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Interactive comment on "Beyond Craig and Gordon: A model of water vapor isotopologues in the marine boundary layer" *by* Xiahong Feng et al.

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A one-dimensional dimensional is developed to study the variations of the water vapour isotopologues under marine boundary layer conditions. The model is used to support the analysis and interpretation of seven observational data sets. They are collected under different sea surface temperature (SST), but they are also influence by the arrival and mixing of upper atmospheric air characterized by different isotopic composition. The later processes was not explicitly modelled on the Craig-Gordon model. Model and observations are discussed with in the deltaD-delta18O space parameter. As a result, the authors identified a region that depends on the SST, the mixing of upper air and the kinetic fractionation improving the interpretation of the observations I found the research very interesting, and in particular the study on the relevance of non-local effects such as the convergence of descending air in influence the isotopic composition

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Discussion paper

near the sea surface. In addition, the model enables to cluster the seven-data sets and consequently provides a more unified explanation of the behaviour of water vapour on marine boundary layers. The paper is very well written and in my opinion deserves to be published after some of my comments are clarified.

1.- Although the Isotopic Marine Boundary Layer Model (IMBLM) has a sound physical reasoning, I believe their application and analysis can gain in depth when it is coupled to other relevant state marine boundary layer variables such as potential temperature, specific humidity and wind. In doing this coupling, they could gain independence on the determination of the eddy-diffusivity turbulent coefficient and the impact of mixing on SST. I believe the reader will appreciate a comment on the necessity of developing a model in the future to the water vapour isotopologues that it is fully coupled to the meteorological state variables.

2.- The use of an exchange coefficient for both diffusion and turbulence (Eq. 4 at page 7) is not common in meteorological models, but it I guess it is needed in studies related to the isotopologues. Km, for molecular diffusion, is normally few order of magnitude small than the turbulent diffusion, and therefore it is normally neglected. Could the authors provide a better justification on the use of Eq. 4? How do the scale the results? What is the vertical resolution needed near the sea surface?

3.- Closely connected to my previous point, normally above the see the exchange coefficient is parameterized using a roughness length that depends on the friction velocity (Charnock, 1955). This formulation can be useful to include the effects of waves and turbulence on the sea surface through a dependence on the friction velocity (page 6, lines 18-22)

4.- Why is a negative sign between the D and the advective vertical velocity at the continuity equation 6? What is the sign convection?

5.- Marine boundary layers are frequently characterized by the presence of clouds. Some of the campaigns, for instance RARA, STRASSE and PIRATE were located in

regions dominated by stratocumulus. In that respect, I would expect a discontinuity between the marine boundary layer and the free atmosphere due to the temperature inversion at cloud top. I cannot find this discontinuity in the profiles shown in Figure 3. Can they provide a more elaborated explanation on the different marine boundary layer under study?

6.- Connected to the last point, how and where is CE (Eq. 8, page 9) depicted in Figure 3

7.- Section 6.1. Could the authors justify the selection of the “few major features”?

8.- Related to the parameters selected in Table 4:

- Section 5.5. Some marine boundary layers can have larger values of the upward velocity driven by long wave radiative cooling at cloud top or the venting driven by the presence of shallow convection.

- How relevant is the height of the MCL as a variable controlling the mixing, entrainment and dilution of the isotopologues?

9.- For the sake of completeness, I believe it is convenient to include how the kinetic fractionation process (page 16, lines 15-20) is represented at the IMBL model.

10.- Page 17 (lines 18-20). Do the conditions with larger Km and lower mixing ratio of subsiding air imply well-mixed conditions? Please explain.

11- In a model in which the processes between the sea surface and MBL dynamics are fully coupled, the mixing of air with lower/higher isotopic content can have an influence on the kinetic fractionation. In other words, could the line AB in figure 4 change when the sea-MBL coupling is important?

12.- To reinforce the originality of the study, I believe the reader will appreciate a more elaborate discussion on the difference of current results with the Craig-Gordon model. For instance, what will be the results of the Craig-Gordon model in Figure 4?

References

Charnock, H. (1955). Wind stress on a water surface. Quart. J. Roy. Meteorol. Soc., 81, 639-640.

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