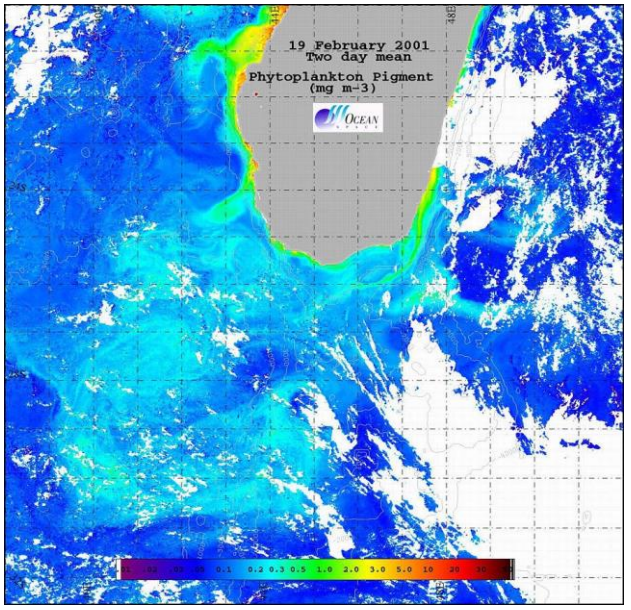
Lecture 1: Observations

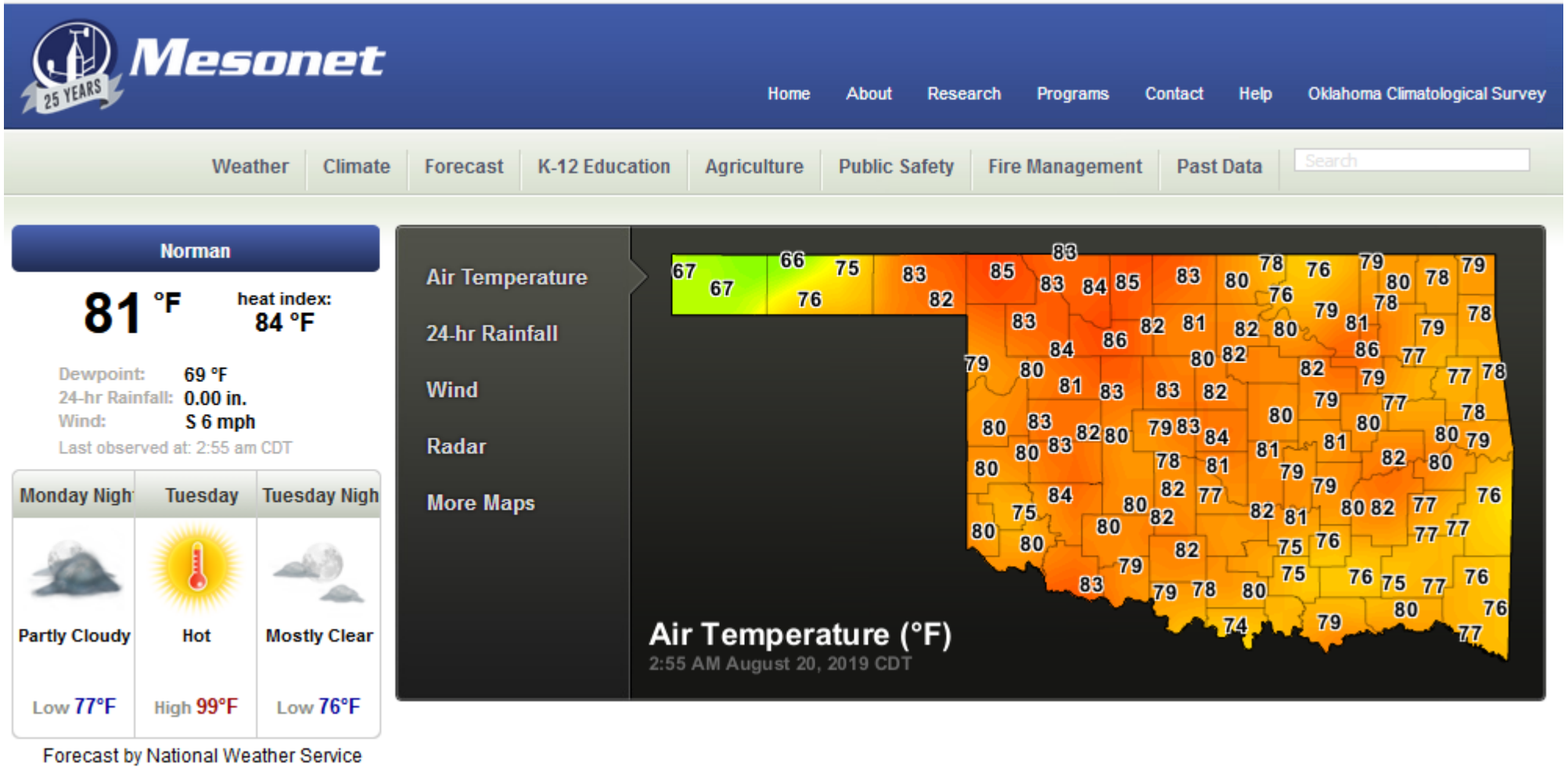
Observations

- **In situ** observations: They are **direct**, but they can be **irregular in space and time,** e.g. ship or aircraft measurements

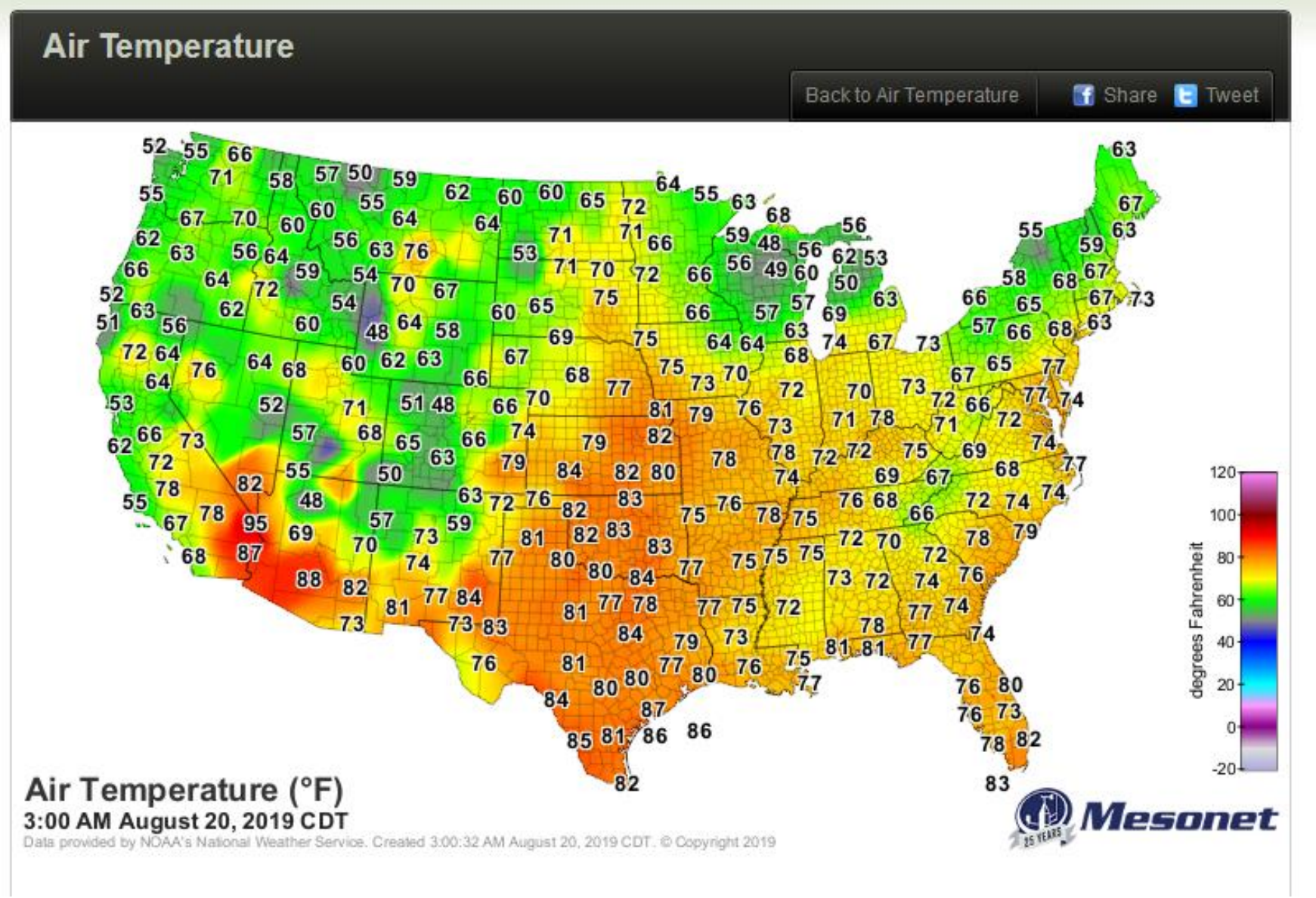
- **Remote sensing** observations: They are **indirect.** E.g. orbiting satellites measuring the sea- surface temperature (in terms of radiance).



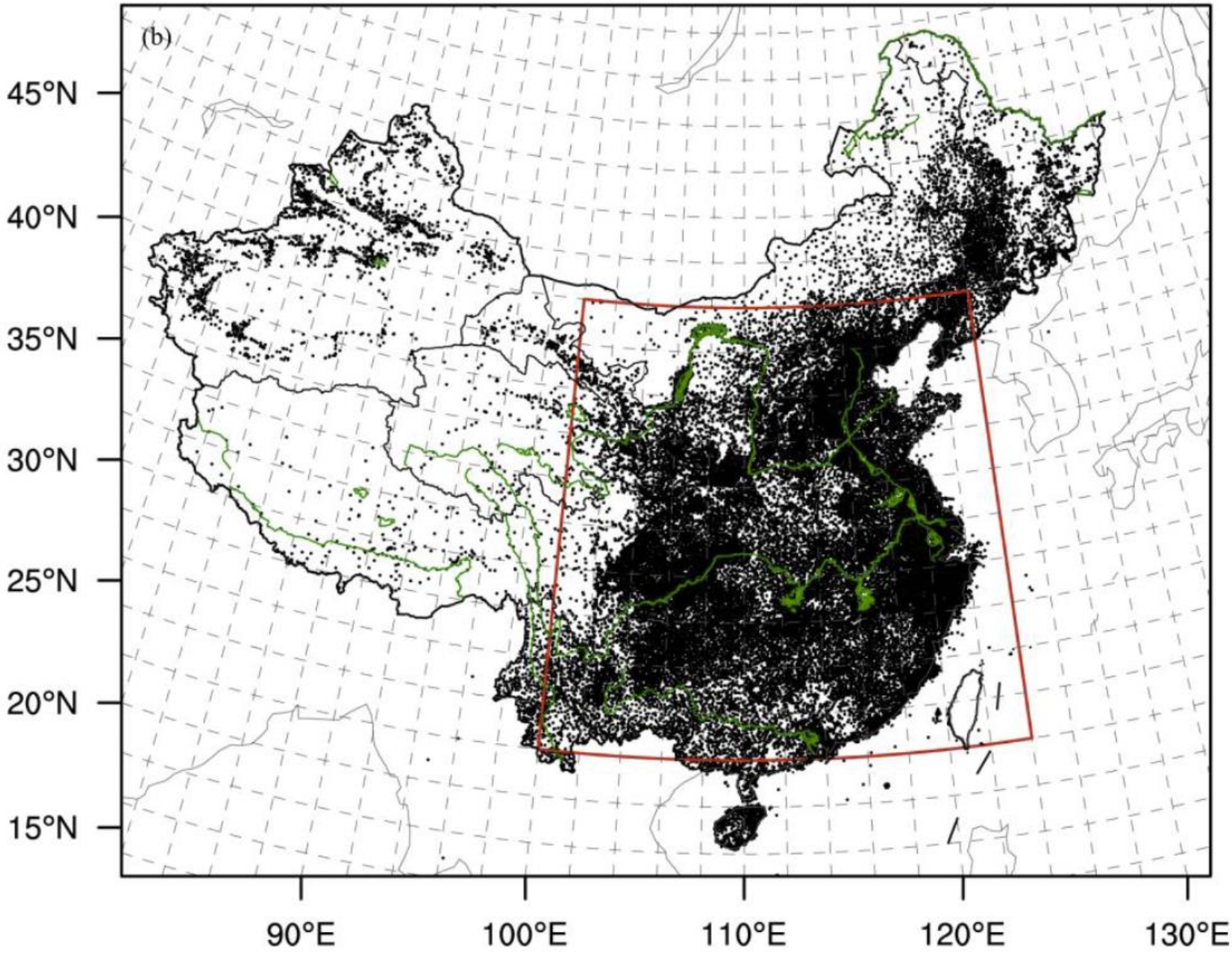
Objective Analysis of Surface Temperature in Oklahoma State Mesonet (mesonet.org)



Objective Analysis of In-situ-Measurements of Surface Temperature over the continental US (from mesonet.org)



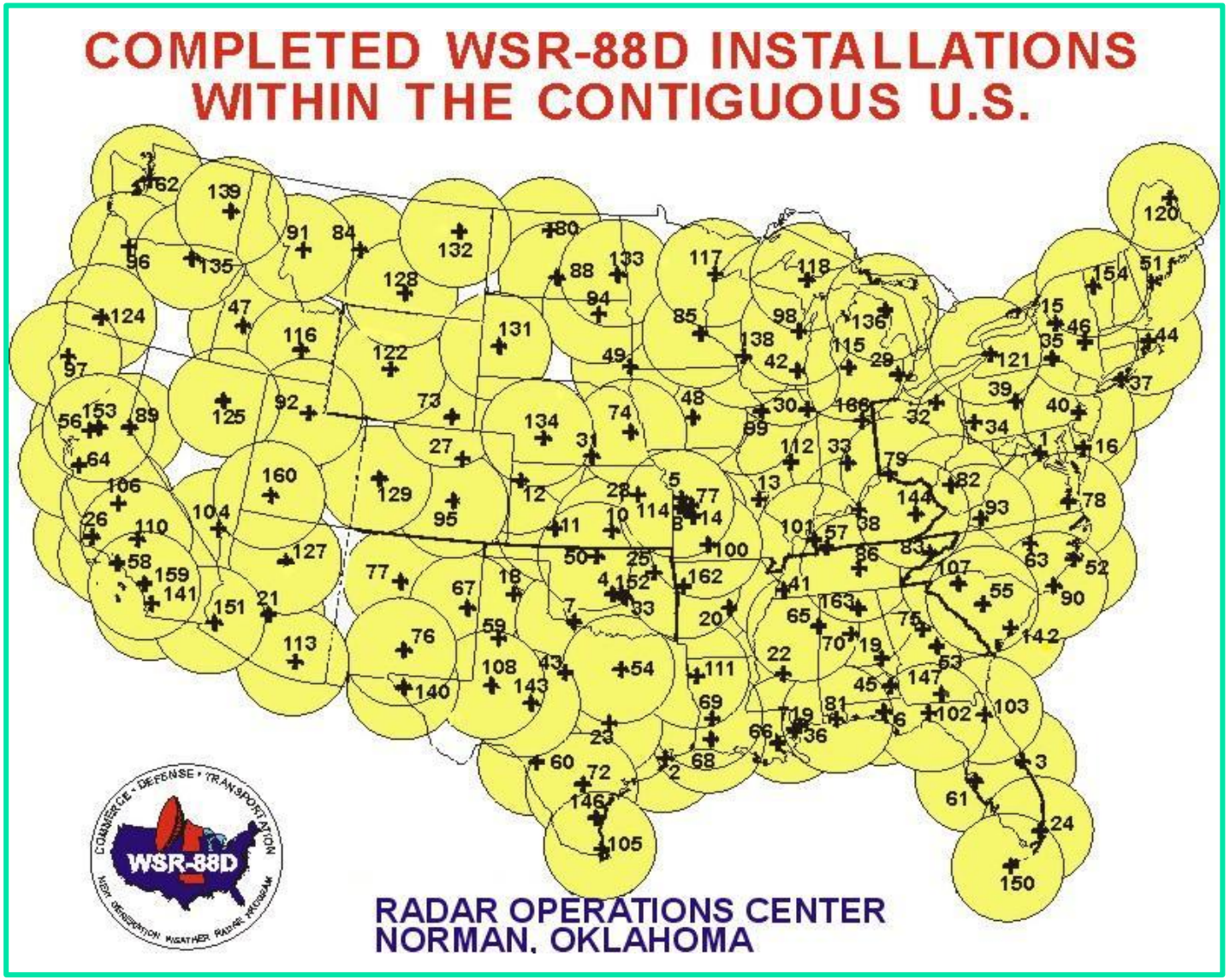
Surface Station Network of China



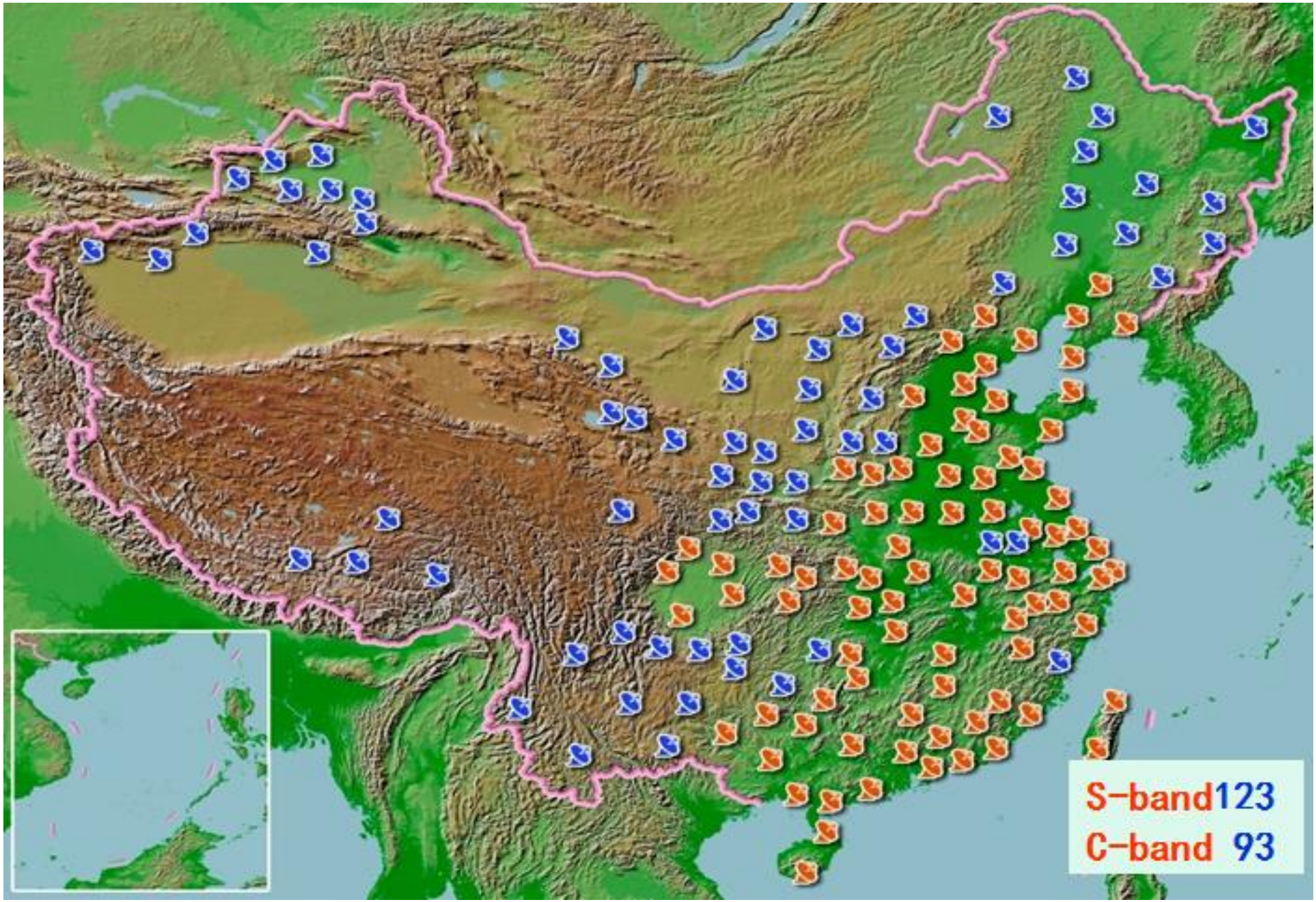
US Operational WSR-88D Radar Network

- 160 S-band 88D radars (NWS, DoD & FAA)
- Vr, Z and spectrum width
- Dual-pol Z_{DR}, CC and K_{DP}

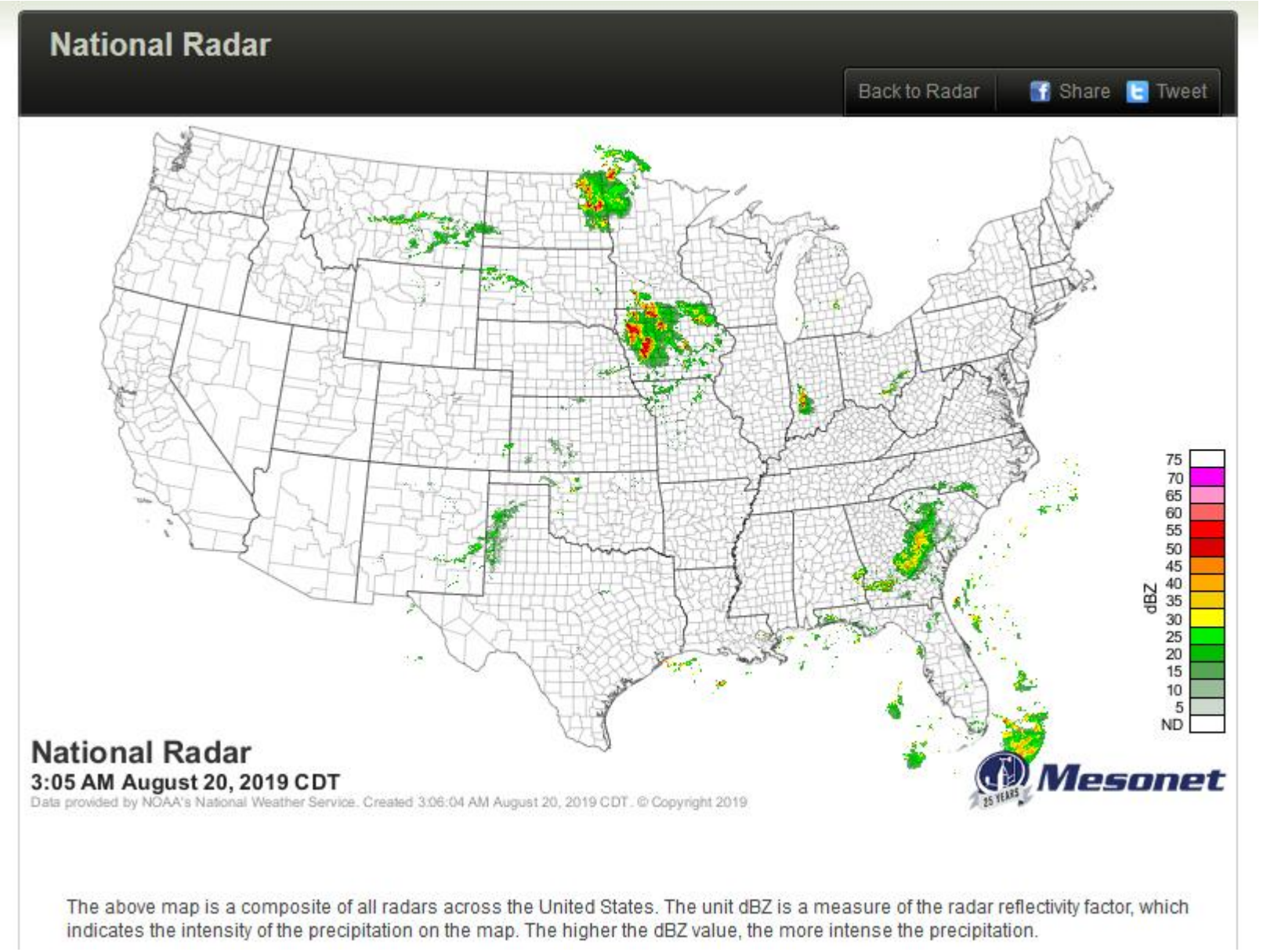
- +Many C-band Airport TDWR radars



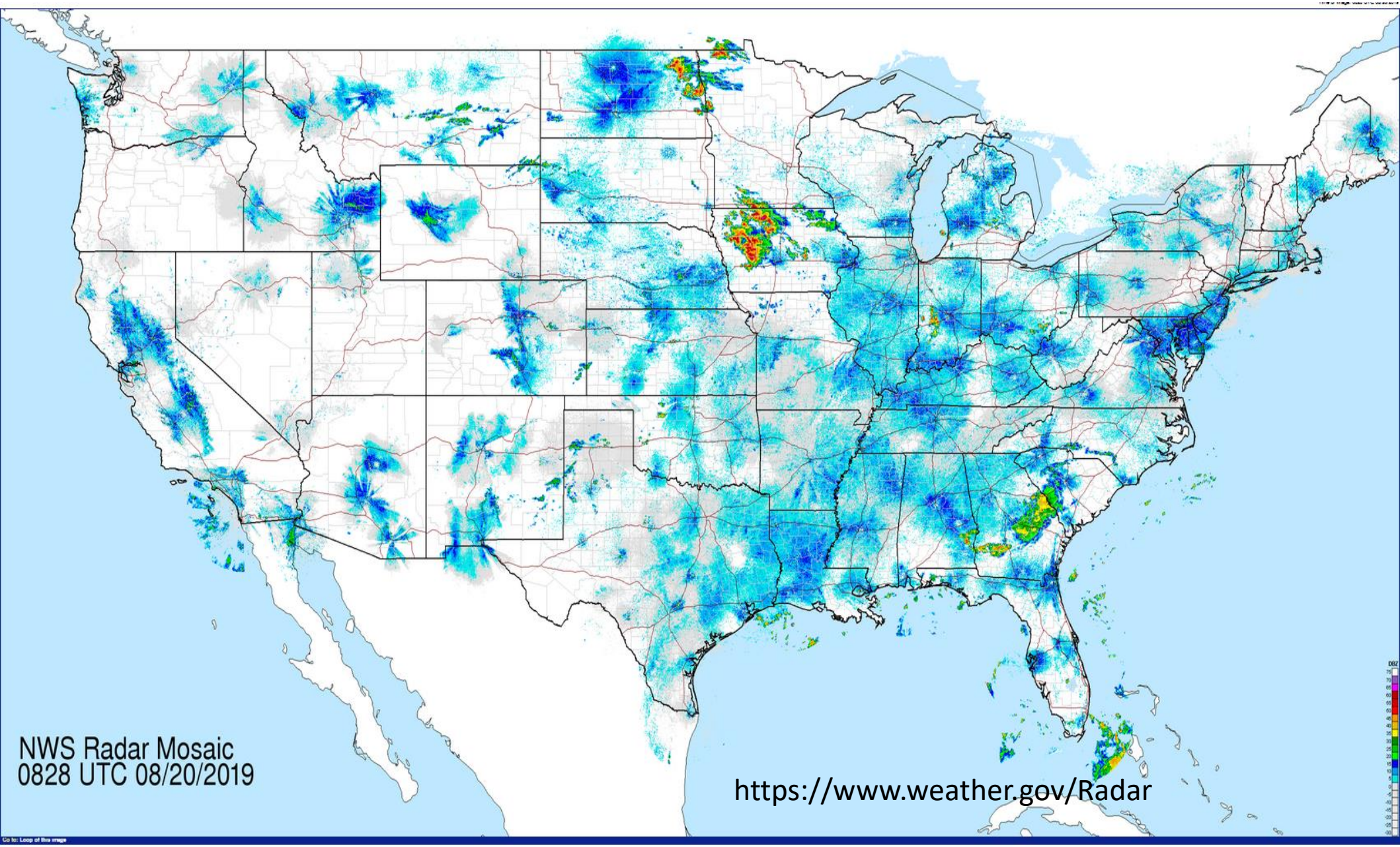
Operational Radar Network of China



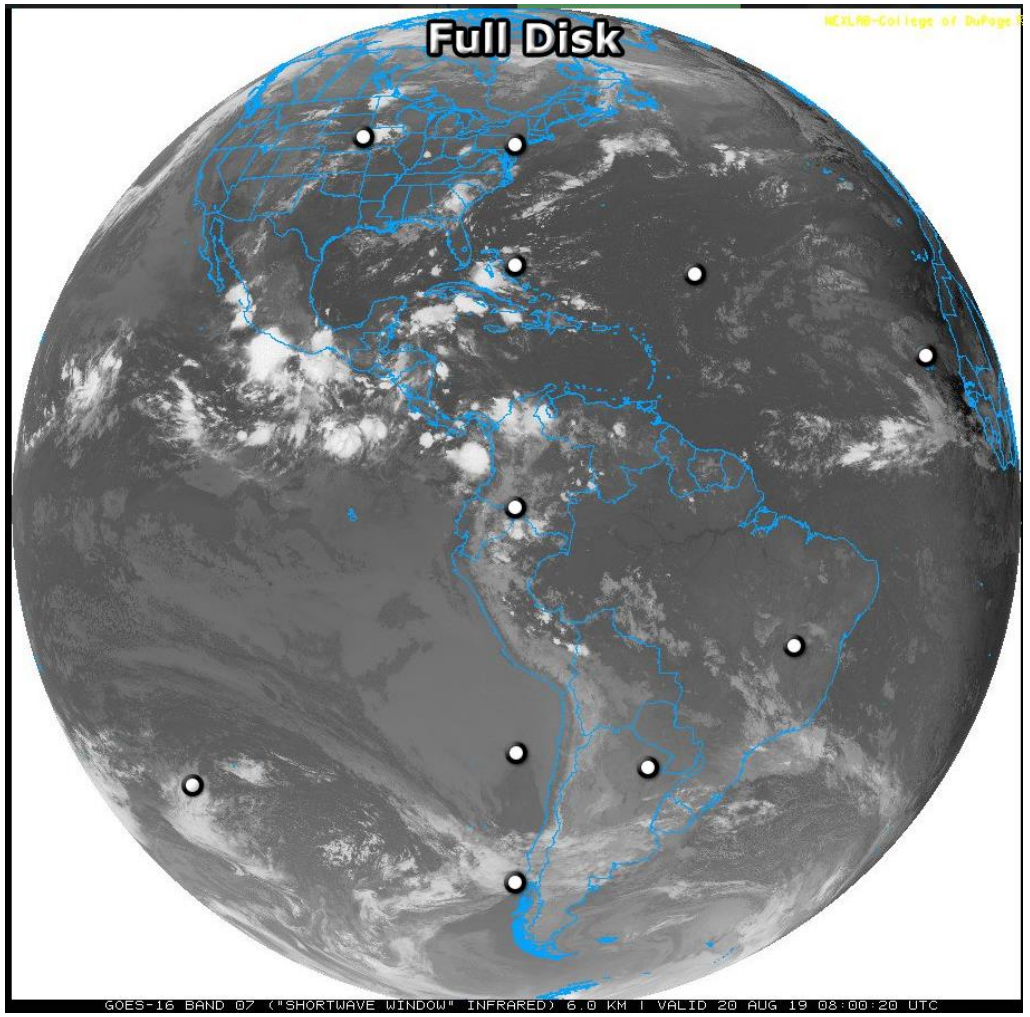
Remotely Sensed Observations – Radar Reflectivity – Mosaic from over 100 Radars



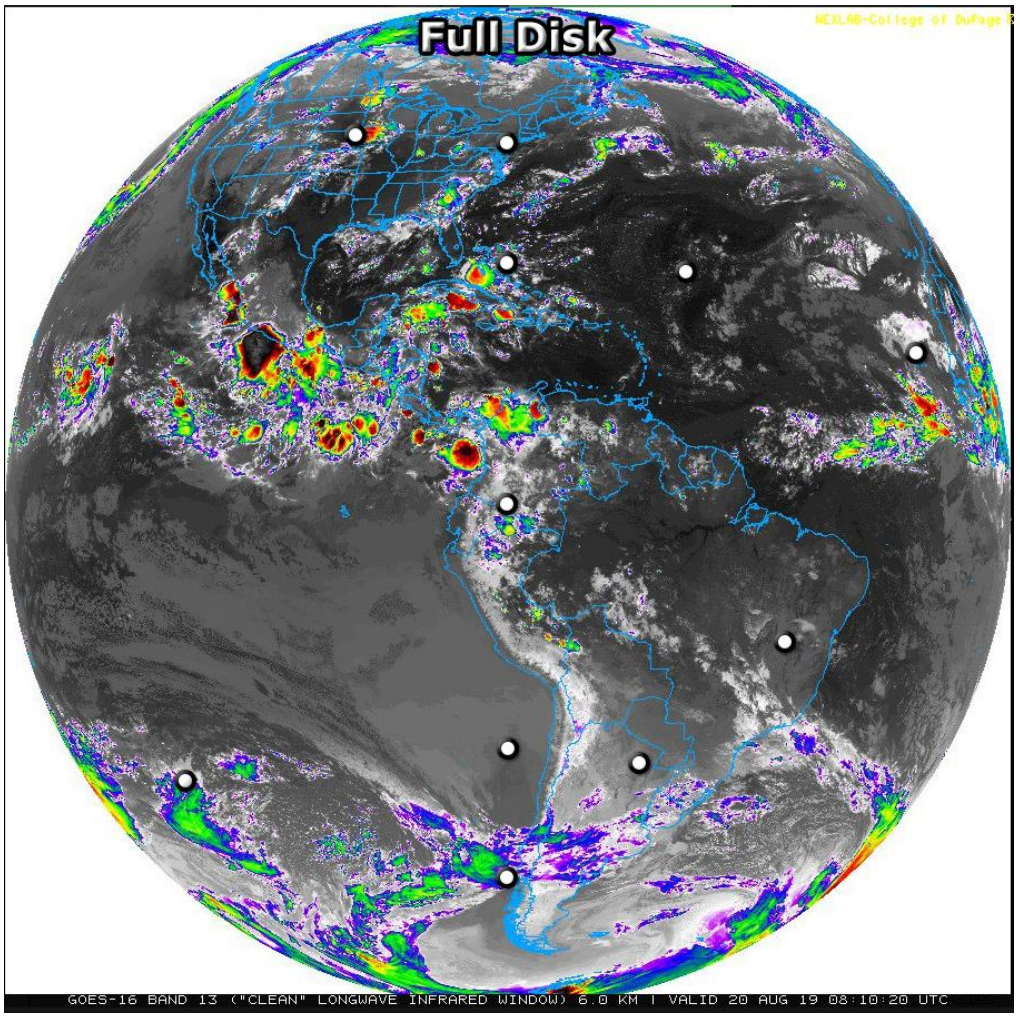
National Radar Reflectivity Mosaic including Ground Clutters



GOES-East Full Disk IR Image



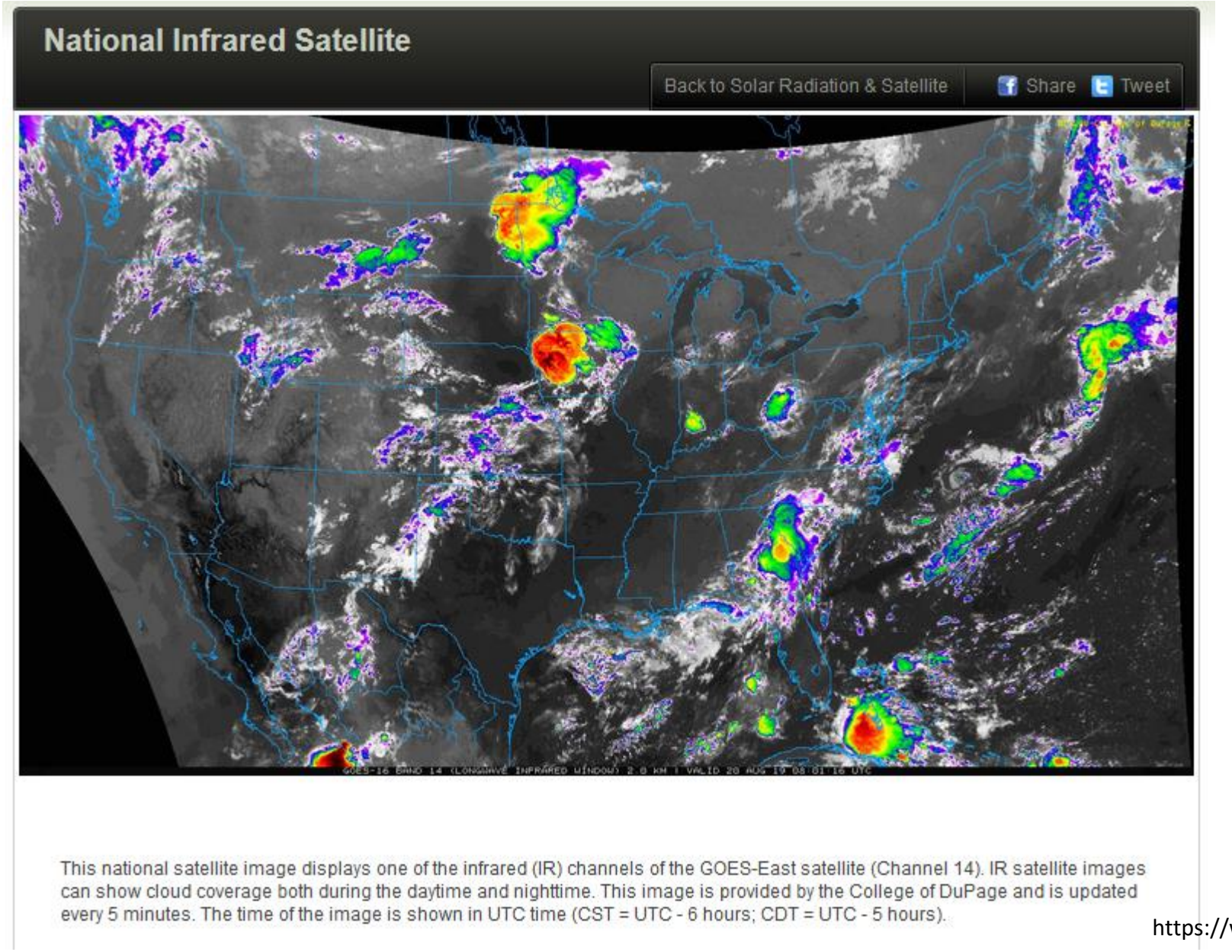
GOES Band 7 (Shortwave Window IR)



GOES Band 13 (Longwave IR Window)

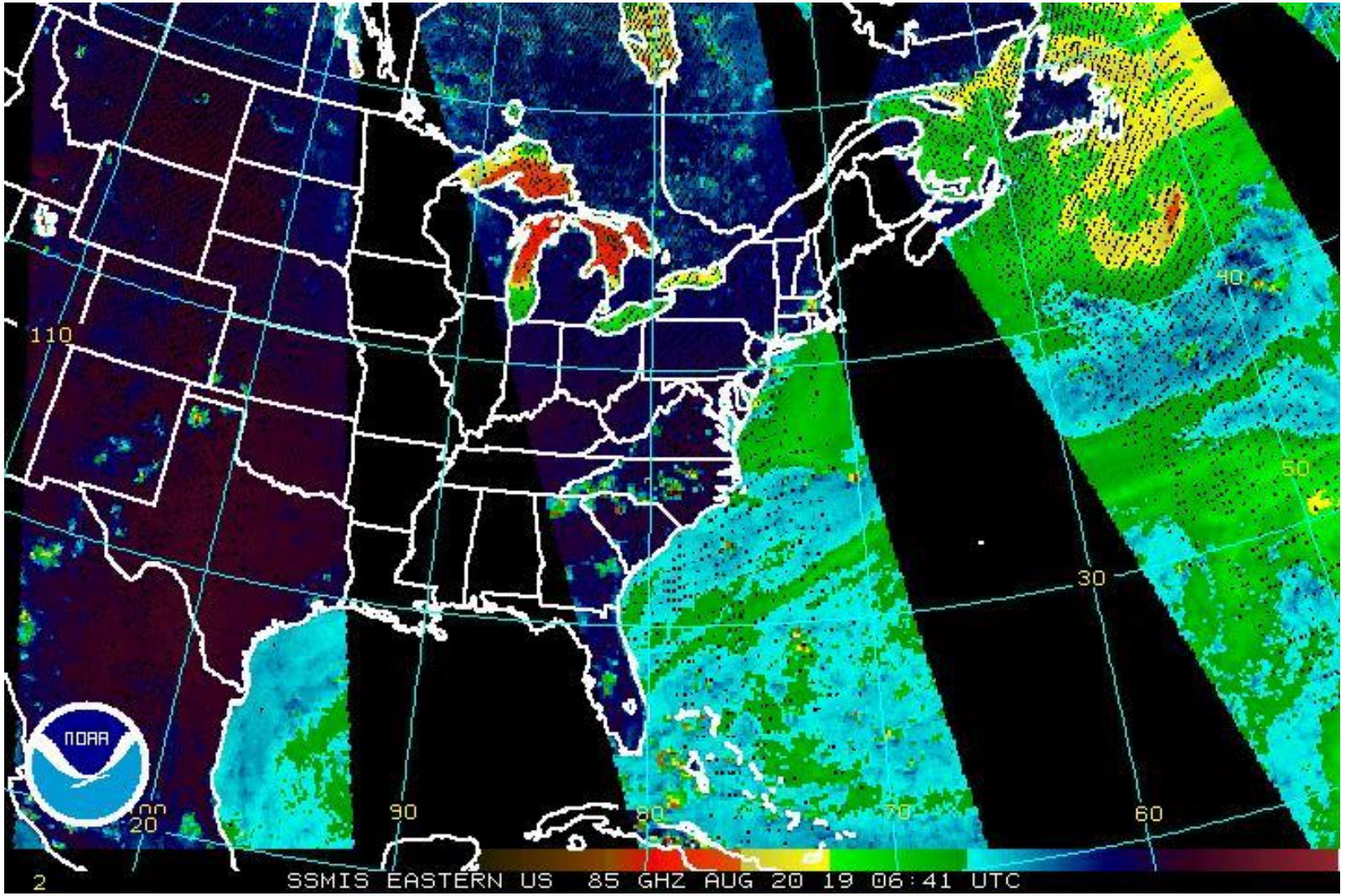
https://weather.cod.edu/

Geostationary Satellite Measurements in brightness temperature at Infrared (IR) Band



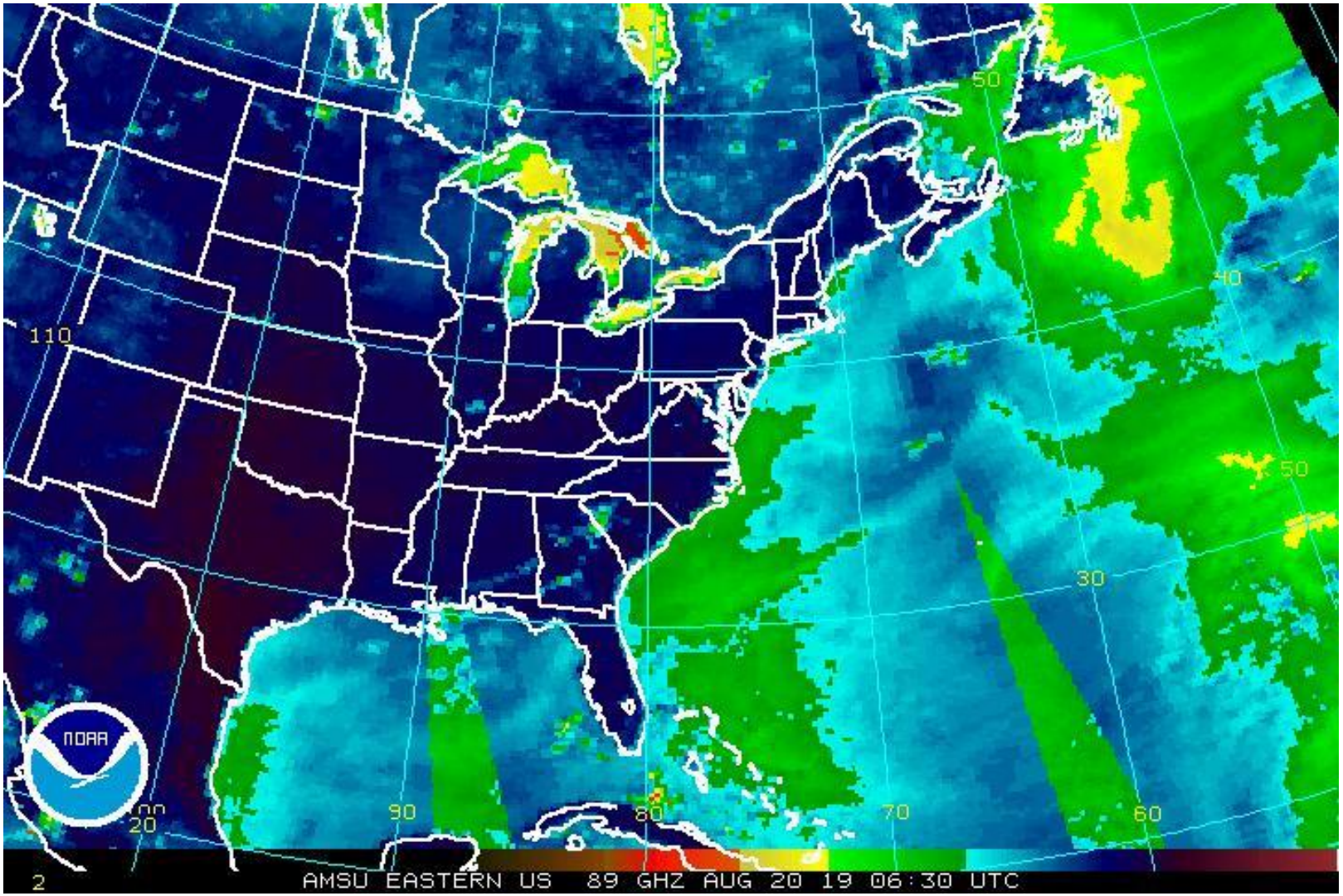
https://weather.cod.edu/

Polar DMSP (Defense Meteorological Satellite Program) SSM/IS (Special Sensor Microwave Imager/Sounder (85 GHz Radiance)



https://www.ssd.noaa.gov/poes/

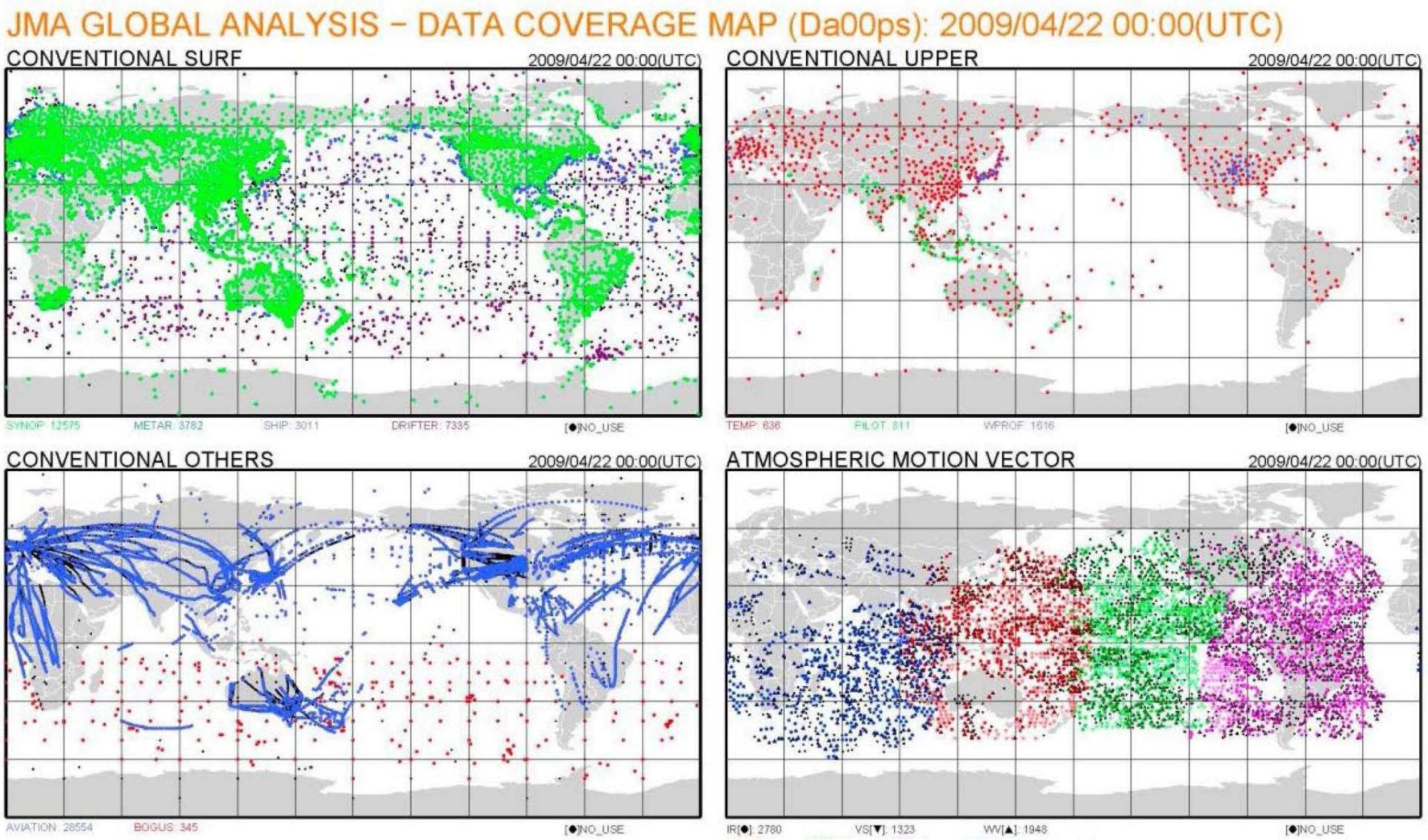
Polar AMSU (Advaned Microwave Sounding Unit) Imagery (89 GHz Radiance)



https://www.ssd.noaa.gov/poes/

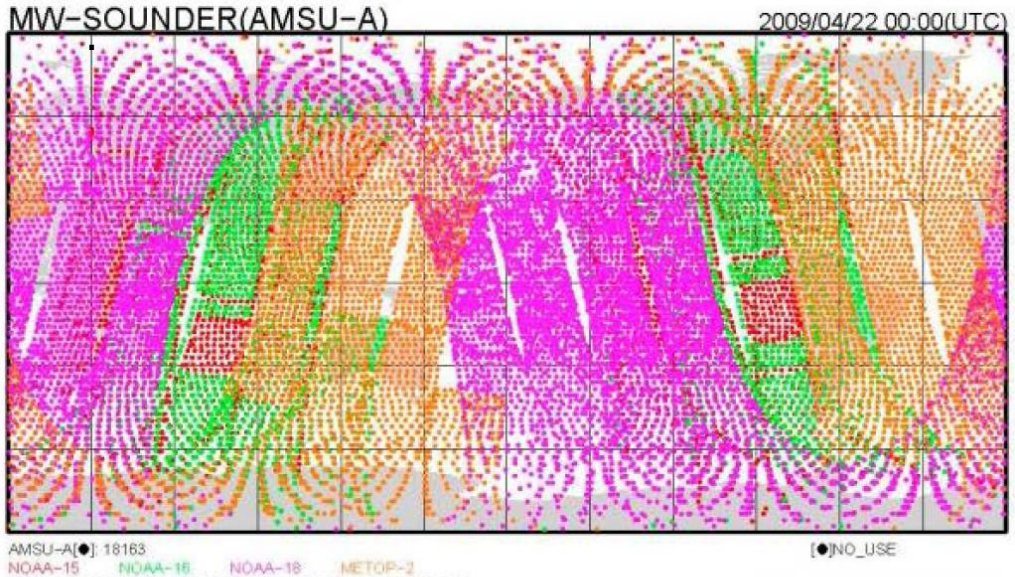
Observation coverage

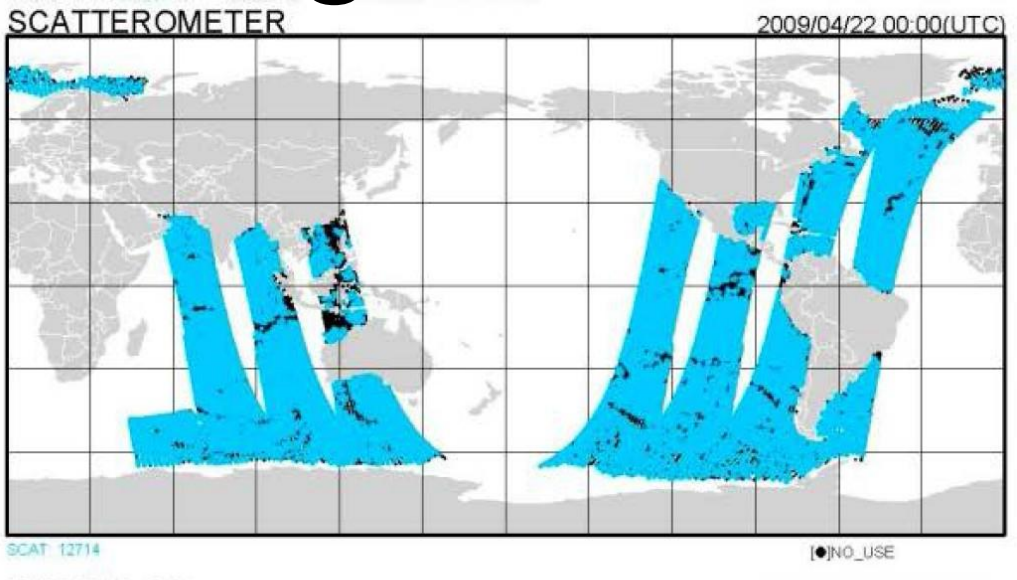
.

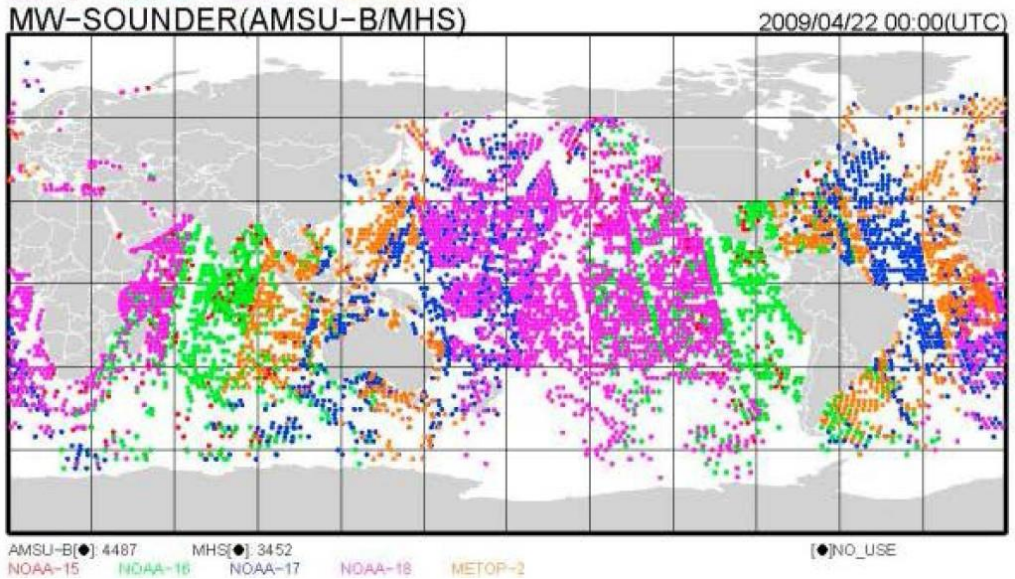


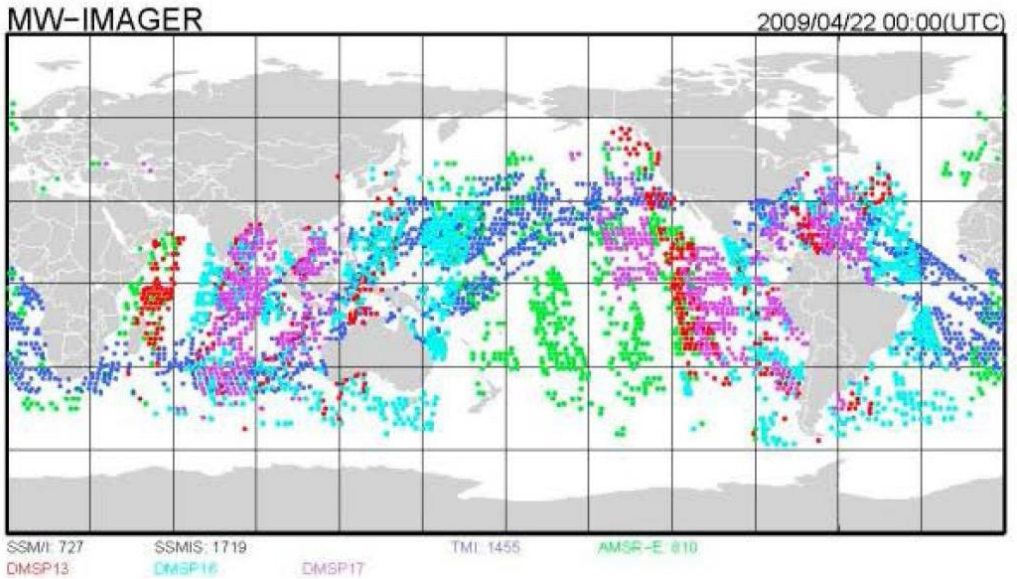
World's effort! (no border in the atmosphere)

Observation coverage









Great coverage nowadays. Nonetheless we do not observe every single variable at every single model gridpoint. The **system is partially observed**[9].

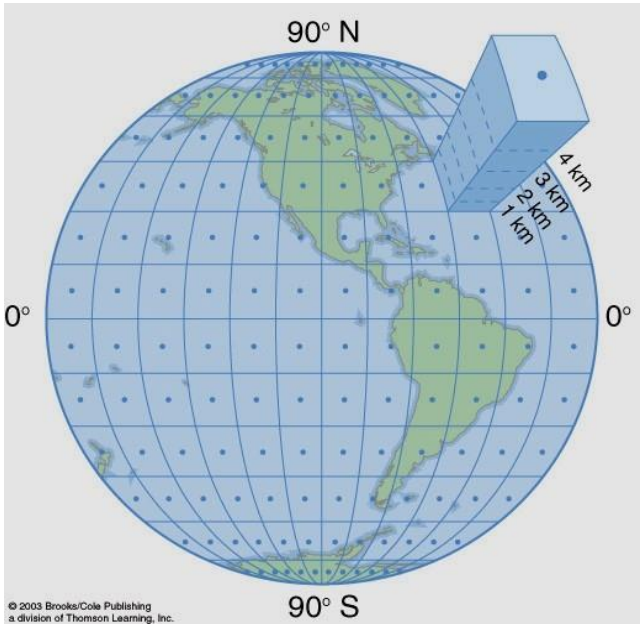
What do we want?

- Values at regular grid points for meteorological (or other environmental) variables at regular times, and ideally with estimates of their uncertainties (expected errors);
- Very often, single instruction/observing platform does not measure all needed variables; other (variables) have to be ‘retrieved’, which goes beyond objective analysis;
- The word ‘objective’ is in contrast to ‘subjective/human’ analyses, as how weather charts/maps were originally produced.

Our system of interest

State variables:

$$\mathbf{x} \in \mathcal{R}^{N_x}$$



The **state variables** of the system are: **meteorological variables** (wind speed, temperature, etc) in **every** single **gridpoint**.