Supplement to "Smoke-charged vortices in the stratosphere generated by wildfires and their behaviour in both hemispheres : comparing Australia 2020 to Canada 2017"

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Warning: The animations run interactively on most operating systems if the directory media containing them is located in the same directory as this file.

S1 Tracking of the smoke bubble

The animation tracking.mov shows how the tracking of the smoke bubble is interactively performed on a scattering ratio section.

S2 Time evolution of vortex O

The animation movieMax_VortexO.mp4 in the media folder shows the time evolution of vortex O in six panels: a) PV at the isentropic level of the vortex according to PV tracking; b) ozone mixing ratio at the isentropic level of the vortex according to ozone tracking; c) PV altitude-latitude section at the longitude of the vortex according to PV tracking; d) ozone mixing ratio altitude-latitude section at the longitude of the vortex according to ozone tracking; e) PV altitude-latitude section at the longitude of the vortex according to PV tracking; f) ozone mixing ratio altitude-latitude section at the longitude of the vortex according to ozone tracking. In all panels the white cross indicates the location of the centroid vortex according to the relevant tracking. In panels a-b, the contours show the Montgomery potential anomaly with respect to its mean in the displayed domain, tracing the isentropic geostrophic flow. Units are $10^3 \mathrm{m}^2\mathrm{s}^{-2}$. In panels c-f, the contours show the potential temperature (K).

Using a standard reader (tested with VLC), the animation can be played in a continuous way or slide by slide to follow the evolution.

S3 Time evolution of vortices A, B1 and B2

The animations movie_VortexA.mp4, movie_VortexB1.mp4 and movie_VortexB2.mp4 show, respectively, the time evolution of vortices A, B1 and B2 in two panels: a) PV at the isentropic level of the vortex according to PV tracking; b) ozone mixing ratio at the isentropic level of the vortex according to ozone tracking. The black cross indicates the location of the centroid vortex according to the relevant tracking. The contours show the Montgomery potential anomaly with respect to its mean in the displayed domain. Units are $10^3 \mathrm{m}^2\mathrm{s}^{-2}$.

S4 Trajectories of vortices O, B1 and B2 in 2017

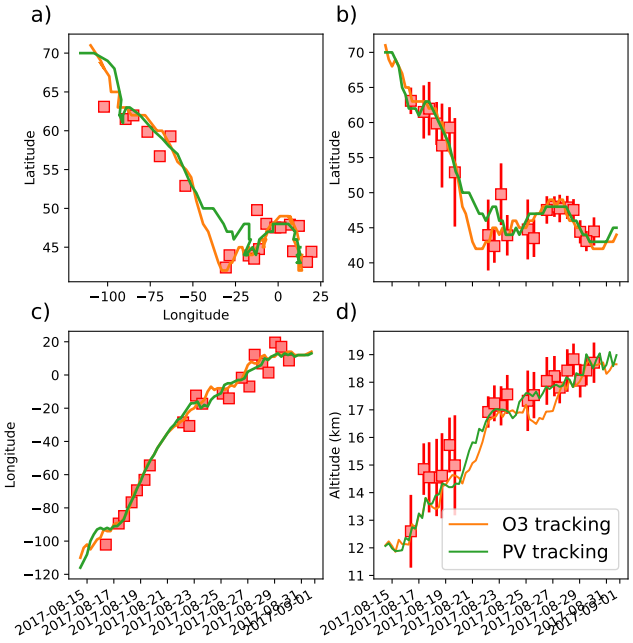

Figure S1. Same as Fig. 5 of the main text but for vortex O.

S5 Potential vorticity at the core of the vortex

Figure S4 show the temporal series of the analysed potential vorticity (PV) and the PV anomaly at the core of the 2020 Koobor vortex. The PV anomaly is defined at each latitude and altitude as the deviation with respect to the zonal average at the same latitude and altitude, the altitude being the hybrid vertical coordinate. From the formation of the vortex until the beginning of March, the PV is close to zero and even slightly positive, meaning that the vortex is on the verge of symmetric instability (Hoskins, 1974). It is actually on the edge of pure inertial instability as well since the absolute vertical vorticity also vanishes

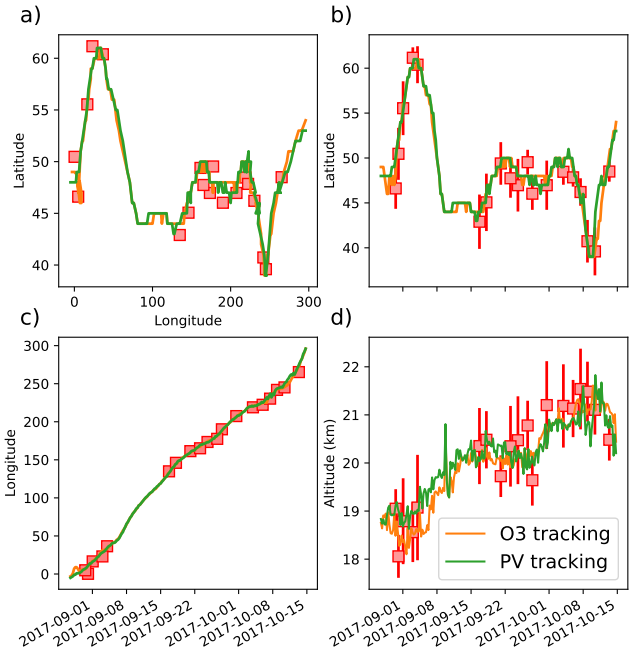

Figure S2. Same as Fig. 5 of the main text but for vortex B1.

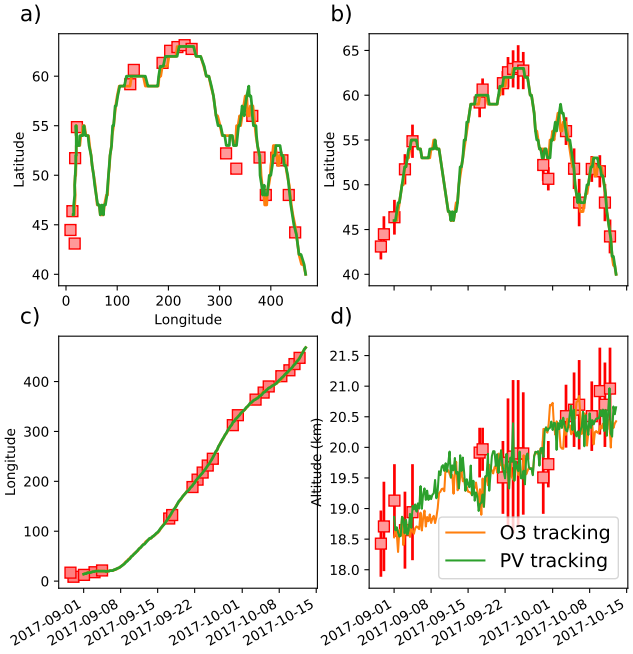

Figure S3. Same as Fig. of the main text but for vortex B2.

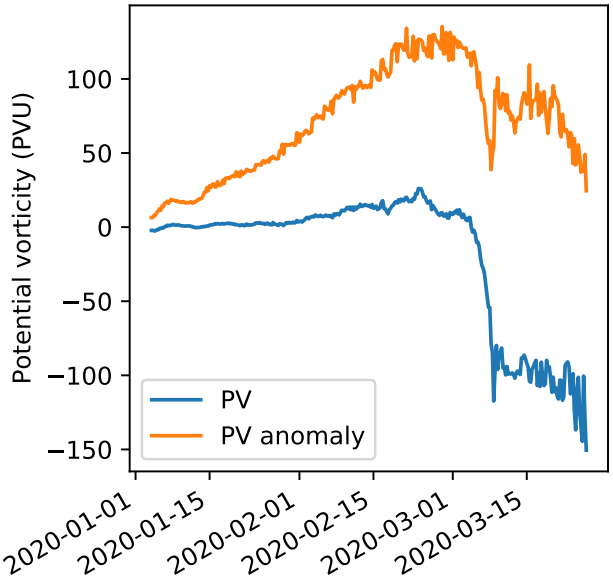

Figure S4. Time evolution of the potential vorticity and the potential vorticity anomaly at the core of the main 2020 vortex

(see Table 1 of the main text). The PV anomaly grows as the low PV bubble rises within an ambient air of increasing PV with height. This sequence ends with the breaking of the vortex by the end of February (Khaykin et al., 2020) and is followed by another sequence where the value of analysed PV suggests an important in mixing of surrounding air during or just after the breaking.

References

Hoskins, B. J.: The Role of Potential Vorticity in Symmetric Stability and Instability, Quarterly Journal of the Royal Meteorological Society, 100, 480–482, https://doi.org/10.1002/qj.49710042520, 1974.

Khaykin, S., Legras, B., Bucci, S., Sellitto, P., Isaksen, L., Tence, F., Bekki, S., Bourassa, A., Rieger, L., Zawada, D., Jumelet, J., and Godin-Beekmann, S.: The 2019-2020 Australian wildfires generated a persistent smoke-charged vortex rising up to 35 km altitude, Communications Earth and Environment, 1, 22, https://doi.org/10.1038/s43247-020-00022-5, 2020.