Implementing Arrangement #27

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

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 and is subject to the general terms and conditions established by the Agreement between the Taipei Economic and Cultural Representative Office in the United States for Technical Cooperation in Meteorology and Forecast Systems Development (TECRO-AIT Agreement) and the American Institute in Taiwan signed by all parties as of March 06, 2012, and any subsequent revision as agreed to by the parties. This Implementing Arrangement is the twenty-seventh such arrangement under a succession of umbrella agreements between TECRO and AIT.

Article III - Services

During the period of Implementing Arrangement #27 (IA #27), TECRO's and AIT's designated representatives respectively, the Taiwan Central Weather Bureau (CWB) and the NOAA/ESRL/GSD have started a new phase V program on hazardous weather monitoring and forecasting. Therefore the CWB-NOAA/ESRL/GSD joint team will expand work to address this hazardous weather theme. Six tasks are identified: (1) Development and improvement of satellite products for tropical storm monitoring and prediction; (2) High-Resolution Quantitative

Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement; (3) Enhancement of Nowcasting Decision Assistance Tools; (4) Development of High-Resolution Product Generation Assistance Tools for AWIPS II; (5) Development of intra-seasonal to inter-annual climate monitoring and forecast; and (6) 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 six tasks:

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

During IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that STAR/SMCD will lead this task. NOAA/STAR/SMCD will continue providing near real-time polar orbiting satellite global 1b radiance and products data from AMSU-A and MHS onboard NOAA-18, NOAA-19, MetOp-A, and MetOp-B satellites. Also STAR/SMCD will provide SSMIS onboard DMSP F17 and F18, blended TPW products, MetOp-A/MetOp-B ASCAT winds products, WindSAT wind products and Global Data Assimilation System (GDAS) surface raw product, as well as gridded data for MiRS. Remote technical support will be provided for satellite 1b data recovery.

For Microwave Integrated Retrieval System (MiRS), STAR/SMCD will provide an updated MiRS package and documentation for multiple satellite product retrieval and on-site or remote technical support for MiRS implementation.

STAR/SMCD will provide Himawari AHI sample datasets for test purpose. Calibration coefficients may also be provided if Himawari raw data will be received by customer. STAR/SMCD will provide remote technical support for calibration coefficient implementation.

Due to the similarity between Himawari AHI and GOES-R ABI instruments, STAR/SMCD will provide GOES-R ABI selected product retrieval algorithm theoretical basis document (ATBD), which will help customer to develop Himawari AHI cloud product retrieval package. The selected products include cloud height, cloud mask, cloud type/phase, aviation convective initiation, and aviation icing threat.

Task #2 – High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement

During IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that NOAA/NSSL (National Severe Storms Laboratory) will continue research towards maintenance, refinement, and improvement of the High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) applications required for TECRO's designated representatives, CWB, the Water Resources Agency (WRA), and the Soil and Water Conservation Bureau (SWCB).

This task will include analysis and documentation of newly available polarimetric radar data and their potential applications in the CWB, WRA, and SWCB's operations. Real-time polarimetric

radar QPE products implemented during IA#25 and 26 will be evaluated systematically, and enhancements and refinements will be developed based on the evaluation results and new requirements from the CWB, WRA, and SWCB. Further, new configurations will be developed in the HRQ2 system to allow future integrations of additional C-band polarimetric radars, which will be deployed by the CWB in the next three to five years.

NOAA/NSSL will make available to TECRO's designated representative, CWB, as requested, documentation of polarimetric radar observations and software source code for the refinements and enhancements of the polarimetric radar QPE algorithms. NOAA/NSSL will also make available to CWB, as requested, the implementation of the enhanced radar QPE in the real-time HRQ2 system as part of QPESUMS technical support.

Task #3 - Enhance of Nowcasting Decision Assistance Tools

As part of IA#27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that MDL will continue to provide technical support and training to TECRO's designated representative, CWB, to enhance CWB's WINS in the area of nowcasting decision assistance tools that have already been implemented. This support includes source code modification and configuration appropriate for CWB's use of the tools which have been already ported.

After customizing most of the MDL's decision assistance tools listed above, the full implementation and configuration of FFMP on WINS were completed and installed onto the operational platform at CWB's Forecast Center in 2014. FFMP conducts precipitation analyses over the areas of small basins and thus is an integrated suite of multi-sensor applications which detect, analyze, and monitor precipitation and generate short-term warning guidance for flash flooding automatically. During 2014, the MDL provided the CWB with more thorough customization and training support on the MDL's decision assistance tools, especially on FFMP to support its operational use at the CWB's Forecast Center.

With the preliminary but successful usage of FFMP, CWB's forecasters want MDL to extend the Hydrologic Unit Code (HUC) layer implementation for FFMP in 2015 as the way that was implemented for all Weather Forecast Office (WFO) in the United States. Currently, the CWB only has two layers ("County/Township" layer and small-basin layer) included, and those layers do not represent the hydrological characteristics as HUC layers would provide. The CWB wants to know the procedures on how the FFMP shapefile is generated using the ArcView/ArcGIS software with their higher resolution DEM dataset and how different HUC layers could be created by aggregating small basins, or by a separate delineation using a larger area threshold.

In the past, CWB made significant changes on one of MDL's decision assistance tools called SAFESEAs and split it into two separated tools called SafeLand and SafeRain in their WINS system to meet their different weather and geographical scenario requirements. SafeRain and SafeLand have been used operationally in CWB's Forecast Center for a few years and received many good feedbacks. Such modification was seeking to be done under the new architecture and framework of NWS AWIPS-II system that CWB is transitioning to. In 2013, MDL assisted and trained CWB developers to learn and understand the AWIPS2 development architecture. In 2015, MDL will mainly focus on providing the consultation/survey support to CWB on SAFESEAS, for its technical implementation under AWIPS2 development environment.

MDL's fourth task on IA#27 will be to provide the CWB's Meteorological Satellite Center (MSC) software and training so that the MSC can continue its automatic tuning on the CWB's ANC in a flexible and timely manner. ANC uses a fuzzy logic algorithm based on conceptual models of storm initiation, storm growth, and storm dissipation. The system assimilates a variety of data sets to analyze characteristic features of the atmosphere associated with pre-storm environments and to produce 60-minute nowcasts of storm initiation, growth, and dissipation. These analyses evaluate convective instability, moisture convergence, and trigger mechanisms to produce interest fields that are used as inputs to the fuzzy logic algorithm. The interest fields used in the storm initiation algorithm are converted into dimensionless likelihood fields using fuzzy membership functions. The various likelihood fields are weighted using values determined by human experts, and the weighted likelihood fields are summed to produce a combined likelihood field that is indicative of storm initiation in the next 60 minutes.

At the MDL, ANC has been significantly re-engineered and reconfigured in order to be able to generate CONUS-wide, 60-minute nowcasts of storm initiation, growth, and dissipation as quickly as possible while using as little disk space as possible. As part of the re-engineering, the MDL has fixed a number of software bugs within ANC, thus making ANC less prone to software crashes. This effort has taken approximately four and one-half years and is still ongoing. Thus, the MDL's version of ANC is substantially different from the original version which the MDL received from NCAR. In contrast, the CWB's version of ANC is essentially the same as the version which the CWB received from NCAR. That version, however, is neither structured as simply nor reconfigured as easily as the MDL's version, and this inhibits the CWB's understanding and use of ANC. As part of its ongoing efforts to incorporate ANC as easily as possible into its daily operations, the CWB wants to obtain the MDL's version of ANC as well as the training and technical support needed to configure and use that version.

Neither the CWB's nor the MDL's version of ANC are yet capable, however, of converting CWB-generated predictor fields in NetCDF format into ANC's proprietary MDV format. Such a conversion is necessary because most of the CWB's predictor fields are stored natively in NetCDF format, but they must be in MDV format in order for the CWB to use ANC to begin to study and evaluate the potential roles which such predictor fields might play in convective storm initiation and evolution over and around Taiwan. So, along with obtaining the MDL's version of ANC, the CWB wants the MDL to modify ANC so that the needed conversion of the CWB's predictors in NetCDF format to MDV format can be achieved.

As part of its multi-year effort to use, understand, and operationalize ANC, the MDL spent a good amount of time developing algorithms and software with which to verify ANC's 60-minute nowcasts of convective initiation. Studies based on the output of such software have been crucial to the MDL's understanding of the proper interpretation of such nowcasts both spatially and temporally. Such understanding is itself necessary in order to describe accurately to operational users exactly what ANC produces and how to interpret the results in a meaningful way. Because of this, the CWB also wants to obtain the MDL's ANC verification software as well as the training and technical support needed to configure it, use it, and interpret its results for Taiwan so that the CWB's forecasters make informed use of ANC's output.

Task #4 - Development of High-Resolution Product Generation Assistance Tools for AWIPS Ii

The National Weather Service (NWS) has been developing AWIPS II for several years. This replacement for the original AWIPS (the basis of the current CWB Weather Integration and Nowcasting System (WINS) is running at 63 NWS operational sites as of December 2014, and is planned to be installed at all remaining field offices by September 2015. AWIPS II provides essentially the same appearance and function ("look and feel") as AWIPS I, reducing the need for extensive forecaster training. The underlying software is written largely in Java and loosely follows a services oriented architecture (SOA) design.

During IA#25, AIT's designated representative, NOAA/ESRL/GSD, received permission from NWS to provide an evaluation copy of the AWIPS II software to CWB. This support continued through IA#26, with periodic updates provided. GSD also provided AWIPS II training for CWB developers. Two CWB visitors to GSD in 2014 learned much about AWIPS II and, with GSD, began design/development work on some CWB-specific data ingest and display plugins, working toward eventual realization of a WINS-II.

For IA#27, GSD will continue to support CWB developers by providing updated versions of the AWIPS II software. GSD will work with NWS/Meteorological Development Laboratory to set up a shared software repository, where GSD and CWB visitor(s) will maintain code that they will share with other CWB staff who are developing and testing new software.

GSD has developed for AWIPS II a CAVE Annotation Tool (CAT) that allows NWS forecasters to create and save drawings, including graphics such as Nowcasts and weather stories to publish on the Web. During IA#27, GSD will support development of a system to extend CAT to support CWB's annotation requirements. Additional collaborative work will address ingest and display of CWB-specific lightning, satellite, and grid datasets.

During IA#27, GSD will provide technical support for the Graphical Forecast Editor (GFE), GFE Smart Tools (techniques to automate or semi-automate grid editing), and the text formatters (TF) used in CWB's Forecast Information Editing System (FIES). In conjunction with NWS, GSD continues to work on improvements in Smart Tools, and is developing new forecast monitoring and ensemble-based forecast support tools, some of which will be included in the AWIPS II release in mid-2015.

This interaction will benefit TECRO's designated representative, CWB, with updated knowledge of the forecast assistant and decision making systems developed at NOAA including AWIPS II. Throughout the period of IA #27, NOAA/ESRL/GSD will provide training and support to CWB visitors and forecasters, continue the exchange of visits, provide reports, attend annual meetings, and continue e-mail interactions.

Task #5 – Development of Intra-seasonal to Inter-annual Climate Monitoring and Forecast

During IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that NWS/NCEP's (National Centers of Environmental Prediction) /Climate Prediction Center (CPC) and Environmental Modeling Center (EMC) will lead this task. NCEP will continue to support

CWB in advancing the monitoring and forecast capabilities, in particular for the intraseasonal to interannual time scales.

Meteorological services around the world all are facing the emerging requirements for providing, and improving, climate services. The services subjects could range from providing extended range forecasts, historical data, hazard outlooks, to tailored derivative information requested by government agencies and industrial sectors for national interests. It mandates the meteorological services, such as CWB, to layout a new strategic plan, developing new capabilities in human talents, absorbing scientific discoveries, devising new tools, and implementing technical advances.

During IA #27, NOAA will continue to assist CWB in developing climate services capabilities, by 1) providing training through NCEP's International Monsoon Training Desk Program; 2) providing planning and scientific expertise to the Taiwan-West Pacific Climate Forecast System (TWPCFS) Workshop; 3) facilitating a GSD visit on ocean wave research; and 4) Assisting and facilitating CWB professionals to attend scientific conferences and meetings in the US.

Task #6 - 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. The task for AIT's designated representative, NOAA/ESRL/GSD, in this area is the development of new tools that extend and enhance the forecast applications. Further NOAA/ESRL/GSD interaction with CWB is critical to keep CWB staff up to date on current AWIPS II developments. This task will directly improve and update CWB's current forecast assistant and decision making systems at appropriate levels, including ALPS (AWIPS Linux Prototype System) which is an upgrade of AWIPS with ensemble forecast products.

NOAA/ESRL/GSD has U.S. export control approval to provide CWB with AWIPS II software as released by the contractor. The software was first made available to CWB in 2013. During IA #27, NOAA/ESRL/GSD will continue provide updated versions and training to CWB visiting scientists on the new AWIPS II extended/ enhanced forecaster applications such as GFE improvements and Collaboration that are being developed by NOAA/ESRL/GSD.

NOAA/ESRL/GSD will continue to provide the NOAAPORT data feed and data transmission support for CWB's data assimilation and forecasting purposes during IA #27. 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 including AWIPS II. Throughout the period of IA #27, NOAA/ESRL/GSD will provide necessary training and support to CWB visitors and forecasters, continue the exchange of visits, provide necessary papers and reports, attend annual meetings, and continue e-mail interactions, as 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 #27.

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 #27.

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. $1,280,000. 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.

NOAA Information
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ALC: 13-14-0001
OMB MAX CODE: 006-48
BETC CODE: COLL

The performance by AIT's designated representative, NOAA/ESRL/GSD, 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 forecast system of AIT's designated representative, NOAA/ESRL/GSD, 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 is December 31, 2015, and the termination date of this Implementing Arrangement is June 30, 2016.

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

李光章

KUANG-JANG LEE
Deputy Representative

08-07-2015
Date

FOR THE AMERICAN INSTITUTE IN TAIWAN

Joseph R. Donovan Jr.
Managing Director

08-06-2015
Date

Statement of Work
For Implementing Arrangement #27
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 Central Weather Bureau (CWB), the designated representative of the Taipei Economic and Cultural Representative Office in the United States (TECRO) and 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) in accordance with the terms of Implementing Arrangement #27 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, NOAA/ESRL/GSD and CWB 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 Estimation 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 National Weather Service (NWS) Office of Hydrology
- A component that contains General X applications

- Dissemination of high spatial and temporal forecast and warning products

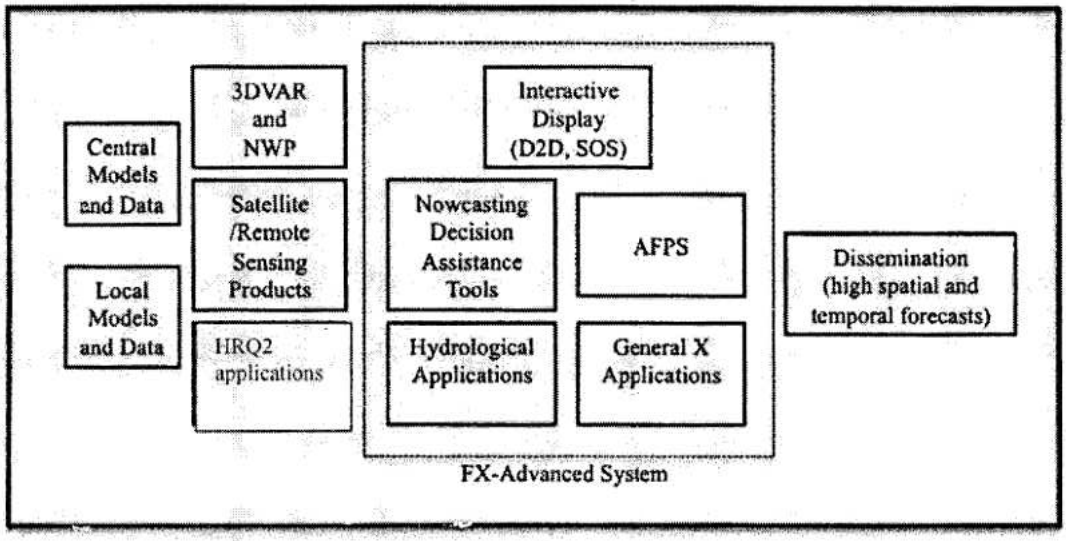

Figure 1: WFO-Advanced

Six tasks are identified: (1) Development and improvement of satellite products for tropical storm monitoring and prediction; (2) High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement; (3) Enhancement of Nowcasting Decision Assistance Tools; (4) Development of High-Resolution Product Generation Assistance Tools for AWIPS II; (5) Development of intra-seasonal to inter-annual climate monitoring and forecast; and (6) 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 (National Environment Satellite, Data, and Information Services) and NOAA/NCEP/CPC (Climate Prediction Center) facility in College Park, Maryland, the NOAA/NWS/MDL (Meteorological Development Laboratory) in Silver Spring, 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 #27 (IA #27). It describes the performance period, deliverables, and resource requirements.

2.0 - Task Descriptions

In terms of the overall program schedule, the following six tasks have been identified as critical during the January 1 to December 31, 2015 time period. Each task is 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 IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that STAR/SMCD will lead this task. NOAA/STAR/SMCD will continue providing near real-time polar orbiting satellite global 1b radiance and products data from AMSU-A and MHS onboard NOAA-18, NOAA-19, MetOp-A, and MetOp-B satellites. Also STAR/SMCD will provide SSMIS onboard DMSP F17 and F18, blended TPW products, MetOp-A/MetOp-B ASCAT winds products, WindSAT wind products and Global Data Assimilation System (GDAS) surface raw product, as well as gridded data for MiRS. Remote technical support will be provided for satellite 1b data recovery.

For Microwave Integrated Retrieval System (MiRS), STAR/SMCD will provide an updated MiRS package and documentation for multiple satellite product retrieval and on-site or remote technical support for MiRS implementation.

STAR/SMCD will provide Himawari AHI sample datasets for test purpose. Calibration coefficients may also be provided if Himawari raw data will be received by customer. STAR/SMCD will provide remote technical support for calibration coefficient implementation.

Due to the similarity between Himawari AHI and GOES-R ABI instruments, STAR/SMCD will provide GOES-R ABI selected product retrieval algorithm theoretical basis document (ATBD), which will help customer to develop Himawari AHI cloud product retrieval package. The selected products include cloud height, cloud mask, cloud type/phase, aviation convective initiation, and aviation icing threat.

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

Resources Required: 18.8 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Near real-time polar orbiting satellite level 1b radiances and products — 11/15/15
    a. AMSU-A/MHS onboard NOAA-18, NOAA-19, MetOp-A, MetOp-B
    b. SSMIS onboard DMSP F16, F17, F18
    c. Blended TPW products
    d. MetOp-A, MetOP-B ASCAT wind products and WindSAT wind products
    e. Global Data Assimilation System (GDAS) gridded data for MiRS
    f. Remote technical support on data recovery

2. Updated MiRS for multiple satellite product retrieval — 11/15/15
    a. Updated MiRS package and document
    b. Technical support for MiRS implementation
3. Himawari AHI sample data and associated calibration coefficients — 11/15/15
    a. Himawari sample data
    b. Himawari data calibration coefficients
    c. Technical support for calibration coefficients implementation
4. GOES-R ABI selected product retrieval ATBD — 06/30/15
    a. GOES-R ABI cloud height ATBD
    b. GOES-R ABI cloud mask ATBD
    c. GOES-R ABI cloud type/phase ATBD
    d. GOES-R ABI aviation icing threat ATBD
    e. GOES-R ABI aviation convective initiation ATBD

Task #2 – High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement

During IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that NOAA/NSSL (National Severe Storms Laboratory) will continue research towards maintenance, refinement, and improvement of the High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) applications required for TECRO's designated representatives, CWB, the Water Resources Agency (WRA), and the Soil and Water Conservation Bureau (SWCB).

This task will include analysis and documentation of newly available polarimetric radar data and their potential applications in the CWB, WRA, and SWCB's operations. Real-time polarimetric radar QPE products implemented during IA#25 and 26 will be evaluated systematically, and enhancements and refinements will be developed based on the evaluation results and new requirements from the CWB, WRA, and SWCB. Further, new configurations will be developed in the HRQ2 system to allow future integrations of additional C-band polarimetric radars, which will be deployed by the CWB in the next three to five years.

NOAA/NSSL will make available to TECRO's designated representative, CWB, as requested, documentation of polarimetric radar observations and software source code for the refinements and enhancements of the polarimetric radar QPE algorithms. NOAA/NSSL will also make available to CWB, as requested, the implementation of the enhanced radar QPE in the real-time HRQ2 system as part of QPESUMS technical

support.

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

Resources Required: 11.7 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Evaluation of Taiwan polarimetric radar information for use in operational forecasts 3/30/15
   a. Collect polarimetric radar data from various events 3/30/15
   b. Analyze and document radar data characteristics of different atmospheric phenomena 3/30/15
2. Assess and refine new polarimetric radar QPE techniques 9/30/15
   a. From the real-time HRQ2 system, identify cases where the new polarimetric radar QPE needs improvements. 9/30/15
   b. Perform case studies, document scientific issues, and develop algorithm enhancements. 9/30/15
   c. Implement the enhancements into the real-time HRQ2 system 9/30/15
3. Configuration of HRQ2 system for the integration of new CWB precipitation radars 10/30/15
4. Technical support for QPESUMS operations 11/15/15

Task #3 - Enhance of Nowcasting Decision Assistance Tools

As part of IA#27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that MDL will continue to provide technical support and training to TECRO's designated representative, CWB, to enhance CWB's WINS in the area of nowcasting decision assistance tools that have already been implemented. This support includes source code modification and configuration appropriate for CWB's use of the tools which have been already ported.

After customizing most of the MDL's decision assistance tools listed above, the full implementation and configuration of FFMP on WINS were completed and installed onto the operational platform at CWB's Forecast Center in 2014. FFMP conducts precipitation analyses over the areas of small basins and thus is an integrated suite of multi-sensor applications which detect, analyze, and monitor precipitation and generate short-term warning guidance for flash flooding automatically. During 2014, the MDL

provided the CWB with more thorough customization and training support on the MDL's decision assistance tools, especially on FFMP to support its operational use at the CWB's Forecast Center.

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In the past, CWB made significant changes on one of MDL's decision assistance tools called SAFESEAs and split it into two separated tools called SafeLand and SafeRain in their WINS system to meet their different weather and geographical scenario requirements. SafeRain and SafeLand have been used operationally in CWB's Forecast Center for a few years and received many good feedbacks. Such modification was seeking to be done under the new architecture and framework of NWS AWIPS-II system that CWB is transitioning to. In 2013, MDL assisted and trained CWB developers to learn and understand the AWIPS2 development architecture. In 2015, MDL will mainly focus on providing the consultation/survey support to CWB on SAFESEAS, for its technical implementation under AWIPS2 development environment.

MDL's forth task on IA27 will be to provide the CWB's Meteorological Satellite Center (MSC) software and training so that the MSC can continue their automatic tuning on the CWB's ANC in a flexible and timely manner. ANC uses a fuzzy logic algorithm based on conceptual models of storm initiation, storm growth, and storm dissipation. The system assimilates a variety of data sets to analyze characteristic features of the atmosphere associated with pre-storm environments and to produce 60-minute nowcasts of storm initiation, growth, and dissipation. These analyses evaluate convective instability, moisture convergence, and trigger mechanisms to produce interest fields that are used as inputs to the fuzzy logic algorithm. The interest fields used in the storm initiation algorithm are converted into dimensionless likelihood fields using fuzzy membership functions. The various likelihood fields are weighted using values determined by human experts, and the weighted likelihood fields are summed to produce a combined likelihood field that is indicative of storm initiation in the next 60 minutes.

At the MDL, ANC has been significantly re-engineered and reconfigured in order to be able to generate CONUS-wide, 60-minute nowcasts of storm initiation, growth, and dissipation as quickly as possible while using as little disk space as possible. As part of the re-engineering, the MDL has fixed a number of software bugs within ANC, thus making ANC less prone to software crashes. This effort has taken approximately four and one-half years and is still ongoing. Thus, the MDL's version of ANC is substantially

different from the original version which the MDL received from NCAR. In contrast, the CWB's version of ANC is essentially the same as the version which the CWB received from NCAR. That version, however, is neither structured as simply nor reconfigured as easily as the MDL's version, and this inhibits the CWB's understanding and use of ANC. As part of its ongoing efforts to incorporate ANC as easily as possible into its daily operations, the CWB wants to obtain the MDL's version of ANC as well as the training and technical support needed to configure and use that version.

Neither the CWB's nor the MDL's version of ANC are yet capable, however, of converting CWB-generated predictor fields in NetCDF format into ANC's proprietary MDV format. Such a conversion is necessary because most of the CWB's predictor fields are stored natively in NetCDF format, but they must be in MDV format in order for the CWB to use ANC to begin to study and evaluate the potential roles which such predictor fields might play in convective storm initiation and evolution over and around Taiwan. So, along with obtaining the MDL's version of ANC, the CWB wants the MDL to modify ANC so that the needed conversion of the CWB's predictors in NetCDF format to MDV format can be achieved.

As part of its multi-year effort to use, understand, and operationalize ANC, the MDL spent a good amount of time developing algorithms and software with which to verify ANC's 60-minute nowcasts of convective initiation. Studies based on the output of such software have been crucial to the MDL's understanding of the proper interpretation of such nowcasts both spatially and temporally. Such understanding is itself necessary in order to describe accurately to operational users exactly what ANC produces and how to interpret the results in a meaningful way. Because of this, the CWB also wants to obtain the MDL's ANC verification software as well as the training and technical support needed to configure it, use it, and interpret its results for Taiwan so that the CWB's forecasters make informed use of ANC's output.

The following summarizes the schedule and goals for Task #3:

Resources Required: 14.1 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Basin customization/modification using CWB's new DEM data with higher resolution, and FFMP shapefile re-generation for WINS system use. Technical and training support for the new implementation to be installed at CWB's Forecast Center. 11/30/15

2. Technical Support to all DAB assistance tools for WINS-A1 system, including SCAN, 11/30/15

SCAN DMD, FFMP, SAFESEAS, GUARDIANS.

3. Assist in the survey study of SAFESEA application tool in the AWIPS2 system so that CWB could start evaluating their SAFELand and SAFERain in the future, compared to the development they have done for WINS system. — 11/30/15

4. Modify the CWB's version of ANC's netCDF to MDV application so that the CWB can convert NetCDF files into the equivalent MDV files needed by the CWB's version of ANC's conus application. As part of this effort, the CWB and the MDL will agree upon a set format for the NetCDF files such that adherence to the format will guarantee the ability to convert those files to the MDV format. — 06/30/15

5. Transfer to the CWB the MDL's version of ANC, and provide both the training needed so that the CWB understands how to use the MDL's version and the technical support needed so that the MDL's version runs on the CWB's systems. — 09/30/15

6. Transfer to the CWB the software developed by the MDL to verify the 60-minute nowcast of convective initiation, and provide both the training needed so that the CWB understands how to use the software and the technical supported needed so that the software runs on the CWB's systems. — 11/30/15

Task #4 - Development of High-Resolution Product Generation Assistance Tools for AWIPS II

The National Weather Service (NWS) has been developing AWIPS II for several years. This replacement for the original AWIPS (the basis of the current CWB Weather Integration and Nowcasting System (WINS) is running at 63 NWS operational sites as of December 2014, and is planned to be installed at all remaining field offices by September 2015. AWIPS II provides essentially the same appearance and function ("look and feel") as AWIPS I, reducing the need for extensive forecaster training. The underlying software

is written largely in Java and loosely follows a services oriented architecture (SOA) design.

During IA#25, AIT's designated representative, NOAA/ESRL/GSD, received permission from NWS to provide an evaluation copy of the AWIPS II software to CWB. This support continued through IA#26, with periodic updates provided. GSD also provided AWIPS II training for CWB developers. Two CWB visitors to GSD in 2014 learned much about AWIPS II and, with GSD, began design/development work on some CWB-specific data ingest and display plugins, working toward eventual realization of a WINS-II.

For IA#27, GSD will continue to support CWB developers by providing updated versions of the AWIPS II software. GSD will work with NWS/Meteorological Development Laboratory to set up a shared software repository, where GSD and CWB visitor(s) will maintain code that they will share with other CWB staff who are developing and testing new software.

GSD has developed for AWIPS II a CAVE Annotation Tool (CAT) that allows NWS forecasters to create and save drawings, including graphics such as Nowcasts and weather stories to publish on the Web. During IA#27, GSD will support development of a system to extend CAT to support CWB's annotation requirements. Additional collaborative work will address ingest and display of CWB-specific lightning, satellite, and grid datasets.

During IA#27, GSD will provide technical support for the Graphical Forecast Editor (GFE), GFE Smart Tools (techniques to automate or semi-automate grid editing), and the text formatters (TF) used in CWB's Forecast Information Editing System (FIES). In conjunction with NWS, GSD continues to work on improvements in Smart Tools, and is developing new forecast monitoring and ensemble-based forecast support tools, some of which will be included in the AWIPS II release in mid-2015.

This interaction will benefit TECRO's designated representative, CWB, with updated knowledge of the forecast assistant and decision making systems developed at NOAA including AWIPS II. Throughout the period of IA #27, NOAA/ESRL/GSD will provide training and support to CWB visitors and forecasters, continue the exchange of visits, provide reports, attend annual meetings, and continue e-mail interactions.

The following summarizes the schedule and resources required for Task #4:

Resources Required: 20.3 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Prepare and deliver updated versions of AWIPS II software	3/15; 7/15; 10/15
2. On-site AWIPS II training for CWB staff	11/30/15
3. Provide technical support on GFE Smart Tools for CWB's TF development	11/15

4. AWIPS II software development support 11/15

Task #5 – Development of Intra-seasonal to Inter-annual Climate Monitoring and Forecast

During IA #27, AIT's designated representative, NOAA/ESRL/GSD, has agreed that NWS/NCEP's (National Centers of Environmental Prediction) /Climate Prediction Center (CPC) and Environmental Modeling Center (EMC) will lead this task. NCEP will continue to support CWB in advancing the monitoring and forecast capabilities, in particular for the intraseasonal to interannual time scales.

Meteorological services around the world all are facing the emerging requirements for providing, and improving, climate services. The services subjects could range from providing extended range forecasts, historical data, hazard outlooks, to tailored derivative information requested by government agencies and industrial sectors for national interests. It mandates the meteorological services, such as CWB, to layout a new strategic plan, developing new capabilities in human talents, absorbing scientific discoveries, devising new tools, and implementing technical advances.

During IA #27, NOAA will continue to assist CWB in developing climate services capabilities, by 1) providing training through NCEP's International Monsoon Training Desk Program; 2) providing planning and scientific expertise to the Taiwan-West Pacific Climate Forecast System (TWPCFS) Workshop; 3) facilitating a GSD visit on ocean wave research; and 4) Assisting and facilitating CWB professionals to attend scientific conferences and meetings in the US.

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

Resources Required: 12.5 %
NOAA/ESRL
NOAA/NWS/NCEP/CPC
NOAA/NWS/NCEP/EMC

Deliverables and Schedule:

1. Support CWB personnel attending NOAA/NCEP's Monsoon Desk training 11/30/15
2. Support the 3rd CWB Workshop on development planning for the next generation Global Forecast Model 11/30/15
3. Support attending the 40th Climate Diagnostics and Prediction Workshop and potentially other workshops and conference meetings relevant for advancing forecast 11/30/15

skills, such as S2S prediction, and visit to NOAA's Weather and Climate Prediction Center and other facilities

4. Facilitate a NCEP visit on ocean wave dynamics research 11/30/15
5. Report on the year's tasks. 11/30/15

Task #6 - 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. The task for AIT's designated representative, NOAA/ESRL/GSD, in this area is the development of new tools that extend and enhance the forecast applications. Further NOAA/ESRL/GSD interaction with CWB is critical to keep CWB staff up to date on current AWIPS II developments. This task will directly improve and update CWB's current forecast assistant and decision making systems at appropriate levels, including ALPS (AWIPS Linux Prototype System) which is an upgrade of AWIPS with ensemble forecast products.

NOAA/ESRL/GSD has U.S. export control approval to provide CWB with AWIPS II software as released by the contractor. The software was first made available to CWB in 2013. During IA #27, NOAA/ESRL/GSD will continue provide updated versions and training to CWB visiting scientists on the new AWIPS II extended/ enhanced forecaster applications such as GFE improvements and Collaboration that are being developed by NOAA/ESRL/GSD.

NOAA/ESRL/GSD will continue to provide the NOAAPORT data feed and data transmission support for CWB's data assimilation and forecasting purposes during IA #27. 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 including AWIPS II. Throughout the period of IA #27, NOAA/ESRL/GSD will provide necessary training and support to CWB visitors and forecasters, continue the exchange of visits, provide necessary papers and reports, attend annual meetings, and continue e-mail interactions, as applicable.

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

Resources Required: 22.6 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. ALPS system (necessary technical support) 11/30/15
2. AWIPS II training to CWB users 11/30/15
3. NOAAPORT data supply support 11/30/15
4. Visitors and travel support 11/30/15

3.0 - Schedule

Tasks	Functions	Milestones
1.	Provide satellite products, algorithms for tropical storm monitoring and prediction	11/30/15
2.	Provide improved HRQ2 system to support operation and evaluation	11/30/15
3.	Provide technical support on decision assistance tools (FFMP and Others) and MDL's version of ANC and necessary training	11/30/15
4.	Provide AWIPS II software releases, training and technical support on GFE smart tools for CWB's FIES development	11/30/15
5.	Provide NCEP Monsoon Desk training, support CWB workshop and CDPW workshop, NCEP visit on ocean wave research and other workshops	11/30/15
6.	Provide technical support of ALPS and AWIPS II user training, and NOAAPORT data transition, visitors and travel support and relevant documents	11/30/15

Schedule by Month

Task 1 Satellite application	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Polar level 1b (or SDR) radiance and products	x	x	x	x	x	x	x	x	x	x	x	
Technical support on MiRS improvement and updates	x	x	x	x	x	x	x	x	x	x	x	
Himawari AH1 data and associated calibration coefficients	x	x	x	x	x	x	x	x	x	x	x	
GOES-R AB1 selected products retrieval ATBD	x	x	x	x	x	x						

Task 2 HRQ2 (NSSL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaluation of Taiwan polarimetric radar information for operation use	x	x	x									
Assess new polarimetric radar QPE techniques	x	x	x	x	x	x	x	x	x			
Configuration of HRQ2 for new CWB precipitation radars	x	x	x	x	x	x	x	x	x	x		
QPESUMS technical support	x	x	x	x	x	x	x	x	x	x	x	

Task 3 Enhanced Nowcasting Decision tools (MDL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Basin customization and FFMP shapefile regeneration for WINS	x	x	x	x	x	x	x	x	x	x	x	

Technical support on all DAB assistant tools	x	x	x	x	x	x	x	x	x	x	x	
Assist SAFESEA tools survey study	x	x	x	x	x	x	x	x	x	x	x	
Modify ANC input data format from netCDF to MDV	x	x	x	x	x	x						
Transfer MDL's ANC software system and provide training	x	x	x	x	x	x	x	x	x			
Transfer MDL verification software to CWB and provide technical support	x	x	x	x	x	x	x	x	x	x	x	

Task 4 High-resolution forecast product generation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
AWIPS II software releases			x				x			x		
On-site AWIPS II training for CWB staff					x	x	x	x	x	x	x	
GFE smart tools technical support	x	x	x	x	x	x	x	x	x	x	x	
AWIPS II software development support	x	x	x	x	x	x	x	x	x	x	x	

Task 5 Climate monitor and forecast (NCEP/CPC)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Organize Monsoon Desk visit	x	x	x	x	x	x	x	x	x	x	x	
Support TWPCFS 3rd workshop	x	x	x	x	x	x	x	x	x	x	x	
Support 40th workshop and other visits	x	x	x	x	x	x	x	x	x	x		
Facilitate a NCEP visit on ocean wave research					x	x	x					
Annual task report	x	x	x	x	x	x	x	x	x	x	x	

Task 6 interaction on earlier projects	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
ALPS system support (necessary technical support)	x	x	x	x	x	x	x	x	x	x	x	
AWIPS II CWB users training	x	x	x	x	x	x	x	x	x	x	x	
NOAAPORT data support	x	x	x	x	x	x	x	x	x	x	x	
CWB visitors and travel support	x	x	x	x	x	x	x	x	x	x	x	

4.0 - Budget

The following are the estimated costs for IA #27

Tasks	Personnel	Travel/Training	Total
Task #1 (NESDIS/GSD)	$225,000	$ 15,000	$ 240,000
Task #2 (NSSL)	$135,000	$ 15,000	$ 150,000

Task #3 (MDL/GSD)	$165,000	$ 15,000	$ 180,000
Task #4 (GSD)	$245,000	$ 15,000	$ 260,000
Task #5 (NCEP/CPC)	$145,000	$ 15,000	$ 160,000
Task #6 (GSD)	$275,000	$ 15,000	$ 290,000
Total	**$ 1,190,000**	**$ 90,000**	**$ 1,280,000**

As stated in IA #27, the funds available from TECRO to support the tasks, travel, and meeting expenses described in this Statement of Work will be a total of US$ 1,280,000. NOAA and AIT understand that US$ 930,000 will be provided by CWB, US$ 250,000 by the Water Resources Agency (WRA), and US$ 100,000 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 Umbrella 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, NOAA/NESDIS, and NOAA/NWS/MDL. The primary effort of CWB staff at NOAA during the IA #27 period will be directed towards the satellite data, GFE and AWIPS II development tasks. The primary effort of CWB staff at NOAA/NCEP/CPC during the IA #27 period will be to get familiar with the operations of the CPC International Monsoon Desk. It is important that qualified CWB staff be available to work at NOAA research and operations facilities during the period of this Implementing Arrangement. 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 product generation assistance tool to support CWB's FIES;
- Development of forecast applications under AWIPS II environment;
- Receiving training at GSD for ocean wave dynamics;
- Receiving training at the NCEP International Monsoon Desk and other facility.