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)

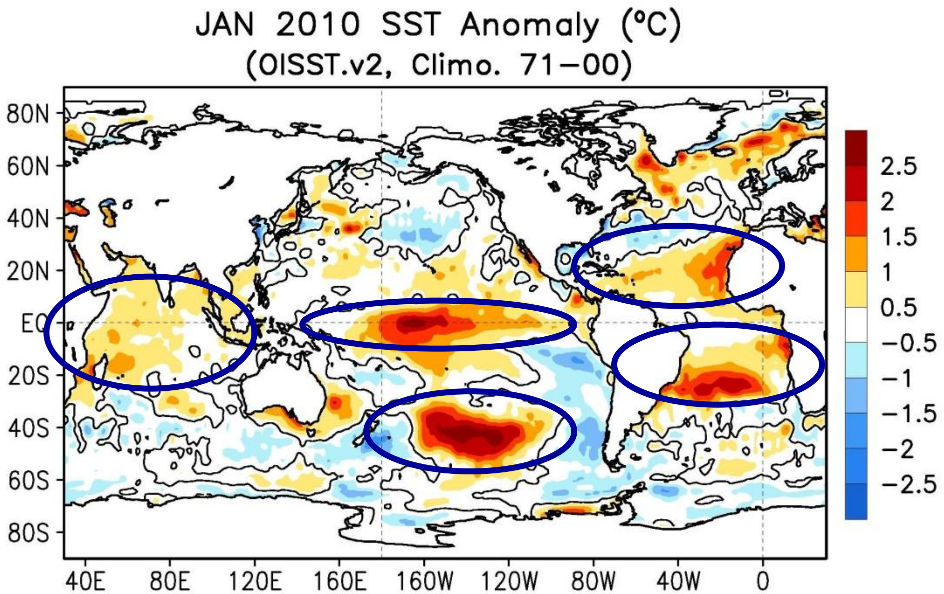
Outline

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

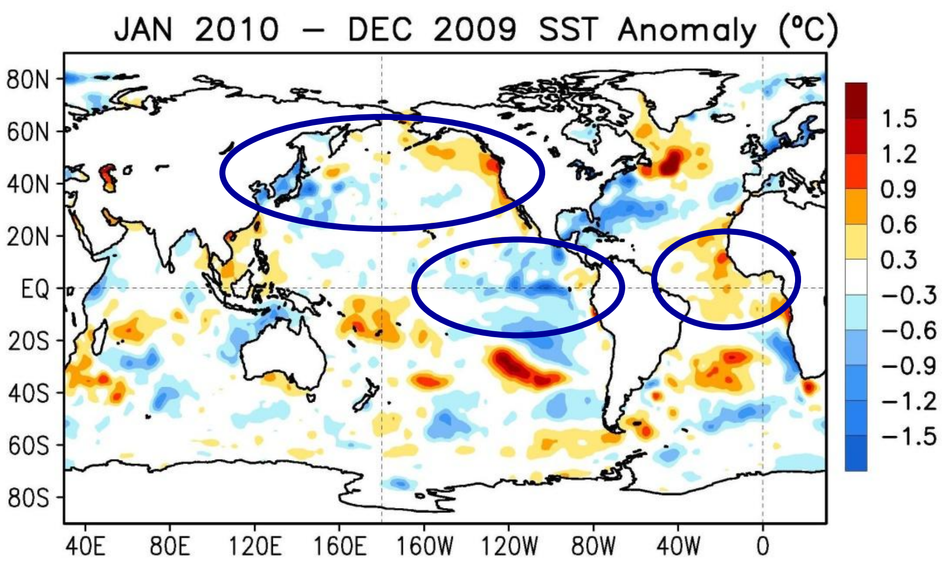
Overview

- **Pacific Ocean**
  - **El Niño conditions (NINO 3.4 > 0.5 ^{o}C), which established in Jun 09, persisted during Jul-Oct 09, strengthened substantially in Nov 09, persisted in Dec 09, and weakened slightly in Jan 10, are expected to continue into April-May-June 10;**
  - **Westerly wind bursts events, active in Jul, Sep, Oct, Dec 09, contributed to the maintenance and strengthening of the 2009/10 El Niño;**
  - **PDO was near-normal in Aug-Dec 2009, and became above-normal in Jan 10;**
  - **Upwelling along the west coast of North America was well below-normal in Jan 10.**
- **Indian Ocean**
  - **Westerly wind anomalies weakened in the central tropical Indian Ocean in Jan 10, probably associated with the Madden-Julian Oscillation activity;**
  - **Positive SSTA weakened slightly in the tropical Indian Ocean in Jan 10, and Dipole Mode Index has been near-normal since Mar 09.**
- **Atlantic Ocean**
  - **Positive SST anomalies in the tropical North Atlantic and subtropical South Atlantic persisted from Sep 09 to Jan 10;**
  - **Convection was mostly suppressed in the tropical North Atlantic;**
  - **NAO is -1.1 in Jan 10; Mid-latitude North Atlantic SSTs have been unusually below-normal from May 09 to Jan 10.**

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



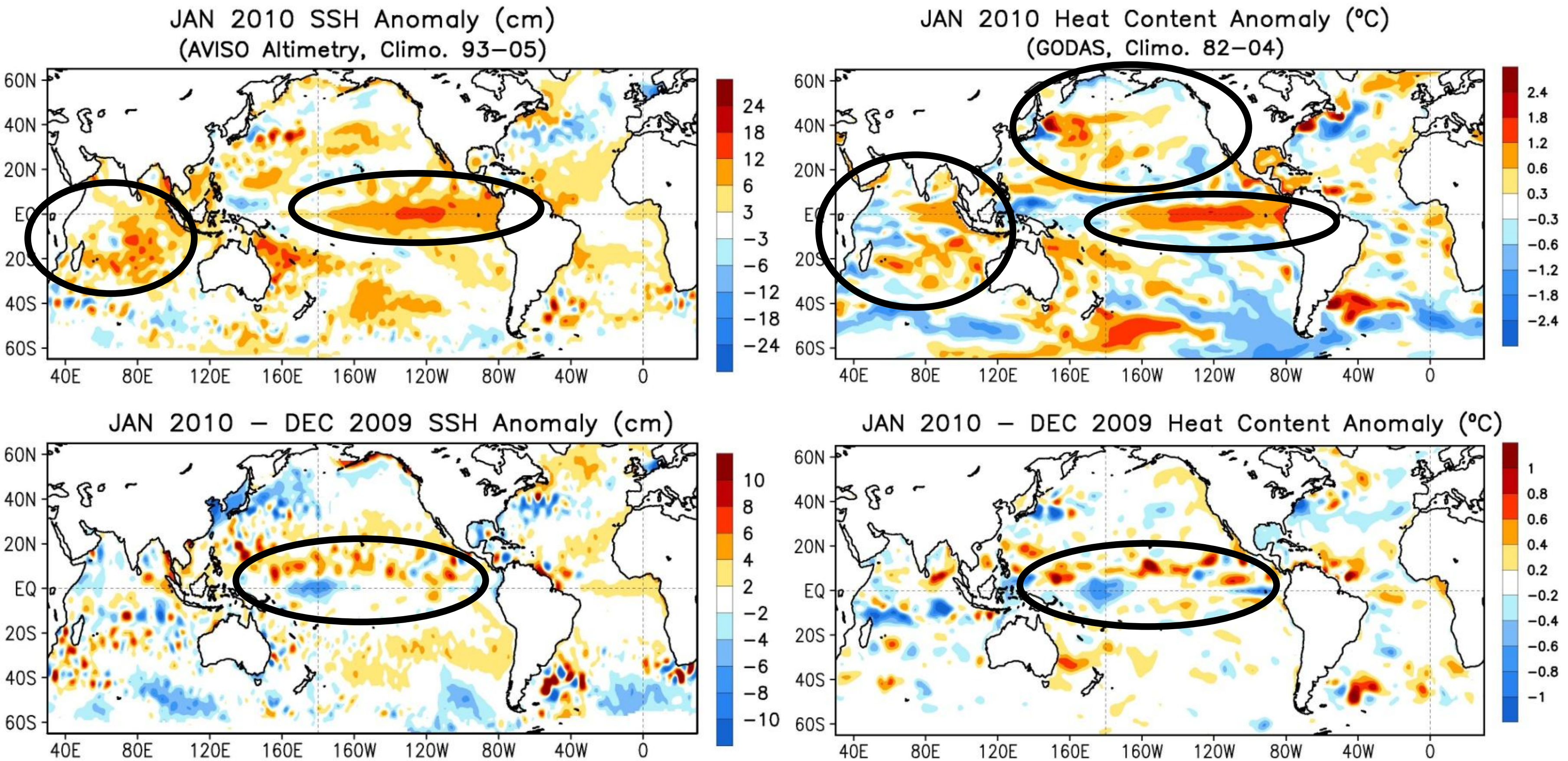
- El Nino condition (NINO 3.4 > 0.5°C) weakened slightly in the tropical Pacific;
- PDO became positive (slide 19);
- SST was above-normal in the tropical Indian Ocean and tropical North Atlantic;
- Large SST anomalies in the subtropical South Pacific, South Atlantic, and North Atlantic



- SST decreased in the eastern tropical Pacific;
- SST decreased (increased) in the western (eastern) subtropical North Pacific;
- SST increased in the tropical Atlantic.

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.

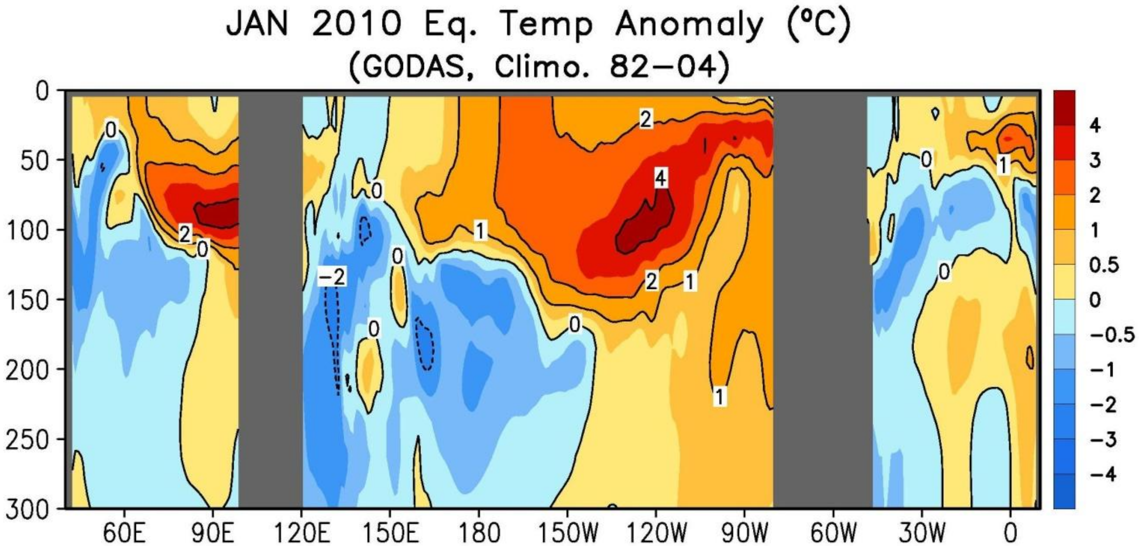
Global SSH/HC Anomaly (cm/^{o}C) and Anomaly Tendency



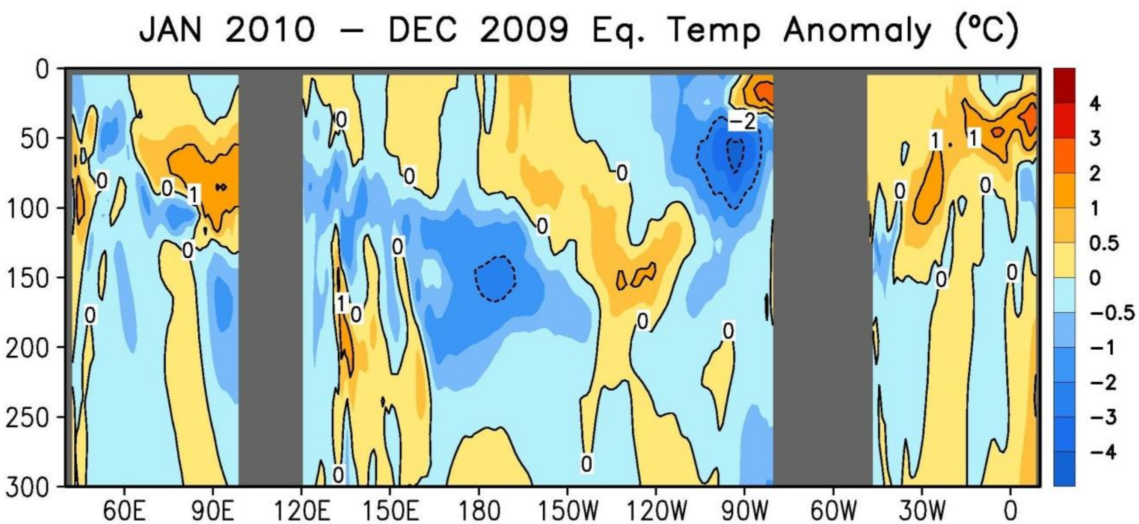
- **Negative PDO-like pattern in HCA in the North Pacific persisted.**
- **Positive SSHA and HCA were present in the east-central equatorial Pacific, consistent with the El Nino conditions.**
- **SSHA and HCA were largely consistent except in the tropical Indian and Southern Oceans where biases in GODAS climatology are large (not shown).**
- **Tendency of SSHA and HCA was largely consistent in the tropical Pacific.**

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 2°S-2°N



- **Positive subsurface temperature anomalies above 2°C were present near the thermocline in the east-central equatorial Pacific, consistent with the El Nino conditions.**

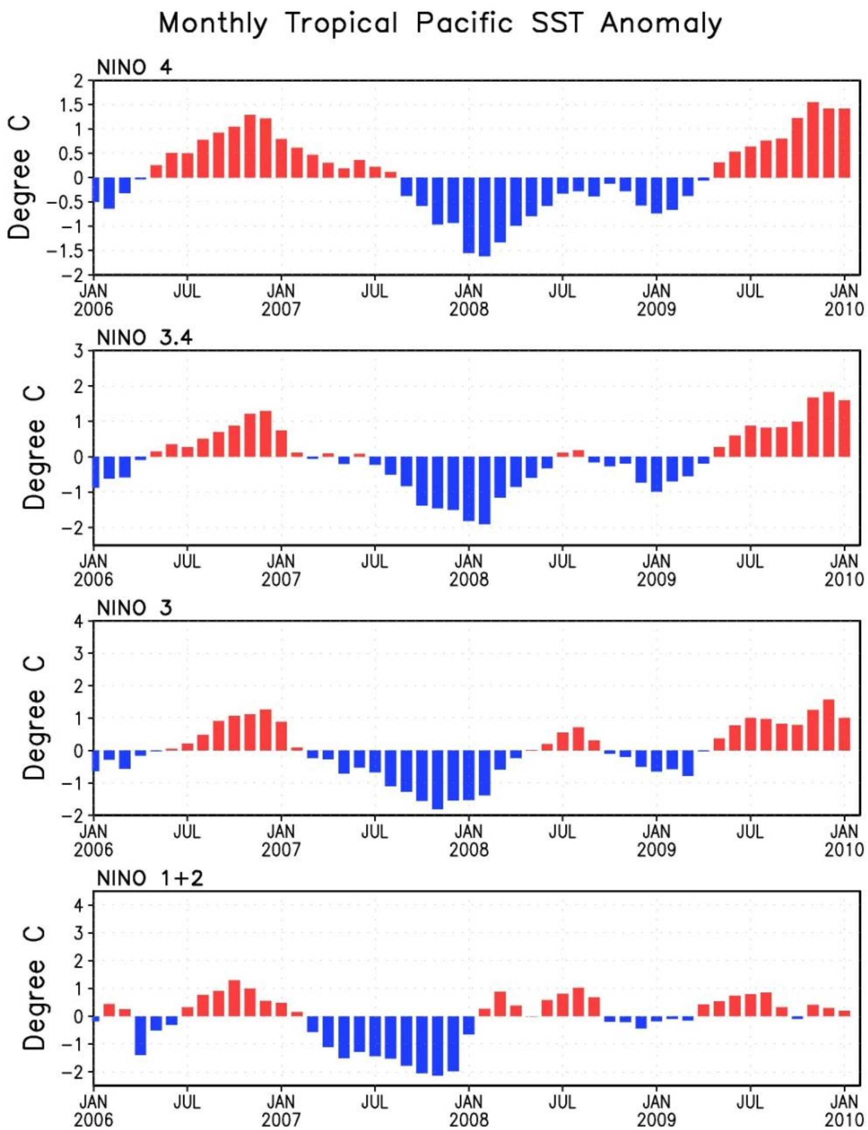


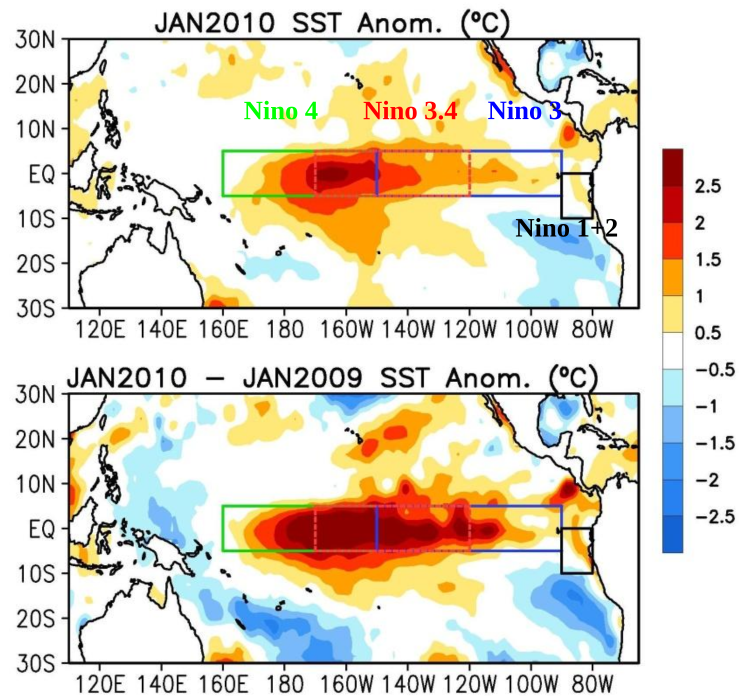
- **Subsurface temperature anomalies decreased by 2°C (1°C) near 90°W (180°W) along the thermocline of the equatorial Pacific.**

Fig. G3. Equatorial depth-longitude section of ocean temperature anomalies (top) and anomaly tendency (bottom). Data are derived from the NCEP's global ocean data assimilation system which assimilates oceanic observations into an oceanic GCM. Anomalies are departures from the 1982-2004 base period means.

Tropical Pacific Ocean

Evolution of Pacific NINO SST Indices

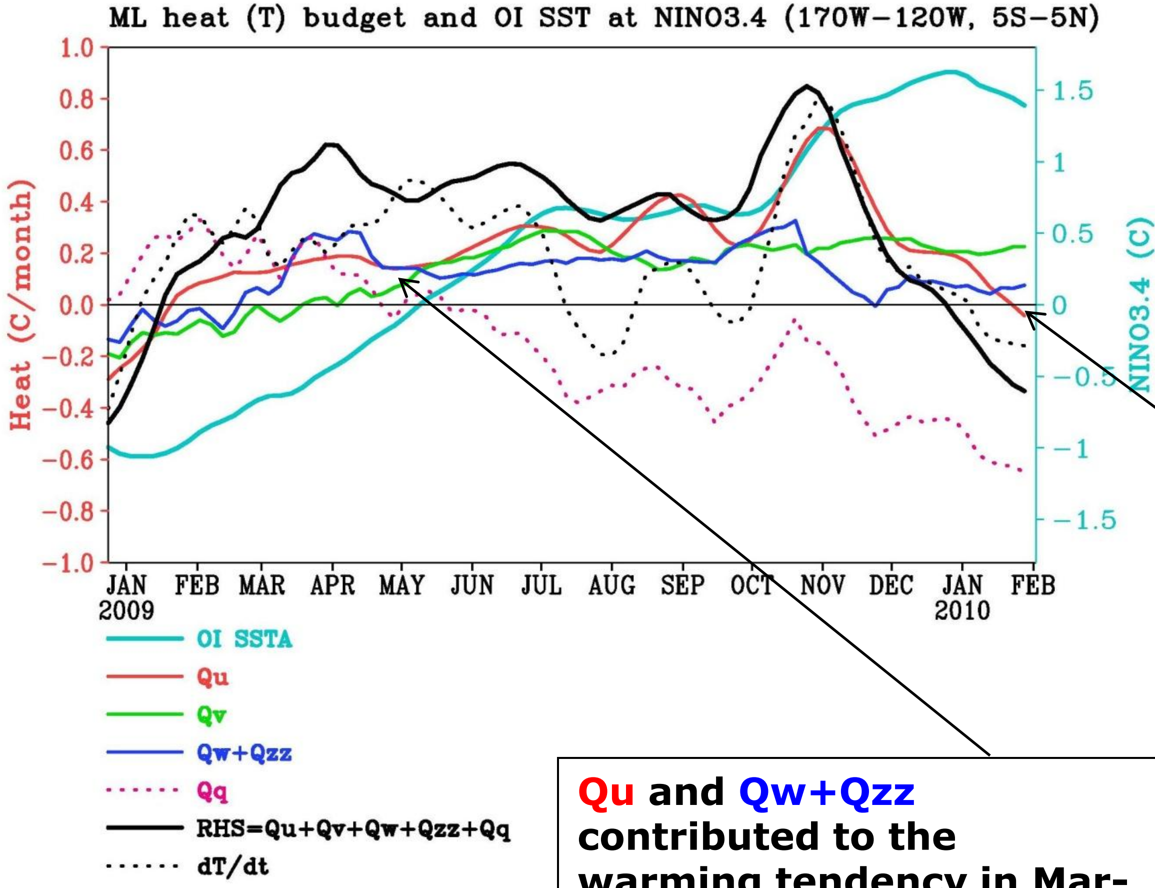




- NINO4 persisted while NINO3.4, NINO3 and NINO1.2 decreased.

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: 09/10 El Nino



Qu and Qw+Qzz contributed to the warming tendency in Mar-May.

The large warming tendency in Oct-Nov is largely due to Qu, suggesting that influences of subsurface temperature anomalies on the recent SSTA changes are likely small.

The small tendency in Dec 09 suggests that the El Nino likely reached its peak phase.

Negative tendency in Jan 10, suggesting weakening El Nino, is caused by reduced warming from Qu and strengthened cooling from Qq.

Qu: Zonal advection; Qv: Meridional advection;

Qw: Vertical entrainment; Qzz: Vertical diffusion

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

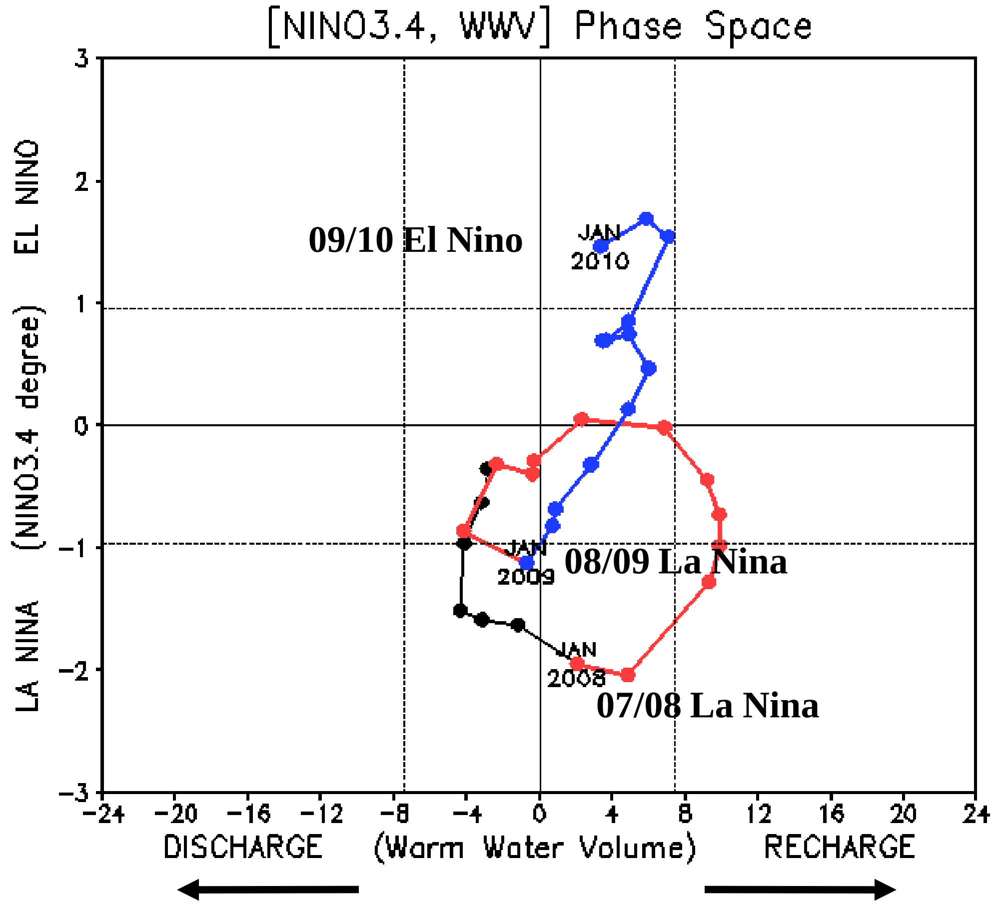
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

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.

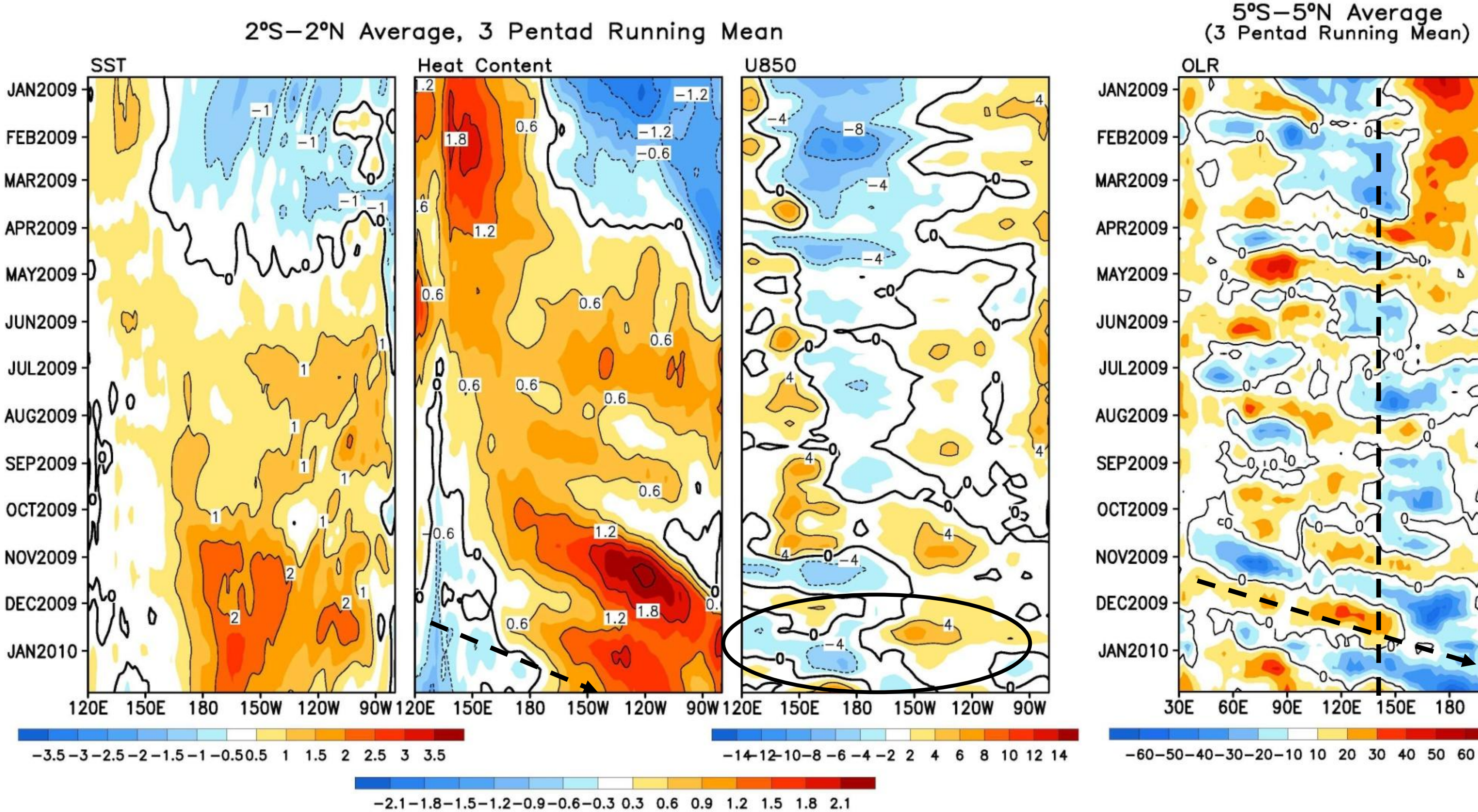


- NINO3.4 and WWV increased steadily during Jan-Jun 2009, persisted during Jul-Oct 09, and increased dramatically in Nov 09; NINO3.4 (WWV) increased (decreased) slightly during Dec 09; Nino3.4 and WWV decreased slightly from Dec 09 to Jan 10;

- The phase trajectory became similar to the typical anti-clockwise rotation during El Nino events.

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.

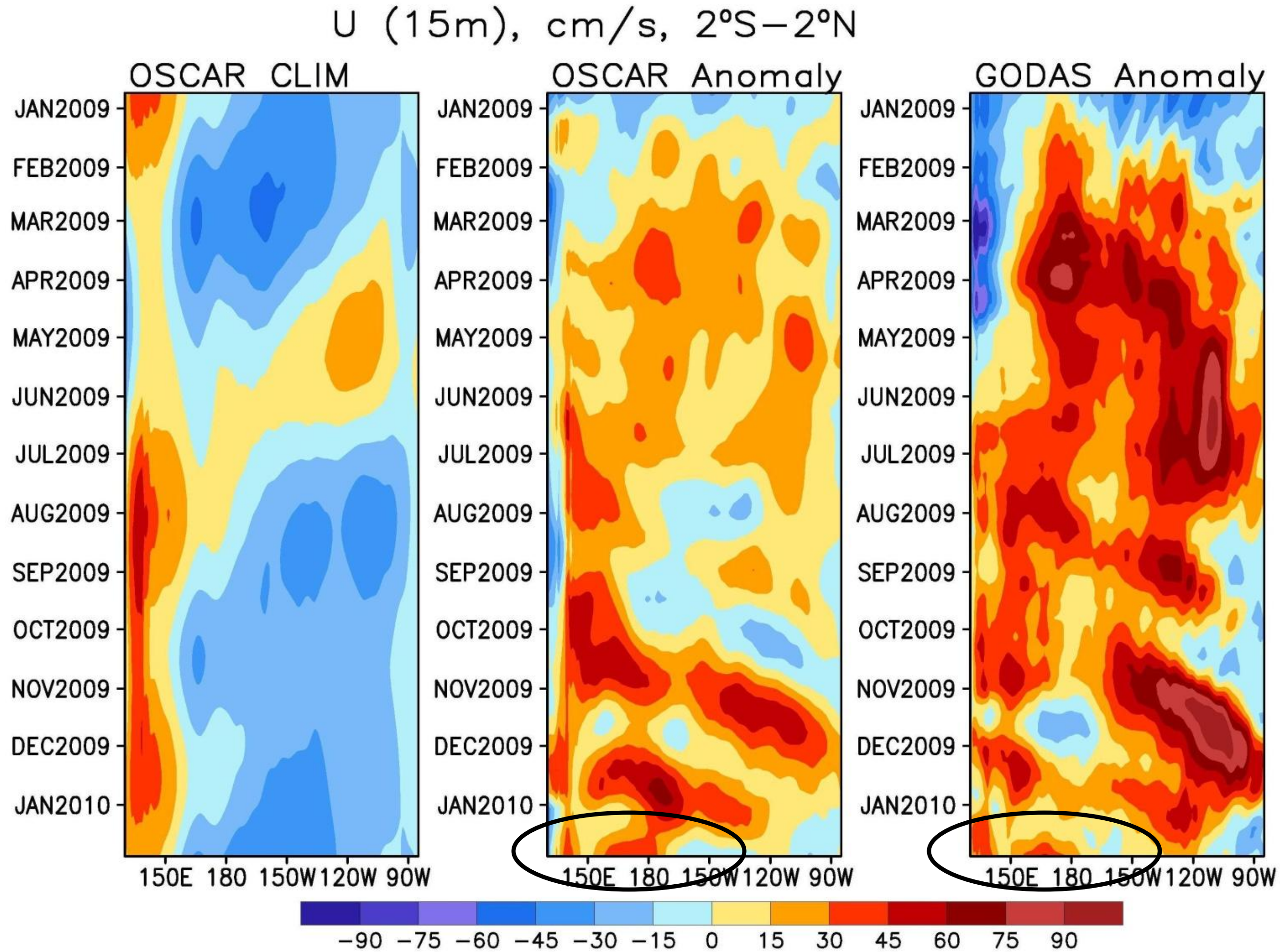
Evolution of Equatorial Pacific SST (ºC), 0-300m Heat Content (ºC), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly



- **SST was about 1-2ºC above-normal in the east-central equatorial Pacific.**
- **Positive heat content anomalies (HCA) propagated eastward during Oct-Nov 09 (Dec 09-Jan 10), in response to the westerly wind anomalies that occurred in Sep-Oct (Nov-Dec 09) in the western and eastern tropical Pacific.**

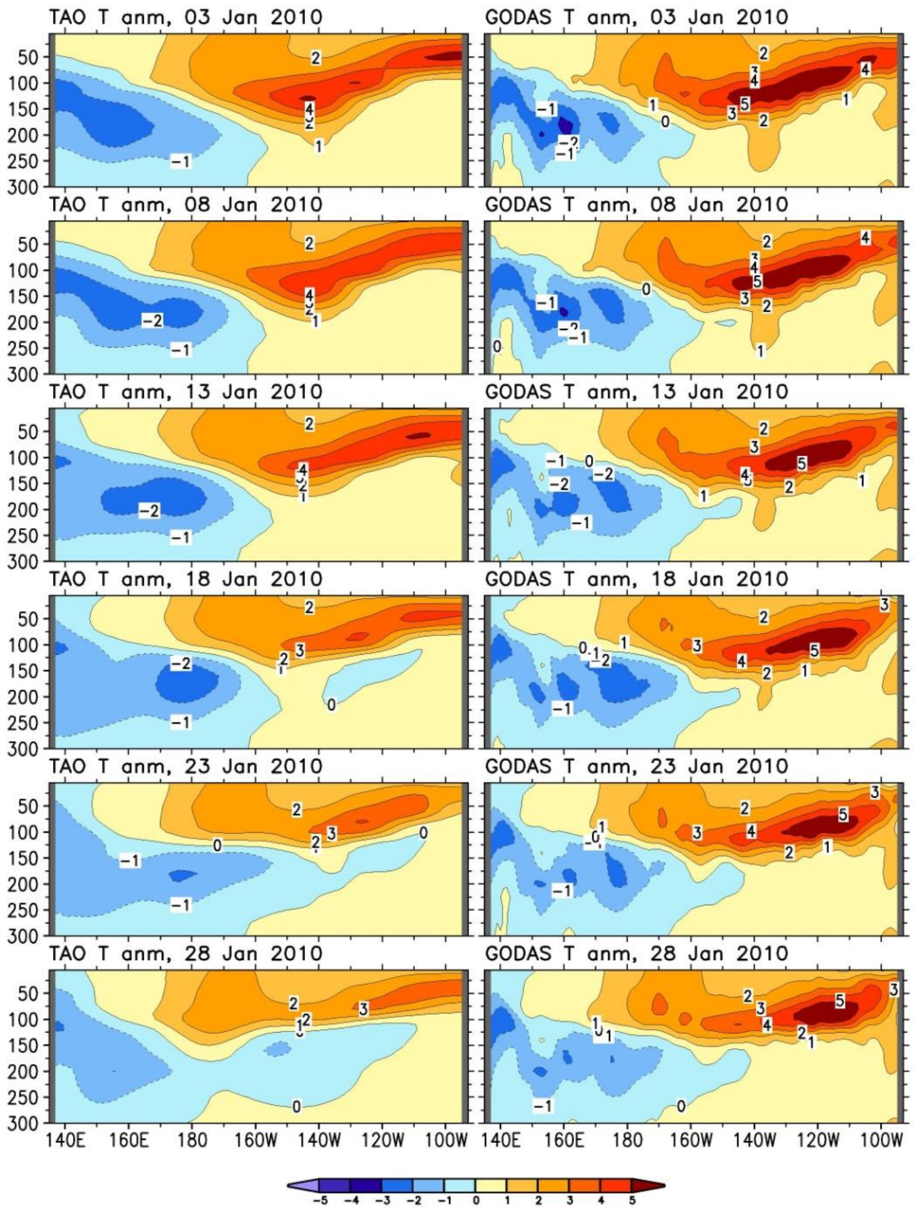
Fig. P4. Time-longitude section of anomalous pentad sea surface temperature (left), upper 300m temperature average (heat content, middle-left), 850-mb zonal wind (U850, middle-right) averaged in 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. SST is derived from the NCEP OI 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.

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



- **Surface zonal current anomaly has been positive since mid-Jan 09, consistent with the transition from La Nina to ENSO-neutral conditions in April 09 and the transition to El Nino conditions in June 09.**
- **Positive surface zonal current anomaly in the west-central equatorial Pacific weakened (strengthened) in early (later) Jan 10 in response to easterly (westerly) wind anomalies.**
- **Surface zonal current anomalies simulated by GODAS were too strong compared with those of OSCAR in the equatorial Pacific.**

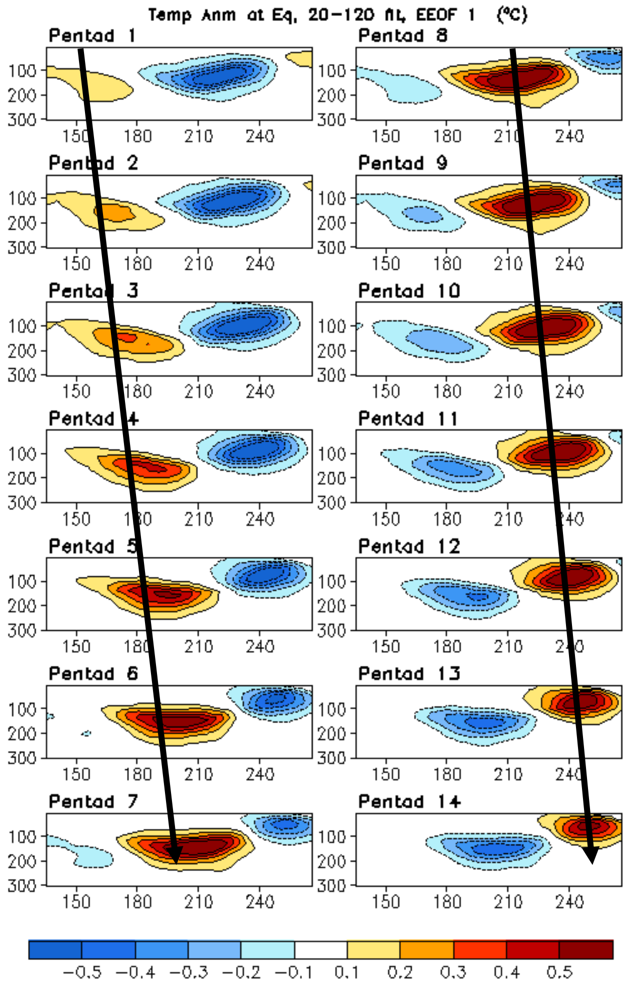
Equatorial Pacific Temperature Anomaly

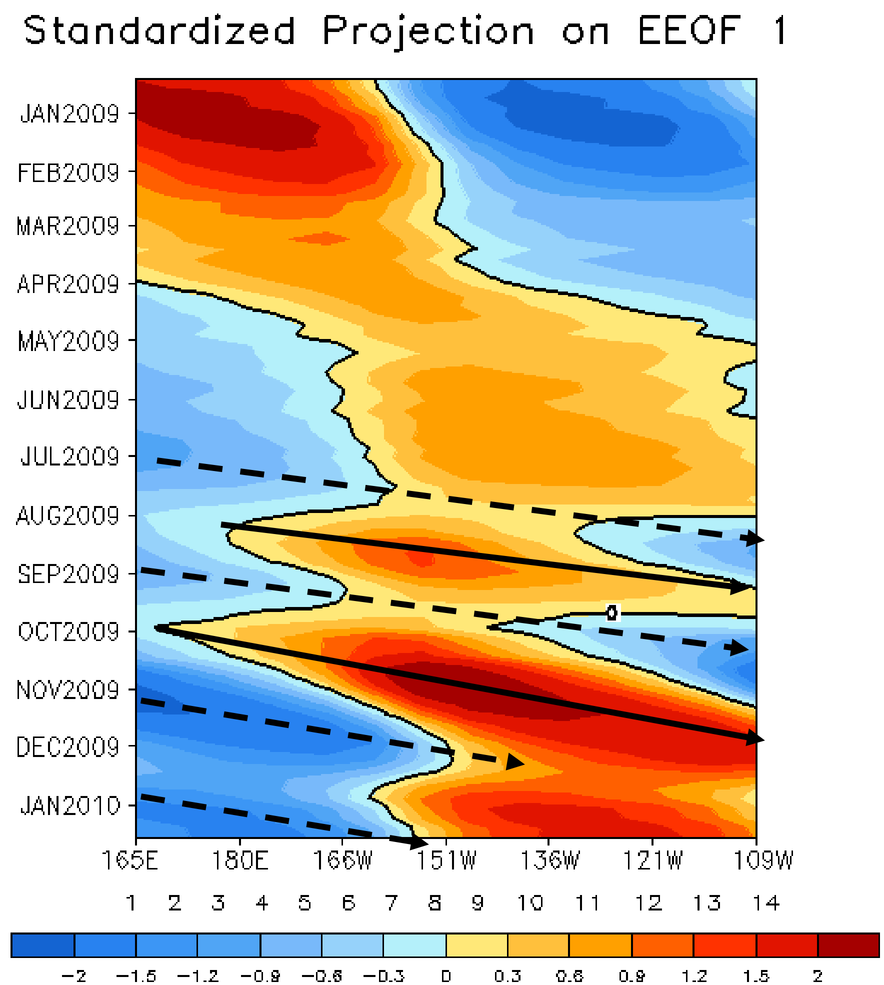


TAO climatology used

- **Positive (negative) temperature anomaly in the east-central (western) equatorial Pacific weakened and propagate eastward in Jan 09.**

Oceanic Kelvin Wave Indices

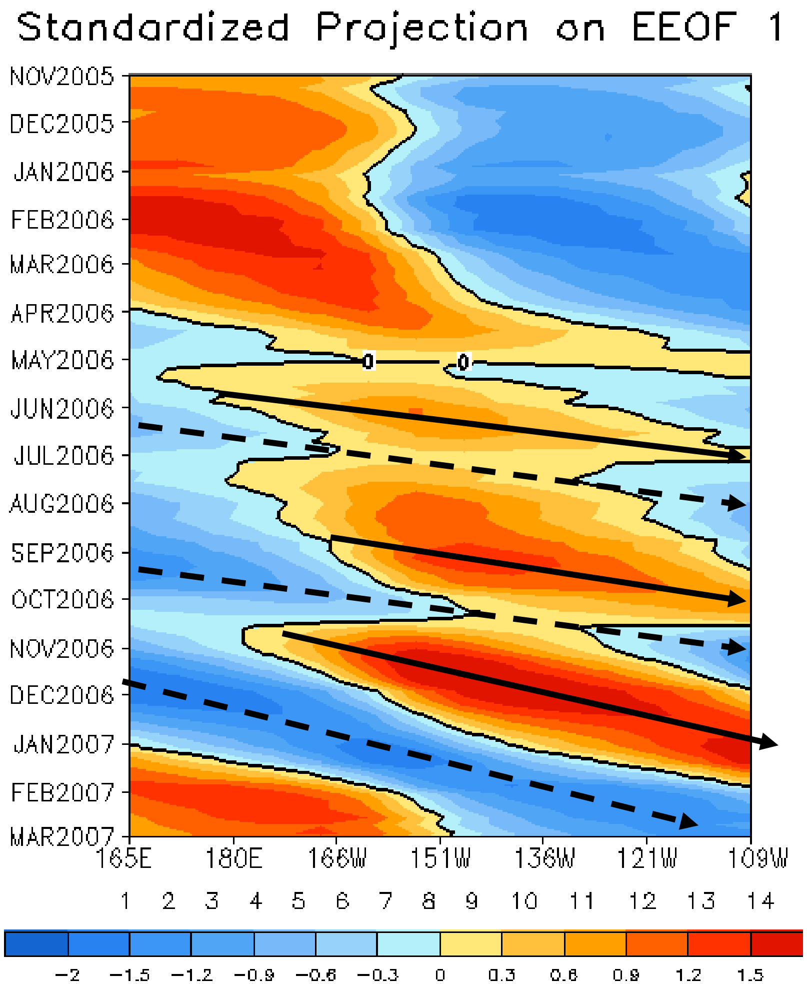




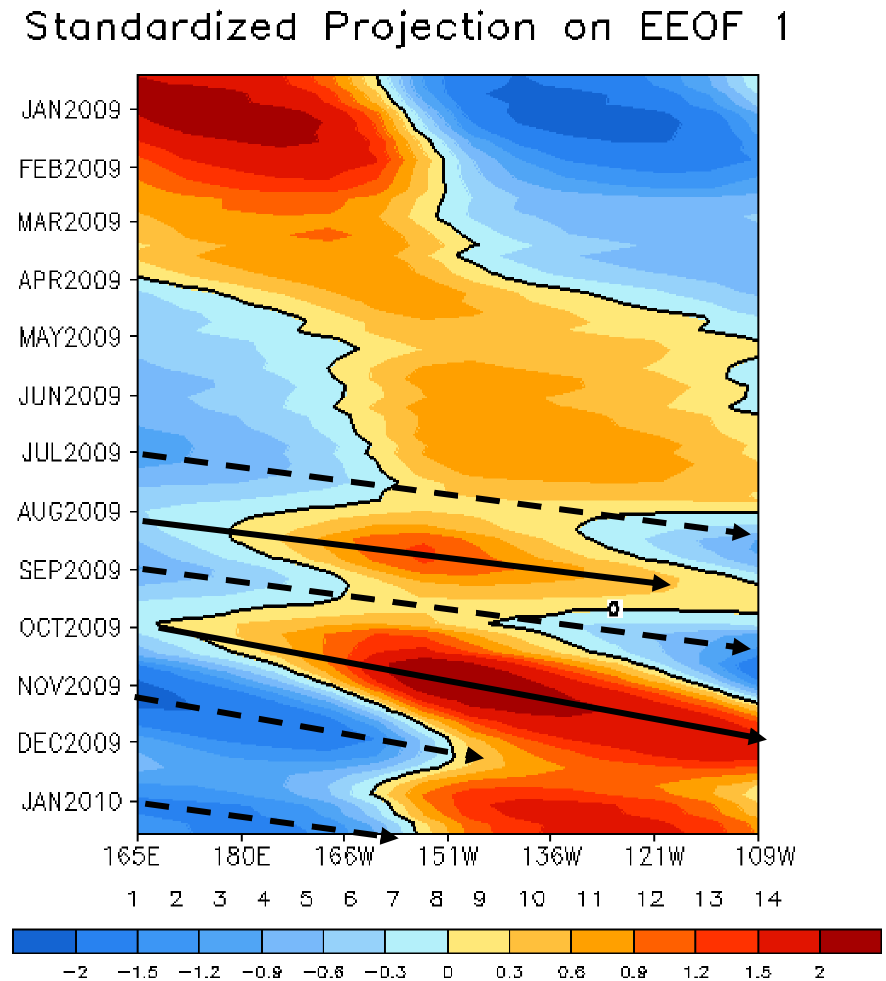
- Extended EOF (EEOF) analysis is applied to 20-120 day filtered equatorial temperature anomaly in the top 300m using 14 lagged pentads (similar to that in Seo and Xue, GRL, 2005).
- EEOF 1 describes eastward propagation of oceanic Kelvin wave cross the equatorial Pacific in about 70 days.
- Oceanic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

Oceanic Kelvin Wave Indices

06/07 El Nino

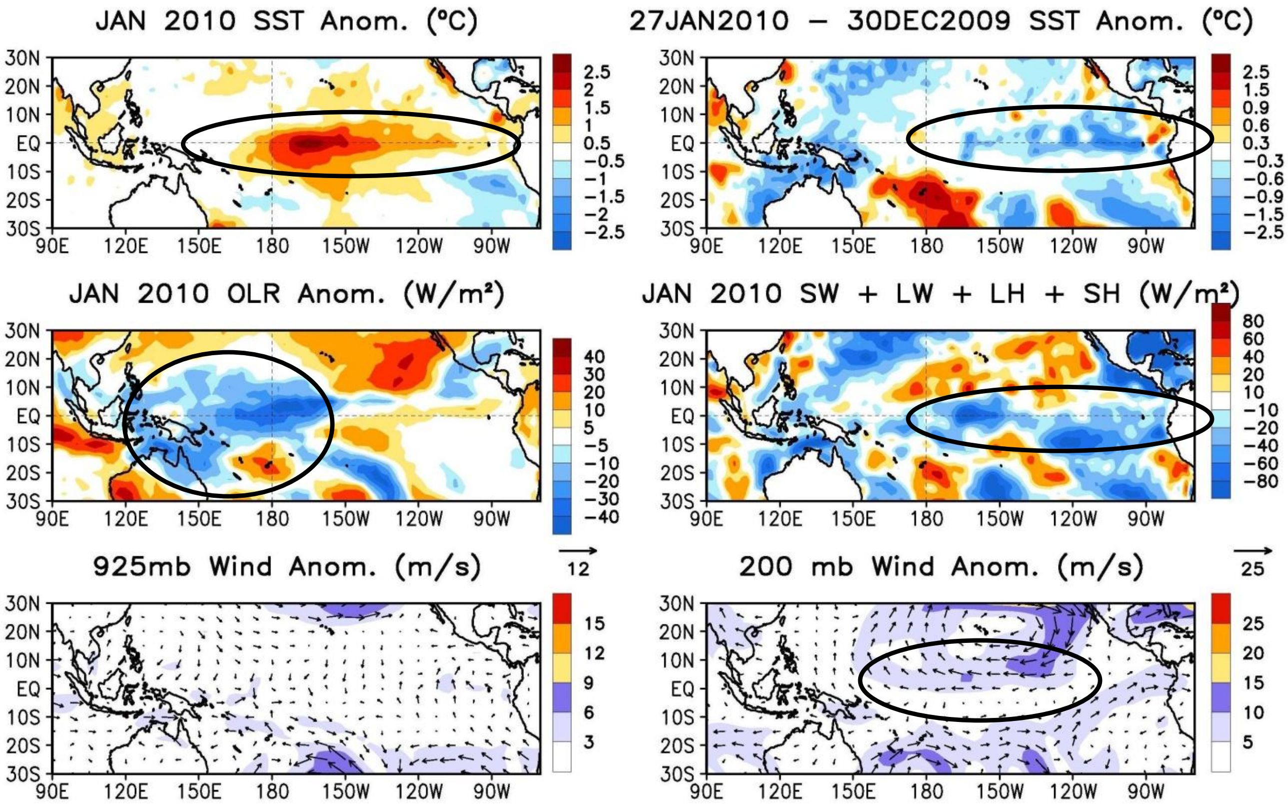


09/10 El Nino



- **The evolution of oceanic Kelvin wave episodes during the 09/10 El Nino is very similar to that during the 06/07 El Nino.**
- **The downwelling Kelvin wave initiated in early Oct 09 and upwelling Kelvin wave initiated in late Oct 09 in the western Pacific are very similar to those that occurred in late Oct 06 and early Nov 06.**
- **The downwelling oceanic Kelvin wave occurred in late Dec 09 in the east-central Pacific, which terminated the upwelling Kelvin wave in the west and central Pacific.**

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

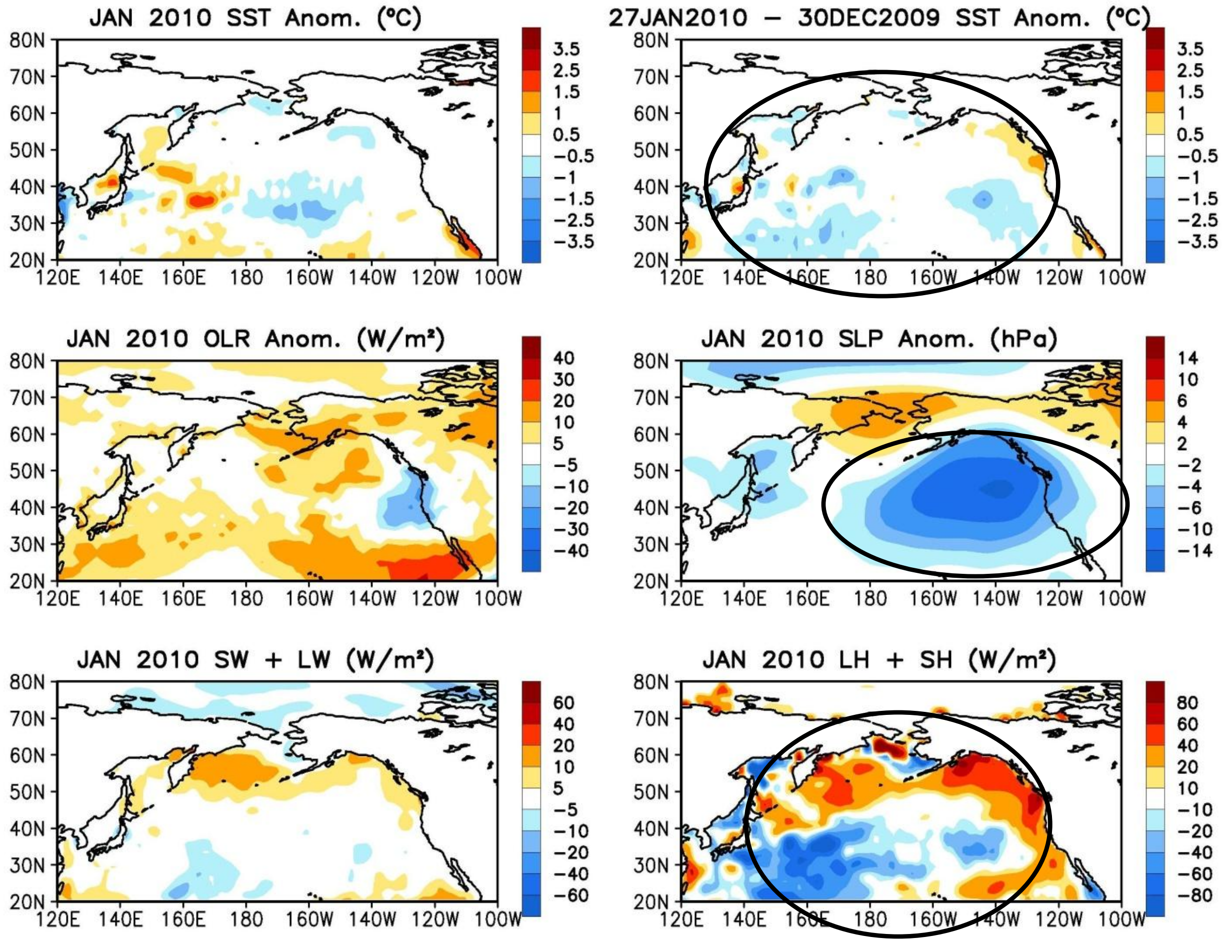


- Positive SSTA presented in the central equatorial Pacific.
- Convection was enhanced over the Maritime Continent and western Pacific.
- Negative SSTA tendency in the tropical eastern Pacific is consistent with net surface heat flux anomaly.
- Easterly wind anomaly were present at the upper-level in the central tropical Pacific.

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

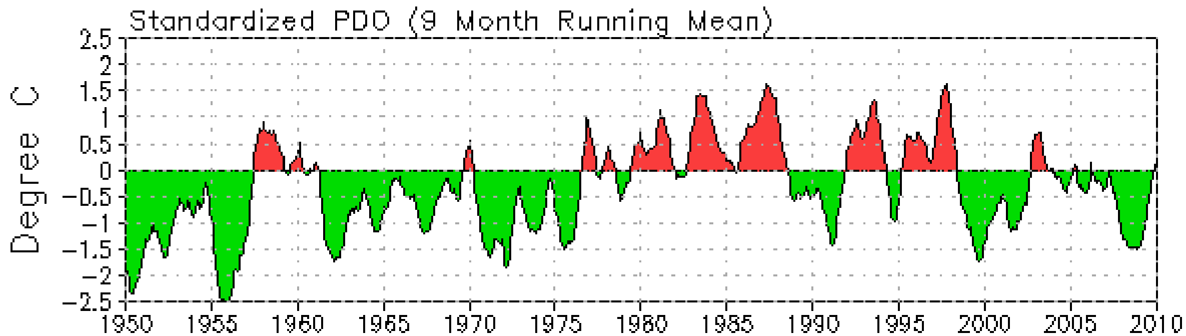


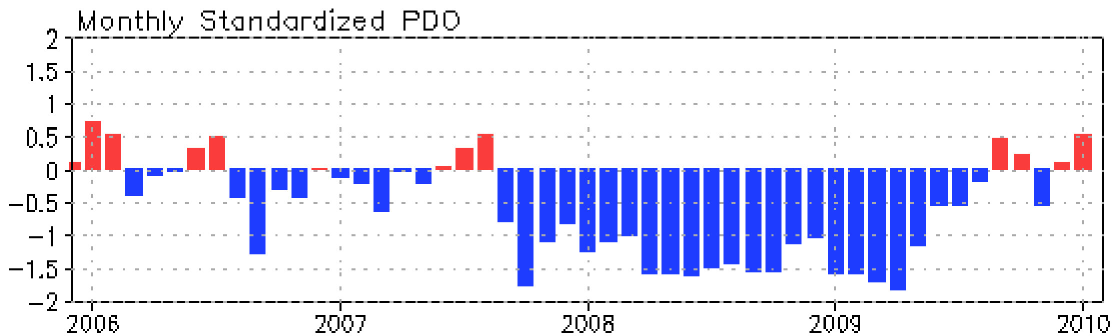
- **The SSTA tendency was largely consistent with the net surface heat flux anomalies, indicating a tendency towards positive PDO pattern.**
- **Below-normal sea level pressure were present in the central North Pacific and the Arctic Ocean, consistent with the negative AO phase**

(AO = -2.6).

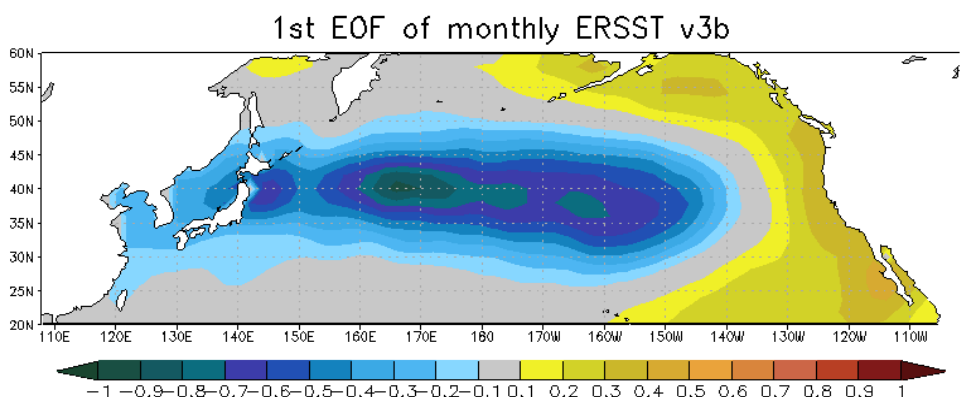
Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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





- **PDO index became above-normal in Jan 10.**

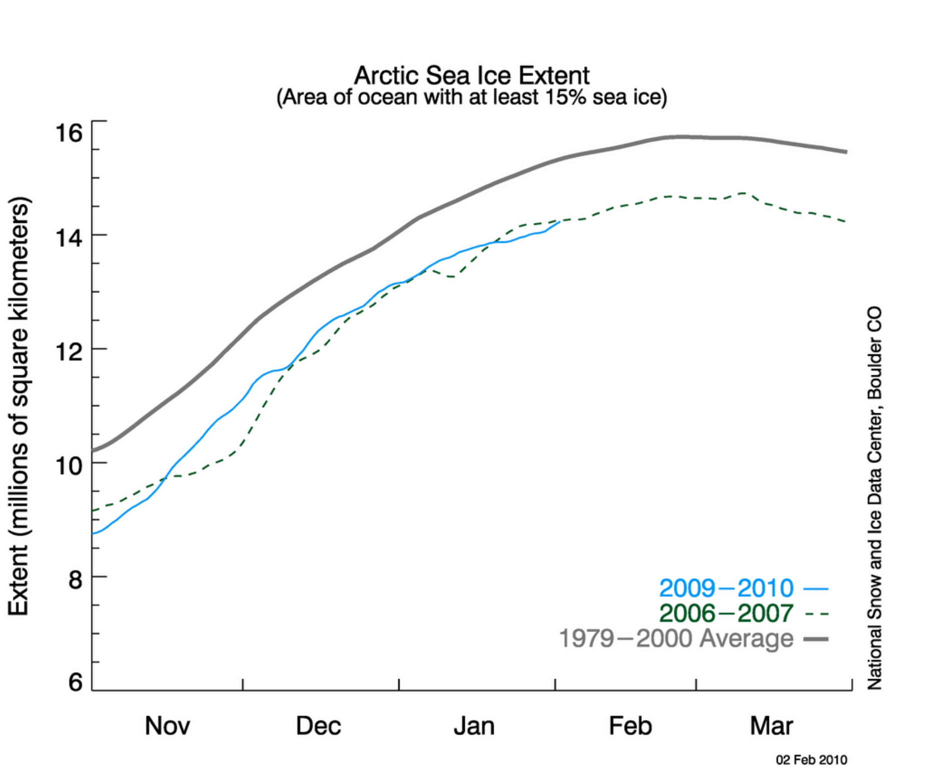


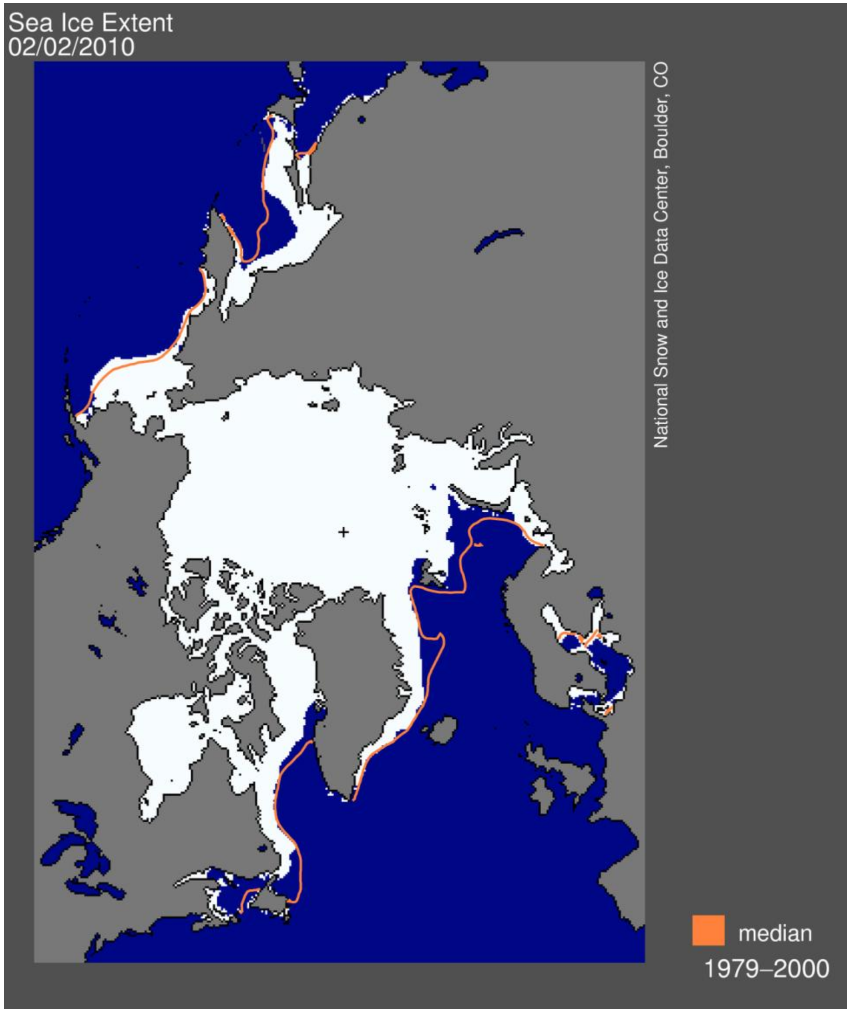
- **Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.**
- **The PDO index differs slightly from that of JISAO, which uses a blend of UKMET and OIv1 and OIv2 SST.**

Arctic Sea Ice

National Snow and Ice Data Center

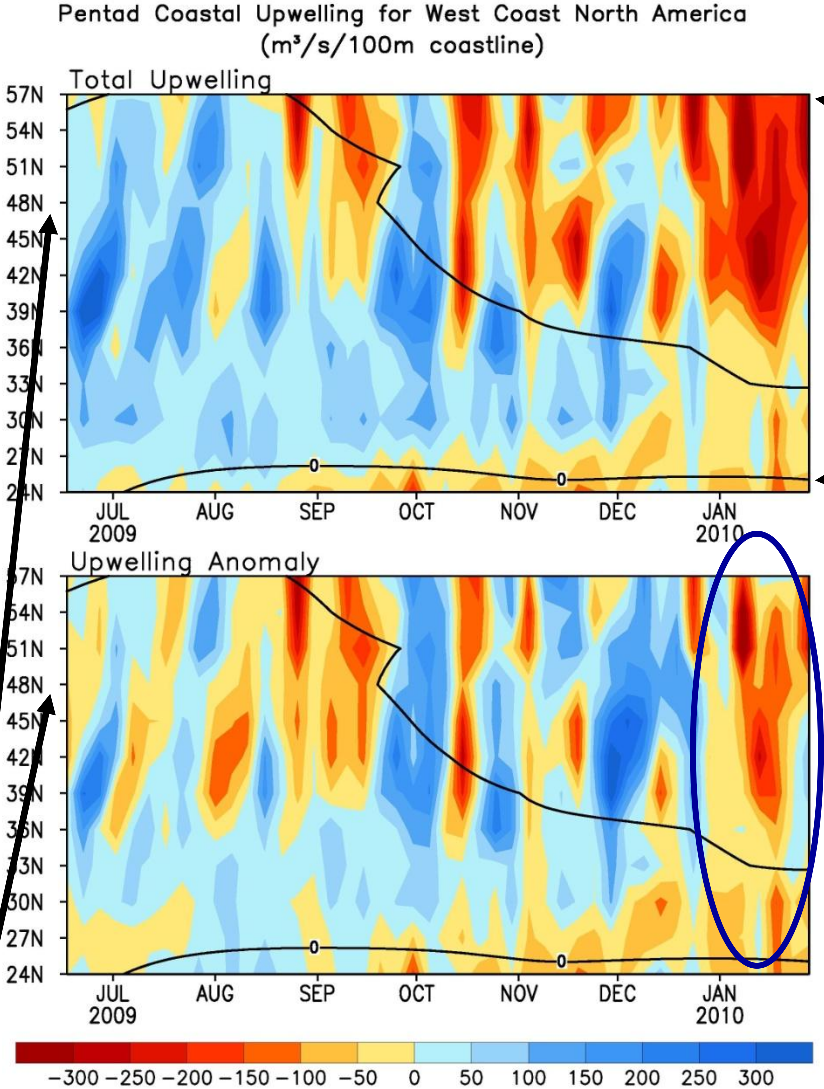
http://nsidc.org/arcticseaicenews/index.html

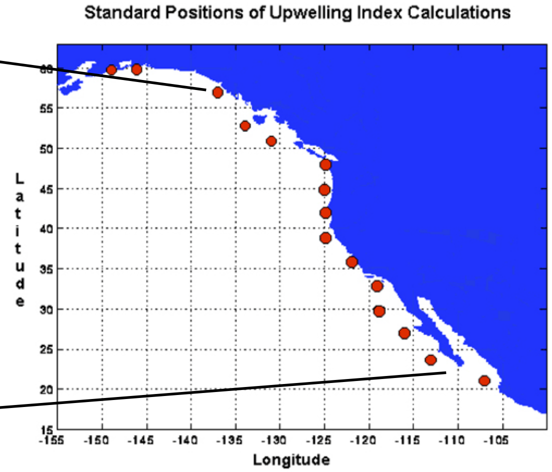




- Sea ice extent continued to increase seasonally, but was near the historic low value in Jan 2009.

North America Western Coastal Upwelling



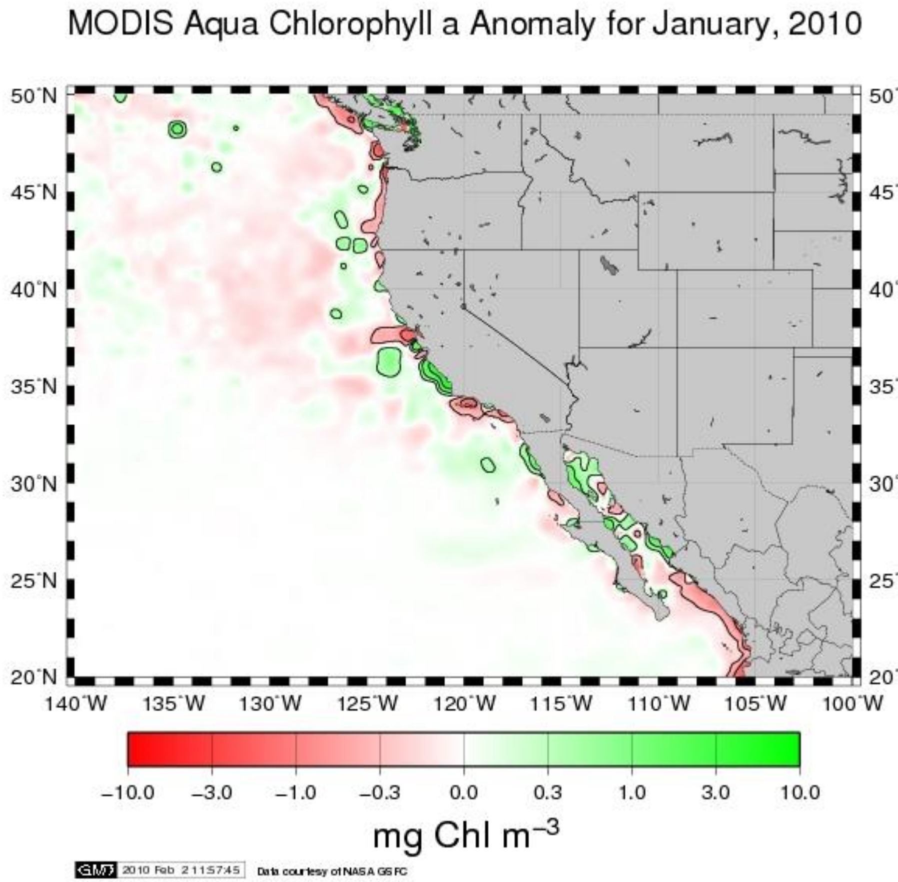


- Upwelling north of 30N was well below-normal in Jan 10.

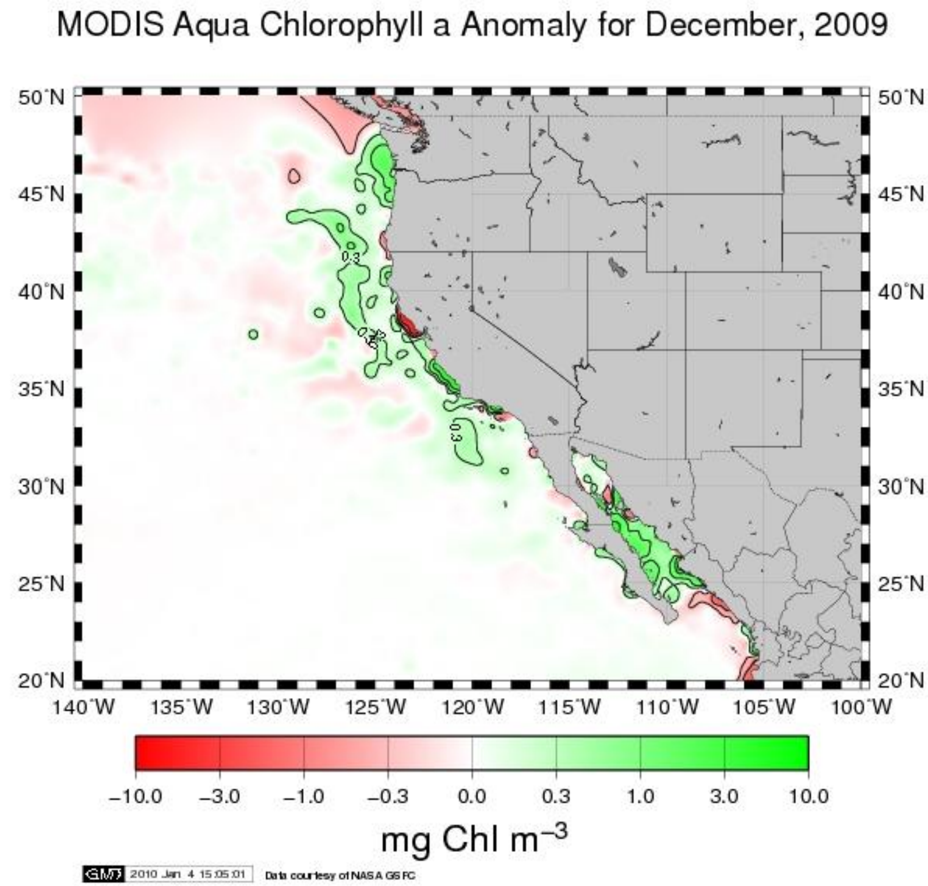
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport 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

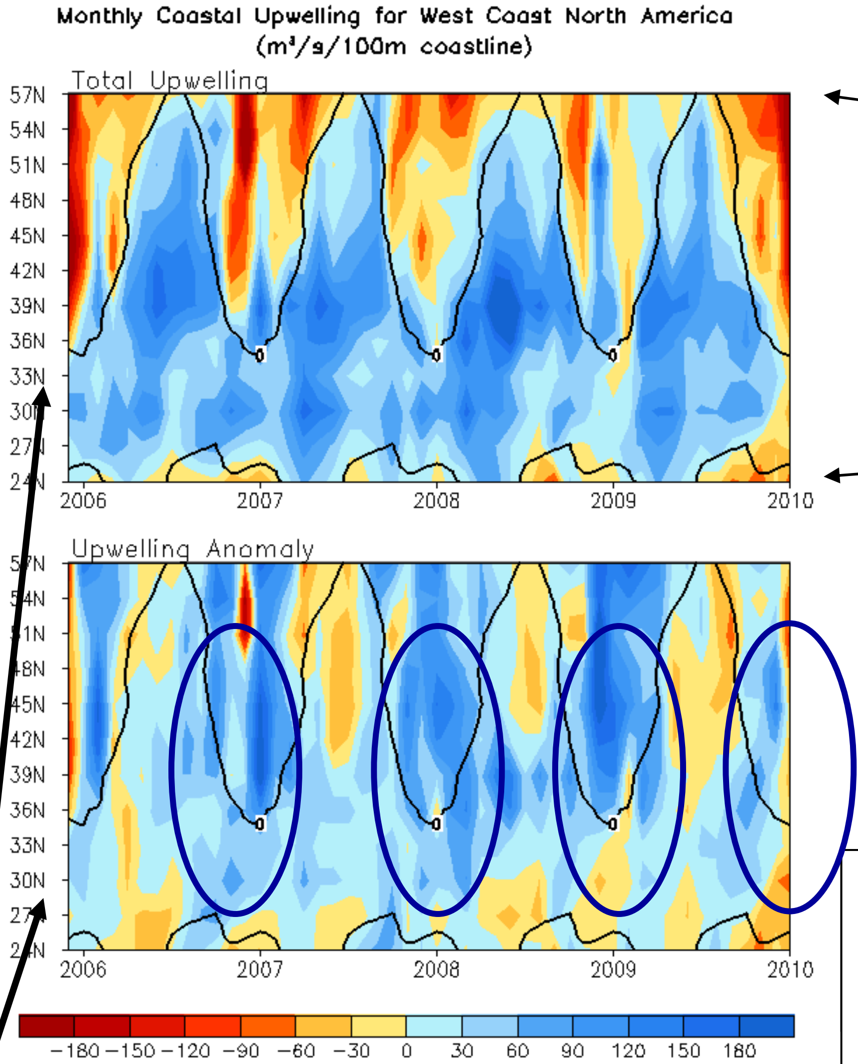


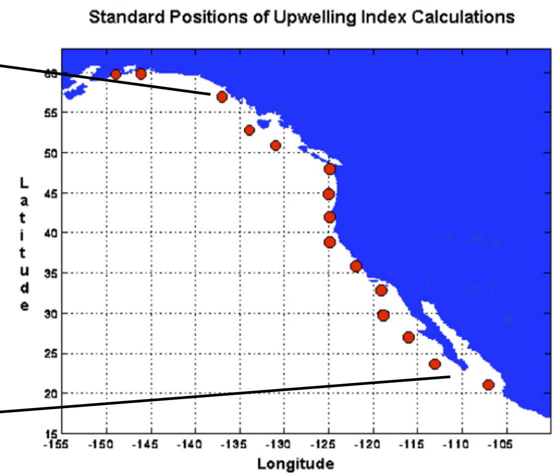
- Chlorophyll was mostly below- (above-) normal in Jan 10 (Dec 09), consistent with the upwelling anomalies.



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

North America Western Coastal Upwelling





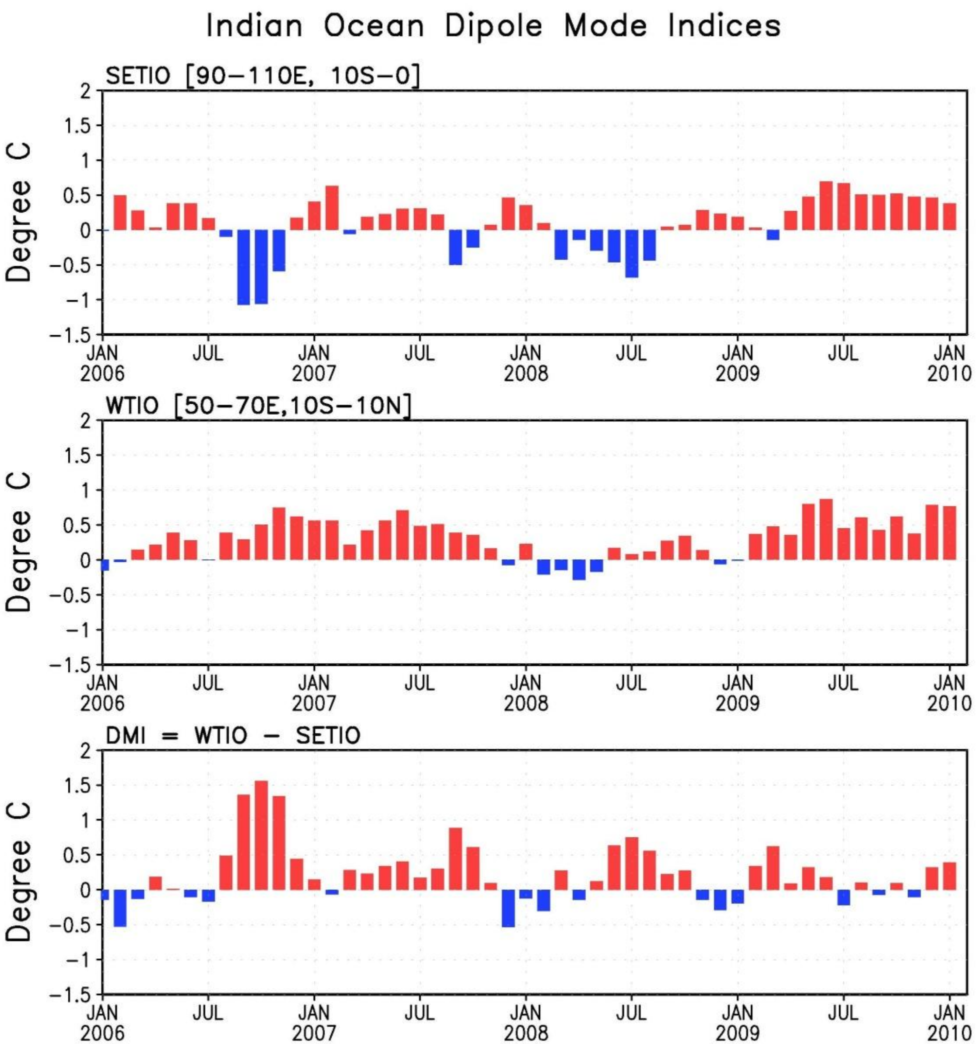
- Upwelling has been above-normal during the winter of 06/07, 07/08, and 09/10.

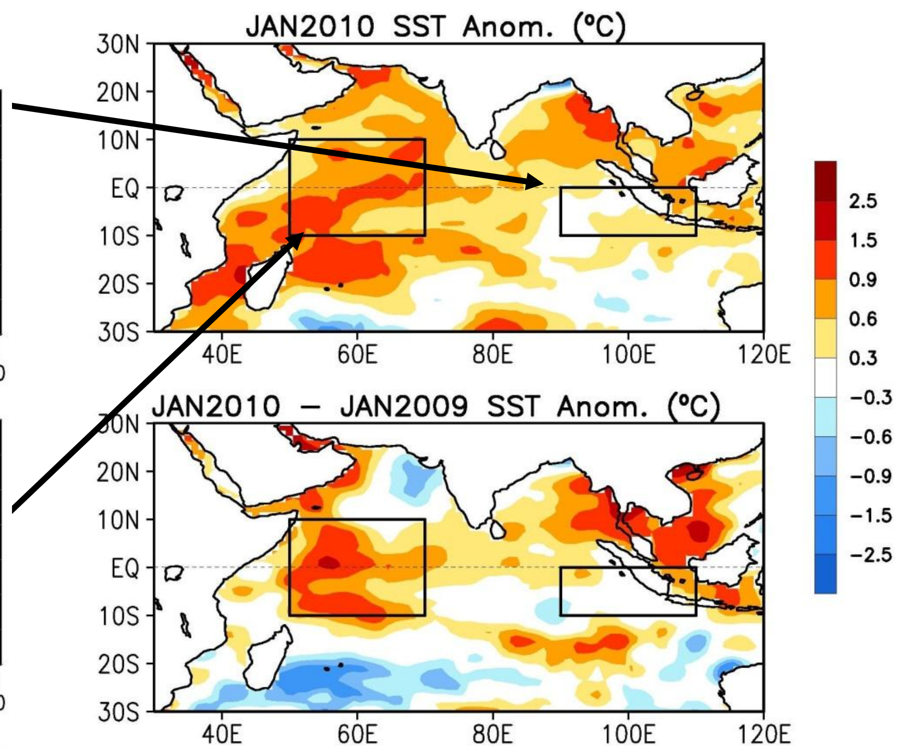
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport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

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

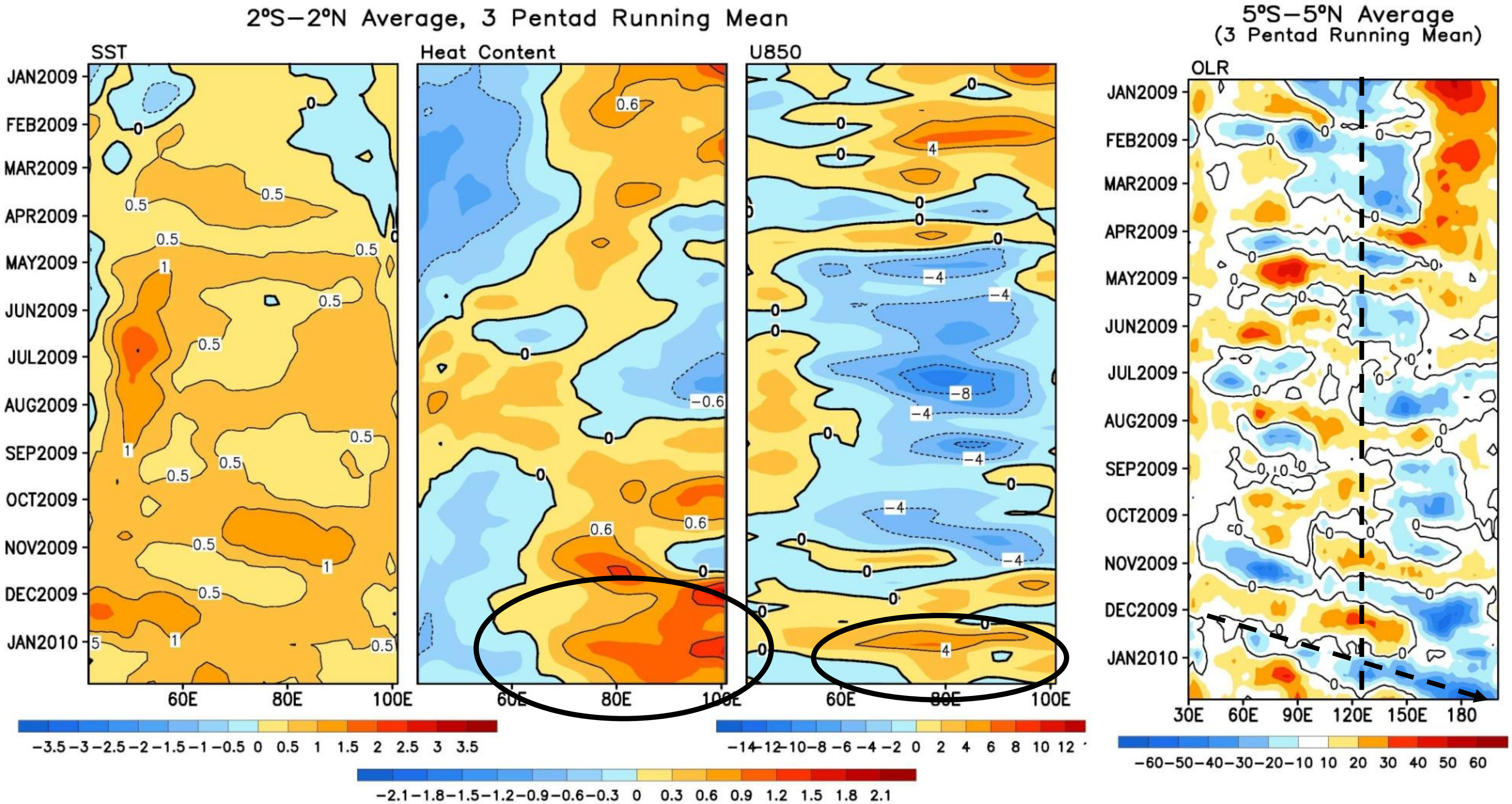




- **Both eastern (SETIO) and western (WTIO) pole SST have been persistently above-normal since April 09.**
- **DMI has been near-normal since March 09.**

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.

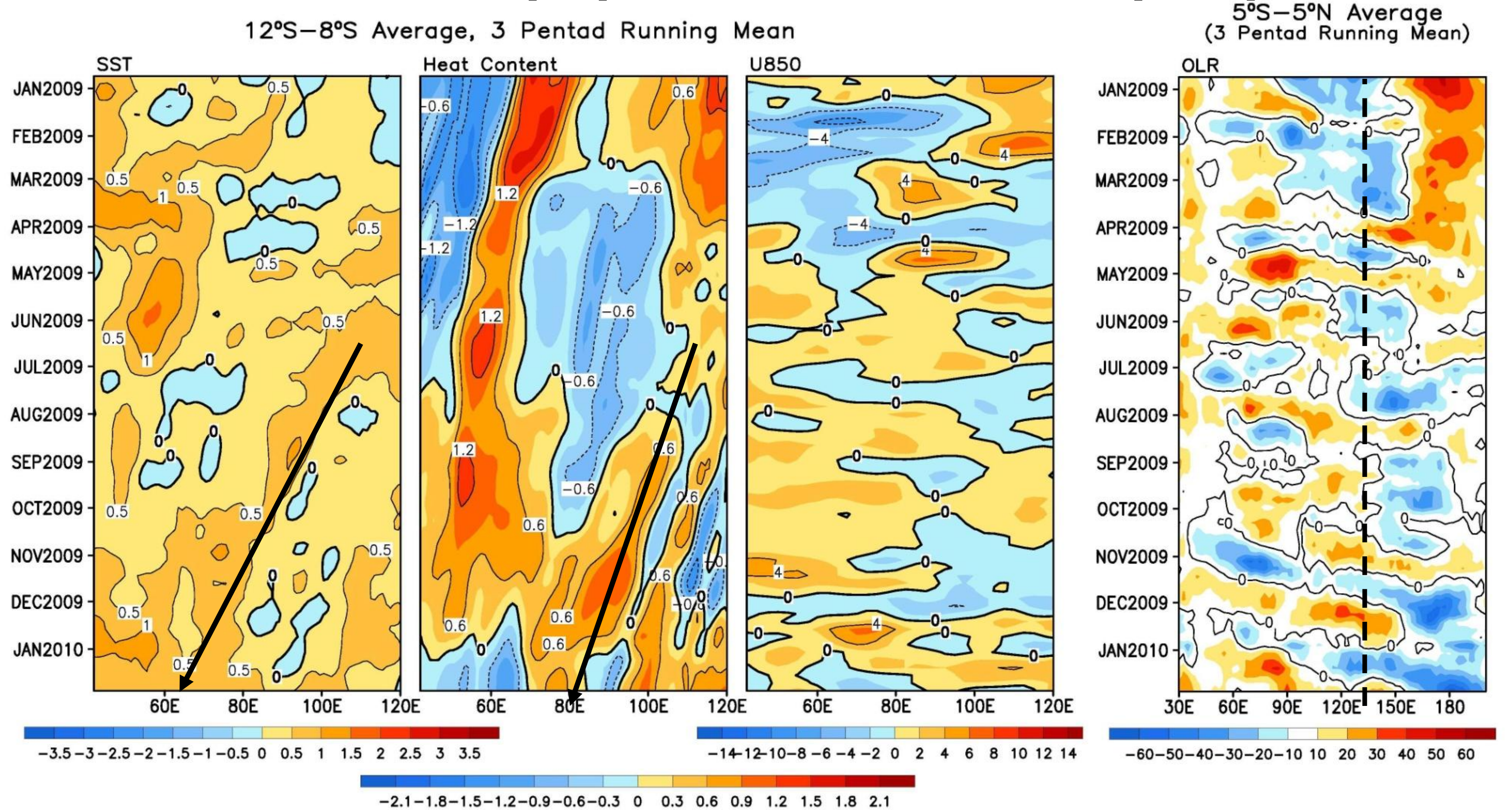
Recent Evolution of Equatorial Indian SST (ºC), 0-300m Heat Content (ºC), 850-mb Zonal Wind (m/s) and OLR (W/m²) Anomalies



- **Westerly wind anomalies weakened in the tropical Indian Ocean in Jan 10, probably associated with the recent MJO activity.**
- **In response to the weakened westerly wind anomalies, positive heat content anomaly in the east-central tropical Indian Ocean weakened slightly.**
- **Positive SSTA weakened slightly in the tropical Indian Ocean in Jan 09.**

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 2ºS-2ºN and Outgoing Long-wave Radiation (OLR, right) averaged in 5ºS-5ºN. 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)



- **Westward propagation of positive HCA and SSTA near 10°S since Apr 09.**

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.

- Positive SSTA presented in the tropical Indian Ocean.
- Net surface heat flux anomalies contributed to the positive SSTA tendency in the subtropical western Indian Ocean.
- Convection was suppressed (enhanced) in the central tropical Indian Ocean (over the Maritime Continent).
- Consistent with the convection pattern were low-level westerly wind anomalies in the eastern tropical Indian Ocean.

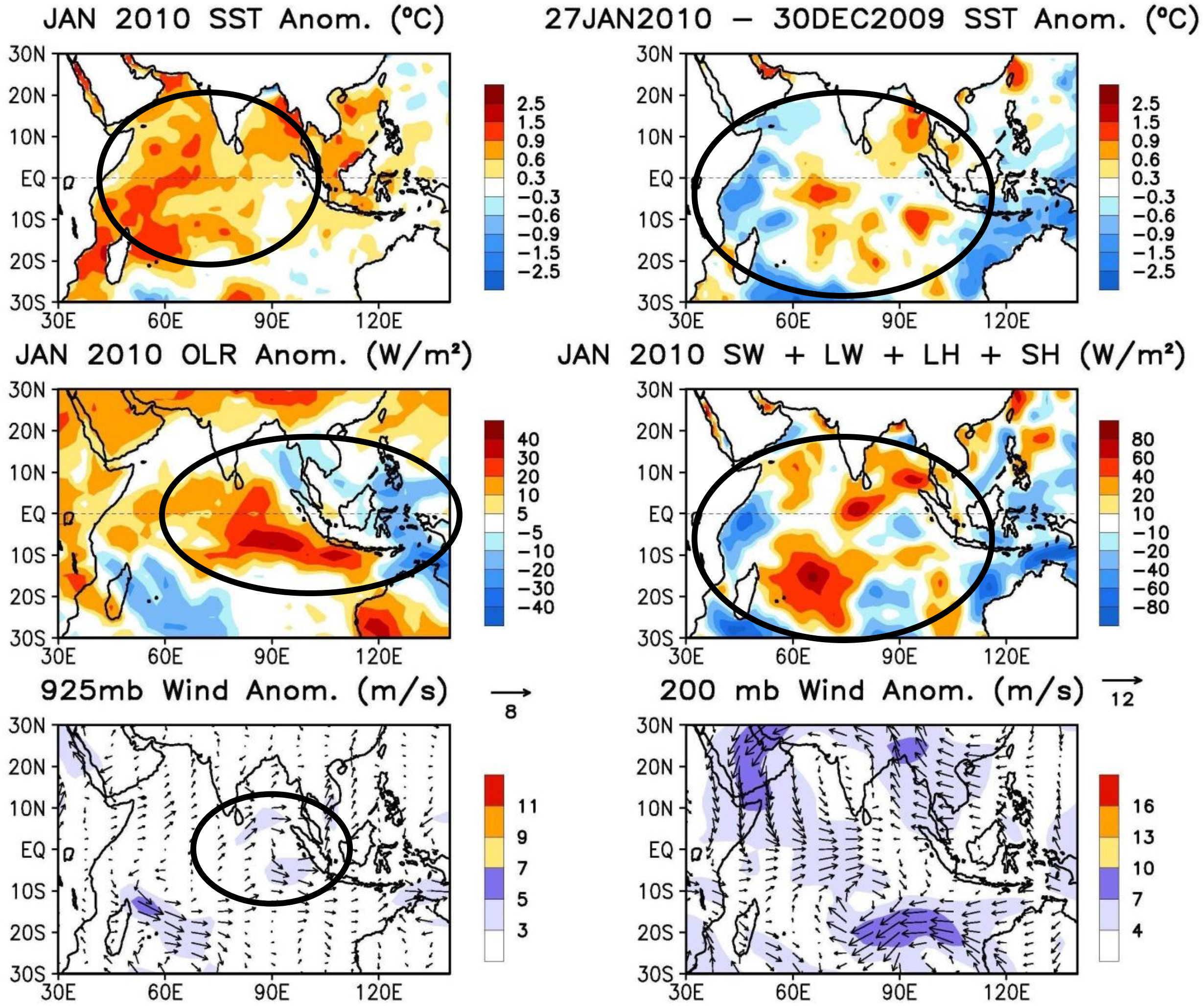
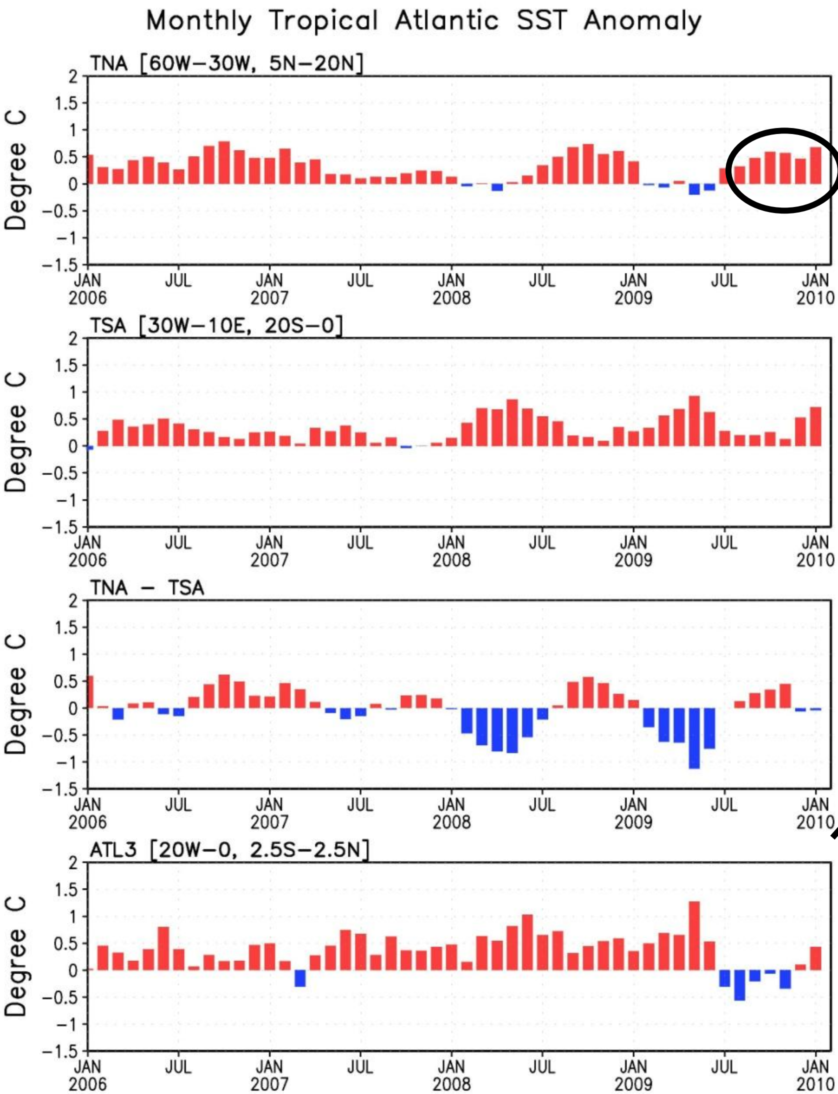
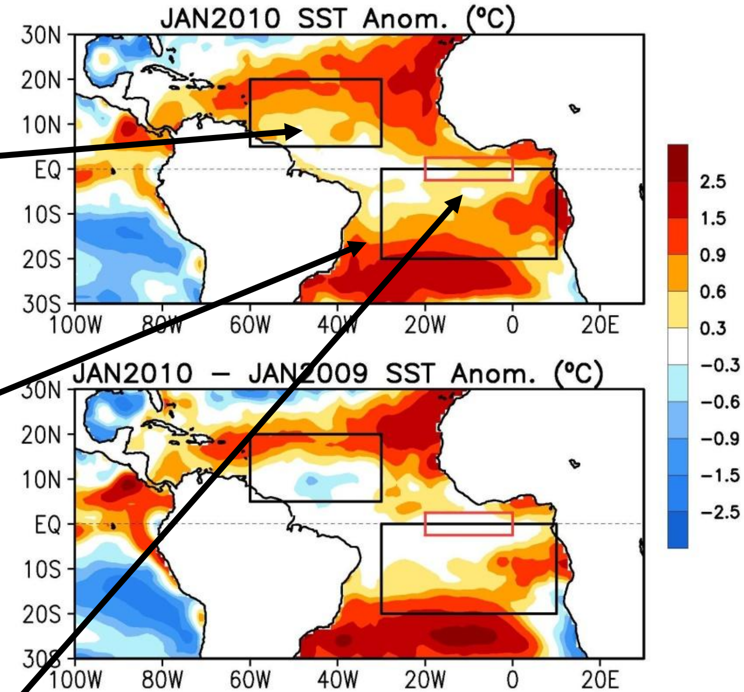


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude (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

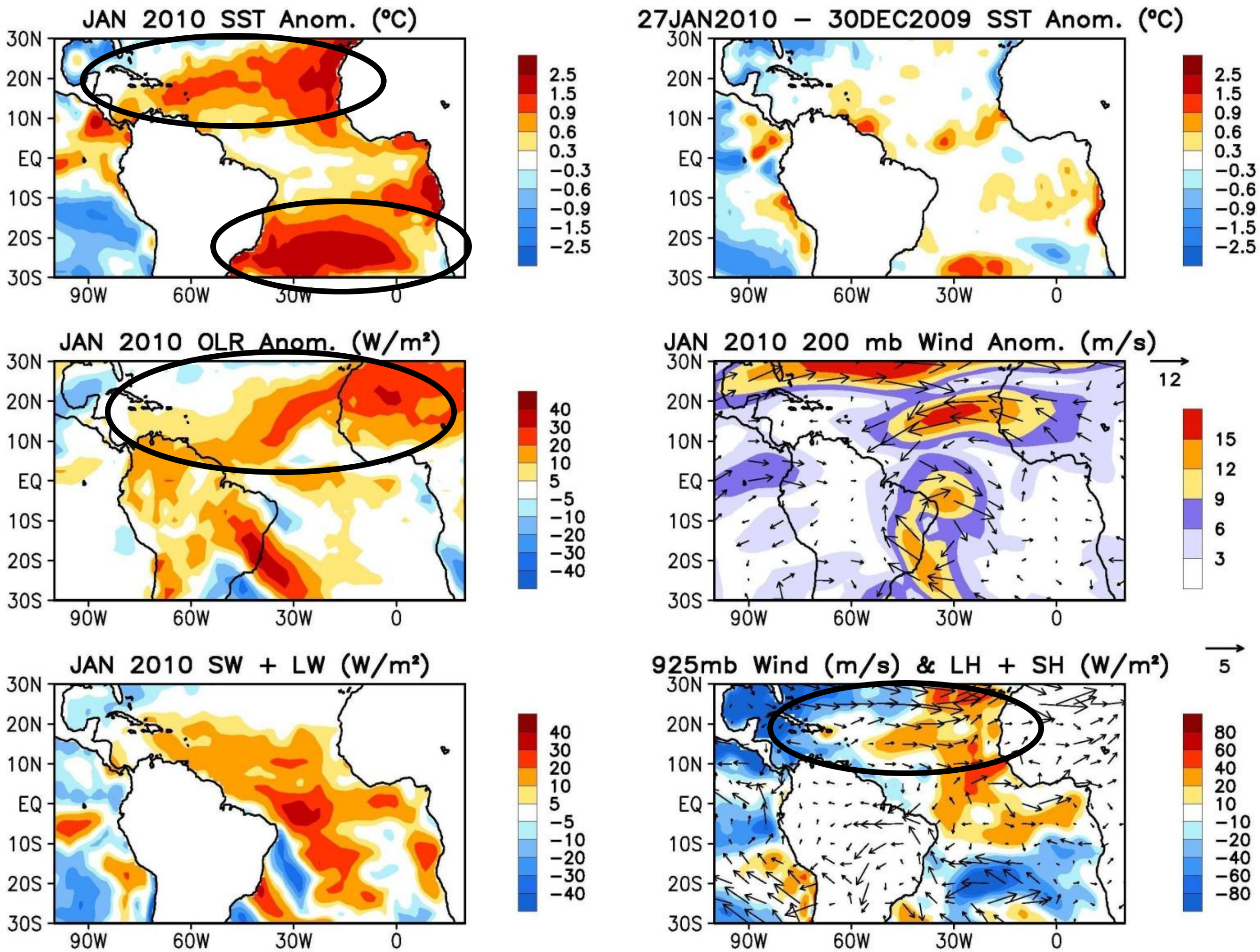




- Tropical North Atlantic SST (TNA) was above-normal from Jul-Dec 09 to Jan 10.
- Tropical South Atlantic SST (TSA remained above-normal.
- Meridional Gradient Mode (TNA-TSA) was near-normal.
- ATL3 SST was slightly above-normal.

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 persisted in the tropical North Atlantic, and subtropical South Atlantic.**
- **Convection was suppressed in the tropical North Atlantic and northern Africa, which might be forced by the Pacific El Nino.**
- **Strong wind anomalies in the subtropical North Atlantic, which appears related to the negative NAO, cooled (warmed) SST north (south) of 30ºN.**

North Atlantic Ocean

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

- NAO was well below-normal (-1.1) in Jan 10 (next slide).
- SSTA tendencies were largely consistent with net surface heat flux anomalies.

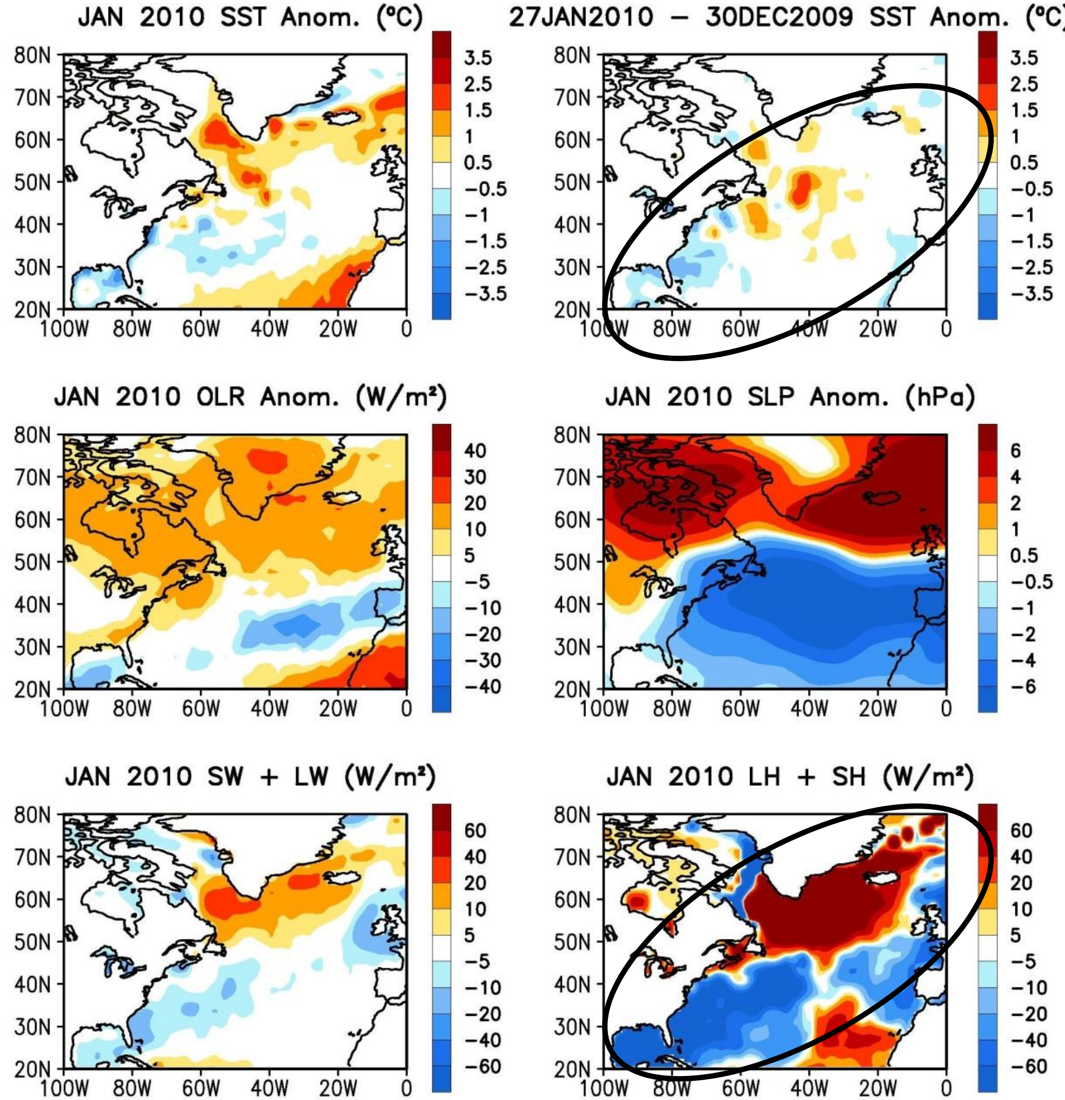
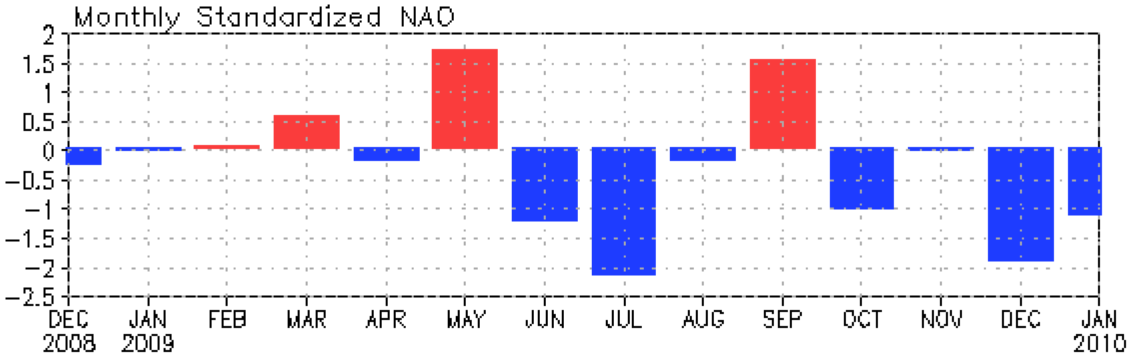
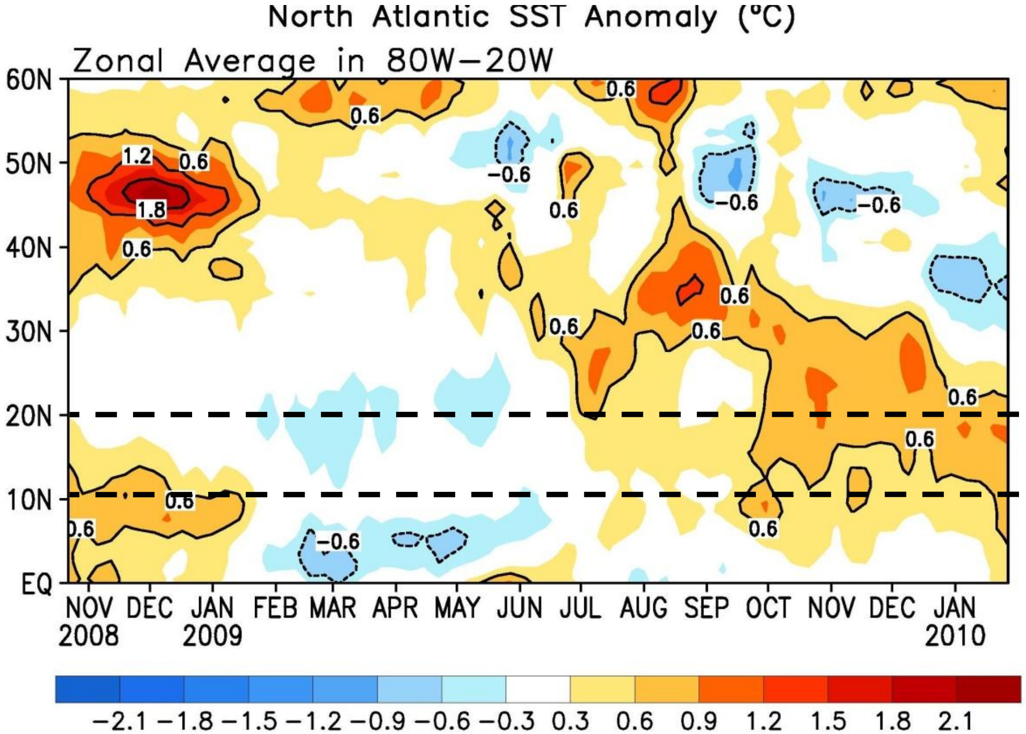
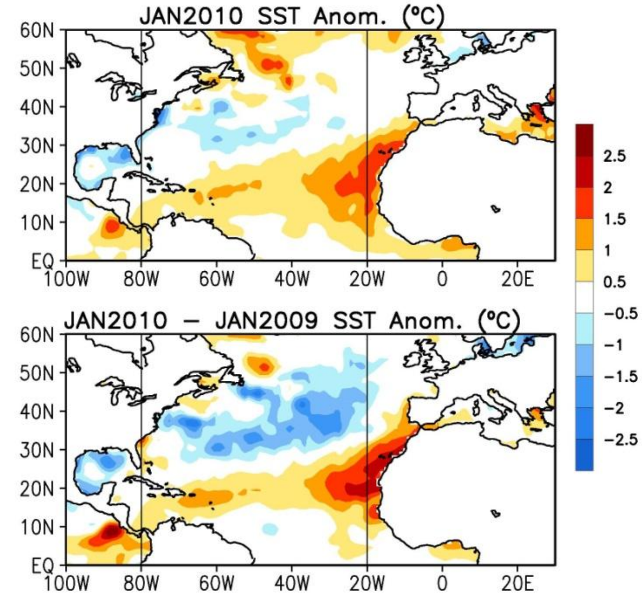


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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



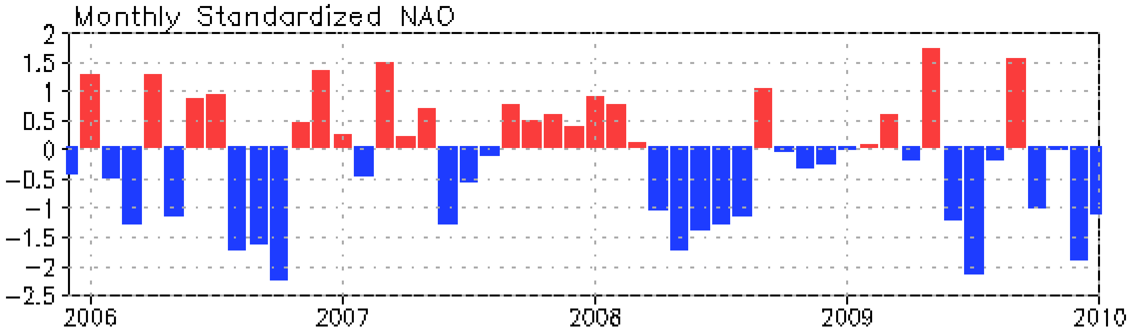


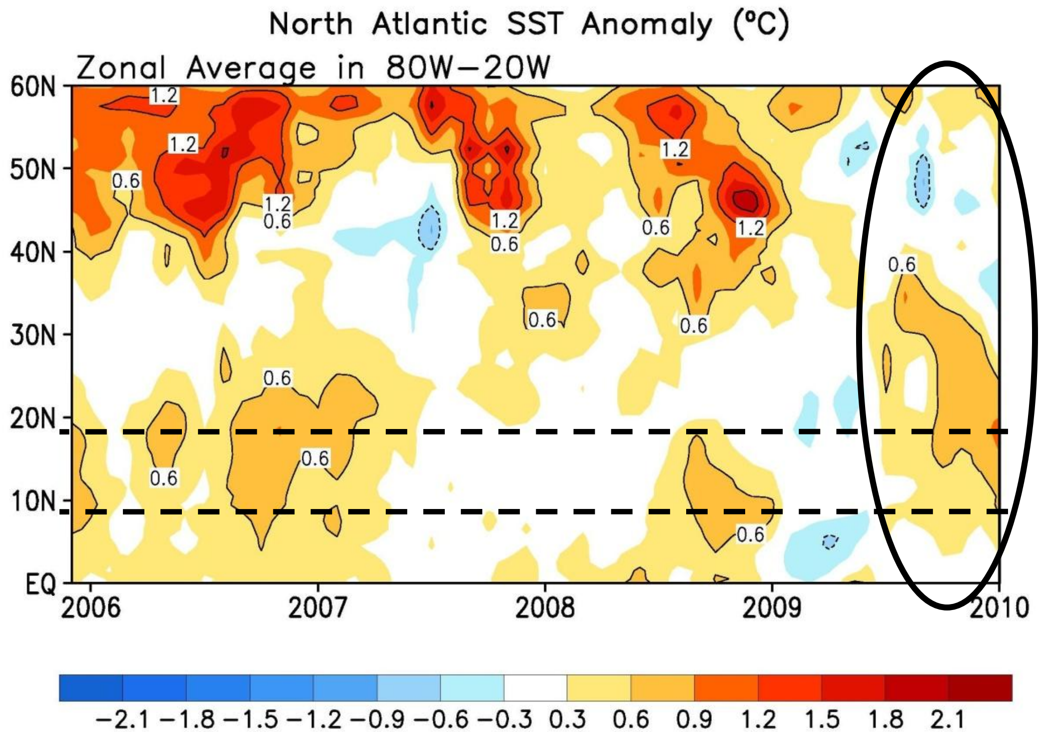


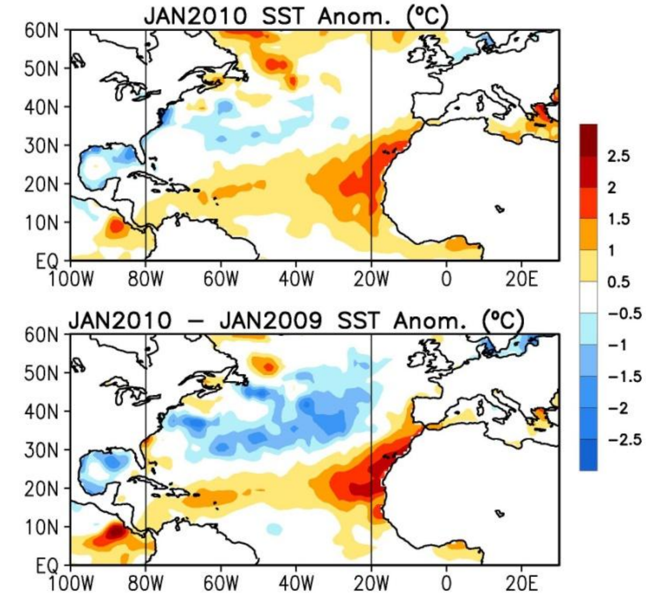
- **High-latitude North Atlantic SSTA are closely related to NAO index – negative (positive) NAO leads to SST warming (cooling).**
- **NAO was below-normal in Dec 09 and Jan 10.**
- **Positive SSTA in the Hurricane Main Development Region persisted in Jan 10.**

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.

NAO and SST Anomaly in North Atlantic







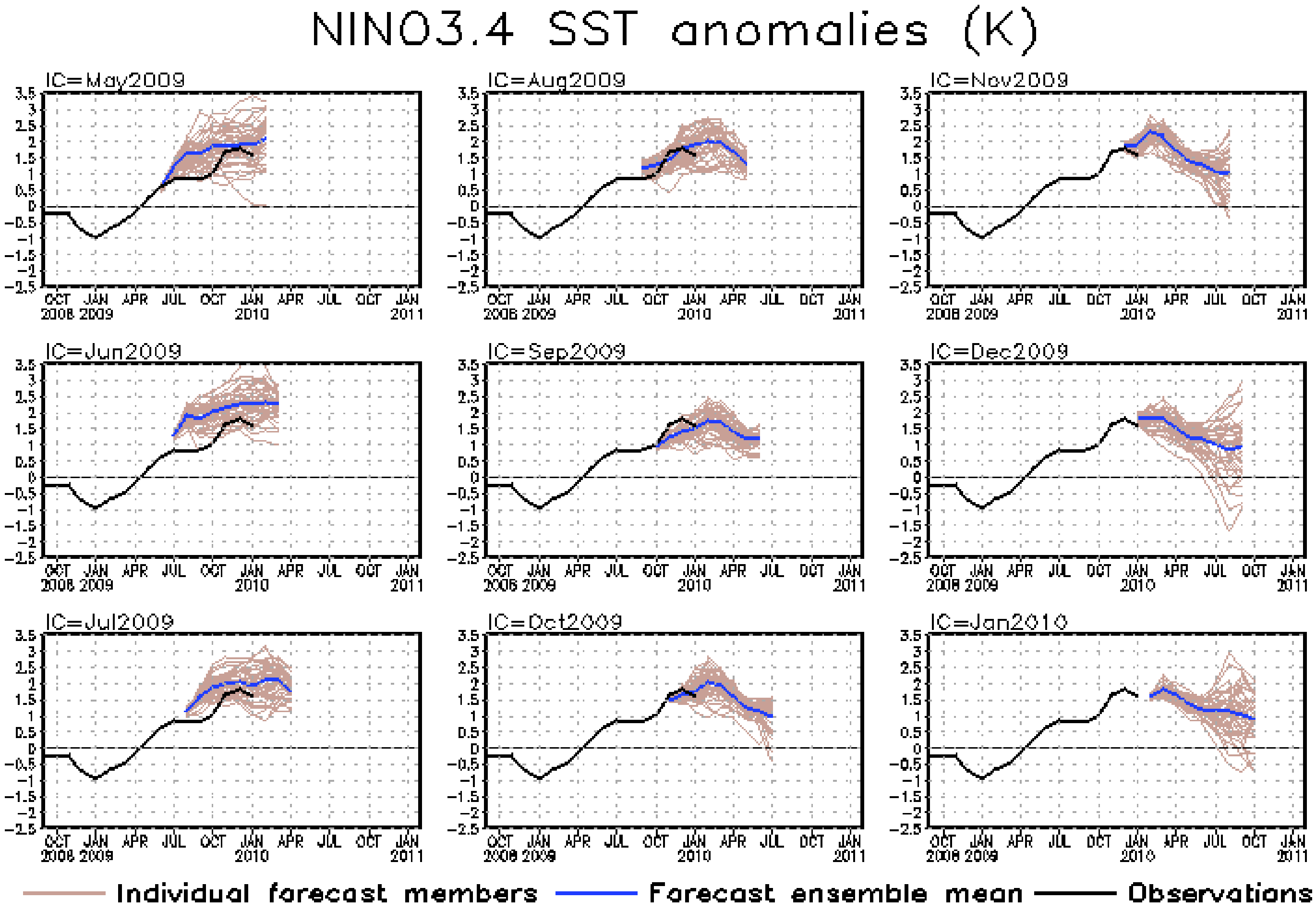
- Mid-latitude North Atlantic SSTs cooled down and became slightly below-normal since Feb 09.

- SST in the Hurricane Main Development Region was weakly above-normal in summer/fall 09, similar to summer/fall 2008.

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.

CFS SST Predictions and Ocean Initial Conditions

CFS Niño3.4 SST Predictions from Different Initial Months



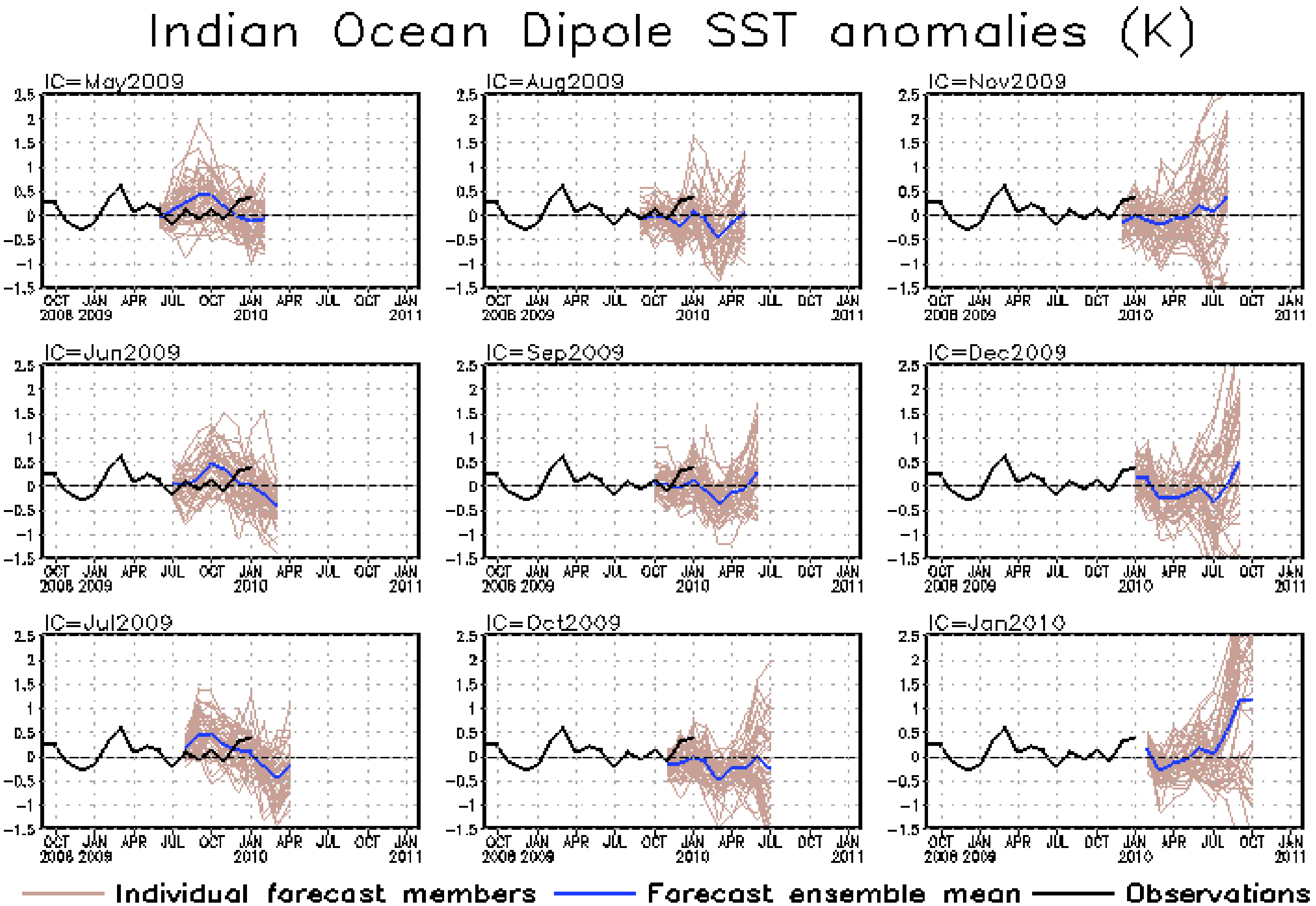
- Too warm forecasts from May-Jul I.C.

- Good forecasts from Aug-Oct I.C.

- Latest forecasts suggest the current El Nino will persist in next 1-2 months, and then decay rapidly in spring, returning to near-normal conditions in summer 2010.

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.

CFS DMI SST Predictions from Different Initial Months



DMI = WTIO- SETIO

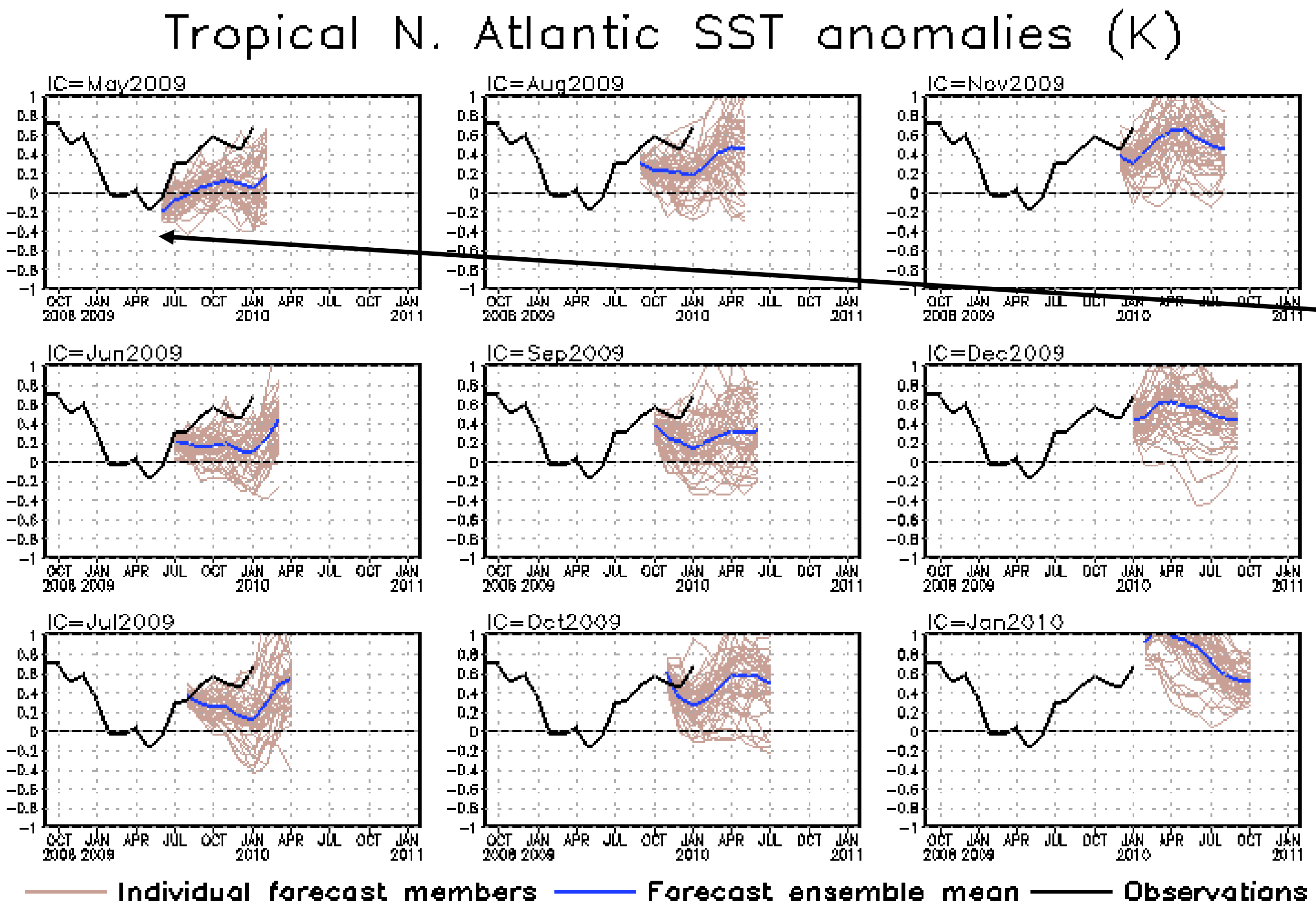
SETIO = SST anomaly in [90ºE-110ºE, 10ºS-0]

WTIO = SST anomaly in [50ºE-70ºE, 10ºS-10ºN]

- Latest forecasts called for near-normal Dipole Mode Index in spring/summer 2010.

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°W-30°W, 5°N-20°N].

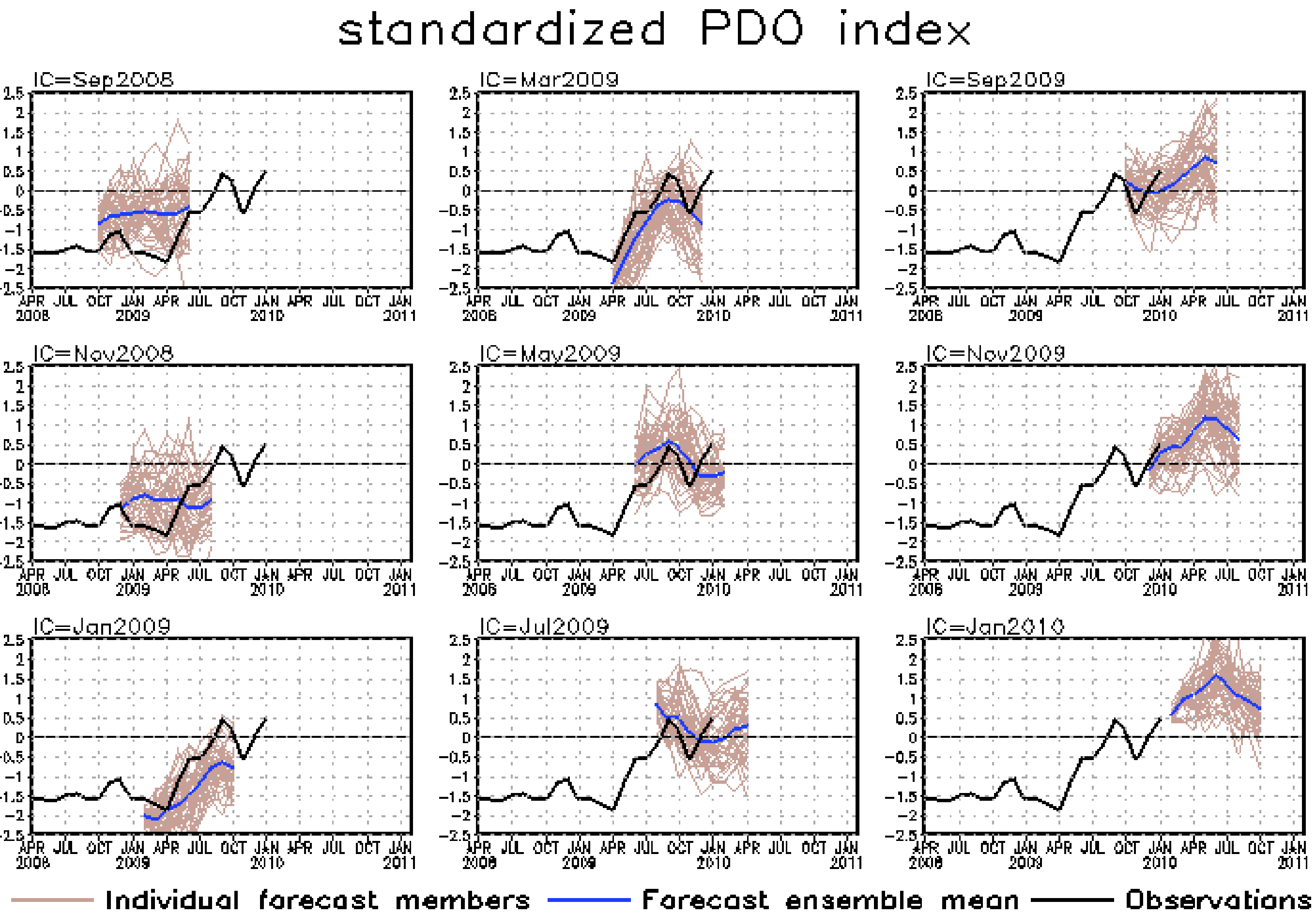
- Missed the warming trend in early summer from May I.C.

- Damped the initial positive SSTA from Jun-Sep I.C.

- Latest forecasts suggested that the positive tropical North Atlantic SST anomalies would strengthen in early spring 2010 due to the impacts of the 09/10 El Nino.

Fig. M3. CFS Tropical North Atlantic (TNA) SST predictions from the latest 9 initial months. Displayed are 40 forecast members (brown) made four times per day initialized from the last 10 days of the initial month (labelled as IC=MonthYear) as well as ensemble mean (blue) and observations (black). 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.

- Nice forecasts from Jan 09 to Nov 09 I.C.

Latest forecasts suggested that the PDO will be above-normal in spring/summer 2010.

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.

Summary

- **Pacific Ocean**
  - **El Niño conditions (NINO 3.4 > 0.5 ^{o}C), which established in Jun 09, persisted during Jul-Oct 09, strengthened substantially in Nov 09, persisted in Dec 09, and weakened slightly in Jan 10, are expected to continue into April-May-June 10;**
  - **Westerly wind bursts events, active in Jul, Sep, Oct, Dec 09, contributed to the maintenance and strengthening of the 2009/10 El Niño;**
  - **PDO was near-normal in Aug-Dec 2009, and became above-normal in Jan 10;**
  - **Upwelling along the west coast of North America was well below-normal in Dec 09.**
- **Indian Ocean**
  - **Westerly wind anomalies weakened in the central tropical Indian Ocean in Jan 10, probably associated with the Madden-Julian Oscillation activity;**
  - **Positive SSTA weakened slightly in the tropical Indian Ocean in Jan 10, and Dipole Mode Index has been near-normal since Mar 09.**
- **Atlantic Ocean**
  - **Positive SST anomalies in the tropical North Atlantic and subtropical South Atlantic persisted from Sep 09 to Jan 10;**
  - **Convection was mostly suppressed in the tropical North Atlantic;**
  - **NAO is -1.1 in Jan 10; Mid-latitude North Atlantic SSTs have been unusually near-normal from Feb 09 to Jan 10.**

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!