Supplement of Weather Clim. Dynam., 2, 507–534, 2021
https://doi.org/10.5194/wcd-2-507-2021-supplement

Supplement of

The three-dimensional life cycles of potential vorticity cutoffs: a global and selected regional climatologies in ERA-Interim (1979–2018)

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5 Supplement

S1. Climatological frequencies of the three cutoff types

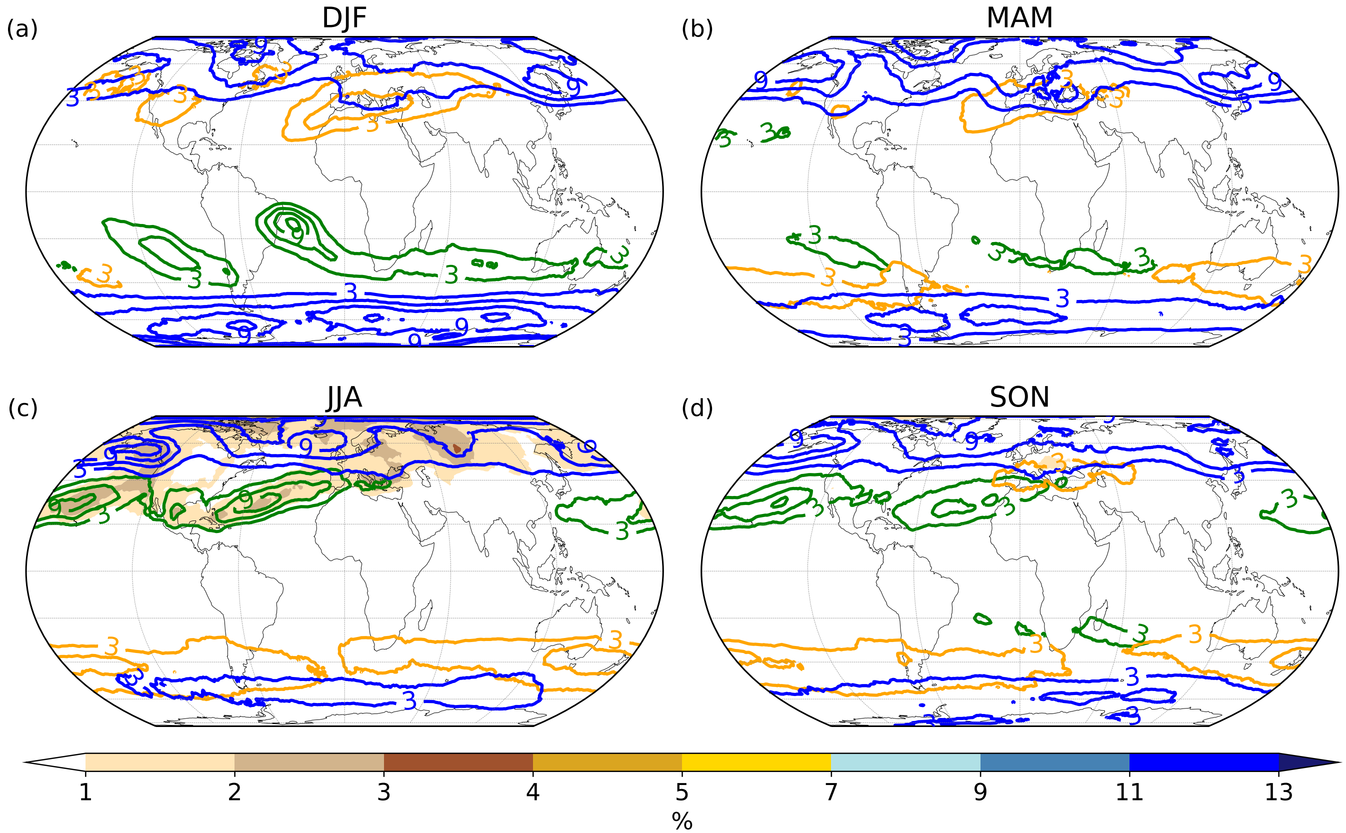

Figure S 1. Seasonally averaged frequencies of PV cutoffs of types I (green contours, every 3 %), II (orange contours), and III (blue contours) and the PV cutoffs that could not be classified (shading, in %) for (a) DJF, (b) MAM, (a) JJA, and (b) SON.

S2. Details of the selected PV cutoff genesis regions

Table S 1 provides an overview of the geographical boundaries of the selected regions and the number of identified tracks with PV cutoff genesis in this region.

Table S 1. Details of the selected PV cutoff genesis regions in DJF and JJA

genesis region	longitudes	latitudes	number of tracks
DJF			
California	105-130°W	25-45°N	688
Nordic Seas	20°W -15°E	55-75°N	808
Mediterranean	0-30°E	35-48°N	729
eastern South Pacific	70-90°E	20-40°S	406
South Africa	0-25°E	20-40°S	491
Antarctica	55-105°E	50-65°S	832
JJA			
central subtropical N. Atlantic	30-60°W	20-35°N	691
eastern subtropical N. Atlantic	5-25°W	25-40°N	477
Mediterranean	0-30°E	35-48°N	891
Hudson Bay	70-115°W	50-70°N	898
Baltic Sea	0-30°E	50-65°N	569
Australia	105-140°E	32-52°S	969

S3. Example cases

The following Figs. S2, S3, and S4 illustrate the application of the tracking method and at the same time provide examples for each of the three proposed life cycle types.

Figure S2 shows PV cutoff genesis over the central subtropical North Atlantic in JJA (Type I. *anticyclonic*). The PV cutoff forms at 18 UTC 18 Jun 2000 from a westward extending PV streamer equatorward of the jet stream and a large ridge. It then remains relatively stationary, slightly grows on 340 K, decays diabatically on 335 K at 18 UTC 19 Jun 2000 and merges with a pre-existing PV cutoff at 00 UTC 20 Jun 2000. It reappears on 335 K and appears for the first time on 345 K at 12 UTC 20 Jun 2000. It is then reabsorbed first on 345 K and later, from 00 UTC to 06 UTC 22 Jun 2000, on 340 K. On 335 K it shrinks and finally decays at 06 UTC 22 Jun 2000. During the whole life cycle it is not linked to a surface cyclone.

Figure S3 shows PV cutoff genesis over Australia in JJA (Type II, *between-jets*). The PV cutoff forms at 00 UTC 25 Aug 2001 from the cyclonic break-up of a anticyclonically tilted PV streamer equatorward of the polar jet stream and poleward of a strong subtropical jet. Alread 12 h after PV cutoff genesis, a surface cyclone forms at the PV cutoff's eastern flank, which subsequently intensifies. As the cyclone intensifies the PV cutoff shrinks at all levels and decays diabatically at 295 and 300 K. Surface cyclone and PV cutoff then form an equivalent barotropic system around 12 UTC 27 Aug 2001. At the same time, the PV cutoff detaches from the stratospheric reservoir on 315 K and is reabsorbed again only 12 h later. The PV cutoff finally decays diabatically on 305 K and 310 K.

Figure S4 shows PV cutoff genesis over the western North Atlantic in DJF (Type III, *cyclonic*). It forms at 06 UTC 06 Jan 1989 on 290-300 K from cyclonic wave breaking equatorward of a large, pre-existing surface cyclone south of Greenland and poleward of the jet stream. Subsequently it moves rapidly northeastward, appears shortly on 305 K and is subsequently reabsorbed again on that isentrope. At the same time, it decays diabatically on 290 K and shrinks substantially on 295 K. At 00 UTC 07 Jan 1989 cyclogenesis occurs ahead of the PV cutoff west of Iceland. The surface cyclone remains in the vicinity of the PV cutoff for about one day and then moves eastward while the PV cutoff remains quasi-stationary between Greenland and Iceland where it is finally reabsorbed at 12 UTC 09 Jan 1989. During the quasi-stationary period, the PV cutoff decays and reappears again on 295 K.

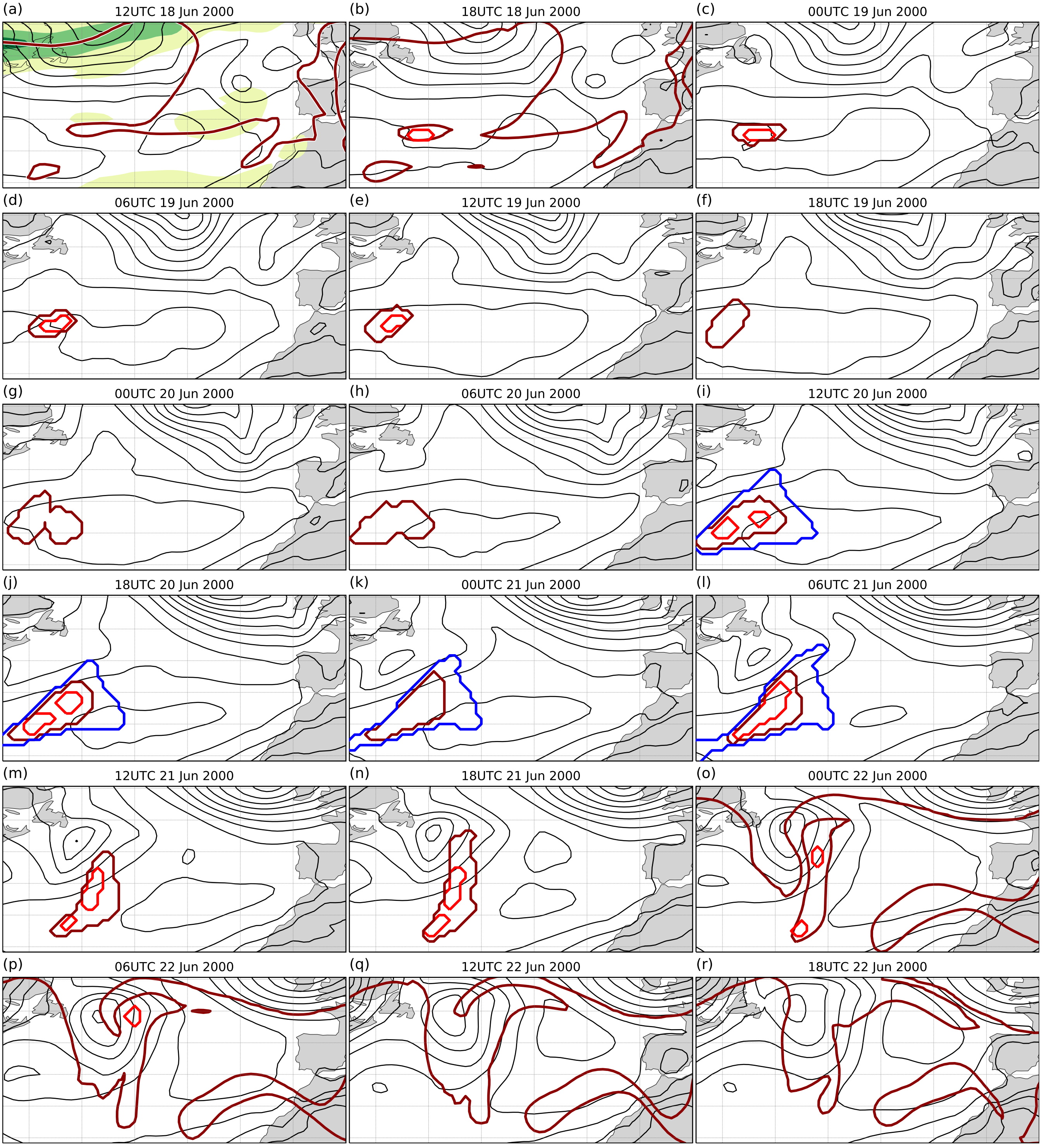

Figure S 2. Case study of a PV cutoff forming over the central subtropical North Atlantic (Type I, *anticyclonic*). Shown are the 2 PVU isoline on 340 K (brown) in panels a,b and o-r and masks of the identified PV cutoff at 335 K (red), 340 K (brown), and 345 K (blue), sea level pressure (black), and, for panel (a), wind speed at 250 hPa (green shading, 20,40,60 m s^{-1}).

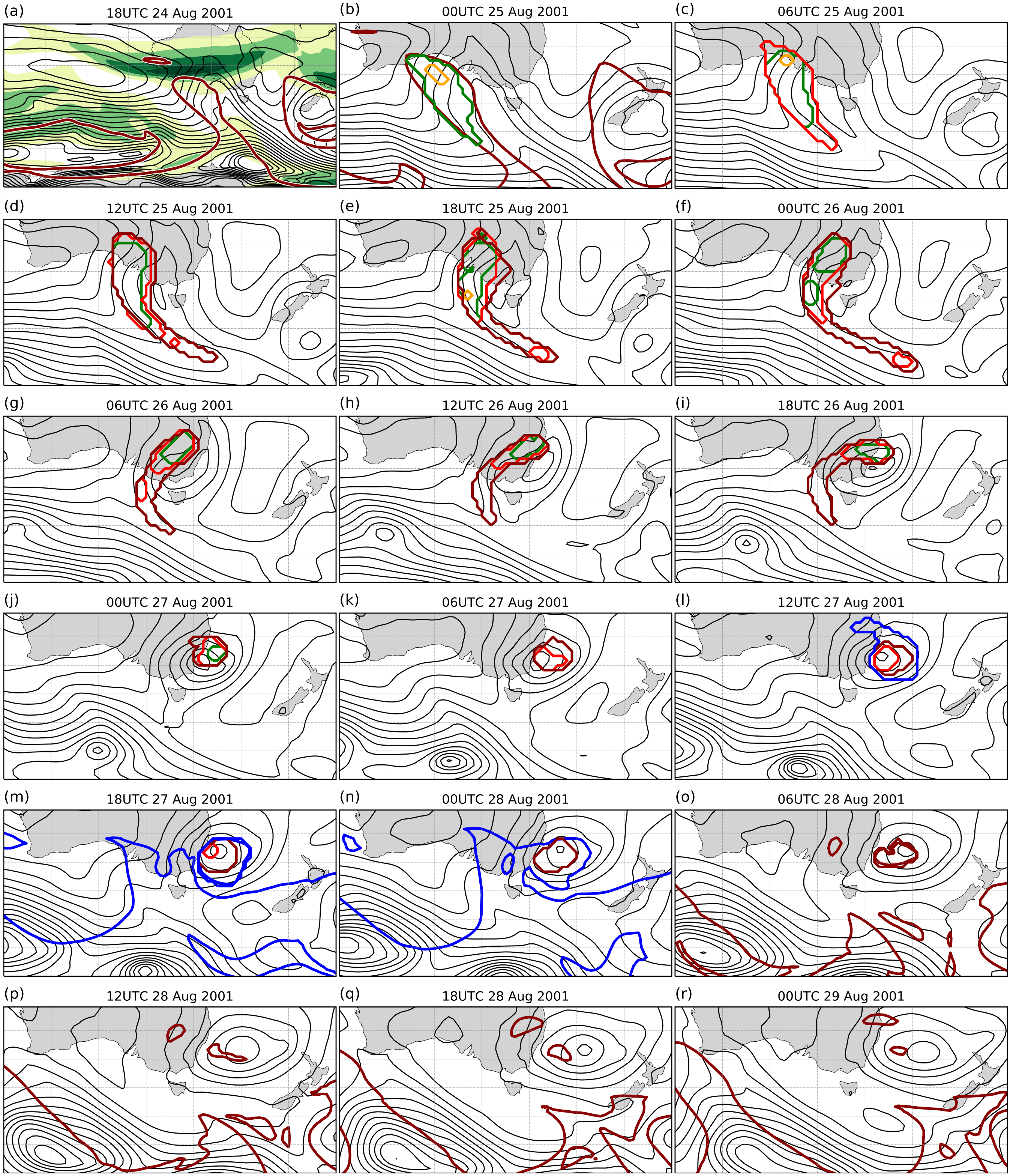

Figure S 3. Case study of a PV cutoff forming over Australia (Type II, *between-jets*). Shown are the 2 PVU isoline on (a,b,o-r) 310 K (brown) and on (m,n) 315 K and masks of the identified PV cutoff at 290 K (orange) and 300 K (green), 305 K (red), 310 K (brown), and 315 K (blue), sea level pressure (black), and, for panel (a), wind speed at 250 hPa (green shading, 20,40,60,80 m s^{-1}).

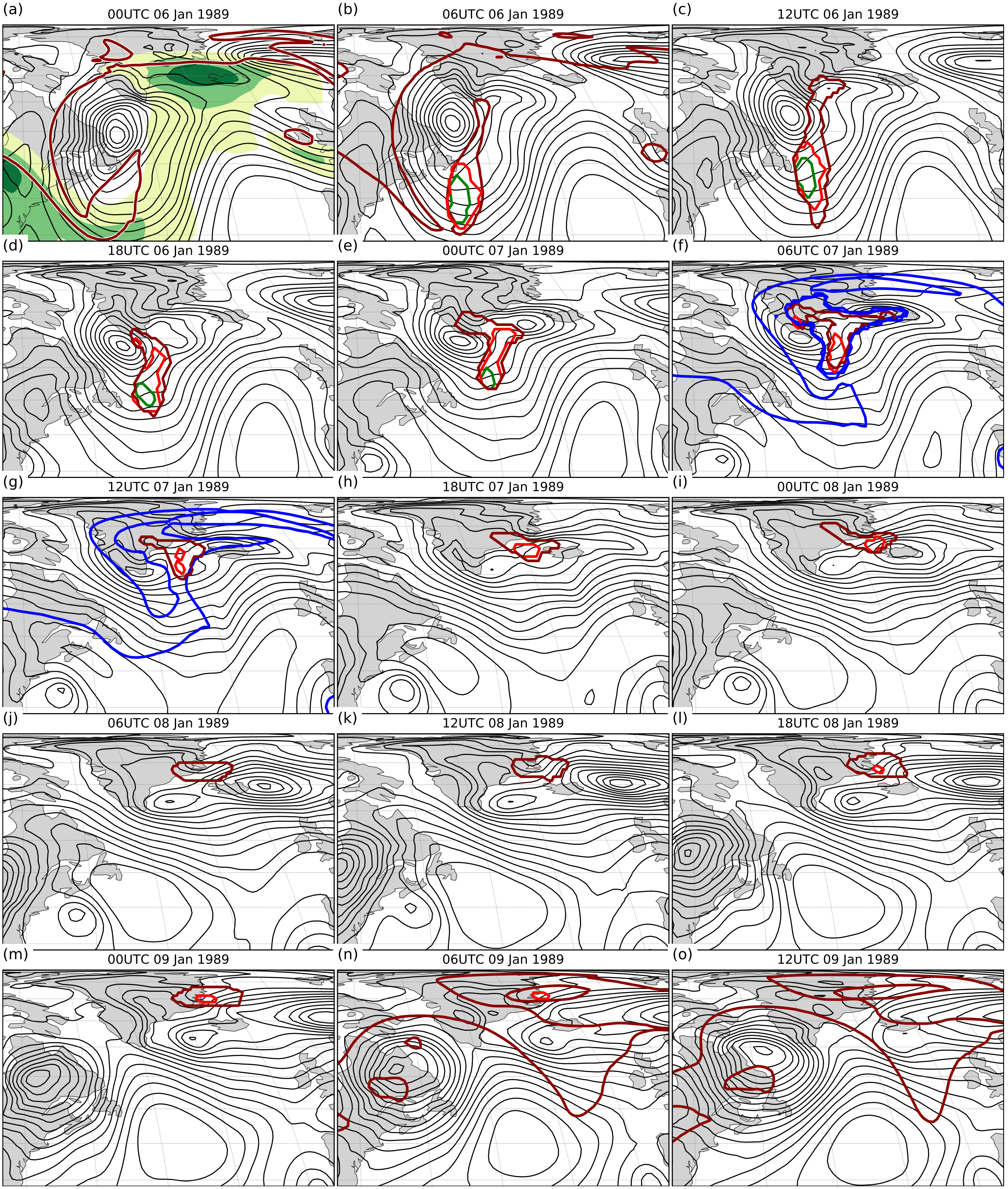

Figure S 4. Case study of a PV cutoff forming over the western North Atlantic (Type III, *cyclonic*). Shown are the 2 PVU isoline on (a,b,n,o) 300 K (brown) and on (f,g) 305 K and masks of the identified PV cutoff at 290 K (green), 295 K (red), 300 K (brown), and 305 K (blue), sea level pressure (black), and, for panel (a), wind speed at 250 hPa (green shading, 20,40,60 m s^{-1}).