Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

AAS23-01 Room:301A Time:May 22 13:45-14:03

Global monsoon and ENSO -Inherent interactive feedback-

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Japanese only

Keywords: global monsoon, air-sea interaction, Indian Ocean dipole mode

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AAS23-02 Room:301A Time:May 22 14:03-14:18

A new perspective on the weak relationship between ENSO and Atlantic Ninos

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While it has long been documented that ENSO has a strong influence on the northern tropical Atlantic, there appears to be no clear link with equatorial Atlantic variability. Thus the correlation between Pacific Ninos and equatorial Atlantic warm events (also called Atlantic Ninos) is rather weak, about -0.1 when ENSO leads by two seasons. Several attempts have been made to explain this weak relationship but a comprehensive understanding remains elusive. This is partly due to the small number of well-documented events, and partly to the poor representation of tropical Atlantic climate in general circulation models (GCMs). The present study re-examines the problem using satellite-era reanalyses and observations as well as GCMs with comparatively realistic representations of tropical Atlantic climate. We find that in both observations and GCMs the influence of tropical Pacific SST on equatorial Atlantic surface winds is strongly seasonal, with pronounced impacts limited to boreal spring. During this season negative Pacific SST anomalies induce equatorial surface westerlies in the tropical Atlantic. In GCMs these equatorial westerlies lead to a deepening of the thermocline, which is typically followed by an Atlantic Nino one season later. Thus the correlation between tropical Pacific SSTs and Atlantic Ninos is about -0.5 when the Pacific leads by two seasons. In observations and reanalyses, on the other hand, the relation between equatorial Atlantic winds and Atlantic Ninos is much weaker. Thus, in both models and observations ENSO induces similar wind patterns over the western equatorial Atlantic in MAM. In observations, however, this wind stress forcing is only one of the factors controlling the evolution of equatorial SSTs. Other factors controlling equatorial Atlantic SSTs will be discussed.

Keywords: ENSO, Atlantic Nino, correlation, surface wind

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AAS23-03 Room:301A Time:May 22 14:18-14:33

The Pacific-Japan teleconnection pattern as an atmospheric internal mode and influence of ENSO

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The Pacific-Japan (PJ) pattern is one of the dominant atmospheric teleconnection patterns that influence East Asian summer climate. The pattern is characterized by meridional dipoles of precipitation and lower-tropospheric circulation over the western North Pacific. While its correlation with decaying El Nino-Southern Oscillation (ENSO) is widely known, recent studies suggested that the PJ pattern is an atmospheric internal mode of variability.

In order to assess this possibility, we have conducted two sets of ensemble experiments based on a coupled general circulation model (CM) and its atmospheric component (AM) developed at U.S. Geophysical Fluid Dynamics Laboratory (GFDL). In CM, sea surface temperature (SST) anomalies are restored toward historical values over the equatorial eastern Pacific, so that the model reproduces historical ENSO. For AM, we have prescribed ensemble-mean SST of the CM commonly to all ensemble members. Thus ensemble-mean anomalies represent variability associated with ENSO, while deviations from ensemble means extract ENSO-independent anomalies in CM and atmospheric internal variability in AM.

Our empirical orthogonal function (EOF) analysis of monthly anomalies detects the PJ pattern as the leading mode both from ensemble-mean and inter-member variance of CM. This result indicates that the PJ pattern exists in the absence of ENSO. Our additional EOF analysis of inter-member AM anomalies reveals that the PJ pattern is an atmospheric internal mode. Yet, the ensemble-mean PJ pattern correlates with both developing and decaying ENSO, and it is revealed that ENSO forces about 40% of the monthly PJ variance. This considerable ENSO forcing is consistent with an interdecadal amplification of the PJ pattern after the mid-1970s climate regime shift and an intensification of ENSO.

Keywords: the summer western North Pacific, GCM, mode of variability

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AAS23-04 Room:301A Time:May 22 14:42-15:00

Variability and change in sea level in the tropical Pacific

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Sea level rise observed in the past 100 years and projected by climate models shows its relationship to the anthropogenic climate change. In addition to the global mean, regional sea level rise has a crucial impact on islands and countries face the ocean. Furthermore, regional sea level varies on a variety of time scales from interannual to multi-decadal and closely relates to natural climate variability. In the Equatorial Pacific (EP), zonal gradient of sea level anomalies has a positive long-term trend (eastern EP $>$ western EP) from 1950s to 1990s century and a negative trend from the late 1990s. Subtropical cell in the North Pacific weakened in the second half of the last century and strengthened at the late 1990s, which is associated with multi-decadal variability in the trade wind over the tropical Pacific. These variations are consistent with those of the Pacific Decadal Oscillation (PDO) whose phase reversal occurred in 1976/77 and near 2000. However, mechanisms of the decadal-to-multi decadal variability are still unclear. Recent increasing occurrences of a new type of the El Nino/Southern Oscillation(ENSO)(Central Pacific ENSO/ENSO Modoki) also influence the decadal variability of the sea level in the equatorial Pacific. Walker circulation weakened during the 20th century, which leads to a positive trend of zonal gradient of the sea level anomalies and accelerates (decelerates) sea level rise regionally in the eastern (western) EP. It also should be noted that a negative trend of zonal gradient of sea level anomalies observed in the last two decades is a part of the multi-decadal variability of the sea level in the tropical Pacific. Future projections associated with the global warming by climate models show that the Walker circulation could weaken in the 21th century. Regional sea level variability and change in the tropical Pacific and its relationship to climate variability and change are discussed using observed data and model simulations for the present and future climates.

Keywords: sea level, tropical Pacific, ENSO, Pacific Decadal Oscillation, global warming

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AAS23-05 Room:301A Time:May 22 15:00-15:15

Regional patterns of tropical Indo-Pacific climate change linked to the Walker circulation slowdown

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Regional patterns of tropical Indo-Pacific climate change are investigated over the last six decades based on a synthesis of in situ observations and ocean model simulations, with a focus on physical consistency among sea surface temperature (SST), cloud, sea level pressure (SLP), surface wind, and subsurface ocean temperature. A newly developed bias-corrected surface wind dataset displays westerly trends over the western tropical Pacific and easterly trends over the tropical Indian Ocean, indicative of a slowdown of the Walker circulation. This pattern of wind change is consistent with that of observed SLP change showing positive trends over the Maritime Continent and negative trends over the central equatorial Pacific. Suppressed moisture convergence over the Maritime Continent is largely due to surface wind changes, contributing to observed decreases in marine cloudiness and land precipitation there. Furthermore, observed ocean mixed layer temperatures indicate a reduction in zonal contrast in the tropical Indo-Pacific characterized by larger warming in the tropical eastern Pacific and western Indian Ocean than in the tropical western Pacific and eastern Indian Ocean. Similar changes are successfully simulated by an ocean general circulation model forced with the bias-corrected wind stress. Whereas results from major SST reconstructions show no significant change in zonal gradient in the tropical Indo-Pacific, both bucket-sampled SSTs and nighttime marine air temperatures show a weakening of the zonal gradient consistent with the subsurface temperature changes. All these findings from independent observations provide robust evidence for ocean?atmosphere coupling associated with the reduction in the Walker circulation over the last six decades.

Keywords: climate change, Walker circulation, air-sea interaction, tropical Indo-Pacific

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AAS23-06 Room:301A Time:May 22 15:30-15:45

Changes in intensity of the wintertime North Pacific Subtropical High on quasi-decadal timescale

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Temporal variations of the North Pacific Subtropical High (NPSH) intensity, which is defined by the sea level pressure averaged within a region of 120?145W, 20?40N, during 60 winters from December 1950/February 1951 to December 2009/February 2010 are investigated using the National Centers Environmental Prediction/National Center Atmosphere Research (NCEP/NCAR) reanalysis dataset. The months from December to February correspond to the period having peak winter conditions in the atmosphere field. The NPSH shows a dominant quasi-decadal (about 10 years) intensity variation and has an equivalent barotropic structure in the vertical direction through the troposphere. The tripole pressure system associated with quasi-stationary Rossby wave packet propagation is found over the wide regions from the NPSH to the Gulf of Mexico: in the strengthening phases of the NPSH, the pressure weakens over the central Canada and strengthens over the Gulf of Mexico. The spatial structure has a resemblance with the Tropical Northern Hemisphere (TNH) teleconnection pattern detected by the Barnston and Livezey (1987, Monthly Weather Review): actually, the NPSH intensity has a significant correlation (R = 0.54) with an index of TNH defined by a rotated empirical orthogonal function (REOF) analysis for the geopotential height at 700hPa field. Changes in the wind associated with the NPSH-related teleconnection pattern impart large impacts on the surface air temperature and precipitable water fields over the America: the associated northerly wind brings cold/dry air onto the western American region and the southerly wind brings the warm/wet maritime air onto the eastern part of the American.

The statistical analyses such as a composite analysis and a correlation analysis show significant relationships between the NPSH and sea surface temperature (SST); a zonal dipole SST structure is found in the tropical ocean: positive SST anomalies are distributed in the western part of tropical ocean and negative anomalies are in the eastern part of tropical ocean in the strengthening phases of the NPSH. The SST pattern is similar to that related to the El Nino/Southern Oscillation (ENSO): actually, the NPSH intensity has a significant correlation (R = ?0.54) with the Nino?3.4 index defined as SST averaged of 120?170W, 5S?5N. A composite analysis shows that, in the La Nina events, a Hadley cell characterized by a upward flow in the northern tropical Pacific around 150W, 15N and a downward flow in the subtropical Pacific region around 140W, 30N is formed locally and resultantly causes a strengthening of the NPSH. It can be pointed out that the NPSH intensity and the NPSH-related teleconnection pattern, i.e., TNH pattern, are induced mainly by the quasi-decadal time scale ENSO found in the recent analysis (Hasegawa and Hanawa 2006, Journal of Oceanography).

Keywords: North Pacific Subtropical High, TNH teleconnection pattern, quasi-decadal timescale, ENSO

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Intraseasonal variability of ocean surface in the western Pacific warm pool and its connection with typhoon activity

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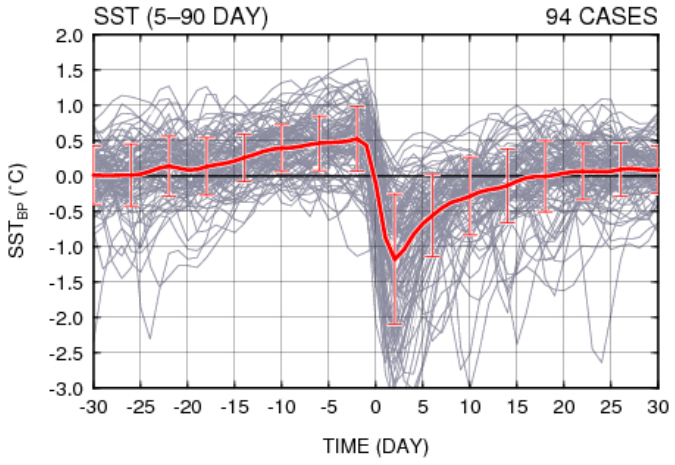
It is known that convective activity over the western Pacific warm pool varies in intraseasonal time scale (30-90 days). Recent studies suggest that frequency of tropical cyclone increases significantly during a convectively active phase. It is also known that a tropical cyclone can intensify through the supply of energy from ocean surface, and a significant cooling of ocean surface is sometimes observed just after the passage of a tropical cyclone. However, the variability in an oceanic mixed layer associated with tropical convective activity is not fully understood. In the present study, the variability of ocean surface layer in a time scale shorter than 90 days is examined using satellite-derived sea-surface temperature and vertical profiles observed by high-repetition drifting floats. The relevance of the short-term variation with tropical cyclone activity is discussed.

A spectral analysis of sea surface temperature (SST) was performed using satellite-derived dataset for 23 years (1988-2010). Results show that there is no significant peak of power spectral density but almost equal power in the bandwidth of 5-90 day, meaning the prevalence of irregular variation (like white noise) in the intraseasonal time scale. A close inspection of the variation in each year revealed that this irregularity was resulted from a mixture of signals in various time scales, such as 60-day cycle in 2004 and 20- or 30-day since 2008. This short-term variation has from one third to equal strength of power relative to the semiannual and annual variations.

The close inspection also revealed that many of short-term variations with significant amplitude were associated with tropical cyclone activity. Using tropical cyclone best-track data, a change in sea-surface temperature at grid points along each tropical-cyclone track was analyzed. Results show that a sequence of warming (˜ +0.5K) prior to the passage and significant cooling (˜ -1.0K) after that is a common feature of variation associated with a tropical cyclone (as shown in the attached figure). The time scale of the sequence varies among cases but was usually in between 20 and 60 days. In many cases, a tropical cyclone track coincided with an area where SST significantly increased. This means that a preconditioning of ocean surface usually occurs before a tropical cyclone comes. The vertical profiles of water temperature observed by high-repetition (1 time/day) drifting floats showed that the set of warming and cooling occur in a whole depth (˜ 50m) of a surface mixed layer.

The results of the present study indicate that the western Pacific warm pool is characterized by irregular variation of ocean mixed layer associated with tropical-cyclone activity in intraseasonal time scale.

Keywords: air-sea interaction, tropical cyclone, tropical meteorology



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AAS23-08 Room:301A Time:May 22 16:18-16:33

The interaction between the Madden-Julian Oscillation and ENSO in the tropical Pacific

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The Madden-Julian oscillation (MJO) is the dominant intraseasonal mode in the tropics and sometimes causes synoptic-scale disturbances accompanied by strong equatorial westerly winds, termed westerly wind bursts (WWBs). WWBs over the Pacific have been known to accelerate El Nino through exciting oceanic Kelvin waves. In this study, MJO behaviors and oceanic responses under the different El Nino-Southern Oscillation (ENSO) phases are examined. During the El Nino developing phases, strong westerly wind forcing and downwelling oceanic Kelvin waves are found in association with MJO convection in the western and central Pacific. On the other hand, the equatorial wind forcing and oceanic responses are weak during the other ENSO phases even though MJO convection has almost the same amplitude. Thus, favorable background states for the WWB generation from MJO and in turn strong impacts on the ocean are associated with ENSO phases.

Keywords: MJO, ENSO, westerly wind bursts

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AAS23-09 Room:301A Time:May 22 16:45-17:00

Observational and model studies on relationship between coastal upwelling in the Bismarck Sea and El Nino events

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We investigate variations of oceanic thermal condition, upper-ocean currents, and surface winds in the western equatorial Pacific, especially in the Bismarck Sea east of New Guinea, using observational data and high-resolution OGCM (OFES) hindcasts, and long-term simulation of high-resolution air-sea coupled global model (SINTEX-F2).

During December 2001-January 2002, coastal upwelling occurred along the Papua New Guinea (PNG) coast, and then upwelled relatively cool water spread out over a wider area to the northeast. Simultaneously, strong northwesterly surface winds occurred along the north coast. At that time, a northeastward outflow toward the equator from the PNG coastal area is also found. This northeastward outflow could bring the upwelled relatively cool coastal water, to the western equatorial South Pacific near PNG. The present results indicate that northeastward transport of the cold water is related to the complicated upper-ocean currents in the Bismarck Sea, and that would strongly affect the upper-ocean thermal change in the western equatorial Pacific near PNG in association of coastal upwelling before the onset of 2002/2003 El Nino event.

It is also shown that the relatively cold water related to the coastal upwelling generates positive zonal gradient of SST in the western equatorial Pacific. At that time, intraseasonal strong surface westerly winds occur in this region. Such relationship between strong surface westerly winds and positive SST gradient in the western equatorial Pacific is consistent with those expected from previous theoretical and model studies.

Furthermore, similar SST patterns to the observed SST pattern during PNG coastal upwelling are also found in 200-year simulation of high-resolution air-sea coupled general circulation model (SINTEX-F ver2). Roughly a half of such SST cooling events appear prior to the El Nino events. The present study suggests that the small-scale phenomenon related to PNG coastal upwelling can contribute to onset of El Nino events via oceanic and atmospheric changes in the western equatorial Pacific.

Keywords: coastal upwelling, El Nino event, tropical western Pacific, airi-sea interaction, intraseasona-to-interannual scale