

## DR. VAISHALI NAIK

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### Research Interests

Chemistry-Climate interactions, Atmosphere-Biosphere interactions, Global Earth System Modeling

### Education

<b>University of Illinois at Urbana-Champaign, Illinois</b> <i>Doctor of Philosophy</i> , Atmospheric Science	1999-2003
<b>University of Illinois at Urbana-Champaign, Illinois</b> <i>Master of Science</i> , Atmospheric Science	1996-1999
<b>University of Delhi, Delhi, India</b> <i>Bachelor of Science</i> , Chemistry with Honors	1992-1995

### Professional Experience

<b>Research Physical Scientist</b> NOAA Geophysical Fluid Dynamics Laboratory (GFDL)	2016-present
<b>Project Scientist</b> University Corporation for Atmospheric Research (UCAR)/NOAA GFDL	2011-2015
<b>Scientist</b> High Performance Computing Inc (HPTi)/NOAA GFDL	2009-2011
<b>Research Scientist (part-time)</b> Atmos Research and Consulting, Lubbock, TX	2008-2009
<b>Associate Research Scholar</b> Woodrow Wilson School, Princeton University Program in Atmospheric and Oceanic Sciences, Princeton University	2006-2007
<b>Postdoctoral Research Associate</b> Woodrow Wilson School, Princeton University	2003-2006
<b>Graduate Research Fellow</b> Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign	2000-2003
<b>Graduate Research Assistant</b> Department of Atmospheric Sciences, University of Illinois at Urbana-Champaign	1996-2000

### Honors

Highly Cited Researcher, Thompson Reuters / Clarivate Analytics	2018, 2019
NASA Graduate Student Fellowship in Earth System Science	2000-2003

### Professional Activities

- **Lead Author** on Chapter 6 (Short-lived Climate Forcers) and **Contributing Author** on Annex II of the Intergovernmental Panel on Climate Change Assessment Report 6 (IPCC-AR6) Working Group I, 2018-2021
- **AerChemMIP Scientific Steering Group Member**, September 2019-present

- **Organizing Committee Member**, Tri-MIP-athlon – the second joint AerChemMIP/RFMIP/PDRMIP Workshop in support of CMIP6, Princeton, NJ, June 12-14, 2019
- **Co-Lecturer**, NCAR ACOM-organized workshop on Fundamentals of Atmospheric Chemistry and Aerosol Modeling, Boulder, CO, August 13-15, 2018
- **Invited Expert**, Expert Meeting on Short-lived Climate Forcers (EM-SLCF), Geneva, Switzerland, May 28-31, 2018
- **Panelist**, Discussion on Model Biases and other Challenging Issues at the GFDL Fall Science Symposium, Princeton, NJ, November 2, 2017
- **Expert Reviewer** for the World Meteorological Organization (WMO) 2018 Scientific Assessment of Ozone Depletion Report, 2017
- **Expert Reviewer** for Hindu Kush Himalayan Monitoring and Assessment Programme (HIMAP), 2017.
- **Participant**, NOAA OAR Forum on Atmospheric Chemistry/Air Composition and Ecosystem Modeling, Silver Spring, MD, June 15-16, 2017
- **Contributing Author**, Fourth U.S. National Climate Assessment (NCA4), Air Quality Chapter, 2017-2018
- **Member**, GFDL Research Council, 2017-2018
- **Co-Lead** on Chapter 7 of the Tropospheric Ozone Assessment Report (TOAR), **Contributing Author** on Chapters 1 and 2, 2015-2017
- **Member**, GFDL Early Career Scientist Committee, 2015-2016
- **Contributing Author** to Chapter 11 (Near-term Climate Change: Projections and Predictability) and Annex II of the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC-AR5) Working Group I Climate Change 2013: The Physical Science Basis, 2013
- **Expert Reviewer** for second order draft of the IPCC-AR5 Working Group I, 2012.
- **Model PI and Analysis Co-Lead** on hydroxyl and methane lifetime in the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP), in support of the IPCC AR5 (2011-2013)
- **Member**, GFDL Computer User's Advisory Board (CUAB), 2010-2013
- **Participant**, Dissertations Initiative for the Advancement of Climate Change Research (DISCCRS II), March 26–April 2 2006, Pacific Grove, CA
- **Co-convenor** of special session in 2005 Joint Assembly, May 23-27, New Orleans, LA

#### Journal Referee

Atmospheric Chemistry and Physics, Earth Interactions, Environmental Science & Technology, Geophysical Research Letters, Global Environmental Change, Journal of Geophysical Research, Atmospheric Environment, Nature, Chemosphere, Chemical Society Reviews, and Current Pollution Reports

#### Proposal Referee

National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), American Association for the Advancement of Science (AAAS) on behalf of Indo-US Science and Technology Forum, Department of Energy (DOE), Environmental Protection Agency (EPA), and Swiss National Science Foundation (FNSNF)

#### Professional Society Membership

American Geophysical Union (AGU), Earth System Women's Network (ESWN), Sound Science Initiative of Union of Concerned Scientists

#### Advising/Teaching

##### Postdoctoral Scientists

- **Yuchao (Chloe) Gao**, Princeton University (2020-present)  
**Project:** Stratospheric Sulfur Aerosols in GFDL Earth System Model for assessing chemistry-climate impacts of aerosol injections
- **Jian He**, Princeton University (2017-2020) (*now at University of Colorado, Boulder/NOAA Chemical Sciences Laboratory*)  
**Project:** Drivers of trends and variability in atmospheric methane
- **Jordan Schnell**, Princeton University (2016-2017) (*now at University of Colorado, Boulder/NOAA Global Systems Laboratory*)  
**Project:** Air quality and climate extremes

##### Doctoral Student Dissertation Committee

- **Maryam Abdi-Oskouei** (Center for Global and Regional Environmental Research, University of Iowa), 2016-2018
- **Jean Guo** (Department of Earth & Environmental Sciences, Columbia University), 2015-2018
- **Meredith M. Fry**, Department of Environmental Sciences and Engineering, University of North Carolina, (2010-2013) (now at U.S.EPA)

#### Graduate Student Interns

- **Maryam Abdi-Oskouei** (Center for Global and Regional Environmental Research, University of Iowa), CICS Research Internship Fellow, Jun-Aug, 2016

#### Undergraduate Student Interns

- **Shaun Howe** (Department of Atmospheric Sciences and Meteorology, Cornell University), Jun-Aug 2015
- **Fernanda Ramos-Garces** (University of Puerto Rico at Mayagüez, Puerto Rico), NOAA Center for Atmospheric Sciences (NCAS) Summer Research Fellow, Jun-Aug 2013
- **Allison Stone**, Department of Geosciences, Princeton University, 2005-2006
- **Guest lecturer** for Global Biogeochemical Cycles, a graduate level course in the Department of Atmospheric Sciences

### Publications

#### *In Review*

Allen, R. J., L. W. Horowitz, **V. Naik**, ..., S. Fujimori and W. J. Collins, Significant climate benefits from near-term climate forcer mitigation in spite of aerosol reductions, submitted to *Environ. Res. Lett.*, 2020

Thornhill, G. D., W. J. Collins, R. J. Kramer, ..., **V. Naik**, ..., G. Zeng, and J. Zhang, Effective Radiative forcing from emissions of reactive gases and aerosols – a multimodel comparison, *Atmos. Chem. Phys. Discuss.*, in review, 2020

Griffiths P. T., L. T. Murray, G. Zeng, ..., **V. Naik**, ... P. J. Young, and P. Zanis, Tropospheric ozone in CMIP6 Simulations, *Atmos. Chem. Phys. Discuss*, in review, 2020

Thornhill, G., W. Collins, D. Olivie, ..., **V. Naik**, ..., S. Tilmes, and J Weber, Climate-driven chemistry and aerosol feedbacks in CMIP6 Earth system models, *Atmos. Chem. Phys. Discuss*, in review, 2020

#### *Peer-reviewed*

Archibald, A., J. L. Neu, Y. Elshorbany, ..., **V. Naik**, ..., H. M. Worden and G. Zeng, Tropospheric Ozone Assessment Report (TOAR): A critical review of changes in the tropospheric ozone burden and budget from 1850-2100, *Elementa*, accepted, 2020.

Stevenson, D. S., A. Zhao, **V. Naik**, F. O'Connor, S. Tilmes, G. Zeng, L. T. Murray, W. J. Collins, P. Griffiths, S. Shim, L. W Horowitz, L. Sentman, L. Emmons, Trends in global tropospheric hydroxyl radical and methane lifetime since 1850 from AerChemMIP, *Atmos. Chem. Phys.*, accepted, 2020

Turnock, S. T., R. J. Allen, M. Andrews, ..., **V. Naik**, ..., T. Wu, and J. Zhang, Historical and future changes in air pollutants from CMIP6 models, *Atmos. Chem. Phys.* accepted, 2020

Morgenstern, O., F. O'Connor, B. T. T. Johnson, ..., **V. Naik**, ..., D. T. Shindell, D. E. Kinnison, Reappraisal of the climate impacts of ozone-depleting substances, *Geophys. Res. Lett.*, 47, e2020GL088295. <https://doi.org/10.1029/2020GL088295>, 2020

R. J. Allen, S. Turnock, ..., **V. Naik**, ..., S. Fujimori, and W. J. Collins, Climate and air quality impacts due to mitigation of non-methane near-term climate forcers, *Atmos. Chem. Phys.*, 20, 9641–9663, <https://doi.org/10.5194/acp-20-9641-2020>, 2020

Peters, D. R., J. L. Schnell, P. L. Kinney, **V. Naik** and D. E. Horton, Public Health and Climate Benefits and Tradeoffs of U.S. Vehicle Electrification, *GeoHealth*, <https://doi.org/10.1029/2020GH000275>, 2020

Saunio, M., A. R. Stavert, ..., **V. Naik**, ..., Q. Zhu, and Q. Zhuang, The Global Methane Budget 2000-2017, *Earth Syst. Sci. Data*, *12*, 1561–1623, <https://doi.org/10.5194/essd-12-1561-2020>, 2020

L. W. Horowitz, **V. Naik**, F. Paulot, P. A. Ginoux, J. P. Dunne, J. Mao, J. Schnell, X. Chen, J. He, J. G. John, M. Lin, P. Lin, S. Malyshev, D. Paynter, E. Shevliakova, and M. Zhao, The GFDL Global Atmospheric Chemistry-Climate Model AM4. 1: Model Description and Simulation Characteristics, *JAMES*, <https://doi.org/10.1029/2019MS002032>, 2020

Dunne, J. P., L. W. Horowitz, ..., **V. Naik**, ... Y Zeng, and M. Zhao, The GFDL Earth System Model version 4.1 (GFDL-ESM 4.1): Overall coupled model description and simulation characteristics, *JAMES*, <https://doi.org/10.1029/2019MS002015>, 2020

Delworth, T. L., W. F. Cooke, ..., **V. Naik**, ..., L. Zhang, and M. Zhao, SPEAR: The Next Generation GFDL Modeling System for Seasonal to Multidecadal Prediction and Projection, *JAMES*, <https://doi.org/10.1029/2019MS0018952020>, 2020

He, J., **V. Naik**, L. W. Horowitz, E. Dlugokencky, and K. Thoning, Investigation of the global methane budget over 1980–2017 using GFDL-AM4.1, *Atmos. Chem. Phys.*, *20*, 805–827, <https://doi.org/10.5194/acp-20-805-2020>, 2020

Pu, B., P. Ginoux, ..., **V. Naik**, ... E. Shevliakova, and M. Zhao, Retrieving the global distribution of the threshold of wind erosion from satellite data and implementing it into the Geophysical Fluid Dynamics Laboratory land–atmosphere model (GFDL AM4.0/LM4.0), *Atmos. Chem. Phys.*, *20*, 55–81, <https://doi.org/10.5194/acp-20-55-2020>, 2020

Held, I. M., H. Guo, ..., **V. Naik**, ..., S. Underwood, and N. Zadeh, Structure and performance of GFDL's CM4.0 climate model, *JAMES*, *11*, 3691-3727, 2019

Schnell, J. L., **V. Naik**, L. W. Horowitz, F. Paulot, P. Ginoux, M. Zhao, and D. E. Horton, Air quality impacts from the electrification of light-duty passenger vehicles in the United States, *Atmos. Environ.*, *208*, 95-102, 2019.

Qin, Y., Y. Fang, X. Li, **V. Naik**, L. W. Horowitz, J. Liu, N. Scovronick, and D. L. Mauzerall, Source attribution of black carbon affecting regional air quality, premature mortality and glacial deposition in 2000, *Atmos. Environ.*, *206*, 144-155, 2019.

Ramaswamy, V., W. Collins, J. Haywood, J. Lean, N. Mahowald, G. Myhre, **V. Naik**, K. P. Shine, B. Soden, G. Stenchikov, and T. Storelvmo, Radiative Forcing of Climate: The Historical Evolution of the Radiative Forcing Concept, the Forcing Agents and their Quantification, and Applications, *Meteor. Monogr.*, *59*, 14.1–14.101. doi: <https://doi.org/10.1175/AMSMONOGRAPHS-D-19-0001.1>, 2018

Ocko, I., **V. Naik**, and D. Paynter, Rapid and reliable assessment of methane impacts on climate, *Atmos. Chem. Phys.*, *18*, 15555-15568, 2018.

Paulot, F., D. Paynter, P. Ginoux, **V. Naik**, and L. W. Horowitz, Changes in the aerosol direct radiative forcing from 2001 to 2015: observational constraints and regional mechanisms, *Atmos. Chem. Phys.*, *18*, 13265-13281, 2018.

Turner, A. J., I. Fung, **V. Naik**, L. W. Horowitz, and R. C. Cohen, Modulation of hydroxyl variability by ENSO in the absence of external forcing, *PNAS*, <https://doi.org/10.1073/pnas.1807532115>, 2018.

Rieder, H. E., A. M. Fiore, O. E. Clifton, G. Correa, L. W. Horowitz, and **V. Naik**, Combining model projections with site-level observations to estimate changes in distributions and seasonality of ozone in surface air over the U.S.A., *Atmos. Environ.*, <https://doi.org/10.1016/j.atmosenv.2018.07.042>, 2018

Schnell, J., **V. Naik**, L. W. Horowitz, F. Paulot, J. Mao, P. Ginoux, M. Zhao, and K. Ram, Exploring the relationship between surface PM2.5 and meteorology in Northern India, *Atmos. Chem. Phys.*, *18*, 10157-10175, 2018.

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- West, J. J., Y. Zhang, S. Smith, R. Silva, J. Bowden, **V. Naik**, Y. Li, D. Gilfillan, Z. Adelman, M. Fry, S. Anenberg, L. W. Horowitz, and J.-F. Lamarque, Cobenefits of global and domestic greenhouse gas emissions for air quality and human health, *The Lancet*, [http://dx.doi.org/10.1016/S0140-6736\(17\)31135-2](http://dx.doi.org/10.1016/S0140-6736(17)31135-2), 2017.
- Saunio, M., P. Bousquet, B. Poulter, A. Peregon, ..., **V. Naik**, ...B. Zhang, and Q. Zhu, Variability and quasi-decadal changes in the methane budget over the period 2000-2012, *Atmos. Chem. Phys.*, <https://doi.org/10.5194/acp-2017-296>, 2017
- Saunio, M., P. Bousquet, B. Poulter, A. Peregon, ..., **V. Naik**, ...B. Zhang, and Q. Zhu, The global methane budget 2000-2012, *Earth Syst. Sci. Data*, 8, 697-751, 2016.
- Westervelt, D. M., L. W. Horowitz, **V. Naik**, A. P. K. Tai, A. M. Fiore, and D. L. Mauzerall, Quantifying PM2.5-meteorology sensitivities in a global climate model, *Atmos. Environ.*, doi:10.1016/j.atmosenv.2016.07.040, 2016.
- Silva, R. A., J. J. West, J.-F. Lamarque, D. T. Shindell, W. J. Collins, S. Dalsoren, G. Faluvegi, G. Folberth, L. W. Horowitz, T. Nagashima, **V. Naik**, S. T. Rumbold, K. Sudo, T. Takemura, D. Bergmann, P. J. Cameron-Smith, I. Cioppi, R. M. Doherty, V. Eyring, B. Josse, I. A., MacKenzie, D. S. Plummer, M. Righi, D. S. Stevenson, S. Strode, S. Szopa, and G. Zeng, The effect of future ambient air pollution on human premature mortality to 2100 using output from the ACCMIP model ensemble, *Atmos. Chem. Phys.*, 16, 9847-9862, doi:10.5194/acp-16-9847-2016, 2016.

- Zhang, Y., J. H. Bowden, Z. Adelman, **V. Naik**, L. W. Horowitz, S. Smith, and J. J. West, Co-benefits of global and regional greenhouse gas mitigation on U.S. air quality in 2050, *Atmos. Chem. Phys.*, 16, 9533-9548, doi:10.5194/acp-16-9533-2016, 2016.
- Zhong, M., E. Saikawa, Y. Liu, **V. Naik**, L. W. Horowitz, M. Takigawa, Y. Zhao, N.-H. Lin, and E. A. Stone, Air quality modeling with WRF-chemv3.5 in East and South Asia: sensitivity to emissions and evaluations of simulated air quality, *Geosci. Model Dev.*, 9, 1201-1218, doi:10.5194/gmd-9-1201-2016, 2016.
- Schnell, J. L., M. J. Prather, B. Josse, **V. Naik**, L. W. Horowitz, G. Zeng, D. T. Shindell, and G. Faluvegi, Effect of climate change on surface ozone over North America, Europe, and East Asia, *Geophys. Res. Lett.*, 43, doi:10.1002/2016GL068060, 2016.
- Paulot, F., P. Ginoux, W. F. Cooke, L. J. Donner, S. Fan, M. Lin, J. Mao, **V. Naik** and L. W. Horowitz, Sensitivity of nitrate aerosols to ammonia emissions and to nitrate chemistry: Implications for present and future nitrate optical depth, *Atmos. Chem. Phys.*, 16, 1459-1477, doi:10.5194/acp-16-1459-2016, 2016.
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- Westervelt, D. M., L. W. Horowitz, **V. Naik**, and D. L. Mauzerall, Radiative forcing and climate response to projected 21st century aerosol decreases, *Atmos. Chem. Phys.*, 15, 12681-12703, doi:10.5194/acp-15-12681, 2015.
- Schnell, J. L., M. J. Prather, B. Josse, **V. Naik**, L. W. Horowitz, P. Cameron-Smith, D. Bergmann, G. Zeng, D. A. Plummer, K. Sudo, T. Nagashima, D. T. Shindell, G. Faluvegi, and S. A. Strode, Use of North American and European air quality networks to evaluate global chemistry-climate modeling of surface ozone, *Atmos. Chem. Phys.*, 15, 10581-10596, doi:10.5194/acp-15-10581, 2015.
- Fiore, A. M., **V. Naik**, and E. M. Leibensperger, Air quality and climate connections, *J. of Air & Waste Management*, 65:6, 645-685, doi: 10.1080/10962247.2015.1040526, 2015.
- Rieder, H. E., A. M. Fiore, L. W. Horowitz, and **V. Naik**, Projecting policy-relevant metrics for high summertime ozone pollution events over the Eastern United States due to climate and emission changes during the 21st century, *J. Geophys. Res.*, doi: 10.1002/2014JD022303, 2015.
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Silva, R. A., J. J. West, Y. Zhang, S. C. Anenberg, J.-F. Lamarque, D. T. Shindell, W. J. Collins, S. B. Dalsøren, G. Faluvegi, L. W. Horowitz, T. Nagashima, **V. Naik**, S. Rumbold, R. Skeie, K. Sudo, T. Takemura, D. Bergmann, P. Cameron-Smith, I. Cionni, R. M. Doherty, V. Eyring, B. Josse, I. A. MacKenzie, D. Plummer, M. Righi, D. S. Stevenson, S. Strode, S. Szopa, and G. Zeng, Global premature mortality due to anthropogenic outdoor air pollution and the contribution of past climate change, *Environ. Res. Lett.*, **8**, doi:10.1088/1748-9326/8/3/034005, 2013.

**Naik, V.**, L. W. Horowitz, A. M. Fiore, P. Ginoux, J. Mao, A. Aghedo, and H. Levy II, Impact of preindustrial to present day changes in short-lived pollutant emissions on atmospheric composition and climate forcing, *J. Geophys. Res.*, doi: 10.1002/jgrd.50608, 2013.

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### **Presentations**

Naik, V., Atmospheric Chemistry-Composition in GFDL Models, GFDL External Review, NOAA/GFDL, Princeton, NJ, October 29, 2019

Naik, V., Exploring Atmospheric Methane & OH Trends and Variability Using the GFDL Earth System Model (GFDL-AM4.1), Joint Atmospheric-Chemistry Seminar, Forschungszentrum Jülich, September 2, 2019

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Naik, V., Drivers of changes in global hydroxyl radical between 1980 and 2014, Tri-MIP-Athlon, University of Reading, Reading, UK, June 14, 2018.

Naik, V., Atmospheric Composition Changes relevant for Air Quality and Climate, Ocean and Climate Physics Seminar Series, Lamont-Doherty Earth Observatory, Palisades, NY, May 3, 2018.

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Naik, V., Methane in Global Chemistry-Climate Models, Environmental Engineering Departmental Seminar, University of Iowa, Iowa City, IA, December 9, 2016.

Naik, V., Uncertainties in the Methane Budget, Nicholas School of Environment Seminar Series, Duke University, Durham, NC, November 4, 2016.

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Naik, V., Effects of CFC and Halon replacements on Global Environment, Department of Atmospheric Sciences Seminar Series, University of Illinois, 1998.

### **Other Activities**

- **Board Member**, GFDL Employees Association (GFDLEA), 2016
- **Treasurer**, GFDL Employees Association (GFDLEA), 2010-2011.
- **Student Representative**, Department of Atmospheric Sciences, UIUC, 2001-2002.
- **Student Member**, Department of Atmospheric Sciences, UIUC, Admissions/Recruitment Committee, 2001-2002.