

Ten years of the Regional Brewer Calibration Centre Europe 2003-2013

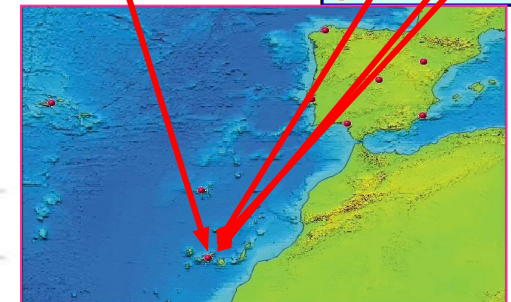
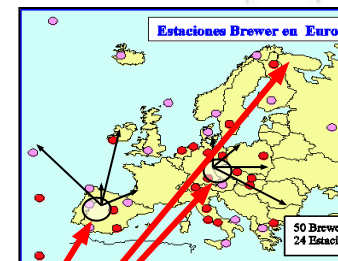
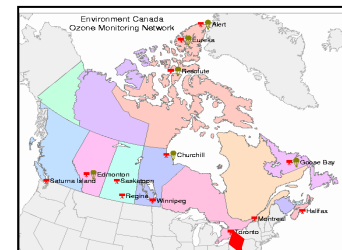
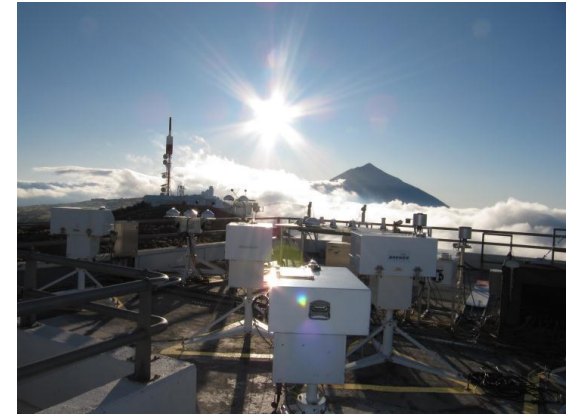
RBCC-E

In November 2003 the WMO/GAW Regional Brewer Calibration Centre for RA-VI region (RBCC-E) was established at the Observatory Izaña of AEMET, Canary Islands (IZO).

IZO is located in subtropical region (28°N) on top of the Izaña Mountain (2370 m.a.s.l.) with clear sky and small ozone variability. This allows routine absolute calibrations of the references similar to the MLO site on Hawaii.

The IZO Triad is linked to the Environment Canada (EC) Triad by yearly calibrations towards the travelling reference BR 017.

Because of doubts about the support of the world triad by EC, the WMO SAG Ozone authorizes at the meeting of 2011, that the RBCC-E transfers its own calibration based on Langley at Izaña Station. Since Arosa 2012 campaign the RBCC-E transfer his own Langley calibration



RBCC-E campainings

RBCC-E campaigns

Status of the network (comparison with reference instruments)

Brewer – Dobson comparison

Absolute Calibration(Langley)

Reference instruments calibration

Nordic campaigns

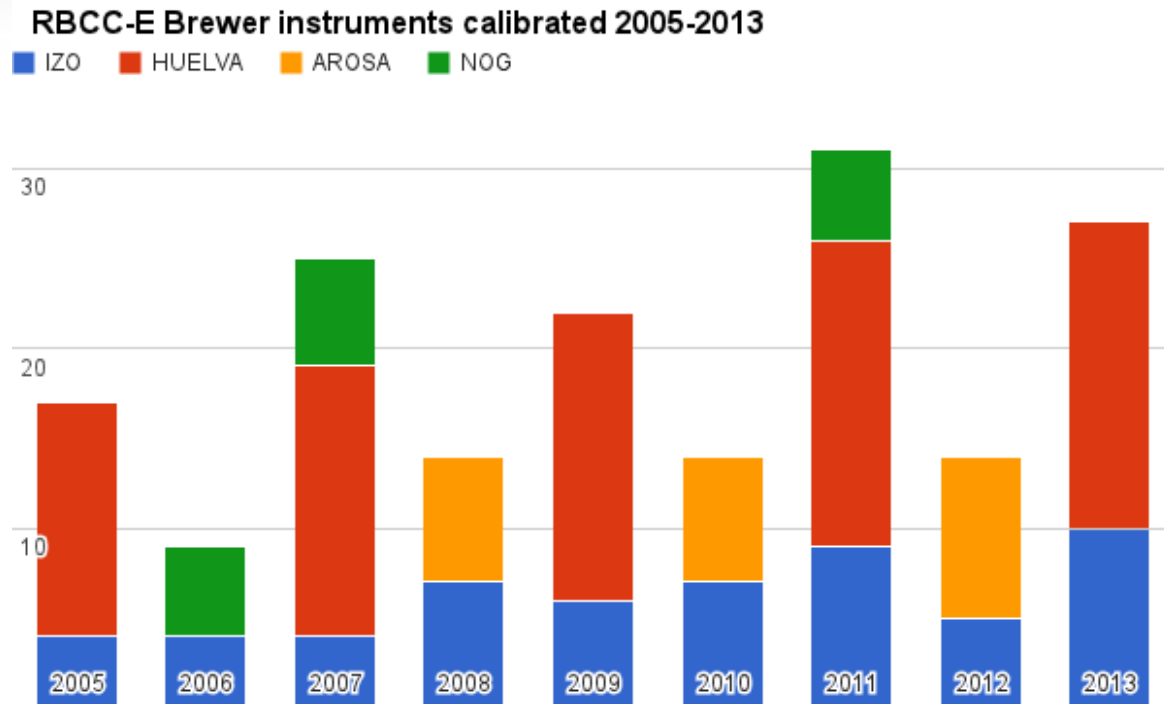
Investigate the calibration methodology at two different ozone atmospheric conditions.

Instrumental issues

Ozone ETC sensitivity Calibration



RBCC-E Campaigns



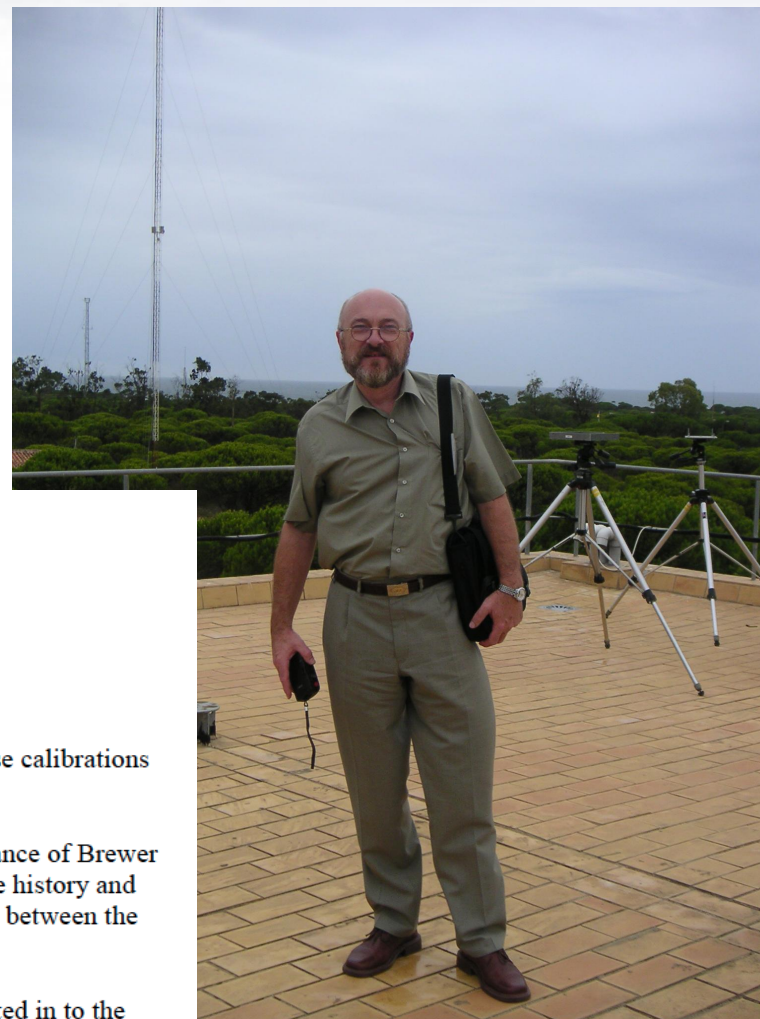
10 year of the RBCC-E

The idea was the creation of an internationally structured Brewer calibration system, under GAW program, with Quality Assurance (QA) procedures similar to those of the Dobson system

Recommendations
of the
Scientific Advisory Group for Ozone of WMO-GAW

(Prepared at the SAG-O3 meeting in Toronto, September 09-10, 2002)

1. WMO GAW should seek support for Dobson calibrations in developing countries. Otherwise calibrations in developing countries will fall behind schedule.
2. A plan must be made to augment and extend the existing system of calibration and maintenance of Brewer instruments, which is presently being performed by private companies. An evaluation of the history and efficiency of the existing Dobson calibration system, which is operated through cooperation between the individual users and WMO-GAW oversight, would be useful in forming this plan.
3. Calibration histories of the Dobson, Brewer and FSU filter instruments should be incorporated in to the WOUDC as assistance to the data users.
4. Creation of a regional Brewer calibration system in the RA-VI Region operated under the GAW Programme is recommended for long-term maintenance of the Brewer network and for continuity of high accuracy of total ozone observations in the region.



- Brewer Ozone Observations since 1992, since 2002 is a NDACC (NDSC) total ozone station.
- Trained personnel , experienced on instruments and campaigns (Nordic 93, 97, Dobson 94, Arenosillo 1999, 2001)
- A good set of complementary measurements including NDAC DOAS and FTIR and UV calibration laboratory.
- The station has the conditions to perform Absolute Langley Calibrations, high altitude, clear atmosphere and stable tropical ozone during major part of the year



In November 2003 IZO has been officially nominated as RBCC-E by WMO

AEMET (Former INM) commitments

- Maintain the Brewer #157 as the reference and buy a new spectrometer as travelling instrument.
- Maintain the link with the World Reference Triad through regular calibration with the #017 and independently through Absolute calibrations of the instruments.
- Organize a yearly calibration to transfer the calibration one on the south of Europe (Huelva, Spain) and a second one in Arosa.
- Scientist is dedicated to the project a phd student and 50% of technical observer.



April 2004 Hradec Králové, Czech Republic RBCC-E preparatory workshop

- Environment Canada calibration and network maintenance.
- AEMET spectrometer network
- Izaña Langley Evaluation



(1st ANNOUNCEMENT)

**THE FIRST GAW REGIONAL BREWER CALIBRATION CENTER-EUROPE
INTERCOMPARISON CAMPAIGN OF BREWER SPECTROPHOTOMETERS**
at the "El Arenosillo" Atmospheric Sounding Station, INTA (Huelva, Spain)
9-18 September 2005



- Ozone calibration against the RBCC-E travelling reference (B185) and against the world travelling reference (B017) managed by IOS (International Ozone Services)
- Minor servicing and refurbishment of the instruments performed by IOS
- UV QA by QASUME unit (finally confirmed !!)
- Compilation of the calibration histories of the instruments
- Aerosol Optical Depth calibration against RBCC-E reference instrument

5 Spanish Network Brewers
1 Brewer from Portugal + 1 from Morocco (?)
2 Reference Instruments (Brewer #017 and Brewer#185)
Participants to be registered
6 more instruments with up to two operators per instrument



Contact person: Alberto Redondas
aredondas@inm.es www.rbcc-e.org

2005 I RBCC-E Campaign

Langley analysis confirms the travelling calibration from IOS #017.

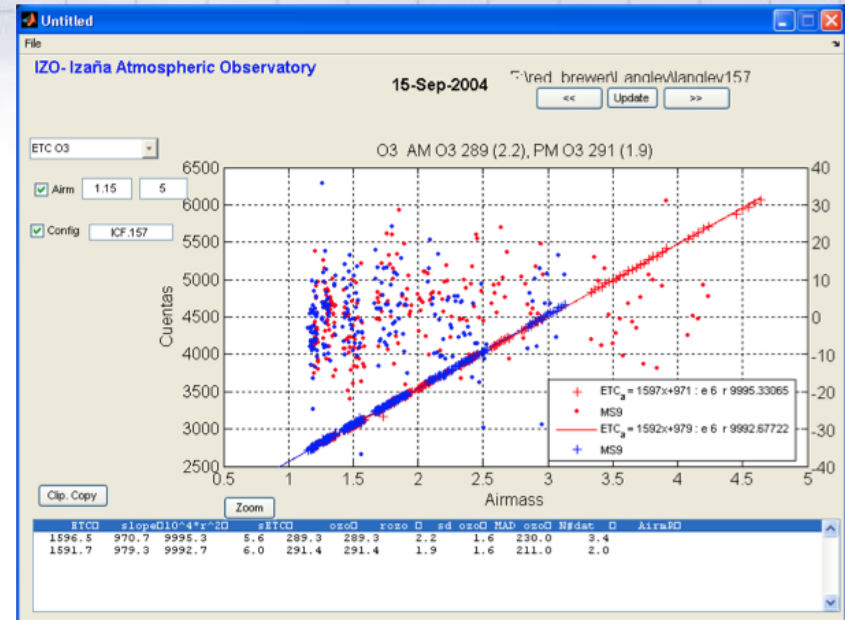
The instruments at Izaña will be calibrated by IOS before the campaign.

We are familiar and have access to the tools developed by **Volodya Savastiouk** used by IOS during calibrations Bfilepro, Dispro, GApró.....

We know the procedures of the canadian network (Tom Grajnar).

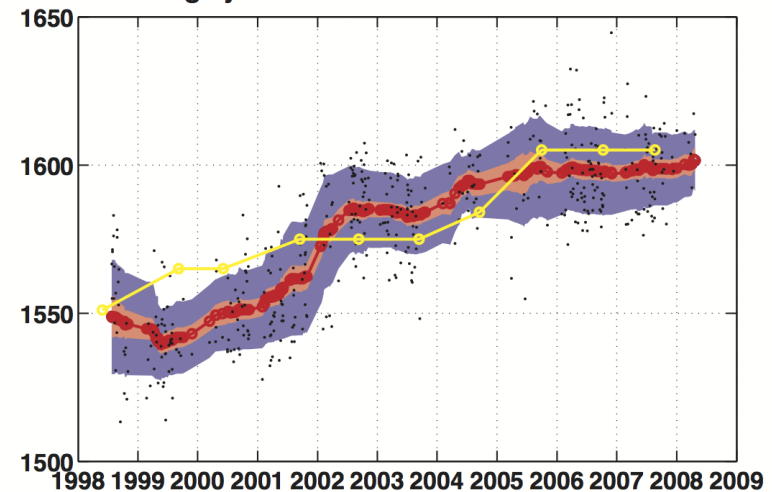
We have developed 'iberonesia', a service to deal with intercomparison data.

And it will be a test campaign IOS will calibrate in the instruments.



ETC determination for Ozone #157 PM

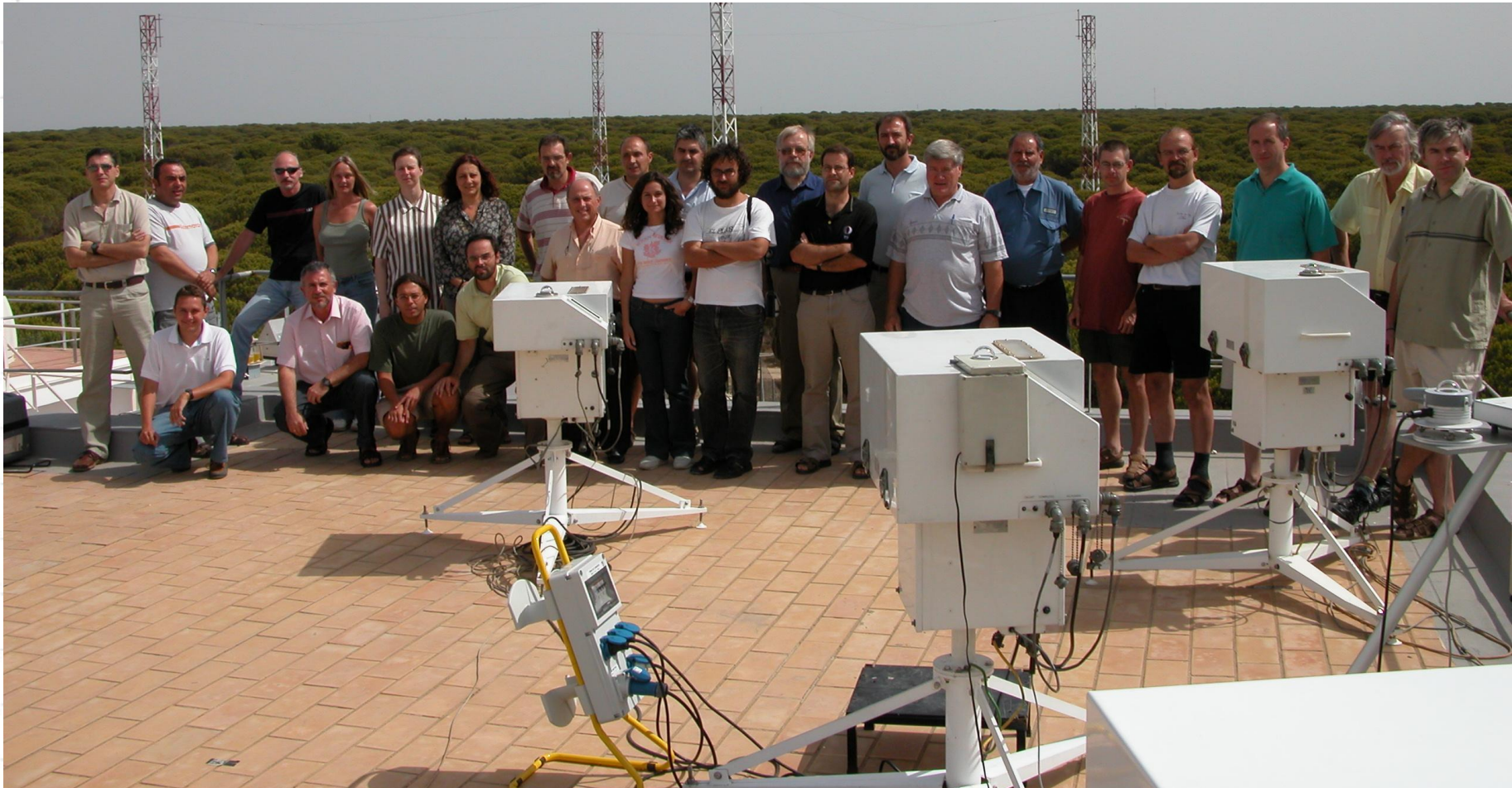
Langley calibration vs Calibration Transfer



El Arenosillo 2003



1st RBCC-E campaign El Arenosillo 2005



SAUNA campaign

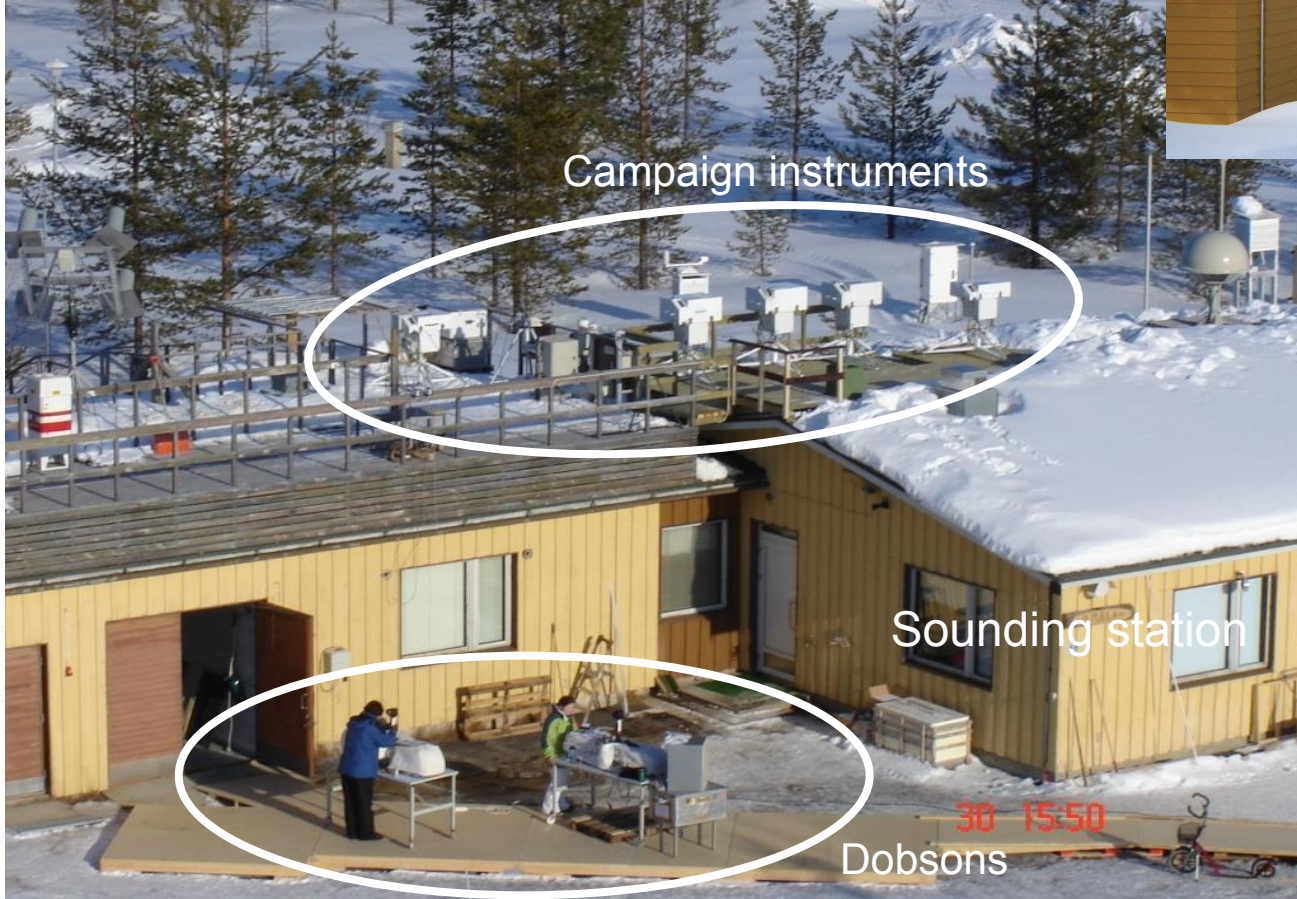
- Organized by NASA, FMI and ESA
- Hosted by the Finnish Meteorological Institute Arctic Research Center at Sodankylä, Finland
- Boreal climate, Arctic atmosphere
- 30+ Scientists from 10 Institutions and 9 Countries:
NASA-GSFC (USA), FMI-ARC (Finland), ESA-ESRIN (Italy), BIRA-IASB (Belgium), CNRS-SA (France), DWD-MOHp (Germany), INM-Izana (Spain), KNMI (Netherlands), MSC (Canada), NOAA-ESRL (USA)
- Funding/Sponsors:
NASA-HQ, FMI, and ESA
EOS-Aura Project Science Office
National contributions from Canada, France and Spain



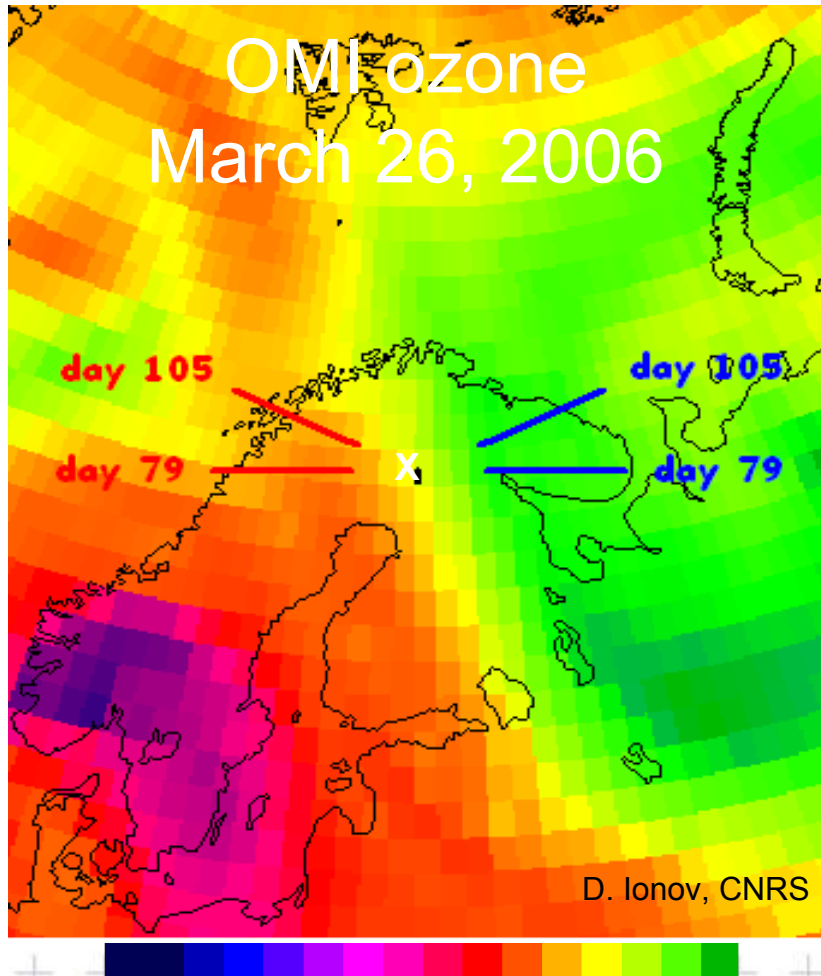
Campaign instruments

Instrument	Principal Investigator	Affiliation
<i>Brewer (single monochromator at FMI-ARC)</i>	<i>E. Kyrö</i>	<i>FMI-ARC (Finland)</i>
<i>Brewer: 1 single (World standard), 1 double</i>	<i>T. McElroy</i>	<i>MSC (Canada)</i>
<i>Brewer: double</i>	<i>A. Cede/R. McPeters</i>	<i>NASA GSFC (USA)</i>
<i>Brewer: 1 double (European Standard)</i>	<i>A. Redondas/E. Cuevas</i>	<i>INM-Izana (Spain)</i>
<i>Dobson (Traveling standard)</i>	<i>R. Evans</i>	<i>NOAA/ESRL (USA)</i>
<i>Dobson (European standard)</i>	<i>U. Koehler</i>	<i>DWD-MOHp (Germany)</i>
<i>DOASs: 1 UV, 1 vis, 1 miniDOAS</i>	<i>M. van Roozendael</i>	<i>BIRA-IASB (Belgium)</i>
<i>miniDOAS</i>	<i>E. Brinksma</i>	<i>KNMI (Netherlands)</i>
<i>SAOZ (permanently located at FMI-ARC)</i>	<i>F. Goutail</i>	<i>CNRS-SA (France)</i>
<i>STROZ-Lite LIDAR (NDSC standard)</i>	<i>T. McGee</i>	<i>NASA-GSFC (USA)</i>
<i>Ozonesondes</i>	<i>R. Kivi B.R. Bojkov</i>	<i>FMI-ARC (Finland) NASA-GSFC (USA)</i>

FMI-ARC facilities during SAUNA

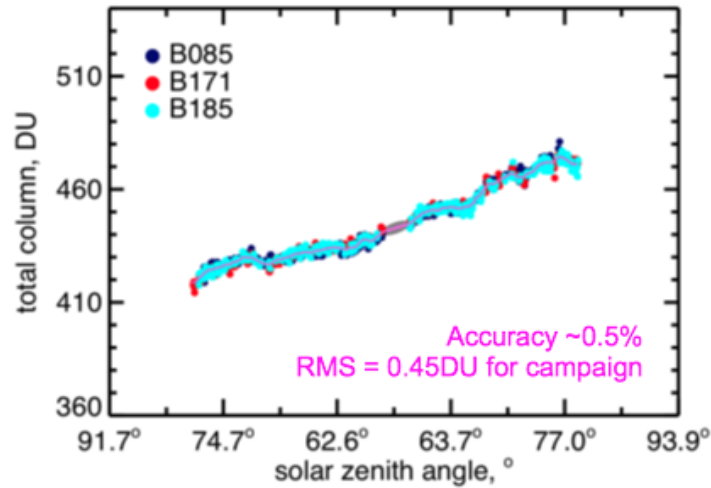


SAUNA 2006

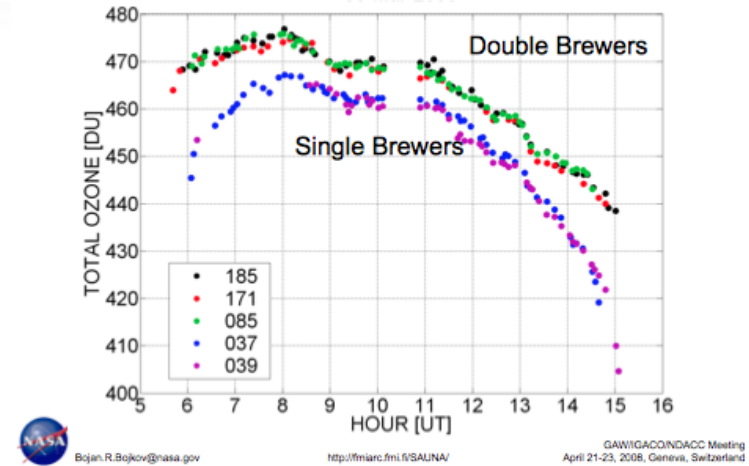


- March/April provides:
 - total ozone columns in the range 400DU to ~520DU
 - High variability/strong gradients
 - 12-16 hour measurement days
 - Minimum solar zenith angle of 65 degrees
 - 75% clear skies (12 of 18 good days!)

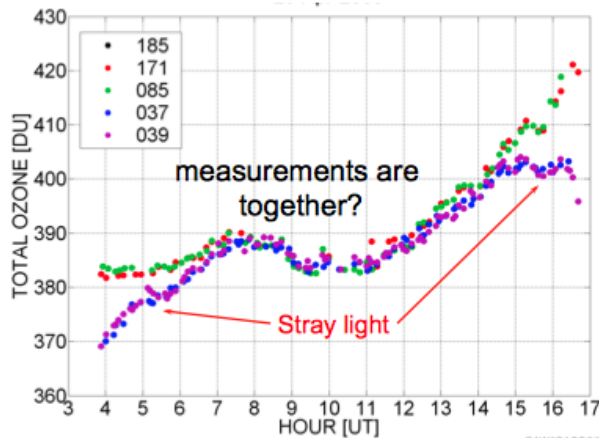
SAUNA: Ref. from double Brewers
2006/04/05



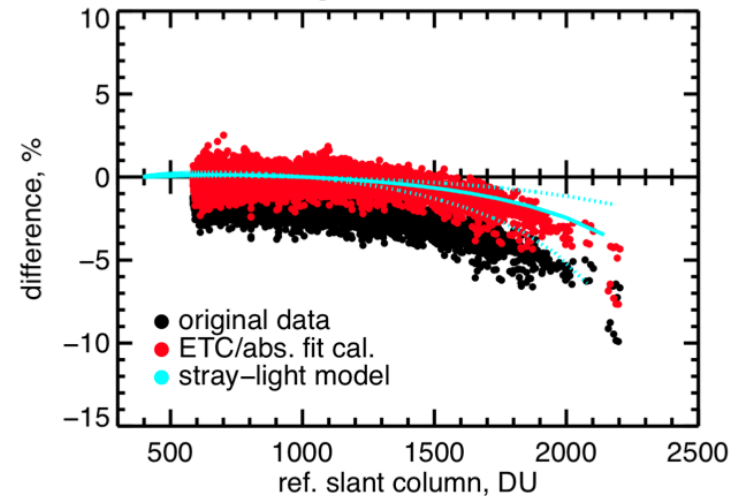
Brewers: March 30 '06



Brewers: April 29 '06



SAUNA: single Brewer stray-light
singles vs. reference



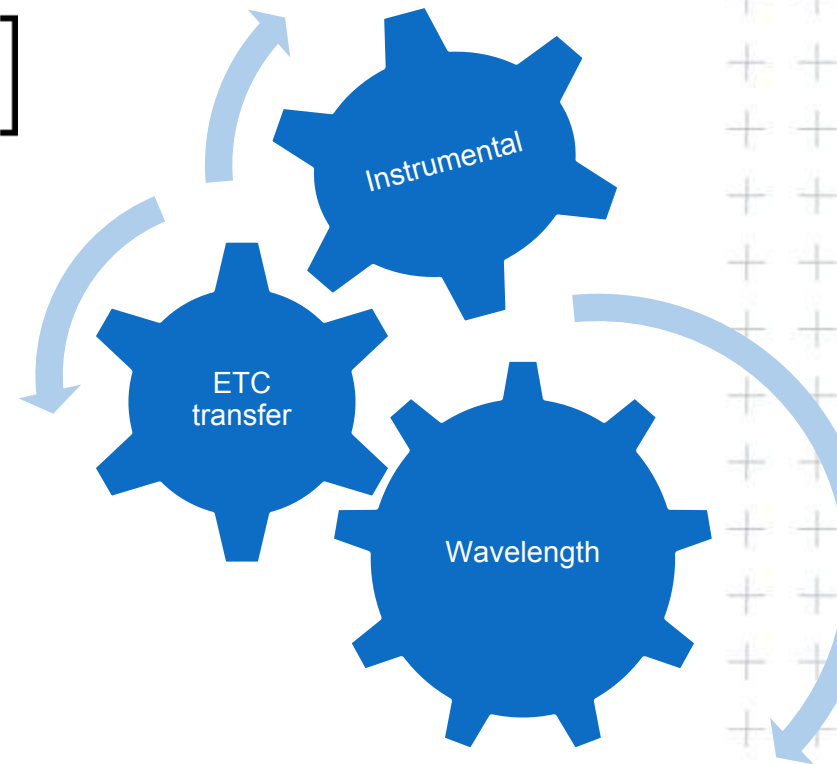
SAUNA 2006 , 2007 (2011) campaigns

- **Straylight** issue on single Brewers.
- **One parameter vs. two parameters calibration**
- **Ozone cross section,**
 - DOAS instruments and GOME satellites use different ozone cross-sections
 - Brewer (and Dobson) temperature effect are different depending of the cross section used.
- **Brewer algorithm** assumptions of ozone effective temperature and height are far from campaign conditions.
- **Brewer Dobson** do not agree on the scale.

Brewer Calibration

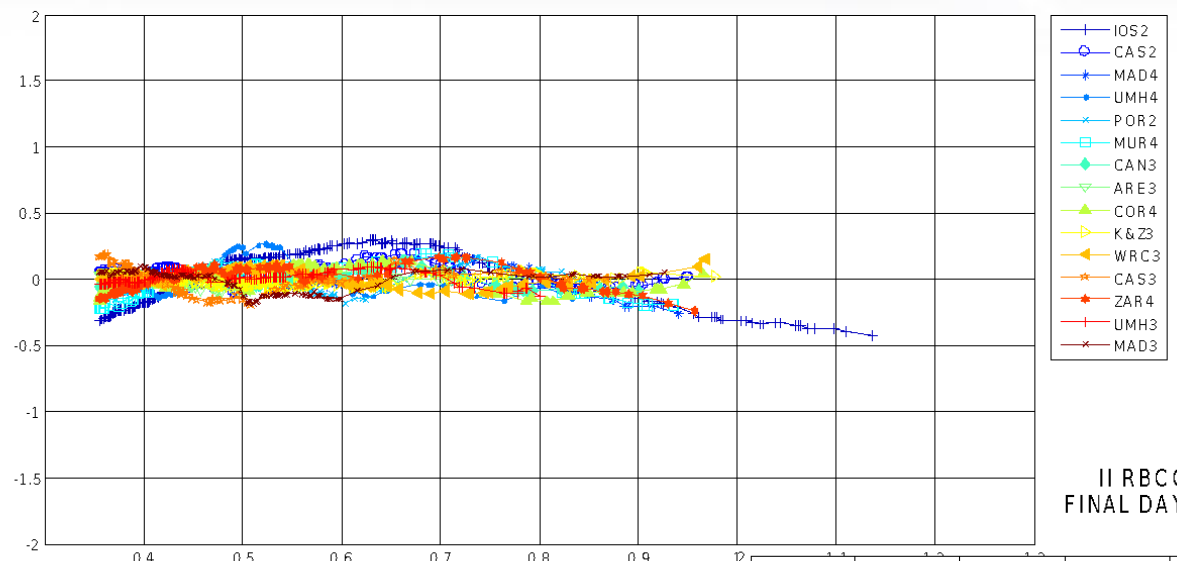
$$[O_3 = \frac{F - ETC}{\alpha m}]$$

- 1: Instrumental Calibration (F)
- 2: Wavelength Calibration (α)
- 3: ETC transfer.



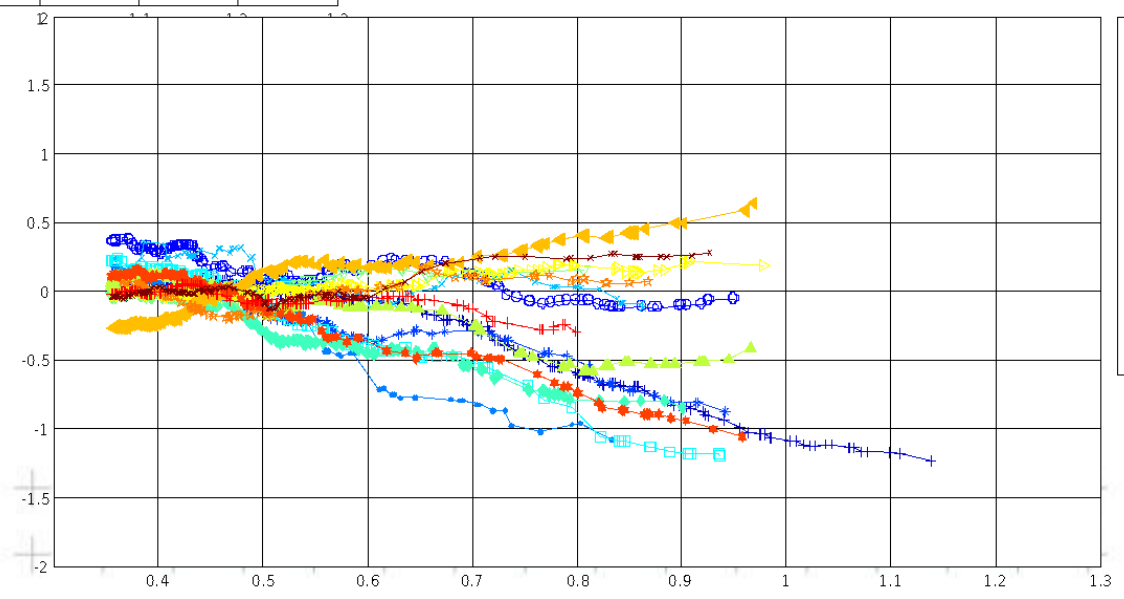
ETC vs ETC and O3 abs calibration

II RBCC-E Campaing September 2007
FINAL DAYS 2p Reference Brw#185



The agreement with two parameter calibration improve the campaigns comparison

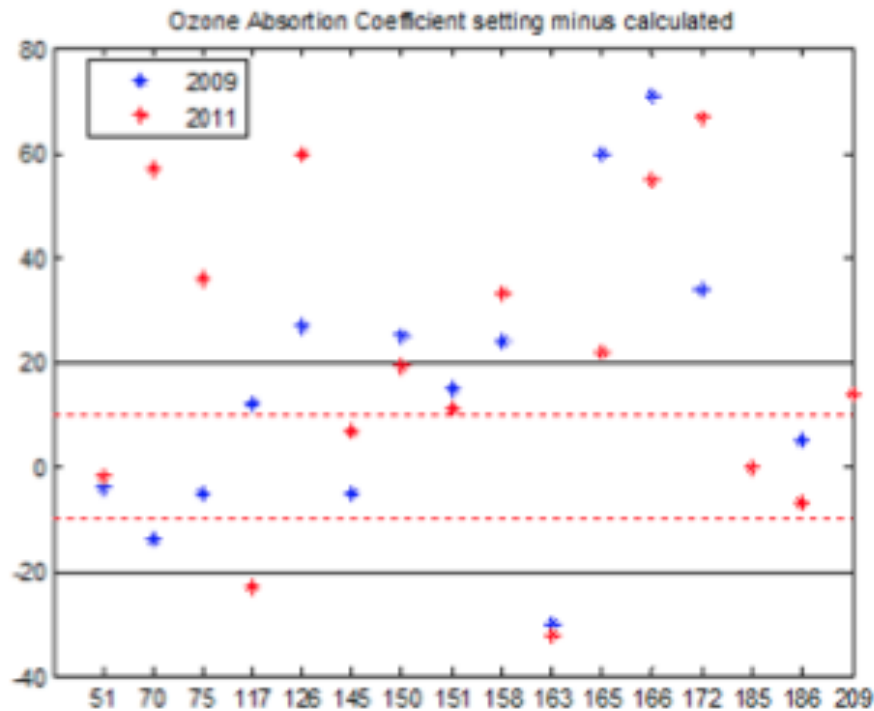
II RBCC-E Campaing September 2007
FINAL DAYS 1p reference RBCC-E Brw#185



But, you are compensating instrumental characteristics with not real parameters.

The calibration could be only valid during campaign conditions

26/01/2008



At Arosa 2008 with well maintained and characterized instrument, **both calibrations are agree.**

During 2011 and 2009 campaigns we can relate this discordance with instrumental characterization mainly attenuation filter nonlinearity and DT.

□
If a proper calibration is used both calibrations agree, and this agreement can be used as an indication of the quality of the instrument.

□ Class I: ETC (± 5 units $\pm 0.4\%$, o_3 abs ± 1 step 0.3%)

□ Class II: ETC (± 10 units $\pm 0.8\%$, o_3 abs ± 2 step 0.6%)

About $\frac{2}{3}$ of the instruments show an agreement of $\pm 0.5\%$ after two-year calibration.

Standard lamp correction is applied or not to the data.

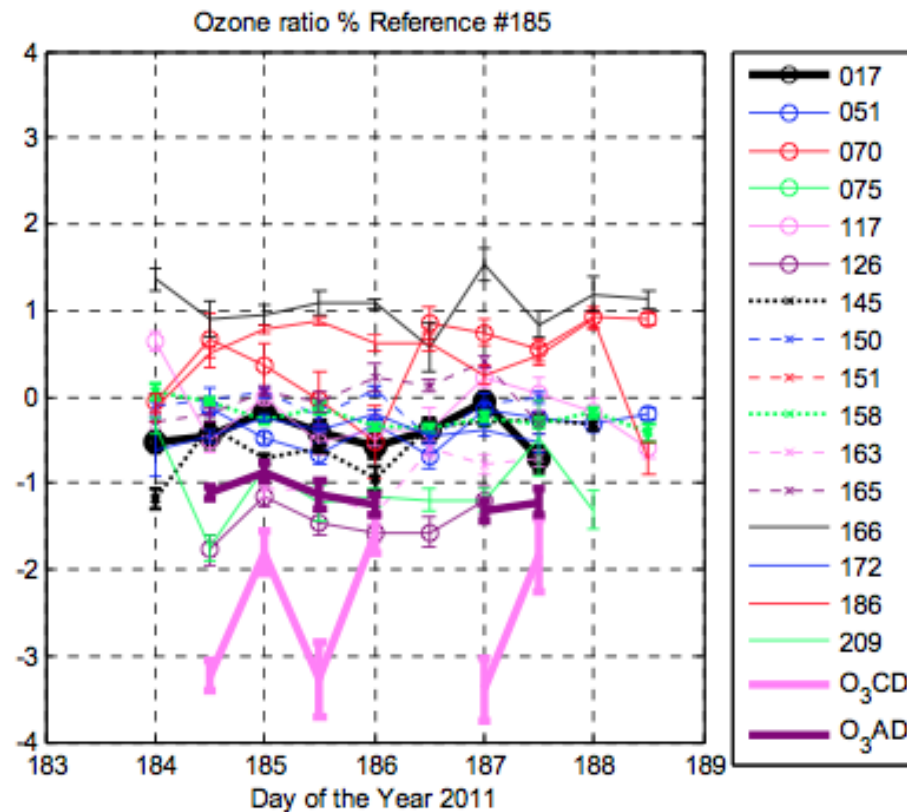
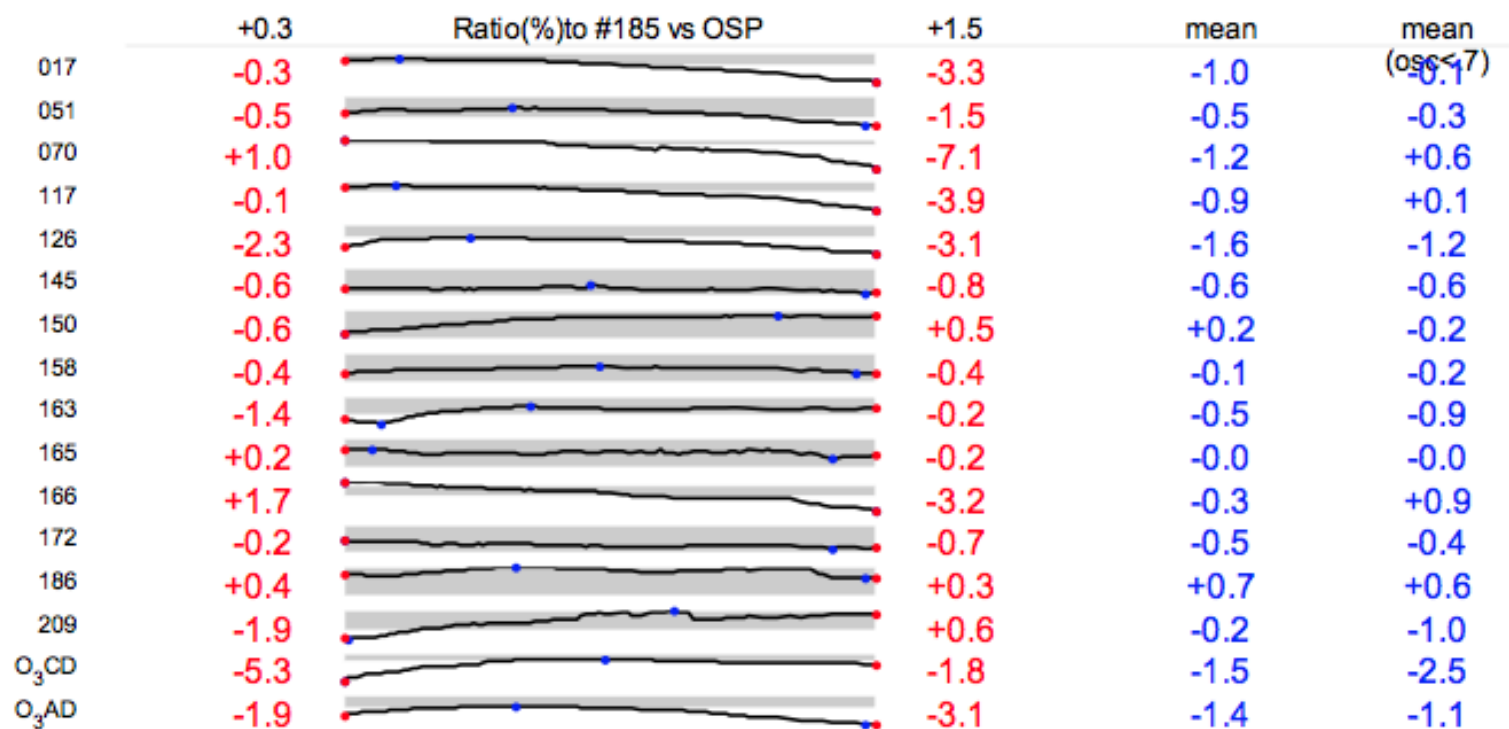
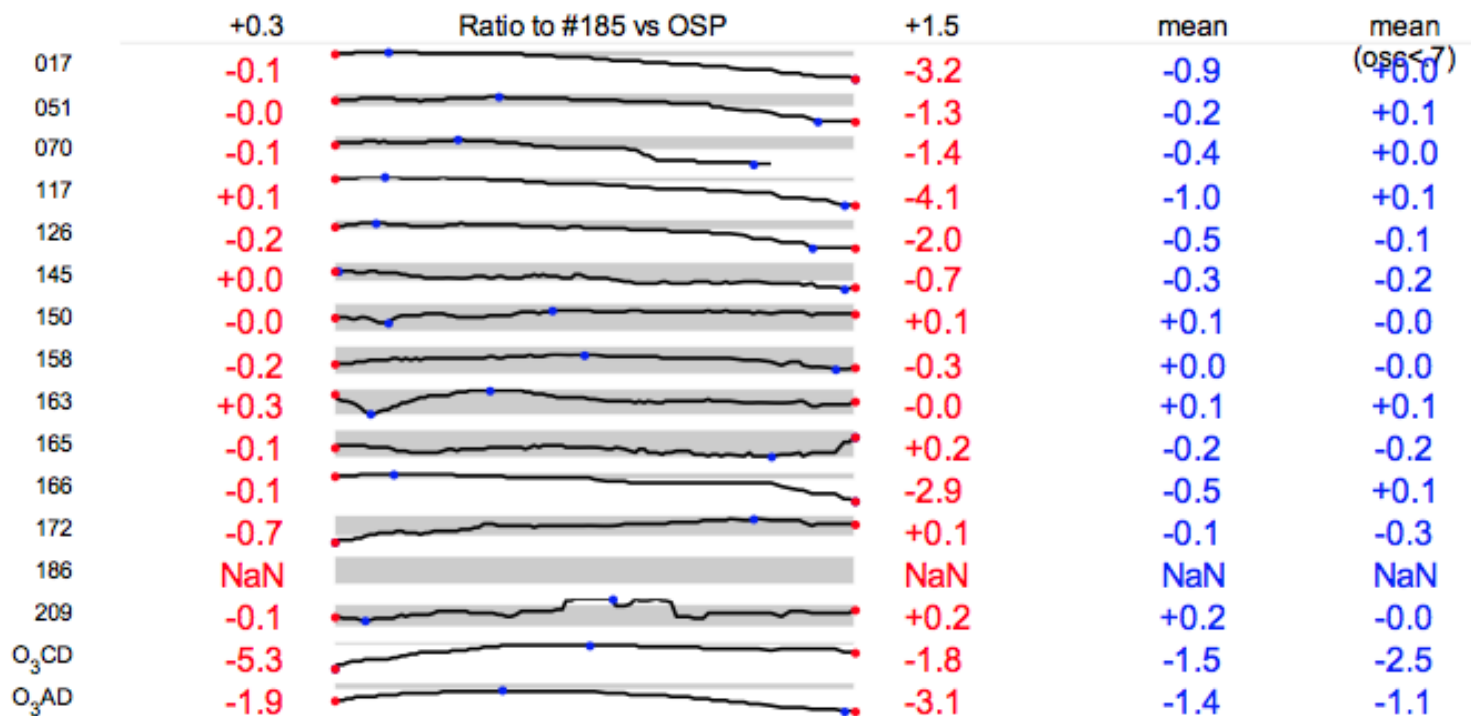


Figure 17: Daily mean of the simultaneous ozone observations at Arenosillo 2011 campaign, initial configuration of the brewer are used. (Reference brewers are marked with thicker lines)

HUELVA 2011 . - Blind Days-

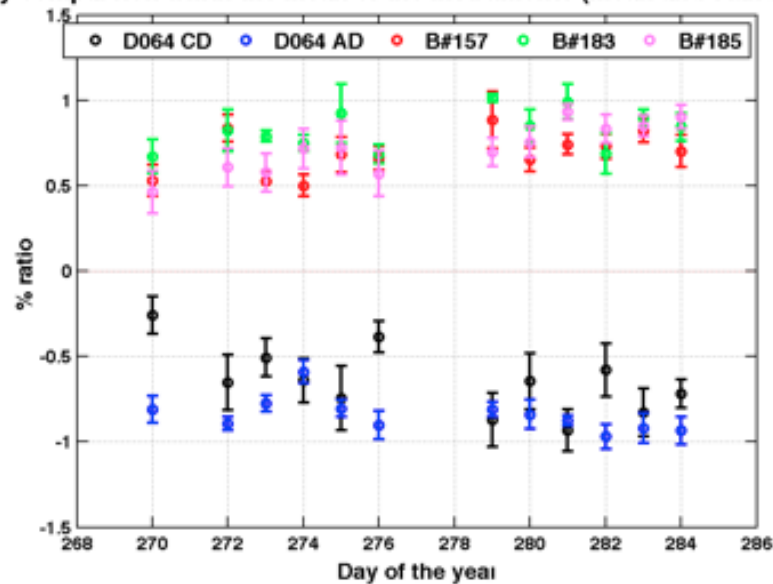


HUELVA 2011 . - Final Days-

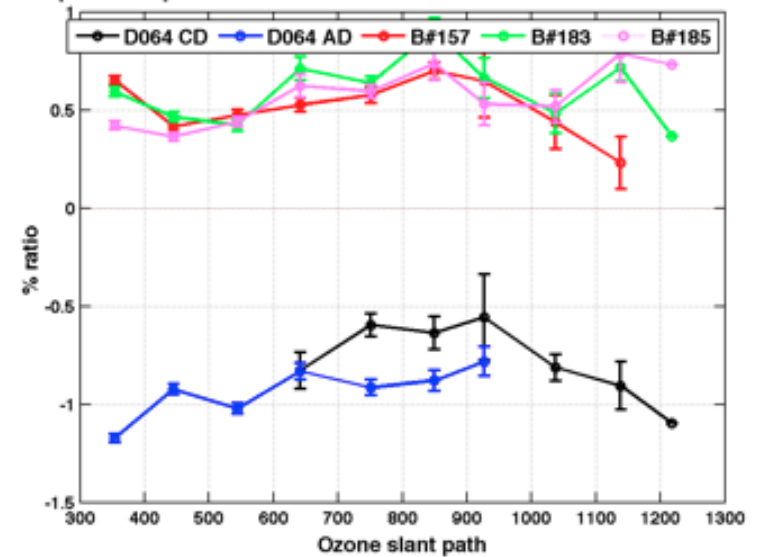


Dobson Brewer Comparison

CEOS Izana Absolute Campaign (Spain), 20 Sep. - 20 Oct., 2012
 Daily comparison with the mean of the instruments (mean and standard error)



CEOS Izana Absolute Campaign (Spain), 20 Sep. - 20 Oct., 2012
 Slant path comparison: Ref: Mean Dobson Brewer mean and standard error



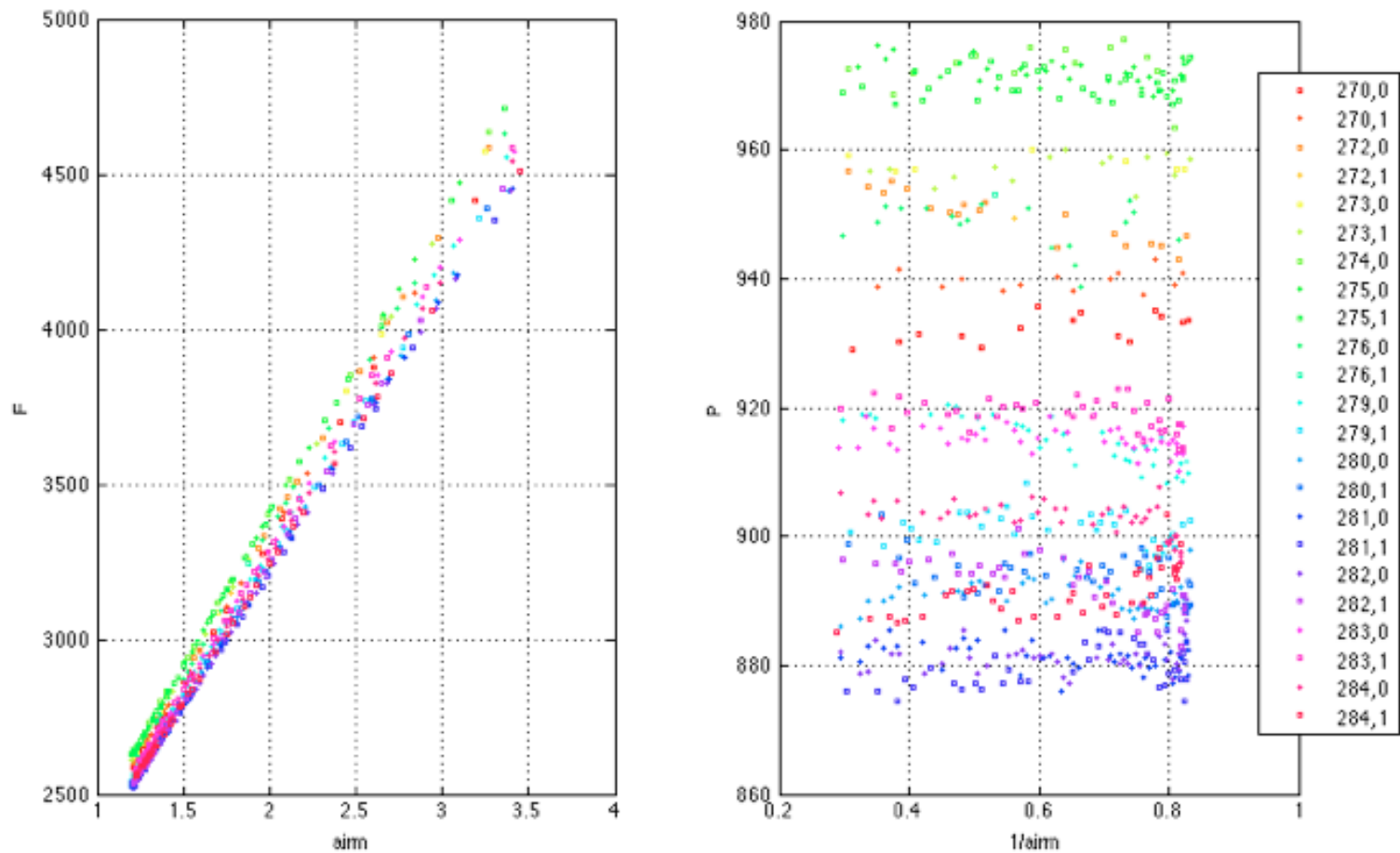
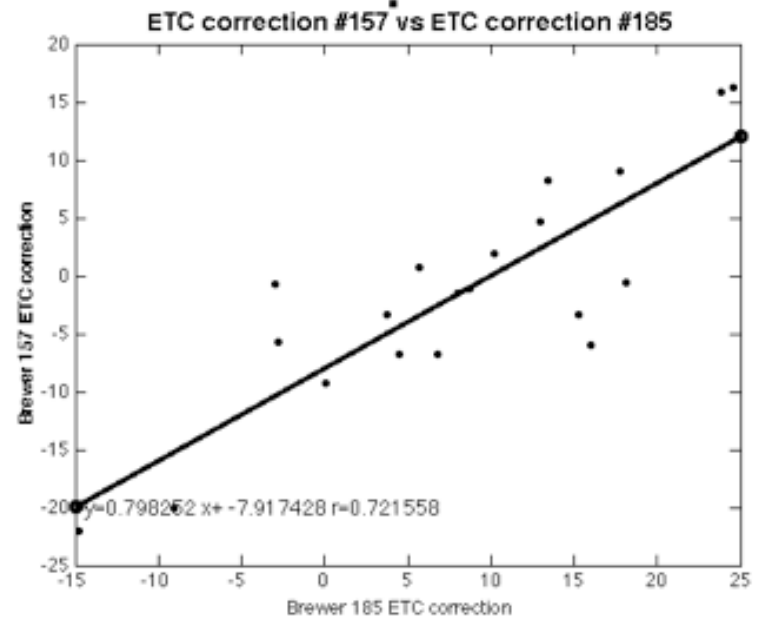
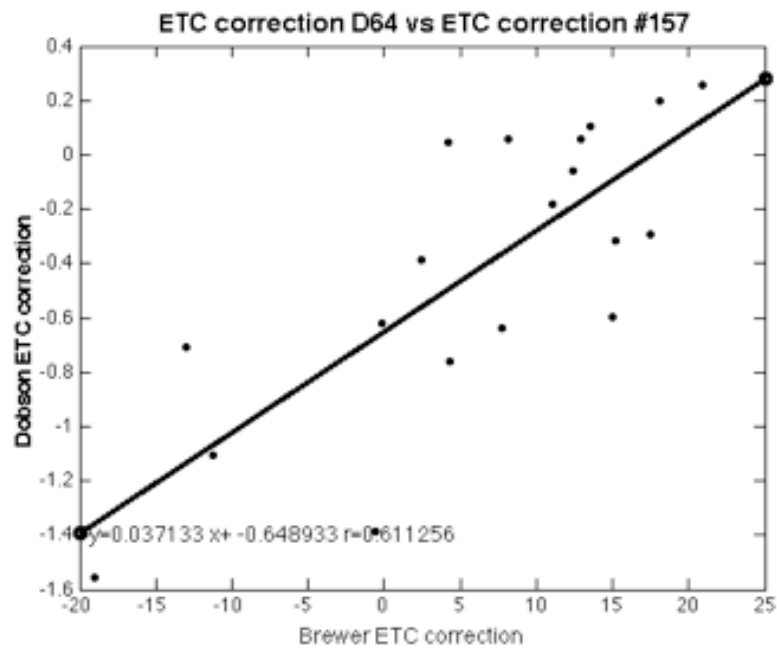
CEOS Izana Absolute Campaign (Spain), 20 Sep. - 20 Oct., 2012
185

Figure 21: Langley plots for the Brewer 185 during the campaign. We show in the left panel the regression vs. μ and in the right panel the Dobson method $P = F - \text{ETC}/\mu$ vs. $1/\mu$

Dobson and Brewer Langley comparison Izaña 2012 campaign



Common Langley Calibration and use different cross sections,

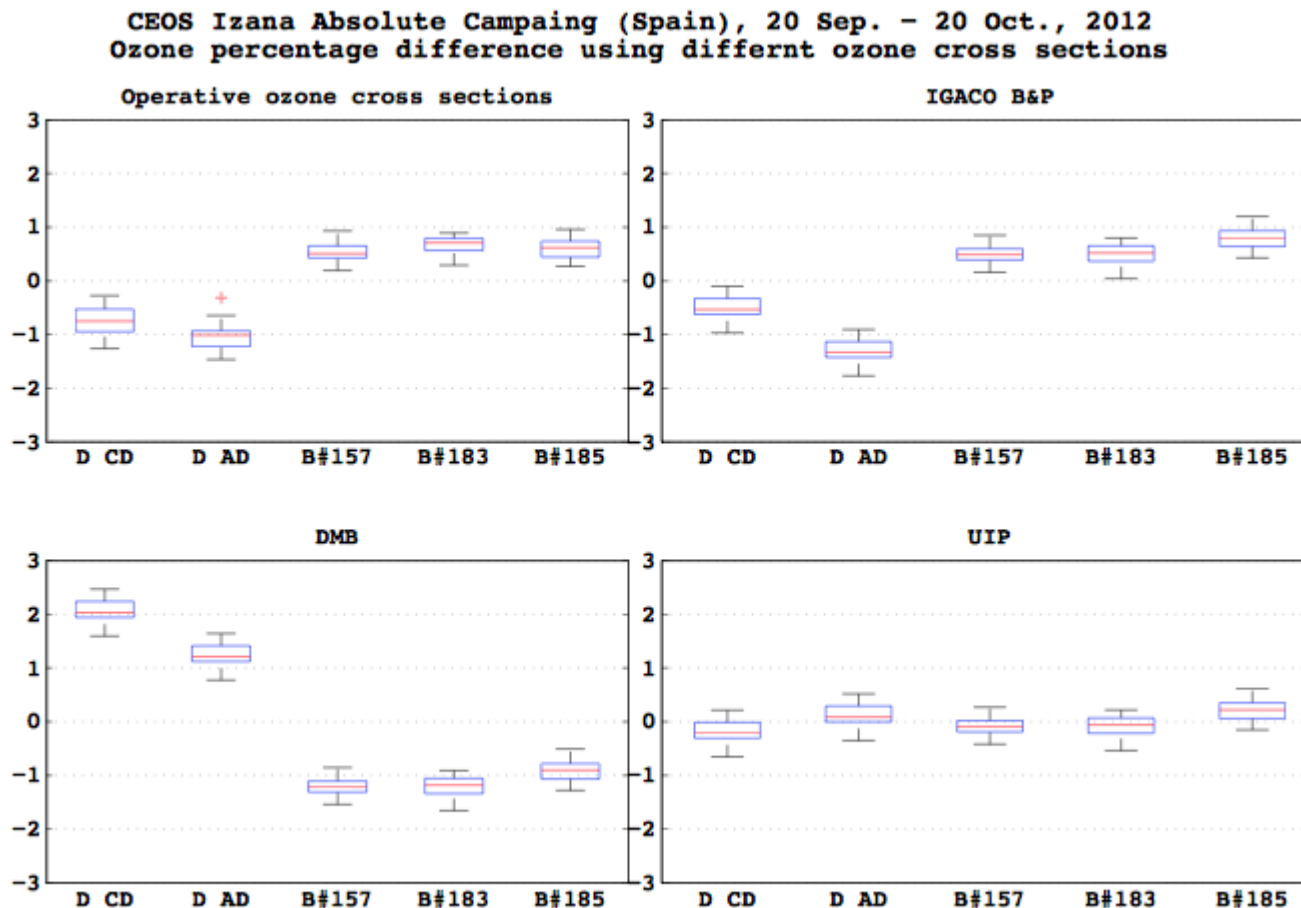
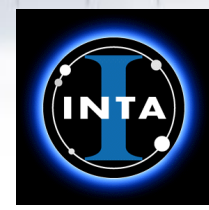


Figure 32 Boxplot of the percentage differences vs. the mean of Dobson and Brewer instruments with four cross sections: 1) Operative ozone cross section, (Bass & Paur) 2) Bass & Paur from quadratic coefficients 3) Daumont Malicet and Brion (DBM) and 4) University of Bremen (UIP)



THANKS !!



**Institute of Geophysics
Polish Academy of Sciences**



**SAPIENZA
UNIVERSITÀ DI ROMA**

