IMPLEMENTING ARRANGEMENT REGARDING INSAT-3D SATELLITE DATA (IA-3D)

Technical and scientific cooperation related to INSAT-3D satellite data applications between the Ministry of Earth Sciences (MoES)/ India Meteorological Department (IMD), Government of India and the National Oceanic and Atmospheric Administration (NOAA)/National Environmental Satellite, Data, and Information Service (NESDIS).

This text constitutes an Implementing Arrangement (hereinafter, "IA-3D") under Article IV of the Memorandum of Understanding (MOU) for Technical Cooperation in Earth Observations and Earth Sciences between the National Oceanic and Atmospheric Administration of the United States of America and the Ministry of Earth Sciences of the Republic of India (MoES MOU), signed 16th April 2008, and therefore is to be interpreted consistently with the terms of the MOU.

I. Purpose

The IA-3D provides a framework for collaboration between the Ministry of Earth Sciences (MoES) of the Republic of India and the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce of the United States of America (hereinafter, "the Participants") concerning the provision of technical and scientific co-operation related to INSAT-3D satellite data applications. While intended to serve as a vehicle for continuing collaboration, it is being implemented for an initial five-year period.

II. Background/Objectives

NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) has successfully collaborated with MoES' India Meteorological Department (IMD) on the exchange of INSAT satellite data and publicly available U.S. Earth observations. The establishment of the Indo-U.S. Data Centre at IMD has further enabled scientists to access data from India's Kalpana and INSAT satellites as well as U.S. Earth observation data and information. These two developments have led to a variety of scientific application of satellite data in India and the U.S. The United States wishes to expand this collaboration to include INSAT-3D Imager and Sounder data when the satellite is launched in 2010. A key area of scientific collaboration will be with respect to the development of scientific algorithms and programs to retrieve various products from INSAT-3D that can enhance environmental monitoring and predictions. Specific products in which IMD is interested include rainfall, sea surface temperature, clouds classification, cloud motion vectors (visible and infrared) and water vapor winds, algorithm of vertical profiles of temperature, humidity and ozone, development of objective

techniques for estimation of intensity, and position of tropical cyclones and assimilation of satellite data in global and regional Numerical Weather Prediction (NWP) models. NESDIS interests include rainfall, aerosols, vegetation health, sea surface temperature, clouds, and winds.

India Meteorological Department under the Government of India has a mandate of providing weather forecasts to the Indian region, and NOAA Scientists are the most experienced in product derivation from Geostationary Operational Environmental Satellites (GOES), which are similar to INSAT-3D. Therefore the algorithm of products derivation from GOES will be suitable after fine-tuning for the Indian region. As is known, the algorithm of a product can be finalized only after the suitable validation of a product over a period of a few years and therefore constant modification in source programs will be required. The algorithms, along with the source programs, provided by NOAA (for easy implementation in generating the product) will result in quick delivery of products from INSAT-3D that can be made operational. Once INSAT-3D is launched, the algorithms will be run on test sample datasets to derive products. Testing of the products by NOAA and IMD using *in situ* data is expected to provide diagnostic understanding on the performance of the algorithms and their limitations. Further collaboration is envisioned in constant updating of research and derivation of products from future similar satellites.

III. Area of Cooperative Activities

Given below are some specific projects that will use GOES and INSAT-3D data and for which IMD has interest for collaborating with NOAA:

- Subject to U.S. export control laws
- Evaluating/improving and transfer of algorithms and software programs for satellite-based precipitation estimates using INSAT-3D satellite data over India
- Development/transfer of a precise Sea Surface Temperature (SST) retrieval algorithm and software programs for Indian Geostationary Satellites
- Development/transfer of algorithm and software programs for derivation of cloud motion vectors (infrared and visible) and water vapor winds using INSAT-3D Imager data
- Development/transfer of algorithms and software programs to estimate vertical profiles of temperature, humidity, and ozone using INSAT-3D Sounder data
- Development of Objective Dvorak Technique for estimation of intensity and position of tropical cyclones using Indian Geostationary satellite data and its implementation at IMD
- Development of assimilation techniques of INSAT-3D data in global and regional models and its implementation at IMD

- Research and development projects, including the exchange of their research work as well as visits of scientists, specialists, and researchers
- Exchange or sharing of scientific, technological information, and documentation through scientific conferences, symposia, and workshops
- Other forms of scientific and technical cooperation as may be mutually agreed

IV. Coordination of Joint Activities

Overall coordination of joint activities is to be accomplished by the NESDIS International and Interagency Affairs Office and the Satellite Division of IMD/Program Office of the Ministry of Earth Sciences.

V. Responsibilities of the Participants

a. NOAA intends to do the following, subject to the availability of appropriated funds and personnel:

- Provide NOAA GOES versions of scientific algorithms and programs for operational implementation at IMD. These include source programs for rainfall estimation, sea surface temperature retrieval, vegetation index retrieval, clouds classification, cloud motion vector (visible and infrared), and water vapor winds. Principal Investigators (PIs) of both sides will be identified during the first meeting of IMD – NOAA Scientists and will be responsible for suitable adaptation of GOES algorithms for INSAT-3D.
- Obtain *in situ* data from IMD to validate INSAT-3D products.
- Host meetings/scientists to discuss progress. Annual Indo-US Workshops on Algorithm Development/Validation/Satellite Data Applications may be held through mutual consultations.

b. Ministry of Earth Sciences intends to:

- Provide operational, processed, and navigated/calibrated INSAT-3D data to NOAA/NESDIS through a reliable file transfer protocol, in accordance with applicable guidance.
- Provide *in situ* data of all measurable parameters related to projects highlighted in section III offline for validation work.
- Adapt NOAA GOES algorithms to INSAT-3D to generate products
- Work with NOAA/NESDIS Principal Investigators (PIs) in inter-comparing products and future enhancement of algorithms and programs.
- Coordinate with the Indian Space Research Organisation (ISRO) as needed.

- Host meetings/seminars to discuss progress. Annual Indo-US Workshops on Algorithm Development/Validation/Satellite Data Applications may be held through mutual consultations.

c. The Participants intend to:

- Commit resources and manpower as needed
- Meet periodically to discuss progress
- Participate in scientific conferences and present material related to the joint efforts in order to gain visibility and data users
- Work jointly on the calibration activities for the INSAT-3D

The Participants are to be responsible for coordinating and engaging with other organizational entities in their own countries, as appropriate and necessary, for the completion of the task designated pursuant to IA-3D. There is to be no exchange of funds between the Participants unless otherwise agreed. The responsibilities of the Participants described in this IA are not legally binding and are subject to the availability of appropriated funds and personnel and are to be carried out in accordance with the respective laws and regulations of each Participant's country.

d. The working level contacts for IA-3D are:

For India

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VI. Amendments, Suspension and Termination of IA-3D

This IA shall enter into force upon the date of final signature and shall remain in force for five (5) years but may be amended or extended at any time by mutual written consent of the Parties. The Parties intend to review this Implementing Arrangement at least once a year to determine whether

it should be modified or discontinued. Either Participant may discontinue IA-3D and should provide 60 days written notice to the other Participant. In the event IA-3D is discontinued, each Participant is to be solely responsible for the payment of any expenses it has incurred.

Done in two originals each in English and Hindi. In case of any divergence in interpretation the English text shall prevail.

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