Statistical evaluation of three distinct automated Doppler dealiasing algorithms using a hand-dealiased shipborne radar dataset

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1. Introduction

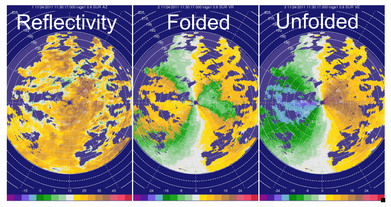
We seek an effective, open-source, automated Doppler dealiasing tool for processing a large number of radar volumes, in order to ingest these data into single- or multi-Doppler retrieval algorithms, as well as into model data assimilation schemes.

The Python Atmospheric Radiation Measurement (ARM) Radar Toolkit (Py-ART) provides three automated dealiasing methods. Evaluation of their performance is required. For this we use the hand-dealiased NASA TOGA C-band radar dataset from the Dynamics of the Madden-Julian Oscillation campaign (DYNAMO).

2. Methodology

TOGA Doppler velocity data

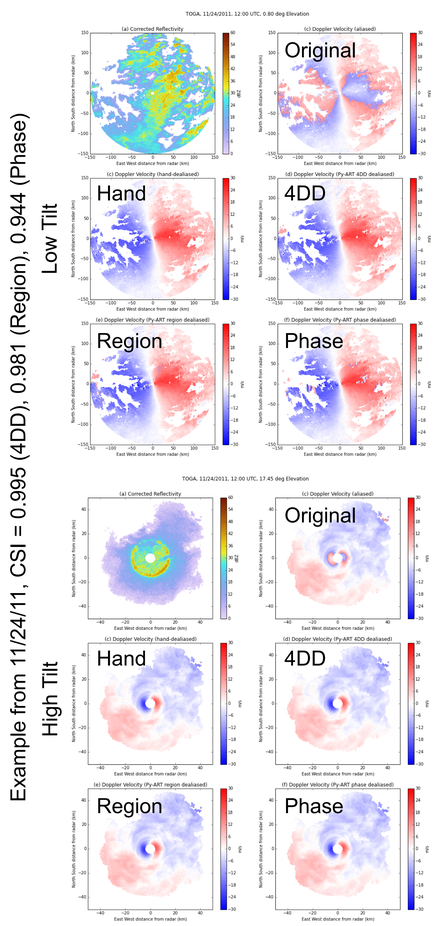
- Hand-dealiased using NCAR Solo3
- One volume every 30 minutes over Cruises 2-4
- 360-deg PPI volumes, normally 22 tilts apiece
- Exclude INU failures, other major radar problems



Example of Manual Dealiasing in Solo3

Py-ART Version 1.5 *(Helmus et al., Poster Session 1)*

- *pyart.correct.dealias_region_based* (**REGION**)
  - Regions of similar velocities identified and unfolded against each other by modeling system as a dynamic weighted graph
  - interval_splits=3, skip_between_rays=100
- *pyart.correct.dealias_unwrap_phase* (**PHASE**)
  - Multi-dimensional phase unfolding method originally designed to analyze optical fringe-patterns
  - unwrap_unit='volume', keep_original=False
- *pyart.correct.dealias_fourdd* (**4DD**)
  - James and Houze (2001), six-step process that uses sounding and previous scan info to correct
  - In present study, previous unfolded radar volume used as sounding, not radiosonde



Statistical Analysis

- Performance evaluated against manually dealiased field (assumed 99% accuracy)
- Python simplifies analysis via dicts and logical masks
- Hit = Correctly dealiased, Miss = Not, False Alarm = Unnecessary dealiasing
- Probability of Detection (POD), False Alarm Rate (FAR), Critical Skill Index (CSI)

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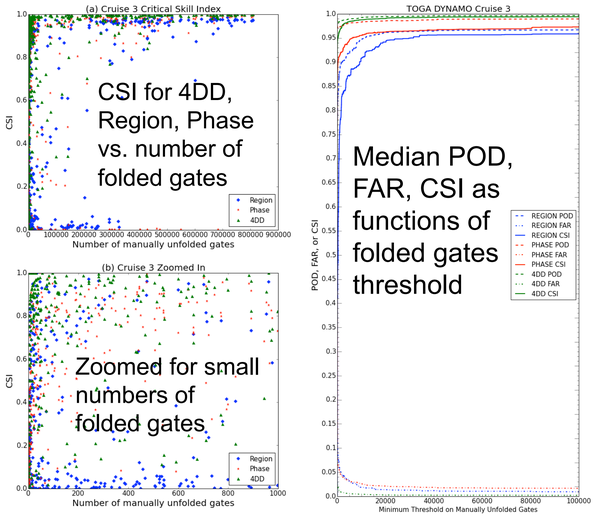
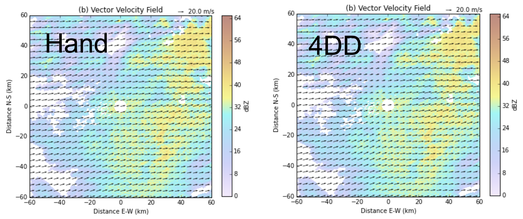
3. Results

- Cruise 3 results shown here – Increasing CSI with increasing number of folds
- Cruise 4 results (not shown) similar to Cruise 3
- Cruise 2 results still being analyzed and debugged – Region-Based failed A LOT.

Cruise 3



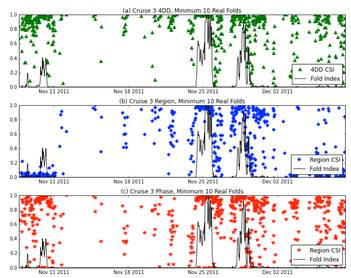


Effects on Single-Doppler Retrievals (*See Talk 12B.2, 4:45p, 11/17*)

Results for 11/24/11, 1200 UTC

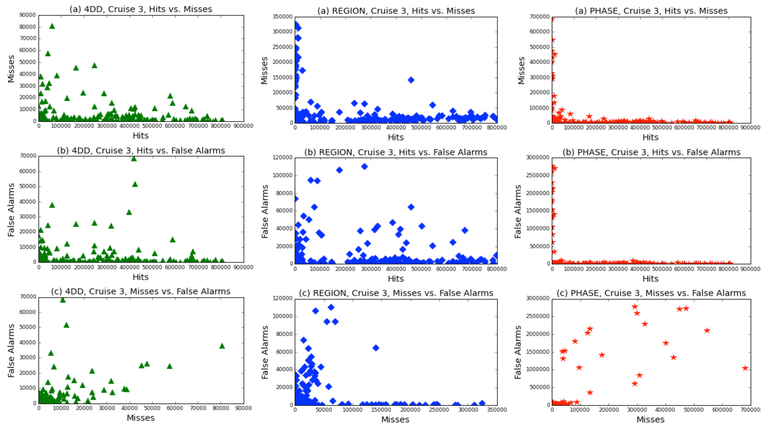
Method	Velocity	Median Absolute Error (m s^{-1})	Mean Square Error (m^2 s^{-2})
4DD	Radial	0.22	0.42
	Tangential	0.23	0.73
Region	Radial	0.28	0.71
	Tangential	0.33	0.82
Phase	Radial	0.29	3.39
	Tangential	0.56	1.51
None	Radial	12.6	293
	Tangential	13.3	269

Time Series of CSI & Folds



- Binary behavior (esp. Phase); algorithms did extremely well or bombed.
- Failures common when few folds, Phase and Region sometimes w/ many folds

Cruise 3 Scatterplots – Hit vs. Miss vs. FA



4. Summary and Conclusions

- Performance of all three algorithms is very high when volumes are significantly aliased (~1000s of folded gates)
- Algorithms may not be worth running if few folds – "Critical mass" of folds needed?
- On average, 4DD performs very similarly to hand-dealiasing, but failures during individual radar volumes can and do occur
- Region-Based and Phase-Unwrap methods perform worse than 4DD, but are good options if 4DD fails. Phase has higher POD and CSI but also higher FAR than Region.
- Region and Phase methods prone to occasional massive failures (CSI ~0)