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The role of clouds and of neutral as well as ion induced pathway for the new particle formation in the tropical upper troposphere: In-situ measurements from continental South America and West Africa

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New particle formation which generates ultrafine aerosol was observed in the continental tropical Upper Troposphere/Lower Stratosphere region (UT/LS), particularly within the Tropical Tropopause Layer (TTL), by in-situ aircraft-borne measurements over South America (January-March, 2005) and West Africa (August, 2006). Measurements with a set of condensation particle counters with different d_{p50} (50 % detection particle diameter) were conducted in the altitude range of 12.0-20.5 km on board the high altitude research aircraft M-55 "Geophysica" and at up to 11.5 km altitude on board the research aircraft DLR Falcon-20. Concentrations of ultrafine particles in the size range of about 6 to 15 nm were derived from these measurements and several recent events of new particle formation (NPF) can be identified. For two flight segments (24 February 2005 and 07 August 2006, at 12.5 km altitude) when recent lifting had influenced the probed air mass, concentrations of ultrafine particle reached up to 7700 particles cm^{-3} (ambient concentration). For clear, cloud free air the measurements are in reasonable agreement with concentrations of ultrafine particle calculated with an aerosol model which includes neutral and ion induced nucleation processes. NPF over South America was observed above thin cirrus clouds while over West Africa, in the outflow of a Mesoscale Convective System (MCS), newly formed particles in the range of several hundred per cm^3 were found to coexist with ice cloud particles as long as the concentration of cloud particles ($d_p > 2$ μm) remained below 2 cm^{-3}. The occurrence of NPF within the upper troposphere and the TTL was generally confined within an altitude band extending from 340 K to 380 K potential temperature. By means of a heated aerosol inlet line (at 250°C) measurements of particle volatility were performed, which show that within the TTL over South America and West Africa, on average 10-25 % of the particles contained non-volatile cores. In background UT/LS conditions the fractions of non-volatile particles typically range up to 50 %. Our measurements provide further evidence for the hypothesis according to which the tropical upper troposphere and the TTL are a major source region for the stratospheric background aerosol by providing freshly nucleated particles.