Coastal Correction to Ta & Tb (TOA, surface)

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Method: radiometer

- The input data used for the Aquarius standard product are not the best available.

\[
T_A = \frac{1}{4\pi} \int_{\text{Ocean}} GT_B \, d\Omega + \frac{1}{4\pi} \int_{\text{Land}} GT_B \, d\Omega + \frac{1}{4\pi} T_{B,\text{space}} \int_{\text{Space}} Gd\Omega
\]

Measured  What we want!  Simulate & remove  Ancillary

- The input data used for the Aquarius standard product are not the best available.

<table>
<thead>
<tr>
<th>Land model elements</th>
<th>This work</th>
<th>V1.2.3 product</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land surface temp.</td>
<td>NCEP 1x1deg *</td>
<td>NCEP 1x1deg (?)</td>
</tr>
<tr>
<td>Soil moisture</td>
<td>NCEP 1x1deg *</td>
<td>NCEP 1x1deg (?)</td>
</tr>
<tr>
<td>Soil texture</td>
<td>Global map</td>
<td>Constant (?)</td>
</tr>
<tr>
<td>Vegetation amount</td>
<td>MODIS 10daily</td>
<td>Monthly climatol. (?)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Constant forest (?)</td>
</tr>
<tr>
<td>Surface roughness</td>
<td>Global map</td>
<td>Constant (?)</td>
</tr>
<tr>
<td>Vegetation albedo</td>
<td>Global map</td>
<td>Constant (?)</td>
</tr>
<tr>
<td>Dielectric model</td>
<td>Mironov</td>
<td>Approximated Dobson (?)</td>
</tr>
<tr>
<td>Pattern integration</td>
<td>On the beam coordinate</td>
<td>On the earth grid</td>
</tr>
</tbody>
</table>

* 0.2deg resolution product under quality check.

(?) Need to verify
Method: radiometer

- Simulation details matter: Difference of 40K due to dielectric modeling can lead to 0.3 psu error at 150km from the coast.
- The current simulation matches observation to ~10 Kelvin error (=0.05K error with 0.5% land fraction).
- Integration of the gain pattern
  - Entire Earth field of view
  - Angular resolution
    - 0.1deg in elevation within 5 x 3dB width: up to 57 deg in beam’s look angle, the ground projected distance of 0.1deg is better than 4-km res land mask.
    - 0.5deg in elevation outside 5 x 3dB width
    - 2deg in azimuth: even in the worst case, up to the first null, I won’t miss any island in 4km-resolution land mask.
    - Integration is accurate to $10^{-5}$ of 4pi.
  - Computing time is 9 hr for 14 orbits with one 3GHz Intel CPU
  - Advantage: fine resolution near the boresight
Method: scatterometer

- Radar (in progress)
  - The difference between land and ocean can be very large (low wind) or can be very small (high wind).
  - Backscatter simulation is available for the global land surface using radar scattering model and input data for 16 IGBP land cover classes

Simulated HH backscatter (dB) for middle beam
Gain Weighted Land Fraction (I assume)

- JPL calculation (left) of land contamination is wider, compared with V1.2.3 (rad_land_frac, right). Discrepancy becomes larger with that.

- Cause of the discrepancy? Projection of the beam? Antenna pattern?
Gain Weighted Land Fraction: cont.

- I am using the theoretical pattern: values in 3\textsuperscript{rd} column or row is much smaller than 1\% except a31 in beam 3 (in terms of modified Stokes).

<table>
<thead>
<tr>
<th>Beam 1</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.9912</td>
<td>0.0223</td>
<td>0.0047</td>
<td>-0.0079</td>
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<tr>
<td></td>
<td>0.0217</td>
<td>0.9944</td>
<td>-0.0002</td>
<td>-0.0004</td>
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<tr>
<td></td>
<td>-0.0038</td>
<td>0.0056</td>
<td>0.9182</td>
<td>0.0091</td>
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<tr>
<td></td>
<td>-0.0038</td>
<td>-0.0224</td>
<td>-0.0111</td>
<td>0.9186</td>
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</table>

<table>
<thead>
<tr>
<th>Beam 2</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.9899</td>
<td>0.0297</td>
<td>-0.0009</td>
<td>-0.0120</td>
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<tr>
<td></td>
<td>0.0266</td>
<td>0.9944</td>
<td>0.0016</td>
<td>0.0001</td>
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<tr>
<td></td>
<td>0.0068</td>
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<td>0.8901</td>
<td>0.0016</td>
</tr>
<tr>
<td></td>
<td>0.0238</td>
<td>-0.0197</td>
<td>0.0048</td>
<td>0.8895</td>
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</table>

<table>
<thead>
<tr>
<th>Beam 3</th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.9772</td>
<td>0.0341</td>
<td>0.0003</td>
<td>-0.0128</td>
</tr>
<tr>
<td></td>
<td>0.0323</td>
<td>0.9901</td>
<td>-0.0006</td>
<td>-0.0008</td>
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<tr>
<td></td>
<td>-0.0127</td>
<td>-0.0038</td>
<td>0.8565</td>
<td>0.0106</td>
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<tr>
<td></td>
<td>0.0146</td>
<td>-0.0532</td>
<td>-0.0142</td>
<td>0.8560</td>
</tr>
</tbody>
</table>
Ta due to Land Emission: comparison

- V1.2.3 does not offer TaLand. I may either convert JPL TaLand to Tb_TOA, or convert V.1.2.3 Tb_TOa to TaLand (the latter is chosen).

\[
\begin{align*}
rad\_toa\_nolc &= APC \left( T_a = \int GT_{b} \, d\Omega \right) \\
rad\_toa\_lc &= APC \left( \left[ T_a - \int_{\text{land}} GT_{b} \, d\Omega \right] / \left[ 1 - f \right] \right)
\end{align*}
\]

- Ignoring cross-pol gain for simplicity
  - gain*rad_toa_nolc = Ta
  - gain(1-f)rad_toa_lc = Ta – TaL
  - TaL = gain* [ rad_toa_nolc - (1-f)rad_toa_lc]

  (e.g.) 300K land is mixed with 100K ocean in half and half
  \[150K = \text{gain} \times \left[ 200 - 0.5 \times 100 \right]\]

- gain_v = gain_h, based on the classical Stokes APC coefficients
  
  Post-Launch V1.1 (classical Stokes)

<table>
<thead>
<tr>
<th>Horn 1</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>0.97087</td>
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<tr>
<td>0.00000</td>
<td>0.92635</td>
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<tr>
<td>0.00300</td>
<td>0.00000</td>
<td>0.95848</td>
</tr>
</tbody>
</table>

  (Frank’s ppt in Nov 2011 CalVal WS)
Ta due to Land Emission: comparison

- Difference in TaLand: JPL minus V1.2.3

- (close-up of beam3 case) In the Pacific side, ascending has negative difference; in the Atlantic side, descending has negative difference
Ta due to Land Emission: comparison

- Comparison along this path provides an example of JPL estimating lower than V1.2.3
The land correction has an interesting feature. SSS - SSS_NOLC (which should always be positive) can be negative (at -0.1K). The area is off S. America (x04.jpg).
Salinity of the East China Sea

- The Aquarius salinity is somewhat low: can be either RFI or land emission.
Summary

- Compared with V1.2.3
  - Geometric:
    - Land contaminated area is wider & increases with incidence angle
  - Radiometric:
    - The difference may be up to +/-1K
    - The difference increases with incidence angle
  - More reliable forward model for emission
  - Not climatology

- Plans for diagnosing the differences
  - Use the latest GRASP pattern
  - (done – no effect) Try higher angular resolution during beam integration
  - Check if the beam pattern is aligned correctly in azimuth direction (if so, all three beams will be affected).
  - Use in situ salinity observation for a reference (will not easy.)
Summary

- Can the current approach be tabulated? What are the axes of the lookup table
  - (static) Lat, Lon, Time index for 10day, polarization, horn
  - (dynamic) dielectric constant, Land surface temp.

- Retrieval of Tb_surface
  - Ta has been converted to Tb TOA: in the open ocean, the difference from V1.2.3 is ~0.1K bias and 0.05K stdev
    - Due to the use of old APC (Nov 2011)?
  - Tb_TOA to Tb_surface is identical to V1.2.3

- Plans
  - Implement correction schemes for scatterometer observation (in the next 2 months)
  - Use of Mv retrieval over land to estimate the land contamination. RFI will be the main concern.
Difference in Ta between JPL and v1.2.3
Aquarius beam pattern
Tb simulation example
- Distance between Brazil and Ivory Coast is about 20deg (2500km).