Dry deposition in the CESM

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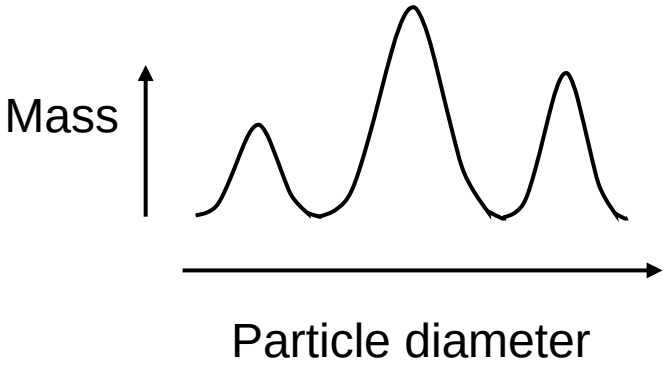
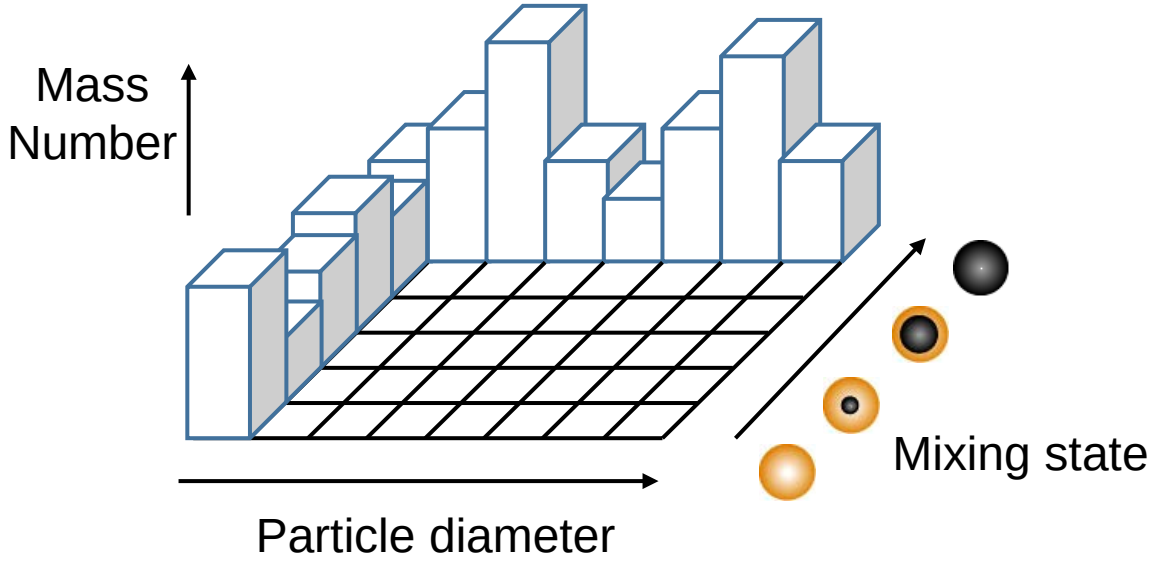
Objective of Hitoshi Matsui's research: implement size and mixing state resolved aerosol model into CESM

Development of a 2-D bin model, ATRAS

[Matsui et al., ACP, 2014]

Typical global aerosol model





Regional model

Months
East Asia

Efficiency, Accuracy

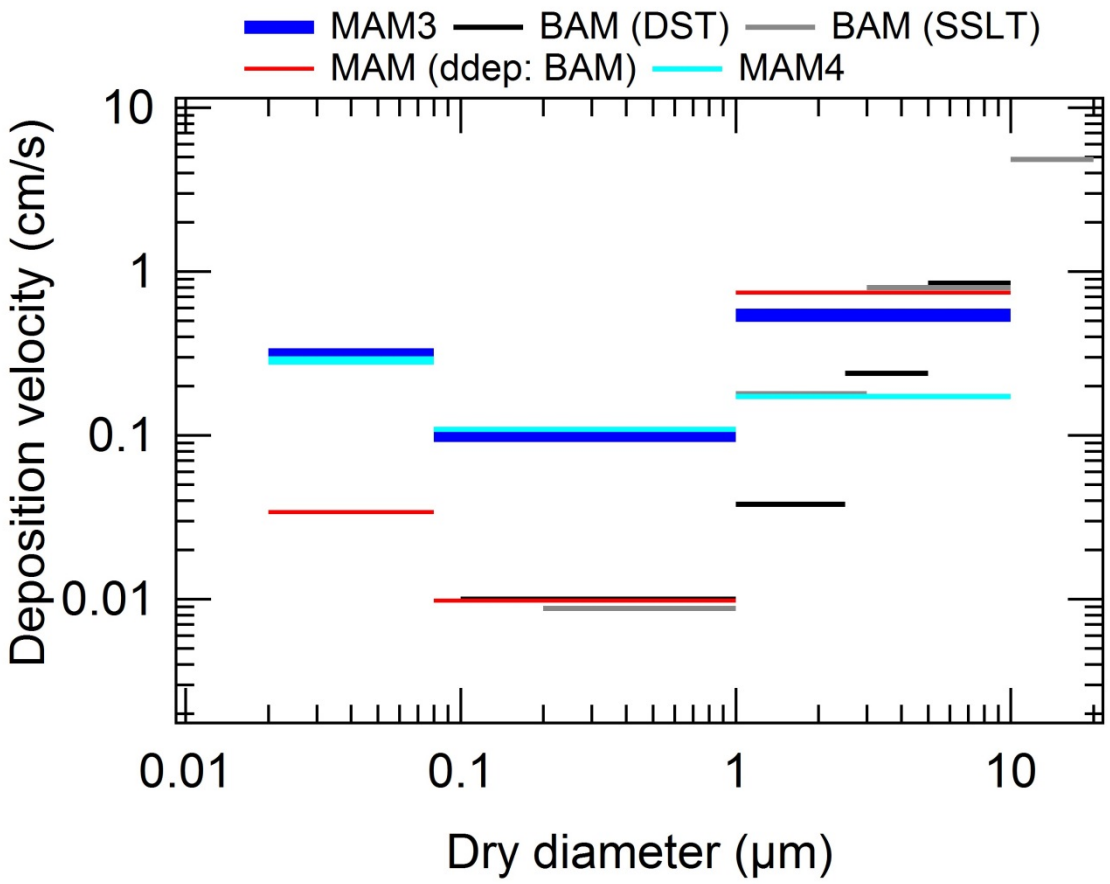
Global model

Years/Centuries
Global

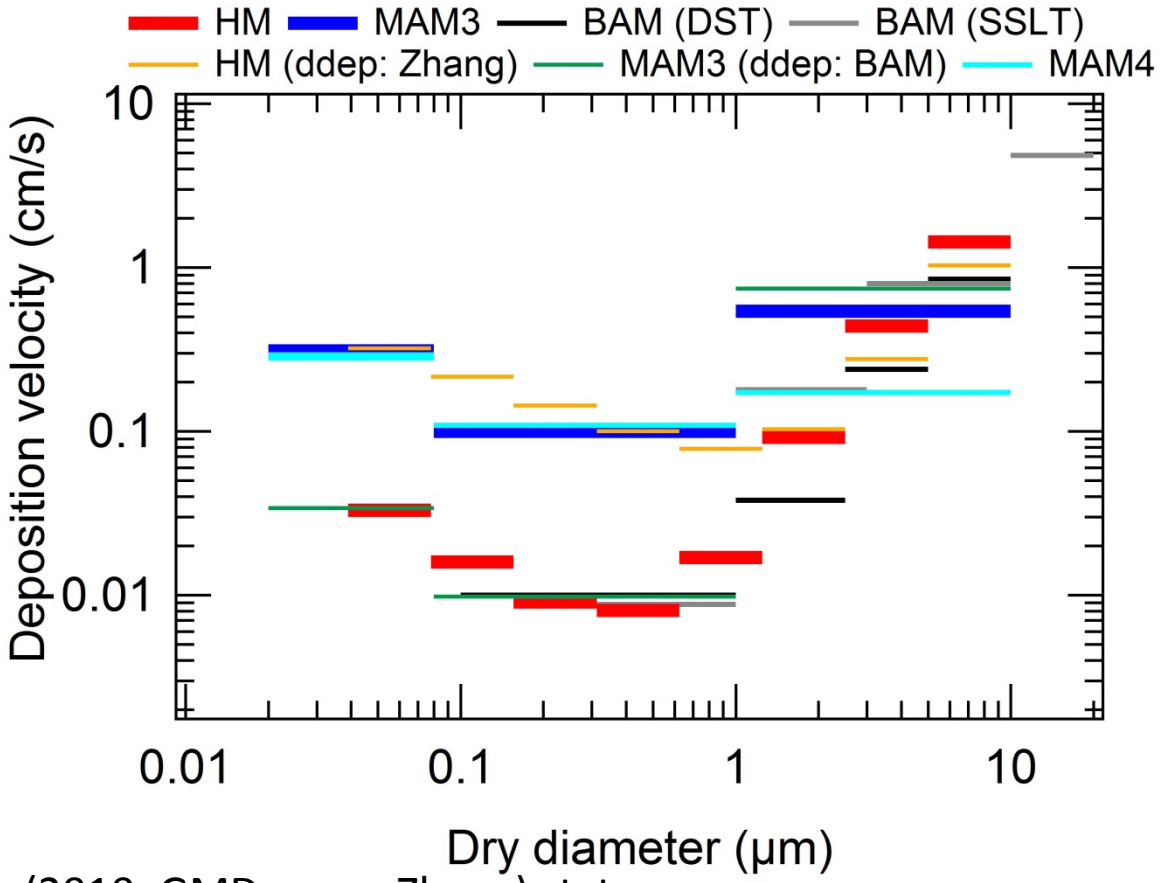
Development of a global aerosol model using a 2-D bin method

- **Development of a box model which is efficient and accurate**
- **Implementation to a global model**
- **Simulations and validations of the new aerosol model**

Dry deposition velocities VERY sensitive to Zhang et al. vs. CAM4 scheme. Especially in small particles



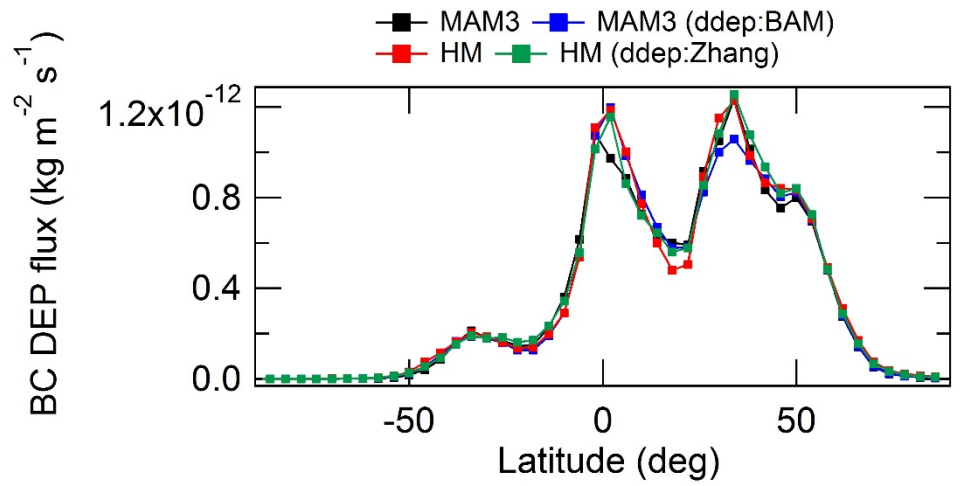
Dry deposition velocities VERY sensitive to Zhang vs. CAM4 scheme. Especially in small particles

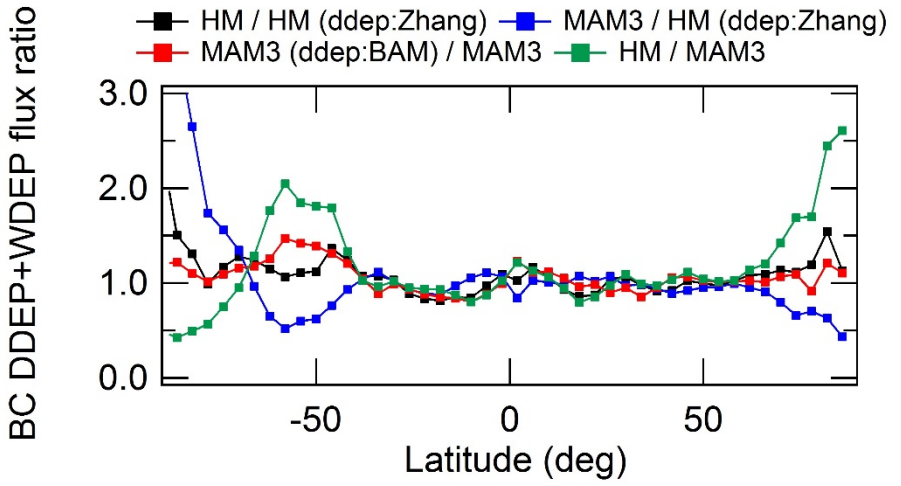


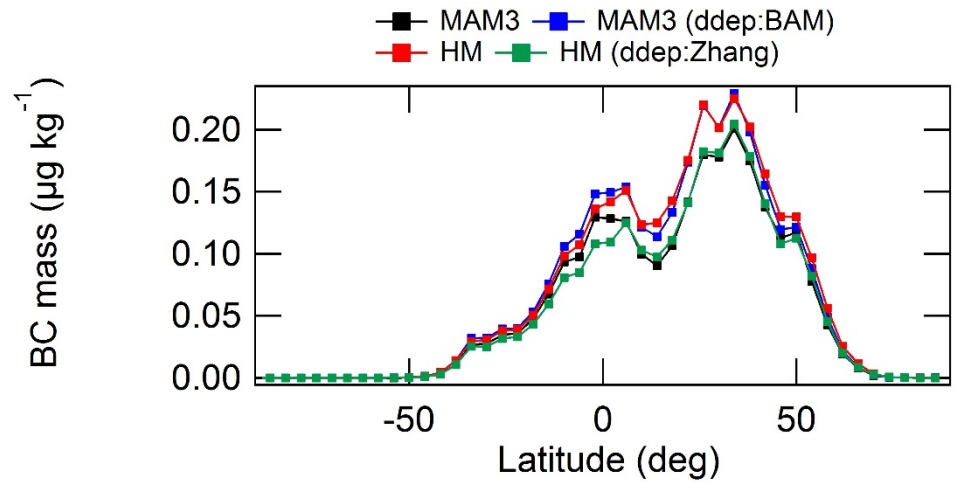
Petrov and Zhang (2010, GMD, same Zhang) states:

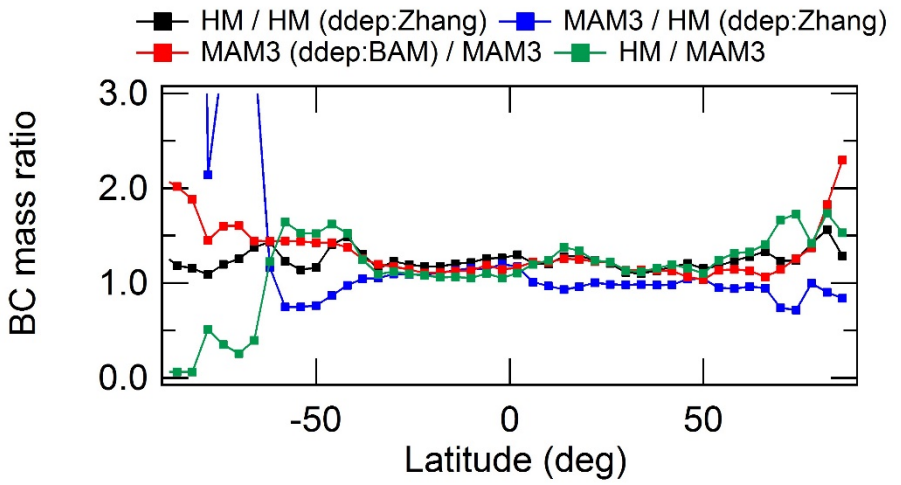
"The predictions of the present model differ from Zhang et al.'s model in the fine mode, where the latter tends to over-estimate in a significant way the particle deposition, as measured by various investigators or predicted by the present model.

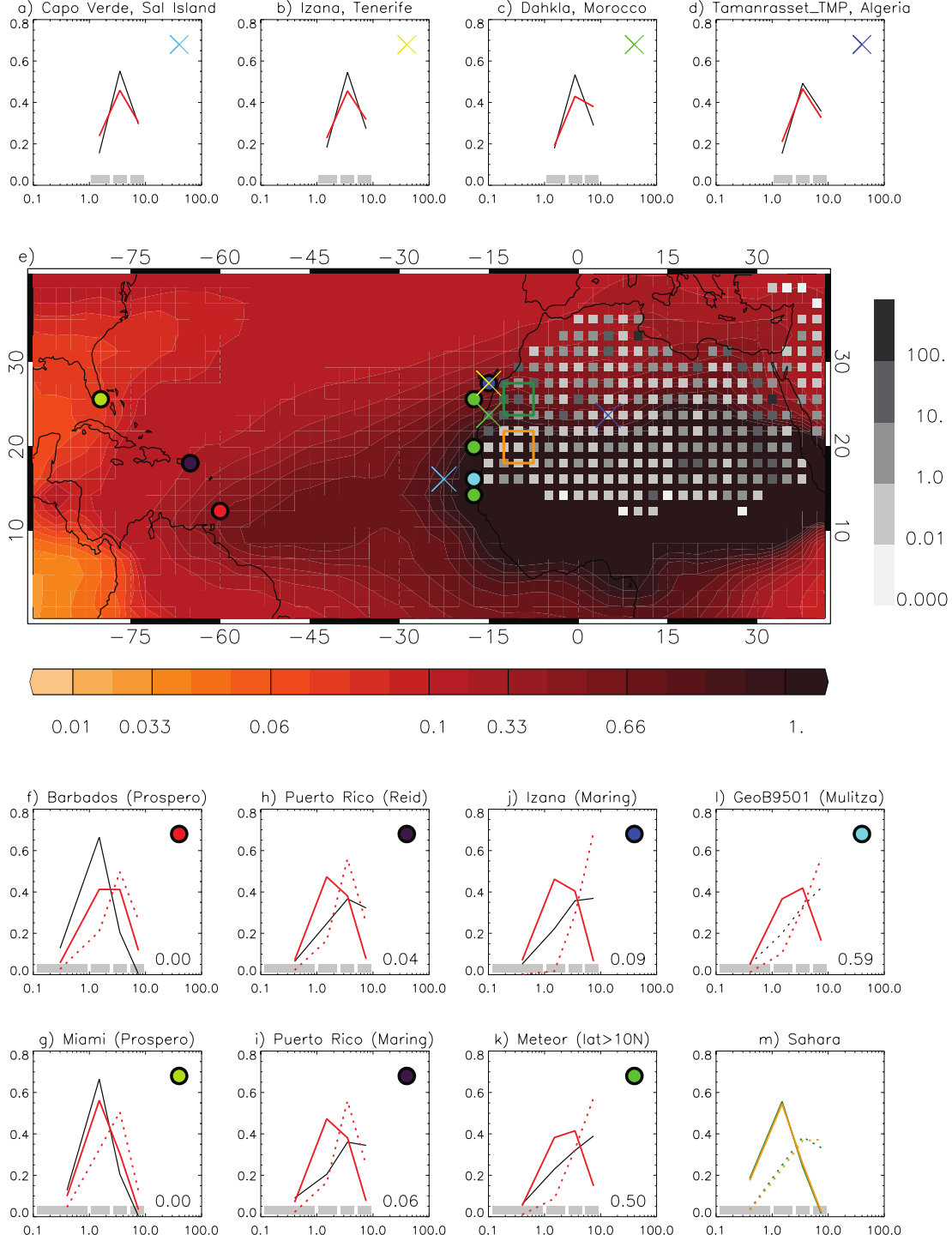
Dry deposition actually matters for BC transport to high latitudes ?
Surprising result that it matters at perhaps 30%-100%?
But as excepted, other processes matter more (hydrophilic vs phobic, BC mixing state)









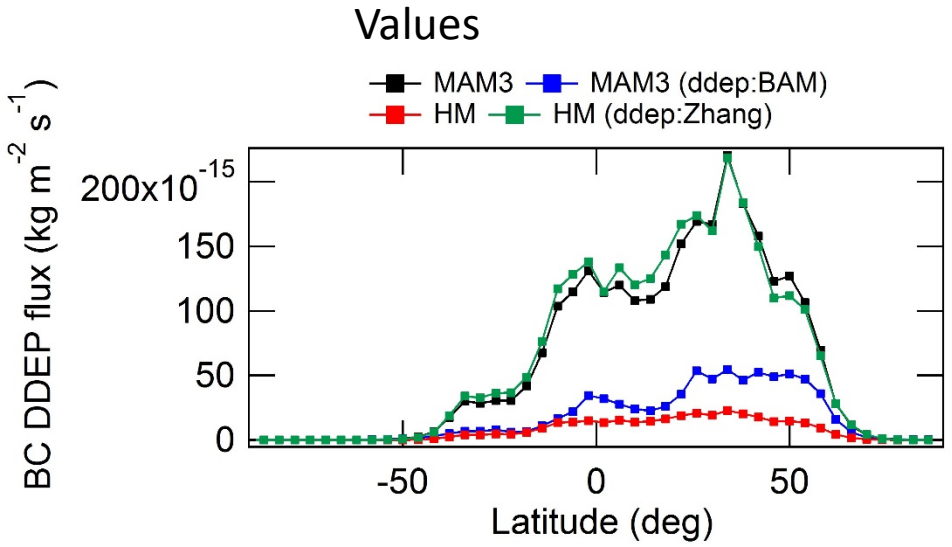


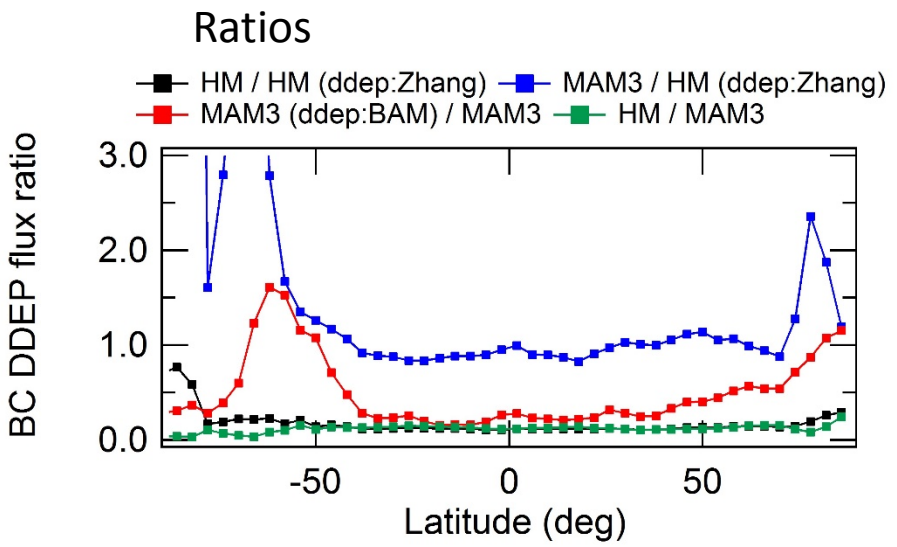
Mahowald et al., 2013: Evolution of dust size in CAM4 simulated versus observations: tends to go from source-like distribution to remote dust size distribution too quickly, but does get remote dust size distribution about right.

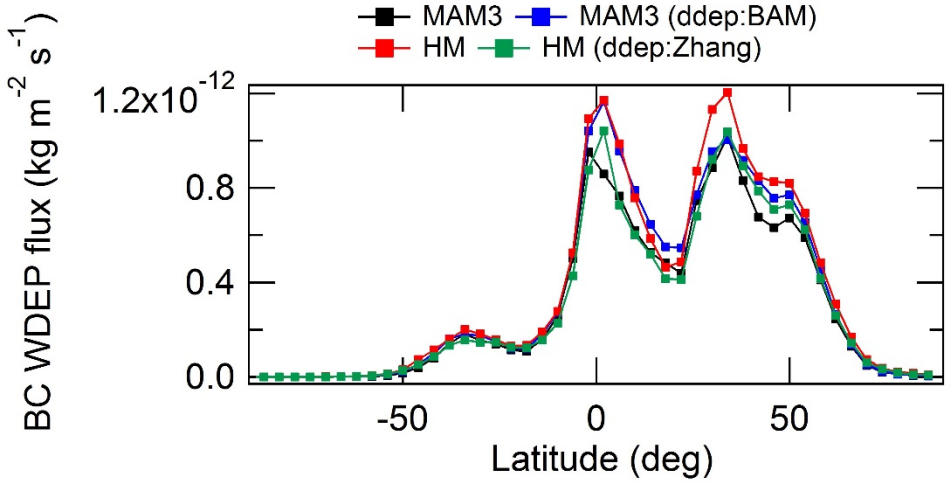
(hard to do comparisons in CAM5, since not as much size resolution)

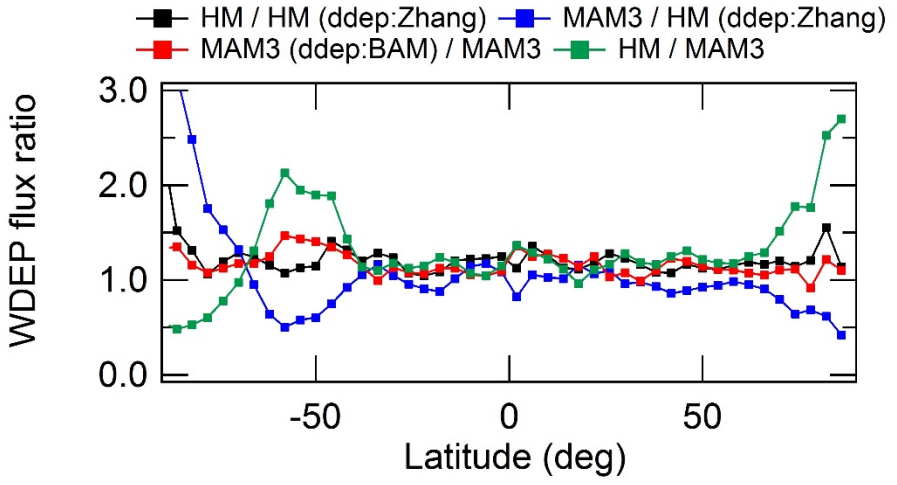
Summary

- With BAM→MAM change, also dry deposition changed
- Matters to coarse mode (of course)
- But matters more than expected for fine mode (BC)
- Should include more up-to-date Petrov and Zhang scheme, which reduces fine mode dry deposition rates (perhaps in process…)


Values
MAM3
MAM3 (ddep:BAM)
HM
HM (ddep:Zhang)
BC DDEP flux (kg m-2 s-1)
200x10-15
150
100
50
0
-50
0
50
Latitude (deg)


Ratios
HM / HM (ddep:Zhang)
MAM3 / HM (ddep:Zhang)
MAM3 (ddep:BAM) / MAM3
HM / MAM3
BC DDEP flux ratio
3.0
2.0
1.0
0.0
-50
0
50
Latitude (deg)


MAM3
MAM3 (ddep:BAM)
HM
HM (ddep:Zhang)
BC WDEP flux (kg m-2 s-1)
1.2x10-12
0.8
0.4
0.0
-50
0
50
Latitude (deg)


HM / HM (ddep:Zhang)
MAM3 / HM (ddep:Zhang)
MAM3 (ddep:BAM) / MAM3
HM / MAM3
WDEP flux ratio
3.0
2.0
1.0
0.0
-50
0
50
Latitude (deg)

		MAM3	MAM3 (ddep:BAM)	HM	HM (ddep:Zhang)
AOD		0.092	0.092	0.17	0.15
AAOD		0.0055	0.0051	0.0062	0.0055
AOD_BC		0.0029	0.0033		
AAOD_BC		0.0024	0.0027		
E_DST	Tg/y	2466	2092	2395	2156
D_DST	Tg/y	1715	1616	1138	866
W_DST	Tg/y	734	474	1252	1273
E_BC	Tg/y	7.7	7.7	7.7	7.7
D_BC	Tg/y	1.3	0.35	0.16	1.4
W_BC	Tg/y	6.4	7.3	7.6	6.4
Burden					
DST	Tg	19.8	13.1	35.7	33.8
BC	Tg	0.085	0.097	0.107	0.091
Srf conc					
NCL	ug/kg	8.3	6.7	11.9	13.1
DST	ug/kg	17.6	11.1	24.5	23.4
OA	ug/kg	1.4	1.5	1.3	1.1
BC	ug/kg	0.076	0.089	0.089	0.074
CCN0.1	cm-3	102	126	82	63
CCN1.0	cm-3	437	544	512	412