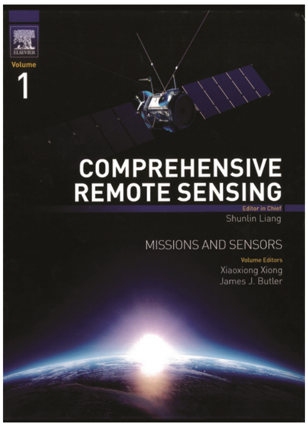

Comprehensive Remote Sensing, Volume 1: Missions and Sensors. Editor in Chief: Shunlin Liang; Volume Editors: Xiaoxiong Xiong and James J. Butler. Elsevier, Radarweg 29, P.O. Box 211, 1000 AE Amsterdam, The Netherlands. 2018. xxii + 545 pages.

Comprehensive Remote Sensing comprises nine volumes devoted to different aspects of remote sensing, such as missions and sensors, data processing, use of remote sensing data to understand processes of different components of terrestrial ecosystems, atmosphere, oceans and applications of societal benefits. Each volume has a series of articles by various authors writing about different aspects of the theme of the volume. This volume, the first in the series, devotes itself to spacecraft missions and sensors.

Remote sensing is the science of sensing objects without being in physical contact with them. Remote sensing of the earth refers to observing the earth's surface and studying the physical characteristics of the earth surface features through measurements made from instruments placed on platforms stationed above the earth's surface. In general, the medium of interaction is through electromagnetic radiation, although acoustics and gravity are also employed in specific circumstances. The basic objective of remote sensing of the earth is to obtain an inventory of its natural resources in a spatial format at different time-intervals, ascertain their conditions, observe the dynamics of the atmosphere and ocean, and also help understand various physical processes in an integrated manner. This requires measurements at different wavelength regions, viz. ultraviolet to microwaves, at different scales/details and at frequent time-intervals, depending upon the timescales of the phenomenon. One needs a variety of instruments/sensors with a great degree of sensitivity and viewing geometries. In order to provide observations at the same illumination conditions, the sensors need to be placed on platforms in sun-synchronous orbits. Polar orbiting satellites provide global coverage. To provide constant surveillance, some sensors are placed in geostationary platforms. While a few sensors can operate in passive mode using the sun's illumination or the earth's emission, some use their own source of radiation (active sensors). Ability to measure polarized radiance becomes necessary as well in certain cases. Considering all this, missions and sensors planned and launched over the years since 1960 when the first satellite TIROS 1 was launched, have been many. This volume provides a comprehensive account of these developments. It consists of 18 sections written by different authors.

How remote sensing of the earth has evolved over the years since 1960s to its present state has been briefly described in the first section. Evolution of EO programmes in the United States by the National Aeronautics and Space Administration (NASA) and the National Oceanic and Atmosphere Administration (NOAA) over the years and the role played by the United States Geological Survey have been provided. Copernicus and meteorological programmes of Europe are also mentioned. In addition, EO programmes of China, Japan, India and Korea are briefly mentioned. A description of sensors operating in different wavelength regions and their advantages is also provided. Notable absence is the mention of Russia and individual EO programmes of other European countries, in particular France.

The next six sections (1.02 to 1.07) describe in detail major remote sensing programmes (seeking science and operational) undertaken by NASA, NOAA, ESA, and EUMETSAT. Section 1.02 provides details of NASA's 10 different missions, viz. TERRA, JASON, SAGE, AQUA, ICESAT, SORCE, AURA, LANDSAT-7, ACRIMSAT and QUIKSAT, as recommended by the Earth System Science Committee constituted at the behest of NASA. These missions aimed at measurement of different physical variables of the land, atmosphere, ocean and cryosphere necessary to understand various processes and climate change. Physical basis for the choice of sensors and their specifications flown on these platforms, and some of the instrument design details have been provided. LANDSAT programme which began as the Earth Resources Technology Satellite in 1970s is described in section 1.03. The author proudly and justifiably claims that this is the only programme which has provided data over the earth for 50 years on a continuous basis. These data have helped in the study of the changing earth in the last 50 years. Excellent references are provided. The Joint Polar Satellite System (JPSS) comprising a series of operational polar orbiting environmental satellites to facilitate weather prediction, ocean state forecast and to provide inputs for numerical weather prediction models, a programme of NOAA has been dealt with in section 1.04. Details of a host of instruments such as infrared and microwave sounders, imager, ozone monitor and earth radiation monitor flown on these platforms and all necessary ground segment elements like data processing, data products, calibration and validation are discussed. Geostationary Operational Environmental Satellites (GOES), including the future GOES-R series, essential components of weather and ocean monitoring programmes of NOAA, the instruments flown on them and ground segment details are provided in section 1.05. This fleet of satellites provides measurement of the globe once every 15 min and over the US once every 5 min. Copernicus programme of ESA has been described in great detail in section 1.06. It comprises a series of satellites called Sentinel-1, -2, -3, -4, etc.; these are global missions. While Sentinel-1 A and B carried synthetic aperture radar, Sentinel-2 A and B carried visible and infrared sensors, while Sentinel-3 carries ocean sensors. Data products are

Narayan parvat, Badrinath – The actual photo compared with Cartosat-1 orthoproduct draped over Catosat-1 DEM.

feely available to all users over the globe. Various aspects of ground stations, data dissemination and rush mode for emergency operations are all covered in the article. Excellent overview of applications is also provided. EUMETSAT Polar System which is part of the Global Operational Observing System under the auspices of the World Meteorological Organisation, is a cooperative programme of NOAA and the French Space Agency CNES. Details of the same are provided in section 1.07.

The next four sections (1.08 to 1.11) provide an account of how earth observation programmes have evolved over the years in China, Japan, India and Korea. China launched its first meteorological satellite in 1988 and since then has progressed considerably to have its own series of satellites devoted to observations over land, ocean and atmosphere. It also had successful collaboration with Brazil in launching China–Brazil Earth Resource Satellites (CBERS). China has developed many advanced sensors such as hyperspectral sensor, SAR, scatterometer, altimeter, etc. In addition to earth observation satellites, China has embarked upon development of a constellation of navigation satellites called BEIDOU. Geostationary Meteorological Satellite GMS-1, Himawari was the first satellite launched by Japan in 1977 for meteorological observations. Since then, Japan has launched a number of advanced remote sensing satellites, e.g. ALOS, PRISM, ADEOS-1 and 2, PALSAR and GOSAT. Japan collaborated with ESA in EARTH CARE programme. ASTER provided data in thermal channels. Indian earth observation programme began with the launch of an experimental remote sensing satellite Bhaskara-1 in 1979; it is applications driven. A number of satellites devoted to observations over land, ocean and atmosphere have been successfully launched over the years. The article provides the rationale for choice of sensors and their specifications flown on-board and also indicates the likely future missions. The Korean programme began with the launch of KITSAT-1 in 1992. Korea has come up with a long-term space development plan.

Detailed description of sensors operating in different parts of the electromagnetic spectrum is provided in the next few sections (1.12 to 1.16). Advances in ultraviolet remote sensing are dealt with in section 1.12. Some of the challenges associated with ultraviolet remote sensing like high level of Rayleigh scattering and presence of strong Fraunhofer lines are highlighted. Generally, this topic is not covered in textbooks on remote sensing, and hence this article may be particularly useful to some of the readers. Detailed aspects of design considerations, choice of specifications, and trade-off analysis in case of visible and infrared sensors are covered in the next section. Thermal sensors are quite distinct from the VNIR systems. Details of detectors used in thermal sensors, methods of cooling, optical systems required and the calibration techniques to be adopted are all described in another section. Description of a Fourier transform spectrometer is also provided. LIDAR systems find detailed description in section 1.15. Some of the advantages of laser-based sensors in remote sensing, such as high temporal and spatial resolutions have been highlighted. How laser systems are used to obtain very fine topographic information, tree structures, atmospheric compositions, wind profiles, fluorescence in oceanic waters, and investigations of planetary surfaces is described. Engineering details of the sensors, data processing tools and technology trends are well covered. Spacecraft systems carrying laser sensors such as ICESAT/GLAS are also described. Microwave sensors are a class apart. There are passive microwave sensors like the sounders, synthetic and real aperture radiometers which sense the emitted microwave radiation. The active sensors have their own source of radiation, which when incident on the object/surface gets reflected/scattered and is detected by the sensor. Some of the active microwave sensors are the scatterometer, altimeter and SAR. Basic physics, engineering details, signal processing and data processing issues are described in great detail in this section. How retrieval of physical parameters is carried out using signals is also discussed.

Vicarious calibration and validation is an important section (1.17) of this volume. While calibration defines quantitative response of the instrument to the known controlled input signal, validation refers to comparing the derived physical variables with the *in situ* physical observations. Vicarious calibration refers to calibration methods without the use of systems directly mounted on-board the satellite. Various vicarious calibration methods used in characterizing remote sensors are described in this section. Mathematical basis of active coherence in radar missions is provided in the last section (1.18).

Overall, the volume is quite comprehensive in providing up-to-date information on remote sensing sensors and platforms, and how they have evolved in the last 40 years or so. It also provides description of remote sensing programmes of different countries and major international programmes. Physical basis to the design of sensors is also provided. Absence of information related to the remote sensing programmes of well-known players such as Russia and France is surprising. In the last few years, smaller platforms such as CubeSats are becoming important in space-based remote sensing. Planet Labs is one such example. This volume does not mention these developments. Notwithstanding these shortcomings, this book is an excellent source for every remote sensing professional. Every library should have this volume on its racks.

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Annual Review of Physiology, 2018. David Julius and Mark T. Nelson (eds). Annual Reviews, 4139 El Camino Way, P.O. Box 10139, Palo Alto, California, 94303-0139, USA. Vol. 80. vi + 429 pages. Price: US$ 112.00.

One of the articles that immediately caught my eye in this volume of the *Annual Review of Physiology* was that by Rucker *et al.* entitled 'Salt, hypertension and immunity'. Hypertension, a major health problem, affecting about 13% (1 billion) of the total population of the world is a major risk factor for a host of diseases, including stroke, myocardial infarction, kidney failure and heart failure, among others. Medical students who have read Guyton's classic *Textbook of Medical Physiology* will be familiar with