

FOUNDATIONAL COURSE

August 21, 2018

Satellite Foundational Course for JPSS (SatFC-J)



MICROWAVE

FOUNDATIONAL COURSE

Microwave Surface Emissivity



Learning Objectives

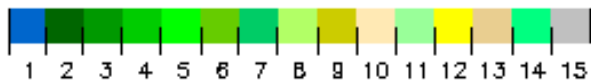
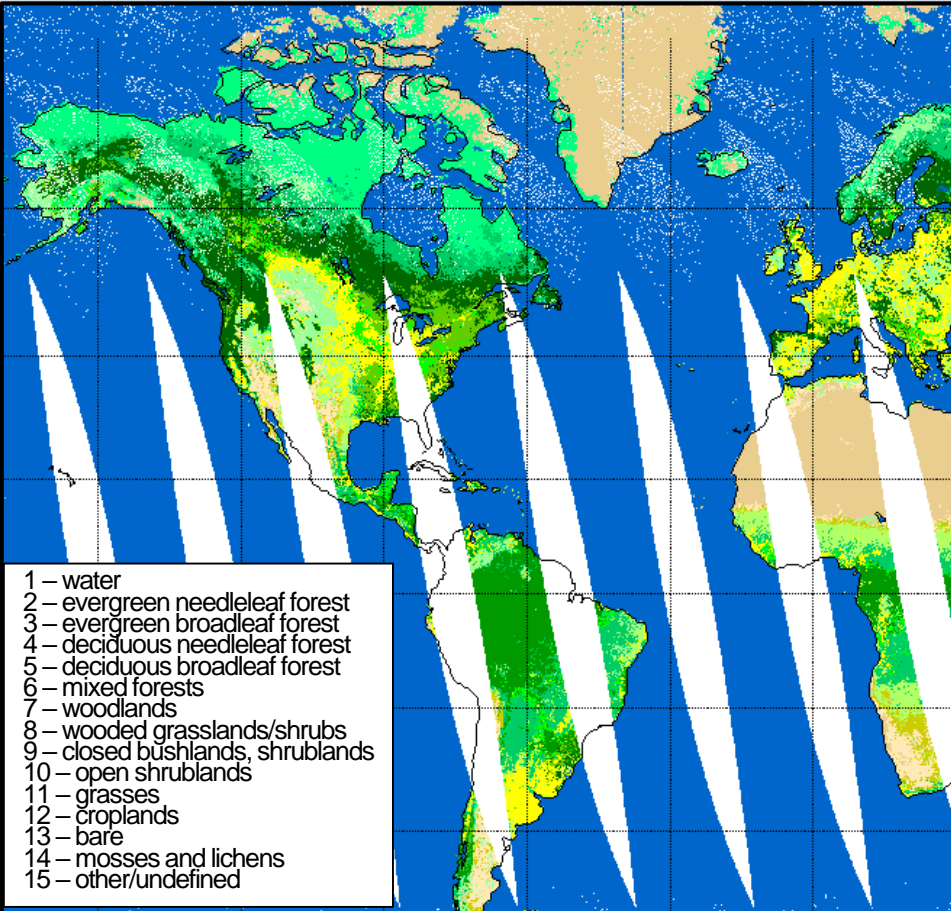


1. Describe differences in microwave surface emissivity that aid in the characterization of land surfaces, snow and ice cover, and ocean and water surfaces.
2. Identify key parameters that affect emissivity.
3. Provide single channel and product examples demonstrating strengths and limitations.

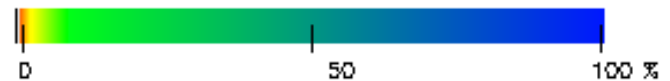
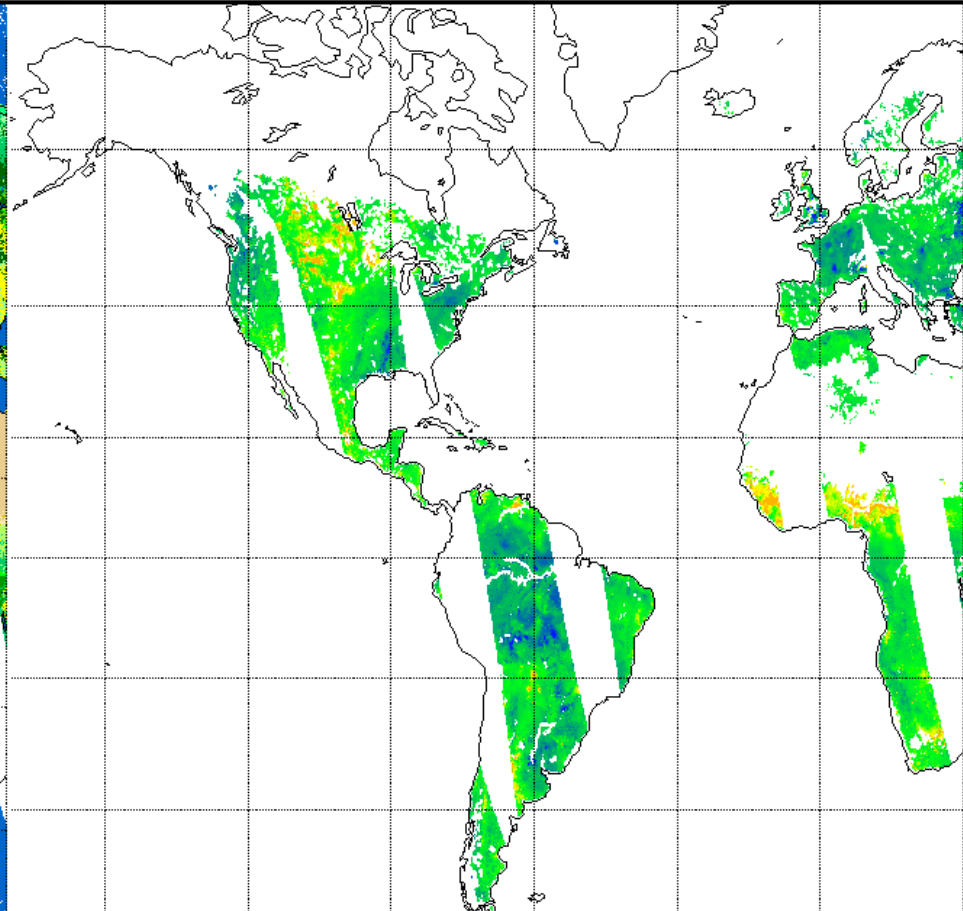
Non-precipitating clouds
are transparent.

Land Products for Input to Models

AMSR-2 Land Cover
11 Feb 2018



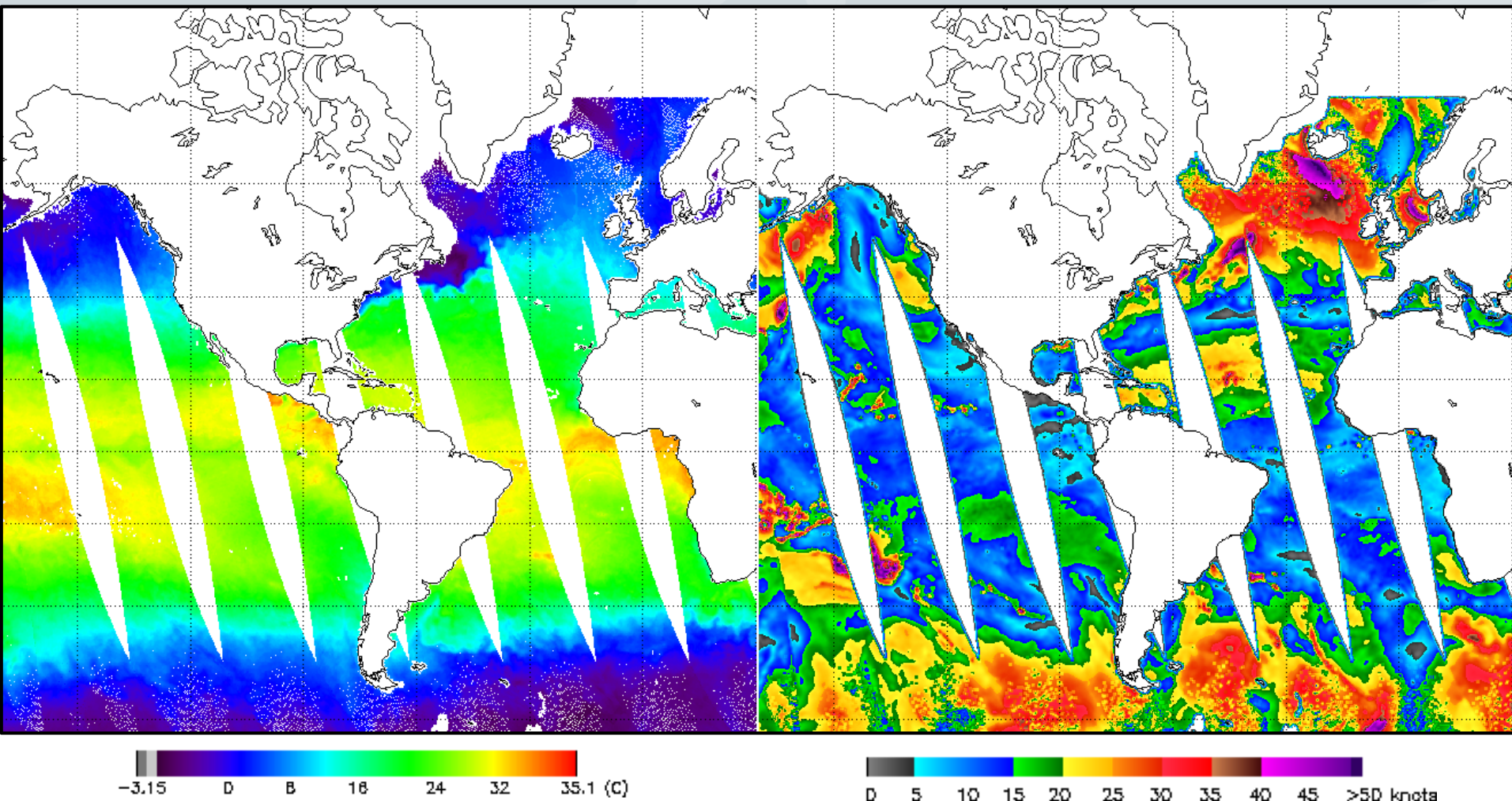
AMSR-2 Soil Moisture
11 Feb 2018



Sea Surface Products

AMSR-2 Sea Surface Temperature
11 Feb 2018

AMSR-2 Sea Surface Wind Speed
11 Feb 2018

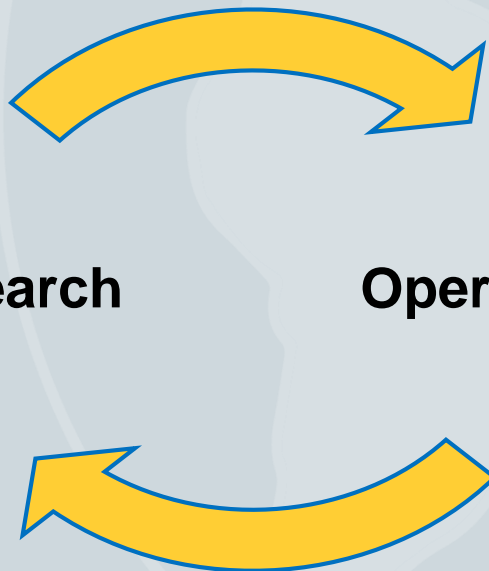


Why Is Learning About Emissivity Important?

Emissivity characteristics strongly affect the interpretation of microwave imagery.

Research

Operations

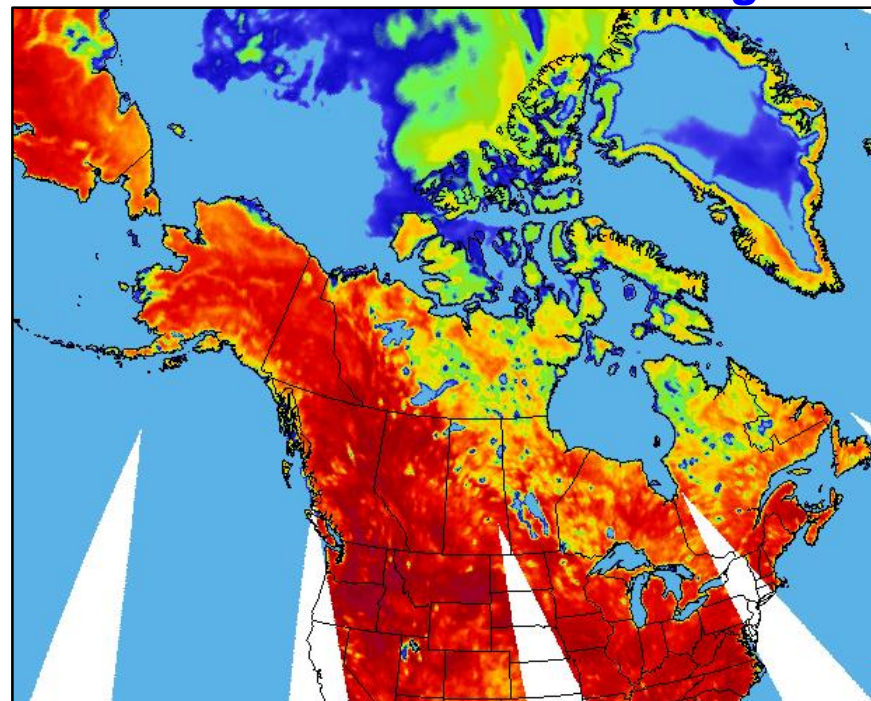
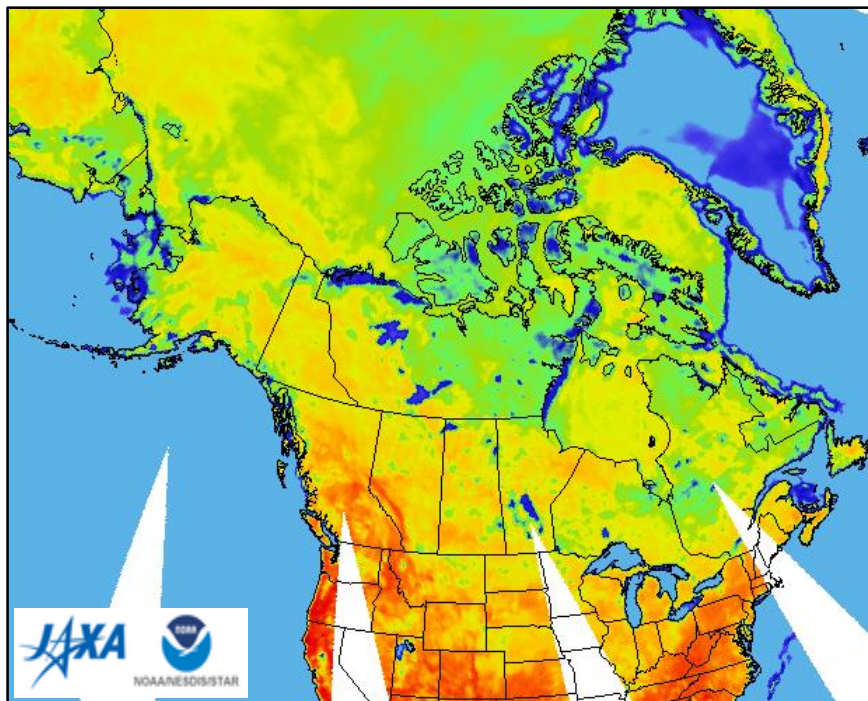


Summer vs. Winter

Winter
29 Jan 2018

AMSR-2 10.65 GHz (H-pol)

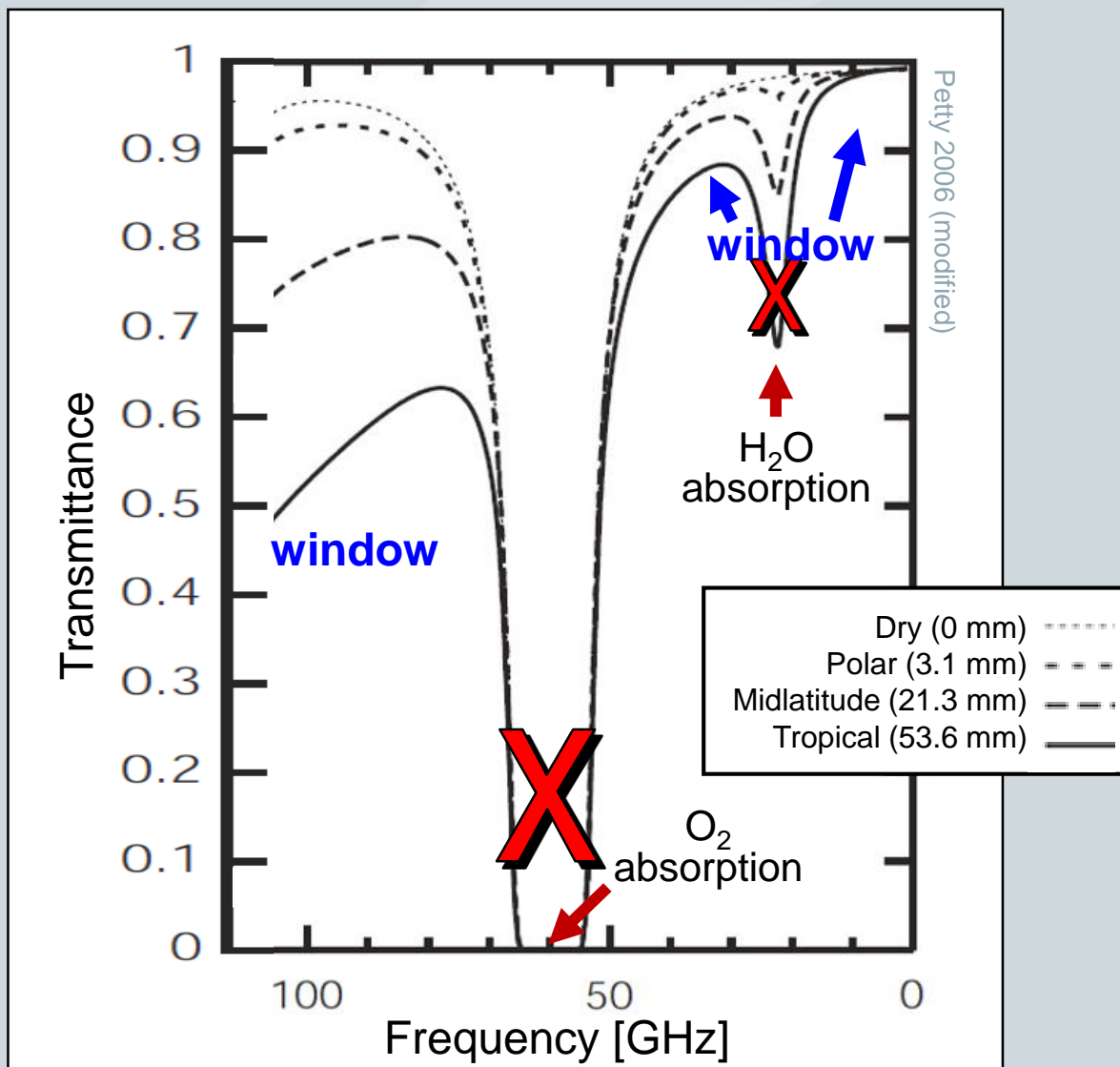
Summer
11 Aug 2017



-105 -85 -65 -45 -25 -5 15 [°C]
165 185 205 225 245 265 285 [K]

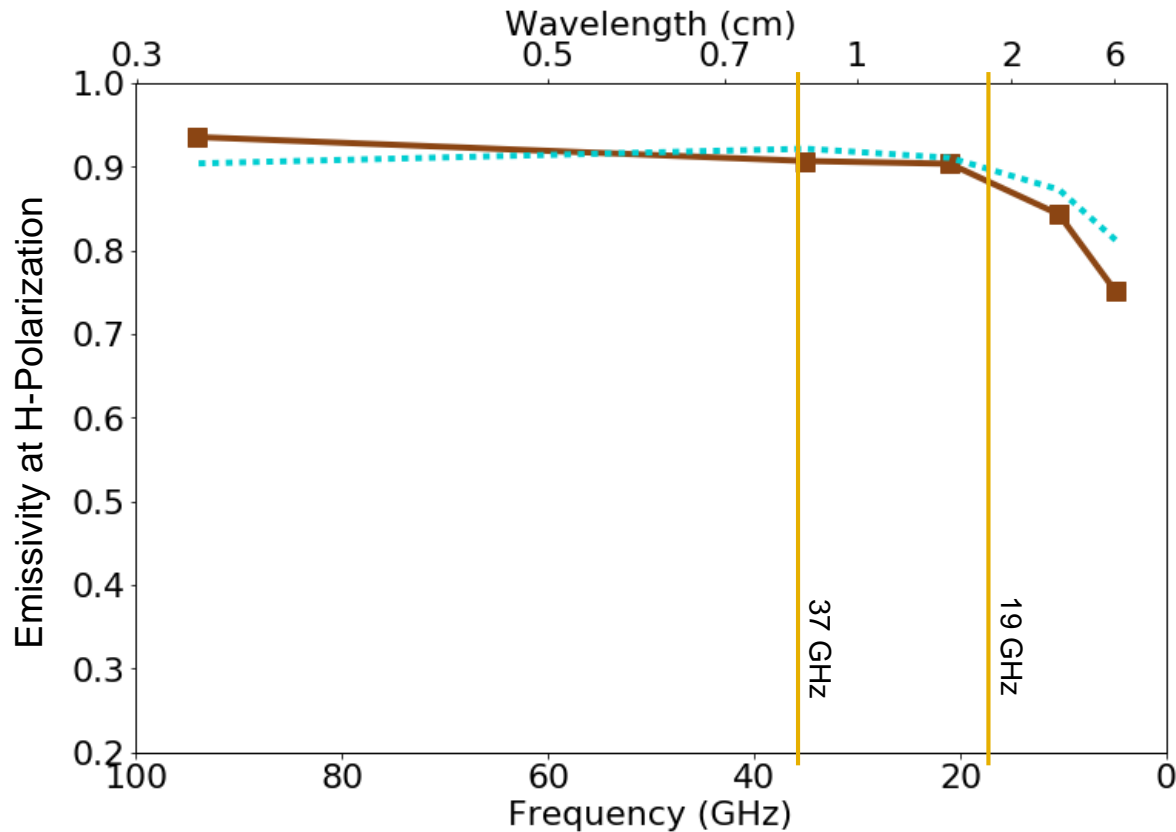
Brightness Temperature

Window Viewing Regions



Emissivity

Surface Emissivity Spectra



Parameters:

- wavelength
- material characteristics
- polarization
- surface roughness
- viewing angle



Data Source: C. Matzler, "Passive Microwave Signatures of Landscapes in Winter", *Meteorol. Atmos. Phys.* (1994)

Land Surfaces

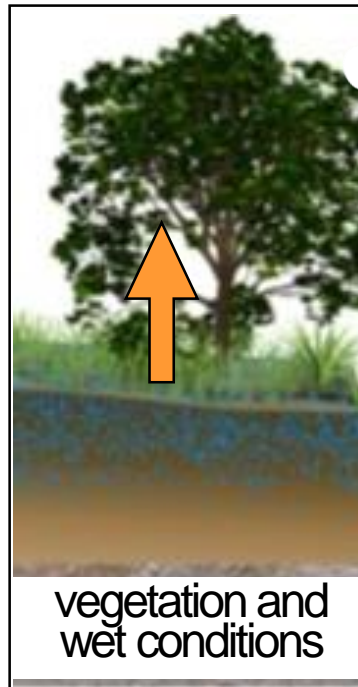
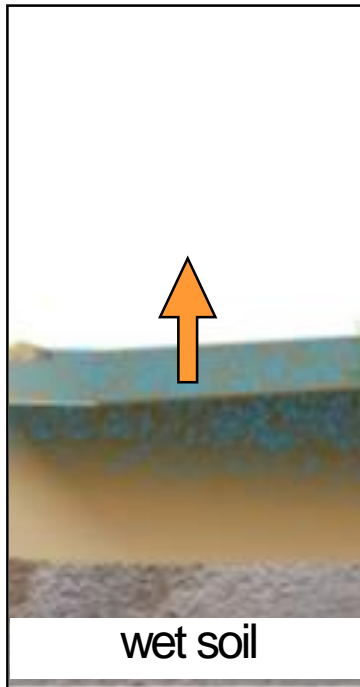
Factors that influence measurements:

- soil type
- vegetation type and amount of coverage
- moisture content

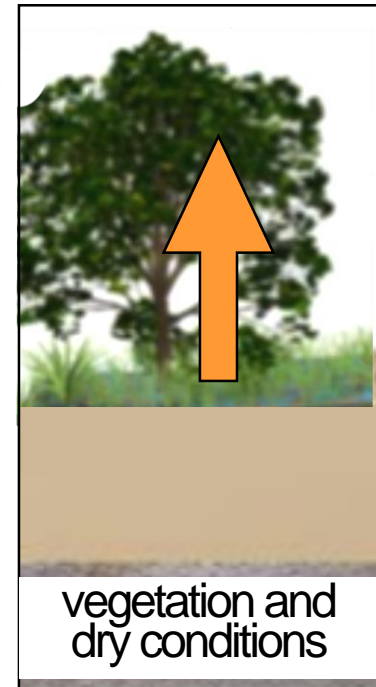
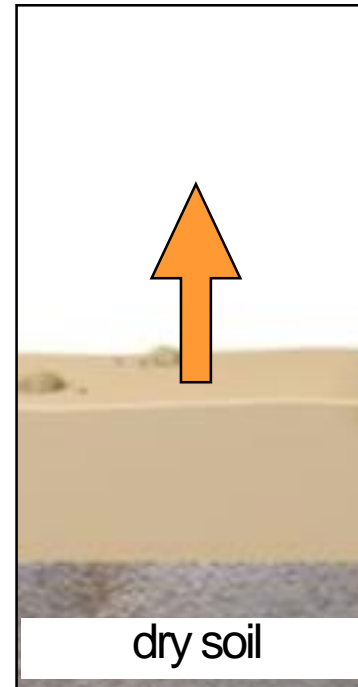
Typical emissivity:

- bare soil < vegetation
- moist < dry

0.6 – 0.8 emissivity



emissivity > 0.9

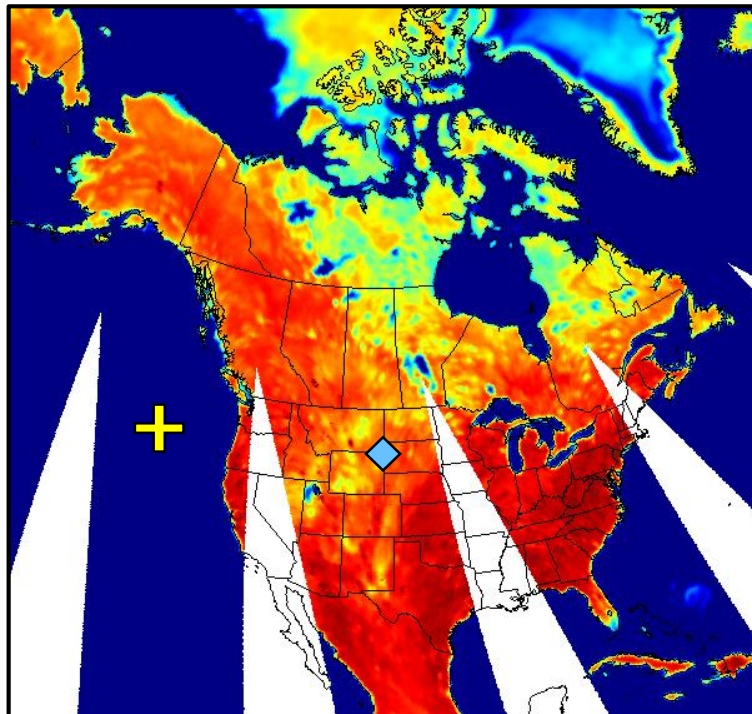


©The COMET Program (modified)

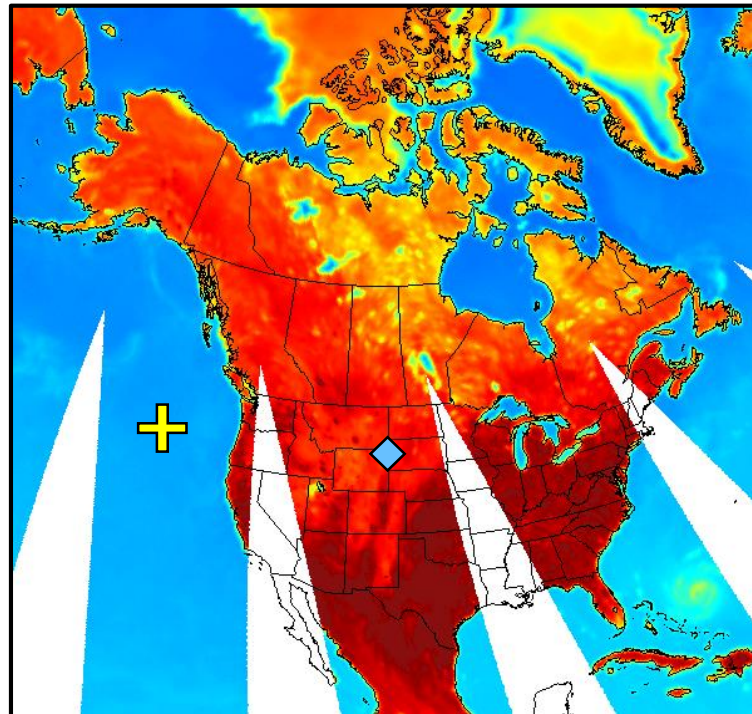
Horizontal vs. Vertical Polarization

- Surface emissivity and the resulting measured brightness temperature (T) is strongly dependent on polarization in the microwave

AMSR-2 6.9 GHz H-pol
23 Sep 2017

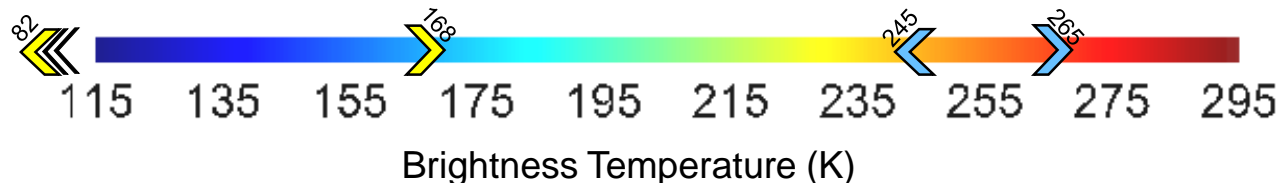


AMSR-2 6.9 GHz V-pol
23 Sep 2017

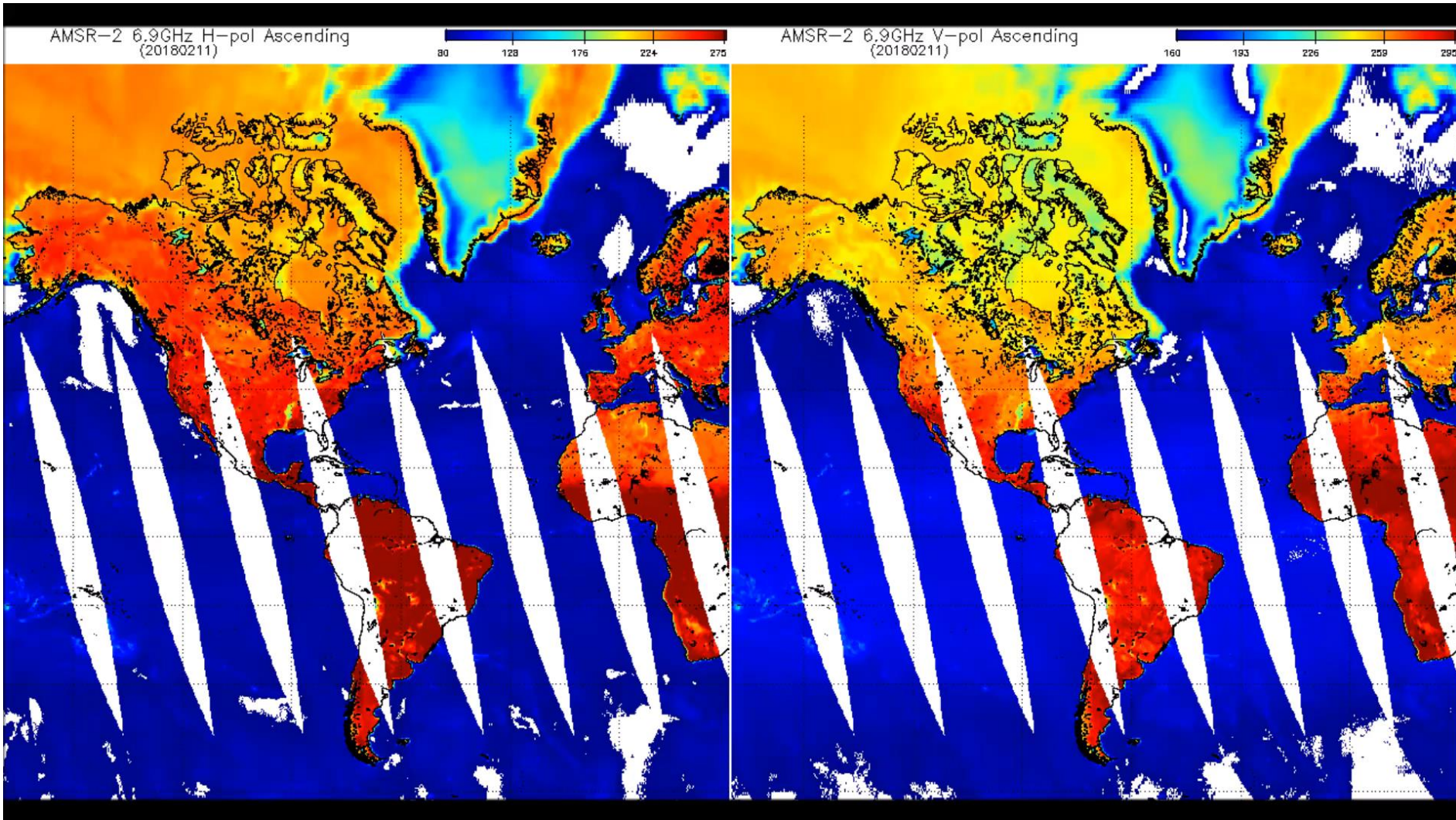


◆ **land**
weak
polarization
 $\Delta T \approx 20 \text{ K}$

✚ **water**
strong
polarization
 $\Delta T \approx 86 \text{ K}$



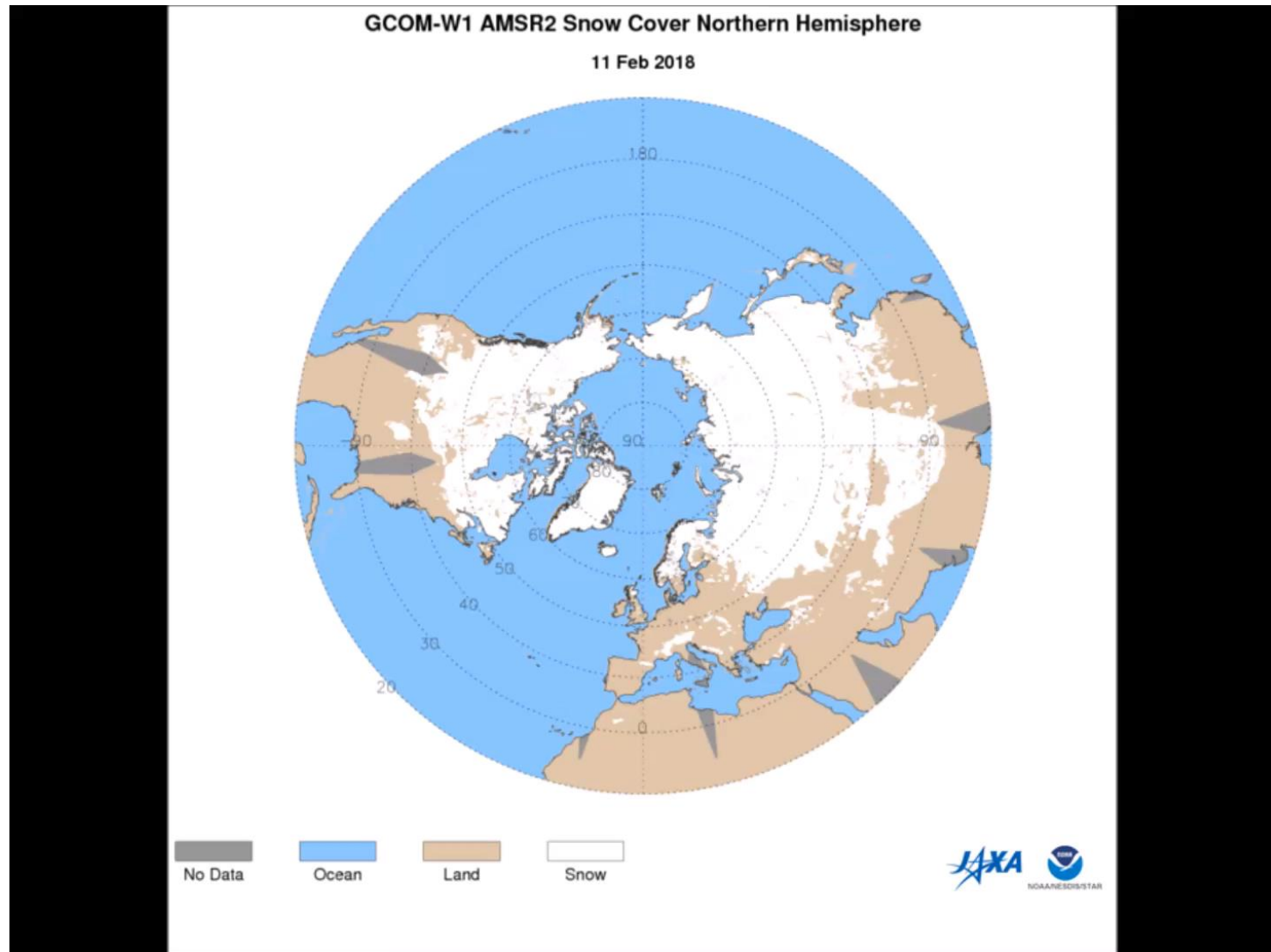
Animation of AMSR-2 H-pol and V-pol Brightness Temperature – 11 Feb 2018



http://rammb.cira.colostate.edu/templates/loop_directory.asp?data_folder=visitview/custom/AMSR2_20180211_Hpol_Vpol

Imagery Source: NOAA Operational GCOM-W1 AMSR-2 Product Maps (BTs)
<http://www.ospo.noaa.gov/Products/atmosphere/gpds/maps.html?GPLCT#gpdsMaps>

Animation of AMSR-2 Snow and Ice Products – 11 Feb 2018



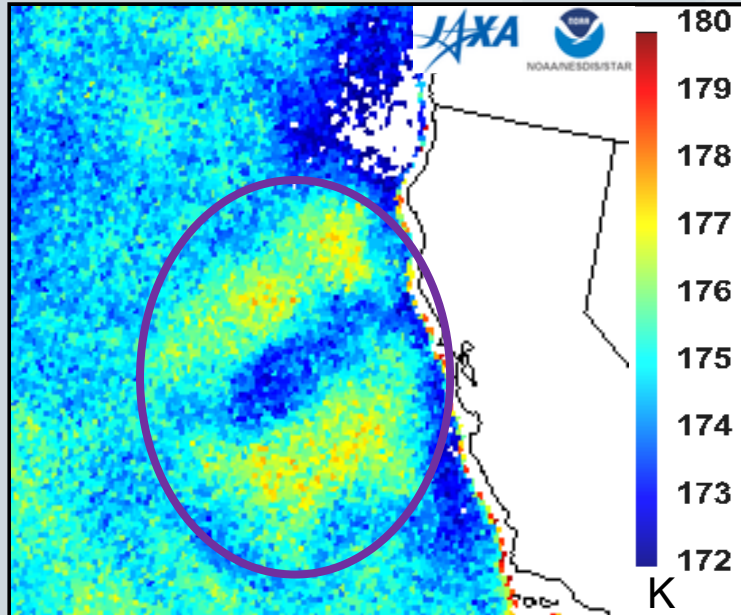
http://rammb.cira.colostate.edu/templates/loop_directory.asp?data_folder=visitview/custom/AMSR2_20180211_NH_seaice_snow

Imagery Source: NOAA/NESDIS/STAR JPSS Environmental Data Records (GCOM AMSR2 Products)
https://www.star.nesdis.noaa.gov/jpss/EDRs/products_gcom.php

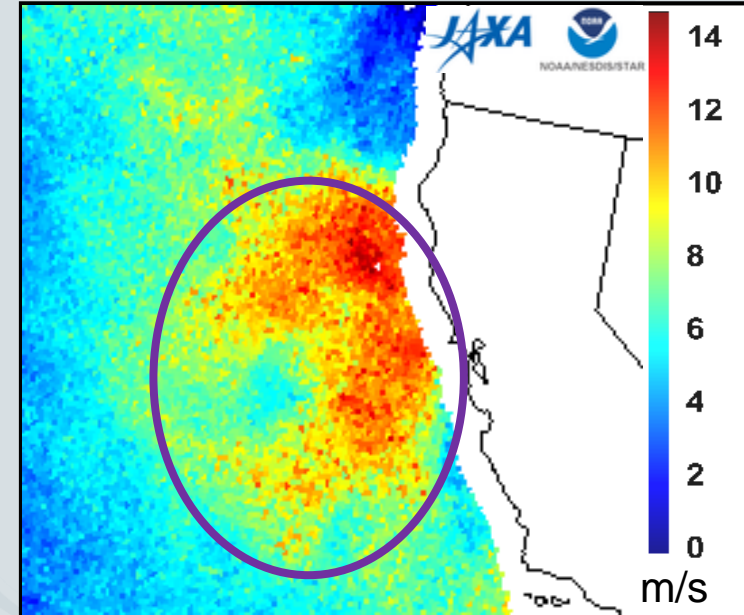
Ocean & Water Surfaces

- Typical emissivity: 0.25-0.5
calm < small waves < foam
- Emissivity differences used in sea surface wind estimation (± 2 m/s)
- Sensitive to sea surface temperature (± 0.2 °C)

AMSR-2 10.65 GHz V-pol
29 Oct 2017



AMSR-2 Sea Surface Wind Product
29 Oct 2017



Summary

Microwave emissivity varies considerably by surface type and accounts for the large differences in observed brightness temperature imagery.

In general...

- dry land surfaces and vegetation covered surfaces are the strongest emitters
- snow- and ice-covered surfaces are moderate emitters
- ocean and water surfaces are the weakest emitters

Observations at multiple frequencies and polarizations (vertical, horizontal) helps in the characterization of various surface properties.

- land cover
- soil moisture
- sea surface temperatures
- near-surface ocean wind speed
- snow cover, depth, and water equivalent
- ice concentration and age

Resources



- Microwave Remote Sensing: Land and Ocean Surface Applications, 2nd Ed.
https://www.meted.ucar.edu/training_module.php?id=1100
- Microwave Remote Sensing Resources
https://www.meted.ucar.edu/training_module.php?id=260
- A First Course in Atmospheric Radiation, 2nd Ed. (Petty 2006)

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