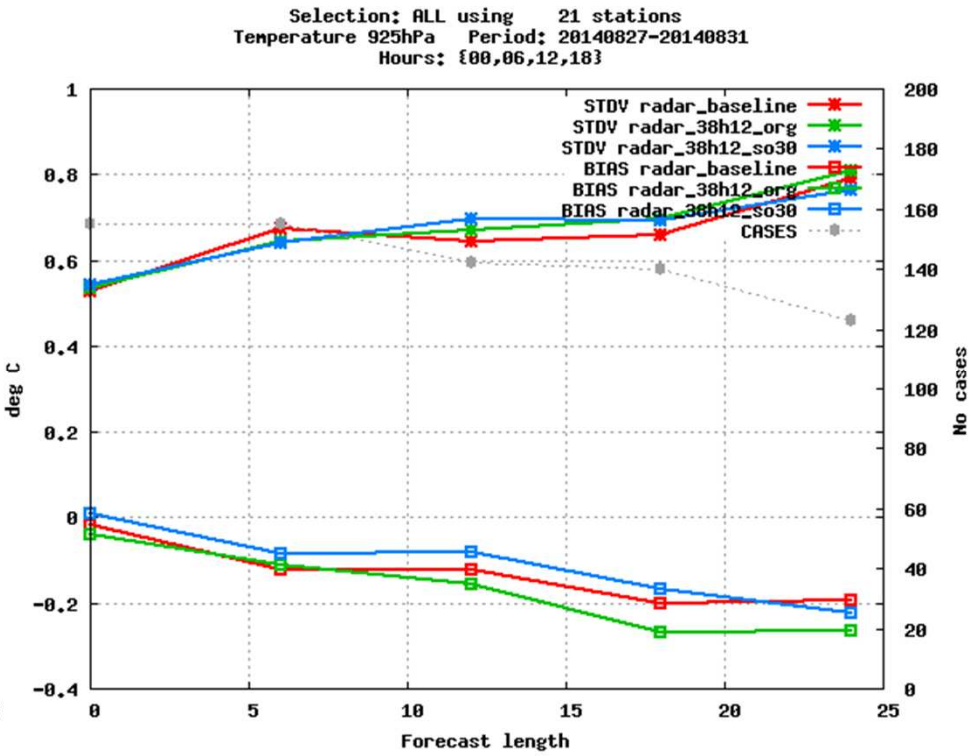
Relative humidity at 925 hPa



Temperature at 925 hPa



Baseline
Old thinning (blind)
Superobservations

Verification examples

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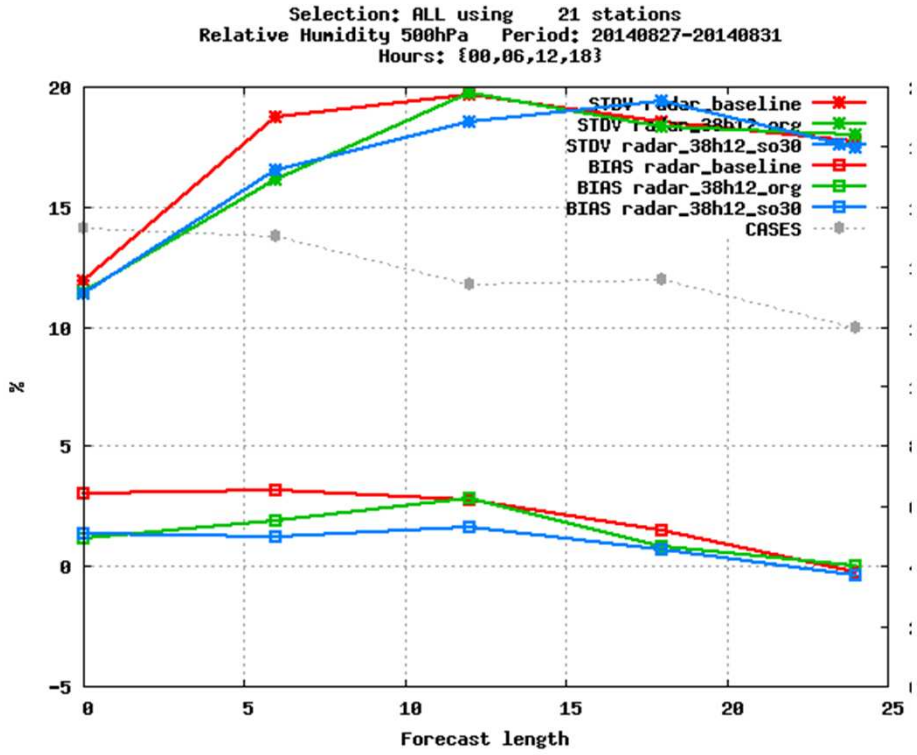
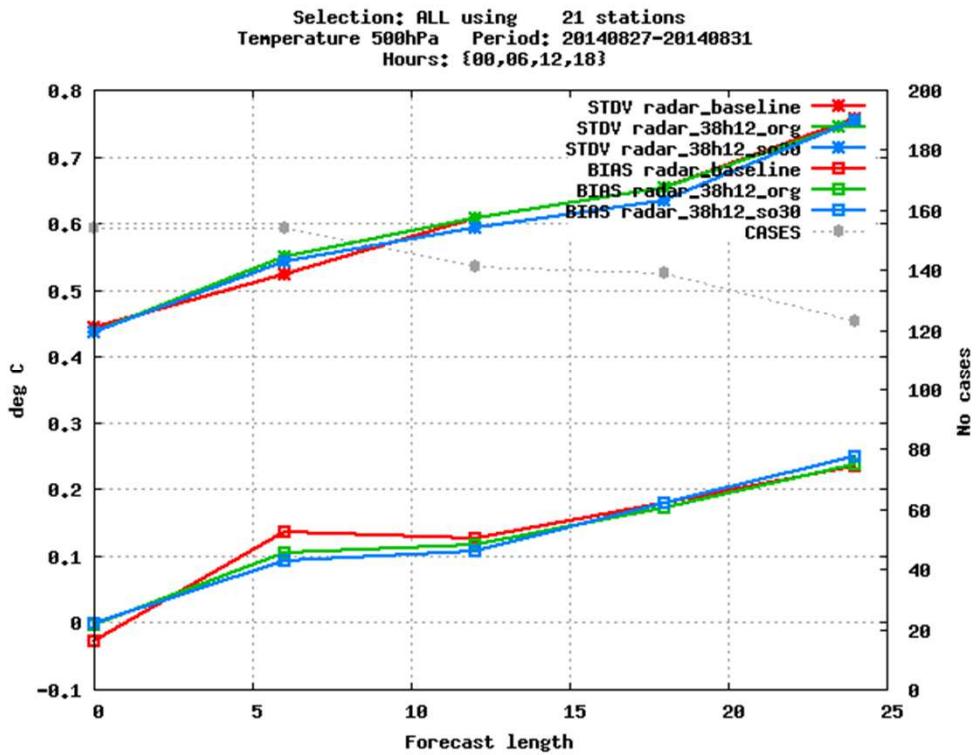
Relative humidity at 500 hPa



Temperature at 500 hPa



Baseline
Old thinning (blind)
Superobservations

Summary and conclusions

- Preprocessing of radar data
  - Data sanity check
  - Clean up bator (HDF5 reader) where many “country specific” things are taken out
  - A check for overlapping or too low elevations is made to avoid observations from the same volume of air
  - Super observation construction or “intelligent” thinning
  - The blind thinning (pixel hopping) is removed from bator (HDF5 reader)

- Impact of super observations and elevation overlap removal
  - In all cases better than the old thinning, especially the bias
  - In almost all cases better or equally good as the baseline experiment

- Next step: Radial winds
  - Needs to be done slightly different since there is no quality information for wind
  - No clear sky to take into account
  - Some problems with the de-aliasing algorithm that need to be handled

This sounds great…

- …what do I need to use this?
  - OPERA data quality controlled using the BALTRAD toolbox (or similar). It will work for data without quality information soon.
  - The preprocessing script (python)
  - A new version of the HDF5 decoder in bator

Contact Martin or Mats