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Observations of stratospheric water vapor in the Arctic

R. Kivi (1) and H. Vömel (2)

(1) FMI Arctic Research Center, Tähteläntie 62, FIN-99600 Sodankylä, Finland, (rigel.kivi@fmi.fi), (2) Cooperative Institute for Research in Environmental Sciences, University of Colorado, Campus Box 216, Boulder, CO 80309, United States

Changes in water vapor have a strong impact on the climate. In the lower stratosphere water vapor concentration has an influence on the formation of the polar stratospheric clouds and thus on the polar ozone depletion. Accurate measurements of stratospheric water vapor remain a technological challenge, for example operational radiosondes generally do not provide useful humidity data in the stratosphere. Recently a new instrument was developed that can be flown on small meteorological balloons and is suitable for polar process studies in the stratosphere as well as for long-term trend studies. The instrument, cryogenic frost point hygrometer (CFH), is currently built at the University of Colorado and is in parts based on the old NOAA/CMDL frost point hygrometer. In Sodankylä, Finland the first flights of the CFH instrument were made during the LAPBIAT Upper Troposphere LOwer Stratosphere (LAUTLOS) campaign in February 2004. Since then the instrument has been improved and the new version of the instrument was flown in Sodankylä between December 2005 and December 2006. In total we made eight flights using the improved version of the instrument. During the Arctic winter of 2005/2006 the stratospheric temperatures allowed the formation of polar stratospheric clouds (PSCs) in December and early January. According to radiosondes temperatures at 50 hPa PSC formation was possible during 20 % of the flights in December 2005 and during 30 % of the flights in January 2006 above Sodankylä. On January 05, 2006 we observed a strong PSC by an aerosol backscatter sonde in the altitude range of 22 to 26 km with maximum backscatter ratio of 27 (at 940 nm) at the altitude of 25.8 km (radiosonde temperature at that level 182 K). From January 5 to January 7, 2006 the radiosondes measured unusually low temperatures in 23 -26 km altitude range: the minimum temperature was between 181.8 K and 184.5 K in each individual profile. On January 18, 2006 we launched a combined payload of an aerosol backscatter sonde and the CFH instrument. This flight was made

under temperatures that were just below the limit of the formation temperatures of polar stratospheric clouds, though no PSCs were detected. We expect to launch similar payload during the International Polar Year. Until December 2006 during four flights another light-weight water vapor instrument (the Fast Lyman-alpha Stratospheric Hygrometer of the Central Aerological Observatory) was flown in a dual balloon payload with the CFH instrument for comparison purposes. In general both instruments have shown good agreement and very similar small scale vertical layering of water vapor in the Arctic lower stratosphere, in most cases related to differential advection. We expect to perform a series of CFH launches during the upcoming polar winters. The CFH instrument can be used for polar process studies and also for the validation of space born and ground based remote sensors, as well as radiosonde humidity sensors.