Implementing Arrangement #30

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 provides a framework for a project between the American Institute in Taiwan (AIT) and the Taipei Economic and Cultural Representative Office in the United States (TECRO), collectively referred to as the "Parties." It describes the scientific and technical activities to be undertaken by the American Institute in Taiwan (AIT), through its designated representative, the National Oceanic and Atmospheric Administration (NOAA), United States Department of Commerce (hereinafter "NOAA/ESRL/GSD") or "GSD". 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 Parties, through their designated representatives, the Central Weather Bureau (CWB), the designated representative of TECRO, and NOAA for AIT. This Implementing Arrangement is of mutual interest to both AIT and TECRO. 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 shall be carried out under and are subject to the general terms and conditions established by the Agreement between AIT and TECRO for Technical Cooperation in Meteorology and Forecast Systems Development, signed by the Parties as of October 20 and 21, 2016, and any subsequent amendment thereof agreed to by the Parties. This Implementing Arrangement is the thirtieth such arrangement under a succession of umbrella agreements between AIT and TECRO specific to the scope of weather forecast improvement as led by NOAA's Global Systems Division.

Article III - Services

During the period of Implementing Arrangement #30 (IA #30), NOAA/ESRL/GSD and CWB have started a new phase VI program on hazardous weather monitoring and forecasting. Therefore the NOAA/ESRL/GSD-CWB joint team shall, under the auspices of AIT and TECRO, expand work to address this hazardous weather theme. Seven tasks are identified: (1) Development and Improvement of Satellite Products for Surface Radiation and Air Quality 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 Next Generation Global to Regional Prediction System (6) Continuing Interaction on Earlier Cooperative Projects and (7) Development of GOES-R Decision Support Products from Himawari-8. 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, shall include the following seven tasks:

Task #1 Development and Improvement of Satellite Products for Surface Radiation and Air Quality Monitoring and Prediction

During IA #30, the Parties agree that NOAA/ESRL/GSD has agreed that NOAA/STAR/SMCD shall lead this task. AIT through NOAA/STAR/SMCD shall improve CRTM in the visible channels to improve surface solar insolation algorithm by using WRF model data and generate surface solar insolation product from Advanced Himawari Image (AHI) for assessment of WRF surface insolation with ground observation data over Taiwan. The expected benefit is the provision of real-time forecasting of solar energy distribution.

NOAA/STAR/SMCD will apply GOES-R ABI Aerosol Algorithms to Himawari-8 AHI. This is possible due to the similarity between Himawari AHI and GOES-R ABI instruments, where both have sixteen bands (three visible, three near-infrared and ten infrared).

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

During IA #30, the Parties agree that AIT, NOAA/NSSL (National Severe Storms Laboratory) shall 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 shall include a training of CWB visitors on the disdrometer data analysis and development of C-band dual-pol radar quantitative precipitation estimation (QPE) applications. This training and study will provide CWB capabilities to customize and enhance their operational precipitation products using their real-time disdrometer observations and the newly deployed precipitation radars. AIT, through NOAA/NSSL shall work with TECRO, through CWB to refine and streamline the radar quality control (QC) workflow for improved accuracy of operational products.

AIT, through NSSL shall make available to TECRO, through its designated representative, CWB, as requested, the updated radar QC and QPE software for the new radars. AIT, through NSSL shall also provide TECRO, through CWB, as requested, consultations as part of QPESUMS technical support.

Task 3 - Enhancement of Nowcasting Decision Assistance Tools

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The Meteorological Development Laboratory (MDL) of NOAA's National Weather Service (NWS) has developed a comprehensive suite of decision assistance tools which cover the full scope of hydrometeorological phenomena and forecaster responsibilities. In the past few years, the MDL has assisted and supported porting various applications into the Weather Integration and Nowcasting System (WINS) of the CWB.

As part of IA #30, the Parties agree that AIT, through the MDL shall continue to provide technical and training support to TECRO's designated representative, the CWB, to enhance the CWB in the area of nowcasting decision assistance tools that have been implemented. That support includes source code and configuration modification that is appropriate for CWB's use.

AIT, through MDL shall continue to focus on migration support of Flash Flood Monitoring and Prediction (FFMP) to AWIPS II systems and continue the technical support on SCAN tools. MDL will also continue to support CWB's VLab (Virtual Laboratory) use to CWB developers including user manuals, download source code and VLab development training.

AIT, through MDL shall continue to provide TECRO, through CWB training and technical support on the AutoNowCaster (ANC) system. The MDL's version of ANC, which is substantially different from its original NCAR version and has been improved with far fewer software crashes and much easier configuration for its operational use, was delivered to CWB along with a verification package in IA #28. The ongoing training and technical support are needed to configure it, use it, and interpret its results so that the CWB's forecasters can 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. The AWIPS II is a replacement for the original AWIPS system which is the basis for the CWB Weather Integration and Nowcasting System (WINS). The AWIPS II system has been used operationally in the US National Weather Service (NWS) Weather Forecast Offices (WFOs) since 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 service oriented architecture (SOA) design.

For IA #30, the Parties agree that AIT, through GSD shall continue to support TECRO, through CWB developers by providing updated versions of the AWIPS II software. GSD shall work with NWS/MDL 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.

Task #5 – Development of Next Generation Global to Regional Prediction System

During IA #30, the Parties that NWS/NCEP (National Centers of Environmental Prediction)/EMC (Environmental Modeling Center) shall lead this task. AIT, through EMC shall facilitate TECRO, through CWB modeling staff, to participate in NOAA/NWS's NGGPS (Next Generation Global Prediction System) activity.

NGGPS's goal is to design/develop/implement a new global atmospheric prediction model with non-hydrostatic scalable dynamics with advanced physics, improved data assimilation and next

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generation high performance computing. Under the NGGPS program, the GFDL's Finite Volume Model Cubed Sphere (FV3) dynamic core has been selected in the implement plan with GFS physics and GDAS (Global Data Assimilation System) as FV3GFS and ready for evaluation test in 2018, and be ready for operation in 2019.

Specific for IA #30, in consultation with the Parties, AIT, through NCEP/EMC shall assist in hosting TECRO, through a long-term CWB modeling staff member, to participate in the NGGPS operational testing and implementation activities, so that TECRO, through CWB can actively make contribution for this program. AIT should be advised by its designated representative whenever these activities are planned. Through this collaboration, CWB could position its own development of a next generation global forecast system from NOAA's NGGPS knowledge and operational experience. NCEP/EMC shall also support a joint annual NCEP-CWB global modeling workshop involving, under the auspices of AIT and EMC scientists to exchange science and operational knowledge in the area of Global Forecast System (GFS) and Global Ensemble Forecast System (GEFS).

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 the CWB. The task for AIT, through NOAA/ESRL/GSD in this area is the development of new tools that extend and enhance the forecast applications. Further AIT and TECRO's interaction, through NOAA/ESRL/GSD and CWB respectively, is critical to keep TECRO, through 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.

During IA #30, AIT, through NOAA/ESRL/GSD shall continue to 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.

AIT, through NOAA/ESRL/GSD shall continue to provide the NOAAPORT data feed and data transmission support for CWB's data assimilation and forecasting purposes during IA #30. This continuing interaction task will benefit AIT and TECRO, through the activities of their designated representatives, with the updated knowledge of the forecast assistant and decision making systems developed at NOAA including AWIPS II. Throughout the period of IA #30, AIT, through NOAA/ESRL/GSD shall provide necessary training and support to TECRO through CWB visitors and forecasters, and through their designated representatives, continue the exchange of visits, provide necessary papers and reports, attend annual meetings, and continue e-mail interactions, as applicable.

During IA #30, GSD shall continue provide CWB MMC (Marine Meteorology Center) with technical support for CWB DART® (Deep-ocean Assessment Reporting of Tsunamis) buoys by Dr. Eddie Bernard, also coordinate DART site visit by CWB staff and/or CWB contractors. AIT, through GSD shall also coordinate a visit from MDL on NOAA storm surge training and a visit on NOAA ocean observation technology and strategy training.

Task #7 – Development of GOES-R Decision Support Products from Himawari-8

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During IA #30, the Parties agree that AIT, through NOAA and pursuant to the NOAA Cooperative Agreement with the University of Wisconsin – Space Science and Engineering Center (SSEC) / Cooperative Institute for Meteorological Satellite Studies (CIMSS) shall continue research in support of satellite-based decision support products. CIMSS will lead this task.

This task shall include hosting a CWB visitor to facilitate training and transfer of Himawari-8 decision support products from CIMSS to CWB. This includes the Advanced Dvorak Technique (ADT) software for estimating typhoon intensity. AIT, through NOAA and NOAA's relationship with CIMSS shall provide support for the ADT installation at CWB and case studies to validate performance of the software at CWB as compared to CIMSS. AIT, through NOAA and NOAA's relationship with CIMSS shall also make available the newly developed SST retrieval product through the CLAVR-x (Clouds from AVHRR Extended) processing system. AIT, through NOAA and NOAA's relationship with CIMSS shall work with TECRO, through its designated representative, CWB to tune the SST product to Himawari-8/AHI and take advantage of the decreased Himarawi-8 processing time implemented this past year.

AIT, through NOAA and NOAA's relationship with CIMSS shall provide support for CWB RGB products, both in terms of recipes and compatibility tools for AWIPS2. AIT, through NOAA and its relationship with CIMSS shall also provide guidance on implementation of GOES-R (now GOES-16) color tables for RGB products. AIT, through NOAA and NOAA's relationship with CIMSS shall also develop tools for conversion of CLAVR-x output to AWIPS2-compatible formats.

Article IV - Responsibilities of AIT

In addition to participation in the joint project team, AIT, through its designated representative, 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 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 #30.

Article V - Responsibilities of TECRO

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

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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 #30.

Article VI - Financial Provisions

In accordance with the Umbrella Agreement, TECRO shall pay AIT, through its designated representative, 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. $2,035,000. 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 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 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, in consultation with the Parties, have approved them in final form.

Article VIII – Privileges, Exemptions, and Immunities

For purposes of visits and any other travel contemplated in the Implement Arrangement #30, staff of the Parties' designated representatives shall be considered consultants to AIT and TECRO, respectively, when in the territory represented by the counterpart organization. The Parties acknowledge that such individuals generally shall not be eligible for privileges, exemptions, and immunities pursuant to the 2013 Agreement on Privileges, Exemptions and Immunities between the American Institute in Taiwan and the Taipei Economic and Cultural Representative Office in the United States ("2013 Agreement") if the visit or any other travel is less than 90 days in duration or if the individual is working at a location other than a facility of the sending organization. Nothing here is intended by the Parties as an amendment or other change to the 2013 Agreement, the provisions of which must be satisfied before any privileges, exemptions, or immunities may be provided by either Party. During the performance of this IA

the Parties do not expect individuals participating in the planned work efforts to be eligible for privileges, exemptions and immunities under the 2013 Agreement.

Article IX - 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 Umbrella Agreement. The estimated start date for the activities described in this Implementing Arrangement is January 1, 2018 and the estimated completion date for the activities described in this Implementing Arrangement is December 31, 2018, and the period of performance end date of this Implementing Arrangement is December 31, 2019.

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

Louis M. Huang
Deputy Representative

12-14-2018
Date

FOR THE AMERICAN INSTITUTE IN TAIWAN

John J. Norris Jr.
Managing Director

12-11-2018
Date

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Statement of Work
For Implementing Arrangement #30
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 U.S. National Oceanic and Atmospheric Administration (NOAA) (including 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 #30 of the Agreement between the American Institute in Taiwan and the Taipei Economic and Cultural Representative office in the United States for Technical Cooperation in Meteorology and Forecast Systems Development, signed by AIT and TECRO on October 20 and 21, 2016, which provides for technical cooperation between AIT, through its designated representative, NOAA and TECRO, through its designated representative, CWB. AIT and TECRO (hereinafter referred to as the "Parties"), cooperate, through their 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 II (AWIPS II) for the U.S. National Weather Service (NWS). The WFO-Advanced system development has been a very important cooperative activity between AIT's and TECRO, through, NOAA/ESRL/GSD and CWB to support the mission of establishing hazardous weather monitoring and forecasting. Figure 1 lists the important components and Figure 2 illustrates the software architecture for WFO-AWIPS II here:

Environmental Data Exchange(EDEX)	Common AWIPS Visualization Environment(CAVE)	Users System
- Notification Subscription Interface - Statistical Analysis - Event framework - Sync Manager - Bandwidth Manager - Authorization Framework - Retrieval Framework - ebXML Manager - PostgreSQL and PDO Database	- Subset Manager - Dataset Discovery Browser - Subscription Manager - Notification Center - System Management - Bandwidth Utilization Graph - Statistics Display - User Admin	-NOAAPORT -GFE -HS -FFMP (MDL) -global model -NESDIS -WSR-88D

Figure 1. The important components of WFO-AWIPSII and Users System

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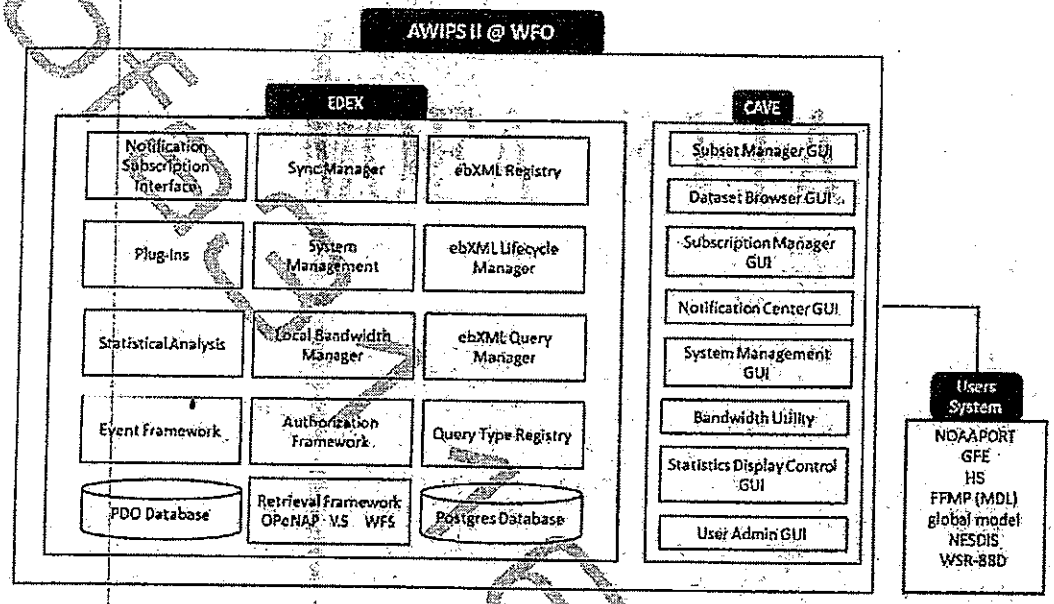

Figure 2. Software architecture for WFO-AWIPSII and Users System

Seven tasks are identified: (1) Development and Improvement of Satellite Products for Surface Radiation and Air Quality 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 Next Generation Global to Regional Prediction System; (6) Continuing Interaction on Earlier Cooperative Projects; and (7) Development of GOES-R Decision Support Products from Himawari-8.

The Parties agree that the tasks shall be undertaken through the NOAA/ESRL/GSD-CWB Joint Team as the designated representatives of the AIT and TECRO, working at the NOAA/ESRL/GSD facility in Boulder, Colorado, the NOAA/NSSL(National Severe Storms Laboratory) in Norman Oklahoma, 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, the University of Wisconsin – Space Science and Engineering Center (SSEC) / Cooperative Institute for Meteorological Satellite Studies (CIMSS) 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 NOAA/ESRL/GSD - CWB Joint Team under the terms of Implementing Arrangement #30 (IA #30). It describes the performance period, deliverables, and resource requirements.

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2.0- Task Descriptions

In terms of the overall program schedule, the following seven tasks have been identified as critical during the January 1 to December 31, 2018 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 Surface Radiation and Air Quality Monitoring and Prediction

During IA #30, the Parties agree that NOAA/ESRL/GSD shall agreed that NOAA/STAR/SMCD will lead this task. NOAA/STAR/SMCD shall improve CRTM in the visible channels to improve surface solar insolation algorithm by using WRF model data and generate surface solar insolation product from Advanced Himawari Image (AHI) for assessment of WRF surface insolation with ground observation data over Taiwan. The benefit is to provide real-time forecast of solar energy distribution.

NOAA/STAR/SMCD will apply GOES-R ABI Aerosol Algorithms to Himawari-8 AHI. This is possible due to the similarity between Himawari AHI and GOES-R ABI instruments, where both have sixteen bands (three visible, three near-infrared and ten infrared).

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

Resources Required: 14.04 % NESDIS/GSD/CWB

Deliverables and Schedule:

1. Improve CRTM for Surface Solar Insolation algorithm and product development — 11/15/18
   a. Enhance CRTM in the visible channels to improve solar insulation by using WRF model data
   b. Retrieve solar radiation using AHI data directly
   c. Assessment of WRF surface insolation with ground observation data over Taiwan
2. GOES-R ABI Aerosol Algorithms Applied to Himawari-8 AHI — 11/15/18

   Suspended matter/aerosol optical depth

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

During LA #30, the Parties agree that NOAA/NSSL (National Severe Storms Laboratory) shall 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 shall include a training of CWB visitors on the disdrometer data analysis and development of C-band dual-pol radar quantitative precipitation estimation (QPE) applications. This training and study will provide CWB capabilities to customize and enhance their operational precipitation products using their real-time disdrometer observations and the newly deployed precipitation radars. The Parties agree that NSSL shall work with CWB to refine and streamline the radar quality control (QC) workflow for improved accuracy of operational products.

AIT, through NSSL shall make available to TECRO, through its designated representative, CWB, as requested, the updated radar QC and QPE software for the new radars. AIT, through NSSL shall also provide CWB, as requested, consultations as part of QPESUMS technical support. The following summarizes the schedule and resources required for Task #2:

Resources Required: 14.04% NSSL/GSD/CWB

Deliverables and Schedule:

1. C-band dual-pol radar QPE development and disdrometer data study — 11/30/18
    a. Collection and quality control of disdrometer data
    b. Development of C-band dual-pol radar QPE algorithms using Taiwan disdrometer data
    c. Testing and evaluation of the C-band dual-pol radar QPE using CWB precipitation radar and gauge data
    d. Documentation of the results and implications for operations
2. Multi-parameter radar data quality control research and development
    a. Identification of radar data quality issues in the QPESUMS system — 11/30/18
    b. Development of a multi-parameter radar data quality control (QC) algorithm.
    c. Testing and evaluation of the radar data QC using CWB radar data
    d. Documentation of the results and recommendations for operational implementation

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3. Technical support for QPESUMS operations 11/30/18

Task 3 - Enhancement of Nowcasting Decision Assistance Tools

The Meteorological Development Laboratory (MDL) of the National Weather Service (NWS) has developed a comprehensive suite of decision assistance tools which cover the full scope of hydrometeorological phenomena and forecaster responsibilities. In the past few years, the MDL has assisted and supported porting various applications into the Weather Integration and Nowcasting System (WINS) of the CWB.

As part of IA #30, the Parties agree that AIT, through the MDL shall continue to provide technical and training support to TECRO, through its designated representative, the CWB, to enhance the TECRO, through CWB, in the area of nowcasting decision assistance tools that have been implemented. That support includes source code and configuration modification that is appropriate for CWB's use.

MDL shall continue to focus on migration support of Flash Flood Monitoring and Prediction (FFMP) to AWIPS II systems and continue the technical support on SCAN tools. AIT, through MDL shall also continue to support TECRO, through CWB's VLab (Virtual Laboratory) use to CWB developers including user manuals, download source code and VLab development training.

AIT, through MDL shall continue to provide TECRO, through CWB training and technical support on the AutoNowCaster (ANC) system. The MDL's version of ANC, which is substantially different from its original NCAR version and has been improved with far fewer software crashes and much easier configuration for its operational use, was delivered to CWB along with a verification package in IA #28. The ongoing training and technical support are needed to configure it, use it, and interpret its results so that the CWB's forecasters make informed use of ANC's output. The following summarizes the schedule and resources required for Task 3:

Resources Required: 15.02 % MDL/GSD/CWB

Deliverables and Schedule:

1. Support Scan and FFMP migration to AWIPS II system. 11/15/18
2. Support VLab to CWB developers who are able to:
   a. Access user manuals, instructions and guidance documentation for AWIPS II operational update. 11/15/18
   b. Download AWIPS II source code.
   c. Provide Vlab software development training.
   d. Establish CWB Readmine project in VLab and establish CWB community in VLab.
3. ANC System Technical Support 11/15/18
   a. Consultation to include new predictor(s) to fit Taiwan weather scenarios.
   b. Consultation for performing auto-tuning to

generate the weights of predictors.

c. Continue support verification of the 60-minute nowcast of the operational TANC.

d. Continue to support the MDL's version ANC for CWB to eventually replacing TANC in operation.

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. The AWIPS II is a replacement for the original AWIPS system which is the basis for the CWB Weather Integration and Nowcasting System (WINS). The AWIPS II system has been used operationally in the US National Weather Service (NWS) Weather Forecast Offices (WFOs) since 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 service oriented architecture (SOA) design.

For IA #30, the Parties agree that AIT, through GSD will continue to support TECRO, through CWB developers, by providing updated versions of the AWIPS II software. GSD shall work with NWS/MDL to set up a shared software repository, where GSD and CWB visitor(s) shall maintain code that they will share with other CWB staff who are developing and testing new software.

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

Resources Required:	10.59 %	GSD/CWB
Deliverable and Schedule:		
1. Prepare and deliver updated versions of AWIPS II versions.		11/15/18
2. Assist with installation and configuration.		11/15/18
3. Working in a shared development environment and continue to train AWIPS II developers (Resource management, building RPMs and installs)		11/15/18
4. Provide CWB annotation support and training.		11/15/18
5. CentOS7 (Red Hat Enterprise 7) necessary upgrade.		11/15/18

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Task #5 – Development of Next Generation Global to Regional Prediction System

During IA #30, the Parties agree that AIT, through NOAA/ESRL/GSD has agreed that NWS/NCEP (National Centers of Environmental Prediction)/EMC (Environmental Modeling Center) shall lead this task. AIT, through EMC shall facilitate TECRO, through CWB modeling staff to participate in NOAA/NWS's NGGPS (Next Generation Global Prediction System) activity.

NGGPS's goal is to design/develop/implement a new global atmospheric prediction model with non-hydrostatic scalable dynamics with advanced physics, improved data assimilation and apply next generation high performance computing. Under the NGGPS program, the GFDL's Finite Volume Model Cubed Sphere (FV3) dynamic core has been selected in the implement plan with GFS physics and GDAS (Global Data Assimilation System) as FV3GFS and ready for evaluation test in 2018, and be ready for operation in 2019.

Specific for IA #30, AIT, through NCEP/EMC shall assist in hosting TECRO, through a long-term CWB modeling staff member to participate in the NGGPS operational testing and implementation activities, so that TECRO, through CWB can actively make contribution for this program. Through this collaboration, CWB could position its own development of a next generation global forecast system from NOAA's NGGPS knowledge and operational experience. AIT, through NCEP/EMC shall also support a joint annual NCEP-CWB global modeling workshop involving EMC scientists to exchange science and operational knowledge in the area of Global Forecast System (GFS) and Global Ensemble Forecast System (GEFS).

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

Resources Required: 10.84 % EMC/CWB

Deliverables and Schedule:

1. Facilitating and hosting long term (6 months or longer) CWB modeling staff to participate in NGGPS evaluation testing and implementation activity.	11/15/18
2. NCEP/EMC colleagues to visit CWB to attend NCEP-CWB annual workshop in the area of Global Forecast System (GFS) and Global Ensemble Forecast System (GEFS).	08/15/18
3. Facilitating CWB manager's short visiting EMC for project review meeting.	11/15/18

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 the CWB. The task for AIT, through NOAA/ESRL/GSD, in this area is the development of new tools that extend and enhance the forecast applications. Further AIT's interaction with TECRO, through NOAA/ESRL/GSD and CWB, respectively is critical to keep TECRO, through 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.

During IA #30, AIT, through NOAA/ESRL/GSD shall continue to provide updated versions and training to TECRO, through 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.

AIT, through NOAA/ESRL/GSD shall continue to provide the NOAAPORT data feed and data transmission support for CWB's data assimilation and forecasting purposes during IA #30. This continuing interaction task will benefit AIT and TECRO, through the activities of their designated representatives, NOAA and CWB, with the updated knowledge of the forecast assistant and decision making systems developed at NOAA including AWIPS II. Throughout the period of IA #30, AIT, through NOAA/ESRL/GSD shall provide necessary training and support to TECRO, through CWB's visitors and forecasters, and through the their designated representatives, continue the exchange of visits, provide necessary papers and reports, attend annual meetings, and continue e-mail interactions, as applicable.

During IA #30, GSD shall continue provide CWB MMC (Marine Meteorology Center) with technical support for CWB DART® (Deep-ocean Assessment Reporting of Tsunamis) buoys by Dr. Eddie Bernard, also coordinate DART site visit by CWB staff and/or CWB contractors. AIT, through GSD shall also coordinate a visit from MDL on NOAA storm surge training and a visit on NOAA ocean observation technology and strategy training.

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

Resources Required:	23.15 % GSD/HRC/MDL/CU/CWB
Deliverables and Schedule:	
1. AWIPS II training to CWB users	11/15/18
2. NOAAPORT data supply support	11/15/18
3. DART consultation and a site visit support	11/15/18
4. NHC Storm Surge training	08/30/18
5. Visitors and travel support	11/15/18

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Task #7 – Development of GOES-R Decision Support Products from Himawari-8

During IA #30, the Parties agree that AIT, through NOAA and pursuant to the NOAA Cooperative Agreement with the University of Wisconsin – Space Science and Engineering Center (SSEC) / Cooperative Institute for Meteorological Satellite Studies (CIMSS) shall continue research in support of satellite-based decision support products. CIMSS shall lead this task.

This task shall include hosting a CWB visitor to facilitate training and transfer of Himawari-8 decision support products from CIMSS to CWB. This includes the Advanced Dvorak Technique (ADT) software for estimating typhoon intensity. AIT, through NOAA and NOAA's relationship with CIMSS shall provide support for the ADT installation at CWB and case studies to validate performance of the software at CWB as compared to CIMSS. AIT, through NOAA and NOAA's relationship with CIMSS shall also make available the newly developed SST retrieval product through the CLAVR-x (Clouds from AVHRR Extended) processing system. AIT, through NOAA and NOAA's relationship with CIMSS shall work with TECRO, through designated representative, CWB to tune the SST product to Himawari-8/AHI and take advantage of the decreased Himarawi-8 processing time implemented this past year.

AIT, through NOAA and NOAA's relationship with CIMSS shall provide support for CWB RGB products, both in terms of recipes and compatibility tools for AWIPS2. AIT, through NOAA and NOAA's relationship with CIMSS shall also provide guidance on implementation of GOES-R (now GOES-16) color tables for RGB products. AIT, through NOAA and NOAA's relationship with CIMSS shall also develop tools for conversion of CLAVR-x output to AWIPS2-compatible formats.

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

Resources Required: 12.3 % NOAA/ESRL/GSD/CWB

Deliverables and Schedule:

1. Complete ADT implementation in MSC/CWB (Phase II) 11/15/18
   a. Validate automated 'first guess' typhoon eye location
   b. Integrate microwave measurements
2. Implementation of SST product at CWB 11/15/18
   a. Derive SST fit coefficients for Himawari-8/AHI domain using in situ data
   b. Upgrade CLAVR-x installation at CWB to include SST
3. Continue RGB and CLAVR-x product support 11/15/18
   a. Provide support for RGB product and color table implementation
   b. Develop tools to convert CLAVR-x

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output to AWIPS2-compatible format

c. Provide atmospheric corrections for AHI channels 1, 2, and 6

4. Technical and training support to CWB visitor 11/15/18

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3.0 - Schedule

Tasks	Functions	Milestones
1.	Development and Improvement of Satellite Products for Surface Radiation and Air Quality Monitoring and Prediction	11/15/18
2.	High-Resolution Quantitative Precipitation Estimation and Quantitative Precipitation Forecast (HRQ2) Applications Improvement	11/15/18
3.	Enhance Nowcasting Decision Assistance Tools	11/15/18
4.	Development of High-Resolution Product Generation Assistance Tools for AWIPS II	11/15/18
5.	Development of Next Generation Global to Regional Prediction System	11/15/18
6.	Continuing Interaction on Earlier Cooperative Projects	11/15/18
7.	Development of GOES-R decision support products from Himawari-8	11/15/18

Schedule by Month

Task 1 Satellite application	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Improve CRTM for Surface Solar Insolation Algorithm and Product development	x	x	x	x	x	x	x	x	x	x	x	
2. GOES-R ABI Aerosol Algorithms Applied to Himawari-8 AHI	x	x	x	x	x	x	x	x	x	x	x	

Task 2 HRQ2 (NSSL)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. C-band dual-pol radar QPE development and disdrometer data study	x	x	x	x	x	x	x	x	x	x	x	
2. Multi-parameter radar data quality control research and development	x	x	x	x	x	x	x	x	x	x	x	
3. Technical support for QPESUMS operations	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
1. Support Scan and FFMP migration to AWIPS II system	x	x	x	x	x	x	x	x	x	x	x	
2. Support VLab to CWB developers	x	x	x	x	x	x	x	x	x	x	x	
3. ANC System Technical Support	x	x	x	x	x	x	x	x	x	x	x	

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Task 4 High-resolution forecast product generation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Prepare and deliver updated versions of AWIPS II versions.	x	x	x	x	x	x	x	x	x	x	x	
2. Assist with installation and configuration	x	x	x	x	x	x	x	x	x	x	x	
3. Working in a shared development environment and continue to train AWIPS II developers.	x	x	x	x	x	x	x	x	x	x	x	
4. Provide CWB annotation support and training	x	x	x	x	x	x	x	x	x	x	x	
5. CentOS7 necessary updrade	x	x	x	x	x	x	x	x	x	x	x	

Task 5 Development of Next Generation Global to Regional Prediction System (EMC)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1. Facilitating and hosting short term (1.6 and 2.6 months) CWB modeling staff to participate in NGGPS evaluation testing and implementation activity.	x	x	x	x	x	x	x	x	x	x	x	
2. NCEP/EMC colleagues to visit CWB to attend NCEP-CWB annual workshop in the area of Global Forecast System (GFS) and Global Ensemble Forecast System (GEFS).	x	x	x	x	x	x	x	x				
3. Facilitating CWB manager's short visiting EMC for project review meeting.	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
1. AWIPS II training to CWB users	x	x	x	x	x	x	x	x	x	x	x	
2. NOAAPORT data supply support	x	x	x	x	x	x	x	x	x	x	x	
3. DART consultation and site visit support	x	x	x	x	x	x	x	x	x	x	x	
4. NHC Storm Surge training	x	x	x	x	x	x	x	x				
5. Visitors and travel support	x	x	x	x	x	x	x	x	x	x	x	

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Task 7 Development of GOES-R decision support products from Himawari-8	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
6. Complete ADT implementation in MSC/CWB (Phase II)	x	x	x	x	x	x	x	x	x	x	x	
7. Validate automated 'first guess' typhoon eye location	x	x	x	x	x	x	x	x	x	x	x	
8. Integrate microwave measurements	x	x	x	x	x	x	x	x	x	x	x	
9. Implementation of SST product at CWB	x	x	x	x	x	x	x	x	x	x	x	

4.0 - Budget

The following are the estimated costs for IA #30:

Tasks	Personnel	Travel/Training	Total
Task #1 (NESDIS/GSD)	$250,000	$35,000	$285,000
Task #2 (NSSL)	$250,000	$35,000	$285,000
Task #3 (MDL/GSD)	$280,000	$25,000	$305,000
Task #4 (GSD)	$200,000	$15,000	$215,000
Task #5 (NCEP/EMC)	$210,000	$10,000	$220,000
Task #6 (GSD)	$165,000	$0	$165,000
(HRC/MDL/CU)	$150,000	$20,000	$170,000
(CSU/GSD)	$130,000	$10,000	$140,000
Task #7 (CIMSS)	$250,000	$0	$250,000
Total	**$1,885,000**	**$150,000**	**$ 2,035,000**

As stated in IA #30, 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$ 2,035,000. US$ 1,650,000 will be provided by CWB, US$ 385,000 by the Water Resources Agency (WRA) and 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 TECRO, through CWB staff at NOAA during the IA #30 period shall be directed towards the satellite data, AWIPS II development tasks. The primary effort of TECRO, through CWB staff at NOAA/NCEP/CPC during the IA #30 period shall 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

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CWB staff members would be as follows:

- Surface Solar Insolation algorithm and product development;
- Enhancement of radar ingest process including decoding software;
- ANC verification package and new predictor(s);
- Development of GOES-R (H-8) algorithm in the area of SST and AMV (Atmospheric Motion Vectors);
- Localization of Decision Assistance Tool called SCAN (System for Convection Analysis and Nowcasting) under AWIPS II environment;
- Receiving training at CPC International Monsoon Desk;
- NGGPS modeling testing and implementation activity.