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S1C Presentation

S1C-1

Decadal Change of the Western North Pacific Summer Monsoon Onset and Break around 2002/03

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A significant decadal change is detected in the western North Pacific (WNP) monsoon break around 2002/03. For the period of 1979-2002, the monsoon break occurs in early August, accompanied with remarkable convection suppression over the ocean to the east of the Mariana Islands (10°-20°N, 140°-160°E). However, for the period of 2003-2011, the occurrence of the monsoon break is delayed to mid-August, and the convection shows an out-of-phased subseasonal evolution in comparison with the former period. This is attributed to the delay of the monsoon onset in the latter period, which tends to lag behind the former period about 5-10 days. Therefore, both WNP monsoon onset and break are delayed in the latter period.

The different sea surface temperature (SST) evolutions in the western Pacific warm pool region between these two periods are responsible for the decadal changes of the monsoon onset and break. In contrast to the former period, for the latter period, the south extent of the warm pool is remarkably warmed, and tends to be higher than the north extent in mid- and late July. This higher SST in the south extent of the warm pool enhances atmospheric convection nearby, which suppresses the convection to the east of the Mariana Islands through a local meridional circulation, and thus contributes to the delay of the monsoon onset. The present results highlight that the spatial pattern of SST changes may modulate the subseasonal evolution of WNP monsoon, including the monsoon onset and break.

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S1C-2

Why was the Summer Rainfall over the Yangtze River Valley in 2016 weaker than that in 1998 under similar preceding El Nino events?

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It is widely recognized that rainfall over the Meiyu rain-band strengthens considerably during the decaying summer of El Nino, as demonstrated by the catastrophic flooding suffered in the summer of 1998. Nevertheless, the rainfall over the Yangtze River valley (YRV) in the summer of 2016 was much weaker than that in 1998, despite the intensity of the 2016 El Nino having been as strong as that in 1998. A thorough comparison of the YRV summer rainfall anomaly between 2016 and 1998 suggests that the difference was caused by the sub-seasonal variation in the YRV rainfall anomaly between these two years, principally in August. The precipitation anomaly was negative in August 2016 - different to the positive anomaly of 1998.

Further analysis suggests that the weaker YRV rainfall in August 2016 could be attributable to the distinct circulation anomalies over the midlatitudes. The intensified "Silk Road Pattern" and upper-tropospheric geopotential height over the Urals region, both at their strongest since 1980, resulted in an anticyclonic circulation anomaly over midlatitude East Asia with anomalous easterly flow over the middle-to-lower reaches of the YRV in the lower troposphere. This easterly flow reduced the climatological wind, weakened the water vapor transport, and induced the weaker YRV rainfall in August 2016, as compared to that in 1998. Given the unique sub-seasonal variation of the YRV rainfall in summer 2016, more attention should be paid to midlatitude circulation - besides the signal in the tropics - to further our understanding of the predictability and variation of YRV summer rainfall.

S1C-3

Northern Hemisphere Autumn and Winter Climate Responses to Realistic Tibetan Plateau and Mongolia Snow Anomalies

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The impact of the Eurasian snow cover extent (SCE) on the Northern Hemisphere (NH) circulation is first investigated by applying a lagged maximum covariance analysis (MCA) to monthly satellite-derived SCE and NCEP reanalysis data. Wintertime atmospheric signals significantly correlated with persistently autumn-early winter SCE anomalies are found in the leading two MCA modes. The first MCA mode indicates the effect of Eurasian snow cover anomalies on the Arctic Oscillation/North Atlantic Oscillation (AO/NAO). The second MCA mode links a persistent dipole of autumn and winter SCE anomalies over the Tibetan Plateau (TP) and Mongolia with winter Pacific-North America (PNA)-like atmospheric variations.

A modeling study further investigates atmospheric responses to above TP and Mongolia snow forcings using multiple ensemble transient integrations of the CAM4 and CLM4.0 models. Model boundary conditions are based on climatological sea ice extent (SIE) and sea surface temperature (SST), and satellite observations of SCE and snow water equivalent (SWE) over the TP and Mongolia from October to March in 1997/98 (heavy TP and light Mongolia snow) and 1984/85 (light TP and heavy Mongolia snow), with model derived SCE and SWE elsewhere. In various forcing experiments, the ensemble-mean difference between simulations with these two extreme snow states identifies local, distant, concurrent, and delayed climatic responses.

The main atmospheric responses to a dipole of high TP and low Mongolia SCE persisting from October to March (versus the opposite extreme) are strong TP surface cooling, warming in the surrounding China and Mongolia region, and a delayed (winter-only) positive PNA-like response over the North Pacific and North America. With a less persistent dipole anomaly, or a persistent anomaly in only the TP or only Mongolia, local responses are similar depending on the specific anomalies, but the winter PNA-like response is noticeably reduced or nearly absent. The localized response is maintained by persistent diabatic cooling or heating, and the remote PNA response results mainly from the increased horizontal eastward propagation of stationary Rossby wave energy due to both snow forcing and transient eddy forcing.

S1C-4

Interdecadal change of the Pacific-Japan pattern in the late 1990s

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Pacific-Japan (PJ) pattern, or the East Asia-Pacific (EAP) pattern, is one of the most important teleconnections affecting the summer rainfall over the East Asia, investigating the variations of PJ pattern is of considerable scientific, societal and economic importance. Although PJ pattern is extensively studied in both intraseasonal and interannual timescales, the interdecadal change of PJ pattern is not well studied. In this study, the interdecadal change of summertime PJ pattern around the late 1990s is investigated using the observational and reanalysis data. Analysis reveals that PJ pattern exhibits a distinct structure change in the late 1990s. Both the external processes and internal processes contribute to this interdecadal change. The climate impact of this interdecadal change is also briefly discussed in this study.

S1C-5

The fundamentals of the East Asian summer monsoon

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During boreal summer, the southerly wind is the key component for moisture transport to East Asia for the monsoon rainfall. The zonal pressure gradient along with the Coriolis force makes this meridional wind. In observation, the steep pressure gradient is located between the monsoon trough and the western north Pacific subtropical high. The low pressure to the west of the southerly wind originates from the Eurasian continental heating, but the high pressure in the east is related to the downward branch of the Hadley circulation. In this study, these fundamental aspects of the East Asian summer monsoon (EASM) rainfall are examined by the Geophysical Fluid Dynamics Laboratory (GFDL) Atmosphere Model, version 2.1 (AM2.1) model. Current state of the art dynamical model is too complicated to discuss fundamental dynamics of the EASM. Thus, the simplest aqua planet simulation is designed as control simulation. On the water Earth, we added simple square land with a grass, mountain and SST anomaly forcing in sequence. Over the land area, the land model version 2 (LM2) calculates surface fluxes, radiation exchange and runoff with conservation of surface energy and water balances. All model experiments are performed by AMIP type using a fixed SST. Basically, the existence of the land causes a land-sea thermal contrast to induce pressure gradient force. Both mechanical and thermodynamical effect of mountain significantly contributes to intensifying the southerly wind and the monsoon rainfall. The SST anomaly forcing to modulate the downward branch of Hadley circulation is closely related to the strength of the subtropical high. In these simplified model experiments, square land means the Eurasian continent and mountain is the Tibetan plateau. The SST anomaly forcing comes from natural variation of the Pacific SST such as Pacific decadal oscillation and El Nino Southern Oscillation.