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Atmos. Chem. Phys., 6, 267-282, 2006
www.atmos-chem-phys.net/6/267/2006/

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Observation of mesospheric air inside the arctic stratospheric polar vortex in early 2003

A. Engel¹, T. Möbius¹, H.-P. Haase^{1,*}, H. Bönisch¹, T. Wetter¹,
U. Schmidt¹, I. Levin², T. Reddmann³, H. Oelhaf³, G. Wetzels³,
K. Grunow⁴, N. Huret⁵, and M. Pirre⁵

¹Institut für Atmosphäre und Umwelt, J. W. Goethe Universität Frankfurt,
Frankfurt, Germany

²Institut für Umweltphysik, Ruprecht – Karls Universität Heidelberg, Heidelberg,
Germany

³Institut für Meteorologie und Klimaforschung, Forschungszentrum Karlsruhe,
Karlsruhe, Germany

⁴Institut für Meteorologie, Freie Universität Berlin, Berlin, Germany

⁵Laboratoire de Physique et Chimie de l'Environnement, CNRS and Université
d'Orléans, Orléans, France

* now at: DEKA Bank, Frankfurt, Germany

Abstract. During several balloon flights inside the Arctic polar vortex in early 2003, unusual trace gas distributions were observed, which indicate a strong influence of mesospheric air in the stratosphere. The tuneable diode laser (TDL) instrument SPIRALE (Spectroscopie Infra-Rouge par Absorption de Lasers Embarqués) measured unusually high CO values (up to 600 ppb) on 27 January at about 30 km altitude. The cryosampler BONBON sampled air masses with very high molecular Hydrogen, extremely low SF₆ and enhanced CO values on 6 March at about 25 km altitude.

Finally, the MIPAS (Michelson Interferometer for Passive Atmospheric Sounding) Fourier Transform Infra-Red (FTIR) spectrometer showed NO_y values which are significantly higher than NO_y* (the NO_y derived from a correlation between N₂O and NO_y under undisturbed conditions), on 21 and 22 March in a layer centred at 22 km altitude. Thus, the mesospheric air seems to have been present in a layer descending from about 30 km in late January to 25 km altitude in early March and about 22 km altitude on 20 March. We present corroborating evidence from a model study using the KASIMA (KARlsruhe SIMulation model of the Middle Atmosphere) model that also shows a layer of mesospheric air, which descended into the stratosphere in November and early December 2002, before the minor warming which occurred in late December 2002 lead to a descent of upper stratospheric air, cutting off a layer in which mesospheric air is present. This layer then descended inside the vortex over the course of the winter. The same feature is found in trajectory calculations, based on a large number of trajectories started in the vicinity of the observations on 6 March. Based on the difference between the mean age derived from SF₆ (which has an irreversible mesospheric loss) and from CO₂ (whose mesospheric loss is much smaller and reversible) we estimate that the fraction of mesospheric air in the layer observed on 6 March, must have been somewhere between 35% and 100%.

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Citation: Engel, A., Möbius, T., Haase, H.-P., Bönisch, H., Wetter, T., Schmidt, U., Levin, I., Reddman, T., Oelhaf, H., Wetzol, G., Grunow, K., Huret, N., and Pirre, M.: Observation of mesospheric air inside the arctic stratospheric polar vortex in early 2003, *Atmos. Chem. Phys.*, 6, 267-282, 2006. ■ [Bibtex](#) ■ [EndNote](#) ■ [Reference Manager](#)