Arctic Stratospheric Measurements of Aerosol, Water Vapor, and Ozone during SABRE

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Water vapor mixing ratios and aerosol number concentration and size can affect polar stratospheric ozone chemistry. To date, however, the number of *in situ* measurements of aerosol or water vapor at high latitudes and high altitudes in the Northern Hemisphere (NH) are limited. These observations constrain global climate model simulations and are critical for the evaluation and improvement of satellite retrievals in this region. The Stratospheric Aerosol processes, Budget and Radiative Effects (SABRE) mission between February and March 2023 was designed, in part, to address these issues. In conjunction with SABRE, our team flew four Baseline Balloon Stratospheric Aerosol Profiles-Intensive Operation Period (B^2SAP-IOP) payloads on weather balloons from near the Barrow Atmospheric Baseline Observatory in Utqiagvik, AK between March 13 and March 20, 2023. These payloads carried a combination of aerosol sondes, NOAA frost point hygrometers, and ozonesondes to ~ 28 km altitude and were timed to overlap with high-altitude WB-57 research aircraft flights (to ~ 16 km altitude) over Utqiagvik, AK.

Our balloon-borne observations showed that ozone mixing ratios and air temperature varied considerably between 15 – 25 km across the edge of the polar vortex. Corresponding water vapor mixing ratios increased gradually from ~5 ppmv to ~7 ppmv with altitude above 15 km, agreeing well with Aura Microwave Limb Sounder (MLS) retrievals. Meanwhile, aerosol number concentrations steadily decreased with altitude in the polar stratosphere. We observed enhancements in aerosol surface area above the tropopause and enhancements in aerosol number concentration at ~25 km, likely related to the transport (and dilution) of the Hunga Tonga-Hunga Haʻapai plume, and the descent of meteoric material descending through the upper branch of Brewer-Dobson circulation, respectively. Overall, these findings provide valuable insights into the current baseline state and variability of polar stratospheric composition, chemistry and dynamics.

Figure 1. Launch from Utqiagvik, AK on March 14th, 2023. Photo by Patrick Cullis.