# The International Workshop on Agromet and GIS Applications for Agricultural Decision Making

Rapporteur: Dr. Miloslav Belorid, Applied Meteorology Research Division, National Institute of Meteorological Sciences, Korea Meteorological Administration

The International Workshop on Agromet and GIS Applications for Agricultural Decision Making took place in Seogwipo, Jeju-do, Republic of Korea on 5-9 December 2016. The aim of the workshop was to gather together scientists and experts from various countries in the field of agro-meteorology and downscaling techniques, and to offer a discussion about needs for agricultural decision making. The workshop was divided into two parts. The first part consisted of eight sessions including keynote speeches where scientists presented experiences and results of their research. The second session consisted of WMO CAgM meetings and a tutorial where participants could learn basics of Quantum GIS for agricultural spatial analysis, R programming language for statistical downscaling, and the Weather Research Forecast model for dynamic downscaling.

## Keynote Lectures

**Byong Lyol LEE, CAgM, World Meteorological Organization: Climate service innovation for global agenda under climate changes from WMO CAgM perspectives**

President Byong Lyol Lee gave overview on the Global Agenda under Climate Change from WMO CAgM perspectives. The Global Agenda consists of Suitable Development goals, Sendai Framework for Disaster Risk Reduction, UNFCCC and IPCC and Future Earth. The WIGOS and WIS systems were explained and pointed out the user needs for Climate Services in Agriculture. Since operational agrometeorology requires diverse data and information from different disciplines for better services, future information system should consider accommodating diverse data and information as well as derived products and supporting

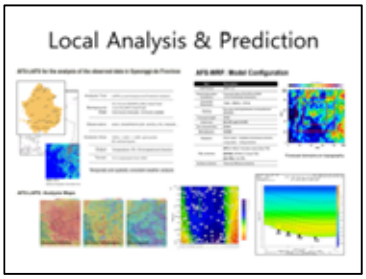
resources including tools, models and ICT infrastructure.

**Jose CAMACHO, , CAgM, World Meteorological Organization : From data to geo-referenced data, improvements in agricultural meteorological projects in Africa**


Dr Jose CAMACHO introduced activities of WMO for digitizing, rescue and preserving of historical meteorological records from 20th century. He gave a brief introduction of WMO Integrated Global Observing System (WIGOS), WMO Information System WIS, Agrometeorological Information Service (WAMIS), Training of Trainers (ToT) program in Ethiopia, and mobile phone alert system for severe weather events. The mobile alert system already has been used by 1000 of fishermen and traders from Ssese Island. The WMO and NMHS are developing successful experience in using mobile phones in Uganda and Ghana.

## Session 1: GIS Task Team - Agromet and GIS Applications for Agricultural Decision Making I.

**Kyu Rang KIM, National Institute of Meteorological Sciences: Agromet and GIS applications for agricultural decision making in our future**



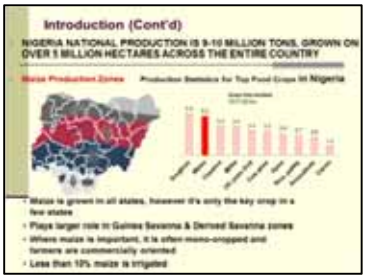

Dr Kyu Rang Kim gave overview of his research and pointed out the main requirements and importance of GIS and downscaling techniques in the field of agrometeorology. The research focused on exact weather conditions, growth and disease observation in paddy field. Several models have been implemented based on experimental and published data. For example, infection rate by hours of surface wetting, fungal growth rate by temperature and humidity etc. were

implemented. To provide site specificity, LAPS (Local Analysis and Prediction System) was utilized. For local weather prediction over a very complex terrain the WRF model was used and compared with in-situ observation. The model succeed in prediction of the cold air pool at the bottom of the valley and warm belt in the middle of the hills however the results were too bulky to be utilized in simple agricultural models. Seamless data are required not only from numerical models but also from observations and various models. To meet such requirement, a more detailed analysis of local aspects of land-use and land-cover are needed.

**Orivaldo BRUNINI, Agrometeorology Information Center - Agronomic Institute: The use of GIS to better understand crop response to climate change and variability**

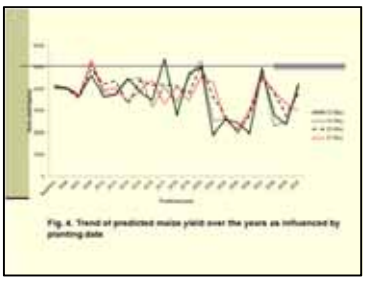
Dr Orivaldo Brunini pointed out that a better understanding crop response to weather factors and climate variability must consider the global interaction between the soil physical properties and spatial variability of land cover, water resources and crop genetic background. He showed the usage of GIS in the field of agriculture and climatology to enhance the agro-meteorology Bulletins. He emphasized what kind of agro-meteorological products should be provided to farmers and as example a case studies for different situations such as water scarcity and water variability, soil moisture, drought index, crop zoning techniques etc were presented.

**Kolapo Olatunji OLUWASEMIRE, University of Ibadan: Prospect and challenges of Agromet and GIS application in agricultural decision making in Nigeria**



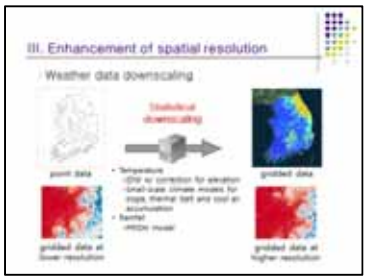

Dr. Oluwasemire briefly introduced the agro-ecology environment of Nigeria. Nigeria has high variability of agro-ecological zones from Sahel through savanna to humid forest. In terms of crop production, the main region is the Guinea savanna and has the highest crop production capacity especially for maize. The objective of the study was to evaluate the effects of planting dates and variability on maize performance under rain-fed conditions in Zaria area (northern Guinea savanna), and

to assess CERES-Maize model performance by comparing the measured and simulated maize phenology for improved growth, development and yields as well as forecasting grain yield of maize production system. The results of CSM-CERES-Maize simulation showed decreasing trends in maximum leaf area index, predicted maize shoot dry weight and predicted maize yield as influenced by planting date. The trends are associated with the delay of rain events due to climate change. The CSM-CERES-Maize showed good performance with less than 10% error and was able to accurately simulate the phenology and yield of maize grown during the rainy season in Guinea savanna agro-ecological environment in Nigeria. The study also showed that the CSM-CERES-Maize model can be a promising tool for yield forecasting for rain-fed maize varieties within predicted planting windows.



**Eun Woo PARK, Soul National University : Web-based information system for Plant disease forecast based on weather data and high spatial resolution**

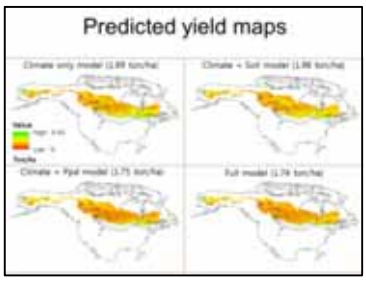
Dr Eun Woo Park introduced a project on development of mobile application of web-based information system for forecast of multiple diseases and insect pests. The requirements for the system was that the provided information has to be site specific, integrated for multiple diseases, and the forecast needed to be fast. To provide the site specific information a high resolution data were generated using GIS, statistical downscaling techniques such as inverse distance weighting method for temperature, PRISM model for precipitation, and small scale climate model to consider the slope effect, thermal belt, cool air, etc. To have the extended forecast of disease development not only AWS data but also the 36 hour weather forecast from Unified Model, 48 hour data from Digital weather Forecast (DF) and 10 day temperature from Mid-term weather forecast were utilized.




**Soo-Hyung KIM, University of Washington: Random Forest for global regional crop yield prediction: Performance evaluation and application for climate impact studies**

Dr Soo-Hyung Kim introduced the random forest

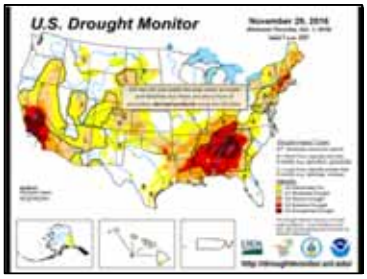
technique and its potential for agro-meteorological applications such as prediction of crop yield. Accurate prediction of crop yield is critical for developing effective agricultural and food policies at the regional and global scales. The Random Forest (RF) is machine-learning technique based on collection of classification and regression trees. This technique was evaluated and compared with multiple linear regression method. The RF showed high performance in terms of accuracy and precision for all studied cases: 30 years maize data, global wheat yield and Northeast Seaboard Region (NESR) potato and silage maize yield. The results showed that the RF technique is highly capable of predicting crop yields at global and regional scales for different crops but has some limitation such as tendency of over-fitting, conditions outside the boundaries of training data and non-additive interactions not included in training.




## Session 2: GIS Application - Agromet I

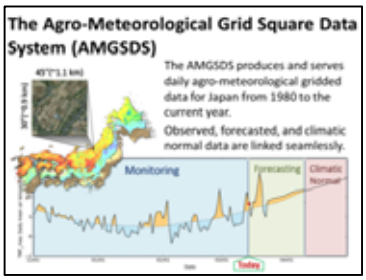
**Eric LEUBEHUSEN, USDA: GIS tools, data, and methods used in the weekly US Drought Monitor**

Dr Eric Leubehusen explained the history and development of US Drough Monitor (USDM). The USDM was established in 1999 and the monitor was based on Coral Draw. Since 1999 the USDM underwent severe modification such as layout, color scheme etc. Since 2003 the USDM is based on GIS. USDM utilizes gridded radar-based precipitation data and station based precipitation data (ACIS - Applied Climate Information System). The radar-based data in raw DBF format comprised of thousands of individual points are converted to GeoTiff format for fast-loading. The systems produce many useful products such as 7-day precipitation, 30-day precipitation departure, 90 and 60-day percent-of normal precipitation (PNP), SPI, SPEI etc. Another in-situ data used for USDM includes stream flow percentiles from USGS, monthly reservoir data etc. Overall, the GIS improved the data handling and efficiency of the USDM. Moreover, it made the maps more accurate and detailed, and also there are host of



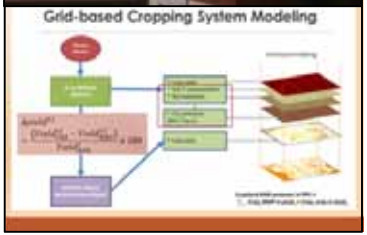
secondary derived products using the GIS data.

**Hiroyuki OHNO, Institute for Agro-Environmental Sciences: Development of agricultural decision supporting tools using gridded meteorological data embedded with weather forecast**




Dr Hiroyuki Ohno introduced the 1-km grid daily meteorological data delivery system Agro-Meteorological Grid Square Data System (AMGSDS). The main goal of the AMGSDS is to quickly grasp the degree and spread of weather based damages and to take measures to reduce them. The AMGSDS produces and serves daily agro-meteorological gridded data for Japan from 1980 to present. The past gridded data are produced using historical records from about 1300 stations throughout Japan. The forecast is based on JMA's Meso-Scale Model (MSM), JMA's Global Spectral Model (GSM) forecasts, and using guidance for 1-month weather forecasts by JMA. The estimated error for the past data is 0.6°C and for the 1-day forecast was estimated to 1.2 °C. In order to deliver the data quickly and conveniently to user a server for data delivery was equipped. The data from server are delivered to user using http-get and OPeNDAP protocols. The agricultural decision supporting tools such as alerts for diseases infection are under development.

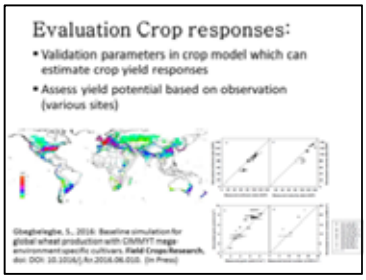
**Ho-Young KWON, International Food Policy Research Institute : Geospatial Data for Modeling Impacts of Climate-Smart Agriculture**




The main objective of the study was to investigate how the adoption of Climate-Smart Agriculture (CSA) on a global scale might affect global prices, world production, GHG emissions and trade flows. For this study the ex-ante economic impact assessment was conducted using IFPRI's International Model for

Policy Analysis of Agricultural Commodities and Trade (IMPACT) system of models. Moreover, the global adoption of CSA practices on maize, wheat and rice was simulated. The results of standard CSA adoption shows increase in production by about 2% for maize, wheat and rice. Due to increase in production the prices shows decrease as well as percentage of malnourished children and reduction in mean $CO_2$ emission. The model results show very positive impact of the CSA adoption on global scale. Overall, CSA has the potential to improve how agriculture responds to climate change. This type of study potentially can initiate dialogs across ministries.

**Uran CHUNG, APEC Climate Center: Understanding on utilization of weather and climate data with GIS tool in Agriculture**




wDr Uran Chung briefly introduced the digital climate mapping of Korea and its various case studies. The daily maximum model, which was introduced from Bio-SIM, has been modified according to terrain of Korea and daily minimum temperature has been developed by quantifying accumulation of cool air which can occur in complex terrain. To estimate precipitation at complex mountainous terrain in Korea, PRISM was introduced, and a precipitation model was developed. The digital climate map has been applied to predict flowering time of apple, pear, peach, cherry etc., and it has been used to assess yield production of crops under climate change in agricultural sector.

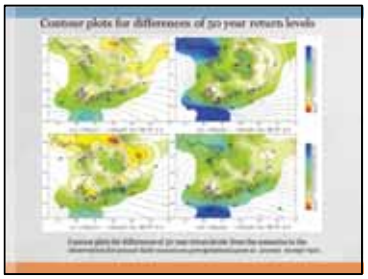
## Session 3: GIS Application - Downscaling Methods

**Jai-Ho OH, Pukyong National University: Ultra-high resolution time traveling argo-meteorological information from seeding to harvesting for prospect estimation of crop yields**


Seasonal prediction has been produced using GME model. To construct an ensemble prediction, time-lagged method was applied with initial conditions from different dates. The ultra-high resolution agrometeorological data has been estimated with QTM, QPM and QWM diagnostic model for downscaling. Due to difference in spatial resolution of GME and Digital Elevation Model (DEM) topography, new dataset of

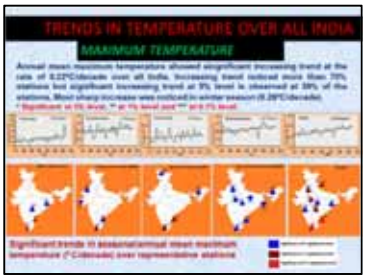
temperature and precipitation were calculated by considering the orographic effect. The daily ultra-high resolution both synthetic data and precipitation data might be useful to the crop scientist.

**Jeong-Soo PARK, Chonnam National University : Spatial modeling of extreme rainfall in Korea via max-stable processes**




Using data from 56 weather stations and employing spatial extreme modeling the annual highest daily maximum temperature in Korea was examined. The approach is based on max-stable processes with two models Schlather's and Smith model, respectively. The parameter modeling was used regression model with several geographic aspects such as latitude, longitude, altitude, and distance from coast and direction from mountain. To avoid overfitting, Takeuchi Information Criterion was applied. The comparison between two characterization models show that the Smith model perform better compare to Schlather model, thus Smith model was used for prediction simulation. According to the RCP scenarios 4.5 and 8.5, the heavy rainfall > 250 mm/day which has occurred once in average in 20 years in the past will occur once in 15 years in near future and once in 10 years by end of this century. In both scenarios, the heavy rainfall > 300 mm/day which has occurred once in 50 years in the past will occur once in 25 years in near future and once in 15 years by the end of this century.

**Gyan Prakash SINGH, Banaras Hindu University: Recent trend in temperature and precipitation extremes over India**



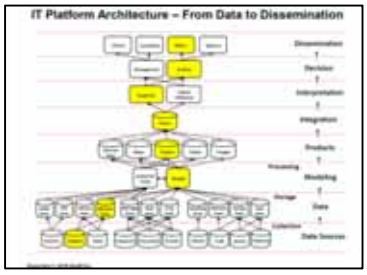

Dr Singh investigated the annual trends and variations in the occurrence of extreme temperatures and rainfall events over different Indian regions and India as a whole. Results show a significant increase in annual frequency of hot days at rate of 5.4 day per decade and significant decline in frequency of cold days at the rate of 2.4 days per decade over country. Number of days and event with daily rainfall above 100 mm and 200 mm in any grid box was observed to be significantly increased over

country. Over the regions, significant increase in annual number of days with rainfall above 100 mm was observed over Northwest and North central regions.

**Jeonghoon MOON, KISTI: KREONET openSciencesCloud service for agrometeorology**

Dr Moon Jeonghoon introduced openScienceDMZ Cloud, international R&D network, the trends and requirements in the field of data intensive science, and World Global Research Network status. He also briefly introduced the Korea Advanced Research Network (KOREN), Webmeet video conferencing application. Engineers and scientists require the next generation TB network system. Also intelligent global system and network integrated global system are needed. Other requirements are workflow optimization and long-range transfer methodology. The openScienceDMZ is cloud system and service as sharable ICT platform. It is solution for data intensive science and applications. The system allows sharing, delivering and storing data. The openScienceDMZ is one thousand times faster compared to current internet. The PRP testing showed transfer speed as high as 1.6 TB per minute. The KREONET openSCiencesCloud service is currently receiving data from other countries with 100Gbps transfer speed. KREONET already build openScienceDMZ Cloud in Seoul and Daejon and in 2017 will build in Busan, Gwang-ju etc.

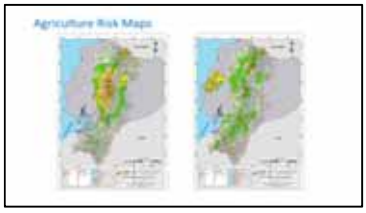
**Joseph M. RUSSO, ZedX Inc.: New role of weather-based models in commercial agricultural decision making.**




Using video presentation Dr Joseph M. Russo presented about new role of weather-based models in commercial agricultural decision making from a historical perspective of data-generating technologies, downscaling methods, a changing climate, and demands being placed on industry stakeholders. He pointed out the role of “big data” in agricultural industry and explained the IT platform architecture and its needs. Big data presents a major challenge to commercial agricultural decision making. This challenge technology or IT paradigm that describes the flow of information from the point of collected data to its use in agricultural decisions. The paradigm itself must be based for the architecture of an operational IT platform.

## Session 4: GIS Task Team - Agromet and GIS Applications for Agricultural Decision Making II

**Diana ESPINOZA, International Research Center in "El Nino" CIIFEN: GIS Technology for making decision in agrometeorology : Early Warning System in Andean Region and its impacts in the agriculture development**




Dr Diana Espinoza explained main agricultural issues in Andean region and activities at CIIFEN. The Andean region is exposed to phenomena such as frost droughts, intense rain that effects its agricultural development. A GIS model was used to evaluate the selected indicator, and generate a map with ranges of vulnerability to each threat. The information generated in the vulnerability analysis in many cases constitutes a starting point for correct planning. An early warning system has been developed using vulnerability analysis and meteorological and climatic monitoring of the territory as basic information through a virtual cartographic platform.

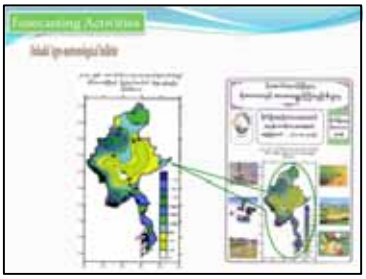
**Eric LUEBEHUSEB, USDA: USDA's operational GIS and related processes for International Weather and Crop Assessment**

Dr Eric Luebehusen explained the process of data management and analysis at USDA's WAOB. A group of 5 meteorologists provide weekly and monthly comprehensive assessments of past and current weather and resultant crop impacts across the globe. The GIS work at the WAOB involves a large suite of in-situ datasets and derived products, and involves a substantial amount of automation of GIS data acquisition as well as product generation. The process involves Wget to download ASCII data and Python code to interpolate the data, convert to Geotiff and to create the regional maps. In addition to the automated maps and products, macros and programs have been written to interpretation within ArcMap for episodic events.

**Nor Adawiah ABDULLAH, Malaysian Met Service: GIS applications of Agro Meteorology for Malaysia**

Dr Abdullah Nor Adawiah introduced the climatological characteristics of Malaysia, existing agro-meteorological products in Malaysian Meteorological Department (MMD) and GIS applications to support Agricultural Sector in the Nation. The MMD provides 10-day of Agro-meteorological Bulletin and Agro-climatic Analysis & Outlook. In the 10-day Bulletin provides information such as rainfall amount, rainfall anomaly, evaporation rate, standardized precipitation index etc. The data are interpolated and used in the bulletin. The Agro-climatic Analysis & Outlook provide overview of rainfall at previous 10 day outlook of following month and weather condition effect to agriculture. The agrometeorological products include agriculture rainfall index, agro-climatic map, crop zonation, agro-ecological regions etc. The maps are provided using Inverse Distance Weighted interpolation technique in ArcGIS. The heat wave maps are provided at district level.

**May Khin CHAW, Ministry of Transport and Communications: Agro-meteorological services of Myanmar**



Dr May Khin Chaw introduced activities at the Department of Meteorology and Hydrology (DMH) in the field of agro-meteorology and explained status and main issues of agro-meteorology in Myanmar. The main issues is lack of agro-meteorological stations (only 17 stations in the whole country), old technology used for the measurements, lack of high educated personnel. The DMH produce the 10-day Agro-meteorological bulletin and agro-met weekly forecast are issued and broadcast in TV Farmer Channel since 2013. The capacity building activities include agro-meteorological basic/intermediate course and Meteorological Grade III course. The Agro-Meterological Division issued the Agro-Meteorological Handbook

which provide information such as "how to take observation, how to analyze the observed Agro-meteorological data, methods of calculating agro-met indices" etc.

## Session 5: GIS Applications - AgroMet II, Meteorological technology for user-customized agricultural management

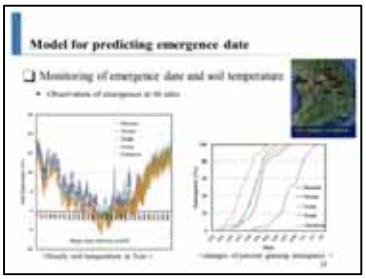
**Eun Woo PARK, Seoul National University: Application of Unified Model (UM) weather prediction data for rice disease forecast.**


In this study Dr Eun Woo Park investigated possible use of numerical weather forecast data as input for disease forecast models for rice blast, sheath blight and bacterial grain rot. The numerical weather forecast data were generated by the Unified Model (UM), which is a numerical weather prediction model adapted by the Korea Meteorological Administration (KMA). The UM data and UM-based disease forecast were evaluated against the AWS data and AWS-based disease forecast, respectively. The UM data show good agreement and correlation with observation in case of Temperature and Relative humidity both has poor correlation in case of the rainfall. For the UM-based disease forecast, the best accuracy and critical success index was produced in case of bacterial grain rot. Another objective of the study was the development of IT platform for agro-met information services, which is currently under developement.

**Kyu-Jong LEE, Seoul National University: Development of an on-demand microclimate information service for Ginseng**

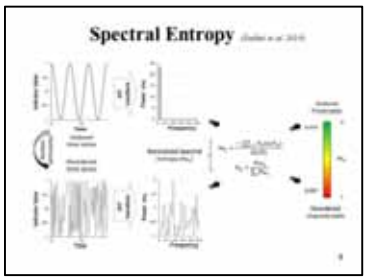
Dr Kyu-Jong LEE introduced project on development of micro-climate information service for Ginseng. The objectives of his study were to develop model for predicting micro-climate conditions under a shade and phenology of Ginseng plant, and disease warning system for Ginseng foliar disease. Micro-climate

model based on energy balance and mass flow in shade structure was developed. The model was calibrated and validated using observation data from two test beds installed at commercial ginseng fields at Yeoju, Korea. The micro-climate model simulates not only air temperature, relative humidity, and plant temperature under a shade but also evapotranspiration and photosynthesis of Ginseng plant with reasonable accuracy. Phenology model based on soil temperature was developed to predict emergence date of Ginseng in the springtime. The model showed good performance with $r^2$ = 0.82. Moreover, TOM-CAST disease warning system was developed to predict occurrence of Ginseng foliar disease. It uses leaf wetness duration (LWD) and temperature as input variable, and the LWD was estimated using fuzzy logic system model. Both LWD and TOMCAST models showed reasonable accuracy.

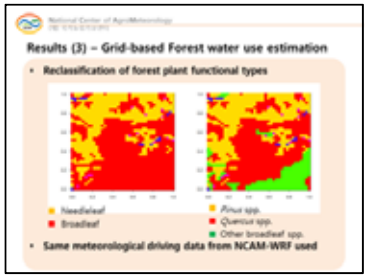



**Joon KIM, Seoul National University: Towards quantifying system resilience for Climate-Smart Forestry**

Dr Joon Kim presented research on quantitative assessment of resilience of a forest. With his colleagues he estimated normalized spectral entropy as a proxy measure of subsystem resilience using tower-based fluxes monitored over two adjacent forests to examine if the current state of forest management is a proper configuration toward climate-smart forestry. Eddy covariance technique was used to measure fluxes of carbon, water and energy along with other micro-meteorological, plant and soil variables from 2006 to 2015. Spectral entropy was calculated from power spectral density and then normalized ($H_{SN}$). The result shows that the coniferous forest was more resilient and more ordered compare to the deciduous forest. As a conclusion, regularity of time series are related to system's responses balancing feedback loops that result in system's paths within preferred bounds. The more adaptive capacity within a system, the greater the likelihood that the system will be resilient to induced stress. Based on information theory, $1\text{-}H_{SN}$ relates to ecological resilience to help gauge effectiveness & strength of balancing (natural and/or human-managed) feedback loops at work.



**Juhan PARK, Seoul National University: Estimation of forest water use with land surface model over Gwangneung watershed**



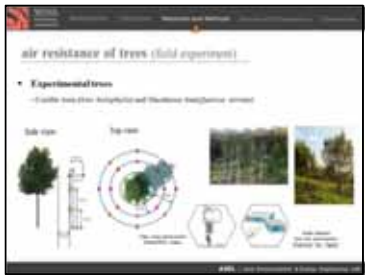

As part of generating water use estimation for entire forest in Gyeonggi province, forest water use of Gwangeung watershed was estimated with JULES land surface model with modified plant functional types and locally optimized parameter set. Plant functional types were reclassified from simple deciduous/coniferous classification to a detailed five main tree species. Plant structural and physiological parameters including canopy height, leaf nitrogen content and leaf conductance, were optimized by sensitivity analysis and comparison with eddy covariance data measured at the mixed deciduous and coniferous forest. A result of site-specific parameterization, model estimated latent heat flux in good agreement with observed value ($r$=0.80 for deciduous forest and $r$=0.77 for coniferous forest), but the accuracy was decreased at leaf onset and offset periods in deciduous forest and at summer time in coniferous forest. Modified plant functional types could provide more accurate estimation of forest water use in target area.

## Session 6: GIS Applications - AgroMet III- Meteorological technology for User-Customized Agricultural Management

**Taehwan HA, Seoul National University: Development of a micro-scale CFD model to predict wind environment on complex-terrain**

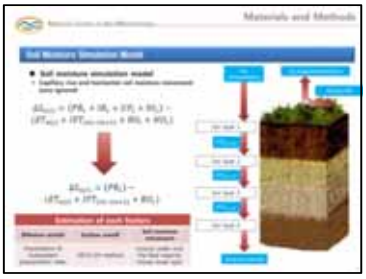
The objective of this study was to develop a micro-scale 3D CFD model to predict wind environment on complex terrain. The ground surface of the CFD model was classified and designed based on land use map provided by National Geographic Information Institute of South Korea in order to simulate air resistance of trees from target area. The designed 3D complex terrain CFD model was validated by using distributions of wind velocity and direction, measured in field experiments. The result showed that the CFD model with standard k-ε

turbulence approach is suitable to simulate wind environment.




**Jin-Yong CHOI, Seoul National University: Development of water demand forecasting service for cropping land**

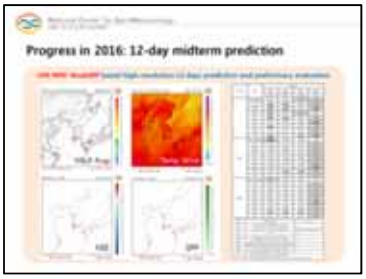
In this study, the water requirements in the paddy and upland were calculated by utilizing NCAM-LAMP (National Center for AgroMeteorology-Land Atmosphere Modeling Package) meteorological data. The grid-based meteorological data derived from NCAM-LAMP were linked to a water balance model and then were compared with nearest weather station data. In paddy, the water requirement was estimated with the water balance model with rainfall and evapotranspiration. In upland, the soil moisture was designed with four layers according to depth of soil and the irrigation requirements at each layer were computed with soil moisture content and evapotranspiration. The results showed difference in rainfall, evapotranspiration, and water requirements. As the grid-based NCAM-LAMP data was in accordance with observation. With the applicability verification, the spatial map of water requirements will be serviced to water management users including local offices of Korea Rural Community Cooperation and expected assistance for better strategic setting in agricultural water supply.




**Seung-Jae LEE, National Center for AgroMeteorology: A Land-Atmosphere Modeling Package (LAMP) for supporting agricultural and forest management at the National Center for AgroMeteorology (NCAM)**

The objective of this was to briefly describe the two components of the NCAM-LAMP and to evaluate their initial performance. The WRF/Noah-MP coupled system was configured with a parent domain over East Asia and five nested domains with a finest horizontal grid size of 90 m. The

standalone LSM simulation is conducted for one year with the original and modified settings, and is compared with the KoFlux site observation for net radiation, sensible heat flux, latent heat flux, and soil moisture variables etc. The two models runs, the original and modified configuration, were driven by local atmospheric forcing data from Haenam farmland site, Gwangneung forest site, and Cheorwon rice paddy site. According to the result, the third nest domain (810 m resolution) among all domains showed the minimum RMSE for 2-m temperature, 10-m wind and 2-m humidity. Turning on the dynamic vegetation had a tendency of reducing 10-m wind simulation errors in all domains. The first nest domain (7290 m resolution) showed the highest precipitation score, but showed little advantage compared with using the dynamic vegetation.

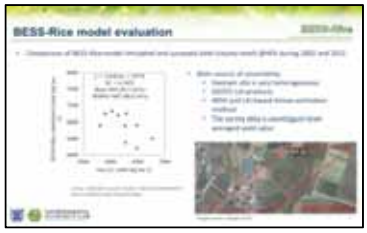



**Minseok KANG, National Center for AgroMeteorology: The Operation of Agricultural and Forest Meteorological Observing System by KoFlux in the National Center for AgroMeteorology (NCAM)**

The objective of this study was to construct and provide database from the eddy covariance technique based agricultural and forest meteorological observing systems. The database includes carbon/water/energy fluxes which used to validate and improve the models in iCAMS (infrastructure of Customized AgroMeteorological support Service) and CAMS (Customized AgroMeteorological support Service) projects. The network of the observing systems covers various ecosystem types which are rice paddy, farmland, coniferous forest, deciduous forest, and mixed forest. In the presentation, monitoring network and some interesting observation results such as how the carbon fluxes have been affected by typhoons were presented. The results show that the mid-season drainage (MSD) decreases $CH_4$ emission from an irrigated rice paddy. Ecosystem-Atmosphere fluxes observations in long-term networks identify trends, temporal scales of variability, spatial patterns and variations of radiation, water carbon, energy and entropy budget.

**Yan HUANG, Seoul National University: Developing and evaluating a satellite derived rice growth and yield estimation model, BESS-Rice**

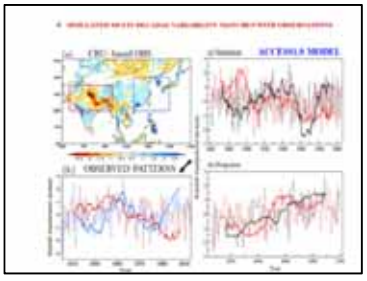
In this study, rice growth and yield estimation model BESS-Rice was developed, by integrating carbon allocation module into satellite remote sensing derived and biophysical process based Breathing Earth System Simulator (BESS) model. Normalized accumulated gross primary productivity (NA-GPP) was used as a scalar for growth development, and the relationships between NA-GPP and dry matter partitioning coefficients were built on the eddy covariance and biometric measurements at the Cheorwon flux tower site. Analysis of correlation shows that over 87% variations in dry matter allocation coefficients of above ground organs could be explained by the NA-GPP. The dynamics of dry matter distribution among rice organs during development was simulated, and the annual grain yield and straw production was estimated finally. Rice growth, yield and straw production were evaluated against the in-situ data at site-level.




**Session 7: GIS Applications - Downscaling Methods II**

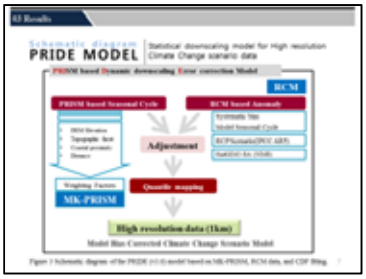
**Amita PRABHU, Pukyong National University: Monsoon variability over South and East Asia: statistical downscaling from CMIP5 models**

In this study CMIP5 historical simulations and future projections of South and East Asian summer monsoon variability and teleconnections are investigated using historical simulations (1861-2005) and future projections under RCP4.5 scenarios (2006-2100). Detailed analyses were performed using nine models having better representation of recent monsoon teleconnections for the interactive Asian monsoon sub-systems. However, these models underestimate rainfall maxima. The simulation biases, underestimations of observed monsoon variability and teleconnections suggest further improvements for better representation of Asian monsoon in climate models.



The performance of Australian Community Climate and Earth System Simulator version 1.0 (ACCESS1.0) such as annual cycle rainfall, over and above multidecadal variation of summer monsoon rainfall, confined to South and East Asia turns out to be relatively more realistic. In spite of large spread among the CMIP5 models, historical simulations as well as future projections of summer monsoon rainfall indicate multidecadal variability.

**Seonae KIM, Kongju National University : Statistical downscaling for daily precipitation in Korea using combined PRISM, and quantile mapping: Part I, Methodology and evaluation in historical simulation**




In this study, the Parameter-elevation Relationship on Independent Slopes Model (PRISM)-based Dynamic downscaling Error correction (PRIDE) model, which is suitable for complex topographies was presented. The PRIDE model is constructed by combining the PRISM module, the Regional Climate Model (RCM) anomaly, and quantile mapping (QM) to produce high-resolution (1km) grid data at a daily time scale. The results show that the systematic bias of the RCM was significantly reduced by simply substituting the climatological observational seasonal cycle at a daily timescale for each grid point obtained from the PRISM. QM was then applied to correct additional systematic bias by constructing the transfer functions under the cumulative density function framework between the model and observation using six types of transfer function. K-fold cross validation of the PRIDE model shows that the number of modeled precipitation days is approximately 90~121% of the number of observed precipitation days for the five precipitation classes.

**Sung-Dae YANG, National Institute of Meteorological Sciences: Issues on downscaling methods and their promising directions in the future on the purpose of agrometeorology**

Dr Sung-Dae Yang briefly introduced future plans of research in agro-meteorology at NIMS and opened discussion about issues on present downscaling methods. The topics of the discussion were: “Which downscaling method is most appropriate for the AgroMet? What are the pros and cons of

dynamical and statistical downscaling techniques? How do we measure the uncertainty in the given downscaling method? What are the most important things in downscaling techniques for high resolution AgroMet information when predicting subseasonal and seasonal forecasts? What is the promising direction for the AgroMet in sense of downscaling in the future?", etc.