Response to Anonymous Referee #3

We would like to thank the reviewer for his/her comments. We have done our best to address each of the points as detailed below.

Note: All reviewer comments in *italics;* all responses by the authors in normal font.

The paper describes the effects of marine organic aerosols on cloud droplet number concentrations and liquid water path and aerosol indirect forcing. The paper is concise and well written. I suggest its publication after minor revisions.

Comments

#1. *Abstract*

I suggest rephrasing the first sentence of the abstract, deleting the current first sentence, which contains a reference (Meskhidze et al., 2011), usually references should not appear in an abstract. It could be rewritten as "A series of simulations with the Community Atmosphere Model version 5 (CAM5) with a 7-mode Modal Aerosol Model was conducted to assess the changes in the cloud microphysical: : :.. from marine organic aerosols."

This suggested change has been included in the updated manuscript. Now the text reads as: "A series of simulations with the Community Atmosphere Model version 5 (CAM5) with a 7-mode Modal Aerosol Model were conducted to assess the changes in cloud microphysical properties and radiative forcing resulting from marine organic aerosols."

#2. *Introduction*

I find the introduction quite brief and half of it is dedicated to describe part 1 of this work. There is a poor literature study and previous works' reporting on the role of marine organics on cloud properties, radiative forcing or their hygroscopic properties, topics that are treated in the manuscript. See: - Ovadnevaite et al, GEOPHYSICAL RESEARCH LETTERS, VOL. 38, L21806, 6 PP., 2011 doi:10.1029/2011GL048869 - Pringle et al., Atmos. Chem. Phys., 10, 5241–5255, 2010 - S. P. Hersey et al., Atmos. Chem. Phys., 9, 2543-2554, 2009 Also Roelofs 2008 is mentioned later in the paper but should be referred here as well.

A more comprehensive introduction has been included in the updated manuscript. The text now reads: "Marine organic aerosols, emitted into the atmosphere as primary particles via bursting of bubbles at the ocean surface and secondary particles via oxidation of volatile organic compounds (VOC) such as isoprene, monoterpenes, amines, and dimethyl sulfide (DMS), have been shown to affect the chemistry and number distribution of aerosols in the marine environment (O'Dowd et al., 2004; Meskhidze and Nenes, 2006; Yoon et al., 2007; Facchini et al., 2008). Part 1 of this study (Meskhidze et al., 2011) described the implementation of marine organic aerosols in the Community Atmosphere Model version 5 (CAM5) with a 7-mode Modal Aerosol Module (MAM-7) (Liu et al., 2011). Meskhidze et al. (2011) showed that addition of marine organics led to improved agreement of the model predicted and measured concentrations of organic aerosols in the marine boundary layer, with annual average submicron aerosol mass concentration increased by up to 400 ng m^{-3} over biologically active oceanic regions. Comparison with long-term observations showed that of the two marine primary organic emission parameterizations implemented into CAM5 (Vignati et al., 2010; Gantt et al., 2011), the Gantt et al. (2011) emissions were slightly better in replicating the seasonal cycle of water

insoluble organic aerosol mass concentrations. In the areas with the highest emission rates of marine organic aerosols, the cloud condensation nuclei (CCN) concentrations increased by up to 20% due to an increase in the accumulation mode (80-300 nm in diameter in CAM5) aerosol number concentration.

The potential influence of marine organic aerosols on cloud microphysical properties and radiative forcing was first discussed by Novakov and Penner (1993) and Novakov et al. (1997), who found that organic aerosols of marine origin contributed to a major fraction of marine boundary layer CCN concentration in the Tropical Atlantic. O'Dowd et al. (2004) described an increase (15-100%) in cloud droplet number concentration (CDNC) at Mace Head with the inclusion of marine organic aerosols derived from size-resolved chemistry and number distribution measurements. Ovadnevaite et al. (2011) reported similar results in an AMS study at Mace Head, finding that periods with high organic fractions and low growth factors also had a higher weighted average particle size, CCN activation efficiency, and estimated CDNC. In a modeling study, Roelofs (2008) reported results from the ECHAM5-HAM model in which marine organic aerosols increased North Atlantic CDNC by a factor of 3-4 (~35 to 120 cm^{-3}) and decreased cloud effective radius from 15-20 μm to 10-14 μm in diameter. These changes brought the model closer to satellite derived values for the region. However, not all studies examining the potential climate impact of marine organic aerosols have found that they have a large impact. Hygroscopic and CCN activity measurements of laboratory bubble bursting experiments from Fuentes et al. (2011) and Moore et al. (2011) found that despite evidence of organic compounds in sea spray aerosol, their higher hydrophobicity and lower CCN activity lead to a prediction of small changes in CCN concentration associated with marine organic aerosols and negligible impact on cloud formation. Westervelt et al. (2012) suggested that marine organic aerosols have a minor impact on climate due to GISS II-prime modeling results showing a decrease in CCN concentration (due to a decrease in particle solute concentration) in all simulation except when marine organic aerosols and sea-salt were treated as externally-mixed. Here in the second part of the study for climate forcing of marine organic aerosol, we focus on the impact of the marine organic aerosols on cloud microphysical properties and shortwave radiative forcing."

#3. *3 Results*

Figure S1: In the caption it should be made clear what the red spots represent, are they the area points not statistically significant?

The figure caption has been corrected in the updated manuscript. The text now reads: "Figure S1. Model grids (in red) with significant (*p*-value of paired t-test < 0.1) differences between the G11 and Default simulations over the 10 simulation years for a) in-cloud droplet number concentration from 940-985 mb, and column b) cloud droplet number concentration, c) liquid water path, and d) shortwave cloud forcing."

#4. *3.2.1 Aerosol activation parameterizations I don't understand what the authors want to say about the fact that the changes between the two activation schemes are consistent means that the variability in the parameterizations does not alter the net effects of marine organic aerosol; please rephrase it.*

The discussion of aerosol activation parameterizations has been rephrased in the updated manuscript. The text now reads: “In current sensitivity simulation, the changes due to marine organic aerosols are relatively consistent between the two schemes (Default vs. G11 and Default-FN vs. G11-FN). The global changes predicted for low-level CDNC, LWP, and SWCF (due to marine organic aerosol emissions) differ slightly between simulations that use FN-scheme (1.2 cm^{-3}, 0.21 g m^{-2}, and - 0.14 W m^{-2}, respectively) and the ones that use AR-G scheme (1.3 cm^{-3}, 0.22 g m^{-2}, and -0.12 W m^{-2}, respectively). Therefore, our simulations indicate that the differences between the AR-G and FN aerosol activation parameterizations appear to be less sensitive to minor changes in CCN concentrations (such as from marine organic aerosols) compared to major changes (such as from anthropogenic aerosols).”

#5. *3.2.3 Hygroscopicity*

Could you please add in the paragraph the effect of changing the k value on CCN as well compare to G11 simulation?

Following discussion for changes in the CCN concentrations due to changing κ values has been added in the updated manuscript: “This small change in cloud properties due to changing organic aerosol hygroscopicity is similar to the slight change in global surface CCN, which only increased from the 184.5 cm^{-3} reported in Meskhidze et al. (2011) to 185.0 cm-3 (0.3%) in G11-κ.”

#6. *References*

Platnick and Twomey 1994 instead of 2007 Orr et al 2005 appears in the reference list but not in the manuscript text

References have been corrected in the updated manuscript.