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Vortex-wide chlorine activation by a localized PSC event in the Arctic winter of 2009/10

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During the polar night chlorine reservoir species react heterogeneously to photo-labile chlorine compounds which drive ozone-loss cycles, eventually leading to the ozone-hole. We investigate this process for the Arctic winter 2009/10 using satellite data and model simulations. CALIPSO observations indicate localized Ppolar Stratospheric Cloud (PSC) occurrences east of Greenland beginning of January 2010 with MLS observations indicating a decrease in HCl mixing ratios co-located and downstream of these PSCs. This localized PSC event has a bigger extent than mountain-wave PSCs but still only covers a fraction of the entire vortex. Trajectory calculations confirm that low HCl mixing ratios correspond to air that has passed through PSCs. Following trajectories started in PCSs show that chlorine is activated in these cluods nad subsequently this air with low HCl mixing ratios is adveted throughout the vortex. Regions with high HCl mixing ratios correspond to air masses which haven't been exposed to PSC. After five days all vortex air has passed through the PSC which shows that such localized PSCs can activate the entire vortex within a week. Chlorine activation does not occur homogeneously throughout the vortex but rather in a localized area with air constantly flowing through. This area corresponds to the area where CALIPSO observed PSCs. Comparing the area where activation occurs with indicators of chlorine activation such as TNAT and TACl we find that these indicators overestimate the area where chlorine activation is expected to occur. In addition, heterogeneous chemistry is modeled along the trajectories passing through PSCs. Trajectory calculations are initialized upstream of PSCs with observations from MLS, tracer-tracer correlations and non-observed species from a CLaMS simulation. The CALIPSO backscatter product is used to estimate surface area density. Our calculations of HCl agree well with MLS observations downstream of PSCs. They also indicate that $ClONO_2$ is the limiting factor in chlorine activation. Overall, we find that heterogeneous chemistry can explain observations of HCl by MLS and that chlorine activation is limited to the area where PSCs are present.