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Temperature thresholds for polar stratospheric ozone loss

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Low stratospheric temperatures are known to be responsible for heterogeneous chlorine activation that leads to polar ozone depletion. We discuss the temperature threshold below which substantial chlorine activation occurs. We suggest that the onset of chlorine activation is dominated by reactions on cold binary aerosol particles, without formation of polar stratospheric clouds (PSCs), i.e. without significant uptake of HNO_3 from the gas-phase. Using reaction rates on cold binary aerosol, a chlorine activation threshold temperature, T_{ACL}, is derived. At typical stratospheric conditions, T_{ACL} is similar in value to T_{NAT} the highest temperature at which nitric acid trihydrate (NAT) can theoretically condense to form PSCs. T_{NAT} is still in use as parameterization for the threshold temperature for the onset of chlorine activation. However, perturbations can cause T_{ACL} to differ from T_{NAT}: T_{ACL} is dependent upon H_2O, potential temperature, and the sulphate aerosol loading, but unlike T_{NAT} is not dependent upon HNO_3. A parameterization of T_{ACL} is provided here, allowing it to be calculated over a comprehensive range of stratospheric conditions. Although considering T_{ACL} as a proxy for chlorine activation can be no substitute for a detailed model calculation, T_{ACL} provides a more accurate description of the temperature conditions necessary for polar ozone depletion than T_{NAT} and can readily be used in place of T_{NAT}.