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Biogeosciences Discussions

Interactive comment on "Atmospheric aerosol deposition fluxes over the Atlantic Ocean: A GEOTRACES case study" *by* Jan-Lukas Menzel Barraqueta et al.

Anonymous Referee #1

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Atmospheric deposition fluxes over the Atlantic Ocean: A GEOTRACES case study

This paper uses the MADCOW model to calculate dust fluxes to the Atlantic Ocean, and compares the results to a dust flux model from Mahowald.

The key issue in this comment is that the residence times used to calculate dust fluxes are obtained from Han et al 2008. Those residence times are calculated using the DEAD dust flux model and the BEC ocean circulation and biogeochemistry model for the dissolved Al distribution. The MADCOW model formulation is this:

G = ([Al]*MLD)/(T*S*D)

Where:

G=dust flux (grams per square meter per year)

[Al] = the dissolved Al concentration in the mixed layer (moles per cubic meter, NOT moles per liter!!)

MLD = mixed layer depth (meters)

T= residence time (years) (from Han et al., 2008)

S= fractional solubility

D= Al concentration in dust (moles/gram)

T is the [Al] inventory from the BEC model divided by the sum of the inputs of dissolved Al from dust and from mixing. The dissolved Al flux from dust was derived from the DEAD dust model using a solubility of 5% and 8% Al in dust (0.002965 moles/gram) and the mixing terms were obtained from the BEC model.

So, T can be written as:

T= ([Al]*MLD)$_{BEC\ model}$/(G*S*D+mixing)$_{DEAD\ and\ BEC\ model}$

T= ([Al]*MLD)$_{BEC\ model}$/(G*0.05*0.002965 + mixing)$_{DEAD\ and\ BEC\ model}$

Substituting T into the MADCOW equation yields:

G$_{Atlantic}$ = ([Al]*MLD$_{Atlantic}$ *(G*0.05*0.002965 + mixing)$_{DEAD\ and\ BEC\ model}$)/([Al]*MLD)$_{BEC\ model}$*(S*D)$_{Atlantic}$)

When the mixing terms for the dissolved Al input (from the DEAD+BEC model) are small, we can further resolve this equation. I assume they both used 8% Al in dust (D=0.002965 moles/gram) so the D terms cancel.

$G_{Atlantic}/G_{DEAD}$ = ([Al]*$MLD_{Atlantic}$)/ [Al]*MLD$)_{BEC\ model}$)*((0.05$)_{DEAD}$/(S$)_{Atlantic}$)

This equation can therefore be used to calculate the ratio of the dust fluxes in this paper to those used by Han et al. (2008) from the DEAD model. You can see that the dust flux ratio is affected by the ratio of the dissolved Al inventory (from the Atlantic data in this paper) to the inventories for the same locations from the BEC model in Han et al. (2008) and, equally as important, by the ratio of the Al solubilities, where the DEAD model used a fixed value of 5% and this paper uses a variety of solubilities obtained from actual aerosol measurements across the Atlantic. If they used a different Al concentration in dust in this paper (it is not specified!) then the D terms would not cancel, further affecting the dust flux ratios.

If the dissolved Al inventories from this paper are the same as those obtained by Han et al. (2008) using the BEC model and if the same fractional solubility is used, then the dust fluxes would be the same and the dust flux ratio would be 1.0.

This paper (Table S3) uses Al solubilities always greater than or equal to 5% (often 2-3 times higher), so if the dissolved Al inventories in this paper and from the BEC model are similar, then the predicted dust flux would always be less than or equal to what the DEAD model shows (and probably also less than or equal to what the Mahowald dust model shows). This is a simple mathematical outcome; it does not really say anything substantially new about the MADCOW model and its ability to compare with dust flux models.

It would also be very instructive to compare the new dissolved Al inventories in this paper to the inventories for the same locations from the BEC model; if the BEC model

inventories are very different from those shown in this paper, then the dust fluxes would not agree with the DEAD model fluxes even if they used the same fractional solubility!

At the very least, using fractional Al solubilities from the Atlantic data in this paper to calculate dust fluxes that are then compared to the Mahowald dust model fluxes is not the correct comparison to make. The dust fluxes should be compared to the DEAD model dust fluxes, since those fluxes were used to estimate the residence times. And the degree of disagreement can then be attributed to differences in the dissolved Al inventories (measured vs. modeled) and/or differences in the Al fractional solubility. This makes the paper less “descriptive” and more “quantitative”.