Satellite Products and Applications

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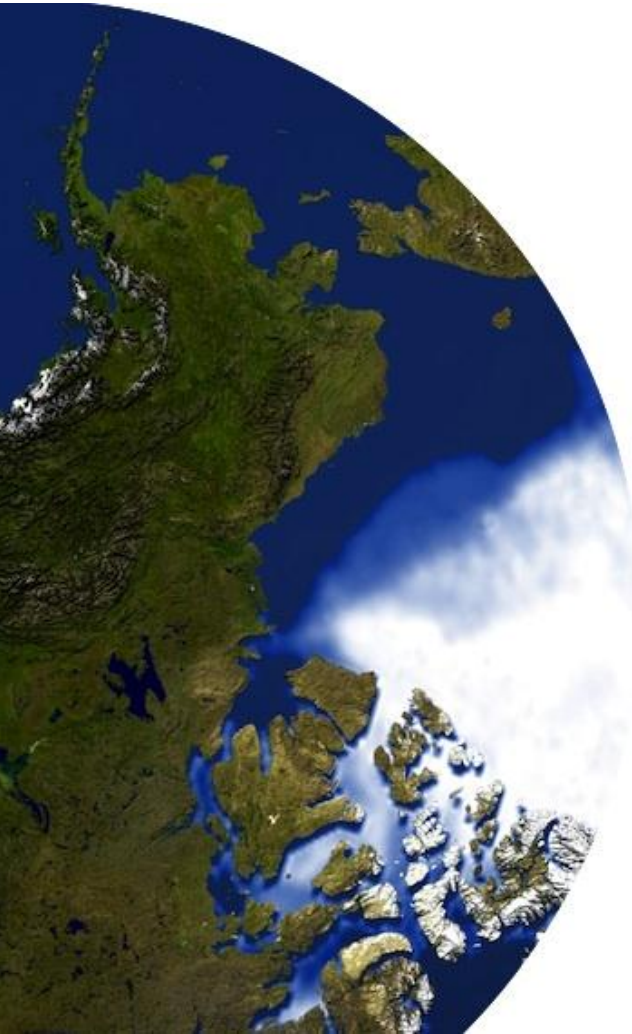
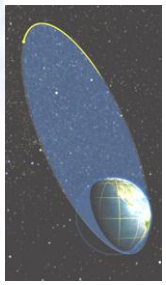
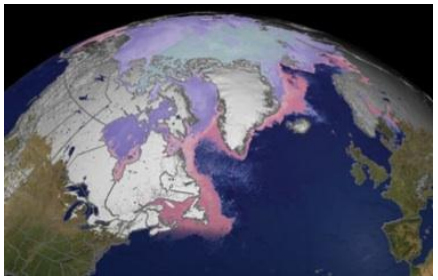
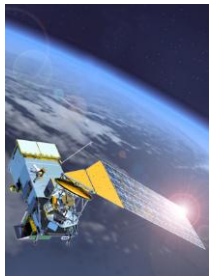


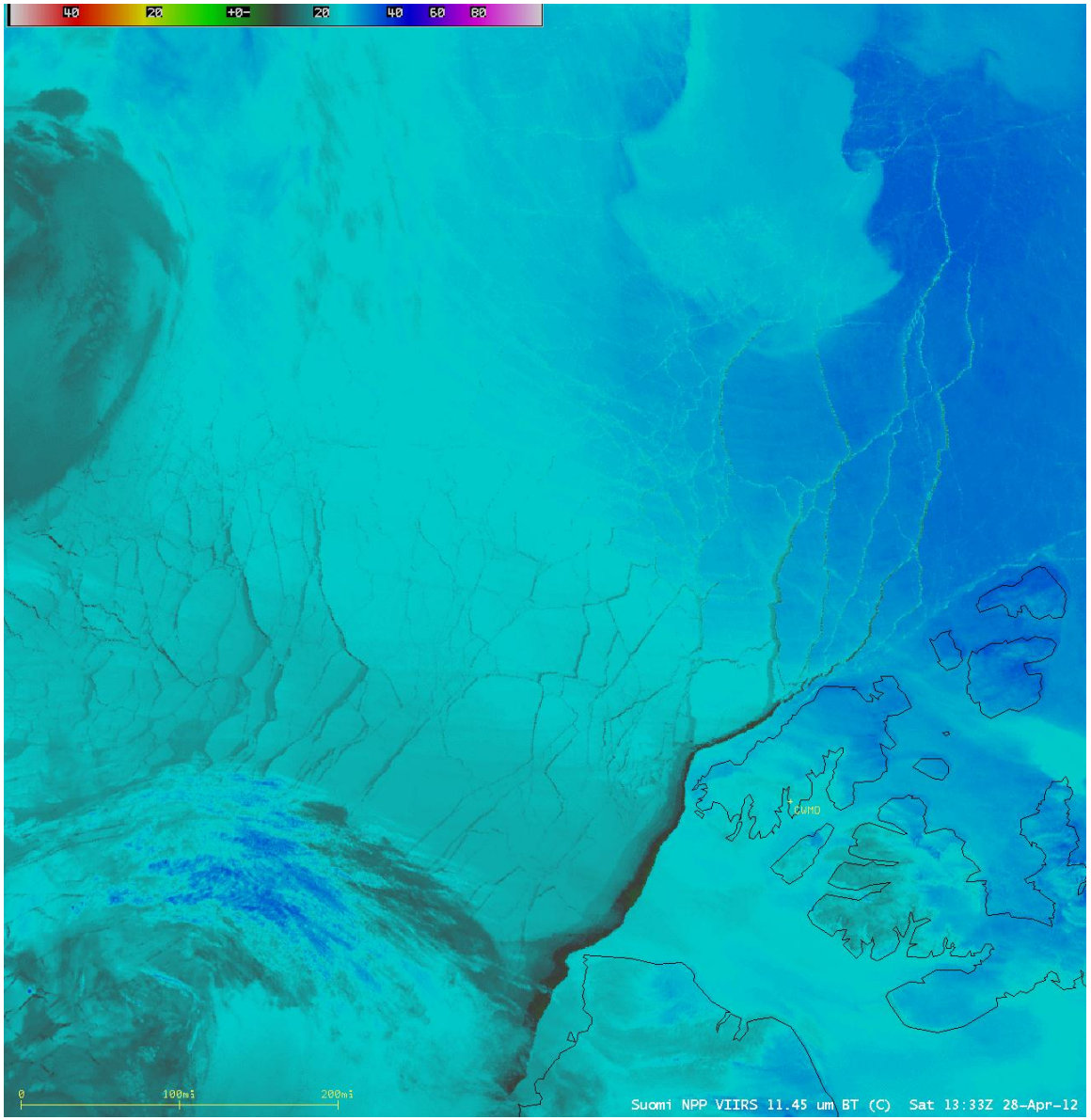
Objective: To provide a brief survey of satellite products relevant to high-latitude meteorological and climatological applications.



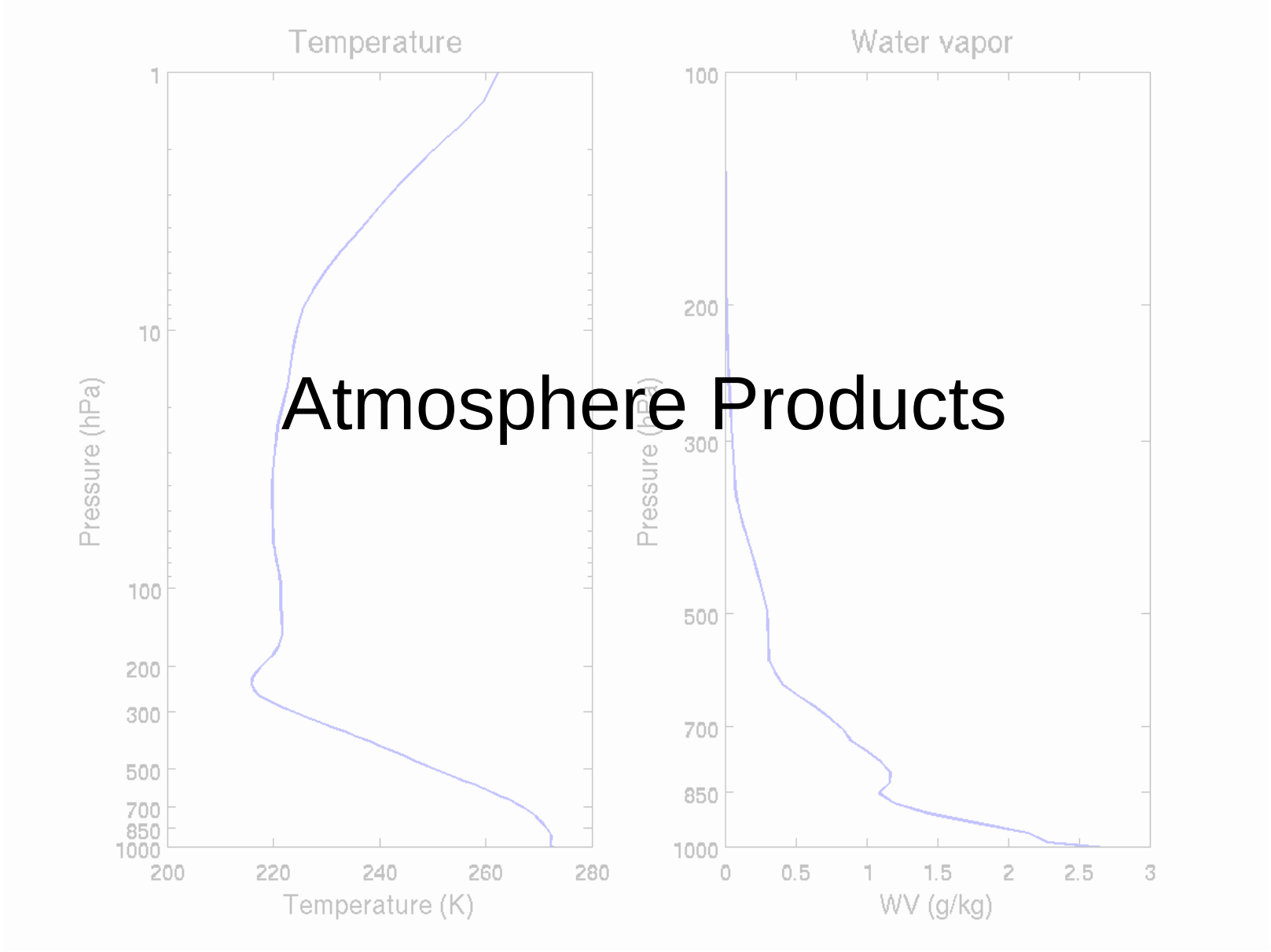




Imagery

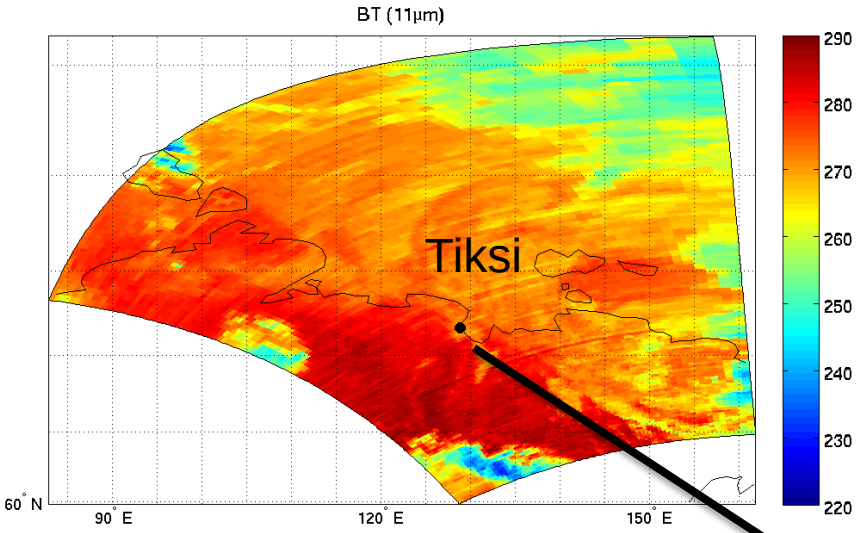


VIIRS IR (11.5 m) animation from consecutive overpasses of Suomi NPP over Prince Patrick Island (located in the far northwestern portion of the Canadian Arctic Archipelago) on 28 April 2012.



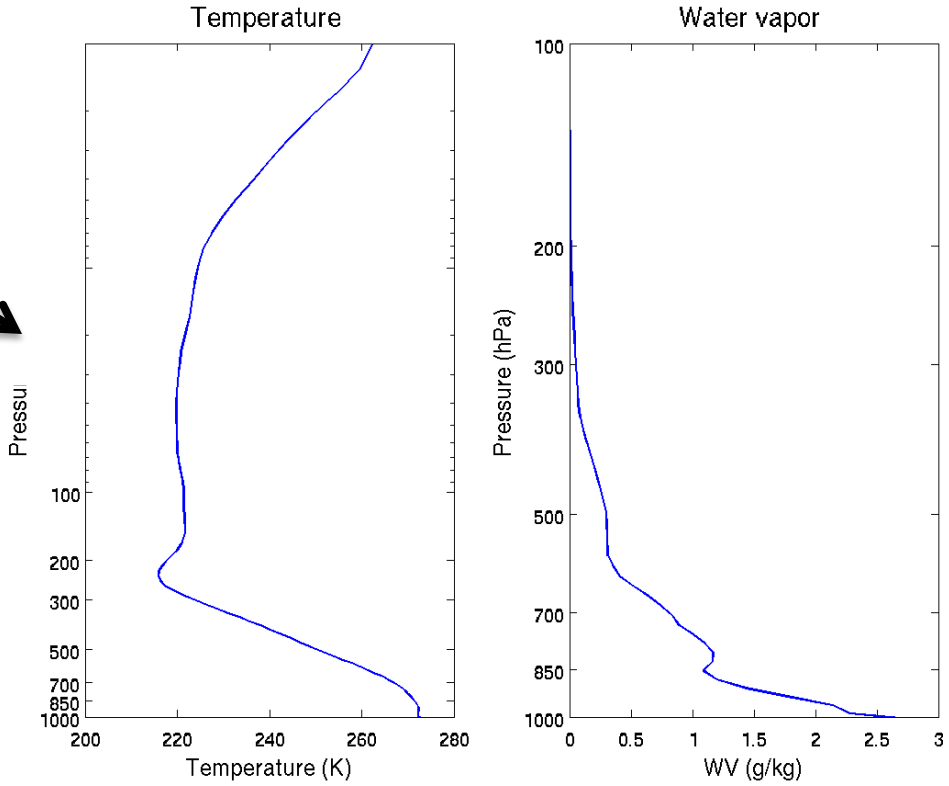
Atmosphere Products

Temperature and Humidity Profiles from AIRS



10 September 2012

Profiles from hyperspectral instruments are high vertical resolution that should improve retrievals of temperature inversions

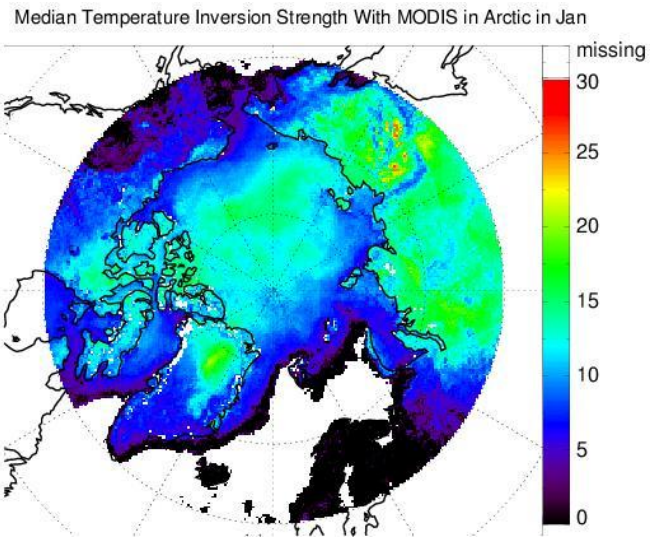


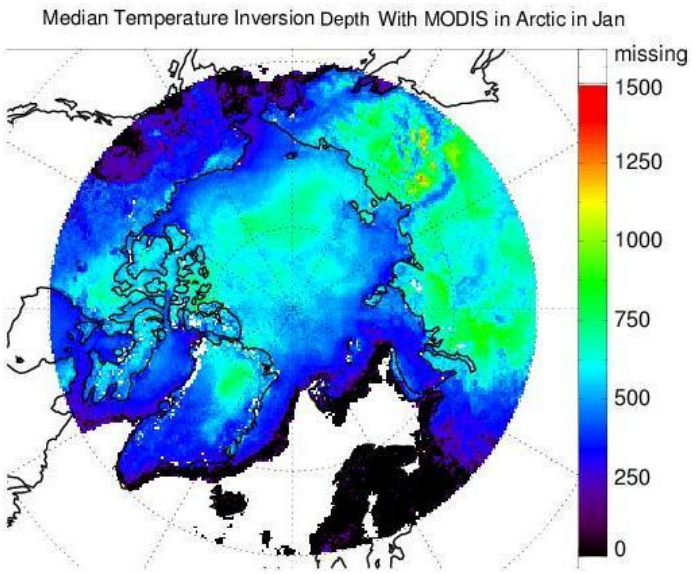
Low-Level Atmospheric Temperature Inversions

Strength (C)

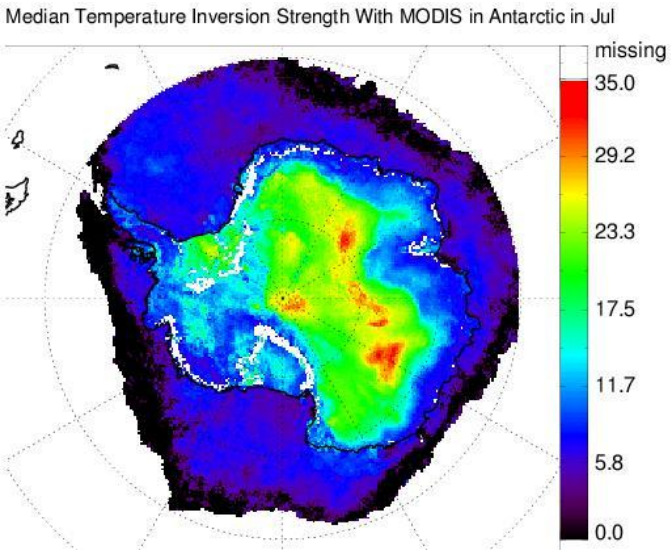
Depth (m)

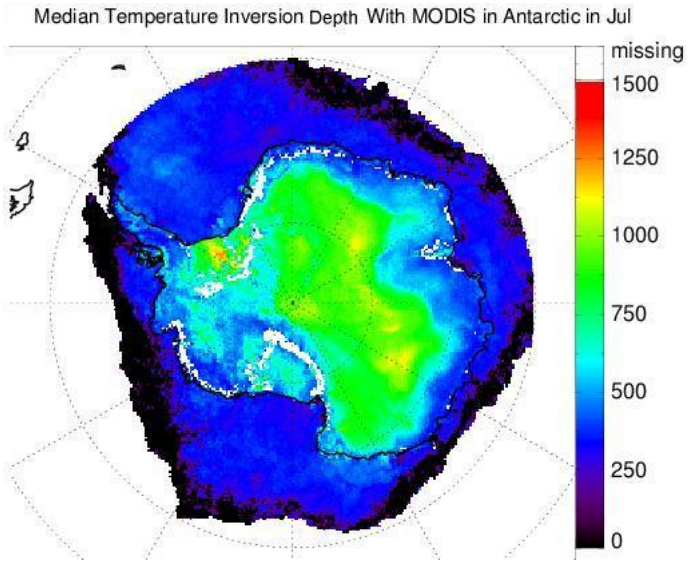
January





July

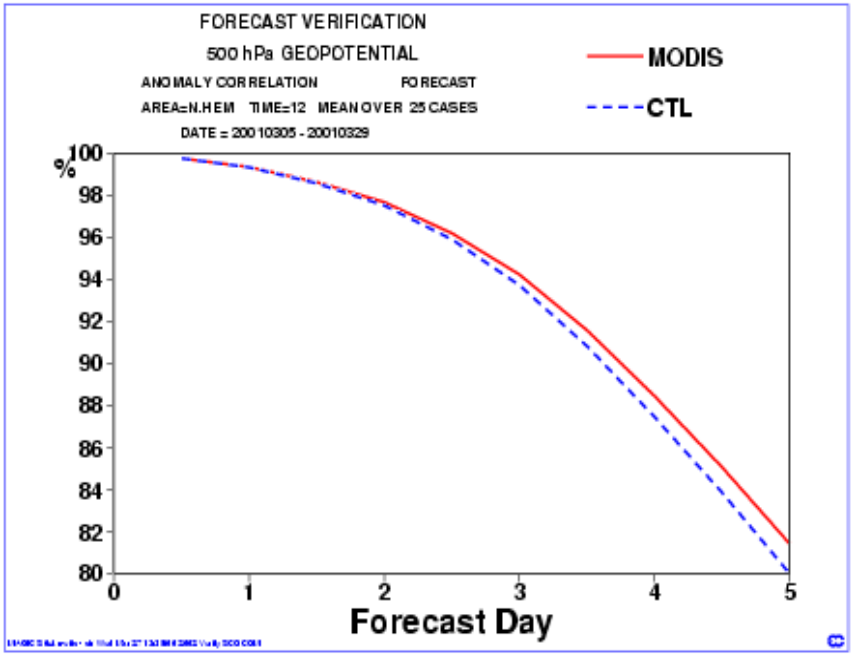


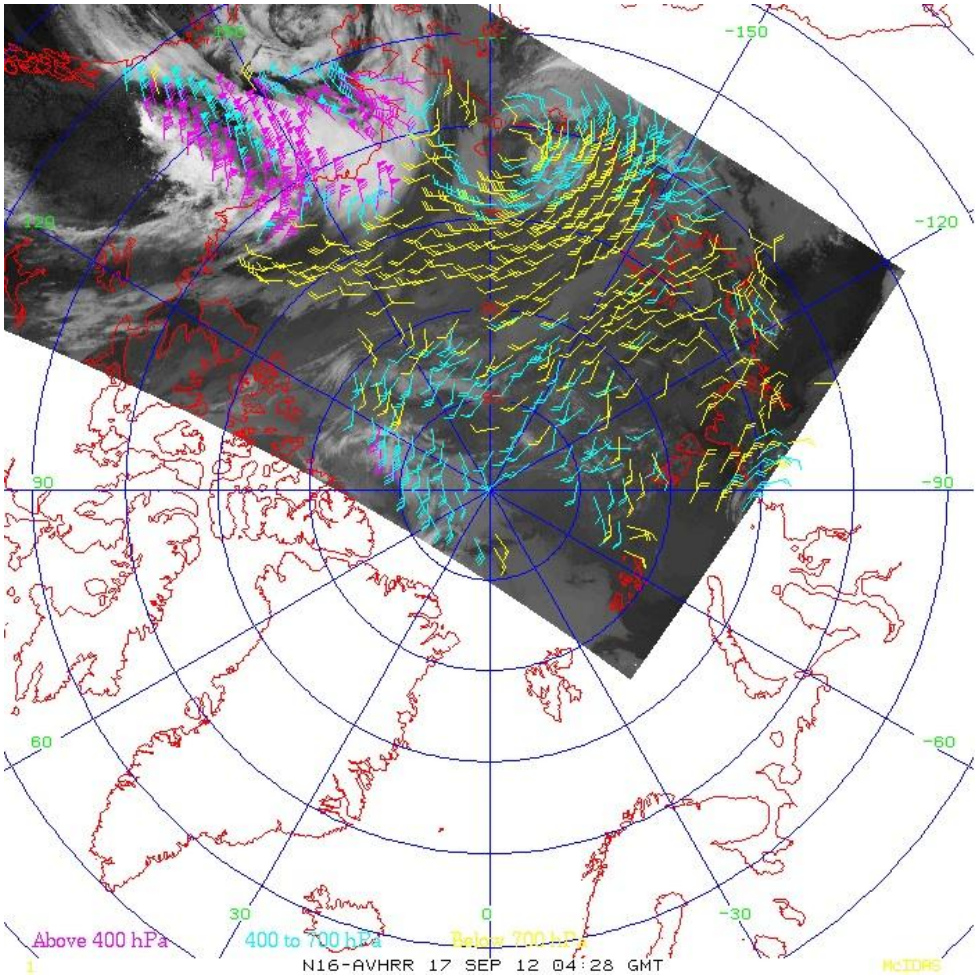


Polar Winds

There is a significant positive impact on forecasts from the assimilation of polar wind data, not just for the Arctic and Antarctic, but also for the extratropics of both hemispheres.

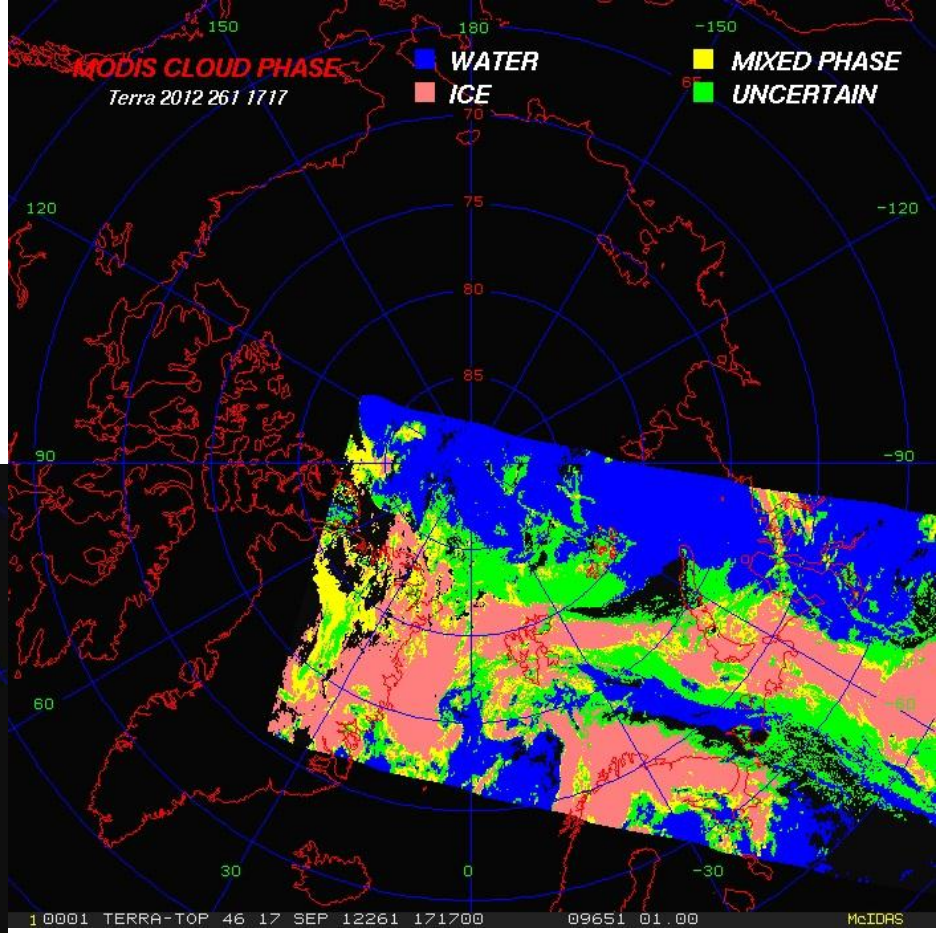
Northern Hemisphere Impact at 500 hPa (ECMWF)

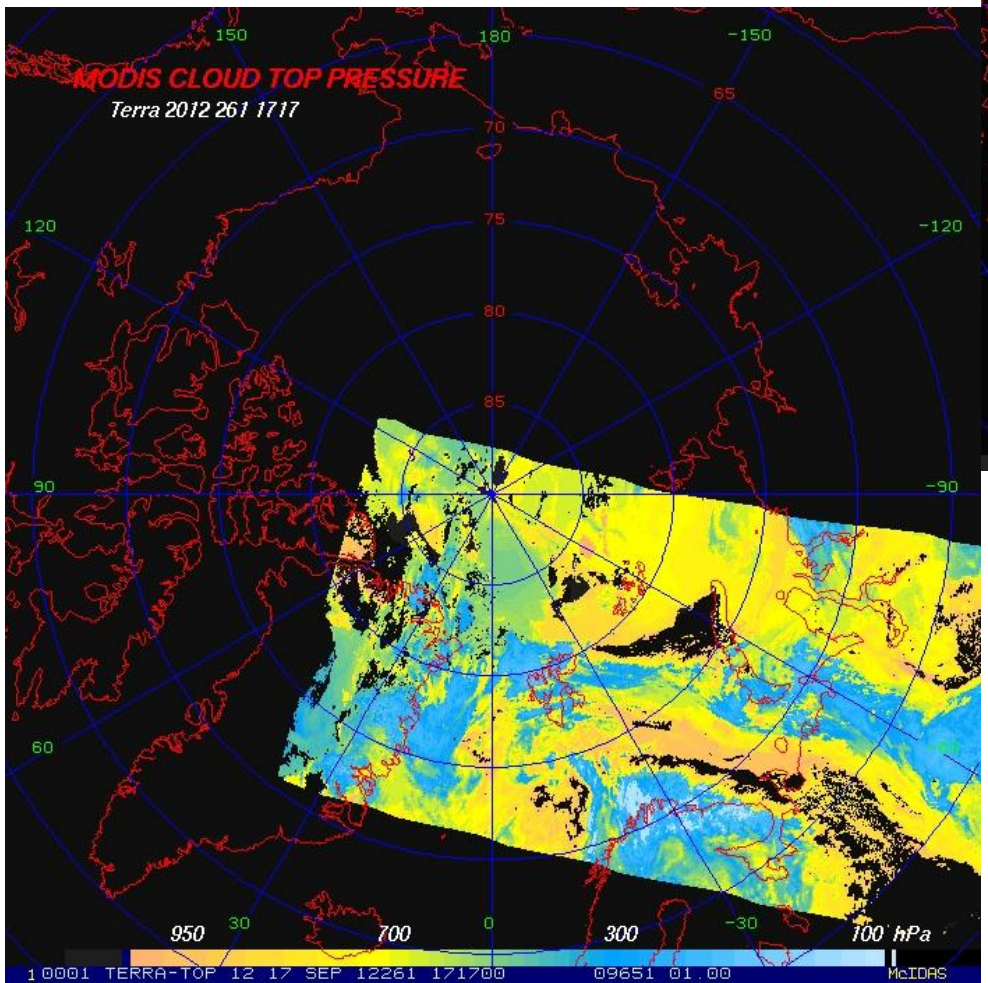




Above: Winds from AVHRR data collected at Barrow on 17 Sept 2012

MODIS Cloud Properties





Above: cloud particle phase,
17 Sept 2012

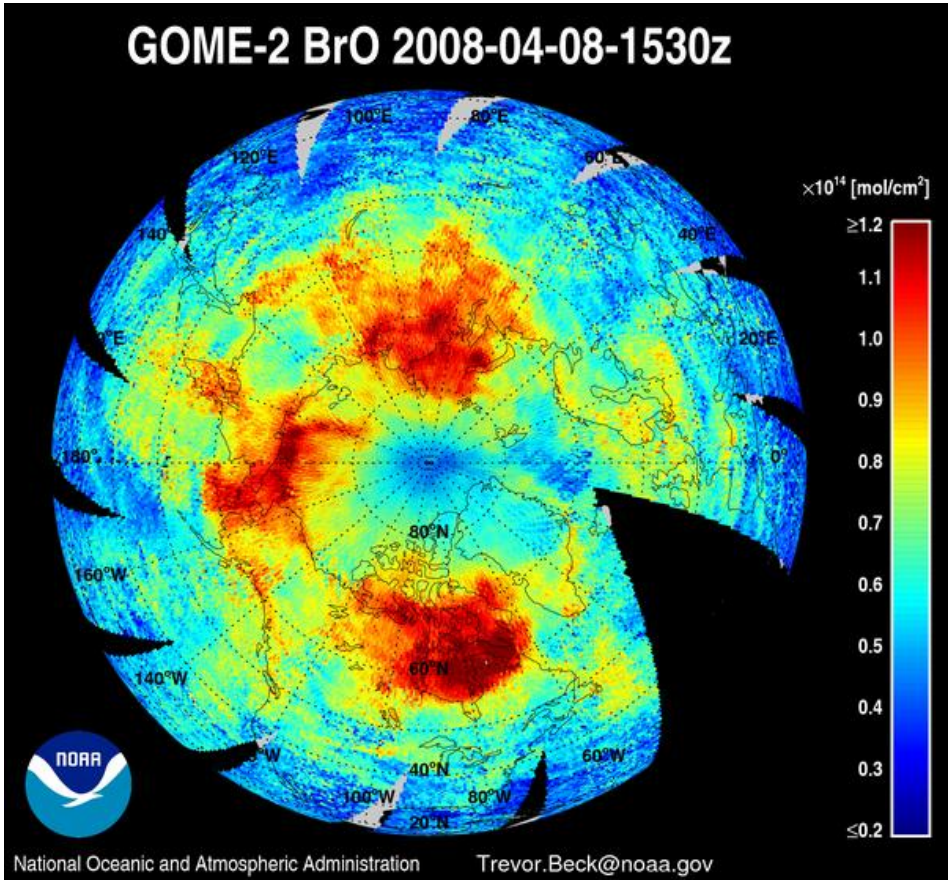
Left: Cloud top pressure

(*Generated at Sodankylä, Finland*)

Atmospheric Composition and Aerosol Measurements

Satellite measurements include:

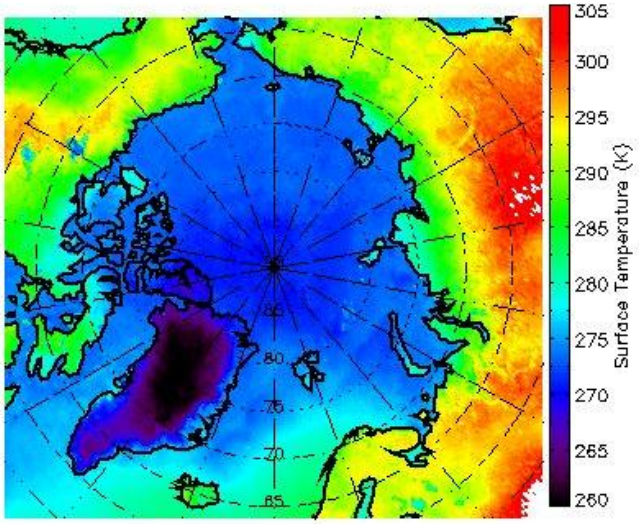
- Total column O3, NO2, NO2, NO, CO, BrO, HcL
- Profiles of O3, CO
- Aerosol optical depth



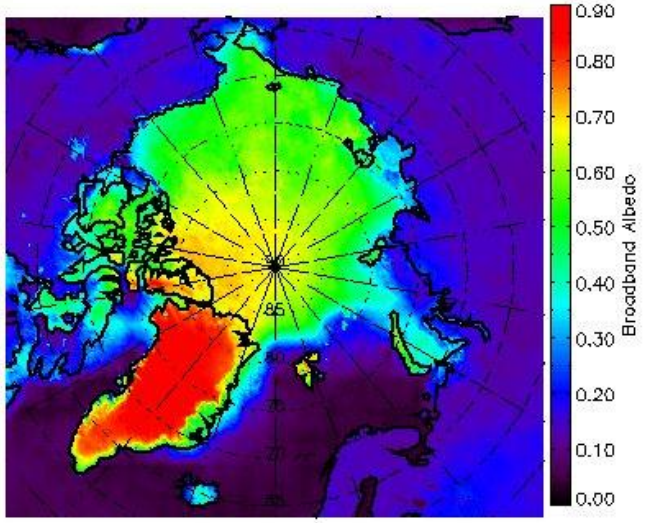
Total vertical column bromine (BrO) observations from GOME-2 (on MetOP-A) for 23:59Z and 15:30Z (24-hr averages) on April 8, 2008. Arctic boundary layer BrO enhancements lead rapid ozone loss within the Arctic boundary layer. (GOME-2 data provided by Trevor Beck, NOAA/NESDIS)

Climate: 30 years of (some) Satellite Products

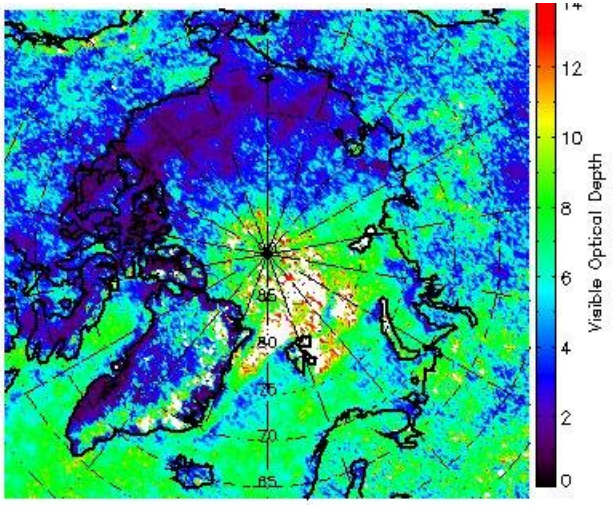
Surface Temperature, June



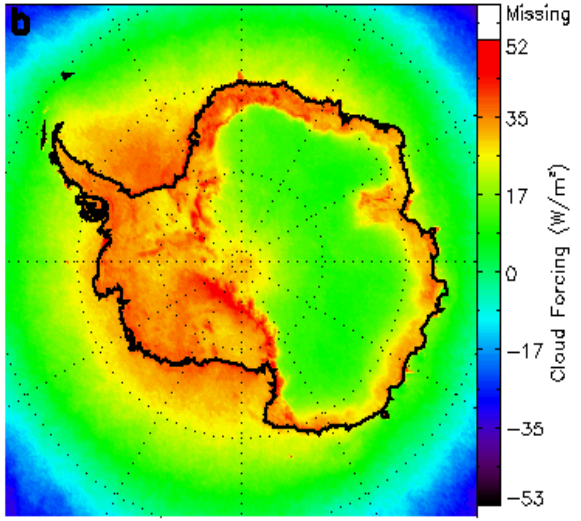
Surface Albedo, June

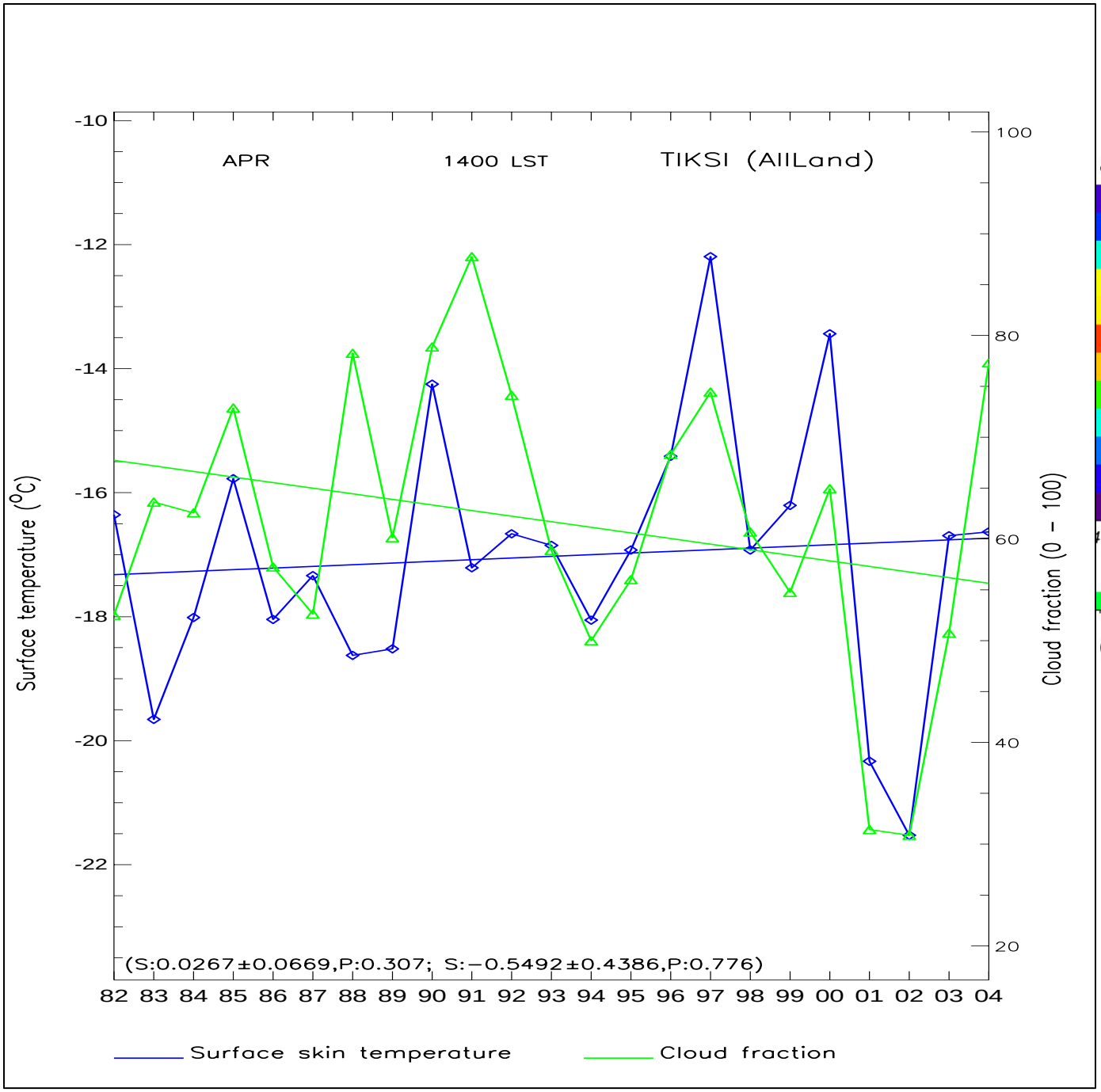


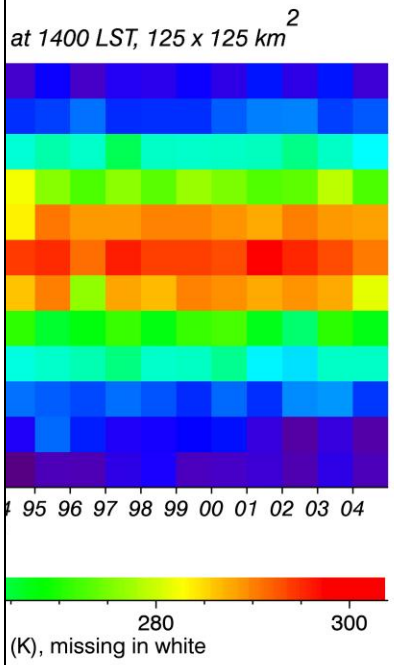
Cloud Optical Depth, June



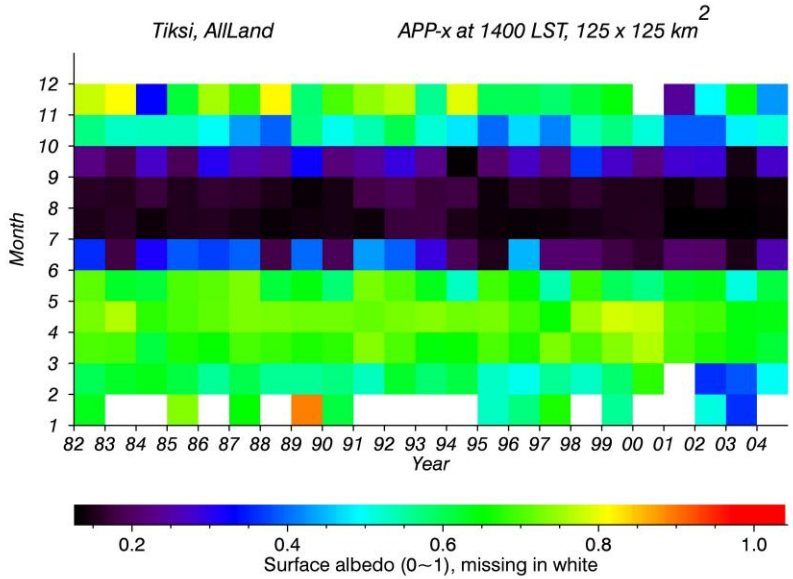
Cloud Radiative “Forcing”, June



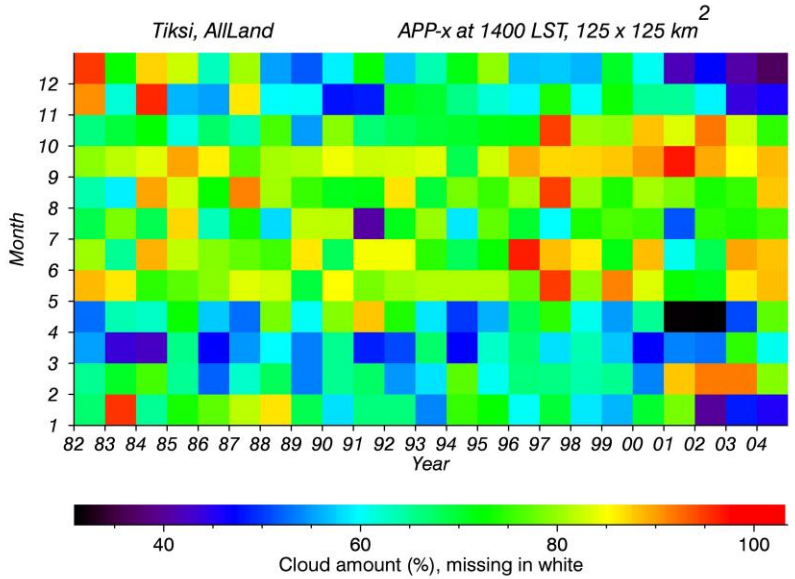

APR
1400 LST
TIKSI (AllLand)
Surface temperature (°C)
Cloud fraction (0 – 100)
-10
-12
-14
-16
-18
-20
-22
100
80
60
40
20
82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04
(S:0.0267±0.0669,P:0.307; S:−0.5492±0.4386,P:0.776)
Surface skin temperature
Cloud fraction


at 1400 LST, 125 x 125 km 2
95 96 97 98 99 00 01 02 03 04
280
300
(K), missing in white

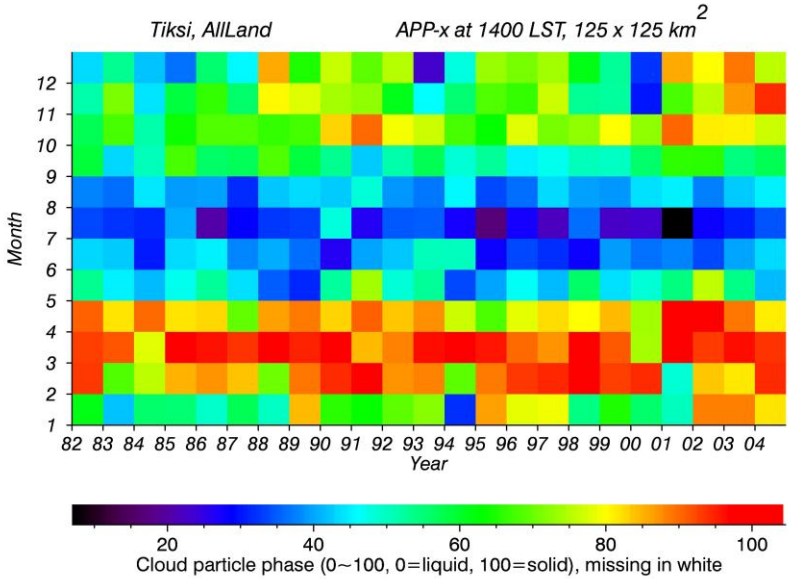
Surface Albedo



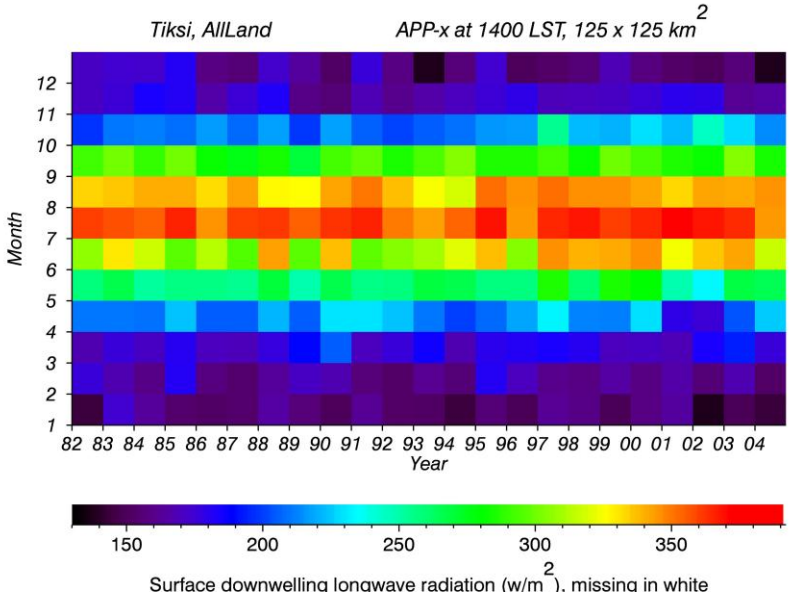
Cloud Amount



Cloud Particle Phase

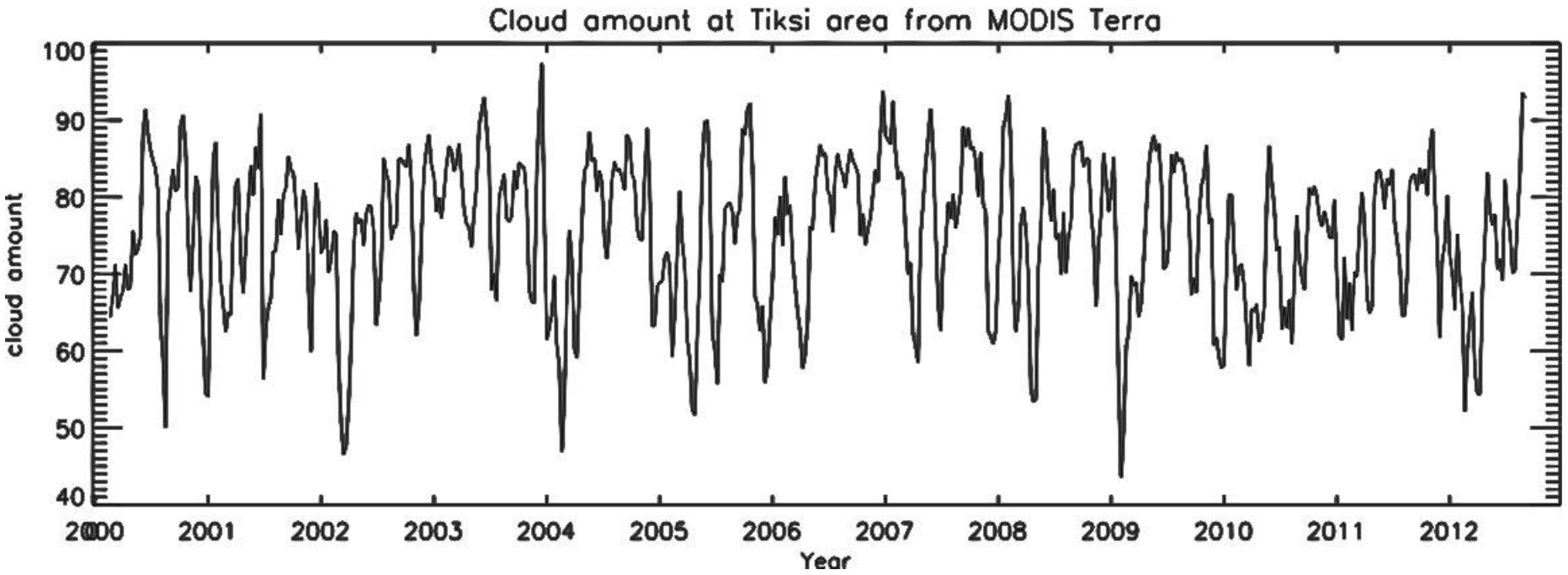


Downwelling Longwave Radiation

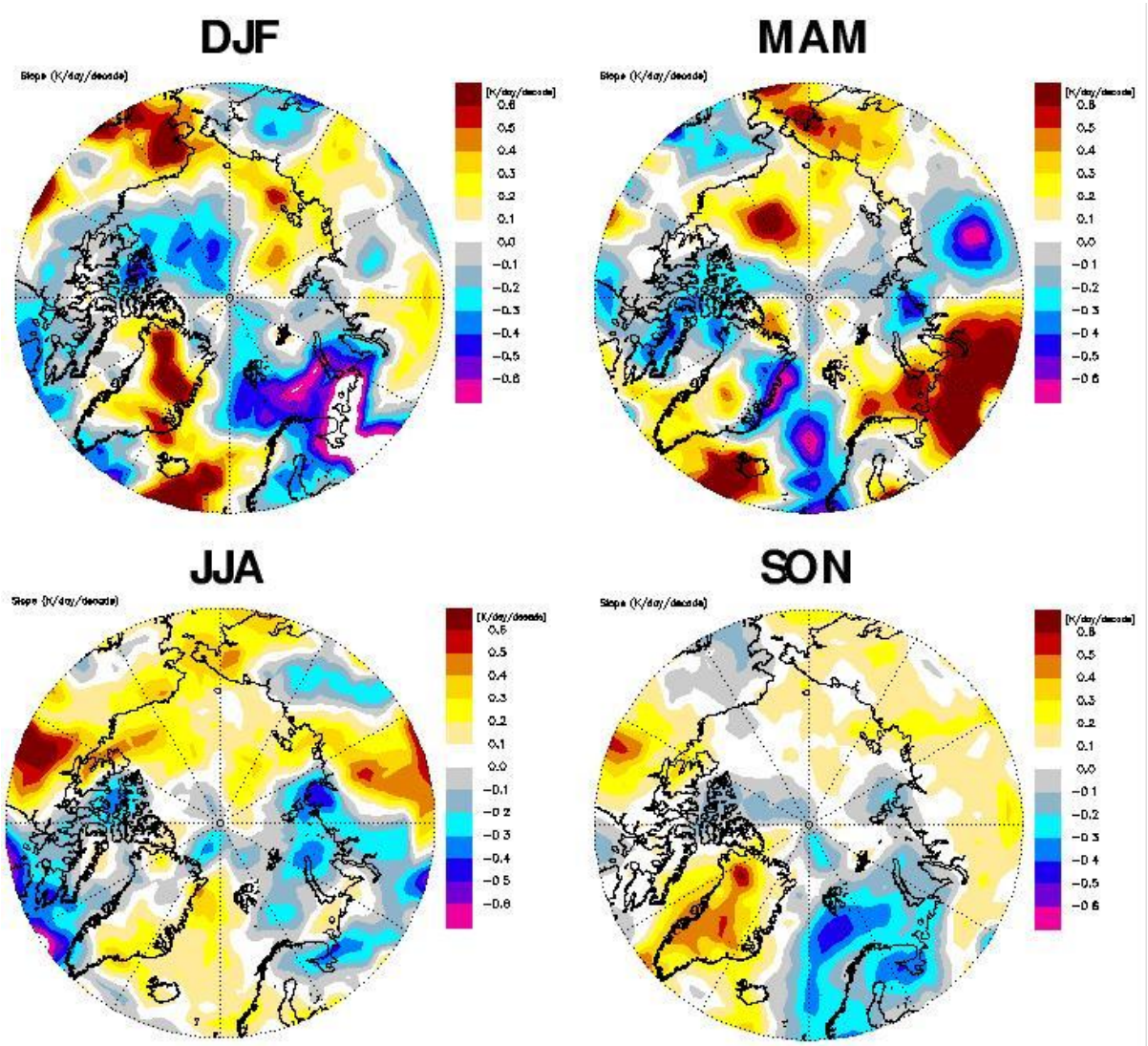


Trends from MODIS

Time series of MODIS cloud amount over a 1 x 1 degree lat/lon area around Tiksi, 2000 – 2012.



Heat and Moisture Advection from TOVS Path-P

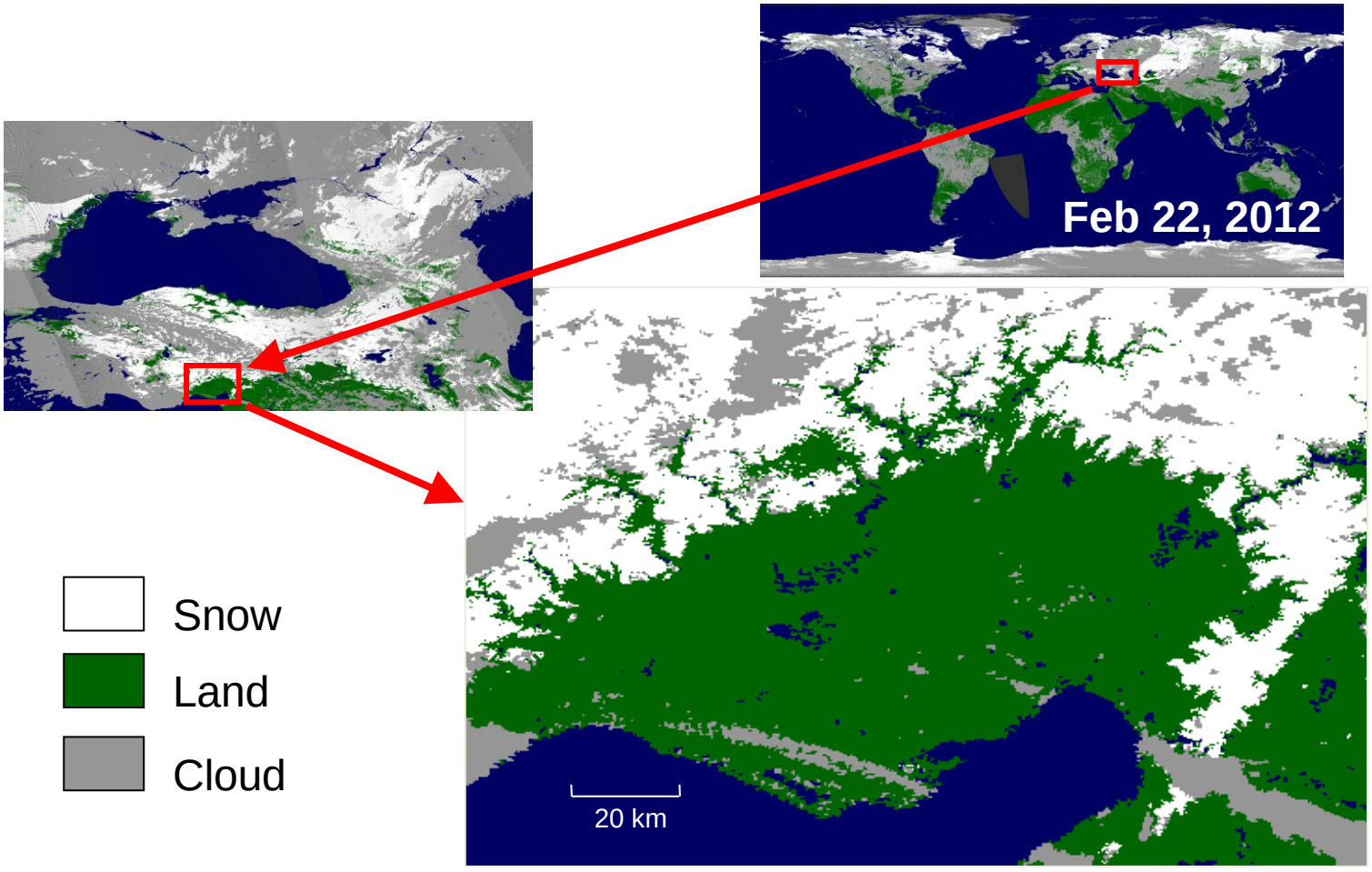


Decadal trends in poleward advective heating in layer between 500 and 300 hPa (K/day/decade) for each season. *(Courtesy of J. Francis)*

Snow and Ice Products

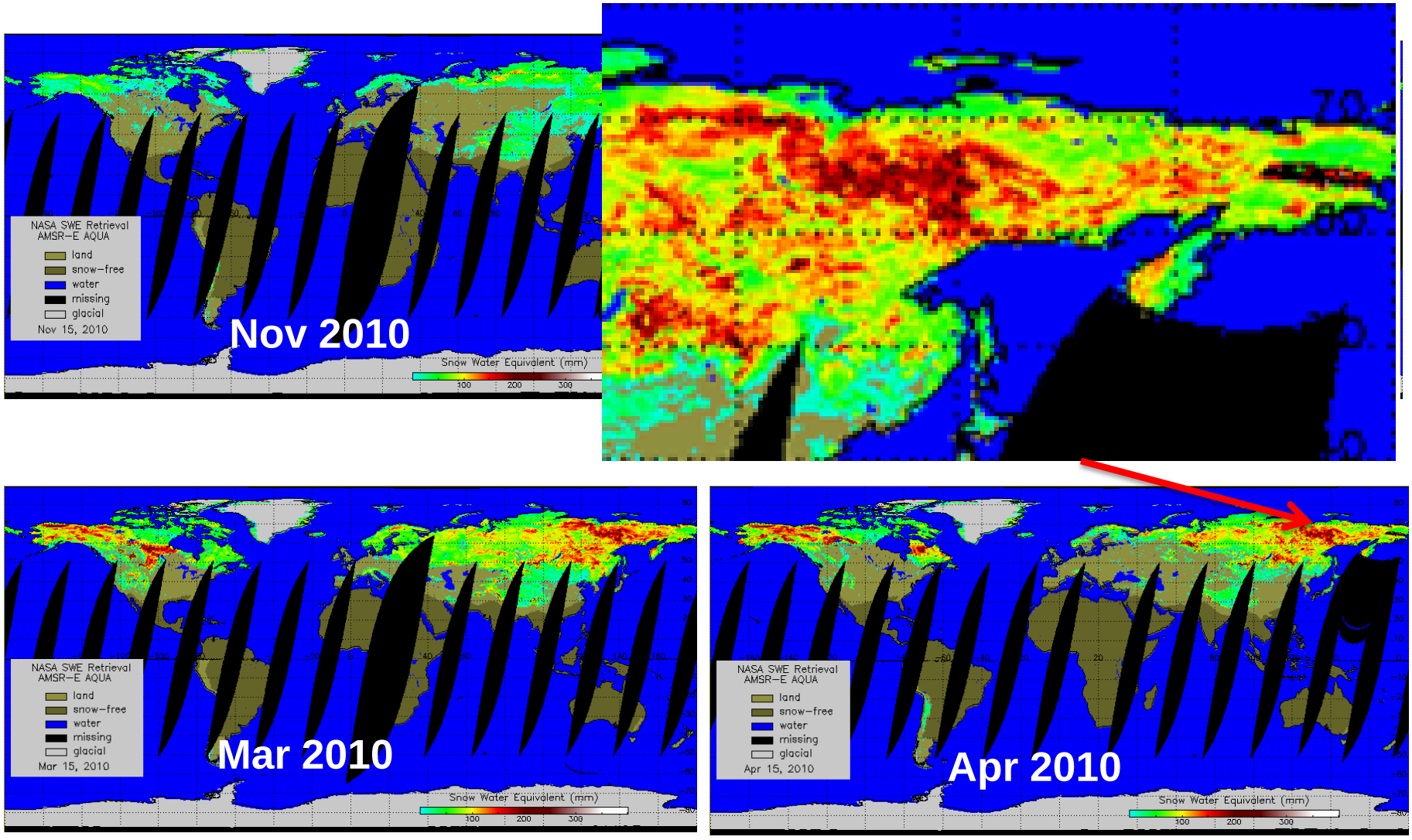
Snow Cover

Global gridded VIIRS snow map gives a realistic estimation of snow cover. Similar products are available from other sensors.

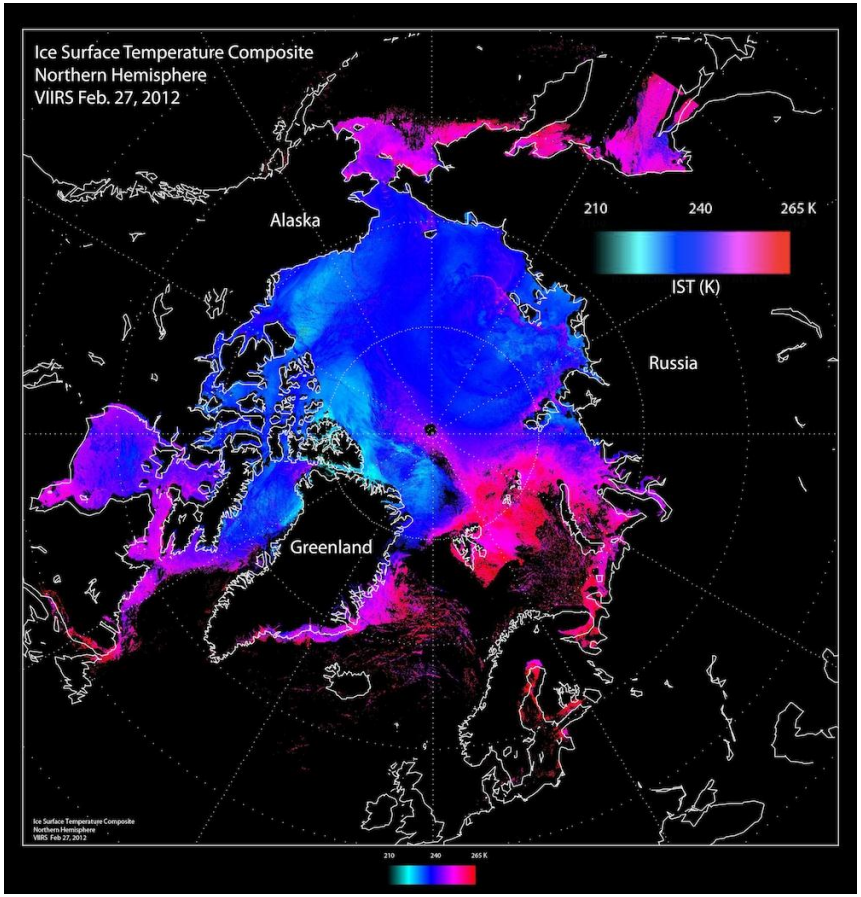


0.5 km spatial resolution

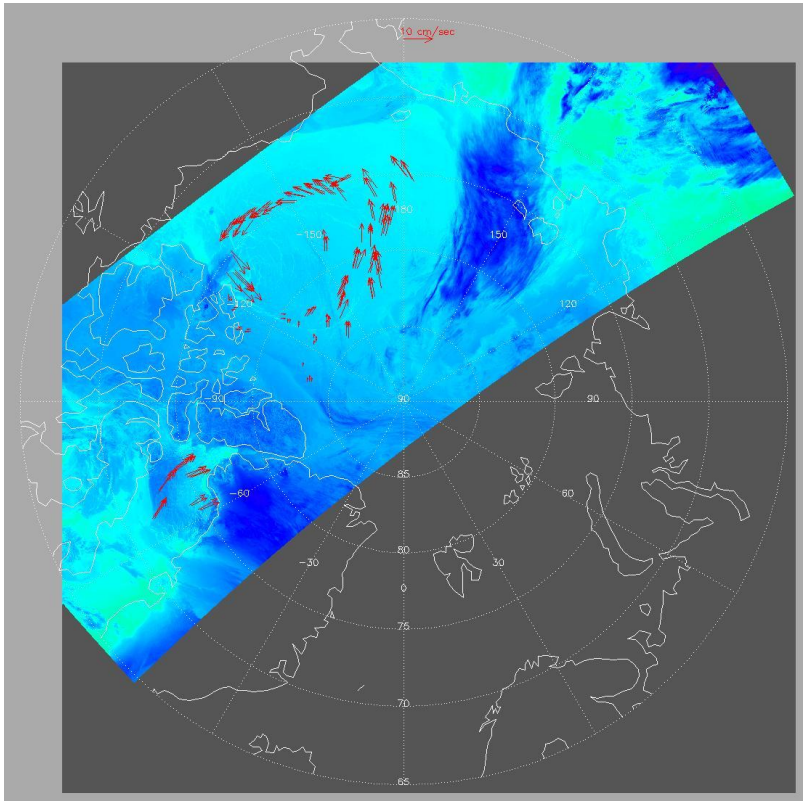
Snow Water Equivalent (AMSR-E)



Ice Surface Temperature

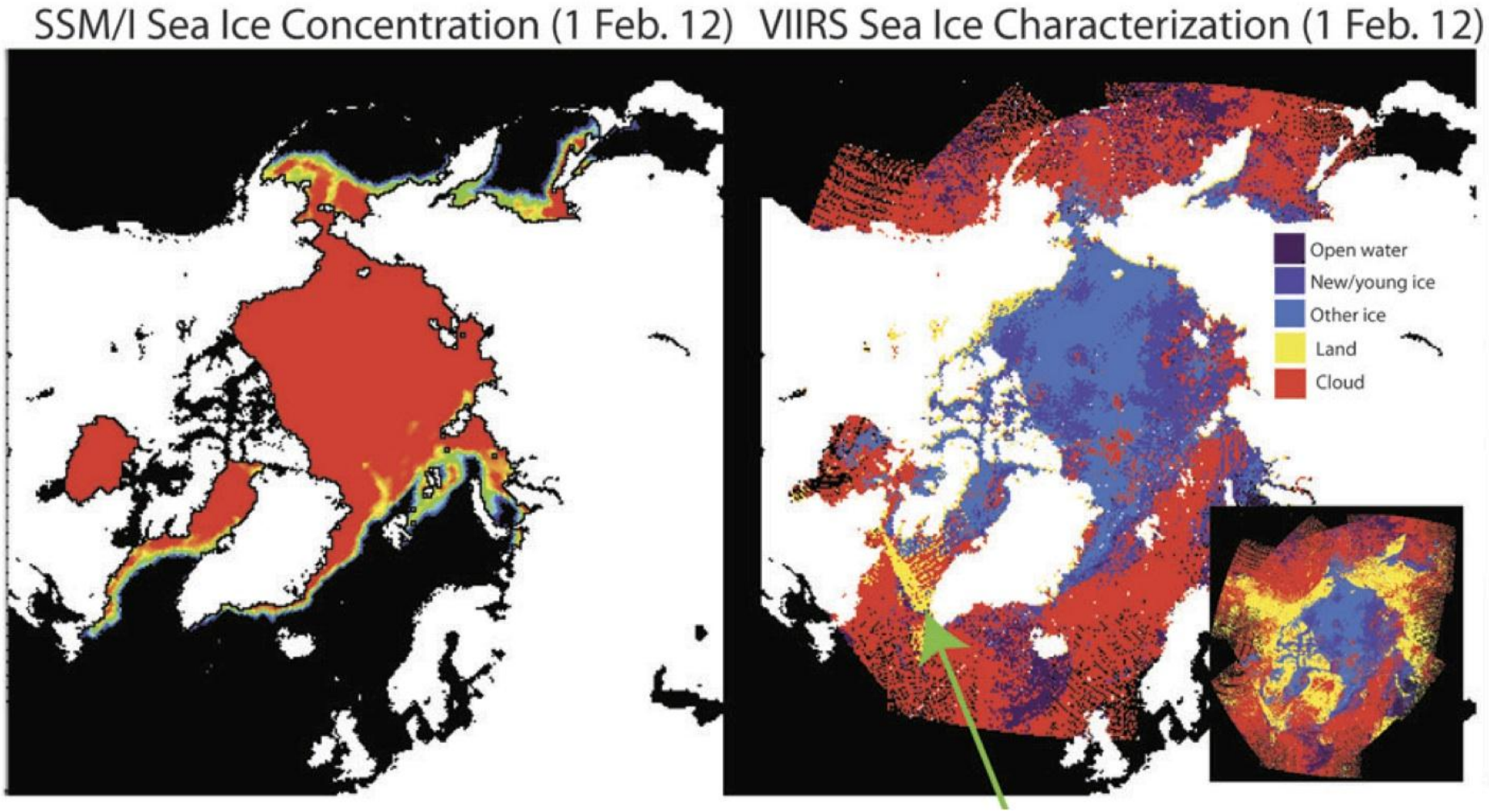


Composite of VIIRS Ice Surface Temperature on 27 Feb 2012.

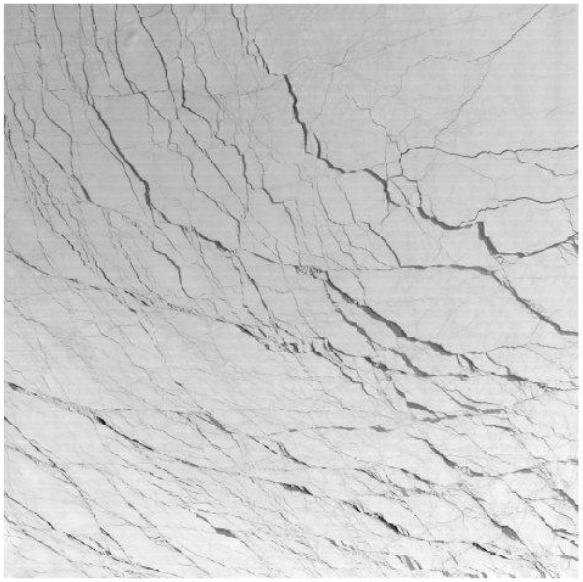


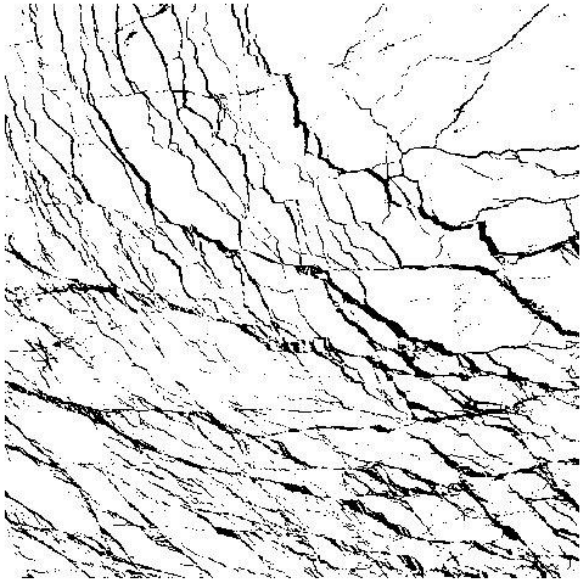
Ice Motion

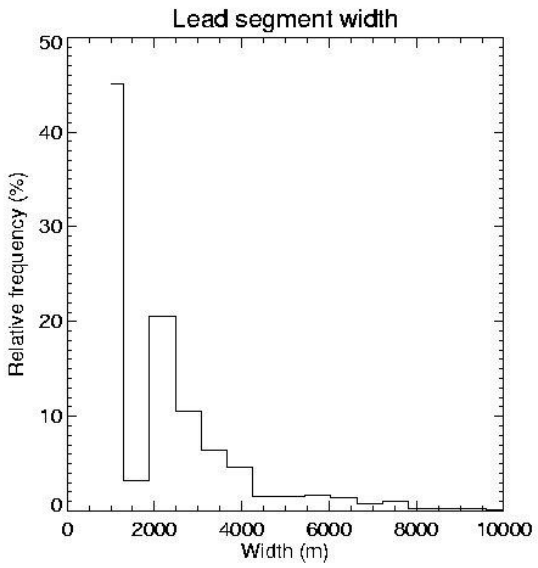
Ice Characterization (Age, Thickness)

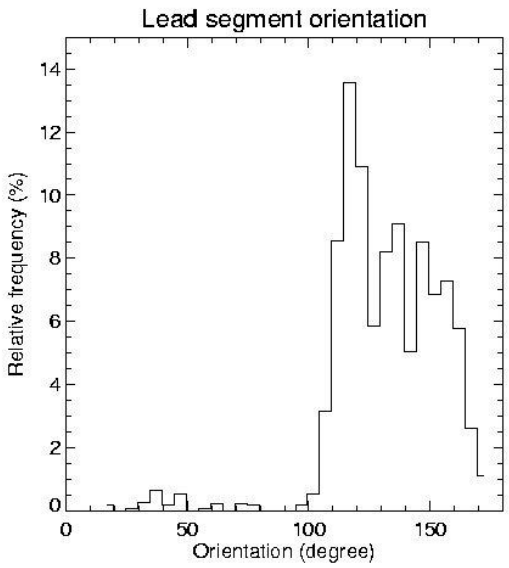


Sea Ice Leads





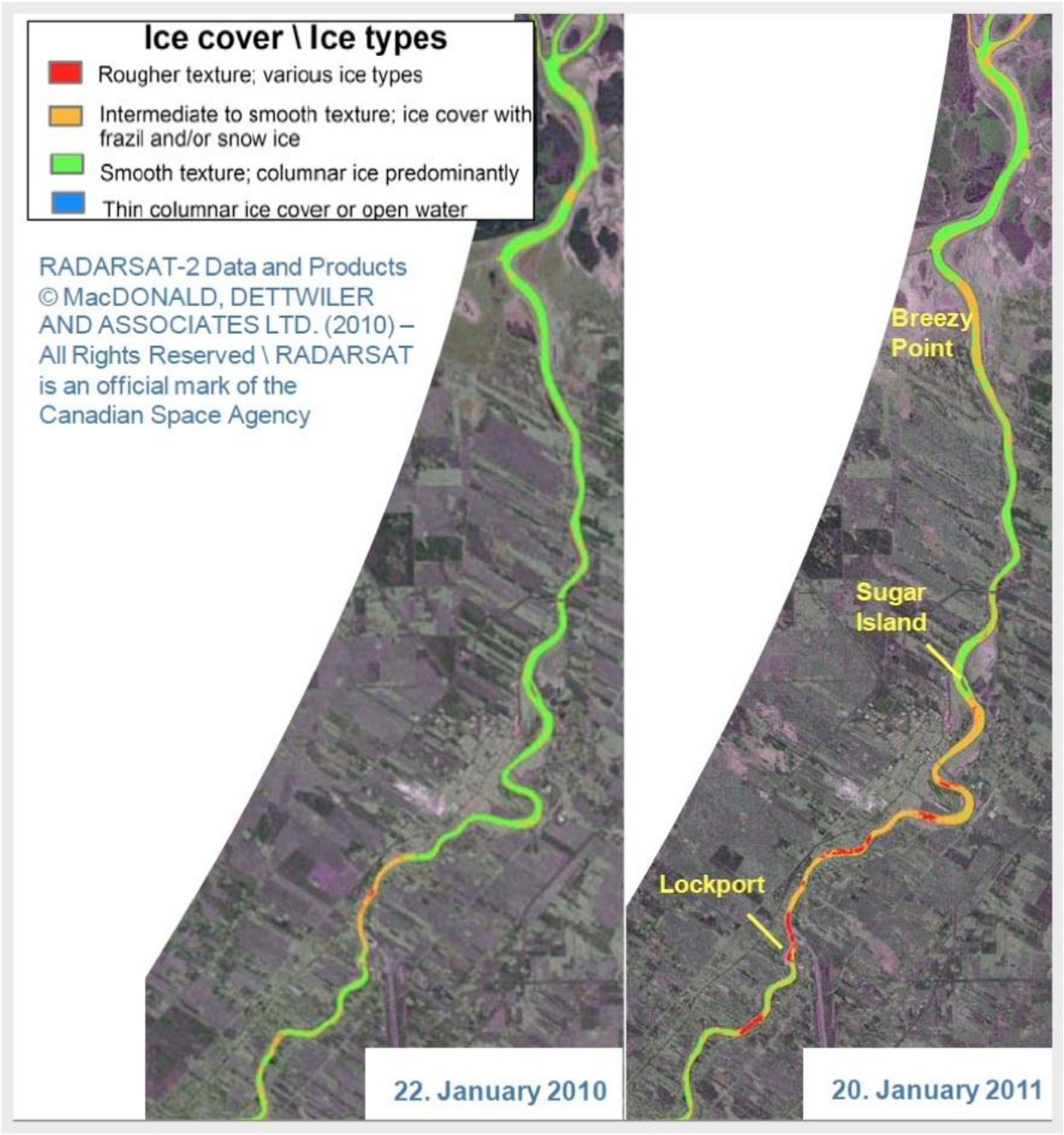


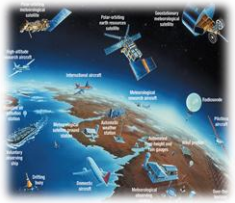


The reflectance at 0.64 μm from MODIS (upper left), mask of leads derived using group thresholds method (upper right), distributions of lead segment width (lower left), and lead segment orientation (lower right) based on the mask of leads. The scene is over the Beaufort and Chukchi Seas on March 11, 2009.

River Ice

Different ice cover and ice types along the Lower Red River, Manitoba, for winter 2009 – 2010 (left) and winter 2010 – 2011 (right) inferred from RADARSAT-2 SAR image analysis.





Summary of Satellite Products

Snow
Snow cover
Snow water equivalent
Snow depth

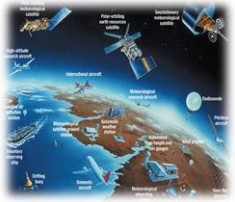
Ice
Ice extent and concentration
Ice age/type
Ice thickness
Ice motion
Ice surface temperature
Snow depth on ice
Leads and polynyas

Land, Permafrost
Land surface temperature
Soil moisture
Ground movement
Vegetation index

Atmosphere
Temperature/humidity profiles
Surface winds (ocean)
Tropospheric winds
Surface air temperature
Temperature inversions
Surface radiation
Cloud cover
Cloud phase, particle size, height
Cloud optical depth
Aerosol optical depth (over land)
Solid precipitation

Not discussed
Glaciers, ice sheets, ice caps
Ocean (SST, currents, salinity, waves)

(Green: mature capability; Blue: moderate/developing capability; Red: little or no capability)



Satellite Products in the Context of Tiksi

Most satellite products are global. A few are “tuned” to optimize high-latitude retrievals.

Satellite products do not generally provide the level of detail or the accuracy of surface measurements.

Some satellite products are assimilated in models (e.g., winds) so their benefit to Tiksi science is indirect.

Satellite data can

- Contribute to process studies
- Be used in models
- Provide information on spatial variability

Surface observations can provide critical information, or “truth”, for the validation of satellite products.