Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

AAS02-01 Room:201B Time:May 26 12:00-12:15

Ultra-high Precision Mesoscale Weather Prediction in SPIRE Field 3

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Accuracy of numerical weather prediction (NWP) has been remarkably improved in recent years, but precise prediction of severe meteorological phenomena such as torrential rains and local heavy rainfalls is still a difficult and challenging. Data assimilation and the ensemble forecast with the cloud-resolving resolution are required, and the computational resource is a key to reduce the compromise of the resolutions and the number of ensemble members.

A research on super high-resolution mesoscale numerical weather prediction with the K-computer is underway. This research project is one of the five fields of the MEXT-funded national research project in Japan, the HPCI Strategic Programs for Innovative Research (SPIRE). Following three subjects are conducted to show the feasibility of precise prediction of local high impact weather phenomena: 1) Development of cloud resolving 4-dimensional data assimilation systems, 2) Development and validation of a cloud resolving ensemble analysis and forecast system, and 3) Basic research with very high resolution atmospheric models.

In the presentation, the background and achievement of the project at present is reviewed, and expectations to the next generation high performance computing is discussed.

References:

Saito, K., T. Tsuyuki, H. Seko, F. Kimura, T. Tokioka, T. Kuroda, L. Duc, K. Ito, T. Oizumi, G. Chen, J. Ito, and SPIRE Field 3 Mesoscale NWP group, 2013: Super high-resolution mesoscale weather prediction. J. Phys. Conf. Ser., 454, 012073: doi:10.1088/1742-6596/454/1/012073.

Keywords: mesoscale NWP, K-computer, data assimilation, ensemble prediction, cloud resolving model, High performance Computing

AAS02-02 Room:201B Time:May 26 12:15-12:30

Assimilation of rainwater estimated by a polarimetric radar for tornado outbreaks on 6 May 2012

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On 6 May 2012, three tornadoes were generated almost simultaneously on the Kanto Plain at about 12:30 JST (Japan standard time). The southernmost one was estimated to be F3 in the Fujita scale, which is one of the strongest tornadoes in Japan. A low-level vortex associated with this tornado was observed by Meteorological Research Institute advanced C-band solid-state polarimetric (MACS-POL) radar. In this study, dense surface observation data and radar data were assimilated with a triple-nested Local Ensemble Transform Kalman Filter (LETKF) system with 32 ensemble members, and the impact of these observation data was evaluated by performing the extended forecast initialized with the LETKF analyses.

In LETKF-1 (horizontal grid interval: 15000 m), hourly operational observation data used in the Japan Meteorological Agency (JMA) operational meso-scale analysis were assimilated with 6 hours intervals. In LETKF-2 (horizontal grid interval: 1875 m), Doppler velocity observed by 4 radars and dense surface data (horizontal wind, temperature and relative humidity) observed by Automated Meteorological Data Acquisition System (AMeDAS) and Environmental Sensor Network (ESN) obtained every 10 minutes were assimilated with 1 hour intervals. In LETKF-3 (horizontal grid interval: 350 m), rainwater estimated from reflectivity and specific differential phase observed by MACS-POL radar as well as Doppler wind and surface data were assimilated with 10 minutes intervals. Using this LETKF-3 analysis at 12:30 JST as the initial condition, the extended forecast with the horizontal resolution of 50 m was performed. As a result, the simulated precipitation relating to the parent clouds of the tornadoes was stronger than that in the experiment without rainwater assimilation. In this case, assimilation of strong rain contributed to increase low-level water vapor in the LETKF-3 analysis through a positive correlation between amounts of low-level water vapor and rainwater. These results imply that the predictability of extreme weather may be improved by assimilating rainwater observations.

Acknowledgement:
This work was supported in part by the research project ”HPCI Strategic Program for Innovation Research Field 3” (ID: hp120282, hp130012, hp140220) and ”Tokyo Metropolitan Area Convection Study for Extreme Weather Resilient Cities (TOMACS)”. ESN data were from NTT DOCOMO INC. The extended forecast was performed by K-computer.

Keywords: tornado, data assimilation, ensemble Kalman filter, polarimetric radar, surface observation

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AAS02-03 Room:201B Time:May 26 12:30-12:45

Comparison of 4DVAR, Hybrid-4DVAR and Hybrid-4DEnVAR at cloud resolving scales

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In the Strategic Programs for Innovative Research (SPIRE) Field 3 state-of-the-art data assimilation methods were implemented in the K Computer, among them 4DVAR, Hybrid-4DVAR, and Hybrid-4DEnVAR. These methods are expected to represent the atmospheric state more accurately, thus improving the forecast quality, especially for severe weather phenomena like local heavy rainfall. All the above methods belong to the variational data assimilation technique which estimates the mode of the posterior distribution through minimization of a cost function. While 4DVAR and Hybrid-4DVAR use the tangent linear and adjoint models to propagate the uncertainty in time, Hybrid-4DEnVAR retrieves this information from the nonlinear forecasts of ensemble members. Both Hybrid-4DVAR and Hybrid-4DEnVAR take ”errors of the day” in consideration when using the background covariance from an ensemble forecast. To provide this ensemble background covariance for the two hybrid systems, a 4D-LETKF system was run in parallel to the 4DVAR module. However, this is not a one-way interaction between 4DVAR and 4D-LETKF. The 4D-LETKF analysis is replaced by the one of 4DVAR, combining this with the ensemble analyses estimated by 4D-LETKF to propagate the system state and its uncertainty in time. Performance of three methods is shown in experiments with real observations. Other aspects like computational cost, complexity, and balance of the analyzed field will be discussed.

Keywords: Variational data assimilation, 4DVAR, Hybrid-4DVAR, Hybrid-4DEnVAR

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AAS02-04 Room:201B Time:May 26 14:15-15:00

Very High Resolution NWP Research at the Met Office

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[1]Met Office

Since 2009 the Met Office has been running a 1.5km gridlength version of the Unified Model (UM) over the UK (the UKV) to provide local NWP forecasts. This model has provided a step change in the representation of convection when compared to earlier and coarser models including a convection parameterisation. However it is clear that problems still remain ? much convection in the UK is still under-resolved in a 1.5km model, hence the often used term “convection permitting” to describe these models.

In this paper we describe research on much higher resolution versions of the UM. The first reason for this work is that an understanding of the behaviour of models as a function of gridlength is important in order to understand the processes in the model. This will aid improving the configuration of the models at lower resolutions also. Secondly we are looking ahead to the benefits from future increases in resolution.

The UM has been run experimentally with order 100m gridlength in several contexts. The first was cold pooling in valleys (which were too small to resolve in the 1.5km model) as part of the LANFEX field experiment. A 100m model was shown to provide good forecasts of cold pooling in the valleys and downslope flows.

A second context in which a 100m version of the UM has been applied has been to has been modelling London. Comparisons with lidar observations made as part of the Actual field project have been made to understand the representation of the convective boundary layer. It is found that most of the vertical heat flux is carried explicitly in a 100m model. We will also discuss results from this model regarding downslope flows into London at night and the representation of sea breezes (both of which are improved by the 100m model). We will also mention an experimental 300m model being run routinely for London.

The largest area of research with 100m scale models has been deep convection. We have used observations from the DYMECS project to investigate the detailed representation of convection in models with gridlenghs from 1.5km down to 100m. It is clear that in the 1.5km model much convection in the UK is under-resolved which manifests itself as the convective cells being too large and too few in number. HIgher resolution helps many aspects (for example improves the representation of small cells) but not others. For example the model has a tendency to collapse larger convective cells down to be too small when measured by the rain or cloud. The same thing is less clear when measured by the size of the convective updrafts. It is also noticeable that the problem, in the 1.5km model, of there being too much heavy rain and not enough light rain is not helped by going to higher resolution. These issues may be related to the microphysics but may also be dynamical, for example the downdrafts might be too strong. A crucial aspect at these resolutions is the handling of the grey zone of turbulence which impacts on convective entrainment etc.

Finally we will describe some order 100m modelling on some major US tornado outbreaks. The Met Office has been running 4.4km and 2.2km models over the US Great Plains as part of the NSSL/SPC Hazardous Weather Testbed experiment. The 2.2km model was nested down to 500m, 200m and 100m. The 200m and 100m models produce tornado like vortices as part of realistic supercell structures. The vortices are weak compared to real tornados but their location and movement are realistic.

A number of key themes arise from order 100m models in all of these contexts. As already mentioned one is partially resolved turbulence which can be important for the behaviour. A related issue is that spin up of turbulence at the inflow boundary can be very important. Currently this is circumvented by using large domains but suitable addition of noise in the boundaries may mitigate this in the future.

Keywords: Numerial Weather prediction, High Resolution, Convection permitting, Turbulence pemitting

AAS02-05 Room:201B Time:May 26 15:00-15:15

Extraction of Favorable Environment Factors for Heavy Rainfall using Multiple Scenarios Obtained by Ensemble Forecasts

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Since computer resources are becoming larger, mesoscale ensemble forecasts are expected to become more popular in the future. Because the number of ensemble forecasts has become too many, the methods that extract useful information from the ensemble forecasts should be developed as well as the techniques of mesoscale ensemble forecasts. For instance, it is expected that the environment factors favorable for heavy rainfalls can be obtained by the comparison of the possible scenarios in which the heavy rainfall is reproduced and not reproduced.

In this study, 51 possible scenarios provided by an ensemble forecast of the northern Kyushu heavy rainfall (Kunii, 2013), which caused severe damage in Kumamoto, Fukuoka and Oita, were used.

Correlation coefficients between the rainfall amount and the environment factors, such as water vapor and southerly wind near the surface, provides the effective factors to judge whether heavy rainfall will occur or not. Because this method is the results of a first trial, further developments of the methods that extract useful information from the possible scenarios are needed.

Acknowledgements:
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Keywords: heavy rainfall, ensemble forecast

AAS02-06 Room:201B Time:May 26 15:15-15:30

Multiple Eyewall Structure and its Wind Features in 2012 Typhoon Bolaven

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Typhoon ‘Bolaven’ passed the Okinawa Main Island at about 1200 UTC 26 August 2012, while moving northwestward. The radar images showed that ‘Bolaven’ had the multiple eyewall structure. The surface observation data at Nago of Okinawa showed that the precipitation and surface wind velocity in the typhoon’s central region were weaker than those of the Japan Meteorological Agency (JMA)’s operational forecast.

Cloud-resolving ensemble simulations were performed to investigate the relations between the multiple eyewall structure and the wind features in the typhoon’s central regions. The ensemble simulations reproduced double eyewall structures in several members. To evaluate the reproducibility of multiple eyewall structures, the multi-eye index (MEI) was defined in this study.

Compared with the members in which the typhoon had the spiral rainband structures, the pressure gradients in the typhoon’s central region of the small MEI (multiple eyewall) members were weak. The precipitation and surface wind velocity were also weaker than those of the typhoons with spiral rainbands. In case of the multiple eyewall typhoon, the gentle pressure gradients and the associated weaker surface inflows suppressed convections in the inner eyewall.

The statistical analysis was performed based on the ensemble prediction. A clear positive correlation was indicated between the MEI and the wind velocity (tangential wind and inward radial wind) in the typhoon’s central region. This result explains the reason why the actual wind velocity was weaker than that of the original JMA’s forecast.

The relationship between the atmospheric environmental factors around the typhoon (e.g., level of free convection and convective available potential energy) and MEI was investigated from the outputs of ensemble simulations. The results indicated that there were no strong relations between them. This suggests that the formation of the multiple eyewall structures is not simply determined by the atmospheric environmental parameters but depends on more complicated conditions around the typhoon at the timing of their formation.

Keywords: Ensemble simulation, Typhoon, Multiple eyewall

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AAS02-07 Room:201B Time:May 26 15:30-15:45

Implementation of a high-resolution atmosphere-ocean coupled model with an ensemble Kalman filter

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For the application of an ensemble Kalman filtering (EnKF) to limited-area models for regional numerical weather prediction, treating uncertainties of boundary conditions has been one of the major issues. Although there are some previous studies focusing on effectiveness of lateral boundary uncertainties, few studies investigated in detail the impact of perturbing the lower boundary conditions with an EnKF. In this study, a high-resolution atmosphere-ocean coupled model is implemented with the EnKF, so that the sensitivity of SST perturbations on an EnKF data assimilation cycles is evaluated.

Keywords: data assimlation, ensemble Kalman filter, atmosphere-ocean coupled model

AAS02-08 Room:201B Time:May 26 15:45-16:00

High resolution experiment of JMA-NHM using K computer

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In August 2014, a strong rainband covered Hiroshima city. A heavy rain triggered by the rain band caused debris flows in the north part of Hiroshima city. To prevent and mitigate these water-related hazards, high resolution weather prediction is very important. This study aims to clarify the impact of model resolution on the accuracy of the numerical weather prediction (NWP) model. Feature of this research was to compute a wide region in multiple resolutions.

This study employed a NWP model ”JMA-NHM” and the ”K computer”, which is the 4th fastest super computer in the world. The research targeted the heavy rain event in Hiroshima city in August 19 to 20, 2014. The main experimental conditions were as follows. The experiments periods were 6 and 9 hours simulation till August 20 at 6 a.m.. The horizontal resolutions were 2 km, 500 m and 250 m. Planetary Boundary Layer Schemes were Mellor-Yamada Level 3 and Deardorff. The experiments of 2 km, 500 m, and 250 m used 72, 1600, and 6400 CPUs of the Kei computer, respectively. In this study, we defined the 2 km resolution as low resolution (LR) and the 500 m and 250 m resolutions as high resolutions (HRs).

The results showed that the HRs experiments showed better result than LR experiment. The ground observation results at Miiri indicated that the precipitation were gradually increasing from August 20 at 2 a.m. and peaked at 4 a.m.. The LR experiment showed precipitation was increasing from 2 a.m. to 4 a.m. as same as the observation results. However, strong rainband reproduced northeast of the Hiroshima city. The HRs results showed the rainband reproduced on the Hiroshima city and the damaged area. The precipitation peak was earlier than observation. The peak of precipitation of the 500 m resolution experiment was 2 a.m. and of the 250 m resolution experiment was 3 a.m.. In the presentation, we show results of the multiple resolution experiments impact on the NWP model.

Keywords: High resolution experiment, JMA-NHM, K computer, Numerical weather prediction

AAS02-09 Room:201B Time:May 26 16:15-16:40

”Big Data Assimilation” Revolutionizing Severe Weather Forecasting

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In 2013, the Japanese government started a strategic funding program for the Big Data science, and the ”Big Data Assimilation” project for severe weather forecasting started. Here, 30-minute forecasts at a 100-m resolution are refreshed every 30 seconds, 120 times more rapid than the current hourly-updated systems. This will help prepare for sudden local torrential rainfalls that may cause flash flood and river outflow only within 10-20 minutes.

This revolutionary NWP is only possible due to the most advanced sensing and computing technologies to date. The recent Phased Array Weather Radar can make a volume scan in 10-30 seconds at a 100-m radial resolution with 100 elevation angles. Also, the Japan Meteorological Agency’s new geostationary satellite Himawari-8 has a capability of the super-rapid scan every 30 seconds for a limited region. These sub-minute data would be frequent enough to capture the nearly linear evolution of rapidly changing convective activities. Assimilating the 30-second data into a high-resolution NWP model may lead to accurate representations of the lifecycles of each convective cell. However, these new observing platforms provide two orders of magnitude more data, and an effective use of these Big Data in very short range NWP is a challenge and may be possible with the Japanese 10-petaflops ”K computer”.

This presentation will discuss the concept and the most recent results of the pioneering ”Big Data Assimilation” research.

Keywords: big data assimilation, severe weather prediction, ensemble kalman filter, numerical weather prediction, data assimilation, high performance computation

AAS02-10 Room:201B Time:May 26 16:40-16:55

Super high-resolution simulation of the 6 May 2012 Tsukuba Supercell Tornado (2012)

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Detailed structure of tornadoes remain poorly understood because of difficulties in collecting observational data around a tornado with fine spatial and temporal resolutions. Most of previous studies have been conducted by photogrammetric analyses, laboratory experiments, and large eddy simulations, which contains nonnegligible calculational errors or some unrealistic aspects. In this study, we performed downscale experiments under realistic conditions for the Tsukuba Supercell Tornado (2012) using nested grids with as small as 10-m horizontal grid spacing to resolve the fine-scale tornado structure. The numerical model used in this study is the Japan Meteorological Agency Nonhydrostatic Model. The model contains 4001 x 3001 grid points in the horizontal and 250 vertical levels with grid intervals of 10 m near the surface.

Minimum pressure of a simulated tornado reaches 937 hPa (pressure deficit; 65 hPa), and maximum ground-relative surface wind speeds exceed 70 m s^{-1}. During the rapid intensifying stage, the vortex core region accompanying large vertical vorticity contracted and was gradually occupied by downdraft. After that, the central downdraft intensified, and multiple vortices formed with an increase of horizontal dimension of a tornado. Thus, it is evident that the simulated tornado evolved from one-celled to two-celled tornado and subsequently exhibited multiple vortices, which are consistent with a tornado-like vortex evolution in laboratory experiments. There exist two prominent cyclonic subvortices associated with pressure deficit when most significant multiple vortices formed. Although subvortices locally intensify winds owing to the superposition of the velocity field associated with the small-scale subvortex and the larger-scale tornado, the strongest wind is found in the shrinking stage prior to multiple vortices. The evolution of the tornado structure roughly depended on the swirl ratio. When the swirl ratio got large, the multiple vortices became prominent.

Keywords: tornado, supercell, numerical simulation

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AAS02-11 Room:201B Time:May 26 16:55-17:10

Large Eddy Simulation of Entire Tropical Cyclone

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Current numerical models of a tropical cyclone do not have a resolution to explicitly simulate turbulent eddies, and their effects have to be usually parameterized. However, such parameterizations are known to introduce significant uncertainties. Owing to the K computer, which is the Japanese most powerful supercomputer, we can perform a large eddy simulation (LES) in which a horizontal grid spacing is taken to be fine enough to reliably simulate large eddies over the computational domain covering an entire tropical cyclone. Such an LES contributes to understand roles of micro-scale processes in a tropical cyclone, and reduce the uncertainties due to the parameterizations.

In the present study, JMA-NHM (Japan Meteorological Agency's Non-Hydrostatic Model) is used as a LES whose horizontal grid spacing dx is 100 m everywhere. The computational domain covers 2000 km by 2000 km in the horizontal and 23 km in the vertical directions, and horizontal boundary conditions are doubly cyclic. The grid number is 20000 by 20000 in the horizontal directions, and 60 in the vertical direction where grid spacing increases with increasing height. The LES has been conducted using 9216 nodes of the K computer, which is believed to be the hugest computation in the current facility. Before starting the LES, a preliminary run with JMA-NHM with dx=2km is made. In this preliminary run, a tropical cyclone develops from an initial weak vortex to a mature stage after 120 hours integration. The grid point values of this mature stage are interpolated to prepare the initial condition for the LES. The time integration of the LES is performed for 10 hours.

A comparison of the results of the LES with those of the preliminary run at the same instants shows that the minimum surface pressure and the maximum surface winds are nearly the same. However, the radius of the eye-wall is smaller and the radial flow near the surface is stronger in the LES.

Horizontal rolls whose horizontal scale is less than or close to 2 km are found near the surface in the LES. There are two different types of rolls: Type-A rolls occur outside of the radius of the maximum wind (RMW) and have their axis nearly directed in the tangential direction with slightly deflection to the center of the cyclone; Type-B rolls are found near the RMW, and have their axis slightly deflected to the outside of the cyclone.

Type-A rolls appear to be caused by the inflection point instability of the Ekman layer as in the previous idealized LES study. They enhance turbulence mixing in the Ekman layer to cause stronger radial inflows, which may have contributed to shrink the radius of the eye-wall in the LES. Type-A rolls lead to updrafts that form eye-wall cumulus clouds.

On the other hand, Type-B rolls appear to be due to a parallel instability that only occurs under a strong rotation. This instability appears to be possible only near the RMW where large centrifugal force operates as if Coriolis force is strengthened. Local maximum surface winds in the tropical cyclone occur at the downdraft regions of the rolls where the momentum is transported downward. Unlike Type-A rolls, the circulation of Type-B rolls is confined to the boundary layer .

The LES is also used to evaluate the gust factor, which is defined by a ratio of three-second mean to 1-minute mean wind speed . WMO guideline (Harper et al., 2010) suggests that it is nearly 1.1 for a tropical cyclone over a sea. The LES results at each grid point shows that the gust factor of the guideline seems to be reasonable. However, it reaches 1.5 near the RMW where Type-B rolls prevail.

Keywords: tropical cyclone, large eddy simulation, turbulent Ekman layer, inflection instability, parallel instability, gust factor

AAS02-12 Room:201B Time:May 26 17:10-17:25

A comparative experiment of warm rain bin schemes using Kinetic Driver for microphysics intercomparison

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1. Introduction

Boundary layer clouds have a significant effect on global radiation budget, and the improvement of their modeling is an important issue for climate study. In order to improve the microphysical model, we have developed a bin microphysical scheme for warm rain called Kuba-Fujiyoshi scheme (Kuba and Fujiyoshi, 2006), and incorporated the scheme into a cloud resolving model called Cloud Resolving Storm Simulator (CReSS) developed at Nagoya University. The model was applied to the 'Rain In Cumulus over the Ocean' (RICO) measurement campaign, and works generally well. However, there are few problems in the results, and in order to improve the model, we compare the scheme with other bin and bulk schemes using the Kinematic Driver (KiD) intercomparison framework developed at Met Office (Shipway and Hill, 2012).

2. Setting of the experiments

In the original KiD, the wind is represented as a simple function of time and space. We modified it to incorporate the wind resulted in a 2-dimensional simulation of RICO using CReSS. We stored the wind field every 1 second, which is the time interval used in the simulation. The initial profiles of potential temperature, specific humidity are set for the case of RICO. We compared the results using Kuba and Fujiyoshi scheme (KF scheme) with the results using the Tel-Aviv University bin scheme (TAU scheme).

3. Discussions

The warm bin model is divided into three parts, i.e., the activation process of aerosols, the deposition process, and the collision process. We set the model as we can select K-F scheme or TAU scheme for each of the three processes. Then we can discuss the effect of each scheme by comparing the results of 8 runs. Figure 1 shows the time change of the surface rain in the 8 runs. The top four figures show the effect of the selection of activation scheme. The center four figures show the effect of deposition scheme, and the bottom four figures the collection scheme. In each figure red line shows the results using KF scheme, and the green line shows the results using TAU scheme. For the activation scheme, KF scheme produces more precipitation, and for the deposition and collection scheme, TAU scheme produces more precipitation. We will discuss how these results are produced.

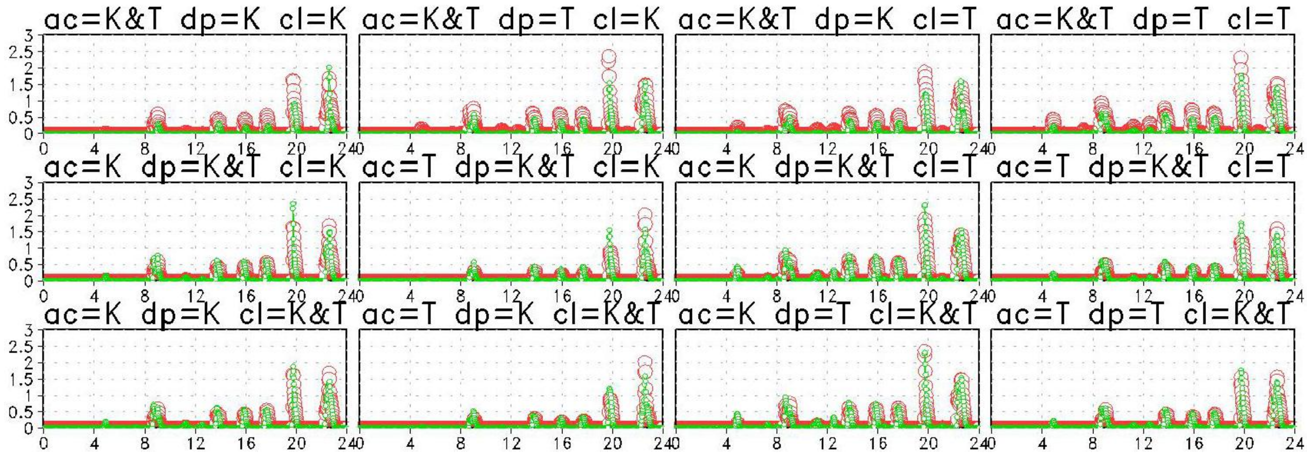
Acknowledgment

The authors would like to thank all people who created KiD.

Fig. 1. Time change of liquid water at the lowest level for the 8 runs. The ac, dp, and cl indicates activation, deposition, and collision process, and K and T means Kuba-Fujiyoshi scheme and TAU scheme respectively.

Keywords: bin micro physical model, boundary layer cloud, kinetic driver

AAS02-12 Room:201B Time:May 26 17:10-17:25



AAS02-13 Room:201B Time:May 26 17:25-17:40

Development of Hydro-debris2D model and its application into Izu Ohsima island

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Hydro-debris2D model has been developed for the purpose of predicting occurrence of the debris flow throughout hydrological regime changes. The model contains three components: (1) Shallow-water based surface flow module in order to predict mountain zone torrential flow regime, (2) rapid subsurface/interflow in the weathered rock, and (3) debris flow components. The model has been applied into Izu Oshima Island debris flow event in 2013. As input data we used observed rainfall station dataset from AMeDAS. With heavy rainfall extensive surface flow occurred in the western part of the island, together with extreme interflow which may induce the initiation process of debris flow in the wall. Simulated debris flow occurrence zone by the model agreed with the real debris flow event on 16 October 2013. Calculation indicated that substantial amount of sediment is flown into ocean, together with the occurrence of the debris flow disaster. Sediment transport from continental(island) zone during extreme weather event should be estimated throughout similar study.

Keywords: Debris Flow, HD2DH, Izu Ohshima, Surface Flow

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AAS02-14 Room:201B Time:May 26 17:40-17:55

Transmission resolving of three-dimensional typhoon moisture field for prediction of surface precipitation hyetograph

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[1]National Taiwan University

The purpose of this study can be divided to three sections: (1) resolve the triggered transmission factor of three-dimensional typhoon moisture field resulting from horizontal vortex, vertical wind shear and turbulence mixing, cumulus convection, gravity wave drag, and interaction between typhoon rain band, terrain, and monsoon; (2) formulate and derive the analytical governing equation (G.E.) of moisture field and surface precipitation hyetograph; and (3) couple the analytical signal processing feature and the G.E. to develop a methodology for prediction. The typhoon moisture field measured by radar-based remote sensing and the observed surface precipitation are resolved by signal processing and data mining technique (e.g. principle component analysis etc.). The G.E. can be manifested by convectional term and external adjunction term. The typhoon moisture field and surface precipitation are simulated and predicted by finite difference-based and moving dynamic-based approach with the consideration of typhoon atmospheric field structure and exponential function-based pressure-wind distribution. This study discovers the nature profound mystery at the Shihmen Reservoir basin, Taiwan. Results show that the typhoon rain band on the studied basin would mainly dominated by the interaction between vortex-based wind field and terrain lifting when typhoon center locates within the influence radius. In addition, the studied basin would suffer cloudburst attack because of circumfluent convection and monsoon co-movement effect while typhoon center pass the extend line with connecting to the basin centroid which is orthogonal to the monsoon and mountain chain direction. Furthermore, the developed methodology can predict surface precipitation hyetograph effectively and accurately with the full consideration of natural cause of formation.

Keywords: typhoon moisture field, prediction of surface precipitation hyetograph, transmission resolving, signal processing, circumfluent convection, monsoon co-movement effect