

DIS
Monitoring of Environmental Change
Data and Information System

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1. Introduction

To implement the objectives of IGBP, quantitative evaluation of changes in natural environment of the Earth through continuous monitoring is one of the first priority themes. Thus Monitoring of Environmental Change was adopted as Project V of Japanese IGBP by the National Committee /1/. In Project V following themes have been identified as appropriate.

(1) Satellite data processing and analysis, (2) Data and information management systems, (3) Monitoring of broad area vegetation and landuse, (4) Monitoring of soil moisture, snow and ice and (5) Monitoring of marine primary productivity. In this project an emphasis is put on application of satellite data.

Although it is a little differently structured, from that of ICSU-DIS the objective is same as that of IGBP-DIS, e.g. to secure relevant data to implement IGBP objectives. In monsoon Asia, Japanese target area for intensive study the data are not necessarily well archived to satisfy the requirements for researches of IGBP /2/. Not a few countries in the area prohibit public uses of detailed maps and some geophysical data and one must break through complicated procedures to establish necessary monitoring stations or to bring in some observing instruments. In satellite data application there are a few problems, one of them is lack of information on the available data and the other is the expense. The information on sensor characteristics and calibration are not well documented especially in case of the so called remote sensing satellites. To get high resolution satellite image data the problem of expense is serious for instance covering China only with Landsat data requires about 537 scenes thus to cover the whole monsoon Asia once a year costs more than \$5 million (US). If we try to collect data at least one for each season the cost becomes enormous. To rectify distortions in the data the expense and time would be enormous too. In view of the fact that the research themes of IGBP is interdisciplinary it is beneficial to set up a data and management system so that the data and the result of the research can be shared for mutual benefit in respective research group. This was a main reason why "Satellite Data Processing and Analysis" and "Data and Information Management System" were identified as separate themes. Although it is not funded under the title of Project V, some activities related with the project have been made which will be described in the following sections.

2. Some Activities Related with Satellite Data in Japan

2.1 GMS (Geostationary Meteorological Satellite) data set by MSC (Meteorological Satellite Center, JMA)

The data of NOAA and GMS have been received and processed at Meteorological Satellite Center, JMA (Japan Meteorological Agency). The data on cloud motion, the height of cloud top, and amount of clouds, sea surface temperature and outgoing longwave radiation have been extracted and archived since March 1981 in Meteorological Satellite Center of JMA. There is a plan to make a data set on solar irradiance and snow distribution.

2.2 Data set by NASDA (National Space Development Agency of Japan)

NASDA started direct reception of Landsat data in 1979 and now receiving the data of MOS-1 and JERS-1 routinely. A part of SPOT and ERS-1 data are also received under agreement with respective responsible organizations. All the received data are archived in EOC (Earth Observation Center, NASDA). As the activities of ISY, NASDA is making the data sets of the sea surface temperature distribution around Japan and Thailand and the sea ice distribution in the Okhotsk Sea and the Antarctic Ocean. EOC is planning to produce various useful data sets for the study of global change.

3. Calibration and Extraction of Physical Parameters

To obtain subtle changes in the global environment which is one order of magnitude smaller than daily change, exact calibration of the sensors and in some research fields elimination of atmospheric effects are essential. Since 1988 processing of multiple satellite data has been one of the key subjects of study in COSPAR, an organization of ICSU families and a problem of calibration and intercalibration of different sensors will be added as the subject of an intensive study from the next meeting of COSPAR. Great efforts have been continued in various space organizations and remote sensing communities to solve the problems. In this regard cooperation of space agencies is indispensable as can be seen in the following examples.

Fig. 1 indicates the difference of the digital counts (correspond to reflected radiance) of each band of Landsat-3 MSS processed at EOC NASDA and NASA/EDC under a system correction level. The ordinate indicates a difference between the values of digital counts recorded on CCT's processed at EOC NASDA and NASA/EDC: (the average digital counts of specified small areas processed at EOC) - (those processed at NASA/EDC).

Although the absolute value is small, there is a small difference due to differences in methods of utilizing calibration lamp data and eliminating stripes in the image data.

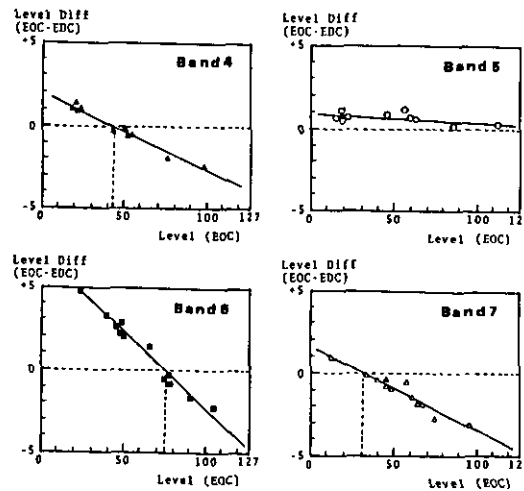


Fig. 1 Comparison of Landsat MSS data (digital counts) processed at EOC/NASDA and EDC/NASA /3/

Fig. 2 (a) shows an extremely short variation of detector gain of Landsat-3 MSS detector due to abrupt change of target scene radiance, in this case there remains aftereffect of radiance, e.g. higher gain for higher radiance while (b) indicates a long term variation of the detector gain and housing temperature. The figure indicates a clear relationship between the housing temperature and the gain. These examples show a necessity of extreme care to extract a subtle long term change from the up-to-date and old data of satellites since these facts were not taken care in old data.

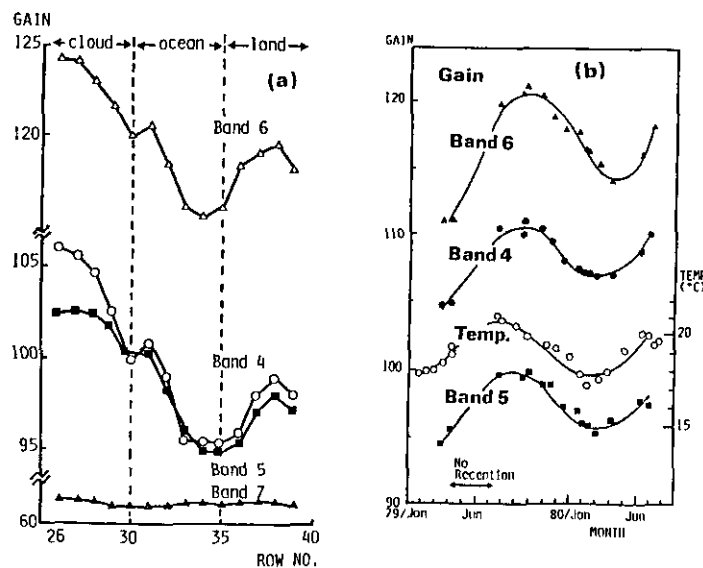


Fig. 2 (a) Variation of gain of Landsat-3 MSS detector for successive 14 scenes in Path 120, Sep. 20, 1979.

(b) Seasonal variation of gain of Bands 4, 5 and 6 of the same detector and Temp. denotes the housing temperature. The data were sampled over the scenes with same average radiance (50 in digital counts)/4/.

The sea surface temperature observed from a satellite is generally lower than the true temperature due to atmospheric effect. Thermal radiation reaching a satellite can be obtained through solution of a radiative transfer equation if true sea surface temperature and profile of air temperature and absorbing gases are given which in turn gives expected sea surface temperature as observed from a satellite. Experiments are made /5/ to compute the expected sea surface temperature to be observed from a satellite through application of 4 computer programs, Lowtran-6, Line-by-Line, Multi Parameter and Narrow Band /6, 7, 8, 9/. The same values of in situ sea surface temperature and the vertical distribution of air temperature and water vapor obtained from nearby radio sounding are input to the respective computer programs together with a filter function of MOS-1 VTIR Channel-3. The result is shown in Fig. 3 in which abscissa is the sea surface black body temperature (TBB) observed with MOS-1 VTIR Channel-3 (10.5 - 11.5 m m) while the ordinate is the estimated black-body temperature to be observed with VTIR Channel-3. The result of each program is satisfactory, however it is interesting to notice that there is a slight difference in the result. It is advisable to continue the effort to improve the program.

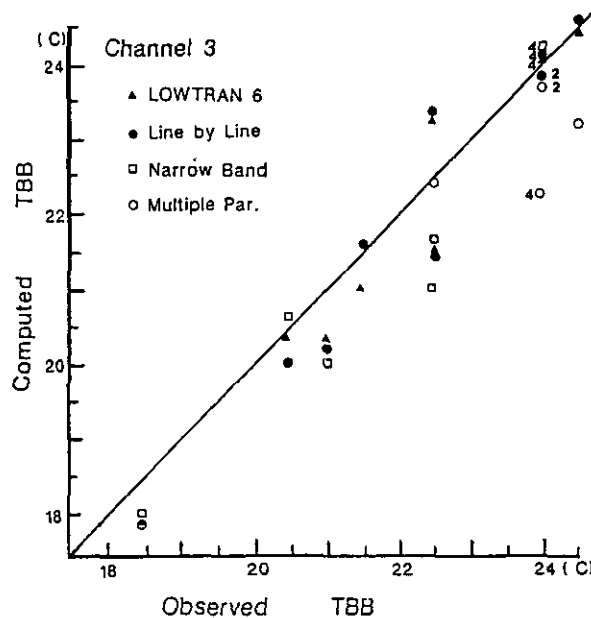


Fig. 3 The TBB of the sea surface temperature observed with MOS-1 VTIR Channel-3 vs the estimated from different computer program to solve radiative transfer equation /5/

4. A Japanese Plan for IGBP-DIS

Although among 18 national committee members of IGBP a few members are assigned to DIS, there has been no fund for the activity. A budgetary plan for the following activities is submitted to the Ministry of Education, Science and Culture.

- (1) Following the principles of IGBP-DIS and through a close cooperation with related international and national organizations, to establish international cooperative networks first among the national committee members of DIS in Asian Monsoon which is a major target area of intensive study of Japan IGBP.
- (2) To formulate the procedure of data exchange and management.
- (3) Collect information on the data relevant to IGBP with an emphasis on satellite data.
- (4) Designing of the most suitable DIS.
- (5) Clarification of technical problems, such as requirements on specification of spatial and time scales of the data, selection of a monitoring site which can be utilized to collect the ground truth data for the analysis of satellite data.
- (6) To identify the anticipated problems which may occur in implementing the above described monitoring.

5. Concluding Remarks

The Foregoing description covers only a part of DIS. Many other subjects such as management of steadily increasing voluminous data, etc. should be formulated in the beginning of a large interdisciplinary project such as IGBP. In many governmental, semigovernmental, academic, municipal as well as private organizations useful data for IGBP objectives have been collected for internal purposes. It would be desirable to formulate a procedure so that scientists of IGBP can utilize the data for scientific purpose.

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DIS

Strategy for Implementation

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[Presented by Will Steffen, GCTE Core Project Officer]

1. Introduction

The acquisition, processing and manipulation of global-scale environmental data sets are all of fundamental importance to the International Geosphere-Biosphere Programme. These activities are necessary not only for the successful implementation of individual IGBP Core Projects, but also for their overall synthesis, in order to meet the objectives of the programme as a whole. The data dependence of IGBP at all levels and phases requires that the development of its Data and Information System should be interactive, responding to the scientific evolution of other IGBP components. But IGBP-DIS must also be pro-active, influencing and assisting the development of the Core Projects by providing leadership in data policy issues and by ensuring that gaps in data provision are filled.

The overall objective of IGBP-DIS is:

To improve the supply and management of data and information in order to facilitate the attainment of IGBP's scientific goals.

2. Strategy

The development of a long term strategy for IGBP-DIS is intimately linked to the development of IGBP as a whole and of the individual IGBP Core Projects. Thus the identification and organization of a suite of needed data sets can only come after there is a clear and well articulated understanding of how these data will be used to support IGBP's scientific objectives. In theory, this understanding can be developed conceptually well in advance of the actual implementation of the research and modeling. In practice, experience indicates that this understanding will evolve as the research progresses. The current suite of needed data sets, as identified by the Core Projects themselves, is shown in Table 1.

Following the nomenclature of other IGBP projects, the DIS programme is organized into Foci and Activities:

Focus 1 Data Set Development

Objective:

To promote the development of global data sets relevant to the scientific needs of IGBP Core Projects.

- Activity 1.1 Development of a '1 km' data base from AVHRR and similar satellite sensors
- Activity 1.2 Creation of global vegetation (land cover/land use) data bases, derived from original data bases obtained from Activity 1.1
- Activity 1.3 Estimation of land surface temperature from AVHRR and similar satellite sensors
- Activity 1.4 Estimation of areal extent and characteristics of global wetlands, from remote sensing and other sources
- Activity 1.5 Determination of terrestrial primary production by remote sensing and other sources.
- Activity 1.6 Development of global biomass data base
- Activity 1.7 Development of global soils data base

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Focus 2 Data Dissemination

Objective:

To facilitate the exchange of data between Core Projects, the acquisition of data from other sources, and the wide distribution of IGBP data sets.

Activity 2.1 Setting up of data exchange formats for data set transfers between Core Projects and IGBP researchers

Activity 2.2 Establishment of regional and global networks for IGBP data exchange

Focus 3 Data Coordination in an International Context

Objective:

To contribute to the overall development of international and inter-agency data and information systems to support global change science.

Activity 3.1 Participation in relevant international planning activities

Activity 3.2 Contribution to production of data directories and other meta-data sets

Activity 3.3 Facilitation of access to important information systems and data bases

3. Links to External Organizations

IGBP-DIS needs to develop and strengthen links with three kinds of organizations external to IGBP: bodies that coordinate space activities related to Earth observations; organizations with research interests complementary to IGBP; and Data Centres. These categories are considered in greater detail below.

3.1 Bodies that Coordinate Space Activities Related to Earth Observations

Nations and regions with relevant satellite programmes and agencies include the USA (NASA and NOAA), Japan (NASDA), Europe (ESA), Canada, China, India and Brazil. International coordination has been effectively carried out in the last few years by the Space Agency Forum of the International Space Year (SAFISY). About a dozen multi-agency projects were started in 1989, on the collection, validation and dissemination of space data relevant to global change.

It has recently been proposed that these SAFISY projects should continue beyond 1992, with coordinating responsibilities shared between IGBP, WCRP and an internationalized Committee of Earth Observations Satellites (CEOS). It is therefore important for IGBP-DIS to develop a closer relationship with CEOS and its working groups on data analysis.

IGBP-DIS should also closely monitor other initiatives for international discussion and collaboration between the space agencies, in liaison with the ICSU Committee on Space Research (COSPAR).

3.2 Organizations with Research Interests that are Complementary to IGBP

There are many other bodies within the ICSU family that have strong interests in global change research. Of particular relevance to IGBP is the World Climate Research Programme, jointly sponsored by ICSU and WMO. WCRP addresses the dynamic and physical aspects of the climate system: its components include the Global Energy and Water Cycle Experiment (GEWEX), the Tropical Ocean and Global Atmosphere project (TOGA); the World Ocean Circulation Experiment (WOCE), and WCRP data projects and global environmental monitoring studies.

WMO/IOC/ICSU/UNEP have recently proposed that a Global Climate Observing System (GCOS) should be established, to provide long-term monitoring of physical and biogeochemical aspects of the global climate system. Because of the many scientific links between the experimental studies, modeling interests and data handling activities of WCRP and IGBP, it is essential that IGBP-DIS establishes a close working relationship with WCRP, and that there is adequate representation of terrestrial, marine and atmospheric IGBP researchers in the planning and implementation GCOS.

Formal liaison between IGBP-DIS and the re-formulated ISLSCP (International Satellite Land-Surface Climatology Project-now based in North America) is also highly desirable.

3.3 Data Centres

The third kind of external link is with institutions with internationally-recognized competence in the archiving and management of environmental data. These include the main components of the ICSU World Data Centre (WDC) system, in the USA, Russia, Europe, Japan and China.

IGBP-DIS welcomes the proposed new US data centres relevant to IGBP needs (in palaeo-climatology, remotely-sensed land data and greenhouse gases), and is willing to assist in the establishment of appropriate contacts between WDCs and IGBP Core Projects.

Other organizations with data archiving interests relevant to IGBP include the Consortium for International Earth Science Information Network (CIESIN; a US body with strong links to NASA's EOS-DIS activities) and UNEP's Global Resource Information Database (GRID).

4. Structure of IGBP-DIS

4.1 General Aspects

In order to fulfill the functions and develop the approach outlined above, the IGBP-DIS structure comprises a Standing Committee, an IGBP-DIS Office, Working Groups on specific activities, and various laboratories, research groups and institutions directly involved in meeting IGBP needs for global data sets. These elements are linked to the Scientific Committee of IGBP, to other components of the programme, and to the agencies and organizations responsible for producing, assembling, processing and distributing other data sets of interest to IGBP. Figure 1 shows the main connections between these bodies.

4.2 IGBP-DIS Standing Committee and Project Office

The IGBP-DIS Standing Committee was established in September 1990 under the chairmanship of Dr. S. I. Rasool. The current composition of the IGBP-DIS SC is listed in Table 2. Members are appointed for three years, on the basis of their scientific expertise. The committee also includes representatives of some of the main external organizations with links to IGBP-DIS: UNEP/GRID, WMO/WCRP, UNESCO/IOC and the ICSU WDC system.

The IGBP-DIS Office was established at the Universite Pierre et Marie Curie, Paris in early 1991. Its role is to assist the Standing Committee, to provide day-to-day management of IGBP-DIS activities, and with the relatively limited software and hardware at its disposal, to carry out data handling tasks and facilitate access of readily-available data sets to data users.

4.3 Management Structure for IGBP-DIS Activities

The more important long term activities, that are beyond the scope of the IGBP-DIS Office, will be taken on by IGBP-DIS Working Groups. These will usually be led by a member of IGBP-DIS SC, along the lines of the IGBP-DIS pilot studies (on Land Cover Change, chaired by J. R. G. Townshend; Land Surface Temperature, F. Becker; Master Directory, J. Thieman; and the Diskette project, S. Ruttenberg).

Proposed IGBP-DIS Activities for which Working Groups will be required are outlined in Section 2. In addition to IGBP-DIS SC representation, WG members will be appointed from laboratories that are well-experienced in the processing and management of environmental data sets, or have other relevant expertise or facilities. Laboratories, research groups and other institutions that contribute significant effort to addressing Activity objectives will be designated IGBP-DIS Associate Laboratories by the IGBP-DIS SC.

Fig. 1 Structures of IGBP Data and Information System and its main functional links, within and outside IGBP.

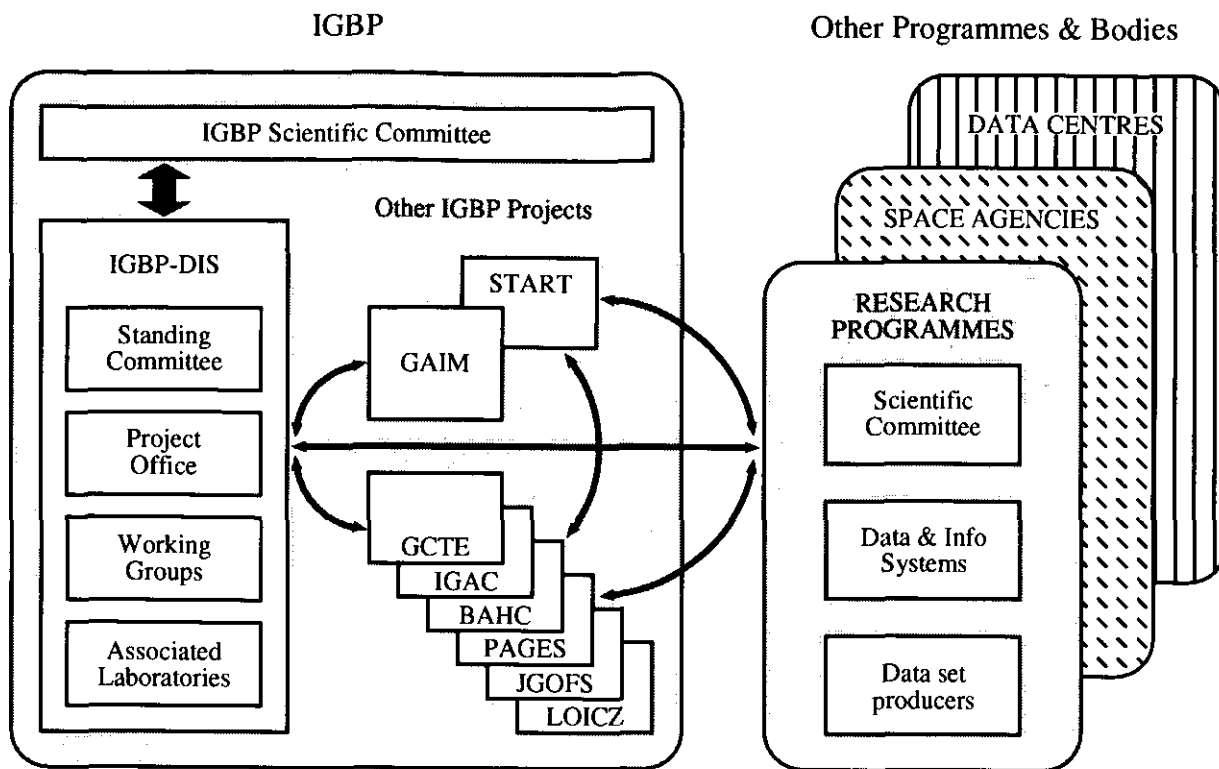


Table 1. Data Needs of IGBP Core Projects

	IGAC	GCTE	BAHC	LOICZ
Data Required				
Land Cover	×	×	×	×
Soils	×	×	×	
Topography		×	×	
Wetlands	×			
Biomass burning	×			
Disturbance pattern		×		
Climate		×	×	
Snow cover			×	
Ocean colour				×
Fertilizer use	×			
Surface O ₃	×			
Atmos. Deposition	×			
Sediment load				×
Aquatic biological activity				×
Notes:	(i) GAIM requires global hydrological and biogeochemical data sets; (ii) JGOFS has established its own data acquisition and management procedures, (iii) PAGES does not require remotely sensed data.			

Table 2. Membership of IGBP-DIS Standing Committee (Dec. 1992)

Chairman

Dr. Ichtiague Rasool Université Pierre et Marie Curie, Paris, France

Members

Dr. Francois Becker Université Louis Pasteur, Strasbourg, France
 Dr. Dean Graetz CSIRO Division of Wildlife & Ecology, Canberra, Australia
 Prof. Vladimir Kozoderov Russian Academy of Sciences, Moscow, Russia
 Dr. John MacDonald Richmond, British Columbia, Canada
 Dr. Gilbert Saint CNES/CNRS Laboratoire d'Etudes et de Recherches en Teledetection Spatiale, Toulouse, France
 Dr. Wim Sombroek FAO, Rome, Italy
 Dr. James Thieman Goddard Space Flight Centre, Greenbelt MD, USA
 Dr. John Townshend University of Maryland, College Park MD, USA
 Dr. Volodya Viskov Russian Academy of Sciences, Moscow, Russia

Organizational Representatives

Dr. Harvey Croze United Nations Environment Programme, Nairobi, Kenya
 Dr. Pierre Morel World Meteorological Organization, Geneva, Switzerland
 Dr. Youri Oliounine International Oceanographic Commission, UNESCO, Paris, France
 Dr. Stan Ruttenberg World Data Centres, University of Colorado, Boulder, USA