To estimate the influence of the Antarctic ozone hole over New Zealand we assumed that the ozone loss was uniform within the vortex, and that there was no transport out of the vortex before breakdown. The ‘depleted ozone’ was advected unchanged, and then integrated over all the parcels originating in the vortex. As before, we assumed a 50 K layer thickness. Figure 11 shows the ozone depletion over the New Zealand region, as percent of the daily undepleted ozone levels, in the layers centred around 550 and 600 K. In the first layer, the anthropogenic component is much larger than the combined reduction (Figure 9), because descent in the vortex increases ozone at this and lower altitudes, masking the effect of chemical depletion.

Figure 12 summarizes the influence of the Antarctic ozone hole over New Zealand in the years 1998, 1999 and 2000. It shows the depleted daily ozone values between 375 and 725 K potential surfaces, calculated using high-resolution ozone fields, and the undepleted values, which are the sum of daily depletion in the seven layers and the depleted values. Since the breakdown dates are different for different heights (Figure 1) the values for days after the first 19-day period represent the lower limit of undepleted ozone.

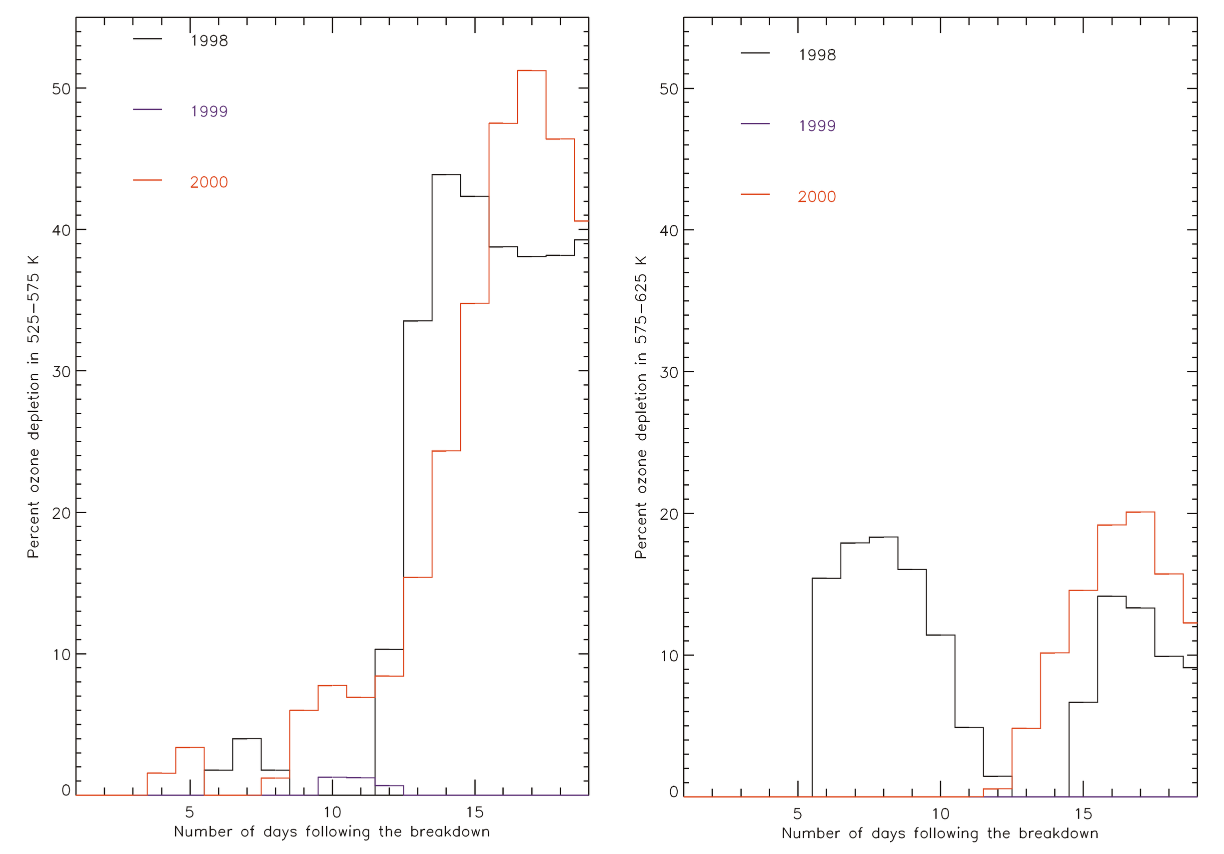

Figure 11: Ozone depletion over the New Zealand region (as percent of the daily undepleted ozone levels) centred around two isentropic surfaces of 550 and 600 K.

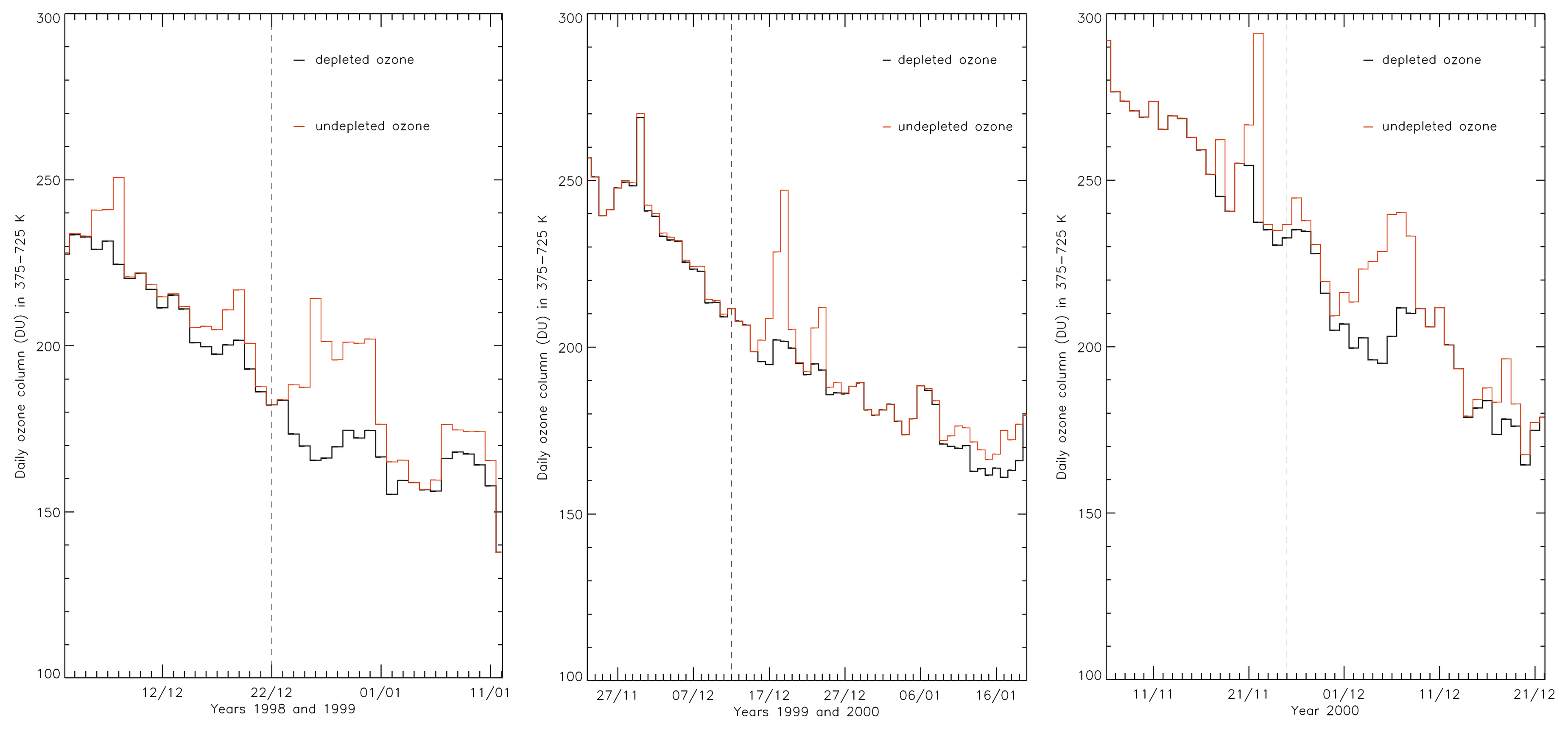

Figure 12: Daily ozone column (in DU) of depleted and undepleted ozone, in 375-725 K layer, for the years 1998, 1999 and 2000. The hashed line signifies the day after which the calculated undepleted ozone values represent its lower limit.

Conclusion

POAM proxy ozone data and isentropic back-trajectory calculations provide a tool for study of the ozone dilution following vortex breakdown. High-resolution ozone maps give an instructive illustration of these processes. Furthermore, the influence of the ozone poor air originating in the vortex and reaching midlatitudes can be quantified.

The analyses for the years 1998, 1999 and 2000, show that the vortex parcels on altitudes where ozone is most abundant, reach New Zealand in a short time-period after vortex breakdown. This leads to altered vertical distribution and total column of ozone. The resulting ozone reduction was most significant in the year 1998, when in the layers centred around 550 and 600 K it amounted to more than 20 % for a number of days. In the year 2000, the reduction was the greatest around the 550 K potential temperature surface. In the year 1999, the impact was the smallest.

The anthropogenic component of the reduction is most pronounced at the altitudes between 400 and 600 K (where the ozone depletion within the Antarctic vortex is most severe). The influence of this effect is masked by the ozone descent in the vortex. The lower limit of depletion was more than 10 % of the ozone between 375 and 725 K for six days in late December 1998, two days around the middle of December 1999 and five days in early December 2000.

Next step in this analysis is to incorporate diabatic back-trajectory calculations. They will allow us to track air parcels originating in the vortex more accurately, and hence lead to a more confident estimate of the full effect of ozone depletion.

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