ACM 2017

ASIAN CONFERENCE ON METEOROLOGY 2017 (ACM2017)

S2A Presentation

S2A-1 (Invited Talk)

Medium-range forecasts with a non-hydrostatic global atmospheric model on a cubed sphere grid

Song-You Hong (Korea Institute of Atmospheric Prediction Systems)
Young-Cheol Kwon (Korea Institute of Atmospheric Prediction Systems)
Kyung-Hee Seol (Korea Institute of Atmospheric Prediction Systems)
Suk-Jin Choi (Korea Institute of Atmospheric Prediction Systems)
In-Hyeok Kwon (Korea Institute of Atmospheric Prediction Systems)
Tae-Hun Kim (Korea Institute of Atmospheric Prediction Systems)
Rae-Seol Park (Korea Institute of Atmospheric Prediction Systems)
Dong-Il Kim (Korea Institute of Atmospheric Prediction Systems)

Korea Institute of Atmospheric Prediction Systems (KIAPS), Seoul, Korea, has embarked a national project in developing a new global forecast system in 2011. The ultimate goal of this 9-year project is to replace the current operational model at Korea Meteorological Administration (KMA), which was adopted from the United Kingdom's Meteorological Office's model. Since July 2015, the test version of the KIAPS Integrated Model (KIM) system that consists of a spectral element non-hydrostatic dynamical core on a cubed sphere and a revised physics package that has been updated every three months has been running in a real-time testbed, with a standard data assimilation of 3-D Var. In 2017, the updated KIM with the advanced 4-D Envar at about 12-km has been launched and its performance and operational deployment schedule will be presented.

S2A-2

Development of a suit of EarthCARE algorithms for cloud studies: Beyond CloudSat and CALIPSO

Hajime Okamoto (Kyushu University)
Kaori Sato (Kyushu University)
Shuichiro Katagiri (Kyushu University)
Hiroshi Ishimoto (Meteorological Research Institute, JMA)
Anatoli Borovoi (V.E. Zuev Institute of Atmospheric Optics)

Japan Aerospace Exploration Agency (JAXA) and European Space Agency (ESA) joint mission, the Earth Clouds, Aerosol and Radiation Explorer (EarthCARE) satellite, will be launched in 2019. The objectives of the mission are to provide global distribution of macroscale and microphysical properties of clouds, aerosols, precipitations and radiative properties from them. Following four sensors will be deployed in the mission; 94GHz-cloud profiling radar (CPR) with Doppler function, 355nm-high spectral resolution lidar (ATLID), multiple spectral imager (MSI) and broad band radiometer (BBR) [Illingworth et al., 2015]. We develop a suite of EarthCARE algorithms to retrieve cloud properties, i.e., CPR-only, CPR-ATLID synergy and CPR-ATLID-MSI synergy algorithms.

CloudSat and CALIPSO satellites were launched in 28 April 2006 and have still been operational after 10 years. Aqua, CloudSat and CALIPSO satellites are flying in tandem and their equatorial crossing time is about 1:30 PM to allow them to observe same clouds and aerosol at same place and close time. CloudSat carries the first 94GHz cloud radar to measure radar reflectivity factor. CALIPSO carries the first polarization lidar that offers attenuated backscattering coefficient at 532nm and depolarization ratio at 532nm. Because of the similarities between the EarthCARE and A-train satellites, we started development of algorithms by using A-train data. There are three categories for algorithms; (1) Cloud mask (KU-mask)[Hagihara et al., 2010,2014, Katagiri et al., in preparation], (2) cloud particle type (KU-type) [Yoshida et al., 2011] and (3) cloud microphysics (KU-micro).

Advanced ground-based active sensors are needed to evaluate and refine the EarthCARE algorithms. Distinct difference exists between space-borne lidar and ground-based one. Space-borne lidar has, in general, a larger foot-print size compared with the conventional ground-based lidar, leading to the significantly larger multi-scattering effect in space-borne lidar signals. In order to fill the gap between space-borne and ground-based lidars, we developed Multiple-field-of-view multiple-scattering polarization lidar (MFMSPL) [Okamoto et al., 2016]. The MFMSPL is the only system that offers the similar degree of depolarization affected by multiple scattering occurred in the space-borne lidar condition. We evaluate the cloud mask and cloud type algorithms by using the new type lidar and identified the underestimation of lower part of the clouds and also misclassification of water clouds as ice in the part for the current algorithms.

To retrieve ice microphysics, details of ice particle shape and orientation should be taken into account. We adopt the physical optics methods for lidar analysis [Borovoi et al., 2012, Masuda and Ishimoto 2017] and the discrete dipole approximation/FDTD for radar analysis [Okamoto et al., 2002, Ishimoto et al., 2012]. Validity of the ice particle models and their scattering properties are also evaluated by (1) comparing the retrieval results for CALIPSO nadir and off-nadir periods also by (2) the ground-based multi-wavelength HSRL-Raman lidar system.

To retrieve water microphysics, we developed the fast semi-analytic code to treat time-dependent radiative transfer equation for the analysis of space-borne lidar [Sato et al., in preparation]. Accuracy and range of its applicability have been done by the Monte Carlo method [Ishimoto and Masuda 2012].

Since EarthCARE can be regarded as the extended version of combination of CloudSat, CALIPSO and MODIS, it is expected to bring a new insight to our understanding the relation between clouds and climate system. Retrieval of vertical air motion and fall velocity of the particles will be planned. Analyses of these quantities together with the retrieved cloud microphysics offer a unique opportunity to evaluate and develop the cloud parameterization schemes.

S2A-3

Impact of the Radiation on the Prediction of Formation, Intensity, Track and Structure of Tropical Cyclone

Xiaodong Tang (Nanjing University)
Fuqing Zhang (The Pennsylvania State University)
Zhe-Min Tan (Nanjing University)
Juan Fang (Nanjing University)
Yong-Qiang Sun (The Pennsylvania State University)

This work examines the impacts of the diurnally varying radiation cycle on the formation, intensity, track, and structure of Hurricane Edouard (2014) at different stages of its life cycle through convection permitting simulations. During the formation stage, nighttime destabilization through radiative cooling may promote deep moist convection that eventually leads to the genesis of the storm, while a tropical cyclone fails to develop in the absence of the night phase despite a strong incipient vortex under moderately strong vertical wind shear. The nighttime radiative cooling further enhances the primary vortex before the storm undergoes rapid intensification. Thereafter, the nighttime radiative cooling mainly increases convective activities outside of the primary eyewall that lead to stronger/broader rainbands and larger storm size during the mature stage of the hurricane; there is, however, less impact on the hurricane's peak intensity in terms of maximum 10-m surface wind speed.

There is a significant leftward track deviation than the observed storm, if radiation restrains the genesis of storm in early development stage. This is likely due to the influence of the effective steering layer, tied to the storm intensity, which is shallower for the weaker tropical cyclone (TC). The track may also be due to a stronger beta effect associated with a stronger TC in control forecast (CNTL).

CNTL undergoes distinct secondary eyewall formation (SEF) during the mature stage of Edouard (as observed), while there is no apparent eyewall replacement cycle as simulated in sensitivity experiments without solar insolation (NoSolarRad) and the moat is narrower in those with switch-on solar insolation at night. In CNTL, there is an area of relatively weak convection between the outer rainbands and the primary eyewall; i.e., a moat region. This area is highly sensitive to solar shortwave radiative heating, mostly in the mid- to upper-level in the daytime, which leads to a net stabilization effect and suppresses convective development. Moreover, the heated surface air weakens wind-induced surface heat exchange (WISHE) feedback between the surface fluxes (that promote convection) and convective heating (that feeds into the secondary circulation and then the tangential wind). Consequently, a typical SEF with a clear moat follows. In NoSolarRad, in contrast, net radiative cooling leads to persistent active inner rainbands between the primary eyewall and outer rainbands, and these, along with the absence of the rapid filamentation zone, are detrimental to moat formation and thus to SEF. Sawyer-Eliassen diagnoses further suggest that the radiation-induced difference in diabatic heating is more important than the vortex wind structure for moat formation and SEF. These results suggest that the SEF is highly sensitive to solar insolation.

S2A-4

Decadal Changes in the Interannual Variability of heat waves in East Asia Caused by Atmospheric Teleconnection Changes

Myong-In Lee (Ulsan National Institute of Science and Technology)
Nakbin Choi (Ulsan National Institute of Science and Technology)
Kyu-Myong Kim (NASA Goddard Space Flight Center)
Young-Kwon Lim (NASA Goddard Space Flight Center)

The heat wave seems to be highly related with the large-scale atmospheric circulations. In this study, the heat wave in East Asia is examined by using EOF analysis for separate large-sclae heat wave pattern and related large-scale atmospheric circulations. We also considered differenct time scale as long-term time scale and interannual scale. The long-term variation of heat wave seems to be highly related with the variation of SST over the North Atlantic Ocean (i.e. AMO). In case of interannual scale, SCAND-like pattern and CGT-like patter are related with the large-scale heat wave patterns.

There is significant change in interannual variation of heat wave in mid-1990s. Before 1993, the heat wave is highly related with CGT-like pattern. However, in recent period, not only the CGT-like pattern but also the SCAND-like pattern are related with the heat wave. In addition, SCAND-like pattern is the most dominant atmospheric circulation pattern for East Asian heat wave in recent period.

This study implies that the mid-latitude large-scale atmospheric circulation is important factor to occur the large-scale heat wave in East Asia. In aspect of long term variation, the impact of North Atlantic Ocean and heat wave in East Asia is already shown in previous studies. However, this study focus on the significant relationship between atmospheric teleconnection pattern and heat wave in East Asia in aspect of interannual variation and the evidence of the role of the North Atlantic Ocean for summer climate of East Asia.

S2A-5

Introduction of "Integrated Research Program for Advancing Climate Models (TOGO)" theme C: Integrated Climate Projection

Izuru Takayabu (Meteorological Research Institute, JMA)
Kazuhisa Tsuboki (Nagoya University)

In TOGO theme C program (FY2017 - FY2021), it is requested to produce information which would contribute to the assessment of risk caused by the climate change. Around East Asian region, it is indispensable to consider heavy precipitation events and typhoons as the cause of the climatic risk. We have to assess not only climatic hazards, but also social exposure and vulnerability, for the risk assessment. How to produce information of climatic hazards is a main purpose of our TOGO theme C program. We would like to challenge the following two approaches. They are (i) to clarify the climate mechanisms and cause of the change in the phenomena, and (ii) to produce applicable information for impact study researchers of climate change. For the first objective, we have to drive sophisticated high resolution regional models to represent the phenomena in detail. Next, we have to analyze physically the cause of the change of the phenomena by using the results of these calculations. In this project, we use a sophisticated typhoon model CReSS-NHOES, and try to clarify the change of the characters of typhoons in the future world. And also, we design to drive multi RCP scenario ensembles of high resolution models around the Japanese Archipelago, to find the extreme precipitation events within the summer monsoon season. For the second objective, we drove several ensemble experiments to get uncertainty, which is requested from hydrological point of view. The hydrologists need to discuss the occurrence probability of disaster, to assess the risk caused by the climate change. Here we adopt many kinds of lateral boundary conditions to drive our regional climate models. This makes it possible to discuss on the hazards comes from rare event, such as super typhoons or heavy precipitation. As this program has started just this FY, we would like to introduce also of the existing program SOUSEI, which was the ancestor of the TOGO program.

This work was conducted under the SOUSEI program and TOUGOU program of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.

S2A-6

The Impact of vertical resolution on forecasting heavy rainfall event over Korea

Emilia Kyung Jin (Korea Institute of Atmospheric Prediction Systems)

To examine the impact of model resolution on numerical weather prediction (NWP), a suite of global numerical experiments of a heavy rainfall event over Korea are performed using the Global/Rregional Integrated Modeling system (GRIMs), which is the reference model in KIAPS. A heavy rainfall case on 6-7 June 2017, which is related with the low pressure system developed in the Southern China and migrated to the Korea Peninsula, is investigated. Two horizontal resolution of T958 (∼12.5km) and T510 (∼25km), and four vertical resolutions of L50, L64, L91, and L137 are tested and three different versions of physics package are also compared. Among these experiments, the results with 50 vertical level show deficiency not to capture the eastward migration of low pressure system developed in the Southern China growth regardless of horizontal resolution and physics package. As a result, it fails to predict the heavy rainfall over Korea. While, other simulations with higher vertical resolutions show reasonal reproduction of the development and movement of this low pressure system and related rain band. The snowfall and associated thermodynamic processes over the Tibet Plateau in the initial time sensitive to the vertical resolution is analyzed and its influence on the downstream region covering the Southern China and Korea is investigated.

S2A-7

Seasonal transition of the East Asian monsoon associated with ENSO

Sunyong Kim (Pohang University of Science and Technology)
Jong-Seong Kug (Pohang University of Science and Technology)

There is distinctive intraseasonal transition of the East Asian fall climate associated with El Nino-Southern Oscillation (ENSO) through the atmospheric teleconnection. In this study, the intraseasonal variation in atmospheric teleconnection and its regional impacts associated with ENSO over Korea, China and Japan are investigated based on the El Nino and La Nina during 1979-2015. The temperature and precipitation trend in East Asia during La Nina years tends to turn faster than El Nino years, with a latter start and earlier termination of fall season. This implies that there is a clear asymmetry in duration of fall season between the El Nino and La Nina years.

The relationship between the anomalous tropical forcing and climate system in East Asia has been well known during El Nino developing summer and winter. However, it needs to consider the intraseasonal transition of fall season associated with ENSO in terms of amplitudes, spatial patterns and temporal evolution. During boreal summer of El Nino developing phase, there are the overall positive temperature and precipitation anomalies in East Asia with respect to Nino3.4 SST anomalies. In September, especially, it has been recently shown that the El Nino-related temperature and precipitation anomalies in East Asia are mostly negative because of the positive precipitation over the subtropical North Pacific. The cyclonic flow response to a given positive precipitation forcing over the North Pacific in September is related to the decreasing temperature and precipitation anomalies in East Asia. However, this subtropical positive precipitation exists only in September and does not affect to East Asian climate anymore. In contrast, the western North Pacific (WNP) precipitation forcing is critical in developing positive atmospheric circulation during El Nino peak phase (especially November to December) in East Asia. Therefore, it is shown here that the temperature and precipitation trend from September to November in East Asia associated with ENSO is the positive correlation. The sign of temperature and precipitation trend in fall season is originally negative, indicating that the negative trend tends to positively (negatively) increase during El Nino (La Nina) years. This further implies that the negative temperature and precipitation trend in East Asia from September to November is moderately decreased during El Nino phase but it experiences relatively rapid decrease during La Nina phase.

It is also found that the Couple Model Intercomparison Project Phase 5 (CMIP5) models simulate well the overall intraseasonal transition of fall season in East Asia associated with ENSO. The CMIP5 models tend to simulate the El Nino-related positive precipitation anomalies over the subtropical North Pacific in September and its sudden disappearance. In November, the simulated ENSO teleconnection patterns in the CMIP5 models are generally weak in East Asia response to the WNP precipitation forcing. Therefore, the CMIP5 models reasonably simulate the rapid transition of the East Asian fall climate associated with ENSO supporting the observational argument. The negative temperature trends in East Asia from September to November among the individual models are quite diverse from model to model. Overall, the response in models for the rapid transition case has relatively good performance in simulating the intraseasonal transition during East Asian fall associated with ENSO.