SPARC Workshop SHARP2016

On the surface impact of Arctic ozone extremes

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A comprehensive stratosphere-resolving atmospheric model, with interactive stratospheric ozone chemistry, coupled to ocean, sea ice and land components is used to explore the tropospheric and surface impacts of large springtime ozone anomalies in the Arctic stratosphere. Coupling between the Antarctic ozone hole and southern hemisphere climate has been identified in numerous studies, but connections of Arctic ozone loss to surface climate have been more difficult to elucidate. Analyzing an ensemble of historical integrations with all known natural and anthropogenic forcings specified over the period 1955-2005, we find that extremely lower stratospheric ozone changes are able to produce large and robust anomalies in tropospheric wind, temperature and precipitation in April and May over large portions of the Northern Hemisphere (most notably over the North Atlantic and Eurasia). Further, these ozone-induced surface anomalies are obtained only in the last two decades of the 20th century, when high concentrations of ozone depleting substances generate sufficiently strong stratospheric anomalies that couple effectively to the surface. Our findings suggest that coupling between chemistry and dynamics is essential for a complete representation of surface climate variability and climate change not only in Antarctica but also in the Arctic.