Panel Report

Review of the USDA Ultraviolet Radiation Monitoring and Research Program

April 12-13, 2001

Panel Members:
Sasha Madronich (NCAR)
Steven Britz (USDA)
John Frederick (U. of Chicago, in absentia)
Richard Grant (Purdue U.)

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The Cooperative State Research, Education, and Extension Service
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Natural Resource Ecology Laboratory
Cooperative Institute for Research in the Atmosphere
Colorado State University
Panel report

Review of the USDA Ultraviolet Radiation Monitoring and Research Program (USDA UVR MRP)

Site visit 12-13 April 2001, Fort Collins, Colorado

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I. INTRODUCTION

The panel wishes to commend the staff of the MRP for the excellence of the presentations given during the panel’s site visit on 12 and 13 April 2001. The presentations were of consistent high quality, both in the scientific and technical content, and in the preparation and clarity of the reports. This panel report consists of two parts: the first is a response to recommendations from the 1991 and 1992 workshops conducted by the MRP, the second is additional panel recommendations resulting from the collective information provided by the MRP in both written and presentation form.

II. RESPONSE TO THE 1991 AND 1992 WORKSHOP RECOMMENDATIONS

The panel considered the recommendations made in two workshops, held in Denver (1991) and Washington DC (1992), in which the objectives and approaches to the USDA UV monitoring program were set forth. These recommendations are summarized briefly below. For more details, the documents describing these workshops should be consulted (Gibson et al., 1991; 1992). The recommendations, and our assessment of how MRP responded to these, are listed below. Except where noted, the recommendations (in italics) are taken from the Denver workshop report.

1. Approximately six sites should be established in the U.S. to provide high quality spectral irradiance monitoring of solar UV radiation on a continuing basis. Emphasis should be placed on the development of instrument characterization and calibration procedures and measurement protocols. These should serve as reference and monitoring research sites and provide data for the verification of modeling and satellite measurement techniques for estimating the flux of UV radiation.

Response: Six (6) spectroradiometers were constructed under the direct guidance of Prof. Lee Harrison (SUNY/Albany). These spectroradiometers (designated U1000) satisfy the stringent specifications set out in the 1991 document, e.g. with respect to wavelength resolution, stray light rejection, and dynamic range. They are clearly state-of-the-art instruments that, if calibration is maintained on a regular schedule, can serve for both research purposes and as references for other instruments. Currently, three of the instruments are located at SUNY/Albany, and one each at the ARM Southern Great Plains (OK) site, Beltsville (MD) and Table Mountain near Boulder (CO). Thus, while six spectroradiometers have been built, they are not deployed at six sites.

2. Site locations should be stratified to provide measurements at different latitudes and altitudes, in different climate regimes, and under different conditions of tropospheric pollution. Where feasible, sites should be collocated where other radiation and atmospheric measurements are being made. Photosynthetically Active Radiation (PAR) (400-700 nm), UV-A (400-320 nm), cloud cover, turbidity, and total column ozone are important ancillary measurements which should be available at each site. In addition, atmospheric profiles of aerosols,
trace gases, and temperatures are of great use in radiative transfer modeling but they are unlikely to be available initially at most sites. The 1992 Washington DC workshop further recommended that a status-and-trends monitoring network should be initiated with the deployment of 10 to 20 sites, including co-deployment with the reference instruments at the intensive sites. These should consist of affordable, easily maintained instruments, e.g. multifilter radiometers.

Response: At the present time, the spectroradiometers are too few, and their data collection duty cycles too limited, to be considered a network. However, a status-and-trends monitoring network of more affordable instruments (the UV Multi-filter Rotating Shadowband Radiometers, or UV-MFRSRs) has been deployed and is active. This network consists of 30 stations in which the UV-MFRSRs are collocated with ancillary instruments, e.g. visible radiometer, met data. The 30 locations are spaced on a grid that provides reasonable coverage of the US including AK and HI. Data from the status-and-trends network is routinely checked for quality, is archived, and is made available to the public through a web site. Recent efforts to locate sites in conjunction with ongoing UV plant/crop effects research are to be encouraged.

3. Centralized administration and coordination of the network is necessary to assure proper instrument characterization and calibration, uniform operational protocols, quality control, operator training, and data archiving.

The MRP main offices (and a majority of supported staff) are based in Ft. Collins, CO. Significant efforts are also at the Central UV Calibration Facility (CUCF) in Boulder, CO, and some activities, i.e. the development of the spectroradiometers, are taking place at SUNY/Albany. While there appears to be close collaboration between the MRP staff in Ft. Collins and Boulder, there seems to be less direct interaction between these labs and the Albany operations. Coordination and administration of the status-and-trend network seems to be quite effective, including coordination with the local operators, and calibrations at the CUCF. Characterization of the MFRSR instruments is well documented in the peer-reviewed literature. Documentation of the operator protocols and maintenance procedures for the instruments and data logger/communication systems is needed.

Coordination and administration of the spectroradiometers has been with SUNY/Albany. The panel believes it is now time for the central coordinated and administration of the spectroradiometers to be housed at MRP. The panel furthermore believes that emphasis should be placed on documentation of the instrument characterization, calibration procedures, maintenance procedures; full blueprints and measurement protocols need to be a priority task of the SUNY/Albany operations. Proper instrument characterization and calibration, uniform operational protocols, quality control, operator training, and data archiving are needed. To date, the coordination and administration is being done by SUNY/Albany, however documentation of instrument characterization and calibration, uniform operational protocols, quality control, operator training, and data archiving has been unavailable.
4. A rigorous evaluation of the best approach to determining regional UV-B climatology is required. The goal is to extend information gained at intensive monitoring effects research sites regionally and globally. Approaches to be considered include the use of satellite remote sensing data and data from other ground-based UV-B radiation measuring instruments, including broadband instruments.

The MRP staff is collaborating with NASA to evaluate the accuracy with which satellite measurements (esp. of ozone, cloud cover, and aerosols) can be used to provide regional UV climatologies, thus extending (by interpolation) the value of the monitoring network. We note that most of this effort has been done using the status-and-trends network, rather than any of the six research spectroradiometers.

5. An international network of UV-B and ozone monitoring stations should be encouraged, possibly under the auspices of the WMO. The existing Brewer spectroradiometer network could be a key component.

The MRP staff participates routinely in international inter-comparisons of UV monitoring instruments. Such inter-comparisons are key to putting different networks on a common scale. In addition, the status and trends network has collocated instruments with the NOAA SURFRAD network, the NOAA Dobson Network, the EPA Brewer Network, and the WMO Ozone status and trends network. The panel considered it important that the MRP provide the status and trends network archived data to the WMO World Ozone and UV Data Center (Toronto). The USDA MRP staff has participated in conferences and has contributed a number of publications. This panel considers the reference to Brewer spectroradiometers as irrelevant to this review, except to the extent already stated. The panel suggests that this recommendation be re-formulated, as follows:

The USDA UV MRP should take an active role in the coordination of an international UV-B network, through leadership and participation in cogent national and international committees, the archiving of data in international repositories (e.g. the WOUDC in Toronto), participation in inter-comparisons, and dissemination of UV-related scientific studies at conferences and scientific journals.

III. ADDITIONAL PANEL RECOMMENDATIONS

1. The panel suggests that significant benefits may be achieved by establishing a fully instrumented research site near the main location of the MRP staff in Fort Collins, Colorado. Two of the three spectroradiometers currently at SUNY/Albany should be moved from Albany to this site. In addition, the site should be designed to support any number of UV multifilter instruments, visible radiometers, etc. The panel believes that establishing such a “home site” would offer several advantages including:
- providing MRP staff with direct, hands-on experience on the operation of all instruments and provide a test-bed for problem solving and network instrumentation upgrades.
- providing MRP staff with direct control of instruments for the purpose of carrying out selected scientific studies, such as spectral reconstruction (see below).
- being reasonably close to the central calibration facility in Boulder

The panel recognizes that the Ft. Collins locations (e.g. the Christman field site visited by the panel) may have a non-ideal horizon. While this may complicate comparisons to some simple models that require ideal conditions, it was felt that for most applications this would not be a significant problem. The Albany lab (Harrison et al.) should maintain a strong active role in the operations of the spectroradiometers, e.g. by training local staff, providing manuals, local calibrators, and technical support as needed, and fully participating in the scientific exploitation of the measurements.

2. Greater value can be added to the multifilter measurements (the 30 stations of the status-and-trends network) if spectral reconstruction methods are developed, refined, applied, and evaluated. Direct comparisons of reconstructed spectra should be made to spectra measured with the U1000 spectroradiometer. Such comparisons should span many different environmental conditions (e.g. solar zenith angle, cloud cover, haze, various ozone levels), so as to clearly establish confidence levels as a function of wavelength and be reported in the peer-reviewed literature. The spectral reconstruction method will then provide a means for calculating biologically relevant measures of UV radiation including erythemal UV, plant-response UV, and DNA-weighted UV.

3. The panel explicitly recognizes the importance of the calibration lab operated in Boulder. This operation is fundamental to the credibility of the measurements obtained by the network. The history of UV monitoring shows that profoundly wrong conclusions can be reached by an improperly calibrated network. For example, the 1974-84 trends reported by the NIH network (Scotto et al. 1988) are now known to be wrong not only in magnitude but even in sign due to inaccurate calibrations, yet for many years those measurements were the source of much (unnecessary) controversy. The panel felt that the location in Boulder is sufficiently close that, for example, with two spectroradiometers based at the “home” site in Ft. Collins, one instrument could be taken to Boulder, calibrated, then brought back and compared with the other.

4. The panel recognizes the MRP staff for their success in publishing their results in the peer-reviewed literature, and encourages efforts to further exploit the data for their scientific value. For example, the data record is sufficiently large now to begin construction of a preliminary climatology of UV radiation over the US, through examination of geographical distributions, seasonal cycles, inter-annual variations, and medium-term trends. The data should be exploited by the scientific community, e.g. as input to the upcoming (2002) WMO/UNEP assessment of the state of the ozone layer and environmental UV radiation, and in education and outreach programs to policy makers, K-12, and the general public.
5. Stringent quality control (QC) is needed for all data made available to the public (e.g. through the web site). The panel was impressed by the dedication of the staff in developing and applying simplified procedures for quality control and calibration (e.g. Langley plots and a cosine correction device) as well as the daily manual examination of a large fraction of the incoming data. The panel was concerned that non-quality-controlled data is available to the public on the Web. Up to January 2001, QC checks and documentation is limited to internal ad-hoc notes not generally available to the non-critical data user. This was improved in 2001 with the addition of public-accessible flagging of data beginning January 2001. This flagging of QC codes needs to be carried back to the full record of data. Ultimately, bad data should either be taken off the web or QC flagged on the web. Given the time needed to back-flag data, the panel suggests that the potential presence of bad data should be indicated in the web-accessible data and in the documentation for the data. There is an urgent need for more automated data inspection that will supplement and simplify the ongoing quality control process as well as speed-up the QC flagging of pre-2001 data, but it is not clear that currently there is high priority on doing this.

6. Together with the establishment of a “home” research station, opportunities should be exploited to take advantage of the strong intellectual environment resulting from the association with Colorado State University. These may include guest lecturers, collocation with effects research, support for student research projects, etc.

7. Efforts should continue to identify and help potential and current users of the UV monitoring network. This could include direct collaborations with effects researchers, as well as holding workshops in coordination with the annual meetings of various scientific societies focusing on users and effects studies. Current collaborations (including modest financial support) with effects researchers have provided a ‘jump start’ to effects research that has flagged due to changes in the national research funding priorities. Enhancement of the collaborations is encouraged, with careful consideration as to the opportunity the program has to provide coordination in effects research priorities and facilitate interaction between these researchers. It is suggested that a yearly meeting/workshop be held to increase interactions between the scientists and minimize duplication of effort. Ultimately these collaborative efforts will provide for the development of second-order value-added products that will take the network measurements to products of direct use to the user community including agricultural and other biological/ecological researchers, the general public, policy makers, and k-12 educators and children.

8. Collaborative efforts with other agencies should be encouraged and continued. For example, USDA and NASA can benefit mutually by comparing network UV data to estimates of surface UV made from satellite ozone and cloud observations. Such efforts, which are already taking place, should be recognized as beneficial to both agencies. Other collaborations, e.g. with UNIDATA for access to ancillary atmospheric measurements databases, should be pursued as needed to enhance the QC effort.
USDA UVB MONITORING AND RESEARCH PROGRAM REVIEW

AGENDA

Thursday, April 12, 2001

1:00  Coffee and bagels
1:10  Welcome and introductory remarks: purpose of the review  Henry Tyrrell
1:20  Overview of program, funding, research directions  Jim Slusser
1:30  Site set up, routine maintenance  Bill Durham
1:50  Database, coding of quality control, web products  Becky Olson
2:10  Data quality control, daily operation  George Janson
2:30  Break
2:40  UV-MFRSR lamp calibrations  Patrick Disterhoft
3:00  Broadband calibrations  Kathy Lantz
3:20  Discussion: network operations
3:40  Langley calibrations, optical depths  Gwen Scott
4:00  General discussion
5:00  Adjourn
6:00  Panel members meet for dinner

Friday, April 13, 2001

9:00  Computer security, increased bandwidth  Bill Davis
9:20  Repeat UV-MFRSR, broadband calibrations  George Janson
9:40  Helio-stat cosine response, hardware issues  Bill Durham
10:00  USDA Reference Spectrometer, calibrator  Lee Harrison
10:20  Break
10:40  Ozone retrievals, agricultural effects  Wei Gao
11:00  General discussion
12:00  Visit of Christman Field UVB research site  lunch
12:30  Panel members meet to formulate findings
2:00  Panel members present findings and conclusions
4:00  Panel members work on written report
5:00  Adjourn
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Cotton Morphological Symptoms Under Different UV-B Irradiance Treatments

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(kJ = kilo joules)

Experiments were conducted in growth chambers at Mississippi State University
Courtesy K. R. Reddy