Accuracy of Radiative Transfer Schemes in Global Modeling: The AeroCom A2 TROP/ARCTIC Experiment

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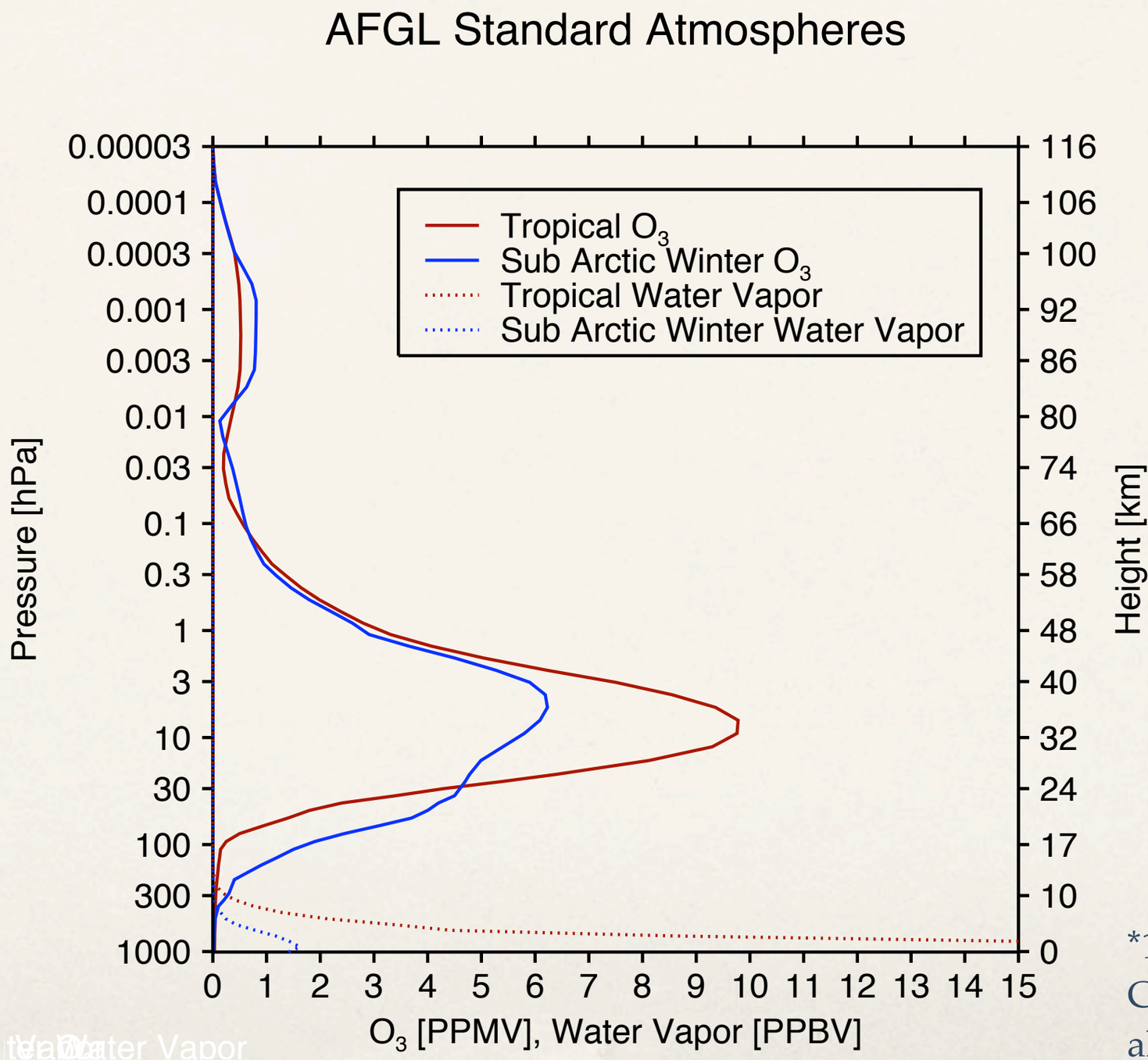
Motivation

- Assess solar radiative transfer schemes in AeroCom global models; solar radiation is the principal determinant of atmospheric state between ~0.3 to 5 μm [*Halthore et al.* 2005]
  - Inter-compare AeroCom model solar radiative transfer schemes *without aerosols or clouds* given standard atmospheres and surface albedo.
- Useful to see how each model treats Rayleigh scattering, ozone absorption, and water vapor absorption.
- Will facilitate analysis of AeroCom Prescribed Forcing Experiments (i.e. A2 CTRL, A2 ZERO, A2 FIX, A2 PRE)
- We encourage models, particularly those participating in the above experiments, to submit to this experiment!

A2 TROP/ARCTIC Setup

- Use the same GCM/CTM as set up for the AeroCom A2-ZERO experiment.
- Protocol following *Halthore et al.* [2005]:
  - Prescribe O_3 and water vapor profiles from provided AFGL standard atmospheres.
  - Prescribe surface albedo at (wavelength-independent, Lambertian) 0.2 globally.
  - Vertical resolution as in host model
- Run 2 one-day (01 Jan 2006) simulations with instantaneous output at **one** model time-step for:
  - Tropical AFGL standard atmosphere (high humidity)
  - Sub-arctic Winter AFGL standard atmosphere (low humidity)

AFGL Profiles*



*1-km Resolution: 0-120 km
Corresponding pressure levels also given.

Diagnostics

- These **4** diagnostics are also diagnostics for the A2-ZERO experiment (DIRECT FORCING diagnostics package).
- **4** 2D global diagnostic fields for the ***aerosol-free***, *clear-sky* atmosphere:
  - Broadband shortwave downwelling (*direct* + *diffuse*) flux at the top of the atmosphere in clear sky.
  - Broadband shortwave downwelling (*direct* + *diffuse*) surface flux in clear sky
  - Broadband shortwave downwelling *diffuse* surface flux in clear sky
  - Visible (0.2-0.7 μm) downwelling (*direct* + *diffuse*) surface flux in clear sky
- Diagnostics should be instantaneous at **one** model time-step.
  - This could be the first time step, but at noon UTC is preferred.
- Data should be in netCDF format following the CF convention
  - Summary of diagnostics via AeroCom website under DIRECT FORCING diagnostics package (http://nansen.ipsl.jussieu.fr/AEROCOM/AEROCOM_diagnostics.xls)
  - CMOR rewriting tool (http://www-pcmdi.llnl.gov/software-portal/cmor/)
  - AeroCom A2 Experiment CMOR tables (http://www-lscedods.cea.fr/aerocom/CMOR)
- In total, report only **8** numbers (4 TROP, 4 SAW)!

Analysis

- Following: *Halthore et al.* [2005], Intercomparison of shortwave radiative transfer codes and measurements, *J. Geophys. Res., 110,* D11206, doi:10.1029/2004JD005293.

- We will examine provided global results at two chosen sun elevations (solar zenith angles of 30° and 75°) for each of the two standard atmospheres.

- Interest from DOE ARM program to archive these results along with the *Halthore et al.* [2005] results as well as other model inter-comparison results (Warren Wiscombe and Alice Cialella, ARM EXternal Data Center (XDC), *personal communication*)

- Ideal time frame for submission: December 2009.

Preliminary Results: ECHAM5 (offline)

**Courtesy Daniel Klocke (MPI) (% change relative to Halthore et al. [2005])*

	ECHAM5*		*Halthore et al.* [2005] (Table 2**)	
AFGL Tropical Profile	SFC Broadband SW Down [W m^{-2}]	VIS SFC SW Down [W m^{-2}]	SFC Broadband SW Down [W m^{-2}]	VIS SFC SW Down [W m^{-2}]
μ_0	0.185/0.25-4.0 μm	0.185/0.25-0.68 μm	0.28-5.0 μm	0.2-0.7 μm
75°	205.3 (8%)	71.5 (12%)	222 (±5.8%)	81.3 (±1.9%)
30°	916.3 (-0.4%)	409.2 (0.1%)	912.5 (±2.9%)	413.3 (±0.4%)

**Average irradiance of 16 radiation codes, including LBL codes (± % STD of mean); best agreement broadband and VIS 30° cases

Committed Models

- HADGEM
- SPRINTARS
- INCA
- ECHAM5

Preliminary Results: ECHAM5 (offline)

	ECHAM5*		*Halthore et al.* [2005] (Table 2**)	
AFGL Tropical Profile	Direct SFC Broadband SW Down [W m^{-2}]	VIS SFC SW Down [W m^{-2}]	Direct SFC Broadband SW Down [W m^{-2}]	VIS SFC SW Down [W m^{-2}]
μ_0	0.68-4.0 μm	0.185/0.25-0.68 μm	0.28-5.0 μm	0.2-0.7 μm
75°	133.8	71.5	184.8 (±1.89)	81.7 (±10.78)
30°	507.1	409.2	848.5 (±0.68)	425.1 (±3.59)

**Courtesy Daniel Klocke (MPI)*

**Average irradiance of 16 radiation codes, including LBL codes (± Std. Dev. as a % of Mean)