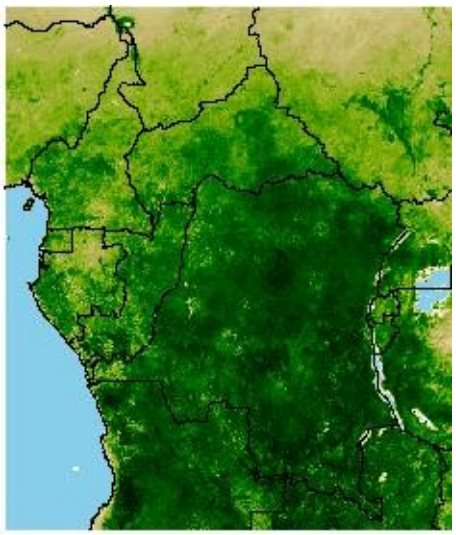
PRACTICE PROJECT



Normalized Difference Vegetation Index Comparaison
in
Democratic Republic Congo (Zaire)
Central Africa

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Summary

I. SATELLITES .

GENERAL :

The principal types of satellites are: communication satellites, navigation satellites, reconnaisance satellites and weather satellites. Major scientific research satellites include many Explorer satellites and various orbiting observartories such as the hubble space telescope. Reactor Soviet or Russian space-science satellites programs include Electron and many cosmos satellites.

HISTORY :

a- artificial satellites :

Object launched by Rocket into orbit around Earth or ocassionaly, another solar-system body. A satellite in circular orbit at an altitude of 22,300 miles(35,880 km) has a period of exactly 24hr , the time it takes the Earth to rotate once on is axis such an orbits is called synchronous. If such an orbit also lies in the equatorial plane, it is called geostationary, because the satellite will remain stationary over one point on the Earth's surface.

The first Satellit, from SPUTNIK 1, was launched by USSR on Oct 4 1957 the economic and the recherche possibility utulisation from the object Flying with propulsion raket and the first American satellite was launched on Jan 31 1958.

A big recherche from Weather Satellit TIROS and from 1964 NIMBUS(only USA) was one for the better solution. The Informations satellit TELESTAR(1962), RELAY, SYCOM (passiv) and EARLY BIRD present a new method with remote sensing from Information for City to City in the Earth.

In the reality we are having three model from Flying Object: Weather Satellit, Space Shuttle and Information Satellit.

Weather Satellit and Space shuttle are taking Information from Space and translate to a the station in the Earth to, but the Information Satellit giving to the resolution or the problem solution.

The three Flying object group having following anonymous: not man , the propulsion with a raket, and the electric part has be taking from the accumulator, in the solar system. All three objects accept the measure transmittions(TELEMETRIC) over the bord condition and Space shuttle(temperature, magnetic, etc ...).

The direction profil from the Solar satellit (LUNAR ORBITER) looking like that: first after starting and propulsion, coming in the atlas with propulsion raket , after we having division for the atlas, and later the first allumage from the agena reactor, first entrance in the Park corridor, the second allumage from the agena reactor, entrance in the mond corridor, division from the agena then Solar surface cellular and the antenne be going in the conduction, then they will be having a better direction in the solar and Canopus. The first corridor correction , then we will now change to the second corridor correction after the

entrance in the beginner Mond corridor, later the entrance in the corridor for photo activities and we are now in the photographic region.

We can starting with the operation from the earth, with our Earth Station to have a Spatial Data from the earth.

b- communication satellite :

Artificial satellite that provides a worldwide linkup of radio and television transmission and telephone service, such a satellite avoids the curvature-of the-earth limitation forely placed on comunications between ground based facilities.

The first comunications satellites was NASA's echo 1, an uninstruented infatible sphere that passively reflected radio signals back to earth.Domestic counications satellites also geostationary, have been launched by any nations, including Canada , the USSR (now russia) and Indonesia and by several private U.S companies. Milatary satellite system have been developed by the U.S and NATO.

c- navigation satellite :

Artificial satellite designed expressly to aid navigation at sea, in the air and on land. Two major navigational system have been launched into orbit, both by the U.S. In the transit system (first launch 1960) a navigator deterines a ship's position by easering the Doppler shift, in radio signals from a transit satellite passing overhead.

d- reconnaisance satellite :

Artificial satellite launched by country to provide intelligence information on the military activities of foreign countries. There are four major types. Early-warnig satellites detect any missile launchings. Nuclear-explosion detected satellites are designed to detected and indentify nuclear explosions in space. Photo-surveillance satellites provide photographs of any military activities e.g the deployment of intercontinental ballistic missiles deployment of intercontinental ballistic missiles(ICBMs). There are two subtypes, close look satellites and area-survey satellites.

Other satellites use radar to provide mirages of any activities when there is cloud cover or it is dark. The U.S and russia before 1991, the USSR have launched numerous reconnaince satellite since 1960.

e- weather satellite :

Artificial satellite used together data on a global basis for improvement of weather forecasting. Information is provided about cloud cover, strom location, temperature and heat balance in the earth's atmosphere. The first experimental weather satellite was Tiros 1, launched by the U.S in 1960. The U.S National Operational etereological System consists of both polar-orbiting and geostationary satellites.

f- observatory, orbiting :

Reasearch satellite designed to study solar radiation, electromagnetic radiation from distant stars, the Earth's atmosphere, or the like. The orbiting solar Observatory program comprised

seven satellites, launched between 1962 and 1971, to study the sun's atmosphere and the sunspot cycle. The orbiting Geophysical Observatory program consisted of six satellites launched between 1964 and 1969, that provided data on the earth's Atmosphere, ionosphere, and magnetosphere and on the Solar wind.

g- satelitte, natural :

Celestial body Orbiting a planet or asteroid. The Earth's only satellite is the MOON, thus satellite of other plantes are often refereed to as oons. The largest in the solar system is jupiter's Ganyede, whose radius of 1,639 mi(2,638 k) is larger than that of the planet mercury.

h- moon :

The single natural satellite of the earth. The lunar orbit is elliptical , and the average distance of the moon from the Earth is about 240,00 mi (385,00 k). The moon's orbital period is around the earth, and also ist rotation period's is 27.332 days.

DEFINITION :

(*)Artificial Flying Body in the Earth Orbit. The Big Satellit we will be frequently a plattform describe. Satellit from Space Shuttle have been taking from free airplane.

The Satellit is in the general Form, from the Satellitbus and from one montage for the unless. The Satellit Shuttle is mechanic carrier structur and have all from unless with general system like the Energy (Solar panal , batterie Power Distribution Unit PDU etc..)

Record the description from the data, communication, the regulation from high water at home, the system regeln (AOCS , Altitude and Orbit Control System)

The segment space: In the small and the same description for the satellit capsel , Space station or the same component with the Earth Orbit. streeckly speaking down and space sonde in to Orbit interplanete or the Earth Orbit and the others Flying Object under the over attack space segment 'end to end 'satellit system have the component from the space and flow component.

* (DLR Glossar Fernekundung und Umweltforschung: Begriffe und Erlauterung vorlaufige version Dezember 1995).

Figure 1: Plan from the condunce to send and receive antenne.

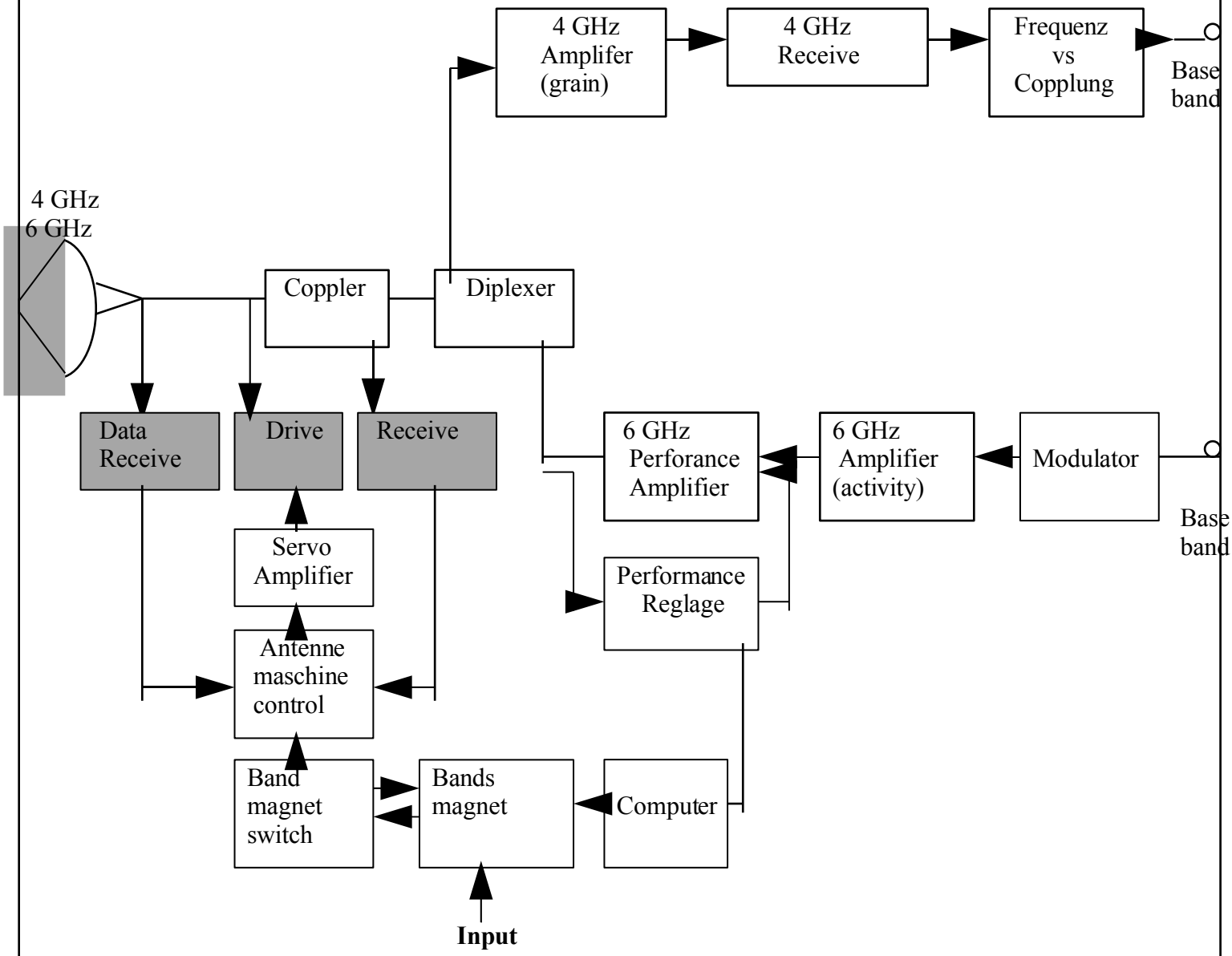
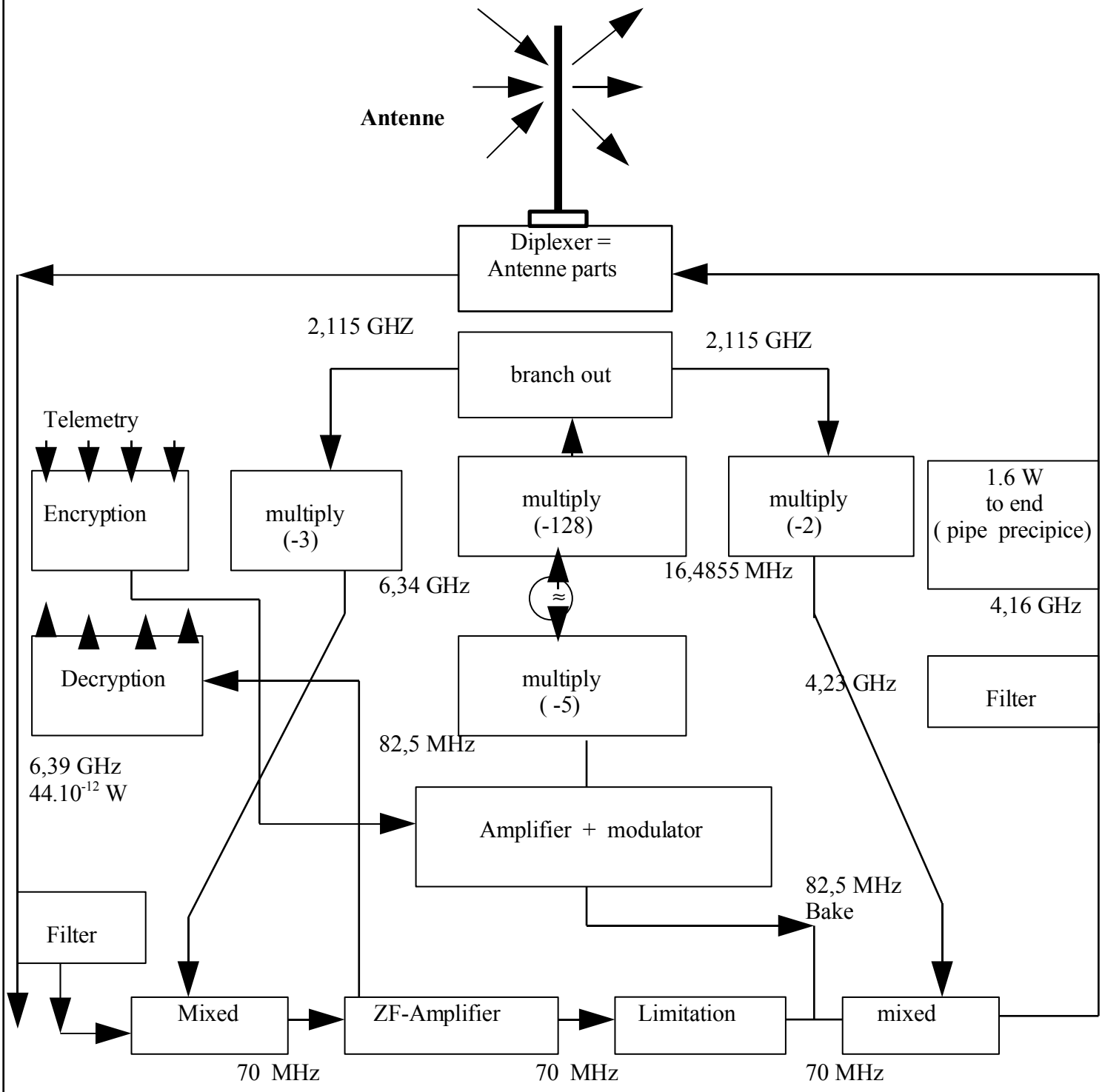


Figure . 2 Antenne converter to satellit :



II. Normalized Difference Vegetation Index (NDVI)

DEFINITION :

Is the calculate methods, from difference reflector for the vegetation, red and infrared spectral. Vegetation have every time doing different room object.

If we have a high value, than is the vegetation very high. The vegetation index must be define with many vegetation indexes.

- NOAA.AVHRR.NDVI(Level 3)

DEFINITION :

Is one parts from satellite with addition from indexes for the products, parts from DLR/DFDs NOAA AVHRR Sensor, activ. The result are in Day, Weeks and in the month NDVI (Normalized Difference Vegetation Index) resume in the Maps orientation from Country, with study of the Earth.

Procedure schema and Algorithms :

Input :

Calibration and Navigation NOAA-11 or 14 Days data in the TeraScan Forat decompress from HRPT(High Resolution Picture Transmission) data.

Calibration :

The VIS and Infrarot Data (Canal 1 and 2) Calibrate from material to % technic , albedo. For NOAA=11 AVHRR Time-paste calibration from Coefficient receive to application. For AVHRR to NOAA-14, bevor-fly parameter which we are working between 19 january until 11 November, 1996. An the 31 July, NOAA NESDIS have a new Calibration to, Coefficient, with that we are calculate to all product between 22 November 1995, and 11 November 1996, The parameter from Calibration haven in month NOAA/NESDIS. The new indexes was first in DLR/DFD production calender, and are now applicate.

General Calculation :

The NDVI calculate :

NDVI = Near Infrared - Red / Naear Infrared + Red

to NOAA –AVHRR is :

Canal 2 – Canal 1 / Canal 2 + Canal1.

- Water Reflection :

* Options and Concentrations for organic and non-organic material.
* Low from body water.
* Rough from space water.

- Vegetation Reflection :

Deminations for Reflection behand :
* Phanologic state or condition
* Part concentration
* Arts conclusions
* Oldier
* Water procent
* Homogenity
* Surface composite organic branches
* Surface Branches estimate

- Informations procent for NDVI :

The Vegetationsindex as normalise Difference (NDVI) :

* base of the art , that better live , activ Vegetation in the Spectral to in Red small and in the NDVI Infrared strong reflection.

NOAA AVHRR Normalized Difference Vegetation Index Maps (NDVI)

Source, Image Characteristics, and Processing.

This product is part of DLR's AVHRR land pathfinder activities. The goal of the product is to provide the user daily, weekly and monthly NDVI synthesis maps in a defined format easy to access with the highest possible reliability on the thematic quality.

After a phase of tests between March and June 1994, the operational production chain was launched on July 1, 1994. Since then, daily, weekly and monthly NDVI synthesis maps covering the European continent were available until September 13, 1994, when the AVHRR on board the NOAA-11 spacecraft failed. The production of daily, weekly and monthly NDVI maps was resumed on February 20, 1995, based on NOAA-14
AVHRR data.

Special emphasis is given to a precise image registration and a reasonable cloud screening procedure to ensure that only cloudfree pixels are taken for the later process of composition. Due to the importance of these two tasks, the generation of the NDVI products is a mixture of unsupervised pre-processing steps and a supervised parametrization of the cloud tests and an image navigation control. Thus, before an image was sent to the data archive and becomes available to the user, it was manually controlled regarding the navigation quality and the cloud tests.

All NDVI products consist of one NDVI channel. The major processing steps are descibed below:

Automatic pre-navigation / Interactive supervision Firstly, a process of auto-navigation is performed using WDB-II coastline and river data to improve the accuracy of the geo-referenzation given by the daily updated "twoline elements". This processing is done over the

entire pass before the remapping procedure is applied. Firstly, appropriate coastline areas with significant features are selected in 1deg*1deg boxes and tested regarding cloudiness.
For the remaining cloudfree boxes a cross correlation algorithm between the "real" coastline in the satellite image and the coastline of the reference data set is performed. Based on the yielding vector array the satellite's yaw, pitch, tilt, and roll angles are corrected.
The complete procedure is first done unsupervised, then the results of the navigation process are checked and if necessary corrected manually. Therefore, best possible quality is guaranteed.

Calibration :

The solar channels 1 and 2 are calibrated into % technical albedo as described by NOAA. For the NOAA-11 AVHRR, pre-launch calibration coefficients were applied for all products between July 1994 and September 1994. Time-adjusted coefficients provided by TEILLET & HOLBEN will be applied for all NOAA-11 data. For the NOAA-14 AVHRR, pre-launch coefficients were used between January 19, 1995, and November 21,1995. On July 31, 1995, NOAA NESDIS published new calibration post-launch coefficients which were applied for all products between November 22, 1995 and November 11, 1996. Since November 12, 1996, the calibration coefficients have been updated once a month by NOAA NESDIS and these updates will be implemented in DFD's production chain after availability.

(Only for costumer-oriented, retrospective production, the calibration coefficients will be determined for each scene using a piecewise linear interpolation method between the existing updates.)

Calibration coefficients for AVHRR channels 1 and 2 are listed below:

Satellite	Year	Day#	Ch1 Slpe	Ch1 Icpt	Ch2 Slpe	Ch2 Icpt
NOAA-11	1988	006	0.0906	-3.73	0.0827	-3.39
	1989	001	0.11472	-4.00475	0.11877	-3.99948
	1990	001	0.11898	-4.00203	0.12883	-4.00106
	1991	001	0.11425	-4.00015	0.12639	-3.99663
	1992	001	0.11745	-3.99482	0.12584	-3.98518
NOAA-14						
	1995	001	0.1081	-3.8648	0.1090	-3.6749
	1995	214	0.1115	-4.5715	0.1337	-5.4817
	1996	317	0.1257	-5.1537	0.1544	-6.3304
	1996	345	0.1255	-5.1444	0.1555	-6.3748
	1997	014	0.1263	-5.1786	0.1568	-6.4299

Day# : Number of Day of JULIAN DATE CALENDAR
Ch1(2) Slpe : Slope for Channel 1(2)
Ch1(2) Icpt : Intercept for Channel 1(2)

The thermal infrared data (channels 3,4, and 5) are converted from raw counts to radiances and then into brightness temperatures by inverting the PLANCK function.

The solar channels are used to calculate the NDVI, the thermal data are used in conjuction with the solar channels to perform the cloud/water detection algorithm.

Cloud / water detection :

To ensure that only NDVI values over cloudfree land surfaces are derived, a couple of cloud/water tests are performed. They are based on the principal spectral characteristics of land, water, and cloud surfaces. The applied thresholds may vary from case to case with regard to the specific characteristics of every single pass. The procedure is performed in two steps:

(1) Arid surface test :

The first four combined tests are used to calculate valid NDVI values over arid areas, where cloudfree areas are assumed to be warm and bright. Because some arid areas are brighter than clouds, these would be flagged as cloudy using an adequate maximum channel 2 brightness threshold for cloudfree vegetated areas. If all conditions are true, the NDVI values are calculated.

(2) The second set of tests determines whether a pixel is cloud/water contaminated or not. If one test is true, the pixel is flagged as cloud or water and excluded from further NDVI processing. For all remaining pixels the NDVI is calculated.

The cloud/water detection scheme is listed below. It was developed by Dr. Stefan Dech at DFD's Value Adding & Visualization group (VAV), 1994 (Copyright DLR 1995).

```
IF  CHANNEL_2_ALBEDO       > VALUE (land brightness)    AND
    CHANNEL_4_BBT          > VALUE (land temperature)   AND
    CHANNEL_4-5_BBT_DIFF   < VALUE (thin clouds)        AND

SATELLITE_ZENITH_ANGLE  < VALUE (Geometry limit)    THEN
    Calculate NDVI
        ELSEIF   CHANNEL_2_ALBEDO   < VALUE (max water brightness) OR
                 CHANNEL_2_ALBEDO   > VALUE (max land brightness)  OR
                 CHANNEL_4_BBT      < VALUE (max cloud temp)       OR
                 CHANNEL_4-5_BBT_DIFF  > VALUE (thin clouds)       OR
                 CHANNEL_3-4_BBT_DIFF  > VALUE (water clouds)      OR

            SATELLITE_ZENITH_ANGLE > VALUE (Geometry limit) THEN
            CLOUD or WATER
            ELSE   Calculate NDVI
```

Derivation of the Normalized Difference Vegetation Index:

The formula which is applied based on the AVHRR channels 1 (RED) and 2 (NIR):

$$\mathbf{NDVI = (NIR - RED) / (NIR + RED)}$$

No atmospheric corrections are presently performed. For the future, it is planned to calculate NDVI values applying an atmospheric correction algorithm developed by Dr. Thomas Popp (DLR). Preparations are in progress.

- Remapping :

The data are remapped into a Stereographic projection with a given geometrical resolution of 1.1132 km at the center of the satellite map at 51.00 N / 15.00 E. The "nearest neighbor" technique is applied to resample the pixels into the map. The total size of the maps is 4100 samples * 4300 lines.

- MV Compositing / synthesis :

Via ISIS, daily, weekly and monthly maps are accessable. Daily maps are composed based on the Maximum Value (MV) at every pixels' position which normally consist of three consecutive

NOAA-14 passages (east, central, west). From these, weekly and monthly synthesis maps are derived taking the daily MV.

- Note : If there is a special user request (e.g. 10-day maximum NDVI, or averages) all single scenes are available in an off-line archive and can be composed with regard to the specific requirements. In that case, please contact the VAV group at DFD (see below).

- Ocean masking :
A WDB-II based land/sea mask in 1 km geometrical resolution is used to mask out remaining NDVI values over ocean areas (e.g. under sunglint conditions). The land/sea mask was created by Gerhard Gesell (DFD).

- Integer scaling
The NDVI data are scaled from their original 10-bit format into the user-friendly 8-bit integer format (values from 0-255). The NDVI values are stored as follows: Greyvalue "0" is referred to "WATER", greyvalue "255" is reserved for "CLOUD" and "NO DATA". The NDVI range starts with "-0.09968454" and is referred to greyvalue "1". The radiometric resolution is "0.0031546", greyvalue 254 is therefore referred to value "0.7" (maximum NDVI). Values below NDVI_MIN are set to NDVI_MIN and values above NDVI_MAX are set to NDVI_MAX.

- NOTE : White triangles in particular in Northern Africa can be seen in the daily NDVI composites (value 255 in the original data sets). They are the edges of the subsequent overpasses opening approching the equator direction where no pass overlapping appears. The triangle size may vary depending on the daily pass geometry and the satellite zenith angle threshold used to limit NDVI calculation close the pass edges.

- Geographical coverage:

The frame coordinates of the NDVI product are:

UL 64.229 N / 35.440 W UR 64.229 N / 65.440 E LL 27.262 N / 07.152 W LR 27.262 N / 37.152 E.

- Temporal Coverage :

One daily NDVI map is composed using three consecutive NOAA-14 acquisitions at noon LT. Weekly and monthly maps are composed based on the daily maximum images using the maximum NDVI for every single pixels' position. Thus, a week composite normally consists of 21 AVHRR passes, a monthly synthesis map of about 90 passes.

- Data Format :

One NDVI map consists of 1 layer in 8-bit resolution with the above given size. The used data format is VFF Raster Standard Format. Other formats (ERDAS LAN, SUNRASTER, etc.) are available. The Quicklooks are stored in JPEG Format. The Europe NDVI map consists of 17.63 Mbyte (uncompressed). A very high compression rate can be achieved for the NDVI products.

- Products :
Digital browse quicklooks can be accessed via network. Small quicklooks of the NDVI maps show the distribution of the NDVI using a color-code. The colar scale starts with brown, which indicates very low NDVIs (down to -0.1) and ends with dark green, which stands for high NDVIs. Ocean and lake areas are blue, and clouds are white.

III. Central Africa Region (Democratic Republic Congo) Coordinantes.

A - Republic Democratic Congo Regions Coordinates.
B - Forrrest and Tropic Region in the Republic Democratic Congo Coordinates.

We look the parts in most coordinates forrest Central Africa (Democratic Republic Congo). Nature region in tropic, and rain forrest in Africa.

The picture caption for climatic phenomene like rain time or cylcon , example vegetation bamboo, board racine, other Nature forms and Animals must be examine.

- Rivers
- Forrest
- Rain time
- Tropic
- Erosion.
- Animals Regions
- Vegetationszone
- Mount Forrest
- North, South, Western, Eastern Congo

A- Republic Democratic Congo Coordinates:

Location: Central Africa, northeast of Angola
Geographic coordinates: 0 00 N, 25 00 E

Map references: Africa
Area:
Total: 2,345,410 sq km
Land: 2,267,600 sq km
Water: 77,810 sq km

Area—comparative: slightly less than one-fourth the size of the US

Land boundaries:
total: 10,271 km
border countries: Angola 2,511 km, Burundi 233 km, Central African Republic 1,577 km, Republic of the Congo 2,410 km, Rwanda 217 km, Sudan 628 km, Uganda 765 km, Zambia 1,930 km.

Coastline : 37 km.

Maritime claims :
exclusive economic zone: boundaries with neighbors
territorial sea : 12 nm

Climate : tropical ; hot and humid in equatorial river basin; cooler and drier in southern highlands; cooler and wetter in eastern highlands; north of Equator—wet season April to October, dry season December to February; south of Equator—wet season November to March, dry season April to October

Terrain: vast central basin is a low-lying plateau; mountains in east

Elevation extremes:
lowest point: Atlantic Ocean 0 m
highest point: Pic Marguerite on Mont Ngaliema (Mount Stanley) 5,110 m

Natural resources: cobalt, copper, cadmium, petroleum, industrial and gem diamonds, gold, silver, zinc, manganese, tin, germanium, uranium, radium, bauxite, iron ore,
coal, hydropower potential, timber

Land use:
arable land: 3%
permanent crops: 0%
permanent pastures: 7%
forests and woodland: 77%
other: 13% (1993 est.)

Irrigated land: 100 sq km (1993 est.)

Natural hazards: periodic droughts in south; volcanic activity
Environment—current issues: poaching threatens wildlife populations; water pollution; deforestation; refugees who arrived in mid-1994 were responsible for significant deforestation, soil erosion, and wildlife poaching in the eastern part of the country (most of those refugees were repatriated in November and December 1996)

Environment—international agreements:
party to: Biodiversity, Climate Change, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Nuclear Test Ban, Ozone Layer Protection, Tropical Timber 83, Tropical Timber 94, Wetlands signed, but not ratified: Environmental Modification

Geography—note: straddles Equator; very narrow strip of land that controls the lower Congo river and is only outlet to South Atlantic Ocean; dense tropical rain forest
in central river basin and eastern highlands

People

Population: 50,481,305 (July 1999 est.)

Age structure:
0-14 years: 48% (male 12,200,532; female 12,136,372)
15-64 years: 49% (male 12,135,901; female 12,692,057)
65 years and over: 3% (male 564,084; female 752,359) (1999 est.)

Population growth rate: 2.96% (1999 est.)
Birth rate: 46.37 births/1,000 population (1999 est.)
Death rate: 14.99 deaths/1,000 population (1999 est.)

Net migration rate: -1.78 migrant(s)/1,000 population (1999 est.)
note: in 1994, about a million refugees fled into Zaire (now called the Democratic Republic of the Congo or DROC), to escape the fighting between the Hutus and the Tutsis in Rwanda and Burundi; the outbreak of widespread fighting in the DROC between rebels and government forces in October 1996 spurred about 875,000 refugees to return to Rwanda in late 1996 and early 1997; additionally,the DROC is host to 200,000 Angolan, 110,000 Burundi, 100,000 Sudanese, and 15,000 Ugandan refugees; renewed fighting in the DROC in August 1998 resulted in more internal displacement and refugee outflows

Sex ratio:
at birth: 1.03 male(s)/female

under 15 years: 1.01 male(s)/female
15-64 years: 0.96 male(s)/female
65 years and over: 0.75 male(s)/female
total population: 0.97 male(s)/female (1999 est.)

Infant mortality rate: 99.45 deaths/1,000 live births (1999 est.)

Life expectancy at birth:
total population: 49.44 years
male: 47.28 years
female: 51.67 years (1999 est.)

Total fertility rate: 6.45 children born/woman (1999 est.)

Nationality:
noun: Congolese (singular and plural)
adjective: Congolese or Congo

Ethnic groups: over 200 African ethnic groups of which the majority are Bantu; the four largest tribes—Mongo, Luba, Kongo (all Bantu), and the Mangbetu-Azande
(Hamitic) make up about 45% of the population

Religions: Roman Catholic 50%, Protestant 20%, Kimbanguist 10%, Muslim 10%, other syncretic sects and traditional beliefs 10%

Languages: French (official), Lingala (a lingua franca trade language), Kingwana (a dialect of Kiswahili or Swahili), Kikongo, Tshiluba

Literacy:
definition: age 15 and over can read and write French, Lingala, Kingwana, or Tshiluba
total population: 77.3%
male: 86.6%
female: 67.7% (1995 est.)

Government

Country name:
conventional long form: Democratic Republic of the Congo
conventional short form: none
local long form: Republique Democratique du Congo
local short form: none
former: Belgian Congo, Congo/Leopoldville, Congo/Kinshasa, Zaire
abbreviation: DROC

Data code: CG

Government type: dictatorship; presumably undergoing a transition to representative government

Capital: Kinshasa

Administrative divisions: 10 provinces (provinces, singular—province) and one city* (ville); Bandundu, Bas-Congo, Equateur, Kasai-Occidental, Kasai-Oriental,

Katanga, Kinshasa*, Maniema, Nord-Kivu, Orientale, Sud-Kivu

Independence: 30 June 1960 (from Belgium)

National holiday: anniversary of independence from Belgium, 30 June (1960)

Constitution: 24 June 1967, amended August 1974, revised 15 February 1978, amended April 1990; transitional constitution promulgated in April 1994; following successful rebellion the new government announced on 29 May 1997 a program of constitutional reform and, in November 1998, a draft constitution was approved by President KABILA and awaits ratification by national referendum

Legal system: based on Belgian civil law system and tribal law; has not accepted compulsory ICJ jurisdiction

Suffrage: 18 years of age; universal and compulsory

Executive branch:
chief of state: Laurent Desire KABILA (since 17 May 1997); note—the president is both chief of state and head of government head of government: Laurent Desire KABILA (since 17 May 1997); note—the president is both chief of state and head of government cabinet: National Executive Council, appointed by the president elections: before Laurent Desire KABILA seized power, the president was elected by popular vote for a seven-year term; election last held 29 July 1984 (next was to be held in May 1997); formerly, the prime minister was elected by the High Council of the Republic; note—the term of the former government expired in 1991, elections were not held, and former president MOBUTU continued in office until his government was militarily defeated by KABILA on 17 May 1997 election results: MOBUTU Sese Seko Kuku Ngbendu wa Za Banga reelected president in 1984 without opposition note: Marshal MOBUTU Sese Seko Kuku Ngbendu wa Za Banga was president from 24 November 1965 until forced into exile on 16 May 1997 when his government was overturned militarily by Laurent Desire KABILA, who immediately assumed governing authority; in his 29 May 1997 inaugural address, President KABILA announced a two-year time table for political reform leading to elections by April 1999; subsequently, in December 1998, President KABILA announced that elections would be postponed until all foreign military forces attempting his overthrow had withdrawn from the country

Legislative branch: legislative activity has been suspended pending the establishment of KABILA's promised constitutional reforms and the elections to be held by April 1999 (now postponed indefinitely) elections: the country's first multi-party presidential and legislative elections had been scheduled for May 1997 but were not held; instead KABILA overthrew the MOBUTU government and seized control of the country

Judicial branch: Supreme Court (Cour Supreme) :

Political parties and leaders: sole legal party until January 1991—Popular Movement of the Revolution or MPR [leader NA]; note—may be replaced by Union for the Republic or UPR [leader NA]; other parties include Union for Democracy and Social Progress or UDPS [Etienne TSHISEKEDI wa Mulumba]; Congolese Rally for Democracy or RCD [Ernest WAMBA dia Wamba]; Democratic Social Christian Party or PDSC [Andre BO-BOLIKO]; Union of Federalists and Independent Republicans or UFERI [Gabriel KYUNGU wa Kumwunzu]; Unified Lumumbast Party or PALU [Antoine GIZENGA] note: President KABILA, who has banned political party activity indefinitely, currently leads the Alliance of Democratic Forces for the Liberation of Congo-Zaire orAFDL

International organization participation: ACCT, ACP, AfDB, CCC, CEEAC, CEPGL, ECA, FAO, G-19, G-24, G-77, IAEA, IBRD, ICAO, ICFTU, ICRM, IDA, IFAD, IFC, IFRCS, IHO, ILO, IMF, IMO, Intelsat, Interpol, IOC, IOM (observer), ITU, NAM, OAU, OPCW, PCA, SADC, UN, UNCTAD, UNESCO, UNHCR, UNIDO, UPU, WCL, WFTU, WHO, WIPO, WMO, WToO

Flag description: light blue with a large yellow five-pointed star in the center and a columnar arrangement of six small yellow five-pointed stars along the hoist side

Economy :

Economy—overview: The economy of the Democratic Republic of the Congo—a nation endowed with vast potential wealth—has declined significantly since the mid-1980s. The new government instituted a tight fiscal policy that initially curbed inflation and currency depreciation, but these small gains were quickly reversed when the foreign-backed rebellion in the eastern part of the country began in August 1998. The war has dramatically reduced government revenue, and increased external debt. Foreign businesses have curtailed operations due to uncertainty about the outcome of the conflict and because of increased government harassment and restrictions. Poor infrastructure, an uncertain legal framework, corruption, and lack of transparency in government economic policy remain a brake on investment and growth. A number of IMF and World Bank missions have met with the new government to help it develop a coherent economic plan but associated reforms are on hold.

GDP: purchasing power parity—$34.9 billion (1998 est.)
GDP—real growth rate: -3.5% (1998 est.)
GDP—per capita: purchasing power parity—$710 (1998 est.)
GDP—composition by sector:
agriculture: 59%
industry: 15%
services: 26% (1995 est.)

Population below poverty line: NA%

Household income or consumption by percentage share:
lowest 10%: NA%
highest 10%: NA%

Inflation rate (consumer prices): 147% (1998 est.)

Labor force: 14.51 million (1993 est.)
Labor force—by occupation: agriculture 65%, industry 16%, services 19% (1991 est.)

Unemployment rate: NA%

Budget:
revenues: $269 million
expenditures: $244 million, including capital expenditures of $24 million (1996 est.)

Industries: mining, mineral processing, consumer products (including textiles, footwear, cigarettes, processed foods and beverages), cement, diamonds

Industrial production growth rate: NA%
Electricity—production: 6.4 billion kWh (1996)
Electricity—production by source:
fossil fuel: 6.25%
hydro: 93.75%
nuclear: 0%
other: 0% (1996)

Electricity—consumption: 6.265 billion kWh (1996)
Electricity—exports: 195 million kWh (1996)
Electricity—imports: 60 million kWh (1996)

Agriculture—products: coffee, sugar, palm oil, rubber, tea, quinine, cassava (tapioca), palm oil, bananas, root crops, corn, fruits; wood products

Exports: $1.6 billion (f.o.b., 1998 est.)
Exports—commodities: diamonds, copper, coffee, cobalt, crude oil
Exports—partners: Benelux 43%, US 22%, South Africa 8%, France, Germany, Italy, UK, Japan (1997)

Imports: $819 million (f.o.b., 1998 est.)

Imports—commodities: consumer goods, foodstuffs, mining and other machinery, transport equipment, fuels

Imports—partners: South Africa 21%, Benelux 14%, China 8%, Netherlands, US, France, Germany, Italy, Japan, UK (1997)
Debt—external: $15 billion (1997 est.)
Economic aid—recipient: $195.3 million (1995)
Currency: Congolese franc (CF)
Exchange rates: Congolese francs (CF) per US$1—2.5 (January 1999); new zaires (Z) per US$1—115,000 (January 1998), 83,764 (October 1996), 7,024 (1995),
1,194 (1994)
note: on 30 June 1998 the Congolese franc (CF) was introduced, replacing the new zaire; 1 Congolese franc (CF)=100,000 new zaires

Fiscal year: calendar year

Communications

Telephones: 34,000 (1991 est.)
Telephone system:
domestic: barely adequate wire and microwave radio relay service in and between urban areas; domestic satellite system with 14 earth stations international: satellite earth station—1 Intelsat (Atlantic Ocean)

Radio broadcast stations: AM 10, FM 4, shortwave 0
Radios: 3.87 million (1992 est.)

Television broadcast stations: 18 (1997)
Televisions: 55,000 (1992 est.)

Transportation
Railways:
total: 5,138 km (1995); note—severely reduced route-distance in use because of damage to facilities by civil strife narrow gauge: 3,987 km 1.067-m gauge (858 km electrified); 125 km 1.000-m gauge; 1,026 km 0.600-m gauge

Highways:
total: 145,000 km
paved: 2,500 km
unpaved: 142,500 km (1993 est.)

Waterways: 15,000 km including the Congo, its tributaries, and unconnected lakes

Pipelines: petroleum products 390 km
Ports and harbors: Banana, Boma, Bukavu, Bumba, Goma, Kalemie, Kindu, Kinshasa, Kisangani, Matadi, Mbandaka

Merchant marine: none

Airports: 233 (1998 est.)

Airports—with paved runways:
total: 23
over 3,047 m: 4
2,438 to 3,047 m: 3
1,524 to 2,437 m: 14
914 to 1,523 m: 2 (1998 est.)
Airports—with unpaved runways:
total: 210
1,524 to 2,437 m: 21
914 to 1,523 m: 95
under 914 m: 94 (1998 est.)

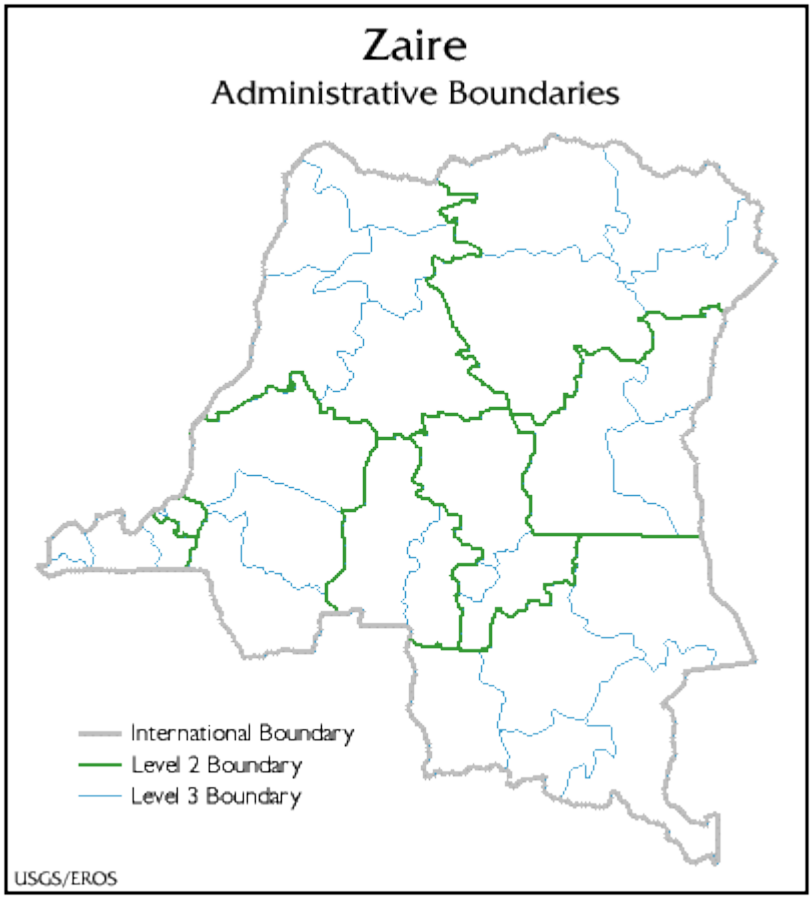
Military

Military branches: Army, Navy, Air Force, Presidential Security Group, Gendarmerie
Military manpower—availability:
males age 15-49: 10,874,744 (1999 est.)
Military manpower—fit for military service:
males age 15-49: 5,536,277 (1999 est.)
Military expenditures—dollar figure: $250 million (1997)
Military expenditures—percent of GDP: 4.6% (1997)

Transnational Issues

Disputes—international: the Democratic Republic of the Congo is in the grip of a civil war that has drawn in military forces from neighboring states, with Uganda and Rwanda supporting the rebel movement which occupies much of the eastern portion of the state; most of the Congo River boundary with the Republic of the Congo is indefinite (no agreement has been reached on the division of the river or its islands, except in the Pool Malebo/Stanley Pool area)

Illicit drugs: illicit producer of cannabis, mostly for domestic consumption


Zaire
Administrative Boundaries
International Boundary
Level 2 Boundary
Level 3 Boundary
USGS/EROS

VI. DEFINITION AND APPLICATIONS :

A . National Oceanic Atmospheric Administration –12 NOAA - Data :

Since October 1978 TIROS-N/NOAA-n satellites provide realtime AVHRR(Advanced Very High Resolution Radiometer) data(KIDWELL 1986). The AVHRR was first tested on the NASA satellite TIROS-N and is flow on NOAA satellites starting with NOAA/6.

The NOAA satellites are typified both by letters and by numbers. The number, however, is not given before a successful launch. Up to now following satellites have been launched:
NOA-A/6, NOAA-C/7, NOAA-E/8, NOAA-F/9, NOAA-G/10 and NOAA-H/11.
NOAA-B and NOAA-D have never become operational.

Besides the AVHRR, the NOAA playload consists of:
* HIRS/2 (High Resolution Infrared Radiation Sounder)
* SSU (Stratospheric Sounding Unit)
* MSU (Microwave Sounding Unit)

They are independent subsystems of the TOVS (TIROS Operational Vertical Sounder). TOVS provides data for computation of vertical atmospheric temperature and humudity profiles, ie for meteorological applications.

Others sensor are :

* SEM (Space Environment Monitor, on NOAA/6 and 10) with three subsystem detectors:
* TED (Total energy Proton and Detector)
* MEPED (Medium Energy Proton and Electron Detector)
* HEPAD (High Energy Proton and Alpha Detector)
* ERBE (Earth Radiation Budget Experiment, on NOAA/9 and 10)

The NOAA Orbit :

As the NOAA satellites follow a sun-synchronous orbit, they pass the polar regions leaving the north pole starboard. The inclination is 90 Grad. The nominal Earth distance of the near circular orbit is 870 Km(SCHWALB 1982). One Orbit is completed within 102 minutes which results in approximaltely 14.1 orbit per day. The orbit shifts from day to day about 3 Grad to the East.

- Satellit in 850 km Heigh , polar , sychron solar.
- Earth orbit from 102 min, it is 14,1 Orbit in Day.
- AVHRR- Instrument calculate that from the system.
- Earth Atmosphere reflect and send resonnace in 5 Spectral canal body pixel large 1.1km
- Receive, Prozess and Archive in DFD since Beginn 80 jahr .
- Product Normalized Diffrence Vegetation Index (NDVI) and Multichannel Sea Surface . and Temperature(MCSST).
- Every Day Maps, Weekly-and Mounth copy.

Refernce Satellite Data :

In the first investigation period in 1989 29 NOAA/11 datasets were processed. They were collected between the beginning of March and the end of june 1989, period including the so-called (long rainy season) from March to May. 47 NOAA/11 datasets were computed in the second study phase from March to December 1990 to describe the vegetation dynamics for the

whole year 1990, including the (long) and (short rainy season). Unfortunately there is a data lack between the 25 th decade and 33 rd decade. It is caused by a communication problem between the data scheduling and the data order at NOAA-SDSD. Therefore the second rainy season from November to December 1990 is incompletely recorded. As the rainy season in 1990 started very early the begin of the vegetation period is not covered by the satellite data.

The time refer to the start of the expousure for each orbit of the satellite. The length of the exposure varies according to the precise orbital path by several minutes and actually there is a corresponding variation in the area of the Earth's surface scanned. The average size of a NOAA overpass is approimately 1400 * 2048 pixels which corresponds to a geographical area of 2700km West to east and 1500 km North to South.

The decade refers to a period in which up to three single NOAA datasets are combined to from one maximum Value Composite(MVC). The time of exposure for single datasets is more or less at the beginning of a decade. It reflects, however, the situation in the previous decade, to which it was therefore attributed, The concept(decade) refers to the Maximum Value Composite corresponding to this period.

B . Advanced Very High Radiometer Resolution :

Mission Context :

AVHRR is the primary sensor operating aboard the NOAA POES series(polar-Orbiting Operational Environmetal Satellites). The Instrument is built by ITT Aerospace of Fort Wayne, Anyone with a broadcasts AVHRR(and other sensor)data continuous;y to the user comminuty.Anyone with a receiving station has access to the data. The prpgramm has evolved over several generations of satellites (TIROS,ESSA,TIROS-M to the TIROS-N series(starting in 1960 with TIROS-1 to the most recent NOAA-14 operational satellite. AVHRR is of VHRR heritage and was first launched on TIROS-N in 1978. The AVHRR instrument flown aboard TIROS-N, NOAA-6, NOAA-8, and NOAA10, has four spectral channels, while the AVHRR sensor aboard NOAA-7, NOAA-9, NOAA11, NOAA-12 and NOAA-14 is providing five spectral channels.

NOTE:
five channel configuration is also referred to as 'AVHRR /2'.

Orbit(average):Sun-sznchronous polar, altitude=800 -850 km (833 km average) , inclination=98-99 Grad, period =102 minutes, repeat cycle = 12 hours, 11 days.

1.2 Sensor Description:

AVHRR (Advanced Very High Resolution Radiometer) is an across-track scanning system. Data output=10 bit, spatial resolution = 1.1 km at nadir and about 6 km at maximum scan (at the swath edges). IFOV= 1.4 mrad (average), scanning rate = 360 per minute, sampling rate 2048 per scan, sample step=0.95 mrad(1.36 samples per IFOV) scan angle (max(=+/- 55,4 Grad from nadir swath width=3000 km aproximatly).

AVHRR is compresed of five modules : Scanner module , electronics module , radiant cooler , optical system and baseplate. The optical system consists of afocal Ceassegrainian telescope with an aperture diameter of 20.3 cm, combined with secondary optics which separate the radiant energy into discrete spectral bands , these are focused onto the respective fields stops. The VIS and the NIR channels(channel 1 and 2) use silicon detectors to measure incident radiation. All IR detectors are cooled to 105 K. Channel Nuber 3 uses InSb detectors, while

channels 4 and 5 use HgCdTe detectors. Radiant cooler : two-stage system(1).

Objectives :

Measurement of radiance data for investigation of clouds, land water boundaries , snow and icextent , sea surface temperature, day and night cloud distribution, vegetation index. The benefit of AVHRR data lies in ist high temporal frequency of coverage global coverage at least once per day.

Applications :

Operational meteorology, oceanography, climatology, vegetation monitoring, land and sea ice observation.

Sensor Operation :

AVHRR is operated continuously on-board of each satellite. The analog sensor data output is digitiliyed on-board at rate of 39,936 samples/s per channel.

Instrument Calibration :

The thermal IR channels are calibrated inflight using a view of a stable blacbody and space as a reference. No inflight visible channel calibration is performed(pre-launch calbration).

Viewing Geometries.

Nadir viewing.

Dataset Information :

DLR/DFD at Oberpfaffenhofen has been tracking NOAA POES satellites in HRPT mode since November 1981 to serve the needs of the national and international user community.

The automatic DFD HRPT station offers a service around the clock(over 1800 passes per year are being received corresponding to 220 Gbyte of HRPT data) . The current (1996) opearation funding level permits tracking of five passes per day, 1 night pass and early-morning pas) The tracking radius is about 3000km , providing coverage of europe and beyond (from Spritybergen to the Sahara and from the Mid=Atlantic to the Ural Mountains and to Lake Aral) . A pass length depends on the S/C orbit in relation to the station. A near zenith pass offers the longest coverage it may contain up to 5600 scan lines in single scene (a scene corresponds to one pass , which in turn corresponds to one image) for a length of up to 7000 km . As of August 1996 more than 16,00AVHRR scenes have been received.

Table 1. The participating high resolution picture transmission receiving stations and their geographic locations

Station	Latitude/Longitude
Casey, Antarctica	66ø17' S 110ø32' E
Terranova Bay, Antarctica	74ø25' S 164ø04' E
Buenos Aires, Argentina	34ø24' S 58ø18' W
Darwin, Australia	12ø23' S 130ø44' E
Hobart, Tasmania, Australia	42ø48' S 147ø18' E
Perth, Australia	32ø06' S 115ø53' E

Townsville, Australia 19ø18' S 146ø48' E
Cachoeira Paulista, Brazil 22ø45' S 45ø00' W
Prince Albert, Canada 53ø12' N 105ø55' W
Maspalomas, Canary Islands 27ø46' N 15ø38' W
Beijing, China 40ø00' N 115ø00' E
Urumqi, China 45ø00' N 85ø00' E
Guanzhou, China 25ø00' N 115ø00' E
Cairo, Egypt 30ø00' N 31ø14' E
La Reunion (France) 20ø52' S 55ø28' E
Oberpfaffenhofen, Germany 48ø03' N 11ø09' E
Scanzano, Italy 37ø54' N 13ø21' E
Tokyo University, Japan 36ø00' N 140ø00' E
Nairobi, Kenya 01ø15' S 36ø45' E
Ulaan Baatar, Mongolia 48ø00' N 107ø00' E
Niamey, Niger 13ø32' N 02ø05' E
Tromsoe, Norway 69ø39' N 18ø56' E
Manila, Philippines 14ø23' N 121ø02' E
Dhahran, Saudi Arabia 26ø13' N 50ø00' E
Jeddah, Saudi Arabia 21ø30' N 39ø15' E
Hartebeesthoek, South Africa 25ø53' S 27ø42' E
Baton Rouge, Louisiana, USA 30ø24' N 91ø10' W
Sioux Falls, South Dakota, USA 43ø44' N 96ø37' W
Wallops Island, Virginia, USA 37ø52' N 75ø27' W

V. RECEIVE AND ANALYSIS FROM DATA :

A. 1999 :

I. Decade January :

- Decade 1:
  Began NDVI in the north congo, a small NDVI points .
- Decade 2:
  Again the same in the north congo modification is small NDVI.
- Decade 3:
  The small NDVI points are now going in the northern part for congo.
- Decade 4:
  In the first until third decade we have the no modification from NDVI in congo but in the regions near congo.

II . Decade February:

- Decade 5 :
  We have a small NDVI component in central , more than one part everywhere in central congo.
- Decade 6 - 8 :
  The decade is the same only into central , we have NDVI points

III. Decade Mars :

- Decade 9 :
  The NDVI points are now in the Southern-West congo, more NDVI points can be everywhere.
- Decade 10 - 11 :
  We haven't any NDVI in congo in this decade.

IV. Decade April :

- Decade 12 - 13 :
  The strong NDVI point are in the middle congo.
- Decade 14 - 15 :
  We have a small NDVI in middle Congo.

V. Decade May:

- Decade 16 :
  Very Strong in the South-eastern Congo.

VI. Decade June and July :

- Decade 17 - 23 :
  The NDVI began in the South parts. decade 17 in the Sourth , decade 18 sorth until Eastern , week 19 , 20 , 21, 22 ,23 all south until western parts.

VII. Decade August and September :

- Decade 24 - 30 :
  Only the parts Sorth until eastern ,one parts in the Matadi City and Lubumbashi part have NDVI.

VIII. Decade October , November and December:
- Decade 31 -35 :
We don't have NDVI points , only Mbandaka city, region Kivu have it. The beginn from NDVI from Bangui city in in central africa republic, are coming in direction congo.

B. 1998

I. Decade January:
- Decade 1 , Decade 2 :
We need informations and pictures for three decade period.
- Decade 3:
From North Eastern are coming some NDVI points , but not in congo territoiry.

II. , III , IV Decade February , Mars and April :
- Decade 4 -5 - 6 -7 - 10 :
Only North Eastern some NDVI points are coming but not everywhere. In sudan very strong NDVI points.

V. Decade Mai :
- Decade 11 -13:
Same NDVI (decade 11 and 12), but now in Kinshasa, south Bandundu, South Kasai regions and Congo-Brazza more in Sudan.

VI. Decade June
- Decade14 - 17:
The NDVI points are in the decade 14 (two or three NDVI points) in Lac Mai
- Ndombe , decade 15 (two or three NDVI) again in the Lac Mai-Ndombe , Decade 16 (NDVI points) in the South Bandundu , Kasai , decade 17 (NDVI points) in the south Bandundu.

VII. Decade July :
- Decade 18 - 19 :
Big NDVI points in the Bas-Congo Region and asmall one in the Bandundu region , in the psrt between Kasai-Occ , strong in the North Bas-Congo, Kabinda, Pointe-Noire until small NDVI points in Kinshasa.
- Decade 20 :
More NDVI in the Atlantic region and strong in the south Bandundu and between Kasai - Occ and South Angola.
- Decade 21 :
Now we have a small points in Bas-Congo , Bandundu , Kasai and North Katanga regions.

VIII. Decade August and September :
- Decade 22 - 23 - 24 - 25 -26:
Decade 22: Very Strong NDVI in the Bas-Congo general until Kinshasa and Inongo Region, than in between Kasai-Occ in the South ,
Decade 23 - 24: than again in the south Western Shaba , very strong until North Katanga Strong in Angola and shaba , Lac Mai-Ndombe and in the regions between Equator and High Congo.
Decade 24 - 25 - 26: Very strong in the Bas-Congo and between middle shaba.

IX. Decade October:
- Decade 27:
No more strong NDVI points in the Bas-congo and in the regions between Lac -Tanganyika and Lac- Moero.
- Decade 28 - 29 :
Decade 28 : More strong NDVI points in the Bas-Congo region and in the middle.
Decade 29 : In the Bas-Congo finish the NDVI points direction Angola with small part NDVI points in The Equator region and Likasi city.

X. Decade November:
- Decade 30 :
All central congo is in the NDVI points , and again strongly NDVI until Kivu, Ruanda and Burundi in the North and South in no more NDVI points.

XI - XII . Decade December:
- Decade 31 - 36
No more NDVI points, everywhere in the country is only green
Decade 31: no NDVI points in the Equator Region , Inongo city, Bas -Congo region and Katanga regions again .
Decade 32: Everywhere nothing a small NDVI points in Katanga region and south likasi.
Decade 33: Everywhere nothing only a small NDVI in Kivu regions and Likasi.
Decade 34: Everywhere nothing only a small NDVI in the Kivu regions
Decade 35: Nothing only small NDVI in the regions between Sudan and Haut -Congo.
Decade 36: Nothing only small NDVI points in the North western , and North Eastern someone NDVI points coming direction congo.

C. Comparaison from Index Vegetation (Clouds, Water, Soils) 1998 until 1999 in :

- Tropical region :

Tropical Hot and humid equatorial river basin, cooler and driver in the southern highlands. Cooler easthern highlands North Equator.

1) 1998 :

North of Equator :
Wet Season : April - October.
Dry Season : December - February.

1- Wet Season :
April : 30 Days
Mai : 31 Days
June : 30 Days
July : 31 Days
August : 31 Days
September : 30 Days
October : 31 Days
November : 30 Days
December : 31 Days
- Summe : 30 + 31 + 30 + 31 + 30 + 31 + 30 + 31 + 30 = 214
- Summe : 214 Days

- Wet Season Northern Equator Normalized Difference Vegetation Index

2- Dry Season :

December : 31 Days
January : 31 Days
February : 28 Days

- Summe : 31 + 31 + 28 = 98
- Summe : 98 Days

- Dry Season Northern Equator Normalized Difference Vegetation Index

South of Equator :

Wet Season : November - March
Dry Season : April - October

1- Wet Season :

November : 30 Days
December : 31 Days
January : 31 Days
February : 28 Days
March : 31 Days

- Summe : 30 + 31 + 31 + 28 + 31 = 151
- Summe : 151 Days.

- Wet Season North Equator Normalized Difference Vegetation Index.

2- Dry Season :

April : 30 Days
Mai : 31 Days
June : 30 Days
July : 31 Days
August : 31 Days
September : 30 Days
October : 31 Days

- Summe : 30 + 31 + 30 + 31 + 31 + 30 = 213
- Summe : 213 Days

- Dry Season North Equator Normalized Difference Vegetation Index.

2) 1999 :

North of Equator :

Wet Season : April - October
Dry Season : December - February.

1- Wet Season :

April : 30 Days
Mai : 31 Days
June : 30 Days
July : 31 Days
August : 31 Days
September : 30 Days
October : 31 Days
November : 30 Days
December : 31 Days

- Summe : 30 + 31 + 30 + 31 + 30 + 31 + 30 + 31 + 30 = 214
- Summe : 214 Days

- Wet Season Northern Equator Normalized Difference Vegetation Index

2- Dry Season :
December : 31 Days
January : 31 Days
February : 28 Days
- Summe : 31 + 31 + 28 = 98
- Summe : 98 Days

- Dry Season Northern Equator Normalized Difference Vegetation Index

South of Equator :

Wet Season : November - March
Dry Season : April - October

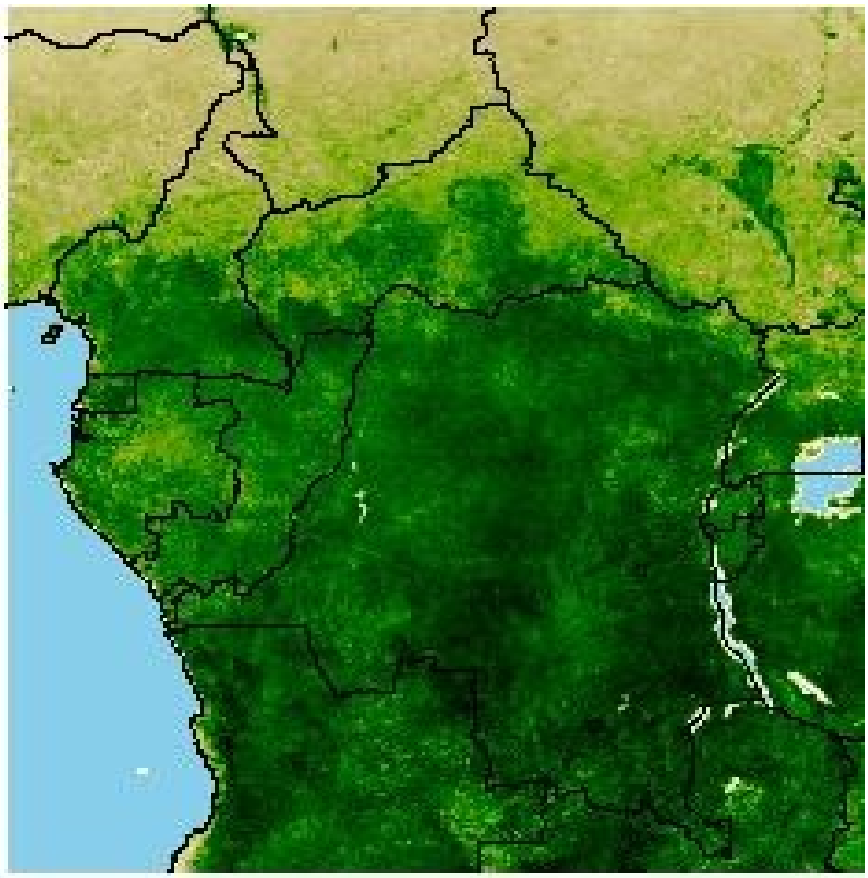
1- Wet Season :
November : 30 Days
December : 31 Days
January : 31 Days
February : 28 Days
March : 31 Days
- Summe : 30 + 31 + 31 + 28 + 31 = 151
- Summe : 151 Days.

- Wet Season North Equator Normalized Difference Vegetation Index.

2- Dry Season :
April : 30 Days
Mai : 31 Days
June : 30 Days
July : 31 Days
August : 31 Days
September : 30 Days
October : 31 Days
- Summe : 30 + 31 + 30 + 31 + 31 + 30 = 213
- Summe : 213 Days

- Dry Season North Equator Normalized Difference Vegetation Index.

NDVI 1997 Central Africa



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