

SPAIN

OBSERVATIONAL ACTIVITIES

Continuous ozone, UV radiation and related atmospheric compounds monitoring and research is mainly conducted by the Instituto Nacional de Meteorología (INM) and the Instituto Nacional de Técnica Aeroespacial (INTA). The Departments of Physics and Meteorology of several Spanish universities do research on ozone and UV. Most of the national actions are financed by the National R+D Plan of the Ministry of Education and Science

Column measurements of ozone and other gases/variables relevant to ozone loss

The longest total ozone record in Spain (since 1980) has been obtained with the Dobson spectrophotometer #120 installed at "El Arenosillo" station (Huelva) and operated by INTA. This instrument has been used in a number of intercomparisons at Davos and is in operation at present. The latest calibration was held at Hohenpeissenberg in July 2003.

Brewer spectrophotometer national network

INM operates a national Brewer spectrophotometer network (Figure 1 and Table 1), partially financed by the National R+D Plan of the former Ministry of Science and Technology. The Brewer at the "El Arenosillo" station, financed by the Andalusian Regional Government, is managed by INTA. This network provides total ozone and spectral UV that is real-time monitored through the INM's intranet.



Figure 1: National UV broadband radiometer and spectrophotometer network.

Since November 1999 the Brewer network has performed a common measurement schedule (ozone and spectral UV) on a daily basis. This information is stored and validated in the centralized INM database.

The Network for the Detection of Stratospheric Change (NDSC) Programme at the Izaña Observatory

Since 2000/2001 the Izaña Observatory has participated in the NDSC network as a complementary station in the following four programmes:

- Total ozone with a double Brewer spectrophotometer managed by INM.
- ECC ozonesonde programme operated by INM.
- UV-VIS: A photodiode array Spectrograph from INTA has been running at Izaña since December 1998. This instrument is able to measure total columns of O₃, NO₂ and H₂O. Retrievals of Iodine monoxide (IO) are being explored to detect whether or not this radical is in measurable magnitudes in the atmosphere outside of the boundary layer. A new UV photodiode array spectrograph from INTA was installed at the Izaña Observatory in November 2001 to expand the capabilities of the previous ones to BrO. Bromine has 50 times more Ozone Depletion Potential (ODP) than Chlorine and its concentration in the atmosphere is still increasing due to Methyl Bromide (CH₃Br) and Halon emissions.
- A UV-VIS (DOAS) spectrometer instrument (EVA) from INTA for measuring total column NO₂ and O₃ has been operating at Izaña Observatory since 1993.
- FTIR: since February 1999 a ground-based FTIR (Fourier Transform InfraRed) spectrometer (Bruker IFS 120 M) is operated at the Izaña Observatory by the Institut für Meteorologie und Klimaforschung (IMK) (Forschungszentrum Karlsruhe, Germany). Besides zenith column amounts (ZCA) of trace gases such as O₃, H₂O, HDO, N₂O, CH₄, HF, HCl, ClONO₂, NO, NO₂, and HNO₃, profiles of gases with narrow absorption lines such as O₃, NO, HCl and HF can be retrieved. In March 2005 a new FTIR spectrometer has been installed at Izaña Observatory.

Table 1: National Brewer Spectrophotometer network.

Station	Location	Instrument	Institution	Since	Last calibration
A Coruña	43°N 8°W	Brewer MK-IV #151	INM	Oct 1998	September 2003
Zaragoza	42°N 1°W	Brewer MK-IV #166	INM	Nov 1998 (#033) Nov 1999 (#166)	September 2003
Madrid	40°N 4°W	Brewer MK-IV #70	INM	1988 (#033) May 1992 (#070)	September 2003
Murcia	38°N 1°W	Brewer MK-IV #117	INM	May 1995	September 2003
El Arenosillo	37°N 6.44°W	Brewer MK-III #150	INTA	June 1997	September 2003
Izaña	28°N 16°W 2400 m a.s.l.	Brewer MK-III #157	INM	May 1992 (#033)	September 2004
		Brewer MK-III # 183	INM	July 1998 (#157) August 1995	September 2004
		Brewer MK-III # 185	INM	March 2005	---
Santa Cruz Tenerife	28°N 16°W Sea level	Brewer MK-II #033	INM	Oct 2000	September 2004

The Antarctic UV-VIS network

In the framework of several projects financed in previous convocations of the National R+D Plan of the Ministry of Science and Technology, three UV-VIS spectrometers (EVA) designed and developed at INTA to measure column NO₂ and O₃ were installed at the permanent Argentinean bases of Belgrano (77° 52' S 34°37' W), Marambio (64° 14' S 56°37' W) and Ushuaia (54° 48' S 68°19' W), respectively, in 1994. The selected stations are scientifically interesting for the study of polar atmosphere as the southernmost, which is Belgrano, is mostly located inside the vortex, Marambio on the edge, and Ushuaia right outside the vortex. A new UV photodiode array

spectrograph from INTA has been installed in October 2002 in Marambio (Antarctica) to retrieve zenith column amounts of BrO, OCIO.

The main objective of this network is to provide both long term and near real-time observations of column O₃ and NO₂, in order to characterize the polar vortex. A description of the network, including instruments and stations, as well as the results of this network can be found at <http://www.inm.es/mar>

INTA's station at Keflavik (Iceland)

A long-term ozonesounding programme between INTA and IMO (Icelandic Meteorological Office) is running at the subArctic station of Keflavik (Iceland, 64°N, 22°W). Activities devoted to monitoring the ozone layer in the region of influence of the stratospheric polar vortex started in 1991 within the First Coordinated European Experiment for Ozone depletion Studies (EASOE). Since then and to date, ozonesondes have been launched during winter through a number of European projects (SESAME, OSDOC, THESEO, QUOBI, SCOUT-O3) and will continue in the near future.

Profile measurements of ozone and other gases/variables relevant to ozone loss

The ECC ozonesonde programme was initiated in November 1992 as part of the GAW programme at Izaña Observatory. The ozonesoundings are launched from Santa Cruz de Tenerife station (36 m.a.s.l.), at a distance of 28 Km from the Izaña Observatory, on a weekly basis and without any interruption since 1992. During intensive campaigns more than twenty sondes per month are launched. This is a NDSC programme. Continuous total ozone monitoring since May 1991, including two Umkehr profiles per day (since January 1992) is performed using Brewer spectrophotometers at Izaña Observatory (see Table 1).

ECC ozonesondes have been launched on a weekly basis at Madrid by INM since 1992, although with some interruption periods. INTA operates an ozonesounding facility at the El Arenosillo station with sporadic launches. Intensive campaigns, most of them financed by European projects, are frequently carried out at the El Arenosillo station.

A long-term ozonesounding programme between INTA and DNA/IAA (Argentina) has been running at the Belgrano station (Argentina, 78°S, 35°W) since 1999. Since then and to date ozonesondes have been launched through a number of Spanish (MAR and "Caracterización del vórtice Antártico y transporte meridional a partir de observaciones remotas de trazadores estratosféricos") and European projects (QUOBI).

INTA and INM have participated in previous years, and participate nowadays, through the mentioned ozonesounding stations, at Keflavik, Madrid and Tenerife in the Match Experiment coordinated by the AWI (Alfred Wegener Institute, Germany). This experiment was carried out in connection with the European projects (EASOE, SESAME (OSDOC), THESEO (O3-LOSS), EUROSOLVE). Sondes were both European and nationally financed.

UV measurements

Broadband measurements

A national UVB broadband network of 17 Yes-pyranometers (Figure 1), managed by INM, has been fully operational since July 1999. This network has been partially financed by the National R+D Plan.

The group of photobiology and algae biotechnology of the Ecology Department at Malaga University manages the "UVIFAN" UV network, based on broadband Eldonet (European Light Dosimeter Network) radiometers, in the Andalusia region. This network has been financed by the

EC FEDER 1FD97-0824 Project. Detailed information of this network can be found at <http://uvifan.scai.uma.es/>

INTA is collaborating with the Institute of Aerospace Medicine from DLR on solar UV dosimetry by biological sensors (biofilms @). The collaboration covers the measurement campaigns at different locations in Spanish and German territory and the improvement of data analysis (image treatments, unattended exposure devices, etc).

Narrowband filter instruments

Three multi-channel narrow-band radiometers (NILU-UV6) were installed by INM in the UV-VIS Antarctic stations (see section 1.1.3) in 1999, thanks to the existent agreements of scientific collaboration between INTA, INM, Dirección Nacional del Antártico (DNA/IAA) and Centro Austral de Investigaciones Científicas (CADIC, Argentina). A fourth NILUT-UV-6 runs on a continuous basis at the GAW Izaña Observatory. The NILU-UV6 instruments measure global radiation at five UV channels and PAR. A radiative transfer model is used to calculate the total ozone content, cloud transmittance and the biologically effective UV doses. These instruments are part of the Spanish Antarctic network that has been coordinated in the framework of the joint INTA-INM's "MAR" (Measurement of Antarctic Radiance for monitoring the ozone layer; REN2000-0245-C02-01) and on-going EGEO ("Estudio de la GENesis del agujero de Ozono y sus implicaciones sobre la radiación UV"; Reference CGL2004-05419-C02-02ANT, financed both by the R+D National Programme.

The Finnish Meteorological Institute (FMI) is in charge of the NILU radiometers' quality assurance system performing intercomparisons twice a year with a travelling reference NILU.

The main objective of this network is to provide both long term and near real-time observations of column O₃ and UV radiation in order to characterize the polar vortex.

Spectroradiometers

UV scans every 20 minutes have been obtained at the Izaña GAW Observatory from the Brewer spectrophotometers since May 1991.

A double spectroradiometer Bentham DM-150, installed in March 1999 at the GAW Izaña Observatory, provides global and diffused UV radiation scans every 15 minutes. This is one of the national UV reference instrument. Since June 2005 is also obtained direct sun UV scans. The Department of the Fundamental Physics of La Laguna University, in collaboration with INM, operates a double Bentham DM-150 spectroradiometer at the Izaña Observatory headquarters (SCO; sea level) in Tenerife. A comparison of the UV and visible spectra obtained from this spectroradiometer with those obtained at the Izaña Observatory (2400 m a.s.l.) have been used to study the connection between UV radiation and radiative properties of the atmospheric aerosols and clouds.

Episodic UV spectra are obtained by the Universities of Barcelona (Bentham DM-300), Valencia (Optronics and LICOR), Valladolid (LICOR) and la Laguna (Bentham and Optronics). Most of the measurements are used in investigations concerning the relationship between aerosol optical depth and spectral UV radiation.

Calibration activities

The WMO/GAW Regional Brewer Calibration Centre for RA-VI region (RBCC-E)

In November 2003 the WMO/GAW Regional Brewer Calibration Centre for RA-VI region (RBCC-E) was established at Izaña Observatory (IZO) at Tenerife (Canary Islands). The project is also intended to contribute to the GAW Programme in the RA-VI Region as a part of the closer co-

operation between WMO and the European Commission being stated in the Memorandum of Understanding signed by WMO and EC in December 2003.

IZO is located in subtropical region (28°N) on the top of Izaña Mountain (2370 m.a.s.l.) with pristine skies and low ozone variability. This location allows routine absolute calibrations of the references in similar conditions to the Mauna Loa Observatory (MLO) site.

The RBCC-E reference is based on three double Mark-III Brewer spectroradiometers (the IZO triad): a Regional Primary Reference (B157), a Regional Secondary Reference (B185) and a Regional Travelling Reference (B183). The IZO triad is regularly sun calibrated by means of Langley method and by external lamps. The travelling reference ensures reference transference to the WMO-Region VI Brewer network.

Though B157, B183 and B185 are routinely calibrated by Langley plots method, these absolute calibrations are not used for definition of a new calibration scale. The MSC triad is respected as the official reference of the GAW Brewer international scale. The establishment of the IZO triad allows the implementation of a self-sufficient European Brewer calibration system that respects the world scale but works as independent GAW infrastructure. The IZO triad is linked to the world reference MSC triad with yearly calibrations towards the Canadian travelling reference B017. Systematic extraterrestrial constants (ETC) have been obtained by Langley method with B157 from 1998 to 2002. A comparison against ETCs transferred by travelling B017 shows an agreement within 1% in this period. This excellent result means, first of all, that IZO is an excellent site to assure independent absolute sun calibration for the Brewer network, and secondly that the process based on ETC transfer from MSC triad to the world Brewer network through the travelling reference B017, is very accurate.

The function of RBCC-E also allows development and testing of new measurement techniques for the ground Brewer network like zenith, polarimetric, UV or aerosol optical depth measurements at IZO. A dark room and an electronic workshop are available at IZO for accurate fittings and indoors calibration and maintenance of the triad instruments.

Total ozone calibrations

The Brewers (#033 and #157) at the Izaña Observatory have been intercompared with the international travelling reference Brewer#17 every year since 1991. The Brewer#17 is routinely calibrated against the World triad (Meteorological Service of Canada). Other Brewers of the network are intercompared and calibrated every two years. Last three intercomparisons were held at the El Arenosillo station in September 1999, September 2001 and September 2003 (see Table 1).

Spectral UV calibrations

Spectral UV Quality Control (QC) consists of 50W lamp tests at each station performed every 2 weeks. Spectral UV Quality Assurance (QA) is carried out every year using a portable 1000W lamp calibration system designed by Int'l Ozone Services Inc. (IOS, Canada). Primary standard lamps (NIST traceable) are located at the optical lab of the Izaña Observatory. Before and after the national calibration trip 1000W secondary standard lamps are calibrated against the primary ones.

UV Broadband instrument calibrations

A primary reference UV pyranometer, located at the Izaña Observatory, and a secondary portable reference UV pyranometer are kept just for the broadband UV network tests. The primary reference instrument participated in a broadband UV detector intercomparison organised by the LAP (Laboratory of Atmospheric Physics) of the Aristotle University of Thessaloniki (Greece) in September 1999. This intercomparison, carried out within the scope of the COST 713 action on "UV-B forecasting", hosted a total of 33 UV broadband detectors from 14 countries.

Comparisons of these pyranometers with double Brewer and Bentham spectroradiometers have been performed at the Izaña Observatory and at the El Arenosillo station.

Three national UV and visible spectroradiometer intercomparisons were held at the El Arenosillo station (INTA) in September 1999, September 2001 and September 2003, respectively. Solar measurements and lamp calibrations were performed.

RESULTS FROM OBSERVATIONS AND ANALYSIS

A total ozone climatology and trend analysis has been performed by INM for each ozone station in Spain, as well as a comparison with overpass TOMS data.

Annual and diurnal UV index variations have been calculated for each capital of province.

Continuous comparison during the life of the satellite with the ground-based NDSC instruments in Izaña has been performed. Up to now only O₃ and NO₂ columns have been intercompared. BrO measurements comparison will be started during the year 2005.

Scientific results from Observations have been published in SCI papers (see section 4.3).

THEORY, MODELLING, AND OTHER RESEARCH

In accordance with the COST-713 action ("UV-B prediction") of the European Commission a H+24 forecasting model of UVI for Spain has been implemented by INM. This model has a resolution of 5'x5' on a geographical domain bounded by 45°N/15°W and 25°N/5°E. The ozone prediction is based on a regression model, and the UVA-GOA radiative model from Valladolid University is used for UVI calculation. A parameterized cloud modification factor has been also included using the cloud forecasts provided by the ECMWF. Validation of forecasted ozone and UVI is routinely validated using the Brewer and the UV broadband national networks.

The daily maximum forecasted UVI up to 72 h for more than 8000 towns in Spain, as well as the daily variation of UVI under clear skies (up to 48 h) for the province capitals of Spain are reported by internet: <http://www.inm.es/web/infmet/predi/ulvip.html>

Departments of several universities are carrying out observations and studies regarding solar UV radiation and related atmospheric components. A summary of the activities performed by the Spanish universities is as follows:

- The Department of Optics and Applied Physics of Valladolid University is working on aerosol optical depth (AOD) characterization, including the UV range.
- The Department of Astronomy and Meteorology at Barcelona University has been taking sporadic measurements of UV and visible spectrum for the last nine years using a LI-COR 1800 spectroradiometer and now with a Bentham DM300 spectroradiometer. This group has also measured UV AOD. Work has also been done on simulation modelling using different radiative transfer codes.
- The Department of Thermodynamics at Valencia University is working on the aerosol observations and validating different radiative transfer codes.
- The Department of Applied Thermodynamics at Valencia Polytechnic University has been carrying out continuous measurements of UV with an Eppley radiometer since 1995.
- The Department of Fundamental and Experimental Physics at La Laguna University is working on aerosol characterization and its relationship with spectral UV radiation.
- The Atmospheric Physics Group at Granada University is working on solar radiation, remote sensing and aerosol characterization.
- The Department of Agriculture and Food at La Rioja University has been studying the effects of UV-B radiation on mountain aquatic bryophytes in their natural surroundings and has evaluated their use as bio-indicators.

DISSEMINATION OF RESULTS

Data reporting

The web-based “Iberonesia” data managing interface (www.iberonesia.com) provides near-real time ozone and UV information of the eight instruments of the national Brewer spectrophotometer network. Three Brewers from Portugal and one from Casablanca (Morocco) have been incorporated into this network. The information is stored and validated automatically.

Total ozone daily means are submitted on a daily basis daily to the WMO Northern Hemisphere Daily Ozone Mapping Centre run by the Laboratory of Atmospheric Physics at the Aristotle University of Thessaloniki (Greece) and to the WOUDC.

Evaluated and refined total ozone data from Madrid, Murcia, El Arenosillo, Santa Cruz de Tenerife and Izaña stations are periodically submitted to the WOUDC database.

Concerning global UV, data from each station is submitted daily to the INM's central database. The UV index (UVI) is disseminated by Internet (www.inm.es/web/infmet/tobsr/ulvio/PRIMERA.html). Ozone soundings from Keflavik/Iceland are posted in real time in the joined IMO-INTA web page: <http://grenjandi.vedur.is:8080/ozone/>. Information of the ozone&UV Antarctic project, including total column NO₂ for the three stations and ozone vertical profiles over Belgrano station are disseminated through www.inm.es/mar.

Table 2: Data reporting for total ozone (Revised on July 25, 2005).

Brewer Station	Institution	Earliest data / Last updated WOUDC	Earliest data / Last updated NDSC
A Coruña	INM	No data	Not NDSC station
Zaragoza	INM	No data	Not NDSC station
Madrid	INM	1992-01-01 / 2002-08-15	Not NDSC station
Murcia	INM	1995-04-01 / 2005-04-18	Not NDSC station
El Arenosillo	INTA	1976-01-13 / 2005-05-02	Not NDSC station
Izaña	INM	1991-04-01 / 2003-08-12	1991-05-01/ 2004-08-01
Santa Cruz Tenerife	INM	1996-01-03 / 2003-06-09	Not NDSC station

Table 3: Data reporting for ECC ozonesonde (Revised on July 25, 2005).

Ozonesonde Station	Institution	Earliest data / Last updated WOUDC	Earliest data / Last updated NDSC	Earliest data/ Last Updated NILU
Madrid	INM	No Data	Not NDSC	
Santa Cruz Tenerife	INM	1996-01-03 / 2003-06-09	1996-01-03 / 2004-08-28	
Belgrano II	INTA		Not NDSC	1999-03.01/ 2005-06-01
Keflavik	INTA		Not NDSC	1991-11-01/ 2005-03-30

Table 4: Data reporting for UV-VIS and FTIR programmes (Revised on July 25, 2005).

Station	Institution	Earliest data/ Last updated NDSC. Also at ENVISAT CAL/VAL database
Izaña (UV-VIS)	INTA-INM	2000-01-01 / 2005-06-01
Izaña (FTIR)	Institut für Meteorologie und Klimaforschung (IMK; Forschungszentrum Karlsruhe, Germany) and INM	1999-02-01 / 2002-12-31

Information to the public

Ozone data over Antarctica are sent to the WMO in almost real time as contribution to the reports on the evolution of the Ozone hole.

The daily maximum forecasted UVI up to 72 h for more than 8000 towns in Spain, as well as the daily variation of UVI under clear skies (up to 48 h) for the province capitals of Spain are reported by internet: <http://www.inm.es/web/infmet/predi/ulvip.html>.

As part of the activities performed by Spain in the framework of the COST 713 Action "UVB forecasting", a "UV-Index for the Public" booklet (in Spanish) has been adapted and expanded with some examples for the Canary Islands region by INM. A printed version of this booklet has been published in collaboration with the Dermatology Department at La Laguna University Hospital of Tenerife (HUC) and the pharmaceutical associations of the Canary Islands.

A second printed booklet entitled "Índice UV para la población" was published in June 2002 by the Health Ministry and the Environment Ministry. The booklet can be seen as a web page at www.inm.es/uvi.

Relevant scientific papers (since 2000)

- Bais, A.F., B.G. Gardiner, H. Slaper, M. Blumthaler, G. Bernhard, R. McKenzie, A.R. Webb, G. Seckmeyer, B. Kjelstad, T. Koskela, P.J. Kirsch, J. Gröbner, J.B. Kerr, S. Kazadzis, K. Leszczynski, D. Wardle, W. Josefsson, C. Brogniez, D. Gillotay, H. Reinen, P. Weihs, T. Svenoe, P. Eriksen, F. Kuik, A. Redondas (2001), SUSPEN intercomparison of ultraviolet spectroradiometers, *J. Geophys. Res.*, 106, D12, 12509-12525.
- Bhosale, C.S., G.S. Meena, A.L. Londhe, D. B. Jadhav, O. Puentedura and M. Gil (2004), Variations of O₃, NO₂, and O₄ densities in association with NAO indices during winter/spring of 1993/94 and 1994/95 at sub-Arctic station, *Indian J. of Radio&Space Phys.*, V33, 104-114.
- Blumenstock, T., A. Griesfeller, F. Hase, M. Scheneider, M. Gil, J.R. Moreta, U. Raffalski, U. Friess, G. Schwartz and E. Cuevas (2003), Validation of MIPAS and SCIAMACHY data by ground-based spectroscopy at Kiruna, Sweden and Izaña, Tenerife Island (AO-191) First ENVISAT Validation Workshop, ESA/ESRIN, Italy, 9-13 Dec. 2002, ESA SP-531.
- Blumenstock, T., S. Mikuteit, A. Griesfeller, F. Hase, G. Kopp, I. Kramer, M. Schneider, H. Fischer, M. Gil, J. R. Moreta, M. Navarro Coma, U. Raffalski, E. Cuevas, B. Dix & G. Schwarz, Validation of MIPAS and SCIAMACHY Data by Ground-based Spectroscopy at Kiruna, Sweden, and Izana, Tenerife island (aoid-191), *Proceedings of the Second Workshop on the Atmospheric Chemistry Validation on ENVISAT (ACVE-2)*, 3-7 May, 2004.ESA-ERINS, Frascati, Italy, 2004.
- Braathen, G., M. Mueller, B.M. Sinnhuber, M. Chipperfield, P. von der Gathen, E. Kyro, I.E. Mikkelsen, V. Dorokhov, H. Fast and C. Parrondo (2003), Quantifying the chemical ozone loss in the polar vortex during the fifteen years from 1988-89 to 2002-2003, *EGS-AGU-EUG Joint Assembly*, (Nice, France, 6-11 April, 2003).
- Carreño, V., E. Cuevas, and A. Redondas, and V. Cachorro, The INM's Ultraviolet Index forecasting model for Spain, *Sixth European Symposium on Stratospheric Ozone*, Göteborg, Sweden, September 2 - 6, 2002.
- Carreño, V., A. Redondas, and E. Cuevas, Validation and new parametrisations in the INM's Ultraviolet Index forecasting model for Spain, *Sixth European Symposium on Stratospheric Ozone*, Göteborg, Sweden, September 2 - 6, 2002.
- De Backer, H., K. Peter, A. Bais, X. de Cabo, T. Frei, D. Gillotay, Ch. Haite, A. Heikkilä, A. Kazantzidis, T. Koskela, E. Kyrö, B. Lapeta, J. Lorente, K. Masson, B. Mayer, H. Plets, A. Redondas, A. Renaud, G. Schaubberger, A. Schmalwiesser, H. Schwander, K. Vanicek, Karl (2001), Comparison of measured and modelled UV indices for the assessment of health Risks, *Meteorological Applications* vol 8(3), 267-277.
- Cuevas, E., M. Gil, J. Rodríguez, M. Navarro, and P. Hoinka (2001), Sea-land total ozone differences from TOMS: The GHOST effect, *J. Geophys. Res.*, Vol. 106, D21, p.p. 27745-27755.
- Díaz, J.P., F.J. Expósito, C.J. Torres, V. Carreño, A. Redondas (2000), Simulations of the mineral dust effect on the UV radiation levels, *J. of Geophys. Res.*, 105, D4, 4979-4992.

- Díaz, J. P., F. Expósito, C.J. Torres, F. Herrera, J.M. Prospero, M.C. Romero (2001), Radiative properties of aerosols in Saharan dust outbreaks using ground-based and satellite data: Applications to radiative forcing, *J. Geophys. Res.* Vol. 106, No. D16, p. 18,403.
- Gil, M., O. Puentedura, M. Yela, E. Cuevas (2000): Observations of NO₂ and O₃ columns by visible spectroscopy during the eclipse of February 26, 1998, *J. Geophys. Res.*, Vol. 105, No. D3, p. 3583.
- Gil, M., O. Puentedura and M. Yela (2002), Measurements of the BrO column at the Northern Subtropics, *Sixth European Symposium on Stratospheric Ozone (Göteborg, Sweden, 2 - 6 September, 2002)*.
- Gil, M., C. Parrondo, M. Navarro, E. Cuevas, A. Redondas, J.L. Camacho, A. Labajo, D. S. Balís, C. S. Zerefos, Extreme Low Ozone events during the 2003/2004 winter, *Proceedings of the Quadrennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) – ORA/PRO 302*.
- Gil, M., M. Yela, M. Navarro, and E. Cuevas, NO₂ diurnal variability at Izaña Observatory, *Proceedings of the Quadrennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) – POS/PRO 384*.
- Gómez, I, A. Labajo and J.L. Camacho (2005), "Analysis of stratospheric ozone over Iberian Peninsula". *EGU General Assembly, Vienna, 24-29 April 2005*.
- Gröbner, J., Vergaz, R., Cachorro, V.E., Henriques, D.V., Lamb, K., Redondas, A., Vilaplana, J.M. y D. Rembes, (2001), Intercomparison of aerosol optical depth measurements in the UVB using Brewer spectrophotometers and a Li-Cor spectrophotometer. *Geophysical Research Letters*, Vol. 28, 9, 1691-1694.
- Hase, F., T. Blumenstock, M. Höpfner, M. Schneider, A. Zimmermann, D. Yashcov, E. Cuevas, and Y. Kondo, Trace Gas Profiles from Ground Based FTIR Observations: Estimation of Error Budget, *NDSC 2001 Symposium, Arcachon, France, 24-27 September, 2001*.
- Horvath, H., Alados-Arboledas, L., Olmo, F.J., Jovanovic, O, Gangl, M., Kaller, W., S., Sánchez, C., Saurzopf, H. y Seidl, S. 2002. Optical Characteristics of the Aerosol in Austria and Spain and its effect on radiative forcing. *Journal of Geophysical Research*, 107 D 19 DOI: 10.1029/2001JD001472.
- INM, *The First Iberian UV-Visible instruments intercomparison: Final Report*, Edited by A. Labajo, E. Cuevas and B. de la Morena, ISBN: 84-8320-274-3, 114 pp, Ministerio de Medio Ambiente, January 2004.
- Kentarchos, A., G.J. Roelofs, J. Lelieveld, E. Cuevas (2000): On the origin of elevated surface ozone concentrations at Izaña Observatory during the last days of March 1996: a model study, *Geophys. Res. Lett.*, Vol. 27, 22, 3699-3702.
- Lait, L.R., P.A. Newman, M. Schoeberl, T. Mcgee, L. Twigg, E. Browell, R. Bevilacqua, S. B., Andersen, H. de Backer, A. Benesova, P. Skrivankova, J. Davies, H. Claude, E. Kyro, R. Kivi, M. Gil, M. Gerding, L. Zenobia, D. Moore, G. Braathen, V. Dorokhov and I. Zaitcev (2004), Non-coincident inter-instrument comparison of ozone measurements using quasi-conservative coordinates, *Atmospheric Chemistry and Physics* 4, 2345-2352.
- Lakkala, K., A. Redondas, T. Koskela, P. Taalas, C. Torres, E. Cuevas, G. Deferrari (2002), Quality assurance of a solar UV network in the Antarctic. *27th General Assembly of the European Geophysical Society, Nice, France, 21-26 April, 2002*.
- Lambert, J-C, J. Granville, M. Allart, T. Blumenstock, T. Coosemans, M. de Maziere, U. Friess, M. Gil, F. Goutail, D.V. Ikonov, I. Kostadinov, E. Kyro, A. Petritoli, A. Piters, A. Richter, H.K. Roscoe, H. Schets, J. D. Shanklin, V. T. Soebijanta, T. Suortti, M. van Roozendaal and C. Varotsos (2003), *Ground-Based Intercomparison of early Sciamachy O₃ and NO₂ columns First ENVISAT Validation Workshop, ESA/ESRIN, Italy, 9-13 Dec. 2002, ESA SP-531*.
- Lambert, J.-C., J. Granville, T. Blumenstock, F. Boersma, A. Bracher, M. De Mazière, P. Demoulin, I. De Smedt, H. Eskes, M. Gil, F. Goutail, F. Hendrick, D. V. Ikonov, P. V. Johnston, I. Kostadinov, K. Kreher, E. Kyrö, R. Martin, A. Meier, M. Navarro-Comas, A. Petritoli, J-P. Pommereau, A. Richter, H. K. Roscoe, C. Sioris, R. Sussmann, M. Van Roozendaal, T. Wagner, and S. Wood (2004), *Geophysical validation of SCIAMACHY NO₂ vertical columns: overview of early 2004 results, ESA SP531, 2004*.
- Martínez-Lozano, J.A., M.J. Marín, F. Tena, M. P. Utrillas, L. Sánchez-Munisoguren, C. González-Frías, E. Cuevas, A. Redondas, J. Lorente, X. De Cabo, V. Cachorro, R. Vergaz, A. De Frutos, J.P. Díaz, F. Expósito, B. De la Morena, and J. M. Vilaplana (2002), UV Index Experimental values During the Years 2000 and 2001 from the Spanish Broad Band UV-B Radiometric Network, *Photochemistry and Photobiology*, 76(2), 181-187.
- Martínez-Lozano, J.A., Utrillas, M.P., Pedrós, R., Tena, F., Díaz, J.P., Expósito, F.J., Lorente, J., de Cabo, X., Cachorro, V., Vergaz, R. and V. Carreño (2002): Intercomparison of spectroradiometers for global and direct solar irradiance in the visible range. *Journal of Atmospheric and Oceanic Technology* (in press).

- Masson, K., T. Koskela, P. Taalas, E. Cuevas, D. M. de la Cruz, A. Redondas (2000), *Solar UV network in Antarctica*. 25th General Assembly of the European Geophysical Society, Nica, France, 25-29 April, 2000.
- Meijer, Y.J., D.P.J. Swart, R. Koelemeijer, M. Allaart, S. Andersen, G. Bodeker, I. Boyd, G. Braathen, Y. Calisesi, H. Claude, V. Dorokhov, P. Von der Gateen, M. Gil, S. Godin.-Beekmann, F. Goutail, G. Hansen, A. Karpetchko, P. Keckhut, H. Kelder, B. Kois, R. Koopman, J.-C. Lambert, T. Leblanc, I.S: McDermid, S. Pal, U. Raffalski, H. Schets, R. Stubi, T. Suortti, G. Visconti and M. Yela (2004), *Pole-to-pole validation of Envisat GOMOS ozone profiles using data from ground-based and balloon sonde measurements*, *J. Geophys. Res.*, 109, D23305, doi: 10.1029/2004JD004834.
- Meinander, O., K. Lakkala, A. Redondas, C. Torres, E. Cuevas, G. Deferrari, T. Koskela and P. Taalas, *Travelling reference NILU-UV at the Antarctic region: solar UV comparisons at Ushuaia and Marambio in 2002*, *Proceedings EGS-AGU-EUG Joint Assembly, Nice, France, 6 - 11 April, 2003*.
- Meinander, O., Koskela, T., Lakkala, K., Redondas, A., Torres, C., Cuevas, E., Deferrari, G., Gröbner, J. (2004), *Antarctic NILU-UV Network Linked to QASUME and NSF Irradiance Scales*, *Proceedings of the Quadriennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) - ORA/PRO 65061*.
- Oltmans S., A. Lefohn, J. Harris, H.-E. Scheel, E. Brunke, H. Claude, D. Tarasick, I. Galbally, G. Bodeker, E. Cuevas, P. Simmonds, T. Fujimoto, K. Anlauf, S. Nichol, J. Davies, K. Hayden, K. Akagi, B. Johnson, C. Meyer, F. Schmidlin, D. Shadwick (2005), *Trends in Tropospheric Ozone*, *Proceedings of the Quadriennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) - POS/PRO 339*.
- Parrondo, C., M. Yela, J. Araujo, M. Chipperfield, M. Gil. *Ozone loss rates in the lower stratosphere over Belgrano, Antarctica (78°S, 35°W) from 1999-2001 as obtained by ozonesondes: comparison with the SLIMCAT model*. *Air Pollution Report 79, EUR 20650, pp 353-357, 2002*
- Parrondo, C., M. Yela, J. Araujo, M. Chipperfield, M. Gil (2002), *Ozone loss rates in the lower stratosphere over Belgrano, Antarctica (78°S, 35° W) from 1999-2001 as obtained by ozonesondes: comparison with the SLIMCAT model* *Sixth European Symposium on Stratospheric Ozone (Göteborg, Sweden, 2 - 6 September, 2002)*.
- Parrondo M.C., M.Yela, M. Gil and J. Araujo (2004), *Fast increase in ozone during the 2002 major warming as observed by ozonesondes located at the vortex splitting point*, *Proceedings of the Quadriennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) - POS/PRO 133*.
- Puentedura, O, M. Gil, M. Navarro, F.Hendrick, M, Chipperfield, and E. Cuevas, *An estimation of the Bromine Monoxide content in the free troposphere of north subtropical regions*, *Proceedings IAMAS 2005, August 2-11, 2005, Beijing, China*.
- Randall, C.E.; D. W. Rusch, R.M. Bevilacqua, K.W. Hoppel, J.D. Lumpe, E. Shettle, E. Thompson, L. Deaver, J. Zawodny, E. Kyro, B. Johnson, H. Kelder, V.M. Dorokhov, P. von der Gathen, G. Koning-Langlo and M. Gil (2003), *Validation of POAM III Ozone: Comparisons with Ozonesonde and satellite data*, *J. Geophys. Res.* 108 (D12) 4367, doi:10.1029/2002JD002944.
- Redondas, A. (2002), *The Regional Calibration Center for Brewers Region VI (Europe)*, *7th Biennial WMO/GAW Brewer Users Group Meeting, Toronto, Canada, September 2002*.
- Redondas, A., E. Cuevas, and A. Labajo, *Management and QA/QC of the Spanish Brewer spectrophotometer Network*, *Sixth European Symposium on Stratospheric Ozone, Göteborg, Sweden, September 2 - 6, 2002*.
- Redondas, A. (2003), *The GAW- Regional Brewer Calibration System- EUROPE*, *Brewer meeting, Mazagón-Huelva, Spain, 2003*.
- Redondas, A. (2005), *Spanish, Portuguese and Moroccan Brewer spectrometer network Management and QA/QC*, *9th Biennial WMO/GAW Brewer Users Group meeting, April 31-May 2, 2005, Amsterdam. Holland*.
- Redondas, A. (2005), *Spanish Regional Brewer Calibration Center- First calibration campaign*, *9th Biennial WMO/GAW Brewer Users Group meeting, April 31-May 2, 2005, Amsterdam. Holland*.
- Roscoe, H.K., S.R. Colwell, J.D. Shanklin, J.A. Karhu, P. Taalas, M. Gil, M. Yela, S. Rodriguez, C. Rafanelli, H. Cazeneuve, C.A. Villanueva, M. Ginsburg, S.B. Diaz, R.L. de Zafra, G. Muscari, G. Redaelli, R. Dragan (2005), *Ground-based and balloon-borne measurements in Antarctic regions in support of APE-GAIA*, *Advances of Space Research, In press*.
- Rex, M., R. J. Salawich, N. R. P. Harris, P. von der Gathen, G. O. Braathen, A. Schulz, H. Deckelmann, M. Chipperfield, B.-M. Sinnhuber, E. Reimer, R. Alfier, R. Bevilacqua, K. Hoppel, M. Fromm, J. Lumpe, H. Küllmann, A. Kleinböhl, H. Bremer, M. von König, K. Künzi, D. Toohey, H. Vömel, E. Richard, K. Aikin, H. Jost, J. B. Greenblatt, M. Loewenstein, J. R. Podolske, C. R. Webster, G. J. Flesch, D. C. Scott, R.

- L. Herman, J. W. Elkins, E. A. Ray, F. L. Moore, D. F. Hurst, P. Romashkin, G. C. Toon, B. Sen, J. J. Margitan, P. Wennberg, R. Neuber, M. Allart, B. R. Bojkov, H. Claude, J. Davies, W. Davies, H. De Backer, H. Dier, V. Dorokhov, H. Fast, Y. Kondo, E. Kyrö, Z. Litynska, I. S. Mikkelsen, M. J. Molyneux, E. Moran, T. Nagai, H. Nakane, C. Parrondo, F. Ravegnani, P. Skrivankova, P. Viatte, and V. Yushkov (2002), *Chemical depletion of Arctic ozone in winter 1999/2000*, *J. Geophys. Res.*, 10.1029/2001JD000533.
- Schneider, M., T. Blumenstock, M. Chipperfield, F. Hase, W. Kouker, T. Reddmann, R. Ruhnke, E. Cuevas, and H. Fischer (2004), *Subtropical trace gas profiles determined by ground-based FTIR spectroscopy at Izaña (28°N, 16°W): Five year record, error analysis, and comparison with 3D-CTMs*, *Atmos. Chem. Phys.*.
- Schneider, M., T. Blumenstock, F. Hase, M. Höpfner, E. Cuevas, A. Redondas, and J. Sancho, *Ozone Profiles and Total Column Amounts derived at Izaña, Tenerife Island, from FTIR Solar Absorption Spectra, and its Validation by an Intercomparison to ECC-sonde and Brewer Spectrometer Measurements*, *J. of Quantitative Spectroscopy & Radiative Transfer*, 91, 245-274, Elsevier, 2005.
- Schneider, M., T. Blumenstock, F. Hase, M. Höpfner, E. Cuevas, A. Redondas, J. M. Sancho, *Ozone Profiles and Total Column Amounts derived at Izaña, Tenerife Island, from FTIR Solar Absorption Spectra, and its Validation by an Intercomparison to ECC-Sonde and Brewer Spectrometer Measurements*, *JQSRT-Elsevier*, in Press.
- Streibel, M., P. von der Gathen, M. Rex, H. Deckelmann, N.R.P. Harris, G.O. Braathen, M.P. Chipperfield, G. Millard, E. Reimer, R. Alfier, M. Allaart, S.B. Andersen, J. Araujo, D. Balis, O. Billett, C. Cambridge, H. Claude, S.R., Colwell, J. Davies, H. De Backer, T. Deshler, H. Dier, V. Dorokhov, J. Easson, H. Fast, M. Gerding, M. Ginzburg, S. Godin Beekmann, B. Johnson, J.A. Karhu, A. Klekociuk, E. Kyrö, Z. Litynska, D. Moore, E., Moran, T. Nagai, H. Nakane, C. Parrondo, F. Ravegnani, H.K. Roscoe, K. Sato, J.D., Shanklin, P. Skrivankova, O.-P. Tripathi, C. Varotsos, C. Vialle, P. Viatte, T. Yamanouchi, M. Yela, N. Yoshizawa, V. Yushkov (2003), *C.S. Zerefos, Ozone Loss Rates over the Arctic and Antarctic Measured with the Match Approach*, *VINTERSOL/SOLVE II Meeting, Orlando, USA, October, 2003*.
- Torres, C., A. Redondas, E. Cuevas, K. Lakkala, P. Taalas, M. Yela, H. Ochoa, and G. Deferrari (2002), *"Correction and validation of total ozone data series from an Antarctic multichannel filter radiometer solar UV network"*, *27th General Assembly of the European Geophysical Society (Nice- France)*, 21 - 26 April, 2002.
- Torres, C., A. Redondas, E. Cuevas, J.P. Díaz, K. Lakkala, P. Taalas, M. Yela, H. Ochoa, G. Deferrari (2002), *Relationship between total ozone and UV dose rate provided by the NILU-UV6 Multichannel Radiometer Network at the Antarctic region. Sixth European Symposium on Stratospheric Ozone*, Göteborg, Sweden, 2-6 September, 2002.
- Vandaele 2003 Vandaele, A-C, C. Fayt, F. Hendrick, C. Hermans, F. Humbled, M. Van Roozendael, M. Gil, M. Navarro, O. Puentedura, M. Yela, G. Braathen, K. Stebel, K. Tørnkvist, P. Johnston, K. Kreher, F. Goutail, A. Mieville, J-P Pommereau, S. Khaikine, A. Richter, H. Oetjen, F. Wittrock, S. Bugarski, U. Friess, K. Pfeilsticker, R. Sinreich, T. Wagner, G. Corlett and R. Leigh (2003), *A NDSC Intercomparison exercise: NO₂, BrO and OClO measurements by Ground-Based UV-Vis spectrometers at the Andoya Rocket Range, Norway (69.3°N, 16°W)*, *VINTERSOL/SOLVE II Meeting, Orlando, USA, October 2003*
- Vandaele, A.C., C. Fayt, F. Hendrick, C. Hermans, F. Humbled, M. Van Roozendael, M. Gil, M. Navarro, O. Puentedura, M. Yela, G. Braathen, K. Stebel, K. Tørnkvist, P. Johnston, K. Kreher, F. Goutail, A. Mieville, J.-P. Pommereau, S. Khaikine, A. Richter, H. Oetjen, F. Wittrock, S. Bugarski, U. Frie□, K. Pfeilsticker, R. Sinreich, T. Wagner, G. Corlett, R. Leigh, *An intercomparison campaign of ground-based UV-Visible measurements of NO₂, BrO, and OClO slant columns. I. NO₂*, In press 2005 *J. Geophys. Res-Atmosphere*.
- Vanicek, K., and E. Cuevas, *A Regional Brewer Calibration System for Total Ozone Observations in the RA-VI Region – Europe*, *GAW SAG-Ozone meeting, Toronto, September 2002*.
- Vilaplana, J.M., B.A. De la Morena, *Ozone and UV measurements at "El Arenosillo" (37.1 N-6.7 W) Spain*, *7th biennial Brewer meeting. Toronto, Canada, September 2002*.
- Yela, M., S. Rodriguez, M. Gil, R. Ozu, S. Diaz, M. Chipperfield (2000), *Seasonal evolution of NO₂ and O₃ outside, at the edge, and inside the Antarctic polar vortex comparison with the SLIMCAT model*, 2° SPARC General Assembly, Mar de Plata 2000.
- Yela, M., S. Rodriguez, M. Gil, M.P. Chipperfield, C. Parrondo, R. Ozu (2000). *NO₂ and O₃ in the core of the Antarctic vortex: Observations and modelling at Belgrano station. International Quadrennial Ozone Symposium, Sapporo, Japón, 3-8 Julio, 2000*.

- Yela, M., C. Parrondo, S. Rodríguez, M. Gil, J. Araujo, H. Ochoa, G. Deferrari y S. Díaz (2003), *The 2002 Antarctic vortex splitting as observed by visible spectroscopy and ozonesoundings*, EGS-AGU-EUG Joint Assembly, Niza, 2003.
- Yela M., Gil M., Rodríguez S., Araujo J., Díaz S., Deferrari G. (2005), *Unusual behaviour of stratospheric NO₂ and ozone during splitting vortex event in the Antarctic winter 2002: Comparison with a 10-years NO₂ climatology at three Antarctic and sub Antarctic sites*, *Proceedings of the Quadriennial Ozone Symposium, IOC, EC, 1-8 June 2004, Kos (EL), IOC, IAMAS (Publs.) – POS/PRO 454.*
- Yela, M., C. Parrondo, M. Gil, S. Rodríguez, J. Araujo, H. Ochoa, G. Deferrari and S. Díaz, *The September 2002 Antarctic vortex major warming as observed by visible spectroscopy and ozonesoundings*: In press 2005, *International Journal of Remote Sensing*.

PROJECTS AND COLLABORATION

INTA has participated in INOVO (INterhemispheric OCIO Polar VOrtex Variability). This is an intensive campaign to test the new high-resolution spectrograph and carry out measurements of OCIO and study the impact of high reflective surface (snowy surface) on the species retrieved during the winter of 2001 at the polar observatory of Sodankyla, Finland. The instrument was installed at Marambio Base, Antarctica in austral summer 2004. The campaign has been financed by the European Commission through the LAPBIAT infrastructure facility.

INTA and INM have participated in the STREAMER project coordinated by the DLR, Germany. It is a European project from the Earth Observation Programme devoted to forecasting ozone and UV-B in the European sector using the GOME/ESA instrument (and SCIAMACHI/ESA in ENVISAT in the future) and meteorological forecasting. The output is level – 3 products (maps) 24h forecasting of both ozone and UV-B on Internet, available to the public.

INM and INTA have actively participated in recent years in European projects related to ozone and UV research, which have recently finished or are still in progress. They are as follows:

- REVUE (Reconstruction of Vertical Ozone Distribution from Umkehr Estimates), ENV4-CT95-0161)
- TRACAS (TRANsport of Chemical species Across Subtropical tropopause) ENV4-CT97-0546.
- STREAMER (Small Scale Structure Early Warning and Monitoring in Atmospheric Ozone and Related Exposure to UV-B Radiation), ENV4-CT98-0756.
- QUILT (Quantification and Interpretation of Long Term UV-Visible Observations of the stratosphere) EVK2-CT2000-0059. Devoted to improvements of Spectroscopic data products (NO₂, O₃, BrO, OCIO, IO), Revision of the data sets, Modeling and interpretation, etc.
- QUOBI (Quantitative Understanding of Ozone Losses by Bipolar Investigations) EVK2-CT-2001-00129 (2002-2004): The main objective of the project is to test our quantitative understanding of the chemical mechanisms that destroy ozone in wintertime Arctic stratosphere and springtime Antarctic and to improve the representation of these processes in chemical models of the atmosphere.
- SCOUT-O3 (Stratospheric-Climatic Links with Emphasis on the UTLS); SCOUT-O3's aim is to provide predictions about the evolution of the coupled chemistry/climate system, with emphasis on ozone change in the lower stratosphere and the associated UV and climate impact, to provide vital information for society and policy use.

INM, INTA and the Universities of Barcelona, Valencia, Valladolid and La Laguna have participated in several large coordinated ozone&UV-related projects financed by the National R+D Plan of the Ministry of Science and Technology:

- "Measurement and Modeling for the space-time distribution of the ultraviolet solar irradiance in Spain" (CLI97-0345-C05).
- DEPRUVISE ("Determination and forecasting of solar ultraviolet Radiation in Spain: influence of ozone, aerosol particles and cloudiness"), financed by the National R+D (Climate National Programme REN2000-0903-C08-02 CLI).

- TROMPETA (“TROpical Monitoring Phase in the Atmosphere”), Reference CGL2004-03669/CLI, financed by the Diversity, Earth Sciences and Global Change R+D National Programme.
- EGEO (“Estudio de la GENesis del agujero de Ozono y sus implicaciones sobre la radiación UV”), financed by the Diversity, Earth Sciences and Global Change R+D National Programme; Reference CGL2004-05419-C02-02ANT.

The “Veleta 2002” field campaign was held in July 2002, in the framework of the DEPRUVISE project, financed by the National R+D Plan of the Ministry of Science and Technology. This field campaign has been designed to obtain experimental data of elevation effects on solar ultraviolet irradiance. For this purpose different radiometers and spectroradiometers have been installed on both slopes of the Sierra Nevada Massif. The stations cover from sea level to 3400 m a. s.l. on the top of the Veleta Peak. This information has been used to evaluate the aerosol radiative forcing on the solar UV irradiance. Several groups from the Universities of Granada, Barcelona, Valencia, Valladolid, Malaga and La Laguna, and the INTA and INM have participated in the field campaign.

STREAMER. INTA has participated in a proposal of the European GMES (Global Monitoring the Environment and Security) Programme devoted to the elaboration of H+24 UV and ozone forecasted maps above Europe and research associated to the ozone layer. The new project will focus on operational aspects regarding data management (GIS, Web, etc), climatology of ozone related species and Streamer events on a global scale based on European satellites and 3D modeling. Validation exercises will also be performed to ensure the data and model quality.

Within the framework of the QUILT project, a NDSC intercomparison was held in the winter of 2002/2003 at the polar facility of Andoya, Norway, (68°N). INTA has participated with its UV-VIS instrument. The purpose was to harmonize results and identify possible causes of discrepancy between instruments. Eleven European Institutes involved in QUILT have participated in this campaign. Unofficial comparison of BrO was carried out as well.

The effects of clouds and the cloud-sea on the spectral UV radiation has been investigated by INM and La Laguna University at the Izaña GAW observatory using radiative models (DISORT/UVSPEC) and in-situ observations made with double spectrophotometers Brewer and Bentham at sea level and 2400 m a.s.l., respectively.

Aerosol optical depth (AOD) at UV range is routinely obtained at Izaña Observatory from the Brewer spectrophotometer triad using the direct sun measurements.

Within the national R+D plan TROMPETA project, a micropulse aerosol lidar (INTA), a plane equipped with ozone and aerosol instruments, and ground-based ozone total column measurements by high quality NDSC (INM and INTA), have been used at the Izaña Observatory facilities (2400 m a.s.l. and sea level) during a heavy Saharan dust storm event was held on July 2005 to find out whether or not the retrieval of satellite operating in backscattering mode such as TOMS and GOME is severely affected by interferences from the absorbent characteristics of mineral aerosols.

INTA and INM contribute to the EU 6th framework programme SCOUT-O₃ project (2003-2007) with activities carried out in the subtropical region around the Tenerife Island. O₃, NO₂ BrO measurements will be focus around the UTLS region.

INTA participates in the TASTE project (2003-2004) funded by the ESA for official validation of O₃ and NO₂ in ENVISAT Sciamachy onboard instrument. The project has been extended two more years within the TASTE-II (2005-2006) for a continuous validation during the satellite lifetime.

Spain has endorsed the EU Action COST 723 ("The Role of the Upper Troposphere and Lower Stratosphere in Global Change"; <http://www.cost723.org/>) with two delegates from INM and INTA.

Dr E Cuevas (INM) is member of the International Ozone Commission (<http://ioc.atmos.uiuc.edu/>) and Mr A. Redondas (INM) is member of the WMO Ozone Scientific Advisory Group (<http://www.wmo.ch/web/arep/gaw/sag.html>)

FUTURE PLANS

Cosine response calibration facilities for Brewer and UV broadband radiometers will be implemented at both, El Arenosillo and Izaña facilities during 2006.

The first GAW Regional Brewer Calibration Center-Europe (RBCC-E) intercomparison campaign of Brewer spectrophotometers will be held at the "El Arenosillo" Atmospheric Sounding Station, INTA (Huelva, Spain) from 9 to 18 September 2005.

A joint collaboration of the National Institute for Aerospace Technology (INTA; Spain), The National Meteorological Institute (INM; Spain), the National Meteorological Service (SMN; Argentina) and the "Tierra del Fuego" Government (Argentina) is being managed in order to establish a permanent ozonesonde programme at the Ushuaia GAW station by the end 2005 or early 2006.

A second intensive campaign using an ozone and aerosol instrument-equipped plane, two aerosol lidars and NDSC instruments is planned to be held in Tenerife in July 2006.

NEEDS AND RECOMMENDATIONS

Satellite community should contribute to financing the ground ozone&UV observation system. Space-borne instruments must be calibrated on a continuous basis with reliable ground based instruments.

Monitoring system should pay special attention to Upper Troposphere- Lower Stratosphere (UTLS) region.

Strong efforts should be done by meteorological forecasting models to improve cloud forecasts. This is needed for a more realistic UVI prediction.
