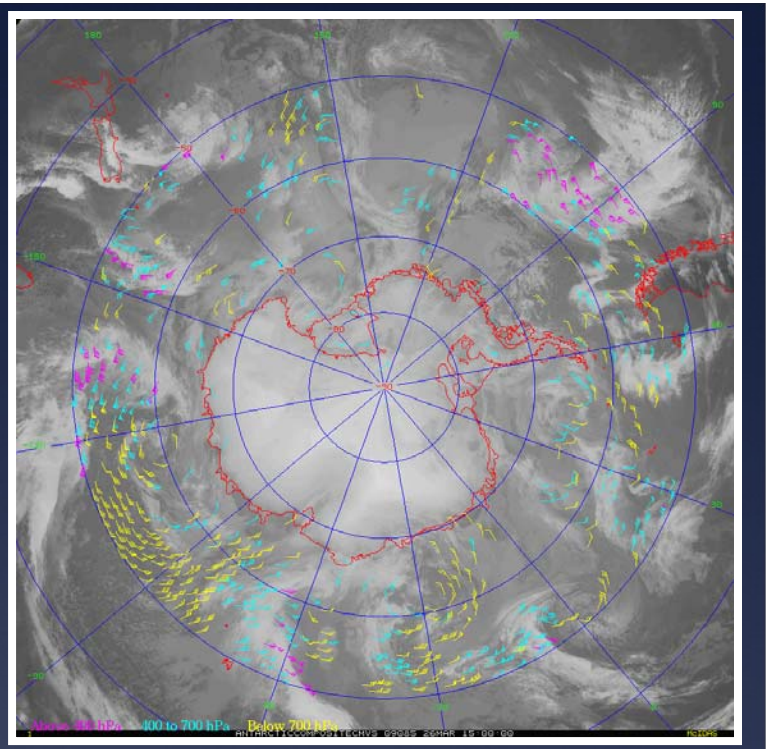
An Overview of Polar Satellite Imagery Composites Project



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Space Science and Engineering Center (SSEC)

University of Wisconsin-Madison, Madison, WI, USA

O-202-M

**Now at the University of Colorado-Boulder*

Polar Satellite Composites

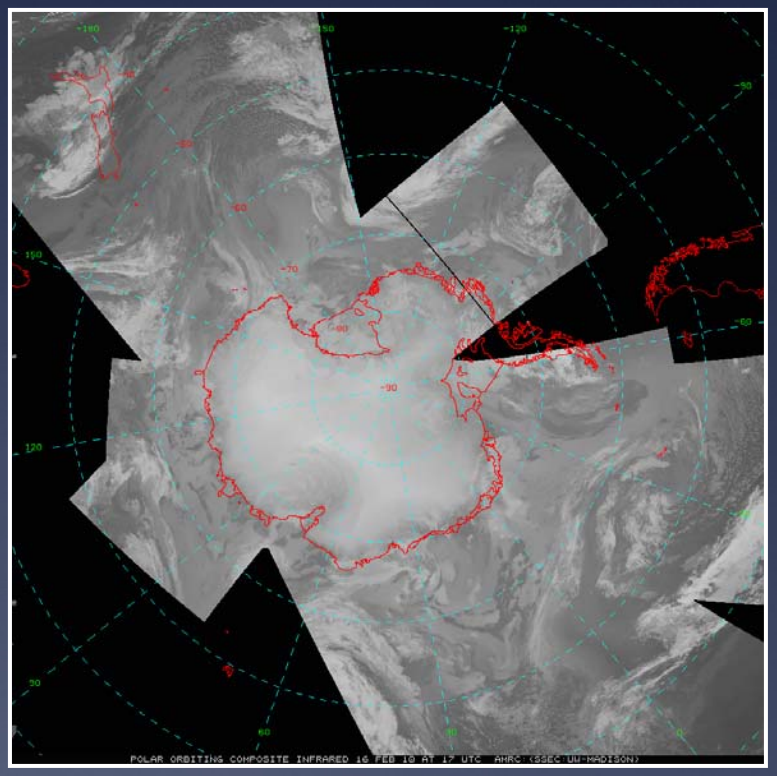
- **Antarctic composites** (inspired from one-time composites - Dr. Charles Stearns)
  - First(?) to use both geostationary and polar orbiting
  - Arctic composites came much later…

- **Applications:**
  - Weather forecasting
  - Cloud mass transport
  - Case studies
  - Glaciology studies
  - ***Atmospheric motion vectors***
  - Semi-automated storm tracking
  - Numerical model verification
  - Education and public outreach
  - Artists and writers program

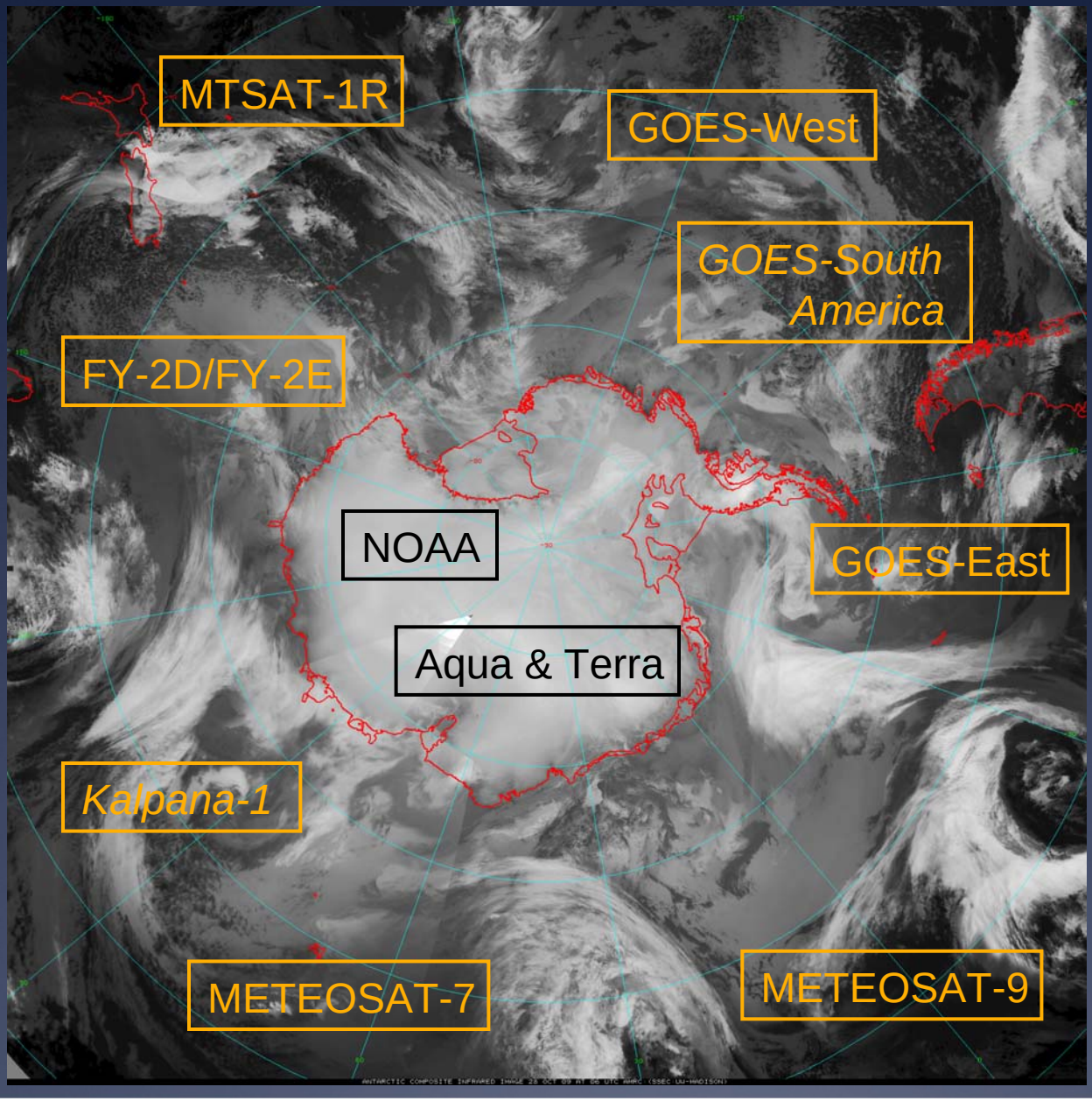
Historical Milestone	Date
First Antarctic Infrared Composite	30 October 1992
First test Arctic Composite	23 March 2000
First Antarctic Water Vapor Composite	2 May 2001
Upgrade of Antarctic Infrared Composite to 5 kilometer resolution	1 November 2002
Start of experimental Antarctic Visible Composite	1 January 2004
"Pseudo-color" Antarctic Composites begin	28 February 2005
First full Arctic Infrared Composite	5 December 2007
Upgrade to Hourly Antarctic Composites	8 April 2009
Upgrade to Hourly Arctic Composites	***9 March 2010***

Composite Generation

- Satellite acquisition at SSEC Data Center with additional acquisition at McMurdo Station and Palmer Station (via Internet)
- “Clean up” of bad lines
- Remapping imagery
- Removal of “space” background
- Merge imagery
  - Geostationary first
  - Polar orbiting last
- Post processing and distribution



Satellites Incorporated



Antarctic & Arctic Composite

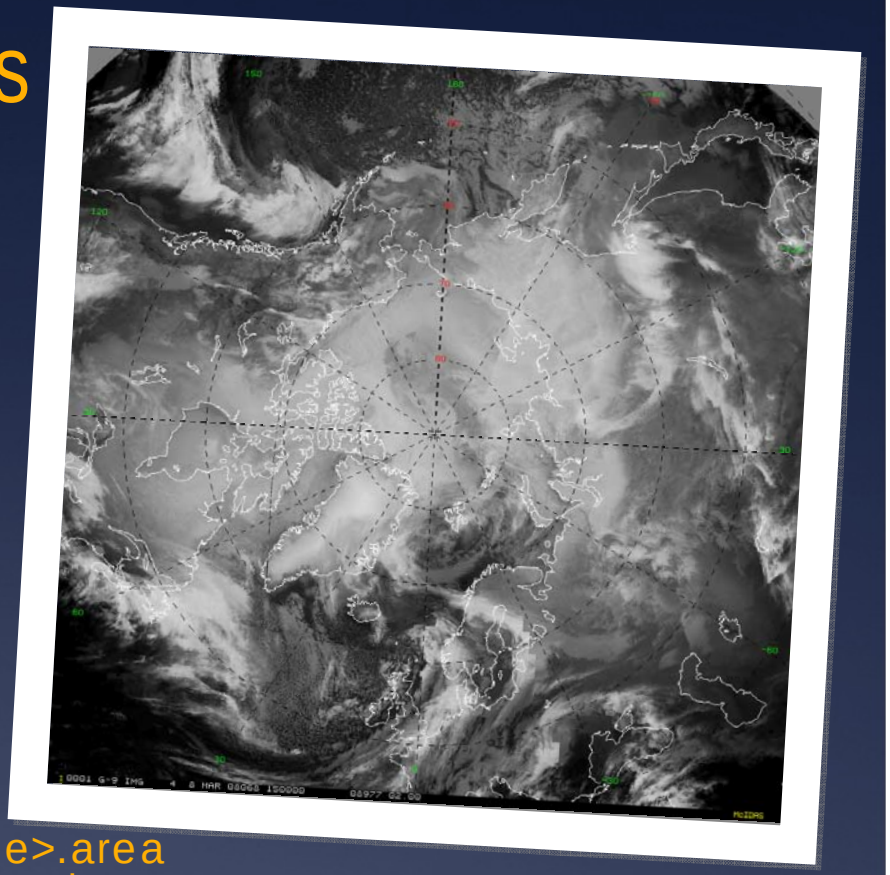
Satellite Sources

- Geostationary:
  - GOES-10, -11, -12
  - *KALPANA-1 (no longer available)*
  - Meteosat-7, -9
  - FY-2D, FY-2E
  - MTSAT-1R
- Polar orbiting
  - NOAA-15, -16, -*17*, -18, -19
  - Aqua and Terra
- Spectral Bands:
  - Infrared Window (~11.0 microns)
  - Water Vapor (~6.7 microns)
  - *Experimental (Visible 0.6 microns – improvements coming soon)*
  - *Shortwave Infrared (~3.9 microns)*
  - *Longwave Infrared (~12.0 microns)*

Specifications

- 1 hourly data!
  - Used to be 3 hourly data (at synoptic hours 0, 3, 6, 9, 12, 15, 18, 21 UTC)
- Geostationary:
  - Most +/- 15 minutes to the top of the hour
    - Some +/- 50 minutes to the top of the hour
  - Otherwise its left missing…
- Polar-orbiting:
  - Coverage within whole hour
- 5 kilometer nominal resolution
- Polar stereographic (Antarctic/Arctic)
  - Centered at South Pole -90º/North Pole 90º
  - Standard/True at -60º South/60º South
  - Standard at 140º West/0º Greenwich down
- Weather depiction focus

Distribution & Formats



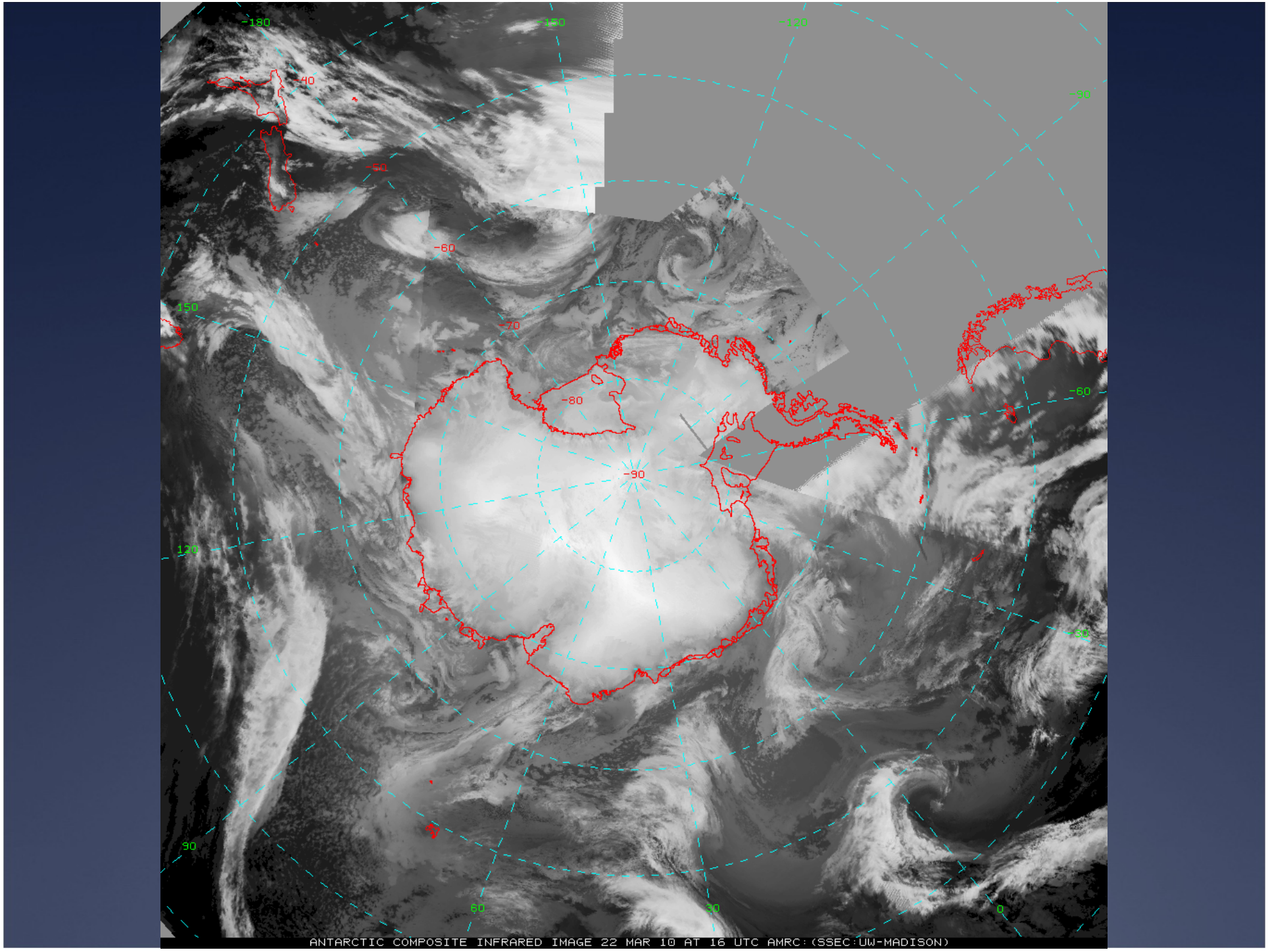
Web:
http://amrc.ssec.wisc.edu
http://arctic.ssec.wisc.edu

FTP & Rsync:
ftp://amrc.ssec.wisc.edu/pub/composite

ADDE:
Group: AMRC
Machine: amrc.ssec.wisc.edu
Group: ARCTIC
Machine: arctic.ssec.wisc.edu

LDM (Antarctic-IDD):
ANT.AMRC.Composite.<band>.<date>.<time>.area
ANT.AMRC.Composite.<band>.<date>.<time>.jpg
ANSP.AMRC.Composite.<band>.<date>.<time>.area
ANSP.AMRC.Composite.<band>.<date>.<time>.jpg
etc.

Formats:
McIDAS AREA, 'netCDF', GIF/JPEG/etc., "flat" file (ASCII, binary), etc.


-180
-150
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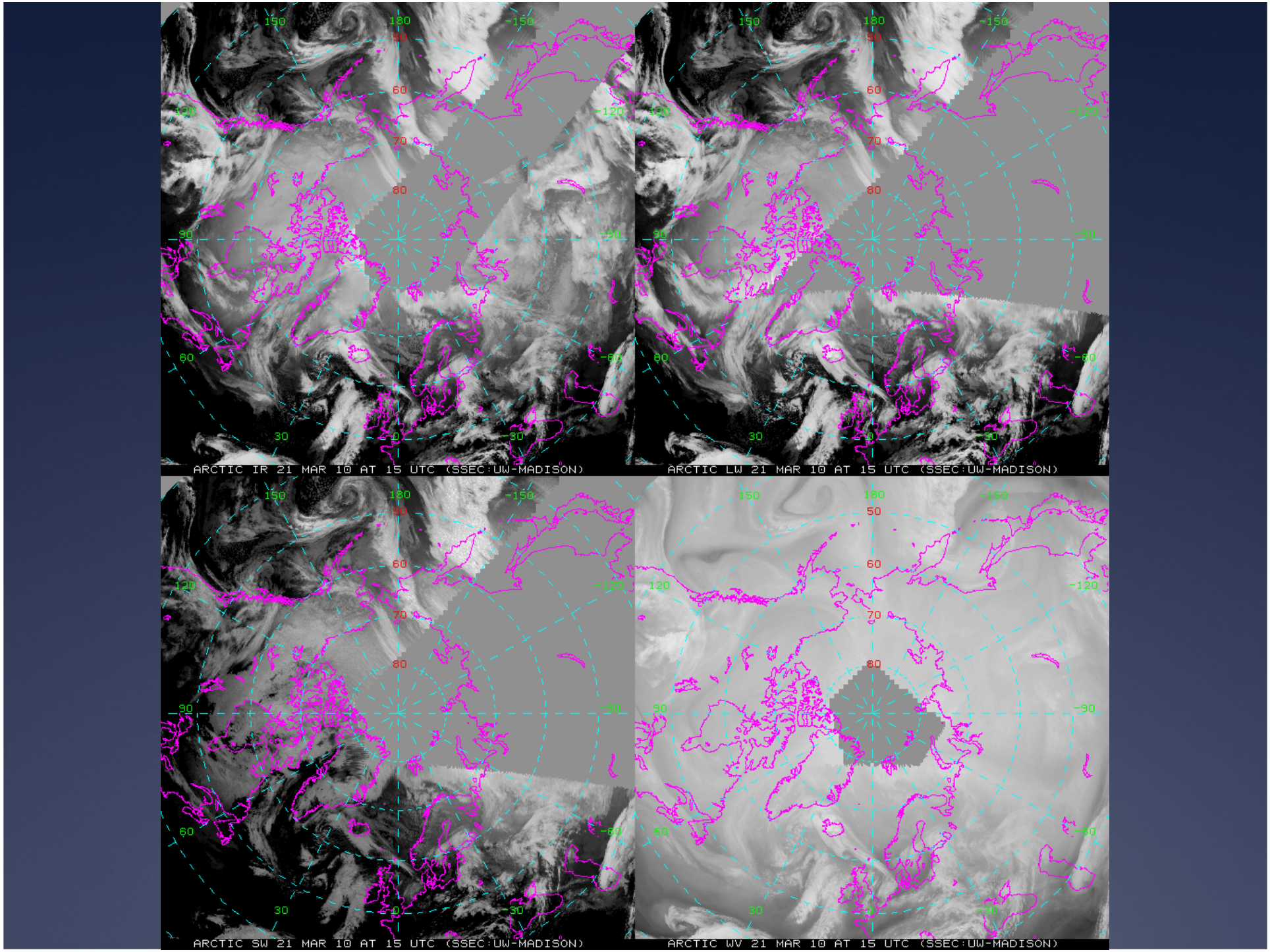
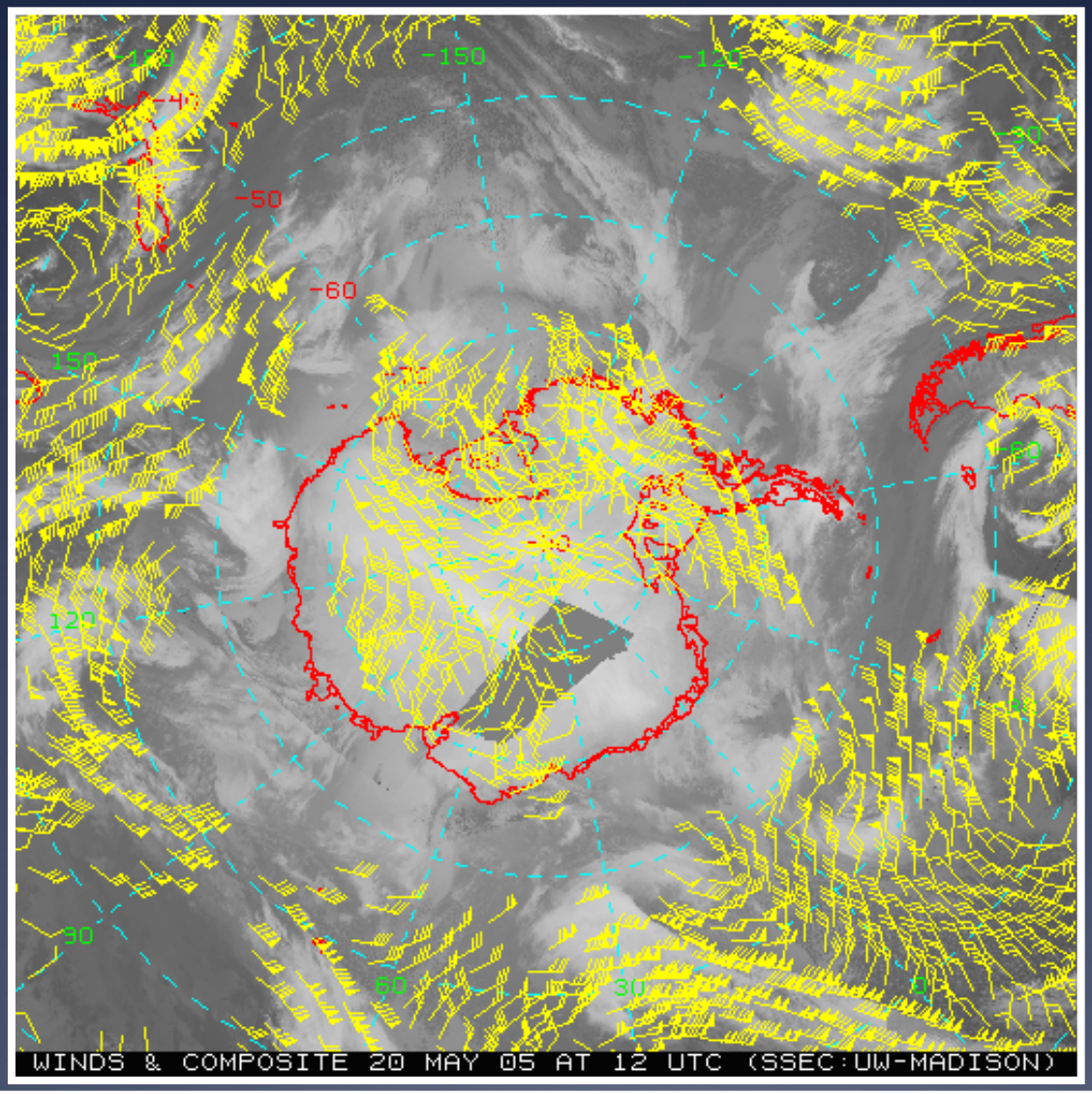
ANTARCTIC COMPOSITE INFRARED IMAGE 22 MAR 10 AT 16 UTC AMRC:(SSEC:UW-MADISON)

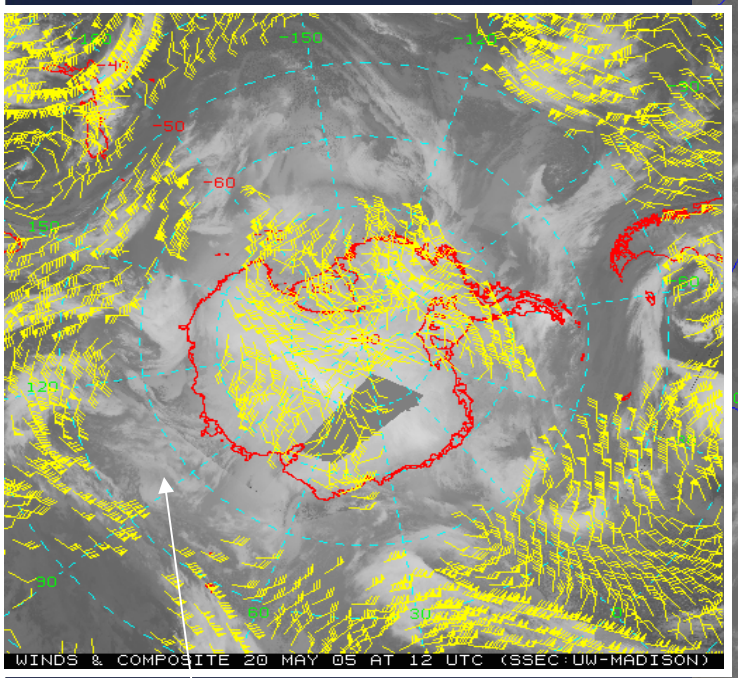

ARCTIC IR 21 MAR 10 AT 15 UTC (SSEC:UW-MADISON)
ARCTIC LW 21 MAR 10 AT 15 UTC (SSEC:UW-MADISON)
ARCTIC SW 21 MAR 10 AT 15 UTC (SSEC:UW-MADISON)
ARCTIC WV 21 MAR 10 AT 15 UTC (SSEC:UW-MADISON)

Sample Application: Atmospheric Motion Vectors (AMV)

Geostationary and Polar-orbiting

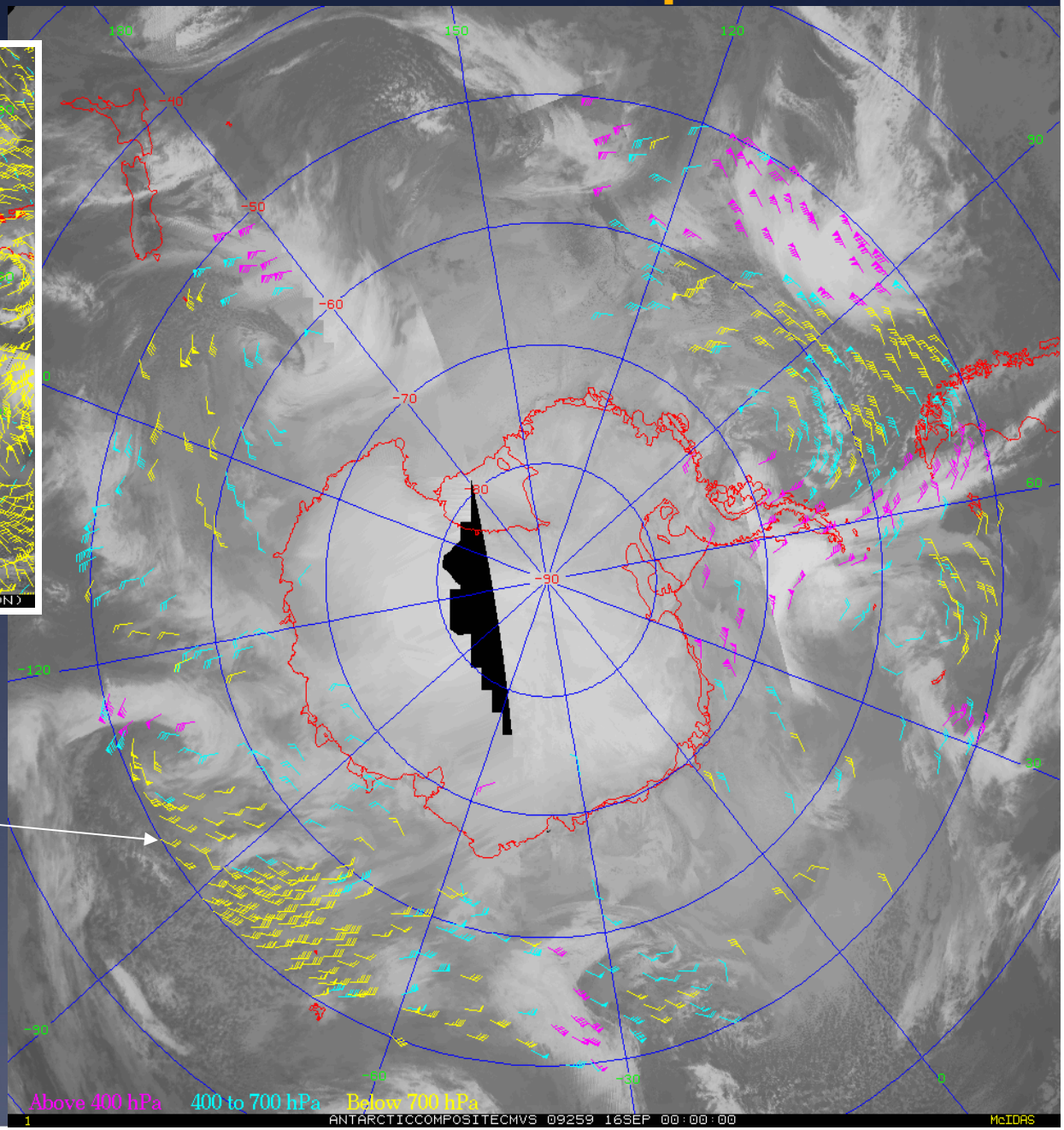


Composite AMV Development



Filling in the Observation Gap

Composite Cloud Motion Vectors (CCMV)



Composite AMV Development

* AMV are being run parallel on two machines with different settings

Take 3 consecutive hourly composites over the Antarctic and input into wind development algorithm (Windco)

Finding targets by calculating local brightness temperature gradients that exceed threshold; 15 (Default) versus 7

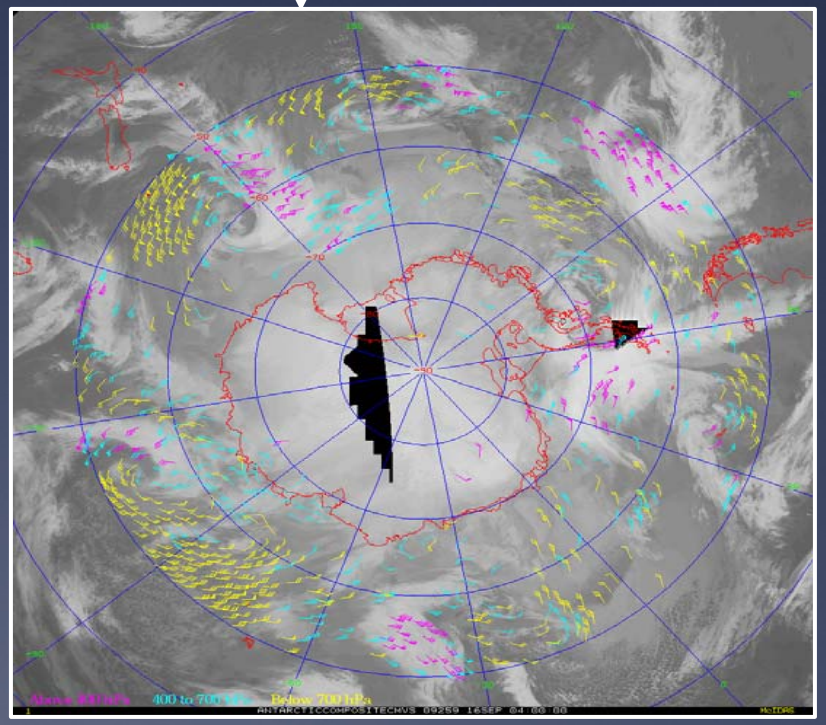
Determine height of target by comparing the average temperature of target pixels to the background field; GFS forecast of 6 to 12 hours

Use background wind field to create search box and find highest correlated gradient point between target and search box

Sub-vectors are generated between images in a triplet and acceleration check is performed to throw out bad vectors.

Post-processing: **With and Without Ckcirrus** etc., Recursive Filtering (RF) to obtain the best possible height assignment and Quality Indicator (QI) values are calculated.

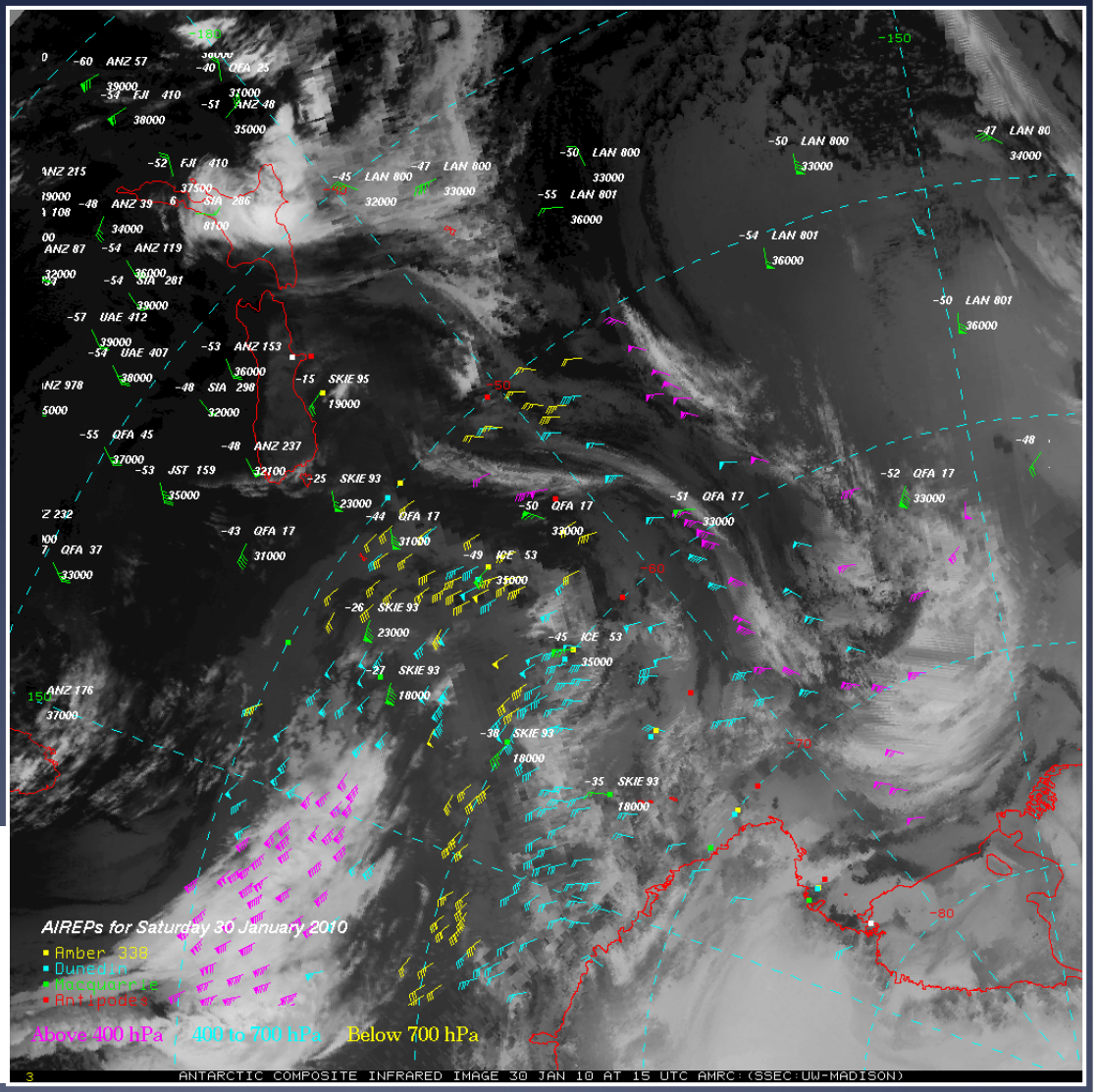
Each vector is given a flag based on RF and QI values(60 vs. 70), and any vectors that surpass threshold are accepted.



Validation Process

- Run Windco process parallel on two computers: AWS/AMRC. Each computer is running Windco on different settings.
- Retrieve Radiosondes data south of 50° S latitude.
- **Retrieve AIREP reports** …
  - ICE = C-17 USAF
  - SKIE = SKIER - LC-130 NYANG
  - KIW = KIWI - C-130 RNZAF
  - SDN = Australia Airbus
  - SFR = SAFAIR/South African Air
  - LAN = LAN Airlines (Chile)
  - QFA = Qantas Airlines
  - British Antarctic Survey
- Compare AMVs on both runs
- Observations…
  - Radiosonde: 100 km/50 hPa
  - AIREPs: 100 km/ 500 meters

	>=850 hPa	850> to 500 hPa	Above 500 hPa
Vector RMS	4.89	6.48	9.46
Vector Diff.	4.37	5.50	7.96
Speed RMS	2.80	4.87	6.49
Speed Bias	-1.66	-0.35	+0.06
AVHRR Spd	15.49	18.88	33.98
VNRMS	.29	.34	.28
Sample Size	21	135	207



AMV Summary & Conclusions

- Antarctic Composites are increased temporally from every 3 to 1 hour. This allows them to be used for the development of Motion Vectors
- AMV/CCMV are validated versus RAOBS and **AIREPS**.
- AMV/CCMV have potential to fill in the observation network, the gap between 60-70°S.
  - Validation indicates much improved quality (especially above 500 hPa) when the ckcirrus routine is removed. However, not seen at 60-70º S
  - Additional validation and sensitivity testing is continuing (QI, DVAL,Target size etc.)
  - Time stamping remains an issue to be resolved in the future. Comparison of MODIS MIX AMVs indicate significant sensitivity with changing cross-time stamps
  - MODIS MIX AMVs and CCMVs are NOT yet ready to be used for model assimilation **,** but hopefully soon. **Work in progress**.
  - Future consideration and planning of modifying windco includes the tagging of individual targets with the true (pixel) time.

Future Work

- Additional hourly composites
  - Additional spectral channels
- Trial new combination methods
- Adding satellites
  - MetOp-A
  - Aqua/Terra (water vapor composites)
- Generate AMVs from Arctic composites
- Generate winds from water vapor composites?
- Test compositing techniques for optimal spatial and temporal resolution of all satellites
- Take into account satellite parallax and time of observation into the compositing process
- Modify the wind-derivation software to work with the new composites and metadata information
- Continue validation and trial testing of the compositing and AMV generation process in real-time using NESDIS methods with radiosondes and verification with aircraft (AIREP) observations

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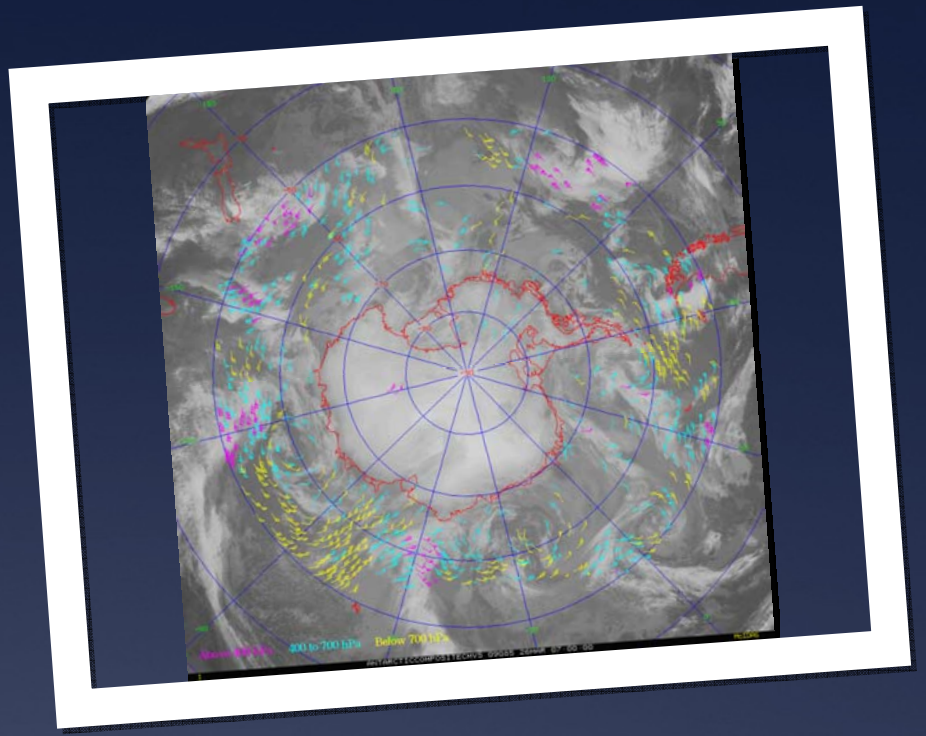
Thank you!



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