

Interactive comment on “Thermal structure of the mesopause region during the WADIS-2 rocket campaign” by Raimund Wörl et al.

Anonymous Referee #2

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The study presents temperature measurements taken by three instruments during a 24 hour period. Thus it can be classified as a case study.

The combination of AMTM, lidar, and CONE measurements is unique, but simultaneous observations taken by AMTM and lidar as well as lidar and CONE instruments have been published before. Given that Wörl et al. show that the addition of the CONE data to AMTM and lidar data provides mostly redundant information concerning large scale gravity waves or tides, I think this manuscript does not provide enough new results for an ACP publication. Therefore, I suggest that the authors focus more on quantitative analysis of gravity waves and tides, and in particular small-scale perturbations. I recommend a major revision or re-submission for this manuscript.

Major comment 1

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According to the authors, the IAP Fe lidar has been operating at the ALOMAR observatory since summer 2014 and the AMT since 2010. It is probably reasonable to assume that a large amount of data was collected by both instruments in the following years until the rocket launch. It is surprising to me that the authors did not even try to classify conditions observed during the rocket launch with respect to the climatological mean state or at least typical conditions. Instead, the authors spend significant time speculating about tides, where most of the speculation is based on a comparison with measurements taken in the southern hemisphere at the wrong time of the year. Discussion of gravity waves is limited to the statement “In contrast to other examples (Bossert et al., 2014; Pautet et al. 2014) no clear small structures are visible”. The authors make no attempt whatsoever to quantify gravity waves in their observations. Thus, the manuscript is merely a presentation of measurement data without any meaningful analysis. Conclusions drawn by the authors are weak.

According to the Review Criteria https://www.atmospheric-chemistry-and-physics.net/peer_review/review_criteria.html reviewers are asked to answer the question “Does the manuscript represent a substantial contribution to scientific progress within the scope of Atmospheric Chemistry and Physics (substantial new concepts, ideas, methods, or data)?” Yes, the data are new in the sense that every observation of the atmosphere is different. However, temperature measurements in the mesopause region are hardly anything new and numerous case studies were published during the last 30 years. Thus, without thorough analysis, publishing the data is of low scientific significance, and the manuscript in its current state might be seen as an attempt to boost the publication statistics with minimum effort.

I am not arguing that the data should not be published. On the contrary, the observational data presented in this study has potential. But the authors should invest the time and analyze the data, critically review their hypothesis, and draw meaningful conclusions.

Suggestions

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1) The speculation about tides can be resolved with the help of meteor radar data (a meteor radar is located in the vicinity of the launch site). Retrieving tidal components and phases from meteor winds is common practice.

2) Keograms created from AMTM data can provide information on the horizontal structure of the larger-scale waves and direction of propagation.

3) There is a paper by Hildebrand et. al discussing winds and temperatures above ALOMAR (<https://doi.org/10.5194/acp-17-13345-2017>). This work could be a starting point for gravity wave analysis.

4) Include temperature data taken by the co-located Rayleigh lidar (I assume it was running during the WADIS-2 campaign). Extending the altitude range down to ~ 70 km may help to distinguish between tides and gravity waves.

Major comment 2

The authors do not meet the data policy (https://www.atmospheric-chemistry-and-physics.net/about/data_policy.html) which clearly states the request for depositing the data in reliable (public) data repositories.

Minor comments

Page 2, line 4: What does "nearly background free measurements" mean?

Page 3, line 20: What is the idea behind "connecting vertical data sets"? What does that mean in practice?

Page 4, line 15: What is the typical temperature error of these lidar measurements?

Caption of Figure 2: "the RMS of all Fe lidar profiles within a period of ± 60 min around launch time" – The integration time is 60 min for all profiles, right? Are you saying that you computed the RMS of all profiles which have their centers in the interval 60 min before launch to 60 min after launch? How many profiles did you use?

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Page 5, line 3: I suggest you move the information concerning resolutions and errors to the beginning of this section, before you discuss the lidar temperature profile in Figure 1.

Page 5, line 6: “Mean temperatures during the observation period are around 190 K which is typical for the mesopause region. . .” - Well, that depends on what altitude you are talking about. According to your Figure 3, the mesopause is at the top of your profiles or above.

Page 5, line 4: “not more than 10 K” – Did you limit the vertical extent of your temperature profiles to altitudes where the error is <10 K?

Page 7, line 1: “deviation from the mean in comparison to the deviation of a temperature field reconstructed. . .” – I assume you computed the mean for each altitude and removed it?

Page 10, line 6: “are averaged correspondingly” - What temperatures are averaged? Earlier you stated that the integration time is 60 min. Please clarify.

Page 11, lines 15-16: “very similar variations of the 3 profiles suggest a dynamic structure at a larger scale than the measurement distances of about 60 km” – That statement is not well supported by your data. In my opinion, all you can safely say here is that there appears to be no significant variability at horizontal scales below about 60 km.

Page 11, lines 19-20: “Variations on scales shorter than the measurement distance would cause either larger differences or a phase shift between the profiles” – Please clarify. What are you referring to? Are you comparing the three profiles which were taken approximately at the same time, or are you referring to the temporal evolution of the lidar measurements? In any case, a phase shift between the profiles causes larger RMS differences, unless the phase shift is 2π .

Page 12, lines 30-33: I do not think you can say that your value (43 km according to Table 1, or 40 km as written in the text?) is in good agreement with a vertical wavelength

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of 30-35 km reported by Forbes.

Page 13, line 8: According to your Table 1 the vertical wavelength of the 8-hour component is 23 km and not 30 km. Please make the values consistent.

Page 14, lines 15-16: “were dominated by larger waves . . . and are nearly undisturbed by gravity waves of smaller scales” – This statement is sort of trivial. It is clear that small-scale waves, in particular waves with small vertical wavelengths, become quickly unstable as amplitudes grow. Therefore, amplitudes of small-scale waves are in general smaller than larger scale waves, and the larger scale waves appear to be undisturbed by the small-scale waves. A more interesting question is whether amplitudes are close to the saturation limit. See for example Smith et al., Evidence for a saturated spectrum of atmospheric gravity waves, 1987.

Typos, grammar, wording

Page 2, line 14: “allows us to study“ or “allows for studies”

Page 2, line 23: something is wrong with the grammar

Page 2, line 3: “allows to” is ungrammatical, there are several instances in the text

Page 6, line 8: mean square error -> mean squared error

Page 6, line16: phase response -> phase progression?

Page 9, line 1: differ from -> is different from?

Page 10, line 7: altitude distribution of the OH layer -> vertical profile of the OH layer?

Page 10, line 12: is found at a centroid altitude -> is found for the centroid altitude 84. . .

Page 10, line 17: is not important to study horizontal structures -> is not important for studies of horizontal structures?

Caption of Figure 9: at the locations of -> at the location of

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Page 11, line 2: Temperatures cannot be smooth -> The profiles are...

Page 11, line 9: lowest range -> lower part?

Page 12, line 1: thermal structure of the mesopause altitudes -> thermal structure in the mesopause region?

Page 12, line 5: long periodic waves -> waves with long periods

Page 14, line 19: "play only a minor." – sentence incomplete

Interactive comment on Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2018-656>, 2018.

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