

AIRS 高解像温度データを用いた重力波の年々変動及び季節内変動の解析 Interannual and intraseasonal variability of gravity waves revealed from high resolution AIRS observations

土屋 主税¹; 佐藤 薫^{1*}; Alexander M. Joan²; Hoffmann Lars³
TSUCHIYA, Chikara¹; SATO, Kaoru^{1*}; ALEXANDER, M. joan²; HOFFMANN, Lars³

¹ 東大院理, ² ノースウエスト研究所, ³ ユーリヒ総合研究機構

¹University of Tokyo, ²NorthWest Research Associates, ³Forschungszentrum Juelich

An analysis was made of high-resolution temperature data from satellite onboard Atmospheric Infrared Sounder (AIRS) over eight years from 2003/2004 to 2010/2011 to examine gravity wave (GW) characteristics around an altitude of 40 km in terms of the interannual and intraseasonal variability in austral summer (DJF). AIRS is a nadir-view instrument and sensitive to the temperature fluctuations with vertical wavelengths greater than 15 km. The S-transform was applied to the data series in both cross-track or along-track directions to estimate GW characteristics. First, the DJF-mean time series of GW amplitudes and precipitation were regressed to the sea surface temperature time series in NINO.3 region. It is shown that both GW amplitudes and precipitation are large to the northeast (southwest) of the South Pacific convergence zone (SPCZ) in the El Nino (La Nina) phase. Second, the intraseasonal variation of GWs were examined in terms of the Madden-Julian Oscillation (MJO). Ten-day-mean time series was examined as a function of the longitude for GW amplitudes and precipitation that were averaged over the latitudes of 0-20S. Large GW amplitudes are observed in association with the eastward migrating precipitation of MJO, which is more clearly described by a regression to the Real-time Multivariate MJO Index. Another interesting finding is that the GW amplitudes are significantly weak when the zonal wind at 100 hPa is eastward regardless of the precipitation amount. These results suggest that the interannual and intraseasonal variations of GWs in the subtropical middle stratosphere are modified largely by ENSO and MJO through the precipitation as GW sources and the zonal wind around the tropopause regulating GW vertical propagation.

キーワード: 重力波, ENSO, MJO, QBO

Keywords: gravity waves, ENSO, MJO, QBO

南極昭和基地における下部成層圏水蒸気観測 Balloon-borne observations of lower stratospheric water vapor at the Antarctic Syowa Station

富川 喜弘^{1*}; 佐藤 薫²; 堤 雅基¹; 中村 卓司¹; 平沢 尚彦¹
TOMIKAWA, Yoshihiro^{1*}; SATO, Kaoru²; TSUTSUMI, Masaki¹; NAKAMURA, Takuji¹; HIRASAWA, Naohiko¹

¹ 国立極地研究所, ² 東京大学

¹National Institute of Polar Research, ²The University of Tokyo

下部成層圏水蒸気量の変化は、大きな放射強制力を持つ。1980~90年代の下部成層圏水蒸気量の増加、および2000年以降の減少は、それぞれの期間の地表気温トレンドを3割程度増減させたと考えられている。しかし、水蒸気量は対流圏界面近傍で高度と共に大きく変動するため、鉛直分解能の低い衛星観測では捉えることができない。ゾンデや航空機による in-situ 観測も、多くは中低緯度域で実施され、極域で実施された例は少ない。南極昭和基地では、2013年に第54次日本南極地域観測隊 (JARE54) により3回の水蒸気ゾンデ観測が実施され、高度25km付近までの水蒸気量の高精度・高鉛直分解能データの取得に成功した。本発表では、これらの水蒸気ゾンデ観測の初期結果を報告し、今後の南極昭和基地での定常的な水蒸気ゾンデ観測の必要性について議論する。

キーワード: 水蒸気, ゾンデ, 南極, 下部成層圏

Keywords: water vapor, sonde, Antarctic, lower stratosphere

El Nino 期、La Nina 期に見られる熱帯域と中高緯度におけるプラネタリー波活動の 3 次元構造に関する研究 Three dimensional structure of planetary wave activity from tropical to extratropical regions in ENSO

木下 武也^{1*}; 佐藤 薫²; Hitchman Matthew, H.³
KINOSHITA, Takenari^{1*}; SATO, Kaoru²; HITCHMAN, Matthew, H.³

¹ 情報通信研究機構, ² 東京大学 大学院理学系研究科, ³ ウィスコンシン大学

¹Natl. Inst. of Information Comm. Tech., Japan, ²Graduate School of Science, The University of Tokyo, ³University of Wisconsin, Madison

El Nino Southern Oscillation (ENSO) に伴う熱帯域の対流活動のシフトに伴い、中高緯度域のオゾン分布が変調されることが知られている (Hitchman and Rogal 2010a,b)。この現象は、「熱帯域の対流に伴う上部対流圏の極向きの流れ」、「低渦位の極向き輸送に伴う亜熱帯高気圧の強化」、「中高緯度における総観規模擾乱活動の変調」といった 10 ~ 20 日スケールの応答によるものと考えられている。一方で、プラネタリースケールの擾乱活動の寄与も示唆されているが、まだ確認されていない。そこで本研究では、Kinoshita and Sato (2013a, 2013b)、Sato et al. (2013) により導出された波動平均流相互作用を 3 次元に記述可能な方程式系と解析手法を用い、上部対流圏から成層圏における ENSO に伴うプラネタリー波活動の変化について解析した結果を報告する。

まず、ERA Interim 再解析データを使用する。解析期間は 8~10 月とし、NOAA の Ocean Nino Index に基づき El Nino 期として 1991, 1997, 2002, 2004, 2006, 2009 年を、La Nina 期として 1998, 1999, 2000, 2007 年を選んだ。本研究で解析対象のプラネタリー波は、東西波数 1~3 の 30 日以上周期を持つ擾乱とした。このプラネタリー波活動を記述する 3 次元波活動度 flux 及びその収束発散を計算したところ、アジアモンsoon 域では、La Nina 期でプラネタリー波活動が大きく、熱帯上部対流圏から南半球高緯度成層圏に伝播している様子が見られ、El Nino 期では逆の応答が見られた。一方、太平洋東部では、El Nino 期でプラネタリー波活動が大きく、上記と同様の伝播が見られ、La Nina 期では逆の応答が確認できた。またどちらの領域・期間においても、高緯度対流圏におけるプラネタリー波は熱帯域上部対流圏から伝播してくる波とは異なる励起源の可能性が示唆された。今後は、上記結果に伴う物質輸送の 3 次元構造を明らかにし、Hitchman and Rogal (2010a,b) が示したメカニズムに伴う輸送と比較する予定である。

キーワード: 中層大気, プラネタリー波, 波活動度フラックス, 残差循環

Keywords: middle atmosphere, planetary wave, wave activity flux, residual mean circulation

A study of Antarctic ozone variation by using FORMOSAT-3/COSMIC observation A study of Antarctic ozone variation by using FORMOSAT-3/COSMIC observation

HSIAO, Chun-chieh¹ ; LIU, Jann-yenq^{1*} ; YU, Shiann-jeng¹
HSIAO, Chun-chieh¹ ; LIU, Jann-yenq^{1*} ; YU, Shiann-jeng¹

¹National Space Organization

¹National Space Organization

The Formosa Satellite 3, also named as the Constellation Observing System for Meteorology, Ionosphere, and Climate (abbreviated as FORMOSAT-3/COSMIC, F3/C), is a constellation of six micro-satellites, designed to monitor weather and space weather. The constellation was launched into an initial circular low-Earth orbit at an altitude of 512 km on 15 April 2006. The six micro-satellites have deployed to six mission orbits at around 800 km altitude with 30-degrees separation in longitude for evenly distributed global coverage. The major payload onboard F3/C, GPS occultation experiment (GOX) instrument daily provides more than 2000 soundings of atmospheric vertical temperature profile. By binning radio occultation observations, the three-dimensional temperature structure can be obtained to monitor Antarctic temperature variation. Real-time measurements of vertical temperature structures over the Antarctic region are important for monitoring the formation of polar stratospheric clouds (PSCs) which is a critical factor in the ozone variation. On the other hand, the Ozone Monitoring Instrument (OMI) in the Aura mission observes for total ozone and other atmospheric parameters related to ozone chemistry and climate. The instrument observes Earth's backscattered radiation with a wide-field telescope feeding two imaging grating spectrometers. In this work, more than 5 years observation will be used to make a quantitative comparison of ozone and atmospheric temperature variation in Antarctic.

キーワード: FORMOSAT 3/COSMIC, ozone, Antarctic

Keywords: FORMOSAT 3/COSMIC, ozone, Antarctic

衛星観測と気候モデルを用いた成層圏水蒸気の年々変動 Interannual variations of stratospheric water vapor in microwave limb sounding observations and climate model simulation

河谷 芳雄^{1*}; ジャエリー³; ハミルトン ケビン²
KAWATANI, Yoshio^{1*}; JAE, Lee³; HAMILTON, Kevin²

¹ 独立行政法人海洋研究開発機構, ² メリーランド大学, ³ ハワイ大学国際太平洋研究センター
¹JAMSTEC, ²University of Maryland, ³IPRC, Univ. Hawaii

Using the almost decade-long record of water vapor (H₂O) measurements now available from the Microwave Limb Sounder (MLS) instrument on the NASA AURA satellite, the time-height structure of interannual variations in H₂O content are investigated. The interannual anomalies display upward propagation below about 10 hPa in a manner analogous to the seasonal tape recorder, but at higher levels the anomalies in H₂O appear to propagate downward. An explanation for this effect is sought by examining stratospheric water vapor in simulations of a fine horizontal and vertical resolution (T106L72) version of the MIROC-AGCM. This model is notable for its rather realistic simulation of the quasi-biennial oscillation (QBO) in the tropical stratosphere. The interannual anomalies in simulated stratospheric H₂O display a similar propagation as seen in the MLS data. Further analysis shows that the upward propagation in the lower stratosphere is related to the mean advection of interannual water content anomalies induced by the QBO at the tropopause, while the downward propagation is due to the advection of the mean vertical gradient of water content by QBO's interannual fluctuations in the vertical wind. This conclusion is supported by additional experiments run with a modified MIROC that had a significantly different the mean vertical H₂O gradient in the middle and upper stratosphere. Also analyzed are global warming simulations in both the MIROC model and in several other global models included in the recent Coupled Model Intercomparison Project 5 (CMIP5). The upward propagating interannual H₂O variations are projected to become weaker in all these models because of a weakened QBO amplitude in the lowermost stratosphere.

キーワード: 赤道準 2 年振動

Keywords: quasi-biennial oscillation

気象庁 1 ヶ月ハインドキャスト実験における予報スキル変動の基本特性 Basic characteristics of forecast skill variations in JMA 1-month hindcast experiments

田口 正和^{1*}
TAGUCHI, Masakazu^{1*}

¹ 愛知教育大学
¹ Aichi University of Education

This study investigates basic characteristics of stratospheric predictability in the Northern Hemisphere using 1-month hindcast (HC) experiment data of the Japan Meteorological Agency for 1979-2009. We describe characteristics of forecast properties of spread, error (root mean square error), and anomaly correlation, contrasting the stratosphere and troposphere for different seasons, as well as explore the so-called spread-skill relationship for the winter stratosphere. We also examine the role of stratospheric sudden warmings (SSWs) in variations in the forecast skills. Our results show that for lead times shorter than about 10 to 15 days, the forecast skills of the HC data are higher on average and more variable in the stratosphere than in the troposphere especially for Northern winter. This is reflected in larger average and variability in predictable time limit, or characteristic time scale of useful predictions, for the winter stratosphere. We also reveal that the spread-skill relationship for the Northern winter stratosphere is characterized by the existence of notable outliers from their expected linear distribution; the outliers have markedly large errors, or low skills, for given spreads. Most of the outliers are contributed by HC sets initialized before observed major SSWs. Such HC data fail to reproduce the strength and/or shape of the stratospheric polar vortex including both onset and recovery phases of SSWs. The HC data tend to yield too strong vortex and shorter-than-average predictable limit.