Incorporation of sea level variation into a global river routing model and its impact assessment

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Global river routing models have been applied to river flood risk assessment such as in regions with poor data of topography observation, and global mapping of flood inundated areas and its interregional comparisons. In these years they have been developed in various research institutions around the world. However, since previous studies mainly focused on flood risk assessment in land areas, sea level variations have not been taken into consideration, and fluvial flood simulations in areas vulnerable to tides and storm surges have been underestimated.
The objective of this study is to elucidate the influence of sea level variation on fluvial flooding by employing a global river ruoting model capable of appropriately expressing the backwater effect, and a global reanalysis of tide and surge that was developed in recent years. First, we modified the river routing model to express sea level variation. Next, we developed a scheme for delivering sea level data from a global reanalysis of tide and surge to the global river routing model, conducted coupled simulation, and evaluated the influence.
Coupled simulation on the global scale revealed that river water levels increased by 0.5 m or more in comparison with the case without considering sea level variation. We found that the sea level fluctuation significantly affected fluvial flood simualtions. Time series of river water levels was analysed for large rivers with catchment areas larger than 160,000 km^2 in the Asian region. As a result, peak water levels increased by 1 m or more in some rivers, and the seasonal variation of river water levels were enhanced in others. In sum, it was clarified that sea level variation had a meaningful impact on fluvial flood simulations.

Keywords: Fluvial flooding, Storm surge, Global river routing model, Global reanalysis of tide and surge

Phosphorus in groundwater discharge to the ocean –A potential source for coral reef degradation

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Phosphorus, the main ingredient of fertilizer, is a limiting factor for sustainable primary production and is recognized as a major source for eutrophication of lakes, estuaries, and watersheds. Phosphorus in the water environment exists in various forms, and its transport form have been remained in many regions. Many sequential extraction methods have been proposed for morphological fractionation of phosphate in soil, but there are problems such as not being usable for morphological classification of polyphosphate and organic phosphorus. However, in recent years, One-dimensional (1D) solution 31P nuclear magnetic resonance spectroscopy (NMR) is currently the tool of choice for molecular-level characterization of organic P in soils 31P nuclear magnetic resonance spectroscopy (31P-NMR) as a morphological separation method of phosphorus in soil in fields such as soil fertilizer has been conducted. In this method, it is possible to classify phosphate in a form which was difficult to classify by the continuous extraction method.
In the present study, 31P-NMR and Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) are used to understand a characteristic of the transport form of phosphate in soil and groundwater. In addition, we estimated the phosphorus load through groundwater to the coral reefs sea region of Okinawa through field measurement and numerical simulations, and investigated the effect of phosphate on in vivo skeleton formation of primary polyp for hard coral Acropora digitifera.

Keywords: Phosphorus, 31P nuclear magnetic resonance spectroscopy, groundwater, coral reefs

Application of Hydro-debris2D into sediment yield prediction from mountain watershed

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Hydro-debris2D model has been developed and improved for predicting occurrence of debris flow throughout hydrological regime changes. The model contains three components: (1) Shallow-water based surface flow modules, in order to calculate mountain zone torrential flow regimes, (2) rapid subsurface/interflow in weathered rock, and (3) debris flow and sendiment-transport components. The model has been applied into Izu Oshima Island' s debris flow event in 2013 and to Hiroshima' s debris flow disaster in 2014. The model was applied into Shirakawa-basin which contains catchment of Aso Volcano. Landslides occur in more frequent manner compared with actual occurrence when projected observed precipitation. This is due to the application of over-estimated value which had been extracted from Hiroshima debris flow disaster.

Keywords: Hydro-debirs2D, sediment transport, mountain watershed

Introduction of the SWOT satellite altimetry mission

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SWOT (Surface Water and Ocean Topography) is a next-generation satellite altimetry mission by NASA and CNES to be launched in 2021, which will measure the spatial-temporal variation of water surface elevations of the land and ocean. Unlike conventional nadir altimeters which measures the elevation of water just below the spacecraft (e.g. Jason 1/2, Cryosat), SWOT is a "swath altimeter" which will observe the 2-dimentional distribution of water surface elevations using radar interferometer. With its 21-day sun-unsynchronized orbit, almost entire areas between N78 and S78 are to be measured without major gap by the observation swath of ~120km width. High-resolution (<100m) observations are planned over land to capture small rivers and lakes, whereas the observation over oceans will be at ~500m resolution mainly targeting mesoscale eddies.
Especially for hydrology, SWOT will be the first-ever comprehensive measurement of water surface elevations, as the spatial scales of rivers and lakes are much smaller than that of oceans. It will observe rivers wider than 100m and lakes and wetlands larger than 5ha with better than 10cm vertical accuracy, and will provide spatial and temporal distributions of surface water extent and storage. In addition to the directly-observable water surface elevations, by delineating water surface slope, SWOT is expected to estimate river discharge from space. The SWOT measurements, in combination with other ancillary datasets and models, will enhance our ability to assess the storage change in lakes and reservoirs, the occurrence of flood and draught, the dynamics of wetland and floodplain, at a global scale.
Toward its launch in 2021, tremendous efforts are ongoing for sensor development, error budget analysis, algorithm development, and ancillary data/model preparation. Overview of the SWOT mission, mainly focusing on hydrology components, will be presented during the JpGU-AGU joint meeting.

Keywords: SWOT, Satellite Altimetry, Surface Water, Sea Surface Height

A particle-in-cell modeling framework for simulating riverine and oceanic suspended sediment transport

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Suspended sediments contained in the river water (and glacial melt water) runoff is one of the primary source for the terrigenous trace elements supply to the ocean and hence it plays an important role in the marine material circulation and biogeochemical cycle. The transport, settling and re-suspension processes of sediment particles in the ocean are controlled by the interaction between the dynamics of individual particles depending on its composition and size-distribution and the complex current systems in the coastal regions. In particular, the suspended sediment concentration at the greater discharge events is several orders of magnitude greater than that in the normal time runoff. In such cases the existence of suspended sediments increases the apparent density of turbid runoff water, and thereby dynamically affects the current structure. In numerical ocean models, the suspended materials have been usually represented by the cell-volume averaged concentration in the Eulerian form as well as salinity and other dissolved materials. However, individual particle is settling with its own settling velocity relative to the ocean current primarily determined by its size and composition. Therefore, the bulk representation of Eulerian cell-averaged concentration has limitations to trace wider range of sediment size-distribution. To address this issue, we introduce a new particle-in-cell (PIC) type modeling framework to simulate oceanic dispersed multiphase flow such as the turbid river water discharge, where the dispersed suspended materials are represented by large number of Lagrangian particles. In the present model Lagrangian particles are solved at each time-step simultaneously with the time progress of the ocean current predicted by a finite-volume non-hydrostatic ocean model. The dynamical effects of the suspended particles are included by appending the sum of the contribution of particles existing inside each cell to the right hand side of the Navier-Stokes equation that predict the velocity at corresponding cell. In the presentation we introduce the detail of the implementation and the result of an idealized experiment on the formation of hyperpycnal flow.

Keywords: sedimient transport, Lagrangian particle tracking, non-hydrostatic ocean model, hyperpycnal flow

The dynamics of the freshwater discharge at the Ganges-Brahmaputra river mouth

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The Bay of Bengal receives significant freshwater input from the Ganges-Brahmaputra river. This freshwater discharge is observed with a prominent seasonal cycle, a minimum in late winter to early spring and a maximum in late summer to early fall. However, the river mouth of the Ganges-Brahmaputra river is a mega-delta and thus has multiple channels rather than just one. We have carried out regional numerical experiments utilizing a land-river-ocean seamless model to investigate the basic dynamics of how this river discharge events near the river mouth occur. On a large-scale, we find freshwater discharge to create river plumes along the coast and to establish a coastal current that flows southwestward when the oceanic currents are assumed quiescent. On a river mouth scale, however, the pathways of the freshwater discharge is complex. Preliminary analysis indicates that this is because of river-ocean interaction and that the various channels of the Ganges-Brahmaputra river delta are dynamically connected.

