2578393

Exploitation of GOMOS, OSIRIS, OMI and MIPAS measurements for studying the change in the middle atmosphere (EGOMO)

Kyrölä, Erkki[1]*; Liu, Yi*[2]

[1]*Finnish Meteorological Institute;* [2]*Key Laboratory of the Middle Atmosphere and Global Environmental Observation (LAGEO), Institute of Atmospheric Physics, Chinese*

The aim of the Dragon 2 EGOMO project (5311) was to study the natural variation in the middle atmosphere using large satellite data sets and modelling tools. We used data from four presently active satellite instruments: GOMOS and MIPAS on ENVISAT, OSIRIS on Odin, MLS and OMI on EOS-Aura. Several middle atmosphere chemistry-transport/climate models were used: Meso-ROSE, FinROSE, MOZART-3, WACCM, and HAMMONIA. We have constructed day and night climatologies for O3, NO2 and NO3 using GOMOS and OSIRIS measurements. The same measurements have been used to build up and analyse stratospheric and mesospheric time-series of ozone, NO2 and NO3 for 2001-2010. Using measurements from the SAGE II instruments we have extended the ozone time series to cover 1984-2011. Time series have also been retrieved from the Meso-Rose model and compared with time series measured by satellites. All these time series have been analysed by fitting trends, annual and semi-annual cycles as well as solar and quasi-biennial oscillation (QBO) proxies. The QBO and semi-annual oscillation (SAO) characteristics of O3, NO2, and NO3 from 2002 to 2008 were analysed using GOMOS observations. We found that dynamical transport is the principal factor controlling the QBO pattern of O3. The QBO signals of O3 originate in the middle stratosphere and propagate downward along with the anomalies of the vertical residual circulation over the equator. We also analysed the NO2 anomalies and found that their QBO pattern was deep and stationary in the middle and upper stratosphere over the equator. The interannual anomalies of NO3 displayed an apparent SAO pattern in the tropical upper stratosphere due to different dynamical and chemical effects in different SAO phases. Extreme events in the atmosphere, such as sudden stratospheric warmings, are one of the central studies of the EGOMO project. The response of the middle atmosphere trace gases during several sudden stratospheric warmings in 2003-2008 was investigated using measurements from GOMOS and MLS. Significant changes in the chemical composition of the middle atmosphere have been found. Changes are not restricted to stratosphere but they extend to mesosphere and lower thermosphere, and they are influenced by chemical and dynamical processes. The experimental spatio-temporal distributions have been compared with the ones calculated by the FinROSE chemistry-transport model and generally a good agreement is found for stratospheric changes. Other research activities within the project include: studies of gravity wave activity and breaking during sudden stratospheric warmings (using the GOMOS scintillation measurements), analyses of small-scale variability of ozone field (using GOMOS and ozone sonde data), the formation of a record ozone minihole over the Tibetan Plateau in December 2003 (using GOMOS and MIPAS data), and studies related to spring-time ozone asymmetry over Antarctica caused by planetary wave activity (using OMI, GOMOS and MLS measurements).

Dragon project id
20 CHEMISTRY / CLIMATE CHANGE (ID. 5311)

利用GOMOS, OSIRIS, OMI 和 MIPAS 观测数据研究中层大气变化过程

Erkki Kyr?l?1 and 刘毅2

1. Finnish Meteorological Institute, Earth observation unit, P. O. Box 503, 00101 Helsinki, Finland
2. 中层大气与全球环境探测重点实验室 (LAGEO), 大气物理研究所,中国科学院 (CAS), P.O. Box 9804, 北京 100029, 中国

龙计划2期EGOMO项目(编号：5311)的研究目标是利用多种卫星观测资料及大气数值模式研究中层大气的自然变化过程。研究使用的分析数据主要来自目前运行状况良好的卫星观测，其中包括欧洲空间局ENVISAT卫星搭载的GOMOS、MIPAS传感器资料，Odin卫星搭载的OSIRIS传感器资料以及美国航空航天局EOS-AURA卫星搭载的MLS和OMI传感器资料。同时，还使用了多种中层大气动力/化学模式对观测资料进行辅助分析，这主要包括：Meso-ROSE、FinROSE、MOZART-3等化学输送模式以及WACCM和HAMMONIA等中层大气化学-气候模式。在本项目执行的四年中,我们利用2001-2010年间GOMOS，OSIRIS观测资料建立了平流层、中间层O3、NO2以及NO3 的日/夜气候态数据集以及时间序列，并利用SAGE II观测资料将臭氧气候序列扩展至1984-2011。在此基础上，利用观测资料对Meso-ROSE模拟结果进行比较，并分析了上述化学成分的长期趋势、季节与半年循环特征，以及它们与太阳活动之间的关系。同时，本项目利用2002-2008年间GOMOS观测资料分析了热带地区O3、NO2以及NO3的准两年振荡（QBO）与半年振荡（SAO）特征。其中，O3的QBO特征主要受大气动力输送的作用所控制，其信号随垂直剩余环流异常自平流层中层向下传播。NO2的异常信号在赤道平流层中、高层较为深厚和稳定。而NO3的年际异常在热带平流层高层表现为明显的半年振荡特征，它与热带平流层不同SAO位相中动力、化学作用有关。

同时，中层大气中的极端事件（如平流层爆发性增温事件）也是本项目的核心研究内容之一。本项目利用GOMOS与MLS卫星观测资料研究了2003-2008年间平流层爆发性增温期间中层大气化学成分的变化。由于受到不同动力、化学过程的影响，上述化学成分的变化在平流层、中间层以及热层低层具有不同的表现。比较研究表明，FinROSE化学输送模式较好地再现了观测资料中化学成分的时空变化特征。 同时，我们还进行了多方面的研究：利用GOMOS观测资料分析了爆发性增温事件中重力波的活动与破碎，利用GOMOS与MIPAS资料揭示了2003年12月青藏高原上空"微型臭氧洞"形成的原因，利用OMI、GOMOS和MLS观测资料分析了行星波扰动在春季南极臭氧非对称性形成中的作用。

龙计划2期EGOMO 项目（编号：5311）