Japan Geoscience Union Meeting 2014
(28 April - 02 May 2014 at Pacifico YOKOHAMA, Kanagawa, Japan)

MIS31-P01 Room:Poster Time:May 2 16:15-17:30

Atmospheric Chemistry Transport Modeling of Organic Nitrogen Input to the Ocean

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Human activities for energy and food production have substantially perturbed the biogeochemical cycle of nitrogen (N) since the industrial revolution. The atmospheric emissions of N-containing compounds from fossil-fuel combustion, intensive agricultural activities, and other anthropogenic processes have substantially increased the supply of reactive N over the oceans downwind of major industrialized regions since 1860. The dominant reactive N species are emitted in the form of nitrogen oxide (NO) and ammonia (NH3) from fossil fuel combustion and agricultural practices, are transformed to a number of other nitrogen oxides (NOy) and ammonium (NHx) during the long-range transport, and then deposited to the oceans. Little is known about the chemical composition of organic N (ON) in the atmosphere or its spatial distribution, due to the limitations of available analytical methods. Over the North Atlantic, a significant fraction of the wet deposition of total soluble N has been measured in the form of soluble ON at coastal and marine locations. The effect of atmospheric ON input on marine ecosystems can either be helpful or harmful depending on the deposition rate and chemical form of ON. Dissolved ON such as urea, amino acids and humic substances can provide an important nutrient source to marine environments These studies suggest that atmospheric models need to predict the chemical speciation of reactive N species to accurately predict the effects of changes in N inputs on marine ecosystems and climate. Here we use a process-based chemical transport model to investigate global supply of soluble organic nitrogen (ON) from continental sources to the ocean.

Keywords: atmospheric deposition, soluble organic nitrogen, environmental changes

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Ecosystem sustainability of 2 degrees celsius scenario using BECCS

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Bioenergy with Carbon Capture and Storage (BECCS) is a key component of mitigation strategies in the future socio-economic scenarios to keep mean global temperature rise below 2 ℃ above pre-industrial, which would require net negative fossil fuel emissions in the end of the 21st century. Large scale BECCS requires additional production of biofuels, which could potentially cause substantial carbon emissions from the land-use change. Developing sustainable low carbon scenarios requires careful consideration of the land-use implications involving large scale BECCS.

We use a global terrestrial biogeochemical cycle model to evaluate effects of land-use change in RCP2.6, which is a scenario with net negative fossil fuel emissions aiming to keep the 2 ℃ temperature target used in CMIP5. We also use a global crop model to examine BECCS attainability in the land-use scenario of RCP2.6. In the evaluation, we consider deployment of bioenergy with both first-generation second-generation biofuels.

Our analysis reveals that first generation bioenergy crop production would not be sufficient to achieve the required BECCS of RCP2.6 scenario even if we consider the higher fertilizer and irrigation use cases. It would require more than doubling the area for bioenergy crops around 2050 assumed in RCP2.6, however, such scenarios implicitly induce large scale land-use changes that emit significant amount of carbon from deforestation.

Keywords: BECCS, land-use, crop yield, bioenergy

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Climate Restoration via Zero Emissions Stabilization: Examination using Earth System Models

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Zero-emissions stabilization is a newly proposed concept that targets reduction of CO_2 emissions to zero in a distant future, after which the atmospheric CO_2 concentration is reduced by a natural atmospharic CO_2 removal process, eventually allowing the atmosphere to reach an equilibrated stable state. The zero-emissions pathway, Z650, has been designed based on this concept as a flexible alternative toward a climate stabilization target. It allows cumulative emissions of 650 GtC during the 21st century and aims to attain zero emissions in the middle of the 22nd century. To confirm the decreases in CO_2 concentrations and temperature that would be achieved with the Z650 pathway, long-term climate and carbon cycle projections have been conducted up to the year 2300 by emission-driven experiment using the Earth system models, CESM1 and MIROC-ESM. Both the models show gradual decreases in the atmospheric CO2 concentration subsequent to the occurrence of temporal peaks of the concentration due to oceanic and terrestrial CO_2 uptakes. The models also project decreases in the globally averaged surface air temperature after the peak temperature increase. These results imply that the climate is eventually stabilized from a temporal warming state to less warmed under the zero emissions with the Z650 pathway. However, the experiments show considerably different increases in the peak concentration and temperature values, which are attributable to the different carbon and climate sensitivities.

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On the 6th phase of Coupled Model Intercomparison Project

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From 2013, when the 5th Assessment Report of IPCC WG1 was approved, scientists started discussion on framework of the next (6th) phase of Coupled Model Intercomparison Project (CMIP6). A couple of meetings were held in Aspen, USA in August and in Victoria, Canada in October to arrange a system for implementing CMIP6 protocol for global warming projection experiments. It has been suggested that CMIP6 will be jointly managed by multiple communities in a distributed manner. That is, the "traditional" CMIP community only manages fundamental experiments common to most modeling groups regardless of their specific interest, while other model intercomparison projects (MIPs) cover those specific to their interest: MIPs possibly include, among others, C4MIP for carbon cycle, PMIP for paleoclimate, and GeoMIP for Geoengineering. These activities as a whole will construct CMIP6. The above-mentioned fundamental experiments might include idealized experiments such as CO2 1%/y increase, and experiments based on scenarios with and without mitigation policy. According to the schedule currently proposed, the socio-economic scenarios will be developed by the end of 2015, experimental design will be mostly fixed in early 2016, and scenario experiments will be conducted by modeling groups from 2017, whereas those fundamental experiments can be started earlier.

Keywords: CMP6, IPCC, Global Warming Projection, Model Intercomparison Project, Socio-economic Scenario, Climate Model