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Remote Sensing Systems
www.remss.com

Ocean Vector Winds in Storms from the SMAP L-Band Radiometer

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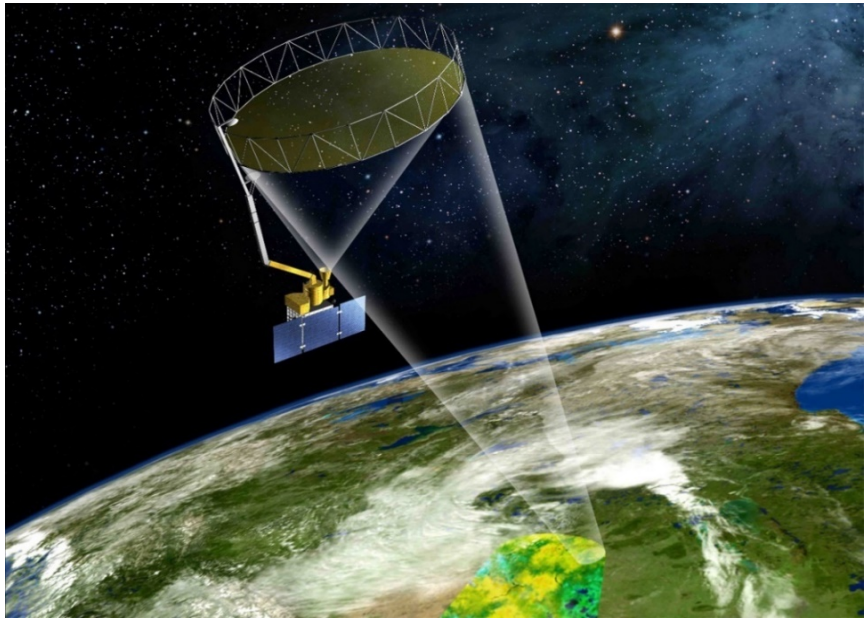
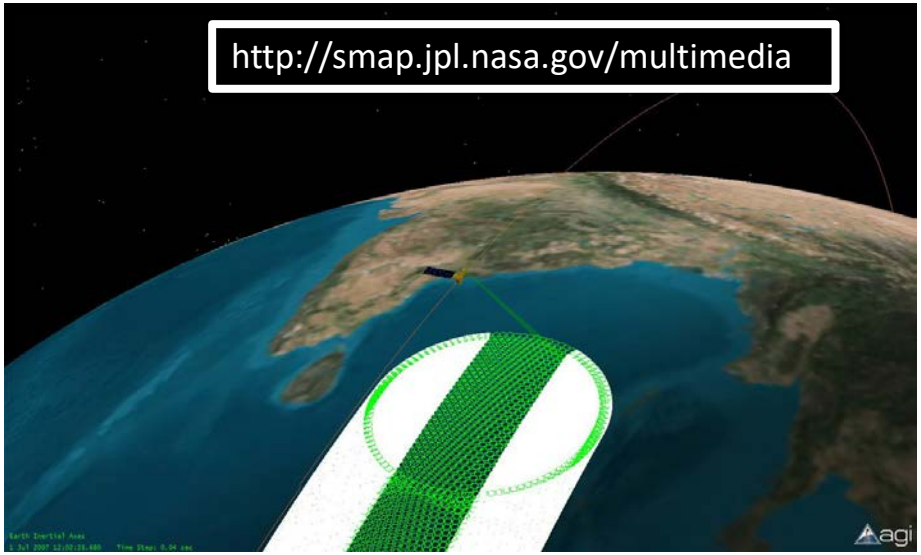
submitted to BAMS

Photo courtesy:
www.DaveSandfordphotos.com

SMAP Soil Moisture Active Passive

Ocean Products: Sea Surface Salinity + Wind Speed



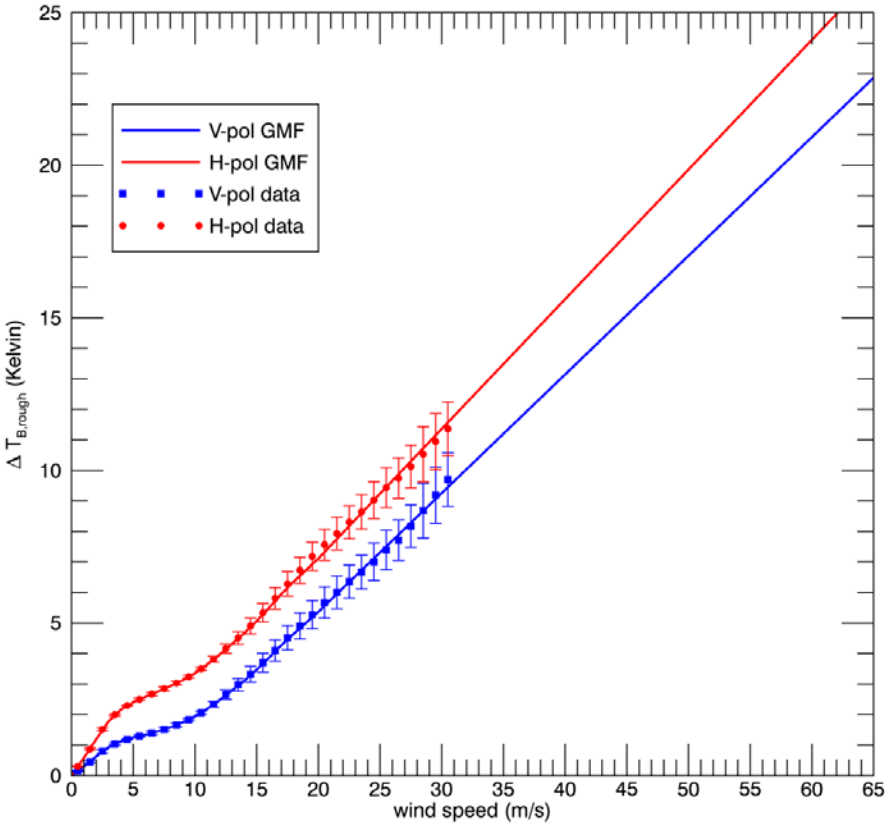


- Orbit Altitude: 685 km.
- Inclination: 98 deg.
- Local ascending/descending time: 6 PM/AM.
- 8-day repeat orbit.

- 6-meter mesh antenna.
- Conical scanning. Scan time: 4.1 sec.
- Earth Incidence Angle: 40°.
- Radiometer: Center frequency: 1.41 GHz ~~Radar.~~
- Full 360° scan views the Earth. 1000 km wide swath.
- 3-dB (half power) footprint size: 40 km.

Wind Speed Response

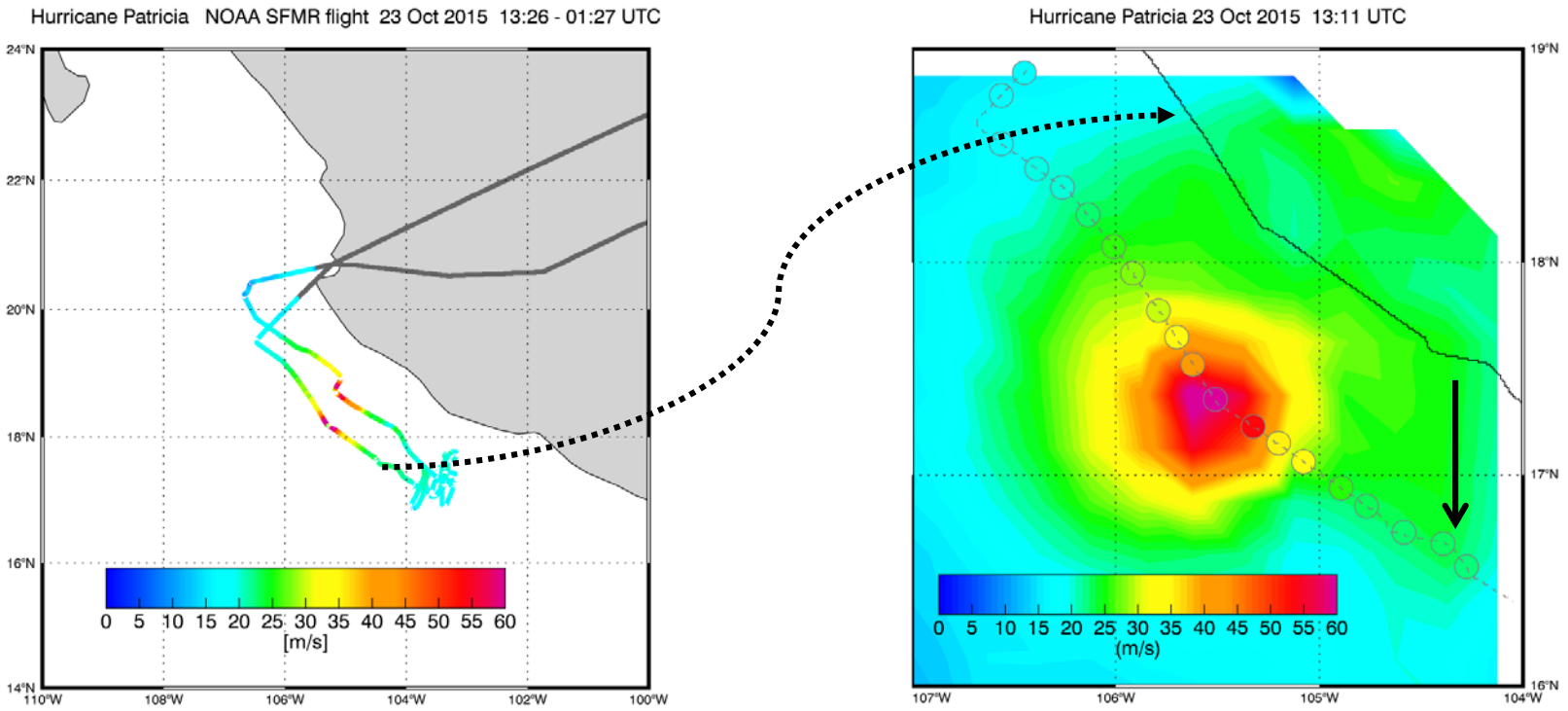
Geophysical Model Function (GMF)



- Wind induced (excess) emissivity: $\Delta T_B = T_{B\ rough} - T_{B\ flat}$
- Derived from **SMAP TB – WindSat wind speed match-ups**.
  - Rain free scenes.
- Linear increase above 18 m/s.
  - **Emissivity signal from sea foam**
  - Extrapolate to high wind speeds.
- Consistent with results from Aquarius L-band radiometer.
- L-band wind GMF is used in salinity and wind speed retrievals for Aquarius and SMAP.
- For wind speed retrievals we need ancillary inputs for sea surface temperature and sea surface salinity.
  - No NWP input is needed for wind speed retrievals.

SMAP – SFMR Match-Ups

Validation against independent source: airborne **S**tep **F**requency **M**icrowave **R**adiometer



- Lower SFMR segment (17:30 h) closest in time to SMAP overpass (13:10 h).
  - The storm intensity has changed very little (NHC best track).
- **Shift** SMAP segment so that SMAP and SFMR storm centers align.
- **Average SFMR observations** (≈10 sec, 3 km) into 0.25° cells to **represent** approximate **resolution of SMAP** (and other spaceborne sensors).

SMAP-SFMR Match-Ups

Time Series

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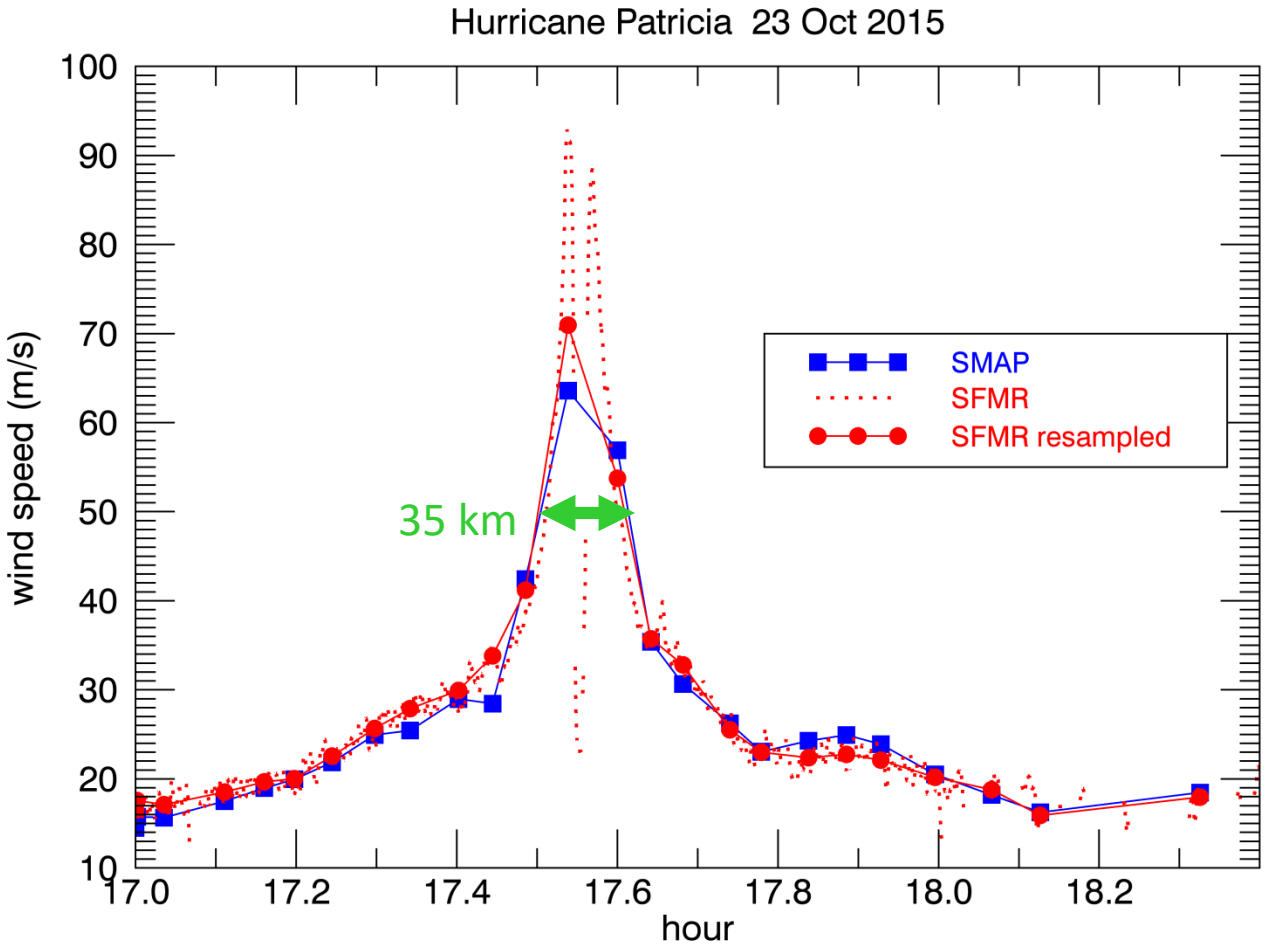

Resampled SFMR wind speeds reach 70 m/s.

They are observable by spaceborne sensors (SMAP, ASCAT, RapidScat, WindSat).

SMAP-SFMR Match-Ups

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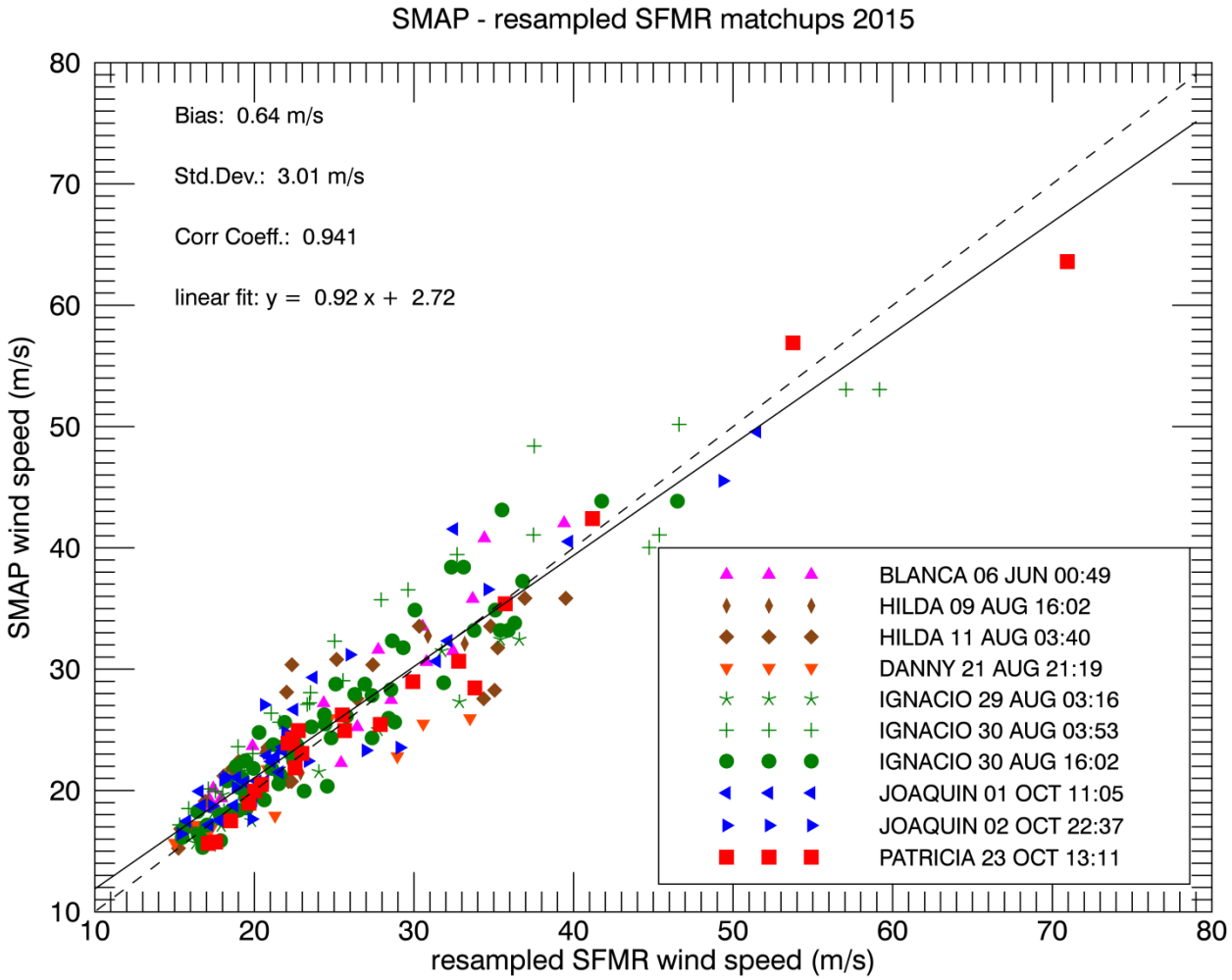
Statistics



about 200 match-ups in 2015

SFMR correlate well with GPS dropsonde wind speeds.

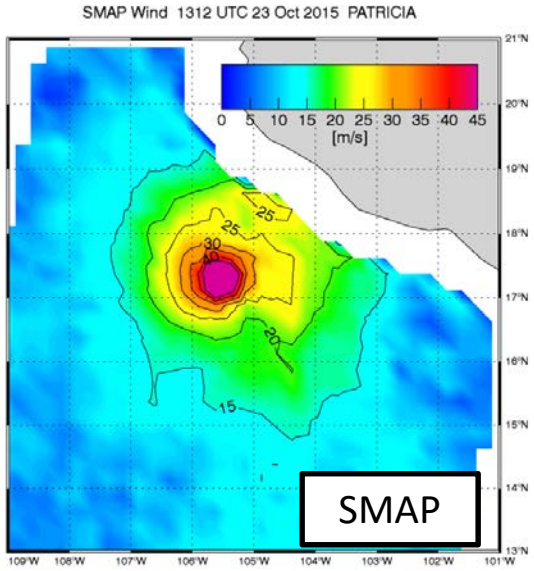
Rain Impact

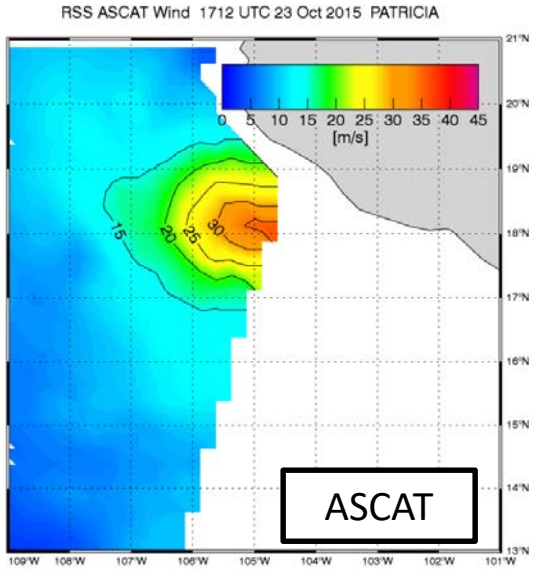
SMAP – SFMR as function of SFMR Rain Rate

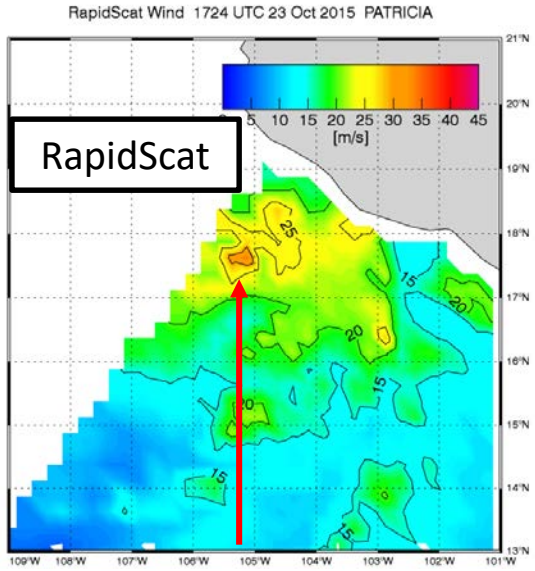
SMAP – SFMR The SFMR rain rates were averaged to 0.25° to represent the rain rate that is approximately seen by SMAP		
Rain Rate (mm/h)	Bias (m/s)	Std.Dev (m/s)
0 – 5	0.68	2.55
5 - 10	1.57	3.37
10 - 15	0.46	2.85
> 15	-1.86	3.69

No systematic degradation in rain.

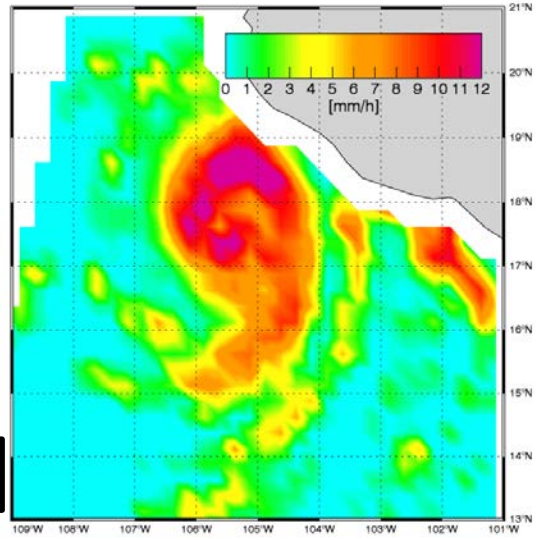
Hurricane Patricia

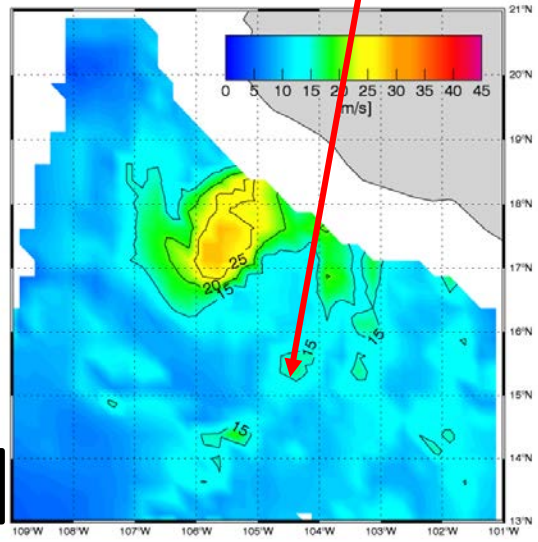






rain

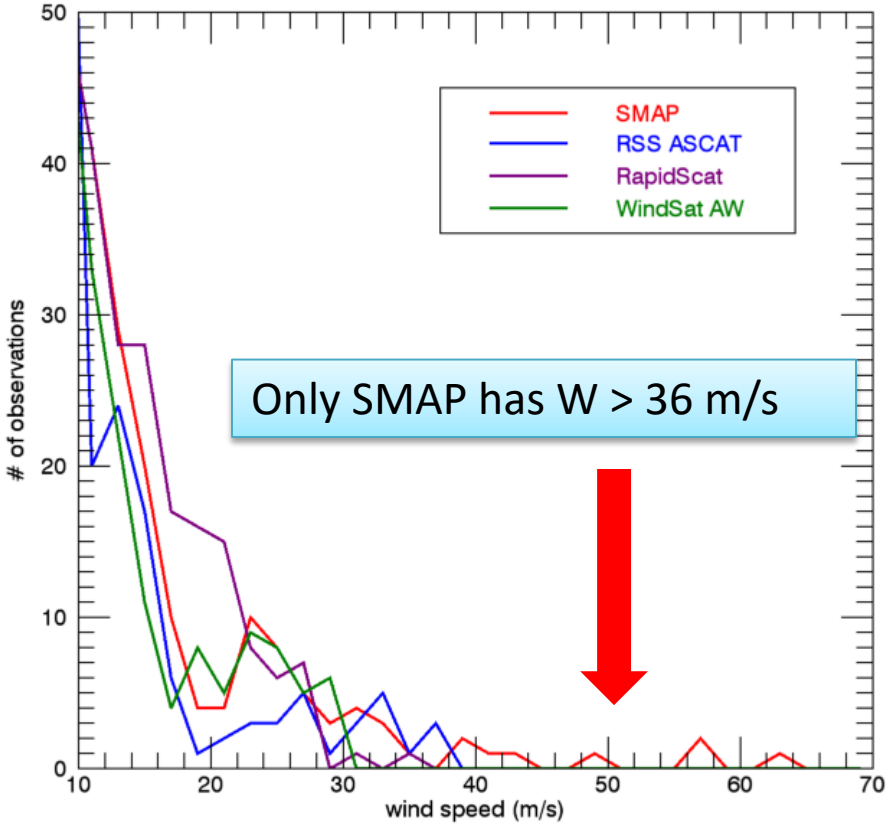




Hurricane Patricia

Collocated Wind Speed Distribution

SMAP – ASCAT – RapidScat – WindSat



	Max wind in storm	33 m/s Radius
SMAP	64 m/s	50 km
ASCAT	36 m/s	50 km
WindSat	29 m/s	
RapidScat	28 m/s	
Best Track 10-min sustained	79 m/s	46 km
SFMR resampled	71 m/s	

All instruments observed the storm within 4.5 hours. The intensity changed very little.

TC Fantala

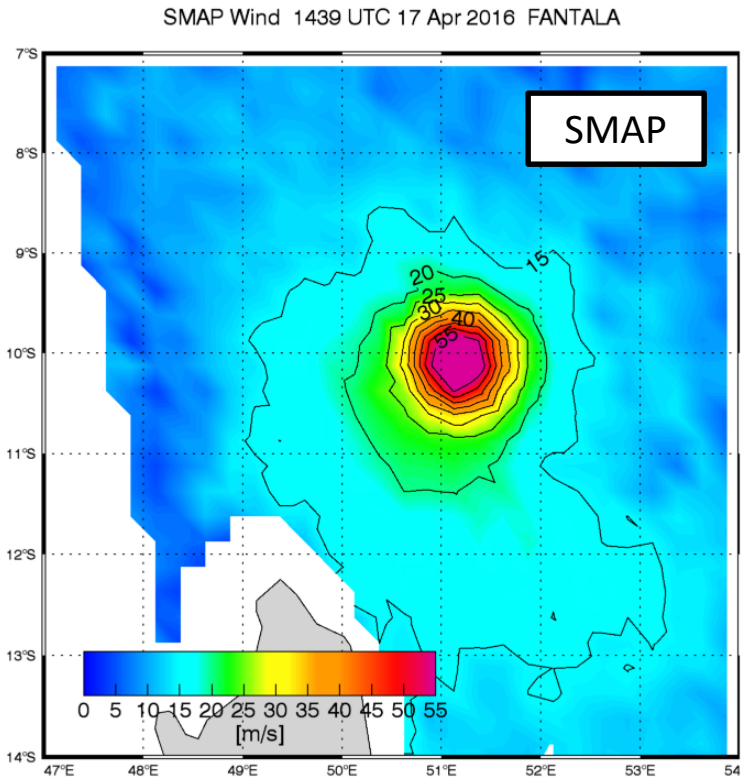
17 April 2016

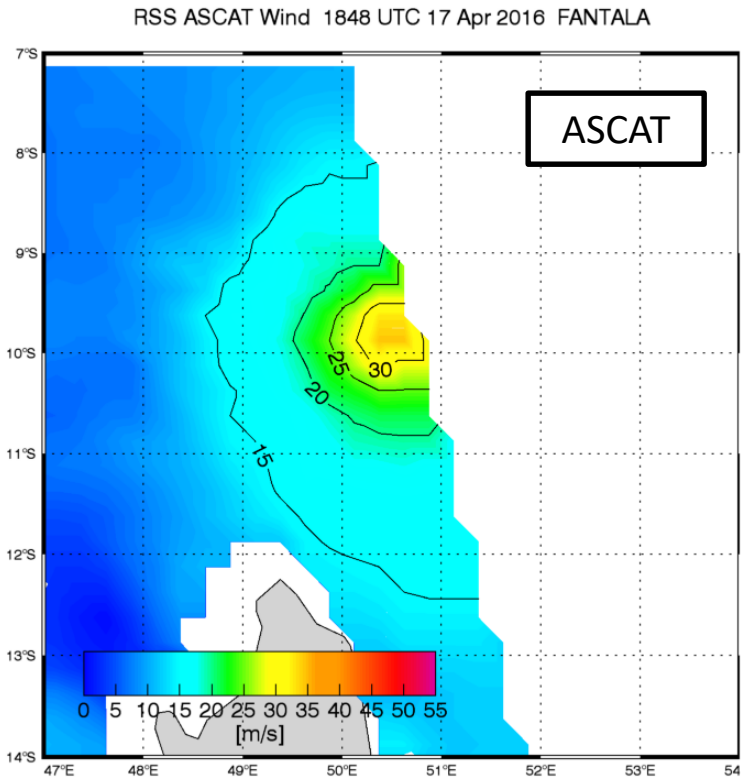
strongest observed cyclone in Indian Ocean (Seychelles)

estimated max. 10-min sustained winds: 69 m/s

provided by Philippe Caroff, Meteo France, Reunion

TC Fantala

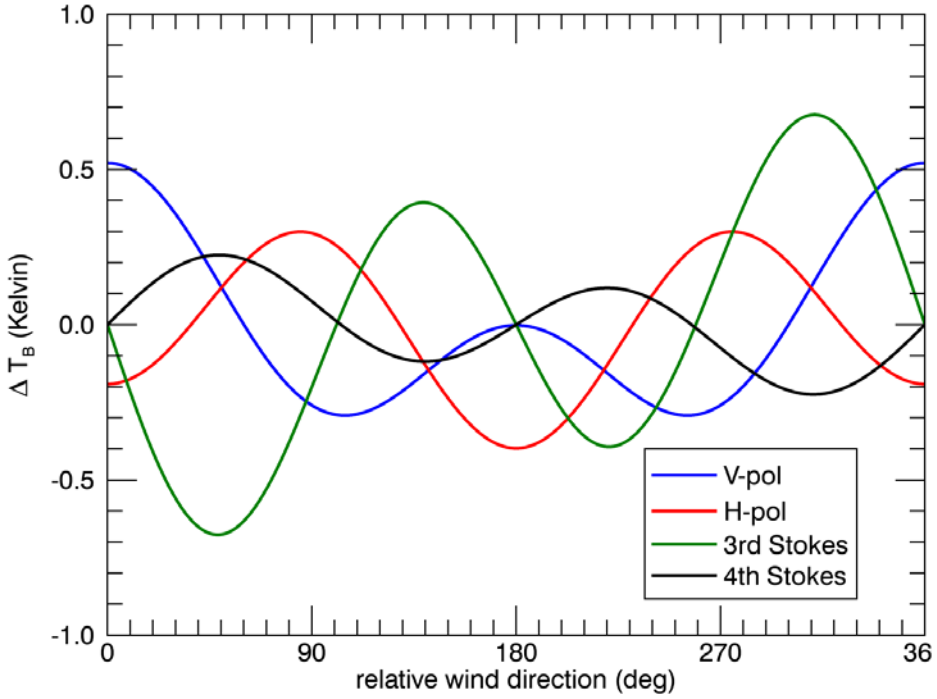


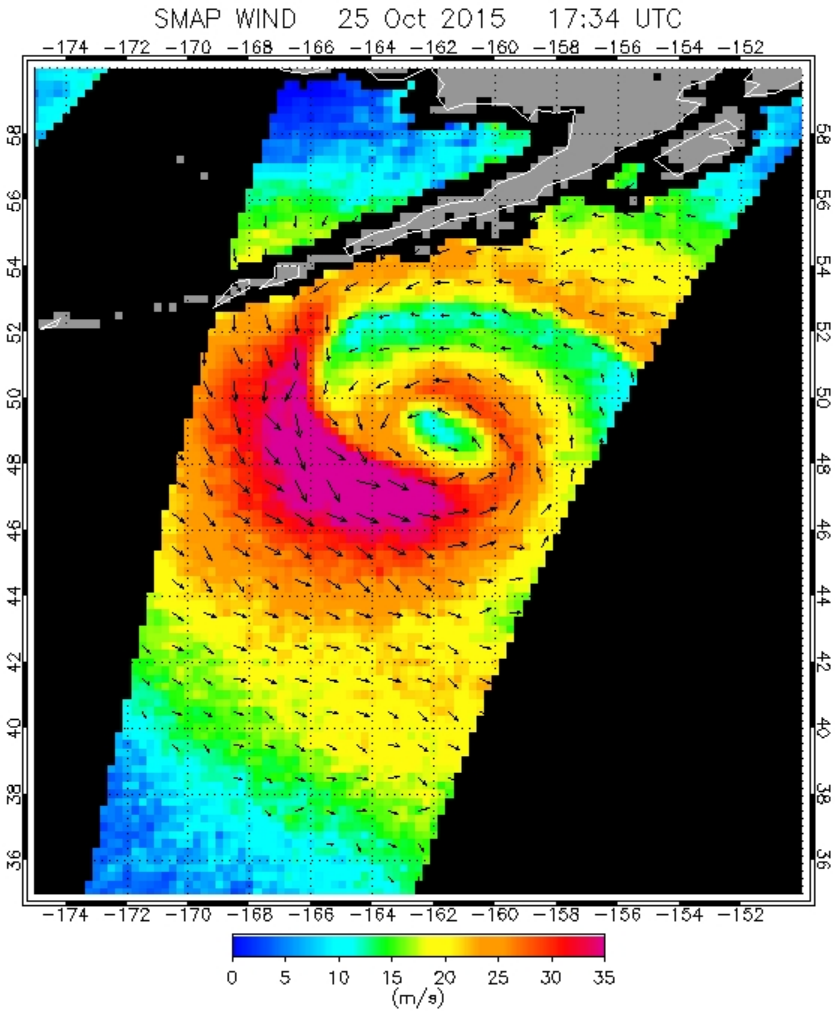


	Max wind	33 m/s Radius
SMAP	70 m/s	55 km
ASCAT	35 m/s	10 km
Best Track 10-min sustained	69 m/s	63 km

Limited Wind Direction Capability

above 12 m/s 100 km average





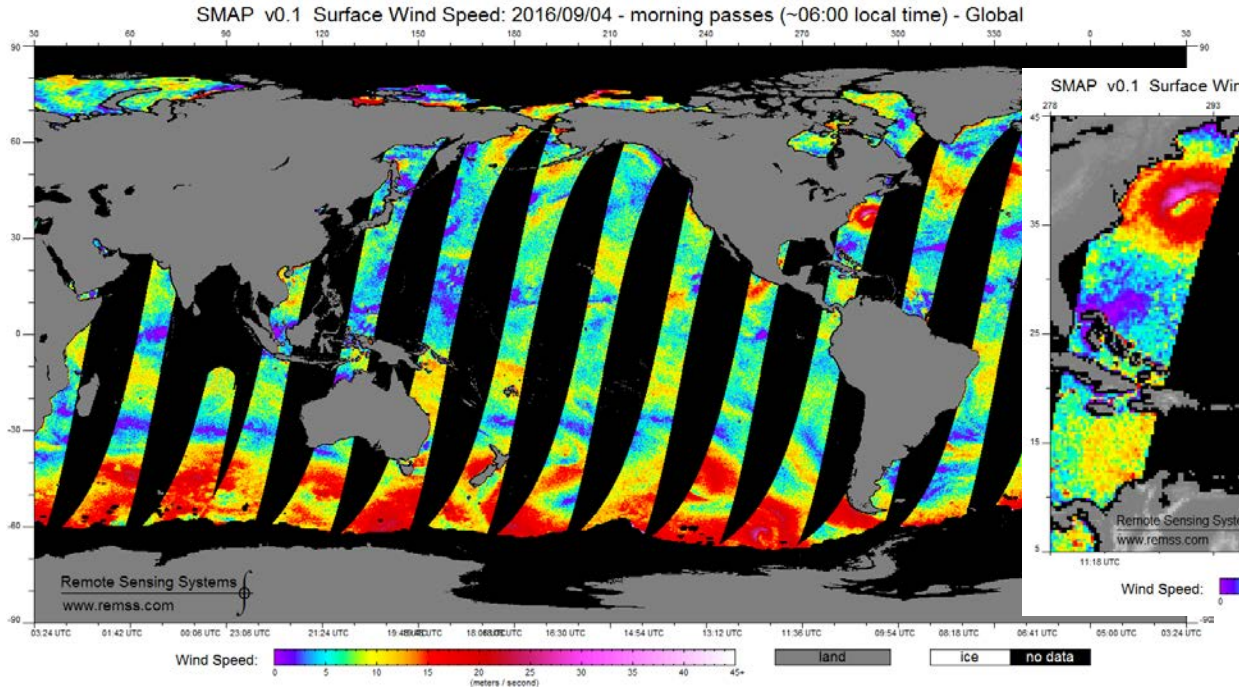
polarimetric signal (similar to WindSat)
small at L-band

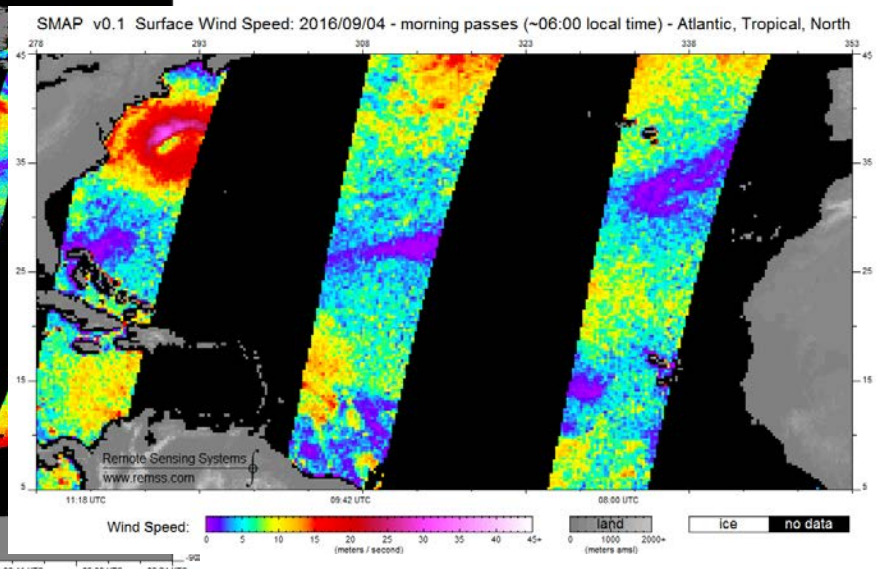
Near Real Time Processing

Daily 0.25° maps @RSS Website

netCDF4

ftp://ftp.remss.com/smap/wind/





TC *Hermine*
Sep-04, 2016

Summary

- The SMAP L-band radiometer has excellent capabilities to measure very strong wind speeds in intense TC.
  - Range: 15 m/s to at least 70 m/s.
  - 40 km resolution.
  - SFMR validation: 10% accuracy.
  - **Valuable tool for assessing intensity and size of TC.**
  - capable to measure wind directions above 12 m/s.
- Key:
  - Keeps good sensitivity at very high wind speeds.
  - No significant degradation in rain.
- **Valuable for calibration of other instruments: CYGNSS, Sentinel-1, …**
- At high winds it outperforms scatterometers (ASCAT, RapidScat), whose signals saturate above ~ 35 m/s and which are affected by rain.
- **Data and images available near-real time from RSS.**
  - ftp://ftp.remss.com/smap/wind/