Supplementary Material

for

Validation of boreal summer tropical-extratropical causal links in seasonal forecasts

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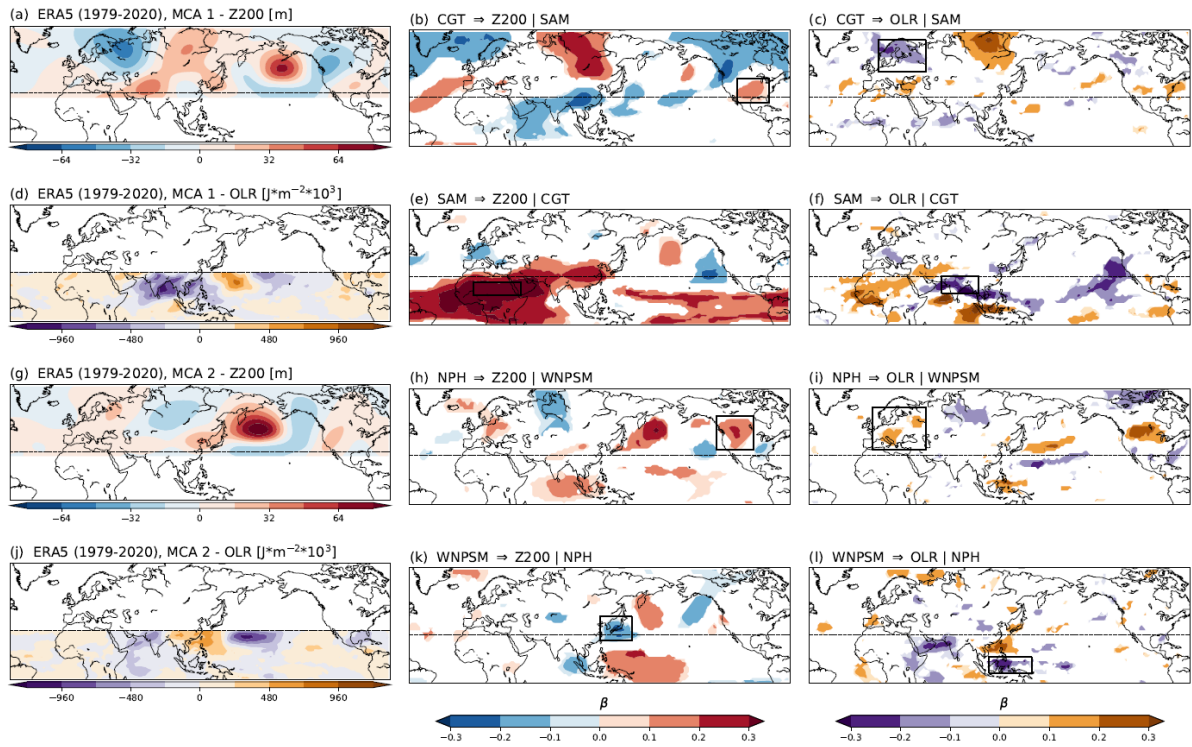
Figures

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Figure S1. MCA modes and causal maps for ERA-long. Same as for Fig. 3 in the main text but for ERA5-long, i.e. 1979-2020.
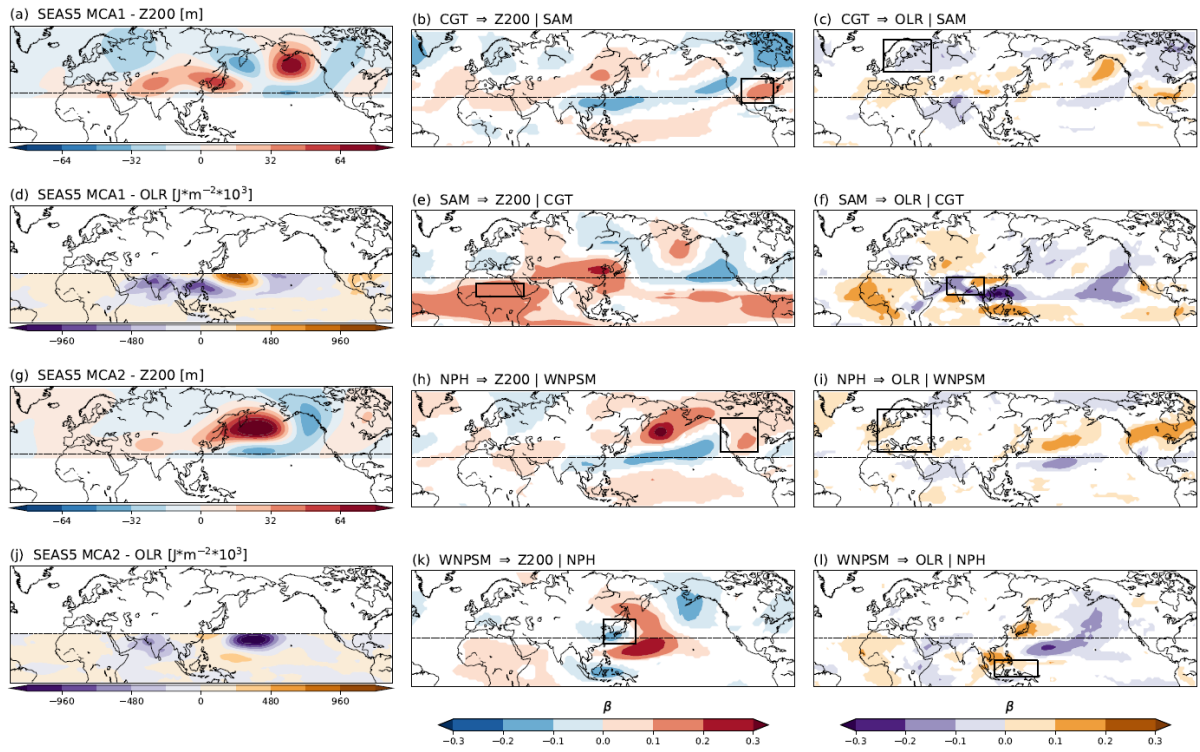
Figure S2. MCA modes and causal maps for SEAS5. Same as for Fig. 4 in the main text but for MCA modes obtained by running directly the MCA analysis on the SEAS5 dataset.
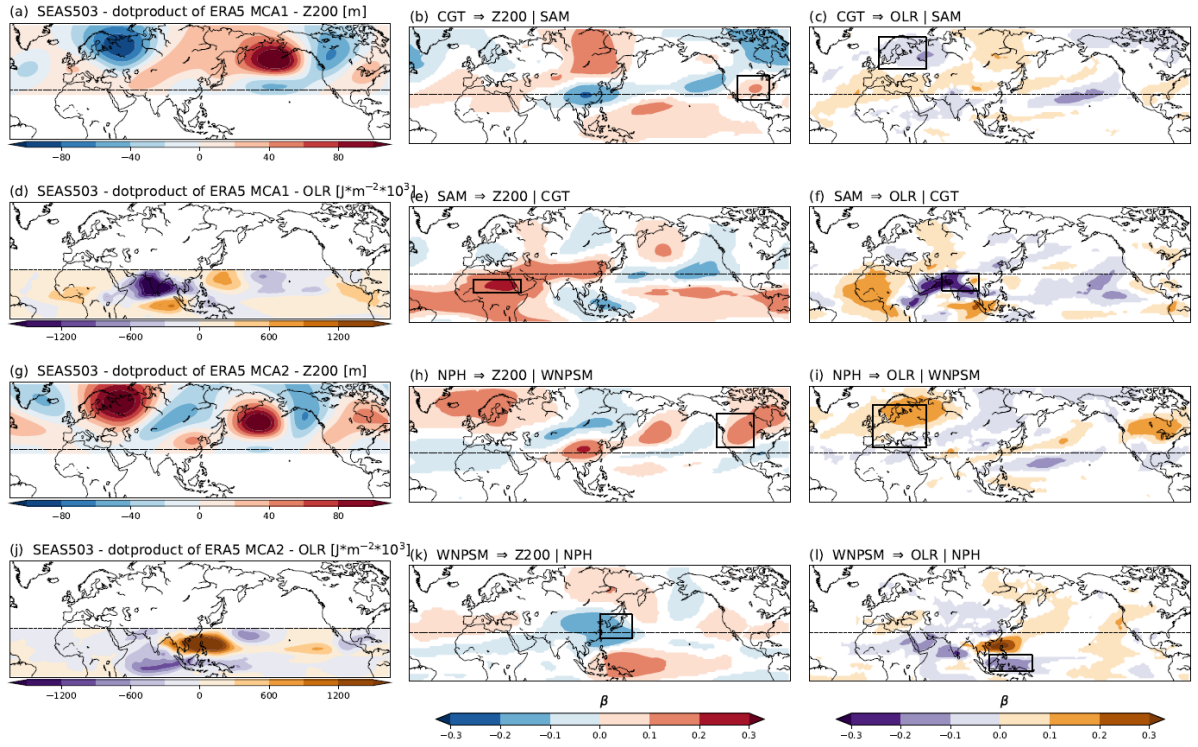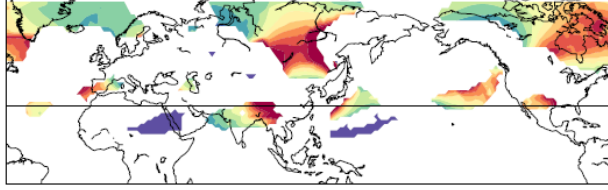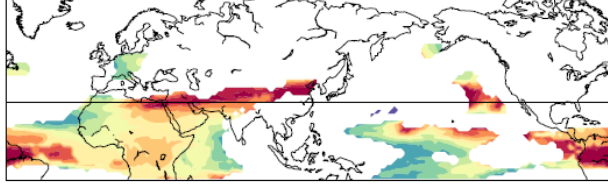
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Figure S3. MCA modes and causal maps for SEAS5-ERA. Same as for Fig. 4 in the main text but for MCA modes obtained with SEAS5 dataset initialized on the 1st of March.
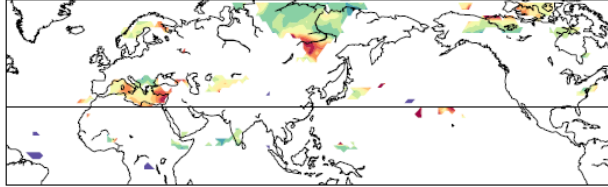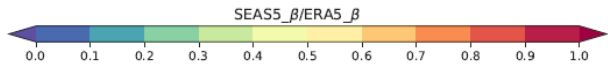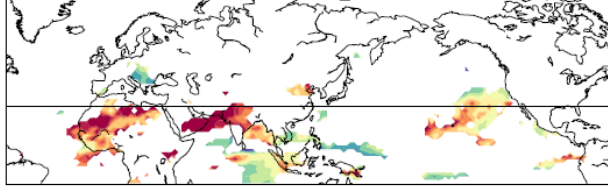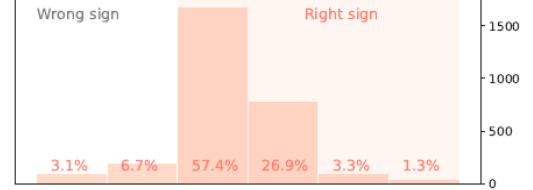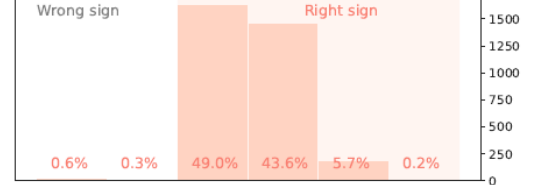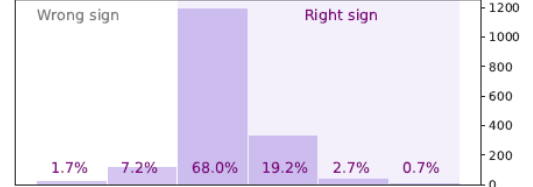
Figure S4. Same as for Fig. 5 in the main text but obtained with SEAS5 dataset initialized on the 1st of March.

(a) NPH ⇒ Z200 | WNPSM; mean: 0.65, std: 0.36
(b) NPH ⇒ Z200 | WNPSM - Histogram
(c) WNPSM ⇒ Z200 | NPH; mean: 0.56, std: 0.53
(d) WNPSM ⇒ Z200 | NPH - Histogram
(e) NPH ⇒ OLR | WNPSM; mean: 0.62, std: 0.25
(f) NPH ⇒ OLR | WNPSM - Histogram
(g) WNPSM ⇒ OLR | NPH; mean: 0.74, std: 0.48
(h) WNPSM ⇒ OLR | NPH - Histogram

Figure S5. Same as for Fig. 6 in the main text but obtained with SEAS5 dataset initialized on the 1st of March.
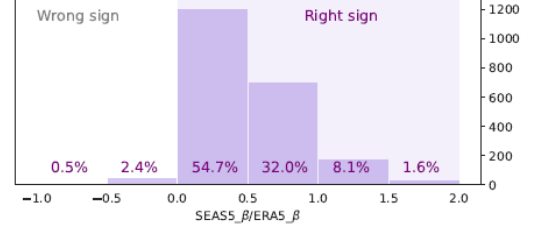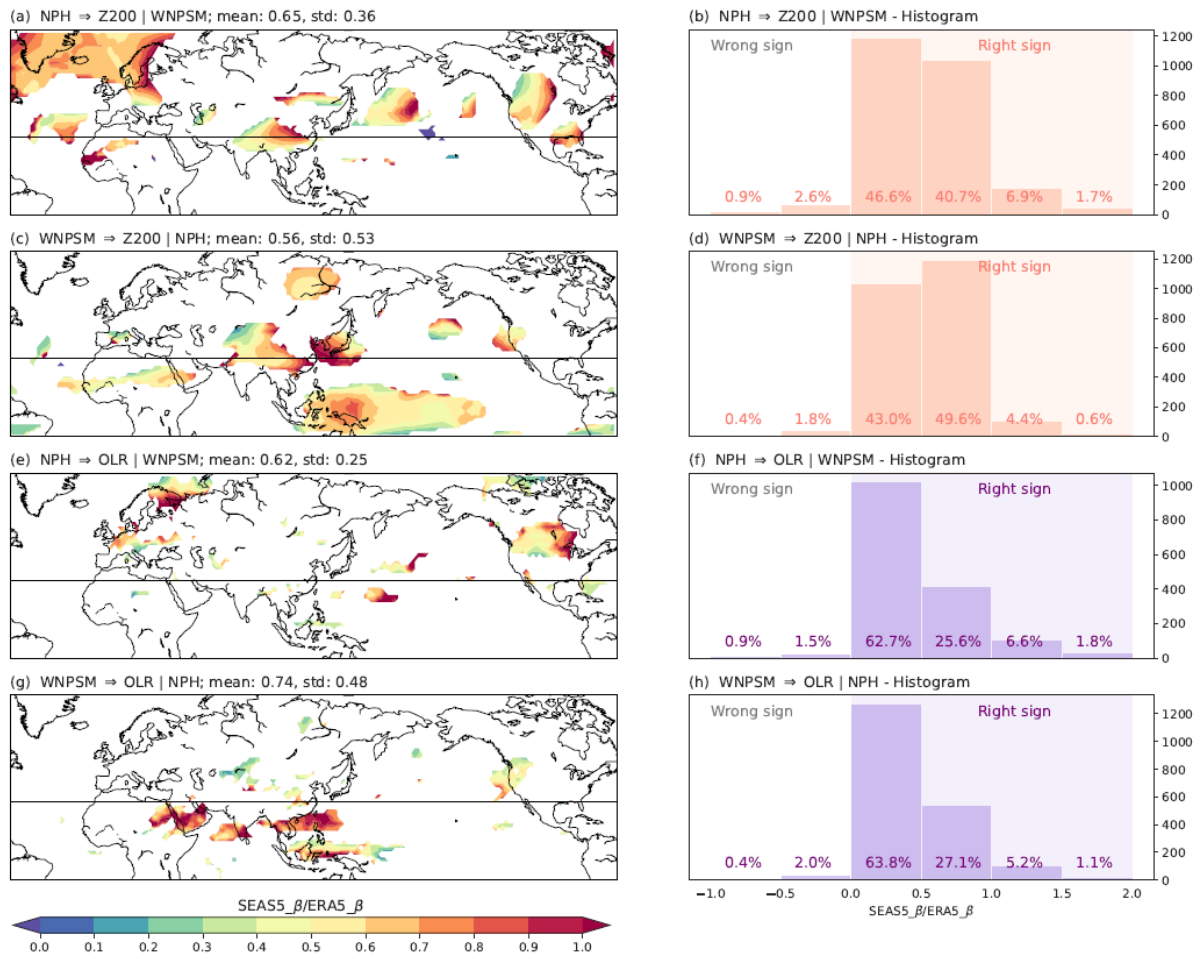
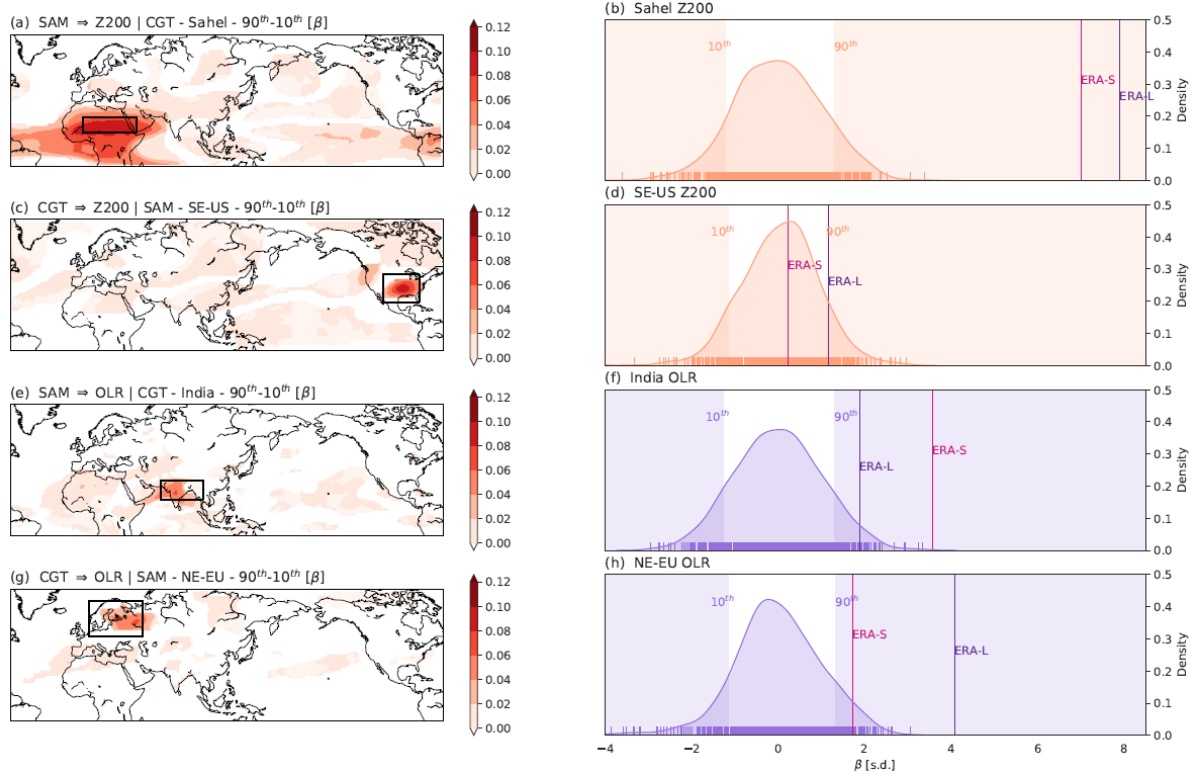**Figure S6.** Same as for Fig. 7 in the main text but obtained with SEAS5 dataset initialized on the 1st of March.
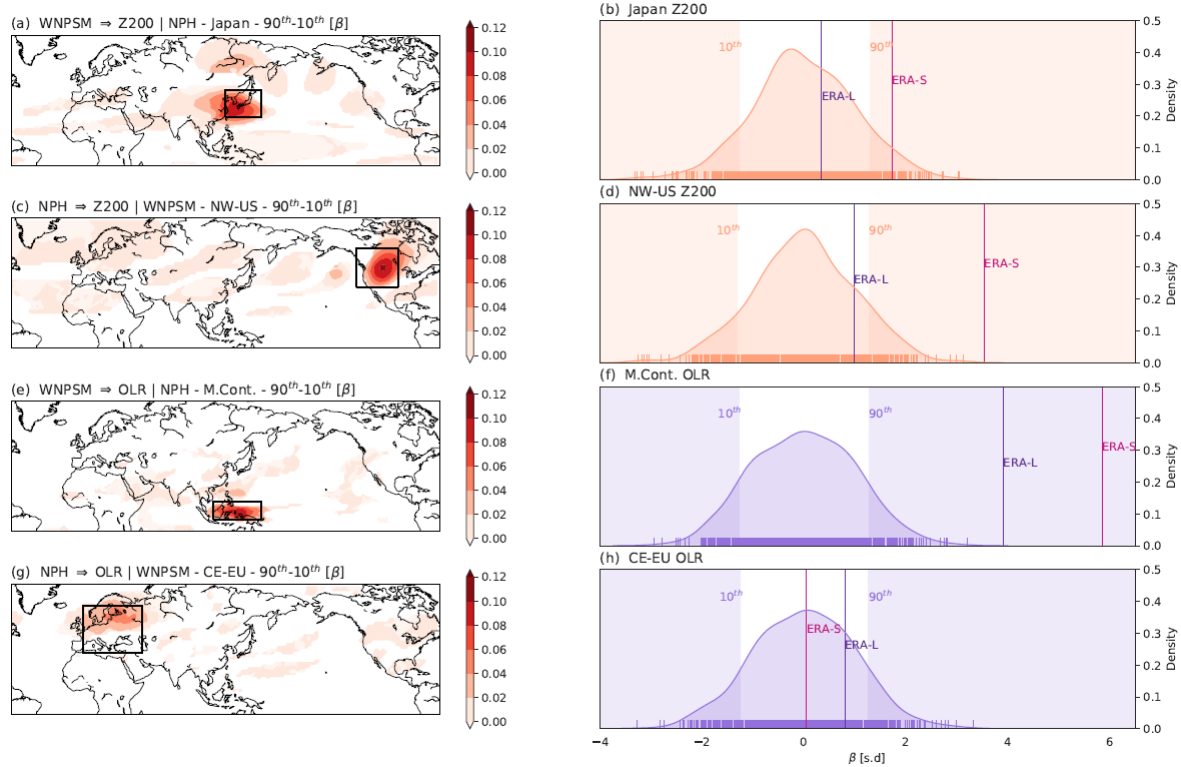
Figure S7. Same as for Fig. 8 in the main text but obtained with SEAS5 dataset initialized on the 1st of March.
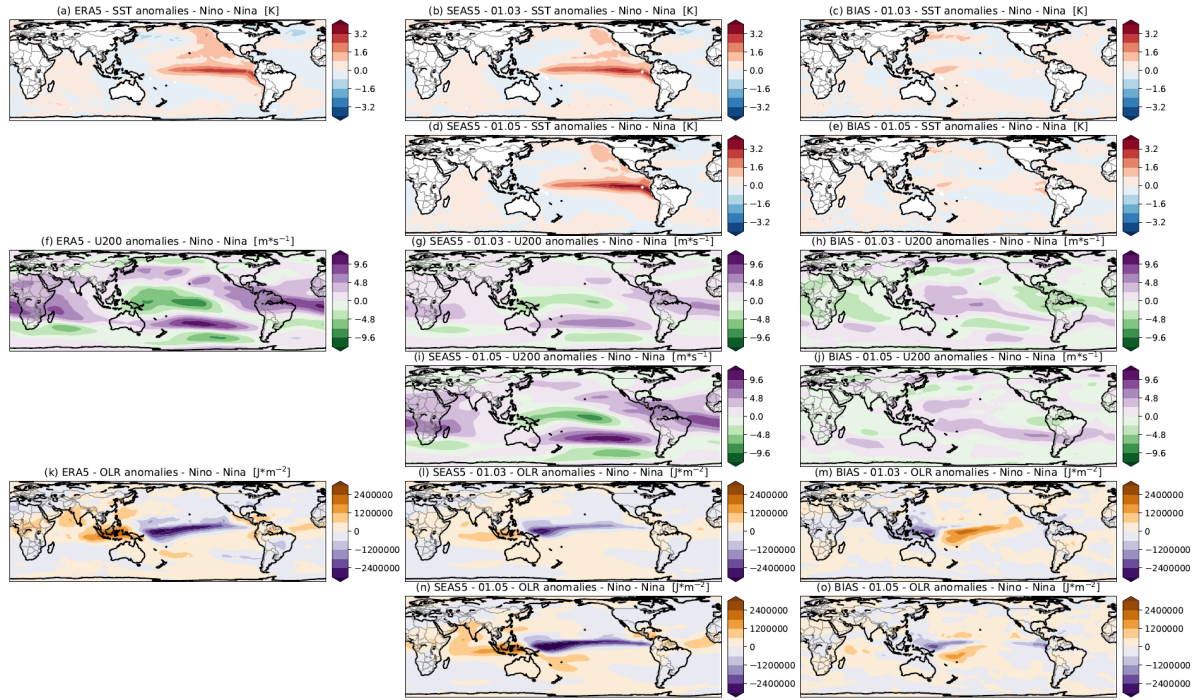
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Figure S8. Panel (a) shows SST anomalies for El Niño – La Niña years for ERA-S. Panels (b) shows SST anomalies for El Niño – La Niña years for SEAS5 initialized on the 1st of March. Panel (c) show the BIAS between ERA-S and SEAS5 for SST fields. Panels (d) and (e) same as for Panels (b) and (c) but for SEAS5 initialized on the 1st of May. Panels (f)-(j) same as for panels (a)-(e) but for U200 fields. Panels (k)-(o) same as for panels (a)-(e) but for OLR fields.
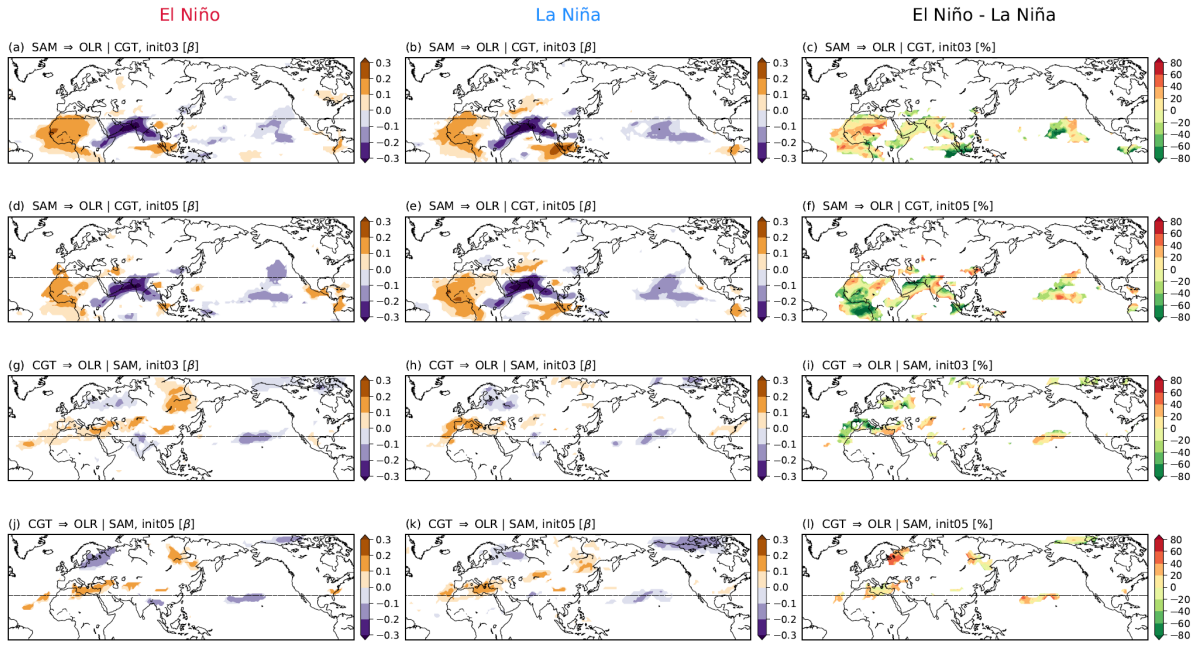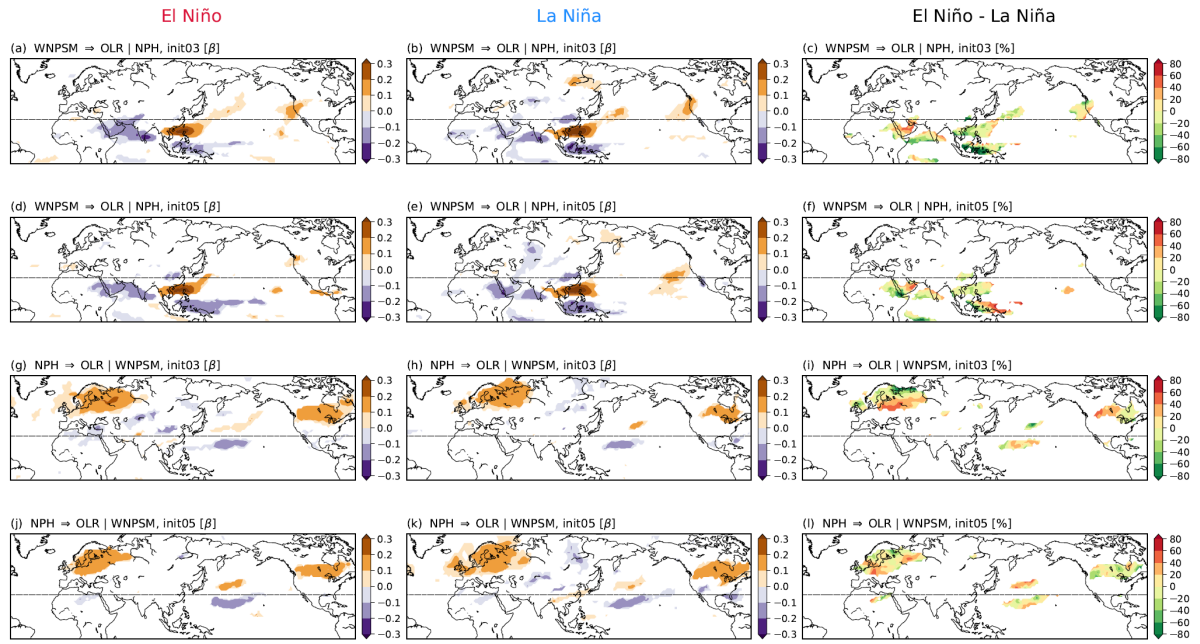
Figure S9. Same as for Fig. 11 but OLR fields.

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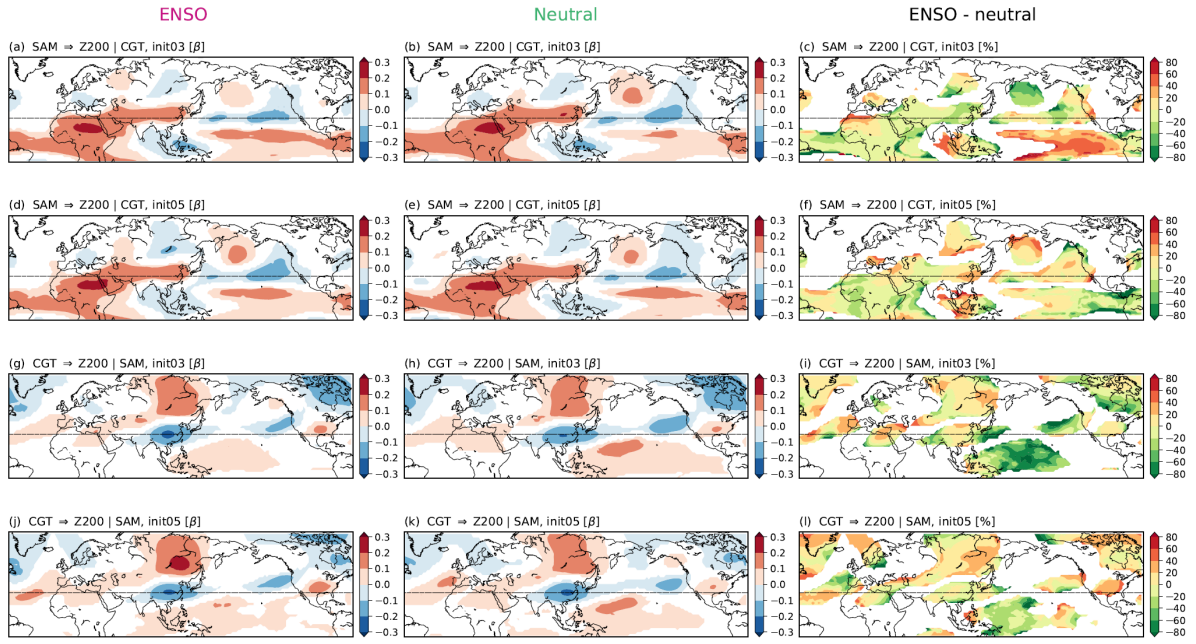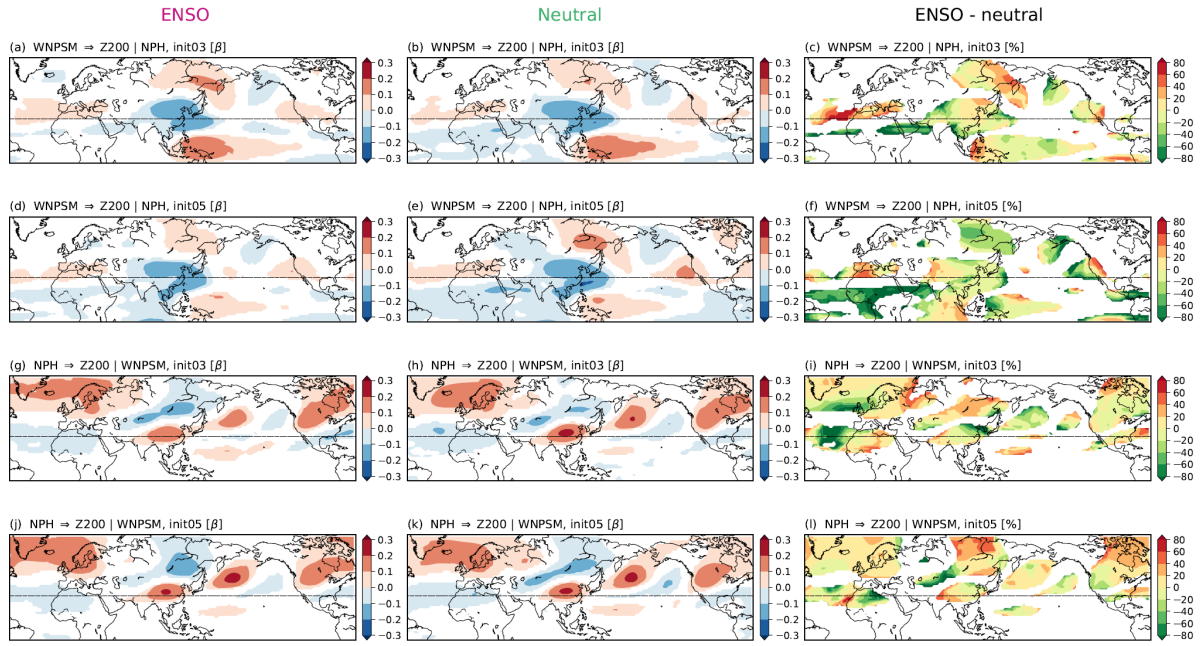**Figure S10.** Same as for Fig. 12 but OLR fields.

Figure S11. Same as for Fig. 11 but for ENSO vs neutral years.

Figure S12. Same as for Fig. 12 but for ENSO vs neutral years.