GROUND RECEIVING AND PROCESSING SYSTEM FOR AVHRR AND MODIS *RADIOMETERS*

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ABSTRACT: *In this paper, we describe the operating of our acquisition system and some applications of the received images. Level 1B image data is the result of the processing of the satellite raw data and constitutes one of the main products of the AVHRR- NOAA and MODIS system. A sample of acquired data is processed by our PCNOAA Software; the results are presented in this paper. Images were acquired daily by our receiving station. It allows for in-situ real time AVHRR data reception (APT and HRPT formats). It uses a motor-steered horn antenna with dual low noise amplifiers. The antenna itself is only 1 m long with a 0.9 m square cross-section. It is linked to a receiver operating on both AVHRR and MODIS transmission frequencies (1698 and 1707 MHz), which in turn is connected via a satellite interface card to a standard PC.*

Key words: *Satellite, Sensors, Acquisition, Images, Data processing, Albedo, radiant energy, Sea surface temperature.*

INTRODUCTION

Satellite space missions need ground stations for mission control, data communication and processing [1]. Meteorological satellite data provided by the geostationary and polar-orbital satellite are operationally received, pre-processed and archived. Meteorological products and geophysical parameters are derived and made available to the operational services like the vegetation coverage state and surface temperature images determination [2]. In October 2011, a new AVHRR and MODIS Earth station was installed and is fully operational including data processing and archiving.
The raw digital counts acquired by AVHRR and MODIS radiometers are calibrated to physical units known as radiance. A mathematical function of the visible and infrared parts of the electromagnetic spectrum can be an indicator of the presence and condition of the vegetation. This leads us to the concept of Normalized Difference Vegetation Index (NDVI), which is an indication of the amount of green vegetation, the NDVI image was processed by combining the Channels 1 and 2, visible and near infrared, respectively, of AVHRR/3-HRPT satellite data. The Surface Temperature is a fundamental thermodynamic quantity in the energy exchange between the surface and the atmosphere and plays an important role in environmental studies. Many studies have proposed various algorithms, such as the split window method, for retrieving surface temperatures from two different thermal infrared bands of NOAA satellite data [3]. Each algorithm is developed for a limited study area and application. Here, as part of the use of one split-window method in raw acquired data. A comparison of a surface temperature image result with the brightness temperature of each thermal infrared band is established to evaluate the performance of the used algorithm.

MATERIALS AND METHODS

Acquisition system

Since September 2011, we archive AVHRR and MODIS data covering some area from terrestrial half disk, centered in North West of Africa. At the beginning of the reception period the station was not completely operational and we lost some passes due to maintenance of the receiving station as well as limited hardware and storage capacity. Since October 2011 we are in an operational status to receive all available NOAA passes per day. The amount of archived data exceeds the number of 200 NOAA-AVHRR images takes from NOAA-17, NOAA-18, NOAA-19 and MODIS-7, respectively. Figure 1 shows a flowchart of the acquirement system. These data sets can be used for a variety of remote sensing applications, and daily captured with a feed horn motorized system and image processing equipment. They concern a large identified users community has expressed the need for information tools operating on environment. Applications are numerous, for example: Coastal protection, Climate and meteorology, Observation, security, Tourism and leisure, Fishing and aquaculture, Sea traffic, Agriculture and stock breeding [4,5].

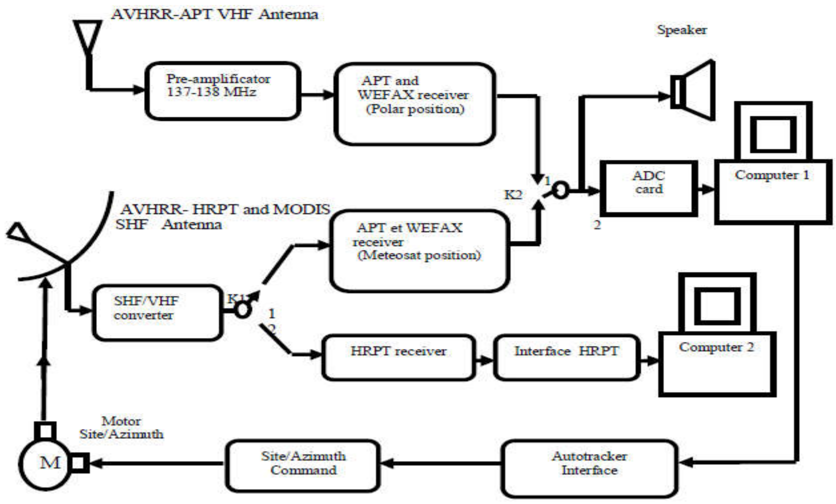


Fig. 1: Flow chart of Satellite images receiving Station.

Pre-processing

High Resolution Picture Transmission (HRPT) imagery was collected in real time from the National Oceanic and Atmospheric Administration's Satellites (NOAA). The visible channels (c1 and c2) were calibrated and converted to percent reflectance (Albedo noted ρ) using equation 1.

$$\rho_{i}= G_{i}.\ Cn_{i} + S_{i},\ i=1.2 \quad (1)$$

with : ρ_i is the Albedo of channel i, G_i ang S_i are respectively the gain and the sequent of the corresponding channel (i).

The thermal IR channels (c4 and c5) were calibrated in brightness temperatures.

Equation (2) shows the brightness temperature (**T_b**) converting algorithm applied to c4 and c5 channels NOAA 19 coefficients are used in this research. n is the count value of each raw pixel from the corresponding channel.

$$T_b = (Cn_2)/\ln(1 + [Cn_1^3]/R) \quad (2)$$

with :

$$R = (X_b - B)/ M \quad (3)$$

$$c_1 = 1.191066.10^{-5}\ mW/(m^2\text{-}sr\text{-}cm^{-4}) \text{ and } c_2 = 1.438833\ K/cm^{-1}$$

R in equation 3 represent the radiance expressed in $mW/(m^2\text{-}sr\text{-}cm^{-1})$, X_b is the raw count number coded in 10 bits. The coefficients M and B are extracted from the header pat of the received image.

RESULTS AND DISCUSSION

Normalized difference vegetation index

The spectral reflectance characteristics of the land cover indicate a degree of separation between the feature types. The measure of the spectral response permits the assessment of type of the feature as well its condition. Specifically, green vegetation absorbs the radiation at 0.62 to 0.7µm and reflects it in near infrared 0.74 to 1.1µm. By observing directly the plant's radiometric response, it is possible to record the canopy reactions to environmental stresses and constraints directly and in real time [6]. Thus, a mathematical function of the visible and infrared parts of the electromagnetic spectrum can be an indicator of the presence and condition of the vegetation. This leads us to the concept of Normalized Difference Vegetation Index (NDVI) [7], which is an indication of the amount of green vegetation. The NDVI is obtained by combining the calibrated Channels 1 and 2, visible and near infrared, respectively. The index is given by the equation 4.

$$NDVI = \rho 2 - \rho 1 \Big/ \rho 2 + \rho 1 \quad (4)$$

Where, indices 1 and 2 are percent reflectance of channel 1 and channel 2 respectively. By normalizing the difference in this way, the values can be scaled between the values of -1 to +1. This also reduces the influence of atmospheric absorption. The result of the NDVI image is given in the image of figure 3.

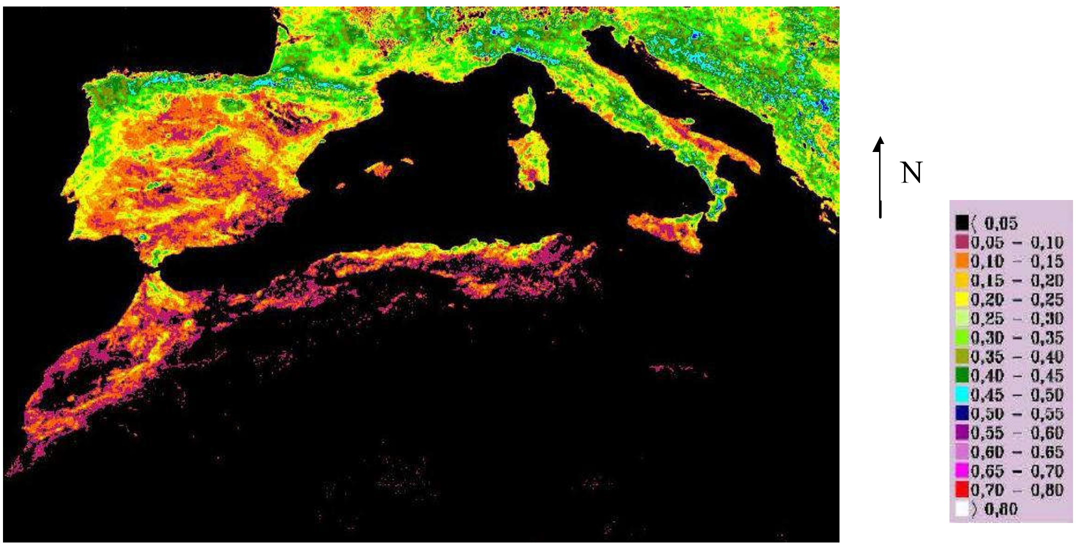


Fig. 3: NDVI image processing from North Africa and South Europe.

Sea Surface Temperature (T)

The Sea surface Temperature (T) is a fundamental thermodynamic quantity in the energy exchange between the sea surface and the atmosphere and plays an important role in environmental studies [8,9]. Continuous measurements of this parameter are likely to yield information about the suspected climate change, Sea Chlorophyll concentration, etc. For the calculation of the Sea surface temperature the knowledge of the surface emissivity is required. Surface emissivity is a measure of the inherent efficiency of the surface (in this case Sea) in converting heat energy into radiant energy above the surface.
Figure 4 shows the algorithm used to extract Sea water temperature from brightness temperature pixels, the latter is developed in PCNOAA software.

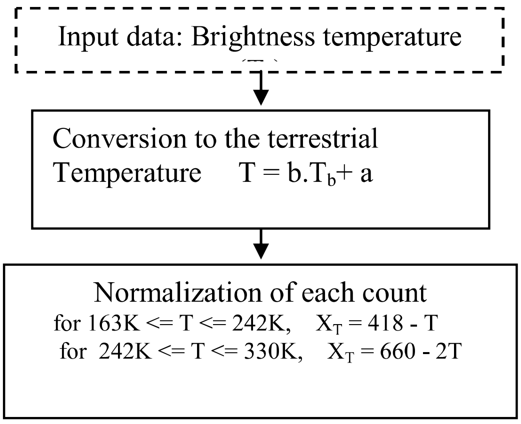
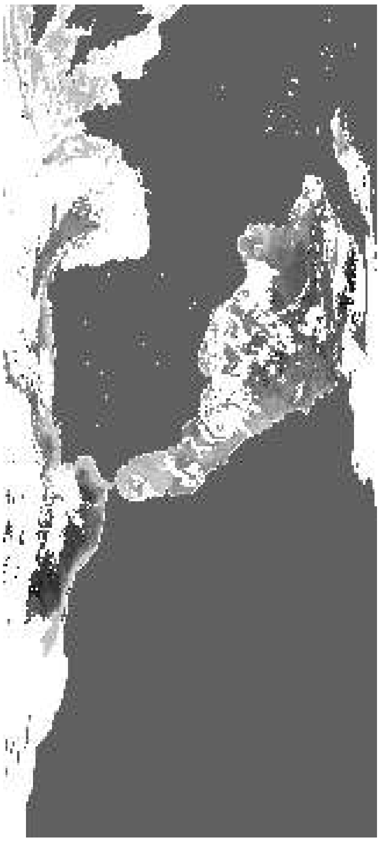


Fig. 4: Sea surface temperature extraction algorithm from brightness temperature pixels.

The use of T_b explains the variation of Planck's function through the spectral band of the infrared channels.
The differences between the values of T and T_b increase with the decrease of the temperature. They are usually about 0.1K. In most unfavorable, in the vicinity of 180K, they are roughly 0.3K. Finally, the numerical Accounts of the temperature are converted into mode 8 bits (X_T). Figure 5 present image result of Sea surface extraction by using the algorithm described in figure 4.

Composite



Sea Surface temperature image

Fig.5: Result of the extraction of the Sea surface temperature (in c) per channel IR 3.9 µm from an acquired image in 24-08-2014 at 12h 30 min UTC, satellite AQUA-MODIS.

CONCLUSION

Since October 2, 2011, raw NOAA AVHRR data were received in our ground station located at 35.9 latitude and –0.2 longitude in North West of Algeria.

There are many steps necessary for computing a remote sensing signal from a raw digital number to a surface broadb and Albedo measurement and Surface Temperature, for this cause, we developed PCNOAA software.

It is acknowledged that emissivity is an important consideration in determining radiometric surface temperatures from remotely sensed data.

The main object of this work is to test the methodology for the retrieval of Sea surface temperature (T) from the raw received data after calibrating operation, for this object, we applied the method based on brightness temperature of the Sea water surface.

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