

## **Polar Stratospheric Cloud evolution and chlorine activation measured by CALIPSO and MLS, and modelled by ATLAS**

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We examined observations of polar stratospheric clouds (PSCs) by CALIPSO and of  $HCl$  and  $ClO$  by MLS along air mass trajectories to investigate the dependence of the inferred PSC composition on the temperature history of the air parcels, and the dependence of the level of chlorine activation on PSC composition. Several case studies based on individual trajectories from the Arctic winter 2009/2010 were conducted, with the trajectories chosen such that the first processing of the air mass by PSCs in this winter occurred on the trajectory. Transitions of PSC composition classes were observed to be highly dependent on the temperature history. In cases of a gradual temperature decrease, nitric acid trihydrate (NAT) and super-cooled ternary solution (STS) mixture clouds were observed. In cases of rapid temperature decrease, STS clouds were first observed, followed by NAT/STS mixture clouds. When temperatures dropped below the frost point, ice clouds formed, and then transformed into NAT/STS mixture clouds when temperature increased above the frost point. The threshold temperature for rapid chlorine activation on PSCs is approximately 4 K below the NAT existence temperature,  $T_{NAT}$ . Furthermore, simulations of the ATLAS chemistry and transport box model along the trajectories were used to corroborate the measurements and show good agreement with the observations. Rapid chlorine activation was observed when an airmass encountered PSCs. Usually, chlorine activation was limited by the amount of available  $ClONO_2$ . Where  $ClONO_2$  was not the limiting factor, a large dependence on temperature was evident.