

## Curriculum Vitae for Ken Caldeira

### PRESENT POSITION

Senior Scientist  
Department of Global Ecology  
Carnegie Institution  
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Professor (by courtesy)  
Department of Environmental Earth System Sciences  
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### EDUCATION

Ph.D., 1991, New York University, Atmospheric Sciences, Department of Applied Science  
M.S., 1988, New York University, Atmospheric Sciences, Department of Applied Science  
B.A., 1978, Rutgers College, Philosophy

### PRIOR RESEARCH EXPERIENCE

Physicist/Environmental Scientist (Lawrence Livermore National Laboratory, 1995 to 2005) Research ocean carbon cycle, atmospheric CO<sub>2</sub>, ocean/sea-ice physics, climate, and energy systems  
Post-Doctoral Researcher (Lawrence Livermore National Laboratory; 1993 to 1995) Research the ocean carbon cycle, atmospheric CO<sub>2</sub> and climate  
NSF Earth Sciences Postdoctoral Fellow (Earth Systems Science Center & Dept. of Geosciences, The Pennsylvania State University; 1991 to 1993) Role of the carbonate-silicate cycle in long-term atmospheric CO<sub>2</sub> content and climate

### GENERAL RESEARCH INTERESTS

Ocean acidification; climate/carbon-cycle interactions; numerical simulation of climate and biogeochemistry; marine biogeochemical cycles; global carbon cycle; long-term evolution of climate and geochemical cycles; intentional intervention in the climate system; energy technology and policy

### ADVISORY PANELS / DISSERTATION COMMITTEES / ETC

Fellow of the American Geophysical Union (2010)  
National Academy of Sciences, America's Climate Choices Panel Member (2009)  
UK Royal Society Geoengineering Report Panel Member (2009)  
Global Carbon Project, Steering Committee Member (2009-present)  
European Project on Ocean Acidification (EPOCA), Advisory Board Member (2008-2012)  
Intergovernmental Oceanographic Commission, Representative at International Maritime Union Negotiations (2008, 2009)  
UK Royal Society Ocean Acidification Report Panel Member (2007)  
IPCC Special Report on CO<sub>2</sub> Capture and Storage, Oceans Chapter, Coordinating Lead Author (2005)  
US Delegation to climate-related negotiations leading up to G8 Summit, Technical Support (2005)  
UNESCO International Oceanography Commission CO<sub>2</sub> Panel of Experts (2002-2004)  
US Global Carbon Cycle Scientific Steering Group (2001-2004)  
Dissertation Committees of students at Stanford, MIT, and University of Illinois

### PRINCIPAL PUBLICATIONS

Bala, G., N Devaraju, RK Chaturvedi, K Caldeira, R Nemani (2013) *Nitrogen deposition: how important is it for global terrestrial carbon uptake?* **Biogeosciences Discussions**, 10, 11077-11109. doi: 10.5194/bgd-10-11077-2013

Bala, G., S Krishna, D Narayanappa, L Cao, K Caldeira, R Nemani (2013) *An estimate of equilibrium sensitivity of global terrestrial carbon cycle using NCAR CCSM4.* **Climate Dynamics**, 1-16. doi: 10.1007/s00382-012-1495-9

Caldeira, K., KL Ricke (2013) *Prudence on solar climate engineering.* **Nature Climate Change**, 3 (11), 941-941

Caldeira, K., NP Myhrvold (2013) *Projections of the pace of warming following an abrupt increase in atmospheric carbon dioxide concentration.* **Environmental Research Letters**, 8 (3), 034039

Caldeira, K., (2013) *Coral Bleaching: Coral refugia amid heating seas.* **Nature Climate Change**, 3, 444-445. doi: 10.1038/nclimate1888

Caldeira, K., G Bala, L Cao (2013) *The science of geoengineering.* **Annual Review of Earth and Planetary Sciences**, 41. doi: 10.1146/annurev-earth-042711-105548

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- Davis, S.J., L Cao, K Caldeira, MI Hoffert (2013) *Rethinking wedges*. **Environmental Research Letters**, 8, 011001. doi: 10.1088/1748-9326/8/1/011001
- Hsieh, W.C., WD Collins, Y Liu, JCH Chiang, CL Shie, K Caldeira, L Cao (2013) *Climate response due to carbonaceous aerosols and aerosol-induced SST effects in NCAR community atmospheric model CAM3.5*. **Atmospheric Chemistry and Physics Discussions**, 13, 7349-7396. doi: 10.5194/acpd-13-7349-2013
- Kravitz, B., K Caldeira, O Boucher, A Robock, PJ Rasch, K Alterskjaer, DB Karam, JNS Cole, CL Curry, JM Haywood, PJ Irvine, D Ji, A Jones, JE Kristjánsson, DJ Lunt, JC Moore, U Niemeier, H Schmidt, M Schulz, B Singh, S Tilmes, S Watanabe, S Yang, JH Yoon (2013) *Climate model response from the Geoengineering Model Intercomparison Project (GeoMIP)*. **Journal of Geophysical Research: Atmospheres**. doi: 10.1002/jgrd.50646
- Mackey, K.R.M., A Paytan, K Caldeira, AR Grossman (2013) *Effect of Temperature on Photosynthesis and Growth in Marine Synechococcus spp.* **Plant physiology**, 163 (2), 815-829
- MacCracken, M.C., HJ Shin, K Caldeira, GA Ban-Weiss (2013) *Climate response to imposed solar radiation reductions in high latitudes*. **Earth System Dynamics**, 4 (2), 301-315
- Ricke, K.L., JB Moreno-Cruz, K Caldeira (2013) *Strategic incentives for climate geoengineering coalitions to exclude broad participation*. **Environmental Research Letters**, 8, 014021. doi: 10.1088/1748-9326/8/1/014021
- Ricke, K.L., JC Orr, K Schneider, K Caldeira (2013) *Risks to coral reefs from ocean carbonate chemistry changes in recent earth system model projections*. **Environmental Research Letters**, 8, 034003. doi: 10.1088/1748-9326/8/3/034003
- Schneider, K., J Silverman, B Kravitz, T Rivlin, A Schneider-Mor, S Barbosa, M Byrne, K Caldeira (2013) *Inorganic carbon turnover caused by digestion of carbonate sands and metabolic activity of holothurians*. **Estuarine, Coastal and Shelf Science**, 133, 217-223
- Ban-Weiss, G.A., L Cao, G Bala, K Caldeira (2012) *Dependence of climate forcing and response on the altitude of black carbon aerosols*. **Climate Dynamics**, 38, 897-911. doi: 10.1007/s00382-011-1052-y
- Caldeira, K., (2012) *Avoiding mangrove destruction by avoiding carbon dioxide emissions*. **Proceedings of the National Academy of Sciences**, 109, 14287-14288. doi: 10.1073/pnas.1211718109
- Caldeira, K., (2012) *The Great Climate Experiment*. **Scientific American**, 307, 78-83. doi: 10.1038/scientificamerican0912-78
- Caldeira, K., NP Myhrvold (2012) *Temperature change vs. cumulative radiative forcing as metrics for evaluating climate consequences of energy system choices*. **Proceedings of the National Academy of Science**, 109, E1813. doi: 10.1073/pnas.1206019109
- Cao, L., G Bala, K Caldeira (2012) *Climate response to changes in atmospheric carbon dioxide and solar irradiance on the time scale of days to weeks*. **Environmental Research Letters**, 7, 034015. doi: 10.1088/1748-9326/7/3/034015
- Kline, D.I., L Teneva, K Schneider, T Miard, A Chai, M Marker, K Headley, B Opdyke, M Nash, M Valetich, JK Caves, BD Russell, SD Connell, BJ Kirkwood, P Brewer, E Peltzer, J Silverman, K Caldeira, RB Dunbar, JR Koseff, SG Monismith, BG Mitchell, S Dove, O Hoegh-Guldberg (2012) *A short-term in situ CO<sub>2</sub> enrichment experiment on Heron Island (GBR)*. **Scientific Reports**, 2. doi: 10.1038/srep00413
- Kravitz, B., DG MacMartin, K Caldeira (2012) *Geoengineering: whiter skies?* **Geophysical Research Letters**, 39.
- MacCracken, M.C., HJ Shin, K Caldeira, GA Ban-Weiss (2012) *Climate response to imposed solar radiation reductions in high latitudes*. **Earth System Dynamics Discussion**, 3, 715-757. doi: 10.5194/esdd-3-715-2012
- MacMartin, D.G., DW Keith, B Kravitz, K Caldeira (2012) *Management of trade-offs in geoengineering through optimal choice of non-uniform radiative forcing*. **Nature Climate Change**. doi: 10.1038/nclimate1722
- Marvel, K., B Kravitz, K Caldeira (2012) *Geophysical limits to global wind power*. **Nature Climate Change**, 3, 118-121. doi: 10.1038/nclimate1683
- Myhrvold, N.P., K Caldeira (2012) *Greenhouse gases, climate change and the transition from coal to low-carbon electricity*. **Environmental Research Letters**, 7, 014019. doi:10.1088/1748-9326/7/1/014019
- Pongratz, J., K Caldeira (2012) *Attribution of atmospheric CO<sub>2</sub> and temperature increases to regions: importance of preindustrial land use change*. **Environmental Research Letters**, 7, 034001. doi:10.1088/1748-9326/7/3/034001
- Pongratz, J., DB Lobell, L Cao, K Caldeira (2012) *Crop yields in a geoengineered climate*. **Nature Climate Change**, 2, 101-105. doi: 10.1038/NCLIMATE1373
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- Silverman, J., DI Kline, L Johnson, T Rivlin, K Schneider, J Erez, B Lazar, K Caldeira (2012) *Carbon turnover rates in the One Tree Island reef: A 40-year perspective*. **Journal of Geophysical Research: Biogeosciences** (2005–2012), 117. doi: 10.1029/2012JG001974

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- Ban-Weiss, G.A., Bala, L Cao, J Pongratz, K Caldeira (2011) *Climate forcing and response to idealized changes in surface latent and sensible heat*. **Environmental Research Letters**, 6, 034032. doi: 10.1088/1748-9326/6/3/034032
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- Devaraju, N., L Cao, G Bala, K Caldeira, R Nemani (2011) *A model investigation of vegetation atmosphere interactions on a millennial timescale*. **Biogeosciences Discussions**, 8, 8761. doi: 10.5194/bgd-8-8761-2011
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- MacMynowski, D.G., DW Keith, K Caldeira, HJ Shin (2011) *Can we test geoengineering?* **Energy & Environmental Science**, 4, 5044-5052. doi: 10.1039/c1ee01256h
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- Rau, G.H., KG Knäuss, K Caldeira (2011) *Capturing and Sequestering Flue-Gas CO<sub>2</sub> Using a Wet Limestone Scrubber*.
- Schneider, K., J Silverman, E Woolsey, H Eriksson, M Byrne, K Caldeira (2011) *Potential influence of sea cucumbers on coral reef CaCO<sub>3</sub> budget: A case study at One Tree Reef*. **Journal of Geophysical Research: Biogeosciences**, 116. doi:10.1029/2011JG001755
- Anderson, R.G., JG Canadell, JT Randerson, RB Jackson, BA Hungate, DD Baldocchi, GA Ban-Weiss, GB Bonan, K Caldeira, L Cao, NS Diffenbaugh, KR Gurney, LM Kueppers, BE Law, S Luyssaert, TL O'Halloran (2010) *Biophysical considerations in forestry for climate protection*. **Frontiers in Ecology and the Environment**, 9, 174-182. doi: 10.1890/090179
- Bala, G., K Caldeira, R Nemani (2010) *Fast versus slow response in climate change: implications for the global hydrological cycle*. **Climate dynamics**, 35, 423-434. doi: 10.1007/s00382-009-0583-y
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- Caldeira, K., DW Keith (2010) *The need for climate engineering research*. **Issues in Science and Technology**, 27, 57-62.
- Cao, L., G Bala, K Caldeira, R Nemani, G Ban-Weiss (2010) *Importance of carbon dioxide physiological forcing to future climate change*. **Proceedings of the National Academy of Sciences**, 107, 9513. doi: 10.1073/pnas.0913000107
- Cao, L., K Caldeira (2010) *Atmospheric carbon dioxide removal: long-term consequences and commitment*. **Environmental Research Letters**, 5, 024011. doi: 10.1088/1748-9326/5/2/024011
- Cao, L., K Caldeira (2010) *Can ocean iron fertilization mitigate ocean acidification?* **Climatic Change**, 99, 303-311. doi: 10.1007/s10584-010-9799-4
- Davis, S.J., K Caldeira (2010) *Consumption-based accounting of CO<sub>2</sub> emissions*. **Proceedings of the National Academy of Sciences**, 107, 5687-5692. doi: 10.1073/pnas.0906974107
- Davis, S.J., K Caldeira, HD Matthews (2010) *Future CO<sub>2</sub> emissions and climate change from existing energy infrastructure*. **Science**, 329, 1330-1333. doi: 10.1126/science.1188566
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- Archer, D., M Eby, V Brovkin, A Ridgwell, L Cao, U Mikolajewicz, K Caldeira, K Matsumoto, G Munhoven, A Montenegro, K Tokos (2009) *Atmospheric lifetime of fossil fuel carbon dioxide*. **Annual Review of Earth and Planetary Sciences**, 37, 117-134. doi:10.1146/annurev.earth.031208.100206
- Caldeira, K., (2009) *Geoengineering to Shade Earth*. **Worldwatch Institute, State of the World**, 96-8.
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- Langer, W.H., CA San Juan, GH Rau, K Caldeira (2009) *Accelerated weathering of limestone for CO2 mitigation: Opportunities for the stone and cement industries*. **Mining Engineering**, 61, 27
- Orr, J.C., K Caldeira, V Fabry, JP Gattuso, P Haugan, P Lehodey, S Pantoja, HO Pörtner, U Riebesell, T Trull, M Hood, W Broadgate (2009) *Research priorities for understanding ocean acidification: summary from the second symposium on the ocean in a high-CO2 world*. **Oceanography**, 22, doi: 10.5670/oceanog.2009.107
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- Silverman, J., B Lazar, L Cao, K Caldeira, J Erez (2009) *Coral reefs may start dissolving when atmospheric CO2 doubles*. **Geophysical Research Letters**, 36, L05606.
- Adams, E.E., K Caldeira (2008) *Ocean storage of CO2*. **Elements**, 4, 319-32. doi: 10.2113/gselements.4.5.319
- Archer, C.L., K Caldeira (2008) *Historical trends in the jet streams*. **Geophysical Research Letters**, 35. doi: 10.1029/2008GL033614
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- Caldeira, K., SJ Davis, L Cao (2008) *Will peak oil accelerate carbon dioxide emissions?* **AGU Fall Meeting Abstracts**, 1, 02.
- Caldeira, K., L Wood (2008) *Global and Arctic climate engineering: Numerical model studies* **Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences**, 366, 4039-4056. doi: 10.1098/rsta.2008.0132
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