Aquarius Satellite Salinity Measurements

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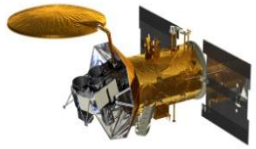
Post Launch Cal/Val team Lead
Jet Propulsion Laboratory
California Institute of Technology

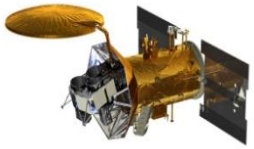
Aquarius/SACD Science Team Meeting
Buenos Aires
April 11-13, 2012

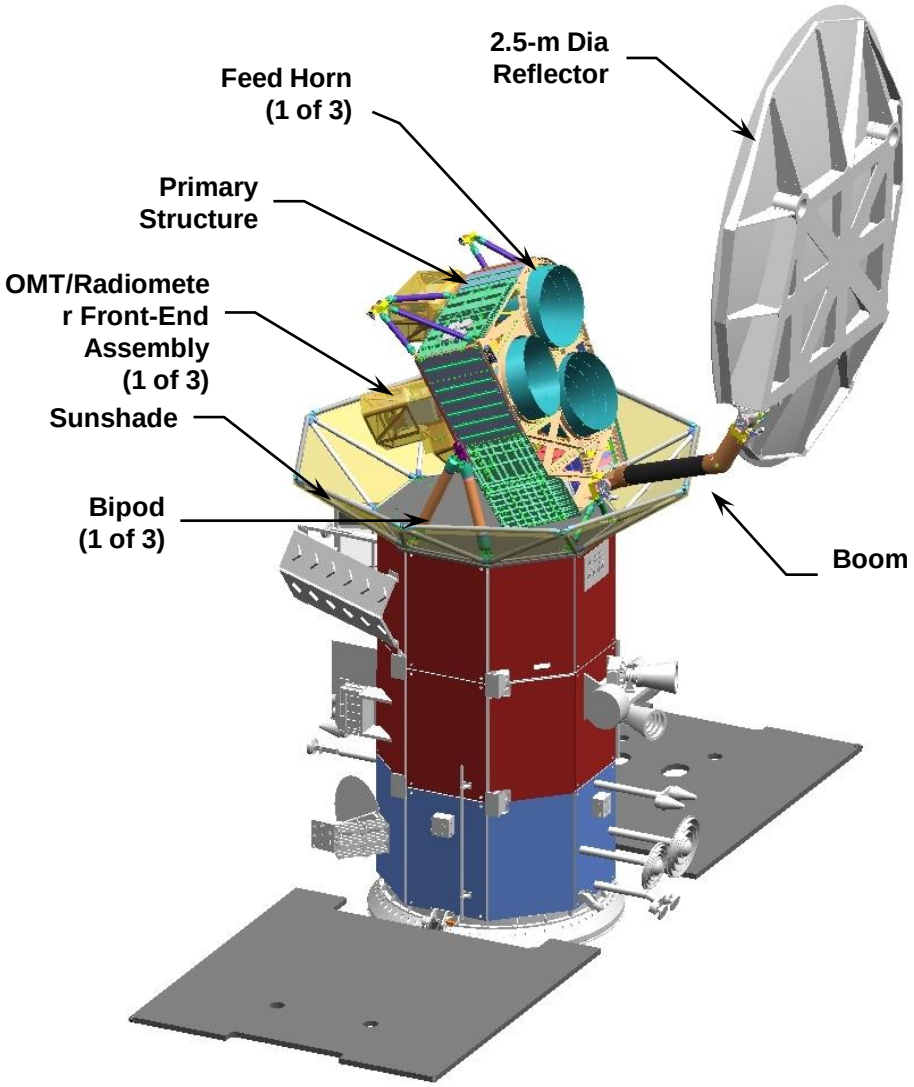
A Team Effort



- Gary Lagerloef (ESR)
- Hsun-Ying Kao (ESR)
- David Carey (ESR)
- David LeVine (GSFC)
- Jeff Piepmeier (GSFC)
- Emmanuel Dinnat (GSFC)
- Paolo de Matthaeis (GSFC)
- Liang Hong (GSFC)
- Cuneyt Utku (GSFC)
- Chris Ruf (U Mich)
- David Chen (U Mich)
- Doug Vandemark (UNH)
- Linwood Jones (UCF)
- Yazan Hejazin (UCF)
- Simon Yueh (JPL)
- Shannon Brown (JPL)
- Sid Misra (JPL)
- Greg Neumann (JPL)
- Adam Freedman (JPL)
- Alex Fore (JPL)
- Wendy Tang (JPL)
- Xiaolan Xu (JPL)
- Rajat Bindlish (USDA)
- Peter Hacker (NASA HQ)
- Yi Chao (RS Solutions)
- Frank Wentz (RSS)
- Kyle Hilburn (RSS)
- Thomas Meissner (RSS)
- Joel Scott (RSS)
- And others

Aquarius Instrument
Active-Passive L-Band Sensing





Aquarius (Sea Surface Salinity)

L-band radiometer and scatteroemter

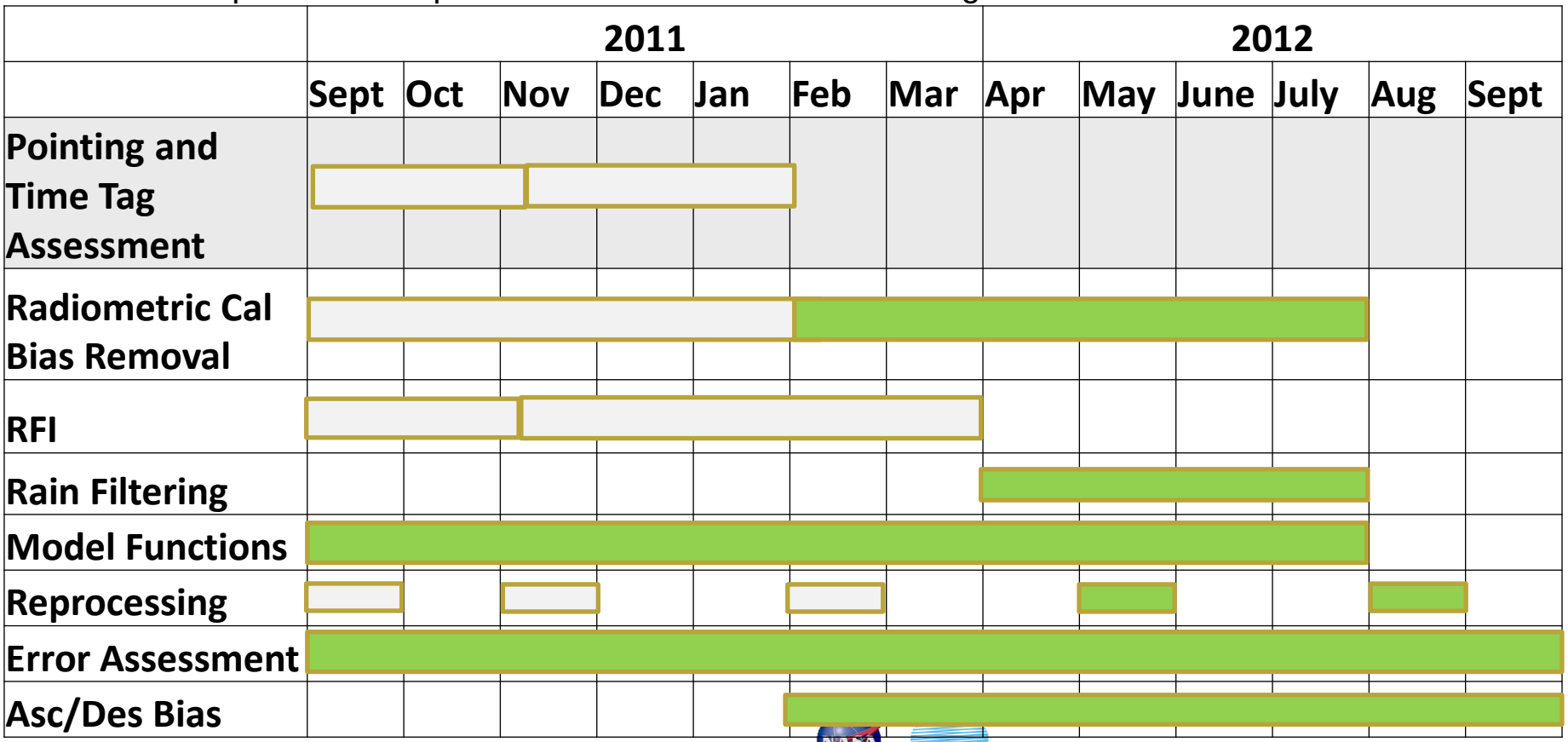
Push-broom (single look)

<0.1 K for radiometer

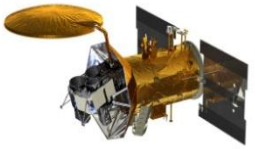
<0.1 dB for scatterometer

Current Schedule for Post Launch CAL/VAL

- Requirement: No later than twelve (12) months after the end of the IOC period, the Aquarius Project shall deliver the first release of data products (containing at least six (6) months of data) to a NASA Distributed Active Archive Center (DAAC).
- OOCO (IOC): Ends in November 2011
- Cal/Val phase begins at the end of OOCO with a duration of 12 months
- Milestones and meetings:
  - Cal/val meetings: November 2011, 26-28 March 2012
  - April 2012 – Aquarius/SACD science team meeting

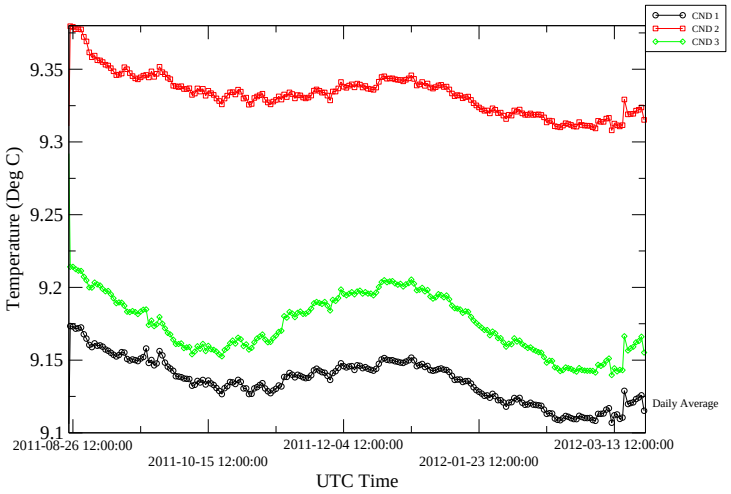


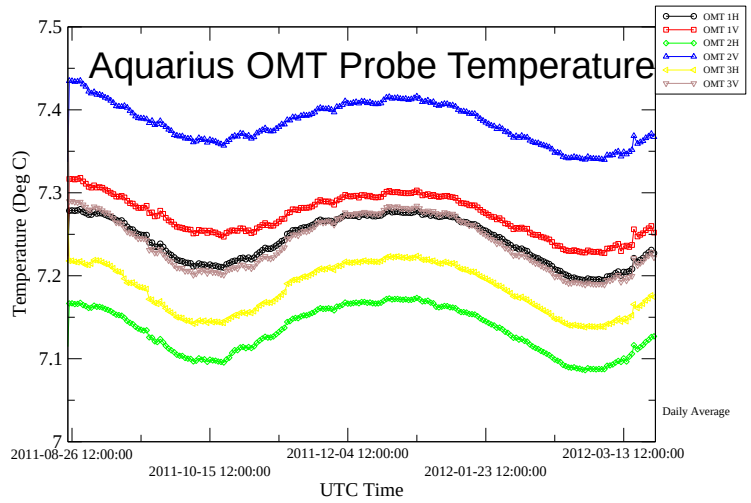
Excellent Thermal Control

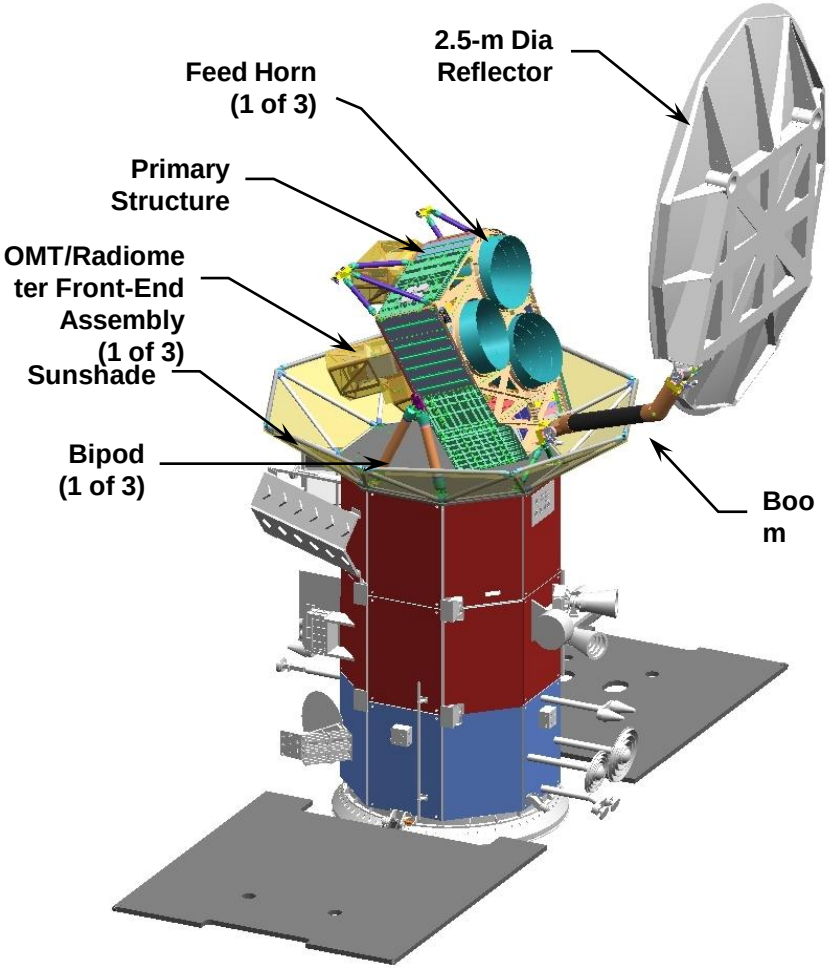


- The Aquarius electronics has been under excellent thermal control since turn on with the temperatures of front end within +/- 0.1 deg C.

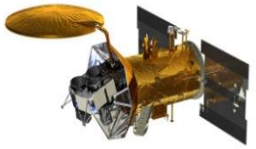
Aquarius CND Temperature



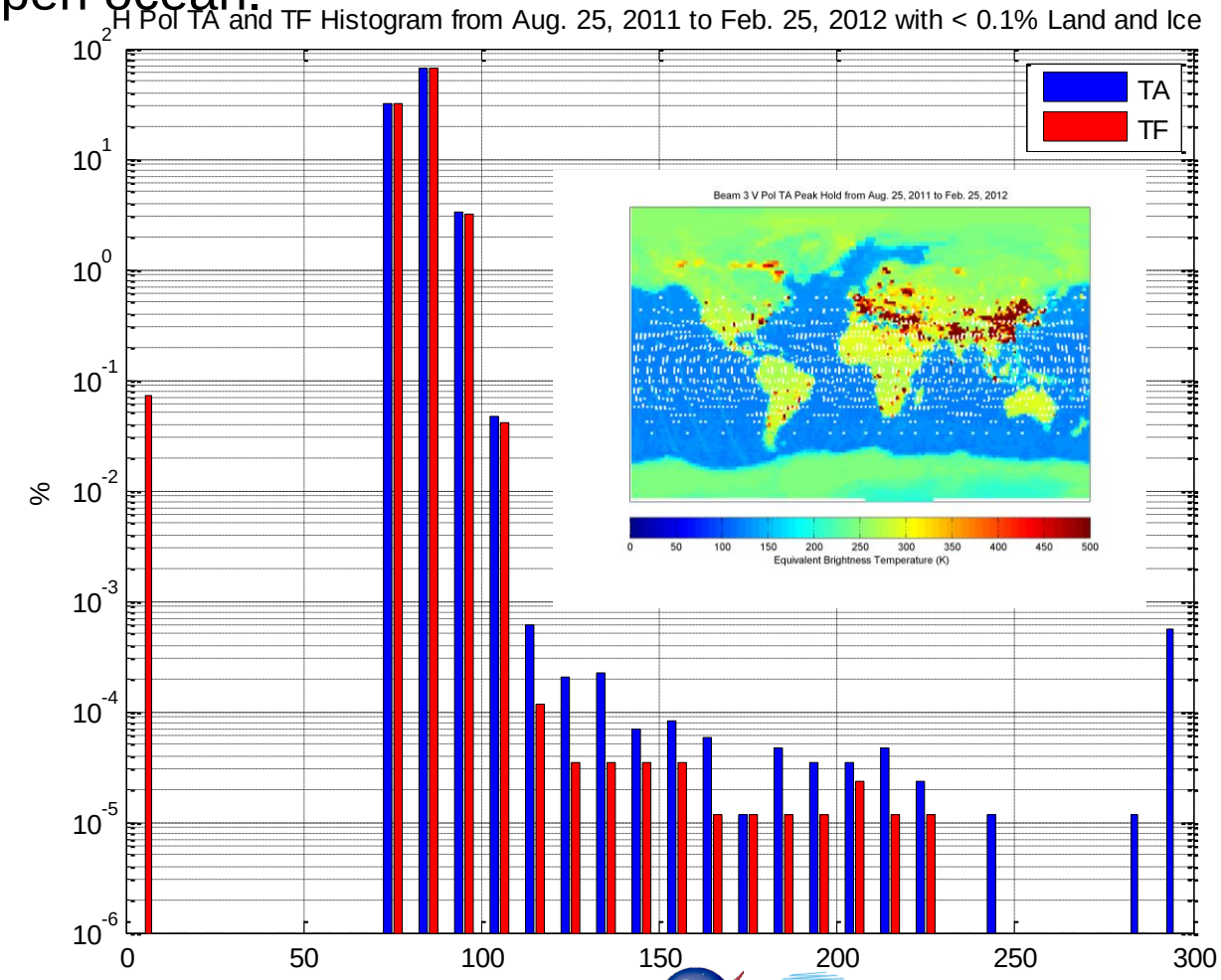




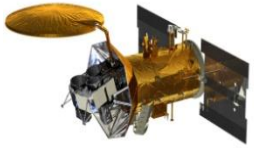
Radiometer Frequency Interference Mitigation



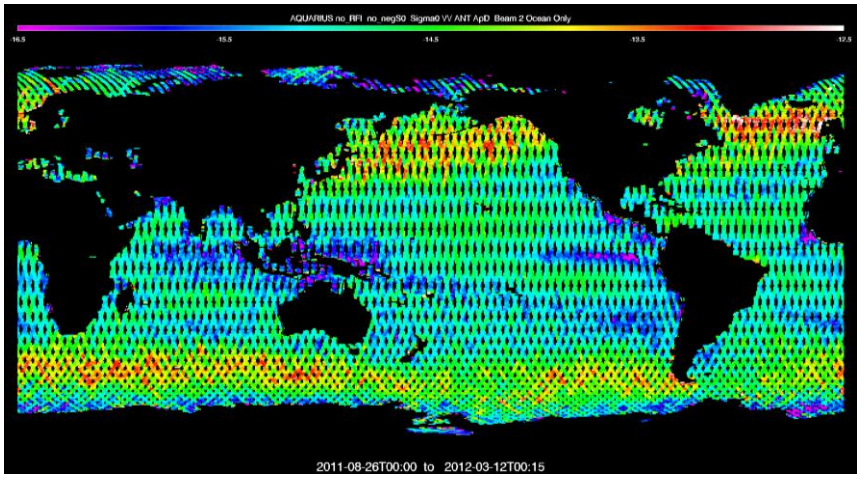
- Built-in high data sampling rate with short accumulation and software threshold adjustment allow effective removal of most RFI over open ocean.



Scatterometer Calibration

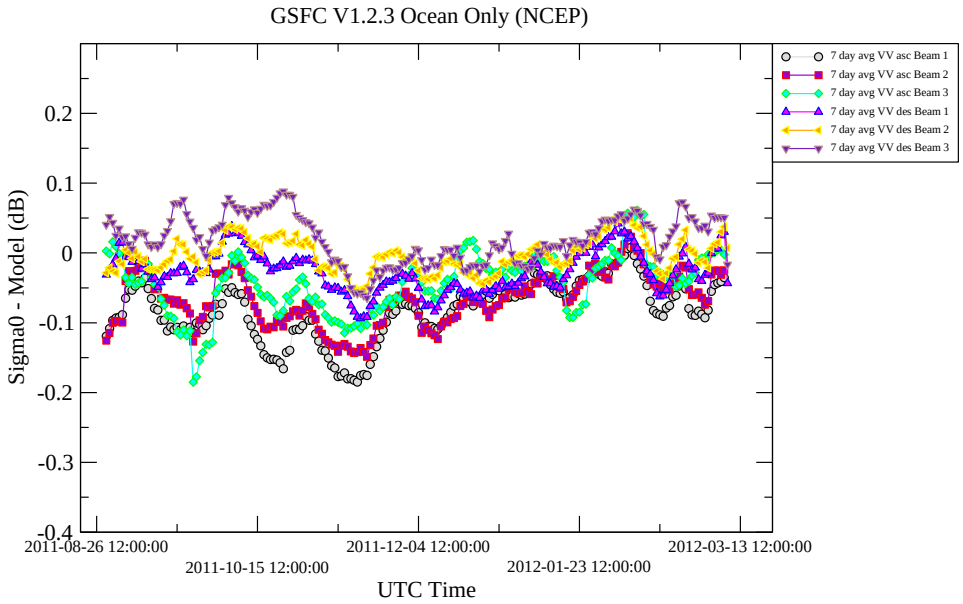


- Scatterometer calibration stability has been within 0.1 dB since turn on.

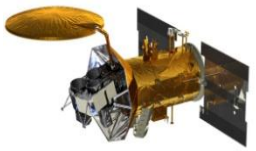


Sigma0 indicates the wind velocity variation oceans (e.g., Beam 2 VV)

The differences of measured and model Sigma0 have been within 0.1 dB
There is a small ascending and descending difference, which seems to be converging.



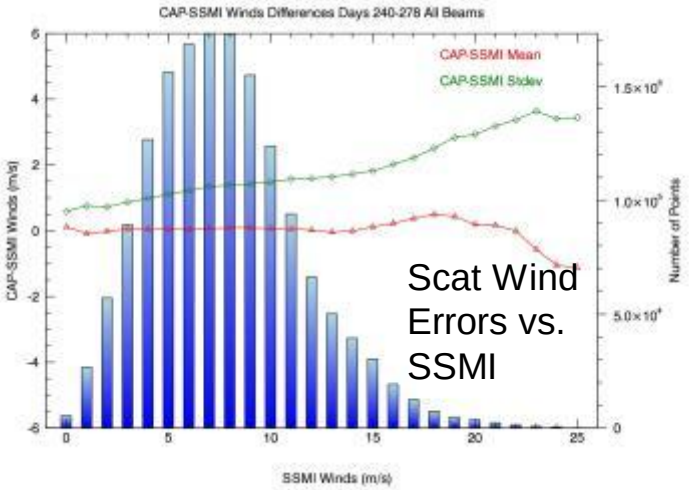
Aquarius Scatterometer Wind has excellent accuracy



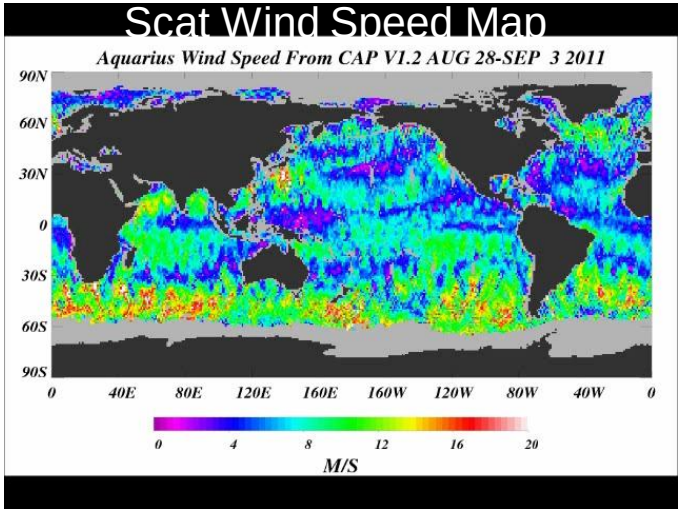
- Minimize cost function in salinity (SSS), wind speed, direction given Aquarius radiometer and scatterometer data (Yueh and Chaubell, TGRS, April 2012)

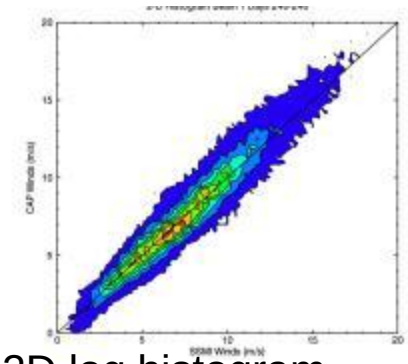
$$F_{pol}(SSS,W,\phi)=\frac{(I-I_m)^2}{2\Delta T^2}+\frac{(\sqrt{Q^2+U^2}-\sqrt{Q_m^2+U_m^2})^2}{2\Delta T^2}+\frac{(\sigma_{0VV}-\sigma_{0VVm})^2}{(k_p\sigma_{0VV})^2}+\frac{(\sigma_{0HH}-\sigma_{0HHm})^2}{(k_p\sigma_{0HH})^2}$$

- Standard deviation of scat speed – SSMI speed < 2 for all speeds less than 15 m/s

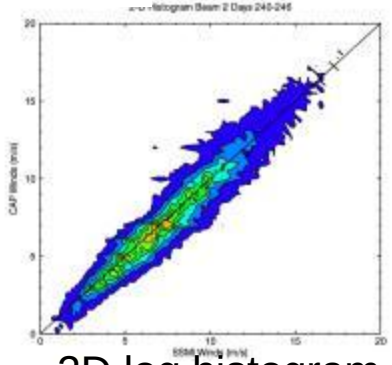


Scat Wind Errors vs. SSMI

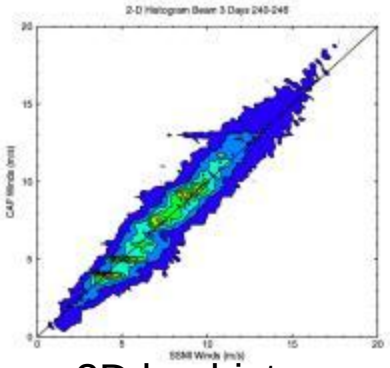




2D log histogram

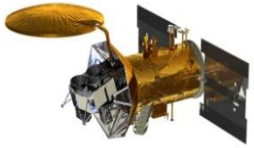


2D log histogram

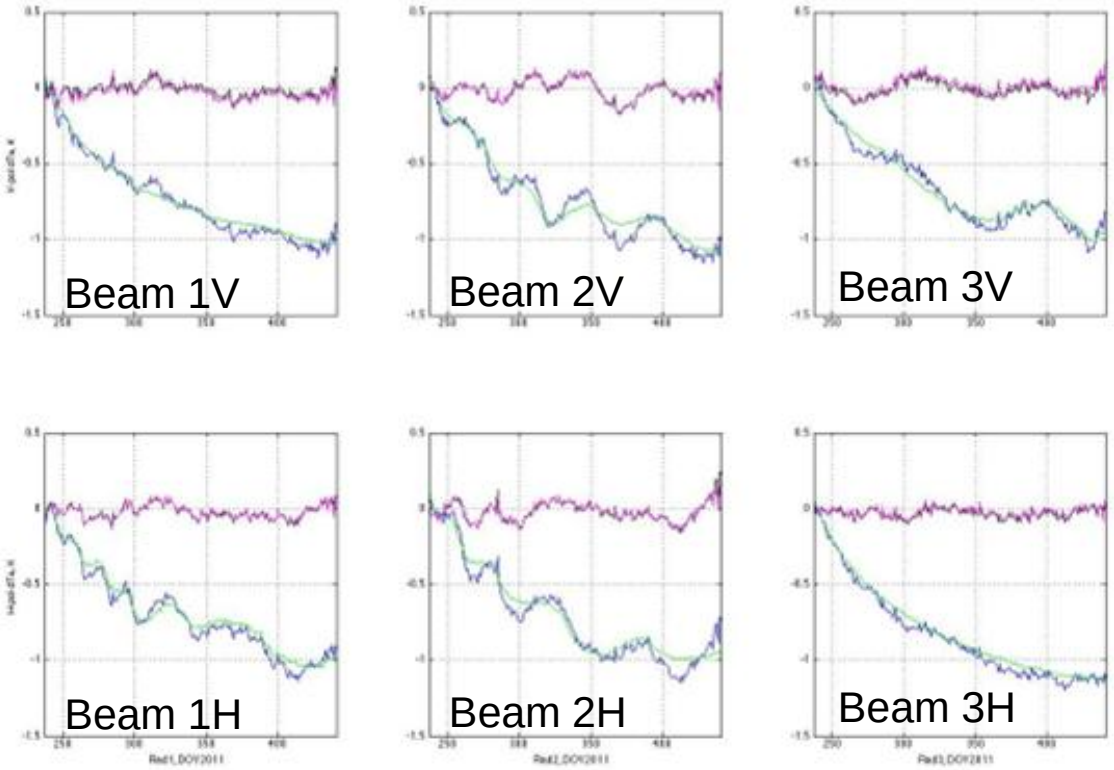


2D log histogram

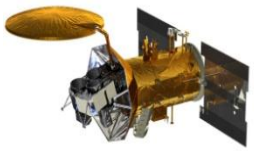
Radiometer Calibration

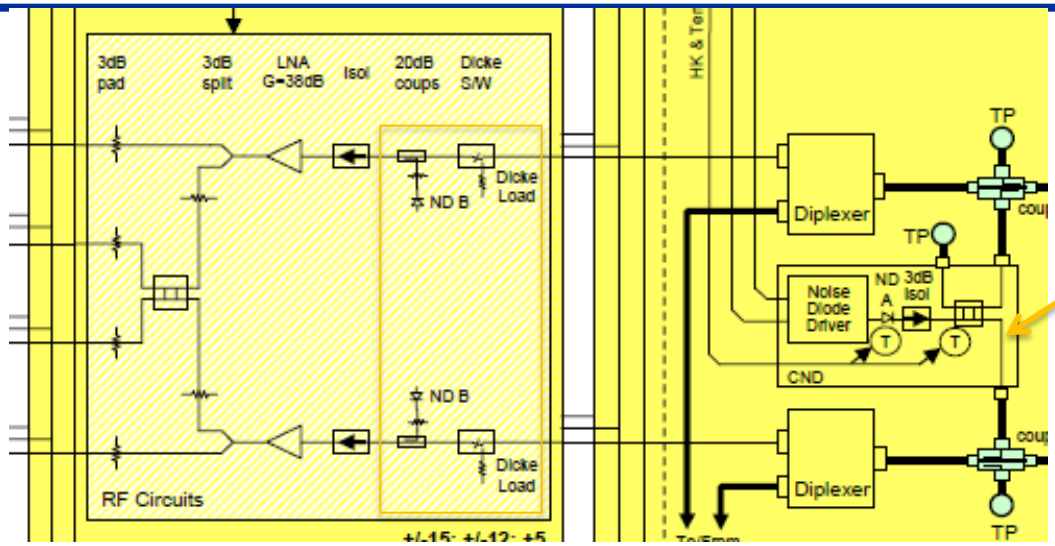


- Radiometer calibration has been meeting the requirement with under 0.13 K changes in 7 days.
- A slow secular calibration drift in all channels detected by two techniques developed by the cal/val team prior to launch: vicarious calibration technique and modeled-measured TB.



Radiometer Calibration Counts and Ratios



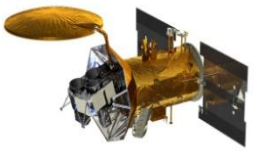


- Five calibration states:
  - Antenna only (globally avg'd)
  - Reference only (Dicke load)
  - Reference + ND
  - *Antenna + ND*
  - *Antenna + CND*

Piepmeier, Microrad 2012

- ND Deflections
  - ND(R) = (Ref+ND)-(Ref)
  - ND(A) = (Ant+ND)-(Ant)
  - CND = (Ant+CND)-(Ant)
- Deflection ratios
  - Unitless
  - Remove downstream systematics

Aquarius Radiometer Deflection Ratio Features

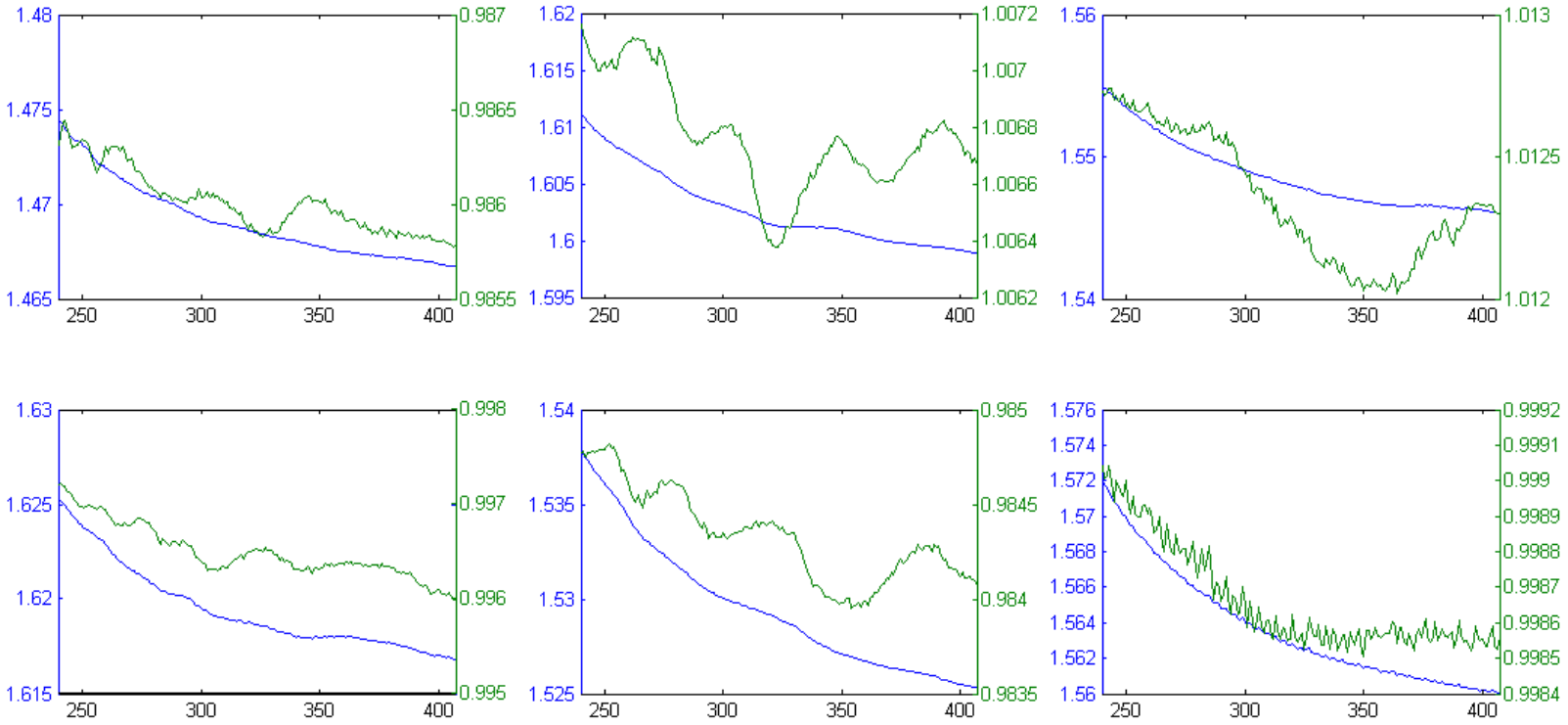


Blue = ND(R)/CND

Green = ND(A)/ND(R)

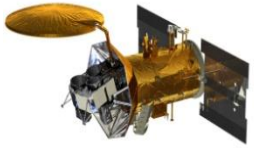
Four features:

1. Monotonic component (~0.5% to 1%)
2. Small variations
3. Variations (0.0005)
4. Monotonic component (0.0005 to 0.001)

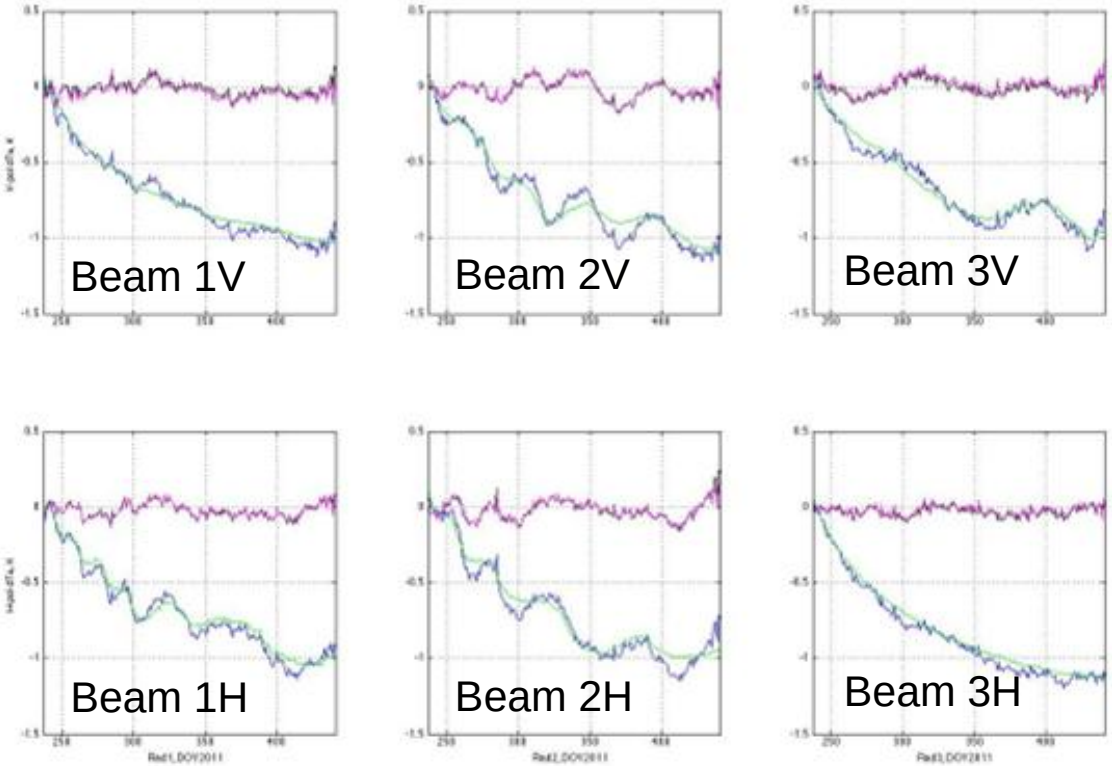


Piepmeier, 2012

Radiometer Calibration

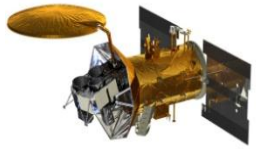


- Instrument-based Deflection Ratio technique is effective in removing the slow calibration drift (blue curves) – the residual effect (red curves) is under 0.2 psu
- Root causes are being assessed to improve the calibration accuracy.
- May exercise the vicarious calibration technique to remove the residual drift

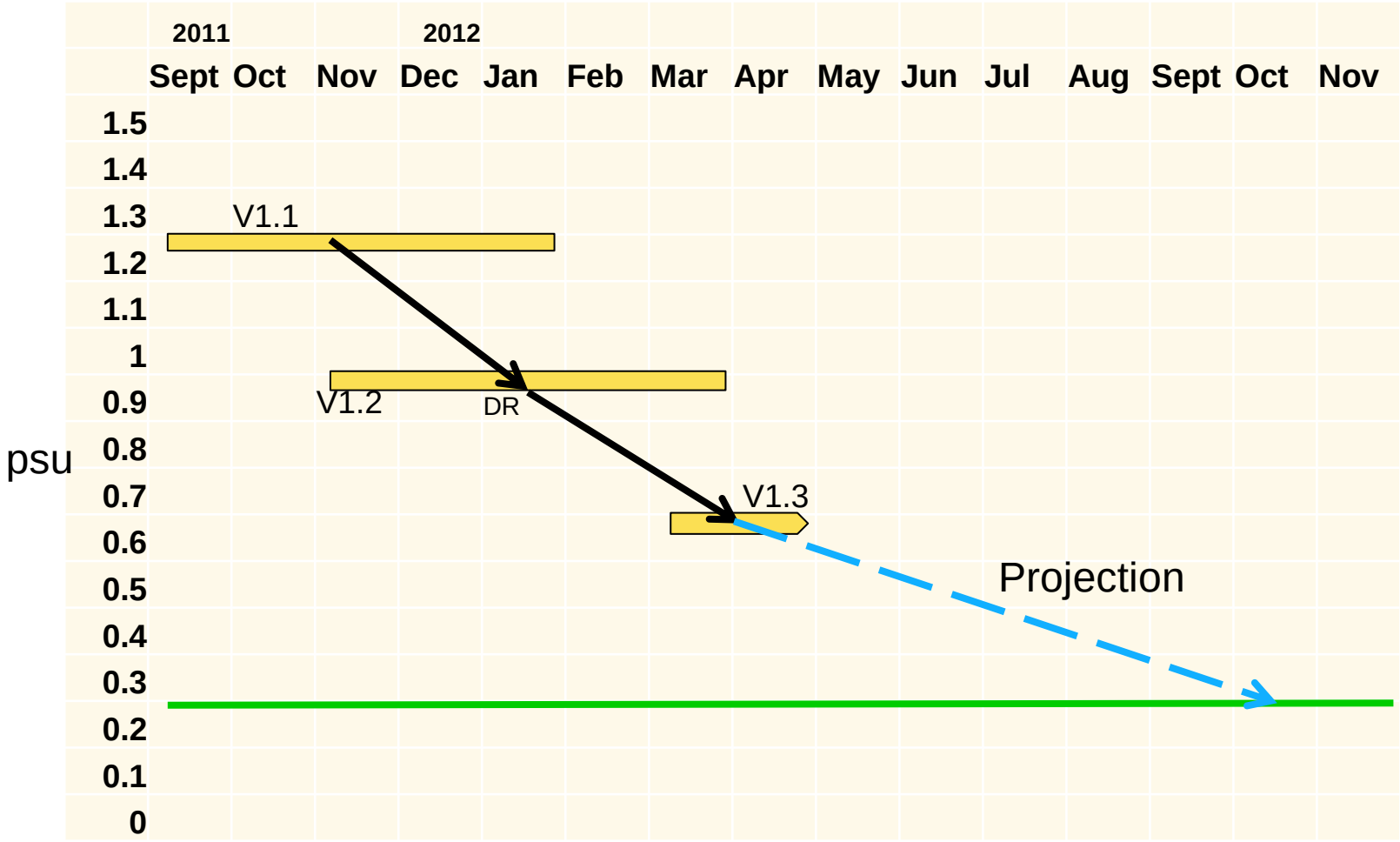


Piepmeier, 2012

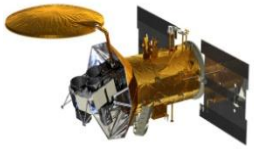
Improving Accuracy



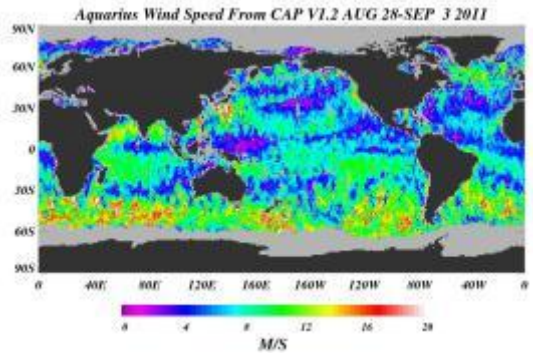
- Accuracy is rapidly improving since the start of mission
  - Detailed assessment by Kao and Lagerloef on day 2



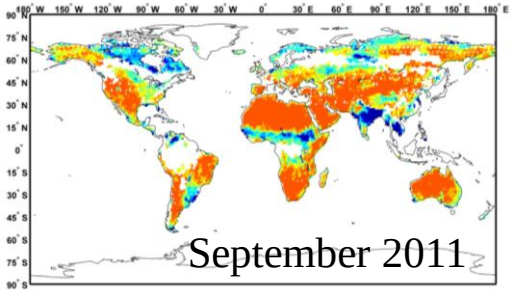
Emerging New Products



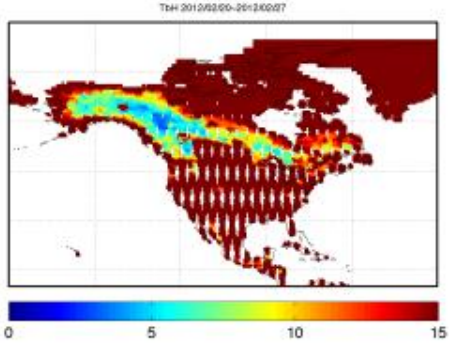
- Features of Aquarius enable the development of several emerging new products – most are going through calibration and validation



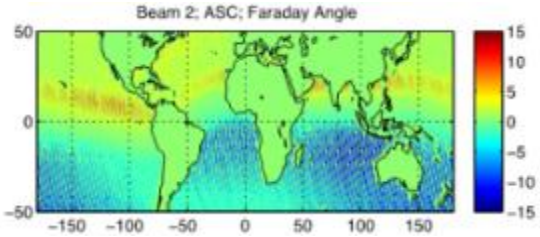
Ocean Surface Wind (Yueh et al.)



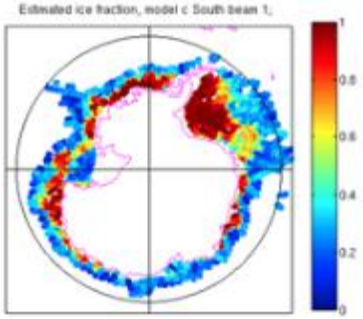
Soil Moisture (Jackson and Bindlish)



Land Surface Freeze/Thaw (Xu et al.)

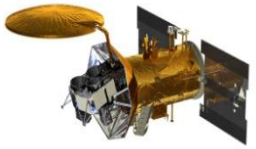


Faraday Rotation Angle (Ionospheric Electron Content)



Polar sea ice fraction (Freedman)

Summary of Current Cal/Val Assessment



- Aquarius instrument has been performing exceptionally well
- On-orbit thermal control meets the design requirement (0.1 deg c stability)
- Scatterometer calibration has been very stable
  - Small residual ascending and descending bias is being examined
- Radiometer calibration meets the calibration requirement (0.13K within 7 days).
  - Vicarious calibration and instrument-based calibration techniques are available to correct the observed calibration drift
  - Being also investigated is a small ascending-descending bias
- There will be many other new science products.
- **Aquarius surface salinity accuracy has been rapidly improving although there are a few challenges ahead for cal/val.**