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PEM05-P01 会場:3 階ポスター会場 時間:5 月 2 日 16:15-17:30

# Diurnal tide and QTD wave in the tropical stratosphere and MLT region: Long-term trends and solar cycle influence

Diurnal tide and QTD wave in the tropical stratosphere and MLT region: Long-term trends and solar cycle influence

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In the present study, long-term trends and solar cycle influence on the diurnal tide (DT) and quasi two day wave (QTDW) in the stratosphere, mesosphere and lower thermosphere (MLT) region over a tropical station Tirununveli (8.7oN, 77.7oE) are investigated using ERA-Interim datasets and MF radar observations available since 1993. As no ground truth is available over Tirununveli, suitability of the ERA-Interim data for the present study is ascertained using simultaneous radiosonde and MST radar observations over Gadanki (13.5oN, 79.2oE) and good consistency is found between the two. Amplitudes of the DT and QTDW over Tirununveli show a long-term linear increasing trend, which becomes prominent in the MLT region. Role of solar cycle on the DT and the QTDW is investigated by separating them with respect to the solar activity (minimum and maximum of solar cycles). Both the DT and QTDW show higher amplitudes during solar minimum and vice versa. Significant higher amplitudes in the recent extended solar minimum are noticed in the MLT region. However, no consistent relation is found between solar activity and DT in the stratosphere although increasing trend is clearly observed. Though increasing trend in the tropical convection is noticed at nearby locations, similar to the DT, it varies from location to location which may be due to large scale circulation effects. This demands data from network of radars located across the globe to see the combined effects of lower atmospheric forcing, circulation and their effects on MLT region.

キーワード: Diurnal Tide, Quasi-two day wave, Long-term trends, Solar cycle, Extended minimum
Keywords: Diurnal Tide, Quasi-two day wave, Long-term trends, Solar cycle, Extended minimum

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# 中間圏および下部熱圏における準二年周期振動と半年周期振動の振幅変調について
# MQBE and Amplitude Modulation of SAO in the MLT

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赤道域において、1 ヶ月平均した東西風に現れる特徴的な振動現象としては、成層圏では準二年周期振動 (QBO)、中間圏および下部熱圏 (MTL) では半年周期振動 (SAO) が有名である。加えて MLT では、二年または三年に一度春に西向き風が強まるという現象が出現することが分かっている。([Rao et al.,2012]) この現象を、以下では MQBE(Mesosphere Quasi-Biennual Enhancement) と呼称する。近年において Rao et al.,(2012) は、1993 年、1995 年、1997 年、2000 年、そして 2002 年の春に MQBE が出現したことを示し、一方で 2002 年以降ではこれらの現象が出現しなくなったということを報告した。しかし、赤道直下におけるレーダー観測の時間分解能が全く十分でないことや、また上空 50km から 80km にかけての風速を十分な空間精度で観測する方法が存在しないことなどから、MQBE の出現特性やその発生メカニズムはいまだに解明されていない。

そこで我々は、MQBE の出現特性を明らかにし、発生メカニズムを解明するため、カウアイ島・インド南部のツルネリベリ・クリスマス島・スマトラ島コトタバンなどのアジア・オセアニア域に展開する流星レーダーおよび MF レーダーから得られた、1990 年以降の長期にわたる風速データの解析を行った。さらに、NASA が提供する MERRA の全球再解析データを用いて、MLT と成層圏における 1 ヶ月平均した東西風の関係を調べた。解析の際、大学間連携プロジェクト”IUGONET”(Inter-university Upper atmosphere Global Obserbation NETwork) の提供する観測データおよび解析ツール”UDAS”を用いた。また、時系列データに対して周波数の変化と振幅変調を分離する Stockwell 変換を用いたスペクトル解析を行った。

東西風について解析した結果、MLT 領域の高度 80-100 km において西向き平均風速 32m/s を超える MQBE は、これまで報告されている年に加えて、2005 年、2008 年、2011 年においても出現することが分かった。また、Stockwell 変換を用いたスペクトル解析の結果、MQBE が出現するときに合わせて MLT 領域の SAO の振幅が増大しているということも分かった。さらに、MERRA の再解析データから得られた成層圏と下部熱圏の東西平均風から 6 ヶ月周期成分を抽出して比較した結果、下部熱圏 (90 km 付近) と成層圏界面付近 (1 hPa 付近) との間には負の良い相関関係 (相関係数は-0.6 程度でラグは 2 ヶ月以内)、および下部熱圏と成層圏下層 (70 hPa 付近) における 1 ヶ月平均した東西風とも良い相関関係 (相関係数は 0.6 程度でラグは 2 ヶ月以内) がみられることも判明した。前者の結果は、成層圏における SAO と中間圏における SAO の位相が逆転することと整合的である。

これらのことから、2002 年以降は出現していないと報告されていた MQBE が、実際には 2005 年以降も出現しているということが分かった。また、MQBE の出現特性についてはよくわかっていなかったが、出現時期と SAO の振幅変調との対応が明らかになった。加えて、MLT と成層圏との対応関係からは、成層圏界面もしくは成層圏下層において MQBE を駆動する現象が起きているのではないかという推測をすることができる。以上のことを総合すると、成層圏 QBO と同様に大気下層において生成される重力波が MQBE の駆動源として浮かび上がる。

今後の課題としては、MQBE を駆動するメカニズムの解明のため、赤道上空における重力波の解析を進めることが挙げられる。

キーワード: 流星レーダー, MF レーダー, 成層圏, 半年周期振動, 準二年周期振動
Keywords: meteor radar, MF radar, stratosphere, SAO, MQBE

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# Meteor Wind Radar Application for the study the dynamics of the neutral winds above at Kototabang and Biak station

Meteor Wind Radar Application for the study the dynamics of the neutral winds above at Kototabang and Biak station

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Currently for meteor observations is not only done with the naked eye and optical equipment such as a telescope, the latest development to detect natural phenomena meteor shower rained almost every day the Earth can be detected using radar technology. Meteor Wind Radar (MWR) is a radar system used to detect, analyse and display meteor entrance events to the Earth's atmosphere. By using of radar meteors (SKiYMET Meteor Radar) was used to observe the meteor trail (ionized air columns) that moves with the wind neutral layer of mesosphere. When a meteor enters the atmosphere it rapidly vaporises leaving behind a trail of ionised gas along its path of travel, this trail can form a target for a radar transmission. Generally the frequencies used for the detection of radar, located on the VHF band wave spectrum. The results of the analysis of radar data output consists of 7th meteor parameter can be used to study the behavior of neutral winds in the Mesosphere. In this paper the utilization of SKiYMet shown to detect Wind speed Meridional and Zonal Wind speed, Temperature in the Mesosphere and the number and received Flux meteor in the Earth, as a sources of data to better understand the dynamics of the neutral winds at an altitude of 70-110 km region of observation locations. Simultaneously measurement data will be shown at Kototabang observations that have been operating since year 2006 and in Biak Station since year 2011. All of the radar installation is a collaboration between LAPAN and RISH - Kyoto, NICT Japan.

キーワード: 流星レーダー, インドネシア, 赤道域, コトタバン, ビアク
Keywords: Meteor radar, Indonesia, Equatorial regiona, Koto Tabang, Biak

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# ISS-IMAP/VISI で観測された酸素分子大気光の同心円構造
# Concentric structures in molecular oxygen emission observed by ISS-IMAP/VISI

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Concentric structures in airglow emissions were often observed from ground based imagers. Some of them were thought to be caused by the active clouds in the troposphere. It was not able to observe the overall structures from the imagers on the ground under the cloudy condition. Field of views of the imagers were not enough to observe whole structure. Space borne imagers are able to observe the structures caused by the disturbances in the lower atmosphere with wider field of view. Concentric structures of the $O_2$ airglow emission in 762-nm wavelength were found by the Visible and near-infrared imager on the International Space Station on June 1, 2013 over the U. S. This is the first case which took the image from edge to the center of the concentric structure. Spatial scale of this concentric structures were estimated to be 1,200 km. Fine structures with 80 km wavelength and no dumping in the intensity were observed in this VISI observation. Amplitude in these fine structures were about 10 % to the background intensity. Circular structures were also observed in the GPS-TEC observations before the VISI observation. These concentric structures were estimated to be caused from the active clouds after tornado and atmospheric gravity waves had propagated in horizontal direction in the emission layer.
Keywords: Near infrared, Airglow, Concentric structure, the Mesosphere, Atmospheric gravity waves

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# Lamb 波と熱圏にトラップされた重力波のカップリング
# Background Lamb waves coupled with thermospheric gravity waves

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Lamb waves of the Earth's atmosphere in the millihertz band have been considered as transient phenomena excited only by large events. Nishida et al. (2014) showed the first evidence of background Lamb waves in the Earth's atmosphere from 0.2 to 10 mHz, based on the array analysis of microbarometer data from the USArray in 2012. The observations suggest that the probable excitation source is atmospheric turbulence in the troposphere. Theoretically, their energy in the troposphere tunnels into the thermosphere at a resonant frequency via thermospheric gravity wave because the Lamb-wave branch intersects that of thermospheric gravity waves at 3.5 mHz and that of acoustic waves trapped near the mesopause at 6.5 mHz [Garrett 1969]. The observed FK spectrum shows a local minimum of Lamb-wave amplitudes at around 3.5 mHz, where the Lamb-wave branch is crossed by the thermospheric gravity-wave branch. Coupled Lamb waves leak a certain amount of energy from the troposphere to the thermosphere, reducing the Lamb-wave amplitudes at the crossover frequency relative to those at neighboring frequencies, when their excitation sources exist in the troposphere. The energy tunnels from the troposphere to the thermosphere at the resonant frequency, although Lamb waves themselves cannot induce an upward flux [Lindzen 1972]. The RMS amplitudes of the coupled modes are estimated to be 0.3 m/s at 150 km and 0.1 m/s at 120 km, respectively. These modes might contribute to the thermosphere energy balance by heating via viscous dissipation [Hickey et al. 2001]. The amplitude suggests that the Lamb waves partly contribute to the excitation of thermospheric wave activity associated with severe convection activity [Hunsucker1982].
Keywords: Atmospheric Lamb wave, Thermospheric gravity wave

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# MLT 領域モニターのためのアルカリ金属蒸気レーザを用いた簡易な共鳴散乱ライダーの提案
# A proposal of simple resonance scattering lidar using an alkali metal vapor laser for monitoring the MLT region

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Many observations of metal atomic layers such as Na, Fe, K, Ca and Ca ion in the mesopause region have been conducted in many parts of the world. We have observed several mesospheric metallic layers at Tokyo and Indonesia using resonance scattering lidars consisting of a dye laser and a Ti:Sapphire laser [1]. Especially, in order to solve the formation mechanism of metallic sporadic layers occurred in the mesopause region, the simultaneous observation of Ca ion and the neutral metal atom is necessary. However since the output power of the Ti:Sapphire laser has a low damage threshold of a crystal, it is difficult to improve the output average power. We propose the resonance scattering lidar consisting of the alkali vapor laser for monitoring the MLT region. Optically pumped alkali vapor lasers have attracted increasing attention because of their potential of achieve high power in a high quality beam. The alkali vapor laser can easily realize narrow-linewidth and precise tuning.

Metal atomic layers in the mesosphere are an excellent tracer of the atmospheric wave motion in the region between 80 and 100km. sudden formation of thin metallic layers, superposed in the background mesospheric metallic layers was discovered and these enhanced layers are called the sporadic metallic layers. We have observed frequently the sporadic sodium layers (Nas) at Hachioji, Japan (35.6N, 139.4E) and the sporadic sodium and iron layers (Fes) at Kototabang, Indonesia (0.2S, 100.3E). The ion recombination mechanism invoking wind shear and sporadic E layers appears to be consistent with many observed characteristics, but their cause is still an open question.

Zhdanov et al. presented optically pumped continuous wave potassium vapor laser operating in a single longitudinal and a single transverse mode at 770 nm [2]. Zweiback et al. demonstrated a high efficiency potassium vapor laser using a 0.15nm bandwidth alexandrite laser as the pump source [3]. The alkali vapor laser operates in a three level scheme. The optical pump source excites the D2 line of alkali atom and lasing occurs on the D1 line. To provide a population inversion, fast quenching must be provided by using a buffer gas. We are developing a high peak power pulsed potassium vapor laser using alexandrite laser as the optical pump source. Sealed potassium vapor cell had AR coated windows, and filled with metallic potassium and helium. The cell was assembled inside an oven which had temperature controlled heaters. A pump beam polarized in the horizontal plane was focused through the polarizing beam splitting cube into the potassium vapor cell with a lens. A laser cavity was created for the vertical polarization by two mirrors and the beam splitting cube.

The development of these kinds of lasers is identified as one of the key topics for advancing the application of resonance scattering lidar systems.

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キーワード: 中間圏界面, 金属原子層, 共鳴散乱ライダー, 金属蒸気レーザー
Keywords: mesopause, metal atomic layer, resonance scattering lidar, metal vapor laser