Operational Monitoring of the Global Sea-Surface Salinity and Fresh Water Flux with In Situ and Satellite Observations

Pingping Xie
Li Ren, Guangyang Fang, and Arun Kumar

NOAA Climate Prediction Center
Pingping.xie@noaa.gov

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Background and Objectives

- Grid analyses of monthly and pentad oceanic surface salinity are routinely produced at NOAA Climate Prediction Center (CPC) through collaborations with NOAA/NESDIS/STAR and NOAA/NESDIS/NCEI;

- Called Blended Analysis of Sea-surface Salinity (BASS), the analyses are constructed through blending the in situ measurements with the satellite retrievals;

- The objectives of this presentation are to provide a description of the BASS products and to illustrate the applications of the BASS in the operational monitoring and analysis of global oceanic salinity and associated fresh water flux.

The BASS Blended Salinity Analysis

1) Inputs

- **Inputs**

  - ***In situ measurements of SSS (NCEI)***
    - **1°x1°lat/lon grid box mean SSS from all measurements collected over the target monthly / pentad period from Argo and other buoy arrays** (e.g. TAO/TRITON, PIRATA, RAMA)
    - **In addition to the grid box mean SSS, number of sampling (profiles) is also available and used to quantify the random error for the grid box mean;**

  - ***Level 2 SSS retrievals at satellite FOVs***
    - **Retrievals from Aquarius, SMOS, SMAP;**
    - **Level 2 retrievals on their native FOVs re-gridded to a global grid of 1°x1°lat/lon;**
    - **Retrievals for the ascending and descending orbits are combined into daily mean to form global maps of gridded fields for daily SSS for each individual satellites;**
    - **Monthly . Pentad mean SSS fields are defined for each individual satellites**

The BASS Blended Salinity Analysis

2) Algorithm

- **A Two-Step approach for the algorithms to define the monthly and pentad blended analyses**

- **Bias correction for satellite retrievals**
  - PDF tables are constructed using co-located satellite and in situ data covering a 5-month period centering at the target month and over a spatial domain centering at the target grid box
  - The spatial domain is expended until sufficient number of data pairs are collected

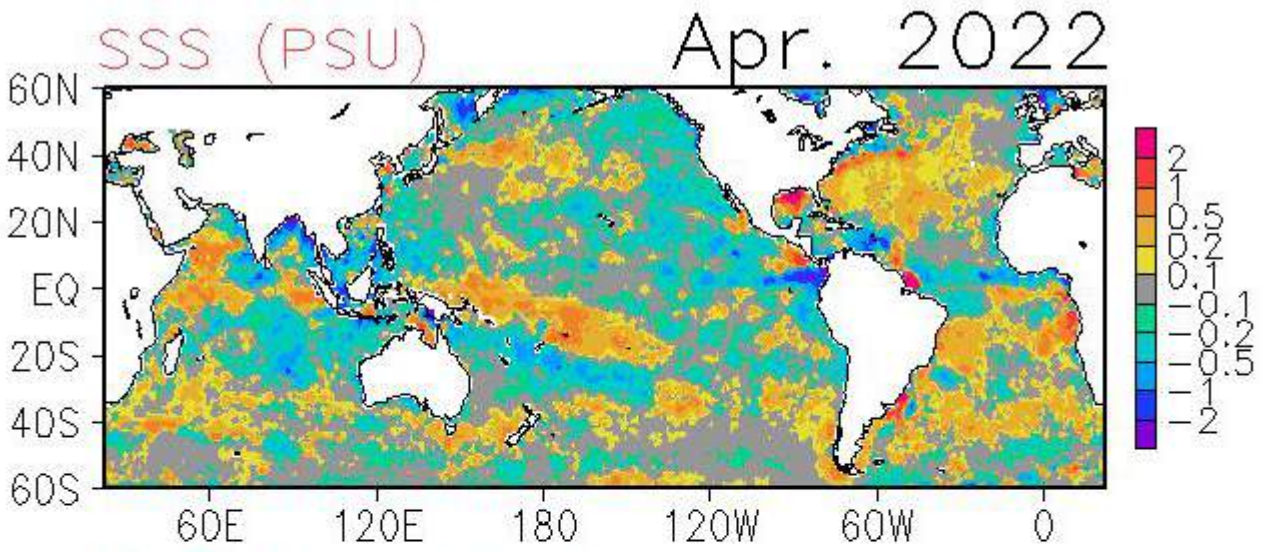
- **Blending in situ measurements and bias corrected satellite retrievals**
  - Optimal Interpolation
  - First Guess : Analysis for the previous time step
  - Observations: In situ, satellite retrievals

The BASS Blended Salinity Analysis

3) Products

Monthly BASS

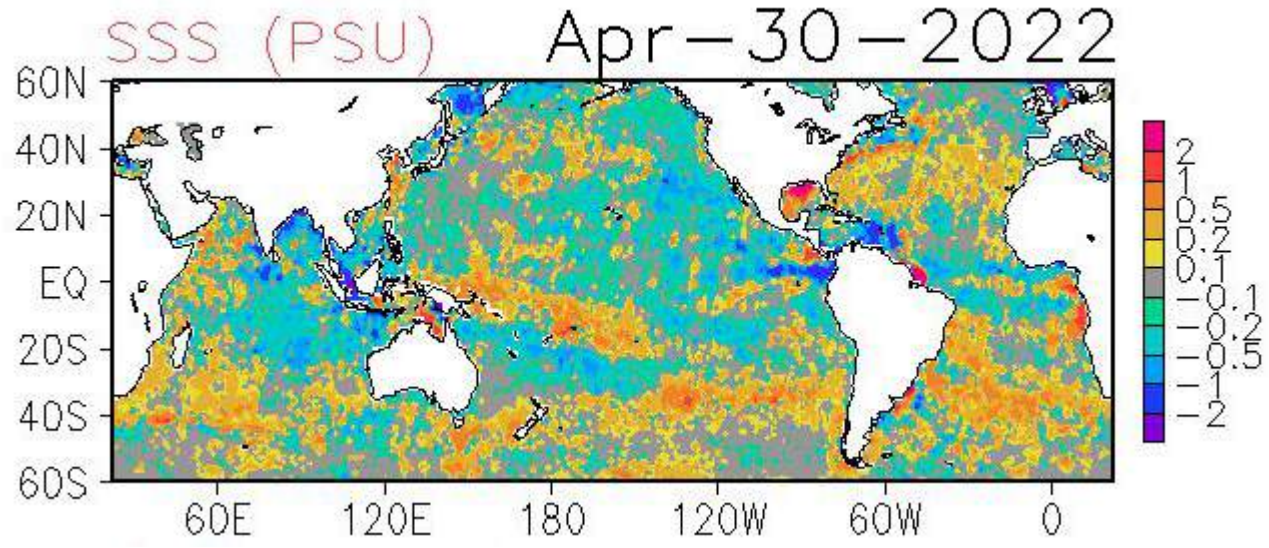
Starting from January 2010 to the present;



Pentad BASS

Starting from January 2016 to the present;

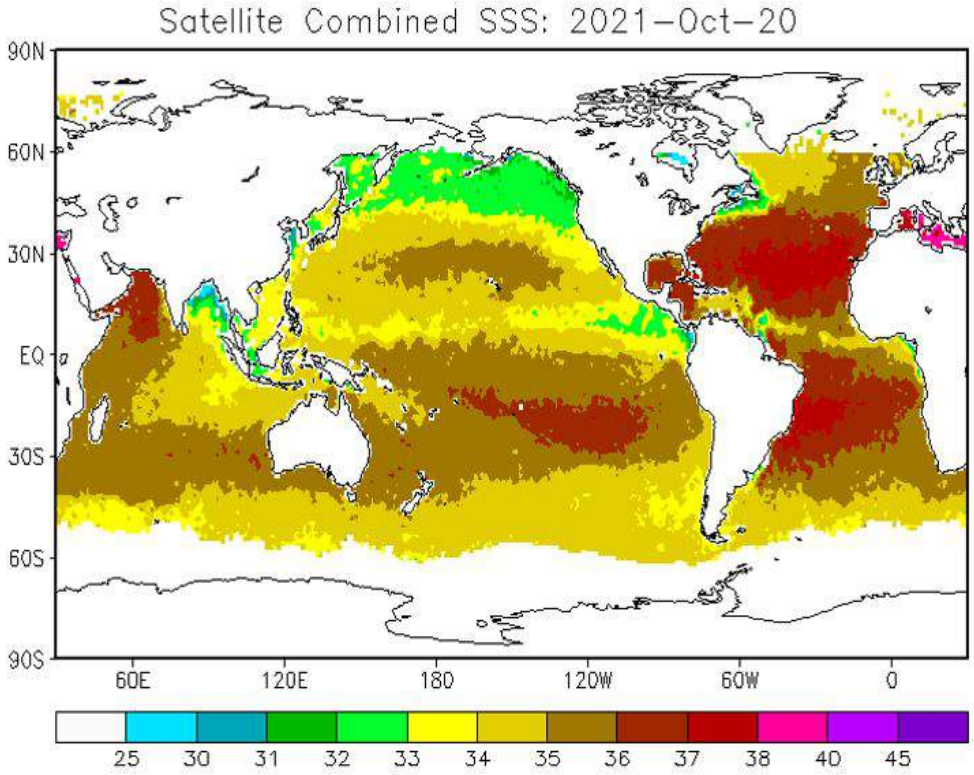
Updated DAILY



The BASS Blended Salinity Analysis

4) Experimental Daily SSS Analysis

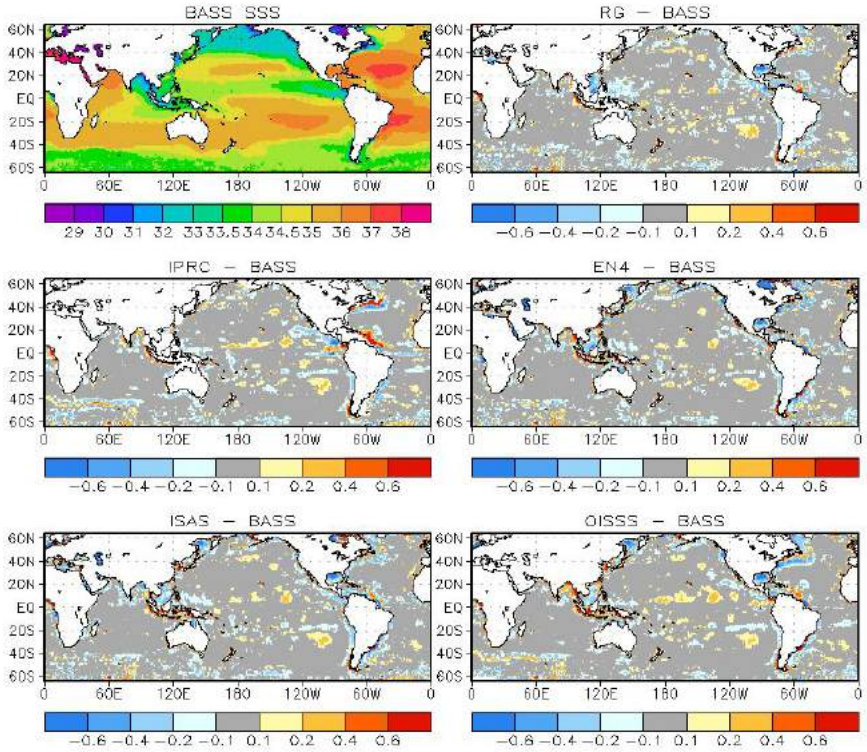
- *As of 2022, in situ measurements of DAILY SSS are still NOT available operationally;*
- *An experimental blended analysis of global SSS is developed:*
  - *Taking the bias-corrected daily SSS for each individual satellites as inputs;*
  - *Defining the random error of the bias-corrected SSS as a function of satellite sensor type, sampling size, region and season;*
  - *Defining the blended SSS as the weighted mean of the individual bias corrected satellite estimates with the weights inversely proportional to the error variance;*



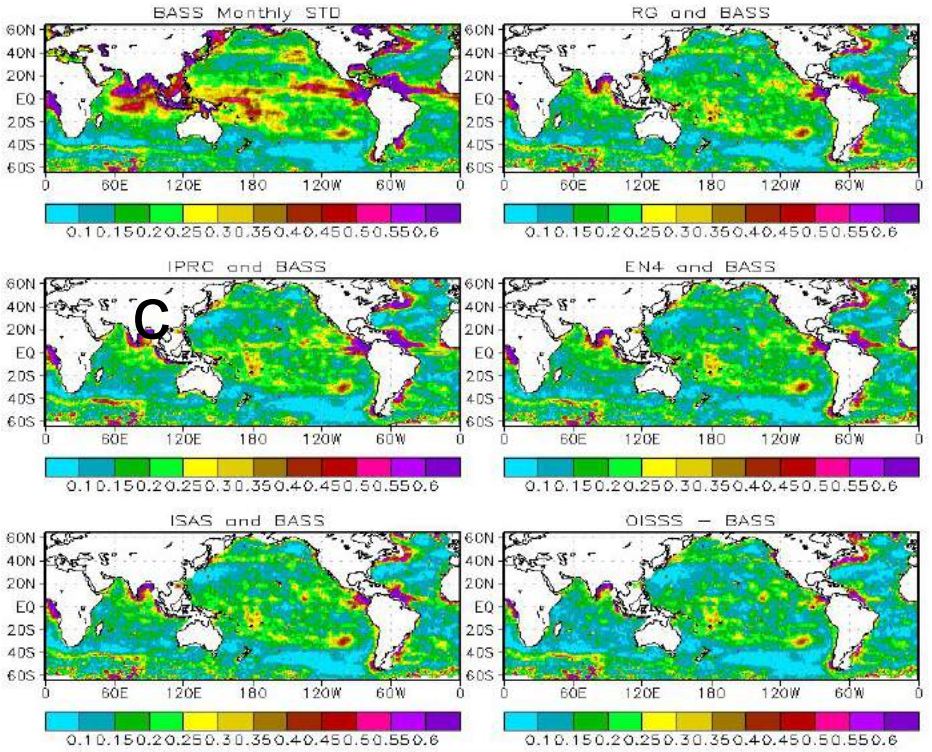
The BASS Blended Salinity Analysis

5) Comparison with other SSS products [1/2]

- **Compared monthly BASS with several SSS data sets, including:**
  - (Top-Right)RG: Roemmich-Gilson Scripps (RG) gridded Argo product,
  - (Middle-Left) IPRC: International Pacific Research Center (IPRC) gridded Argo product,
  - (Middle-Right) EN4: the latest version 4 the "EN" series of data sets (EN4) from Met Office Hadley Centre,
  - (Bottom-Left) ISAS: In Situ Analysis System (ISAS) from Laboratoire de Physique des Océans (LPO), and
  - (Bottom-Right) OISSS: the Optimal Interpolation analysis of SSS (OISSS) from IPRC and Remote Sensing System (RSS).



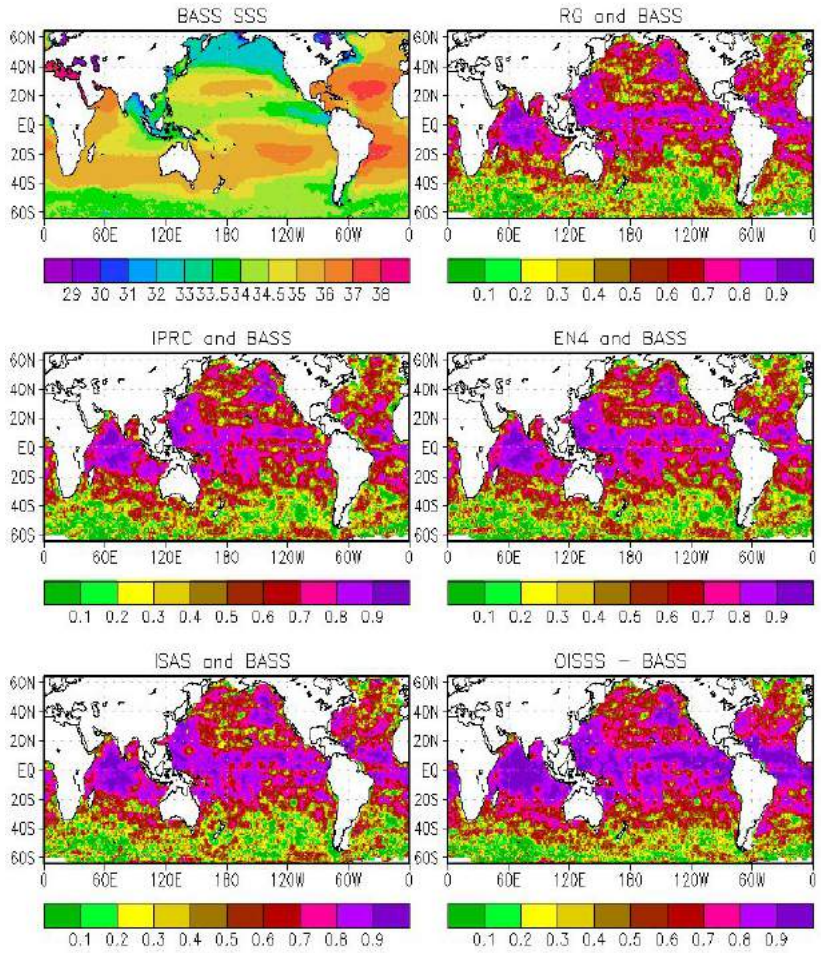
(top-left) BASS annual mean SSS;
(Other panels) Differences if other products against BASS



(top-left) Standard Deviation of monthly BASS SSS
(Other panels) RMS differences between other products and BASS

The BASS Blended Salinity Analysis

6) Comparison with other SSS products [2/2]



(top-left) BASS annual mean SSS;

(Other panels) Monthly anomaly correlation between BASS and other products

- BASS and all other SSS products examined here are capable of capturing the large-scale patterns of SSS variations quite well;
- However, they do show differences over regions of Gulf Streams, eastern Equatorial Pacific Ocean, Amazon river mouth, and Southern Ocean;
- Among the 5 other SSS products examined here, the OISSS exhibits the closest overall agreements with our BASS data set;

SSS and E-P Monitoring Package

1) Overview

- Using the monthly and pentad BASS SSS analyses and the satellite precipitation and evaporation data sets, an observation based product suite is constructed and updated to monitor the SSS and associated fresh water variations on a real-time basis;

- The real-time updated package is provided to CPC Monthly Ocean Briefing

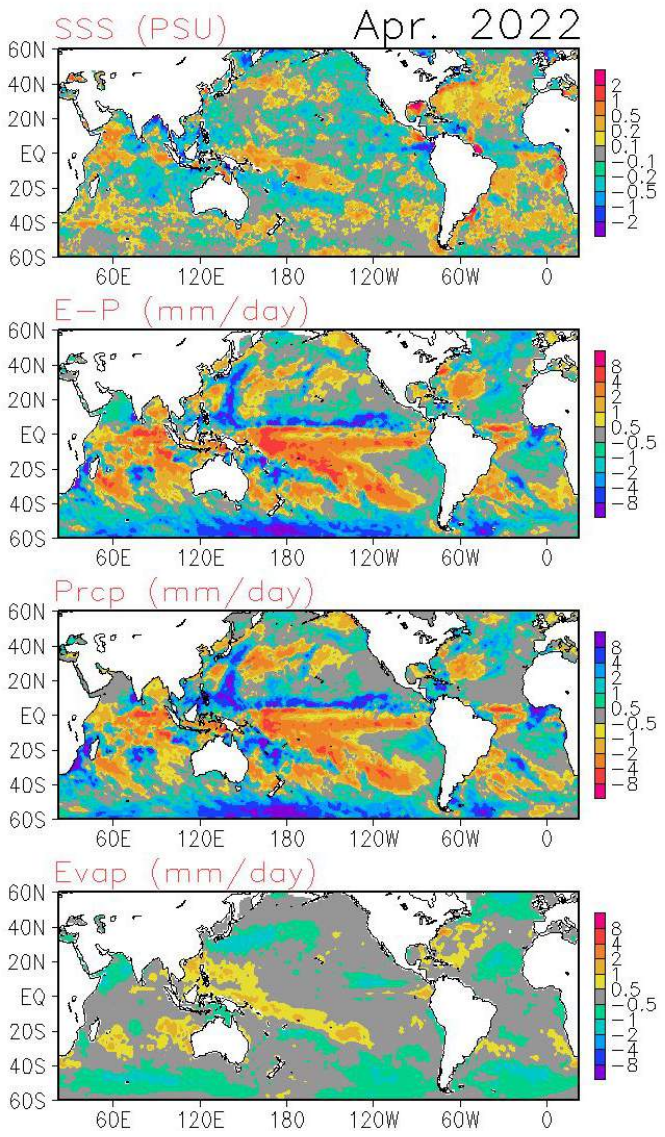
- **Observational Data Sets:**

  SSS: BASS in situ – satellite blended

  Precipitation: CMORPH satellite estimates

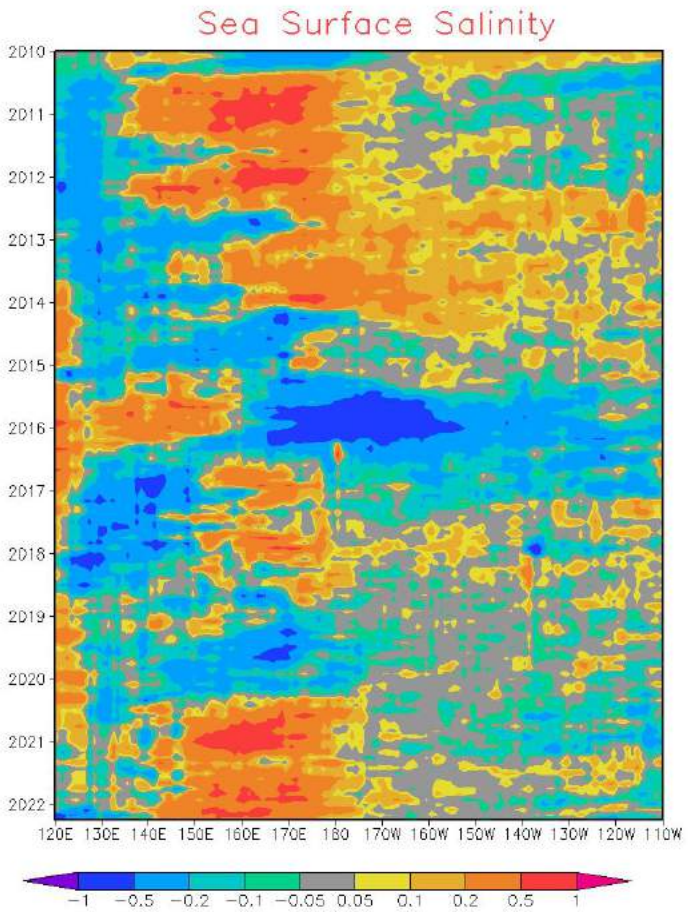
  Evaporation: CFSR adjusted OAFlux

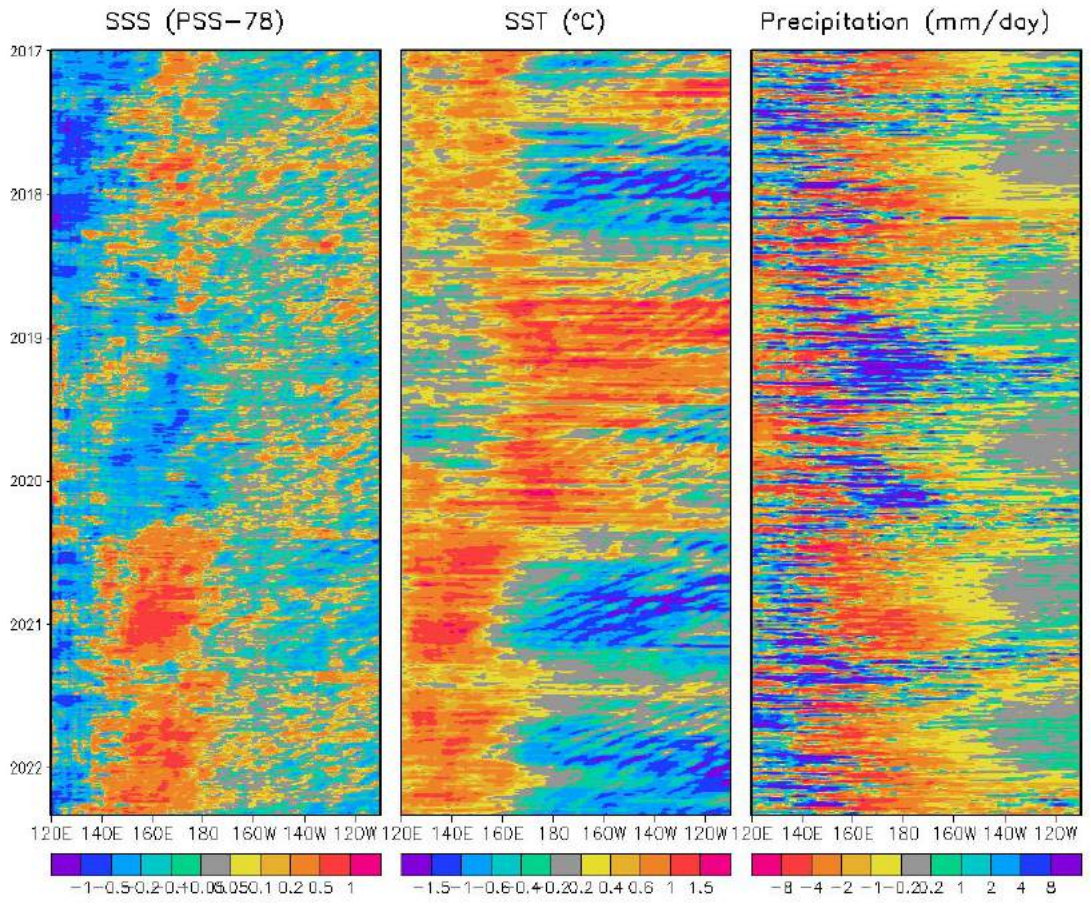
- *(Right) Example of the monthly anomalies of SSS (top), E-P (2nd from top), precipitation (3rd from top), and evaporation (bottom) for April 2022.*\



SSS and E-P Monitoring Package

2) Hovermoller Diagrams





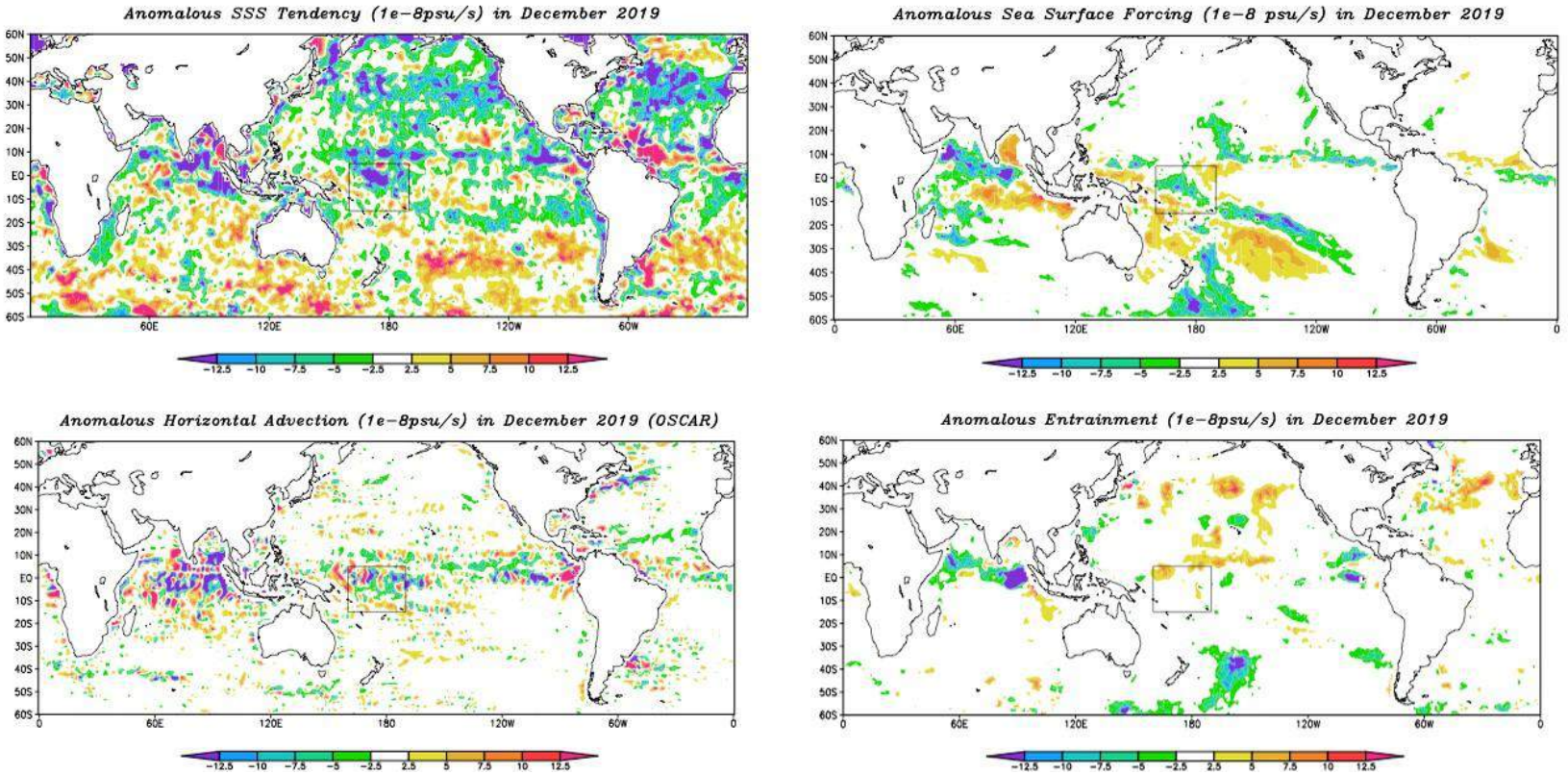
- Hovemoller diagram for equatorial **MONTHLY** SSS anomaly **(5°S-5°N);**

Hovemoller diagram for equatorial (5°S-5°N) **PENTAD (5-day) mean** SSS, SST and precipitation anomalies.

SSS and E-P Monitoring Package

3) Attribution of Monthly Salinity Anomaly

A prototype tool is developed to conduct quantitative attribution of the SSS anomaly observed over various parts of the global ocean. Components of SSS anomaly caused by a) fresh water flux (E-P), b) horizontal advection, and c) vertical entrainment are computed. The computation is carried out through mixed layer budget model using SSS, evaporation, precipitation data from the CPC SSS-fresh water flux package, and ocean currents data from OSCAR.



*(**top-left**) Total SSS anomaly tendency, and anomaly components contributed by (**top-right**) surface forcing of fresh water flux, (**bottom-left**) horizontal advection, and (**bottom-right**) vertical entrainment for December 2019.*

Summary

- Analyses of monthly, pentad, and daily sea surface salinity are constructed on a 1olat/lon grid over the global ocean through blending the information from the in situ measurements and satellite retrievals;

- The monthly and pentad analyses are updated on a real-time basis and available through ftp at:

  https://ftp.cpc.ncep.noaa.gov/precip/BASS/

  (The daily analysis is still experimental as of May 2022.)

- An observation based package is generated to monitor the global SSS and associated fresh water flux variations. The package is provided to the CPC Monthly Ocean Briefing and available at the above mentioned ftp site;

- Work is underway to complete the development of the tool to conduct quantitative attribution of the SSS anomaly to three different components (fresh water flux, advection and vertical entrainment).