Development of MODIS Data Application System

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ABSTRACT

The Moderate Resolution Imaging Spectroradiometer (MODIS) on the Earth Observing System (EOS) Terra and Aqua satellites, launched in 1999 and 2002, is directly received by Korea Aerospace Research Institute (KARI) ground station facility. KARI engineers develop a system to receive direct broadcast downlink from MODIS to provide near-realtime, remotely-sensed, spaceborne data to the user community in Korea. MODIS scans a swath width of 2330 km that is sufficiently wide to cover Korean peninsular, Yellow and East Sea at once. The MODIS has 36 spectral bands between 0.415 μm and 14.235 μm, i.e. through the visible into the thermal infrared. MODIS has been observed active fires, floods, smoke transport, dust storms, severe storms since February of 2000. The KARI is preparing for distribution of direct broadcasted MODIS data to users in Korea. The MODIS database system will be designed and developed by KARI engineer for data service from year of 2003. MODIS data user group will be organized from October to December 2002.

Key Word : MODIS, Terra, Aqua, EOS

1. INTRODUCTION

The Moderate Resolution Imaging Spectroradiometer (MODIS) on the Earth Observing System (EOS) Terra and Aqua satellites, launched in December 1999 and May 2002, has been directly received by Korea Aerospace Research Institute (KARI) ground station facility from this spring. These MODIS instruments efforts based on the works with several heritage sensors such as the Landsat Thematic Mapper, the Nimbus-7 Coastal Zone Color Scanner (CZCS), the Sea-viewing Wide-Field-of-view Sensor (SeaWiFS), and the NOAA Advanced Very High Resolution Radiometer (AVHRR). In many aspects, the two MODIS instruments launched on Terra and Aqua are identical, although not all. In essence, bands 31 and 32 of the Aqua/MODIS, used for observing sea surface temperatures (SST) and fires, saturate at about 340 K, whereas the same bands on the Terra/MODIS saturate at 400 K. Therefore, bands 31 and 32 on the Terra/MODIS can observe details about fires at temperatures of 340 – 400 K that will be impossible using the Aqua/MODIS. Simultaneously, by saturating at about 340 K, bands 31 and 32 on the Aqua/MODIS can provide more detail at temperatures below 340 K, thereby acquiring improved SST. In anticipation of improvements, there are other changes made to the Aqua/MODIS as a result of operation of Terra/MODIS.

The MODIS is a 36-band sensor that covers a band of wavelength of visible and/or thermal infrared radiation, with the full wavelength range being from 0.4 to 14.4 μm (Table 1). The spectral band of MODIS have spatial

resolutions of 250m, 500m, and 1km at nadir, depending on particular spectral band and data products. The intent of this paper is to introduce a development plan of MODIS data application system which is intended for MODIS data user in Korea. In advance, the direct broadcasting receiving system of MODIS was developed by Korea Aerospace Research Institute (KARI) engineer (Ahn et al., 2002).

Table 1. Properties of MODIS Spectral Band

Primary Use	Band	Center Wavelength (nm)	Bandwidth (nm)	Pixel Size (m)	L_{typ}	SNR @ L_{typ}
Land/Cloud/Aerosol	1	645.0	48.0	250	21.8	129.0
Boundaries	2	856.5	38.4	250	24.7	200.8
Land/Cloud/Aerosol	3	465.6	18.8	500	35.3	243.4
Properties	4	553.6	19.8	500	29.0	228.3
	5	1241.6	24.0	500	5.4	74.0
	6	1629.1	28.6	500	7.3	270.4
	7	2114.1	55.7	500	1.0	111.1
Ocean Color/	8	411.3	14.8	1000	44.9	880.4
Phytoplankton/	9	442.0	9.7	1000	41.9	838.0
Biogeochemistry	10	486.9	10.6	1000	32.1	802.5
	11	529.6	12.0	1000	27.9	754.1
	12	546.8	10.3	1000	21.0	750.0
	13	665.5	10.1	1000	9.5	913.5
	14	676.8	11.3	1000	8.7	1087.5
	15	746.4	9.9	1000	10.2	600.0
	16	866.2	15.5	1000	6.2	516.7
Atmospheric	17	904.0	35.0	1000	10.0	166.7
Water Vapor	18	935.5	13.6	1000	3.6	57.1
	19	935.2	46.1	1000	15.0	250.0
Cirrus Clouds	26	1383.0	35.0	1000	6.0	150.0

Primary Use	Band	Center Wavelength (μm)	Bandwidth (μm)	Pixel Size (m)	$L_{typ}(T_{typ})$	SNR @ L_{typ} = L_{typ}/NE L
Surface/Cloud	20	3.785	.19	1000	0.45(300K)	900.0
Temperature	21	3.990	.08	1000	2.38(335K)	203.4
	22	3.970	.09	1000	0.67(300K)	837.5
	23	4.056	.09	1000	0.79(300K)	987.5
Atmospheric	24	4.472	.09	1000	0.17(250K)	141.7
Temperature	25	4.545	.09	1000	0.59(275K)	453.8
Water Vapor	27	6.752	.25	1000	1.16(240K)	252.2
	28	7.334	.33	1000	2.18(250K)	641.2
Cloud Properties	29	8.518	.35	1000	9.58(300K)	2661.1
Ozone	30	9.737	.30	1000	3.69(250K)	444.6
Surface/Cloud	31	11.017	.54	1000	9.55(300K)	2808.8
Temperature	32	12.032	.52	1000	8.94(300K)	1824.5
Cloud Top	33	13.359	.31	1000	4.52(260K)	452.0
Altitude	34	13.675	.33	1000	3.76(250K)	298.4
	35	13.907	.33	1000	3.11(240K)	220.6
	36	14.192	.29	1000	2.08(220K)	106.7

SNR = Signal-to-Noise Ratio
NE = Noise Equivalent
L_{typ} (in W/m²-μm-sr) = Spectral radiance at typical conditions for this product
T_{typ} = Temperature at typical conditions for this product

2. MODIS DATA PROCESSING SYSTEM

The KARI has operated EOS direct broadcast system since 20 July, 2002. Fig. 1 and Fig 2 show level 0 MODIS images observed by Aqua/MODIS (at 1:56:00 p.m.) and Terra/MODIS (at 10:43:00 a.m.) on 23 July, 2002. In the middle of images, sunglint phenomena over the ocean was observed. The typhoon Fungwong can be vividly observed in the lower part of images and the Korean peninsular was covered by thick cloud, Changma front.
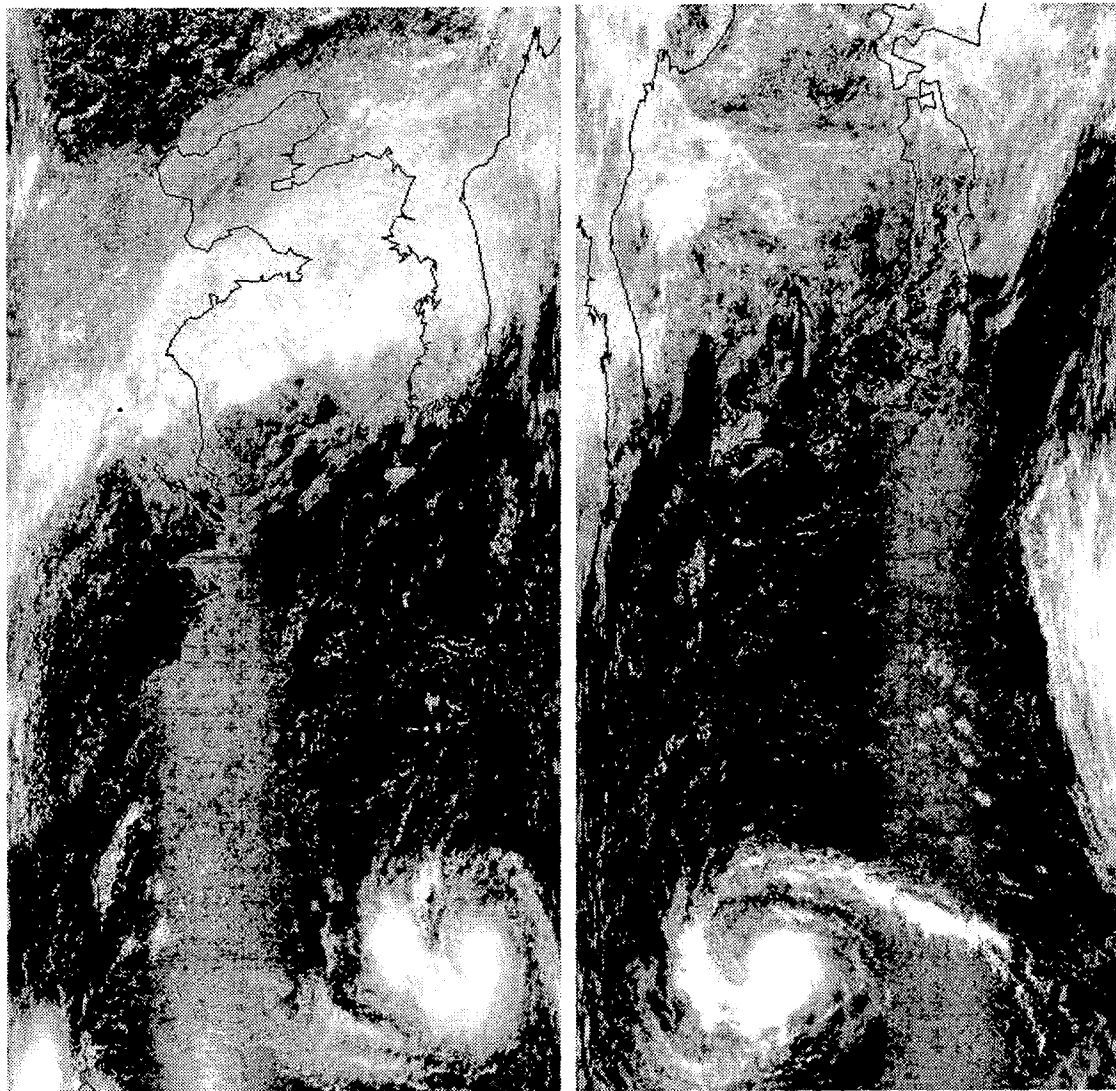

Fig. 1 Aqua/MODIS level 0 image on 1:56:00 p.m.,   Fig. 2 Terra/MODIS level 0 image on 10:43:00 a.m

23 July, 2002.   23 July, 2002

Figure 3 shows the MODIS data processing architecture which is carried out at KARI ground station. In order to make MODIS level 0 data, KARI developed in-house software named terra_wizard and aqua_wizard. Each program produces MODIS level 0 Production Data Set (PDS) files from Terra and Aqua raw data stored in DIS RAID. The level 1 data processing software, International MODIS/AIRS Processing Package (IMAPP), has been developed from the operational MODIS processing software at NASA/GSFC and is modifed to be compatible with direct broadcast data by Space Science and Engineering Center (SSEC)/University of Wisconsin-Madison. The IMAPP software supports UNIX platforms. The R&D center ScanEx has adopted it to run on Microsoft Windows platform, namely IMAPPW. The KARI ground station has used the IMAPPW that lets anybody to process MODIS data from level 0 to level 1A and 1B products. KARI will distribute the MODIS level 1 data to user group which is planning to form from October to December 2002.
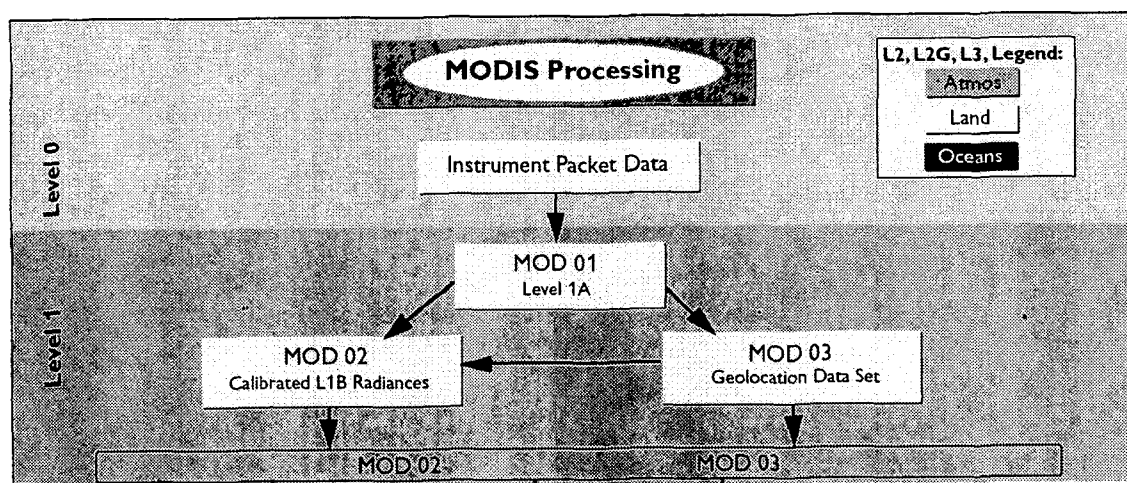

Fig. 3 MODIS Data Processing Architecture

At NASA, the MODIS level 0 to level 1 processing is done by the Goddard Distributed Archive Center (DAAC). The MODIS science product processing, MODIS level 2 to 4 processing, is done by the MODIS Adaptive Data Processing System (MODAPS) from calibrated and geolocation data set. The MODIS science products are delivered to the MODIS Science Team for quality assurance and to DAACs for distribution to the user community as shown in Fig. 4. Recently, MODAPS completed the reprocessing of all MODIS data from November 2000 to September 2002 and MODIS products from level 1 to level 4 are now available from NASA DAACs. These products are stored at one of three DAAC's; namely, the Goddard DAAC (for atmospheric and ocean products), the EROS Data Center (EDC) DAAC (for land products) and the National Snow and Ice Data Center (NSIDC) DAAC (for snow and ice cover). The MODIS data can be accessed via EOS Data Gateway (EDG) and instructions on how to use the EDG can be achieved in the MODIS Home Page at : http://modis.gsfc.nasa.gov/data/ordering.html or http://redhook.gsfc.nasa.gov/~imswww/pub/imswelcome/.
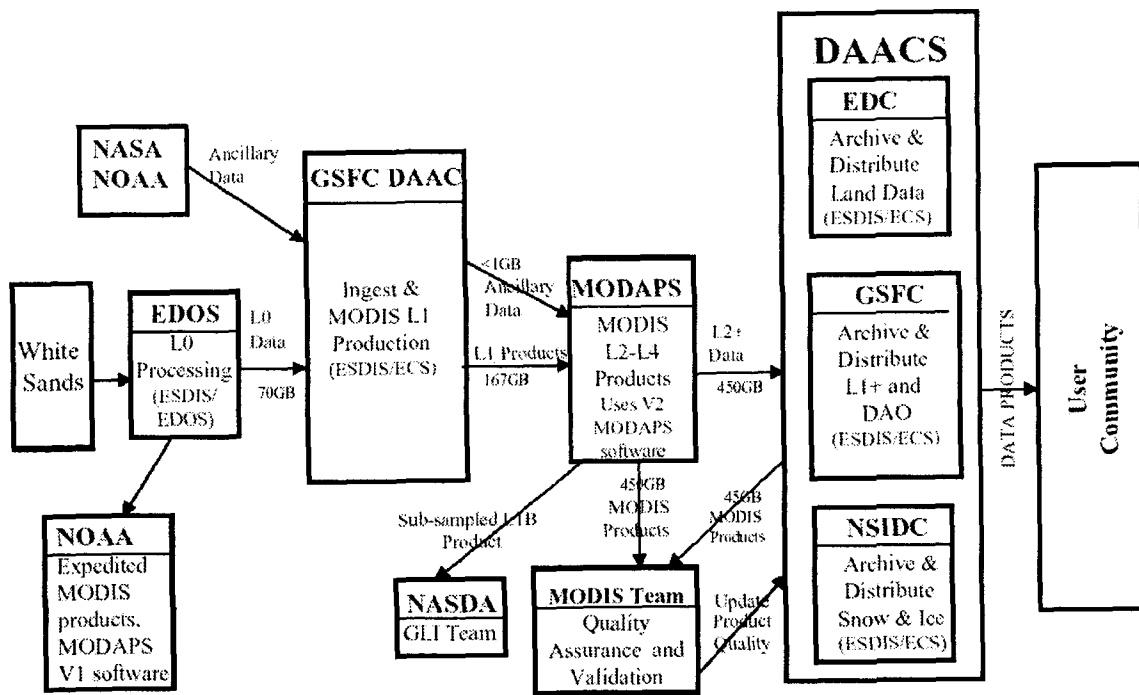
NASA NOAA   Ancillary Data

GSFC DAAC
Ingest & MODIS L1 Production (ESDIS/ECS)

EDOS
L0 Processing (ESDIS/ EDOS)
L0 Data
70GB

White Sands

NOAA
Expedited MODIS products. MODAPS V1 software

MODAPS
MODIS L2-L4 Products Uses V2 MODAPS software

<1GB Ancillary Data
L1 Products
167GB

DAACS
EDC
Archive & Distribute Land Data (ESDIS/ECS)

GSFC
Archive & Distribute L1+ and DAO (ESDIS/ECS)

NSIDC
Archive & Distribute Snow & Ice (ESDIS/ECS)

L2+ Data
450GB

450GB MODIS Products

Sub-sampled 1TB Product

NASDA GLI Team

MODIS Team
Quality Assurance and Validation

Update Product Quality

DATA PRODUCTS

User Community

Fig. 4 Data Product Flow during MODIS Processing

3. MODIS DATA DISTRIBUTION BY KARI

KARI is in preparation to distribute the MODIS level 1 data to users in Korea. First of all, database of Terra/MODIS and Aqua/MODIS has been designed and constructed by KARI engineer. Everyone can be a member of MODIS data user group if he has a research interest in any fields, such as land, atmosphere and ocean, using MODIS data. KARI will send a survey sheet which is consisted of questions, whether possible users have some interest in MODIS data. From October to December 2002, the survey will be carried out to know whom will use MODIS data for their research The direct broadcast MODIS level 1 data can be ordered using the access methods at home page of Korea Remote Sensing Center (KRSC). The home page of KRSC will be open at the end of this year and MODIS data ordering system will be installed in the home page.

4. CONCLUSIONS

The KARI is preparing for distribution of direct broadcasted MODIS data, which has been received from July 2002, to users in Korea. The MODIS database system will be designed and developed by KARI engineer for data distribution service from year of 2003. MODIS data user group will be organized from October to December 2002 and they will be able to access the data through the home page of KRSC.