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)

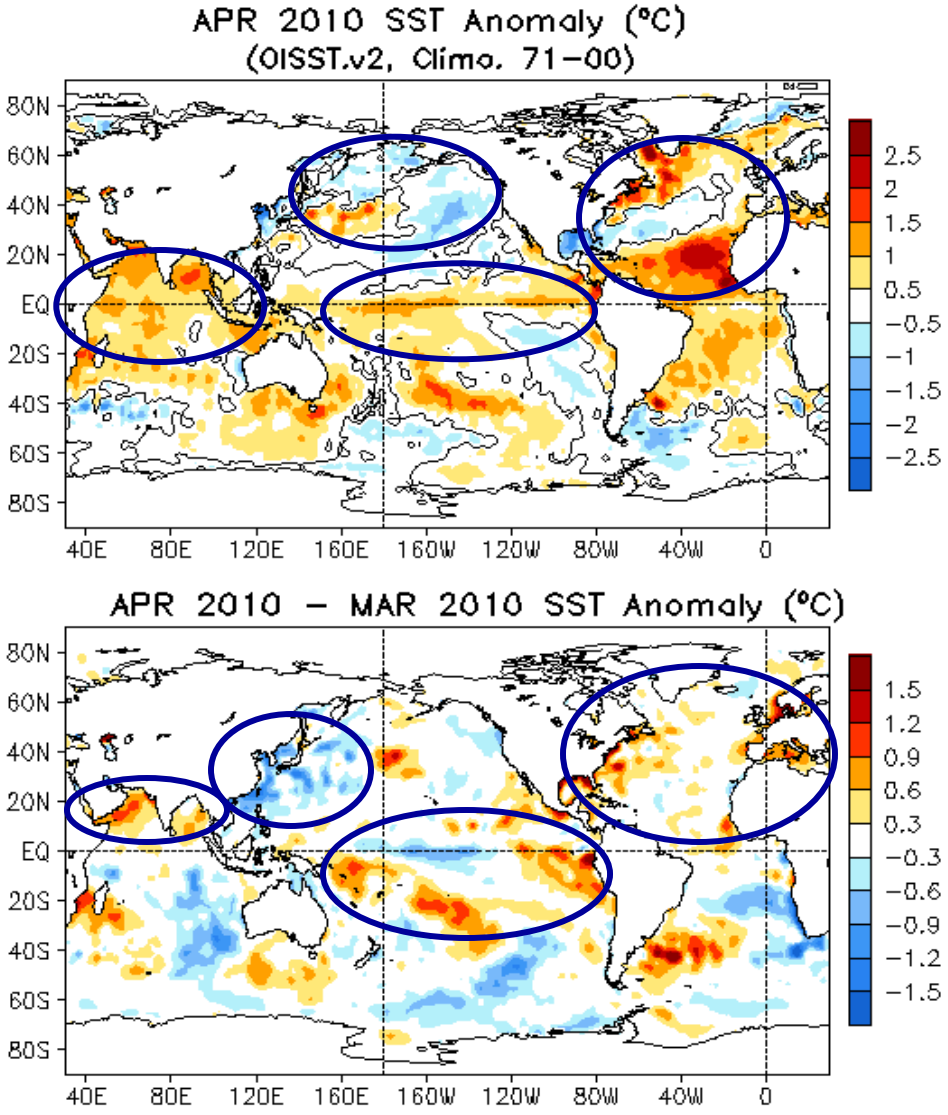
Outline

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

Overview

- **Pacific / Arctic Ocean**
  - El Niño conditions (NINO 3.4 > 0.5 ºC) peaked in Dec 09, and weakened steadily since then, are expected to transition into ENSO-neutral conditions by June 2010;
  - Upwelling oceanic Kelvin waves forced by persistent low-level easterly wind anomalies during Mar-Apr 2010 pushed negative heat content anomalies eastward to near 120ºW and generated westward zonal current anomalies that cover the whole Pacific basin;
  - PDO was near-normal in Aug-Dec 2009, and became weakly above-normal in Jan-Apr 2010;
  - Upwelling along west coast of North America was mostly above-normal in Apr 2010, consistent with above-normal Chlorophyll;
  - Arctic sea ice content was near-normal in Apr 2010, the first time since 2001.
- **Indian Ocean**
  - Positive SSTA enhanced slightly in the tropical Indian Ocean in Apr 2010.
- **Atlantic Ocean**
  - Positive SSTA persisted (weakened) in the tropical North (South) Atlantic in Apr 2010, probably due to the impacts from the Pacific El Nino;
  - Convection was enhanced in the tropical North Atlantic;
  - NAO remained negative in Apr 2010;
  - Mid-latitude North Atlantic SSTs have been unusually below-normal from May 2009 to Apr 2010, and SSTs in hurricane main development region reached historic high in Mar-Apr 2010.

Global SST Anomaly (°C) and Anomaly Tendency

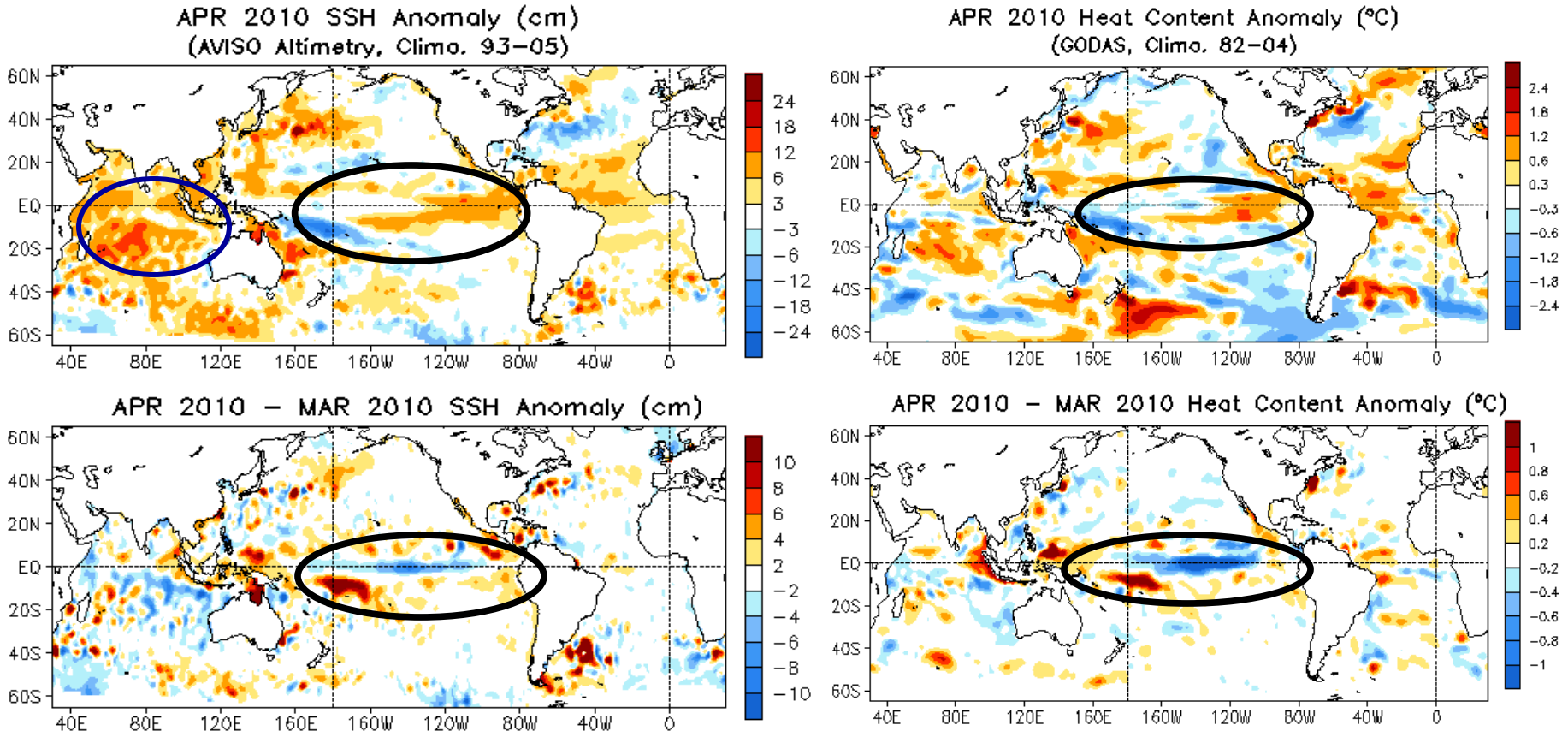


- El Nino condition (NINO 3.4 > 0.5°C) weakened continually in the tropical Pacific;
- PDO was weakly positive (slide 19);
- SST anomaly has a tripole pattern in North Atlantic, and the SST in the tropical North Atlantic was at a historical high value during March-April 2010;
- SST was also above-normal in the tropical Indian Ocean and tropical South Atlantic;

- SST decreased in the central tropical Pacific, but increased in the south-western and eastern tropical Pacific;
- SST decreased in the NW Pacific;
- SST increased along the coast lines of North Atlantic;
- SST increased in the northern Indian Ocean;

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.

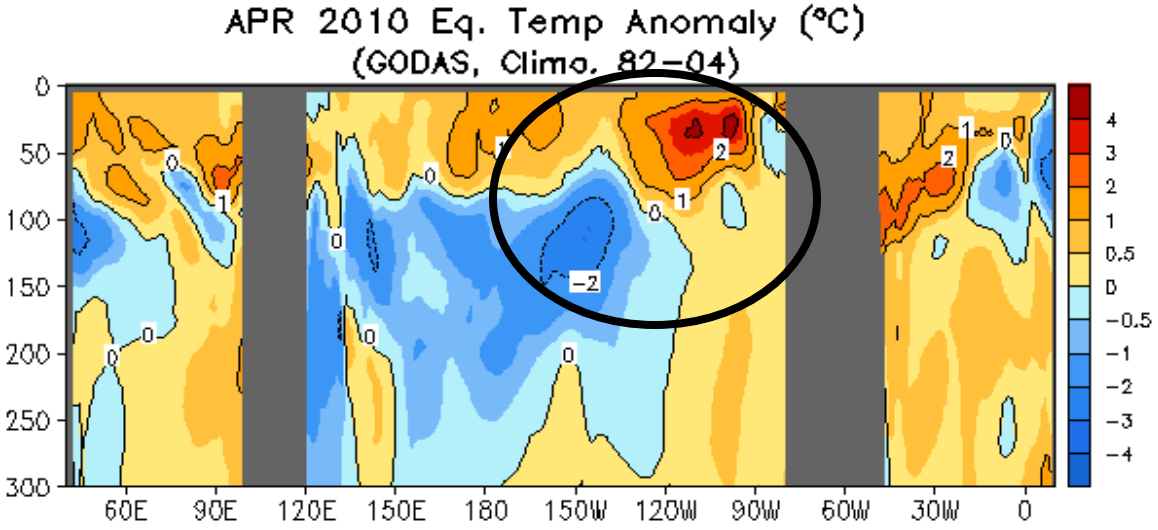
Global SSH / HC Anomaly (cm / °C) and Anomaly Tendency

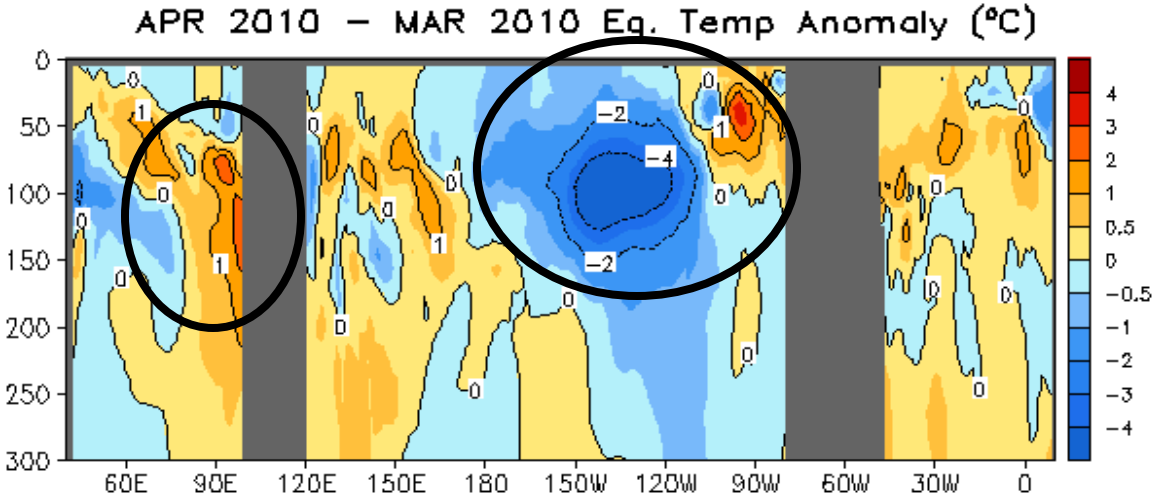


- **Positive (negative) SSHA and HCA were present in the eastern (south-western) tropical Pacific, consistent with the El Nino conditions; The tripole SSHA and HCA pattern in North Atlantic are consistent with the tripole SSTA pattern there.**
- **Negative PDO-like pattern in HCA and SSH in the North Pacific persisted;**
- **SSHA and HCA were largely consistent except in the Southern Ocean where biases in GODAS climatology are large (not shown).**
- **Tendency of SSHA and HCA was largely consistent.**

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 temperature anomalies remained in the top 70m cross the equatorial Pacific, consistent with the El Nino conditions.**

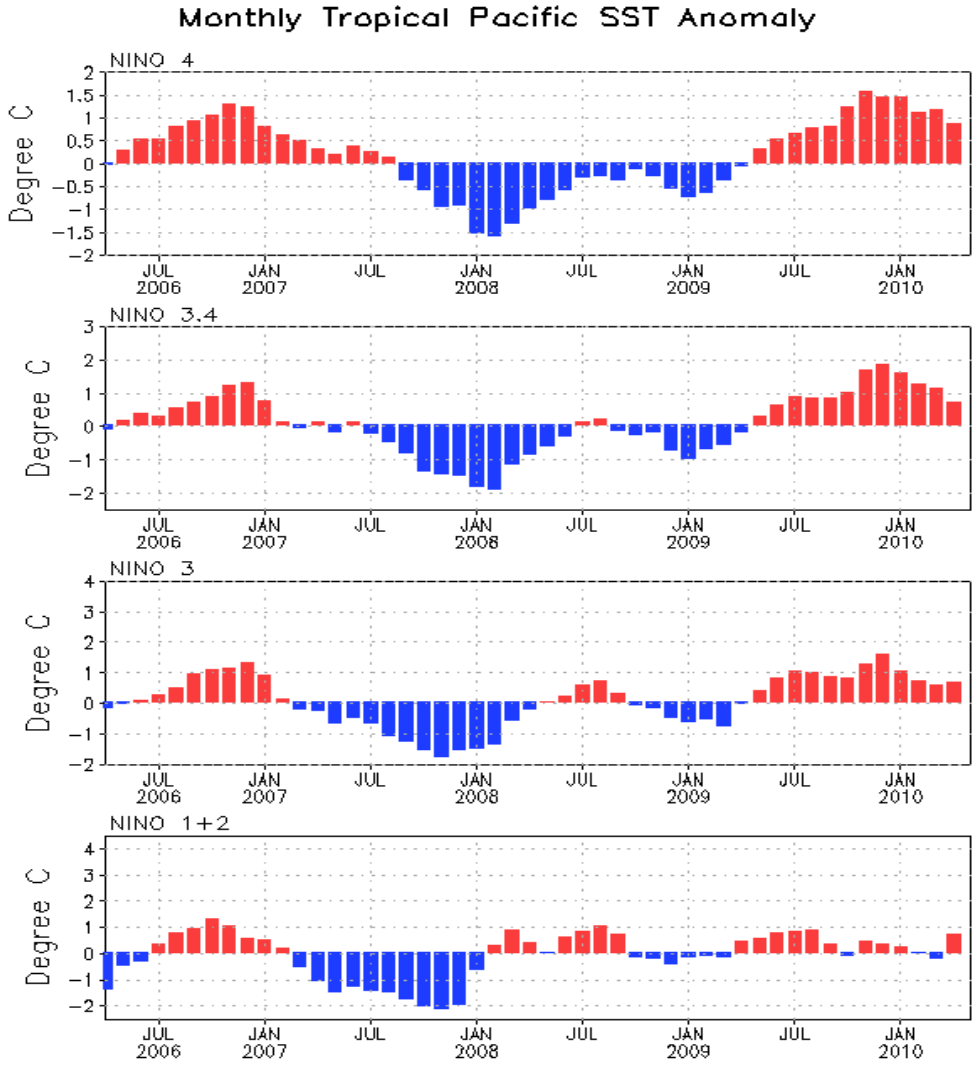
- **Negative temperature anomalies presented near the thermocline in the west-central Pacific.**

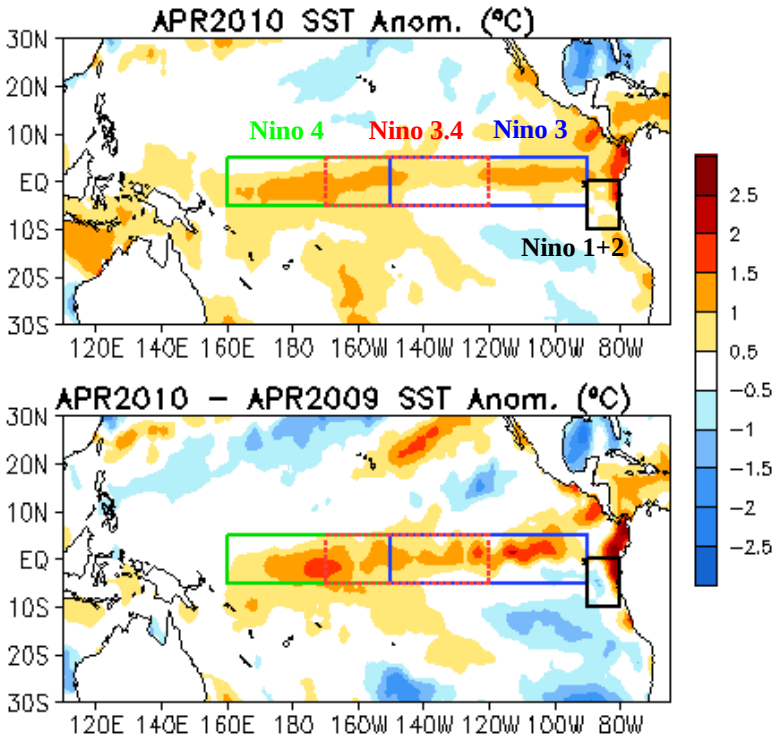
- **Subsurface temperature anomaly decreased (increased) by 2-4°C near 150-110°W (110-90°W) near the thermocline in the equatorial Pacific.**
- **Positive temperature anomaly intensified in the eastern Indian Ocean at 80-200 m.**

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

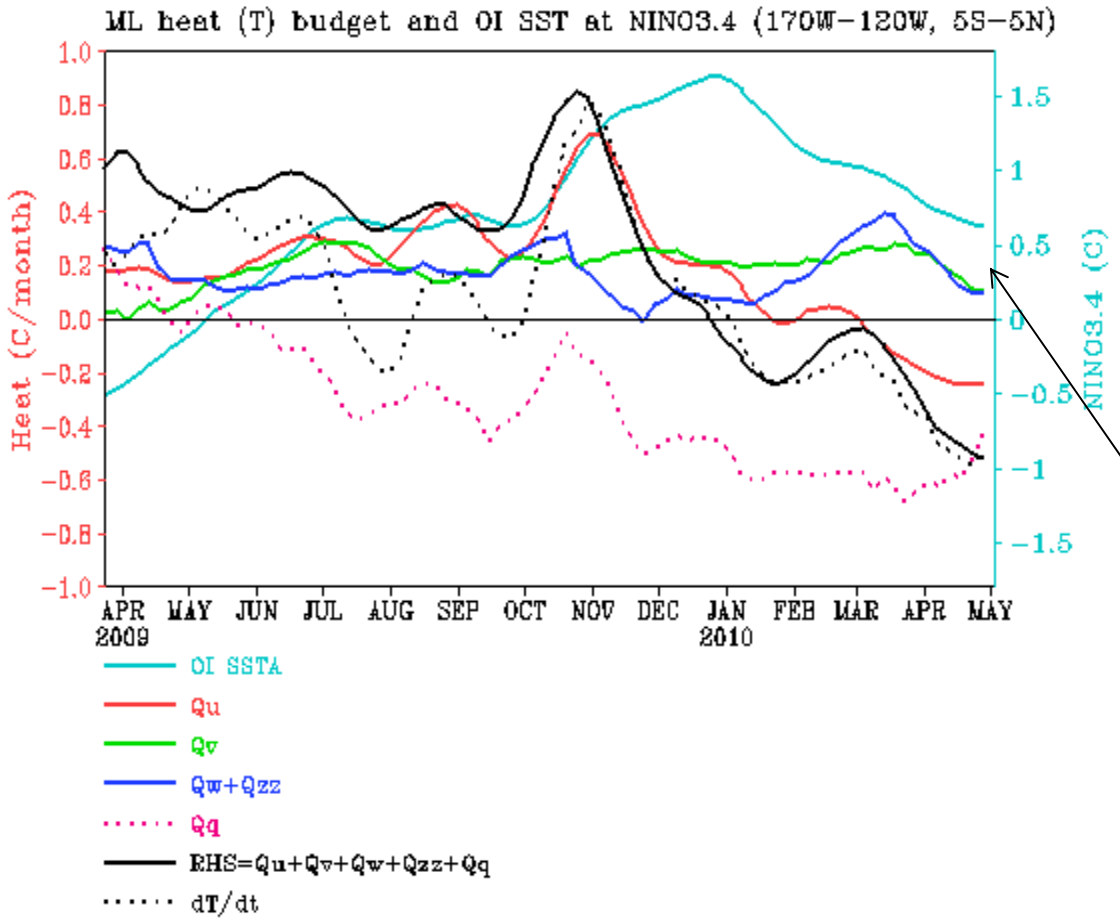




- **All indices are positive**
- **NINO4 and NINO3.4 indices decreased**
- **NINO3 slight increased.**
- **NINO1+2 increased from negative to positive**

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



The negative tendency since Jan2010 suggests that the El Nino is in its decay phase.

Strong negative tendency is consistent with total heat flux (RHS) in Apr 2010, may imply a speed up of the ENSO decay, which is mainly caused by reduced warming from Qw+Qzz and strengthened cooling from Qu, Qq.

The decay due to Qu and Qq, suggesting that influences of subsurface temperature anomalies on the recent SSTA changes are small.

Qw+Qzz is positive, implying a contribution to the persistent positive SSTA.

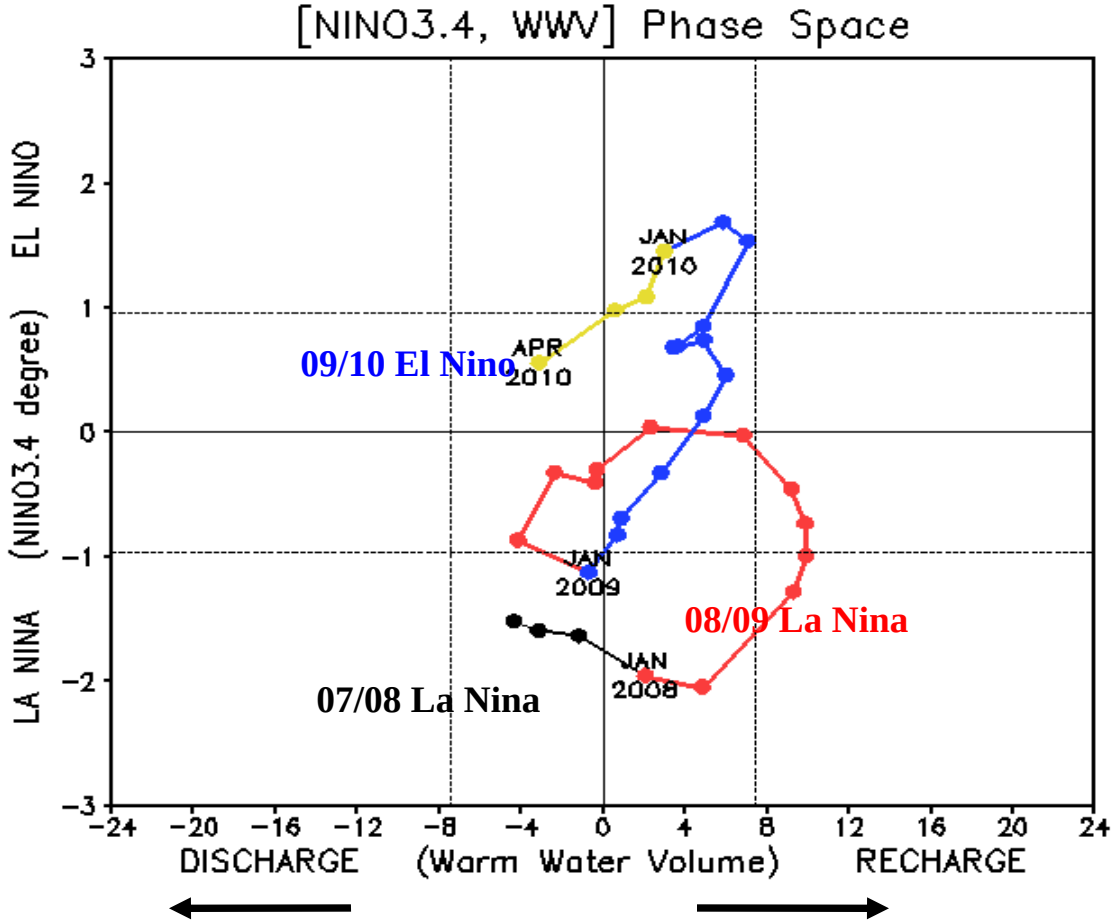
Qu: Zonal advection; Qv: Meridional advection;
Qw: Vertical entrainment; Qzz: Vertical diffusion
Qq: (Qnet - Qpen + Qcorr) / ρcph; Qnet = SW + LW + LH +SH;
Qpen: SW penetration; Qcorr: Flux correction due to relaxation to OI SST

Warm Water Volume (WWV) and NINO3.4 Anomalies

-WWV is defined as average of depth of 20°C in [120°E-80°W, 5°S-5°N] (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).

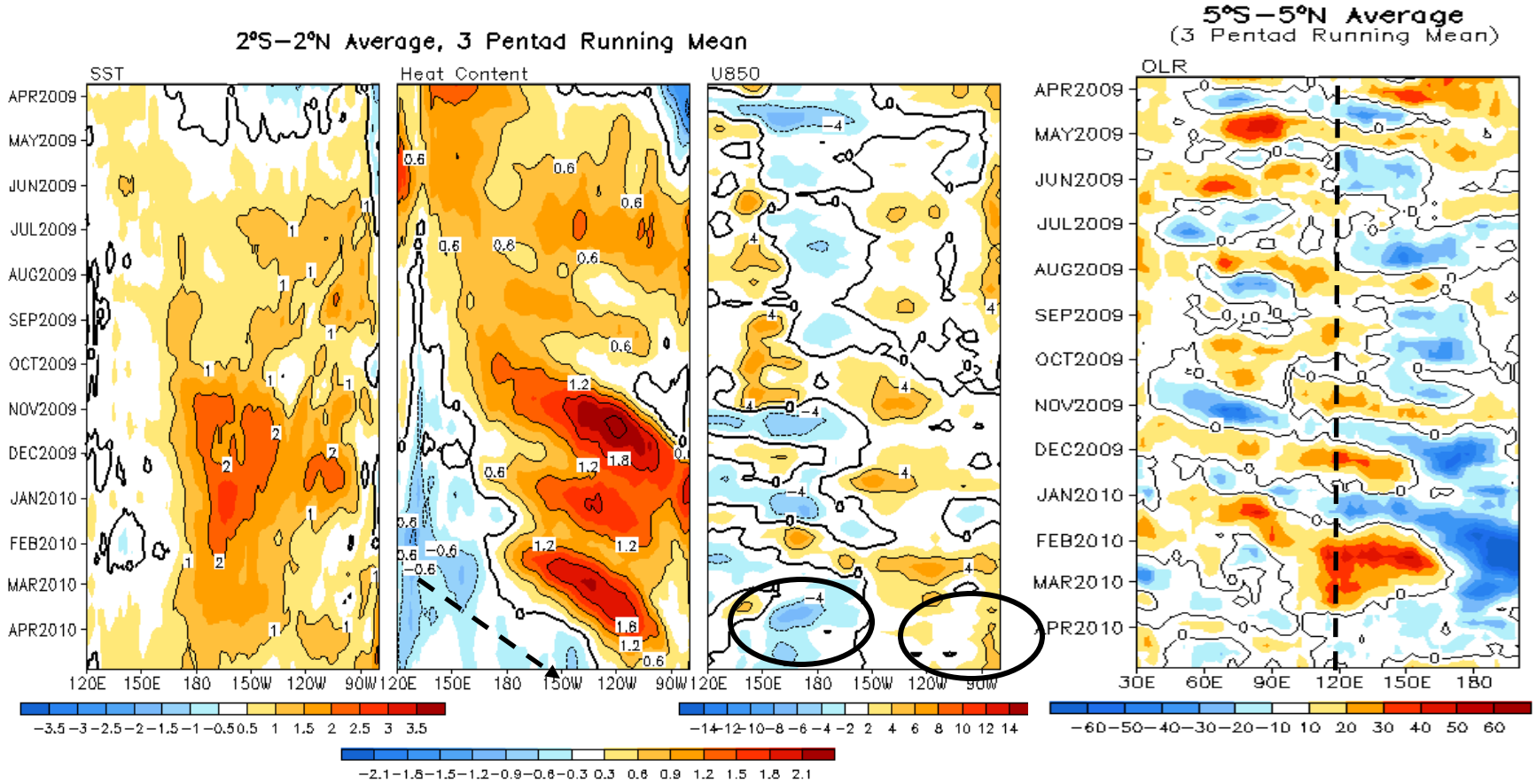
- Increase (decrease) of WWV indicates recharge (discharge) of the equatorial oceanic heat content.



- Nino3.4 and WWV decreased steadily from Dec 2009 to Apr 2010;

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 for WWV (NINO 3.4) are departures from the 1982-2004 (1971-2000) base period means.

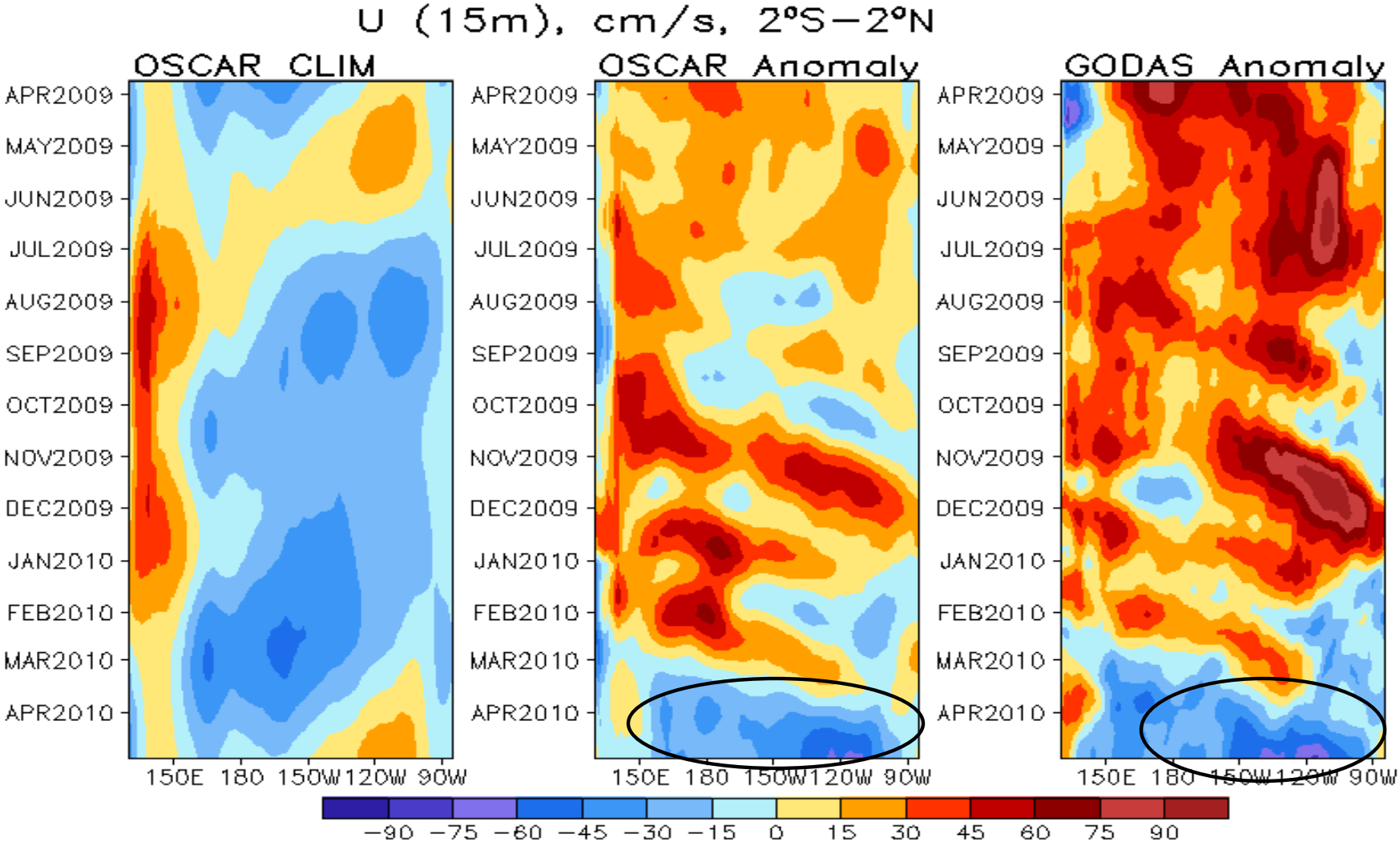
Evolution of Equatorial Pacific SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s), and OLR (W/m²) Anomaly



- **Positive SSTA in the central (eastern) equatorial Pacific weakened (strengthened) in Apr 2010, consistent with easterly (westerly) wind anomaly in the western (eastern) Pacific.**
- **Consistent with the weakened SSTA, negative heat content anomalies (HCA) moved eastward in Mar-Apr 2010.**
- **Convection weakened near the Dateline in Apr 2010, consistent with the weak low-level divergence in Apr 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.

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

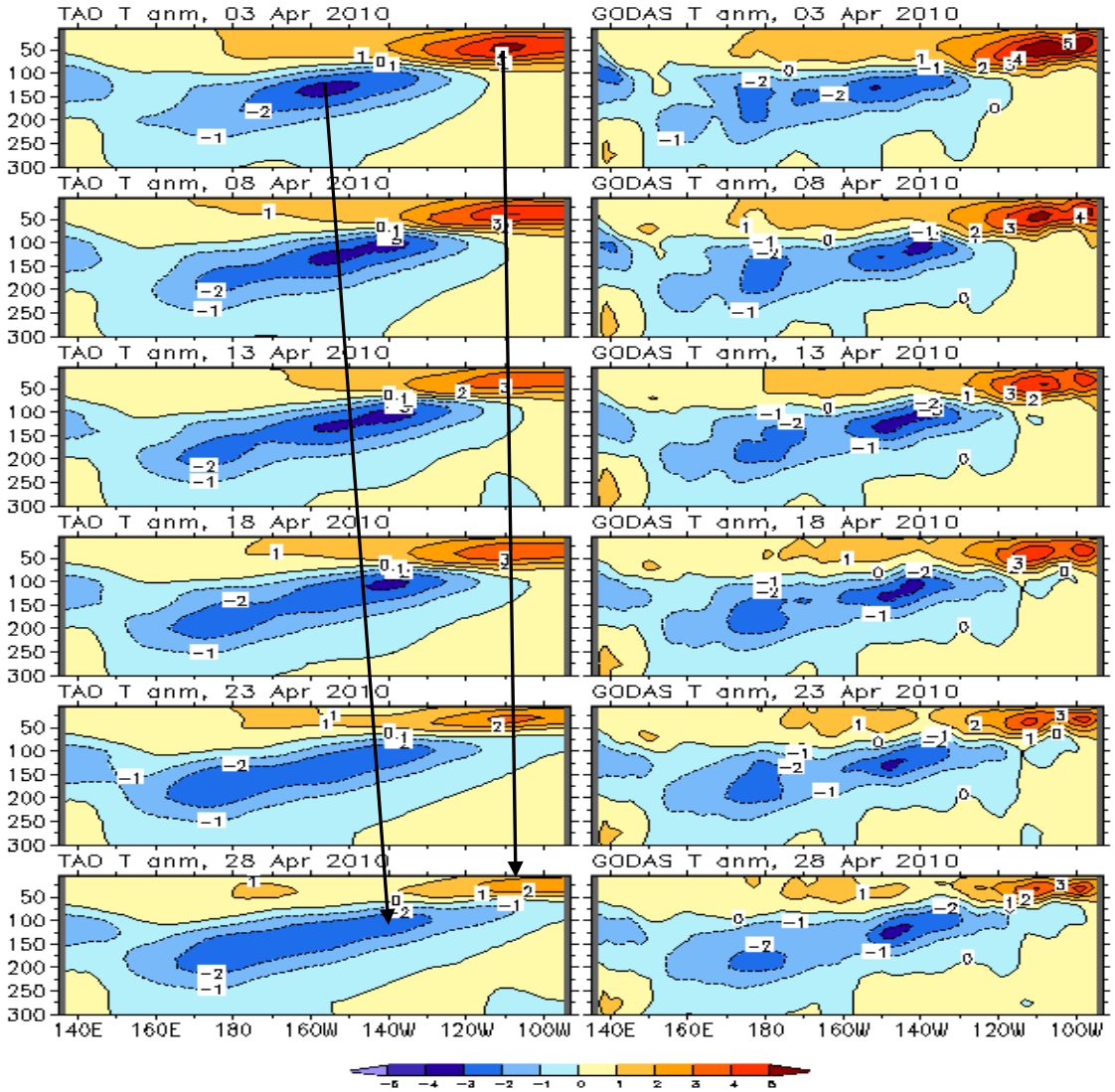


- **Surface zonal current anomaly became negative since mid-Mar 2010, and intensified in Apr 2010, consistent with the decay of the El Nino conditions.**

- **Surface zonal current anomalies simulated by GODAS were overall too strong compared with those of OSCAR in the equatorial Pacific, but they were comparable in recent months.**

Equatorial Pacific Temperature Anomaly

TAO GODAS

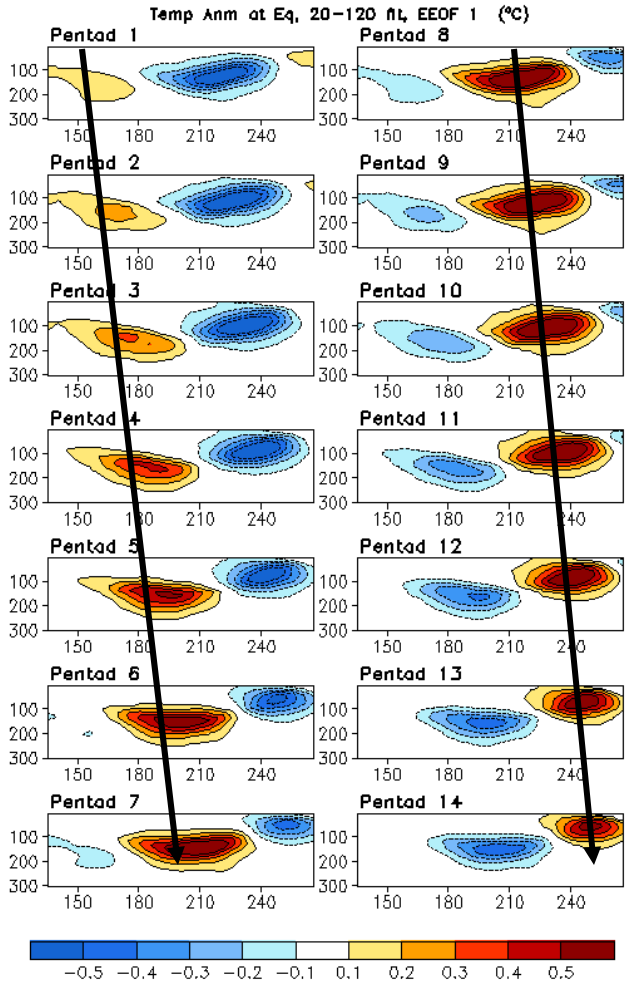


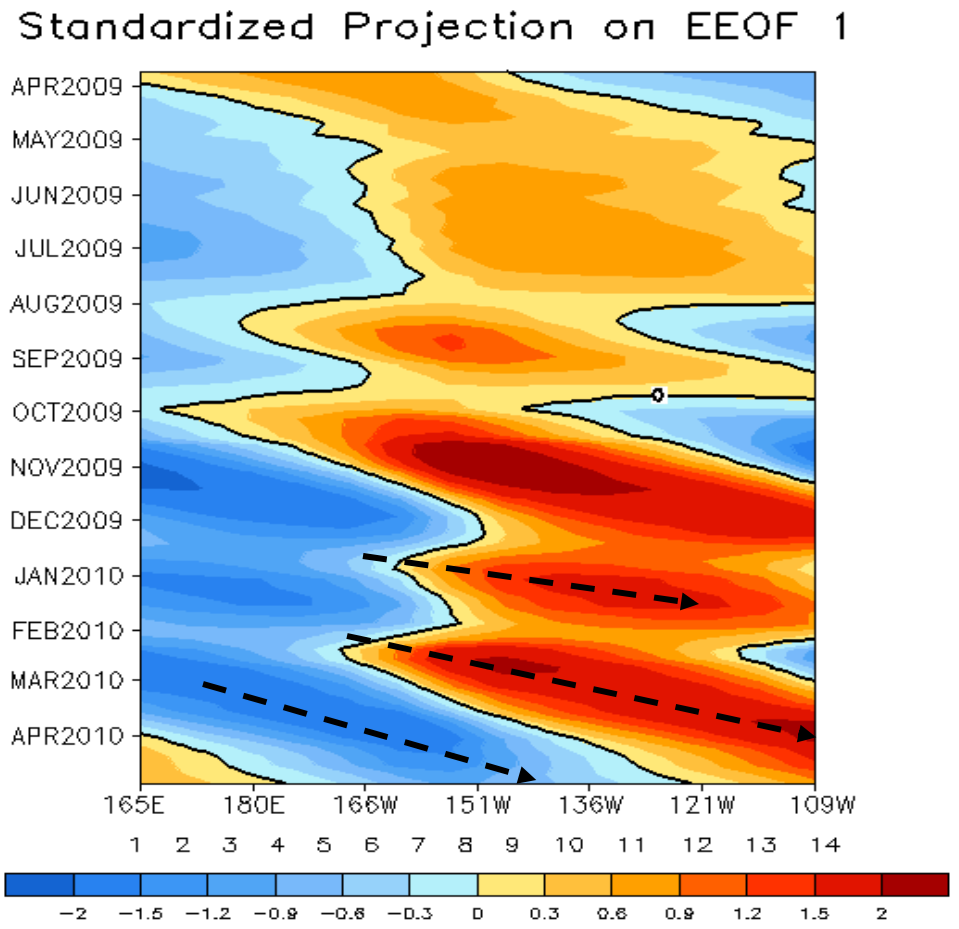
TAO climatology used

- **Positive temperature anomaly near the surface in the east-central equatorial Pacific weakened substantially in Apr 2010**

- **Negative temperature anomaly near the thermocline in the west-central equatorial Pacific propagated eastward in Apr 2010.**

Oceanic Kelvin Wave Indices





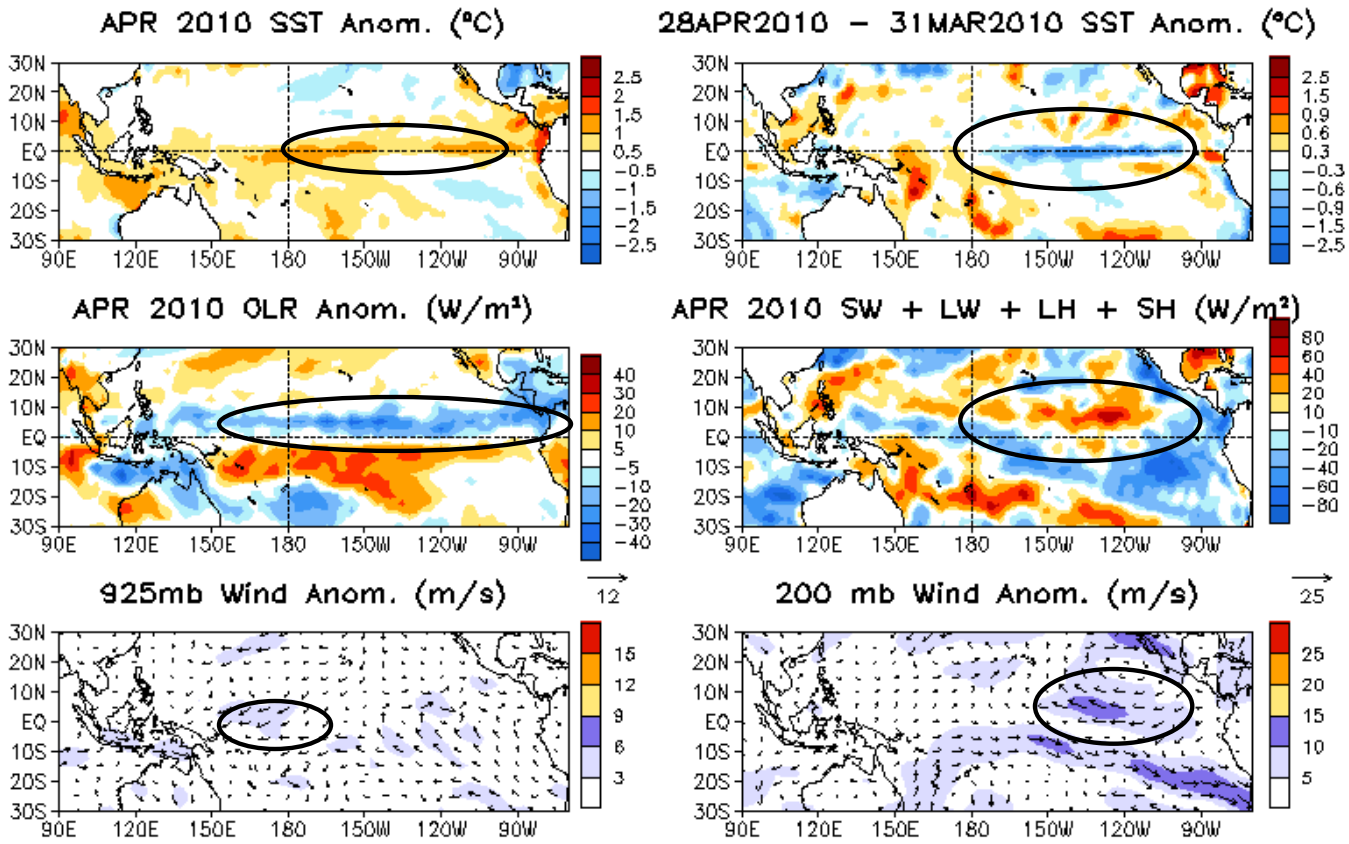
- **The upwelling oceanic Kelvin wave occurred in late Feb2010 in the W. Pacific and propagated eastward, which may weaken the positive SSTA in the central and eastern tropical Pacific.**

- **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

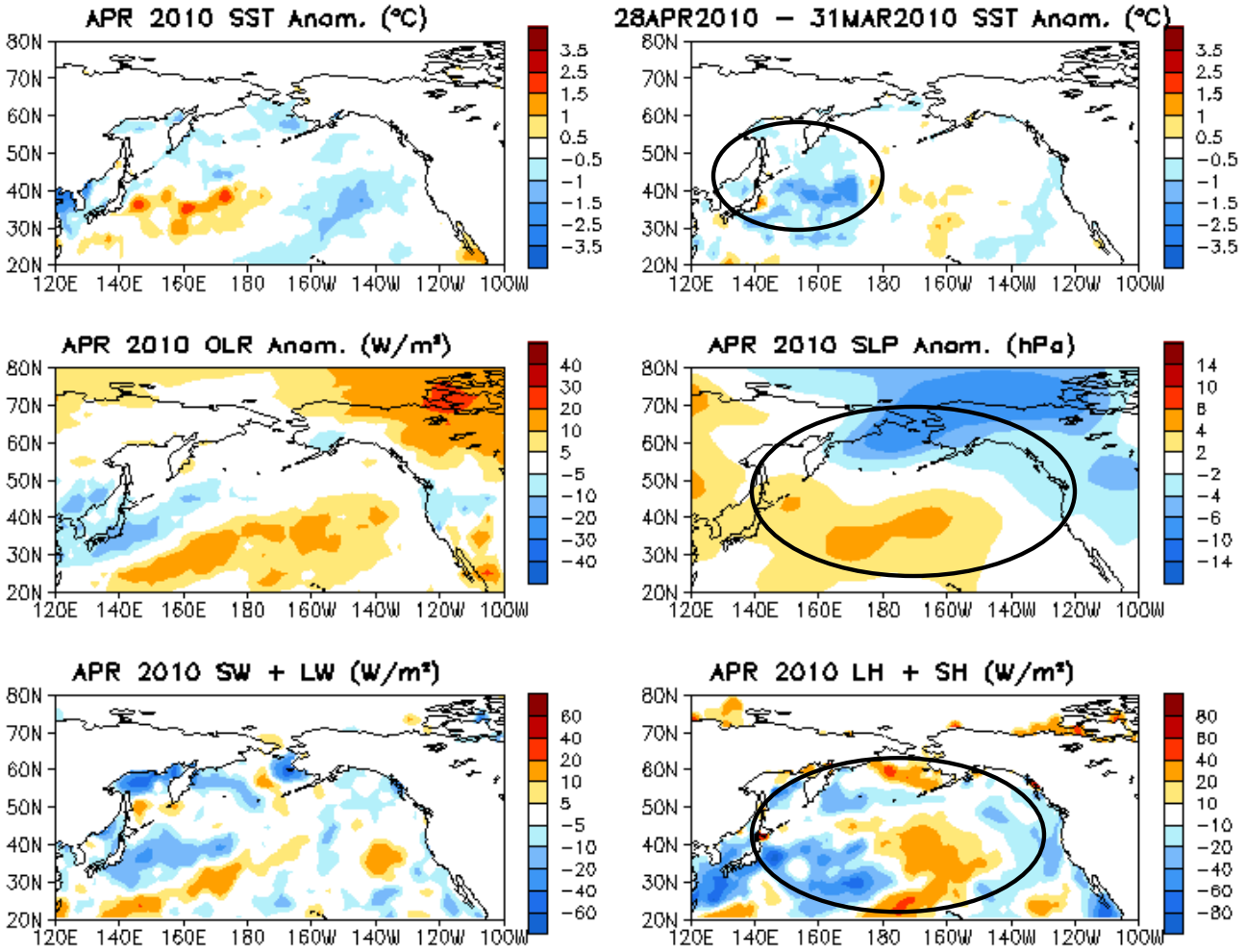


- **Positive SSTA weakened in the east-central equatorial Pacific.**
- **Convection was enhanced (suppressed) over the Maritime Continent and north of the equator (south of the equator).**
- **Negative SSTA tendency in the east-central equatorial Pacific is not consistent with net surface heat flux anomaly, indicating ocean dynamics is important.**
- **Low-level easterly (upper-level easterly) wind anomaly presented in the western (eastern) 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

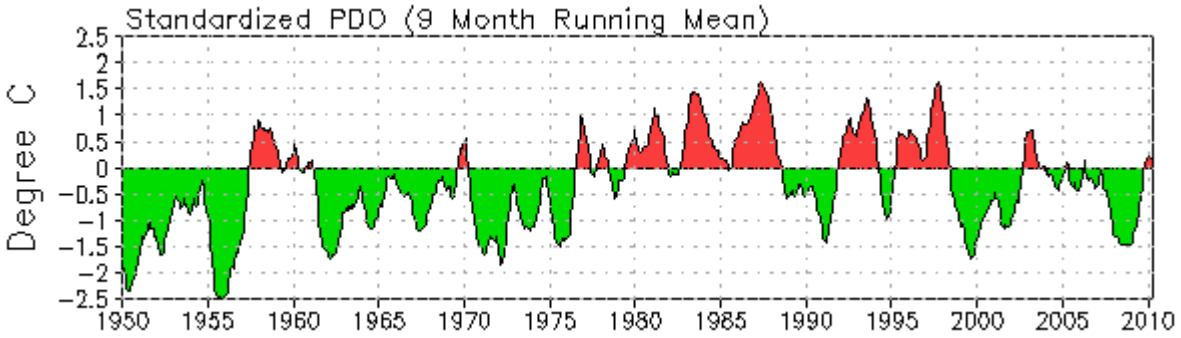
North Pacific & Arctic Ocean: SST Anom., SST Anom. Tend., OLR, SLP, Sfc Rad, Sfc Flx

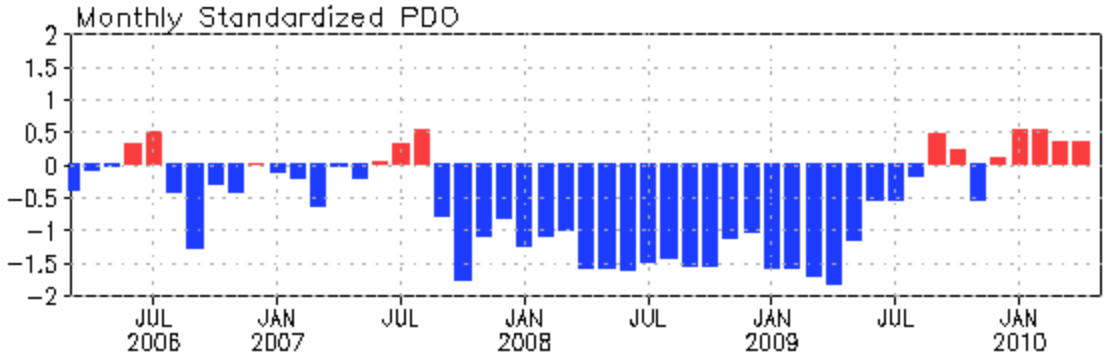


- The SSTA tendency was negative in the western North Pacific, consistent with surface heat flux anomaly.
- Heat flux does not favour the positive phase of PDO (next slide)
- Negative (positive) SLP anomaly in northern (southern) part of North Pacific, consistent with above-normal upwelling.

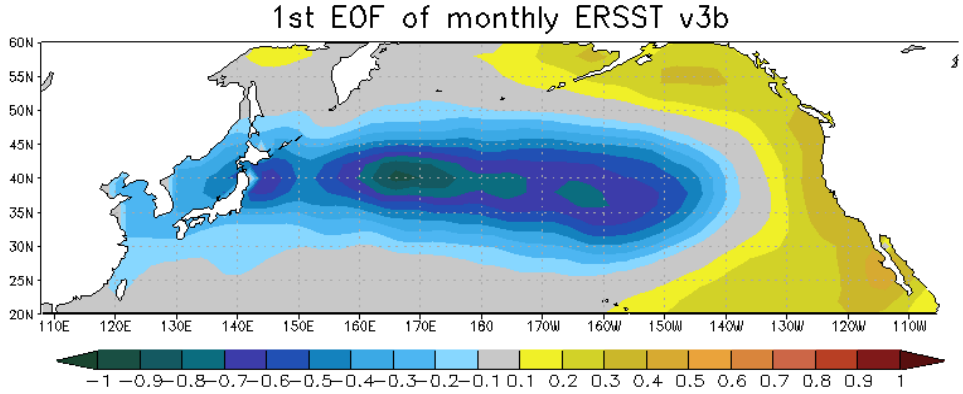
Fig. NP1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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





- **Weak positive PDO index persisted in Apr 2010.**

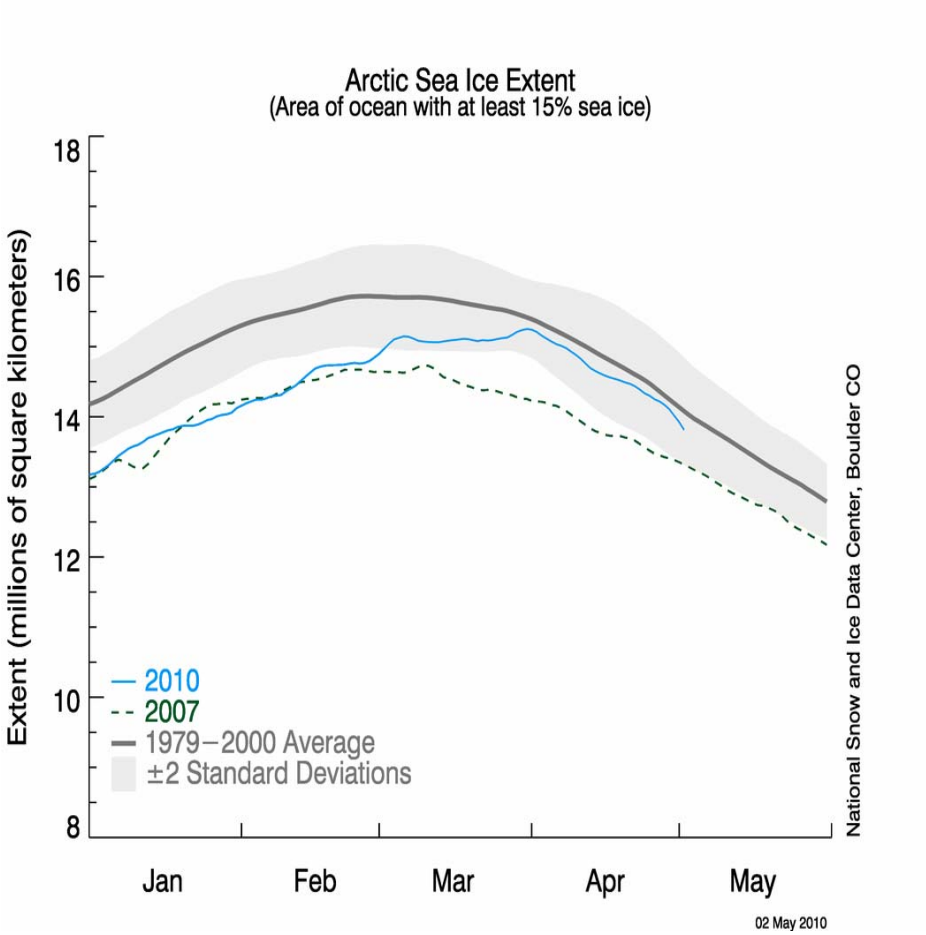


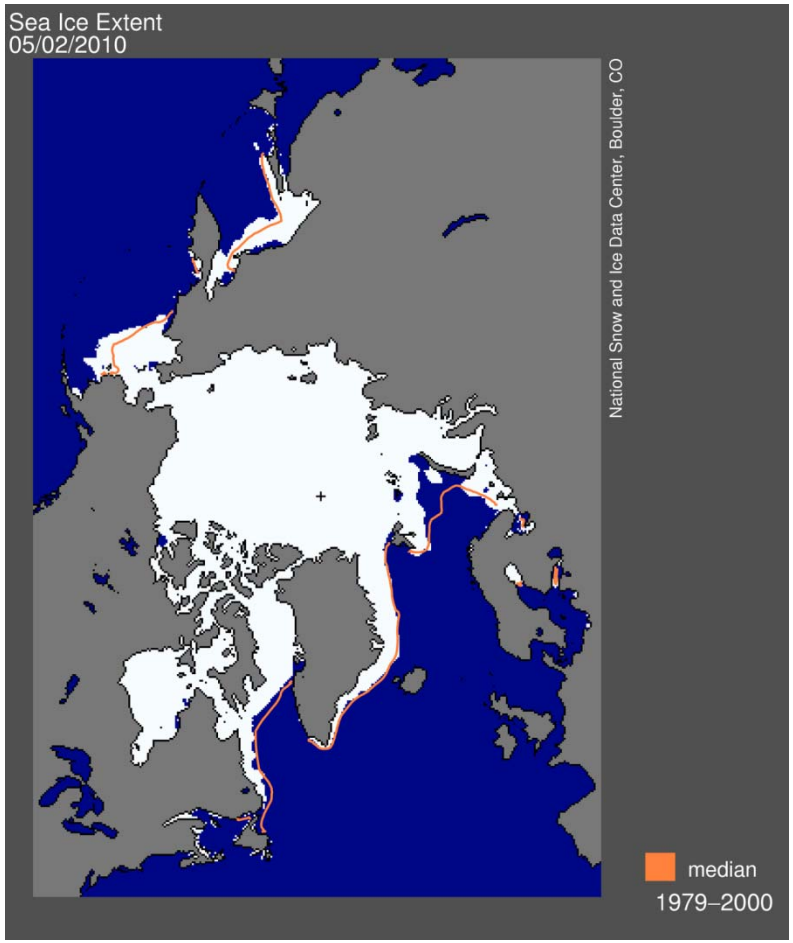
- **Pacific Decadal Oscillation is defined as the 1st EOF of monthly ERSST v3b in the North Pacific for the period 1900-1993. PDO index is the standardized projection of the monthly SST anomalies onto the 1st EOF pattern.**
- **The PDO index differs slightly from that of JISAO, which uses a blend of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

Arctic Sea Ice

National Snow and Ice Data Center

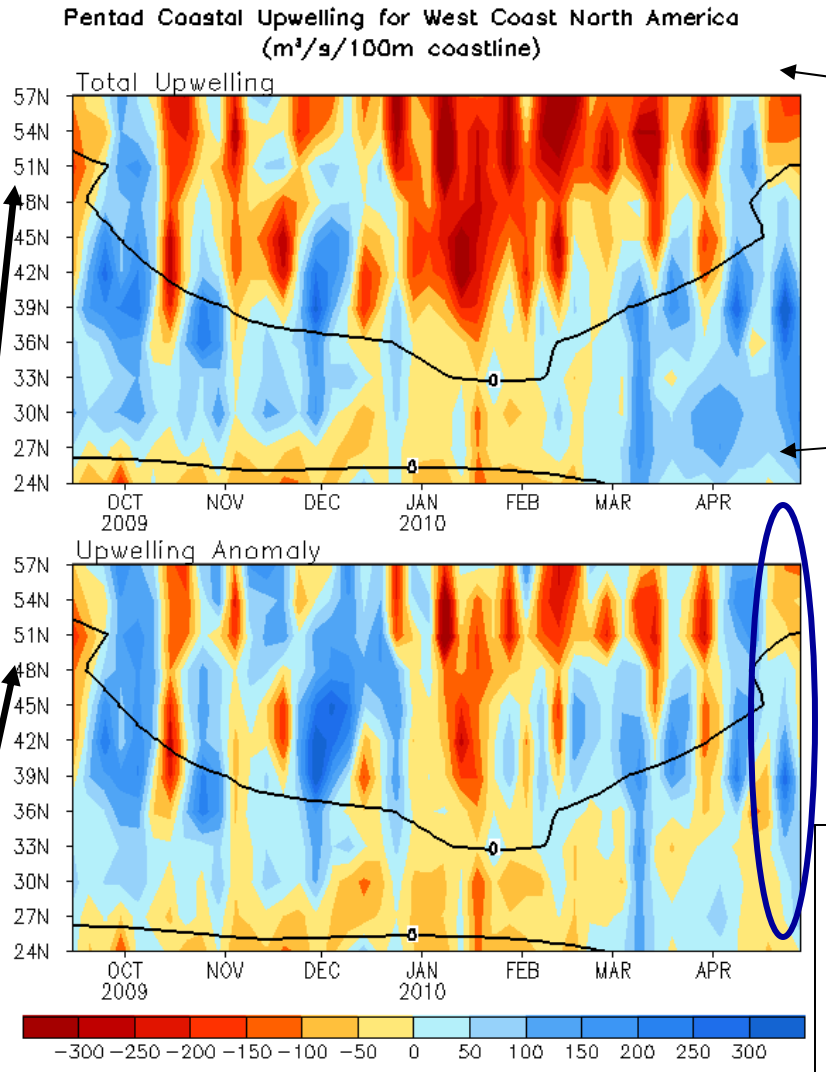
http://nsidc.org/arcticseaicenews/index.html

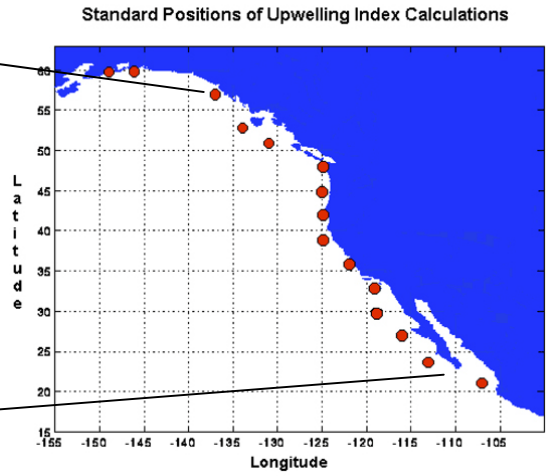




- **Sea ice extent in Apr 2010 is closed to the climatology, which is the first time since 2001.**

North America Western Coastal Upwelling



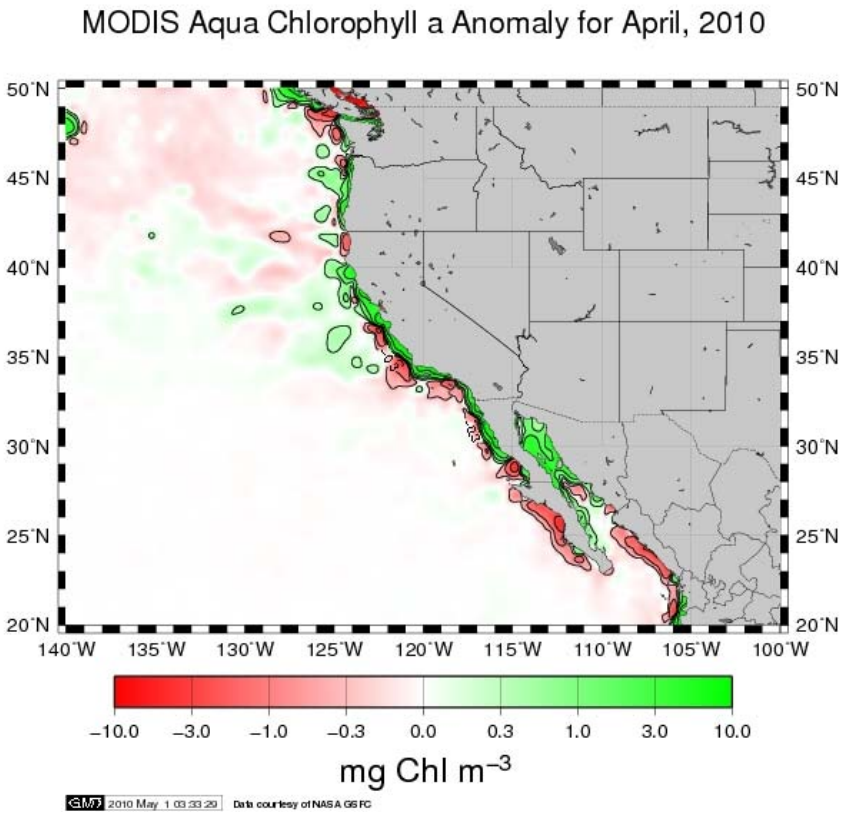


- **Both the downwelling north of 50N and upwelling south of 50N were above-normal in Apr 2010.**

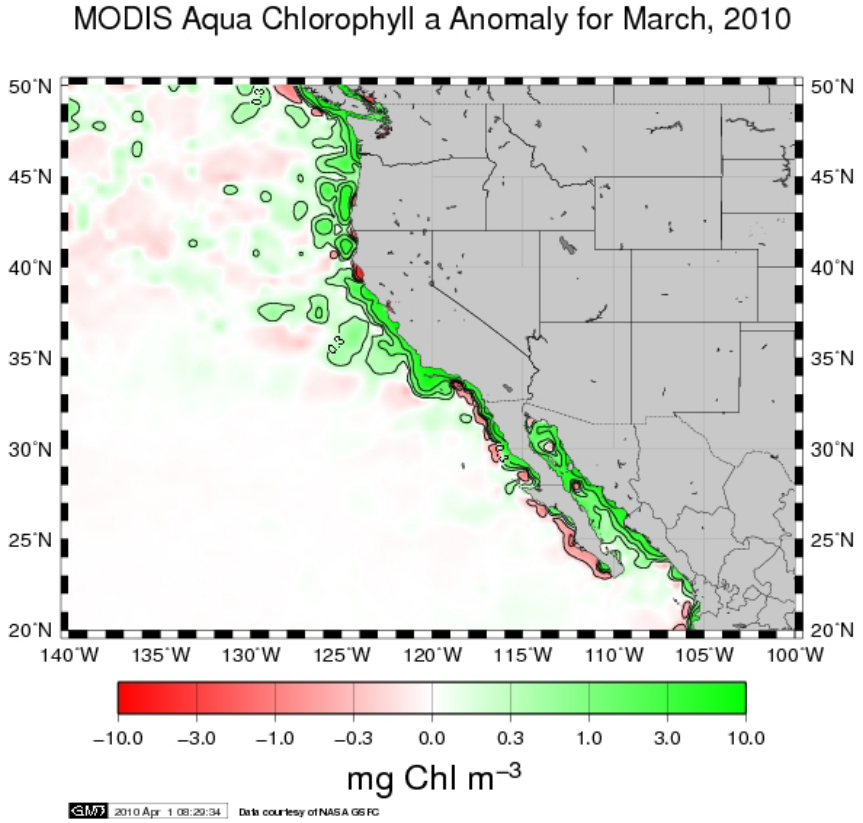
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport at 50 meter depth from each location to its nearest coast point (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 36°N to 57°N.**

Monthly Chlorophyll Anomaly

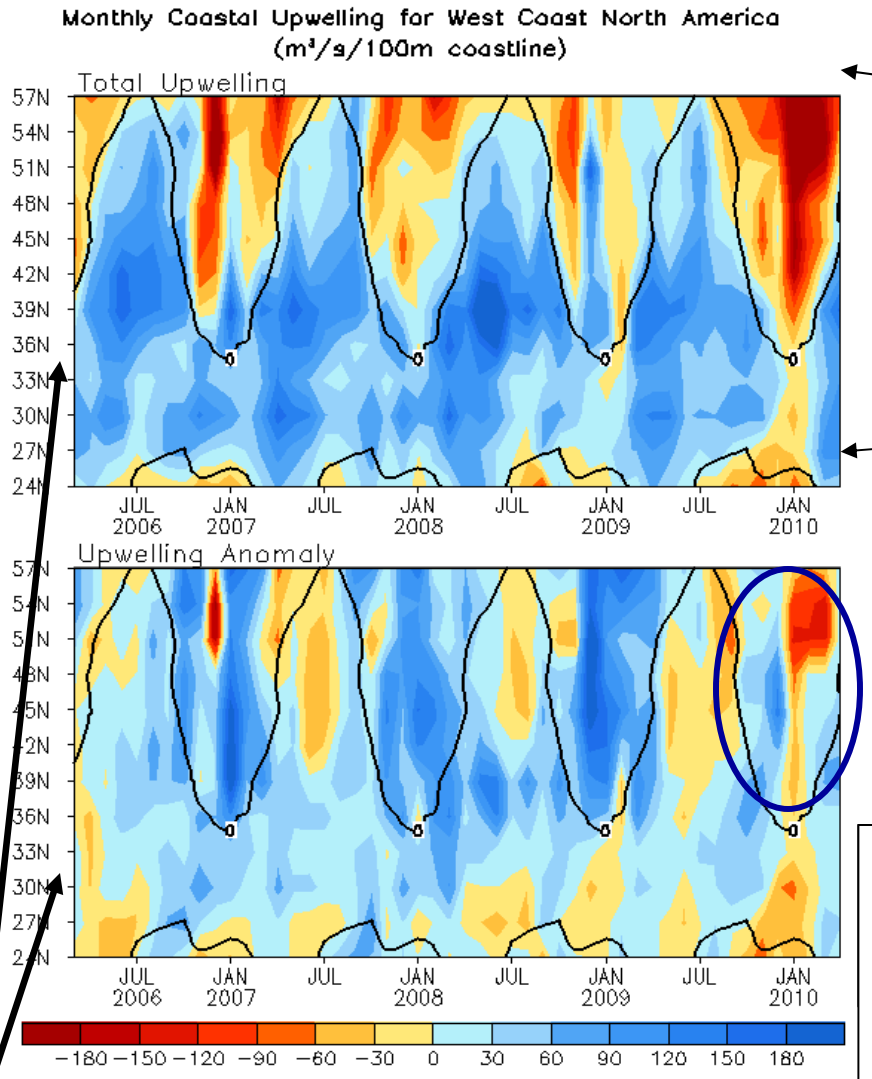


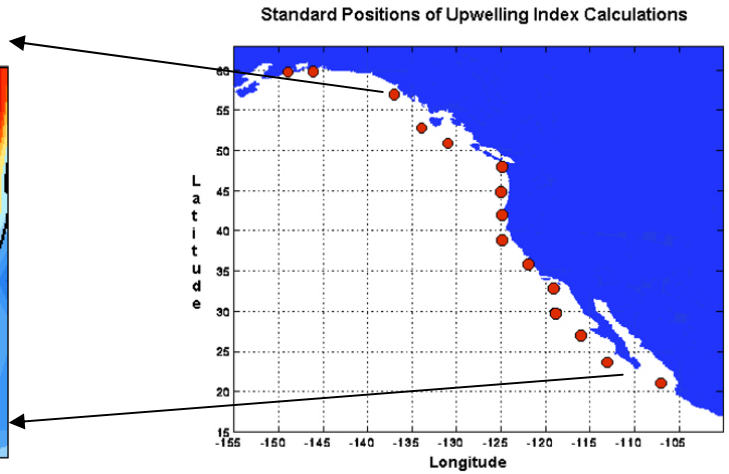
- **Chlorophyll was above-normal between 50N and 25N in Apr 2010, which is consistent with above-normal upwelling.**



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

North America Western Coastal Upwelling





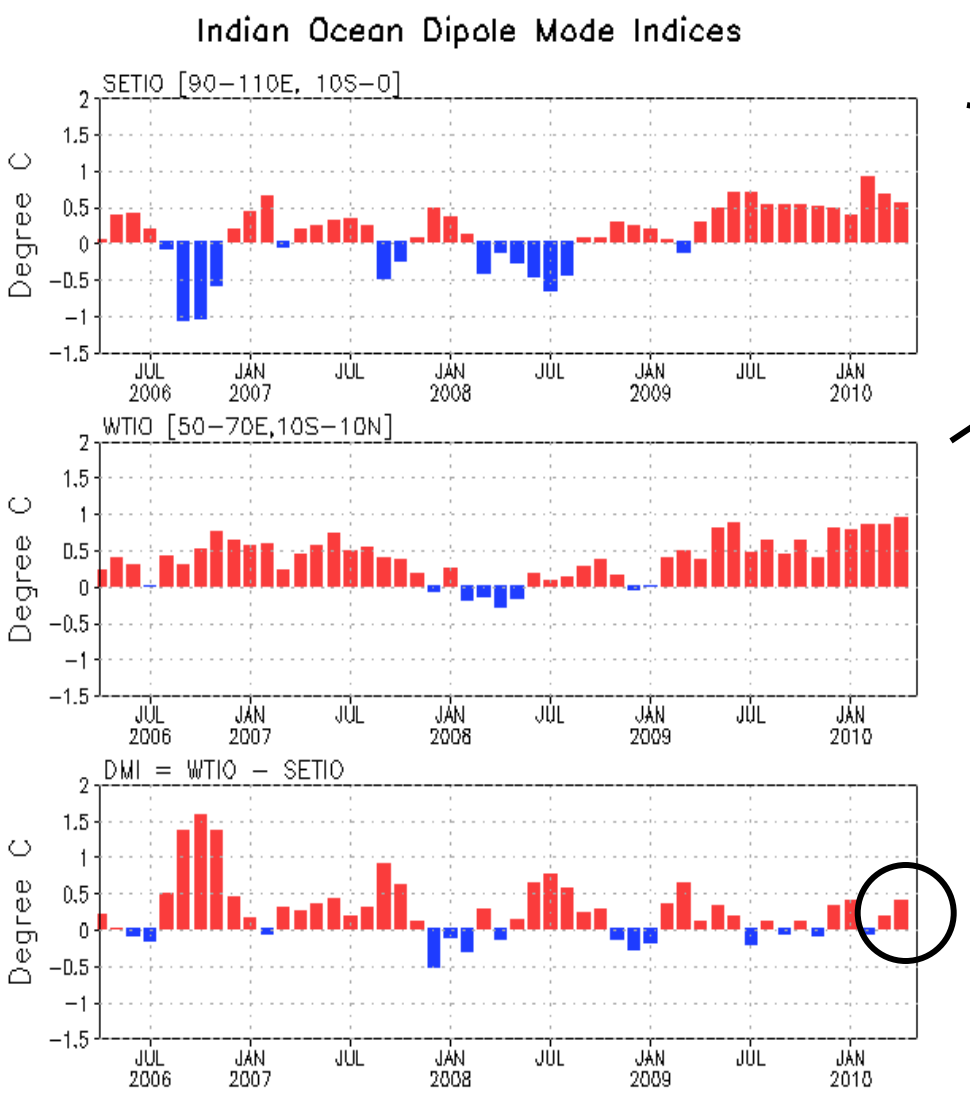
- **Upwelling had been above-normal during the winter of 2006/07, 2007/08, and 2009**
- **Upwelling during the winter of 2010 was near-normal (below-normal) south (north) of 48N.**

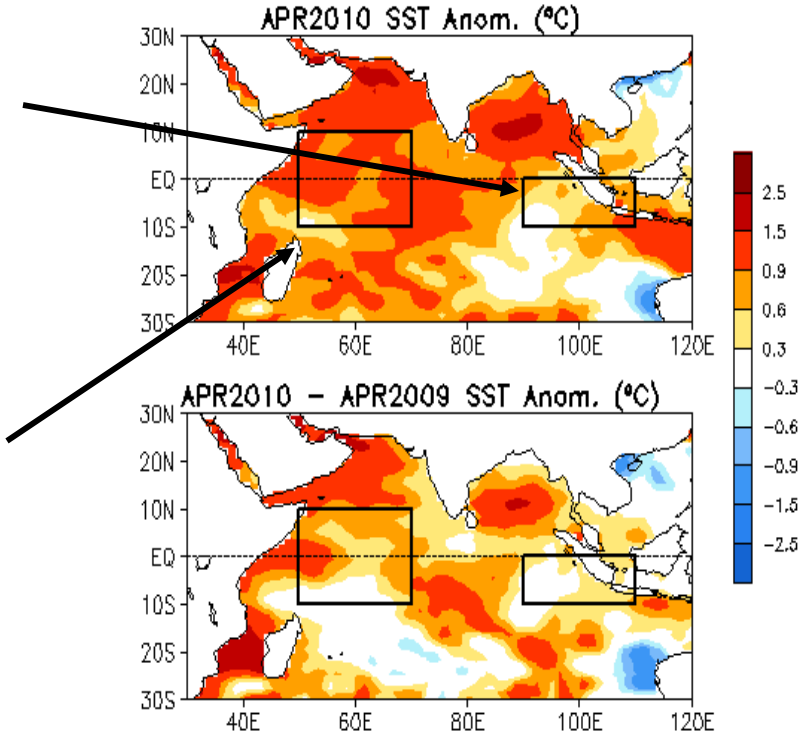
Fig. NP2. Total (top) and anomalous (bottom) upwelling indices at the 15 standard locations for the western coast of North America. Upwelling indices are derived from the vertical velocity of the NCEP's global ocean data assimilation system, and are calculated as integrated vertical volume transport 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 36°N to 57°N.**

Tropical Indian Ocean

Evolution of Indian Ocean SST Indices

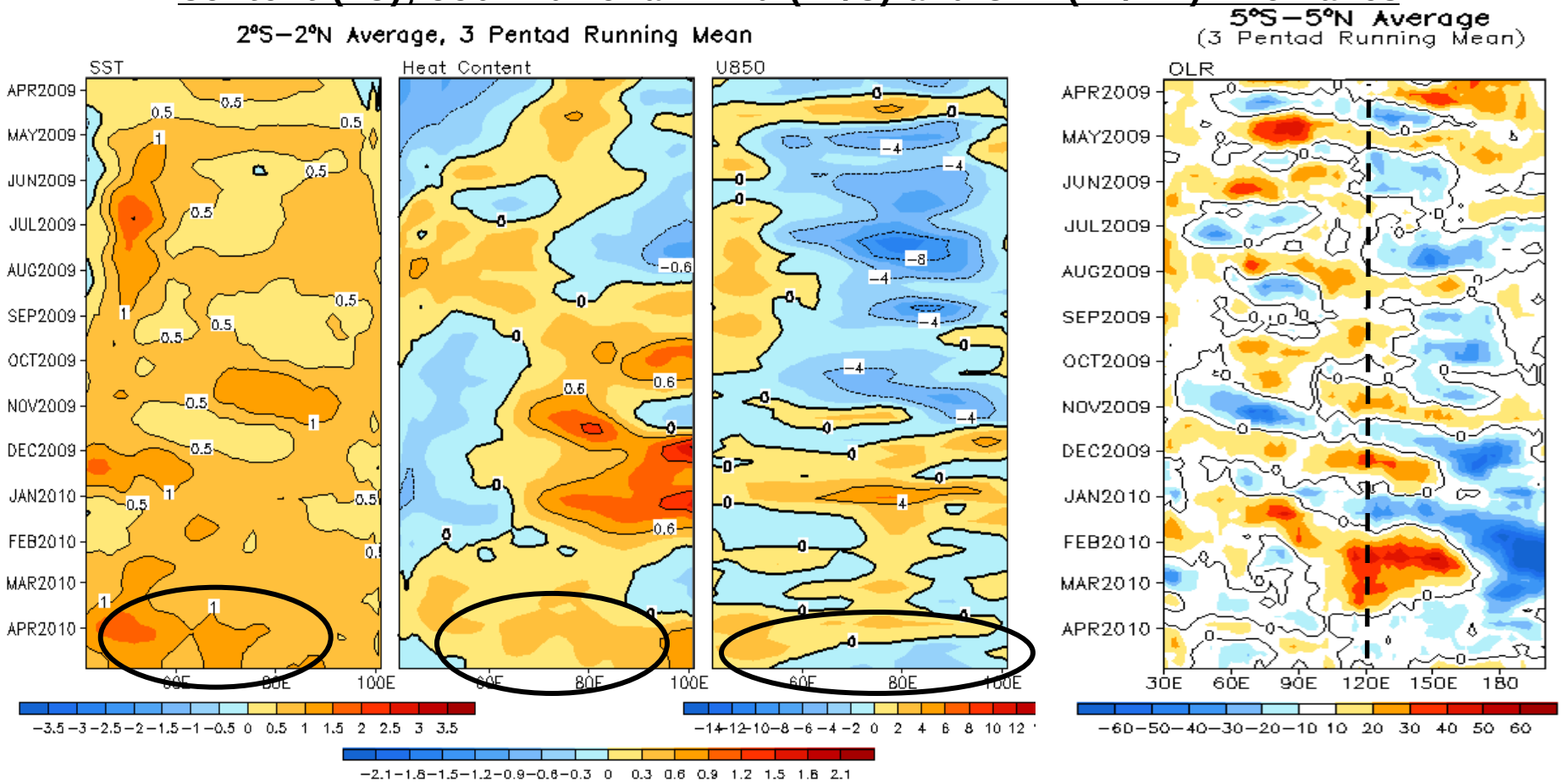




- **Both eastern (SETIO) and western (WTIO) pole SST have been persistently above-normal since Apr 2009.**
- **Positive DMI enhanced slightly in Apr 2010.**

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.

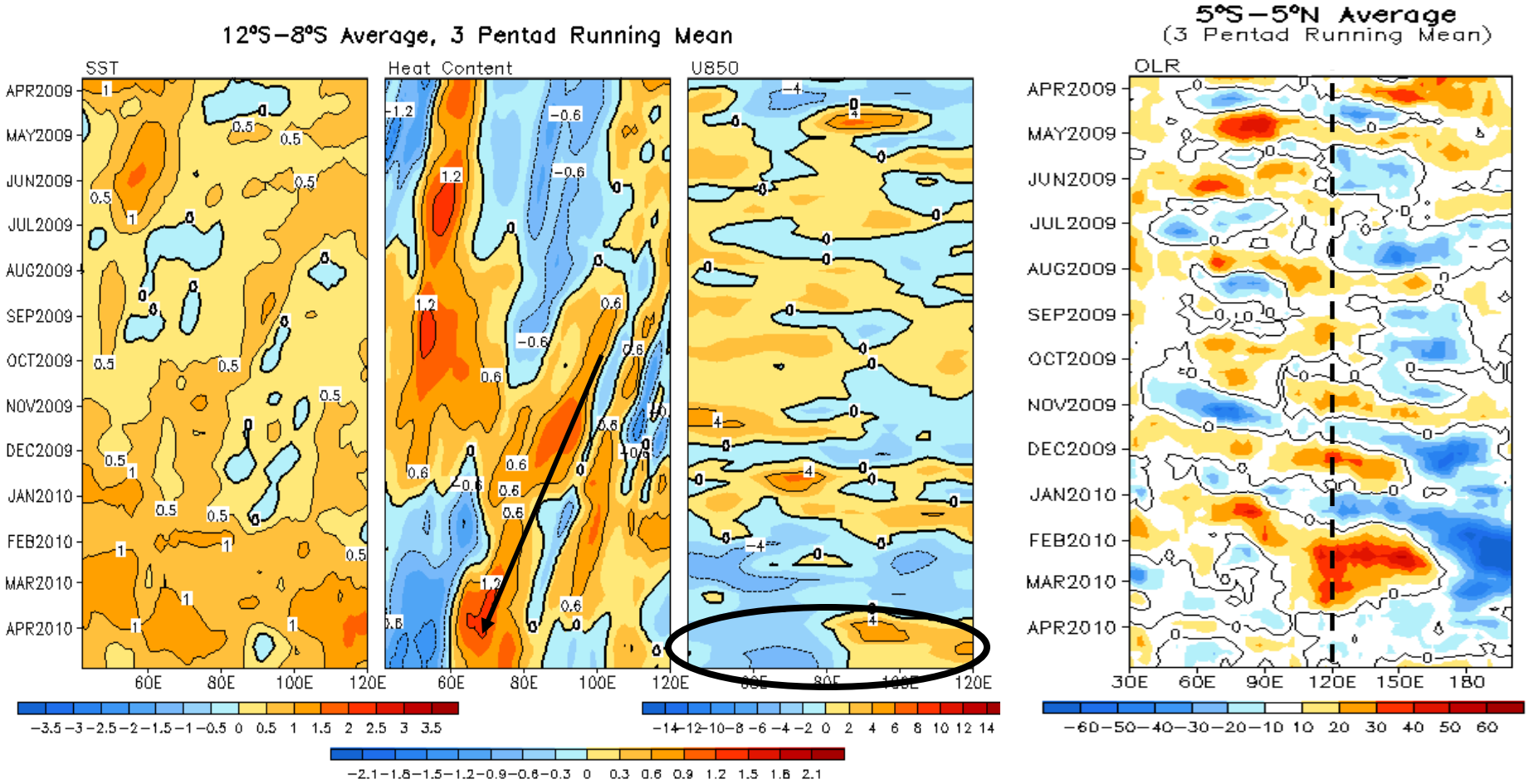
Recent Evolution of Equatorial Indian SST (°C), 0-300m Heat Content (°C), 850-mb Zonal Wind (m/s) and OLR (W/m²) Anomalies



- **Positive SSTA enhanced in Apr 2010.**
- **Heat content anomaly was positive in the eastern-central tropical Indian Ocean.**
- **Easterly wind anomalies developed in the tropical Indian Ocean in Apr 2010, consistent with the east-west SSTA gradient.**

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 of 1.0°C persisted.**
- **Positive HCA propagated westward in the central-eastern tropical Indian since Jun 2009.**
- **Low-level divergent wind anomaly in the central Indian Ocean .**

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.

- SSTA exceeding +1C presented in the tropical Indian Ocean.
- Net surface heat flux anomalies contributed to the positive (negative) SSTA tendency in the north (south) Indian Ocean.
- Convection was enhanced over north-eastern Indian Ocean and the Maritime Continent, and suppressed in southern Indian Ocean.
- Consistent with the enhanced convection was low-level convergent (up-level divergent) wind anomalies over the Maritime Continent.

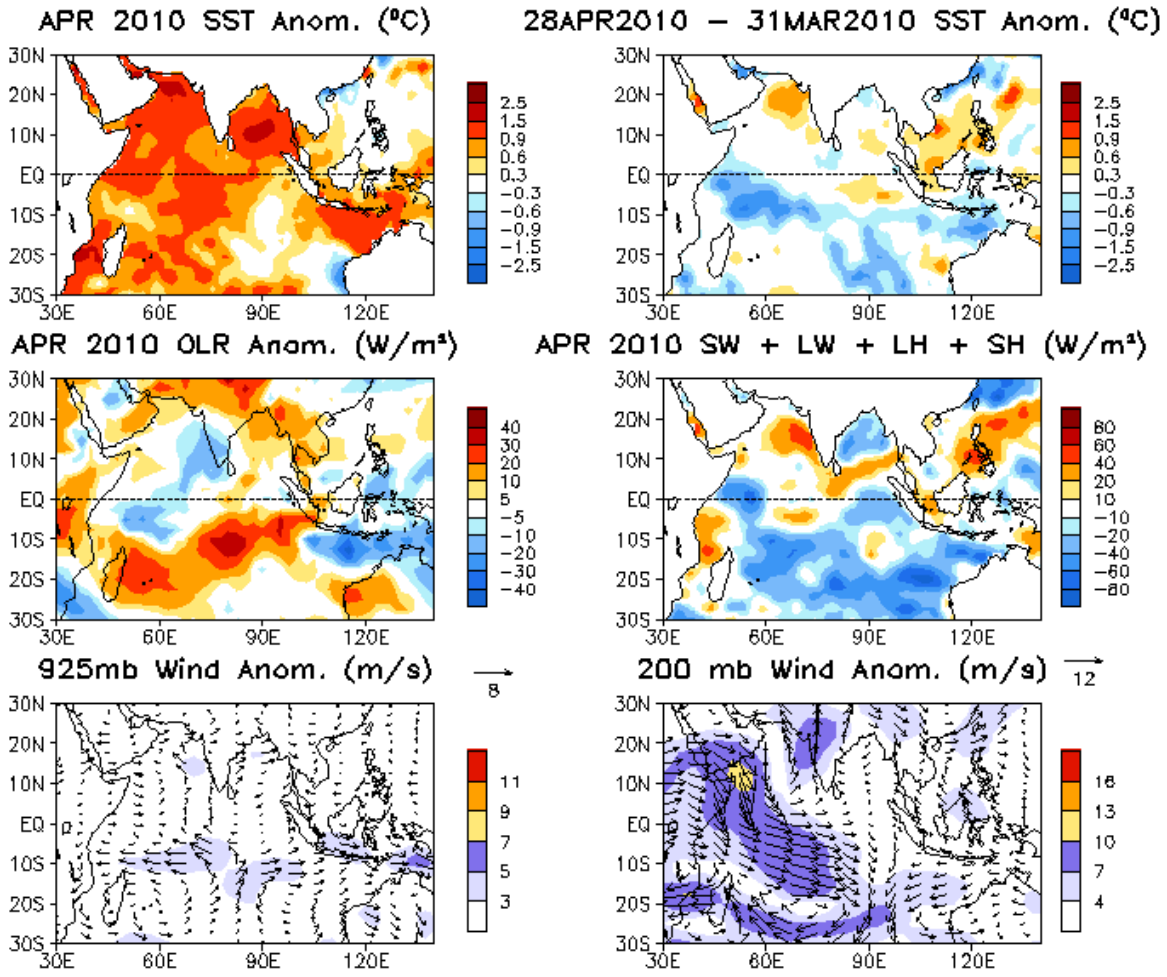
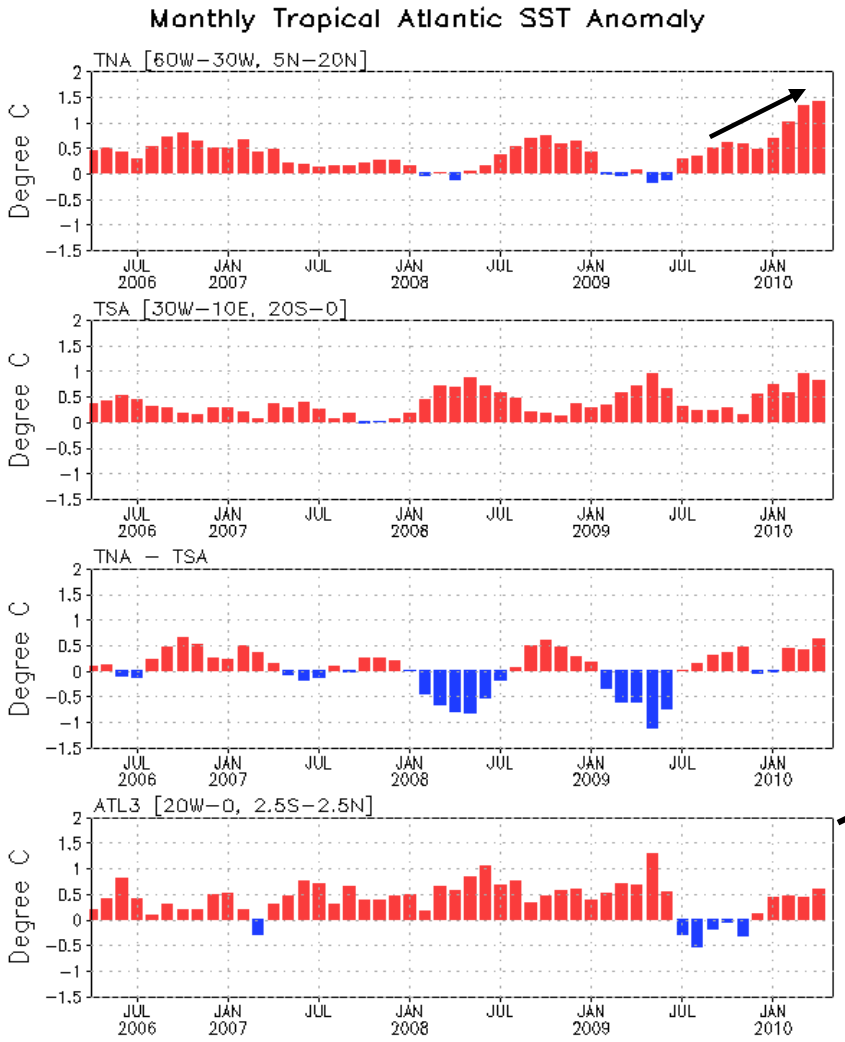
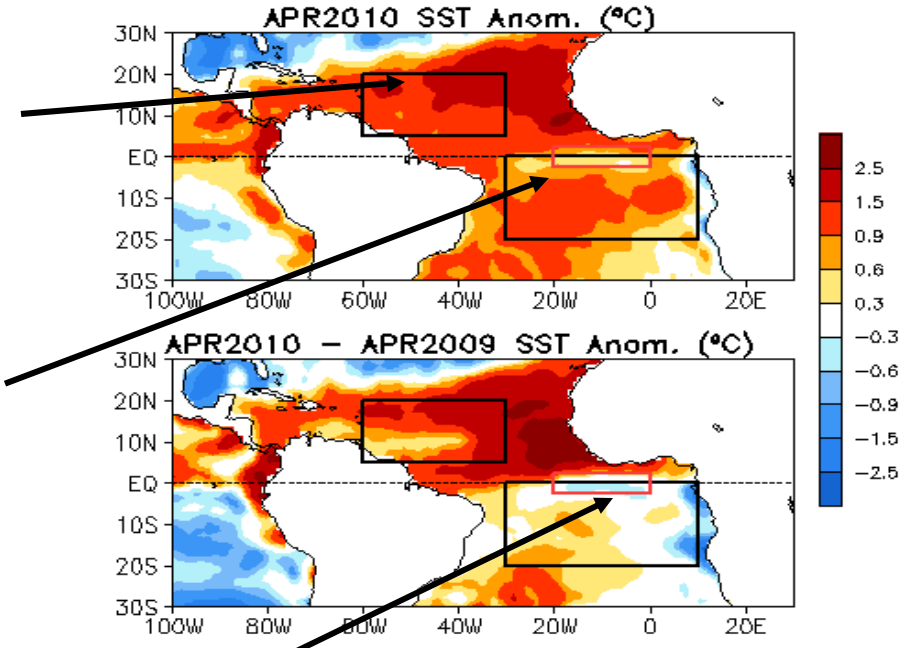


Fig. I2. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sum of net surface short- and long-wave radiation, latent and sensible heat flux anomalies (middle-right), 925-mb wind anomaly vector and its amplitude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

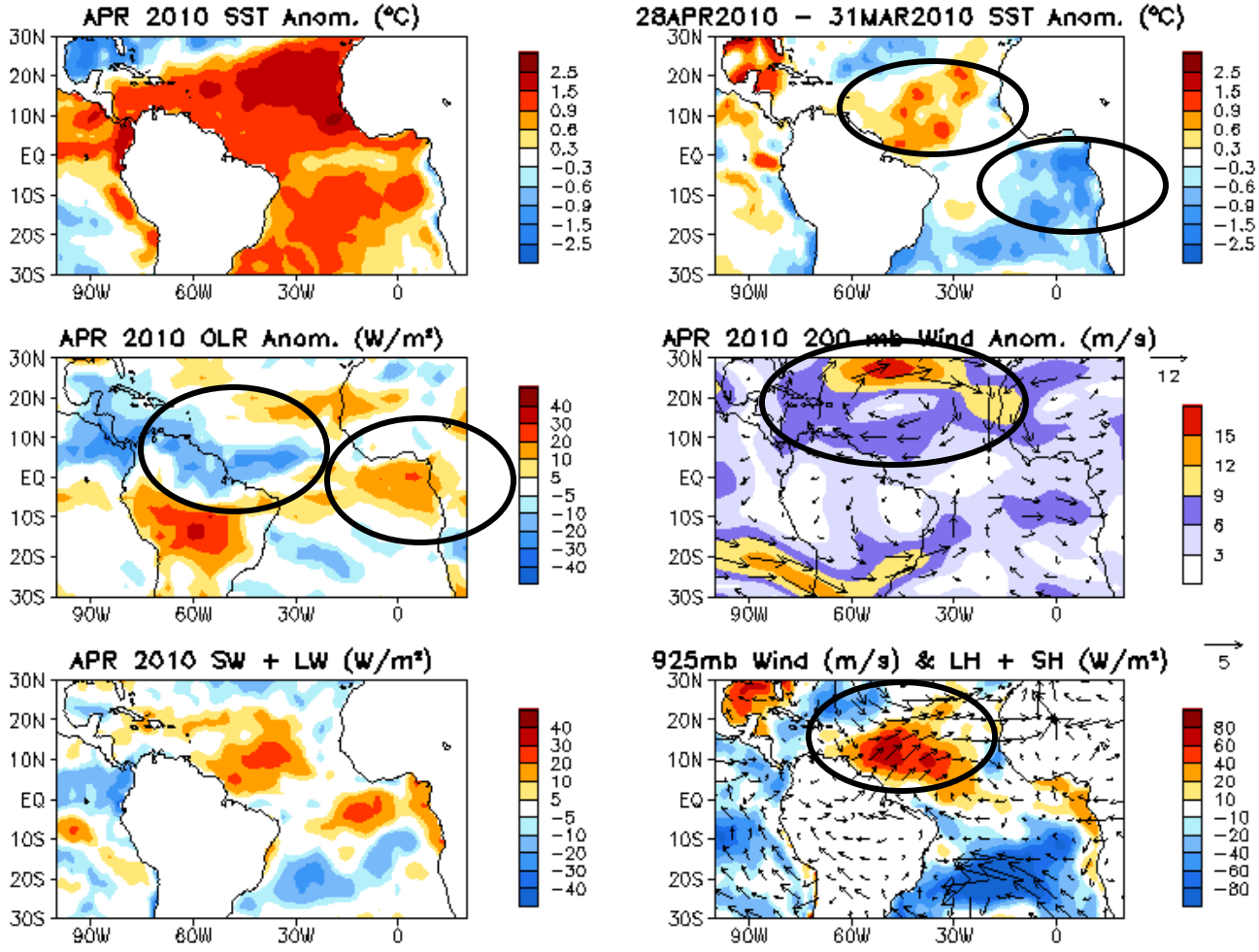




- **SST in the tropical North Atlantic (TNA) increased steadily from Dec 09 to Apr10, and SSTA exceeded +1.3C during Mar-Apr 2010.**
- **Tropical South Atlantic SST (TSA) remained above-normal.**
- **Meridional Gradient Mode (TNA-TSA) remained above-normal.**
- **Positive ATL3 SST persisted.**

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 intensified (weakened) in the tropical North (South) Atlantic.**
- **Convection was enhanced (suppressed) in the tropical western (eastern) Atlantic.**
- **Strong convergent (anti-cyclonic flow) wind in the tropical North Atlantic at (low) high levels, which was consistent with the enhanced convection there.**

North Atlantic Ocean

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

- Negative NAO continue in Apr 2010 (next slide), consistent with SLP.
- Consistent with the negative NAO are the tri-pole pattern of SSTA, OLR anomalies, and LH+SH anomalies.
- SSTA tendencies were consistent with surface heat flux anomalies.

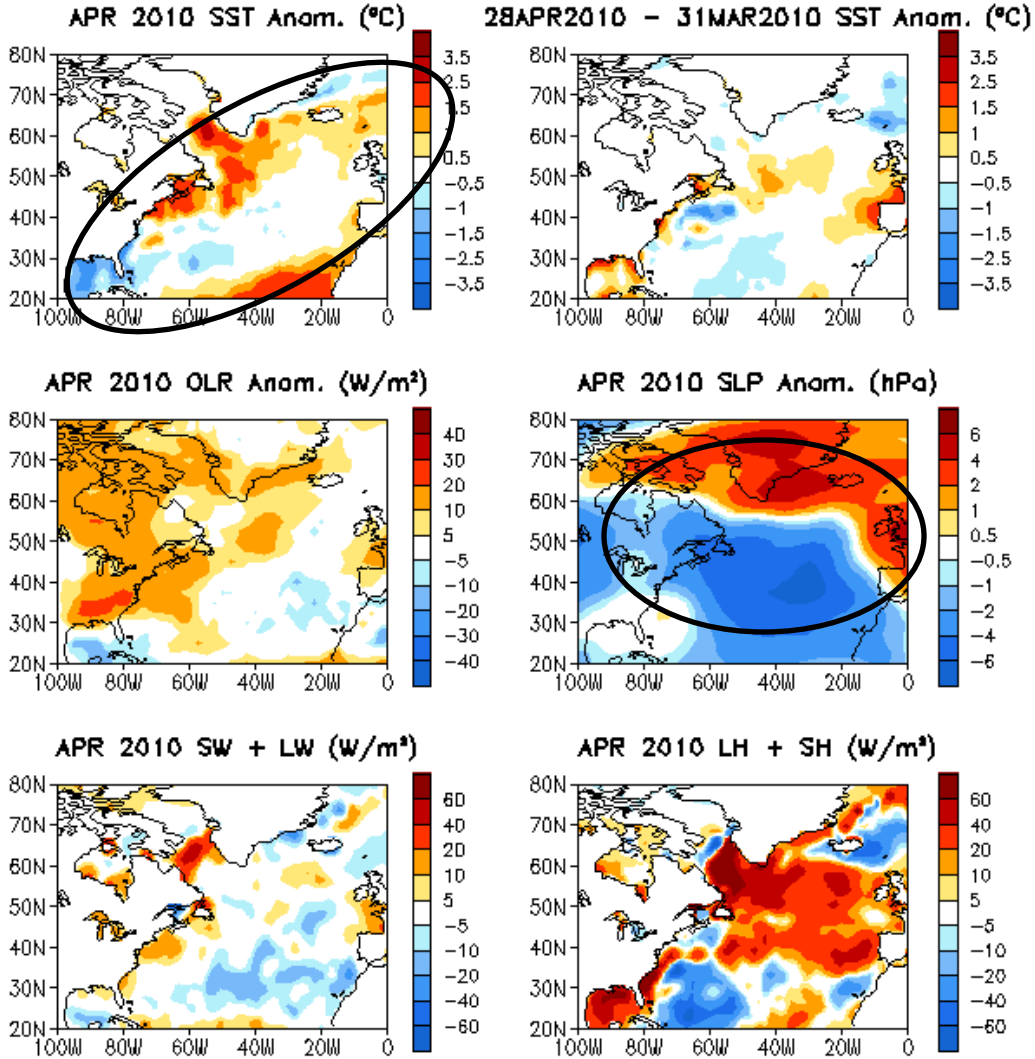
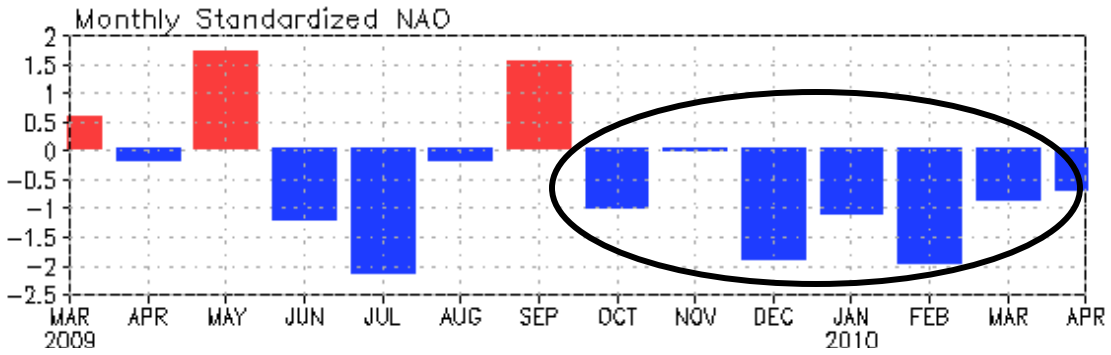
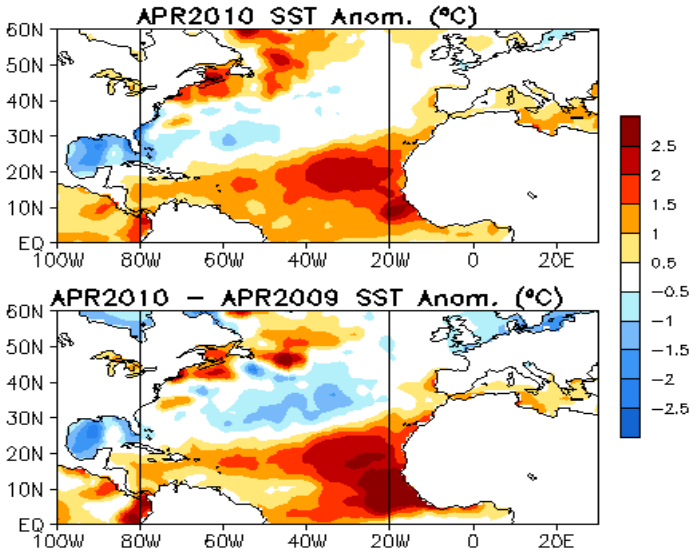
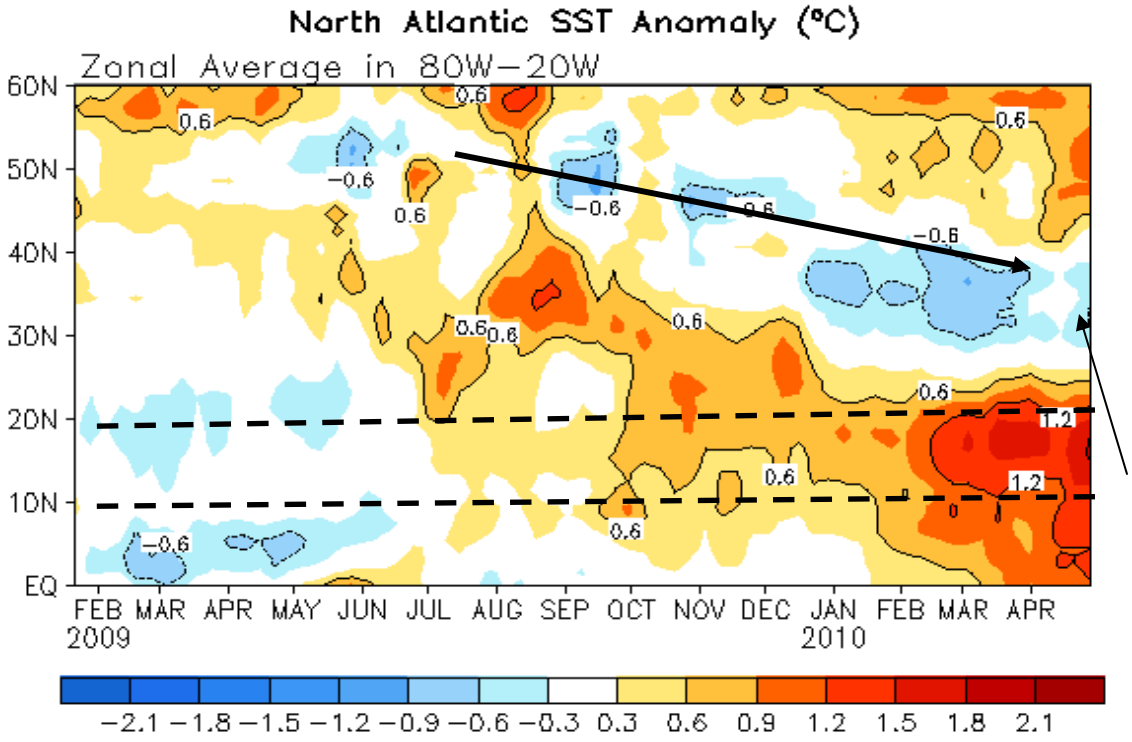


Fig. NA1. Sea surface temperature (SST) anomalies (top-left), anomaly tendency (top-right), Outgoing Long-wave Radiation (OLR) anomalies (middle-left), sea surface pressure anomalies (middle-right), sum of net surface short- and long-wave radiation anomalies (bottom-left), sum of latent and sensible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



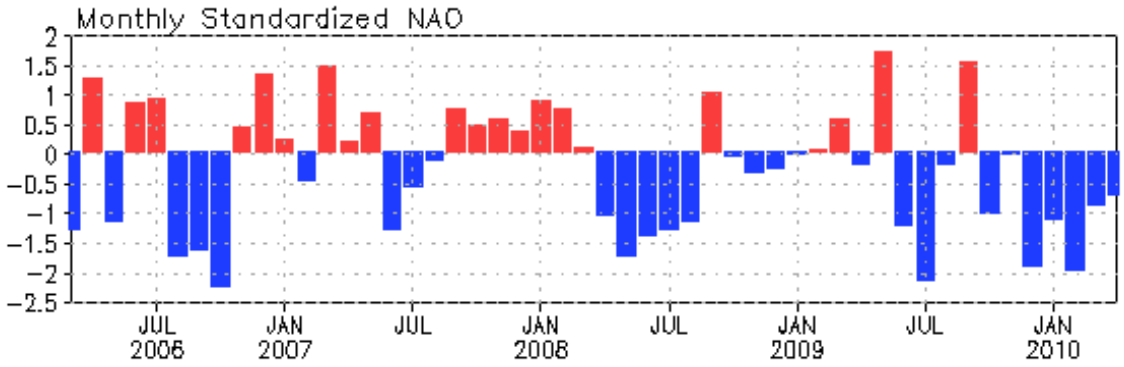


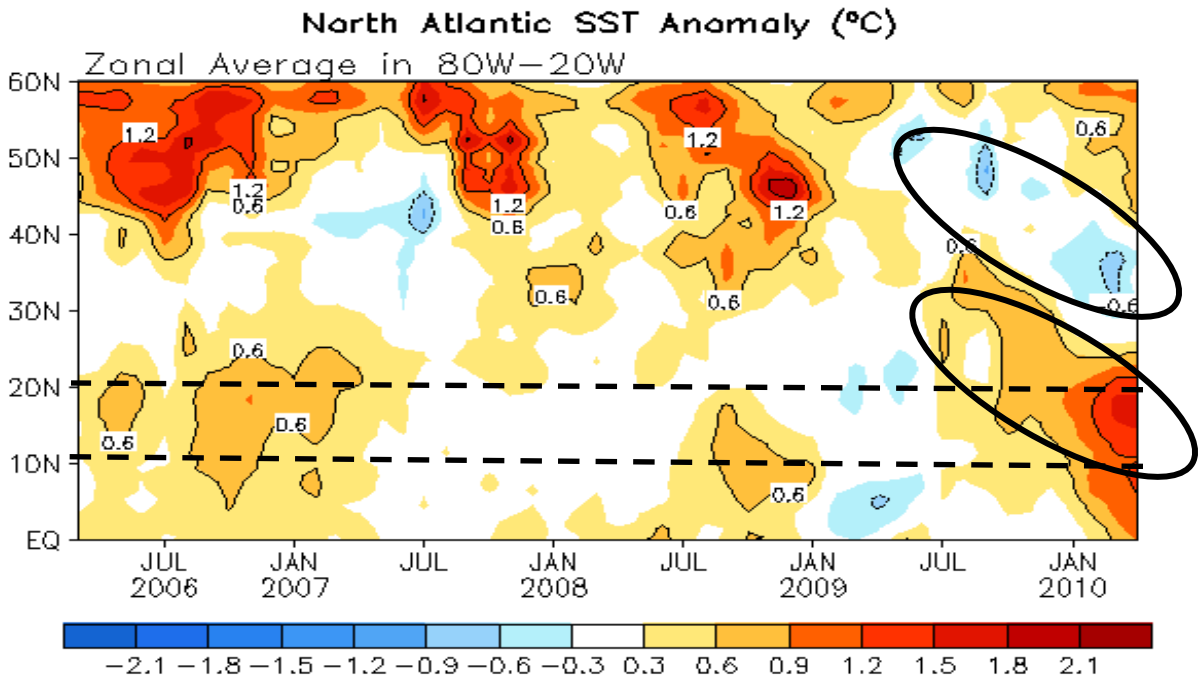


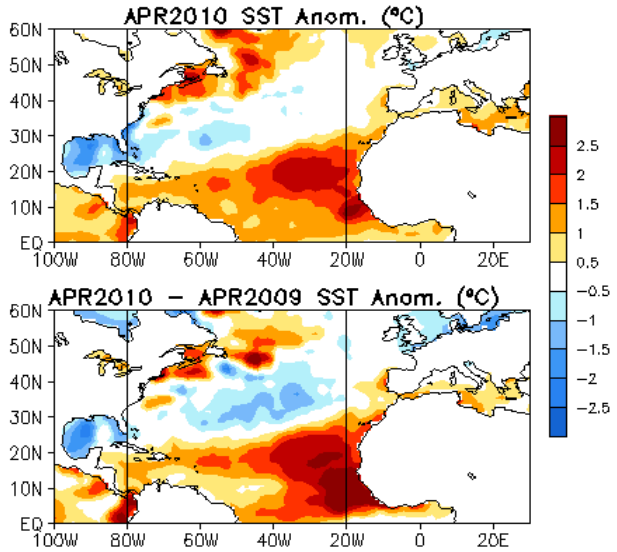
- Mid-latitude North Atlantic SSTA are closely related to NAO index – negative (positive) NAO leads to SST cooling (warming).
- NAO has been persistently below-normal since Oct 09, which contributed to the development and maintenance of negative (positive) SSTA in mid-latitude (tropical) North Atlantic.
- Positive SSTA in the Hurricane Main Development Region has been above-normal since Oct 09 and intensified since Feb 10, consistent with the impacts of the 2009/10 El Nino.

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





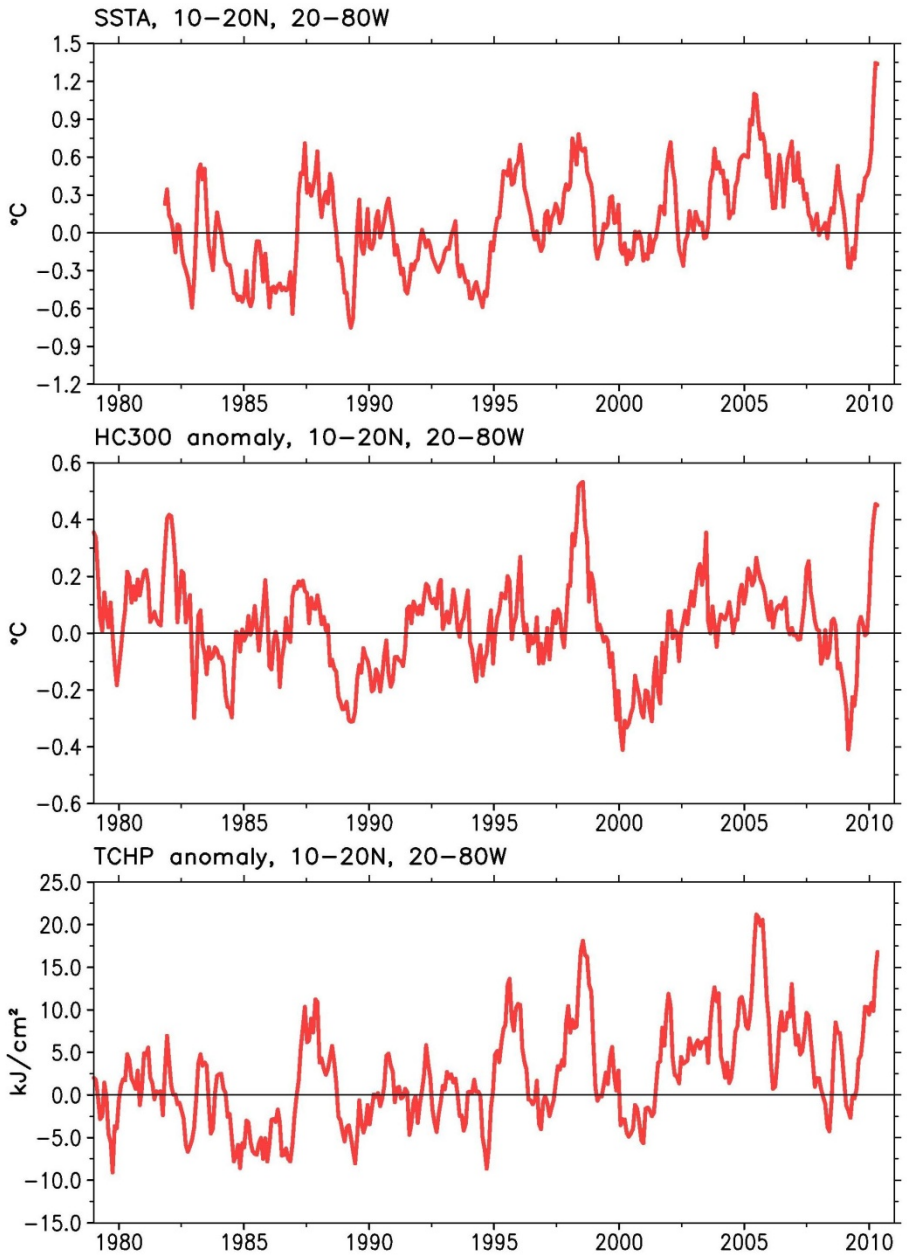


- **Mid-latitude North Atlantic SST has been below-normal since May 09.**

- **SST in the Hurricane Main Development Region has been above-normal since Jul 09, and intensified significantly since Feb 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.

SST and Tropical Cyclone Heat Potential (TCHP) Anomaly in Hurricane Main Development Region (HMDR)



- SSTA in HMDR reached a historical high in Mar-Apr 2010, exceeding the previous high in 2005.

- The high SSTA may be attributable to the warming influences from the persistent negative NAO during the past 6 months and the early spring warming impacts by the 2009/10 El Nino (e.g. Lee et al. 2008, GRL).

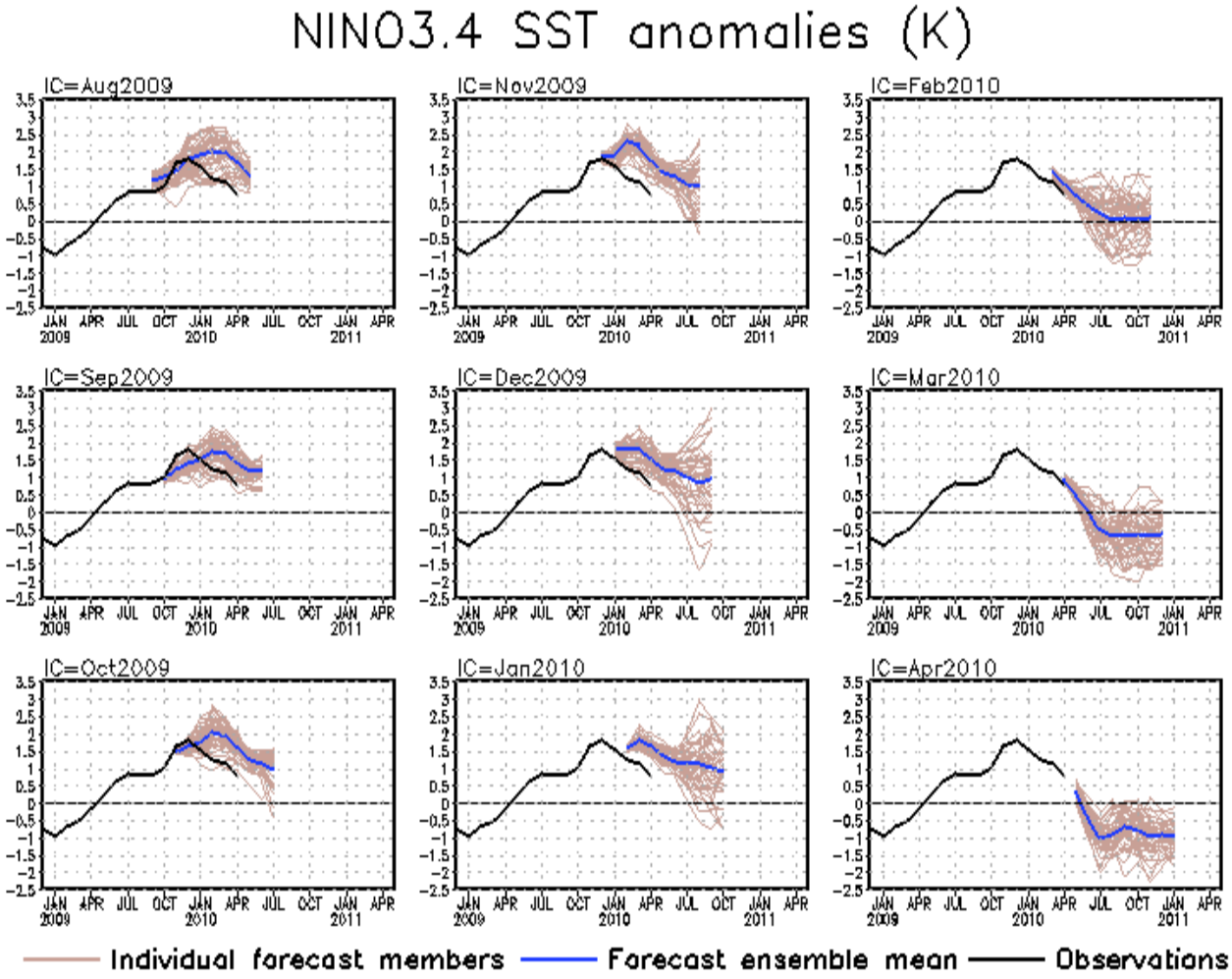
- HC300A in HMDR increased rapidly from a low in 2009, and its recent value became close to the historical high in 1998. There is no apparent trend in HC300A.

- TCHPA in HMDR reached a historical high in 2005.

- TCHPA has a downward trend from 2005 to 2009, but it increased rapidly since late 2009, becoming comparable to the second peak in 1998.

CFS SST Predictions and Ocean Initial Conditions

CFS Niño3.4 SST Predictions from Different Initial Months

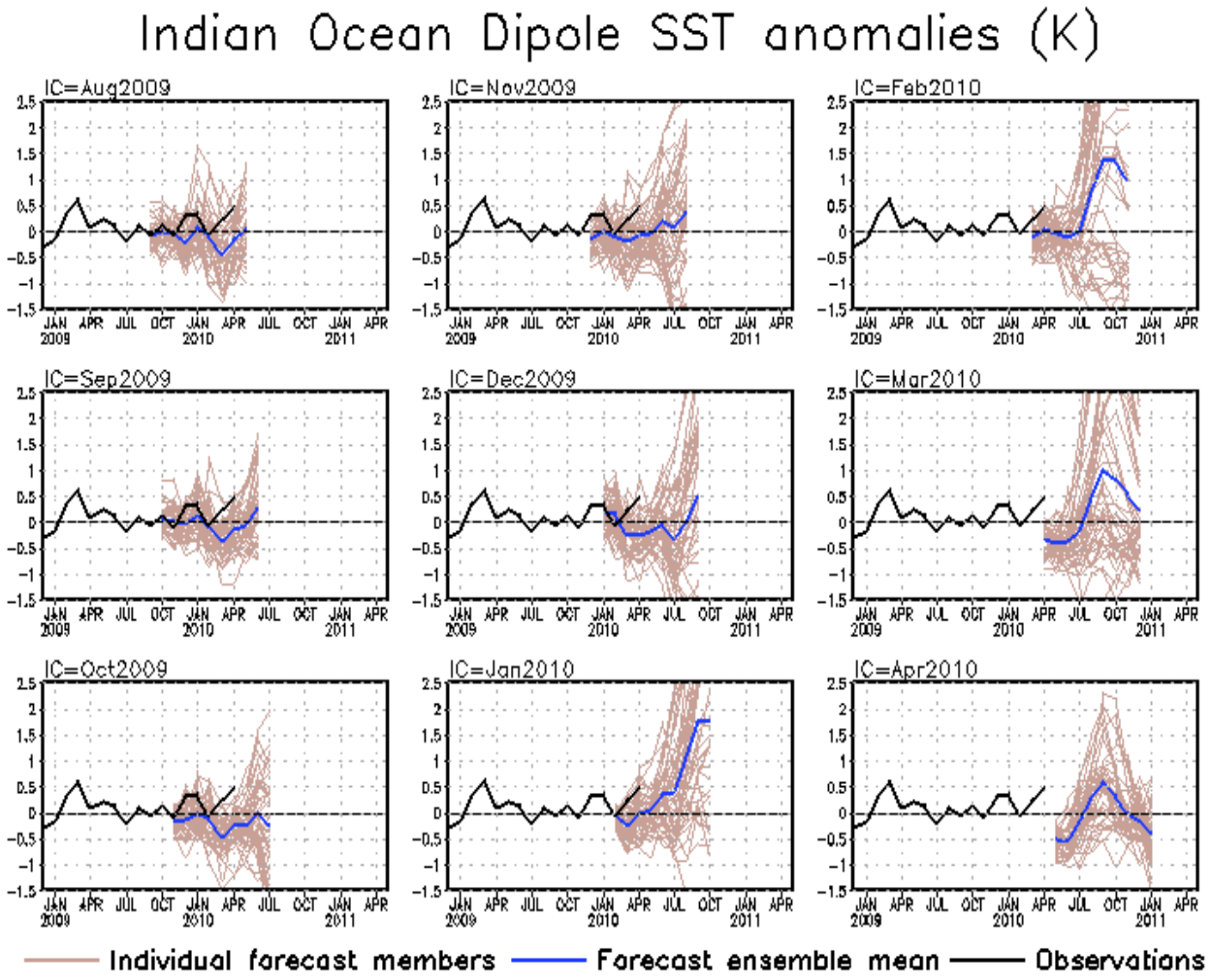


- **Forecasts from Aug-Feb I.C. overshoot the peak phase, and delayed the transition to the decay phase in Jan-Feb 2010.**

- **The latest forecast from Apr 2010 I.C. suggests the current El Nino will decay rapidly in spring, returning to near-normal or transiting to La Nina condition 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

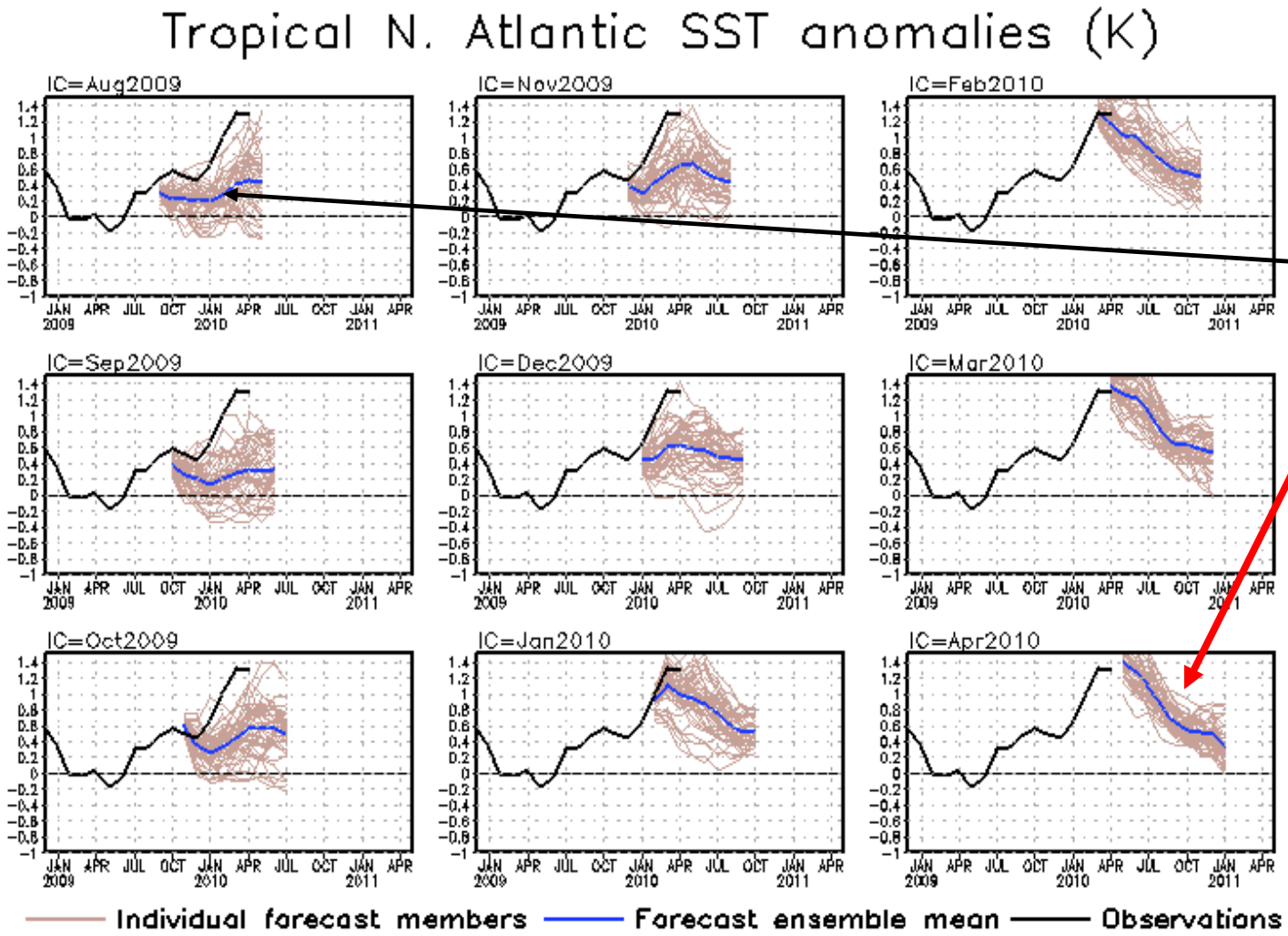
SETIO = SST anomaly in [90°E-110°E, 10°S-0]

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

- **Latest forecasts called for a near-normal IOD in fall 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



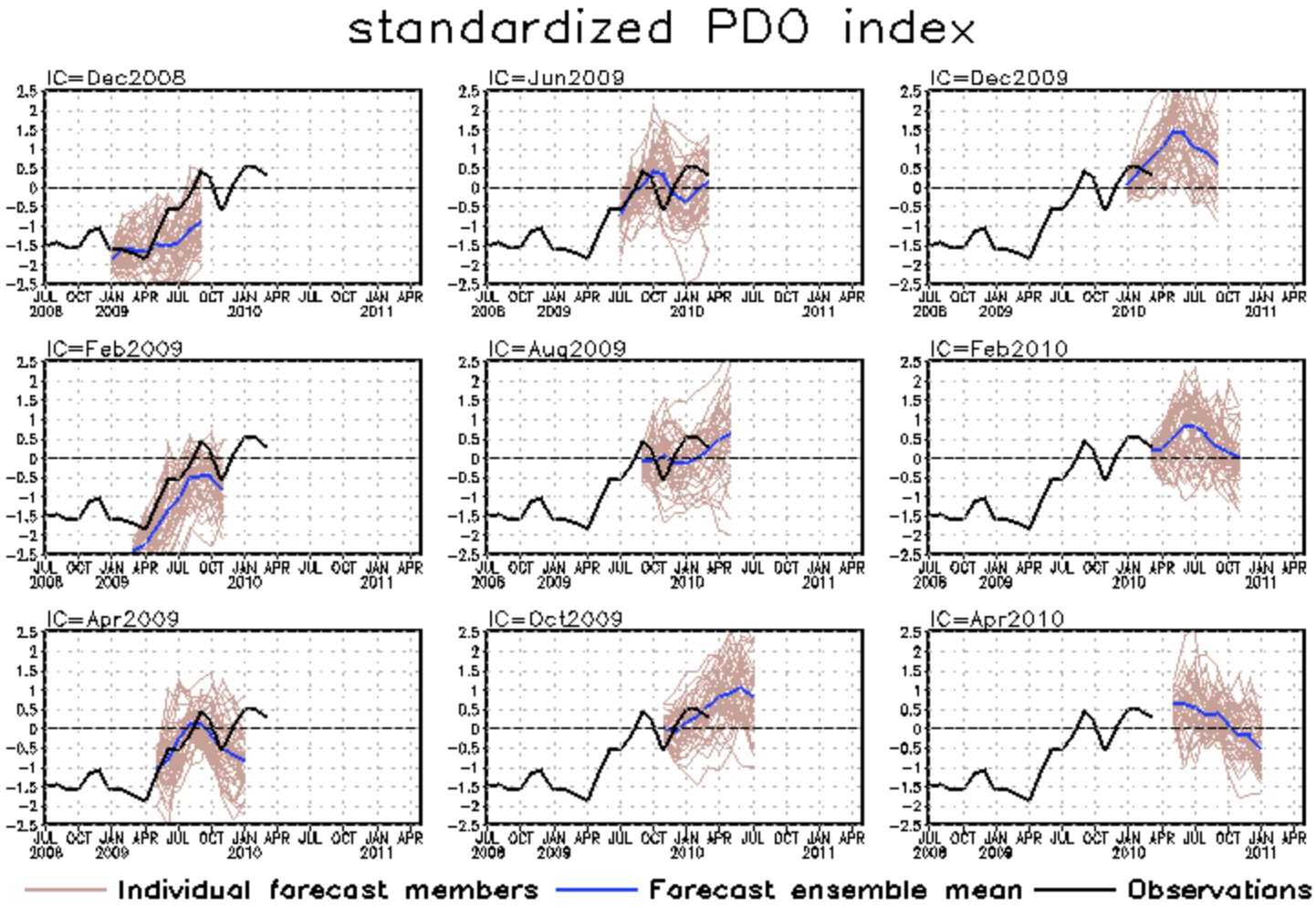
TNA is the SST anomaly averaged in the region of [60°W-30°W, 5°N-20°N].

- **Cold biases from Aug-Feb I.C.**
- **Less spread in the latest forecasts**

- Latest forecasts suggested that the positive tropical North Atlantic SST anomalies would peak in spring 2010 due to the weakening impacts of the 2009/2010 El Nino, and likely remain positive through summer/fall 2010.

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.

- Latest forecasts suggested that the PDO will remained near-normal throughout winter 2010/2011.

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.

Summary

- **Pacific / Arctic Ocean**
  - El Niño conditions (NINO 3.4 > 0.5 ºC) peaked in Dec 09, and weakened steadily since then, are expected to transition into ENSO-neutral conditions by June 2010;
  - Upwelling oceanic Kelvin waves forced by persistent low-level easterly wind anomalies during Mar-Apr 2010 pushed negative heat content anomalies eastward to near 120ºW and generated westward zonal current anomalies that cover the whole Pacific basin;
  - PDO was near-normal in Aug-Dec 2009, and became weakly above-normal in Jan-Apr 2010;
  - Upwelling along west coast of North America was mostly above-normal in Apr 2010, consistent with above-normal Chlorophyll;
  - Arctic sea ice content was near-normal in Apr 2010, the first time since 2001.
- **Indian Ocean**
  - Positive SSTA enhanced slightly in the tropical Indian Ocean in Apr 2010.
- **Atlantic Ocean**
  - Positive SSTA persisted (weakened) in the tropical North (South) Atlantic in Apr 2010, probably due to the impacts from the Pacific El Nino;
  - Convection was enhanced in the tropical North Atlantic;
  - NAO remained negative in Apr 2010;
  - Mid-latitude North Atlantic SSTs have been unusually below-normal from May 2009 to Apr 2010, and SSTs in hurricane main development region reached historic high in Mar-Apr 2010.

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!