# How does the Amur River discharge spread over the northwestern continental shelf in the Sea of Okhotsk?

*Humio Mitsudera[1], Ayumi Manome[2]

1.Institute of Low Temperature Science, Hokkaido University, 2.Cooperative Institute for Limnology and Ecosystems Research (CILER), University of Michigan

Iron is a micro-nutrient that is necessary for photosynthesis of the phytoplankton. It is now well known that the iron transported by the Amur River is deposited on the continental shelf in the northwestern shelf of the Sea of Okhotsk, and is then transported out to the intermediate layer of the Sea of Okhotsk; it further spreads to the western North Pacific and supports phytoplankton bloom there. Despite their significance in transporting dissolved and particulate iron, however, the paths of the Amur River discharge on the continental shelf in the Sea of Okhotsk are still unknown. In this study, we conduct a coupled ice-ocean simulation for the northern Sea of Okhotsk from June 1998 to September 2000 to answer a question: Can the Amur River discharge deposit materials to the pathway of the dense shelf water? In a series of numerical experiments, we identified two routes (the western and eastern routes) that could transport the river water more than 100 km offshore over the northwestern continental shelf. The two routes share the clockwise gyre in the Sakhalin Gulf and the northeastward flow on the northwestern continental shelf. These features are connected through the westward jet along the slope from the Sakhalin Gulf (the western route), and the northward transport over the shelf break canyon (the eastern route). The river water, the dense shelf water, and the easterly wind are in a fine geophysical balance for those features, and all are required for the formation of the two routes. The model results show these unique joint effects in the Sea of Okhotsk that allow the Amur River discharge to be effectively transported over the northwestern continental shelf, unlike a general river discharge that flows along the coast, and can deposits materials into the pathway of the dense shelf water.

Keywords: Amur River, Sea Ice Formation, Dense Shelf Water, Coastally Trapped Waves

# Geomorphological view of the aqueous history of Mars and candidates of current habitable environments

*Hideaki Miyamoto[1], James Dohm[1]

1.The University Museum, The University of Tokyo

Ancient Mars is now considered to have had an environment similar to that of Earth. This is often discussed in terms of the existence of large bodies of water, a wide range of surface oxidation states, an active dynamo and associated magnetic field, magmatism and tectonism including mountain building and basin formation, and a variety of chemical components that are potential building blocks of life. Similar to Earth, ancient Mars had hydrological cycling among atmosphere, ocean, and landmass (southern cratered highlands). Endogenic activities continued until recently, and recent water-related geological features indicate the prolonged existence of aquifer systems, where habitable environments may exist for a significant period. Occasional releases of volatiles from such aquifer systems may ultimately account for Curiosity rover detecting methane in the Gale crater and inconclusive results obtained with metabolism-detection instruments onboard Viking landers. Unequivocal evidence of the existence of subsurface aquifers or extant endogenic activity is, however, still lacking possibly due to the existence of homogeneous regolith materials covering the surface of Mars. Besides, even if a habitable environment exists at depth, accessing the environment with a spacecraft (either a lander or a rover) has been challenging because such an environment is generally thought to exist more than several kilometers below the Martian surface. Recent findings of a recurring slope lineae (RSL) point to traces of possible seasonal liquid water flows along slopes, findings that are likely to change the above prevailing view; some of these features might result from the partial discharges from an aquifer. In other words, RSLs might provide a natural bridge between a subsurface aquifer and the surface accessible by a rover. Thus, subsurface structures near such features are prime targets to be explored by future missions. Once the presence of groundwater is confirmed, especially an aquifer, mapping and characterizing the distribution of subsurface water would significantly help address the ever-important question of whether life exists on Mars.

Keywords: Mars, aqueous environment, geomorphology

# The SINTEX-F2 seasonal prediction system

*Takeshi Doi[1], Swadhin Behera[1], Toshio Yamagata[1]

1.JAMSTEC

The SINTEX-Frontier coupled general circulation model version 1 (SINTEX-F1) was developed within the EU-Japan collaborative framework to study global climate variability and its predictability. The seasonal prediction system based on the SINTEX-F1 has demonstrated its outstanding performance of predicting El Niño/Southern Oscillation (ENSO) and the Indian Ocean Dipole (IOD) since 2005. However, there is much room for improvement in predicting mid-latitude climate variations. To deal with this, we have developed a prototype of a new high-resolution version of SINTEX-F embedded with a dynamic sea-ice model, which we call SINTEX-F2. Similar to the SINTEX-F1 system, we have adopted the SST-nudging coupled initialization scheme as in the SINTEX-F2 system; model SSTs are strongly nudged toward daily observations by applying three large negative feedback values to the surface heat flux. Concerning large uncertainties in ocean vertical mixing estimations, ocean physics is perturbed in two different ways by considering or neglecting ocean vertical mixing induced by small vertical scale structures (SVSs) within and above the equatorial thermocline. Therefore, our ensemble prediction system takes into account uncertainties of both initial conditions and model physics. Preliminary analysis has shown that the SINTEX-F2 system shows the high skill in predicting ENSO just like the SINTEX-F1 system. In addition, we have found that the SINTEX-F2 system is much more skillful in predicting the Indian Ocean Subtropical Dipole. This may contribute to improving prediction skills of the regional rainfall distribution in Southern Africa.

Keywords: Seasonal prediction, Coupled general circulation model

# Development of an ocean-river-surface runoff seamless model

*Shinichiro Kida[1]

1.Japan Agency for Marine-Earth Science and Technology

The ocean receives significant amount of freshwater through river discharges. One of the challenges of regional-scale numerical ocean models is to capture this input of freshwater that often occurs spontaneously. Weather events are not well captured by monthly data sets that are publically available. The boundary between river water and oceanic water masses are also difficult to capture with a lateral boundary condition that is physically fixed in space. In order to simulate the movement of freshwater cycle from land to the ocean, we have developed an ocean-river-surface runoff seamless model based on an oceanic isopycnal model. This approach enables simulations of river discharge events based on precipitation data, which is more publically available in space and time, compared to river discharge data. The movement of water based is also solved with a same dynamical core. We previously demonstrated the capability of this new approach through validation of Abukuma river discharge event during a typhoon. We now extend this model to solve the rivers of main Japanese islands for various other rivers. Preliminary results show promising results, with multiple freshwater plumes forming at various river mouths of Japan, small to large, as the center of the typhoon moves from south to north.

Keywords: surface runoff, river discharge, oceanic model

# Role of central Pacific in Typhoon characteristics

*Swadhin Behera[1], Masato Yasuike[2], Takuji Waseda[2]

1.Climate Variation Predictability and Applicability Research Group, Application Laboratory, JAMSTEC, 3173-25 Showa-machi, Yokohama 236-0001, 2.OTPE, University of Tokyo, Tokyo

In this study, we have investigated the roles of climate variations in some of the typhoon characteristics of northwest Pacific. The influence of El Nino/La Nina on the east-west shift of the typhoon genesis region is well known. In El Niño years, stronger typhoons tend to approach Japan traveling long distances over warm oceans since the genesis region shift eastward during those years. Interestingly, it is also noticed here that the genesis region shifts northward during El Nino Modoki years (such as 2004) as compared to El Nino years. Therefore, it is found that more number of typhoons approach Japan during the El Nino Modoki years. On the other hand, composite analyses about oceanic conditions in the years of less number of typhoon genesis have indicated La Niña Modoki. It is also found that the distance of movement, lifetime and lowest pressure of typhoons are more related to central Pacific heat content compared to conventional ENSO indices.

Keywords: Typhoon, ENSO Modoki, Central Pacific

# How much is the precipitation amount over the tropical coastal region?

*Shin-Ya Ogino[1], Manabu D. Yamanaka[1], Shuichi Mori[1], Jun Matsumoto[1,2]

1.Department of Coupled Ocean-Atmosphere-Land Processes Research, Japan Agency for Marine-Earth Science and Technology, 2.Department of Geography, Tokyo Metropolitan University

Motivated by observational evidence of rainfall concentration near tropical coastlines with diurnal cycle, we quantified annual mean precipitation amount in the tropics (latitudes lower than 37º) obtained as a function of coastal distance, and compared them between land and ocean sides (Ogino et al., 2016). The data is from the Tropical Precipitation Measurement Mission (TRMM). Precipitation amount peaks at the coastline and decreases rapidly over a distance of 300 km from the coastline on both sides of the coastline (Fig. 1). The precipitation inside the “coastal region” (defined by distance <300 km from the coastline) accounts for approximately 34% of the total over the whole tropics, while that outside the coastal region accounts for 52% and 14% on the ocean and land sides, respectively. Since the coastal regions are about 29% of the total tropical areas, the precipitation per unit area inside the coastal regions is higher than that outside. Examining the grid number variation in the coastal regions with respect to the annual precipitation amount resulted in the finding that more than 90% of the annual precipitation with the amount of 3500 mm/yr or more occurs exclusively in the coastal regions, indicating that precipitation systems unique to coastal regions are needed for producing the highest annual precipitation on the Earth. The results above were obtained from the precipitation data over the whole tropics. The regional difference will be discussed in the presentation.

References

Ogino, S.-Y., M. D. Yamanaka, S. Mori, and J. Matsumoto (2016), How much is the precipitation amount over the tropical coastal region?, *J. Clim.*, *29*(3), 1231–1236, doi:10.1175/JCLI-D-15-0484.1., http://journals.ametsoc.org/doi/abs/10.1175/JCLI-D-15-0484.1

Keywords: Precipitation, Tropics, Coastal region

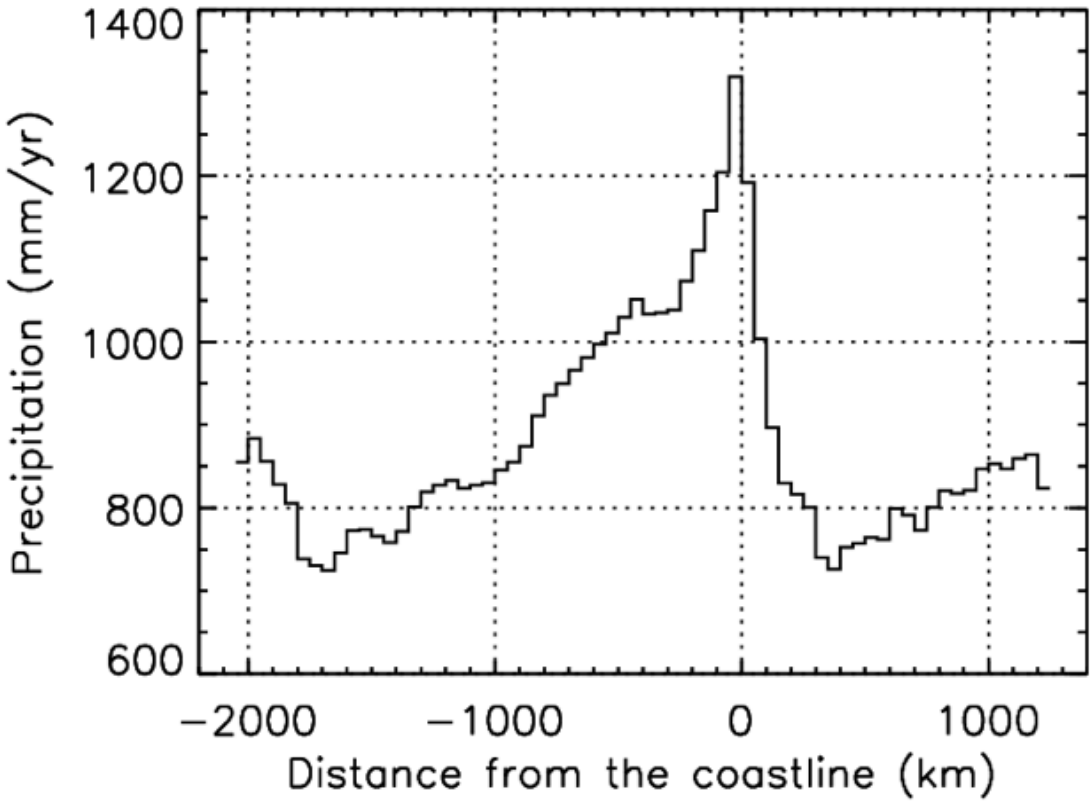



Figure 1. Relationship between precipitation amount and distance from the coastline.

# Space Activities and the United Nations Programme on Space Applications

*TAKAO DOI[1]

## 1.United Nations Office for Outer Space Affairs

Space exploration fires people’s imaginations. Since the first human spaceflight in 1961, over 500 explorers from different nations have ventured into space, motivated by curiosity, the drive for knowledge, and the belief that space exploration could benefit people on Earth. The involvement of a growing number of countries means that space exploration and the use of outer space are now truly global undertakings. Given the great importance of international cooperation in the peaceful exploration and use of outer space, the Committee on the Peaceful Uses of Outer Space (COPUOS) fills the need for an intergovernmental platform at the global level in this regard.
The United Nations Programme on Space Applications was established in 1971 and has made substantial progress in fostering knowledge of and experience related to space applications around the world. The activities of the Programme are carried out by the Office for Outer Space Affairs, with the annual endorsement of COPUOS. The mission of the Programme is to enhance the understanding and subsequent use of space technology for peaceful purposes in general, and for national development in particular, in response to expressed needs in different geographic regions of the world.
The overall strategy of the Programme is to focus on selected areas that are critical for developing countries. Those priority areas of the Programme are: (a) environmental monitoring; (b) natural resource management; (c) satellite communications for tele-education and telemedicine applications; (d) disaster risk reduction; (e) development of capabilities in the use of global navigation satellite systems; (f) the Basic Space Science Initiative, including the International Space Weather Initiative; (g) climate change; (h) the Basic Space Technology Initiative; (i) the Human Space Technology Initiative; and (j) biodiversity and ecosystems.
The docking of the Apollo and Soyuz spacecraft in 1975 was the first international human space mission. Since 2000, a multinational permanent human presence in outer space has been maintained onboard the International Space Station (ISS). Since the beginning of the construction of the ISS, the Programme has invited experts to address topics such as the utilization of the ISS to provide benefits on Earth, and to discuss opportunities for developing countries to participate in research activities conducted on the ISS.
In addition, the need for capacity-building in space science and technology and their applications has increased in many non-spacefaring countries. In response to the interest expressed by many countries, the Programme considered activities related to human space flight and exploration, which led to the launch of the Human Space Technology Initiative (HSTI) in 2010.
HSTI is aimed at raising awareness among countries of the benefits of utilizing human space technology and its applications and at involving more countries in activities related to human space exploration through international cooperation, to make space exploration a truly international effort. The role of HSTI in these efforts consists of providing a platform to exchange information, to foster collaboration between partners from spacefaring and non-spacefaring countries and to encourage emerging and developing countries to take part in space research and to benefit from space applications.

Keywords: Space Activities, United Nations Programme on Space Applications, International Space Station

# Forcing mechanism controlling the variability of circulations and associated larval transport in the Seto Inland Sea, Japan

*Yusuke Uchiyama[1], Taichi Kosako[1,2], Satoshi Mitarai[3]

1.Graduate School of Engineering, Kobe University, 2.Port and Airport Research Institute, 3.Okinawa Institute of Science and Technology Graduate University

Oceanic currents in the Seto Inland Sea (SIS), Japan, are mainly driven by tides, density and sea-surface wind. It has been reported that fluctuating Kuroshio path situated south of the SIS also plays a significant role in development of the mean circulation in the entire SIS. Hence dispersal patterns of material, such as larvae, nutrient and toxic substances, are substantially influenced by this overall circulation. Evaluation of effects of the circulation on material transport leads to further elucidation of the marine ecosystem and desirable marine environment in the SIS. In the present study, seasonal and interannual variability of larval dispersal in the entire SIS and effects of each forcing factor on the dispersal patterns are examined in detail with a multiple-year oceanic reanalysis based on a JCOPE2-ROMS double nested downscaling system along with a Lagrangian particle tracking submodel. The model results are compared with observations of temperature and salinity, tidal elevation and current in the SIS, and the Kuroshio path to demonstrate a good agreement.
Lagrangian PDFs are exploited to illustrate larval dispersal. In summer, the larvae in several regions are trapped by convergent cyclonic gyres locally-developed around dome-shaped bottom cold water mass, referred to as cold dome. In winter, southwestward Ekman transport have a prominent influence on dispersal of the larvae released from Iyo Sea, whereas the clockwise circulation associated with northwesterly monsoon rather than the transient Kuroshio path predominantly transports the larvae released from Harima Sea towards Kii Channel. However, the fluctuating Kuroshio is found to largely affect inter-annual variability of larval dispersal. When the Kuroshio path is located close to Cape Ashizuri, the clockwise mean circulation is enhanced in the entire SIS, promoting eastward transport of larvae in Harima Sea.

Keywords: Seto Inland Sea, Kuroshio-induced through flow, larval dispersal, JCOPE2-ROMS oceanic downscaling

# Evaporation from forest during rainfall: a basic principle of moisture transport from the ocean to inland continent

*Shigeki Murakami[1]

1.Tohkamachi Experimental Station, Forestry and Forest Products Research Institute

## Introduction

Evaporation of canopy interception $I$ accounts for some 20% of rainfall. Because of $I$, evapotranspiration ET from forest is larger than any other surfaces on our planet. However, the amount of $I$ estimated by the heat balance equation sometimes severely underestimates the observed values, which has been an enigma. Murakami[1)] proposed that $I$ is not evaporation from wet canopy surface but evaporation of splash droplets of raindrops. The objective of the present study is 1) to try to prove splash droplet evaporation (SDE) hypothesis based on measurements, and 2) to combine $I$ with the biotic pump theory[2)] that presumes precipitation in the inland of a forested continent is driven by ET of forest.

## Methods

Artificial Christmas trees were arranged on a tray and were placed outside under the natural rainfall[3)]. Drainage from the tray as net rainfall $P_N$ and the weight of a single tree to calculate water storage on canopy $S$ were measured. Gross rainfall $P_G$ and $P_N$ were measured with a 5-minutes interval and $S$ was a 1-minute interval. Separation time of rainfall $Spt$ that divides rainfall into each individual rain event was set at 6 hours. The storm break time $Sbt$ is defined as an intra-storm separation time and was set at 20 minutes, which divides a rain event into sub-rain events, i.e. 20 minutes $\leq Sbt <$ 6 hours $\leq Spt$. $I$ during $Sbt$ is defined as $I_{Sbt}$, $I$ after rainfall ceases as $I_{Aft}$, and $I$ during rainfall when rainfall is observed as $I_R$. $I_R$ and $I_{Sbt}$ can be calculated using $P_G$, $P_N$ and $S$, while $I_{Aft}$ is derived from $S$ only.

## Results and discussion

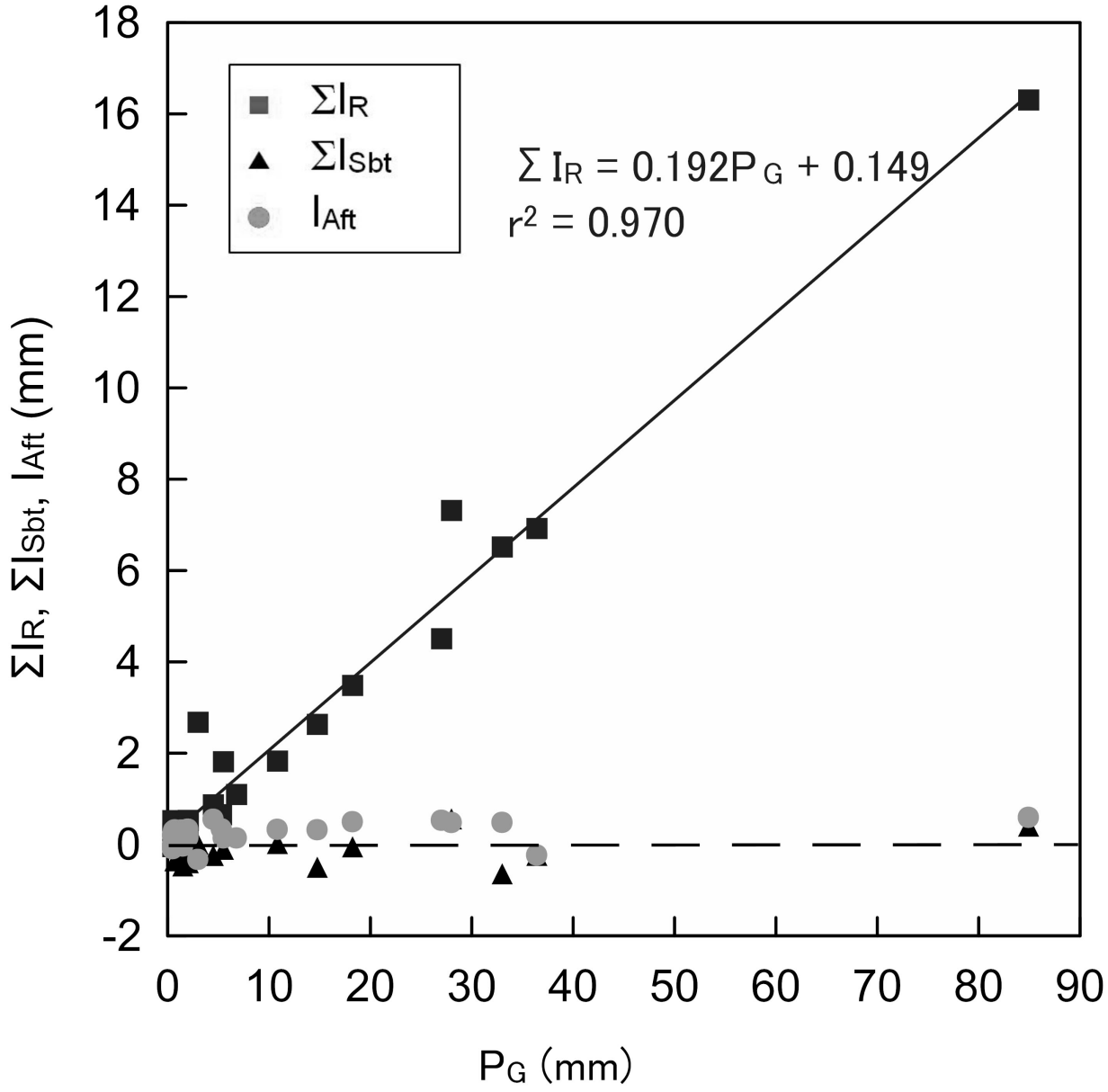
Figure shows $\Sigma I_R$, $\Sigma I_{Sbt}$, and $I_{Aft}$ against $P_G$ on a rain event basis for a Christmas tree stand. $I_R$ and $I_{Sbt}$ are shown as the sum of the values since the rain event usually consists of plural sub-rain events. For $P_G >$ 5 mm $I_{Aft} \approx$0.5 mm, while $\Sigma I_{Sbt}$ is almost zero. It is clear that $\Sigma I_R$ is proportional to $P_G$. For the largest rain event in Figure (below is called Rain event A) $P_G$, $\Sigma I_R$, $\Sigma I_{Sbt}$ and $I_{Aft}$ were 84.9 mm, 16.6 mm, 0.5 mm and 0.4 mm, respectively. The largest sub-rain event in Rain event A recorded during nighttime with $P_G$ of 59.6 mm, $\Sigma I_R$ of 11.6 mm and an evaporation rate of 1.91 mm/h. The results strongly suggest that rainfall *per se* drives evaporation during rainfall, i.e. SDE. Makarieva et al. (2013)[2)] showed precipitation does not decline with increasing distance from the coast in the continent over thousands of kilometers, if it is covered with forest, and vice versa. They presume that large ET of forest sucks water vapor from the ocean, which is called “the biotic pump”. They also proposed a principle that condensation of water vapor circulates air due to reduction in volume. Their theory can explain removal of water vapor from the canopy and supply of latent heat for $I_R$. As is well known the cause of large ET in forest is $I$ and SDE is the main mechanism of $I$. That is to say, SDE is the basic principle of the biotic pump.

## References

1) Murakami 2006 J Hydrol 319, 72-82.
2) Makarieva et al. 2013 Theor Appl Climatol 111: 79-96.
3) Murakami and Toba 2013 Hydrol Res Let 7: 91-96.

Keywords: Canopy interception, Splash droplet, Biotic pump



# Coastal ocean processes responsible for radionuclide dispersion: A case study for Seto Inland Sea and Enshu-nada

*Yukio Masumoto[1], Daisuke Tsumune[2], Xinyu Guo[3], Yusuke Uchiyama[4], Yasumasa Miyazawa[5]

1.Graduate School of Science, The University of Tokyo, 2.Central Research Institute of Electric Power Industry, 3.Ehime University, 4.Graduate School of Engineering, Kobe University, 5.Japan Agency for Marine-Earth Science and Technology

Results from four different numerical models of radiocesium dispersion are compared in terms of key physical processes responsible for the dispersion. Two regions are selected as typical oceanic conditions of coastal region around Japan. One is the Seto Inland Sea, which can be considered as a semi-closed basin connecting to the open ocean through several passages, and the other is Enshu-nada, where open ocean influences may directly affect coastal region. Results indicate that, in addition to tidal residual currents, local wind forcing and isolated cold water in the deeper layer affect surface flow pattern and radiocesium dispersion in the Seto Inland Sea. On the other hand, intrusion of Kuroshio and a narrow eastward flow along the coast play important role in dispersion processes in the Enshu-nada area.

Keywords: coastal ocean processes, radionuclide dispersion

# Introduction of canopy component into Isopycnal-layered model for hydrological calculation

*Yosuke Yamashiki[1], Manisha Maharjan[2], Minoru Yoneda[2], Shinichiro Kida[3]

1.Global Water Resources Assessment Laboratory - Yamashiki Laboratory Graduate School of Advanced Integrated Studies in Human Survivability Kyoto University, 2.Graduate School of Science, Kyoto University, 3.JAMSTEC

Isopycnal-layered model (Kida and Yamashiki, 2014) was proven to be an innovative river-ocean interactive model capable for handling both land-ocean and ocean-land interaction without creating specific physical component. According to their modeling, calculated discharge at each subbasin showed good agreement with gauged data without making any specific adjustment. At the same time, the original model was, since established for oceanographic usages, no component was prepared to trace hydrological processes.
In this study, we introduced how to develop basic hydrological component in the model and performed several testing calculation comparing the original model output and revised model scheme. The infiltration ratio and storage ratio in each canopy is set and included in hydrological processes in forest zone.
By introducing this basic hydrological component, this Isopycnal-layered model can be applicable for all different basins with minimum requirement (DEM and Land-use), which may facilitate significantly for the continental-oceanic integrated calculation.

Keywords: Isopycnal-layered model, Canopy model