Global Ocean Monitoring: Recent Evolution, Current Status, and Predictions

Prepared by

Climate Prediction Center, NCEP/NOAA

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http://www.cpc.ncep.noaa.gov/products/GODAS/

This project to deliver real-time ocean monitoring products is implemented by CPC in cooperation with NOAA's Ocean Observing and Monitoring Division (OOMD)

Outline

- **Overview**
- **Recent highlights**
  - **Pacific/Arctic Ocean**
  - **Indian Ocean**
  - **Atlantic Ocean**
- **Global SSTA Predictions**

➢ **Tropical Pacific was modulated by an MJO event**

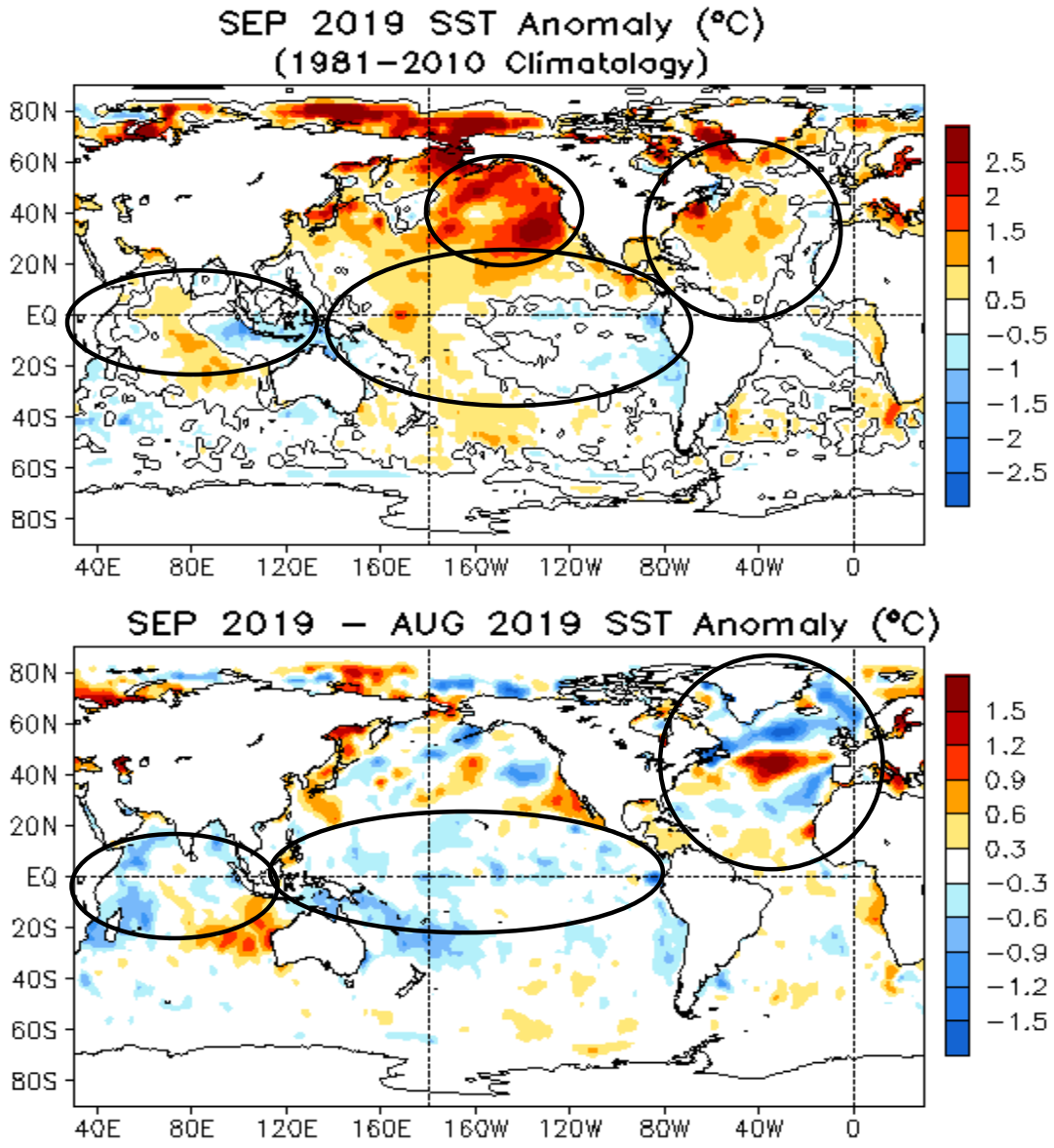
➢ **Sea level predictions**

Overview

- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 10 October 2019 indicated that *"ENSO-neutral is favored during the Northern Hemisphere fall 2019 (~85% chance), continuing through spring 2020 (55-60% chance)"***
  - **SSTs were near normal in the tropical Pacific with small positive (negative) anomalies in the west (east) in Sep 2019, and NINO3.4 = -0.02^{o}C.**
  - **Positive SSTAs persisted in the NE Pacific in Sep 2019. The PDO switched to positive phase since March 2019 with PDOI = 0.25 in Sep 2019.**
- **Indian Ocean**
  - **IOD was in a strong positive phase during May-Sep 2019 with SSTAs generally positive (negative) in the west (far east), and IODI = 1.3.**
- **Atlantic Ocean**
  - **NAO was near normal in Sep 2019.**
  - **Positive SSTAs dominated in the N. Atlantic in Sep 2019, and previous tripole/horseshoe –like pattern became less evident.**

Global Oceans

Global SST Anomaly (^{0}C) and Anomaly Tendency



-SSTs were near normal in the tropical Pacific with small positive (negative) anomalies in the west (east); A Pacific Merdional Mode structure.

- Strong positive SSTAs persisted in the NE Pacific.

- Positive SSTAs dominated in the North Atlantic.

- In the Indian Ocean, SSTAs were positive in the west and central and negative in the far east, featuring the positive IOD structure.

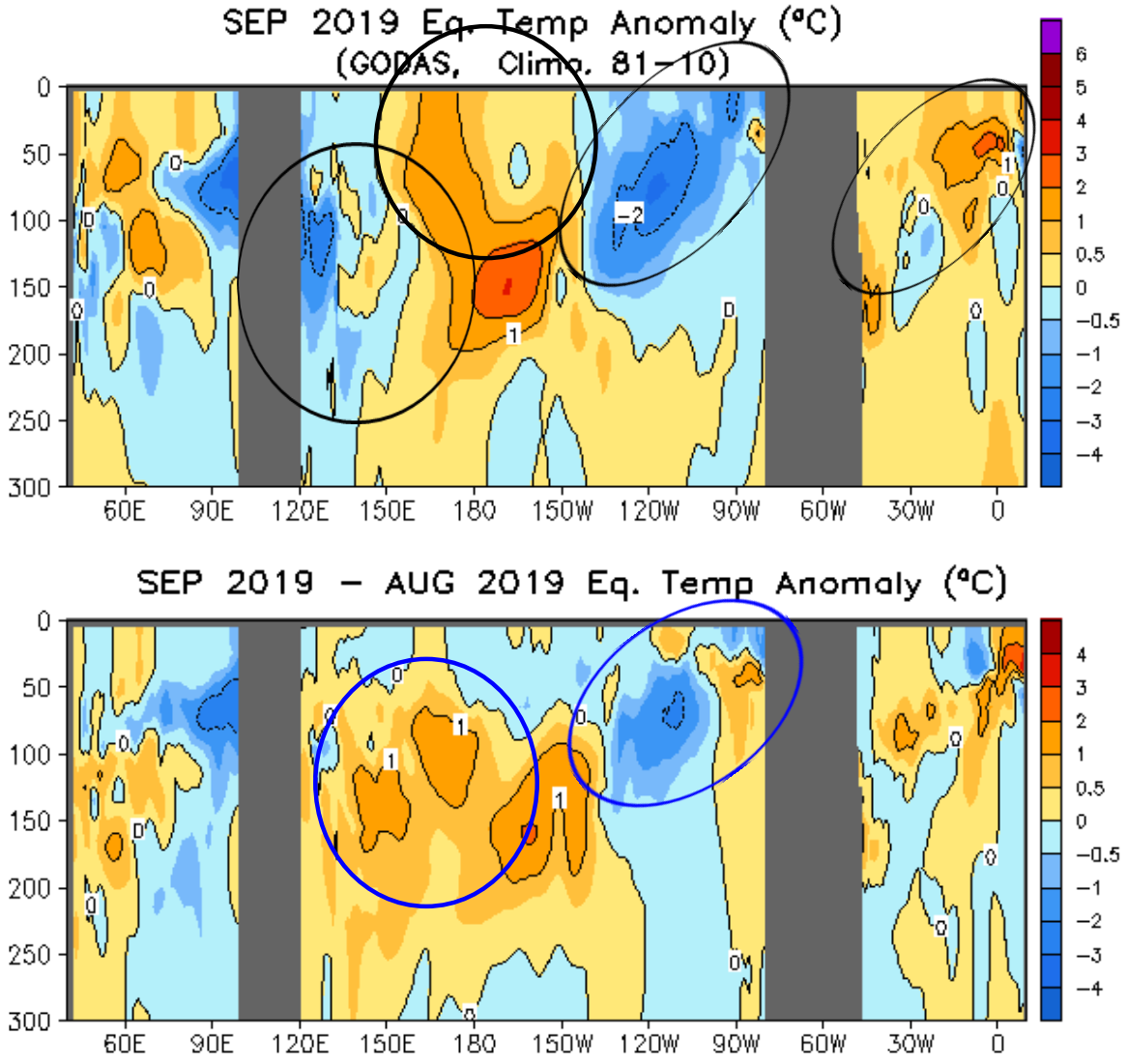
-Negative SSTA tendencies dominated in the whole tropical Pacific.

-Horseshoe/tripole-like SSTA tendencies were present in the North Atlantic.

-Negative (positive) SSTA tendencies were in the western (southeastern) Indian, indicating a weakening of IOD

Fig. G1. Sea surface temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N



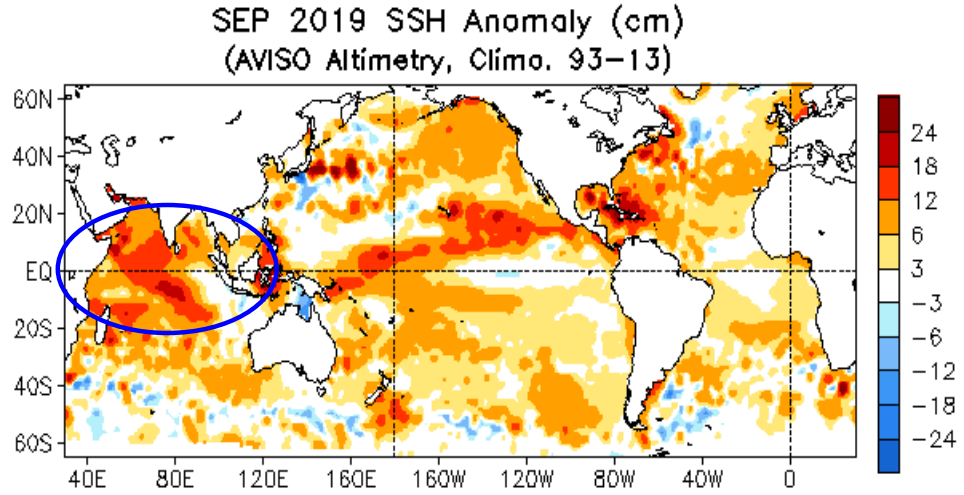
- **Positive (negative) temperature anomalies presented in the central (western and eastern) equatorial Pacific.**

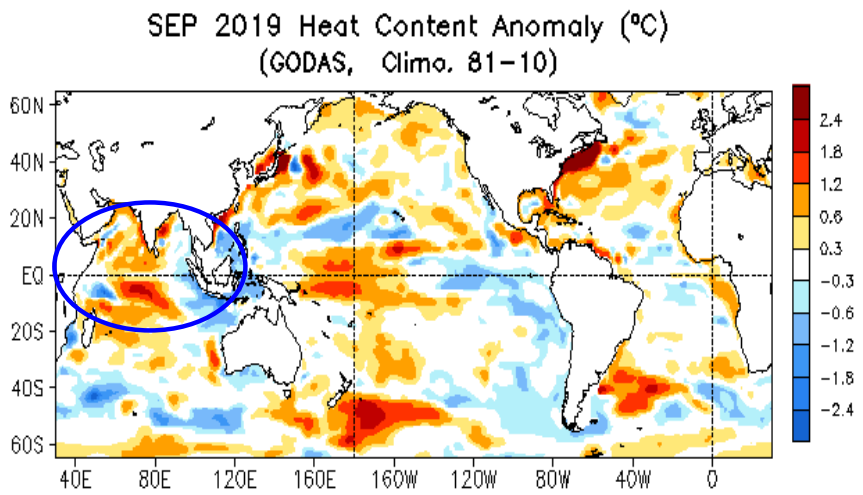
-**Positive temperature anomalies were present along the thermocline in the Atlantic Ocean.**

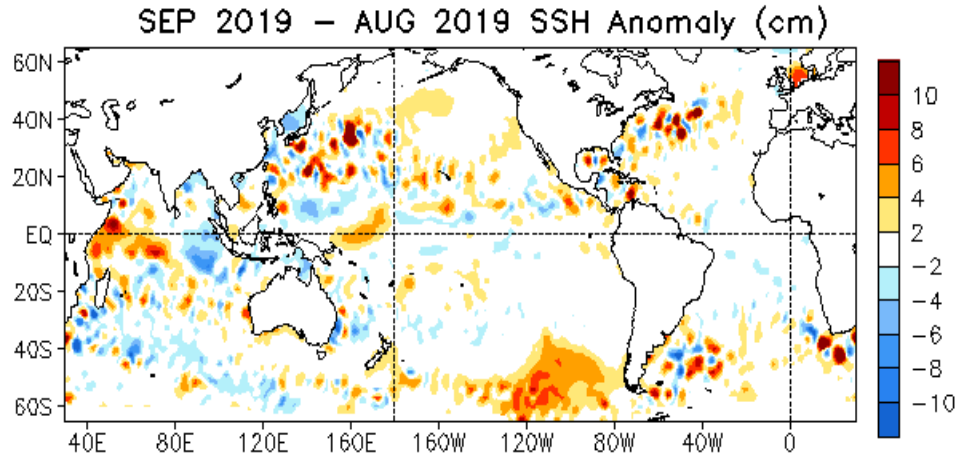
-**Temperature anomaly tendency was positive (negative) in the western and central (eastern) Pacific.**

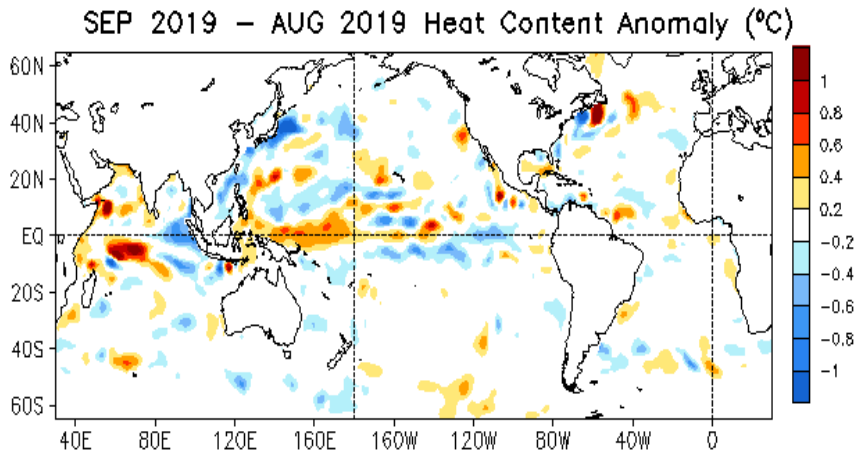
Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1981-2010 base period means.

Global SSH and HC300 Anomaly & Anomaly Tendency





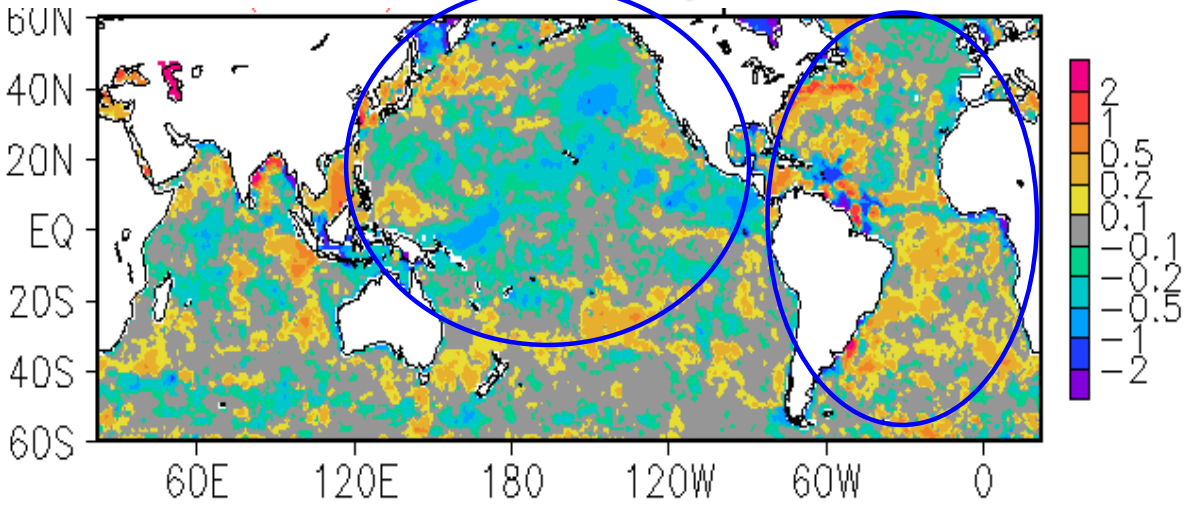




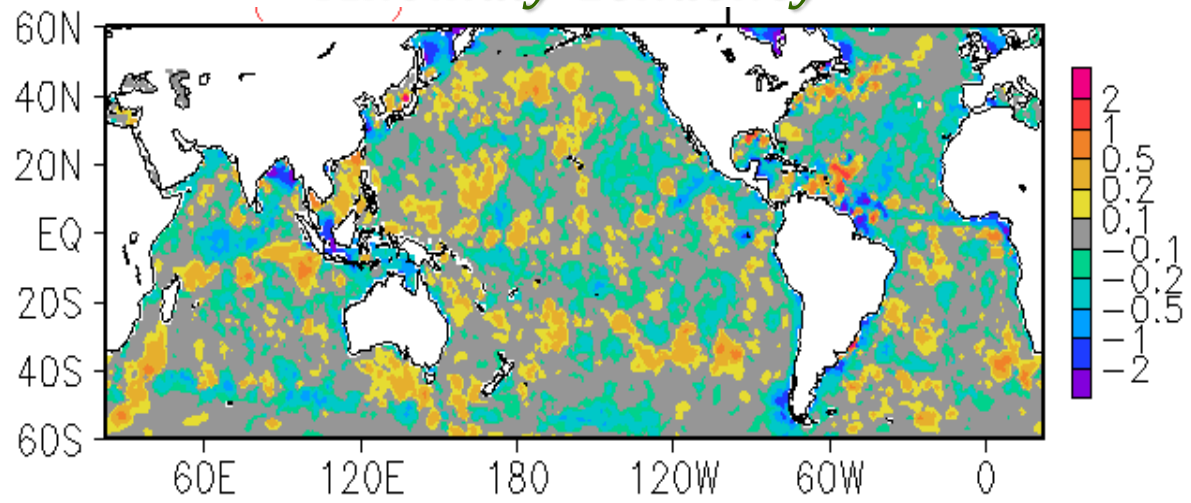
- **The SSHA pattern was overall consistent with the HC300A pattern.**
- **Both SSHA and HC300A in the tropical Indian were consistent with the positive IOD state.**
- **Tendencies of SSHA and HC300A include many small scale anomalies (e.g., mesoscale eddies).**

Global Sea Surface Salinity (SSS) for September 2019

Anomaly



Anomaly Tendency



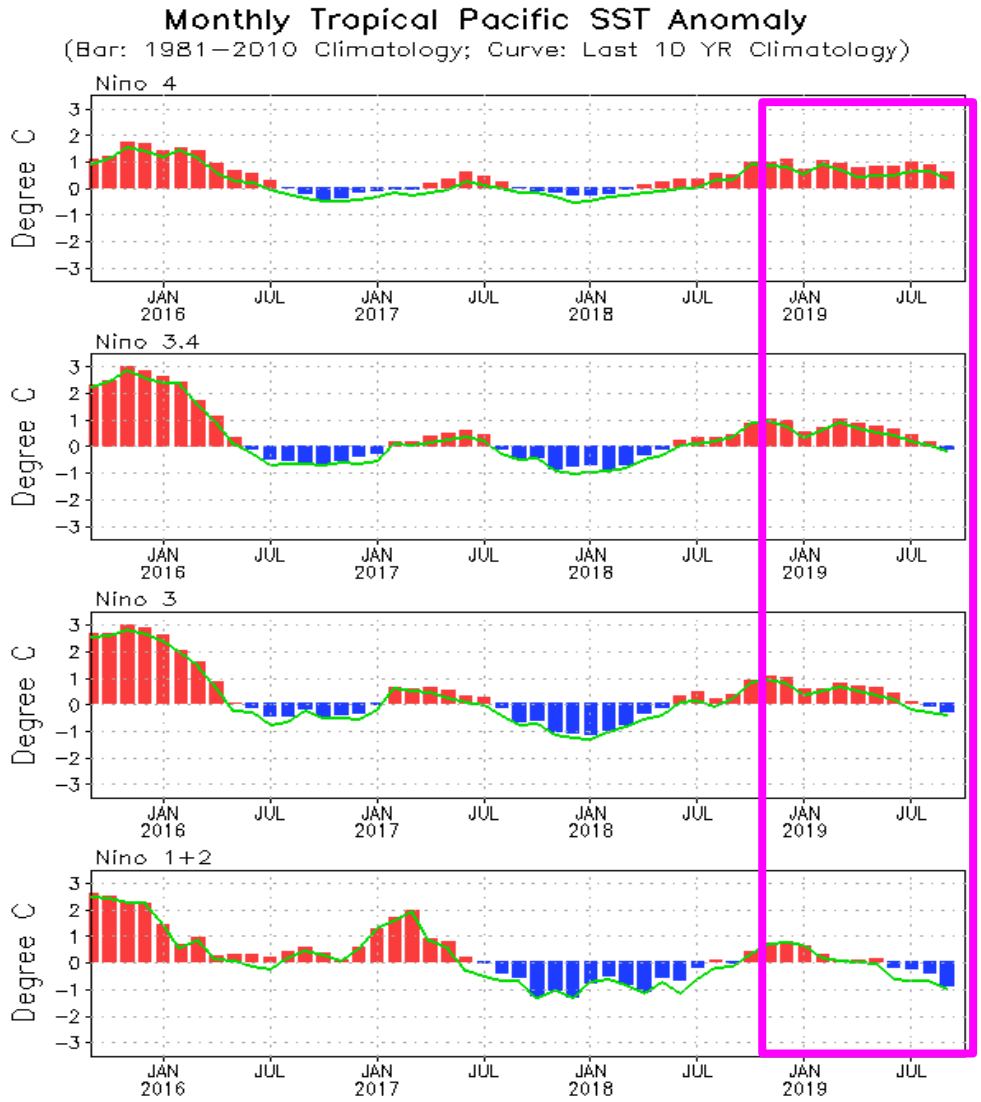
- **Most of the Pacific were featured by negative SSS anomalies**

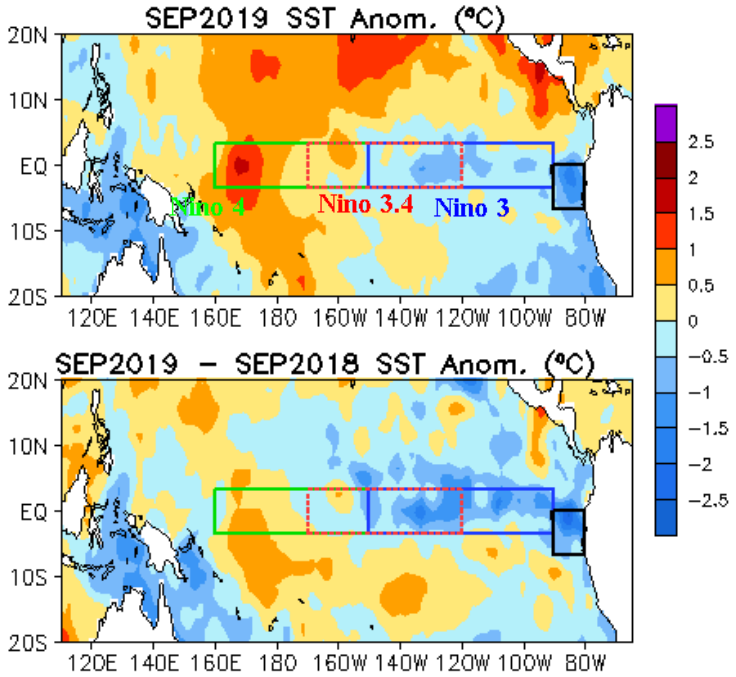
- **The Atlantic were generally featured by positive SSS anomalies**

Blended Analysis of Surface Salinity (BASS) V0.Z (Xie et al. 2014)

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices





- **All indices decreased, with Nino3.4, Nino3 and Nino1+2 negative in Sep 2019.**

- **Nino3.4 = -0.02C in Sep 2019.**

- **Compared with Sep 2018, the central and eastern equatorial Pacific was cooler in Sep 2019.**

- **The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v5.**

Fig. P1a. Nino region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the specified region. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Tropical Pacific: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Winds

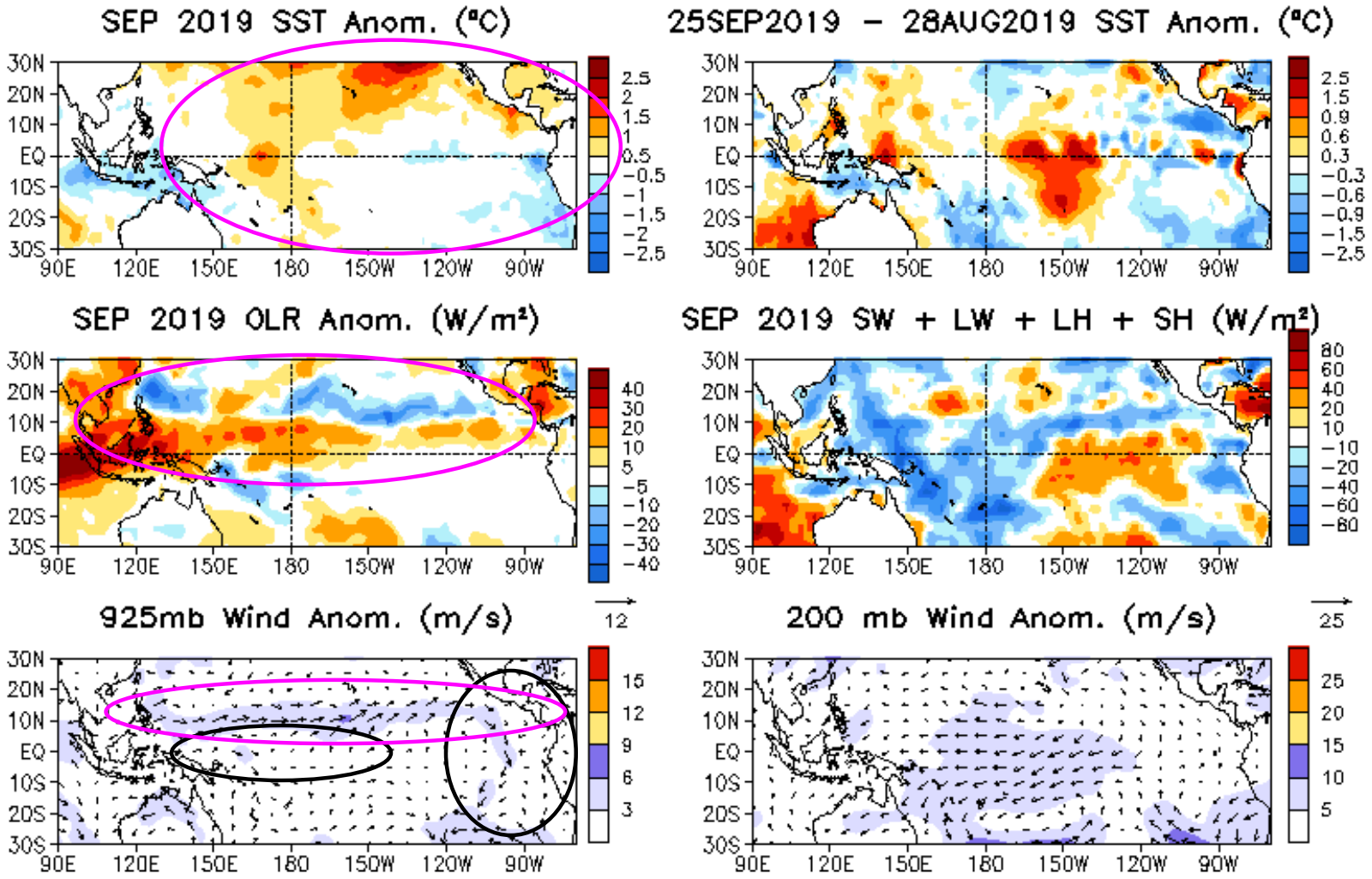
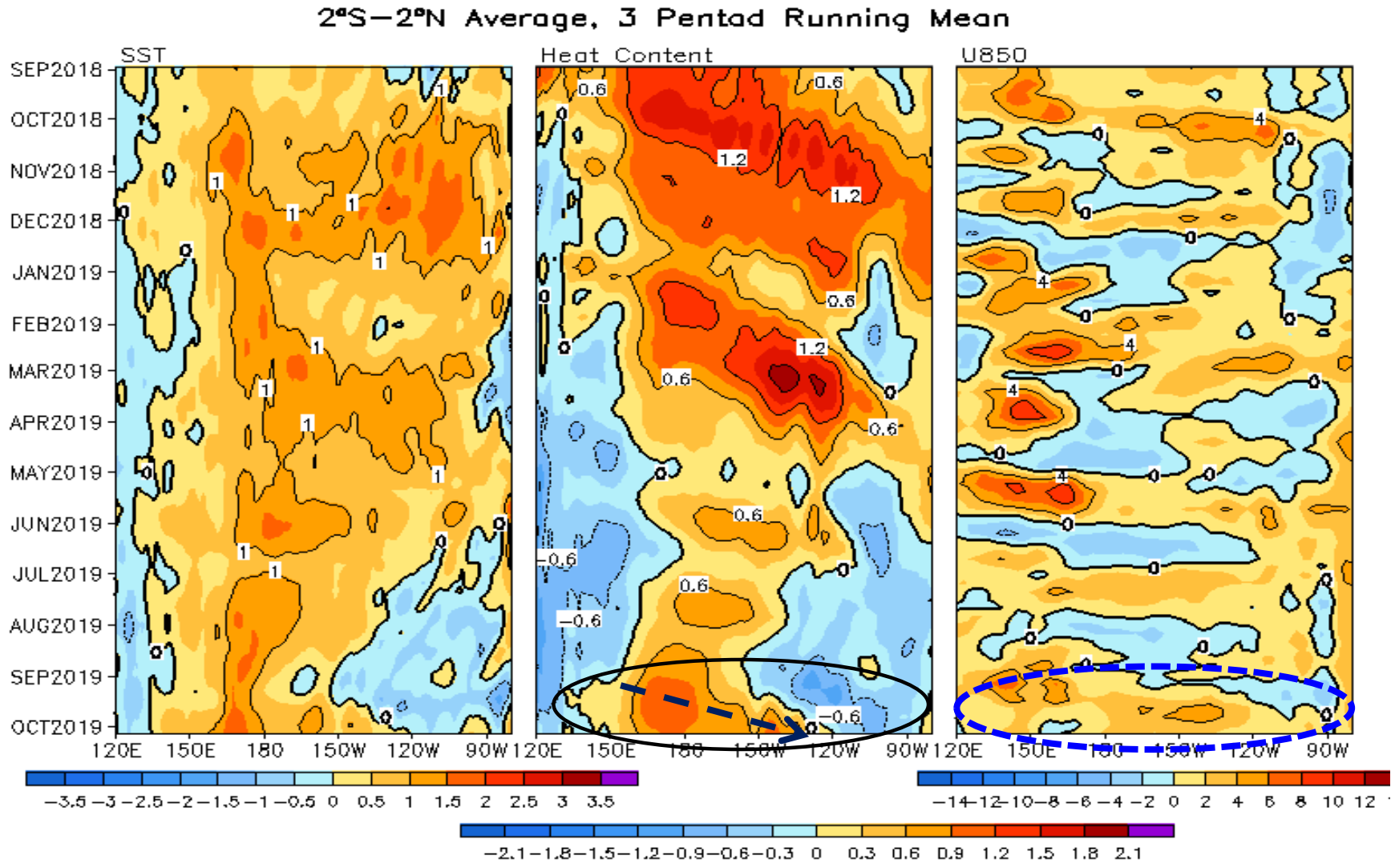


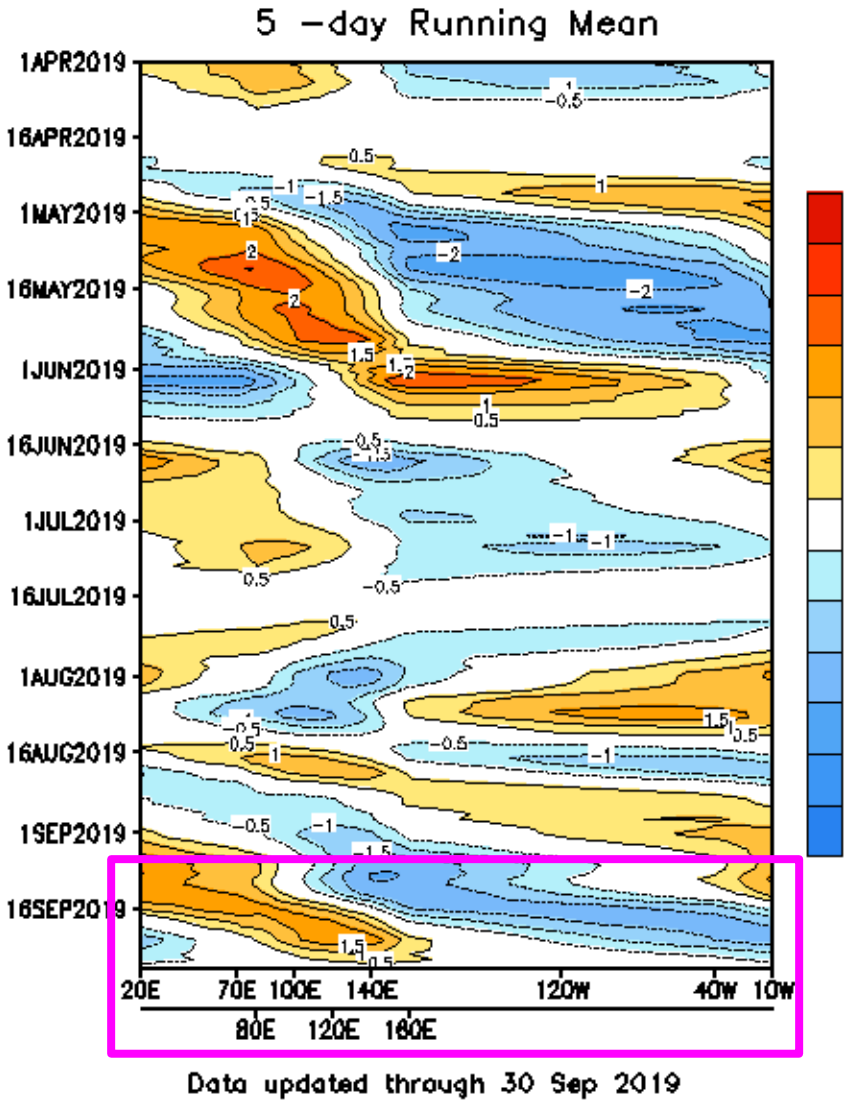
Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

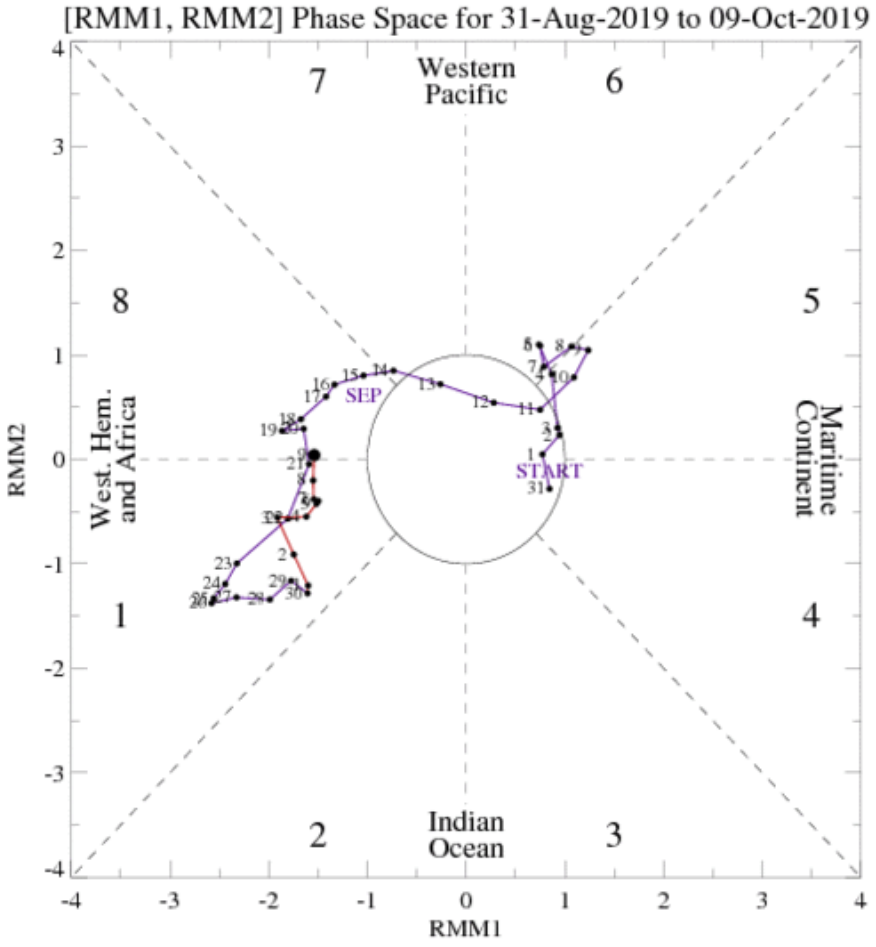
Equatorial Pacific SST (°C), HC300 (°C), u850 (m/s) Anomalies



- **SSTAs were positive (negative) in the western and central (eastern) Pacific in Sep 2019.**
- **Positive HC300A propagated from the western to eastern Pacific, consistent with low-level anomalous westerlies.**

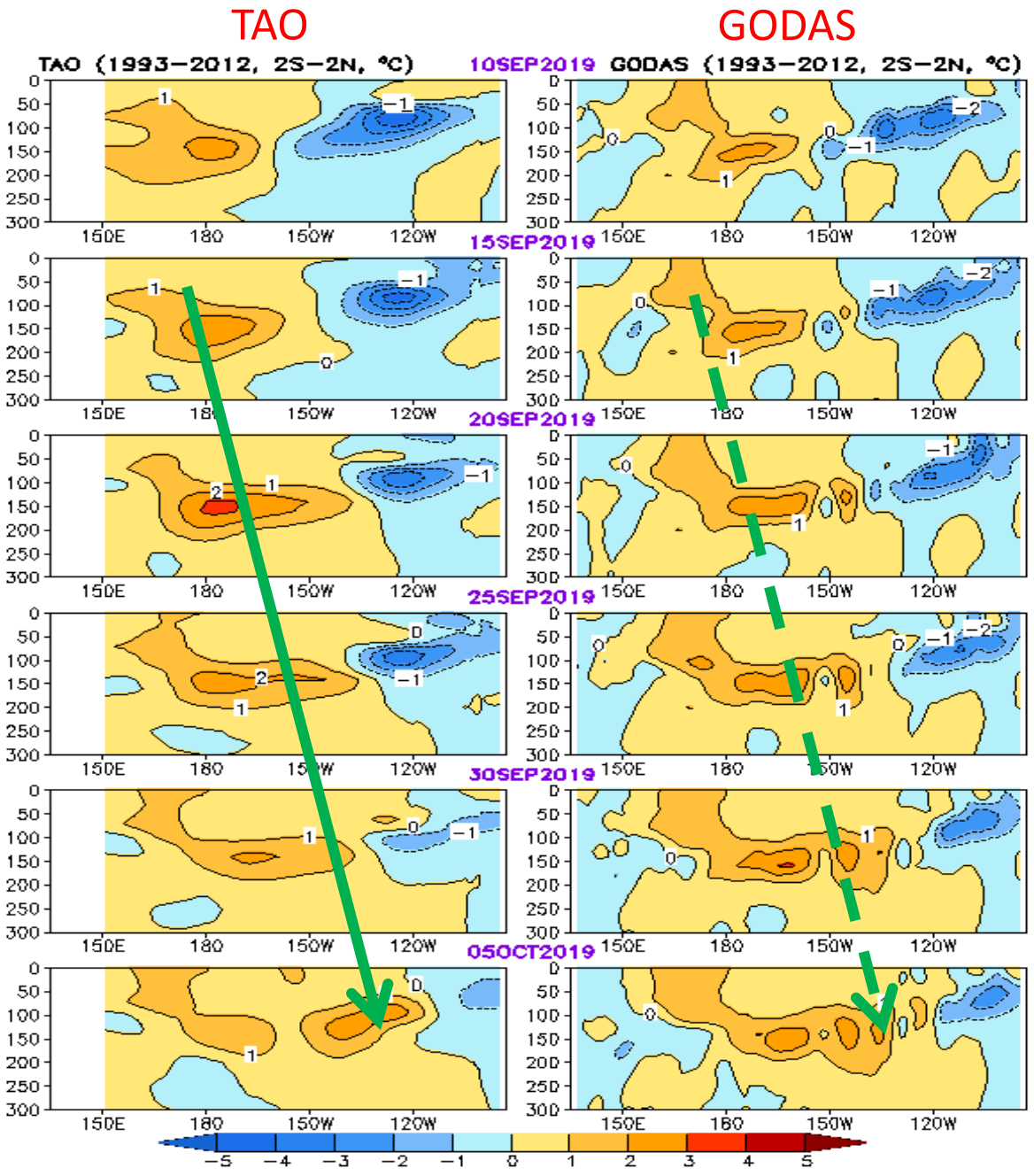
An MJO event occurred in Sep 2019





https://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/mjo.shtml#current

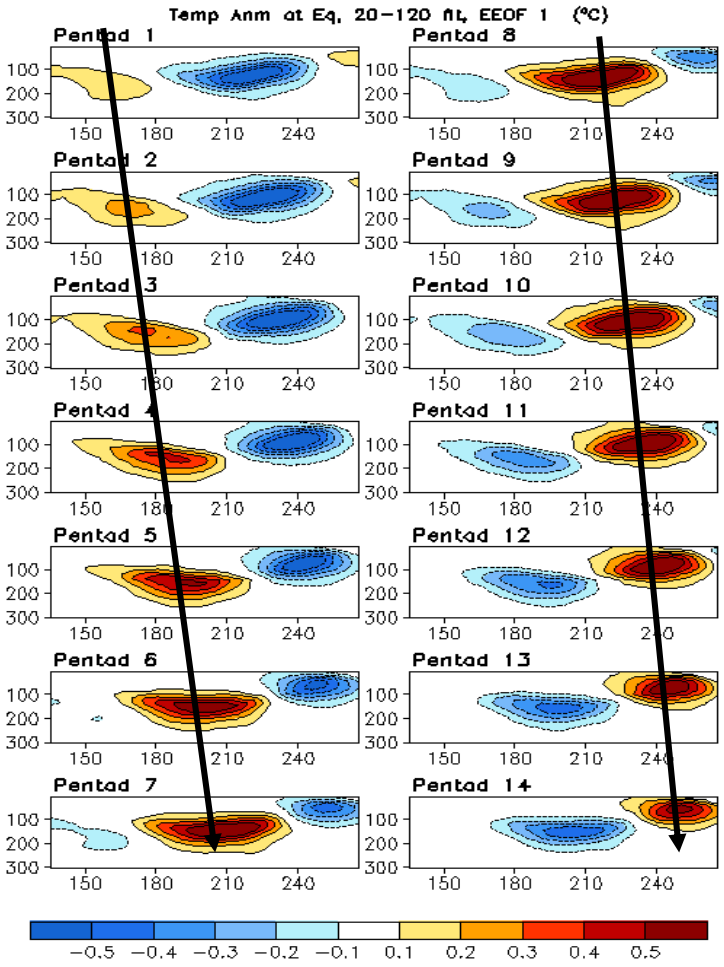
Equatorial Pacific Ocean Temperature Pentad Mean Anomaly

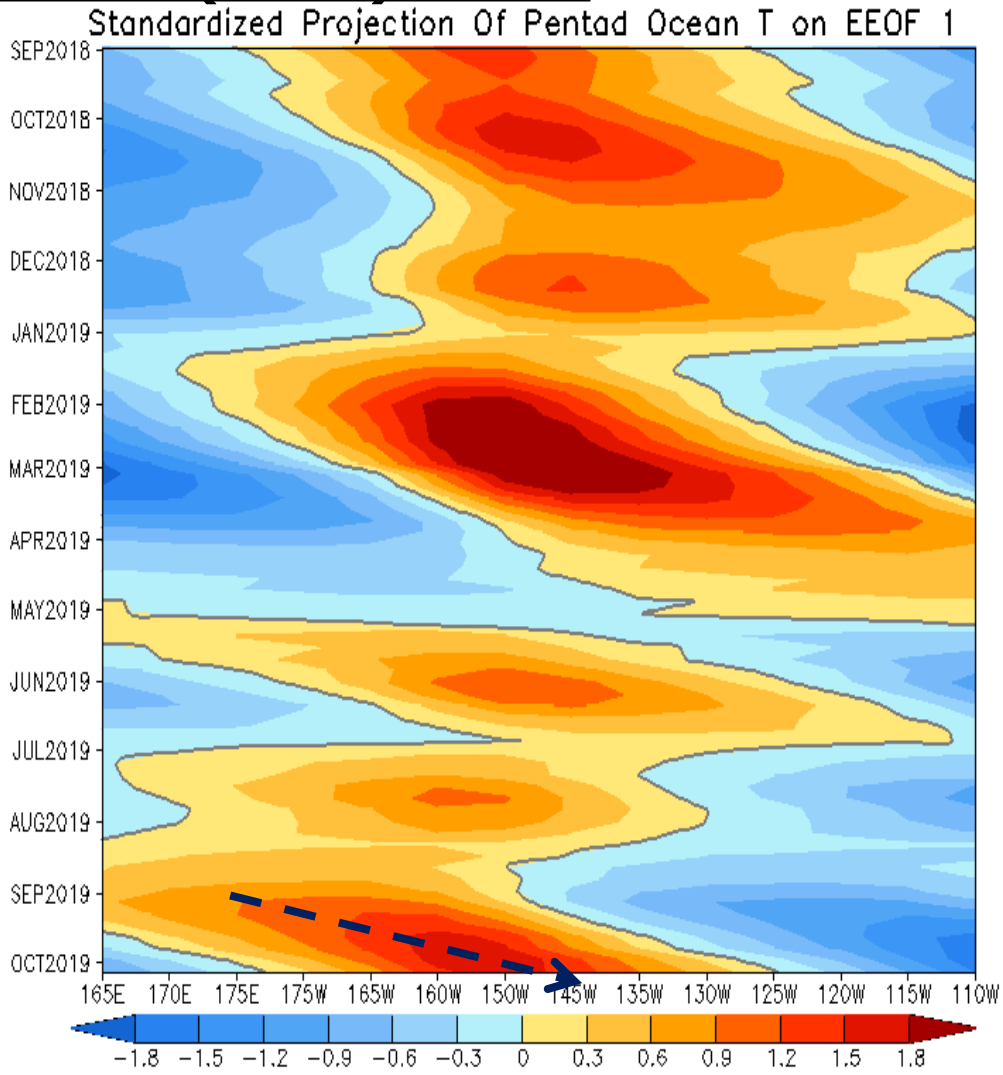


- **Positive ocean temperature anomalies propagated eastward.**

- **The features of the ocean temperature anomalies were similar between GODAS and TAO analysis.**

Oceanic Kelvin Wave (OKW) Index

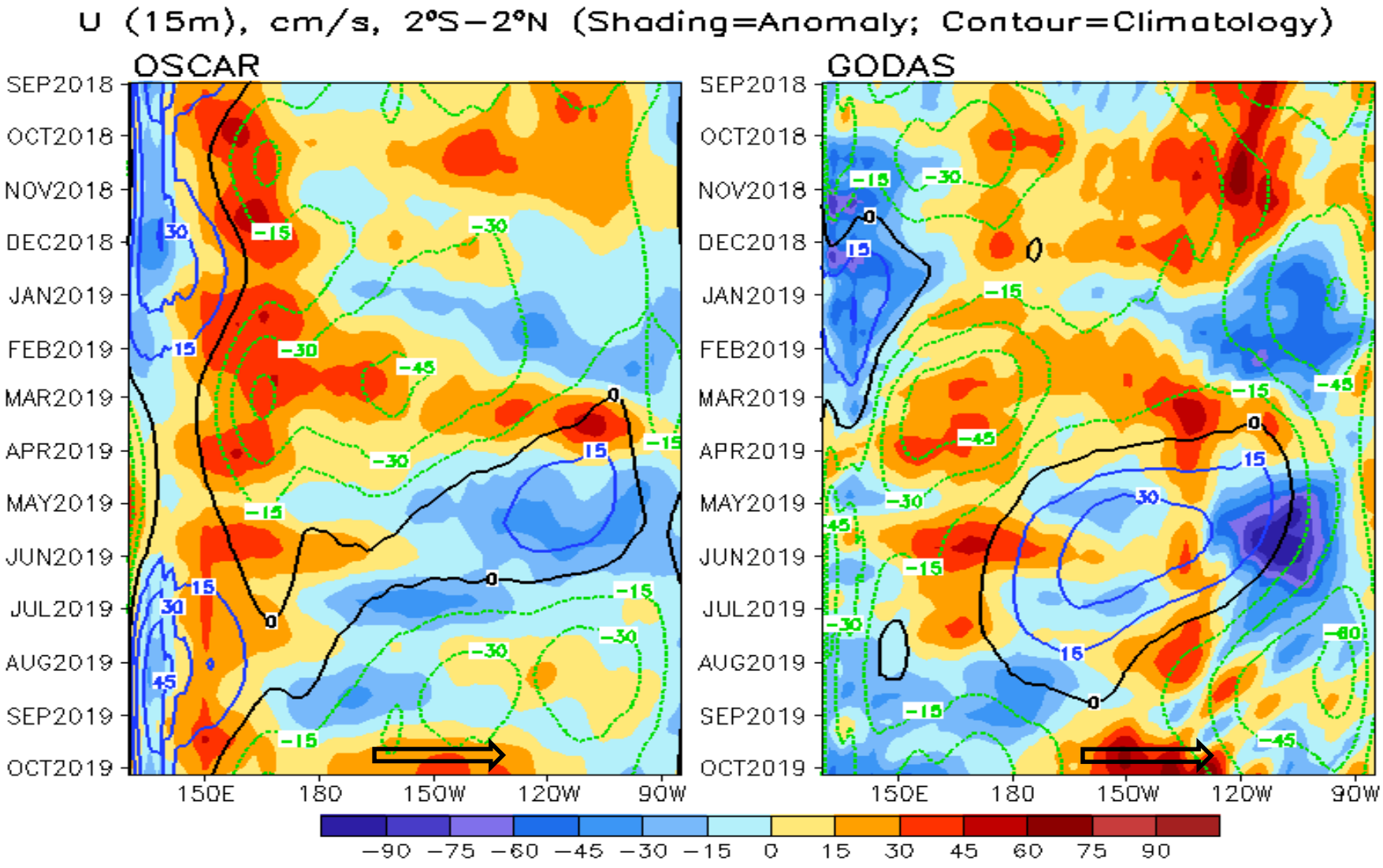




-Downwelling Kelvin wave activities were present in Sep 2019.

(OKW index is defined as standardized projections of total anomalies onto the 14 patterns of Extended EOF1 of equatorial temperature anomalies (Seo and Xue , GRL, 2005).)

Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- **Anomalous eastward currents appeared in the central Pacific in Sep 2019 in both OSCAR and GODAS.**

Warm Water Volume (WWV) and NINO3.4 Anomalies

- **WWV is defined as average of depth of 20°C in [120°E-80°W, 5°S-5°N]. Statistically, peak correlation of Nino3 with WWV occurs at 7 month lag (Meinen and McPhaden, 2000).**

- **Since WWV is intimately linked to ENSO variability (Wyrtki 1985; Jin 1997), it is useful to monitor ENSO in a phase space of WWV and NINO3.4 (Kessler 2002).**

- **Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.**

- **Equatorial Warm Water Volume (WWV) has been in a discharged phase since Apr 2019.**

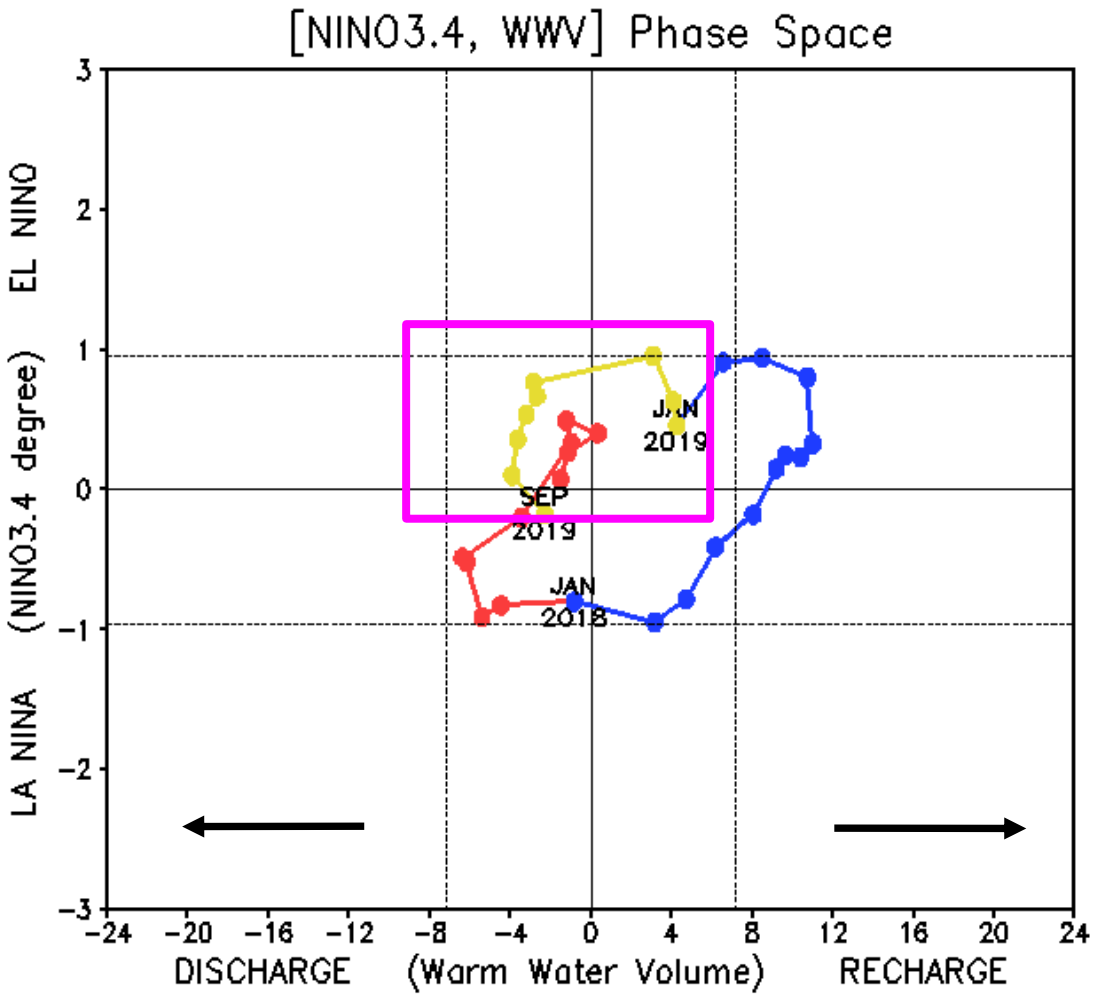
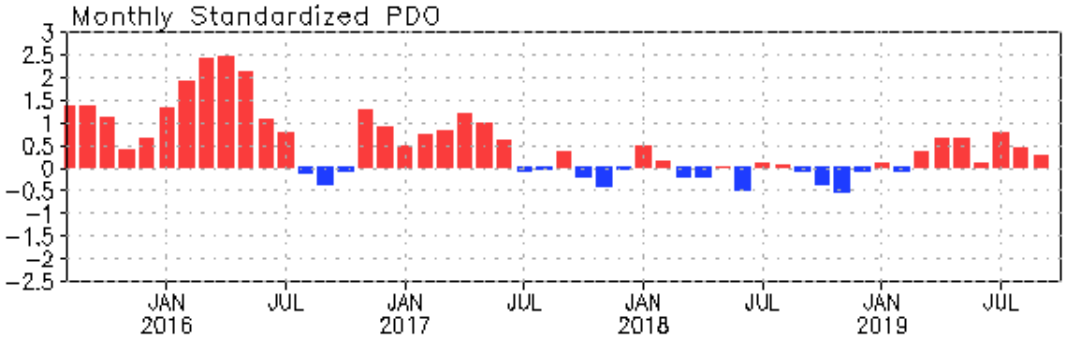
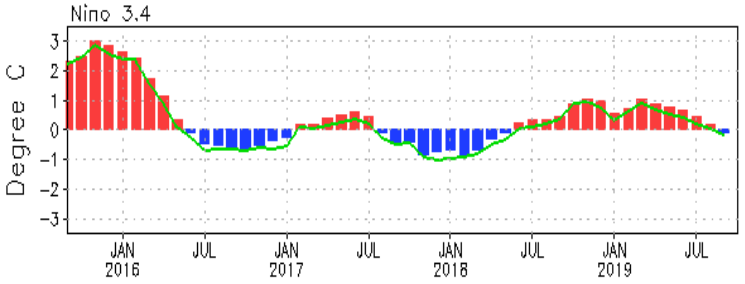


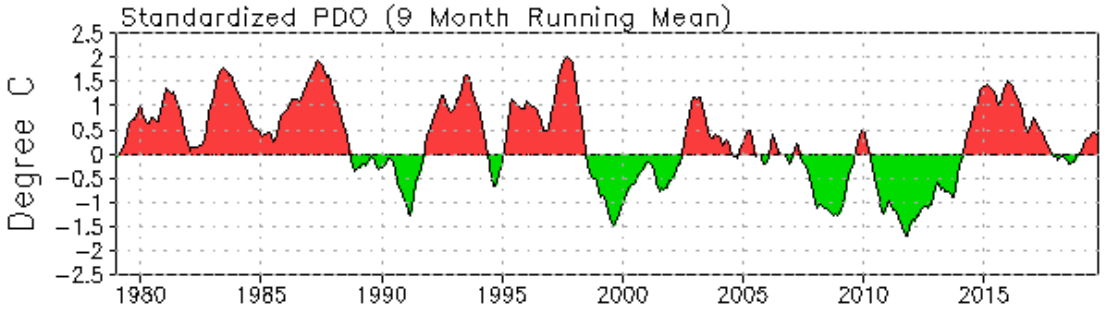
Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

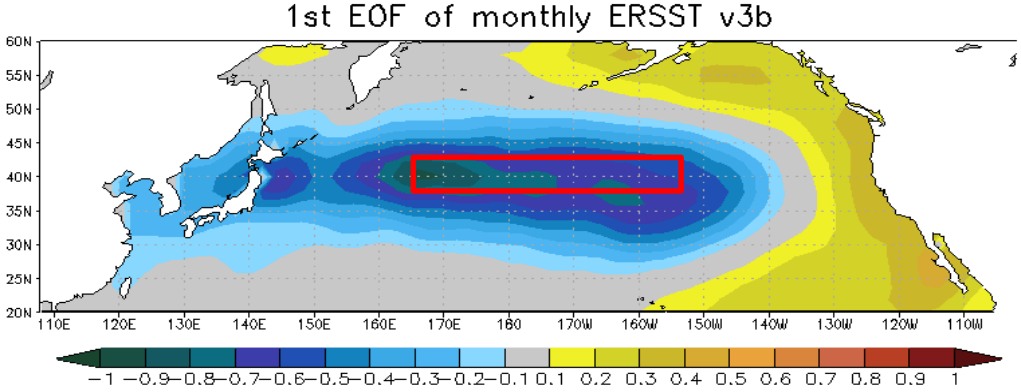
North Pacific & Arctic Oceans

PDO index









- The PDO switched to positive phase since Mar 2019 with PDOI = 0.25 in Sep 2019.

- Statistically, ENSO leads PDO by 3-4 months, through teleconnection via atmospheric bridge.

- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

- The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

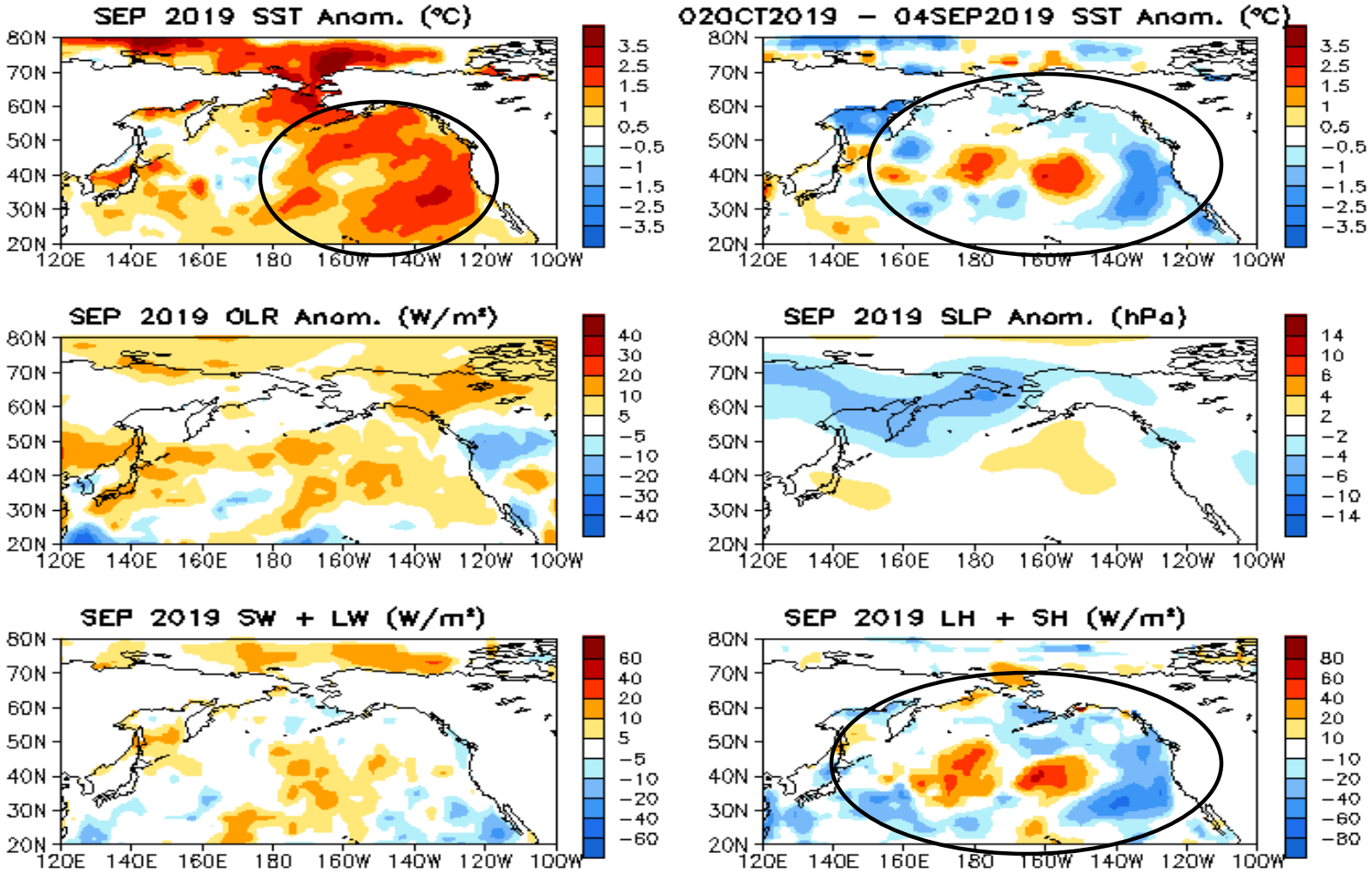
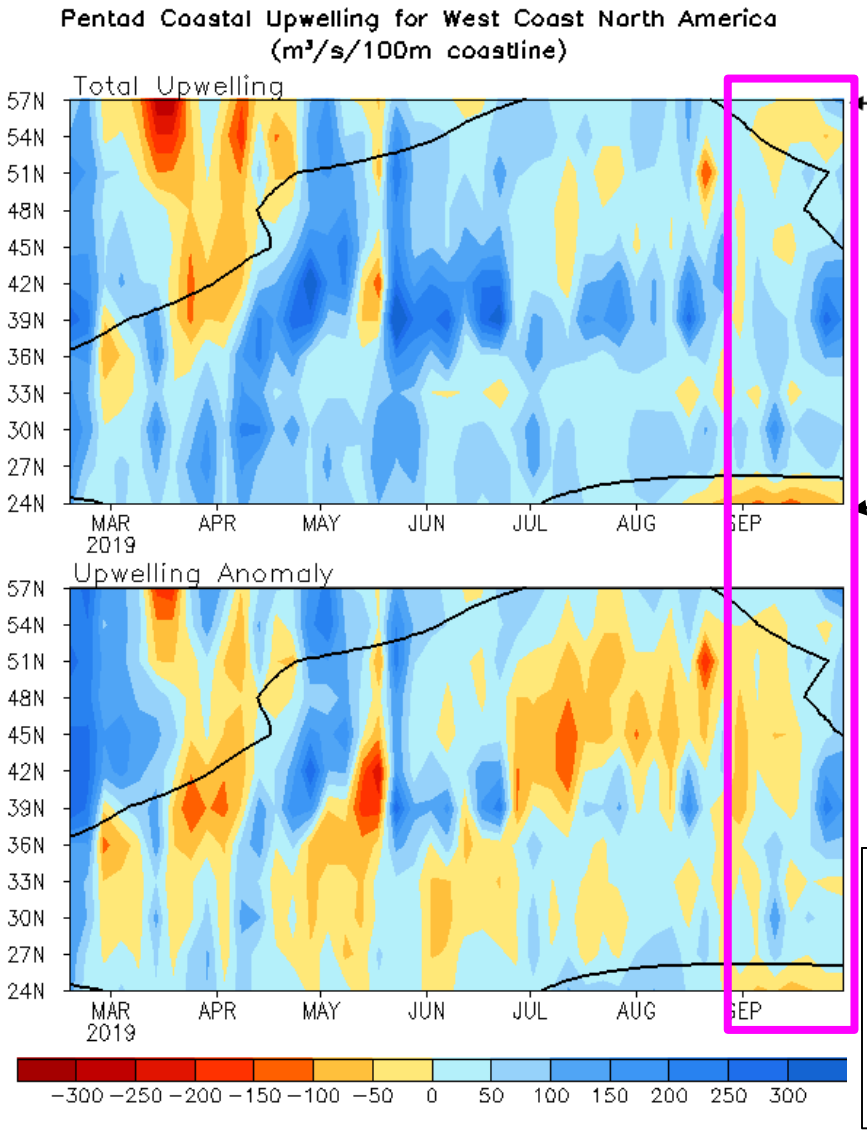
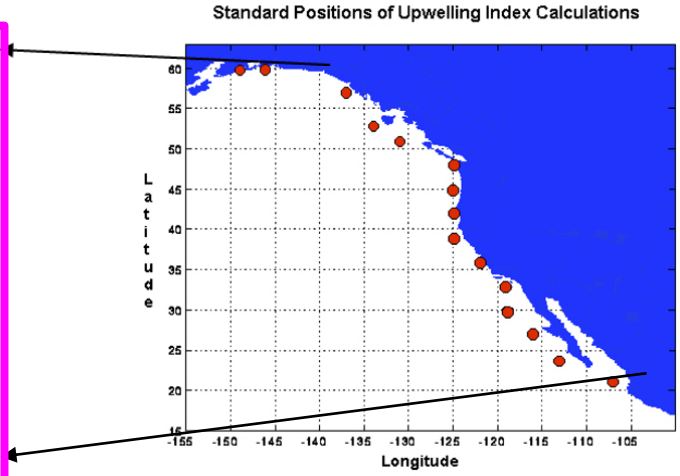


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

North America Western Coastal Upwelling



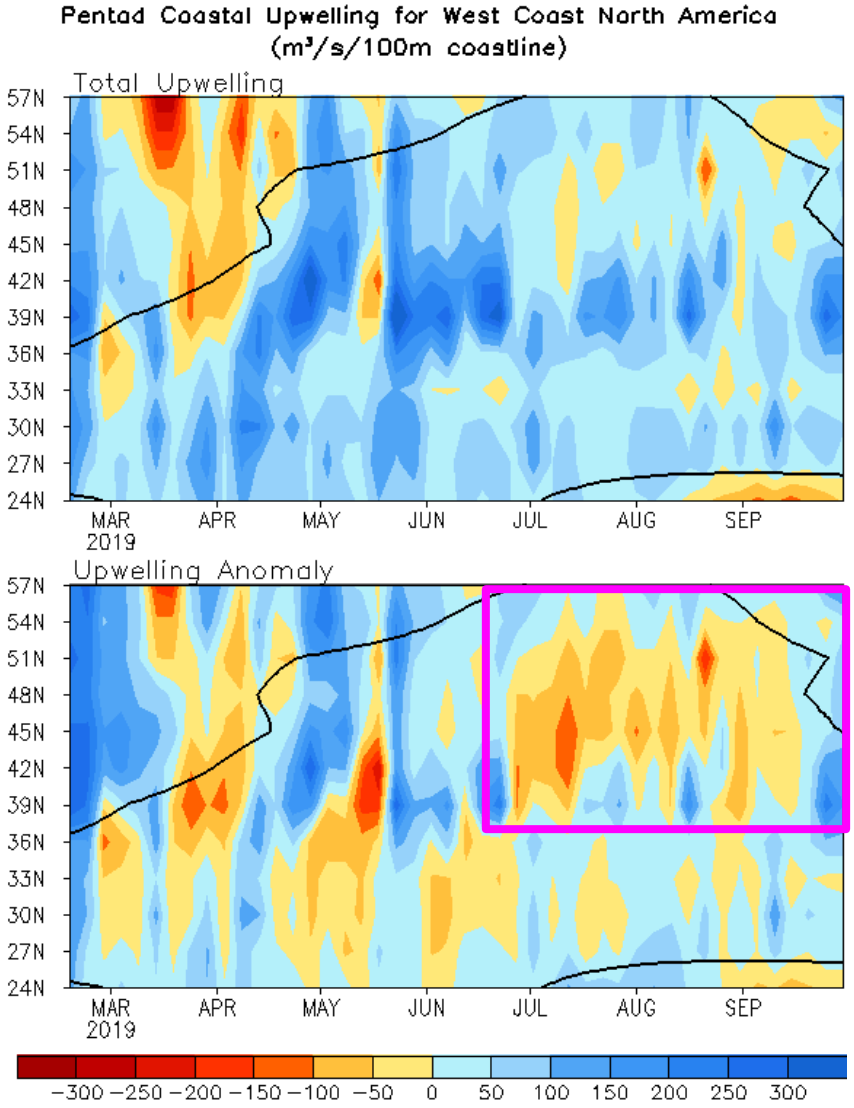


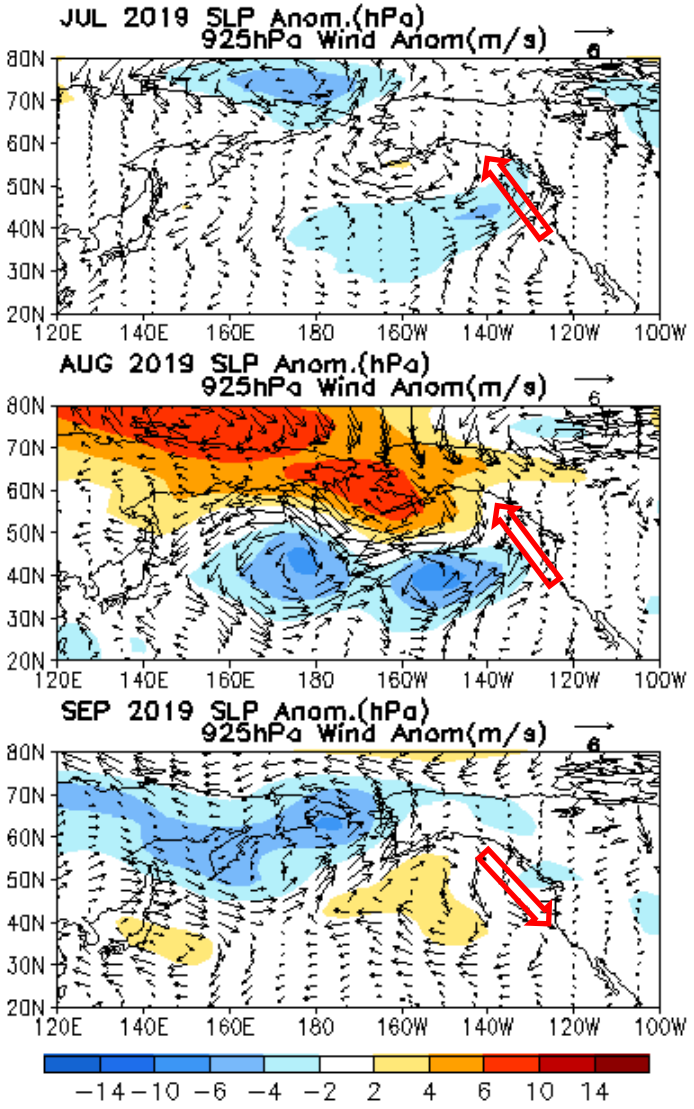
- **Upwelling north of 35N became stronger since mid-Sep 2019.**

Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point (m³/s/100m coastline). Anomalies are departures from the 1981-2010 base period pentad means.

- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.**

North America Western Coastal Upwelling

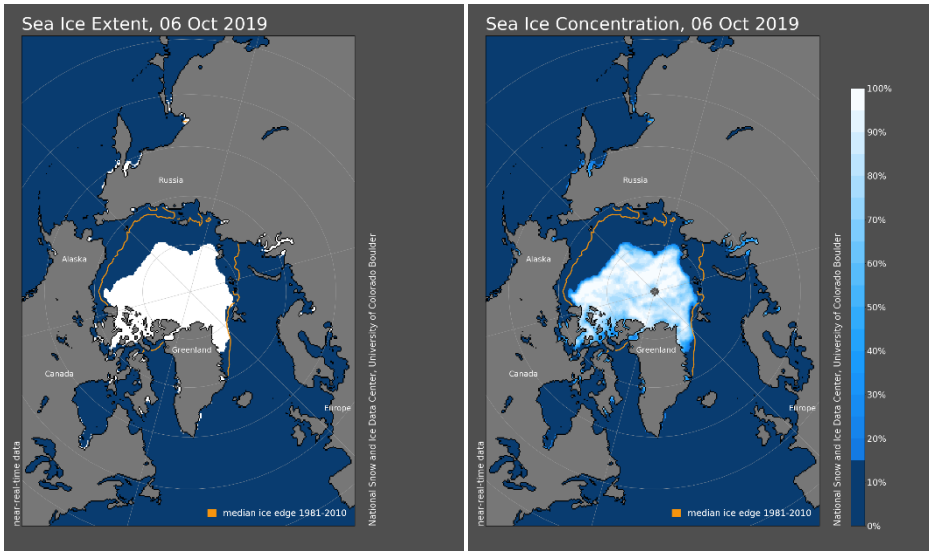


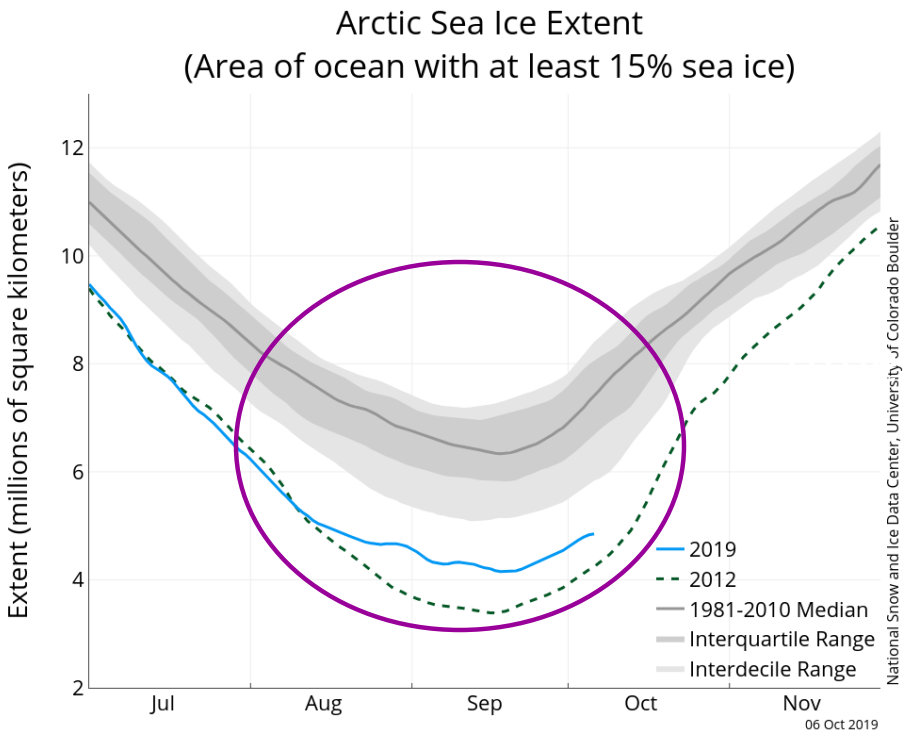


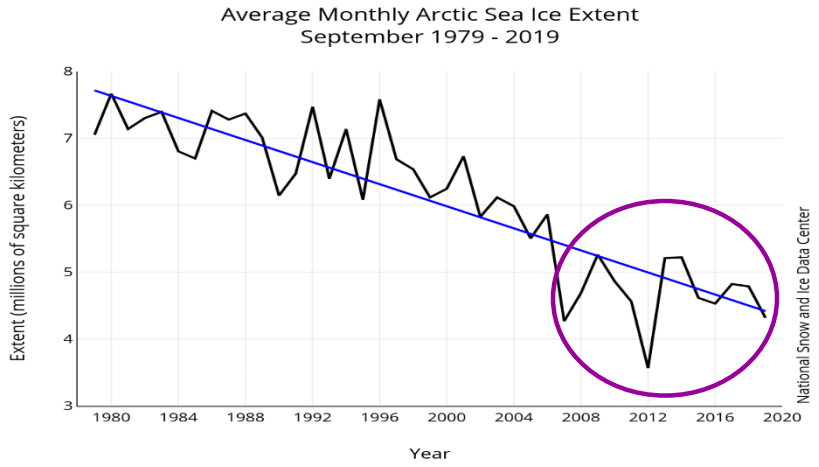
- **Along-coastal winds changed directions in Sep 2019.**

Arctic Sea Ice

National Snow and Ice Data Center
http://nsidc.org/arcticseaicenews/index.html







- **Arctic sea ice extent was well below the normal in Sep 2019.**

- **The monthly average extent for Sep 2019 of 4.32 million square kilometers ended up as the third lowest since satellite observations in 1979, only above Sep 2012/2007.**

Experimental Sea Ice Outlook
Provided by Dr. *Wanqiu Wang*

September 2019 SIE forecast

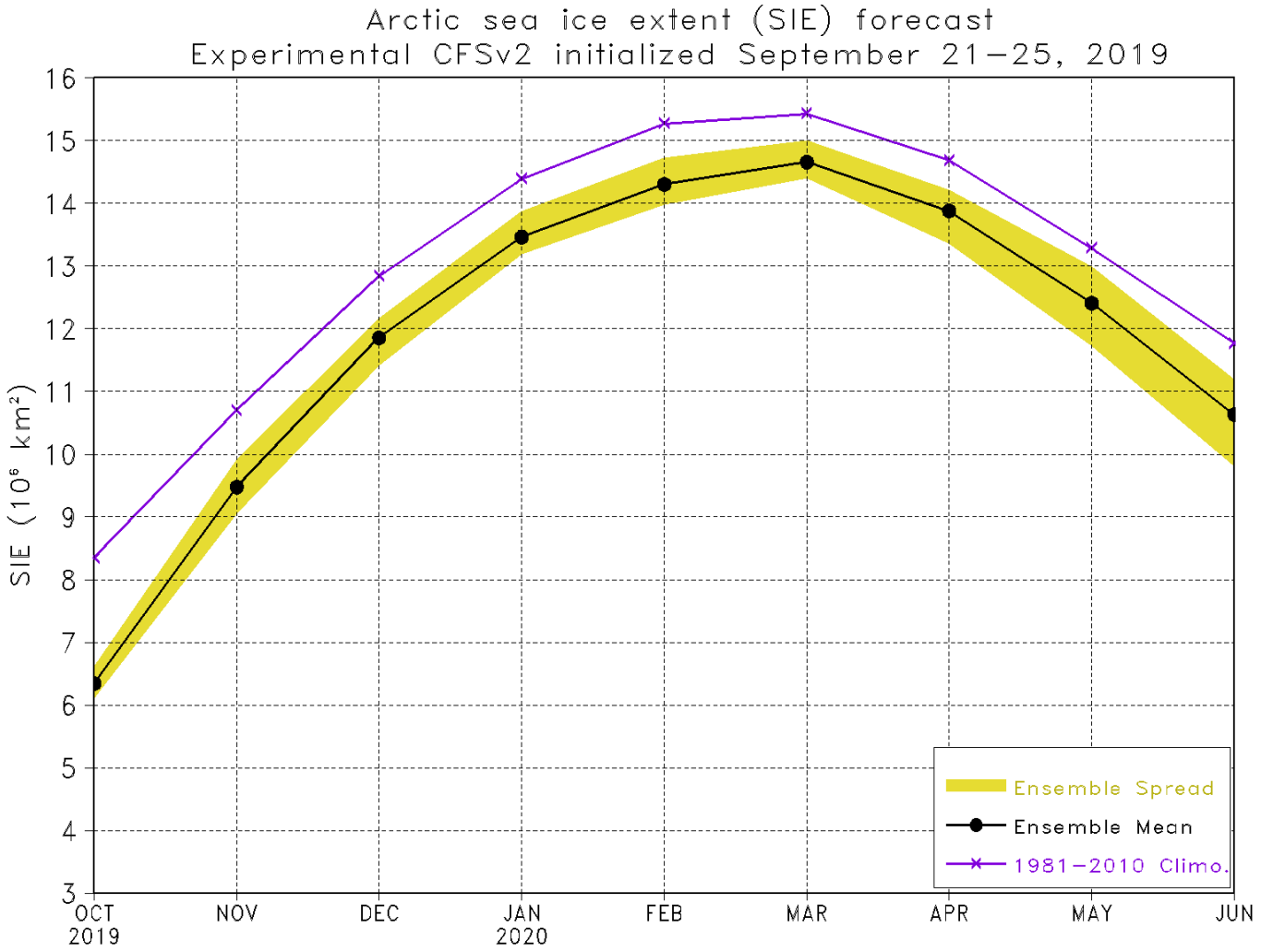
Source	SIE Value (10^6 km^2)
NSIDC 1981-2010 Climatology	6.41
NSIDC 2018	4.79
NSIDC 2012 (record low)	3.57
Experimental CFSv2 2019 forecast	**4.50**

September 2019 SIE Observation: 4.32

Based on these simulations, the September 2019 sea ice extent minimum is forecasted to be above the record minimum set in 2012 and slightly below last year's value.

Month to Month September Prediction for this year's forecasts

Month	March	April	May	June	July	August
Ens. Mean	4.87	4.71	4.62	4.55	4.31	4.50
Std. Dev.	0.34	0.33	0.26	0.24	0.14	0.11



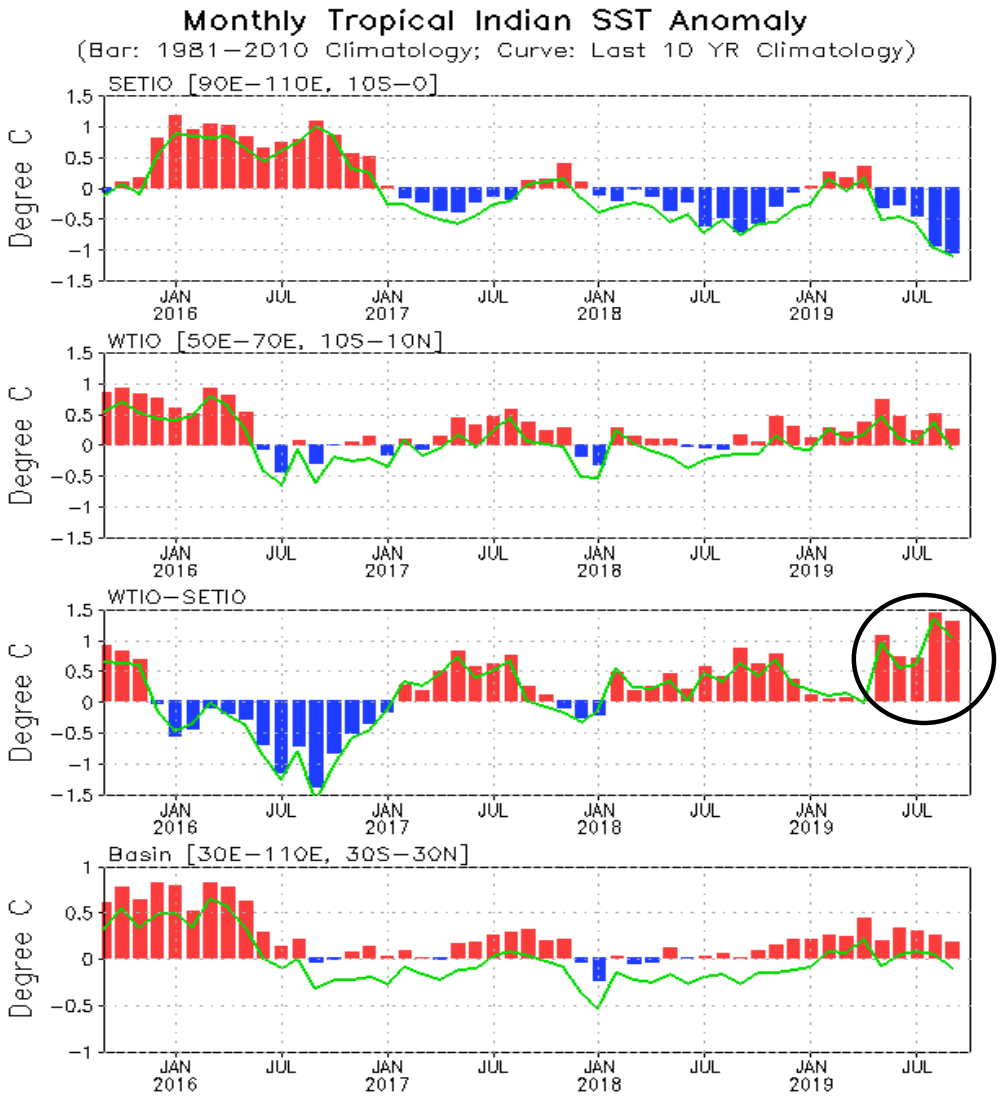
Experimental Sea Ice Outlook

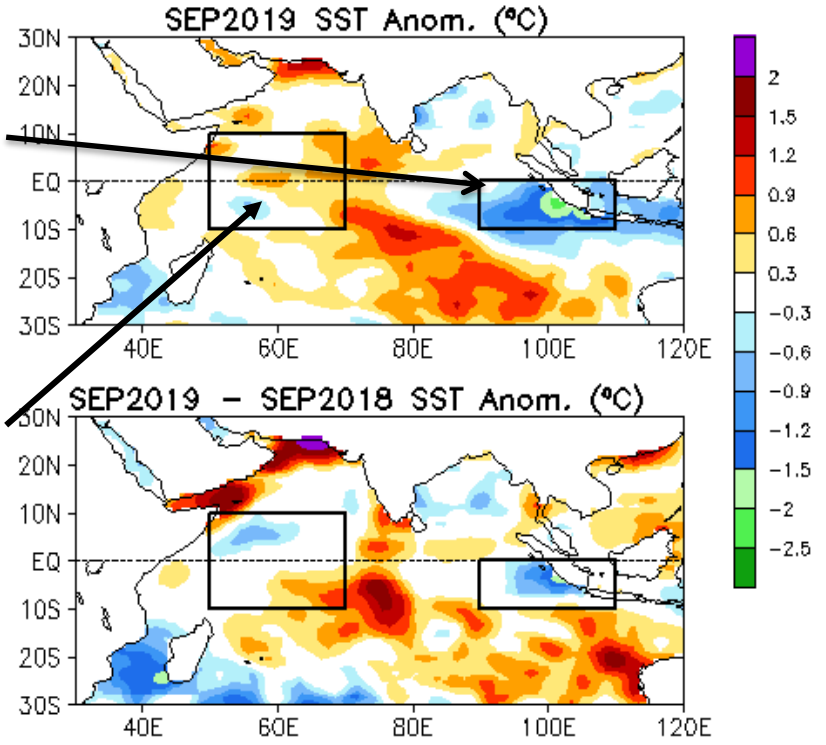
Climate Prediction Center, NCEP/NWS/NOAA

Provided by Dr. *Wanqiu Wang*

Indian Ocean

Evolution of Indian Ocean SST Indices





- IOD was in a strong positive phase since May 2019, with IODI=1.3 in Sep 2019.

Fig. I1a. Indian Ocean Dipole region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the SETIO [90°E-110°E, 10°S-0] and WTIO [50°E-70°E, 10°S-10°N] regions, and Dipole Mode Index, defined as differences between WTIO and SETIO. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

Tropical Indian: SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb & 200-mb Wind Anom.

- SSTAs were overall positive in the west and central, and negative in the far east (a dipole pattern).

- Convection was suppressed over the eastern Indian Ocean and Indonesia.

-Anomalous easterlies were present in the eastern basin (no further westward extension might limit the IOD's further development).

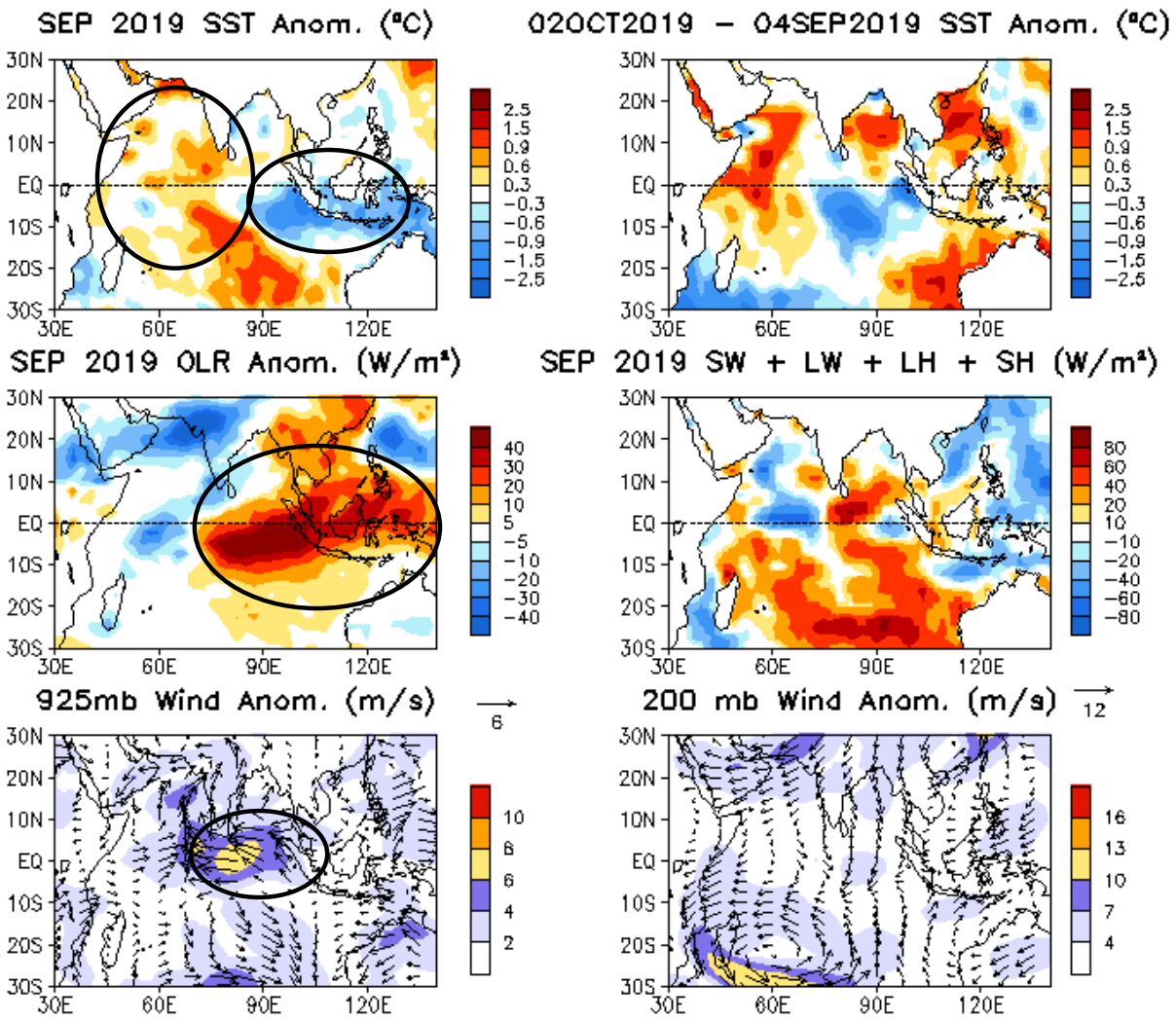
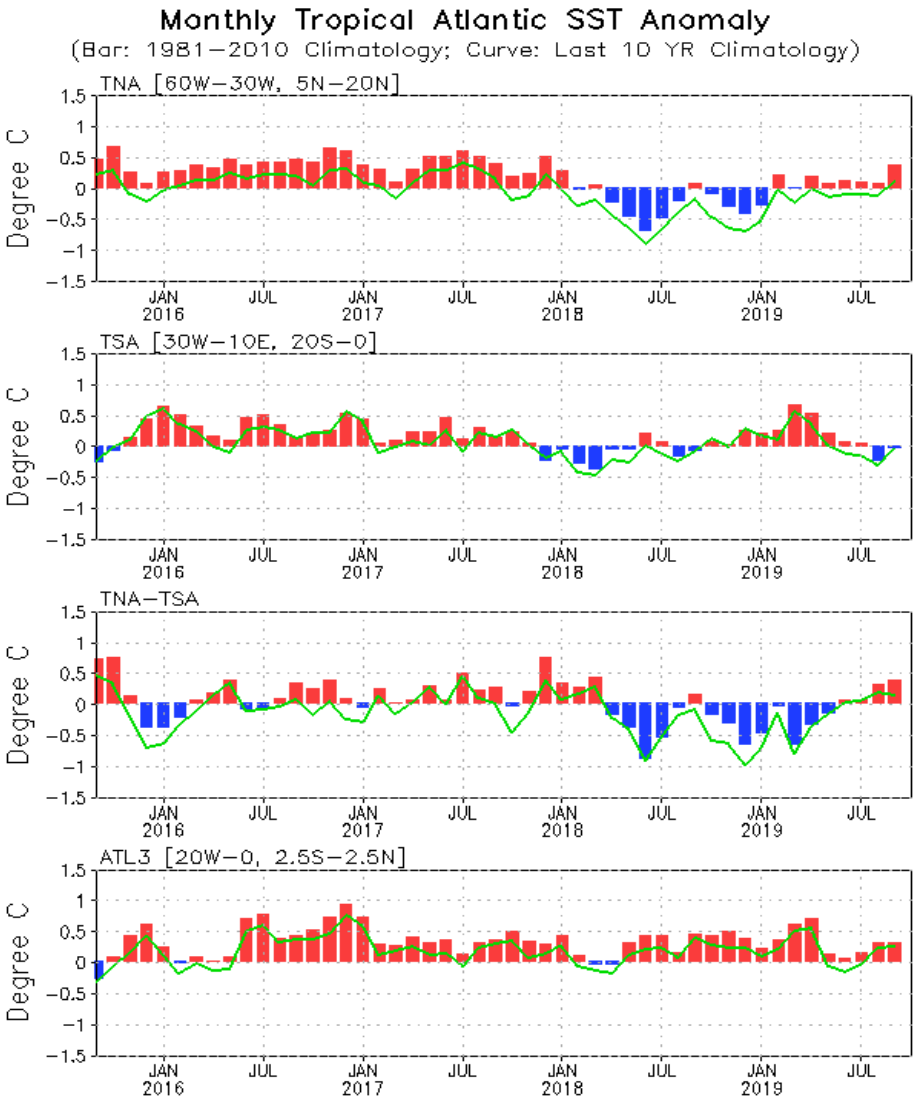
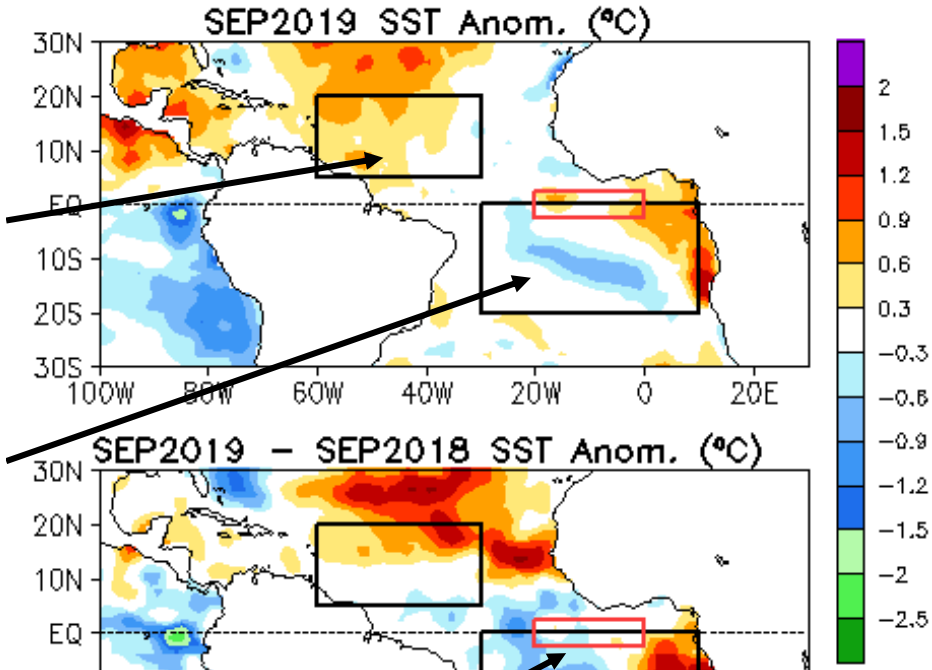


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (bottom-left), 200-mb wind anomaly vector and its amplitude (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, winds and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

Tropical and North Atlantic Ocean

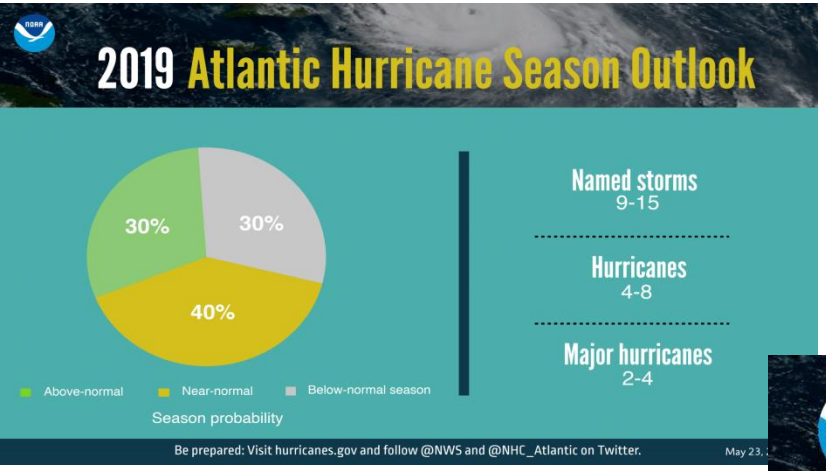
Evolution of Tropical Atlantic SST Indices

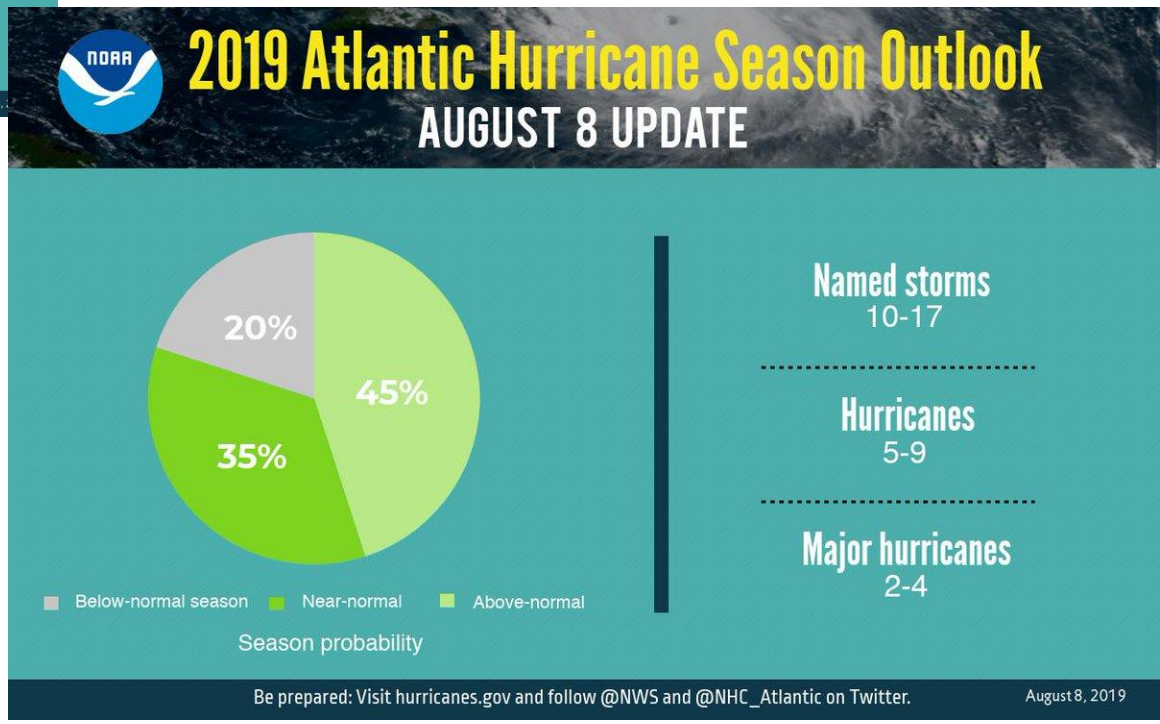




- **All indices were small (<0.5 C) in Sep 2019.**

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.



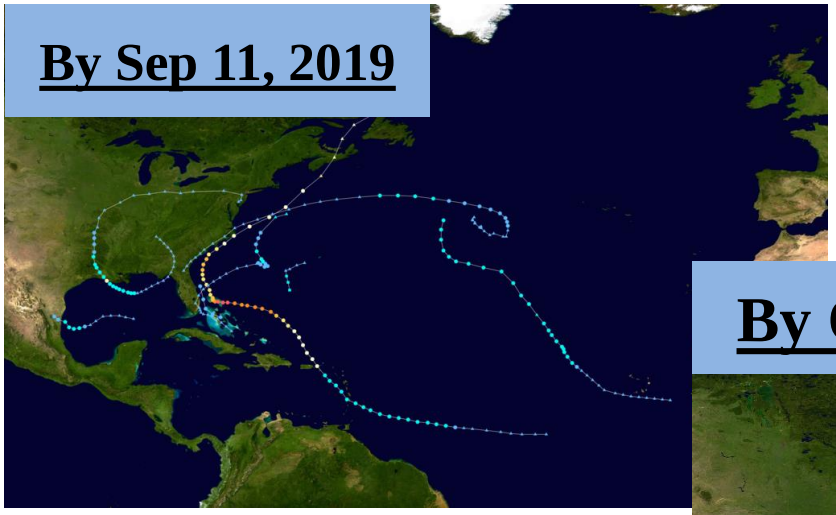


(August 8 update)

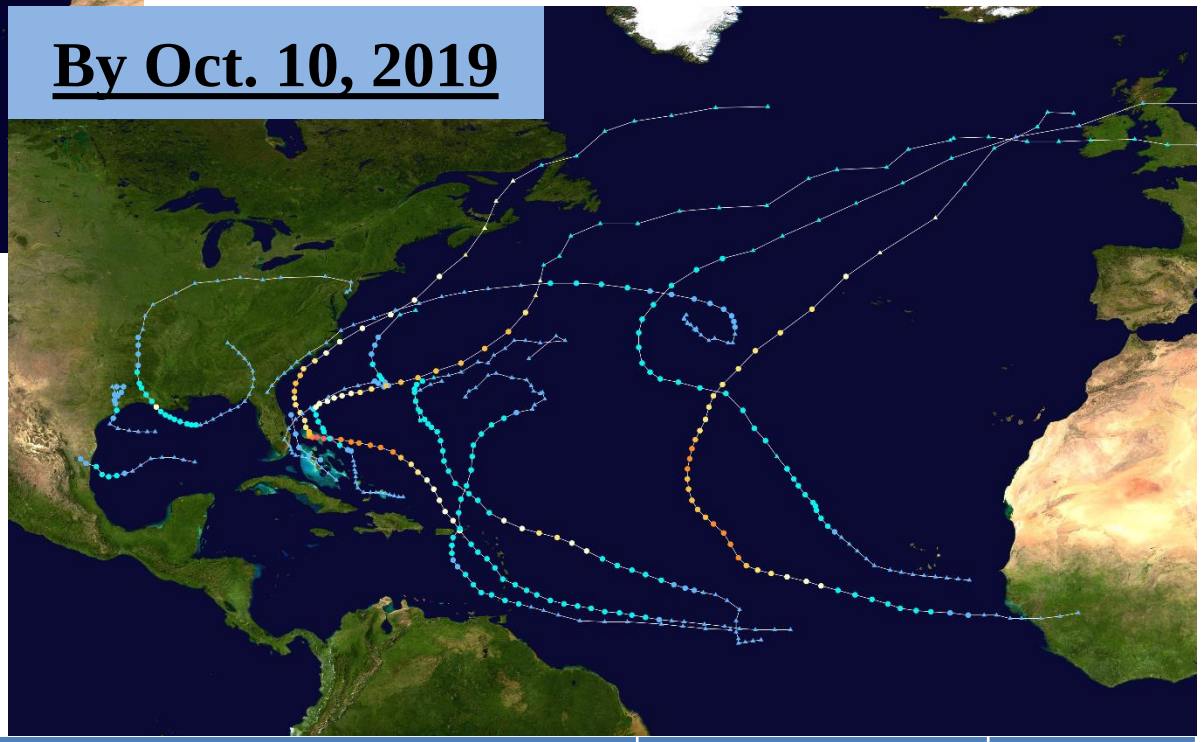
NOAA's updated outlook for the 2019 Atlantic Hurricane Season indicates that an above-normal season has the highest chance of occurring (45%), followed by a 35% chance for near-normal season and a 20% chance for a below-normal season.

https://www.cpc.ncep.noaa.gov/products/outlooks/hurricane2019/August/hurricane.shtml

By Sep 11, 2019



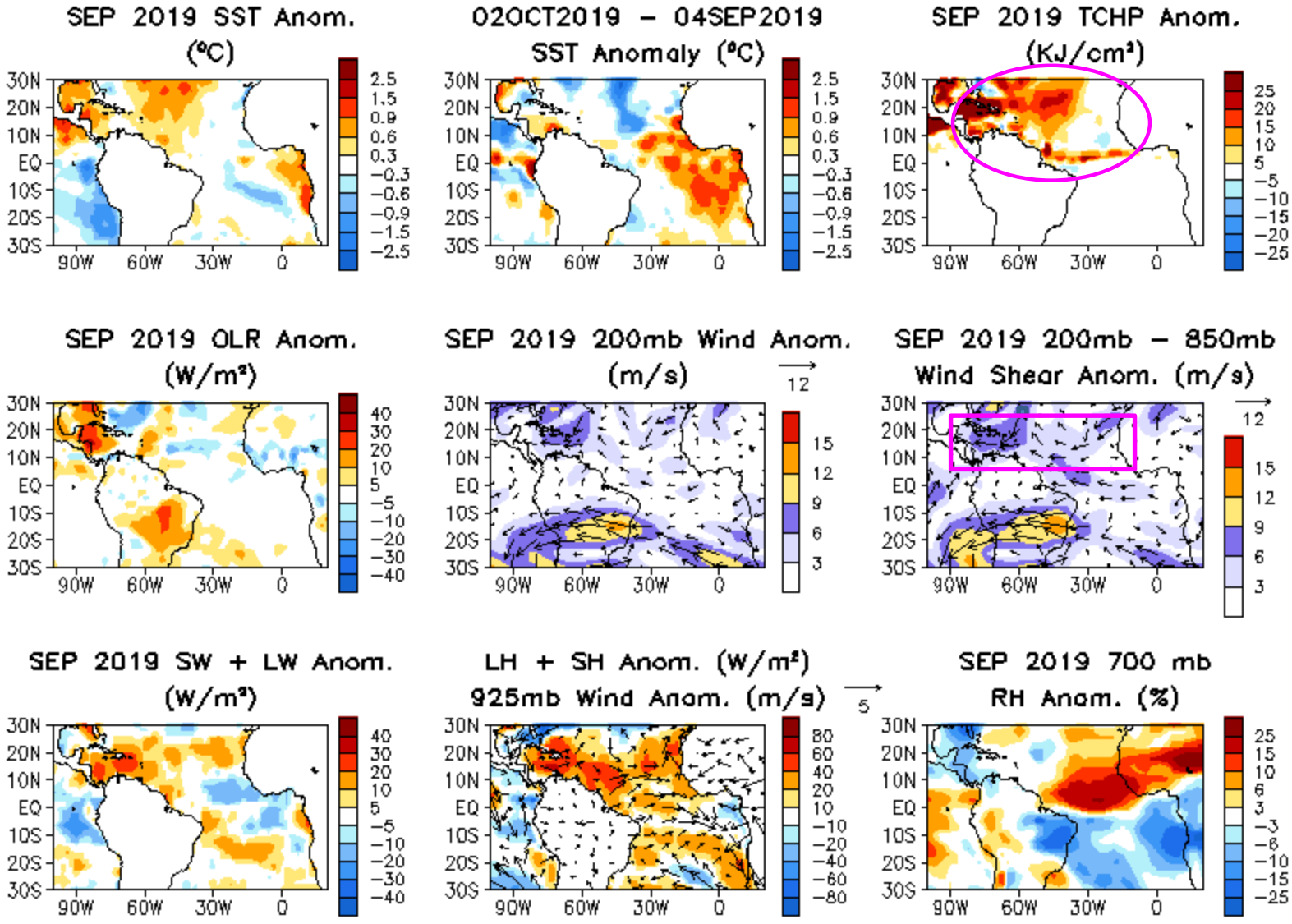
By Oct. 10, 2019



By Oct. 10, 2019

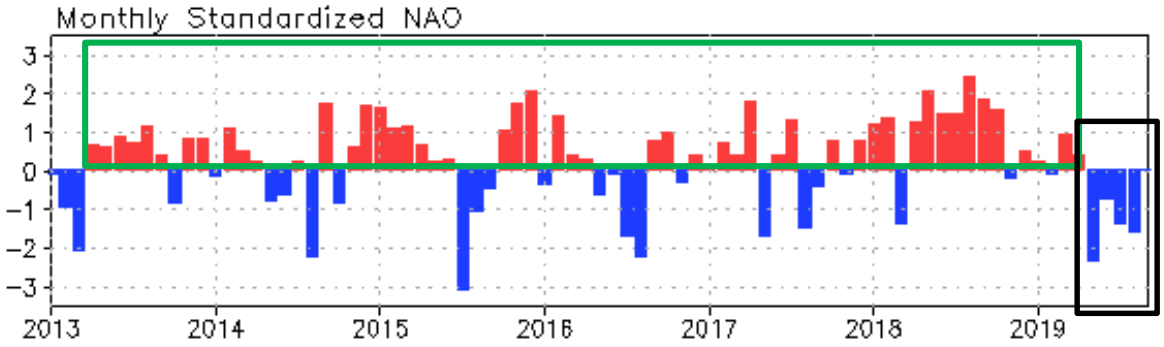
2019		Outlook Aug 8 & May 23	(1981-2010)
Total storms	**12**	10-17 & 9-15	12.1
Hurricanes	**5**	5-9 & 4-8	6.4
Major hurricanes (Cat. 3+)	**3**	2-4 & 2-4	2.7

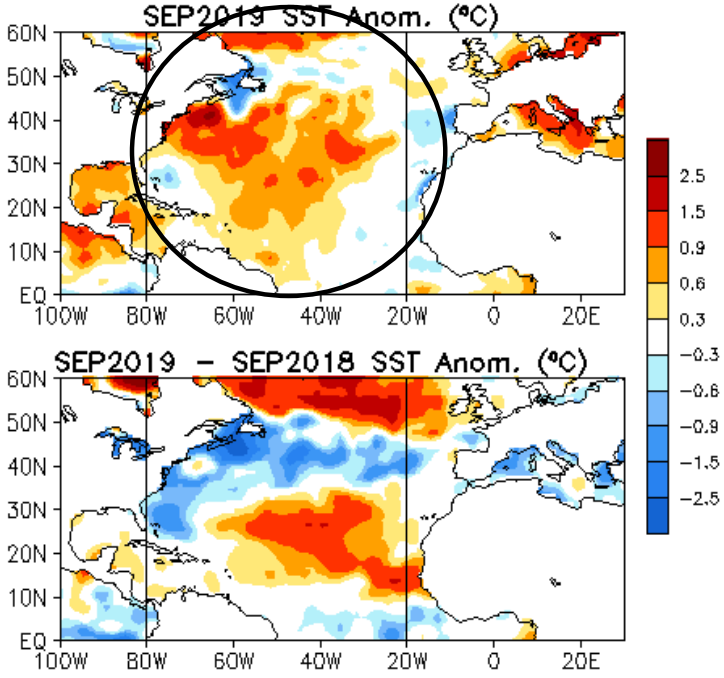
Tropical Atlantic:

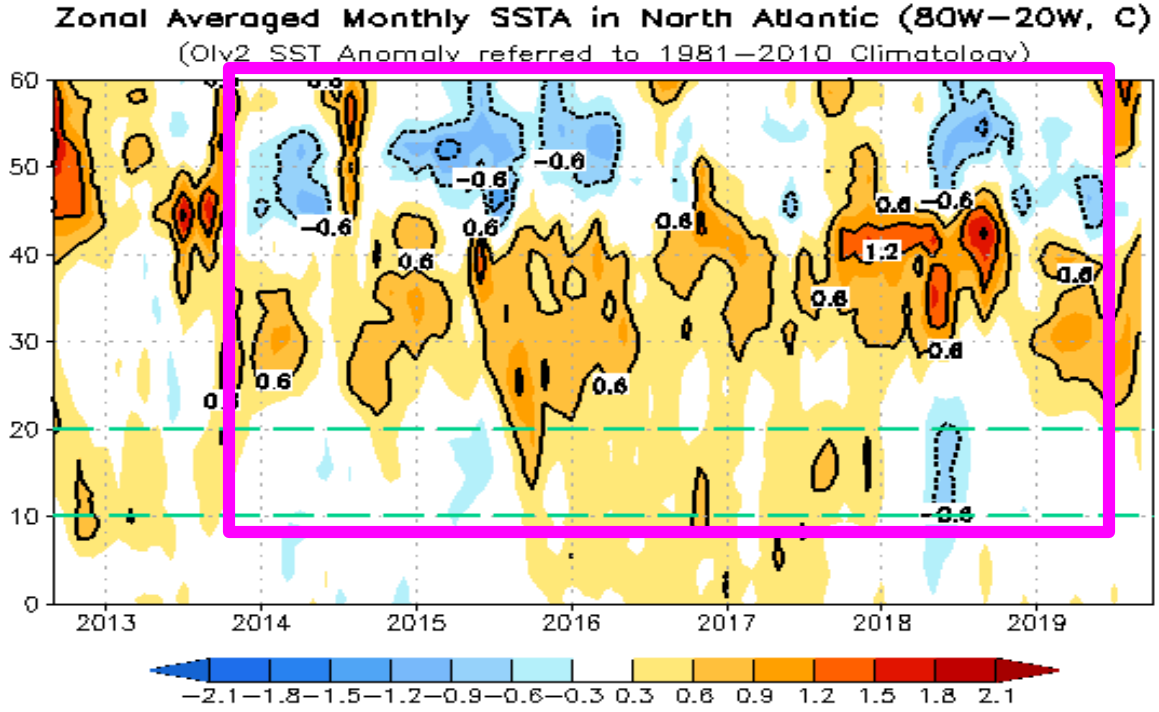


- **During Sep 2019, the weaker vertical wind shear and positive TCHP anomalies in the MDR favored more hurricanes.**

NAO and SST Anomaly in North Atlantic







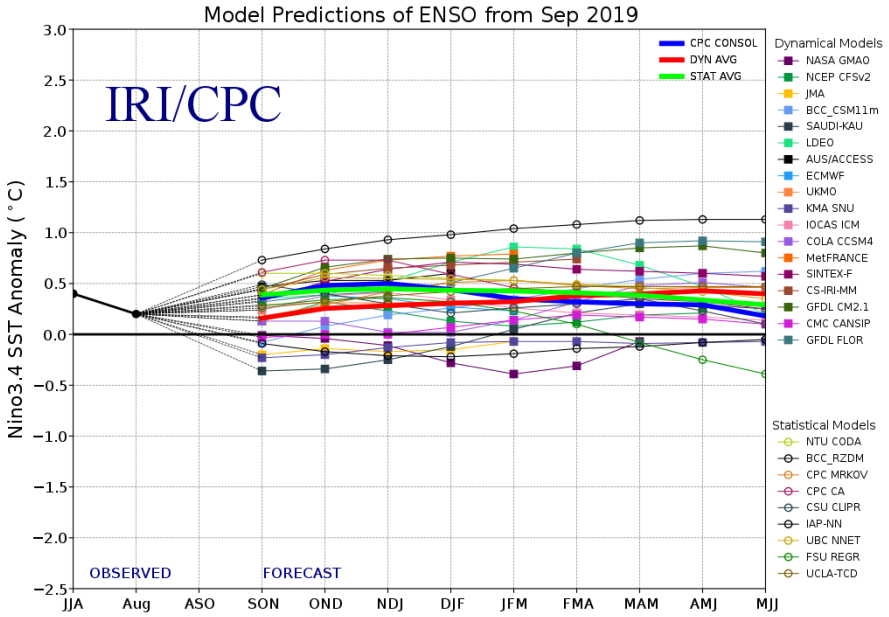
- NAO was near normal in Sep 2019 with NAOI= -0.0.

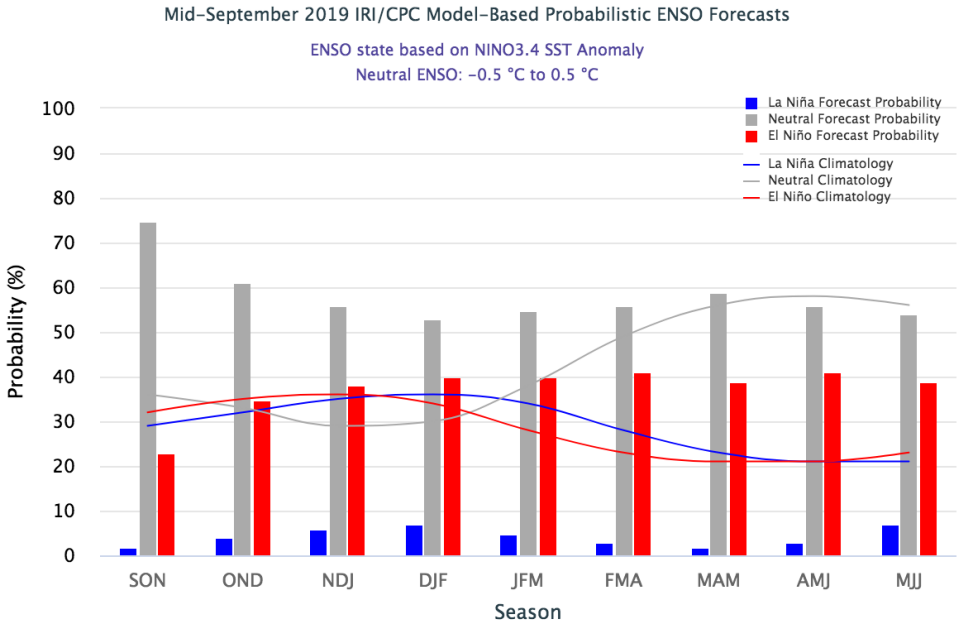
- Positive SSTAs dominated in the NA. Previous tripole/horseshoe –like pattern of SSTA became less evident in Sep 2019, due to the change in NAO phase since this May.

Fig. NA2. Monthly standardized NAO index (top) derived from monthly standardized 500-mb height anomalies obtained from the NCEP CDAS in 20ºN-90ºN (http://www.cpc.ncep.noaa.gov). Time-Latitude section of SST anomalies averaged between 80ºW and 20ºW (bottom). SST are derived from the NCEP OI SST analysis, and anomalies are departures from the 1981-2010 base period means.

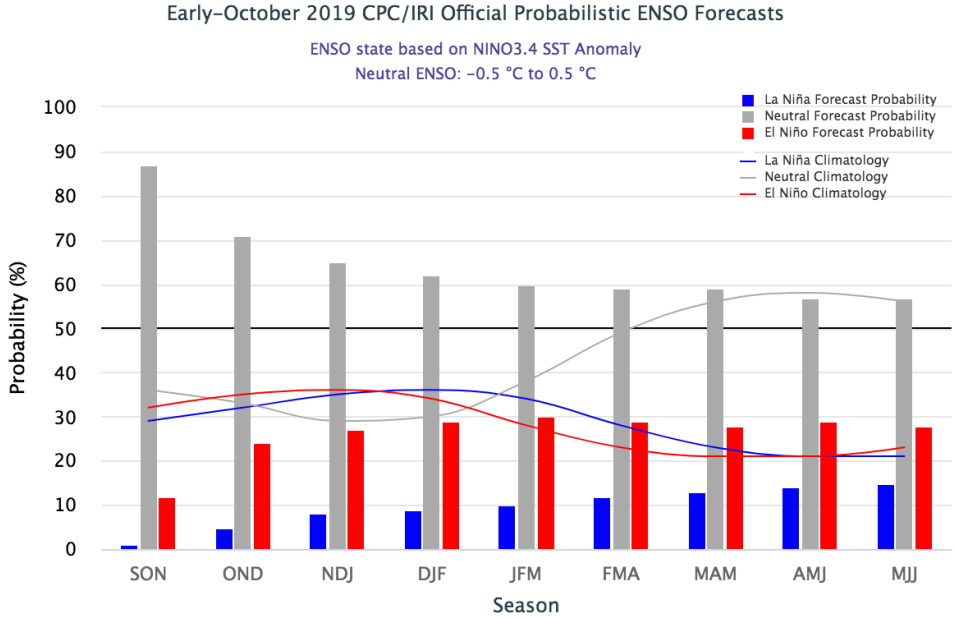
ENSO and Global SST Predictions

IRI NINO3.4 Forecast Plum



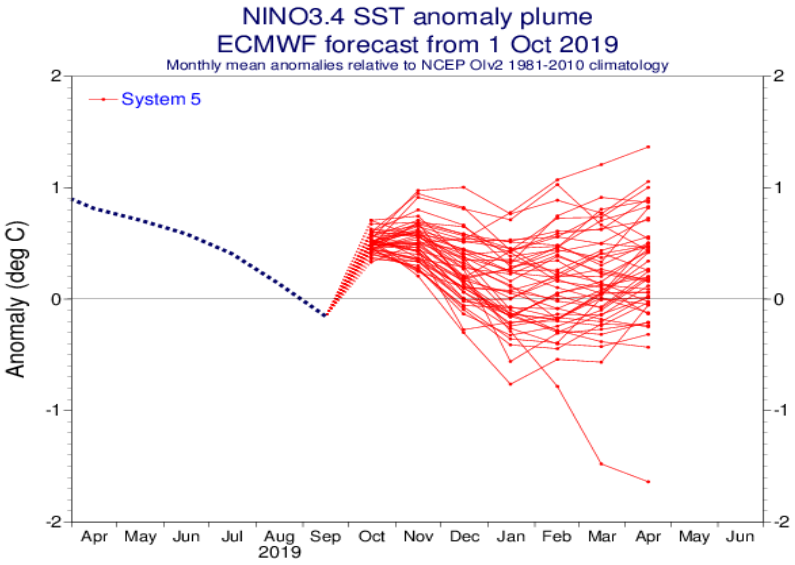


- **Most models predicted a ENSO-neutral with ICs in Sep 2019.**
- **NOAA "ENSO Diagnostic Discussion" on 10 Oct 2019 indicated that *"ENSO-neutral is favored during the Northern Hemisphere fall 2019 (~85% chance), continuing through spring 2020 (55-60% chance)"***

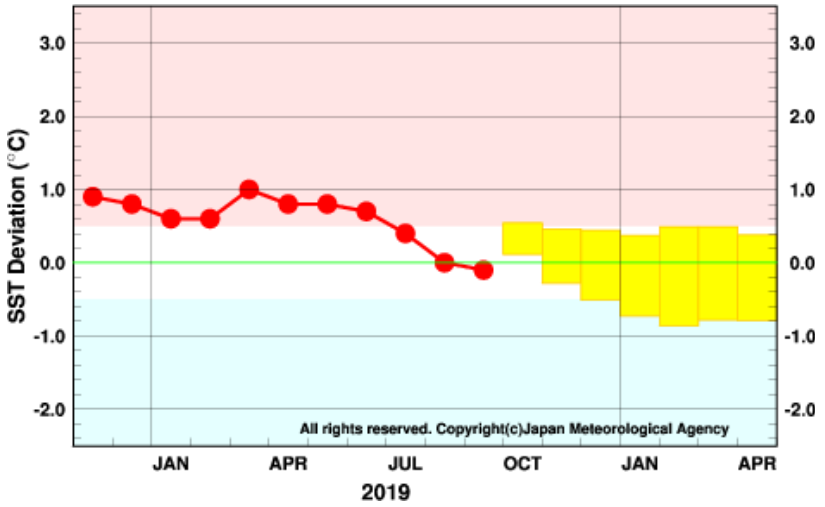


Individual Model Forecasts: ENSO-Neutral

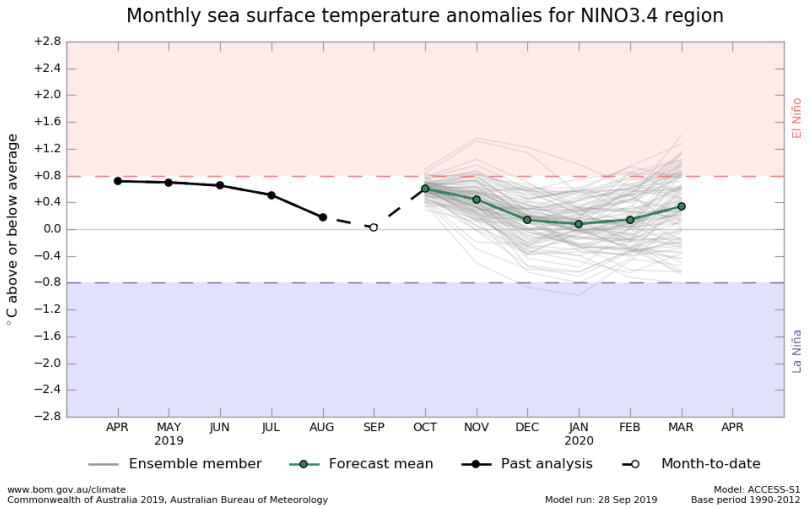
EC: Nino3.4, IC=01Oct 2019



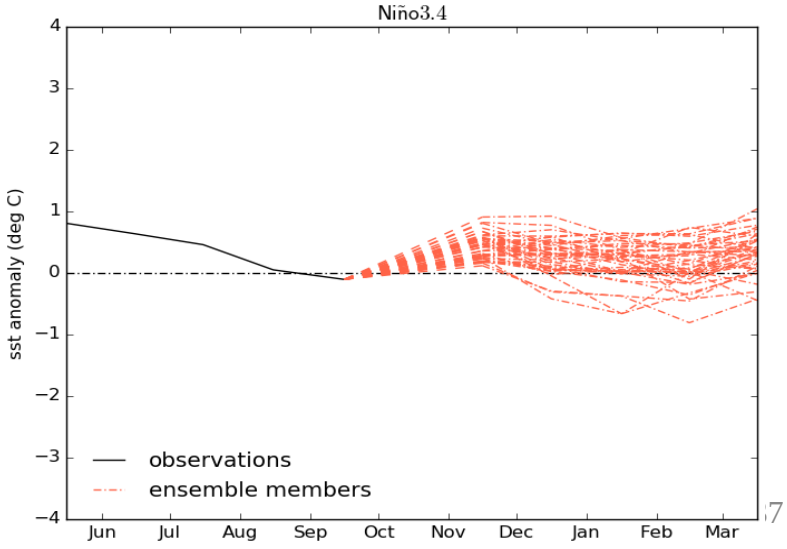
JMA: Nino3.4, Updated 10Oct 2019

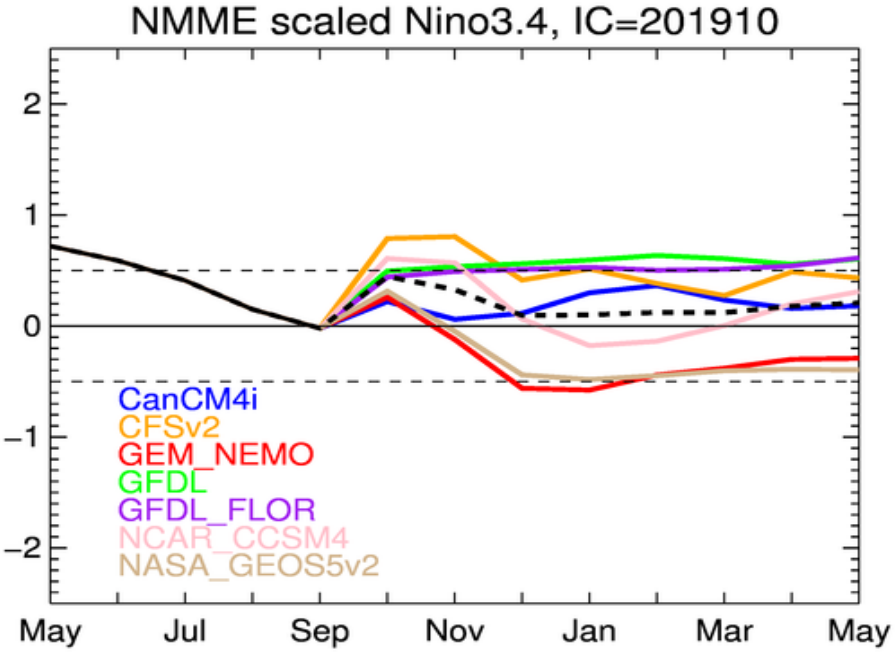


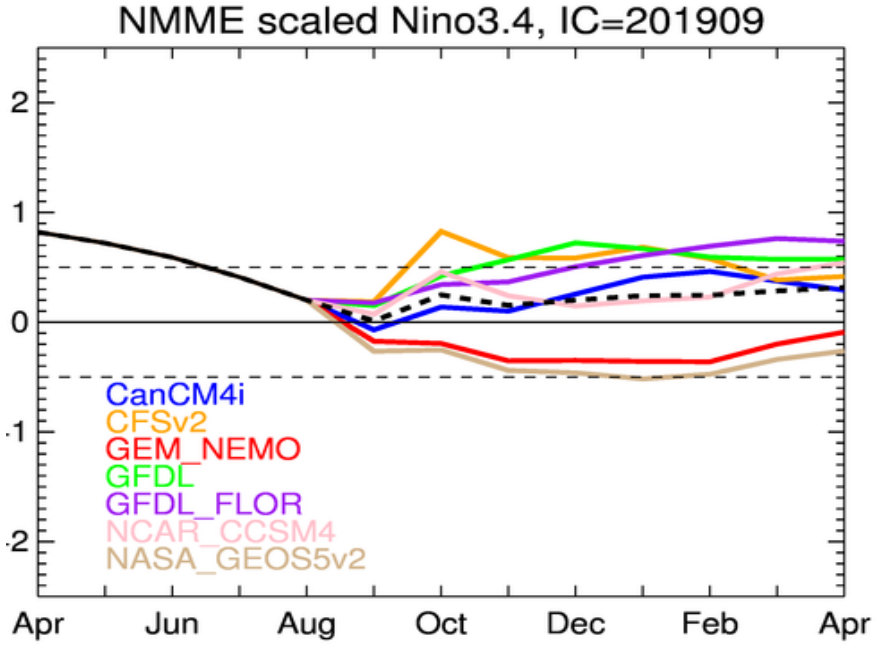
Australia: Nino3.4, Updated 28 Sep 2019

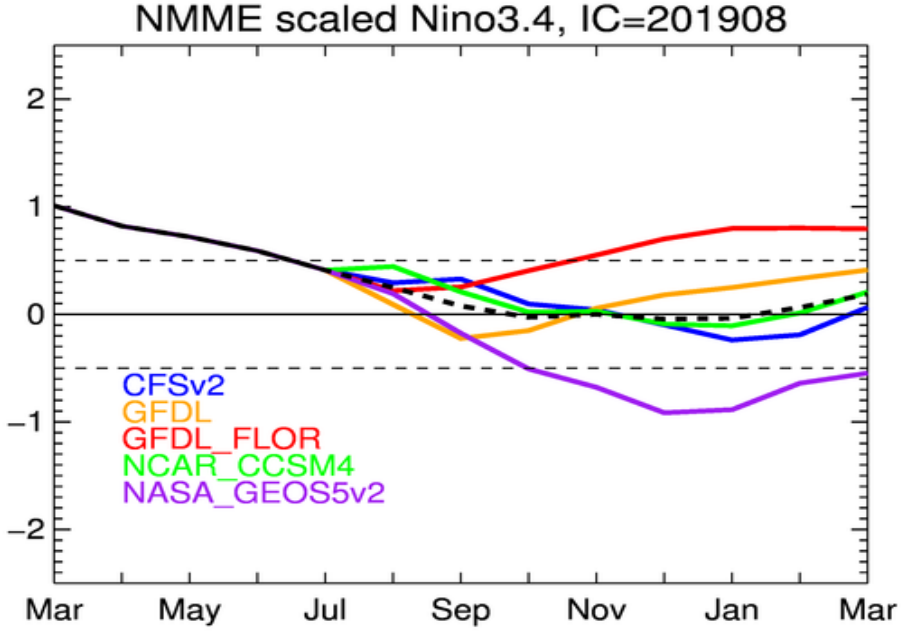


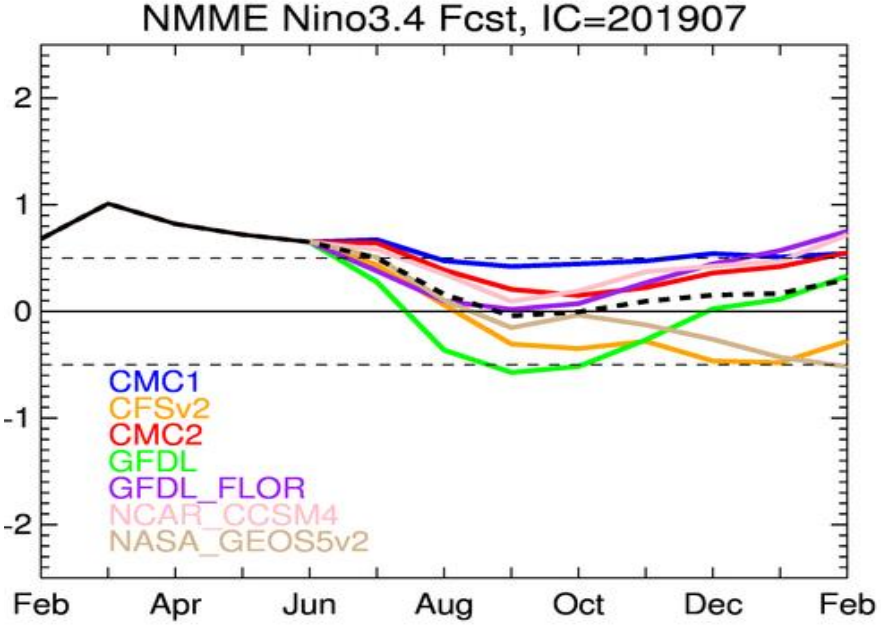
UKMO: Nino3.4, Updated 11Oct 2019



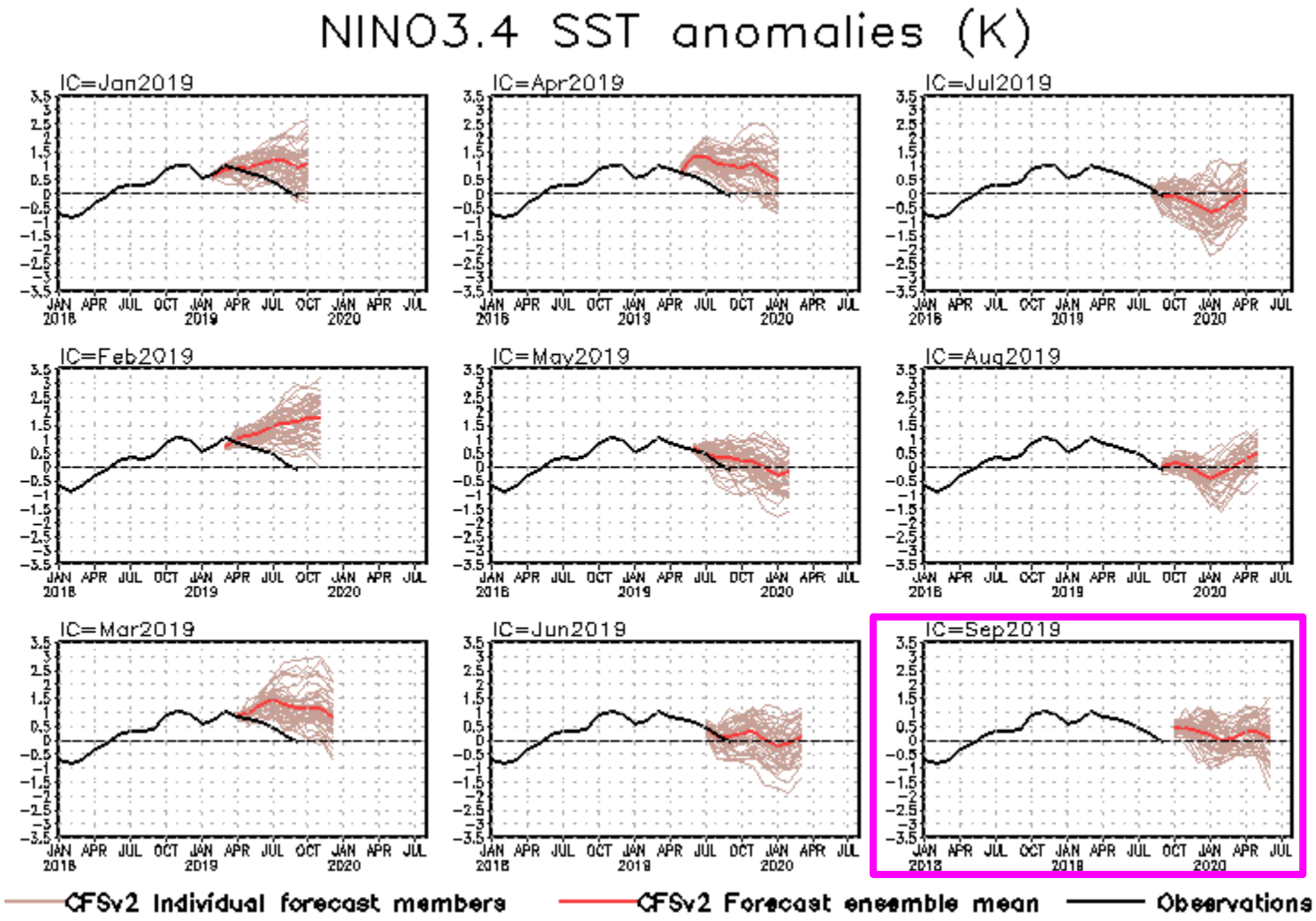

NMME scaled Nino3.4, IC=201910
2
1
0
−1
−2
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
May
Jul
Sep
Nov
Jan
Mar
May


NMME scaled Nino3.4, IC=201909
2
1
0
-1
-2
CanCM4i
CFSv2
GEM_NEMO
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
Apr
Jun
Aug
Oct
Dec
Feb
Apr


NMME scaled Nino3.4, IC=201908
2
1
0
−1
−2
CFSv2
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
Mar
May
Jul
Sep
Nov
Jan
Mar


NMME Nino3.4 Fcst, IC=201907
2
1
0
-1
-2
CMC1
CFSv2
CMC2
GFDL
GFDL_FLOR
NCAR_CCSM4
NASA_GEOS5v2
Feb
Apr
Jun
Aug
Oct
Dec
Feb

CFS Niño3.4 SST Predictions from Different Initial Months

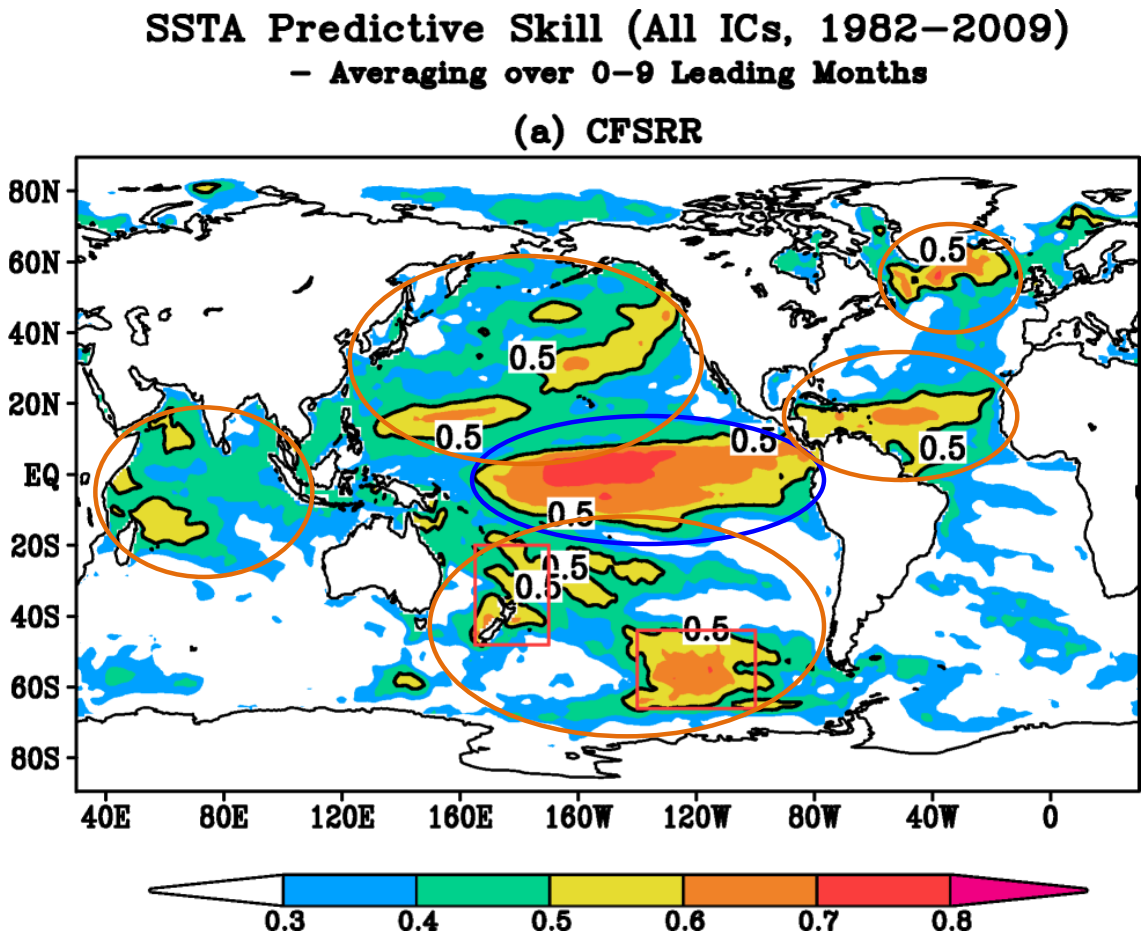


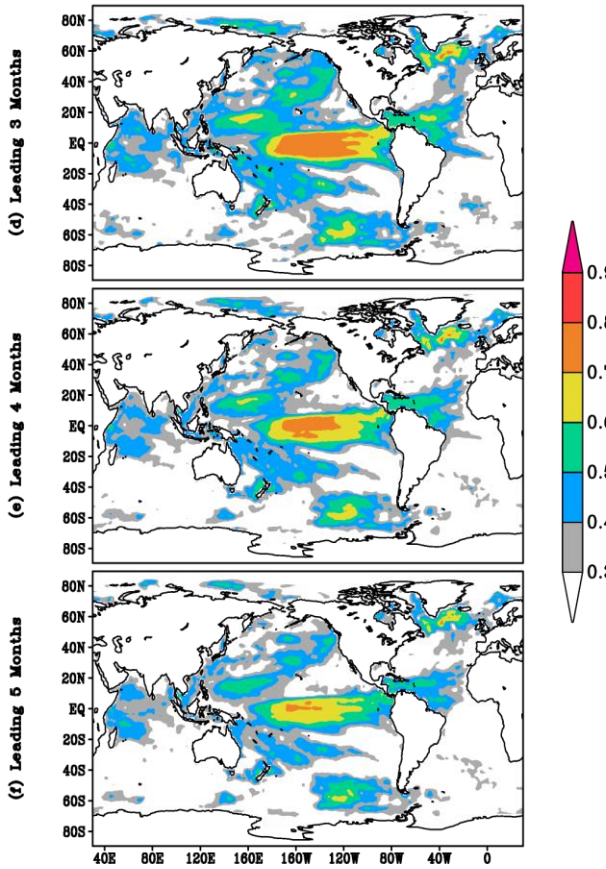
- CFSv2 predicted a decline of positive SSTAs with ICs since Mar 2019.

- The latest forecasts call for a ENSO-neutral state in coming seasons.

Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

Spatial Distribution of SSTA prediction skill with CFSv2

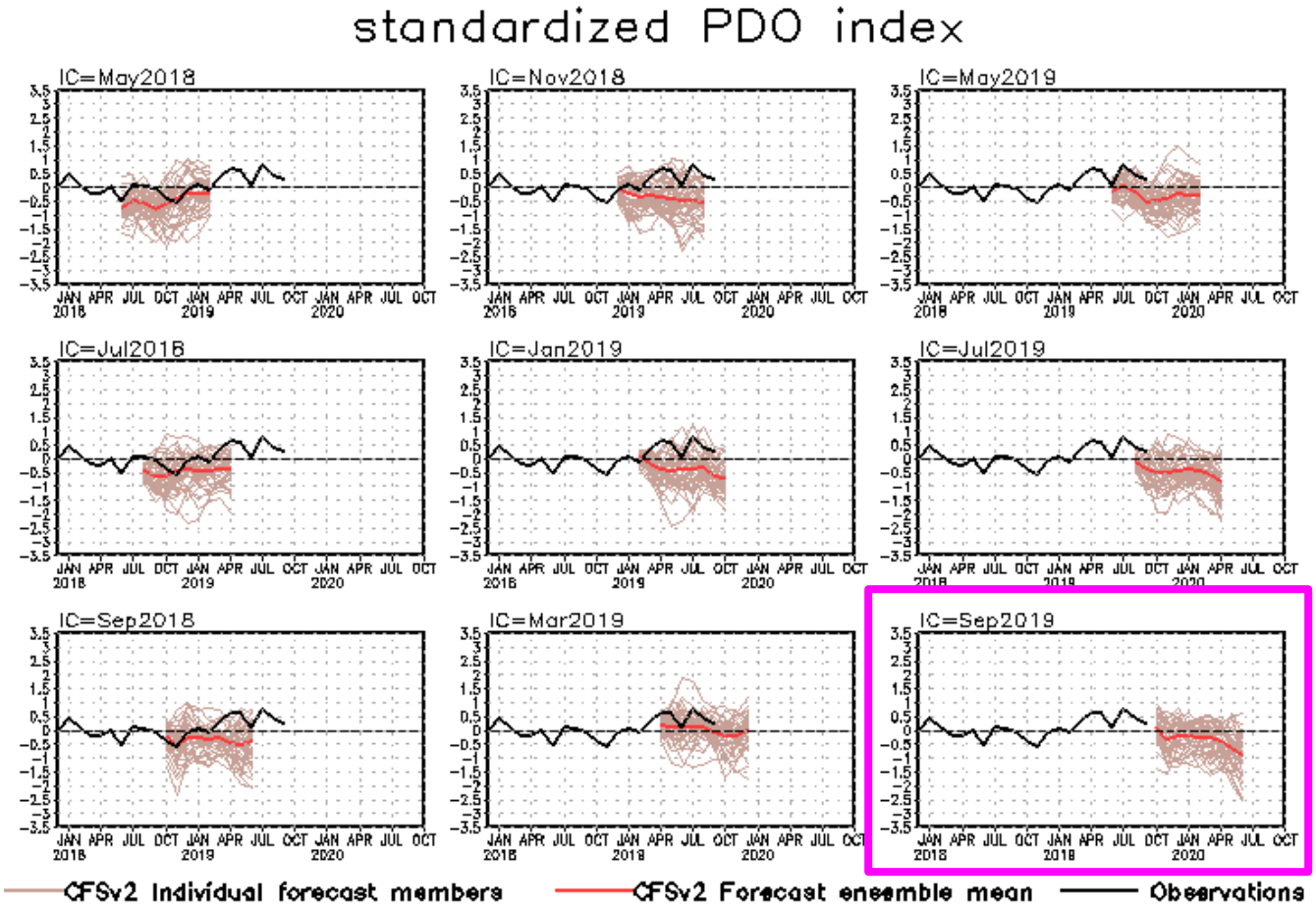




(Guan et al. 2014)

- **ENSO-related SST presents the highest prediction skill;**
- **Other skillful regions include: tropical North Atlantic, South Pacific, tropical Indian Ocean, part of extratropical North Pacific,...**

CFS Pacific Decadal Oscillation (PDO) Index Predictions from Different Initial Months



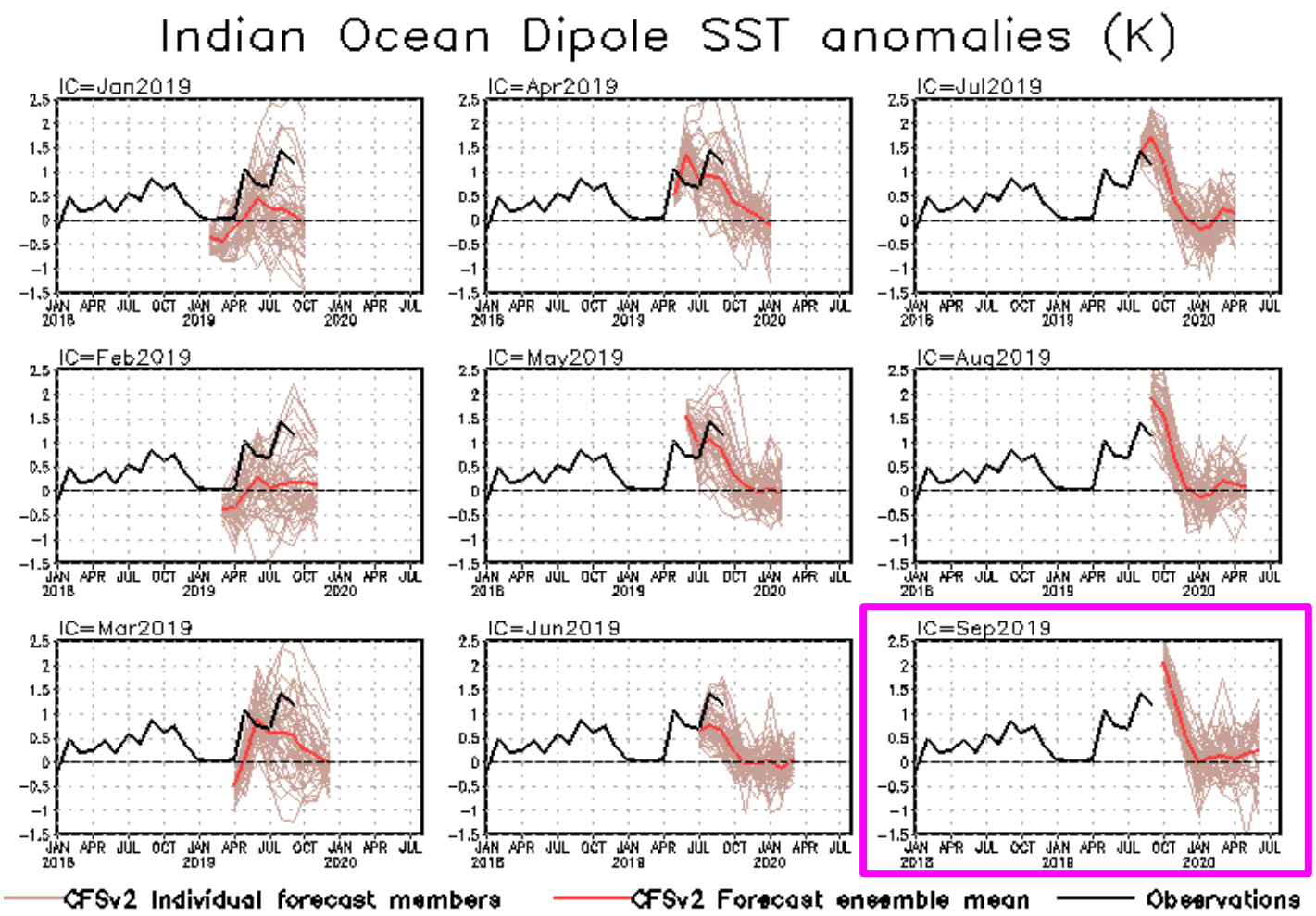
PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

CFS PDO index is the standardized projection of CFS SST forecast anomalies onto the PDO EOF pattern.

- CFSv2 predicts a neutral phase of PDO in coming seasons.

Fig. M4. CFS Pacific Decadal Oscillation (PDO) index predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

NCEP CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

SETIO = SST anomaly in [90°E-110°E, 10°S-0]

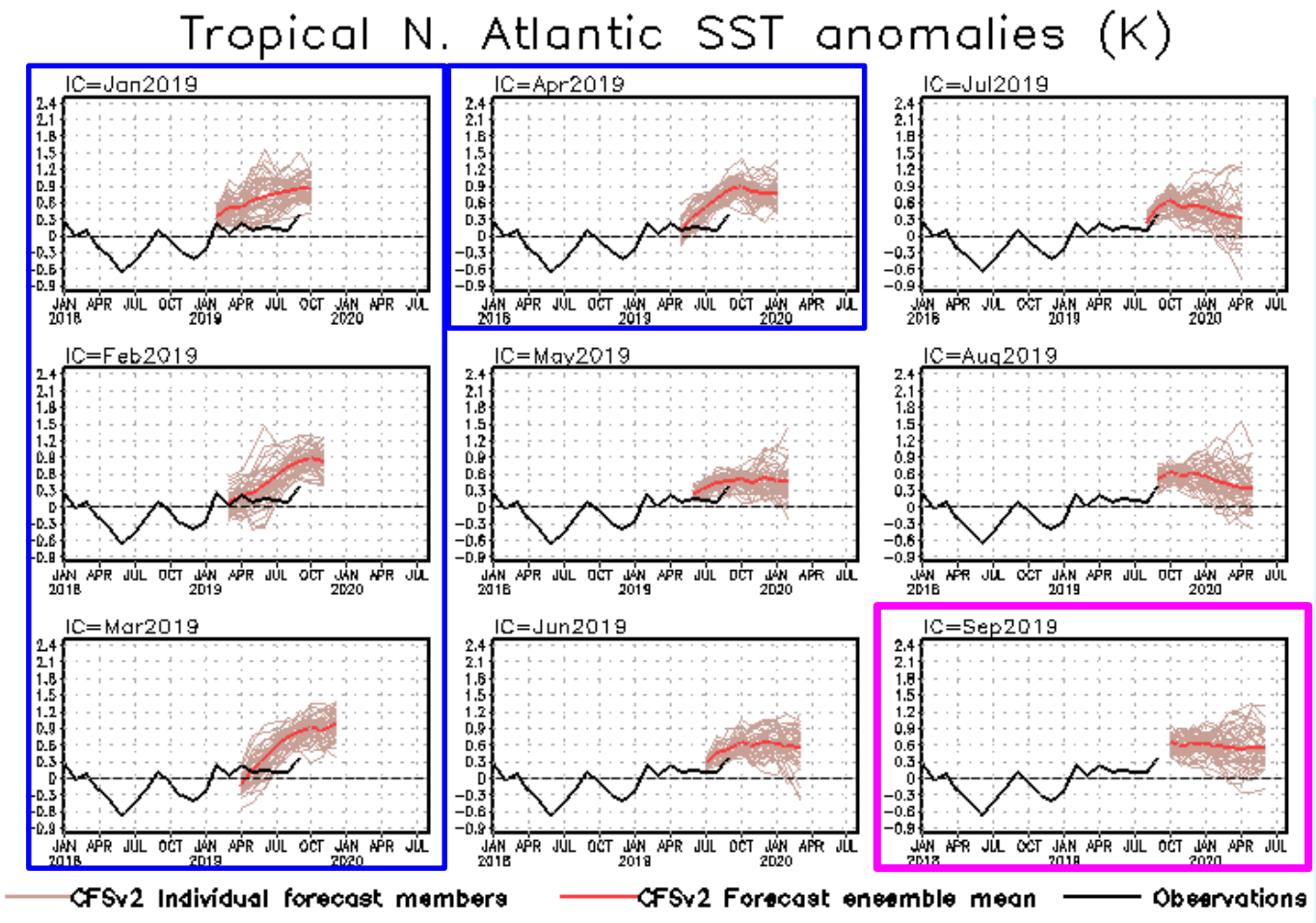
WTIO = SST anomaly in [50°E-70°E, 10°S-10°N]

- **CFSv2 predicts the current positive IOD event will decay quickly.**

Fig. M2. CFS Dipole Model Index (DMI) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1981-2010 base period means.

CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months

TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].



- **Predictions had warm biases for ICs in Sep 2018-Apr 2019. The warm bias was partially associated with the warm bias in CFSR I.C. due to a decoding bug.**

- **Latest CFSv2 predictions call above normal SSTA in the tropical N. Atlantic in fall and winter 2019, a lag response to El Nino.**

Fig. M3. CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). Anomalies were computed with respect to the 1981-2010 base period means.

Observing and forecasting seasonal sea level anomalies in the tropical Pacific

Multi-model sea level forecasts are combined with astronomical tide predictions to provide better predictions of coastal water levels in an *experimental* monthly forecast product.

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https://uhslc.soest.hawaii.edu/sea-level-forecasts/

Multimodel Ensemble Sea Level Forecasts for Tropical Pacific Islands

(*JAMC*, 2017)

Matthew J. Widlansky[a,b], John J. Marra[c], Md. Rashed Chowdhury[d], Scott A. Stephens[e], Elaine R. Miles[f], Nicolas Fauchereau[e], Claire M. Spillman[f], Grant Smith[f], Grant Beard[f], and Judith Wells[a]

[a] *Joint Institute for Marine and Atmospheric Research, School of Ocean and Earth Science and Technology, University of Hawai'i at Mānoa, Honolulu, Hawaii*

[b] *International Pacific Research Center, School of Ocean and Earth Science and Technology, University of Hawai'i at Mānoa, Honolulu, Hawaii*

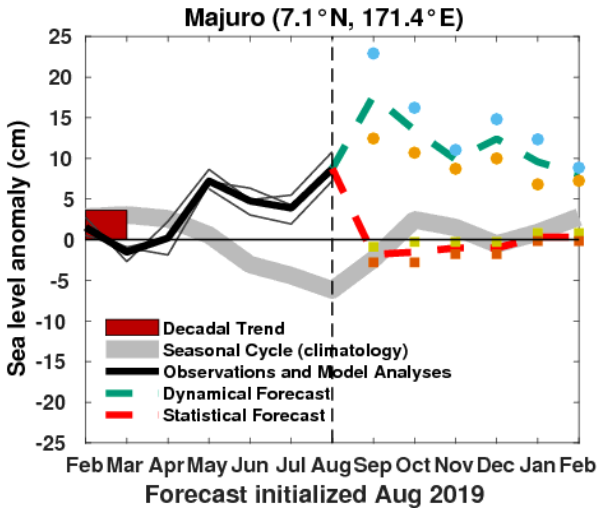
[c] *NOAA/NESDIS/National Centers for Environmental Information, Inouye Regional Center, Honolulu, Hawaii*

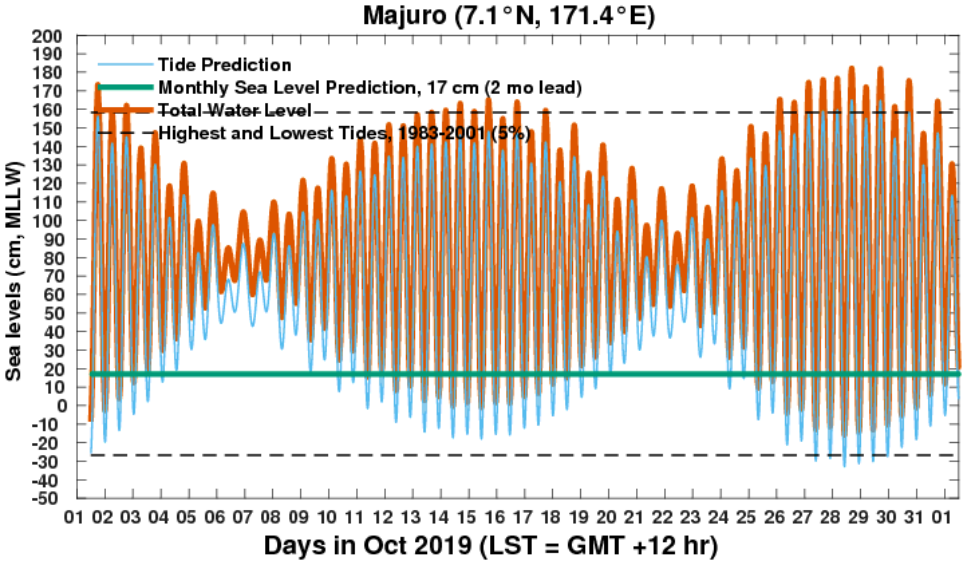
[d] *Pacific ENSO Applications Climate Center, Joint Institute for Marine and Atmospheric Research, University of Hawai'i at Mānoa, Honolulu, Hawaii*

[e] *National Institute of Water and Atmospheric Research, Hamilton, New Zealand*

[f] *Bureau of Meteorology, Melbourne, Victoria, Australia*

Sample forecast for the Marshall Islands:
Above-normal sea levels are expected to **elevate high tides** during late October.

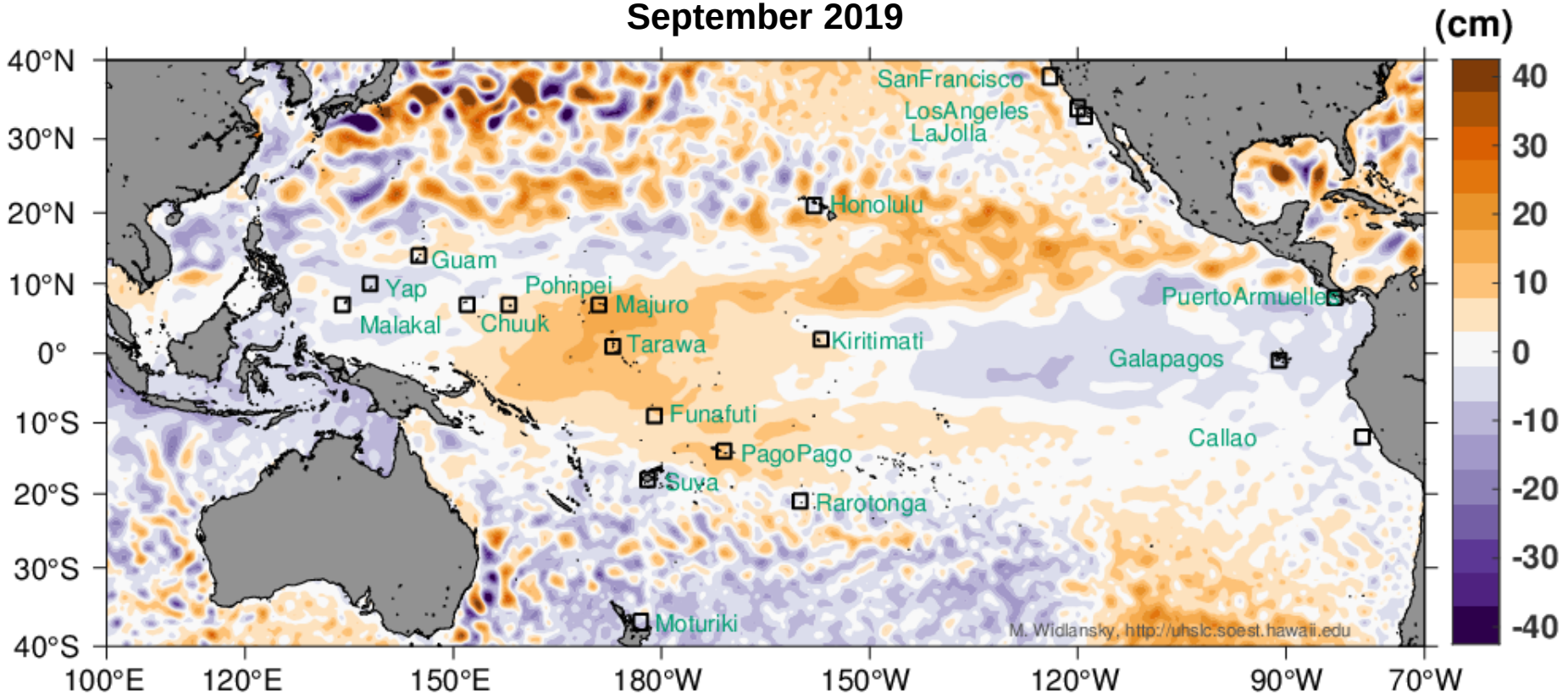




Sea Surface Height (SSH) anomalies

During the last month, sea levels were above average in the central Pacific and below average in the equatorial eastern Pacific.

Average SSH anomalies (cm) from CMEMS satellite altimetry
September 2019



Seasonal cycle (1999–2010) and trend (1999–2017) removed

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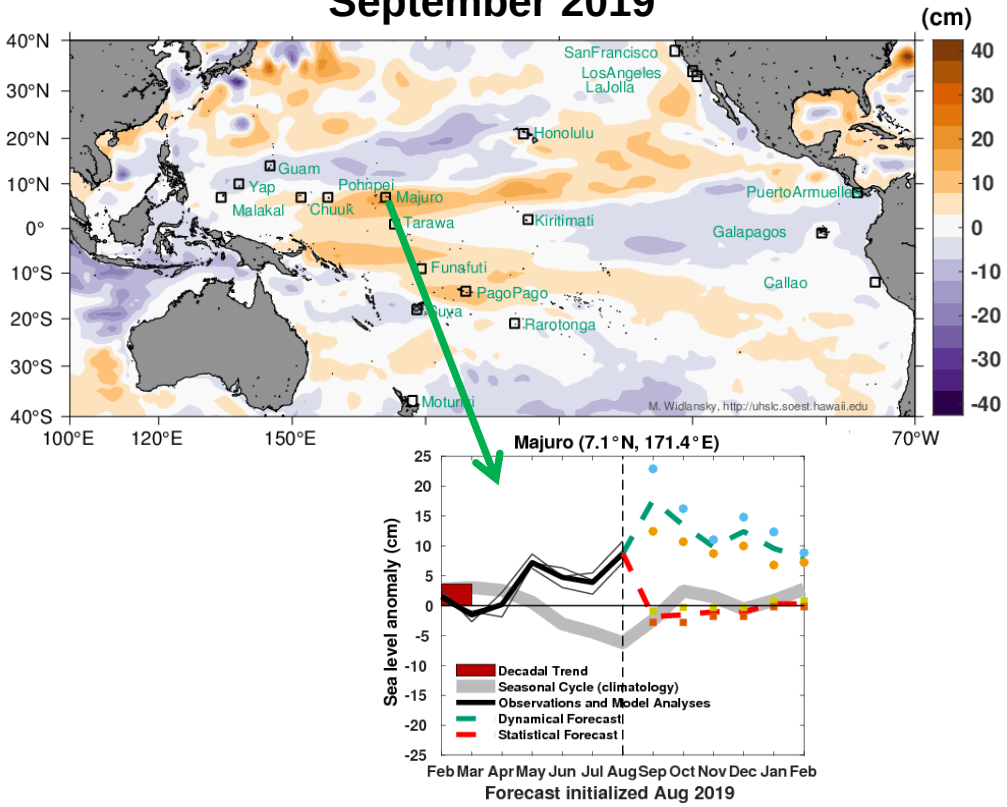
https://uhslc.soest.hawaii.edu/sea-level-forecasts/

Sea Surface Height (SSH) outlook: NCEP CFSv2 Forecast

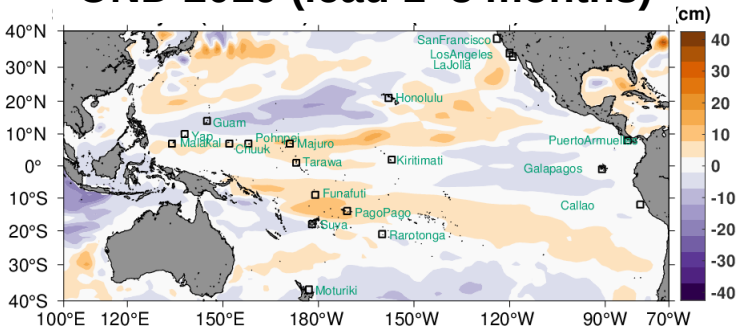
Updated: 2 October 2019
with 120 forecast initializations

Over the next 3 to 9 months, sea levels are forecast to rise in the central South Pacific, including around American Samoa (Pago Pago).

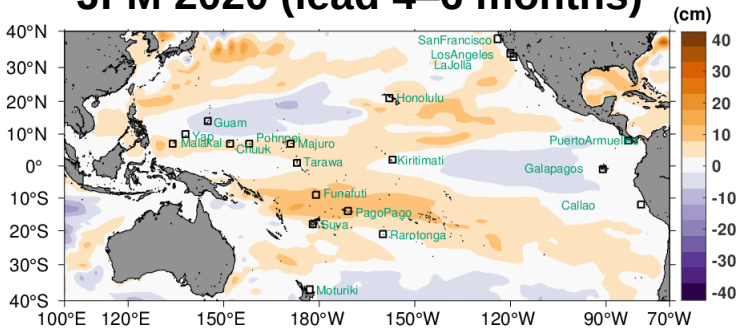
SSH analysis September 2019



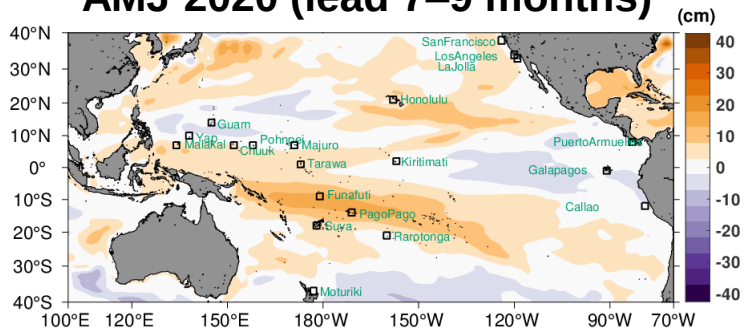
OND 2019 (lead 1–3 months)



JFM 2020 (lead 4–6 months)



AMJ 2020 (lead 7–9 months)



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https://uhslc.soest.hawaii.edu/sea-level-forecasts/

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- Drs. Zeng-Zhen Hu, Caihong Wen, and Arun Kumar: reviewed PPT, and provide insightful suggestions and comments

- Drs. Li Ren and Pingping Xie provided the BASS/CMORPH/CFSR EVAP package

- Dr. Wanqiu Wang provided the sea ice forecasts and maintained the CFSv2 forecast achieve

- Dr. Matthew Widlansky (U. Hawaii) provided slides about sea level predictions.

Please send your comments and suggestions to:

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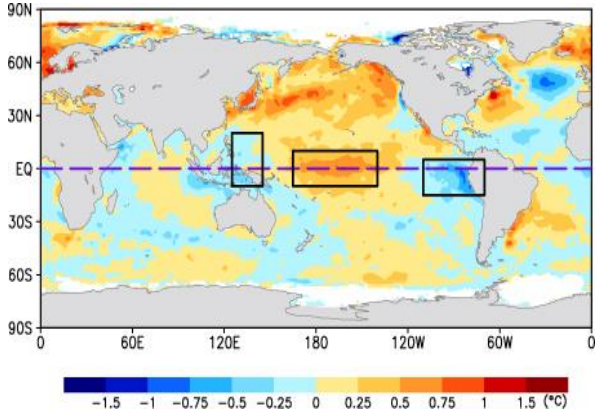
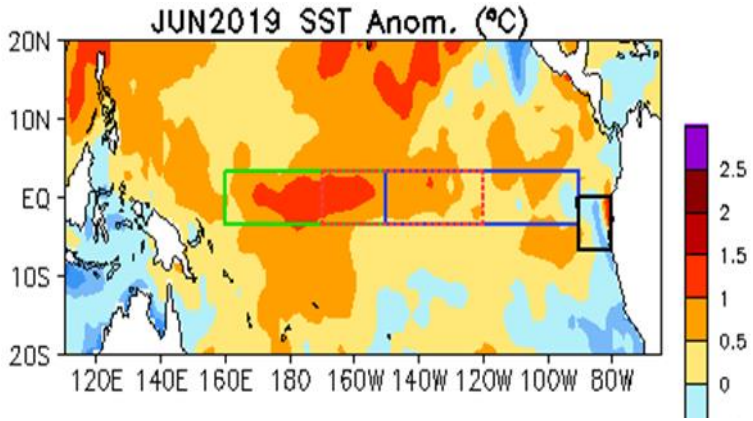
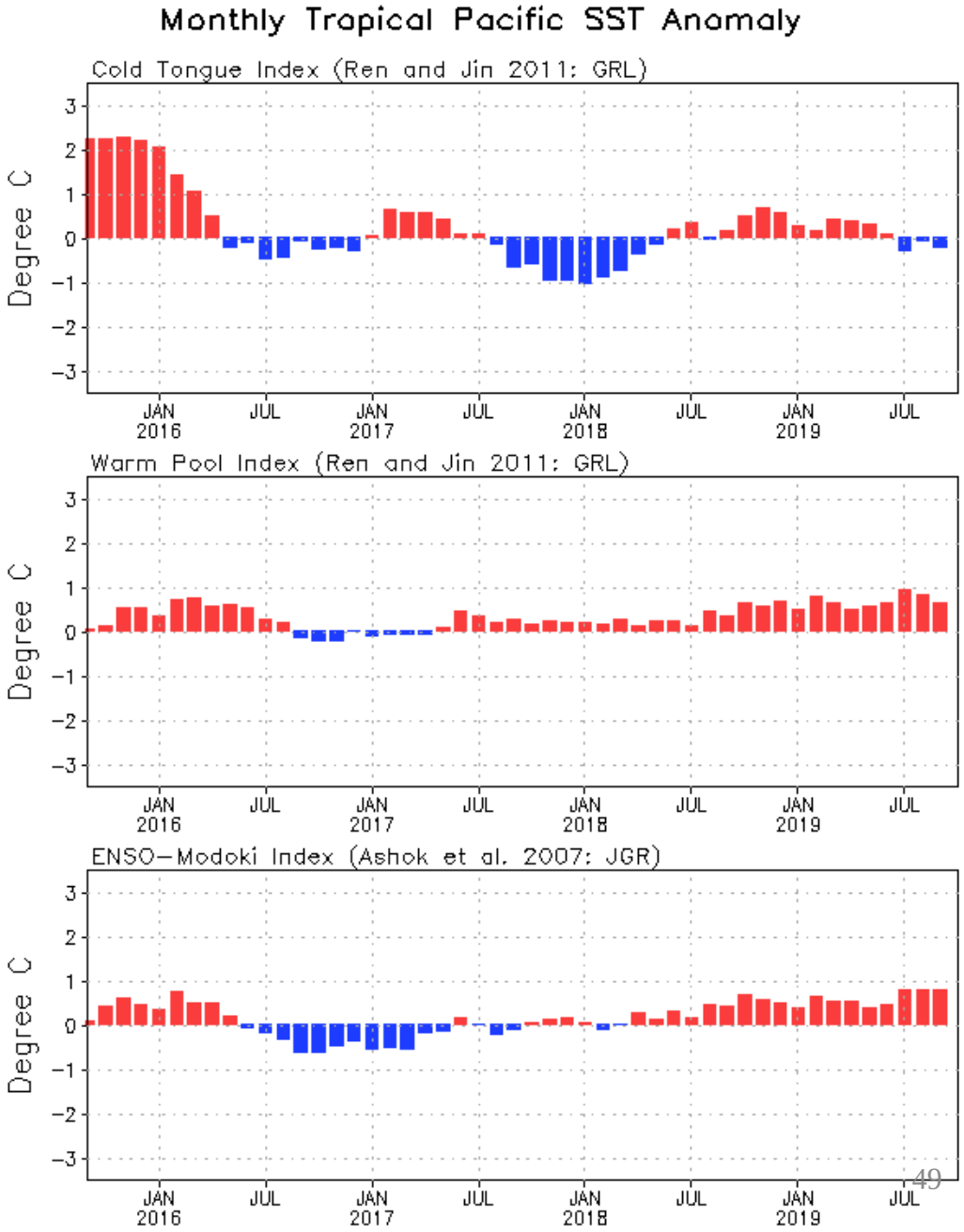
Caihong.Wen@noaa.gov

Jieshun.Zhu@noaa.gov

Backup Slides


90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0
−1.5 −1 −0.75 −0.5 −0.25 0 0.25 0.5 0.75 1 1.5 (°C)


JUN2019 SST Anom. (°C)
20N
10N
EQ
10S
20S
120E 140E 160E 180 160W 140W 120W 100W 80W
2.5
2
1.5
1
0.5
0


Monthly Tropical Pacific SST Anomaly
Cold Tongue Index (Ren and Jin 2011: GRL)
Degree C
3
2
1
0
−1
−2
−3
JAN 2016
JUL
JAN 2017
JUL
JAN 2018
JUL
JAN 2019
JUL
Warm Pool Index (Ren and Jin 2011: GRL)
Degree C
ENSO−Modoki Index (Ashok et al. 2007: JGR)
Degree C

North Atlantic: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

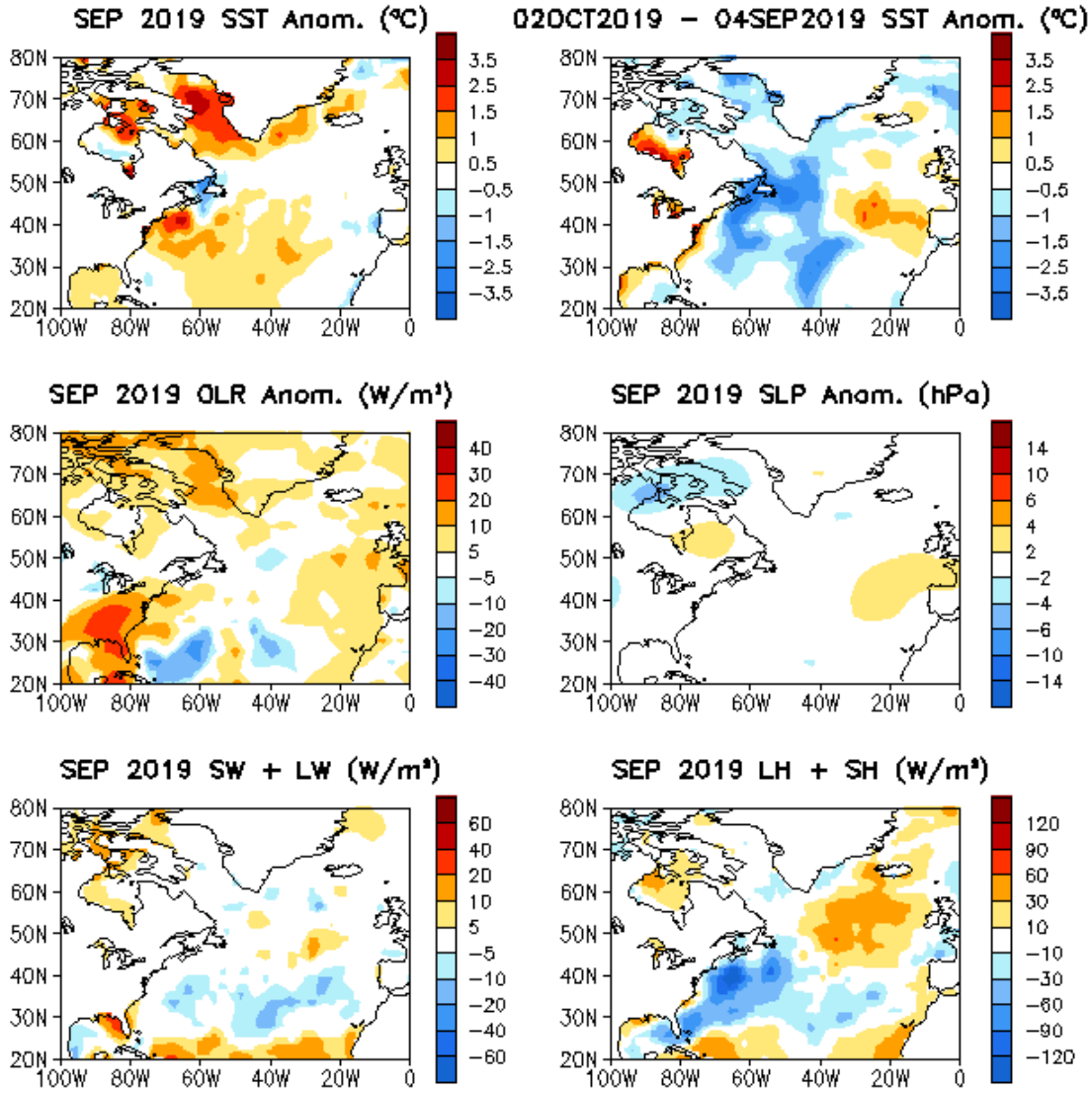


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible heat flux anomalies (bottom-right). SST are derived from the NCEP OI SST analysis, OLR from the NOAA 18 AVHRR IR window channel measurements by NESDIS, sea surface pressure and surface radiation and heat fluxes from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period means.

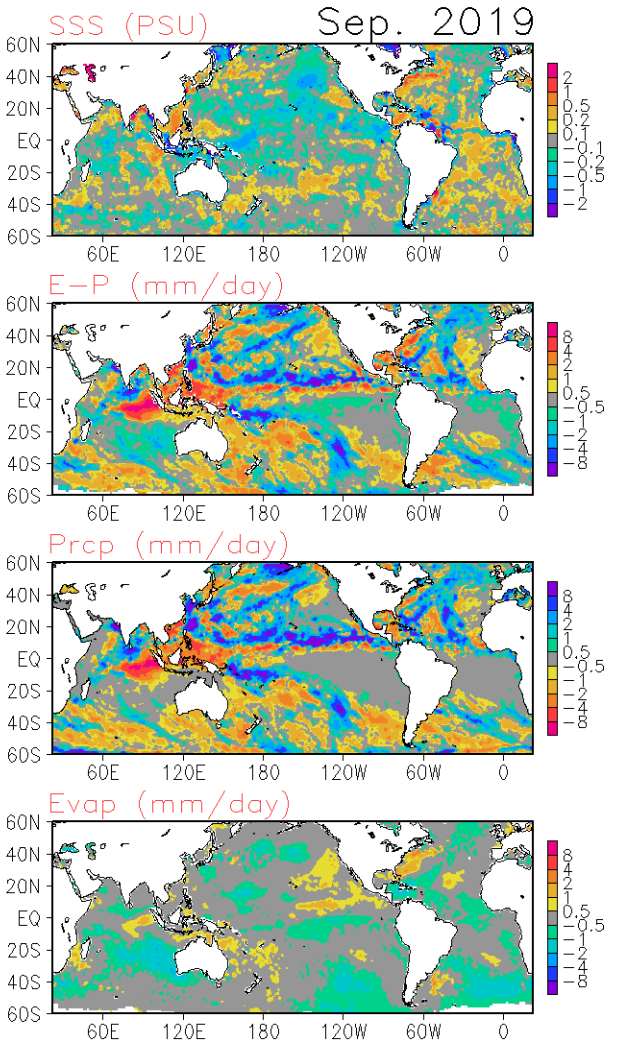
Global Sea Surface Salinity (SSS)

Anomaly for September 2019

- New Update: The input satellite sea surface salinity of SMAP from NSAS/JPL was changed from Version 4.0 to Near Real Time product in August 2018.
- In the equatorial Pacific, negative SSS anomalies are continuing in the western basin and near coastal region of the eastern basin. Negative SSS anomalies are also continuing in the northeast Pacific ocean, which is likely due to the heavy precipitation. Negative SSS signal is across the central N. Atlantic Ocean co-incident with increased precipitation. Such phenomena is likely related to the hurricane activities in this area. Meanwhile, in the Sea of Okhotsk, negative SSS anomaly continues/enhances and it is likely due to the river discharge.

- **Data used**

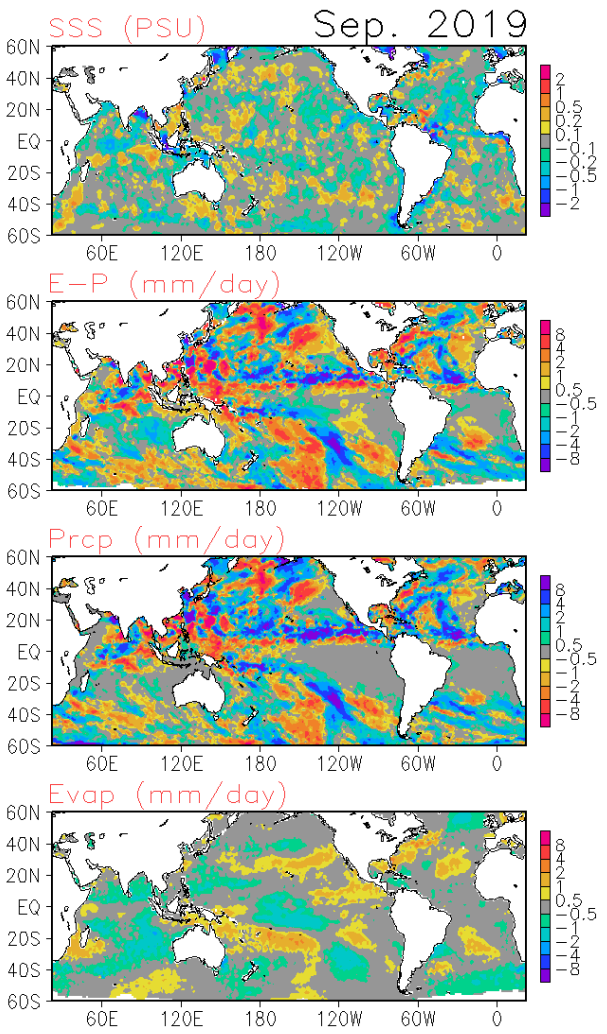
  SSS : Blended Analysis of Surface Salinity (BASS) V0.Z
  (a CPC-NESDIS/NODC-NESDIS/STAR joint effort)
  (Xie et al. 2014)
  ftp.cpc.ncep.noaa.gov/precip/BASS
  Precipitation: CMORPH adjusted satellite precipitation estimates
  Evaporation: Adjusted CFS Reanalysis



Global Sea Surface Salinity (SSS)

Tendency for September 2019

Compared with last month, the SSS decreased in the Indo-Pacific region with decreasing precipitation. Therefore, such SSS decreasing is likely caused by oceanic advection/entrainment. The SSS decreased across the central N. Atlantic Ocean with heavy precipitation in the area. The SSS continues decreasing in the Sea of Okhotsk. In Bay of Bengal, the oceanic advection/entrainment might cause the SSS decreasing.

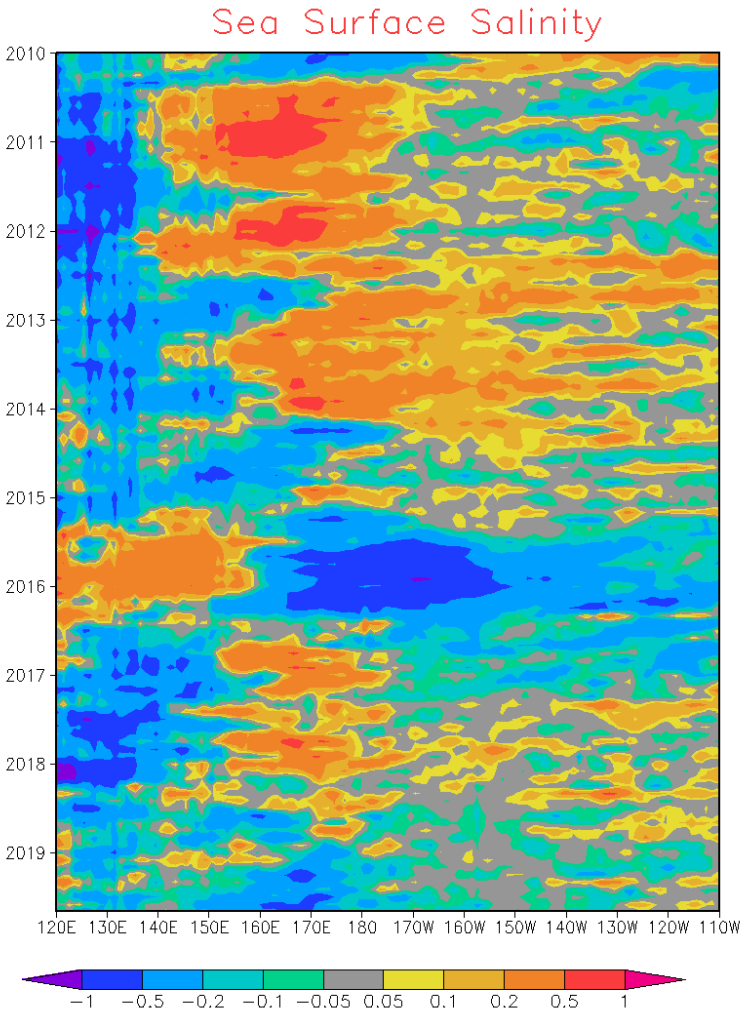


Global Sea Surface Salinity (SSS)

Anomaly Evolution over Equatorial Pacific from Monthly SSS

NOTE: Since June 2015, the BASS SSS is from in situ, SMOS and SMAP; before June 2015,The BASS SSS is from in situ, SMOS and Aquarius.

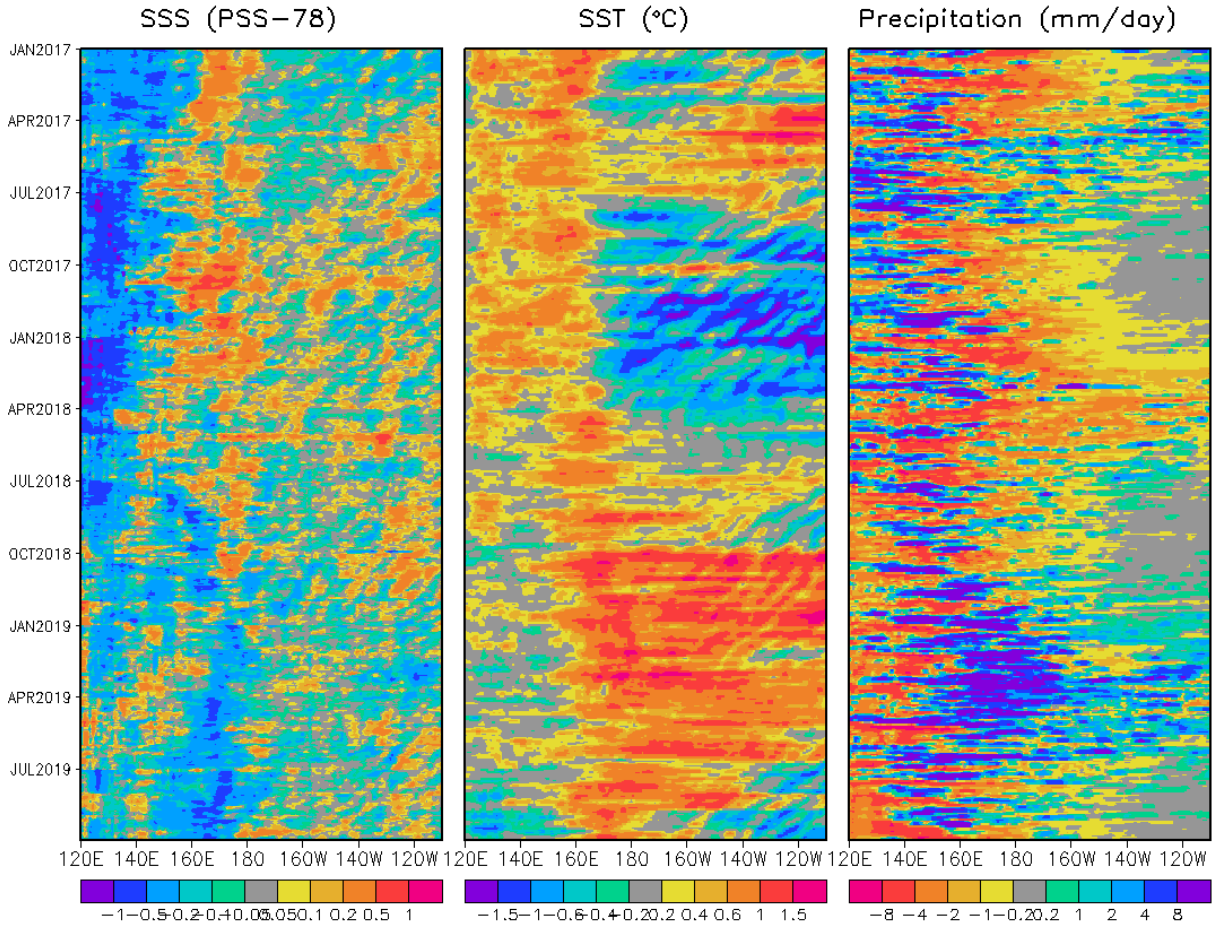
- Hovemoller diagram for equatorial SSS anomaly **(5˚ S-5˚ N);**
- In the equatorial Pacific Ocean, the SSS signal is continually negative west of dateline with stronger signals between 160˚ E and 175˚ E; east of dateline, particularly towards east, the SSS anomalies do not show strong signals.



Global Sea Surface Salinity (SSS)

Anomaly Evolution over N. of Equatorial Pacific from Pentad SSS

Figure caption:
Hovemoller diagram for equatorial (5° S-5° N) 5-day mean SSS, SST and precipitation anomalies. The climatology for SSS is Levitus 1994 climatology. The SST data used here is the OISST V2 AVHRR only daily dataset with its climatology being calculated from 1985 to 2010. The precipitation data used here is the adjusted CMORPH dataset with its climatology being calculated from 1999 to 2013.



September 2019 Experimental Sea Ice Outlook

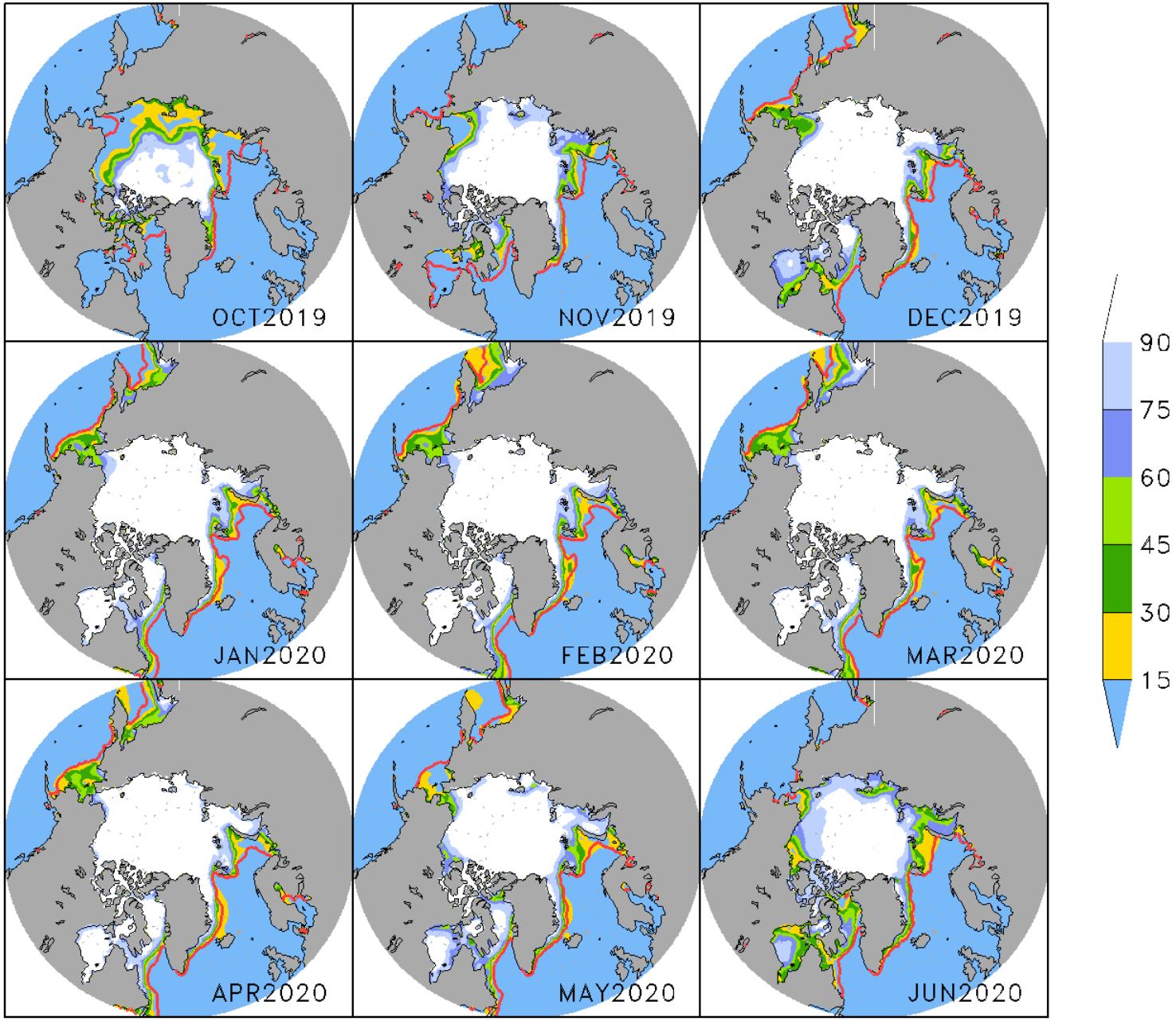
Climate Prediction Center, NCEP/NWS/NOAA

Acknowledgments: Both hindcasts and forecasts were produced on NOAA GAEA computer.

Procedure

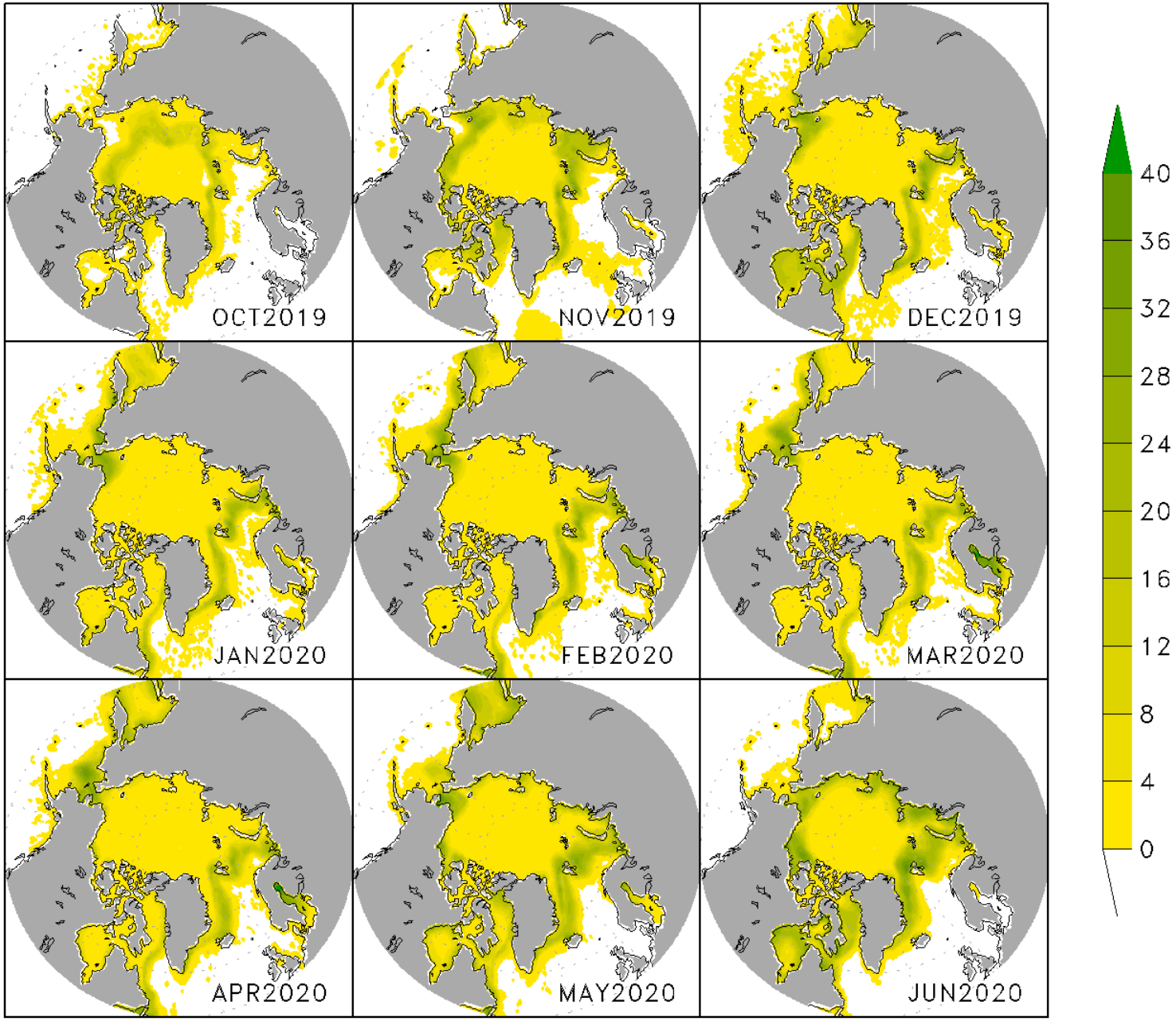
- Use Climate Forecast System (CFS) coupled model initialized with CPC Sea Ice Initialization System (CSIS) initial sea ice conditions (20 initializations: September 21-25, 2019).
- Correct biases using 2006-2018 mean error with respect to NSIDC observations
- Present unbiased results
- The following maps are included
  - SIE Monthly time series (mean and spread)
  - SIC Monthly forecast panels (Ensemble mean)
  - SIC Monthly standard deviation panels
  - Monthly ice cover probability
  - Mean first ice melt day/ standard deviation (Alaska region)
  - First ice melt day prediction difference from previous month
  - Mean first ice freeze day/ standard deviation (Alaska region)

Arctic sea ice concentration (SIC, %) forecast
Experimental CFSv2 initialized September 21–25, 2019

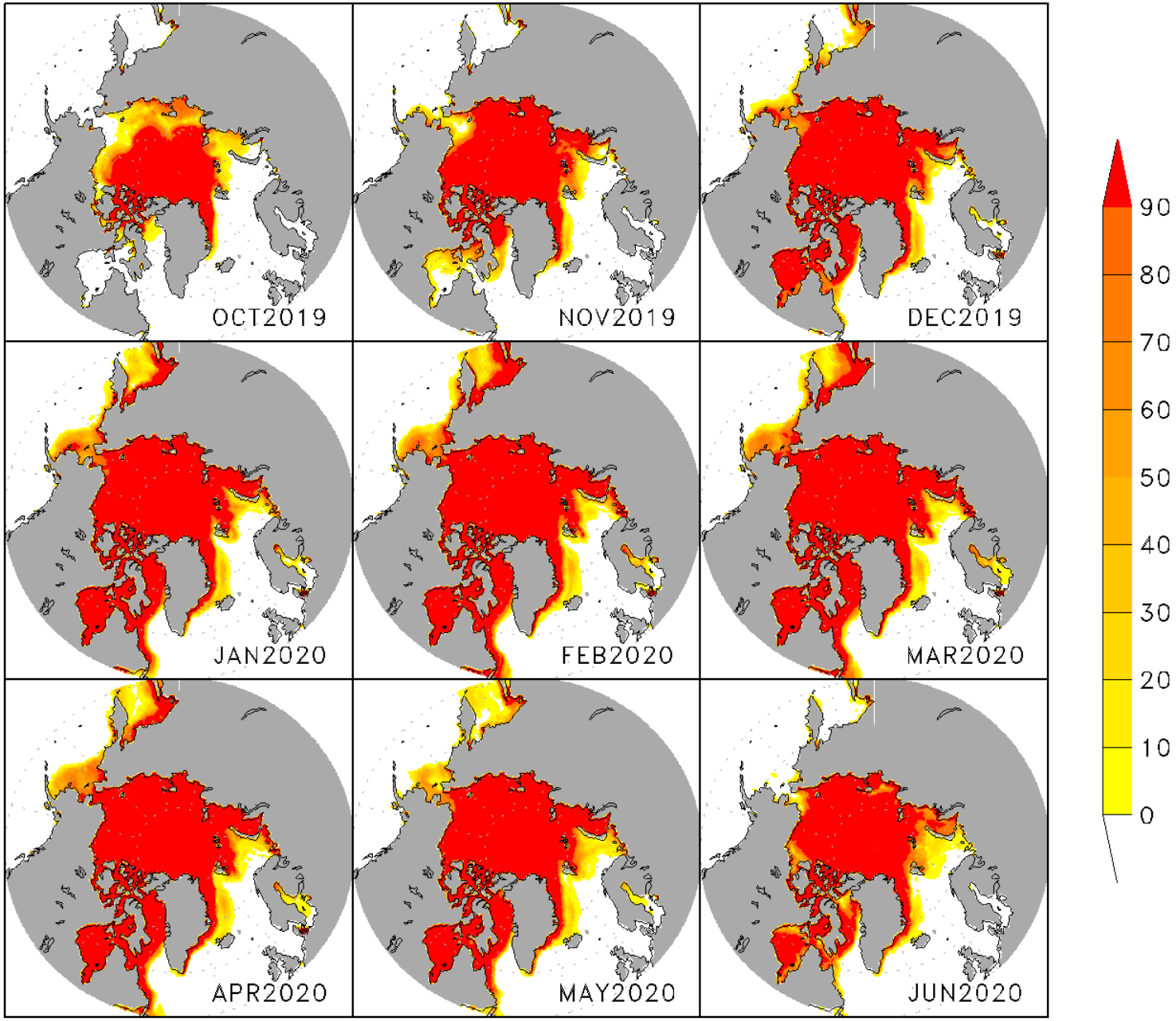


* 1981–2010 climatology of 15% NASA Team SIC countoured red *

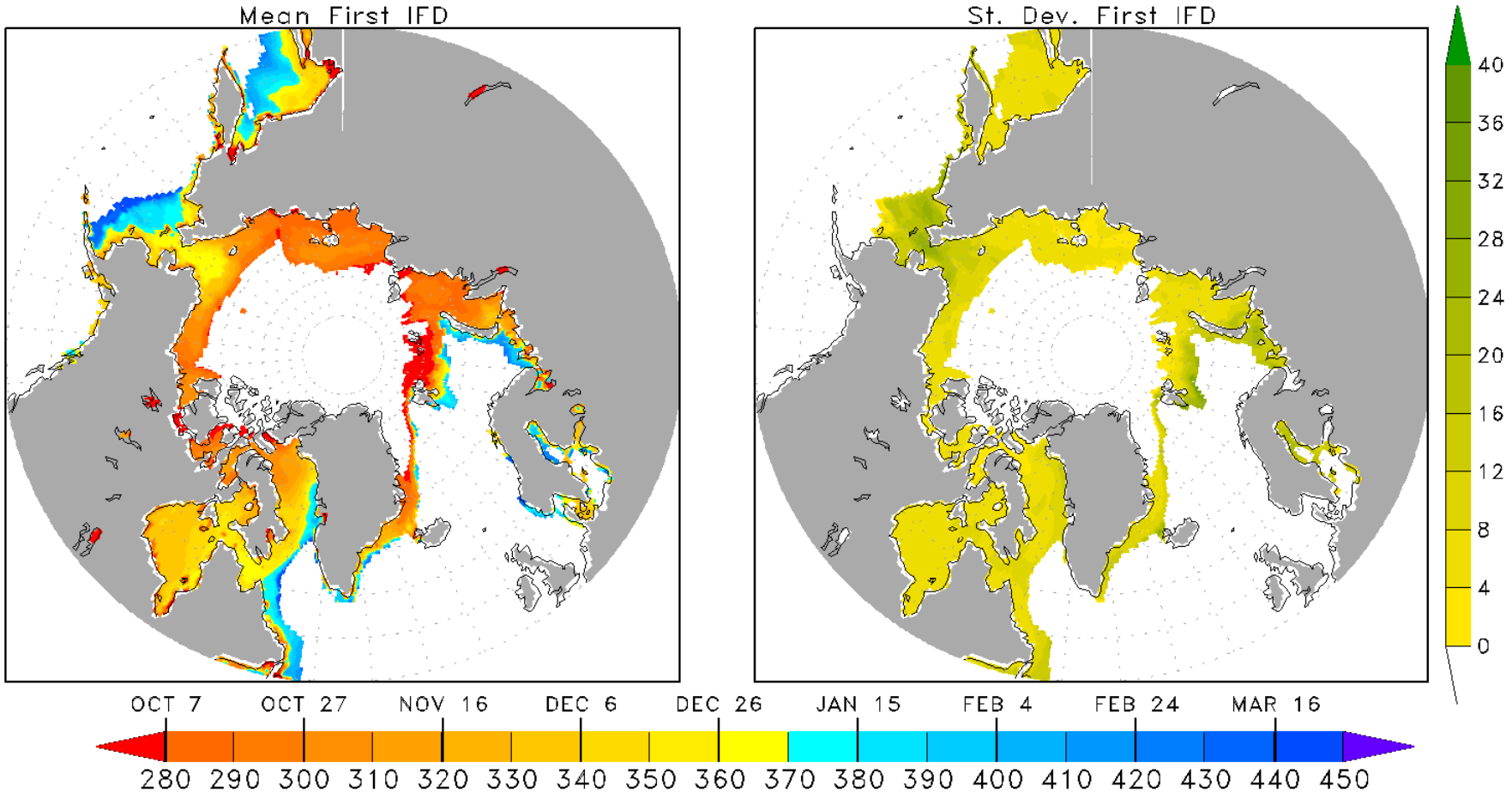
Arctic sea ice concentration standard deviation (SICstd, %)
Experimental CFSv2 initialized September 21–25, 2019



Arctic sea ice concentration probability ≧ 15% (SIP)
Experimental CFSv2 initialized September 21–25, 2019



First sea ice freeze date of 2019–2020
Experimental CFSv2 initialized September 21–25, 2019



Data Sources (climatology is for 1981-2010)

- Weekly Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)
- Extended Reconstructed SST (ERSST) v5 (Huang et al. 2017)
- Blended Analysis of Surface Salinity (BASS) (Xie et al. 2014)
- CMORPH precipitation (Xie et al. 2017)
- CFSR evaporation adjusted to OAFlux (Xie and Ren 2018)
- NCEP CDAS winds, surface radiation and heat fluxes (Kalnay et al. 1996)
- NESDIS Outgoing Long-wave Radiation (Liebmann and Smith 1996)
- NCEP's GODAS temperature, heat content, currents (Behringer and Xue 2004)
- Aviso altimetry sea surface height from CMEMS
- Ocean Surface Current Analyses – Realtime (OSCAR)
- In situ data objective analyses (IPRC, Scripps, EN4.2.1, PMEL TAO)
- Operational Ocean Reanalysis Intercomparison Project

  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html

  http://www.cpc.ncep.noaa.gov/products/GODAS/multiora93_body.html