frontiers

Supplementary Material

1.1 Supplementary Figures

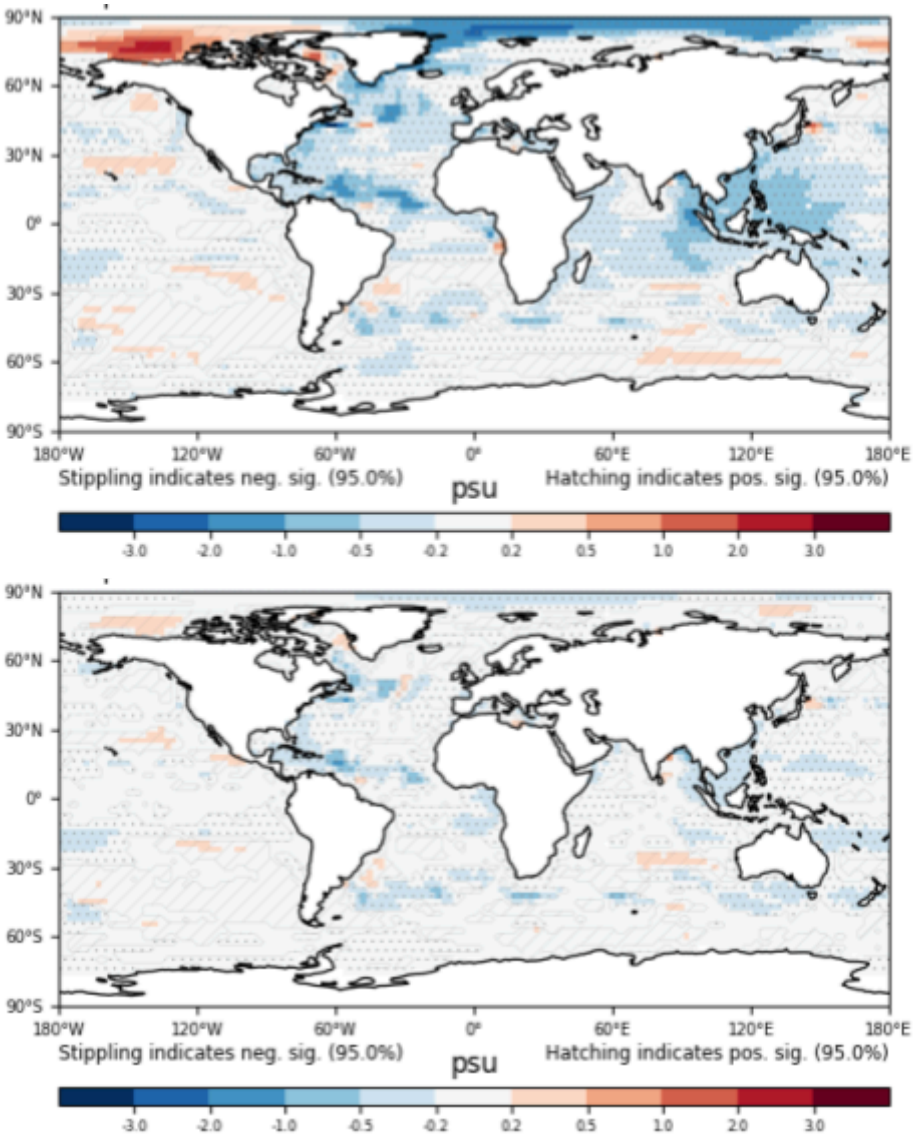

Figure S1: Observational impact on the mean state of Sea Surface salinity forecasts: Difference maps of week4 SSS forecasts started on the 1st of November during the post-Argo period, 2005-2015, NoInsitu – Ref (top), NoArgo – Ref (bottom).

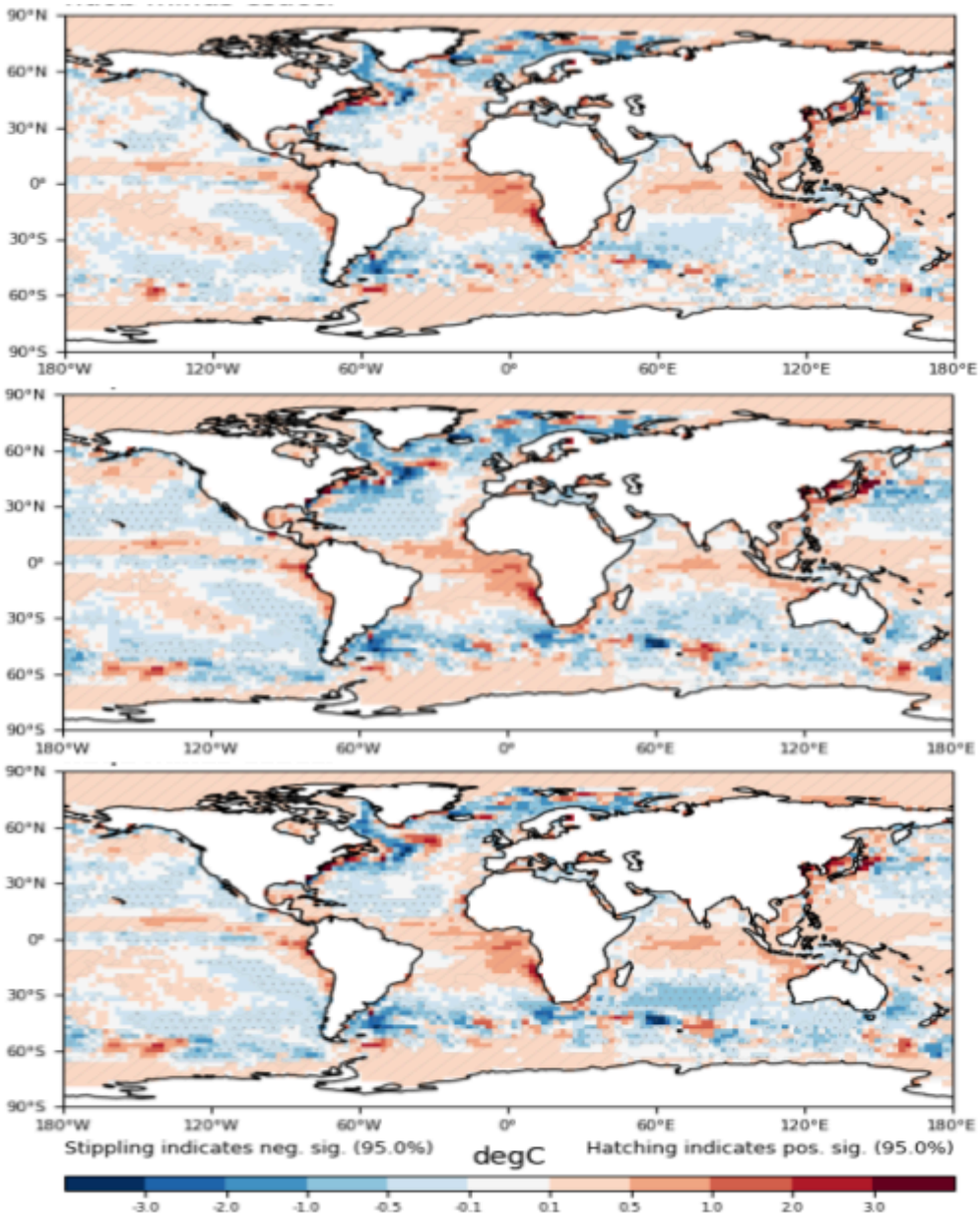

Figure S2: Bias in Sea Surface temperature forecasts: Bias maps of week4 SST forecasts started on the 1st of November during the post-Argo period, 2005-2015, verified against ESA-CCI SST observational dataset. Ref (top), NoInsitu (middle) and NoArgo (bottom).

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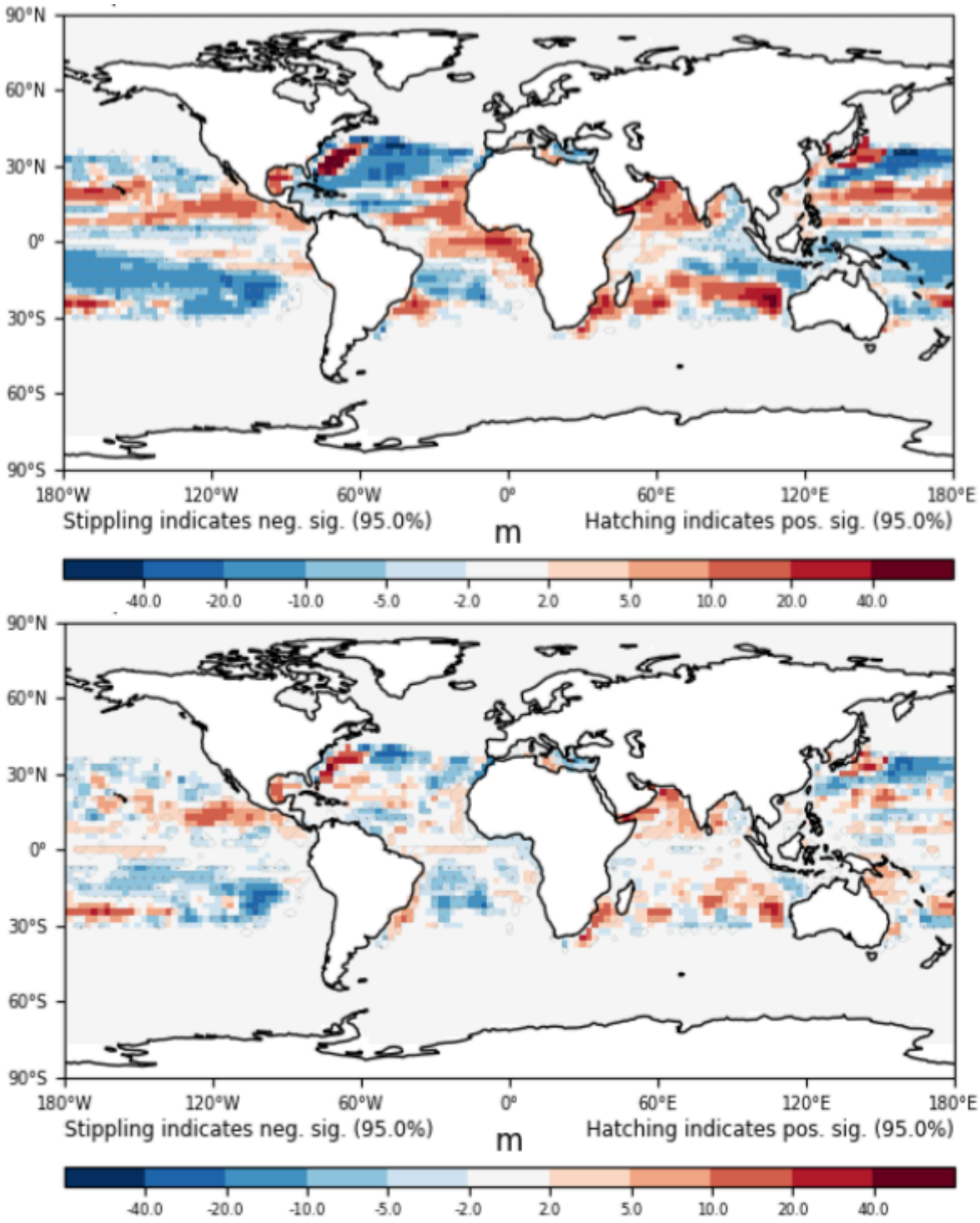

Figure S3: Observational impact on the mean state of Thermocline forecasts: Difference maps of week4 Depth of 20 °C isotherm (t20d) forecasts started on the 1st of November during the post-Argo period, 2005-2015, NoInsitu – Ref (top), NoArgo – Ref (bottom).

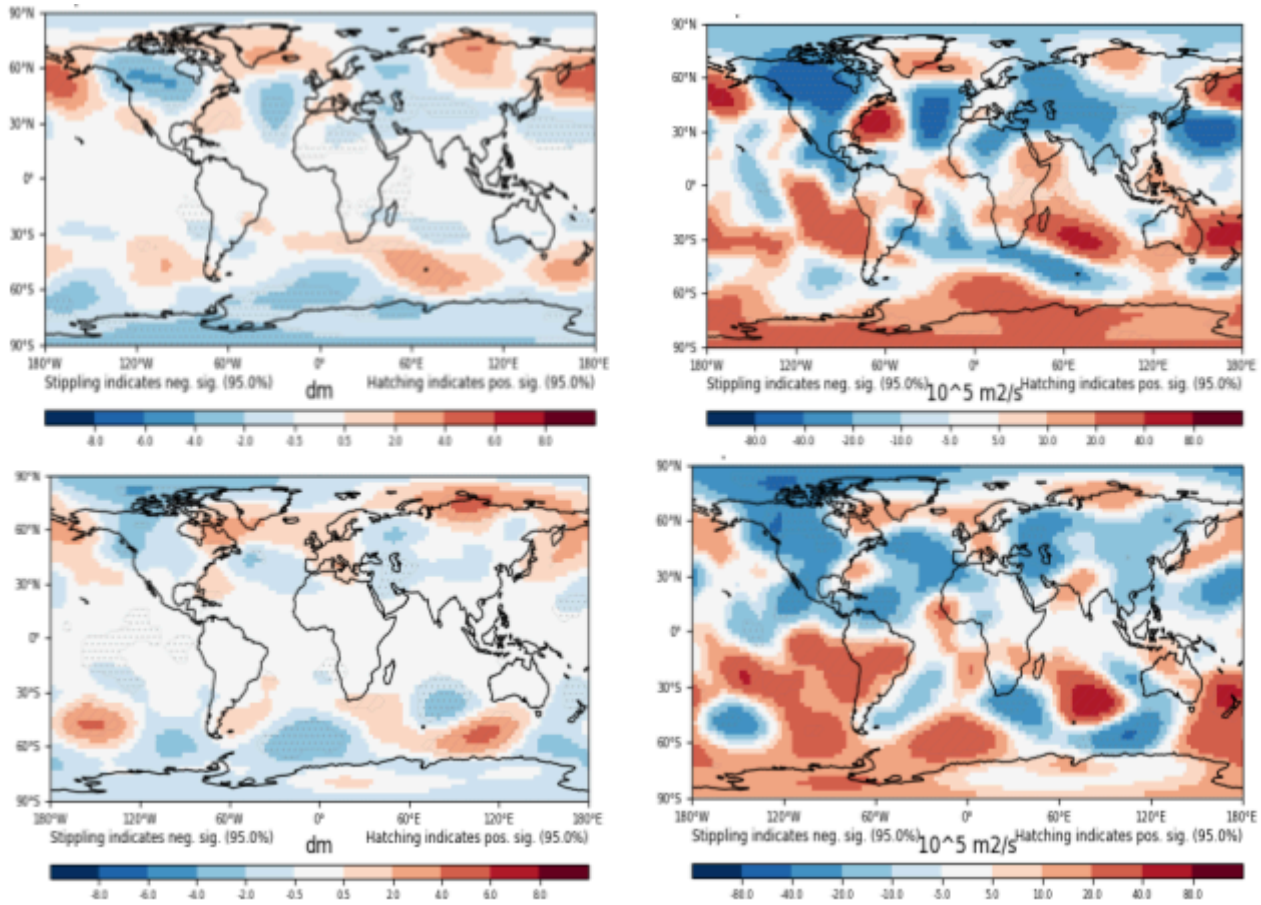

Figure S4: Observational impact on the mean state of upper atmospheric forecasts: Difference maps of week4 geopotential height forecasts at 500 hPa (left) and barotropic stream function forecasts at 200 hPa (right) started on the 1st of November during the post-Argo period, 2005-2015, NoInsitu – Ref (top), NoArgo – Ref (bottom).

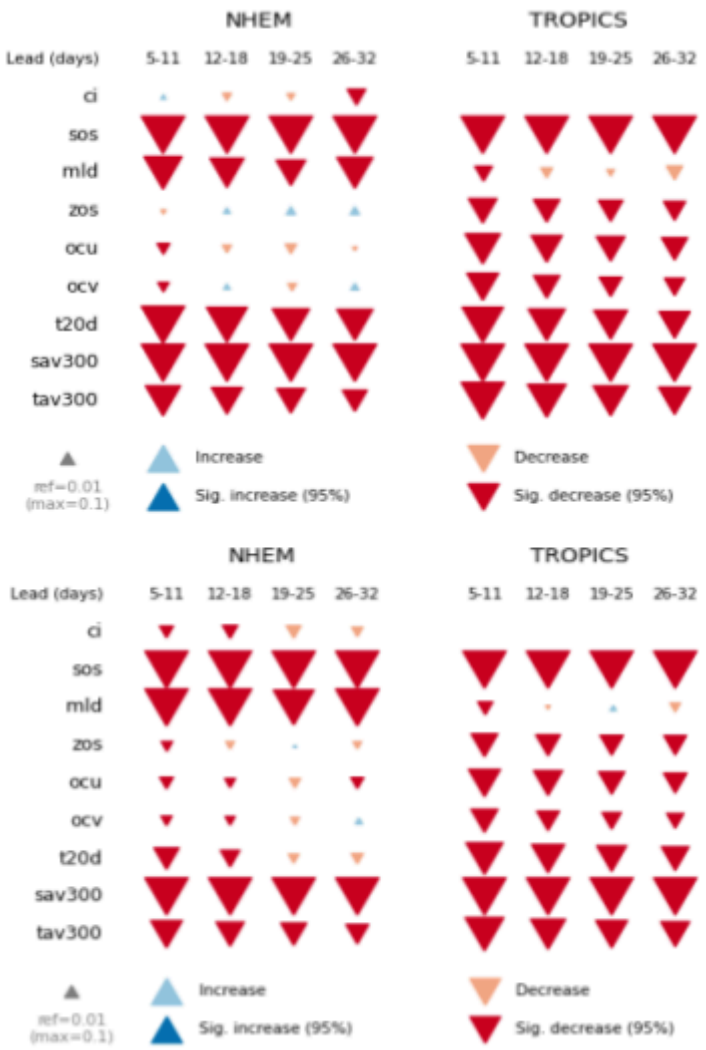

Figure S5: Observational impact on probabilistic forecast skill of surface and subsurface ocean forecasts: Continuous Ranked Probability Skill Score (CRPSS) card of ocean variables for lead times of week 1 to week 4, started on the 1st of each calendar month during the post-Argo period, 2005-2015 for whole of the Northern Hemisphere and tropical regions. Variables shown are sea ice concentration (ci), surface salinity (sos), mixed layer depth (mld), sea surface height (zos), zonal current velocity (ocu), meridional current velocity (ocv), depth of 20^{o}C isotherm (t20d), average salinity in the upper 300m (sav300), and average temperature in the upper 300m. CRPSS is calculated across all grid points and all start months (Equation 2, Roberts et al. 2021). Size of the triangles indicate the magnitude of the skill scores. Red triangles denote significant degradation in forecast skill due to the removal of ocean in-situ observations in the initial conditions.

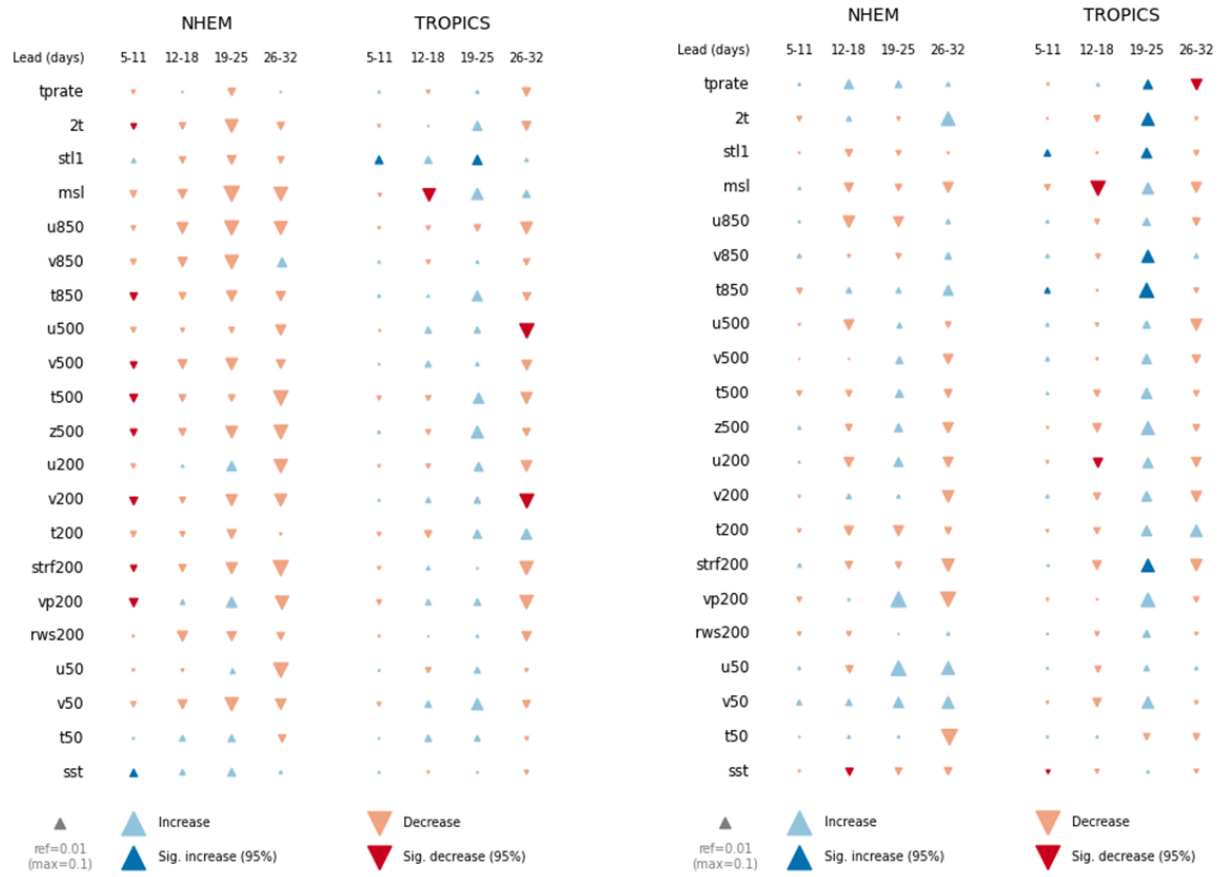

Figure S6: Observational impact on probabilistic forecast skill of surface and upper atmospheric forecasts: Continuous Ranked Probability Skill Score (CRPSS) card of atmospheric variables for lead times of week 1 to week 4, started on the 1st of each calendar month during the post-Argo period, 2005-2015 for whole of the Northern Hemisphere and tropical regions. The variables shown are 2 m temperature (2t), surface temperature (stl1), mean sea level pressure (msl), zonal/meridional wind (u/v), temperature (t), geopotential height (*z*), barotropic streamfunction (strf), velocity potential (vp), rossby wave source (rws) and sea surface temperature (sst). Numbers in variable names correspond to a specific pressure level in hPa. CRPSS is calculated across all grid points and all start months (Equation 2, Roberts et al. 2021). Size of the triangles indicate the magnitude of the skill scores. Red triangles denote significant degradation in forecast skill due to the removal of ocean in-situ observations in the initial conditions.