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The Combined Influence of the QBO and ENSO on the Arctic Polar Vortex

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Both the quasi-biennial oscillation (QBO) and El Nino-Southern Oscillation (ENSO) are known to affect the Northern Hemisphere winter stratospheric polar vortex. When the QBO is in its easterly phase in the equatorial stratosphere around 40hPa (QBO-E), and during El Nino events, the vortex winds are weaker and temperatures over the polar cap in the lower stratosphere are higher. Modelling studies have shown that during QBO-E and El Nino, stratospheric sudden warmings are more frequent. Studies have shown that variability in the vortex affects surface weather, in particular the North Atlantic Oscillation, so that understanding these effects may aid seasonal forecasting.

It is only recently that it has come to light that the QBO and ENSO may combine to influence the vortex in a non-linear way. Averaged over the winter, the QBO influence is weaker during El Nino events than during La Nina events, and the ENSO influence is weaker during the easterly QBO phase than during the westerly phase. The mechanism of this non-linear interaction is not currently understood.

We present an examination of the combined QBO-ENSO influence on the vortex in ERA-40 and in the latest high-top Met Office coupled ocean-troposphere-stratosphere general circulation model HadGEM2-CCS. We show that the QBO influence differs in early winter and late winter in ERA-40, with a wave-1 response in early winter and a NAM-like response in late winter. We find in our model that during La Nina events, the QBO influence occurs at an earlier time than during El Nino events. We present an analysis of the physical mechanisms behind this relationship.