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Evaluation of the MOCAGE chemistry transport model during the ICARTT/ITOP experiment

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[1] Intercontinental Transport of Ozone and Precursors (ITOP), part of International Consortium for Atmospheric Research on Transport and Transformation (ICARTT), was a large experimental campaign designed to improve our understanding of the chemical transformations within plumes during long-range transport (LRT) of pollution from North America to Europe. This campaign took place in July and August 2004, when a strong fire season occurred in North America. Burning by-products were transported over large distances, sometimes reaching Europe. A chemical transport model, Modélisation de la Chimie Atmosphérique Grande Echelle (MOCAGE), with a high grid resolution ($0.5° \times 0.5°$) over the North Atlantic area and a daily inventory of biomass burning emissions over the United States, has been used to simulate the period. By comparing our results with available aircraft in situ measurements and satellite data (MOPITT CO and SCIAMACHY NO_2), we show that MOCAGE is capable of representing the main characteristics of the tropospheric ozone-NO_x-hydrocarbon chemistry during the ITOP experiment. In particular, high resolution allows the accurate representation of the pathway of exported pollution over the Atlantic, where plumes were transported preferentially at 6 km altitude. The model overestimates OH mixing ratios up to a factor of 2 in the lower troposphere, which results in a global overestimation of hydrocarbons oxidation by-products (PAN and ketones) and an excess of O_3 (30–50 ppbv) in the planetary boundary layer (PBL) over the continental United States. Sensitivity study revealed that lightning NO emissions contributed significantly to the NO_x budget in the upper troposphere of northeast America during the summer 2004.

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1. Introduction

[2] In recent years, global monitoring from space has offered the unique opportunity to observe intercontinental transport of pollution [*Wilkening et al.*, 2000; *Husar et al.*, 2001; *McKendry et al.*, 2001]. Long-range transport (LRT) events have frequently been observed between Asia and North America [*Jaffe et al.*, 1999; *Fiore et al.*, 2002; *Hudman et al.*, 2004] and between North America and Europe [*Trickl et al.*, 2003; *Auvray et al.*, 2007]. Hemispheric-scale transport has also been reported [*Damoah et al.*, 2004]. During transport, pollution plumes undergo complex chemical transformation. In order to better understand these processes, several field campaigns have been carried out over the last decade, including NARE (North Atlantic Regional Experiment) and OCTA (Oxidising Capacity of the Tropospheric Atmosphere) in 1993 [*Wild et al.*, 1996]. These field experiments have shown that LRT from one continent to another may occasionally influence regional air quality on a downwind continent [*McKendry et al.*, 2001].

[3] Between 1 July and 15 August 2004, in the framework of the ICARTT (International Consortium for Atmospheric Research on Transport and Transformation) project, several scientific teams from Germany, France, the UK and the United States carried out aircraft measurements of chemical species concentrations between N. America and Europe [*Fehsenfeld et al.*, 2006; *Singh et al.*, 2006]. The aim of the ICARTT project, which included smaller national projects such as ITOP (International Transport of Ozone and Precursors) and INTEX-NA (Intercontinental chemical Transport Experiment–North America), was to better un-

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