Modelling acetone with the LMDz-INCA Chemistry-Transport Model: spatial distribution, temporal variability, budget components and comparison with CARIBIC data

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In the objective to represent atmospheric chemistry in sufficient detail, it is essential to simulate precisely the spatial distribution and the temporal variability of acetone, which might act as a source of OH in the Upper Troposphere (UT). Observations made by the CARIBIC experiment are exploited to evaluate fields of acetone concentrations simulated in the UT by the global chemistry-transport model LMDz-INCA. We use observations onboard the CARIBIC passenger aircraft (www.caribic-atmospheric.com). Acetone mixing ratios are measured onboard the CARIBIC Airbus 340-600 during approximately four long-distance flights per month since 2006, using a PTR-MS instrument. Around 600 h of data is currently available. Most flights considered here were to Asia, namely to the South China Sea in 2006 and 2007, and to South India in 2008. Simulated acetone concentrations are computed by the LMDz-INCA chemistry-transport global model, at a 3.75°x2.5° horizontal resolution and on 19 altitude levels. 30-minute temporal resolution results were either interpolated to the flight tracks either averaged for providing regional maps of daily means.

Comparison between measurements and simulations demonstrate that our modelling is able to capture the temporal variability of the manifestation of the South Asian plume along the Chinese South East coast. Temporal variability is important: acetone concentration varies by a factor 2 to 3 from winter season to summer, day-to-day variability can reach 150 ppt, and diurnal cycle 100 ppt. A 20-50% systematic overestimation of the acetone load is generated by the model.

Mean atmospheric burden of acetone is 5.1 Tg, with little inter-annual variability. Given a global source/sink strength of 94 Tg/yr, the mean residence time is 20 days. While sources and sinks are balanced over the globe, computation of the budget components by LMDz-INCA indicates that South Asia (5-45°N, 45-150°E) is a strong and systematic net source of acetone, in part due to a strong chemical activity, as 25% of global chemical production of

acetone occurs over South Asia. However the fairly constant mean annual acetone content indicates that excess acetone produced over South Asia is transported to other regions.