The lack of westerly wind bursts in 2014 and its relation to background wind states

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The strong El Niño in late 2014 was predicted by many climate scientists based on high warm water volume and successive equatorial westerly wind bursts (WWBs) in early 2014. However, it turned out to be a weak El Niño and developed again in 2015. Several studies have been devoted to elucidate the reasons of the unmatured El Niño in 2014. One of the reasons addressed is the lack of WWBs after boreal spring. In this study, we examine what caused the lack of WWBs in 2014 focusing on background wind states.
The successive WWBs from January to March 2014 excited strong oceanic Kelvin waves, resulting in a large increase in the eastern Pacific sea surface temperature (SST). However, there are no successive WWBs or the Kelvin waves after April, resulting in a decrease in the SST.
Our previous studies have shown that WWBs occur frequently when tropical intraseasonal convection, so-called the Madden-Julian Oscillation (MJO), propagates over the Pacific under the equatorial westerly background states, which contribute to develop eddy disturbances via background zonal wind convergence near the equator. In 2014, there were several MJO events throughout the year. However, few WWBs accompanied the MJO convection.
Focusing on the background states after the WWB occurrences in early 2014, zonal wind convergence was retracted and did not reach the equatorial central Pacific. In boreal summer, climatologically, convectively active and westerly regions shift north of the equator. Because this environmental condition is not favorable for the WWB occurrences, the WWB frequency in boreal summer is statistically low. In 2014, unchanged background states can be a reason for the lack of WWBs even with several MJO events.

Keywords: El Niño, westerly wind bursts, Madden Julian Oscillation

Long-term modulation of the quasi-decadal scale variation in the tropical Pacific during the 1990s and 2000s

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To explore a low-frequency-modulation of ENSO-like quasi-decadal (QD)-scale variation in the tropical Pacific, relationship between QD-scale modulation and inter-annual scale variation (i.e., El Nino, El Nino modoki, La Nina, and La Nina modoki) is compared between the 1990s and 2000s. QD-scale sea surface temperature (SST) anomaly averaged in the central equatorial Pacific (i.e., Nino-3.4 region) is used for the index of the QD-scale variation. Periods of the positive values of the index are defined as the “QD positive period” in this study. QD-scale SST anomalies averaged over QD positive period in the 2000s show stronger positive and weaker negative values in the central equatorial Pacific and Philippine Sea than the 1990s, respectively. The spatial pattern is similar to the El Nino modoki, as pointed out in previous studies. To explore a relationship between such QD-scale modulation and inter-annual scale variation, composite analyses are conducted. A composite map for inter-annual SST anomalies during El Nino and El Nino modoki periods within the QD positive period of the 1990s shows stronger positive SST anomalies in the central equatorial Pacific and stronger negative SST anomalies in the Philippine Sea than the 2000s. A composite map for La Nina and La Nina modoki during QD positive period of the 1990s shows negative SST anomalies both in the central equatorial Pacific and Philippine Sea. On the oher hand, a composite map for LA Nina and La Nina modoki during QD positive period of the 2000s shows weak negative SST anomalies in the central equatorial Pacific and positive SST anomalies in the Philippine Sea, in contrast to the 1990s. Such differences in SST anomalies of El Nino/El Nino modoki and La Nina/La Nina modoki between the 1990s and 2000s may lead the QD-scale modulation of SST anomalies during the 1990s and 2000s. In addition to those results, analyses results of temperature profiles obtained along 137E repeated line conducted by JMA and atmospheric reanalysis data will be showed in the presentation.

Keywords: quasi-decadal scale variation, El Nino/Southern Oscilaltion, tropical Pacific

The Pilot Aeroclipper Campaign in North Pacific Cyclones (PACNPaC)

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Tropical Cyclones (TCs) are a major threat for many tropical and subtropical coasts. Their monitoring and forecasting are thus of great importance to deliver accurate early warnings. Most of the real time data available for operational centers is however coming from satellite observations. For example, the Dvorak technique gives an indirect estimate of the wind intensity based on the structure of the cyclone cloudiness. Yet, there is no device able to measure continuously the surface pressure in the eye of the TC that is critical to follow the evolution of its intensity. The Aeroclipper developed by the French Space Agency (Centre National d’Études Spatiales, CNES) is a quasi-lagrangian device (small streamlined balloon) drifting with surface wind at about 20-30m above the ocean surface. It is a new and original device for real-time and continuous observation of air-sea surface parameters in open ocean remote regions. This device enables the sampling of the variability of surface parameters in particular under convective systems toward which it is attracted. The Aeroclipper is therefore an ideal instrument to monitor TCs in which they are likely to converge and provide original observations to evaluate and improve our current understanding and diagnostics of TCs as well as their representation in numerical models.
We will present the challenges of the test Aeroclipper flight during the Pilot Aeroclipper Campaign in North Pacific Cyclones (PACNPaC) that will take place from Palau, an archipelago situated in the most cyclonic region on Earth, during next northern hemisphere cyclonic season. This campaign aims at obtaining the first continuous observation of surface parameters in a TC It should provide a crucial first step toward an operational use of Aeroclippers in real-time operations to improve the reliability of TCs forecasts and warning procedures.

Keywords: Aeroclippers, Tropical Cyclones, Observation campaign

Variation of North Pacific subtropical gyre heat transport caused by the interior flow change

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The subtropical gyre of the North Pacific consists of the northward flowing Kuroshio and the southward interior return flow. The variation of the net heat transport of the gyre is caused by the changes of the volume transport distribution with respect to temperature in the Kuroshio and the interior flow in addition to the gyre volume transport change. In this study, we focused on the volume transport distribution change in the interior flow, which can be taken into accounted by the volume transport-weighted temperature. By applying the altimeter-derived gravest empirical mode method to hydrographic and altimetric data from San Francisco to 30N, 145E via Honolulu, we estimated the geostrophic interior flow of the subtropical gyre between 1993 and 2012. Anomaly of the volume transport-weighted temperature from the seasonal mean cycle is caused by the change of the volume transport in a layer just above the isopycnal of 25.5sigma-theta. Peaks in a quasi-decadal variation of the volume transport-weighted temperature are found approximately one year before peaks of sea surface temperature in the tropical western Pacific warm pool region.

Keywords: North Pacific subtropical gyre, quasi-decadal variation, Tropical western Pacific warm pool

Methods to evaluate prediction skill in the Madden-Julian oscillation phase space

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Indices of prediction skill over the Madden-Julian oscillation (MJO) phase space are examined with reanalysis and forecast data provided by the Japan Meteorological Agency (JMA). In addition to the bivariate root-mean-square error (RMSE) and the bivariate anomaly correlation coefficient (ACC), the mean-error vector is assessed. Conventionally, the ACC and RMSE has been used, although this approach misses information on the model bias for MJO events. Moreover, the ACC is not suitable for models in which the MJO signal tends to damp in some phases, because the ACC strongly depends on the MJO amplitude. The mean-error vector compensates for this drawback by associating a model's erroneous mean tendency with RMSE. For example, the JMA forecast produces a leftward mean error vector field uniformly distributed over the MJO phase space with its amplitude related to RMSE. RMSE should be then used with the mean error vector for evaluating MJO prediction skill.

Keywords: Madden-Julian oscillation, predictability

Subsurface salinity anomalies in the eastern equatorial Indian Ocean during positive IOD events

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The Indian Ocean Dipole (IOD) is known as an important climate mode in the tropical Indian Ocean. Previous studies have reported that not only sea surface temperature (SST), but also subsurface oceanic temperature and sea surface salinity (SSS) undergo significant variations owing to the anomalous oceanic circulation during IOD years. However, influences of the IOD on subsurface salinity are not fully understood due to the scarcity of observations. In this study, using an ocean reanalysis product, subsurface salinity variability in the eastern equatorial Indian Ocean (95°-100°E, 3°S-3°N) associated with the IOD and its influence on the upper-ocean stratification have been investigated. It is found that salinity near the pycnocline becomes anomalously high off Sumatra in boreal fall-winter of positive IOD (pIOD) years. Anomalies with an opposite sign but smaller amplitude were observed in negative IOD years. Enhanced upwelling and eastward transport of high salinity water seem to be the main causes of those positive salinity anomalies. By decomposing density anomalies into contributions from temperature and salinity anomalies, it is demonstrated that positive density anomalies associated with high salinity anomalies lead to stronger density stratification in the upper-ocean and shoaling of the mixed layer during the mature phase of pIOD events. Our results suggest that subsurface salinity anomalies have a potential to influence the air-sea interaction by modifying the upper-ocean stratification and mixed layer processes.

Keywords: The Indian Ocean Dipole, salinity variation, upper-ocean stratification, mixed layer depth

Phase locking of equatorial Atlantic variability through the seasonal migration of the ITCZ

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The equatorial Atlantic is marked by significant interannual variability in sea-surface temperature (SST) that is phase-locked to late boreal spring and early summer. The role of the atmosphere in this phase locking is examined using observations, reanalysis data, and model output. The results show that equatorial zonal surface wind anomalies, which are a main driver of warm and cold events, typically start decreasing in June, despite SST and sea-level pressure gradient anomalies being at their peak during this month. This counterintuitive behavior is explained by the seasonal northward migration of the intertropical convergence zone (ITCZ) in early summer. The north-equatorial position of the Atlantic ITCZ contributes to the decay of wind anomalies in three ways: 1) Horizontal advection associated with the cross-equatorial winds transports air masses of comparatively low zonal momentum anomalies from the southeast toward the equator. 2) The absence of deep convection leads to changes in vertical momentum transport that reduce the equatorial surface wind anomalies. 3) The cross-equatorial flow is associated with increased total wind speed, which increases surface drag and deposit of momentum into the ocean.
Previous studies have shown that convection enhances the surface wind response to SST anomalies. The present study indicates that convection also amplifies the surface zonal wind response to sea-level pressure gradients in the western equatorial Atlantic, where SST anomalies are small. This introduces a new element into coupled air-sea interaction of the tropical Atlantic.

Keywords: equatorial Atlantic, phase locking, ITCZ

Development of a Coupled Atmosphere-Ocean Model in JMA/MRI

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A coupled atmosphere-ocean data assimilation (DA) system is a system in which atmospheric and oceanic observation data are assimilated into a coupled atmosphere-ocean model. Many researchers consider a coupled DA system as an indispensable tool for seamless forecasting of daily weather to interannual climate variations. Using a coupled DA system is also considered to be effective to improve the skill of ENSO forecasting. For example, JAMSTEC developed a coupled DA system based on a four-dimensional variational (4DVAR) method, and confirmed its potential for improving ENSO forecasts (e.g. Sugiura et al. 2008; Masuda et al. 2015). JMA/MRI has also been developing a quasi-coupled DA system in which only ocean data are assimilated into a coupled model (atmospheric data is not assimilated) since 2006, and confirmed that the system improved key atmospheric climate features such as the Walker Circulation, the Monsoon Trough, and the Typhoon activities in the Philippine Sea over simulation of an uncoupled atmospheric model forced by observed SST data, that is, AMIP-Run (Fujii et al. 2009, 2011).
Recently, operational agencies such as NCEP, ECMWF, and UKMO, have started to develop or to use coupled DA systems in order to realize the seamless forecasting and to improve climate predictions (Saha et al. 2010, Laloyaux et al. 2015, Lea et al. 2015). Those systems are, however, so-called weakly-coupled data assimilation systems; atmospheric and ocean analyses are generated independently by separated atmosphere and ocean data assimilation systems. First-Guess fields for next analysis time-windows are given by the simulation of a coupled model from the ocean and atmospheric analysis fields. Although a weakly-coupled data assimilation system is not sufficient for generating balanced analyses fields of atmosphere and ocean due to the lack of explicit evaluation of the balance, development of the system is relatively easy because existing atmosphere and ocean data assimilation systems can be exploited.
JMA/MRI have also started to develop a weakly-coupled DA system by coupling the 4DVAR global atmosphere DA system, MRI-NAPEX, the global ocean data assimilation system, MOVE-G2, and the coupled atmosphere-ocean model for seasonal forecasting, JMA/MRI-CGCM2. In the plan, the system will use assimilation time-windows of 6 hours for the atmosphere and 10 days for the ocean. The system simulates time-evolution of the atmosphere and ocean from the atmospheric analyses fields generated by MRI-NAPEX and ocean fields at the end of the previous simulation using JMA/MRI-CGCM2. In the simulation, the ocean fields are continuously modified by adding oceanic analysis increments estimated by MOVE-G2. Atmospheric first-guess fields for the next assimilation time-window are prepared by the simulation. Thus, the system uses the uncoupled atmospheric model for the inner loop and the coupled model (JMA/MRI-CGCM2) for the outer loop in the 4DVAR DA system. Here, it should be noted that MOVE-G2 and JMA/MRI-CGCM2 have been used in the operational seasonal forecast in JMA since June 2015.
We have also developed a new quasi-coupled DA system using MOVE-G2 and JMA/MRI-CGCM2, and performed a reanalysis experiment for the period after 2000. In the presentation, we will introduce results of the reanalysis experiment as well as the features of the weakly-coupled DA system which we are developing now.

Keywords: Data Assimilation, Seamless Forecasting, Seasonal Forecasting

