

# The Asian Tropopause Aerosol Layer chemical composition – a conundrum resolved by aircraft borne in-situ particle mass spectrometry

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The Asian Tropopause Aerosol Layer (ATAL) is an aerosol layer that develops every year during the Asian monsoon in an altitude band between

≈14 and 18 km. Since its discovery in the late 2000s by CALIPSO satellite observations the longstanding unresolved issue is the ATAL chemical composition. During the 2017 EU StratoClim project in-situ experiments were performed on board the M-55 “Geophysica” aircraft based in Kathmandu, Nepal. The novel ERICA (for “ERC Instrument for the Chemical composition of Aerosols”) particle mass spectrometer was deployed for automated direct-reading measurements up to 20 km altitude inside the Asian Monsoon Anticyclone (AMA) over Nepal, India, Bangladesh and the Bay of Bengal. ERICA combines in one instrument the techniques of (1) the laser desorption single particle mass spectrometry and (2) the thermal desorption method (TDI, as in the AMS from Aerodyne Inc.) for quantitative bulk information. Particle sizes from 110 nm to 3.5 μm are covered.

Concurrent measurements with optical and condensation particle counters from the eight conducted research flights exhibit significant

enhancements of the number densities for particles with diameters from 10 nm to 3 μm within the ATAL. The ERICA measurements between

≈13 and 18 km show that these particles in the ATAL mostly consist of ammonium nitrate and organics. The single particle analyses also demonstrate that a significant particle fraction results from the conversion of inorganic and organic gas-phase precursors, rather than

from the uplift of primary particles from below. The oxidative state of the secondary organic particles reflects the slow radiative upwelling

within the AMA.

In this contribution an overview of the StratoClim measurements in the AMA and the ATAL is presented with emphasis on aerosol microphysical properties, and details of the results concerning particle chemical composition and further open questions are provided.

-Höpfner, M., et al., Ammonium nitrate particles formed in upper troposphere from ground ammonia sources during Asian monsoons,

*Nat. Geosci.*, 12, 608–612, <https://doi.org/10.1038/s41561-019-0385-8>, 2019

-Appel, O., et al., Chemical analysis of the Asian tropopause aerosol layer (ATAL) with emphasis on secondary aerosol particles using