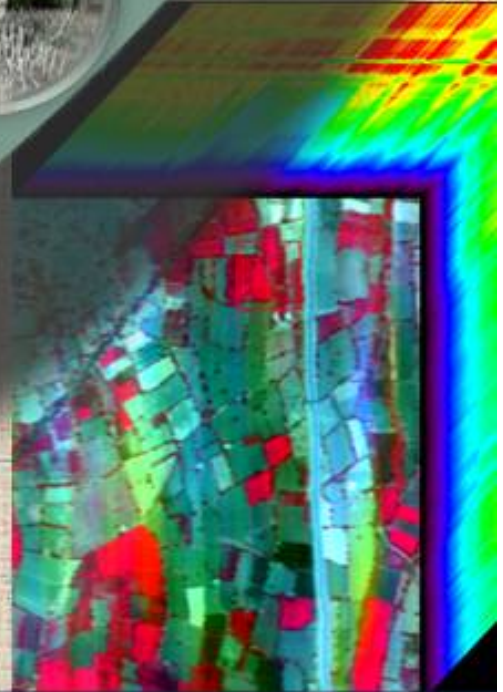
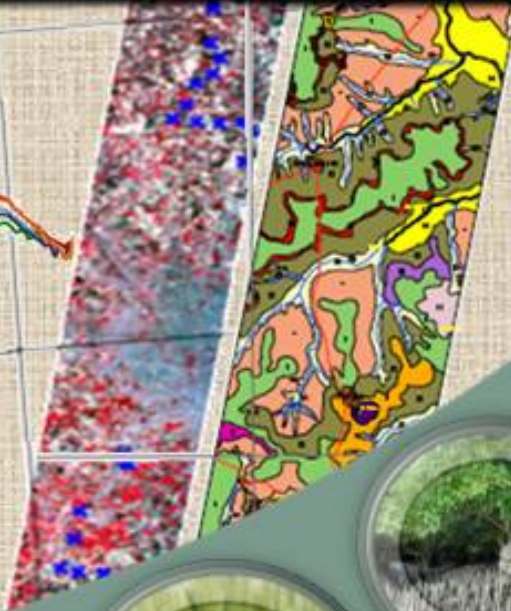
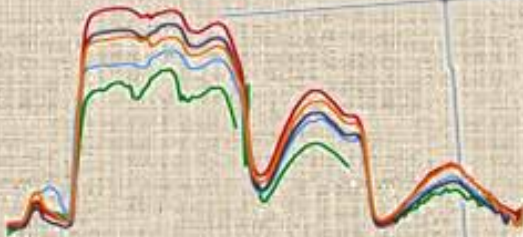




Announcement of Opportunity (Hyper-AO) Airborne Hyperspectral Mission – Science & Applications



**Space Applications Centre
Indian Space Research Organisation
Ahmedabad 380 015
June, 2015**



1.0 DESCRIPTION OF THE OPPORTUNITY

1.1 Airborne Hyperspectral Mission – Science Data Utilization Plan AO

Space Applications Centre (SAC), Indian Space Research Organisation (ISRO), Department of Space (DOS), Government of India, declares an “Announcement of Opportunity (AO)” to carry out scientific research for the utilisation of science data to be acquired from Airborne flights of Hyperspectral sensor called AVIRIS Next Generation (NG) over India in collaboration with Jet Propulsion Laboratory (JPL), NASA. The AVIRIS flights over Indian sub-continent have been planned during October – November and January - February, 2015. Presently, this AO is targeted towards utilizing the data to be acquired from AVIRIS NG flights.

The AVIRIS-NG can take observations over a continuous electromagnetic spectrum spread over 380 – 2510 nm at 5 nm band interval. This is capable of providing hyperspectral observations at 6 m pixel resolution over a flight swath of 6 km when the flight altitude is about 6 – 7 km. In the past, ISRO has developed and launched hyperspectral satellite sensor such as HySI in Indian Mini Satellite 1 (IMS-1) mission and Chandrayan-1 mission. In the past ISRO has carried out hyperspectral applications using ground, airborne and spaceborne sensors in various fields. Department of Science and Technology (DST), Govt. of India also set up a committee that supports the hyperspectral studies.

The major objectives of ISRO - JPL AVIRIS-NG Collaborative Efforts :

- This effort will bring together important talents of both NASA and ISRO to address unique and urgent Earth remote measurement set of science and application research
- The collaboration will provide opportunity for joint development of science models, algorithms, atmospheric corrections and can open up new avenues.
- JPL and SAC has expertise in instrumentation and applications and this will lead to sharing of scientific knowledge
- Airborne campaigns will provide the required precursor ground truth data and science and application research demonstrations for present and future ISRO space imaging spectrometer missions.

Indian researchers are actively engaged in making use of the potential of hyperspectral data since late 90's in various fields of applications such as agriculture, forestry, coastal studies, snow and glaciers and geological exploration. Indian Academy of Science, Bangalore has come up with a set of review articles in a special section on hyperspectral remote sensing in India, which was published recently in the March, 2015 issue of the

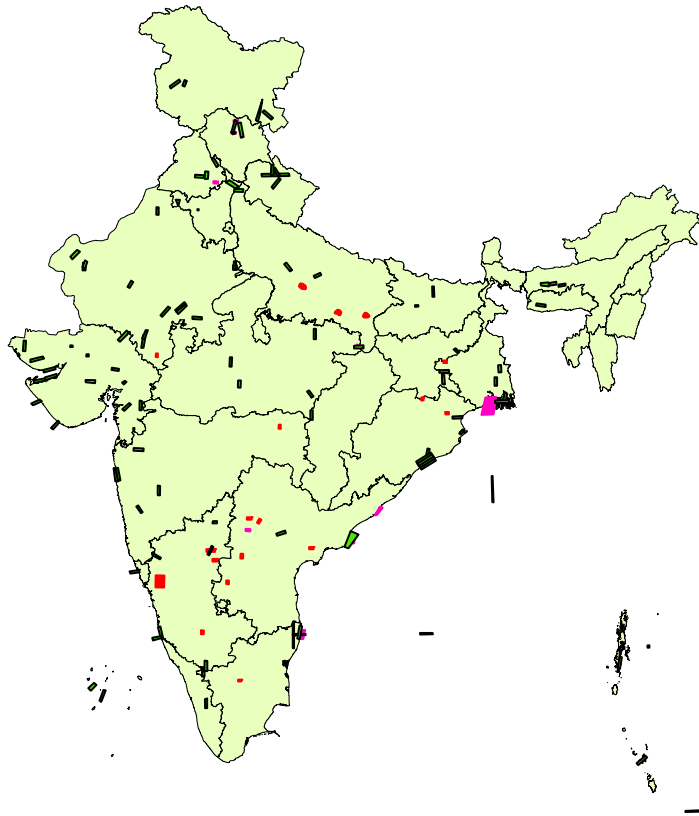
journal “Current Science”. Also, Space Applications Centre (SAC), ISRO, Ahmedabad has published a book entitled “Investigations on Hyperspectral Applications” comprising a collection of papers and reports on the work carried out under EOAM project. The studies encompass groundbased, airborne and space based data exploration, pre processing, classification and tools development for hyperspectral analysis. The spectral signature bank for different vegetation species and prototype spectral library was also created and PROSAIL Model Inversion techniques were also evaluated. Some of the details were crop disease diagnosis in mustard, forest species discrimination and biochemical parameter retrieval, mangrove species identification and discrimination, wetland ecosystem assessment, underwater radiometer based analysis of coastal and open ocean waters, phytoplankton function types and species identification, water quality evaluation and eutrophication, mineral studies etc. The effects of soil and coal contamination and grain size on the snow reflectance were studied. Continuous field-based spectral measurements were conducted in the Himalayan cryosphere which are useful to develop new algorithms for retrieving various snow and glacier parameters. A spectral cataloguing of the rocks and minerals associated with the mineralogical provinces and Precambrian terrain of eastern and northern Gujarat has also been prepared. The spectral characterization of Martian analogues was also carried out.

This Announcement of Opportunity (AO) is open to national scientific community for submitting research proposals towards utilisation of data from AVIRIS-NG Flights over India in the following broad categories:

- Agriculture and Ecosystems
- Mineral resource Mapping & Geochemistry
- Coastal, Ocean & Atmosphere
- Rivers and Water Quality
- Urban and Cities
- Snow and Ice Hydrology

There will be about 100 sites over which flights will be carried out. The tentative distribution of sites are given below :

Proposed sites for AVIRIS-NG Flights



Science Objectives:

- To explore and develop hyperspectral techniques and tools for various terrestrial and marine ecosystems applications.
- To develop, test and validate algorithms for surface physical, chemical and biochemical properties with respect to land and ocean and atmosphere.
- To develop scaling functions for process studies using hyperspectral spectra with *in situ* measurements
- To develop hyperspectral input ingestion/assimilation techniques into process models.

AOs to institutes with infrastructure for analysis without financial commitments would be given first preference. It may be noted that few selected project proposals through this AO will be provided restricted financial support towards meeting the field data collection and research support, and limited travel to attend Project meeting and workshops in India, not exceeding more than Rs. 6.00 lakhs per year. The project duration will be for a maximum period of three years. Principal Investigators (PI) will also be provided access

to relevant airborne hyperspectral datasets free of cost depending upon the availability.

1.2 Who can submit a Proposal?

Proposals could be submitted by individuals or a group of scientists, academicians and research scholars belonging/affiliated to recognized institutions, universities and government organisations of India. The proposals must be forwarded through the Head of the Institution, with appropriate assurance for providing necessary facilities for carrying out the AO projects.

2.0 OVERVIEW OF AVIRIS-NG

Next Generation Airborne Visible/Infrared Imaging Spectrometer (AVRIS – NG) has been developed by JPL (NASA) and has been used for various airborne missions. The advanced AVIRIS instrument, i.e., AVIRIS-NG uses most advanced state-of-the-art detector array and grating for dispersion of light. Most importantly, the blazing and grooving technique employed in the grating of AVIRIS-NG could successfully maintain the spectral as well as spatial uniformity, thus completely removing the SMILE and KEYSTONE effects that used to be the integral part of all the earlier hyperspectral instruments.

Table 1: Specifications of AVIRIS – NG

Sr No	PARAMETER	Specifications
Spectral performance		
1	Range	380 to 2510 nm
2	Position	5 nm
3	Response	1 to 1.5 X sampling
4	Calibration	+/-0.1 nm
Radiometric performance		
1	Range	0 to specified saturation radiance
2	SNR	>2000 @ 600 nm >1000 @ 2200 nm
Spatial performance		
1	FOV	34 deg
2	IIFOV	1 mrad
3	Response	1 to 1.5 X sampling
Others		
1	Data storage	1 TB
2	IMU & GPS	Included, GPS antenna required
3	Display & Analysis	Real-time, streaming
4	Environmental control	Cryogenic instrument, needs power 24/7

3.0 DATA AVAILABILITY

Data will be made available to the selected Principal Investigators (PIs) from the SAC-POC (Payload Operation Centre) and Indian Space Science Data Centre (ISSDC), Bangalore. The datasets required for executing the AO projects would be provided after evaluation of the project proposal. The term “data” refers to the data products produced and archived at the data processing facility at Space Applications Centre, (ISRO), Ahmedabad and distributed.

4.0 EVALUATION OF PROPOSALS

This Announcement of Opportunity (AO) for potential Principal Investigators is aimed towards stimulating newer and extensive research, development and applications in the field of hyperspectral remote sensing under various themes elaborated in section 1.1. Towards this, the proposals received in response to this AO will be evaluated considering primarily the scientific/technical merits. The principal elements considered in selecting the proposals, among other things, would be:

- The overall, scientific or technical merit of the proposal, uniqueness and innovative methods, approaches or concepts planned to be demonstrated.
- Potential for contributing to innovative science by making synergistic use of airborne hyperspectral data with other Indian satellite data.
- The competence and relevant experience of the PIs and / or co-investigators and infrastructure for achieving the proposed objectives.
-

It is generally not envisaged to select multiple projects addressing the same geographical area or science theme or multiple proposals from the same institution.

5.0 SPECIFIC AREAS OF INTEREST

Proposals are invited in the following areas of interest for utilisation AVIRIS-NG data in the following specific areas:

5.1 AGRICULTURE & ECOSYSTEMS

5.1.1 Agriculture & Soils

- Species/variety composition (e.g. Basmati vs other rice crop, Bunching crop spreading crop of groundnut) discrimination
- Vegetation or crop type (e.g., pulse crop vs. cereal crop) discrimination
- Crop stage discrimination (vegetative vs reproductive)

- Biophysical properties (e.g., LAI, biomass, yield, density) studies
- Biochemical properties (e.g, Anthocyanins, Carotenoids, Chlorophyll) assessment
- Disease and stress (e.g., insect infestation, drought) assessment
- Nutrients (e.g., Nitrogen) stress assessment
- Moisture (e.g., leaf moisture) stress studies
- Light use efficiency studies
- Net primary productivity studies
- Crop residue studies
- Soil fertility (organic carbon, nitrogen) status assessment
- Soil variability mapping
- Discrimination of horticultural crops, Spectral library

Study sites: Haryana, Gujarat, Karnataka, IARI, West Bengal, UP, Bihar, Assam, Maharashtra

5.1.2 Wetland Ecosystems

- Physical water quality parameters such as transparency, turbidity, suspended sediment concentration.
- Biological characteristics like chlorophyll concentration.
- Vegetation type/species and density discrimination.

A new avenue for research to detect the chemical water quality parameters especially that enhance the eutrophication and detect pollutants.

Study Site: Chilika lake, Orissa

5.1.3 Mangrove Ecosystems

- Discrimination of mangroves at genus/ species level and mapping of floristic composition of mangrove forests
- Discerning wet soils (mudflats) of different inundation levels within mangrove ecosystems
- Assessment of carbon dynamics/ physiological status of mangrove forests
- Mangrove forest health

Study site: Chilka lake, Orissa, Bhitarkanika, Odisha, Pichavaram Mangrove Forest (TN)

5.1.4 Coral Reef Ecosystems

- Mapping of Submerged Macrophytes/Macroalgae in a coral reef environment
- Habitat discrimination into bethic and litho-substrate zones
- Water column characterization and depth estimation

Study site: BuralChank, Gulf of Kutch

5.1.5 Forest Ecosystem

- Species / Community level mapping of forests
- Identification of physiologically quantitative vegetation stresses
- Development of fuel moisture index for fire risk modeling
- Quantification of foliar biochemistry and fluxes
- Understanding flowering phenology, and Development of Plant Functional Types

Study sites: Central India –Kanha MP, Valley of flowers National Park, Kaas plateau (Satara, Maharashtra), Tungnath (Rudraprayag district), Zukertang (Gulmarg location), Yellapur, Uttarakannada, Karnataka, Gujarat, Tamil Nadu, Himachal Pradesh.

5.2 MINERAL EXPLORATION

Goal: Identification of mineral prognostic zones for base metals & bauxite deposits using imaging spectroscopy measurements

- Evaluation of the potentials of spectral data in discriminating surface minerals/rock types having diagnostic spectral features.
- To understand effect of weathering and soil on the spectral behavior of different rock types.
- Upgradation of existing geological map using imaging spectroscopy measurements.
- Utilization of spectral and other remote sensing data for identifying guides for mineral exploration, such as, lithological, structural, geomorphological, stratigraphical, geobotanical etc. and correlation of these guides for identification of mineral prognostic zones.
- Mapping mineral resources, surface geochemistry, hydro-thermal diagnostics and potential.

Study sites:

Jahazpur region (Parts of Tonk, Bundi, Ajmer and Bhilwara districts), Rajasthan

Western and South-Western Parts of Bhuj district, Gujarat.

Area around Zawar mines (Mochia, Ballaria, Zawarmala & Baroi, Parts of Udaipur district, Rajasthan).

Dariba-Rajpura-Bethumni Region (Parts of Rajsamand and Chittaurgarh districts), Rajasthan.

Ambaji, Banaskantha district, Gujarat

Pur-Banera Region (Parts of Bhilwara district), Rajasthan.

Bhukia, Sakoli. Baula, NOTAPAHAR, Singhbhum, Sukinda, Khatangabeku, Hutti-Maski Schist Belt, Wajrakarur AP, Kiriburu, Jharkhand, Ladakh.

Udaipur

5.3 SNOW AND GLACIER

- To understand spectral characteristics of snow in different Himalayan environments.
- To develop techniques to retrieve the snow grain size and their rate of growth.

- To understand spatial and temporal variability of grain size at different latitude and altitudes.
- To develop techniques to estimate snow density
- To improve automated methods of snow type mapping
- To understand role of snow pack characteristics on albedo estimates
- To understand role of snow pack characteristics on snow melt estimates
- To assess the feasibility of deriving lake ice & snow properties using data acquired by ISRO-JPL airborne imaging spectrometer mission.

Study Area: snow & glacier : Dhundi & Patsio, Chhota sigri & Samudra tapu, H.P, Gangotri, UK

Study Area: Lake ice: Tso Moriri, J&K (Ladakh), Bhrigu Lake, Himanchal Pradesh, Kedar Tal, Uttarakhand

5.4 COASTAL / OCEANOGRAPHIC & ATMOSPHERIC APPLICATIONS

A) Physical Oceanography

- Estimation of bathymetry in clear waters
- Identification of coastal fronts & sub-mesoscale features in littoral zones (or coastal waters)

Study sites: North BoB, East BoB, East equatorial Indian Ocean (EEIO)

B) Biological Oceanography

- Inherent optical properties (absorption, backscattering) and composition (chlorophyll –a , suspended sediments, CDOM) of coastal oceans
- Phytoplankton community structure through phytoplankton size classes and pigment composition
- Detection of harmful algal bloom, other blooms such as Trichodesmium
- Dissolved organic matter flux
- Identification of absorbing aerosols
- Phytoplankton physiology through chlorophyll fluorescence and absorption
- Bathymetry, bottom characterisation and benthic habitat mapping
- Bio-optical characterisation of Chilka lake

Study sites:

Coastal –offshore waters off Veraval and Porbandar region of Gujarat (Jan- March)

Coastal –offshore waters off Goa (March-April)

Coastal –offshore waters off Krishna-Godavari Basin (October-December)

Chilka Lake (October-December)

Coastal –offshore waters off Mangalore/Karwar (October-December, April- May)

vi. Lagoon area Off Bangaram, Agatti and Kavaratti (January -March)

C. CRZ Studies

- Understanding spectral signatures of various coastal land cover and landform classes
- Understanding spectral signatures of various nearshore water quality parameters such as pollutants/sewage/oil slicks etc. within CRZ classes as per 2011 Notification.
- Improving discrimination and classification accuracy of above mentioned features related to CRZ.
- Improving HTL/LTL discrimination

Study Area:

Gulf of Kachchh in Gujarat

Chilika lagoon and environs, Odisha

Coringa creek, Kakinada coast of Andhra Pradesh

Selected Coastal Metropolitan cities Mumbai,/Chennai

South Karnataka coast around Mangalore region

Parts of Lakshadweep and A&N islands

D. Atmosphere

- Cloud microphysical parameters
- Aerosol properties
- Water vapour concentration
- Surface/ cloud top pressure derived from O₂ absorption band

Study Area: North BoB, East BoB, East equatorial Indian Ocean (EEIO (Upto a height of 17 kms)

5.5 URBAN AND CITIES

- To characterize urban land cover material composition and building roof types using airborne spectral data.
- To characterize impervious/pervious land cover types in urban areas.

Study Area: Ahmedabad, Jodhpur, Srinagar, Lucknow, Kolkata, Bangalore

5.6 Calibration of aircraft and satellite sensors

- The vicarious calibration of airborne sensor has challenge in modelling the radiative transfer code below the layer of 2Km where at atmosphere is heterogeneous while compared to the satellite sensor altitude.
- An hybrid approach of reflectance based method along with spectra measured with the ASD (Analytical Spectral Device) field spectrometer, radiative transfer model will be used to simulate radiance and reflectance spectra at aircraft level for multiple theoretical geometry (the uncertainty of the reflectance based methods can reach upto 2.5%).

- The main restriction with the reflectance-based method is the state of the atmosphere.
- It requires knowledge about the atmospheric transmission, the vertical column profiles of water vapor, pressure, temperature, the total column ozone, and aerosol asymmetry as well as the size distribution.
- During the field campaign (areal survey) ASD, CIMEL sun photometer, MicroTop-II sun photometer and ozonometer will be used for the modeling purpose.
- This acquired low-altitude spectral data sets along with other mentioned ancillary measurement will be used to produce benchmark data sets in the spectral bands and thus will be used to define the future space borne spectral instruments

Study area: Little Rann, Desalpar site, Hyderabad (Shadnagar) Ground-based

The above-mentioned topics are only indicative and PIs are free to suggest other potential topics of direct relevance. The proposals can also be a combination of several of those areas mentioned in the topics of interest. It may also happen that only a portion of the proposal is accepted, in which case, the PI will be given the opportunity to accept/modify or decline such partial acceptance.

6.0 GUIDELINES FOR PROPOSAL PREPARATION

The potential PI should submit the proposal in a format described in the following sections. The format for the cover page is given in *Annexure - 4*. The format for the detailed proposal is given in *Annexure - 5*.

The format for proposal includes a Declaration to be signed by the Principal Investigator and the Head of the Institution.

6.1 Instructions for Submitting a Proposal

Proposals should be limited to around 10 pages in length on standard A4 size paper, typed double-spaced and in the prescribed format. Two copies of the proposal prepared in the formats given in **Annexure I, II and III** should be mailed to:

[Nodal person at SAC for AO]
Space Applications Centre
Indian Space Research Organisation
Jodhpur-Tekra Ambawadi Vistar P. O.
Ahmedabad - 380 015, India
Telephone : +91 - 79 – 2691 ;
Fax : +91 - 79 – 2691 ;
E-mail : @sac.isro.gov.in

6.2 Description of the Proposal

The main part of the proposal should contain a summary (briefing the objectives, methodology, deliverables of the project and the time schedule), followed by a detailed description of the objectives and the scientific rationale being addressed. The data requirement and the analysis methods should be highlighted. The methodology or approach to be followed, the expected results of the project must be presented. Targeted schedule for various stages of the project must be indicated including the completion date. Criteria for assessing the success of the project should be projected. The data requirements (including collateral data and field observations) particularly that call for large quantum of data should be justified.

6.2.1 Project Duration

It is expected that the project will be completed within maximum 3 years. Projects will be evaluated and shortlisted by **September 30, 2015**. PIs are expected to present the plan and results in a pre and post launch workshops. **PIs would be encouraged to publish the findings from these studies in national/international peer reviewed journals subject to approval from SAC.**

6.2.2 Data Requirements

As described in section 6.2, the proposal should identify hyperspectral bands, band region either radiance or reflectances or indices for the study. **Space Applications Centre (SAC) Data Centre situated at Ahmedabad, India will make the hyperspectral data available to the PIs.** The project should clearly indicate the type of data product, tentative geographical area of interest. Details of coverage of actual flights and data availability will be circulated to PIs. **These data sets can also be downloaded from ISSDC, Bangalore. The data access and publication may be as per the data distribution and publication policy of SAC/ISRO or government policy that would be in force from time to time.**

[N.B: Data products from AVIRIS-NG airborne flights would be made available in the Standard data products such as:

Level 1: Radiometrically corrected and geometrically mapped radiance products in VNIR and SWIR regions.

Level 2: Top-Of-Atmosphere (TOA) reflectances in all the VNIR and SWIR band regions]

6.2.3 Personnel

The project may involve joint efforts involving many individuals from the concerned institution(s). However, only one PI will be recognized. Other participants could be designated as "Co-Investigators". PI/Co-Investigator shall provide Curriculum Vitae

referring to educational qualifications, the work carried out in the related areas and list of recent publications. The PI is responsible for ensuring timely completion of the project. The assurance of necessary administrative and financial spending support to PI and Co-Investigators from Head of the Institution(s) is a must. In case of additional technical expertise, if needed, from ISRO/SAC, must be made at the time of the proposal submission.

6.2.4 Facilities and Equipment

Describe available computer facilities, image analysis software packages, field and laboratory equipments in the home institution or in sister concerns that are accessible for the project.

6.2.5 Project Evaluation

It is proposed that a workshop will be conducted at the end of every year for the purpose of reviewing the progress of the AO projects and sharing the results with scientific community. PIs of each project are expected to attend these workshops and brief about the progress of the respective project. The expert committee would evaluate the progress of AO project and would recommend for continuation.

7.0 TERMS AND CONDITIONS

- SAC/ISRO reserves the right to revoke in part or in whole its support for a project at any time without assigning any reason.
- The data sets provided must be used only for the purpose specified in the proposal. The project personnel do not have the right to copy, lease or loan the satellite data without the prior permission of ISRO/DOS. Ownership and copyright of the data lies with ISRO. Also, these data are supplied free of cost purely for scientific research and it should not be used for any commercial purposes. Commercial use is defined as that involving the sale or resale of data, as well as data derived there from, for more than the cost of reproduction.
- The user will make available to the scientific community the salient results of the AO projects through publication in appropriate journals or other established channels. Acknowledgement of SAC/ISRO support must be made in all reports and publications arising out of the AO projects. Copies of all publications resulting from these research projects must be submitted to SAC/ISRO. SAC/ISRO reserves the right to use the published results in its reports and publications with due reference to the publication.

- An exclusive web-based portal has been planned for data archival/dissemination. The PIs should submit field data and analysed outputs/algorithms/tools for hosting on this website.
- The PI is required to submit six-monthly progress reports during the duration of the project. A detailed report is to be submitted during the mid-term and final reviews in soft copy form.
- The PI must maintain an inventory of data products received / obtained under the AO project(s) and the data products must be deposited with the home institution after the end of the project.
- The PIs/Institutes receiving funds for hyperspectral project under DST or others funding agencies would be given hyperspectral data but funding may not be supported through AO.
- The time of release of funds would be decided by SAC/ISRO. ISRO does not guarantee the availability of airborne hyperspectral data if not collected due to policy decisions.

The declaration contained in the proposal format must be signed by the PI and Head of the Institution (Annexure 6). Otherwise the proposal will not be considered valid and is liable to be rejected.

8.0 SCHEDULE

Deadline for submission of proposals	August 30, 2015
Evaluation of proposal	September 30, 2015
Notification of evaluation results to Principal Investigators	October, 10, 2015

Cover Page of the Proposal

Title of the Proposal

Name and Designation of PI:

Telephone, Fax and E-mail Address:

Name of Institution with full Address:

Signature of PI with Date

Signature of Head of Institution

Announcement of Opportunity (AO) proposal
Submitted to Space Applications Centre (ISRO) on -----

Format of the Proposal

1. Title of the Proposal:
2. Name of the Principal Investigator:

Institution;
Telephone:
Fax:
E-mail:
Mailing Address:
3. Summary of the proposed work
4. Details on the preliminary work done/background experience, if any
5. List of Publications in the related field
6. Past/Ongoing Hyperspectral Project(s), if any. If yes, period and source and amount of funding
7. Description of the project
 - Theme
 - Objectives
 - Study area (latitude/ longitude)
 - Type of data products required (season(s), periodicity and number)
 - Methodology
 - Schedule
 - Expected results and its possible applications
8. Name of Co-investigator(s) in the AO project (please include bio-data of all Investigators)
9. Available facilities and equipment (field, laboratory) at your institution

Format for Declaration

Declaration

We have carefully read the terms and conditions of Airborne Hyperspectral Mission Science Data Utilization Plan AO programme and agree to abide by them.

It is certified that if the AO proposal is accepted and supported by the Space Applications Centre, Indian Space Research Organisation (ISRO), the facilities as identified in the proposal and administrative support available at our institute and needed to execute the project will be extended to the Principal Investigator and other Co-investigators.

We certify that the data products provided would be used only for the intended AO project.

It is agreed that data products will be returned to ISRO in case the AO project does not progress / completed as scheduled.

Signature of PI with Name and Designation

Signature of Head of Institution with Name and Designation

Date:

Seal of Head of Institution

List of Abbreviations

- AO - Announcement of Opportunity
- DOS - Department of Space
- SAC – Space Applications Centre
- ISRO - Indian Space Research Organisation