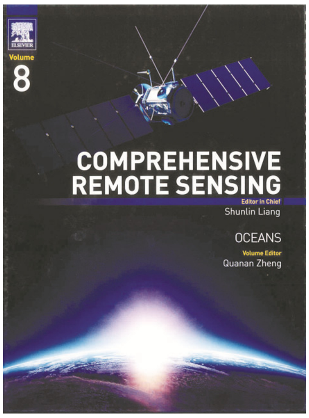


Comprehensive Remote Sensing, Volume 8: Oceans. Shunlin Liang (Editor in Chief). Stephen J. Walsh (Volume Editor). Elsevier, Radarweg 29, P.O. Box 211, 1000 Amsterdam, The Netherlands. 2018. xxii + 325 pages. Price: Not mentioned.

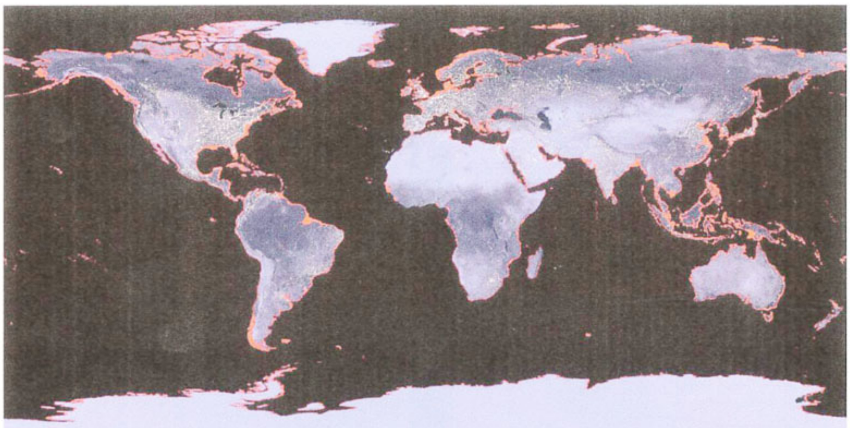
Comprehensive Remote Sensing is a series of nine volumes comprising all-inclusive discussions across various disciplines of the earth system in the context of remote sensing. The editor-in-chief, Shunlin Liang, has done a commendable job in bringing together more than 100 authors to contribute nearly 120 chapters in these series. Volume 8 of the series is specifically dedicated to the oceans. This volume comprises 11 chapters covering various aspects of ocean remote sensing.

Ocean remote sensing is incomplete without a detailed and dedicated chapter on ‘satellite altimetry’. A few examples, however, are cited in chapter 8.01. Altimeter-derived ocean surface wave and sea-level information is an integral component of operational oceanography and hence should have been discussed at length. Also, while some of the chapters are quite lengthy (e.g. chapter 8.08 on SAR), some others (e.g. chapter 8.03 on ‘ocean surface wind and stress’) are too small.

Chapter 8.01 provides an overview of satellite oceanography, past legacy and the future in terms of various sensors for different parameters. It provides a detailed description of the development of spaceborne remote sensing technologies for various oceanographic parameters such as ocean colour, sea-surface temperature (SST), sea-surface salinity, sea-surface height, sea ice, etc. The chapter lists different sensors that provide information on the above-mentioned parameters along with their spatial and temporal resolution. It further discusses development of airborne technologies that are used to monitor the oceans, unmanned UAVs (different types) for coastal monitoring, and concludes with a brief discussion on the progress made in the various applications, e.g. ocean monitoring in the context of climate change, defence purpose, etc. One of the promising and challenging forthcoming missions, viz. wide-swath altimetry (SWOT) is also deliberated in this chapter. TRMM was deactivated on 8 April 2015, but figure 6 (legend) shows 27 July 2016 1800 UTC. This needs to be corrected. Also, for figure 28, the source has not been mentioned.

Chapter 8.02 provides details about radiative transfer (RT) theory (techniques) for understanding light propagation in the ocean and interaction with water constituents that form the basis for ocean colour remote sensing. It comprehensively discusses the inherent optical properties (absorption and scattering) as well as the apparent optical properties (spectral irradiance reflectance of the ocean constituents such as phytoplankton, CDOM, non-algal particles, etc.). Using these concepts, the RT equation is derived and its various possible solutions are discussed in brief. There is detailed discussion on ocean colour remote sensing from both polar and geo-stationary platforms, various optical sensors that are currently available and different algorithms that are used to derive the various ocean colour parameters. The chapter also highlights the complexities involved (such as atmospheric corrections), and advantages and shortcomings of existing techniques (both physical and empirical). Spectral matching and spectral optimization methods are briefly outlined. Finally, the chapter concludes with a discussion on the various applications pertaining to marine ecosystems such as monitoring the conditions that impact biological organisms, studying phytoplankton physiology, water clarity, ocean biogeochemistry, ocean hazards, etc. India has launched the Ocean Colour Monitor (OCM) on-board Oceansat-1 and Oceansat-2, and is also planning to launch it on Oceansat-3 (which will provide simultaneous measurements of winds, colour information and SST). This should have been mentioned in the chapter.

Chapter 8.03 is a brief introduction to remote sensing of the ocean surface winds. This chapter is found to be technically weak. There should have been a general overview section on wind retrieval from a sacatterometer. However, the chapter highlights the significance of winds for ocean and weather prediction, and for cyclone warnings. The first scatterometer instrument, Seasat (launched in 1978 by NASA, USA) till the latest one in orbit, Scatsat (launched by ISRO) are listed in this chapter. There is also good review of papers describing the difficulty in retrieving the high winds under cyclonic conditions and the need for improved geophysical model function. One important aspect discussed in this chapter is the steep decrease in drag coefficient with wind speed over 25 m/s. Stress feedback to the combined effect of ocean surface current and SST, especially over mesoscale eddies has been emphasized. The chapter ends by posing some interesting science/research topics like, the effect of ocean mixing and reduced drag on tropical cyclone intensification, and



Map of the earth with a 6-m sea-level rise represented in red. Credit: USA NASA.

the impact of strong wind gradients in the cyclone inner core on air–sea transfer.

Chapter 8.04 on coastal ocean environment deliberates the usefulness of satellite remote sensing for coastal monitoring and protection. The chapter begins with a discussion on the ways in which various parameters (salinity, temperature, currents) are mapped either by conventional observations (*in situ*, field measurements), airborne platforms or shore-based platforms. Availability of very high resolution satellite measurements to map flow patterns of small-scale features such as thermal fronts, algal blooms, etc. is discussed. Application of satellite data in the impact assessment of natural phenomena (cyclones, tsunamis) through monitoring coastal changes such as beach erosion, shoreline changes, land-cover changes and wetland losses is also discussed. However, the chapter does not provide any technical description about the mapping of coastal currents.

Chapter 8.05 provides a comprehensive review of estuarine dynamics and tidal circulation. It also discusses estuarine classification based on hydrodynamics, stratification, geomorphology and water balance. It touches upon the river plume structures and classification, and provides examples based upon high-resolution satellite remote-sensing images from synthetic aperture radar (SAR). Detailed summary of estuarine dynamics and related processes provides a basis of identifying them from remotely sensed data. However, the potential use of optical data, specifically hyperspectral data application for estuarine studies is missing.

Chapter 8.06 provides an in-depth account of SAR data application in studying ocean processes (ocean vortex, spirals in the ocean, near inertial oscillations, estuary outflow jet and internal waves), and detecting ocean bottom topography from Envisat, ERS-1 and Radarsat-1 missions. The chapter begins with the physics of SAR imaging for oceans, providing the theoretical understanding of radar wave modulation transformation function due to ocean waves from which different ocean features are identified. In the second section, the authors provide a lucid description about SAR imaging of ocean bottom topography. However, India's SAR mission, RISAT-1 does not find a mention in table 1.

Chapter 8.07 describes in detail the retrieval of physical oceanographic parameters and also bathymetric features from seismic reflections, although not being strictly part of space-based remote sensing. However, this is one of the emerging areas where lateral fine-scale structures can be studied, and could be complementary/supplementary to satellite-based observations. Mathematical formulations of inversion techniques and processing of seismic reflections have been discussed. Various applications, e.g. vertical displacements associated with meddies and internal waves, retrieval of temperature and salinity, seafloor processes, internal solitary and Lee waves, upwelling currents and sediment resuspension have been discussed.

Chapter 8.08 is exclusively dedicated to oil-spill detection using SAR imagery in the context of frequency, polarization mode, incidence angle and algorithms best suited for detecting such events. A few examples from ENVISAT, RADARSAT-1/2, ALOS-PALSAR, TerraSAR and COSMO-SkyMED SAR data have been provided. The distinctive feature of this chapter is the discussion on how quad and compact polarimetric SAR allows both detection and characterization of oil slick.

Chapter 8.09 on remote sensing of lake-water environment gives a detailed account of how remote sensing can help determine the lake surface area, water quality and lake bathymetry. Authors have shown a few examples of estimating lake surface area by calculating NDVI to delineate land/water boundaries using optical and SAR data. Physics of the interaction of light with lake-water constituents is the basis for retrieving water quality parameters (Chl-*a*, CDOM, TSM) using remotely sensed reflectance. The theoretical basis, retrieval algorithms, data processing towards this retrieval for different types of water (case 1 and case 2) are provided in detail. At the end, a brief account of estimating lake bathymetry using lidar, SAR and hyperspectral remote sensing has been provided. This chapter is incomplete without the mention of altimetry to monitor lake levels. Nowadays, high-rate altimetry data are widely used to monitor lake levels.

Chapter 8.10 provides an overview of the ocean satellite programmes (HY-1 series for ocean colour, HY-2 series for altimeter, scatterometer and radiometer, HY-3 series for ocean surveillance satellites) of China. One notable aspect about HY-2 series is an *L*-band experimental salinity sensor (*L*-band synthesis aperture microwave radiometer) along with *L*-band scatterometer and *C*/*K*-band microwave scatterometer, to be launched in 2019. CFOSAT, scheduled for launch in 2018, will carry a scatterometer and wave spectrometer to characterize wind–wave interactions. The chapter ends with a small note on ground segments, different types of data products and data distribution services.

The last chapter (8.11) provides an overview of the evolution of ocean remote sensing in Russia. The Russian space programme started with the launch of Kosmos-243 in 1968, which consisted of a microwave radiometer for measuring oceans (ice boundary around Antarctica and SST anomaly around the Gulf Stream). Algorithms developed for Kosmos-283 data processing with some advancements were later applied to the microwave data obtained using DMSP, ADEOS-II, Aqua, etc. for geophysical parameter retrieval. Oceanographic measurements continued from the Kosmos series and interesting information on ocean fronts, eddies, currents and upwelling biological productivity was inferred. The Russian ocean remote sensing ushered in a new arena with the launch of Kosmos-1500 in 1983, which had an all-weather side-looking radar and a scanning radiometer which helped in studies on internal waves, oil spills and sea ice.

In conclusion, all the chapters are written in simple language and therefore easy to understand. This volume will be useful to undergraduate and postgraduate students, and practising oceanographers in the field of satellite remote sensing.

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