models in interpreting and using the future climate-change projections. In the final chapter, the problems and prospects of monsoon prediction are discussed. There are known limitations of the statistical models, like secular variations of correlation, choice of optimum number of predictors and training period, etc. However, in spite of these known constraints, statistical models continue to be popular for several reasons. The users, while interpreting forecasts from these statistical models, should understand and appreciate the limitations of these models. There are other issues like the definition of all-India summer monsoon rainfall (averaged over the whole country and whole season from 1 June to 30 September), changes in the global teleconnection patterns, especially with ENSO. Statistical models cannot be used for prediction on much smaller spatial and temporal scales. For this specific need, we have to use dynamical models. The future prospects of monsoon prediction are completely dependent on the skill of advanced dynamical models, which showed an improvement in the model skill over the recent years. Specifically, monsoon field experiments and Indian climate research programmes will improve our understanding of the monsoon variability and thus monsoon prediction.

This book is specifically designed on monsoon prediction as it discusses the current state-of-the-art of monsoon prediction, its problems and prospects. It provides a critical analysis on how good we are in monsoon prediction and what are its future prospects in the context of improvement in dynamical models and monsoon field experiments. The book contains a good compilation of useful and updated references at the end of each chapter. The book will be useful to meteorologists, especially operational forecasters and students in meteorology and anyone interested in knowing more about monsoon prediction.

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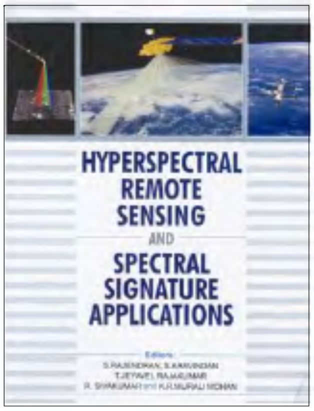


Hyper Spectral Remote Sensing & Spectral Signature Applications. S. Rajendran *et al.* (eds). New India Publishing Agency, 101, Vikas Surya Plaza, Pitam Pura, New Delhi 110 088. 2009. xvii + 483 pp. + 62 pp. (plates). Price: Rs 2540/US$ 125.00.

This book is a compilation of (a) some papers on the state of research developments in hyper spectral (HS) remote sensing and spectral signature applications in India, (b) extension of some research papers presented at the National Seminar on 'Hyper Spectral Remote Sensing and Spectral Signature Database Management System – Hyperspec 2008' held on 14–15 February 2008 at Annamalai University and (c) some papers in high resolution and multi spectral (MS) data applications.

HS imaging, also known as imaging spectrometry or imaging spectroscopy, acquires images of objects in a large number of narrow, contiguous and preferably non-overlapping spectral bands of the electromagnetic (EM) spectrum. Such data enables one to derive the complete reflectance spectrum at each picture element (pixel) of the image. After adjusting the settings for the sensor, atomospheric and terrain effects, these calibrated spectra can be compared with the laboratory or field reflectance curves of different objects, to identify the surface materials (compositional information). Spectrometers can measure signatures of molecules (forming the structure of a substance) and scatterers from the spectra, thus providing physical quantities such as upwelling radiance, emissivity, temperature and reflectance at the earth's surface.

Spectral reflectance together with the absorption features in the visible and near infrared regions of the EM spectrum offers a rapid and inexpensive technique for determining the soil mineralogy, rock types and vegetation characteristics. Reflectance spectra of various surface features of the earth have been well studied with different spectral resolutions and are stored in spectral libraries in digital form. The applications of HS imaging include fields such as geology and soils (mineralogy, chemical composition, soil type, etc.), plant ecology (chlorophyll, leaf water, pigments, structure, etc.), snow and ice hydrology (snow cover, grain size, etc.), coastal and inland waters (plankton, chlorophyll, sediments, etc.), biomass burning, smoke, combustion products, and for environmental studies and modelling .

Mentioned above are only a few of the vast spectral characterization studies available in books and research papers. In short, minute spectral reflectance bands of many objects have been researched[1,2].

With regard to processing of HS data, the primary premise is that each material has a unique signature and therefore any pixel containing a certain number of such materials can be analysed to the constituents present, and to their relative percentages. Concepts such as 'end members' (signatures of pure materials) and 'spectral unmixing' (deriving the relative percentage of each end member within the pixel) are adopted to discriminate the objects.

This book is an attempt to bring out to the various users of remote sensing, data on three aspects, viz. HS remote sensing, HS signature and its applications, and applications of high resolution and MS remote sensing satellite data.

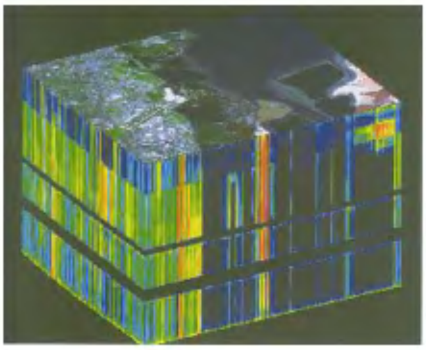
HS remote sensing: In this section, there are four papers dealing with HS remote sensing, historical developments of the various sensors and applications. Imaging spectroscopy, commonly used for HS remote sensing, collects spectral information of objects on the ground, in 200 bands, in the range of 0.38–2.5 μm, at 10 nm interval. The CCD detectors used are silicon microchips in the visible band and indium – antimony alloy in the short wave. Also mentioned is the HyMap sensor which records 128 channels in 0.4–2.5 μm, and with an IFOV of 3 × 4 m. As has been brought out by the authors in this section, ISRO has made a beginning for HS data availability by launching the 64 channel Hyper Spectral Imager (HySI), operating at 0.43–0.95 μm, onboard the mini satellite, IMS-1. This should provide a platform for several future studies. A similar sensor has also been mounted on the Lunar Mission, *Chandrayaan-1*, to assist in the study of mineral composition of the lunar surface and possibly for finding minerals. India also has plans to cover beyond the VNIR range up to 2500 μm.

The US Government is launching several satellites to test the full potential of HS data of about 30 m spatial resolution to characterize natural targets, minerals and vegetative cover. The Australian Government is also encouraging its private sector for the commercial development and operation of HS satellites to explore the potential of using the full spectral response.

The HS image is an image cube, where the spectral channels form the column at each pixel. HS data are large. Many preprocessing steps and image analysis have been described. Applications in this section include, briefly, mineral exploration, ocean applications (near-shore bathymetry, coral reef mapping, etc.), crop stress, plant physiology and structure, water quality, flood detection and monitoring, wetland mapping, pollutant detection, camouflaged target detection and also counterfeit currency detection.

A lot of overlap is noticed among all the four review papers in this section. MS and HS applications have been mentioned together, leaving a lot of ambiguity to the readers in resolving the differences across these two different kinds of datasets that are to be analysed considering their potential for applications. This section could have addressed the atmospheric corrections and processing techniques of HS data in a more elaborate manner. The contents of this section could have been integrated in a rational manner to familiarize the reader about the sensors vis-à-vis applications and processing techniques. Surprisingly, many authors are common for these papers and efforts to integrate the contents in a logical sequence would have been more substantive.

This section contains several tables listing HS space-borne satellites/sensors, both Indian and foreign. But, it is noticed that sensors such as SAR (microwave single band sensor), and SPOT (three-channel MS sensors) are also included, which is not correct. Though the authors have given a lot of information in all the four review papers, these are not exhaustive in the sense of new findings and/or potential areas of research.



AVIRIS hyperspectral data cube over Moffett Field, CA.

HS signature and its applications: This section contains 17 papers (nos 5–21), mostly dealing with Indian case studies, some in detail, on different topics utilizing HS data in many cases. The topics include: Problems in mineral mapping of planets, including environmental and physical parameters, rock discrimination and mineral exploration/mapping, problems of inter sensor variability in calculating NDVI, marine clays, snow, crop growth, data processing using FFT, biochemical content of fodder, coastal sediments, coastal aquatic system, data mining, HS databases, etc. Paper no. 5 dealing with lunar mineralogy and paper no. 6 dealing with the earth's mineralogy do not contain original work of the authors and thus, could have been placed in section 1 appropriately. Paper nos 15 and 17 contain literature on applications and these also could have been integrated in section 1. Paper no. 7 deals with only very few bands (2) of the HS data of Hyperion-1 to derive parameters such as NDVI and SR, which are otherwise feasible from simple MS data, while paper nos 8 and 11 fit the appropriate context by dealing with the analysis of space-borne HS data. Paper nos 9, 10, 12–14 are studies conducted using ground-based spectrometer data on crops, snow, clay, etc. Paper nos 16 and 18 do not seem to fit this theme, as these do not deal with HS data analysis or utilization. Only paper nos 20 and 21 deal with the organization of HS database for developing spectral signatures and transformation of HS data.

The colour plates given after p. 275 do not get connected properly to the actual papers (say nos 6 and 7) to which they are referred to. These could have been placed following the corresponding papers. Further, the references to these pictures, such as 'chapter 6', 'chapter 7', etc. should have been 'paper 6', 'paper 7', etc. respectively.

Applications of high resolution and MS remote sensing satellite data: This last section has 15 assorted papers dealing with applications, utilizing traditional remote sensing and GIS techniques, and a variety of sensor data such as optical, microwave, etc. Twelve papers have little relevance to the HS data, one paper (no. 29) deals with the application of HS tools on Landsat TM data and the two paper (nos 32 and 37) deal with the utilization of GIS techniques. In fact, paper nos 32 and 37 contain a review of the literature. This section, in the overall sense, does not fit into the title of the book.

In summary, this book brings out the current status of HS remote sensing, available sensors, some data-processing techniques and several applications in the fields of mineralogy, soil and vegetation studies, etc. The results presented in the book deal with mainly satellite-based HS data from Hyperion. Several papers also have dealt with field-based spectroradiometer data. International and national efforts are being made towards developing spectral signature libraries that play an important role in the analysis and interpretation of HS data. Utilization of such spectra was also illustrated in some of the studies.

However, the editors have just collated the papers of the conference together. Efforts towards organizing these papers according to the title of the book would have been more appropriate. On the whole, the authors have made a good effort in bringing together several Indian case studies on HS remote sensing, and provided a useful reference book for people pursuing research and utilization of HS data.

1. vander Meer, F. D. and de Jong, S. M. (eds), *Imaging Spectrometry*, Springer, 2006.
2. Schanda, E., *Physical Fundamentals of Remote Sensing*, Springer-Verlag, 1986.

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