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seasonal dependency of long-term trends in Asian monsoon rainfall in the recend several decades

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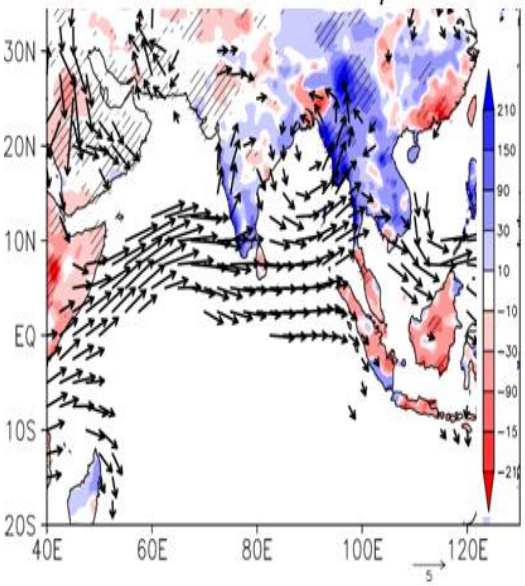
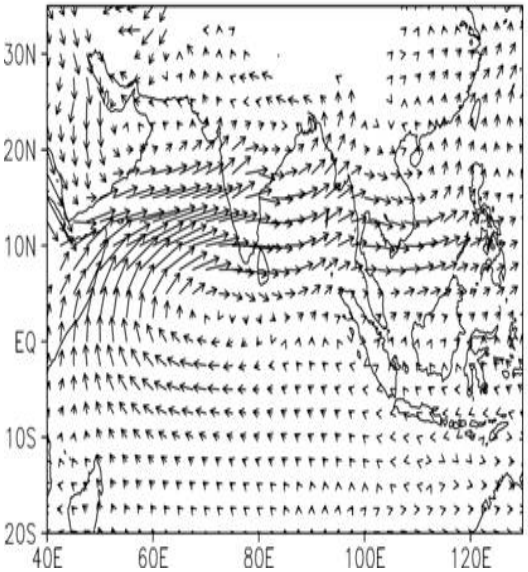
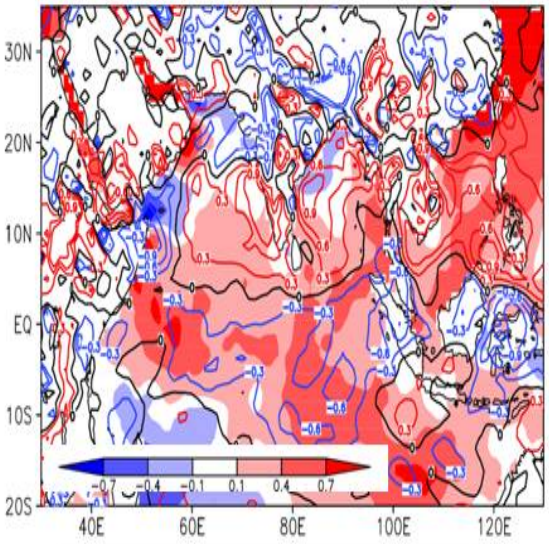
Trends of precipitation and wind at 850hPa in May

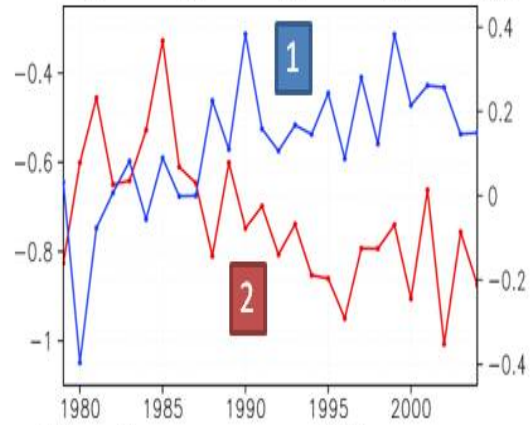


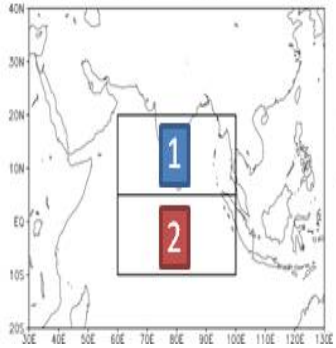
Difference of climatological wind filed at 850hPa in June and May



Trends of SST and Vapor Flux Div. in June







Interannual Variability of Vapor Flux Div. in Jun.

Seasonal dependency of long-term trends of Asian monsoon rainfall in the recent several decades

Tetsuzo YASUNARI, Syuhei YOSHIDA and Hatsuki Fujinami

Abstract
Change of monsoon rainfall associated with the global warming is a matter of great concern in Asian countries. Here, we have investigated spatial patterns of trends in the Asian monsoon rainfall and associated atmospheric circulation and sea surface temperature (SST) in the recent several decades (1960-2005), when the global surface temperature increased significantly presumably due to increase of the greenhouse gases (IPCC, 2007).
The analyses are made with monthly basis, since the dynamics of monsoon variability greatly differ in the course of seasonal march primarily due to different characteristics of land-atmosphere -ocean interaction (e.g., Ailikun and Yasunari, 2001)
Two rainfall datasets, GPCC Full Data Product (Fuchs et al. 2007) and APHRODITE (Yatagai et al. 2009) are used.
JMA & JCDAS reanalysis data (JRA-25) for 1979-2004 are used (Ohnogi et al., 2007) for atmospheric circulation and water vapor flux field. NOAA SST data (Smith and Reynolds 2003)is also used.
In May, rainfall are increasing over most regions. In contrast, JJA rainfall are decreasing over most regions during 1961-2005. This trend are even more enhanced in 1979-2004 when reanalysis datasets exit. Over the Indian subcontinent and Indochina, precipitation increase (decrease) in May (JJA), while the southeast China, precipitation decrease (increase) in May (JJA).
We also analyzed the onset dates of monsoon rainfall (Matsumoto, 1993), and found that the earlier onset dates at the recent 10 years (1995-2004) than those of the previous 10 years (1979-1 988). This suggests that the increasing of precipitation amount is caused mainly by extension of rainy season in May. Interestingly, the trend pattern of lower tropospheric wind field in May during 1979 to 2004 (Figure 1 upper) has proved to resemble well the difference of the climatological mean wind field from May to June (Figure 1 lower). This strongly suggests that the south Asian monsoon circulation has started earlier in the recent 10 years (1995-2004).
on the other hand, the overall decreasing trends of rainfall in June (through August) has been found to correspond to the weakening of the monsoon (local reversed Hadley) circulation as seen in the moisture divergence field over the Indian sector centerd along the Bay of Bengal longitudes (Figure 2 lower). This weakening of the monsoon circulation, with enhanced divergence over the Bay of Bengal, coupled with the enhanced convergence over the equatorial Indian Ocean is likely to be associated with the increasing trend of SST in the equatorial Indian Ocean throughout the year (Figure 2 upper).
A question may arise why the increasing trend of south/southeast Asian monoon rainfall in May has changed to overall decreasing trends in June through August (and September) under the increasing trend of SST persisted throughout the year. One answer for this drastic change of trend pattern may be attributed to seasonally different response of monsoon circulation to the persistently increasing SST in the equatorial Indian Ocean.

Keywords: Asian monsoon, rainfall, long-term trend, SST change, monsoon onset