Response to Anonymous Referee 1

General:
This article presents a study on the determination of the temperature of the upper stratosphere from observations of Rayleigh scattering at the limb of the Earth's atmosphere. There is little data on the temperature in this region, which is very sensitive to climate change, and the technique of measuring Rayleigh scattering at the limb is very promising as a complement to existing techniques based on observations of atmospheric radiance in the infrared or microwave spectrum. This article makes a valuable contribution to the subject with a careful analysis of performance and error budget using Odin-OSIRIS data. I recommend its publication on EGUsphere after a minor revision detailed below

- We thank the reviewer for their helpful comments, following are the reviewers comments and our replies.

Section 2, lines 52-55: the downward measurements are taken at around 06:00 local time, also close to dawn or dusk. Could you explain why the geometric configuration is better for observations of the bright limb in the morning part of the orbit? Is it to do with the direction of pointing in relation to the plane of the orbit? This is probably linked to the solar zenith angle (SZA) at the tangent point. Information on the SZA as a function of latitude and season is lacking for a better understanding of the observation conditions.

- Sorry for the confusion here, the primary reason that only the morning measurements are used is due to the drift of the Odin-OSIRIS orbit. The orbit has generally drifted later in time with some oscillations since launch. This causes the ascending node (dusk) measurements to have very inconsistent sampling during the mission. The measurements are not of poorer quality, the sampling is just non-uniform. We have added some clarifications to the text.

Section 4.1: This section describes the absolute calibration effect. It is not clear to me why the absolute calibration correction has an impact on the recovered temperature. This is obtained using a comparison with SASKTRAN simulations used as a black box, but it would be interesting to know what the physical reason is. Is it related to the estimation of the multiple scattering contribution to the radiance?

- The multiple scattering estimation is definitely one effect, as the estimation of surface albedo relies on the relative calibration between the two channels, but the general effect is non-linearity of the radiative transfer equation and occurs even in single scatter. The conversion from Rayleigh scattering number density to temperature only depends on the shape of the profile, doubling the number density will have no effect on the retrieved

temperature profile. However, doubling the number density will only scale the observed radiance (by a constant factor) if the fraction of multiple scatter is constant in altitude and the optical depth along each line of sight is small so that we are in the linear regime. If either of these two conditions is not satisfied then the absolute calibration can affect the retrieved temperature. We have added some additional explanation to the text.

Section 4.4, lines 275-279: Is it not possible to develop an algorithm to filter the radiance profiles contaminated by PMCs and keep the non-contaminated profiles in the database?

- In theory, yes. The main problem is that it is not straightforward to develop a PMC screening algorithm for OSIRIS since the top altitude of each scan is ~65km, well below the bottom of the PMC. It is further complicated by the fact that OSIRIS takes ~90s to perform a full limb scan, if the PMC is not homogeneous in the along orbital track dimension then certain lines of sight may hit it, miss it completely, or maybe even look under it but not through it. All that said we are planning on revisiting this problem for a future data version.

Section 5.3, Seasonal cycle: It is difficult to understand the seasonal evolution of temperature differences between satellites from Figure 11 showing the absolute temperature for each data set. It would be useful to show the seasonal cycle of these temperature differences directly.

- The figure has been updated to show the differences. We have also indicated areas where OSIRIS does not uniformly sample the latitude band on the updated figure.