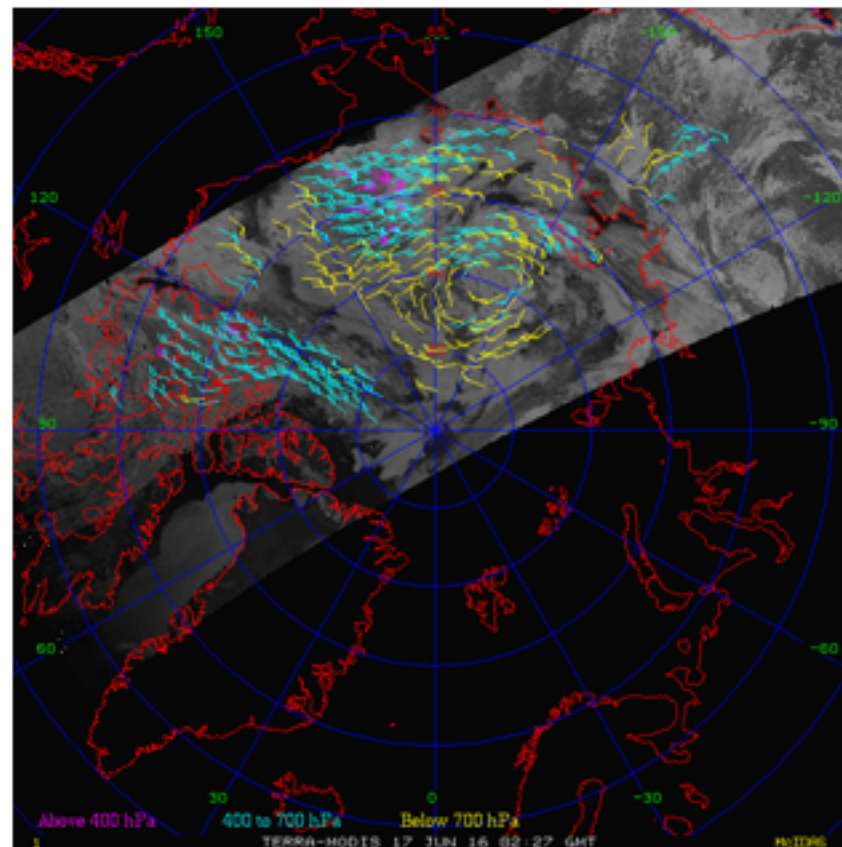


Polar Winds from Shortwave-Infrared Band Cloud Tracking

Jeff Key*, Dave Santek+, and Rich Dworak+

*NOAA/National Environmental Satellite, Data, and Information Service, Madison, WI
+ Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin-Madison



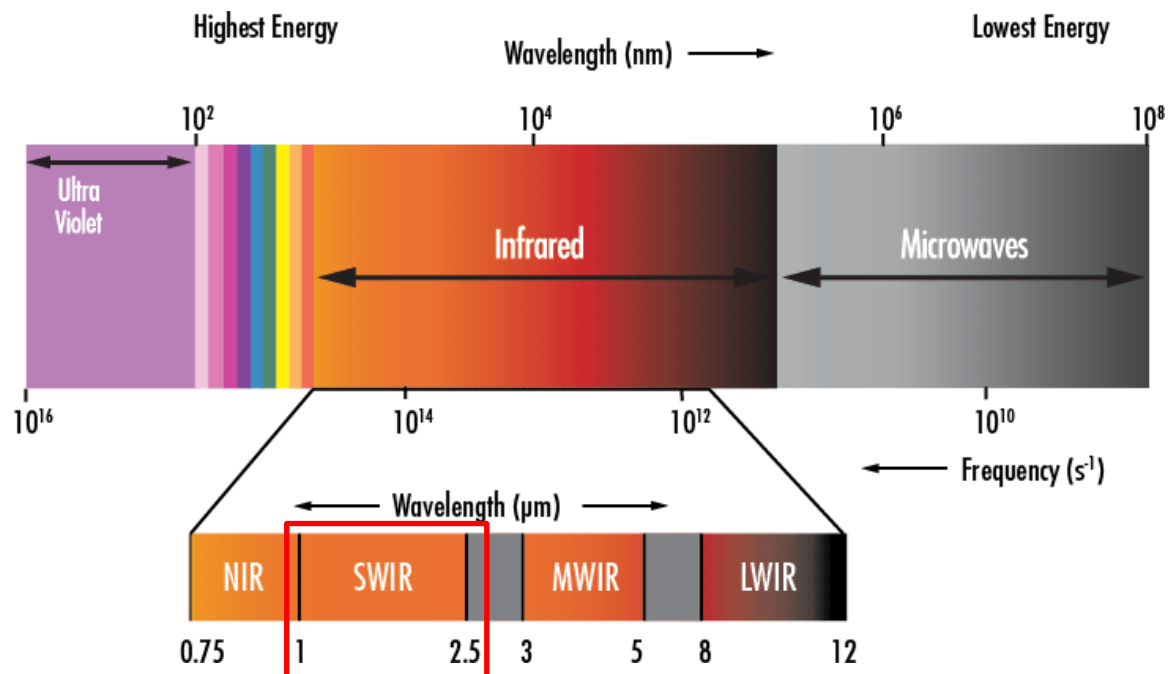
Before proceeding...

Near Infrared or Shortwave Infrared?

Imager bands at 1.6 and 2.1 μm are best termed “shortwave infrared” (SWIR).

Division Name	Abbreviation	Wavelength	Frequency
Near-infrared	NIR, IR-A <i>DIN</i>	0.75–1.4 μm	214–400 THz
Short-wavelength infrared	SWIR, IR-B <i>DIN</i>	1.4–3 μm	100–214 THz
Mid-wavelength infrared	MWIR, IR-C <i>DIN</i> ; MidIR. ^[12] Also called intermediate infrared (IIR)	3–8 μm	37–100 THz
Long-wavelength infrared	LWIR, IR-C <i>DIN</i>	8–15 μm	20–37 THz
Far-infrared	FIR	15–1000 μm	0.3–20 THz

(From wikipedia)



(From edmundoptics)

ISO 20473 scheme [\[edit\]](#)

ISO 20473 specifies the following scheme:^[14]

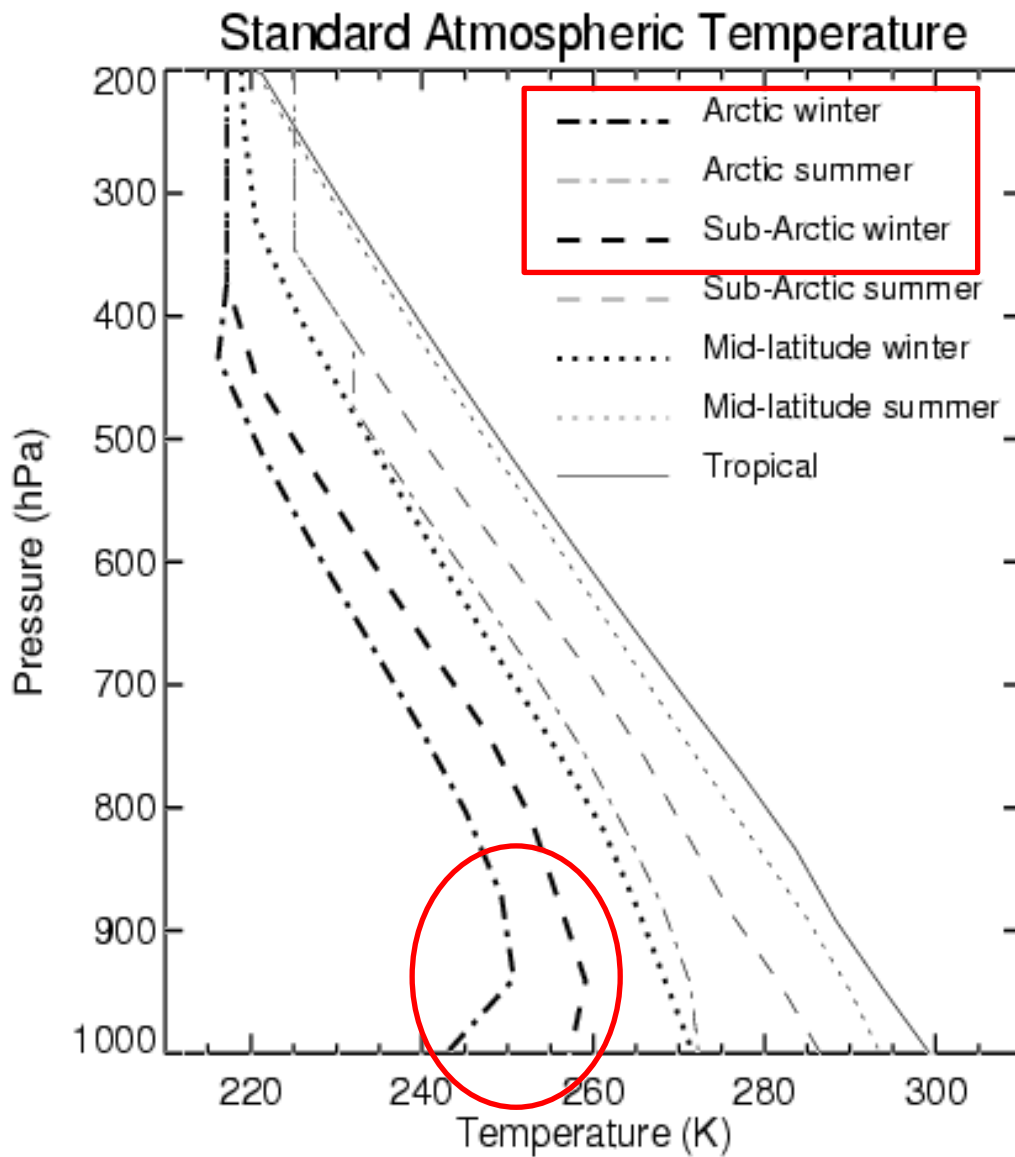
Designation	Abbreviation	Wavelength
Near-Infrared	NIR	0.78–3 μm
Mid-Infrared	MIR	3–50 μm
Far-Infrared	FIR	50–1000 μm

Motivation



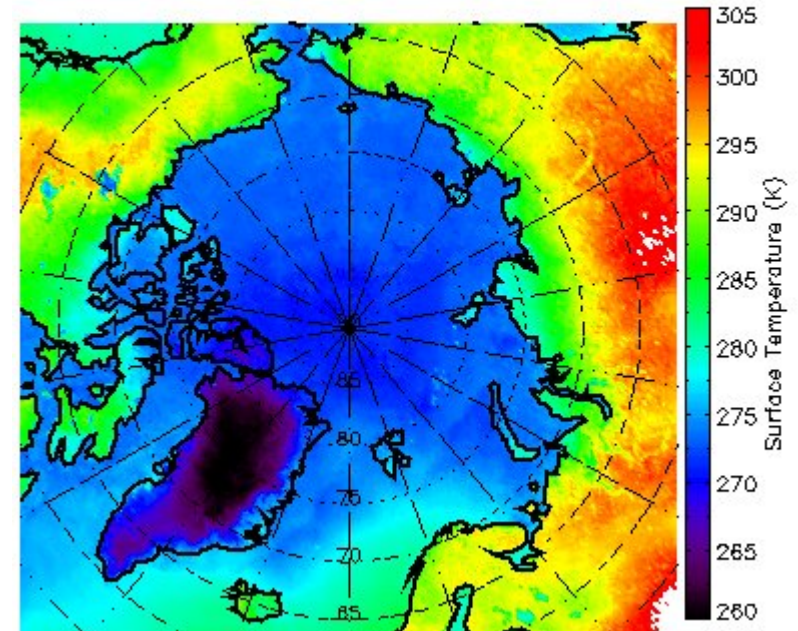
- Winds are derived by tracking clouds (in this case). However, polar clouds are notoriously difficult to detect because of the similarities between their temperature and reflectance properties and those of the underlying snow and ice surface, resulting in less well-defined targets for tracking.
- In the shortwave infrared, however, the scattering properties of liquid clouds and snow/ice are significantly different, and therefore the contrast between low clouds and the surface is large.
- In theory, SWIR data will provide more good features for cloud tracking and atmospheric motion vector derivation during the “daytime”, especially for low clouds.

Temperature

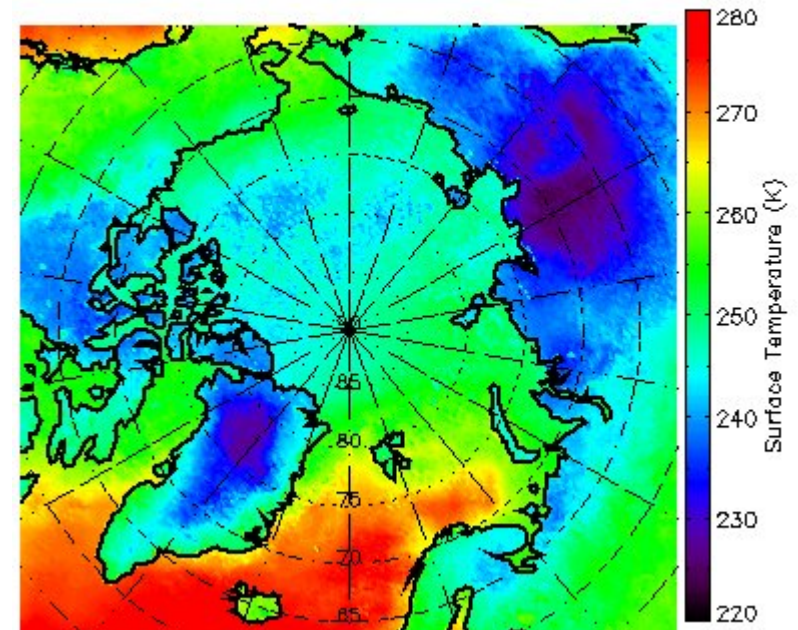


Low, liquid clouds are often warmer than, or similar in temperature to, the surface.

Surface Temperature
June

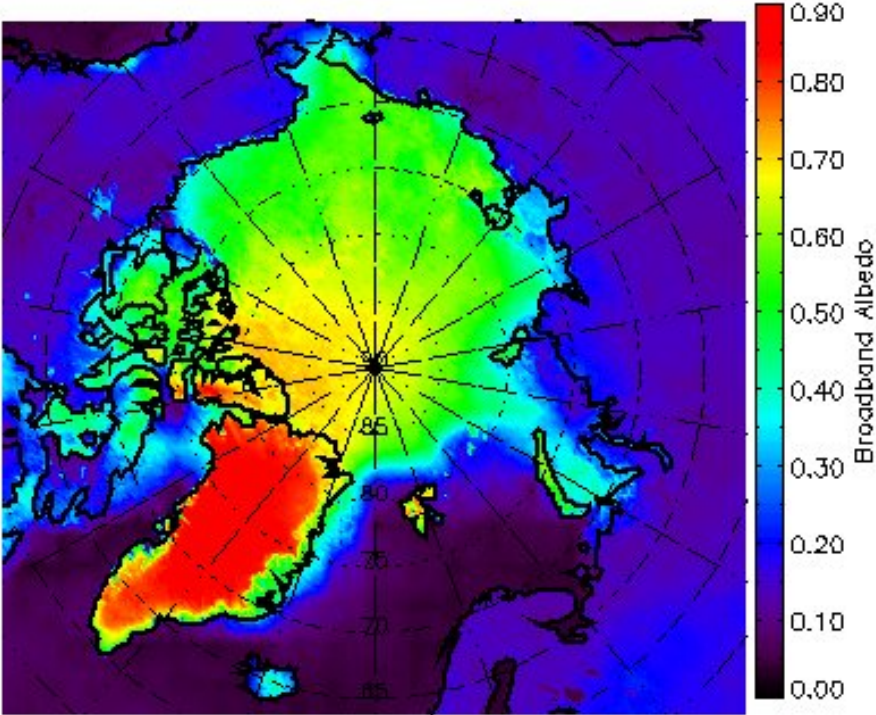


Surface Temperature
January

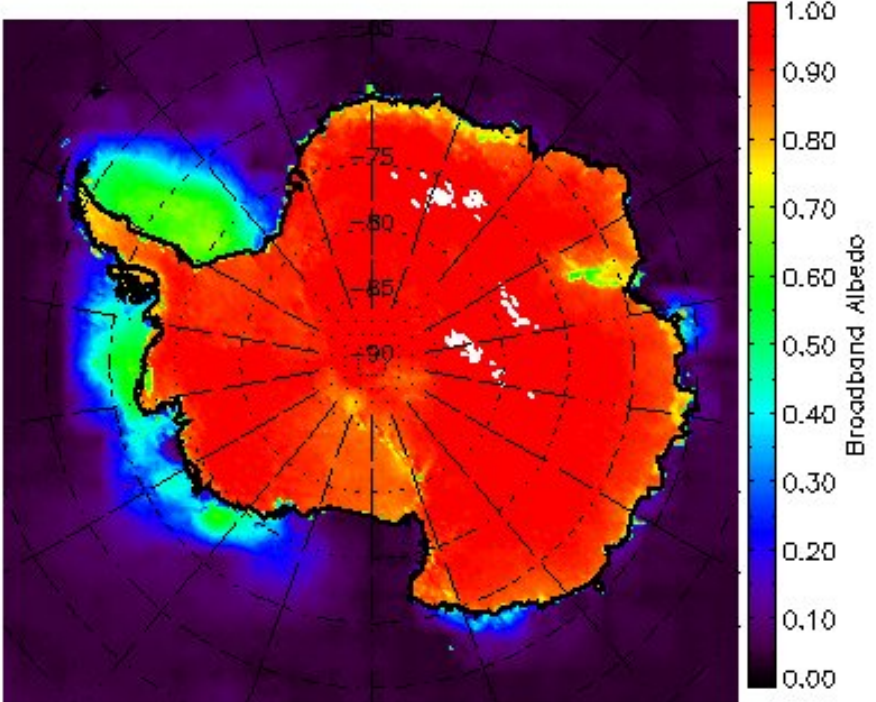


When it's not dark, it's bright!

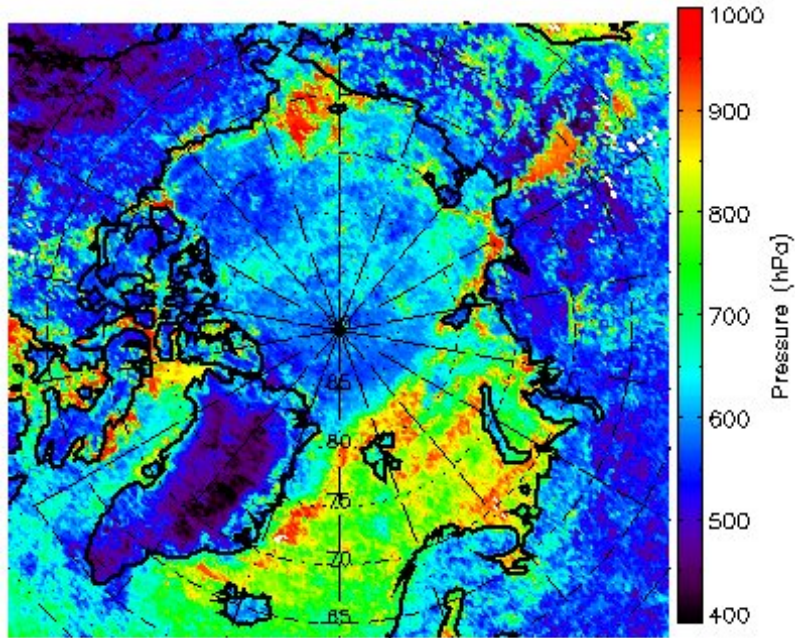
Surface Albedo
June



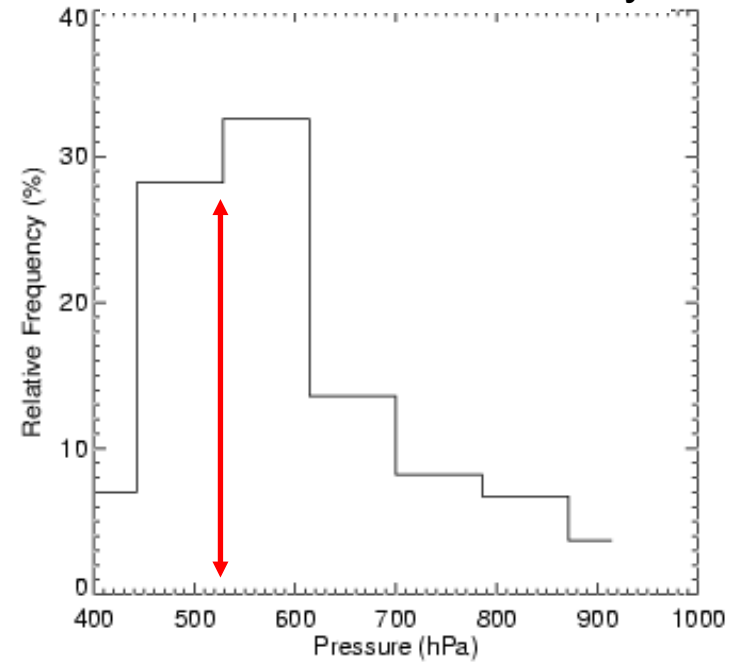
Surface Albedo
January



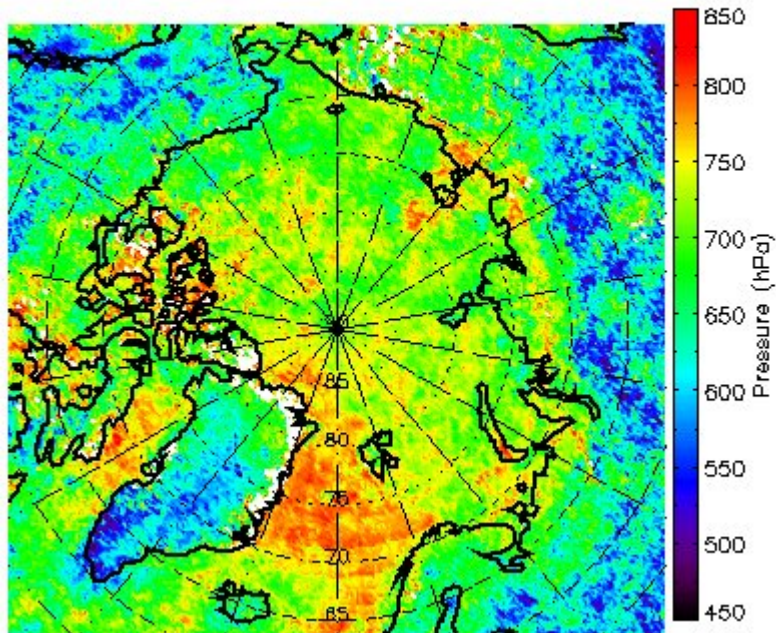
Cloud Pressure, January



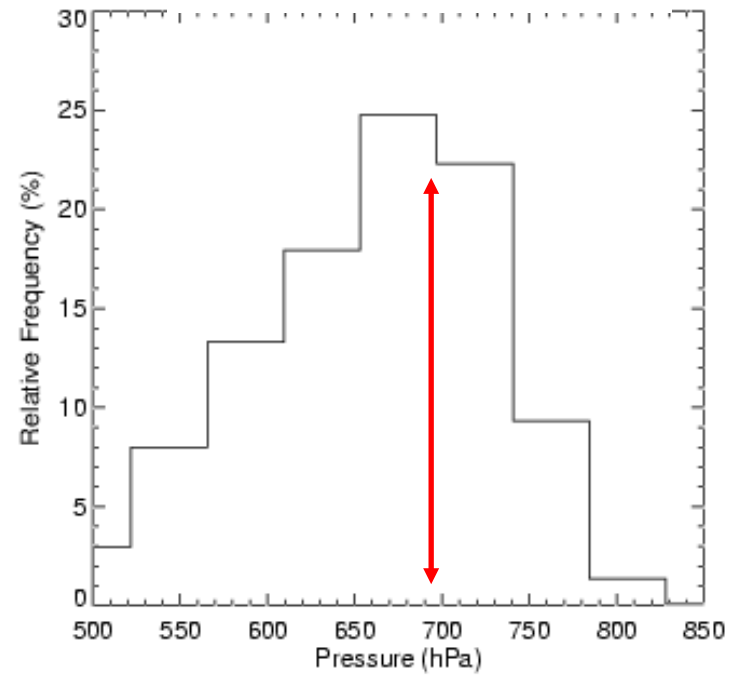
Cloud Pressure, January



Cloud Pressure, June

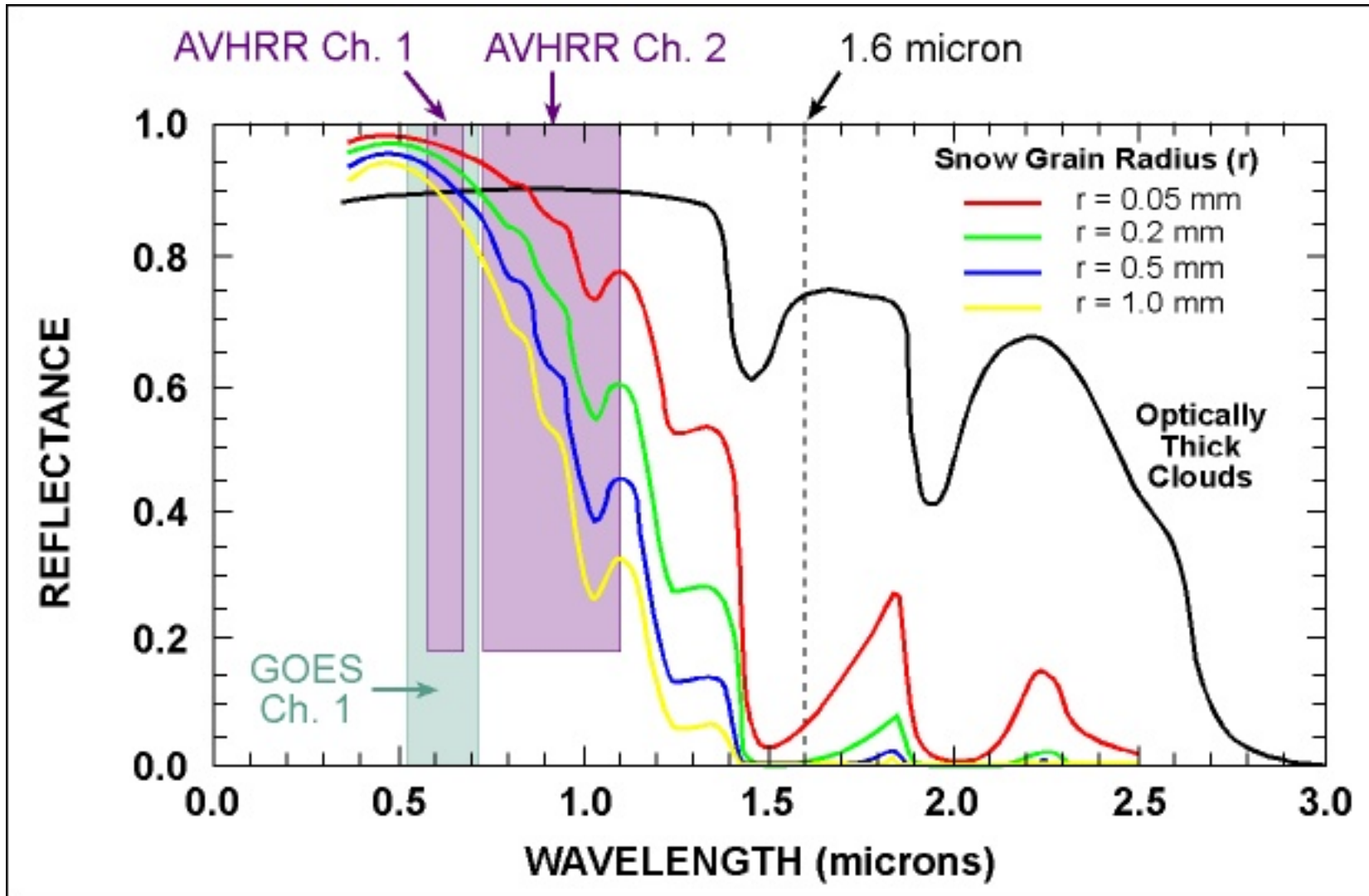


Cloud Pressure, June



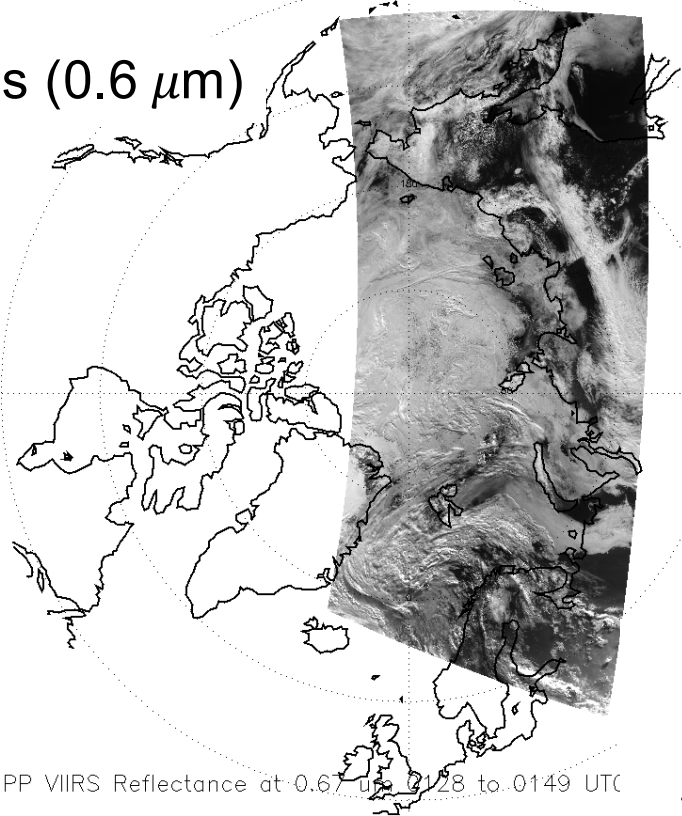
Spectral Signatures

Liquid clouds and snow/ice are similarly bright in the visible, but are much brighter than snow/ice in the shortwave- and mid-infrared.

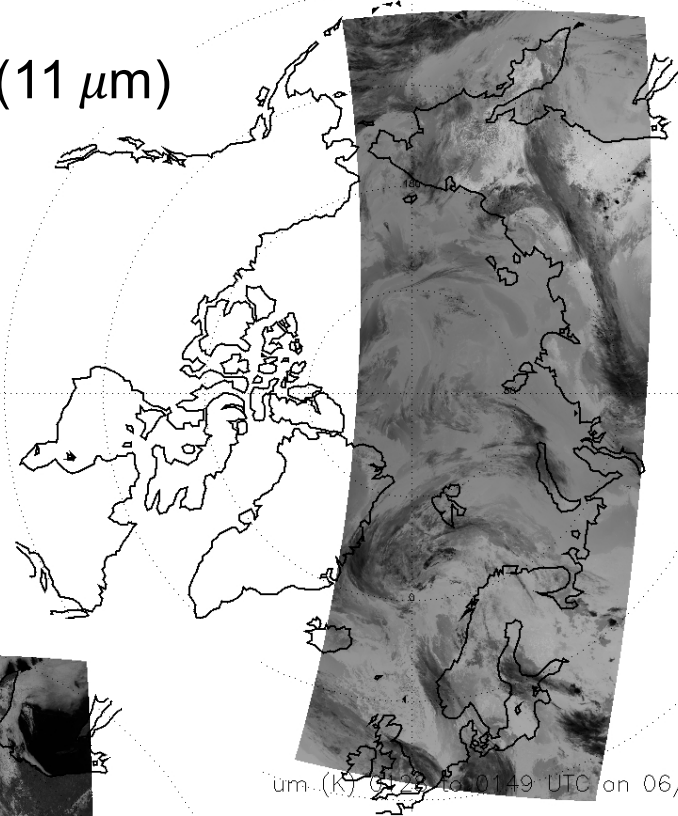


MODIS Visible, SWIR, and IR: Arctic

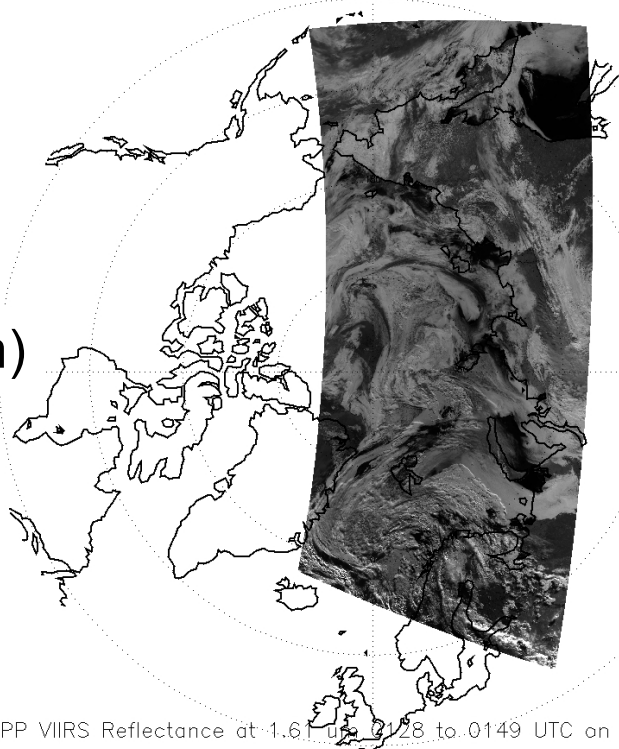
Vis (0.6 μm)



IR (11 μm)



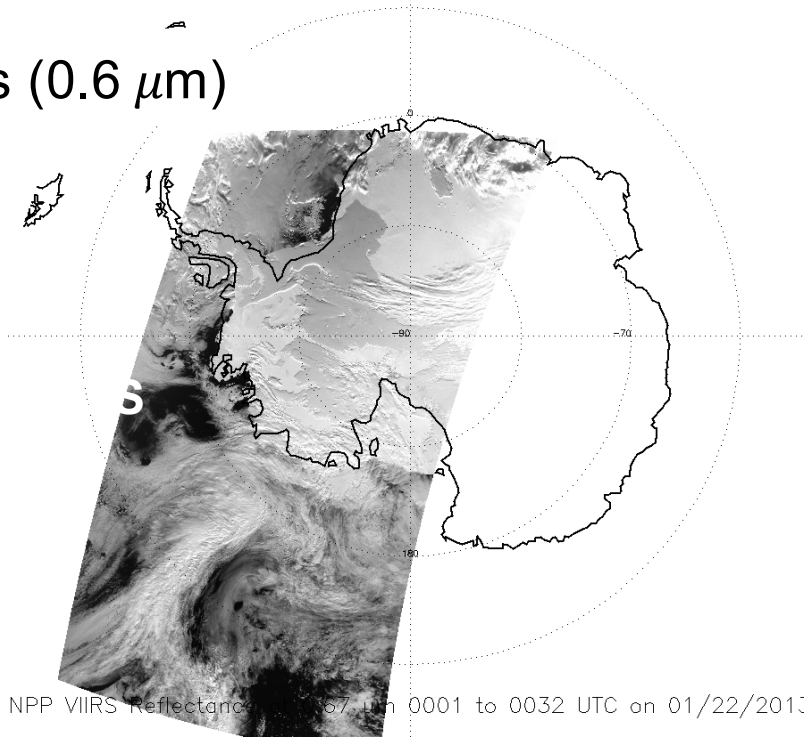
SWIR (2.1 μm)



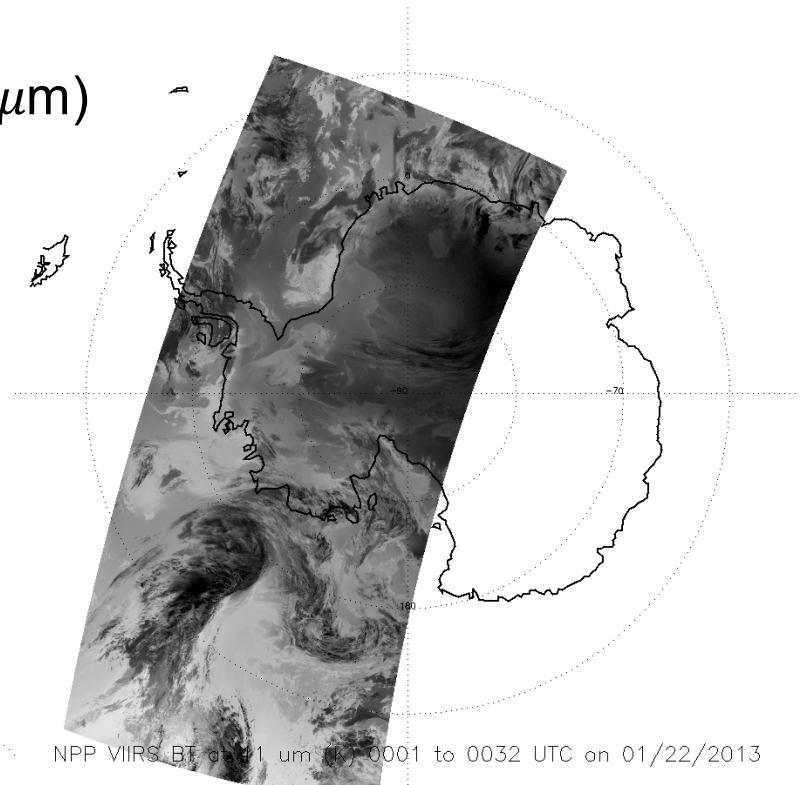
(animations)

MODIS Visible, SWIR, and IR: Antarctic

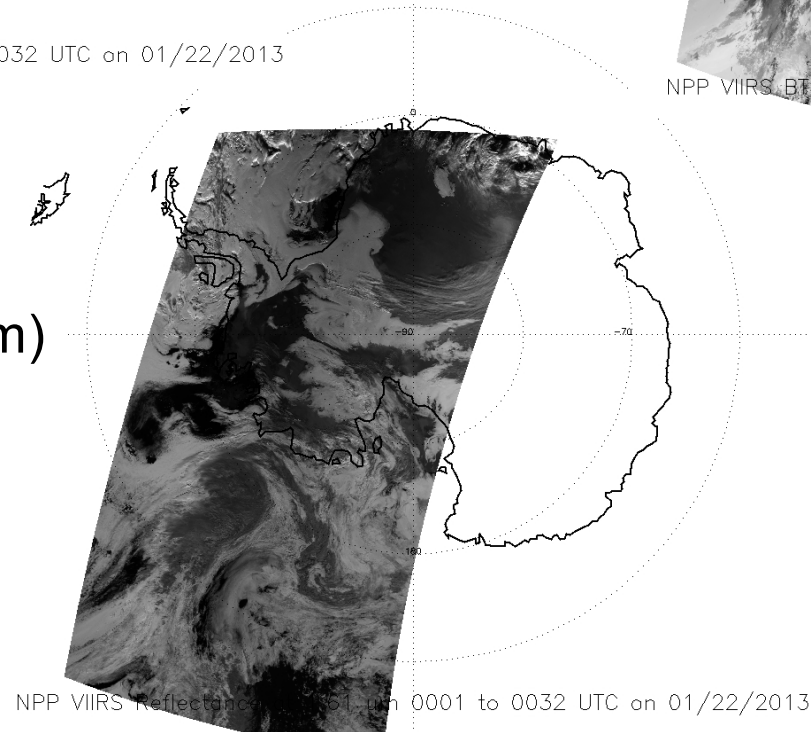
Vis (0.6 μm)



IR (11 μm)



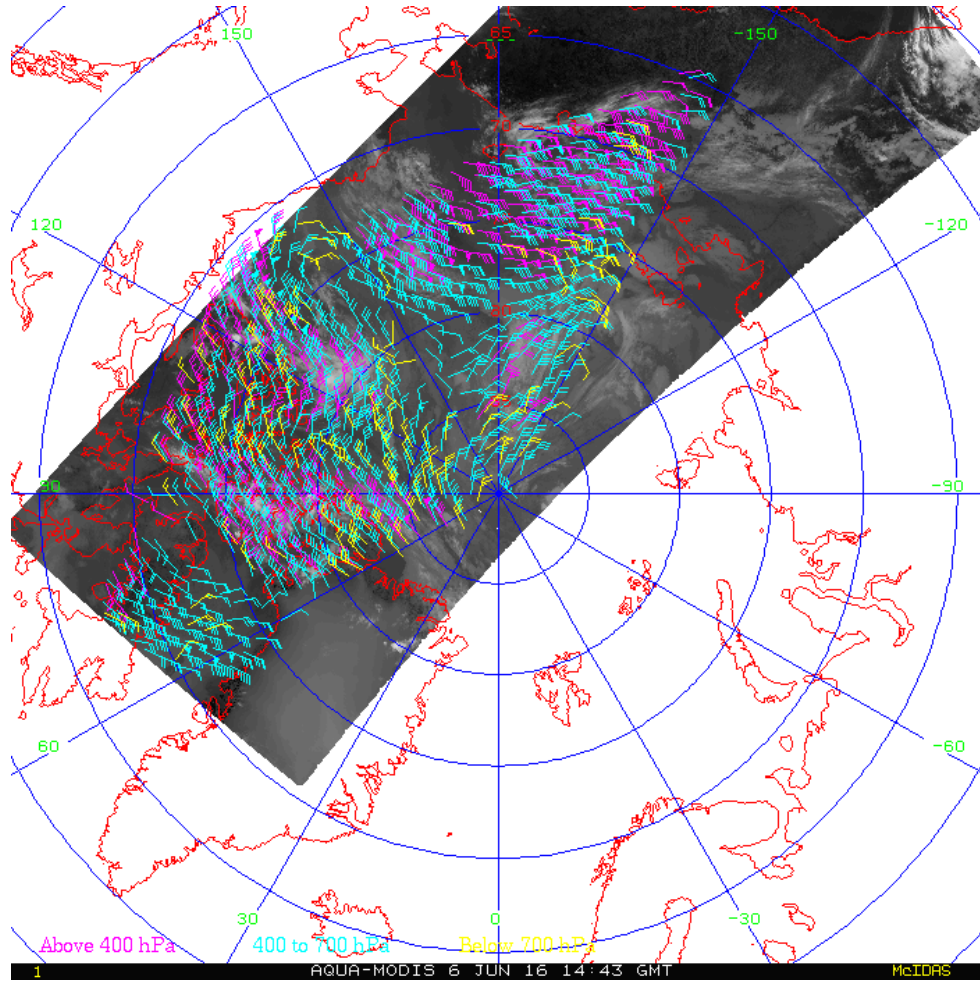
SWIR (2.1 μm)



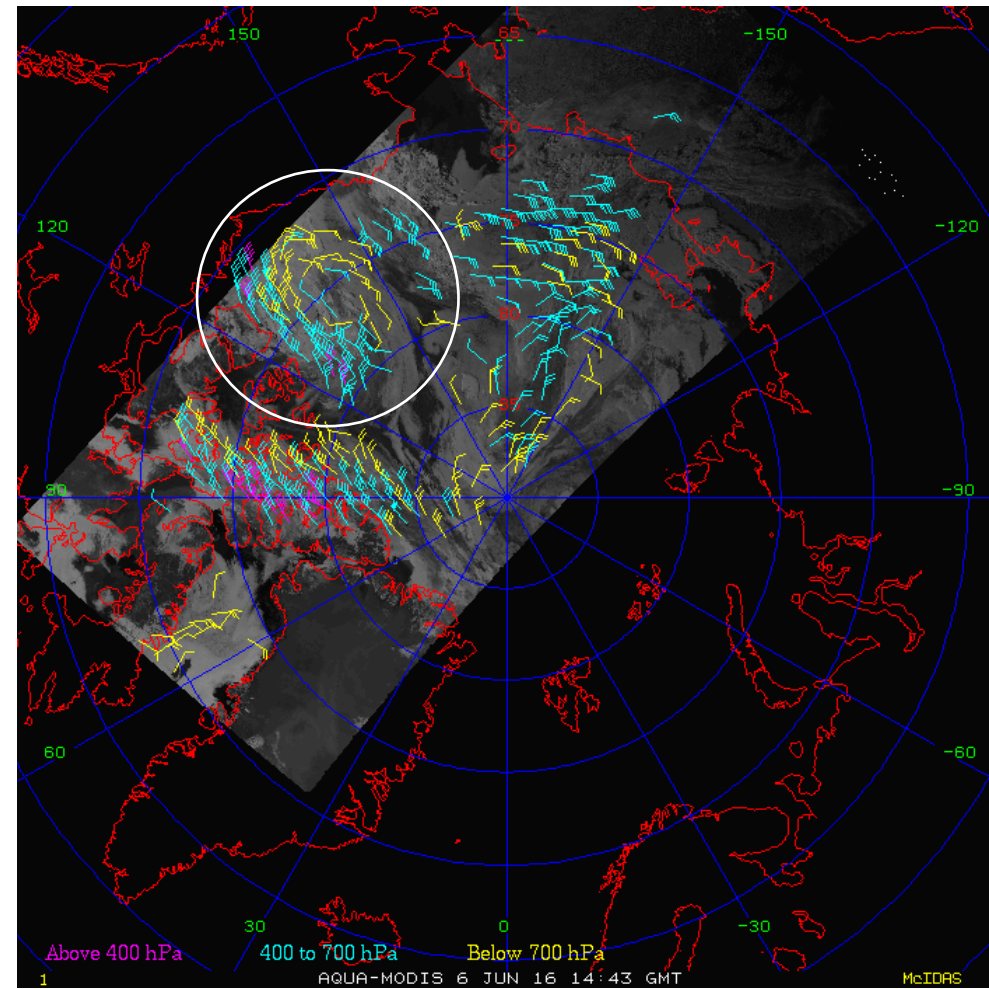
(animations)

Retrieval Examples

WV + IR

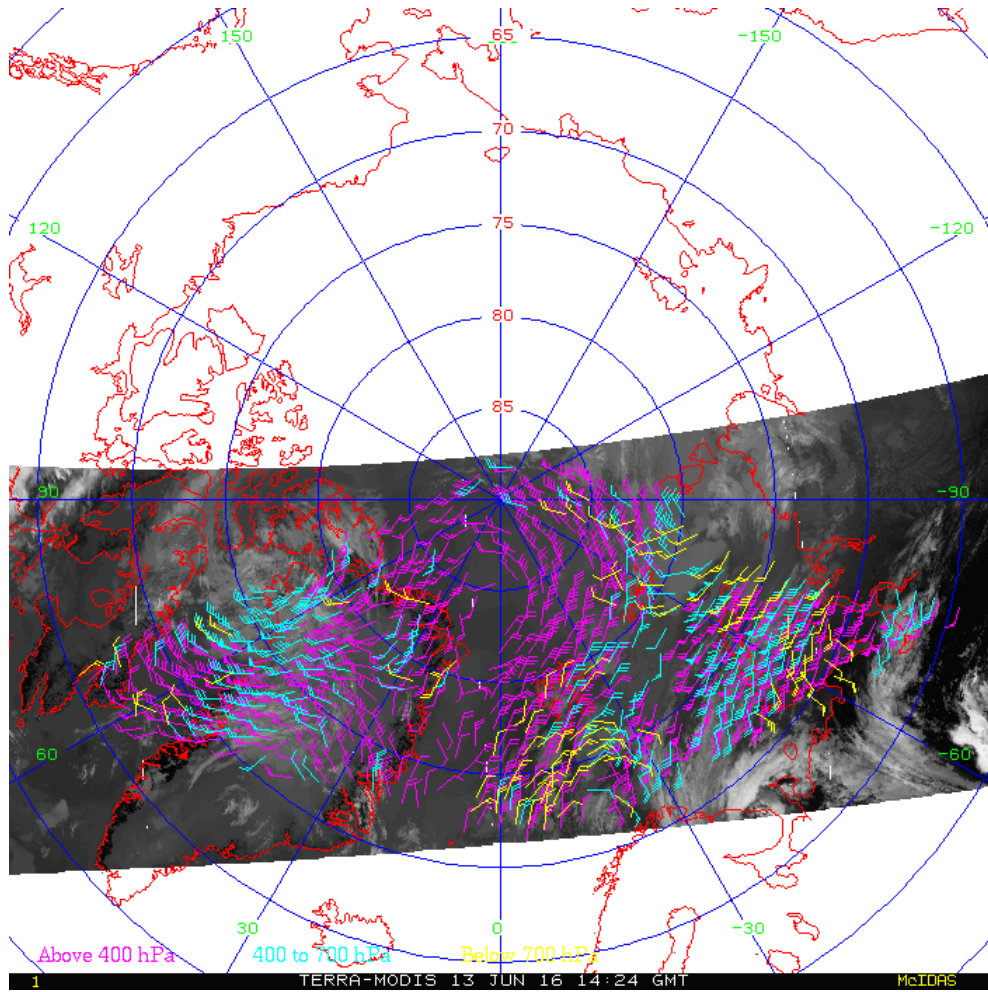


SWIR

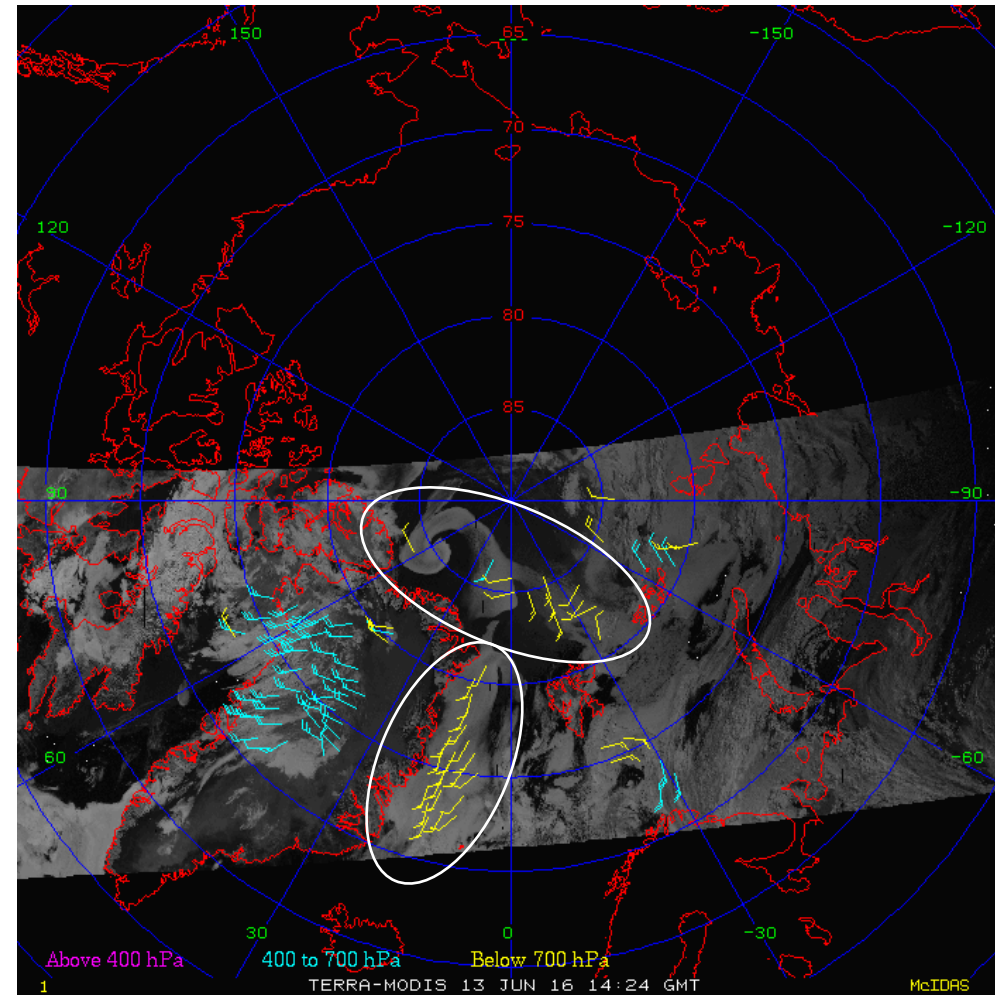


Retrieval Examples

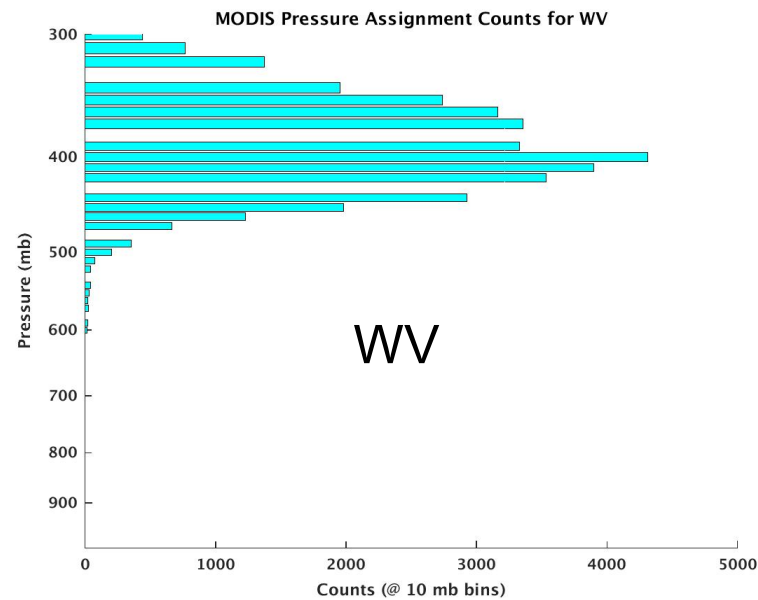
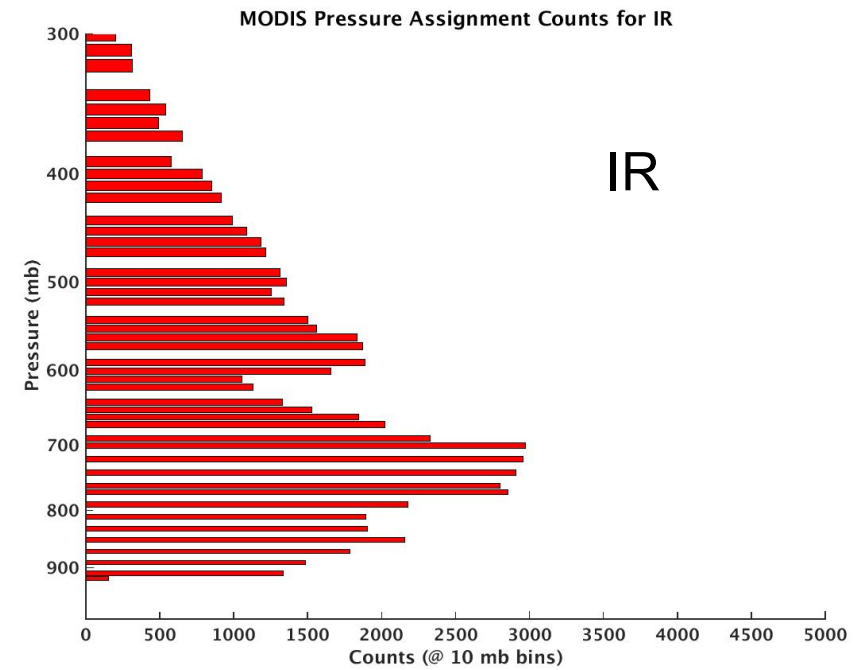
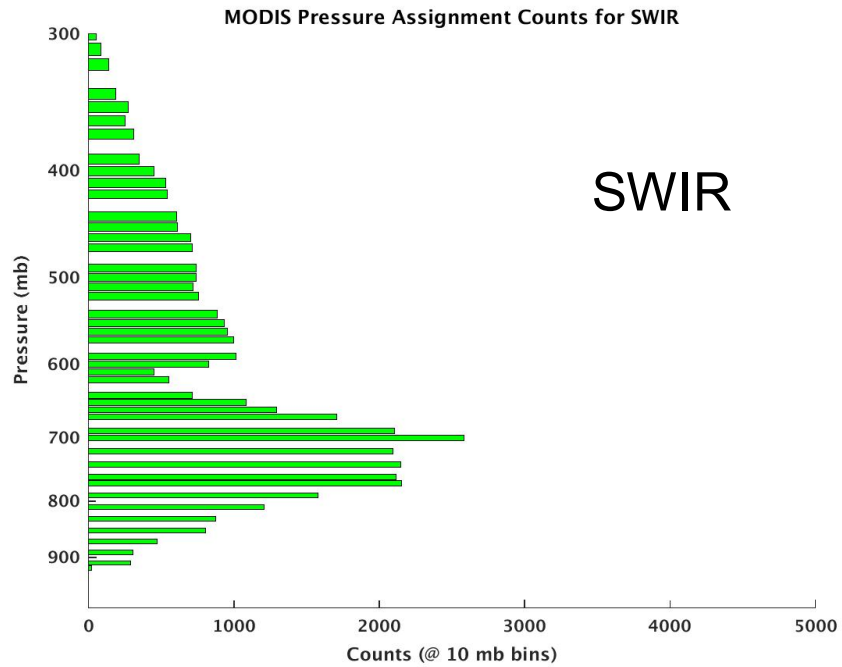
WV & IR



SWIR



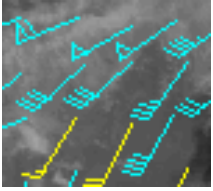
Vertical Distributions of SWIR, IR, and WV Winds



MODIS Aqua & Terra, Arctic & Antarctic Comparison to Raobs

	Count	Vector RMSE		Normalized Vector RMSE		Speed Bias		Average Wind Speed	
		IR	SWIR	IR	SWIR	IR	SWIR	IR	SWIR
HIGH	15	6.70	6.63	0.32	0.32	-0.93	0.07	20.21	21.09
MID	92	4.81	5.24	0.30	0.33	-0.49	-0.78	14.98	15.10
LOW	28	4.97	4.72	0.47	0.45	-1.62	-1.34	9.03	9.13
TOTAL	135	5.11	5.31	0.33	0.35	-0.78	-0.80	14.53	14.71

While the sample size is small, the SWIR wind statistics are as good or marginally better than the IR winds.

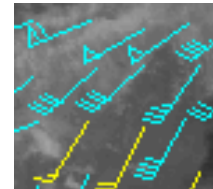


Summary



- The optical properties of liquid clouds and snow/ice are such that tracking in the shortwave infrared should provide additional tracking targets, particularly for low- to mid-level clouds.
- Polar winds from the MODIS 2.1 μm band are now routinely produced at CIMSS for the Arctic and Antarctic (<http://stratus.ssec.wisc.edu/products/rtpolarwinds/>, labelled as “Terra-SW” and “Aqua-SW”).
- There is some evidence that the SWIR winds do, in fact, provide wind information in areas not covered by IR or water vapor winds.
- The SWIR wind statistics are as good or marginally better than the IR winds.
- The SWIR winds are still experimental.
- Next up: VIIRS day-night band (DNB) winds?

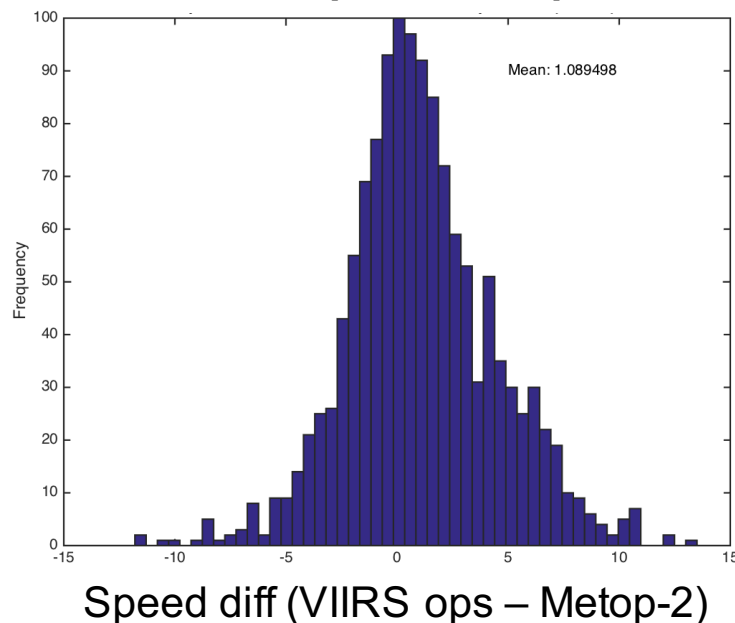
Mystery of the Week: Operational VIIRS Winds Bias



- A speed bias in the operational VIIRS winds has been observed in NCEP monitoring.
- A comparison of ops vs direct broadcast winds shows the same, as does a comparison to other satellites.
- Is it real? (Apparently) What is causing it?

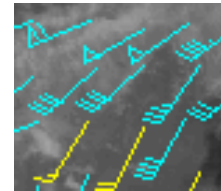
Sat BUFR code	VIIRS ops 224	VIIRS DB ---
VIIRSops	Bias Matches	
VIIRSDB	1.2 2900 ¹	X
Metop-1	1.3 ----	0.3 600 ¹
Metop-2	1.1 ----	0.3 300 ¹
NOAA-15	1.2 ----	0.03 200 ¹
NOAA-18	1.1 ----	0.2 400 ¹
NOAA-19	1.0 ---- ¹	0.4 100 ¹
Aqua	0.9 ----	-0.1 70 ¹
Terra	1.3 ----	0.1 700 ¹

VIIRS Ops vs Metop-2

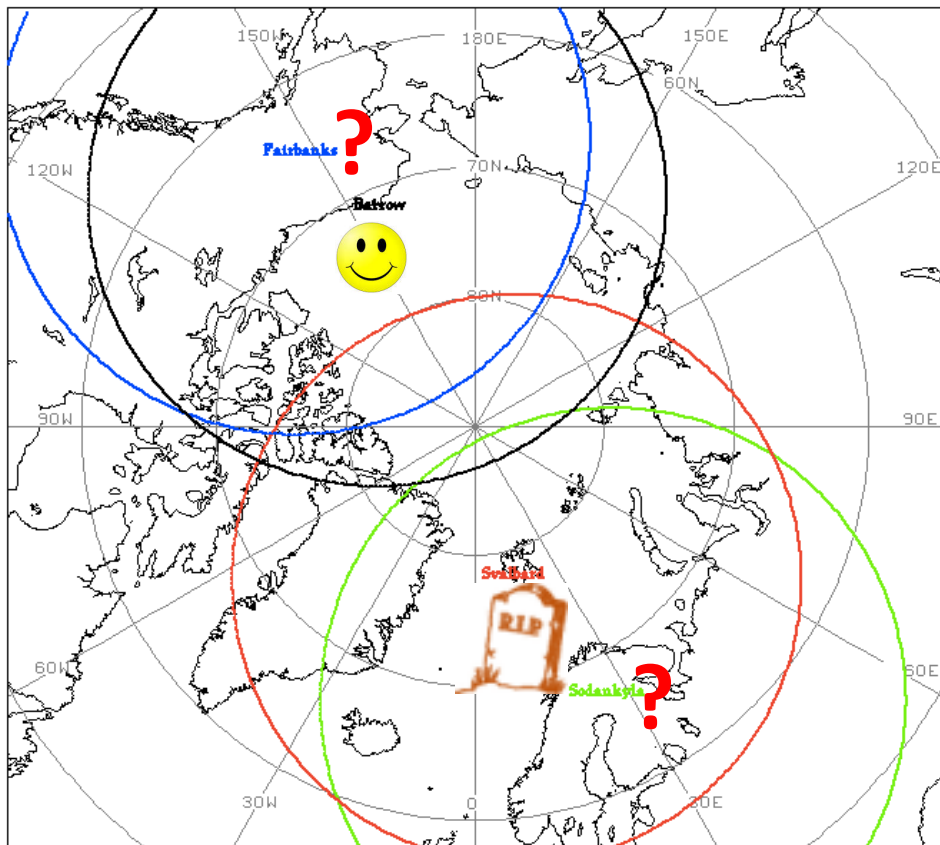


*Matchups within 15 km,
0.5 hrs 20 hPa*

Direct Broadcast Polar Winds Status



Arctic



Antarctic

