Universidad de La Laguna

GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE
AEMet Agencia Estatal de Meteorología

Brewer-OMI comparisons using EUBREWNET

Regional Brewer Calibration Center for Europe

Outline

→ EUBREWNET : Brewer database

→ EUBREWNET Ozone OMI comparison

→ EUBREWNET Ultraviolet OMI comparison

→ Next Steps: AOD

1-EUBREWNET: start page

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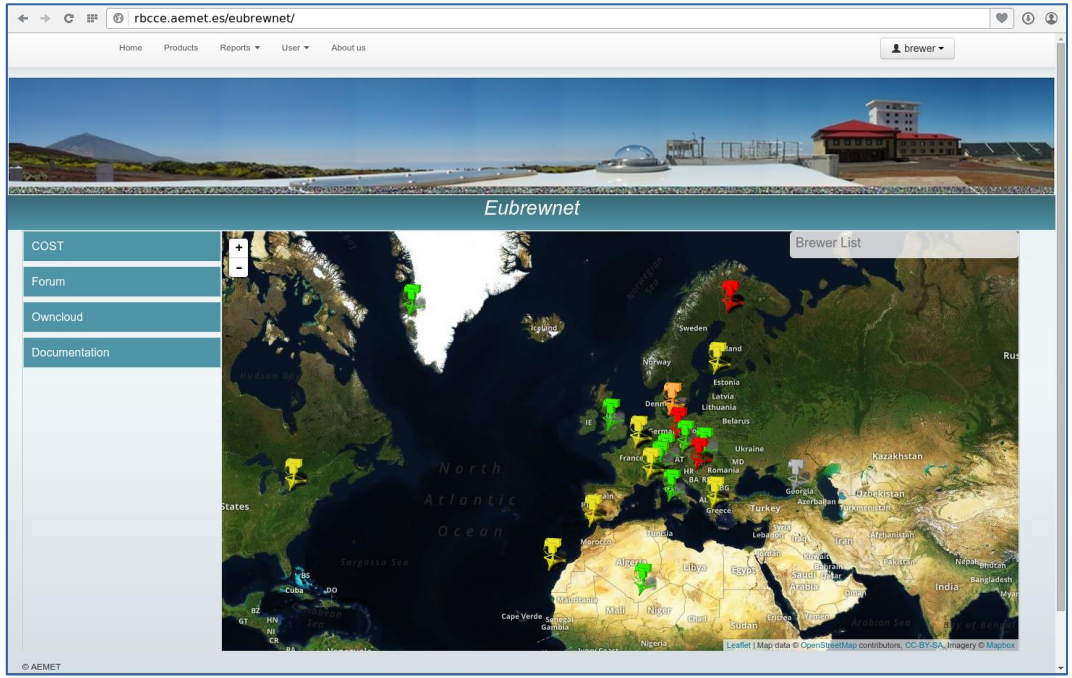
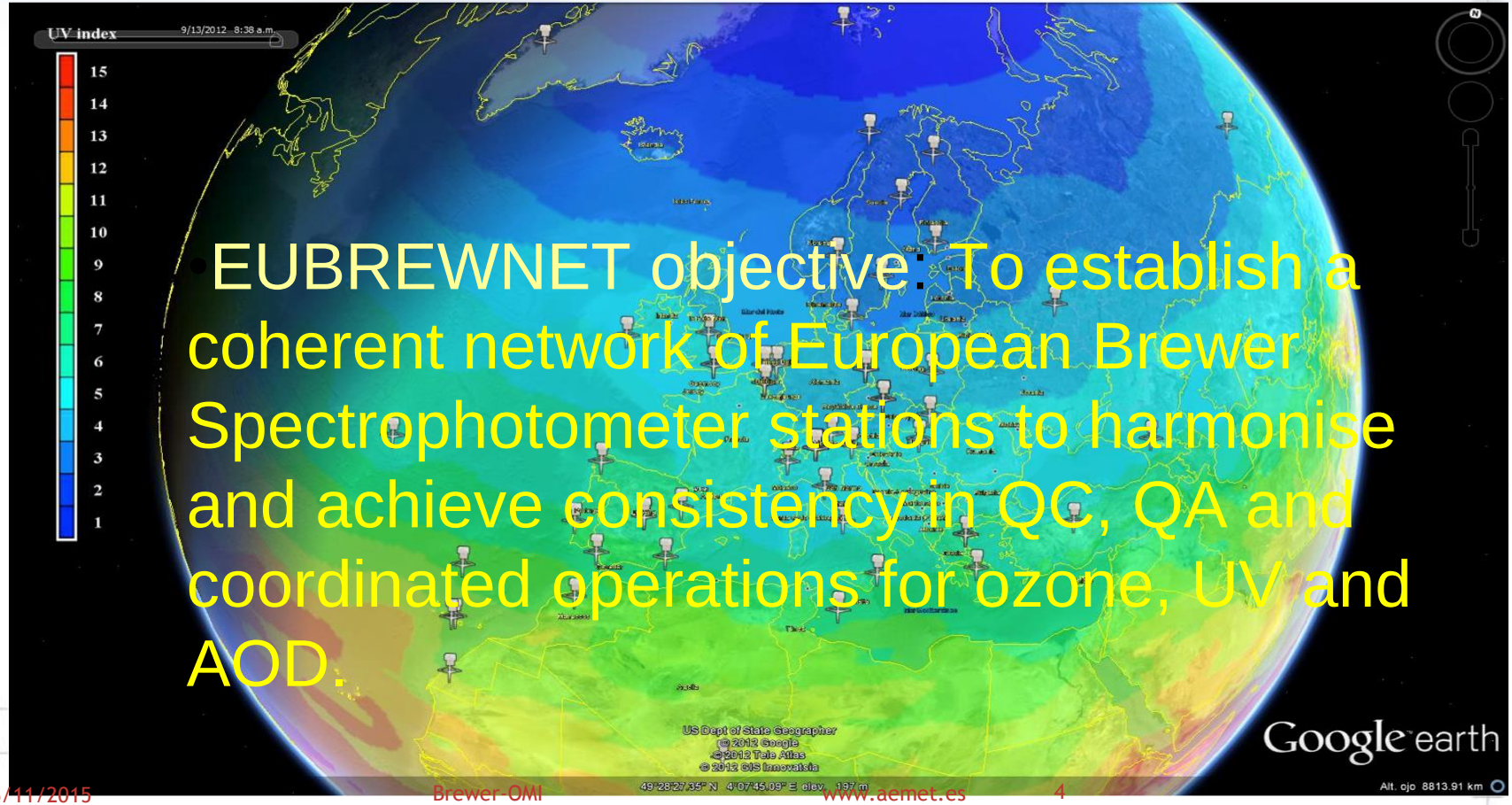
http://rbcce.aemet.es/eubrewnet





- EUBREWNET objective: To establish a coherent network of European Brewer Spectrophotometer stations to harmonise and achieve consistency in QC, QA and coordinated operations for ozone, UV and AOD.

Research directions on EUBREWNET

- Instrument characterisation.
- Standardisation of calibration protocols.
- Standard data processing algorithms.
- Effective QA/QC systems linked to satellite data.
- Understanding of uncertainties.

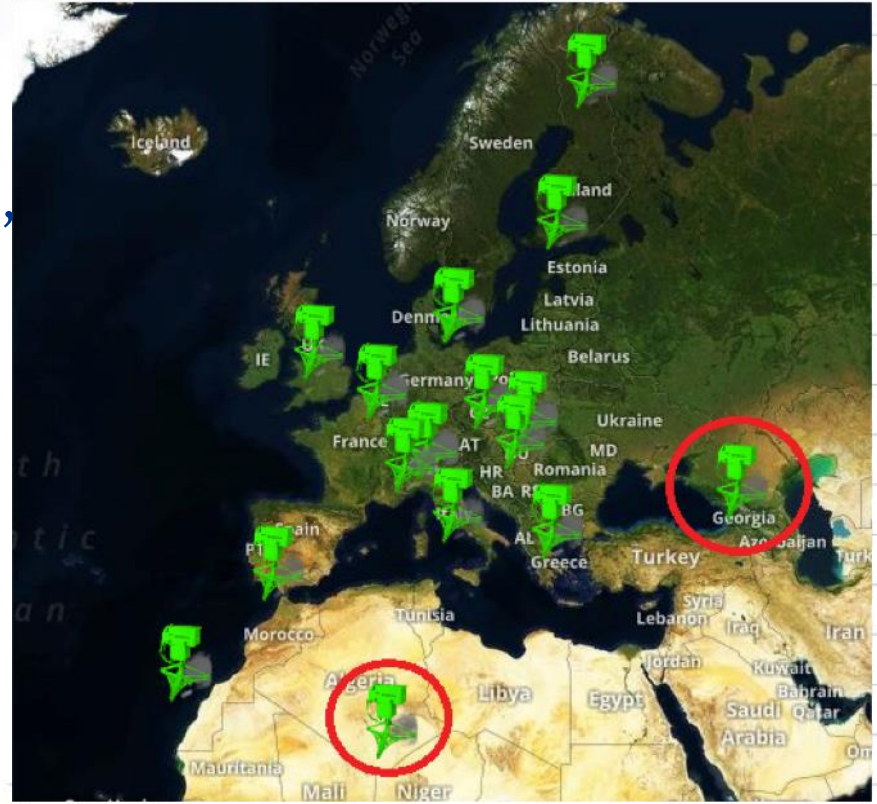
COST ACTION WEB
http://rbcce.aemet.es/eubrewnet

- 19 European participants:

AT, BE, CH, CZ, DE, DK, EL, ES, FI, HU, IE, IT, NL, NO, PL, PT, SK, SE, TR, UK

Non-European Partners :

- WMO.
- NOAA (USA).
- York University (CA).
- International Ozone Services (CA).
- Enviromental Canada (Appliying).
- Argelia (Tamanrraset Station).
- University of Tasmania (AUS).



FEDERATED NETWORK: Every station is responsible for his observations proper operation of the instrument and its calibration.

Calibration information will determine the level of the data.

- Level 1 : Observations as are recorded by the instrument
- Level 1.5 : Real Time Observations **uniform processed.**
- Level 2.0 : Uniform process with **calibration information, validated by the calibration center** RBCC-E for Ozone and PMOD-WRC- (QASUME) for UV) and AOD (RBCC-E/WRC project)

The data processing is uniform and open

Brewer Processing Library (Kipp & Zonen):
http://rbcce.aemet.es/dokuwiki/doku.php?id=devel:brewerpythonmodule

Based on the calibration history of the instrument:
http://rbcce.aemet.es/eubrewnet/configuration/history

And documented
http://rbcce.aemet.es/dokuwiki

1-EUBREWNET: wiki

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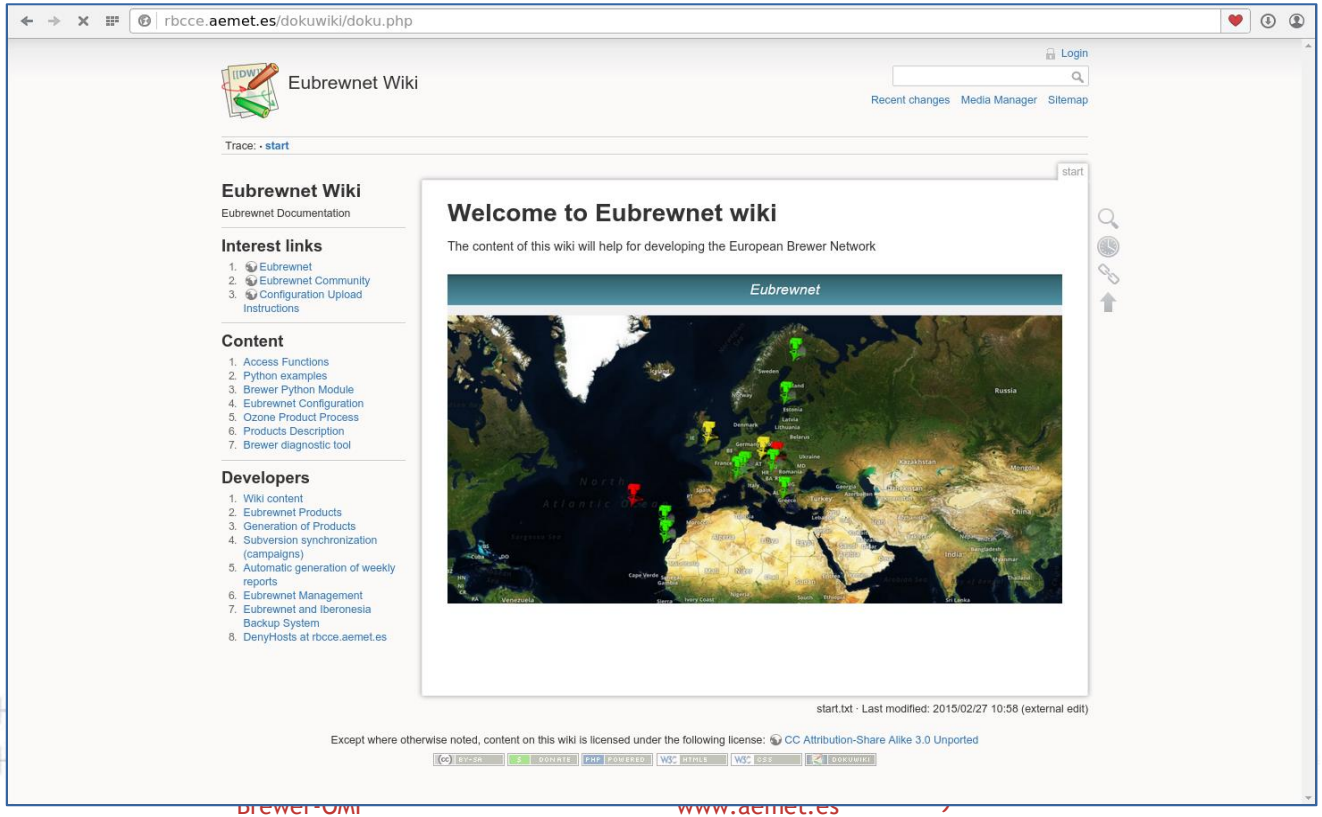
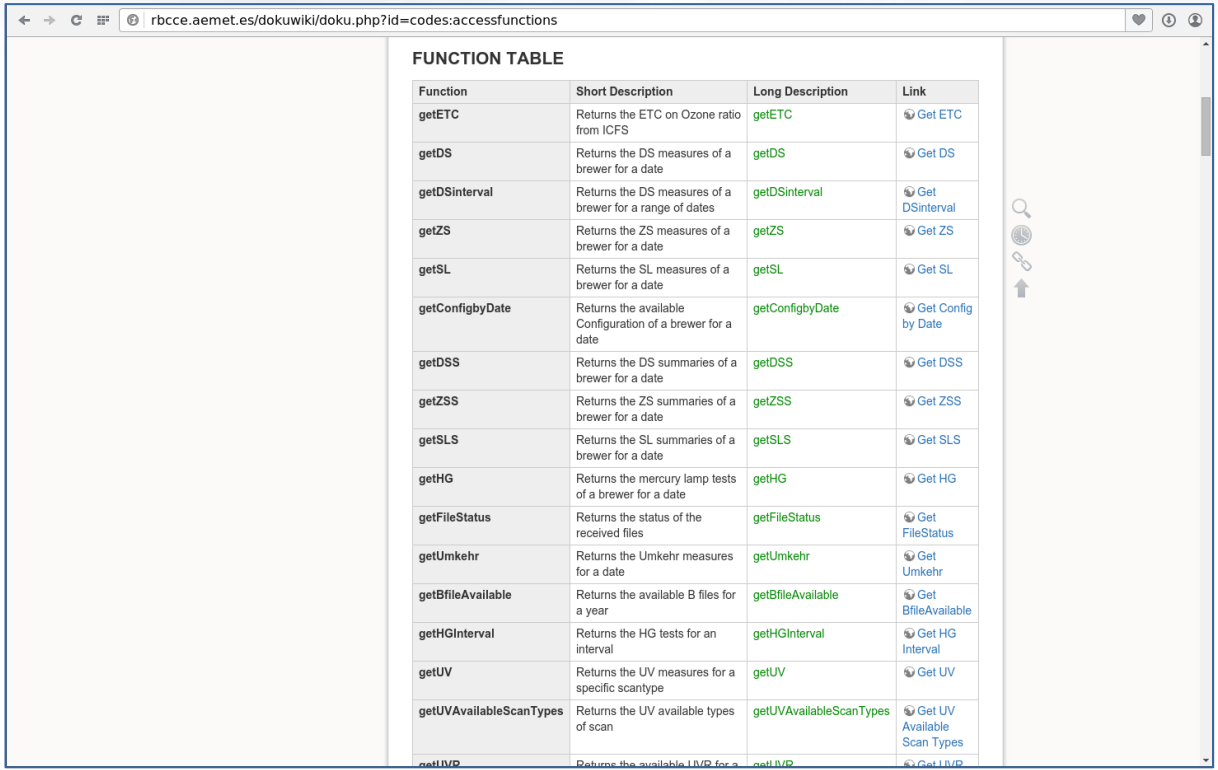
http://rbcce.aemet.es/dokuwiki



1-EUBREWNET: wiki



FUNCTION TABLE

Function	Short Description	Long Description	Link
getETC	Returns the ETC on Ozone ratio from ICFS	getETC	Get ETC
getDS	Returns the DS measures of a brewer for a date	getDS	Get DS
getDSinterval	Returns the DS measures of a brewer for a range of dates	getDSinterval	Get DSinterval
getZS	Returns the ZS measures of a brewer for a date	getZS	Get ZS
getSL	Returns the SL measures of a brewer for a date	getSL	Get SL
getConfigbyDate	Returns the available Configuration of a brewer for a date	getConfigbyDate	Get Config by Date
getDSS	Returns the DS summaries of a brewer for a date	getDSS	Get DSS
getZSS	Returns the ZS summaries of a brewer for a date	getZSS	Get ZSS
getSLS	Returns the SL summaries of a brewer for a date	getSLS	Get SLS
getHG	Returns the mercury lamp tests of a brewer for a date	getHG	Get HG
getFileStatus	Returns the status of the received files	getFileStatus	Get FileStatus
getUmkehr	Returns the Umkehr measures for a date	getUmkehr	Get Umkehr
getBfileAvailable	Returns the available B files for a year	getBfileAvailable	Get BfileAvailable
getHGInterval	Returns the HG tests for an interval	getHGInterval	Get HG Interval
getUV	Returns the UV measures for a specific scantype	getUV	Get UV
getUVAvailableScanTypes	Returns the UV available types of scan	getUVAvailableScanTypes	Get UV Available Scan Types
getUVB	Returns the available UVB for a	getUVB	Get UVB

1-EUBREWNET: JSON output

http://rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=157&date=2015-01-01&enddate=2015-01-02

→ On board of NASA's Aura satellite

→ Data available since October 2004

→ Ozone products: OMTO3 (TOMS-like) and
OMDOAO3 (DOAS algorithm)

→ UV product: OMUVB

→ Level 2 station-overpass data: Aura Validation Data Center

2-OMI: AVDC overpass data

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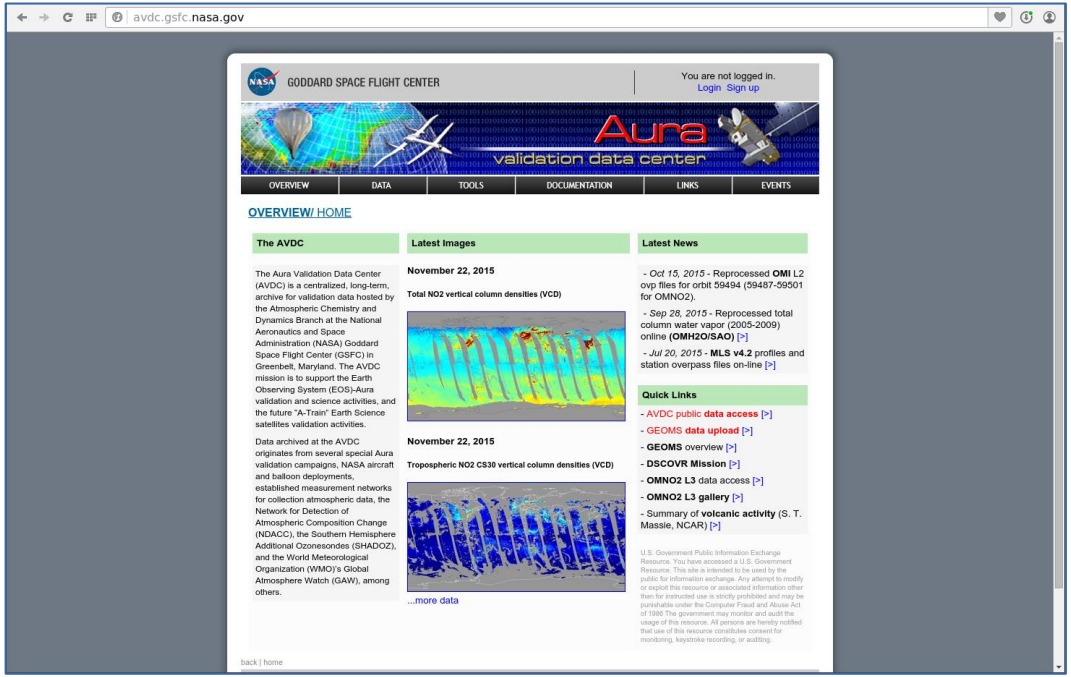
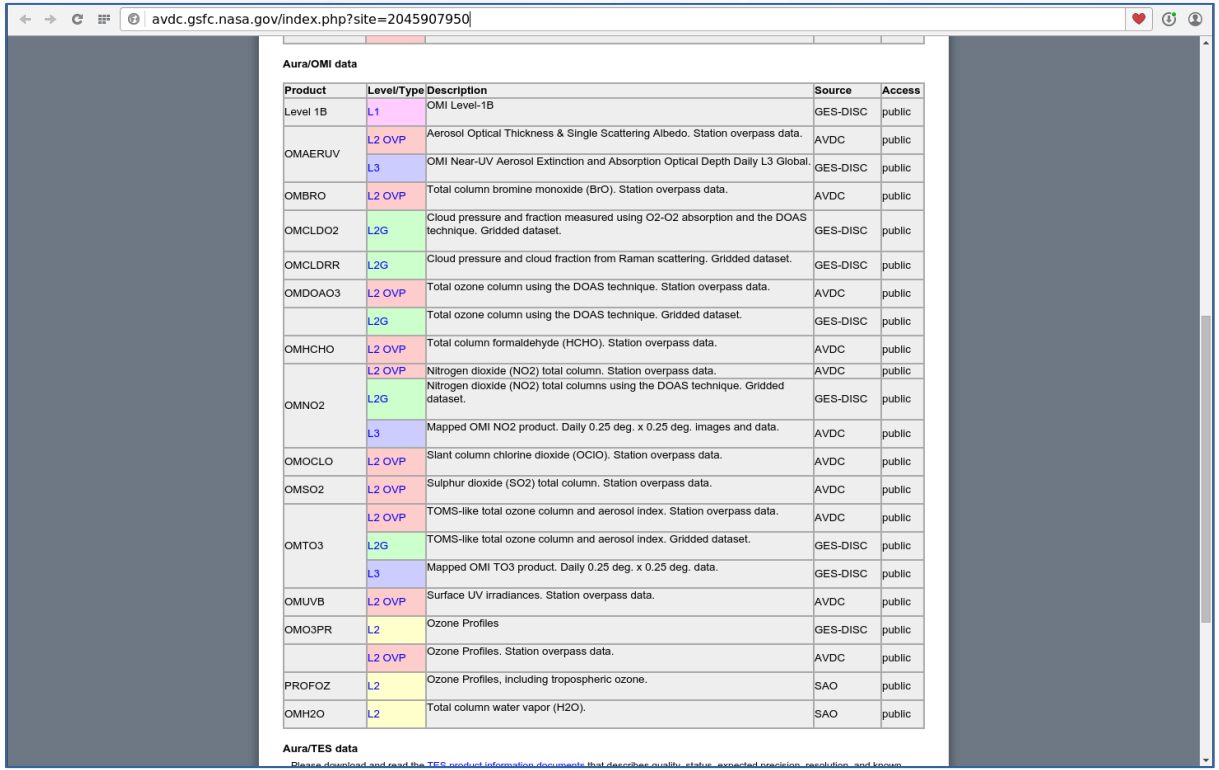
http://avdc.gsfc.nasa.gov



2-OMI: AVDC overpass data



Aura/OMI data

Product	Level/Type	Description	Source	Access
Level 1B	L1	OMI Level-1B	GES-DISC	public
OMAERUV	L2 OVP	Aerosol Optical Thickness & Single Scattering Albedo. Station overpass data.	AVDC	public
	L3	OMI Near-UV Aerosol Extinction and Absorption Optical Depth Daily L3 Global.	GES-DISC	public
OMBRO	L2 OVP	Total column bromine monoxide (BrO). Station overpass data.	AVDC	public
OMCLDO2	L2G	Cloud pressure and fraction measured using O2-O2 absorption and the DOAS technique. Gridded dataset.	GES-DISC	public
OMCLDRR	L2G	Cloud pressure and cloud fraction from Raman scattering. Gridded dataset.	GES-DISC	public
OMDOAO3	L2 OVP	Total ozone column using the DOAS technique. Station overpass data.	AVDC	public
	L2G	Total ozone column using the DOAS technique. Gridded dataset.	GES-DISC	public
OMHCHO	L2 OVP	Total column formaldehyde (HCHO). Station overpass data.	AVDC	public
OMNO2	L2 OVP	Nitrogen dioxide (NO2) total column. Station overpass data.	AVDC	public
	L2G	Nitrogen dioxide (NO2) total columns using the DOAS technique. Gridded dataset.	GES-DISC	public
	L3	Mapped OMI NO2 product. Daily 0.25 deg. x 0.25 deg. images and data.	AVDC	public
OMOCLO	L2 OVP	Slant column chlorine dioxide (OClO). Station overpass data.	AVDC	public
OMSO2	L2 OVP	Sulphur dioxide (SO2) total column. Station overpass data.	AVDC	public
OMTO3	L2 OVP	TOMS-like total ozone column and aerosol index. Station overpass data.	AVDC	public
	L2G	TOMS-like total ozone column and aerosol index. Gridded dataset.	GES-DISC	public
	L3	Mapped OMI TO3 product. Daily 0.25 deg. x 0.25 deg. data.	GES-DISC	public
OMUVB	L2 OVP	Surface UV irradiances. Station overpass data.	AVDC	public
OMO3PR	L2	Ozone Profiles	GES-DISC	public
	L2 OVP	Ozone Profiles. Station overpass data.	AVDC	public
PROFOZ	L2	Ozone Profiles, including tropospheric ozone.	SAO	public
OMH2O	L2	Total column water vapor (H2O).	SAO	public

Aura/TES data

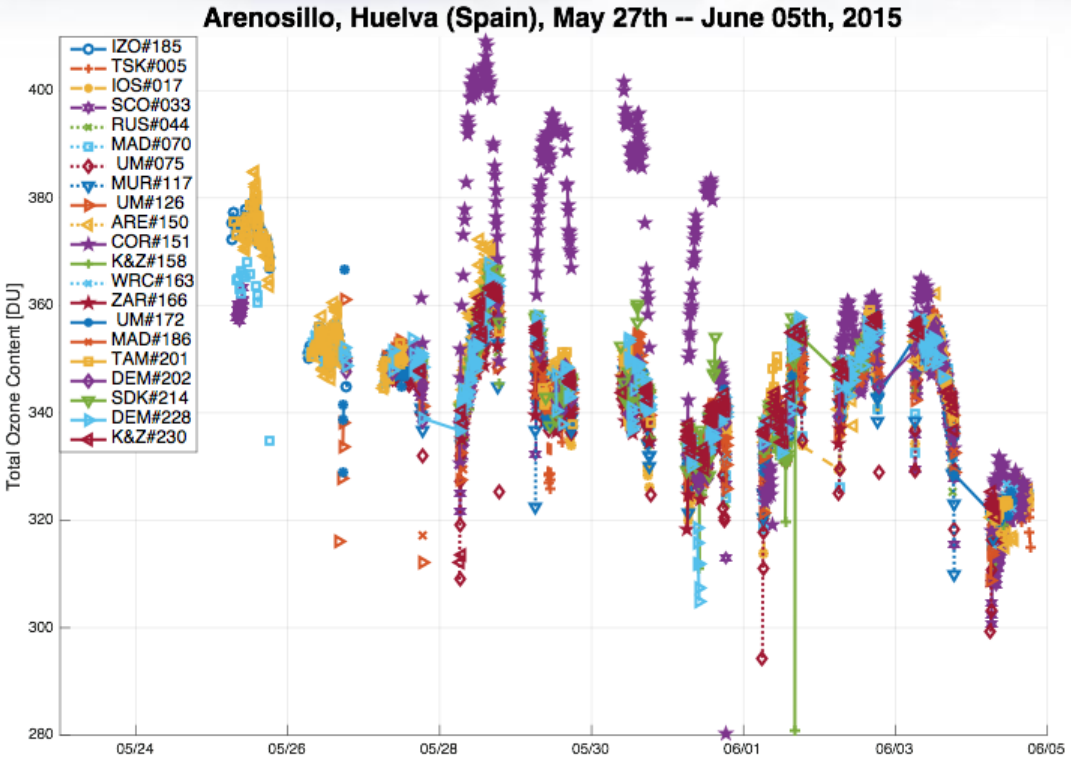
Please download and read the TES product information documents that describes quality, status, expected precision, resolution, and known

→ Brewers at El Arenosillo (2015 campaign, May 25th to June 5th) or at their stations (January 1st 2013 to October 15th 2015)

→ Average of Brewer data within 30 minutes of each OMI observation (usually, 1 per day)

→ Relative difference =


He-Cd LASER


Arenosillo, Huelva (Spain), May 27th -- June 05th, 2015
IZO#185
TSK#005
IOS#017
SCO#033
RUS#044
MAD#070
UM#075
MUR#117
UM#126
ARE#150
COR#151
K&Z#158
WRC#163
ZAR#166
UM#172
MAD#186
TAM#201
DEM#202
SDK#214
DEM#228
K&Z#230
Total Ozone Content [DU]
400
380
360
340
320
300
280
05/24
05/26
05/28
05/30
06/01
06/03
06/05

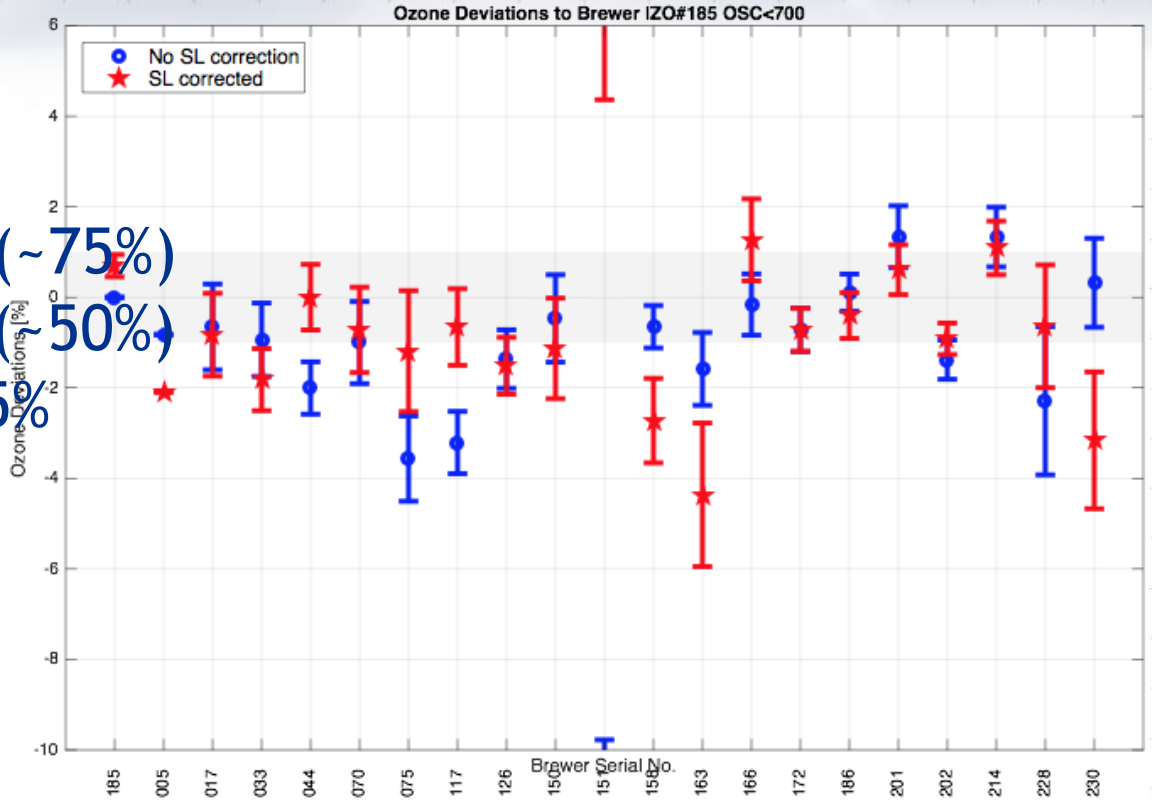
Blind Days:

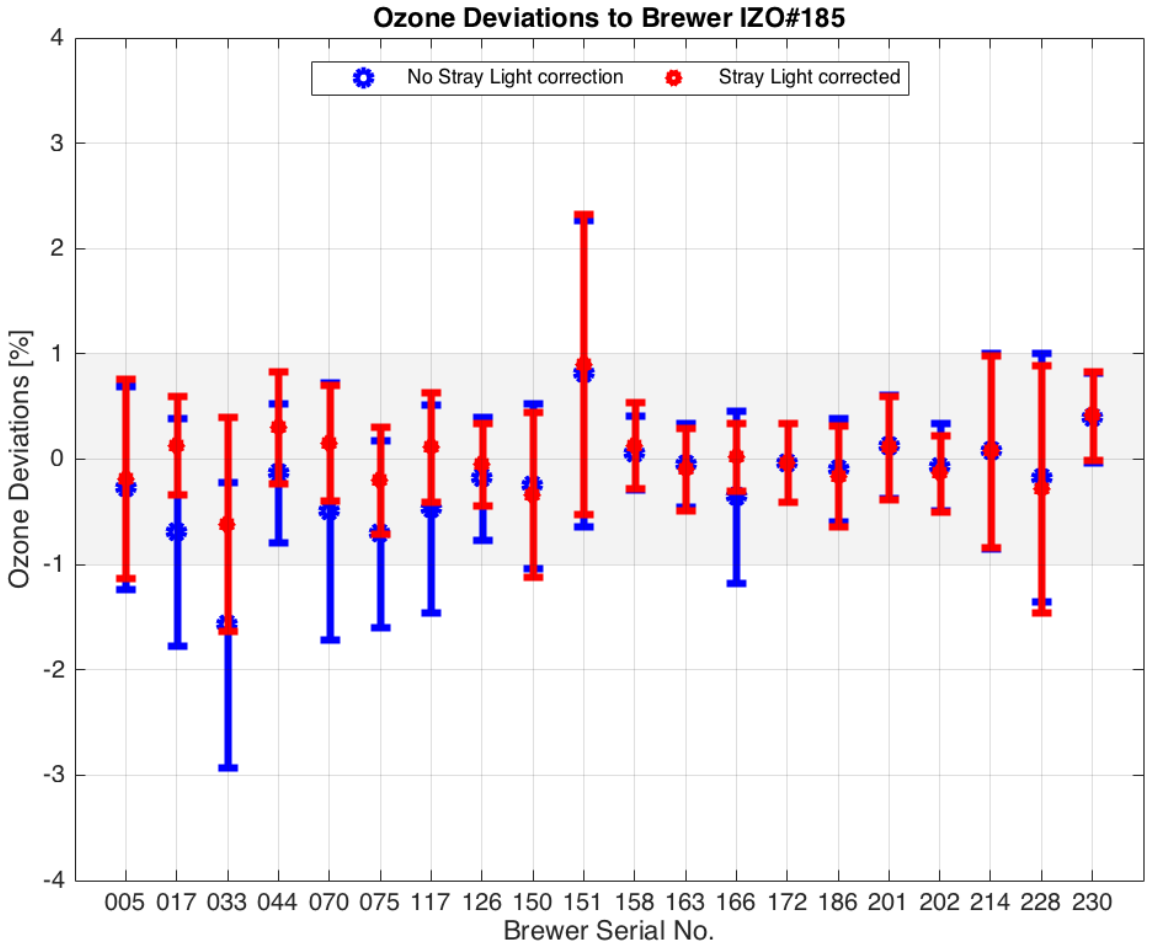
16 Brewer inside 1% (~75%)

10 Brewer +/- 0.5% (~50%)

Max average error 1.5%

(OSC < 700)




Ozone Deviations to Brewer IZO#185
No Stray Light correction
Stray Light corrected
Ozone Deviations [%]
4
3
2
1
0
-1
-2
-3
-4
005 017 033 044 070 075 117 126 150 151 158 163 166 172 186 201 202 214 228 230
Brewer Serial No.

→ O_3 products:

Level 0 : All data from B files (raw)

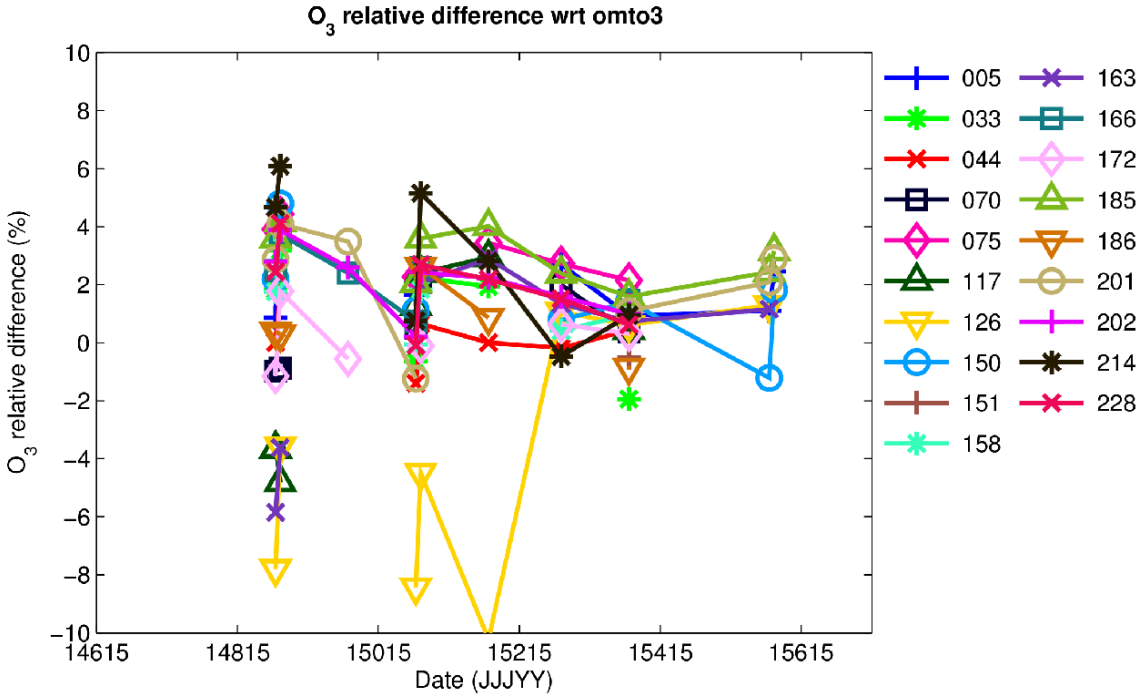
Level 1: Counts from B files, configurations in EUBREWNET, processed with the Brewer Processing Library

Level 1.5 : L1 data with cloud mask, airmass, and Hg filters, plus standard lamp, filter, and stray-light corrections

Level 2 : Using configurations which have been validated

UV products:
Level 0) Data from UV and UVR files, processed with the Brewer Python Module

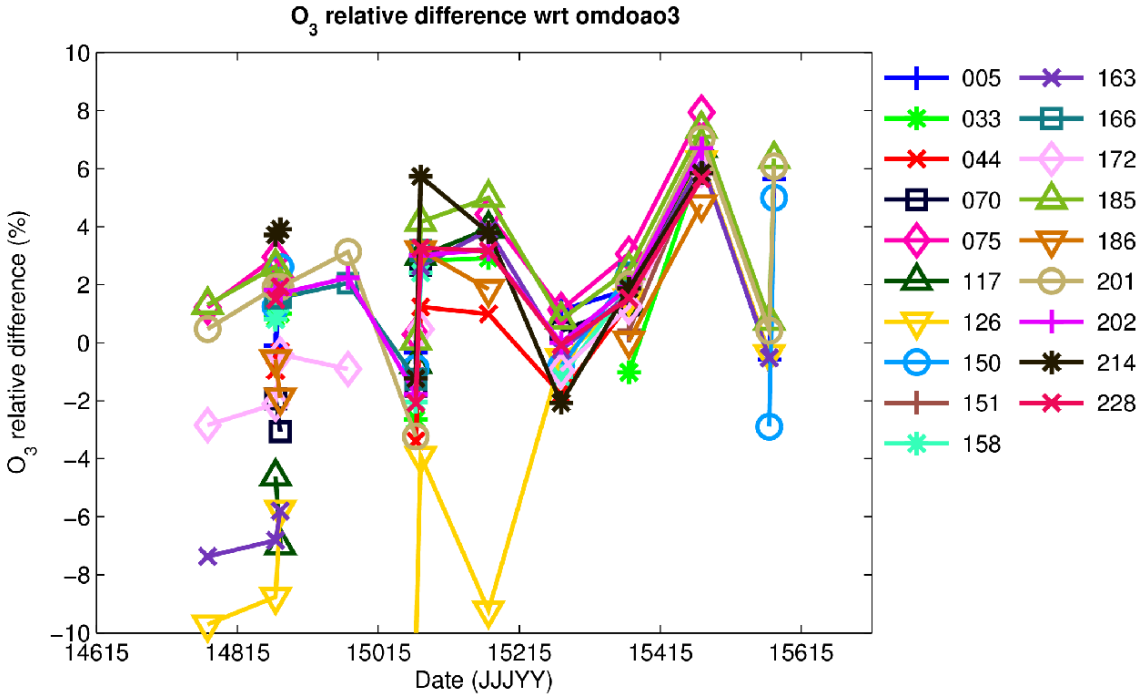
4-O_3: EUBREWNET L1 vs OMI OMTO3 L2



El Arenosillo 2015

Most Brewers behave in the same way during the last days of the campaign

4-O_3: EUBREWNET L1 vs OMI OMDOAO3 L2

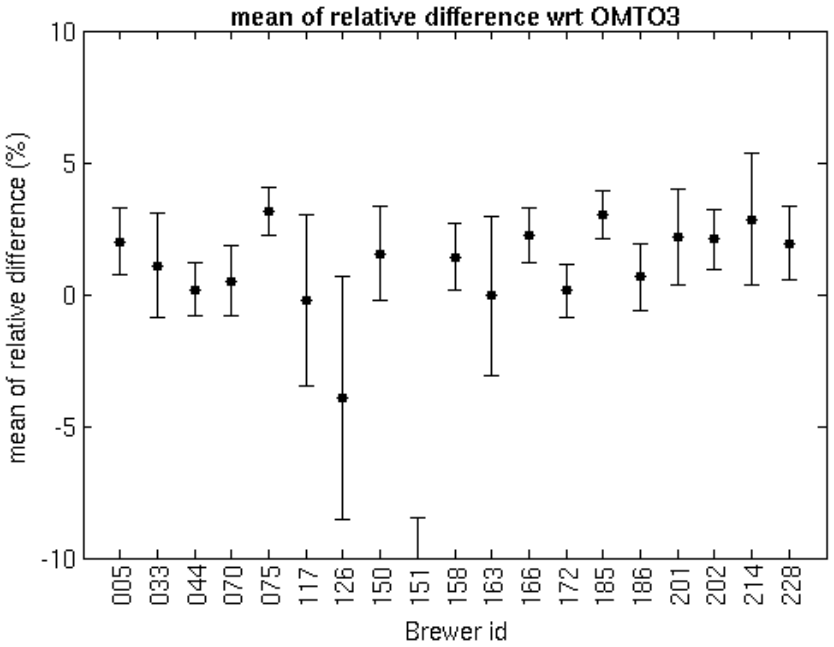


El Arenosillo 2015

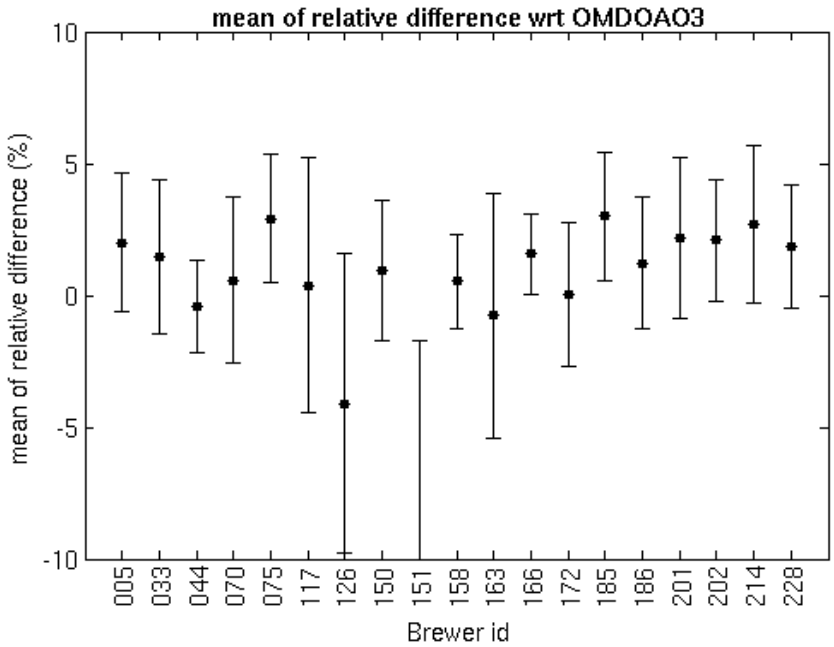
Differences w.r.t. OMI's TOMS-like and DOAS products are roughly the same

El Arenosillo 2015 campaign

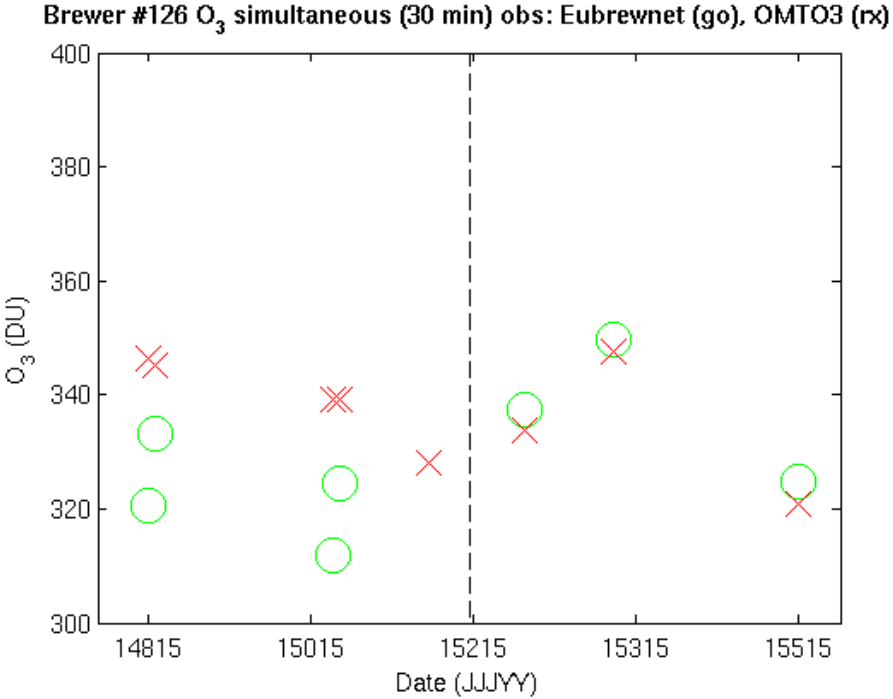
OMTO3

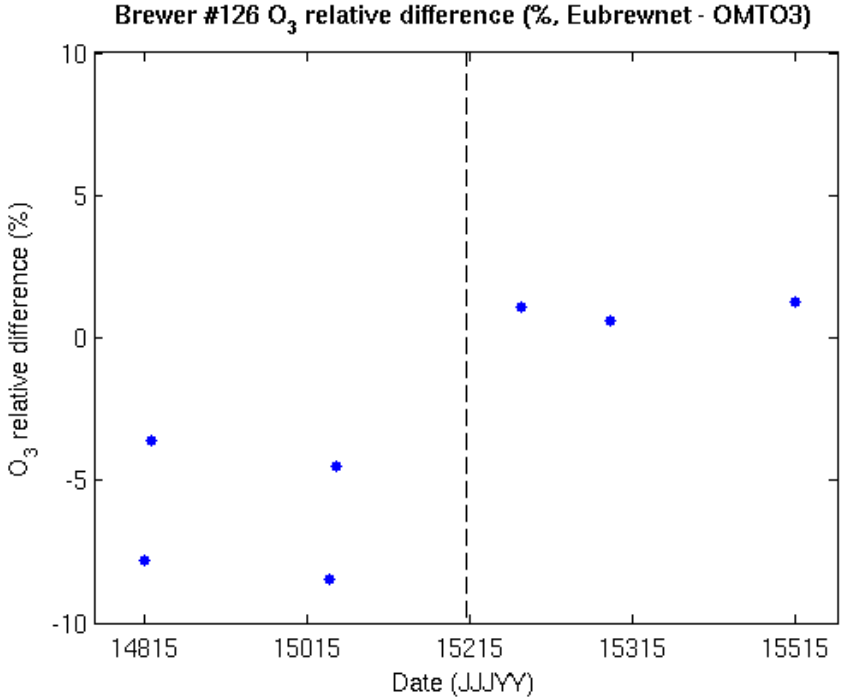


OMDOAO3



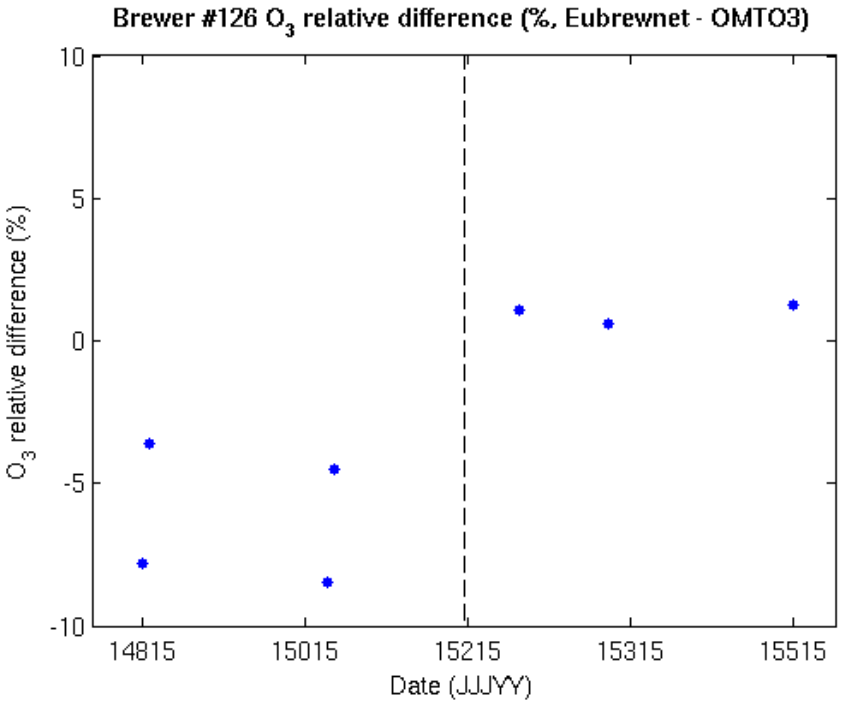
Brewer #126@El Arenosillo 2015 campaign
→ Maintenance on June 1st



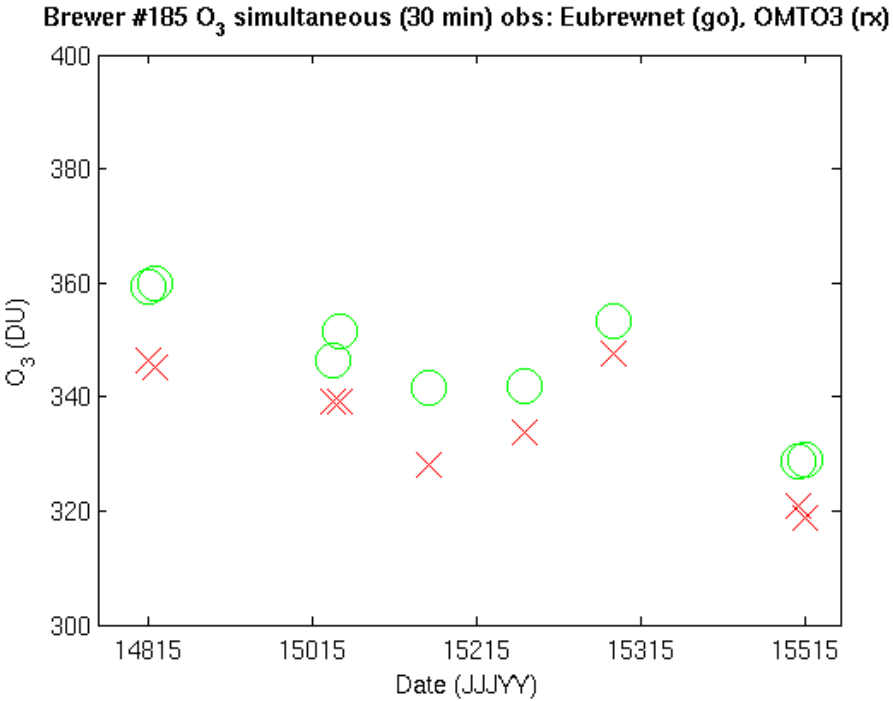


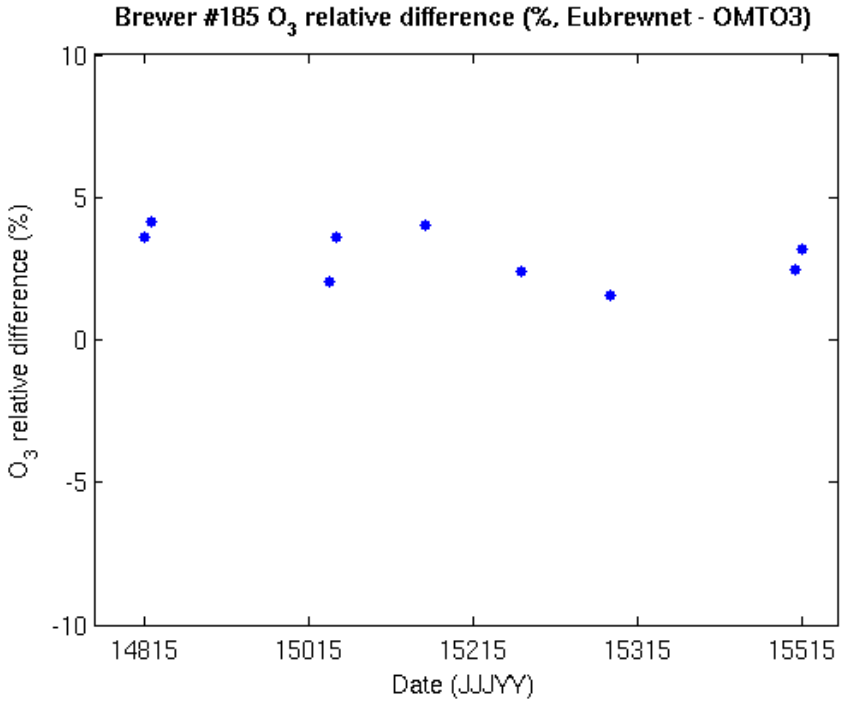
Brewer #126@El Arenosillo 2015 campaign

Calibration date	2013-06-15	2015-06-01
Brewer model	MKIV	mkii
O3 temp. coeff. slit 1	0	0
O3 temp. coeff. slit 2	0.5518	0.5518
O3 temp. coeff. slit 3	0.3869	0.3869
O3 temp. coeff. slit 4	-0.1935	-0.1935
O3 temp. coeff. slit 5	-1.3538	-1.3538
O3 on O3-ratio	0.3435	0.34
ETC on O3-ratio	3250	3240
Dead time	0	3.4e-08
Calibration step number	290	290
Neutral-density filter 0	0	0
Neutral-density filter 1	4900	4900
Neutral-density filter 2	9200	9200
Neutral-density filter 3	13900	13900
Neutral-density filter 4	21520	21520
Neutral-density filter 5	25000	25000
R5 reference	4500	4446
R6 reference	2100	2093
ETC corr. slit 0	0	0
ETC corr. slit 1	0	0
ETC corr. slit 2	0	0
ETC corr. slit 3	0	0
ETC corr. slit 4	0	0
ETC corr. slit 5	0	0
Straylight multiplier A	0	0
Straylight exponent B	0	0



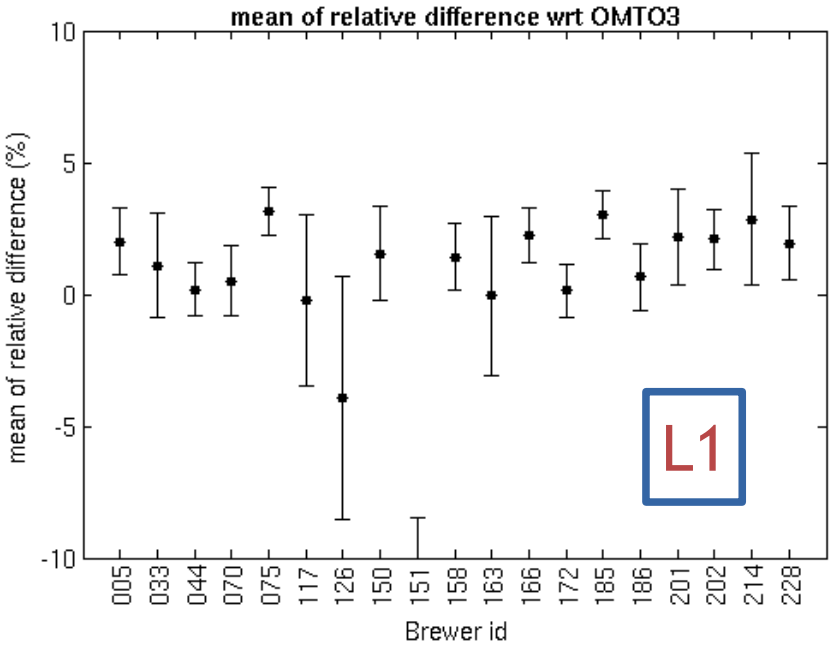
Brewer #185@El Arenosillo 2015 campaign



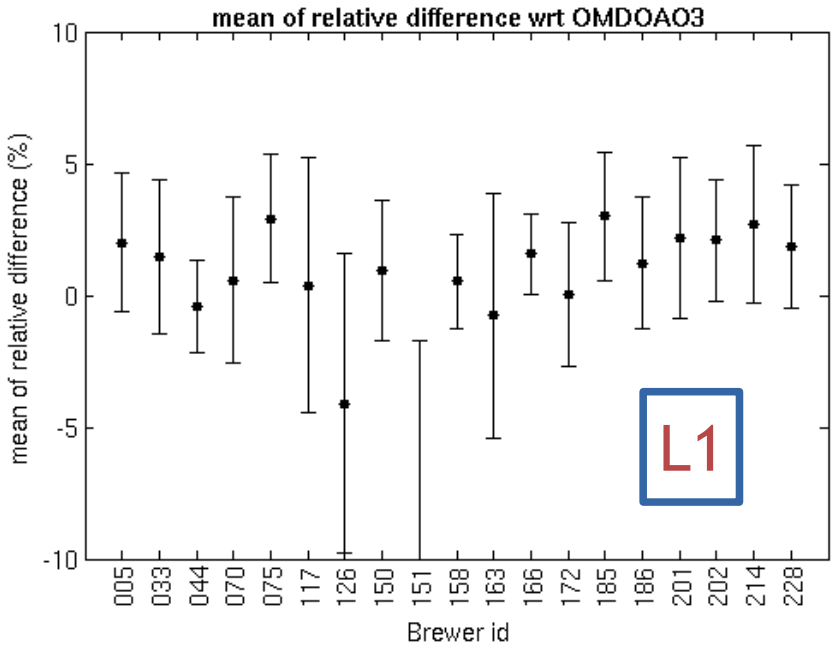


El Arenosillo 2015 campaign

OMTO3

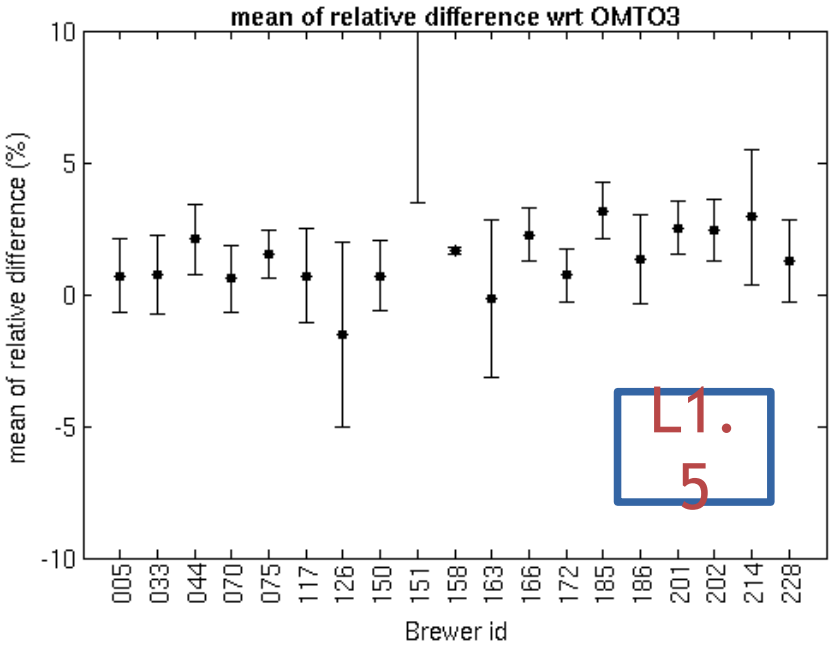


OMDOAO3



El Arenosillo 2015 campaign

OMTO3



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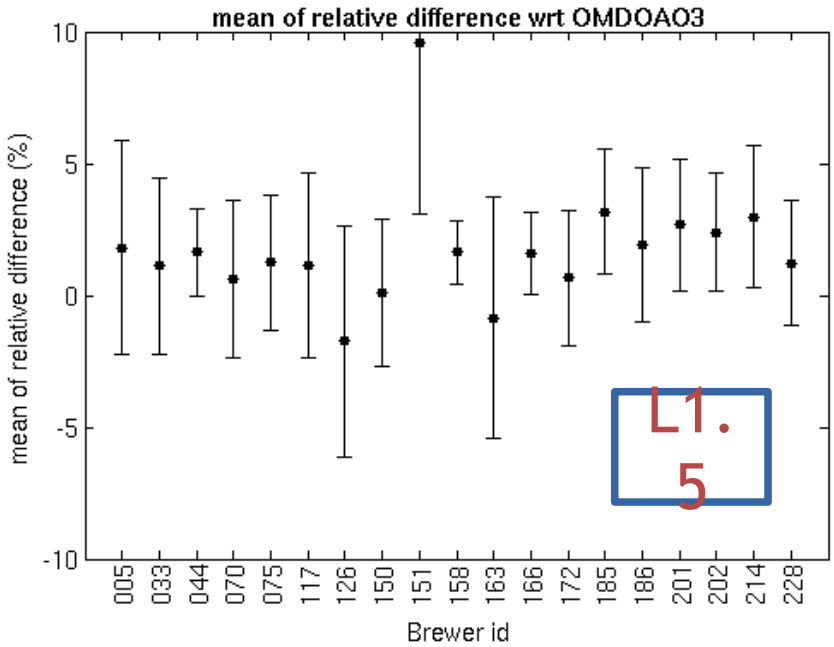
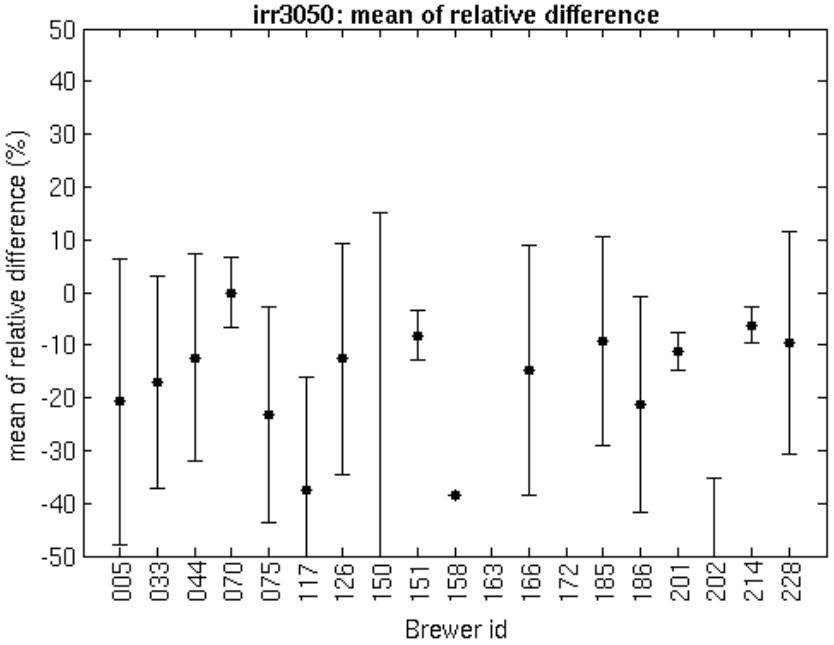
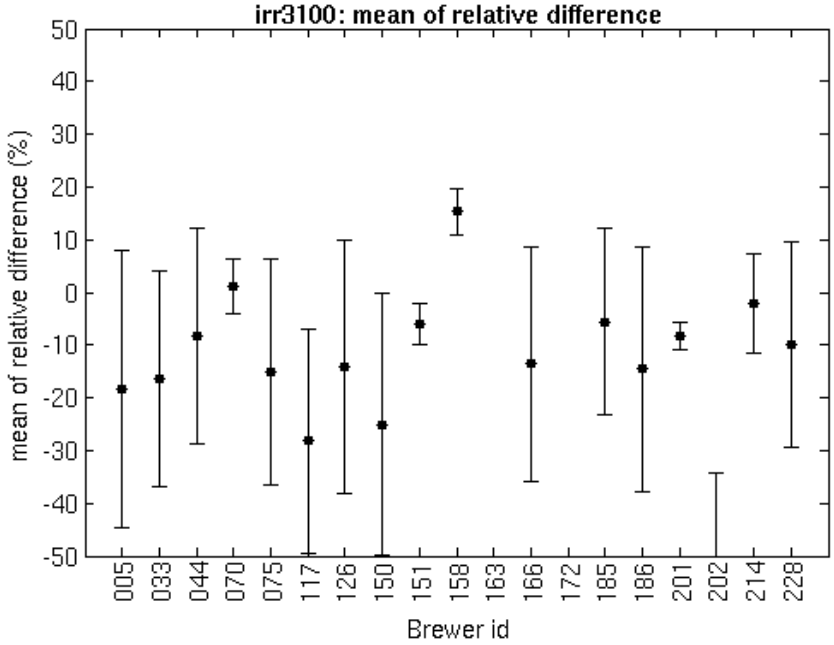


El Arenosillo 2015 campaign

Irradiance@305 nm

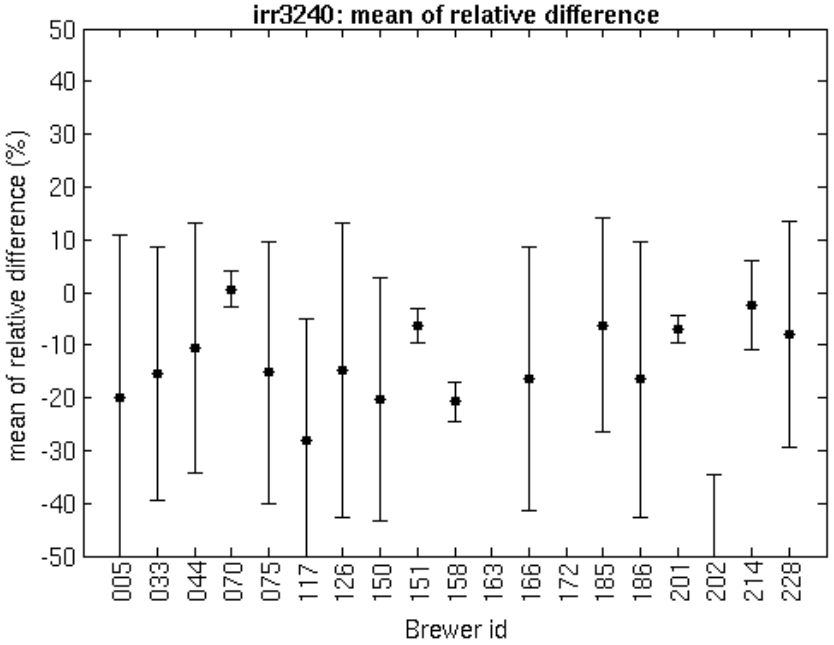


Irradiance@310 nm

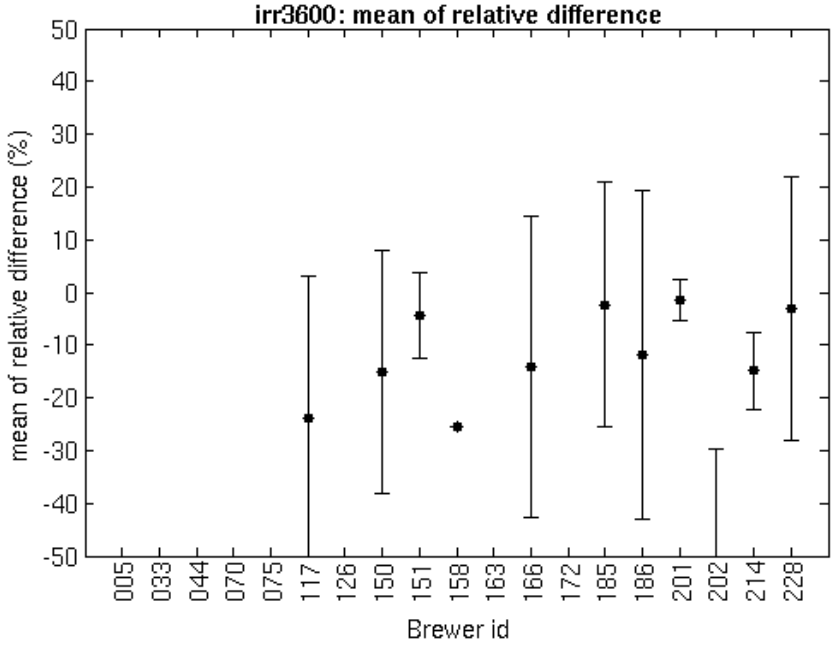


El Arenosillo 2015 campaign

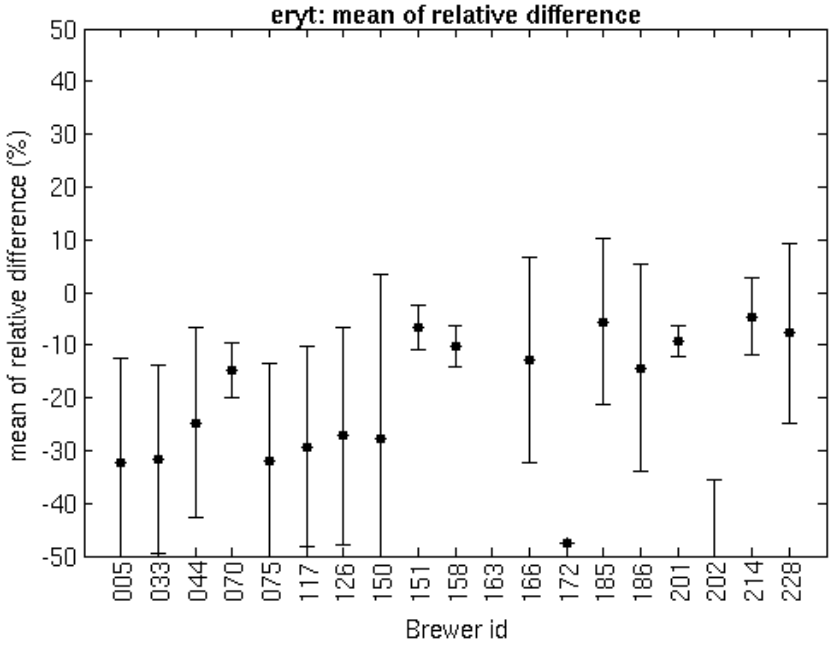
Irradiance@324 nm



Irradiance@360 nm



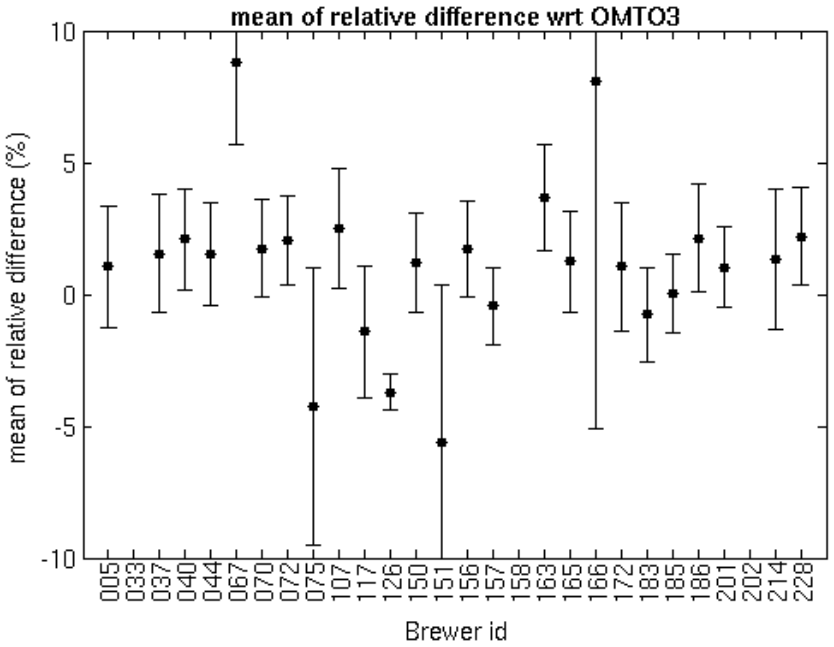
El Arenosillo 2015 campaign
Erythemal Daily Dose Rate



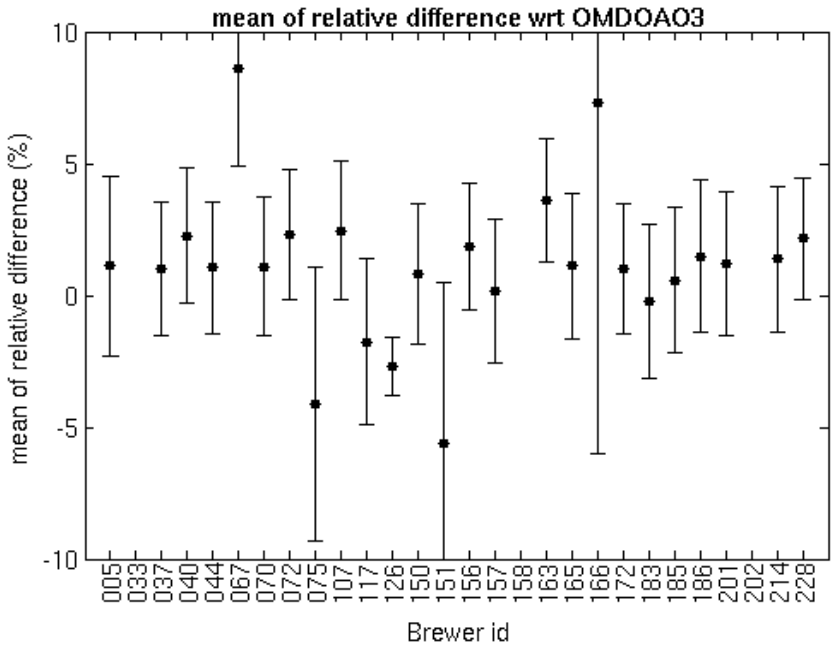
7-O_3: EUBREWNET L1 vs OMI L2

2013 – 2016

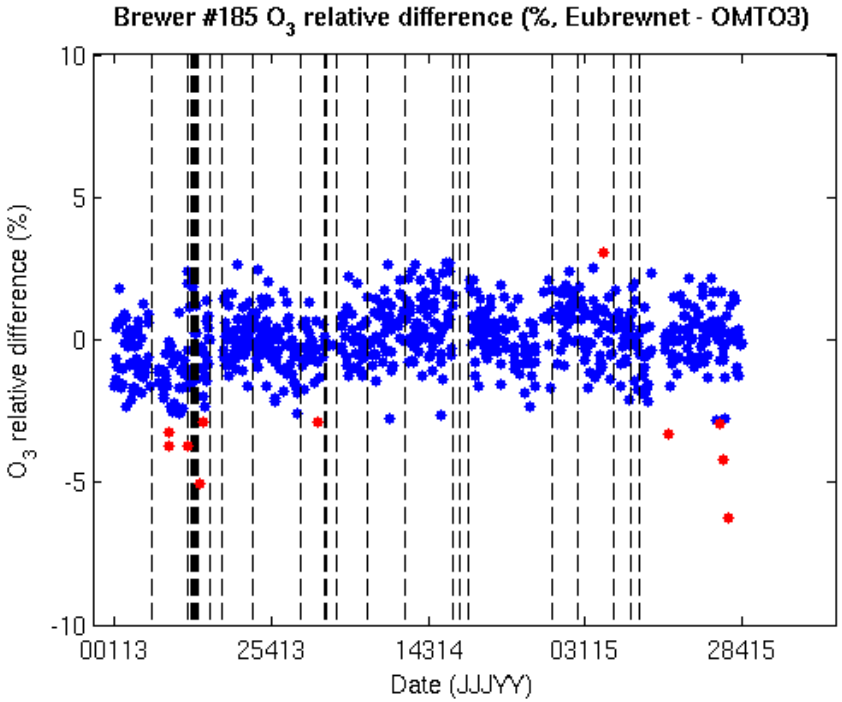
OMTO3

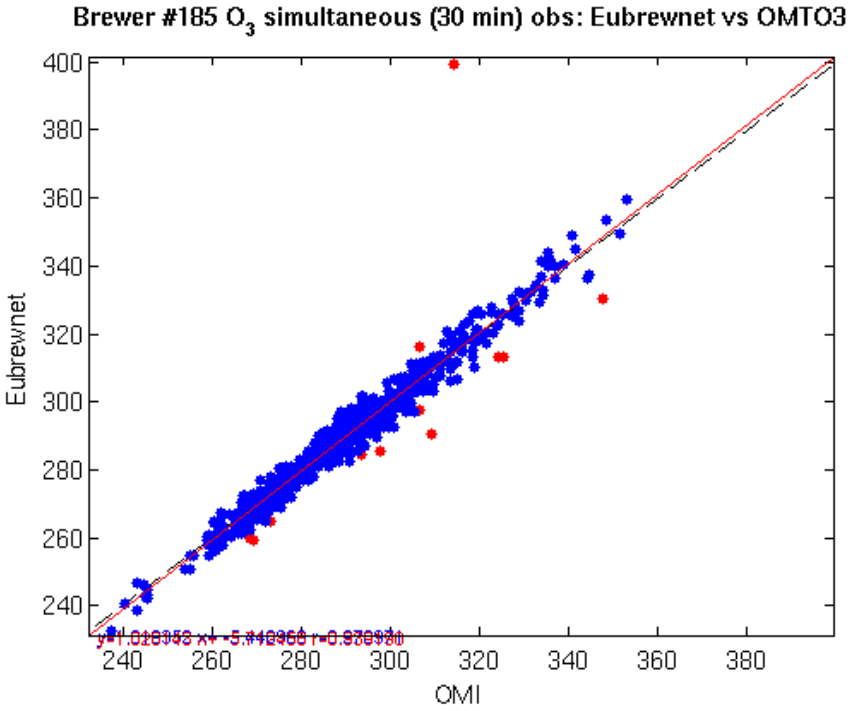


OMDOAO3

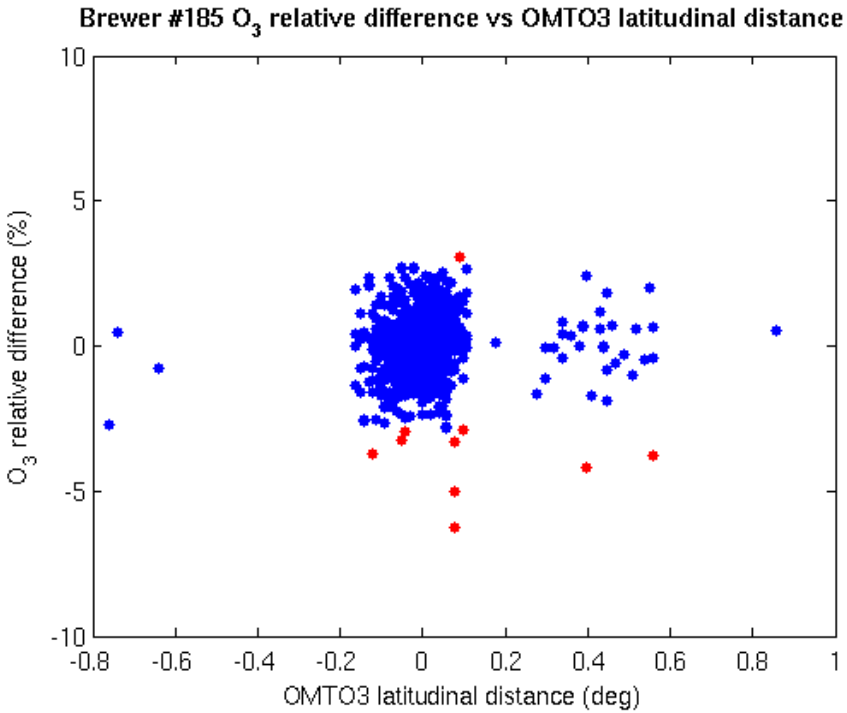


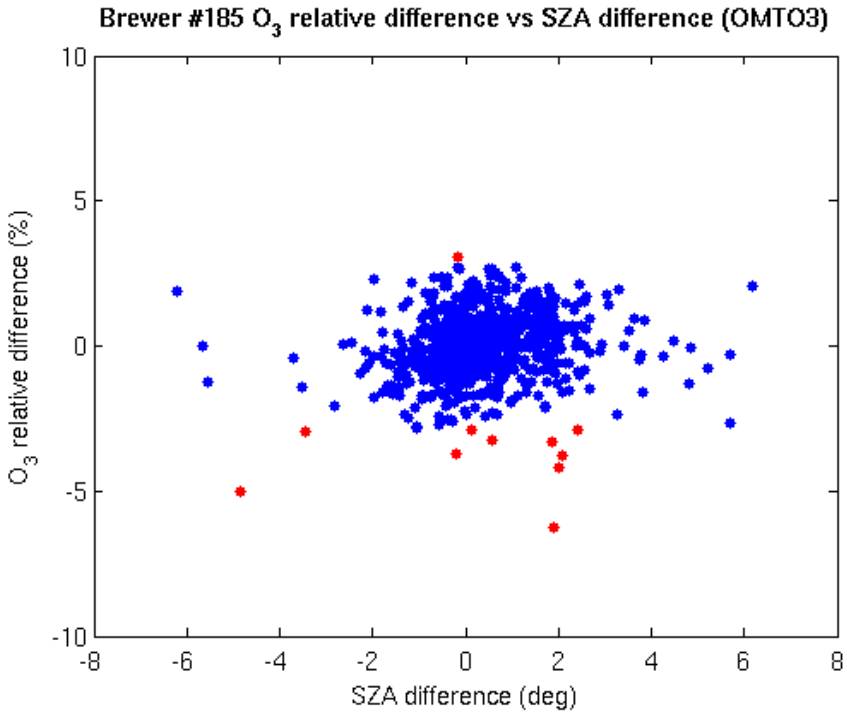
Brewer #185@Izaña 2013-2016



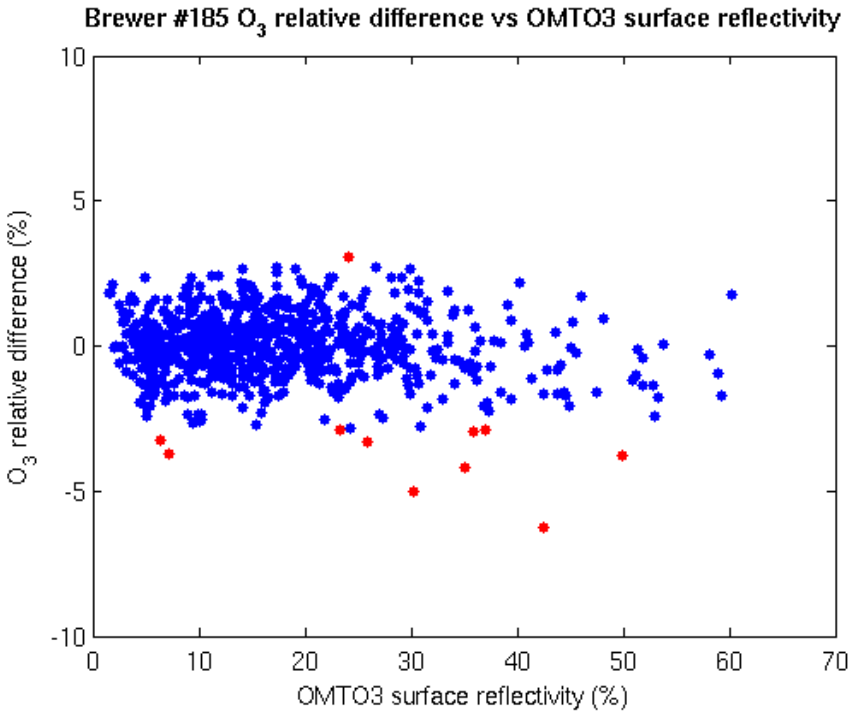


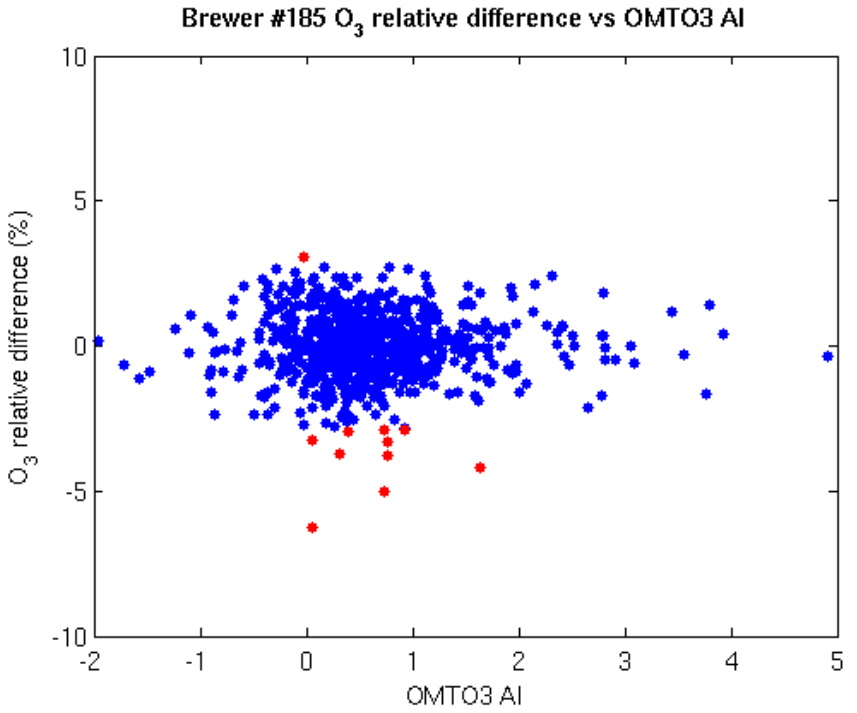
Brewer #185@Izaña 2013-2016



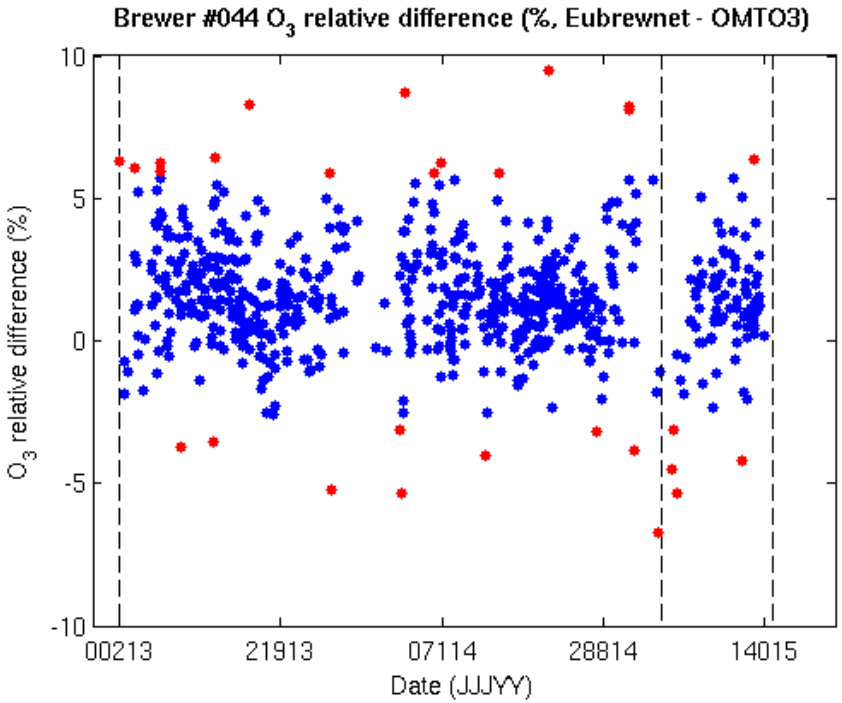


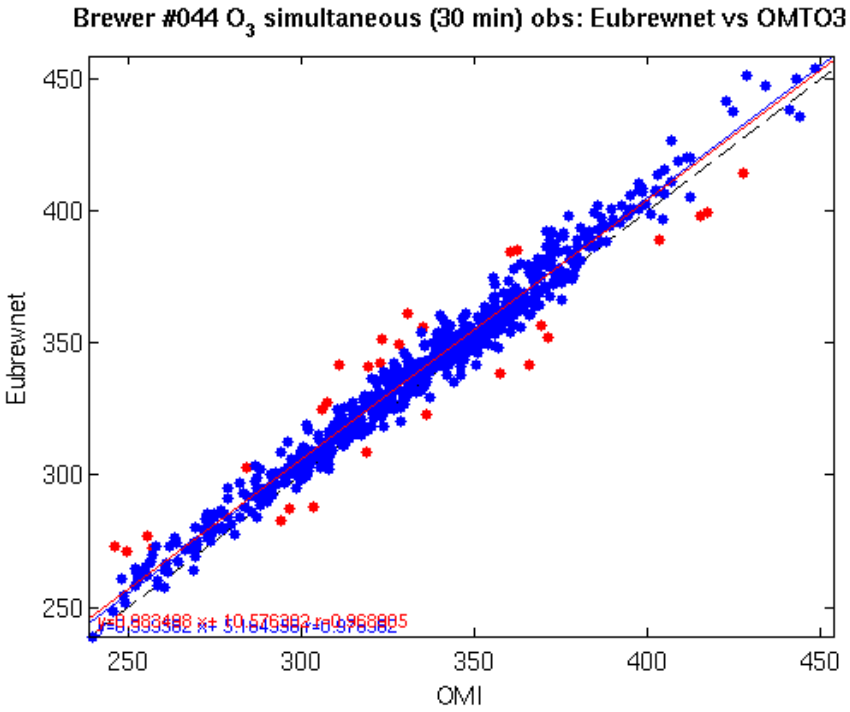
Brewer #185@Izaña 2013-2016



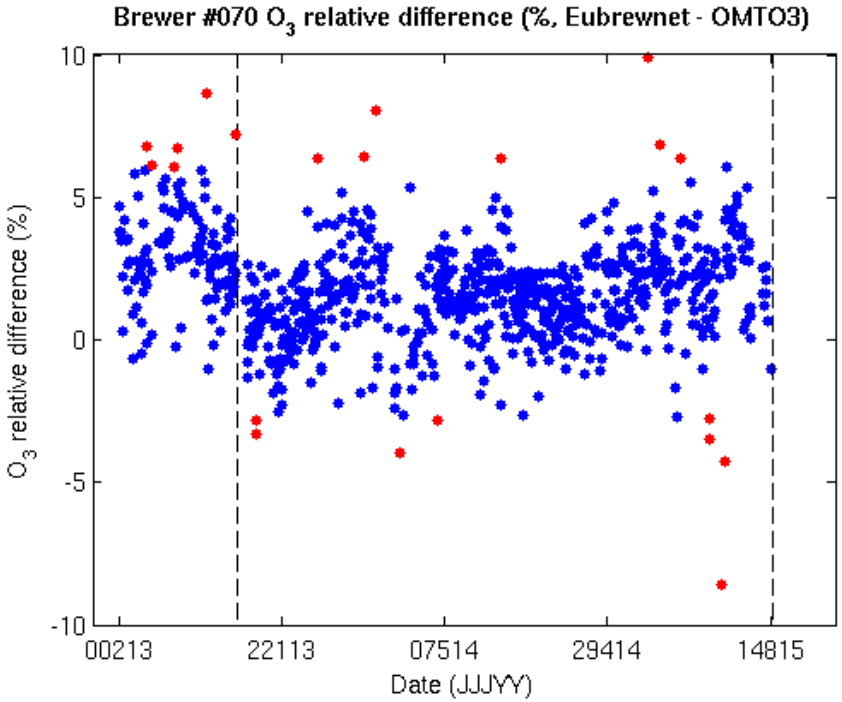


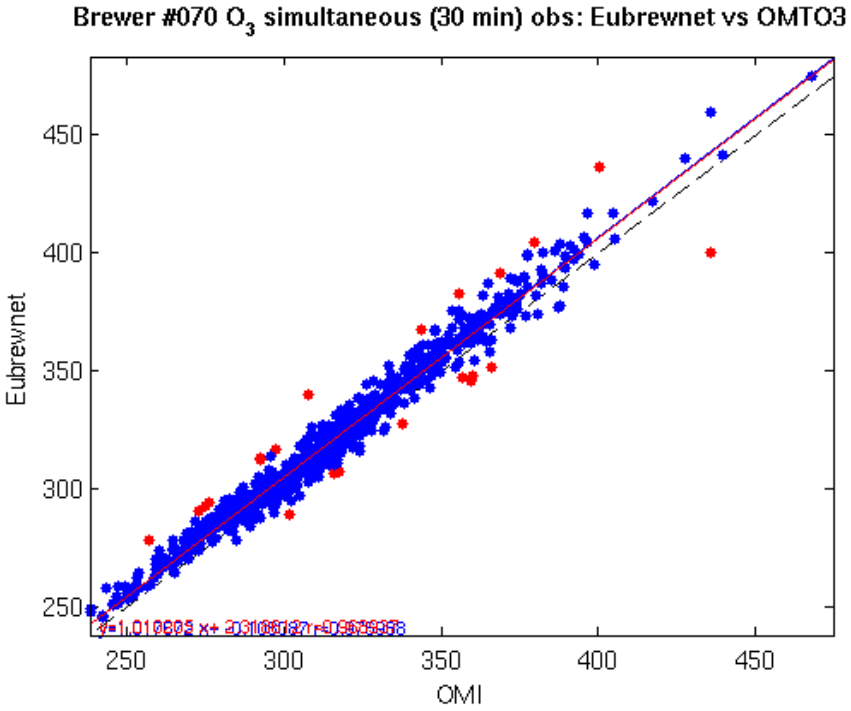
Brewer #044@Obninsk 2013-2016



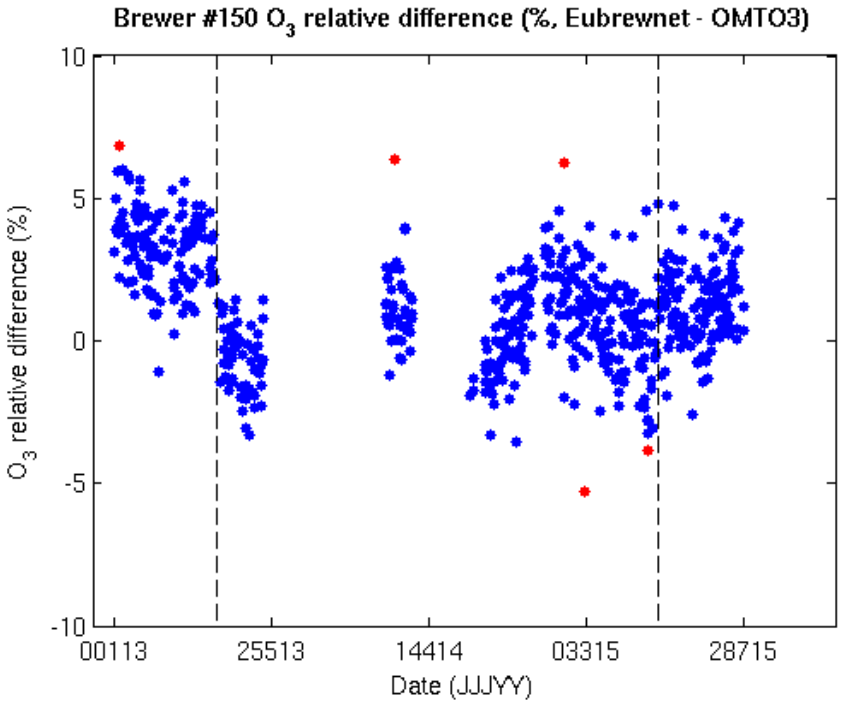


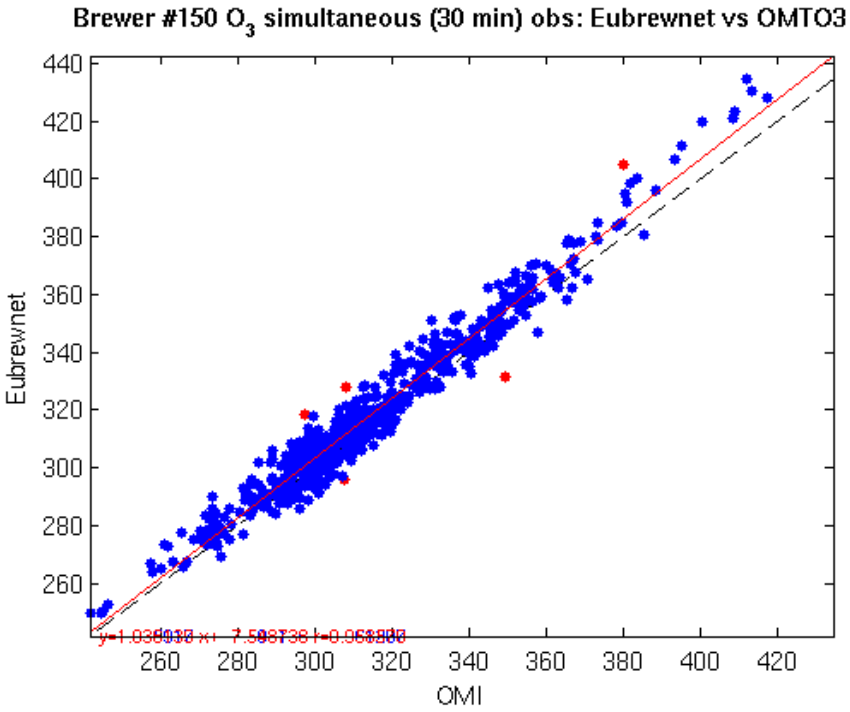
Brewer #070@Madrid 2013-2016



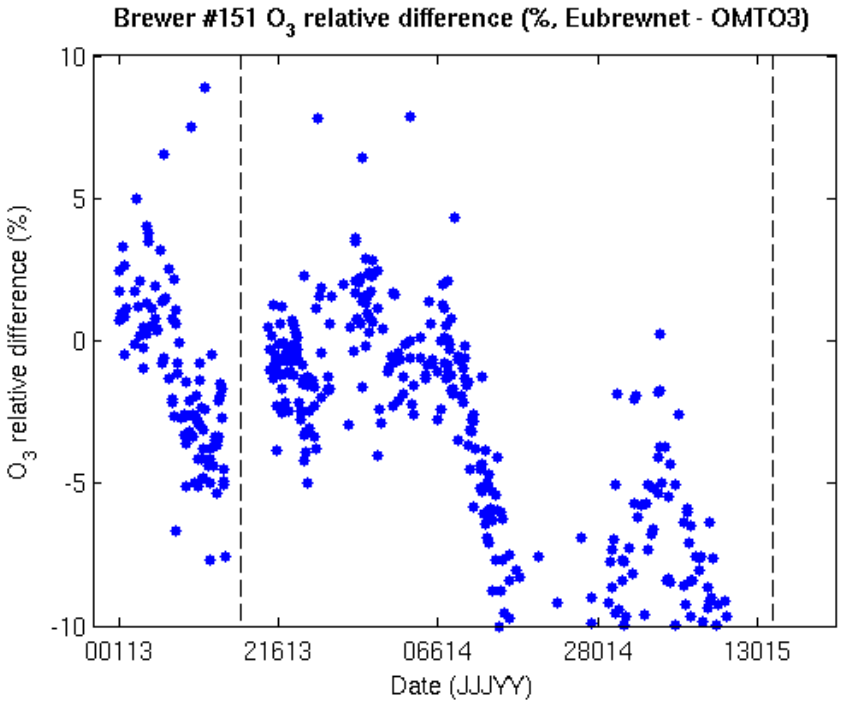


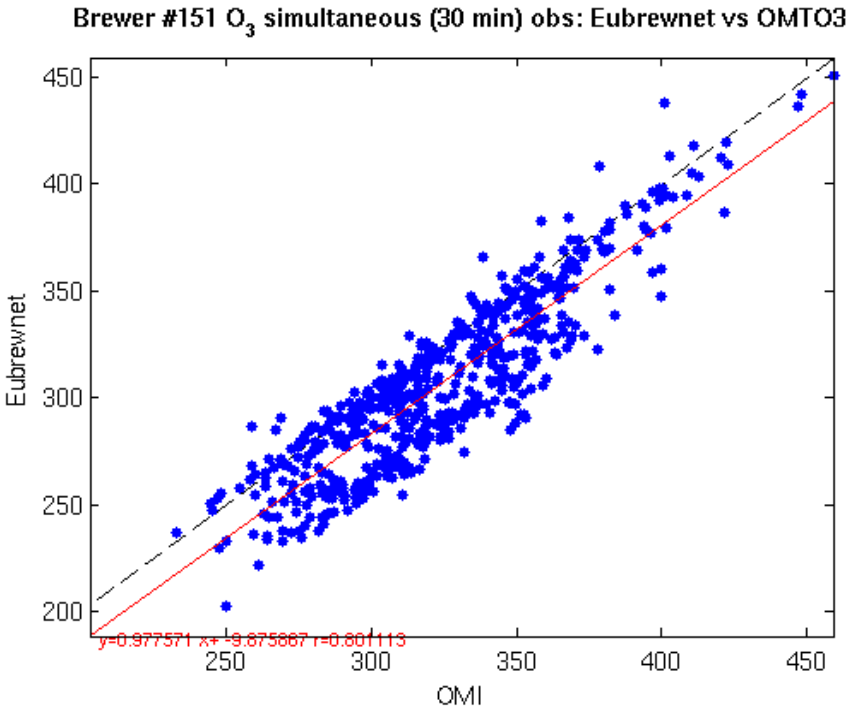
Brewer #150@El Arenosillo 2013-2016



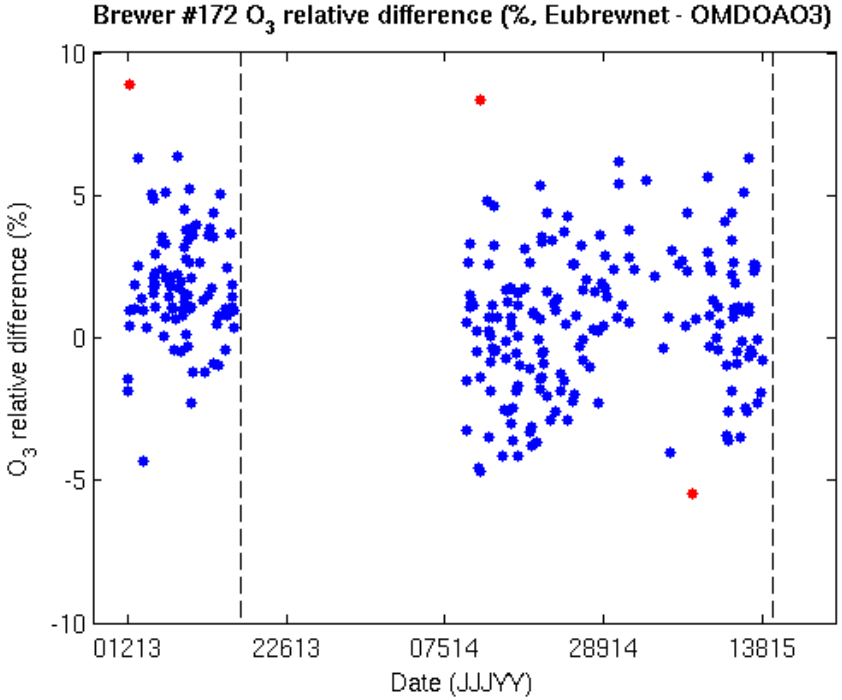


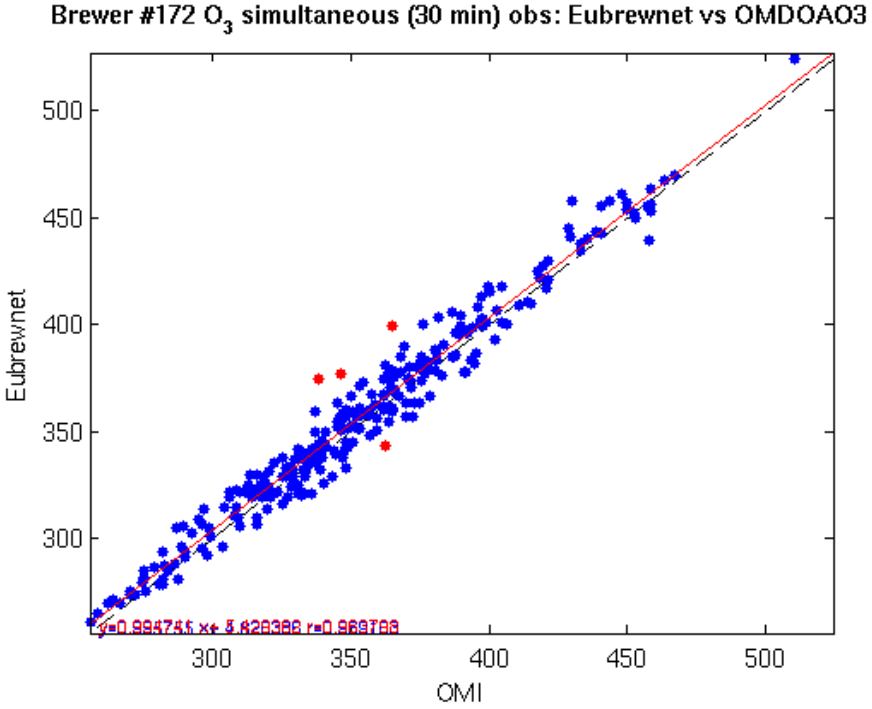
Brewer #151@La Coruña 2013-2016



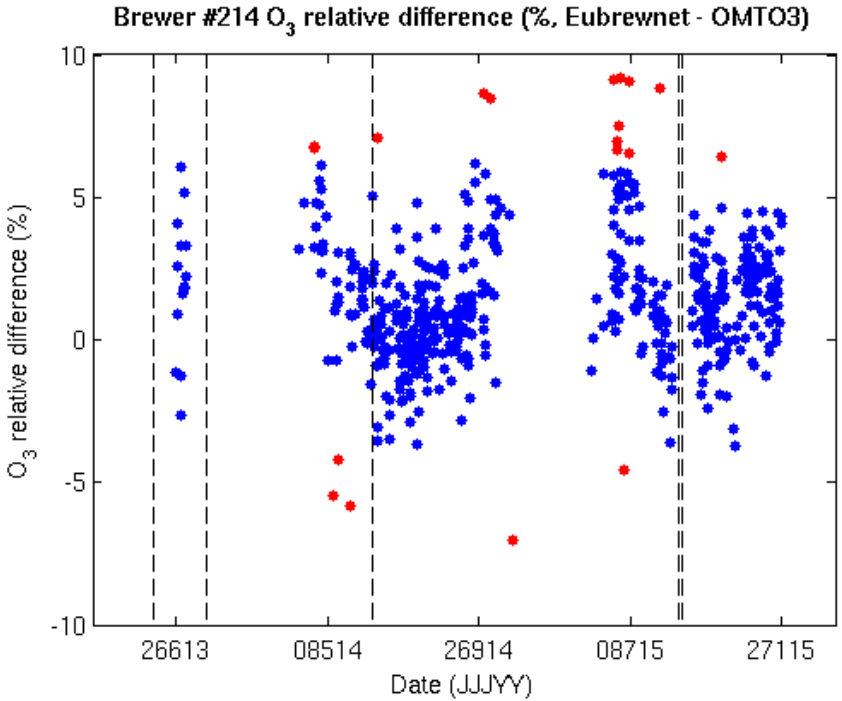


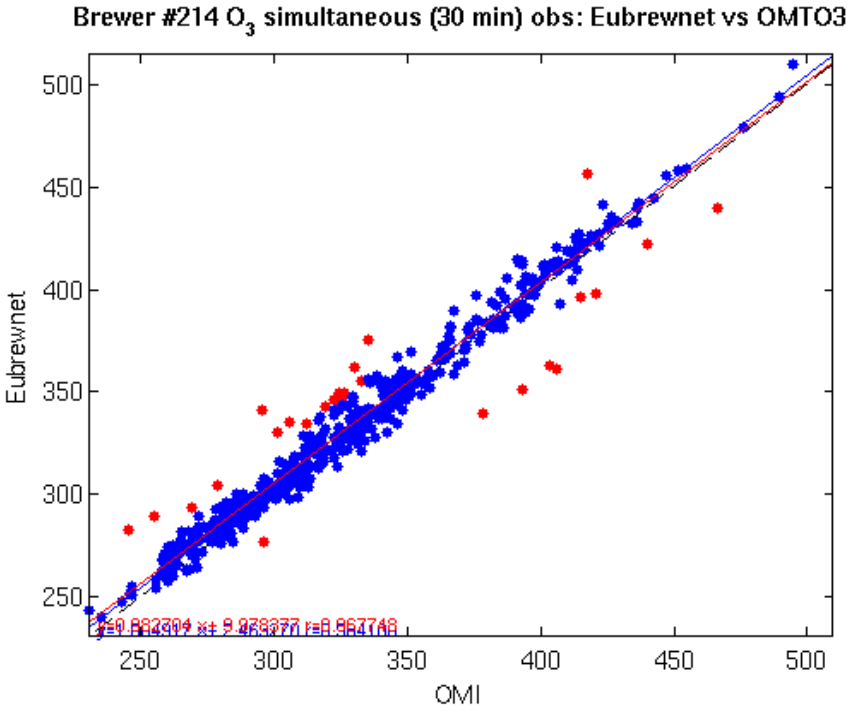
Brewer #172@Manchester 2013-2016





Brewer #214@Sodankylä 2013-2016





Closing remarks

→ EUBREWNET is ready for production

→ O_3 relative differences <~5%, correlations ~0.9

→ UV relative differences <~15%, correlations ~0.8 ←Level 0!

→ Brewer observation quality will depend on calibration information.

→ Brewer-OMI comparison products will be included EUBREWNET

Closing remarks

→ UV Level 2 data definition
→ AOD Brewer transfer calibratión/product

Getting data from EUBREWNET

O_3 L1:

http://rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&date=2015-06-02

Configuration:

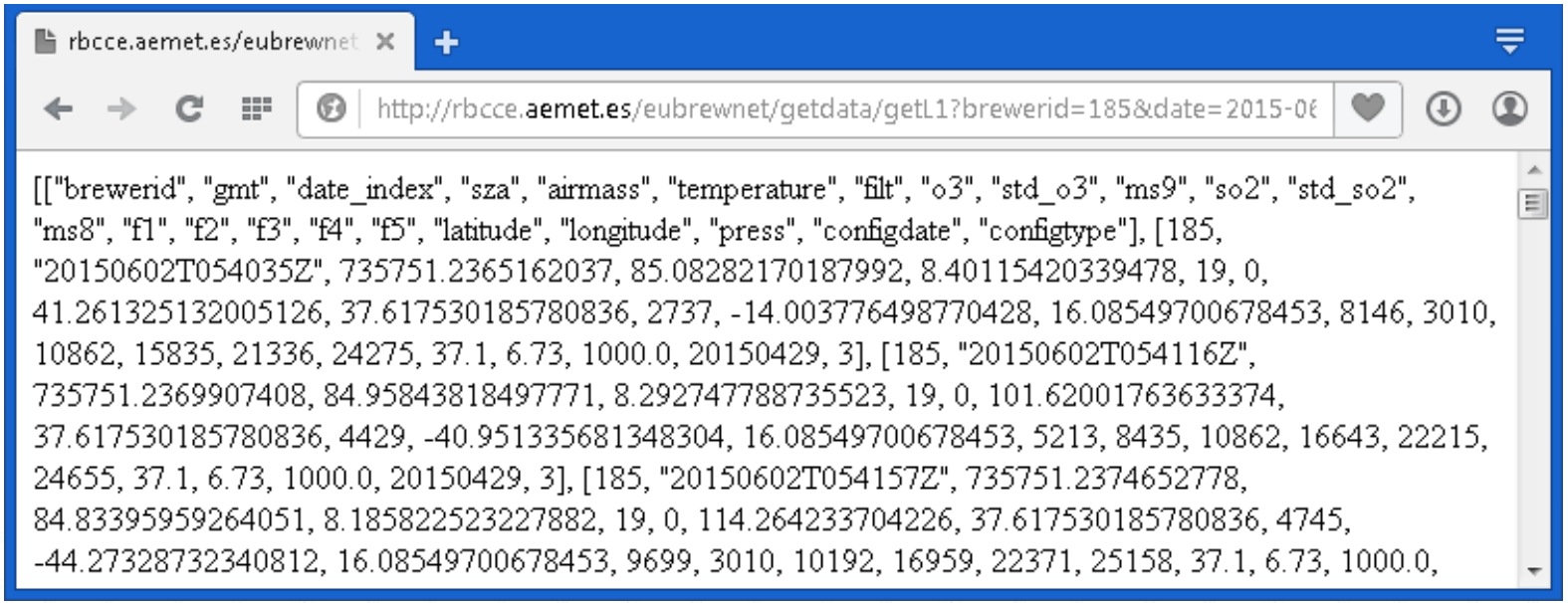
http://rbcce.aemet.es/eubrewnet/getdata/getConfigbyDate?brewerid=185&date=2015-06-02

UV L0:

http://rbcce.aemet.es/eubrewnet/getdata/getUVL0?brewerid=185&date=2015-06-02

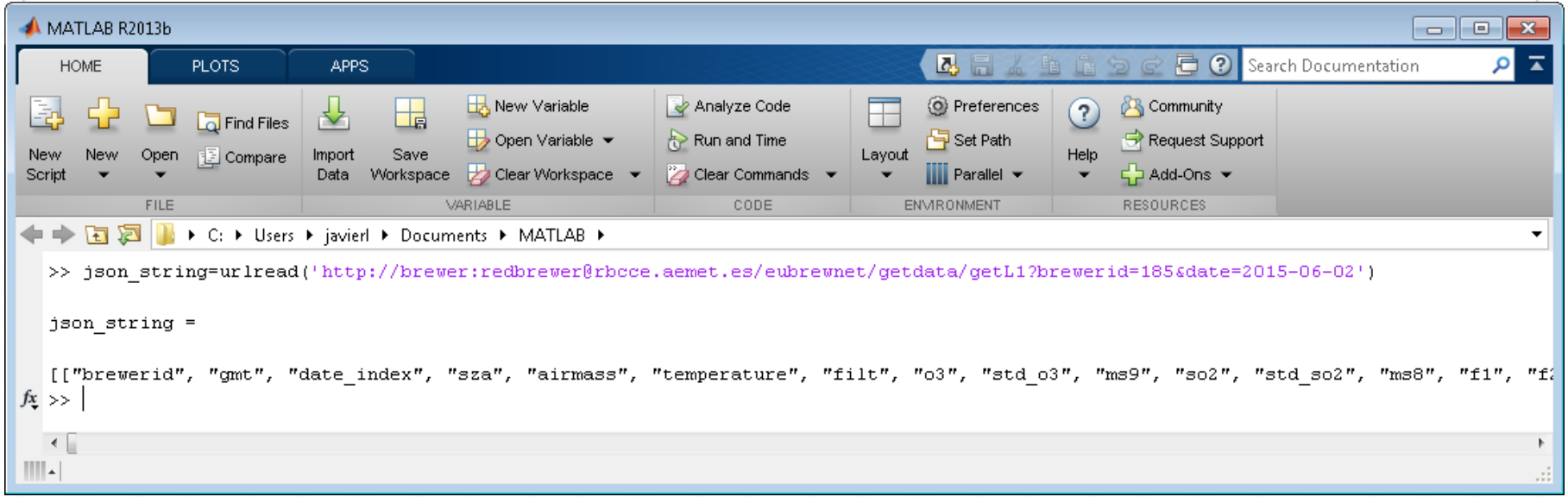
Getting data from EUBREWNET with a browser

http://rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&date=2015-06-02



Getting data from EUBREWNET with MATLAB

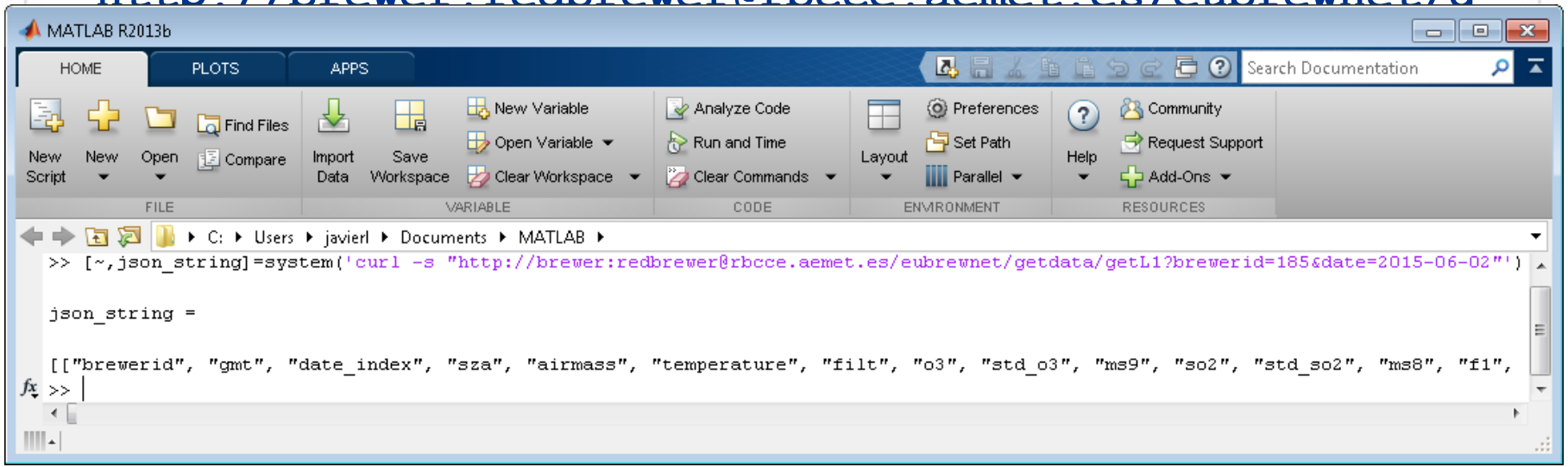
```
urlread('http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&date=2015-06-02')
```



Getting data from EUBREWNET with MATLAB

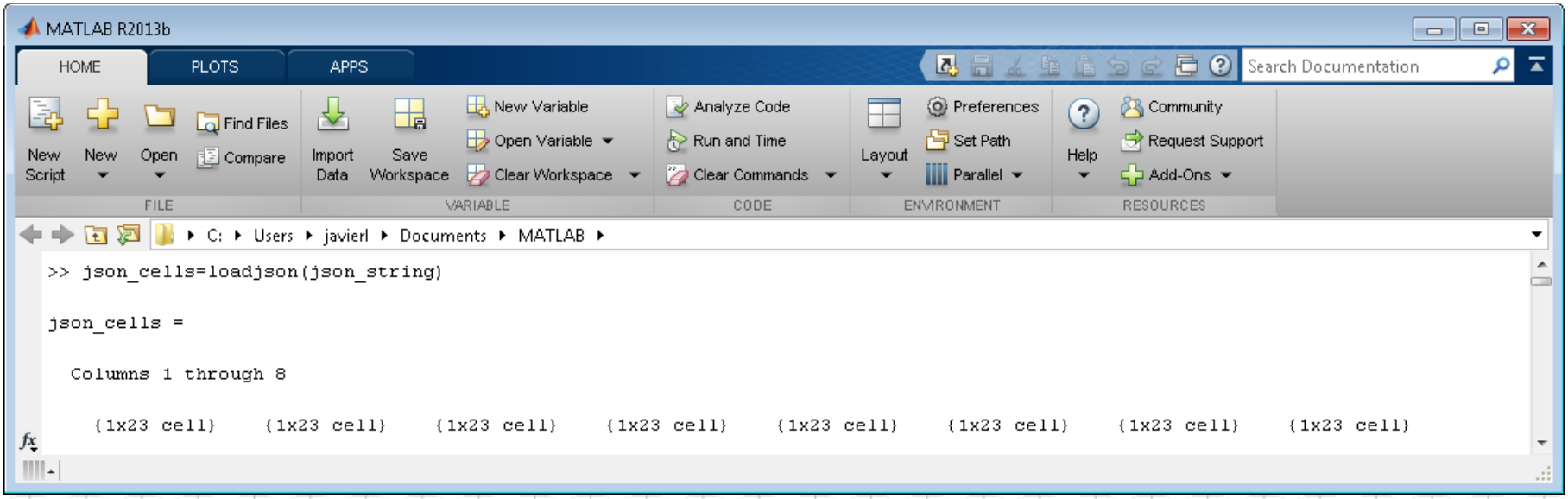
Problems with **urlread**? **curl** is your friend!

```
system('curl -s
"http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/g
```



Parsing the data from EUBREWNET with MATLAB

Use **jsonlab (http://iso2mesh.sourceforge.net/cgi-bin/index.cgi?jsonlab)**

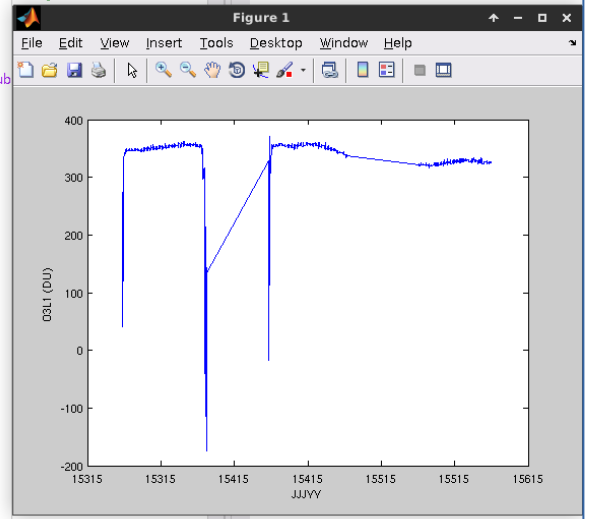


→ JSONlab

http://iso2mesh.sourceforge.net/cgi-bin/index.cgi?jsonlab

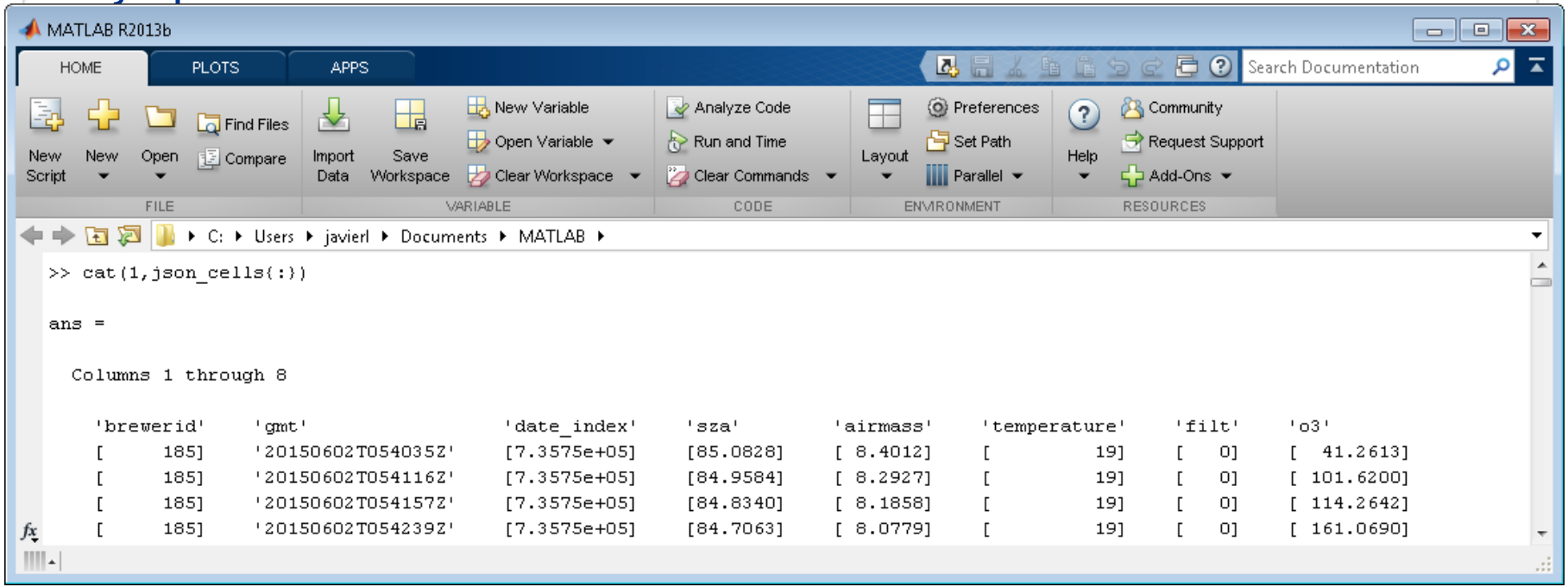
```
% download, parse and plot O3 L1 data from EUBREWNET
% JLS 201511

% download the json string
%json_string=urlread('http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&d

% bullet-proof alternative to urlread: use curl
% set the library path to stop matlab from using their own versions
setenv('LD_LIBRARY_PATH', '/usr/lib/x86_64-linux-gnu/');
[~,json_string]=system('curl -s "http://brewer:redbrewer@rbcce.aemet.es/eub

% we will use jsonlab to parse the json_string
addpath('./jsonlab')

% json string to cells
json_cells=loadjson(json_string);

% tidy up the result
json_cat=cat(1,json_cells{:});

% store each variable in the field of a structure
variables=json_cat(1,:);
data=json_cat(2:end,:);
json_struct=cell2struct(data,variables,2);

fields=fieldnames(json_struct);
o3l1=struct();
for this_field=1:numel(fields)
    o3l1.(fields{this_field})=cat(1,json_struct(:).(fields{this_field}));
end

% add a new field with the date as a datenum
o3l1.datenum=datenum(o3l1.gmt,'yyyymmddTHHMMSSZ');

% plot o3l1 vs time
plot(o3l1.datenum,o3l1.o3)
```

```
>>
```

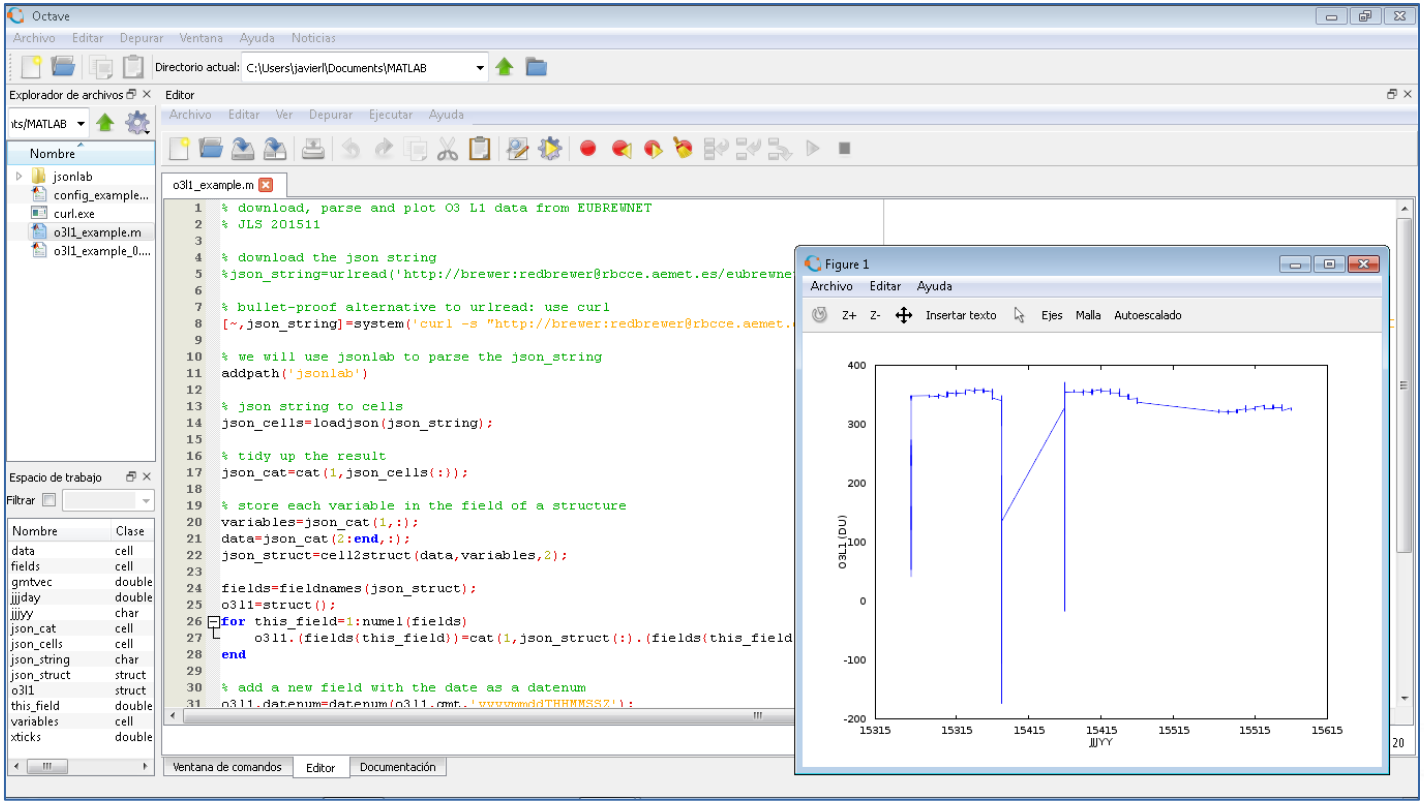


Parsing the data from EUBREWNET with MATLAB

Tidy up the result



Also works in OCTAVE



Complete examples

1) Download, parse, and plot O_3 L1 data

2) Download and parse a configuration

```
% download, parse and plot O3 L1 data from EUBREWNET
% JLS 201511

% download the json string
%json_string=urlread('http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&date=2015-06-01&enddate=2015-06-06');

% bullet-proof alternative to urlread: use curl
[~,json_string]=system('curl -s "http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getL1?brewerid=185&date=2015-06-02&enddate=2015-06-06"');

% we will use jsonlab to parse the json_string
addpath('jsonlab')

% json string to cells
json_cells=loadjson(json_string);

% tidy up the result
json_cat=cat(1,json_cells{:});

% store each variable in the field of a structure
variables=json_cat(1,:);
data=json_cat(2:end,:);
json_struct=cell2struct(data,variables,2);

fields=fieldnames(json_struct);
o3l1=struct();
for this_field=1:numel(fields)
    o3l1.(fields{this_field})=cat(1,json_struct(:).(fields{this_field}));
end

% add a new field with the date as a datenum
o3l1.datenum=datenum(o3l1.gmt,'yyyymmddTHHMMSSZ');

% plot o3l1 vs time
plot(o3l1.datenum,o3l1.o3)
```

1

```
% download and parse a configuration from EUBREWNET
% JLS 201511

% download the json string
%json_string=urlread('http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getConfigbyDate?brewerid=185&date=2015-06-02');

% bullet-proof alternative to urlread: use curl
[~,json_string]=system('curl -s "http://brewer:redbrewer@rbcce.aemet.es/eubrewnet/getdata/getConfigbyDate?brewerid=185&date=2015-06-02"');

% we will use jsonlab to parse the json_string
addpath('jsonlab')

% json string to cells
json_cells=loadjson(json_string);

% tidy up the result
json_cat=cat(1,json_cells{:});

% store each variable in the field of a structure
variables=json_cat(1,:);
data=json_cat(2:end,:);

config=cell2struct(data,variables,2);

disp(config)
```

2