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The NASA/RSS SMAP Salinity Version 5 Release

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Major Changes from V4 to V5

- Added formal uncertainty estimates for L2 and L3 products.
- Improved sea-ice detection and sea-ice correction.
  - Includes iceberg detection.
- Ingest V5 L1B TA.
- Use ¼-deg ancillary NCEP atmospheric profiles for temperature, vapor, cloud water, etc...
  - Version 4 used 1-deg.
- NASA/RSS and JPL SMAP Version 5 SSS are different products.
  - Ancillary fields.
  - Geophysical model used in the retrievals.

Sea-Ice Detection: Background

Retrieving sea-surface **salinity** close to the **sea-ice edge** with spaceborne **L-band radiometers** (SMAP, SMOS, Aquarius) is very challenging:

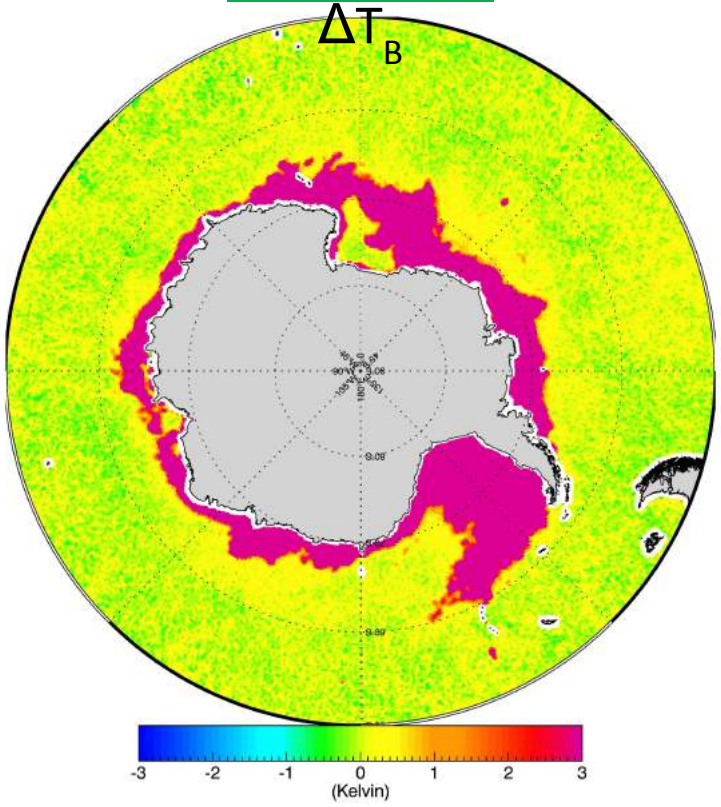
1. Sea-ice contamination through antenna sidelobes.
2. Low sensitivity in cold water.
3. External sea-ice products are not accurate enough.

1% sea-ice contamination results in a salinity error of about 5 psu!

Problems with External Sea-Ice Products

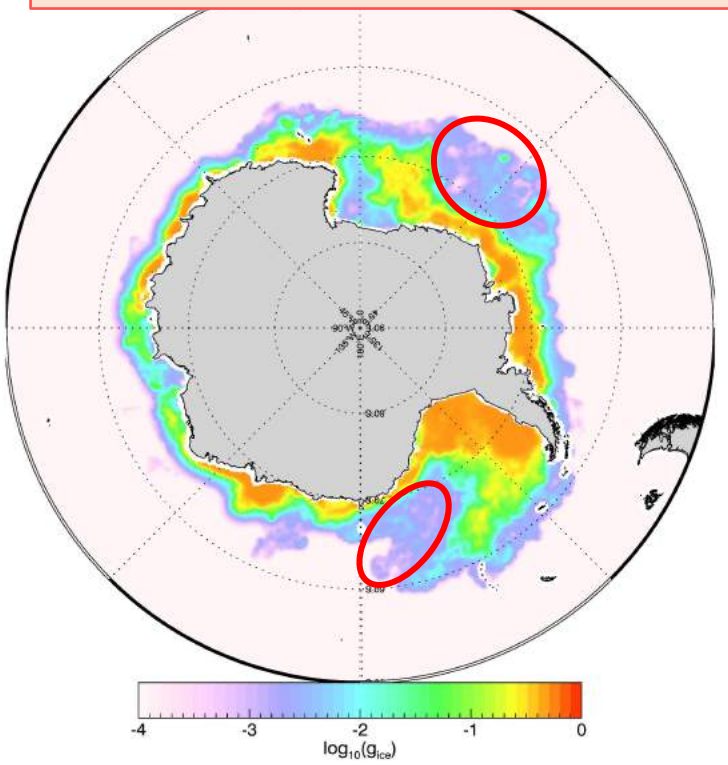
SMAP

ΔT_B



OSI-SAF SIC

over-estimates SIC in circled areas



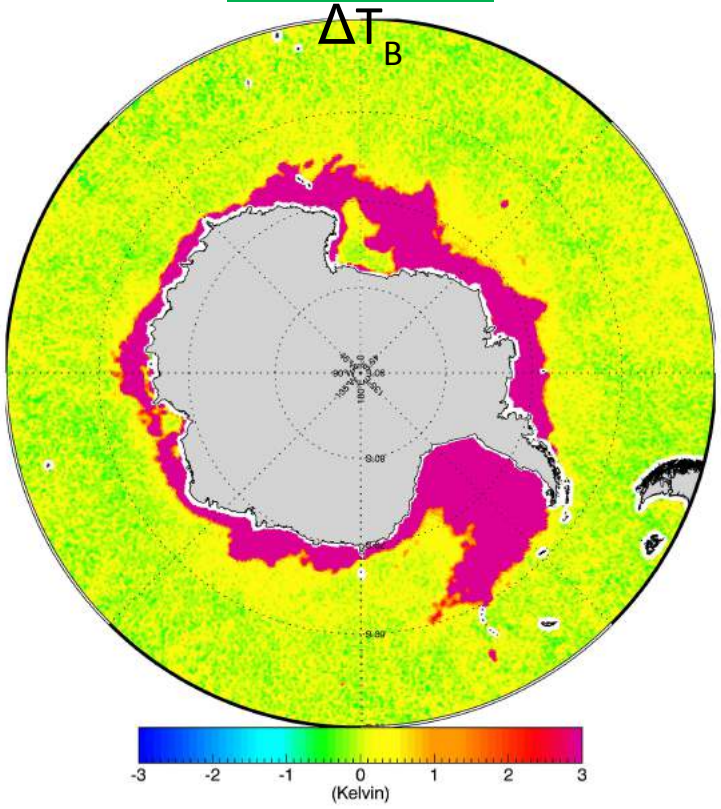
Basic Metric for Assessing Sea-Ice Contamination: ΔT_B = T_B (measured) – T_B (computed)

1% sea-ice concentration $\Delta T_B \approx +1.25$ K $\Delta SSS \approx -5$ psu

Problems with External Sea-Ice Products

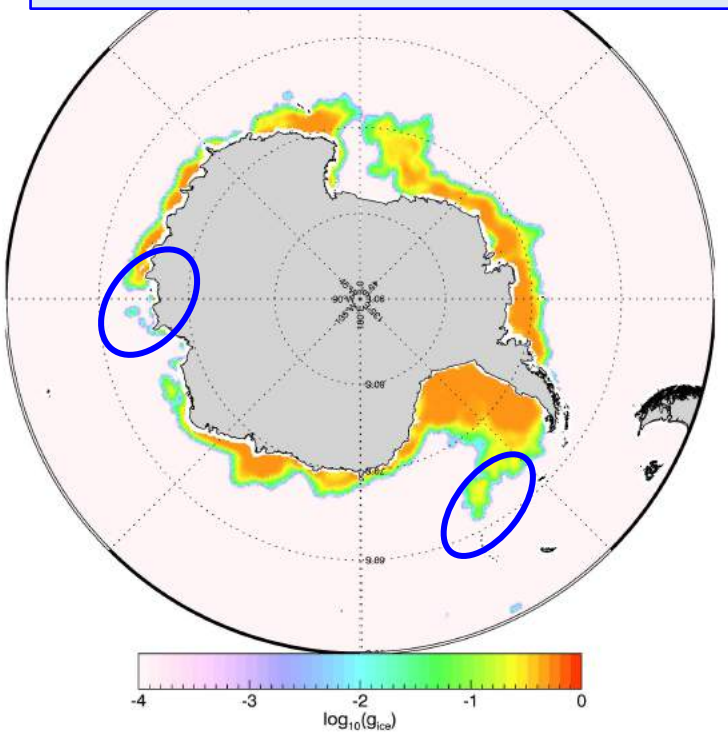
SMAP

ΔT_B



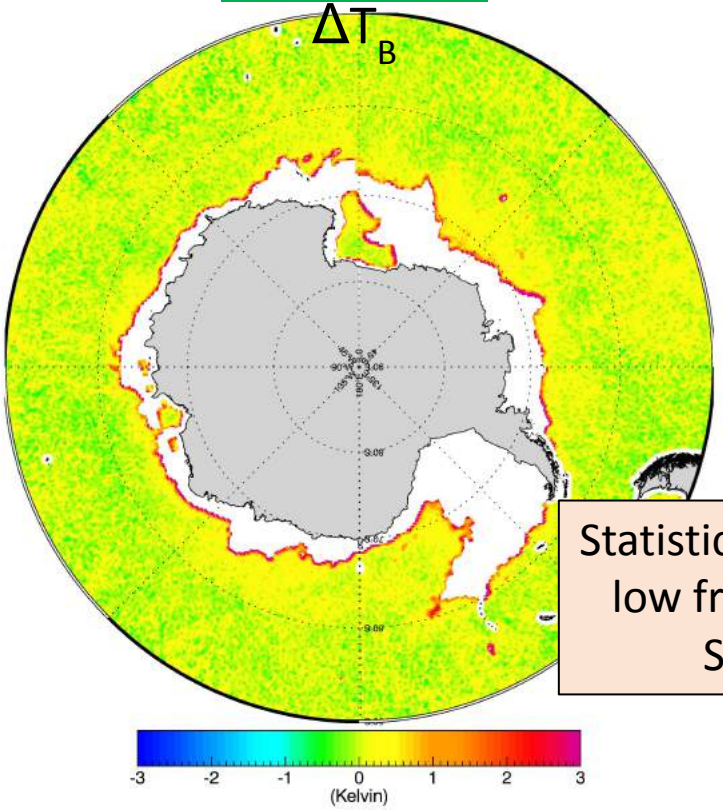
NSIDC CD SIC

under-estimates SIC in circled areas

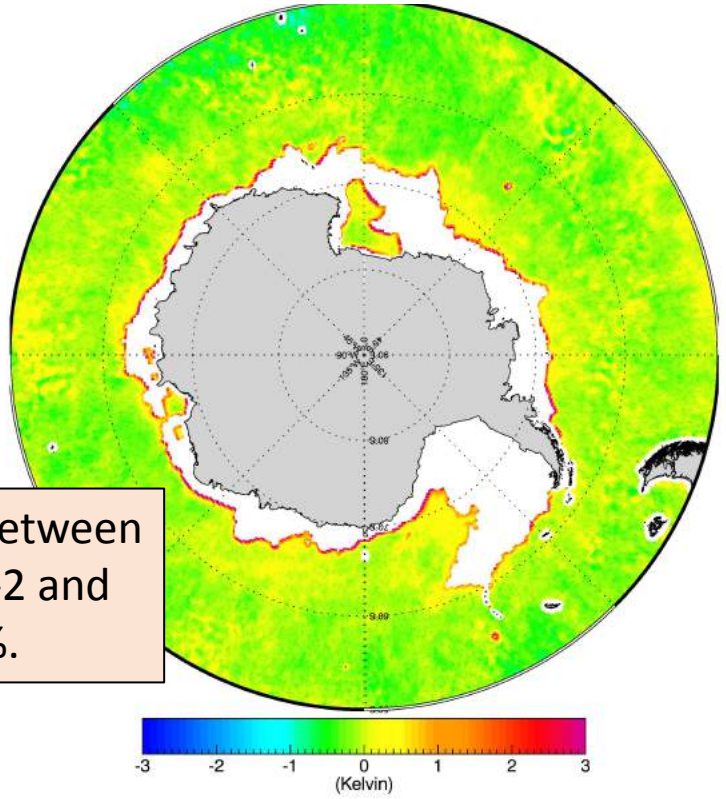


Excellent Correlation between SMAP and AMSR-2 ΔT_B near the Sea-Ice Edge

SMAP ΔT_B



AMSR-2 ΔT_B 6V



Statistical correlation between low frequency AMSR-2 and SMAP ΔT_B is 96%.

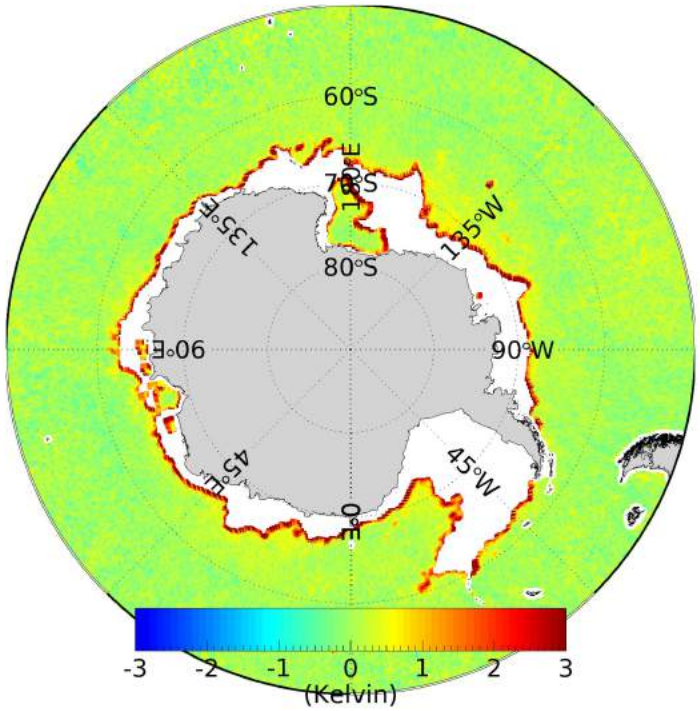
Sea-Ice Detection and Mitigation in SMAP Salinity Retrievals

Details: See Poster by A. Manaster

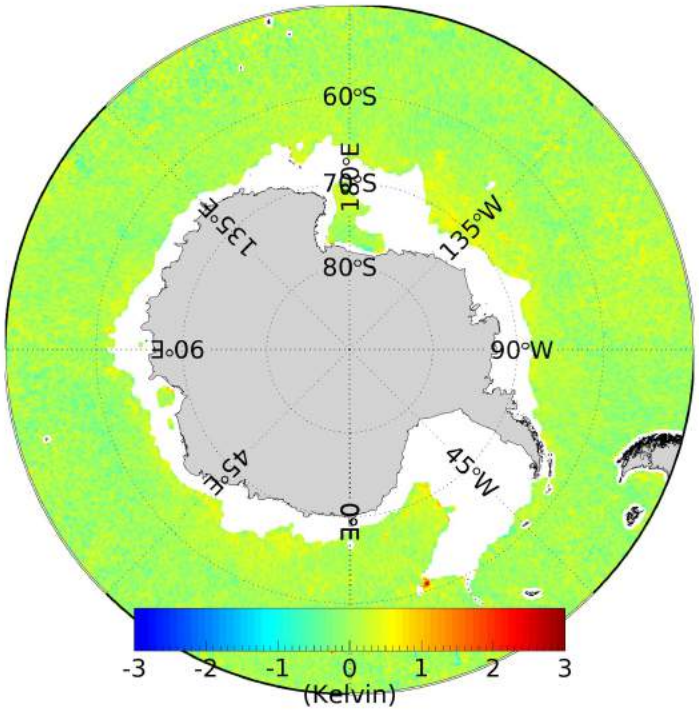
1. Direct use of AMSR-2 T_B (6 – 37 GHz, V/H-pol)
   - Instead of external sea-ice concentration ancillary data.
   - Sampled to 50-km resolution.
   - ¼ deg lat-lon Earth grid for both SMAP and AMSR-2.
2. 8-day aggregate AMSR-2 $\Delta T_B = T_B(\text{measured}) - T_B(\text{computed})$.
   - Most science applications use 8-day SMAP SSS.
   - Taking 8-day averages aids to distinguish weather systems form sea-ice contamination.
3. SMAP and AMSR2 8-day averages see approximately the **same Earth scenes**.
4. AMSR-2 ΔT_B do **NOT depend** (or depend only very weakly) on **salinity**.
5. The computation of AMSR-2 T_B requires the same ancillary data that are already used in the SMAP SSS retrievals.
   - wind speed, wind direction, SST, atmospheric profiles.
   - **NO external salinity** is required.

Example: S-Hemisphere Summer (Jan. 4th, 2019)

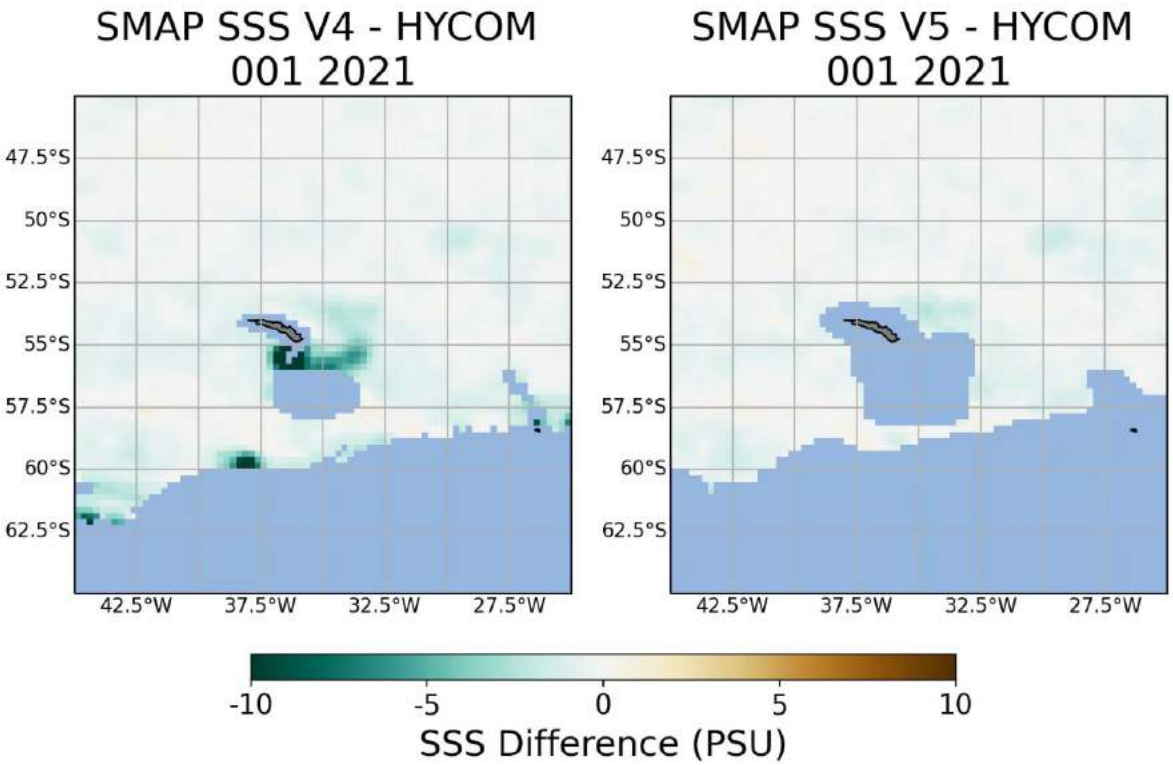
uncorrected SMAP ΔT_B



corrected SMAP ΔT_B



Example: Iceberg Detection



Basis of Formal Uncertainty Estimate: Perturbed Salinity Retrieval

Adapted from AQUARIUS
Meissner (2015), Meissner et al. 2018

$$\frac{\partial S}{\partial x}(x_0) \approx \frac{S(x_0+\Delta x)-S(x_0-\Delta x)}{2\cdot\Delta x}$$

Parameter to be perturbed: x at scene x_0.
Run salinity retrieval S with small perturbation Δx.
$\Longrightarrow$ **Sensitivity** $\frac{\partial S}{\partial x}$

$$\delta S(x_0) \approx \frac{\partial S}{\partial x}\cdot\delta x$$

Model for uncertainty: δx

Resulting salinity uncertainty: δS

1. Running perturbed retrieval for *each error source* at **each scene** (computationally intensive).
2. Error model for $\boldsymbol{\delta x}$.
3. Error propagation model:
   - Fore – aft averaging.
   - 40-km to 70-km: spatial averaging.
   - L2 to L3 time averaging.
   - Depends on type of error source.

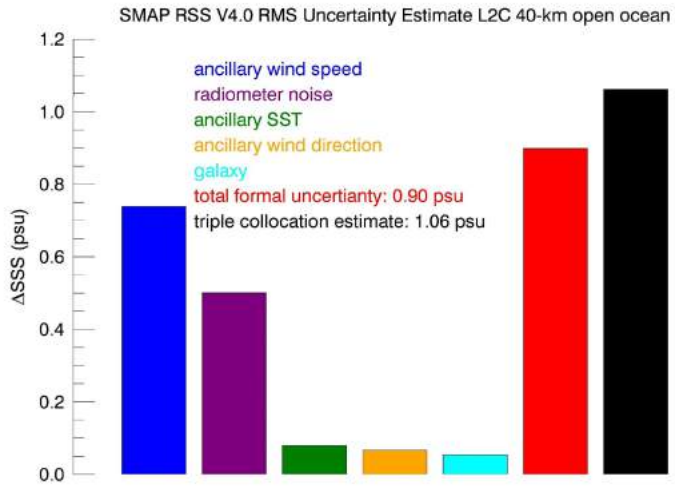
Error Sources (1)

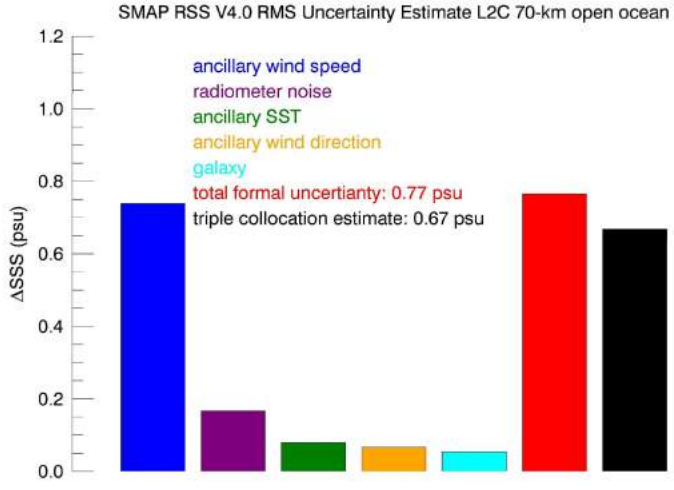
error source	method of estimation	propagation		
		spatial smoothing	fore-aft	time average
wind speed (random)	**Std.Dev. of CCMP – buoy wind speed.** The error depends on CCMP wind speed and the number of satellite observations in the CCMP VAM. Mears et al. 2019.	sys	sys	ran
NEDT	Instrument parameter. Ocean NEDT: 0.9 K NRF: 0.4.	ran	ran	ran
wind speed (systematic)	**Bias of CCMP – buoy wind speed.** The error depends on CCMP wind speed and the number of satellite observations in the CCMP VAM.	sys	sys	sys

Error Sources (2)

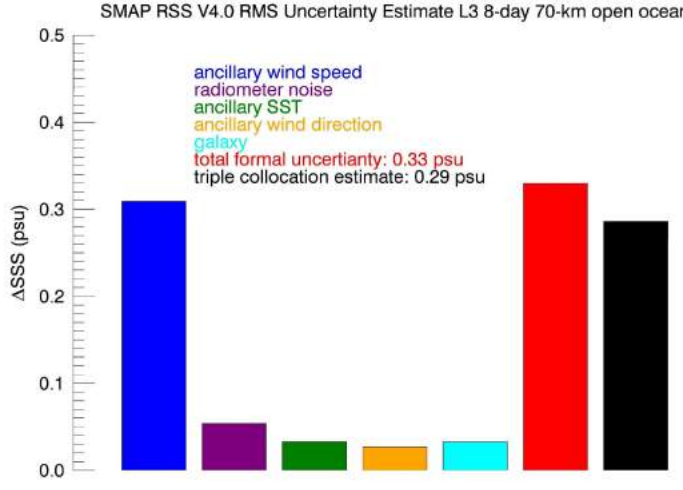
error source	method of estimation	propagation		
		spatial smoothing	fore-aft	time average
SST	SST uncertainty values from CMC.	sys	sys	ran
wind direction	**Std.Dev. of CCMP – buoy wind direction.** The error depends on CCMP wind speed and the number of satellite observations in the CCMP VAM.	ran	ran	ran
reflected galaxy	We allocate 5% of the reflected galaxy as residual error in the 40-km L2C product.	ran	ran	ran
land contamination	Analysis of TB (meas – exp) in coastal areas.	ran	sys	sys
sea-ice contamination	Analysis of TB (meas – exp) near Antarctica.	sys	sys	sys

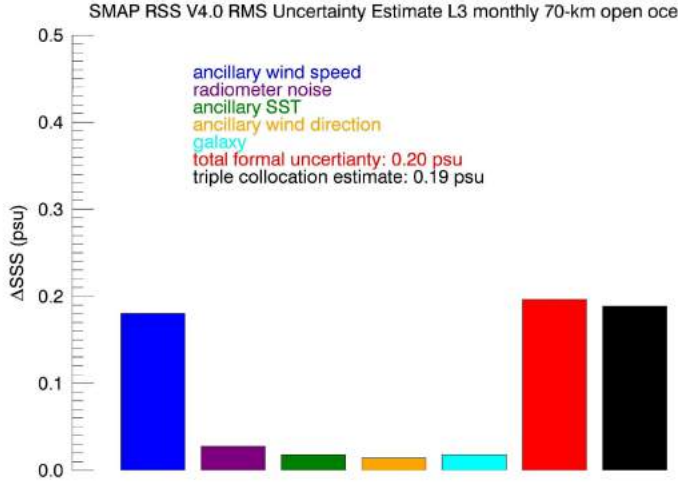
Open Ocean Error Budgets: Total





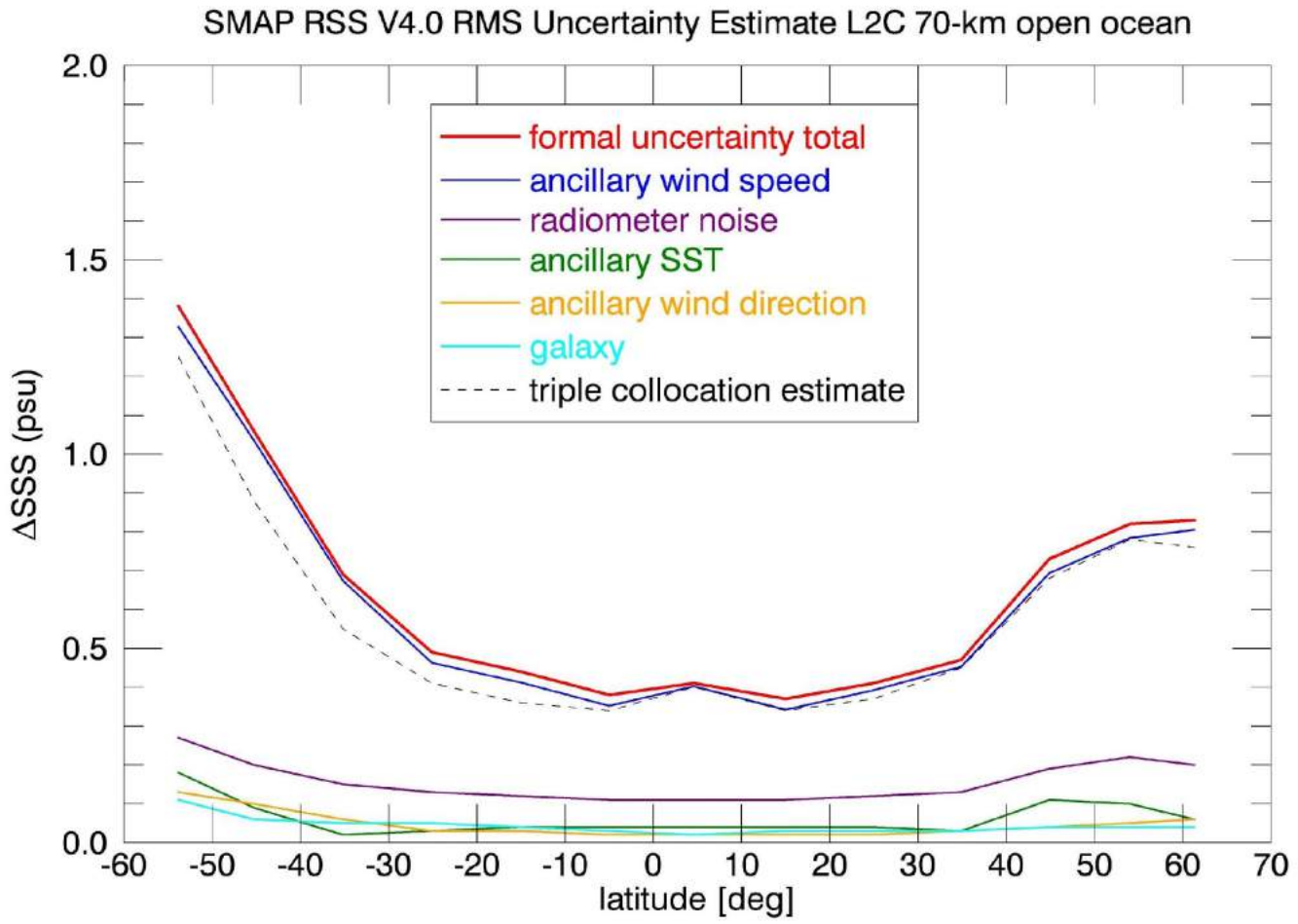
y-axis scale different





Triple collocation estimate: SMAP – HYCOM - ARGO

Open Ocean Error Budgets: Zonal



Compare with triple collocation estimate: SMAP – HYCOM - ARGO

Data Availability

- RSS SMAP Version 5 data products are available on Remote Sensing System's website at: https://www.remss.com/missions/smap/salinity/
- Will be available on NASA PO.DAAC in the near future as well.