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 Climate Observation Division (COD)
Outline

• Overview

• Recent highlights
  – Global Oceans  
    (NOAA 2014 Hurricane Prediction)
  – Pacific/Arctic Ocean
  – Indian Ocean
  – Atlantic Ocean
  – Global SST Predictions  
    (Possibility of occurrence of an El Nino in 2014/15)
Overview

Pacific Ocean
- ENSO neutral condition continued with OIv2 NINO3.4=0.46°C in May 2014.
- Positive anomalies of subsurface ocean temperature along the equator weakened in May 2014.
- Majority of models predicted an El Nino starting this summer.
- NOAA “ENSO Diagnostic Discussion” on 5 June 2014 continually issued “El Nino Watch” and suggested that “Chances of El Niño are 70% during the Northern Hemisphere summer and reach 80% during the fall and winter.”
- PDO switched to positive phase in Mar and strengthened in Apr-May with PDO index =1.2 in May 2014.

Indian Ocean
- Positive SSTA presented in the whole Indian Ocean in May 2014.

Atlantic Ocean
- NAO switched into negative phase with NAOI=-0.8 in May 2014.
- Tripole pattern of SSTA presented in North Atlantic in May 2014.
- NOAA predicts near-normal or below-normal 2014 Atlantic hurricane season.
Global Oceans
Global SST Anomaly (°C) and Anomaly Tendency

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.

- Positive SSTA in the equatorial central and eastern Pacific.
- Positive phase of PDO associated SSTA in North Pacific.
- Tripole SSTA pattern in the North Atlantic.
- Positive SSTA in the Indian Ocean.
- Some SSTAs in the South Ocean.

- Large positive SSTA tendencies in the eastern equatorial Pacific Ocean.
- Negative SSTA in Mid-latitudes of N. Pacific.
- Some cooling tendencies in the northwestern Atlantic.
Global SSH and HC300 Anomaly & Anomaly Tendency

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

- Positive SSH/HC200 anomalies presented in the central and eastern equatorial Pacific.

- Negative SSHA /HC300A tendency in the central and eastern equatorial Pacific is associated with Kelvin wave activity.
- Positive TCHP anomalies presented in the c. equatorial Pacific and negative ones in the w. Pacific.
- Small negative anomalies were observed over the tropical North Atlantic Ocean.
- The tendency was positive (negative) in the tropical e. (w.) Pacific and small in the tropical N. Atlantic.

*TCHP* field is the anomalous heat storage associated with temperatures larger than 26 °C.
**NOAA Predicts Near-Normal or Below-Normal 2014 Atlantic Hurricane Season**

(http://www.noaanews.noaa.gov/stories2014/20140522_hurricaneoutlook_atlantic.html)

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<th>2014 prediction (issued on May 22) (1981-2010)</th>
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<td><strong>Named storms</strong></td>
<td>8-13 (12.1)</td>
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<tr>
<td><strong>Hurricanes</strong></td>
<td>3-6 (6.4)</td>
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<td><strong>Major hurricanes</strong></td>
<td>1-2 (2.7)</td>
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- The main driver of this year’s outlook is the anticipated development of El Niño this summer.
- El Niño causes stronger wind shear, which reduces the number and intensity of tropical storms and hurricanes.
- El Niño can also strengthen the trade winds and increase the atmospheric stability across the tropical Atlantic, making it more difficult for cloud systems coming off of Africa to intensify into tropical storms.
NOAA Predicts Near or Above-Normal E. Pacific Hurricane Season in 2014
(http://www.cpc.ncep.noaa.gov/products/Epac_hurr/Epac_hurricane.html)

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- **El Nino:** The 2014 seasonal hurricane outlook reflects the likely development of El Niño. El Niño reduces the vertical wind shear in the eastern Pacific hurricane basin, making atmospheric conditions more conducive to hurricane activity.

- **Low-activity era for eastern Pacific hurricanes:** Eastern Pacific hurricane seasons have been less active since 1995.
Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2°S-2°N

- Strong positive (weak negative) ocean temperature anomalies in the central and eastern (western) equatorial Pacific emerged.
- Ocean temperature anomalies were mainly positive in both Indian and Atlantic Oceans.

- Ocean temperature anomaly tendencies were mainly negative along the thermocline of the equatorial Pacific, suggesting a weakening tendency of subsurface ocean temperature positive anomalies.
- Some positive temperature anomaly tendencies were observed in both Indian and Atlantic Oceans.

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.
Tropical Pacific Ocean and ENSO Conditions
Positive ocean temperature anomalies presented in the central and eastern Pacific and moved eastward slowly.

Some disagreements between TAO and GODAS may be partially due to lack of TAO observations recently (see next slide).
- TAO data delivery rate decreased significantly since late 2012, and became worse since late 2013.
- There was a sharp increase of Argo data since late Jan 2014.
The spread is large (>0.6°C) between 140W-100W, and 120E-140E, where data distribution is poor.
Oceanic Kelvin Wave (OKW) Index

- Downwelling OKW (solid line) emerged since Jan 2014 in the W. Pacific, while upwelling OKW initiated in mid-Feb in the W. Pacific. The upwelling may be associated with the weakening of subsurface ocean temperature positive anomalies in May 2014.

- OKW activities may be associated with the westerly wind burst events in Jan 2014.

(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).)

- Standardized Projection on EEOF 1
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)

Strong eastward current initiated in Feb 2014 and propagated eastward and reached the eastern boundary in the end of Mar 2014, and then weakened.

That is consistent with the evolution of ocean temperature & D20 anomaly along the equatorial Pacific in the last a few months.
First EOF mode of ocean surface current (SC) and SST anomalies for the past decade extending through the latest 10-day period. The amplitude time series (top panel) are computed by fitting the data sets to 10-year base period eigenvectors (1993-2002). The amplitudes are then normalized by their respective standard deviations. The bottom panel shows the corresponding EOF maps, scaled accordingly. The El Niño signal can be seen as periods of positive excursions (> 1 Std. Dev.) of the amplitude time series. The near real-time SC are the output from a diagnostic model. (see “http://www.esr.org/enso_index.html” for details)
Positive SSTA tendency along the equatorial Pacific was observed during the last 4 months.

Positive HC300 anomalies initiated in Dec 2013, propagated eastward, and reached the coast in Apr 2014.

3 westerly wind burst events emerged in Jan, Feb, and Apr 2014, respectively.

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.

http://www.cpc.ncep.noaa.gov/products/precip/CWlink/daily_mjo_index/mjo_index.shtml
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.

- Positive SSTA and tendency along the equatorial Pacific were observed.
- OLR anomalies were small in May 2014.
- Small westerly (easterly) wind anomalies at 925 hPa (200 hPa) were seen in the eastern Pacific.
Evolution of Pacific NINO SST Indices

All NINO indices were positive and had a positive tendency in May 2014.

Nino3.4 = 0.46°C in May 2014.

Compared with last May, SST was much warmer in the equatorial Pacific in May 2014.

The indices were calculated based on OISST. They may have some differences compared with those based on ERSST.v3b.

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.
SST Differences between OIv2 and ERSSTv3b (From: Michelle L'Heureux)

(a) Nino3.4 in May 2014: 0.46 (OIv2), 0.14 (ERSSTv3b)
(b) in Apr and May 2014, OIv2 is warmer than ERSSTv3b in the equatorial Pacific.

North Pacific & Arctic Oceans
PDO index

The Pacific Decadal Oscillation (PDO) 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.

- PDO switched to positive phase in Mar 2014 and then strengthened with PDO index = 1.2 in May 2014.
- Statistically, ENSO and PDO are connected, 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

Climatologically upwelling season progresses from March to July along the west coast of North America from 36ºN to 57ºN.

- Upwelling in 36-51N weakened since second-half of Apr 2014.

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 36ºN to 57ºN.
- Arctic sea ice extent was below normal and within -2 standard deviation in May 2014.
Indian Ocean
Evolution of Indian Ocean SST Indices

- Positive SSTA presented in the whole Indian Ocean.
- Compared with May 2013, 2014 is warmer.
- DMI became near normal in May 2014.

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.

- Positive SSTA were in the whole Indian Ocean.
- Warming (cooling) tendency was observed in the Arabian Sea (Bay of Bengal and South China Sea) in May 2014.

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

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (ºC) 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.

- Tropical North Atlantic (TNA) index was negative since Jan 2014 and then strengthened.
- Tropical South Atlantic (TSA) index was positive since Feb 2014 and intensified in May 2014.
- Meridional Gradient Mode (TNA-TSA) has been switched to negative phase in Feb 2014 and then strengthened.
- ATL3 SSTA became strong positive in May 2014.
- Tropical North Atlantic in May was cooler in 2014 than in 2013.
Tropical Atlantic:

MAY 2014 SST Anom. (°C)

MAY 2014 OLR Anom. (W/m²)

MAY 2014 SW + LW Anom. (W/m²)

MAY 2014 700 mb RH Anom. (%)

28 MAY 2014 - 30 APR 2014 SST Anomaly (°C)

MAY 2014 200mb Wind Anom. (m/s)

LH + SH Anom. (W/m²)

MAY 2014 200mb - 850mb Wind Shear Anom. (m/s)
NAO and SST Anomaly in North Atlantic

- NAO switched to negative phase with NAOI=-0.8 in May 2014.
- North Atlantic tripole-like SSTAs were observed, may partially due to the forcing of positive phase of NAO in last a few months.

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.
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
Almost all models predicted a warming tendency and a majority of them predicted an El Nino in second half of 2014. Consensus probabilistic forecasts favor a warm phase of ENSO since JJA 2014.

NOAA “ENSO Diagnostic Discussion” on 5 June 2014 continually issued “El Nino Watch” and suggests that “Chances of El Niño are 70% during the Northern Hemisphere summer and reach 80% during the fall and winter.”

“If El Niño forms, the forecasters and most dynamical models, such as NCEP CFSv2, slightly favor a moderate-strength event during the Northern Hemisphere fall or winter (3-month values of the Niño-3.4 index between 1.0°C and 1.4°C).”
CFS Niño3.4 SST Predictions from Different Initial Months

**NINO3.4 SST anomalies (K)**

- CFSv2 predicts a warming tendency, and suggests development of an El Nino in second half of 2014.
- Latest forecasts with IC in May 2014 suggest a moderate-strength El Nino peaking in late autumn or early winter (Oct-Nov).

**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.
Latest forecasts of CFSv2 (updated 03 June 2014)

Some ensemble members predict neutral condition!

CFSv2 forecast Nino3.4 SST anomalies (K) (PDF corrected)

Latest 8 forecast members
Earliest 8 forecast members
Other forecast members
Forecast ensemble mean
NCDC daily analysis

Individual Model Forecasts: Predict an El Nino/neutral in 2014

**Australia: Nino3.4, IC= 1June2014**

POAMA monthly mean NINO34 - Forecast Start: 1 JUN 2014

**UKMO: Nino3.4, IC=May2014**

**JMA: Nino3, IC=May2014**
NMME: Prediction with IC May 2014
All predict El Nino, except that GFDL predicts neutral
Since last winter, SHB index was positive, then decreased in recent months, and became negative in May 2014, suggesting no major El Nino in 2014-15.

- Nino3 had positive tendencies in last a few months.

- Based on Hong et al. (2014 GRL), SHB index peaks at August with 3-mon lead to El Nino, so SHB index value in summer is a good indicator to predict if there is a strong El Nino in winter.

Red/blue shading: normalized Nino3
Black line: Southern Hemisphere booster (SHB) index: v850 averaged over 10°S–30°S, 140°E–170°E and normalized ERSSTv3b and NCEP/NCAR reanalysis: 1981-2010 climatology; 7-month running mean

CFSR: Westerly wind burst (WWB) events
a) stronger in 1997-98 than in 1982-83
b) strong multi-WWB events in 1997-98
Kelvin activity

a) stronger in 1997-98 than in 1982-83
b) multi-Kelvin activity events in 1997-98

Monthly Mean D20 Anomaly (5S–5N, GODAS; m)

(a) Feb1981–Feb1984
(b) Feb1996–Feb1999
(c) Feb2013–Feb2016
Warm Water Volume Index

Anomalous Depth (m) of 20°C isotherm Averaged in [120E−80W, 5S−5N]

Real-Time Multiple Ocean Reanalysis Intercomparison

http://www.cpc.ncep.noaa.gov/products/GODAS/multiora_body.html
Correlation of Dec Nino3.4 with HC300 Anomaly

Correlation of Mthly Upper 300m Temp (180-100W) with December Nino3.4

Correlation of Dec Nino3.4 with E. Pacific HC300 in May is larger than 0.7.

From: Michelle L'Heureux
CFS Tropical North Atlantic (TNA) SST Predictions from Different Initial Months

Tropical N. Atlantic SST anomalies (K)

- Forest from May 2014 IC calls for near-normal SST in the tropical North Atlantic next 9 months.
- Large warm biases were seen in the forecasts with ICs in last 9 months.

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

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.
Overview

- **Pacific Ocean**
  - ENSO neutral condition continued with OIv2 NINO3.4=0.46°C in May 2014.
  - Positive anomalies of subsurface ocean temperature along the equator weakened in May 2014.
  - Majority of models predicted an El Nino starting this summer.
  - NOAA “ENSO Diagnostic Discussion” on 5 June 2014 continually issued “El Nino Watch” and suggested that “Chances of El Niño are 70% during the Northern Hemisphere summer and reach 80% during the fall and winter.”
  - PDO switched to positive phase in Mar and strengthened in Apr-May with PDO index =1.2 in May 2014.

- **Indian Ocean**
  - Positive SSTA presented in the whole Indian Ocean in May 2014.

- **Atlantic Ocean**
  - NAO switched into negative phase with NAOI=-0.8 in May 2014.
  - Tripole pattern of SSTA presented in North Atlantic in May 2014.
  - NOAA predicts near-normal or below-normal 2014 Atlantic hurricane season.
Backup Slides
Global Sea Surface Salinity (SSS)
Anomaly for May 2014

- Sea water freshened over western equatorial Pacific and eastern Indian oceans and salted over central northern Pacific, SE Pacific, and majority of the Atlantic.

- SSS changes over the Pacific and the Indian oceans are attributable largely to the fresh water flux, while those over the Atlantic seem to be caused by other factors.

- Data used
  SSS: Blended Analysis of Surface Salinity (BASS) (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: CFS Reanalysis
Global Sea Surface Salinity (SSS) Tendency for May 2014

- Majority of the western equatorial Pacific and Indian ocean continue to be freshened in association with the fresh water flux, especially the precipitation;
- SSS anomaly presents weak but positive tendency over a large portion of the Atlantic ocean that does not seem to be closely related to E-P variations.
Global Sea Surface Salinity (SSS)

Anomaly Evolution over Equatorial Pacific

- Hovemoller diagram for equatorial SSS anomaly (5°S-5°N);
- SSS exhibits negative / positive anomalies over the Western / Central-Eastern Pacific over recent three years;
- Negative SSS anomaly continues all the way slightly east of the date line;
NINO3.4 Heat Budget

- SSTA tendency (dT/dt) in NINO3.4 (dotted line) was positive since Feb 2014.
- Both Qu, Qv and Qw+Qzz were positive in last a few months.
- The total heat budget term (RHS) agreed with the tendency (dT/dt) since mid-Mar 2014.


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
Equatorial subsurface ocean temperature monitoring: The recharge process weakened since Apr 2014.

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:
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.

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.
Ocean Temperature and D20 Anomaly (intensified and eastward propagation)
Evolution of SST and 850mb Wind Anom.
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.
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.

- Forecast from May 2014 IC calls for weak PDO in next 9 months.
NCEP CFS DMI SST Predictions from Different Initial Months

Indian Ocean Dipole SST anomalies (K)

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.
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), and 850-mb Zonal Wind (m/s) Anomalies

Fig. I3. 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 are derived from the NCEP OI SST, heat content from the NCEP's global ocean data assimilation system, and U850 from the NCEP CDAS. Anomalies are departures from the 1981-2010 base period pentad means.
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.


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

Be aware that new climatology (1981-2010) was applied since Jan 2011
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°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)
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!
Real Time Multiple Ocean Reanalysis Intercomparison

(with contributions from NCEP, ECMWF, JMA, GFDL, NASA, BOM based on 1981-2010 Climatology)

Background Information

Tropical Pacific Ocean

- Climate Indices
  - Depth of 20C isotherm anomaly in NINO3: last 4 years  last 15 years  1979-present
  - Depth of 20C isotherm anomaly in NINO4: last 4 years  last 15 years  1979-present
  - Upper 300m heat content anomaly in NINO3: last 4 years  last 15 years  1979-present
  - Upper 300m heat content anomaly in NINO4: last 4 years  last 15 years  1979-present
  - Warm Water Volume: last 4 years  last 15 years  1979-present
  - Warm Water Volume average in last two months ending in:
    Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

- Spatial Maps
  - Equatorial temperature anomaly: last month  month before last month  1979-present
  - Depth of 20C isotherm anomaly: last month  month before last month  1979-present
  - Upper 300m heat content anomaly: last month  month before last month  1979-present

Global Ocean

- Spatial Maps
  - Equatorial temperature anomaly: last month  month before last month  1979-present
  - Depth of 20C isotherm anomaly: last month  month before last month  1979-present
  - Upper 300m heat content anomaly: last month  month before last month  1979-present

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