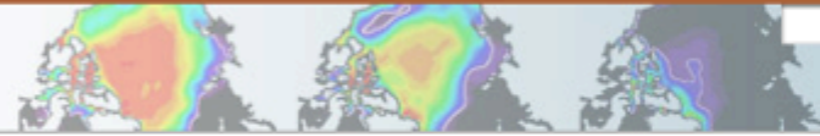


## WACCM Working Group

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Dan Marsh, NCAR

## Community Climate System Model



Search

### CCSM WHOLE ATMOSPHERE MODEL WORKING GROUP

#### WELCOME TO CCSM

EXPAND  COLLAPSE

About CCSM

CCSM Administration

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CSEG

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Events

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CCSM Support

The **Whole-Atmosphere Community Climate Model (WACCM)** is a comprehensive numerical model, spanning the range of altitude from the Earth's surface to the thermosphere. The development of WACCM is an inter-divisional collaboration that unifies certain aspects of the upper atmospheric modeling of HAO, the middle atmosphere modeling of ACD, and the tropospheric modeling of CGD, using the NCAR Community Climate System Model (CCSM) as a common numerical framework.

#### Upcoming Meetings

[13th Annual CCSM Workshop](#), The Village at Breckenridge, Breckenridge, CO, 17-19 June 2008. Registration is now closed. [[logistics](#)] [[agenda](#)] [[webcast](#)]

#### WAWG Projects

- text
- text

#### WAWG Community Liaison:

**TBD**

#### Co-Chair Contact Information:

##### Dr. Daniel Marsh

NCAR-ACD, P.O. Box 3000, Boulder, CO 80307-3000

Tel: 303-497-1160, Fax: 303-497-1400, e-mail: [marsh@ucar.edu](mailto:marsh@ucar.edu)

#### CCSM PROJECT

The Community Climate System Model (CCSM) is a fully-coupled, global climate model that provides state-of-the-art computer simulations of the Earth's past, present, and future climate states.

CCSM is sponsored by the National Science Foundation (NSF) and the U.S. Department of Energy (DOE). Administration of the CCSM is maintained by the Climate and Global Dynamics Division (CGD) at the National Center for Atmospheric Research (NCAR).

#### RELATED

- [CCSM Working Group Co-chairs](#)
- [CCSM Working Group Co-Chairs Terms of Reference](#)
- **[WACCM Swiki](#)**

#### CONTACT INFORMATION

- Email: [CCSM Working Group Co-Chairs](#)
- Email: [CCSM Contact](#)

Please subscribe to the WACCM mailing list:

<http://mailman.cgd.ucar.edu/mailman/listinfo/waccm>

# WACCM status

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- Fully interactive model (WACCM 3.1.9) is tested, has been used for numerous science investigations
- WACCM 3.1.9 is in use by outside community, as an “informal” release (e.g., CU/LASP, NASA/Goddard); mainly in collaborative work with WACCM team members at NCAR
- WACCM 3.1.9 is ready for release as a community model following today’s first WACCM WG session (A. Gettelman presentation)
- WACCM 3.1.9 has been extended to 500 km for space weather studies (S. Solomon presentation)
- WACCM 3.1.9 has been coupled to the CARMA sectional microphysics codes
- Next version of WACCM, based upon CAM 3.5, is currently being tested and will be used for future science work

# Some recent WACCM publications

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## 2007

- Charlton, A.J., L. Polvani, J. Perlwitz, F. Sassi, E. Manzini, K. Shibata, S. Pawson, J.E. Nielsen, and D. Rind, A new look at stratospheric sudden warmings. Part II: Evaluation of numerical model simulations, *J. Climate*, **20**, 470-488, 2007.
- Pan, L. L., J. C. Wei, D. E. Kinnison, R. R. Garcia, D. J. Wuebbles, and G. P. Brasseur, A set of diagnostics for evaluating chemistry-climate models in the extratropical tropopause region, *J. Geophys. Res.*, **112**, D09316, doi:10.1029/2006JD007792, 2007.
- Rohrer, F., D. Ehhalt, D. Blake, D. Kinnison, P. Konopka, On the Use of NMHC from the Determination of Age Spectra in the Lower Stratosphere, *J. Geophys. Res.*, **112**, D12208, doi:10.1029/2006JD007686, 2007.
- Garcia, R.R., D.R. Marsh, D.E. Kinnison, B.A. Boville, and F. Sassi, Simulation of secular trends in the middle atmosphere, 1950-2003, *J. Geophys. Res.*, **112**, D09301, doi:10.1029/2006JD007485, 2007.
- Gettelman, A., and D. E. Kinnison, The global impact of supersaturation in a coupled chemistry-climate model, *Atmos. Chem. Phys.*, **7**, 1629-1643, 2007. Eyring, V., et al., Multi-model projections of stratospheric ozone in the 21st century, *J. Geophys. Res.*, **112**, D16303, doi:10.1029/2006JD008332, 2007.
- Tilmes, S., D.E. Kinnison, R.R. Garcia, R. Müller, F. Sassi, D.R. Marsh, and B.A. Boville, Evaluation of heterogeneous processes in the polar lower stratosphere in the Whole Atmosphere Community Climate Model, *J. Geophys. Res.*, **112**, D24301, doi:10.1029/2006JD008334, 2007.
- Kinnison, D.E., et al., Sensitivity of chemical tracers to meteorological parameters in the MOZART-3 chemical transport model, *J. Geophys. Res.*, **112**, D20302, doi:10.1029/2006JD007879, 2007.
- Marsh, D.R. and R.R. Garcia, Attribution of decadal variability in lower-stratospheric tropical ozone, *Geophys. Res. Lett.*, **34**, L21807, doi:10.1029/2007GL030935, 2007.
- Marsh, D.R., R.R. Garcia, D.E. Kinnison, B.A. Boville, F. Sassi, and S.C. Solomon, Modeling the whole atmosphere response to solar cycle changes in radiative and geomagnetic forcing, *J. Geophys. Res.*, **112**, D23306, doi:10.1029/2006JD008306, 2007.
- Gettelman, A. and T. Birner, Insights on tropical tropopause layer processes using global models, *J. Geophys. Res.*, **112**, D23104, doi:10.1029/2007JD008945, 2007.

## 2008

- Yuan, T., C.-Y. She, D.A. Krueger, F. Sassi, R.R. Garcia, R.G. Roble, H. Liu, and H. Schmidt, Climatology of mesopause region temperature, zonal wind, and meridional wind over Fort Collins, Colorado (41°N, 105°W), and comparison with model simulations, *J. Geophys. Res.*, **113**, D03105, doi:10.1029/2007JD008697, 2008.
- Jackman, C. H., D.R. Marsh, F.M. Vitt, R.R. Garcia, E. L. Fleming, G.J. Labow, C.E. Randall, M. López-Puertas, B. Funke, T. von Clarmann, and G. P. Stiller, Short- and medium-term atmospheric constituent effects of very large solar proton events, *Atmos. Chem. Phys.*, **8**, 765–785, 2008.
- Richter, J., F. Sassi, R.R. Garcia, K. Matthes, and C.A. Fischer, Dynamics of the middle atmosphere as simulated by the Whole Atmosphere Community Climate Model, version 3 (WACCM3), *J. Geophys. Res.*, in press, 2008.
- Garcia, R.R. and W.J. Randel, Acceleration of the Brewer-Dobson circulation due to increases in greenhouse gases, *J. Atmos. Sci.*, in press, 2008.
- Son, S.-W., L.M. Polvani, D.W. Waugh, T. Birner, R.R. Garcia, A. Gettelman, and D.A. Plummer, The tropopause in the 21st century as simulated by stratosphere-resolving Chemistry-Climate Models, *J. Climate*, in press, 2008.
- Mills, M. J., O. B. Toon, R. Turco, D. E. Kinnison, and R. R. Garcia, Catastrophic ozone loss following a regional nuclear conflict, *Proc. Nat. Acad. Sci.*, in press, 2008.
- Lamarque, J.-F., D.E. Kinnison, P.G. Hess, J.J. Orlando, and F. Vitt, Simulated lower stratospheric trends between 1970 and 2005: identifying the role of climate and chemistry changes, *J. Geophys. Res.*, in press, 2008.
- Gettelman, A., et al., The tropical tropopause layer 1960-2100, *Atmos. Chem. Phys. Discuss.*, **8**, 1367-1413, 2008.
- Austin, J., et al., Coupled chemistry climate model simulations of the solar cycle in ozone and temperature, *J. Geophys. Res.*, **113**, D11306, doi:10.1029/2007JD009391, 2008.

# WACCM 3.5.x in development

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- Based upon CAM 3.5
- Chemistry updated to JPL 2006
- Updated gravity wave parameterization
- Ability to specify TOA solar fluxes vs. parameterized via F10.7
- Interactive with deep ocean model (requires CCSM-4 coupler)

# Future Science Activities

# 2006 WMO/UNEP Scientific Assessment of Ozone Depletion

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 111, D22308, doi:10.1029/2006JD007327, 2006



## Assessment of temperature, trace species, and ozone in chemistry-climate model simulations of the recent past

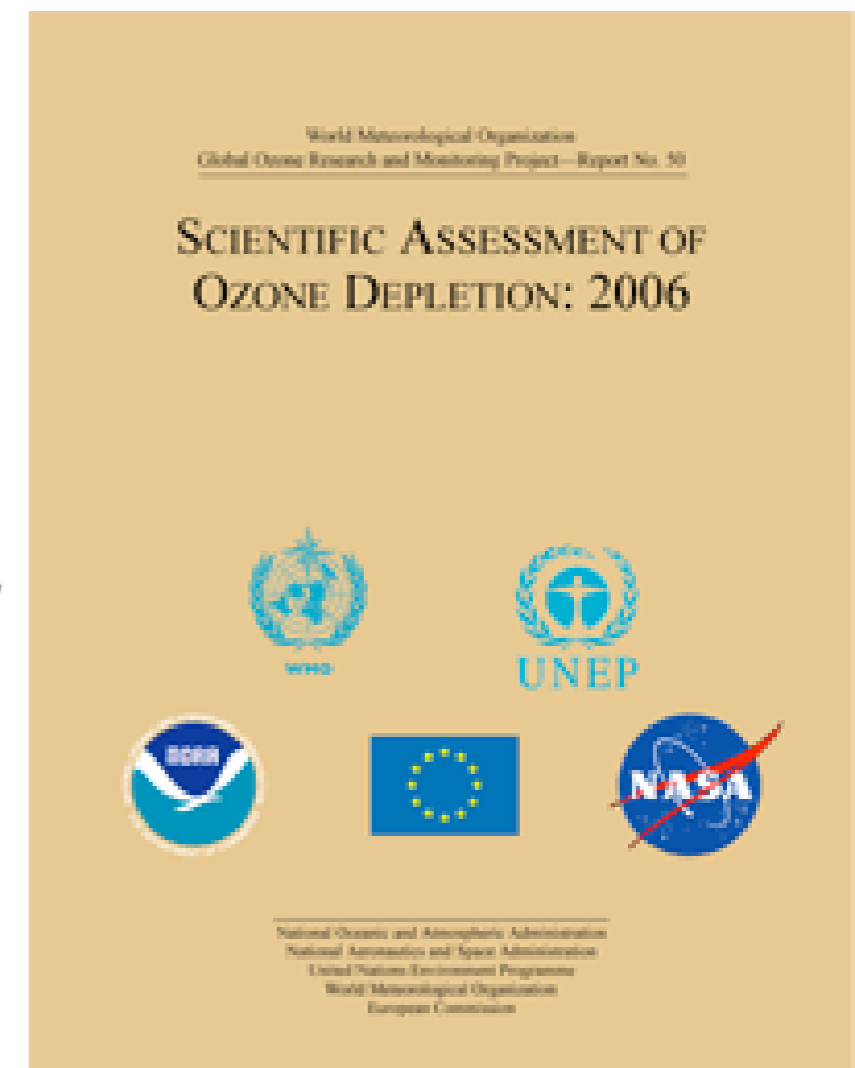
V. Eyring,<sup>1</sup> N. Butchart,<sup>2</sup> D. W. Waugh,<sup>3</sup> H. Akiyoshi,<sup>4</sup> J. Austin,<sup>5</sup> S. Bekki,<sup>6</sup> G. E. Bodeker,<sup>7</sup> B. A. Boville,<sup>8</sup> C. Brühl,<sup>9</sup> M. P. Chipperfield,<sup>10</sup> E. Cordero,<sup>11</sup> M. Dameris,<sup>1</sup> M. Deushi,<sup>12</sup> V. E. Fioletov,<sup>13</sup> S. M. Frith,<sup>14</sup> R. R. Garcia,<sup>8</sup> A. Gettelman,<sup>8</sup> M. A. Giorgetta,<sup>15</sup> V. Grewe,<sup>1</sup> L. Jourdain,<sup>6</sup> D. E. Kinnison,<sup>8</sup> E. Mancini,<sup>16</sup> E. Manzini,<sup>17</sup> M. Marchand,<sup>6</sup> D. R. Marsh,<sup>8</sup> T. Nagashima,<sup>4</sup> P. A. Newman,<sup>18</sup> J. E. Nielsen,<sup>14</sup> S. Pawson,<sup>18</sup> G. Pitari,<sup>16</sup> D. A. Plummer,<sup>13</sup> E. Rozanov,<sup>19</sup> M. Schraner,<sup>20</sup> T. G. Shepherd,<sup>21</sup> K. Shibata,<sup>12</sup> R. S. Stolarski,<sup>18</sup> H. Struthers,<sup>7</sup> W. Tian,<sup>10</sup> and M. Yoshiki<sup>4</sup>

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, D16303, doi:10.1029/2006JD008332, 2007



## Multimodel projections of stratospheric ozone in the 21st century

V. Eyring,<sup>1</sup> D. W. Waugh,<sup>2</sup> G. E. Bodeker,<sup>3</sup> E. Cordero,<sup>4</sup> H. Akiyoshi,<sup>5</sup> J. Austin,<sup>6</sup> S. R. Beagley,<sup>7</sup> B. A. Boville,<sup>8</sup> P. Braesicke,<sup>9</sup> C. Brühl,<sup>10</sup> N. Butchart,<sup>11</sup> M. P. Chipperfield,<sup>12</sup> M. Dameris,<sup>1</sup> R. Deckert,<sup>1</sup> M. Deushi,<sup>13</sup> S. M. Frith,<sup>14</sup> R. R. Garcia,<sup>8</sup> A. Gettelman,<sup>8</sup> M. A. Giorgetta,<sup>15</sup> D. E. Kinnison,<sup>8</sup> E. Mancini,<sup>16</sup> E. Manzini,<sup>17</sup> D. R. Marsh,<sup>8</sup> S. Matthes,<sup>1</sup> T. Nagashima,<sup>5</sup> P. A. Newman,<sup>18</sup> J. E. Nielsen,<sup>14</sup> S. Pawson,<sup>18</sup> G. Pitari,<sup>16</sup> D. A. Plummer,<sup>19</sup> E. Rozanov,<sup>20</sup> M. Schraner,<sup>21</sup> J. F. Scinocca,<sup>22</sup> K. Semeniuk,<sup>7</sup> T. G. Shepherd,<sup>23</sup> K. Shibata,<sup>13</sup> B. Steil,<sup>10</sup> R. S. Stolarski,<sup>18</sup> W. Tian,<sup>12</sup> and M. Yoshiki<sup>5</sup>

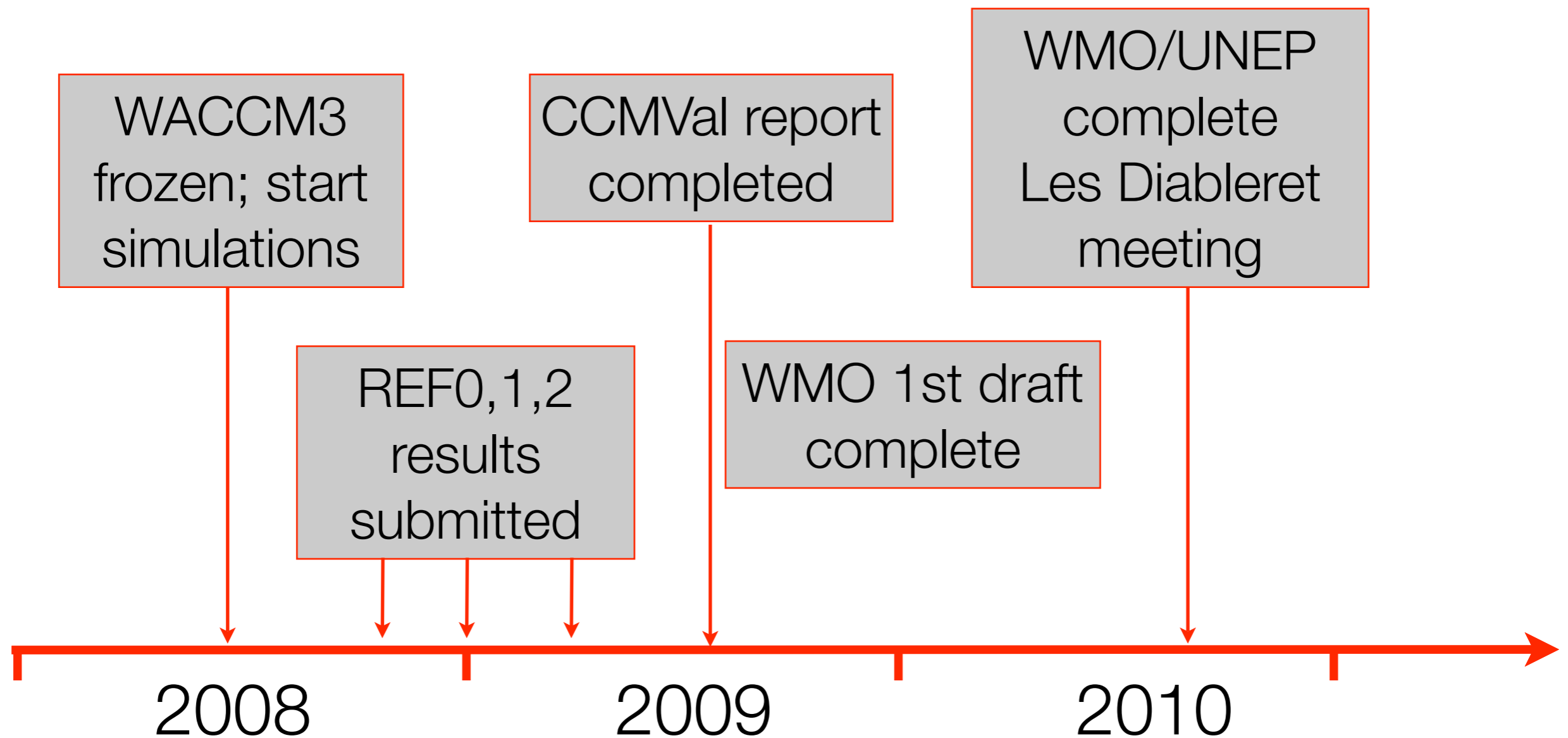




# Contribute to CCMVal / WMO ozone assessment

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- First simulations due later this year. Will use 3.5.x or later.



# CCMVal / WMO simulations

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Priority	Scenario	Period	Real.	Comments	Yes/No
1	REF1	1960-2006	3	Obs SST/SICs	Yes
1	SCN2d	1870-2100*	3	Fully Coupled	Yes
1	CNT0	1870	1	Time-slice	Yes
1	REF0	2000	1	Time-slice	Yes
1	SCN1	1960-2006	1	En-BrOY	Yes
2	SCN1*	1960-2006	1	En-BrOY+NMHC	maybe
2	Scn2c	1960-2100	1	NCC	maybe
-	REF2	1960-2100	-	Limited forcings	No
-	SCN2a	1960-2100	-	SRES A2	No
-	Scn2b	1960-2100	-	Fixed Halogens	No

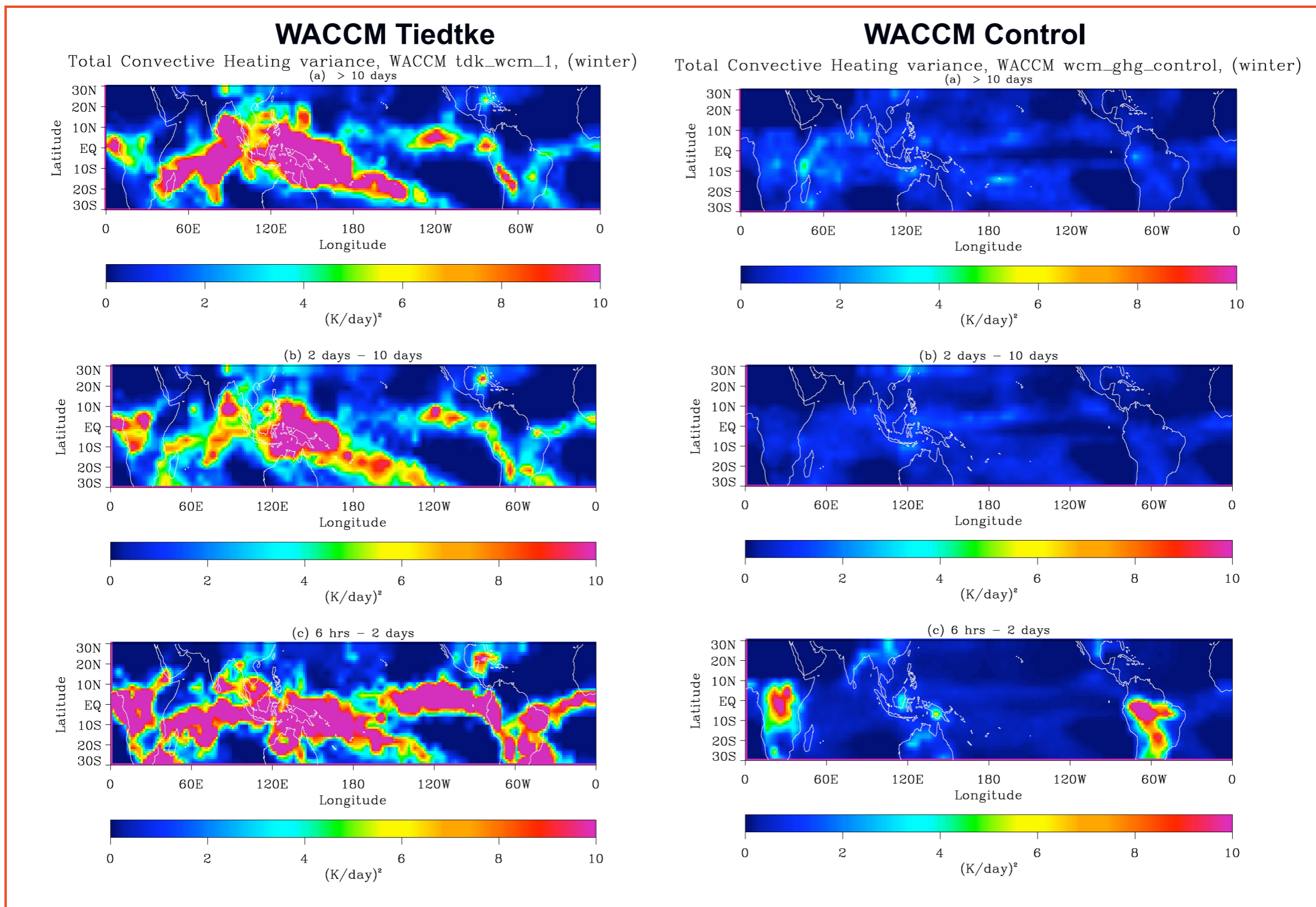
\* C20C simulation for comparison with CAM, plus scenario extension into 21st century

# Other future activities

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- Validate a “specified dynamics” version of WACCM for ongoing model / data comparisons
- Continue to extend physics in 500 km version (better handling of electrodynamics)
- Continue solar and energetic particle studies & involvement in Solar Influence for SPARC (SOLARIS) (see presentations by F. Sassi & C. Randall)
- Continue studies of polar mesospheric clouds
- Meteoric metal chemistry in the MLT
- Possible modeling of the QBO following implementation of new convection parameterization

# Tiedtke Convective Param. Increases Variability



# Increased variability forces equatorial waves

	<b>GCI satellite</b>	<b>WACCM 4x5 control</b>	<b>WACCM 4x5 Tiedtke</b>	<b>WACCM 1.9x2.5 Tiedtke</b>	
Westward waves	<b>Rossby</b>	<b>1.75</b>	<b>0.32</b>	<b>2.22</b>	<b>2.17</b>
	<b>Rossby- gravity</b>	<b>0.09</b>	<b>0.02</b>	<b>0.20</b>	<b>0.20</b>
	<b>Gravity</b>	<b>0.83</b>	<b>0.06</b>	<b>0.21</b>	<b>0.39</b>
Eastward waves	<b>Kelvin</b>	<b>-0.34</b>	<b>-0.07</b>	<b>-0.40</b>	<b>-0.38</b>
	<b>Rossby- gravity</b>	<b>-0.13</b>	<b>-0.01</b>	<b>-0.05</b>	<b>-0.07</b>
	<b>Gravity</b>	<b>-0.32</b>	<b>-0.05</b>	<b>-0.20</b>	<b>-0.26</b>

A necessary condition for generation of the QBO

# Agenda

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8:50 Andrew Gettelman (NCAR)  
Description and Public Release of WACCM3

9:10 Stan Solomon (NCAR)  
Thermosphere and Ionosphere Extension of the Whole Atmosphere Community Climate Model

9:30 Fabrizio Sassi (NCAR)  
A whole-atmosphere modeling perspective on sun-climate effects

9:50 Michael Mills (University of Colorado)  
Energetic particles, meteoritic dust, sulfate aerosol and nuclear war: WACCM and WACCM/CARMA studies at LASP

10:10 Break (poster viewing)

Please visit the posters during the break

10:50 Chaim Garfinkel (University of Washington)  
The Different ENSO Teleconnections and Their Effects on the Stratospheric Polar Vortex

11:10 Jadwiga Richter (NCAR)  
Source oriented gravity wave drag parameterization in WACCM3

11:30 Discussion

- Development priorities
- Involving the CEDAR community
- External co-chair
- WACCM-WG meeting (Winter 2008/Spring 2009)
- Coordination with AMWG & ChemClim WG

12:00 Adjourn



# Discussion topics

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- Development priorities
  - Migrate WACCM to CAM4.0
  - Add spectral irradiance variation to RRTM
  - Merge code with CAM-Chem
  - Specified-Dynamics WACCM
  - Merge WACCM-CARMA into WACCM?
- Involving the CEDAR community
- External co-chair
- WACCM-WG meeting (Winter 2008/Spring 2009)
  - Coordination with AMWG & ChemClim WG