

## ***Interactive comment on “Processes controlling the seasonal variations of $^{210}\text{Pb}$ and $^7\text{Be}$ at the Mt. Cimone WMO-GAW global station, Italy: A model analysis” by Erika Brattich et al.***

**Anonymous Referee #1**

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The submitted manuscript aims to contribute in the understanding of the roles of transport and precipitation scavenging processes in controlling seasonality of Pb-210 and Be-7 radionuclide aerosol tracers at Mt. Cimone, Italy using a global chemistry transport model. It has an added value and I suggest acceptance of the manuscript for publication after taking into consideration the following comments.

Comments 1) page 10, line 9: What is the spatial resolution of the model simulations?  
2) page 11, lines 3-6,: The authors state " For the simulations of radionuclides, each simulation was run for six years, recycling the meteorological data for each year of the simulation, to equilibrate the lower stratosphere as well as the troposphere". Does this practically mean that it is simulated the same year for six times and that the first five

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years were used as a spin up time? Also please mention again here that the actual year of the simulation is 2005. 3) page 13, lines 20-21: The authors state that " In the model Mt. Cimone appears to be in a location where there is a large horizontal gradient of wind (transport)." Mind though that the model's winds in Figure 2 are from specific months in a single year (the year 2005) and hence do not actually represent a wind climatology of the respective months. 4) page 14, line 10-14: Note also that the etesian wind system at eastern Mediterranean in July is also well represented in Figure 2. 5) page 15, line 11-14: The authors state that "Large differences between the MERRA precipitation and that locally observed at the station are instead present (not shown): in particular, the MERRA precipitation is larger during winter-autumn, while it is much more similar to that observed during spring-summer." I would suggest to add information or a graph with the station-based observations of precipitation at Mt Cimone (even as supplementary material). Of course, MERRA data reflect large scale precipitation features while the station-based observations reflect local features. Nevertheless in your analysis you compare modelled Pb-210 and Be-7 radionuclide concentrations with the respective station based measurements at Mt Cimone, but these station based radionuclide measurements are presumably linked more with the local observation of precipitation than with large scale MERRA precipitation data. 6) page 17, line 21-23: The authors state that "The correlation between observed and simulated monthly  $^7\text{Be}$  activities also increases from  $R^2 = 0.03$  at "ij" to  $R^2 = 0.11-0.60$  at adjacent model gridboxes." Please specify at which grid-box you get 0.6 and discuss the reason for this considerable improvement. 7) page 17, line 21-23: The authors state that " As for  $^7\text{Be}$ , the model well captures the March maximum (i.e., secondary maximum in the observations) and the general seasonal pattern during the cold and transition seasons." I think that this statement is not very consistent with Figure 5b. Actually, according to Figure 5b the model does not seem to capture the general seasonal pattern for Be-7. 8) page 18, line 19-21: The authors state that " The simulated seasonal pattern of the  $^{10}\text{Be}/^7\text{Be}$  ratio is very similar to the observations at Zugspitze (Germany, 2962 m asl) (Zanis et al., 2003), characterized by a not-pronounced seasonal cycle" . In fact

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the simulated Be-10/Be-7 ratio in Figure 5d has a clear seasonal cycle and looking the respective graph Figure 3 from the cited paper of Zanis et al., 2003, I see a better agreement with Jungfaraujoch than with Zugspitze. 9) page 19, line 9-11: The authors state that " However, the model tends to overestimate the observed  ${}^7\text{Be}$  concentrations and  ${}^7\text{Be}/{}^{210}\text{Pb}$  ratios during December-February, suggesting that STE and/or subsidence in the model is likely too fast in this region." This is a rather speculative comment. It needs more justification. What do you mean with too fast? Maybe stronger STE fluxes? Are there any references showing how the STE fluxes of this model compares with other global CTMS or GCMs? 10) page 19, line 11-13: The authors state that "As reported by Huang et al. (2013), a stronger net subsidence of air masses to the surface could be due to unrealistic meteorological conditions (e.g., boundary layer structure, wind fields, vertical mixing)." This is a rather general comment. Is this true for the meteorological data used here in the CTM? Please clarify this issue.

11) page 20, line 19-20: The authors state that "The model annual average biases are about 8% for  ${}^{210}\text{Pb}$  and about 19% for  ${}^7\text{Be}$ , respectively. By contrast, the model average bias for  ${}^7\text{Be}/{}^{210}\text{Pb}$  ratios is about -13% (Figure 7)." Please comment on the error propagation on the ratio. 12) page 22, line 8-9: The authors state that " ... suggesting that large-scale circulation in this region with complex topography may not be resolved by the coarse-resolution model." I guess you mean that regional and local circulations are not resolved by the global model. 13) page 24, line 1-4: The authors state that " The model underestimate of  ${}^7\text{Be}$  levels in the warm months is partly due to the sensitivity to spatial sampling in the model, but also suggests that the mixing of air masses between the PBL and the lower free troposphere is likely too weak." If the model mixing between the PBL and the lower free troposphere becomes stronger then this will result in more mixing of PBL air poor in Be-7 with free tropospheric air, hence even smaller concentrations of Be-7 and larger model underestimate of Be-7 at Mt Cimone.

14) To my understanding, the authors claim that the CTM cannot capture the observed seasonal cycle of Be-7 with a summer max at Mt Cimone because of local features

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which are not resolved in the model. However mind that the summer maximum Be-7 at Mt Cimone is also apparent at Jungfrauoch, Sonnblick and Zugspitze (see e.g. Figure 7 in Gerasopoulos et al., 2001). So maybe this feature does not seem to be a very local phenomenon but is rather of larger horizontal scale.

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