A11K-2704 - An Online Air-Sea Exchange Model Framework for Trace Gases powered by Machine-Learning

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Swirl Topics

Climate - SWIRL

Abstract

The ocean emits a wide range of trace gases, such as volatile organic compounds, or sulfur-, nitrogen-, and halogen-containing compounds. Many of these gases play critical roles in the atmosphere, including aerosol and cloud formation, tropospheric and stratospheric ozone budget, as well as the self-cleaning capacity of the atmosphere. Most chemistry-climate models use prescribed oceanic emissions (often derived from observations). These prescribed (offline) emissions generally do not respond to changes in local conditions. A process-level representation of the bi-directional oceanic emissions of trace gases remains challenging, mainly because the ocean biogeochemical processes controlling the natural synthesis of these compounds in the seawater remain poorly understood. We present a new online air-sea exchange framework for the NCAR CESM2, with an observationally trained machine-learning emulator to couple the ocean biogeochemistry with the air-sea exchange. This machine-learning based approach so far has been tested for a number of important trace gases, including dimethyl sulfide (DMS), acetone, bromoform ($CHBr_3$), and dibromomethane (CH_2Br_2), and the preliminary results are evaluated with observations around the globe. This new model framework is more skillful than the widely used top-down approaches for representing the seasonal/spatial variations and the annual means of atmospheric concentrations. The new approach improves the model predictability for the coupled earth system model, and can be used as a basis for investigating the future ocean emissions and feedbacks under climate change.

Authors

Siyuan Wang
National Center for Atmospheric Research

Louisa K Emmons
National Center for Atmospheric Research

Simone Tilmes
National Center for Atmospheric Research

Douglas Edward Kinnison
NCAR

Matthew C Long
National Center for Atm Res

J F Lamarque
NCAR

Eric C Apel
National Center for Atmospheric Research

Rebecca S Hornbrook
National Center for Atmospheric Research

Stephen A Montzka
NOAA/ESRL Global Monitoring Division

Alfonso Saiz-Lopez
Spanish National Research Council

Rafael Fernandez
Spanish National Research Council