Duration of stratospheric polar vortex intensification events

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In 2011 spring, persistent cooling of the polar stratosphere (i.e. a polar vortex intensification (VI)) was observed, which led significant ozone depletion (Manney et al. 2011). A study attributed this cooling to positive sea surface temperature (SST) anomalies in the North Pacific, which induced tropospheric circulation anomalies similar to the Pacific North American pattern or Western Pacific (WP) pattern (Hurwitz et al. 2011). The latter has been shown to suppress upward planetary waves into the stratosphere, thereby lowering polar stratospheric temperatures (Nishii et al. 2010). It is, however, not yet clear why the VI had such a long persistency. To understand what control the duration of VIs, we picked up such events whose duration is longer than 20 days from reanalysis data, then compare them with shorter VIs whose duration is less than 10 days.

Both of longer and shorter VIs tend to accompany anomalous suppression (enhancement) of upward EP flux from the troposphere at their beginning (ending), which suggests that both longer and shorter VIs are affected by anomalous upward planetary wave propagation from the troposphere. The results contrast with those of Tomikawa (2010) who found that the end of shorter stratospheric sudden warmings (SSW) tend to accompany shear instability. The durations of the vertical EP flux anomalies tend to be longer in the longer VIs at their beginning and ending than in the shorter VIs. Decomposition of eddy heat flux, which is equivalent to the vertical EP flux, into the nonlinear and linter interference terms reveals that both of the two terms contribute positively to the enhancement of eddy heat flux at the end of longer VIs while only the liner interference term contributes to the end of shorter VIs.

Key words: polar vortex intensification, stratospheric extreme events, EP flux

References

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