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Summertime stratospheric processes at northern mid-latitudes: comparisons between MANTRA balloon measurements and the Canadian Middle Atmosphere Model

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Abstract. In this paper we report on a study conducted using the Middle Atmospheric Nitrogen TRend Assessment (MANTRA) balloon measurements of stratospheric constituents and temperature and the Canadian Middle Atmosphere Model (CMAM). Three different kinds of data are used to assess the inter-consistency of the combined dataset: single profiles of long-lived species from MANTRA 1998, sparse climatologies from the ozonesonde measurements during the four MANTRA campaigns and from HALOE satellite measurements, and the CMAM climatology. In doing so, we evaluate the ability of the model to reproduce the measured fields and to thereby test our ability to describe mid-latitude summertime stratospheric processes. The MANTRA campaigns were conducted at Vanscoy, Saskatchewan, Canada (52° N, 107° W) in late August and early September of 1998, 2000, 2002 and 2004. During late summer at mid-latitudes, the stratosphere is close to photochemical control, providing an ideal scenario for the study reported here. From this analysis we find that: (1) reducing the value for the vertical diffusion coefficient in CMAM to a more physically reasonable value results in the model better reproducing the measured profiles of long-lived species; (2) the existence of compact correlations among the constituents, as expected from independent measurements in the literature and from models, confirms the self-consistency of the MANTRA measurements; and (3) the 1998 measurements show structures in the chemical species profiles that can be associated with transport, adding to the growing evidence that the summertime stratosphere can be much more disturbed than anticipated. The mechanisms responsible for such disturbances need to be understood in order to assess the representativeness of the measurements and to isolate long-term trends.

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