

BOOK REVIEW

Book Review: *Thermal Remote Sensing of Active Volcanoes: A User's Manual*. Andrew Harris (2013) Cambridge University Press, U.K., 736 p. ISBN: 9780521859455. Adobe eBook also available.

Instruments that record the heat signatures of volcanoes have provided useful diagnostic observations for several decades. This book describes, in incredible detail, the efforts volcanologists have made to glean insight into volcanic processes, such as how lava flows move, by one of the world's leading proponents. Every conceivable angle is covered, from detailed explanations of the underpinning physics through to what to try if your thermal camera image is blurry. It is a tour de force of thermal infrared remote sensing and will be a useful text for anyone from graduate students, grappling with challenging details, through academic staff, who will find it an invaluable resource. The book presents a wonderful synthesis of historical review, crisp theory, and simple straightforward instructions; it is the sort of book you can imagine a graduate student pouring over when trying to wrestle with the theory and also consulting in the field when their imagery doesn't look quite right. The book itself is divided into three sections containing three introductory chapters, three chapters on space-based radiometry and then finally three chapters on ground-based radiometry and thermometry. Nine appendices follow, and the book is rounded off by 29 pages of references. It is much more than a simple descriptive text, something the reader will quickly appreciate. As an example, some of the first figures (1.2 and 1.3) are an insightful timeline of six critical themes of the development of the field, brilliantly marrying the literature with a clever visualization, and setting the tone for this excellent work.

The introductory chapters cover both the history of remote sensing of active volcanism and the underpinning physics of remote sensing, particularly those details that pertain most to the thermal infrared. While much of the theory is, as it should be, founded in mathematics, Harris also manages to distil key messages succinctly. He picks figures apart, pulling out key messages that allow the reader to really follow his train of thought in a way very rarely seen in text books. As you would expect for such a thorough text, the referencing throughout is helpful, appropriate, and guides the reader toward further information. The final subsection approaches the issues that govern the resolutions that impinge on satellite imagery. Figure 3.15 is characteristic of this work where the effects of viewing geometry and footprint on a theoretical volcanic hotspot, again a clever and clear explanation of a complicated effect. This really is the book's key strength, incredible attention to detail being supplemented with brilliantly simple explanations in the form of both figures and bullet point text.

The section on satellite imagery continues where the introductory chapters leave off. The book dives into reality with the revelation that not all pixels are thermally pure, like some sort of confession. I teach much of this material at masters' level and I will be pulling out various examples from the text that will supplant current slides. Again, particularly adroit (and augmenting Figures 1.2 and 1.3) is the concise review of critical papers through the lens of key obser-

ventions. The author's thoughtfulness is apparent and one is left with the impression that an awful lot of work has gone into the development of this book. The section rattles on apace through the sections on automated detection (hotspot) algorithms that the author is most renowned for. As you would expect from a doyen of the field, Harris speaks with considerable authority, without falling into the trap of only citing his own work. Although the structure of the book allows for a predictable progression through the field, Harris does allow himself the odd minor digression too, including the fine example discussion in 6.6.0.2. The text warns, rightly, of the danger of extrapolation too easily fallen into by simply joining the dots in a time series plot, as a plea to objectivity.

The final section focuses on ground-based observations of thermal activity at active volcanoes. Observations of the previous section also pertain to this, namely (1) much thought has gone into the construction of an exceptionally comprehensive text; (2) the examples, figures, and tables all enhance the section and allow the reader to really explore, in detail, genuine observations that have been made at volcanoes; and (3) the author speaks with both authority and clarity. Both observations from broadband (spot) radiometers (chapters 7 and 8) and imaging cameras (chapter 9) are discussed. Chapter 9 is particularly heavy on technological detail, an admirable, and one might argue necessary approach, but one that might date this section quickly as new instruments come online. Nevertheless, the utility is obvious as the book again proves its value to a range of positions from those just beginning to embark on research in the thermal infrared through to those with great experience searching for a very specific detail or solution.

The color plates, located in the middle of the book, provide a great enhancement, although irritatingly some of the directions back to the captions are wrong as the page numbers are incorrect. This is certainly true for plates that refer to Figures 8.12, 9.4, and 8.14 and these also really ought to be in chronological order anyway. This is the most negative thing I can find about the book.

This review took me considerably longer than it should for two reasons. First, at over 700 pages, it covers every aspect of thermal remote sensing in exceptionally comprehensive detail and second, I gave it to a Ph.D. student who refused to give it back! In summary, I can do little better than simply repeat what the student told me when I finally got it back: "Thanks for letting my borrow it, it's amazing to see just how much Andy knows about TIR remote sensing. I'm going to have to buy the book when I get back to the States."

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