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

Prepared by
Climate Prediction Center, NCEP/NOAA
May 10, 2018

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 SST Predictions

• Is an El Nino Coming?

• Biases in CFSR and the Possible Impact on ENSO Forecast
Overview

Pacific Ocean
- NOAA “ENSO Diagnostic Discussion” on 10 May 2018 issued “Final La Niña Advisory” and indicated “ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19.”
- Negative SSTAs weakened in the eastern tropical Pacific with NINO3.4=-0.41°C in Apr 2018.
- Positive subsurface ocean temperature anomalies presented in the equatorial Pacific in Apr 2018.
- SST anomalies were mainly positive in the N. Pacific with PDOI=-0.2 in Apr 2018.

Indian Ocean
- SSTs were negative in the east-central S. Indian Ocean in Apr 2018.

Atlantic Ocean
- NAO switched to positive phase with NAOI=1.2 in Apr 2018, and SSTAs were a tripole/horseshoe pattern with large positive anomalies in the middle latitudes of N. Atlantic.
Global Oceans
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.

- SSTAs were positive (negative) in the NE (SE) tropical Pacific, showing a large meridional gradient in the E. Pacific.
- SSTAs were mainly positive in the N. Pacific.
- Horseshoe/tripole-like SSTA pattern presented in the N. Atlantic.
- SSTAs were negative in the east-central S. tropical Indian Ocean.

- Positive SSTA tendencies were observed in the central and eastern tropical Pacific, consisting with the decline of La Nina.
- Strong negative SSTA tendencies were seen in the NE Indian Ocean to the central N. Pacific via NW Pacific.
Positive (negative) ocean temperature anomalies presented along the thermocline in the western-central (far-eastern) equatorial Pacific.

There was a tripole tendency pattern in the Pacific: negative in the west and far-east, and positive in the east.

Positive (negative) tendencies presented along the thermocline in the western (eastern) Indian Ocean.
Anomalously Temperature (°C) Averaged in 1S-1N: APR 2018

- NCEP GODAS
- JMA
- ECMWF
- GFDL
- NASA
- BOM
- MET
- MERCATOR
- NCEP CFSR
- ENS. Mean
- Spread
- SN Ratio

Legend:
-4 -3 -2 -1 -0.5 0 0.5 1 2 3 4 5 6
- The SSHA pattern was overall consistent with HC300A pattern, but there were many detailed differences between HC300A and SSHA.
- Both SSHA and HC300A in the tropical Pacific were consisted with the decay phase of La Nina.
- The negative and positive tendencies of SSHA and HC300A in the tropical Pacific are associated with Kelvin wave activity.
Tropical Pacific Ocean and ENSO Conditions
- Positive ocean temperature anomalies in the western and central Pacific Ocean propagated eastward during last month and reached far-eastern Pacific, associated with eastward propagation of downwelling Kelvin wave.

- Both the anomalous amplitude and propagation speed are comparable between TAO and GODAS.
Oceanic Kelvin Wave (OKW) Index

- A downwelling Kelvin wave propagated eastward from Feb - Mar 2018, and a stationary variation presented since Apr 2018.

(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).)

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

2°S–2°N Average, 3 Pentad Running Mean

- Negative SSTA in the eastern Pacific weakened since Mar 2018.
- Positive HC300A in the western and central Pacific propagated eastward in Feb-Mar 2018.
- Three low-level westerly wind burst events were observed during Jan-Apr 2018.
Anomalous eastward currents weakened in Apr 2018 in OSCAR and GODAS.
- The anomalous currents showed some differences between OSCAR and GODAS.
Equatorial Warm Water Volume (WWV) indicated recharging in Feb-Apr 2018.

- 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.

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.
Equatorial subsurface ocean temperature monitoring: ENSO was in recharge phase since Dec 2017.

Projection of OTA onto EOF1 and EOF2 (2S-2N, 0-459m, 1979-2010)

EOF1: Tilt mode (ENSO peak phase);
EOF2: WWV mode,
Recharge/discharge oscillation (ENSO transition phase).

Recharge process: heat transport from outside of equator to equator: Negative -> positive phase of ENSO

Discharge process: heat transport from equator to outside of equator: Positive -> Negative phase of ENSO

For details, see:
**NINO3.4 Heat Budget**

- Both observed SSTA tendencies ($dT/dt$; dotted black line) and total heat budget (RHS; solid black line) in the Nino3.4 region were positive.

- Both dynamical terms ($Qu$, $Qv$, $Qw+Qzz$) and heat-flux terms ($Qq$) were small in last month.

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**Qu: Zonal advection; Qv: Meridional advection;**

**Qw: Vertical entrainment; Qzz: Vertical diffusion**

**Qq: ($Q_{net} - Q_{pen} + Q_{corr})/\rho cph; Q_{net} = SW + LW + LH +SH;$**

**Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST**
Evolution of Pacific NINO SST Indices

- Nino4 became positive, and Nino3 and Nino3.4 were negative and weakened in Apr 2018.
- Nino3.4 = -0.41°C in Apr 2018.
- Compared with last Apr, the central and eastern equatorial and southern Pacific was cooler in Apr 2018.
- 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.
SSTA projections were larger in the cold tongue in 2017/18 La Nina than in 2016/17 La Nina
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 Oceans
PDO index

- 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.

- The positive SSTAs presented with PDO index = -0.2 in Apr 2018.

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

- Both anomalous upwelling and downwelling were small since mid-Apr 2018.

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 \( (m^3/s/100m\text{ coastline}) \). 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 April to July along the west coast of North America from 36\(^\circ\)N to 57\(^\circ\)N.
- Sea ice extent in the Bering Sea remains at record low levels for this time of year. Total ice extent over the Arctic Ocean also remains low.
- Given the uncertainty in measurements, NSIDC considers 2016 and 2018 as tying for lowest April sea ice extent on record.
- 20-member ensemble experimental CFS Arctic sea ice forecast was initialized April 21-25, 2018 using initial conditions from the CPC Sea ice Initialization System (CSIS).

- The projected September Arctic sea ice extent based on this forecast is $4.50 \pm 0.29 \times 10^6 \text{ km}^2$ (March forecast was $4.44 \pm 0.51 \times 10^6 \text{ km}^2$).

- There is a slight increase in the mean and a large decrease in the ensemble variability compared to last month.
Indian Ocean
Evolution of Indian Ocean SST Indices

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.

- Values of all the indices were small in last two months.
SSTAs were small and positive in the west and negative in the central-east.

- SSTAs were small and positive in the west and negative in the central-east.
- SSTA tendency was partially determined by heat flux.
Tropical and North Atlantic Ocean
Evolution of Tropical Atlantic SST Indices

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60ºW-30ºW, 5ºN-20ºN], TSA [30ºW-10ºE, 20ºS-0] and ATL3 [20ºW-0, 2.5ºS-2.5ºN] 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.

- SSTAs were small in the equatorial and South Atlantic and negative in the North Atlantic in Apr 2018.
NAO and SST Anomaly in North Atlantic

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.

- NAO switched to positive phase with NAOI= 1.2 in Apr 2018.
- SSTA was a tripole/horseshoe-like pattern with positive in the mid-latitudes and negative in lower and higher latitudes.
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.
ENSO and Global SST Predictions
EL NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION

issued by

CLIMATE PREDICTION CENTER/NCEP/NWS
and the International Research Institute for Climate and Society
10 May 2018

ENSO Alert System Status: Final La Niña Advisory

Synopsis: ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19.

During April 2018, the tropical Pacific returned to ENSO-neutral, as indicated by mostly near-to-below average sea surface temperatures (SSTs) along the equator (Fig. 1). The latest weekly Niño indices were near zero in all regions (between +0.2°C and -0.3°C), except for Niño-1+2, which remained negative (-0.6°C; Fig. 2). Subsurface temperature anomalies (averaged across 180°-100°W) remained positive (Fig. 3), due to the continued influence of a downwelling oceanic Kelvin wave (Fig. 4). Atmospheric indicators related to La Niña also continued to fade. While convection remained suppressed near and east of the Date Line, rainfall near Indonesia was also below average during the month (Fig. 5). Low-level winds were near average over most of the tropical Pacific Ocean, and upper-level winds were anomalous westerly over the eastern Pacific. Overall, the ocean and atmosphere system reflected a return to ENSO-neutral.

The majority of models in the IRI/CPC plume predict ENSO-neutral to continue at least through the Northern Hemisphere summer 2018 (Fig. 6). As the fall and winter approaches, many models indicate an increasing chance for El Niño. Therefore, the forecaster consensus hedges in the direction of El Niño as the winter approaches, but given the considerable uncertainty in ENSO forecasts made at this time of year, the probabilities for El Niño are below 50%. In summary, ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19 (click CPC/IRI consensus forecast for the chance of each outcome for each 3-month period).

This discussion is a consolidated effort of the National Oceanic and Atmospheric Administration (NOAA), NOAA’s National Weather Service, and their funded institutions. Oceanic and atmospheric conditions are updated weekly on the Climate Prediction Center web site (El Niño/La Niña Current Conditions and Expert Discussions). Forecasts are also updated monthly in the Forecast Forum of CPC’s Climate Diagnostics Bulletin. Additional perspectives and analysis are also available in an ENSO blog. The next ENSO Diagnostics Discussion is scheduled for 14 June 2018. To receive an e-mail notification when the monthly ENSO Diagnostic Discussions are released, please send an e-mail message to:
ncep.list.enso-update@noaa.gov.
NOAA/NCEP/CPC issued La Niña Watch on 14 September 2017

NOAA/NCEP/CPC issued La Niña Advisory on 9 November 2017

NOAA/NCEP/CPC issued last La Niña Advisory on 10 May 2018

<table>
<thead>
<tr>
<th>Season (Nino3.4)</th>
<th>SON17</th>
<th>OND17</th>
<th>NDJ17/18</th>
<th>DJF17/18</th>
<th>JFM18</th>
<th>FMA18</th>
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<tr>
<td>ERSSTv5</td>
<td>-0.7</td>
<td>-0.9</td>
<td>-1.0</td>
<td>-0.9</td>
<td>-0.8</td>
<td>-0.6</td>
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<tr>
<td>OIv2</td>
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<td>-0.7</td>
<td>-0.8</td>
<td>-0.8</td>
<td>-0.8</td>
<td>-0.6</td>
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</table>

A threshold of +/- 0.5°C for the Oceanic Niño Index (ONI) [3 month running mean of ERSST.v5 SST anomalies in the Niño 3.4 region (5°N-5°S, 120°-170°W)] is met for a minimum of 5 consecutive over-lapping seasons, based on centered 30-year base periods updated every 5 years.
- Majority of models predict ENSO-neutral or El Nino in 2018.

- NOAA “ENSO Diagnostic Discussion” on 10 May 2018 issued “Final La Niña Advisory” and indicated “ENSO-neutral is favored through September-November 2018, with the possibility of El Niño nearing 50% by Northern Hemisphere winter 2018-19.”
Individual Model Forecasts: neutral or El Nino

EC: Nino3.4, IC=01May2018

Australia: Nino3.4, IC=6 May 2018

JMA: Nino3, IC/updated = 10 Apr 2018

UKMO: Nino3.4, IC=Apr 2018
CA with ICs through April 2018: El Nino (Peitao.Peng@noaa.gov)

CPC CON (CA, CCA, MKV, CFSv2)
- Warm Water Volume (WWV) index is defined as average of depth of 20°C in [120ºE-80ºW, 5ºS-5ºN]. It is inferred from the slow ocean adjustment via zonal mean heat content exchange between the equatorial and off-equatorial regions.

- Central tropical Pacific (CTP) index is defined as average of depth of 20°C in [160ºW-110ºW, 10ºS-10ºN]. It includes equatorial thermocline variations involving the equatorial wave processes in response to the wind-stress-curl anomalies and off-equatorial thermocline variations related with Subtropical cells (STCs).


CTP(April). VS. Nino34 (DJF)

2x2 contingency table
El Nino Case

April
Percent Correct rate 0.7 (25/38)
Hit rate 0.5 (6/12)
False Alarm rate 0.5 (7/13)

Except for GODAS and NASA, CTP indices in Apr 2018 from the ensemble mean and other ocean reanalysis prefer El Nino condition in the coming Northern Hemispheric winter.
All WWV indices in Apr 2018 favor El Nino condition in the coming Northern Hemispheric winter.

<table>
<thead>
<tr>
<th>2x2 contingency table</th>
<th>April</th>
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<tbody>
<tr>
<td>Percent Correct rate</td>
<td>0.7 (26/38)</td>
</tr>
<tr>
<td>Hit rate</td>
<td>0.5 (6/12)</td>
</tr>
<tr>
<td>False Alarm rate</td>
<td>0.5 (6/12)</td>
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</table>
Markv(April).VS. Nino34 (DJF)

2x2 contingency table

<table>
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<tr>
<th>April</th>
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<tbody>
<tr>
<td>Percent Correct rate</td>
</tr>
<tr>
<td>Hit rate</td>
</tr>
<tr>
<td>False Alarm rate</td>
</tr>
</tbody>
</table>

* Markv 2nd PC in Apr 2018

corr=0.64

(a) Apr2017

(b) Apr2018

(c) Apr2018–Apr2017

TAO

GODAS

CFSR
850-hPa Zonal Wind Anomalies

[5°S-5°N]

From:
http://www.atmos.albany.edu/student/ventrice/real_time/timeLon/u.anom.30.5S-5N.gif
Biases in CFSR and the Possible Impact on ENSO Forecast
CFS Niño3.4 SST Predictions from Different Initial Months

NINO3.4 SST anomalies (K)

Fig. M1. CFS Niño3.4 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.

- Latest CFSv2 forecasts call for a ENSO-neutral during summer-autumn 2018.
- CFSv2 predictions had cold biases with ICs in Aug-Dec 2017 and Jan 2018.
Based on the 1999-2010 climatology, the D20A of CFSR-GODAS reaches -10 m before 1999 and after 2015.

The shift of the CFSR bias around 1999 was related to the shift of CFSR surface wind bias resulted from assimilation of ATOV satellite observations (Xue et al. 2011; Zhang et al. 2012).

The shift of the CFSR bias around 2015 may be related to the reset of CFSR ocean conditions with a parallel GODAS run to control a cold bias growth in the tropical Atlantic ocean in CFSR (see slide 51).
5S-5N Average D20 Anomalies; 1981-2010 climatology
A periodic reset of the CFSR ocean with the parallel GODAS run is used to remove the cold bias in the tropical Atlantic, which is indicated as a fast growth of RMSD between CFSR and GODAS. The cold biases were largest in 2014 and 2015.

The dates of the resets can be identified as the time when the RMSD rapidly decreased (2015: Jan) (2016: Mar, Jul, Nov) (2017: Jan, 18Apr, Aug, Oct) (2018: Feb)

There were cold biases in D20 anomaly in MDR in Mar-Apr 2015, 2016, 2017, which might contributed to the cold biases in the summer MDR SST forecast.
Emily Becker: “**CFSv2 and CCSM4** both respond to the CFSR re-re-adjustment with flat forecasts, while GEOS5, FLOR, and CanCM3&4 are sticking with weak-moderate El Nino. The ensemble mean of both original and PDF-adjusted call for ONI about +1C, peaking in OND/NDJ. Overall, the probabilities are confident for El Nino, but the magnitude is pretty borderline.”
CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months

Tropical N. Atlantic SST anomalies (K)

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.

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

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

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.

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 negative phase of PDO in 2018.
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.
Acknowledgements

• Drs. Caihong Wen, Yan Xue, and Arun Kumar: reviewed PPT, and provide insight and constructive suggestions and comments

• Drs. Li Ren and Pingping Xie: Provided SSS slides

• Dr. Emily Becker: timely provided NMME plot

• Dr. Peitao Peng: updated CA ENSO forecast

• Drs. Thomas Collow and Wanqiu Wang: Provided sea ice slides

• Dr. Dan Collins: Updated CPC CON forecast
Backup Slides
New Update: The input satellite sea surface salinity of SMAP from NSAS/JPL was changed from Version 3.0 to Version 4.0 in January 2018.

The negative SSS signal continued in the Indonesia equatorial Pacific, meanwhile, the precipitation was reduced in this area, which indicates that the negative SSS is probably caused by oceanic advection/entrainment. The heavier precipitation in the west basin of South Pacific subtropics causes the persistent negative SSS in this region. In the Bay of Bengal, the negative SSS signal continued in the northern basin. In the Atlantic Ocean, the positive SSS signal between 20ºS to 40ºN also continued in this month.

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
Compared with last month, the SSS in the northern basin of Bay of Bengal decreased possibly due to ocean advection/entrainment. In the west basin of the South Pacific subtropics, the SSS decreased with the precipitation increasing in this area. A large scale of SSS increasing appeared in the North Pacific Ocean from equator to 40°N. The SSS increased in the subtropics of North Atlantic ocean with reduced freshwater input.
Global Sea Surface Salinity (SSS) Anomaly Evolution over Equatorial Pacific

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, from 120°E to 150°E, the negative SSS signal continues in this month. The positive SSS anomaly signal in the central equatorial Pacific (150°E to 170°W) Ocean becomes weaker. Meanwhile, the SSS west of 170°W becomes positive this month.