Book Review for The Photogrammetric Record

CALIBRATION OF A FIELD SPECTRORADIOMETER. Remote Sensing Series, Volume 31. By M.E. SCHAEPMAN. *Remote Sensing Laboratories, Department of Geography, University of Zurich*, 1998. 170 x 243 mm. Xiv + 146 pages, 63 figures and 30 tables. Price sFR35.

This book is a research monograph in a series published by the University of Zurich Department of Geography. It describes a programme of research conducted by Michael Schaepman to commission and calibrate a field spectroradiometer supplied to the Remote Sensing Laboratories (RSL) by the Geophysical Environmental Research (GER) company of Millbrook, New York. The instrument in question is a GER3700 spectroradiometer which is designed to measure spectral reflectance in visible to short wave infra-red wavelengths (0.3 – 2.5μm). The production of a high-performance field spectroradiometer is a difficult task, demanding state-of-the-art electro-optical design and a good understanding of the requirements of users in the field. The high R&D costs and the limited worldwide market for such instruments means that they are produced in small batches by a limited number of manufacturers and therefore are very expensive and best regarded as 'one-offs' rather than a standardised product as is the case with consumer electronic items. The first GER3700 was delivered to the Canadian Centre for Remote Sensing and that group, together with the RSL, worked closely with GER to improve the capabilities of the instrument. This book describes the calibration of the instrument which resulted from this collaborative effort. The book has several chapters on the principles of field spectroradiometry and on the laboratory calibration of the GER3700 and then one chapter each on the use of the GER3700 for vicarious calibration of an airborne sensor and the Airborne PRISM experiment (APEX). A summary of the chapters on the calibration of the GER3700 has recently been published by Schaepman and Dangel (2000).

Michael Schaepman sets the scene by quoting HJ Kostkowki (1997) that 'spectroradiometric measurements are one of the least reliable of all physical measurements', he could have added that *field* spectroradiometric measurements are considerably less reliable than spectroradiometric measurements in general, and so this is a particularly challenging area of instrumentation and experimental design. He tackles the question of why this should be so, and what can be done to establish the nature and significance of errors in field spectroradiometry and thereby reduce them. Chapter 3 describes the GER3700 and the associated equipment used by the RSL in the field. The most interesting ancillary item is the FIGOS field goniometer developed to allow the GER3700 to be used to estimate the bidirectional reflectance distribution function (brdf) of natural targets and which is described in more detail elsewhere (Sandmeier and Itten, 1999).

The laboratory methods used to calibrate the GER3700 are described in Chapter 4 of the book and this section begins with a useful discussion of the choice of calibration strategy. Schaepman shows how a calibration plan can be devised which is cost-effective in terms of resources and time spent, but also meets the needs of the end-users. The plan involves characterisation of the signal-to-noise ratio using a variable intensity integrating sphere, measurement of the dark current, wavelength calibration using a tunable dye laser, linearity measurement, determination of the field-of-view and, finally, measurement of the sensitivity of the instrument to polarization and to changes in ambient temperature. The latter point is especially significant in the field environment as the GER3700 uses two uncooled PbS arrays to measure the signal in the short-wave infra-red region. Schaepman identifes improved monitoring or modelling of temperature effects as a desirable upgrade path in the future for the instrument, a conclusion also reached by staff of the NERC Equipment Pool for Field Spectroscopy in their independent evaluation of the instrument (Rollin, pers. comm.).

The weakest chapter of the book is that devoted to the measurement of spectral reflectance in the field. The important subject of sampling is covered very briefly, with no reference to geostatistical approaches (e.g. Webster *et al*., 1989) and anyone looking for advice concering practical methodologies for making spectral measurements in the field is likely to be disappointed. The uncertainty introduced by variations in the atmosphere is inferred from data collected with a sunphotometer and this provides the basis for an extended discussion of the uncertainty surrounding reflectance measurements in chapter 6. Although limited to the GER3700, Schaepman derives a number of 'figures of merit' which could usefully be adopted for other spectroradiometers and this attempt at standardisation is to be welcomed.

Chapter 7 describes the process of 'vicarious calibration' by which an airborne or satellite sensor is calibrated using one or more ground targets of known, stable, spectral reflectance or spectral radiance. The author highlights the difficulty of finding targets in Europe that are sufficiently stable over time, and proposes that simultaneous ground measurements with the GER3700 would be a way of overcoming this problem. An experiment to perform a simultaneous vicarious calibration of the DAIS 7915 airborne sensor is described using reflectance measurements made using the GER3700 spectroradiometer, supplemented with simultaneous sunphotometry and radiosonde data. The penultimate chapter of the book consists of a design for an airborne imaging spectrometer intended as test bed for a satellite sensor to be flown on the proposed ESA Land Surface Processes and Interactions Mission (LSPIM) and seems rather out of place in a book on the calibration of a field spectroradiometer.

Overall, this book is to be welcomed as a useful contribution to the subject of field spectroradiometry. It describes a careful and detailed technical evaluation of one of the most widely used field spectroradiometers on the market today. However, more importantly, it offers a first tentative step towards an integrated methodology for quantitative remote sensing that would provide accurate and reliable data for use in process models across many disciplines. In the conclusion to the monograph Michael Schaepman alludes to the important problem of transferring calibrations performed under laboratory conditions to the much more demanding environment of the field, and from there to the yet more challenging environment of an aircraft or satellite. Clearly, there is still some way to go before such end-to-end calibration can be routinely achieved, but the first steps have been taken.

References cited

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