

# Climate effects of aerosols in the GISS GCM

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Using AEROCOM-B emissions we evaluate direct and indirect aerosol effects on climate in terms of:

**Climate sensitivity to carbonaceous aerosols**

**Heating effects of black carbon**

**Aerosol-convective cloud effects**

# Forcings due to aerosols in the GISS GCM

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Case	Sulfate	OC	BC	BC	Total
	Total	(fossil/bio-fuel/biomass)	(fossil/bio-fuel)	(biomass)	
Direct forcing (W m <sup>-2</sup> )	-0.29	-0.13	0.18	0.06	-0.18
Forcing efficiency (W g <sup>-1</sup> )	-103	-106	1385	857	NA

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**(From Menon and Del Genio, 2004)**

## Forcings due to aerosols in the GISS GCM

Case	Sulfate	OC	OC	BC	BC	Net Cloud forcing (W m <sup>-2</sup> )
	Total	(fossil & bio-fuel)	(biomass & terpene)	(fossil & bio-fuel)	(biomass)	
M02	2.66/0.42	1.57/0.14		-	-	-4.36
	5.03/1.05	2.46/0.27		-	-	-2.41
Exp A	2.96/0.15	0.98/0.57	1.61/0.80	0.13/0.0	0.12/0.06	-0.65
Exp A_S	4.34/0.14	0.96/0.55	1.63/0.15	0.12/0.0	0.12/0.01	-1.03

(From Menon and Del Genio, 2004)

# Simulations to determine aerosol climate sensitivity

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Simulation	Type
<b>Exp A</b>	<b>Standard run with both indirect effects</b>
<b>Exp NBC</b>	<b>Like Exp A but without fossil/bio-fuel Black Carbon</b>
<b>Exp 2BC</b>	<b>Like Exp A but with twice fossil/bio-fuel Black Carbon</b>

**$\Delta$  : denotes differences between simulations with present-day aerosol emissions (AEROCOM) and pre-industrial aerosols (terpenes, DMS, volcanic, some portion of biomass, sea-salt and dust).**

# Climate sensitivity

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**Climate sensitivity is determined from ratio of surface temperature change to forcing.**

Climate sensitivity for:

**$\Delta$ Exp A            0.12 K W<sup>-1</sup> m<sup>2</sup>**

**$\Delta$  Exp NBC        0.097 K W<sup>-1</sup> m<sup>2</sup>**

**$\Delta$  Exp 2BC        1.14 K W<sup>-1</sup> m<sup>2</sup>**

Sensitivity in same model coupled to a mixed ocean slab model for:

**2xCO<sub>2</sub>            0.66 K W<sup>-1</sup> m<sup>2</sup>**

**(From Menon and Del Genio, 2004)**

# Climate sensitivity

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In an atmosphere only model (Hadley Center climate model) with **4 times as much fossil fuel Black Carbon as in Exp A:**

Annual mean surface temperature change is  $\sim 0.436\text{K}$

Climate sensitivity =  **$0.56 \text{ K W}^{-1} \text{ m}^2$**

(Roberts and Jones, 2004).

Effects of Black Carbon on cloud properties not considered.

Within the same model the climate sensitivity to doubled  $\text{CO}_2$  is  $\sim$   **$0.91 \text{ K W}^{-1} \text{ m}^2$** .

# Change in climate due to varying black carbon induced heating

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<b>Indian Ocean (Jan-Mar) (0-20N, 40-100E)</b>	<b>TOA (Wm<sup>-2</sup>)</b>	<b>Surface (Wm<sup>-2</sup>)</b>	<b>Atmosphere (Wm<sup>-2</sup>)</b>	<b>Precipitation (mm/d)</b>
<b>Δ Exp A</b>	<b>-2.97</b>	<b>-7.33</b>	<b>4.36</b>	<b>0.35</b>
<b>Δ Exp NBC</b>	<b>-2.07</b>	<b>-3.52</b>	<b>1.45</b>	<b>-0.08</b>
<b>Δ Exp 2BC</b>	<b>-2.06</b>	<b>-5.71</b>	<b>3.65</b>	<b>0.01</b>

(From Menon and Del Genio, 2004)

# Change in climate due to aerosol-convective clouds effects

