



45
Session of TC



TCS
Activities



Members
Activities 2013



1st Semester 2013 Newsletter

45th Session
ESCAP/WMO Typhoon Committee
Hong Kong, China
29 January - 1 February 2013

Logos: ESCAP, WMO, 香港天文台 HONG KONG OBSERVATORY

Group photo of the Participants in the forty-fifth Session of the Typhoon Committee

THE FORTY-FIFTH SESSION OF THE TYPHOON COMMITTEE

The Government Hong Kong-China, in cooperation with ESCAP and WMO hosted the forty-fifth Session of the Typhoon Committee, which was held at the YMCA Salisbury Hotel, Hong Kong, China, from 29 January to 1 February 2013.

The Session was attended by 83 participants from 12 of 14 Members of the Typhoon Committee: Cambodia; China; Hong Kong, China; Japan; Lao PDR; Macao, China; Malaysia; Philippines; Republic of Korea; Thailand; the United States of

America (USA); and the Socialist Republic of Viet Nam.

The Session was also attended by four observers, from International Civil Aviation Organization (ICAO), Panel on Tropical Cyclone (PTC), Asian Disaster Reduction Center (ADRC) and Asian Disaster Preparedness Center (ADPC). Seven representatives of the Philippines Typhoon Committee Foundation Incorporated attended the Opening Ceremony. Representatives of the Economic and Social Commission for Asia and the Pacific (ESCAP), WMO and Typhoon Committee



The former Chairwoman, Ms. JIAO Meiyan and the current Chairman, Mr. SHUN Chi Ming

Official launching of the Typhoon Committee Community Weather Information Network Project

The TC Weather Information Network Project was officially launched at the Opening Ceremony of the 45th TC Session. The Project is conducted under Working Group on Disaster Risk Reduction and is led by the Hong Kong Observatory with the aim to raise community awareness towards weather and climate through hands-on educational activities in running weather stations in participating Members of the Typhoon Committee. Community weather stations have recently been installed in the Philippines and Guam, USA.

Secretariat (TCS) also attended the Session.

Mr. Shun Chi-ming, Director of the Hong Kong Observatory (HKO), Hong Kong-China, was elected Chairperson and Mr. Worapat Tiewthanom, Director-General of Thai Meteorological Department (TMD) was elected Vice-Chairperson of the Committee. Mr. Jeff LaDouce, Regional Director National Oceanic and Atmospheric Administration (NOAA), National Weather Service, Pacific Region was elected Chairperson of the Drafting Committee.

Delivery of Dr. Kintanar Award-2012

Dr. Roman L. KINTANAR Award-2012 for Typhoon related Disaster Mitigation was presented to the Government Flying Service of Hong Kong by Mr. So Kam-leung, the Secretary for Commerce and Economic Development and Congressman Angelo Palmones, Chairperson of the Philippines Typhoon Committee Foundation Incorporated.



Delivery of the Dr. Kintanar Award-2012 to the representative of the Government Flying Service of Hong Kong



Official launching of the Typhoon Committee Community Weather Information Network Project, during the opening ceremony of the 46th TC Session



TCS ACTIVITIES

Meetings and Workshops

69th Session of ESCAP – Senior Officials Segment – Bangkok, 25-27 April 2013

The Secretary of TC attended the Senior Officials segment of the 69th Session of ESCAP, in Bangkok, Thailand, on 25-27 April 2013, under invitation of Dr. Noeleen Heyzer, UN Under-Secretary-General and Executive Secretary of ESCAP.



Opening ceremony of the 69th Session of ESCAP

Severe Weather Forecasting Demonstration Project (SWFDP), Macao, China, 8-19 April 2013

TCS collaborated with the Macao Meteorological and Geophysical Bureau (SMG) and WMO to conduct the Regional Training Workshop on Severe Weather Forecasting and Warning Services under the framework of the Severe Weather Forecasting Demonstration Project (SWFDP) for Southeast Asia and the Bay of Bengal



Opening ceremony -The master of ceremony introduces Dr. Alice Soares (WMO), Dr. Fong Soi Kun (SMG) and Mr. Olavo Rasquinho (TCS)



Group photo of the participants at the SWFDP workshop - Macao, China on 8-19 April 2013

SSOP Workshop, Bangkok, Thailand, 8-9 May, 2013

The Typhoon Committee and the Panel on Tropical Cyclones Secretariat, with the support of ESCAP, WMO, and the Thai Meteorological Department (TMD) jointly conducted a workshop on Standard Operating Procedures as part of the project Synergized Standard Operating Procedures for Coastal Multi-Hazards Early Warning System (SSOP) on May 8-9, 2013. The Workshop was successfully held at the UN Conference Center (UNCC) in Bangkok, Thailand.





Workshop on Synergized Standard Operating Procedures for Coastal Multi-hazards Early Warning System - SSOP -



Group photo of the participants of SSOP Workshop

Advisory Working Group Meeting, Bangkok, Thailand, 10 May 2013

Taking advantage of the SSOP Workshop, the AWG of TC met in Bangkok, on 10 May 2013. Various issues were tackled, particularly related to the programme for the 8th IWS/2nd TRCG Forum, realization of the 46th TC Session, SSOP progress and review, WGM field experiment, Strategic Plan mid-term review.



Participants at the AWG meeting

Participation of the TCS Hydrologist in the East Asia Summit (EAS) on Risk Management of Major Natural Disasters'- Beijing, China, 24-28 June 2013

At the invitation with funding support of the National Disaster Reduction Center of China (NDRCC), the hydrologist of TCS Mr. Jinping LIU participated in the 'EAS Seminar on Risk Management of Major Natural Disasters' (EAS: East Asia Summit) held from June 24 to 28, 2013 in Beijing, China. Mr. Jinping LIU introduced 'Typhoon Committee Strategic Plan and Its Cooperation Mechanism on Typhoon-related Disaster Risk Reduction', and he was invited to address at closing ceremony.



Group photo of the participants of EAS in Beijing

- Steps of requesting Financial support from Ministry of Strategy (MOSF) and Finance or Korea International Cooperation Agency (KOICA) of Republic of Korea for the projects submitted by Members with the collaboration of NDMI and TCS.

- The concept on the post-2015 DRR Framework with the focus on three objectives: Effective Disaster Policy Making, Developing state-of-the-art Technology for DRR and Implementing DRR Policies and Technologies were also introduced.

TCS also took this opportunity to brief the WGDRR members about the progress of the SSOP as well as introducing the Field Experiment Project – Typhoon Experiment on Structure and Intensity Change in the Coastal Area (TEXSICA), which will be developed by WGM. WGDRR members were invited to provide further cooperation for the SSOP and the input on formulation the project proposal.

The 8th WGDRR Meeting, Seoul, 29-30 May 2013

With the kind support from National Disaster Management Institute (NDMI) of Republic of Korea, the 8th International Workshop of Typhoon Committee Working Group on Disaster Risk Reduction was successfully held in Seoul on 29 – 30 May 2013. Besides the participants from the WGDRR members, representatives from TCS and ADRC were also invited to participate at the Workshop.

This Workshop provided a good opportunity for the WGDRR members to discuss the current annual operating plans as well as the strategy of the future works of WGDRR. Among the various topics discussed in the Workshop, certain issues were highlighted:

- Enhancement of the Typhoon Committee Disaster Information System (TCDIS) as well as the continuation of the expert mission regarding the TCDIS. NDMI is much concerned about the lack of disaster information data from some Members for the TCDIS and reiterated the necessity of the cooperation from Members in providing the data.

VISIT of NDMI delegation to TCS (Macao, China - February 2, 2013)

Dr. YEO Woon Kwang, Chairman of the WGDRR and President of the National Disaster Management Institute (NDMI) of Republic of Korea, together with Dr. SHIM Jaehyun, Dr. LEE Chihun and Dr. KIM Yun Tae, researchers of NDMI, visited the TCS office on February 2, 2013.

It was taken advantage of this visit to establish talks on WGDRR related activities, in particular as regards international cooperation and training in disaster management. It was agreed that NDMI would contact TCS, requesting collaboration, and giving details on the areas to cooperate. TCS would then contact potential interested Members.



Group photo of the participants of 8th WGDRR Meeting



NDMI in TCS

Macao- China Government seconded an expert on DRR to TCS



The Macao-China government decided to second an expert to fill the post of specialist in DRR, in TCS. The new staff, Mr. Lei Pun Chi, Barrie, has the degree in Engineering of Protective Safety. He worked at the Macao Fire Service Bureau (MFSB) and has several diplomas and certificates in the area of civil protection. He recently performed the functions of Deputy

Commander of MFSB.

Mr. Barrie began to work in TCS headquarters on July 17, 2013.

TV & Newspaper



Mr. Olavo Rasquinho on the TDM Talk Show broadcasted on the Portuguese/English channel of the Macao TV. The half-hour talk was about tropical cyclones and the role of Macao-China under the framework of the Typhoon Committee.

WGM News

Since the 45th Typhoon Committee Session held in Hong Kong on January 2013, WGM members have put up their efforts to implement the annual operating plans which are progressing satisfactorily. Some of the actions that have already undertaken are summarized as below:

- A study of the evaluation of predicting TC genesis events has been carried out by JMA under the NWP-TCEFP and the preliminary results show that the EPSs has the potential to predict genesis events sometimes with a lead time of 5 days.
- Starting from 3 June 2013, JMA has extended the forecasting region of the storm surge model and added 7 stations for storm surge time-series forecasting services. The extended region now covers 95-160° E in longitude and 0-46°N in latitude. JMA has already received requests from Members for the inclusion of their stations in the time series forecasts.
- Regarding the study of the methodology to compare the best track datasets as well as to discuss the scientific reasons for discrepancy among the datasets of the concerned centers, namely, CMA, JMA, HKO and JTWC, and as the first step, the centers that do not possess the digitized CI numbers are now working on the digitization of the CI numbers.
- The Task Force on tropical cyclone intensity analysis for upgrading TD has now identified 9 discrepancy cases between CMA and RSMC Tokyo during 2007 – 2011. It is currently gathering the supporting observations/information in order to identify the reasons behind the discrepancies in each of these 9 cases.
- To further develop the techniques of typhoon seasonal prediction, KMA is working on to include the current climate index condition which is related to the typhoon seasonal activities into the web-based seasonal prediction portal system. The ENSO, Arctic Oscillation (AO), Antarctic Oscillation (AAO), Pacific Decadal Oscillation (PDO), Eastern Indian Ocean SST Anomaly (EIO SSTA) will be the major components for climate monitoring. The web-based typhoon seasonal prediction portal system will be linked to the English page of National Typhoon Center homepage (<http://typ.kma.go.kr/eng>) and open to registered users of TC Members at the end of year 2013.
- The improvement of the severe weather forecasting web portal of SWFDP-Sea (<http://swfdp-sea.com.vn>) is undertaking by NCHMF of Viet Nam with more products are available which includes daily severe weather forecasting Guidance for short and medium range, global deterministic and ensemble NWP products of



various institutions among many useful products.

- The project on development of regional radar network undertaken by TMD with the technical assistances of JMA has been progressing well according to the road map. TMD is now working on the development of source codes for conversion from UF format to GRIB2 format as well as ones for production of DILS with the assistances from JMA. Either an expert mission of the radar expert from JMA to TMD or attachment training will be organized later of this year.
- The second assessment report on the impacts of climate change on tropical cyclones has been published in February 2013 and now it is available on the TCS website (<http://www.typhooncommittee.org/docs.htm>)

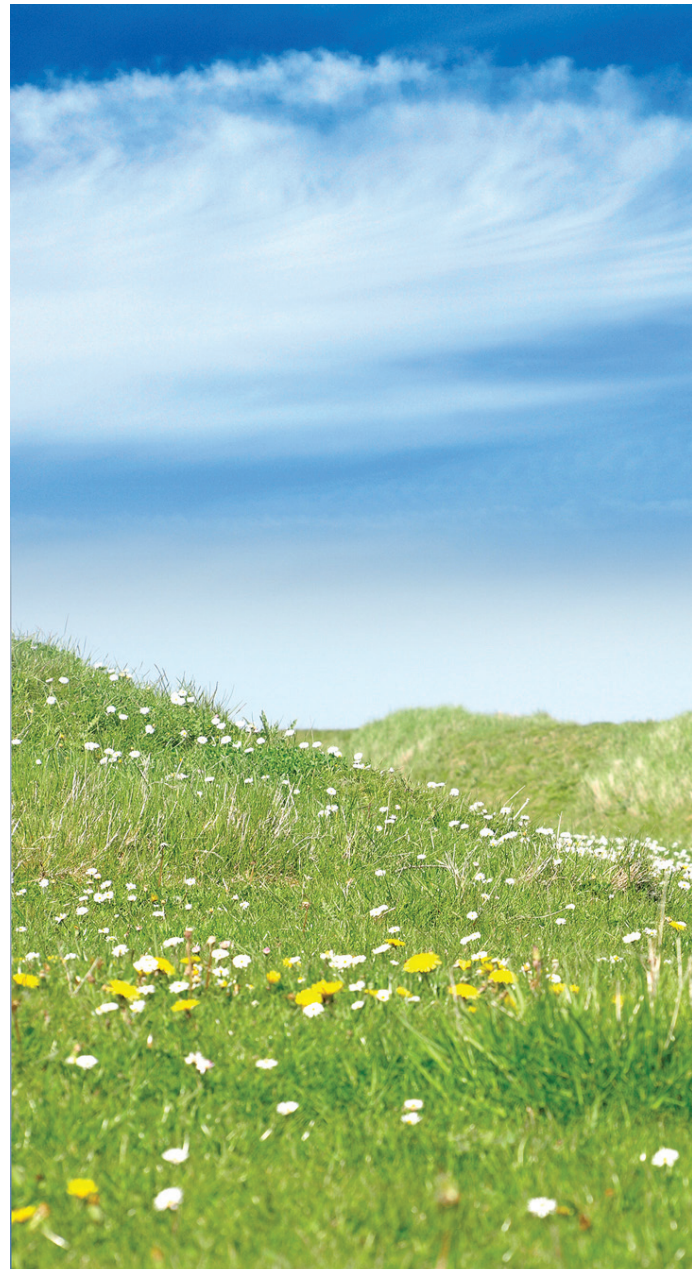
With the kind support from RSMC Tokyo, KMA, STI/CMA and HKO as well as the support from the allocated TCTF budget, WGM has been organizing quite a few training activities through the attachment training and the research fellowships. Two operational forecasters from Laos and Thailand will participate at the RSMC attachment training in July which will include the storm surge and QPE/QPF training in the course while 3 experts from PAGASA, TMD and Viet Nam participated at the Research Fellowship on TAPS offered by KMA on May to June 2013. Currently, TCS has made the announcement of 2 more fellowships offered by HKO and STI with the research focus on the development of location-specific severe weather nowcast products and tropical cyclone genesis forecast verification. Both Fellowships will take place later of this year.

In addition to the above highlighted WGM activities, Chair of WGM has drafted the proposal of the field experiment - Typhoon Experiment on Structure and Intensity Changes in the Coastal Area (TEXSICA) based on the recommendation at the 45th TC Session. The objective of the experiment is to gather the comprehensive observation data of the core structure and intensity evolution of the near-coast and landfalling tropical cyclones and the subsequent application of the collected data in the research in order to enhance the understanding of their structure, intensity changes mechanism and micro-physical characteristics and process. The revised draft proposal will soon be sent to the WGM members for discussion and further inputs from Members before submitting to the Session.

At last, thanks to the dedicated work of the editorial office of the TC Journal "Tropical Cyclone Research and Review", 6 issues of the Journal with 54 articles have already been published since the official launch of the Journal in February

2012. It is recognized by Members that the Journal has been becoming one of the important means of sharing the research work of the Members as well as promoting the visibility of Typhoon Committee internationally. The editorial office wishes to thank all the Members for their supports as well as the contributions from the authors of the articles, and encourages more submission of the articles from the Members to share their research works to the Members. Members can consult the articles through the website <http://tcrr.typhoon.gov.cn>. To further improve the editorial work of the editorial office, TCS has recently announced the invitation for a visiting editor to work at the editorial office for 5 days tentatively in August.

Above are just a few highlights of the activities of WGM. Looking forward to the second half of the year, WGM members will sure do their best in order to successfully accomplish all the projects. At last, on behalf of Chair of WGM, we wish to thank all the Members in particular the coordinators of the AOPs for their significant contributions.





TC NEWS FROM MEMBERS



1. Hong Kong, China hosted the 45th Session of the Typhoon Committee

The 45th Session of the Typhoon Committee, hosted by Hong Kong, China, was conducted from 29 January to 1 February 2013. Around 90 meteorological, hydrological and disaster reduction experts in the region participated.

Mr Shun Chi-ming, Director of the Hong Kong Observatory and Permanent Representative of Hong Kong, China with WMO, succeeded Ms Jiao Meiyuan as the Chairperson of the Typhoon Committee and presided at the Session. Mr Shun and Ms Jiao were instrumental in driving for reform in the effective governance of the Committee in the past couple of years, with fruitful results already evident at the 45th Session. Mr Edwin Lai, Assistant Director of the Hong Kong Observatory, was elected as Chairperson of the Advisory Working Group.

The annual Dr Roman L Kintanar award was presented to the Hong Kong Government Flying Service (GFS) (Figure 2) in recognition of its commitment and outstanding work in collecting crucial meteorological data in the vicinity of tropical cyclones over the South China Sea.

At the Hong Kong Observatory (HKO), developments were underway to provide the aircraft reconnaissance data online to facilitate tropical cyclone analyses and studies by forecasters and researchers. In particular, in-situ measurements collected on 22 July 2012 for the tropical cyclone Vicente were provided to RSMC Tokyo for data sharing with other Members to conduct post-analysis of cyclone intensity and wind distribution. The dataset was also provided to ECMWF to develop data encoding format for near real-time data exchange, as well as impact studies on data assimilation and model forecasts.



Figure 1
Mr Shun Chi-ming, Director of the Hong Kong Observatory, addressing the meeting at the opening ceremony.



Figure 2 Mr Gregory So, Secretary for Commerce and Economic Development of Hong Kong Special Administrative Region Government (right) and representative from the Philippines Typhoon Committee Foundation, Mr Angelo Palmones (left), presenting the 2012 Dr Roman L Kintanar Award to the Controller of the Government Flying Service, Captain Michael Chan (middle).

The Community Weather Information Network (Co-WIN), a project developed by HKO in collaboration with the Hong Kong Polytechnic University, aims to raise public awareness on weather and climate through hands-on educational activities in the operation of weather stations by schools and other community groups. The Co-WIN concept was recently extended to Typhoon Committee Members, and two stations were set up at Mindanao, the Philippines and Guam, USA in December 2012. The two stations were officially launched during the opening ceremony. Observation data from these stations are available on the internet (<http://www.icowin.org>).



Figure 3 Officiating guests launching the Typhoon Committee Community Weather Information Network at the 45th Session.

2. Online global tool for tropical cyclone forecasters

The Tropical Cyclone Forecaster Website of WMO (<http://severe.worldweather.wmo.int/TCFW/>) (Figure 4), developed and hosted by HKO on behalf of WMO, has been put into operation in March 2013. The main purpose of the website is to assist weather forecasters around the world in gaining access to a comprehensive source of tropical cyclone information useful for operational forecasting. The website serves

as a portal of real-time information as well as forecast products concerning tropical cyclone development, movement, intensity and structure.

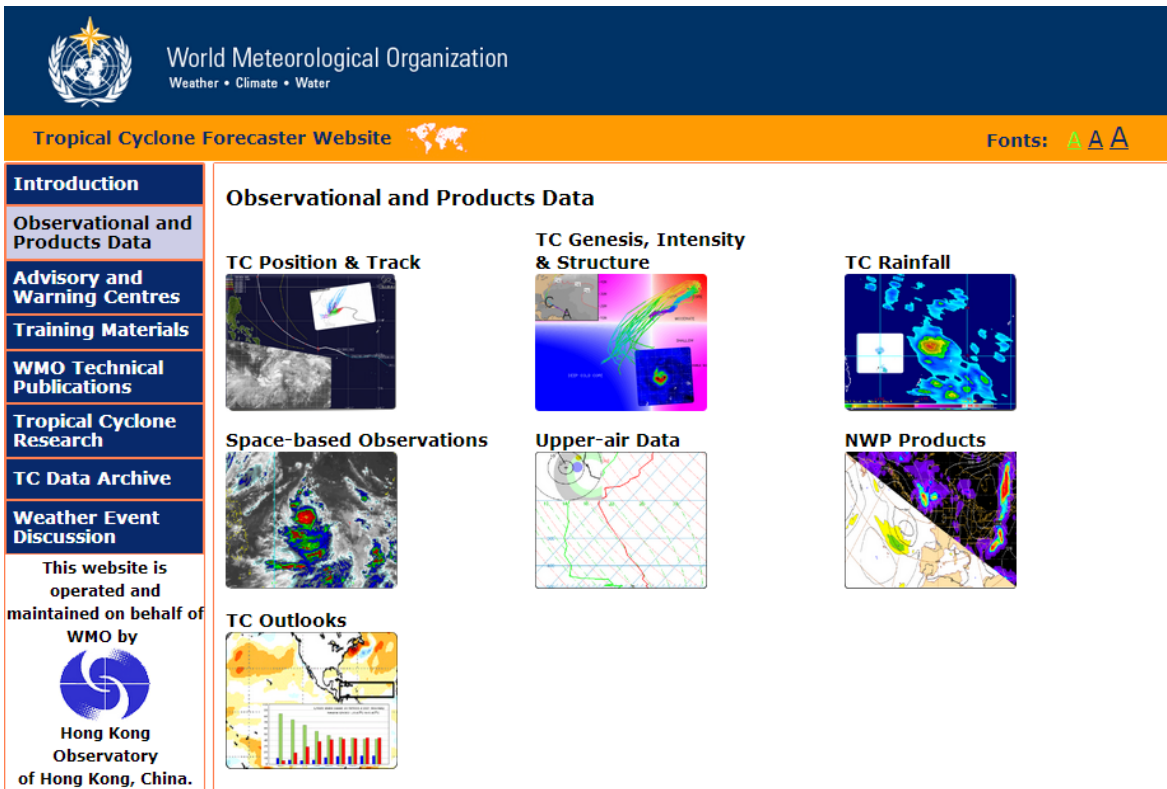


Figure 4 The WMO Tropical Cyclone Forecaster Website.

3. Training workshop on tropical cyclone intensity analysis

Under the auspices of the Shanghai Typhoon Institute of the China Meteorological Administration, Mr Chan Sai-tick, Senior Scientific Officer of HKO, conducted a training workshop on tropical cyclone intensity analysis using the Dvorak technique in Shanghai during 28-30 May 2013 (Figure 5).

Among the workshop participants were forecasters and researchers from Shanghai, as well as operational meteorologists from six provinces and two municipalities in eastern China. Topics included the history and evolution of the Dvorak technique, its detailed workflow, current practices in the application of the technique in different countries/regions and historical case studies. The workshop aimed to

enhance capabilities in the operational use of the Dvorak technique and the development of related technology.



Figure 5 Mr Chan Sai-tick lecturing at the training workshop.

4. Fruitful results from the Typhoon Committee Research Fellowship Scheme

Based on the work of the research fellows from the Philippine Atmospheric, Geophysical & Astronomical Services Administration and the Malaysian Meteorological Department under the Typhoon

Committee Research Fellowship Scheme 2012, algorithms on rainfall nowcasting during tropical cyclone situations were developed at HKO. One of the algorithms subtracted the large-scale tropical cyclone motion from the radar echo motion field, restrained the motion vectors in a circularly rotating form, and then translated the reflectivity and resultant motion field simultaneously. It was found to be capable of preserving the structure of a tropical cyclone in motion (Figure 6), thereby achieving generally higher skill scores for the rainfall nowcast when compared with SWIRLS, the operational nowcasting system of HKO. A joint paper on the research findings is under preparation for submission to the “Tropical Cyclone Research and Review” journal.

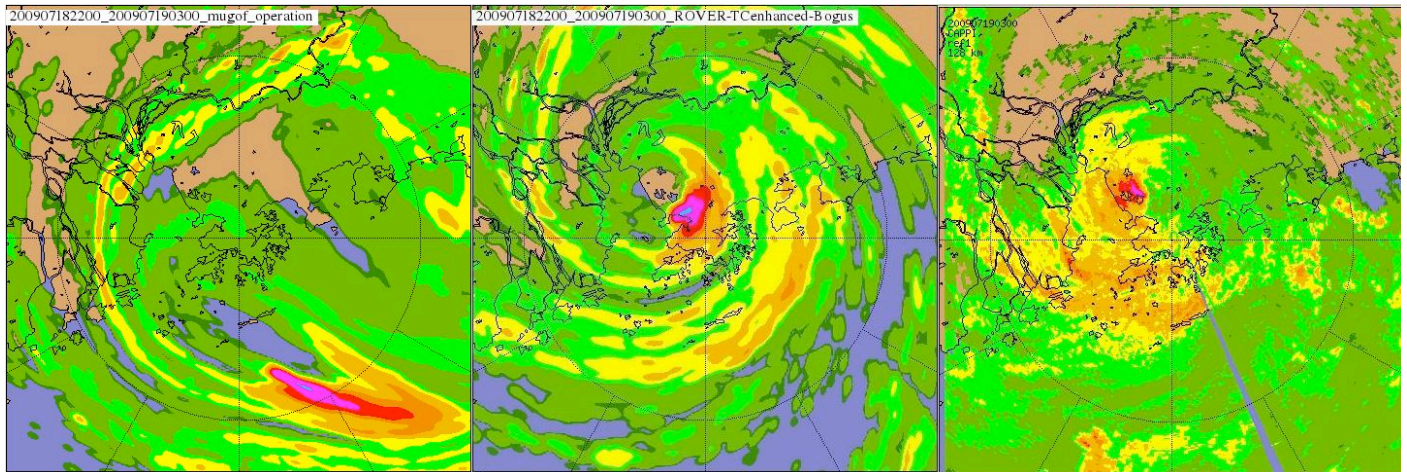
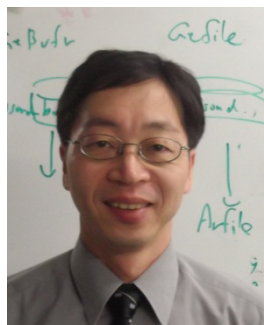


Figure 6 5-hour reflectivity forecast showing a deformed tropical cyclone generated by the operational algorithm (left), compared with a relatively well-preserved tropical cyclone structure under the new algorithm (middle) that better resembles the actual radar image (right) at 3:00 a.m. local time on 19 July 2009 during the passage of Typhoon Molave.

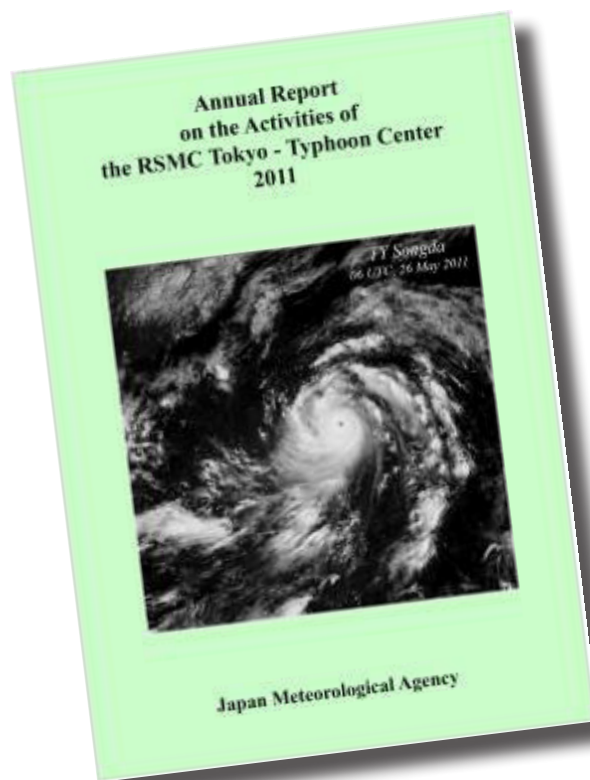


Tsukasa Fujita Appointed as NTC-JMA Head



Tsukasa Fujita was appointed as the new head of the National Typhoon Center at the Japan Meteorological Agency (JMA) on 13 May, 2013, succeeding Masashi Kunitsugu. Mr Fujita graduated from The University of Tokyo and started his career as a scientific officer at JMA

in 1988. After working as Deputy Director of the Administration Division in the Forecast Department, he transferred in 2011 to the Numerical Prediction Division, where he spent most of his time developing Numerical Weather Prediction (NWP) models. From 2011 to 2012, he was in charge of managing NWP operation and development in his role as Deputy Director. From 2012 to 2013, he led the development of JMA's NWP models in his capacity as Senior Coordinator for Numerical Weather Prediction Modeling.



Annual Report (DVD version also available)

Publications released by the RSMC Tokyo - Typhoon Center

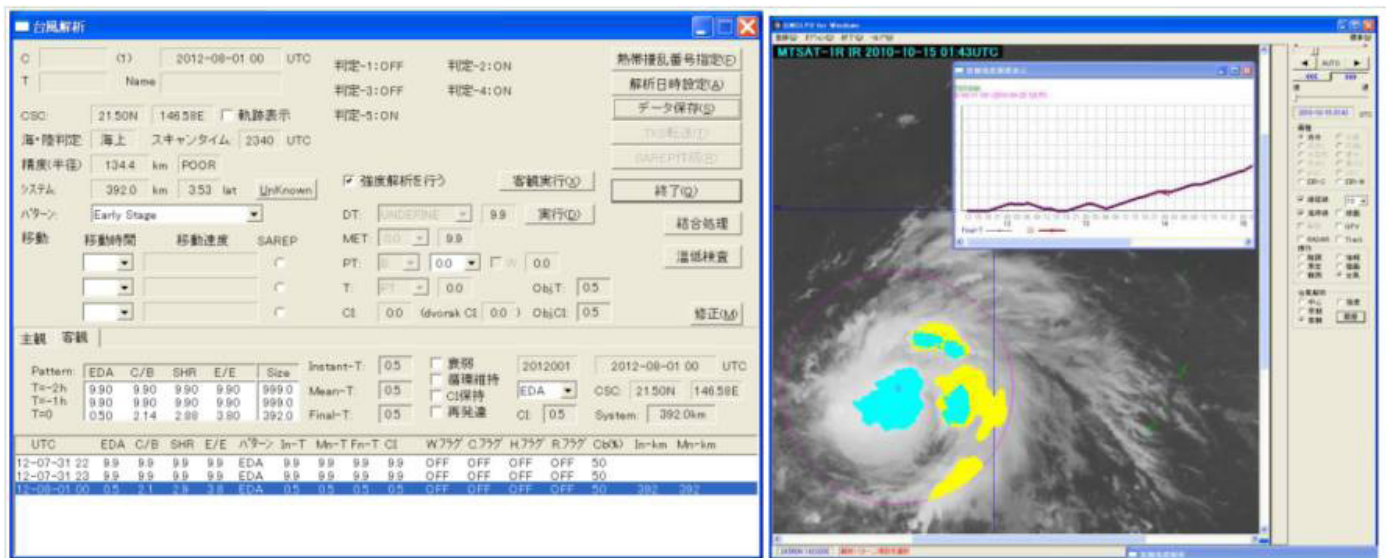
➤ Annual Report on the Activities of the RSMC Tokyo - Typhoon Center

The Annual Report on the Activities of the RSMC Tokyo - Typhoon Center 2011 was released in December 2012. The publication details RSMC products, analysis of tropical cyclones, and verification/specifications of numerical models. The DVD version distributed to Members includes MTSAT satellite images of all 2011 tropical cyclones along with the SATAID satellite viewer program.

➤ RSMC Technical Review No. 15

The RSMC Technical Review No. 15 was released in March 2013.

This issue features the Cloud Grid Information Objective Dvorak Analysis (CLOUD) scheduled for introduction into the operations of RSMC Tokyo in 2013, and includes details of the analysis method and verification results.



CLOUD prototype sample in SATAID

The Annual Report and the Technical Review are both available on the RSMC Tokyo - Typhoon Center website at http://www.jma.go.jp/jma/jma-eng/jma-center/rsmc-hp-pub-eg/RSMC_HP.htm.

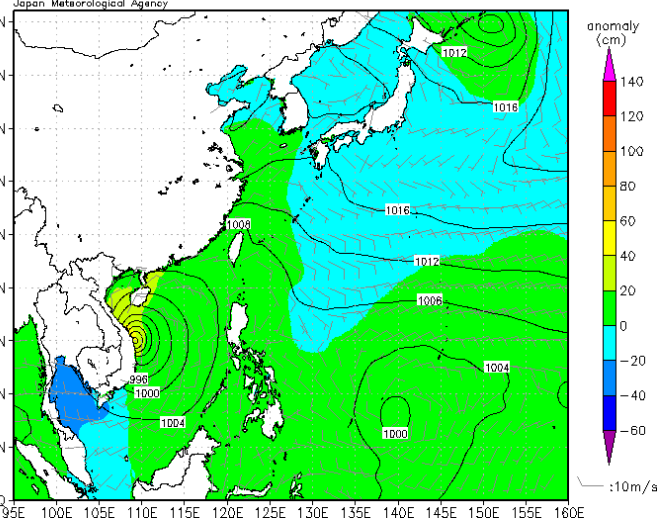
Enhancement of Storm Surge Information for Typhoon Committee Members

The Japan Meteorological Agency (JMA) introduced improved storm surge forecasts for Typhoon Committee (TC) Members on 3 June, 2013. The forecast region of the storm surge model was extended, and seven stations were added to support storm surge time-series forecasting services. These improvements were made in line with recommendations included in the Annual Operating Plan 2013 of the TC Working Group on Meteorology.

The new forecasting region, which is almost twice as large as the previous one, covers the area from 95° to 160°E longitude and 0° to 46°N latitude and includes the Mariana Islands and most of the Caroline Islands. This extension enables various users to understand the general characteristics of forthcoming storm surges, thereby supporting the issuance of early warnings and helping users in the extension area to access forecasts for the issuance of local warnings and advisories.

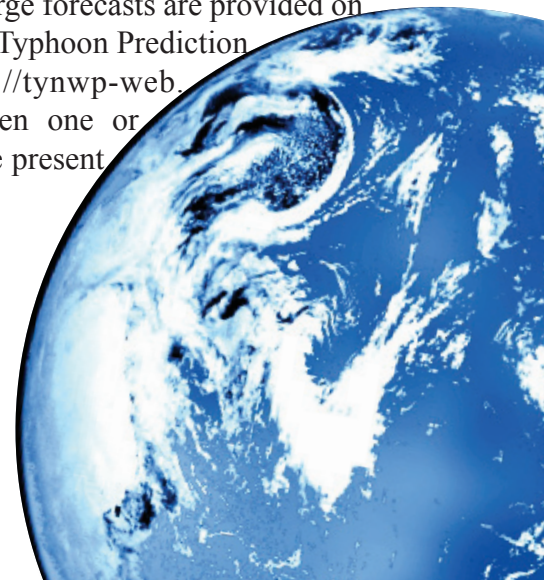
The additional stations for time-series forecast services are at Chumphon (Thailand), Boryeong, Busan, Incheon, Jeju, Mokpo, and Sokcho (Republic of Korea). JMA is currently preparing to add further stations in response to requests from TC Members in due course.

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Example of a storm surge horizontal map for the new region. The shading indicates storm surge values. Sea level pressure values (hPa) and surface wind barbs are also plotted.

This service is provided within the framework of the WMO Storm Surge Watch Scheme (SSWS), and real-time storm surge forecasts are provided on JMA's Numerical Typhoon Prediction website (<https://tyntp-web.kishou.go.jp/>) when one or more typhoons are present in the region.





World Meteorological Day 23 March 2013

Every year on March 23 is the “World Meteorological Day”. Members of the World Meteorological Organization have celebrations on the same day to commemorate “Convention of the World Meteorological Organization” became effective on March 23, 1950. The subject of this year’s World Meteorological Day was “Watching the weather to protect life and property”. It had underlined the importance of meteorological service and stressed that effective weather monitoring is helpful in minimizing the impact made by weather and climate.

In order to promote the importance of meteorological service and common meteorological knowledge, the Macao Meteorological and Geophysical Bureau (SMG), together with the Maritime Administration, the Energy Sector Development Office, the Macao Science Center and the Macao Electronic Company jointly organized a fun fair on the World Meteorological Day. The fun fair included Inter-school meteorological knowledge quiz, game booths, a drama about SMG’s service and exhibition boards on meteorological knowledge.

The celebration dinner was held on March 22 for those present and retired meteorological professionals, as well as organizations which have close relationship with SMG in order to enhance friendship. During the dinner, commendation medals were awarded to SMG staff members who have been serving in SMG for 20, 25 and 30 years.



Dr. Fong Soi Kun, Director of SMG, at the activities for the World Meteorological Day 2013.

Training Workshop on Severe Weather Forecasting and Warning Services Macao, China during 8 - 19 April 2013

The Training Workshop on Severe Weather Forecasting and Warning Services was held in Macao on April 8 to 19 by the World Meteorological Organization and the Macao Meteorological and Geophysical Bureau. About 35 participants of meteorological department from Southeast Asia and Bay of Bengal joined this workshop.





Group photo on the SWFWS

The purpose of this workshop was to strengthen the understanding of regional meteorological departments on numerical weather prediction product, as well as to improve ability of severe weather forecasting. In addition, the workshop also served as an academic exchange platform for professionals who engaged in meteorology service.

The first week of the workshop mainly strengthened product application on disaster weather forecasting and of nowcast. The second week mainly focused on technical exchange of weather forecasting and warning in emergency situations. The teachers were from many countries including Canada, Hong Kong, India, Japan, New Zealand, Sweden, Thailand and Britain.

The 5th meeting of the Pearl River Delta Aviation Weather Working Group in Macao, China during 21-23 May 2013

The 5th meeting of the Pearl River Delta Aviation Weather Working Group was held in Macao on May 21, 2013. During the meeting, the Civil Aviation Administration of China, Hong Kong Observatory and the Aeronautical Meteorology Center of the Macao Meteorological and Geophysical Bureau summarized the work of last year and discussed the working plan of this year.

In addition, the aeronautical meteorology experts had discussions on how to analyse the meteorological information and data exchange, the personnel exchange visits and learning, as well as analysis on important weather cases. The main discussion was the importance of Collaborative Decision Making (CDM) for enhancing safety and efficiency in the Pearl River Delta Aviation. For the purpose of upgrading professional ability of our staff members, SMG arranged a visit in the Aeronautical Meteorology Center at the Macao International Airport for the experts of Guangdong and Hong Kong.





1. Capacity Building of Typhoon Analysis and Forecast through the Typhoon Research Fellowship Program

The 2013 Typhoon Research Fellowship Program, as part of the Training and Research Coordination Group (TRCG) Fellowship Program of the ESCAP/WMO Typhoon Committee was successfully completed. Three typhoon forecasters who are from the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA), Vietnam National Center for Hydro-Meteorological Forecasting (NCHMF), and the Thailand Meteorological Department (TMD) were trained during two months (1 May to 30 June 2013) by the staffs of the National Typhoon Center of the Korea Meteorological Administration (NTC/KMA). The trainees carried out training on optimal usages of NTC/KMA's Typhoon Analysis and Prediction System (TAPS) for typhoon forecast. And each trainees are also performed on research work in the area of typhoon numerical prediction bias tendencies. The three topics are 'Development of consensus methods in typhoon model track forecast using model ensembles', 'Development of systematic bias error correction methods in major interaction with synoptic condition cases', and 'Analysis of typhoon numerical model forecast bias error tendencies in case of anomalous typhoon tracks. They participated enthusiastically in research collaboration with NTC/KMA staffs and drafting a research report in rather short duration of Fellowship Program. They contributed in improvement of TAPS by sharing their ideas on the future plan of upgraded version of TAPS. Since 2011, the NTC/KMA had carried out the Fellowship Program for a number of typhoon experts from Asian countries. The Fellowship Program will be continued in the next year in beautiful Jeju island of South Korea where the NTC/KMA are located (the period may be from May to June). Overall expenses (including round-trip ticket and living expense during

their stay (if available, accommodation) will be supported by the KMA. The circular letter or offering the KMA's fellowship will be sent to the members by the TCS at least one month before the commencement. Anyone from Typhoon Committee member countries who has interest in operational and research fields of TC forecast can apply to the Fellowship Program.

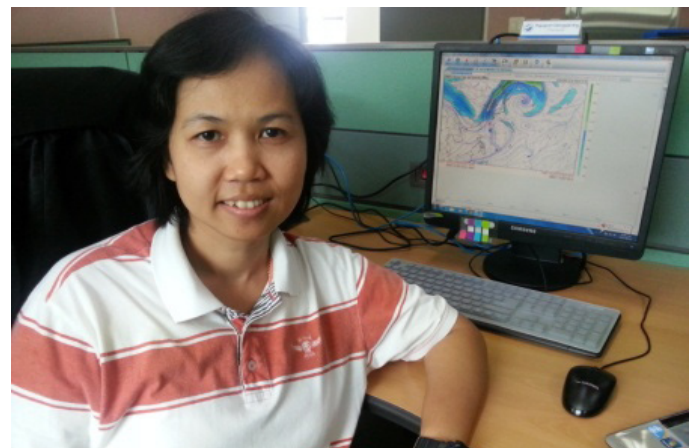


Figure 1. Three beneficiaries of the Typhoon Research Fellowship in 2013. Mr. Bonifacio Galit Pajuelas (PAGASA), Ms. Prapaporn Wongsaming (TMD), and Mr. Nguyen Huu Thanh (NCHMF) from left to right.



2. The 6th China-Korea Joint Workshop on Tropical Cyclones

Staffs of National Typhoon Center/KMA participated and made presentations in the 6th China-Korea Joint Workshop on Tropical Cyclones held in Shanghai Typhoon Institute in China on 27 and 28 May. In the workshop, approximately 30 presentations were made under the themes of typhoon models, typhoon analyses using satellite data, and typhoon climates. After the presentations, the two countries agreed to exchange the newest typhoon analysis and forecast technologies and promised to jointly cope with typhoons that might influence on both countries. On 29 and 30 May, the staffs of National Typhoon Center/KMA visited Zhejiang Meteorological Observatory, Zhejiang Institute of Meteorological Science, and Zhejiang Lightning Protection Centre to identify the present state of meteorological forecast science and lightning stroke alarms in Zhejiang Province. On 31 May, the staffs of National Typhoon Center/KMA visited the head office of the China Meteorological Administration in Beijing to discuss measures to cope with typhoon related disasters and dangers. The present usage state of typhoon prediction models in both organizations is exchanged. In that visit, measures to quickly exchange typhoon forecast information between the two organizations were prepared such as the establishment of a hot line between two operational typhoon forecast centers.



Figure 2. The workshop photos in Shanghai Typhoon Institute (upper panel) and Typhoon and Marine Weather Forecasting Center (lower panel) of China Meteorological Administration.

3. Improving the legibility of typhoon warning graphics

The typhoon warning graphics in advisory has been changed to enhance the awareness of the uncertainty of analyzed locations of typhoon center and to improve the legibility of typhoon information since 2013. The typhoon forecast tracks can be in error. This forecast uncertainty is conveyed by the



track forecast cone, the red shaded area up to 5 days. Historical data indicate that the 5-day path of the typhoon center will remain within cone about 70% of the time. The cone is made from the circles along the forecast track at the 24, 48, 72, 96, 120 hours position where the size of each circle is set to enclosing 70% of recent 3 years (2010-2012) official forecast errors (old type). In a new graphical typhoon product, the cone type is introduced, which is formed by smoothly connecting the area swept out by the set of circles. There are also changes in intensity forecast expression. The 10-minutes averaged maximum wind speed of 15 ms^{-1} and 25 ms^{-1} influencing area for 24, 48, 72 hours are expressed in dotted (for 15 ms^{-1}) and straight line (for 25 ms^{-1}) circle or ellipse shape due to elongation of strong typhoon winds distribution. In a new graphics, these circle or ellipse of strong winds area is smoothly connected at each forecast time. The main reasoning behind of these changes is on the important fact that the effect of typhoon force can be extended beyond the enclosed circles (old type) and seen as continuous effects along forecasted track.

4. KMA has launched its first aircraft project for the targeted observation

Since 2012, KMA has begun the observation aircraft project for the purpose of severe weather observation, the precipitation enhancement experiment, and the characterization of the atmospheric climate change components. In May 2013, KMA has made up the contract of its first aircraft procurement with the bidder of Daejoo ENT (Korea) and SPEC (US) consortium. According to the contract, an aircraft, BeechCraft King Air 350 H/W that is already widely used in atmospheric research area, will be delivered to Korea by the end of 2015. KMA's aircraft will be equipped with 14 kinds of instruments at the wings, fuselage, and inside, which include a dropsonde system, glaciogenic and hygroscopic cloud seeding systems, four kinds of cloud physical property measurement systems, and atmospheric aerosol and pollutant gas monitoring systems. As the main purpose of this project is to observe the severe weather phenomena, this aircraft is going to fly over the seas around Korea peninsula and approach close to the upcoming storm

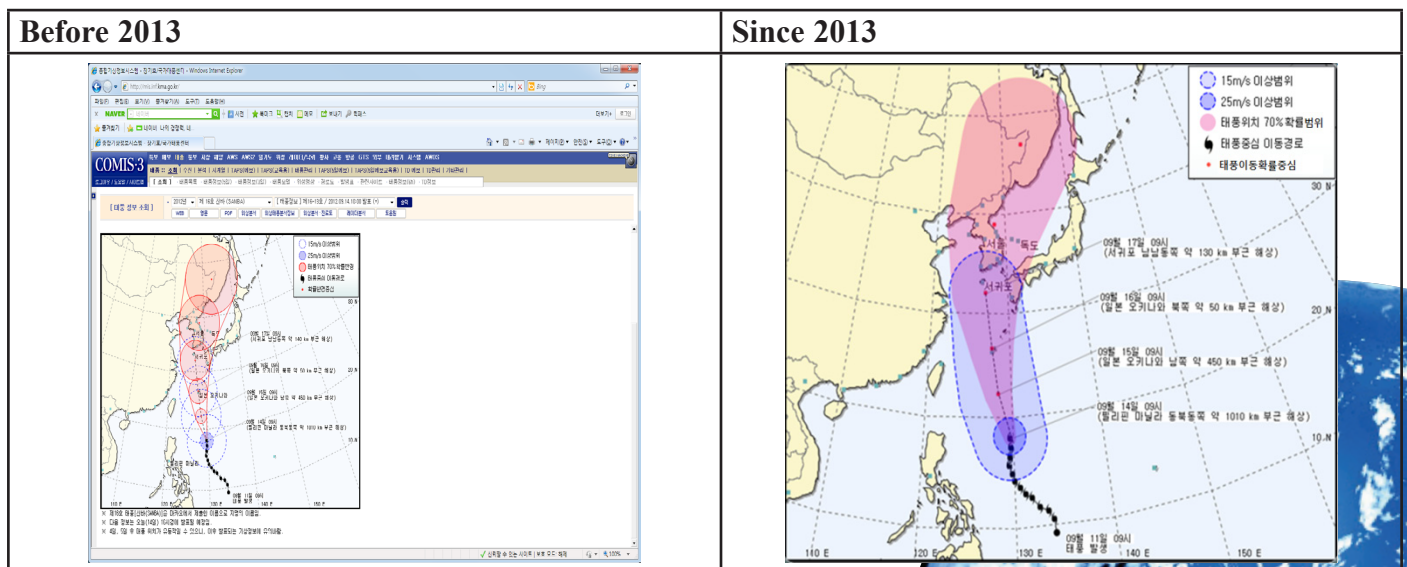


Figure 3. The typhoon warning graphics changes in advisory since 2013.

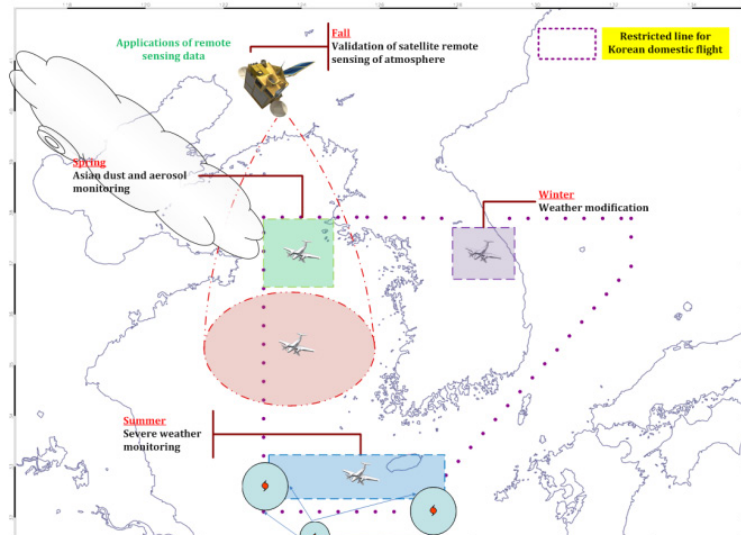
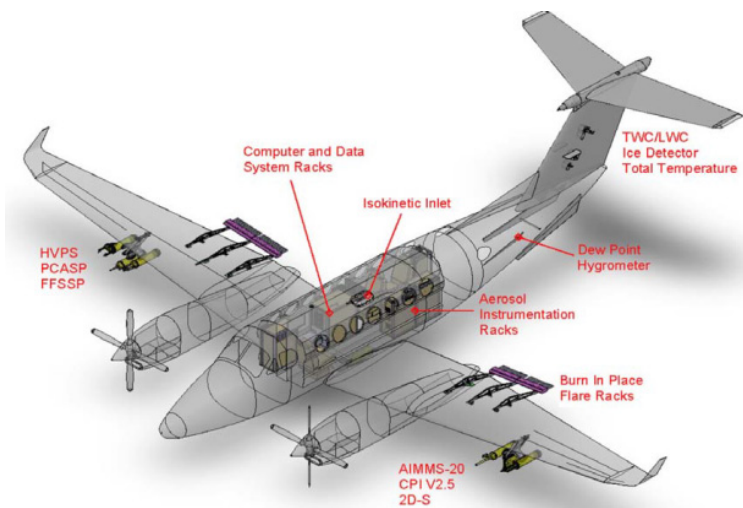


Figure 4. (left) Schematics of the aircraft operation over the Korea peninsula, (right) a preliminary design of equipment installation onto King Air 350 H/W aircraft to be procured by KMA

systems as far as safety conditions permit. And it will also contribute atmospheric sciences and climate change monitoring. From the year of 2016, it is expected that KMA would produce three dimensional targeted observation data from this aircraft and these would be shared openly for regional or international operation and research purpose.

KMA New Administrator

Mr. LEE Ilsoo was appointed as new Administrator of KMA. He is graduated by the University of Manchester, in Science and Technology Policy and he has got the Master's Degree in Science and Technology Policy, Master's Degree in Public Administration and Bachelor's Degree in Engineering.

He has a long experience in the area of science and technology and, before being appointed KMA administrator, performed important roles namely as Deputy Administrator at KMA; Director General for Planning & Coordination at KMA; Administrator at Busan Regional

Meteorological Administration; Director of General Affairs at the Ministry of Science and Technology (MOST); Director of the Americas Technology Cooperation at Science and Technology Cooperation Bureau (MOST); Science Councilor of the Korean mission to OECD (Paris, France); Secretary to the Minister, Personnel section

chief, Director of General Affairs (MOST); Administrative deputy director at the Ministry of Science-Technology (the Seoul Olympics Organizing Committee).

Dr. LEE Ilsoo also developed other activities such as Member of Steering Committee under National Science & Technology Commission; Mentor for local talents (Busan Human Resources Development Institute); Science and Technology Ambassador (Korea Foundation for the Advancement of Science & Creativity); Columnist at science essay of Busan International newspapers; Member of Commission for Meteorological Science Development; Member of competency evaluations on high-ranking public servants at the Ministry of Public Administration & Security.

Dr. LEE Ilsoo, during his military service, served as Lieutenant of the Republic of Korea Air Force.





7th World Water Forum Kick-off Meeting

In 2015, the 7th World Water Forum will open in Gyeongbuk and Deagu, Korea and the Kick-off Meeting as the first official event in preparation for the Forum was held in Daegu on May 14th and 15th of 2013.

At the Kick-off Meeting, projects conducted by the Working Group on Hydrology of TC were introduced. Especially, it was introduced that the Flood Control Measures Assessment System was developed by the HRFCCO, MOLIT, the Republic of Korea and distributed to TC member countries for more accurate assessment and efficient implementation of flood control. Also, the Extreme Flood Management System, which is being newly developed, was introduced to collect extensive opinions of various experts.

As the 7th World Water Forum will be one of

the largest and the most important global events for water-related issues, we hope to see active participation and support from TC and member countries.



TC WGH Homepage

The homepage for activities of Working Group on Hydrology is just about to open to TC members. This web-page consists of each section for introduction of general information on TC's and WGH's activities, for distributing project outcomes and developed systems & guidelines, and for sharing data and information among TC members.

We, HRFCCO, MOLIT, the Republic of Korea,

expect that the WGH's homepage will be an invaluable platform to conduct relevant projects and activities successfully and to strengthen cooperation and networks stably among TC members.

You are able to visit the English version homepage in the early November 2013.

REMARKS: the images of the homepage are in Korean now, but you will see the English version soon.



The 8th WGDRR Annual Workshop

The 8th Working Group on Disaster Risk Reduction Annual Meeting was held in Seoul from 29 May to 30 May. Total 8 Members including China, Hong Kong, Japan, Macao, Malaysia, Philippines, Republic of Korea, and Viet Nam participated on the workshop. Also, there were participants from international organizations of WMO (Mr. Koji Kuroiwa), ADRC (Mr. Junji Moriwaki), UNESCAP (Dr. Yejin Ha). Mr. Jae Yul Lee who is the director of Safety Management Headquarters in Ministry of Security and Public Administration (MOSPA) had a congratulatory address and also, there were valuable congratulatory addresses from Mr. Koji Kuroiwa of WMO and Mr. Olavo Rasquinho of TCS.

The main theme of the 8th WGDRR Annual Workshop is “New Challenges and Tasks of WGDRR”. In the workshop, the ways of strengthening on international cooperation for DRR are mainly discussed. With reference to the main theme, Dr. Shim, Jae Hyun from NDMI suggested the future ways of WGDRR which include 1) New concept of Expert Mission, 2) Upgrade of TCDIS, 3) International Cooperation for DRR, and 4) Post-2015 DRR Framework.

The presentations in the 8th WGDRR Annual Workshop are as follows;

- 1) Review of WGDRR Action Sheet (Mr. Olavo Rasquinho)
- 2) New Challenges and Tasks of WGDRR (Dr. Shim, Jae Hyun)
- 3) Strengthening and Example of Community Based Resilience (Dr. Ying-Wa CHAN)
- 4) Member reports
 - : China, Hong Kong, Japan, Macao, Malaysia, Philippines, Republic of Korea, Viet Nam
- 5) Planning on the 2nd TRCG Forum (Dr. Ying-Wa CHAN)
- 6) Synergized Standard Operating Procedures (SSOP) for Coastal Multi-Hazards Warning System (Mr. Kai Hong Leong)



- 7) Proposed WGM Field Experiment (Mr. Kai Hong Leong)



New Centre for Climate Research Singapore

The Meteorological Service Singapore (MSS) recently established the Centre for Climate Research Singapore (CCRS), the first research centre in the world dedicated to the tropical climate and weather of Singapore and the wider Southeast Asia region. This includes improving its understanding and prediction of tropical convective thunderstorms and Northeast Monsoon surges, enhancing its understanding of complex climate system processes, and producing climate projections for different time scales. The Centre will also be a leader in the use of high resolution computer models to simulate climate and weather over this region.

CCRS is headed by Director Dr Chris Gordon, formerly Met Office Head of Science Partnerships and head of the Met Office Hadley Centre.

CCRS will undertake research and studies in the following key areas:

- Advance the science of research to improve understanding and prediction of high-impact or extreme weather, in particular, intense precipitation from thunderstorms and Northeast Monsoon surges;
- Use climate models and statistical downscaling techniques, to simulate local and regional climate variability and change in the past, and to produce climate projections for different time scales (seasonal, decadal, century);
- Produce long-term projections of sea level rise and storm surges in the region;
- Monitor and assess local climate variability and change, and attribute recent changes or significant trends in local and regional climates to specific factors; and

- Adapt and improve Numerical Weather Prediction (NWP) models and predictive techniques to produce reliable and accurate products spanning forecast ranges from instantaneous to the long term, and from local to regional scales.

The Centre was officially opened on 26 March 2013 as part of the celebration of World Meteorological Day 2013. The new logo for MSS was also unveiled at the opening.



The Official Opening of CCRS: (left to right) Director of the CCRS Dr Chris Gordon, Minister for the Environment and Water Resources Dr Vivian Balakrishnan, Director-General of the Meteorological Service Singapore Ms Wong Chin Ling, CEO of the National Environment Agency Mr Andrew Tan, Permanent Secretary of the Ministry for the Environment and Water Resources Mr Choi Shing Kwok



The Centre for Climate Research Singapore



Dr Chris Gordon
Director of
the Centre for
Climate Research
Singapore – CCRS



The new logo for MSS.



1. TMD hosted SSOP Workshop, In Bangkok

Thai Meteorological Department (TMD) collaborated with ESCAP/WMO Typhoon Committee (TC) and WMO/ESCAP Panel on Tropical Cyclones for the Bay of Bengal & the Arabian Sea (PTC) to organize the Workshop on Standard Operating Procedures under the project Synergized Standard Operating Procedures (SSOP) for Coastal Multi-hazards Early Warning System at UNESCAP, Bangkok from 8 to 9 May 2013 with the aims to promote the coastal community resilience to coastal multi-hazards through having standard Operating procedures for effective Multi-hazards Early Warning System (EWS) and improving the policy and institutional arrangements at national and community levels.

The workshop was conducted successfully with actively participation of 45 participants from TC and PTC members including representatives from WMO, ESCAP, TCS, PTC secretariat and international organizations partners participating the SSOP Project.



Picture 2 and 3 : Workshop's opening ceremony



Picture 1 : Participants of the Workshop



Picture 4 : Participants in front of Siam Niramit, where Welcome Reception and shows of Thai arts and culture were held on the evening of 8 May 2013

Dr. Songkran Aksom, Deputy Director-General, Thai Meteorological Department (TMD) welcomed all participants and made opening address on behalf of Mr. Worapat Tiewthanom, Director-General, TMD in the Workshop's opening ceremony on Wednesday 8 May 2013 at Meeting Room F, UNESCAP, Bangkok.

2. TMD sent one staff to join in 2013 Typhoon Committee Research Fellowship Scheme

One staff from Thai Meteorological Department (TMD), Miss Prapaporn WONGSAMING, Meteorologist, Numerical Weather Prediction Division, Weather Forecast Bureau, had been selected to participate in the 2013 Typhoon Committee Research Fellowship Scheme held at the National Typhoon Center of Korea Meteorological Administration (KMA), Jeju, Republic of Korea from 1 May to 28 June 2013.





Miss Prapaporn WONGSAMING and other researchers at National Typhoon Center of Korea Meteorological Administration (KMA)



USA

New Director of the National Weather Service Forecast Office in Honolulu, Hawaii

Tom Evans serves as the Director of Operations of the National Weather Service Forecast Office in Honolulu, Hawaii and as the Deputy Director of the Central Pacific Hurricane Center. In this capacity, he provides guidance, resources and direction for the forecasters and hydro-meteorological technicians who issue observed and predicted weather messages and supportive services. Our services include warning the citizens and visitors of the State of Hawaii along with the mariners and aviators navigating the central Pacific Ocean of impending weather hazards. We strive to provide timely information so everyone can keep themselves, their loved ones, and their property safe.

served as a forecaster in offices located in Santa Maria, San Diego, and Monterey, California; and in Tucson, Arizona before transferring to the Honolulu office in 2012. Weather has become a way of life for Tom and he always enjoys not only talking about weather, but discussing what can be done about it too.



Tom was born and raised in Tucson, Arizona and received a Bachelor of Science degree in Atmospheric Science from the University of Arizona in 1993. He started with the National Weather Service in 1994 at an office along the central coast of California. He



Taken June 2006 in Kahalu'u, Ka'u District on the Big Island
(photo by Glenn Bisdee)

Progress in interpreting Regional Forecasting Support Center - Ha Noi in Severe Weather Forecasting Demonstration Project of WMO in South-East Asia

1. Roles of Regional Forecasting Support Centre (RFSC) - Ha Noi

The Severe Weather Forecasting Demonstration Project (SWFDP) is a WMO Commission of Basic Systems (CBS) initiative, commenced in 2005, to demonstrate how warning services provided by NMHSs in developing countries can be enhanced and links with disaster management authorities improved through cooperative work among meteorological centers. The scope of the project is to test the usefulness of currently available and promising experimental products available from Numerical Weather Prediction (NWP) centers in improving severe weather forecasting services in countries where sophisticated model outputs are either not available, or not effectively used.

The first meeting of the SWFDP for South East Asia (SWFDP-SeA) Regional Subproject Management Team (RSMT) to develop an implementation strategy for the SWFDP-SeA was held in September 2010 in Tokyo. The meeting reviewed a draft SWFDP-SeA Implementation Plan which proposed three types of Regional Centers with the roles: regional forecasting support (Ha Noi), training and technical support (Hong Kong Observatory, HKO), and tropical cyclone forecasting support (RSMCs Tokyo and New Delhi). Although the National Centre for Hydrological and Meteorological Forecasting (NCHMF) in Ha Noi is not a designated RSMC within the WMO GDPFS, the SWFDP concept of operation requires an operational regional centre to support severe weather forecasting in the participating NMHSs. A follow-up WMO mission to Ha Noi in February 2011 determined that the NCHMF Ha Noi appeared to have an excellent development potential to undertake the role of the Regional Forecasting Support Centre (RFSC) in a

SWFDP-SeA project. It is proposed that NCHMF Ha Noi be designated the Regional Forecasting Support Centre to perform the function of the lead regional centre for the SWFDP-SeA.

Following the “*SWFDP Guidebook for planning Regional Subprojects*” a SWFDP-SeA Implementation Plan was developed for the anticipated meeting of the RSMT, wherein the responsibilities and functions of the Regional Forecasting Support Centre (RFSC) in Ha Noi are described, as follows:

- to redirect toward the NMHSs relevant products issued from the global centre (if necessary);
- to provide NMHSs with its own interpretation of the medium-range guidance, including EPS products;
- to provides the NMHSs with the short-range NWP guidance (including products adapted to severe weather events), as frequently as possible;
- to indicate existing satellite/radar imagery and satellite/radar based products that could be used for nowcasting purposes;
- to issue Daily Severe Weather Forecasting Guidance products summarizing interpretation of NWP products with respect to severe weather over the responsibility area of the NMHSs;
- to provide the other centers with short-range NWP guidance and EPS output including probabilistic products specially adapted to the concerned severe weather events;
- to tailor products to the requirements of the National Centers including the provision of sub-domains and probabilistic products according to the lists given in Annex C;
- to evaluate its own interpretation of EPS products as well as its NWP guidance;
- to provide global centers with a feedback about the usefulness and efficiency of global products;

- to facilitate the flow of all forecasting guidance information to all participating Centers in the SWFDP through a dedicated password protected Web site and portal. Ideally this Web site would be maintained on a 24/7 basis and dedicated for the Regional Subproject;
- to coordinate real-time 24/7 communications among the participating centers in the region of the project (to maintain a list of 24/7 contact information; telephone, fax, e-mail).

The above additional functions of RFSC Ha Noi in the context of the SWFDP regional subproject is not intended to affect the existing national responsibilities of NCHMF Ha Noi within Viet Nam.

2. Current Status

The SWFDP-SeaA webpage is developed and taken into operationally since June 2012 under the link of <http://www.swfdp-sea.com.vn> (username: swfdp-sea and password: RA2 - in case sensitive) for NHMSs of Lao PDR, Cambodia, Thailand to access and use available products (see Fig. 1 and 2). At present, the following products are operationally provided through the SWFDP-SeaA portal:

- + Short range (1-2 days) and Medium range (3-5 days) Guidance products: the guidance is made by forecasters of NHMS of Vietnam and operationally issued at 00UTC. The guidance includes warning maps related to severe weather such as heavy rainfall, strong wind for responsible areas and categorical warning table for all given locations of relevant countries.
- + MTSAT-2's IR1 and VIS products: horizontal resolution of 5km x 5km, 48 pictures per day, update every 30 minutes.
- + Global Satellite Mapping of Precipitation (GSMAP) is global rainfall estimates by the retrieval algorithm for brightness temperatures from satellite-born microwave radiometers. The horizontal resolution is 0.25 x 0.25 deg, 24 pictures per day, update every 1 hour. The delayed time is about 4 hours.
- + Storm tracks: this product is developed by NHMS of Vietnam in order to issue warning the direction and speed of the movements of deep convective systems of up to 3 hours. The algo-

gorithms are based on 3 steps: motion vector fields are derived two successive images using multi-scale variational method; deep convective clouds are simply recognized by multi-threshold method from MTSAT-2 data (infrared channels); and convective systems are separated by deep first searching (DFS) algorithm.

+ ASCAT: this product provides a measure of wind speed and direction near the sea surface. The measurements are obtained through the processing of scatterometer data originating from the ASCAT instrument on EUMETSAT's Metop-A satellite.

+ Global deterministic NWP products from GSM model of JMA, GFS of NCEP and NOGAPS of US Navy, GEM of CMC and GME of DWD. The products of GSM, GFS and NOGAPS has resolution of 0.5 x 0.5 deg. Meanwhile, GEM and GME products have respectively resolution of 0.6 x 0.6 deg and 0.3 x 0.3 deg. All of global model products is updated every 6 hours at 00UTC, 06UTC, 12UTC and 18UTC. The available surface forecasting products include charts for precipitation, pressure of mean sea level, temperature at 2 meters, wind at 10 meters, 1000-500mb thickness. For upper levels (850, 700, 500 and 300mb), the forecasting charts of wind and geo-potential height, relative humidity, relative vorticity and vertical velocity is also provided.

+ Global Ensemble Prediction Products based on 21 ensemble members of GFS ensemble system (NAEPS) for forecasting 5-10 day ahead: these products have resolution of 1.0 x 1.0 deg and are updated every 12 hours at 00UTC and 12UTC. The available EPS products include charts for ensemble mean (i.e. pressure of mean sea level, wind and geo-potential height at 850mb and temperature at 850mb), stamp map of 24-hours accumulated precipitation, and probabilistic maps (i.e. 24-hours precipitation quartile, 24-hours precipitation probability, 24-hours maximum wind-gust probability, 24-hours maximum CAPE probability, etc). In addition, the EPS-diagram for the 22 locations of Cambodia, 17 locations of Lao PDR and 16 locations of Thailand are also provided.

+ Regional Ensemble Prediction Products based on two operational EPS of NHMS of Vietnam, namely is SREPS and LEPS. The SREPS (Short Range Ensemble Prediction System) is multi-model multi analysis EPS in which running HRM

(High resolution Regional Model of DWD) and WRF (with two dynamic cores ARW and NMM) with initial and boundary conditions separately from 5 global models including GSM, GEM, GFS, GEM and NOGAPS. The SREPS has 15 members with resolution of 0.15 x 0.15 deg and is updated every 6 hours at 00UTC, 06UTC, 12UTC and 18UTC. The main aim of SREPS is in order to provide ensemble products for forecasting 1-3 days ahead. The LEPS is developed to provide ensemble products from 3 to 5 days ahead by running HRM model with initial and boundary conditions separately from 21 members of global EPS of GFS model. The LEPS has 15 members with resolution of 0.2 x 0.2 deg and is updated every 12 hours at 00UTC, and 12UTC. All available ensemble mean and probabilistic products of SREPS and LEPS is the same as with NAEFS.

3. Working plan in 2014

The SWFDP-SeA webpage is taken into operationally since June 2012 and the forecasters of NHMS's Lao PDR, Cambodia, Thailand can access and use available products as above mentioned. Recently, NHMS's of Philippines and Myanmar are interested in the SWFDP-SeA webpage and asked NHMS's Viet Nam to expand responsible areas of specific products to cover these countries. In order to ensure all functions of WMO's RFSC and improve predictability of severe weather phenomena for South-East Asia in SWFDP project, the key task in 2014 will be more paid attention to:

- + Provide forecast product of the motion of observed precipitation areas up to 3 hours ahead (1 hour cycle) using Semi-Lagrangian advection scheme in combination with satellite data
- + Provide tropical cyclone track and intensity forecasting products based

- on RSMCs and NWP models;
- + Provide verification products for guidance and near real-time NWP verification products.
- + Provide weather forecasting charts from regional non-hydrostatic model with 2-5km resolution to increase predictability of severe weather phenomena.
- + Add "Forecast Forum" tool in SWFDP-SeA website in order to NHMS's forecaster can discuss and share information
- + Set up FTP server to share raw data between NHMS's Viet Nam with the other NHMSs

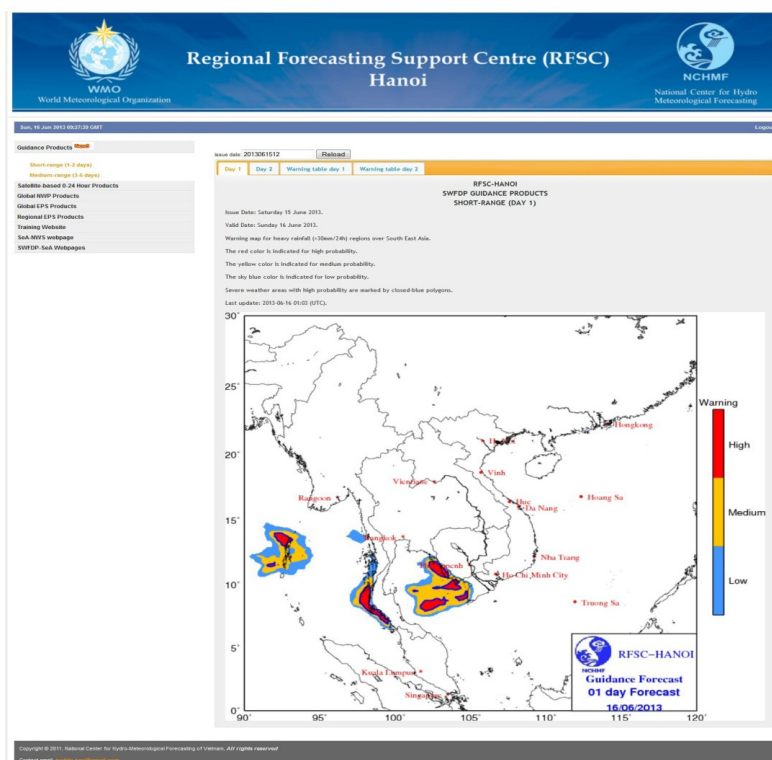
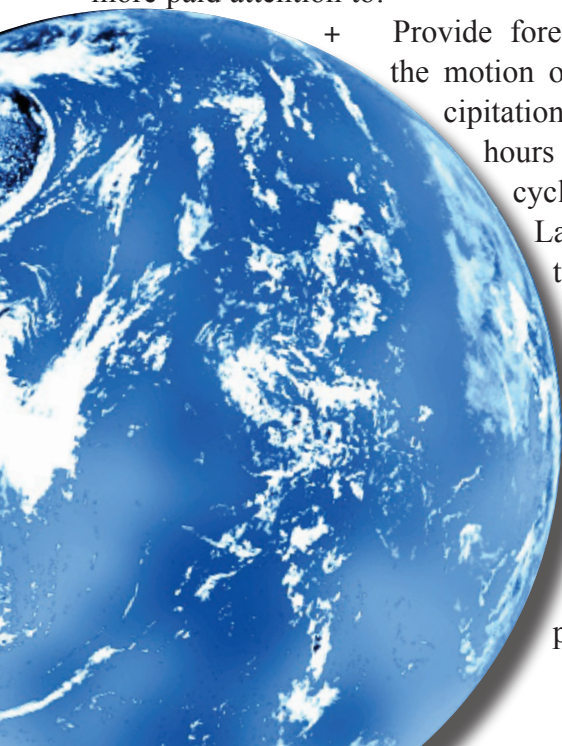


Fig. 1: The short range (1-2 days) and medium range (3-5 days) guidance products



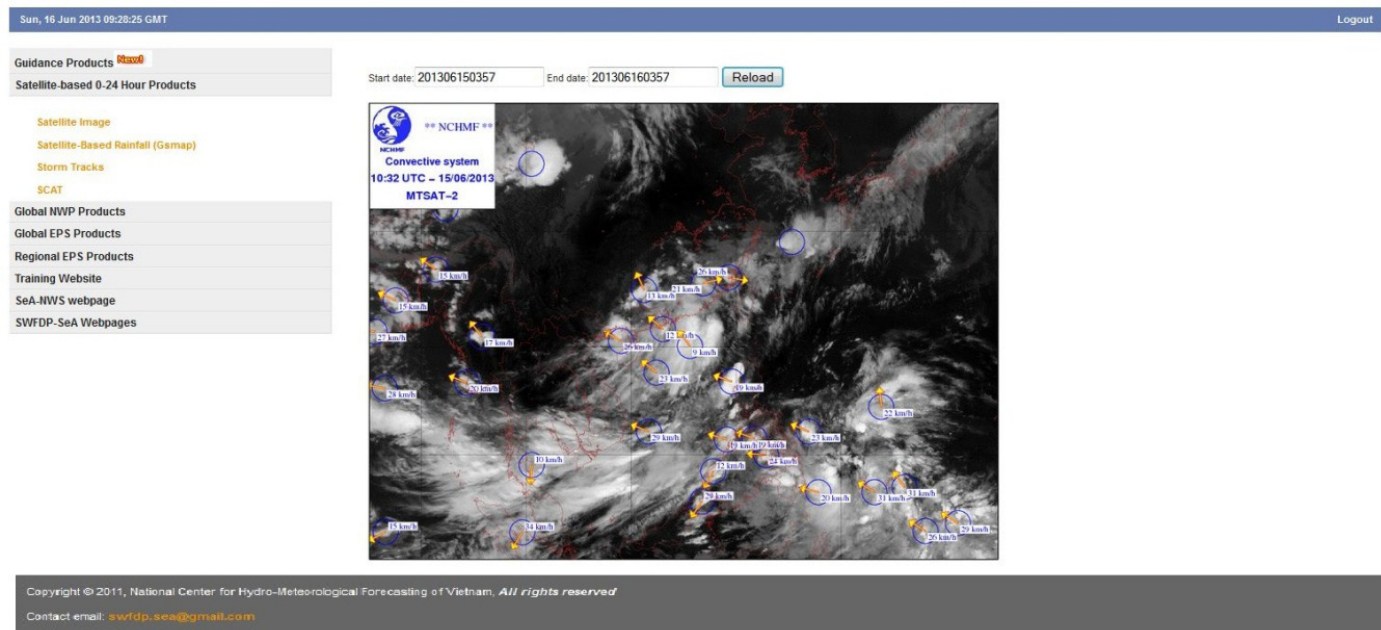


Fig. 2: The storm tracks product: warning the direction and speed of the movements of deep convective systems of up to 3 hours

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Avenida 5 de Outubro, Coloane, Macau-China
Phone: +853 88010531
Fax: +853 88010530
Email: info@typhooncommittee.org

The newsletter is available on request to the Editor at the above address

Editor: Olavo Rasquinho, Secretary of TC

Staff Members:
Leong Kai Hong, Derek • Meteorologist
Liu Jinping • Hydrologist
Barrie Lei • DRR expert
Denise Lau • Senior Secretary
Kou Meng Kit, Lisa • Senior Finance Clerk

