The Influence of the Antarctic Vortex Breakdown on the Stratosphere over New Zealand in late 1998 (and 1999 and 2000)

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Introduction

Breakdown of the Antarctic vortex has an important effect on southern midlatitude ozone. The date of vortex breakdown is much nearer summer solstice in the Southern Hemisphere than in the Northern. Thus the resulting ozone decreases have more impact on biologically important UV.

Vortex breakdown has usually been in early to mid December since 1991 (Figure 1).

Ozonesonde measurements at Lauder, New Zealand, suggest that the northwards transport of ozone poor air from remnants of the Antarctic ozone hole have a significant short-term effect on column ozone (Figure 2). According to the work of Bodeker et al. (2001), the increase in the area of the Antarctic ozone hole is a consequence of the increasing annual loss within the vortex. Hence, the dilution processes following the vortex breakdown might be the most important reason for the strongest negative ozone trends over New Zealand in summer (WMO, 1999).

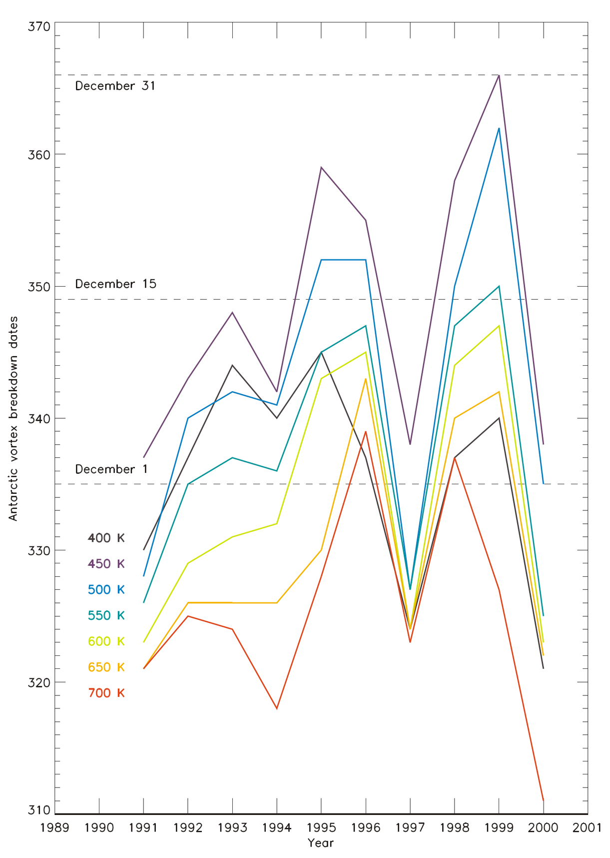

Figure 1: Antarctic vortex breakdown dates on seven potential temperature surfaces between 400 and 700 K, for the years 1991 – 2000. The procedure for vortex breakdown date determination is described in **Method**.

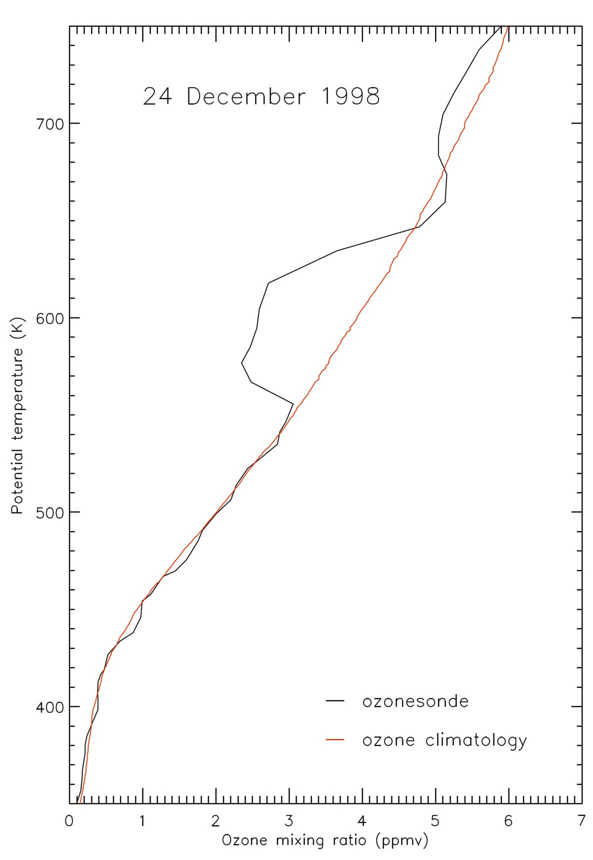

Figure 2: Vertical profile of ozone between isentropic surfaces 350 – 750 K for Lauder, New Zealand on 24 December 1998. The ozonesonde climatology for the month of December is plotted for comparison.

Method

Vortex breakdown dates for the years 1991 – 2000 were determined separately at seven potential temperature surfaces between 400 and 700 K. The procedure is based on the work of Nash et al. (1996), whereby the product of the first derivative of potential vorticity vs. equivalent latitude and mean wind speed along potential vorticity isolines is representative of vortex strength. The calculated dates are in good agreement with the dates determined by Waugh and Randel (1999).

Isentropic back-trajectory calculations were then used to quantify the prevalence of vortex air reaching the New Zealand region (34 – 48 S, 162 – 178 E) in the weeks immediately following the breakdown. The vortex parcels were identified by comparing their potential vorticity (PV) values with the PV values defining the vortex edge (calculated using the method defined by Nash et al. (1996)).

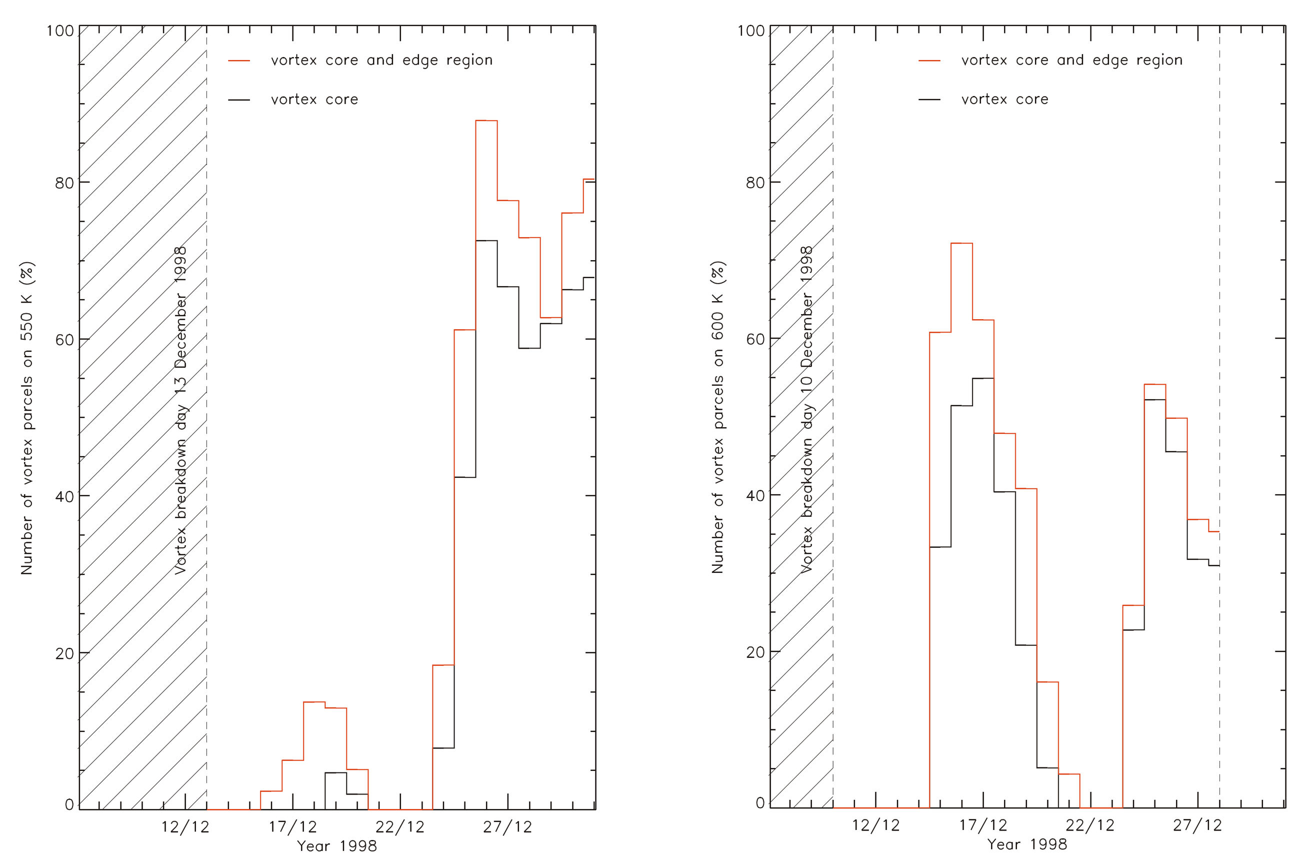

Figure 3: Number of the Antarctic vortex air parcels (in %) reaching the New Zealand region in December 1998. The calculations were performed for the period of 19 days following the vortex breakdown. The hashed regions represent the time when the vortex still existed. Dashed lines represent the days when the calculations ended.

The results of back-trajectory calculations show that in the years 1998 and 2000 a significant number of vortex air parcels on almost all of the examined potential temperature surfaces reached New Zealand. In 1998, the most striking event was on 550 and 600 K, around Christmas time. Vortex core air covered more than 50 % of the New Zealand region on several days (Figure 3) and nearly all of the South Island after Christmas (not shown). In 2000, on 550 K nearly the whole New Zealand region was covered by vortex air (not shown).