New NOAA-EPA UV Network: Characterization, Software and Hardware Issues of MKIV Brewers

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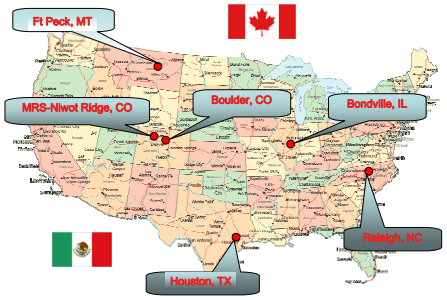
The UV Network

Primary objectives	Secondary objectives
• Daily average ozone column (ds, zs)	• O_3 daily trends from ds and zs
• Ozone profile (um)	• NO_2 column from zs
• UV total horizontal irradiance (ux)	• SO_2 column from ds
• UV erythemal dose (ux)	• AOD from ds and ps
	• O_3 from ux scans - all sky conditions



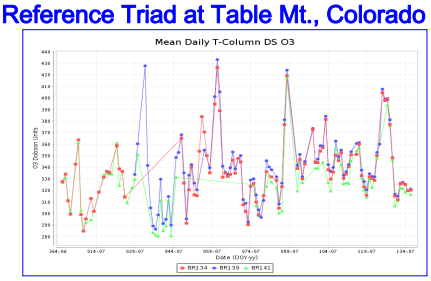
BREWER	SERIAL #	LATITUDE	LONGITUDE	ELEVATION
Raleigh, NC	96-140	N 35.728	W 078.680	124 masl
MRS, CO	97-146	N 40.032	W 105.533	2923 masl
Ft Peck, MT	97-147	N 48.308	W 105.102	634 masl
Houston, TX	97-154	N 29.718	W 095.341	84 masl
Bondville, IL	96-144	N 40.053	W 088.372	213 masl
Table Mtn, CO	94-134	N 40.125	W 105.237	1689 masl
Table Mtn, CO	96-139	N 40.125	W 105.237	1689 masl
Table Mtn, CO	96-141	N 40.125	W 105.237	1689 masl

Additional Brewer sites: There are two Brewer Mark IV's operating at the Queensland University of Technology in Brisbane, Australia. They are operated by Dr Michael Kimlin. Dr Kimlin is with the Australian Sun and Health Research Laboratory, which is part of the University's Institute of Health and Biomedical Innovation. Dr Kimlin's main research effort is the study of vitamin-D production in humans and its health effects. The Australian Brewer serial numbers are 96-132 and 96-138.

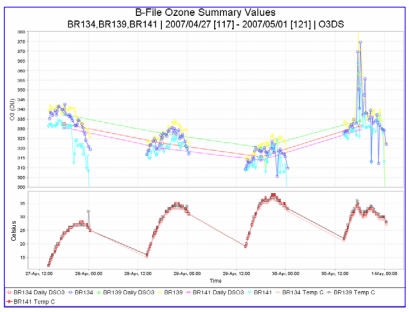
There is an additional unofficial NEUBrew site currently operating Brewer 96-135 for special studies. Brewer 135 is operating on top of the penthouse at NOAA's David Skaggs Research Center in Boulder, CO. The Dobson reference standard also operates on the roof of the DSRC, thereby allowing Intercomparison between ozone profiling techniques. Brewer 135 only performs Umkehr measurements from sunrise until -70 degrees solar zenith angle, from -70 until +70 degrees it runs the normal NEUBrew schedule, and then at +70 degrees only performs Umkehr measurements again until sunset.

Development of the NOAA/Global Monitoring Division's Mauna Loa site for installation of a NEUBrew Mark IV Brewer is proposed. During a site visit in February 2007 a survey of the infrastructure was performed. The feasibility of installing another Brewer on the deck structure that is built over the main building was studied. There is sufficient space and staff support for installing and operating a NEUBrew Mark IV permanently at this site.

Reference Triad at Table Mt., Colorado

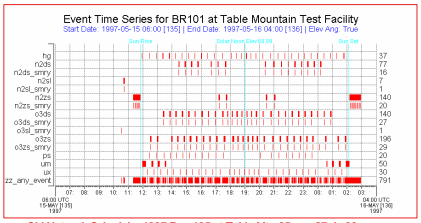


Daily average ozone column values from the triad instruments (*Ozone values from Brewer algorithm*)

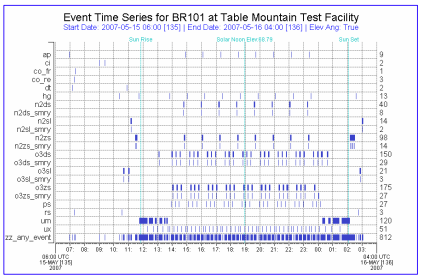


Individual ozone retrievals display a slight SZA dependence that isn't strongly correlated to temperature

Maximizing Schedule Duty Cycle



Old Network Schedule: 1997 Doy 135 at Table Mt - 25 um, 27 ds 30 ux



New Network Schedule: 2007 Doy 135 at Table Mt - 60 um, 29 ds, 51 ux

New NOAA-EPA Brewer Schedule

-115.0
jdb2w1cib0
-105.0
pfpdo3b1hgb0rssldtsln2slb0
-94.0
pfpdn2zszszszszs
-92.40
Pfpdo3b1hgb0kaum**
-90.0
pfpdo3kaum
-85.0
pfpdo3uxkeum30
-80.0
pfpdo3kcumuxdekdumuxkcum30
-70.0
pfpdo3b1uxhguxdszsuxdszsuxdszsuxdszsuxdszsuxdszs n2dszsap30
*(pfpdo3b1uxhguxdszsuxdszsuxdszsuxdszsuxdszsuxdszsuxdszsb2uxcib0n2dszsap30)**
70.0
pfpdo3kdumo3uxdekdumuxo30
80.0
pfpdo3keumo3uxo30
85.0
Pfpdo3kaum
91.0
pfpdn2zszszszszs
94.0
pfpdo3b1hgb0rssln2slb0
105.0
pfo3
180.0
07088A2

* Section with internal lamps scans ci run every fifth day
**Modified um routine to force finite number of cycle with new precursor routines ka, kb, kc, kd, ke

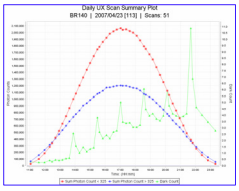
Dark Count "Hysteresis"

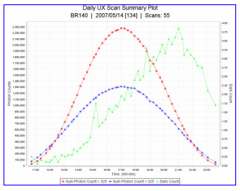
Elevated dark signals and magnitudes that varied between different modes and routines were discovered. It was determined that the Brewer did not shutter the exit slits before exiting certain routines while in schedule (DS, ZS, UX, & PS). This leaves the PMT exposed to direct sun or global irradiances. The problem occurs after the second (and follow-on) execution of the routines after a full reset, but not the first execution. The correct shuttering occurs for each routine if performed individually from the command line.

The Brewer routines UX (UV), DS, ZS, and PS were modified to correct the non-shuttering of the slit-mask when performing multiple commands in schedule. The routines are from Brewer software version 3.75f. The Brewer software is currently operated on Windows 98 platform.

The following code was added to the DS and ZS routines in the "Clean up and exit" portion of the code at the following line numbers. In the UV.RTN it is within the "End Scanning Procedure" section. The PS.RTN has been extensively rewritten.

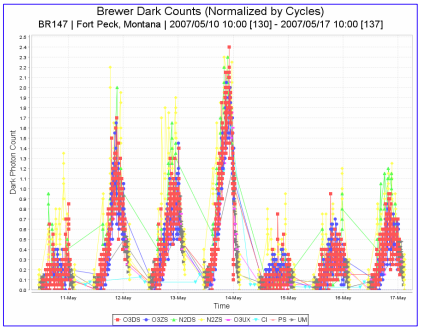
NEW COMMAND: O1$="R,1,1,1;O": GOSUB 9450
(command effectively shutters the exit slits and clears accumulator before exiting the routine):
DS.RTN line 13012, UV.RTN line 18043, and ZS.RTN line 13012



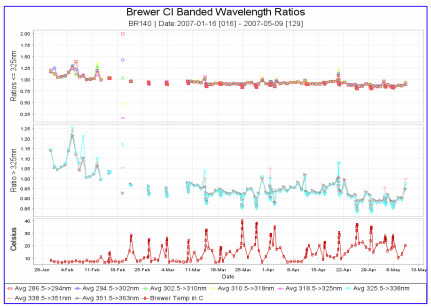


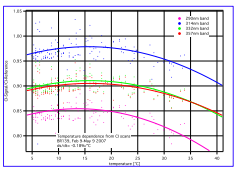
Dark count in ux scans (green curve) with spikes (left) and dark count temperature signature only after modification (right)

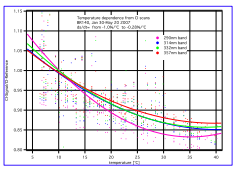
Elevated dark counts in N2 mode



Temperature: Throughput & PMT



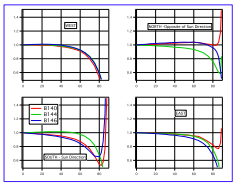


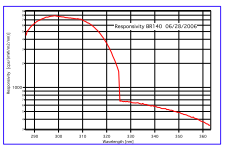


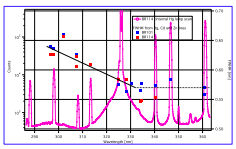
Approximate temperature coefficients derived from CI-Scans for BR139 and BR140 Winter-Spring 2007

Characterization for UV Scan Processing

- Each instruments has absolute responsivity determined by measuring multiple horizontal CUCF FEL lamps in field at least once every six month.
- Angular responsivity (cosine response) in two perpendicular axes is measured at NOAA's CUCF laboratory.
- Resolution (fwhm) is determined using internal Hg lamp scans and external Hg, Cd and Zn spectral lamps in the field. Historical data are also used.







Various hardware issues

- Proposed additional modification to the UV.RTN to modify for all NEUBrew Brewer Mark IV's to use NDF 1.0 above 325 nm instead of the current NDF 1.5. The modification is to increase the signal and decrease the uncertainty above 325 nm. It will be necessary to recalibrate all network Brewers for the spectral UV measurements after the modification.
- We are currently testing potential $NiSO_4$ replacement filters for the Brewer Mark IV. We are characterizing the Hoya U340 and the Rapp-Opto UV1 and comparing to the original $NiSO_4$ filter. They are being characterized for bandpass, long-wavelength suppression, and transmittance as a function of temperature.
- We are performing polarization characterization of Brewer throughput and it's impact on ozone retrieval at low and high sun zenith angles. We don't anticipate replacing the quartz window with a cylindrical window as was done by NASA-Goddard in their Brewer MKIII.
- Temperature dependence of throughput and PMT responsivity is an ongoing characterization process that will lead to adaptive correction routines for UX scan data. Internal tungsten-halogen lamps scans, external CUCF lamp calibrations, temperature coefficients developed in the past and vicarious calibration with the collocated UV-MFRSR will be employed.

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