Weather Satellites and Alaska Weather

“It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.” --Mark Twain

...or...

“Bad data is worse than no data” –Rick Thoman and Others
Ask of Me Anything But Time

• Why are we here: to investigating our wonderful state and its weather as seen by satellites
• **October 21**: Satellite Orbits and Satellite Instruments
• **November 4**: The Electromagnetic Spectrum and Multispectral Imagery
• **November 1**: Weather Maps and Numerical Weather Prediction
• **November 8**: The Peoples’ Choice Awards: Ice and etc…
Previously on OLLI SCI-11...
October 2018 is in the Books

• Q: How did the snow and temperature numbers finish in Fairbanks and Utqiagvik?
• A: Let’s consult the famous “Weather Service Form F-6” as archived on line at
  – www.weather.gov/afg
  – Under “climate and past weather” select “local,” which takes us to...
  – Lots of good stuff here, including the F-6 form, “Preliminary Monthly Climate Data”
Shortwave Sun, Longwave Earth

Graphic from:  http://remote-sensing.net/concepts.html
Okay, What’s a Micron (or Micrometer)?
USCG Rescues Mariner in Sailboat Trapped in Ice North of Barrow

WFO Anchorage sea ice forecasters provided “phenomenal weather products” that proved key to USCG decision makers, said Rear Adm. Dan Abel, commander, 17th Coast Guard District.
Reflects off liquid cloud droplets and to lesser degree by vegetation; absorbed by snow/ice and bodies of water.

Reflects off living vegetation and snow/ice; absorbed by liquid water.

Reflects off anything the human eye sees as bright; absorbed by anything the human eye sees as dark.
“Mr. Osborne, may I be excused? My brain is full.”
Special Topic: How to Define “Up”

• There are a handful of vertical coordinates used in meteorology, ranging from the intuitive to the bizarre.
  1. Constant height above ground, expressed in feet or meters
  2. Constant pressure, expressed in millibars, mb
  3. Constant ratio of atmospheric mass below and above the surface in question
  4. Constant “potential temperature,” defined as the temperature a piece of air would have if brought down to the sea level

• Today we will focus on the first two approaches, especially constant pressure
What is a “Surface of Constant Pressure”?

• Consider a weather balloon at Fairbanks International.
  • At what height does the balloon reach the pressure level of 500mb?
• Consider similar weather balloons launched simultaneously all over the world.
  • At what height do these balloons reach the pressure level of 500mb?
• Now connect the dots!
• Result is a contour map depicting a continuous “skin” of the 500mb pressure surface covering the entire world (except the top of Denali, Mt. Everest, and etc.)
• Works for any pressure surface: 925mb, 850mb, 700mb, 250mb, etc.
“Mr. Osborne, may I be excused? My brain is full.”
All right men, we have to take Hill 505!

- Reading weather maps is similar to reading contour maps of terrain.
- A terrain map depicts the intersection of the surface of the earth with height above mean sea level.
- Let’s go play in the sandbox!
Numerical Weather Prediction (NWP)

• Also known as “The Models” or “NWP Models”
• Computer simulations of future weather, using the most powerful computing resources available to humanity
  • Idea is to use computers to answer the question, “where is this storm going to go?” and etc
• Essential tools in the business of weather forecasting
  • What is the role of the human in the forecast process?
• Complicated as (insert your term of choice here)
• Nice article on Wikipedia https://en.wikipedia.org/wiki/Numerical_weather_prediction
• US NWP output available at... http://mag.ncep.noaa.gov/
Who Dropped the Ball?

• **Q**: So if we’re all so smart, and these computers are so powerful, how can an NWP forecast go wrong?

• **A**: Fundamentally, the atmosphere is a non-linear system
  

• **Consequence Number One**: Imperfect initialization of the atmosphere will (eventually) ruin any NWP forecast
  
  • Due to the non-linearity of the atmosphere, these imperfections “upscale” over time and take over the model

• **Consequence Number Two**: Some atmospheric processes operate at spatial and temporal scales too fine to explicitly model; thus these processes are “parameterized” and will (eventually) ruin any NWP forecast
  
  • Due to the non-linearity of the atmosphere, the particulars of these fine-scale processes “upscale” over time and take over the model
Time for The Chaos Machine!
Is NWP Modeling Useless?

• Nope
• NWP is not perfect, but still useful
• NWP is getting better all the time (a double-edged sword)
• Other tricks up the NWP sleeve:
  • Model Output Statistics (MOS)
  • NWP Ensembles
Model Output Statistics: MOS

• Correlations between aspects of the atmosphere can be identified if you have a big (enough) archive of past NWP forecasts and weather observations to sift through

• You don’t need to model or even know the underlying mechanisms that produce the correlation

• The Good: easterly winds at Unalakleet

• The Bad: MOS can get stuck in a rut (see next slide), and can be out of its depth during unprecedented events

• The Ugly: Forecasters can be tempted to just “load and go” with MOS
NWP Ensembles

• Accept that, with current technology, “The Impenetrable Horizon of Deterministic Predictability” cannot be overcome by NWP models

• Instead of investing all effort into building one perfect NWP model, run an ensemble of slightly different NWP models
  • The result will be a cloud of solutions (probabilistic approach) rather than a single solution (deterministic approach)
  • Let’s take a look, courtesy of our good pals at Penn State: http://cms.met.psu.edu/sref/ensembles/
“I’m sick of all this weasel-word pussy-footing around! Just give me a straight yes or no answer for once, is that too much to ask?”

Yep

The public needs to learn to properly handle probabilistic information. The very existence of Las Vegas and Powerball demonstrate the dire magnitude of this need. People tend to hear what they want to hear, rather than hear what the numbers say.

Examples that I like because they reinforce the way I already think:
- Gordon Haber taught me to combine probabilities and confidence
- A forecast of 50% is not a know-nothing forecast
- The RAF’s pasty-skinned pencil-necked Boffins
- Do not conflate probabilities of occurrence and intensity:
  - Precipitation in Fairbanks and the Global War on Terror

The Op/Ed Page
How do you verify ensemble forecasts?

• Deterministic forecasts are easy to verify

• Probabilistic forecasts are more of a challenge
  • A broad set of forecasts and events are required
  • Any single event means (almost) nothing when verifying probabilistic forecasts
    • Tuesday’s election: were the polls wrong?

• The “reliability diagram” to the rescue

• http://research.metoffice.gov.uk/research/nwp/ensemble/verif-example.html