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DYNAMICS, EFFECTS AT OTHER LATITUDES

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by

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If chemical processes particular to polar latitudes are important in the development of the Antarctic ozone hole, then it is likely that the dynamical configuration of the Southern Hemisphere is instrumental in maintaining the conditions necessary for the chemical processes to take place. More precisely, the strength of the southern polar vortex, coupled with the weaker planetary wave forcing in the Southern Hemisphere, inhibits the mixing of midlatitude air into the polar region during much of the winter. The Northern Hemisphere is characterized by extensive midlatitude/polar mixing particularly during stratospheric warmings. In the Southern Hemisphere during the breakdown of the vortex there is significant meridional mixing as is evidenced in satellite derived total ozone fields. If there is substantially depleted polar ozone, does the mixing during the final warming cause any significant depletion of ozone at midlatitudes or does the final warming essentially just fill up the hole?

Two numerical experiments have been performed with a three dimensional ozone transport model to determine what the effect of depleted polar ozone on midlatitude ozone might be. In the baseline experiment the redistribution of a wintertime ozone field during the growth and decay of a planetary wave is calculated. In the second experiment, an artificial ozone "hole" is placed in the initial ozone field poleward of 60^{o}. The depletion at the pole is $>$ 80%. The experiment is run for 60 days.

The numerical experiments are designed to isolate the effects of planetary wave transport on the preexisting ozone hole. The experiments

should give some idea of how ozone is transported during the breakdown of the polar vortex (the final warming). Since planetary wave transport is the primary mechanism of north/south transport during the winter and early spring, the amount of reduction of midlatitude ozone due to depleted polar ozone is revealed.

When compared to the baseline case, the original depletion of 80% at the pole is reduced to < 40% by day 15 between 30 and 40 km. The depletion is reduced to less than 10% by day 30. Above and below the 30-40 km layer, the reduction of the polar ozone deficit is smaller.

The initial ozone depletion is confined to latitudes poleward of 60^{o}. By day 30, depletions relative to the baseline are computed between 30^{o} and 60^{o}. The magnitude of this depletion is < 10% and decreases towards lower latitude.

These experiments indicate that during the breakdown of the polar vortex, enough ozone is transported to high latitudes to largely fill in the ozone hole. The concomitant "propagation" of the ozone hole to midlatitudes during the breakdown of the polar vortex should not lead to major deficits of midlatitude ozone.