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

AAS03-01 Room:101A Time:May 23 09:00-09:10

Introduction

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A brief introduction is given by the chief convener about the purpose and program of this international session.

Keywords: Air-sea interaction

Japan Geoscience Union Meeting 2012
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AAS03-02 Room:101A Time:May 23 09:10-09:25

Atmosphere-Ocean Interaction over the Kuroshio-Oyashio Extension

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The variability of the upper ocean heat content in western boundary currents and their extension (hereafter WBC) is strongly controlled by low frequency changes in the WBC strength and position. In the North Pacific, these changes are primarily forced by previous basin-scale wind stress fluctuations via Rossby wave propagation. The growing evidence that sea surface temperature (SST) anomalies in the Kuroshio-Oyashio Extension (KOE) region influence the large-scale atmospheric circulation, motivates us to investigate the links between KOE SSTs and WBC changes, and the extent to which ocean-atmosphere feedback processes enhance low-frequency variability.

We are in the initial phase of this project which will include: 1) analyses of atmosphere and ocean data sets, 2) diagnosis of Pacific decadal variability in global climate model simulations and 3) experiments with specified SST anomalies in the KOE region using a high-resolution atmospheric GCM. We will outline the full research plan for our project but focus on the first two tasks. Specifically, We use an empirical patterns-based approach applied to daily SST, surface air temperature, and surface specific humidity to estimate the effect of air-sea coupling on total and persistent variability. We also explore the role of KOE fluctuations in Pacific decadal variability in the NCAR CCSM4.

Keywords: air-sea interaction, western boundary current, North Pacific, Kuroshio Extension, surface heat fluxes

Japan Geoscience Union Meeting 2012
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AAS03-03 Room:101A Time:May 23 09:25-09:40

Long-term modulations in the decadal climate variability over the North Pacific

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Observations for the post-war period suggest that (quasi-) decadal climate variability over the wintertime North Pacific may have undergone notable modulations. A 20-year segmented EOF analysis of 3-year running-mean anomalies of the North Pacific SST reveals that the subarcitic oceanic frontal zone was the primary center of action of the extratropical decadal SST variability until the 1980s. The SST variability there exhibits high correlation with the decadal variability of the surface Aleutian Low and a PNA-like pattern aloft but no significant simultaneous correlation with the tropical SST variability. Though extracted in the second EOF, however, this extratropical ocean-atmosphere variability has lost its predominance in the 1990s and 2000s. Instead, the primary center of action has shifted to the subtropical oceanic frontal zone, where the decadal SST variability that accompanies the variability of the subtropical anticyclone is strongly anti-correlated with the tropical SST variability that has enhanced since the 1980s. A 150-year CGCM integration is found to simulate similar long-term modulations both in the decadal variability over the extratropical North Pacific SST and in the associated atmospheric variability.

Keywords: decadal variability, Pacific, sea surface temperature

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AAS03-04 Room:101A Time:May 23 09:40-09:55

Influence of SST front on baroclinic development of atmospheric low-frequency variability

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Understanding of extratropical atmospheric low-frequency variability (LFV) like a blocking high and teleconnection pattern, whose time scale is longer than transient baroclinic waves, is important for mid-range weather forecast. Most of LFV, especially over the ocean, have been considered to have equivalent barotropic vertical structure in a sense that phases of associated height and temperature anomalies are vertically not tilted. Their development has thus been analyzed in a framework of barotropic development in many previous studies. If a horizontal flow associated with LFV crosses mean temperature gradient associated with a strong SST front, however, it will tend to induce temperature anomaly off its geopotential height center, and to make its vertical structure become baroclinic. The baroclinic structure thus induced will contribute to the LFV development by converting available potential energy of climatological-mean state to that of anomaly through baroclinic energy conversion as in the development of the transient baroclinic waves.

In this study, this speculation is investigated by composite analysis of prominent LFV events based on an atmospheric reanalysis data set in winter season. We first focused on anticyclonic low-frequency height anomalies developing over the western North Pacific that accompany anomalous southerlies crossing strong mean meridional temperature gradient over the Kuroshio extension region to the west of their centers. We found that the baroclinic energy conversion is actually large in the lower troposphere over the Kuroshio extension region. If we compared its amount with that of barotropic energy conversion, the former is more than two times as large as the latter during the developing stage.

We then repeated the above analysis for anticyclonic anomalies all over the Northern Hemisphere. We found that baroclinic energy conversion associated with anticyclonic anomalies tends to be larger than barotropic energy conversion in most of the Northern Hemisphere. they tend to be large over regions where horizontal temperature gradient is large in association with SST front, and temperature contrast between continent and ocean. We also estimated contribution from the transient baroclinic waves to the development of anticyclonic anomalies in terms of energy conversion. Their contribution via barotropic energy conversion is positive. It is, however, mostly canceled by their negative baroclinic energy conversion, resulting in small net contribution to anticyclonic anomaly development. Our results suggest importance of the SST front in the growth of not only transient baroclinic waves as shown in previous studies, but also LFV.

Keywords: Sea surface temperature front, baloclinic zone, blocking high, teleconnection pattern, baroclinic energy conversion

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

AAS03-05 Room:101A Time:May 23 09:55-10:10

A numerical study of the climatological dependence of westerly jets and storm tracks on the latitude of a SST front

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Major "storm tracks", where migratory cyclones and anticyclones recurrently develop, are observed around midlatitude oceanic frontal zones characterized by strong meridional gradient of sea-surface temperature (SST). A set of atmospheric general circulation model experiments is performed with zonally uniform SST prescribed at the model lower boundary. The SST profile for each hemisphere is characterized by a single front whose latitude is varied systematically from one experiment to another, while the intensity of the frontal gradient is kept unchanged. Though idealized, the experiments reveal an obvious tendency in the climatological-mean low-level storm track to be organized along or slightly poleward of the SST front if located in the subtropics or midlatitudes. As a surface manifestation of an eddy-driven polar-front jet (PFJ), the climatological-mean axis of surface westerlies tends to be situted on the poleward flank of the front. This anchoring effect of the SST front is also hinted at upper levels, but the positions of the storm track and PFJ are less sensitive to the frontal latitude. For the SST front at subpolar latitude, the joint primary axes of the upper-level storm track and PFJ are located in midlatitudes away from the front. Their positions correspond to those simulated with a particular SST profile from which frontal gradient has been removed (NF experiment). This result suggests that the anchoring effect of a subpolar SST front on the storm track and PFJ is overshadowed by atmospheric internal dynamics, namely self-maintenance mechanisms of a midlatitude storm track and PFJ through their interactions. As the SST front is placed more equatorward, the climatological amplitude of upper-level transient eddies tends to increase, which is presumably caused by enhanced moisture supply to individual disturbances from the warmer ocean surface, a contribution of eddy development in the mid-tropospheric baroclinic zone associated with STJ, and weaker decay of eddies during their propagation toward STJ. At the same time, the climatological core velocities of PFJ and STJ tends to increase and decrease, respectively, due to the stronger eddy transport of westerly momentum from STJ to PFJ.

Keywords: SST front, storm track, westerly jet, atmospheric general circulation, baroclinic zone

AAS03-06 Room:101A Time:May 23 10:10-10:25

COMMUNITY ATMOSPHERE MODEL SIMULATIONS OF THE RESPONSE TO OCEAN FRONTS.

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This presentation investigates climate responses to western boundary currents using the Community Atmosphere Model (CAM). Recent observational and regional model studies performed at high resolution have revealed a significant impact of western boundary currents on the atmosphere. However the typical grid spacing of most climate models is too coarse to resolve the large air-sea heat fluxes and sea surface temperature gradients occurring at ocean fronts. Here we employ global atmospheric simulations at 1/2deg. or finer which both better resolve the fronts and also allow for determination of distant responses. Particular focus areas are i) how does the coupling between SST and surface momentum and heat fluxes vary with resolution in the horizontal and vertical? ii) what are the local effects of western boundary currents on the atmosphere and iii) what is the far-field atmospheric response to western boundary currents?

Keywords: Air-Sea Interaction, Ocean Fronts, Community Atmosphere Model

AAS03-07 Room:101A Time:May 23 10:45-11:00

Formation and erosion of the seasonal thermocline in the Kuroshio Extension Recirculation Gyre

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Data from the Kuroshio Extension Observatory (KEO) surface mooring are used to analyze the balance of processes affecting the upper ocean heat content and surface mixed layer temperature variations in the recirculation gyre (RG) south of the Kuroshio Extension (KE). Cold and dry air blowing across the KE and its warm RG during winter cause very large heat fluxes out of the ocean that erode the seasonal thermocline in the RG. Some of this heat loss is replenished through horizontal heat advection. Enhanced diffusive mixing at the base of the mixed layer tends to transfer heat downward, potentially eroding and even modifying subtropical mode water. Diffusivity at the base of the mixed layer, estimated from the residual of the mixed layer temperature balance, has values of 3-5x10^{-4} m^2/s during the summer and values a couple of orders of magnitude larger during winter. The enhanced diffusivities appear to be due to large inertial shear generated by wind events associated with winter storms and summer tropical cyclones. The nature of the storms that result in strong inertial oscillations and enhanced mixing will be discussed.

Keywords: air-sea interaction, ocean heat budget, Kuroshio Extension, mixing processes, KEO, surface mooring

Japan Geoscience Union Meeting 2012
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AAS03-08 Room:101A Time:May 23 11:00-11:15

Origin of Decadal-scale Eastward-propagating Signals of Oceanic Heat Content in the North Pacific Ocean

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The mid-latitude North Pacific Ocean supports both eastward and westward moving subsurface signals. Typically studies of sea surface height anomalies report westward propagation and interpret these as the first baroclinic mode Rossby waves (RWs), while investigations of upper ocean heat content (OHC) find eastward propagation and cite mean flow advection as an underlying cause. Yet, OHC in general affects the velocity field via density change and thus also evolves as RWs. We investigate this dichotomy using a 150-year CGCM integration. Simulated OHC signals are distinguished in terms of two processes that can support eastward propagation: higher baroclinic RW modes and density-compensated temperature and salinity anomalies, a.k.a. spiciness. Our analysis suggests a unique role of the Kuroshio/Oyashio Extension (KOE) region as an origin of the spiciness and higher mode RW signals as follows. First, wind-forced, westward-propagating first baroclinic RW causes circulation anomalies in the KOE region, accompanying the meridional shift of the subarctic front. Anomalous advection of mean temperature and salinity gradients then generates spiciness anomalies, which are advected eastward by mean currents, manifested as eastward co-propagation of OHC and sea surface salinity anomalies. While being advected, the surface temperature anomaly associated with the spiciness signal is damped by air-sea heat exchange and thus generates density anomalies, which further propagate eastward as higher mode RWs. The result suggests that the commonly used indices of OHC of the upper ocean result from a mixture of different dynamics that are transformed one another in the KOE region.

Keywords: Oceanic Heat Content, Decadal Varaibility, Rossby Waves, Spiciness, Air-sea Interaction, Subarcitic Frotal Zone

Japan Geoscience Union Meeting 2012
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AAS03-09 Room:101A Time:May 23 11:15-11:30

Decadal response of the Kuroshio Extension jet to Rossby waves

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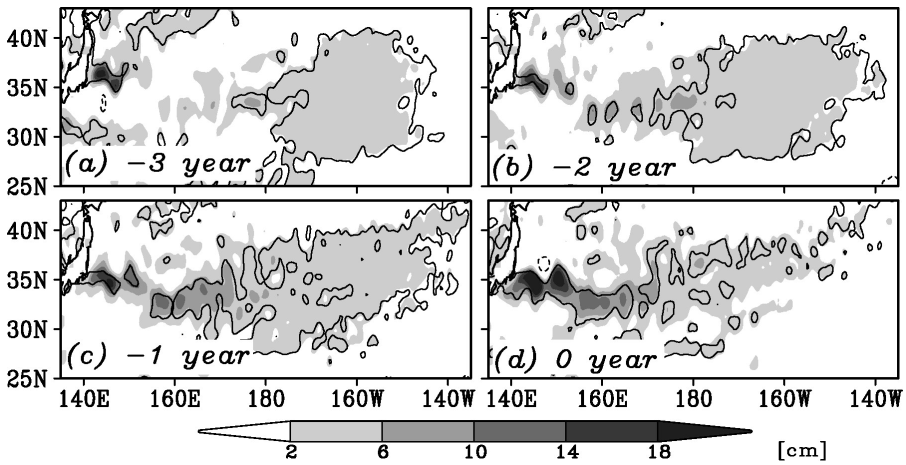
This study examines interannual to decadal variability of the Kuroshio Extension (KE) jet using satellite altimeter observations from January 1993 to December 2010. The leading Empirical Orthogonal Function (EOF) mode of low-frequent sea level variability in the KE region represents the northward (southward) shift of the KE jet, followed by the strengthening (weakening) of the KE jet with a few month lag. This result indicates that the latitude changes of the KE jet are a key process in the sea level decadal variability in the KE region.

A Singular Value Decomposition (SVD) analysis between sea level anomalies (SLAs) and 1000-hPa geopotential height reveals that the shift of the KE jet is lagged to atmospheric fluctuations in the eastern North Pacific by about three years. Consistent with the lagged relation, broad SLAs emerge in the eastern North Pacific 3-4 years before the KE jet shift, and propagate westward to the KE region along the KE jet axis (see figure). In the course of the propagation, the meridional scale of the SLAs gradually decreases, although their amplitude gradually increases.

This westward propagation of SLAs is attributed to the westward propagation of the meridional shift of the jet axis from the dateline to the upstream KE region with a phase speed of about 5 cm s^{-1}. This mechanism for westward propagation signals is explained by the thin-jet theory by Sasaki and Schneider (Decadal shifts of the Kuroshio Extension jet: Application of thin-jet theory, 2011, JPO), which indicates that the meridional shifts of the jet propagate westward as Rossby waves trapped along a potential vorticity jump accompanied by the jet. The reconstruction of SLAs on the basis of the thin-jet theory indicates the strong relation of westward propagation signals between SLAs and the shift of the jet. This result also suggests that the meridional scale change of the SLAs results from the amplitude change of the meridional jet displacement. In addition, the gradual decrease of SLAs to the east is likely attributed to the decay of the jet. Interestingly, this change of the strength of the jet is inversely proportional to the change of the amplitude of the jet shifts, suggesting the conservation of volume (quasi-geostrophic potential vorticity) anomalies during the westward propagation. This conservation also indicates that broad-scale positive (negative) SLAs in the eastern North Pacific likely induce the northward (southward) shift of the downstream jet around the dateline.

After the westward propagation signals of the positive (negative) SLAs reach at the east coast of Japan, the upstream KE jet strengthens (weakens) due to the coherent intensification (weakening) of the northern and southern recirculation gyres. Hence, the time-lag between the shift of the jet and its strength change can be considered as a response time of the recirculation gyres. It is worth noting that this strength change of the KE jet propagates eastward with a speed of about 6 cm s^{-1}, suggesting an importance of potential vorticity advection associated with a higher-mode Rossby waves from the western boundary in response to the incoming Rossby waves.

Keywords: Kuroshio Extension, decadal timescales, thin-jet, air-sea interaction



Japan Geoscience Union Meeting 2012
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AAS03-10 Room:101A Time:May 23 11:30-11:45

Response of atmospheric pressure to sea surface temperature over the Kuroshio Extention

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The western boundary currents transport warm water from the tropics to the mid-latitudes, and forms sharp surface temperature fronts in the west of the oceans. The annual mean climatology of surface heat flux is the largest over the Gulf Stream and the Kuroshio and its extensions. The effects of the large heat flux over these regions on the mid-latitude atmosphere have attracted much attention. For example, some researchers showed from in situ data that seasonal mean sea level pressure (SLP) was locally minimum (trough) and the surface wind converges except summer on the southern flank of the Kuroshio Extention (KE) front, where sea surface temperature (SST) and surface turbulent heat flux are the maximum (Tokinaga et al., 2009; Tanimoto et al., 2011). However, they showed only climatological features and the spatial resolution of the historical in situ dataset they used was coarse. We need to clarify the response of the lower atmosphere to SST fronts on a finer scale to fully understand the mid-latitude air-sea interaction.

Two surface buoys have been moored north and south of the KE front (about 38.1N, 146.4E, and about 32.4N, 144.6E). Both the buoys measure SST, SLP, and some other meteorological factors. We performed meteorological observations across the KE front between the two buoys to investigate atmospheric responses to SST. Surface meteorology and SST were continuously observed on the moving research vessels, and the radiosondes were also launched at intervals of 0.25-0.5 degree in latitude from the vessels. Spatial SLP distribution was extracted by subtracting fixed-point SLP observations at the moored buoys from that observed at a moving ship at the same time.

The spatial SLP anomaly tended to be larger (smaller) where SST was lower (higher) on a scale of about 100 km, although they did not always clearly correspond to each other. The radiosonde observations showed that the atmospheric mixed layer became higher over the warmer SST, which is consistent with the former studies. Furthermore, it appears that the low-level air converged over the warmer SST, although the zonal wind component could not be considered in this study. This means that local circulations similar to the sea breeze circulation might have been formed over the SST fronts. The spatial scale of this circulation was 100 km or more, which is larger than the typical sea breeze circulation. High-resolution SST is necessary to simulate such phenomena in atmospheric numerical models. However, we found that there can be large discrepancies between in situ and satellite microwave SSTs around the fronts.

Keywords: air-sea interaction, mid-latitudes, Kuroshio Extention, sea level pressure, sea surface temperature, local circulation

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AAS03-11 Room:101A Time:May 23 11:45-12:00

Upper ocean heat content, SST, and surface heat flux in midlatitude oceanic frontal zones

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In studies of midlatitude air-sea interaction, increasing attention has been paid to oceanic frontal zones where oceanic variability can induce sea surface temperature anomalies (SSTAs) that may be able to exert some feedback onto the overlying atmosphere. This strongly contrasts with broader regions in the midlatitude ocean basins where SSTAs are mainly caused by atmospheric thermal forcing. To understand impacts of oceanic variability on the atmosphere and climate, many studies have been conducted on atmospheric responses to SSTAs. There is, however, a concern that even in oceanic frontal zones, SSTAs are affected by atmospheric variability and thus can be not only the cause for but also a response to atmospheric variability. Then, in this study, we propose to use upper ocean heat content, which is defined as vertically integrated temperature from the surface to 700-m depth, rather than SST as a variable representing oceanic variability as its variability is dominantly influenced by thermocline depth variations.

In the subarctic frontal zone in the western North Pacific, high SSTAs tend to be associated with enhanced turbulent heat release from the ocean to the atmosphere. This relation is found more clearly between the upper ocean heat content and surface latent heat flux. This is probably because the heat content is less likely to be influenced directly by atmospheric thermal forcing than SST and thus more likely to represent ocean to atmosphere feedback. Further, lag-correlation analysis for monthly interannual anomalies between SLP and upper ocean heat content suggests atmospheric responses to oceanic variability in the subarctic frontal zone, although the counterpart between SLP and SST indicates atmospheric forcing to SST below. These results indicate that upper ocean heat content can better represent oceanic variability than SST and thus be useful for investigating air-sea interaction in midlatitude.

Keywords: midlatitude air-sea interaction, oceanic frontal zones

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AAS03-12 Room:101A Time:May 23 13:45-14:00

Predictability of the western North Pacific summer climate demonstrated by the coupled models of ENSEMBLES

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In this study, a comprehensive assessment of the interannual predictability of the WNP summer climate has been performed using the 1-month lead retrospective forecasts (hindcasts) of five state-of-the-art coupled models from ENSEMBLES for the period of 1960?2005. Spatial distribution of the temporal correlation coefficients (TCC) shows that the interannual variation of precipitation is well predicted around the Maritime Continent and east of the Philippines. The high skills for the lower-tropospheric circulation and SST spread over almost the whole WNP. These results indicate that the models in general successfully predict the interannual variation of the WNP summer climate.

The WNP lower-tropospheric circulation index (WNPMI), have been used to quantify the forecast skill. The correlation coefficient between five models multi-model ensemble (MME) mean prediction and observations for the WNPMI reaches 0.68 for the during 1960?2005. The WNPMI-regressed anomalies of lower-tropospheric winds, SSTs and precipitation are similar between observations and MME.

On the other hand, the prediction of the WNP summer climate anomalies exhibits a remarkable spread resulted from uncertainty in initial conditions. The anomalous atmospheric circulation related to the prediction spread, including the SST and precipitation anomalies, shows a Pacific-Japan (PJ) or East Asia-Pacific (EAP) pattern, with a wave-like distribution in the meridional direction over the WNP, Comparing with those in the MME prediction, the summer anomalies related to the WNP prediction spread are relatively weaker over the tropical and subtropical WNP and resemble better the anomalies in observations over the mid-latitude WNP. Our further investigations suggest that the WNPMI prediction spread arise mainly from the internal dynamics in local air-sea interaction over the WNP, since the anomalies associated with the spread are dynamically consistent with each other and to some extent independent of the remote forcing from the tropical Ocean.

Keywords: western North Pacific, coupled models, seasonal forecast, summer climate, prediction spread

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AAS03-13 Room:101A Time:May 23 14:00-14:15

Global relationship of low cloud amount with inversion strength and its association with sea surface temperature

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Ship-based cloud observations and temperature and sea level pressure data obtained from the ECMWF 40-year reanalysis (ERA-40) are used to investigate the seasonal relationship between the amount of low stratiform clouds (LSCs) and estimated inversion strength (EIS) proposed by R. Wood and C. S. Bretherton over the global ocean. The LSC amounts are positively correlated with EISs over all ocean areas including those in which the LSC amounts are climatologically small. The sea surface temperature (SST) is also examined. The global correlation between EIS and SST is shown to be negative, but two linear relationships with different sensitivities exist. Their boundary lies at an SST of 16–22^{o}C. The amounts of stratocumulus (Sc) and stratus/sky-obscuring fog (St/Fo) increase in the warmer and colder SST domains, respectively, as EIS increases. These differences are more clearly explained by the difference between the surface air temperature (SAT) and SST. In the colder SST domain, EIS increases as SAT-SST differences increase from negative to positive, which corresponds to an increase in the St/Fo amount. In the warmer SST domain, where the Sc amount increases with EIS, the SAT-SST difference is generally negative but has no correlation with EIS. Examination of the expected difference in the vertical levels of the inversion contributing to EIS reveals that the inferred inversion strength between 925 hPa and the surface (850 and 925 hPa) increases in the colder (warmer) SST domain, following the above-mentioned variations in the LSC types. It is found that the boundary of the two domains coincides with that of the large and small SST gradients observed in the global distribution.

Keywords: low stratiform clouds, temperature inversion strength, lower-tropospheric stability, sea surface temperature, air-sea temperature difference

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AAS03-14 Room:101A Time:May 23 14:15-14:30

Response of summertime low-level clouds in the Okhotsk Sea to oceanic meso-scale SST variability

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In summer, the Okhotsk Sea is often covered by low-level clouds or marine fog. The low-level clouds are formed mainly by downward sensible heat flux, which is in turn caused by low sea surface temperatures (SSTs) in the Okhotsk Sea. After cloud formation, mixing layers develop below the clouds because of longwave emission from the clouds together with shielding of incident shortwave radiation, leading to the enhancement of upward turbulent heat fluxes at the sea surface. These processes would thus produce a feedback between SST and low-level clouds, which by a rough estimate contribute significantly to keeping SST low in the Okhotsk Sea.

On the other hand, recent studies revealed atmospheric responses to SST variations with scales of western boundary currents to meso-scale eddies. Because this kind of SST variability is also abundant in the Okhotsk Sea, questions would occur whether or not summertime low-level clouds respond to such SST variability, and if it does, in what conditions, how strong, whether it affects the SST–cloud feedback or not.

In order to investigate these possibilities, we conducted numerical simulations of summertime low-level clouds in the Okhotsk Sea with a horizontal resolution that permits the oceanic meso-scale variability.

Keywords: Okhotsk Sea, low-level clouds, sea surface tempetarure, meso-scale variability

Japan Geoscience Union Meeting 2012
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AAS03-15 Room:101A Time:May 23 14:30-14:45

Interannual variability of low-level stratified clouds over the western North Pacific and associated air-sea interaction

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Low-level stratiform clouds, which act to cool the earth/atmosphere system, tend to prevail in summer over maritime regions where low-level stratification is high. Previous studies on low-level clouds focused mostly on subtropical regions, including those off California and Peruvian coasts. Much less attention has been paid, however, to the subpolar western North Pacific, where summertime low-level stability and cloudiness are as high as those observed off California. Some previous studies suggested that a positive feedback loop may be operative within the subarctic oceanic frontal zone over the western Pacific among summertime anomalies in low-level clouds, near-surface stratification and sea-surface temperature (SST). Based on archived shipboard measurements, however, those analyses were limited to their seasonal-mean anomalies and therefore unable to resolve characteristics of interannual variability for each calendar month in the presence of apparent seasonal evolution of the climatological-mean state under the influence of the East Asian monsoon.

Utilizing the 25-year long ISCCP archive of satellite measurements of clouds and their radiative properties, a state-of-the-art reanalysis dataset of the global atmosphere (ERA-Interim) with fine vertical resolution in the lower troposphere and high-resolution satellite-measured SST (OISST), the present study investigates detailed aspects of the seasonal march and interannual variability of summertime low-level cloudiness over the western North Pacific and its linkage with particular focus on the cloud amounts itself and associated meteorological and oceanic variables.

Our analysis reveals that, unlike what has been suggested from shipboard measurements, significant positive correlation in interannual variability between low-level cloudiness and lower-tropospheric stability (LTS: defined as potential temperature difference between the 700hPa level and the surface) is observed in rather limited domains. In June and July, the positive correlation is observed only in the subtropical oceanic frontal zone, which is located south of the Honshu and then migrates northeastward into July. It is only August when the significant positive correlation is observed over the entire subarctic oceanic frontal zone in the Kuroshio-Oyashio Extensions. In those regions, the low-level cloudiness also exhibits significant negative correlation with SST, confirming with satellite data that the aforementioned positive feedback loop can be operative only in the limited spatial domains and calendar months but not ubiquitously over the extratropical North Pacific.

Keywords: low-level stratiform clouds, stratification, air-sea interaction, oceanic frontal zone, interannual variability, warm advection

AAS03-16 Room:101A Time:May 23 14:45-15:00

Baiu rainband termination in an atmospheric and coupled model

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The climatological termination of Baiu rainband is investigated using a stand-alone atmospheric GCM (AFES) with observed SST (AMIP run) and a coupled GCM (CFES) integration (CFES run). Baiu rainband over the North Pacific abruptly shifts northward and almost disappears in early July in the AMIP run, while in the CFES run Baiu persists around 40 degree N during summer with a slow northward shift. In another simulation of AFES forced with CFES-simulated SST (CFES-SST run), the rainband behavior is similar to that in the CFES run. The mid-troposphere westerly jet and its thermal advection explain this difference in simulated Baiu. In the AMIP run, deep convection in the subtropical Northwest Pacific sets in prematurely, displacing the westerly jet northward over cold ocean surface earlier than observations. Although the mid-tropospheric thermal advection and vertically integrated moisture convergence are similar in magnitude between the AMIP and CFES runs, sea surface evaporation under the westerly jet is much suppressed in the AMIP run as a result of cold ocean temperature. Therefore Baiu rainband abruptly weakens after the northward shift in the AMIP run. In contrast, Baiu rainband continues during summer in the CFES run because of a strong westerly jet and weak deep convection in the subtropics, which are in turn due to a cold SST bias. Colder SST biases cool the troposphere in high latitudes, strengthening the westerly jet. In addition a cold SST bias in the subtropics inhibits deep convection, slowing down the poleward march of the westerly jet. As a result, ascending motion induced by the strong westerly jet, and Baiu rainband persist over the northwestern Pacific through summer in the CFES run. Our analysis suggests that the local sea surface evaporation under the seasonal marching westerly jet is also important for the termination of the Baiu rainband.

Keywords: Baiu, AGCM, CGCM, atmosphere-ocean interaction, monsoon, Earth Simulator

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

AAS03-17 Room:101A Time:May 23 15:00-15:15

Atmospheric responses to the Gulf Stream and the Kuroshio: Similarities and Differences

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In this presentation, we explore similarities and differences in atmospheric responses to the Gulf Stream and the Kuroshio. The both western boundary currents strongly influence the atmosphere, but reflecting the background SSTs and large-scale atmospheric structures the atmospheric responses also exhibit substantial differences. Over the Gulf Stream, two atmospheric modes of responses are prominent. One is the shallow heating mode in winter, and is characterized by strong surface wind convergences, maximal ascent in the lower troposphere associated with sensible and latent heatings in that layer. The other is the deep heating mode in summer, and is characterized by the maximal ascent in the middle of the troposphere accompanied by strong convective latent heating. The shallow heating mode is also clearly seen over the Kuroshio Extension, but in this region the deep heating mode is much weaker than that over the Gulf Stream. Interestingly, however, deep heating mode is identified over the Kuroshio in the East China Sea in June, i.e., Baiu-Meiyu season. The atmospheric response of deep heating mode in this region is embedded in the large-scale Baiu-Maiyu precipitation band, and act to locally enhance precipitation and ascent over the Kuroshio.

Keywords: air-sea interaction, precipitation, Baiu

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Role of the East-Asian marginal sea SST in the regional predictability and the North Pacific climate variability

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Processes in the East Asian marginal seas add a great complexity in understanding mid-latitude air-sea interaction and prediction of weather and climate in the western North Pacific. Strongly controlled by ocean current and bathymetry, the extent to which these marginal sea SST anomalies are conducive to any modulation of downstream synoptic variability and a mid-latitude storm track has not been clearly understood. Focusing primarily on the East/Japan Sea (EJS), we will discuss 1) key processes leading to dominant modes of SST variability on seasonal and longer timescales, 2) their impact on local air-sea boundary-layer coupling and 3) potential implications for air-sea interactions downstream over the Kuroshio-Oyashio Extensions. Using the synthesis of satellite and in situ ocean measurements with a suite of meteorological reanalysis products, we will identify the characteristic EJS heat content and SST variability, and the associated atmospheric circulation patterns. The identified patterns are then used in a series of process-WRF model simulations to assess the local, downstream and upscaling effect of EJS SST. The model domain covers the Northern Hemisphere poleward of 20N with the multi-scale nesting and two-way feedback to best represent the small semi-enclosed EJS processes in the context of large-scale climate system.

Keywords: Air-sea interaction, Regional climate modeling, East Asian marginal seas, Mid-latitude storm track, Ocean heat content, Kuroshio-Oyashio Extensions

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AAS03-19 Room:101A Time:May 23 15:45-16:00

A Regional air-sea coupled model adopted over the winter yellow and east china seas

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In regions of strong sea surface temperature (SST) fronts such as Yellow and East China Sea (YES) shelves, surface winds are positively correlated with SST. In the winter YES shelves, SST is also determined by surface winds due to the surface heat flux and wind-driven ocean currents over the shallow shelves. It is therefore anticipated that SST over these areas is determined by an air-sea coupled process, and so we have established a regional air-sea coupled model to examine how SST in the YES is controlled by the coupled process. The coupled model consists of MM5 and POM. The MM5 provides POM with surface heat, freshwater and momentum fluxes, while POM gives SST as a lower boundary condition of MM5. It is interesting that the SST in the couple model is closer to the observed one than that computed in the uncoupled POM.

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AAS03-20 Room:101A Time:May 23 16:00-16:15

Numerical simulation of a snow cloud band over the Sea of Okhotsk

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Numerical simulations were made to investigate the formation mechanism of a frequently appeared thick snow band over the Sea of Okhotsk along the northern coast of Hokkaido island. Weather Research and Forecast Model (WRF), a non-hydrostatic model with multiple domain setup was used for the simulations to reproduce the satellite observed snow band on December 26th 2008.

WRF Model was able to reproduce the observed snow band and its characteristics. North-east ward moving Synaptic scale system rotated the wind direction from northerlies to north westerlies to become parallel to the northern coast of Hokkaido island. The snow band generated along the coast line initially and was associated with a low level wind across the coast which pushed the snow band over to the relatively warm Sea of Okhotsk where the development was taken place.

The cold air from Sakhalin island as North-westerlies continued to blow to form a strip of convergence zone just above the northern coast of Hokkaido island. Sensitivity experiments revealed the presence topography over the Hokkaido island also contributed formation of the snow band.

Keywords: snow band, cloud, wrf, convection, hokkaido, simulation

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AAS03-21 Room:101A Time:May 23 16:15-16:30

Extratropical ocean influence on climate: The East China Sea example

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By now it is well established that the atmospheric boundary layer is strongly modulated by ocean fronts, characterized by sharp cross-frontal variations in wind velocity and cloud. Still under debate, however, is the relative importance of sea surface temperature (SST) effects on vertical mixing and atmospheric pressure. Along the Kuroshio front in the East China Sea, both mechanisms appear at work albeit on different timescales. On monthly or longer timescales, the thermal wind due to the SST front anchors northeasterly winds at the surface. On synoptic scales, enhanced surface instability on the warm flank of the SST front intensifies transient wind speed. As a result, a maximum of scalar wind speed is displaced southward from the maximum of the northeasterly vector wind.

In Qingdao (representative of the Chinese coast of the Yellow Sea), the fog season sets in April associated with the onset of the southerly winds and its advection of warm and moist air. The southerly winds in the western Yellow is part of a basin-scale anticyclonic circulation trapped in the atmospheric boundary, which forms in spring over the cold ocean surface surrounded by the warming Asian Continent to the west and warm Kuroshio to the southeast. The fog season of the Yellow Sea lasts until late July, the time of the Meiyu-Baiu termination.

The Meiyu-Baiu rain band is perhaps the single most important climate phenomenon for East Asia. The Kuroshio front induces a band of surface wind convergence on the warm flank, presumably contributing to rainfall including Baiu. Meiyu-Baiu is also controlled by larger-scale features such as the westerly jet aloft. These and other ocean factors for the summer rainband will be discussed.

Keywords: Ocean-atmosphere interaction, Climate