SST Impact on RapidScat and QuikSCAT Measurements

Lucrezia Ricciardulli and Frank Wentz

Remote Sensing Systems, Santa Rosa, California

Acknowledgments: This work is supported by NASA OVWST and JPL RapidScat Cal/Val and Science Team
Outstanding issues in Ocean Wind Climate Data Record development

RapidScat and QuikSCAT

- Verify RSCAT observed sigma0 follow Ku2011 Geophysical Model Function (GMF) at QuikSCAT incidence angles
- Tune RSCAT pre-launch GMF N2014 (inferred from NSCAT+QSCAT) to actually match RSCAT sigma0 at other incidence angles
- Explore SST-depend Ku-band GMF
- Analyze issue with RSCAT direction discontinuity at swath center

- Finalize new Ku-SST GMF
- Final end-of-mission RapidScat reprocessing (JPL)

QuikSCAT, ASCAT, WindSat

- Calibrate high winds using SFMR, SMAP (presentation Meissner et al)

ScatSat

- Validation of early release data (see poster Ricciardulli et al.)
1. Tune pre-launch GMF using observed RapidSCAT sigma0

Method

- Use only pre-anomaly data (High SNR I), GLOBAL
- Rain-free (radiometer flag)
- Only QSCAT angle
- Compare to QSCAT obs. sigma0 distribution
- Compare to pre-launch GMF (N2014)

Problem

RSCAT sigma0
Did not match QSCAT sigma0 distribution at UPWIND for the same inc. angle
Solution: consistent RSCAT/QSCAT sampling

RapidScat sampled
Mostly mid-latitudes

Cold SST impact skews
sigma0 distribution

QuikScat samples
60NS almost
uniformly

- Good match between RapidScat and QSCAT observed sigma0, and the pre-launch GMF (at QUIKSCAT angles)
- At other angles V-Pol RapidScat did not perfectly match GMF at upwind/downwind \( \rightarrow \) we retuned RSCAT GMF
- But this turned out not to be the cause of discontinuity in wind direction (GMF acquitted)
2a. SST-impact on sigma0 → regional wind speed bias

- **Ku-band is impacted**: RSCAT bias > QSCAT bias
- **ASCAT – WSAT No bias**: C-band impact Negligible (?)
2b. SST-impact $\rightarrow$ wind speed bias estimates

Method
- Use 5 yrs rain-free QSCAT/WSAT colocation
- Use daily Reynolds SST as reference
- Buoys have too little data in cold SST, no ground truth
- Use WSAT as ground truth for wind speed
- Stratify bias as a function of wind speed and SST

Comparison with WSAT (calibrated on global scale with QSCAT) confirmed SST-dependency of bias

Largest effect
- 0.3-0.4 m/s negative bias in very cold water at 2-10 m/s
- 0.3-0.4 m/s positive bias at high winds for SST>25C
2c. SST-impact on QuikSCAT sigma0 → Ku-SST GMF

- We used 5 yrs of QSCAT observed sigma0 and stratified them as a function of SST, using WSAT as ground truth for winds
- We calculated new coefficients of the GMF as a function of SST

Non-directional coefficient A0 (90% signal)

Significant spread of the coefficients at 10 m/s as a function of SST for V-Pol, but not for H-pol.
This indicates a real “physical” signal in the Ku-band sigma0, not in WindSat.
(See paper by Wang, Stoffelen et al (2016) for explanation of SST impact on V-pol and H-pol backscatter)
2d. SST-impact on RapidScat sigma0 (@ QSCAT angle)

Non-directional coefficient A0 (90% signal)

Very consistent SST-impact with QuikSCAT, V-pol affected, H-pol not (real signal !)
We also explored doing it separately for N and S hemisphere, there is no difference (ruled out geographical bias)
2e. SST-impact on QuikSCAT directional coefficient A2

Similarly to A0, V-pol affected, H-pol not
3. Ku-SST: SST-dependent adjustment to current Ku2011 GMF

Total adjustment is about the average between V-Pol and H-Pol, max about -0.4 dB (~0.4 m/s) for very cold waters SST < 3°C
Conclusions and work in progress

• SST-dependent GMF became high priority for scatterometers’ consistency
• Corrects for real SST signal at Ku-band sigma0, mostly V-Pol
• Developed new GMF Ku-SST (QSCAT angles) as adjustment to Ku-2011
• Early results: no need to adjust GMF for high winds > 30 m/s (SMAP-SFMR-QSCAT cross calibration)
• RSCAT GMF: prelaunch GMF has been readjusted for average SSTs to tune it to actual RSCAT observed sigma0s

Work in progress

• We need to be very careful with new Ku-SST at high winds not to spoil the calibration
• Determine simple way to implement Ku-SST in QSCAT/RSCAT retrieval algorithm
• Ku-SST will be delivered in the next few months to JPL for final reprocessing of RSCAT
Extra slides
The figure highlights the largest error due a direction discontinuity in the middle of the swath.
RapidScat sigma0 distribution at some incidence angles departed from pre-launch GMF at upwind and downwind. 

→ Need for a retuned GMF R017 (directional coefficients)
BUOYS

Noisy curves, and little buoy data in very cold waters lead to inconclusive result

NCEP (or ECMWF)

NCEP regional biases mask SST-dependency bias due to wind regime/region
Not a good ground truth for Ku-SST
SST-Dependence of A1 (directional) coefficients
AO V- N and S Hemisphere, RapidScat