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)



Forecast by National Weather Service

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



The above map is a composite of all radars across the United States. The unit dBZ is a measure of the radar reflectivity factor, which indicates the intensity of the precipitation on the map. The higher the dBZ value, the more intense the precipitation.

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



This national satellite image displays one of the infrared (IR) channels of the GOES-East satellite (Channel 14). IR satellite images can show cloud coverage both during the daytime and nighttime. This image is provided by the College of DuPage and is updated every 5 minutes. The time of the image is shown in UTC time (CST = UTC - 6 hours; CDT = UTC - 5 hours).

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:





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

