Weather Satellites and Alaska Weather

SCI-06, Fall Semester 2017, Session II

“Prediction is very difficult, especially about the future.”
--Niels Bohr, Danish Physicist
Why Are We Here?

• To learn about weather satellites and how they can monitor weather in Alaska and around the world.
  • ...and to look at fun “eye candy” imagery!
• October 19: Orbits, All Kepler All the Time
• October 26: Instruments, The Electromagnetic Spectrum, and You. Or, “Microwaves aren’t only good for making popcorn any more.”
• November 2: Classic weather patterns for Alaska
• November 9: The People’s Choice Awards
"Son, all I've ever asked of my Marines is that they obey my orders as they would the word of God."
The Actual Ground Rules

• Please think critically, be curious, and ask questions: participation will be 50% of your grade. Bribery will be the other 90%.

• Jargon Alert: Please ask if an acronym or term is unfamiliar

• In case a question is too challenging to answer on the spot, your instructor dodge, obfuscate, and defer an answer to the following week’s session

• Fun is mandatory, suffering can be endured for optional extra credit
Your Instructor and (tor)Mentor’s Credentials

• Born and raised in North Dakota, moved to Fairbanks for the nicer winters
• Master’s in Atmospheric Science from Colorado State University
• Meteorologist with National Weather Service 1993-2011.
• eric@gina.alaska.edu
The Alaska Challenge

• Alaska is a synoptic-scale region within a mesoscale-oriented NWS area.
• Areas of responsibility are (comparatively) huge.
• The land portions of these areas of responsibility are topographically complex, yielding myriad microclimates.
• Many observational networks (such as 88Ds) are very sparse...
  • Big problem because the first step in forecasting is analyzing and understanding the weather now at time=0.
• The specter of climate change being concentrated in the high latitudes means that old "rules of thumb" may suffer from diminishing relevance.
The High Latitude Proving Ground

- Thanks to its high latitude, Alaska enjoys frequent coverage from polar orbiting satellites.
- The University of Alaska Fairbanks receives data from a number of polar orbiting satellites.
  - The data are then processed into imagery in a variety of formats for a variety of users.
  - Popular formats include GeoTIFFs, AWIPS-ready files for the NWS, and good old .jpgs on the web.
- This approach minimizes latency.
Johannes Kepler: The Lawgiver

1. Orbit of a planet is an ellipse, with the sun at one foci
2. A planet “sweeps out” equal areas in equal time
3. The square of the orbital period of a planet is proportional to the cube of the semi-major axis of its orbit.

*Good grief, luckily for our purposes tonight we can pretty much forget about law #3*
Kepler’s Second Law
Kepler’s Second Law

• Planet sweeps out equal areas in equal time
• The closer to the sun, the faster the planet moves.
• The further from the sun, the slower the planet moves.
• Kepler’s Laws also apply to weather satellites orbiting the earth
An Alphabet Soup of Satellite Orbits

• GEO: GEostationary Orbit
• LEO: Low Earth Orbit
• HEO: Highly Elliptical Orbit
• EIEIO: Old MacDonald Orbit
• MLPs: Magical Lagrange Points
GEO and LEO

Polar Orbiters (850 km)

Geostationary (35800 km)
The GOES Advantage

• Welcome to The Future, Your Tax Dollars at Work
  • GOES-R was launched last November, now in orbit as GOES-16. Still undergoing last bits of calibration and validation...moving to GOES-East position (75W longitude) in November
  • Advanced Baseline Imager (ABI) is a serious leap forward in technology
    • More channels, sharper spatial resolution, finer temporal resolution. Faster, better, more!
  • Alaska will get GOES-S, to become GOES-17 and eventually as GOES-West at 137W longitude late 2019(?)

• Can see the “full disk”
• Constant frame of reference means...movies!
Where Were You on August 21st?

• [http://rammb-slider.cira.colostate.edu/?sat=goes-16&sec=full_disk&x=5696&y=10912&z=0&im=12&ts=1&st=20170821080038&et=20170821200037&speed=130&motion=loop&map=1&lat=0&p%5B0%5D=17&opacity%5B0%5D=1&hidden%5B0%5D=0&pause=0&slider=-1&hide_controls=0&mouse_draw=0&s=rammb-slider](http://rammb-slider.cira.colostate.edu/?sat=goes-16&sec=full_disk&x=5696&y=10912&z=0&im=12&ts=1&st=20170821080038&et=20170821200037&speed=130&motion=loop&map=1&lat=0&p%5B0%5D=17&opacity%5B0%5D=1&hidden%5B0%5D=0&pause=0&slider=-1&hide_controls=0&mouse_draw=0&s=rammb-slider)

• Say that ten times fast
The GOES Disadvantage

- Poor view of higher latitudes: Alaska
  - Degraded spatial resolution
  - Parallax
  - Some instruments or products simply not available poleward of a certain latitude
    - The “Goestationary Lightning Mapper” (GLM) on the new generation of geo birds
- The solution: Polar Orbiters
LEO Pros and Cons

• Pros: Pass directly overhead, no matter where you are
  • Fine-scale spatial resolution
  • No parallax
  • High latitudes (Alaska) get lots of coverage

• Show that nifty cartoon

• Cons: no constant frame of reference (no movies), hard edge at side of images
Suomi NPP/JPSS, Metop, DMSP/DOD
Three-Orbit System
HEO: Highly Elliptical Orbit

- Doesn’t exist yet, at least as a civilian weather satellite
- Canadians leading effort for PCW mission: “Polar Communications and Weather”
- Idea is to blend GEO and LEO advantages into a single orbit
- If PCW happens, it will be great for Alaska, stay tuned...
The Magical “Lagrange Points”...Kepler is spinning in his grave
Fun Web Sites Featured in Today’s Session

• Colorado State’s “GOES-16 Loop of the Day”
  • Great eye candy from a variety of locations and situations, often following events in the news such as wildfires and hurricanes
  • http://rammb.cira.colostate.edu/ramsdis/online/loop_of_the_day/

• Colorado State’s “Slider”
  • Nice archive, allows users to cook up custom movie loops from GOES-16 and Himwari-8.
  • http://rammb-slider.cira.colostate.edu/
Thank You!

• eric@gina.alaska.edu
Free Bonus Extra Slides!
Shortwave Sun, Longwave Earth

Graphic from: http://remote-sensing.net/concepts.html
VIIRS Day Night Band
2am December 25, 2015
Minimal Light Pollution in Alaska: Plenty of Aurora

Legacy “Adaptive” DNB enhancement

New “Dynamic” DNB enhancement
Not Every Rectangle is a Square

- **Multi-spectral Product**: any product made from more than one single-channel image
  - Thus the classic 11µm-3.9µm channel difference “fog product” is multi-spectral

- **RGB**: a multi-spectral product that contains single-channel or multi-spectral products in each of the red, green, and blue components of a color image
  - Thus all RGBs are multi-spectral, but not all multi-spectral products are RGBs
The Multi-spectral Advantage

• The Whole is Greater Than The Sum of the Parts
  • Some meteorological and terrain features only become obvious in multi-spectral products

• A more time-efficient way to evaluate all the new channels available from JPSS and GOES-R
  • Can combat data sprawl with data density: multispectral products are “more dense”
Environment

Pavlov Volcano settles down after March eruption

Associated Press | April 6, 2016

A remote Alaska volcano has settled down more than a week after it sent an ash cloud 37,000 feet into the sky.

Officials at the Alaska Volcano Observatory in Anchorage said Wednesday that eruptive activity at Pavlov Volcano has ended, and they downgraded its alert level to advisory status.

The volcano 625 miles southwest of Anchorage on the Alaska Peninsula erupted with little warning on March 27. It sent an ash cloud about 7 miles into the air, which drifted across interior Alaska and into Canada.

**RELATED:**
- Ash from Pavlov Volcano coats nearby village and drifts into Canada
- Flights resume Tuesday as Pavlov Volcano eruption slows

Alaska Airlines canceled nearly 70 flights because of the ash, which can damage plane engines.

Authorities say Pavlov is one of Alaska's most active volcanoes, and it could again start erupting with little warning.
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.