STATEMENT OF WORK FOR IMPLEMENTING ARRANGEMENT #23 DEVELOPMENT OF A HAZARDOUS WEATHER MONITORING AND FORECASTING SYSTEM BETWEEN THE TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE IN THE UNITED STATES AND THE AMERICAN INSTITUTE IN TAIWAN

1.0 - Background and Objectives

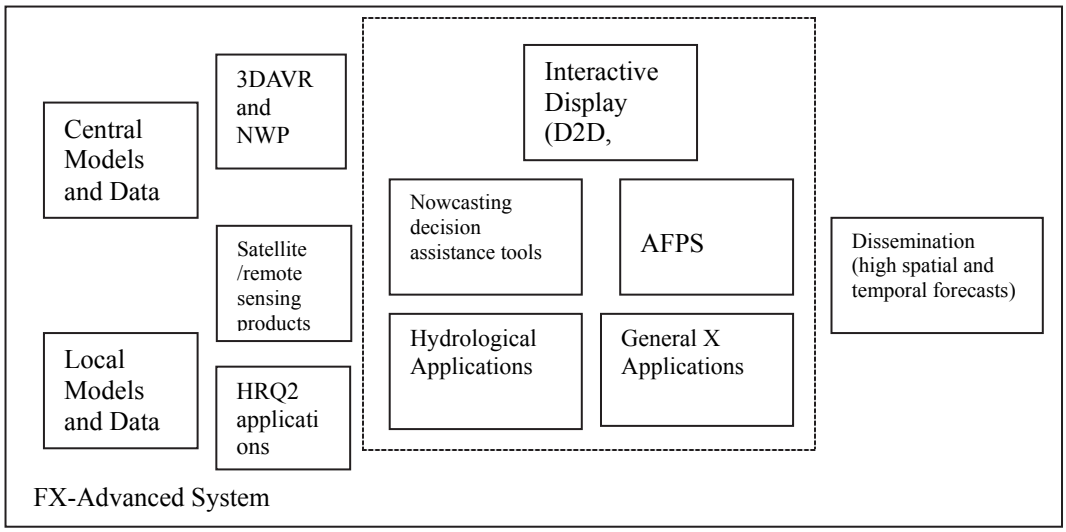
This Statement of Work addresses tasks that will be undertaken by the joint team of the Global Systems Division (GSD) of the Earth System Research Laboratory (ESRL), the designated representative of the American Institute in Taiwan (AIT) and personnel of the Central Weather Bureau (CWB), the designated representative of the Taipei Economic and Cultural Representative Office in the United States (TECRO) in accordance with the terms of Implementing Arrangement #23 of 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, which provides for technical cooperation between TECRO's designated representative, the Taiwan Central Weather Bureau (CWB) and AIT's designated representative, the U.S. National Oceanic and Atmospheric Administration's Global Systems Division (NOAA/ESRL/GSD). The two designated representatives cooperate on the development of meteorology and forecast systems.

The Weather Forecast Office system (WFO-Advanced) currently under development at NOAA/ESRL/GSD in Boulder, Colorado, has been deployed as an essential part of the Advanced Weather Interactive Processing System (AWIPS) for the U.S. National Weather Service (NWS). The WFO-Advanced system development has been a very important cooperative activity between TECRO's and AIT's designated representatives, CWB and NOAA/ESRL/GSD to support the mission of establishing hazardous weather monitoring and forecasting. Figure 1 illustrates the potential WFO-Advanced components listed here:

- National and local data feeds
- 3DVAR data assimilation and NWP (Numerical Weather Prediction)
- Satellite and remote sensing products
- HRQ2 (High-Resolution Quantitative Precipitation and Quantitative Precipitation Forecast) applications
- The interactive display system (D2D) and SOS (Science On a Sphere®)
- Nowcasting decision assistance tools
- The AWIPS Forecast Preparation System (AFPS)

- Hydrological applications developed at the NWS Office of Hydrology
- A component that contains General X applications
- Dissemination of high spatial and temporal forecast and warning products

Figure 1 WFO-Advanced



Eight tasks are identified: (1) Development and improvement of satellite products for tropical storm monitoring and prediction; (2) Real-time Analysis and Forecasting with the Advanced Regional Prediction System (ARPS); (3) Improvement and verification of short-range forecasting using the Space-Time Mesoscale Analysis System (STMAS) with remote sensing data; (4) High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement; (5) Enhanced Nowcasting Decision Assistance Tools; (6) Development of High-Resolution Product Generation Assistance Tools; (7) Global Positioning System (GPS) Radio Occultation Satellite Data Assimilation Using the National Center for Environmental Prediction (NCEP) and Joint Centers for Satellite Data Assimilation (JCSDA) Gridpoint Statistical Interpolation (GSI) Analysis System; and (8) Continuing Interaction on Earlier Cooperative Projects.

The tasks will be undertaken by the CWB-NOAA/ESRL/GSD Joint Team as the designated representatives of the TECRO and AIT working at the NOAA/ESRL/GSD facility in Boulder, Colorado, the NOAA/NESDIS facility in Camp Springs, Maryland, and by CWB staff at the CWB facility in Taipei, Taiwan, as appropriate. This Statement of Work addresses only tasks that will be undertaken by the CWB-NOAA/ESRL/GSD Joint Team under the terms of Implementing Arrangement #23. It describes the performance period, deliverables, and resource requirements.

2.0 - Task Descriptions

In terms of the overall program schedule, the following eight tasks have been identified as being critical during the January 1 to December 31, 2011 time period. These are listed in detail below, along with the estimated proportion of resources that is to be allocated to each task.

Task #1 Development and Improvement of Satellite Products for Tropical Storm Monitoring and Prediction

During Implementing Arrangement #23, AIT's designated representative, NOAA/ESRL/GSD, agrees that NOAA/NESDIS (National Environmental Satellite, Data, and Information Service)/STAR (Center for Satellite Applications and Research) will lead this task. NOAA/NESDIS/STAR will focus on the development of quantitative precipitation estimates from the geostationary satellite (MTSAT). Task #1 will provide NOAA operational blended Total Precipitable Water (TPW), as well as TPW anomaly, digital products and DMSP (Defense Meteorological Satellite Program) Special Sensor Microwave Imager/Sounder (SSMIS) environmental data records (EDR) retrieval algorithms for TECRO's designated representative, CWB, for its weather prediction applications. NOAA/NESDIS/STAR scientists will collaborate closely with TECRO's designated representative, CWB, for a seamless transition of all science and software into its operational systems.

During Implementing Arrangement #23, NOAA/NESDIS/STAR will provide the initial capability of Quantitative Precipitation Estimation (QPE) from MTSAT. Using both polar orbiting satellites and geostationary satellites, an improved retrieval algorithm SCaMPE (Self-Calibrating Multivariate Precipitation Retrieval) has been developed at NOAA/NESDIS/STAR for future GOES-R program improvement. Because the current algorithm is exclusively developed for GOES satellites that unfortunately do not cover the Taiwan area, additional development has to be conducted to use geostationary satellite data over this area, which is covered by the Japanese MTSAT at present. NOAA/NESDIS/STAR will deliver the SCaMPE algorithm to TECRO's designated representative, CWB, however it is CWB's responsibility to make the algorithm work in operations using local MTSAT data to provide precipitation estimation over the Taiwan area. This subtask will include (1) providing documentation of the SCaMPE package, (2) delivering the SCaMPE package and operation manual, (3) supporting the installation of the SCaMPE package, and (4) supporting the migration of SCaMPE for MTSAT.

During Implementing Arrangement #23, NOAA/NESDIS/STAR will also provide the global Total Precipitable Water (TPW) and anomaly digital products. Integrated water vapor content or TPW is an important fact for hydrological analysis. TPW products are currently available from various satellites. However, these products carry different biases and sampling errors due to the difference in algorithms, instruments, and temporal and spatial sampling resolutions. An operational product through blending AMSU, SSM/I and GPS TPW has been developed to generate a unified, meteorologically significant TPW field with a no-gap global coverage in NOAA. NOAA/NESDIS/STAR will deliver real-time blended TPW and anomaly digital products to TECRO's designated representative, CWB for forecasters' analysis.

During Implementing Arrangement #22, NOAA/NESDIS/STAR delivered sounding products from the SSMIS (Special Sensor Microwave Imager and Sounder). During Implementing Arrangement #23, NOAA/NESDIS/STAR will deliver DMSP SSMIS environmental data records (EDR) retrieval algorithms to provide hydrological related analysis.

Microwave Integrated Retrieval System (MiRS) is a multiple instrument one-dimensional (1D Var) environmental data retrieval package which is focusing on the all-weather all-surface retrieval of temperature and water vapor profiles, as well as surface meteorological parameters, such as rain rate, surface temperature, and so on. This package has been delivered to TECRO's designated representative, CWB, for pre-operational testing during Implementing Arrangement #22. As a developing package, some major and minor updates have been implemented after delivery. During Implementing Arrangement #23, NOAA/NESDIS/STAR will provide an update and further improvement of MiRS.

Cloud optical depth and cloud top height can be estimated by combining dual geostationary satellites. However, due to the viewing angle difference, error could be introduced in the detection of clouds. To eliminate such error, viewing angle correction has to be implemented. NOAA/NESDIS/STAR will work with TECRO's designated representative, CWB, to develop geostationary satellite viewing angle error correction algorithms to improve the accuracy of cloud detection. During Implementing Arrangement #23, NOAA/NESDIS/STAR will continue providing current delivered satellite data during the collaborative period. In addition, new satellite data, such as SSMIS F18 TDR and NOAA operational global data assimilation system products will also be provided for TECRO's designated representative, CWB, for its satellite product development.

The following summarizes the schedule and resources required for Task #1:

Resources Required: 18.6 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1.	Quantitative precipitation estimation from MTSAT (SCaMPE document and software module)	06/30/11
2.	Real-time blended TPW and anomaly digital products	06/30/11
3.	DMSP SSMIS environmental data records (EDR) retrieval algorithms	06/30/11
4.	Technical report on MiRS improvement and updates	11/15/11
5.	Geostationary satellite viewing angle error correction package for cloud detection	11/15/11
6.	Real-time satellite data and operational forecast products transfer	11/15/11

Task #2 Real-time Analysis and Forecasting with ARPS

The principal goal of Task #2 is to configure, demonstrate, and deploy a real-time forecasting system at convection-allowing resolution (2.5 km grid spacing) for the TECRO's designated representative, CWB, to obtain accurate 0-3h heavy precipitation forecasts. The forecast system uses ARPS (Advanced Regional Prediction System) developed at the Center for Analysis and Prediction of Storms (CAPS) at the University of Oklahoma. ARPS is a comprehensive regional- to storm-scale atmospheric modeling system. It is a complete system that includes a real-time 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 computationally efficient for producing convective-scale initial conditions, 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 #23, AIT's designated representative, NOAA/ESRL/GSD, agrees that CAPS at the University of Oklahoma will lead this task. For the IA #23, CAPS will focus on three main task areas: 1) to refine and improve, through the predictions of Morakot and Meiyu cases, the current CWB ARPS forecast system by including additional observations, including those used by CWB WRF; 2) to refine the cloud analysis package for the case studies and make adjustments for the tropical environment and cycled data assimilation, including defining the best strategy for cycled analysis (continuous versus periodic restart from WRF analysis); and 3) to implement a real-time forecast system on the CWB computing system by linking the system with CWB real-time WRF and radar data, and perform limited quasi-real-time testing on CWB computer together with CWB scientists. CAPS will also examine and improve definitions of land surface characteristics and soil model initial conditions, when possible, and perform objective evaluation of the forecast system for the cases and real-time tests.

TECRO's designated representative, CWB, will provide support to set up CWB's HPC systems and link the system with CWB real-time WRF and radar data for running the real-time ARPS Forecast System at CWB. CAPS will provide technical support for CWB scientists to perform case studies for heavy precipitation cases and the real-time test runs. This task will benefit TECRO's designated representative, CWB, by improving its very-short-range forecasting capabilities, in particular those related to 0-3h heavy precipitation.

The following summarizes the schedule and resources required for Task #2:

Resources Required: 13.3 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. ARPS forecast system case studies
    a. Add additional observations for the Morakot case — 06/30/11
    b. Add additional observations for the Meiyu case — 06/30/11
    c. Refine cloud analysis for the cases
    d. Experiment cycling strategy for the cases — 11/15/11
    — 11/15/11
2. Be able to generate timely QPF products (0-3 hr) in real-time at CWB
    a. Setup the real-time system at CWB with linked CWB WRF and observation data — 06/30/11
    b. Perform test runs in real-time setting
    c. QPF products (0-3 hr) available to CWB scientists for evaluation — 08/30/11
    — 11/15/11
    d. Perform objective evaluation for the real-time forecasts — 11/15/11

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 the benefit from using STMAS for its operational applications, especially for surface analysis and verification against observation data.

During Implementing Arrangement #23, AIT's designated representative, NOAA/ESRL/GSD, will further improve STMAS 3D analysis for CWB short-range forecasts. For IA #23, there are four main task areas: 1) STMAS hot-start; 2) STMAS-WRF cycling experiment; 3) Downscaling; and 4) Satellite data assimilation.

Under the STMAS hot-start task, AIT's designated representative, NOAA/ESRL/GSD, will implement a fully thermodynamic balanced analysis capability with microphysics for hot-starting WRF model forecasts instead of the cold-start currently being used in WRF forecasts. A cold-started WRF forecast takes 3-6 hours to spin up a balanced microphysics fields, thus resulting in short-range forecasts being unbalanced. STMAS hot-start will

introduce a thermodynamic balanced initial condition for WRF forecasts for improving short-range forecasts.

Under the STMAS-WRF cycling experiment task, AIT's designated representative, NOAA/ESRL/GSD, will implement a cycling scheme to improve the problem of the lack of observations over the ocean and improve the STMAS background field. A cycling scheme provides a background field for STMAS with its fine resolution WRF forecast. The fine resolution WRF forecast would contain the fine resolution structure of typhoons. It runs a fine resolution of STMAS analysis to initialize a fine resolution WRF forecast, which will be used as a background field at the next data assimilation time. This cycle will be repeated so that the fine resolution background field of STMAS contains finer scale information. The cycling scheme will be tested and evaluated for TECRO's designated representative, CWB, for improving short-range forecasts.

Under the Downscaling task, AIT's designated representative, NOAA/ESRL/GSD, will implement a downscaling technique that downscales a coarse model forecast into fine scale analysis. Over Taiwan, the complex terrain structure makes coarse resolution forecasts impossible for providing detailed wind and precipitation forecasts. When a typhoon approaches Taiwan, a downscaling uses a coarse resolution forecast and downscales the forecast to a fine resolution in hopes of delivering fine scale wind and precipitation structures so that detailed warning information will be significantly improved. The downscaling software will be delivered to TECRO's designated representative, CWB, for wind structure analysis.

Under the Satellite data assimilation task, AIT's designated representative, NOAA/ESRL/GSD, will implement the Community Radiation Transfer Model (CRTM) as a forward operator in STMAS satellite data assimilation. To assimilate satellite data in a variational scheme, the gradient of CRTM is needed, and is called the K-matrix in CRTM. The K-matrix has been carefully tested with the support from the NESDIS. During IA #23, GSD will perform experiments of assimilating satellite data into STMAS analysis and deliver a STMAS with AMSU-A satellite data assimilation capability.

For the four STMAS 3D system implementing tasks, AIT's designated representative, NOAA/ESRL/GSD, will start the development of a hot-start capability using the STMAS 3D radar reflectivity analysis operator. TECRO's designated representative, CWB, will help test the cycling scheme at CWB, and AIT's designated representative, NOAA/ESRL/GSD, will provide technical support for the testing. GSD will develop and evaluate the downscaling software at GSD and STMAS satellite data assimilation for the AMSU-A data. These software modules will be delivered to CWB 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. These tasks will benefit TECRO's designated

representative, CWB, in improving and verifying short range forecasting operations.
The following summarizes the schedule and resources required for Task #3:

Resources Required: 16.7 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1.	STMAS 3D data assimilation software with a variational hot- start capability	11/30/11
2.	Cycling scheme for STMAS and WRF systems	11/30/11
3.	STMAS downscaling software	11/30/11
4.	STMAS 3D with CRTM (Community Radiative Transfer Model) and AMSU-A satellite data assimilation capability	11/30/11

Task #4 – High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement

During Implementing Arrangement #23, AIT's designated representative, NOAA/ESRL/GSD, agrees that NOAA/NSSL (National Severe Storms Laboratory) will continue research towards refinement, development, and maintenance of HRQ2 applications required for TECRO's designated representatives, CWB, the 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 real-time calibration correction for C-band dual-pol radars in Taiwan. A new calibration scheme using cloud microphysics observed in Taiwan will be developed and evaluated. This task will monitor the real-time HRQ2 system and improve quality control processes for the dual-pol fuzzy-logic hydrometeor classification. This task will continue to evaluate and refine the dual-pol QPE algorithms and to provide technical support for TECRO's designated representative, CWB, for its QPESUMS operations.

NOAA/NSSL will make available to the TECRO's designated representative, CWB, as requested, software source code for the calibration correction algorithms for the C-band dual-pol radar, the dual-pol fuzzy-logic hydrometer classification module and the dual-pol QPE algorithm module.
The following summarizes the schedule and resources required for Task #4:

Resources Required: 16.7 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1.	Real-time calibration correction for C-band dual-pol radars	03/30/11
2.	Dual-pol fuzzy logic hydrometeor classification	06/30/11
3.	Evaluation and refinement of dual-pol QPE algorithms	09/30/11
4.	Technical support for QPESUMS operations	11/30/11

Task #5 – Enhanced Nowcasting Decision Assistance Tools

The Meteorological Development Laboratory (MDL) of the National Weather Services (NWS) of NOAA has developed a comprehensive suite of decision assistance tools in AWIPS to cover the full scope of hydro-meteorological phenomena and forecaster responsibilities. These tools are SCAN (System for Convection Analysis and Nowcasting), SCAN DMD (SCAN Digital Mesocyclone Detection), FFMP (Flash Flood Monitoring and Prediction), SAFESEAS (System on AWIPS for Forecasting and Evaluation of Seas and Lakes), SNOW (System for Nowcasting of Winter Weather), Fog Monitor, GUARDIAN (General User Alert Display Panel), and the GUI interface to ANC (AutoNowCaster). In the past few years, NOAA/NWS/MDL assisted and supported porting some of those decision assistance tools into the Weather Integration and Nowcasting System (WINS) for TECRO's designated representative, CWB, including SCAN, SCAN DMD, and SAFESEAS.

During Implementing Arrangement #23, AIT's designated representative, NOAA/ESRL/GSD, agrees that NOAA/NWS/MDL will continue to provide technical support and training to the TECRO's designated representative, CWB, to enhance CWB's current WINS system, in the area of nowcasting decision assistance tools that have been already implemented. Those supports include source code modification and configuration appropriate for CWB use. In addition, NOAA/NWS/MDL will provide customization support and training on a few more decision assistance tools for CWB, including the ANC-AWIPS bridge software, GUARDIAN, and FFMP. The ANC-AWIPS bridge implementation on the WINS system has been initiated and will continue upon the update of CWB's ANC system setup. The GUARDIAN was developed to be a general communicator between the software and the user that could be personally configured in ways to reduce notification distractions and maximize situational awareness. The FFMP is an integrated suite of multi-sensor applications which detects, analyzes, and monitors precipitation and generates short-term warning guidance for flash flooding automatically within NWS's AWIPS system. It conducts precipitation analyses in a "basin world", which means all QPE and QPF calculations over a certain time period are done over the areas of small basins with the minimum basin area of about 2 square miles.

The following summarizes the schedule and resources required for Task #5:

Resources Required: 15.3 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. ANC
    a. CWB localization support 06/30/11
    b. Data ingest support between ANC and WINS 06/30/11
    c. User training for WINS maintenance 06/30/11
2. GUARDIAN
    a. Technical support for its porting into WINS 11/30/11
    b. User training for coming configuration and use 11/30/11
3. FFMP
    a. Support for the FFMP installation on CWB's workstation where the standard AWIPS package was installed using the shapefiles (basins & stream links) from Baltimore/Washington D.C. WFO (Weather Forecast Office, LWX is the WFO in Sterling, Virginia) 09/30/11
    b. Provide archived data that were obtained from the LWX for the test case 09/30/11
    c. User training based on the archived cases which cover the LWX 09/30/11

Task #6 – Development of High-Resolution Product Generation Assistance Tools

During Implementing Arrangement #23, AIT's designated representative, NOAA/ESRL/GSD, will continue providing technical support on GFE, 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 the 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 and #22. GSD will continue to coordinate necessary forecaster training of using BOIVerify during hazardous weather situations during Implementing Arrangement #23 if needed. 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.

The following summarizes the schedule and resources required for Task #6:

Resources Required: 8.7 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Support CWB's FIES (Forecast Information Editing System) development
   a. Provide technical support on GFE for CWB's TF development 09/30/11
2. Provide technical support on GFE verification tool (as needed) 11/30/11

Task # 7 – Global Positioning System (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 or improvement of GPS Radio Occultation (RO) observations from the COSMIC mission into the NCEP's regional and global system with the Gridpoint Statistical Interpolation (GSI) data assimilation 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 and global 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 the GSI data assimilation system, which was implemented in July 2010. Through this collaboration, CWB would further enhance its global data assimilation system and make optimal use of satellite data, including COSMIC/FORMOSAT-3. 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 NCEP regional and global system.

The following summarizes the schedule and resources required for Task #7:

Resources Required: No funding exchanged

Deliverables and Schedule:

1. NOAA will provide GSI code with necessary training support on the use of GPS RO data	11/30/11
2. NOAA will host CWB visitors	11/30/11

Task #8 - 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 interaction with CWB 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, released the latest AWIPS OB 9.2.6 and necessary test datasets to TECRO's designated representative, CWB, near the end of 2010. This version is the one currently being 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 #23.

Under a NOAA/NWS contract with the Raytheon Technical Services Company (since 2005), the next generation of AWIPS (called AWIPS II) is being developed. AWIPS II is based on the 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 will provide training and share 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 to CWB visitors during Implementing Arrangement #23.

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. NOAA/ESRL/GSD will provide necessary support in the area of porting ALPS during Implementing Arrangement #23.

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 #23.

This continuing interaction task will benefit TECRO's designated representative, CWB, with the updated knowledge of the forecast assistant and decision making systems 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.

The following summarizes the schedule and resources required for Task #8:

Resources Required:	10.7 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1.	ALPS system (source code and necessary dataset)	06/30/11
2.	AWIPS II training	11/30/11
3.	NOAAPORT data support	11/30/11
4.	Forecaster training support including necessary training and travel	11/30/11

3.0 - Schedule

Tasks	Functions	Milestones
1.	Provide satellite products, algorithms and improvement on NWP modeling and data assimilation	12/11
2.	Provide ARPS for case studies and real-time QPE products	12/11
3.	Provide STMAS 3D update with cycling, downscaling capability and Satellite assimilation using CRTM	12/11
4.	Provide improved HRQ2 system to support operation and evaluation	12/11
5.	Provide technical support on decision assistance tools (ANC, GUARDIAN and FFMP)	12/11
6.	Provide technical support on GFE/TF for CWB's FIES development	12/11
7.	Provide GSI code and necessary visitor technical support	12/11
8.	Provide technical support and software of ALPS, AWIPS II training and, NOAAPORT data transition, and relevant documents	12/11

Schedule by Month

TASKS	1/1	2/1	3/1	4/1	5/1	6/1	7/1	8/1	9/1	10/1	11/1	12/1
Task 1 (Satellite application)												
SCaMPE document and software module	x	x	x	x	x	x						
Real-time blended TPW and TPW anomaly digital products	x	x	x	x	x	x						
DMSP SSMIS EDR retrieval algorithms	x	x	x	x	x	x						
Technical support on MiRS improvement and updates	x	x	x	x	x	x	x	x	x	x	x	x
Geostationary satellite viewing angle error correction package for cloud detection	x	x	x	x	x	x	x	x	x	x	x	x
Real-time satellite data and operational forecast products transfer	x	x	x	x	x	x	x	x	x	x	x	x
Task 2 (ARPS)												
ARPS case study (for Morakot)	x	x	x	x	x	x						
ARPS case study (Meiyu)	x	x	x	x	x	x						
ARPS refine cloud analysis for case study	x	x	x	x	x	x	x	x	x	x	x	
ARPS cycling for case study	x	x	x	x	x	x						
QPF setup real-time system	x	x	x	x	x	x	x	x	x	x	x	
QPF test run	x	x	x	x	x	x	x	x				
QPF product available at CWB	x	x	x	x	x	x	x	x	x	x	x	
QPF product evaluation	x	x	x	x	x	x	x	x	x	x	x	

Task 3 (STMAS 3D)												
STMAS 3D with hot-start	x	x	x	x	x	x	x	x	x	x	x	x
STMAS 3D with cycling scheme and WRF	x	x	x	x	x	x	x					
STMAS 3D with downscaling	x	x	x	x	x	x	x	x	x	x	x	x
STMAS 3D with CRTM (satellite data assimilation)	x	x	x	x	x	x	x	x	x	x	x	x
Task 4 HRQ2 (NSSL)												
Calibration for C-band dual-pol radar	x	x	x									
Dual-pol hydrometeor classification	x	x	x	x	x	x						
Evaluation of dual-pol QPE algorithms	x	x	x	x	x	x	x	x	x			
QPESUMS technical support	x	x	x	x	x	x	x	x	x	x	x	x
Task 5 nowcasting decision tools (MDL)												
ANC localization support including data ingest and user training	x	x	x	x	x	x						
GUARDIAN technical support and user training	x	x	x	x	x	x	x	x	x	x	x	x
FFMP installation support	x	x	x	x	x	x	x	x	x			
FFMP test case support and user training	x	x	x	x	x	x	x	x	x			
Task 6 high resolution forecast product generation												
Support GFE for CWB's TF development	x	x	x	x	x	x	x	x	x			
Provide technical support on GFE verification tools (as needed)	x	x	x	x	x	x	x	x	x	x	x	x

Task 7 GSI technical support (NESDIS/JCSDA)												
Provide GSI update code	x	x	x	x	x	x	x	x	x	x	x	x
Support CWB's visitor(s)	x	x	x	x	x	x	x	x	x	x	x	x
Task 8 interaction on earlier projects												
ALPS system installation support	x	x	x	x	x	x						
AWIPS II training			x	x	x	x	x	x	x	x		
NOAAPORT data support	x	x	x	x	x	x	x	x	x	x	x	x
Forecasters training support			x	x	x					x	x	x

4.0 - Budget

The following are the estimated costs for Implementing Arrangement #23

Tasks	Personnel	Travel/Training	Total
Task #1 (NESDIS/GSD)	$265,000	$ 15,000	$ 280,000
Task #2 (OU)	$185,000	$ 15,000	$ 200,000
Task #3 (GSD)	$235,000	$ 15,000	$ 250,000
Task #4 (NSSL)	$235,000	$ 15,000	$ 250,000
Task #5 (MDL/GSD)	$215,000	$ 15,000	$ 230,000
Task #6 (GSD)	$115,000	$15,000	$ 130,000
Task #7 (NESDIS/JCSDA)	(no funding exchanged)		
Task #8 (GSD)	$130,000	$ 30,000	$ 160,000
Total	**$ 1,380,000**	**$ 120,000**	**$ 1,500,000**

As stated in Implementing Arrangement #23, the funds available from TECRO to support the tasks, traveling, and meeting expenses described in this Statement of Work will be a total of US$ 1,500,000. NOAA and AIT understand that US$ 1,000,000 will be provided by CWB, US$ 250,000 by the Water Resources Agency (WRA), and US$ 250,000 by the Soil and Water Conservation Bureau (SWCB). All budget figures are estimated. Actual amounts will be accrued for purposes of fulfilling the financial arrangements described in the Implementing Arrangement, in accordance with the terms of the Agreement.

All programs within the Global Systems Division (GSD) use the same budget procedures, whether they are base-funded programs or externally-funded programs. Beginning in U.S. Government Fiscal Year 1991, a facility charge has been applied to all programs to cover management and administrative costs, as well as the use of the NOAA/ESRL/GSD facility and all associated equipment and data.
NOAA/ESRL/GSD staff time is charged at the employee's salary plus the normal NOAA benefit, leave, and overhead charges. NOAA/ESRL/GSD professional staff people are primarily in the civil service grade scales of GS-11 to GS-14. Contract staff is in equivalent categories.

5.0 - CWB Joint Team Assignments at NOAA/ESRL/GSD

Several tasks encourage CWB staff in residence at NOAA/ESRL/GSD and NOAA/NWS/NCEP. The primary effort of CWB staff at NOAA/ESRL/GSD during the Implementing Arrangement #23 period will be directed toward AWIPS II and GFE development tasks. The primary effort of CWB staff at NOAA/NESDIS during the Implementing Arrangement #23 period will be to get familiar with the GSI code and to receive basic training on use of GPS RO data for the data assimilation system. It is important that qualified CWB staff be available to work at NOAA/ESRL/GSD and NOAA/NESDIS facilities during the period. Specific assignments will be made to most efficiently use the available personnel resources. Assignments for the qualified CWB staff members would be as follows:

- Development of high-resolution forecast products generation assistance tool to support CWB's FIES.
- Development of forecast applications under AWIPS II environment.
- Study and improve the forward operator for GPS Radio Occultation (RO) data.