2.6 Types of image

2.6.1 Introduction

Section 2.2.1 on radiation in the atmosphere outlines the sources of radiation and the effects of scattering and absorption in the atmosphere. Instruments known as radiometers (described in Section 2.2.2) measure radiation in narrow wavelength bands called channels. The channels are designed to identify specific sources of radiation and take advantage of reflection, scattering and absorption in the atmosphere. As examples, the channel wavelengths for the METEOSAT and NOAA polar orbiting satellites are described in separate sections.

In this section, we will examine typical images in three ranges in the electromagnetic spectrum;

visible (0.4 to 0.7 microns)

near infra-red (0.7 to 8 microns)

thermal infrared (10 to 1000 microns) .

The example images are produced by METEOSAT and NOAA satellites. They are representative of similar images that are also available from the other satellites.

2.6.2 Visible Images (0.4 to 0.7 microns)

The atmosphere is mostly transparent at wavelengths between 0.6 and 1.1 microns (see Figure 2.2.3 in Section 2.2.1 Radiation in the atmosphere). This allows solar radiation in the red end of the visible wavelengths and certain near-infrared wavelengths to be reflected from the land surface or cloud tops, and then be recorded by the satellite. Almost all visible radiation detected by satellites is solar radiation reflected in this way. Cloud tops and fresh snow come out brightest with the highest reflectivity, followed by the land, with the sea relatively dark (low reflectivity).

Visible images are useful for identifying cloud-types (for example distinguishing between cirrus and cumulonimbus). A major limitation of visible images is that they are only available during the day. Consequently, quantitative applications are limited.

METEOSAT produces a visible image on Channel 1 (0.5 - 0.9 microns). The image is a full disc with a sub-point resolution of 2.5km. See Section 2.3.2 METEOSAT for more details. Channel 1 (0.58 - 0.68 microns) on the NOAA satellites measures the red visible radiation. Images are of a swath of the Earth 3000km wide, with a sub-point resolution of 1.1km. See Section 2.4 Polar Orbiting Satellites for more details.

Click here for the latest METEOSAT channel 1 image (Full disc) from Nottingham University
Click here for the latest polar-orbiting channel 1 image from the Dundee (UK) Satellite Receiving Station

2.6.3 Near Infrared Images (0.7 - 8 microns)

There are three wavelength bands in this range that are commonly used in remote sensing. From 0.6 to 1.1 microns and from 3.5 to 4 microns the atmosphere is mostly transparent. The third important band is from 5.7 to 7.1 microns where radiation is strongly absorbed by water vapour. These bands are shown in Figure 2.2.3 in Section 2.2.1 Radiation in the atmosphere.

Channel 2 on the NOAA satellites (0.725 - 1.10 microns) takes advantage of the 0.6 to 1.1 microns band to measure solar infrared radiation reflected from the Earth's surface and atmosphere. Channels 1 (see previous section) and 2 are used together to measure vegetation on the land surface. They are combined in the Normalised Difference Vegetation Index (NDVI), which is discussed in Section 3.3 and which has wide applications.

Channel 3 on NOAA satellites (3.55 - 3.93 microns) takes advantage of the transparent band from 3.5 to 4 microns. Similar to channels 1 and 2 this allows solar radiation that has been reflected from the surface and atmosphere to be detected. However, there is a certain amount of overlap between the reflected solar and emitted terrestrial radiation at these wavelengths. Some of the radiation detected by the satellite originates from the Earth itself. This channel is best used at night, eliminating solar radiation. Common applications include locating 'hotspots' such as fires. This channel supplements the thermal infrared channels which are described in the next section.

Channel 3 on METEOSAT (5.7 - 7.1 microns) takes advantage of the third wavelength band, mentioned above. This band is different from the other bands described so far. The atmosphere is not transparent in this band and the radiation is strongly absorbed by water vapour. Consequently, none of the Earth's surface can be "seen" by the satellite, but water vapour in the upper atmosphere shows up strongly. Therefore clouds are clearly identified and their associated water vapour is seen extending beyond the clouds in swirls. These images show some of the dynamism in the atmosphere. Images from this channel are usually only available at night, when they replace visible data transmission, and at certain other times of the day.

Click here for latest METEOSAT channel 3 image (from Nottingham University)
Click here for NOAA channel 3 image showing forest fires in South America

2.6.4 Thermal Infrared Images (8 - 1000 microns)

The wavelength band in this range most commonly used in remote sensing is from 8 to 13 microns (see Figure 2.2.3 in Section 2.2.1 Radiation in the atmosphere). This is a broad band in which the atmosphere is fairly transparent. This is of critical importance for the Earth's climate, allowing the Earth to emit infrared radiation to space, and thereby cool itself. For this reason, this band is called the "atmospheric window".

The thermal infrared channels are channel 2 on METEOSAT (10.5 - 12.5 microns) and channels 4 (10.3 - 11.3 microns) and 5 (11.5 - 12.5 microns) on the NOAA satellites. They detect radiation from the Earth's surface and atmosphere. Thermal infrared images can be used equally well, day or night; a great advantage over solar radiation channels. Furthermore, the images allow detailed, quantitative analysis. For example, they are useful for monitoring the temperatures of cloud tops (see Section 3.1 Cold Cloud Duration), water and land.

Click here for latest METEOSAT channel 2 image (from Nottingham University)

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