Advanced studies of climate change projection –Area Theme 2: Biogeochemical modeling and climate simulations for carbon budget assessment

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The advanced studies of climate change projection, or SENTAN (abbreviation taken from its Japanese name), is a national project for climate change projection launched in June 2022. The program aims to improve our understanding of climate change mechanisms, reduce uncertainties, and create highly accurate projections that can be used as the scientific basis for developing climate change adaptation and mitigation measures. While the entire program deals with a wide range of natural scientific aspects and consequences of climate change, Area Theme 2 focuses on the development of a state-of-the-art Earth system model (ESM) incorporating biogeochemical processes with a particular emphasis on carbon budget assessment. Also in perspective is an exploration of interactions between climate change and human socio-economics. The IPCC Sixth Assessment Report (AR6), published in 2021, estimated that the remaining carbon budget for limiting global warming to below 1.5 ˚C is about 400–650 GtCO2 (33%–67% likelihood). The quantification of the carbon budget has substantial consequences for society but has very large uncertainty. Therefore, it is necessary to narrow the uncertainty as much as possible by increasing ESM sophistication and understanding the sources of uncertainty; nitrogen and nutrient cycles, for example, need to be incorporated into the conventional carbon cycle to improve our understanding of the dynamics of all the major greenhouse gases. Furthermore, hydroxyl (OH) radicals play a critical role in determining the lifetime of greenhouse gases such as methane but their past and future changes under the influence of anthropogenic pollutants remain a subject of debate, which in turn affects carbon budget estimate. To advance our understanding of the interactions between society and climate change, we will quantify the carbon budget and explore corresponding emission reduction pathways using a model suite that combines an ESM with a socioeconomic model. We will also focus on outreach, and our research findings can be used as a scientific basis for planning and decision-making, including supporting international negotiations on emission reductions and the Global Stocktake.

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