Geophysical Journal International

Geophys. J. Int. (2013) doi: 10.1093/gji/ggt314

Geophysical Journal International Advance Access published September 18, 2013

Book review

Physical principles of remote sensing: third edition

Rees, W.G., *Cambridge University Press,* 2013, ISBN 13: 978-1107004733, £80 HC, 470 pp.

Satellite remote sensing is a vast topic with applications in solid earth science, physical oceanography, land/ocean biology, cryospheric science, atmospheric science and near-earth space science. There is a wide array of passive and active sensors currently in orbit around the Earth providing a wealth of remote sensing products that are transformed into information using a variety of techniques and tools. Learning the entire field would require studying perhaps a dozen books on the topic. Physical principles of remote sensing: third edition does not attempt to cover all these tools and applications but instead exposes the basic physics and chemistry underlying remote sensing methods. The book is written for a student with a strong background in the physical sciences. For the past 15 yr, we have used this book as the primary reference for our satellite remote sensing class. This is the third edition of the book originally published in 1990. I keep all three editions on my bookshelf and actually prefer the first edition because it is more concise and offers just enough material to cover during our short 10-wk quarters. The third edition has summaries and on-line materials for the student although for the researcher, the content is similar to the second edition.

The first three chapters provide an overview of satellite remote sensing as well as an elegant review of some basic physics including propagation of electromagnetic waves, Fraunhofer diffraction, blackbody radiation and the effects of real materials on the speed and attenuation of electromagnetic waves as well as the reflection of waves from rough surfaces. The students find that this is a wonderful review of the basic concepts learned in their freshman physics class, and it also exposes them to real-world applications of fundamental physics. Chapter 4 covers the interactions of EM waves with the atmosphere and ionosphere. As a scientist with a background in geodesy and active microwave remote sensing, I especially enjoy the section on ionospheric dispersion and the importance of dual-frequency measurements employed in GPS and radar altimetry.

The remainder of the book covers five possible types of remote sensing of the earth from space where the main limitations are: the transparency of the atmosphere and ionosphere to electromagnetic waves; the space–time sampling that is possible from an orbiting sensor; and the types of sensors—passive or active.

Chapter 5 covers passive optical sensors with a focus on the underlying concepts of resolution, focal length, field of view and stereo imaging. This chapter provides the essential geometry without getting bogged down on all the engineering of these complex cameras in space. Chapter 6 on electro-optical systems introduces the concepts of viewing the Earth in multiple wavelength bands. The main windows are in the visible and thermal infrared. Multi- and hyper-spectral sensors add a third dimension to imaging the Earth that can be used to investigate properties such as vegetation on land or chorophyll in the ocean. This chapter also includes a nice discussion of the physical principles behind diurnal and seasonal changes in land, ocean and ice temperature. Nice but non-essential colour figures are also imbedded in this chapter but more important they are available on the Cambridge University Press web site for use in preparing lectures. Chapter 7 discusses passive microwave systems, which have low spatial resolution because of the longer wavelength radiation, but are highly sensitive to temperature and emissivity, so they are excellent for decadal monitoring of sea ice cover and ocean surface temperature. Chapter 8 covers laser and radar altimeters—nicely explaining the strengths and weaknesses of each system in terms of surface type (i.e. land, ice or ocean). Chapter 9 is a brief overview of the physical principles of active microwave systems such as scatterometers for measuring ocean winds, synthetic aperture radars for all-weather, day–night, high-resolution imaging of land, ocean and ice and radar interferometry for mapping topography and surface deformation.

Chapter 10 covers platforms used for remote sensing and is primarily focused on satellite orbits. This chapter assumes that the reader is familiar with the laws of Newton and Kepler, and then provides just the essential orbital dynamics and kinematics to understand concepts such as geosynchronous orbits, sun synchronous orbits and the need for highly precise orbits for active remote sensing instruments.

One of the highlights of the book is Chapter 11 on data processing. This chapter covers the basics of image processing (e.g. contrast enhancement and spatial filtering) as well as band transformation, principal component analysis and supervised image classification. All of this material can be presented in two class lectures and a Matlab exercise so that students can understand the concepts behind more sophisticated remote sensing software packages.

In summary, this is an excellent book for an introductory course in Satellite Remote Sensing appropriate for students with strong backgrounds in the physical sciences or engineering. The mostly mathematical homework exercises at the end of each chapter are well designed to help the student understand physical principles. The book does not cover any particular applications in detail and I commonly have the graduate students in the class write a remote sensing term paper related to their research topic. I highly recommend this book to any advanced student or researcher who wants to learn the basics of satellite remote sensing as a foundation to more advanced remote sensing books on particular methods.

DAVID T. SANDWELL

Scripps Institution of Oceanography, La Jolla, CA, USA.
E-mail: dsandwell@ucsd.edu