

IRS-1C data products generation and dissemination

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The success of a satellite launch depends on the usage of satellite data. The usefulness of satellite data, in turn, depends to a large extent, on the way in which data are archived, processed and distributed. The NRSA Data Centre (NDC) in NRSA, Hyderabad, is responsible for supplying the satellite data products to various organizations both in India and abroad. In this article we give details of the type of services available to assist users in the selection of data, the procedure for placing an order, the operations which are required to be done for the generation of the final product and the various types of data products, with special reference to IRS-1C, that are going to be supplied to the users.

IRS-1C is the third satellite in the operational Remote Sensing Satellite series launched on 28 December 1995 from Baikanur. IRS-1C incorporates more advanced features than its predecessors. It also carries a tape-recorder onboard for recording the data when data are not being transmitted in real time. IRS-1C has three cameras onboard, viz. (i) a panchromatic camera (PAN), (ii) a Linear Imaging Self-Scanning Sensor-III (LISS-III) and (iii) a Wide Field Sensor (WiFS). Considering the complex nature of the payloads, generation of good data products and their dissemination to the users assumes paramount importance.

The On Board Tape Recorder (OBTR) is capable of recording specified sensor data. It has the capability to receive and record a stream of 42.4515 Mbps data. Hence, either half swath of PAN (PAN-I or PAN-Q) or LISS-III (with or without WiFS) can be recorded. The payload operation sequence for the whole day can be loaded daily onto the onboard command memory of the OBTR when the satellite is within the visibility range. The recorded data are downlinked over the Indian ground station at Shadnagar, Hyderabad during the night passes of satellite.

Any improvement in the satellite/sensor technology is of no use unless a matching change takes place in the ground segment. For this reason, an effective data-dissemination mechanism is of utmost importance.

The imaging segment comprising of satellite data reception and archiving systems, data processing for products generation systems and data dissemination centre are established at Hyderabad. The reception and

recording of various payload data are done at the Ground Station of the National Remote Sensing Agency (NRSA) at Shadnagar. Products generation and dissemination are carried out at the Balanagar facilities. The NRSA Data Centre (NDC) takes care of dissemination of data products, besides taking care of advising users. The usefulness of the satellite data depends, to a large extent, on the way in which it is archived, processed and distributed.

A number of tools are available at NDC to assist users in the selection of appropriate data. With the help of the browse and accession data from the Integrated Information Management System (IIMS), NDC provides these services to users. The sequence of data products supply operations is shown in Figure 1.

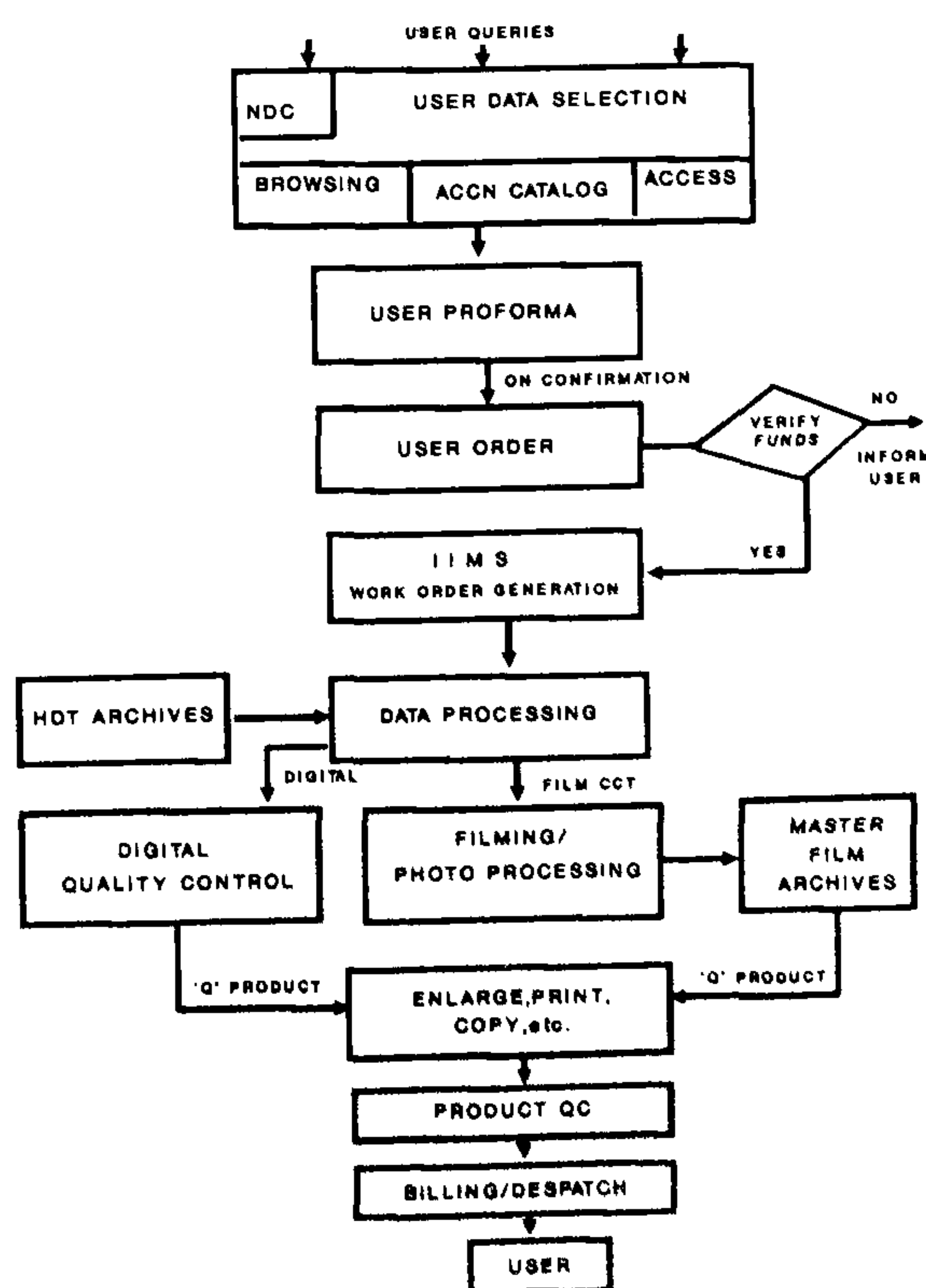


Figure 1. Data products supply operations.

Services

Data availability

Information on all IRS-1C data accessions is available in the form of accession catalogues in IIMS, which is updated everyday with the meta data of the day's passes. It is also planned to append the IRS-1C accessions acquired all over the world by the various International Ground Stations (IGSs) and OBTR. This data base is maintained at NRSA and Earth Observation Satellite Company (EOSAT), USA (world wide marketing partners).



Figure 2. LISS-III browse image.

Auto cloud cover estimation

Manual cloud cover estimation, which is being done at NDC currently, for other missions is time-consuming. For cloud/snow cover estimation automatically, a system 'ACCESS' and an expert system 'ACCEPT', (for converting the results into effective cloud/snow cover values) are being implemented. This process will be run for all IRS-1C data acquired to generate cloud cover percentages, quadrantwise.

Provision exists to estimate cloud/snow cover for a given mapsheet or quadrant and for generation of Bit



Figure 3. PAN browse image.

Table 1. Typical IRS-1C orbital calendar

Day	Path number													
1	1	318	294	270	246	222	198	174	150	126	102	78	54	30
2	6	323	299	275	251	227	203	178	155	131	107	83	59	35
3	11	328	304	280	255	232	208	184	160	136	112	88	64	40
4	16	333	309	285	261	237	213	189	165	141	117	93	69	45
5	21	338	314	290	266	242	218	194	170	146	122	98	74	50
6	2	319	295	271	247	223	199	175	151	127	103	99	55	31
7	7	324	300	276	252	228	204	180	156	132	108	84	60	36
8	12	329	305	281	257	233	209	185	161	137	113	89	65	41
9	17	334	310	285	262	238	214	180	156	132	108	84	60	36
10	22	339	315	291	267	243	219	195	171	147	123	99	75	51
11	3	320	296	272	248	224	200	176	152	128	104	80	56	32
12	8	325	301	272	253	229	205	181	157	133	109	85	61	37
13	13	330	306	282	258	234	210	186	162	138	114	90	66	42
14	18	335	311	287	263	239	215	191	167	143	119	95	71	47
15	23	340	316	292	268	244	220	196	172	148	124	100	76	52
16	4	321	297	273	249	225	201	177	153	129	105	81	57	33
17	9	326	302	278	254	230	206	182	158	134	110	86	62	38
18	14	331	307	283	259	235	211	187	163	139	115	91	67	43
19	19	335	312	288	264	240	216	192	168	144	120	96	72	48
20	24	341	317	293	269	245	221	197	173	149	125	101	77	53
21	5	322	298	274	250	226	202	178	154	130	106	82	58	34
22	10	327	303	279	255	231	207	183	159	135	111	87	63	39
23	15	332	308	284	260	236	212	188	164	140	116	92	68	44
24	20	337	313	289	265	241	217	193	169	145	121	97	73	49
25	1	318	294	270	246	222	198	174	150	126	102	78	54	30



Figure 4. IRS-1C reference scheme map.

map printouts showing cloud-covered areas for a given full/quadrant scene/mapsheet.

Digital browse facility

Using the digital browsing facility, users can browse the image for deciding on the acceptability of the image with respect to cloud cover over the scene and data quality.

LISS-III and PAN browse images are generated and

compressed at the Browse Processing System (BPS) the day after acquisition. This is transferred to NDC via the (facility wide) Network for archiving the data on Optical Jukebox. The optical jukebox provides on-line storage of browse data for the entire mission period. For IRS-1A/1B, Landsat and other missions, optical disks are being used and these can store data of a few months only. Handling of multiple optical disks manually can be avoided with the optical jukebox.

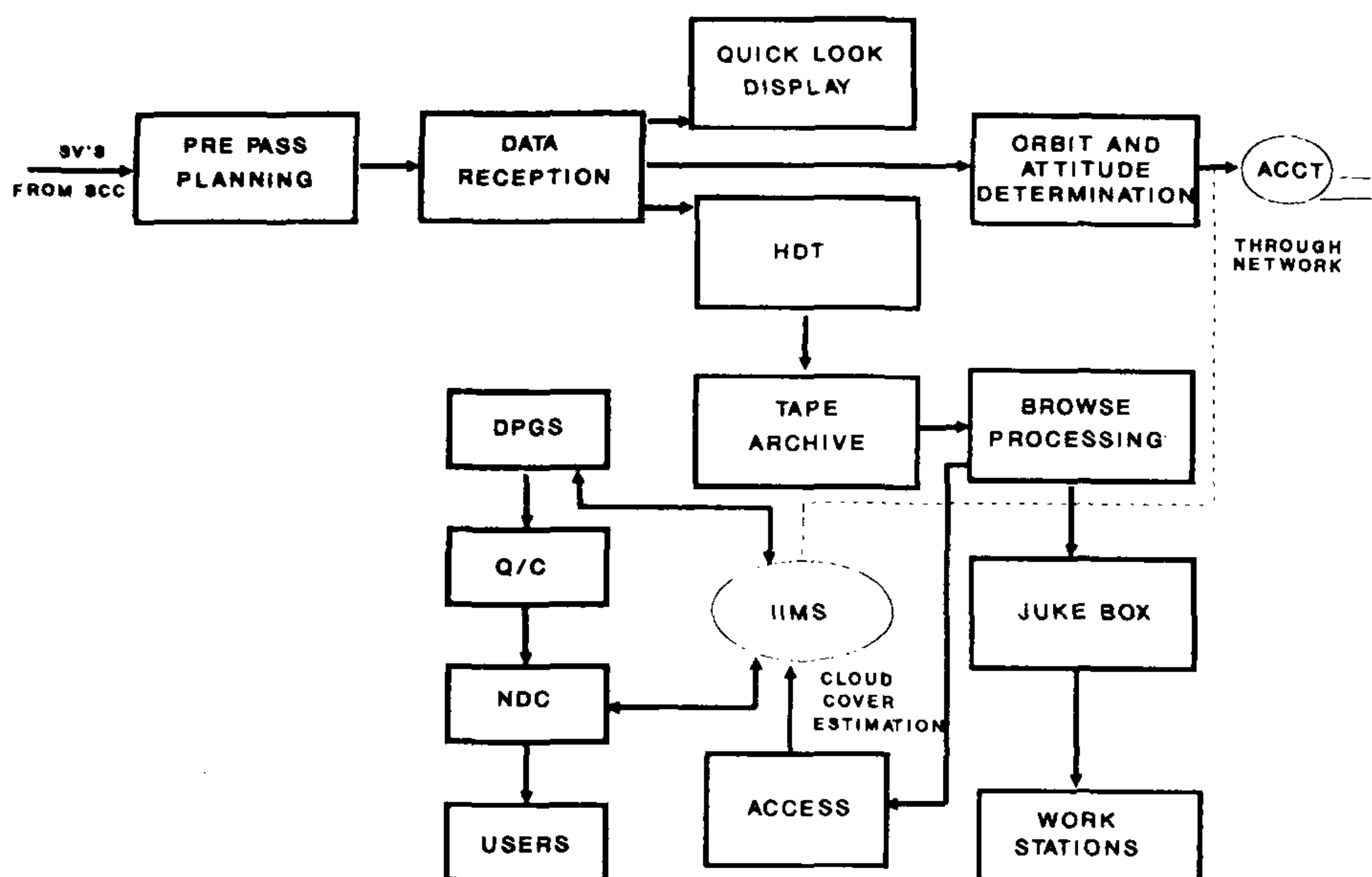


Figure 5. Data products generation chain.

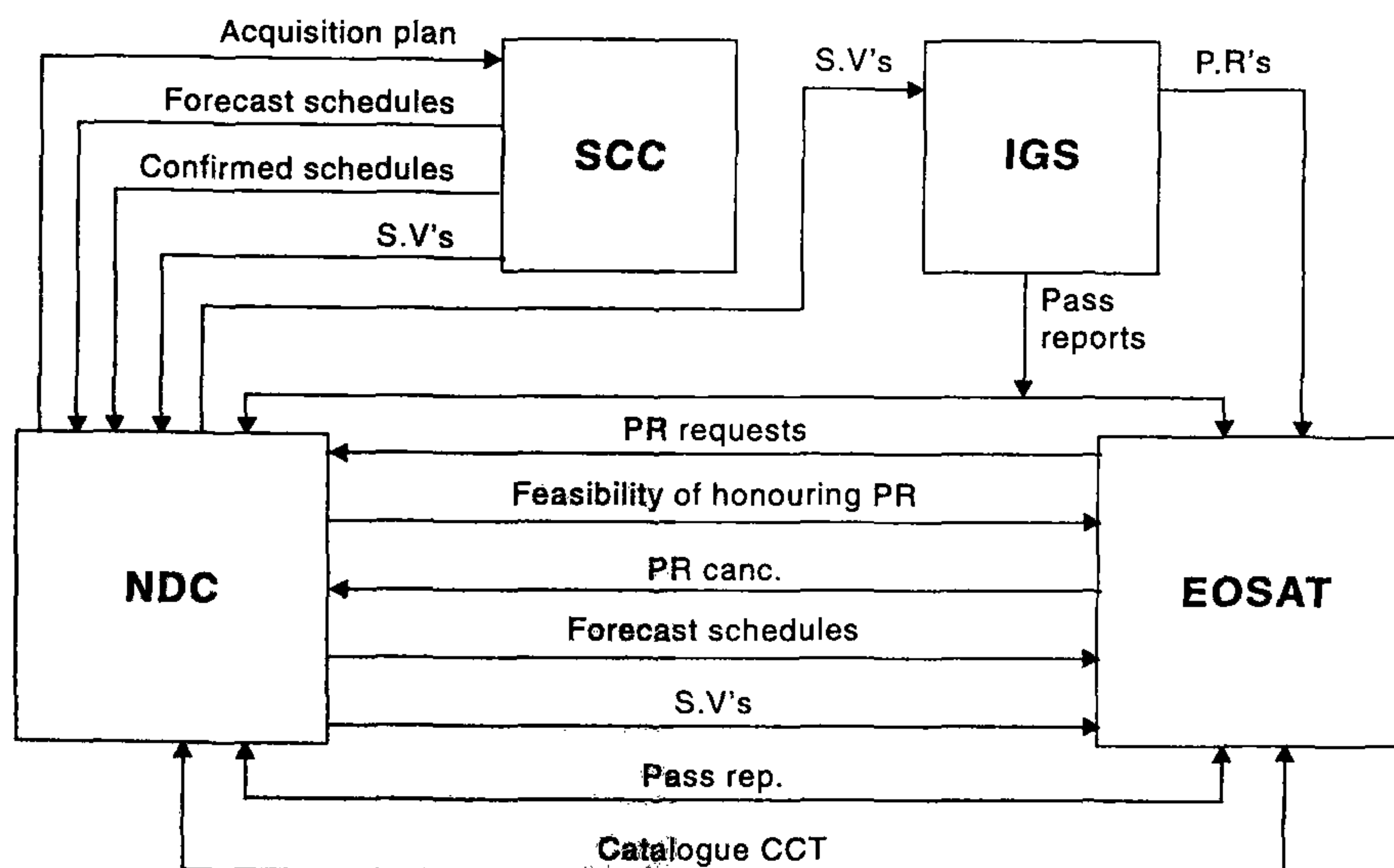


Figure 6. Payload programming activities.

Menu-driven browsing software is provided on each browsing station. Based on the user input, the requested data will be retrieved from the jukebox, decompressed and displayed along with the corresponding annotation. Data manipulation like enhancements can also be carried out for better assessment.

LISS-III browse images are subsampled to 512 scanlines \times 512 pixels. The images are in colour (3 bands) while PAN browse data have 1024 \times 1024 pixels in B&W. Sample LISS-III and PAN images are shown respectively in Figures 2 and 3.

Referencing scheme maps

Referencing scheme maps are generated with path/row and scene centre marked on a baseline map to assist users in identifying the area of interest. The referencing scheme map for IRS-1C is provided to users in three different types: for India (Figure 4) and neighbouring countries on 1 : 6,000,000 scale; six zones of India, viz.

Central, North, South, East, West and Andaman and Nicobar on 1 : 4,500,000 scale; and the entire coverage of the Hyderabad earth station.

A world referencing scheme map showing the coverage of IRS-1C on land and water from 81°N to 81°S will assist users in global programming. The map is in Mercator projection on 1 : 62 million scale. The referencing scheme map of the world zones, Asia, Europe, North America, Africa, Australia and Antarctica is also available.

Orbital calendar

Orbital calendar, giving the details of paths covered on different days, is helpful to users to plan their procurement of satellite data products. Using this, it is possible to know, on which day the required data have been collected or are going to be collected. A sample IRS-1C orbital calendar is given in Table 1.



Figure 7. Standard LISS-III, full scene.

Table 2. IRS-1C standard products

Sensor	Product	Product description	Media (Digital, photographic)	Scale
PAN	Sub-scene	Based on path/row and sub-scene (1-9)	CCT, CART, DAT, Floppy	1 : 250,000 1 : 50,000
	Shift along track	Same like sub-scene, shifted along the track by user specified percentage. This is to accommodate user area if it falls between two rows	CCT, CART, DAT	1 : 250,000 1 : 50,000
	Basic stereo pair (2 sub-scenes)	Based on path/row sub-scene B/H ratio. Only radiometrically corrected	CCT, CART, DAT	1 : 250,000
	Basic stereo pair (2 sub-scenes)	Based on path/row sub-scene B/H ratio, with partial geometric correction	CCT, CART, DAT	1 : 250,000
	Geocoded, ($7\frac{1}{2} \times 7\frac{1}{2}$)	Based on map sheet and quadrant number. North oriented	CCT, CART, DAT	1 : 25,000
WiFS	Standard	Path/row-based	CCT, CART, DAT	1 : 6 M 1 : 2 M
	Shift along track	Like standard with shift in the forward direction as per user specified percentage	CCT, CART, DAT	1 : 6 M
LISS-III	Standard (Figure 7)	Path/row based	CCT, CART, DAT	1 : 1 M 1 : 250,000
	Shift along track	Like standard with shift in the forward direction as per user specified percentage	CCT, CART, DAT	1 : 6 M 1 : 250,000
	Quadrant (Figure 8)	One fourth of a full scene, based on path/row and quadrant no.	CCT, CART	1 : 500,000 1 : 125,000
	Geocoded ($15' \times 15'$) (Figure 9)	Corresponds to map sheet number. North oriented	CCT, CART, DAT	1 : 50,000

CART, Cartridge of 525 MB; DAT, 8 mm Exabyte tape with 5 GB capacity; CCT, Computer compatible tapes of 6250 bpi.

Data products generation facility

The data products generation facility is for operational generation of photographic and digital products from IRS-1C data after various levels of processing. IIMS is used for routing and monitoring. The production chain linked through is shown in Figure 5.

IIMS

IIMS is one of the systems in the IRS-1C operations

infrastructure to support and link the chain of operations from data acquisition through distribution. This system handles large volume of users (more than 1,000) and products (20,000 per year) and it is capable of handling all IRS missions as well as SPOT, Landsat, ERS and NOAA.

Archival and retrieval: The data recorded on high density tapes (HDDTs) are catalogued and archived before they are used by data products generation system as required. The retrieval through IIMS is automatically carried out

Table 3. IRS-1C special products

Sensor	Product	Product description	Media (Digital, photographic)	Scale
PAN	5' × 5' Geocoded	Based on area centre lat./long. standard correction. North oriented		1 : 125,000
	Full scene	Generated by mosaicing the data collected by all the three arrays, path/row based	CCT, CART	1 : 125,000
	Shift along track	Like full scene with shift in the forward direction as per user specified percentage	CCT, CART, DAT	1 : 125,000
	Quadrant	One fourth of a full scene. Applicable to OBTR data	CCT, CART, DAT	1 : 250,000
	Ortho image	Based on path/row sub-scene and B/H ratio		1 : 50,000
WiFS	Zonal (Figure 10)	India is divided into 10 zones. These products are supplied zone wise by mosaicing the scenes	CCT, CART, DAT	1 : 2M
	VIM zonal (Figure 11)	Vegetation index maps from WiFS		1 : 2M
	VIM full India (Figure 12)	Same as above for the full country		1 : 6M
LISS-III	District geocoded	Districtwise north-oriented products by mosaicing the scenes. Districts are categorized into four classes (A, B, C, D) depending on area extent	CCT, CART, DAT	1 : 250,000 (Class A, B) 1 : 500,000 (Class C, D)
LISS-III	Merged	Based on PAN sub-scene merged with LISS-III		1 : 25,000

during the routing process of user request to data processing systems.

User services: A complete updated catalogue of available images, master films and HDDTs is maintained. Various utilities for conversion of geographic coordinates into path-row and corresponding mapsheet numbers and vice versa are prepared.

Order processing: Requests for photographic and digital products are converted into a sequence of order-processing instructions, to either the data processing system and/or Photolab via respective terminals. This module handles various sub-systems of the production chain like digital quality control system, filming system, photolab, master quality control, master film archival as well as billing and despatch.

Accounting and management: IIMS is equipped with invoicing and accounting capabilities. Monitoring functions include identification of the production history of a specific product, production scheduling, etc.

Data archival

Raw data acquired by NRSA from all sensors/satellites are archived in HDDTs. Master films of geocoded and fixed full scenes of the processed photo products are also archived.

Browse processing system (BPS)

As already described, BPS generates digital subsampled chips of LISS-III and PAN scenes acquired.

Data processing system (DPS)

DPS systems convert the raw video data into different specified products after necessary processing. For IRS-1C operations, three processing systems are used. They are DPS-1 and DPS-2 for generation of standard and special products of LISS-III and PAN. DPS-3 is for generation of WiFS data products, processing for swath modelling, digital quality evaluation and ground control point library updation.

Filming system

The filming system is a centralized facility for generating B/W and colour master films for all sensors. The filming system is equipped with B/W and colour FIRE-240 recorders for exposing 10" × 10" films. For high resolution PAN data of IRS-1C, large format photowrite system is planned, which can expose B/W films and colour films of 40" × 40" size. The filming systems accept photo compatible tapes (PCT) generated at various data processing

systems for exposing on the film. Films are exposed according to priority. After updating in the IIMS data base, the exposed films are sent to photo processing laboratory for processing along with the despatch report.

Photo products generation system

Photo processing laboratory is responsible for master film processing and generation of all B/W and colour photo products in the form of film transparencies and paper prints. It is equipped with master film processing systems, photo printers, enlargers, and duplicate products processing systems.

Quality control

Quality checks are done for both photographic and digital products. Photographic products are quality checked both at the photographic master level and at the product level before they are delivered to users.



Figure 8. LISS-III quadrant.

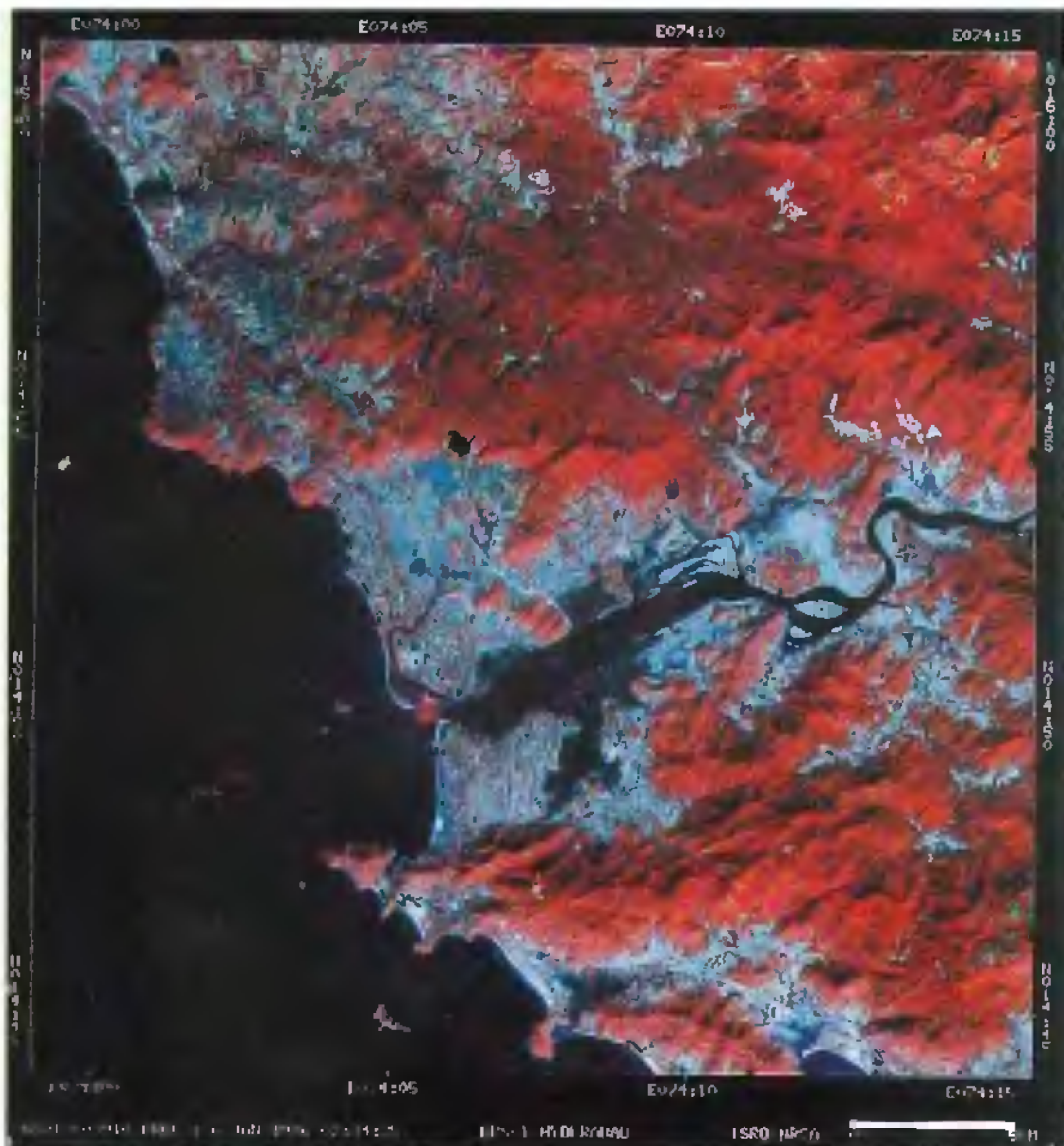


Figure 9. LISS-III geocoded.

All digital products like CCT, DAT, cartridge and floppy are quality checked at the digital quality checking system (DQC). The system checks the errors related to product media. It also provides a facility for visual inspection of the image data for line losses, band mixing, etc. and verifies the histogram of the scene. Depending upon the quality criteria, a certificate is generated indicating the acceptance or rejection along with reasons. It is configured around a Pentium PC with SCO UNIX.

Data products

A large number of new varieties of data products on both photographic and digital media are available from IRS-1C. Highlights of the IRS-1C data products are; launch of new products in different formats and media to meet user needs and supply of data products with an average turn around time (TAT) of better than 10 days, priority services (TAT of 3 days/1 day), supply of customised and special products, digital browse facilities to select data products and improvement in the quality of the products. The products are mainly classified into standard and special products. The different types of products, the media and scale on which they are available are given in Tables 2 and 3.

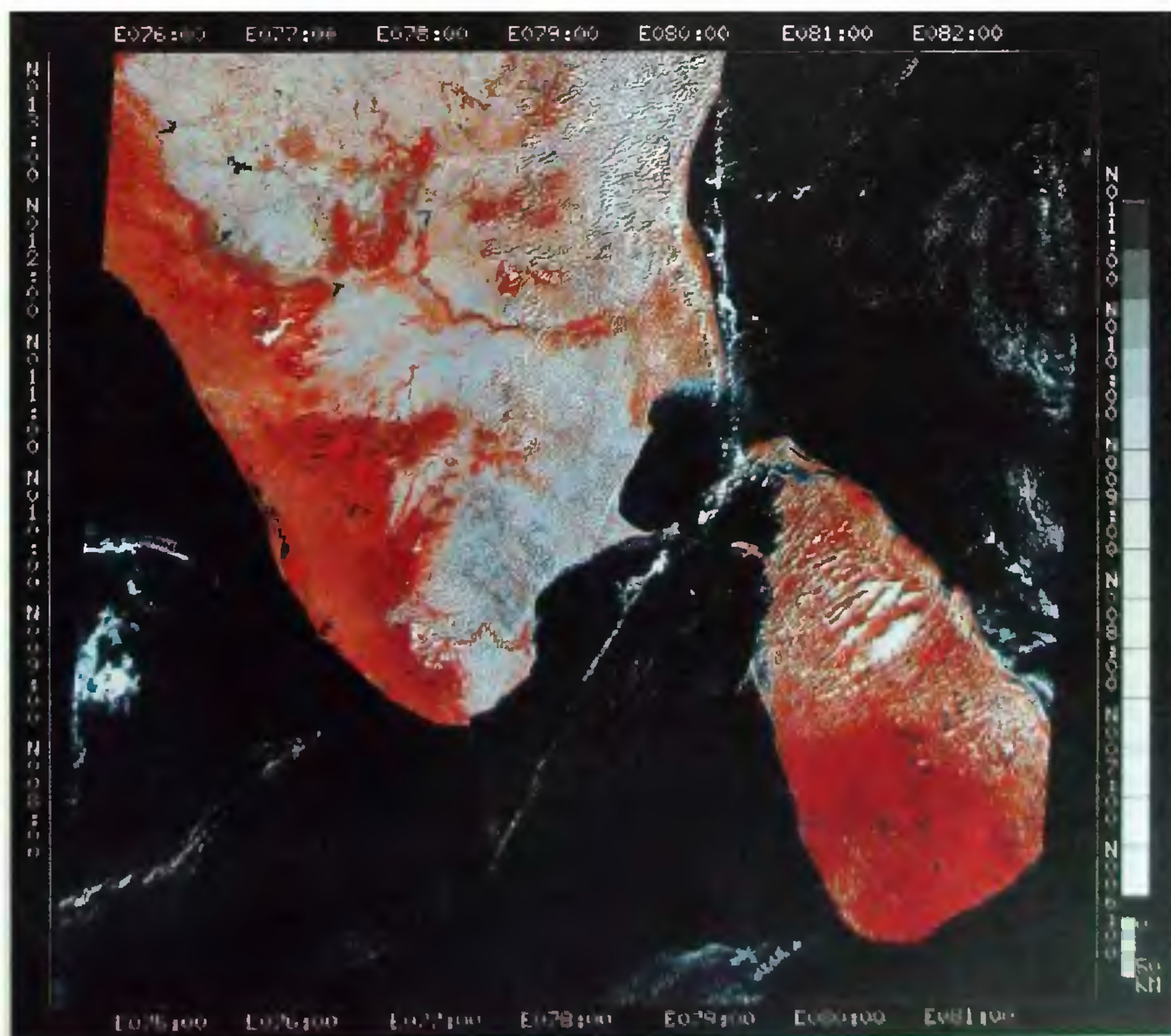


Figure 10. WIFS zonal FCC.

Payload pass programming

The steerability of the PAN camera, the scheduling of OBTR and the IGSs requirements to receive IRS-1C data, necessitate programming. Indian users send their programming requests to NDC with all the required details like area to be programmed, date/period of interest and sensor. The requests from various users are studied and priorities are assigned depending on various factors. Based on these priorities, an optimal acquisition plan is prepared. NDC sends the acquisition plan to Spacecraft Control Centre (SCC), where the necessary commands for the satellite to acquire/transmit the data are worked out. Figure 6 shows activities connected with payload programming. After the successful acquisition of a pass, a scene that meets the user's requirement fully is processed and the products are delivered to the user.

International data supply

The Earth Observation Satellite Company (EOSAT), USA, is in the business of distribution of Landsat and IRS data products to users across the world. The Department of Space (DOS) has entered into a marketing agreement with the EOSAT company. As per the agreement, EOSAT will acquire IRS-1C data at its ground station at Norman, Oklahoma, USA and distribute IRS data worldwide. EOSAT's exclusive marketing territory will consist of the entire world outside the coverage of NRSA ground station.

EOSAT, with the help of DOS is planning to set up a number of International Ground Stations (IGSs) all over the world to receive IRS-1C data. These will be either the existing Landsat/SPOT data receiving stations (which will be suitably upgraded to receive IRS-1C data) or new receiving stations.

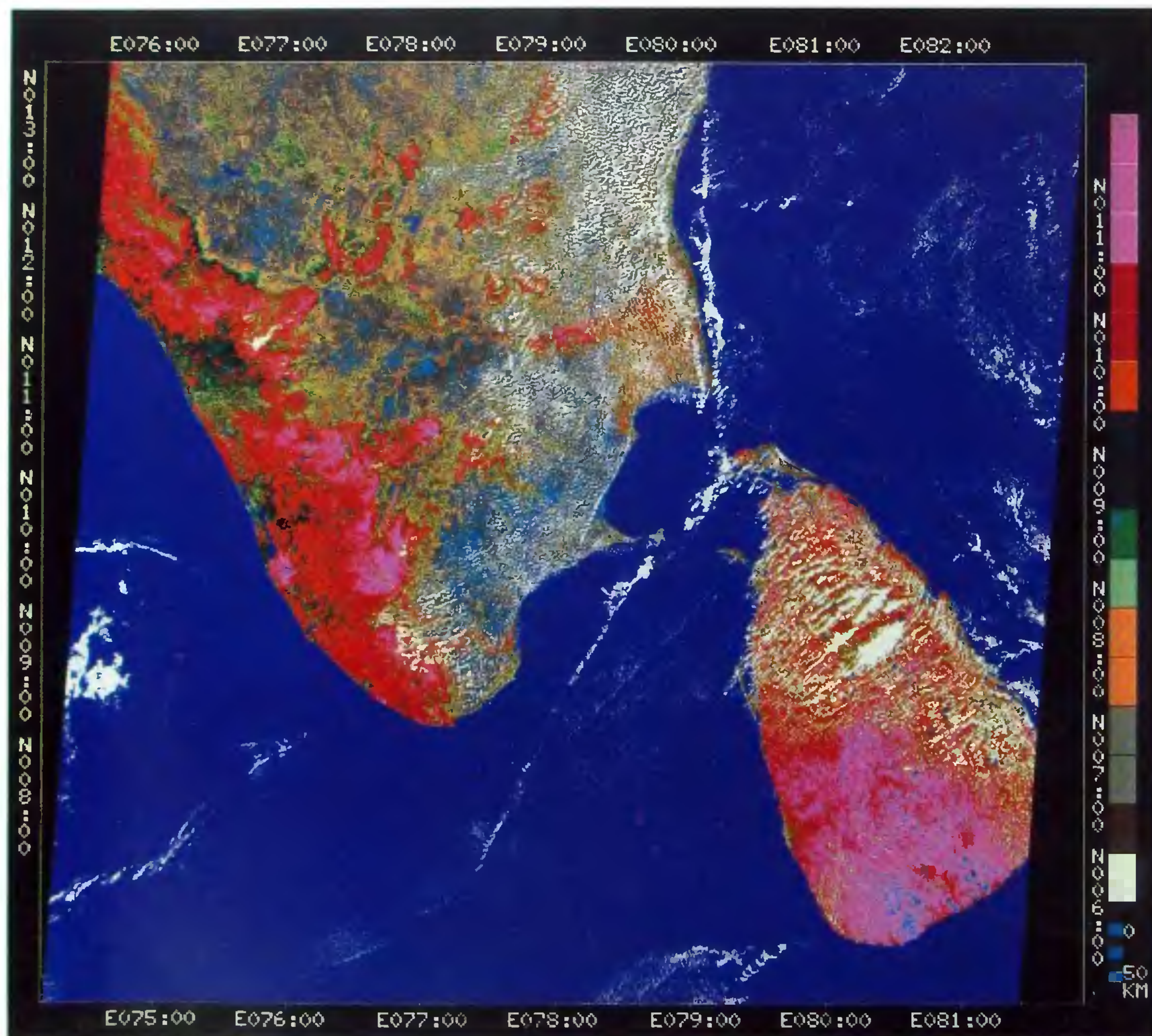


Figure 11. VIM zonal.

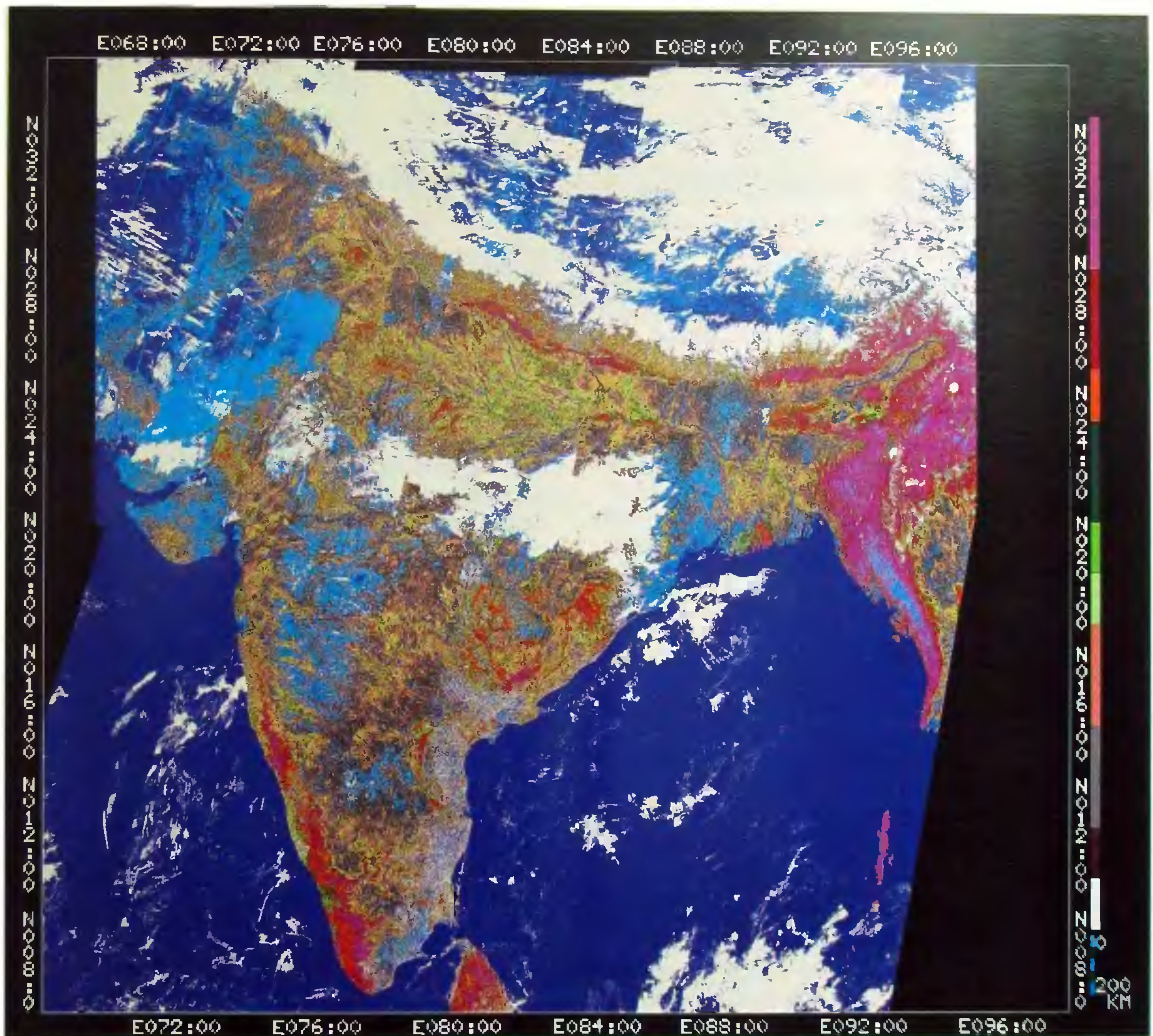


Figure 12. VIM full India.

Conclusion

Various activities were and are being taken up both during the pre-launch and post-launch phases to disseminate IRS-1C data products to the remote sensing community. A series of articles on IRS-1C were published in the Quarterly Bulletin of NDC *Interface*¹. The new elements in IRS-1C satellite and the new types of products were introduced in the Annual User Interaction Workshops and Regional Workshops². A comprehensive Hand Book³ on IRS-1C detailing the mission, the products and its generation was brought out by NRSA. It is now proposed to introduce publicity brochures and cards. The goal is to satisfy the users, with prompt response and supply as well as by providing associated services needed by them.

1. *Interface*, Quarterly Bulletin from NDC, 1994, 5, Nos 1 to 4; 1995, 6, Nos 1 to 4.
2. *IRS-1C Data Products Production Chain, Operations Flow and Time Line*, Department of Space, September, 1995, vols 1 & 2.
3. *IRS-1C Hand Book*, NRSA Data Centre, December, 1995.

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