HOOF

Latest developments

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DAWD&DAsKIT meeting, September 2021

Status at last update

HOOF - **H**omogenization **O**f **O**PERA **F**iles

Goals:

- Prepare HDF5 files with radar data from OPERA for input into BATOR by homogenization of file structure (groups, datasets) and its metadata,
- Reduce file size by retaining only data and metadata needed by BATOR.

Achieved by specifying needed data and metadata via a namelist.

New developments - overview

- Code reviewed and restructured and rewritten in Python 3.6,
- Added dealiasing of radial wind (VRAD) measurements,
- Added superobing of reflectivity (DBZ) and VRAD measurements,
- Developed a HOOF graphical user interface (GUI).

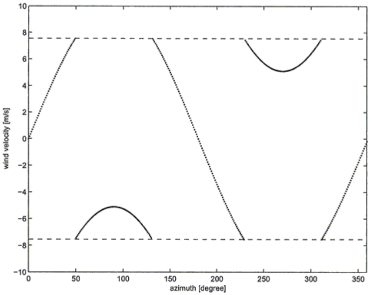
New developments - homogenization

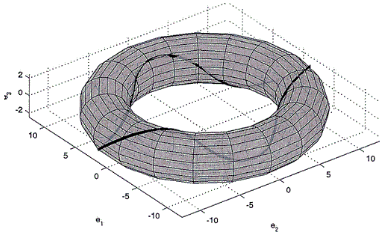
- Code restructured - needed because of new developments and new Python,
- Some minor bugs found and corrected,
- Namelist redone to be more readable.
- Results stay the same as in previous version.

Dealiasing

theory

Radial winds aliased on a Nyquist velocity interval. Idealised example for a constant velocity field for one bin range - left picture.
Data dealiased with the torus method [1], map data onto a surface of a torus as a parametric curve - right picture.





[1] G. Haase, T. Landelius, 2004 and V. Švagelj, master thesis, 2020

Dealiasing

theory

Assume a linear wind model:

$$v_m(u, v) = (u \sin\alpha + v \cos\alpha) \cos\vartheta$$

Express derivative of the third component of the torus curve ($\vec{F}$) with the wind model:

$$D = \frac{\partial F_3}{\partial \alpha} = -au + bv, \quad a = \cos\alpha \cos\vartheta \sin\left(\pi \frac{v_{obs}}{v_{ny}}\right), \quad b = \sin\alpha \cos\vartheta \sin\left(\pi \frac{v_{obs}}{v_{ny}}\right),$$

D, a, and b can be calculated from data points, and we get u and v from minimization over a chosen set of points:

$$u, v = \min \sum_{k=1}^{N} (D_k - [-ua_k + vb_k])^2$$

The Nyquist multiplier is obtained for each data point from minimization of:

$$n = \min[v_{obs} + 2nv_{ny} - v_m]$$

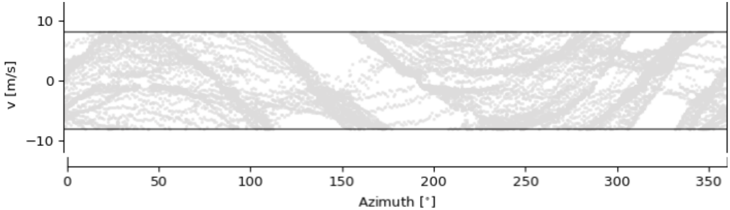
Dealiasing
method - height intervals

- Linear wind assumption more accurate on data subsets with similar height.
- Apply dealiasing on separate subsets of data in different height intervals (100 m).
- Data used from all radar scans in the HDF5 file at once.
- Could be a problem in OPERA files, which usually contain 3 radar volumes over period of 15 minutes (but not really seen in results).

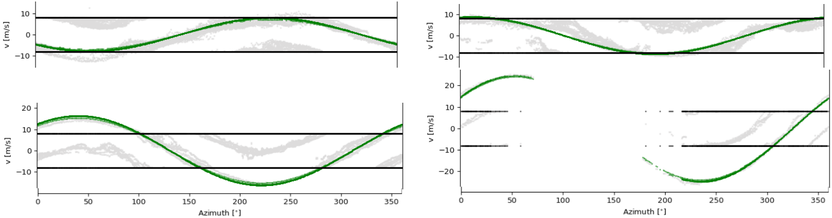
Dealiasing

method - height intervals

Plot of all data points in one radar scan:



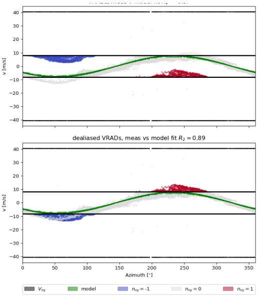
Wind model fit from separate height intervals (randomly chosen):

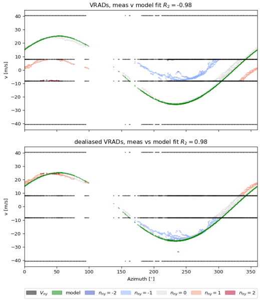


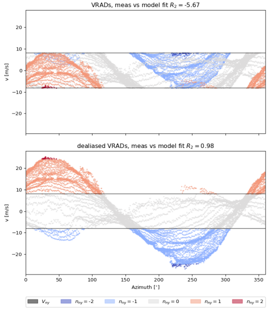
Dealiasing

Results

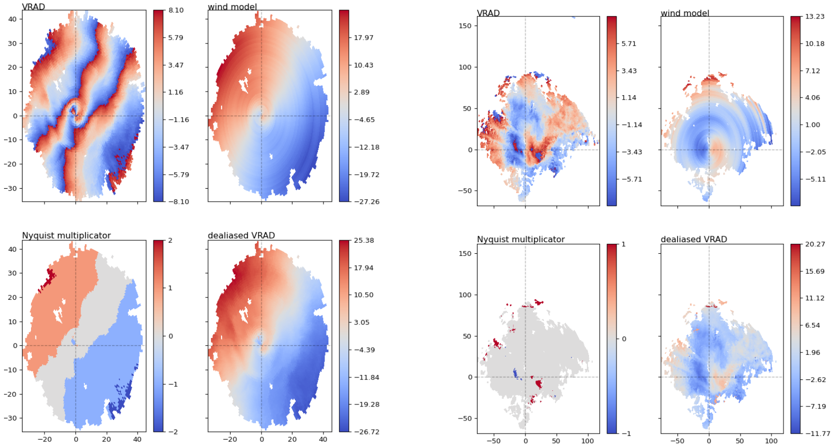
Azimuth plots of results, left - individual height intervals, right- whole radar scan:







Geographical plots for two radar scans:

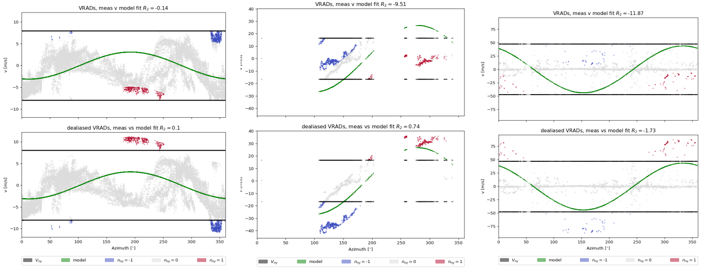


Dealiasing

Results

Fit on wind model does not always converge, main reasons:

- Linear wind assumption not satisfied even in a single height interval, very convective cases (left),
- The measurements fill only a small portion of the whole azimuth angle (middle),
- Strange data in the file (echoes, noise, etc) (right).



- **TODO**:
- Need to find a way to reject the wrongly dealiased data (with a smart statistic, algorithm, ...)
- Given the amount of data, better to reject more and retain data that is surely correct.
- Validation of results with independent data.

Superobing

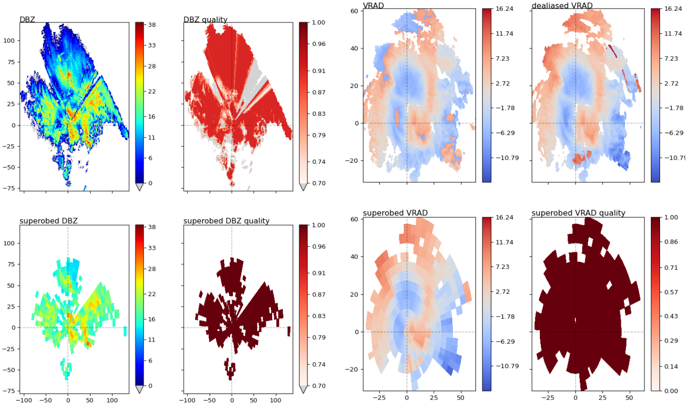
Overview

- Superobing done on DBZ and VRAD measurements as in the *prepopera.py* script:
- For each DBZ superob point:
  - If we have enough ($> 30\%$) good quality (> 0.7) rainy (> 12 dB) points, set to average,
  - Otherwise if we have at least one good quality dry point, set to the minimum value (undetect, usually -32 dB),
  - Otherwise, discard the point.
- For each VRAD superob point:
  - If we have enough good quality points with small standard deviation (< 10 m/s), set to average,
  - Otherwise, discard the point.

Superobing

Results

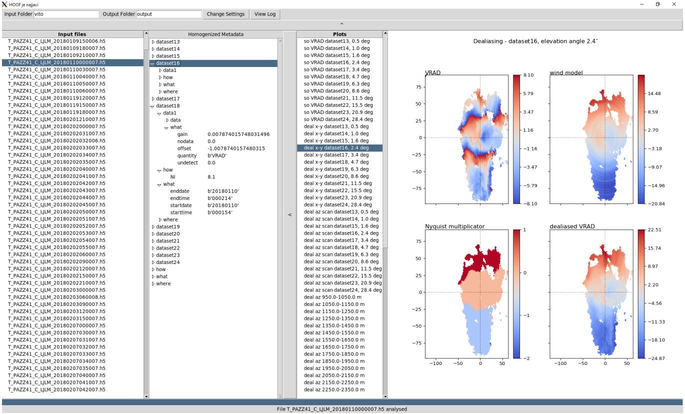
DBZ and VRAD geographical plots for one radar scan:



One superob point : every 5000 m radial direction, every 5 degrees azimuth direction, undetect DBZ values not shown

GUI

- At first, written for viewing results when testing,
- Evolved into a useful tool, that does everything that HOOF does (for one file at a time).



Conclusion

DONE:

- Restructured code, revritten in Python 3.6 and new namelist,
- added dealiasing and superobing,
- dealiasing works quite fast and very well, for the majority of cases,
- superobing works the same as in *prepopera.py*,
- a graphical tool was written for analiysis and reults review.

TODO:

- A way for rejecting erroneus data from dealiasing,
- Speeding up the code for superobing,
- Handle writing of results back to HDF5 files,
- Small corrections to the GUI.
- Write new documentation.