4.061 Using Multi-model Intercomparison and Aircraft Observations to Advance Constraints on the Methane Lifetime.

Early Career Scientist

Presenting Author:
Julie Nicely, NASA Goddard Space Flight Center, Greenbelt, MD, USA; Universities Space Research Association, Columbia, MD, USA, julie.m.nicely@nasa.gov

Co-Authors:
Eric Apel, National Center for Atmospheric Research, Boulder, CO, USA
William Brune, The Pennsylvania State University, University Park, PA, USA
Roisin Commane, Department of Earth and Environmental Sciences, Columbia University, Palisades, NY, USA
Bruce Daube, Harvard University, Cambridge, MA, USA
Makoto Deushi, Meteorological Research Institute (MRI), Tsukuba, Japan
Glenn Diskin, NASA Langley Research Center, Hampton, Virginia, USA.
Bryan N. Duncan, NASA Goddard Space Flight Center, Greenbelt, MD, USA
Clare M. Flynn, Department of Earth System Science, University of California, Irvine, CA, USA
Samuel R. Hall, National Center for Atmospheric Research, Boulder, CO, USA
Thomas F. Hanisco, NASA Goddard Space Flight Center, Greenbelt, MD, USA
Amund S. Haslerud, Center for International Climate and Environmental Research-Oslo (CICERO), Oslo, Norway
Rebecca S. Hornbrook, National Center for Atmospheric Research, Boulder, CO, USA
Patrick Jöckel, Institut für Physik der Atmosphäre, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Oberpfaffenhofen, Germany
Beatrice Josse, CNRM UMR 3589, Météo-France/CNRS, Toulouse, France
Douglas E. Kinnison, National Center for Atmospheric Research, Boulder, CO, USA
Andrew Klekociuk, Antarctica and the Global System Program, Australian Antarctic Division, Kingston, Australia; Antarctic Climate and Ecosystems Cooperative Research Centre, Hobart, Australia
Michael E. Manyin, NASA Goddard Space Flight Center, Greenbelt, MD, USA; Science Systems and Applications, Inc., Lanham, MD, USA
Kathryn McKain, National Oceanic and Atmospheric Administration, Boulder, CO, USA
David Miller, The Pennsylvania State University, University Park, PA, USA
Olaf Morgenstern, National Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand
Lee T. Murray, Department of Earth and Environmental Sciences, University of

Rochester, Rochester, NY, USA
Gunnar Myhre, Center for International Climate and Environmental Research-Oslo (CICERO), Oslo, Norway
Luke D. Oman, NASA Goddard Space Flight Center, Greenbelt, MD, USA
Jeff Peischl, National Oceanic and Atmospheric Administration, Boulder, CO, USA; Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, CO, USA
Giovanni Pitari, Department of Physical and Chemical Sciences, Universitá dell’Aquila, L’Aquila, Italy
Andrea Pozzer, Max-Planck-Institute for Chemistry, Air Chemistry Department, Mainz, Germany
Laura E. Revell, Institute for Atmospheric and Climate Science, ETH Zürich (ETHZ), Zürich, Switzerland; Bodeker Scientific, Christchurch, New Zealand
Eugene Rozanov, Institute for Atmospheric and Climate Science, ETH Zürich (ETHZ), Zürich, Switzerland; Physikalisch-Meteorologisches Observatorium Davos – World Radiation Center (PMOD/WRC), Davos, Switzerland
Thomas Ryerson, National Oceanic and Atmospheric Administration, Boulder, CO, USA
Ross J. Salawitch, University of Maryland, College Park, MD, USA
Andrea Stenke, Institute for Atmospheric and Climate Science, ETH Zürich (ETHZ), Zürich, Switzerland
Kane Stone, School of Earth Sciences, University of Melbourne, Melbourne, Australia; Massachusetts Institute of Technology, Cambridge, MA, USA
Susan Strahan, NASA Goddard Space Flight Center, Greenbelt, MD, USA; Universities Space Research Association, Columbia, MD, USA
Alexander Thames, The Pennsylvania State University, University Park, PA, USA
Chelsea Thompson, National Oceanic and Atmospheric Administration, Boulder, CO, USA; Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder, Boulder, CO, USA
Simone Tilmes, National Center for Atmospheric Research, Boulder, CO, USA
Holger Tost, Institute for Atmospheric Physics, Johannes Gutenberg University, Mainz, Germany
Kirk Ullmann, National Center for Atmospheric Research, Boulder, CO, USA
Daniel M. Westervelt, Lamont-Doherty Earth Observatory, Columbia University, Palisades, New York, USA; NASA Goddard Institute for Space Studies, New York, NY, USA
Guang Zeng, National Institute of Water and Atmospheric Research (NIWA), Wellington, New Zealand

Abstract:

Advances in methods using machine learning enable us to systematically quantify the factors that cause differences in tropospheric hydroxyl radical abundances and methane

lifetime between atmospheric models. We apply these methods to a larger group of models than ever before, 13 chemistry-climate models (CCMs) with free-running meteorology and 12 models that constrain their meteorological fields (i.e., specified dynamics or SD), using simulations conducted for the Chemistry-Climate Model Initiative (CCMI). Current analysis suggests the factors driving the largest differences in CH_4 lifetime within the free-running simulations are local O_3 concentration, the photolysis frequency of O_3 to $O(^1D)$ ($J(O^1D)$), and the abundance and partitioning of NO_x (=$NO+NO_2$). Analysis of the SD simulations for CCMI is currently underway, but past work showed that CO is also a top factor responsible for OH variations between models with constrained meteorology [Nicely et al., *JGR*, 2017]. In addition to sharing the latest results from the model intercomparison and compelling case studies of how these results can be applied, we also demonstrate how the machine learning approach can be adapted to include global-scale measurements. By incorporating observations from the Atmospheric Tomography Mission (ATom) aircraft campaign, we directly evaluate the impact of chemical and radiative biases within models that provide output at relatively high temporal frequency (30 minutes). Preliminary neural network analysis of the CAM-Chem and GEOSCCM models has been performed using data from ATom-1. Over the tropical Pacific ocean, differences in model versus observed local O_3 and CO drive the largest changes in OH from CAM-Chem, while $J(O^1D)$ and CO differences have the most influence on OH within GEOSCCM. Quantification of these findings, examination of additional flights and ATom deployments, and synthesis of these results will be presented.