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Rapid intercontinental air pollution transport associated with a meteorological bomb

A. Stohl¹, H. Huntrieser², A. Richter³, S. Beirle⁴, O. R. Cooper⁵, S. Eckhardt¹, C. Forster¹, P. James¹, N. Spichtinger¹, M. Wenig⁶, T. Wagner⁴, J. P. Burrows³, and U. Platt⁴

¹Department of Ecology, Technical University of Munich, Germany

²Institute for Atmospheric Physics, DLR, Oberpfaffenhofen, Germany

³Institute of Environmental Physics, University of Bremen, Germany

⁴Institute of Environmental Physics, Heidelberg University, Germany

⁵Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado/NOAA Aeronomy Laboratory, Boulder, USA

⁶NASA Goddard Space Flight Center, Code 916, Greenbelt, MD, USA

Abstract. Intercontinental transport (ICT) of trace substances normally occurs on timescales ranging from a few days to several weeks. In this paper an extraordinary episode in November 2001 is presented, where pollution transport across the North Atlantic took only about one day. The transport mechanism, termed here an intercontinental pollution express highway because of the high wind speeds, was exceptional, as it involved an explosively generated cyclone, a so-called meteorological "bomb". To the authors' knowledge, this is the first study describing pollution transport in a bomb. The discovery of this event was based on tracer transport model calculations and satellite measurements of NO₂, a species with a relatively short lifetime in the atmosphere, which could be transported that far only because of the high wind speeds produced by the bomb. A 15-year transport climatology shows that intercontinental express highways are about four times more frequent in winter than in summer, in agreement with bomb climatologies. The climatology furthermore suggests that intercontinental express highways may be important for the budget of short-lived substances in the remote troposphere. For instance, for a substance with a lifetime of 1 day, express highways may be responsible for about two thirds of the total ICT. We roughly estimate that express highways connecting North America with Europe enhance the average NO_x mixing ratios over Europe, due to North American emissions, by about 2-3 pptv in winter.

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