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The impact of monsoon outflow from India and Southeast Asia in the upper troposphere over the eastern Mediterranean

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Abstract. A major objective of the Mediterranean INtensive Oxidant Study (MINOS) was to investigate long-range transport of pollutants (notably ozone precursor species). Here we present trace gas measurements from the DLR (German Aerospace Organization) Falcon aircraft in the eastern Mediterranean troposphere. Ten day backward trajectories and a coupled chemistry-climate model (ECHAM4) were used to study the nature and origin of pollution observed in the upper troposphere between 6 and 13 km altitude. We focus on a large pollution plume encountered over the eastern Mediterranean between 1 and 12 August originating in South Asia (India and Southeast Asia), referred to as the Asian plume, associated with the Asian Summer Monsoon. Vertical as well as longitudinal gradients of methane, carbon monoxide, hydrocarbons including acetone, methanol, and acetonitrile, halocarbons, ozone and total reactive nitrogen (NO_y) are presented, showing the chemical impact of the Asian plume compared to westerly air masses containing pollution from North America. The Asian plume is characterized by enhanced concentrations of biomass burning tracers (acetylene, methyl chloride, acetonitrile), notably from biofuel use. Concentrations of the new automobile cooling agent HFC-134a were significantly lower in the Asian plume than in air masses from North America. Relatively high levels of ozone precursors (CO, hydrocarbons) were found in both air masses, whereas lower ozone concentrations in the Asian plume suggest NO_x-limited conditions. Consistently, ECHAM model simulations indicate that the expected future increase of NO_x-emissions in Asia enhances the photochemical ozone production in the Asian plume. The size and location of the Asian plume near the tropopause provides an important potential for pollution transport into the lowermost stratosphere. We present observations indicative of Asian pollution transport into the lower stratosphere.

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