

## ***Interactive comment on “The impacts of regional shipping emissions on the chemical characteristics of coastal submicron aerosols near Houston, TX” by Benjamin C. Schulze et al.***

### **Anonymous Referee #1**

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#### General comments.

Overall, this paper is well written and of high quality. It provides a significant contribution to our understanding of how anthropogenic emissions in the marine atmosphere effect atmospheric composition in the marine boundary layer. It also provides insight on how these perturbations may be effecting the atmosphere once this air is advected over urban areas, and the possible benefits for further controls on marine anthropogenic emissions. I recommend publication once the major and minor specific comments listed below are addressed.

Specific comments - major:

C1

Page 8, line 173. The meteorological resolution of 1 degree by 1 degree for back trajectories is quite coarse compared to other available datasets on HYSPLIT. With such coarse resolution, the question arises as to how well that dataset captures the land-sea interface and related meteorological dynamics (e.g., diurnal land-sea breezes, continental air mass outflow and recirculation back to the coast). Given that your monitoring site is right on the coast, this could be a significant issue. Some comparisons that would help allay such concerns would be (a) to compare wind roses generated with observed data and wind roses generated with the GDAS 1x1 dataset at the observation lat-lon and for each of the defined meteorological regimes and (b) compare back trajectories from the 1x1 dataset with a sample of those generated from the available 3 km resolution data (HRRR, more than an order of magnitude higher resolution). For (b), do the 3 km back trajectories identify any continental recirculation, especially for the defined ‘marine’ periods?

Page 12, line 262. The Savoie et al. paper reports Bermuda and Barbados marine nss-SO<sub>4</sub>/MSA mass ratios as  $19.6 \pm 2.1$  and  $18.8 \pm 2.2$  (as listed in that paper’s abstract). So the corresponding marine MSA/nss-SO<sub>4</sub> ratios are 0.051 and 0.053 for Bermuda and Barbados. Your paper is using 0.053, the Barbados ratio, but you say you are using the Bermuda ratio. Bermuda does match up better with your monitor latitude, so you likely need to recalculate using the 0.051 ratio.

Pages 21 & 58, Figure 5 (and all maps depicting the ECA region). The ECA region drawn on Figure 5 and other maps is substantially incorrect. The ECA is not in effect in the territorial waters of other countries. Hence, the ECA is cut off at the US-Mexico border and, more significantly for this analysis, narrows substantially around Florida’s southern and south-eastern region due to the territorial waters of Cuba and the Bahamas. For a full description of the ECA boundaries, see <https://www.epa.gov/sites/production/files/2016-09/documents/mepc1-circ-re-na-eca.pdf>. ECA boundary shapefiles for mapping purposes are readily available on the web.

C2

Page 22, lines 471 – 484. A Gulf marine anthropogenic emissions source that needs to be considered and discussed in this paper is emissions from offshore oil and gas platforms (e.g., gas flaring, support operations). While the WPSCF analyses presented in Figure 5 suggests less contribution from areas where these sources are located, compared to contributions in the shipping lanes, the authors should perform a similar emissions analysis for these sources as was done for point sources in Florida (i.e., historical and current SO<sub>x</sub> emissions comparisons).

Page 26, lines 560 and 561. Assuming ECA compliance, it is not at all clear that there will be significant NO<sub>x</sub> reductions when switching to lower sulfur fuels. Browning et al. (2012) reports only a very small benefit, 1-6% reductions in NO<sub>x</sub>, due to fuel switching. The paper would benefit from the authors exploring this lack of significant NO<sub>x</sub> benefit in the ECA regulations, and its implications on the perturbations caused by marine shipping before the ECA and after. The ECA does include some NO<sub>x</sub> regulations that went into effect in 2016 (Tier III engine standards), but the immediate benefit of this is unclear.

Page 32, lines 697-704. There is a large body of research that has been done on ship emissions and their impact on marine aerosol optical properties, including ALW. As one example, see publications related to the Monterey Area Ship Tracks Experiment. So I think it is likely that there is significant information available related to "... measurement-based predictions of the role of shipping on the production of ALW in coastal marine environments." Have the authors delved into this body of literature?

Specific comments - minor:

Page 4, line 87. The Kotchenruther (2016) paper showed only 2 sites (not 3) along the gulf coast that had significantly less average reductions compared to the other sites analyzed.

Page 8, line 175. The html link is broken, replace with working link.

C3

Page 15/16, lines 333/334. In addition to the hypothesis of a major anthropogenic source in the gulf, recirculation of continental air masses could also support the observed elevated SO<sub>4</sub>.

Page 17, line 377/378. How well do diurnal profiles match the land/sea breeze pattern? Could this simply represent the difference between continental and marine air?

Page 22, lines 471 – 484. Once the ECA boundaries are properly drawn on the maps presented (see comment related to Figure 5), the authors should also point to the significant narrowing of the ECA boundaries off the SW, S, and SE coast of Florida as a potential source of unregulated ship emissions.

Page 25/26, lines 559/560 and Figure S20. As mentioned in another comment, the ECA boundary is significantly incorrect as drawn and is not in effect in Mexican territorial waters. So there is a much larger portion of the back trajectories mentioned here that are outside of the ECA regulation zone. Having said that, the trajectories are not in major shipping lanes, so the authors' line of reasoning is still supported.

Page 37, lines 812-817. Can the authors reach any conclusions about the relative dependence of marine OOA-3 production on anthropogenic nss-SO<sub>4</sub> emissions vs. anthropogenic NO<sub>x</sub>? If global shipping FSC lead to further SO<sub>x</sub> decreases in 2020, but there are only relatively modest NO<sub>x</sub> reductions, how would that effect marine OOA-3 production (i.e., do you still expect significant reductions, or less of an effect)?

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C4