AIM Cloud Imaging and Particle Size (CIPS) PMC wind tracking and first validation relative to NOGAPS-ALPHA winds

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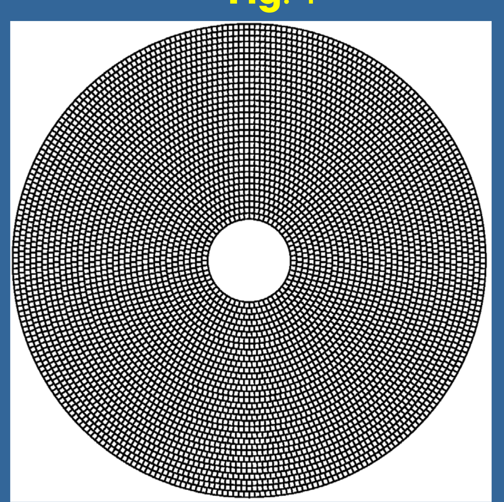
1. Overview

- The technique of tracking satellite-measured clouds or moisture to derive horizontal winds has been applied and increasingly refined since the 1960s.
- Clouds generally serve as an excellent tracer because the cloud mass within a given framed area can be conserved in shape within certain time periods and can be clearly identified by satellite imagery, namely pattern matching.
- Polar mesospheric clouds (PMCs) can serve as tracers of wind advection at ~83km during summer given the condition that the clouds do not respond to rapid local changes in temperature or water vapor. Repetitive nature of gravity wave structures can also lead to false wind detections.
- It is proven that AIM CIPS PMC tracking is successful in a substantial fraction of the cloud covered region.
- We have conducted both the statistical and individual wind validation relative to NOGAPS-ALPHA assimilated dataset.
- The agreement in both types of validation is enlightening, while some differences in the individual winds provide further insights.

2. Datasets and approaches:

- Retrieved orbital strips of CIPS albedo are used to conduct this research. (http://lasp.colorado.edu/aim/).
- A 5km×5km grid system is adopted to resample the orbital strips and a frame of 500km lon×400km lat is used to track the same cloud mass via selecting the highest correlation between adjacent orbits. A threshold coefficient of 0.8 is used in this study.
- The frame size is empirically chosen so that the displacement corresponding to <100 m/s of wind causes a notable fraction but not many times of the frame-size movement which is a desired condition.
- NOGAPS (Navy Operational Global Atmospheric Prediction System) with Advanced Level Physics and High Altitude (ALPHA) assimilated data in the mesosphere include wind product and the 1-hourly output for 2009 northern summer makes it possible for us to validate the wind tracking results.

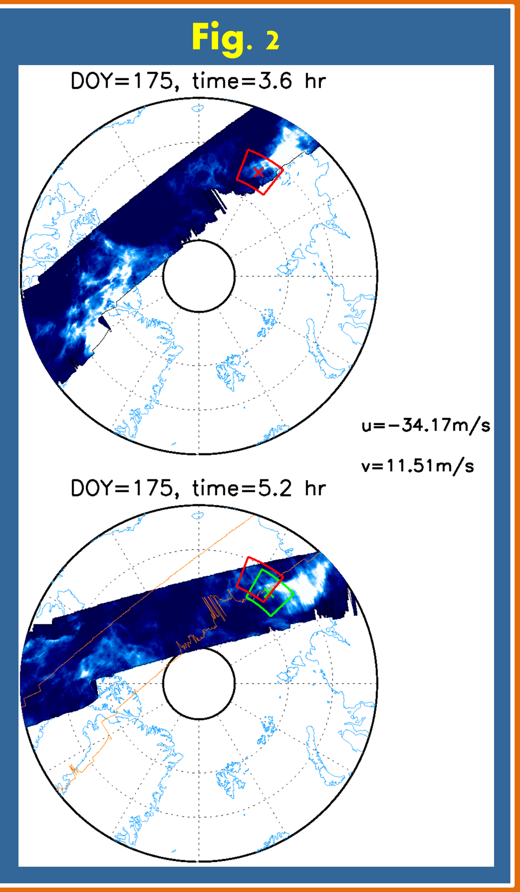
Fig. 1



70N

The grid system

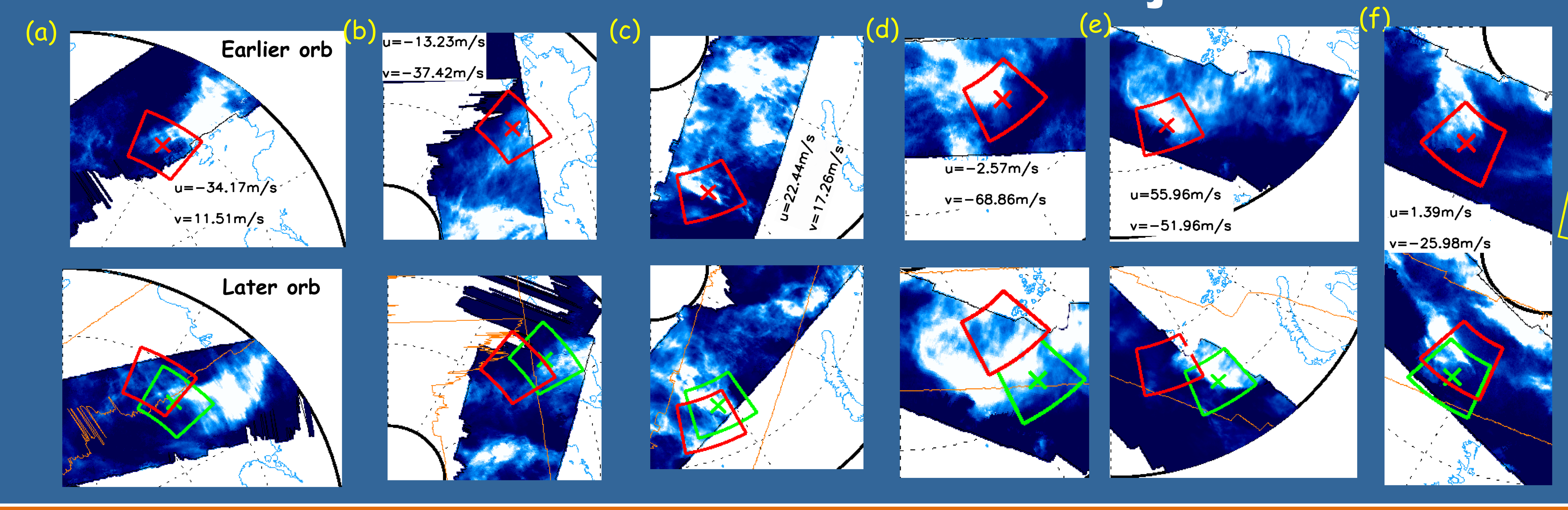
Fig. 2



A full demonstration of wind tracking between two orbits

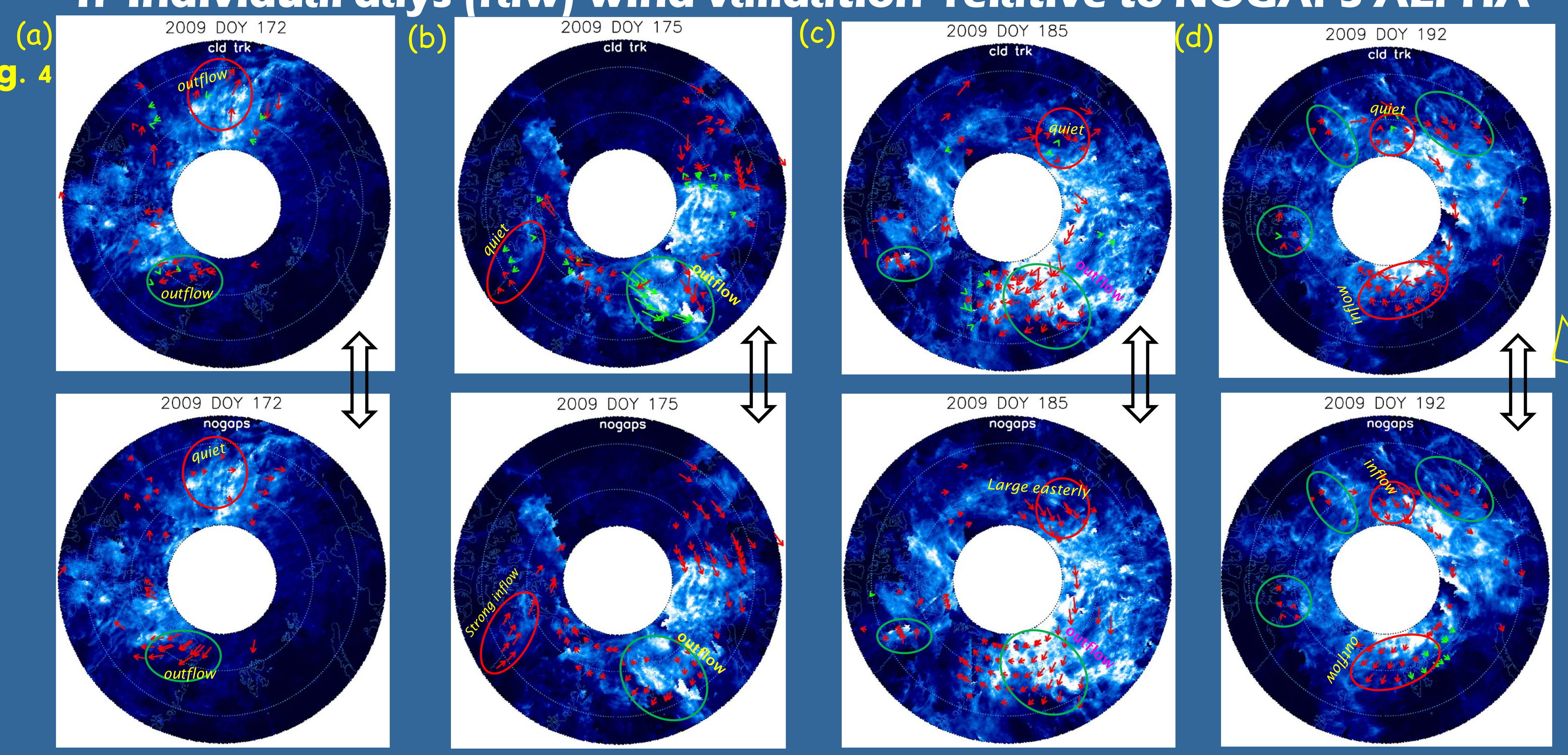
3. individual wind detections between two adjacent orbits

Fig. 3



4. Individual days (raw) wind validation relative to NOGAPS-ALPHA

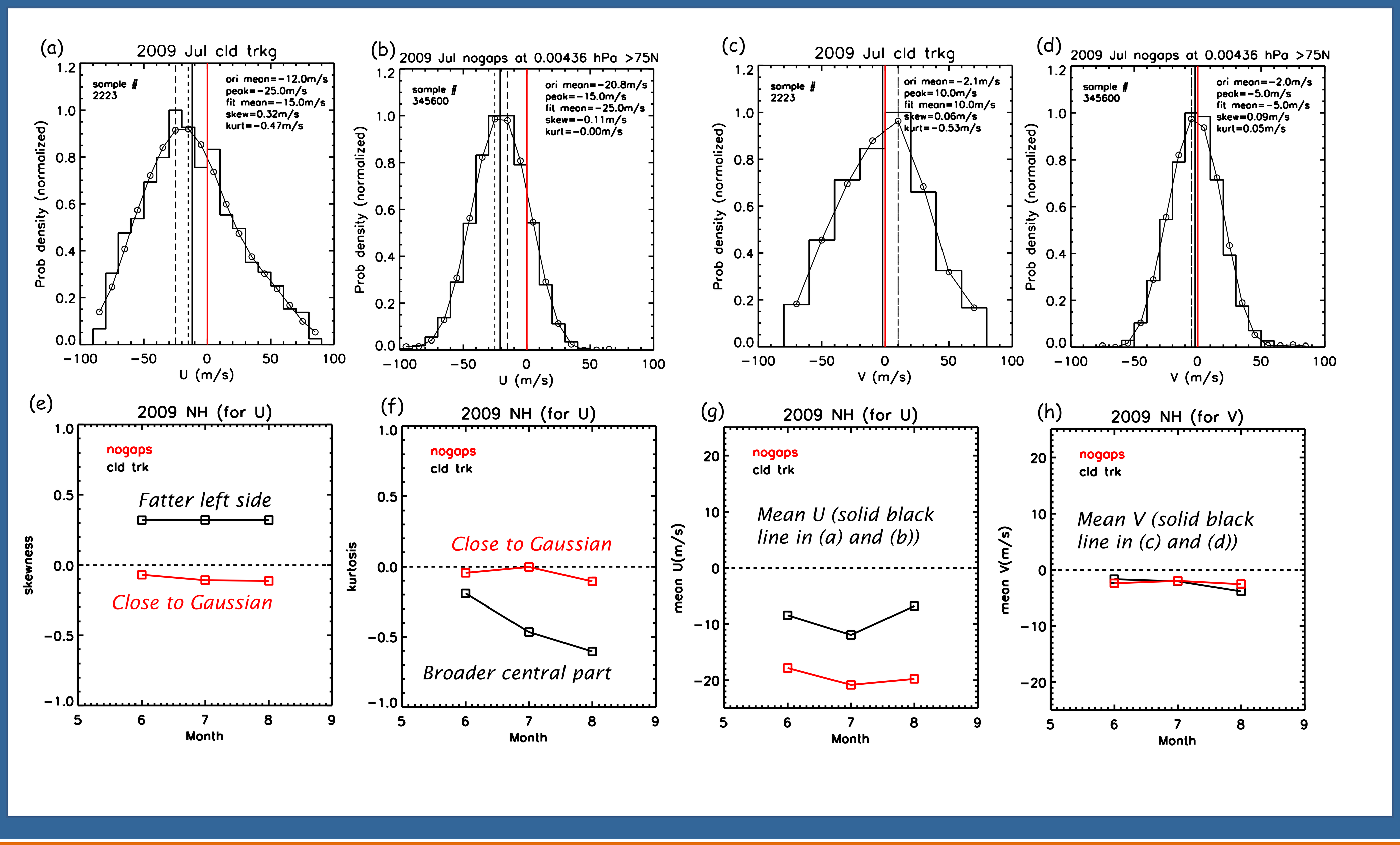
Fig. 4



1. Daily wind vectors are over-plotted on the daily daisy albedo maps that combined all orbits
2. NOGAPS-ALPHA winds (lower panels) are on the coincident times and locations
3. Green circle pairs are for consistency and red circle pairs are for discrepancy
4. The maximum vector length is roughly 80m/s.

5. Wind statistics validation relative to NOGAPS-ALPHA

Fig. 5



5. Conclusions

- The demonstrated examples show seemingly valid pattern matching.
- Repetitive nature of the PMC gravity wave patterns, which are wide spread, can affect the results. But we find that the semi-organized cloud features in CIPS rarely distinctly travel. As a result, the false detections will be greatly limited.
- Cloud features with less complexity (e.g., in (e)) can also lead to non-unique matching results.

5. Conclusions-conti.

- Easterly winds seem to prevail in both wind tracking and NOGAPS-ALPHA but the latter show much smoother variation pattern.
- In the wind tracking results an outflow (southward) often occurs mostly corresponding to a longitudinal section where clouds reach lower latitudes while in the NOGAPS-ALPHA this is not always true.
- The small winds (quiet region) in the wind tracking are more trustworthy (as expected) and it shows that they appear to correspond to fairly dim cloud regions.

5. Conclusions-conti.

- The statistically averaged states of the wind tracking and NOGAPS-ALPHA winds show qualitative agreement, suggesting a dominant easterly wind and a weak southward wind.
- Due to the lower sample number, the wind tracking histograms show deviation from Gaussian, reflected by asymmetry (toward easterly winds) and broader central parts (associated with larger variability).

6. Future plan

- Raw wind tracking results will undergo a smoothing procedure toward consistency within the frames, which will eventually provide us with the most reliable results from the PMC wind tracking approach.
- Gravity wave development in CIPS within a day will be investigated to eventually reveal how these semi-organized features in PMCs may have traveled, if at all.

References:

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