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James L. Mueller[1] and Giulietta S. Fargion[2]
Editors

[1] *CHORS, San Diego State University, San Diego, California*
[2] *Science Applications International Corporation, Beltsville, Maryland*

Ocean Optics Protocols For Satellite Ocean Color Sensor Validation, Revision 3, Volume 1

J. L. Mueller, C. Pietras, S. B. Hooker, D. K. Clark, A. Morel, R. Frouin, B.G. Mitchell, R. R. Bidigare, C. Trees, J. Werdell, G. S. Fargion, R. Arnone, R. W. Austin, S. Bailey, W. Broenkow, S. W. Brown, K. Carder, C. Davis, J. Dore, M. Feinholz, S. Flora, Z.P. Lee, B. Holben, B. C. Johnson, M. Kahru, D. M. Karl, Y. S Kim, K. D. Knobelspiesse, C. R. McClain, S. McLean, M. Miller, C. D. Mobley , J. Porter, R.G. Steward, M. Stramska, L. Van Heukelem, K. Voss, J. Wieland, M. A.Yarbrough and M. Yuen.

National Aeronautical and
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Goddard Space Flight Space Center
Greenbelt, Maryland 20771

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Chapter 7

Calibration of Sun Photometers and Sky Radiance Sensors

Christophe Pietras[1], Mark Miller[2], Kirk D. Knobelspiesse[3], Robert Frouin[4], Brent Holben[5] and Ken Voss[6]

[1]*Science Applications International Corporation, Beltsville, Maryland*
[2]*Department of Applied Science, Brookhaven National Laboratory, Upton, New York*
[3]*Science Systems and Applications, Inc., Greenbelt, Maryland*
[4]*Scripps Institution of Oceanography, University of California, San Diego, California*
[5]*Biospheric Sciences Branch, NASA Goddard Space Flight Center, Greenbelt, Maryland*
[6]*Physics Department, University of Miami, Florida*

7.1 INTRODUCTION

Atmospheric sensors are designed to measure direct solar signals and sky radiances in order to retrieve the radiative properties of the atmosphere. There are two major types of instruments in use to perform these measurements: sun photometers and sky radiance scanning systems including fast rotating shadow-band radiometers.

Sun photometers capture photometric intensity of the direct solar beam. Their fields of view are small, typically between 1 and 3 , in order to minimize contamination of the transmitted solar signal by scattered skylight. Some photometers are manually aimed at the sun using sun-sighting optics, while other types of photometers are fixed in place and are equipped with automatic sun-tracking mechanisms.

MicroTops II (Morys *et al*. 1998; Porter et al 1999) and SIMBAD (Deschamps *et al*. 2000; Fougnie *et al*. 1999a, 1999b) are two examples of hand-held sun photometers. The fields of view (FOV) of hand-held sun photometers are typically between 2 and 3 , which is generally larger than the FOVs of the automatic sun-tracking photometers (Table 7.1). The wider FOV allows the user to manually aim the instrument at the sun from the rolling deck of a ship. The even wider field of view of SIMBAD (Table 7.1) is intended to measure marine reflectance as well as the solar signal. An improved version, called SIMBADA, has been recently developed and is available since 2001. SIMBADA new features are an integrated GPS and 11 channels.

Examples of fixed, automated tracking sun photometers include the CIMEL (Holben *et al*., 1998) and the PREDE (Nakajima *et al*., 1996). The design of a particular sun tracking mechanism is dependent on whether it is to be used on a moving platform (e.g., PREDE POM-01 Mark II), or on a stable station (e.g., CIMEL, PREDE POM-01L). CIMEL and PREDE instruments perform both sun photometric and sky radiance measurements. In sky radiance mode, these instruments measure sky radiances within 3 of the sun in the aureole, and also scan the sky radiance distribution in the principal solar plane. The FOV of the CIMEL and PREDE instruments are less than 1.5 and the instruments are equipped with collimators for stray light rejection (O'Neill *et al*., 1984; Holben *et al*. 1998; Nakajima *et al*. 1996).

Fast rotating shadow-band radiometers measure solar intensity values indirectly from diffuse and global upper hemispheric irradiance. They have a 2π FOV and are equipped with a solar occulting apparatus. Finally, electronic camera systems equipped with "fisheye" lenses may be used to measure the full sky radiance distribution (Voss *et al*. 1989).

Sun photometers and sky radiometers commonly have several channels from 300 nm to 1020 nm and narrow bandwidths (approximately 10 nm). Their characteristics are summarized in Table 7.1. This chapter will describe calibration techniques, and uncertainties of the sun photometers and sky radiometers. Measurement and data analysis protocols and procedures are discussed in Chapter 14.