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A closer look at Arctic ozone loss and polar stratospheric clouds

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The empirical relationship found between column-integrated Arctic ozone loss and the presence of polar stratospheric clouds is updated and examined in more detail. The relationship is found to hold at different altitudes as well as in the column. Analysis of the photochemistry leading to the ozone loss shows that the early winter activation is limited by the photolysis of nitric acid. This step produces nitrogen dioxide which is converted to chlorine nitrate which in turn reacts with hydrogen chloride on any polar stratospheric clouds to form active chlorine. The rate-limiting step is the photolysis of nitric acid: this occurs at the same rate every year and so the interannual variation in the ozone loss is caused by the extent and persistence of the polar stratospheric clouds. In early spring the ozone loss rate increases as the solar insolation increases the photolysis of the chlorine monoxide dimer. However the length of the ozone loss period is determined by the photolysis of nitric acid which also occurs in the near ultraviolet. As a result the amount of the ozone loss is principally limited by the extent of original activation rather than its timing. In addition a number of factors, including the vertical changes in pressure and total inorganic chlorine as well as of de-nitrification and re-nitrification, offset each other. As a result the extent of original activation is the most important factor influencing ozone loss, and the interannual variability is relatively small, as observed. These results indicate that relatively simple parameterisations of polar ozone loss could be developed for use in coupled chemistry climate models.