

# Impact of RADAR observations in HARMONIE-AROME

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# Outline

- Introduction
- OPERA radar observations
- Pre-processing
- Assimilation method
- Examples of results



## SRNWP Consortia in Europe



### ALADIN

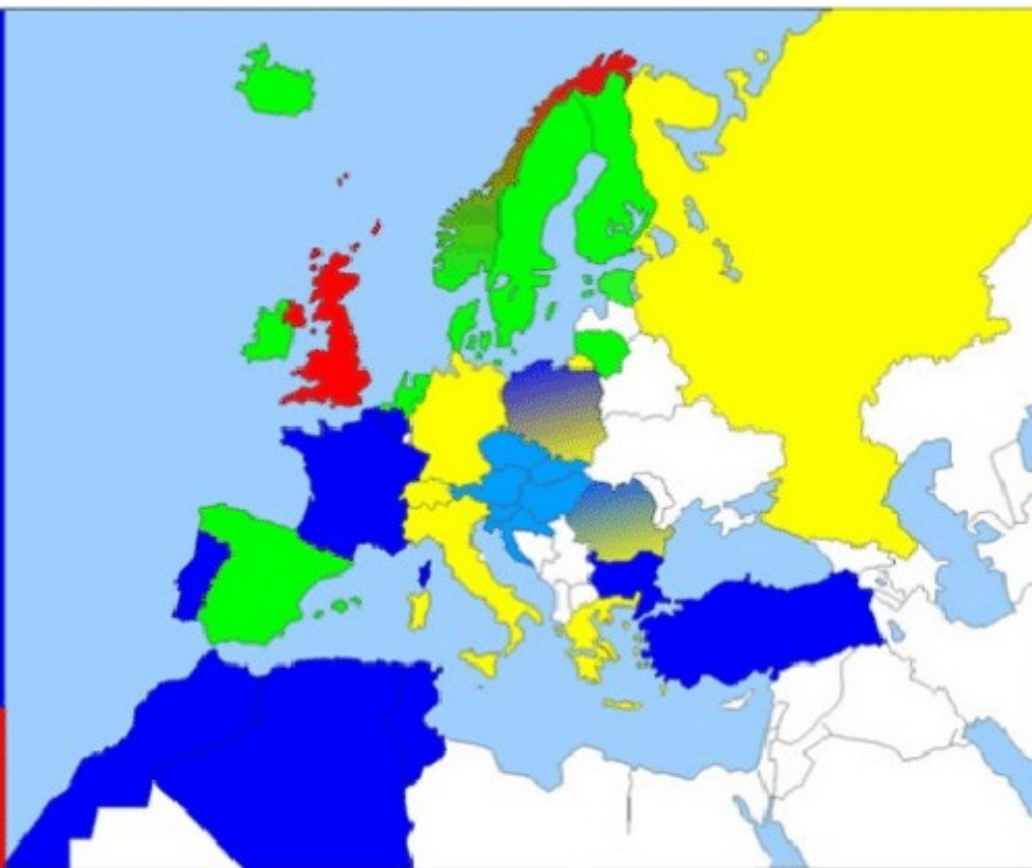
Algeria  
Belgium  
Bulgaria  
France  
Morocco  
Poland  
Portugal  
Tunisia  
Turkey

Austria  
Croatia  
Czech Rep.  
Hungary  
Romania  
Slovakia  
Slovenia



### UKMO

United Kingdom  
Norway

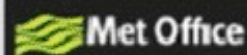


### HIRLAM

Denmark  
Estonia  
Finland  
Iceland  
Ireland  
Lithuania  
Netherlands  
Norway  
Spain  
Sweden

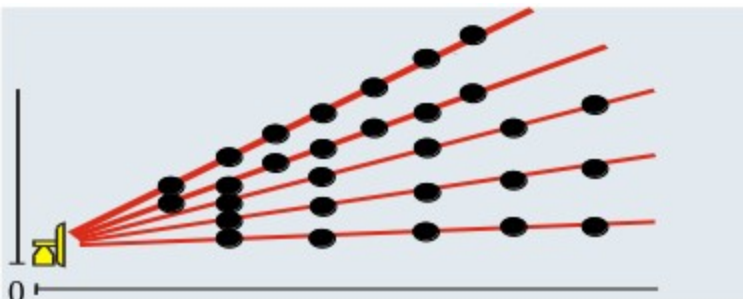
### COSMO

Germany  
Greece  
Italy  
Poland  
Romania  
Russia  
Switzerland

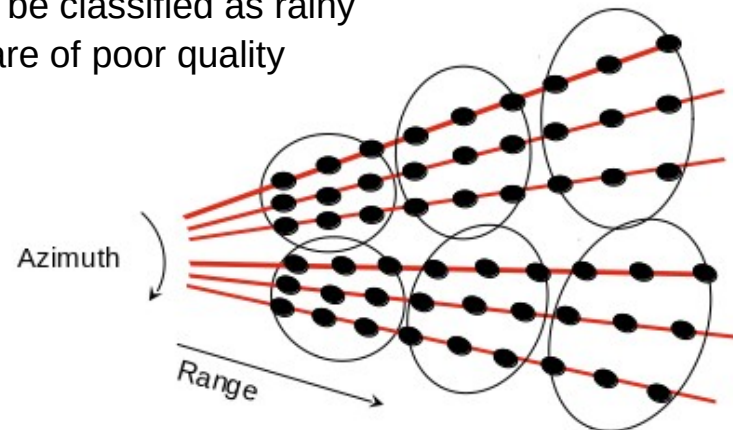
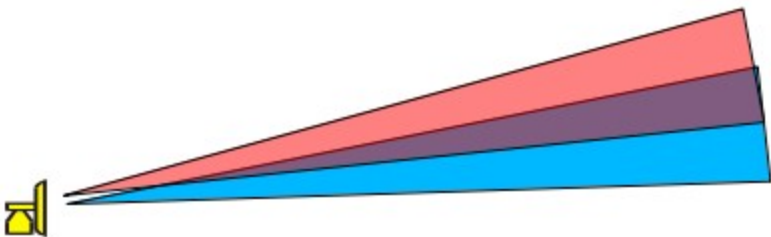


# OPERA radar data

- OPERA Information Data Model (ODIM)
  - Well specified and documented
  - All in HDF5
- Different data amount
  - Very large amounts of data
  - Different volume sizes
  - Can vary both in azimuth and range
- Different scan strategies
  - Can be different for different elevations
  - Can be different for reflectivity and radial velocity
- Quality controlled reflectivity
  - All reflectivity observations comes with a quality index.

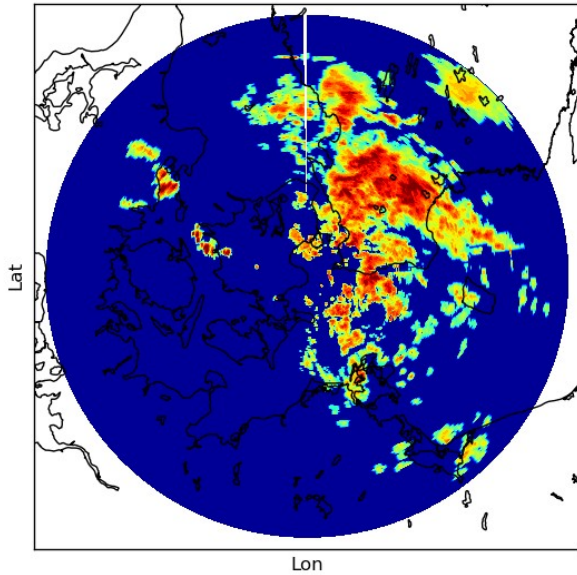


- Data sanity check
  - Checks that all attributes needed are present and have correct units
  - In not units are corrected and missing attributes added
  - Values of the attributes must be known
- Elevation check
  - To avoid using the same air volume twice
  - Elevation angle and beamwidth is checked
  - If elevations overlap or risk to hit the ground one of the elevations is removed
- Thinning
  - Super observations are created
  - 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
  - For wind the variability in the SO is checked as well

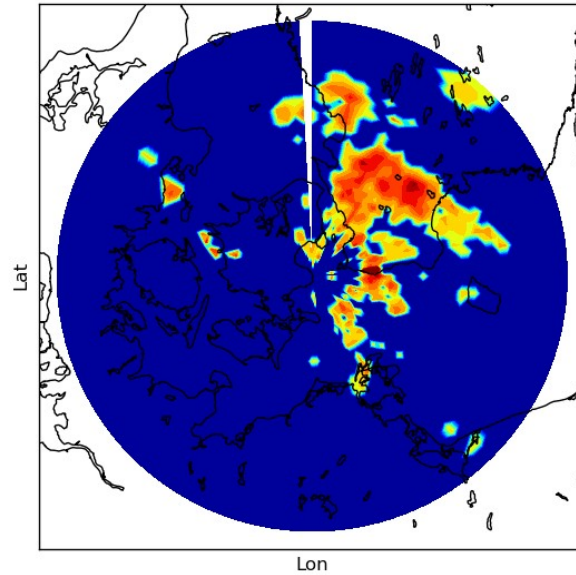


# Example, Copenhagen (Stevns)

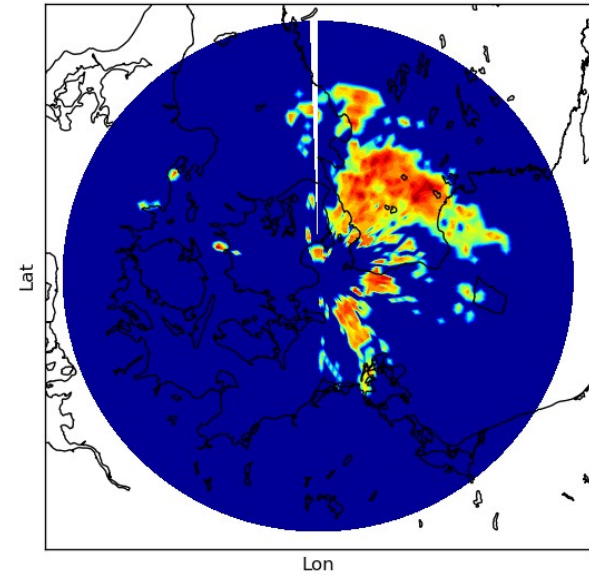
Original data



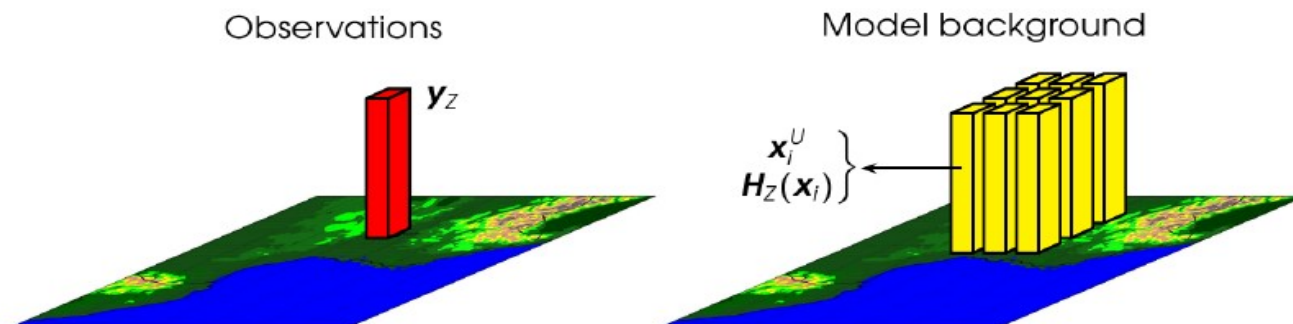
Super observations



Thinning



- Combination of 1D Bayesian and 3DVAR schemes
  - Developed by MeteoFrance (Caumont et. al, 2010)
- 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 measurements, humidity is set to 100%
- Pseudo-observations assimilated using 3DVAR
- Areas of no precipitation
  - It is also important to assimilate pixels with no reflectivity to dry the model
  - Signal that is above noise but no echoes



Operational status. All using 2.5 km grid with 65 vertical levels and 3DVar

- MetCoOp (Sweden, Norway, Finland, Estonia)
  - Used in operational NWP production
  - 45 radars from 6 countries (se, no, fi, dk, ee, de)
  
- DMI (Denmark)
  - Used in operational NWP production
  - 70 radars from 12 countries (se, no, fi, dk, ee, de, uk, nl, be, pl, ie, fr)
  
- KNMI (Netherlands)
  - Included in pre-operational runs
  - 27 radars from 2 countries (nl, fr)
  
- AEMET (Spain)
  - Used in operational NWP production
  - 42 radars from 3 countries (es, pt, fr)
  
- METIE (Ireland)
  - Still in development phase
  - Aiming at 23 radars from 3 countries (ie, uk, fr)



## Examples from the Danish domain (DKCOEXP)

Relative humidity at the surface and at 500 hPa

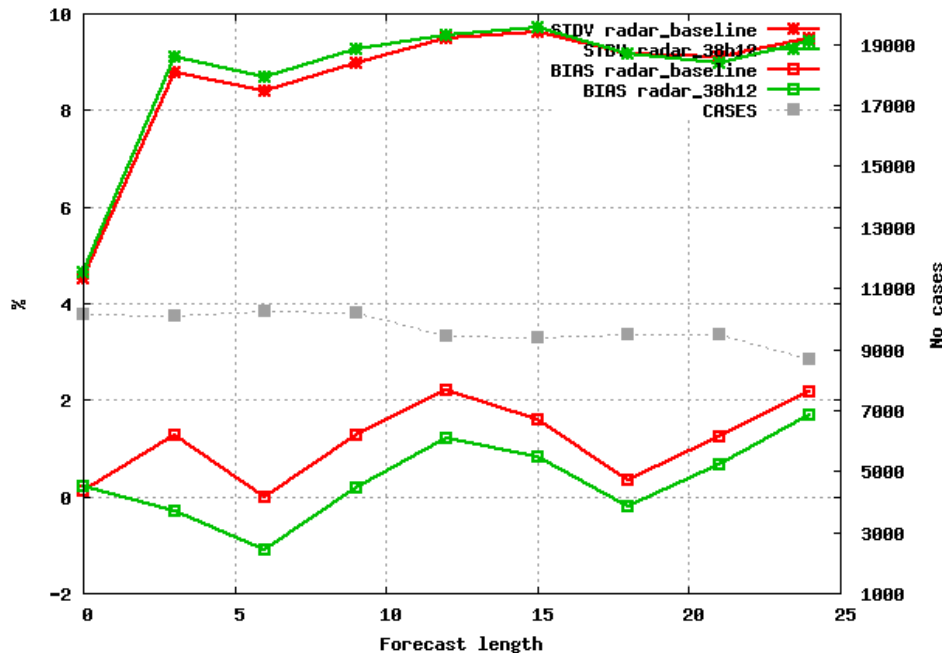
Red – No reflectivity assimilated

Green – With reflectivity assimilated

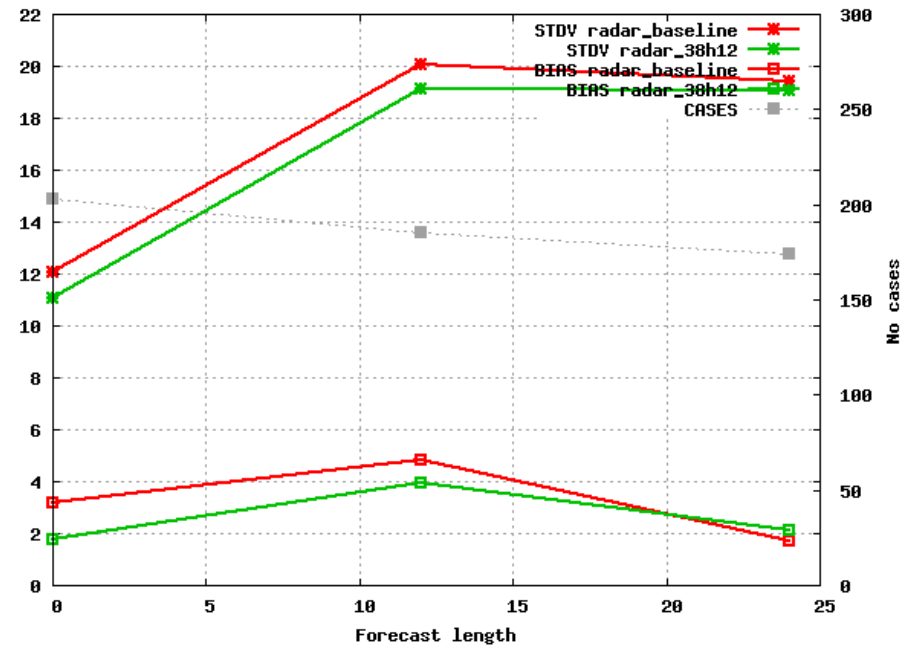
Surface

500 hPa

Selection: ALL using 743 stations  
Rh2m Period: 20140825-20140831  
Hours: {00,12}



Selection: ALL using 20 stations  
Relative Humidity 500hPa Period: 20140825-20140831  
Hours: {00,12}



## Examples from the MetCoOp domain

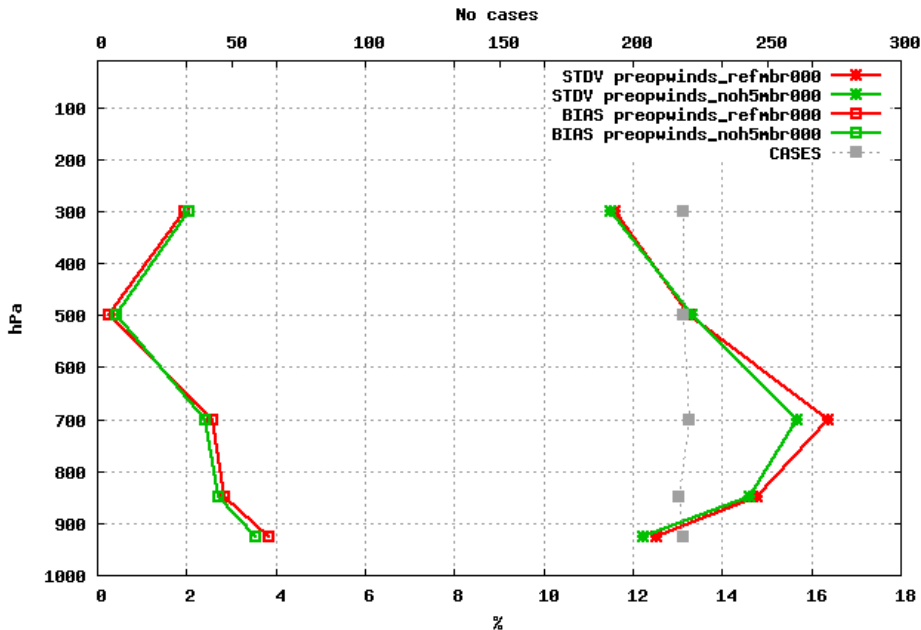
Vertical profiles of relative humidity

Red – Thinning applied to the reflectivity

Green – Super observations of reflectivity

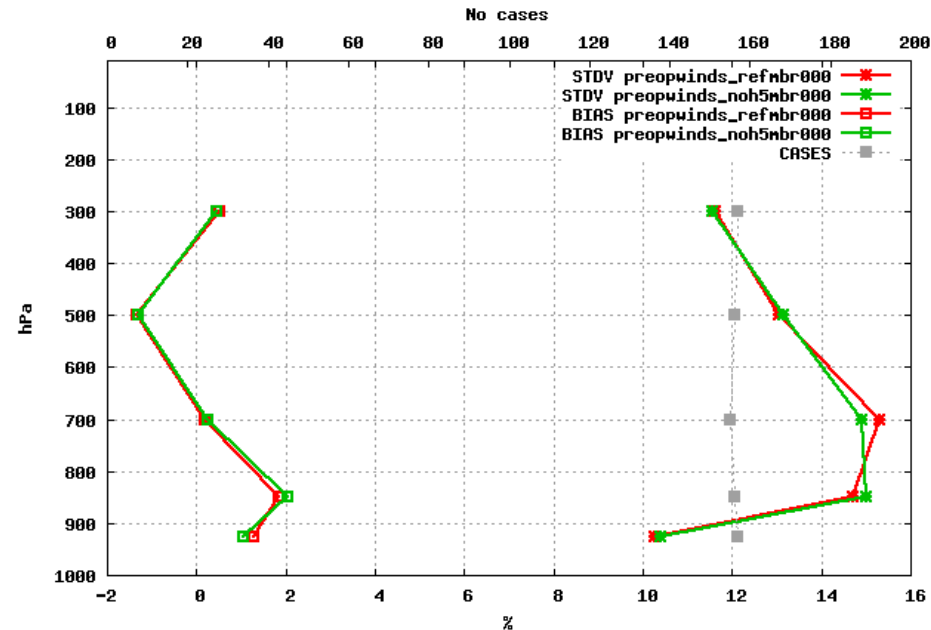
Valid at 00

18 stations Selection: ALL  
Relative humidity Period: 20190324-20190407  
Statistics at 00 UTC Used {123} + 12

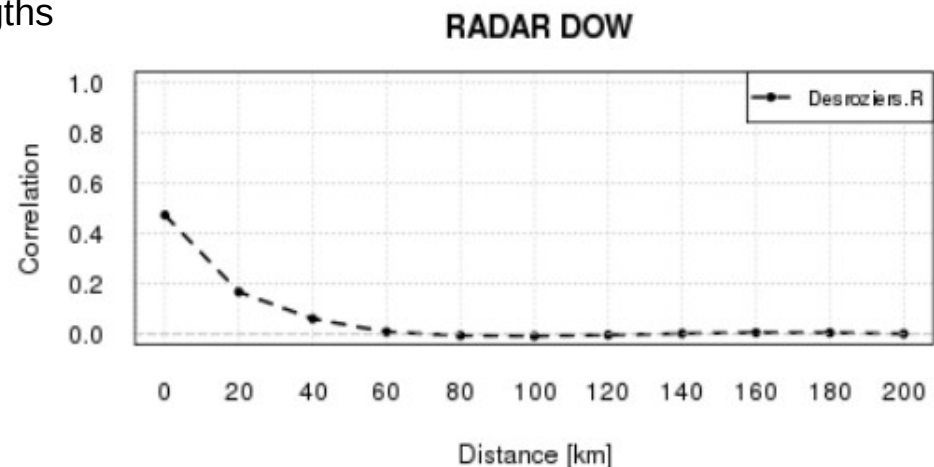


Valid at 12

15 stations Selection: ALL  
Relative humidity Period: 20190324-20190407  
Statistics at 12 UTC Used {003} + 12



- Not mandatory in OPERA
  - Reporting practice differ
  - Wind optimized volumes, wind optimized scans, a compromise...
- Quality control difficult
  - Needs co-located reflectivity observations
  - The QC index can then be applied to the Doppler winds
- Aliasing effects
  - De-aliasing algorithms does not seem reliable
  - Only winds with NI higher than 30 m/s are used
- Recent investigations show that we have not been using winds optimally
  - Too small observation error
  - Assuming too short correlation lengths



## Recent results from the Iberian domain

Red - Control run

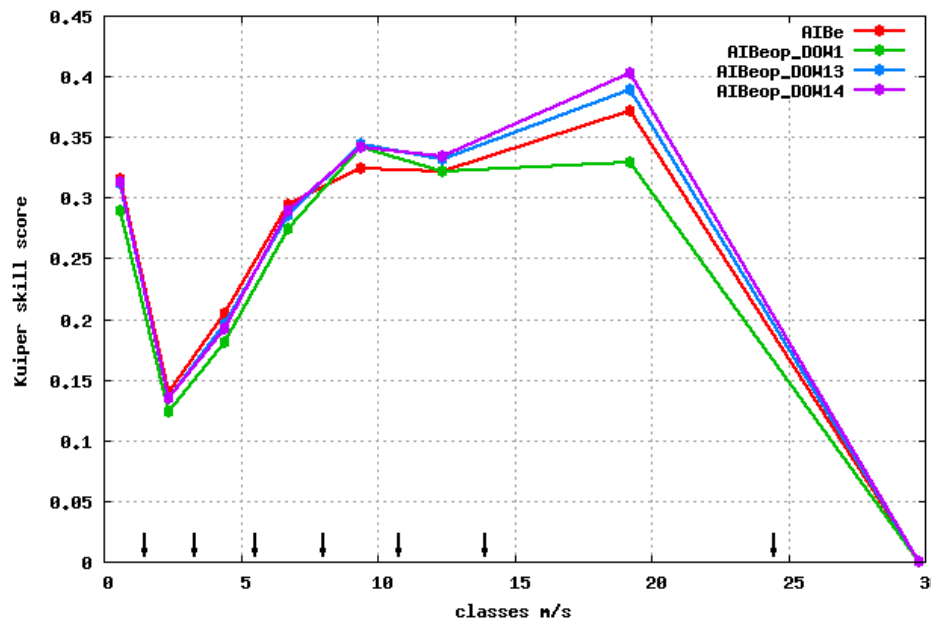
Green - DOW by default

Blue - DOW with increased observation error

Purple - DOW like blue + increased thinning

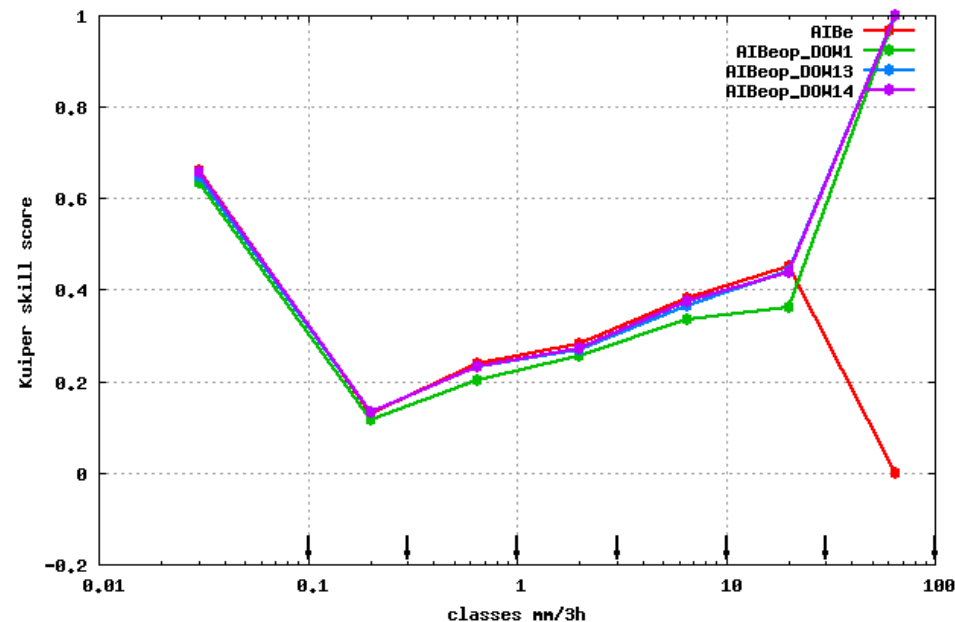
Kuiper skill score  
for 10m wind

Kuiper skill score for U10m (m/s)  
Selection: SpainPortugal 715 stations  
Period: 20200301-20200331  
Used {00,03,...,21} + 00 03



Kuiper skill score for  
3h precipitation

Kuiper skill score for 3h Precipitation (mm/3h)  
Selection: SpainPortugal 708 stations  
Period: 20200301-20200331  
Used {00,03,...,21} + 03-00



- Radar reflectivity from the OPERA radar network is used operationally or pre-operationally in 5 domains over Europe
  - Pre-processing and quality control is important
  
- Radial winds are under development
  - Wind optimized scans must be used
  - Quality control from co-located reflectivity observations must be used
  
- Further harmonization/calibration of the radar observations would be desirable