Overview of SPRINTARS
(Spectral Radiation-Transport Model for Aerosol Species)

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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, SO$_2$, 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
- **SO$_2$** (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: $\text{DMS} + \text{OH} \rightarrow \text{SO}_2 + \ldots$, $\text{SO}_2 + \text{OH} \rightarrow \text{SO}_4^{2-} + \ldots$
- 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 (0.55µm) | Ångström exponent | single scattering albedo (0.55µm)

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.