Are Radiometers and Scatterometers Seeing the Same "Wind Speed" ?

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Radiometer and Scatterometers See Different Scales of Sea-Surface Roughness

Scatterometers see backscatter from the Bragg-resonance capillary wave.
Backscatter is proportional to amplitude of Bragg capillary wave

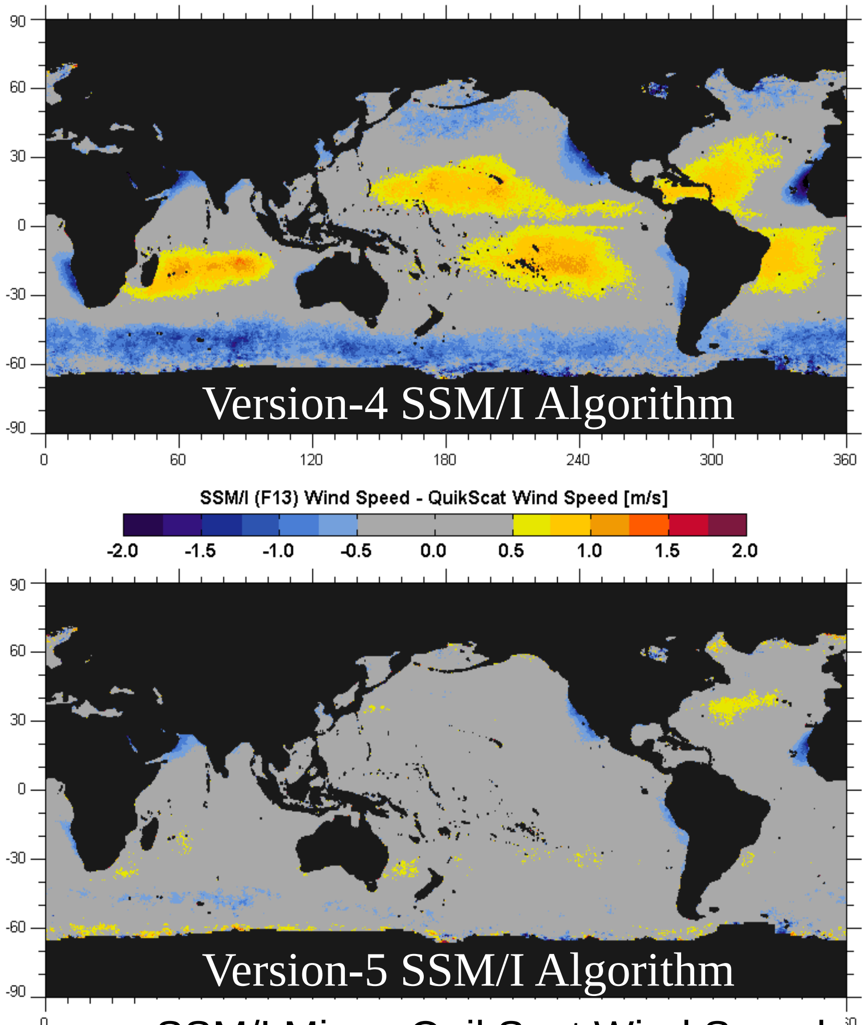
$$\lambda_{capillary} = \frac{\lambda_{radar}}{2\sin\theta} \approx 1.5\ cm$$

Radiometers see polarization mixing of tilted gravity waves
Specular surface is highly polarized: Roughness reduces polarization
Ocean waves from 1000 cm to 0.1 cm contribute to rms slope.

What is the correlation between

$S\,(k_{bragg})$ and $\int_{0.001}^{10} dk k^3 S(k)$

Making Radiometer Winds Look Like Scatterometer Winds (and Buoys)



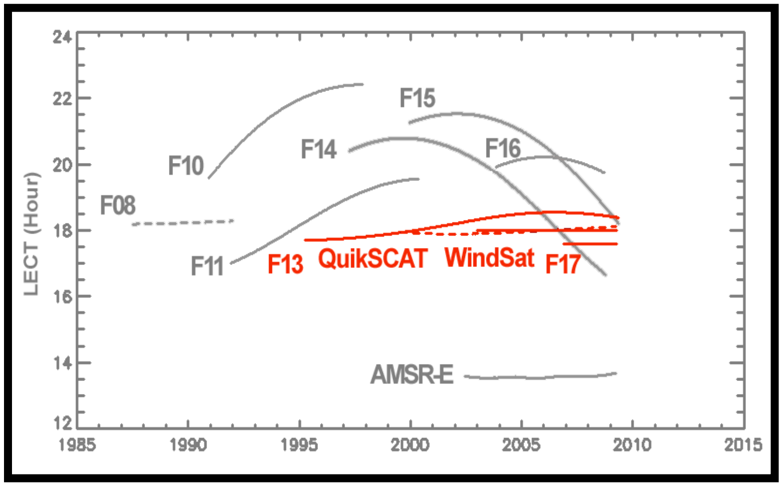
SSM/I Minus QuikScat Wind Speed
Color Scale from -2 to +2 m/s

In 2002, adjustments were made to the Radiative Transfer Model to bring agreement to the SSM/I and QuikScat wind retrievals.

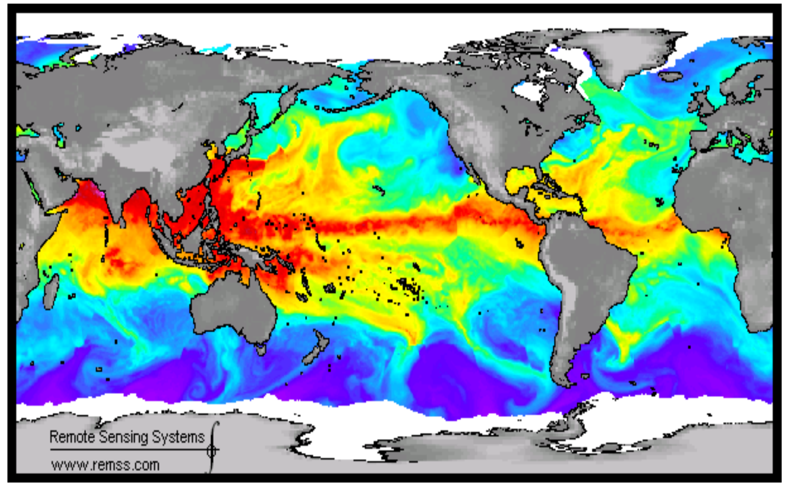
Adjustments were:
1. Wind-Induced emissivity a function of SST
2. Ad Hoc adjustment to specular emissivity.

Good agreement was obtain,
BUT WHY were these adjustments needed?

Satellite MW Sensor Inter-Calibration Project: Consistency



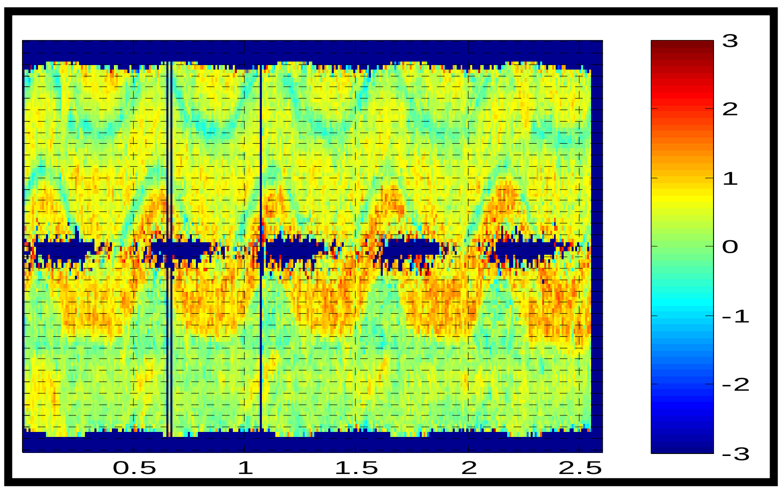
Sensors: ~100 satellite-years



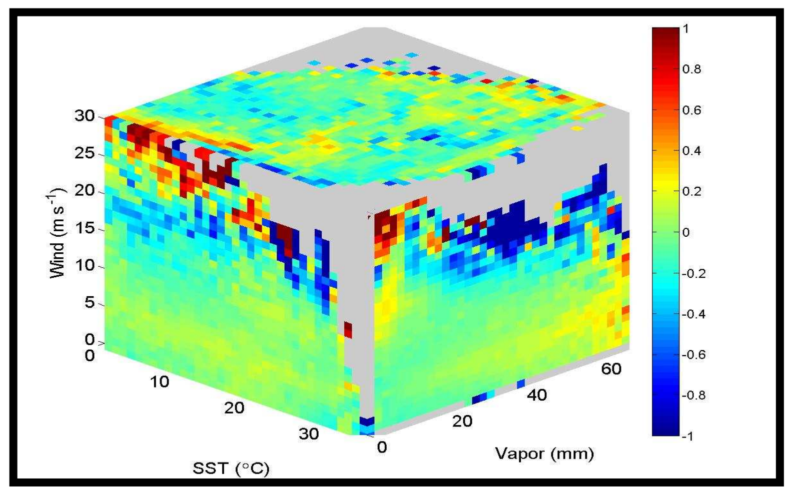
Inputs: Environmental Scenes

$$T_{Amea} - T_{Artm}$$

Sensor Calibration Errors



Radiative Transfer Model



A New RTM is Emerging

Clearer and More Consistent Picture of the Physics of Radiative Transfer over the 6 to 90 GHz Microwave Spectrum

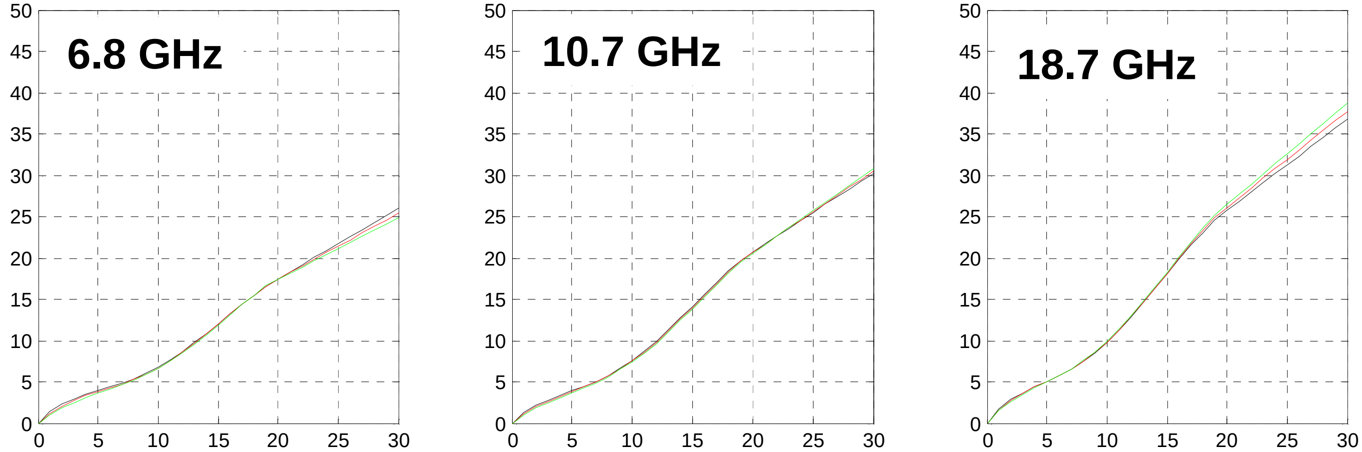
- WindSat is providing better sensor calibration at the lower frequencies (for the first time)
- SSM/I continues to demonstrate its classic calibration at the higher frequencies
- Advancements in data management and analysis visualization

RTM Needs to be Updated

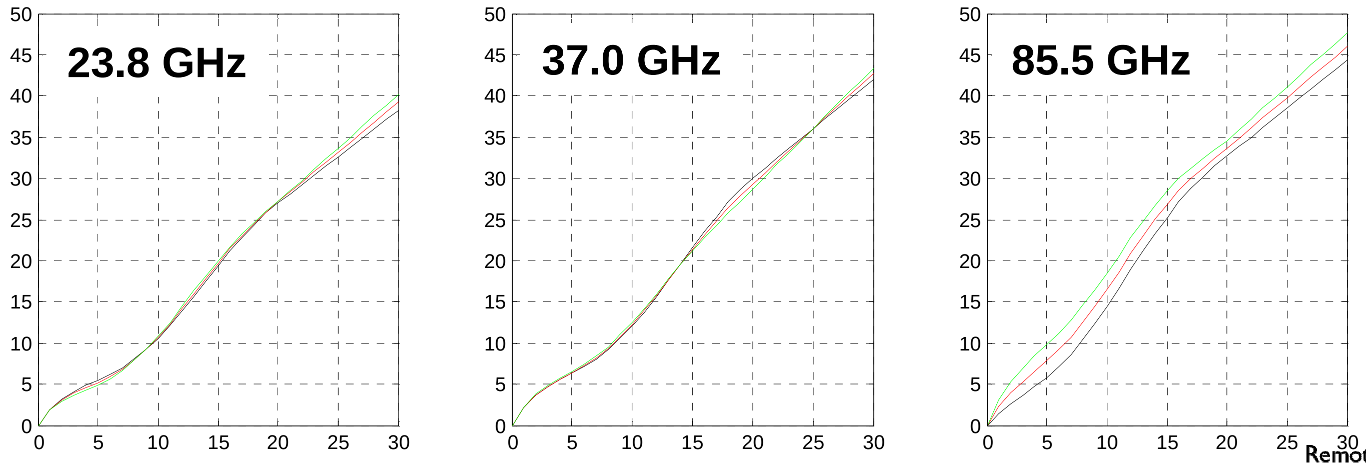
- Analysis provides adjustments to atmospheric absorption models and dielectric constant
- Adjustments are well within experimental error of the original laboratory data.
- WindSat and SSMI give essentially the same results for overlapping frequencies (19-37 GHz).

New Sea-Surface Emissivity has no Anomalous SST Dependence (both Specular and Wind-Induced Components)

H-Pol



Black, red, green = SST 3,16, 29 C.   WindSat for 7-37 GHz and SSMI for 85 GHz
X-axis = wind speed (0-30 m/s)   Y-axis = increase in surface Tb (0-50K)



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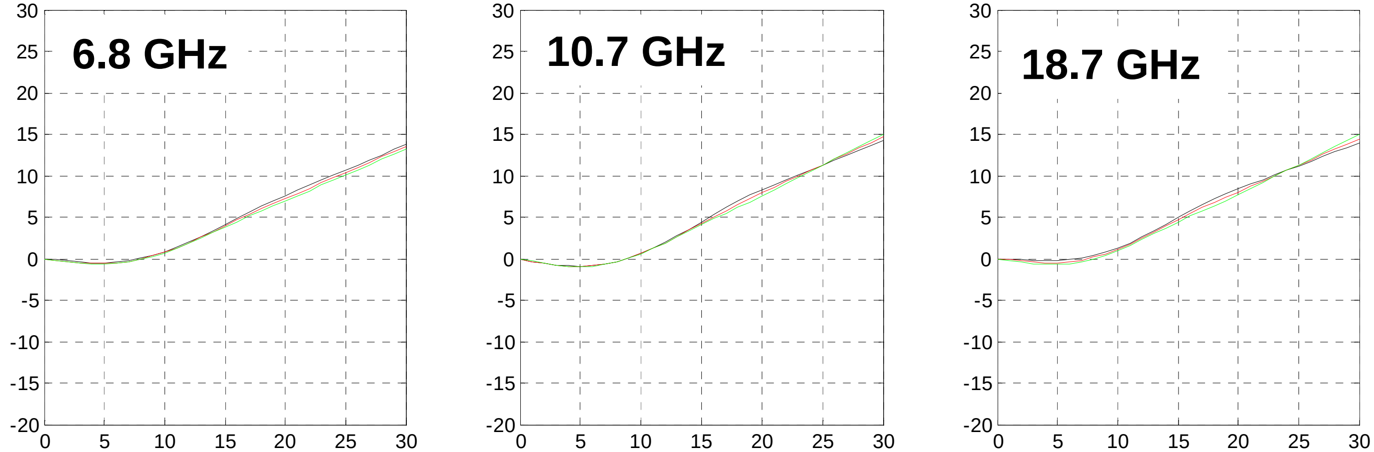
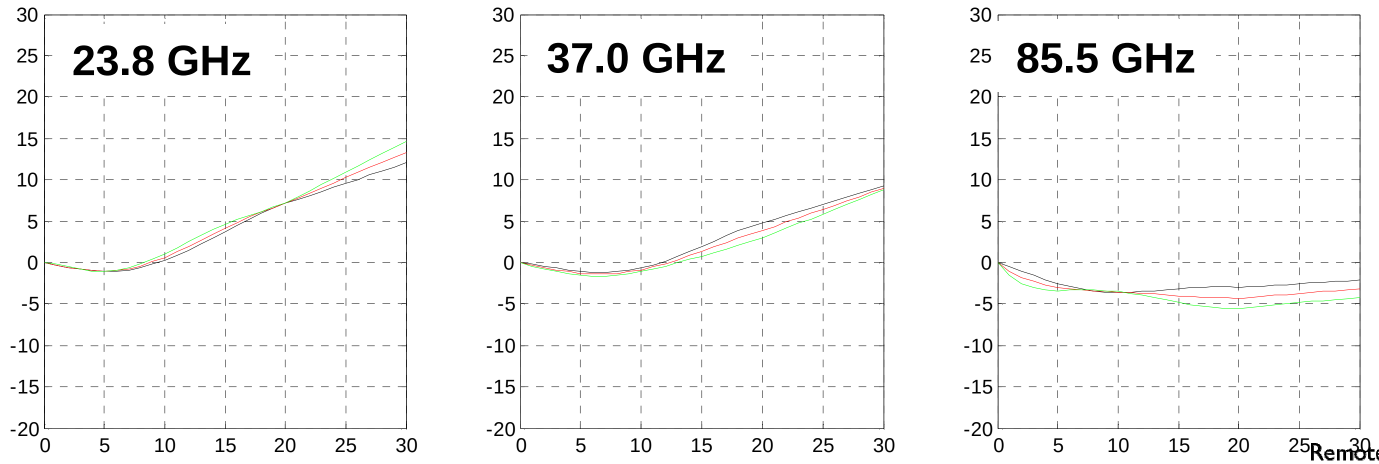
New Sea-Surface Emissivity has no Anomalous SST Dependence (both Specular and Wind-Induced Components)

V-Pol



Black, red, green = SST 3,16, 29 C.   WindSat for 7-37 GHz and SSMI for 85 GHz
X-axis = wind speed (0-30 m/s)   Y-axis = increase in surface Tb (-20 to 30K)



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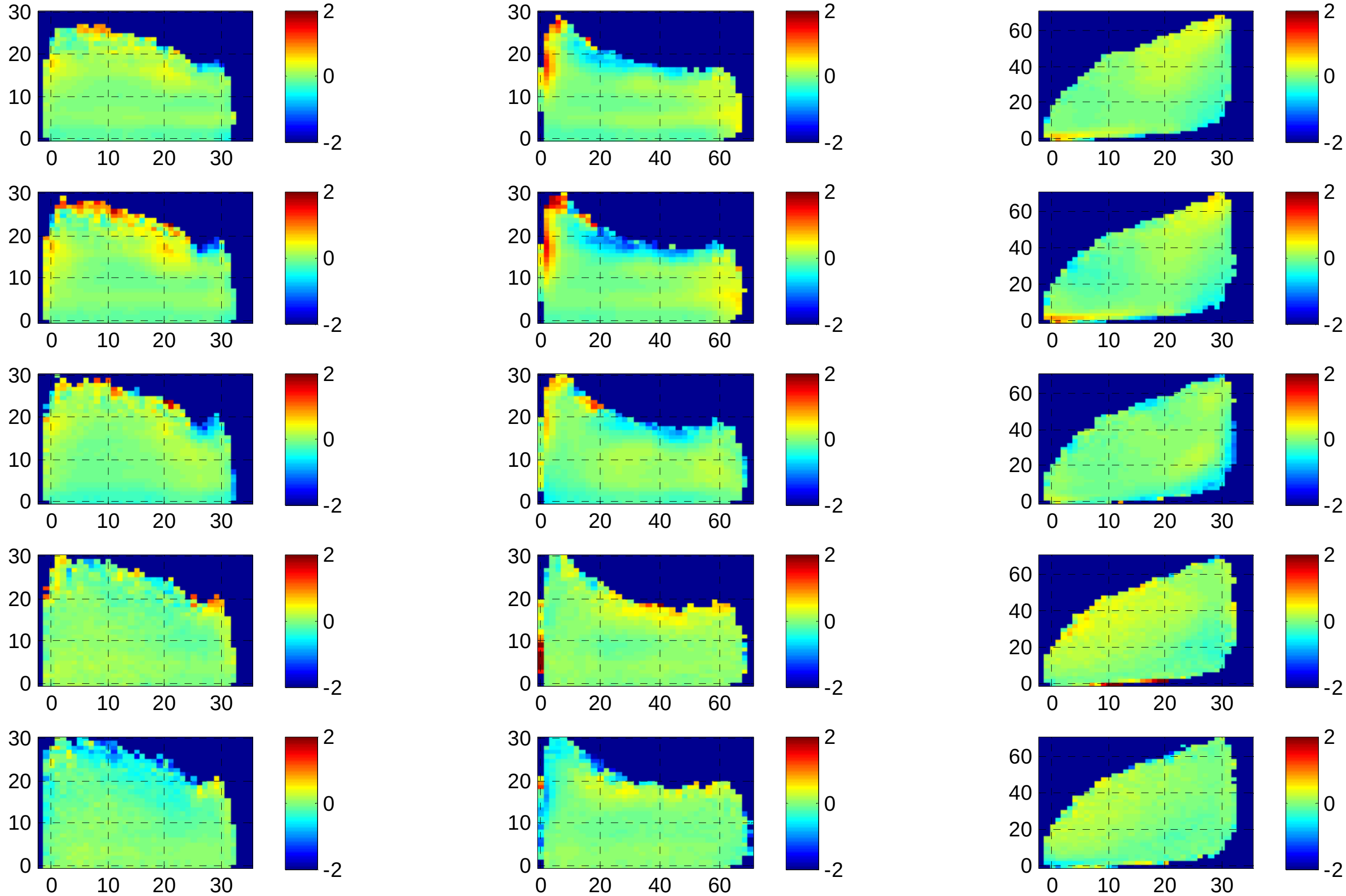
QuikScat Winds → New RTM → Simulated WindSat T_A



x=sst, y=wind   x=vapor, y=wind   x=sst, y=vapor

When QuikScat winds are inputted into new RTM, the simulated and measured brightness temperatures are in good agreement over SST, wind, vapor space.

Conclusion

$S\,(k_{bragg})$ and $\int_{0.001}^{10} dk k^3 S(k)$ are highly correlated in {T,W,V} space

For the most part, radiometers and scatterometers see the same wind.

There are probably some specific processes, which are geographical unique, that do not reveal themselves in {T,W,V) space, like:

- Arabian Monsoons
- Upwelling areas

Radiometer wind retrievals using new RTM will reveal these processes

Need to Separate High-Wind Effect from Rain Effects

HRD ➔ WindSat ➔ QuikScat

- WindSat can easily detect rain
- 7 GHz H-pol channel increases linearly with wind at high winds (SFMR)

Thomas Meissner Investigation

- Wind vectors from Surface Wind Analysis from the NOAA's Hurricane Research Division (HRD)
- Collocated with WindSat brightness temperatures
  - NRL Level0 data processed by RSS into Level2
  - Calibrated
  - Optimum interpolated onto 1/8 deg fixed Earth grid (X-band resolution)
- 17 storms during 2003 and 2004
- Rain flagged (TB exceeds boundary for rain free ocean scenes)
- 3 hour time window
- Scale HRD winds (1 minute sustained) by 0.88 to compare with satellite winds (10 minute sustained)
- Resample HRD winds (5 km) onto WindSat footprint (30 km for X-band)
- Visual shift of HRD field so that storm center coincides with WindSat
- Half of the set is used for training, the other half for testing
- About 24,000 wind vector cells for test set

New All-Wind Model Function