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S1&S2B Presentation

S1&2B-1

Possible role of tropical stratospheric cooling on recent tropical change through modulation of extreme deep convection

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Recent tropical circulation change in summer monsoon and the cooling in the equatorial eastern Pacific ocean from the end of 1990's under the global warming tendency is investigated. Northward shift of the Hadley circulation during the boreal summer produced anomalous cooling in the tropical cold tongue regions through enhanced cross-equatorial southerlies. According to the seasonal march from boreal summer to winter, convective active center moves southward over equatorial Indian Ocean-Maritime continent region, which induces stronger easterlies over the equatorial central Pacific. Accordingly, the ocean surface cools over the central Pacific. It is suggested, that the fundamental factor causing the recent decadal change in the tropical troposphere and ocean would be a poleward shift of the raising branch of the summertime Hadley cell resulted from an intensified extreme deep convection over the continents. It is conjectured that such change can be produced by a combined effect of stratospheric cooling and surface warming due to increased CO_2.

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Relationships between Antarctic Ozone Hole and Dynamical Fields

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The extreme Antarctic ozone depletion during early austral spring, i.e., Antarctic ozone hole, shows large interannual changes in its area as well as its ozone depletion amount. In recent years, the ozone hole in 2006 was in the largest level. On the other hand, in 2012 the size of ozone hole was in the smallest level in the 21th century. What kind of processes make such large differences between these two years has not been clarified yet. So in this study, we use Aura Microwave Limb Sounder (MLS) observations and the Japanese 55-year Reanalysis (JRA-55) data to try to find plausible relationships between the ozone volume mixing ratio associated with ozone hole and dynamical field changes. Resultantly, our ozone volume mixing ratio analyses show that in the polar region clear negative anomalies appeared in early spring of 2006 and positive ones in 2012, which corresponds to the observed ozone hole changes. In order to find the reason that brought about the different feature between the two years we examine the dynamical analyses base on the Eliassen-Palm (E-P) flux and the residual mean meridional circulation by using MLS and JRA-55 data sets. It is found that the wave activity in 2012 was obviously strong to enhance the downward motion compared with that in 2006, which might bring about an enhanced downward advection of ozone-rich air, leading to the small size of ozone hole. In the presentaion, we will discuss barotropic/baroclinic instability associated with the polarnight jet strength, as one of plausible factors which could cause the different planetary wave activity between the two years.

Key words: ozone hole, planetary wave, MLS data, JRA-55 reanalysis

S1&2B-3

Thorough survey of downward influence of the stratospheric QBO on the troposphere

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This study investigates downward influence of the stratospheric QBO on the tropospheric circulations and convection in the zonal-mean perspective and its statistical significance for neutral ENSO periods (the periods without El Nino or La Nina events) during 1979-2015, with the monthly mean datasets of NOAA/OLR, GPCP precipitation, and ERA-Interim reanalysis datasets (JRA-55 and MERRA as well).

The QBO phase is defined with the first two principal components (PCs) derived from the EOF analysis of the zonal-mean zonal wind in the equatorial lower stratosphere, in order to obtain two groups of data samples with opposite QBO phase in the two-dimensional PC phase space. The central value, ψ, and the range, $\Delta\alpha$, of the phase angle in the polar coordinate are introduced to define the two groups with ψ and $\psi + 180°$. We perform a composite analysis of any quantity for the two groups and determine statistical significance of the composite difference by a two-sided Student's t-test. The parameters ψ and $\Delta\alpha$ are swept from 0° to 180° with an 1° interval to conduct a thorough survey of the QBO influence on the troposphere.

This study reveals statistically significant differences of the vertical wind and measures of moist convection in the troposphere together with the corresponding zonal wind differences during the Austral summer (December-February) and the Boreal summer (June-August).

During the Austral summer, statistically significant composite differences exist in the troposphere over six areas. Three of them are consistent with some previous findings; (1) the zonal wind and temperature differences associated with the QBO modulation of the polar vortex, known as the "Holton-Tan relationship", (2) the zonal wind difference extending from the tropical lower stratosphere into the upper troposphere over the northern midlatitudes, and (3) the vertical wind, OLR, and precipitation differences in the tropics. The other three statistically significant differences are (4) the temperature differences in both subtropics in the upper troposphere, together with differences of the vertical wind and OLR beneath the temperature difference in the southern hemisphere, (5) the zonal wind differences associated with meridional shift of the tropospheric jet in the southern midlatitudes, together with the difference of the temperature in the lowermost stratosphere, the vertical wind in the lower troposphere, and the precipitation, and (6) the precipitation difference with the zonal and vertical wind differences near the south pole.

During the Boreal summer, when little literature has reported the QBO-related modulations in the troposphere, statistically significant composite differences in the troposphere are found over four areas, together with the statistically significant differences of the precipitation. The most noticeable difference is (1) the zonal wind differences associated with the jet shift in the southern midlatitude, together with the temperature differences in the lowermost stratosphere and the vertical wind differences extending from the lower stratosphere into the surface. The other differences are (2) the zonal and vertical wind differences below the midlatitude jet core in the northern hemisphere, together with the temperature difference in the lowermost stratosphere, (3) the zonal and vertical wind differences near the south pole, and (4) the zonal and vertical wind differences near the north pole extending from the lower stratosphere into the surface, together with the temperature differences in the lowermost stratosphere

S1&2B-4

Decadal modulation of the ENSO-East Asian winter monsoon relationship by the Atlantic Multidecadal Oscillation

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This work investigates the decadal modulation of the El Niño-Southern Oscillation (ENSO)-East Asian winter monsoon (EAWM) relationship by the Atlantic Multidecadal Oscillation (AMO). A stable ENSO-EAWM relationship is found during the positive AMO phase but not during the negative phase. While the impact of El Niño events on the EAWM does not depend on the AMO phase, a different picture is observed for La Niña events. The La Niña boreal winter season coincides with a strengthened EAWM during a positive AMO phase and a weakened EAWM during a negative AMO phase. We suggest that the AMO's modulating effect mainly comprises two pathways that influence ENSO's impact on the EAWM. On one hand, when La Niña coincides with a positive AMO, the warm SST anomalies over the western North Pacific (WNP) are amplified both in intensity and spatial extent, which favors strengthened WNP cyclonic anomalies and an enhanced EAWM. During La Niña with a negative AMO, only very weak SST anomalies occur over the WNP with reduced WNP cyclonic anomalies that are confined to the tropics, thus having little effect on the EAWM. On the other hand, an eastward-propagating Rossby wavetrain across the mid-high latitudes of Eurasia during a warm AMO phase strengthens the Siberian high and thus leads to a strengthened EAWM, while during a cold AMO phase the Siberian high is weakened, leading to a reduced EAWM. In contrast, El Niño and its associated atmospheric responses are relatively strong and stable, independent of the AMO phase. These results carry important implications to the seasonal-to-interannual predictability associated with ENSO.

S1&2B-5

Changes of river-mouth positions and its impact on seasonal prediction in NIMS/KMA Seasonal Forecasting System (GloSea5)

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River discharge is very important process for connecting hydrological cycle between land and ocean. It directly affects on ocean salinity as well as water density, mixed-layer depth and sea surface temperature, and it is connected to global watercycle and climate system. GloSea5 is the coupled NIMS/KMA seasonal forecast system, which includes TRIP (Total Runoff Integrating Pathways) network as river-routing model (Oki and Sud, 1998). The objective of this study is to assess the effects of changes of river-mouth position along the East-Asian coastal lines in TRIP, and shows the impact of this on seasonal prediction over the East-Asian region.

S1&2B-6

On the existence of a potential multidecadal AMOC-AMO-NAO feedback loop in MIROC

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Atlantic Multidecadal Oscillation (AMO) is a low frequency fluctuation of sea surface temperature over the North Atlantic basin with a period of 50-80 years. Previous studies show that this mode of climate variability has wide-ranging impacts on global scale. A synthesis of previous studies further suggest that there possibly exists a multidecadal feedback loop among AMO, Atlantic Meridional Overturning Circulation (AMOC), and North Atlantic Oscillation (NAO). In this work, we investigate the existence and the mechanisms of this possible multidecadal feedback loop among AMOC, AMO and NAO with use of two state-of-the-art climate models: MIROC5 and MIROC6. Identifying this potential multidecadal feedback loop could entail important implications for potential predictability of the multidecadal climate phenomena, as well as for isolating the impacts of the anthropogenic warming from those of the natural variability. Our preliminary results indicate that the updated version of the model, MIROC6, which is a high-top model with a shallow convection scheme, exhibits a lead-lag relationship among each phenomenon that is similar to the previous observational and modelling studies.