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The role of the ozone hole and elevated greenhouse gases as drivers of Antarctic sea ice extent increase via changes in atmospheric circulation

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Antarctic sea ice extent has displayed an overall increase across the duration of the 35-year satellite record. However, the cause of this increase is uncertain, with both anthropogenic and natural forcing changes proposed as drivers. Here, we investigate two possible anthropogenic forcings that could influence sea ice extent via changes in the near-surface wind field over the Southern Ocean; (i) ozone depletion and (ii) greenhouse gas increases. We employ an atmosphere-only version of the UK Met Office model, HadGEM3, with prescribed sea surface temperatures and sea ice coupled to the UKCA interactive climate-chemistry model. Starting from a pre-industrial control simulation, two additional simulations were spun off, one investigating the forcing from increased 21st century greenhouse gases and one investigating the forcing from the ozone hole. Based on the work of Holland & Kwok (2012) we analyse the changes in Antarctic circulation, in particular the surface wind properties which have been shown to correlate with sea ice extent. We examine changes in the surface wind field in these two model simulations relative to that in the pre-industrial control simulation, compare them to observed changes during the satellite record, and assess their potential role in driving a response in sea ice extent at both continental and regional scales.