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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Metal layers at high altitudes: A possible connection to meteoroids" *by* J. Höffner and J. S. Friedman

Anonymous Referee #2

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Review of Metal layers at high altitudes: A possible connection to meteoroids, by J. Höffner and J. S. Friedman, Atmos. Chem. Phys. Discuss., 4, 399-417, 2004

General comments: 1. By studying the metal layers of K, Ca, Ca+, Fe, and Na at high altitudes (above 105 km), the authors established a possible link between the atmospheric metal layers and the input meteors. This is a brilliant idea in sense of studying the meteor impacts on the atmosphere compositions. Although modern resonance fluorescence lidars can measure the metal layers very well in the mesosphere and lower thermosphere (MLT) region, what these lidars measure are the neutral metal atoms and/or their atomic ions. The abundance ratio of these metal layers is not necessary to be proportional to the input meteoroids, since chemical reaction might dominant the recycle of the metal atoms in the 'main layer' (80-105km). Besides neutral metal layers, the compounds of these metal atoms may contain more portions of the input metal

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atoms, which cannot be detected by the Na, K, Fe, Ca, or Ca+ resonance lidars. This is why these metal layers exhibit different seasonal variations in the main layer region. Fortunately, the high altitude layers (above 105 km) suffer the least effects from the chemical reactions with O, O2, O3, or OH, etc. With the chemical reactions out of the way (or mostly out of the way), it is possible to link the high altitude metal layers directly to the input meteoroids. The approach used in this paper is an excellent idea, and could lead to some new understandings of the meteor impacts on the atmosphere. 2. Several findings in this paper are remarkable, e.g., despite their difference seasonal characteristics at 'main layers', K, Ca, Ca+, Fe, and Na layers show an extension of the layers to altitudes as high as 120 km predominantly during summer and similar seasonal variations for the 'high altitude layers'; nearly constant abundance ratios between different metal atoms on the topside of the layers; some correlations between the topside metal layers and meteor showers, etc. 3. All these factors give this paper enough credits for publication. It would excite further investigations on these metal layers versus meteor issues.

Specific comments: 1. The main concern about this approach is the uncertainty in determining the metal layer densities above 105 km. Due to the extreme low density, especially above 110 km, the derived density would be very sensitive to (1) background subtraction; (2) photon noise; (3) extinctions due to the main metal layers at lower altitude, etc. It would be necessary for the authors to quote their measurement uncertainty in the paper and give the confidence for the abundance ratios they derived from observations. 2. The authors lean to the conclusion that the topside of the metal layers is mainly determined by the sporadic or daily meteor events that could be observed by meteor radar, although meteor showers have some contributions to the density enhancement. However, no meteor data were presented in this paper to support this conclusion. It would be better if the authors could find some long-term meteor radar data to show how the daily meteor rate or flux varies over the seasons. If the meteor flux also peaks in the summer, it would be a more persuasive evidence. This meteor flux variation could be added to Figure 2 as an additional panel. 3. It would be bene-

ACPD

4, S113–S115, 2004

ficial if the topside seasonal variations of Ca+, Fe and Na observed at 54°N can also be shown in this paper. 4. As stated in above general comments, the main difference between the topside layer and the main layer is the role of chemistry: main layer is dominated by the chemical reactions while the topside layer is dominated by diffusion. It would be beneficial for the authors to point out this in the paper. This would explain why the topside (instead of the bottom-side) of the layers is chosen for this study.

Technical comments: 1. First paragraph in Introduction, it would be better to write the second sentence in the following way: 'The invention of resonance lidars has made it possible to measure the densities of different metal atoms quantitatively with high vertical and temporal resolution, Ě' 2. In the same paragraph, it is not quite clear about the following sentence: 'That said, only 4 percent of all observed meteor trails could be observed in more than on metal'. Please rephrase. 3. In the first paragraph of Section 3, it is not clear how the authors suppressed all data below a certain density level. Please explain. 4. In the 3rd paragraph of Section 3, the sentence 'There are during that season at Arecibo.' is not a complete sentence. What does it mean here? 5. In Conclusion, the sentence 'The metal abundance ratios of K, Ca, Fe, and Na at 113 km altitude are on average constant with respect to altitude and time variations, Ě', should the 2nd 'altitude' be 'latitude'? 6. In References, von Zahn et al. 2002 should be listed at the end of the references, not in the middle. 7. Through the paper, the authors try to identify which is more important to the topside metal layers: meteor showers or sporadic meteoroids. However, both Abstract and Conclusion did not mention this point explicitly. It would be better to rephrase the Abstract and Conclusion to make it clear.

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