Atmospheric references over oceans with MICROTOPS sunphotometers

MICROTOPS

Reference for satellite remote sensing and global modeling are sparse over ocean regions. Thus, NASA's AERONET group (lead by Alexander Smirnov) distributes (for ship cruises of opportunity) calibrated handheld (MICROTOPS) sun-photometers to sample atmospheric column average properties for aerosol and water vapor. The derived solar attenuations (from measurements of the direct sun-light at the ground) offer highly accurate data, unlike interpretations of changes to backscattered solar radiation by satellite sensors. A MICROTOPS samples simultaneously at five different solar spectral intervals, to allow not only information on aerosol amount, but also on aerosol particles size, to distinguish between contributions from smaller aerosols (e.g. wildfires or pollution) and from larger aerosols (e.g. seasalt or mineral dust). In addition, information on the atmospheric water vapor content is provided, by combining solar attenuation in a trace gas free and a water-vapor absorption affected solar spectral interval. The battery powered MICROTOPS is paired with a battery powered GPS unit. The GPS provides the needed position information (which is continuously changing on a voyage) in order to define the solar elevation and thus the reference radiation at the top of the atmosphere.

work at sea

MICROTOPS measurements are performed in a handheld mode, by orienting the instrument during a measurement with the help of a pointing device into the sun. MICROTOPS measurements require unobstructed views of the sun's solar disk. Thus data sampling is only possible during the day when the sun is not covered by (even optically thin) clouds. Also contamination by ship exhaust and interference by ship obstructions must be avoided. For the regular data recording, a measurement-sequence is requested about every 15 min. Hereby a measurement-sequence requires 5 to 10 consecutive (ca 8 second long) samples (conditions permitting) to better identify and filter poor data from cloud-contamination and mis-orientation. The MICROTOPS can store about 500 samples. At the end of the day the data are (see sample output below) are requested to be e-mail to Alexander Smirnov at NASA, where data are quality checked and uploaded on the web-site. (http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html).

MPI-Met involvement

The MPI-Met assured that MICROTOPS instruments where operated on the four German Research Vessels (POLARSTERN, METEOR, MARIA.S.MERIAN and SONNE) during transit cruises. Since 2008 the MPI-Met has delivered instruments to the ships and on at least 40 cruises has staffed employees to conduct the (labor intensive handheld) sampling.

sampling actions

regular measurements at cloud–free conditions only (not even thin cirrus) - in case you are not sure take a camera snapshot

each ‘recorded’ measurement is a set of at 10 (at least 5) consecutive scans – each ‘scan’ takes about 8 seconds. During each scan try to keep the image of the sun in the center of the ‘dart-board projection’ at least for a short time, because only the highest transmission data sub-sample of ca 20 sub-samples is recorded

The procedure in short - connect the GPS unit and turn the GPS on and wait until a proper location is found - turn the instrument on (with the lid covered – to initialize) … it take only a few seconds o the instrument will beep 3 times to indicated that is gets a GPS - then open the lid and point the instrument’s window into the sun - when aligned, make a scan (‘scan button’) and keep the sun alignment during the scan (the instrument shows ‘scan’ and an ongoing ‘scan number’ on its display) - the instrument will beep 2 times to indicate that the scan is completer - 10 (at least 5) consecutive scans complete a measurement - repeat measurements every 15 to 30 minutes … weather conditions permitting - the instrument can collect ca 500 scans in its memory - at the end of the day (or if MICROTOPS memory is full: ca 500 max) download data to a laptop

1. connect the serial cable into the GPS connector and turn the MICROTOPS on
2. make sure to have a terminal software installed (to capture the screen data to a file)
3. make sure to have software installed that recognizes the serial port via USB
4. use a terminal server and 4800baud N/1 setting: is correct … a menu will show up on ‘enter’
5. selecting “P” will display the data on the laptop screen.
6. open a capture file and hit “P” again … so all displayed data will be mirrored in the file
7. close the file and check if this file includes all data
8. when all data are ‘saved’ then hit “C” to free all memory of the MICROPTOPS

- send the file via internet to Alexander Smirnov at NASA (alexander.smirnov-1@nasa.gov). Alexander (Sascha) will look at the data, offer help if needed and places data on the web

http://aeronet.gsfc.nasa.gov/new_web/maritime_aerosol_network.html

- make sure the window behind the lid does not get dirty! (e.g. avoid sea-spray). Be careful if trying to clean window, as to avoid scratches (best: confer with Sascha on procedure).

data download from MICROTOPS to a Laptop

the single connector on the MICROTPOS used for the GPS instrument during data samples, is also used for the data-download. The data download is done via a cable with SERIAL port. Such ports are not available on newer laptops, so that aside from a terminal software (e.g. hyperterminal for PC or Coolterm for MAC) also a SERIAL to USB adapter is required - along with the driver/software to make to adaptor work.

download on a MAC laptop

Install Coolterm a “Port Terminal Application” http://freeware.the-meiers.org/CoolTermMac.zip. -

connect the Microtops to your MAC using a “USB to Serial” (you will need a USB-C to USB adapter aswell if you use the newest MAC) - adapter DIGITUS USB auf Seriell Adapter - RS232 Konverter - USB 2.0 Typ-A zu DSUB 9M - FTDI Chipsatz - 80 cm Verlängerungs-Kabel - once the serial adapter connected and the MICROTOPS powered on:

1. Go to the menu Connections/Options menu:
2. set in Serial port, the **port to “USBserial”**
3. eventually re-scan serial ports
4. set in Serial port the **Baudrate to 4800**
5. click icon “connect”
6. Press p on keyboard.
7. Scans get print on screen
8. CUT and Paste to Textediting program, (comma separated values)
9. after saving. check that the data has been saved up to the “END” mark then Scan Clear microtops of DATA using C

download on a PC laptop

use the hyperterminal software (works with windows xp/7/10) and make sure the USB port identifies the SERIAL COM port. - connect the MICROTOPS via the serial cable and the USB adapter to your laptop and turn the MICROTOPS on. - start ‘hyperterminal’

1. NO at default question
2. CANCEL at location information
3. YES at cancel confirm
4. OK at hyperterminal question
5. enter an arbitrary name for a session (e.g. ttt)
6. CANCEL at location information
7. YES at cancel confirm
8. find a right COM port (COM4? COM9? – depends on your computer) and hit OK
9. set baud rate (bits per second) to 4800 (all other parameters in port settings unchanged) and
10. confirm with OK

1. now hit the return (enter) key on your laptop and a menu should appear (if not, then the USB port is wrong/not recognized … try another offered USB port or reinstall the driver)

This is the menu (if you see this, you are connected): MICROTOPS II Ozone Monitor-Sunphotometer Ver. 5.6AO/08 S/N ?????

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  A - show current location
  B - set current location
  C - clear data buffer
  L - list saved locations
  M - modify saved location
  P - print data buffer
  S - initiate scan
  T - set the date and time
  X - print calibration constants
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Two options are only revelant: - Option P: shows all data on the screen / and optionally mirrors data into a data-file - Option C: removes all data (ONLY use this option, when all data are save on the

computer)

- saving the data to the laptop

1. click on the 'TRANSFER' option (one of the top line choices of hyperterminal) and pick the CAPTURE TEXT... option from the menu
2. under 'BROWSE' set location and name(with the date) of the file for the data to be stored
3. hit 'START'
4. now back at the MENU hit P on your keyboard (now all the data shown on the screen and are mirrored at the same time into your named data-file)
5. wait until the data display on the screen comes to an end.
6. click on the 'TRANSFER' option (in the top line) and pick the CAPTURE TEXT... option and click on STOP
7. check if all the data were downloaded into the file (you selected) on your laptop (e.g. using notepad)
8. if certain, that all data are saved properly ... at the MENU hit C on the keyboard (so that the memory on the MICROTOPS is cleared to make room for new data-samples) - there is room for ca 500 samples on the MICROTOPS

- close Hyperterminal (confirm close with YES and with NO at the save your session (e.g.ttt) question)
- disconnect the MICROTOPS on turn the MICROTOPS off

Example microtops Data

each sample is shown in a single line ... - starting with the instrument-ID, the data and the location and - ending with the internally calculated (subtracting Rayleigh scattering) AOD at 380nm, AOD at 440nm, AOD at 670nm, AOD at 870nm, AOD at 940nm and finally the atmospheric total water content.

Gerät ID	Datum	uhrzeit	Breitengrad	längengrad	Alt	Pressure	SZA	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	0.38um	AOT 0.44um	0.67um	0.87um	094um	WATER CM/M2
16824	05/20/2019	9:24:15	53.567	9.977	17	1000	39.91	1.303	1.026	24.6	81	392.63	349.51	565.76	963.44	227.76	NaN	NaN	NaN	NaN	NaN	1.1234	0.6178	0.5872	4.2301	0.895	0.685	0.554	0.417	0.379	2.23
16824	05/20/2019	9:24:53	53.567	9.977	17	1000	39.85	1.301	1.026	24.8	81	658.70	505.71	756.67	1219.26	326.21	NaN	NaN	NaN	NaN	NaN	1.3025	0.6683	0.6206	3.7377	0.499	0.402	0.331	0.236	0.215	1.88
16824	05/20/2019	9:25:52	53.567	9.977	17	1000	39.75	1.299	1.026	25.0	81	669.26	517.81	848.29	1319.21	366.13	NaN	NaN	NaN	NaN	NaN	1.2925	0.6104	0.6430	3.6031	0.488	0.384	0.244	0.176	0.160	1.78
16824	05/20/2019	9:26:05	53.567	9.977	17	1000	39.73	1.299	1.026	25.0	81	666.69	518.39	846.77	1328.60	370.24	NaN	NaN	NaN	NaN	NaN	1.2861	0.6122	0.6373	3.5885	0.491	0.384	0.245	0.171	0.155	1.77
16824	05/20/2019	9:26:24	53.567	9.977	17	1000	39.69	1.298	1.026	25.1	81	673.01	520.12	856.51	1341.46	367.78	NaN	NaN	NaN	NaN	NaN	1.2940	0.6073	0.6385	3.6474	0.484	0.381	0.236	0.163	0.149	1.80
16824	05/20/2019	9:26:36	53.567	9.977	16	1000	39.67	1.298	1.026	25.1	81	664.45	514.71	846.10	1311.67	356.70	NaN	NaN	NaN	NaN	NaN	1.2909	0.6083	0.6451	3.6773	0.494	0.390	0.246	0.181	0.164	1.83
16824	05/20/2019	9:27:09	53.567	9.977	16	1000	39.62	1.297	1.026	25.2	81	630.10	503.13	848.87	1340.01	367.80	NaN	NaN	NaN	NaN	NaN	1.2524	0.5927	0.6335	3.6433	0.536	0.408	0.244	0.164	0.149	1.80
16824	05/20/2019	9:27:16	53.567	9.977	16	1000	39.61	1.297	1.026	25.2	81	667.95	516.57	858.10	1347.42	370.67	NaN	NaN	NaN	NaN	NaN	1.2931	0.6020	0.6369	3.6351	0.491	0.387	0.235	0.160	0.146	1.80
16824	05/20/2019	9:27:25	53.567	9.977	16	1000	39.59	1.297	1.026	25.3	81	666.09	515.90	852.62	1339.38	362.15	NaN	NaN	NaN	NaN	NaN	1.2911	0.6051	0.6366	3.6984	0.493	0.389	0.240	0.165	0.150	1.84
16824	05/20/2019	9:27:41	53.567	9.977	16	1000	39.57	1.296	1.026	25.3	81	621.61	482.19	814.65	1299.38	346.75	NaN	NaN	NaN	NaN	NaN	1.2892	0.5919	0.6270	3.7473	0.547	0.441	0.276	0.188	0.171	1.88
16824	05/20/2019	9:27:48	53.567	9.977	15	1000	39.55	1.296	1.026	25.4	81	675.61	521.21	860.09	1352.40	370.10	NaN	NaN	NaN	NaN	NaN	1.2962	0.6060	0.6360	3.6541	0.483	0.381	0.234	0.157	0.143	1.81
16824	05/20/2019	9:27:59	53.567	9.977	15	1000	39.53	1.295	1.026	25.4	81	659.38	507.91	838.86	1333.84	365.12	NaN	NaN	NaN	NaN	NaN	1.2982	0.6055	0.6289	3.6532	0.502	0.401	0.253	0.168	0.153	1.81
16824	05/20/2019	9:28:10	53.567	9.977	15	1000	39.52	1.295	1.026	25.5	81	661.55	513.91	854.59	1332.79	360.21	NaN	NaN	NaN	NaN	NaN	1.2873	0.6014	0.6412	3.7000	0.500	0.392	0.239	0.169	0.154	1.84
16824	05/20/2019	9:28:21	53.567	9.977	15	1000	39.50	1.295	1.026	25.5	81	669.57	517.11	848.82	1341.45	371.10	NaN	NaN	NaN	NaN	NaN	1.2948	0.6092	0.6328	3.6148	0.491	0.388	0.244	0.164	0.149	1.79
16824	05/20/2019	9:28:31	53.567	9.977	15	1000	39.48	1.294	1.026	25.6	81	662.93	511.30	837.44	1330.78	363.85	NaN	NaN	NaN	NaN	NaN	1.2966	0.6106	0.6293	3.6575	0.499	0.396	0.255	0.170	0.155	1.82
16824	05/20/2019	9:28:40	53.567	9.977	15	1000	39.47	1.294	1.026	25.6	81	656.03	507.96	847.48	1338.79	368.28	NaN	NaN	NaN	NaN	NaN	1.2915	0.5994	0.6330	3.6352	0.507	0.402	0.246	0.165	0.150	1.80
16824	05/20/2019	9:28:50	53.567	9.977	15	1000	39.45	1.294	1.026	25.6	81	660.01	510.50	850.70	1336.11	366.71	NaN	NaN	NaN	NaN	NaN	1.2929	0.6001	0.6367	3.6435	0.502	0.398	0.243	0.167	0.152	1.81
16824	05/20/2019	9:29:06	53.567	9.977	15	1000	39.42	1.293	1.026	25.7	81	669.26	517.57	852.37	1343.69	370.36	NaN	NaN	NaN	NaN	NaN	1.2931	0.6072	0.6344	3.6281	0.492	0.388	0.241	0.163	0.148	1.80
16824	05/20/2019	9:29:14	53.567	9.977	15	1000	39.41	1.293	1.026	25.7	81	664.96	516.40	845.47	1350.15	371.65	NaN	NaN	NaN	NaN	NaN	1.2877	0.6108	0.6262	3.6329	0.497	0.389	0.248	0.159	0.145	1.80
16824	05/20/2019	9:29:40	53.567	9.977	15	1000	39.37	1.292	1.026	25.7	81	645.41	506.48	831.06	1325.66	364.58	NaN	NaN	NaN	NaN	NaN	1.2743	0.6094	0.6269	3.6361	0.521	0.405	0.261	0.173	0.158	1.81
16824	05/20/2019	9:29:49	53.567	9.977	15	1000	39.35	1.292	1.026	25.7	81	667.46	517.47	854.38	1350.21	372.03	NaN	NaN	NaN	NaN	NaN	1.2898	0.6057	0.6328	3.6293	0.495	0.388	0.240	0.159	0.145	1.80
16824	05/20/2019	9:29:57	53.567	9.977	15	1000	39.34	1.292	1.026	25.7	81	666.85	518.24	849.08	1337.18	361.05	NaN	NaN	NaN	NaN	NaN	1.2868	0.6104	0.6350	3.7036	0.496	0.387	0.245	0.167	0.152	1.85
16824	05/20/2019	9:30:06	53.567	9.977	15	1000	39.32	1.292	1.026	25.7	81	643.76	499.74	815.32	1304.24	359.19	NaN	NaN	NaN	NaN	NaN	1.2882	0.6129	0.6251	3.6310	0.523	0.416	0.276	0.186	0.169	1.81
END.																																