NOAA/NESDIS Near-Real Time Wind Vectors from WindSat Polarimetric Measurements

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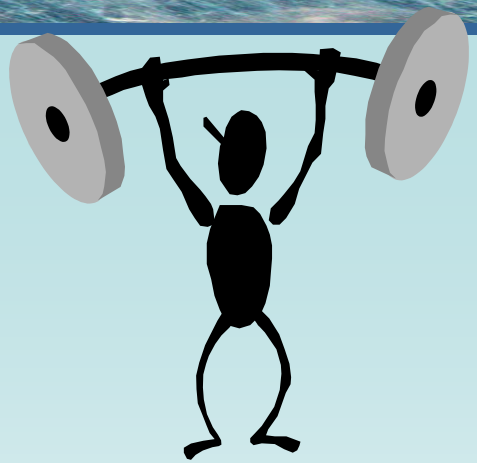
Why Microwaves?

- **Strengths**
  - Relatively insensitive to atmospheric effects
  - Clouds are mostly transparent
  - Sensitive to surface roughness
- **Weaknesses**
  - Poorer resolution
  - Sensitivity to rain



Scatterometer

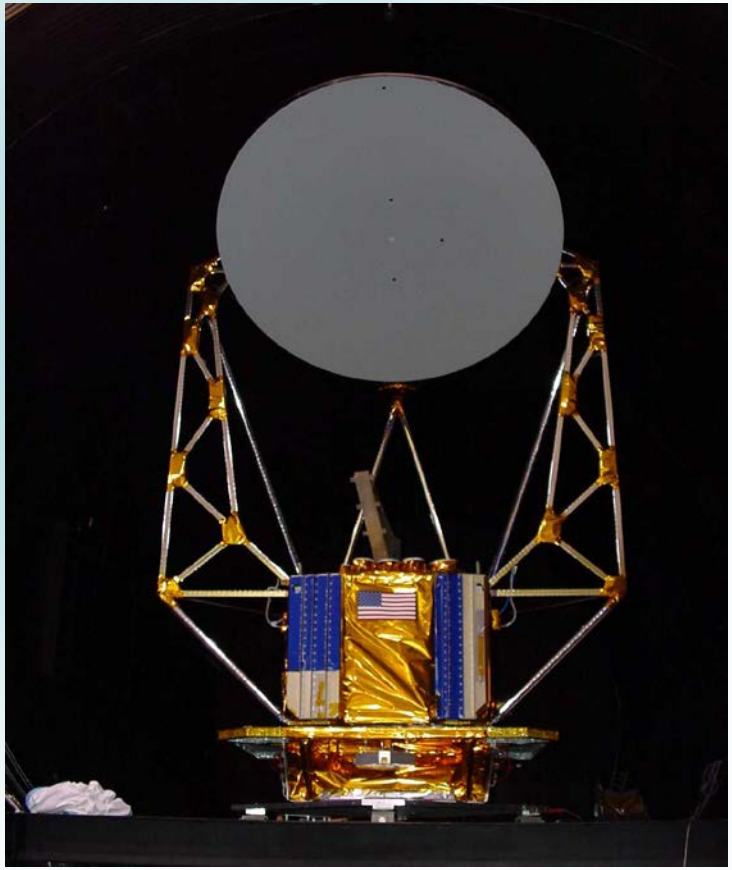
Radiometer

- A scatterometer is an active instrument that transmits a known microwave signal and measures the backscattered energy from the ocean surface.
- Designed to retrieve the wind speed and direction in all weather conditions
- Currently being used by the operational weather community
- Retrievals impacted only in higher rain events

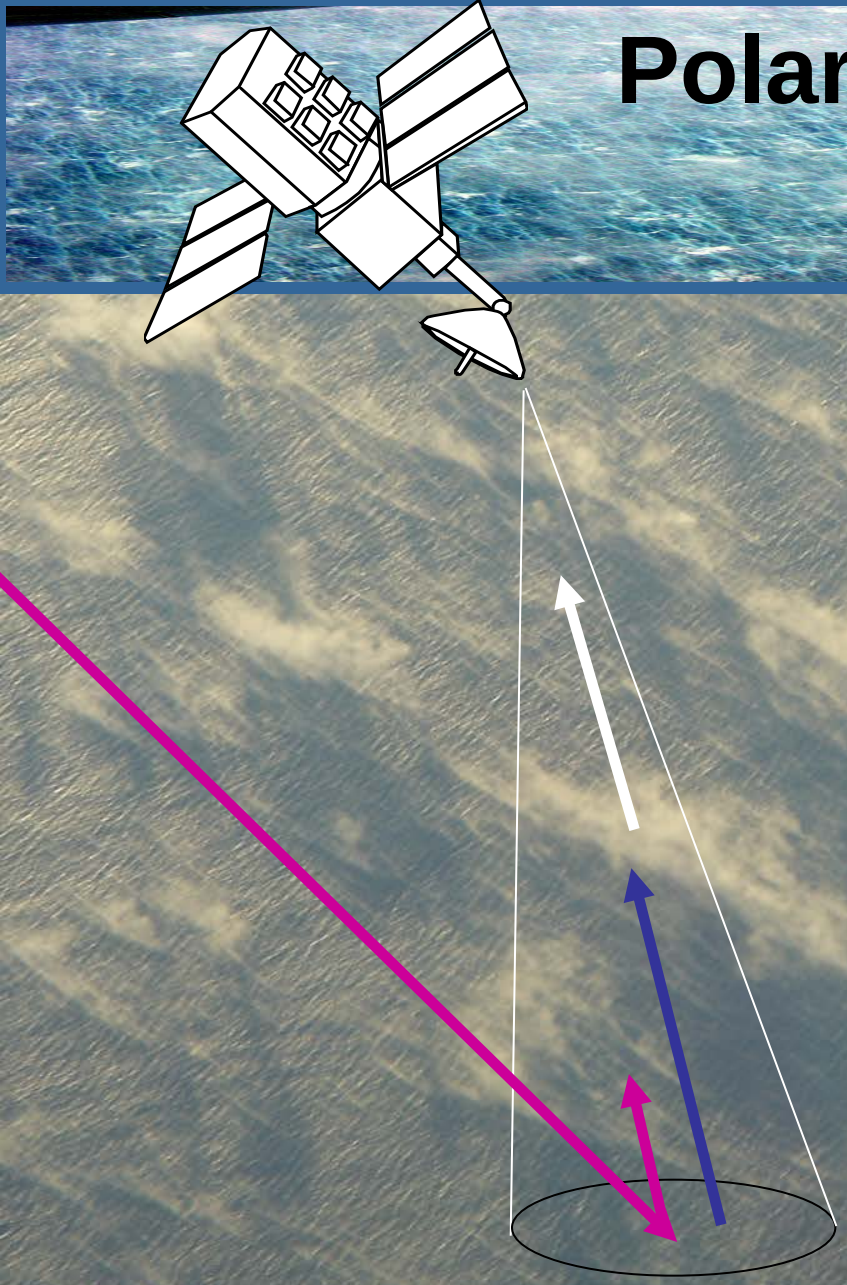
- MW radiometer directly measure naturally originating thermal mw radiation from wind roughened ocean surface that is in general partially polarized
- Multiple frequencies and polarizations allow for simultaneous retrievals of different surface and atmospheric parameters
- Surface parameter retrievals more complicated in storms

WindSat-Mission

- Risk reduction mission for NPOESS CMIS
- Successfully launched on January 6th 2003 with the objectives to:
- Demonstrate the capability of Polarimetric Microwave Radiometry to measure the Ocean Surface Wind Vector from Space
- Show potential to measure other EDR's: SST, Water Vapor, Cloud liquid water, rain rate, sea ice and snow cover



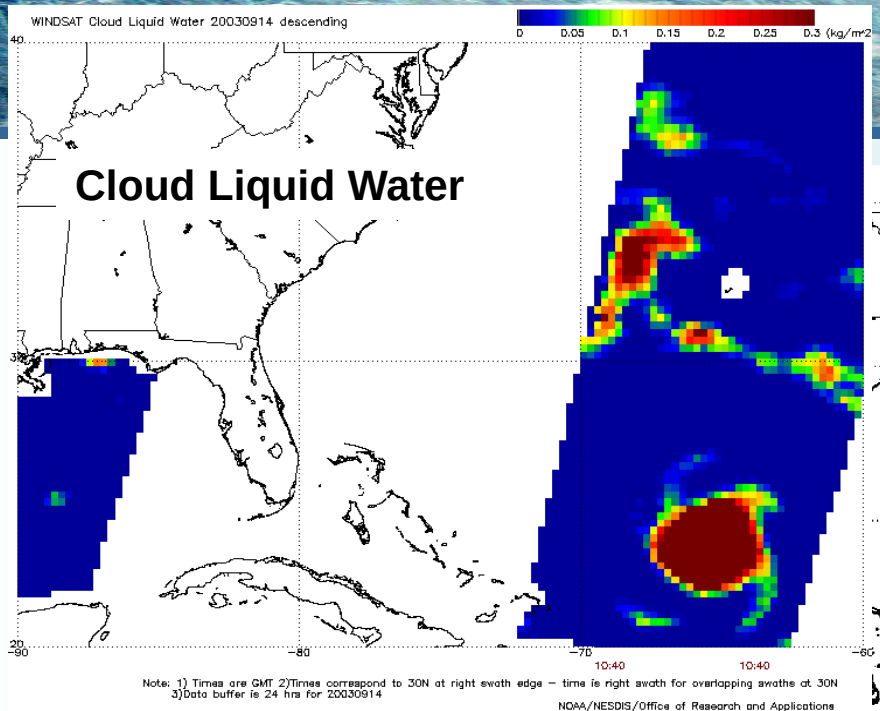
Polarimetric Microwave Radiometry

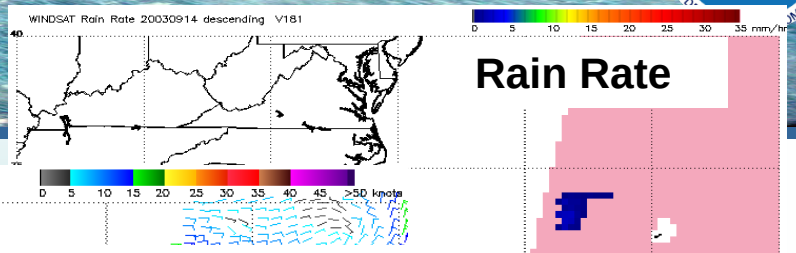


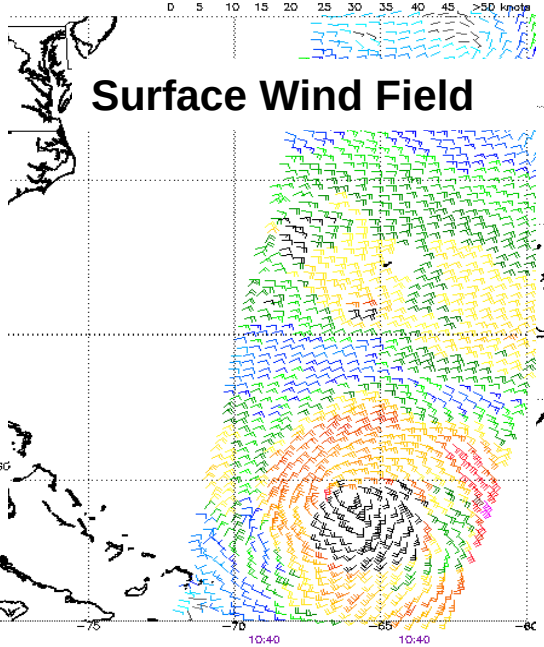
- Tb's measured by satellite radiometer consists of:
  - Signal that is emitted from the ocean surface and travels upwards
  - Upward traveling atmospheric radiation
  - Downward traveling atmospheric and cold space radiation that is scattered back from the ocean surface

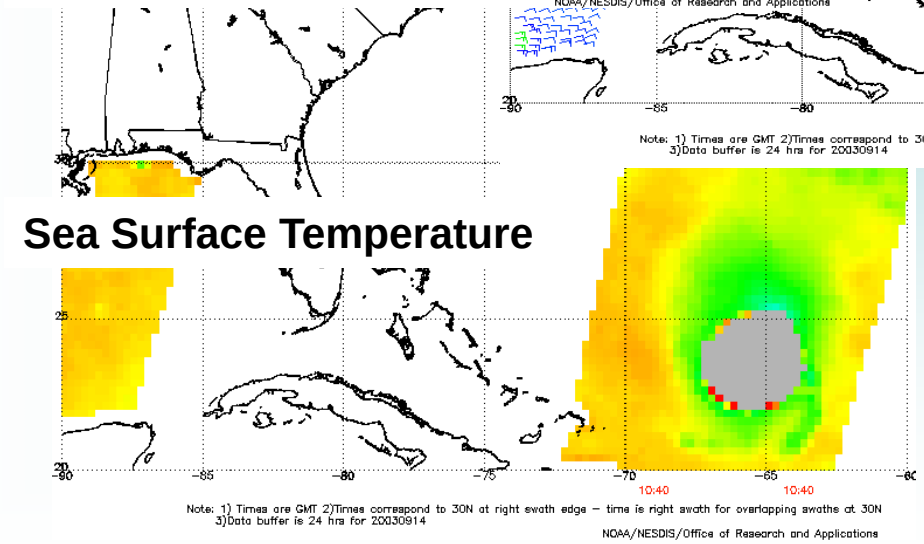
$$Tb = f(ws, \varphi, sst, wv, clw)$$

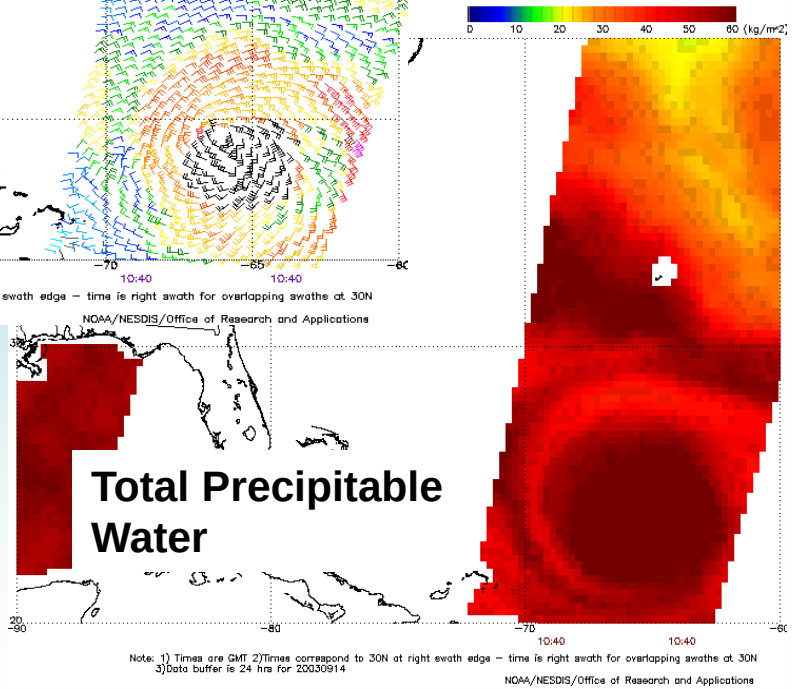
WindSat EDR's





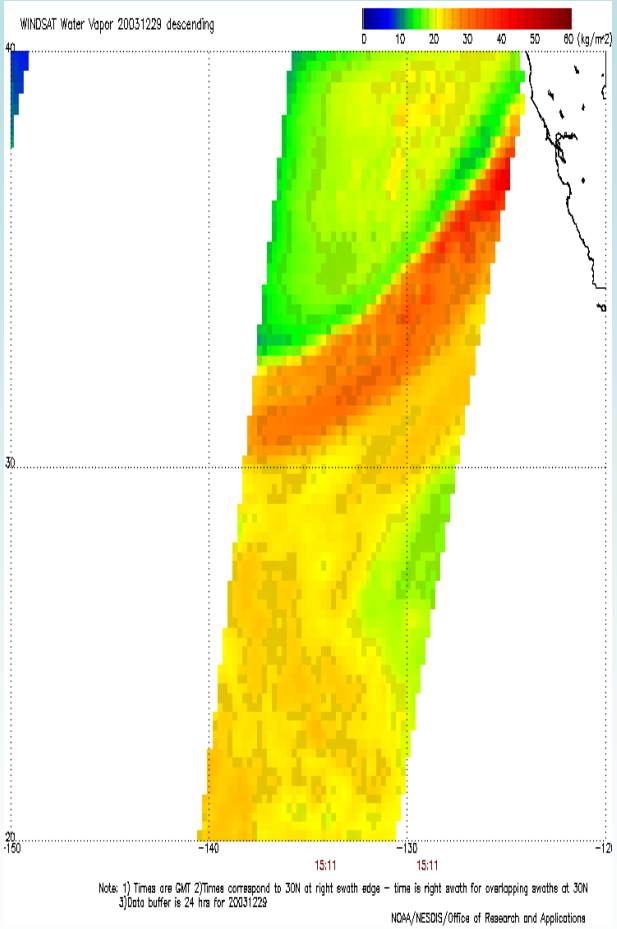




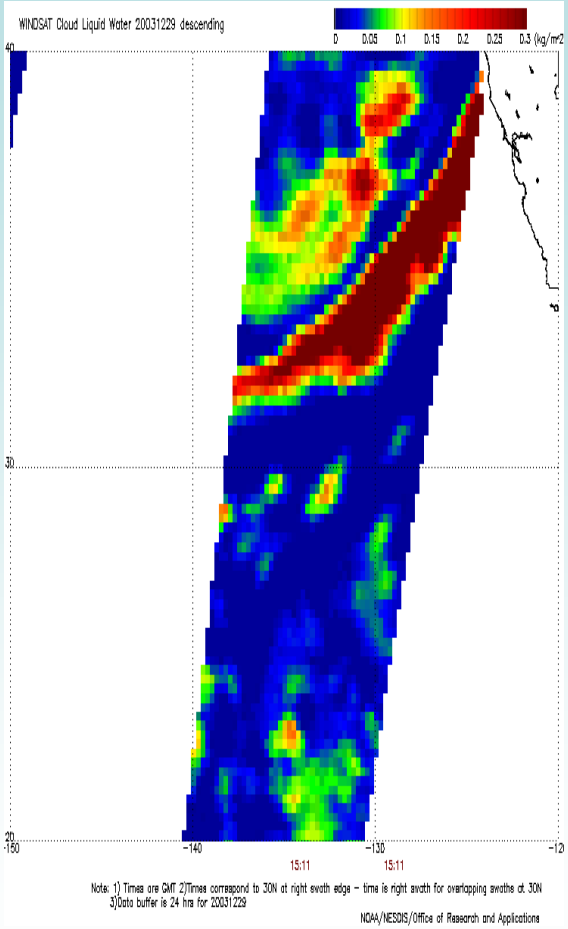


Together the EDR's Tell a More Complete Story

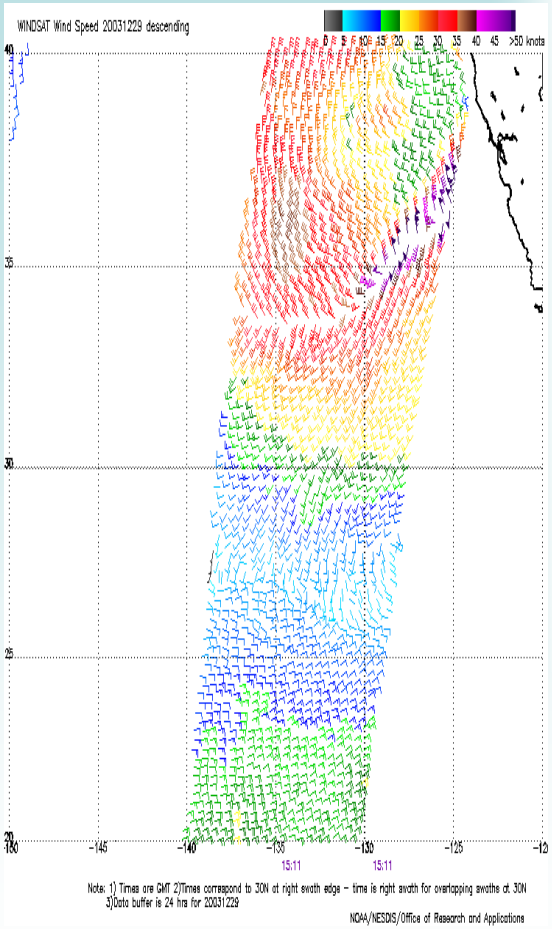
Total Precipatable Water



Cloud Liquid Water

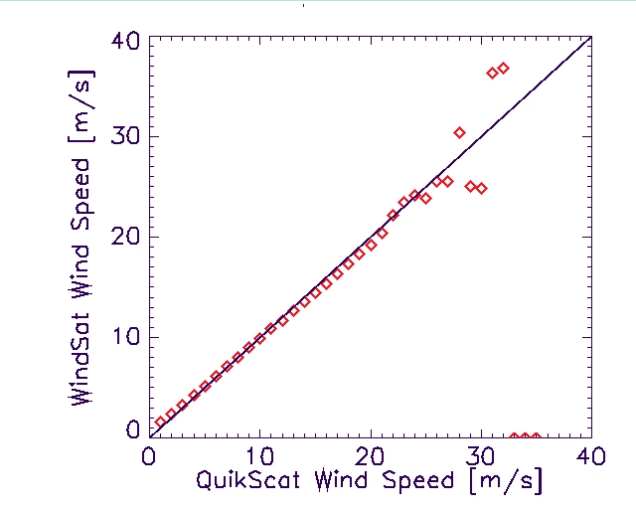


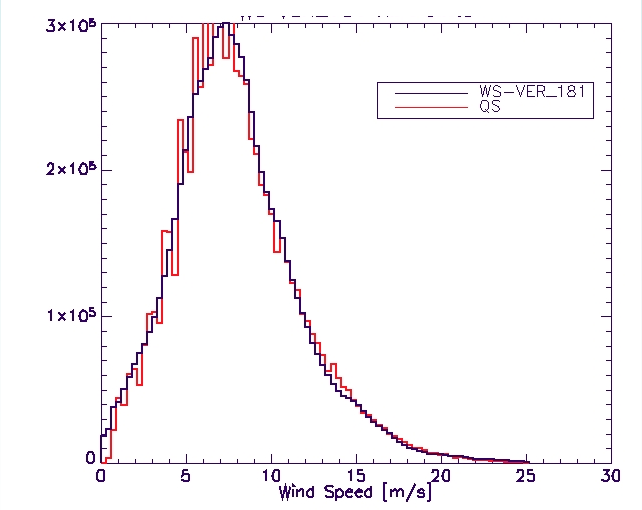
Surface Wind Field



Wind Speeds Retrievals

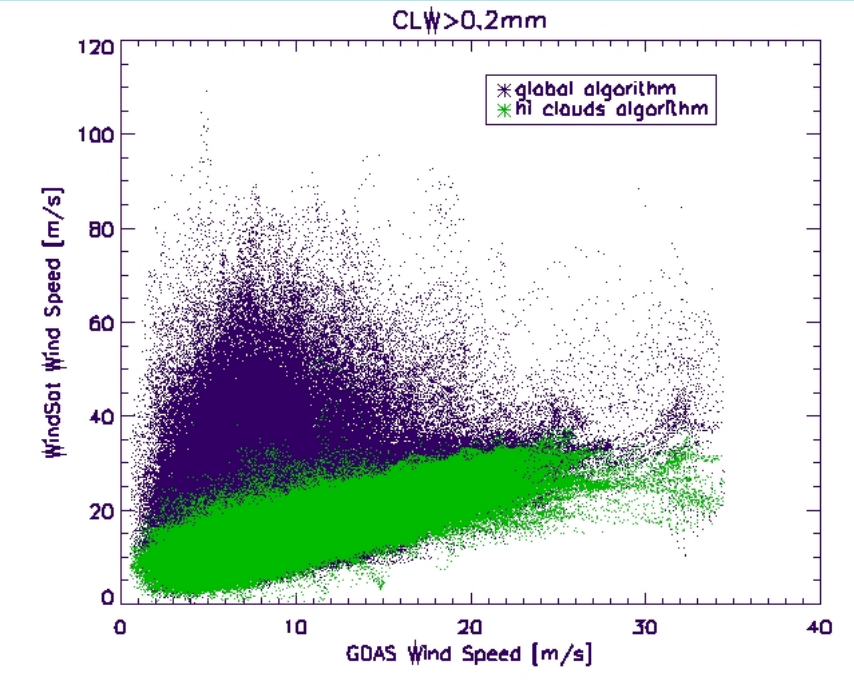
Clear Sky – CLW<0.2

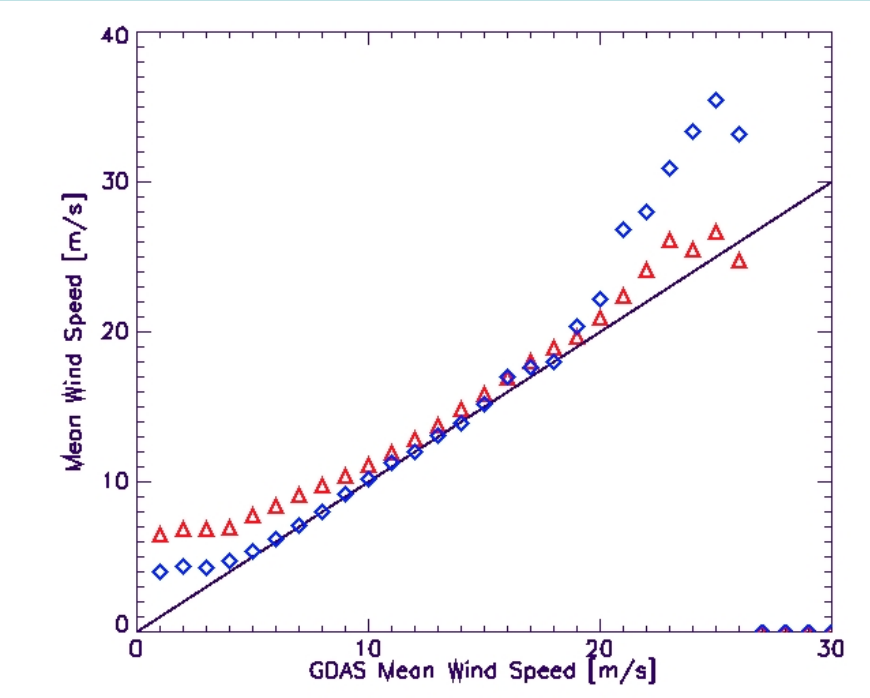




- **RMS error 0.9m/s for cloud free regions**
- **Retrieval algorithm dependent on all EDR's**
- **Stand alone high clouds and rain algorithm**
- **Stand alone wspd retrieval algorithm addresses RFI influenced points**

Wind Speed Retrievals in High CLW and Rain Regions



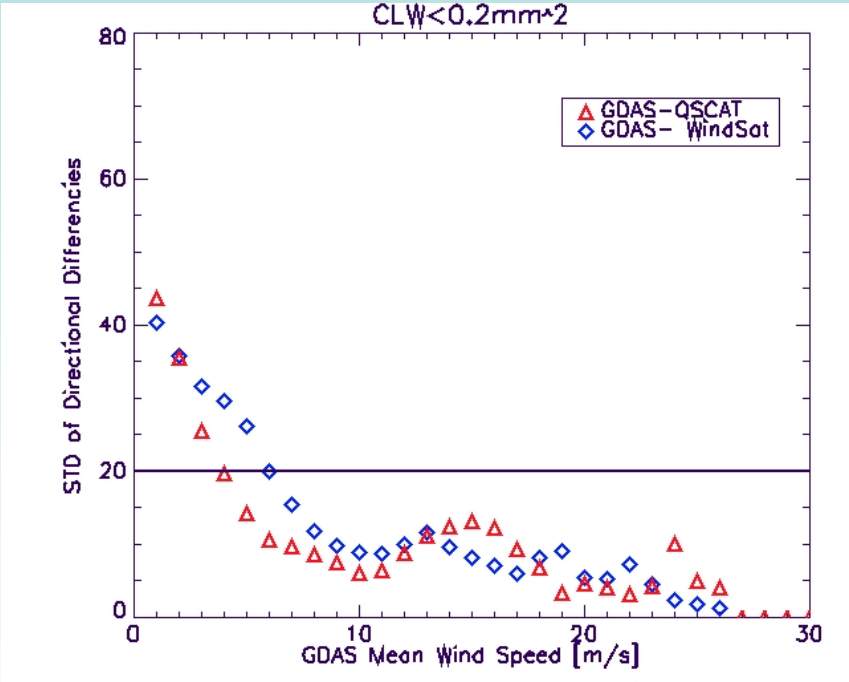


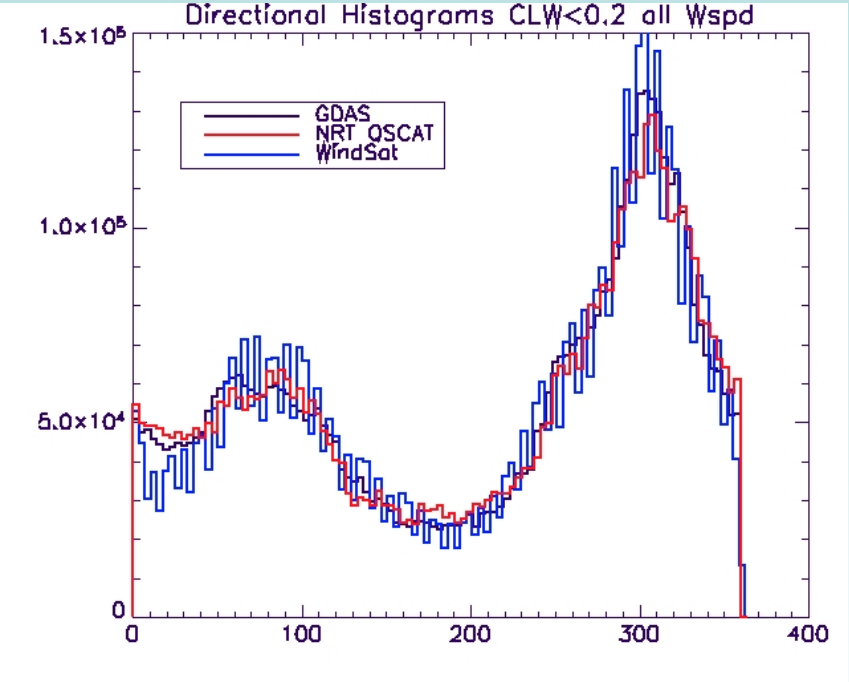
Global WindSat (SSMI-like) wind speed retrievals (purple) and new WindSat wind speed retrievals (green) in high-CLW

QuikScat (red) and WindSat (blue) wind speed retrievals in high CLW

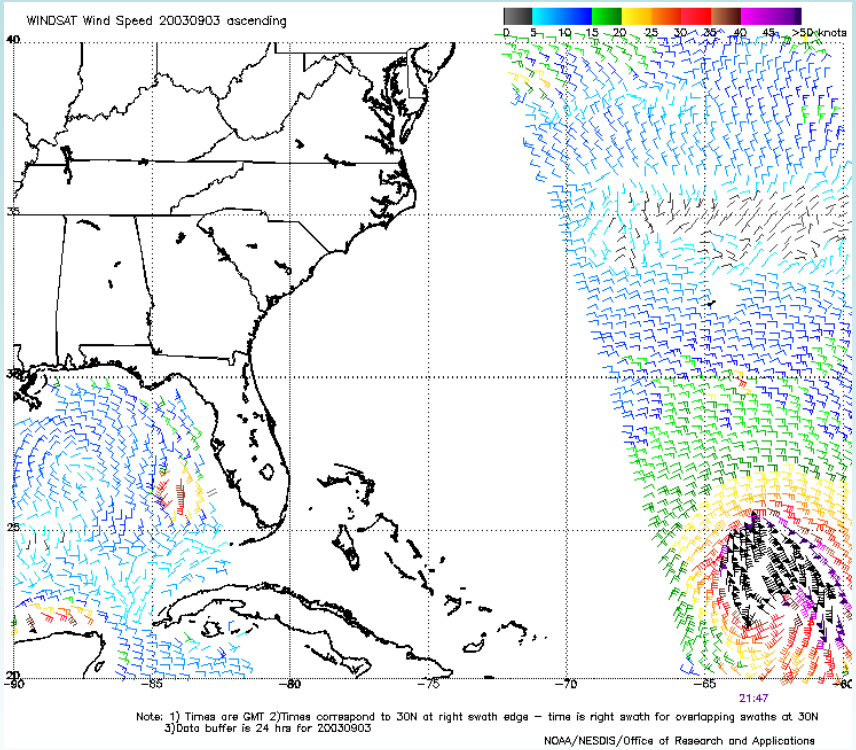
Wind Direction Retrievals

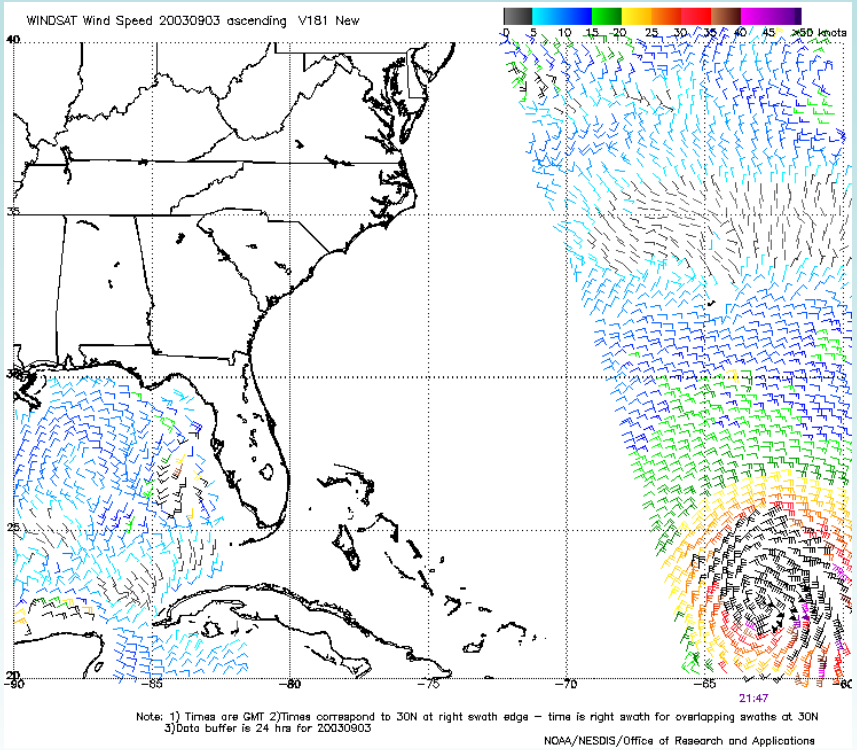
Clear Sky – CLW<0.2





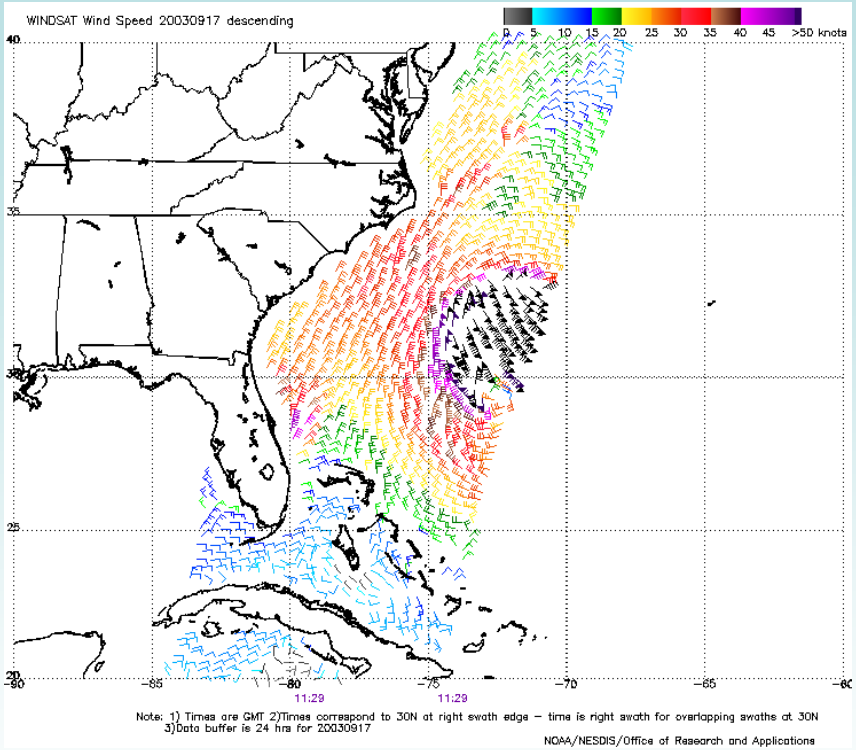
Hurricane Fabian

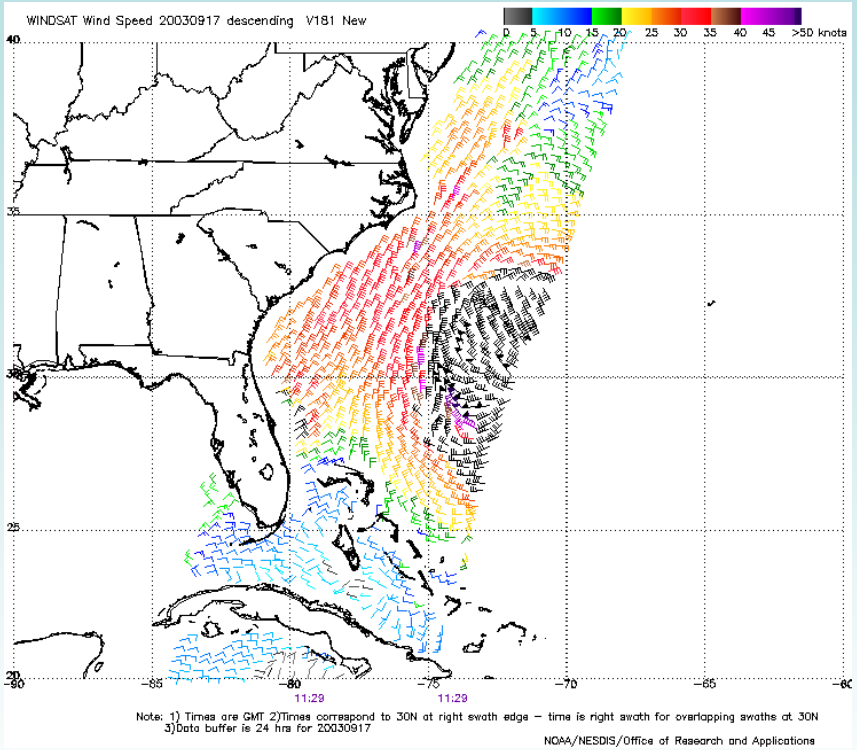




Hurricane Isabel

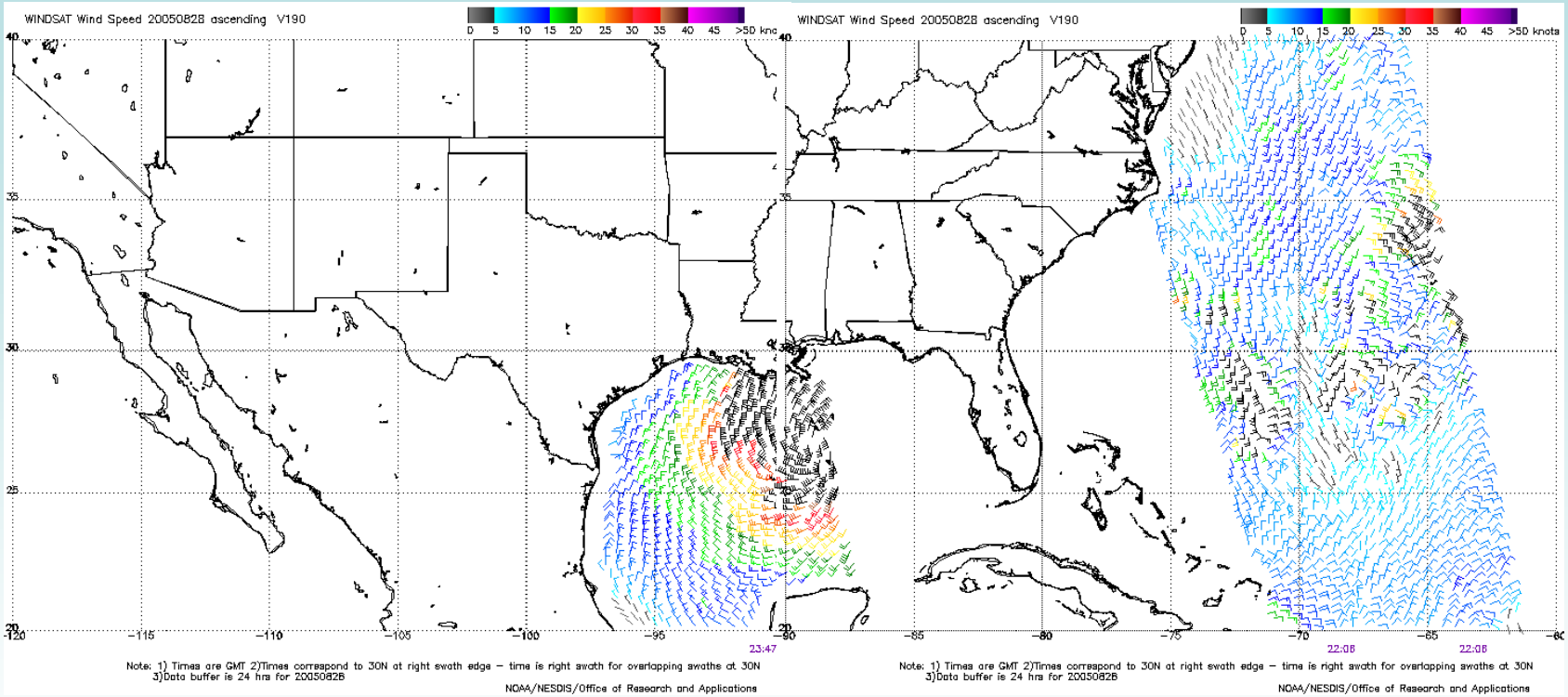
09/17/2003



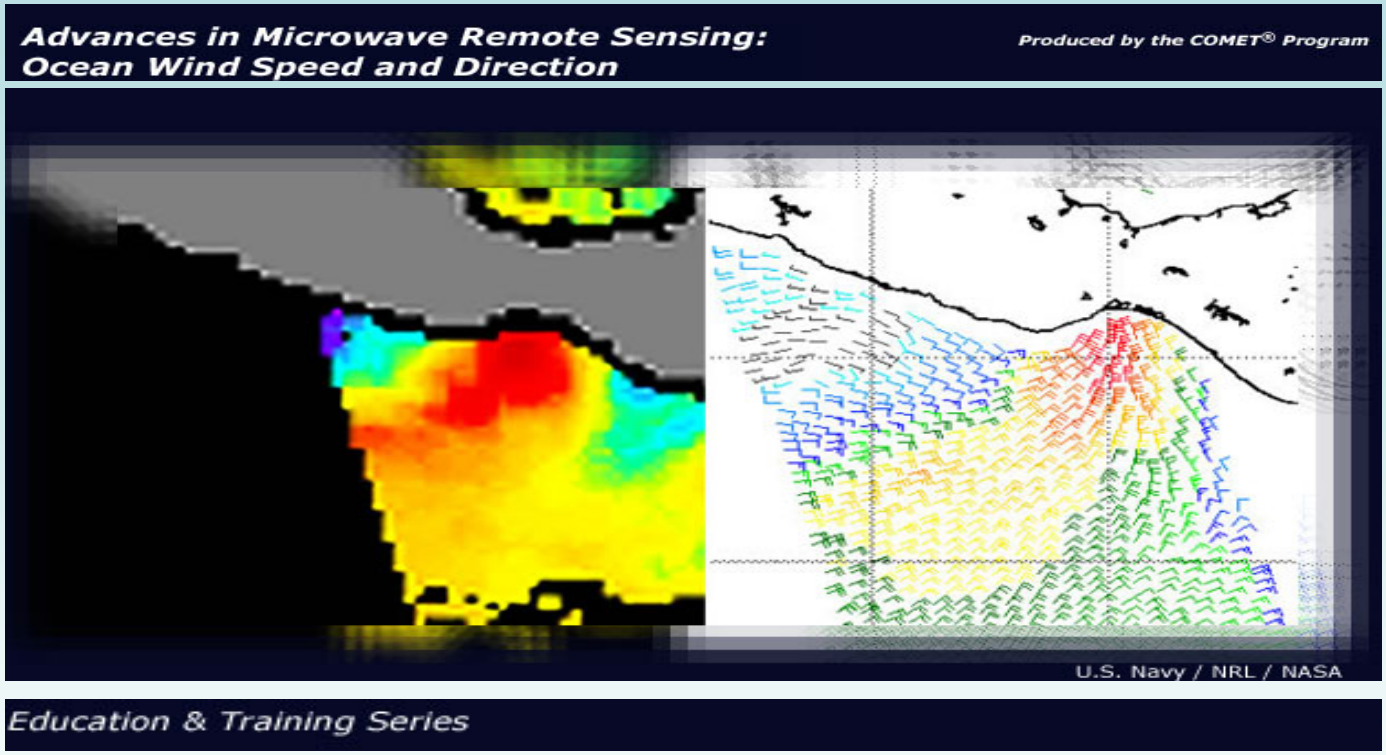


Hurricane Katrina

08/28/2005



Ocean Surface Winds Training Module
COMET Program



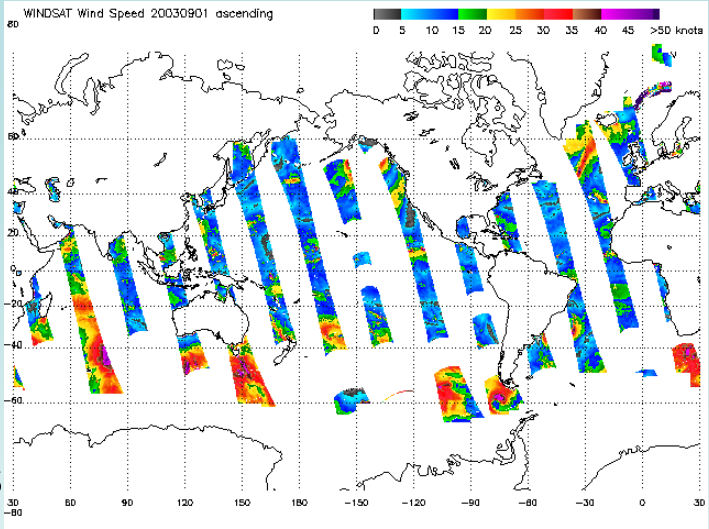
http://deved.meted.ucar.edu/npoess/ocean_winds

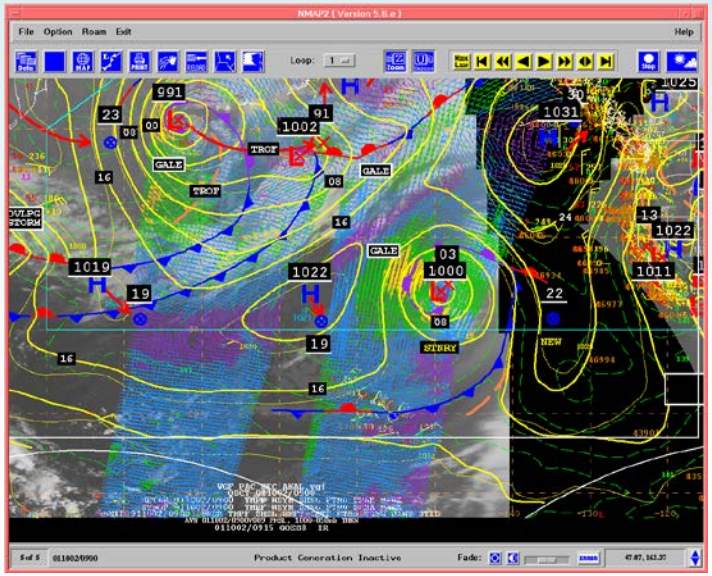
Conclusions - Operational Utilization and Validation

- Leverage operational tools and collaborations developed for QuikScat
  - NRT web page access

    http://manati.orbit.nesdis.noaa.gov/windsat

  - NCEP/OPC and TPC ocean vector winds impacts on operational warnings and forecasts
- Leverage QuikScat NAWIPS and AWIPS efforts to get WindSat into NWS operational environment





Summery

WindSat

- **Resolution**
  - 60km
- **EDR's**
  - TPW
    - std~1mm [0-50]mm
  - CLW
    - std~0.03mm [0-2]mm
  - Rain Rate
    - std~1mm [0-30]mm/hr
  - SST
    - std ~0.7C [5-32]C (both 10.7Ghz and 6.8Ghz channels available)
  - Wind Speed
    - std~0.8m/s [3-20]m/s
  - Wind Direction
    - Std~25° for wspd<6m/s
    - Sdt~17° for wspd >6m/s
- **Limitations**
  - Clw>0.2mm degradation in retrievals of surface parameters
  - RFI
  - Coast

QuikScat

- **Resolution**
  - 25km
  - 12.5km
  - 2.5km
- **EDR's**
  - Wind Speed
    - **Std ~0.8m/s [3-35m/s]**
  - Wind Direction
    - Std ≤ 20° for wspd>3m/s
- **Limitation**
  - Wind speed and direction retrievals degrade in rainy areas