Simulation of carbonaceous aerosols driven by different emissions

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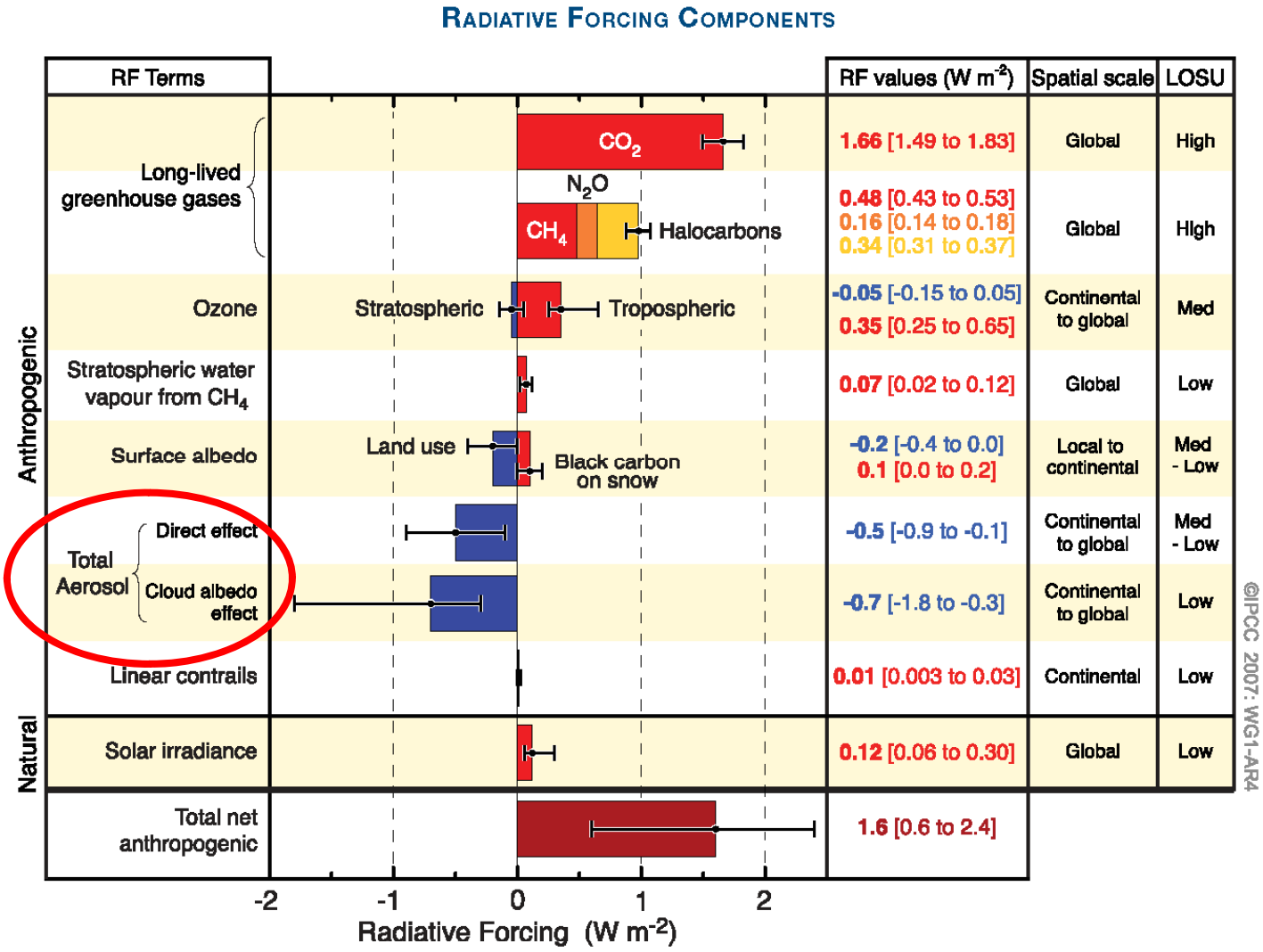
Contents

Introduction



(IPCC, 2007)

BCC_AGCM2.0.1/CUACE/Aero

Aerosols	**12bin sectional model：r=0.005-20.48μm（dry）**
Sources	**Seal-salt：** Monahan 1986, Vignati2001, Gong 2003 **Soil Dust：** size-segregated (Marticorena and Bergametti1995) **BC/OC：** ***fossil fuel(Cook et al.)*** ***biomass burning (Liousse and Penner et al)*** boreal (Lavoue et al) **Sulphate：** anthropogenic SO_2 and SO_4（GEIA 1B: 2-LEVEL) oceanic DMS concentration（Kettle et al. 1999) land H_2S（Benkovitz et al.)
Prognostic Variables	Aerosol mass mixing ratio in each size bin, DMS, SO_2, H_2S, H_2SO_4(g)
Clear-sky processes	Nucleation, condensation, coagulation, on-line S chemistry with MOZART'S OH和NO_3
Wet Processes	Below- and In-cloud scavenging(Gong et al, 2003) Cloud activation and cloud chemistry with O_3, H_2O_2, HNO_3 (von Salzen et al, 2000)
Dry Deposition	Size-dependent particle and SO_2，Zhang et al (2001)
Resolution	128×64×26，20min

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Model run and Valiation data

- **Model run: climatologically monthly SST were used to drive the climate aerosol model continuously.**

  ***Cook emissions etc*: climatologically**

  ***IPCC-AR5 Emissions*: 1850-2000**

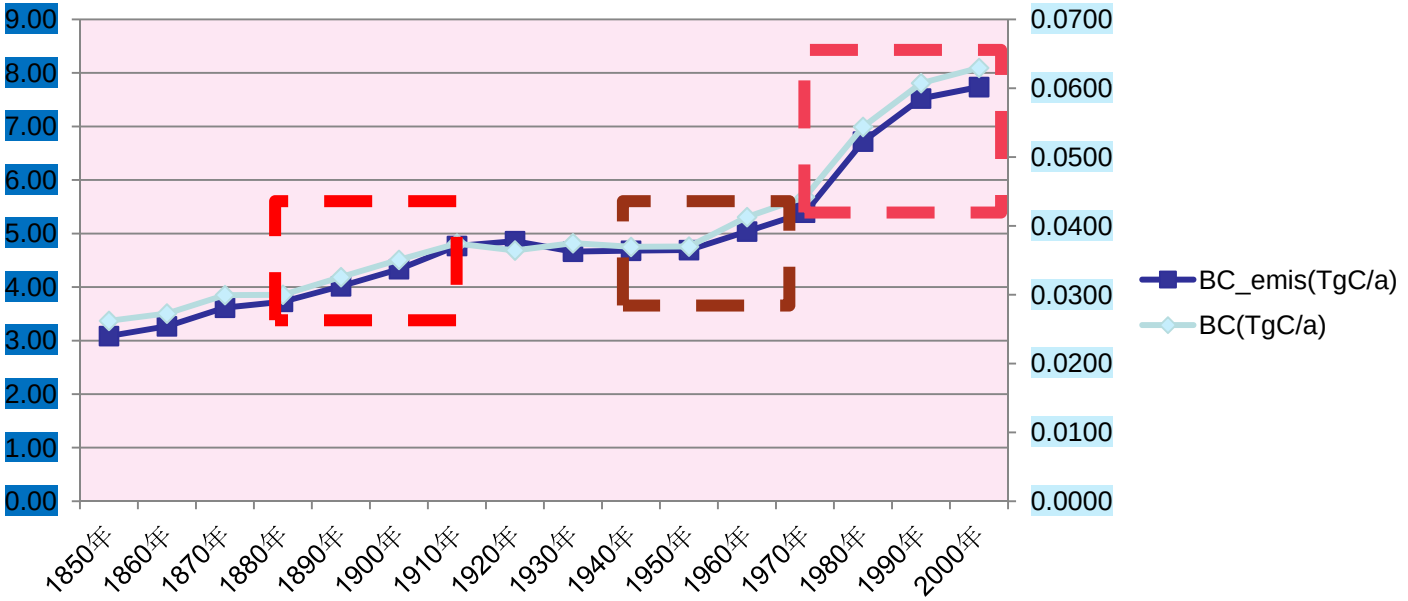
- **Validation data: Aerocom, AEROCE, EMEP**

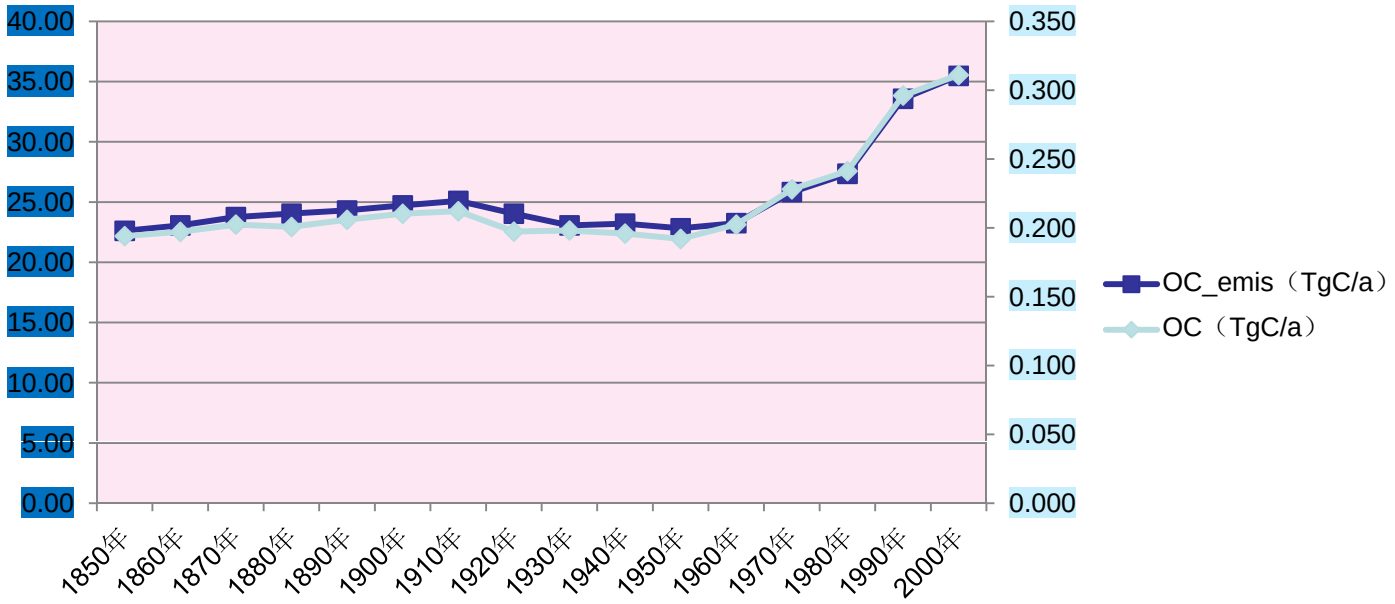
- **Variables: Annually average column concentrations, monthly average mass concentrations, bugets, radiative fluxes etc**

1890-1919

1940-1969

1970-1999



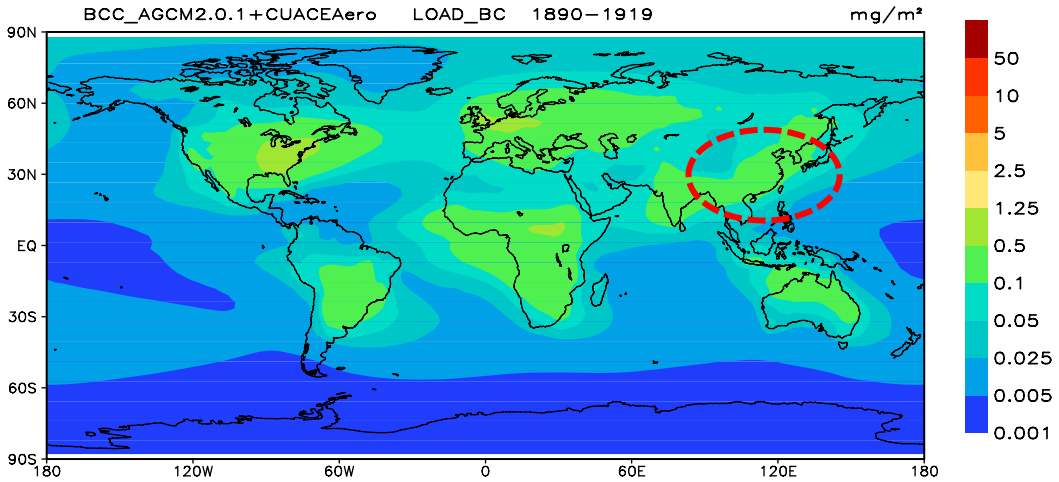


Budgets

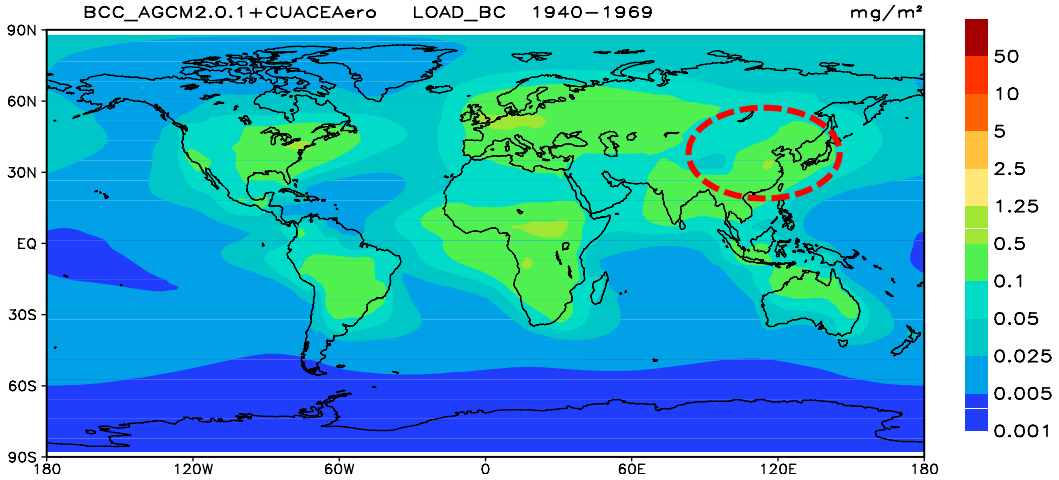
	BC			OC		
	1850	2000	old	1850	2000	old
Emissions(Tg/yr)	3.08	7.74	11.02	22.61	35.48	69.18
In-Cloud (Tg/yr)	-1.42	-3.54	-5.02	-10.36	-16.75	-34.20
Below-cloud(Tg/yr)	-0.04	-0.09	-0.49	-0.27	-0.36	-3.40
Dry Dep. (Tg/yr)	-1.64	-4.11	-5.52	-12.02	-18.46	-31.63
Total Dep.(Tg/yr)	-3.10	-7.74	-11.03	-22.65	-35.56	-69.23
Burden(Tg/yr)	0.026	0.063	0.115	0.194	0.31	0.853
Residence Time (d)	3.09	2.97	3.79	3.13	3.19	4.50

BC

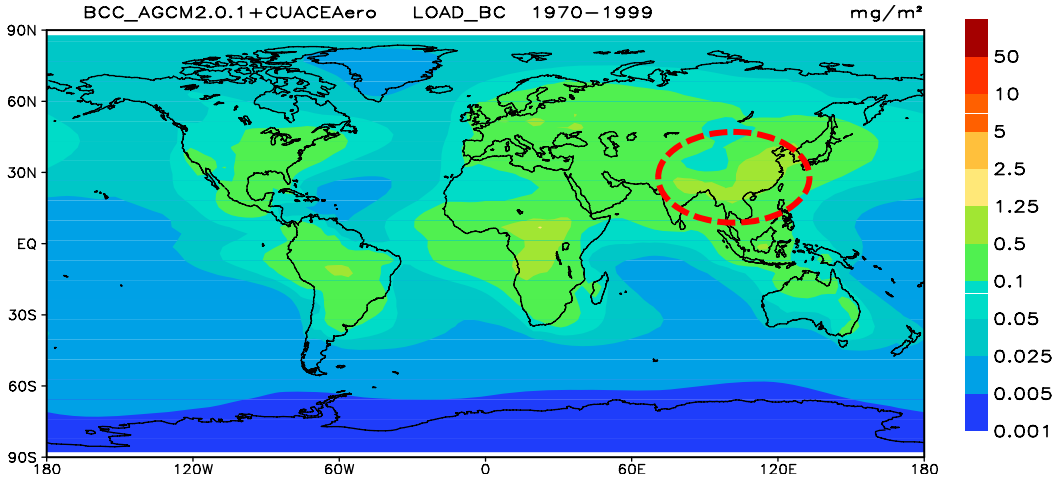
1890-1919



1940-1969

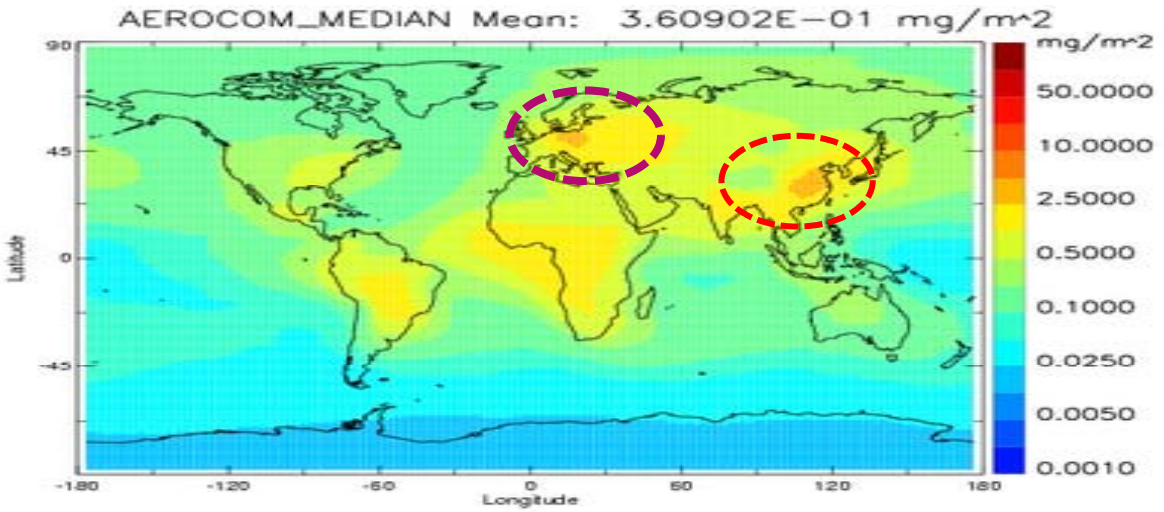


1970-1999

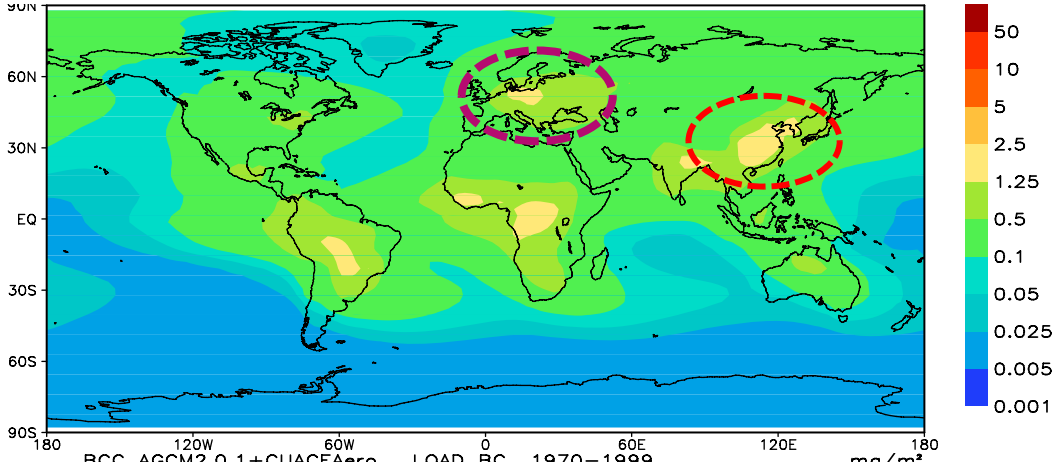


BC

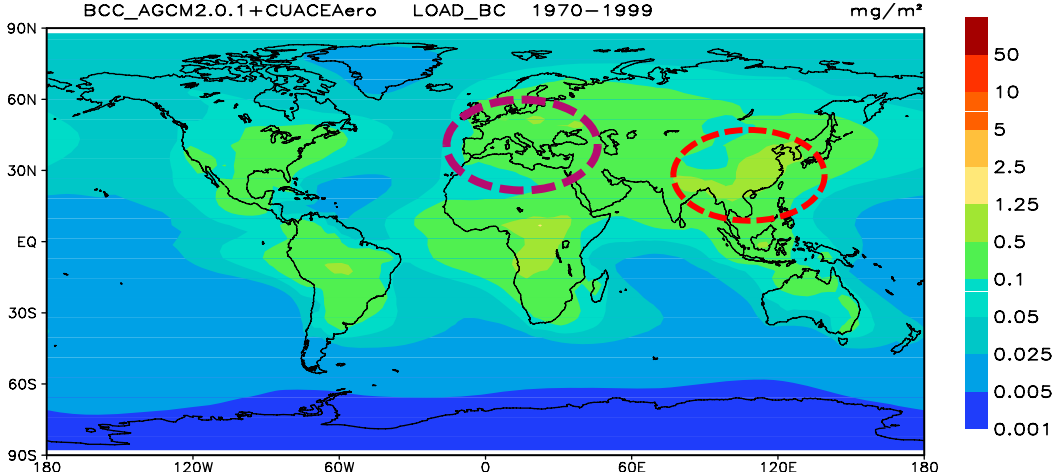
AeroCom



Old

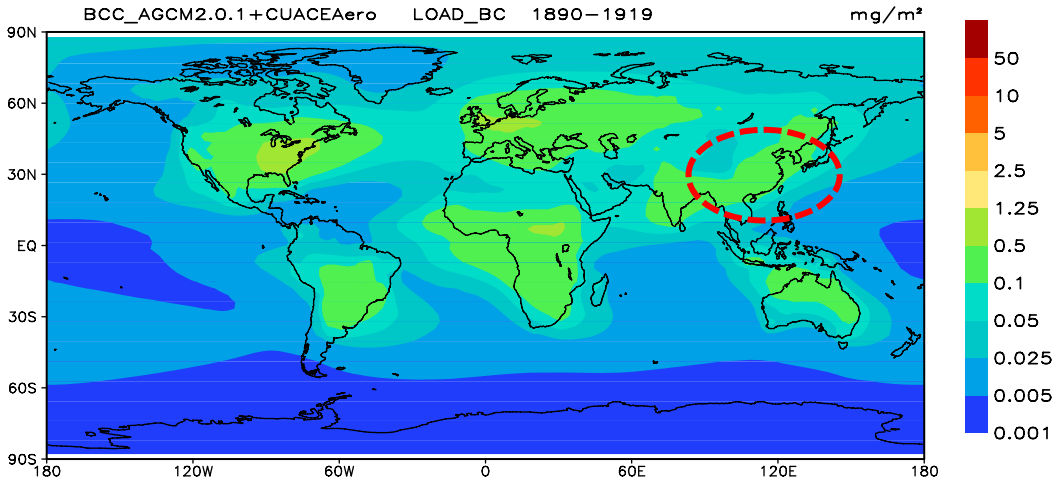


1970-1999



OC

1890-1919



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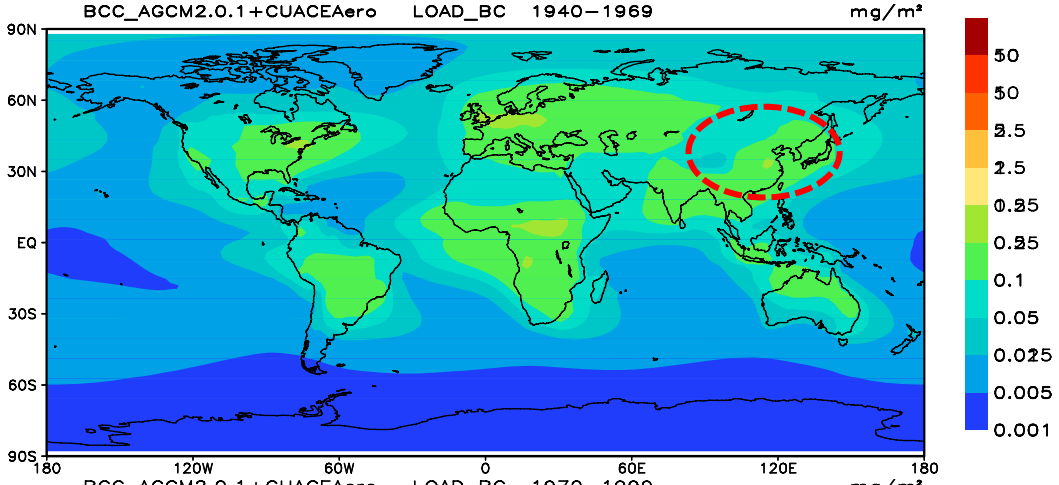

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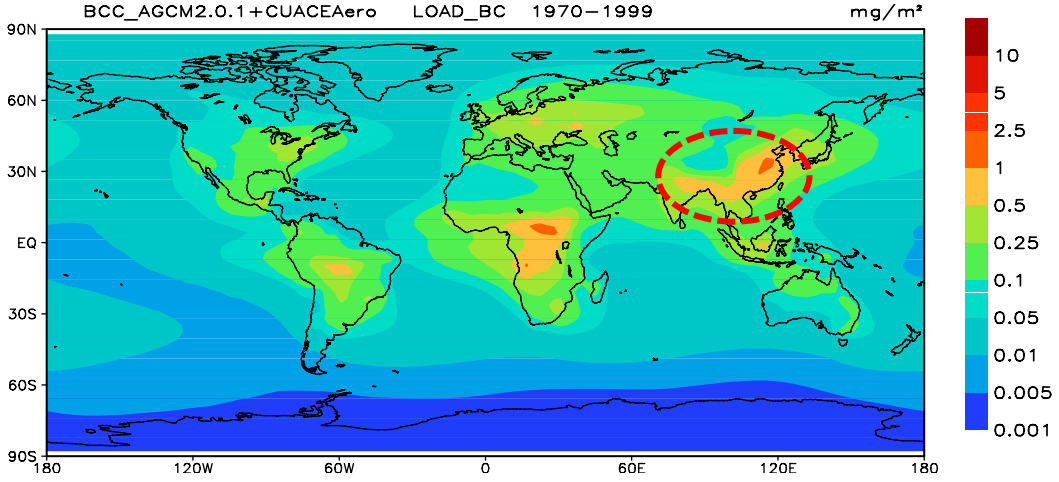
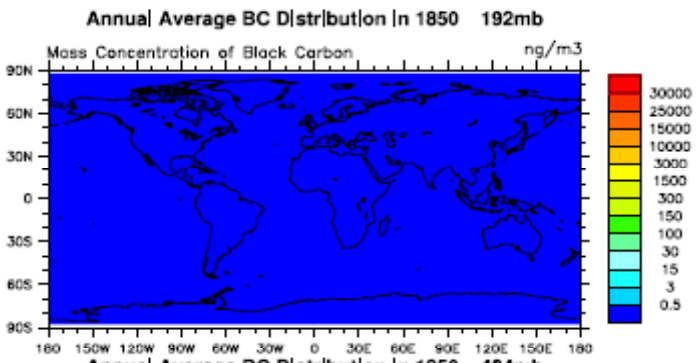
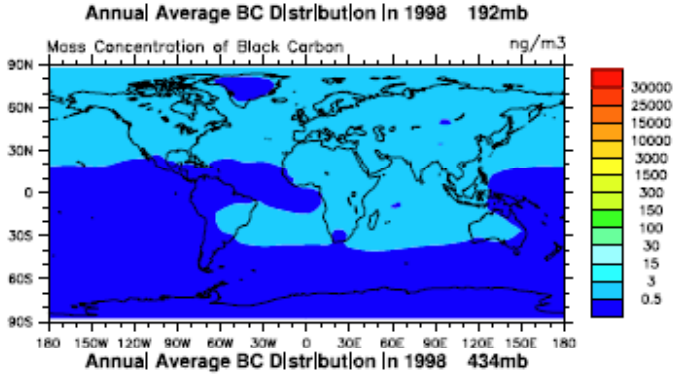


BC

1850

1998


Annual Average BC Distribution in 1850 192mb
Mass Concentration of Black Carbon
ng/m3
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180
30000
25000
15000
10000
3000
1500
300
150
100
30
15
3
0.5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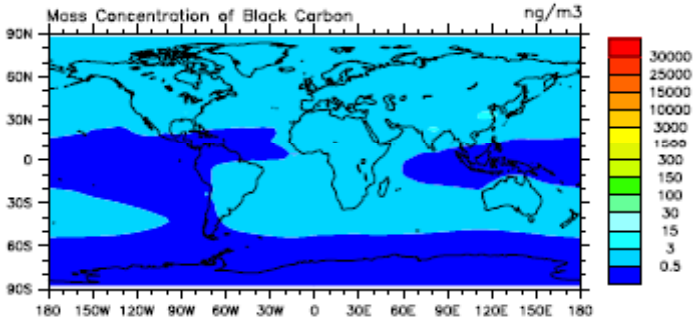
300
150
100
30
15
3
0.5


Annual Average BC Distribution in 1850 434mb
Mass Concentration of Black Carbon
ng/m3
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180
30000
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1500
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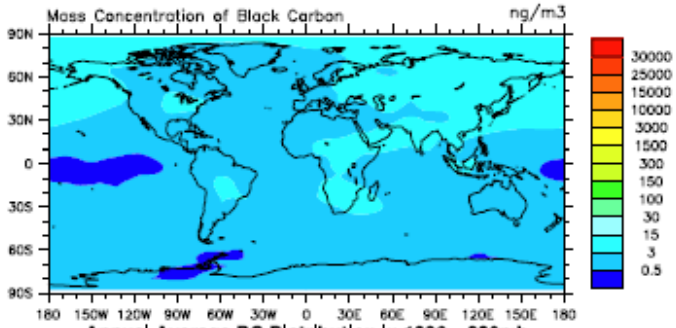
0.5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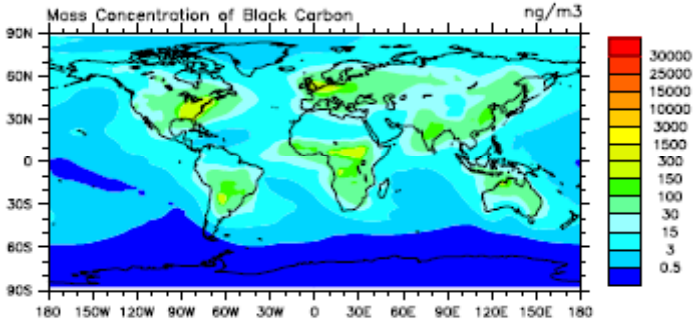
1500
300
150
100
30
15
3
0.5


Annual Average BC Distribution in 1850 930mb
Mass Concentration of Black Carbon
ng/m3
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180
30000
25000
15000
10000
3000
1500
300
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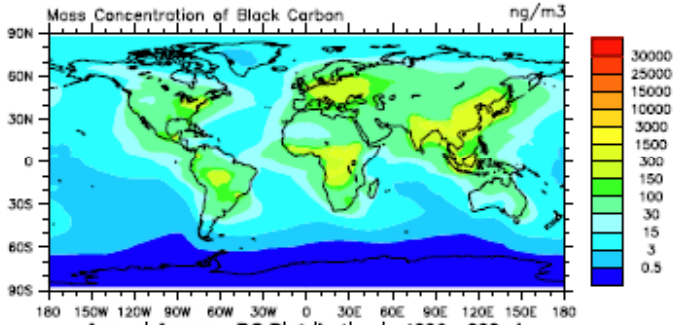
30
15
3
0.5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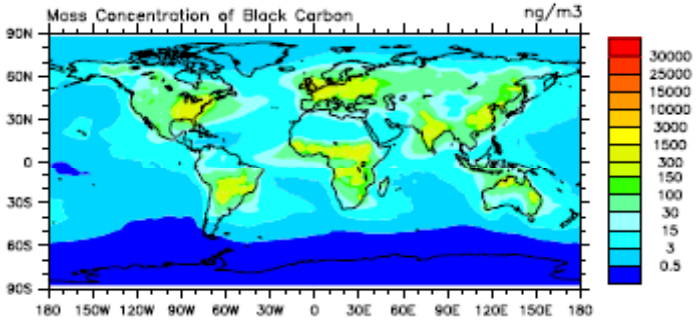
3
0.5


Annual Average BC Distribution in 1850 992mb
Mass Concentration of Black Carbon
ng/m3
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180
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25000
15000
10000
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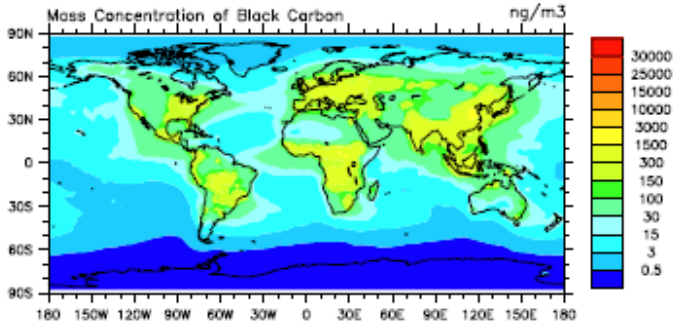
1500
300
150
100
30
15
3
0.5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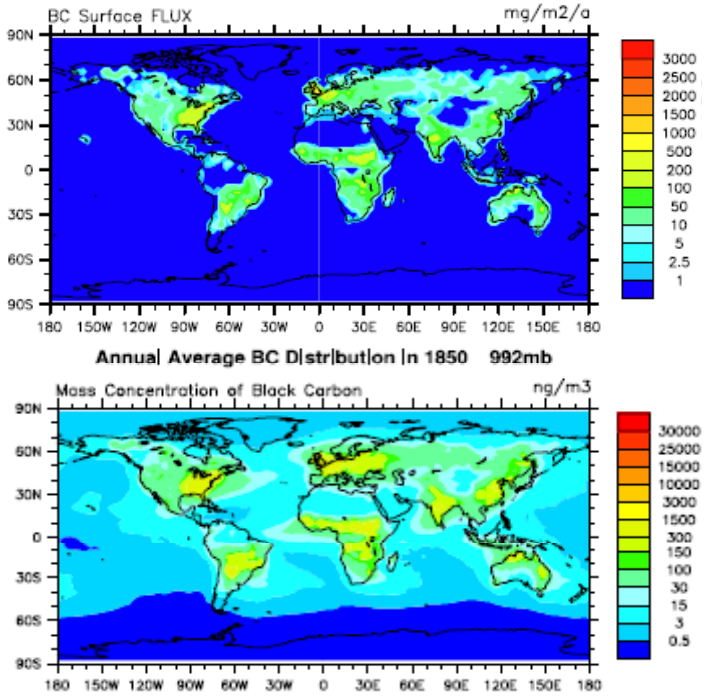
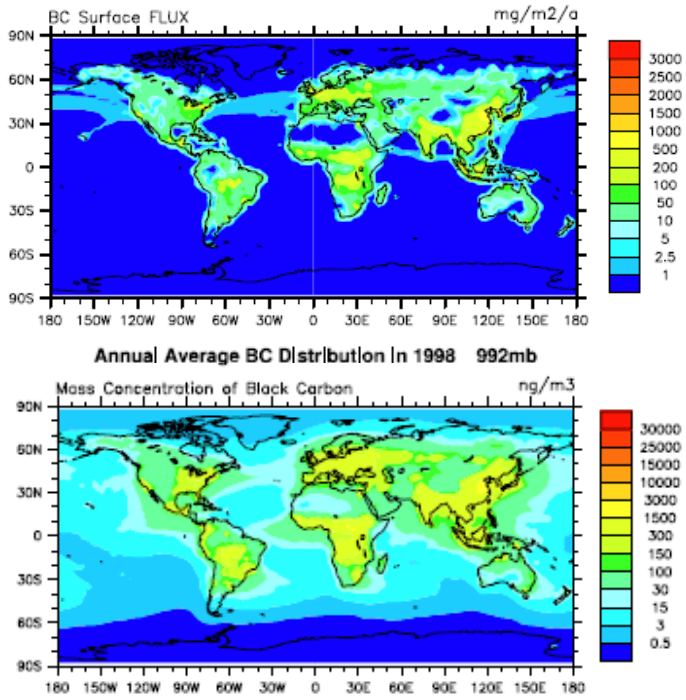
BC

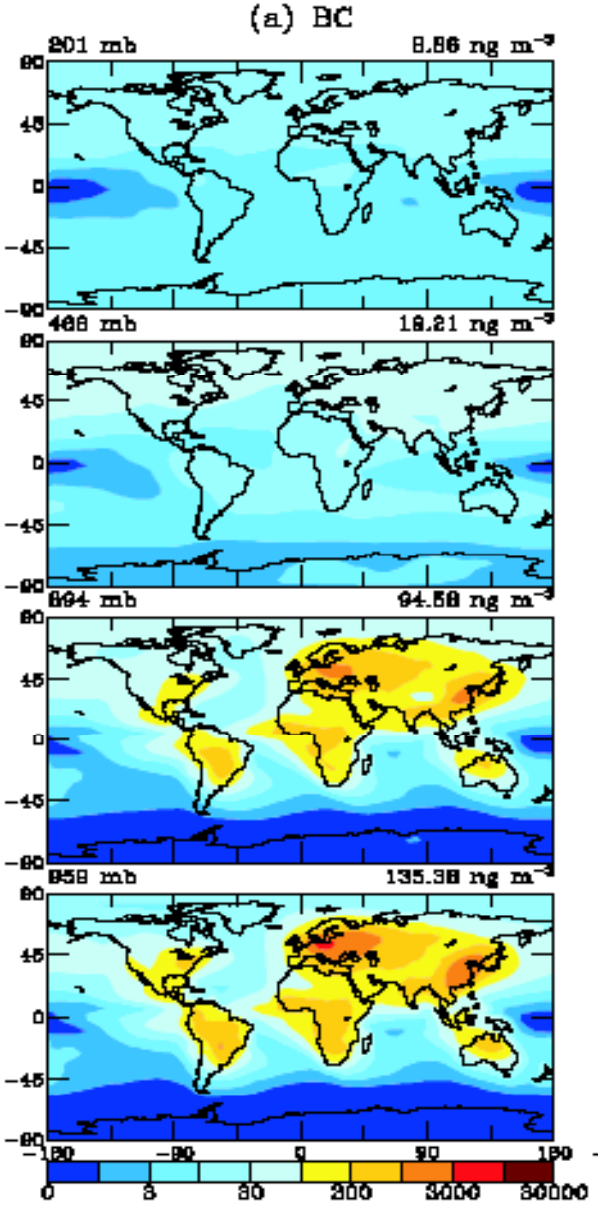
一八五零年



一九九八年



Serena and Seinfeld,2002, 2001JD001397



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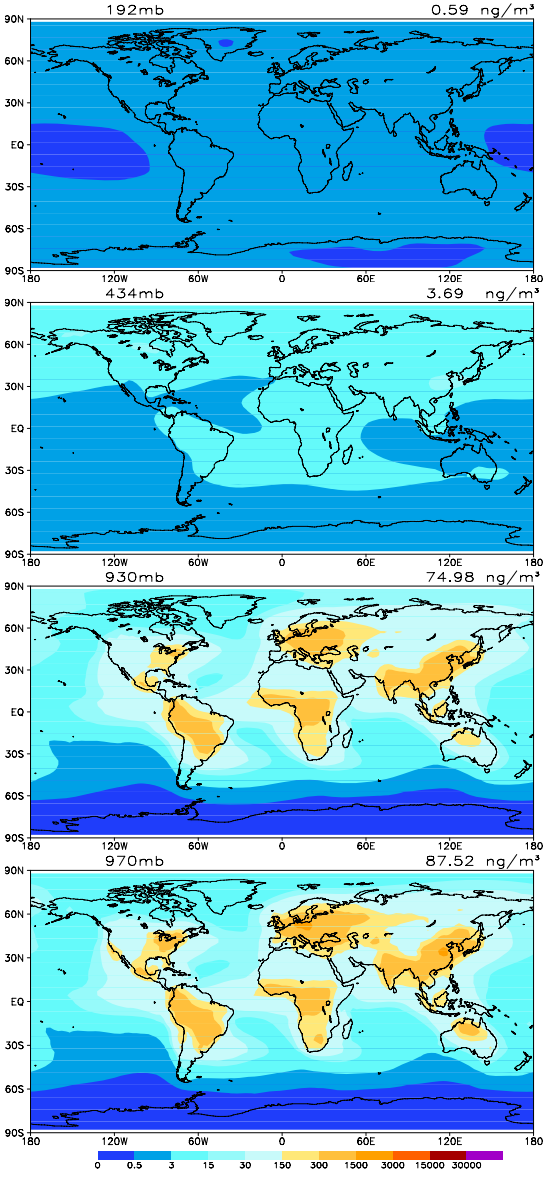
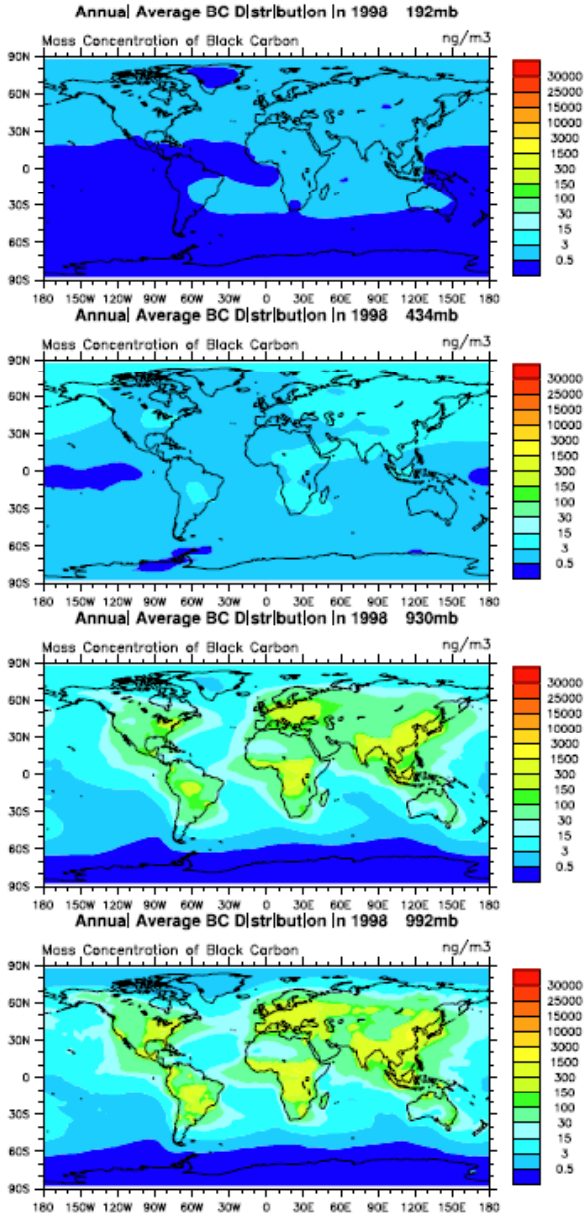


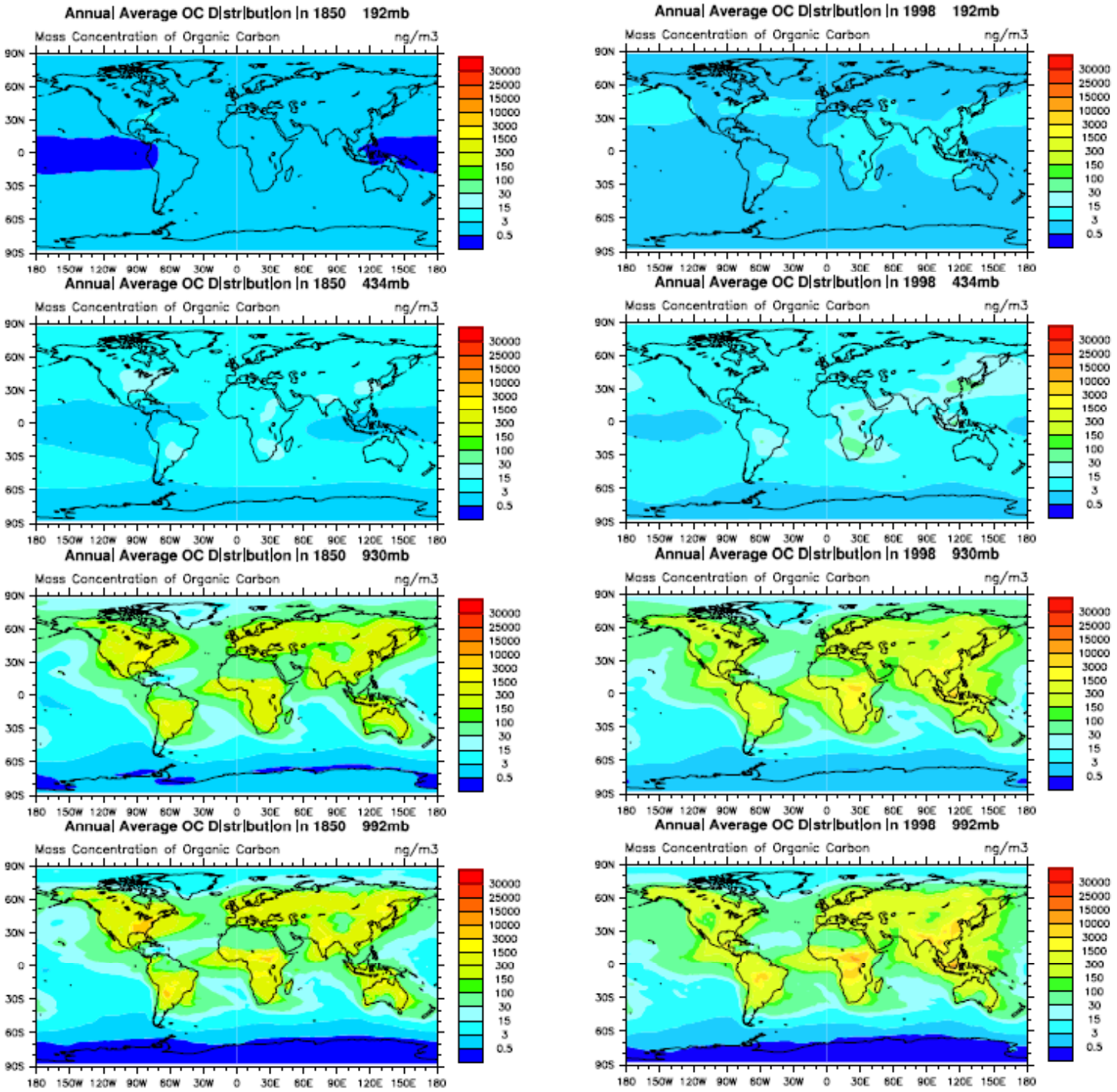
1998



OC

1850

1998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Annual Average OC Distribution in 1850 434mb
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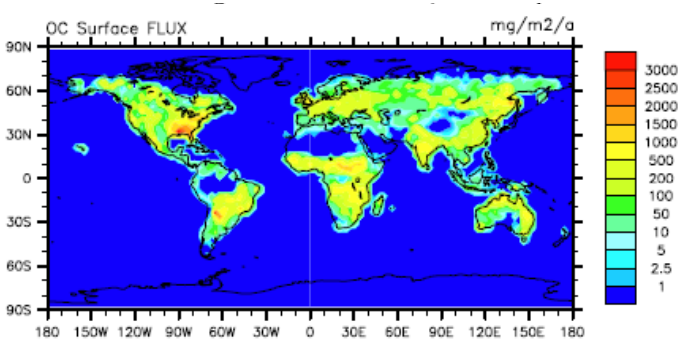
Annual Average OC Distribution in 1998 930mb
Annual Average OC Distribution in 1850 992mb
Annual Average OC Distribution in 1998 992mb
Mass Concentration of Organic Carbon
ng/m3
30000
25000
15000
10000
3000
1500
300
150
100
30
15
3
0.5
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180

OC

1850


OC Surface FLUX
mg/m2/a
90N
60N
30N
0
30S
60S
90S
180 150W 120W 90W 60W 30W 0 30E 60E 90E 120E 150E 180
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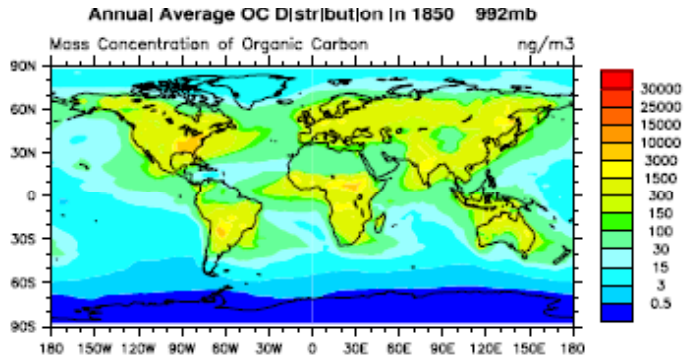
2500
2000
1500
1000
500
200
100
50
10
5
2.5
1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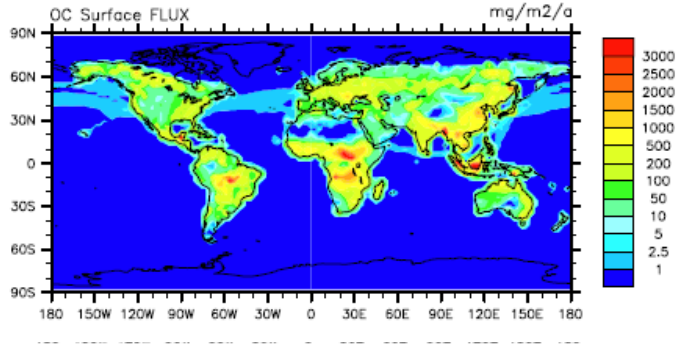
0.5

1998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mg/m2/a
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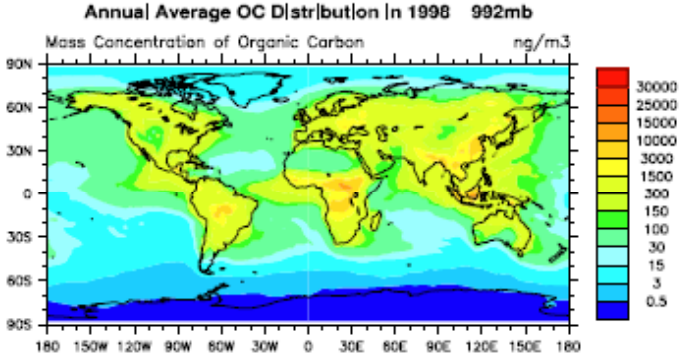
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30000
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150
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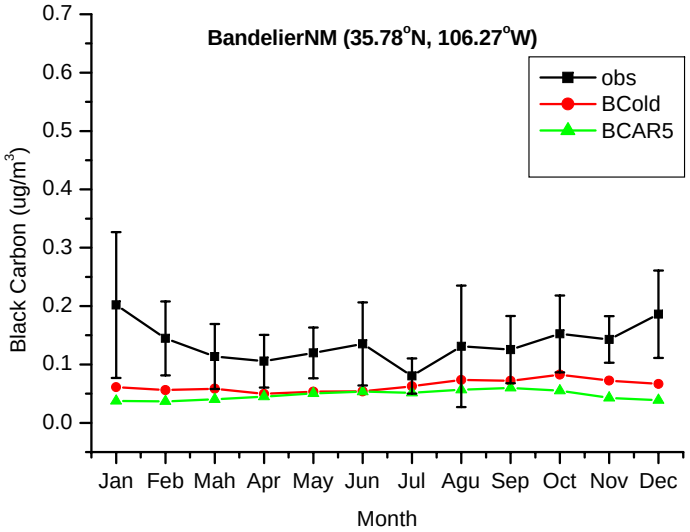
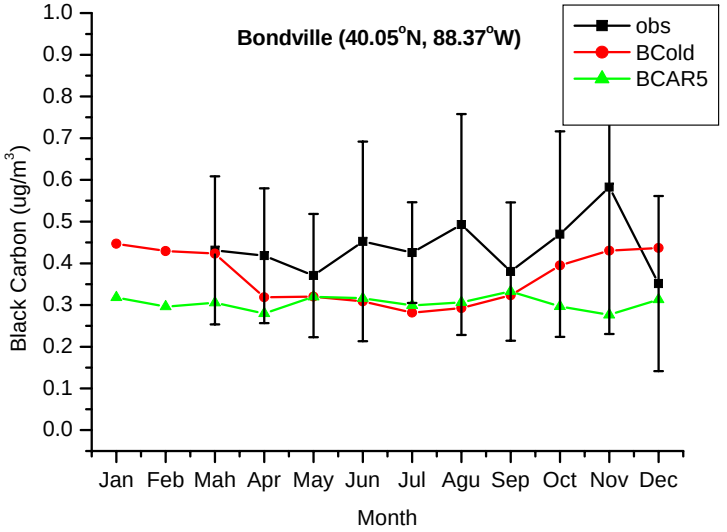
15
3
0.5

BC


BandelierNM (35.78°N, 106.27°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month


Bondville (40.05°N, 88.37°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
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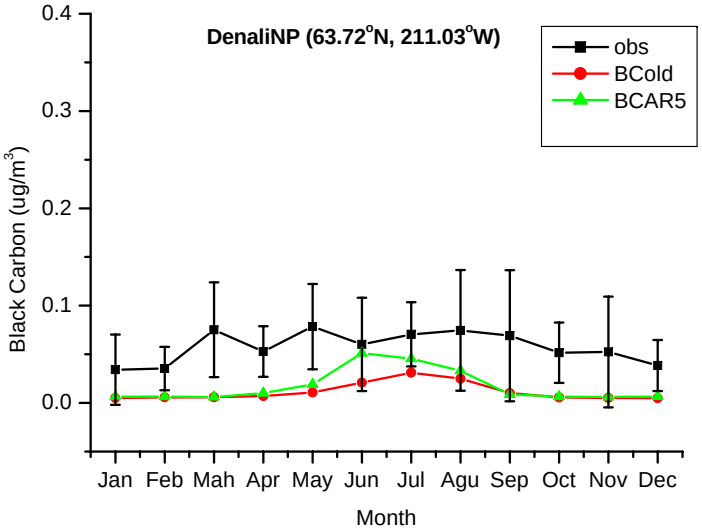
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month


DenaliNP (63.72°N, 211.03°W)
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BCold
BCAR5
Black Carbon (ug/m3)
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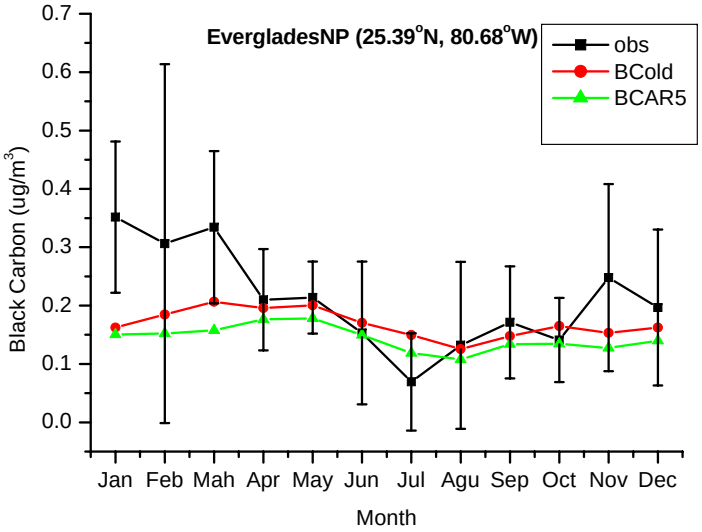
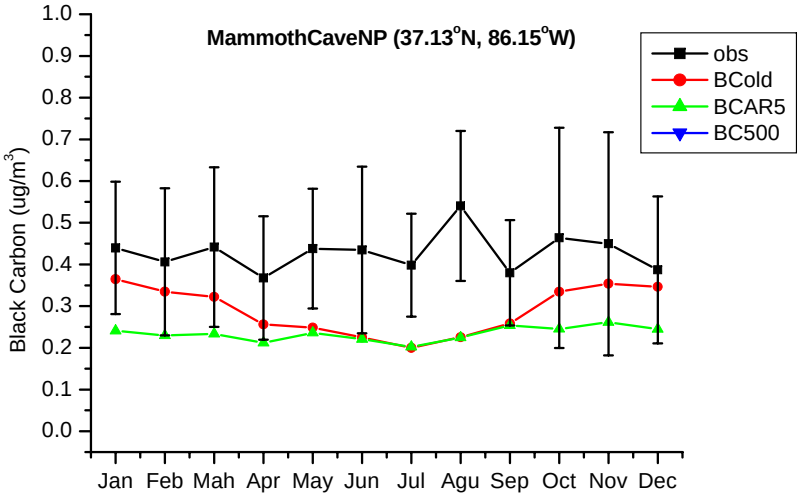
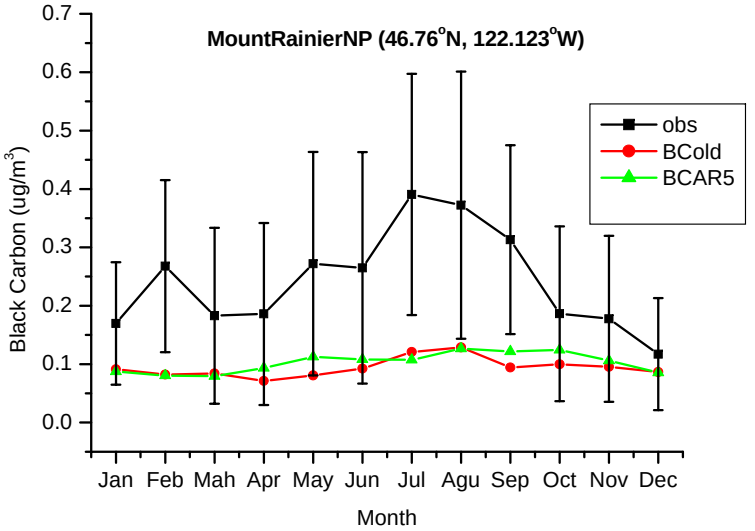
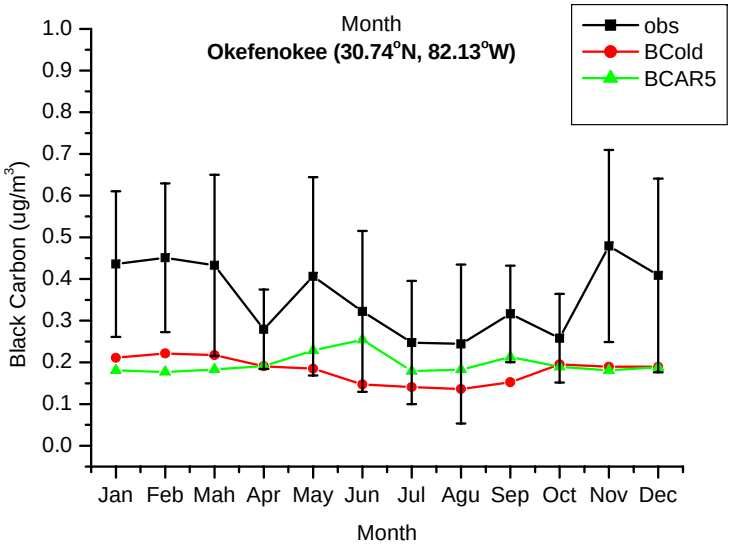
0.2
0.3
0.4
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month

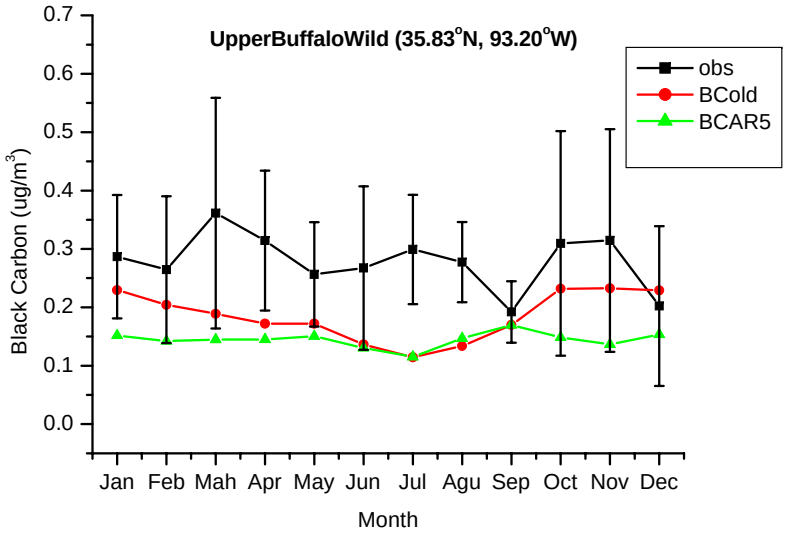

EvergladesNP (25.39°N, 80.68°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month

BC


MammothCaveNP (37.13°N, 86.15°W)
obs
BCold
BCAR5
BC500
Black Carbon (ug/m3)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month


MountRainierNP (46.76°N, 122.123°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month


Okefenokee (30.74°N, 82.13°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month


UpperBuffaloWild (35.83°N, 93.20°W)
obs
BCold
BCAR5
Black Carbon (ug/m3)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Jan Feb Mah Apr May Jun Jul Agu Sep Oct Nov Dec
Month

Variables	obs	1890-1909	1940-1969	1979-1999	old
RESTOM		**1.024**	**1.059**	**1.016**	**-0.467**
FSNTOA(W m-2)	234.004	236.405	236.403	236.381	235.259
FLUT（W m^{-2}）	233.946	233.432	233.395	233.415	235.725
RESSURF		**1.016**	**1.056**	**1.012**	**-0.608**
FSNS	168, 165.9	161.154	161.145	161.051	162.215
FLNS	66, 49.4	59.873	59.885	59.84	60.037
LHFLX（W m^{-2}）	84.948	78.258	78.19	78.212	82.380
SHFLX（W m^{-2}）	15.795	22.007	22.015	21.986	20.407
CLDTOT （%）	62.5, 66.715	58.768	58.807	58.799	59.038
LWCF（W m^{-2}）	30.355	29.096	29.135	29.113	28.333
SWCF（W m^{-2}）	-54.163	-55.326	-55.335	-55.342	-55.956
PREH2O(mm)	24.575	23.508	23.494	23.503	23.365
PRECT(mm/day)	**2.69, 2.61**	**2.682**	**2.68**	**2.68**	2.820

Summary

- **The model results showed that the aerosol model system can reasonably grasp horizontal and vertical dispersal of carbonaceous aerosols except for a little lower in some emission regions than AeroCom data.**
- **Compared with the old emissions driven simulation results, the AR5-emissions driven ones seemed to be a little underestimate BC concentrations in some regions, especially in anthropogenic areas.**
- **Compared with some surface observation sites, both of the simulation can basically reproduce BC seasonal variations, however, they all tend to underestimate.**

OUTLOOK

- **More observation data should be got to test the model performance, so I need more help and suggestions from you.**
- **Can all the AeroCom observation data can freely be downloaded? Where and How to get them?**


Thank you !