# Annual Report 2011

KMA Korea Meteorological Administration

## CONTENTS

# *ANNUAL REPORT 2011*

# Opening Remarks

Recent climate change, caused by an accelerating warming of the Earth, has made abnormal weather events to be the new normal. It would not be wrong to say that we are living in an era of climate change. Korea was no exception in 2011. For example, last winter's cold snap swept over the country, while damaging our vegetables and fruits in spring. In summer, we suffered from heat waves for an extended period with threatening of a nationwide blackouts made much worse by an exponentially growing demand for electricity consumption.

Another extreme event was the Japanese earthquake of March 11, 2011, which triggered the public fear on the spread of radioactive materials. Torrential rainfall catastrophically flooded downtown Seoul in late July and raised both social and economic concerns over extreme weather events. However, the KMA worked hard to achieve various advances in climate, forecast, information and telecommunication, and international cooperation sectors, based on the efforts that the KMA staff has put so far. As a result, the reliability of the KMA's weather information was upgraded domestically, while the exchanges with the international partners, including developing countries, became more active.

While being rated at 90.7% for the accuracy of our weather forecasts, the KMA began providing 'public-friendly' weather services, such as improved warning standard for heavy rainfall and 5-day typhoon forecast. Health- and industry-related weather information are also available to ensure vulnerable people have necessary information. In addition, various means, including mobile web, weather widget, and/or SNS were used to promptly disseminate our perishable products. All of these efforts resulted in the KMA receiving 81.8% for its public satisfaction score on KMA's services and products. The KMA produced high-resolution climate change outlook that considers special climatic features of the Korean Peninsula, based on the internationally standardized new set of green house gas scenarios. We exerted our utmost efforts to lead the sustainable development of our

nation by vitalizing the meteorological industry with increased investment on relevant R&D and 'Certification of Weather Management'.

As the KMA was elected as an Executive Council member of the WMO, it contributed to upgrading the national standing of the Republic of Korea by transforming itself from a recipient to a donor. The KMA continues to provide our satellite data and NWP data to developing countries, while supporting their modernization process. The KMA built the multi-agency weather radar network that led to the cooperative administration among governmental organizations.

The year of 2011 served as a foundation to prepare advanced meteorological infrastructure for securing Korea's independent technologies. The satellite 'Cheollian' launched in June, the observing vessel 'Weather 1' constructed in May, and the establishment of the Korea Institute of Atmospheric Prediction Systems were part of the effort. We also prepared an institutional ground for space weather forecast and warning.

The KMA developed meteorological technologies and strengthened the international cooperation by supporting projects for developing countries. For example, the KMA helped establish an early warning system for the Philippines, provided a satellite antenna and analysis system for Sri Lanka, offered numerous training programs, and dispatched technical advisors to those countries in need.

In retrospect, I believe that the year of 2011 served as a cornerstone in the history of the KMA, because it not only upgraded the national weather services, but also expanded the nation's meteorological territory to the world, and the space beyond.

Like the medical doctors who save the lives of their patients from dangerous diseases, the KMA as a meteorological-doctor will not spare any efforts in fulfilling its mission to protect our people's lives from hazardous weather events. KMA's various activities regarding international cooperation, multi-agency cooperation, and industry vitalization will greatly improve the public safety and the national economy.

I hope that this annual report will serve as a useful reference not only for the governmental hydro-meteorological services across the world but also for those who are interested in the KMA, including the WMO and WMO member countries.

**CHO Seok Joon**

Administrator
Korea Meteorological Administration

| Month | Key Events | Venue |
|---|---|---|
| January | · The 43rd Typhoon Committee (17-22 Jan.) | Jeju |
| February | · The 6th Meteorological Cooperation Meeting between KMA and BoM (14-15 Feb.) | Seoul |
| | · The 9th Administrator of KMA, Mr. Seok Joon CHO, took office (9 Feb.) | |
| | · Meteorological Industry Symposium for Market Expansion (24 Feb.) | Seoul |
| March | · WMO GSICS International Conference to secure the quality of COMS meteorological data (22-25 Mar.) | Seoul |
| | · Beginning of a smart phone weather application service (29 Mar.) | Seoul |
| April | · The 3rd Formal Meeting on Meteorological Cooperation between KMA and PAGASA (2-4 Apr.) | Philippines |
| | · Commissioning of COMS (1 Apr.) | |
| | · Africa Capacity Building Programme for Weather Disaster Response (3-23 Apr.) | Seoul |
| | · Capacity Building Programme for Better Meteorological Services Using ICT (19 Apr.-14 May) | Seoul |
| | · Opening ceremony of the Korea Institute of Atmospheric Prediction System (KIAPS) (28 Apr.) | Seoul |
| May | · Launching ceremony for ocean observation vessel "Gisang 1" (30 May) | |
| | · Administrator Seok Joon CHO elected as a WMO EC member | |
| | · The Korea-China Asian Dust cooperation meeting (18-20 May) | Seoul |
| June | · WMO EC meeting (6-8 Jun.) | Geneva |
| July | · The 3rd Session of the NOAA-KMA Joint Working Group (25-27 Jul.) | Maryland, USA |
| August | · Delegation from Vietnamese Ministry of Natural Resources and Environment visited for a consultation meeting (8-12 Aug.) | Seoul |
| September | · The 1st Korea-China-Japan Numerical Prediction Workshop (1-2 Sep.) | Jeju |
| | · The 11th Korea-China Meteorological Cooperation Meeting (15-20 Sep.) | Seoul |
| | · High level bilateral meeting between KMA and Vietnamese Ministry of Natural Resources and Environment (26-30 Sep.) | Seoul |
| | · International Workshop on CODEX-East Asia (22-23 Sep.) | Seoul |
| | · The 3rd Asia GAW Workshop on Greenhouse Gases (29-30 Sep.) | Seoul |
| October | · Signing of an MOU between KMA and UNESCO/IOC for the 4th JCOMM (17 Oct.) | Paris |
| | · The UNCCD General Assembly (17-20 Oct.) | Germany |
| | · The 3rd Technical Cooperation Meeting between KMA and EUMETSAT (18 Oct.) | Changwon |
| | · The 5th Joint Meeting of Korea, China, Japan Meteorological Society (24-26 Oct.) | Busan |
| November | · Korea-Africa Symposium on Coping with Climate Change (1-3 Nov.) | Seoul |
| | · The 9th Working Group Meeting on Earthquake Cooperation between KMA and CEA (2 Nov.) | Buyeo |
| | · Experts Workshop for Development of On-board Sensor for GEO-KOMPSAT-2A (7-8 Nov.) | Jincheon |
| | · Meeting on the Korea-Central Asia meteorological cooperation (15-17 Nov.) | Uzbekistan |
| | · An Advisory Group to support the modernization of the meteorological sector in Vietnam dispatched (15-18 Nov.) | Vietnam |
| December | · RA II Working Group Meeting on WMO Integrated Observing System and WMO Information System (30 Nov.-7 Dec.) | Seoul |
| | · The International Symposium on the 20th Anniversary of Operational Numerical Weather Prediction (6-7 Dec.) | Seoul |
| | · KMA Experts Visited Africa to Strengthen Korea-Africa Cooperation (18-25 Dec.) | Kenya, Tanzania Ethiopia |

# INTRODUCTION



## A Look Back

### *17-22 January*

The KMA hosted the 43rd Session of Typhoon Committee in Jeju. The TC Session is annually held by its member country to enhance technological and administrative cooperation, reduce the impacts of typhoon-related disasters, share typhoon damage information among members, and establish the joint response system.

### *9 February*

Mr. SeokJoon CHO took office as the 9th Administrator of the KMA.

### *14-15 February*

The KMA hosted the 6th meeting between the KMA and the BoM in Seoul, Korea. Mr. KwangJoon Park from the KMA and Dr. Rob Vertessy from the BoM signed the minutes on mutual cooperation for operating UM-based integrated numerical forecast model.

### *24 February*

The KMA held the Meteorological Industry Forum attended by some 150

experts from the industry and academia to expand the weather market and create jobs.

### 22-25 March

The KMA held the joint meeting of the GSICS Research and Data Working Group in Daejeon to secure the quality of COMS data.

### 29 March


The KMA launched the weather information service for smart phones. Through the Mobile apps, users in isolated environments such as mountainous, remote or coastal areas can access weather information in real time in cases of severe weather such as heavy snowfall, heavy rain, and disasters.

### 1 April

COMS (Communication, Ocean and Meteorological Satellite) went into regular operation on April 1 (the mission lifetime is 7 years).

### 2-4 April

During the 3rd Korea-Philippines meteorological cooperation meeting held in the Philippines, the KMA attended the ground breaking ceremony for the project aimed at implementing the early warning system for disaster prevention in the Philippines.

### 3-23 April

The KMA conducted the Africa capacity building programme for disaster response, inviting 17 climate experts and forecasters from 10 African countries to help the countries better respond and adapt to climate change.

### 19 April-14 May

The KMA conducted the ICT programme for 14 trainees from 12 met. offices in Asia and Africa to enhance developing countries' ICT capabilities for meteorology.

### 28 April

The KMA held a signboard hanging ceremony of the Korea Institute of Atmospheric Prediction Systems (KIAPS), which was set up in January to develop an independent numerical forecast model for Korea.

### 30 May

The KMA launched Gisang 1, an ocean observation vessel, to play a leading role in strengthening its monitoring of severe weather phenomena in the offing.

### 6-8 June

The KMA administrator CHO Seok Joon attended the sixty-third session of WMO EC.

### 25-27 July

At the KMA-NOAA JWG-3 held in Silver Spring, Maryland, both sides exchanged opinions on the bilateral cooperation includ-


ing weather satellite, numerical weather forecast and space weather.

### *8-12 August*

The delegation from the Vietnamese Ministry of Natural Resources and Environment (MONRE) visited the KMA to share the KMA's experience and information, which intended to enhance and modernize Vietnam's upper weather system and meteorological radar network.

### *1-2 September*

KMA, CMA and JMA held "the Joint Workshop on Numerical Weather Prediction" to effectively deal with weather disasters in North East Asia. Participants agreed to share latest research results and the system to examine physical processes for improving NWP models and interpreting results; and set up a working group forum among three organizations for active technical discussions in each sector.

### *15-20 September*

KMA and CMA held the 11th session of the Joint Working Group meeting in Seoul to work together to deal with climate change and extreme weather events by sharing meteorological skills and expertise. The next meeting will be held in China 2013.

### *19 September*


The National Institute of Meteorological Research (NIMR) of KMA and the Chinese Academy of Meteorological Sciences (CAMS) signed a sisterhood agreement to expand cooperation in meteorology and climate research.

### *26-30 September*

The delegation from the Vietnamese Ministry of Natural Resources visited KMA to promote cooperation in meteorology between two countries, having discussions on various issues including meteorological observation instruments; structure and operation of an observation network; institutional arrangements of the organization, satellite data receiving system, radar utilization and meteorological technology development. This meeting contributed to strengthen the cooperative activities between the two countries.

### *29-30 September*


The KMA hosted the Third Asia GAW (Global Atmosphere Watch) Workshop on Greenhouse Gases at Seoul, inviting 11 experts from seven countries including China and Japan. 50 Korean experts shared policies, technologies and analysis results regarding greenhouse gases.

### *22-23 September*

The National Institute of Meteorological Research held the International Workshop on CORDEX-East Asia at Jeju, Korea. CORDEX is a program to organize an international coordinated framework to produce an improved generation of regional climate change projections for evaluating and adapting to consequences of climate change. Participants exchanged detailed climate change

scenarios of East Asia such as production and sensitivity of regional climate simulations, regional climate prediction and climate models.

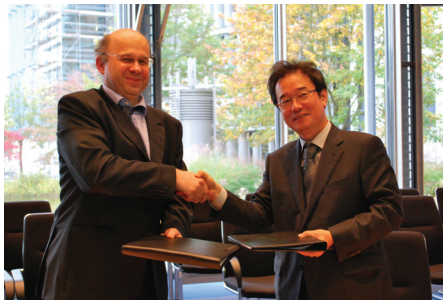
### 17 October

KMA signed an MOU with IOC/UNESCO at the HQ of IOC-UNESCO in Paris to successfully host the fourth session of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), which is to be held on 23-31 May 2012, in Yeosu, Korea, in conduction with EXPO 2012 YEOSU KOREA.

### 17-20 October

WMO Secretary General, Mr. Michel Jarraud, visited Korea to participate in the high-level meeting of the 10th UNCCD held in Changwon, Korea. During his visit, he also attended the Global Framework for Climate Service (GFCS) side event with the Administrator of KMA, and gave a presentation on the status and plan of GFCS. In his presentation, he stressed the importance and urgency of implementation of GFCS and drew much attention from audience. Also, Mr. CHO and WMO SG agreed on the need to expand support for the developing countries and the GFCS implementation.

### 18 October



"The 3rd bilateral meeting between the KMA and the EUMETSAT" was held at the EUMETSAT HQ. Two organizations as satellite operators shared information about current and upcoming satellite development plans and programs, and discussed satellite data exchanges, technical cooperation on NWC SAF, experts exchanges and joint research, etc. The next bilateral meeting will be held in Korea in 2013.

### 24-26 October

The KMA held the 5th Korea-Japan-China Joint Conference on Meteorology at BEXCO in Busan, Korea. It was a valuable opportunity to share research results and information on meteorology with 100 participants from abroad, including Japan and China.

### 1-3 November

The KMA held the Korea-Africa Symposium on Coping with Climate Change, inviting 11 participants including heads of met. offices and meteorological experts from Kenya, Ethiopia, Sudan, Burundi, Rwanda, Tanzania, Uganda, Zambia, DR Congo, Zimbabwe and ICPAC to secure a foundation for green partnership with Africa and to strengthen climate change response capabilities.

### 2 November


The KMA and the CEA held the 9th Working Group Meeting on Earthquake Cooperation in Buyeo, Korea with the purpose of sharing seismic technologies and strengthening cooperation to mitigate earthquake damage. Participants exchanged seismic data and information, agreed to promote cooperation to reduce seismic damage and develop new technologies.

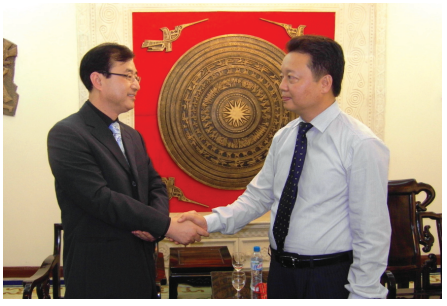
### 7-8 November

The KMA held a Space Weather Workship in Cheongju, Korea, to discuss the development of space weather sensor for the GEO-KOMPSAT-2A (COMS follow-on scheduled to be launched in 2017). Invited experts from NOAA/SWPC, NASA/GSFC, UCLA, KIST (Korea Institute of Science and Technology) and KARI (Korea Aerospace Research Institute) explored ways to develop optimal sensors under the limited specifications and gave the overall direction for the development of a space weather sensor such as the coronagraph and high/low energy particle detector.

### 15-17 November

The KMA took part in the 5th Korea-Central Asia Cooperation Forum in Uzbekistan and had a meeting with NMHSs of Uzbekistan, Tajikistan, Kyrgyzstan and Kazakhstan. At the meeting, participants discussed future cooperative activities and agreed to make concrete action plans including expanding data exchange, signing an MoU at the 6th Forum to be held in Korea in 2012.

### 15-18 November



The KMA delegation visited the Vietnamese Ministry of Natural Resources and Environment (MONRE) to discuss future cooperation for modernizing meteorological services of Vietnam. The First Vice Minister of MONRE (Dr. Tran Hong Ha) expressed his hope for active project implementation and strong bilateral relationship.

### 30 November-7 December

The RA II Working Group Meeting on WMO Integrated Observing System and WMO Information System was held in Seoul. About 30 participants including WG-IOS/WIS members, experts and WMO Secretariat officials joined the meeting.

### 6-7 December

Celebrating the 20th anniversary of launching Numerical Weather Prediction Service, KMA held an International Symposium on Numerical Prediction Model Development at COEX, in Seoul, to share the NWP achievements with representatives from industry, academia, research institutes and government agencies and to strengthen international cooperation.

### 18-25 December

There was an extensive discussion over how to promote cooperation in meteorology between Korea and Africa at the Korea-Africa High-Level Meeting on Climate Change held in Seoul in November 2011. To implement the meeting results, 3 experts from KMA visited Africa (Kenya, Tanzania, Ethiopia) to assess the environment for development such as meteorological facilities and observation equipment. The KMA delegation visited Kenya Meteorological Department (KMD), IGAD Climate Prediction Application Center (ICPAC), Tanzania Meteorological Agency (TMA) and National Meteorological Agency (NMA) to conduct a field survey and identify their demands for capacity building.

# INTRODUCTION



## Top 10 List of KMA 2011

### First ever weather correspondent-turned Administrator, Mr. Cho, took office

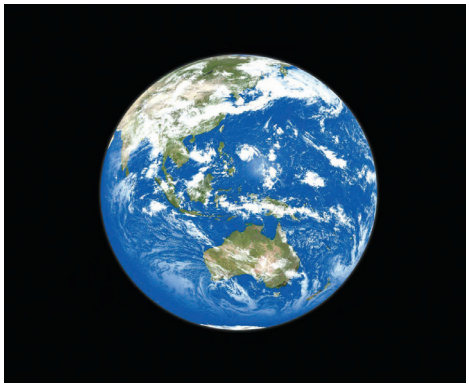
On 9 February 2011, Mr. Seok Joon CHO, former President of the Education Center for Sustainability Management of the Seoul School of Integrated Sciences and Technologies, took office as the 9th Administrator of the KMA. He is the first ever weather correspondent-turned Administrator.

### Aftermath of 3.11 Japanese Earthquake and KMA's Preemptive Response

On March 11, 14:46:28, an earthquake of magnitude 9.0 hit 179km NE coast of Sendai, Honshu, Japan. Although there was no direct damage to South Korea, the KMA responded swiftly to dispel the public concerns over the radioactive inflow.

### Operations of COMS in Space and Gisang 1 on Sea

The Communication, Ocean and Meteorological Satellite (COMS), Korea's first geostationary weather satellite, was launched on 27 June, 2010 and performed IOT (In-Orbit Test) successfully for 7 months. It started regular



> The first COMS image


> Commission ceremony of Gisang 1

operation on 1 April, 2011.
The COMS has enabled 2.2 billion people in 30 countries over the Asia-Pacific region to receive and use HRIT/LRIT data. Gisang 1, the nation's first ocean observation vessel, is a 489-ton comprehensive observatory vessel and was designed to track weather conditions through the simultaneous observation of upper-level, sea level, ocean and environment. It went into its regular operations on 30 May, 2011.

## KMA Administrator CHO elected a WMO EC and Expanded Technology Transfer for Developing Countries

The PR of ROK was elected a WMO Executive Council (EC) in the sixteenth WMO Congress held in Geneva, Switzerland (15 May-3 June)

> WMO Congress

> The ground breaking ceremony

## Record downpour and flood in central Seoul, and Mt. Umyeon Landslide

From 26 to 28 July in 2012, about 500mm of heavy rain fell in Seoul/Gyeonggi area and Gangwon Youngseo area (587.5mm in Seoul). This torrential rainfall caused Mt.Umyeon landslide, claiming 16 lives. In Chuncheon, 9 people were killed and 26 injured due to the collapse of a lodge.

## Meteorological Industry Market, Passed the 100bn mark

Thanks to the KMA's endeavor to secure technological capabilities and expand the weather market, the meteorological industry posted KRW 106.9 billion in sales in 2011, passing the 100 billion mark in 14 years since the meteorological business system was introduced in 1997.

### Talent Show, Superstar KMA, successfully held to promote creative and interactive corporate culture

Superstar KMA was held to nurture a sense of unity among KMA members and build a vigorous corporate environment.


> 'God, you dance!' Team


> 'So Hot, So Cool' Team

### Nation's Standard Climate Change Scenario to lead national climate policies

In order to support each region's efforts to establish policies to adapt to climate change, the KMA developed the National Standard Climate Change Scenario, which is valid until 2100, by applying IPCC's new Representative Concentration Pathways or RCP.

### On an Award Streak, KMA's reputation lifted

At the Governmental Evaluation Committee on Business Performance held on 6 Dec, 2011, the KMA was selected as an outstanding organization in the category of policy. Also, the Administration ranked first in the policy satisfaction rated by citizens and experts, and came in third in the civil administrative satisfaction.

### KMA first held the Comprehensive Measure Conference on Improving Disaster Management presided over by Prime Minister

The KMA held the Comprehensive Measure Conference on Improving Disaster Management which focused on seeking fundamental solutions to repetitive natural disasters including localized torrential rain, heavy snow and drought.

# INTRODUCTION

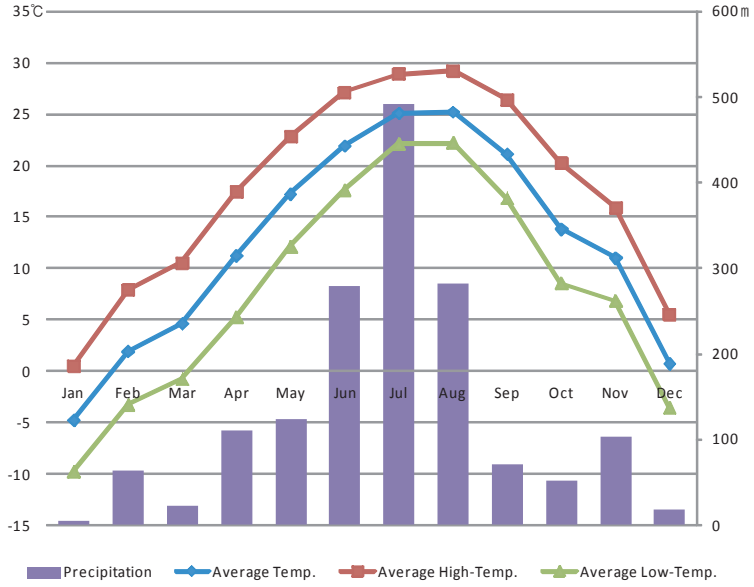


## Weather Status in 2011

The annual average and the highest temperatures of the country stood at 12.4℃ and 17.7℃, down 0.1℃ and 0.4, respectively from normal years while the average lowest temperature was 7.8℃, up 0.1℃. The average precipitation was 1622.6mm, 24% higher than usual.

Seoul's annual average temperature was 12.0℃ with its average highest of 16.4℃ and lowest of 8.4℃, down 0.5℃, 0.6℃ and 0.2℃, respectively from normal years. The average amount of rainfall was 2039.3mm, 41% higher than usual and the rainy days were 108, 0.9 days less than usual. By history, the long-term weather trend shows that the country and Seoul's average temperatures have continued to rise and the increase in the lowest average temperature is bigger than that in the highest average.

**Average monthly Temperatures and Precipitation in 2011**



# ACTIVITIES

Observation

Information and Communication

Weather Forecast

Climate Change & Prediction

Weather Industry

Aviation Meteorology

Meteorological Research

International Cooperation

# ACTIVITIES



## Observation

### Enhancement of Meteorological Observation Networks

#### Surface Observation

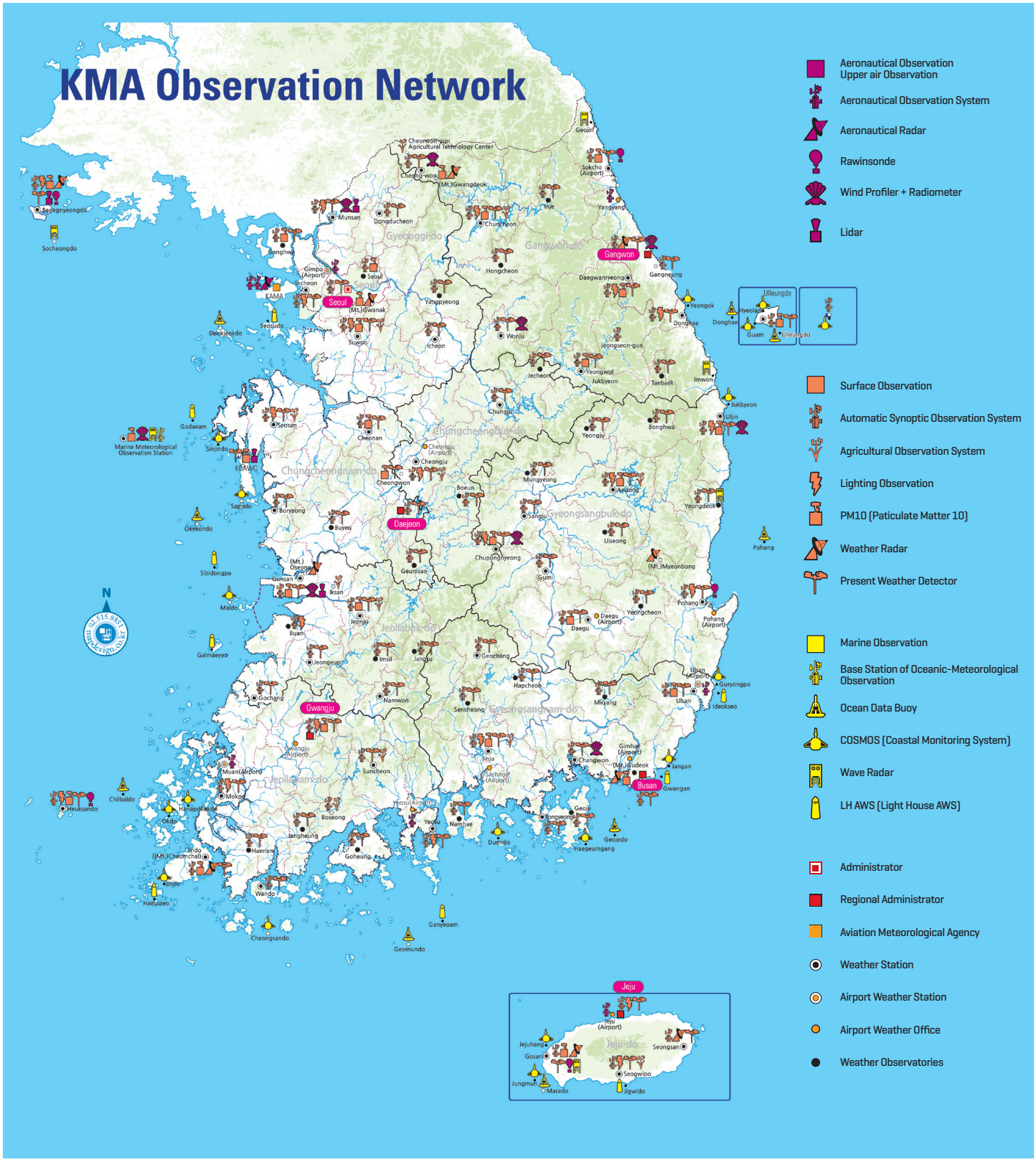
There are two types of automatic surface observation networks operated by the KMA: ASOS network for synoptic surface observation and AWS network for monitoring severe weather. The KMA started to install ASOS at the synoptic weather stations in 1995 for the purpose of automation of surface observation, and now operates a total of 80 ASOSs nationwide as of the end 2011.

The KMA set up the "Master Plan for the Enhancement of Automatic Weather Equipment" in March 2010 to produce high-quality of observational data by advancing methods of automatic surface observation and automatizing observation elements that used to be measured with eye. The KMA has completed the implementation of the Master Plan to exchange automatic equipment, including seven ASOSs in 2011, for 147 sites.

#### Upper-Air Observation

The KMA performs GPS-based rawinsonde observation. Currently, there are five upper-air weather stations (Sokcho, Baengnyeong-do, Pohang, Heuksando and Gosan) registered in the WMO.
Beside the synoptic upper-air network, the KMA operates nine wind profilers and nine radiometers to improve time and spatial resolutions of upper-air observation. The KMA collects vertical profile data of wind direction and speed, temperature, humidity every ten minutes from nine sites.
The KMA also participates in the AMDAR Programme and has been collecting aeronautical meteorological observation data since 2006 (currently, 14 planes from Korean Air and five planes from Asiana Airlines are taking part in the AMDAR project).

**> *KMA Observation Network***



### Marine Meteorological Observation

The KMA has a marine observation network of the ocean data buoy (9), the light house AWS (9), the wave radar (6), the coastal wave buoy (18), the coastal long wave monitoring system (11), the port weather monitoring system (1), the marine meteorological observation station (1), and the research vessel, GISANG 1. The KMA has been providing marine weather radio services for ships moving around the regional sea around the Korean Peninsula by using SSBs since 26 December 2011. The detailed marine information services such as marine weather forecast, severe weather alerts, real-time weather status are available in four languages (Korean, English, Japanese and Chinese) every day for 24 hours on the radio frequency of 5857.5kHz.

Also, the Korea Meteorological Administration actively participates not only in the conferences with relevant domestic organizations but also in international conferences and activities such as JCOMM, ETWCH, ETOOFS and DBCP in an effort to efficiently establish national marine meteorological observation systems, share ocean observation data and produce high-quality marine meteorological data.

### Asian Dust Observation

To provide smooth forecasting services on Asian dust, the KMA introduced and installed PM10s designed to observe the ground concentration of Asian dust in 28 centers and LIDAR (Light Detection and Ranging) in four centers to measure vertical profile of Asian dust.
In addition, the Administration has built nationwide solid surveillance networks consisting of 28 PM10s and four LIDARs to make real-time observations on Asian dust, and is performing regular inspections and calibration tests on observatory equipment.

## Marine Observation Vessel "Gisang 1"

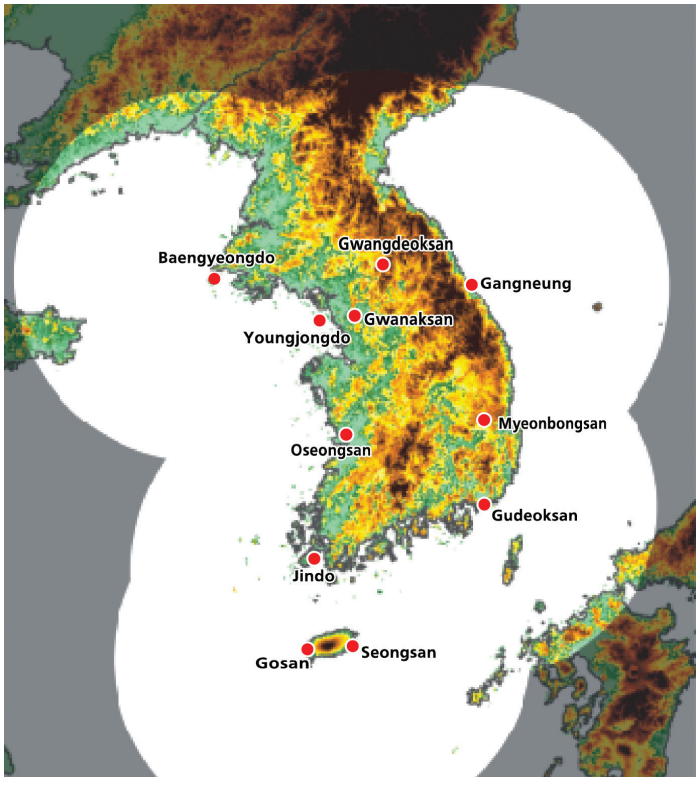
Korea's first marine observation vessel, Gisang 1, was launched in a ceremony and went into regular operation on 30 May 2011 after two years' of shipbuilding

The 498-ton, 64m-long ship, which cost KRW 13.3 billion (KRW 0.8 billion for design, KRW 12.5 billion for constructing), has the capacity for up to 47 passengers and a maximum speed of 33km/h. It can sail coastal waters off the Korean peninsular for more than 25 days without refueling.
Gisang 1 is a comprehensive observatory ship designed to track weather conditions through the simultaneous observation of upper-level, sea level, ocean and environment. With ASAP installed for the first time in Korea, the ship is expected to contribute to better predicting severe weather emerging from the West Sea and it observes temperature, humidity, air pressure and wind of the atmospheric layers up to 20km above the sea level in the ocean including the West Sea. In addition, Gisang 1 performs three-dimensional comprehensive observation: it observes water temperature, salinity and dissolved oxygen of up to 3,000m below sea level, ocean currents of up to 700m below sea level, and height, cycle and direction of waves of up to 1km ahead as well as particle concentration of Asian Dust coming from China and Mongolia.

## Weather Radar Observation

The first radar observation began with the installment of the first weather radar on Mt. Gwanak. Currently, there are a total of 12 weather radars of eight S-band, three C-band and one laboratory X-band.

The most common weather radar in Korea is S-band which is considered the most suitable for observation of regional torrential rain and typhoon in the summer. The radar moves in the range of from 0° at the lowest altitude angle to 24° at the highest, producing solid observation data of the atmosphere. The observatory data from the radar are reviewed through quality management process, used to provide radar-AWS's accumulated amount of rainfall and utilized as basic data for radar precipitation prediction/verification system and forecasting of dangerous weather conditions and other types of numerical figures.




> Weather radar network

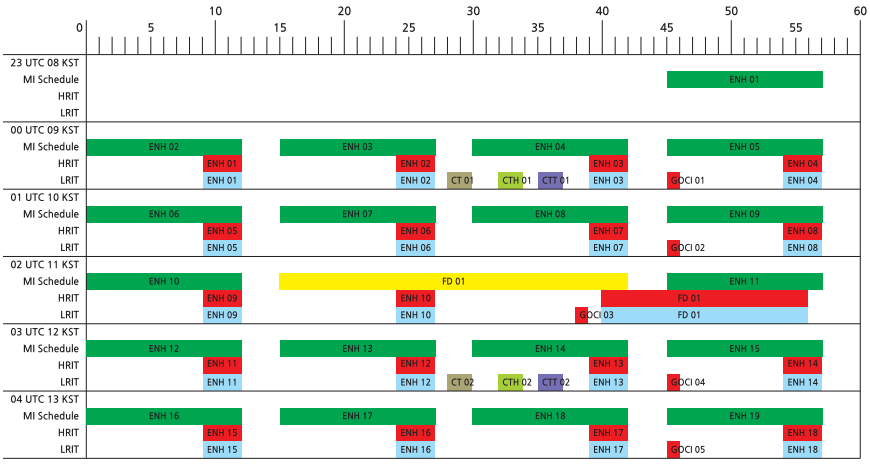
## Lightning Observation

The KMA introduced and has operated the Improved Accuracy from Combined Technology + Lightning Detection And Ranging system composed of a group of spectrometers, 7 IMPACT ESPs and 17 LDARs. The system observes lightning and provides real-time information on lightning location, polarity and strength.


> Weather lightning network

## Meteorological Satellite Observation

Along with the COMS which started operation on 1 April 2011, weather forecasters are provided with cloud analysis information four times a day, or eight times a day when severe weather conditions are predicted. The COMS data were also applied to nowcasting and very-short range system, which was built in 2010, in order to support weather forecast under the severe weather conditions such as convective clouds and typhoon. This system detects/tracks convective clouds and produces data on rainfall strength of convective clouds, auto-interpreted information on satellite image, expected precipitation and predicted satellite




***> COMS observation and distribution schedule***

image.

In addition, the system may combine and utilize numerical model data and observation data from radar, lightning and AWS (Automatic Weather System). The COMIS-3's satellite menu structure has been changed in collaboration with the Department of information technology, in order to provide the data of nowcasting and very short-range analysis from COMS since 5 August 2011. The outputs from nowcasting and very short-range analysis and COMS products are used as objective information to analyze developing convective clouds and localized torrential rain around the Korean Peninsula.

The first public service of COMS products for six categories: cloud detection, and cloud analysis, cloud top temperature/height, Asian dust, fog and atmospheric motion vector, was opened on 1 April 2011. Soon after the start of the first service, the second public service of COMS products was begun on 5 August 2011, covering rainfall intensity, sea surface temperature, upper tropospheric humidity and outgoing longwave radiation. With the COMS service, more than 30 countries over the Asian Pacific region can now directly receive and utilize the COMS data and/or satellite images through ground network system, which can contribute to strengthening their own capability to expected severe weather conditions.

Since 2010, the KMA/NMSC (National Meteorological Satellite Center) have prepared a project to develop a COMS follow-on which is scheduled to be launched in 2017, in order to secure space-based observation continuity initiated with the COMS. In particular, the foundation has been laid to promote the project and a plan to develop a COMS follow-on was established. The plan established the system among the related ministries/divisions and set the strategy and direction of each project including development of meteorological imager, space weather sensor, data processing system, and ground segment.

## Space Weather instrument Workshop for GEO-KOMPSAT-2A

The KMA/NMSC held the Space Weather instrument Workshop for Geo-KOMPSAT-2A in Cheongju from 7-8 November and discussed the development of space weather instrument by inviting the experts from home and abroad (WMO, NOAA/SWPC, NASA/GSFC, UCLA, KAIST and KARI). The KMA will install space weather instrument in COMS follow-on (Geo-KOMPSAT-2A), which is are scheduled to be launched in 2017, to observe and predict space weather phenomenon. The workshop served as a venue to explore ways to find best solution to develop the space weather instrument under the limited specifications.

## Global Atmospheric Watch

KMA has been monitoring the global atmosphere since 1987 in order to actively support the government's efforts for establishment of policies on global environmental changes, and striving to provide and systematically manage a variety of global atmospheric monitoring data which help to objectively and scientifically understand atmospheric changes on the Korean Peninsula. Currently, Korea Global Atmosphere Watch Center in Anmyeondo, a regional GAW station, is playing a pivotal role for monitoring the atmospheric changes in the nation by measuring 37 different kinds of parameters. The Center has continued to improve greenhouse gases monitoring systems such as dehumidification equipment for more precise and accurate measurement. In order to increase the use of climate change monitoring data which are considered the basic data for establishing the national climate policies, the Center started its services in 2011 for the trends of aerosol mass concentrations. In addition, the KMA began to perform special observation on airs surrounding the Korean oceanic areas and analyze concentration of greenhouse gases transported along the sea routes.

## Standardization of Meteorological Observations

Standardization of Meteorological Observation is to standardize the ways of conducting meteorological observation services, meteorological observation environments and dealing with observational observatory data from meteorological facilities and run by a number of organizations in Korea.

The purpose of standardization is to protect the lives and properties from natural disasters and promote well-being of the public by increasing the accuracy of meteorological observation, operating better observatory equipment and raising the efficiency of joint utilization of observatory data.

Observatory organizations need attention and interest of the public to produce high-quality observation data which are to be shared by other organizations. To that end, the KMA, as a leading organization of the standardization of meteorological observation, operates the Committee for the Standardization of Meteorological Observation, a deliberative body, and announces policies on the Standardization and requirements for standard

## The 3rd Asian GAW Workshop on Greenhouse Gases

The KMA and the Korea Global Atmosphere Watch Center held the 3rd Asian GAW Workshop on Greenhouse Gases that attracted a total of 56 domestic and overseas specialists including 11 people from six countries (China, Japan, Indonesia, Malaysia, Australia and the U.S.) and WMO's GAW member countries and consolidated the international cooperation among Asian GAW member countries. At the workshop, member countries organized the Asian GAW Greenhouse Gases Working Group and created a network for them to share and exchange information and technologies, and agreed to publish the Asian GAW Greenhouse Gases News Newsletter, which was released in December. The Newsletter includes the monitoring findings on greenhouse gases of six WMO's GAW observatory centers run by six organizations in five Asian countries (South Korea, Japan, Indonesia, Malaysia and Australia).




> English summary of Korea Global Atmosphere Watch Report (Aug. 2011), Asian GAW Greenhouse Gases Newsletter (Dec. 2011) and the 3rd Asian GAW Workshop on Greenhouse Gases (29-30 September 2011, Seoul)

observatory equipment.

To produce the observatory data recommended by the Meteorological Observation Standardization Law, standard observatory environments, the approved meteorological instrument to conduct observation and quality inspection of the KMA for the data are needed to re-transfer the data to observatory organizations. The observation instrument should be examined by the Head of the KMA and the Korea Meteorological Industry Promotion Agency was designated as an examining agency according to the Article 14 (1) in 1 July 2011.

As a functional check of examination instrument is necessary to examine the meteorological observation instrument, calibrating work is carried out for examination instrument. The KMA has gained international official approval in terms of temperature, humidity and precipitation, and is planning to gain official approval for solar radiation area in the future.

### Examination of Meteorological Instruments

In accordance with the Article 14 of the Meteorological Observation Standardization Law, the KMA designated the Korea Meteorological Industry Promotion Agency to examine meteorological instrument and carry out professional examination process. As the contract was signed by the two organizations in 2010, the Korea Meteorological Industry Promotion Agency purchases, maintains and examines the meteorological observation instruments operated by the KMA.

In 2011, 592 meteorological instruments owned by the KMA were examined and other organizations had a total of 2,418 instruments from other organizations (522 automatic meteorological observation instruments, 137 thermometers, 30 hygrometers, 365 wind vanes and anemometers, one heliograph, eight vaporimeters and 727 precipitation meters, etc.) Those instruments were examined, creating a commission of KRW 503 million as tax revenue.

## Earthquake Observation and Response

Seismicity in Korea

Looking at seismicity with magnitude greater than 2.0 in Korea, a total of 52 quakes, with 19 on the land and 33 in the sea, occurred. This is larger number than 42 in 2010 and 43.6 as the average value since 1999 when the digital seismic observation started, but is smaller than 60 in 2009.

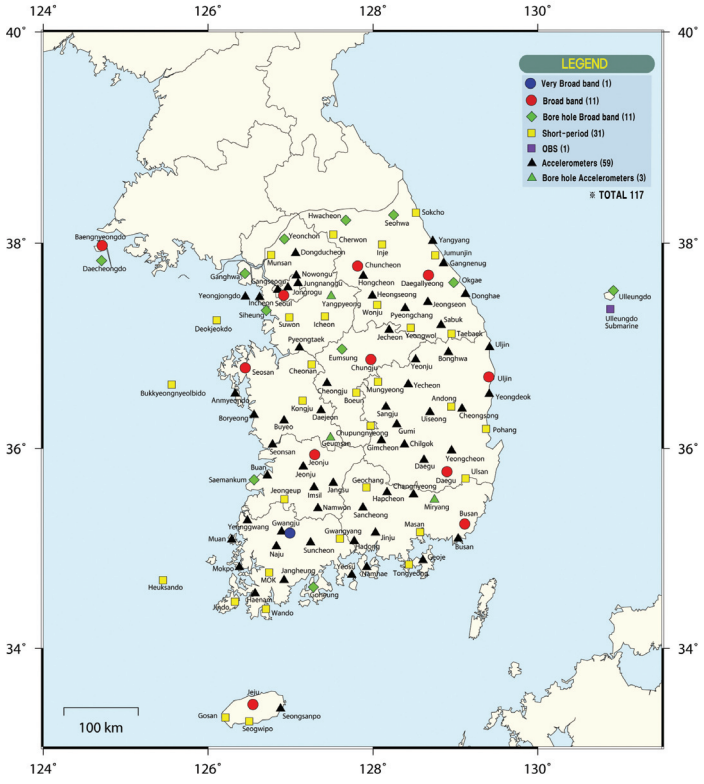
In 2011, 14 earthquakes with magnitude over 3.0 occurred and seven earthquakes were felt. Classifying by region, 10 events, which is the largest number, occurred in North Korea, 4 events in Daegu and Northern Gyeongsang Province, 2 events in Daejeon and Southern Chungcheong Province, 2 events in Gwangwon Province and 1 event in Northern Chungcheong Province. In the sea, 13 earthquakes occurred in the West Sea and 10 events in the East and South Sea, respectively.

The largest earthquake in 2011 was the event with magnitude of 4.0 which occurred 16km far west-southwesterly from Baengnyeongdo (37.91°N, 124.50°E). This earthquake shook some buildings in Baengnyeongdo and was felt in the downtown of Incheon.

### Establishment and Operation of National Earthquake Observation Network

In 2011, the National Earthquake Observation Network was operated with a total of 117 seismic stations with newly added four borehole stations. An infra-sound observation station was installed to improve the detection ability of artificial earthquakes in North Korea, so that the accuracy of analysis on artificial earthquakes can be improved. In order to upgrade the performance of instrument, five outdated short-period seismometers, which installed in 1999, were replaced and three accelerometers were replaced by borehole type.

Since 1 July 2011, the Korea Meteorological Administration (KMA) has started real-time service of earthquake information to the




> Integrated national earthquake observation network

public through SNS, such as twitter (twitter.com/kma_earthquake) and me2day (me2day.net/kma_quake). The information is provided as prompt report, earthquake information and alert, and tsunami advisory and warning.

## Earthquake Prediction Technology

The KMA is conducting a research to build a system, which produces and shares internationally standardized geomagnetic data, and is trying to join INTERMAGNET, an international organization collecting and utilizing geomagnetic data and providing the international standard.

The KMA announces prompt report and earthquake alert within 120 and 300 seconds, respectively, after the detection of earthquake.

The KMA is working on a project for establishing a national earthquake early warning system to promptly issue earthquake alert within 50 seconds by 2015 and within 10 seconds by 2020, respectively. To do this, the KMA developed an earthquake early analysis system (first step of the project) to shorten the lag time for seismic analysis by creating algorithm based on analysis elements and hardware for the algorithm.

## Efforts to Strengthen International Cooperation

The KMA attended the 24th ICG/PTWS held in China from 24 to 26 May 2011 for international cooperation and exchange related to tsunami warning system, exchanged experts for international cooperation on earthquake and tsunami (Chinese Earthquake Department, 25-29 July 2011), exchanged Korea-Japan human resources for investigating technology on volcanic monitoring and prediction and the response (Japan Meteorological Agency, 24-26 August 2011), and carried out a training on acquisition and analysis of seismic and volcanic observation data of Mt. Bakdu (Chinese Earthquake Department, 9 October-5 November 2011). At the Seminar on East-Asia Earthquake Studies held in Beijing from 19 to 21 October 2012, which was agreed upon at the 4th Summit Meeting among Korea, China and Japan in Japan on 22 May 2011, the delegates of KMA discussed on study results on earthquakes, tsunami and volcanic activities with experts from China, Japan and other East Asian countries. At the Korea-China earthquake science and technology conference held in Buyeo, Southern Chungcheong Province on 2 November 2011, the KMA and the Chinese Earthquake Administration agreed upon seven agenda including sharing observation data on volcanic activities of Mt. Bakdu, promoting exchanges of human resources, experts and young scientists, and sharing earthquake early warning technology.

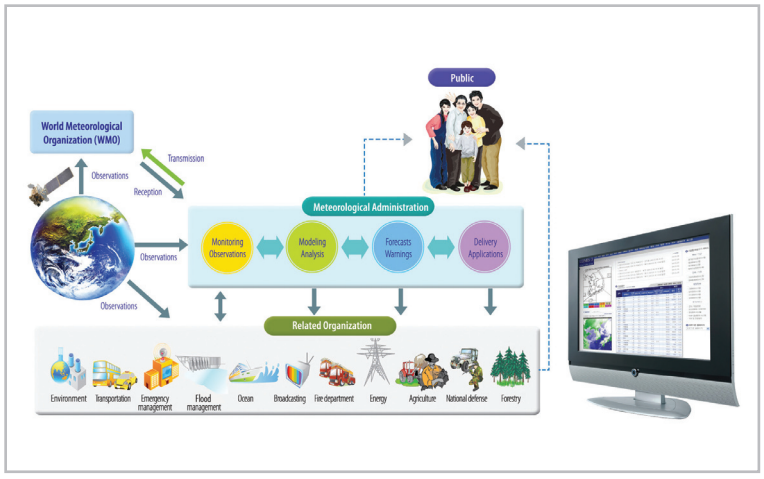
# ACTIVITIES



## Information and Communication

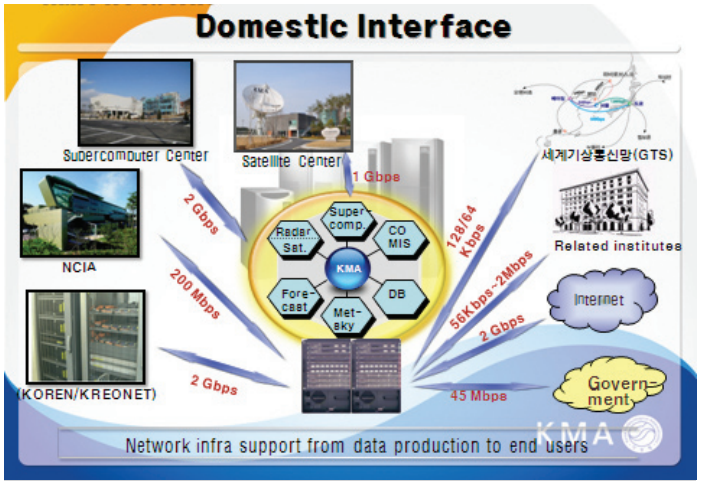
### COMIS (COmbined Meteorological Information System)

The COmbined Meteorological Information System (COMIS) is KMA's system for collecting, processing, storing and disseminating continuous flow of high-volumed real-time data. This system enables exchange of domestic and global (distributed via the Global Telecommunication System) surface, marine, upper-air, and satellite observations, all of which are used as initial data for numerical weather prediction models.

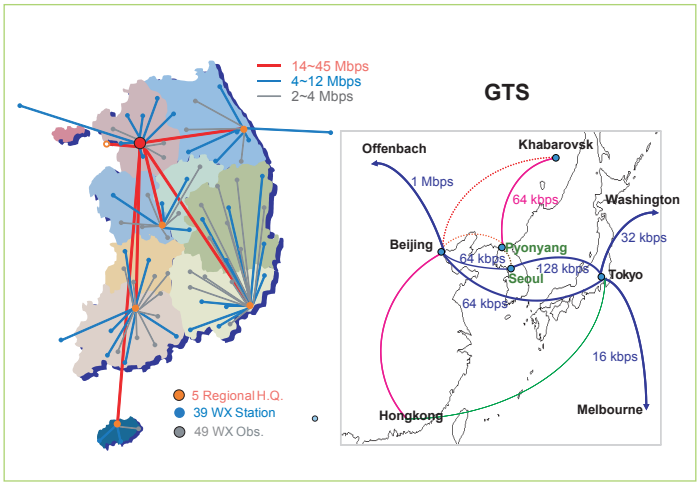



### Meteorological IT Network

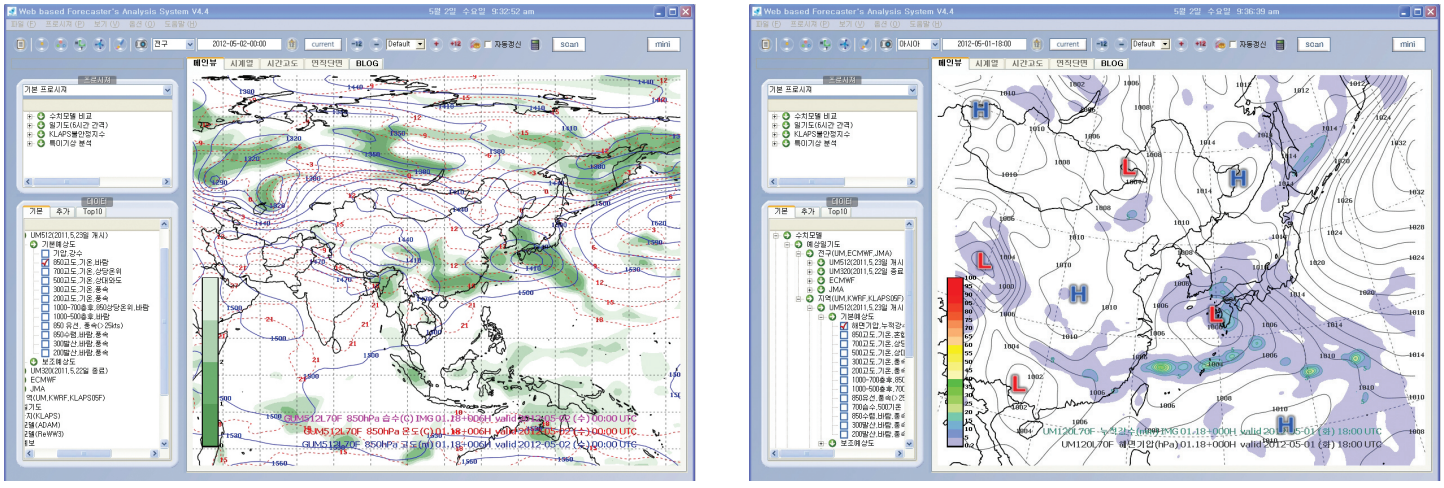
To promote swift and reliable collection and exchange of such data on surface, marine, upper air, satellite, radar, aerial photograph, earthquake, images and IP-based verbal information, the KMA operates meteorological IT network such as dedicated line and satellite among KMA's HQ and 105 weather stations and the meteorological observatory network linking about 850 meteorological observatory instruments in remote areas. In addition, the KMA exchanges global meteorological data through the Global Telecommunication System.




> Domestic Interface




> Telecommunication Network

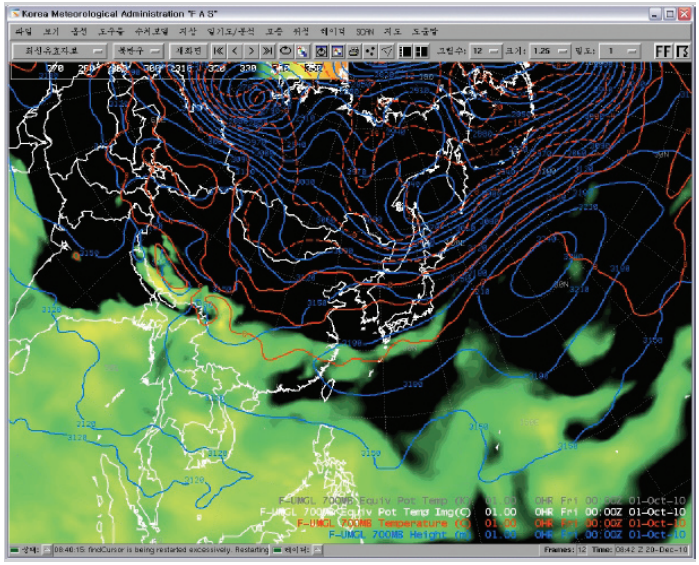


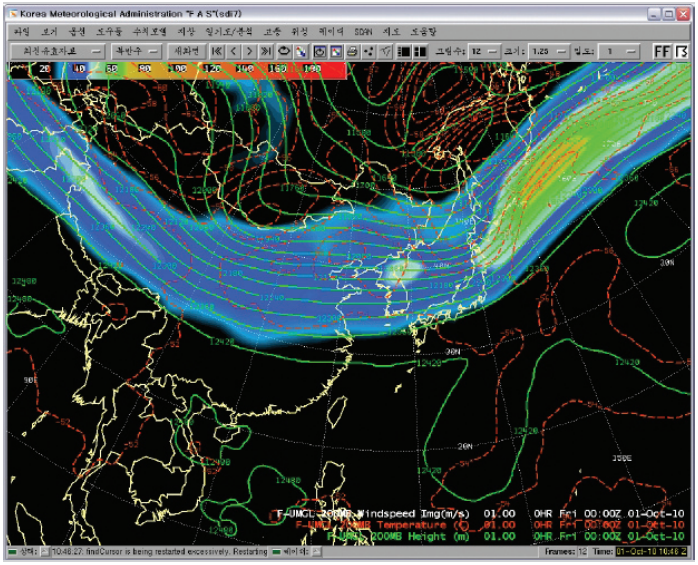
> WebFAS UM-Applied Display Example

## Forecaster's Analysis System (FAS)

Over the last 6 years from 2000 to 2005, in the international partnership with the NOAA GSD (Global System Division), the KMA established an advanced Forecaster's Analysis System as well as SCAN (System for Convection Analysis) and Nowcasting, which help promptly and accurately calculate meteorological data and comprehensively analyze the data to support on-the-spot weather forecast. In addition, the KMA developed WebFAS and WebSCAN, which are currently in operation. In 2009, the KMA applied virtualization and cloud computing technology to enhance operation environment of the existing LINUX FAS, making it available anywhere in the INTRANET environment without a separate LINUX server.

UM512 (high resolution model), COMS and Korea-China-Japan combined radar have been provided in WebFAS since 2011.





> vFAS Application Display Example




> OpenWebFAS web site and blog for external users

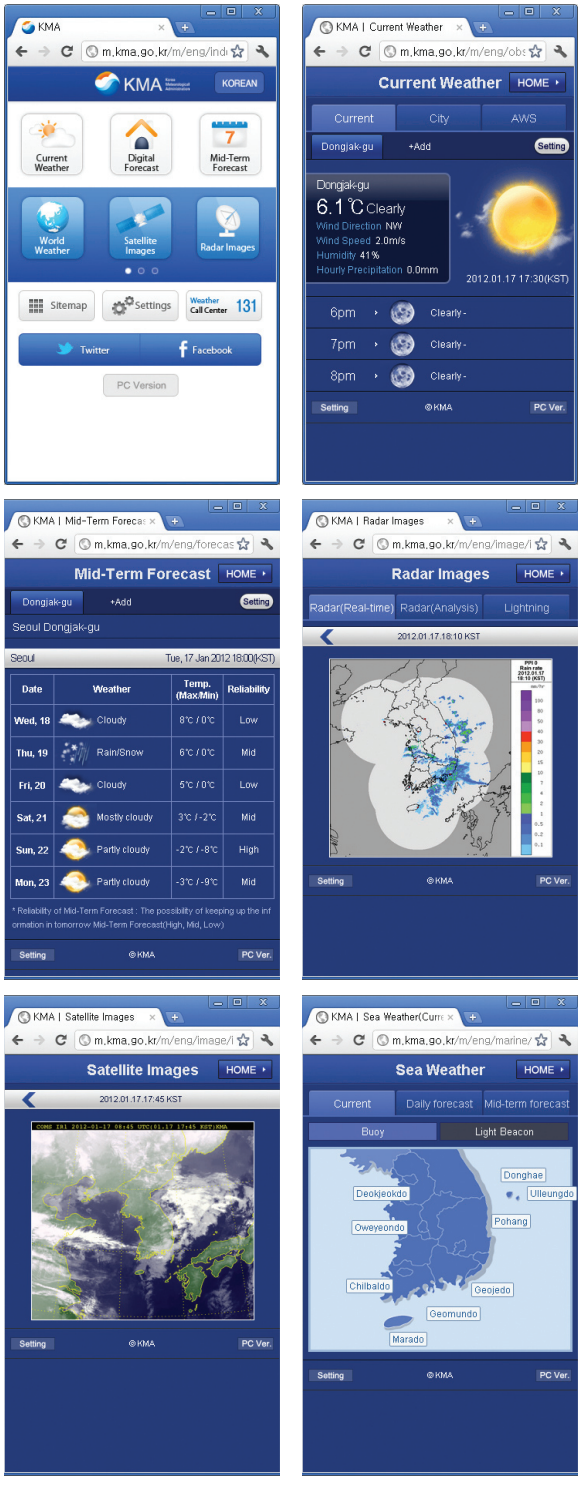
## Internet Services on Weather Information

The KMA has made an extensive renewal to its web interface to enhance its mobile weather services and to make it more convenient for users using a touchscreen. The KMA has offered mobile weather information to the public since April 2011 and the service is available on mobile devices (http://m.kma.go.kr). The information available includes warning reports, current weather, digital weather forecast, weather images and various life weather index. In addition, the KMA provides regional weather warning reports and auto-connection weather data services through SNS (Social Network Service) to establish a systemic environment which connects and enables communication via mobile devices. The KMA also provides weather information twice a day during commuting and office-leaving hours, encouraging users to share weather information. 131 WINC (Wireless Internet Number for Contents) service is also available on mobile phones for those with no access to information-users can receive weather information through wireless mobile network with a simple press of phone buttons.

## WMO Implementing WMO Information System

As the KMA was selected as a candidate for GISC in November 2011, the administration was required to create a system to build WIS center. To this end, the KMA took part in OpenWIS development project, a joint international project for developing core WIS software, joined by five organizations from Korea, UK, France and Australia in April 2010. The KMA secured core technology to operate the GISC on the completion of the project in 2011.

Based on its capabilities, the KMA is planning to establish GISC Seoul, serving as a global meteorological data distribution center which collects and disseminates both weather and climate information while enhancing reliability, flexibility and scalability of data service.




> Mobile images at KMA's English web site

# ACTIVITIES



## Weather Forecast

### Weather Forecast and Warning

The KMA releases warning, typhoon information or weather information—to protect public lives and property when dangerous weather conditions such as heavy rain and typhoon are expected. The KMA also issues, Dong-Nae forecast (Digital forecast), weekly forecast and one-month or three-month forecast, which are released on a regular basis to support the public to enjoy activities.

**Dong-Nae forecast (Digital forecast)**, a weather forecasting service supporting people's lifestyle and activities, divides the whole country in grids of 5km x 5km and shows 12 elements for eight times a day at three-hour intervals, including temperature (per hour, maximum, minimum), forms and probability of precipitation, precipitation, snow, sky conditions, wind direction, wind speed, humidity and ocean wave height in a form of text, time-series and graphics.

**Weekly forecast** provides information such as weather forecast, land and ocean conditions, maximum and minimum temperature and ocean wave height for six days from the day after tomorrow, twice a day.

**One-month forecast** predicts the trend of synoptic pattern, temperature and precipitation forecast on a 10-day basis.

**Three-month forecast** covers the trends of synoptic pattern, temperature and precipitation forecast on a monthly basis.

Warning is to inform or warn the public when serious disasters are expected due to weather conditions. Weather warning includes watches and warning, covering heavy rain, heavy snow, storm surge, typhoon, strong wind, wind waves, Asian Dust, droughtiness, dry air, cold wave and heat wave.


> Forecasting Region
Forecasting region consists of regionalized forecasting region including 17 land and 18 marine forecast areas and localized forecast area including 171 cities and districts and 24 areas of the sea.

## Very Short-range Forecast

Weather forecast can be classified into very short-range, short-range, weekly and long-range forecast based on Meteorological Act enforcement ordinance. The pilot service of very short-range forecast was launched on 15 June 2010 to meet continuous demands for prompt response and short-range forecast of weather events which occur and disappear within a short period of time. The official forecast was first provided in June 2011 after a successful year of the pilot service and lightning nowcasting as well as forecasting elements were added, and forecasting areas have been expanded across the whole Korean Peninsula by including North Korea land areas that had not been part of the pilot service.

Generally, very short-range forecast uses very short-range prediction system based on nowcasting and numerical forecasting model which utilize weather radar data.

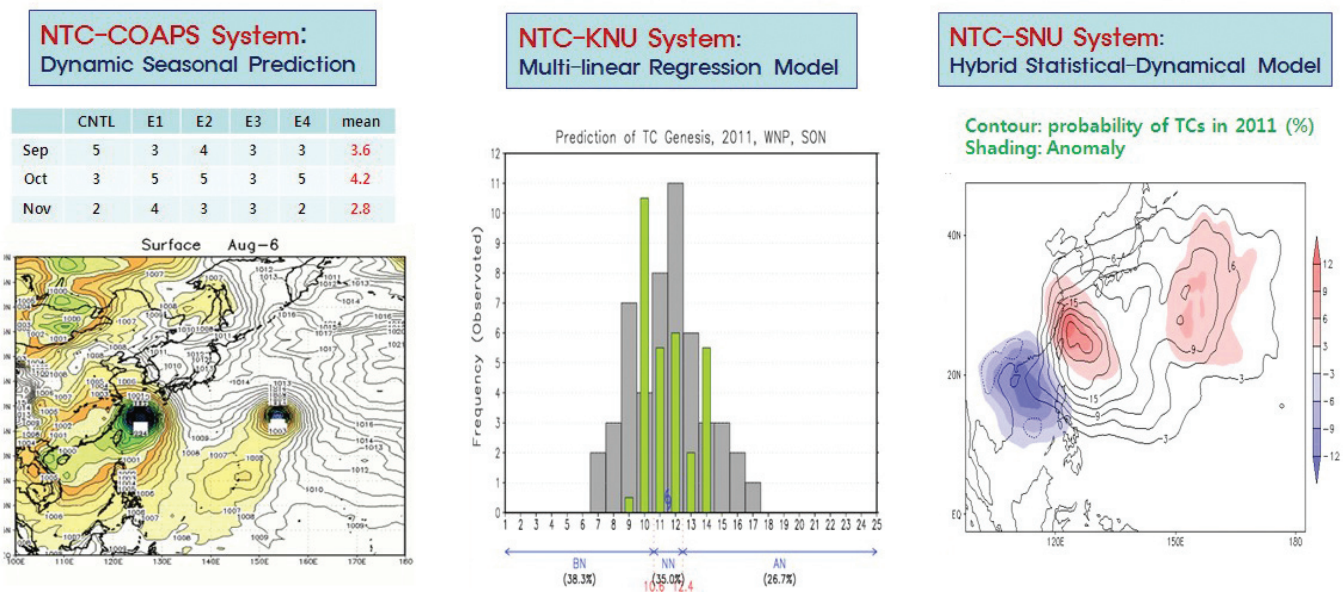
Very short-range forecast shows eight present elements of weather including temperature, precipitation, precipitation type, relative humidity, wind direction, wind speed, sky conditions and lightning and four forecasting elements such as precipitation type, precipitation, sky conditions and possibility of lightning. The very short-range forecast is issued for upcoming 3 hours forecast and forecast and produced at one to three hour-interval, depending on the time of announcement.

## Typhoon Forecast

National Typhoon Center was established in Seogwipo City, Jeju Special Self-Governing Province in April 2008 to systematically and effectively respond to ever-growing typhoon disasters along with climate change. The center observes and forecasts all types of typhoon occurring in the northwest pacific region and all information on typhoon is promptly delivered to the public and disaster prevention centers. It employs satellites, radar, AWS and buoy to analyze weather and ocean conditions on a real-time basis and utilizes numerical model data to predict typhoon direction and intensity.

National Typhoon Center introduced typhoon seasonal prediction-related systems which had been studied and developed in academia and institutes and established the typhoon seasonal prediction information production system. Typhoon frequency and seasonal prediction method about typhoon direction can be classified into a dynamic model, a statistical model and a hybrid form of dynamic and statistical

***> Summary of National Typhoon Center Seasonal Forecasting System***




models. NTC-COAPS[1], a seasonal prediction system based on the global atmospheric dynamic model (horizontal resolution 0.94°) developed in the U.S., provides typhoon prediction information by analyzing frequency and direction of vortex generated around the equator in the Pacific region. NTC-KNU[2] is a seasonal prediction system developed by Kongju National University. It produces typhoon prediction information by determining the most relevant forecast factors in regards to typhoon frequency from synoptic variables (sea level pressure, sea surface temperature, geo-potential height at 500hPa, wind speed and temperature field at 850hPa) in the atmosphere and finding regression formula. NTC-SNU[3] is a seasonal prediction system developed by Seoul National University. It is a hybrid-typed typhoon information production system, integrating prediction data of dynamic model and typhoon direction types classified by Fuzzy Algorithm. The prediction information produced by three typhoon seasonal prediction systems were utilized for the KMA typhoon forecast in the summer (June to August) and winter (September to November).

*1) NTC-COAPS: National Typhoon Center - Center for Ocean Atmosphere Prediction Studies*

*2) NTC-KNU: National Typhoon Center - Kongju National University*

*3) NTC-KNU: National Typhoon Center - Seoul National University*

## Numerical Forecasting System

The current numerical prediction system of the KMA mainly consists of Global Data Assimilation and Prediction System (GDAPS), Regional Data Assimilation and Prediction System (RDAPS), Korea Local Analysis and Prediction System (KLAPS) and various application systems derived from such systems. WaveWatch-III (WWIII) includes global WWIII, regional WWIII and local forecast models. Statistical forecasting models are medium-range temperature model, 3-hour temperature and Kalman Filter models. These models operate at least once to four times a day depending on the forecast subjects and the predicted products are immediately given to weather forecasters to be used for the public weather forecast service.

GDAPS (UM 25km L70), which has been operated on supercomputer-3 since 23 May 2011, consists of 25km of horizontal resolution and 70 vertical layers (the maximum of approximately 80km). Forecast data is provided for 10.5 days (72 hours for 06, 18UTC), four times a day. RDAPS (UM 12km L70) is made up of 12km of horizontal resolution and 70 vertical layers and KWRF (10km L40) consists of 10km of horizontal resolution and 40 vertical layers. Both models provide forecast data for 72 hours, four times a day.

***> Current status of numerical prediction model operation at KMA***

| Region | Model | Horiz. Resol. (Vert. Layers) | Target Length | Purpose / etc. |
|---|---|---|---|---|
| Global | UM (Global) | 25km (70) | 252h | Medium-range |
| | | 40km (70) | 240h | Medium-range (M24) |
| Regional | UM (E.Asia) | 25km (70) | 72h | Short-range |
| | KWRF (E.Asia) | 25km (40) | 72h | Short-range |
| Local | KLAPS (Korea) | 5km | 12h | Very Short-range |
| | UM (Korea) | 1.5km | 24h | Very Short-range |
| App. & Stat. Models | Wave Model | 60km | 252h | GWW3 (Global) |
| | | 8km | 72h | RWW3 (E.Asia) |
| | | 1km | 24h | CWW3 (Coast) |
| | Tide & Storm (RTSM) | 8km | 72h | E.Asia |
| | Asian Dust (ADAM2) | 30km | 72h | Asia |
| | Typhoon (DBAR) | 35km | 72h | Track & Intensity |
| | Digital Foprecast/stat. | - | 2-10d | |

KLAPS has been improved and operated for the public service of very short-range forecast which was launched on 15 June 2010. The very short-range forecast system was established by using the initial data filed from KLAPS. The system is creating forecast product for 12 hours.

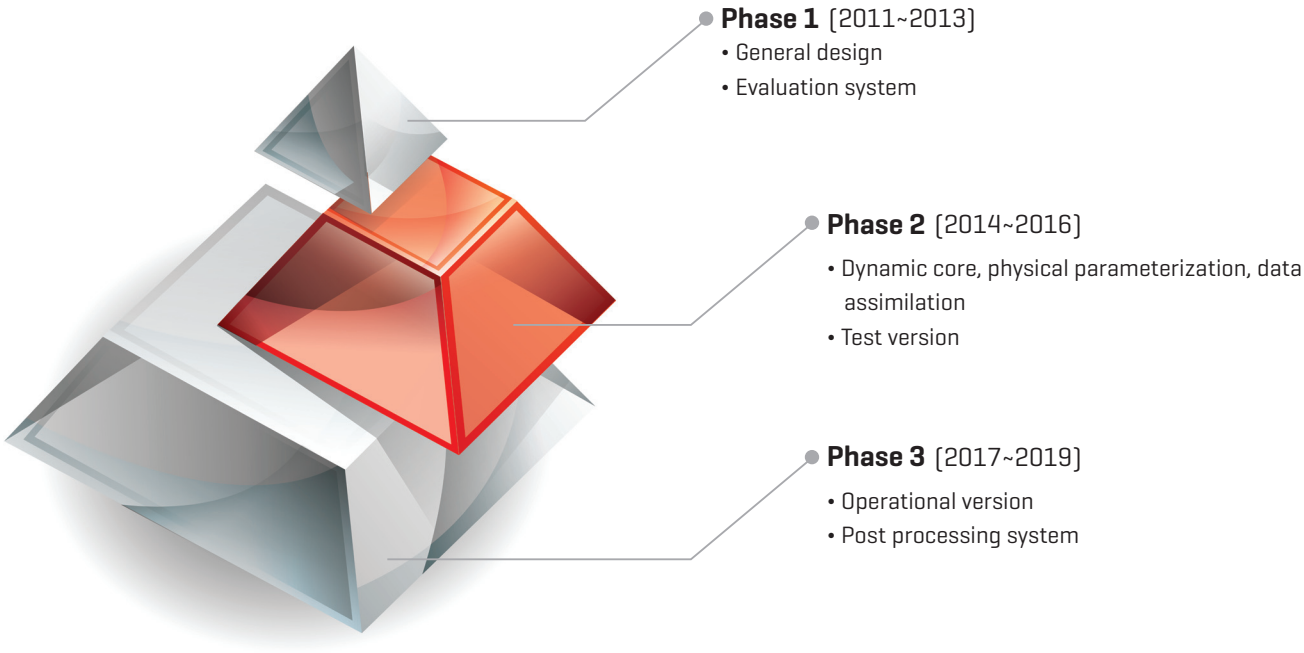
## Korean Numerical Weather Prediction Model Development

The KMA started Korean numerical weather prediction model development project in 2011 after approximately two years of pre-planning/research and feasibility study, in order to enhance meteorological technology for numerical prediction and provide more accurate weather forecast service by developing the Korean numerical weather prediction model for the medium to long-term. The year 2011 was the first year of the Korean numerical weather prediction model development project planned for the next 9 years. In addition, the Korea Institute of Atmospheric Prediction Systems (KIAPS) has been established for stable development projects based on intensive R&D resources.

The KIAPS started to develop source technology development for various modules comprising the numerical weather prediction system, such as dynamic core, physical process parameterization, and data assimilation measures. The KIAPS will develop commercialization version of the Korean Numerical Weather prediction Model based on integrated technologies developed for a long time. About KRW 10 billion will be invested for 9 years through the three-staged development for the project (refer to the diagram below).

> Signboard hanging ceremony of the Korea Institute of Atmospheric Prediction Systems (KIAPS)

To develop a KMA's own operational NWP model (2011~2019, $81M)




> Three-staged development plan for Korean numerical weather prediction model

## International Symposium on the 20th Anniversary of Operational Numerical Weather Prediction

Marking the 20th anniversary of the numerical prediction service, the KMA and the KIAPS held the international symposium on the latest advancement of numerical weather prediction models from 6 to 7 December 2011, in order to share achievements of the numerical prediction science with the industry, academia, institutes and government and discuss ways for future development and the international cooperation. About 100 prominent scientists at home and abroad including climate model and climate change prediction specialist Dr. Tarsushi Tokioka from Japan Agency for Marine-Earth Science and Technology (JAMSTEC) attended the symposium and had presentations and discussion in five sessions under the theme of the latest advancement of numerical weather prediction. The current prediction data of the KMA are utilized in the ensemble prediction experiments managed by WMO WWRP and also used by major cities in 18 Asian countries.

# ACTIVITIES



## Climate Change & Prediction

### Climate Change Watch

Enhancing climate change monitoring infrastructure in order to scientifically and systematically monitor for any environmental change on the Korean Peninsula includes expanding climate change monitoring network and elements, and developing the relevant technologies. As a part of the effort, The 'Korea Global Atmosphere Watch Center (KGAWC)' and climate change watch station were established in Anmyeondo, Jeju Gosan and the Ulleungdo/Dokdo climate change watch station construction projects have started in 2011 in order to install and operate greenhouse gas real-time observation system which observes $CO_2$ and $CH_4$ in Dokdo as a remote system. The design for construction of Ulleungdo/Dokdo climate change watch station has also been completed. The climate change monitoring system of Korea will be completed once the Ulleungdo/Dokdo climate change watch station, which is located at the eastern side of Korea peninsula, is built by 2013, along with the KGAWC in Anmyeondo toward the west and Jeju Gosan climate change watch station toward the south.

The Korean universities and institutes which have climate change watch technology and specialists have been set and operated as designated observatories by KMA. There are five designated observatories in Seoul (Ozone, Yonsei University), Gwangju (Aerosol, Gwangju Science and Technology University), Gwangneung (Forest flux, Seoul University), Antarctic King Sejong Station (CO2, ozone, uv rays, Korea Polar Research Institute) and Jeju (Radon, Jeju University).
In addition, WMO approved that the KMA hosted the WMO Sulphur hexafluoride World Calibration Center, in order to contribute for the observation technology and round-robin-test, etc to the GAW stations. It means that not only the greenhouse gas measurement and analysis technologies of Korea are highly recognized in the world but also the KMA is taking a leading role in the international climate change watch field.
The KMA will continue to consistently observe source materials causing

***> The instruments of the climate change watch installed in 2011***

| Name of Instrument | Measuring elements | Measuring location |
|---|---|---|
| Greenhouse gas remote observation system | carbon dioxide, methane concentration | Ulleungdo, Dokdo |
| Solar irradiance observation system for different wavelengths | Multiple wavelengths aerosol optical depth | Ulleungdo, Jeju Gosan |
| Automatic precipitation measurement system | pH, acidity | Anmyeondo |
| Sulphur hexafluoride testing system | Sulphur hexafluoride testing | Anmyeondo (World Calibration Center) |
| Gas chromatograph-ECD | Nitrous oxide concentration | Ulleungdo |
| Yellow dust particle counter | PM10, PM2.5, PM1.0 concentration | Jeju Gosan |
| UV Biometer | UV-A, UV-B | Ulleungdo, Jeju Gosan, Pohang weather station |

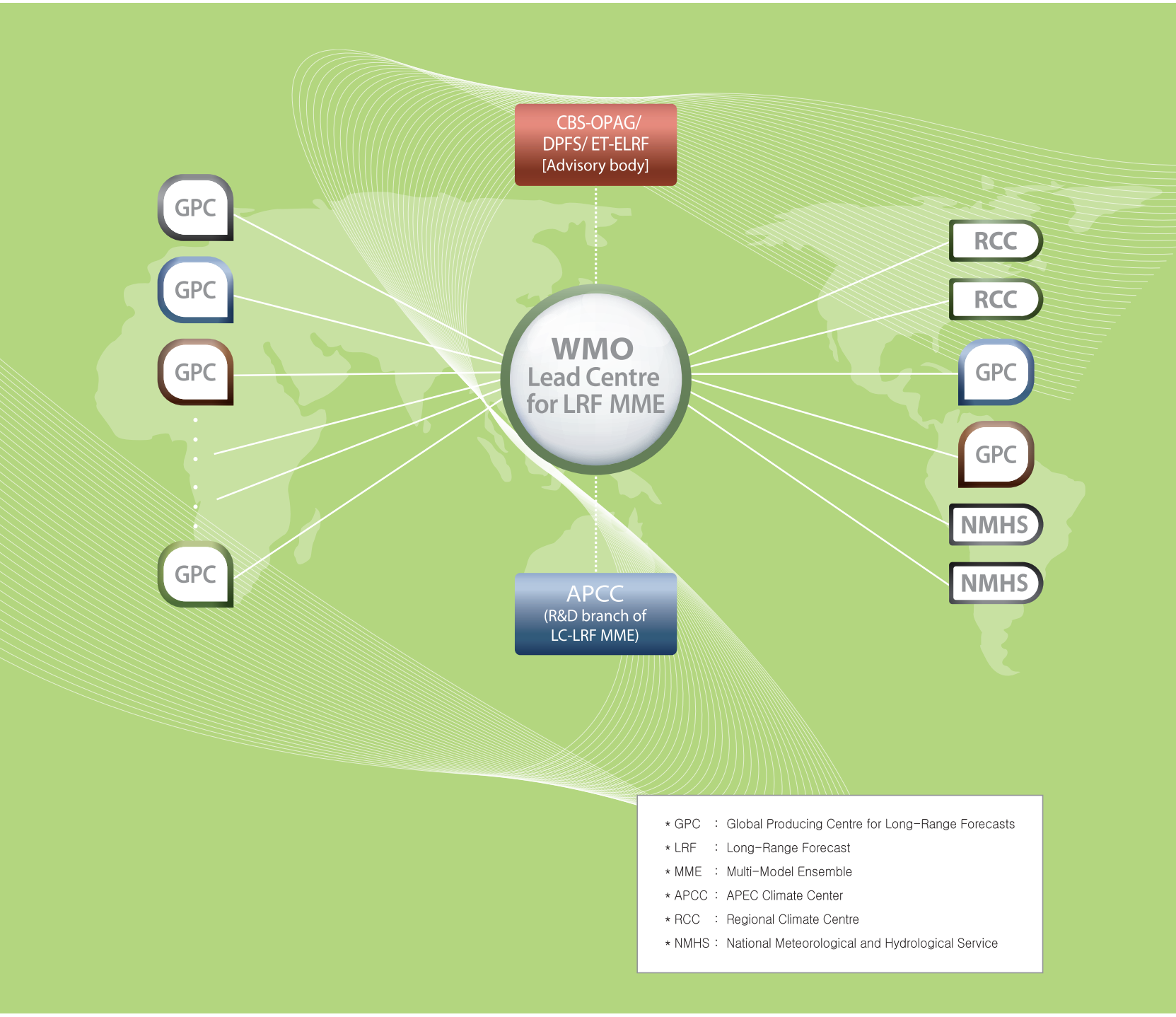
climate change by utilizing the climate change watch Station in Anmyeondo, Jeju Gosan, Ulleungdo and Dokdo and designated observatory in the universities and institutes.

## Climate Prediction Service

To enhance cooperation with the relevant organizations and hydrometeorology services, the KMA established Hydrometeorological Team in Climate Prediction Division of Climate Science Department in April 2011. The KMA provided weekly, monthly, seasonal precipitation statistics for different regions which compared and analyzed with precipitation data for the last decade (2001-2010), in order to provide user-customized hydrometeorological services with improved observation and prediction capabilities. In addition, to respond to climate change and establish early warning system for drought, Drought Early Warning System observing and providing forecast data on meteorological and hydrometeorological drought index was established and carried out as a pilot service in KMA in December. The KMA also strives to enhance international cooperation with the advanced countries in terms of hydrometeorological services through the WMO Hydrometeorological Committee, United Nations Convention to Combat Desertification and World Water Forum, in order to minimize disasters.

The KMA and the NWS have co-established and operated the WMO Lead Center for Long-Range Forecast Multi-Model Ensemble (http://www.wmolc.org), in order to share global Climate prediction information with other countries and improve Climate prediction reliability by developing better prediction technology. The KMA, as a leading centre for long-range forecast of the WMO, develops WMO standardization measures for global Climate prediction data being produced from 11 WMO Global Producing Centre for LRF, contributing to sharing and exchanging high-quality global Climate prediction data and enhancing Climate prediction technology.

***> The Role of LC-LRF MME***



### Providing Climate Change Scenario

Considering the geographical details and climate features, the KMA prepared the RCP 8.5-based South Korea detailed (1km) climate change scenario in order to support climate change adaption policies in December 2011. PRIDE statistical model was used to produce the detailed climate change scenario from the Korean Peninsula (12.5km) climate change scenario made by regional climate change model. That is, a new climate change scenario was produced by adding the observational climatology to the anomaly of the Korean Peninsula climate change scenario in which model's systematic errors were removed. The produced information includes temperature (mean, maximum, minimum) and precipitation and it will be provided from February 2012 by online.

The KMA strived to strengthen its communication to expand the use of climate change scenario in 2011. The KMA organized the Climate Change Scenario Users' Consultative Body in February in order to support climate change adaptation policies and to strengthen communication between producers and users. The user's workshop, training tour and user's manuals were provided to help understanding and utilization of scenario.

### Regional Climate Service

Recognizing the fact that the climate change impact varies from region to region and different strategies are required in different regions depending on seriousness of climate change, the KMA started Regional Climate Service Project in 2011. The project supports local governments to respond to climate change, help come up with counter-measures, protect the public from climate change-induced dangers and produce and provide customized, high-quality climate information, thereby boosting the local economy and achieving low carbon green growth.

### National Climate Data Management and Service System Establishment

The KMA invested about KRW 2.4 billion and started National Climate Data Management and Service System Establishment Project (24 March to 19 November 2011) in 2011 in order to set up an independent integrated DB system for the national climate data, and improve the public service system by making it more optional and customized. Based on the data standardization guidelines for integrated management of the national climate data, the project laid the foundation to enhance climate data reliability as it established integrated database for climate data, data management system to collect, process and store information and quality management system, including development of 19 climate data quality management algorithms and metadata management system. In addition, the KMA established national climate statistics production/analysis/support systems that enable user-oriented production and analysis of climate statistics, improving the climate data utilization system.

## Hosting the Korea-Africa Symposium on Coping with Climate Change


Heads of the African National Meteorological Services (Kenya, Ethiopia, Sudan, Burundi, Tanzania, Uganda, Zambia, DR Congo and Zimbabwe) and a climatologist from IGAD Climate Prediction and Applications Centre (ICPAC) visited Korea to attend a Symposium on Coping with Climate Change held by KMA in Seoul on 1-3 November with the aim of establishing green partnership and strengthening capacity in dealing with climate change.

A total of 100 climate change experts, at home and abroad, participated in the Symposium and discussed Korea-Africa cooperation projects and climate change policies while sharing their ideas through the post session presentations on 5 subjects - weather/climate, agriculture, meteorological industry, IT and health care.

In particular, at the "Korea-Africa High-Level Meeting on Cooperation in Meteorology", participants reaffirmed the importance of Korea-Africa/ICPAC cooperation projects, and had a substantial discussion on expanding the utilization of climate data and capacity building programs.

## Participation in the 10th session of UNCCD

The KMA operated Asian Dust/Desertification and Climate Change Green Growth PR Center in PR exhibition as a part of the 10th session of UNCCD contributing to the public understanding about climate change.

WMO Secretary-General Michel Jarraud visited Korea for four days from 17 to 20 October 2011 to attend the 10th session of UNCCD High-level segment. He spoke about climate change due to global warming, desertification prevention, abnormal weather conditions, current status of environmal issues and international response at Busan Provincial KMA on 19 October 2011. Secretary-General Jarraud presented GFCS current status and plans in the WMO side event and emphasized the importance of GFCS. He and KMA Administrator CHO Seok Joon also exchanged opinions about the need to nurture capability of developing countries to implement GFCS.

# ACTIVITIES



## Weather Industry

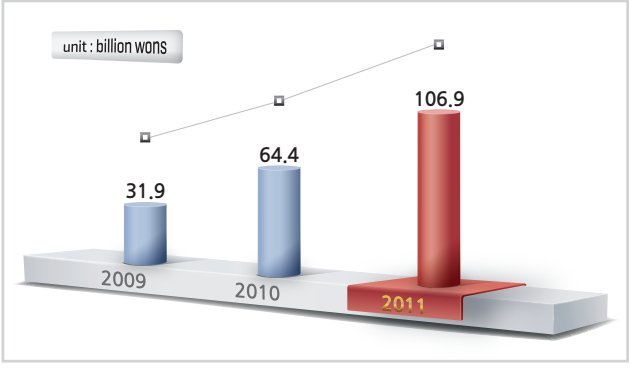
The KMA introduced the weather industry system in 1997 and institutionalized the system in order to sell the weather forecast to certain users who could not receive services from the KMA. As fostering weather/climate industry was designated as one of the top individual national projects in October 2008, the KMA prepared various ways to promote the industry and allowed private weather industry to provide forecast service for the general public. With the establishment of Weather Industry Promotion Acts (promulgated on 9 June 2009 and enforced on 10 December 2009) that enables private weather industry to provide forecast service to the public, the KMA set the concrete standards for human resources and facilities to support weather forecast service providers not to have problems to perform their service. The KMA strives to minimize any problem that may result from opening the service, through holding a public hearing for the academia, industry, media and civic groups, and benchmarking the weather industry system in advanced countries.

### Introduction of Weather Management Certification (W-mark) and Excellent Weather Application Certification System

The KMA introduced weather management certification system in order to expand use of weather information in private companies. Weather management certification acknowledges that the organization (company, public organization, etc.) applying for certification creates added values by utilizing weather information in management in a variety of ways and ensures safety against disasters. The certification process includes document screening, on-the-spot inspection and final assessment and the organization which scores 70 and more (full score: 100) is set to receive the certificate. The certified organization may enjoy a variety of benefits such as customized support for weather management consulting and PR activities, extra points in case of participating in "Korea weather information contest", etc. The KMA also introduced excellent

날씨경영인증
Weather Management Certification

> The mark of Weather Management Certification illustrates the Sun, the source of life, and nature elements such as water, wind and land, with the acronym of Weather, W. The surrounding oval symbolizes the company which ensures safety against weather disasters with the help of weather information.




***> Market volume of weather industry in Korea***

weather application certification system in order to prevent any confusion due to uncertain update period and sources over weather information of the applications available in the online market, laying the foundation for high-quality weather information trade.

The mark of Weather Management Certification illustrates the Sun, the source of life, and nature elements such as water, wind and land, with the acronym of Weather, W. The surrounding oval symbolizes the company which ensures safety against weather disasters with the help of weather information.

## R&D Investment to Enhance Technology of the Weather Industry

With the Weather Industry Promotion Acts enforcement in December 2009, weather industry support and application technology development project has been promoted in order to push for policies effectively fostering the weather industry, brace and invest in R&D in weather industry . The project selected and supported 24 research tasks (KRW 2 billion) related with weather service and domestic equipment utilization projects in order to enhance competitiveness of weather industry technology and also discovered 12 new projects which can promote integration development and create synergy through running three Project Identification Research Groups such as an IT-integrated weather service development research group. Starting in 2011, the project made contributions to increasing applications of weather information across the industry, both socially and economically as it supported 16 tasks in the industry and 11 weather enterprises participated in the project as supervising institutes.

# ACTIVITIES

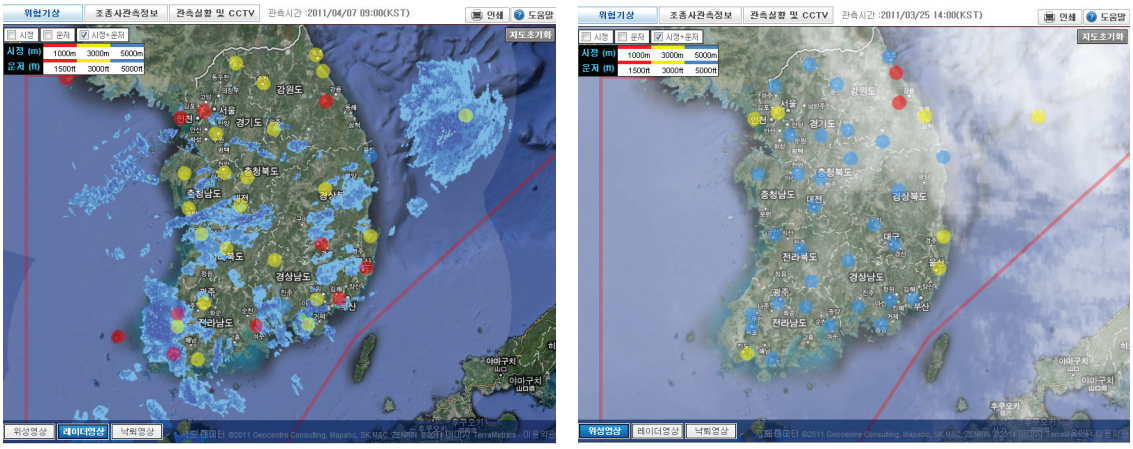


## Aviation Meteorology

Korea Aviation Meteorological Agency (KAMA), located at Incheon International Airport, is in charge of aviation meteorological services in the nation. KAMA provides aviation meteorological products to contribute towards safety, regularly and efficiency of air navigation in accordance with Standards and Recommended Practices (SARPs) of ICAO and WMO. KAMA conducts aviation meteorological observations, and issues aviation weather forecasts, warnings, SIGMETs. It also collects weather information from around the world through the Aeronautical Fixed Telecommunication Network (AFTN) for service to airlines and relevant organizations.

### Development of a Specialized Weather Content for Low-level flight

The KAMA developed weather support content for low-level flight and is providing graphic weather information to users to help them better understand the information in letters and numbers. It is also enhancing convenience of users and securing safety and economic efficiency of aeronautical operation through warning dangerous weather conditions in a specific area and offering optimal routes. This content is available on the website (kama.kma.go.kr) or mobile phone.




> Graphical display for aviation hazard


> Aviation weather contents for mobile web


> Aviation Weather Application for Smart Phones

### Weather Content for Air Leisure and Aviation Weather Service Application Service for Smart Phone

The KAMA increased information use efficiency and convenience in utilizing the aeronautical weather information by reflecting the changed lifestyles, employing the advanced IT and improving the aeronautical weather information transfer system. In addition, as the air transport industry and number of smart phone users expanded, the aviation weather service application for smart phones was distributed for free to meet the demands of aeronautical weather services in the future. Along with the advancement of the sky leisure industry including activities using light planes, hang gliders and para gliders, the KAMA developed sky leisure specialized weather content and realized the customized, practical aeronautical weather service.

### International Cooperative Activities of KAMA

In light of the cooperative agreement with National Agency for Meteorology, Hydrology and Environment Monitoring of Mongolia (NAMHEM) and KMA, the KAMA invited Aviation Meteorological Center (AMC) staff from 22 to 26 August 2011 to enhance international cooperation with NAMHEM and advance aeronautical weather service in developing countries. The KAMA shared technology of aeronautical weather observation instrument and aeronautical weather forecast to them and provided advice on installation of service quality management system. During the period, the AMC staff actively asked questions and discussed instrument introduction and operation when they were introduced to the advanced equipment owned by the KAMA, including Terminal Doppler Weather Radar (TDWR), Aeronautical Meteorological Observation System (AMOS) and Low Level Windshear Alert System (LLWAS). Throughout this event, the KAMA has considered the infrastructure and observation environment of developing countries to be huge obstacles for safe operation of aircraft and is searching for ways to transfer the advanced aeronautical meteorological technology to adjacent developing countries such as Mongolia from this year, referring to the Korea's advanced aeronautical meteorological technology and the previous experience of training.

To follow up the discussions and decisions of International Organizations in aviation meteorology services, the KAMA participated in the seminar of ICAO/WMO Asia Pacific Air Traffic Management and Meteorology, and the 2nd meeting of the ICAO Asia Pacific Air Traffic Management and Meteorology Task Force in January 2011 in order to collect information on the current status of meteorological service in member countries and the relevant international issues for the sake of safe navigation.
In the seminar, Korea gave a presentation titled 'Meteorological briefing for Air Control Center (ACC) controllers' to introduce the meteorological support service for safe navigation. In July, Korea participated in the 15th meeting of ICAO Asia Pacific Communication, Navigation, Surveillance and Meteorology to review agendas in different sectors which are to be applied to the international and domestic aeronautical meteorological services by improving or supplementing in the future.

# ACTIVITIES



## Meteorological Research

### Development and application of technology for weather forecasting (III)

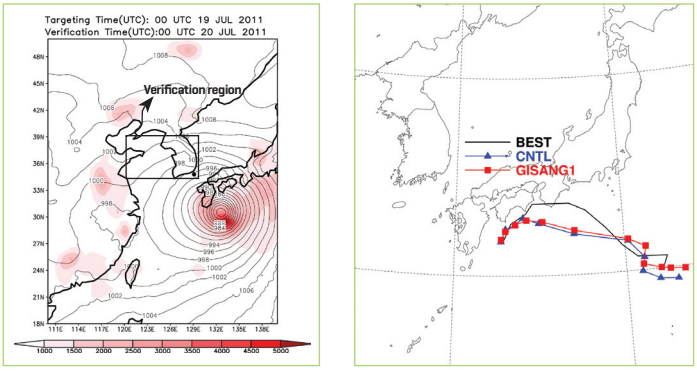
In oder to make advancements of technology for weather forecast and improve the predictability of severe weather, we carried out the study for the improvement and practical application of the short and medium range numerical model, the research for the enhancing the predictability of severe weather, and the development of the research-purpose numerical prediction system.

In the study on the improvement and practical application of the short and medium range numerical model, the 13 physical parameters of the unified model ensemble were optimized to the atmospheric characteristics of East Asia using a genetic algorithm. The real-time regional ensemble prediction system based on the use of a super computer (Cray XE6) was constructed and the prediction information on Digital Forecast points was diversified. we developed the MOS (Model output statistics) on the temperature of Digital Forecast points and serviced the forecast guidance through real-time operation. To support improving the special weather report for heavy rain, reasonable and scientific standard-time and rainfall amount were provided in consideration of the possibility of damage occurrence due to heavy rain and the concept of rainfall intensity. The test-bed for the mountain weather prediction system was constructed on the Yeongdong area and the effects through the application of radiation effects in consideration of mountainous topography were tested. The regional monitoring and prediction system (1km) was developed in the metropolitan areas using the VDRAS (Variational Doppler Radar data Analysis System) technique for four-dimensional data assimilation.

In the study on enhancing the predictability of severe weather, the National Center for Intensive Observation of Severe Weather (NCIO, Boseong Center) was operated stably to secure high quality observation data and the study on the microphysical processing of severe weather was constructed. The real-time adjoint model based targeting observation system was conducted and the targeting observation using

a ship (GISANG1) was supported. The predictability on the typhoon track and intensity was assessed. The track forecasts in the case of typhoon "Ma-On" was improved by 9 %. As participating in the International observation program (THORPEX, THe Observing system Research and Predictability EXperiment), the Grand Ensemble using TIGGE (THORPEX Interactive Grand Global Ensemble) data was composed and assessed on the rainfall predictability.

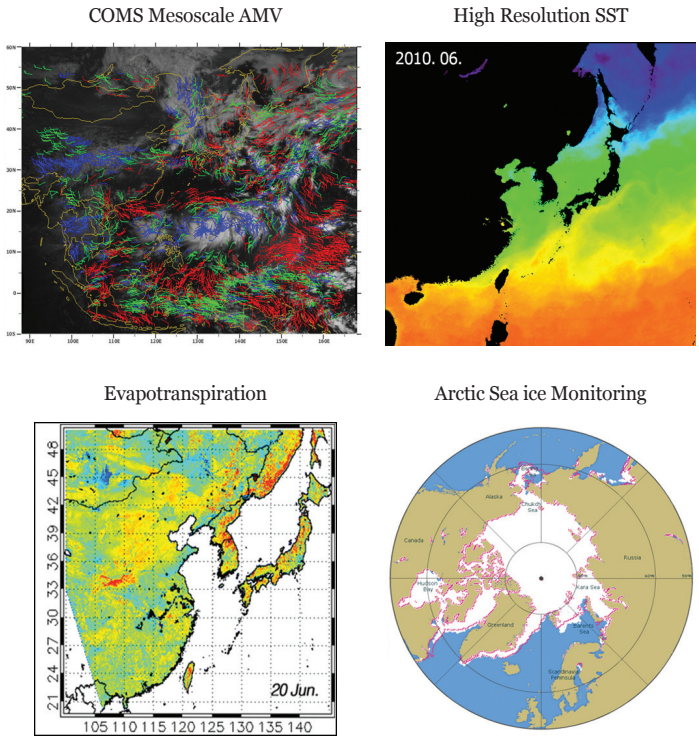
In the study on developing the research-purpose numerical prediction system, the three-dimensional statics system of geodesic grids was enhanced and verified its performance as a research model. With user interface of the Korean Unified Model (KUMUI 1.0) extended and developed, the user interface was established to verify and evaluate numerical test-bed.




> Distribution of sensitivity regions and track forecasts in the case of typhoon "Ma-On"

## Satellite-based Global Environment Monitoring and Research on GPM Application

This study is to secure application methodology of a variety of high-quality/high-resolution global observation satellites and to expand the utility of satellite information across a variety of fields including climate, hydrometeorology and numerical models. In order to apply for monitoring climate change, long-term variability of atmospheric parameters including ground vegetation and cloud was investigated on the basis of the satellite data observed for a long period. In addition, the database reflecting the geographical features of the East Asian region based on remote sensing from satellites was established for developing an algorithm which retrieves the daily amount of evapotranspiration.



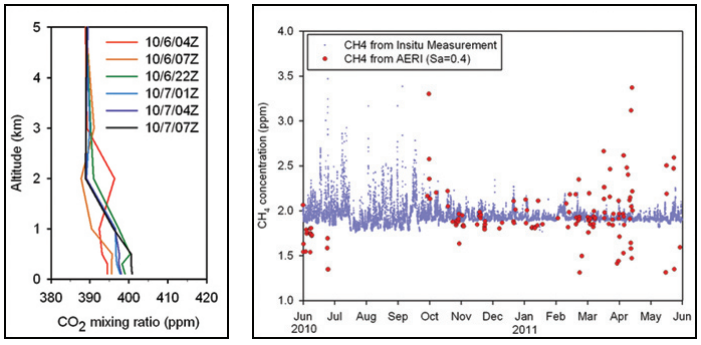

> Utilization of Earth Observation Satellites

To utilize the Earth Observing Satellite (EOS), an environmental sensor data were used to analyze the spatio-temporal change of CO2 and it was compared with ground observations and carbon tracker for verification. In addition, temperature and humidity retrieval algorithm was improved and greenhouse gas retrieval algorithm was established by using ground-based FT-IR. The FT-IR

retrievals were compared and validated with various data including sonde, aircraft observation, satellite, model, etc. In particular, the field observations (radiosonde observations: 40 times) and aircraft observations for greenhouse gases (23 times) from 2010 to 2011 play an important role as verification data for accuracy assessment of atmospheric environmental information generated from satellites and FT-IR. The data also contributed to describing background features of weather and climate observation elements in the observation area.

Radiosonde Obs. Aicraft Obs. FT-IR

CO2 Profiles CH4 Retrievals vs Obs.

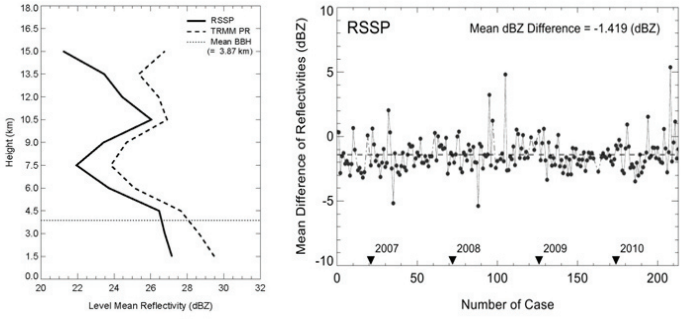



> Field observations (radio sonde, aircraft and FT-IR) and the results

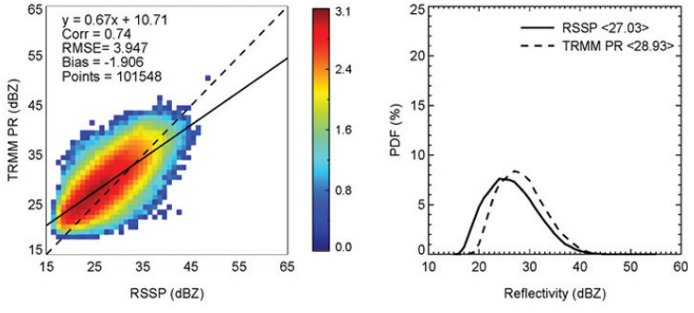
Regarding the expanded application of satellite information to climate and numerical models, atmospheric motion vector (AMV) retrieval algorithm using water vapor channel was improved to secure high-quality wind information both in cloud area and cloudless area. In addition, quality management optimization of AMV using high-resolution visible channels enhanced the number of mesoscale AMV and its accuracy. Every 30-minute SST provides full coverage in the East Asia without data sparse region by using the merging technique of two SST fields from satellites and an atmosphere-ocean mixed layer model, which can improve the limitations of satellite SSTs due to clouds.

As the need of satellite utilization in hydrometeorology and climate increases, many countries including the U.S., Japan and Europe are co-promoting GPM satellite projects. The National Institute of Meteorological Research (NIMR) and U.S. NASA (National Aeronautics and Space Administration) are collaborating on an international project on GPM ground validation. And the NIMR has analyzed physical features of precipitation over the Korean

Layer-averaged Reflectivity Mean dBZ Difference




Scatter Plot (left) and PDF (right) of dBZ from Ground-based Radar and TRMM/PR for Stratiform Rain Clouds




> GPM ground validation prototype

peninsula and characteristics of satellite precipitation in East Asia. The analysis and display system for global environmental information provides real-time monitoring for polar sea ice and global soil moisture. This system was utilized in prediction and analysis of the period of minimum sea ice amount in the Arctic in 2011.

### Technology Support and Utilization Research of Climate Change Prediction

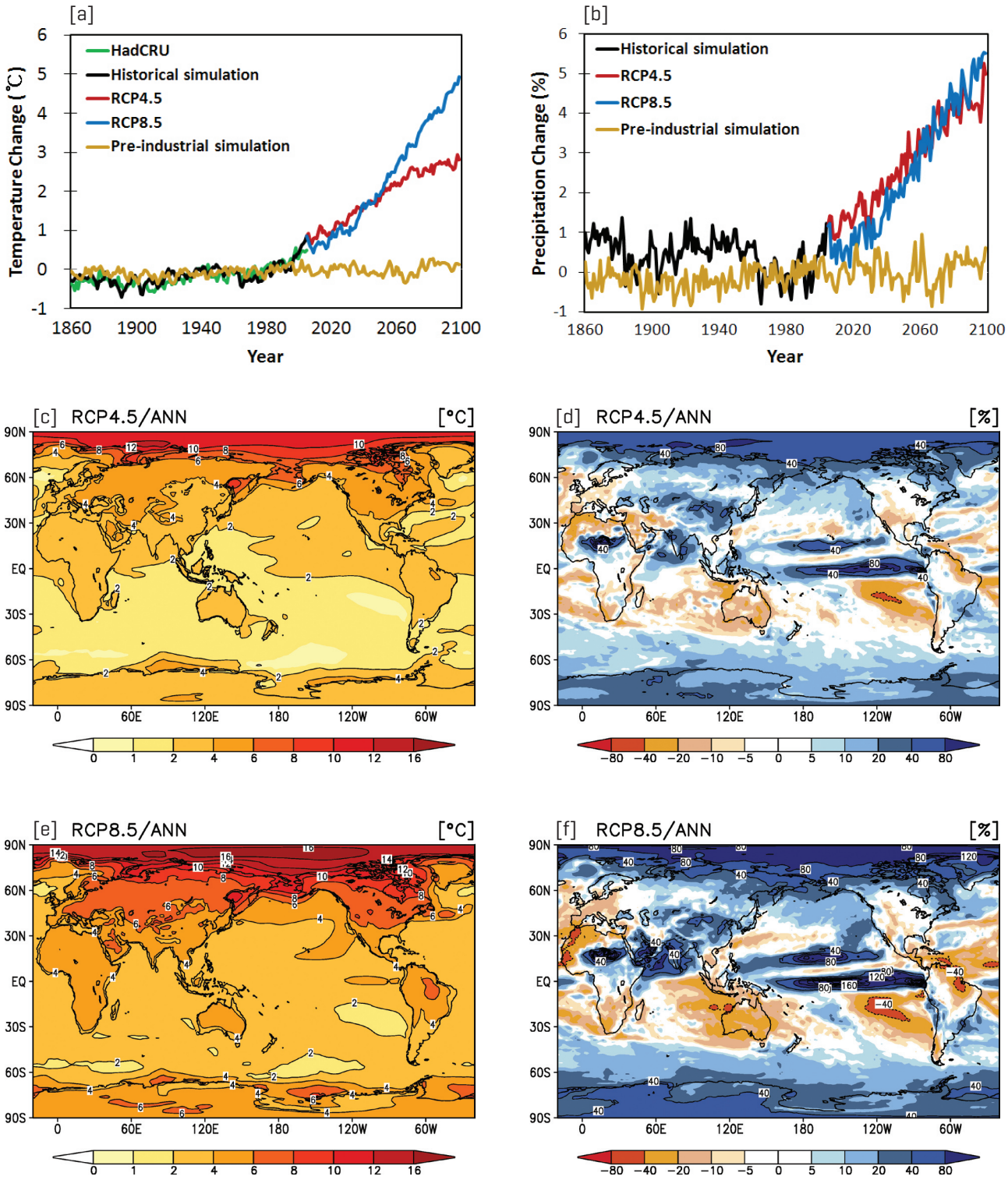
Korea has established the national strategy on green growth to convert the crisis into an opportunity to create a new growth engine and strived to prepare and implement systematic measures to respond climate change. To do this, the information on climate science is essential.

And also Climate modeling communities are undertaking a set of climate change simulations contributing to the climate model experiment coordinated by the Coupled Model Inter comparison Project Phase 5 (CMIP5) for the IPCC Fifth Assessment Report (AR5) using the newly-developed Representative Concentration Pathways (RCPs) of greenhouse gases, aerosols, and land use changes (Taylor et al., 2009).

NIMR/KMA is also participating in CMIP5 long term experiments jointly with Met Office Hadley Centre using HadGEM2-AO. It has performed the pre-industrial control and historical run (1860-2005) and future projection (2006-2100) by using RCP4.5 and RCP8.5 under the experiment framework of CMIP5 and assessed future global climate change. The simulation data were delivered to CMIP5 data center for the 5th IPCC assessment report.

Impact, Adaptation, and Vulnerability communities demand for high resolution climate information because GCMs are not enough to resolve local features and their extremes. We also completed experiments of dynamical regional downscaling on RCP 4.5 & 8.5 covering Asian region at 50 km grid spacing and Korean Peninsular at 12.5 km grid spacing, respectively.

As climate change accelerates, it is becoming more difficult to predict the extreme weather conditions (heavy rain, typhoon, drought, etc.) for a year or different seasons. The KMA and the U.K. Meteorological Office have been cooperating to establish the joint seasonal forecasting system based on the GloSea4. The GloSea4 consists of the UM for atmosphere, NEMO for ocean and CICE for sea-ice. It is going to be operational in the middle of 2013.



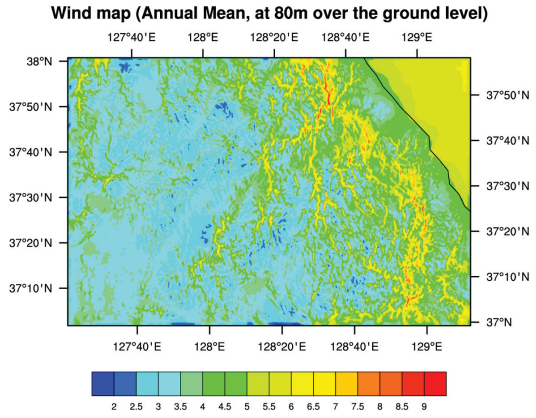

> Changes of global mean surface air temperature (a) and precipitation (b) from 1860 to 2100 and their future changes (2071-2100) projected by RCP4.5 (c, d) and RCP8.5 (e, f) relative to present level (1971~2000).

## Research and Development of Green Growth Support Technology

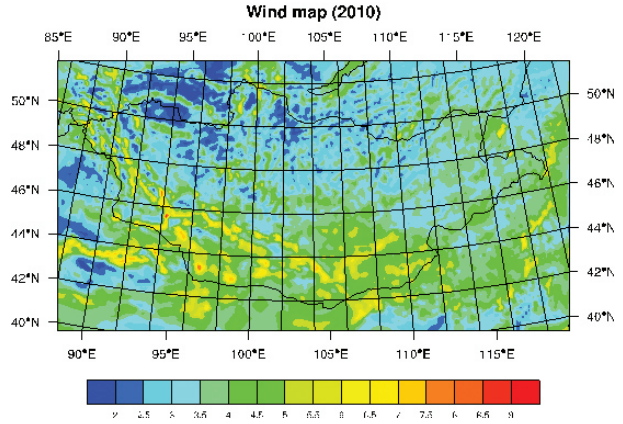
Research and development of green growth support technology improved the wind/solar-meteorological resource map to develop the technology supporting low-carbon green growth. In 2011, the KMA improved initialization process by utilizing high-resolution sea surface temperature data and synoptic observation data as an input and applied statistic correction process to reduce errors on the map. Focusing on Daegwanryeong wind power development complex designated as a pilot area, Large Eddy Simulation (LES) model was applied to exquisitely illustrate turbulence parameterization physical process in the mountainous area and the detailed meteorological resource map (333m resolution) was developed. To nurture climate change response capability in developing countries and support the domestic meteorological industry to make inroads into overseas countries, wind and solar meteorological resource maps (10km resolution) for Mongolia, the overseas pilot area of the KMA, were developed by utilizing medium-size numerical models and satellite data. By developing micro-scale data assimilation and prediction technologies which apply the four-dimensional data assimilation to non-synoptic observation data, the KMA established the customized-point prediction system for the complex, laying the foundation for establishment of user-customized meteorological resource prediction system in real-time.

For improvement of solar meteorological resource map, the KMA performed comparative analysis on one-layer solar radiation model and line-by-line solar radiation model, which were utilized in calculating solar energy on the ground. This improved the accuracy of the map by revising parameterization process of the atmosphere absorber and cloud data processing procedures. The improved solar radiation models were used to reflect more detailed geographical features of the Korean Peninsula, and also developed a solar meteorological resource map of 1km horizontal resolution for the period from 2009 to 2010. In addition, based on the radiation model and solar radiation amount, solar meteorological resource map of 4km x 4km resolution had been enhanced thanks to the last 11 years (2000-2010) of meteorological data, reflecting the climate effect of solar resource. Solar meteorological resource map of 100km x 100km resolution was developed based on the data from reanalyzing global models. Regarding the transfer of global solar meteorological resource analysis technology in particular, the KMA selected Mongolia as an overseas pilot area, produced a high-resolution solar meteorological resource map (5km x 5km resolution) based on reanalysis and satellite data and verified it based on the reanalysis data of the model, in order to help the weather industry to advance into overseas countries.

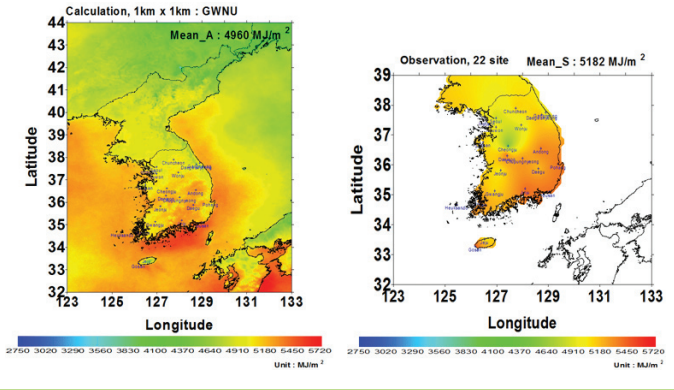
The KMA analyzed regional atmospheric circulation to develop technology of regional weather/climate environmental impact assessment which covers the metropolitan areas. Observation of slope current caused by the gap of atmosphere density was performed on the hill in Eunpyong-gu, Seoul. The analysis clearly showed the inversion of day/night temperature difference between the upper and lower areas of the hill. A clear inversion of vertical air temperature for the same spot was found as well. Regional atmospheric circulation was observed in Gangneung with the help of wind radar and auto-weather observation instrument. The difference of the intensity of sea breeze and development time between coastal boarder and 6km inland helped to identify the structure of the regional circulation. Such regional circulation observation technology is expected to be applied in observation of wind roads and so on.



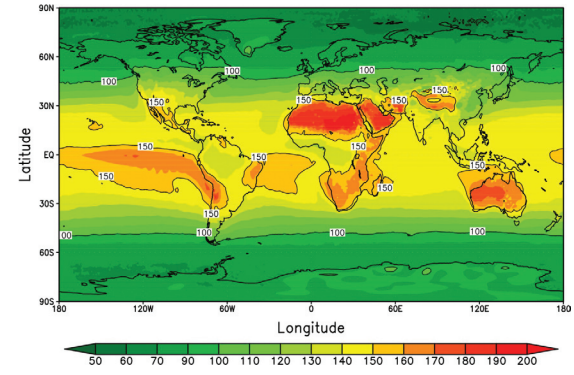

> Wind-meteorological resource map (333m resolution)



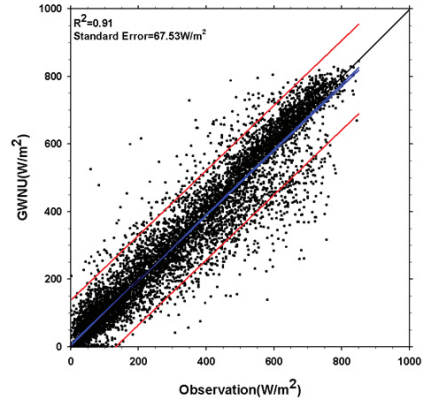

> overseas pilot area (Mongolia) wind resource map (10km resolution)



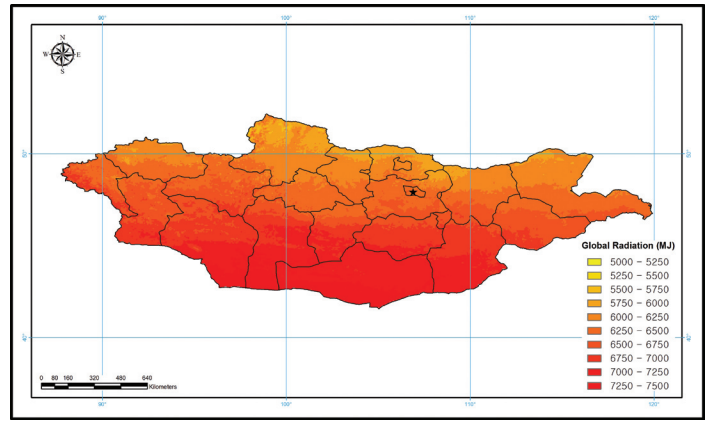

> Solar meteorological resource map of Korean Peninsula (1km resolution)




> Verification result of solar meteorological resource map of Korean Peninsula based on observation data




> Global solar meteorological resource map (100 km resolution)




> Mongolia solar meteorological resource map (5 km resolution)

# ACTIVITIES



## International Cooperation

The KMA is conducting multilateral cooperation with international organizations including WMO. WMO is a specialized agency under the United Nations for the status and movement of the Earth atmosphere, its interaction with oceans, as well as climate and ocean resources distribution. Founded in 1950, WMO has 189 members (including territories) as of the end of 2011. Korea joined WMO in 1956 as the 68th member, and has been showing active participation including the introduction of the first supercomputer in 1999, establishment of APEC climate center in 2005, launch of COMS in 2010, and commission of ocean weather observation vessel "Gisang 1" in 2011.
In terms of cooperation with international organizations, the greatest achievement in 2011 includes the election of administrator Seok Joon Cho as WMO Executive Council in the sixteenth WMO Congress, and the election of former administrator ByungSeong Chun as Typhoon Committee chair at the ESCAP/WMO TC. This feat shows that the KMA is expanding the international activities and its role is strengthening.

### Participation in the 16th WMO Congress

The 16th WMO Congress was held in Geneva, Switzerland from May 16 through June 3 2011, and 11 Korean delegates led by the KMA's administrator Seok Joon Cho attended the Congress. The Congress examined, agreed on future plans over the WMO science technology programmes, finances, WMO Secretariat operation and others, and elected WMO chairs and executive council members.
To actively respond to the increasing number of requirements from the international community due to climate change, the Congress selected five priority areas: the Global Framework for Climate Services (GFCS); capacity building; WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS); disaster risk reduction and aviation meteorological service. In particular, the Congress decided to enhance ties with other international organizations including UN agencies and

financial organizations, and noticed that the GFCS would be a key area in this process.
CHF 276,000,000 was allocated as the regular budget for the 16th accounting period (2012-2015), and during the 16th accounting period, CHF 142,000,000 of voluntary contribution has been secured to be invested in the five priority areas.
WMO Strategy Plan (2012-2015) and WMO Action Plan (2012-2015) were also adopted. The Strategy Plan includes strategies to meet three general social needs through five strategic points (thrusts) to bring about eight expected results in 2012-2015.
The PR of ROK was elected a WMO Executive Council (EC) in the sixteenth WMO Congress.

## Participation in the 63rd WMO EC

The 63rd WMO EC was held in Geneva, Switzerland from June 6 through 8, 2011 and five Korean delegates led by the KMA administrator Seok Joon Cho attended the meeting.
As the 15th WMO Congress had decided to conduct a 10-year project for the Global Integrated Polar Prediction System (GIPPS) and to organize the Inter-Commission Coordination Group on WIGOS (ICG-WIGOS), the EC assigned the 10-year GIPPS project to the Panel of Experts on Polar Observations, Research and Services (EC-PORS), and organized ICG-WIGOS members.
Besides, the EC organized EC members, and selected administrator Cho as a member of ECTT-GFCS, EC working group for service delivery and WMO Young Scientist Award selection committee; Director Jung Kyu Park as a panelist of EC expert panel for training and education; and Meteorological Researcher Mee Rym Oh as a EC-PORS member.

## Mandatory Contributions in WMO and Contribution of Trust Fund

The share of Korea's mandatory contribution to WMO is on the rise with 2.23% in 2011, ranking 11th among 189 member countries. Korea's mandatory contributions over the past 5 years are as follows.

**> Korea's contributions to WMO over the past 5 years**

[unit : Swiss francs]

| Year | 2007 | 2008 | 2009 | 2010 | 2011 |
|---|---|---|---|---|---|
| Amount | 1,099,120 | 1,336,430 | 1,336,430 | 1,336,430 | 1,392,635 |
| Share (%) | 1.76% | 2.14% | 2.14% | 2.14% | 2.23% |

In addition, Korea contributed to the Trust Fund for activities such as WMO voluntary Cooperative Programme ($30,000), ESCAP/WMO Typhon Committee ($12,000), WMO AMDAR programme ($4,000), THORPEX ($1,000), IPCC (111,276 CHF), GEO ($77,768) and IOC tsunami programme ($1,000).

## Participation in Other WMO Activities

Korea, with the KMA's administrator Cho as a EC member, is a member of WMO management group and has played a leading role in WMO activities. Participating in the 1st ECTT-GFCS meeting (2011.10.10.-12./ Geneva), Korea contributed to building a framework for GFCS implementation plans. In addition, Korea participated in the 3rd RA Ⅱ management group meeting (27 May 2011/ Geneva) to review the RA Ⅱ activities, and discussed plans for building regional strategic plans and holding the next regional meeting. Meanwhile, the KMA co-hosted WMO's GFCS events with WMO, UNESCO and UNCCD during the Congress to promote GFCS activities to participated countries, and explained Korea's plan to contribute to GFCS.
At Best Western Premier Guro Hotel in Seoul from November 30 to December 7 2011, the KMA held the WG-IOC/WIS meeting by 30 participants including WG members, invited experts and staff

from WMO Secretariat. The working group came up with a draft for WIGOS implementation plan based on the lessons and experiences earned by conducting the relevant pilot projects by the KMA.

## Hosting the 43rd ESCAP/WMO Typhoon Committee

The KMA held the 43rd ESCAP/WMO Typhoon Committee from January 17 to 22, 2011 at Hotel Shilla in Seogwipo-si, Jeju Special Self-Governing Province, and 95 participants from 11 TC members attended the meeting. The Committee reviewed what TC did in 2010, and decided the programmes for 2011 and beyond. Former administrator Byung Seong Chon was elected as TC chair.

## Meteorological Technology Cooperation among Countries

**> Australia**

The first cooperation meeting took place in 1996, and the 6th meteorological cooperation meeting was held in Seoul from February 14-15 in 2011. The two countries agreed on 9 cooperative activities in four areas, and decided to cooperate on technology assimilation as both countries operate the integrated model of the UK, and to share and develop meteorological technologies such as climate prediction, maritime prediction and WIS.

**> The Philippines**

The 3rd KMA-PAGASA Meteorological Cooperation Meeting was held from April 4-5 in the Philippines, and the two parties exchanged meteorological publication and agreed to develop joint projects including establishing the reception system for satellite data use and sharing urban forecast data.

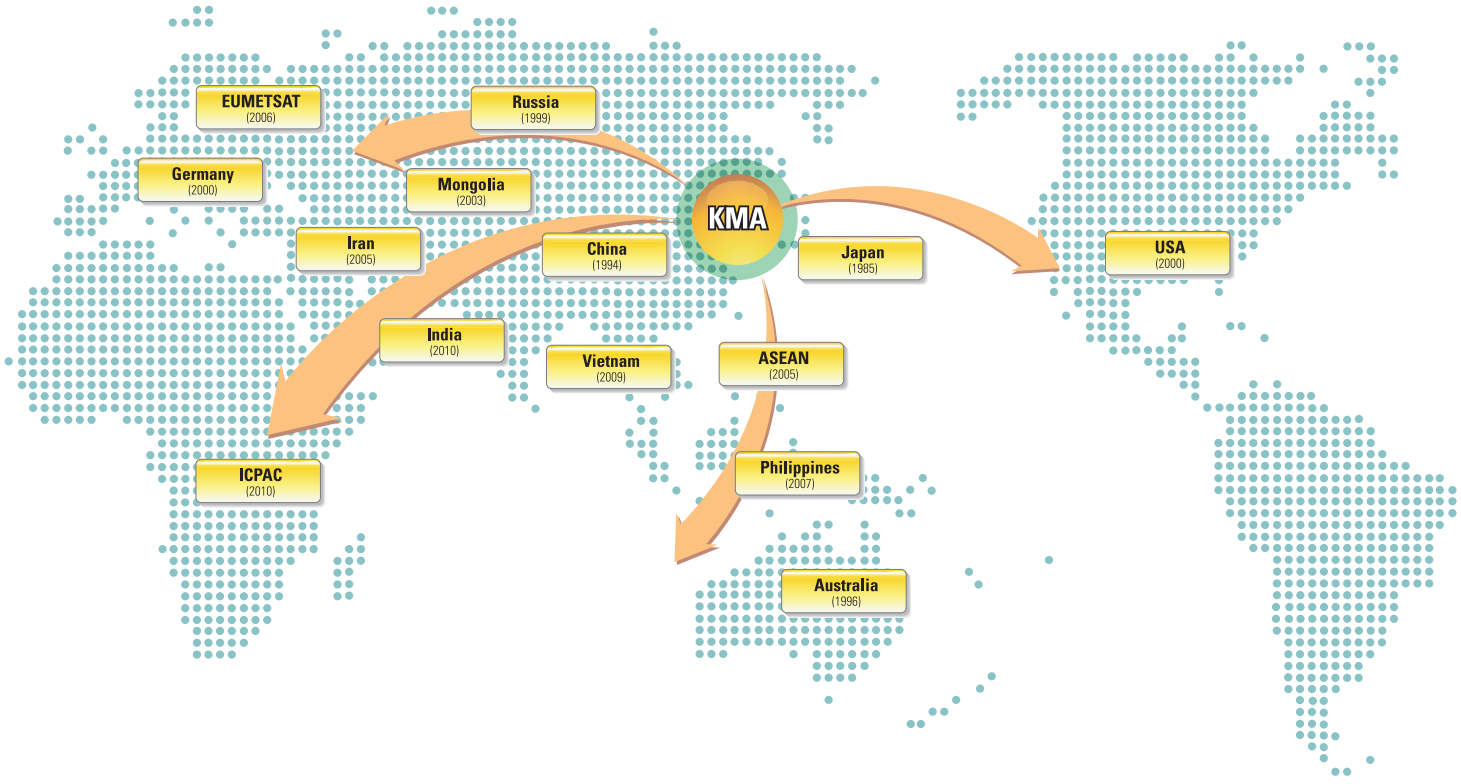
**> USA**

The KMA held the 3rd meteorological cooperation meeting in Silver Spring from July 24-26 in 2011 in collaboration with the National Oceanic and Atmospheric Administration or NOAA. The two parties signed an agreement to extend the expiration date of the Korea-US meteorological cooperation pact. The two administrations also agreed to conduct long-range forecast technological cooperation, push for space weather cooperation through WMO, share satellite data, cooperate with WIS (information system in WMO), co-develop the next generation observation system and provide education on dangerous weather forecast.

**> China**

The two organizations had a working-level meeting on Asian Dust Storm and a training programme for staff at the Asian Dust joint observation center in May and November, respectively, and the participants discussed ways to secure a joint observation network for Asian Dust, to exchange technologies to use Asian Dust observation data and to implement the World Meteorological Organization Sand and Dust Storm Warning and Assessment System (WMO SDS-WAS). Also, they exchanged technologies for the restoration of climate data, establishment of database and short-and mid-term forecast, and held the 13th East Asia experts meeting for long-range forecast in the summer season, the 4th Korea-China joint typhoon workshop, and the sisterhood relationship · joint workshop for meteorological research institutes in Korea and China.

The KMA held the 11th KMA-CMA Meteorological Cooperation Meeting from September 15 to 20 in Seoul to carry out 18 cooperative projects. Both organizations will be able to share radar data to apply the observation data to numerical forecast, cooperate on Asian Dust centered around WMO's SDS-WAS projects for Asia, enhance joint research projects by signing an agreement on meteorological studies of meteorological research institutes under both administrations, and exchange technologies on long-range forecast, climate data management and operational forecast.




### > Japan

The KMA and the JMA agreed in writing to exchange experts on various themes including volcanic activity monitoring, long-range forecast, satellite operation and aviation meteorology. In the annual Korea-China-Japan numerical weather forecast workshop (1 Sep 2011), the participants agreed to improve forecast quality in North East Asia to generate socio-economic benefits in many sectors such as maritime affairs, aviation, distribution and tourism.

### > EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites)

The KMA signed an MOU on 1 August 2011 on the cooperation in meteorological satellite and satellite meteorology with the EUMETSAT to facilitate satellite data exchange as the KMA successfully launched COMS. The two organizations held the 3rd meteorological cooperation meeting on 18 October 2011 in the EUMETSAT headquarters in Darmstadt, Germany and agreed to work together on scientific projects for satellite data exchange, training programmes through WMO-CGMS VLab, and satellite data calibration and validation.

### > East Africa Climate Prediction Application Center

The KMA held the Korea-Africa Symposium on Coping with Climate Change from November 1 to 3 in Seoul to secure a foundation for green partnership with Africa and better respond to climate change, inviting heads of meteorological offices and climate experts from 10 African countries. In this symposium, climate change response policies of 10 African countries and Korea's Africa support programme were presented, and ways to expand

Korea-Africa cooperation and support projects were discussed, including observation, weather and climate data utilization and training. The administration dispatched team of experts to African meteorological offices (Kenya, Tanzania, Ethiopia) and IGAD Climate Prediction and Application Centre (ICPAC) to understand the status of observation equipment, observation network, and communication infrastructure.

**> Korea-Central Asia, Moving toward Meteorological Cooperation**

The KMA attended the 5th Korea-Central Asia Cooperative Forum held in Uzbekistan from November 15 to 17 and held Meteorological Cooperation Meeting between Korean and Central Asian (Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan) meteorological officials. In this meeting, the KMA discussed the development of cooperative activities with Central Asian NHMSs, and further details will be discussed, including signing an MOU on meteorological cooperation, in the 6th Korea-Central Asia Cooperative Forum to be held in Korea in 2012.


> AWS equipment installation

## Support Projects for Developing Countries

**> Implementation of Early warning and Response System for Disaster Prevention in the Philippines**

The KMA has been conducting projects on the implementation of early warning and response system for disaster prevention in the Philippines with $3 million fund support from KOICA since 2010. As a part of the projects, the administration invited five hydrology experts from the Philippines meteorological office for training on flood warning and advisory system (18 Sep.-1 Oct. 2011).

The KMA has installed 48 instruments including automated weather observation equipment, rain gauge, water level observation instrument and warning post in 36 spots along the Pasig-Marikina river in the metro Manila area. In addition, the KMA has realized optimal collection and watch service by installing and operating stable observation instruments, developed flood forecast model tailored to the regional features of the Pasig-Marikina river area, including size and topography of the river basin and climate statistics, and provided flood forecast system based on comprehensive flood bulletin and flood hydrological data monitoring system. In addition, it installed wireless communication and emergency warning system for the data obtained from the flood forecast system so that warning messages could be quickly

sent to the metro Manila residents. It is expected that KMA's support, projects, and efforts to secure basic infrastructure would highly contribute to preventing flood-related disasters in the metro Manila and reducing the loss of life and property in the community.

**> Support for Modernization of Meteorological Services in Vietnam**

As Korea-Vietnam relationships were elevated into strategic cooperative partnership during the Vietnamese Prime Minister's visit to Korea in May 2009, the KMA planned to support modernization of meteorological services in Vietnam to strengthen the bilateral cooperation for development, science and technology, and established the supporting plan in 2009 to help Vietnam build response capability for disastrous weather and climate change, which drives low carbon green growth in Vietnam. This plan includes basic implementation measures for 5 projects: the establishment of meteorological disaster mitigating system; and support for nurturing meteorological experts; developing region-specific meteorological service; and enhancing meteorological research capability; as well as consulting services for meteorological modernization. In particular, as part of the support for the establishment of meteorological disaster mitigating system, the KMA developed programmes for the transfer of the Typhoon Analysis and Prediction System-2 (TAPS-2) to the Vietnamese meteorological office.

**> Korea-ASEAN Medium-Scale Numerical Forecast Training Workshop II**

After hosting the first workshop on training for monsoon rainfall seasonal prediction using the Korea-ASEAN cooperative fund, in 2002, the KMA successfully held workshops on numerical forecast and aviation meteorology in 2006 and 2008 at the requests of members. As the demands for the programmes to improve medium-scale numerical forecast technologies have increased since then, the KMA held the first training workshop in Korea in 2010, and the second training workshop in Malaysia in 2011. The training workshops focused on the operation of Weather Research and Forecasting (WRF) model, which is used in most countries, and 23 trainees from 6 countries answered "very satisfied" in the course evaluation.

## Training Programmes for Visiting Trainees

**> Africa Capacity Building Programme for Weather Disaster Response**

The KMA operated the Africa Capacity Building Programme for Weather Disaster Response (3-23 Apr 2011) for 17 climate and forecast experts from ten African countries to help those countries better respond to and adapt to climate change. This programme was intended to build capacity, which was a part of KMA's projects for Africa. It aimed at helping African countries predict and address disasters related to weather, water and climate, and providing African meteorological offices with KMA's technologies for climate prediction and numerical forecast. The programme consisted of modules for long-range forecast and climate prediction, climate data management and restoration, severe weather forecast, and relevant policy activities, and it combined practice with theory.

**> Programme for Better Meteorological Services with ICT**

The KMA conducted the Programme for Better Meteorological Services Using Information and Communication Technologies or ICT (18 April-13 May 2011) for 14 trainees from 12 meteorological offices in Southeast Asia, Africa and South Pacific. The programme aimed at promoting developing countries' ICT capabilities for meteorology by introducing Korea's ICT, which is recognized as the world's best by WMO, and presenting guidelines for meteorological service development based on the KMA's advanced ICT meteorological services. The programme consisted of applicable ICT, meteorological services using ICT, national ICT policies

and international cooperation, and helped participants better understand and develop meteorological services.

### > Training on Flood Warning/Forecast System for the Philippine meteorological office

The KMA invited 5 hydrology experts from the Philippine meteorological office for the project, the Implementation of Early warning and Response System for Disaster Prevention in the Philippines, and trained them for 2 weeks (19~30 Sep) on flood warning and forecast system. This training consisted of lectures and industrial facility tour for flood forecast, hydrological observation and equipment operation, and was successfully held thanks to the active participation of the Philippine trainees.

### > Technology Transfer for Mitigating Weather Disaster in Sri Lanka

The KMA conducted a programme for "Training for COMS data utilization and system operation" to train seven Sri Lankan staffers on receiving, processing, and utilizing COMS data from 21 November to 2 December. This programme consisted of two categories: one is 'COMS data analysis and, interpretation', and the other is 'System installation and operation', and took both theoretical and practical approaches for them to operate "the COMS receiving and analysis system" to be built in Sri Lanka by June next year and utilizing products from the system.
The programme also included a tour to KARI (Korea Aerospace Research Institute) to help the trainees better understand satellite development and utilization.


### > Training for CMA staff in charge of Asian Dust

From November 23 to 30, the KMA invited 14 CMA staff in charge of Asian Dust observation equipment to train them on the Korea-China joint observation network for Asian Dust. This course was expected to contribute to improving the collection rate of the observation data by promoting their capabilities for Asian Dust observation and equipment management.

## Programme for dispatching meteorological advisors to developing countries

Organized by the Ministry of Foreign Affairs and Trade, and conducted by the National IT Industry Promotion Agency, the programme contributes to the socio-economic development in recipient countries by providing them with meteorological technologies, management and consulting services. In 2011, advisors were dispatched to the meteorological offices in Vietnam (July 2010-June 2012), Malaysia (Nov. 2011-Oct. 2012), Kenya (Dec. 2010-Nov. 2011) and Mongolia (Dec. 2010-Nov. 2011). The advisors served as a bridge in international cooperation activities with the meteorological offices, identifying meteorological technology needs in recipient countries, and enhancing international reputation of the KMA.

# ORGANIZATION

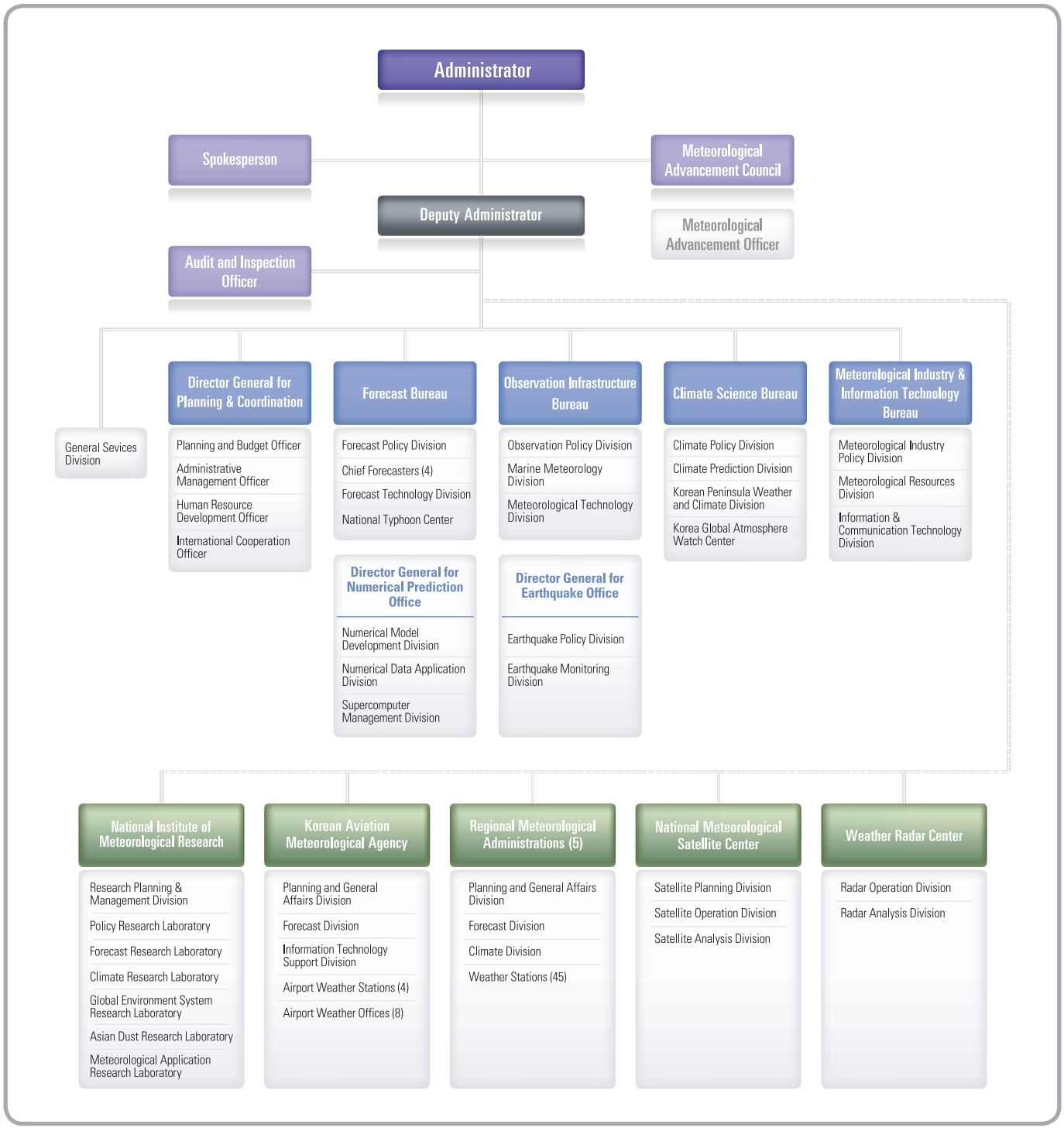


## History, Organization, Human resources, Budget

### History

| | |
|---|---|
| Mar. 1904 | Korea starts modern meteorological observation (Busan, Mokpo, Incheon, Wonsan, Yongampo) |
| Aug. 1949 | National meteorological service is established under the name "Centra Meteorological Office (CMO)" |
| Feb. 1956 | Korea joins the World Meteorological Organization (WMO) |
| Jan. 1959 | Aviation meteorological Services begin |
| Aug. 1961 | Meteorological Services Act is enacted |
| Sep. 1963 | Upper-air meteorological observation begin |
| Dec. 1969 | Observation begin with weather radars |
| Dec. 1970 | Reception of meteorological satellite data begin |
| Jun. 1971 | Dedicated Seoul-Tokyo international communication network is launched |
| Apr. 1978 | Meteorological Research Institute is established |
| May 1985 | Computer communication network is completed |
| Jan. 1989 | Meteorological observations begin at Sejong Base in Antarctica |
| Dec. 1990 | Organization is promoted to an Administration (renamed "KMA") |
| Jul. 1993 | Dedicated Seoul-Beijing international communication network is launched |
| Dec. 1998 | KMA relocates to new headquarters |
| Jun. 1999 | Supercomputer No.1 is introduced |
| Oct. 2004 | Supercomputer No.2 is introduced |
| Jul. 2005 | KMA Administrator is promoted to the rank of Vice Minister |
| May 2007 | KMA Administrator is elected to the WMO Executive Council |
| Oct. 2008 | Digital Forecast service is launched |
| Apr. 2009 | National Meteorological Satellite Center is established |
| Jun. 2010 | Communication, Ocean and Meteorological Satellite (COMS) is launched |
| Oct. 2010 | Supercomputer No.3 is introduced |
| May 2011 | The first ocean observation vessel "Gisang 1" is operated |

### > *Organization Chart*



## Function & Organization

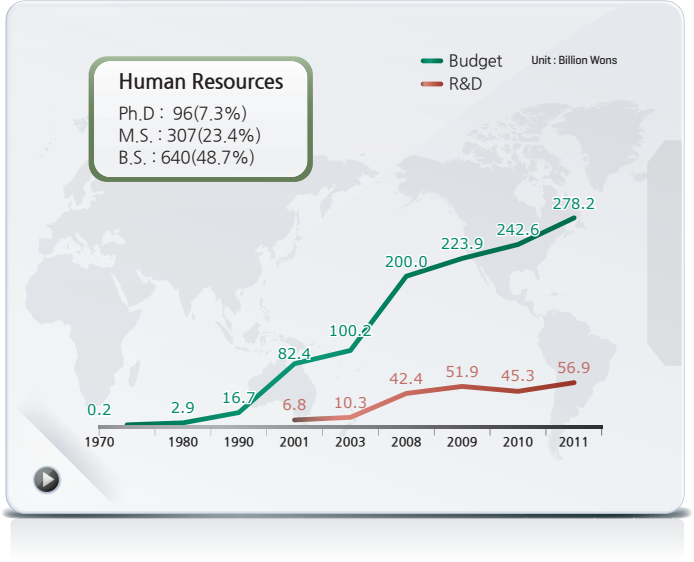
The KMA is a governmental organization of the Republic of Korea under the Ministry of Environment (MOE). Its mission is defined to protect citizens' lives and properties from natural disasters and improve wellbeing of the public in ways such as support for economic activities.

KMA conducts observation and analysis of meteorological phenomena and earthquake events on land and sea, and provides weather forecasts, weather data statistics and industrial meteorological information. KMA also oversees research and development of meteorological technology and shares other weather services through the exchange of meteorological data and information with WMO Members. The organization consists of one vice administrator, seven directors-generals, 28 divisions, and two centers. Its subsidiaries include the National Institute of Meteorological Research (NIMR), five regional administrations (in Busan, Gwangju, Gangwon, Daejeon, and Jeju), the National Meteorological Satellite Center, the Weather Radar Center, and the Korea Aviation Meteorological Agency (KAMA). The total number of KMA staff is approximately 1,314.

## Human Resources

As the modern society has rapidly become more global and turned into knowledge and information-intensive one, the demand for a variety of specialized meteorological services is increasingly on the rise. To sustain qualified workforce for more advanced meteorological services, the KMA recruited master's and doctor's degree holders, and hired Grade 9 public officials in meteorology additionally to secure working-level workforce. Breaking the newly employed into educational background, one Doctor (senior official) and 5 Masters (1 Specialized Contract Worker, 2 Researchers, 1 Junior Official for Meteorology, 1 Junior Official for Computerizing) were hired through a special recruitment, and 40 Grade 9 public officials (1 Master, 38 Bachelors, 1 highschool graduate) were hired through an open recruitment conducted by the KMA. As of the end of 2011, there are 433 master's and doctor's degree holders (109 doctors, 324 masters), the same as the 2010 figure, and 1,117 staff members (80.6%) have bachelor's or higher degrees.

***> Budget & Human Resources***



## Financial Statements

### Budget Overview

The KMA's 2011 budget consists of general accounts and special accounts for innovative city construction . General accounts include the estimated revenue which is KRW 2.153 billion, down by KRW 19 million or 0.9% from those of 2010. The estimated expenditure is KRW 288.876 billion (general accounts: KRW 278.245 billion; innovative city construction special accounts: KRW 10.631 billion), up by KRW 41.847 billion or 16.9% year-on-year.

The estimated expenditures in General accounts are classified based on expenses, including labor costs (KRW 69.808 billion, up by KRW 4.287 billion or 6.5% YoY), basic expenses (KRW 16.680 billion, down by KRW 2.593 billion or 13.4% YoY) and major projects expenses (KRW 191.758 billion, up by KRW 33.959 billion or 21.5% YoY). Those expenses account for 25.1%, 6.0% and 68.9% respectively. Among the major projects expenses, there are general project, R&D and digitalization project expenses, taking up KRW 84.909 billion (44.3%), KRW 56.886 billion (29.7%) and KRW 49.963 billion (26.1%), respectively.

As National Institute of Meteorological Research and Meteorological Radio Transmission Station moved to Seogipo City in Jeju and Gimcheon in Northern Gyeongsang Province under the public organization relocation plan, estimated expenditure of special accounts for the Innovative city construction is set at KRW 10.631 billion (up by KRW 6.195 billion or 139.7% YoY) for land purchase and construction.

### Estimated Revenue and Expenditures Statements

The 2011 estimated revenue consists of asset (KRW 12 million), current transfer income (KRW 160 million), sales revenue of goods and services (KRW 1.971 billion) and government's property sale (KRW 10 million).

Based on programs, it may be subdivided into weather forecast (KRW 34.258 billion), weather observation (KRW 33.067 billion), climate change science (KRW 9.682 billion), weather industry information (KRW 20.844 billion), regional weather service (KRW 8.521 billion), weather research (KRW 29.620 billion), executive agency operation (KRW 10.666 billion) and weather administrative support (KRW 131.587 billion) in general accounts and weather administrative support (KRW 10.631 billion) in special accounts for innovative city construction .

Major projects with increased budget among general projects include weather radar operation project (KRW 8.475 billion, increased by KRW 4.835 billion) for radar advancement and establishment of early earthquake warning system (KRW 5.160 billion, up by 2.610 billion) in the reinforcement project for earthquake observation network . The budget for Busan Provincial Government Office improvement project such as Daegu Weather Station relocation amounts to KRW 11.470 billion, increased by KRW 7.425 billion, and Gwangju Provincial Government Office improvement project including Bosung Global Standard Observation Station construction is KRW 11.307 billion, increased by KRW 3.774 billion. In terms of R&D project, Asia-Pacific climate information service and R&D project budget is allocated KRW 3.700 billion, increased by KRW 1.900 billion, in order to better support and respond to climate change. Digitalization project budget increased by KRW 4.014 billion to KRW 7.614 billion, as the real-time basis forecasting and special reporting service was reflected in the project for the establishment of advanced forecasting system.

There are nine new projects (KRW 17.293 billion in total) including regional climate change science service (KRW 2.500 billion), nurturing specialized talents in advanced forecasting (KRW 800 million), experience of weather camp (KRW 417 million), R&D of hydrometeorological technology at pilot areas (KRW 2.380 billion), R&D of weather industry technology support and utilization (KRW 2 billion), R&D of Korean numerical prediction model (KRW 3.146

***> 2011 Estimated Expenditures Based on Programs***

[unit : KRW million]

| Classification | '10 budget (A) | '11 budget (B) | up (△) down (B-A) | up (△) down (B-A/A) |
|---|---|---|---|---|
| **Total** | **247,029** | **288,876** | **41,847** | **16.9%** |
| **General accounts** | 242,593 | 278,245 | 35,652 | 14.7% |
| 1. Weather forecast | 28,764 | 34,258 | 5,494 | 19.1% |
| 2. Weather observation | 31,009 | 33,067 | 2,058 | 6.6% |
| 3. Climate change science | 3,770 | 9,682 | 5,912 | 156.8% |
| 4. Weather industry information | 17,412 | 20,844 | 3,432 | 19.7% |
| 5. Regional weather service | 4,260 | 8,521 | 4,261 | 100.0% |
| 6. Weather research | 26,627 | 29,620 | 2,993 | 11.2% |
| 7. Executive agency operation | 10,331 | 10,666 | 335 | 3.2% |
| 8. Weather administrative support | 120,420 | 131,587 | 11,168 | 9.3% |
| **Special accounts for innovative city construction** | 4,436 | 10,631 | 6,195 | 139.7% |
| 1. Weather administrative support (relocation of the Meteorological Radio Transmission Station and the National Institute of Meteorological Research) | 4,436 | 10,631 | 6,195 | 139.7% |

billion), establishment and operation of R&D center for disastrous weather (KRW 1.500 billion), R&D in Ulleungdo/Dokdo climate change watch station construction (KRW 1.850 billion) and national climate data management and establishment of service system (digitalization, KRW 2.700 billion).

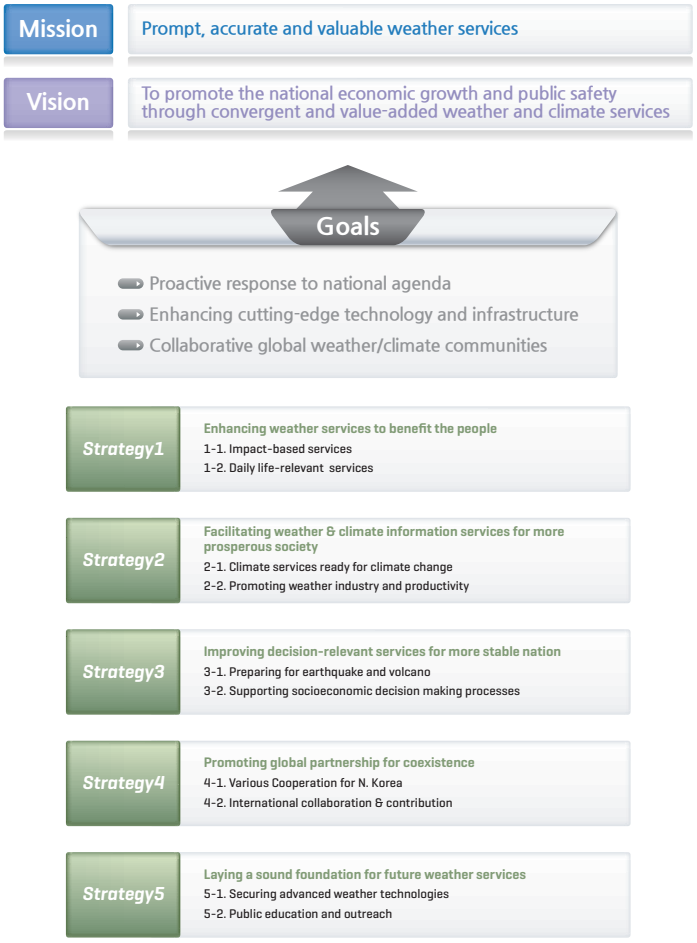
# Overview

History, Organization,
Human resources, Budget

KMA's Mid Term Plans

## KMA's Mid Term Plans

After the first basic plan for meteorological service development (2007~2011), the KMA devised the second basic plan for the national level meteorological service development (2012~2016) to meet the growing social and economic needs for meterological services.
For this, it set a new vision of "promoting public safety and national economic growth by combining weather and climate services and spreading the values," and selected five strategies and 10 key tasks for three goals: pro-actively respond to national agenda; secure cutting-edge meteorological technologies; enhance meteorological infrastructure; and establish global weather and climate networks.



Five strategies and key tasks are as follows. First, to make the public happy without the threats of weather disasters, the KMA will strengthen its response to severe weather to provide relevant meteorological services to the public. It will identify weather hazards better with the establishment of the system, share national weather observation data, increase numerical prediction model resolution to improve the numerical prediction, and promptly carry out the whole process of forecast production from monitoring to notifying with the implementation of advanced forecast systems. The KMA will also expand the weather services for those with no access to them as well as ordinary people, and produce region-specific information to be delivered through new media such as mobile, Wavigation (weather plus navigation, or GPS system) and digital weather broadcasting channel.

Second, the KMA will turn weather and climate data into resources for a more prosperous society. Providing scientific facts and prediction data about climate change, and supporting climate change adaptation and greenhouse gas emission reduction policies, the KMA will operate Ulleungdo/Dokdo climate change watch station and develop sophisticated national climate change scenario and carbon tracing system. The massive amount of climate data collected with the observation standard methods will be offered as various forms of applied information for renewable energy and industrial management after the strict quality control process. The KMA will develop strategic service products and cutting-edge observation equipment in order to transfer them to private sector and to support relevant industries to export them.

Third, the KMA will reinforce the weather service for policy making process in various fields such as society and economy to build a resilient nation. It will advance the quake · tsunami observation network, improve very-short range forecast to +6 hours (from current 3 hours), Dong-Nae forecast to +72 hours (from current +48 hours), and weekly forecast to +10 days (from current +7 days), and introduce quantitative probability forecast to long-range forecast. In addition, by combining weather factors with non-weather ones, it will offer converged weather information for energy production, landslide, agricultural produce management, and other purposes and establish a meteorological support system in preparation for terror, military operation, active sun, and so forth.

Forth, the KMA will strengthen the global partnership for co-existence of the world. As it will pursue strategic meteorological cooperation with the North, considering inter-Korean ties and international affairs, it will generally focus on helping North Korea accumulate weather technologies and prepare for the national reunification through indirect cooperation with international organizations. Furthermore, the KMA will provide developing countries with its world's 7th level of weather services and technologies, and create mutual weather service systems with China and Japan to address weather disasters in Northeast Asia together.

Fifth, the KMA will lay a foundation for meteorological services for the future. It will focus on the development of Korean numerical prediction model, introduction of supercomputer-4 and multi-purpose aircraft, and development of a geostationary satellite following COMS. It will continue to expand and streamline the National Institute of Meteorological Research, and secure specialized professionals at it to support national policies and practical research activities. Also, the KMA will create an environment where people can enjoy benefits of weather, and develop programmes for the public participation so that people can better understand meteorological science.

# Acronyms

**A**

| | |
|---|---|
| ACC | Air Contral Center |
| AFTN | Aeronautical Fixed Telecommunication Network |
| AMC | Aviation Meteorological Center |
| AMDAR | Aircraft Meteorological Data Acquisition and Relay |
| AMOS | Aerodrome Meteorological Observation System |
| AMV | Atmospheric Motion Vector |
| APCC | APEC Climate Center |
| ASOS | Automated Surface Observing System |
| AWS | Automatic Weather System |

**C**

| | |
|---|---|
| CGMS | Coordination Group for Meteorological Satellite |
| COMIS | COmbined Meteorological Information System |
| COMS | Communication, Ocean and Meteorological Satellite |
| CORDEX | COordinated Regional climate Downscaling Experiment |

**D**

| | |
|---|---|
| DBCP | Data Buoy Cooperation Panel |

**E**

| | |
|---|---|
| EOS | Earth Observing Satellite |
| ESCAP | Economic and Social Commission for Asia and Pacific |
| ETOOFS | Expert Team on Operational Ocean Forecasting Systems |

**F**

| | |
|---|---|
| FAS | Forecaster's Analysis System |

**G**

| | |
|---|---|
| GAW | Global Atmosphere Watch |
| GDAPS | Global Data Assimilation and Prediction |
| GFCS | Global Framework for Climate Service |
| GIPPS | Global Integrated Polar Prediction System |
| GISC | Global Information System Centres |
| GPC | Global Producing Centre for Long-Range Forecasts |
| GPS | Global Positioning System |
| GSICS | Global Space-based Inter-satellite Calibration System |

**H**

| | |
|---|---|
| HRIT | High Rate Information Transmission |

**I**

| | |
|---|---|
| ICAO | International Civil Aviation Organization |
| ICPAC | IGAD Climate Prediction Application Center |
| ICT | Information and Communication Technologies |
| IOC | Intergovernmental Oceanographic Commission |
| IPCC | Intergovernmental Panel on Climate Change |

**J**

| | |
|---|---|
| JCOMM | Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology |

**K**

| | |
|---|---|
| KAMA | Korea Aviation Meteorological Agency |
| KARI | Korea Aerospace Research Institute |
| KGAWC | Korea Global Atmosphere Watch Center |
| KIAPS | Korea Institute of Atmospheric Prediction Systems |

# Acronyms

| | |
|---|---|
| KIST | Korea Institute of Science and Technology |
| KLAPS | Korea Local Analysis and Prediction System |
| KOICA | Korea International Cooperation Agency |

**L**

| | |
|---|---|
| LES | Large Eddy Simulation |
| LIDAR | Light Detection and Ranging |
| LLWAS | Low Level Windshear Alert System |
| LRF | Long-Range Forecast |
| LRIT | Low Rate Information Transmission |

**M**

| | |
|---|---|
| MME | Multi-Model Ensemble |

**N**

| | |
|---|---|
| NIMR | National Institute of Meteorological Research |
| NWP | Numerical Weather Prediction |

**R**

| | |
|---|---|
| R&D | Research and Development |
| RCC | Regional Climate Centre |
| RCPs | Representative Concentration Pathways |
| RDAPS | Regional Data Assimilation and Prediction |

**S**

| | |
|---|---|
| SARPs | Standards and Recommended Practices |
| SDS-WAS | Sand and Dust Storm Warning and Assessment System |
| SNS | Social Networking Service |

**T**

| | |
|---|---|
| TAPS | Typhoon Analysis and Prediction System |
| TDWR | Terminal Doppler Weather Radar |

**U**

| | |
|---|---|
| UNCCD | United Nations Convention to Combat Desertification |
| UNESCO | United Nations Educational, Scientific and Cultural Organization |

**W**

| | |
|---|---|
| WIGOS | WMO Integrated Global Observing System |
| WINC | Wireless Internet Number for Contents |
| WIS | WMO Information System |
| WRF | Weather Research and Forecasting |

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