Atmos. Chem. Phys. Discuss., 13, C6585–C6588, 2013
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Atmospheric Chemistry and Physics Discussions
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ACPD
13, C6585–C6588, 2013

Interactive Comment

Interactive comment on "Uncertainty in modeling dust mass balance and radiative forcing from size parameterization" *by* C. Zhao et al.

Anonymous Referee #2

Received and published: 6 September 2013

Overview

The paper "Uncertainty in modeling dust mass balance and radiative forcing from size parameterization" contrasts the sectional and modal representation of dust aerosol in the WRF-Chem model and how this influences important aerosol processes, such as deposition and the direct radiative effect. The work builds upon findings from Zhao et al. (2010) that highlighted the differences resulting from size distribution representation. The key findings are that the modal representation under-estimates coarse dust and over-estimates the fine dust aerosol, relative to the sectional schemes. This results in a longer dust lifetime, greater AOD and greater radiative impact relative to the bin schemes.

While this feels like a relatively small increment in extra knowledge upon the Zhao et al. (2010) research, the paper is mostly well-written and the figures generally clear. However, there are several points that need addressing relating to both the method and also the presentation prior to recommendation for publication.

Key Comments

The MOSAIC model can be implemented as either a bin or modal aerosol scheme. This would make comparison between the two size representations much more transparent. The authors need to explain why they did not take this approach.

The GOCART dust scheme is well validated within the GOCART model. Is there a reference for validation of the dust scheme within WRF-Chem? I couldn't see one in Zhao et al. (2010) - was this the first implementation? It would be good to see some validation of this, especially since the estimated global emissions are 6000Tg/year – almost double that produced by the GOCART model (for 2000) and 5 times the median of the AEROCOM models (Huneeus et al., 2011).

Other studies have performed bin-mode aerosol comparisons (e.g. Mann et al., 2012). While this study does not consider dust it may be useful to compare and contrast your findings in how a modal scheme influences the size distribution relative to a sectional scheme.

Radiative forcing is the change in radiative effect relative to pre-industrial conditions. This is not what is shown in the paper, therefore the title and relevant text throughout the paper require alteration.

Often results and numbers are simply listed in the text (e.g. for mass loading, deposition, radiative effects). I recommend tabulating these to create a useful reference for the reader and then discussing the differences between aerosol distribution representations in the text. This will reduce the amount of unnecessary text and allow for a more involved discussion of the differences and the implications.

ACPD
13, C6585–C6588, 2013

The prescribed modal standard deviation is considered the main contributor to the bias in the modal representation relative to the sectional scheme. However, Fig. 6 suggests that the distribution produced in remote regions by the sectional schemes may not be able to be reproduced by a modal scheme even with a varying modal standard deviation. Has any research previously been done to determine if a three-moment implementation does give a modal scheme more skill? Would the extra degree of freedom negate any computation saving gained by using a modal scheme rather than a sectional scheme?

What is the reason for using a "quasi-global" simulation? It would be interesting to know how the two representations affect the radiative effect in the polar regions in light of recent research (e.g. Lambert et al., 2013) especially as this is one of the metrics used to contrast the schemes.

Is the model co-sampled with MODIS and MISR data availability? Is Level 3 MODIS data used? Was any additional cloud screening and filtering applied?

Figures and Minor Comments

pg 19672, ln 25 - "focing"

Table 1 seems redundant, consider merging with Table 2

Table 2 – Other than for emission, the separation of D < 10um and Total seems redundant. These could be stated in the caption to make the table more concise and legible.

Fig. 4 and Fig. 5 - consider using a different color scale that highlights the relative differences (e.g. blue-white-red as in Fig. 7)

References

Lambert, F. et al. Nature Clim. Change 3, 487–491 (2013) Huneeus, N. et al. Atmos. Chem. Phys. 11, 7781–7816 (2011) doi:10.5194/acp-11-7781-2011 Mann et al.

ACPD
13, C6585–C6588, 2013

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