CGD SEMINAR

NCAR

DATE: Tuesday 24 September, 2019

TIME: 11 am – 12 pm

LOCATION: NCAR, 1850 Table Mesa Drive
Mesa Lab, Main Seminar Room

TITLE: The seasonal cycle of sea-air CO2 fluxes in the Southern Ocean: diagnosing anomalies in CMIP5 Earth Systems Models

SPEAKER: Precious Mongwe, NCAR

ABSTRACT:

The Southern Ocean forms a vital component of the earth system as a sink of CO_2 and heat, taking over 40% of the annual oceanic CO_2 uptake (75% of global heat uptake). Recent studies based on the Coupled Model Intercomparison Project version 5 (CMIP5) Earth System Models (ESMs) show that CMIP5 ESMs disagree on the phasing of the seasonal cycle of the CO_2 flux (FCO_2) and compare poorly with available observed estimates in the Southern Ocean. Because the seasonal cycle is the dominant mode of variability for CO_2 and chlorophyll in the Southern Ocean, these biases raise important concerns about ESMs long-term projection skill in the Southern Ocean. This study is two parts; first, uses 10 CMIP5 models to investigate the mechanistic basis for the seasonal cycle of FCO_2 biases in these models. We find that FCO_2 biases in CMIP5 models can be grouped into two main categories, i.e., group-SST and group-DIC. Group-SST models are characterized by an exaggeration of the seasonal rates of change of Sea Surface Temperature (SST). These faster-than-observed rates of change of SST exaggerate the role of temperature-driven solubility in surface pCO_2 and FCO_2. While almost all analyzed models show these SST-driven biases, 3 out of 10 (namely NorESM1-ME, HadGEM2-ES, and MPI-ESM, collectively the group-DIC models) compensate the solubility bias because of their excessive primary production, such that biologically-driven DIC changes become primary regulators of the seasonal cycle of FCO_2 which also contrary to observed estimates. In the second part, 7 of the 10 are used to investigate what role these present climate seasonal cycle of CO_2 biases might play on the simulated (2090 - 2099) net CO_2 sink change and its driving mechanism under the RCP8.5 climate scenario. We find the analyzed models generally agree on the entire Southern Ocean CO_2 sink increase but disagrees on the mechanism driving the increased sink. Biological CO_2 uptake is the primary driver in group-DIC models linked to decreasing of the CO_2 buffering capacity, which also amplifies the FCO_2 seasonality. On the contrary, temperature-driven CO_2 solubility is the primary driver for group-SST models. This outcome highlights that CO_2 seasonality biases propagates to the end of the century and maybe an important uncertainty for predicting seasonal scale marine ecosystem anthropogenic impacts in the Southern Ocean.

Live webcast: http://ucarconnect.ucar.edu/live

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