# Comparisons of mesospheric temperatures between 70 and 110 km: USU lidar, NASA's TIMED satellite, and the MSIS2 empirical model

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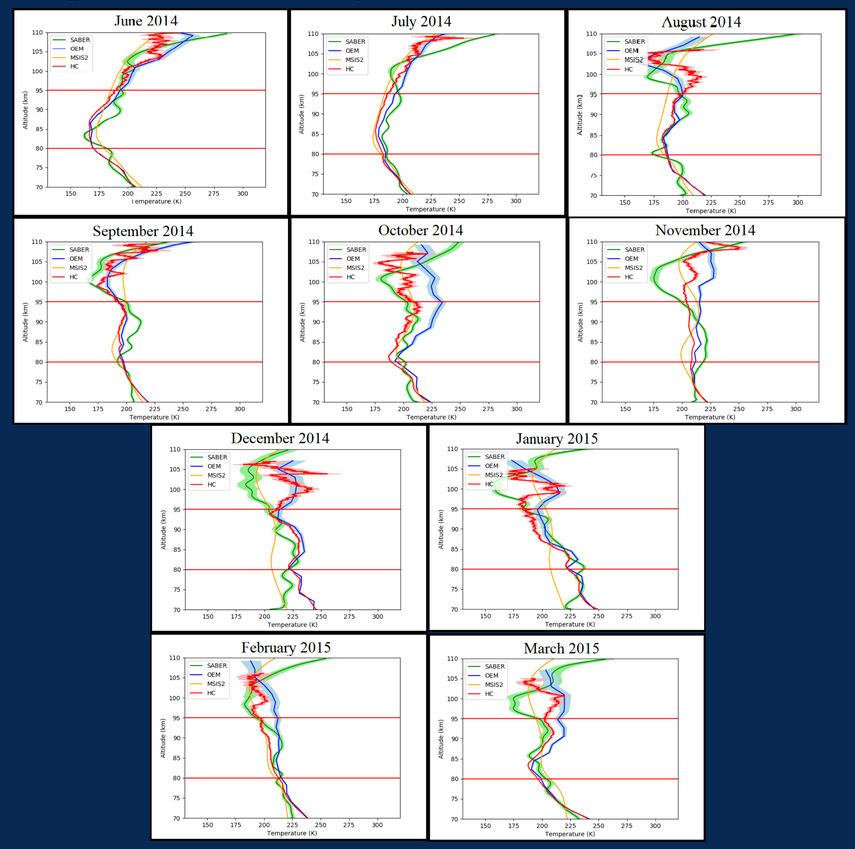
## Introduction

- The mesosphere extending from 50 km to ~100 km is the least studied portion of the neutral atmosphere.
- Since 1993, the Rayleigh-scatter lidar (RSL) at USU has been collecting data on the mesosphere. In 2014 and 2015, these measurements were extended from 80 km to 110 km.
- The temperatures and their uncertainties from the RSL are compared to temperatures and their uncertainties from NASA's TIMED satellite recorded for the same nights.
- These data sets are also compared to temperatures from NRL's empirical MSIS2 model for the same nights.

## Resources Used

- RSL data were acquired from 1993 to 2015, although only the highest altitude data from 2014 to 2015 were used in this comparison.
- The temperatures from the SABER observations were accessed from saber.gats-inc.com.

## Figure 1 – Comparisons for measured nights




*Comparisons of the measured nights averaged by month. The legend is to be interpreted as follows:*

*SABER – temperatures recorded by the SABER instrument on NASA's TIMED Satellite.*

*OEM – RSL temperatures reduced using the new Optimal Estimation Method. The altitude resolution was 2 km.*

*MSIS2 – NRL's newest empirical model*

*HC – RSL temperatures reduced using the original Hauchecorne-Chanin method*

## Results

- All the curves are very similar in Jun and Jul, with a distinct summer mesopause near 85 km. However, above 105 km, the SABER temperatures are significantly greater.
- In Feb through Sept, the temperatures for the RSL data agree well with the SABER data and the MSIS2 model up to 85 km, and in some cases, up to 95 km.
- In Oct, through Mar, excluding Feb, the SABER temperatures are far below the RSL temperatures and increase considerably above 105 km.
- The MSIS2 model temperatures at 85 km and below in Dec and Jan are considerably below the observed RSL and SABER temperatures.

## Methods

- Temperatures derived from the data collected by the USU RSL were compared (using Python) to temperatures obtained on the same nights from the SABER instrument on the TIMED satellite.
- The RSL temperatures were reduced using both the original Hauchecorne-Chanin (HC) method and the new Optimal Estimation Method (OEM).
- The four sets of temperatures were compared on the same individual nights and combined into monthly averages.

**Figure 2** – USU's green beam Rayleigh Scatter lidar

*Shown are the two transmitted laser beams and part of the 4-mirror detector system*

## Conclusions

The RSL, SABER, and MSIS2 temperatures showed considerable agreement. However, there were significant differences that need further investigation. These differences could come from many sources, such as instrument error or incorrect assumptions in the analysis. One item of particular interest is the difference between the MSIS2 model temperatures and the observations in Dec and Jan.

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Scan for **graphs,** and **full abstract**

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