



Ocean Surface Salinity from SMAP: Continuing the Legacy of Aquarius

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Salinity and Freshwater Changes in the Ocean
Hamburg, October 12 - 15, 2015



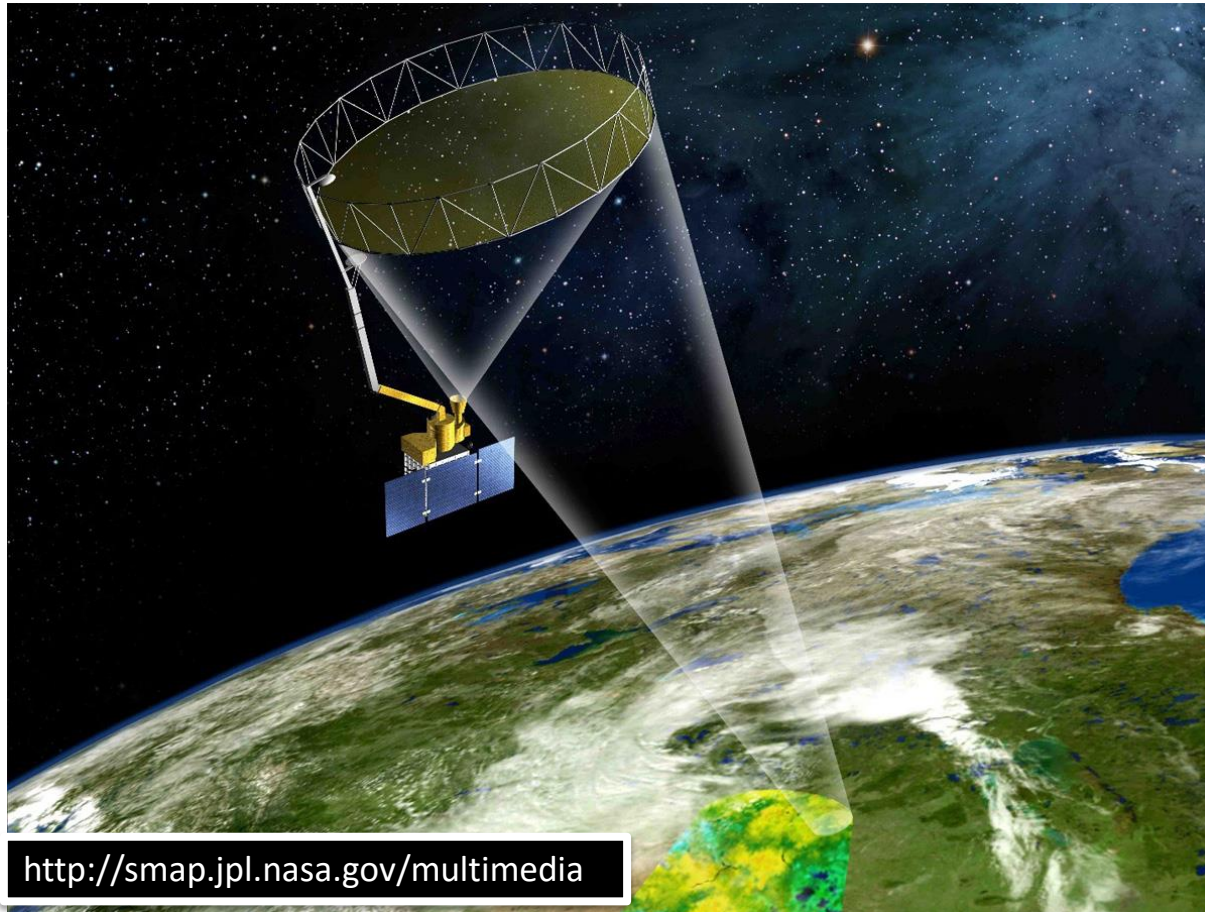
Outline

- Overview of SMAP Instrument
- SMAP Salinity Retrieval Algorithm
- First Light Image of SMAP Salinity
- Problems and Concerns
- Planned Data Release



SMAP

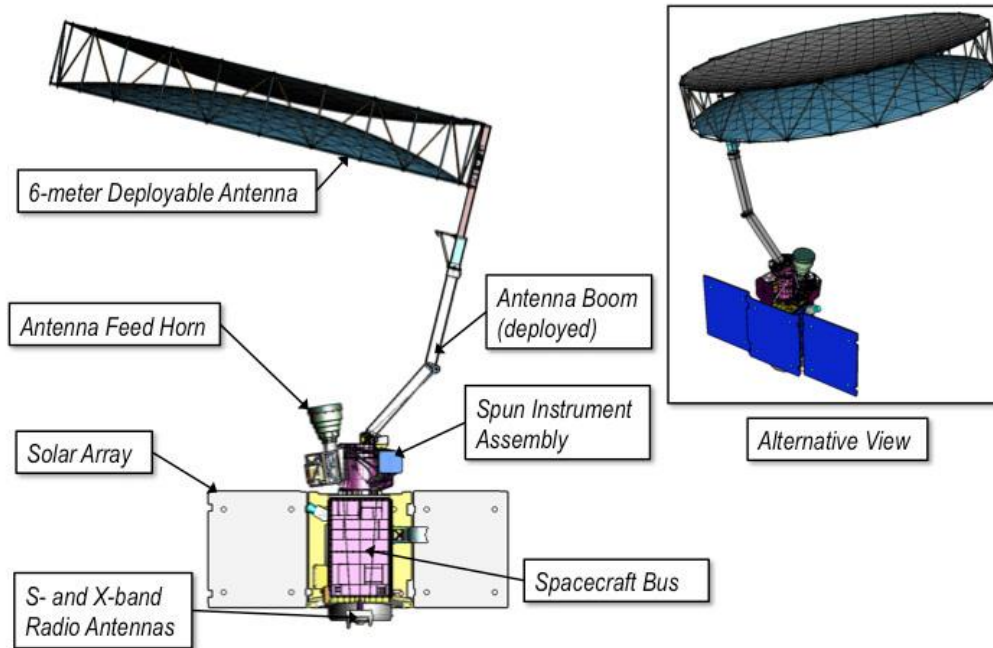
Soil Moisture Active Passive



Orbit Altitude: 685 km. Inclination: 98 deg.
Local ascending/descending time: 6 PM/AM.
8-day repeat orbit.

SMAP

Instrument



6-meter mesh antenna.

Conical scanning @ 14.6 rpm. Scan time: 4.1 sec

Earth Incidence Angle: 40°.

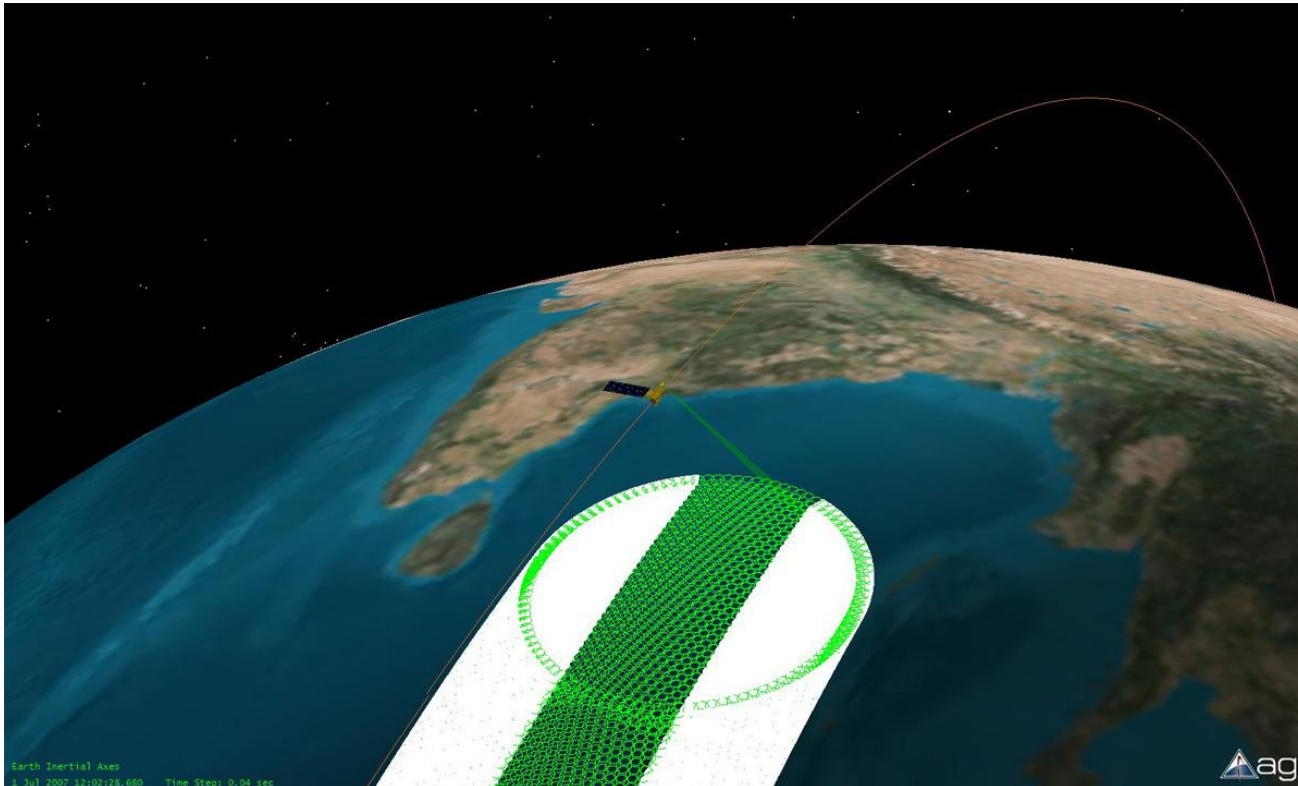
Radiometer: Center frequency: 1.41 GHz ~~+ Radar.~~

Taking observations since April 2015.



SMAP

Swath and Footprint

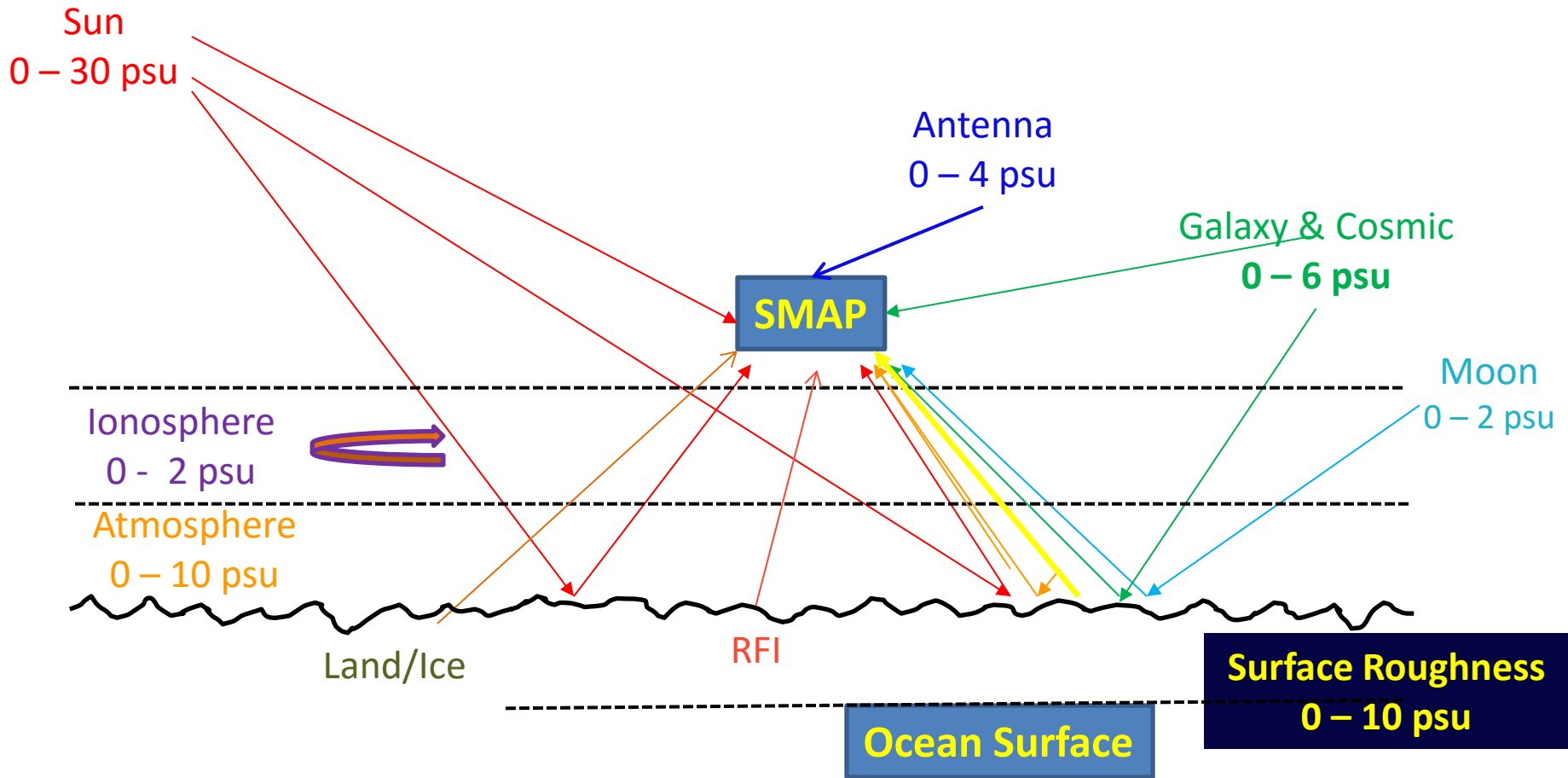


Full 360° scan views the Earth. 1000 km wide swath.
3-dB (half power) footprint size: 40 km.
Time for sampling 1 footprint: 17 msec.

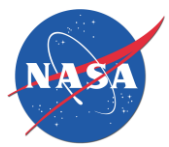


SMAP Salinity Retrieval Algorithm Challenge

Removal of Many Large Spurious Signals



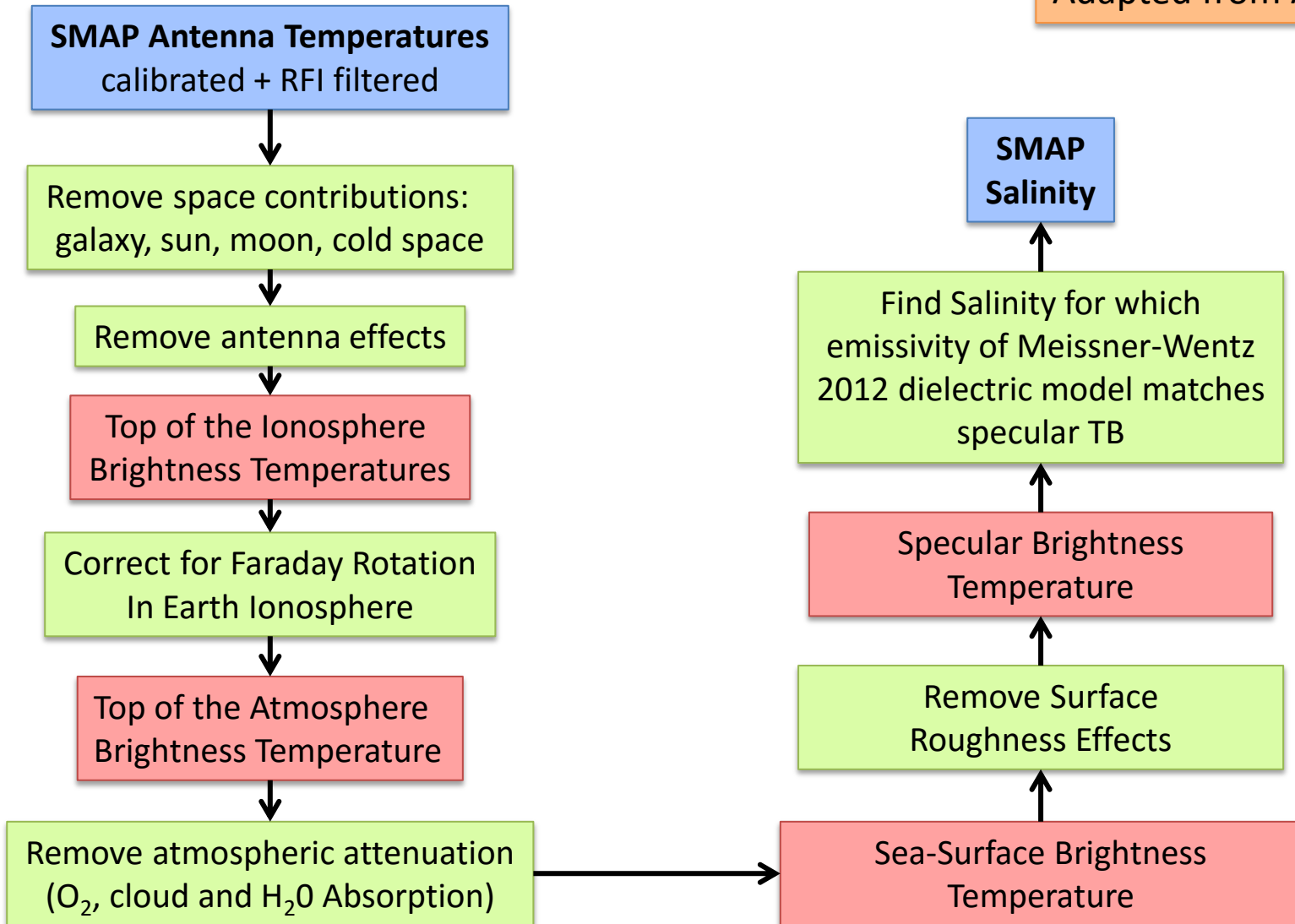
Needs to be done to 0.2 psu = 0.1 Kelvin accuracy



Level 2 Salinity Retrieval

Basic Steps

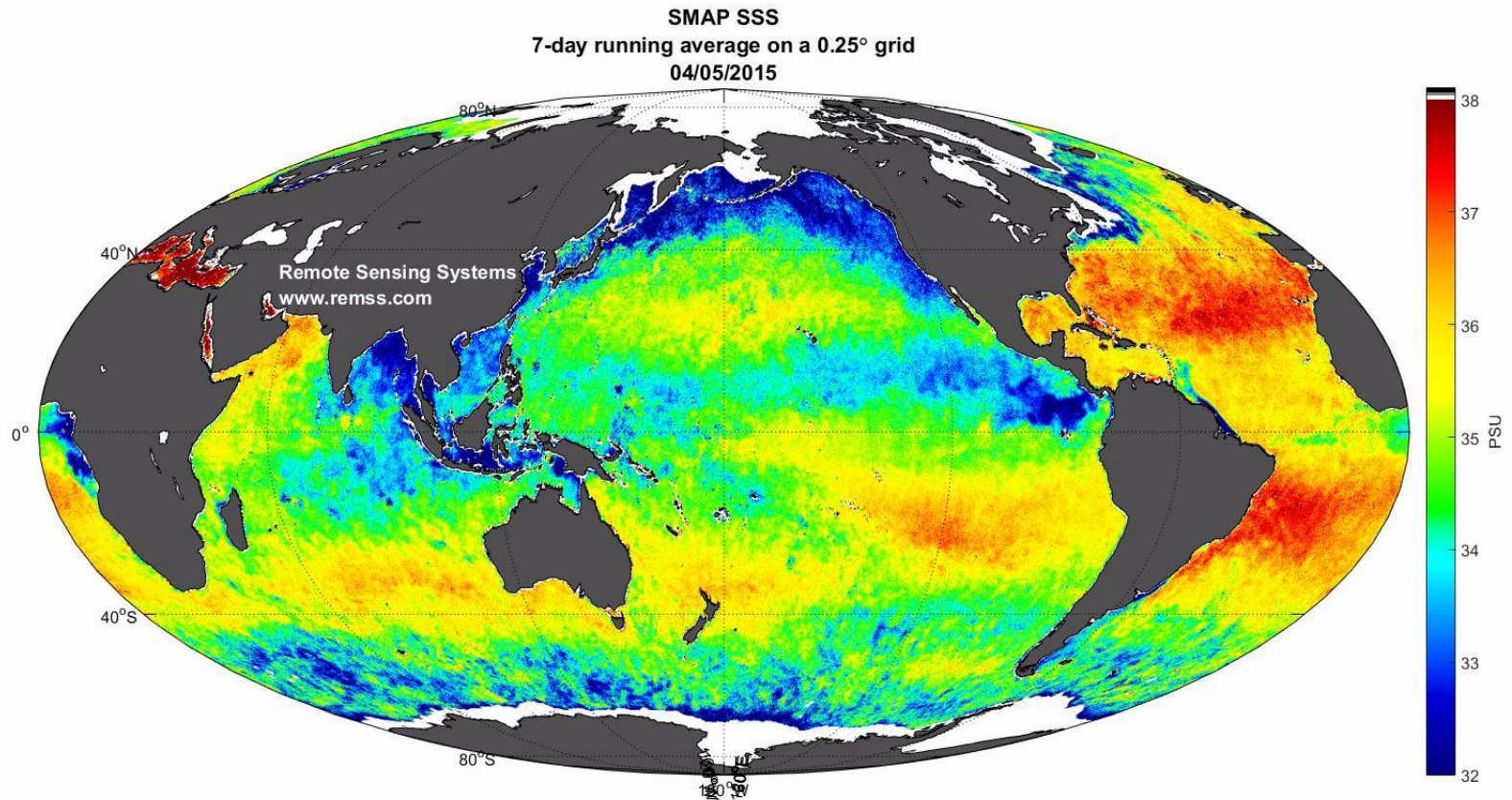
Adapted from Aquarius





SMAP Salinity

First Light Image: Running 8-day average

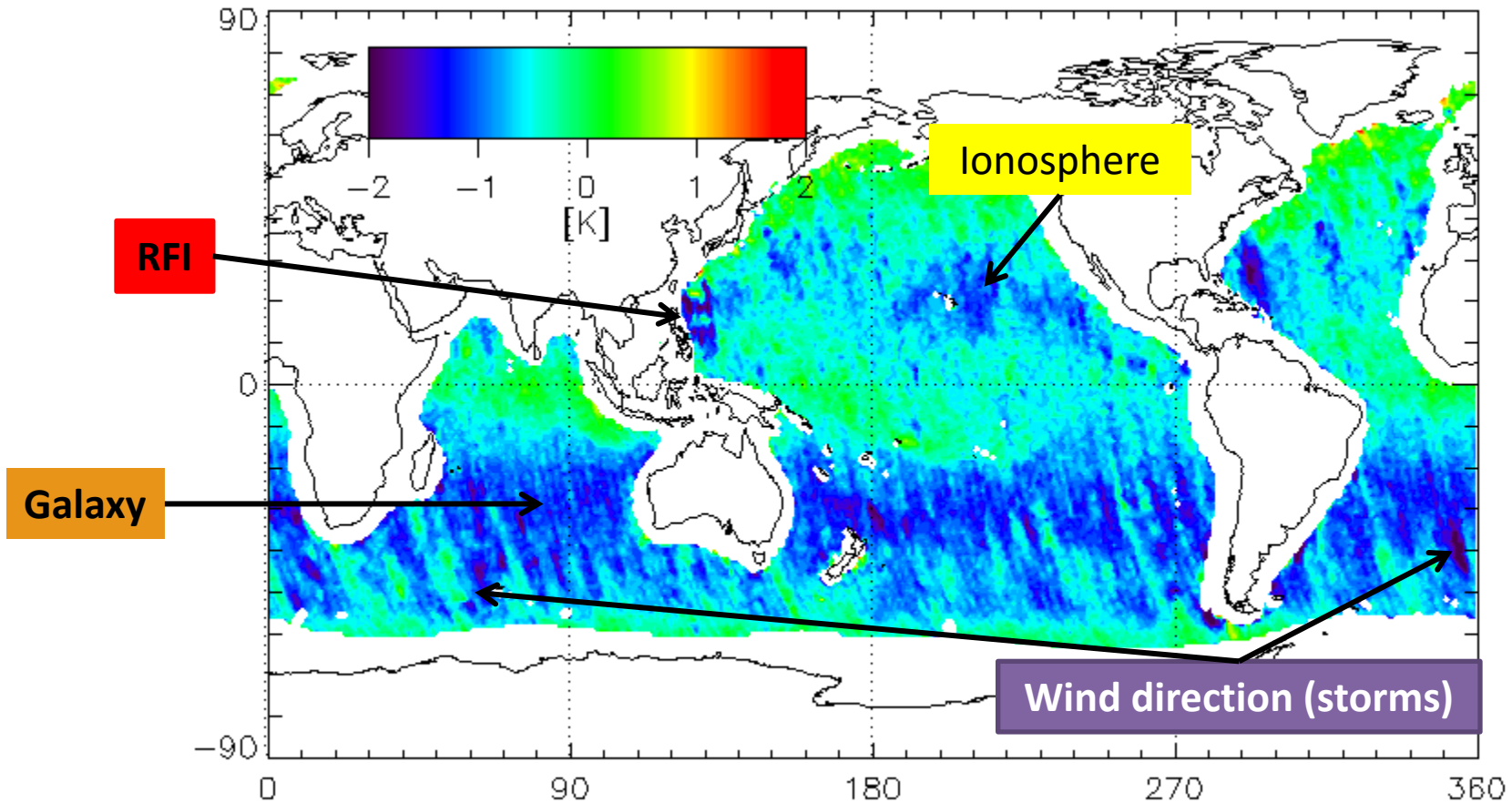




Forward – Backward Look

allows assessment of removal of spurious signals if they depend on looking direction without any external reference salinity field

for – aft asc TA orbit 02001 – 02120



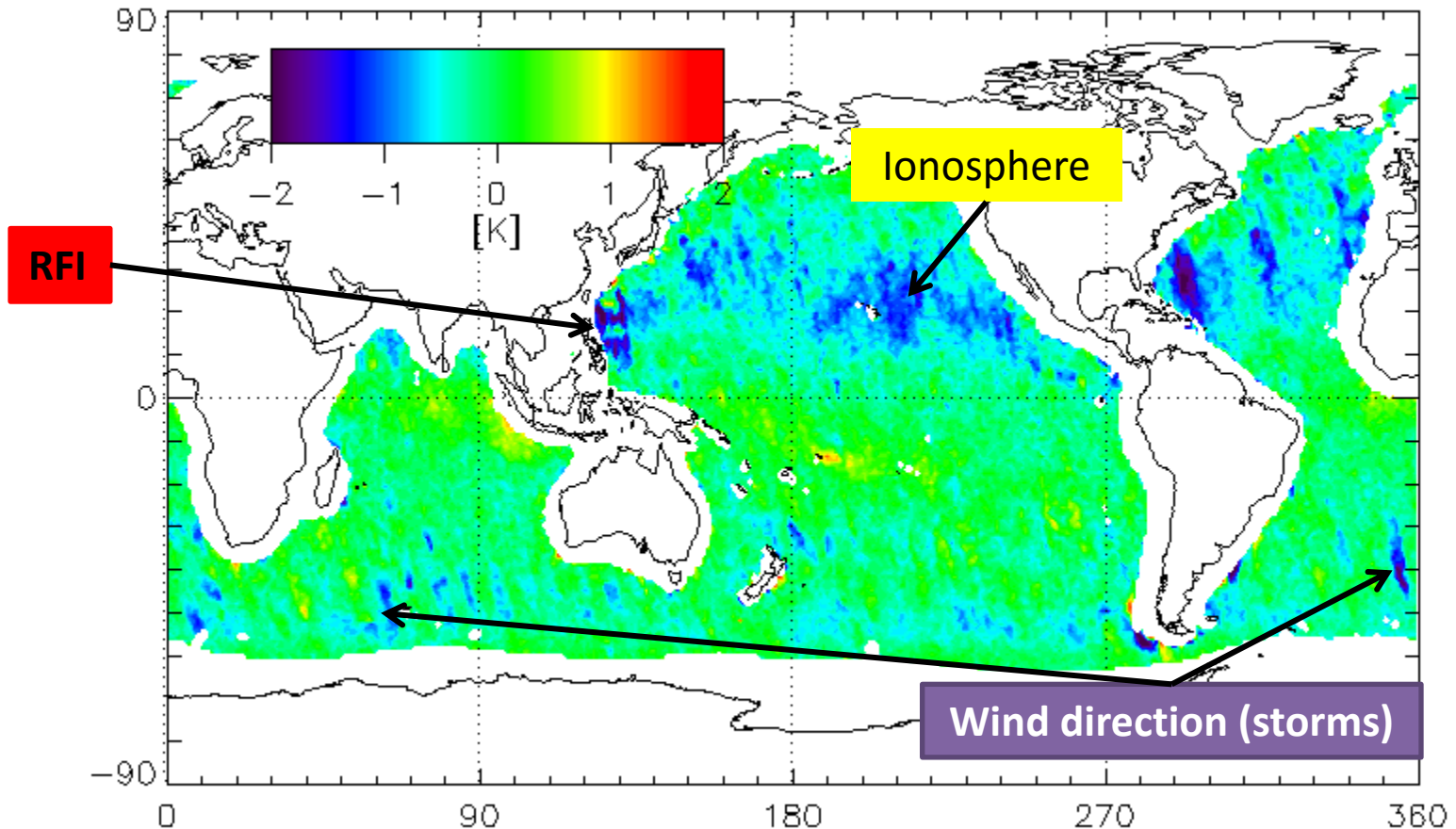
1 Kelvin = 2 psu



Forward – Backward Look

after removing galactic reflection

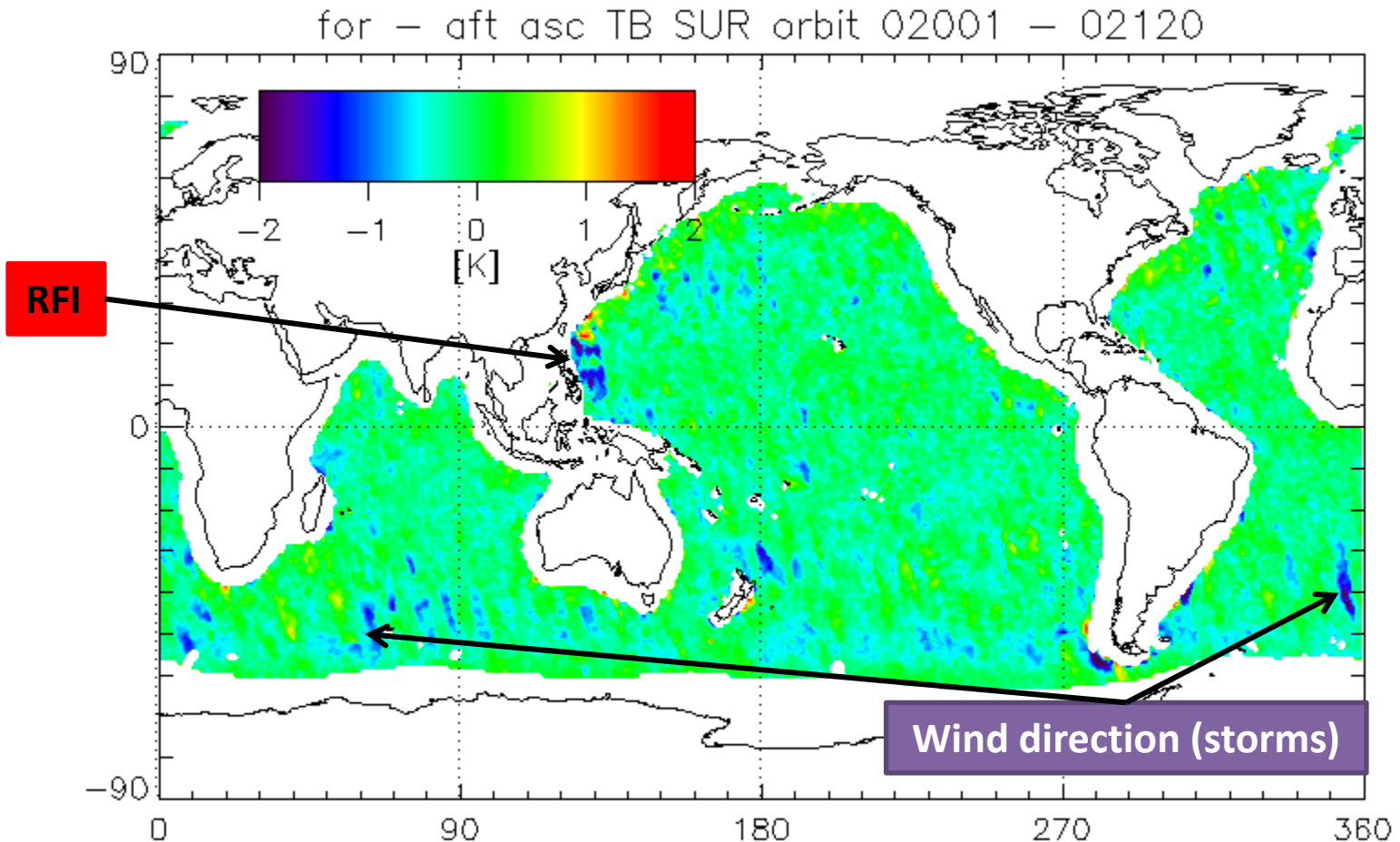
for – aft asc TB TOI orbit 02001 – 02120





Forward – Backward Look

after removing Faraday Rotation in Earth Ionosphere

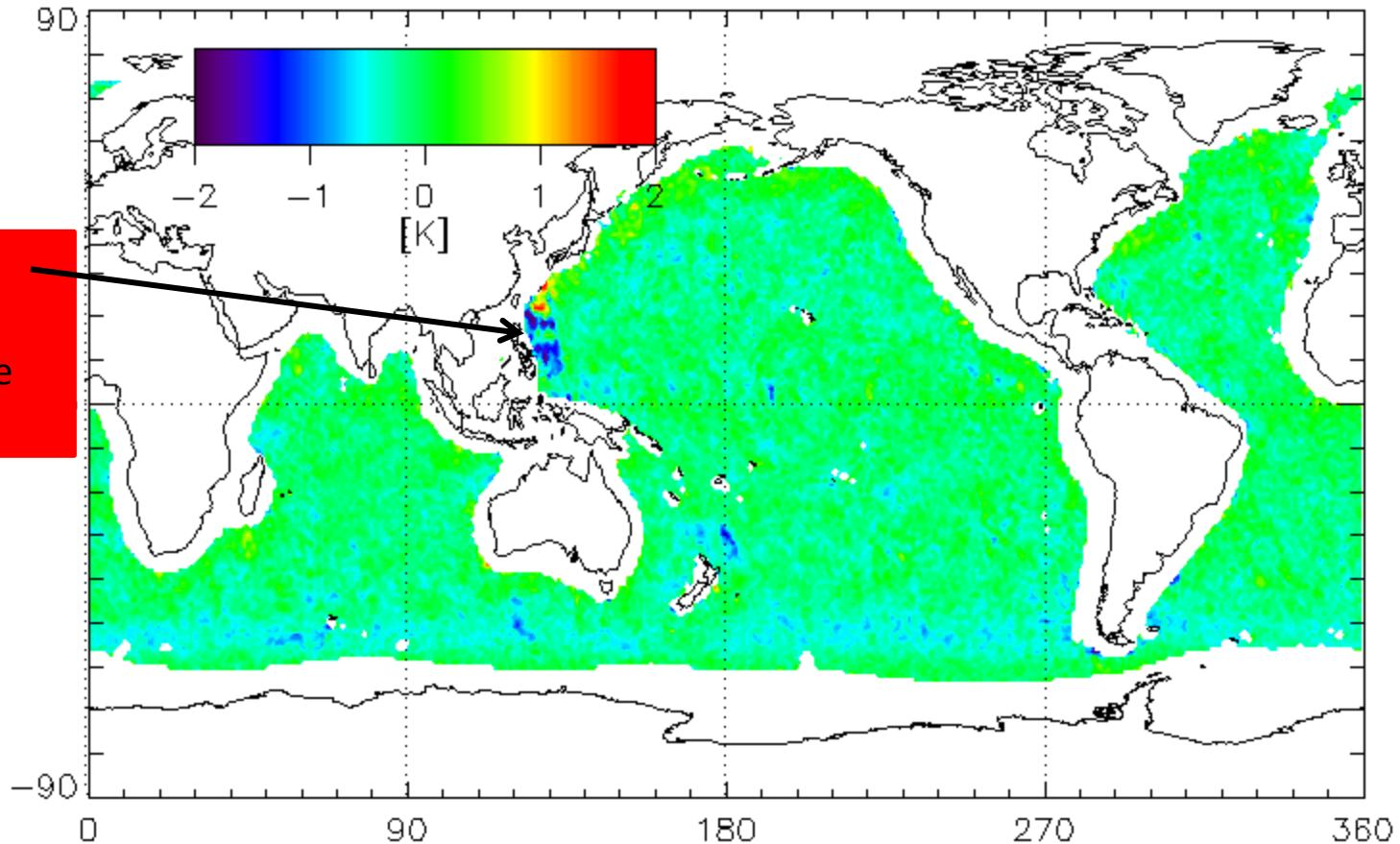




Forward – Backward Look

after removing wind direction component of surface emissivity

for – aft asc TB SUR0 orbit 02001 – 02120





Expected Accuracy + Performance

- SMAP resolution 40 km versus Aquarius 100 – 150 km.
 - We can expect to get closer to land with SMAP than with Aquarius.
- SMAP sampling time 17 msec versus Aquarius 1.44 sec.
 - Observation of single SMAP footprint (Level 2) about 9 times noisier than Aquarius.
 - SMAP Level 2 data accuracy is about 1.5 psu.
 - However the wide swath + 2-look allows sufficient samples so that at monthly averages can be beat down the **random noise** to the 0.2 psu level without compromising the resolution.
 - As with Aquarius the **driver in the performance** are the **systematic errors**.
- Calibration accuracy.
 - SMAP was solely designed for land applications (soil moisture, freeze-thaw state).
 - Radiometric accuracy requirement: **1.3 Kelvin**.
 - **To measure ocean salinity at 0.2 psu accuracy we need it accurate to 0.1 Kelvin.**
 - **There is a big additional calibration effort necessary in addition to what is provided by the SMAP radiometer team in order to achieve that level of calibration accuracy.**



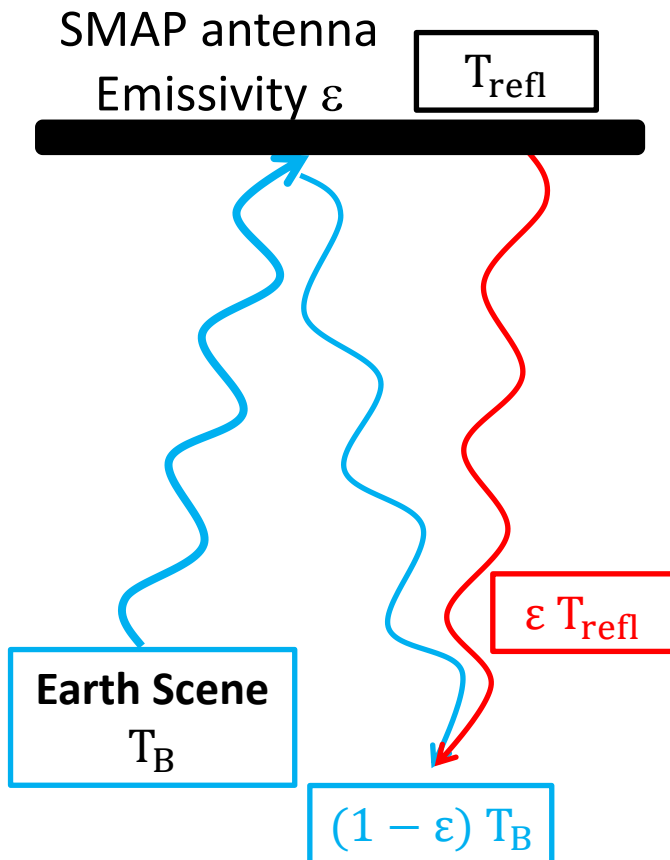
Problems + Concerns (1)

- **No Radar (correction for surface roughness)**
 - Use wind speeds from WindSat and SSMIS F17
 - Same ascending node time as SMAP (good overlap)
 - Unavailable in rain (use NCEP wind speeds).
- **Sun**
 - Aquarius was staring away from the sun. SMAP performs full scan.
 - SMAP sees sun reflection (glint) from the ocean surface
 - Can be large (exceeding 15 K = 30 psu)
 - Difficult to model
 - Solar radiation at L-band is strong and variable (1 Mio Kelvin)
 - Signal enters through sidelobes of the antenna.
 - Signal depends on surface roughness (not well modelled)
 - Approach: Flag out areas of potential strong signal (<10% lost data).

Problems + Concerns (2)

- **Reflector (Antenna)**

- The SMAP reflector mesh is lossy (emission) at L-band
- **Emissivity about 1%, which is 4 times larger than pre-launch value!**
- Antenna temperature (TA) dependent on its physical temperature T_{refl}
 - Large biases between the ascending and descending orbits (up to 1 psu).
 - During summer eclipse large spurious cold biases in the Southern Ocean (up to 2 psu).
- **No measurement of physical temperature of SMAP antenna**
 - Only thermal model data are available
 - Thermal model appears to be inaccurate when S/C goes into eclipse (50 K temperature change).





Status and Outlook

- Undergoing effort to track down and remove those spurious calibration biases.
- Planned data release: late 2015/early 2016.
 - Version 1.0.
 - Level 2 (swath data)
 - Level 3: temporal averages (weekly, monthly)
 - Both at 40 km resolution.
 - Available through PO.DAAC.
 - First limited release planned: NASA Ocean Salinity Science Team and, other interested researchers.