Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

AAS020-P01 Room:Convention Hall Time:May 23 16:15-18:45

Phase speed and period of equatorial Kelvin waves around the tropopause

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We investigated period and phase speed of equatorial Kelvin waves around the tropopause. Typical cases of Kelvin waves with extremely large amplitude have different speed and period from those which are detected as a spectral peak in widely-used (e.g. Suzuki and Shiotani 2008, JGR) k-omega spectral diagram; in these cases, the period of the wave is longer (10-30 days) and speed is smaller (around 15 m/s) than those in spectral diagrams (5-10 days and 20-30 m/s).

We analyzed zonal wind at 100 hPa in re-analysis data made by European Centre for Medium-range Weather Forecast (ERA-40, 1979-2001). We can explain the difference in period by plotting the power value above the background value, instead of the significance defined by the ratio of power to the background. Peak of wave energy was found to be located in the lower frequency range than that of the significance. However, this alteration still does not account for the difference in phase speed. We traced zonal propagation of every Kelvin-wave case by using the method of Suzuki et al. (2010, JGR) and calculated the speed of waves. The average of speed is around 12-16 m/s at all longitude. The number of cases with the speed of larger than 20m/s, which corresponds to the spectral peak in a diagram, is very small.

We examined relationship between faster waves and slower waves. We found that slower waves ($<$20m/s) have shorter zonal wavelength, which results in a sharp shape in a zonal direction, and that they are rather confined in zonally smaller packet than faster waves ($>$20m/s). Therefore, they can be well traced regardless of their rather smaller power in climatological spectral diagram. In longitude-time section, both modes are seen to propagate rather independently and to be superposed almost linearly. On the other hand, Suzuki et al. (2010) has shown that both speeds are observed in a lifecycle of each wave case: slower waves initially coupled with convective activity at 200 hPa have faster speed in the eastern longitude after losing coupling several days later. The faster waves propagate further eastward and upward, and then re-couple with convection at 100 hPa and have smaller speed again. Our results indicate that, when investigating the mechanism of propagation and amplification of Kelvin waves, the relationship between two kinds of waves with different speed should be carefully examined.

Keywords: Kelvin wave, equatorial wave

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Simulations of 21st century climate using a chemistry-climate model: Comparison with fixed-halogen and -climate runs

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Future changes in wave forcing and transport characteristics of the middle atmosphere are examined using multidecadal simulations carried out with a chemistry-climate model (CCM) developed at the Meteorological Research Institute (MRI-CCM). First, we conducted a control experiment through the 21st century under the forcing prescribed according to the CCM Validation Activity (CCMVal-2) for SPARC REF2 scenario, in which both the greenhouse gas (GHG) and ozone depleting substance (ODS) forcings vary transiently in time. In the control experiment, subtropical wave forcing strengthens in the lower stratosphere especially in both summer hemispheres. However, wave forcing over the Antarctic is decreased in spring and summer as a result of an earlier breakdown of the polar vortex in the future period. Next, we conducted two sensitivity experiments in which either GHGs or ODSs are held fixed at 1960 levels, while the other forcing varies transiently as in the control experiment. Comparing the two sensitivity experiments with the control experiment, the relative impacts of the ODS and GHG forcings on the climate of the middle atmosphere are evaluated through 21st century.

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Early validation of the SMILES level 2 products

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To demonstrate the high sensitivity of 4-K cooled sub-mm limb sounders and to monitor global distributions of the stratospheric trace gases, the Japan Aerospace eXploration Agency (JAXA) launched the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES) instrument to the International Space Station (ISS) in 2009 using the H-II Transfer Vehicle (HTV). SMILES has been transferred to normal operation phase on 6th November, 2009. Currently, level 2 products of the SMILES measurements has been evaluated.

Here we compare the latest data of SMILES with coincident observations from the other satellite-borne instruments (ACE-FTS, Aura/MLS, Odin/SMR and SCIAMACHY), by analysing volume mixing ratio profiles. The average values of the mean relative differences are consistent within the margin of error.

Keywords: SMILES

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Development of semi centimeter-wave atmosphere observation system for stratospheric water vapor distribution

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For better understandings of the mechanism of long-term changes of the stratospheric water vapor distribution and the relation with the global warming, it is important to monitor variations of the stratospheric water vapor continuously. Observations of the stratospheric water vapor are mainly made with a technique of UV and infrared spectroscopy. These can be observed only in daytime because these require the sunlight. On the other hand, an observation of the stratospheric water vapor with a microwave spectroscopy technique can be made in daytime and nighttime, because they observe an emission spectrum of the water vapor at 22 GHz band and do not require any light sources. In addition, a microwave observation is expected to be obtained an accurate dataset, because the atmospheric attenuation in this region is relatively smaller than that in the UV and infrared region. However, at present, ground-based microwave observations of the stratospheric water vapor are carried out only in 5 sites in the world because there are difficulties of the size of the instrument and lack of sensitivity of the receiver system. To improve these situations, we have newly developed a microwave observation system for the stratospheric water vapor which is equipped with low noise detector consisting of microwave MMIC amplifiers and a cooling system. The size of this instrument is expected to be much reduced than any other ones. In this presentation, we show hardware features, results of evaluation of the system as well as measurement results of the stratospheric water vapor.

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Feasibility Study on Observation of Water Vapor between Upper Troposphere and Lower Stratosphere using DIAL on JEM

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The need to improve the description of the global water vapour distribution extends to the upper troposphere and lower stratosphere. This is needed to improve our understanding of stratosphere/troposphere exchanges. Feedback processes linking the various components need to be better understood to realistically simulate, for instance, the level of increase of water vapour in a global warming scenario. For both the climate and numerical weather prediction communities, the specific need for improved vertical coverage and quality of water vapour observations is particularly evident. We propose on observation of water vapor between upper troposphere and lower stratosphere using DIAL on standard payload of JEM exposed facility.

Keywords: water vapor, upper troposphere, lower stratosphere, lidar, JEM

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Emission location dependent ozone depletion potentials for very short-lived halogenated species

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We present trajectory-based estimates of Ozone Depletion Potentials (ODPs) for very short-lived halogenated source gases as a function of surface emission location. The ODPs are determined by the fraction of source gas and its degradation products which reach the stratosphere, depending primarily on tropospheric transport and chemistry, and the effect of the resulting reactive halogen in the stratosphere, which is determined by stratospheric transport and chemistry, in particular by stratospheric residence time. Reflecting the different timescales and physico-chemical processes in the troposphere and stratosphere, the estimates are based on calculation of separate ensembles of trajectories for the troposphere and stratosphere. A methodology is described by which information from the two ensembles can be combined to give the ODPs.

The ODP estimates for a species with a fixed 20 d lifetime, representing a compound like n-propyl bromide, are presented as an example. The estimated ODPs show strong geographical and seasonal variation, particularly within the tropics. The values of the ODPs are sensitive to the inclusion of a convective parametrization in the trajectory calculations, but the relative spatial and seasonal variation is not. The results imply that ODPs are largest for emissions from South and South-East Asia during Northern Hemisphere summer and from the Western Pacific during Northern Hemisphere winter. Large ODPs are also estimated for emissions throughout the tropics with non-negligible values also extending into northern mid-latitudes, particularly in the summer. These first estimates, whilst made under some simplifying assumptions, show larger ODPs for certain emission regions, particularly South Asia in NH Summer, than have typically been reported by previous studies for emissions distributed over land in within broad latitudinal bands.

Keywords: ozone, troposphere-stratosphere-transport, short lived species, boundary layer emissions