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Atmospheric Chemistry and Physics Discussions

# *Interactive comment on* "Neutral atmosphere temperature change at 90 km, 70 N, 19 E, 2003–2014" *by* S. E. Holmen et al.

**Anonymous Referee #2**

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The paper presents new temperature observations from a high latitude station and diagnoses the solar cycle response and linear trend from the observations.

General comments

Due to the difficulty of measuring temperature in the upper mesosphere and lower thermosphere, particularly in polar regions, there is always a need for new observations. The observations discussed in the paper use a technique that is unfamiliar to this reviewer. According to the discussion in the paper, there are some significant uncertainties associated with determining temperature from the data. The paper is straightforward about these uncertainties and discusses the limitations in some depth; nevertheless, I was not left with a lot of confidence in the results.



Two aspects of the analysis and discussion are problematic. First, the validation by comparison with MLS raises several questions; see comments 1-4 below. Second, the separation of annual cycle, solar cycle, and secular trend from the time series is not really possible given the limited time span of the observational record. Perhaps these data could be used to investigate interannual variability (which would be particularly valuable if combine with analyses of wind data) but I do not see how they can contribute convincingly to trend investigations until the length of the observational record is greater.

Specific comments

1. The altitude of your analysis (90 km) is near the upper limit of MLS temperature data, and the uncertainties are large there. There are several other satellite instruments that provide intermittent but extensive measurements of temperature at 90 km over the period of the observations (AIM/SOFIE, ACE-FTS, TIMED/SABER, Envisat/MIPAS). Given all the uncertainties in your temperature retrieval, it would be appropriate to take advantage of these data to improve the confidence in the results.

2. The technique for comparisons with MLS is not optimal. Rather than using monthly means to derive correction factors, I suggest that you start with observations that you can compare directly. This would mean first comparing the radar data at times of the MLS overpasses for comparison directly with the MLS temperatures. Finding individual coincident profiles would be the best but even using monthly means of similar variables (e.g. from a similar local time) is better than the comparison shown in Figure 1. The process described in the paper wraps several "corrections" (local time, bias) together is a way that comes across as arbitrary. It would be useful to the reader to see a separation of the local time correction and the bias correction.

3. As a related comment, I was uneasy that you applied all the corrections to MLS, which is an extensively investigated and widely used dataset, rather than to your own retrieved temperatures. Did you look at MLS temperature validation papers for further

guidance?

4. Another advantage of using coincidences to compare with MLS would be the option to compare your pressure with the pressure from the MLS dataset. This would provide additional much-needed validation.

5. The period of your data coverage presents difficult challenges for diagnosing trends and solar cycle. The period covers substantially less than one full solar cycle. Moreover, the net trend in the F10.7 radio flux over these 11 years is not negligible (for example see http://www.swpc.noaa.gov/products/solar-cycle-progression). It is premature to apply trend and solar cycle analysis to these or any observations for this time period.

6. The discussion indicates that the trends are quite different for different seasons of the year. With this being the case, deseasonalizing the data and then calculating the trend using all months of the year will give a result that is very difficult to interpret.

7. Section 5.2 mentions that gravity wave activity could affect the temperature trend. Since you have radar wind data, this would be an important addition to the study. You could, at a minimum, determine whether there is a relationship between the interannual variability of gravity waves, mean winds, and temperature.

Editorial

There is an abrupt transition between the first and second paragraphs of Section 3 that is hard to follow.

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Interactive comment on Atmos. Chem. Phys. Discuss., 15, 15289, 2015.