

RFROM V2.2

John Lyman



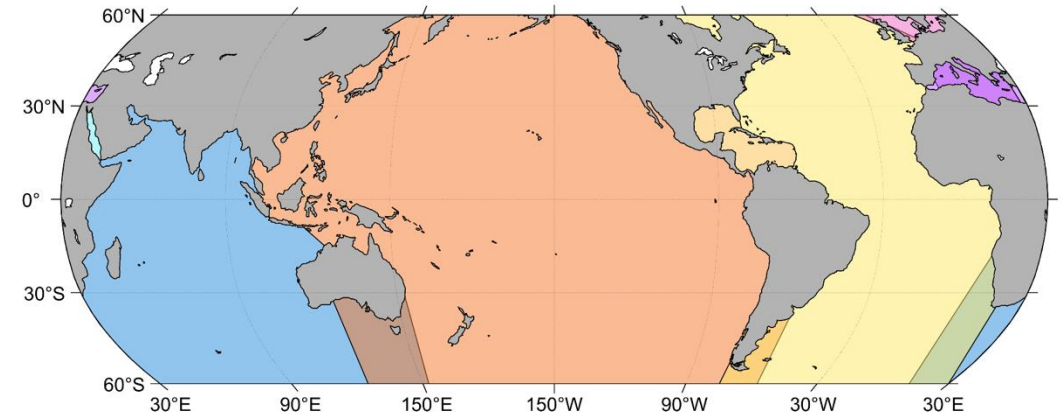
<https://www.pmel.noaa.gov/rfrom/>



Random Forest Regression Ocean Maps (RFROM)

- $\frac{1}{4}^\circ \times \frac{1}{4}^\circ \times 7$ -day maps
- 10 layers (0–40 m, 40–90 m, 90–190 m, 190–290 m, 290–450 m, 450–700 m, 700–950 m, 950–1450 m, 1450–1950 m, and 1950–2000 m)
- 8 Overlapping Basins adapted from Lavin and Johnson 2022
- 1st made a mean field to define the annual cycle and anomalies
 - Overlapping yearly data overlapped from 2008 to 2025
- 2nd made anomaly maps
 - From 2006 to 2025, the same yearly Random Forest as the mean
 - From 1993 to 2008, one Random Forest was made with all the data
 - The two sets of maps were linearly tapered where they overlapped

Basins



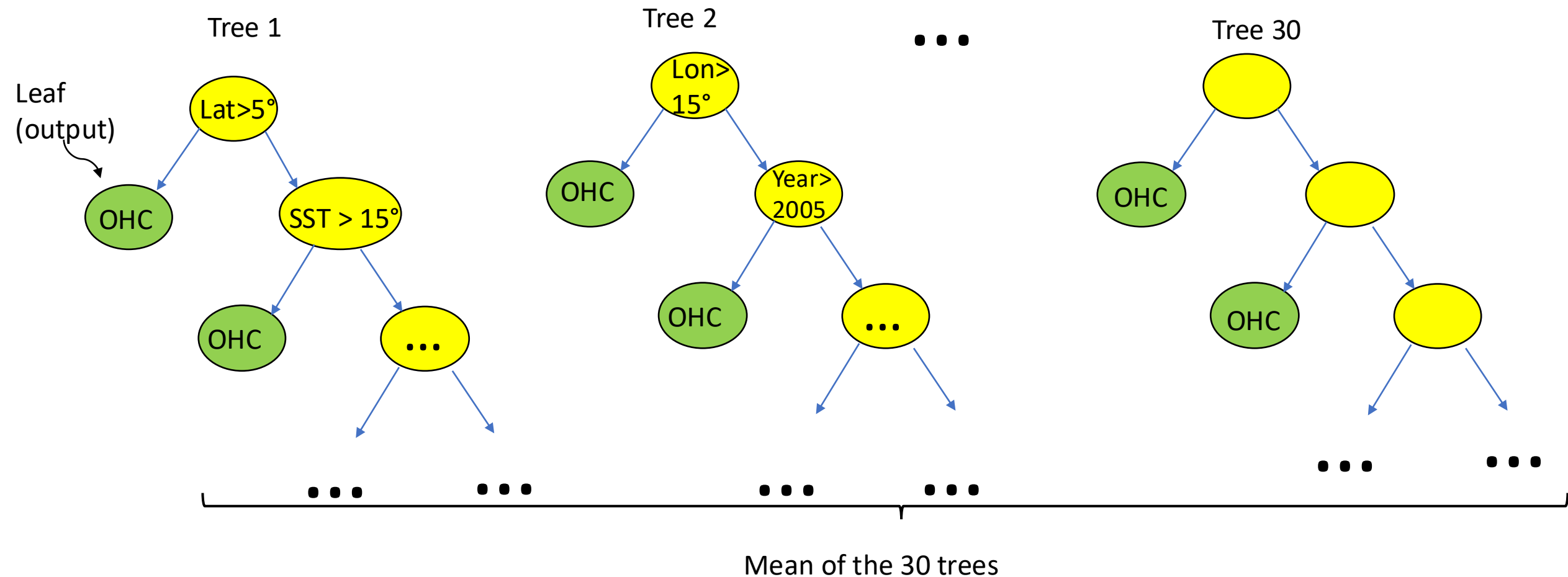
Random Forest Regression

Predictors

- Sea Surface Temperature (NOAA OI SST V2)
- Sea Surface Height (CMEMS, SEALEVEL_GLO_PHY_L4_MY_008_047)
- Latitude
- Longitude
- Time (decimal year)

Training Data (in situ profiles)

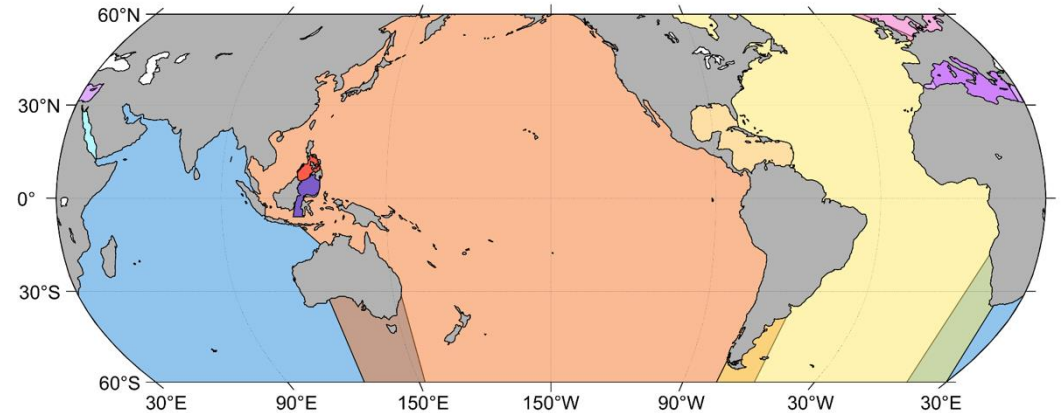
- Argo
- EN4.2.2 Gouretski and Cheng 2020



RFROM V2.2 expansion and updates to Methods

1. Now include the Sulu and Celebes basins
2. Added tiles where longitude and latitude are single-valued
3. Now map Conservative Temperature and Absolute Salinity on 58 layers
4. GCM-based uncertainty rather than from holding out data

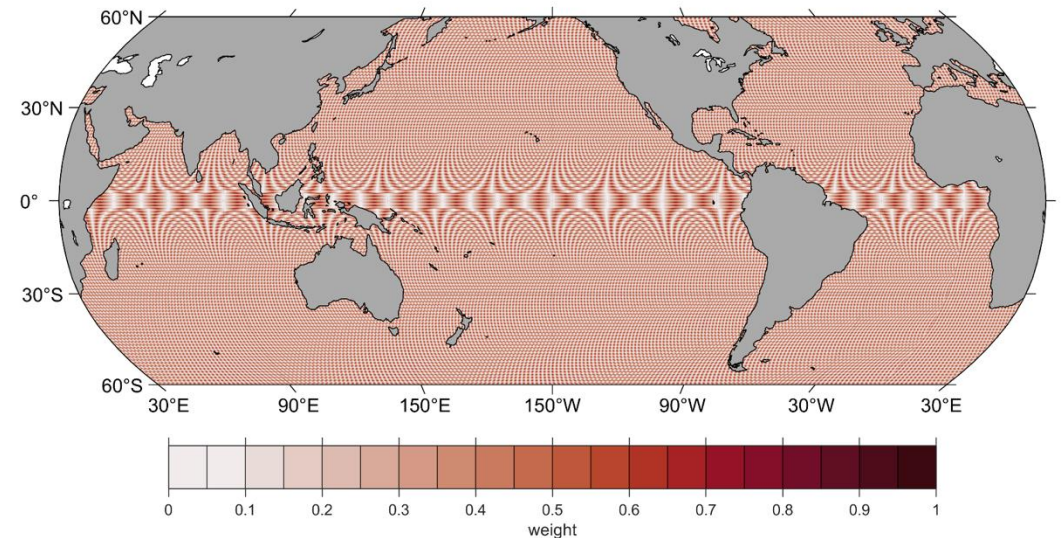
Updated Basins



Tiles with single-valued Latitudes and Longitudes

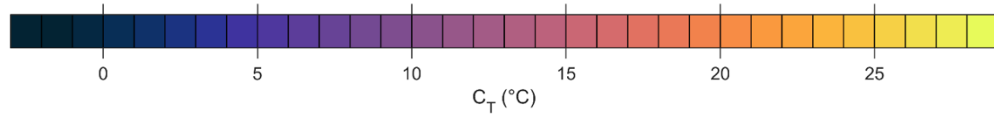
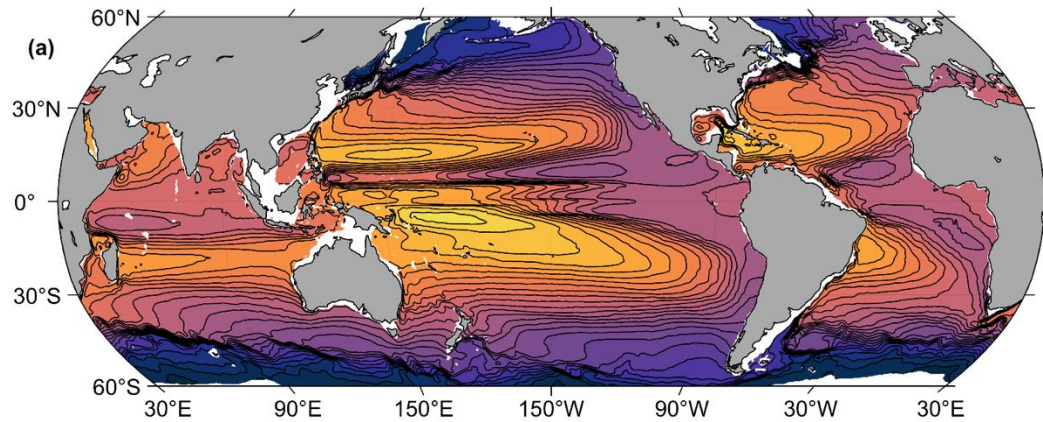
- 4 overlapping maps for each 7-day map
- Tiles
 - $10^\circ \times 1^\circ$ boxes at the Equator
 - Longitude decreases as $1/\sin(\text{lat})$ until 20° off the equator
 - $111 \text{ km} \times 111 \text{ km}$ tiles from 20° off the equator to the poles
- Maps for each of the 4 maps are linearly weighted based on the distance from the center of the tiles
- Gets rid of non-physical trees
- Smooths where predictors, particularly SSH and SST, are not highly correlated to in situ field

Map Weights for one of the four tile arrangements

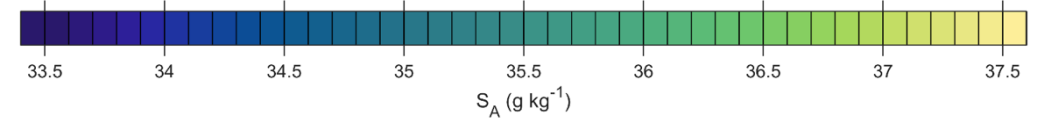
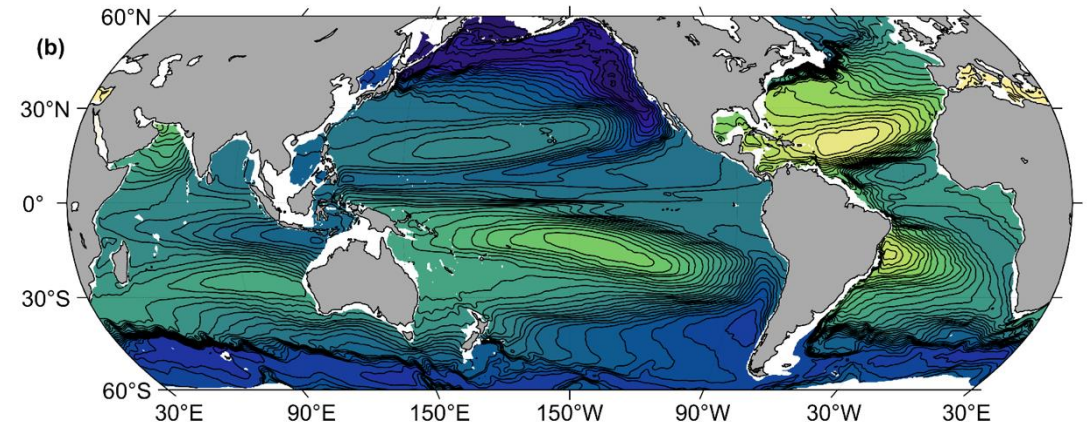


RFROM expanded to include Conservative Temperature and Absolute Salinity Mean maps at 150 dbar

C_T



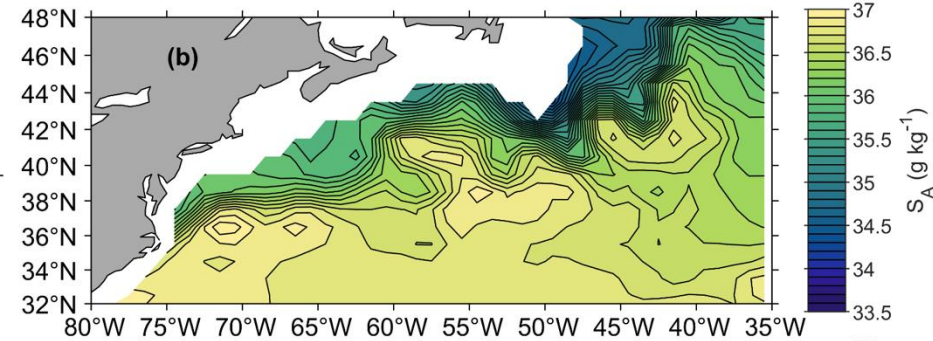
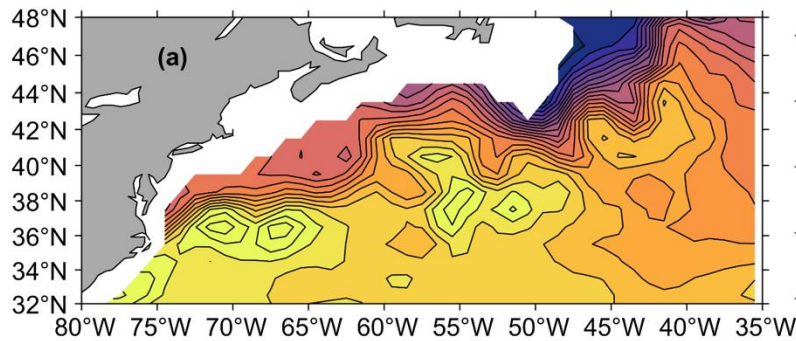
S_A



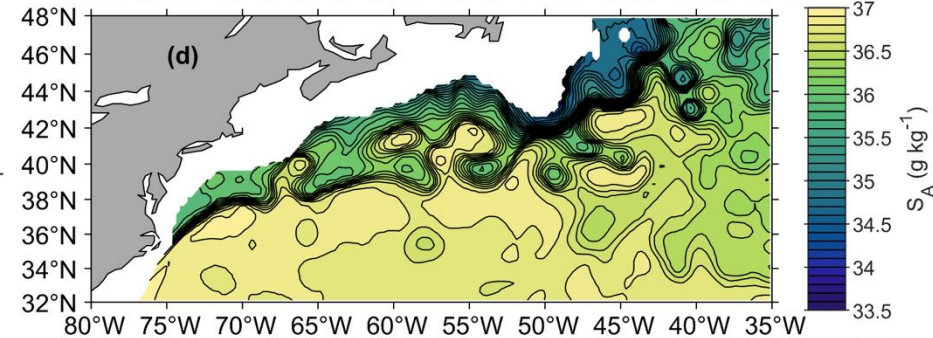
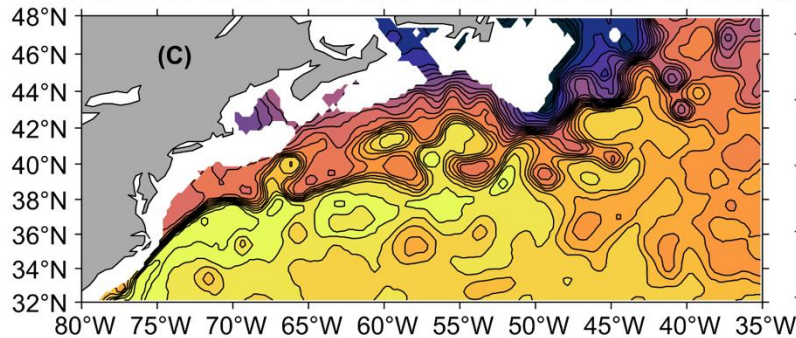
C_T @ 150 dbar

S_A @ 150 dbar

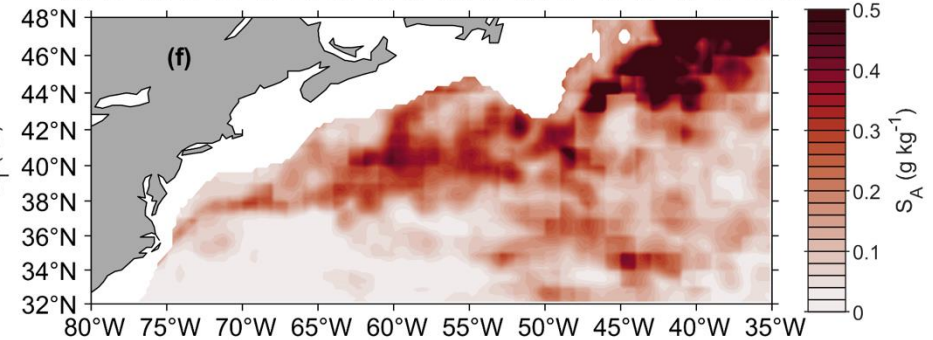
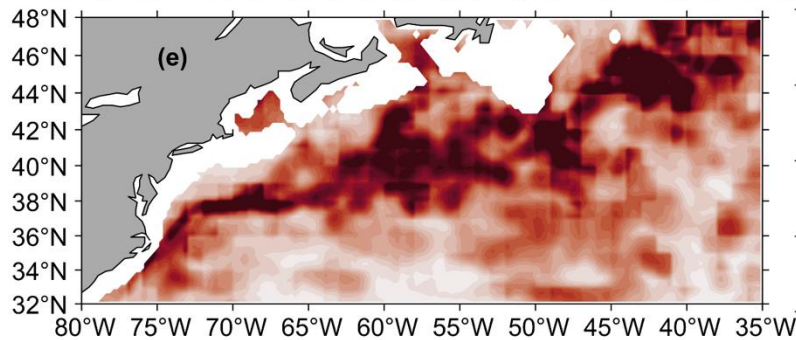
RG09 October 2016



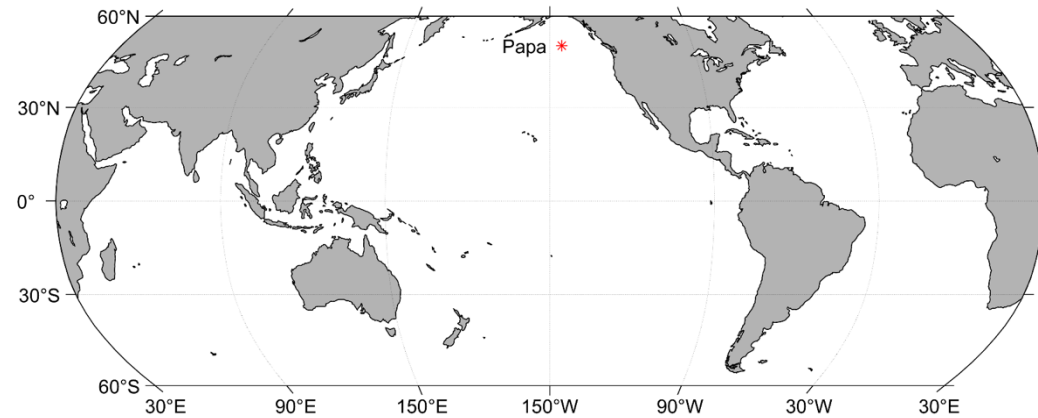
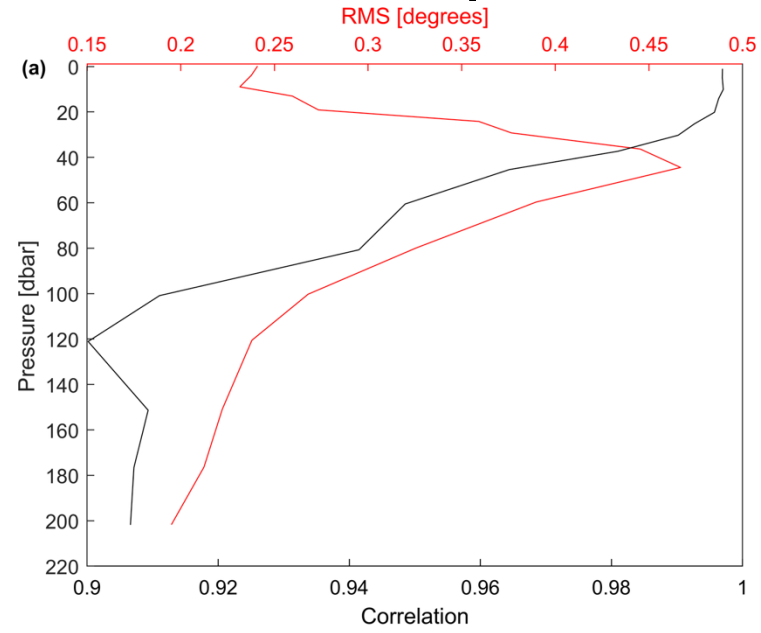
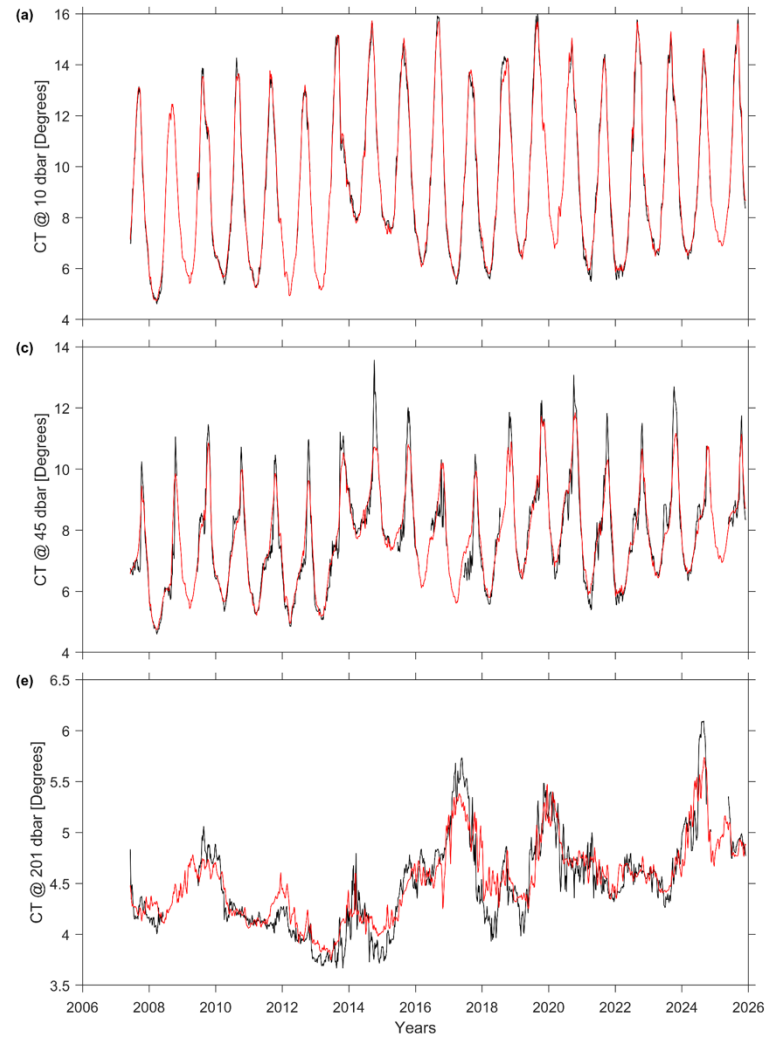
RFROM October 21st, 2016



RFROM uncertainty

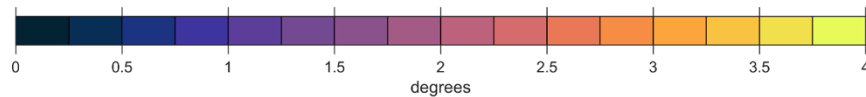
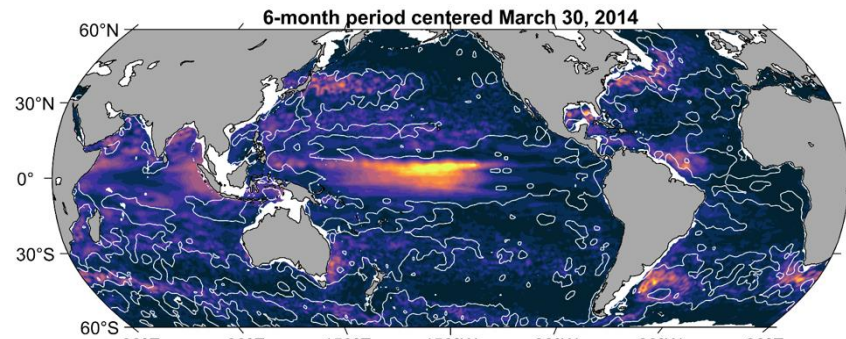


Ocean Station Papa holdout experiment



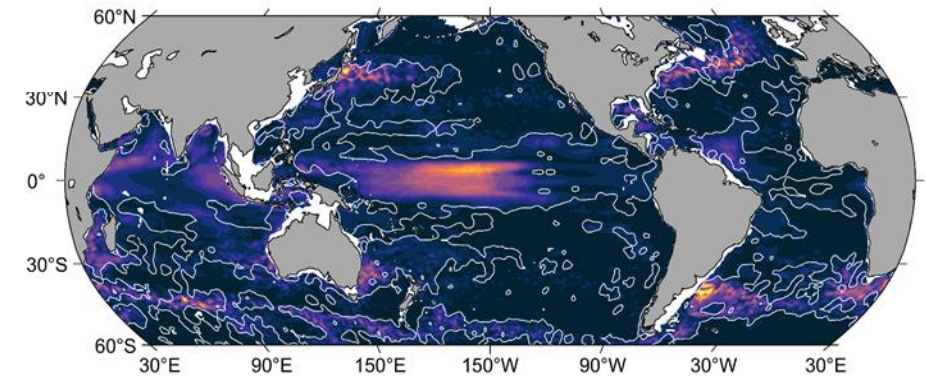
New Uncertainty estimate based on Subsampling NCAR-POP forced with JRA-55

RFROM Observations STD C_T @ 150 m

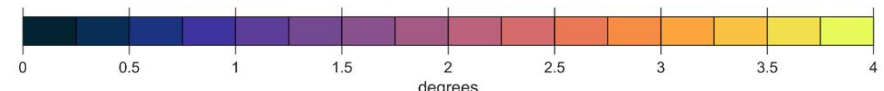
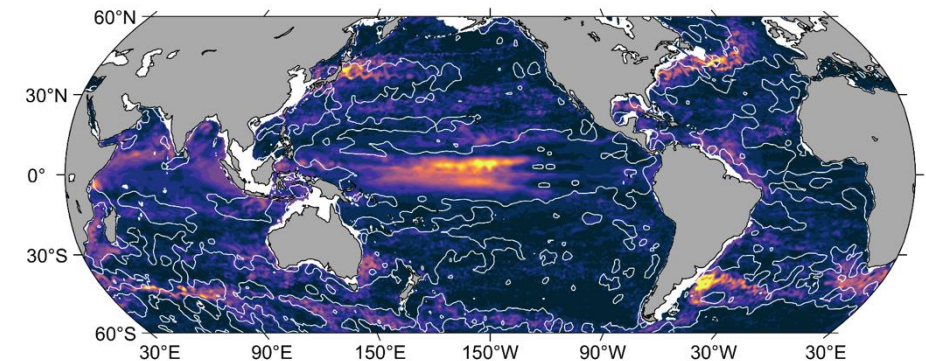


- 6-month period centered on March 30, 2014
- RFROM Observations: RFROM using in situ measurements
- NCAR-POP RFORM: synthetic profiles from NCAR-POP mapped using RFROM methods
- NCAR-POP Truth: NCAR-POP full fields

NCAR-POP RFROM STD C_T @ 155 m

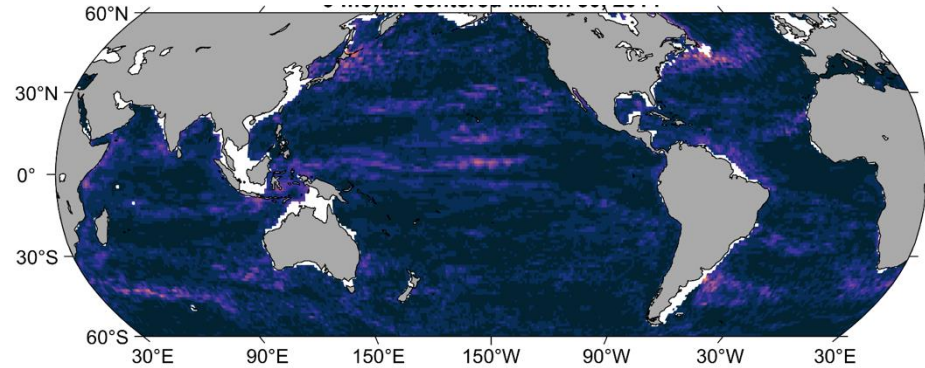


NCAR-POP Truth STD C_T @ 155 m

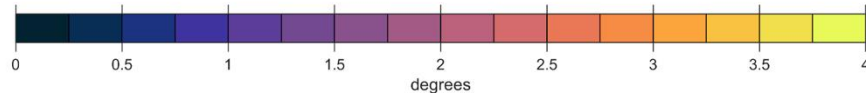
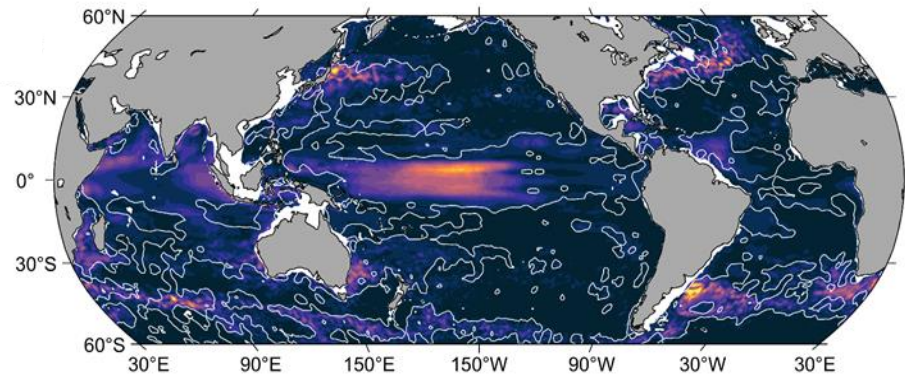


Ratio of Root Mean Squared Error to Standard Deviation

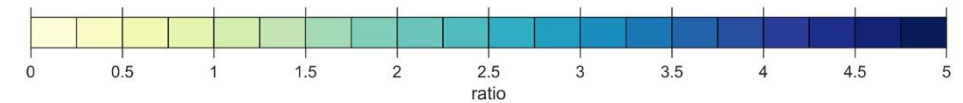
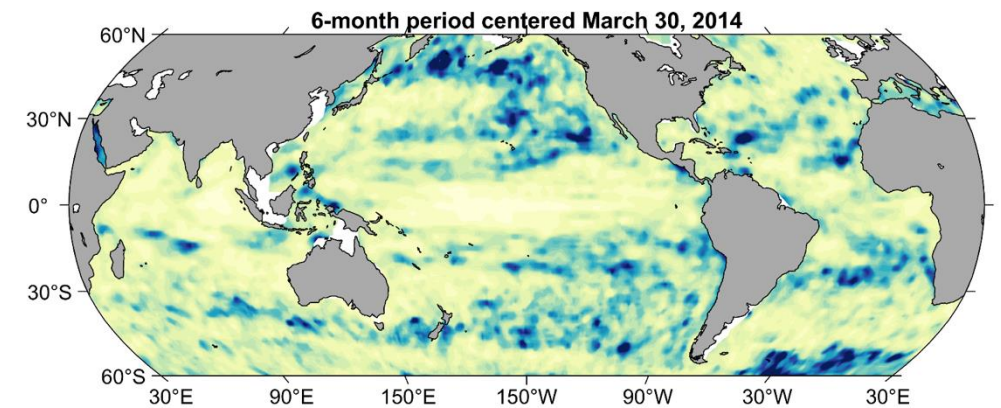
NCAR-POP RFROM RMSE C_T @ 155 m

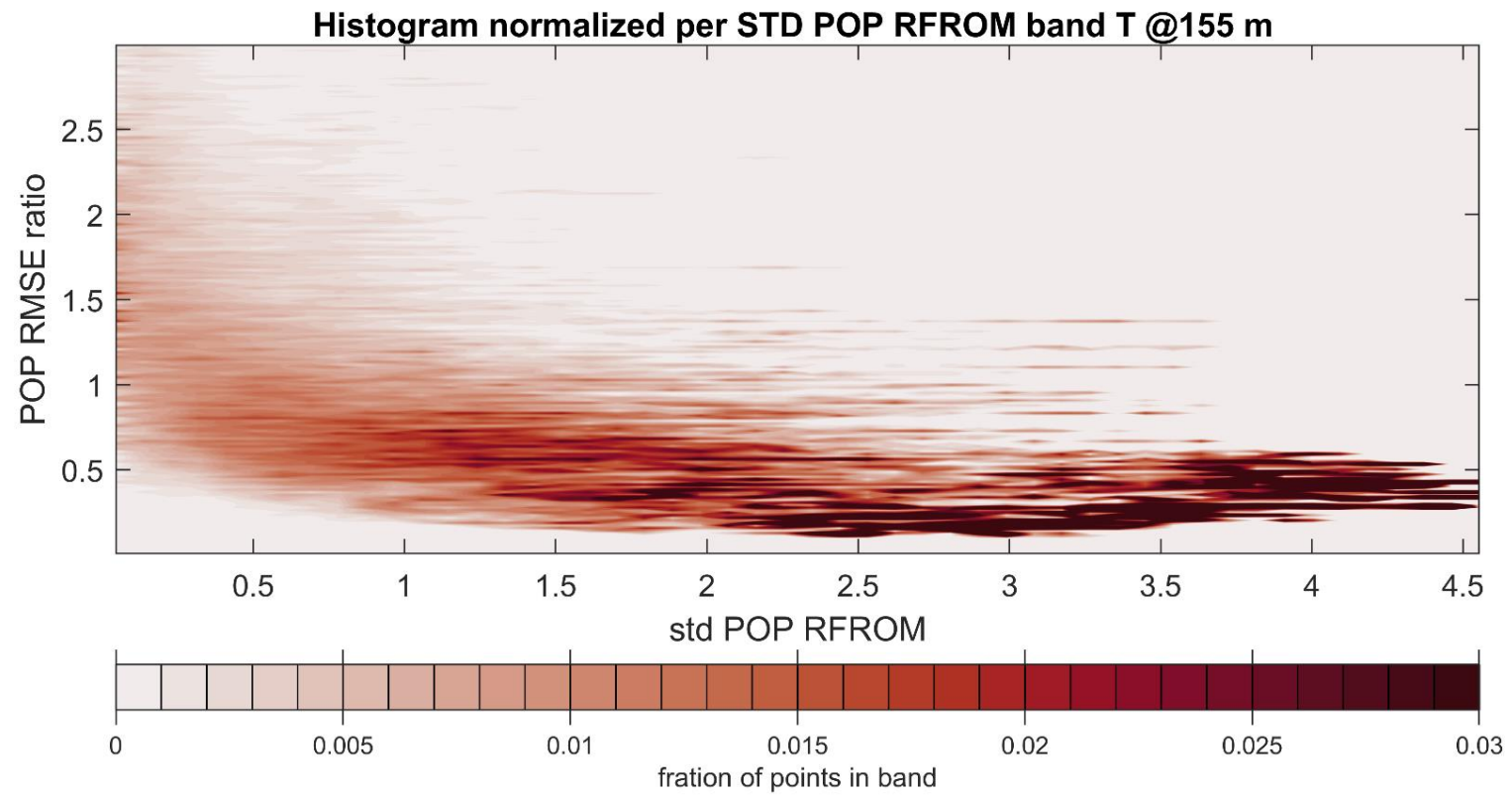


NCAR-POP RFROM STD C_T @ 155 m

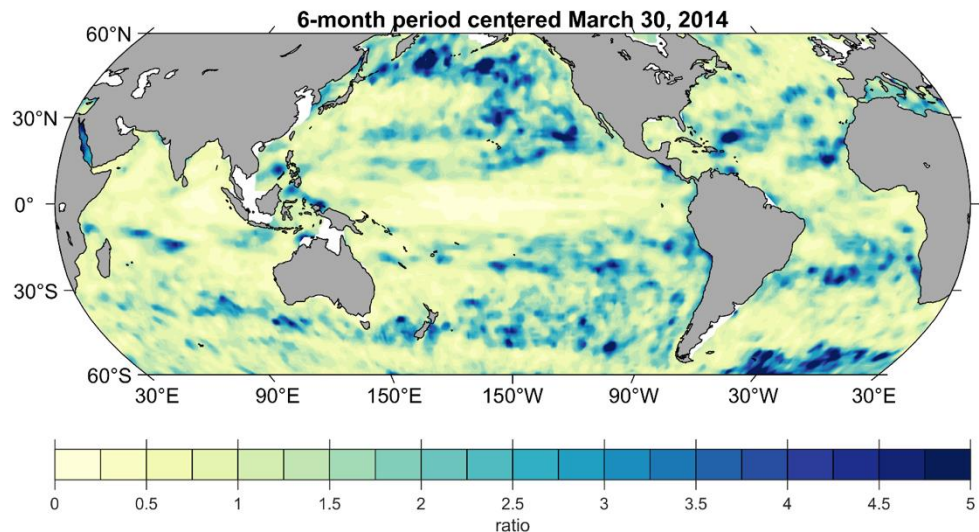


NCAR-POP RFROM RMSE/STD Ratio C_T @ 155 m

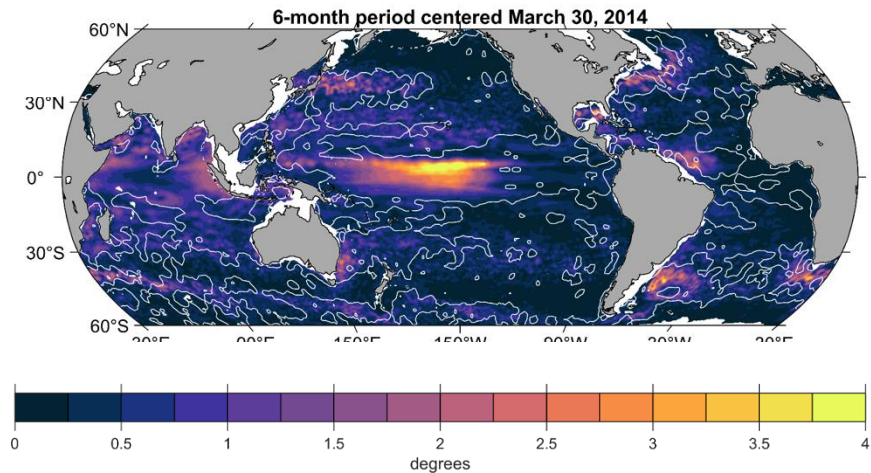




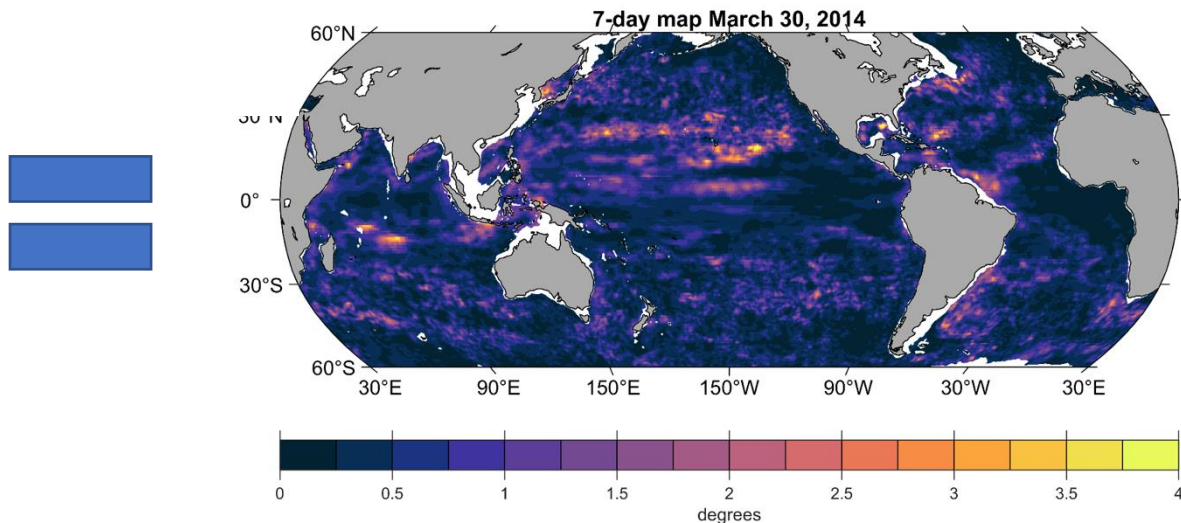
NCAR-POP RFROM RMSE/STD Ratio C_T @ 155 m



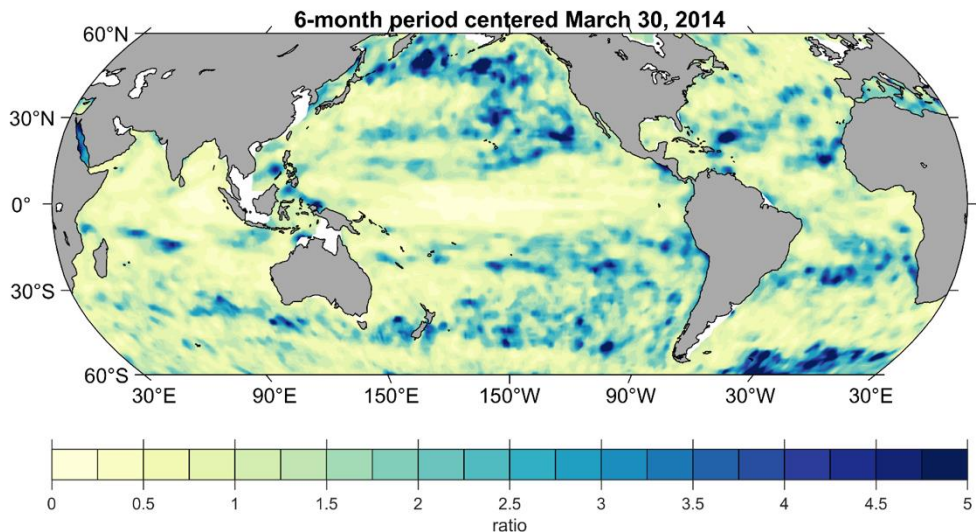
RFROM Observations STD C_T @ 150 m



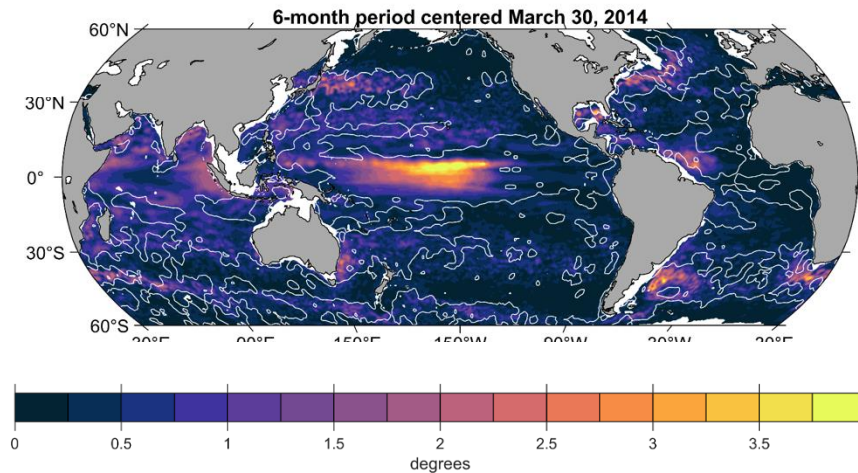
RFROM Observational Uncertainty C_T @ 150 m



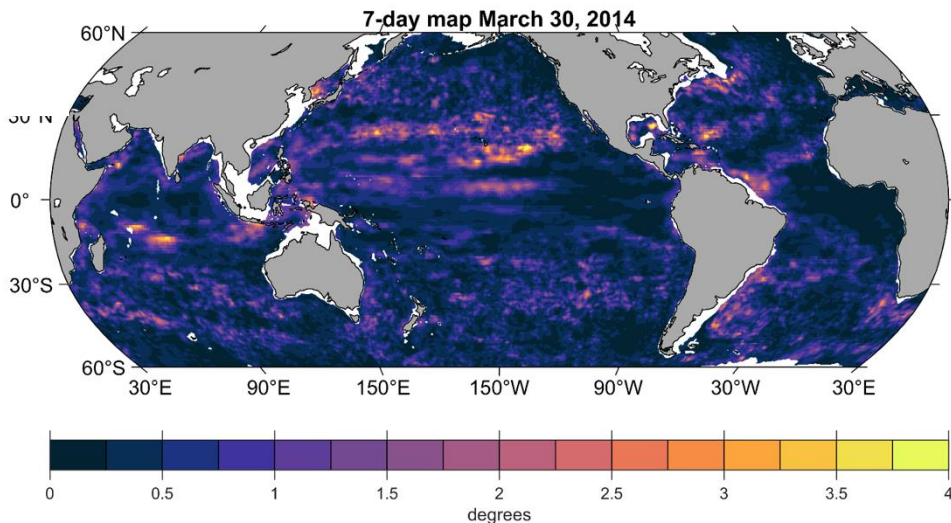
NCAR-POP RFROM RMSE/STD Ratio C_T @ 155 m



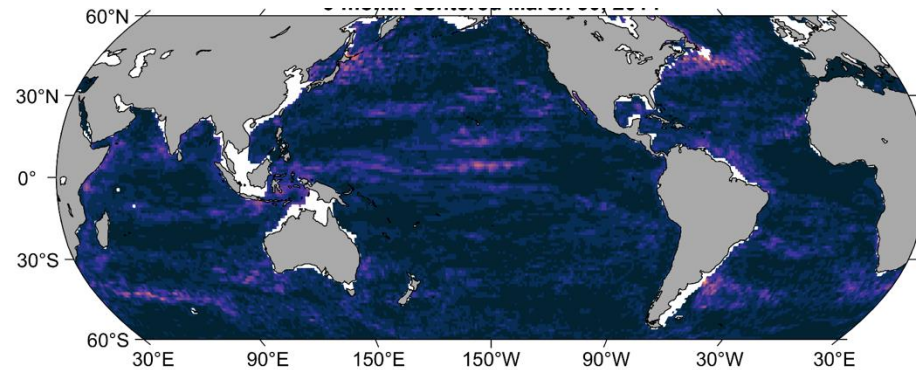
RFROM Observations STD C_T @ 150 m



RFROM Observational Uncertainty C_T @ 150 m



NCAR-POP RFROM RMSE C_T @ 155 m





Takeaways

- Updated Basins and Added tiles where longitude and latitude are single-valued, both of which reduce mapping artifacts from random forest trees
- Update Uncertainty Based on NCAR-POP
- Now 3 products!
 - Heat content 10-layers
 - C_T and S_A on 58 layer
 - All from the surface to 2000 m
- Heat content data available at <https://www.pmel.noaa.gov/rfrom/>, C_T and S_A soon!