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

Prepared by

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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 Office of Climate Observation (OCO)

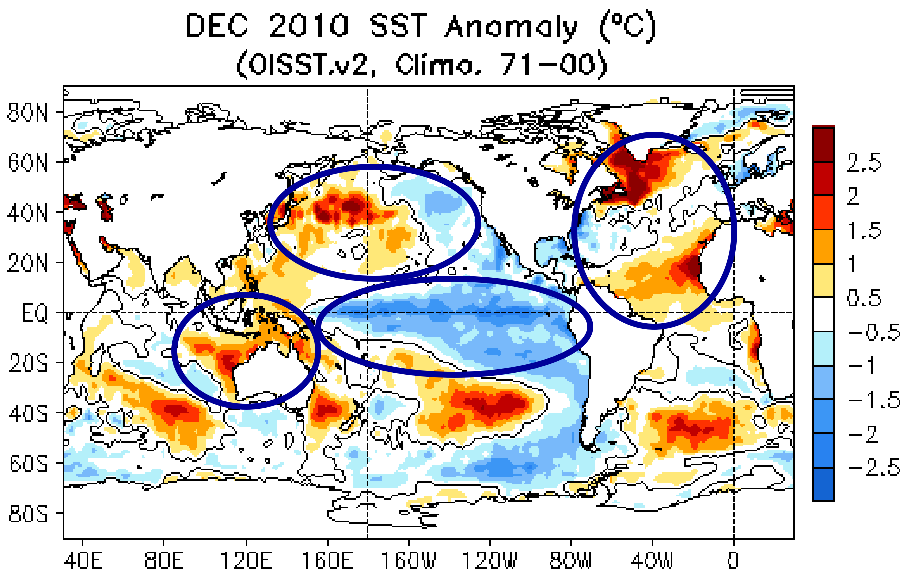
Outline

- Overview
- Recent highlights
  - Pacific/Arctic Ocean
  - Indian Ocean
  - Atlantic Ocean
- CFS SST Predictions

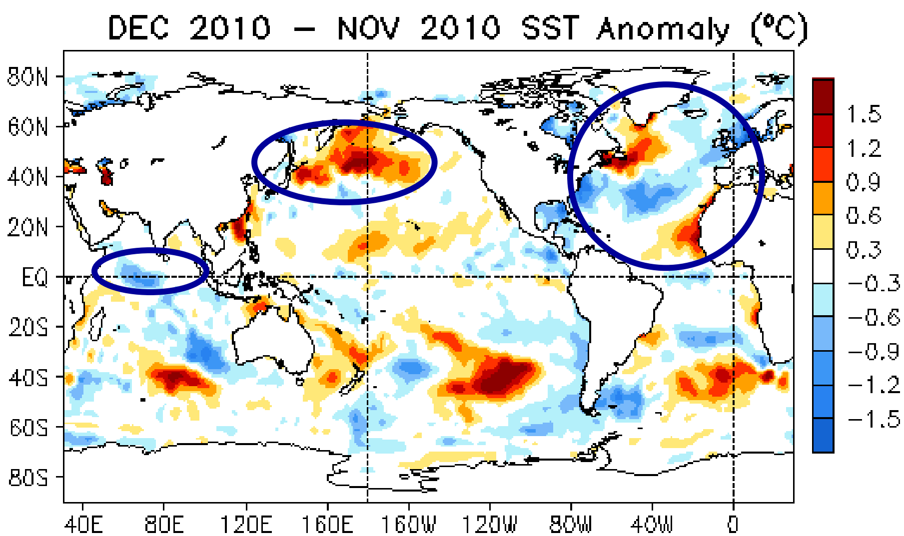
Overview

- **Pacific/Arctic Ocean**
  - **ENSO cycle: La Niña conditions persisted with NINO3.4=-1.5°C in Dec 2010. The current La Nina is as strong as the 1998/99 La Nina in terms of anomaly amplitude in SST, heat content and surface winds.**
  - **NOAA/NCEP Climate Forecast System (CFS) predicted the La Niña will continue well into the Northern Hemisphere spring/summer 2011.**
  - **PDO has been negative since Jul 2010, with PDOI=-1.5 in Dec 2010.**
  - **Downwelling strengthened at 36°N-45°N along the west coast of North America in Dec 2010.**
  - **The Arctic sea ice extent was smaller than the 2007 value in Dec 2010.**
- **Indian Ocean**
  - **Westerly wind anomalies strengthened in the tropical Indian Ocean since late Nov, which were probably part of enhanced atmospheric circulations associated with the La Nina conditions.**
- **Atlantic Ocean**
  - **NAO index has been persistently below-normal since Oct 2009, and it was -1.8 in Dec 2010.**
  - **Strong positive SSTA (>2.5°C) persisted in the high latitudes since Sep 2010.**
  - **Positive SSTA in the tropical North Atlantic has been above-normal since Oct 2009, peaked during Mar-May 2010, and slowly weakened since then.**

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



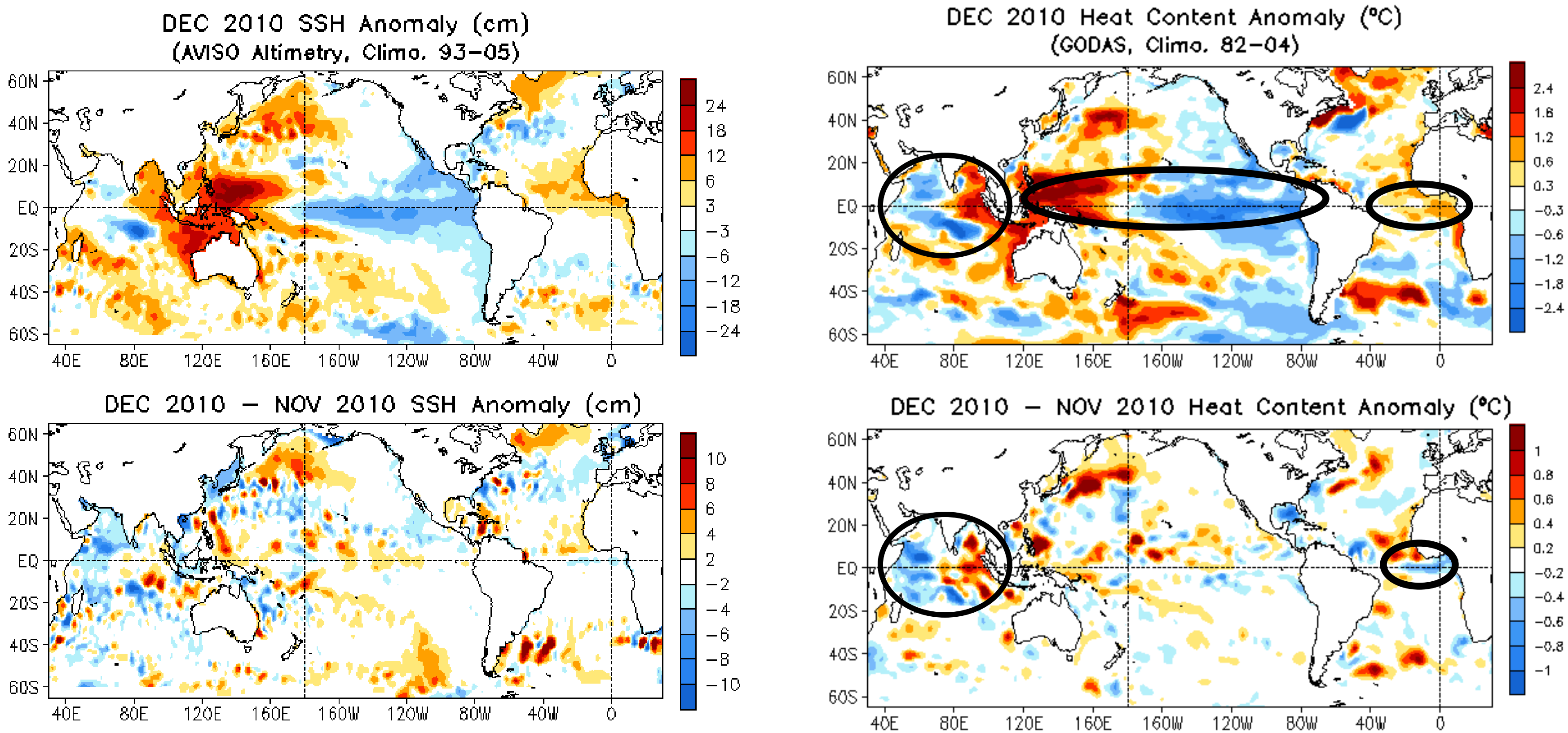
- La Nina conditions presented in the tropical central and eastern Pacific.
- Negative PDO pattern presented in N. Pacific.
- A tripole SSTA pattern presented in North Atlantic.
- Positive SSTA was observed in the S.E. Indian Ocean, W. tropical Pacific and southern mid-latitude oceans.



- Large positive SSTA tendency was observed in the W. N. Pacific, indicating strengthening of negative PDO.
- Negative SSTA tendency was observed in the central tropical Indian Ocean.
- A tripole SSTA tendency pattern was evident in N. Atlantic.
- Large SSTA tendency was observed over the midlatitude southern 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 1971-2000 base period means.

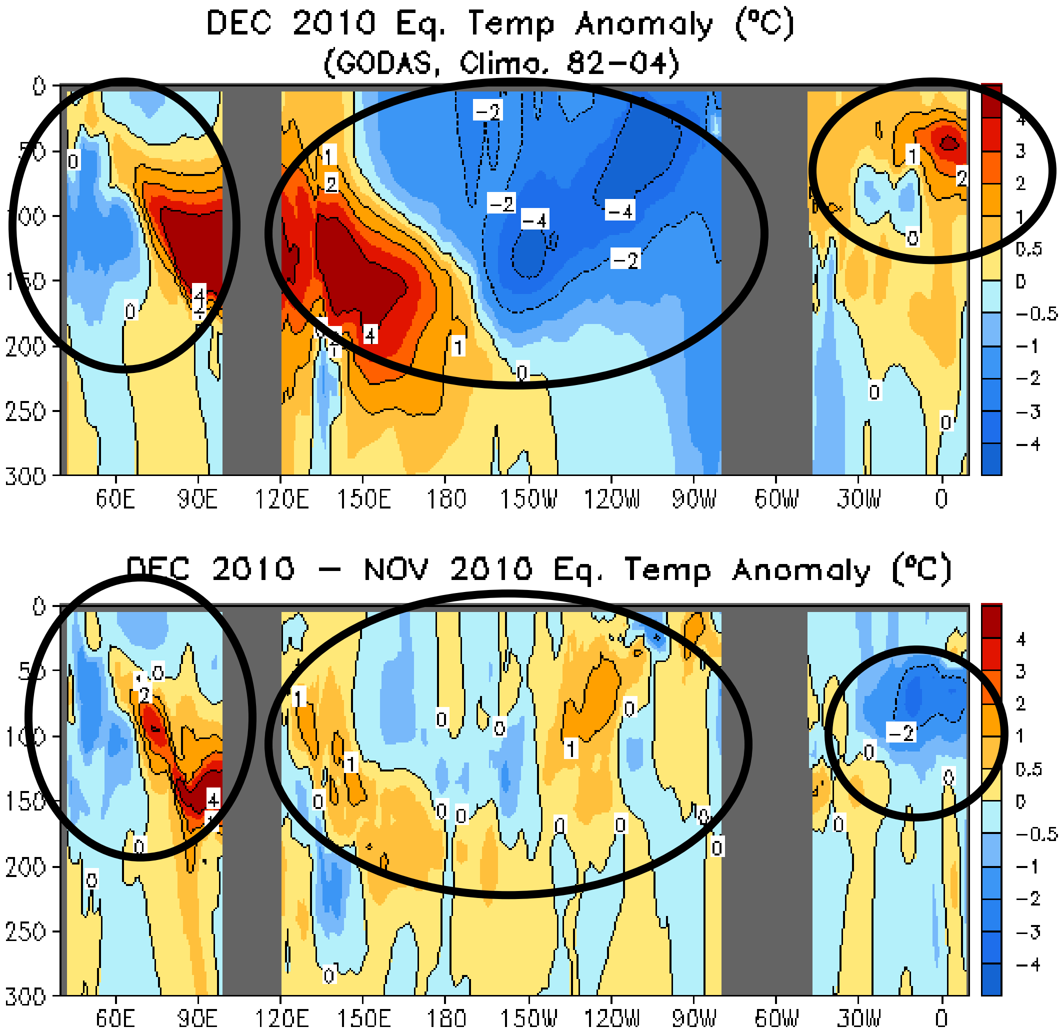
Global SSH/HC Anomaly (cm/°C) and Anomaly Tendency



- In the tropical Pacific Ocean, negative (positive) SSHA and HCA in the central and eastern (western) basin persisted.
- In the tropical Indian Ocean, positive (negative) SSHA and HCA in the eastern (central) basin strengthened in response to anomalous westerly winds, which are probably associated with the La Nina conditions.
- In the eastern equatorial Atlantic, positive SSHA and HCA weakened.
- SSHA and HCA anomalies as well as their tendencies were largely consistent, except in the Southern Ocean where biases in GODAS climatology are large (not shown).

Fig. G2. Sea surface height anomalies (SSHA, top left), SSHA tendency (bottom left), top 300m heat content anomalies (HCA, top right), and HCA tendency (bottom right). SSHA are derived from http://www.aviso.oceanobs.com, and HCA from GODAS.

Longitude-Depth Temperature Anomaly and Anomaly Tendency in 2ºS-2ºN



- Negative (positive) temperature anomalies dominated in the equatorial central and eastern (western) Pacific, consistent with the La Niña conditions.

- Negative (positive) temperature anomalies presented near the thermocline in the equatorial western (eastern) Indian Ocean. Note temperature anomalies near the surface were opposite to those near the thermocline.

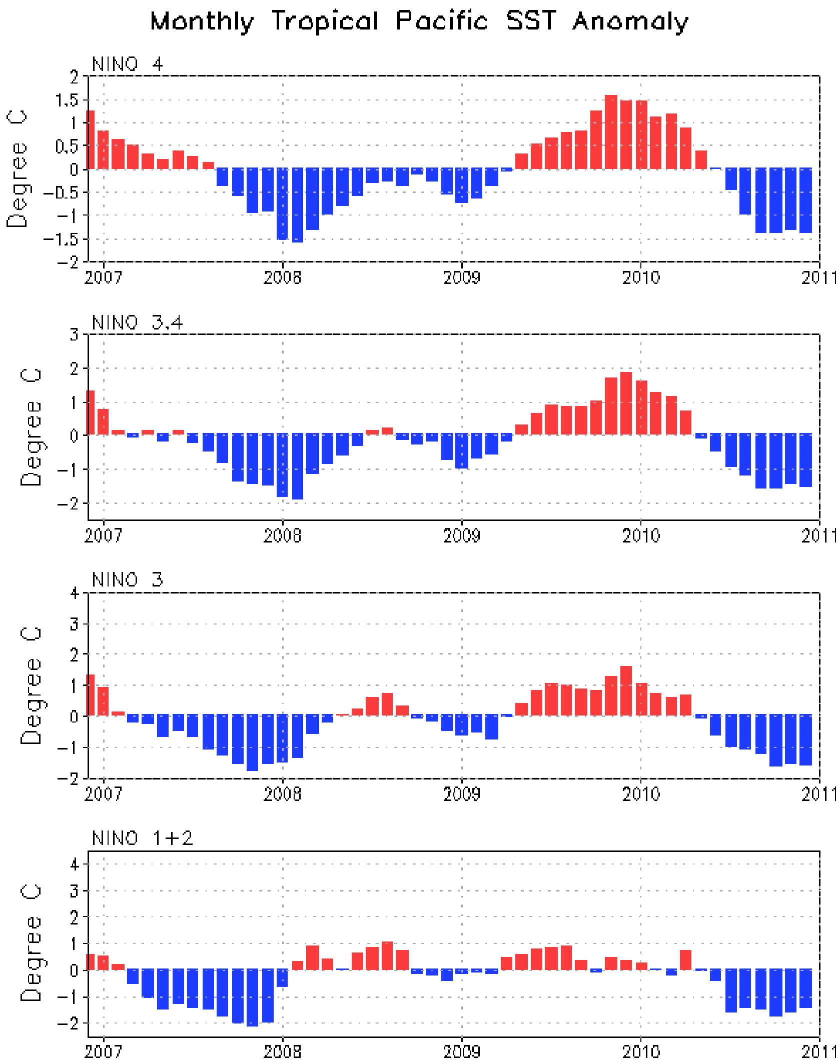
- Positive temperature anomalies presented near the thermocline in the eastern equatorial Atlantic Ocean.

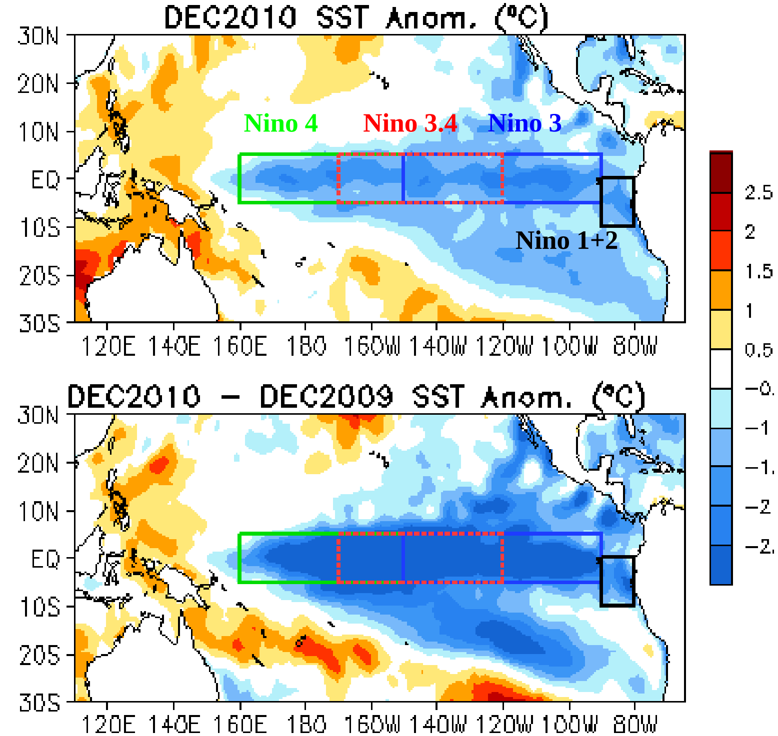
- Temperature increased across most of the equatorial Pacific.
- Dipole subsurface temperature anomaly in the tropical Indian Ocean strengthened, while temperature near the surface decreased.
- Positive temperature anomaly in the eastern equatorial Atlantic Ocean weakened substantially.

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 1982-2004 base period means.

<u>Tropical Pacific Ocean</u>

Evolution of Pacific NINO SST Indices



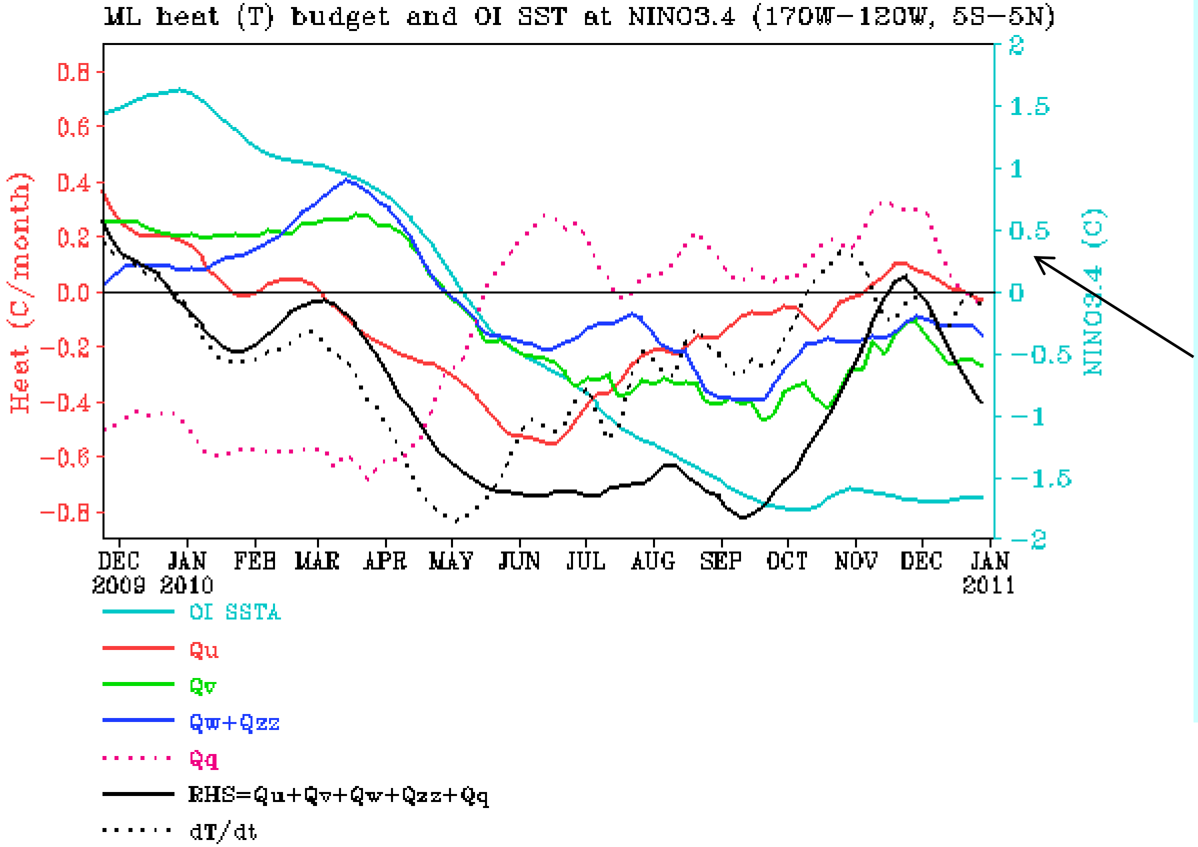


- **All NINO indices persisted.**

- **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 1971-2000 base period means.

NINO3.4 Heat Budget



- **Tendency (dT/dt) in NINO 3.4 (dotted line) has been near zero since Oct 2010, indicating the La Nina has been near its peak strength during the past three months.**

- **Qu switched to positive in Nov 2010, while other dynamical terms (Qv, Qw+Qzz) remained negative.**

- **The thermodynamic processes (Qq) have been positive since Jun 2010.**

- **The total heat budget term (RHS) indicated a strong cooling tendency since early December, but it was not observed in dT/dt.**

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;

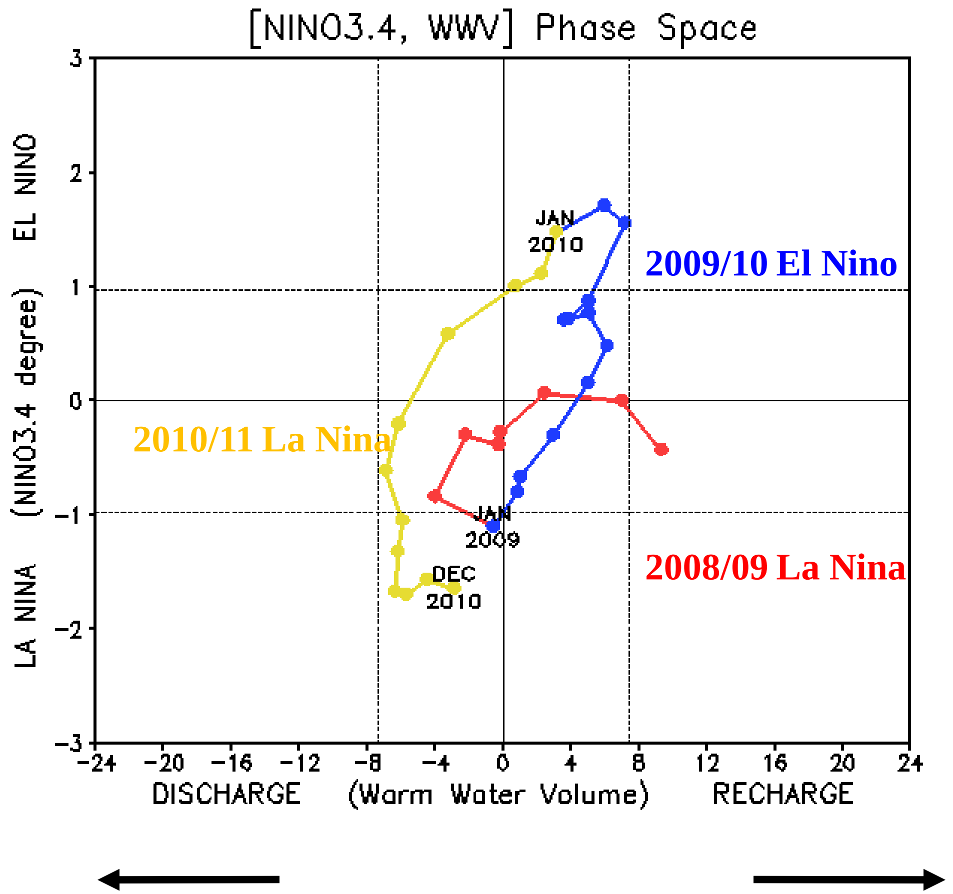
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

Warm Water Volume (WWV) and NINO3.4 Anomalies

-WWV is defined as average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] (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.

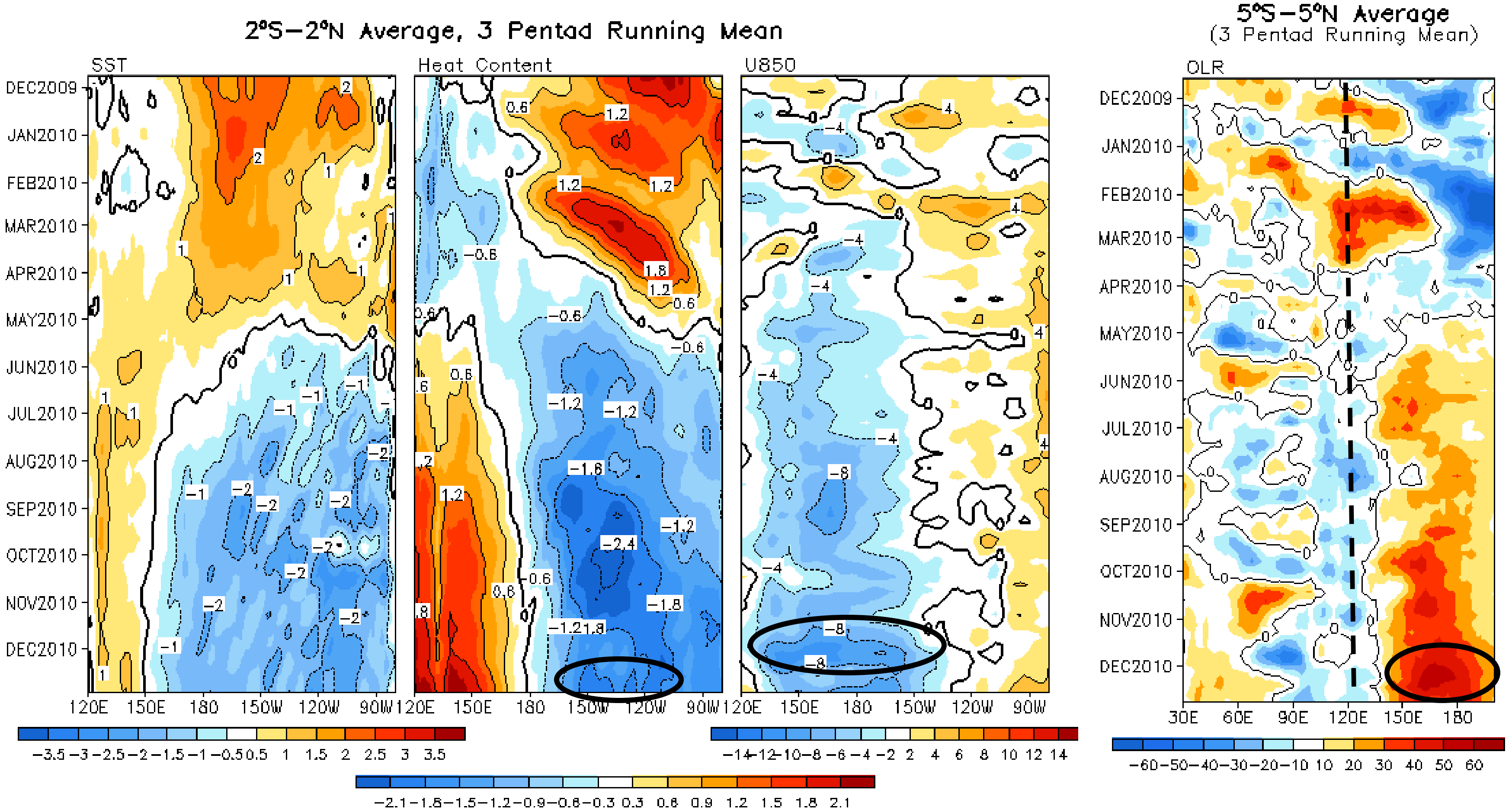


- Nino3.4 became less than -1C since Jul 2010, indicating moderate-strong La Nina conditions.

- Nino3.4 has persisted from Sep to Dec 2010, while WWV weakened slowly in the past three months.

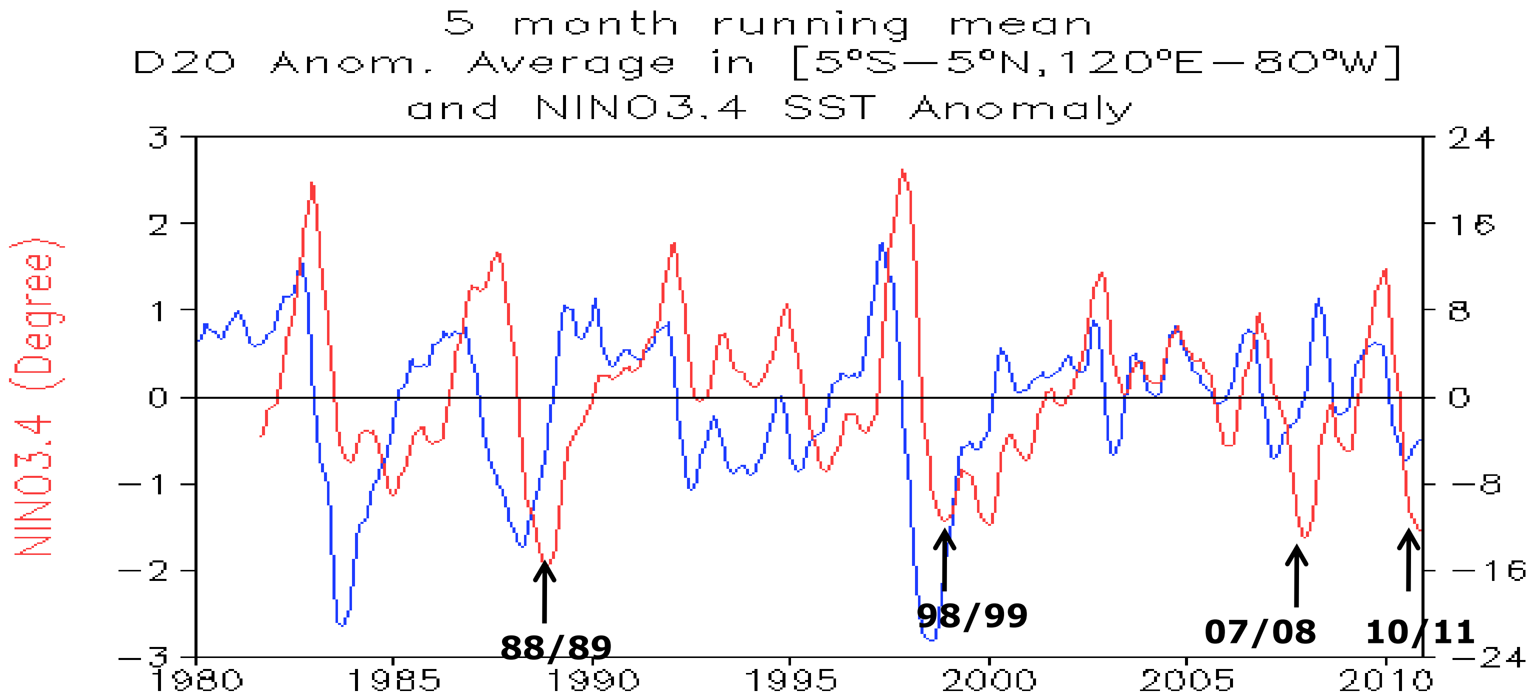
Fig. P3. Phase diagram of Warm Water Volume (WWV) and NINO 3.4 SST anomalies. WWV is the average of depth of 20ºC in [120ºE-80ºW, 5ºS-5ºN] calculated with the NCEP's global ocean data assimilation system. Anomalies for WWV (NINO 3.4) are departures from the 1982-2004 (1971-2000) base period means.

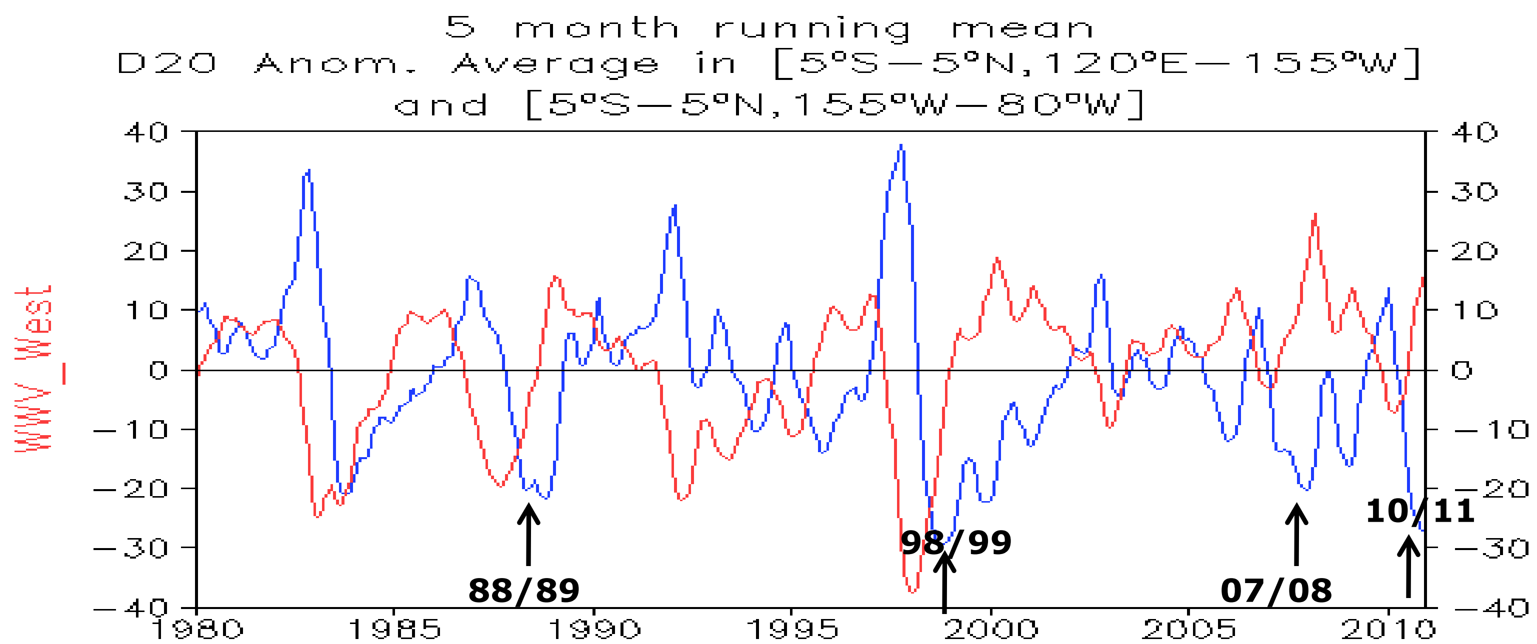
Evolution of Equatorial Pacific SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly

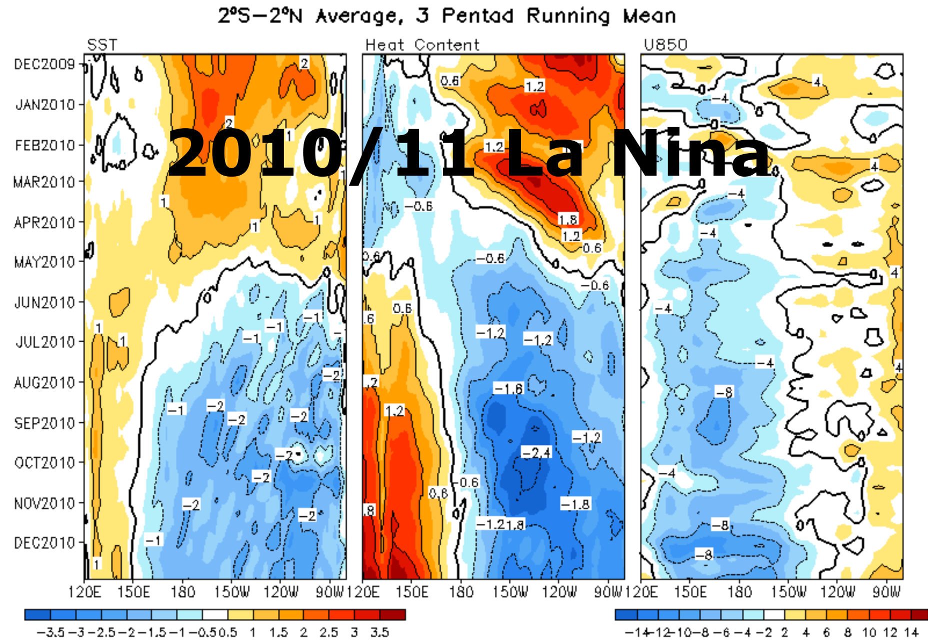


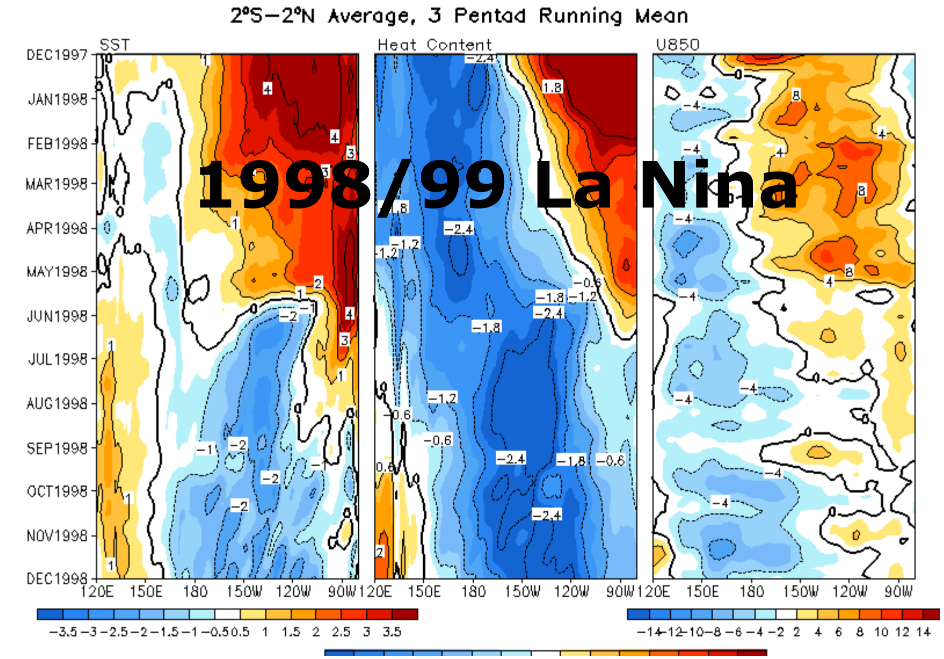
- **Negative HC300A in the eastern tropical Pacific strengthened since mid-Dec in response to enhanced anomalous easterly winds in late Nov and early Dec 2010.**
- **Suppressed convection in the equatorial central Pacific strengthened in Dec 2010.**

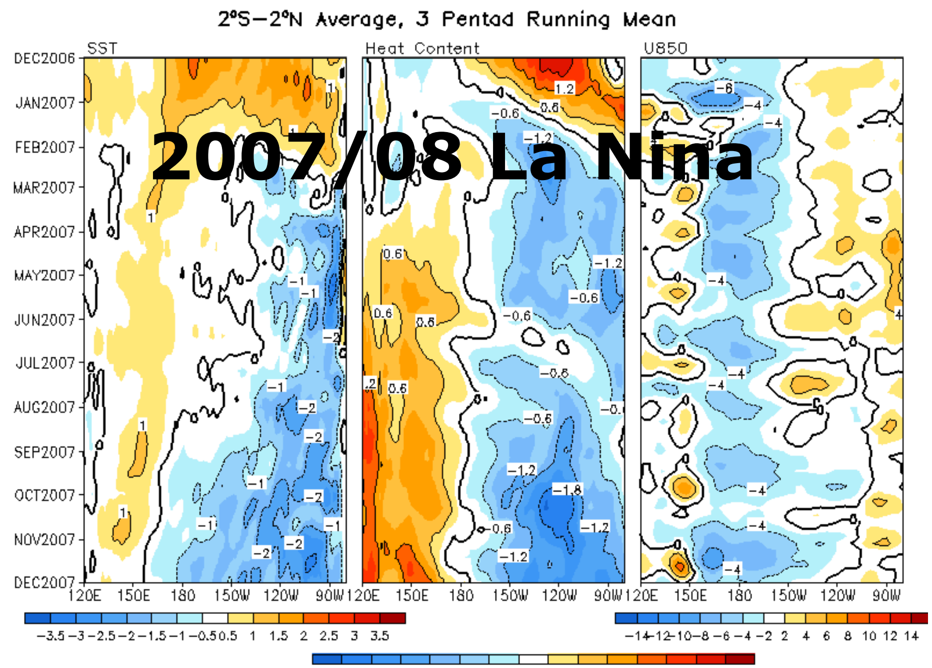
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2°S-2°N and Outgoing Long-wave Radiation (OLR, right) averaged in 5°S-5°N. SST is derived from the NCEP OI 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 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

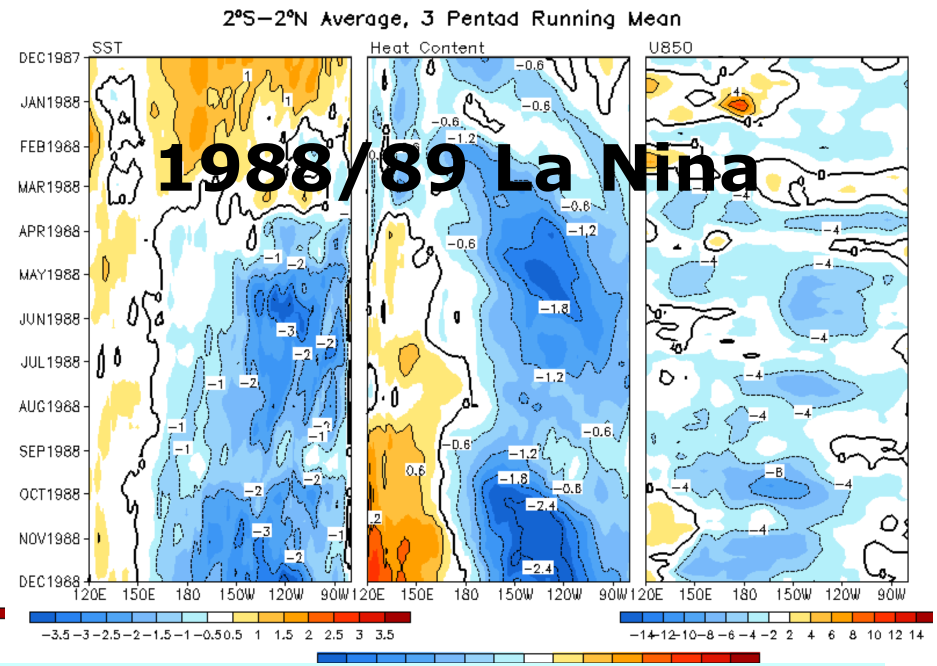

5 month running mean
D20 Anom. Average in [5°S—5°N,120°E—80°W]
and NINO3.4 SST Anomaly
NINO3.4 (Degree)
D20 (meter)
88/89
98/99
07/08
10/11


5 month running mean
D20 Anom. Average in [5°S—5°N,120°E—155°W]
and [5°S—5°N,155°W—80°W]
WWV_West
WWV_East
88/89
98/99
07/08
10/11



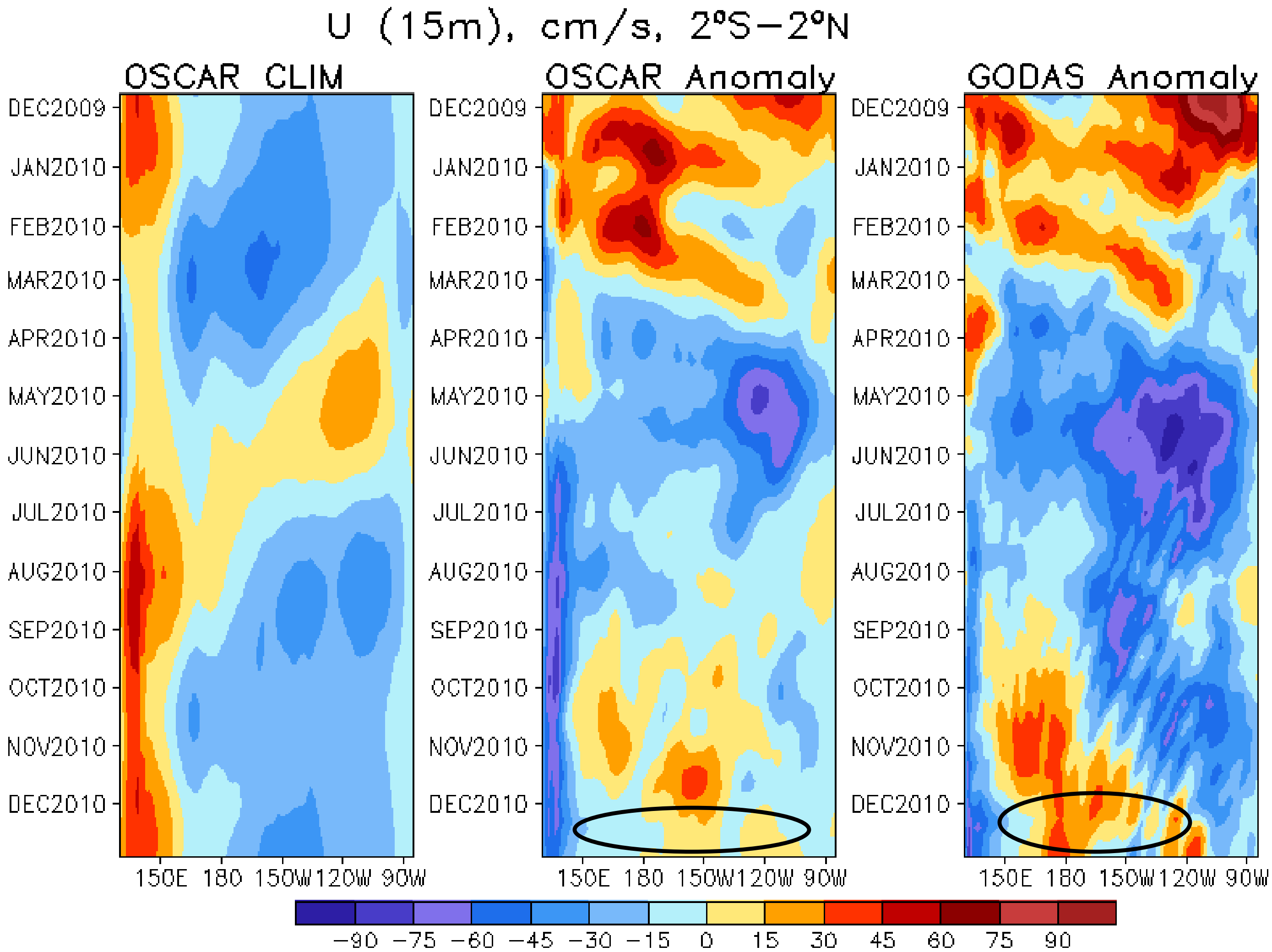






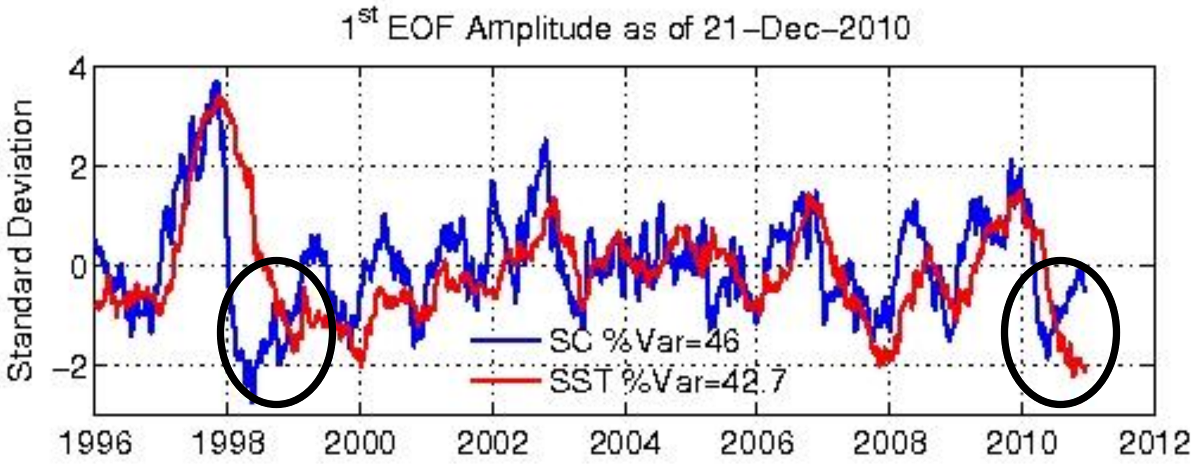
- The 2010/11 La Nina is as strong as the 1998/99 La Nina in terms of anomaly amplitude in SST, HC and u850mb.

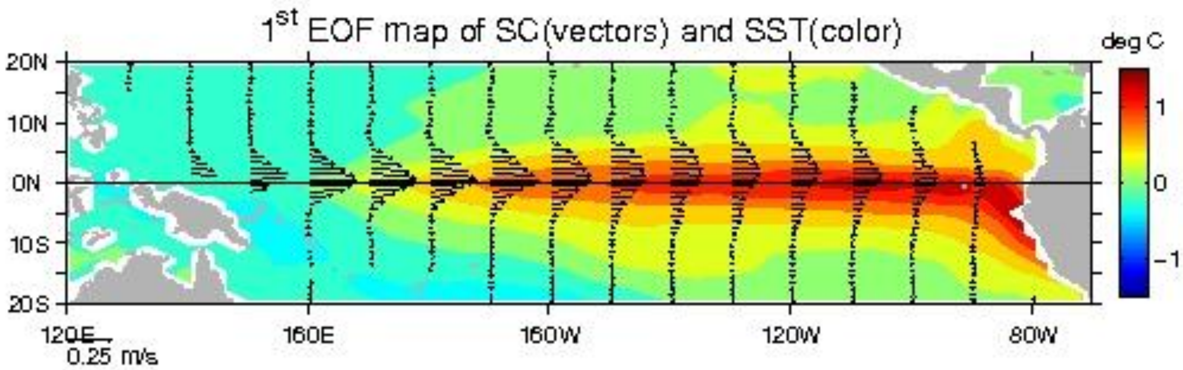
Evolution of Equatorial Pacific Surface Zonal Current Anomaly (cm/s)



- **Zonal current was near-normal in the central and eastern equatorial Pacific in Dec 2010.**
- **Anomalous zonal current in the OSCAR transitioned from negative (westward) to positive (eastward) west of 120W in Sep 2010, implying reduction of the zonal advection contribution to the cooling associated with the La Niña conditions.**
- **However, anomalous zonal current in the GODAS remained strongly negative east of 170W.**

ENSO cycle as indicated by 1st EOF of surface current and SST anomalies



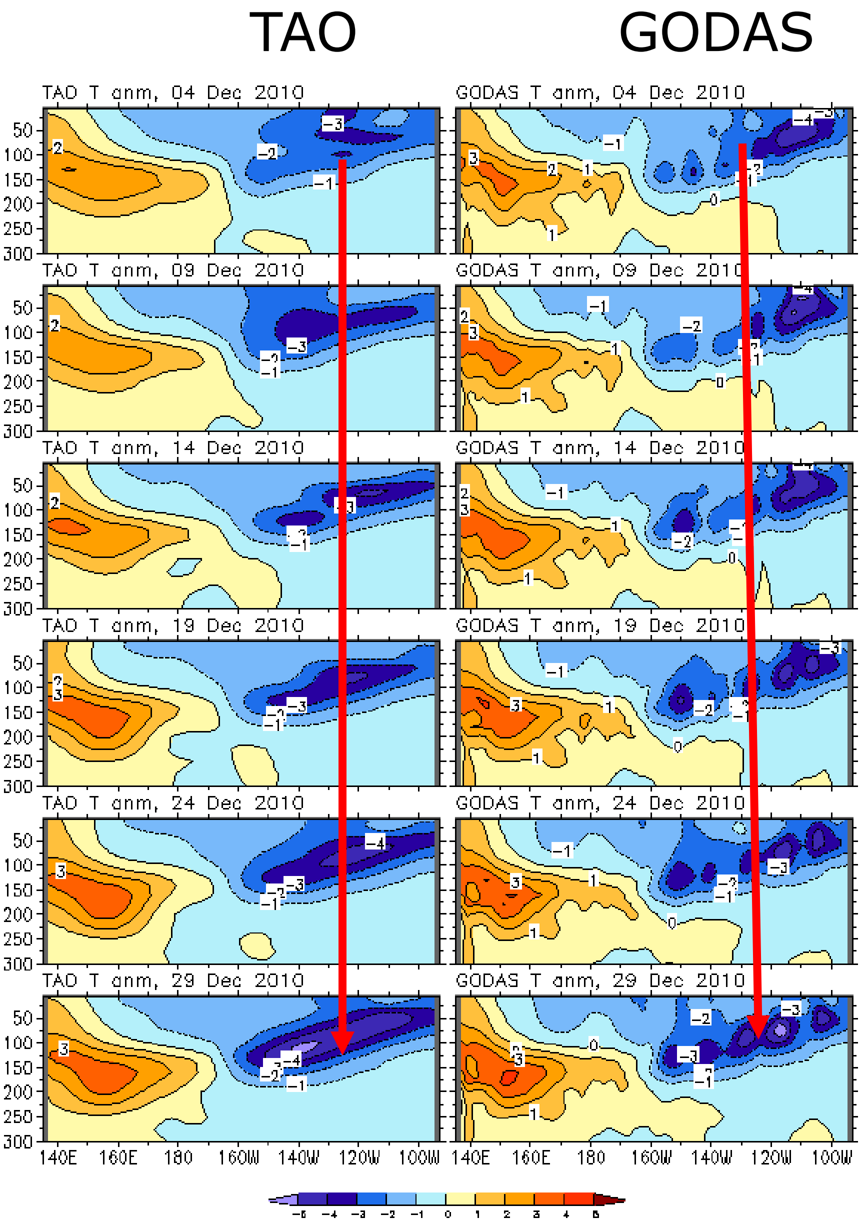


- Negative surface zonal current anomaly has weakened rapidly since Jul 2010, and was near zero in Nov-Dec 2010.

- On average, ocean surface zonal current anomaly leads the SSTA by 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. T the near real-time SC are the output from a diagnostic model.
(supplied by Dr. Kathleen Dohan and see "http://www.esr.org/enso_index.html" for details)

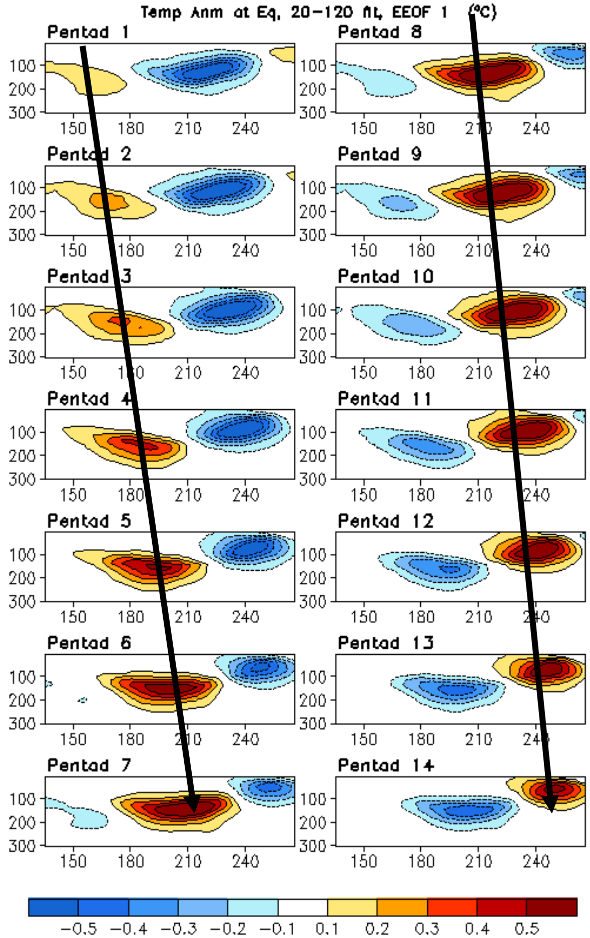
Equatorial Pacific Temperature Anomaly

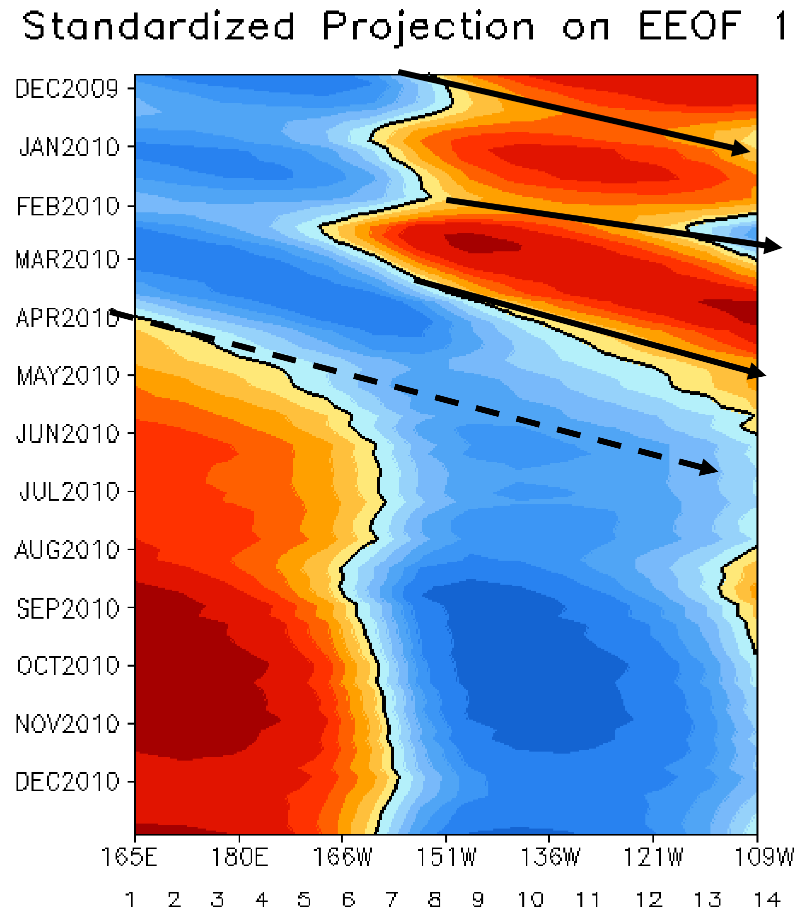


TAO climatology used

- Negative (positive) temperature anomalies in the equatorial east central (western) Pacific strengthened slightly in Dec 2010, and had little eastward propagation.

Oceanic Kelvin Wave Indices

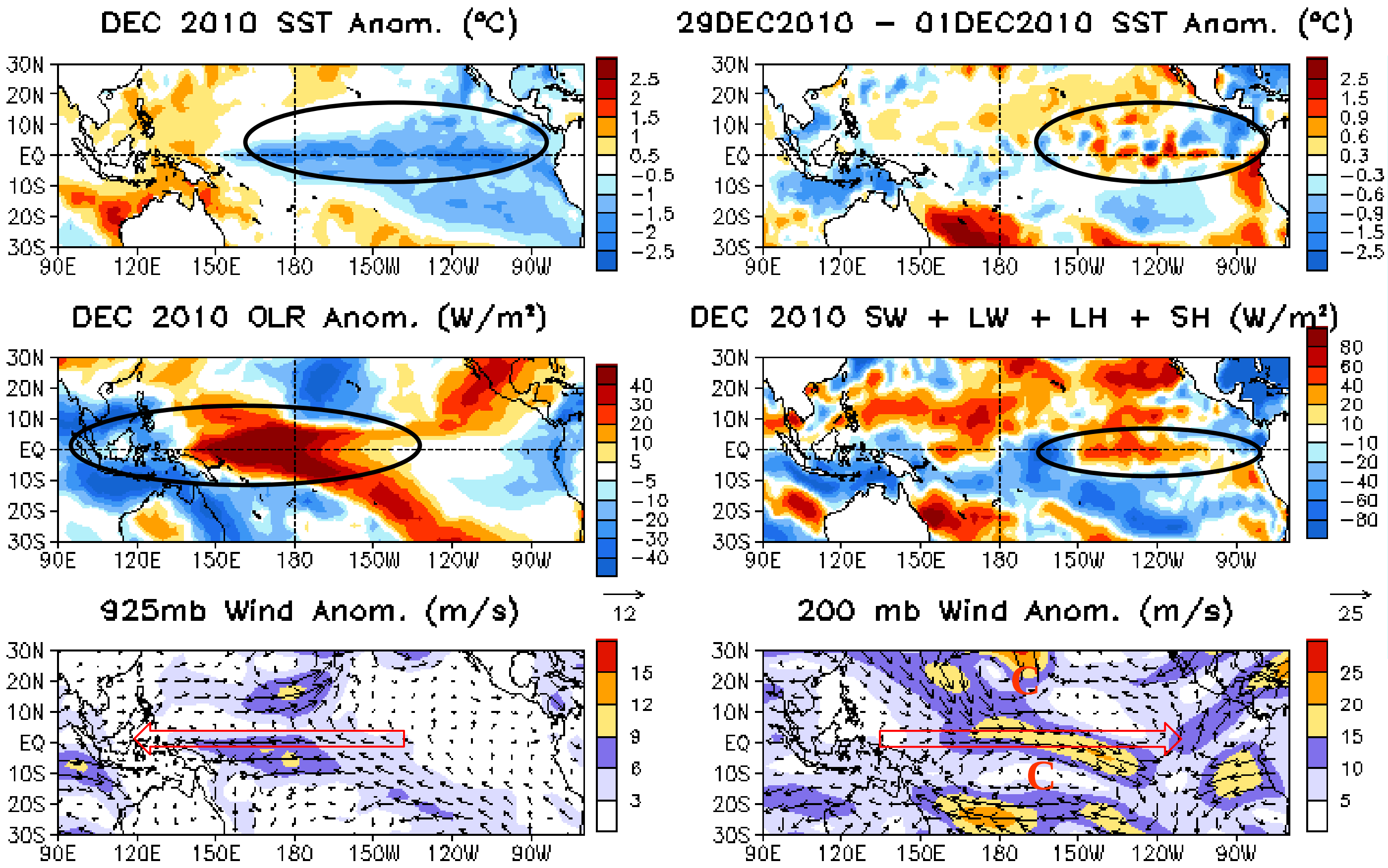




- There were no Kelvin wave propagations since Jun 2010, indicating the dominant low frequency signal associated with the 2010/11 La Nina.
- Upwelling Kelvin wave occurred in late Feb 2010 in the W. Pacific and propagated eastward, which may have contributed to the transition of ENSO cycle from the warm phase to the cold phase.

- Extended EOF (EEOF) analysis is applied to 20-120 day filtered equatorial temperature anomaly in the top 300m using 14 lagged pentads (similar to that in Seo and Xue, GRL, 2005).
- EEOF 1 describes eastward propagation of oceanic Kelvin wave cross the equatorial Pacific in about 70 days.
- Oceanic Kelvin wave indices are defined as standardized projections of total anomalies onto the 14 patterns of EEOF 1.

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

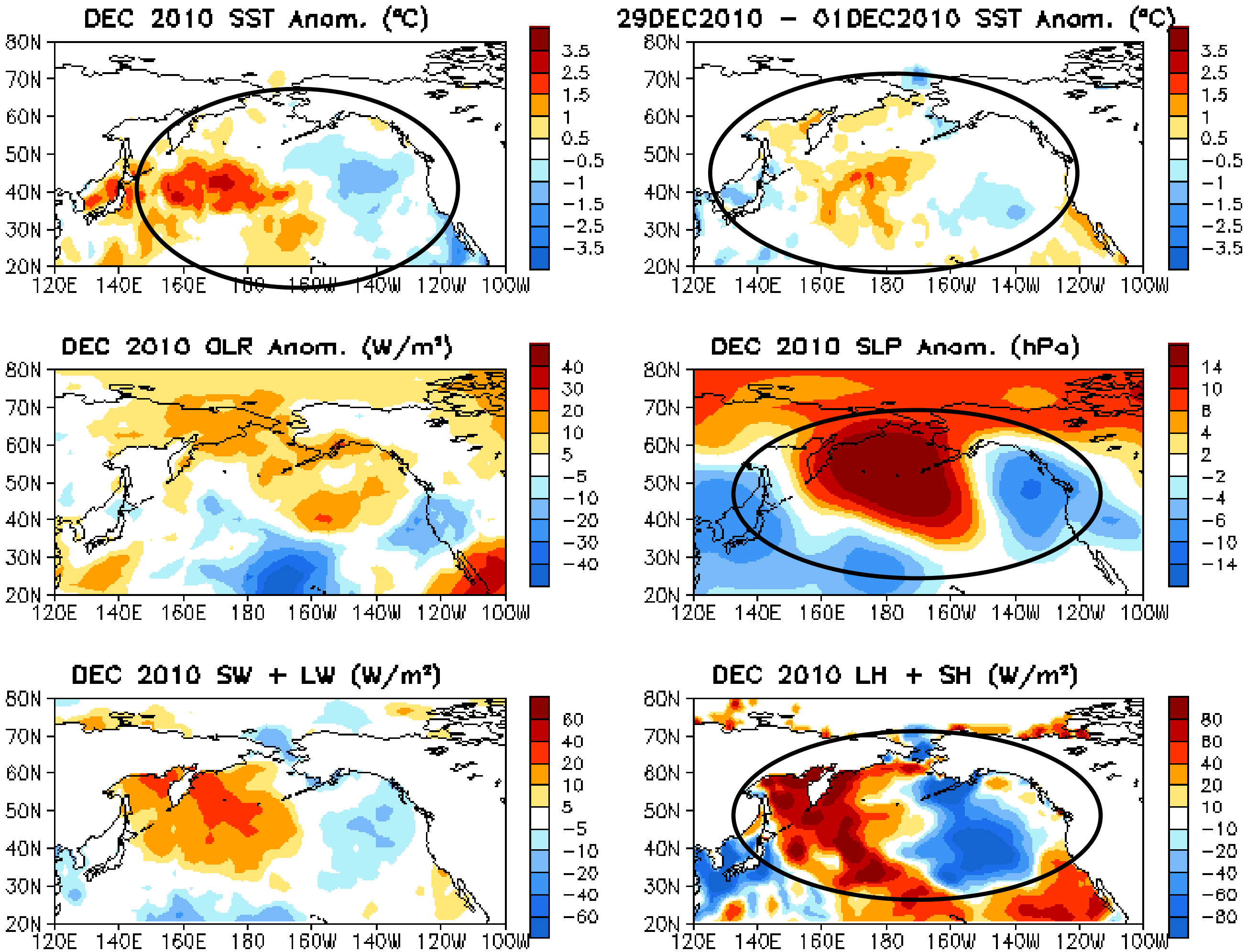


- **Negative SSTA persisted in the east-central equatorial Pacific in Dec 2010.**
- **Convection was enhanced (suppressed) over the Maritime Continent (in the west-central tropical Pacific).**
- **Net surface heat flux anomalies damped SSTA between 150W-90W.**
- **Easterly (westerly) wind anomaly in low (high) level in the western and central tropical Pacific was much stronger in Dec 2010 than in Nov 2010.**

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 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

North Pacific & Arctic Ocean

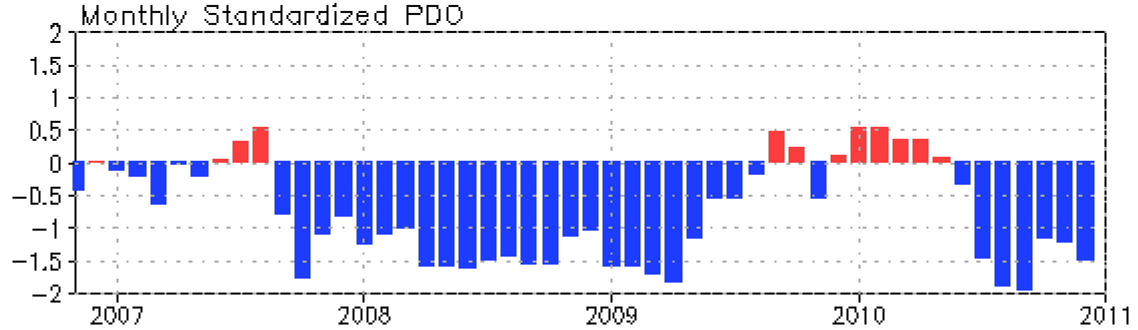
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

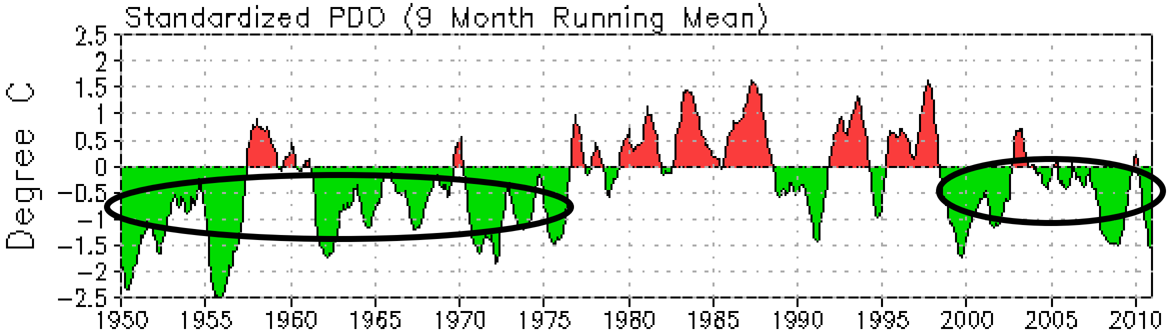


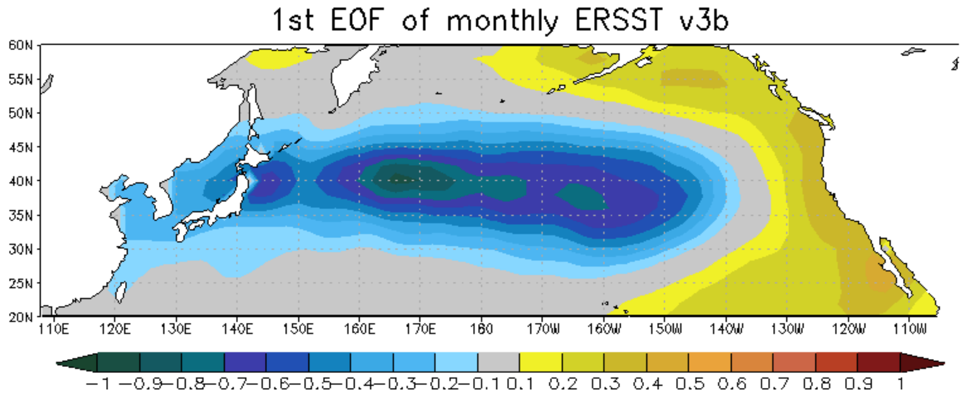
- Positive (negative) SSTA was observed in the west-central N. Pacific (in the eastern N. Pacific) in Dec 2010, consistent with the negative PDO index (next slide).
- SSTA tendency is generally consistent with total heat flux anomalies (LH+SH+SW+LW).
- Positive (negative) SLP anomaly presented in the central N. Pacific (near the west coast N. America and subtropical W. Pacific).

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 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

PDO index







- The PDO index was near -1.5 in Dec 2010, which is similar to the low value during the winter of 2008/09.

- The PDO index has been below normal since Jun 2010.

- Negative PDO index was coincident with the La Nina conditions.

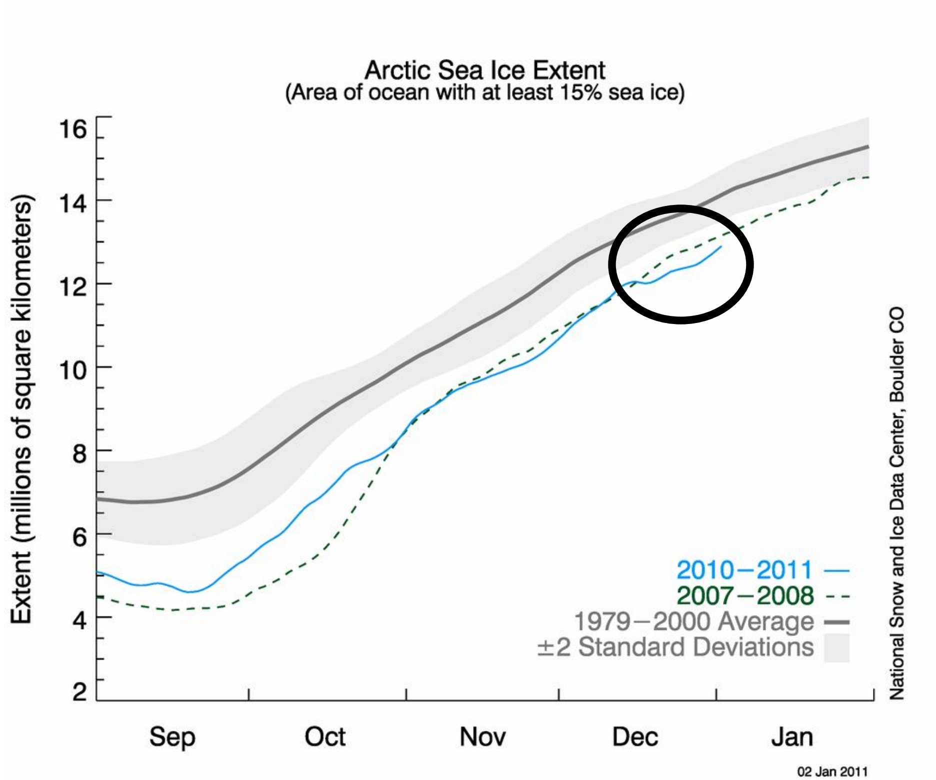
- Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.

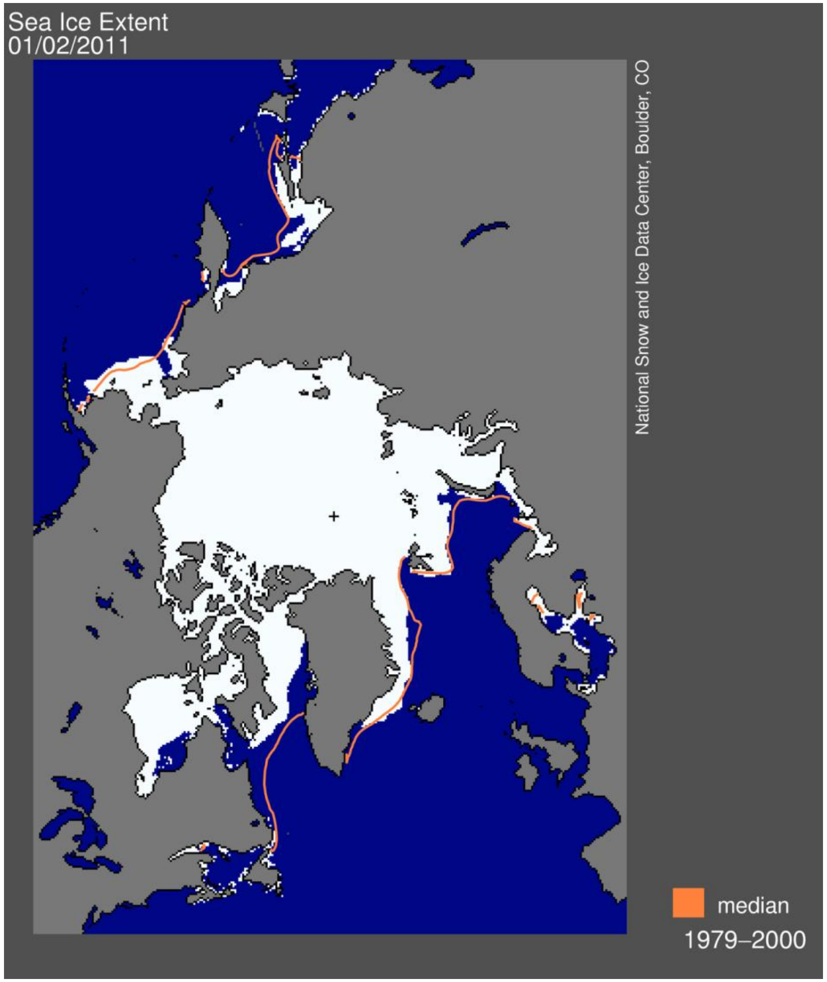
- The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.

Arctic Sea Ice

National Snow and Ice Data Center

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

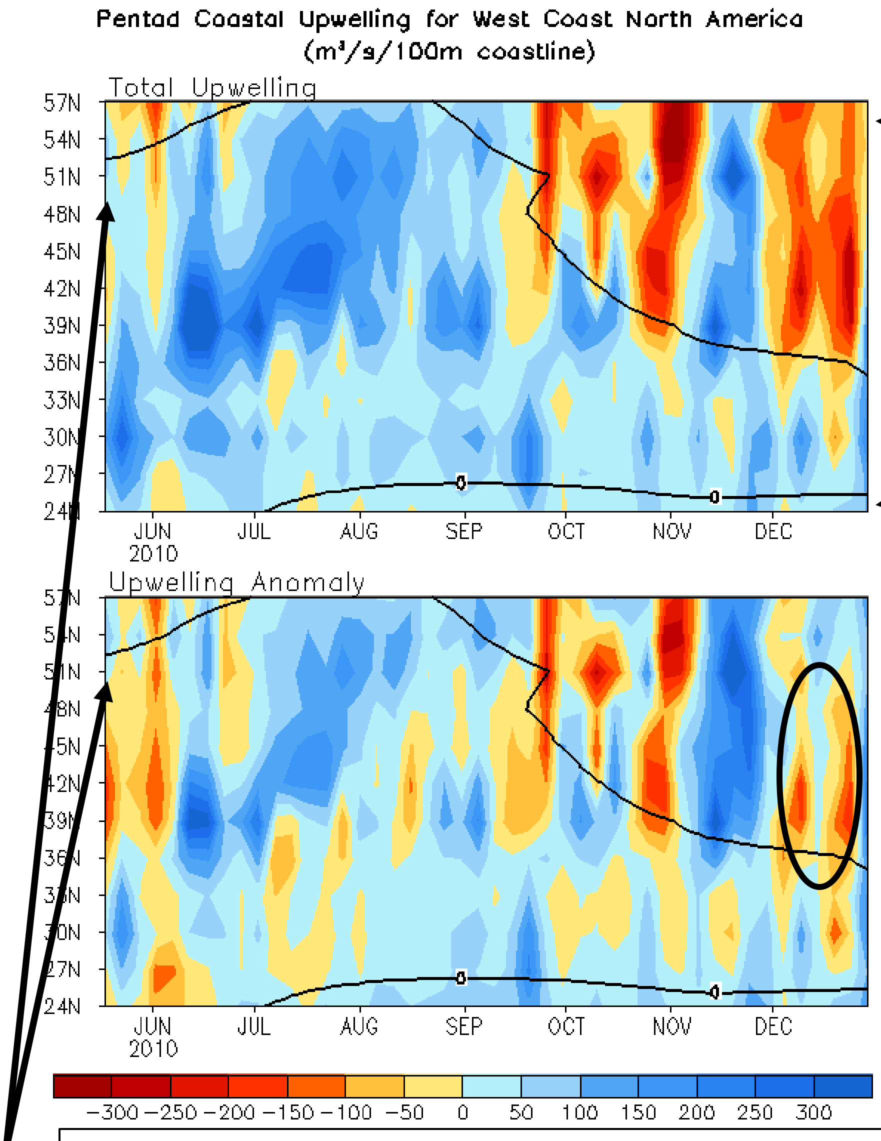


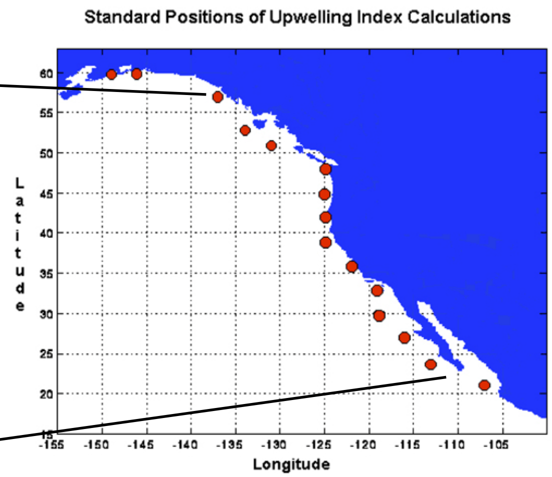


- The Arctic sea ice extent became smaller than the 2007 value in Dec 2010, and most of sea ice deficit was in the subpolar region of N. Atlantic.

- But the Arctic sea ice extent has been larger than the 2007 value from Jun to Oct 2010.

North America Western Coastal Upwelling





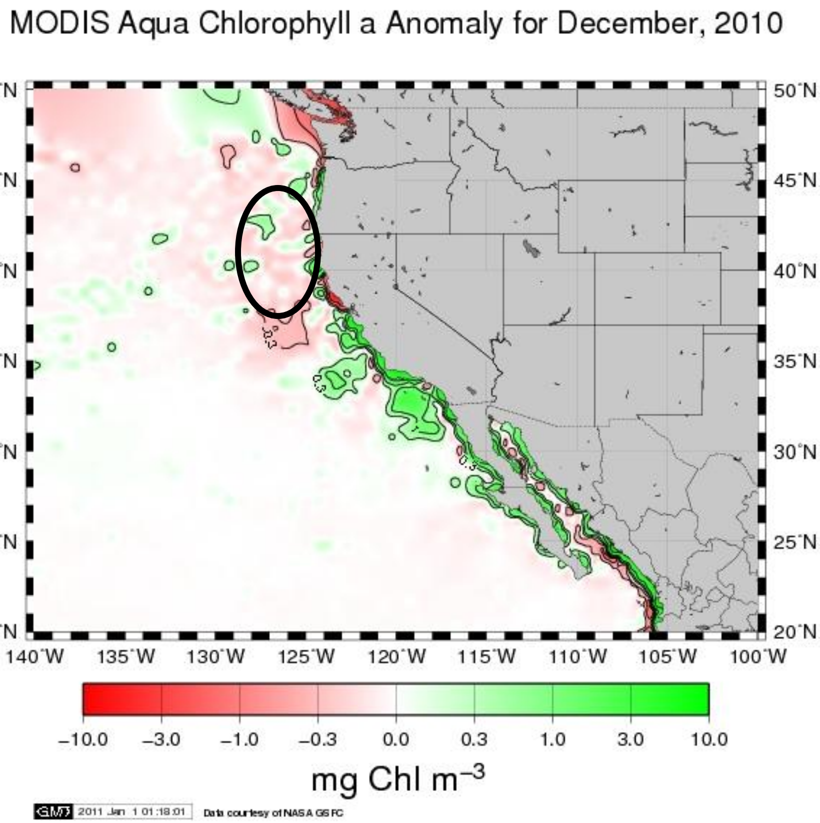
- **Downwelling strengthened at 36N-45N in Dec 2010.**

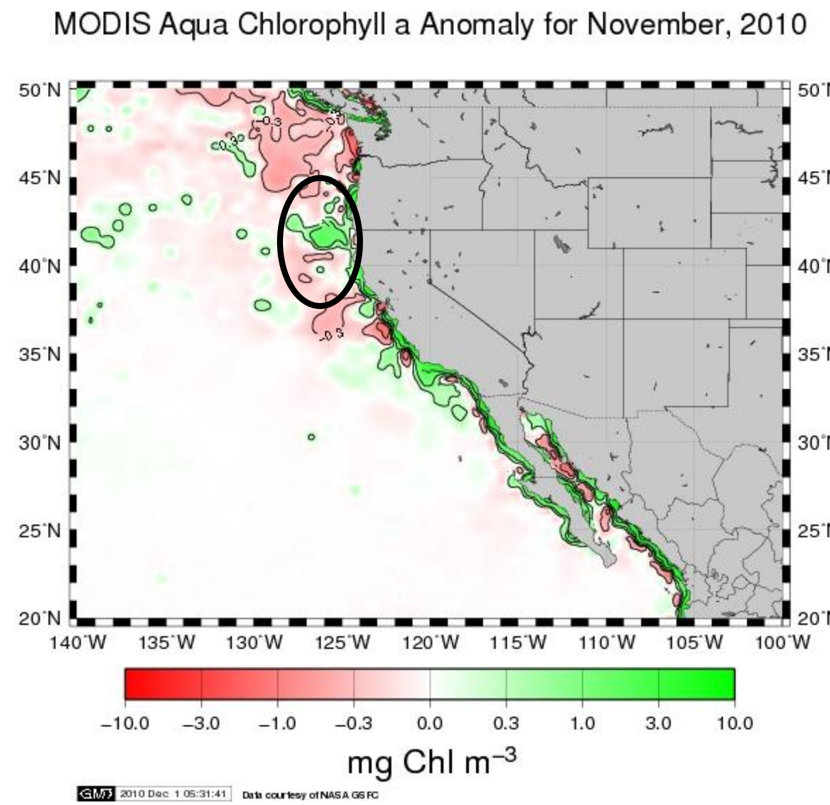
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1982-2004 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.**

Monthly Chlorophyll Anomaly

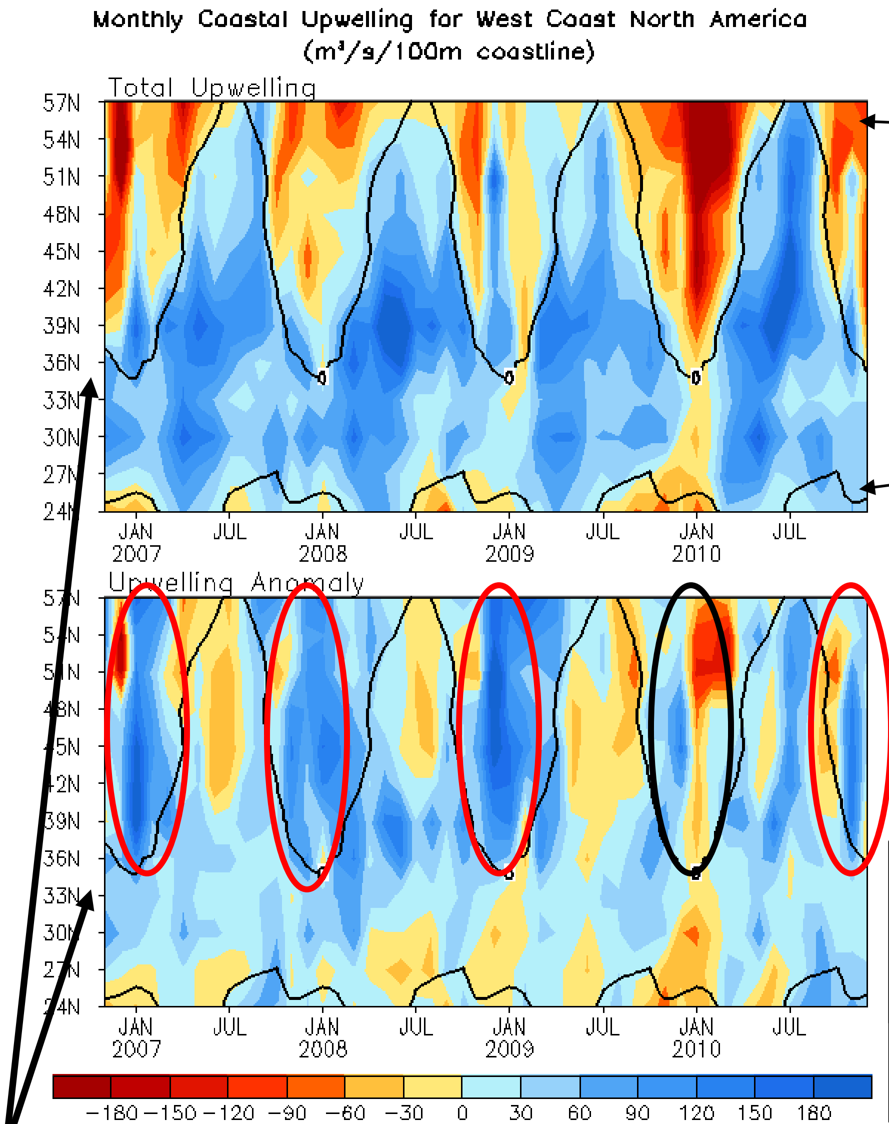
- **Positive chlorophyll anomalies decreased at 36N-45N from Nov to Dec 2010, generally consistent with strengthened downwelling.**

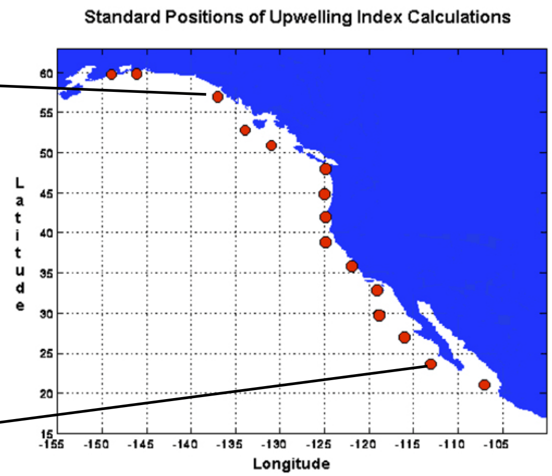




http://coastwatch.pfel.noaa.gov/FAST

North America Western Coastal Upwelling





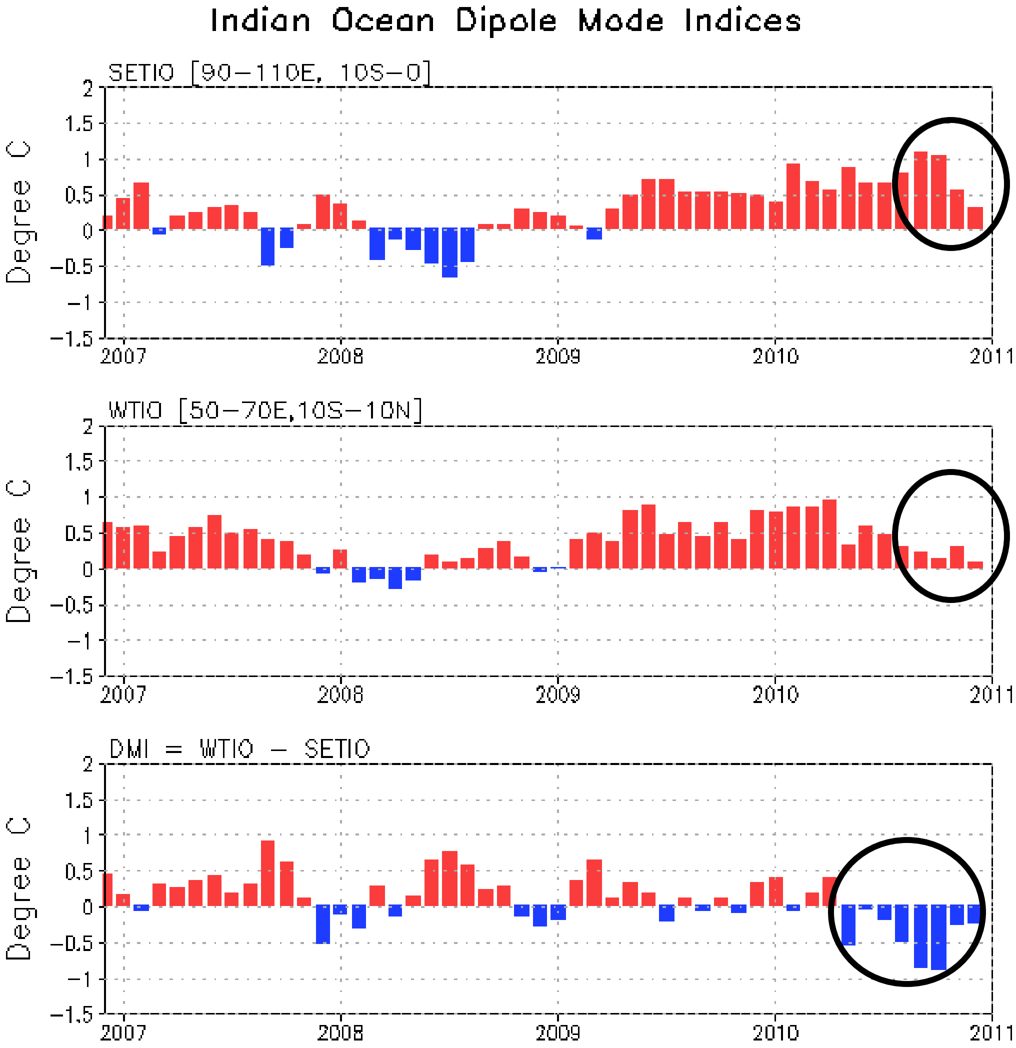
- Upwelling had been above-normal during the winter of 2006/07, 2007/08, 2008/09.
- But, upwelling was below-normal during the winter of 2009/10.
- Upwelling was relatively strong in spring and summer 2010, relatively weak from mid-Sep to Oct 2010, but became relatively strong since Nov 2010.

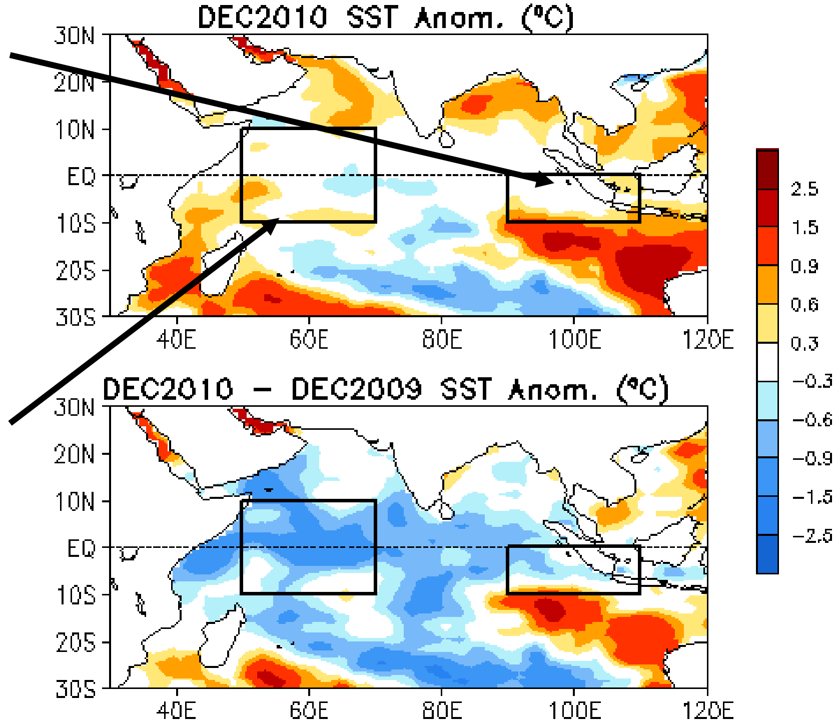
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point ($m^3/s/100m$ coastline). Anomalies are departures from the 1982-2004 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.

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

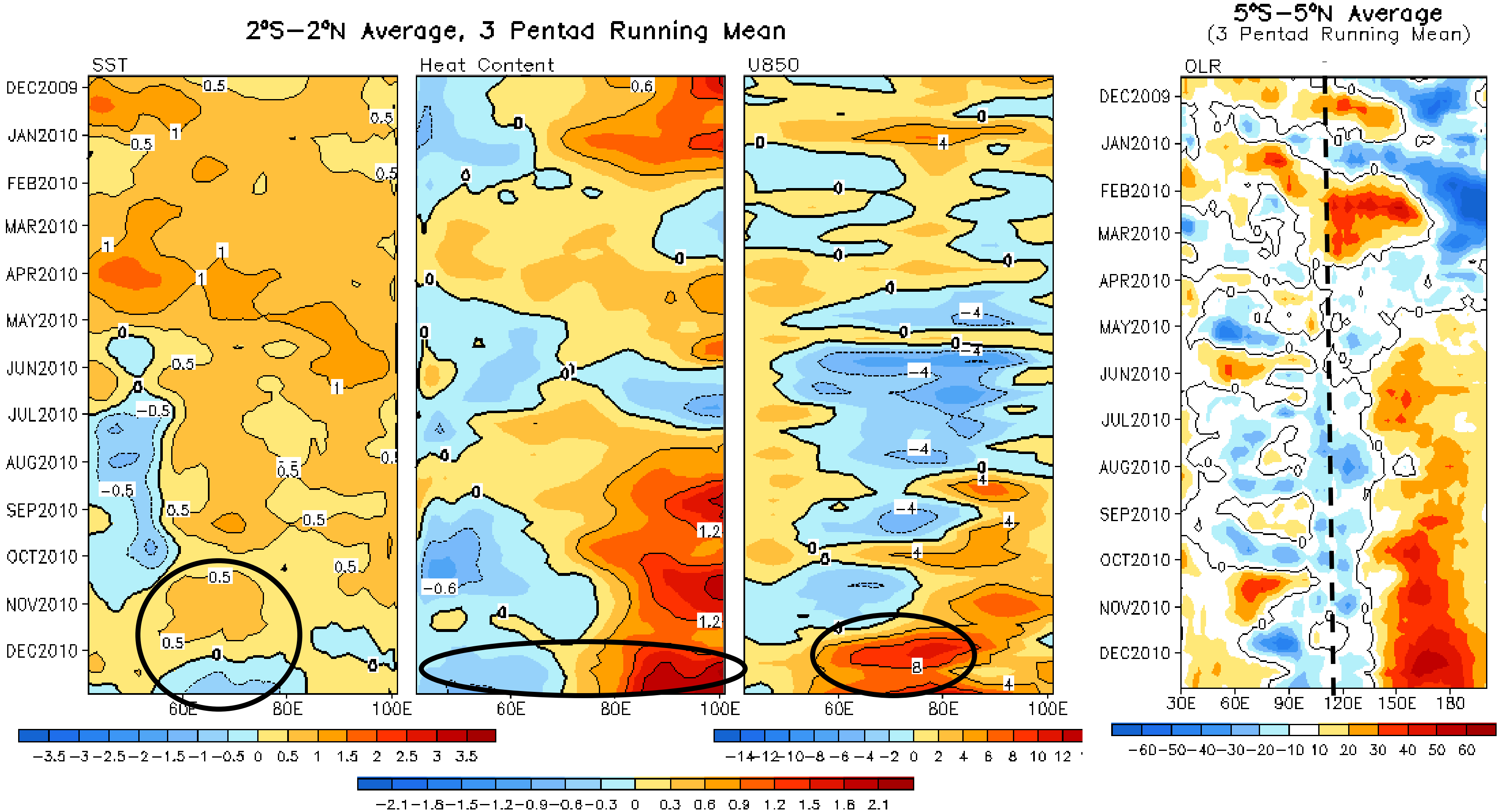




- **Both eastern (SETIO) and western (WTIO) pole SSTA decreased and was near-normal in Dec 2010.**
- **DMI has been below-normal since May 2010, strengthened to be about -0.8 during Sep-Oct 2010, but returned to near-normal in Nov-Dec 2010.**

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 1971-2000 base period means.

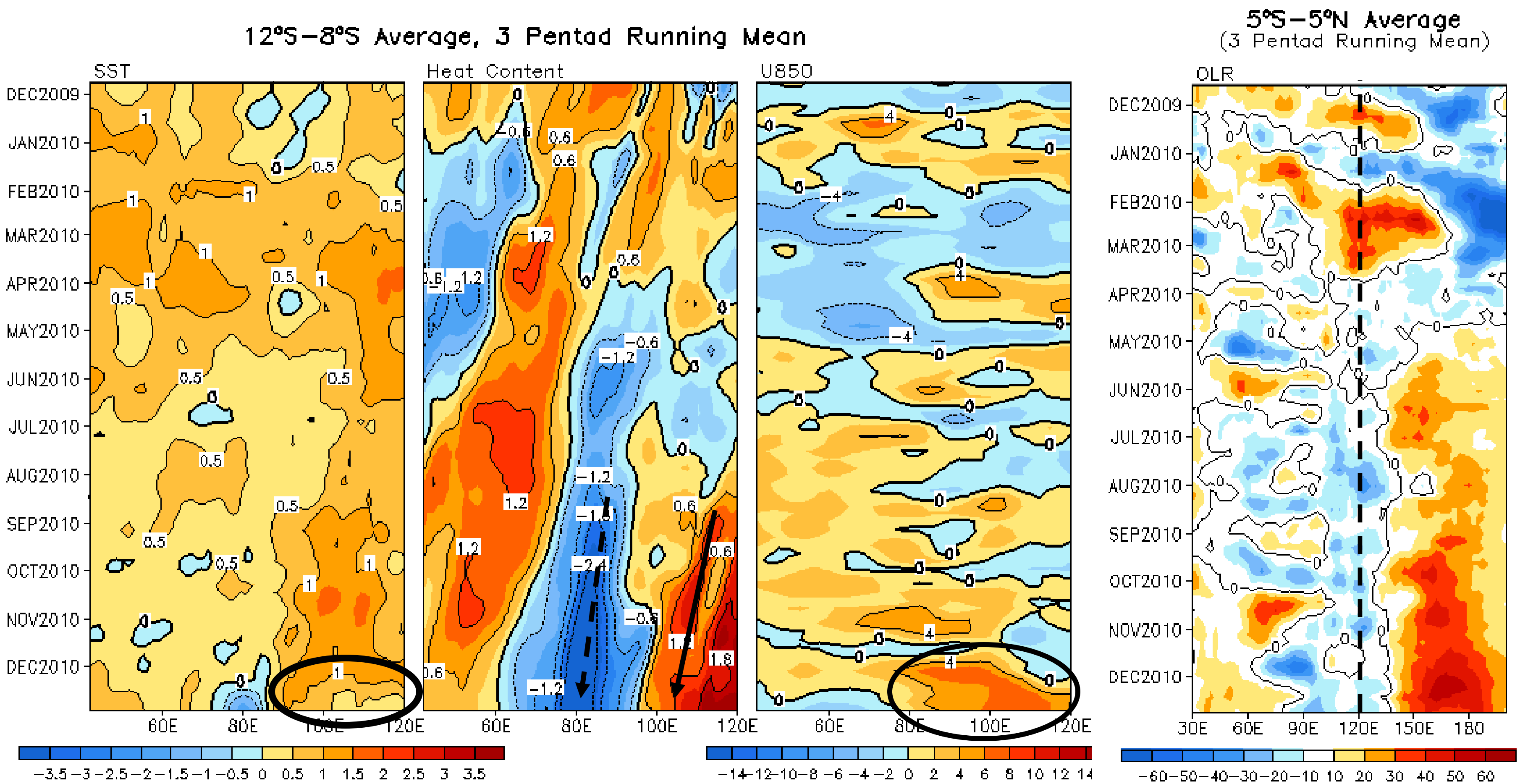
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s) and OLR (W/m^2) Anomalies



- **The positive SSTA in the eastern Indian Ocean has weakened significantly in Nov 2010, resulting in a drastic reduction of negative DMI index. The SSTA in the central tropical Indian Ocean switched from positive to negative from Nov to Dec 2010.**
- **Positive (negative) heat content anomaly strengthened in the eastern (western) Indian Ocean in response to anomalous westerly wind forcing in the central tropical Indian Ocean.**

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 for SST, heat content and U850/OLR are departures from the 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

Recent Evolution of 10°S Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s)



- **Positive SSTA in the southeast Indian Ocean weakened.**
- **Westerly wind anomalies strengthened in the southeastern tropical Indian Ocean, which are probably part of enhanced atmospheric circulations associated with the La Nina conditions (see slide 18).**
- **The dipole HC300A, negative near 80E and positive near 110E, propagated westward.**

Fig. I4. 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 12°S-8°S 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 for SST, heat content and U850/OLR are departures from the 1971-2000, 1982-2004, 1979-1995 base period pentad means respectively.

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

- SST cooled down significantly in the central tropical Indian Ocean and near Java coast.
- SSTA tendency is mostly consistent with net surface heat flux anomalies.
- Convection was enhanced (suppressed) in the eastern (southwestern) tropical Indian Ocean, which is probably associated with the La Nina conditions.

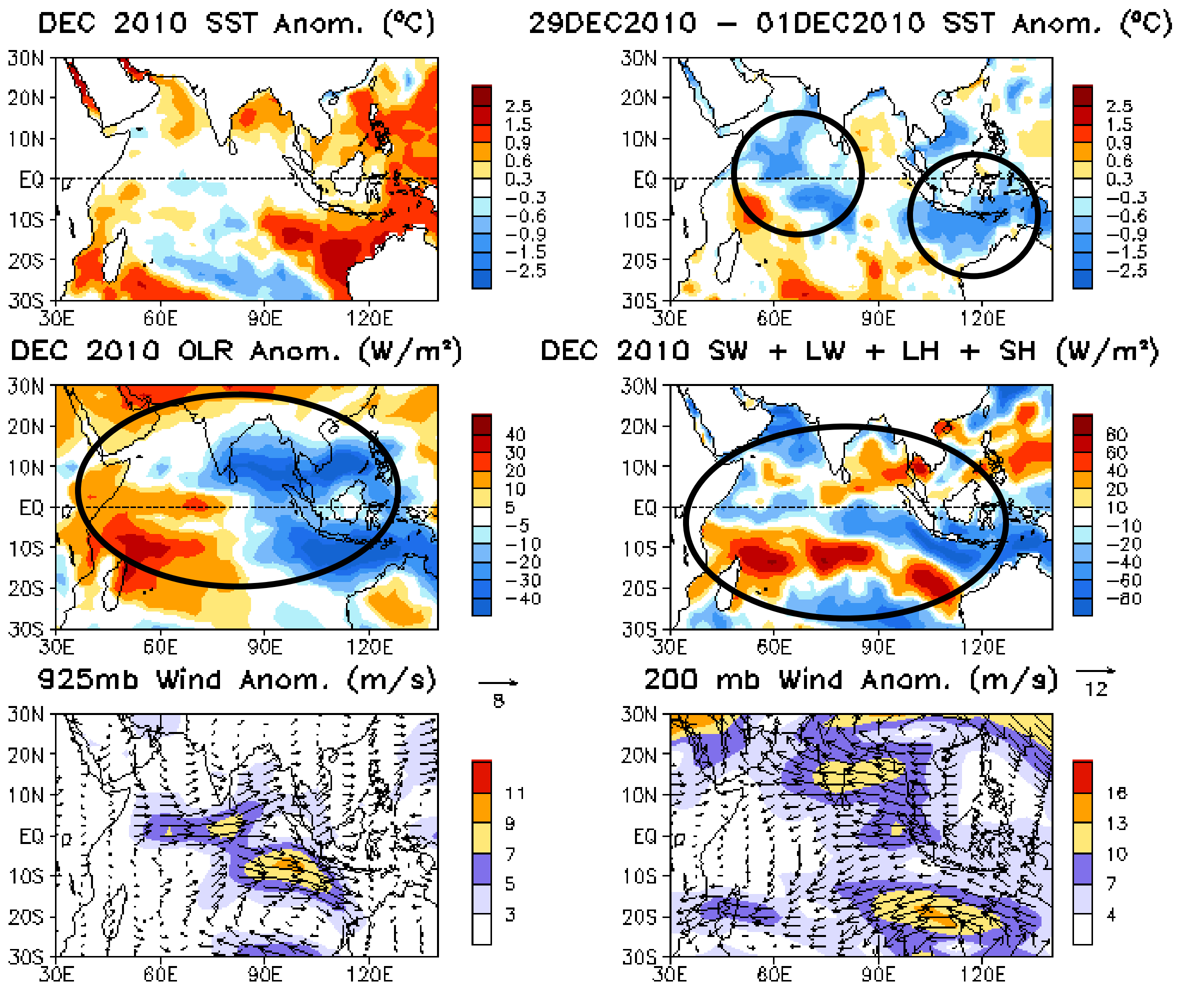
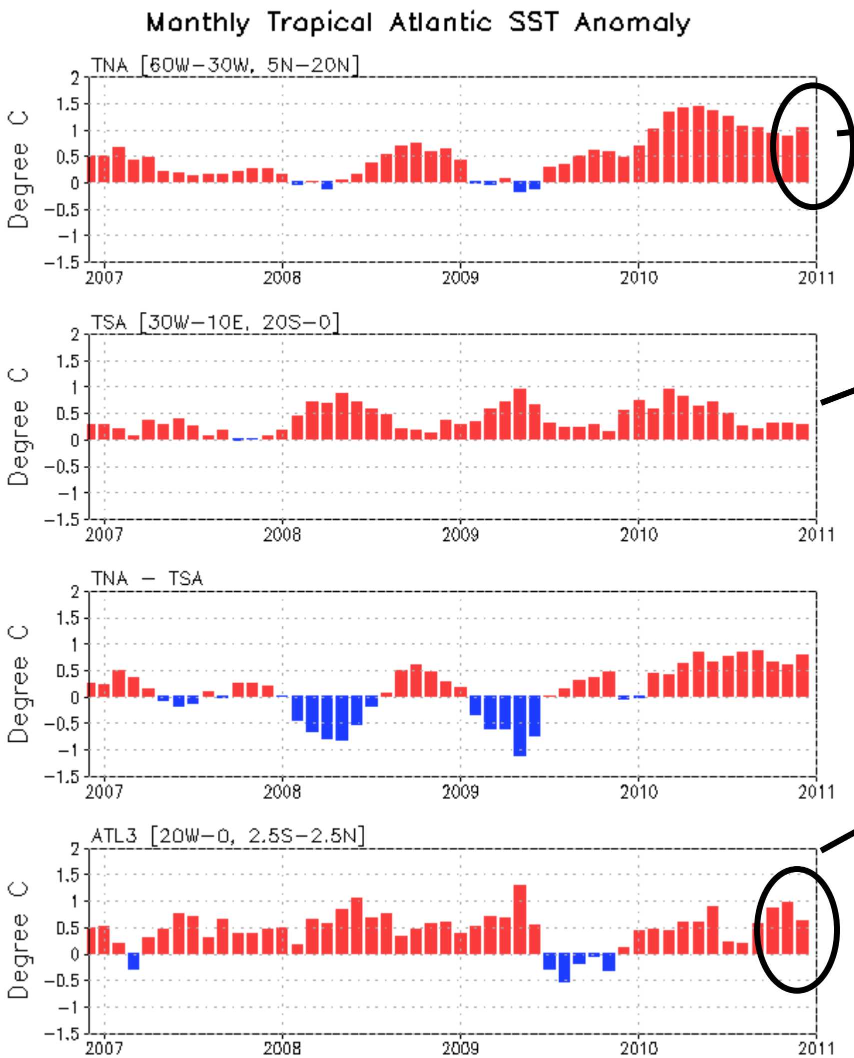
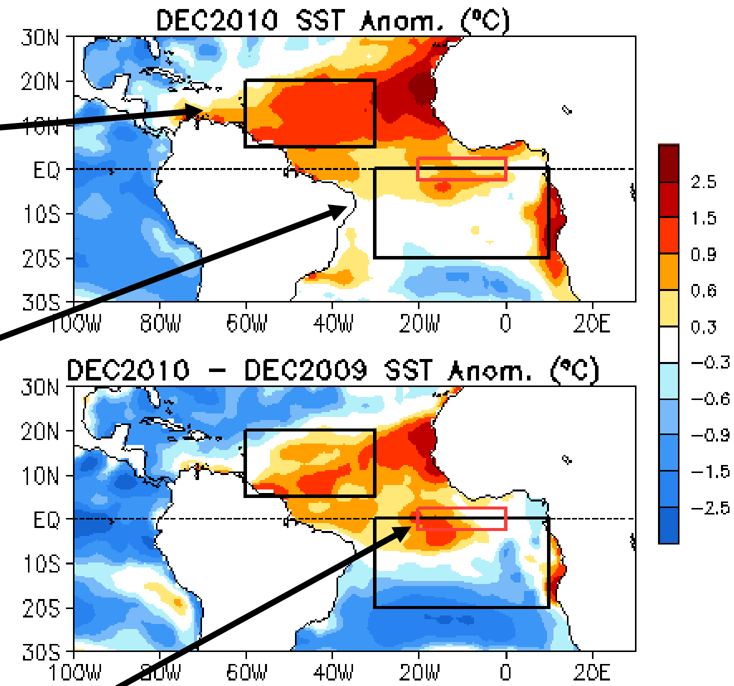


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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 1979-1995 base period means except SST anomalies are computed with respect to the 1971-2000 base period means.

Tropical Atlantic Ocean

Evolution of Tropical Atlantic SST Indices

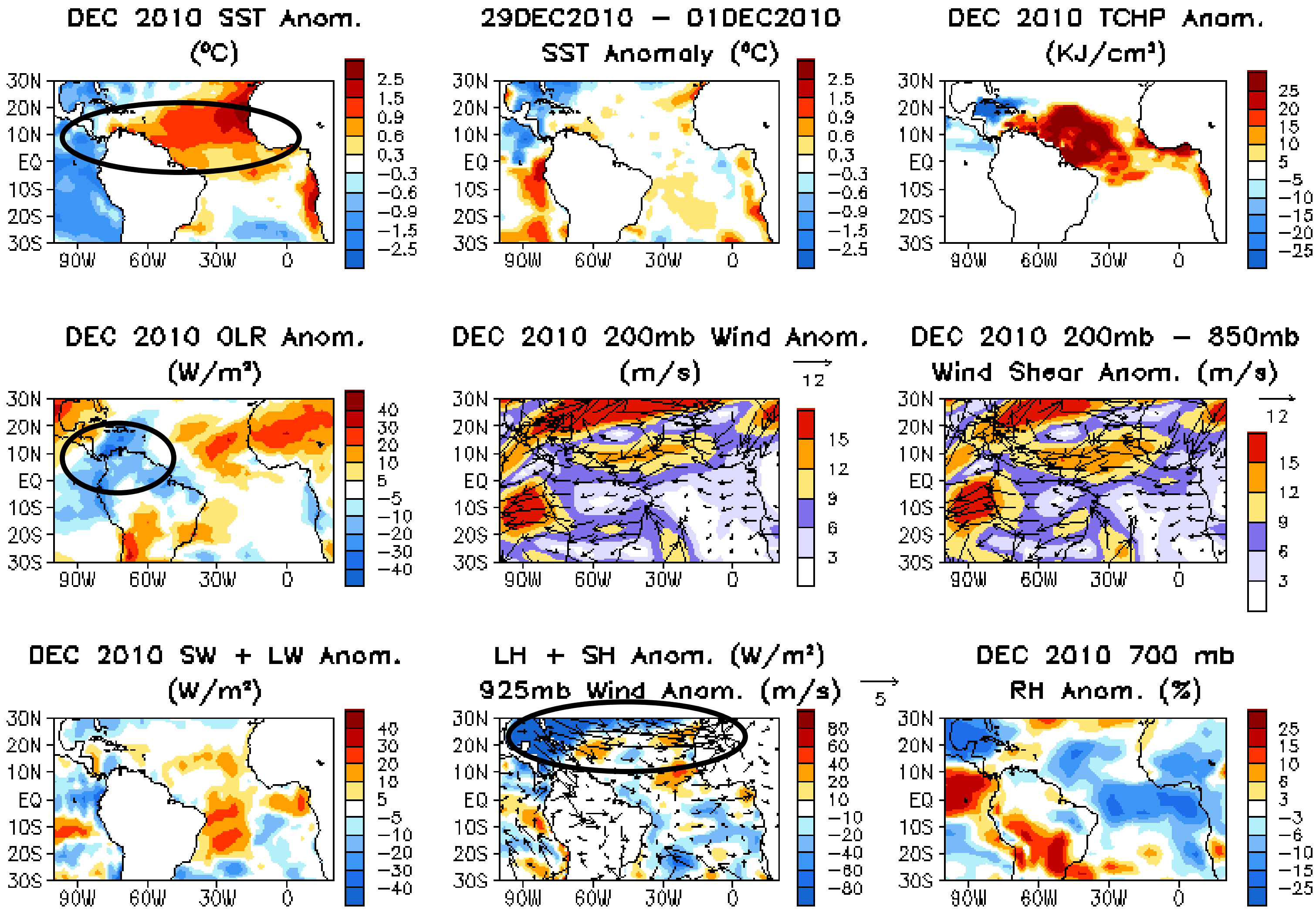




- Positive SSTA in TNA increased in Dec 2010.
- Meridional Gradient Mode (TNA-TSA) has been above-normal since Feb 2010.
- Positive ATL3 SST weakened substantially in Dec 2010.

Fig. A1a. Tropical Atlantic Variability region indices, calculated as the area-averaged monthly mean sea surface temperature anomalies (°C) for the TNA [60°W-30°W, 5°N-20°N], TSA [30°W-10°E, 20°S-0] and ATL3 [20°W-0, 2.5°S-2.5°N] regions, and Meridional Gradient Index, defined as differences between TNA and TSA. Data are derived from the NCEP OI SST analysis, and anomalies are departures from the 1971-2000 base period means.

Tropical Atlantic:



- **Positive SSTA in the tropical N. Atlantic strengthened slightly.**

- **Convection was enhanced over the northern S. America, the eastern tropical Pacific and Caribbean Sea, consistent with the La Nina conditions.**

- **Anomalous cyclonic circulation in the subtropical N. Atlantic is probably associated with the negative NAO (see slide 35).**

North Atlantic Ocean

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

- **Negative NAO strengthened in Dec 2010 (next slide), consistent with the SLP anomaly pattern.**
- **SSTA tendency was largely consistent with surface heat flux anomalies (SW+LW+LH+SH).**

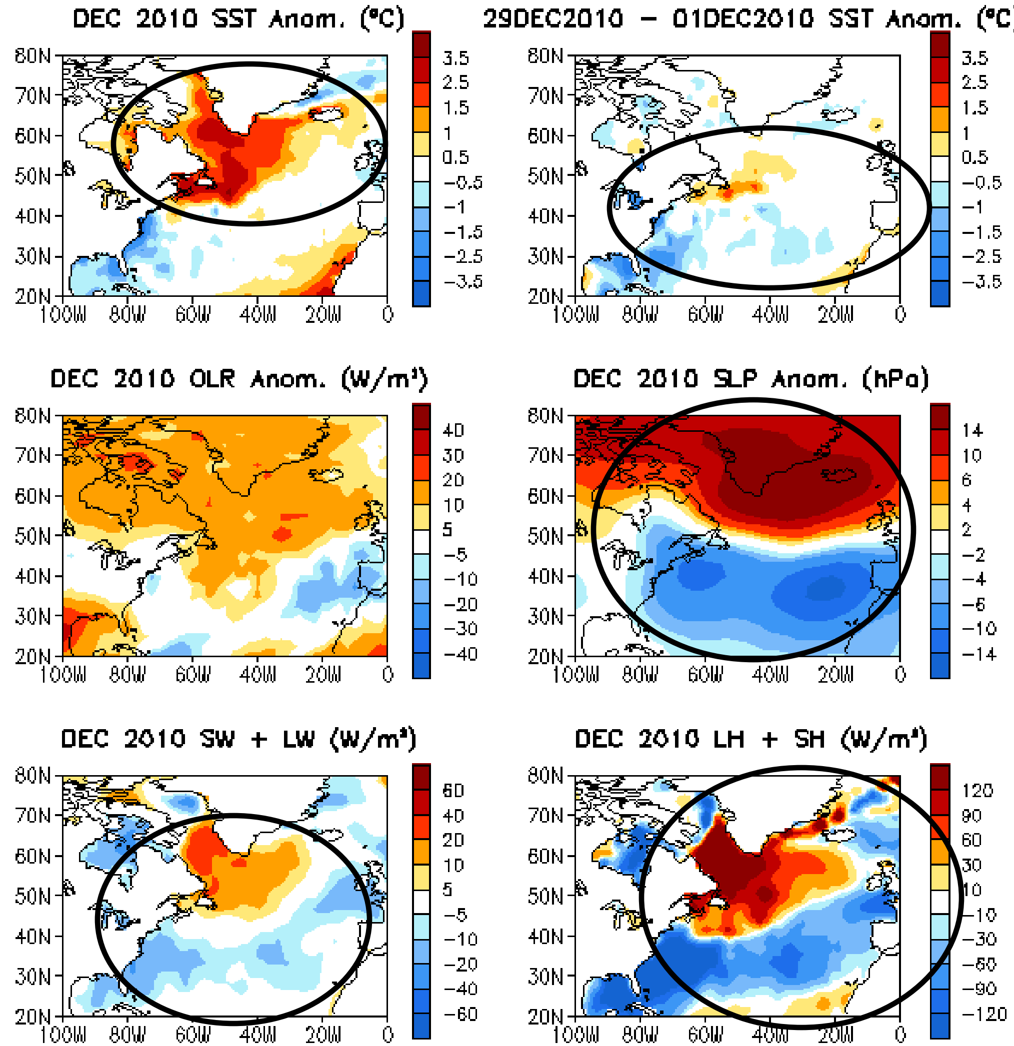
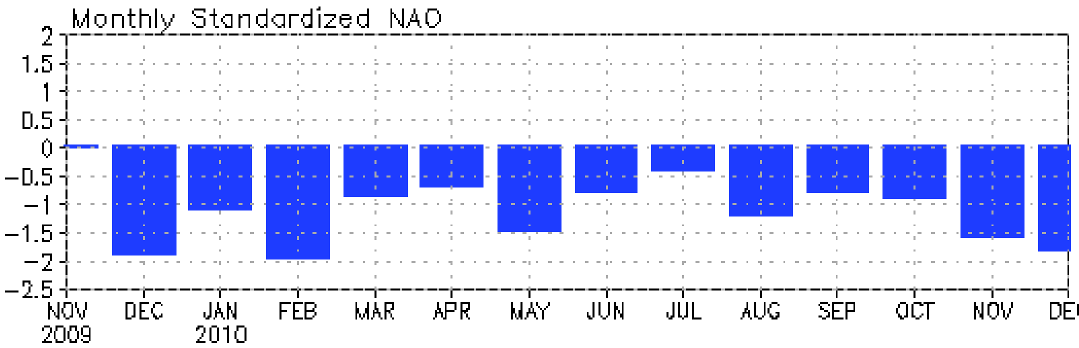
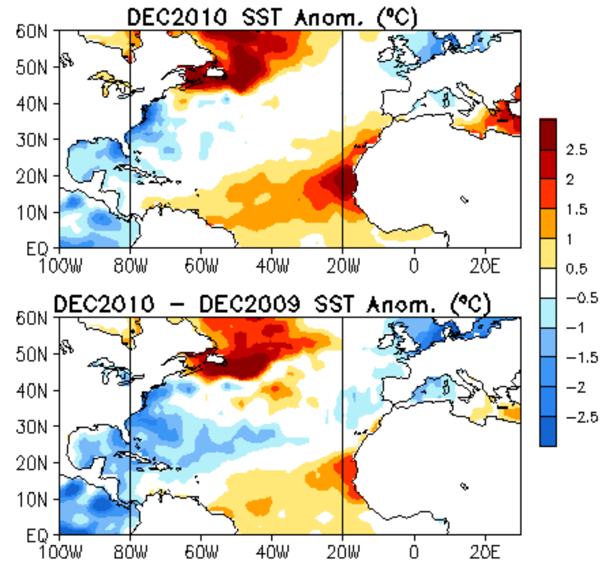
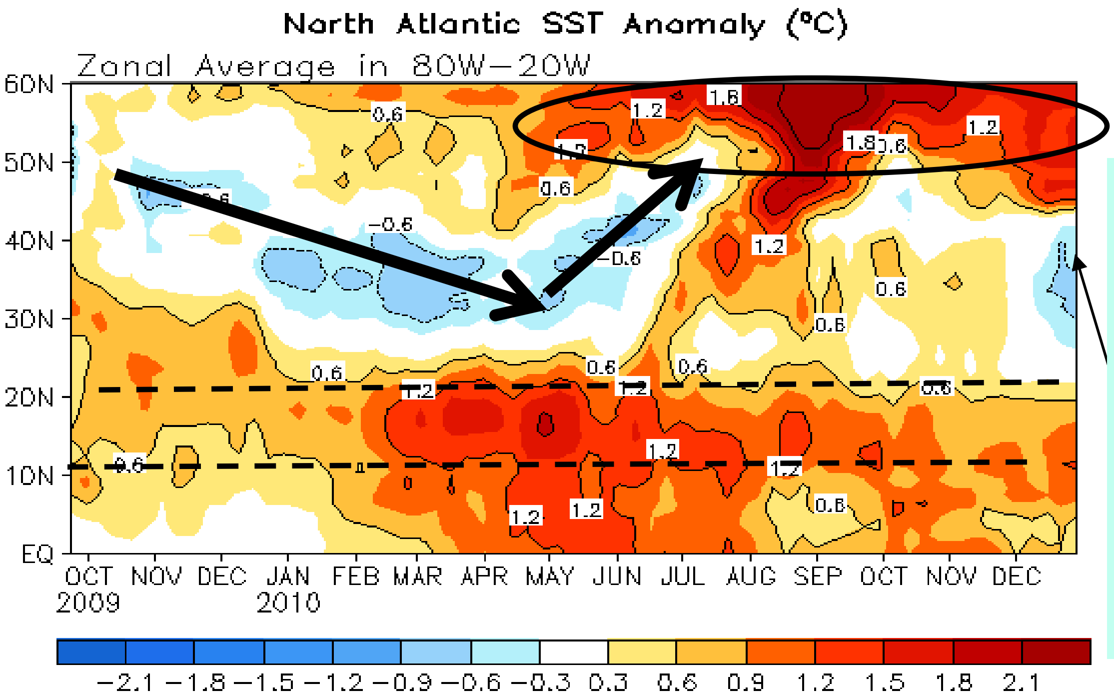


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible 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.

NAO and SST Anomaly in North Atlantic



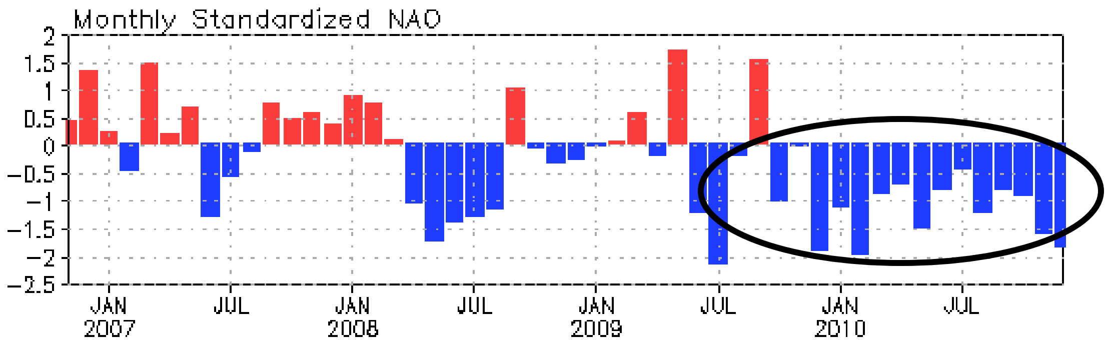


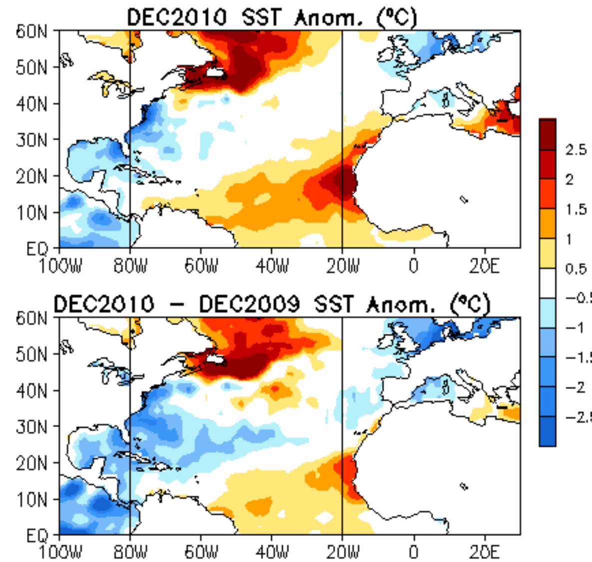


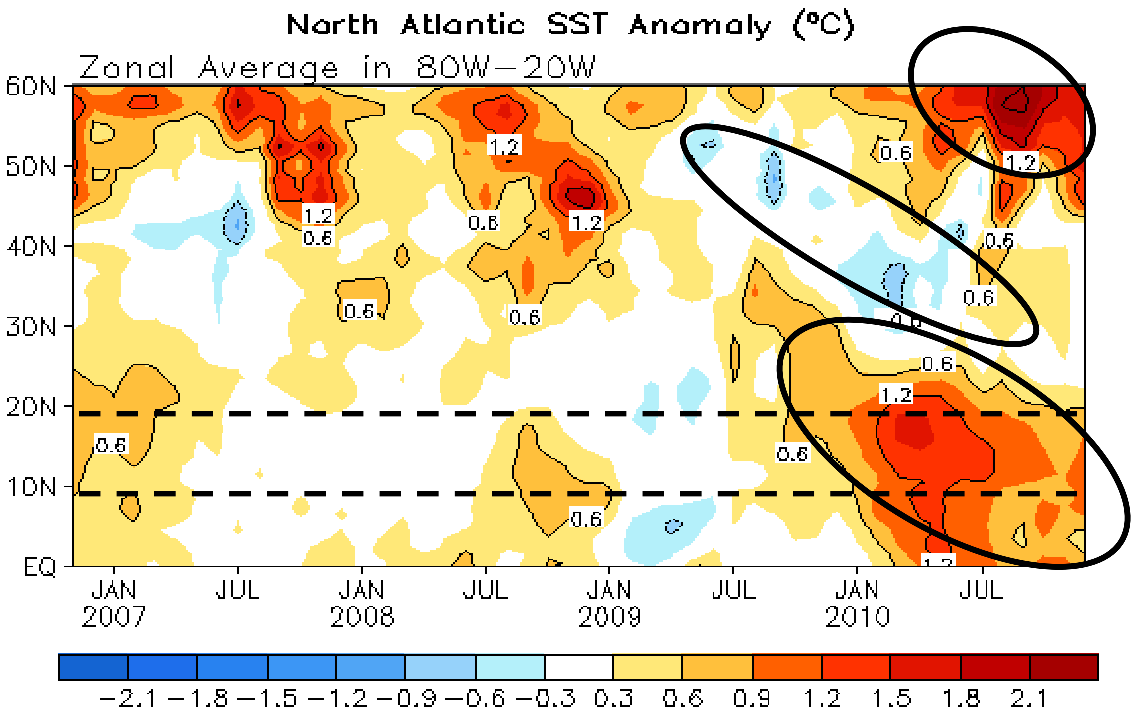
- NAO Index=-1.8 in Dec 2010.
- NAO has been persistently below-normal since Oct 2009, which contributed to the development and maintenance of negative (positive) SSTA in mid-latitude (tropical) North Atlantic. Negative SSTA appeared in mid-latitude in Dec 2010.
- Strong warming presented in the high latitudes North Atlantic Since May 2010.
- Positive SSTA in the Atlantic hurricane MDR has been above-normal since Oct 2009, peaked during Mar-May 2010, and then slowly weakened afterwards.
- The combination of persistent negative NAO phase and delayed impact of the 2009/10 El Nino resulted in the strongly positive SSTA in MDR in spring 2010, which is similar to 2005.

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 1971-2000 base period means.

NAO and SST Anomaly in North Atlantic







- **NAO has been mostly in negative phase since Jun 2009 (covering 19 months).**

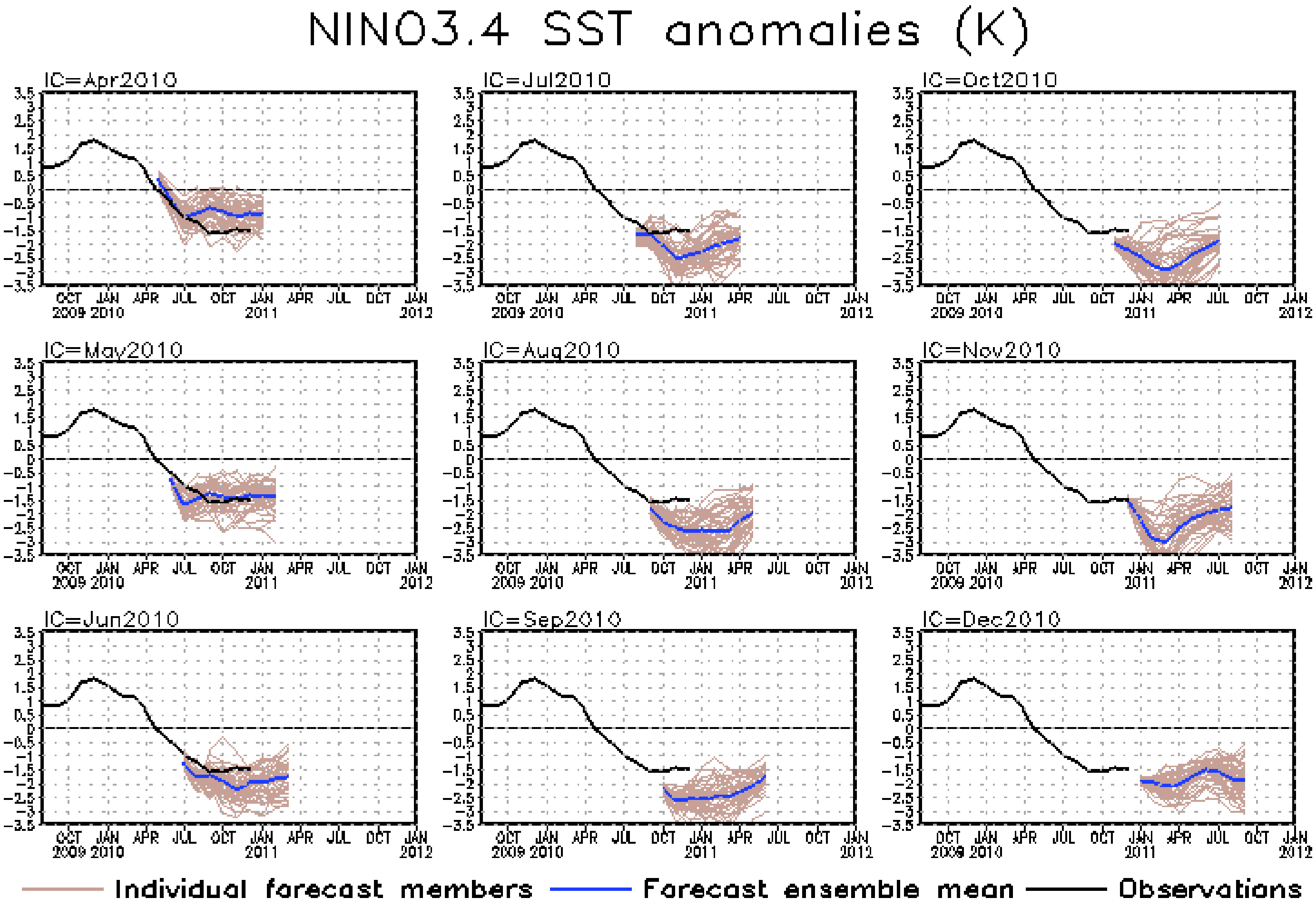
-Mid-latitude North Atlantic SST has been below-normal since May 2009 and became positive since Jul 2010.

- **SST in the Atlantic hurricane MDR has been above-normal since Jul 2009, intensified significantly during Feb-May 2010, and slowly weakened since Jun 2010.**

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 1971-2000 base period means.

CFS SST Predictions and Ocean Initial Conditions

CFS Niño3.4 SST Predictions from Different Initial Months



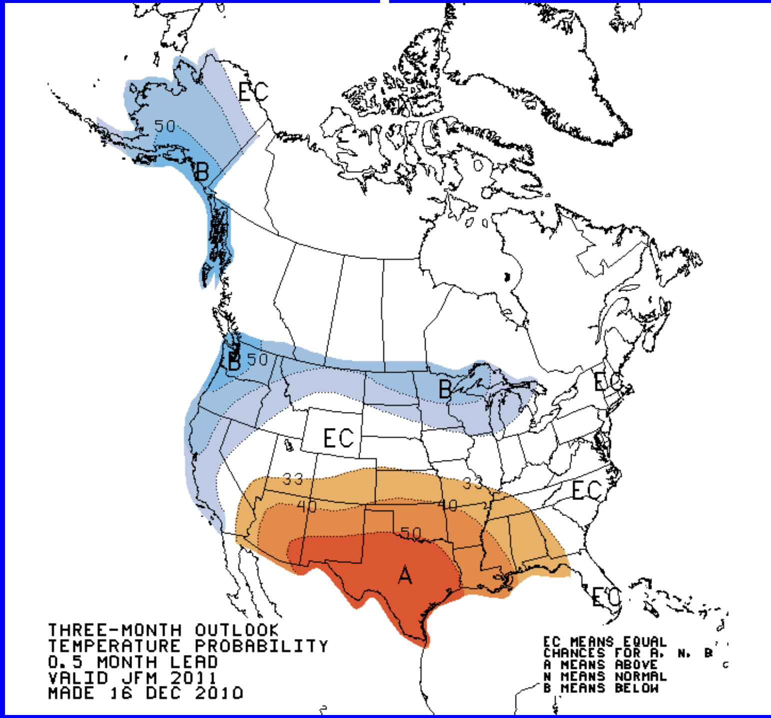
- Forecasts from Jun-Sep I.C. had cold biases. The recent cold forecast biases can be alleviated through statistical model corrections (http://www.cpc.ncep.noaa.gov/products/people/wwang/cfs_fcst).

- The latest forecasts from Dec 2010 I.C. suggest that the current La Niña will reach its peak phase in the early spring of 2011, and last into the summer 2011.

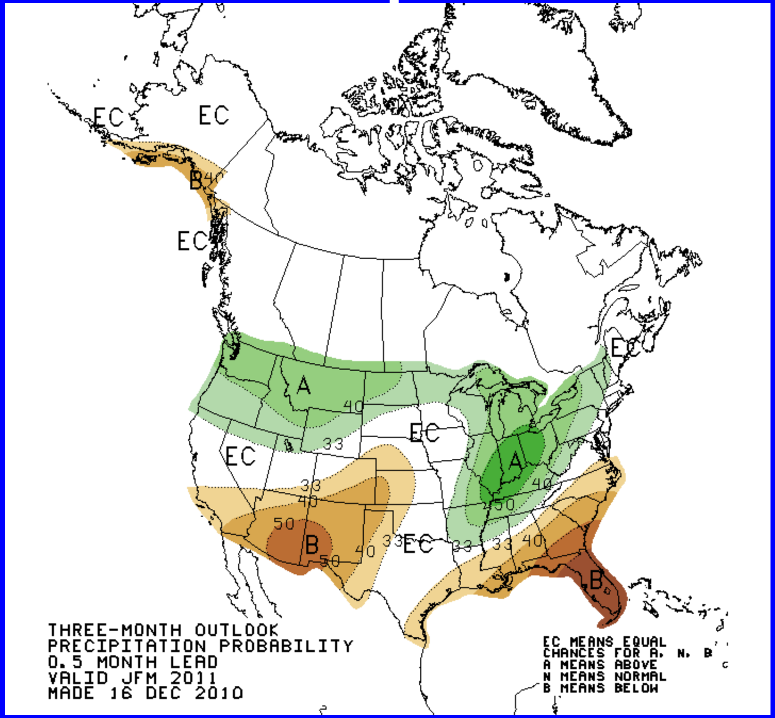
Fig. M1. CFS Nino3.4 SST prediction from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). The hindcast climatology for 1981-2006 was removed, and replaced by corresponding observation climatology for the same period. Anomalies were computed with respect to the 1971-2000 base period means.

U. S. Seasonal Outlooks (January - March 2011)
(updated on 16 Dec 2010)

Temperature



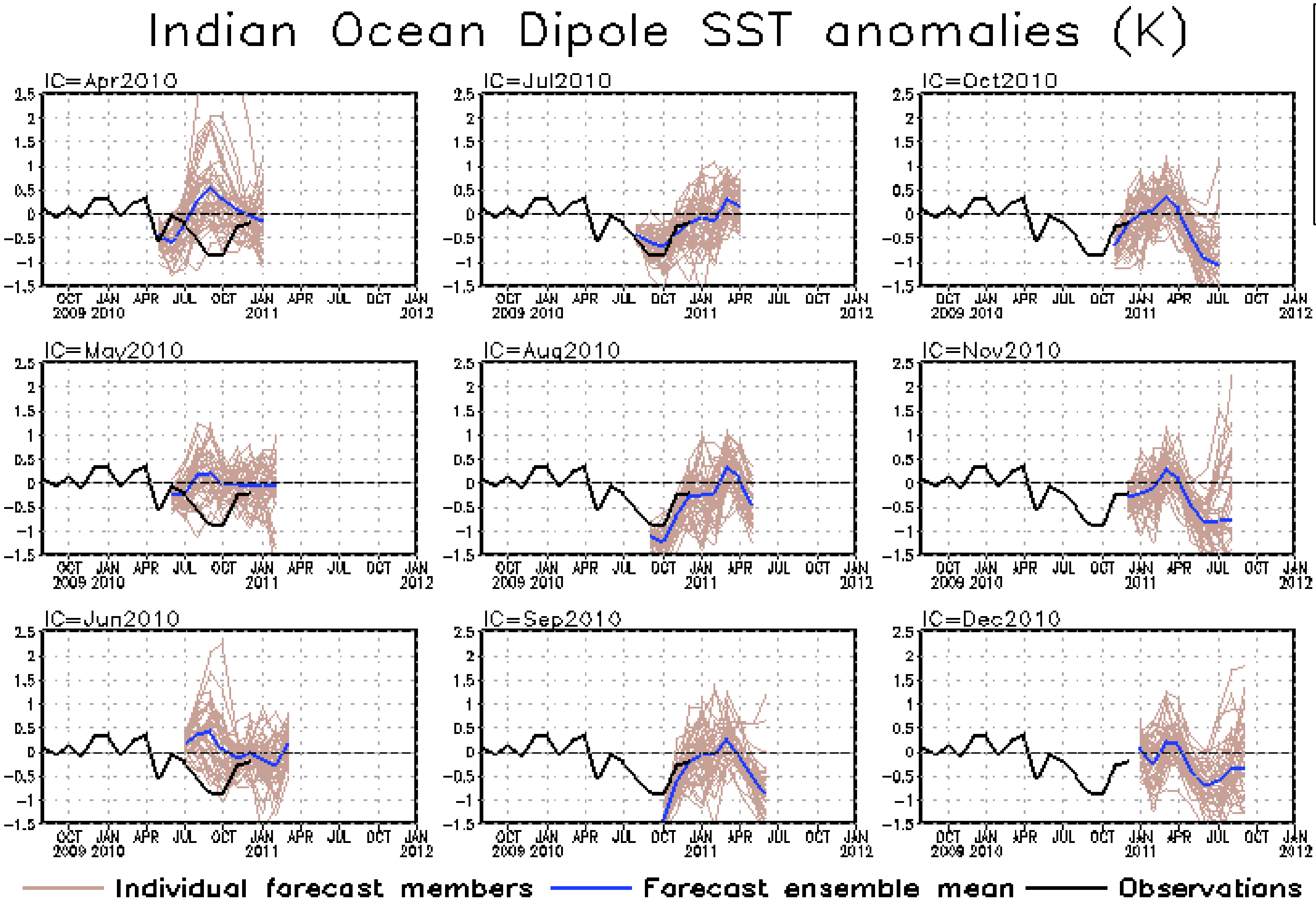
Precipitation



The seasonal outlooks combine the effects of long-term trends, soil moisture, and, when appropriate, the ENSO cycle.

From http://www.cpc.ncep.noaa.gov/products/precip/CWlink/MJO/enso.shtml

CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

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

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

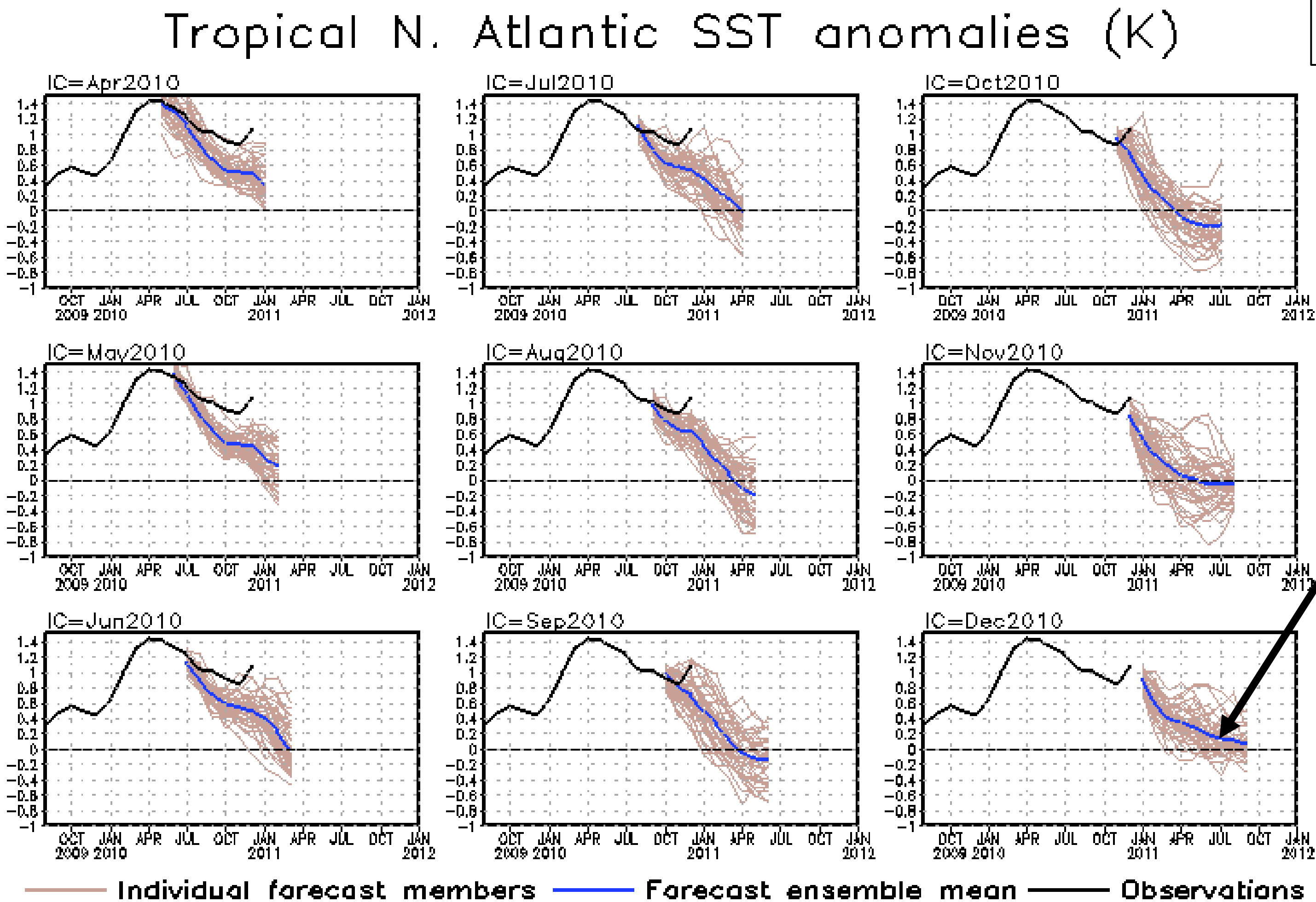
- The onset phase of the negative IOD event was poorly forecast, but the decay phase was well predicted.

- Forecasts from Dec 2010 I.C. suggest a weak negative IOD will develop in summer 2011.

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 1971-2000 base period means.

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

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

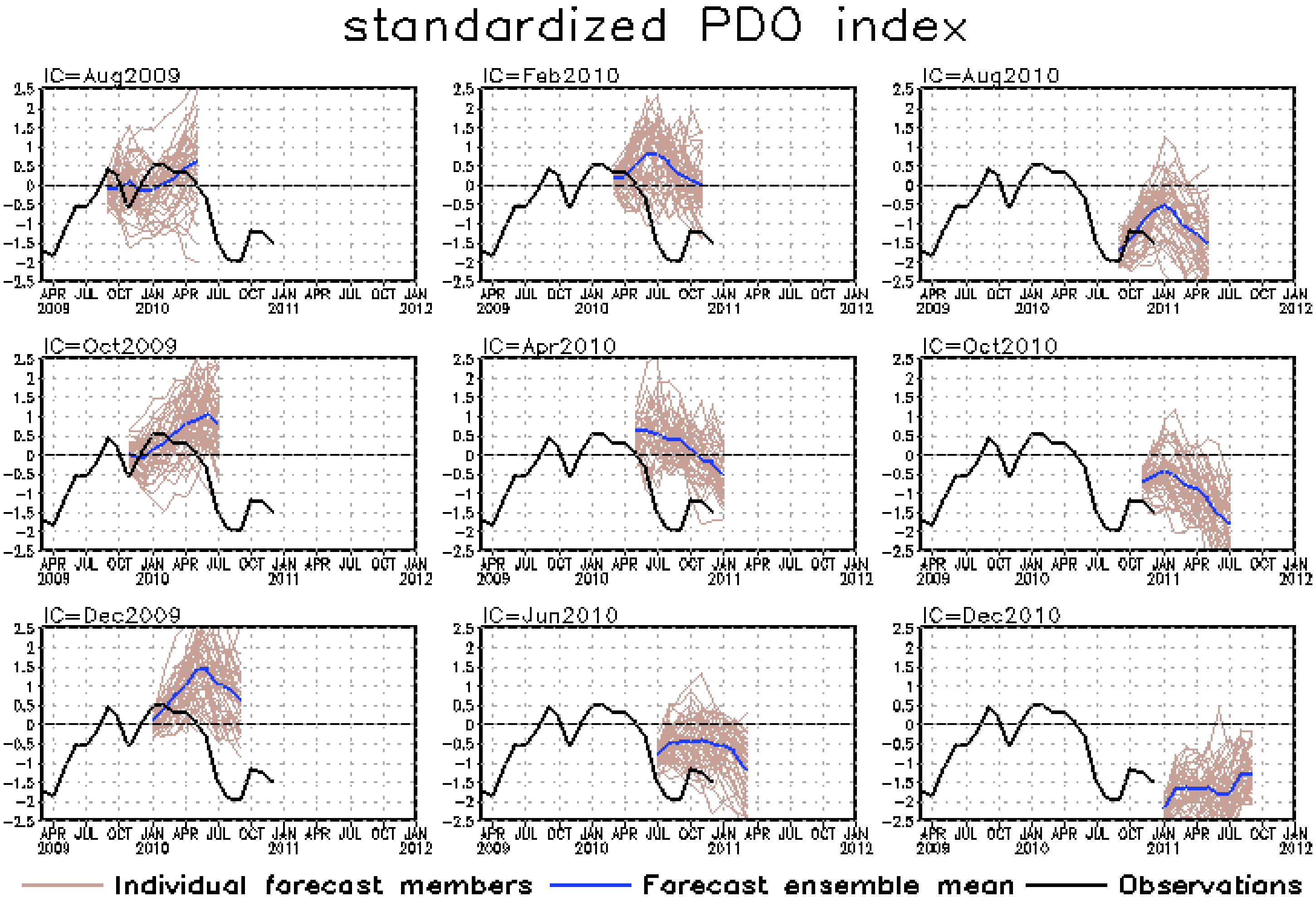


- Cold forecast biases were evident.

- Latest forecasts suggest that positive SSTA in the tropical North Atlantic will decay rapidly in next few months, and become near-normal in spring/summer 2011.

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). 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 1971-2000 base period means.

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



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

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

- The onset of the negative PDO phase was poorly forecast.

- Latest forecasts suggest that the negative PDO will strengthen in next few months and a moderately strong negative PDO will last well into the summer 2011.

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). 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 1971-2000 base period means.

Overview

- **Pacific/Arctic Ocean**
  - ENSO cycle: La Niña conditions persisted with NINO3.4=-1.5°C in Dec 2010. The current La Nina is as strong as the 1998/99 La Nina in terms of anomaly amplitude in SST, heat content and surface winds.
  - NOAA/NCEP Climate Forecast System (CFS) predicted the La Niña will continue well into the Northern Hemisphere spring/summer 2011.
  - PDO has been negative since Jul 2010, with PDOI=-1.5 in Dec 2010.
  - Downwelling strengthened at 36°N-45°N along the west coast of North America in Dec 2010.
  - The Arctic sea ice extent was smaller than the 2007 value in Dec 2010.
- **Indian Ocean**
  - Westerly wind anomalies strengthened in the tropical Indian Ocean since late Nov, which were probably part of enhanced atmospheric circulations associated with the La Nina conditions.
- **Atlantic Ocean**
  - NAO index has been persistently below-normal since Oct 2009, and it was -1.8 in Dec 2010.
  - Strong positive SSTA (>2.5°C) persisted in the high latitudes since Sep 2010.
  - Positive SSTA in the tropical North Atlantic has been above-normal since Oct 2009, peaked during Mar-May 2010, and slowly weakened since then.

Backup Slides

Data Sources and References

- **Optimal Interpolation SST (OI SST) version 2 (Reynolds et al. 2002)**
- **SST 1971-2000 base period means (Xue et al. 2003)**
- **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!