High Latitude Atmospheric Motion Vectors from Combined Geostationary and Polar Orbiting Observations

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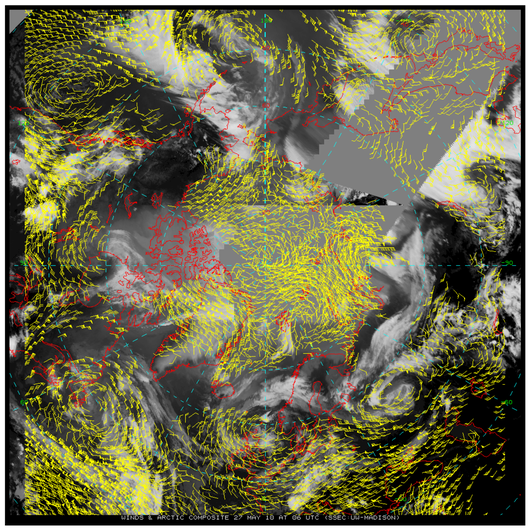
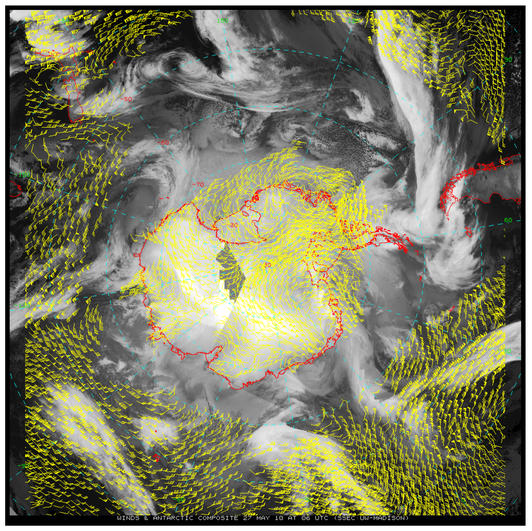
The Challenge: Minding the Gap!

Deriving atmospheric motion vectors (AMV) from satellite observations has been successfully done for many years from geostationary platforms and more recently from polar orbiting platforms. The spatial coverage of satellite-derived AMV is generally equatorward of 60° latitude for geostationary satellites and poleward of 70° latitude for the polar satellites. This coverage results in a 10° gap, which has been noted as a problem by numerical weather prediction (NWP) centers. Specifically, the dynamically active polar jet stream can be located in this latitudinal zone and improper model initialization can lead to rapidly growing errors in the forecasts.



Arctic Composite with
Polar and Geostationary AMVs
revealing a gap in coverage



Antarctic Composite with
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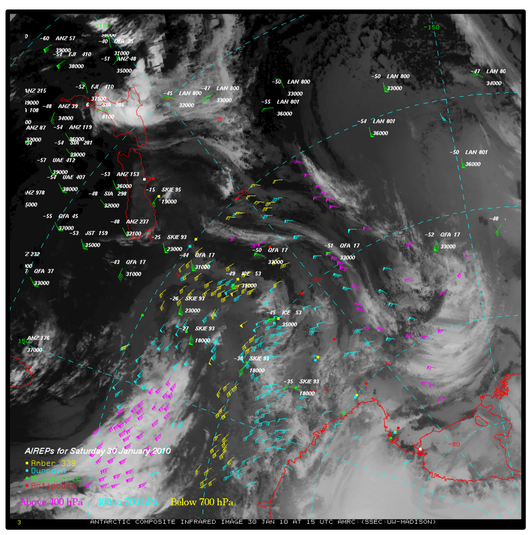
Therefore, developing novel ways to fill this AMV-void gap is the next logical step toward providing complete wind coverage for the NWP applications. This requires an advanced image compositing technique designed to blend the data from the many polar and geostationary weather satellites. Combination of geostationary polar orbiting observations seen in the Antarctic, and more recently the Arctic, provide inspiration and an initiation point for this effort.

While the composites have the strength of observations from both geostationary and polar-orbiting platforms, it is not yet clear how well the AMV will validate as compared to the very limited radiosonde observations and aircraft reports in the latitude band study area, especially in the Southern Hemisphere. While verification and validation activities are currently on going, this activity is expected to continue through the upcoming 2010-2011 Antarctic field season. This emphasizes the critical importance of aircraft reports (AIREPs) from US Antarctic Program aircraft (e.g. 109th New York Air National Guard LC-130s) and other aircraft that fly missions between the middle latitudes and the Antarctic. Similar needs exist over the Arctic. Observations of winds enroute has the potential to provide a significant set of validating observations needed to determine if the composite AMVs will be on the order of accuracy as its cousin polar orbiting and geostationary wind sets.

The Validation: Using Aircraft Data!



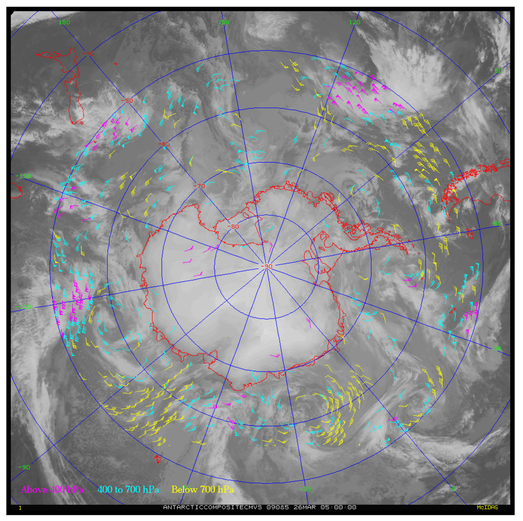
60 to 70 Degree South			
(m/s)	All	850-500 hPa	>500 hPa
Vector RMS	7.95	6.24	9.24
Vector Diff.	6.40	5.28	7.47
Speed RMS	5.08	3.61	6.08
Speed Bias	0.08	0.21	0.00
Sample Size	149	63	81

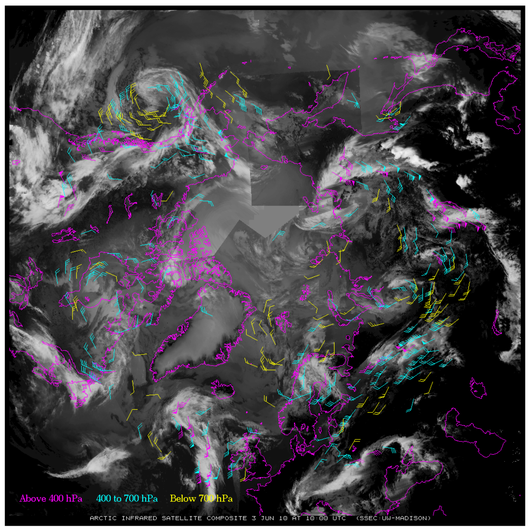
AIREPs (All Latitudes)			
(m/s)	All	850-500 hPa	>50 hPa
Vector RMS	9.14	10.55	9.11
Vector Diff.	7.57	10.55	7.51
Speed RMS	6.97	10.40	6.90
Speed Bias	1.22	10.40	1.05
Sample Size	56	1	55

Antarctic composite AMV statistics from the gap latitudes show RMS values (7.95 m/s) close to that of polar (8 m/s) and geostationary (6 m/s) RMS values*

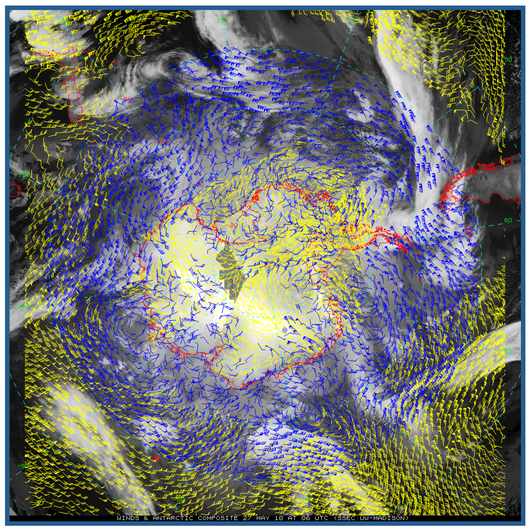
In Memoriam
Dr. Charles R. Stearns
1925-2010

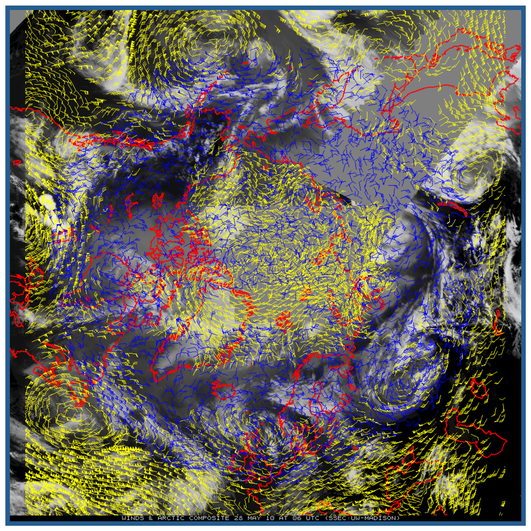
The Results: It Works!





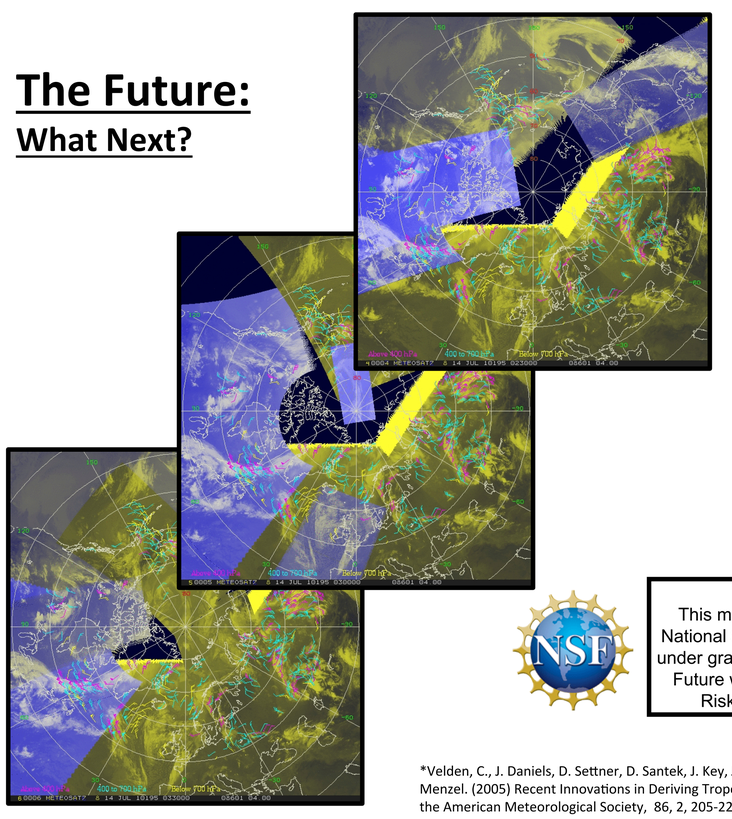
AMV are successfully being calculated and derived from the traditional infrared composite observations over both sub-Antarctic and sub-Arctic.





Arctic and Antarctic composite AMV (in blue) fill the gap between the geostationary and polar AMV (in yellow)

The Future:
What Next?



To reduce errors a new satellite composite built for generating AMVs has been created and has been proven to create AMVs. Using a different technique to combine the satellite observations – highest resolution data always composited on top, along with critical metadata (e.g. time of all satellite pixels) and considering parallax at the time of AMV computation, a better vector is expected. Verification of this new method is underway now.

Acknowledgments:
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*Velden, C., J. Daniels, D. Settner, D. Santek, J. Key, J. Dunion, K. Holmlund, G. Dengel, W. Bresky, and P. Menzel. (2005) Recent Innovations in Deriving Tropospheric Winds From Meteorological Satellites. Bulletin of the American Meteorological Society, 86, 2, 205-223.