Curriculum Vitae — Philip John Rasch

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Education

B.A. Chemistry	1976	University of Washington
B.S. Atmospheric Science	1976	University of Washington
M.S. Meteorology	1979	Florida State University
Ph.D. Meteorology	1984	Florida State University

Professional Positions

2004–present	Chair	International Global Atmospheric Chemistry Project
2003–present	Chair	Atmosphere Working Group, Community Climate System Modeling Project
2001–present.	Adjunct Faculty,	Univ. of Colorado, Boulder, CO.
2000–present.	Senior Scientist,	Nat. Center for Atmos. Research, Boulder, CO.
1991–2000.	Scientist III,	Nat. Center for Atmos. Research, Boulder, CO.
Sep 1990–May 1991	Visiting Scientist	Eur Ctr for M-Range Wea Fcsts, Reading, England.
Apr 1990–Sep 1990	Visiting Scientist	Stockholm Univ., Stockholm, Sweden.
1987–1991	Scientist II	Nat. Center for Atmos. Research, Boulder, CO.
1984–1987	Scientist I	Nat. Center for Atmos. Research, Boulder, CO.
1983–1984	Postdoctoral Fellow	Nat. Center for Atmos. Research, Boulder CO
1981–1983	Graduate Research Fellow	Nat. Center for Atmos. Research, Boulder CO

Professional societies and committees

American Meteorological Society, 1977–present.
American Geophysical Union, 1975 –present.
American Association for the Advancement of Science, 1999–present.

Awards

1993: American Meteorological Society, Editors Award, Monthly Weather Review.

Committees, panels, courses:

Tellus Editorial Advisory Board, 1991–present.
Member, NSF Science and Technology Center for Clouds, Chemistry and Climate (C^4). 1990-2000.
Co-chair, Chemistry Modeling Group of C^4 1990-2000.
Steering Committee — International Global Atmospheric Chemistry
group (IGAC) on Stratospheric and Upper Tropospheric Aerosols (SUTA) 1998-1998.
Numerous NASA Science Teams (1995-present).

Steering Committee International Global Atmospheric Chemistry (IGAC) Program. 2003-present;
VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) SSC 2006-present
Polar Study using Aircraft, Remote Sensing, Surface Measurements and Models, of Climate, Chemistry, Aerosols, and Transport (POLARCAT) SSC 2006-present
Community Climate System Model (CCSM) Program Scientific Steering Committee 2007-present
Organizer: *Summer Colloquium on The Art of Climate Modeling*; 2006. Advanced Study Program of the National Center for Atmospheric Research
Numerous Workshops for IGAC, and NCAR CCSM/AMWG activities over the last 5 years.
National Research Council review panel for CCSP Synthesis and Assessment Product 3.2., 2007.

Publications by year

[1] P. J. Rasch, J. T. Kiehl, and W. T. Wyman, *Translation of "The mechanism of meteorological noise" by K. Hinkelmann (1951, Tellus) from the German*. NCAR Tech. Note TN–203+STR, Boulder, Colo.: Nat. Cent. for Atmos. Res., 1983. NTIS PB83–241489.

[2] P. J. Rasch, "Developments in normal mode initialization. part I: A simple interpretation for normal mode initialization," *Mon. Weather Rev.*, vol. 113, pp. 1746–1753, 1985.

[3] P. J. Rasch, "Developments in normal mode initialization. part II: A new method and its comparison with currently used schemes," *Mon. Weather Rev.*, vol. 113, pp. 1753–1770, 1985.

[4] P. J. Rasch, "Toward atmospheres without tops: Absorbing upper boundary conditions for numerical models," *Q. J. R. Meteorol. Soc.*, vol. 112, pp. 1195–1218, 1986.

[5] R. M. Errico and P. J. Rasch, "A comparison of various normal-mode initialization schemes and the inclusion of diabatic processes," *Tellus*, vol. 40A, pp. 1–25, 1988.

[6] L. J. Donner and P. J. Rasch, "Cumulus initialization in a global model for numerical weather prediction," *Mon. Weather Rev.*, vol. 117, pp. 2654–2671, 1989.

[7] P. J. Rasch and D. L. Williamson, *A comparison of shape preserving interpolators*. NCAR Tech. Note, NCAR/TN–339+STR, Boulder, Colo.: Nat. Cent. for Atmos. Res., 1989. NTIS PB89–226336/AS.

[8] D. L. Williamson and P. J. Rasch, "Two-dimensional semi-Lagrangian transport with shape-preserving interpolation," *Mon. Weather Rev.*, vol. 117, pp. 102–129, 1989.

[9] P. J. Rasch and D. L. Williamson, "Computational aspects of moisture transport in global models of the atmosphere," *Q. J. R. Meteorol. Soc.*, vol. 116, pp. 1071–1090, 1990.

[10] P. J. Rasch and D. L. Williamson, "On shape-preserving interpolation and semi-Lagrangian transport.," *SIAM J. Sci. Stat. Comput.*, vol. 11, no. 4, pp. 656–687, 1990.

[11] D. L. Williamson, P. J. Rasch, and D. E. Hartley, "The WCRP $CFCL_3$ experiment.," Tech. Rep. 24, WMO, Bermuda, 1990.

[12] P. J. Rasch and D. L. Williamson, "Sensitivity of a general circulation model climate to the moisture transport formulation," *J. Geophys. Res.*, vol. 96, pp. 13,123–13,137, 1991.

[13] P. K. Smolarkiewicz and P. J. Rasch, "Monotone advection on the sphere: An eulerian versus semi-lagrangian approach," *J. Atmos. Sci.*, vol. 48, pp. 793–810, 1991.

[14] J. J. Hack, B. A. Boville, B. P. Briegleb, J. T. Kiehl, P. J. Rasch, and D. L. Williamson, "Description of the NCAR Community Climate Model (CCM2)," Tech. Rep. *NCAR/TN-382+STR*, NTIS PB93-221802, NCAR, 1993. 120 pp.

[15] J. J. Hack, B. A. Boville, B. P. Briegleb, J. T. Kiehl, P. J. Rasch, and D. L. Williamson, *Description of the NCAR Community Climate Model (CCM2)*. NCAR Tech. Note, NCAR/TN–382+STR, Boulder, Colo.: Nat. Cent. for Atmos. Res., 1993.

[16] J. J. Hack, B. A. Boville, B. P. Briegleb, J. T. Kiehl, P. J. Rasch, and D. L. Williamson, "Description of the NCAR Community Climate Model (CCM2)," Tech. Rep. NCAR/TN-382+STR, National Center for Atmospheric Research, 1993. 120 pp.

[17] P. G. Hess, D. S. Battisti, and P. J. Rasch, "Maintenance of the intertropical convergence zones and the large-scale tropical circulation on a water-covered earth," *J. Atmos. Sci.*, vol. 51, no. 5, pp. 691–713, 1993.

[18] J. J. Hack, B. A. Boville, J. T. Kiehl, and P. J. Rasch, "Climate statistics from the National Center for Atmospheric Research Community Climate Model CCM2," *J. Geophys. Res.*, vol. 99, pp. 20785–20813, 1994.

[19] D. Hartley, D. Williamson, P. Rasch, and R. Prinn, "Examination of tracer transport in the NCAR CCM2 by comparison of $CFCl_3$ simulations with ALE/GAGE observations," *J. Geophys. Res.*, vol. 99, pp. 12,855–12,896, 1994.

[20] P. J. Rasch, X. X. Tie, B. A. Boville, and D. L. Williamson, "A three-dimensional transport model for the middle atmosphere," *J. Geophys. Res.*, vol. 99, pp. 999–1017, 1994.

[21] P. Rasch, X. Tie, B. Boville, and D. Williamson, "A three-dimensional transport model for the middle atmosphere.," *J. Geophys. Res.*, vol. 99, no. D1, pp. 16445–16490, 1994.

[22] P. J. Rasch, "Conservative shape preserving 2-dimensional transport on a spherical reduced grid," *Mon. Weather Rev.*, vol. 122, no. 6, pp. 1337–1350, 1994.

[23] X. X. Tie, G. P. Brasseur, P. Friedlingstein, C. Granier, and P. J. Rasch, "The impact of high altitude aircraft on the ozone layer in the stratosphere," *J. Atmos. Chem.*, vol. 18, pp. 103—128, 1994.

[24] D. L. Williamson and P. J. Rasch, "Water vapor transport in the NCAR CCM2," *Tellus*, vol. 46A, pp. 34–51, 1994.

[25] M. W. Hecht, W. R. Holland, and P. J. Rasch, "Upwind-weighted advection schemes for ocean tracer transport: An evaluation in a passive tracer context," *J. Geophys. Res.*, vol. 100, no. C10, pp. 20763–20778, 1995.

[26] N. M. Mahowald, P. J. Rasch, and R. G. Prinn, "Cumulus parameterizations in chemical transport models.," *J. Geophys. Res.*, vol. 100, pp. 16173–26189, 1995.

[27] P. J. Rasch, B. A. Boville, and G. P. Brasseur, "A three-dimensional general circulation model with coupled chemistry for the middle atmosphere," *J. Geophys. Res.*, vol. 100, pp. 9041–9071, 1995.

[28] P. J. Rasch, H. Feichter, K. Law, and J. Penner, "Modeling of Trace Constituents by Global Models," tech. rep., World Meteorological Organization, 1995.

[29] D. J. Erickson, P. J. Rasch, P. P. Tans, P. Friedlingstein, P. Ciais, E. Maier-Reimer, K. Six, C. A. Fischer, and S. Walters, "The seasonal cycle of atmospheric CO2: A study based on the NCAR community climate model (CCM2)," *J. Geophys. Res.*, vol. 101, no. D10, pp. 15079—15097, 1996.

[30] J. T. Kiehl, J. Hack, G. B. Bonan, B. A. Boville, B. P. Briegleb, D. L. Williamson, and P. J. Rasch, *Description of the NCAR Community Climate Model (CCM3)*. NCAR Tech. Note, NCAR/TN–420+STR, Boulder, Colo., U.S.A.: National Center for Atmospheric Research, 1996.

[31] V. Ramanathan, P. J. Crutzen, J. A. Coakley, A. Clarke, W. D. Collins, R. Dickerson, D. Fahey, B. Gandrud, A. Heymsfield, J. T. Kiehl, J. Kuettner, T. Krishnamurti, D. Lubin, H. Maring, J. Ogren, J. Prospero, P. J. Rasch, D. Savoie, G. Shaw, A. Tuck, F. P. J. Valero, E. L. Woodbridge, and G. Zhang, "Indian Ocean Experiment (indoex), A Multi-Agency Proposal for a Field Experiment in the Indian Ocean," tech. rep., Center for Clouds, Chemistry, and Climate (C4), Scripps Institution of Oceanography, June 1996. URL = `http://borneo.ucsd.edu/publications/proposal`.

[32] D. J. Wuebbles, P. J. Rasch, D. Jacob, , D. H. Rind, J. Logan, J.-F. Müller, J. M. Rodriguez, C. J. Walcek, and Y. Wang, "Chapter 4: Modeling the global effects of aircraft emissions," in *The Atmospheric Effects of Subsonic Aircraft: Interim Assessment Report of the Advanced Subsonic Technology Program* (R. R. Friedl, ed.), Reference Publication 1400, (Wahington, D.C.), p. 168, NASA, 1997.

[33] D. J. Jacob, M. J. Prather, B. A. Boville, P. J. Rasch, J. Feichter, P. S. Kasibhatla, Verver, J. E. Penner, D. Bergmann, C. Genthon, Y. J. Balkanski, P. Zimmermann, S. R. Beagley, W. T. Blackshear, D. A. Rotman, M. Chiba, M. Chipperfield, P. D. Brown, R.-L. Shia, K. Law, C. Reeves, and M. Brown, "Intercomparison of convective and synoptic transport in global models using ^{222}Rn and other tracers," *J. Geophys. Res.*, vol. 102, pp. 5953—5970, 1997.

[34] T. N. Krishnamurti, B. Jha, P. J. Rasch, and V. Ramanathan, "A high resolution global reanalysis highlighting the winter monsoon," C4 Publication 181, Scripps Inst. Oceanography, La Jolla, CA, USA, 1997.

[35] T. N. Krishnamurti, B. Jha, P. J. Rasch, and V. Ramanathan, "A high resolution global reanalysis highlighting the winter monsoon. part I, reanalysis fields," *Meteorol. Atmos. Physics.*, no. 64, pp. 123—150, 1997.

[36] T. N. Krishnamurti, B. Jha, P. J. Rasch, and V. Ramanathan, "A high resolution global reanalysis highlighting the winter monsoon. part II, transients and passive tracer transports," *Meteorol. Atmos. Physics.*, no. 64, pp. 151—171, 1997.

[37] N. M. Mahowald, R. G. Prinn, and P. J. Rasch, "Deducing CCl_3F emissions using an inverse method and chemical transport models with assimilated winds," *J. Geophys. Res.*, vol. 102, no. D23, pp. 28153—28168, 1997.

[38] N. Mahowald, P. Rasch, B. Eaton, S. Whittleston, and R. Prinn, "Transport of ^{222}Radon to the remote troposphere using MATCH and assimilated winds from ECMWF and NCEP/NCAR," *J. Geophys. Res.*, vol. 102 (D23), pp. 28139–28151, 1997.

[39] P. J. Rasch, N. M. Mahowald, and B. E. Eaton, "Representations of transport, convection, and the hydrologic cycle in chemical transport models: Implications for the modeling of short-lived and soluble species," *J. Geophys. Res.*, vol. 102, pp. 28127–28138, 1997.

[40] D. W. Waugh, T. M. Hall, W. J. Randel, P. J. Rasch, B. A. Boville, K. A. Boering, S. C. Wofsy, D. C. Daube, J. W. Elkins, D. W. Fahey, G. S. Dutton, C. M. Volk, and P. F. Vohralik, "Three-dimensional simulations of long-lived tracers using winds from MACCM2," *J. Geophys. Res.*, vol. 102, pp. 21493–21513, 1997.

[41] G. P. Brasseur, X. Tie, P. Rasch, and F. Lefvre, "A three-dimensional simulation of the antarctic ozone hole: Impact of anthropogenic chlorine on the lower stratosphere and upper troposphere," *J. Geophys. Res.*, vol. 102, pp. 8909–8930, 1997.

[42] G. P. Brasseur, D. Hauglustaine, S. Walters, P. Rasch, J.-F. Mller, C. Granier, and X. Tie, "MOZART, a global chemical transport model for ozone and related chemical tracers: 1, model description," *J. Geophys. Res.*, vol. 103, pp. 28265–28289, 1998.

[43] D. A. Hauglustaine, G. P. Brasseur, S. Walters, P. J. Rasch, J. F. Müller, L. K. Emmons, and M. A. Carroll, "MOZART: A global chemical transport model of ozone and related chemical tracers, part 2. model results and evaluation," *J. Geophys. Res.*, pp. 28291—28335, 1998.

[44] J. T. Kiehl, J. J. Hack, G. B. Bonan, B. B. Boville, D. L. Williamson, and P. J. Rasch, "The National Center for Atmospheric Research Community Climate Model: CCM3," *J. Climate*, vol. 11, pp. 1131–1149, 1998.

[45] P. J. Rasch and M. G. Lawrence, "Recent developments in transport methods at NCAR," in *MPI workshop on conservative transport methods* (B. Machenhauer, ed.), Report No. 265., (Hamburg, Germany), p. 93, Max Planck Institute for Meteorology, 1998.

[46] P. J. Rasch and J. E. Kristjánsson, "A comparison of the CCM3 model climate using diagnosed and predicted condensate parameterizations," *J. Climate*, vol. 11, pp. 1587—1614, 1998.

[47] G. J. Zhang, J. T. Kiehl, and P. J. Rasch, "Response of climate simulations to a new convective parameterization in the National Center for Atmospheric Research.," *J. Climate*, vol. 11, no. 8, pp. 2097—2115, 1998.

[48] W. D. Collins, P. J. Rasch, and B. E. Eaton, "Forecasting aerosols using a CTM with assimilation of satellite aerosol retrievals 1. Methodology for INDOEX," *EOS*, vol. 80, no. 17, pp. S31–S32, 1999.

[49] A. R. Douglass, M. P. Prather, T. Hall, S. E. Strahan, P. J. Rasch, L. Sparling, L. Coy, , and J. Rodriquez, "Choosing meteorological input for the global modeling initiaitve assessment of high speed aircraft," *J. Geophys. Res.*, vol. 104, pp. 27545–27564, 1999.

[50] M. J. Lawrence, P. J. Crutzen, P. J. Rasch, B. E. Eaton, , and N. M. Mahowald, "A model for studies of tropospheric photochemistry: Description, global simulation characteristics, and evaluation," *J. Geophys. Res.*, vol. 104, no. D21, pp. 26245–26278, 1999.

[51] M. G. Lawrence, P. J. Crutzen, and P. J. Rasch, "Analysis of the CEPEX ozone data using a 3D chemistry-meteorology model," *Q. J. R. Meteorol. Soc.*, vol. 125, pp. 2987–3009, 1999.

[52] U. Lohmann, W. Leaitch, K. Law, L. Barrie, Y. Yi, D.Bergmann, C. Bridgeman, M. Chin, J. Christensen, R. Easter, J.Feichter, A. Jeuken, E. Kjellstrom, D. Koch, C. Land, P. J. Rasch, and G.-J. Roelofs, "vertical distributions of sulfur species simulated by large scale atmospheric models in COSAM:comparison with observations," *Tellus*, vol. 53, pp. 646–672, 1999.

[53] P. J. Rasch, W. D. Collins, and B. E. Eaton, "Forecasting aerosols using a CTM with assimilation of satellite aerosol retrievals 2. A 4D aerosol analysis for INDOEX," *EOS*, vol. 80, no. 17, p. S32, 1999.

[54] P. J. Rasch, J. Feichter, K. Law, N. Mahowald, J. Penner, C. Benkovitz, C. Genthon, C. Giannakopoulos, P. Kasibhatla, D. Koch, H. Levy, T. Maki, M. Prather, D. L. Roberts, G.-J. Roelofs, D. Stevenson, Z. Stockwell, S. Taguchi, M. Kritz, M. Chipperfield, D. Baldocchi, P. McMurry, L. Barrie, T. Balkanski, R. Chatfield, E. Kjellstrom, M. Lawrence, H. N. Lee, J. Lelieveld, K. J. Noone, J. Seinfeld, G. Stenchikov, S. Schwarz, C. Walcek, and D. Williamson, "Proceedings of a WCRP workshop on modelling the transport and scavenging of trace constituents by clouds in global atmospheric models," Tech. Rep. 29, WMO / TD-No. 950, World Meteorological Organization, Geneva, Switzerland, 1999.

[55] M. Barth, P. J. Rasch, J. T. Kiehl, C. M. Benkovitz, and S. E. Schwartz, "Sulfur chemistry in the National Center for Atmospheric Reseach Community Climate Model: Description, evaluation, features and sensitivity to aqueous chemistry," *J. Geophys. Res.*, vol. 105, no. D1, pp. 1387—1415, 2000.

[56] A. Clarke, W. C. Collins, P. J. Rasch, V. Kapustin, K. Moore, and S. Howell, "Dust and pollution transport on global scales: Aerosol measurement and model predictions," *J. Geophys. Res.*, vol. 106, no. D23, pp. 32,555–32,569, 2000.

[57] J. T. Kiehl, T. L. Schneider, P. J. Rasch, M. Barth, and J. Wong, "Radiative forcing due to sulfate aerosols from simulations with the National Center for Atmospheric Research Community Climate Model, version 3," *J. Geophys. Res.*, vol. 105, pp. 1441–1457, 2000.

[58] P. J. Rasch, J. Feichter, K. Law, N. Mahowald, J. Penner, C. Benkovitz, C. Genthon, C. Giannakopoulos, P. Kasibhatla, D. Koch, H. Levy, T. Maki, M. Prather, D. L. Roberts, G.-J. Roelofs, D. Stevenson, Z. Stockwell, S. Taguchi, M. Kritz, M. Chipperfield, D. Baldocchi, P. McMurry, L. Barrie, Y. Balkanski, R. Chatfield, E. Kjellstrom, M. Lawrence, H. N. Lee, J. Lelieveld, K. J. Noone, J. Seinfeld, G. Stenchikov, S. Schwartz, C. Walcek, and D. Williamson, "A comparison of scavenging and deposition processes in global models; results from the WCRP Cambridge workshop of 1995," *Tellus*, vol. 52B, pp. 1025—1056, 2000.

[59] P. J. Rasch, M. Barth, J. T. Kiehl, C. M. Benkovitz, and S. E. Schwartz, "A description of the global sulfur cycle and its controlling processes in the National Center for Atmospheric Research Community Climate Model, version 3," *J. Geophys. Res.*, vol. 105, pp. 1367–1385, 2000.

[60] B. A. Boville, J. T. Kiehl, P. J. Rasch, and F. O. Bryan, "Improvements to the NCAR CSM-1 for transient climate simulation," *J. Climate*, vol. 14, pp. 164–179, 2001.

[61] W. D. Collins, P. J. Rasch, B. E. Eaton, B. Khattatov, J.-F. Lamarque, and C. S. Zender, "Simulating aerosols using a chemical transport model with assimilation of satellite aerosol retrievals: Methodology for INDOEX," *J. Geophys. Res.*, vol. 106, no. D7, pp. 7313—7336, 2001.

[62] P. R. Jöckel, R. von Kuhlmann, M. G. Lawrend, B. Steil, C. Brenninkmeijer, P. J. Crutzen, P. J. Rasch, and B. Eaton, "On a fundamental problem in implementing flux-form advection schemes for tracer transport in 3-dimensional general circulation and chemistry transport models," *Q. J. R. Meteorol. Soc.*, vol. 127, pp. 1035–1052, 2001.

[63] V. Ramanathan, P. J. Crutzen, J. Lelieveld, D. Althausen, J. Anderson, M. O. Andreae, W. Cantrell, G. Cass, C. E. Chung, A. D. Clarke, W. D. Collins, J. A. Coakley, F. Dulac, J. Heintzenberg, A. J. Heymsfield, B. Holben, J. Hudson, A. Jayaraman, J. T. Kiehl, T. N. Krishnamurti, D. Lubin, A. P. Mitra, G. McFarquhar, T. Novakov, J. A. Ogren, I. A. Podgorny, K. Prather, J. M. Prospero, K. Priestley, P. K. Quinn, K. Rajeev, P. J. Rasch, S. Rupert,

R. Sadourney, S. K. Satheesh, P. Sheridan, G. E. Shaw, , and F. P. J. Valero, "The indian ocean experiment: An integrated assessment of the climate forcing and effects of the great indo-asian haze," *J. Geophys. Res.*, vol. 106, pp. 28371–28398, 2001.

[64] P. J. Rasch, W. D. Collins, and B. E. Eaton, "Understanding the Indian Ocean Experiment INDOEX aerosol distributions with an aerosol assimlation.," *J. Geophys. Res.*, vol. 106, no. D7, pp. 7337—7335, 2001.

[65] G.-J. Roelofs, , P. Kasibhatla, L. Barrie, D. Bergmann, C. Bridgeman, M. Chin, J. Christensen, R. Easter, J. Feichter, A. Jeuken, E. Kjellstrm, D. Koch, C. Land, U. Lohmann, P. J. Rasch, and Y. Yi, "Analysis of regional budgets of sulfur species modelled for the COSAM exercise," *Tellus*, vol. 53, p. 673, 2001.

[66] J. W. Bergman and P. J. Rasch, "Parameterizing vertically-coherent cloud distributions," *J. Atmos. Sci.*, vol. 410, 2002. 255TSKL30.

[67] W. D. Collins, P. J. Rasch, B. Eaton, D. W. Fillmore, J. Kiehl, T. C. Beck, and C. Zender, "Simulation of aerosol distributions and radiative forcing for INDOEX: Regional climate impacts," *J. Geophys. Res.*, vol. 107, 2003. DOI 10.1029/2000JD000032.

[68] B. Steil, C. Brühl, E. Manzini, P. J. Crutzen, J. Lelieveld, P. J. Rasch, E. Roeckner, and K. Krüger, "A new interactive chemistry-climate model: 1. present-day climatology and interannual variability of the middle atmosphere using the model and 9 years of HALOE/UARS data," *J. Geophys. Res.*, vol. 108, 2003. doi:10.1029/2002JD002971.

[69] M. G. Lawrence, P. J. Rasch, R. von Kuhlmann, J. Williams, H. Fischer, M. de Reus, J. Lelieveld, P. J. Crutzen, M. Schultz, P. Stier, H. Huntrieser, J. Heland, A. Stohl, C. Forster, H. Elbern, H. Jakobs, and R. R. Dickerson, "Global chemical weather forecasts for field campaign planning: predictions and observations of large-scale features during MINOS, CONTRACE, and INDOEX," *Atmospheric Chemistry and Physics*, pp. 267–289, 2003.

[70] M. G. Lawrence, R. von Kuhlmann, M. Salzmann, and P. J. Rasch, "The balance of effects of convective transport in deep cumulus clouds on tropospheric ozone," *Geophys. Res. Lett.*, vol. 30, no. 18, 2003. doi:10.1029/2003GL017644.

[71] R. von Kuhlmann, M. G. Lawrence, P. J. Crutzen, and P. Rasch, "A model for studies of tropospheric ozone and non-methane hydrocarbons: Model description and ozone results," *J. Geophys. Res.*, no. 108, 2003. DOI: 10.1029/2002JD002893.

[72] R. von Kuhlmann, M. G. Lawrence, P. J. Crutzen, and P. Rasch, "A model for studies of tropospheric ozone and non-methane hydrocarbons: Model evaluation of ozone related species," *J. Geophys. Res.*, no. 108, 2003. 4729, doi: 10.1029/2002JD003348.

[73] M. Zhang, W. Lin, C. S. Bretherton, J. J. Hack, and P. J. Rasch, "A modified formulation of fractional stratiform condensation rate in the NCAR Community Atmospheric Model (CAM2)," *J. Geophys. Res.*, vol. 108, no. D1, 2003. 4035, doi:10.1029/2002JD002523.

[74] W. D. Collins, P. J. Rasch, B. A. Boville, J. J. Hack, J. R. McCaa, D. L. Williamson, J. T. Kiehl, B. P. Briegleb, C. M. Bitz, S.-J. Lin, M. H. Zhang, and Y. Dai, "Description of the NCAR Community Atmosphere Model: CAM3.0," Tech. Rep. NCAR/TN-464+STR, National Center for Atmospheric Research, Boulder, Colorado, USA, June 2004. 226 pp., URL = `http://www.ccsm.ucar.edu/models/atm-cam`.

[75] K. M. Hines, D. H. Bromwich, P. J. Rasch, and M. J. Iacono, "Antarctic clouds and radiation within the NCAR climate models," *J. Climate*, vol. 17, pp. 1198–1212, 2004.

[76] M. J. Lawrence and P. J. Rasch, "Tracer transport in deep convective updrafts: plueme ensemble versus bulk formulations," *J. Atmos. Sci.*, vol. 62, pp. 2880–2894, 2005.

[77] B. A. Boville, P. J. Rasch, J. J. Hack, and J. R. McCaa, "Representation of clouds and preciptiation processes in the Community Atmosphere Model 3 (CAM3)," *J. Climate*, pp. 2184–2198, 2006.

[78] J. J. Hack, J. M. Caron, S. G. Yeager, K. W. Oleson, M. M. Holland, J. E. Truesdale, and P. J. Rasch, "The simulation of the global hydrological cycle in the CCSM community atmosphere model CAM3: Mean state," *J. Climate*, vol. 19, no. 11, pp. 2199–2221, 2006.

[79] P. J. Rasch, D. B. Coleman, N. Mahowald, D. L. WIlliamson, S.-J. Lin, B. A. Boville, and P. Hess, "Characteristics of transport using three formulations of atmospheric dynamics in a single GCM framework," *J. Climate*, vol. 19, pp. 2243—2266, 2006.

[80] P. Rasch, M. J. Stevens, L. Ricciardulli, A. Dai, R. Wood, B. A. Boville, B. Eaton, and J. J. Hack, "A characterization of tropical transient activity in the CAM3 atmospheric hydrologic cycle," *J. Climate*, vol. 19, pp. 2222–2242, 2006.

[81] W. D. Collins, P. J. Rasch, B. A. Boville, J. J. Hack, J. R. McCaa, D. L. Williamson, B. Briegleb, C. M. Bitz, S.-J. Lin, and M. Zhang, "The formulation and atmospheric simulation of the Community Atmosphere Model: CAM3," *J. Climate*, vol. 19, pp. 2144–2161, 2006.

[82] J.-L. Lin, G. N. Kiladis, B. E. Mapes, K. M. Weickmann, K. R. Sperber, W. Lin, M. Wheeler, S. D. Schubert, A. D. Genio, L. J. Donner, S. Emori, J.-F. Gueremy, F. Hourdin, P. J. Rasch, E. Roeckner, and J. F. Scinocca, "Tropical intraseasonal variability in 14 IPCC AR4 climate models part I: Convective signals," *J. Climate*, vol. 19, pp. 2665–2690, 2006. doi:10.1175/JCLI3735.1.

[83] N. M. Mahowald, D. R. Muhs, S. Levis, P. J. Rasch, M. Y. nd C. S. Zender, and C. Luo, "Change in atmospheric mineral aerosols in response to climate: Last glacial period, preindustrial, modernn, and doubled carbon dioxide climates," *J. Geophys. Res.*, vol. 111, 2006. D10202, doi:10.1029/2005JD006653.

[84] S. C. Doney, N. Mahowal, I. Lima, R. A. Feely, F. T. Mackenzie, J.-F. Lamarque, and P. J. Rasch, "Impact of anthropogenic atmospheric nitrogen and sulfur deposition on ocean acidification and the inorganic carbon system," *Proc. Nat. Acad. Sci.*, vol. 104, no. 37, pp. 14680–14585, 2007. doi:0.1073pnas.0702218104.

[85] M. G. Flanner, C. S. Zender, J. T. Randerson, and P. J. Rasch, "Present-day climate forcing and response from black carbon in snow," *J. Geophys. Res.*, vol. 112,D112102, 2007. doi:10.1029/2006JD008003.

[86] G. G. Pfister, P. G. Hess, L. K. Emmons, P. J. Rasch, and F. M. Vitt, "Impact of the summer 2004 alaska fires on TOA clear-sky radiation fluxes," *J. Geophys. Res.*, 2007. in press.

[87] P. J. Rasch, P. J. Crutzen, and D. B. Coleman, "Exploring the geoengineering of climate using stratospheric sulfate aerosols: The role of particle size," *Geophys. Res. Lett.*, 2007. in press.

[88] J. R. Richter and P. J. Rasch, "Effects of convective momentum transport on the atmospheric circulation in the Community Atmosphere Model, version 3 (CAM3)," *J. Climate*, 2007. in press.

In-preparation or submitted Articles

[1] D. Kim, C. Wang, A. M. L. Ekman, M. C. Barth, and P. J. Rasch, "Distribution and direct radiative forcing of carbonaceous and sulfate aerosols in an interactive size-resolving aerosol-climate model," *J. Climate*, 2007. submitted.

[2] C. C. Chen and P. J. Rasch, "A finite volume isentropic general circulation model," *J. Climate*, 2008. in preparation.