The wave geometry of final stratospheric warming events

Amy H. Butler and Daniela I.V. Domeisen
National Oceanic and Atmospheric Administration, Chemical Sciences Laboratory, United States of America
(amy.butler@noaa.gov)

Every spring, the stratospheric polar vortex transitions from its westerly wintertime state to its easterly summertime state due to seasonal changes in incoming solar radiation, an event known as the "final stratospheric warming" (FSW). While FSWs tend to be less abrupt than reversals of the boreal polar vortex in midwinter, known as sudden stratospheric warming (SSW) events, their timing and characteristics can be significantly modulated by atmospheric planetary-scale waves. Just like SSWs, FSWs have been found to have predictable surface impacts. While SSWs are commonly classified according to their wave geometry, either by how the vortex evolves (whether the vortex displaces off the pole or splits into two vortices) or by the dominant wavenumber of the vortex just prior to the SSW (wave-1 versus wave-2), little is known about the wave geometry of FSW events. We here show that FSW events for both hemispheres in most cases exhibit a clear wave geometry. Most FSWs can be classified into wave-1 or wave-2 events, but wave-3 also plays a significant role in both hemispheres. Additionally, we find that in the Northern Hemisphere, wave-2 events are more likely to occur later in the spring, while in the Southern Hemisphere, wave-1 or wave-2 events show no clear preference in timing. The FSW enhances total column ozone over the pole of both hemispheres during spring, but the spatial distribution of ozone anomalies can be influenced by the wave geometry and the timing of the event. We also describe the stratosphere's downward influence on surface weather following wave-1 and wave-2 FSW events. Significant differences between the tropospheric response to wave-1 and wave-2 FSW events occur over North America and over the Southern Ocean, while no significant differences are found over the North Atlantic region, Europe, and Antarctica.