

# Combined Impact of ENSO and Antarctic Oscillation on Austral Spring Precipitation in Southeastern South America (SESA)

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## Motivataion

- **Southeastern South America (SESA) region:** most active agricultural region, one of the most populated part in South America.
- **Precipitation:** an obvious increasing trend since 20<sup>th</sup> century; influenced by El Niño Southern Oscillation (ENSO), especially in austral spring.

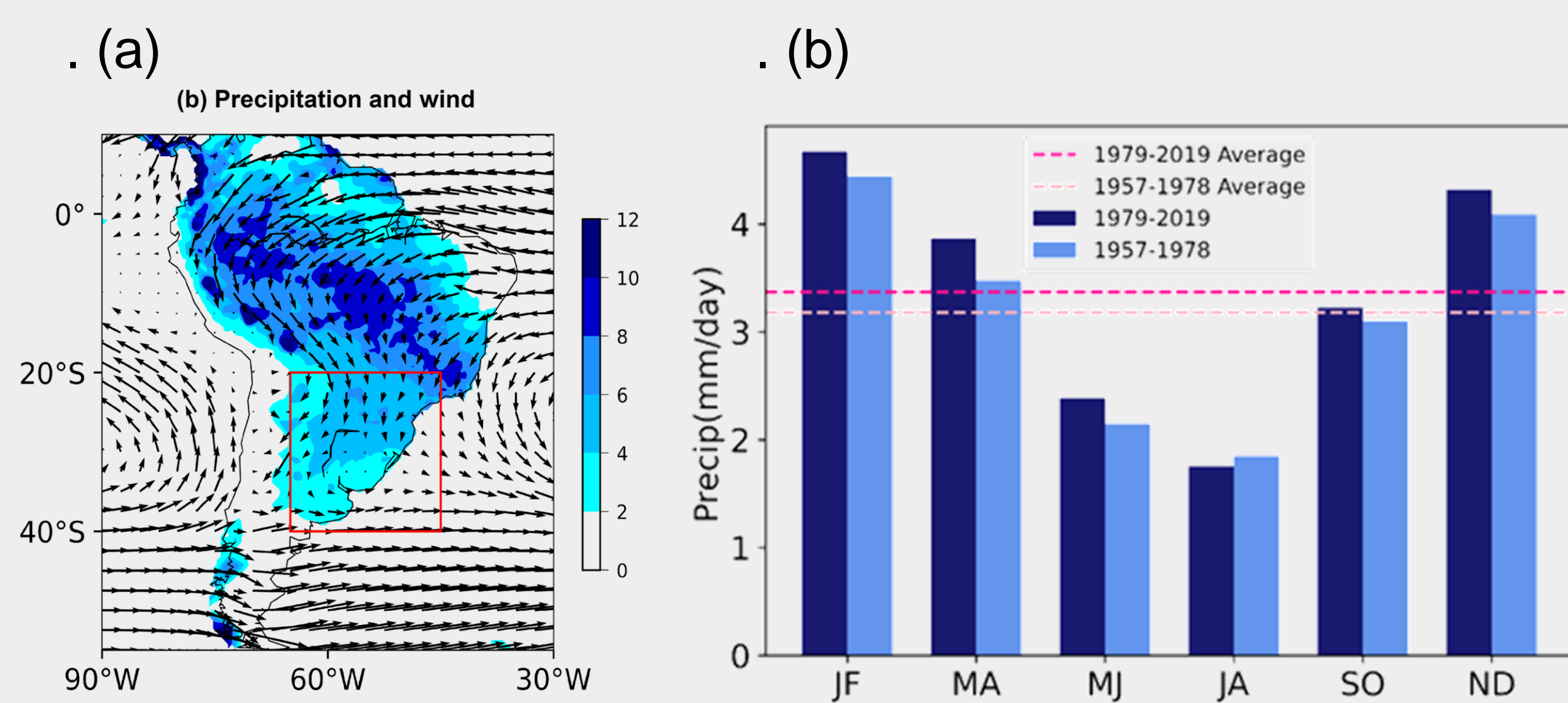
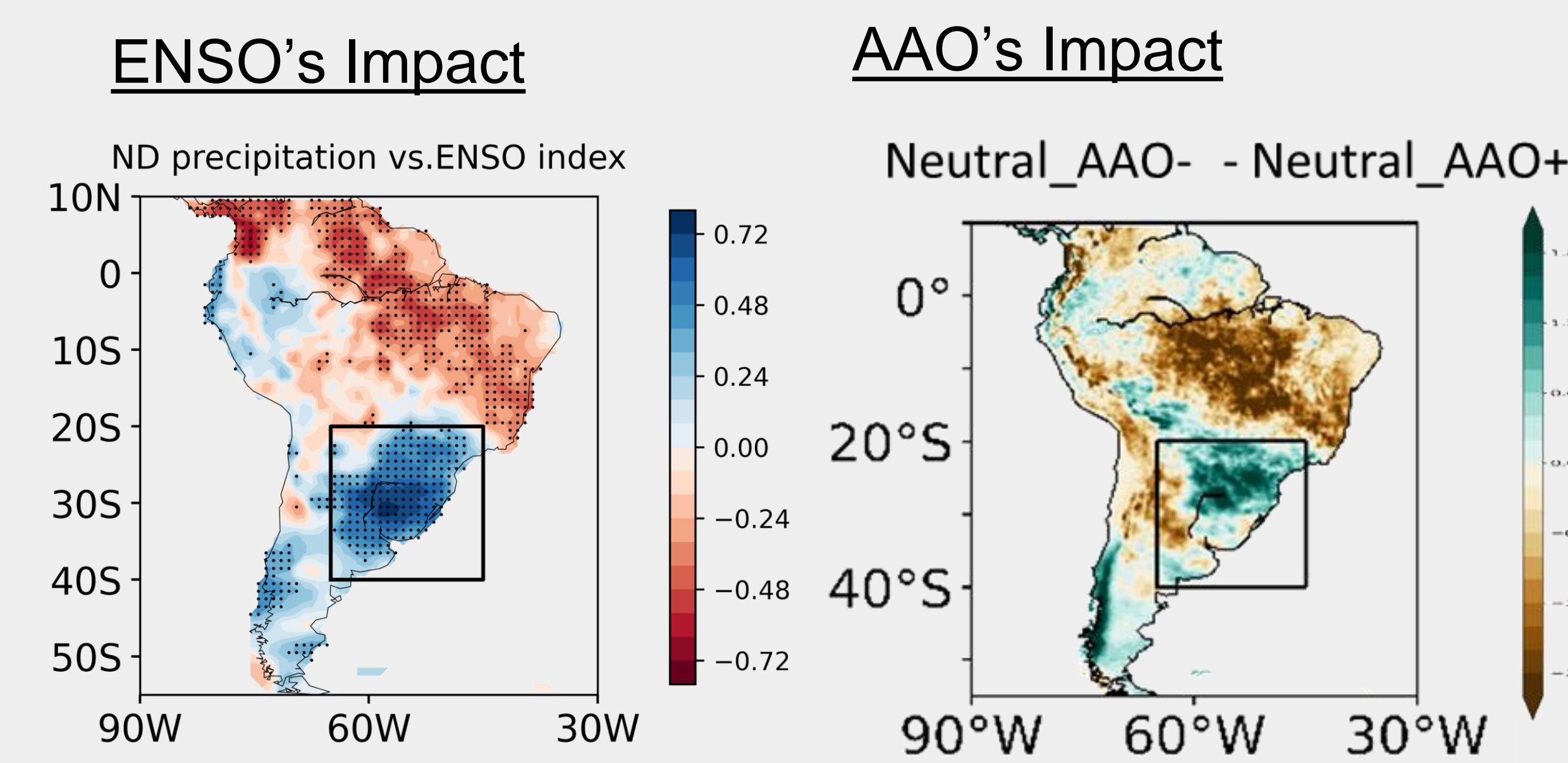


Fig1. (a) Climatological mean of precipitation (shading, unit: mm/day) and 850hPa horizontal wind (unit: m/s) of ND season (b) Climatological mean of bimonthly precipitation during two periods

- **ENSO's impact:** can be modulated by other factors; the Antarctic Oscillation (AAO) has a strong modulation of ENSO's impact on SESA precipitation during austral spring, according to correlation analysis.



- **Combined impact:** correlation analysis may not be sufficient to figure out the combined impact considering the decadal variation of AAO-ENSO relationship; besides, whether the impacts of AAO are the same among EN events or LN events is unknown

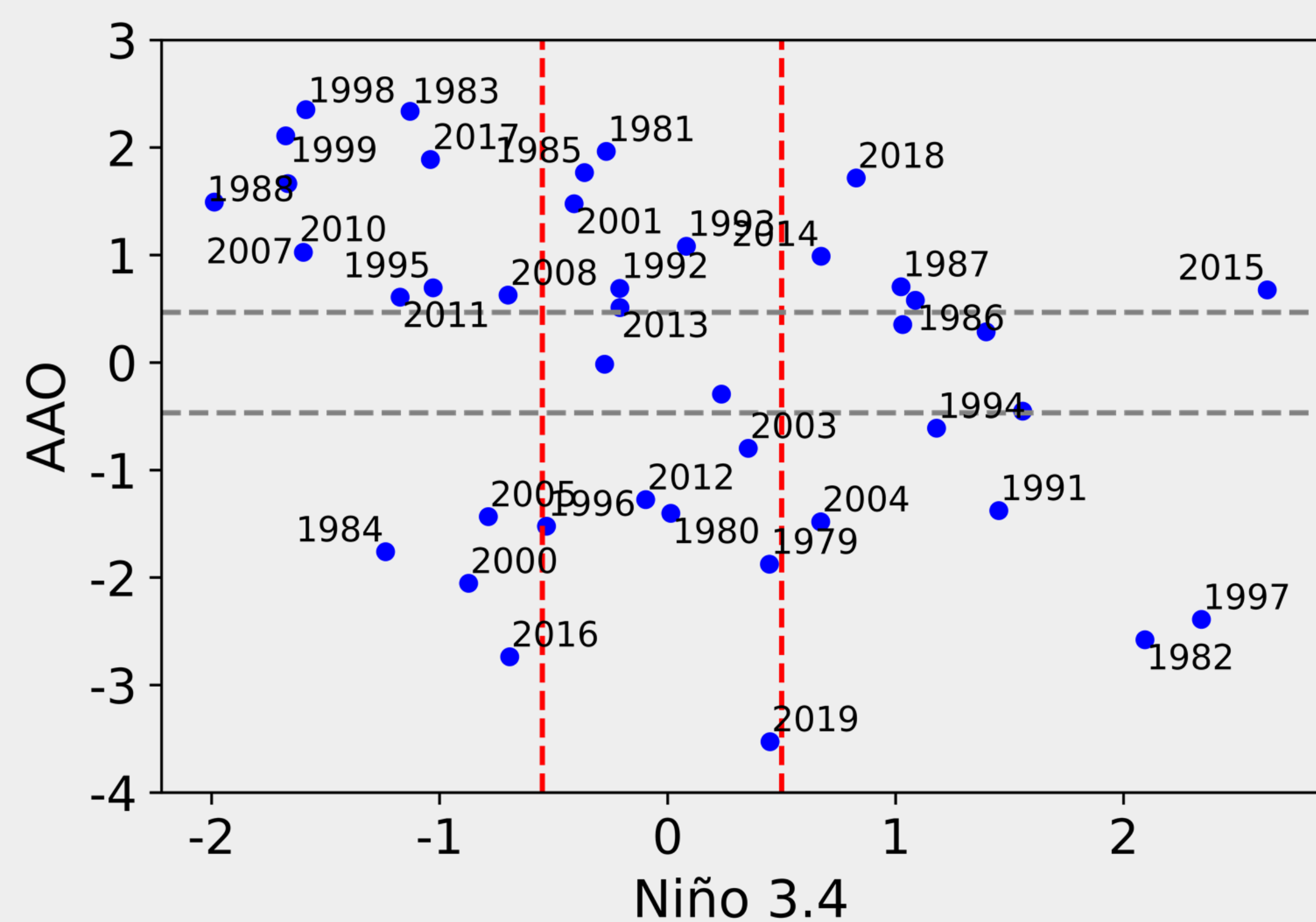


Fig2. Scatter diagram between SAM and Niño 3.4 index for ND (red dashed lines: thresholds for separating La Niña and El Niño events; Grey dashed lines: thresholds for defining AAO+ and AAO-).

## Combined impact on precipitation

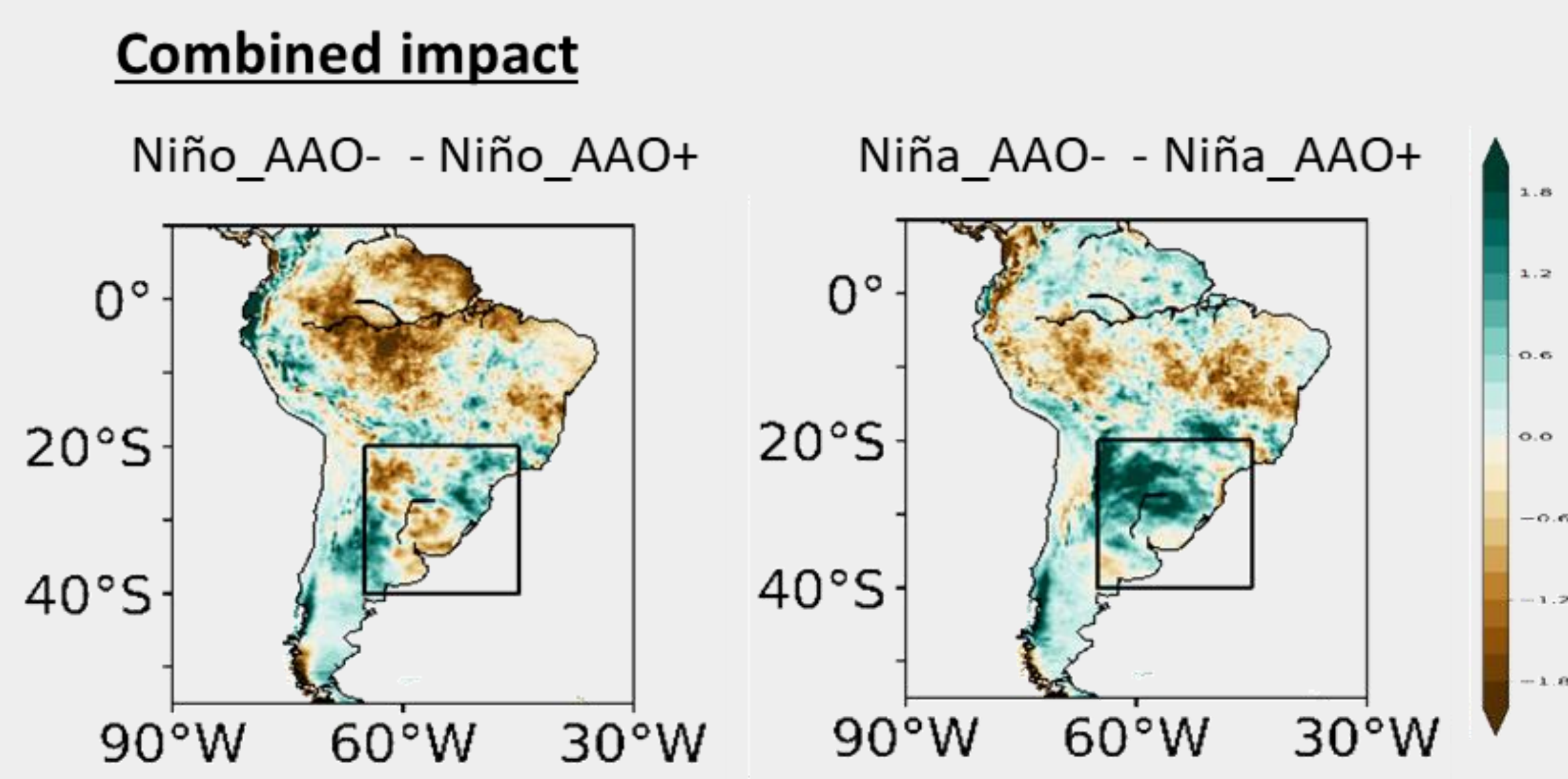


Fig3. Differences of precipitation composites (unit: mm/day) in ND based on different groups in Fig.2; Statistical significance is tested at the 95% confidence level estimated by two-tailed Student's t test

AAO modulate ENSO's impact on precipitation nonlinearly, mainly modulate La Niña's influence

## Moisture transport

- **Vertically integrated flux of water vapor**

$$Q = \int_{P_t}^{P_s} (q \cdot \mathbf{V}) dp / g$$

vertically integrated flux of water vapor      vector wind (u,v)

**Box model:** calculate the mean convergence of the water vapor flux over SESA

$$Tr_{meridional} = \int_0^y Q dy$$

$$Tr_{zonal} = \int_0^x Q dx$$

Meridional direction of water vapor contributes the most of moisture convergence in all groups

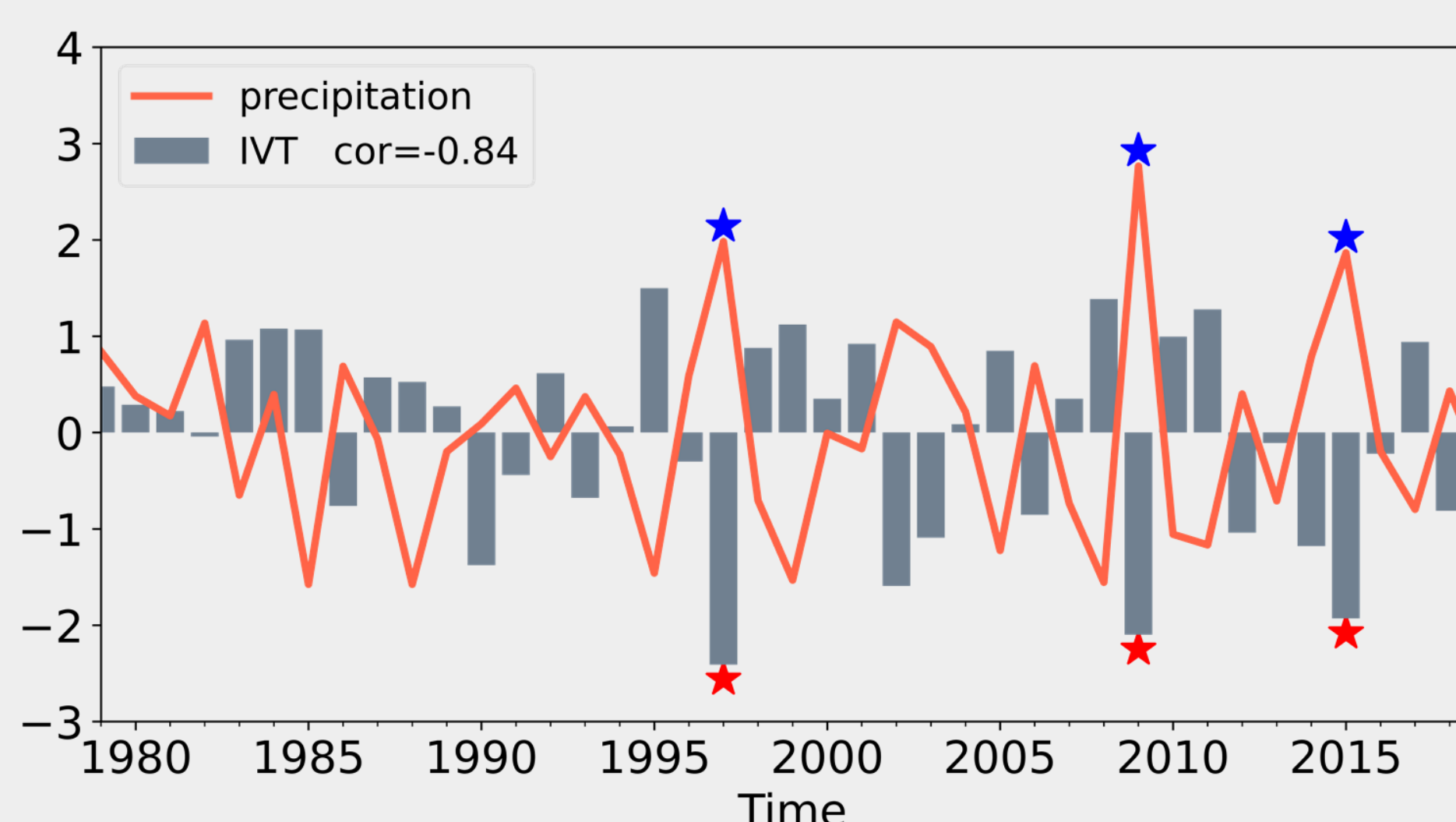
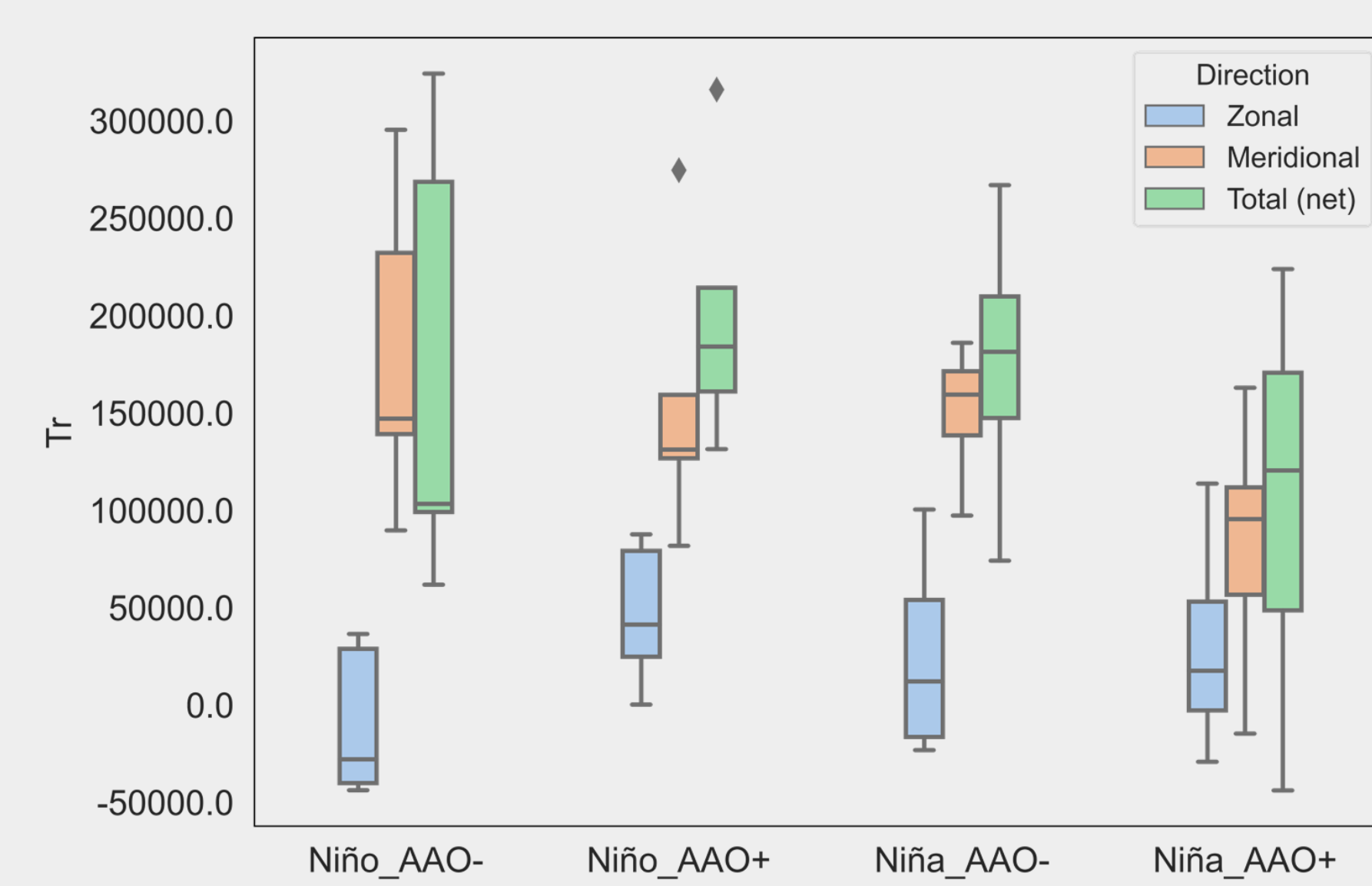


Fig4. Normalized time series of precipitation and vertical integral of northward water vapor flux (IVT) in the SESA region (Extreme high precipitation and IVT in the same year are marked by stars)

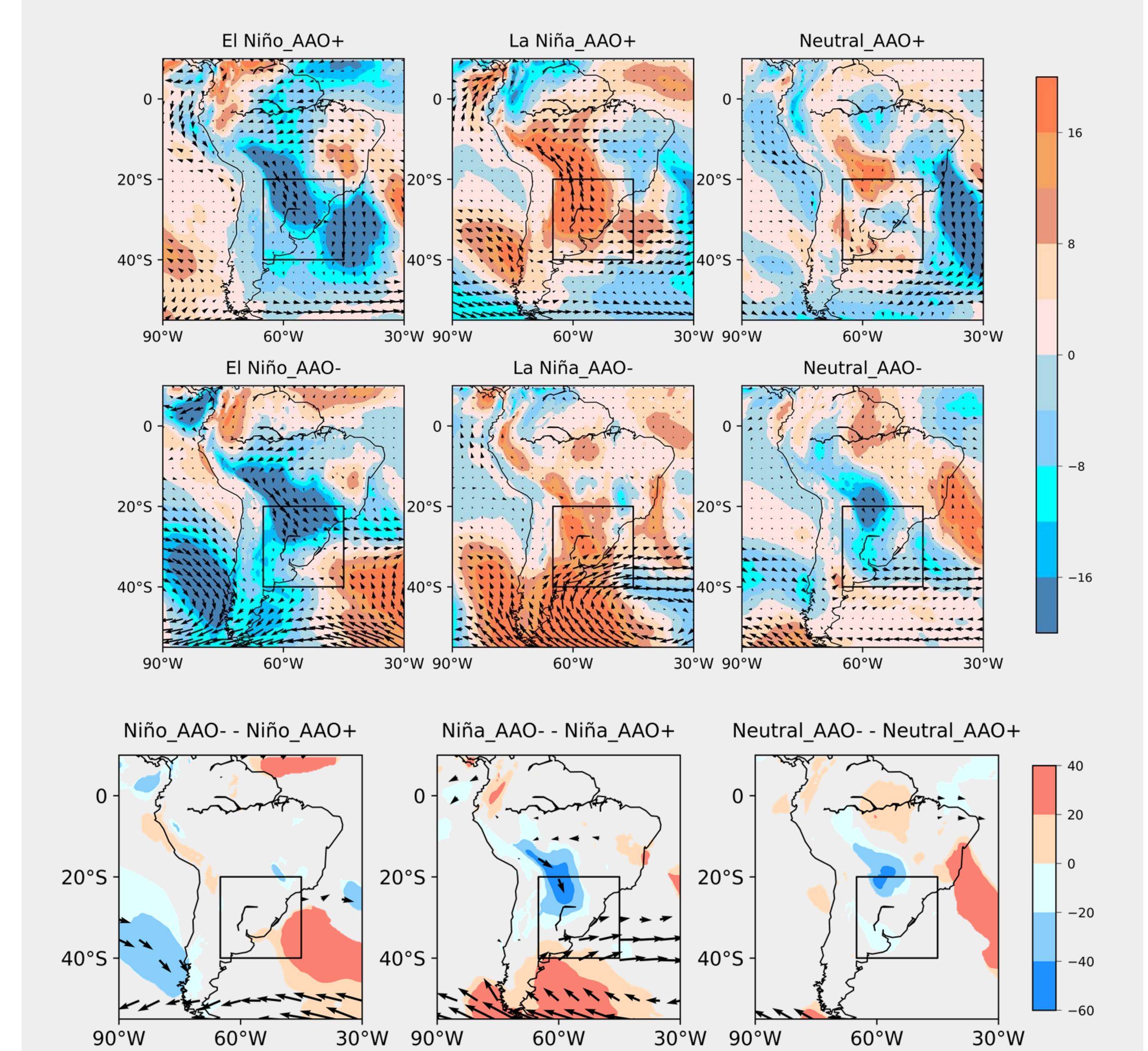


Fig5. Composite of vertical integral of northward water vapor flux anomalies (negative values indicate a flux from north to south, unit: kg·m<sup>-1</sup>·s<sup>-1</sup>) and 850hPa horizontal wind anomalies (vectors, unit: m/s) in different groups

## Atmospheric circulation

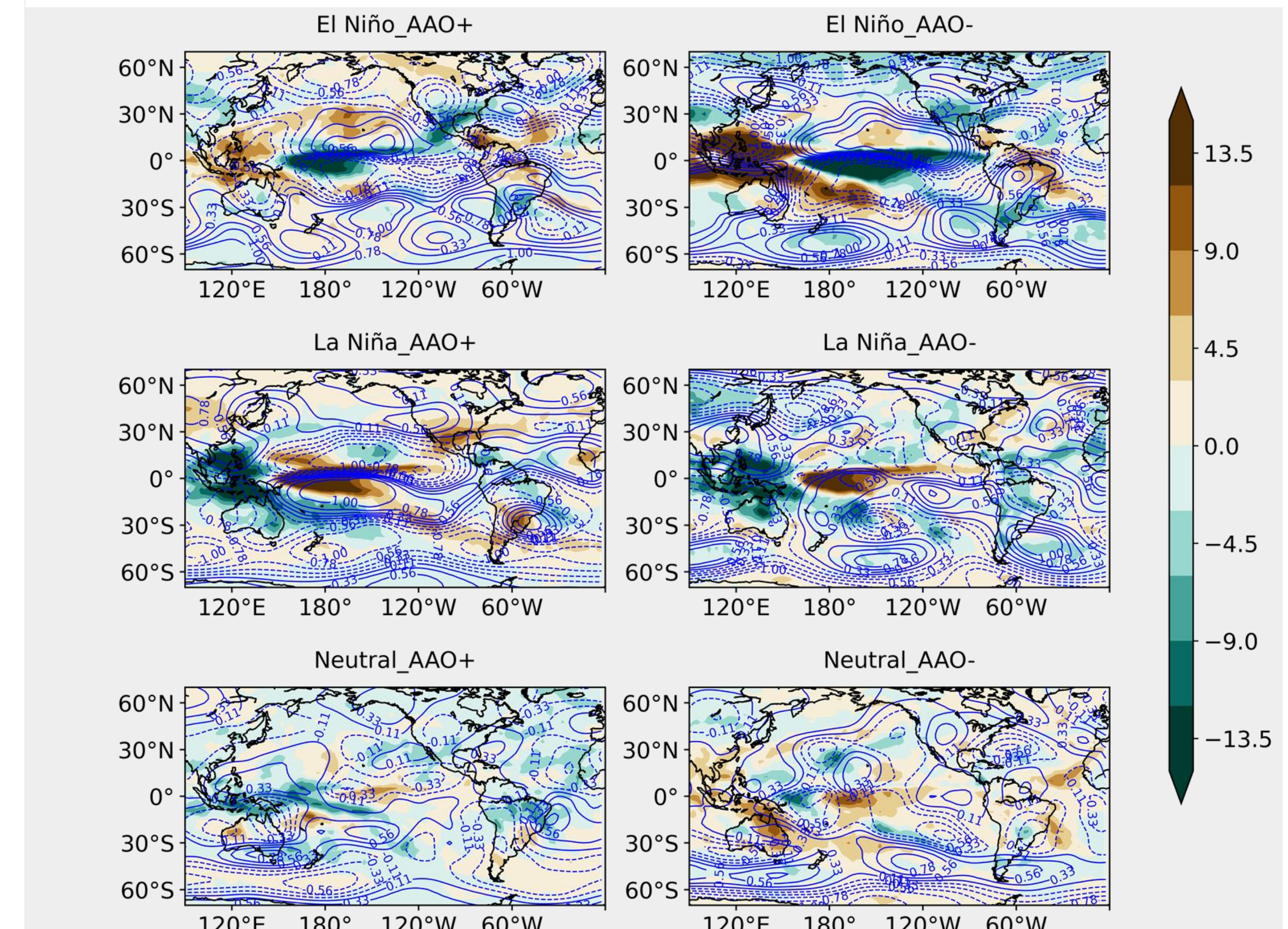
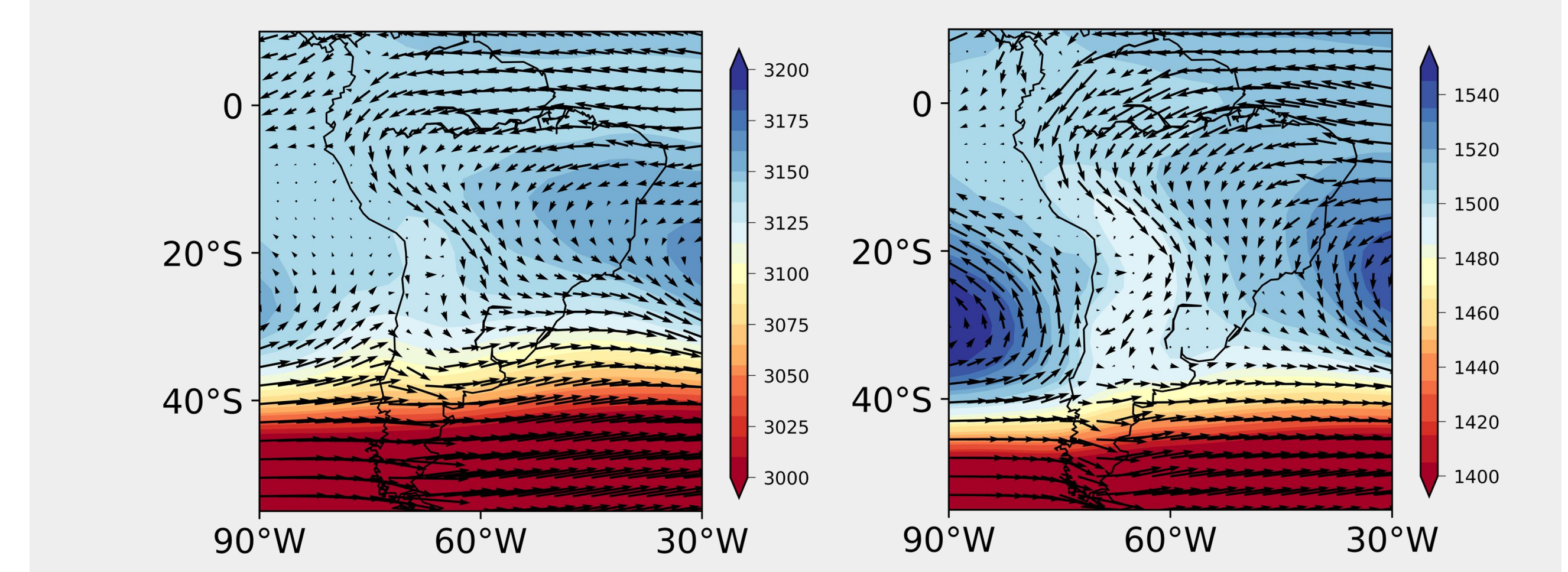


Fig6. Composite of stream function at 200hPa (blue contours, unit: m<sup>2</sup>/s) and outgoing longwave radiation (OLR, shading, unit: W/m<sup>2</sup>)



## Conclusion

- AAO strongly modulates La Niña's impact, with opposite effects on precipitation of AAO negative and positive phases.
- Meridional IVT contributes most of moisture into the SESA region and is highly correlated with the regional precipitation anomalies.
- Low-level jet transporting moisture and upper-level circulation providing the dynamical lift for moisture, are influenced by ENSO and AAO, leading to different impact on precipitation over the SESA region.