

**法規名稱：**(終)IMPLEMENTING ARRANGEMENT #22 DEVELOPMENT OF A HAZARDOUS WEATHER MONITORING AND FORECAST SYSTEM PURSUANT TO THE AGREEMENT BETWEEN THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE IN THE UNITED STATES AND THE AMERICAN INSTITUTE IN TAIWAN FOR TECHNICAL COOPERATION IN METEOROLOGY AND FORECAST SYSTEMS DEVELOPMENT

**簽訂日期：**民國 99 年 07 月 19 日

#### Article I - Scope

This Implementing Arrangement describes the scientific and technical activities to be undertaken by the American Institute in Taiwan (AIT), through its designated representative, the Global System Division (GSD), (formally the Forecast Systems Laboratory) of the Earth System Research Laboratory (ESRL) of the National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce. It provides for continuing development of the forecast system being developed by the Joint Forecast Systems Project. This project is a cooperative effort between the Central Weather Bureau (CWB), the designated representative of the Taipei Economic and Cultural Representative Office in the United States (TECRO), and AIT's designated representative, NOAA/ESRL/GSD. This Implementing Arrangement is of mutual interest to both TECRO and AIT, hereafter referred to as the parties. The products of this Implementing Arrangement will provide substantial value through development of new and upgraded capabilities and applications that can be integrated into other NOAA/ESRL/GSD systems.

#### Article II - Authorities

The activities described in this Implementing Arrangement will be carried out under the general terms and conditions established by the Agreement between the Taipei Economic and Cultural Representative Office in the United States and the American Institute in Taiwan for Technical Cooperation in Meteorology and Forecast Systems Development (TECRO-AIT Agreement), and any subsequent revision as agreed to by the parties. This Implementing Arrangement is the twenty second such

arrangement under a succession of umbrella agreements between TECRO and AIT.

This Implementing Arrangement is hereby attached to that Agreement and becomes part of the Agreement.

#### Article III - Services

During the period of Implementing Arrangement #22, TECRO 's and AIT 's designated representatives respectively, the CWB and NOAA/ESRL/GSD joint team, will expand our work to address the hazardous weather theme. Nine tasks are identified as: (1) development and improvement of satellite products for tropical storm monitoring and prediction, (2) Realtime analysis and forecasting with ARPS system, (3) Improvement and verification of short range forecasting using STMAS with remote sensing data, (4) HRQ2 (High-resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast) applications improvement, (5) Enhancement of nowcasting decision assistance tools, (6) Development of high resolution product generation assistance tools, (7) Installation of NOAA Science On a SphereR (SOS), (8) GPS Radio Occultation satellite data assimilation using the NCEP/JCSDA Gridpoint Statistical Interpolation (GSI) analysis system, and (9) Continuing interaction on earlier cooperative projects. Tasks under this Implementing Arrangement range from full scale developmental collaboration to system upgrades and support that allow systems to operate with the latest technical and scientific capabilities and specifications. These ongoing activities, described in more detail in the Statement of Work, will include the following nine tasks:

Task #1 Develop and improve satellite products for tropical storm monitoring and prediction

Primary hazards from tropical cyclones including storm surge, inland flooding and wind damage (directly from the storm winds

and from typhoon-spawned tornados). Preparing for these hazards requires accurate forecasting of storm tracks, storm intensities, sizes of storm wind field, and precipitation. These forecasts are currently obtained from numerical model predictions and from simpler empirically-based techniques. The United States (NOAA/NESDIS and NASA) has invested in satellite products from operational and research satellites that can be used for storm monitoring and forecasts. But, the product quality needs to be improved further under severe storm conditions. Also, transition of existing algorithms and products to operational centers needs to be improved and accelerated.

During Implementing Arrangement #22, AIT ' s designated representative, NOAA/ESRL/GSD, agrees that NOAA/NESDIS (National Environmental Satellite, Data, and Information Service) will lead this task. NESDIS will provide the access to advanced microwave satellite products, product analysis system and algorithms for SST and SSW products from the Aqua satellite. NESDIS will also provide improved microwave sounding products and the data processing system from AMSU (Advanced Microwave Sounding Unit) and SSMIS (Special Sensor Microwave Imager and Sounder).

In order to demonstrate the forecast improvement value of using satellite data, NESDIS will improve the quality control software for microwave sounding products, develop tangent linear and adjoints of clouds and moisture physics, and demonstrate the use of microwave sounding products over land in the NWP system. This task will benefit TECRO ' s designated representative, CWB, in improving the use of satellite products for tropical storms ' monitoring and prediction.

Task #2 Real-time analysis and forecasting with ARPS system

The ARPS (Advanced Regional Prediction System) has been

developed at the Center for Analysis and Prediction of Storms (CAPS) at the University of Oklahoma. The ARPS a comprehensive regional to storm-scale atmospheric modeling system. It is a complete system that includes a realtime data analysis and assimilation system, a forward prediction model and a post-analysis package. The assimilation of radar and other high-resolution observations for convective-scale forecasting is a noted strength of the ARPS system. The 3DVAR-cloud analysis package of ARPS is a computationally efficient for producing convective-scale initial condition including radar data, while ARPS ' s Ensemble Kalman Filter (EnKF) data assimilation system promises to provide optimal initial conditions for both deterministic and ensemble predictions when computational resources become available.

During Implementing Arrangement #22, AIT ' s designated representative, NOAA/ESRL/GSD, agrees that CAPS at the University of Oklahoma will lead this task. CAPS will set up an ARPS domain within the CWB ' s Nonhydrostatic Forecast System (NFS) model, assimilating radar data for CWB ' s initial ARPS Forecast System. TECRO ' s designated representative, CWB, will provide support to set up CWB ' s HPC systems for running the ARPS Forecast System at CWB. CAPS will perform case studies for heavy precipitation cases, that include the evaluation of domain size, computational requirements and configurations for HPC platforms, as well as forecast performance evaluation. This task will benefit TECRO ' s designated representative, CWB, in improving its short-range forecasting capabilities, in particular, those related to heavy precipitation.

Task #3 - Improvement and verification of short-range forecasting using STMAS with remote sensing data

STMAS (Space and Time Multi-scale Analysis System) is a new and advanced data assimilation technique with a superior analysis

advantage. STMAS combines the advantages of objective analysis and modern variational analysis into a unified data assimilation system and removes the limitations of these data assimilation schemes. During the past few years, TECRO ' s designated representative, CWB, has demonstrated its benefit from using this system for its operational applications especially for surface analysis and verification against observation data.

During Implementing Arrangement #22, two STMAS tasks will be performed by AIT ' s designated representative, NOAA/ESRL/GSD; one is STMAS surface analysis, and the other is STMAS 3D system implementation. The surface analysis is mainly used for CWB weather reanalysis to provide the ground-truth for establishing climatology statistics. The STMAS 3D system can further improve CWB weather reanalysis using upper air datasets to overcome the complex terrain effect.

Under the STMAS surface analysis task, AIT ' s designated representative, NOAA/ESRL/GSD, will modify the software package to improve the performance against complex terrain problems in Taiwan to meet the application requirement for TECRO ' s designated representative, CWB. Also, the AIT ' s designated representative, NOAA/ESRL/GSD, will start developing a multi-grid 4DVAR system to handle terrain changes.

With support of AIT ' s designated representative, NOAA/ESRL/GSD, TECRO ' s designated representative, CWB, will perform a 3-year reanalysis with calibrated parameters for STMAS, such as length-scale, multi-grid levels, smoothing and penalty function for various reanalysis fields such as P, T, Td, U, V and precipitation. For a longer-term reanalysis, a careful verification is required to examine each of the reanalysis fields and to build up climatology verification statistics. These verification statistics can provide valuable evidence for further improvement of STMAS surface analysis in the future.

Under the STMAS 3D system implementing task, AIT ' s designated representative, NOAA/ESRL/GSD, will assimilate all conventional data and radar radial wind, perform case studies, and initialize the WRF model with STMAS 3D at the GSD facility. AIT ' s designated representative, NOAA/ESRL/GSD, will start the model forecast process using the STMAS analysis, and develop a hot-start capability using the STMAS 3D radar reflectivity analysis operator. This will be applied to the CWB regional models for improving short range forecasts. TECRO ' s designated representative, CWB, and AIT ' s designated representative, NOAA/ESRL/GSD, will collaborate on the verification and model initialization of the STMAS 3D system. This task will benefit TECRO ' s designated representative, CWB, in improving and verifying short range forecasting operations.

Task #4 - HRQ2 (High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast) applications improvement

During Implementing Arrangement #22, AIT ' s designated representative, NOAA/ESRL/GSD, agrees that the National Severe Storms Laboratory (NSSL) will continue research towards refinement, development, and maintenance of HRQ2 applications required for TECRO ' s designated representatives, CWB, Water Resources Agency (WRA), and the Soil and Water Conservation Bureau (SWCB) operations. The NSSL research is directed towards the integration of the dual-pol (dual-polarization) radar applications in the HRQ2 system.

This task will include the integration of the dual-pol radar reflectivity and the radar QPE in the real-time HRQ2 system to support CWB operations. This task will perform an initial evaluation of the real-time reflectivity mosaic and QPE with

dual-pol radar.

Two brand-new C-band dual-pol radars have been installed in Taiwan (RCMK at Makung and RCCK at Ching Chung Kung). These radars will add new capability to measure rainfall and discriminate hydrometer types. These two radars and a CWB radar at Chi-Kuo will provide excellent area coverage over the western Taiwan. NSSL will implement a hydrometer classification algorithm and a QPE merging algorithm encompassing the dual polarized radars. NSSL will make available to the CWB, as requested, software source code for the hybrid scan reflectivity module, dual-pol hydrometer classification module and dual-pol QPE module.

Task #5 - Enhancement of nowcasting decision assistance tools

During Implementing Arrangement #22, AIT's designated representative, NOAA/ESRL/GSD, agrees that the Meteorological Development Laboratory (MDL) will provide technical support to the TECRO's designated representative, CWB, to enhance CWB's current forecast workstation, called the Weather Integration and Nowcasting System (WINS), in the area of nowcasting decision assistance tools. One of the MDL missions is to develop a comprehensive suite of decision assistance tools, called SCAN (System for Convection Analysis and Nowcasting), implemented in AWIPS to cover the full scope of hydro-meteorological phenomena and forecaster responsibilities. The current MDL activity is to migrate SCAN from AWIPS to AWIPS II.

One of the SCAN suites is SAFESEAS (System on AWIPS for Forecasting and Evaluation of Seas and Lakes), which is a decision assistance tool engineered to continuously monitor marine and adjacent overland conditions for specific marine weather hazards. It automatically alerts CWB forecasters when such conditions are detected. SAFESEAS provides capabilities to

display observed marine conditions in ways that help CWB focus on the most important events. Thus, the benefit of SAFESEAS is to assist CWB in making fast, earlier, and higher-quality decisions regarding marine watches and warnings.

During Implementing Arrangement #22, MDL will provide SAFESEAS technical support and customize the thresholds at which conditions will be considered threatening and the thresholds at which conditions will be considered hazardous. MDL will also provide experience to CWB forecasters for training and evaluation of using other decisions assistance tools such as FFMPA (Flash Flood Monitoring and Prediction Advanced), and the preliminary ANC (AutoNowCaster) system.

Task #6 - Development of high-resolution forecast product generation assistance tools

During Implementing Arrangement #22, AIT ' s designated representative, NOAA/ESRL/GSD, will continue providing technical support on GFE, and Text Formatter (TF) and GHG (Graphical Hazards Generator) to support CWB ' s development of formatter infrastructure of FIES (Forecast Information Editing System). CWB plans to implement its own rule-based Chinese text formatter to provide a heavy rainfall report. GSD will also provide necessary training to CWB visitor(s) to implement such a Chinese text formatter system as part of CWB ' s FIES.

GFE/verification system software training (BOIVerify) was coordinated by the AIT ' s designated representative, NOAA/ESRL/GSD, to TECRO ' s designated representative, CWB, during Implementing Arrangement #21. GSD will continue to coordinate necessary forecaster training of using BOIVerify during hazardous weather situations during Implementing Arrangement #22. The benefit of this task is for the TECRO ' s designated representative, CWB, to establish its text formatter infrastructure and assistance tools to support the high

resolution forecast product generation.

#### Task #7 - Installation of NOAA Science On a SphereR (SOS)

Science On a SphereR (SOS) is a large visualization system that uses computers and video projectors to display animated data onto the outside of a sphere. SOS can display dynamic, animated images of atmosphere, oceans, earthquakes, and the land of a planet. During Implementing Arrangement #22, AIT's designated representative, NOAA/ESRL/GSD, will provide standard SOS implementation, consultation, setup and training to the TECRO's designated representative, CWB. GSD will also provide currently available NOAA SOS education content material and will provide training to enhance presentation skills during installation. CWB will be responsible for all necessary hardware procurements and site facility preparations associated with the SOS system. The benefit of SOS is for CWB to possess an excellent visualization tool to expand meteorological services with local government agencies and to promote public education of hazardous weather monitoring and forecasting for educational institutions.

Task # 8 - GPS Radio Occultation satellite data assimilation using the NCEP/JCSDA Gridpoint Statistical Interpolation (GSI) analysis system

As part of the COSMIC (Constellation Observing System for Meteorology, Ionosphere and Climate) mission, TECRO's designated representative, CWB, will support the inclusion of GPS Radio Occultation (RO) observations from the COSMIC mission into the NCEP's regional system to implement the Gridpoint Statistical Interpolation (GSI) data assimilation of GPS radio occultation data under the joint collaboration project between NOAA/NASA/DoD, JCSDA and CWB. NCEP is the National Centers for Environmental Prediction under NOAA's NWS. JCSDA (Joint

Center for Satellite Data Assimilation) is a multi-agency research center tasked with improving the use of satellite data for analyzing and predicting weather, the ocean, climate and the environment. JCSDA partner agencies are NASA (National Aeronautics and Space Administration), NOAA and DoD (Department of Defense).

The main objectives of this collaborative project are to tune and test the assimilation of GPS RO data in the NCEP regional system and to accelerate and enhance the use of GPS RO data in global numerical weather prediction at CWB. Currently, TECRO ' s designated representative, CWB, is performing global numerical weather prediction using its own global model and an older version of the NCEP data assimilation system, the Spectral Statistical Interpolation (SSI). Through this collaboration, CWB would enhance their global data assimilation system and make optimal use of satellite data, including COSMIC/FORMOSAT-3. Accordingly, CWB would migrate from SSI (Spectral Statistical Interpolation) to GSI, and initialize the CWB global model with an analysis generated by GSI. This task will cover the use of GSI for both global and regional capabilities. In exchange, CWB will contribute to the tuning and testing of the GPS RO assimilation in the regional model.

Task #9 - Continuing interaction on earlier cooperative projects

Several earlier cooperative tasks have been completed. Technology has been transferred successfully and is beginning to be used operationally at the facilities of TECRO ' s designated representative, CWB. NOAA/ESRL/GSD ' s development activities in these areas will continue, and further NOAA/ESRL/GSD-CWB interaction is important to keep CWB staff up-to-date on current developments. This task will directly improve and update CWB ' s current forecast assistant and decision making system at an appropriate level, including new AWIPS and relevant forecast

assistant application software releases and available documents.

AIT's designated representative, NOAA/OAR/GSD, has released the latest AWIPS OB 8.3.1 and necessary test datasets to TECRO's designated representative, CWB, near the end of 2008. This version is the one currently used by NOAA/NWS. This version is ready to accept dual-pol radar products and has the capability to integrate radar data with environment sampling of temperature, relative humidity, wind, equivalent potential temperature, wet-bulb temperature, and pressure at the height of the radar beam. CWB will access data from two new dual-pol radars soon, so this new radar product display capability will be extremely useful for its forecast and decision making operation. NOAA/ESRL/GSD will continue to make available any latest AWIPS-build software, and technical support of AWIPS applications such as warning tools (WarnGen, GHG) if applicable, during Implementing Arrangement #22.

Under a NOAA/NWS contract to the Raytheon Technical Services Company (since 2005), a next generation of AWIPS (called AWIPS II) is being developed. AWIPS II is based on Service Oriented Architecture (SOA). AIT's designated representative, NOAA/ESRL/GSD, is tasked with performing an Independent Validation and Verification (IV &V) for each task order released by Raytheon. NOAA/ESRL/GSD plans to share some of its experience with AWIPS II in the area of SOA, EDEX (Environmental Data Exchange handles data ingest, storage and communication) and CAVE (Common AWIPS Visualization Environment is the graphical user interface) with CWB, if appropriate, during Implementing Arrangement #22.

AIT's designated representative, NOAA/ESRL/GSD, has a long history of supporting research and operational weather forecasting by developing advanced prototype workstation display systems, including an ongoing ALPS (AWIPS Linux Prototype

System) development, which is an update of AWIPS, and FXC (FX-Collaborate) development. FXC is an Internet-based system for displaying data from AWIPS with additional drawing and briefing tools. CWB has interest in adopting the ensemble forecast products display tool from ALPS.

For the data feed support, AIT's designated representative, NOAA/ESRL/GSD, will continue to provide the NOAAPORT data feed for CWB's data assimilation purposes during Implementing Arrangement #22.

This continuing interaction task will benefit TECRO's designated representative, CWB, with the updated knowledge of the forecast assistant and decision making system developed at NOAA. This task also provides the important data feed of NOAAPORT for CWB's daily numerical weather prediction operation needs. Finally, AIT's designated representative, NOAA/ESRL/GSD, will provide necessary training and support to visitors and forecasters, continue the exchange of visits, provide necessary papers and reports, and continue our e-mail interactions, if applicable.

#### Article IV - Responsibilities of TECRO

In addition to participation in the joint project team, TECRO through its designated representative, CWB shall:

- A. Provide overall coordination project activities at the CWB facility;
- B. Assign appropriate staff to perform the activities defined in this Implementing Arrangement and provide support in accordance with the terms of the umbrella agreement; and
- C. Fulfill its responsibilities under the Statement of Work for Implementing Arrangement #22.

#### Article V - Responsibilities of AIT

In addition to participation in the joint project team, AIT,

through its designated representative, NOAA/ESRL/GSD shall:

- A. Provide overall coordination project activities at the NOAA/ESRL/GSD facility in Boulder, Colorado;
- B. Provide administrative support for preparing reports for delivery to TECRO ' s designated representative, CWB, in accordance with this Implementing Arrangement;
- C. Assign appropriate staff to perform the activities defined in this Implementing Arrangement and provide support in accordance with the terms of the umbrella agreement; and
- D. Fulfill its responsibilities under the Statement of Work for Implementing Arrangement #22.

#### Article VI - Financial Provisions

In accordance with the TECRO-AIT Agreement, TECRO is required to reimburse AIT for all costs incurred by AIT ' s designated representative, NOAA/ESRL/GSD, in association with the project covered by this Implementing Arrangement. AIT shall transfer to NOAA/ESRL/GSD all payments made by TECRO to AIT for costs incurred by NOAA/ESRL/GSD in association with this Implementing Arrangement.

The total cost for activities described in this Implementing Arrangement is mutually agreed to be U.S. \$1,620,000. TECRO agrees to transfer fifty percent of the funds to AIT in advance, with the remaining fifty percent to be transferred upon completion of the year ' s activities, to the extent that funds for this purpose have been provided by TECRO.

The performance by AIT ' s designated representative of activities under this Implementing Arrangement is subject to the availability of funds.

#### Article VII - Intellectual Property Considerations

No intellectual property considerations are expected to arise in conjunction with activities described in this Implementing



Arrangement. Existing system designs and computer software of the AIT's designated representative's, NOAA/ESRL/GSD, Forecast System are in the public domain. Reports, specifications, and computer software prepared under this Implementing Arrangement also will be in the public domain once NOAA and CWB have approved them in final form.

Article VIII - Effective Date, Amendment, and Termination

This Implementing Arrangement is effective on the date of the last signature hereto. This Implementing Arrangement may be amended and/or terminated in accordance with the terms of the Agreement. The estimated completion date for the activities described in this Implementing Arrangement and the termination date of this Implementing Arrangement is December 31, 2010.

FOR THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE  
IN THE UNITED STATES

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