論文 / 著書情報
Article / Book Information

題目(和文)	国際宇宙ステーション搭載超電導サブミリ波リム放射サウンダによって観測された中間圏・下部熱圏の大気微量成分の変動
Title(English)	Variability in atmospheric minor constituents in the mesosphere and lower thermosphere observed by the Superconducting Submillimeter-Wave Limb-Emission Sounder from the International Space Station
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	化学環境学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（　理学　）
学生氏名： Student's Name	栗林 康太	指導教員（主）： Academic Advisor(main)	吉田 尚弘
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The mesosphere and lower thermosphere (MLT) is intermediate region between Earth' atmosphere and space, and affected both from space and lower Earth's atmosphere. High energy protons, produced by solar eruptions, reach to the MLT region and produce active radicals, such as nitric oxide and hydrogen oxide, which contributes to the natural ozone variability in the stratosphere. On the other hand, atmospheric waves induced in the lower atmosphere transports energy and momentum to the MLT region, which causes meridional and vertical circulations in the MLT region. The measurements of atmospheric minor constituents in the MLT region is difficult relative to one in the stratosphere, since the abundance of atmospheric minor constituents become smaller, and observation methods are limited. A quantitative understanding of the chemical, dynamical, and radiative behavior of minor constituents is required to improve the understanding of the atmospheric system in the MLT region.

The purpose of this thesis is to understand a feature and mechanism of chemical and dynamical behaviors of atmospheric minor constituents in the MLT region. The limb-emission spectra acquired by the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) were used for this study. The SMILES spectra of ozone (O3) and hydroperoxy radical (HO2) were used to understand diurnal variations of hydrogen-oxygen chemistry in the MLT region, since O_3 and HO_2 are short-lived species in the MLT region. Moreover, the SMILES spectra of hydrogen chloride (HCl) were used to understand dynamics in the MLT region, since HCl is one of the long-lived species in the MLT region. The vertical, latitudinal, and seasonal variations of HCl are controlled by the dynamics in the MLT region. I developed the optimized retrieval algorithm for vertical profiles of O_3, HO_2, and HCl in the MLT region that includes (1) an improvement of an a priori profile and covariance matrix of target species using the Whole Atmosphere Community Climate Model version 4 driven with specified dynamical fields (SD-WACCM) calculations, (2) an optimization of spectral windows and retrieval altitude grid, and (3) an improvement of temperature and pressure profiles using the Ground-to-topside model of Atmosphere and Ionosphere for Aeronomy (GAIA) calculations. The vertical profiles of O_3, HO_2, and HCl in the MLT region were obtained with lower random and systematic errors compared with previous products.

The diurnal variations of HO_2 and O_3 in the mesosphere and mesopause were derived from SMILES observations using developed optimal retrieval method. The diurnal variation in the mesopuase is reveled for the first time, and diurnal variations of HO_2 and O_3 in the mesopause are different from that in the mesosphere and stratosphere. The event enhancement peak appeared after the sunset in a day for both HO_2 and O_3. I also developed 1D chemical box model for quantitative understanding of the chemical mechanism of diurnal variations of HO_2 and O_3 in the mesosphere and mesopause. I understood that the event behavior during a day in the mesopause is caused by the longer life time of atomic oxygen and atomic hydrogen in the mesapuase than that in mesosphere and stratosphere. By comparison of model result and observation.

The vertical distribution of HCl in the MLT region were obtained by SMILES observations, and showed an increase and decrease in the upper stratosphere and lower thermosphere, respectively. The MLT vertical profile of HCl agree well between SMILES observation and SD-WACCM model calculation in equator region. The latitudinal and seasonal variations of HCl in the lower thermosphere were also revealed for the first time. These variations were caused by various dynamical process in the MLT region, including the semi-annual oscillation and intraseasonal oscillation.

I revealed the actual atmospheric conditions in the MLT region using SMILES observation data sets as follows: 1) Diurnal variations of HO_2 and O_3 from mesosphere to mesopause: The chemical mechanism of hydrogen-oxygen chemistry was qualitatively understood in MLT region including diurnal variation. 2) Vertical, seasonal, and latitudinal variations of HCl in the MLT region: The Cl atomic radical might open a new active chemistry in the MLT region after the anthropogenic chlorine injection into the atmosphere in the 1950s. Future investigations should be important for understanding what humans have done to the upper atmosphere.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).