Seasonal forecasting of the polar stratosphere and its coupling with the troposphere
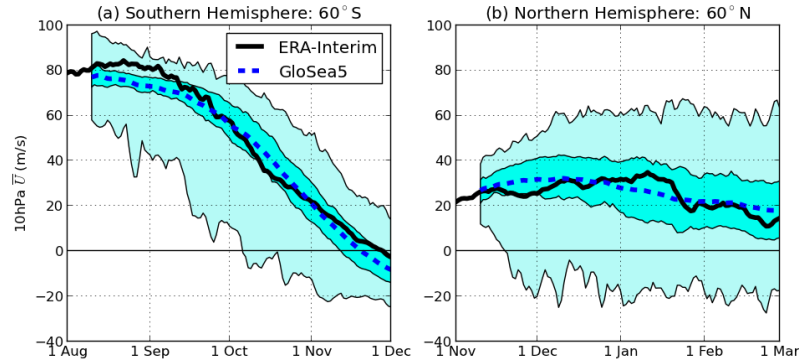
Figures and captions

Figure 1: Time series of 10 hPa zonal-zonal mean zonal wind ($\overline{U}$) at 60°S for GloSea5 hindcasts initialised near 1st August (a) and at 60°N for hindcasts initialised near 1st November (b). The ERA-Interim mean over 1996-2009 (black line) and the GloSea5 mean over all ensemble members (blue dashed line) are shown, along with the interquartile range and range of all ensemble members.
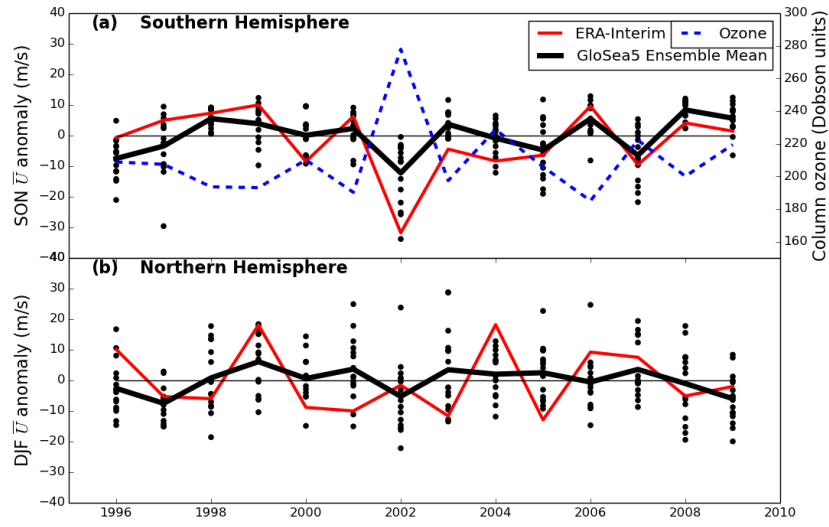
Figure 2: Time series of stratospheric polar vortex (60°S/N, 10hPa) zonal-mean zonal wind anomalies, averaged over SON for the Southern Hemisphere (a) and DJF for the Northern Hemisphere (b). Dots indicate individual GloSea5 ensemble members, the thick black line the ensemble mean, and the thin red line ERA-Interim. The correlation of the GloSea5 ensemble mean and ERA-Interim is 0.74 in the SH and 0.16 in the NH. Also plotted in (a) is the polar cap (60-90°S) SON mean total column ozone from ERA-Interim (blue dashed line).
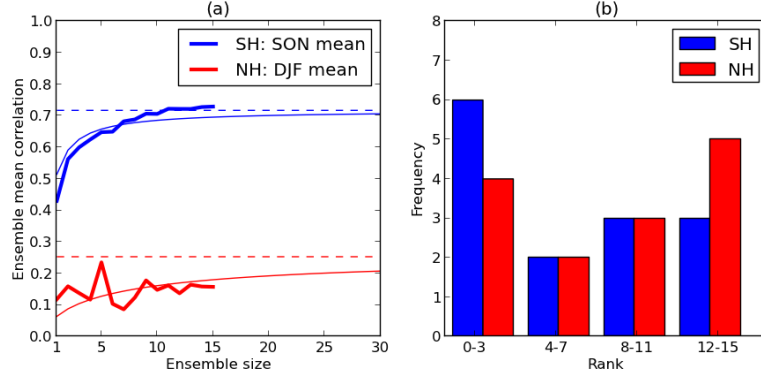
Figure 3: (a) Variation with ensemble size (between 1-15) of GloSea ensemble mean correlation with ERA-Interim for stratospheric polar vortex $\overline{U}$ anomalies (thick lines), with a fitted theoretical distribution [Sardeshmukh et al., 2000] (thin lines) and its asymptote (dashed line). (b) Rank histogram of vortex wind anomalies, showing where observed values lie in the ensemble hindcasts.
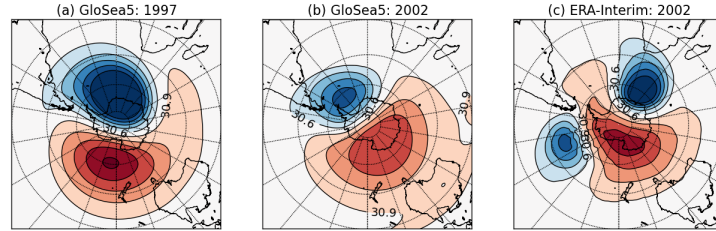

Figure 4: Geopotential height at 10hPa at the central date (date at which Uat 60°S, 10 hPa is at its minimum value) of the two GloSea5 ensemble members which simulate a SH SSW (a,b), and for ERA-Interim at the central date of the 2002 SSW (c). Units are km and the contour interval is 0.3 km.
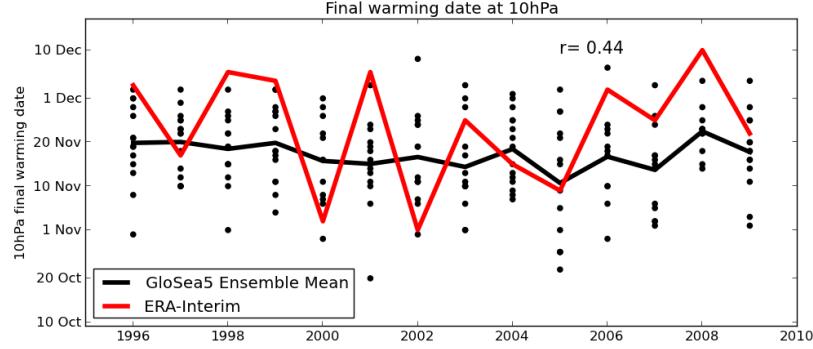
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Figure 5: Time series of the SH final warming date at 10hPa in GloSea5 and ERA-Interim. The final warming date is defined as the date at which U at 60°S, 10hPa becomes negative for the last time. The correlation between the GloSea5 ensemble mean and ERA-Interim is 0.44 which is statistically significant at the 95% level.
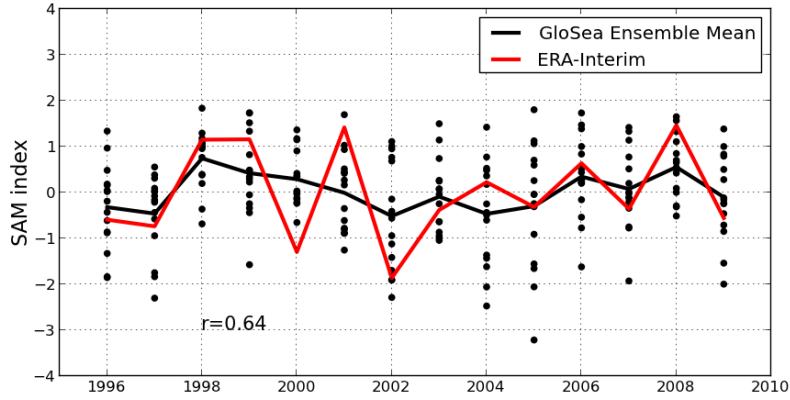

Figure 6: SON mean Southern Annular Mode (SAM) index in individual GloSea5 ensemble members (dots), ensemble mean (black line) and ERA-Interim. The SAM is calculated from mean sea-level pressure data. The correlation of the ensemble mean and ERA-Interim values is 0.64, which is statistically significant at the 99% level.
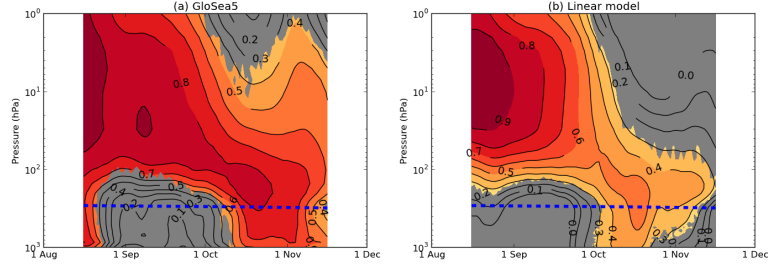
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Figure 7: (a) Correlation of GloSea5 ensemble mean polar cap (60-90°S) geopotential height anomalies (Z') with ERA-Interim values, as a function of time and height for forecasts initialised near 1st August. (b) Correlation of ERA-Interim Z' values with those predicted by the linear statistical model based on Z' at 10 hPa on 15th August. Z' values are smoothed using a 30 moving window. Grey shading indicates regions which not are greater than zero at the 95% confidence interval. The blue dashed line indicates the polar cap mean tropopause level from Wilcox et al., 2012.
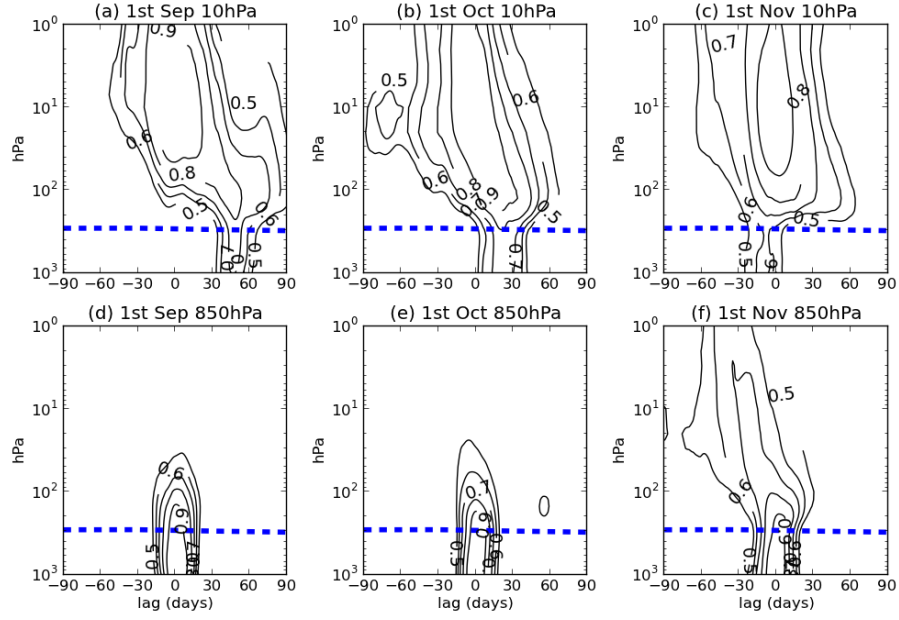
Figure 8: Lag-height correlations of SH polar cap (60-90°S) geopotential height anomalies (Z') in ERA-Interim. Z' values are smoothed with a 30-day running mean before calculating correlations. (a,b,c) Show correlations with Z' at 10 hPa on the 1st of September, October and November respectively. (d,e,f) Show correlations with Z' at 850 hPa. The blue dashed line indicates the polar cap mean tropopause level from Wilcox et al., 2012. ADD SIGNIFICANCE TESTS
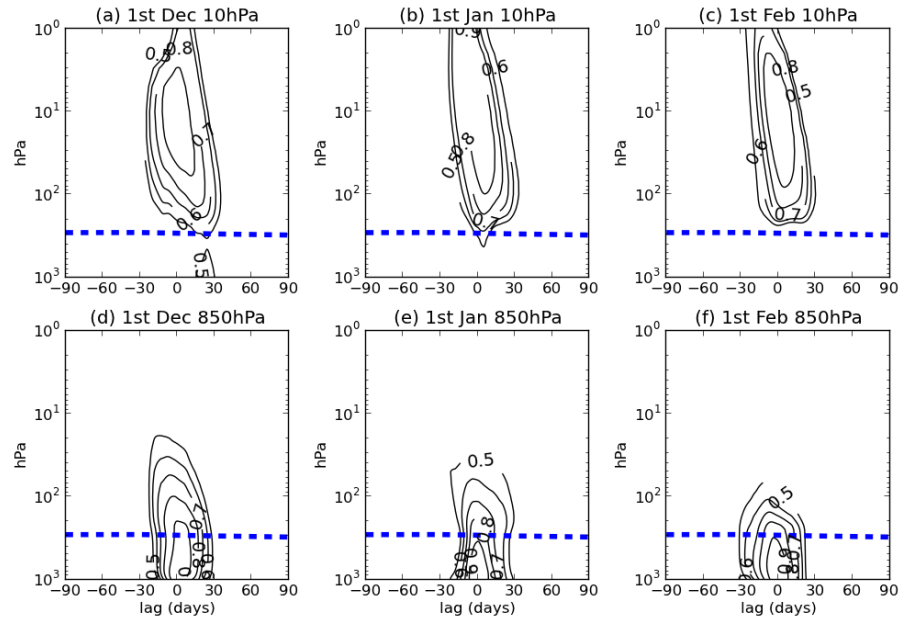
Figure 9: As Figure 8 but for the NH polar cap (60-90°N), with correlations calculated from 1st December, January and February respectively. ADD SIGNIFICANCE TESTS