LIDAR OBSERVATIONS OF STRATOSPHERIC AND MESOSPHERIC TEMPERATURE STRUCTURE OVER THE EQUATOR

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ABSTRACT

In the equatorial region, temperature observations have hardly been reported. A lidar site was built in Kototabang, Indonesia (0°S, 103°E) and the Rayleigh lidars are continuously performed to observe temperature structure. During April 2005 to February 2006, about 40 succesful datasets was obtained. Here, we report the characteristics of temperature structures in these nights.

1. INTRODUCTION

Information regarding the temporal and spatial structure of the Earth's atmospheric temperature over a wide vertical range is essential for an understanding of the Earth's climate. Discontinuous measurements of temperature profiles are insufficient for observational coverage of the temperature structure. Dynamic processes, such as tidal and gravity waves, strongly influence the temperature profile from the upper troposphere to the mesosphere. The vertical propagation range and the changes in properties of these waves (wavelength, amplitude, etc) are still under scientific discussion. Experimental analyses of these dynamic processes in the Earth's atmosphere require continuous observation with good temporal and vertical resolution. The Rayleigh lidar technique has been used for atmospheric probing and proven to be a very powerful technique for investigating the middle atmosphere. Many observations has been reported[1; 2].

2. OBSERVATIONS

The continuous temperature observations have been established in Kototabang (0°S, 103°E). From April 2005 to February 2006, about 40 nights have been performed, of which 13 nights were performed more than 3 hours. For example, Fig.1 shows one of the mean temperature profiles, observed 2 June 2005. Although vertical resolution is 150 m, vertical profiles are smoothed 1.05, 2.25, 3.75, 6.15 and 9.15 km in altitude 30-39, 39-50, 50-64, 64-75 and 75-84 respectively to improve Signal to Noise ratio. The smoothing method is reported by *R.A.Ferrare et al.*[3]. Observation period is 7 hours. It is necessary to fit the temperature profile with an atmospheric model at the top level of the measurement. We have used the respective latitude and monthly values of MSISE-90[4]. Error bars are temperatures when the reference temperature is changed ±30 K. In mesosphere altitude range 70-84 km, the inversion layer can be confirmed. In stratosphere altitude range 35-50 km, the wave can be confirmed.

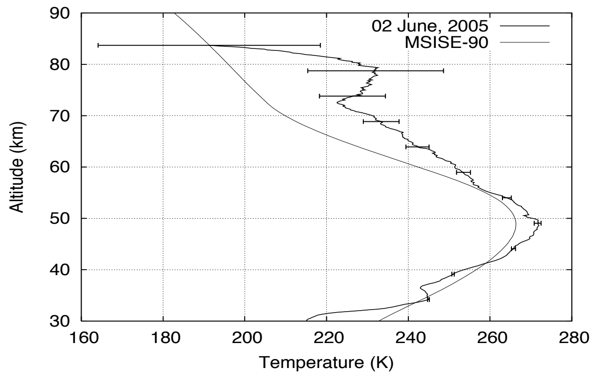

Figure 1. Temperature profile during the night of 02 June 2005 and MSISE-90 model in June at 0°S.

Beside the absolute measured temperature it is the temperature variation that shall be quantified depending on time and altitude. This can be used to characterize the wave parameters. The contour map of the altitude and temporal relative temperature perturbation is helpful to investigate the wave's amplitude, period and vertical wavelength. Here, the relative temperature perturbations are the ratio of the deviation of the particular temperature profile from the night mean profile to the night mean profile. Fig.2 shows the altitude-time contour of the relative temperature perturbation during the 30 May to the 1 June 2005. Below 45 km, the downward phase propagation of the upward propagating waves is visible. The color coding reveals dominating vertical wavelengths of about 7 km, depending on time and altitude. The phase is downward from altitude 39km at 22 to 35 km at 28(4 of the next day). So, the phase velocity is found -0.5 km/h.

Because the pressure fluctuations are negligible in comparison with the associated density and temperature fluctuations, the ideal gas law can be used to show that

$$\frac{\rho'_a}{\bar{\rho}_a} \approx -\frac{T'}{\bar{T}} \tag{1}$$

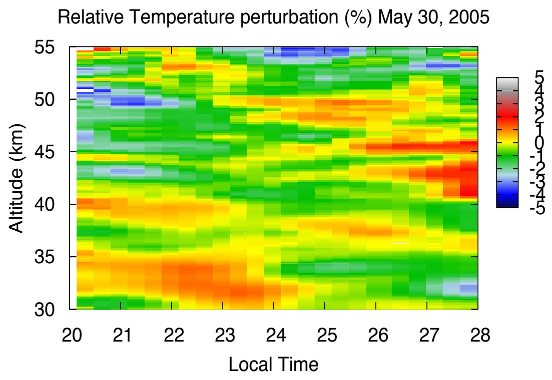

Figure 2. Altitude-time contour of the relative temperature perturbation during 30 May to 1 June 2005.

Where, $\rho'_a/\bar{\rho}_a$ is relative atmospheric density perturbation, and $T'/\bar{T}$ is relative temperature perturbation. Because the density perturbations are caused by gravity waves, the lidar data were used to investigate the mean-square density perturbations as a function of altitude. The density profiles are calibrated by model value at altitude 30 km. The mean-square atmospheric density perturbations can be estimated by averaging $(\rho'_a/\bar{\rho}_a)^2$ over the observation period. The 13 successful nights observed more than 3 hours are calculated the mean-square atmospheric density perturbations. These are averaged in the dry season (April-August 2005) and the monsoon season (January-February 2006). Fig:3 shows the seasonal average rms atmospheric density perturbation. The average rms atmospheric density perturbation in the dry season is constant (2 %) to 55 km and then rapidly increases. The average rms atmospheric density perturbation in the monsoon season increases slowly 2.5 % near 35 km to 4.8 % near 57 km. Comparing The average rms atmospheric density perturbations in 1989 at Arecibo(18°N, 67°W)[5] to the perturbations at Kototabang, the perturbations at Arecibo is almost constant (1 %) to 45 km and then increase to 5 %. Thus the perturbations at Kototabang are larger than at Arecibo and the point that increase rapidly is higher. Here the altitude of stratopause at Kototabang, Arecibo is 50, 45km respectively. The perturbations at Kototabang increase rapidly over stratopause.

3. CONCLUSIONS

The existence of inversion layer in mesosphere in equatorial region during 2 June 2005 was confirmed. Because also in 5 June 2005 the inversion layer was confirmed, it's considered that for a few days the inversion layer existed or often occurred. In 13 nights observed more than 3 hours during April 2005 to February 2006 the relative temperature perturbations were computed. The characteristic profile during 30 May 2005 in particular shows as altitude-time contour. Below 45 km, wave propagating

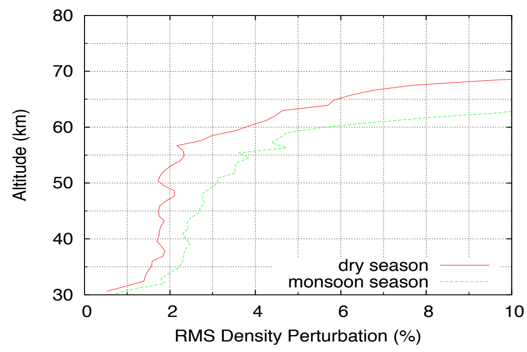

Figure 3. Altitude profile of the average rms atmospheric density perturbations for the dry and monsoon season in 2005, 2006.

was visible. The phase velocity is -0.5 km and wavelength is about 7 km. In addition, about 13 nights the rms atmosphere density perturbations were computed, compared between the average perturbation in dry and monsoon season, and compared between at Kototabang and at Arecibo. As a result, the perturbations at Kototabang were larger than at Arecibo. In future, more data should be collected, analyzed.

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