File Revision Date:
August 2, 2023

Data Set Description:

PI: A. G. Geddes NIWA, NZ
Instrument: UV Spectrometer (UVL JYDH10, UVM Bentham DM300, UV4 Acton 270, UV9 Bentham DTM300)
Site(s): Lauder, New Zealand (45.04S, 169.68E, 370m) Dec 1989. (UVL, UVM, UV4, UV9)

PI: A. G. Geddes NIWA, NZ and Scott Stierle NOAA, USA
Instrument: UV Spectrometer (UVL JYDH10 system, UV3 Bentham DTM300, UV4 Acton 270, UV5 Bentham DTM300)
Site(s): Mauna Loa Obs, Hawaii (19.53N, 155.57W, 3400m) Jul 1995.. (UVL, UV3)
Boulder, Co, USA (40.13N, 105.24W, 1650m) Aug 1999. (UVL, UV4, UV5)

PI: A. G. Geddes NIWA, NZ and Stephen Rhodes BoM, Australia
Instrument: UV Spectrometer (UV6 and UV7 Bentham DTM300)
Site(s): Melbourne Australia (37.69S, 144.94E, 110m) Jan 2001-Apr 2003 (UV6), Mar 2001-Jun 2003(UV7), May 2009 ... (UV6)
Alice Springs, Australia (23.80S, 133.89E, 547m) Apr 2003-Oct 2005 (UV6), Jun 2006 (UV7)
Darwin, Australia (12.42S, 130.89E, 32m) Jun 2003-Dec 2005 (UV7)

PI: A. G. Geddes NIWA, NZ and Yutaka Kondo University of Tokyo, Japan
Instrument: UV Spectrometer (UV8 Bentham DTM300, with actinic head)
Site(s): Tokyo, Japan (35.65N, 135.67E, 20m) Nov 2003-Nov 2008(UV8)
+ irradiances: Jun 2004-June 2005 (UV4)

Measurement Quantities:

Spectral irradiance on a horizontal surface (cosine weighted) of UV 285-450 nm at 0.6 to 1 nm resolution. In routine operation, scans are taken at intervals of 5 degrees in solar zenith angle and at midday. On cloudless days "sky only" measurements can be made at midday using a shadow band to obscure the direct sun. Since 1993 scans have been from sunrise to sunset (sza=95), and in addition, scans are taken at midnight.

The data summaries on the NDSC database include the following:

1. 285-450 nm integral	(290-450 nm for uvl and uvm instruments)
2. UVA, 315-400 nm	(Wm^{-2})
3. UVB, 290-315 nm	(Wm^{-2})
4. Erythemal UV	(Wm^{-2})
5. DNA-damaging UV	(Wm^{-2})
6. VitD weighted UV (or Generalised plant-damaging)	(Wm^{-2})
7. Cosine correction applied to UVA	(CosUVA)
8. Calculated UVA transmission	(TrUVA)
9. Instrument EHT range	(EHTmin and EHTmax)
10. Statistics of intensity changes during the scan	(Diode_mean & Stdev)
11. Instrument Temperature	(C)
12. Wavelength shift applied	(nm)
13. Derived ozone (from ratio:305/340)	(DU)

Contact Information:

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Oral Presentation, "Updates to the Operational UV Index – Validation Against GRAD Observations", Craig S. Long, Hai-Tien Lee (NOAA National Weather Service, National Centers for Environmental Prediction, Climate Prediction Center, College Park, MD), Global Monitoring Annual Conference (GMAC), May 23 - 24, 2023

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Bernhard, G. H., Bais, A. F., Aucamp, P. J., Klekociuk, A. R., Liley, J. B., & McKenzie, R. L. (2023). Stratospheric ozone, UV radiation, and climate interactions. Photochemical & Photobiological Sciences, 1-53. 10.1007/s43630-023-00371-y

UNEP SAP 2022 Q & A:
Salawitch, R.J., McBride, L.A., Thompson, C.R., Fleming, E.L., McKenzie, R.L., Rosenlof, K.H., Doherty, S.J., Fahey, D.W. (2023) Twenty questions and answers about the ozone layer: 2022 update. Scientific Assessment of Ozone Depletion: 2022: 75. https://ozone.unep.org/science/assessment/sap
.
NIWA Boulder instrument is used as NOAA/ESRL/CMD annual transfer standard for UVB1 radiometers that are a part of the SURFRAD and SOLRAD networks (14 sites).

Instrument Description:

[UVB: Include list of instrument spec's that are or are not met. See UVB instrument validation appendix for list of instrument specs.]

UVL JYDH10. Bandpass too broad for NDSC (1200 g/mm 1.15 nm fwhm)
and detection threshold of 0.001 uW cm-2 nm-1
Not NDSC quality - cosine response inadequately characterised for MLO
- detection threshold too high
- mismatch for data at MLO between UVL and UV3 at MLO
(especially for large sza in morning data)
- bandpass too broad

UVM Bentham DM300 Bandpass NDSC standard (2400 g/mm, 0.9 nm fwhm) but detection threshold of 0.0001 μW cm^{-2} nm-1 requires several scans.

Later instrument (UVn, n>2) all meet NDSC specs, but direct sun obs require manual intervention

UV3 Based on Bentham DTM300. NDSC standard (2400 g/mm, 0.8 nm fwhm) NOAA
UV4 Based on Acton 270. NDSC standard (2400 g/mm, 0.8 nm fwhm) NIWA.
UV5 Based on Bentham DTM300. NDSC standard (2400 g/mm, 0.8 nm fwhm) NOAA
UV6 Based on Bentham DTM300. NDSC standard (3600 g/mm, 0.6 nm fwhm) BoM
UV7 Based on Bentham DTM300. NDSC standard (3600 g/mm, 0.6 nm fwhm) BoM
UV8 Based on Bentham DTM300. NDSC standard (3600 g/mm, 0.6 nm fwhm) Univ Tokyo
UV9 Based on Bentham DTM300. NDSC standard (3600 g/mm, 0.6 nm fwhm) NIWA

Instruments UVL and UVM: Fixed speed scan in the forward direction only
Data stored as integers
12-bit a/d converters
Dynamic range achieved by changing EHT to pmt during scans

Instruments UVn (n>=3) : Variable speed scans in both directions
Data stored as floating point numbers
20-bit, or 24-bit a/d converters
No EHT gain switching during scans

All instruments operate in additive dispersion.

Algorithm Description:

Programme written in Python3 based on the original MS Visual Basic version, UVP3.6

Reads file of instrument-dependent parameters

Selection of cal file depends on date as specified in above file

(ref McKenzie et al., 1992) Intensity calibration:

Uses calibrations made with 1000W FEL lamps to form files of calibration factors at each wavelength.

For NDSC instruments, can transfer cal to internal 45W lamp used in weekly stability calibrations.

A facility exists for removing emission line features from k-files generated from lamps with contaminant gases (e.g., Al near 390 nm)

Wavelength calibration:

Correlation alignment against Solar Fraunhofer lines non-linear wavelength errors deduced from Hg lamp scans.

Expected Precision/Accuracy of Instrument:

+/- 5% see McKenzie et al., 1992.

Irradiances are derived from FEL lamps for which calibrations traceable to NIST are provided by standards laboratories at 10 nm intervals. For the older FEL lamps it was safe to interpolate between the set wavelengths to determine the lamp output at intermediate points. However, most of the more recent FEL lamps contain emission lines from impurities, which introduce errors at the ~1% level at the specific wavelengths that correspond to these emission features. The FEL lamps used at Boulder and Mauna Loa have the largest emissions. However, for the weighted irradiances reported here, any errors traceable to these emissions is less than 0.1%. For spectrally-resolved data, it is possible in principal (though time consuming in practise) to apply corrections to remove these feature. In 2005, ambient temperatures have been logged, and an algorithm has been added to the processing to apply corrections for the temperature dependence of the PTFE diffusers (see McKenzie, Badosa, et al., 2005).

Instrument History:

Dates and description of significant changes in instrument or algorithm

Dec 1989. UVL Lauder (JY DH10) Observations began at Lauder
Feb 1990. UVL Lauder Instrument rotated 180 degrees (azimuth 23)
Oct 1990. UVL Lauder First observations with on-site calibration
Jan 1992. UVL Lauder Cross calibration at Lauder (Seckmeyer)
Feb 1993. UVL Lauder Cross calibration at Lauder (Seckmeyer, Roy)
Jan 1993. UVM Lauder Bentham DM300 -with integrating sphere Obs began at Lauder
Dec 1993. UVM Lauder Reliable measurements began at Lauder
Jul 1994. UVL Garmisch Cross calibration in Garmisch-P, Germany
Oct 1994. UVM Lauder Wavelength drive replaced.
Feb 1995. UVL Lauder Albedo measurements. Last routine UVL obs at Lauder
Jul 1995. UVL Hawaii Mounted in weatherproof box. Installed at MLO (NOAA).
Aug 1996. UVL Hawaii Testing sensitivity to rotation
Jun 1997. UVL Hawaii Instrument damaged by lightning and removed
Aug 1997. UV3.Greece SUSPEN intercomparison Nea Michionia (see Bais et al)
Nov 1997. UV3 Hawaii NOAA Collab Bentham DTM300 observations started at MLO
Sep 1998. UVL Boulder Modified version with new diffuser/fibre optic installed at Boulder
Sep 1998. UVM Lauder Integrating sphere replaced with diffuser/fibre optic
Mar 1999. UVL Boulder Moved to new lab in Skaggs building
May 1999. UVL Boulder Fibre optic broken. Replaced day 168
Sep 1999. UV4 Boulder Instrument installed day 251
Nov 1999. UVL Boulder Instrument decommissioned. Returned to Lauder
Nov 2000. UV6 Alice Springs Australian BoM collaboration
May 2001. UV4 Boulder Moved to Table Mt for campaign, installed day 143
Jul 2001. UV5 Boulder NOAA Collab. Instrument, installed day 214
Oct 2001. UV4 Boulder Instrument decommissioned. Returned to Lauder
Nov 2001. UV7 Darwin Australian BoM collaboration
Jun 2003. UV5 Boulder USDA campaign at Boulder
Nov 2003. UV8 Tokyo Actinic flux measurements
Jun 2004. UV4 Tokyo University of Tokyo. Returned to Lauder July 2005
Jun 2005. UV9 Thule NDACC-cerify UV spectrometer of Danish Met Instr
Sep 2005. UV9 Lauder returned from Thule
Oct 2005. UV6 Alice Springs Instrument damaged, returned to Melbourne & Lauder for repair
Jun 2006. UV7 Alice Springs Australian BoM collaboration
Aug 2006. UV4 Lauder Diffuser replaced by temperature-controlled Schreder Head
Nov 2006. UV9 Arr.Hgts. NDACC-certify Biopsherical's NSF UV spectrometer
Feb 2007. UV9 Lauder returned from Arr.Hgts.
May 2007. UV7 Alice Springs Temperature Control of instrument failed; instrument turned off until repaired in March 2008

Mar 2008. UV7 Alice Springs Good data resumed
Mar 2008. UV5 Boulder Noisy data produced by new logging PC, will be reprocess at later data
Mar 2008. UVM Lauder Logging PC failed & replaced
Jun 2008. UV5 Boulder Logging PC replaced good data resumed
May 2009. UV6 Melbourne Australian BoM collaboration, good data resumed
Aug 2009. UV5 Boulder Temperature Control of instrument failed, instrument turned off until repaired in Sept 2009
Oct 2009. UV5 Boulder Temperature Control of instrument restored 26 Oct
Jun 2011. UV4 Lauder Instrument offline during work to building.
Substituted UVM data for Mar-Jul 2011
May 2012. UV5 Boulder Level left on top of entrance optic for 8 days 8-16 May 2013
2013 UV5 Boulder instrument has suffered from significant noise relative to very low signal levels (below 285 nm wavelength, in dark measurements, and between Hg lines in stability checks. The cause was found by Paul Johnston to be processor switching during scans in multi-CPU machines. Symantec virus updates can also cause problems. These issues may not translate directly for other hardware, but they highlight the difficulty of continuing long measurement records as computer hardware and software evolves away from their origins.
Mar 2014 UV5 Boulder logging PC OS upgrade
Jun 2014 UV5 Boulder logging program off due to OS & Anti-virus updates
Dec 2014 UV5 Boulder power outage & component replacement, possible misalignment of fibre optic or slit diode issue 15 Dec 2014
Jan 2015 UV3 Mauna Loa logging PC OS upgrade
Mar 2015 UV3 Mauna Loa logger pc program crashes
Apr 2015 UV3 Mauna Loa logging program off,
May 2015 UV3 Mauna Loa server outage
Nov 2015 UV5 Boulder slit diode replaced
Dec 2015 UV4 Lauder Last 3 days missing, server failed to transfer data.
Jan 2016 UV4 Lauder January 29 to February 12, 2016 Intercomparison with the travelling reference spectroradiometer QASUME from PMOD/WRC". Gröbner, J. (2016), Davos, PMOD.
Mar 2017 UV5 Boulder 8 Mar 2017 4 days missing – damaged fibre-optic
May 2017 UV5 Boulder 5 May 2017 examine damaged fibre-optic
Sep 2019 UV5 Boulder 23 Sep 2019 replace fibre-optic borrowed from NIWA,
60% increase in throughput
Sep 2019 UV3 Mauna Loa Missing September 2019 data due to data transfer issue.
Feb 2020. UV7 Alice Springs aircon unit failed. Temperature instability
Sep 2020. UV7 Alice Springs due to increased temperature instability and COVID travel restrictions prevented a repair, instrument hibernated until restrictions lifted 16 Nov 2022
Oct 2020 UV3 Mauna Loa Missing 25 days data due to failed computer power supply
Nov 2020 UV5 Boulder failed temperature controller

2021	UV3 Mauna Loa	Missing 8 days data due to power cuts and PC updates
Mar 2021	UV5 Boulder	temperature controller replaced; Temperature instability affected wavelength shift slightly.
2021	UV5 Boulder	Monthly PC system updates with no auto-startup caused missing data.
Nov 2022.	UV7 Alice Springs	aircon units repaired
Nov 2022.	UV3 Mauna Loa	Volcanic Eruption site power and access lost 28 Nov 2022
Jan 2023.	UV7 Alice Springs	logging computer failed. No data until replacement win7 PC or system upgrade. No on-site staff
Jul 2023.	UV3 Mauna Loa	Power restored 5 Jul 2023, access by helicopter
Jul 2023.	UV3 Mauna Loa	Calibration Power supply fuse blew 9-25 Jul 2023

The data processing algorithm has undergone many revisions, which will continue.

Jun 2000.	Processing version: uvp25.exe (MS Quick Basic)
Jul 2005.	Processing version: uvp3.6.exe (MS Visual Basic)
2022	pyuvp37 (Python3 implementation of uvp3.6)
Jun 2023.	Current processing version: pyuvp37 2023-06-09 13:46:30.892268