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Chemical composition of the Upper Troposphere and Lower Stratosphere during the Asian summer monsoon

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The rapid economic growth in Asia has led to acute consequences on the air and water quality. During the Asian summer monsoon, deep convection is the main transporter of polluted air to the Upper Troposphere and Lower Stratosphere (UTLS) region. Enhanced aerosol levels observed by the Cloud Aerosol Lidar and Infra-red Pathfinder Satellite Observations (CALIPSO) and the Stratospheric Aerosol and Gas Experiment (SAGE-II) known as the Asian Tropopause Aerosol Layer (ATAL), coincide with the gas phase pollutants such as CO in the UTLS region. Global transport model simulations suggest that sulfate, nitrate, and organics produced from gas-phase precursors populate the UTLS in various relative fractions depending on models. While the physical and optical properties of the ATAL have been inferred from satellite observations and balloon-borne measurements for several years, the chemical composition of the ATAL remains uncertain. We present here a new balloon-borne method for sampling aerosols in the UTLS region using zero pressure balloon flights. In the summer of 2017, a field campaign of the Balloon measurement of the Asian Tropopause aerosol Layer (BATAL), was held at the Balloon facility of the Tata Institute of Fundamental Research, Hyderabad in India. During this campaign, aerosol samples were filtered using a 4-stage impactor connected to a pump and a mass flow controller. The impactor was committed to float for several hours near the Tropopause, during 2 balloon flights, for aerosol collection. Water soluble major ions (SO42−, NO_3-, NO_2-, Cl-, Na+, K+, Ca2+, and Mg2+) were extracted using ultra-pure milli-q water in pre-cleaned polypropylene vials using ultrasonic technique, and analyzed using Dual Channel Ion Chromatograph. We report the dominant presence of NO_3-, and NO_2- aerosols, with traceable amount of the proxies of mineral dust (Ca2+) and biomass burning (K+) within the ATAL region. Nitrate could be in the form of liquid Nitrate and/or solid Nitric Acid Trihydrate (NAT) particles. The GEOS-Chem Model simulation results showed that the 2 zero-pressure flights sampled at different ambient conditions. While zero-pressure flight-2 sampled inside the Asian anticyclone, the sampling of zero-pressure flight-3 was most likely influenced by the air at the edge of the anticyclone and/or the Tropical upper Troposphere. As a result, ZF-2 showed enhanced amounts of CO and NO_3- whereas the concentrations of the same were low in ZF-3 flight as simulated by the GEOS-Chem model.