Supplement of "The curious case of a strong relationship between ENSO and Indian summer monsoon in CFSv2 model"

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1 Supplementary Note 1

1.1 Moisture flux computation

The variability of ISMR is influenced by external climatic forcing, which alters the surface pressure gradient surrounding the Indian region and thus modifies the boundary moisture fluxes. The incoming moisture flux over the Arabian Sea (F_W) and the outflux over the Bay of Bengal (F_E) plays significant in controlling moisture convergence over the Indian region. We compute the vertically integrated moisture flux at the western (70°E) and eastern (90°E) boundaries using the following method:

$$F = \int_{P_{sfc}}^{P_{top}} (qu)\, \mathrm{d}p/g$$

Here, the q and u vectors represent the specific humidity (kg/kg) and winds vector (m/s) at the respective boundaries. The integration is performed from the surface (P_{sfc}) to the top of the atmosphere (P_{top}), which is set to 100 hPa. All variables are detrended, and departures from the monthly mean are considered over the entire period.

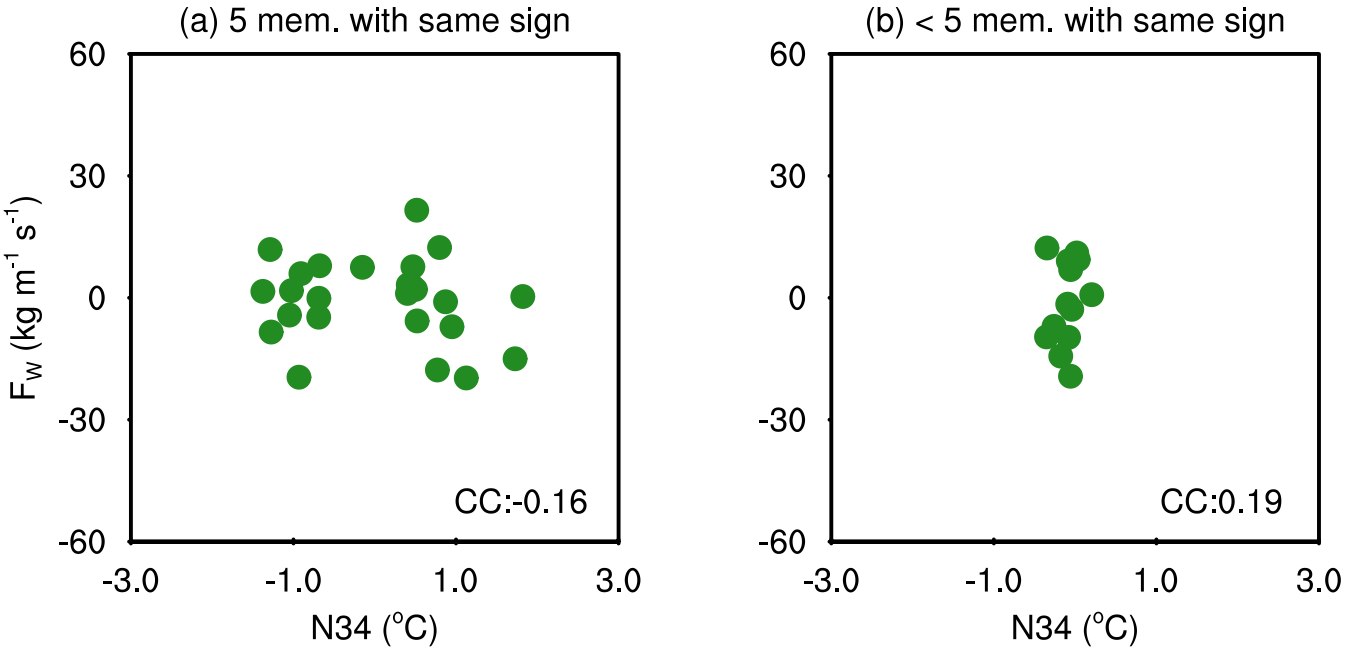
1.2 ENSO and Non-ENSO components

To determine the impact of tropical variability apart from ENSO, we remove the linear dependence of ENSO from all variables. This involves computing the residual time series of all variables, such as ISMR and moisture flux.

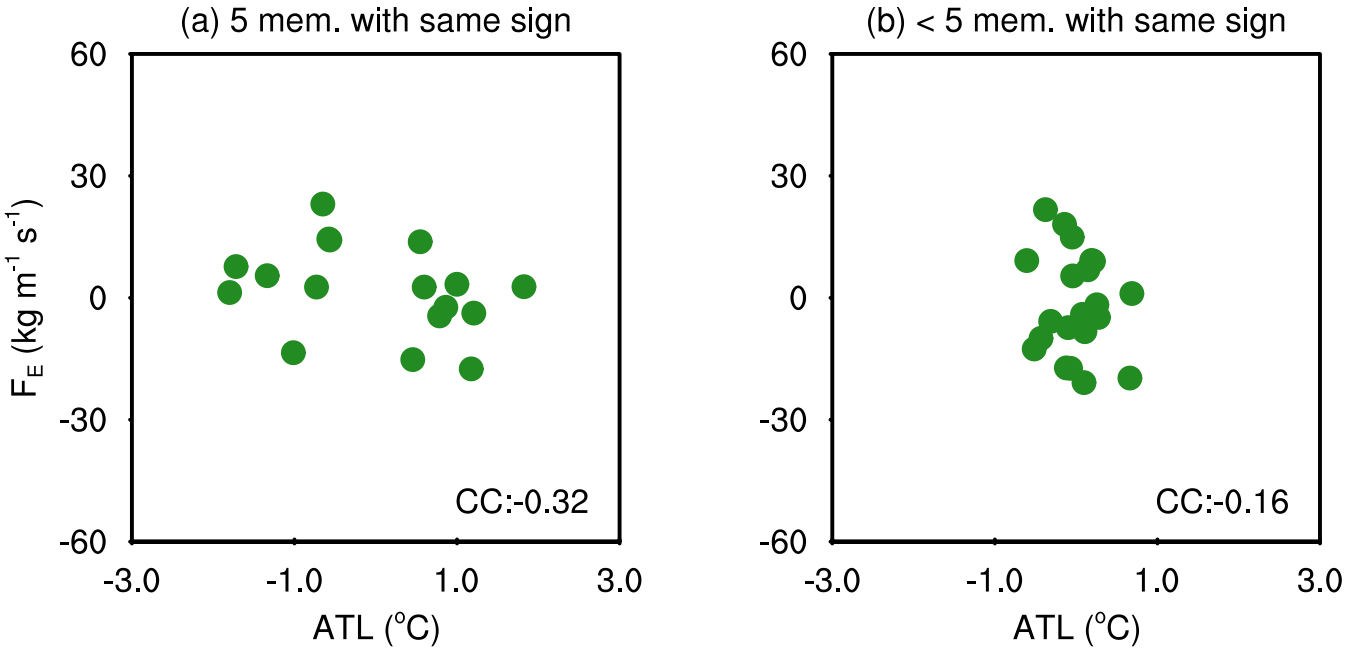
$$Res(t) = M(t) - ENSO(t), \tag{1}$$

$$ENSO(t) = b.Nino34(t), \tag{2}$$

where $Res(t)$ is residual at time t, $M(t)$ and ENSO(t) are variables and ENSO time series, respectively. Equation 2 uses the least-squares linear fit to obtain the value of b. This method helps us examine ATL's role in modulating the Indian monsoon, as shown in Figures **??** and **??**. It is important to note that we have not regressed the impact of ENSO on SST representing ATL, as it follows a standard definition.



Supplementary Figure 1. The scatter plot shows the relationship between the ENSO index and moisture flux over the Arabian Sea (F_W) when there is a maximum of (a) five and (b) less than five ensemble members with the same signs of ENSO anomaly.



Supplementary Figure 2. The scatter plot shows the relationship between the ATL forcing and moisture flux over the Bay of Bengal (F_E) when there is a maximum of (a) five and (b) less than five ensemble members with the same signs of ATL anomaly.