

The Role of Tropical Inter-Basin Interactions in Initiating the 2020–2023 La Niña: A Hindcast-Based Predictability Study

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OHC Ensemble Correlation with Nino3.4 (NDJ)

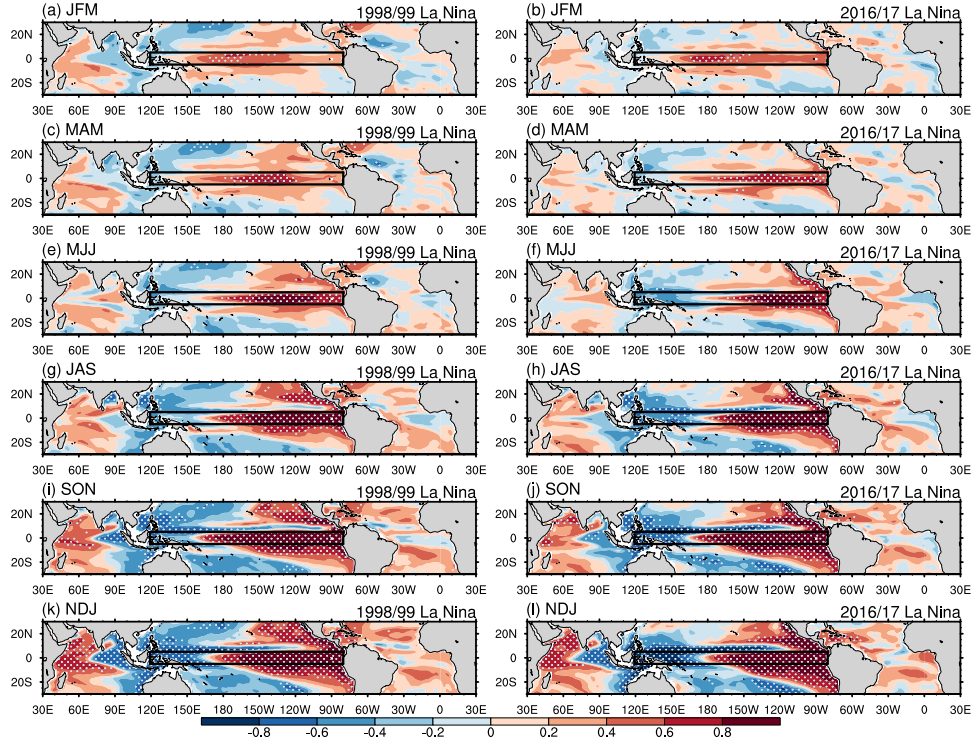


Fig. S1 Inter-ensemble correlation of OHC300eq with the Niño3.4 index for the NDJ season among the 40 hindcast members for 1997/98 and 2015/16 events, during (a-b) JFM, (c-d) MAM, (e-f) MJJ, (g-h) JAS, (i-j) SON, and (k-l) NDJ. In the inter-ensemble correlation maps, anomalies are calculated as deviations of each member from the ensemble mean of the 40 members initialized on January 1st of each initialization, and the inter-ensemble correlation is calculated as the correlation of each member with the ensemble mean. The black boxes indicate the regions defined for the OHC300eq index. The dots represent areas with statistical significance at the 99% confidence level.

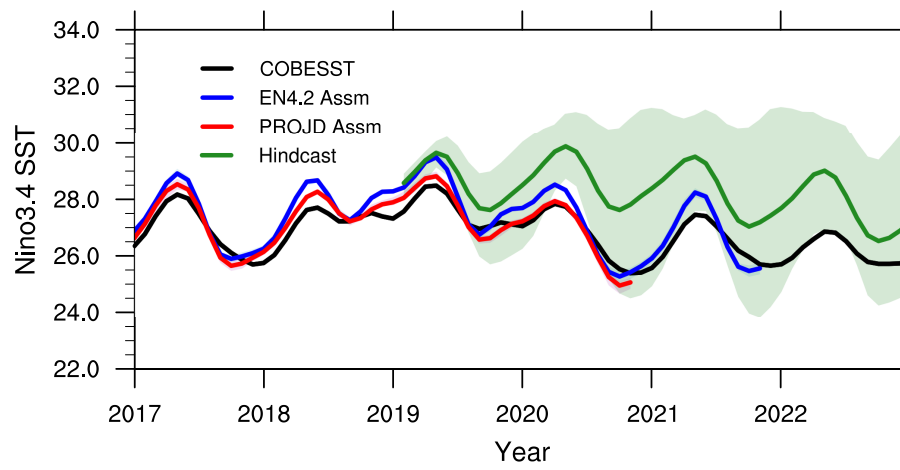


Fig. S2 Time series of Niño3.4 SST in observation (black), two assimilation datasets (blue and red), and hindcast (green). The thick line represents the ensemble mean, and shading represents ensemble spread.

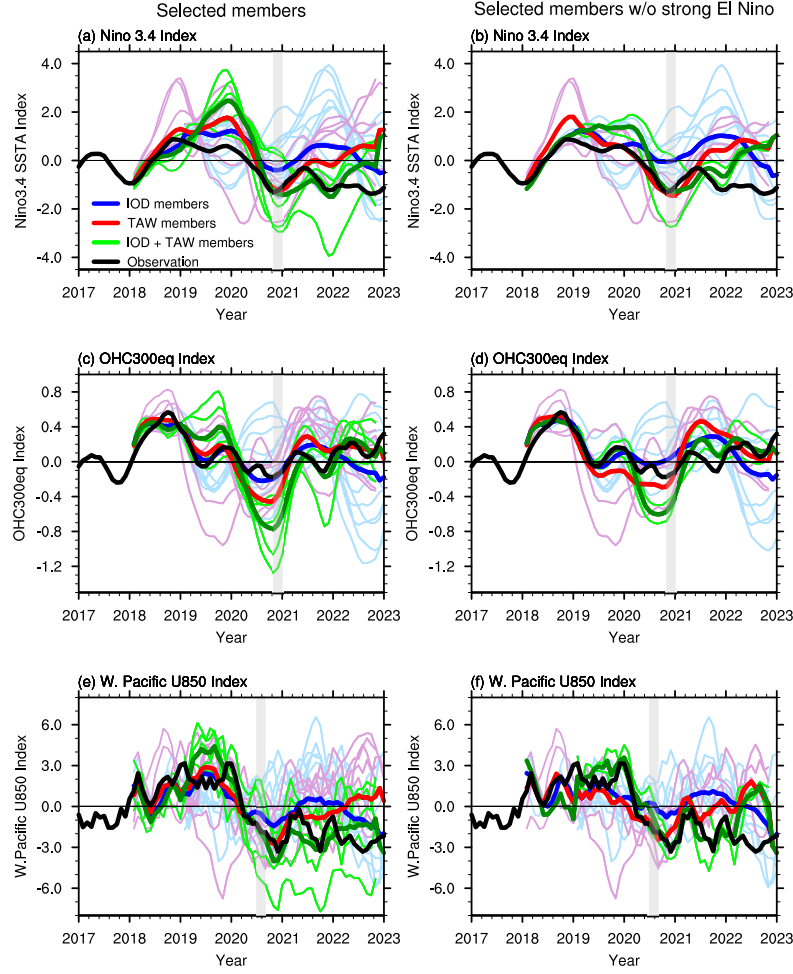


Fig. S3 Time series of (a, b) Niño3.4 SST, (c, d) OHC300, and (e, f) western Pacific U850 anomalies for selected members (left) and without strong preceding El Niño (right) in the 40-member hind-cast experiments. Members are selected based on their IOD and TAW indices being greater than 2 observational standard deviations. Among these selected members, those with greater than 2 observational standard deviations in the Niño3.4 index during NDJ 2019/20 are categorized as selected members with strong preceding El Niño, while the rest are designated as selected members without strong preceding El Niño. The reference period to calculate the observational standard deviation is 1981–2022. Thick lines indicate the ensemble mean, while thin lines correspond to individual members. Blue, red, and green lines represent IOD, TAW, and IOD + TAW members, respectively. The solid black line denotes observational anomalies. The light gray boxes in (a-d) indicate the first-dip La Niña event during NDJ, and in (e-f) they indicate the JAS 2020 period for U850 anomalies.

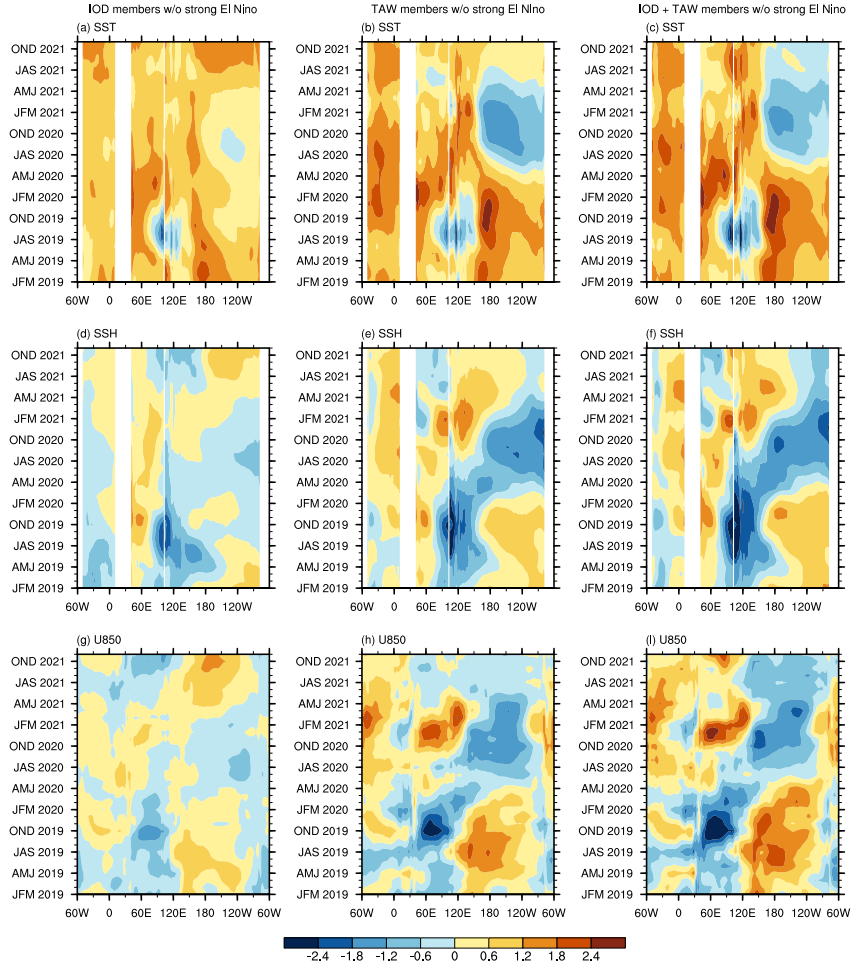


Fig. S4 Hovmöller diagrams of normalized (a, b, c) SST, (d, e, f) SSH, and (g, h, i) 850 hPa zonal wind anomalies averaged over the 5°S – 5°N latitude band for (a, d, g) IOD members (11), (b, e, h) TAW members (5), and (c, f, i) IOD + TAW members (3) in the hindcast experiments without El Niño preconditioning in 2019/20. Member selection follows Fig. 7 with the additional categorization of their Niño3.4 index in NDJ 2019/20 being below 2 observational standard deviations (referred to as w/o strong El Niño). Anomalies are normalized by one standard deviation of the observed anomalies.

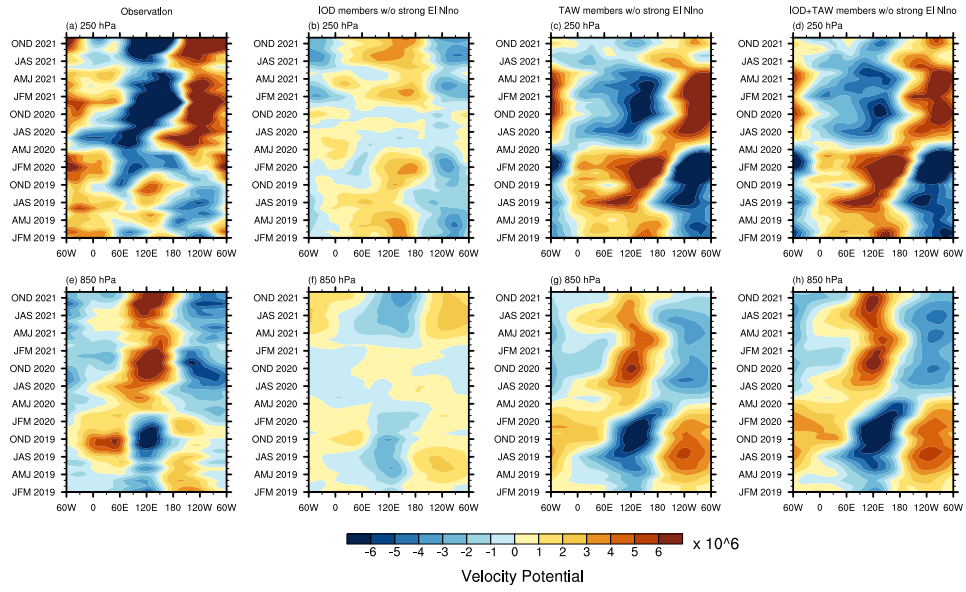


Fig. S5 Hovmöller diagrams of velocity potential at 250 hPa (top) and 850 hPa (bottom) for (a, e) observation, (b, f) IOD members (11), (c, g) TAW members (5), and (d, h) IOD + TAW members (3) in the hindcast runs without El Niño preconditioning in 2019/20, averaged over the 5°S – 5°N latitude band. Member selection follows Fig. S6. Shading interval is $10^6 \text{ m}^2/\text{s}$.

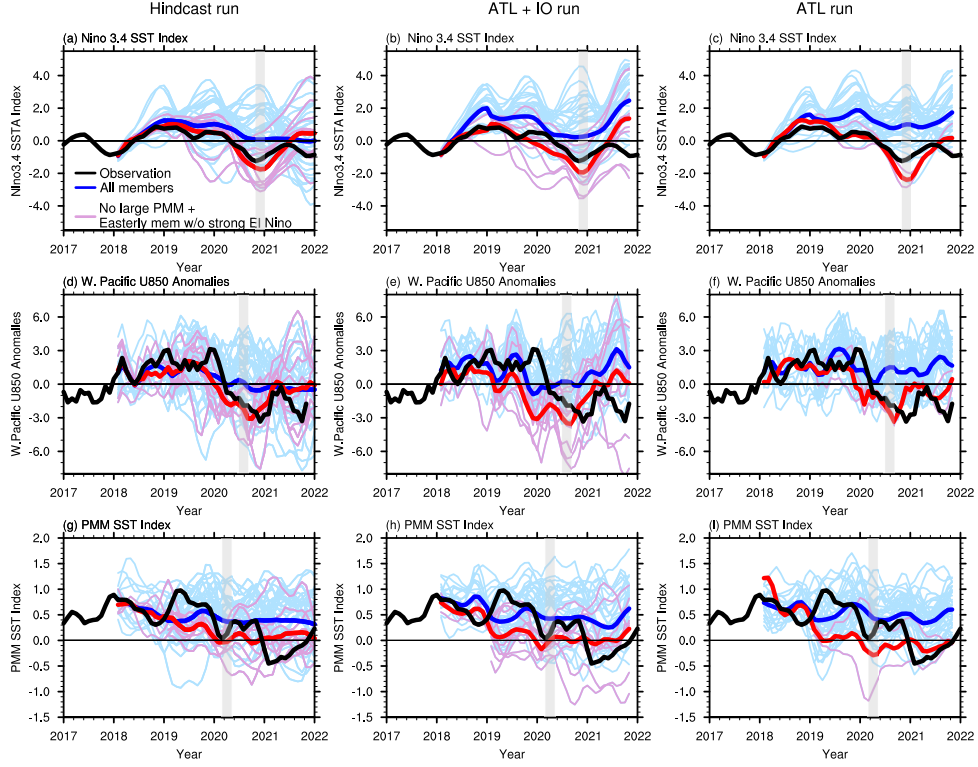


Fig. S6 Time series of (a-c) Niño3.4 SST, (d-f) western Pacific U850, and (g-i) PMM SST anomalies for the hindcast (left), ATL + IO (center), and ATL (right) runs. Thick lines represent the ensemble mean, while thin lines show individual members. Black, blue, and red lines correspond to observations, all 40 members, and selected members, respectively. Member selection follows Fig. 12 with the additional categorization of their Niño3.4 index in NDJ 2019/20 being below 2 observational standard deviations (referred to as w/o strong El Niño). The light gray box highlights (a-c) the first-dip La Niña event during NDJ, (d-f) U850 anomalies during JAS 2020, and (g-i) PMM SST anomalies during MAM 2020.

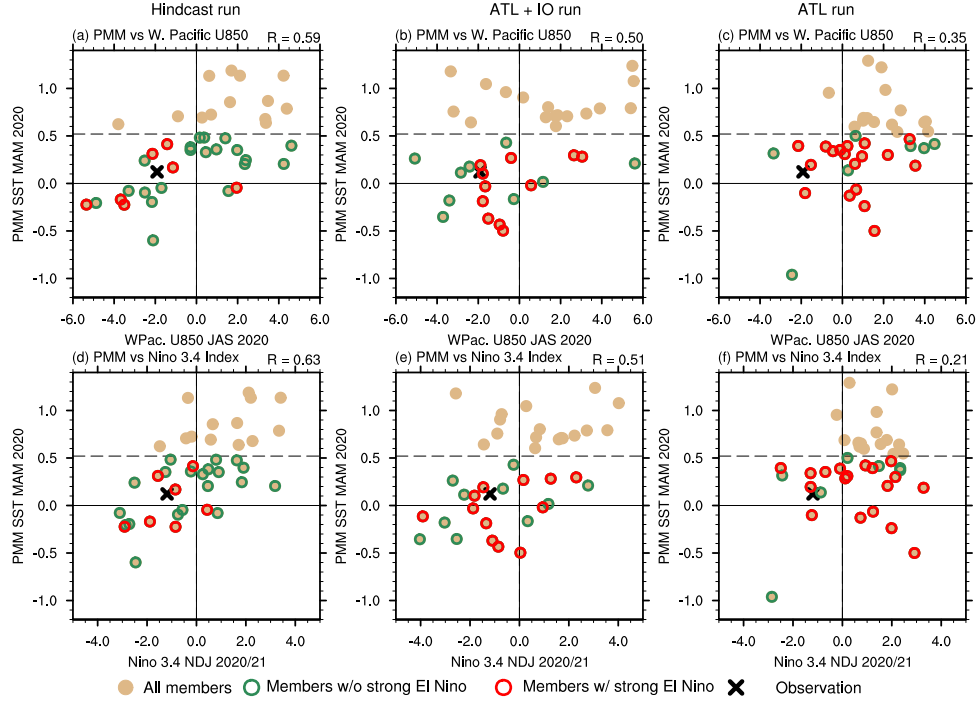


Fig. S7 Scatterplots of PMM SST anomalies in MAM 2020 with (a-c) western Pacific U850 anomalies in JAS 2020, and (d-f) Niño3.4 SST anomalies in NDJ 2020/21 for (a, d) hindcast, (b, e) ATL + IO, and (c, f) ATL runs. The member selection is based on excluding positive PMM values that exceed 1.0 standard deviation from observed values during 2020. Solid light-brown dots represent individual hindcast members, while red and green-circled dots represent members w/ strong preceding El Niño or w/o strong preceding El Niño (their respective Niño3.4 indices in NDJ 2019/20 higher or lower than 2.0 observational standard deviations). The black cross indicates observational values. Dashed lines in (a-f) indicate the thresholds for selecting the members.

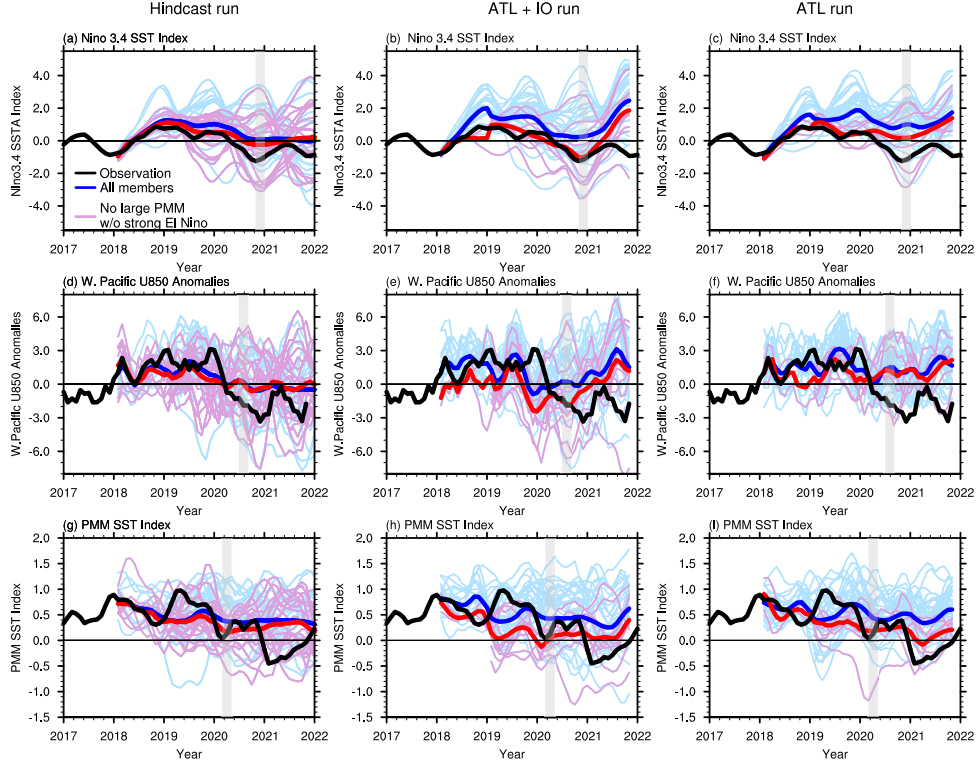


Fig. S8 Time series of (a-c) Niño3.4 SST, (d-f) western Pacific U850, and (g-i) PMM SST anomalies for the hindcast (left), ATL + IO (center), and ATL (right) runs. Thick lines represent the ensemble mean, while thin lines show individual members. Black, blue, and red lines correspond to observations, all 40 members, and selected members, respectively. Member selection follows Fig. S7 with the additional categorization of their Niño3.4 index in NDJ 2019/20 being below 2 observational standard deviations (referred to as w/o strong El Niño). The light gray box highlights (a-c) the first-dip La Niña event during NDJ, (d-f) U850 anomalies during JAS 2020, and (g-i) PMM SST anomalies during MAM 2020.

No large Positive PMM + Easterly members w/o strong El Nino

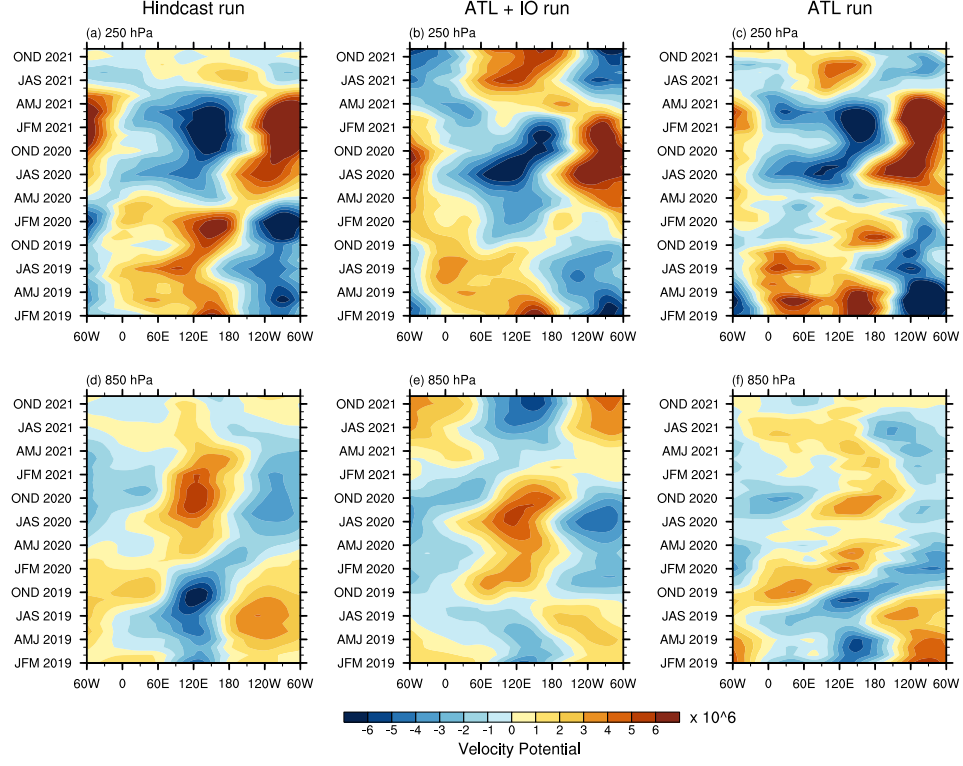


Fig. S9 Hovmöller diagrams of velocity potential anomalies at 250 hPa (top) and 850 hPa (bottom) for the selected members of the (a, d) hindcast (9 members), (b, e) ATL + IO (9 members), and (c, f) ATL (2 members) runs, averaged over the 5°S – 5°N latitude band. Member selection follows Fig. S6. Shading interval is $10^6 \text{ m}^2/\text{s}$.