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Site report: Boulder, USA

(Submitted by Dale Hurst and June Wang)

Summary and Purpose of Document

This document contains an overview of the measurement programme at the Boulder site with respect to GRUAN requirements, and addresses the questions to be discussed in this session.

2010 Site Update for Boulder, Colorado, USA

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The Boulder GRUAN site continues to prepare for its first balloon flight utilizing a Vaisala RS-92 radiosonde and a new DigiCORA MW31 ground station provided by the US GCOS Office. As of February 9, 2011, the sondes and DigiCORA system had been received in Boulder but had not yet been released by NCAR to NOAA pending formal loan agreement paperwork. The DigiCORA system has the latest Vaisala software version that includes new corrections to both temperature and relative humidity data. Additionally, we have received a Vaisala PTU300 for ground-based measurements of pressure, temperature and humidity at the balloon launch site. This sensor package will be used to ground check radiosonde PTU measurements for accuracy just prior to launch.

Boulder water vapor soundings with the NOAA frost point hygrometer (FPH) continued on a bi-weekly to monthly basis throughout 2010. Weekly ozone soundings with EnSci ECC ozonesondes also continued, with 1-2 soundings per month as part of the FPH payload. The current FPH payload also includes an InterMet-RS1 radiosonde with Humirel humidity sensor. The more frequent ozone soundings continue to rely on Vaisala RS-80 radiosondes though these are becoming scarce. Within the next year the InterMet-RS1 will replace the RS-80 in weekly ozone soundings. Every Boulder balloon payload will soon also include a RS-92 radiosonde (as a separate transmitter), for redundant PTU measurements and GPS data, and to fulfill the GRUAN-required weekly launch of a “best” production radiosonde.

Two ancillary measurement programs are already producing data as part of the Boulder GRUAN site. First, a ground-based FTIR at the NCAR Foothills Laboratory (Jim Hannigan) collects solar spectra during each FPH flight. Retrievals from these spectra are used to create vertical profiles of water vapor and ozone mixing ratios for comparison to the in situ FPH and ozonesonde profiles. Preliminary results are very promising that the FTIR profiles will provide valuable data to GRUAN, especially for days without balloon flights. The second ancillary measurement is GPS-based precipitable water vapor (PW) in the overhead column. PW retrievals are provided independently by collaborators at NOAA (Seth Gutman) and NCAR (John Braun) using the same GPS receiver at the Marshall balloon-launch site. Additional PW retrievals are also available for the NOAA building in southwest Boulder and the NCAR Foothills Laboratory in north central Boulder. Comparison of these three sites provides important information about the spatial variability of tropospheric water vapor within the Boulder area.

During 2010 a small-scale field intercomparison of in situ humidity measurements by several balloon-borne sensors was conducted at the Boulder site. Two large balloons (1500 and 3000 g) were launched side-by-side carrying InterMet RS-1 and Vaisala RS92 radiosondes, two chilled-mirror frost point hygrometers (FPH and CFH), Vaisala's new reference radiosonde (RR01) and a new TDL-based hygrometer from Southwest Sciences, Inc. The humidity data from the CFH and FPH show very good agreement from the surface through UT/LS, the RS-92 data are in excellent agreement within the troposphere, and the TDL data show good instrument responsiveness and sensitivity for the entire profile. As a stand-alone instrument the TDL prototype lacked quality onboard T and P sensors, and was found wanting of a better low-end water vapor calibration. The new Vaisala RR01, with its Drycap sensor for improved humidity measurements in the UT/LS, did not perform as hoped and is still under development.

An analysis of trends in stratospheric water vapor over Boulder during 1980-2010 was recently published [*Hurst et al*., 2011]. This paper is based on the 30-year Boulder record of water vapor sounding data from the NOAA FPH. Though quite variable during the last three decades, stratospheric water vapor over Boulder has increased by 1.0 ± 0.2 ppmv (27 ± 6%) since 1980.

Hurst, D. F., S. J. Oltmans, H. Vömel, K. H. Rosenlof, S. M. Davis, E. A. Ray, E. G. Hall, and A. F. Jordan (2011), Stratospheric water vapor trends over Boulder, Colorado: Analysis of the 30 year Boulder record, *J. Geophys. Res*., *116*, D02306, doi:10.1029/2010JD015065.