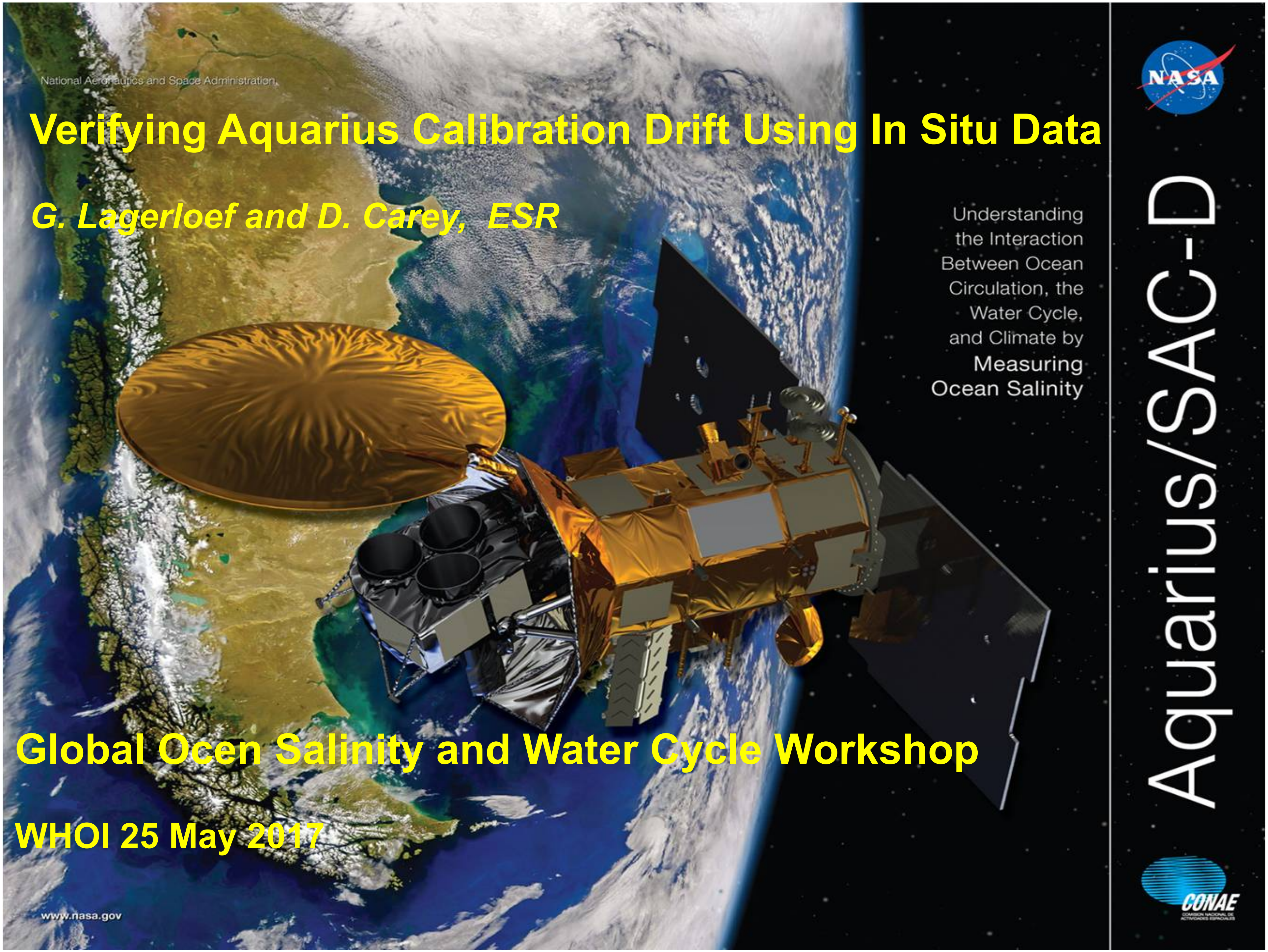
Verifying Aquarius Calibration Drift Using In Situ Data

G. Lagerloef and D. Carey, ESR



Global Ocen Salinity and Water Cycle Workshop

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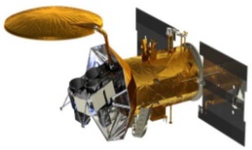
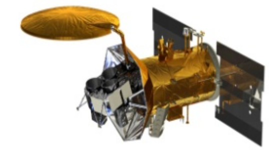


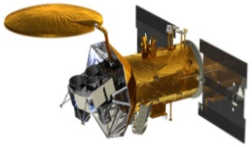
First, I will finish the summary of Monday's presentation

Aquarius Mission Status



- Mission failure on June 7, 2015 due to spacecraft power supply electronics. Full mission data record 3 years & 9 months (Sep 2011 through May 2015).
- Data release (V4.0) for Prime Mission was released June 2015 (monthly global rms error is 0.17).
- NASA Phase F (Mission Closeout) began October 2015.
- *Final Project-generated data version (V5.0) will be to improve the accuracy and quality as far as we are able with our present knowledge and experience. RMS ~0.1*
- *Release date: mid-late 2017.*
- *Legacy data set. Cornerstone for a satellite salinity climate data record.*

Schedule



- June 2017: Release V4.6 (V5.0 testbed)
- Jun-Sep: OSST evaluation and analysis
- 18-20 Sep 2017:   OSST Workshop, Washington DC
- Oct 2017: V5.0 Release
- Dec 2017:   Aquarius Project ends.

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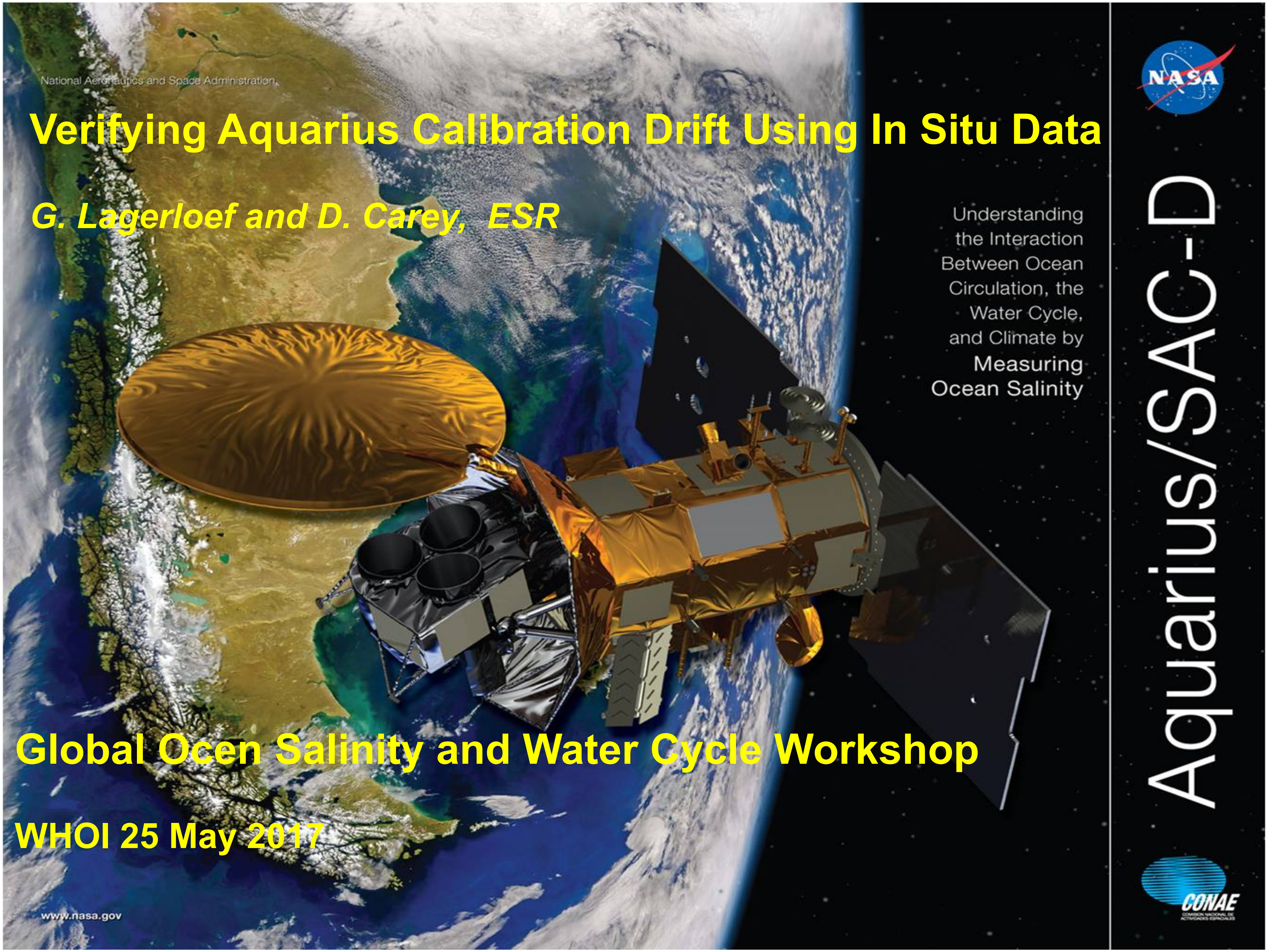

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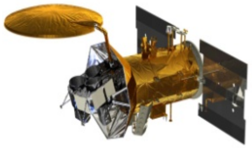
Motivation



- To study seasonal to interannual variations in Aquarius data, are there calibration variations to worry about? How to verify?

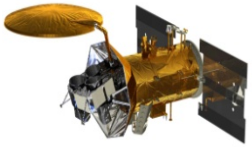
Aquarius calibration approach

- Ocean Target calibration: Use the global ocean mean SSS as a calibration target. HYCOM output used as salinity reference
  - HYCOM has some abrupt changes (model updates).
  - HYCOM SSS is restored to historical climatology to control model drifts. This may imprint that climatology on the sensor calibration, and thus on the Aquarius SSS data.

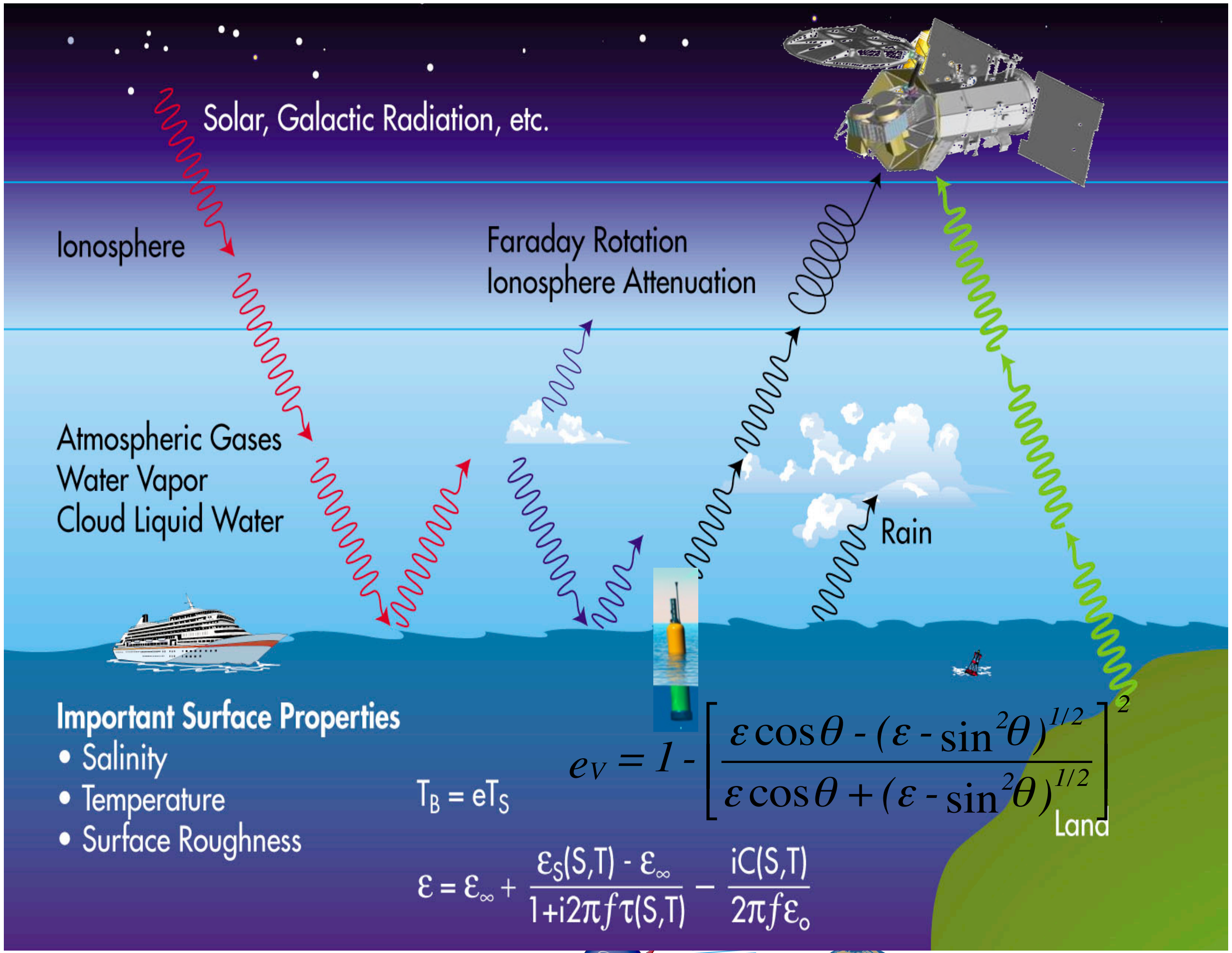
- For Aquarius V5, we are replacing HYCOM with an OI Argo SSS field (SIO).

- <u>Problem:</u> Calculate calibration drifts using co-located in situ observations (Argo) for verification.

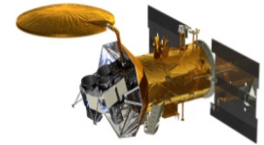
AQUARIUS/SAC-D Steps in Science Retrieval



In addition to the surface ‘flat sea’ emission, we must account for corrections due to the sky, atmosphere, ionosphere, land and ice, and <u>especially surface roughness</u>.



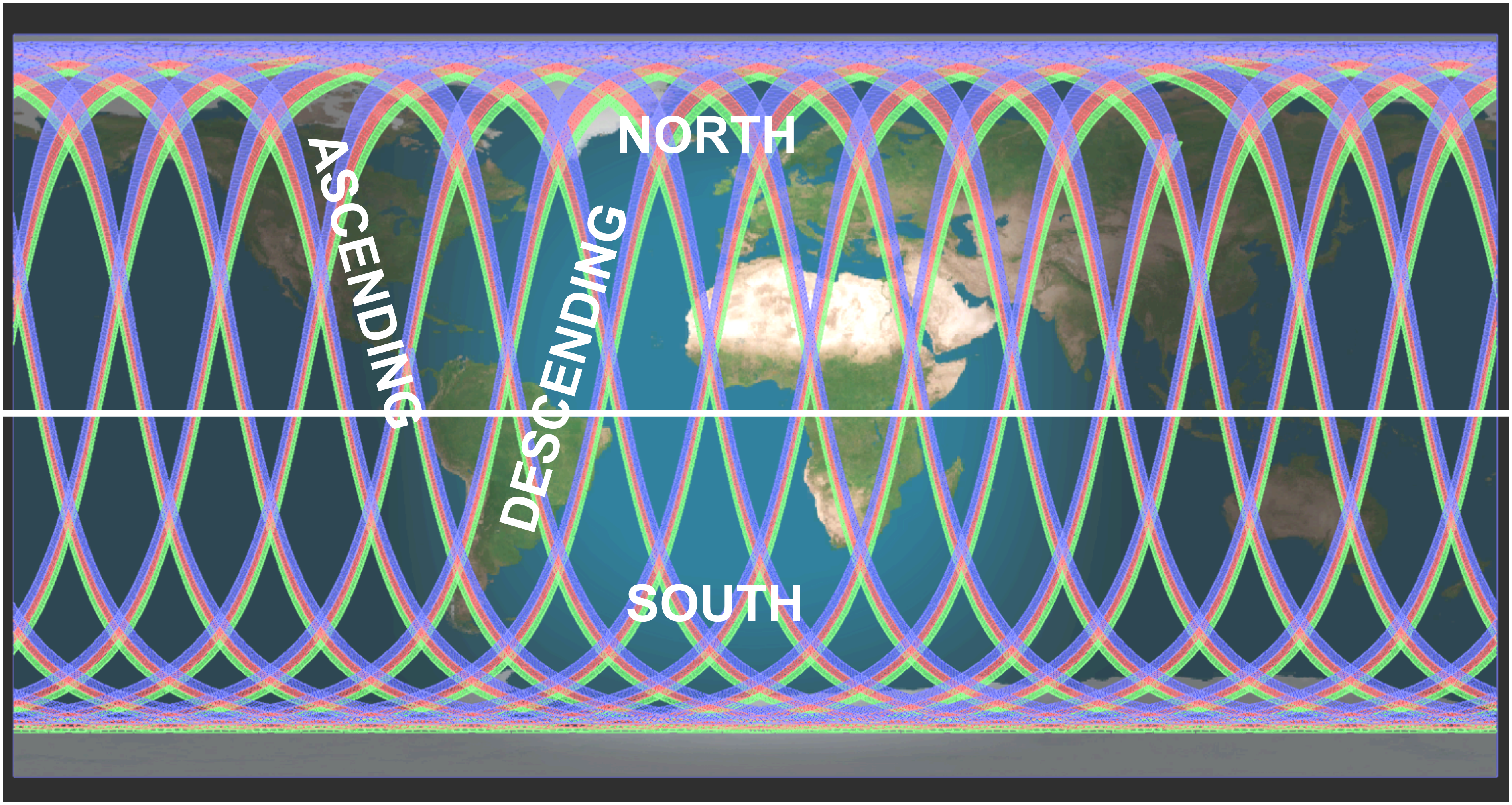
Statement of the Problem



- Aquarius calibration has been done by estimating the radiometer brightness temperature (Tb) estimated from the geophysical models and and a reference salinity field (usually HYCOM) and using that to adjust the radiometer calibration for each radiometer (1, 2, 3) and each polarization (V, H). *[Ocean target approach]*
- To understand the calibration drifts, we must separate the sensor error from the geophysical model errors.
  - dTb = Aquarius Tb – Validation Tb (Argo floats)
  - dTb = Geophysical errors (dTg) + Calibration error (dTc)
- Assumption: The calibration error we wish to quantify is long term calibration drift of the sensor (>> 1 week).
- Problems with HYCOM are (1) model changes, and (2) adjustment to historical climatology. We are now testing an Argo OA field from SIO for V5.0 as a more reliable reference salinity.

Sampling Regimes

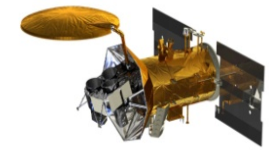
N, S, A, D

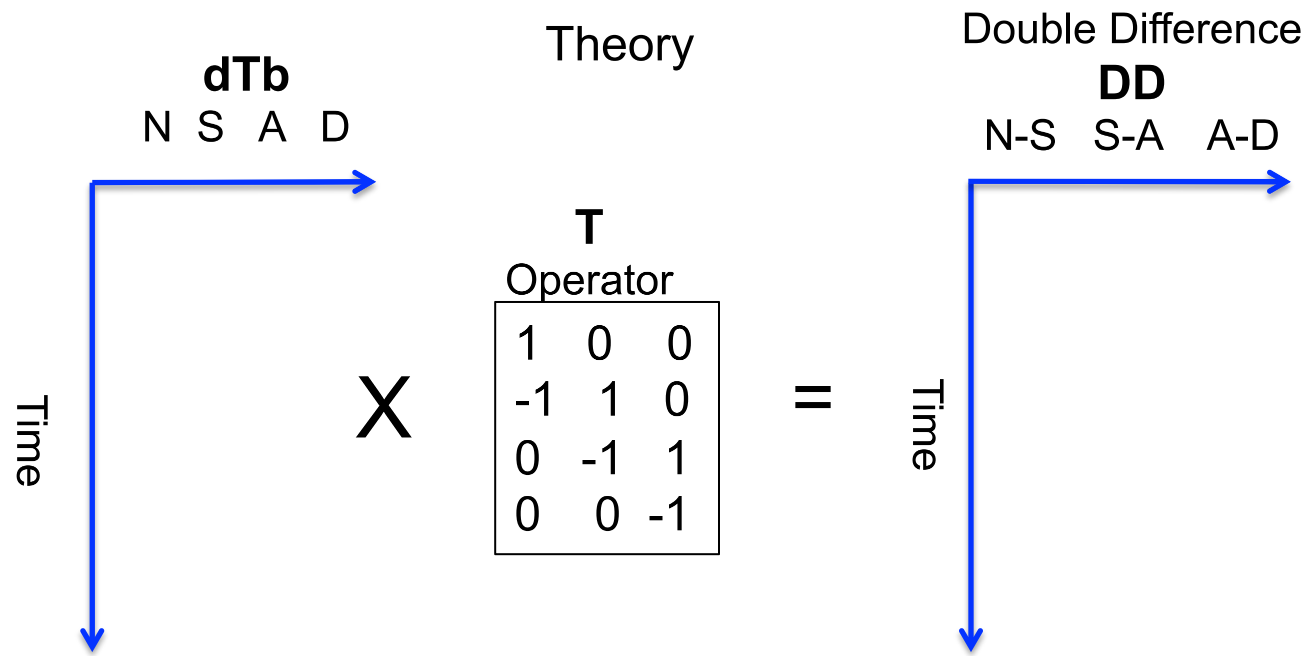


Input Data Processing

- Aquarius Level 2 – AVDS colocation (matchup) processing
- Daily accumulation files, including only data that meets Aquarius L2 calibration flag criteria.
- AVDS SSS and ancSST converted to TH & TV (M&W dielectric model)
- Difference these from Aquarius L2 (rad_TbX_rc (where X = {V, H} polarizations))
  - Compute dTb = Aq_Tb – AVDS_Tb
  - Compile daily mean (dTb) within each zone and beam number; 43 month record of daily values.
- 7-day median filter

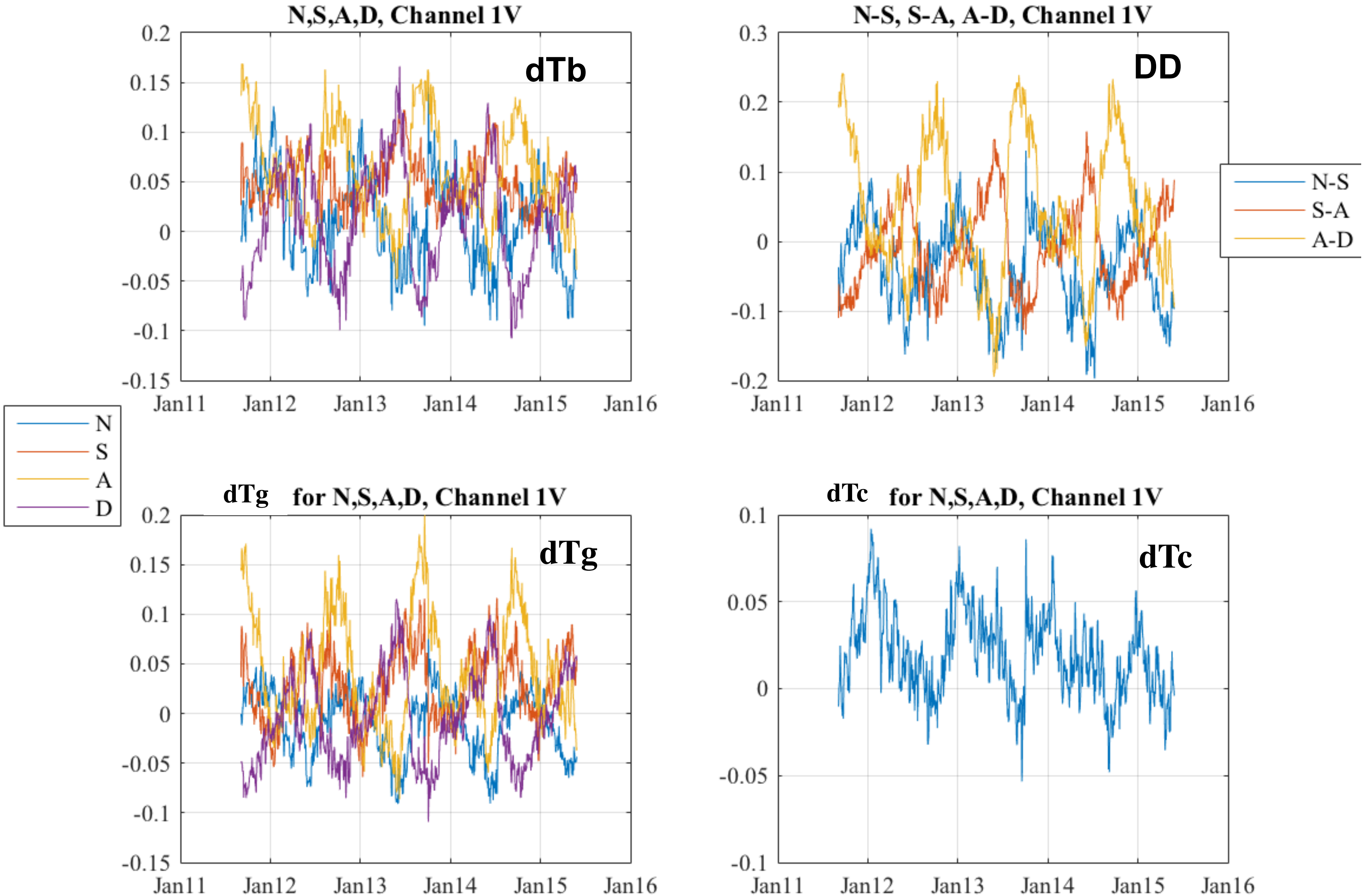
Matrix manipulation





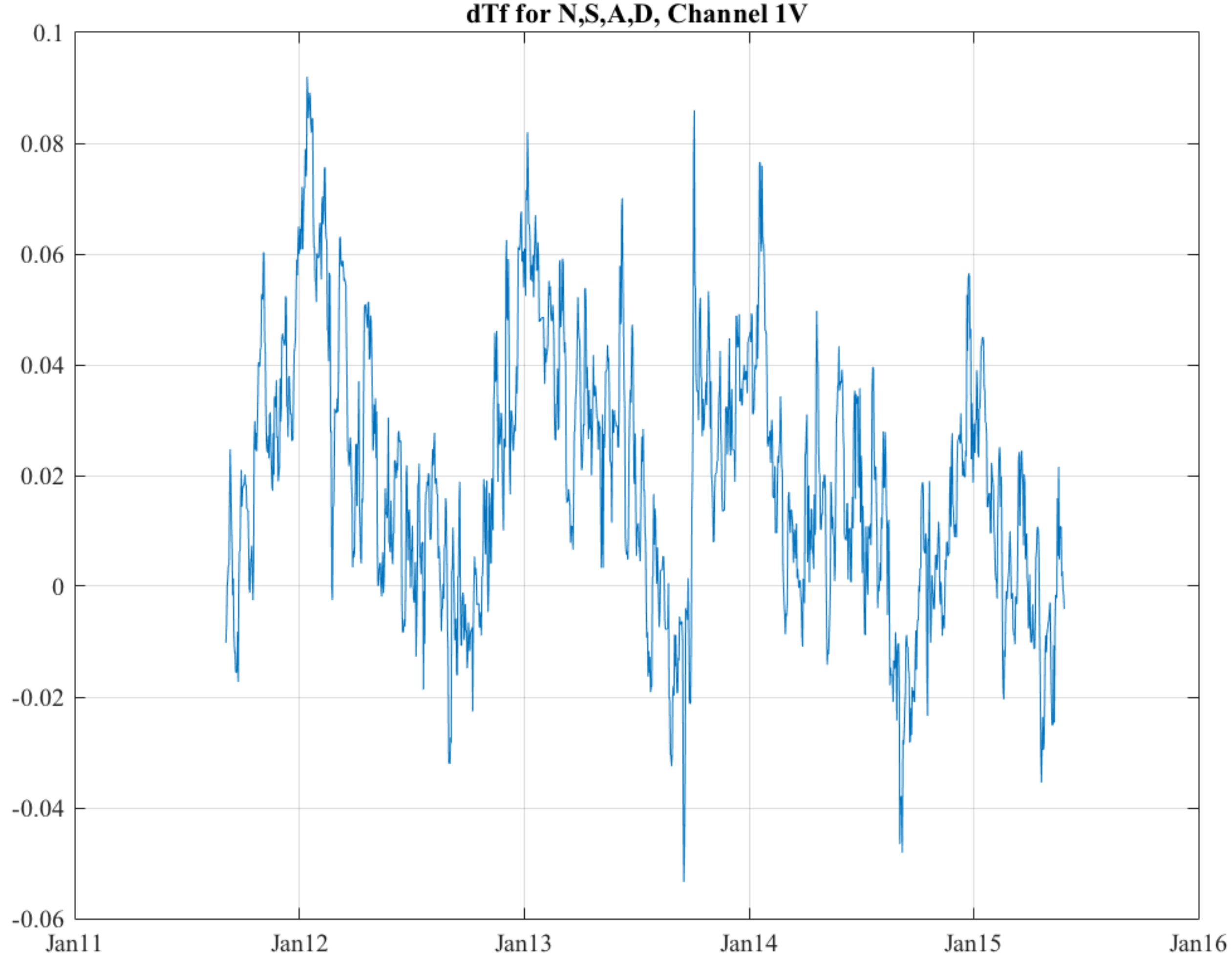
1. Operator: dTb x T = DD
2. Regression: R = DD\dTb
3. Inverse: dTb_r = DD*R Expected to contain geophysical model error (dTe) but not instrument error (dTc)
4. **dTb – dTb_r = dTc**
5. **dTg = dTb_r**

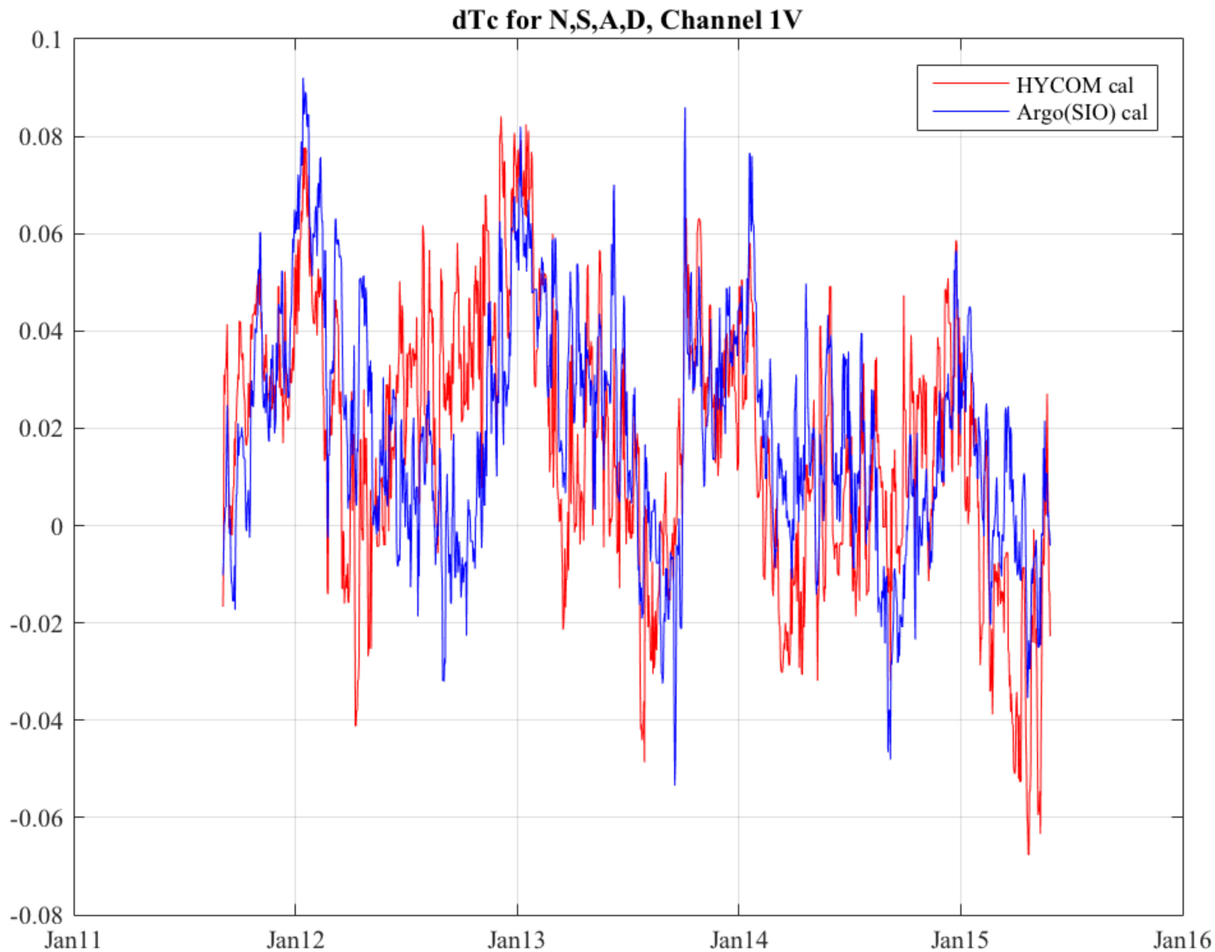
Argo OA SSS Calibration reference



dTc Result, Argo (SIO) cal.

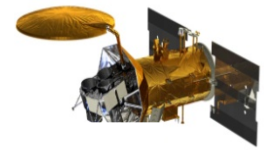
Data V.5.4

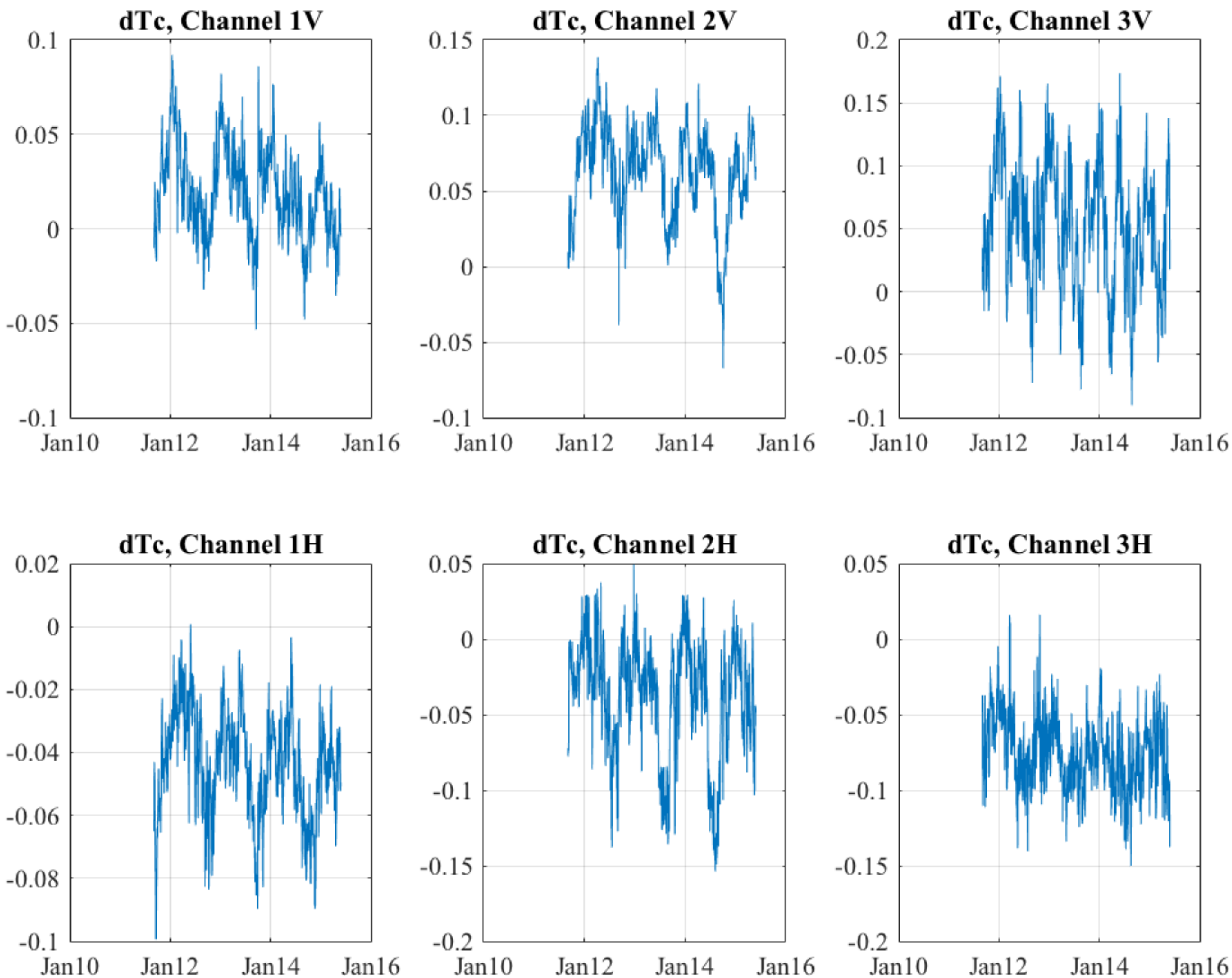



dTc for N,S,A,D, Channel 1V
HYCOM cal
Argo(SIO) cal
0.1
0.08
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
Jan11
Jan12
Jan13
Jan14
Jan15
Jan16

AQUARIUS/SAC-D

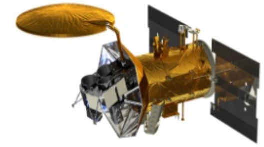
Applied to all 6 Radiometer Channels





AQUARIUS/SAC-D

Summary

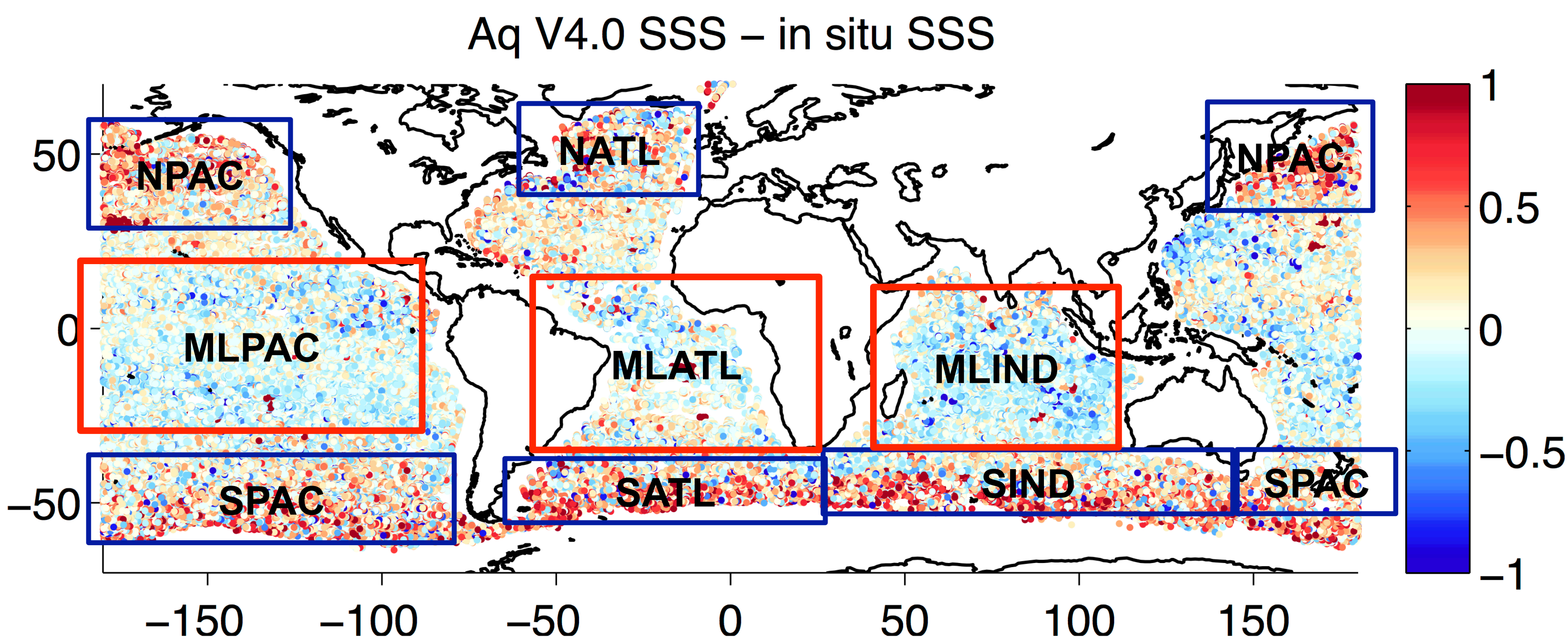


- We present a method to separate Tb errors into a sensor calibration drift and signals attributed to geophysical corrections.
- Different calibration results were found with ocean target reference SSS (HYCOM and Argo analyzed fields) for seasonal to interannual timescale.
- The apparent geophysical errors accumulated over the hemisphere zones (dTg) are quite substantial and outweigh the apparent radiometer calibration error.
- Recommendation: Use this extraction of apparent sensor calibration drift to apply a 2nd order calibration adjustment if the L2 processor.
- This requires a decision on the initial calibration loop: Ocean target only (i.e.V4.2.0) or combination of Instrument-only and ocean target (V4.2.1).
- What to do about residual dTe errors?

Future work:

Test analysis using ocean zones (below)

Apply technique to SMOS and SMAP to inter-calibrate missions




Todo pasa y todo queda,
pero lo nuestro es pasar,
pasar haciendo caminos,
caminos sobre el mar.
NASA
Understanding the Interaction Between Ocean Circulation, the Water Cycle, and Climate by Measuring Ocean Salinity
Aquarius/SAC-D
CONAE
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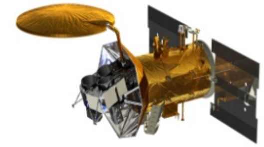
Epilogue



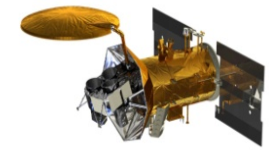
- NASA intends to maintain an ocean salinity science program.
- SMAP SSS data processing will be supported as long as is viable
- NASA OSST will continue to be supported (NASA/ROSES)
- Additional Aquarius algorithm improvements can be addressed within the OSST
- New mission concepts are being considered.

- The complete Aquarius data record (L1A, L2 & L3) will remain archived at PO.DAAC for continued research.

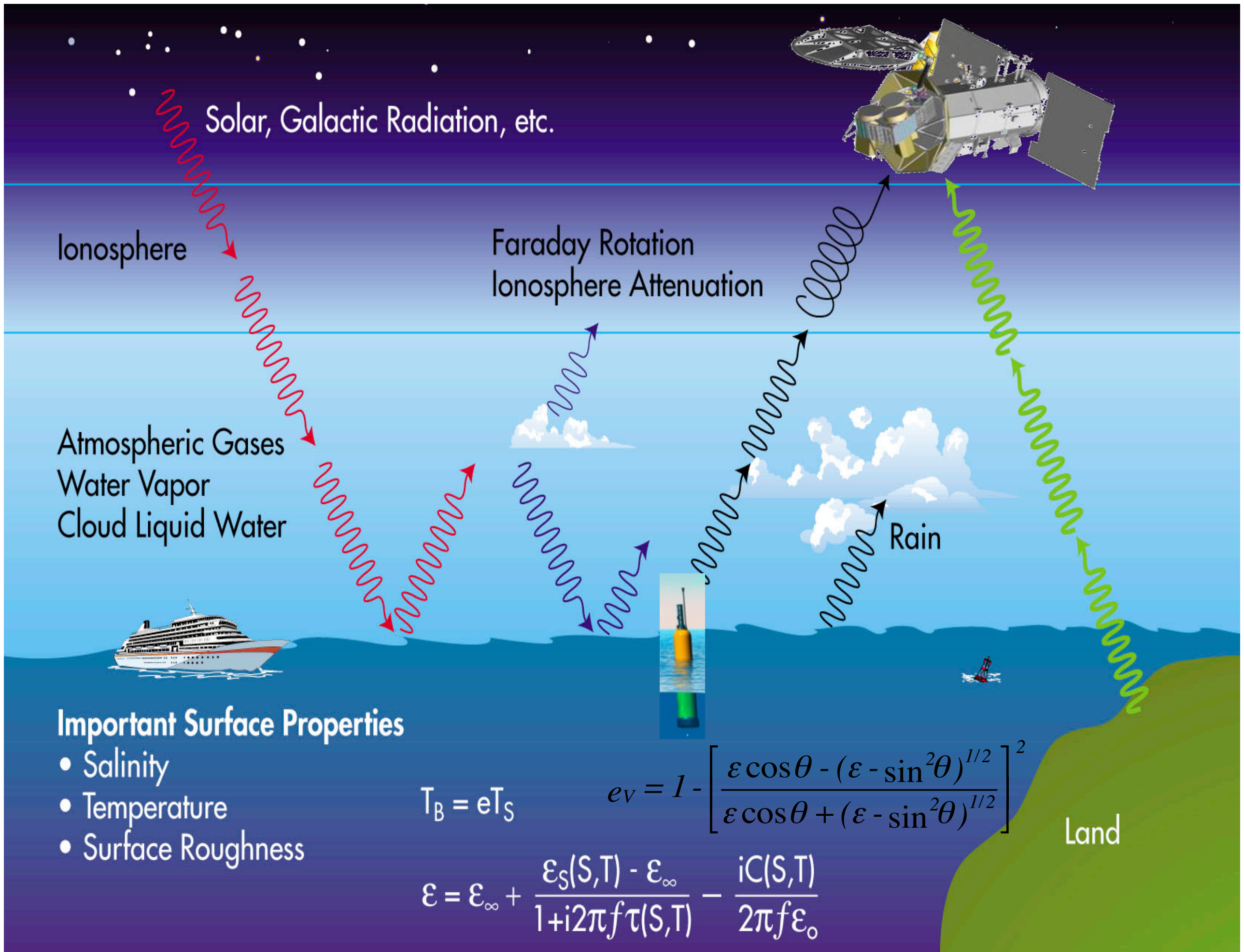
Backup

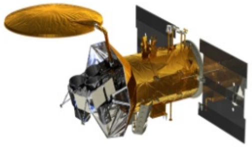
AQUARIUS/SAC-D

Steps in Science Retrieval



In addition to the surface 'flat sea' emission, we must account for corrections due to the sky, atmosphere, ionosphere, land and ice, and especially surface roughness.





$$e_V = 1 - \left[\frac{\varepsilon \cos\theta - (\varepsilon - \sin^2\theta)^{1/2}}{\varepsilon \cos\theta + (\varepsilon - \sin^2\theta)^{1/2}} \right]^2$$

Steps in Science Retrieval

In addition to the surface ‘flat sea’ emission, we must account for corrections due to the sky, atmosphere, ionosphere, land and ice, and especially surface roughness.