We thank the reviewer for their helpful comments on the original version of the manuscript and respond to each point below.

Response to Anonymous Referee #1

The manuscript describes the integration of the chemistry module MECCA into the atmosphere model CAM/CCSM. I very much congratulate the authors on this unusual combination of "European" (MECCA) and "United-States" (CCSM) codes. Such exercises especially make it possible to compare different chemistry models in the same atmospheric environment, an important task in assuring the highest quality of earth system models. Unfortunately there are from my point of view several major shortcomings requiring overhaul of the manuscript.

1. The manuscript is I think too short in many aspects for the described task. For example, the programming languages are not mentioned. The technical implementation should be made much clearer (graphical depictions might help). At the current stage, the manuscript reads often like a paper to non-specialists - especially part 4 could be made much more detailed for CAM or MECCA specialists.

The programing language, a graphic depicting the implementation, and associated text have been added to the revised manuscript. The description of the coupling of SO_4^{2-} between the aerosol and chemical modules and also been expanded to clarify details.

2. For a non-CAM / CCSM / CESM -user it does not get clear initially what model or model version of CAM you used. From my understanding, this is a CAM3.6.33 with a special additional module for modal aerosols? Similarly, the MECCA description could be more detailed, (flexibility, interface, language, the MESSy concept in which the code is written, ...).

The version numbers have been added to the abstract. The MECCA description section has been expanded to include programming language specifications (Line 80), and a note regarding the MESSy interface. It is specified that the interface used for this study was developed from scratch since neither CAM nor the modal aerosol module are MESSy compliant.

3. Model versions: Unfortunately, it appears to me that rather old model versions have been used, MECCA v2.5 was made available in 2008 (now mainly called CAABA as referenced), CSSM3 was available from 2004 (now CAM5.1.1 in CESM). It should be described why the employed model versions were used, how the technical implementation can be used in modern CESM versions and if this is planned. The usage of old model versions and modern references to the current model versions is also confusing for the reader.

This study was started in 2006 using at the time in-development, unreleased model versions of both CAM/CCSM and MECCA. While we were using a modified version of CAM3, it was the state-of-the-art version that contained a complete rendering of the modal aerosol physics package, and was technically more akin to CAM5 in terms of development stage. The results of this research were completed before the release of CAM5. Converting to CAM5 release code and rerunning the simulations is beyond the scope of resources available for this work. Based on published analysis of CAM, our knowledge of the working state of the Modal Aerosol Module, and the authors' familiarity and experience with MECCA, we are confident that the model performance and results are robust.

Further, due to MECCA's modular structure, it is relatively easy to upgrade to the newer version of MECCA were the need to arise. While there are several new features added to MECCA since the release of v2.5, they do not affect the chemical mechanism as it was used here.

We also point out the difference between MECCA and CAABA. MECCA is the chemistry mechanism, and CAABA is a box-model built using MECCA for its chemistry routine. In the case of this study, we only used MECCA. To avoid confusion, this difference has been addressed in the text.

4. Please at least cite other 3-D modeling studies using ECHAM5/MESSy with MECCA.
This was a poor oversight on our part. The following text has been included to address this:

L92: "MECCA, as a MESSy sub-model is part of the ECHAM5/MESSy for Atmoshperic Chemistry (EMAC) chemistry climate GCM (CCM), which consists of the 5th generation of the European Centre Hamburg General Circulation Model (ECHAM5) as base model and the Modular Earth Submodel System (MESSy). A large variety of investigations have been performed using this system: Using MECCAs gas phase chemistry EMAC has been evaluated for the troposphere up to the mesosphere by Jöckel et al. 2006. It was applied by Kerkweg et al. 2008a and Kerkweg et al., 2008b.to simulate halogen chemistry including gas phase as well as aerosol phase reactions. Gromov et al., 2010 made use of a tagging technique, which is also part of MECCA to study the isotopic composition of the atmosphere. Chemistry on polar stratospheric clouds have been investigated by Kirner et al., 2011. A full list of EMAC applications can be found on http://messy-interface.org."

5. Why was such a large chemical mechanism used? This is almost never used in 3-D modeling studies sing ECHAM5/MESSy with MECCA.

The reviewer's point is addressed in the introduction. The main innovation that renders this manuscript valuable is the use of a fully implicit multiphase chemical mechanism coupled to an online size-resolved aerosol physics scheme. This includes gas-aerosol exchange, aqueous and gas phase reactions, acid-base chemistry, and photochemistry. The purpose of the research using this system is to examine inorganic halogen cycling, its impacts on atmospheric chemistry on a global scale, and then, to examine its potential impact on aerosol and greenhouse gas chemistry, and associated impacts on weather and climate. Available evidence supports the hypothesis that halogen cycling plays a major role in many of these processes, but the chemistry is such that a highly resolved multiphase mechanism such as MECCA is necessary to effectively simulate it on a large scale. It's unfortunate that these results can't be presented in context with this paper, but it was clear early on in the write-up that it was far too unwieldy. This point, though, is now more thoroughly articulated in the MS.

6. I strongly suggest to couple this paper to the announced manuscript of an evaluation. If this is not done, a very basic evaluation of a few chemical species, in comparison with the original CAM chemistry scheme, should be shown.

As stated above, we attempted a combined MS, and it was very unwieldy. Article title and anticipated journal for the upcoming paper are now presented in the MS. If possible, the two papers will be crosslinked as companions.

7. How is the surface / 900mb comparison so helpful for the evaluation of the new CAM version? This needs to be much clearer described, at this stage I cannot see what the main reason for such a graphic is – apart from the fact that it works in some form.

The following explanation has been added the text to address the review's comment:

L238: "In the implicit solution to the multiphase mechanism, the main sources of instability and stiffness involved complex, fast, multiphase chemistry in the near-surface layers. In addition to high liquid water contents in these layers relative to others, there were large, wind and geography driven 3-D gradients in reactive species and trace intermediates due to reactions in neighboring grid regions, emissions,

deposition, microphysical processing, and scavenging. Thus, it is in close proximity to the surface that the limitations of each numerical method – whether in computational stability or accuracy of the solution – was best evaluated."

8. The short title is confusing "Implementation of the chemistry module MECCA (v2.5)", in CAM3.6 should in some form be added.

We agree that the title should be changed and thank the reviewer for bringing this to our attention. It has been revised to "Implementation of MECCA chemistry in CAM". The full title as submitted to GMDD is "Implementation of the chemistry module MECCA (v2.5) in the modal aerosol version of the Community Atmosphere Model component (v3.6.33) of the Community Earth System Model".