Observed and simulated teleconnections between the stratospheric Quasi-Biennial Oscillation and boreal winter atmospheric circulation

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The Quasi-Biennial Oscillation (QBO) is the dominant mode of interannual variability in the tropical stratosphere. It consists of alternately descending easterly and westerly zonal wind regimes with a mean period of ~ 28 months. The QBO also has an impact on the extratropical atmosphere, specifically the boreal winter stratospheric polar vortex. Furthermore, an influence on the strength of the polar vortex is expected to be linked to changes to the atmospheric circulation near the Earth's surface. If these connections are indeed robust, the QBO could provide a source of skill in both seasonal and multi-annual forecasts, as it has been shown to be predictable out to years ahead in climate models. However, the relatively short observational record makes unequivocal identification of a surface climate influence of the QBO challenging, as there are many competing influences with similar teleconnections to northern extratropical winter, such as solar variability, tropical volcanic eruptions and El-Niño-Southern-Oscillation. By using a multi-centennial control simulation of a climate model with a realistic and spontaneously-generated QBO, we demonstrate a robust QBO teleconnection to the Arctic Oscillation (AO) in boreal winter. The strength of the QBO-AO teleconnection inferred from the approximately 60-year observational record is shown to be consistent with the simulated teleconnections but is significantly weaker in the model. The teleconnection with the North Atlantic Oscillation (NAO) is particularly weak. Similarly, the observed surface pressure response downstream over China is not evident in the simulation. Examination of a shorter atmosphere-only simulation with a different model suggests the weakness of the simulated teleconnections is present in other models. We also examine the response to deep QBO westerly and easterly phases, and establish an increase in the strength and significance of both the AO and NAO response although these are still weaker than observed. This suggests that more vertically coherent QBO forcing produces a larger extratropical response. We conclude that the QBO has the potential to provide an additional source of skill for boreal winter climate prediction if models can be developed that accurately represent the strength of the QBO-surface teleconnection

Key words: QBO, AO, NAO, teleconnection