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Overview of SPRINTARS

(Spectral Radiation-Transport Model for Aerosol Species)

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SPRINTARS

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Model Description

Takemura et al. (JC, 15, 333, 2002)

Takemura et al. (JGR, 105, 17853, 2000)

Base model: CCSR/NIES AGCM (ver. 5.6)

Resolution: T106 (320x160) L20

Tracers: BC, OC, sulfate, soil dust, sea salt, SO₂, DMS

Selectable on-line/off-line

Computer: NEC SX6 (usually 8PE)

Emission

- **BC, OC** (from biomass burning, fossil fuel, biofuel, agriculture, and terpene): based on SRES, GEIA, and FAO
- **SO₂** (from fossil fuel and continuous volcano eruption): based on GEIA
- **DMS** (from oceanic phytoplankton): dependent on surface solar flux
- **soil dust:** dependent on wind at 10-m height, soil moisture, vegetation, and snow amount
- **sea salt:** dependent on wind at 10-m height

Advection

- Flux-Form Semi-Lagrangian (FFSL) method
- Arakawa-Schubert cumulus convection

Diffusion

- Mellor-Yamada parameterization

Chemical Reaction (sulfur)

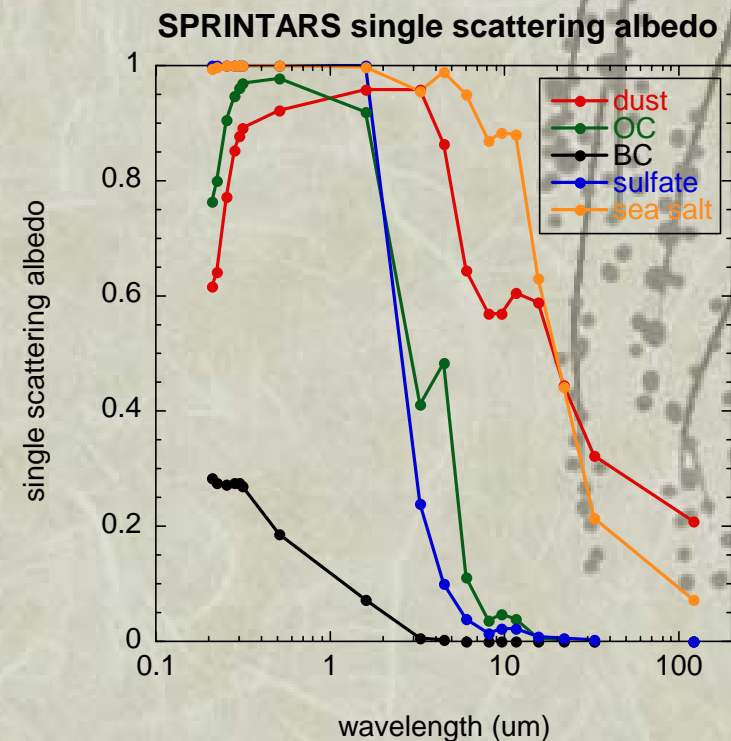
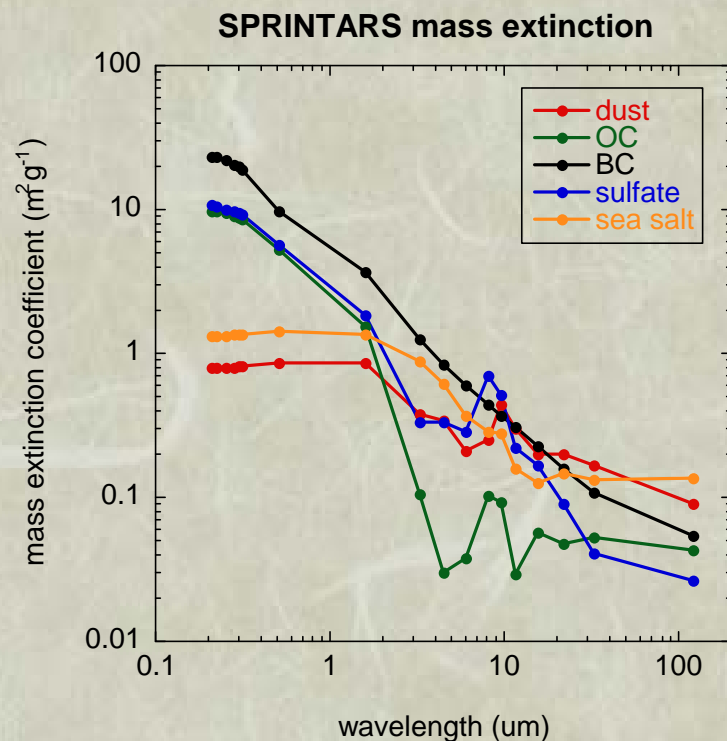
- gas phase: $\text{DMS} + \text{OH} \rightarrow \text{SO}_2 + \dots$, $\text{SO}_2 + \text{OH} \rightarrow \text{SO}_4^{2-} + \dots$
- liquid phase: $\text{S(IV)} + \text{O}_3 \rightarrow \text{SO}_4^{2-} + \text{O}_2$, $\text{S(IV)} + \text{H}_2\text{O}_2 \rightarrow \text{SO}_4^{2-} + \text{H}_2\text{O}$

Deposition

- wet deposition: sub-cloud scavenging (wash out)
in-cloud scavenging (rain out)
re-emission due to evaporation of rain
- dry deposition
- gravitational settling

Radiation

- code: 2–stream discrete ordinate/adding method (Nakajima et al. 2000)
- direct effect: considering refractive index depending on wavelength, size distribution, and hygroscopic growth for each aerosol species.
- indirect effect (optional): simple parameterization of the relationship between aerosol and cloud number concentrations.
 - diagnosis of changes in cloud water content, cloud droplet radius, and precipitation rate.



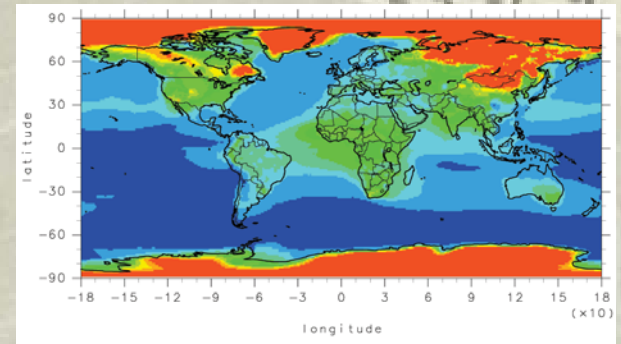
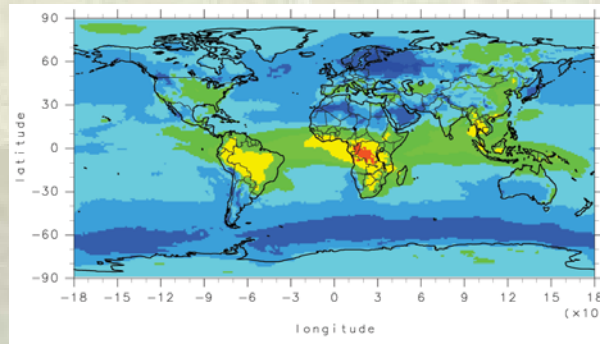
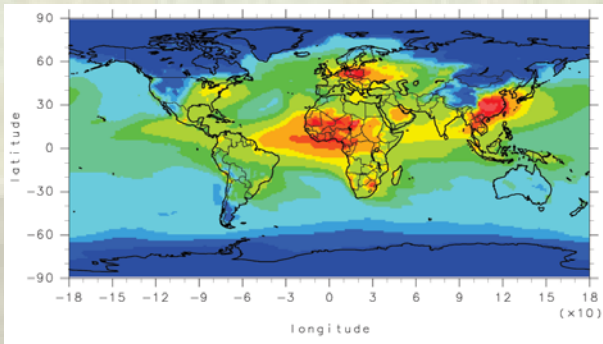
Aerosol optical properties by SPRINTARS

optical thickness
(0.55 μm)

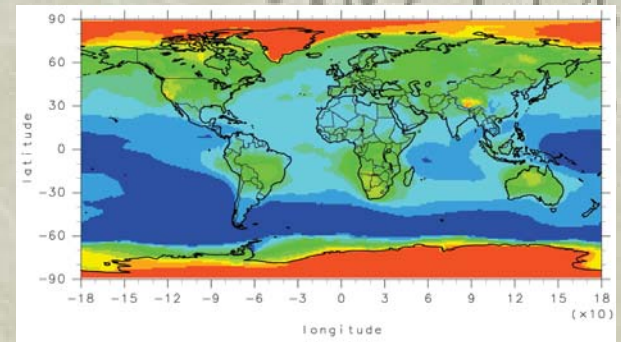
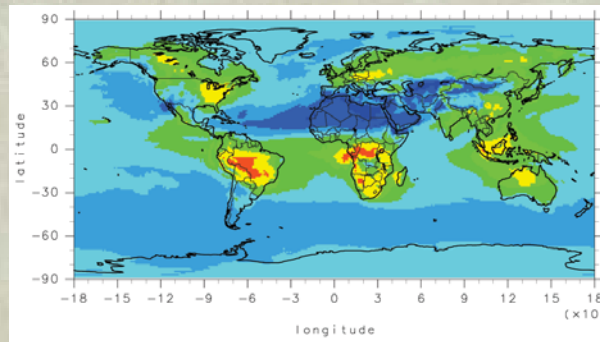
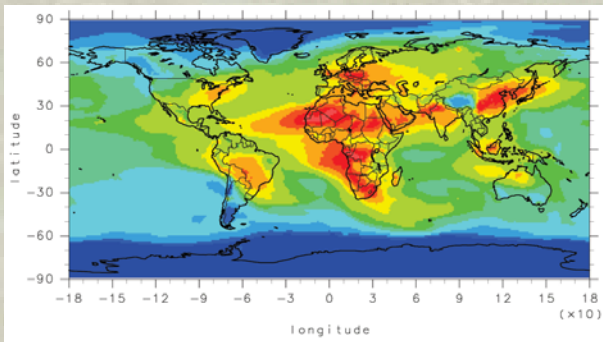
Ångström exponent

single scattering albedo
(0.55 μm)

Northern Hemisphere winter

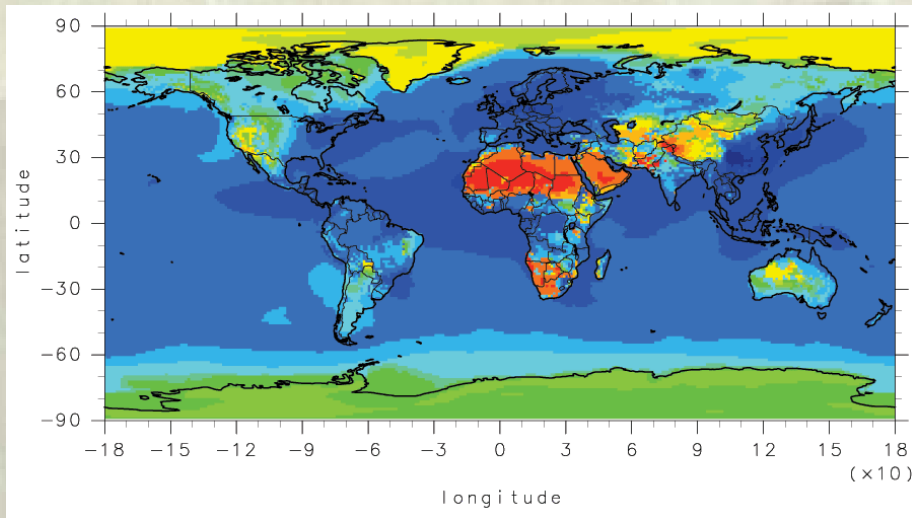


Northern Hemisphere summer

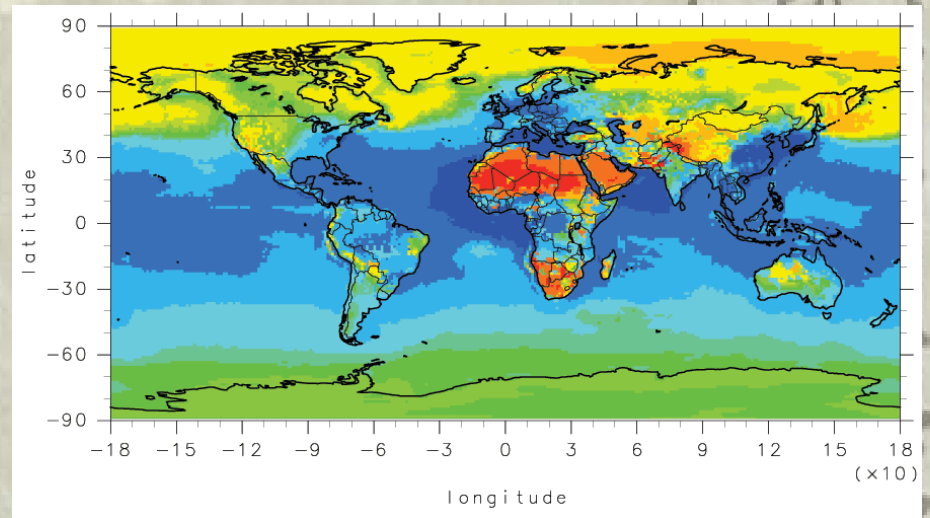


Aerosol direct radiative forcing by SPRINTARS

Clear-sky



Whole-sky



Future plan

- Participation in the AEROCOM Experiment B.
- Introduction of the simplified cloud microphysical scheme (parameterization of curvature effect, solute effect, updraft velocity, etc.) for the estimate of the aerosol indirect effect.
- Detailed analysis of climate response to the aerosol direct and indirect effects.
- Simulation from the pre-industrial era (1850) to the present.
 - Climate of the 20th Century International Project
- CCSR/NIES/FRSGC ocean-atmosphere GCM coupled with SPRINTARS on the Earth Simulator
 - Projection of future climate change
 - IPCC Fourth Assessment Report

AEROCOM status

SPRINTARS simulation in 1996, 1997, 2000, and 2001 were completed for the Experiment A.