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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Multi-model study of mercury dispersion in the atmosphere: Vertical distribution of mercury species" *by* Johannes Bieser et al.

Anonymous Referee #2

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The vertical distribution of mercury (Hg) in the atmosphere is an important aspect of studies on global atmospheric Hg cycling. Many previous studies have observed clear vertical gradients of Hg species in the global atmosphere, which were thought to be influenced by atmospheric physicochemical transformation and atmospheric transport processes. This paper conducted a comprehensive modeling study and compared it with field observations on a global scale. This paper provides a significant contribution to current research questions. The modeling results are generally in line with recent observations from air-craft campaigns and at high-altitude sampling sites, indicating conversions of atmospheric Hg species is a global phenomenon. The paper is well written and the methods and discussions are overall credible. I suggest to publish the

paper after minor revisions and clarifications: 1) Please clarify whether the heights mentioned throughout the manuscript are referred to the height above sea level (asl) or above ground level (agl). If the height refers to als, the authors should also compare their modeling results with observations at high-altitude peaks worldwide (e.g., Mount Bachelor Observatory, USA, 2700 m asl; Storm Peak, USA< 3200 m asl; Lulin Atmospheric Background Station, Taiwan, 2862 m asl; Pic du Midi Observatory, France, 2877 m asl and Mt. Leigong, China, 2178 m asl. These observations are in the free troposphere and can be compared with the modeling results). 2) Line 480: Please clarify the mean of 'source regions'. Are they related to anthropogenic or natural sources (GOM and PBM formation in the atmosphere)? 3) Line 480: the citation should be Fu et al., 2016. 4) The authors modeled the vertical concentrations of GEM, GOM, and PBM in the troposphere and stratosphere. Will it be possible to give the total quantity (Mg) of GEM, GOM, and PBM in the PBL, lower free troposphere, middle free troposphere, upper free troposphere and stratosphere? 5) The atmospheric physicochemical properties over the oceans and continents are generally different. I suggest the authors should also calculate the average vertical distributions of atmospheric Hg species over oceans and continents. 6) The measurements of GOM and PBM have many uncertainties. As mentioned the in the paper, previous studies for GOM and PBM measured utilized several different techniques. The authors should introduce the uncertainties of these observations and the effects on their comparisons. 7) Line 1418, Shah et al., 2015 should be Shah et al., 2016. 8) GEM, GOM, and PBM (generally the Hg bounded with fine particulates) are the three major forms of atmospheric Hg. In many parts of the paper, the authors used TM (total atmospheric Hg) and RM (reactive atmospheric Hg), and this is not completely right under some situations. Hg bounded with coarse particulates could represent a large fraction of total particulate Hg in the PBL. Also, GEM, GOM, and PBM could be transformed to other Hg species including Hg in cloud vapor, fog, etc.. These Hg species in the atmosphere sometimes represents an important fraction of atmospheric Hg. Should we define these species as RM? Have the authors taken these species into the modeling? I think this might be an important

element influencing the comparisons between observations and modeling.

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