SESSION: (B6) Frontiers in earth system prediction

(B6-02)

Integration of carbon cycle components into ESM-based prediction systems

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Advancement of ESM-based prediction systems by integrating the carbon cycle components enables predictions of variations of the ocean and land carbon sinks. This new knowledge is pivotal for predicting the Advancement of ESM-based prediction systems by integrating the carbon cycle components enables predictions of variations of the ocean and land carbon sinks. This new knowledge is pivotal for predicting the fate of anthropogenic CO2 emissions and for facilitating verification of near-term emission trends in support of the UNFCCC global stocktakes.

Such prediction systems are typically forced with prescribed historical atmo- spheric CO2 concentrations and assimilate only the physical climate data, albeit using different assimilation and initialization designs. The land and ocean carbon cycle models run as passive components adjusting to the state and the phase of the physical climate system.

Due to the lack of coherent biogeochemical datasets, recent studies mostly focused on the potential prediction skill of the carbon sinks. These perfect model studies provide mechanistic understanding of the sources of predictability of the carbon cycle variations with assessment of uncertainties. They furthermore suggest a large contribution of natural variability that take place in the background of the forced signal driven by rising CO2 emissions. Despite substantial uncertainties associated with quantitative estimates of yearly to decadal variations in the land and ocean carbon sinks, there is a robust potential prediction skill established in a number of prediction systems. For instance, potential prediction skill for land and ocean carbon sink is about 4 years (S´ef´erian et al. 2018) and regionally in the North Atlantic it is up to 7 years (e.g. Li et al., 2015).

Available observational synthesis products based on neural networks or satellite observations of land and ocean biogeochemistry enable assessment of the effective prediction skill. Moreover, newly emerging ocean and land biogeochemical measurements facilitate the development of novel carbon cycle initialization techniques.

It is becoming standard across several major modeling centers to include the land and ocean carbon cycle components into their decadal and seasonal prediction systems. Yet, these different prediction systems use various approaches regarding initialization, data assimilation, and spin up techniques. What are the implications of these different methodologies for the carbon cycle predictability? Furthermore, to date multi-model assessments are not yet available, but first isights from different prediction systems suggest consistent features of the carbon cycle predictability. What are the sources and time scales of predictability of the carbon cycle, as well as of the other biogeochemical variables in different prediction systems? These questions will be addressed in the context of carbon cycle predictions available from different ESM-based prediction systems..