Raymond T. Pierrehumbert

The University of Chicago
Department of the Geophysical Sciences
5734 S. Ellis Ave
Chicago, IL 60637
(773) 702-8101
rtp1@geosci.uchicago.edu
http://geosci.uchicago.edu/∼rtp1

Research Interests

Physics of climate, especially regarding the long term evolution of the climates of solar system and extrasolar planets. Water vapor and global change. Baroclinic instability. Hamiltonian chaos and fluid mixing.

Education

- **Massachusetts Institute of Technology**,Cambridge, MA
  Ph.D. March, 1980 (Dept. of Aeronautics and Astronautics)
- **University of Cambridge** Cambridge, England
  Knox Fellow, 1976-1977 (Dept. of Applied Mathematics and Theoretical Physics)
- **Harvard College**, Cambridge, MA
  A.B. Magna cum Laude in Physics June, 1975

Positions and Fellowships

- **Louis Block Professor** University of Chicago, 2005-present
- **Professor in Geophysical Sciences** University of Chicago, 1989-present
- **Directeur de Recherche** Ecole Polytechnique, France (2003-2004,visiting position)
- **John Simon Guggenheim Fellow** Laboratoire de Meteorologie Dynamique, Ecole Normale Superieur, Paris. 1996/1997 (sabbatical visit)
- **Professor of Geology and Geophysics** Princeton University 1988-1989
- **Guest Investigator**Stockholms Universitet, Meteorologiska Institutionen 1987/1988 (sabbatical visit)
- **Research Scientist** Geophysical Fluid Dynamics Laboratory/NOAA. 1982-1988.
  Concurrent appointments at Princeton University: Visiting Lecturer with Rank of Associate Professor (Atmospheric & Oceanic Sciences Program), Affiliated Faculty Member, Applied & Computational Mathematics Program.
- **Assistant Professor of Meteorology** Massachusetts Institute of Technology, 1980-1982

Awards

- **John Simon Guggenheim Fellow**
- **Fellow, American Geophysical Union**
- **Chevalier de l'Ordre des Palmes Academiques**
- **King Karl XVI Gustaf Royal Professorship, Stockholm 2014-2015**

Selected Professional Activities

- **E**ditorial board, *Annual Reviews of Earth and Planetary Science.*
- **C**o-organizer *Exoclimes 2012*, Aspen, CO and *Exoclimes 2014*, Davos
- **C**o-author National Research Council Report on Geoengineering (in progress)
- **C**o-author National Research Council Report on Climate Stabilization Targets

- ◇ **M**ember, National Research Council Board on Atmospheric Science and Climate
- ◇ **M**ember, City of Chicago Mayor's Task Force on Climate Change.
- ◇ **C**o-organizer, 2008 Kavli Institute of Theoretical Physics Program on Physics of Climate.
- ◇ **L**ead Author, Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report (1997-2001)
- ◇ **M**ember, National Research Council Panel on Abrupt Climate Change and its Societal Impacts (2000-2001).
- ◇ **E**ditor, Journal of the Atmospheric Sciences (1988-1991)

PhD Students

- ◇ **B. Reinhold** (PhD, MIT 1981) Dynamics of Weather Regimes: Quasi-Stationary Waves & Blocking
- ◇ **D. Dritschel** (PhD, Princeton 1984) The Stability of Certain two dimensional and three dimensional Vortical Motions
- ◇ **J. Bacmeister** (Princeton GFD program, PhD 1987) Nonlinearity in Transient two dimensional flow over topography.
- ◇ **B. Carissimo** (Princeton GFD program, PhD Aug. 1987) Observation and modelling of drag during transient airflow over mountains
- ◇ **F. Parham** (Princeton Appl. Math. PhD. June 1988) Rossby wave critical levels in a baroclinic atmosphere.
- ◇ **S. Lin** (Princeton GFD program, PhD. July 1988) The instability mechanism of synoptic scale eddies
- ◇ **K. Lamb** (Princeton Appl. Math, PhD. July 1988) Nonlinear gravity wave critical levels
- ◇ **M. Dahleh** (Princeton Appl. Math 1989) Subject: Discrete vortex methods on the beta plane
- ◇ **J. Anderson** (Princeton GFD program 1989, jointly advised with Isaac Held) Subject: Numerical methods for large non Hermitian eigenvalue problems
- ◇ **Kyle Swanson** (U. of C. Geophysical Sciences, Ph.D 1995) Subject: Storm tracks and low frequency variability
- ◇ **Stefanella Boatto** (U. of C. Physics, Ph.D 1995) Subject: Chaotic mixing by aperiodic flows.
- ◇ **Yongyun Hu** (U. of C. Geophysical Sciences PhD 2001) Subject: Atmospheric stirring and mixing.
- ◇ **Hui Zhang** (U. of C. Geophysical Sciences PhD 2002) Tropical upper tropospheric water vapor distribution.
- ◇ **Jai Sukhatme** (U. of C. Geophysical Sciences PhD 2003) Subject: Multifractal and stochastic models in geophysics
- ◇ **Jude Sabado** (U.of C.Geophysical Sciences PhD 2006) Subject: Baroclinic instability on Early Mars
- ◇ **Jonathan Mitchell** (U. of C. Astrophysics PhD 2007) Subject: Climate Dynamics of Titan
- ◇ **Ian N. Williams** (U. of C. Geophysical Sciences PhD 2011) Subject: Tropical convection and Climate Sensitivity
- ◇ **Dawei Li** (U. of C. Geophysical Sciences PhD, in progress) Subject: Sea glaciers and neoproterozoic climate
- ◇ **Feng Ding** (U. of C. Geophysical Sciences PhD, in progress) Subject: GCM modeling of exoplanet climates

◇ **Andrew Malone** (U. of C. Geophysical Sciences PhD, in progress) Subject: Mountain glaciers as climate proxies

◇ **Jonah Bloch-Johnson** (U. of C. Geophysical Sciences PhD, in progress) Subject: Bifurcations and climate sensitivity

Recent Postdocs

◇ **Huijun Yang**
◇ **Keith Ngan**
◇ **Chris Poulsen**
◇ **Gilles DeLaygue**
◇ **Jason Goodman**
◇ **Rodrigo Caballero**
◇ **Johnny Lin**
◇ **Christian Dieterich**
◇ **Yannick Donnadieu**
◇ **Helene Brogniez**
◇ **Dargan Frierson**
◇ **David McInerney**
◇ **Dorian Abbot**
◇ **Jung-Eun Lee**
◇ **Robin Wordsworth**

Selected invited lectures

◇ **D**istinguished Planetary Science Lecturer, Bern University (2014)
◇ **T**yndall Lecture, American Geophysical Fall Meeting (2012)
◇ **D**istinguished Atmospheric Science Lecturer, Beijing University (2012)
◇ **I**nvited lecturer, Swedish Royal Academy Bolin Symposium (2012)
◇ **U**niversity Lecturer, Cornell University (2012)
◇ **N**iels Bohr Lecture, Copenhagen University (2011)
◇ **F**airchild Lecture, University of Rochester (2010)
◇ **N**oble Lecturer, University of Toronto (Toronto, 2010)
◇ **I**nvited lecturer, Vatican study group on astrobiology (Rome, 2009)
◇ **H**alley Lecture (Oxford University, 2009)
◇ **K**ibbe lecture (Bowdoin College, 2008)
◇ **B**erkeley Distinguished Atmospheric Science Lecture (Berkeley, 2008)
◇ **A**ggasiz Lectures (Harvard, 2008)
◇ **T**hompson Lectures (National Center for Atmospheric Research, 2008)
◇ **"**Low Order Models" Invited lecture at The Lorenz Symposium (MIT, Dec. 1987)

RECENT PUBLICATIONS

Open access versions of most recent papers are available at
`http://geosci.uchicago.edu/~rtp1/papers/publist.html`

Wordsworth R and Pierrehumbert RT 2014: Abiotic Oxygen-dominated Atmospheres on Terrestrial Habitable Zone Planets.*Ap. J. Lett.*, **785** 785 L20. doi:10.1088/2041-8205/785/2/L20

Glotter M, Pierrehumbert RT, Elliott J and Moyer, EJ 2013: A Simple Carbon Cycle Representation for Economic and Policy Analyses. *Climatic Change* (in review). RDCEP Working Paper No. 13-04. Available at SSRN: http://ssrn.com/abstract=2331074 or http://dx.doi.org/10.2139/ssrn.2331074

Pierrehumbert RT 2013: Hot Climates, High Sensitivity. *Proc. Nat. Acad. Sci.*, **110**,14118-14119, doi:10.1073/pnas.1313417110

Pierrehumbert RT 2014: Short Lived Climate Pollution. *Annual Reviews of Earth and Planetary Sciences* **42**, doi:10.1146/annurev-earth-060313-054843

Wordsworth R and Pierrehumbert RT 2013: Water loss from terrestrial planets with CO2-rich atmospheres. *Astrophysical J.*, **778** doi:10.1088/0004-637X/778/2/154

Abbot DS, Voigt A, Li D, Le Hir G, Pierrehumbert RT *et al* 2013: Robust elements of Snowball Earth atmospheric 2 circulation and oases for life. *J. Geophys. Res. – Atmospheres*, **118(12)**,6017-6027, doi:10.1002/jgrd.50540

Shields A, Meadows VS, Bitz C, Pierrehumbert RT *et al* 2013: The Effect of Host Star Spectral Energy Distribution and Ice-Albedo Feedback on the Climate of Extrasolar Planets. *Astrobiology*, **13(8)**, 715-739, doi:10.1089/ast.2012.0961

Pierrehumbert RT 2013: Strange news from other stars. *Nature Geoscience* **6**, 81-83. doi:10.1038/ngeo1711

Wordsworth R and Pierrehumbert RT 2013: Hydrogen-nitrogen greenhouse warming in Earth's early atmosphere. *Science*, **339**, 64-67. doi:10.1126/science.1225759

Pierrehumbert RT 2012: Cumulative Carbon and Just Allocation of the Global Carbon Commons. *Chicago Journal of International Law*, **13.2** pp 527-548 .

Pierrehumbert RT 2012: *Computation in Python for the Mathematical and Physical Sciences*. Princeton University Press (under contract).

Abbot DS, Voigt A, Branson M, Pierrehumbert RT *et al* 2012: Clouds and Snowball Earth deglaciation. *Geophys. Res. Lett.*, **39**, doi:10.1029/2012GL052861

Solomon S, Pierrehumbert RT, Matthews D Daniel JS and Friedlingstein P 2012: Atmospheric composition, irreversible climate change, and mitigation policy. in *Climate Science for Serving Society: Research, Modelling and Prediction Priorities*, Hurrell, J. and Asrar, G., eds., Springer.

Matthews HD, Solomon S and Pierrehumbert RT 2012: Cumulative carbon as a policy framework for achieving climate stabilization. *Phil. Trans. Roy. Soc. A*, **1974**,4365-4379, doi:10.1098/rsta.2012.0064

Li D., and R. T. Pierrehumbert 2011: Sea glacier flow and dust transport on Snowball Earth, *Geophys. Res. Lett.*, **38**, L17501, doi:10.1029/2011GL048991.

Pierrehumbert RT and Gaidos E. 2011: Hydrogen greenhouse planets beyond the habitable zone. *Ap. J. Lett.* **734** doi:10.1088/2041-8205/734/1/L13.

Pierrehumbert RT 2011: A palette of climates for Gliese 581g. *Ap. J. Lett.*, **726** doi: 10.1088/2041-8205/726/1/L8.

Pierrehumbert RT 2011: Infrared radiation and planetary temperature. *Physics Today* **64**, 33-38.

Abbot DS and Pierrehumbert RT 2010: Mudball: Surface dust and Snowball Earth deglaciation, *J. Geophys. Res.-Atmospheres* **115**, doi: 10.1029/2009JD01200

Pierrehumbert RT, Abbot DS, Voight A and Koll D 2011: Neoproterozoic Climate. *Annual Reviews of Earth and Planetary Sciences* 39:417-60, doi:10.1146/annurev-earth-040809-152447.

Abbot DS, Silber M, and Pierrehumbert RT 2011: Cloud Feedbacks and Arctic Sea Ice Tipping Points. *J. Geophys. Res.- Atmospheres* **116**, D19120, doi:10.1029/2011JD015653 .

Pierrehumbert RT 2010: *Principles of Planetary Climate.* Cambridge University Press, 652pp.

Archer DA and Pierrehumbert RT 2010: *The Warming Papers.* Wiley/Blackwell.

Solomon S, Battisti D, Doney S, Hayhoe K, Held I, Lettenmaier D, Lobell D, Matthews D, Pierrehumbert RT, Raphael M, Richels R, Root T, Steffen K, Tebaldi C and Yohe G 2010: *Climate Stabilization Targets: Emissions, Concentrations and Impacts over Decades to Millennia.* National Academy Press:Washington 190pp.

Williams IN, Pierrehumbert RT and Huber M 2009: Global warming, convective threshold and false thermostats. *Geophys. Res. Lett.* **36**. doi:10.1029/2009GL03984

Abbot DS, Eisenman I and Pierrehumbert RT 2010: Sea Ice Resolution and the Snowball Diurnal Cycle. *J. Climate* **23**, 6100-6109.

Lee J.-E.,Pierrehumbert RT, Swann A, and Lintner BR 2009: Sensitivity of stable water isotopic values to convective parameterization schemes. *Geophys. Res. Lett.* **36** L23801. doi:10.1029/2009GL040880.

Mitchell JL, Pierrehumbert RT, Frierson DMW and Caballero R 2009: The impact of methane thermodynamics on seasonal convection and circulation in a model Titan atmosphere. *Icarus* **203**, 250-264. doi:10.1016/j.icarus.2009.03.043

Halevy I, Pierrehumbert RT, Schrag DP 2009: Radiative transfer in CO2-rich paleoatmospheres *J. Geophys. Res.-Atmospheres* **114** D18112. doi:10.1029/2009JD011915 .

Le Hir G, Donnadieu Y, Godderis Y, Pierrehumbert RT, Macouin M, Halverson G, Nedelec A, and Ramstein G 2008: The Snowball Earth aftermath: exploring the limits of continental weathering processes. *Earth Plan Sci Lett* doi:10.1016/j.epsl.2008.11.010.

Caballero R, Mitchell J and Pierrehumbert RT 2008: Axisymmetric, nearly inviscid circulations in non-condensing radiative-convective atmospheres. *Quart J Roy Meterol Soc* **134**,1269-1285.

Goddris Y, Donnadieu Y, de Vargas C, Pierrehumbert RT, Dromart G 2008: Causal or casual link between the rise of nannoplankton calcification and a tectonically-driven massive decrease in Late Triassic atmospheric CO2 ? *Earth Plan Sci Lett* **267**,247-255.

Le Hir G, Ramstein G, Donnadieu Y and Pierrehumbert RT 2007: Investigating plausible mechanisms to escape a hard Snowball-Earth. *Comptes rendus Geoscience* **339 (3-4)**, 274-287

Brogniez H and Pierrehumbert RT 2007: Intercomparison of the tropical tropospheric humidity in GCMs with AMSU-B water vapor data. *Geophysical Research Letters* **34**, L17812, doi:10.1029/2006GL029118

Brogniez H and Pierrehumbert RT 2006: Using microwave observations to assess large-scale control of free tropospheric water vapor in the mid-latitudes. *Geophysical Research Letters* doi:10.1029/2006GL026240

Donnadieu Y, Godderis Y, Pierrehumbert R, Dromart G, Fluteau F and Jacob R 2006: A GEOCLIM simulation of climatic and biogeochemical consequences of Pangea breakup. *Geochemistry Geophysics Geosystems* **7: Art. No. Q11019**

Mitchell J, Pierrehumbert RT, Frierson D and Caballero R 2006: The dynamics behind Titan's tropospheric methane clouds. *Proc. Nat. Acad. Sci.* **103 (49)**,18421-18426.

Pierrehumbert RT 2006: Climate change: A catastrophe in slow-motion. *Chicago Journal of International Law* **6**, 573-596.

Donnadieu Y, Pierrehumbert R, Jacob R and Fluteau F 2006: Modelling the primary control of paleogeography on Cretaceous climate. *Earth Plan Sci Lett* **248**, 426-437.

Pierrehumbert RT, Brogniez H, and Roca R 2007: On the relative humidity of the Earth's atmosphere. in *The Global Circulation of the Atmosphere*, T Schneider and A Sobel, eds. Princeton University Press 400pp.

Pierrehumbert RT 2005: Climate dynamics of a hard snowball Earth. *J. Geophys Res – Atmospheres*, Vol.110,No.D1,D01111 doi:10.1029/2004JD005162.

Pierrehumbert 2004a: Warming the world. *Nature* **432** 677.

Pierrehumbert 2004b: Translation of *Mémoire sur les Températures du Globe Terrestre et des Espaces Planétaires* by J-B J. Fourier. *Nature* **432** (online supplementary material to Pierrehumbert, 2004a)

Pierrehumbert RT 2004: High levels of atmospheric carbon dioxide necessary for the termination of global glaciation *Nature* **429**, 646-649. doi:10.1038/nature02640

Goodman JC, Collins GC, Marshall J and Pierrehumbert RT 2004: Hydrothermal Plume Dynamics on Europa: Implications for Chaos Formation. *J. Geophys. Res.* **109(E3)**,E03008, doi:10.1029/2003JE002073.

EARLIER PUBLICATIONS

Goodman, JC and Pierrehumbert RT 2003: Glacial flow of floating marine ice in Snowball Earth. *J. Geophys. Res.* **108 (C10)**,3308,doi:10.1029/2002JC001471.

Alley RB, Marotzke J, Nordhaus WD, Overpeck JT,Peteet DM,Pielke RA Jr., Pierrehumbert RT, Rhines PB, Stocker TF,L. Talley LD,Wallace JM 2003: Abrupt Climate Change. *Science* **299**, 2005-2010.

Pierrehumbert RT 2003: Counting the Cost (Review of *Risk and Reason* by C. Sunstein). *Nature* **422** 263.

Sukhatme J and Pierrehumbert RT 2002: Decay of passive scalars under the action of single scale smooth velocity fields in bounded two-dimensional domains: From non-self-similar probability distribution functions to self-similar eigenmodes. *Phys. Rev. E* **66**, art. no. 056302.

Sukhatme J and Pierrehumbert RT 2002: Surface quasigeostrophic dynamics: The study of an active scalar. *Chaos* **12**, 439-450.

Pierrehumbert RT 2002: The Hydrologic Cycle in Deep Time Climate Problems. *Nature* **419**,191-198.

Alley RB, Marotzke J, Nordhaus W, Overpeck J, Peteet D, Pielke R, Pierrehumbert RT, Rhines P, Stocker T, Talley L and Wallace JM 2002: *Abrupt Climate Change: Inevitable Surprises* National Academy Press,244pp.

Stocker TF,Clarke GKC,Le Treut H, Lindzen RS, Meleshko VP, Mugara RK, Palmer TN, Pierrehumbert RT, Sellers PJ, Trenberth KE, and Willebrand J 2001: Physical Climate Processes and Feedbacks, Ch. 7 in *The Physics of Climate Change: IPCC WG1 Third Assessment Report*, Cambridge University Press.

Rowley DB, Pierrehumbert RT and Currie BS 2001: A new approach to stable isotope-based paleoaltimetry: implications for paleoaltimetry and paleohypsometry of the High Himalaya since the Late Miocene. *Earth and Planetary Science Letters* **188** ,253-268.

Poulsen CJ, Pierrehumbert RT, and Jacob RL 2001: Impact of ocean dynamics on the simulation of the Neoproterozoic Snowball Earth; *Geophysical Research Letters* , **28** ,1575-1578.

Hu Y and Pierrehumbert RT 2001: The Advection-Diffusion Problem for Stratospheric Flow: Part II. Probability distribution function of tracer gradients. *J. Atmos. Sci.* **59**, 2830-2845.

Hu Y and Pierrehumbert RT 2001: The Advection-Diffusion Problem for Stratospheric Flow: Part I. Concentration probability distribution function. *J. Atmos. Sci.* **58** ,1493-1510.

Ngan K and Pierrehumbert RT 2000: Spatially inhomogeneous and intermittent random advection. *Phys. Fluids* **12** , 822-834.

Pierrehumbert RT 2000: Climate change and the Tropical Pacific: The Sleeping Dragon Wakes. *Proc. Nat. Acad. Sci.* 97, 1355-1358.

Pierrehumbert RT 2000: Lattice models of advection-diffusion *Chaos* **10** , 61-74.

Pierrehumbert RT 1999: Huascaran $\delta^{18}O$ as an indicator of tropical climate during the Last Glacial Maximum. *Geophysical Research Letters* , **26** , 1341-1344.

Pierrehumbert RT 1999: Subtropical water vapor as a mediator of rapid global climate change. . in Clark PU, Webb RS and Keigwin LD eds. *Mechanisms of global change at millennial time scales* . American Geophysical Union:Washington, D.C. Geophysical Monograph Series **112** , 394 pp.

Boatto S and Pierrehumbert RT 1999: Dynamics of a passive tracer in a velocity field of four identical point vortices. *J. Fluid Mech* **394** , 137-174.

Pierrehumbert RT and Roca R 1998: Evidence for control of Atlantic subtropical humidity by large scale advection. *Geophysical Research Letters* 25, 4537-4540.

Pierrehumbert RT 1998: Lateral mixing as a source of subtropical water vapor. *Geophysical Research Letters* **25** , 151-154.

Forget, F and Pierrehumbert RT 1997: Warming Early Mars with carbon dioxide clouds that scatter infrared radiation. *Science* **278** , 1273 - 1276.

Pierrehumbert, RT and Erlick C 1997: On the scattering greenhouse effect of CO2 ice clouds. *J. Atmos. Sci* **55,** 1897-1903.

Pierrehumbert, RT 1996: Anomalous scaling of high cloud variability in the tropical Pacific. *Geophysical Research Letters* **23** , 1095-1098.

Swanson K and Pierrehumbert RT 1997: Lower-tropospheric heat transport in the Pacific storm track. *J. Atmos. Sci* **54** , 1533 - 1543 .

Emanuel, K and Pierrehumbert, RT 1996: Microphysical and dynamical control of tropospheric water vapor. in *Clouds, Chemistry and Climate*, Nato ASI Series **35**. Springer:Berlin, 260pp.

Pierrehumbert, RT 1996: Some remarks on mechanisms for the regulation of tropical sea surface temperature. in *Clouds, Chemistry and Climate*, Nato ASI Series **35**. Springer:Berlin, 260pp.

Held, I. M. , Pierrehumbert, R. T. , Garner, S.T. and Swanson, K.L. 1995: Surface quasi-geostrophic dynamics. *J. Fluid Mech* **282** , 1-20.

Vainshtein, S. I Sreenivasan, K.R., Pierrehumbert, R. T. , Kashyap, V., and Juneja, A. 1994: Scaling exponents for turbulence and other random processes and their relationships with multifractal structure. *Phys. Rev* . **E50,** 1823-1835.

Swanson, K. and Pierrehumbert, R. T. 1995: Potential Vorticity Homogenization and Stationary Waves. *J. Atmos. Sci* **52** , 990 - 994.

Pierrehumbert, R. T. 1995: Thermostats, Radiator Fins, and the Local Runaway Greenhouse. *J. Atmos. Sci.* **52** , 1784-1806.

Pierrehumbert, R.T. and K.L Swanson 1995: Baroclinic Instability *Ann. Rev. Fluid Mech* . **27** , 419-467.

Yang, H. and Pierrehumbert, R. T. 1994: Production of dry air by isentropic mixing. *J. Atmos. Sci* . **51** , 3437-3454.

Pierrehumbert, R. T., Held, I.M. and Swanson, K. 1994: Spectra of local and nonlocal two dimensional turbulence. *Chaos, Solitons and Fractals* , **4** , 1111-1116.

Pierrehumbert, R. T. 1994: On tracer microstructure in the large-eddy dominated regime. *Chaos, Solitons and Fractals* , **4** , 1091-1110.

Swanson, K. and Pierrehumbert, R. T. 1994: Nonlinear wave packet evolution on a baroclinically unstable jet. *J. Atmos. Sci* **51** , 384 - 396.

Pierrehumbert, R. T. and Yang, H. 1993: Global chaotic mixing on isentropic surfaces. *J. Atmos. Sci* **50** , 2462-2480.

Lin, S-J. and Pierrehumbert, RT 1992: Is the mid-latitude zonal flow absolutely unstable? *J. Atmos. Sci* **50** , 505 - 517.

Lamb, K. and Pierrehumbert, RT 1992: Steady state nonlinear internal gravity wave critical levels satisfying an upper radiation boundary condition. *J. Fluid Mech.* **238** , 371-404.

Pierrehumbert, R. T. 1992: Spectra of tracer distributions: A geometric approach. in *Nonlinear phenomena in atmospheres and oceans* , R. Pierrehumbert and G. Carnevale, eds. Springer-Verlag:New York 229pp.

Pierrehumbert, R. T. 1991: Chaotic mixing of tracers and vorticity by modulated travelling Rossby waves. *Geophys. Astrophys. Fluid. Dyn* . **58** , 285-320.

Pierrehumbert, R. T. 1991: Large scale horizontal mixing in planetary atmospheres. *Phys. Fluids A* , **3** ,1250-1260.

Pierrehumbert, R. T. 1991: Dimensions of Atmospheric Variability. in *Beyond Belief:Randomness, Prediction and Explanation in Science* . J. L. Casti and A. Karlqvist, eds. CRC Press:Boston, 110-142.

Carissimo, B.C., Pierrehumbert, RT, and H.L. Pham 1988: An estimate of mountain drag during ALPEX for comparison with numerical models. *J. Atmos. Sci* **45** , 1949-1960.

Bacmeister, J. T. and Pierrehumbert, RT 1988: On high drag states of nonlinear stratified flow over obstacles. *J. Atmos. Sci* **45** , 63 - 80.

Pierrehumbert, RT 1987: An essay on the parameterization of orographic gravity wave drag. in *Observation, theory and modelling of orographic effects* . European Center for Medium Range Weather Forecasting: Reading, England 1987.

Lin, S-J and Pierrehumbert, RT 1988: Does Ekman friction suppress baroclinic instability? *J. Atmos. Sci* **45** , 2920-2933.

Lin, S-J and Pierrehumbert, RT 1987: Absolute and convective instability of stratified shear flow. in *Proceedings of the 4th international symposium on stratified flow* , Caltech 1987 . Elsevier

Pierrehumbert, RT and J. Bacmeister 1987: On the realizability of Long's Model solutions for nonlinear stratified flow over obstacles. in *Proceedings of the 4th international symposium on stratified flow* , Caltech 1987 . Elsevier.

Lin, S-J and Pierrehumbert, RT 1987: Comment on "Richardson criteria for stratified vortex motions under gravity"; *Phys. Fluids* **30** 1231-1232.

Panetta, R.L., I. Held and Pierrehumbert, RT 1988: External Rossby waves in the 2-layer model. *J. Atmos. Sci* **44** , 2924-2933.

Pierrehumbert, RT 1986: A universal shortwave instability of two-dimensional eddies in an inviscid fluid. *Phys Rev Letters* **57** , 2157-2159.

Pierrehumbert, RT 1986: Spatially amplifying modes of the Charney baroclinic instability problem. *J. Fluid Mech* ., **170** , 293-317.

Pierrehumbert, RT 1986: Remarks on a paper by Aref and Flinchem. *J. Fluid Mech.* , **163** ,21-26.

Held, I., Pierrehumbert, RT, and R. L. Panetta 1986: Dissipative destabilization of external Rossby waves. *J. Atmos. Sci.* , **43** ,388-396.

Pierrehumbert, RT 1985: The effect of local baroclinic instability on zonal inhomogeneities of vorticity and temperature. *Adv. Geophysics* , **29** , 165-182.

Pierrehumbert, RT 1985: A theoretical model of orographically modified cyclogenesis. *J. Atmos. Sci.* , **42** , 1244-1258.

Pierrehumbert, RT 1986: Lee cyclogenesis. Chapter 13 of *Mesoscale Meteorology and Forecasting* , P. Ray ed. American Meteorological Society: Boston.

Held, I., R. L. Panetta and Pierrehumbert, RT 1985: Stationary external Rossby waves in vertical shear. *J. Atmos. Sci.* , **42** , 865-883.

Pierrehumbert RT, and B. Wyman 1985: Upstream effects of mesoscale mountains. *J. Atmos. Sci.* , **42** ,977-1003.

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Pierrehumbert RT 1985: Orographic distortion of fronts. *Revista di Meteorologia Aeronautica, Anno* **44** , 1234.

Pierrehumbert RT 1985: Formation of shear layers upstream of the Alps. *Revista di Meteorologia Aeronautica* , Anno **44** , 1234.

Pierrehumbert RT 1984: Local and global baroclinic instability of a zonally varying flow. *J. Atmos. Sci.* **41** , 2141-2162.

Pierrehumbert RT 1984: Linear results on the barrier effects of mesoscale mountains. *J. Atmos. Sci.* **41** , 1356-1367.

Pierrehumbert RT , and P. Malguzzi 1984: Forced coherent structures and local multiple equilibria in a barotropic atmosphere. *J. Atmos. Sci.* **41** , 246-257.

Pierrehumbert RT 1983: Bounds on the growth of perturbations to non-parallel steady flow on the barotropic beta plane. *J. Atmos. Sci.* **40** , 1207-1217.

Reinhold, B. B. and Pierrehumbert RT 1982: Dynamics of weather regimes: Quasi-stationary waves and blocking. *Mon. Wea. Rev.* **110** , 1105-1145.

Pierrehumbert RT , and S. E. Widnall 1982: The two and three dimensional instabilities of a spatially periodic free shear layer. *J. Fluid Mech.* **114** , 59-82.

Pierrehumbert RT , and S. E. Widnall 1981: The structure of organized vortices in a free shear layer. *J. Fluid Mech.* **102** , 301-313.

Pierrehumbert RT 1980: *The Structure and Stability of Large Vortices in an Inviscid Flow.* Ph.D. Thesis, Massachusetts Institute of Technology.

Pierrehumbert, R. T. 1980: A family of steady, translating vortex pairs with distributed vorticity. *J. Fluid Mech.* **99** , 129-144.