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Supplemental Material

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A New Robust Frontal Disturbance Index of the Oyashio Extension Sea Surface Temperature
Front

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**Supplemental Information for “A New Robust Frontal Disturbance Index of the
Oyashio Extension SST Front.”**

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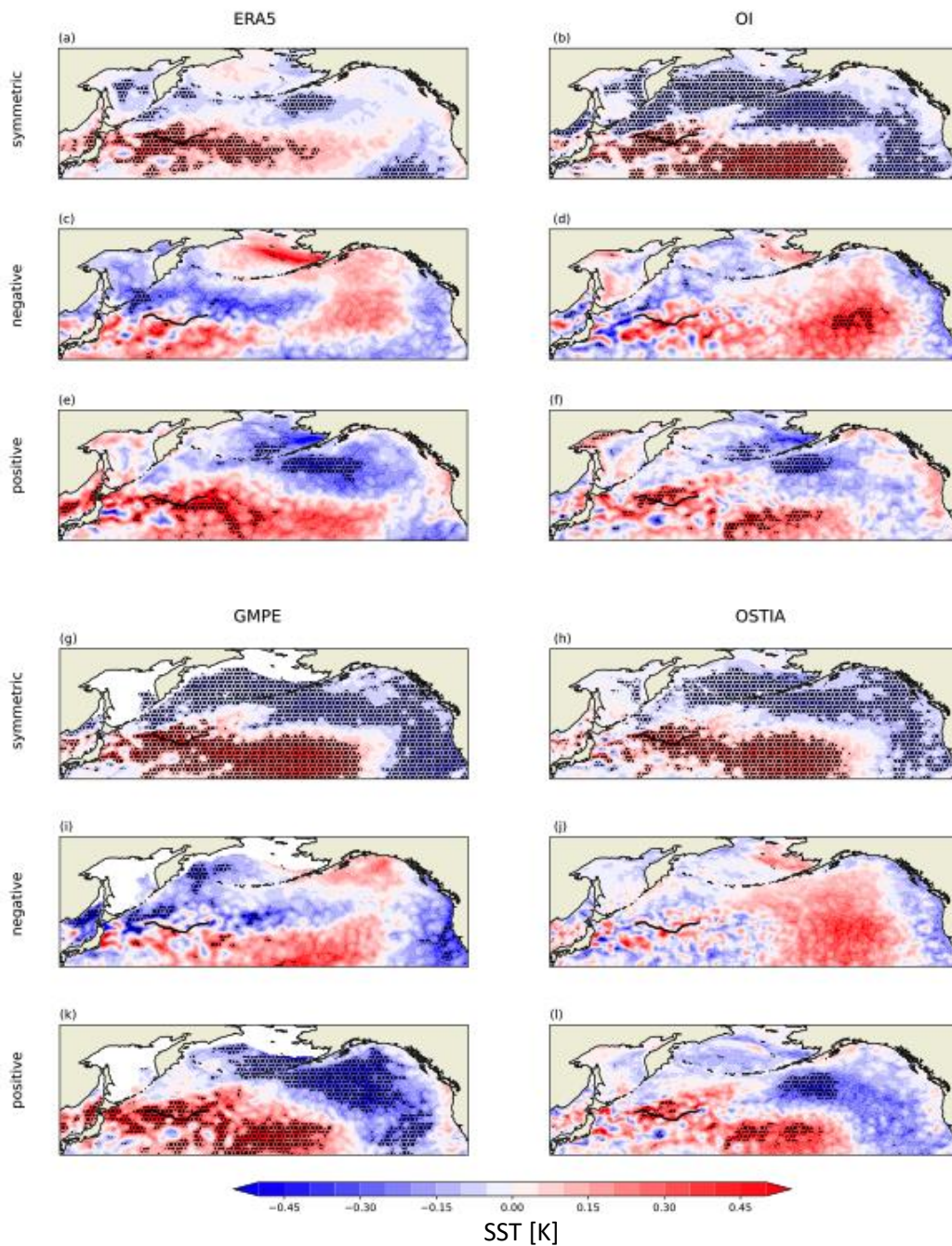


Figure S1. Symmetric, negative and positive regression of the DJFM OEI against DJFM SST for ERA5 (a,c,e), OI (b,d,f) GMPE (g,i,k) and OSTIA (h,j,l). Stippling shows where the regression coefficients are significant ($p < 0.1$, after applying the FDR). Black bold line shows the mean position of the OE Front for DJFM.

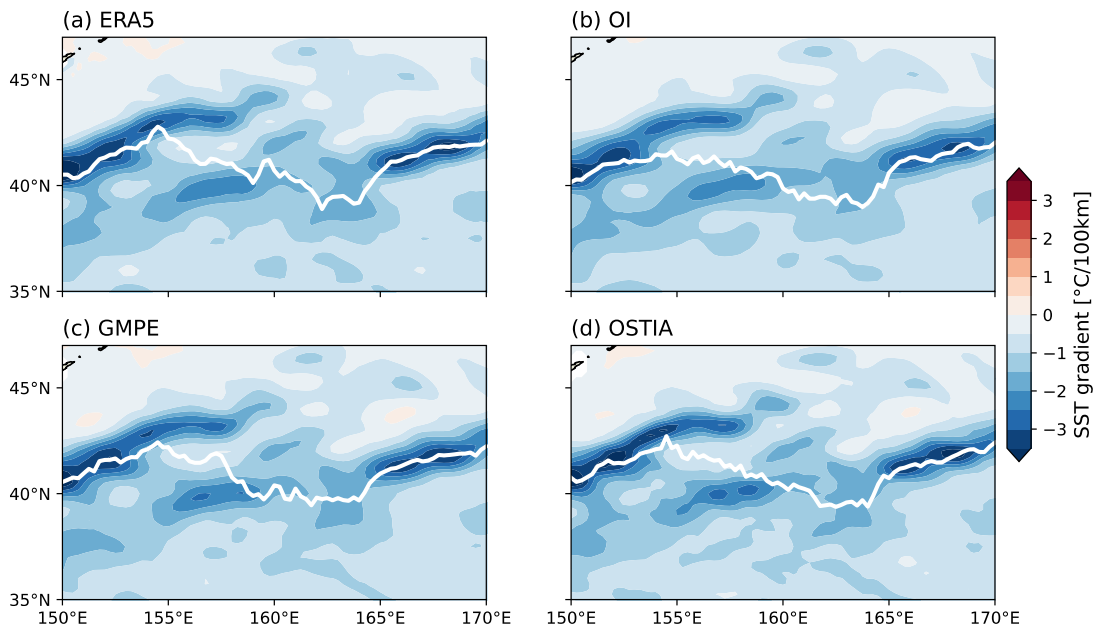


Figure S2. Mean February SST gradients from the four datasets and the February mean maximum SST gradient location (white line).

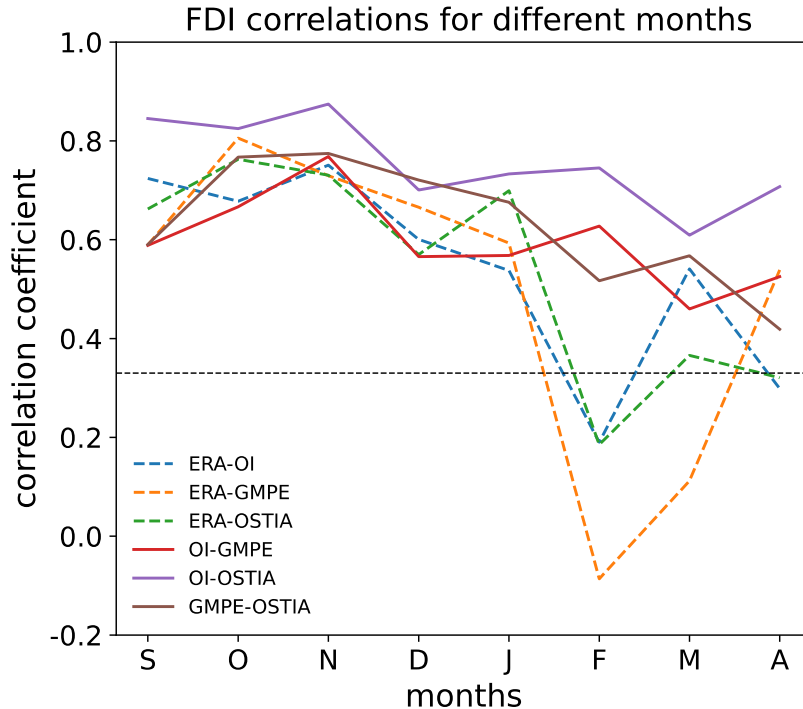


Figure S3. Monthly correlations between FDI from different datasets, for the window September -April. Correlations with ERA5 are shown as dashed as ERA5 is not used in much of the analysis. The dashed horizontal line shows the 95% significance level.

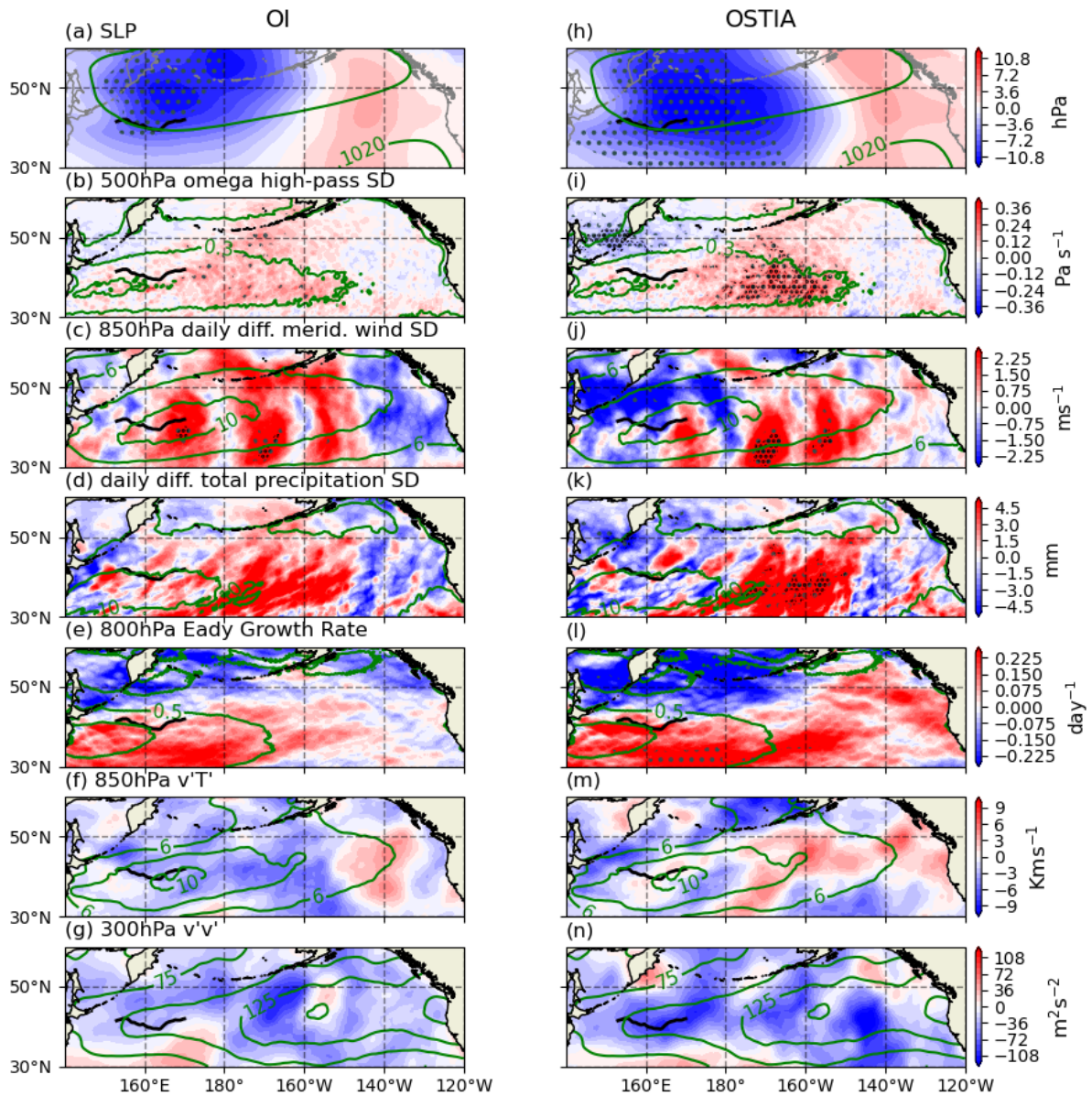


Figure S4. Asymmetric (positive) regression on the FDI for JF, for various FM atmospheric fields related to storm tracks (a)-(g) using OI FDI, (h)-(n) using OSTIA FDI. Shading shows significance at $p < 0.2$ (coarse gray) or $p < 0.1$ (fine black) after application of the FDR. The solid black line shows the mean position of the OE front. Green contours show the climatological mean values of the respective atmospheric field. Contour intervals: 10 hPa (SLP); 0.1 Pa s^{-1} (omega); 2 ms^{-1} (v wind differences); 5mm (total precipitation differences); 0.25 day^{-1} (EGR); 2 K ms^{-1} ($v'T'$); 25 m^2s^{-2} ($v'v'$).

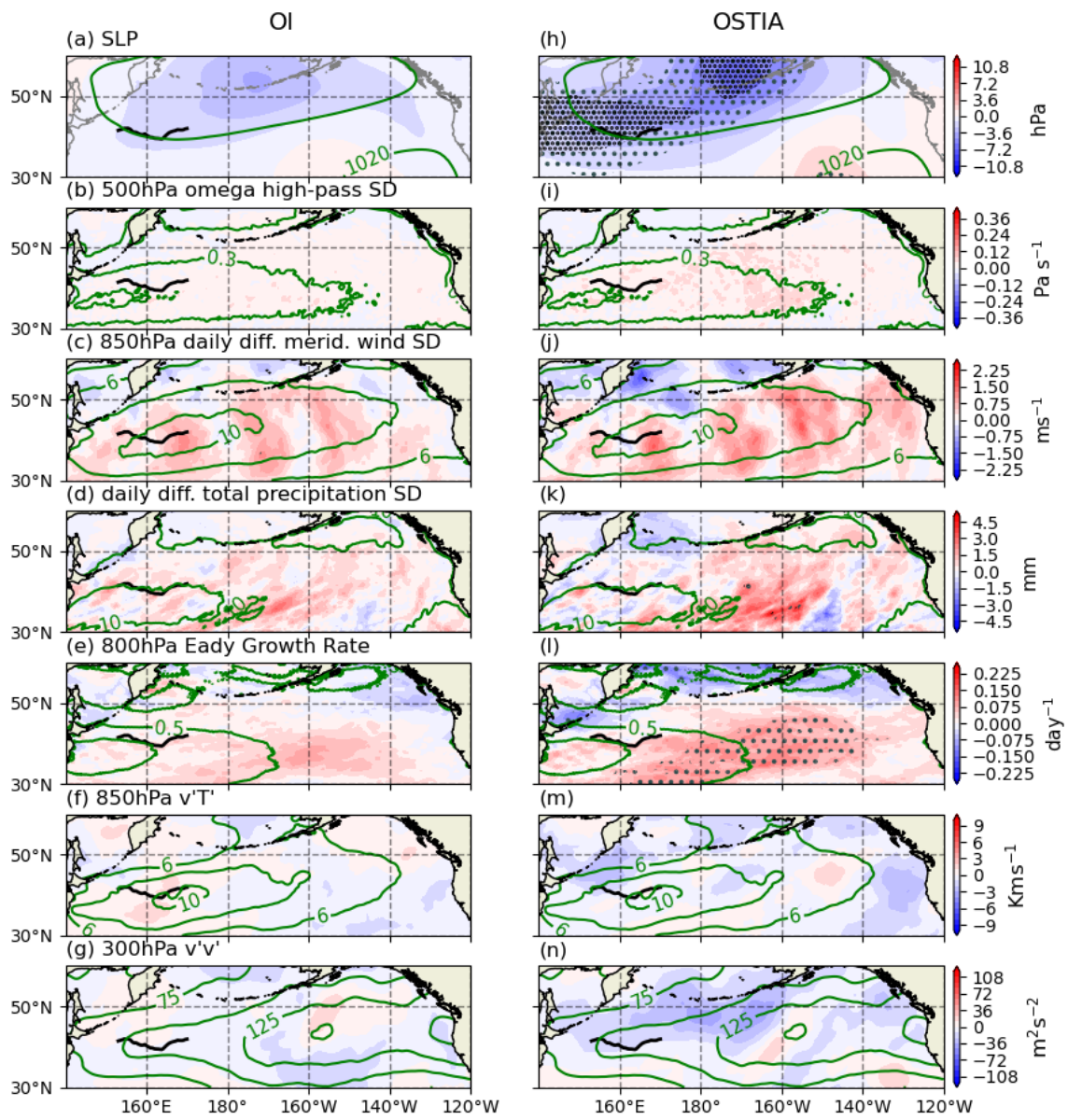


Figure S5 As for Figure S5 except using OEI

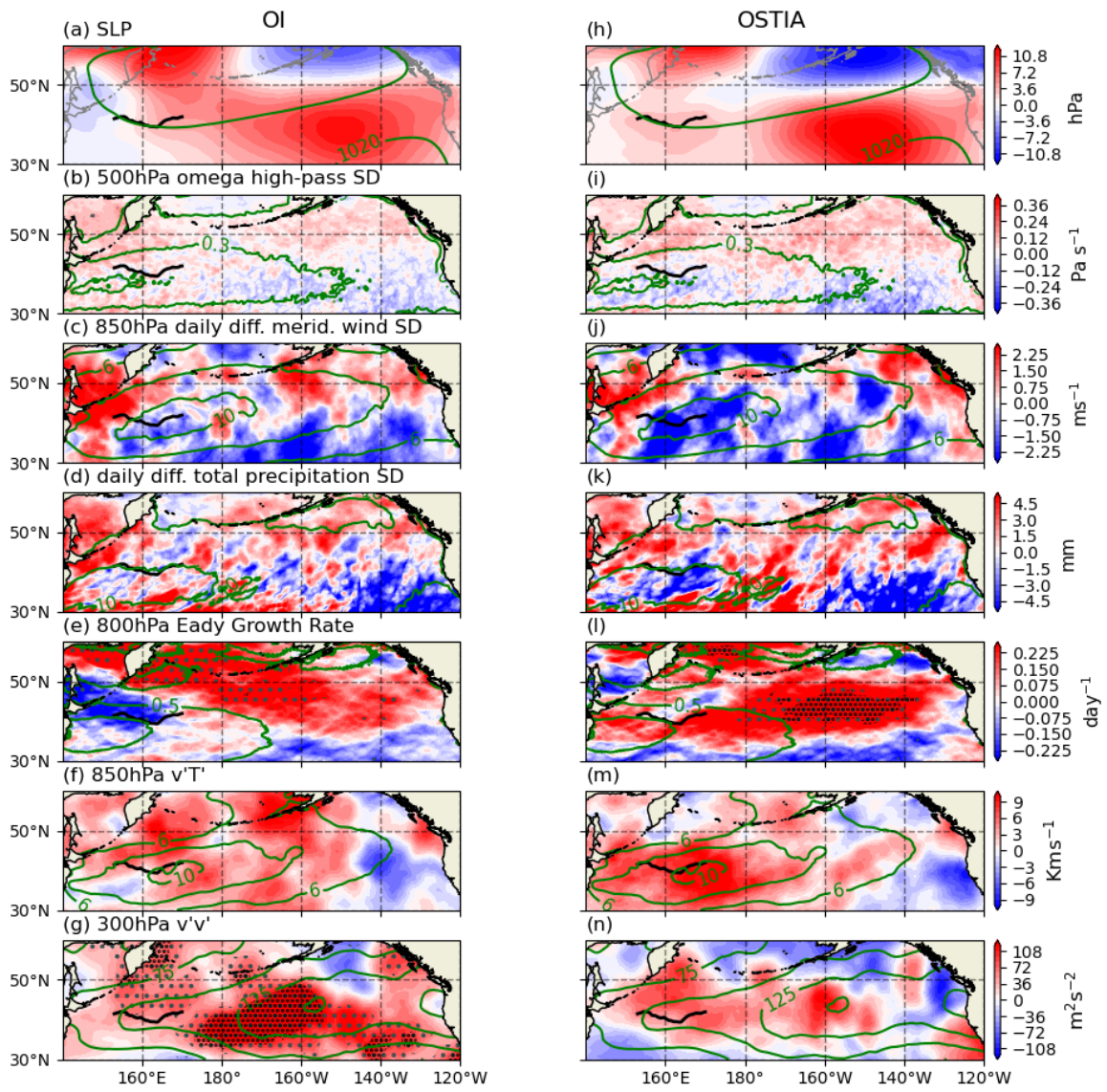


Figure S6 As for Figure S4 except for asymmetric (negative) regression on the FDI.

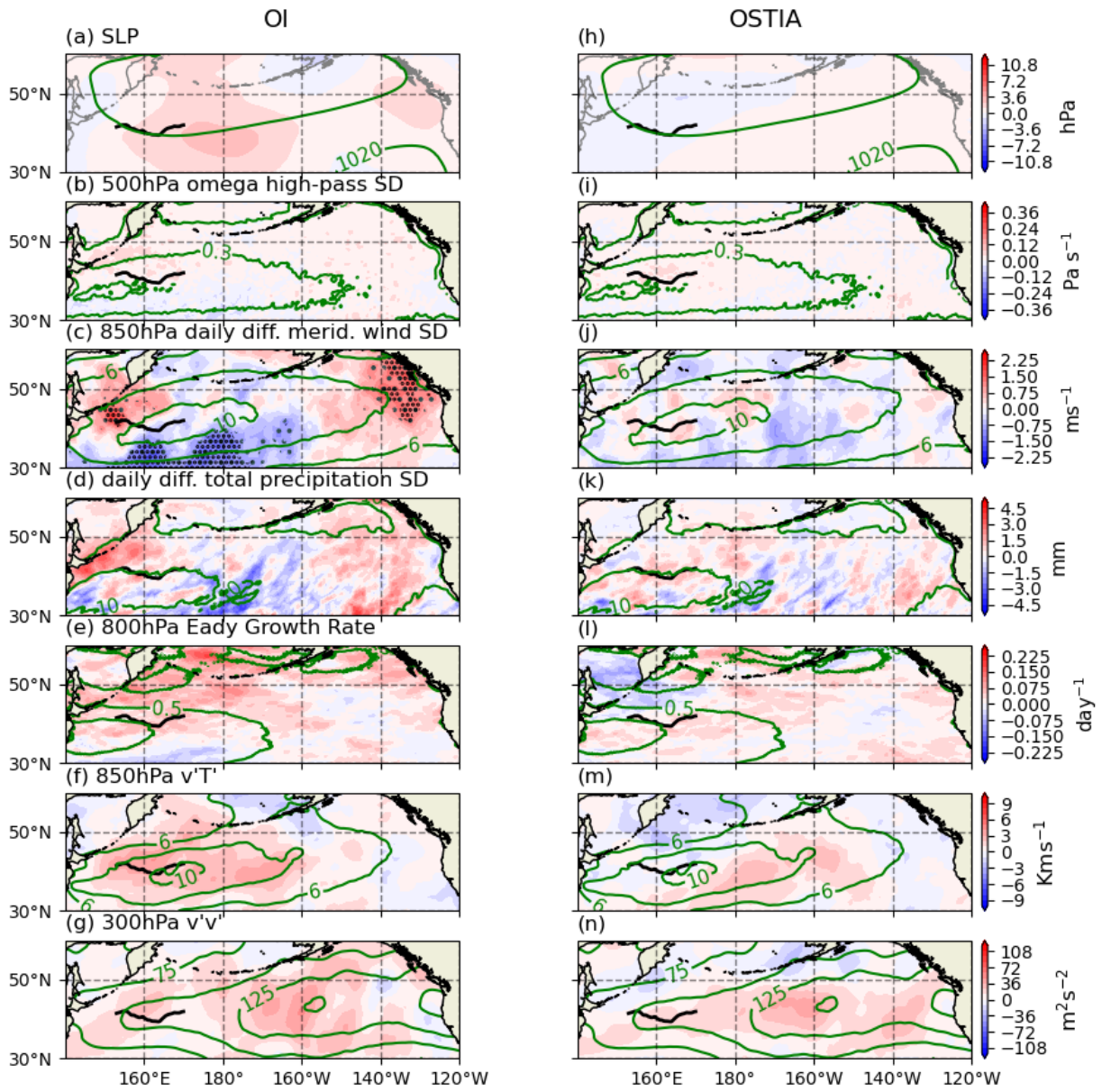


Figure S7 As for Figure S4 except for asymmetric (negative) regression on the OEI

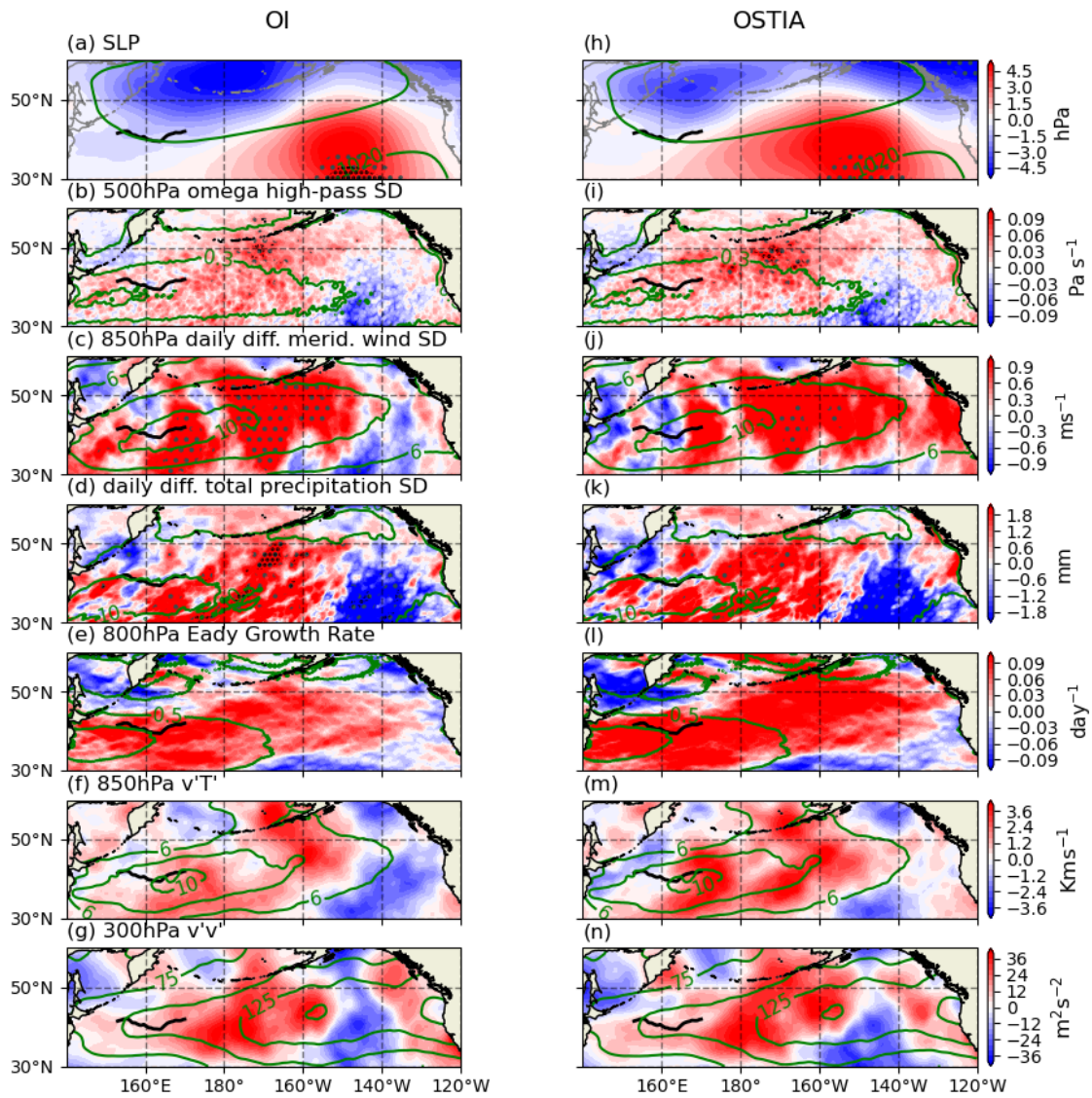


Figure S8 As for Figure S4 except for symmetric regression on the FDI (note the different colorbar scales to Figures S4-S7)

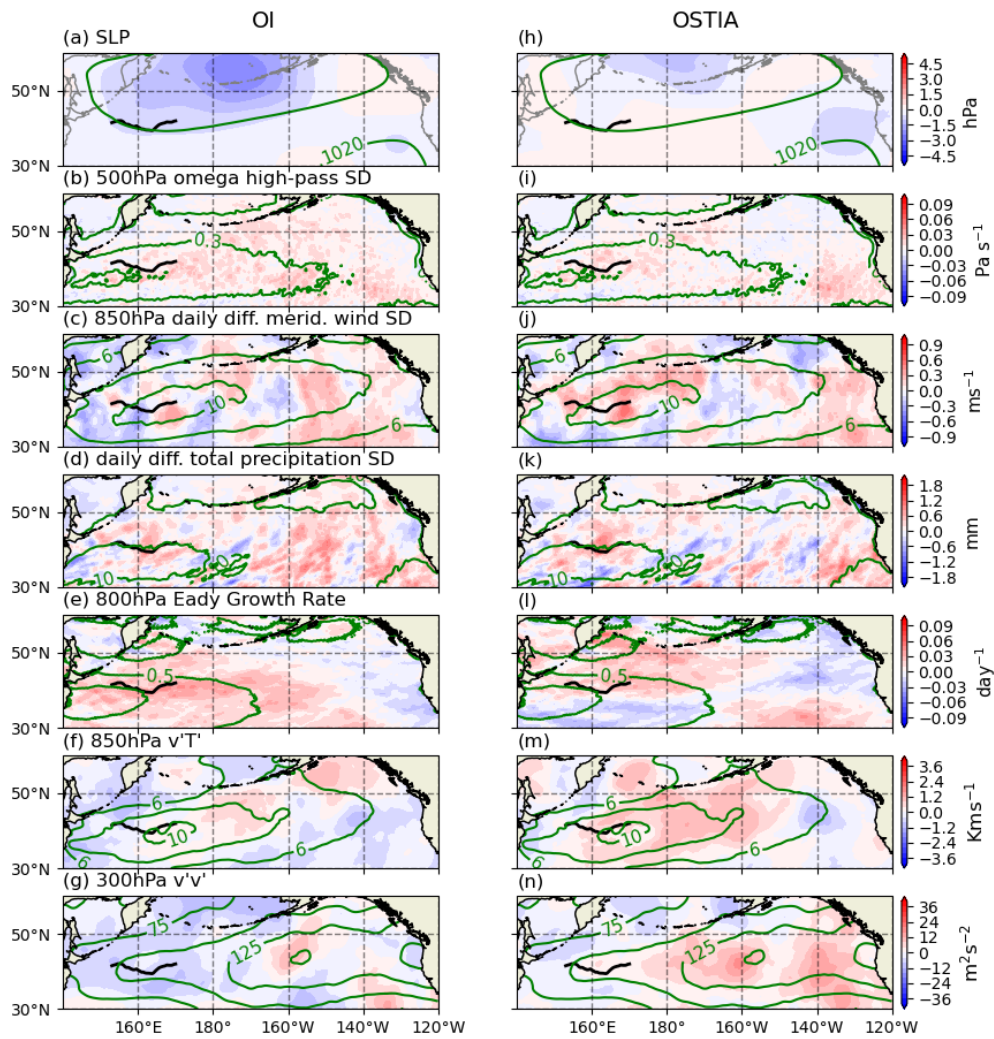


Figure S9 As for Figure S4 except for symmetric regression on the OEI (note the different colorbar scales to Figures S4-S7)

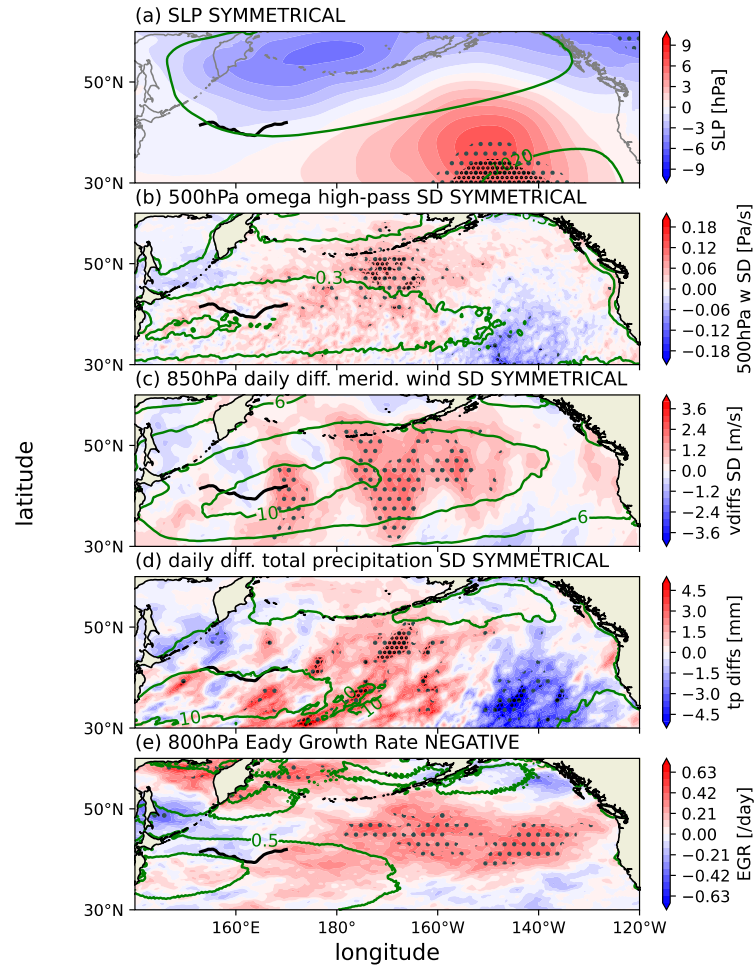


Figure S10. (a) to (d) symmetric and (e) negative regressions on the JF average FDI of various FM atmospheric fields related to storm-tracks, 1982-2021. Maps are only shown where there are significant regression coefficients ($p < 0.2$), after the FDR is applied. Shading shows significance at $p < 0.2$ (coarse gray) or $p < 0.1$ (fine black). The solid black line shows the mean position of the OE front. Green contours show the climatological mean values of the respective atmospheric field. Contour intervals: 10hPa (SLP); 0.1 Pa s^{-1} (highpass-filtered omega SD); 2 ms^{-1} (v wind differences); 5mm (total precipitation differences); 0.25 day^{-1} (EGR).

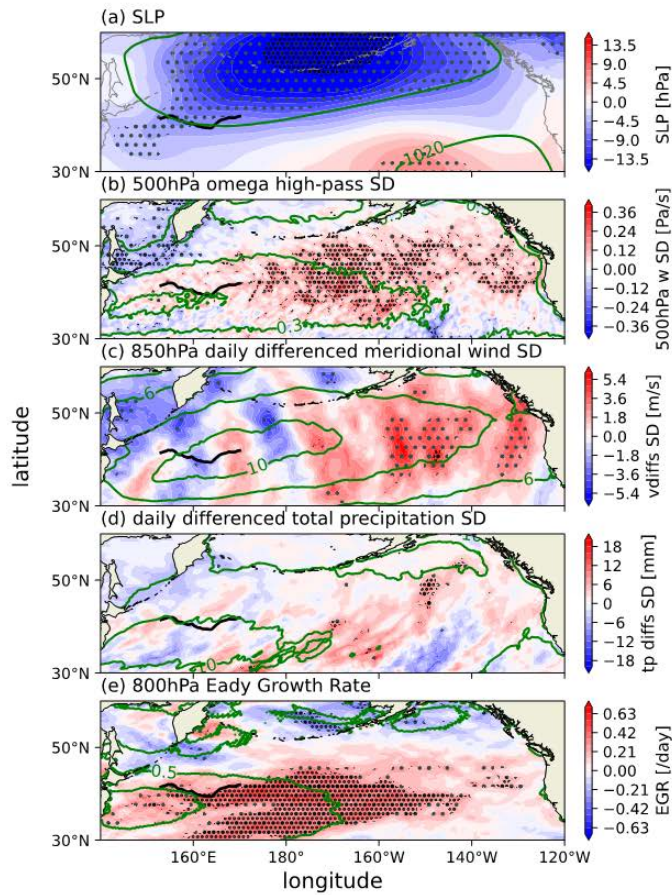


Figure S11. Asymmetric (positive) regression on the JF EKE Index (155-165°E, 41-45°N) for JF, for various FM atmospheric fields related to storm-tracks, 1993-2021. Maps are only shown where there are significant regression coefficients ($p < 0.2$), after the FDR is applied. Shading shows significance at $p < 0.2$ (coarse gray) or $p < 0.1$ (fine black). The solid black line shows the mean position of the OE front. Green contours show the climatological mean values of the respective atmospheric field. Contour intervals: 10hPa (SLP); 0.1 Pa s⁻¹ (highpass-filtered omega SD); 2ms⁻¹ (v wind differences); 5mm (total precipitation differences); 0.25 day⁻¹ (EGR).

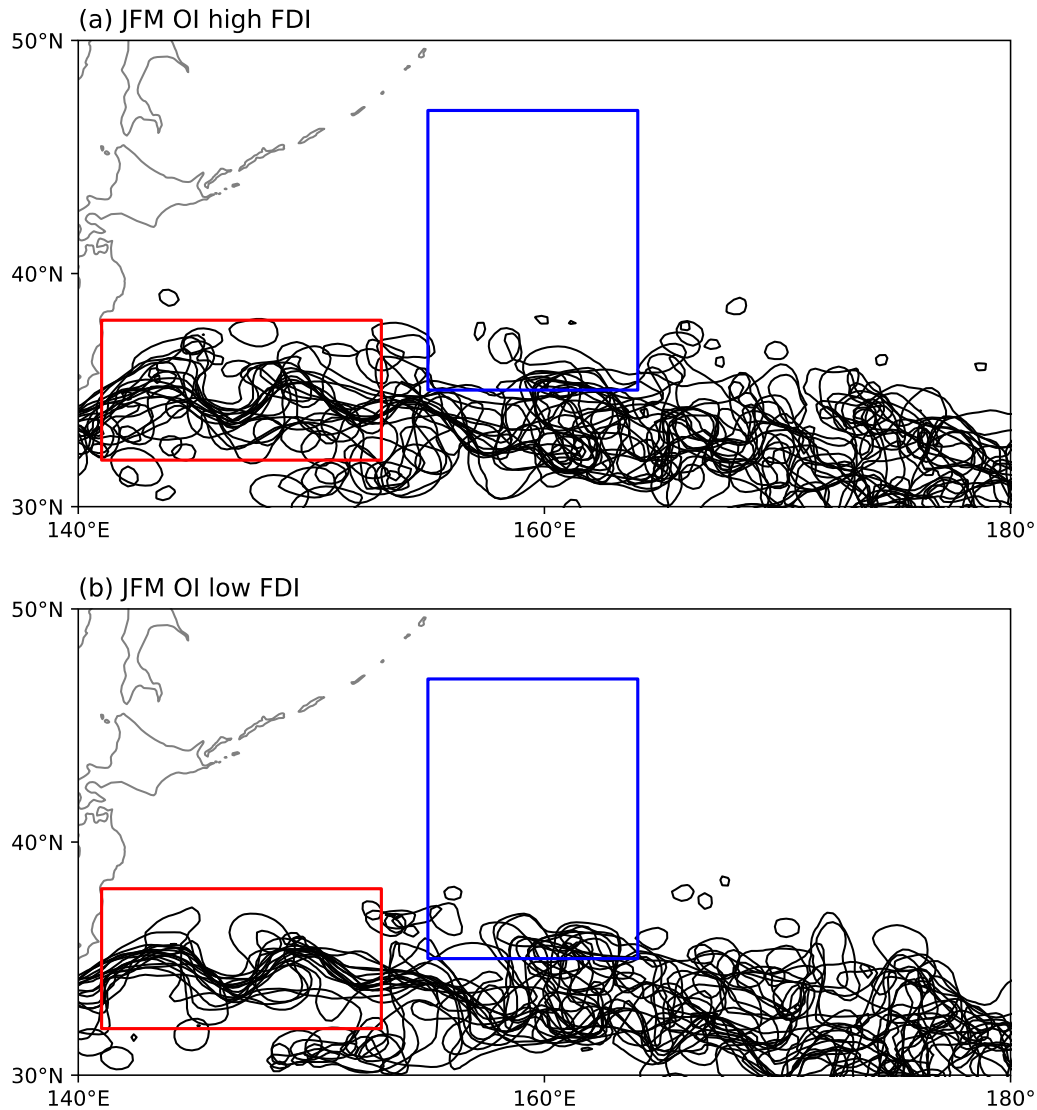


Figure S12. Mean monthly location for JFM of the 1m SSH contour from detrended SSH field, for (a) the months where FDI exceeds the JFM upper quartile (high FDI) and (b) where the FDI is below the JFM lower quartile (low FDI). Red box indicates the region used in Qiu et al. (2014) to define the upper KE path length. Blue box shows the region used to calculate the FDI.

References

Qiu, B., S. Chen, and N. Schneider (2014), A Coupled Decadal Prediction of the Dynamic State of the Kuroshio Extension System, *Journal of Climate* 27, 1751-1764, doi: 10.1175/JCLI-D-13-00318.1