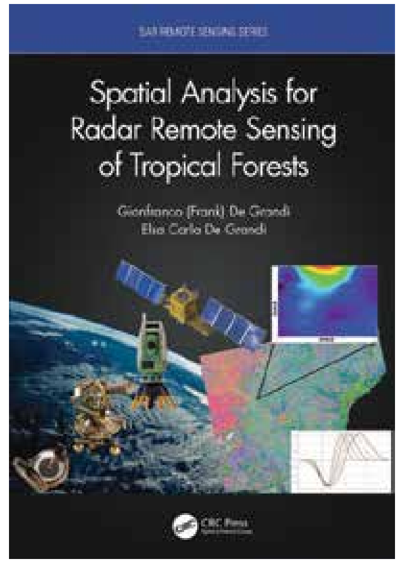

Spatial Analysis for Radar Remote Sensing of Tropical Forests

Gianfranco D. Grandi and Elsa Carla De Grandi.

Available from VitalSource Bookshelf, Taylor & Francis, 2021.

Reviewed by Konrad Kern, Mostly retired, image scientist who develops national technical means for the government of the US.

The title might lead one to expect a description and assessment of results found in their study of Tropical Forests. However, this is more of a “how-to” book than a “what-we-learned” book. As a result, the book has infinitely more value to an aspiring remote sensing technologist. The book addressed a synoptic study of the tropical African forest. The magnitude of the problem becomes evident when the size of the study area is considered. The greatest width of the African continent of interest is about 2800 nautical miles with an area of nearly 2 million square nautical miles. The book presents a detailed approach to how to select, prepare, and use your remote sensing tool suite for a monstrous problem.

Dr’s De Grandi wrote an extremely lucid book on how to conduct a remote sensing campaign. They describe their professional journey through multiple generations (decades) of Synthetic Aperture Radar (SAR) development. Their purpose was a synoptic study of the African Tropical Jungle with a specific focus on anthropological impacts. Their approach was a monster-mosaic map on the scale described and supervised, well vetted computer analysis and classification. This is clearly unique, offering many benefits and challenges.

The first four chapters describe the tools and products to achieve these ends. Hearing Dr’s De Gandi elaborate on the benefits and limitations of the various SAR satellites employed is a great lesson in knowing your tools. In image chain analysis, this understanding is referred to as radiation / material interaction. The earlier SAR’s were medium to long wavelength. These long wavelength radars had real canopy penetration and showed geological patterns otherwise obscured by canopy cover. The later SAR’s were phased array radars with polarization selectability. The use of polarization information in the scene demonstrates feature discrimination not otherwise available. Finally, interferometric SAR is described with its unique signatures and capabilities for coherence matching.

Continuing the theme of know your tools, the authors describe their need for scene revisit, management of noise in a SAR system and correction of the 1/R4 energy loss in an active imaging system.

- The SAR satellites they could access all had a polar orbit. While this orbit is great for optical systems, the revisit rate for a SAR sensor to mid-latitude areas of interest is horrible; the author cited 30 days. Temporal changes on this scale had to be ignored.
- Regarding noise, SAR systems have two noise contributors: Additive and multiplicative noise. The authors refer to additive noise as thermal noise and deal with characterizing and managing additive noise very well. Multiplicative noise is generally a force majeure of SAR processing and addressed with various apodization techniques. Multiplicative noise is the result of transform functions on the phase history. A radar return results in a main lobe and sidelobes. The sidelobes can be large and distracting from the image interpretation. Apodization is the process of squashing these sidelobes. As this study took place over a couple decades, apodization technology underwent huge changes. Based upon the study scale, apodization probably did not impact their analysis methods. This study involved very large impulse responses (IPR) the need for apodization could have been ignored. IPR is radar speak for smallest resolvable size,
- The radar equation gives received power as proportional to the inverse of the range from the transmitter to scene to the fourth power. Occasionally, this can be reduced to 1/R^3 from phase history compression. This difference of

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the energy loss across the huge swaths generated by these radar collections required a radiometric equalization. Without correction, the scene brightness differences across a swath would be a detriment to interpretation. Their radiometric compensation was well described and effective.

The remaining six chapters are often analysis doublets. The first chapter in the pair describes the theoretical basis for an analytic technique. The second chapter in the pair shows the validation of the analytic technique using known ground truth and field application. Finally, the authors provide an appendix discussing wavelet theory and analysis. Read this first before enjoying the final six chapters. It is very good and will help you to understand the analysis chapters.

This was a fun book to read. For the Dr Gianfranco in the writer combination, this appears to be his lifework sayonara piece. As a result, his narrative is pleasantly light; but the math and analysis is rigorous. He offers a number of concessions to the those who only understand optical systems; Resolution vs. IPR, Ground Plane presentation vs. Slant Plane collection, etc. I would have enjoyed more discussion of the magic in the middle of SAR; image formation processing from the phase history. Showing the integration of their analytical methods with image formation processing would have been interesting, but vastly increased the size of the book. Perspective is useful. Compared to the overall value of the book, my critical observations are inconsequential. If you are serious about practicing Remote Sensing, this is a must read.

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