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

Prepared by
Climate Prediction Center, NCEP/NOAA

August 11, 2016

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 Ocean Climate Observation Program (OCO)

Outline

- **Overview**

- **Recent highlights**
  - **Pacific/Arctic Ocean**
  - **Indian Ocean**
  - **Atlantic Ocean**

- **Global SST Predictions**

❖ **Will a La Nina come?**

❖ **Real-time salinity analysis intercomparison**

❖ **Experimental Arctic Sea Ice Prediction**

Overview

- **Pacific Ocean**
  - NOAA "ENSO Diagnostic Discussion" on 11 August 2016 issued "La Niña Watch" and suggested that "La Niña is slightly favored to develop during August - October 2016, with about a 55-60% chance of La Niña during the fall and winter 2016-17.";
  - Negative SST anomalies (SSTA) near the equator has enhanced and extended westward with NINO3.4=-0.5^{o}C in Jul 2016, while negative temperature anomalies near the thermocline weakened across the equatorial Pacific;
  - Sea surface salinity was fresher than normal off-equator in the western and eastern tropical Pacific;
  - Positive phase of PDO has persisted for 25 months, and weakened with PDOI=+0.5 in Jul 2016.
- **Indian Ocean**
  - Positive (negative) SSTA presented in the eastern (western) tropical Indian Ocean, and Dipole Mode Index = -1.2^{o}C in Jul 2016.
- **Atlantic Ocean**
  - NAO was in negative phase with NAOI=-1.7 in Jul 2016.
  - SST and Tropical Cyclone Heat Potential (TCHP) were above-normal and vertical wind shear was below-normal in the hurricane Main Development Region (MDR), which is favorable for hurricane activity

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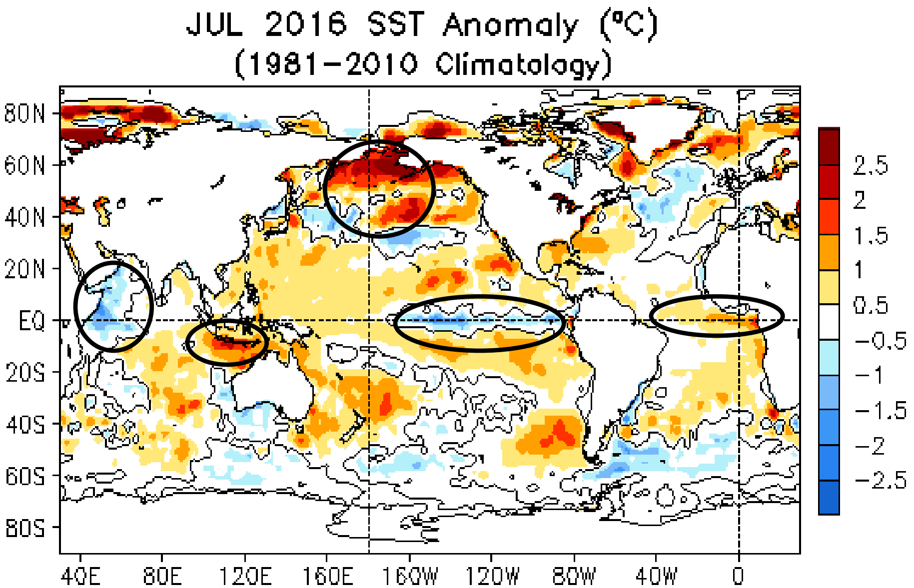
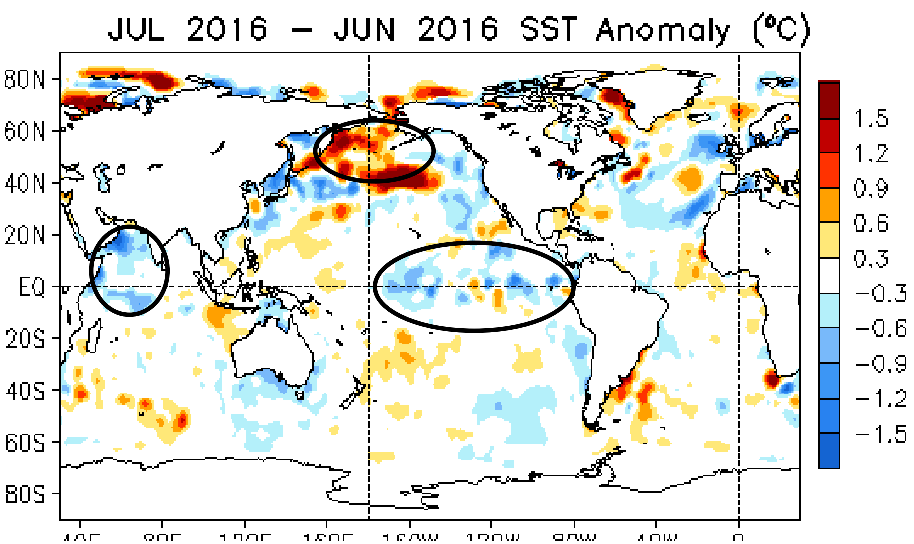
Global Oceans

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



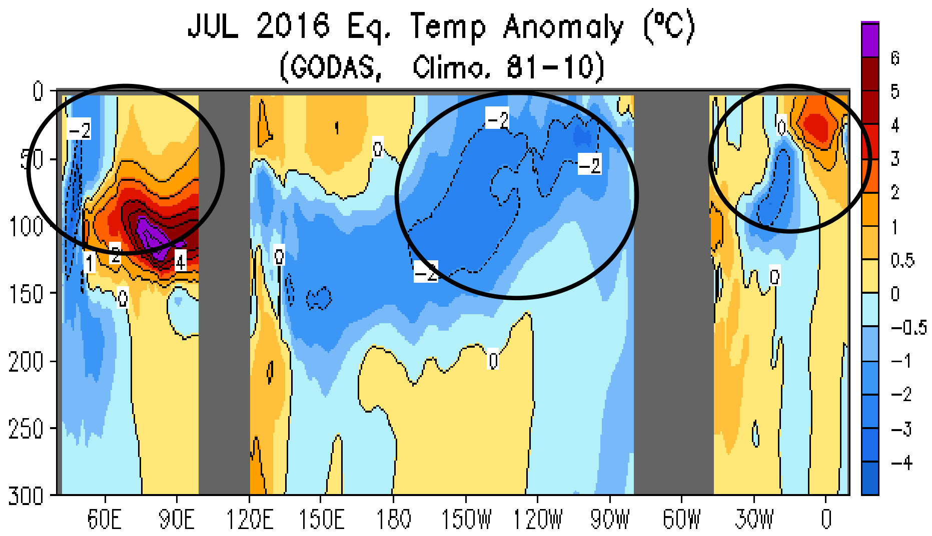
- Negative SSTA was observed in the C.-E. equatorial Pacific, and surrounded by positive SSTA in off-equatorial regions and the W.-C. Pacific.
- Positive SSTA was observed near Bering Strait and in middle-latitude N. Pacific.
- A east-west dipole of SSTA existed in the tropical Indian Ocean.
- Positive SSTA occupied in the equatorial Atlantic.



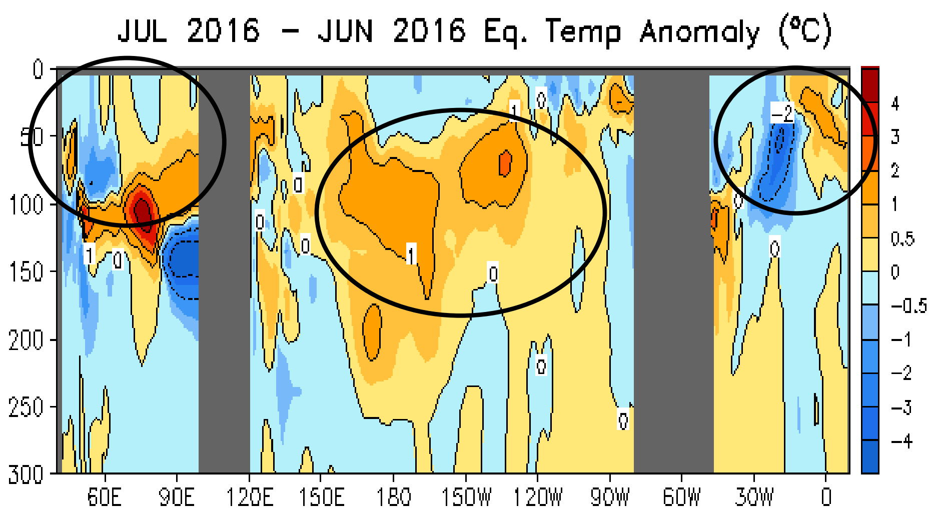
- Negative SSTA tendency presented in the C.-E. equatorial Pacific and western Indian Ocean.
- Positive SSTA tendency was observed in high-latitude N. Pacific.

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^{O}S-2^{O}N



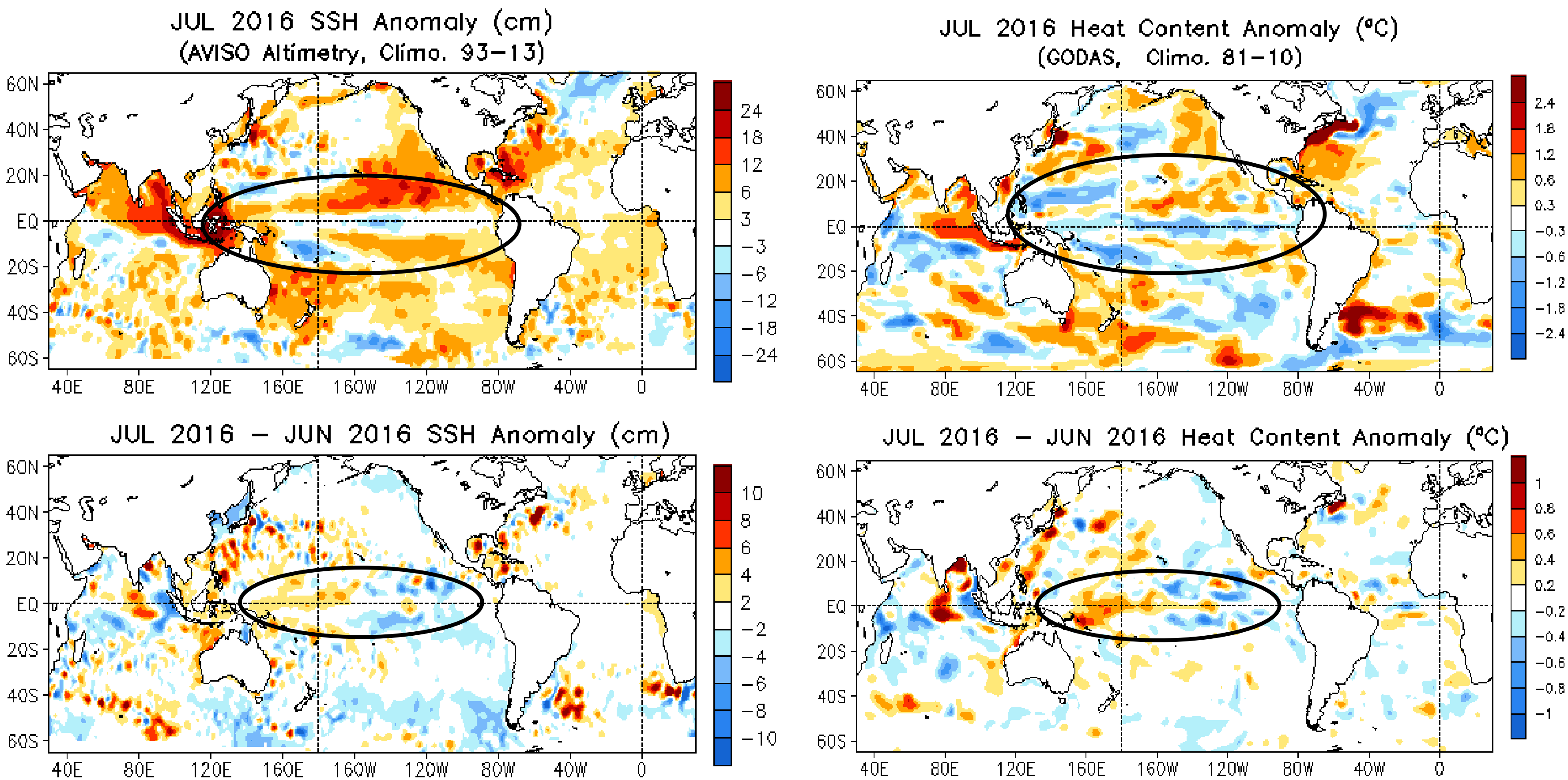
- Negative temperature anomalies presented along the thermocline in the whole Pacific, while positive temperature anomalies were confined near the surface in the W.-C. Pacific.
- Positive temperature anomalies were observed in the eastern Indian Ocean and Atlantic Ocean.



- Positive temperature anomaly tendency presented near the thermocline in the whole Pacific.
- Positive temperature anomalies enhanced in the equatorial Indian Ocean and Atlantic Ocean.

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

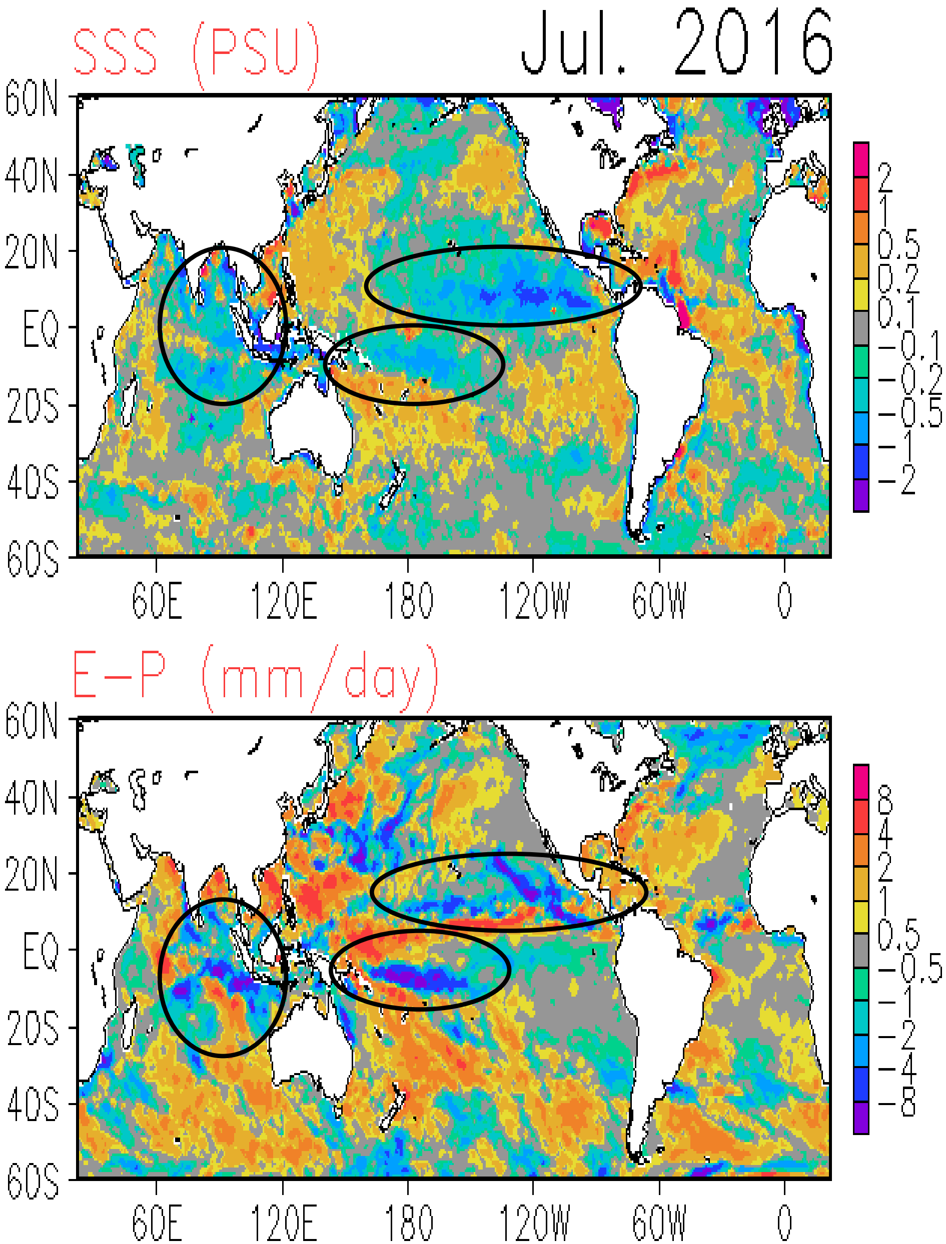


- The SSHA was overall consistent with HC300A: Positive (negative) HC300A is tied up with positive (negative) SSHA.

- Both SSHA and HC300A were weakly negative along the equatorial Pacific, reflecting the neutral phase of ENSO.

- Tendencies of both SSHA and HC300A were positive in the W.-C. Pacific and negative in off-equatorial eastern Pacific.

Sea Surface Salinity and Freshwater Flux (E-P) Anomaly



SSS: Blended Analysis of Surface Salinity (BASS) based on in situ and satellite observations (Xie et al. 2014)
ftp.cpc.ncep.noaa.gov/precip/BASS

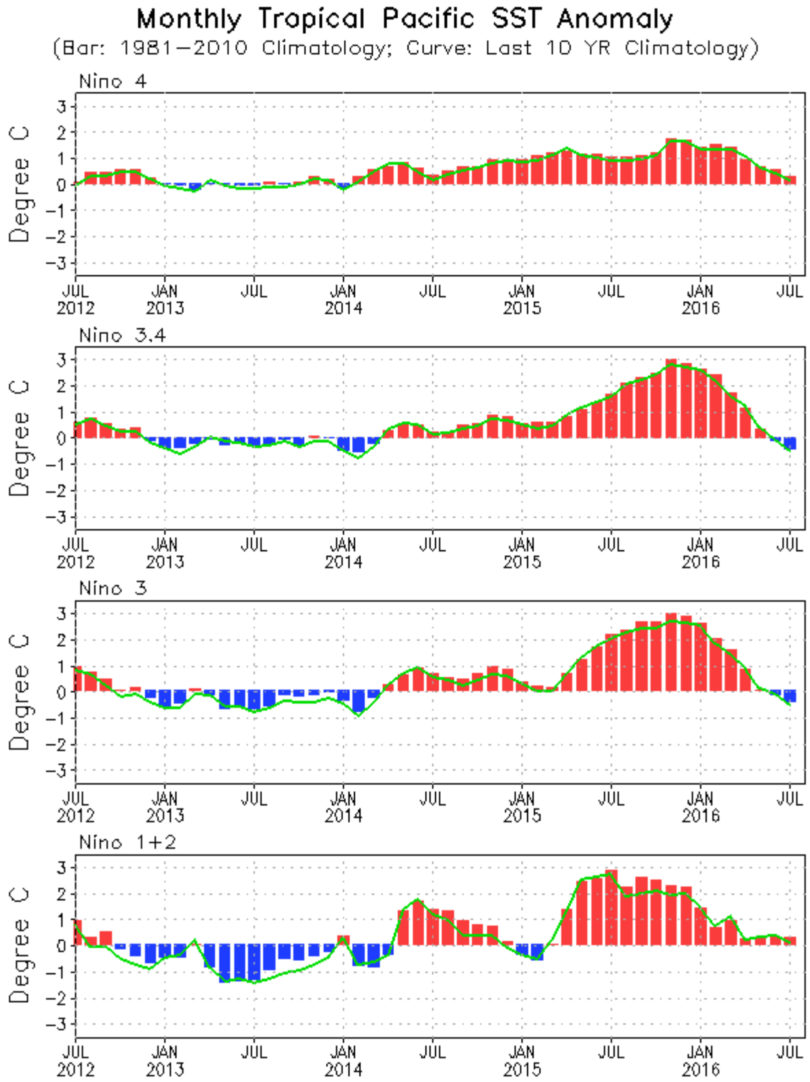
Precipitation: CMORPH adjusted satellite precipitation estimates

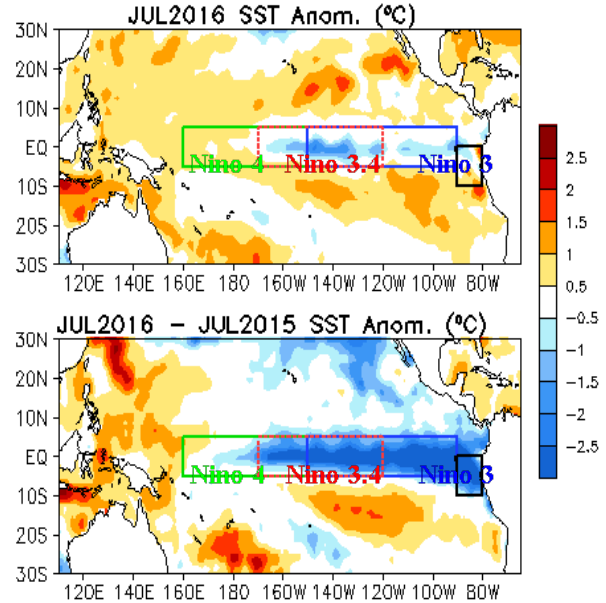
Evaporation: CFSR

- **Positive (negative) SSS anomaly is generally tided up with positive (negative) E-P anomaly, indicating the dominant role of E-P forcing on SSS variability.**
- **Fresher than normal SSS presented in the off-equator of the western and eastern tropical Pacific, and also in Bay of Bengal and eastern tropical Indian Ocean.**
- **Saltier than normal SSS presented across most of the tropical Atlantic and along the eastern coast of U.S..**

Tropical Pacific Ocean and ENSO Conditions

Evolution of Pacific NINO SST Indices





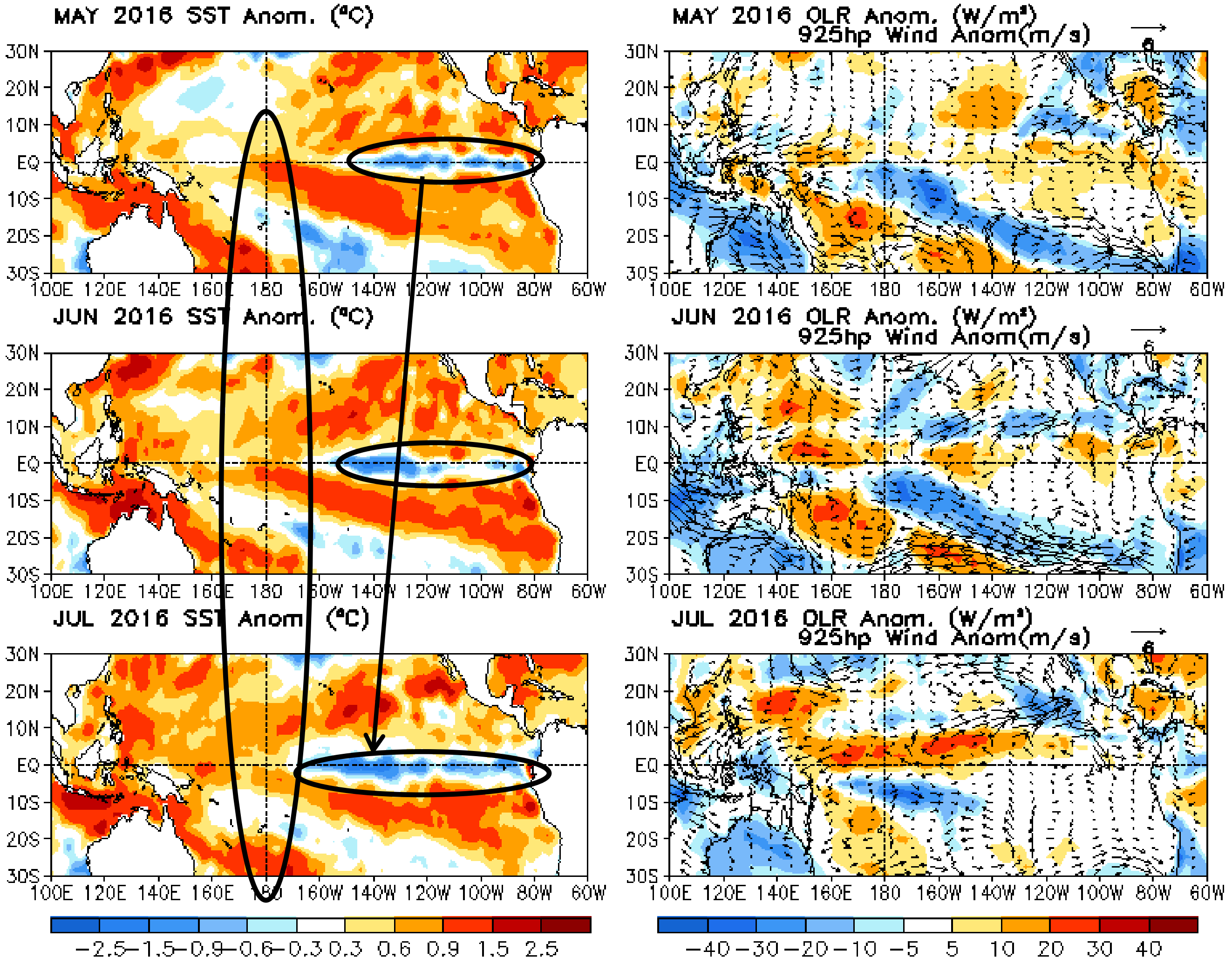
- All Nino indices decreased except NINO 1+2.

- Nino3.4 = -0.5°C in Jul 2016.

- The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v4.

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 (bar) and last ten year (green line) means.

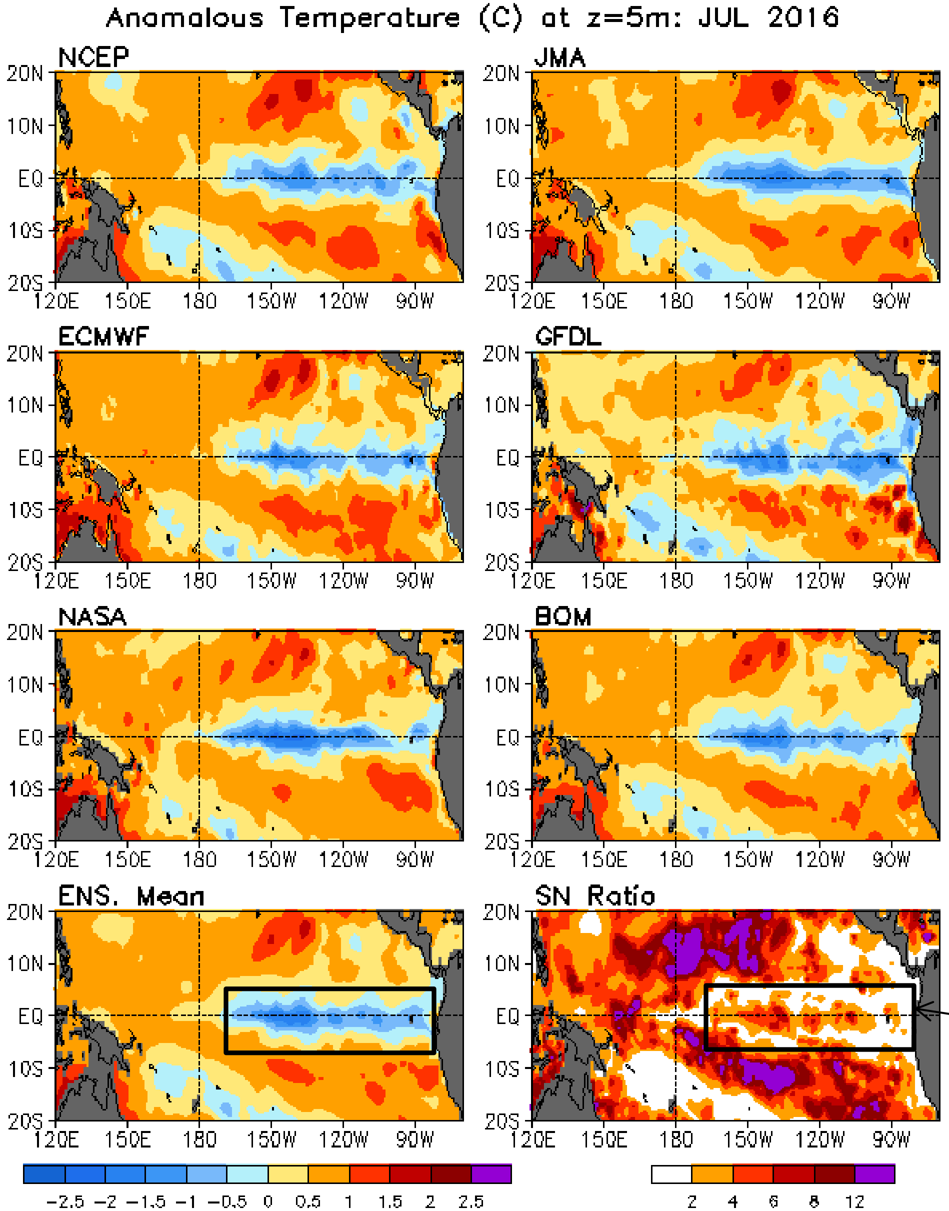
Last Three Month SST, OLR and 925hp Wind Anom.

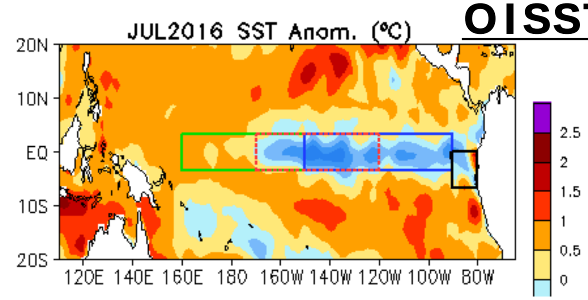


- Negative SSTA enhanced and extended westward in the past two months, while positive SSTA weakened near the dateline.
- Surface easterly wind anomalies persisted in the western Pacific, consistent with enhanced convection over the Maritime Continent and in the eastern Indian Ocean.

Real-Time Ocean Reanalysis Intercomparison: Temperature

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



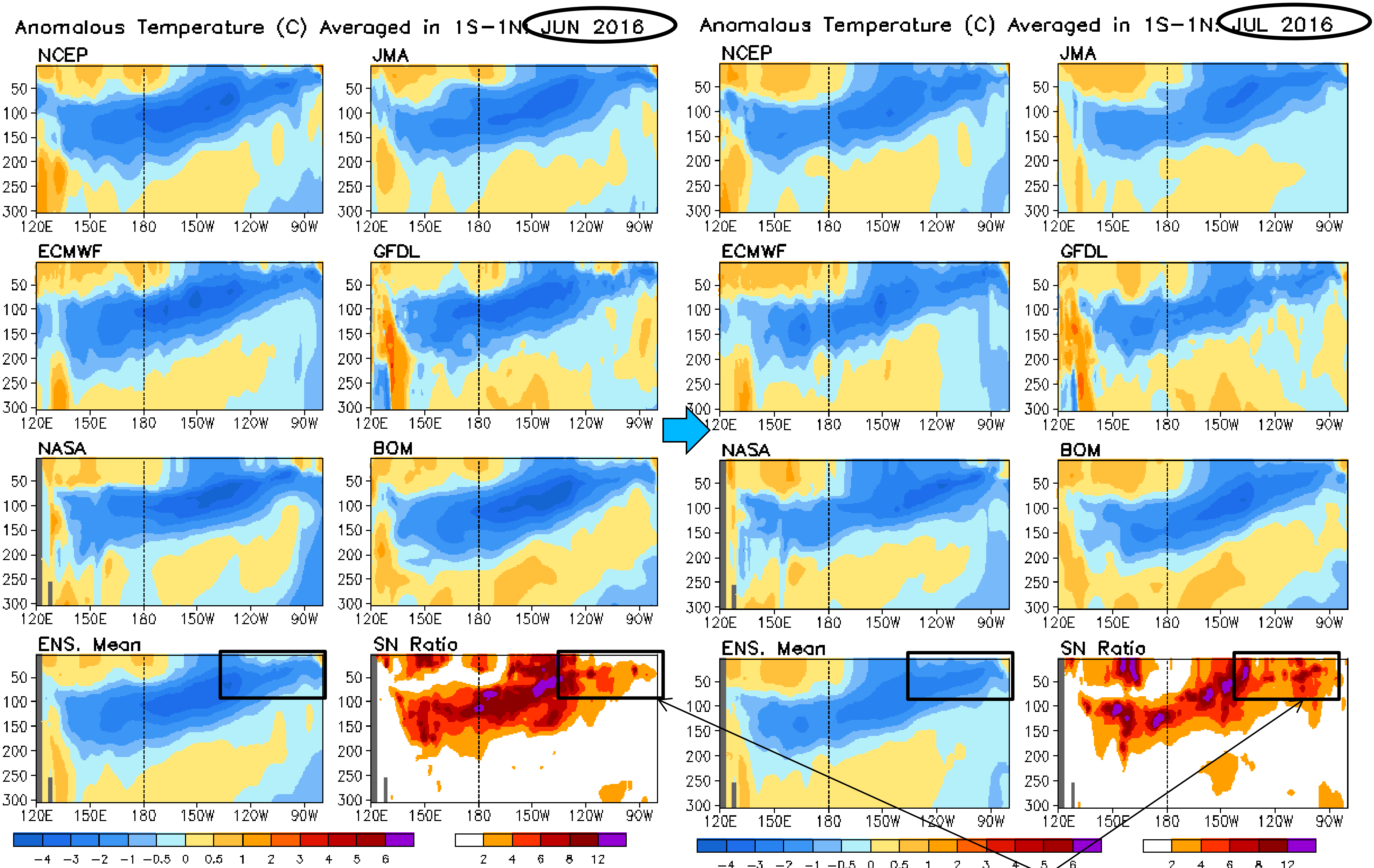


- The SSTA pattern was simulated well by the operational ocean reanalyses, but the signal (ensemble mean) to noise (ensemble spread) ratio was relatively low for the cold SSTA near the equator.

Low signal to noise ratio

Real-Time Ocean Reanalysis Intercomparison: Temperature

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

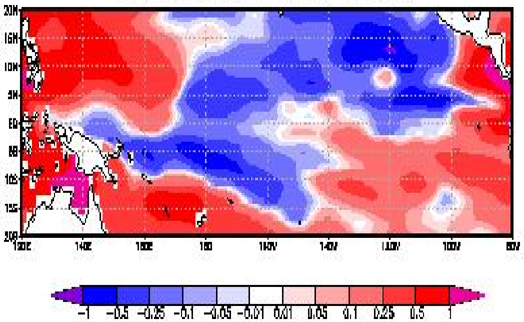


Low signal to noise ratio

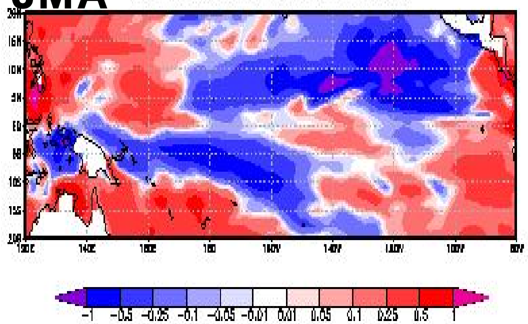
Real-Time Ocean Reanalysis Intercomparison: Sea Surface Salinity

http://poama.bom.gov.au/project/salt_19812010/

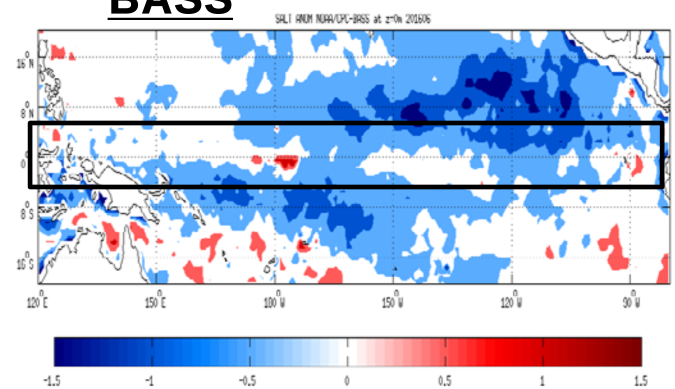
BOM SALT ANOM POAMA at z=5m 201606



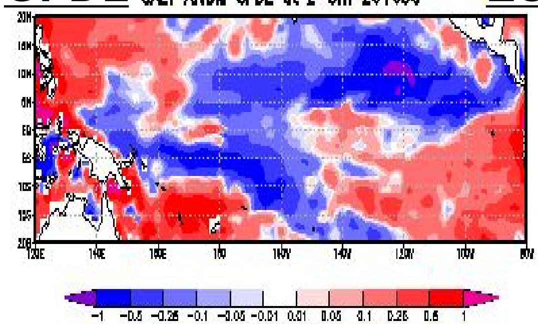
JMA SALT ANOM JMA at z=5m 201606



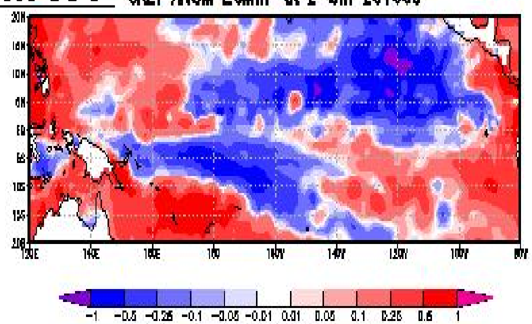
BASS



GFDL SALT ANOM GFDL at z=5m 201606

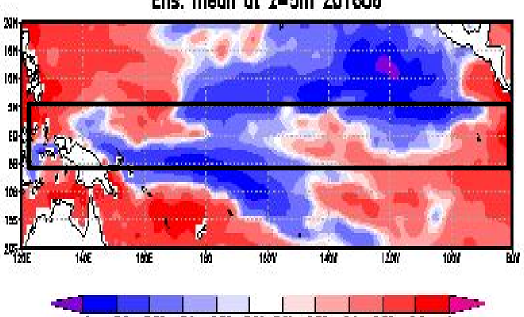


ECMWF SALT ANOM ECMWF at z=5m 201606

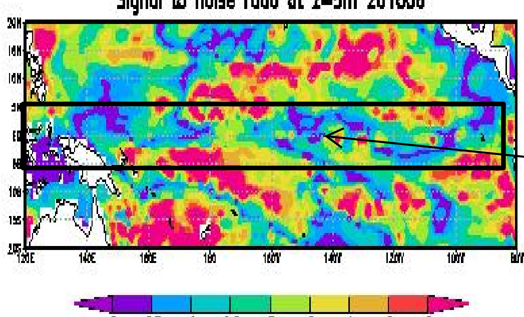


ENS MEAN

Ens. mean at z=5m 201606



Signal to noise ratio at z=5m 201606

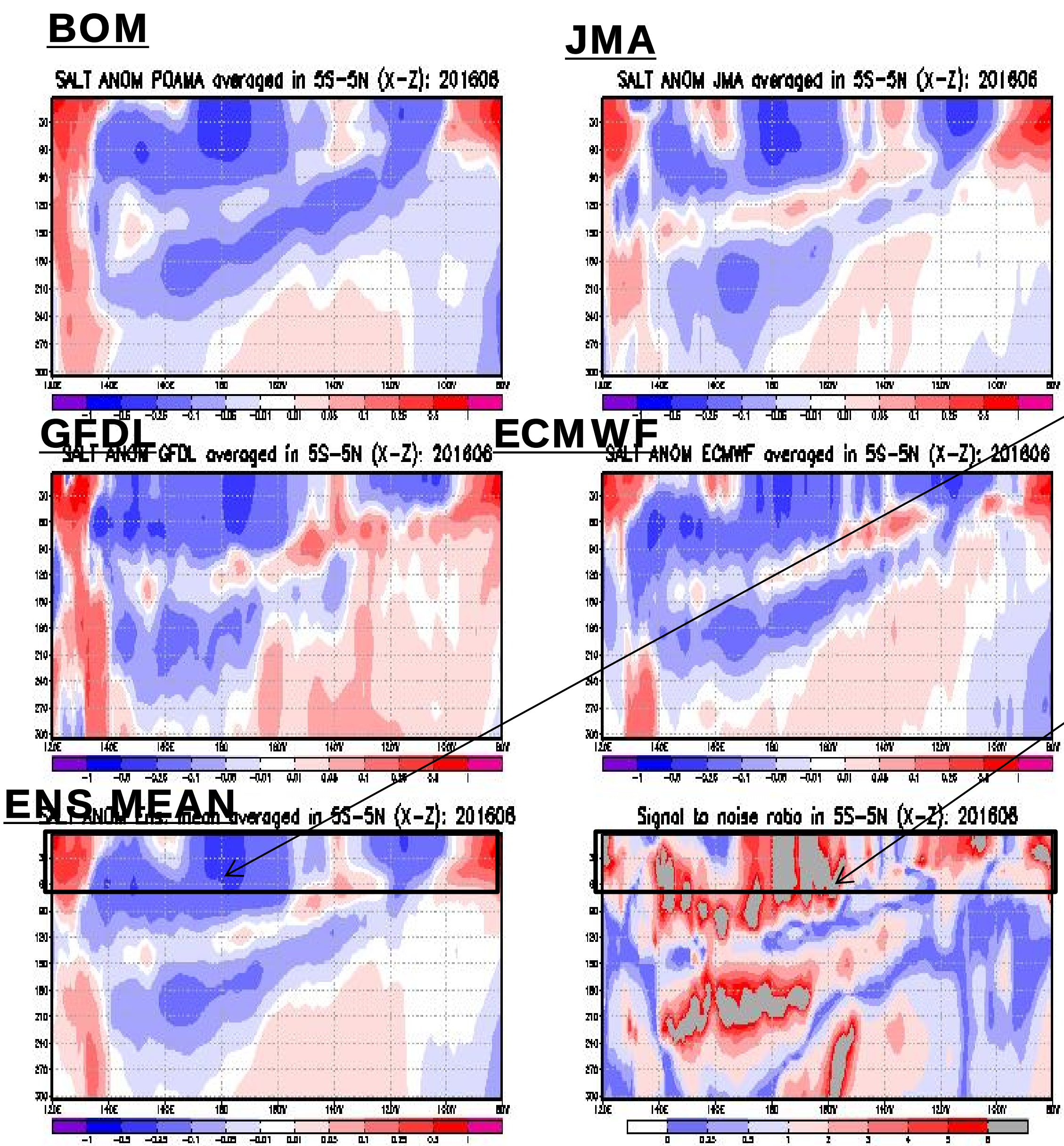


- The SSS anomaly pattern was simulated well by the operational ocean reanalyses, but the signal (ensemble mean) to noise (ensemble spread) ratio was relatively low for the SSS anomaly near the equator.

Low signal to noise ratio

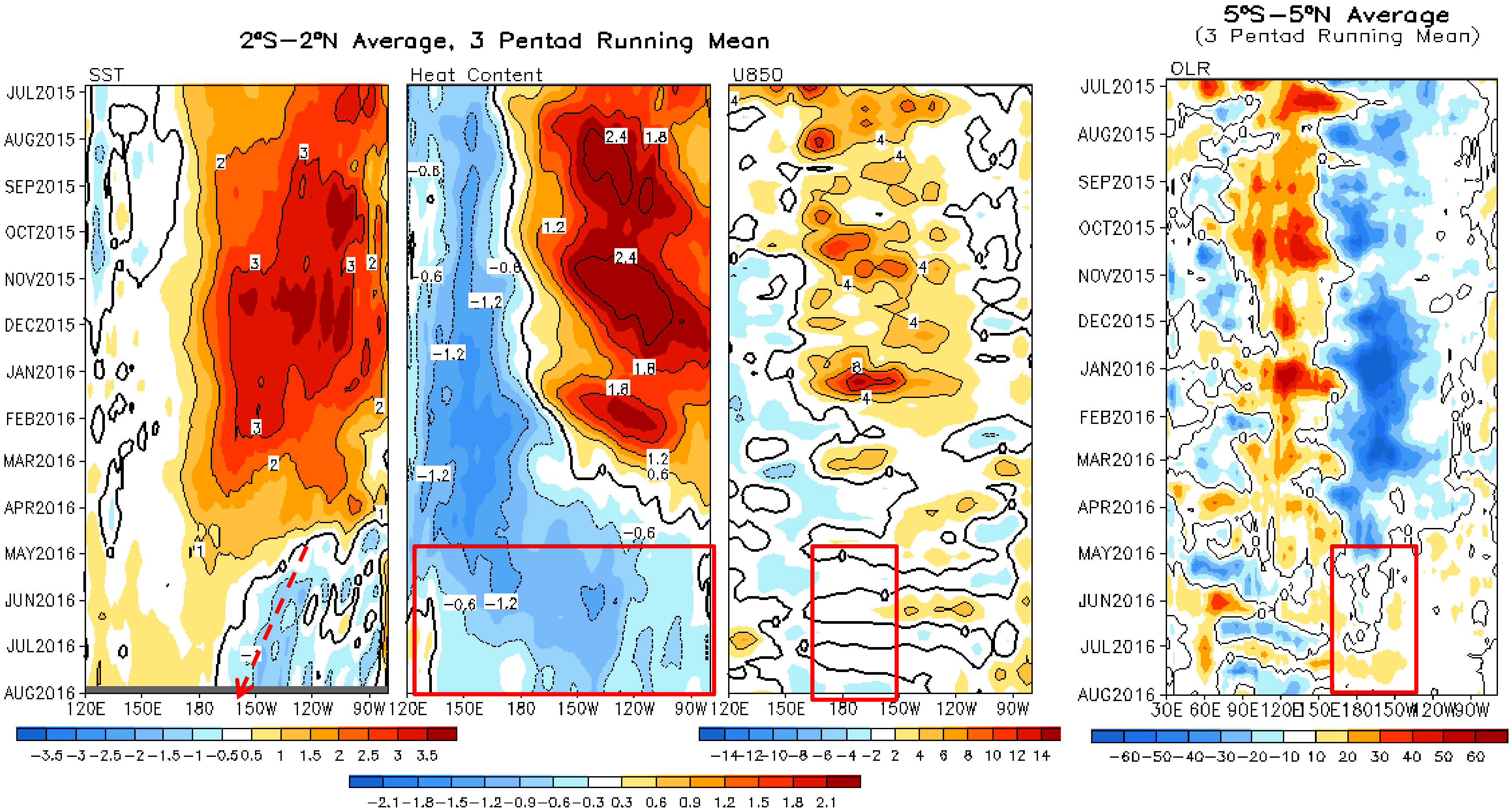
Real-Time Ocean Reanalysis Intercompariso: Subsurface Salinity in 5S-5N

http://poama.bom.gov.au/project/salt_19812010/



- The signal (ensemble mean) includes generally fresh salinity anomalies in the whole equatorial Pacific.
- However, the signal was only reliable where the signal to noise (ensemble spread) ratio was high.

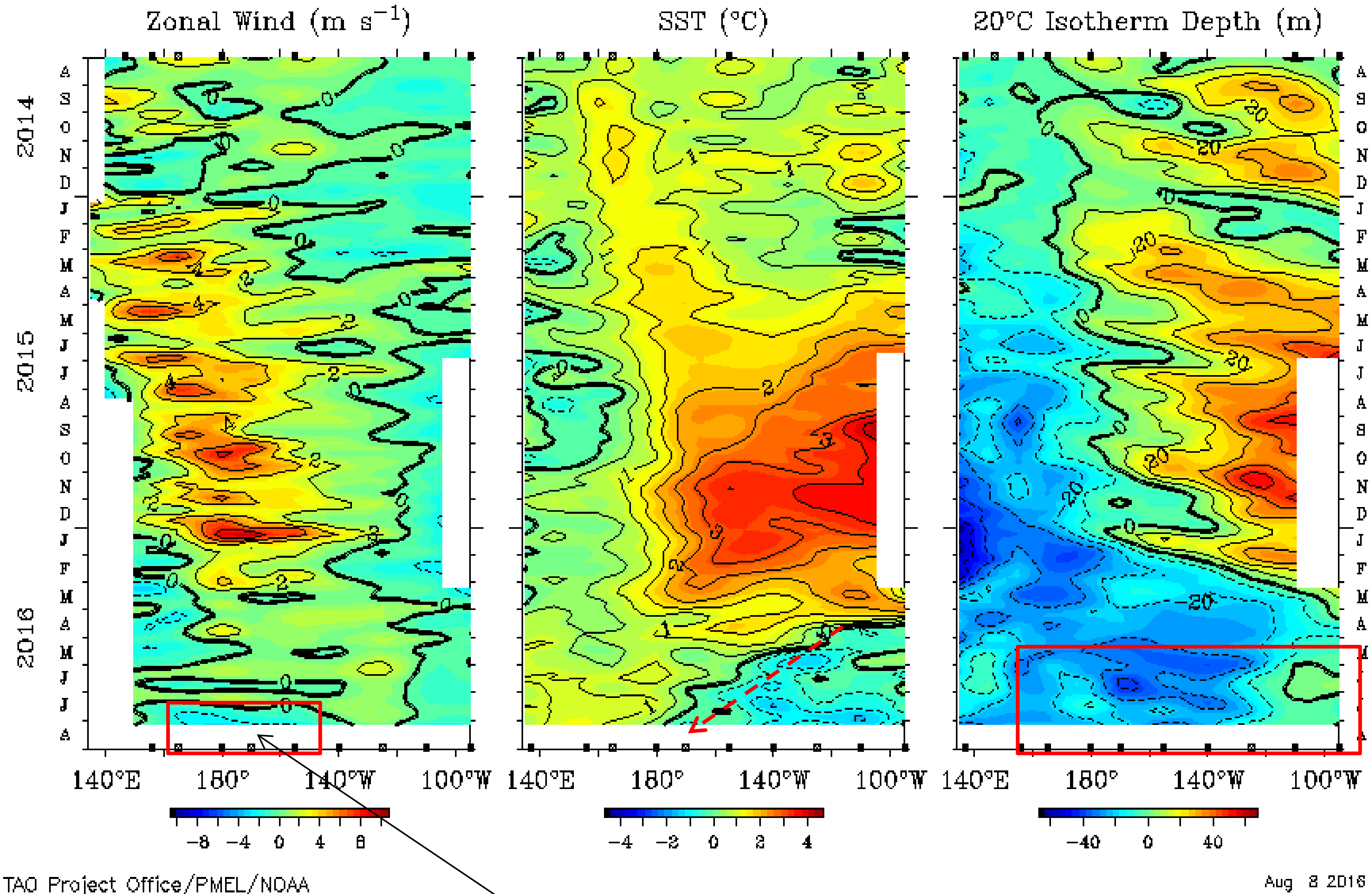
Equatorial Pacific SST (°C), HC300 (°C), U850 (m/s) and OLR(W/m²) Anomalies



- **Negative SSTA developed in the far eastern Pacific in May 2016, and has extended westward since then.**
- **Negative HC300 anomalies propagated eastward and weakened significantly in July 2016.**
- **Surface wind and OLR have been near-normal since May 2016, indicating ENSO-neutral conditions.**

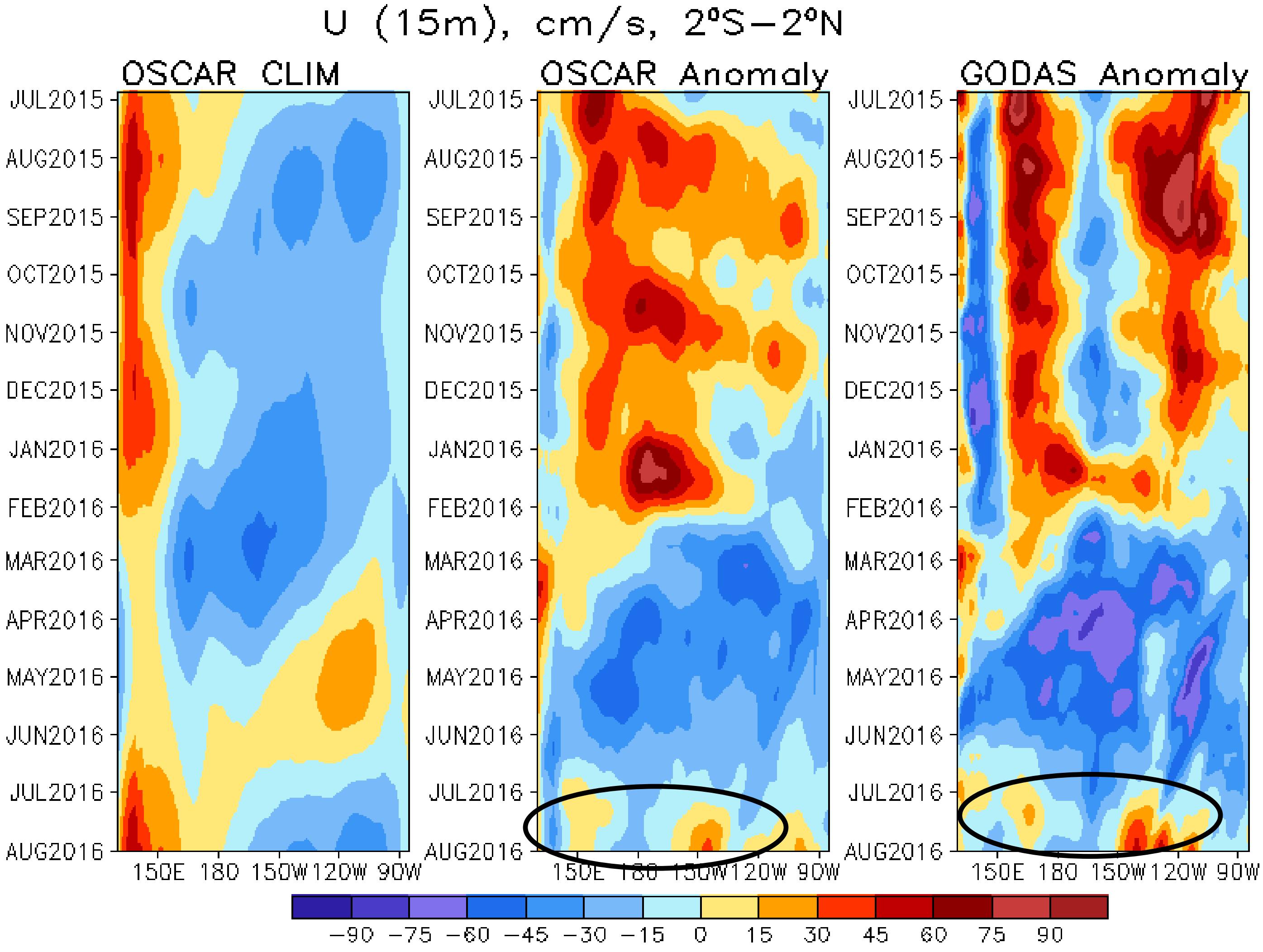
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST is derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, U850 from the NCEP CDAS. Anomalies for SST, heat content and U850/OLR are departures from the 1981-2010 base period pentad means respectively.

Five Day Zonal Wind, SST, and 20°C Isotherm Depth Anomalies 2°S to 2°N Average



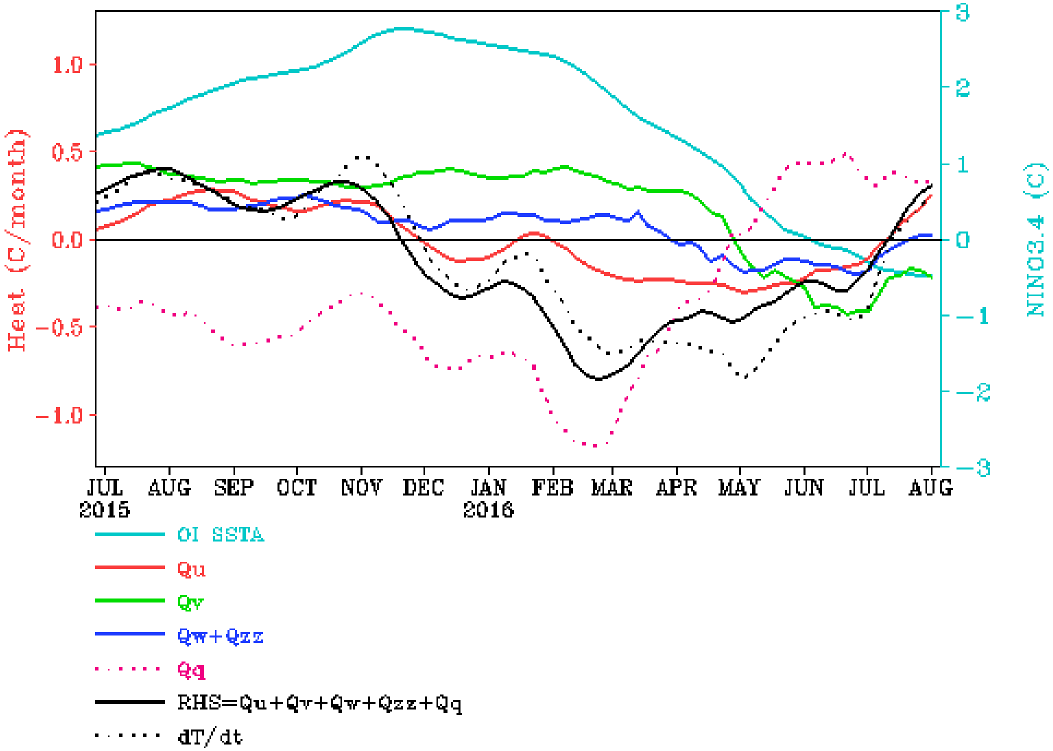
- **Surface easterly wind anomalies emerged in the central Pacific in late July, which will probably enhance negative ocean heat content anomalies in next two months.**

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



- Eastward zonal current anomalies presented across the equatorial Pacific in July 2016, which were unfavorable for La Nina development.

NINO3.4 Heat Budget



- **Observed SSTA tendency (dT/dt) in NINO3.4 region (dotted black line) became positive since early July.**

- **-Qv was negative but weakened, Qw+Qzz was near zero, and Qu switched to positive in July, which all contributed to weakening cooling tendency.**

Huang, B., Y. Xue, X. Zhang, A. Kumar, and M. J. McPhaden, 2010 : The NCEP GODAS ocean analysis of the tropical Pacific mixed layer heat budget on seasonal to interannual time scales, J. Climate., 23, 4901-4925.

Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

Qq: (Qnet - Qpen + Qcorr)/ρcph; Qnet = SW + LW + LH +SH;

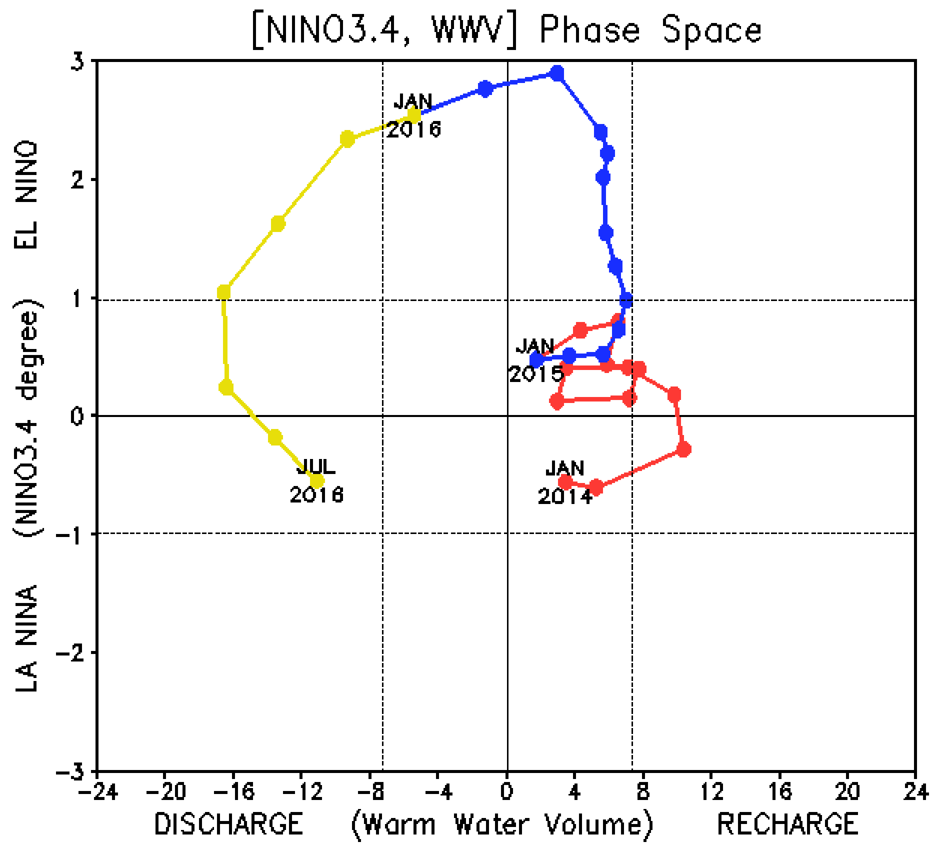
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

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.**

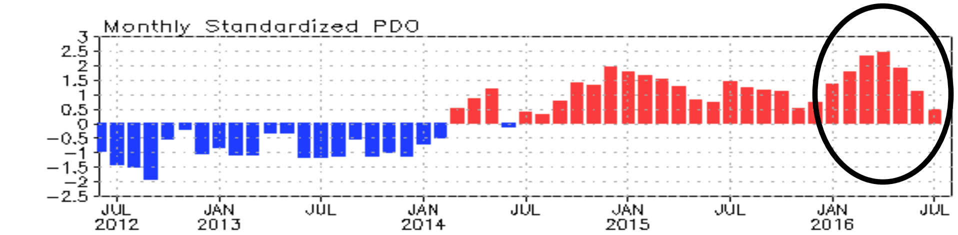


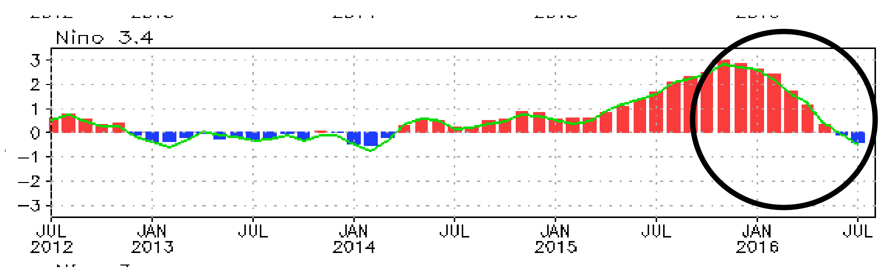
- **Equatorial Warm Water Volume (WWV) has started to recharge since May 2016.**

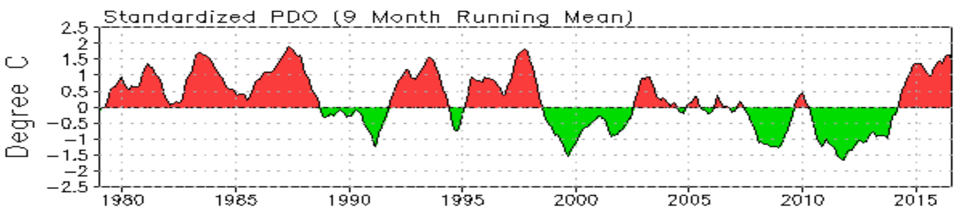
Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20°C in [120°E-80°W, 5°S-5°N] calculated with the NCEP's global ocean data assimilation system. Anomalies are departures from the 1981-2010 base period means.

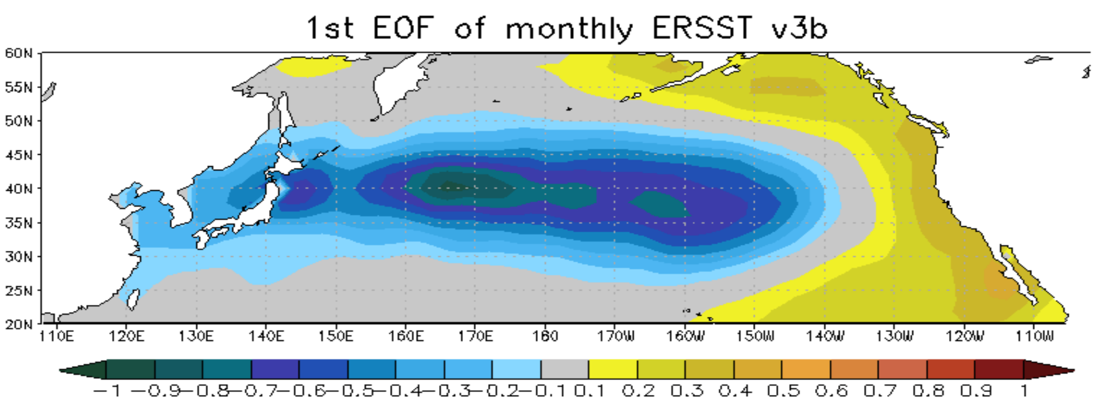
North Pacific & Arctic Oceans

Pacific Decadal Oscillation Index









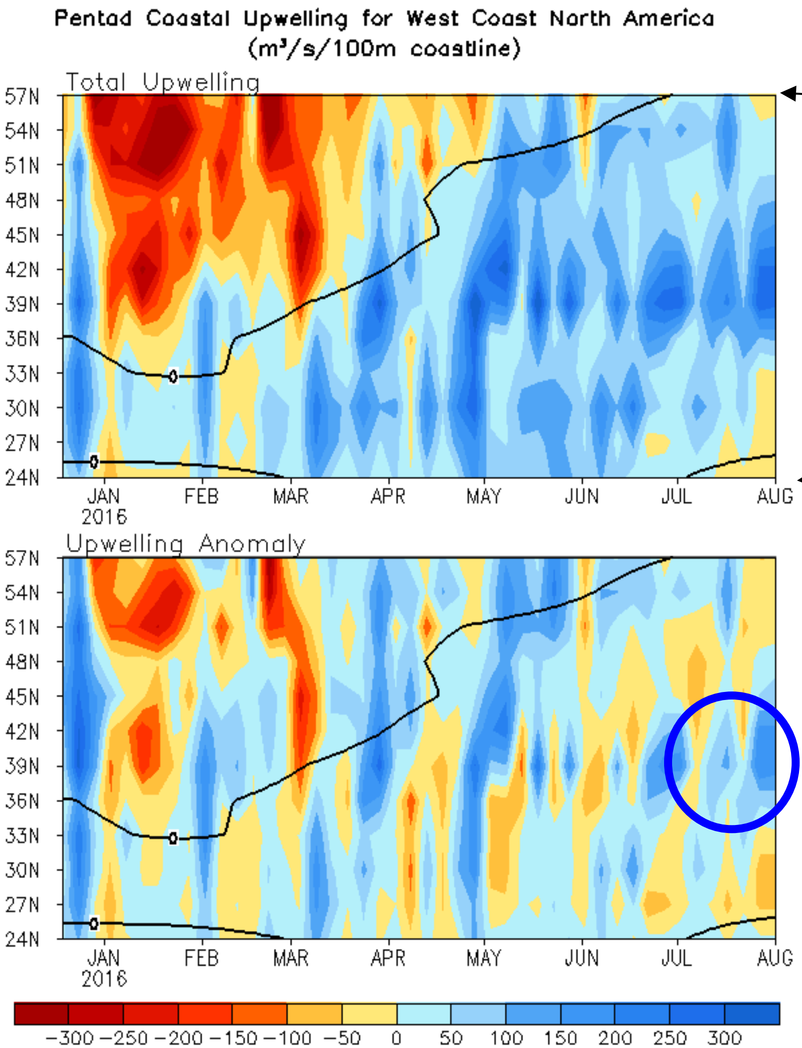
- The positive phase of PDO index has persisted 25 months since Jul 2014, and weakened with PDO index = +0.5 in Jul 2016.

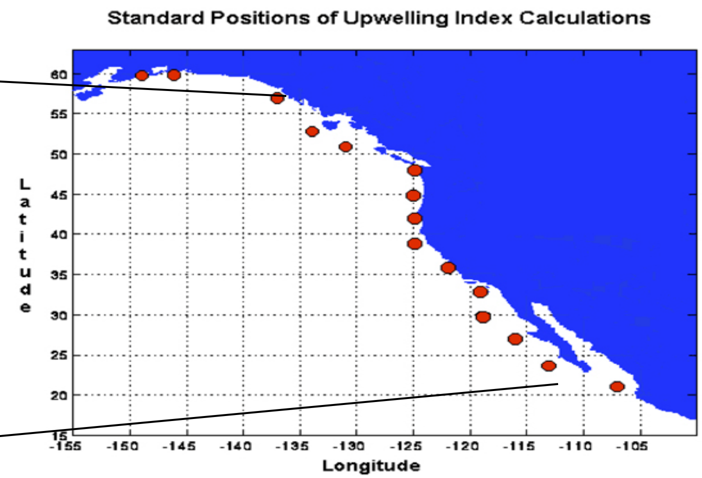
- Statistically, ENSO leads PDO by 3-4 months, may through atmospheric bridge.

- 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 America Western Coastal Upwelling





- **Upwelling near 36N-42N was above-average.**

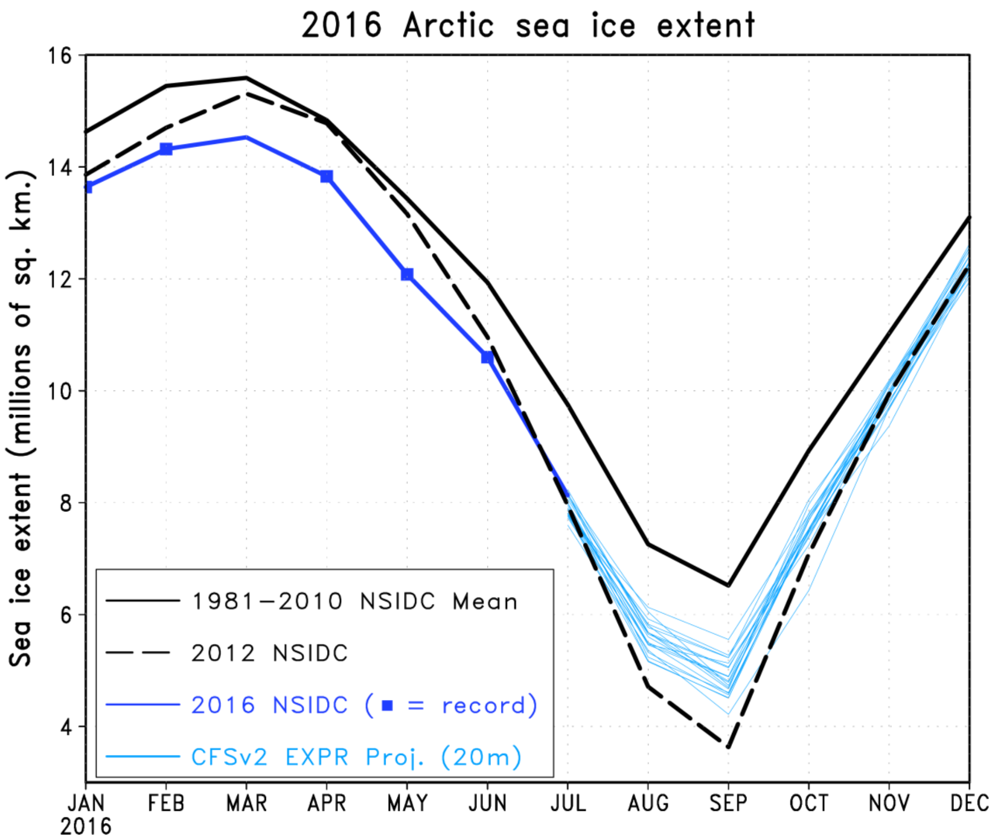
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1981-2010 base period pentad means.

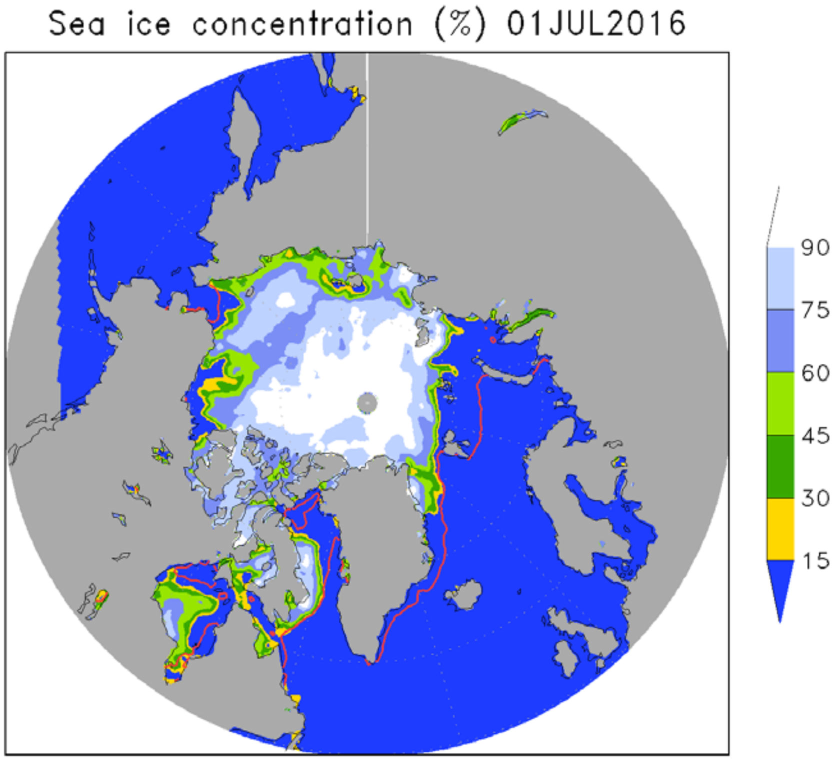
- **Area below (above) black line indicates climatological upwelling (downwelling) season.**
- **Climatologically upwelling season progresses from March to July along the west coast of North America from 36°N to 57°N.**

Arctic Sea Ice

National Snow and Ice Data Center

http://nsidc.org/arcticseaicenews/index.html

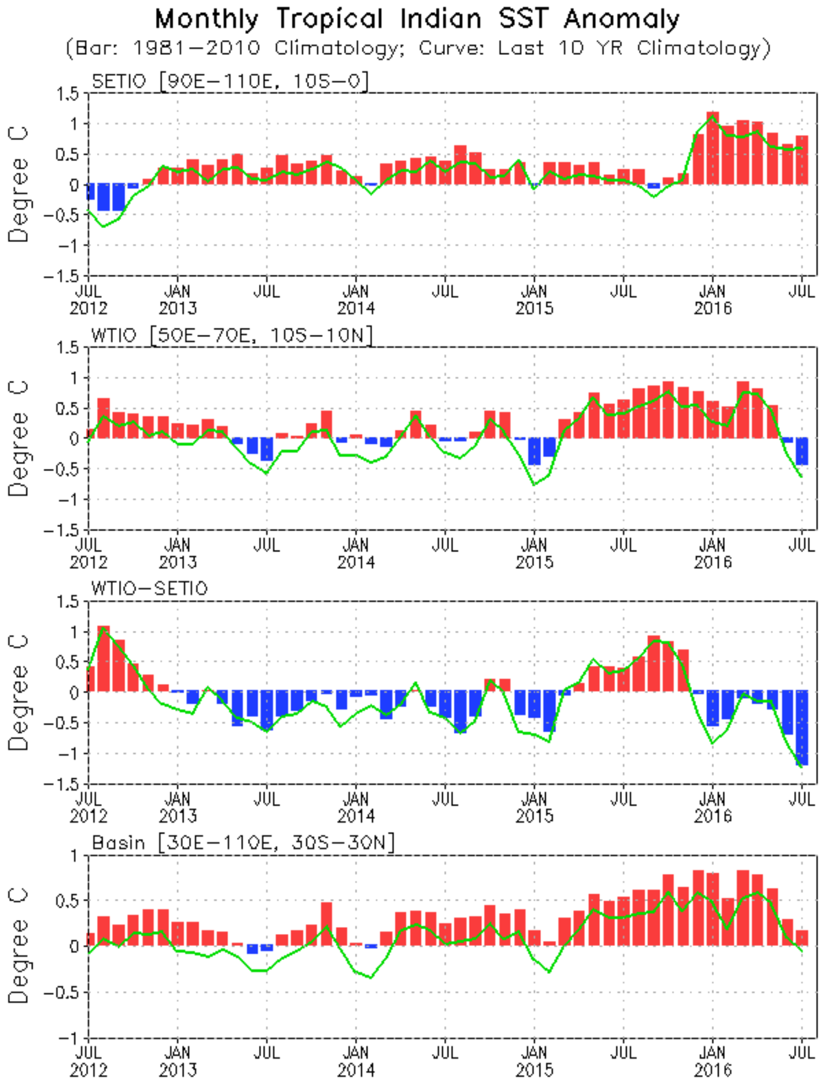


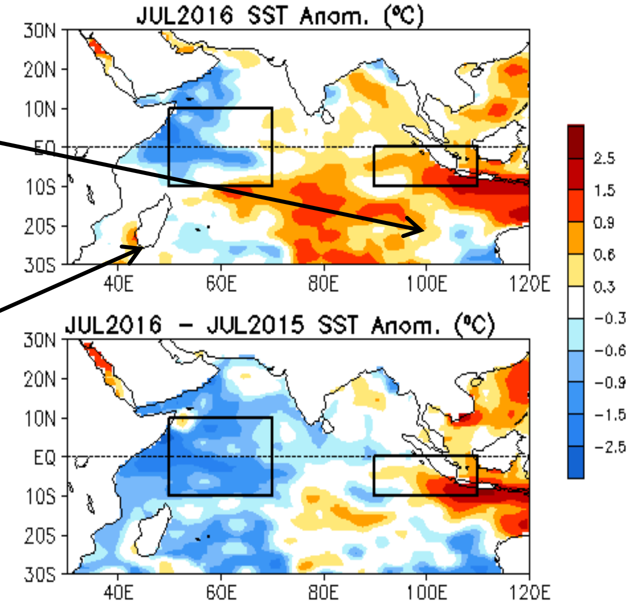


- **July 2016 sea ice extent did not set a new record low (2nd month of 2016 to not do so)**
- **Sea ice extent is now slightly above 2012 levels, well below 1981-2010 climatology**
- **Projections from experimental CFSv2 do not show a record low for this September; are in line with last year's minimum. Uncertainty remains in atmospheric influence**

Indian Ocean

Evolution of Indian Ocean SST Indices





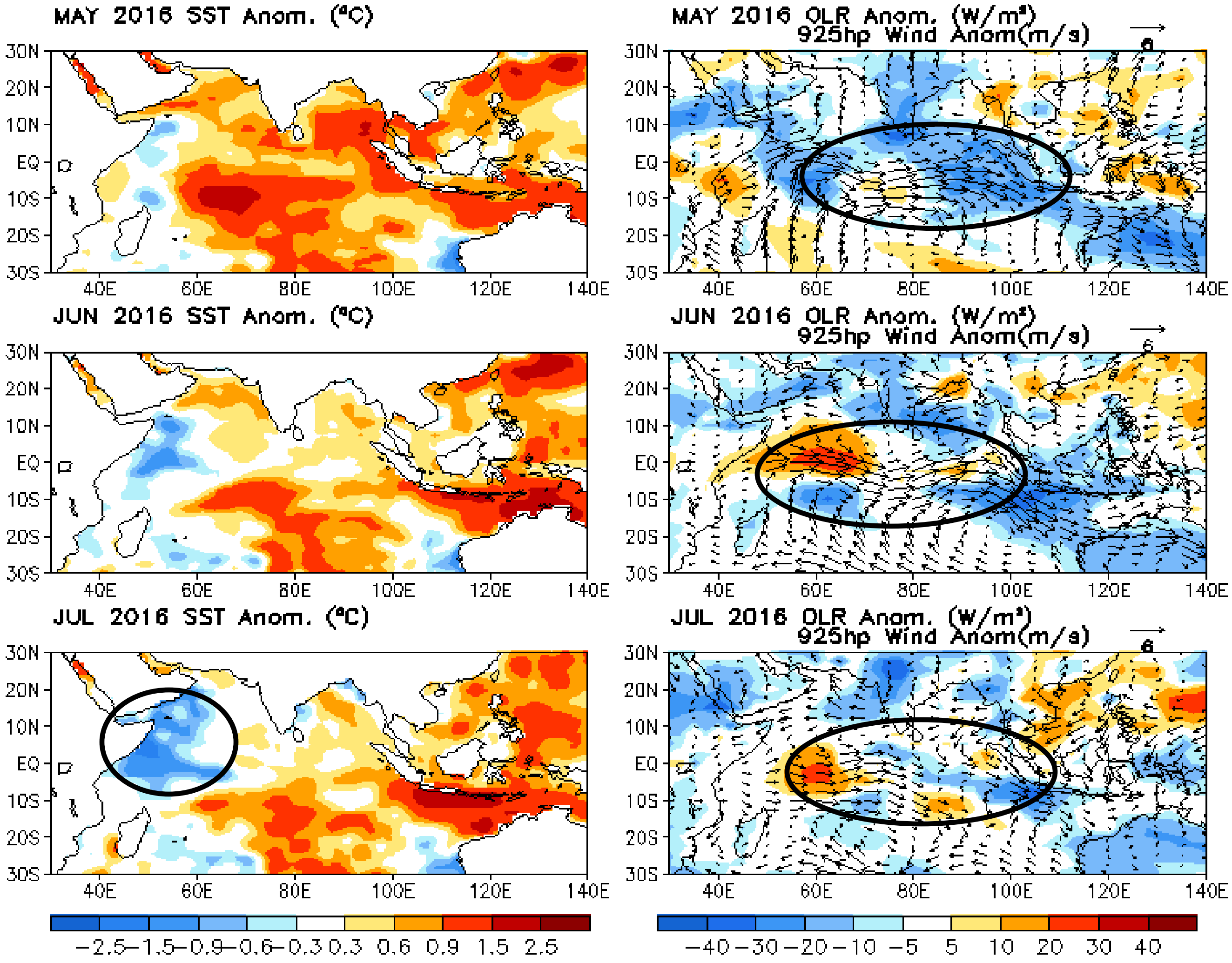
- **SETIO has been strong positive (> +0.7°C) since Dec 2015, while WTIO switched from positive to negative in the past two months and became -0.4°C in Jul 2016.**

- **DMI decreased rapidly in the past two months, became -1.2°C in Jul 2016.**

- **The basin wide warming weakened.**

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 departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

Last Three Month SST, SLP and 925hp Wind Anom.

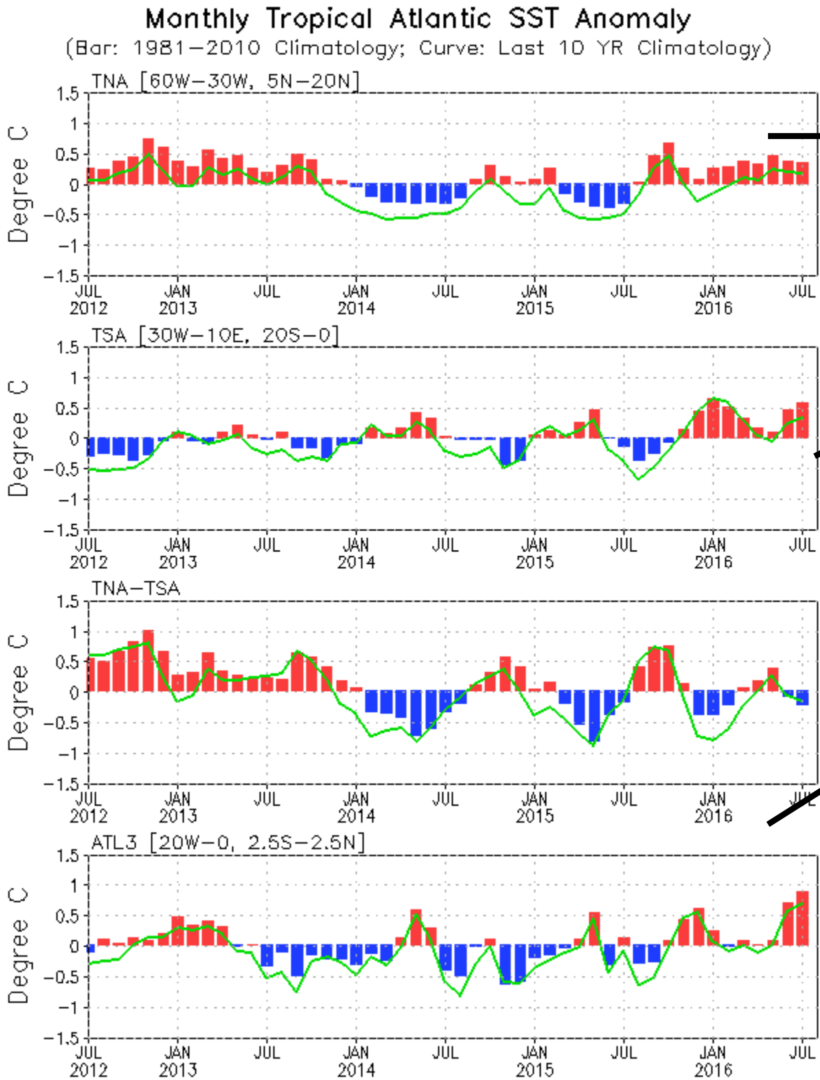


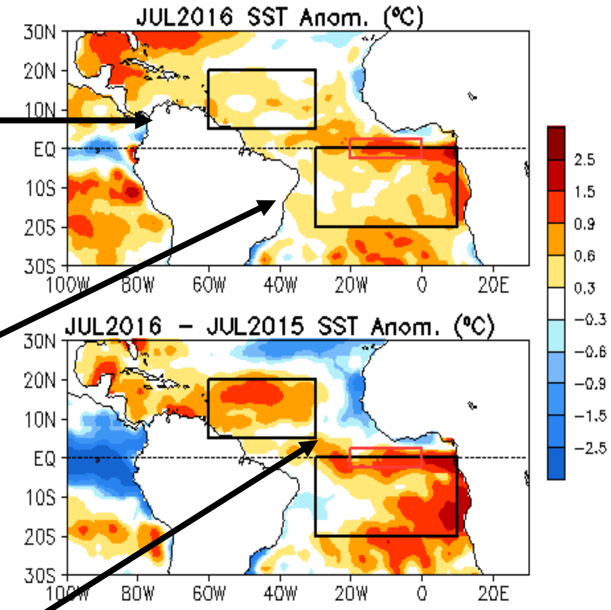
- **Surface westerly wind anomalies persisted in the tropical Indian Ocean in the past three months.**

- **Positive SSTA persisted in the eastern and southern Indian Ocean, while negative SSTA developed in the western tropical Indian Ocean in Jun-Jul 2016.**

Tropical and North Atlantic Ocean

Evolution of Tropical Atlantic SST Indices



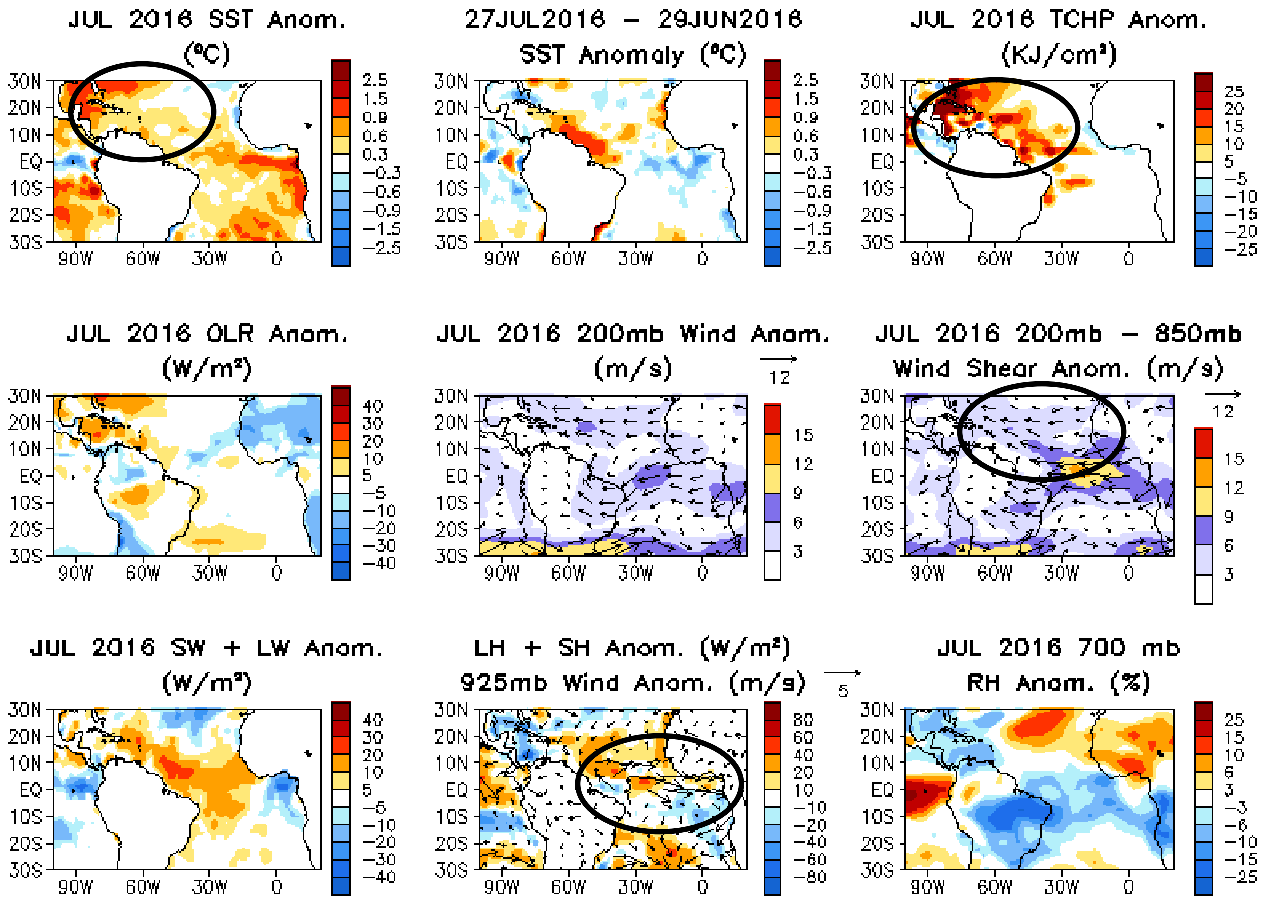


- **ATL3 index had large positive value in Jun-Jul 2016.**
- **Compared with Jul 2015, SST in the tropical Atlantic was much warmer in Jul 2016.**

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 departures from the 1981-2010 base period means and the recent 10 year means are shown in bars and green lines.

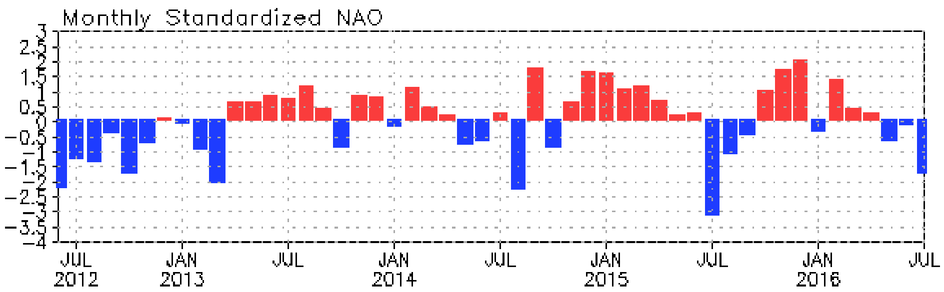
Tropical Atlantic:

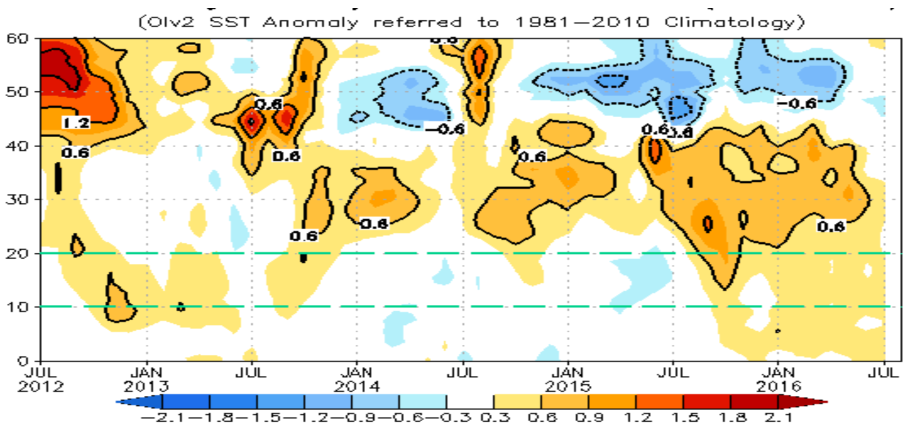
SST Anom., SST Anom. Tend., OLR, Sfc Rad, Sfc Flx, 925-mb/200-mb Winds

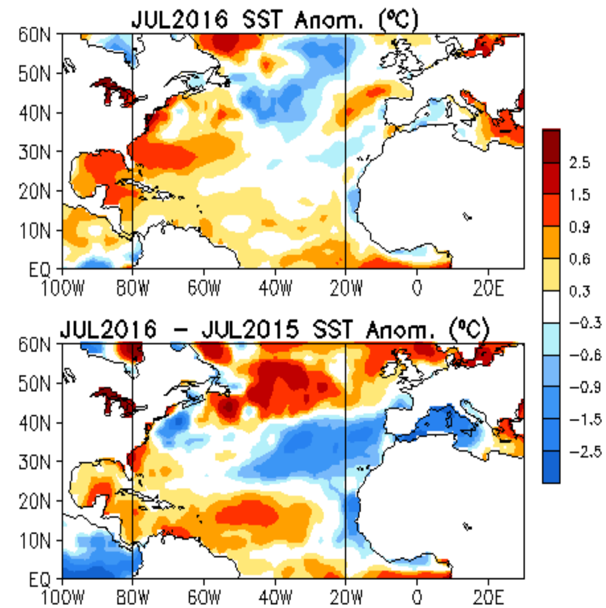


- Above-normal SSTA and TCHP presented in the hurricane Main Development Region (MDR) .
- Below-normal vertical wind shear presented in MDR, which is favourable for hurricane activity.
- Westerly low-level wind blew towards the western Africa, indicating enhanced west African monsoon.

NAO and SST Anomaly in North Atlantic

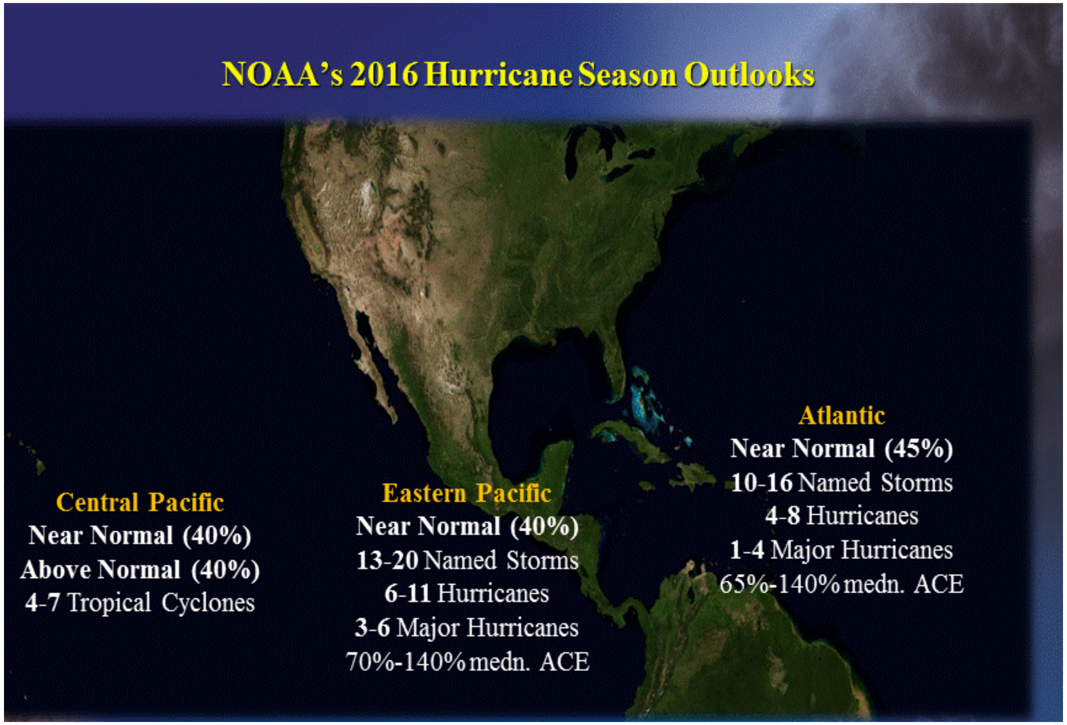




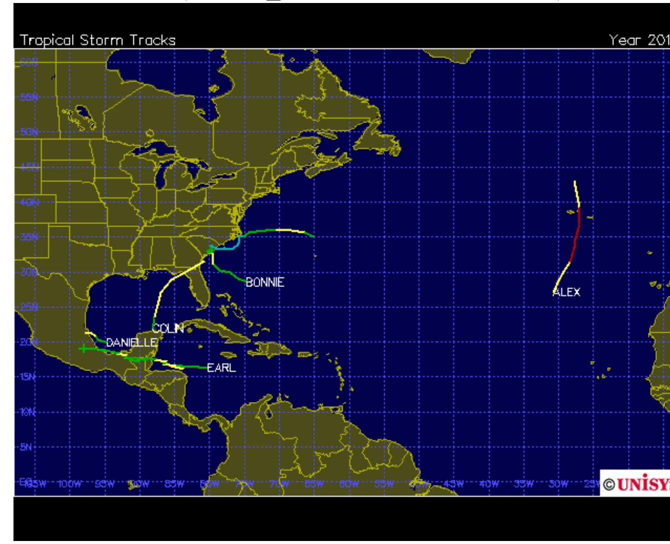


- **NAO was in negative phase with NAOI= -1.7 in Jul 2016.**
- **Positive SSTA presented in tropical North Atlantic and Gulf of Mexico.**

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



2016 Hurricane Season *(Tropical Atlantic)*



Atlantic	Observation by Aug 11, 2016	2016 prediction (issued on May 27)	1981-2010
Named storms	5	10-16	12.1
Hurricanes	2	4-8	6.4
Major hurricanes	0	1-4	2.7

http://www.cpc.ncep.noaa.gov/products/outlooks/hurricane.shtml/
https://en.wikipedia.org/wiki/2016_Atlantic_hurricane_season)

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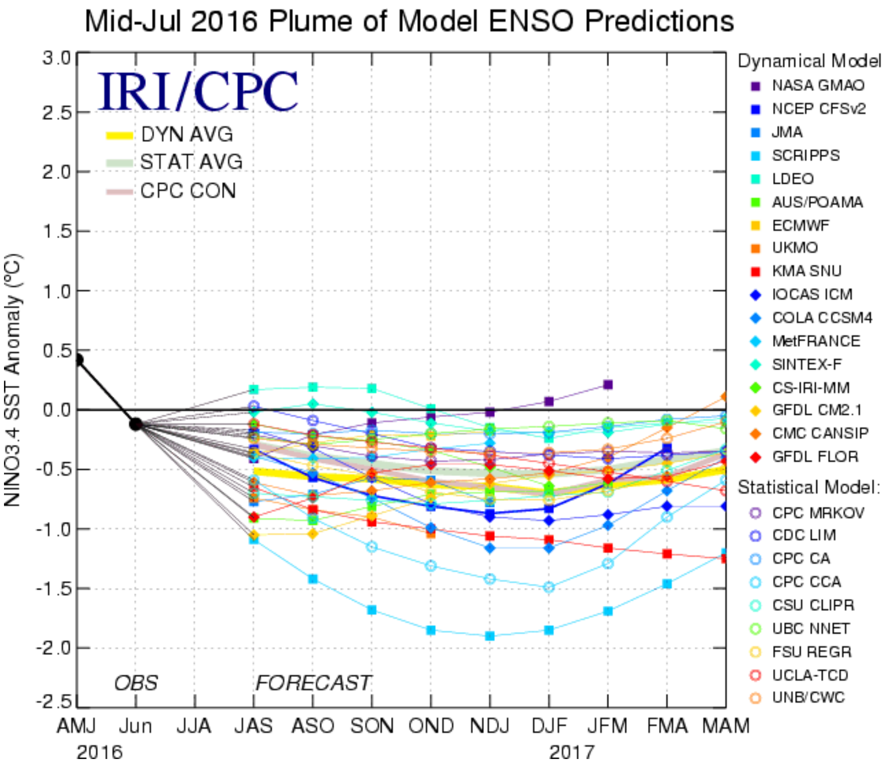
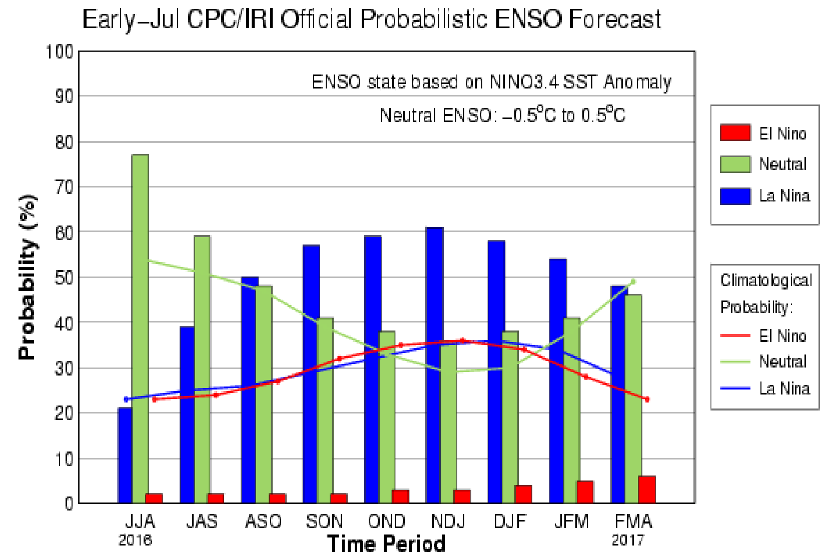
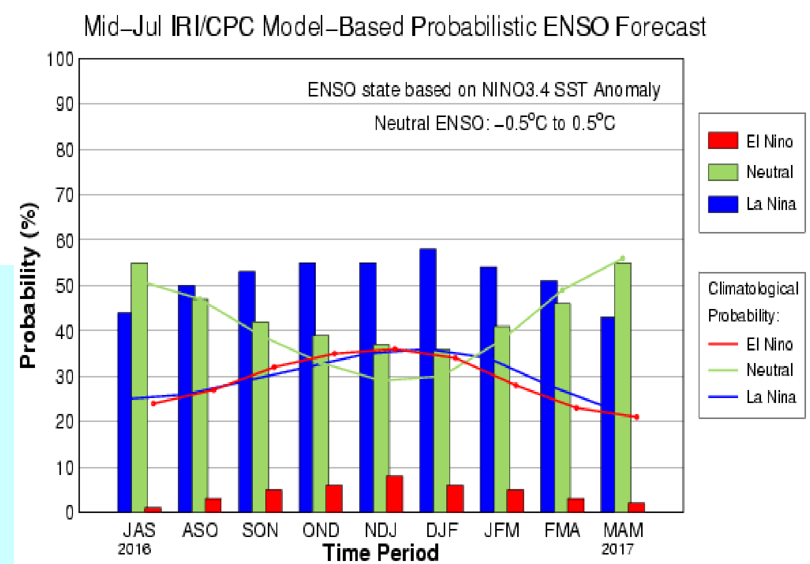
Global SST Predictions

IRI NINO3.4 Forecast Plum



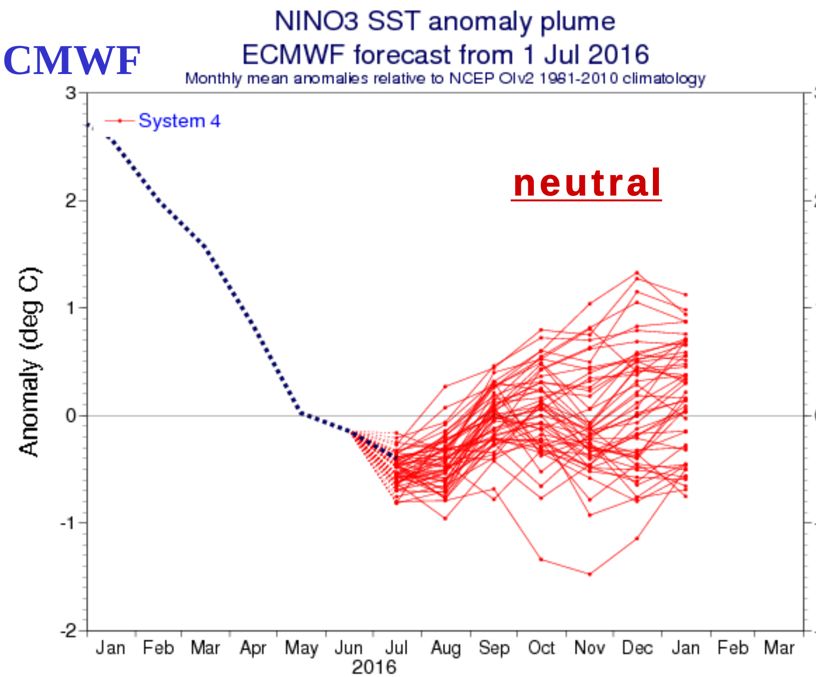




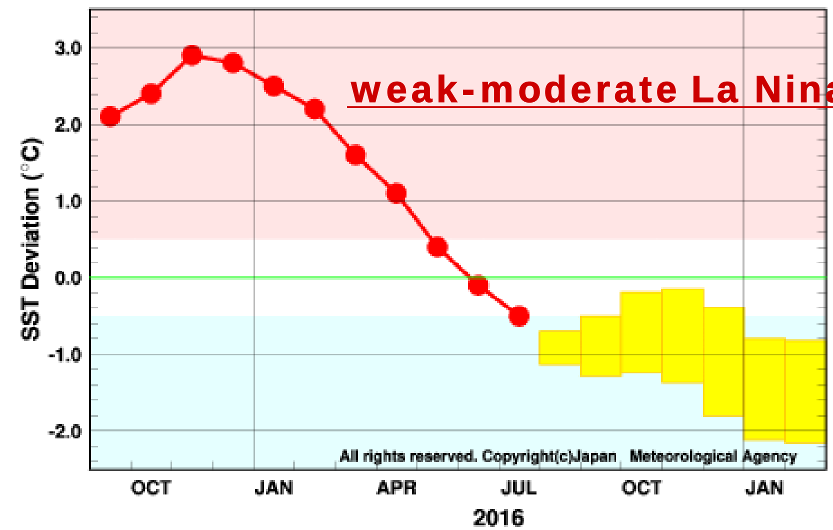
- **Majority of models predicted a La Nina in fall/winter 2016-17, and some models predicted neutral.**
- **NOAA "ENSO Diagnostic Discussion" on 14 July 2016 issued "La Niña Watch" and suggested that *"La Niña is favored to develop during August - October 2016, with about a 55-60% chance of La Niña during the fall and winter 2016-17."***

Individual Model Forecasts

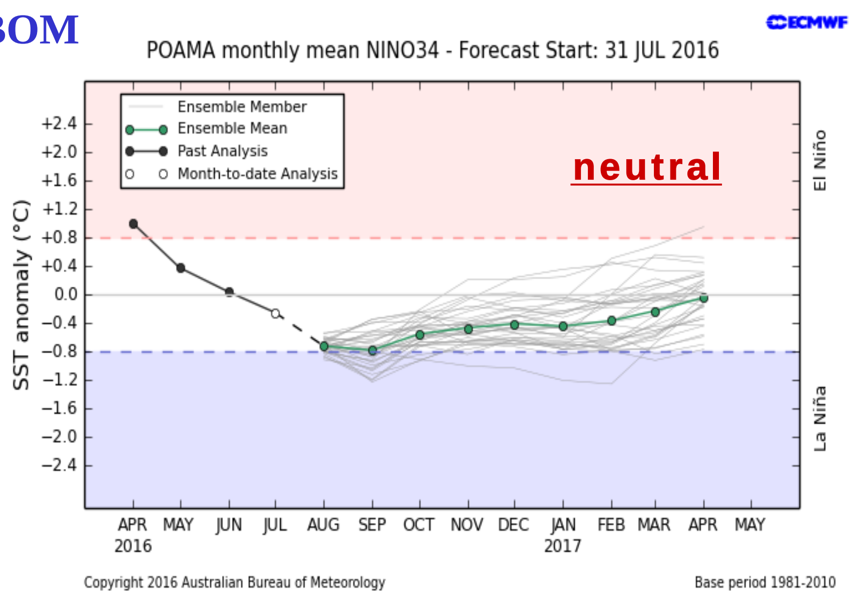
ECMWF



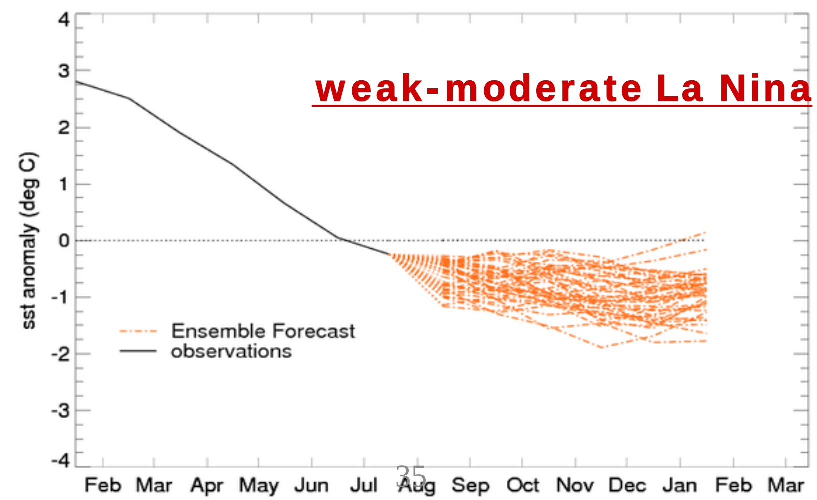
JMA: Nino3.4, IC= Aug 2016



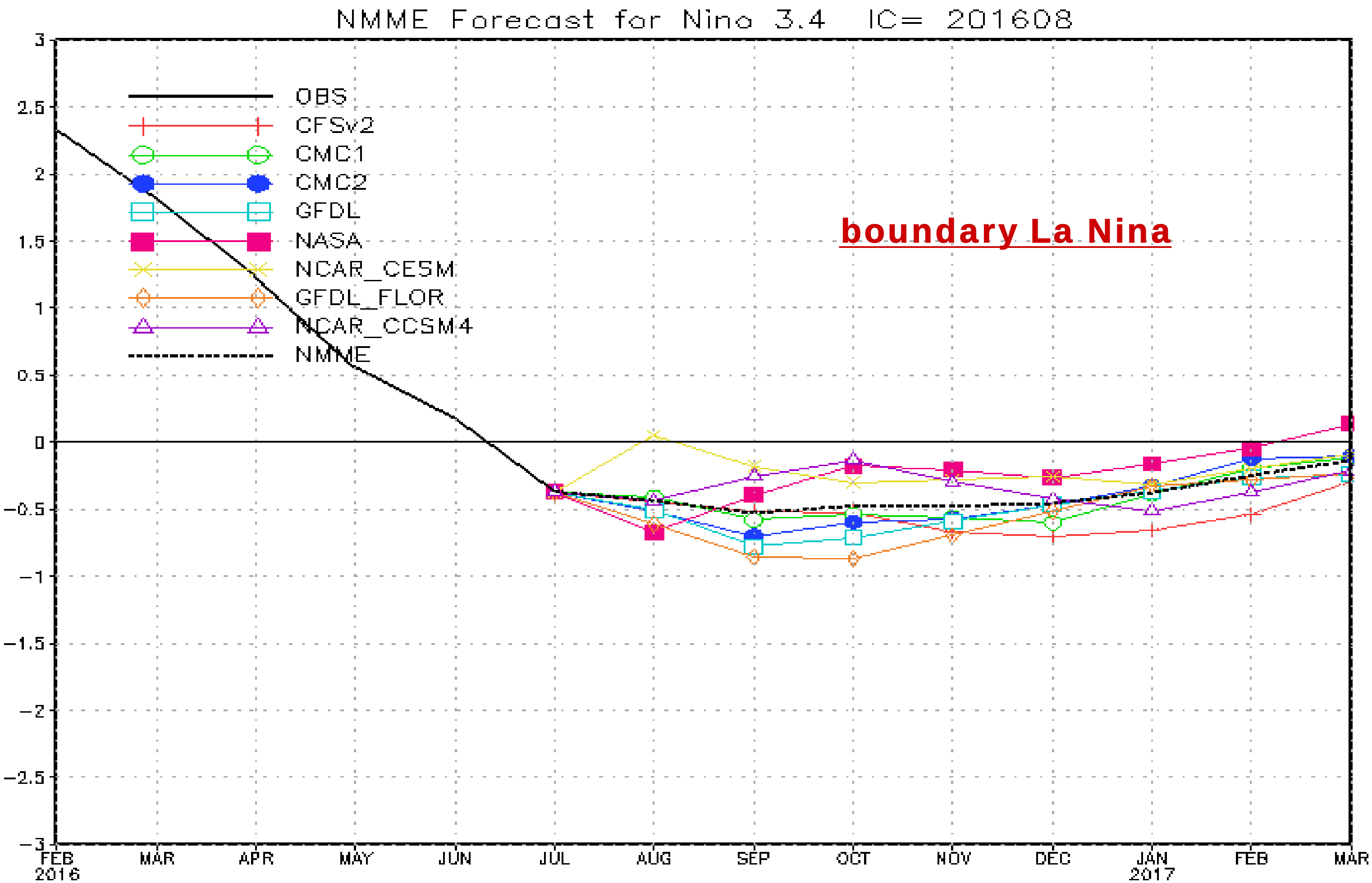
BOM



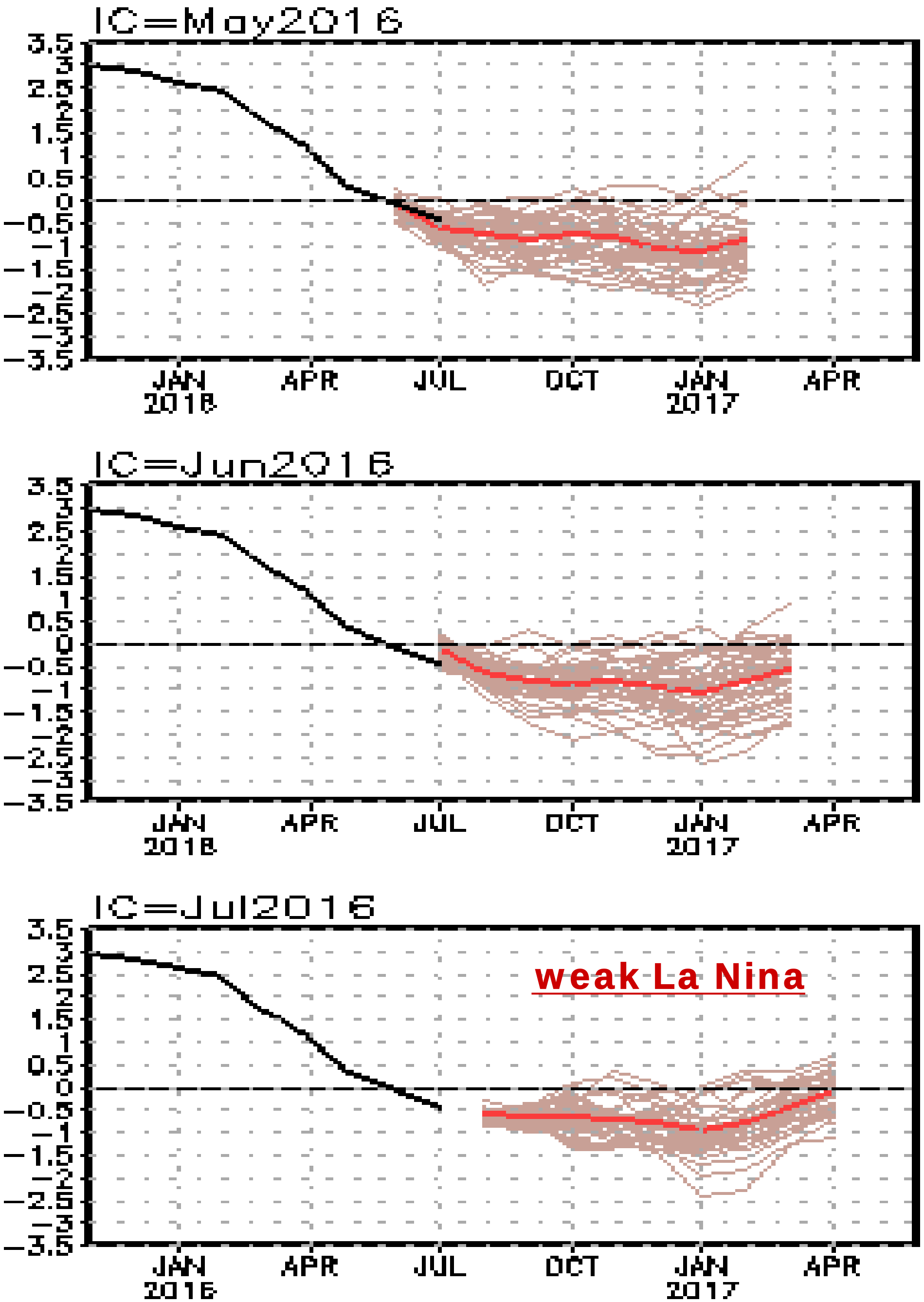
UK MET: Nino3.4, IC= Aug 2016



North American Multi-Model Ensemble (NMME) NINO3.4 Plume



- **The NMME ensemble mean forecast (dash line) suggests La Nina conditions (NINO3.4=-0.5ºC) will likely develop in fall / winter 2016-17.**
- **However, NASA, NCAR_CCSM4, NCAR_CESM forecast ENSO-neutral conditions in fall / winter 2016-17.**



NINO3.4 Forecast by NCEP CFSv2

- CFSv2 forecast La Nina will likely develop during the fall and winter 2016-17.
- However, the latest forecast was less cool compared to the earlier forecasts.

Constructed Analogue Prediction of Global SSTA

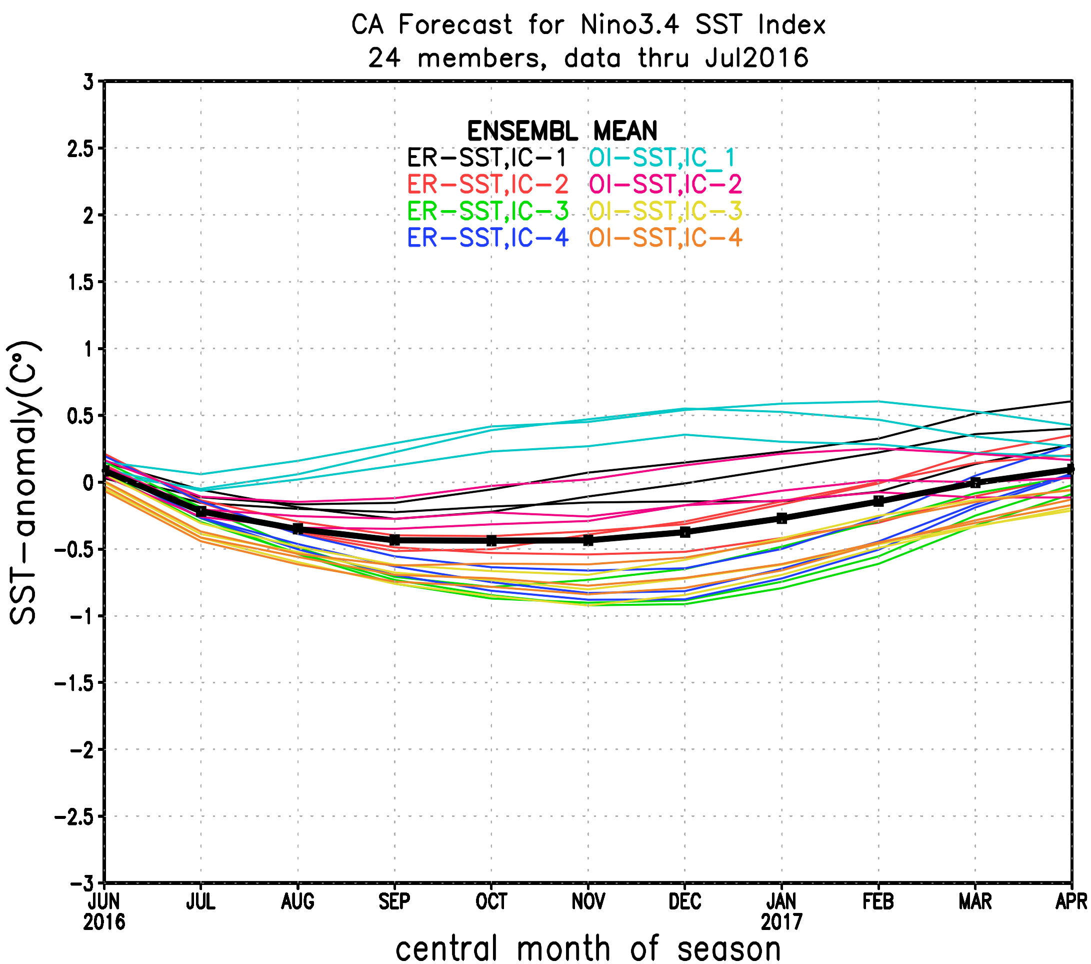
- ❑ Use weighted average of historical data to approximate current data (IC);
- ❑ The weights are obtained by minimizing the RMS error;
- ❑ Construct forecast by applying the weights to the lagged data in history

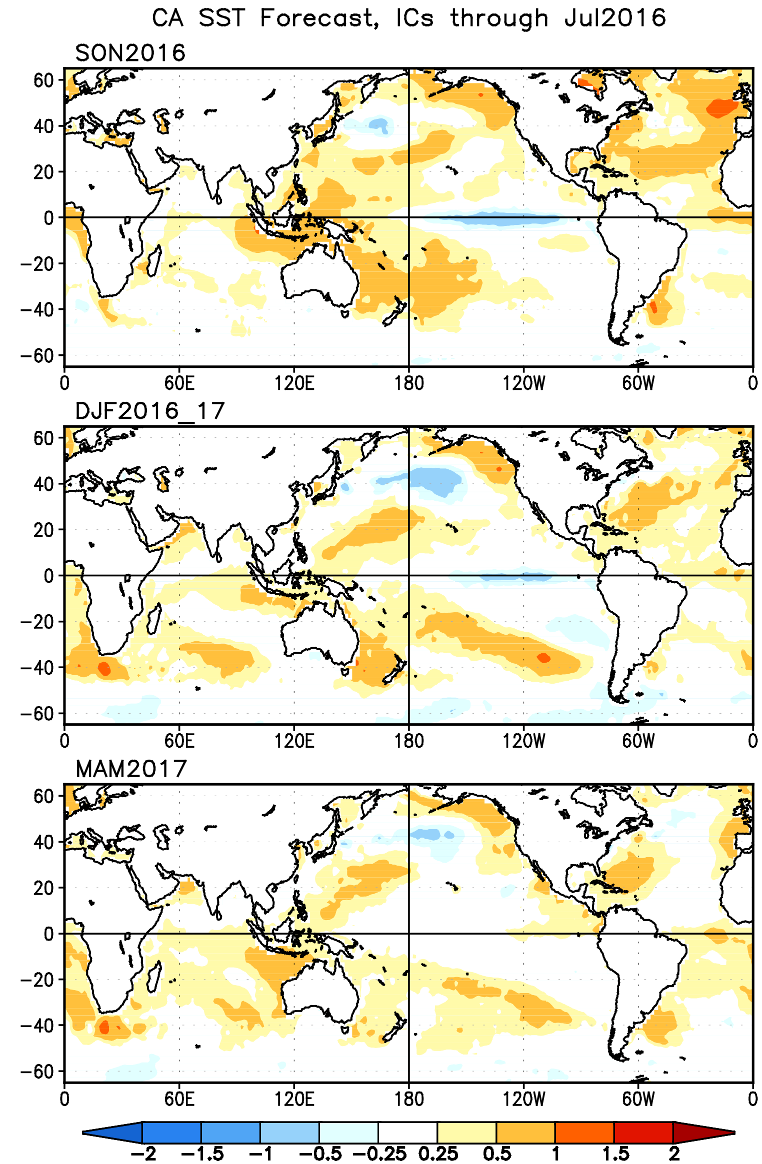
1. Use both HAD-OI SST and ERSST since 1948;
2. Choose EOF truncations at 15, 25, 40;
3. Have season number 1 to 4 in ICs;

Combine 1-3 above to have a 24-member ensemble

Provided by Peitao Peng

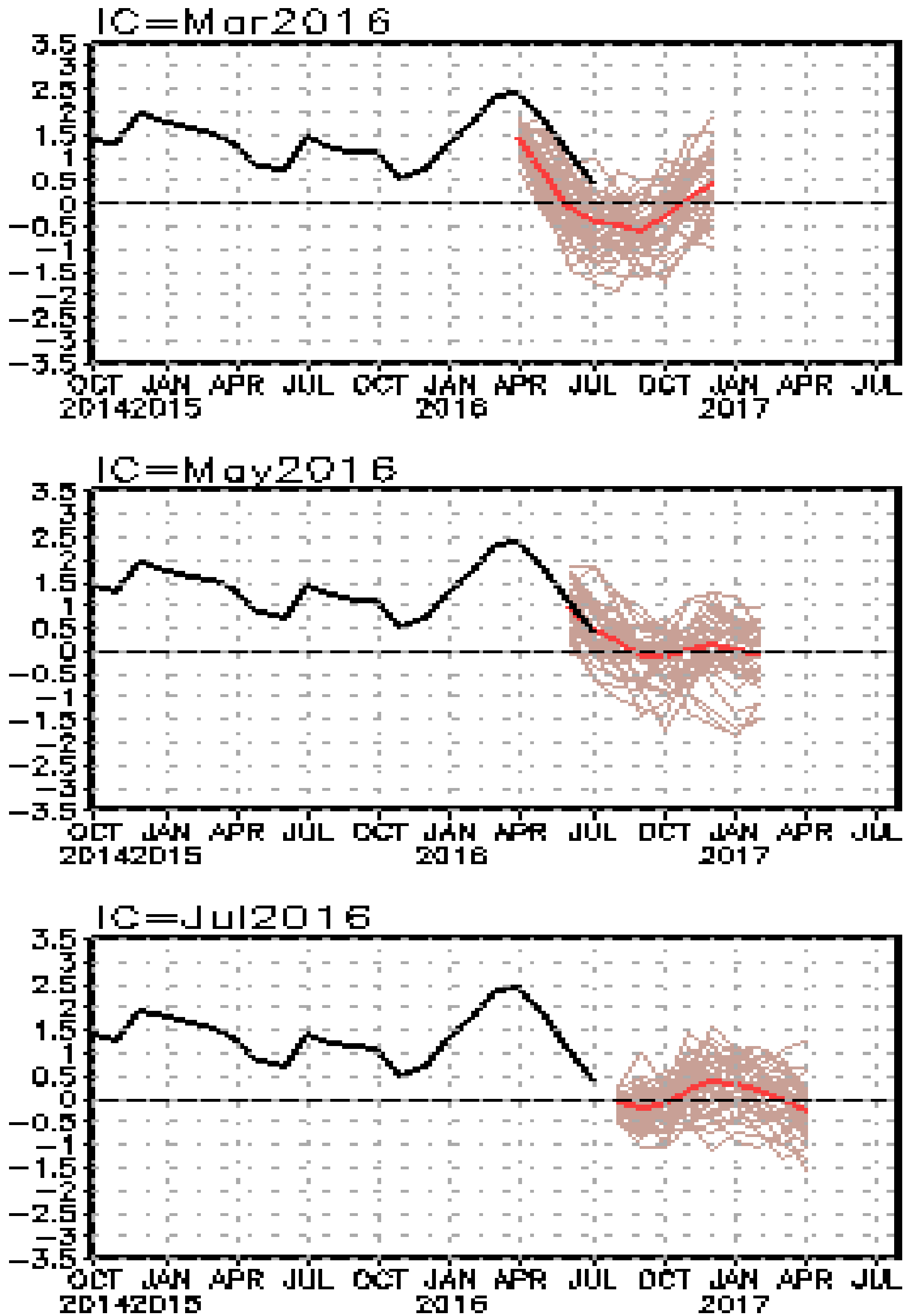
CA 24-member Ensemble Forecast for SST





ENSO-neutral or weak La Nina is expected for 2016/17 winter

Provided by Peitao Peng

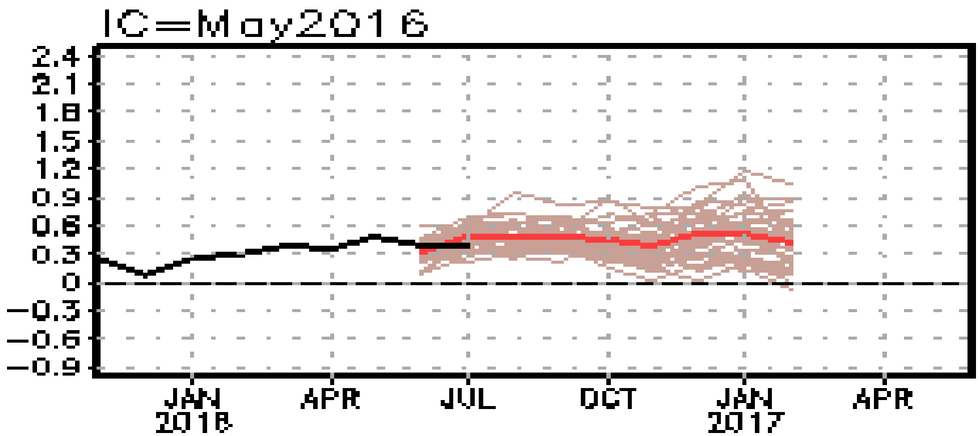


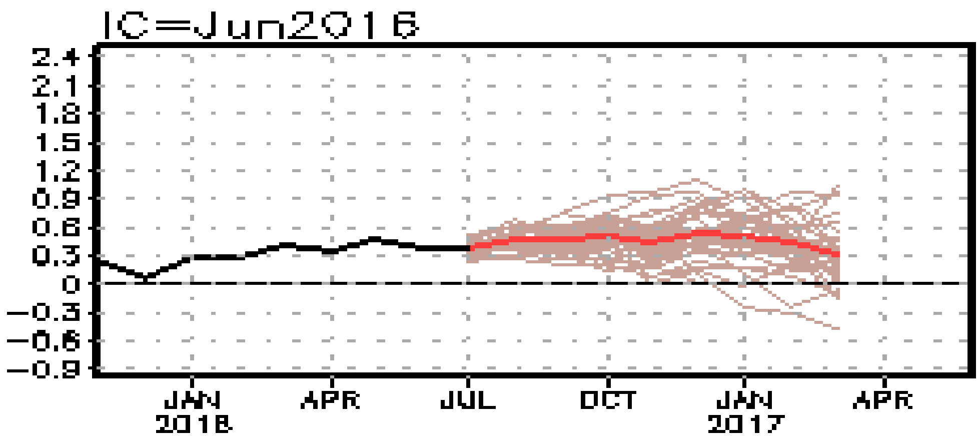
PDO Forecast by NCEP CFSv2

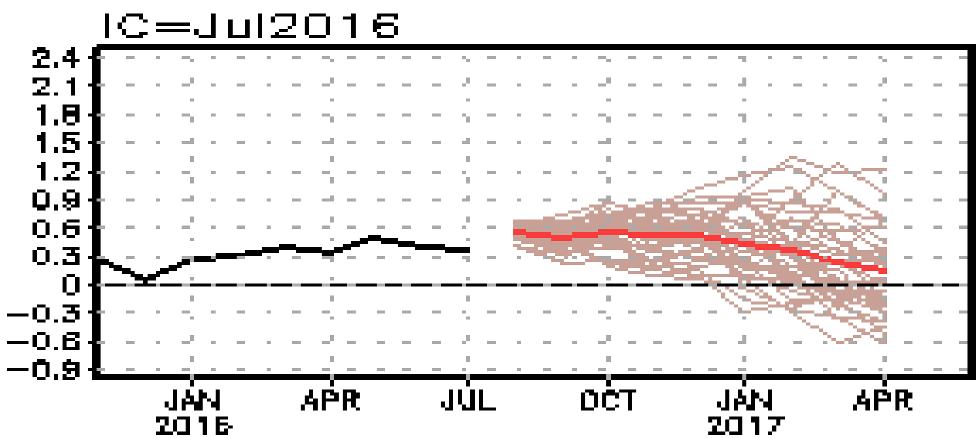
PDO is the first EOF of monthly ERSSTv3b anomaly in the region of [110°E-100°W, 20°N-60°N].

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

- CFSv2 forecasts PDO will return to neutral during the fall and winter 2016-17.





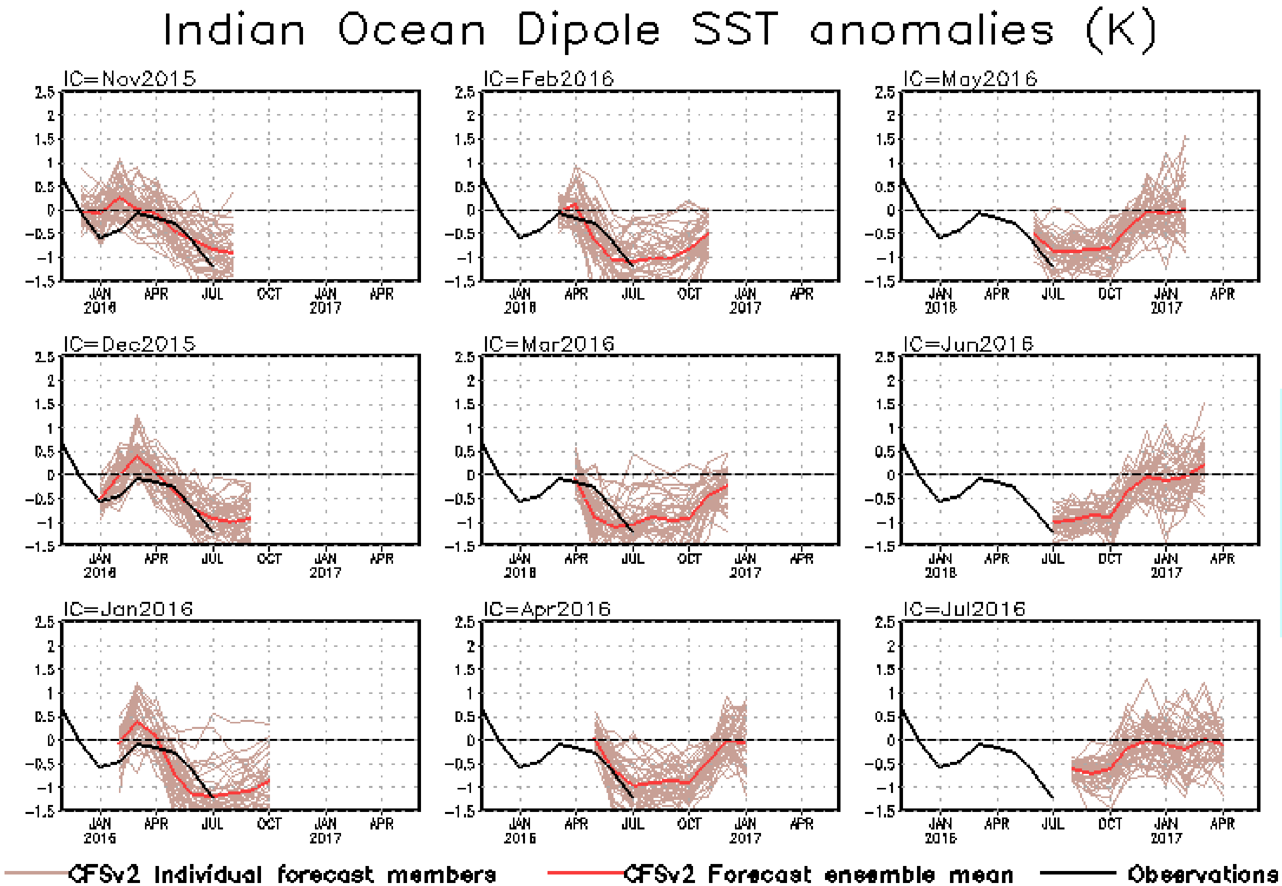


Tropical North Atlantic SST

Forecast by NCEP CFSv2

- CFSv2 forecast the tropical North Atlantic SST will be weakly above-normal during the fall and winter 2016-17.

CFSv2 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 has persistently forecast negative DMI to develop during the summer and fall 2016 since Nov 2015 I.C..

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.

Overview

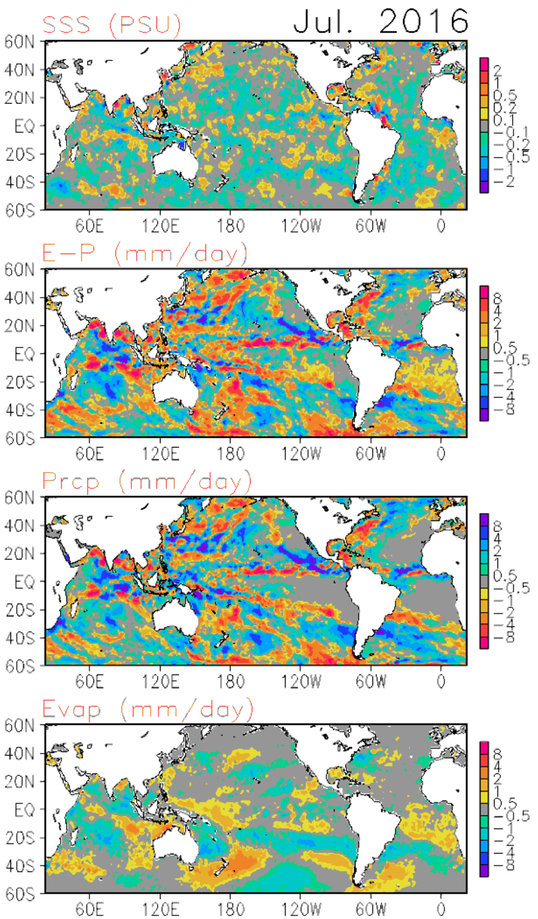
- **Pacific Ocean**
  - **NOAA "ENSO Diagnostic Discussion" on 14 July 2016 issued "La Niña Watch" and suggested that "La Niña is favored to develop during August - October 2016, with about a 55-60% chance of La Niña during the fall and winter 2016-17";**
  - **Negative SST anomalies (SSTA) near the equator has enhanced and extended westward with NINO3.4=-0.5°C in Jul 2016, while negative temperature anomalies near the thermocline weakened across the equatorial Pacific;**
  - **Sea surface salinity was fresher than normal off-equator in the western and eastern tropical Pacific;**
  - **Positive phase of PDO has persisted for 25 months, and weakened with PDOI=+0.5 in Jul 2016.**
- **Indian Ocean**
  - **Positive (negative) SSTA presented in the eastern (western) tropical Indian Ocean, and Dipole Mode Index = -1.2°C in Jul 2016.**
- **Atlantic Ocean**
  - **NAO was in negative phase with NAOI=-1.7 in Jul 2016.**
  - **SST and Tropical Cyclone Heat Potential (TCHP) were above-normal and vertical wind shear was below-normal in the hurricane Main Development Region (MDR), which is favorable for hurricane activity**

Backup Slides

Global Sea Surface Salinity (SSS)

Tendency for July 2016

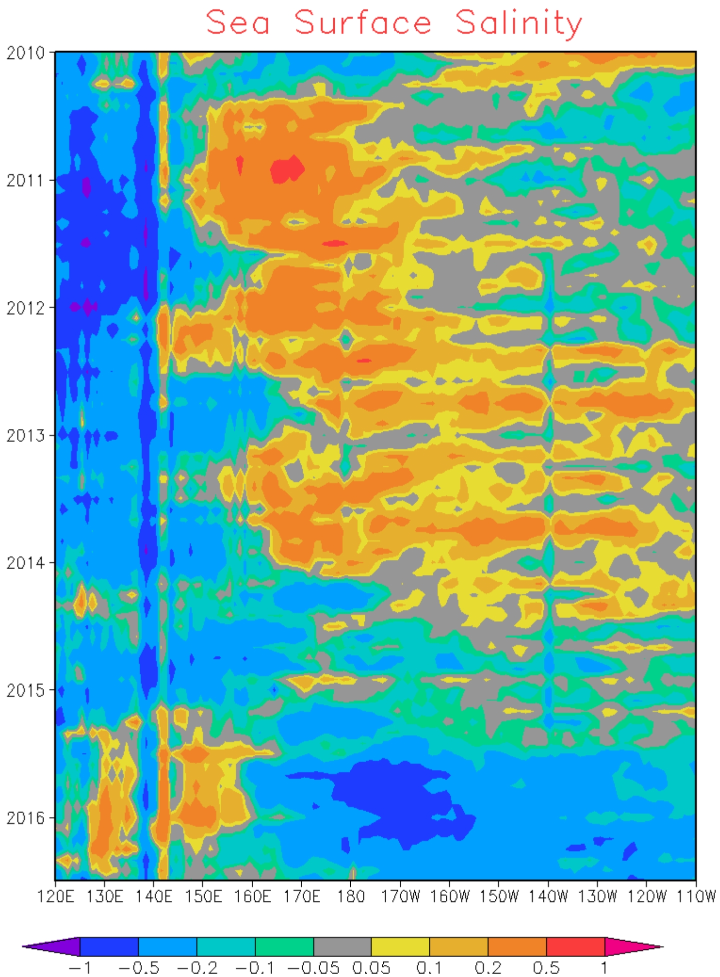
Compared with last month, SSS becomes fresher in the central North Pacific Ocean, which is likely caused by the increase of precipitation. In the North Indian Ocean, the SSS in the Bay of Bengal and Arabian Sea both increase, mostly likely due to the negative precipitation anomalies. The negative SSS anomalies in the west South Atlantic Ocean between 20° S and 40° S, is due to the combination of ocean current the positive precipitation anomalies. There is significant precipitation increase in the eastern tropical Pacific Ocean extending north westward from the coast near the equator. However, there is no significant freshening was observed in this region indicating that the oceanic process plays important roles in the SSS changes in that region.



Global Sea Surface Salinity (SSS)
Anomaly Evolution over Equatorial Pacific

- Hovemoller diagram for equatorial SSS anomaly **(10ºS-10ºN);**

- The anomaly evolution in this region shows similar pattern as last month. Negative SSS in the Eastern Equatorial Pacific from 160ºE to 110ºW has been present for more than a year, but its maximum anomalies centered from 180ºE to 160ºW was continually reducing in recent months and such anomalies are propagating to the east. At the meantime, a stretch of positive SSS anomaly remains over the western Pacific and eastern Indian Ocean from 130ºE – 160ºE;



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

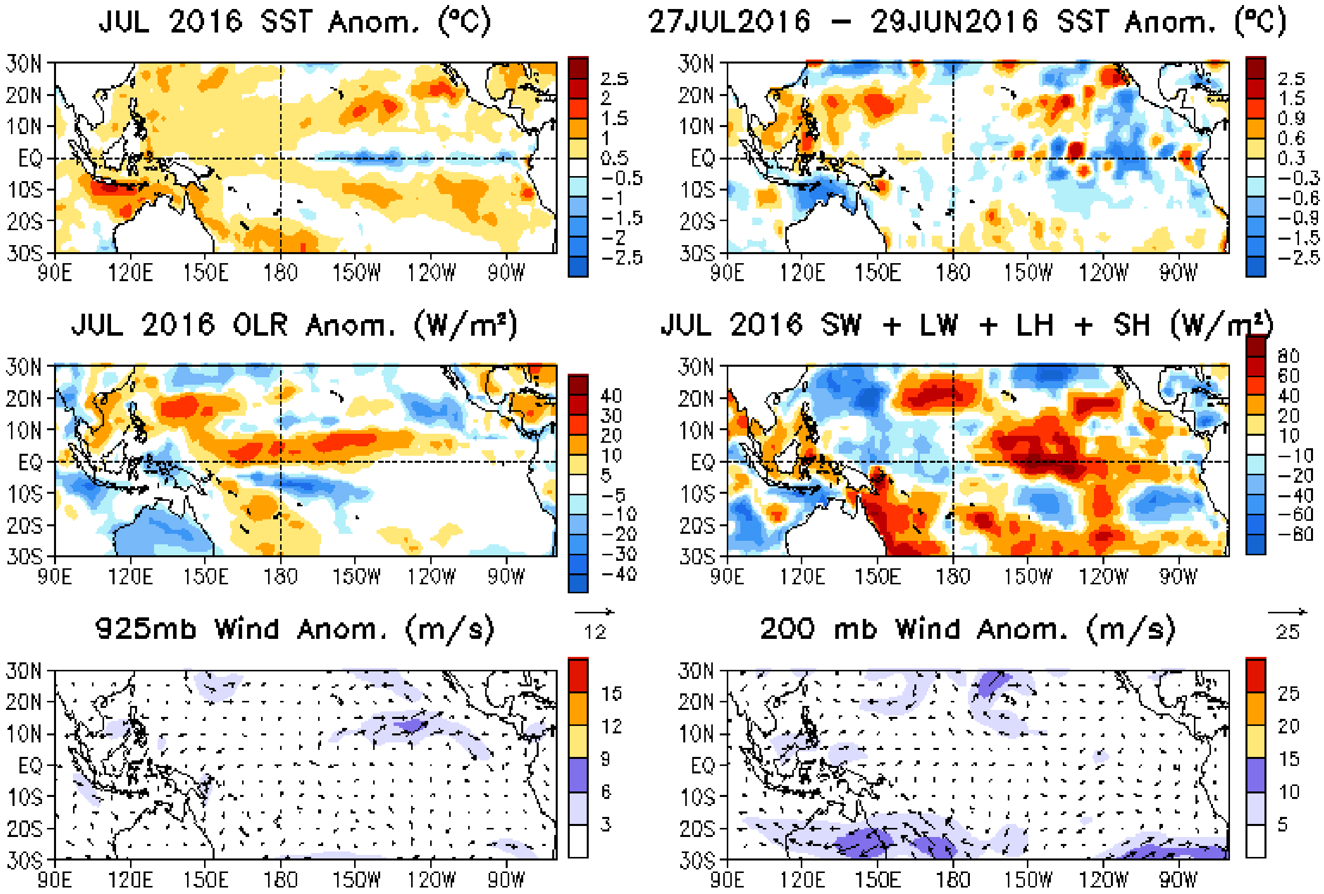


Fig. P2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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.

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

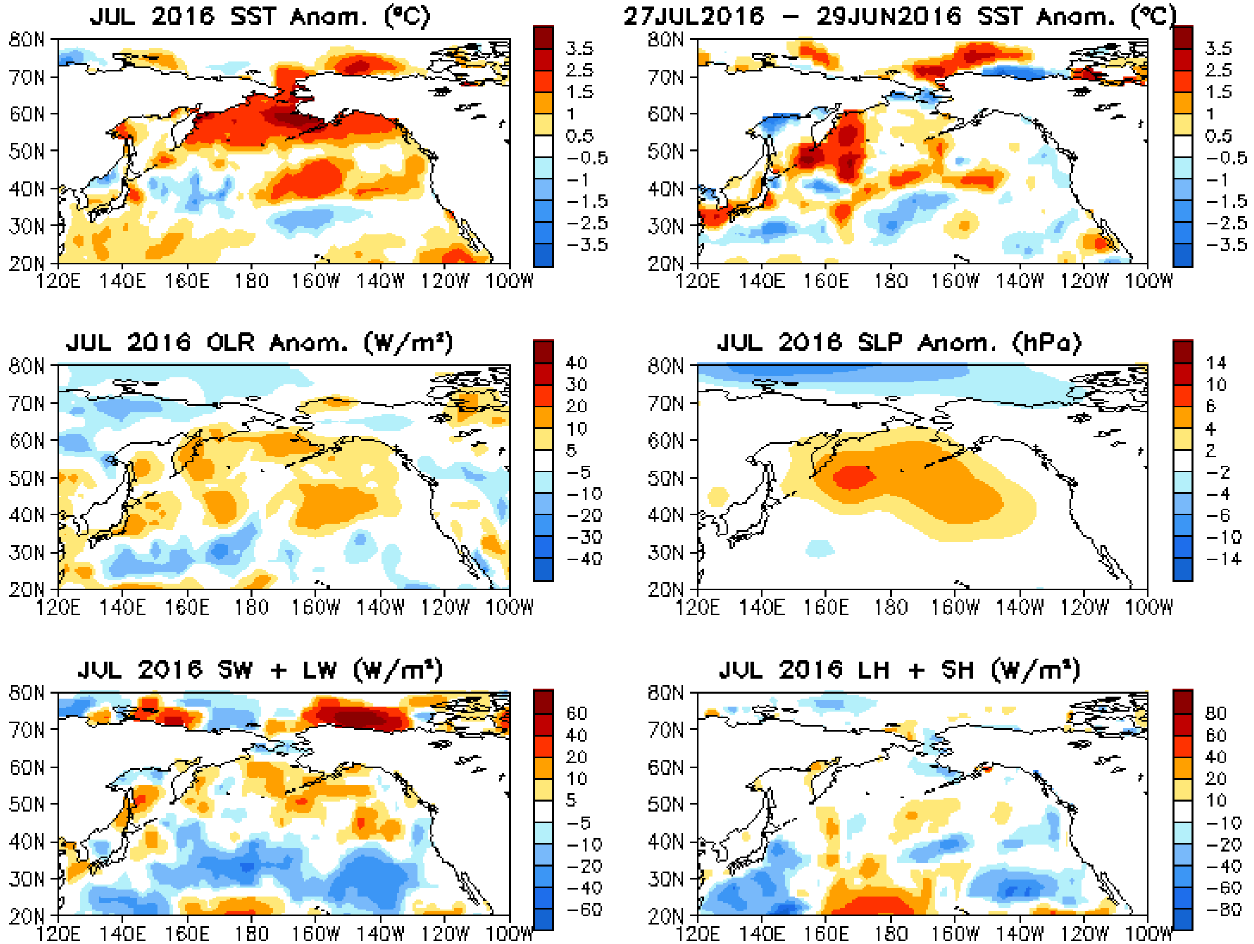


Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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.

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

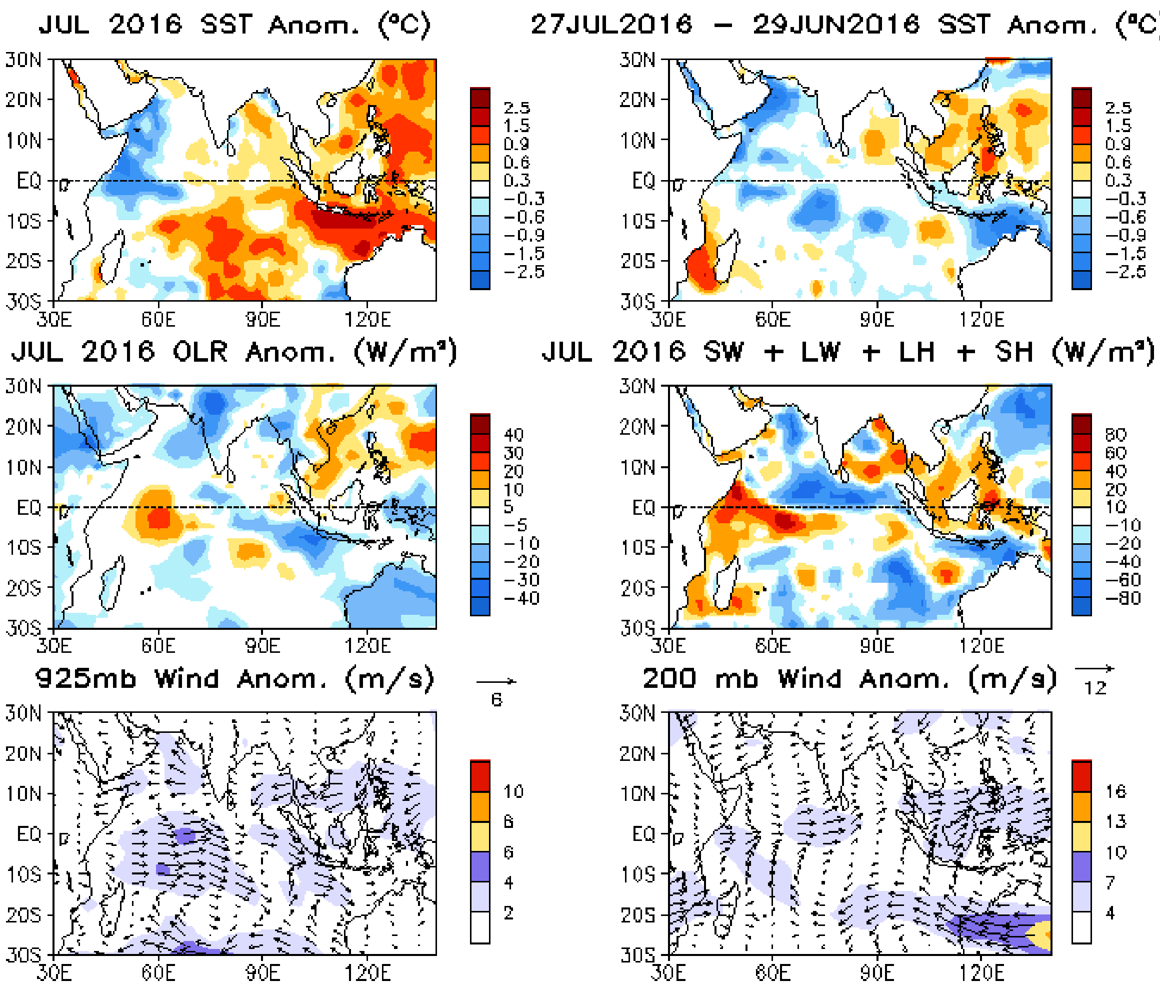


Fig. 12. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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.

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

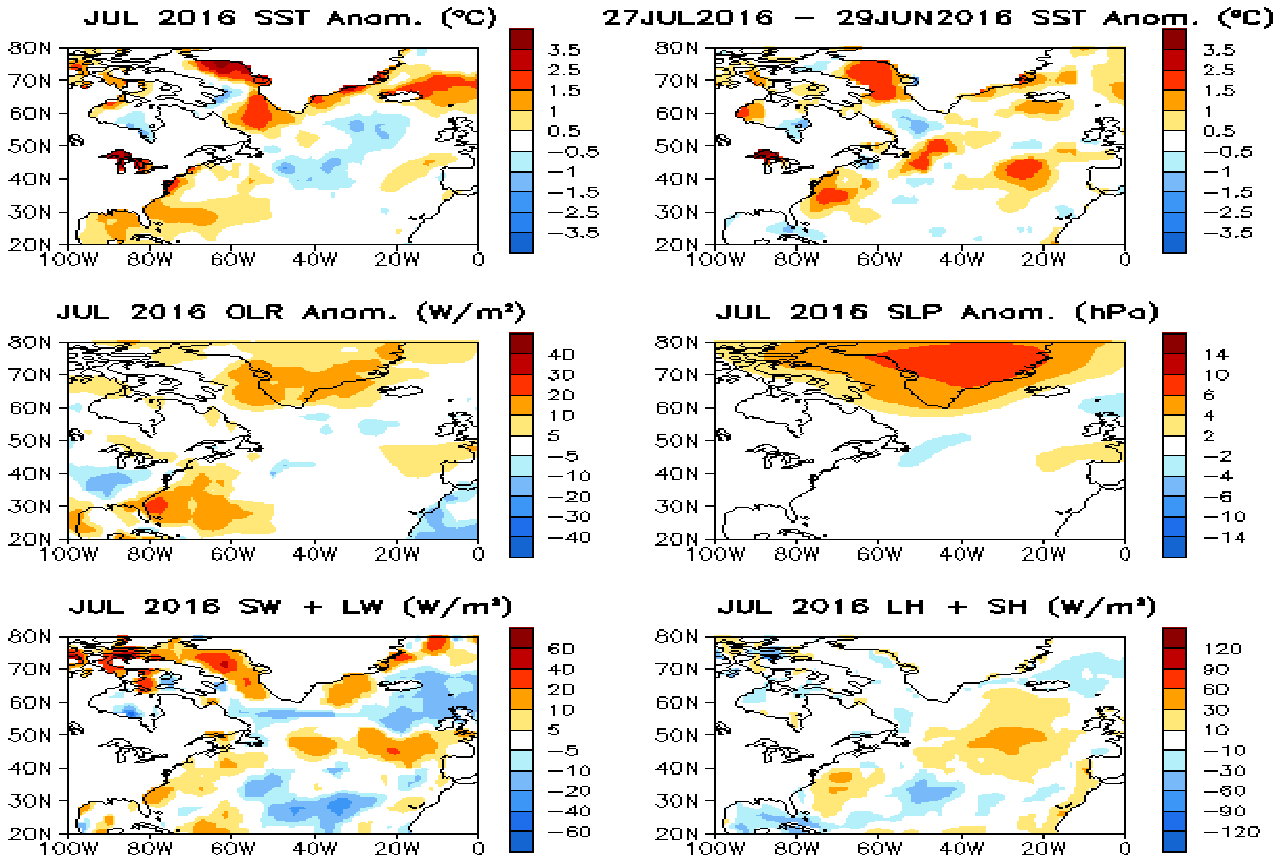
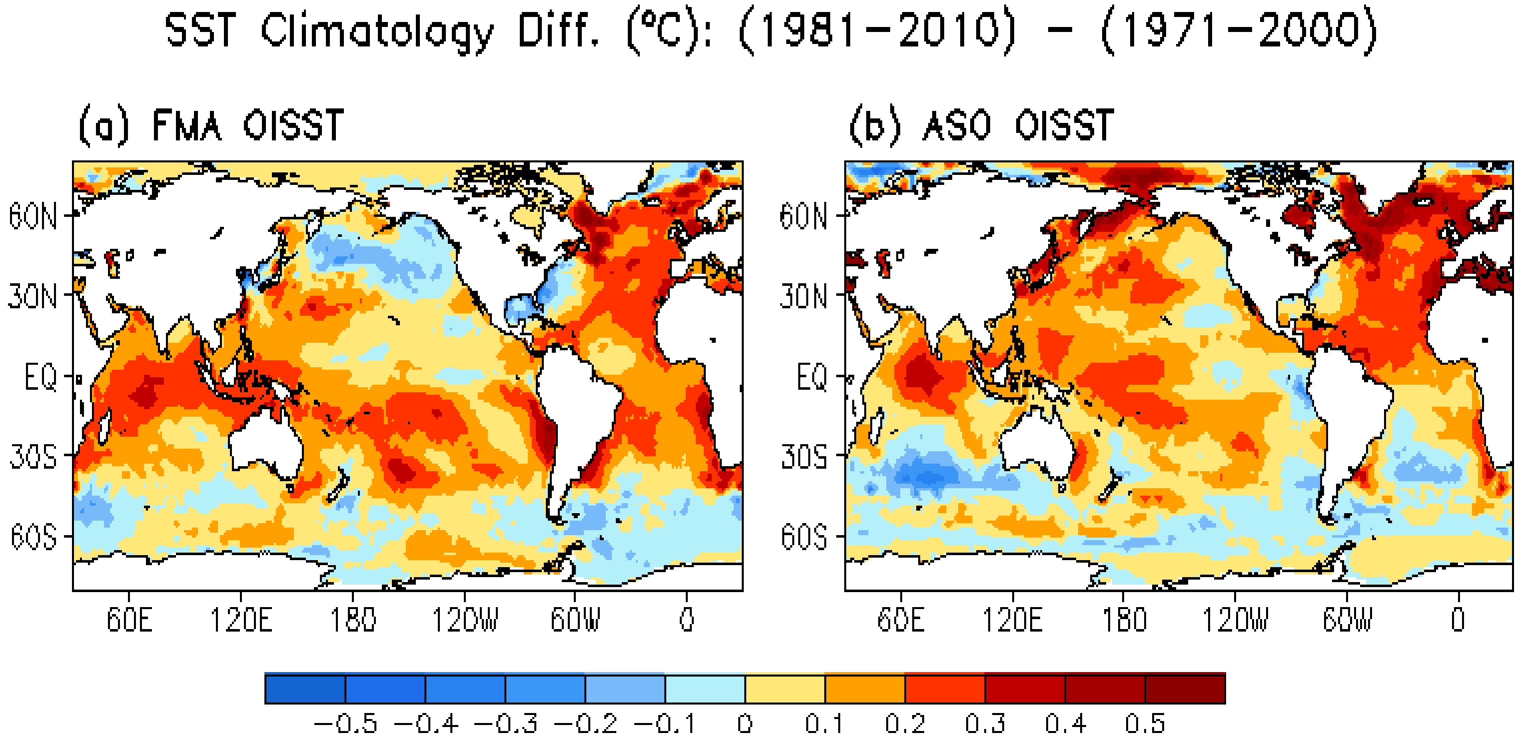


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

Switch to 1981-2010 Climatology

- **SST from 1971-2000 to 1981-2010**
  - **Weekly OISST.v2, monthly ERSST.3b**
- **Atmospheric fields from 1979-1995 to 1981-2010**
  - **NCEP CDAS winds, sea level pressure, 200mb velocity potential, surface shortwave and longwave radiation, surface latent and sensible fluxes, relative humidity**
  - **Outgoing Long-wave Radiation**
- **Oceanic fields from 1982-2004 to 1981-2010**
  - **GODAS temperature, heat content, depth of 20^{o}C, sea surface height, mixed layer depth, tropical cyclone heat potential, surface currents, upwelling**
- **Satellite data climatology 1993-2005 unchanged**
  - **Aviso Altimetry Sea Surface Height**
  - **Ocean Surface Current Analyses – Realtime (OSCAR)**

Be aware that new climatology (1981-2010) was applied since Jan 2011



1971-2000 SST Climatology (Xue et al. 2003):
http://www.cpc.ncep.noaa.gov/products/predictions/30day/SSTs/sst_clim.htm

1981-2010 SST Climatology: http://origin.cpc.ncep.noaa.gov/products/people/yxue/sstclim/

- The seasonal mean SST in February-April (FMA) increased by more than 0.2°C over much of the Tropical Oceans and N. Atlantic, but decreased by more than 0.2°C in high-latitude N. Pacific, Gulf of Mexico and along the east coast of U.S.

- Compared to FMA, the seasonal mean SST in August-October (ASO) has a stronger warming in the tropical N. Atlantic, N. Pacific and Arctic Ocean, and a weaker cooling in Gulf of Mexico and along the east coast of U.S.

Data Sources and References

- Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)
- NCEP CDAS winds, surface radiation and heat fluxes
- NESDIS Outgoing Long-wave Radiation
- NDBC TAO data (http://tao.noaa.gov)
- PMEL TAO equatorial temperature analysis
- NCEP's Global Ocean Data Assimilation System temperature, heat content, currents (Behringer and Xue 2004)
- Aviso Altimetry Sea Surface Height
- Ocean Surface Current Analyses – Realtime (OSCAR)

Please send your comments and suggestions to Yan.Xue@noaa.gov. Thanks!