WACCM Applications for the Polar Stratosphere and Mesosphere

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Outline

● Polar Stratospheric Ozone Loss

● Polar Mesospheric Temperatures and Clouds
  ○ Verification of summer polar temperatures
  ○ Inter-hemispheric teleconnections

● Energetic Particle Precipitation
  ○ Auroral electron precipitation effects
  ○ MLT Transport

● WACCM CO₂ evaluation
Specific Motivation: To evaluate diurnally varying species in WACCM by comparison with satellite data, for diagnosing ozone loss processes.
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WACCM Vortex Avg from instantaneous output (all local times)
Example:
satellite_profilelist_20020125_20110331.nc

- MLS, ACE-FTS, HIRDLS, SABER, and SOFIE
- **Mandatory Variables:** Date, Time, Lat, Lon, Orbit #, Profile #, Instrument
- **Optional Variables:** DOY, Local Time, Occultation Type, SZA, Julian Day
PMCs: WACCM Summer Polar Mesosphere T
(Susanne Benze)

- SD-WACCM run: “SD-WACCM wa4_sdna4_beta0” provided by Dan Marsh.
- Years 2007-2009
- Compare to MLS V3.3, SABER V1.07, and SOFIE V1.1, and Luebken.
PMCs: WACCM Summer Polar Mesosphere T
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- Mesopause shape: model still “frowning”.
- Low mesopause compared to MLS, SABER, SOFIE, and Luebken.
  - 3 km too low near solstice,
  - Up to 10 km too low at beginning and end of PMC season.
- NH: model T ~agrees with MLS and Luebken, colder than SABER and SOFIE.
- SH: model T colder than MLS, SABER, Luebken, and SOFIE.
- T variability compared to SOFIE: only fair correlation (R ~ 0.3) in most seasons, better (~0.5) in SH2008.
Energetic Particle Precipitation (EPP)

Free-Running WACCM

Constant Year Repeating (1950 vs. 2000 SST/GHG/Halogens)

Transient Simulations (1992-Present)
- Auroral Electrons
- Higher Energy Electrons
- Solar Proton Events (C. Jackman)

Specified Dynamics WACCM

1992-Present (No EPP, Aurora, Aurora+MEE, Aurora+MEE+SPE)
2004 (2003 Halloween storms imposed in ~1 January)

Cora Randall, CU-LAMA Group
Significant EPP-NOy descent in both hemispheres, but stronger in South

Cora Randall, CU-LAMA Group
Energetic Particle Precipitation (EPP): SH Ozone

O3, Aur - NoAur, -86° lat

- HO\textsubscript{x}-induced O\textsubscript{3} loss
- NO\textsubscript{x}-induced O\textsubscript{3} loss
- Signals persist (?)
- EPP-NO\textsubscript{x} ties up ClO?
Rigorous significance tests will be done.

HOx- and NOx-induced ozone depletion, including persistence through August, possibly "real".

UTLS signals are spurious.
Energetic Particle Precipitation (EPP): NH Ozone

Few, if any, significant effects on ozone in the North.
Energetic Particle Precipitation (EPP): SH Temp

- Tantalizing results for temperature, but need more statistics
- Possible effect on PMCs?
EPP: Is the WACCM meteorology correct?

(Laura Holt)
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WACCM T from 20-yr NoAur run

Lat>80N
EPP: Is the WACCM meteorology correct?

WACCM4 much better than WACCM3: But is the average vortex too small now?

Cora Randall, CU-LAMA Group
EPP: How is EPP-NO redistributed?
(Lynn Harvey)

WACCM4 for 1 Jan

Maintained chemically

Maintained dynamically

NO

140 km

Ions

100 km
EPP: MLT Trajectories
(Lynn Harvey)

- Initialize trajectories with latitude & ions
- Advect over 24 hours on 1 Jan with WACCM U, V, and diabatic heating rates
- Results imply very rapid transport of NO out of auroral oval and to lower latitudes
WACCM CO$_2$ compares very well with ACE overall

Disagreement at high SH latitudes by end of winter: Too much descent in WACCM
Thanks very much!!