The Aquarius Salinity Retrieval Algorithm

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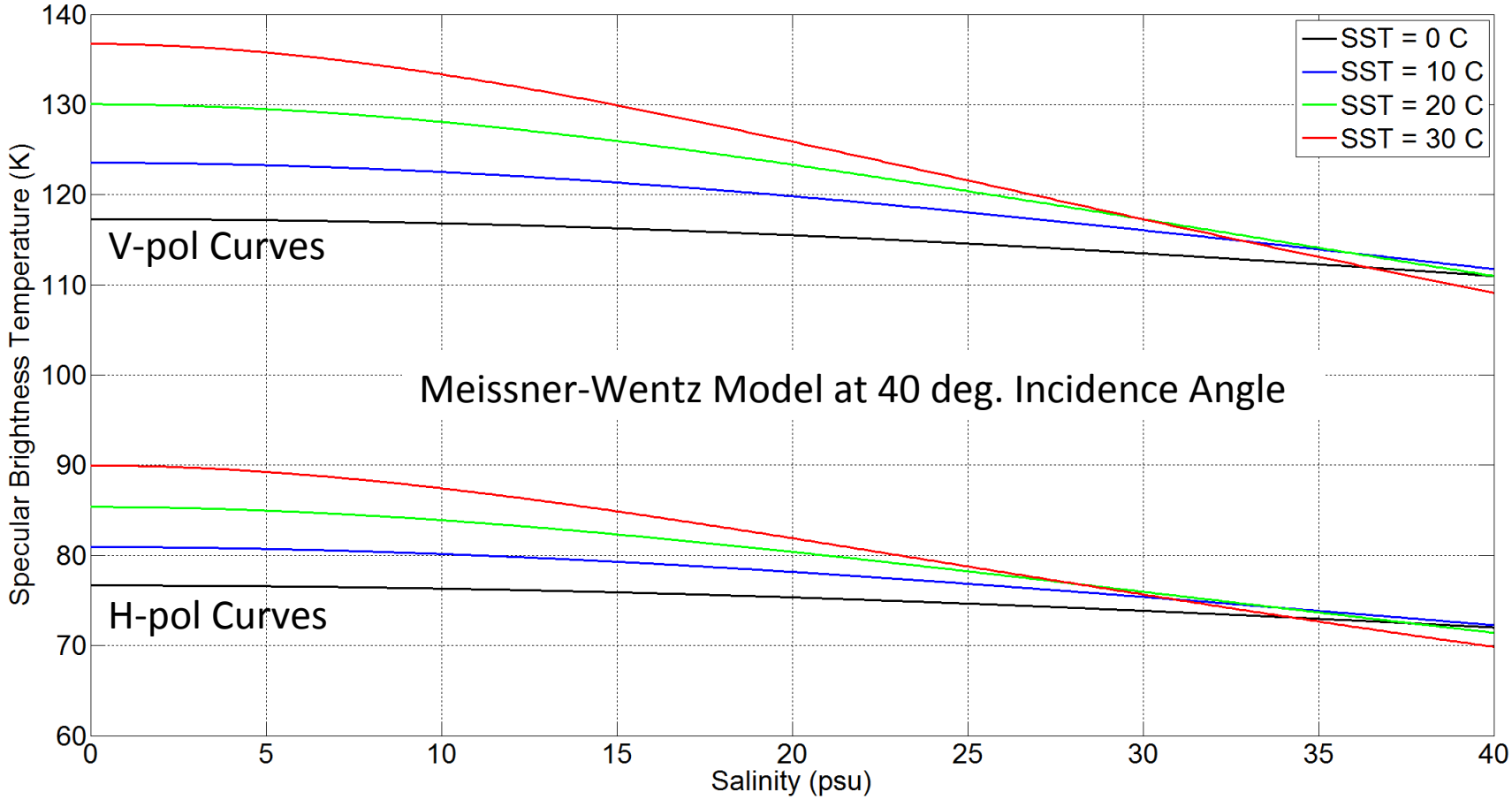
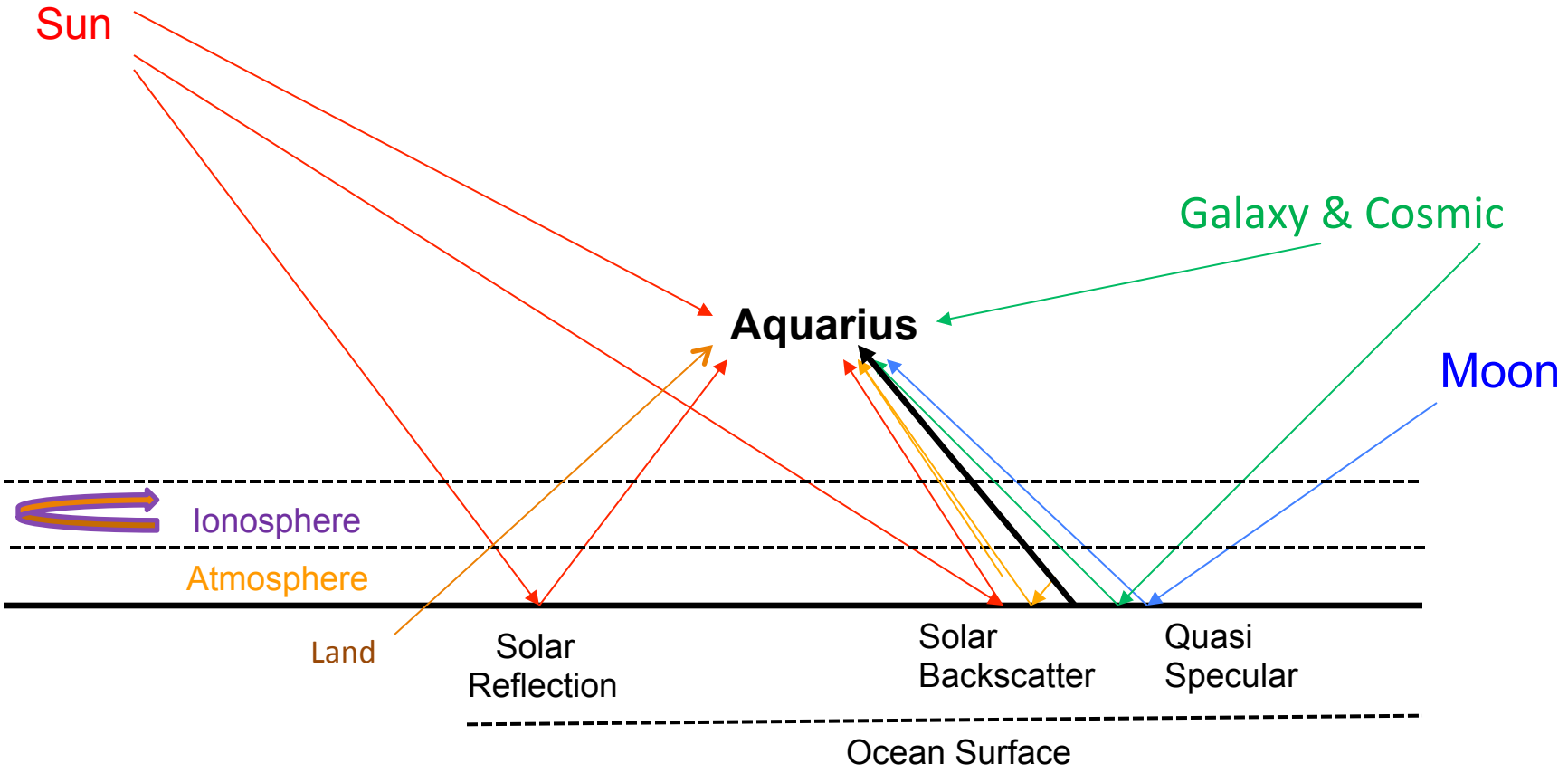
Principle:
Microwave Emission Decreases with Increasing Salinity

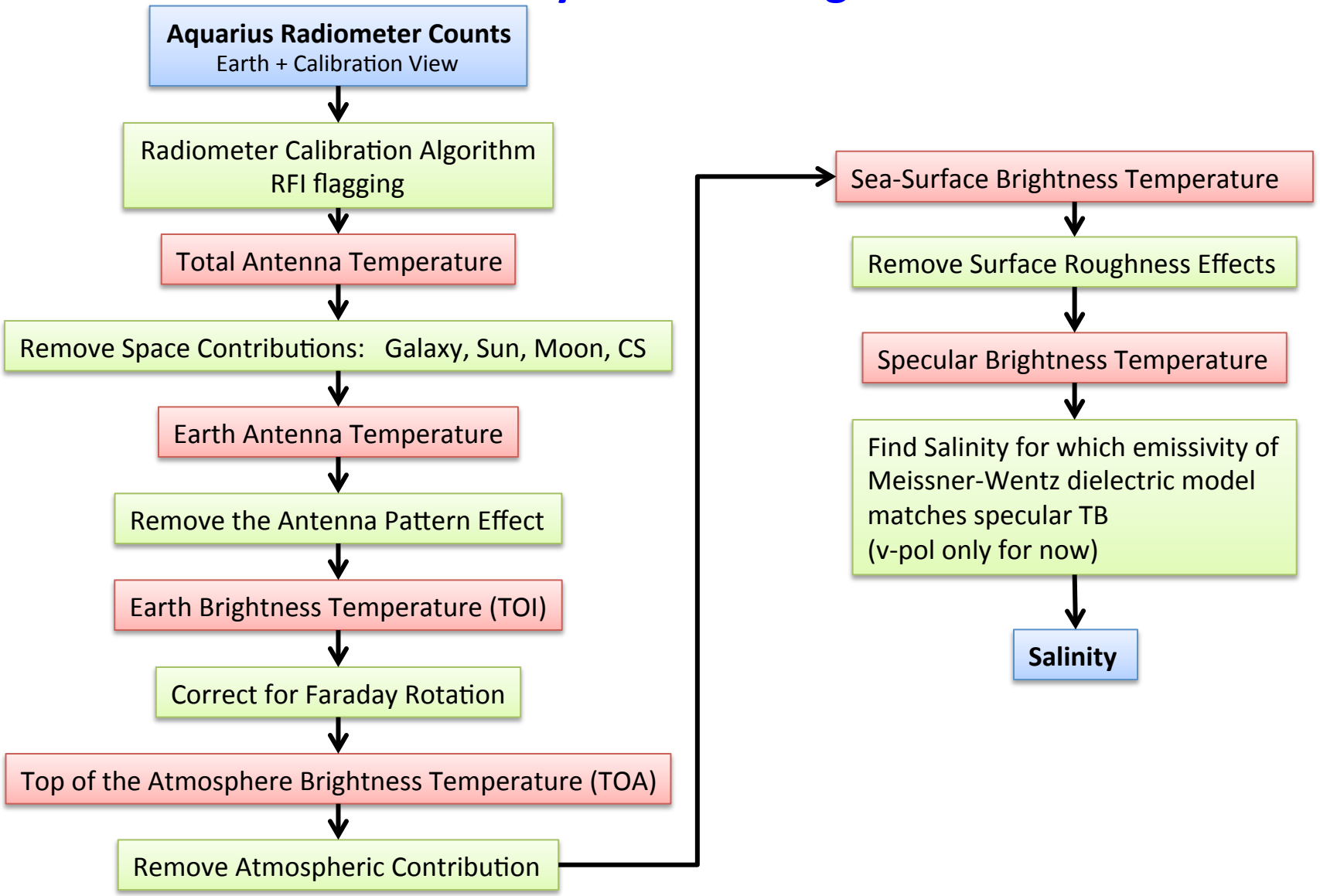
Slopes steeper in warm water and V-pol is steeper than H-pol



Challenge:
Many Other Signals Must be Removed



Salinity Retrieval Algorithm

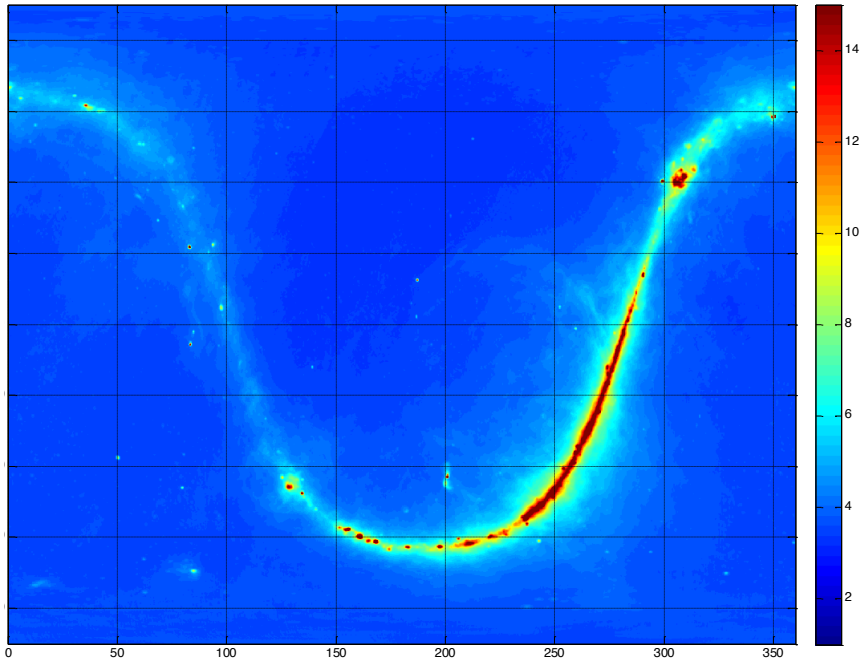


Required Ancillary Data

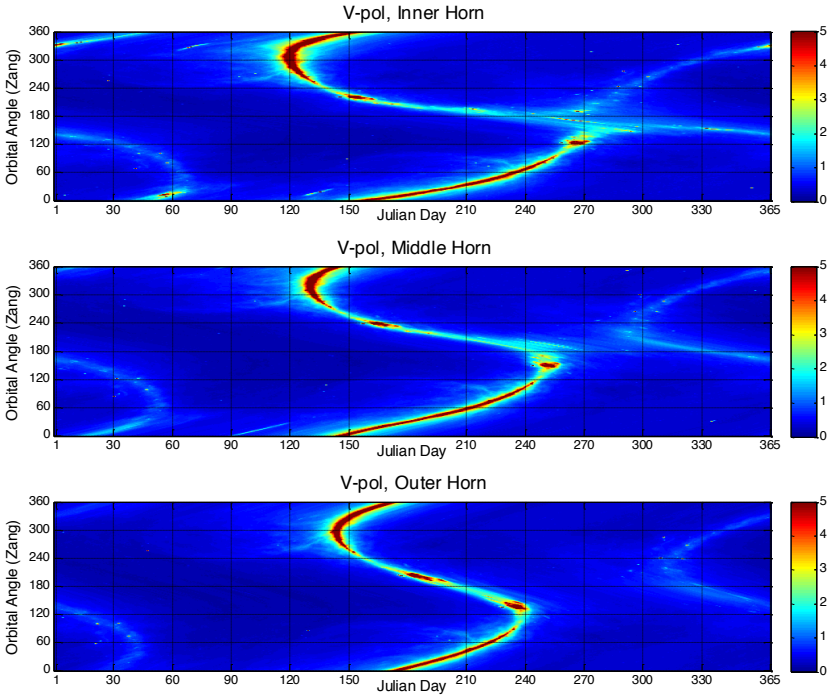
- **Remove Space Contribution**
  - 1.4 GHz Daily Solar Flux Measurements
  - (Galaxy Table is Fixed)
- **Correct Faraday Rotation**
  - No ancillary data required; uses Aquarius 3rd Stokes Measurement
- **Remove Atmospheric Contribution**
  - NCEP Profiles of temperature, pressure, vapor, and cloud water
- **Remove Surface Roughness**
  - NCEP Surface Wind Speed and Direction
  - Aquarius Scatterometer Radar Cross Section Measurements
- **Retrieve salinity from specular emissivity**
  - Reynolds OI SST

Reflected Galactic Radiation: A Big Signal that is Hard to Compute

Galaxy Emission at 1.4 GHz (up to 15 K)

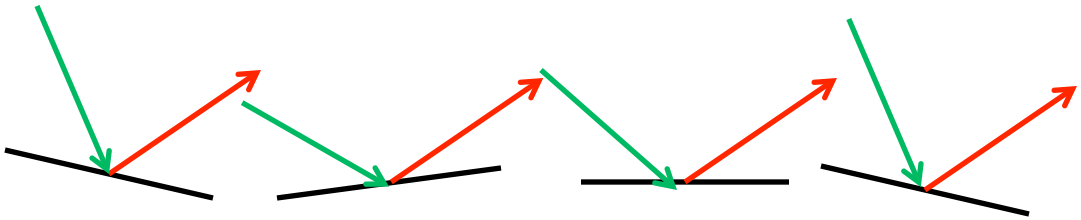


Specular Reflection of Galaxy off the Ocean (up to 6 K)



LeVine and Abraham, IEEE Trans. Geosci & Remote Sens., 42(1), 2004

Modeling Galactic Radiation: A Tilted Facet Model



Green arrows from Galaxy to Ocean: Red arrows from Ocean to Aquarius

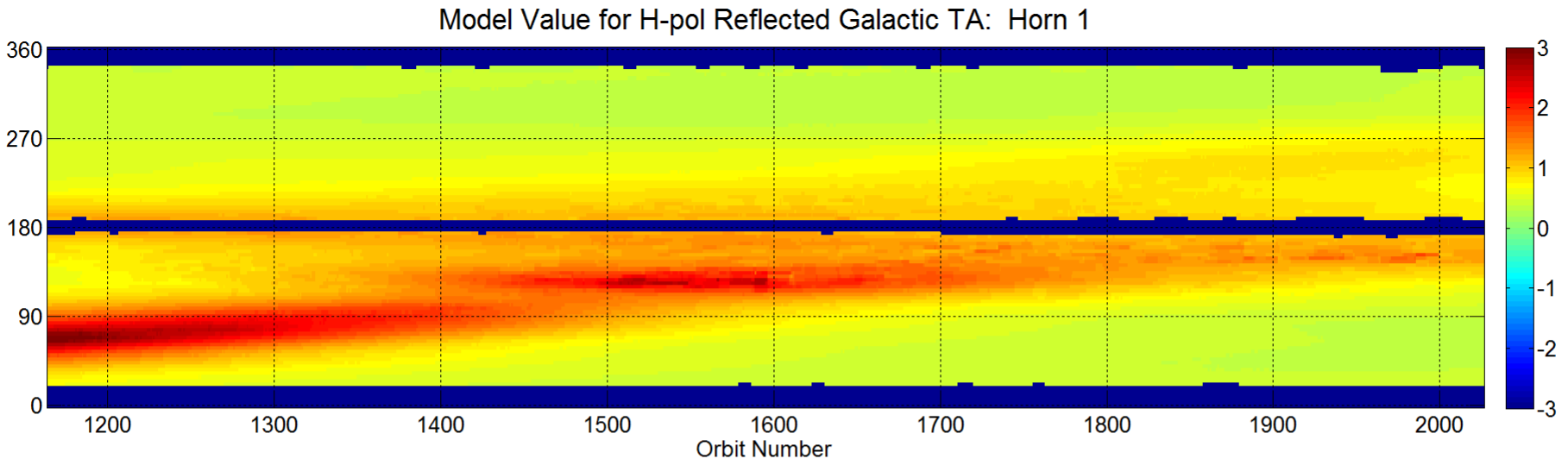
Facet integration must be done for every ocean pixel seen by Aquarius Antenna

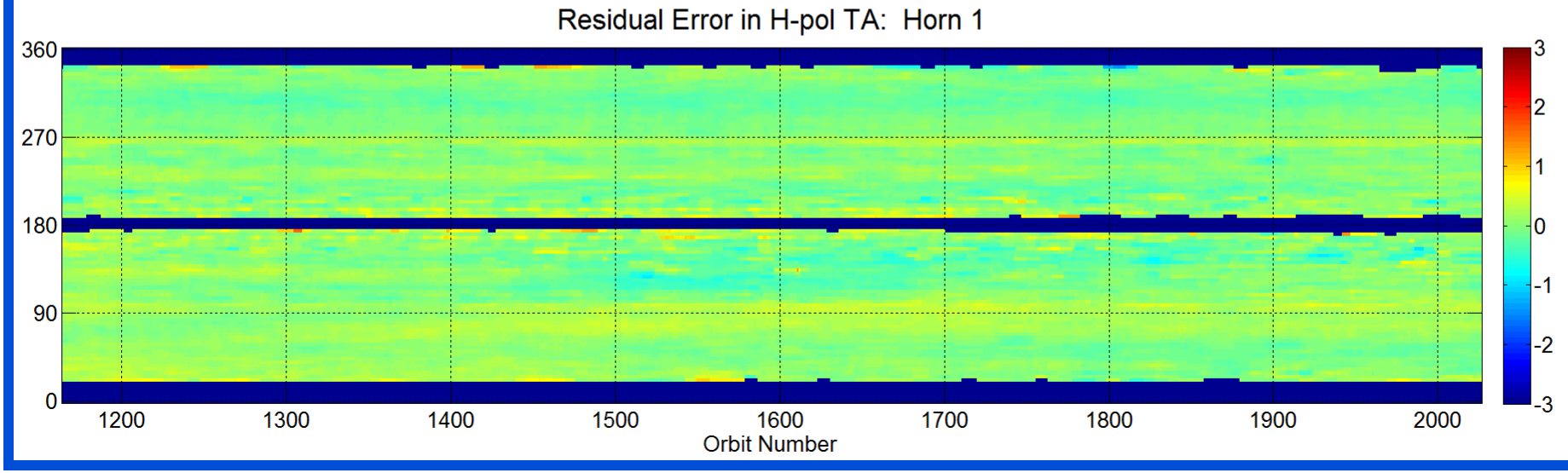
$$T_B\left(\mathbf{k_s},\mathbf{P_s}\right)=\tau^2\iint dz_u dz_c T_B\left(\mathbf{k_i}\right)\left(\mathbf{k_s g n}\right)\frac{P_z\left(z_u,z_c\right)}{\left(\mathbf{k_s g z}\right)\left(\mathbf{n g z}\right)}\Upsilon$$

Computation is a 4-fold integral that must be computed to an accuracy of 0.05 K.

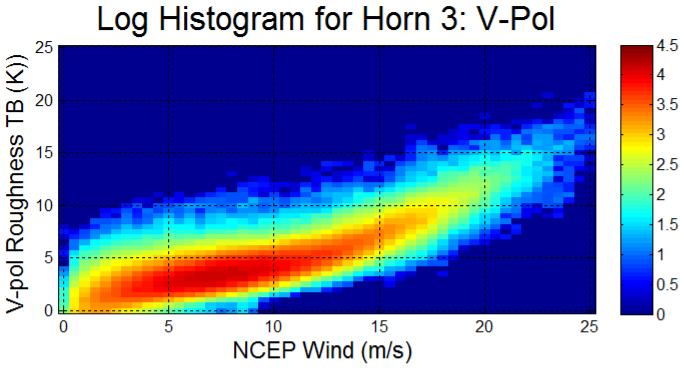
Overall effect is a smoothing of the galaxy map as winds increase.

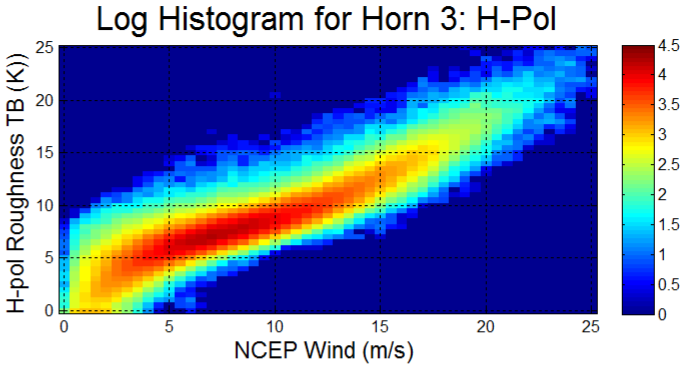
Performance of Galaxy Model with Real Data

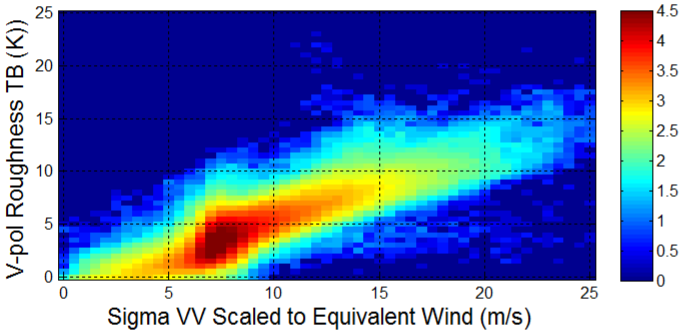


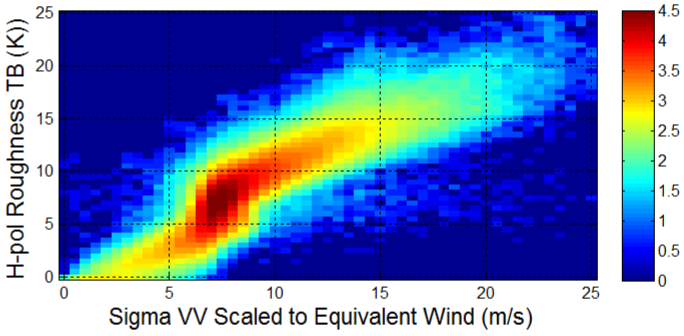


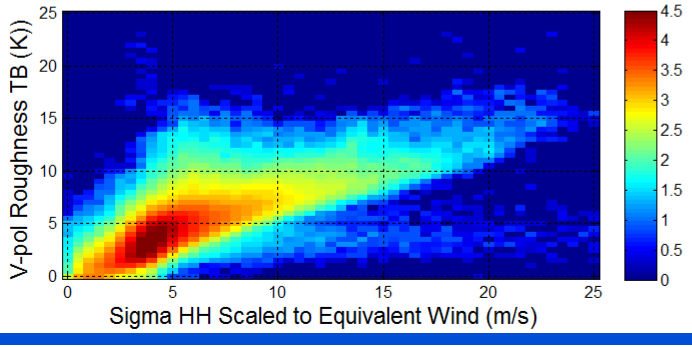
Rough Oceans Emit More Radiation

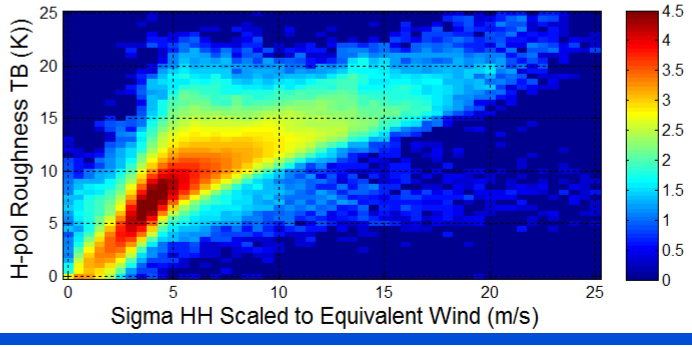




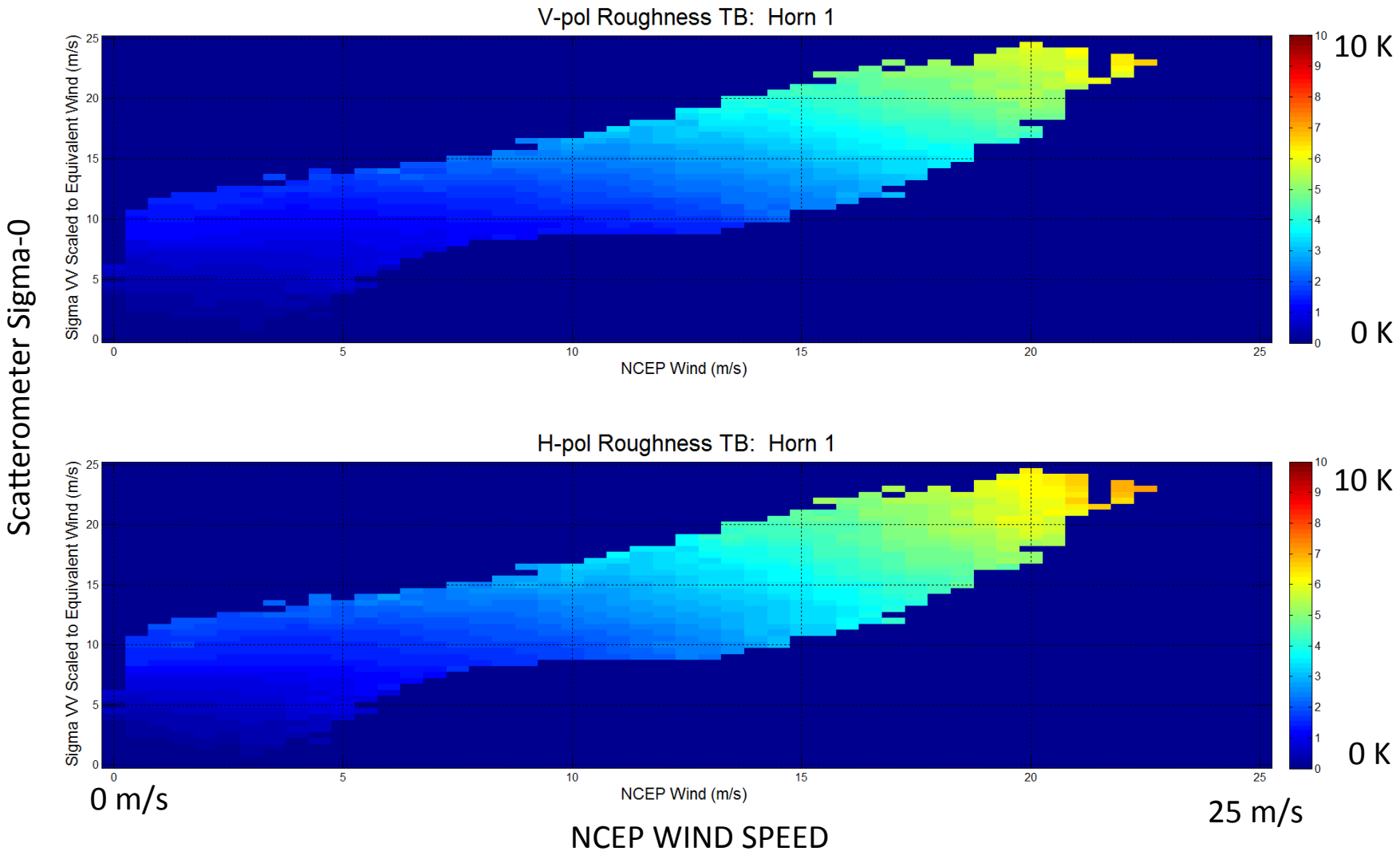




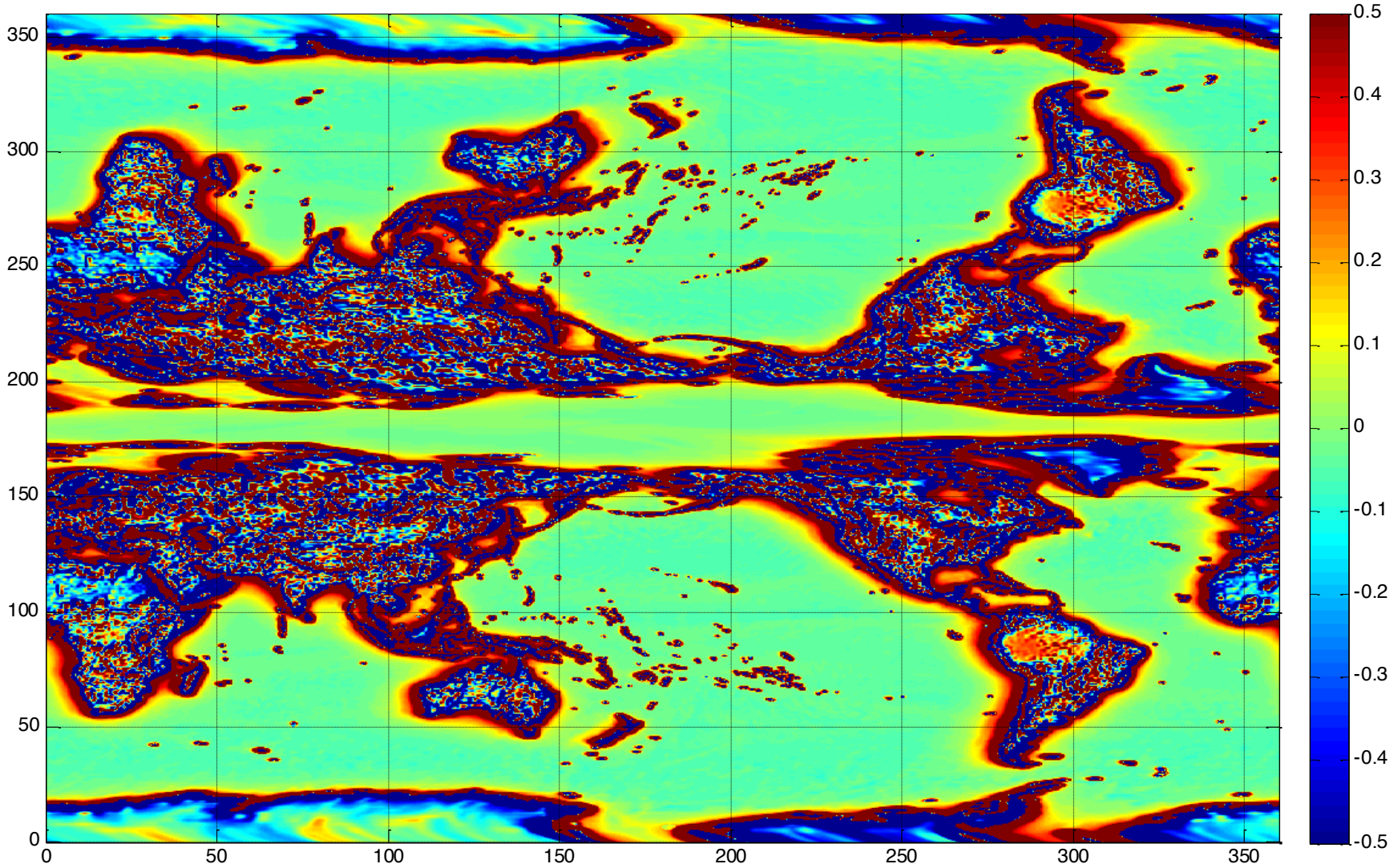




Combined NCEP and Scatterometer Roughness Correction



Land (Sidelobe) Correction



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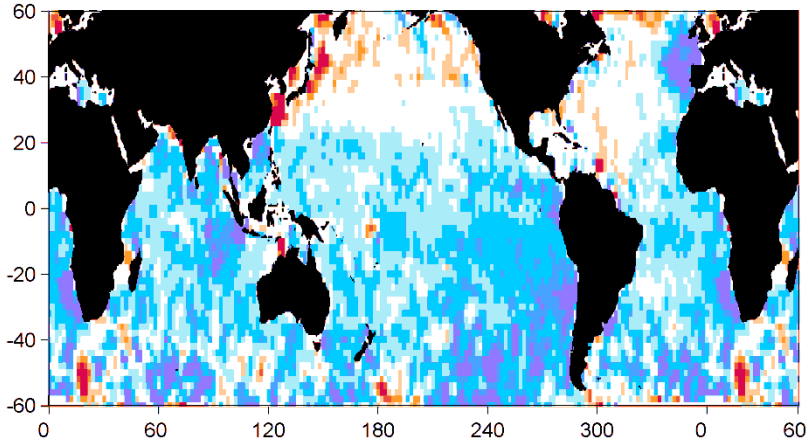
AQUARIUS/SAC-D

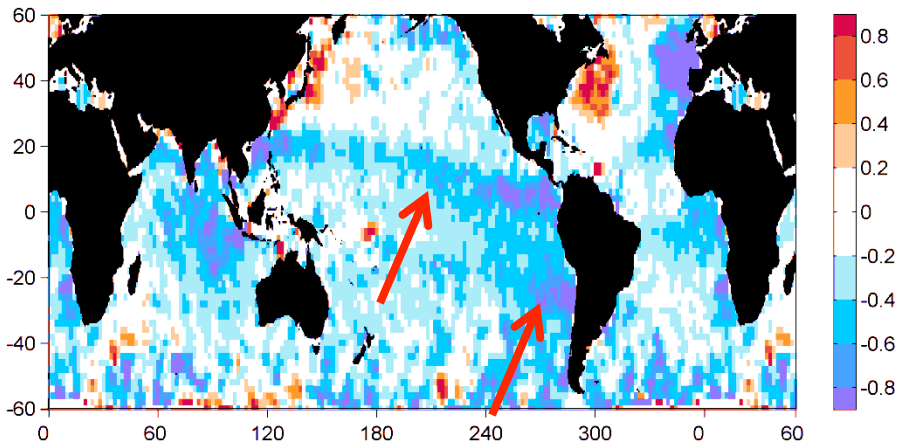
Ascending minus Descending Salinity Differences

O. Melnichenko, P. Hacker, et al.

September 2011



October 2011



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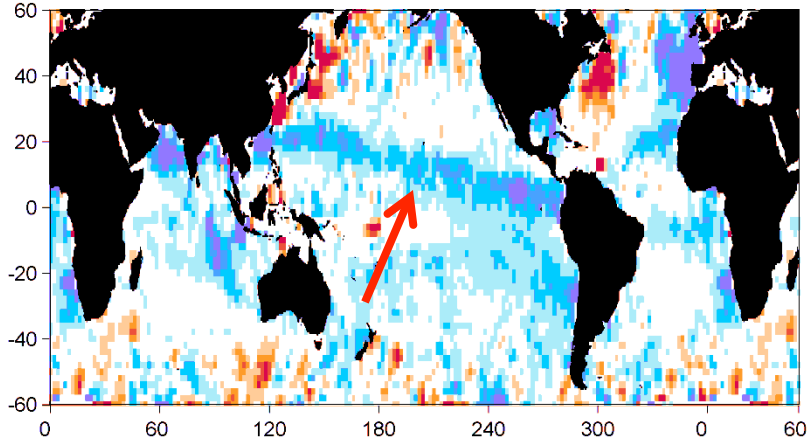

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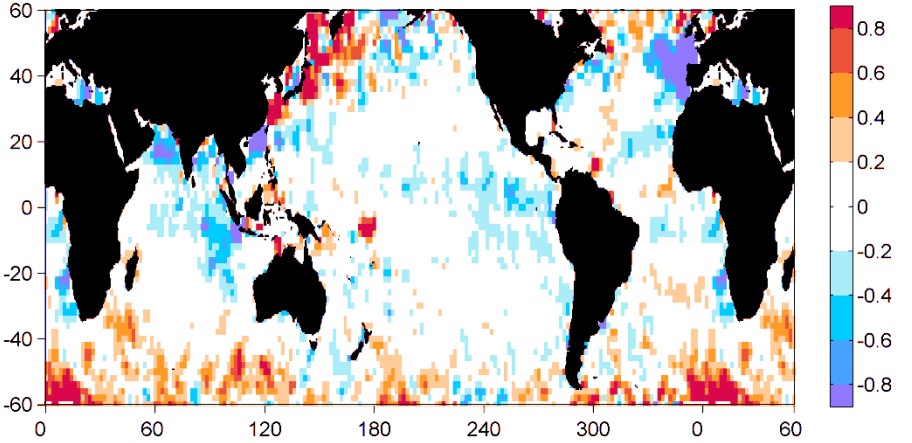


Scintillation Map of Ionosphere

Two bands around Magnetic Equator: http://www.insidegnss.com/node/1579

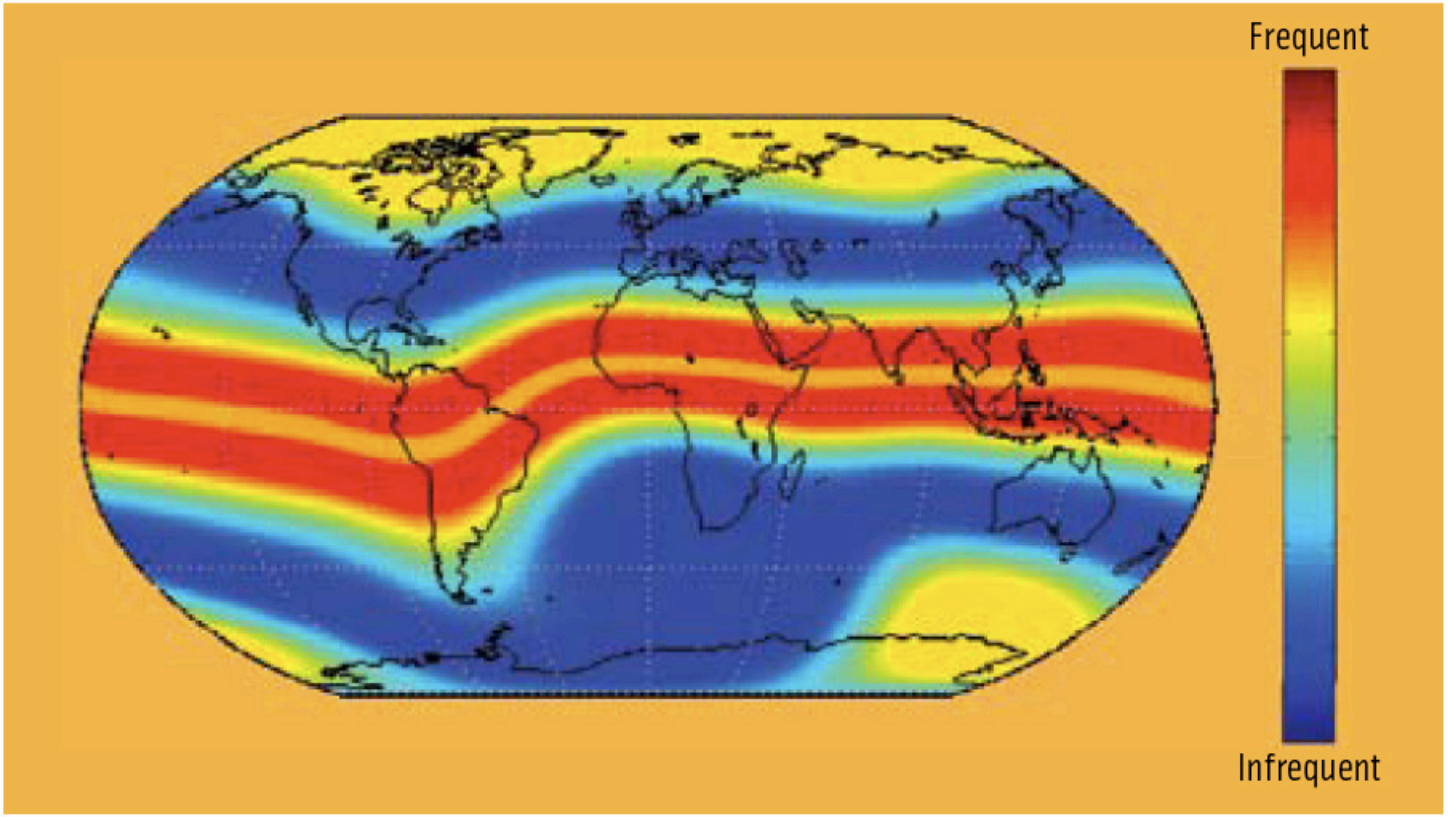
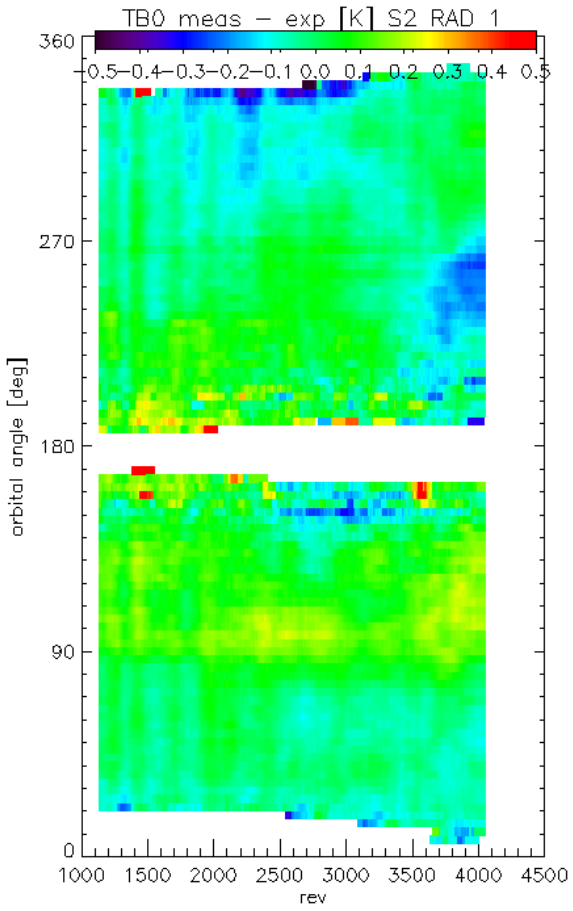


FIGURE 1 Scintillation map showing the frequency of disturbances at solar maximum. Scintillation is most intense and most frequent in two bands surrounding the magnetic equator, up to 100 days per year. At poleward latitudes, it is less frequent and it is least frequent at mid-latitude, a few to ten days per year.

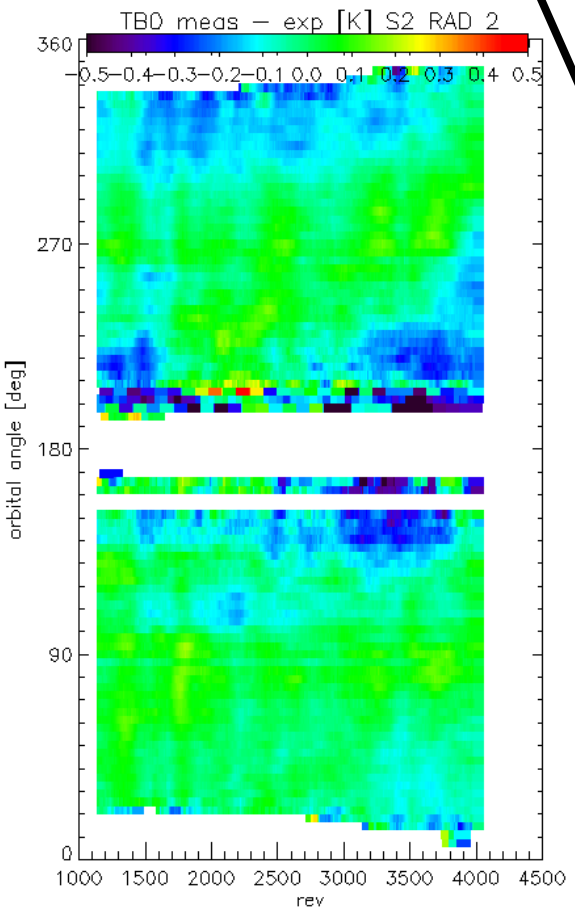
Ascending minus Descending Vpol - Hpol TB Differences

Orbital Position Maps: Possible Cause: Third Stokes radiation leaking into Second Stokes

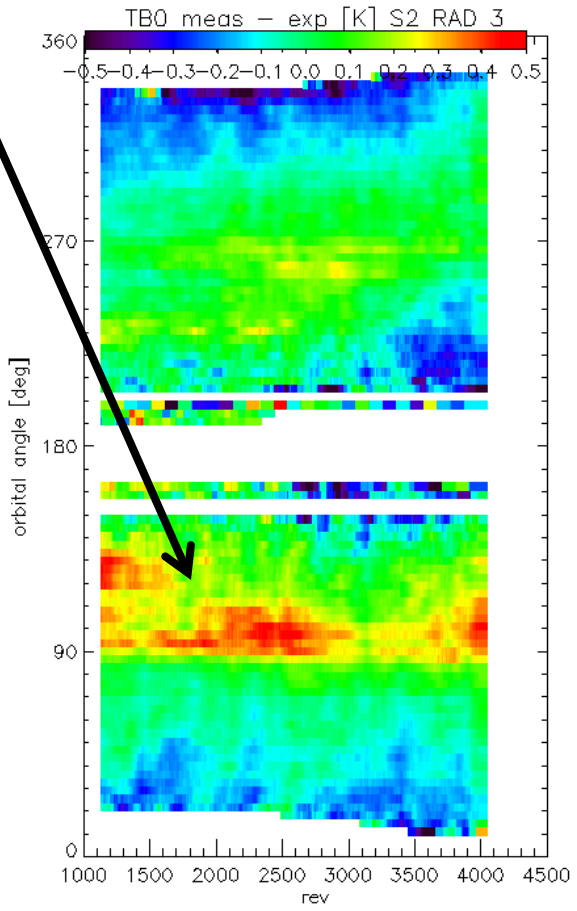
Inner Horn



Middle Horn



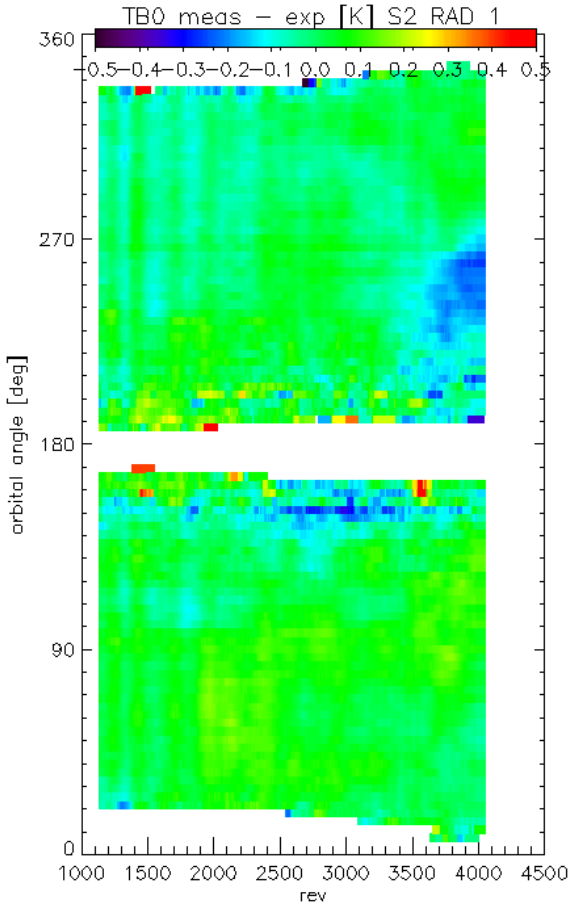
Outer Horn



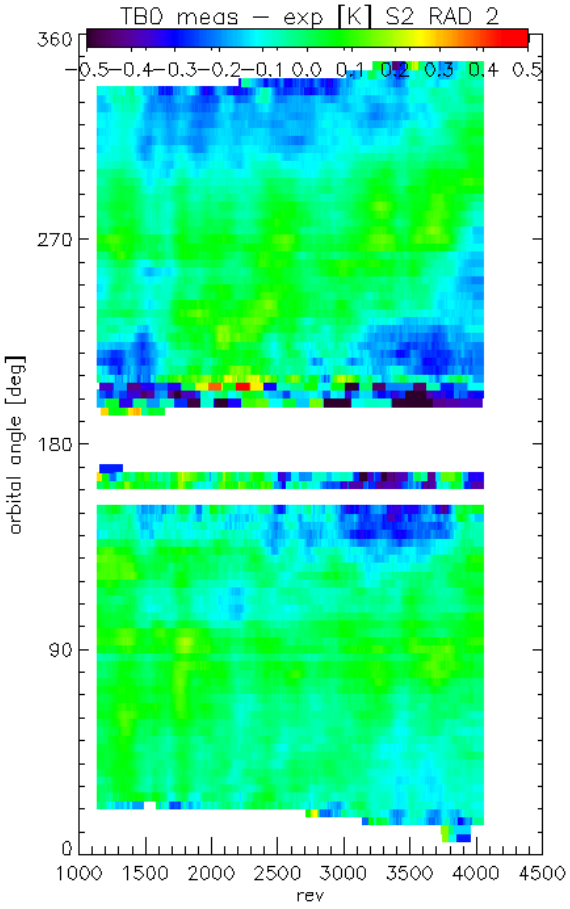
Ascending minus Descending Vpol-Hpol TB Differences

Orbital Position Maps: Antenna Pattern Correction modified

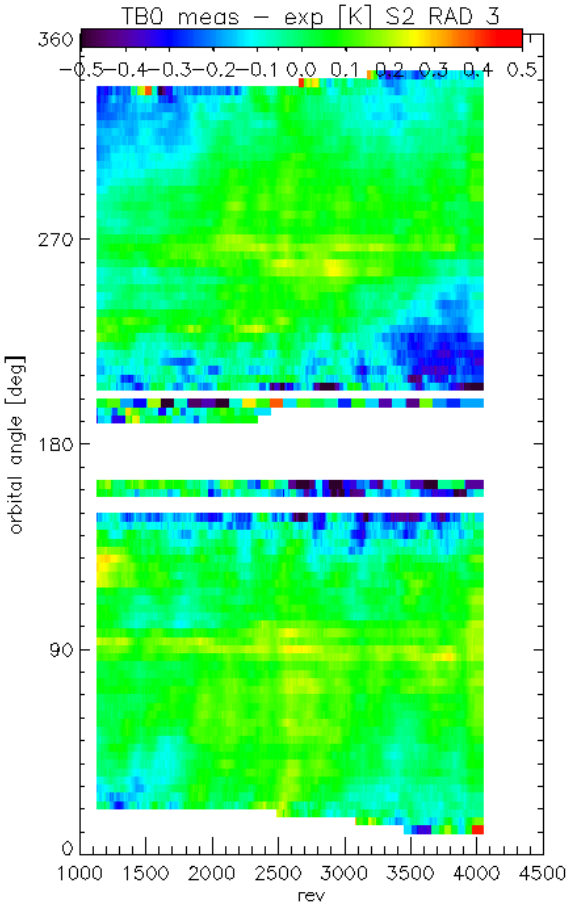
Inner Horn



Middle Horn



Outer Horn



Conclusions

Aquarius and the Salinity Retrieval Algorithm are working well.

Standard deviation of retrieval salinity versus HYCOM Salinity Model = 0.6 psu

- **Individual measurements (7-sec averages)**
- **In the open ocean well away from land and excluding cold water (SST<5C)**

Standard deviation for monthly averages = 0.4 psu.

Many issues/problems need to be resolved to achieve the mission goal of 0.2 psu.

- **Small radiometer pointing errors**
- **Radiometer calibration time drifts**
- **Ascending versus descending anomalies**
- **Revised Antenna Pattern Correction**
- **Optimum roughness correction**
- **Better land contamination calculations; problem with islands**
- **Influence of longer wave, galaxy, sun, faraday rotation, etc.**
- **TBD**