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The 25-year Purple Crow Lidar Middle Atmospheric Temperature Climatology

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The temperature trend in the middle atmosphere is an important measurement to evaluate climate change. Rayleigh-scatter lidars are one of the few in-situ instruments that can be used to make measurements of the middle atmosphere for periods of hours with a high spatial resolution on the order of 100 meters. Rayleigh-scatter lidar measurements are commonly used to measure temperature and gravity wave properties in the stratosphere, mesosphere, and lower thermosphere.
The Purple Crow Lidar (PCL) facility located near The University of Western Ontario, Canada, has been making Rayleigh measurements since 1994. The PCL uses two overlapping Rayleigh channels to measure temperature in the middle atmosphere and lower thermosphere from 24 km to 110 km.
In 1980, Hauchecorne and Chanin developed a method of retrieving lidar temperature measurements (henceforth the HC method). The HC method requires the assumption of a "seed" pressure or temperature at the highest altitude - usually taken from a model. The top 10 or more km of temperature retrievals are unreliable due to large geophysical variation in the higher middle atmosphere and the lower thermosphere and are typically discarded because of the large uncertainties due to this pressure assumption.
In 2015, Sica and Haefele presented an Optimal Estimation Method (OEM) to retrieve atmospheric temperature profiles and found that it had many advantages over the HC method. Unlike the HC method, which only included estimates of random uncertainty, the OEM produces a uncertainty budget for all uncertain parameters in the retrieval procedure. Also, the OEM quantitatively determines a valid top altitude in retrieval procedure where the contribution of the measurement is much larger than that of the a priori. This allows the profiles to extend to greater heights than in the traditional analysis.
We will present a 25 year PCL temperature climatology using the OEM for the 500+ nights of Rayleigh temperature measurements which will also include an evaluation of the different parameters systematic uncertainties and random uncertainties, as well as a quantitative method to determine the top valid altitude of the temperature retrieval. In addition, the middle atmosphere temperature trend of the months that the PCL has enough measurements is calculated over the 25 year period.