THE TOPSIDE BEHAVIOR IN THE MESOSPHERIC SODIUM LAYER OBSERVED BY LIDAR AT YANQING AND AT HAIKOU

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1. INTRODUCTION

Due to meteoric ablation, large amounts of metal atoms deposit in the mesopause region, forming the metal layers that can be observed by ground based lidars. It is widely acknowledged that the meteoric metal layers are normally confined to altitudes of 75-115 km. In fact, the density decreases with increasing altitude and becomes undetectable at a certain altitude due to noise, thus the high metal layer is often overlooked.

As Hoffner and Friedman (2005) pointed out, the observable upper limit of the topside layer depends largely on the performance of the instruments, the integration time and the observation conditions. With the support of the Chinese Meridional project in the eastern hemisphere, two brand new sodium fluorescence lidars with the same configuration were respectively set up at Yanqing (40.45°N, 115.98°E) and Haikou (20.04°N, 110.34°E) in April, 2010. They displayed powerful detection capabilities which allow us to study the mesospheric sodium layer topside.

2. DATA DESCRIPTION AND METHODOLOGY

The data at Yanqing is obtained from April 2010 to June 2012, and a total of 358 nights of data are valid, corresponding to 266 days of year. The overwhelming majority of the data gaps are only 1-2 days with the largest gap of 12 days. The data at Haikou is obtained during the period of April 2010 to December 2012. A total of 289 nights of data are valid, covering 216 days of year. The typical data gap is 1-2 days, with the largest data gap of 16 days. Due to the good coverage, these datasets may reflect the actuality more accurately. Following the method of (Hoffner and Friedman, 2004) in which all the sporadic layer profiles were included in calculation of the seasonal/annual variations of the sodium layers: First, the nightly mean sodium density profiles are derived for each observational night of year. Only the profiles with the sensitivity at 88.32 km greater than the mean plus the standard deviation were used to calculate the nightly mean. Besides, the valid profiles must exceed 2 hours. Second, linear interpolations are applied to fill the data gaps. Third, the data are smoothed with a two dimensional Hanning filter of 14 days and ±2.5 km.

3. OBSERVATIONS

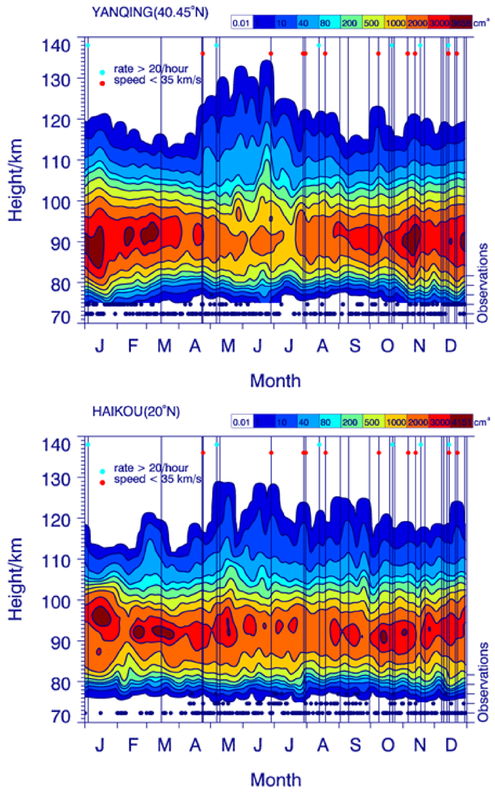

Figure 1. Seasonal variations of Na densities at Yanqing (40.45°N) and Haikou (20°N). The day of year when observations were made are denoted in the lower part of the panels, with the number of observations on a given day indicated by the height of the symbol with right-hand ordinate. The vertical lines indicate dates of known meteor shower activity provided by http://www.imo.net/ during the same period as the observations performed. The colored dots provide information about different properties of the meteor showers.

- Sodium layers exist consistently above 110 km, often observable at altitudes as high as 130 km.
- There are always certain extensions at the topside layer all year long.
- During summer, these extensions are especially obvious due to their remarkable height and intensity.

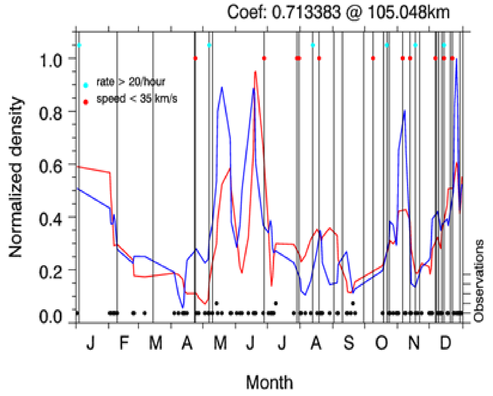

Figure 2. The seasonal densities at 105 km for 90 nights of simultaneous observations at Yanqing (red) and Haikou (blue) with a Hanning filter of 6 days applied. The correlation coefficient reaches 0.71.

- The variation trends are remarkably similar.
- Almost all of the major peaks can be found one by one, and their relative strengths are reproduced to a large degree.
- The correlation coefficient is calculated to be 0.71.

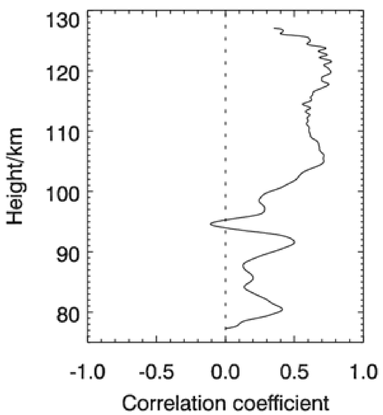

Figure 3. Correlation coefficients at different altitudes for 90 nights of simultaneous observations at Yanqing and Haikou.

4. SUMMARY

The comparison of the Na layer at Yanqing (40.45oN) and Haikou (20oN) reveals a strong correlation between these two sites (~2300 km apart) in the topside layer. They both show an extension to 120 km and above, predominantly during summer. Simultaneous observations at these two sites show that the topside extension effect is global. Comparison with known meteor showers shows that most of these extensions correspond well to one or more meteor showers, although not one by one. Meteor showers with velocities less than 35 km/s appear to have more influence on these extensions.

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