SMAP Radiometer-Only Tropical Cyclone Size and Strength

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SMAP Overview

Primary Science Objectives
- Global, high-resolution mapping of soil moisture and its freeze/thaw state to
  - Link terrestrial water, energy, and carbon-cycle processes
  - Estimate global water and energy fluxes at the land surface
  - Quantify net carbon flux in boreal landscapes
  - Extend weather and climate forecast skill
  - Develop improved flood and drought prediction capability

Mission Implementation

| Partners   | JPL (project & payload management, science, spacecraft, radar, mission operations, science processing)  
|           | GSFC (science, radiometer, science processing) |
| Launch    | January 31, 2015 on Delta 7320-10C Launch System |
| Orbit     | Polar Sun-synchronous; 685 km altitude |
| Duration  | 3 years |
| Payload   | L-band (non-imaging) synthetic aperture radar (JPL)  
|           | L-band radiometer (GSFC)  
|           | Shared 6-m rotating (13 to 14.6 rpm) antenna (JPL) |

NRC Earth Science Decadal Survey (2007) recommended SMAP as a Tier 1 mission

http://smap.jpl.nasa.gov/
## SFMR Matchups for 2015-2017

<table>
<thead>
<tr>
<th>DTime</th>
<th>SFMR &gt; 20 m/s</th>
<th>SFMR &gt; 25 m/s</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Counts</td>
<td>Bias</td>
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<tr>
<td>15</td>
<td>43</td>
<td>0.88</td>
</tr>
<tr>
<td>30</td>
<td>79</td>
<td>1.61</td>
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<td>45</td>
<td>116</td>
<td>1.51</td>
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<td>90</td>
<td>261</td>
<td>1.15</td>
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<tr>
<td>180</td>
<td>523</td>
<td>1.21</td>
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<td>240</td>
<td>632</td>
<td>0.90</td>
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<tr>
<td>300</td>
<td>791</td>
<td>0.58</td>
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<tr>
<td>360</td>
<td>954</td>
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- Average SFMR along-track to 60 km, pick point of nearest approach to SMAP cell.
- Use best-track to shift SFMR tracks to SMAP observation time.
SMAP vs SFMR; Best Fit Slope: 0.96; Corr: 0.81
Mean Pct Error > 15 m/s: 15

360 min matchup time
SMAP Wind Radii

- We validate against the ATCF B-deck datasets.
- For each SMAP cyclone hit:
  - Compute contours at (34, 50, 64) knot wind thresholds.
  - Extract longest contour in each compass quadrant and compute the 90% threshold value.
Wind Radii Results

- SMAP wind radii are in reasonable agreement with ATCF B-deck radii:
  - ATCF wind radii estimates have ~ 20-40% error.
  - Good correlation to ATCF radii.
  - SMAP relatively unbiased.
Summary

• Using SFMR we find good agreement to about 40 ms$^{-1}$
  – Positive bias between 30-40 ms$^{-1}$ no larger than 3 ms$^{-1}$
  – Overall STD as compared to SFMR is on the order of 4 ms$^{-1}$ for wind speeds larger than 25 ms$^{-1}$
• Comparisons to ATCF B-deck datasets shows SMAP provides reasonably unbiased size estimates with good correlation to ATCF values.
• Overall, SMAP can provide valuable information on Tropical Cyclone size and averaged intensity.
• Peer-reviewed publications:

Wind Speed [m/s]

Rain Rate [mm/hr]

SFMR SPD 5km
SFMR SPD 40 km
SMAP SPD
SFMR RR 5 km
SFMR RR 40 km

From SFMR stat plot
360 minutes / 60 km avg SFMR

<table>
<thead>
<tr>
<th>Wind Speed Bin</th>
<th>Bias</th>
<th>STD</th>
<th>Counts</th>
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<td>3.05</td>
<td>985</td>
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<td>50-55</td>
<td>-5.94</td>
<td>4.06</td>
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Shift SFMR tracks using best-track (time, location) to SMAP time
Identify closest points of approach to SWC; may be multiple

For each closest point of approach:
Average SFMR along-track to 60 km centered on that point
Keep if closer than 12.5 km and time offset less than 360 min

SMAP SWCs

25 km SWC spacing
SMAP / RapidScat / WindSat collocations (30m)

- Only extract joint collocations within 30 minutes of SMAP.
  - 3.7 million matchups.
- Use WindSat to remove rainy observations.
- Find nearly zero speed bias up to 26 m/s, not enough data past that.
- 2d histogram does not show any trend of increasing SMAP speed bias as compared to RapidScat

![Graph showing SMAP/RapidScat Wind Speed Matchups and 2D Histogram of SMAP/RS wind Speeds]

WindSat / SSM/I/S indicate no-rain; Within: 30 minutes

2D Histogram of SMAP/RS wind Speeds [dB Counts]
Within: 30 minutes; 3705445 total
SMAP / RapidScat / WindSat collocations (90m)

- Same as previous with 90 minute collocation time.
  - 13 million matchups.
- Find very small speed bias up to 30 m/s (order 1 m/s).
- 2d histogram show data distributed near 1:1 line, no evidence of large positive SMAP bias near 30 m/s as compared to RapidScat.
Wind Speed bias versus SFMR rain rate (SFMR spd > 20 m/s)

SFMR 60 km average
SFMR > 20 m/s
Match-up time within 360 min

Insufficient data
**L2A Gridding**

Fig. 3. An example of the L2A gridding algorithm: the solid black grid lines represent the boundaries between the SWCs while the two ellipses represent two sequential L1B footprint observations. **i** represents the cross-track coordinate while **j** represents the along-track coordinate. The dashed boxes within each SWC indicate the size of the "overlap" region. Any L1B observation whose footprint falls within the dashed "overlap" region for each SWC will be included in that SWC for salinity processing. For example, the dark gray footprint will be assigned to SWCs \{(i, j-1), (i, j), (i+1, j-1), (i+1, j)\}.

"latitudes" are linearly scaled to generate the Salinity Wind Cell (SWC) grid indices which are approximately 25 km in spacing. After computing the SOM coordinates for all T\(^B\) footprints, we assign each T\(^B\) footprint to every SWC that the footprint 3 dB contour overlaps a configurable portion of. This gridding algorithm was developed for Version 3 of the QuikSCAT data products and is currently used for processing RapidScat data, and is known as the overlap method. This gridding algorithm over-samples the T\(^B\) observations onto the SWC swath in a way that is consistent with the measurement geometry. In Figure 3 we have an example of the L2A gridding algorithm. In this figure the solid black lines represent the boundaries of the SWCs while the dashed lines indicate the size of the "overlap" region, which is set to 0.75 the size of the SWC. Any L1B T\(^B\) observation whose footprint falls within the dashed "overlap" region for each SWC will be included in that SWC for salinity processing. For example, the dark gray footprint will be assigned to SWCs \{(i, j-1), (i, j), (i+1, j-1), (i+1, j)\}.

The data are posted at approximately 25 km, however, the intrinsic resolution of the L2A data is somewhat larger than the resolution of the L1B footprints which is 40 km. After assigning every L1B T\(^B\) observation to SWCs we apply land and ice flagging to the individual T\(^B\) measurements and remove all observations that are flagged as land/ice from each SWC. Any SWC containing an observation that is flagged as land/ice and was removed is then flagged as having possible land/ice contamination in the quality flag. We then average the H-pol and V-pol T\(^B\) for fore and aft looks separately to obtain up to four looks for each SWC. We refer to these four looks as "flavors" of T\(^B\) (fore H-pol, aft H-pol, fore V-pol, aft V-pol). The reason we must aggregate the fore and aft looks separately is that the wind directional response is a function...