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中国科学院 大气物理研究所
中层大气和全球环境探测重点实验室

# 中层大气和全球环境探测论坛

**Colloquiums of Middle Atmospheric and Global Environment Observation**

**(07)**

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报告时间： **2018**年**04**月**23**日，星期一，

上午**09:30-11:30**

报告地点： 大气所**40**号楼**912**会议室

## Topic 1: Structure and tracer distributions in the Asian Summer Monsoon Anticyclone inferred from balloon measurements and modeling

## Topic 2: The Basis and Development of the CMIP6 Stratospheric Aerosol Record

### 报告人简介

Peter教授1988年在德国Technical University Munich获得物理学博士学位（方向：等离子体物理），1988-1990年在德国马普研究所（MPI）量子光学部工作，1990-1994年在马普研究所大气化学部Paul Crutzen教授（1995年诺贝尔化学奖获得者）团队工作，1999年起任苏黎世联邦理工学院（ETH Zürich）大气化学教授。曾担任WCRP核心计划SPARC联合主席、WCRP科学指导委员会委员，苏黎世联邦理工学院环境系统科学系主任，1999年成为欧洲科学院院士（Member of the Academia Europaea），2002年获得美国AGU颁发的“Charney Lecturer”奖。

Peter教授数十年来领导和从事气溶胶物理化学特性、极地平流层云等方面的飞机观测、实验室试验和模式研究，取得了一些引领性的重大成果。在Chemical Reviews（SCI影响因子IF=47）、Nature（IF=40）、Science（IF=37）、Annu. Rev. Phys. Chem.（IF=14）等权威刊物发表学术论文270多篇，被引用10000余次（H指数为56）。Peter教授已指导培养博士50余名，指导博士后11人，其中12人已经在美国、英国、德国等国大学取得永久教职。

# Topic 1: Structure and tracer distributions in the Asian Summer Monsoon Anticyclone inferred from balloon measurements and modeling

The Asian summer monsoon anticyclone (ASMA) is a major meteorological system of the upper troposphere-lower stratosphere (UTLS) during boreal summer. It is enriched in tropospheric trace species and aerosols, due to rapid lifting from the boundary layer by deep convection, and subsequent horizontal confinement. Given its dynamical structure, the ASMA offers a very efficient pathway for the transport of these gases and aerosols to the global stratosphere. For a detailed understanding of the ASMA structure and processes, accurate in-situ measurements are required. To this end, high-precision balloon-borne measurements of temperature, water vapor, ozone and aerosol backscatter were conducted within the StratoClim project from two stations at the southern slopes of the Himalayas. In particular, we performed 58 balloon soundings during two monsoon campaigns, one in August 2016 in Nainital, India (NT16) and one in July-August 2017 in Dhulikhel, Nepal (DK17). These measurements provide unprecedented insights into the ASMA thermal structure, its relations to the vertical distributions of water vapor, ozone and aerosols, and interannual variability. Here, we adopt the concept of the tropical tropopause layer (TTL), and define the region of altitudes between the lapse rate minimum (LRM) and the cold-point tropopause (CPT) as the Asian Tropopause Transition Layer (ATTL). Further, based on air mass trajectories, we define the Top of Confinement (TOC) level of ASMA, which divides the lower stratosphere (LS) into a Confined LS (CLS), below TOC and above CPT, and a Free LS (FLS) above the TOC. Our analysis reveals that the composition of ATTL and CLS are strongly affected by convection, whose influence extends 1.5-2 km above the CPT. This is shown by enhanced water vapor in the Confined LS compared to background stratospheric values in the Free LS, observed in both the NT16 and DK17 measurements.

Enhanced aerosol backscatter of the Asian tropopause aerosol layer (ATAL) was found to extend across both the ATTL and CLS in NT16, suggesting that the LRM coincides with the onset of the horizontal confinement by ASMA, while the polluted convective outflow penetrates into the Confined LS. The CPT was significantly higher and colder in DK17 compared to NT16, suggesting that the convective activity of the monsoon season 2017 was stronger than in 2016. This is corroborated by strong ozone depletion in the ATTL and CLS in DK17, which was not observed in NT16. Finally, an isolated water vapor maximum in the Confined LS was found in DK17, which we argue is due to overshooting convection injecting ice crystals directly above the CPT, and hence hydrating the CLS. This evidence suggests that the ASMA contributes to moistening the global stratosphere.

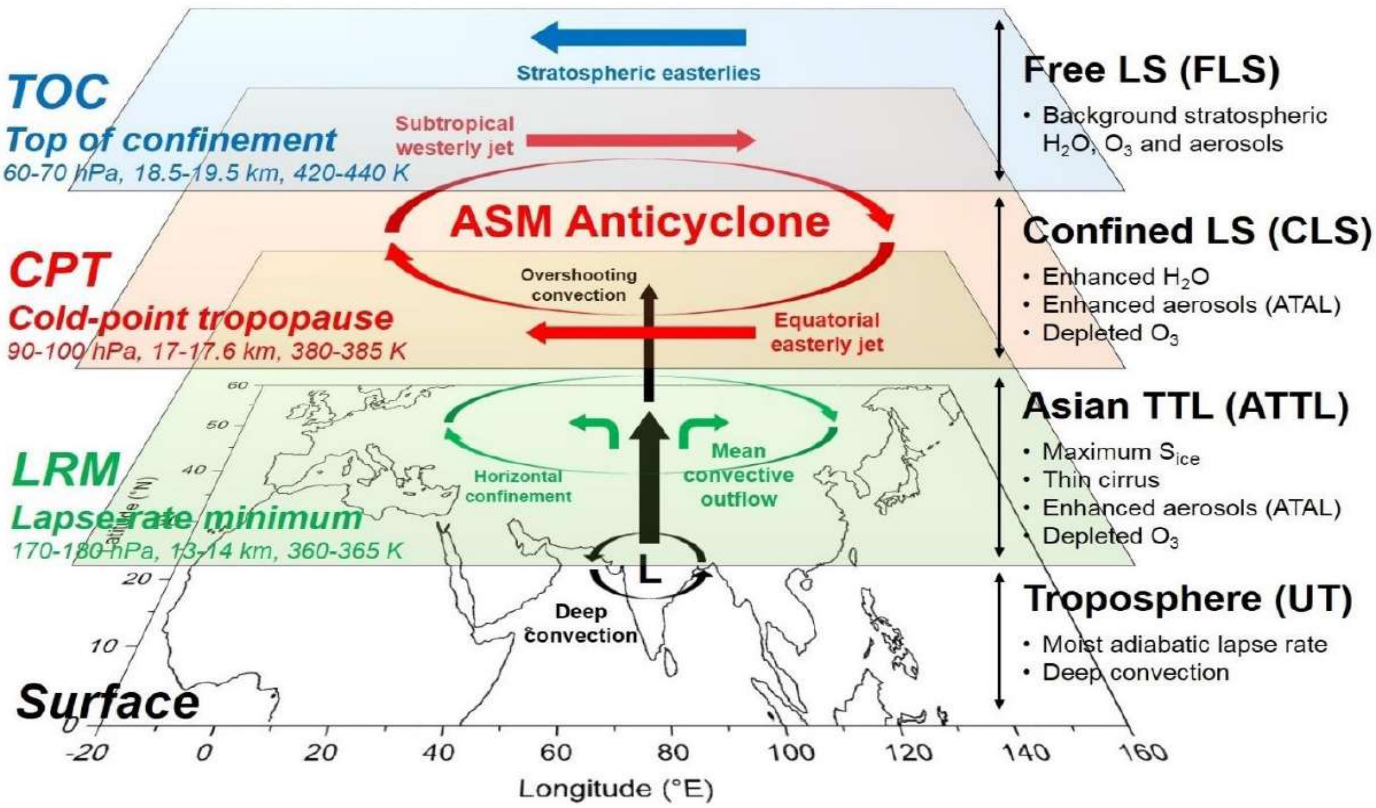


Figure 1. Schematics of the vertical structure of the Asian summer monsoon anticyclone (ASMA) above the southern slopes of the Himalayas. The ASMA consists of two layers: the Asian tropopause transition layer (ATTL) and the confined lower stratosphere (CLS). These layers are confined by three levels: the lapse rate minimum (LRM, green), the cold-point tropopause (CPT, red) and the top of confinement (TOC, blue).

## Topic 2: The Basis and Development of the CMIP6 Stratospheric Aerosol Record

Stratospheric aerosols are important climate forcers as they scatter a part of the incoming solar radiation back to space, thus cooling the earth surface and troposphere, and absorb a part of the upwelling terrestrial radiation, thus heating the stratosphere. In addition, they are important players in stratospheric ozone chemistry, hosting important heterogeneous reactions. Volcanic eruptions can modulate both radiative and chemical effects of stratospheric aerosol by more than an order of magnitude. Here we present a data record of size distributions and the radiative properties of stratospheric aerosols from 1850 to 2014. Backbone of the dataset is GloSSAC1, the Global Space-based Stratospheric Aerosol Climatology, a continuous 35-year record of stratospheric aerosol extinction coefficients (1979-2014), tackling the issue of data gap filling. GloSSAC is based on the SAM/SAGE series of instruments through mid-2005 and on the OSIRIS and CALIPSO data thereafter. In the pre-satellite era, we use pyrheliometer data providing aerosol optical depth at 550 nm between 1883-1979, complemented by microphysical modeling, and before 1883 observations of moon eclipses and modeling. The resulting data set is termed “SAGE-3λ record”, because its backbone is the use of three SAGE II wavelengths. For the SAGE II time period, this allows to fit a lognormal size distribution to the extinction data, with mode radius $r_m$ and width $\sigma$. From the size distribution, the radiative properties required to force climate models (extinction coefficient, single scattering albedo, asymmetry factor) were calculated using the Mie theory for each wavelength band of each model. For other times, we apply correlations obtained from the SAGE II period of $r_m$ and of $\sigma$ to reduce the number of unknowns. SAGE-3λ compares well with other data not used in the record, making it ideal for use in global climate modeling such as CMIP6.

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