

AUSTRALIA

OBSERVATIONAL ACTIVITIES

Column measurements of ozone and other gases/variables relevant to ozone loss

Column measurements are primarily taken by the Australian Government's Bureau of Meteorology (BoM) and certain universities:

- The BoM Dobson network consisting of stations located at Brisbane, Darwin, Macquarie Island, Melbourne, and Perth (in conjunction with NOAA).
- Brewer spectrophotometer at the University of Tasmania (operating costs financed by the BoM).
- Remote sensing FTIR at the University of Wollongong (the measurements are made as part of the Network for the Detection of Atmospheric Composition Change, NDACC).

Profile measurements of ozone and other gases/variables relevant to ozone loss

Regular ozonesonde measurements are taken by the BoM at:

- Macquarie Island (weekly flights since 1994)
- Melbourne (weekly flights operated from various locations around Melbourne since 1965).
- Davis station, Antarctica, in conjunction with the Australian Antarctic Division (AAD). Since Feb 2003 there have been weekly flights between Jun-Oct and monthly flights between Nov-May). In conjunction with these ozonesonde flights, the AAD operates a Rayleigh/Mie/Raman lidar at Davis to measure temperature and aerosol loading in the stratosphere.

Rayleigh/Mie lidar profiling of stratospheric temperature and aerosol loading has been undertaken since Feb 2001.

UV measurements

Broadband measurements

The BoM has had a Solar Light SL501A broadband instrument running at Cape Grim, Tasmania, since 1993. The status of this instrument currently is unknown as its calibration depends on a co-located spectral radiometer.

The Australian Radiation and Nuclear Safety Agency (ARPANSA) maintain a network of UV detectors in capital cities around Australia since 1989 and in 1996 they were changed over to Solar Light UVB 501 broadband biometers. Kingston, Tasmania was recently added as a new site. Biometers have also been collecting data at Macquarie Island since 2001 and the Australian Antarctic stations at Mawson since 2002 and both Davis and Casey since 1996. The sites in Antarctica are currently being upgraded with new biometers. The biometers are intercompared at Yallambie before placement in the field. Once the biometer is running at the site their performance are checked against clear sky solar UVR models. The models require total column ozone values which are obtained from satellite data.

Narrowband filter instruments

N/A

Spectroradiometers

A UV spectroradiometer has been generating data at Cape Grim since 1999 (2006 data is due to be calibrated), while NIWA is soon to fully establish spectroradiometers in Alice Springs and Darwin as part of the BoM's network.

ARPANSA currently uses a Spex spectroradiometer based at the Melbourne site to simultaneously measure solar UVR and transfer a traceable calibration to the biometers before installation. A new

Bentham spectroradiometer is currently being tested and will be installed at the Melbourne site to provide continuous spectral scans.

Calibration activities

The BoM holds the RA V Dobson standard and operates the Regional Dobson Calibration Centre (RDCC) for Australia. The regional standard Dobson is inter-compared regularly with the world standard Dobson. ARPANSA meets the WMO's instrument specifications and characterization as a health advisory agency that provides the daily UV levels.

RESULTS FROM OBSERVATIONS AND ANALYSIS

Ground-based total ozone data and satellite data sets have been used by the BoM to estimate the total ozone variations for several Australian cities over the period 1958 to 2004. The data sets have been de-seasonalized and the differences with the pre-ozone hole period 1970-1980 established. All data sets show changes in the rate of the total ozone decline during the 1980s while the ozone decline during the 1990s was fairly constant.

The UV Index distributions within the period 1958-2004 have been calculated using the ground-based total ozone as input to the "single column model version" of the Australian Ozone and UV Forecasting System. The UV Index has been compared with the occurrence of non-melanoma skin cancer rate over Australia (the first results were presented by Lemus-Deschamps et al., at AMOS and AGU Conferences in 2007).

Monthly, seasonal and annual UV Index and UV dose are due to be calculated (1958-2008) for the Southern Hemisphere. The deviation from the 1970-1980 average will be recalculated for this data set and will complement the Australian UV Index and Ozone climatology (Lemus-Deschamps et al., 2004)

Analyses of ozonesonde data from Davis station (Antarctica) are used in the following areas;

- Investigation of polar ozone loss processes and ozone variability through project 737 of the Australian Antarctic program (e.g. Klekociuk and Tully, 2007; Innis and Klekociuk, 2006; see also http://cs-db.aad.gov.au/proms/public/projects/report_public.cfm?season=0708&project_no=737)
- Near real-time analyses of ozone in the Southern Hemisphere winter (WMO Antarctic Ozone Bulletins; see <http://www.wmo.ch/pages/prog/arep/gaw/ozone/index.html>)
- Satellite and instrument validation (e.g. Dupuy et al., 2008).

Existing UVR measurements have had difficulties in detecting any increase in UVR due to the natural variability in solar UVR at the earth's surface (Peter Gies et al., 2004).

THEORY, MODELLING, AND OTHER RESEARCH

The BoM UV forecast is based on satellite radiance and total ozone analysis. The analysed ozone field is mapped to potential vorticity and advected using the BoM weather forecast model fields. The resulting total ozone fields and meteorological fields are then used in a two stream delta-Eddington radiation code to generate global and Australian UV fields (Lemus-Deschamps et al., 2007, 2006, 2004, 1999).

The UV and ozone forecast system: <http://www.bom.gov.au/weather/uv/>, is under continuous development (upgrades to the system are described by Lemus-Deschamps et al., 2008 at: <http://www.bom.gov.au/bmrc/mdev/expt/uvindex/uvi.shtml>)

Satellite measurements are being used to investigate the long-term behaviour of longitudinal asymmetries in the Southern Hemisphere 'ozone collar' and ozone near the tropopause (e.g. Grytsai et al., 2007).

DISSEMINATION OF RESULTS

Data reporting

The BoM Ozone and UV Forecast System has been part of the "Scientific Assessment of ozone Depletion" reports for 2006 and 2002.

- Chapter 7, 7.3.4 Short Term UV Forecasting 2006.
 - Chapter 5, 5.2.2 Daily Forecasting of Ozone and UV.2002
- The UV data from Cape Grim are included in the BoM's UV database.

Measurements of column amounts from the FTIR system at Wollongong are reported via the NDACC database (see <http://www.ndsc.ncep.noaa.gov/data/>). Ozone sonde and Dobson data from all stations are archived at the WOUDC.

Information to the public

The UV forecast is issued daily by the Bureau of Meteorology. The UV forecast is important because approximately 380,000 Australians still get skin cancer every year. The UV forecast is released to the public by the Bureau of Meteorology regional office in each state and it is provided to the media as part of the weather report (Deschamps et al., 2006). It is also available at <http://www.bom.gov.au/weather/uv/>, and it is extensively used in Australia's SunSmart promotional and educational campaigns. Ozone analyses and forecasts are used by a number of groups to issue statements on the development of the ozone hole each year.

ARPANSA provide measured real-time UV levels which are updated every minute. A plot of the UV levels for Australian sites is available on the ARPANSA web site at <http://www.arpansa.gov.au/uvindex/realtime/index.cfm>.

Historical UV index data since 2004 is also available on the ARPANSA web site at <http://www.arpansa.gov.au/uvindex/monthly/ausmonthlyindex.htm>

Relevant scientific papers

Deschamps L., P. Gies, L. Rikus, R. Dare and K. Strong, 2006: *UV Index for Sun Safety*. *BMRC Res.Lett.* No4, 34-35.

E. Dupuy, K. A. Walker, J. Kar, et. Al, 2008. *Validation of ozone measurements from the Atmospheric Chemistry Experiment (ACE)*. *Atmos. Chem. Phys. Discuss.*, 8, 2513-2656, 2008

[Grytsai, A.V., Evtushevsky, O.M., Agapitov, O.V., Klekociuk, A.R., Milinevsky, G.P.](#) 2007. *Structure and long-term change in the zonal asymmetry in Antarctic total ozone during spring*. *Annales Geophysicae* 25. 361-374.

[Innis, J.L., Klekociuk, A.R.](#), 2006. *Planetary wave and gravity wave influence on the occurrence of polar stratospheric clouds over Davis Station, Antarctica, seen in lidar and radiosonde observations*. *Journal of Geophysical Research*. 111. D22102, doi:10.1029/

[Klekociuk, A.R.](#), 2007. *Seasonal variation of ozone above Macquarie Island and Davis* *BMRC Research Letters* 6. 12-16.

Lemus-Deschamps L., 2007: *The Ozone and UV Forecasting System, Presented at the AMOS Conference, Adelaide, Australia, February 2007.*

Lemus-Deschamps L., J. Easson and P. Shinkfield, 2007: *Changes in Ozone and UV Index of Australian Cities (1958-2004)*. Presented at the AGU Conference, Acapulco Mexico, May 2007.

Lemus-Deschamps L., B. Tacal, L. Huntington, J. Easson and P. Shinkfield, 2007: *Ozone and UV Index over Australia (1958-2004)*. Presented at the AMOS Conference, Adelaide, Australia, February 2007.

Lemus-Deschamps, L., P. Gies, L. Rikus, K. Strong and H. Dixon, 2006: *UV Index: Forecasts and Media Weather Reports. UV Radiation and its Effects, Report of the NIWA Workshop, Dunedin, New Zealand, April 2006*. *RSNZ, Miscellaneous series* 68,25-26.

Lemus-Deschamps L., L. Rikus, S. Grainger, P. Gies, J. Sisson and Z. Li, 2004: *UV index and daily total UV dose distributions for Australia (1997-2001)*. *Aust. Met. Mag.* 53,239-250.

Lemus-Deschamps Lilia, Lawrie Rikus and Peter Gies, 1999: The operational Australian ultraviolet index forecast 1997. Meteorol. Appl. 6, 241-251.

Wilson, S. R. (2006), The Cape Grim Scanning UV Spectrometer, in Baseline Atmospheric Program (Australia) 2003-2004, edited by J. M. Cainey, et al., pp. 9-16, Bureau of Meteorology/ CSIRO Atmospheric Research, Melbourne.

Wilson, S. R. (2007), Effect of temperature on the Cape Grim UV-B records, in Baseline Atmospheric Program (Australia) 2005 - 2006, edited by J. M. Cainey, et al., pp. 25-30, Australian Bureau of Meteorology and CSIRO Marine and Atmospheric Research, Melbourne.

Peter Gies, Colin Roy, John Javorniczky, Stuart Henderson, Lilia Lemus-Deschamps and Colin Driscoli, 2004. Global Solar UV Index: Australian Measurements, Forecasts and Comparison with the UK. Photochem. Photobiol. 79, 1, 32-39.

PROJECTS AND COLLABORATION

Bureau of Meteorology has ongoing collaboration projects:

- With the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) on UV Index validation against surface measurements.
- With SunSmart (Cancer Council Australia) on the use of the UV Index to promote sun protection.
- With University of Colorado on ozone inter-annual variability.

The Australian Antarctic Division's ozonesonde and lidar measurements at Davis station in Antarctica contribute to the International Polar Year cluster project ORACLE-O3.

FUTURE PLANS

- The scanning spectrometer used at Cape Grim is approaching end of life. A replacement system is currently being developed in conjunction with the BoM's Radiation Group.
- Total column FTIR measurements of ozone and related trace gases at Davis station are currently being validated by the AAD.
- An ozonesonde program at Darwin is being planned by the BoM.
- A low-cost UV spectroradiometer is also being developed by the BoM and is currently at the prototype stage.

NEEDS AND RECOMMENDATIONS

Continued provision and development of international data archival facilities (e.g. WOUDC) and instrument calibration standards and inter-comparisons (e.g. through NDACC and WMO).
