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Quantifying Transport into the Arctic Lowermost Stratosphere

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The radiative and chemical balance of the tropopause region and the lowermost stratosphere is largely controlled by transport processes bringing in air with very different chemical compositions from the stratosphere above and from the troposphere. Assuming a simple model of the lower stratosphere, the air in the LMS (tropopause to 400 K) is a mixture of air having been transported from either i) the troposphere across the tropopause, ii) the mid to high latitude stratosphere or iii) the Arctic vortex region across the 400 K isentrope. With a simple mass balance calculation, fractions of air originating from each of these regions were determined by solving an over-determined linear equation system, using a quality data set of tracers obtained in situ. A Monte Carlo simulation was performed to study the sensitivity of the results to measurement errors and sampling biases.

The tracer data were obtained with the High Altitude Gas Analyzer (HAGAR, Univ. Frankfurt) (CH_4, N_2O, CFC-11, H-1211) during two campaigns of the Russian high altitude aircraft M55 Geophysica from Kiruna, Sweden between January and March 2003. O_3 was measured by the instruments FOX (DLR, Germany) and FOZAN (CAO, Russia), and H2O was measured by FISH (FZ Jülich, Germany).

The results exhibit a shallow layer of 20 K above the local tropopause with increased tropospheric influence. The tropospheric fraction in this layer decreases during the winter from values larger than 50% to about 20%. Regions above 350 K are mostly

dominated by air masses coming from above 400 K, while the tropospheric influence is generally close to zero. A strong influence ($>$ 50%) from the vortex is only evident down to 370 K for data obtained below the vortex region. However, at the end of the winter a slightly increased fraction of air (about 30%) coming from the vortex is found above 360 K even at lower latitudes.