Investigating Methane Trends and Variability Using the GFDL-AM4 Model and NOAA GMD Observations

J. He[1,2], V. Naik[2] and L. Horowitz[2]

[1]Program in Atmospheric and Oceanic Sciences, Princeton University, Princeton, NJ 08540; 609-452-5851, E-mail: Jian.He@noaa.gov
[2]NOAA Geophysical Fluid Dynamics Laboratory (GFDL), Princeton, NJ 08540

Large uncertainties persist in our understanding of the trends and variability in atmospheric methane (CH_4) over the past few decades. Bottom-up global Earth System Models (ESMs) that realistically simulate the physical, chemical, and biogeochemical processes characterizing the global methane cycle, and interactions and feedbacks between these processes are powerful tools for quantifying the global methane budget, its time evolution, and impacts on composition and climate. In this work, the representation of methane in the atmospheric chemistry model of ESM4 (AM4) has been improved with prescribed anthropogenic and natural emissions (Emis) and compared to that forced by methane concentrations as lower boundary conditions (Conc). We force the emission-driven simulation with anthropogenic methane emissions over the 1980-2014 from the Community Emissions Database System (CEDS) inventory developed in support of the Intergovernmental Panel on Climate Change (IPCC) - 6th Assessment Report. Our simulation with anthropogenic methane emissions increased by 30% is able to best capture the observed surface methane trend and variability (Figure 1) although there are moderate overpredictions, possibly indicating a problem in the emissions. Future work will focus on correcting these biases by optimizing the emissions and will explore the role of individual sources and sinks in driving methane variability by including a representation of methane isotopes in the model.

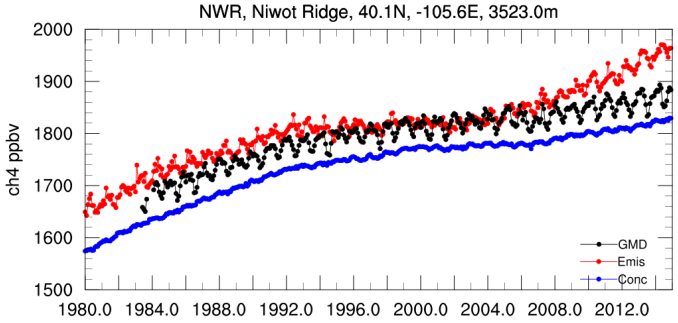

Figure 1. Comparison of surface methane dry mole fractions from GFDL-AM4 against ESRL/GMD surface observations at Niwot Ridge site. Black lines represent ESRL/GMD surface observations, blue lines represent simulated methane concentrations forced by prescribed concentrations as lower boundary condition (Conc), and red lines represent simulated methane forced by emissions (Emis).

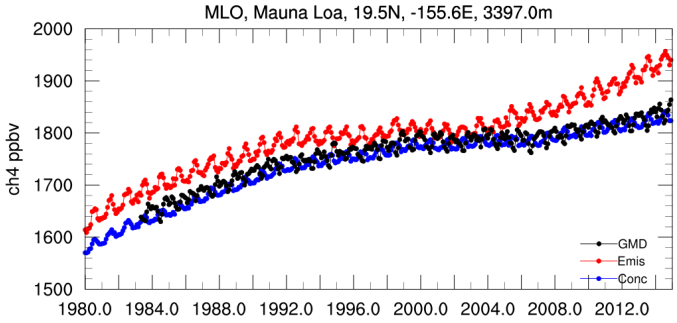

Figure 2. Comparison of surface methane dry mole fractions from GFDL-AM4 against ESRL/GMD surface observations at Mauna Loa site. Black lines represent ESRL/GMD surface observations, blue lines represent simulated methane concentrations forced by prescribed concentrations as lower boundary condition (Conc), and red lines represent simulated methane forced by emissions (Emis).