Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

AAS21-P01 Room:Poster Time:April 30 18:15-19:30

Interannual and intraseasonal variability of gravity waves revealed from high resolution AIRS observations

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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.

Keywords: gravity waves, ENSO, MJO, QBO

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Balloon-borne observations of lower stratospheric water vapor at the Antarctic Syowa Station

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A variation of water vapor in the lower stratosphere has a large radiative forcing. It is considered that increase and decrease of lower stratospheric water vapor before and after 2000, respectively, altered the surface temperature trend by up to 30% in each period. However, since the water vapor content abruptly changes with height around the tropopause, it is hard to capture its variation exactly by satellite observations with a low vertical resolution. Many in-situ (i.e., balloon-borne and aircraft) observations with a high vertical resolution have been performed in low and middle latitudes, but few in the polar region. At the Antarctic Syowa Station (69.0S, 39.6E), three balloon-borne cryogenic frost-point hygrometer observations were performed in 2013 by the 54th Japanese Antarctic Research Expedition (JARE54), so that high precision and high vertical resolution data up to about a 25km altitude were obtained successfully. In this paper, a preliminary result of these observations is presented, and it will be discussed how important it is to continue the water vapor observation at Syowa Station.

Keywords: water vapor, sonde, Antarctic, lower stratosphere

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Three dimensional structure of planetary wave activity from tropical to extratropical regions in ENSO

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It is kwon that the distribution of extratropical column ozone is modulated with El Nino Southern Oscillation (ENSO) (Hitchman and Rogal 2010a, b). This modulation is recognized as the 10 ˜20 day-scale responses including ”Tropical convective outflow into the upper troposphere and lower stratosphere”, ”amplification of subtropical anticyclone associated with transport of low potential vorticity” and ”modulated synoptic scale disturbances in extratropical regions”. On the other hand, it is suggested that planetary scale disturbances influence the distribution of extratropical column ozone. However, this is yet to be identified. The present study examines the modulation of planetary wave activity associated with ENSO from upper troposphere to stratosphere using the formulae describing wave-mean interaction in three dimensions and analytical techniques derived by Kinoshita and Sato (2013a, 2013b) , Sato et al. (2013).

First, we use the ERA-Interim reanalysis data and focus from August to October. Based on the Ocean Nino Index by NOAA, 1991, 1997, 2002, 2004, 2006, 2009 are selected as El Nino seasons and 1998, 1999, 2000, 2007 are selected as La Nina seasons. The Planetary scale disturbances are defined as the waves with zonal wavenumbers 1 ˜3 and periods more than 30 days.

We calculated the three dimensional wave activity flux and its divergences associated with the planetary scale disturbances. The results show that the planetary wave activity is amplified around Asian monsoon regions in La Nina seasons and the planetary wave propagates from tropical upper troposphere to polar stratosphere. The planetary wave activity in El Nino seasons is weak in this region. On the other hand, in the eastern pacific regions, the planetary wave activity in El Nino seasons is amplified and the planetary wave propagates from tropical upper troposphere to polar stratosphere, while the activity in La Nina seasons is weak. It is suggested that the source of tropospheric planetary waves is different between tropical and polar regions in both seasons. We plan to calculate the three dimensional material transport associated with the planetary waves and compare the transport and that associated with the mechanism shown by Hitchman and Rogal (2010a, b).

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

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

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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 obits 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.

Keywords: FORMOSAT 3/COSMIC, ozone, Antarctic

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Interannual variations of stratospheric water vapor in microwave limb sounding observations and climate model simulation

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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 anomlies 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.

Keywords: quasi-biennial oscillation

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Basic characteristics of forecast skill variations in JMA 1-month hindcast experiments

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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.