Consiglio Nazionale delle Ricerche
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ITALIAN CLIMATE OBSERVATORY "O. VITTORI"
Mt. CIMONE
GAW-WMO Global Station

SUMMER 2014 REPORT

CNR - ISAC

National Research Council

Institute of Atmospheric Sciences and Climate

ITALY

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Earth and Environment Department
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Rete di infrastrutture per la ricerca su aerosol, nubi e gas in tracce

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SHARE
Stations at High Altitude for Research on the Environment
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WDCGG
World Data Center for Greenhouse Gases
Centro Dati Mondiale per i Gas Serra
http://ds.data.jma.go.jp/gmd/wdcgg/

WDCA
World Data Center for Aerosol
Centro Dati Mondiale per gli Aerosol
http://www.gaw-wdca.org/

MACC
Monitoring Atmospheric Composition & Climate
http://gmes-atmosphere.eu/

SDS-WAS
WMO Sand and Dust Storm Warning Advisory and Assessment System
http://sds-was.aemet.es/

AGAGE
Advanced Global Atmospheric Gases Experiment
http://agage.eas.gatech.edu/

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Foreword

This report summarizes the results concerning the atmospheric observations carried out during SUMMER 2014 at the Italian Climate Observatory "O. Vittori" (ICO-OV), managed by the Institute of Atmospheric Sciences and Climate (ISAC) of the National Research Council of Italy (CNR). This research infrastructure is part of the WMO/GAW global station of Monte Cimone together with the Meteorological Observatory of the Italian Air Force(GAW ID: CMN).

Firstly, we provide a brief description of the measurement site and running experimental programmes is given. *Results from two new measurement programmes were added in respect to the previous reports: sulphur dioxide and aerosol scattering coefficient*.

Then, an overview of the atmospheric and weather conditions during summer 2014 is provided, by considering:

- **surface ozone**
- **carbon monoxide**
- **nitrogen oxides**
- **sulphur dioxide**
- **black carbon**
- **aerosol scattering coefficient**
- **fine and coarse particles**
- **halogenated gases**
- **volatile organic compounds**
- **stratospheric nitrogen dioxide**
- **meteorological data (temperature, relative humidity, pressure, wind speed and direction)**
- **solar radiation and UV-B**

For each atmospheric parameter, we provide basic statistical information (minimum, maximum and average values) together with a comparison with the climatological reference for Mt. Cimone.

Then, a list of special events is also presented, together with a description of the adopted selection methodologies:

- **pollution transport**
- **mineral dust transport**
- **transport of air-masses from the stratosphere**

For each observed parameter, a specific paragraph presents:

- **the time series of the daily mean values (calculated basing on 30-minute aggregated values, if the daily data coverage of 75% has been achieved)**
- **a table reporting the basic statistical parameters (on a 30-minute basis)**
- **a comparison with the seasonal historical mean values: for each year, the summer mean values are calculated by averaging data from 2014, June 1st to August 31th.**

Premessa

Questo rapporto riassume i risultati relativi alle osservazioni atmosferiche effettuate durante l'ESTATE 2014 presso l'Osservatorio Climatico "O. Vittori " (ICO-OV) dell'Istituto di Scienze dell'Atmosfera e del Clima (ISAC) del Consiglio Nazionale delle Ricerche Italia (CNR). Questa stazione di ricerca è parte, insieme all'Osservatorio Meteorologico dell'Aeronautica Militare, della stazione globale WMO/GAW di Monte Cimone (GAW ID: CMN).

In questo Report viene innanzitutto fornita una breve descrizione del sito di misura e dei programmi di ricerca in atto. A partire da questo report, sono considerati due nuovi programmi di misura: l'anidride solforosa ed il coefficiente di scattering dell'aerosol.

Quindi viene data una panoramica delle condizioni atmosferiche e meteorologiche che hanno caratterizzato il periodo invernale 2014 considerando:

- **ozono superficiale**
- **monossido di carbonio**
- **ossidi di azoto**
- **anidride solforosa**
- **black carbon**
- **particolato fine e grossolano**
- **gas alogenati**
- **composti organici volatili**
- **biossido di azoto stratosferico**
- **dati meteorologici (temperatura , umidità relativa , pressione, velocità e direzione del vento)**
- **radiazione solare e UV- B**

Per ogni parametro atmosferico sono fornite informazioni statistiche di base (valori minimi, massimi e medi) ed un confronto con il riferimento climatologico dell'Osservatorio "O. Vittori" per Monte Cimone.

Successivamente viene presentata una lista di eventi "speciali" dentificati con procedure opportunamente messe a punto e descritte.

- **trasporto di masse d'aria inquinate**
- **trasporto di polvere minerale**
- **trasporto di masse d'aria dalla stratosfera**

Per ogni parametro osservato uno specifico paragrafo presenta:

- **le serie storiche dei valori medi giornalieri (calcolati basandosi su valori mediati di 30 minuti, se la copertura dei dati giornaliera del 75% è stata raggiunta)**
- **una tabella con i parametri statistici di base (su un base di 30 minuti)**
- **Il confronto con i valori medi storici stagionali per ogni anno, considerando che i valori estivi sono calcolati come media dal 1 giugno al 31 agosto 2014.**

Monte Cimone GAW/WMO Global Station

The **Global Atmosphere Watch (GAW)** programme of WMO is a partnership involving the Members of WMO, contributing networks and collaborating organizations and bodies which provides reliable scientific data and information on the chemical composition of the atmosphere, its natural and anthropogenic change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere.

A network of measurement stations is the backbone of the GAW programme. This network consists of GAW Global and Regional measurement stations with additional measurements from Contributing stations. Both Global and Regional stations are operated by their host countries, either by their National Meteorological Services or by other national scientific organizations. More than 80 countries actively host GAW stations.

Currently GAW coordinates activities and data from 29 Global stations, more than 400 Regional stations, and around 100 Contributing stations operated by Contributing networks

Location of the 29 Global Stations of the WMO/GAW programme

Mt. Cimone is the only WMO/GAW Global Station in Italy

Global station name	Altitude (a.s.l.)	Country
Assekrem/Tamanrasset	2710 m	Algeria
Izaña	2372 m	Spain
Jungfraujoch	3580 m	Switzerland
Mauna Loa,	3397 m	United States
Monte Cimone*	2165 m	Italy
Mt. Kenya	3678 m	Kenya
Mt. Waliguan	3810 m	China
Nepal Climate Observatory – Pyramid*	5079 m	Nepal
Zugspitze/ Hohenpeissenberg	2962 m	Germany

*Managed by Italian Institutions

List of GAW/WMO high altitude global station (for more information: http://gaw.empa.ch/gawsis/)

La Stazione Globale GAW/WMO di Monte Cimone

Il programma **Global Atmosphere Watch (GAW**) dell'OMM coinvolge gli Stati Membri della OMM e diverse reti osservative, organizzazioni ed Istituzioni con lo scopo di fornire dati scientifici ed informazioni attendibili sulla composizione dell'atmosfera, sui cambiamenti naturali e dovuti alle attività umane, contribuendo a migliorare la conoscenza delle interazioni fra atmosfera, oceani e biosfera.

La spina dorsale del programma GAW è costituita dalla propria rete osservativa. Essa è formata da Stazioni Globali e Regionali, oltre che da Stazioni definite "Contributing" che forniscono informazioni addizionali. Le Stazioni Globali e Regionali sono gestite dai Paesi di appartenenza, sia attraverso i Servizi Meteorologici Nazionali che gli Enti Pubblici di Ricerca. Le Stazioni GAW sono ospitate in oltre 80 Paesi del mondo.

Allo stato attuale il programma coordina 29 Stazioni Globali e oltre 400 Stazioni Regionali, oltre a 100 Stazioni "Contributing".

Dislocazione delle 29 Stazioni Globali del programma WMO/GAW

Monte Cimone è l'unica Stazione Globale WMO/GAW in Italia

Nome	Quota (s.l.m.)	Paese
Assekrem/Tamanrasset	2710 m	Algeria
Izaña	2372 m	Spagna
Jungfraujoch	3580 m	Svizzera
Mauna Loa	3397 m	USA
Monte Cimone*	2165 m	Italia
Mt. Kenya	3678 m	Kenya
Mt. Waliguan	3810 m	Cina
Nepal Climate Observatory – Pyramid*	5079 m	Nepal
Zugspitze/ Hohenpeissenberg	2962 m	Germania

*Stazioni gestite da Istituzioni Italiane

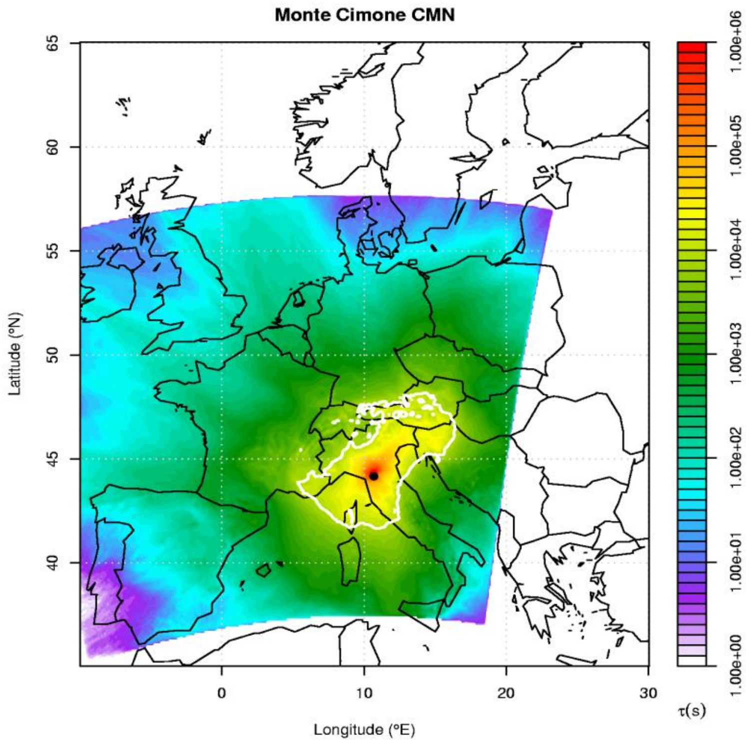
Lista delle stazioni globali GAW/WMO in aree di alta quota (for more information: http://gaw.empa.ch/gawsis/)

Geographical location

Mt. Cimone (44°12' N, 10°42' E, 2165 m a.s.l.) is the highest peak of the Northern Apennines, the border line of two different climatic regions: the continental Europe northwards and the Mediterranean Basin southwards.

The closest inhabited areas are small villages placed 15 km from and about 1100 m below the Observatory, whereas major towns (500000 inhabitants) are situated in the lowlands about 60 km away (Bologna, Firenze). The industrial areas are not closer than 40 km and 2 km lower. The closest roads with some traffic are 7 km far and 1 km lower. Forest of conifers and beech trees grow up to 1600 m, so that the Laboratory is above the timberline. Only some patches of vegetation are on the top of the mountain

Mt. Cimone is characterized by a completely free horizon for 360° and air masses originated in different areas can reach the station. In the following figure, the annual 48 hour catchment areas, (i.e. the areas from which the air masses come) is provided for ICO-OV (EU-Project GEOMON).



The catchment area of the site for the 48-hour integration time backwards in time is given by the intersection of the topography with the volume containing the largest residence time densities and comprises 50% of the total residence time.

Il "bacino di raccolta" delle masse d'aria a 48 ore è ottenuto considerando le aree geografiche sopra le quali si totalizza almeno il 50% del tempo di residenza totale delle masse d'aria durante il trasporto verso Monte Cimone.

For more information:
http://geomon.empa.ch/.

The atmospheric observations carried out at Monte Cimone can be considered representative of the free tropospheric conditions of the Mediterranean Basin/South Europe. Only during the warm periods of the year the measurement site can be affected by transport of air masses from PBL (planetary boundary layer).

Posizione geografica

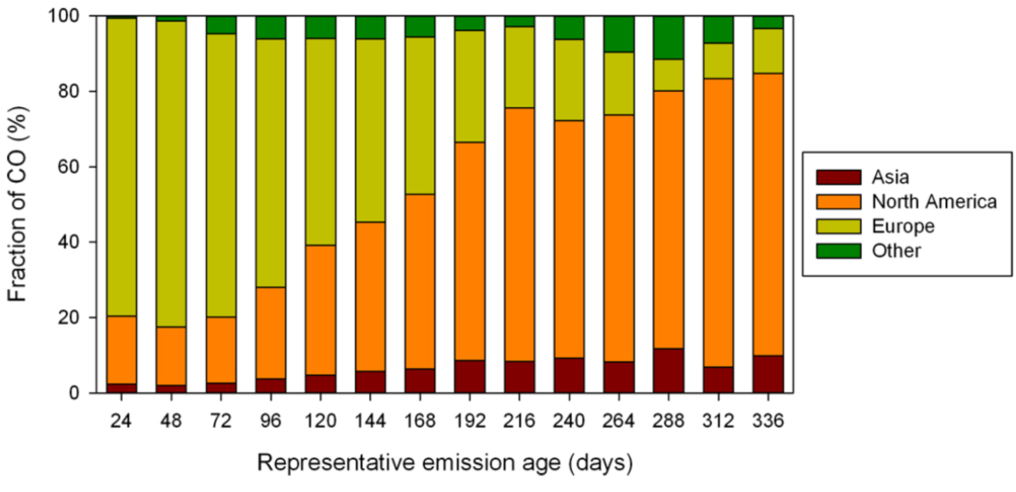
Monte Cimone (44°12' N, 10°42' E, 2165 m s.l.m.) è la cima più alta dell'Appennino Settentrionale, la linea di confine tra due diverse regioni climatiche: l'Europa continentale a Nord ed il bacino del Mediterraneo a Sud.

Le zone abitate più vicine sono piccoli paesi a circa 15 km di distanza e 1100 m di più in basso rispetto all'Osservatorio, mentre le città più grandi (Bologna, Firenze) sono situate in pianura a circa 60 km di distanza. Non vi sono importanti aree industriali nel raggio di circa 40 km. Le strade trafficate più vicine distano circa 7 km (1 km di quota più in basso). Boschi di conifere e faggi crescono fino a 1600 m. Nei pressi della cima si trovano prati e zone rocciose.

Monte Cimone è caratterizzato da un orizzonte completamente libero e quindi le masse d'aria possono raggiungere il sito di misura senza incontrare ostacoli orografici. Nella pagine precedente viene mostrata la media annuale del "bacino di raccolta" delle masse d'aria che nel giro di 48 ore sono arrivate a Mt. Cimone (EU-Project GEOMON).

An air-mass transport analysis, presented by a paper published on "Atmospheric Chemistry and Physics", assessed that when the age of anthropogenic emission increase at CMN, the contribution of pollution from very far regions (North America) become predominant.

Un'analisi presentata sul giornale "Atmospheric Chemistry and Physics", ha valutato che all'aumentare dell'età delle masse d'aria inquinate, a Monte Cimone aumenta in modo significativo l'influenza di emissioni provenienti da aree sorgenti molto distanti (es. Nord America)



Fraction of anthropogenic CO at CMN (y-axis) as a function of source regions (stacked coloured bars) and representative emission age (x-axis)/Frazione del CO di origine antropica a Monte Cimone (asse y) in funzione delle regioni di emissioni (colori delle barre) e dell'età della massa d'aria (asse x).
From Cristofanelli et al. (ACP, 2013)

Le osservazioni di composizione dell'atmosfera condotte a Monte Cimone possono essere considerate rappresentative delle condizioni di fondo della libera troposfera del bacino del Mediterraneo e del Sud Europa. Solo durante i mesi caldi, i processi convettivi possono favorire il trasporto di masse d'aria dallo strato limite planetario (PBL).

List of parameters

In the following table, we provide the list of the atmospheric parameters presented in this report, together with a brief description of their key roles in the atmospheric investigations and the experimental set-up at the ICO-OV.

Parameters	Key role	Instrumentation
Surface ozone	Short-lived climate forcer, greenhouse gas, secondary pollutant	UV-absorption analyser *(Thermo Tei 49i)*
Carbon monoxide	Primary pollutant, ozone precursor, combustion tracer	Non dispersive IR absorption *(Thermo Tei48c-TL)*
Nitrogen oxides	Primary (NO) and secondary (NO_2) pollutants, ozone precursors, combustion tracers.	Chemiluminescence analyser (*Thermo Tei42i-TL)*
Sulphur dioxide	Primary pollutant, secondary aerosol precursor, volcanic tracer.	UV-fluorescence analyser (*Thermo 43i-TLE*)
Black carbon	Short-lived climate forcer, primary pollutant, combustion tracer. It contributes to PM_1	Multi-Angle Absorption Photometer *(Thermo MAAP 5012)*
Aerosol light scattering coefficient	Investigation of the aerosol climate direct forcing	3 –wavelenghts Integrating nephelometer *(TSI 3563)*
Aerosol number concentration (fine)	Short-lived climate forcer, primary and secondary aerosol, pollution tracer. It contributes to PM_1.	Optical particle counter *(GRIMM 1108)*
Aerosol number concentration (coarse)	Short-lived climate forcer, primary aerosol, mineral dust and sea salt tracer. It contributes to PM_{10}.	Optical particle counter *(GRIMM 1108)*
Halogenated gases	Stratospheric ozone depleting substances and climate forcer	Gas chromatography-Mass spectrometry. *(Agilent 6850–5975)*
Volatile organic compounds	Ozone and PM precursors	Gas chromatography-Mass spectrometry *(Agilent 6850–5975)*
Stratospheric nitrogen dioxide	Ozone destroying substance and buffer against halogen catalysed ozone loss	GASCOD-MTC: UV-Vis spectrometer (Since 1993)
Temperature and relative humidity	Meteorology and data interpretation	*Rotronic, IRDAM WS 7000*
Atmospheric pressure	Meteorology and data interpretation	*Technoel, IRDAM WS 7000*
Wind	Meteorology and data interpretation	*Vaisala WS425, IRDAM WST7000*
Solar radiation	Meteorology and data interpretation	Silicon cell pyranometer *(Skye SKS110)*
UV-B radiation	Meteorology and data interpretation	Silicon photodiode *(Skye SKU 430)*

Lista dei parametri

Nella tabella è presentata la lista dei parametri presentati in questo report, assieme ad una breve descrizione dei ruoli nelle ricerche condotte ed il set up sperimentale utilizzato presso l'ICO-OV.

Parametri	Ruolo chiave clima – qualità dell'aria	Strumentazione
Ozono superficiale	Forzante climatico a breve tempo di vita, gas serra, inquinante secondario.	Analizzatore ad assorbimento UV *(Thermo Tei 49i)*
Monossido di carbonio	Inquinante primario, precursore dell'ozono, tracciante della combustione	Analizzatore ad assorbimento infra-rosso *(Thermo Tei48c-TL)*
Ossidi d'azoto	Inquinanti primari (NO) e secondari (NO_2), precursori dell'ozono, traccianti della combustione. In stratosfera NO_2 influenza le concentrazioni di ozono.	Analizzatore a chemiluminescenza (*Thermo Tei42i-TL)*
Anidride solforosa	Inquinante primario, precursore dell'aerosol secondario, tracciante di eruzioni vulcaniche	Analizzatore a fluorescenza UV (*Thermo Tei43i-TLE)*
Black carbon	Forzante climatico a breve tempo di vita, inquinante primario, tracciante della combustione. Contribuisce al PM_1	Fotometro per l'assorbimento multi-angolare *(Thermo MAAP 5012)*
Coefficiente di scattering delle particelle	Studio della forzante climatica diretta degli aerosol	Nefelometro a 3 lunghezze d'onda*(TSI 3563)*
Numero delle particelle fini	Forzante climatico a breve tempo di vita, aerosol primario e secondario, tracciante dell'inquinamento. Contribuisce al PM_1	Contatore ottico *(GRIMM 1108)*
Numero delle particelle grossolane	Forzante climatico a breve tempo di vita, aerosol primario, tracciante delle polveri minerali e del sale marino. Contribuisce al PM_{10}	Contatore ottico *(GRIMM 1108)*
Gas alogenati	Distruggono l'ozono stratosferico, forzanti climatici	Gas cromatografia-Spettrometria di massa *(Agilent 6850–5975)*
Composti organici volatile	Precursori dell'ozono troposferico e del PM	Gas cromatografia-Spettrometria di massa *(Agilent 6850–5975)*
Biossido di azoto stratosferico	Distrugge l'ozono stratosferico e sostanza "tampone" per alogeni attivi nella deplezione dell'ozono stratosferico	Spettrometro UV/Vis GASCOD-MTC
Temperatura ed umidità relativa	Meteorologia ed interpretazione dei dati	*Rotronic, IRDAM WS 7000*
Pressione atmosferica	Meteorologia ed interpretazione dei dati	*Technoel, IRDAM WS 7000*
Vento	Meteorologia ed interpretazione dei dati	*Vaisala WS425, IRDAM WST7000*
Radiazione solare	Meteorologia ed interpretazione dei dati	Piranometro a celle di silicio *(Skye SKS110)*
Radiazione UV-B	Meteorologia ed interpretazione dei dati	Fotodiodo al silicio *(Skye SKU 430)*

Summary

OVERWIEV

Summer 2014 did not present high average levels of short-lived climate forcers (SLCF): a value lower than the climatological mean was observed for carbon monoxide, black carbon, surface ozone and fine particles. Only the coarse particles showed an average value similar to the climatological summer season. This can be related to the anomalous weather conditions (high relative humidity, low air-temperature) which characterized the majority of summer 2014, preventing the accumulation of pollutants at regional scales and the transport up to Monte Cimone and the free troposphere.

Only 3.2% of the summer days have been affected for a significant fraction of time by acute pollution event, all of them during June. The most important pollution event was recorded on June, 12nd, when ozone increased up to 100 ppb (200 μg m^{-3}), possibly in association with long-range transport from continental Europe and the occurrence of the only recorded heatwave (8th to 13th June).

14 days (15.4%) were affected by mineral dust transport, with a major event occurring from July 4th to 6th, when a southerly circulation favored the advection of mineral dust from west northern Africa.

The selection methodology allow the identification of a single event distinctly related with air-mass transport from the stratosphere (7th June).

Daily **surface ozone** peak was recorded on 12-06 (87.1 ppb). 30-minute average values ranged from a minimum of 32.2 ppb (27-08) to 102.5 ppb (12-06), with an average seasonal value of 57.9 ppb. This value is lower than the average climatological summer value obtained from the last 18 years (62.4 ppb).

Daily **carbon monoxide** peak was recorded on 12-06 (140.3 ppb). 30-minute average values ranged from a minimum of 68.7 ppb (07-06) to 158.7 ppb (12-06), with an average seasonal value of 115.0 ppb. This value is comparable with the value of obtained from the last 2 years(118.3 ppb).

Daily **nitric oxide** and **nitrogen dioxide** peaks were recorded on 10-07 (0.07 ppb) and 12-06 (0.52 ppb), respectively. 30-minute average values ranged from values below the detection limit to 0.25 ppb (for NO) and 1.92 ppb (for NO_2).

Daily **sulfur dioxide** peak was recorded on 12-06 (0.24 ppb). 30-minute average values ranged from values below the detection limit to 1.11 ppb (11-07), with an average seasonal value below the detection limit.

Sommario

VISIONE DI INSIEME

L' estate del 2014 non ha presentato valori medi elevati di *short-lived climate forcers* (SLCF): il black carbon, il monossido di carbonio, le particelle fini e l'ozono hanno mostrato valori inferiori rispetto alle medie climatologiche. Solo le particelle grossolane hanno mostrato valori in linea con quelli dei precedenti anni. Ciò anche grazie alle anomale condizioni meteorologiche spesso caratterizzate da situazioni di tempo perturbato con elevata umidità relativa e bassa temperatura, non favorevoli all'accumulo a scala regionale di inquinanti ed al successivo trasporto in regime di brezza verso Monte Cimone e la libera atmosfera.

Solo il 3.2 % dei giorni sono stati influenzati da eventi significativi di inquinamento, tutti durante il mese di giugno. L'evento più importante è stato osservato il 12 giugno, quando è stato registrato un valore di ozono superiore a 100 ppb (200 µg m^{-3}), anche in associazione a trasporto di masse inquinate dall'Europa continentale ed all'occorrenza dell'unica ondata di calore registrata (8-13 giugno).

14 giorni (15.4%) sono stati caratterizzati da eventi di trasporto di sabbia sahariana: l'episodio più intenso è stato osservato dal 4 al 6 luglio, quando una circolazione atmosferica prevalentemente meridionale ha favorito il trasporto di masse d'aria dall'Africa nord-occidentale.

La metodologia di selezione, ha permesso di identificare un solo evento di trasporto chiaramente associabile a masse d'aria provenienti dalla stratosfera (7 giugno 2014).

Il valore massimo giornaliero della concentrazione di **ozono superficiale** è stato registrato il 12-06 (87.1 ppb). Le medie semi-orarie variano da 32.2 ppb (27-08) a 102.5 ppb (12-06), con un valore medio stagionale di 57.9 ppb. Tale valore è inferiore a quello climatologico relativo agli ultimi 18 anni (62.4 ppb).

Il valore massimo giornaliero della concentrazione di **monossido di carbonio** è stato registrato il 12-06 (140.3 ppb). Le medie semi-orarie variano da 68.7 ppb (07-06) a 158.7 ppb (12-06), con un valore medio stagionale pari a 115.0 ppb. Tale valore è confrontabile con quello delle ultime due estati (118.3 ppb).

I valori massimi giornalieri di **ossido d'azoto** e **biossido d'azoto** sono stati registrati rispettivamente il 10-07 (0.07 ppb) e il 12-06 (0.52 ppb). Le medie semi-orarie sono variate da valori inferiori al limite di rivelazione sino a 0.25 ppb (per NO) e 1.92 ppb (per NO_2).

Il valore massimo giornaliero di **biossido di zolfo** è stato registrato il 12-06 (0.24 ppb). Le medie semi-orarie sono variate da valori inferiori al limite di rilevabilità sino a 1.11 ppb (11-07), con un valore medio stagionale inferiore al limite di rilevabilità.

Daily **black carbon** peak was recorded on 12-06 (508.6 ng m^{-3}). 30-minute average values ranged from a minimum of 10.7 ng m^{-3} (30-07) to 741.3 ng m^{-3} (12-06), with an average seasonal value of 175.1 ng m^{-3}. This value is considerably lower than the average climatological summer value obtained from the last 9 years (297.8 ng m^{-3}).

Daily **fine aerosol particles** peak was recorded on 12-06 (135.2 cm^{-3}). 30-minute average values ranged from a minimum of 0.01 cm^{-3} (29-07) to 266.9 cm^{-3} (12-06), with an average seasonal value of 30.0 cm^{-3}. This value is lower than the average climatological summer value obtained from the last 12 years (36.9 cm^{-3}).

Daily **coarse aerosol particles** peak was recorded on 24-06 (1.2 cm^{-3}). 30-minute average values ranged from a minimum of 0.005 cm^{-3} (01-06) to 2.3 cm^{-3} (04-07), with an average seasonal value of 0.23 cm^{-3}. This value is similar to the average climatological summer value obtained from the last 12 years (0.26 cm^{-3})

Daily **aerosol scattering coefficient at 550 nm** peak was recorded on 12-06 (74.2 Mm^{-1}). 30-minute average values ranged from a minimum of 0.11 Mm^{-1} (30-07) to 120.1 Mm^{-1} (12-06), with an average seasonal value of 12.67 Mm^{-1}. This value is considerably lower than the average climatological summer value obtained from the last 7 years (41.56 Mm^{-1}).

Maximum **HFC-134a** peak was recorded on 12-07 (123.1 ppt): relatively high values were observed since 15-07 to 18-07. The lowest value (78.2 ppt) was recorded on 24-06 during a long period (since 23-06 to 27-06) of background conditions (average value: 83.6 ppt) during a Saharan dust event.

Maximum **benzene** peak was recorded on 12-07 (74.3 ppt): relatively high values were observed since 15-07 to 18-07. The lowest value (23.8 ppt) was recorded on 06-07.

The maximum value of **nitrogen dioxide columnar** amount was recorded on 09-07 ($6.57 \cdot 10^{15}$ mol/cm^2) for the sunset, and 31-07 ($5.54 \cdot 10^{15}$ mol/cm^2) for the sunrise. The minimum value of the columnar amount of nitrogen dioxide was recorded on 19-07 ($4.66 \cdot 10^{15}$ mol/cm^2) for the sunset, and 25-08 ($3.75 \cdot 10^{15}$ mol/cm^2) for the sunrise.

Il valore massimo giornaliero della concentrazione di **black carbon** è stato registrato il 12-06 (508.6 ng m^{-3}). Le medie semi-orarie variano da 10.7 ng m^{-3} (30-07) a 741.3 ng m^{-3} (12-06), con un valore medio stagionale pari a 175.1 ng m^{-3}. Tale valore è considerevolmente inferiore a quello climatologico relativo agli ultimi 9 anni (297.8 ng m^{-3}).

Il valore massimo giornaliero della concentrazione di **particelle fini** è stato registrato il 12-06 (135.2 cm^{-3}). Le medie semi-orarie variano da 0.01 cm^{-3} (29-07) a 266.9 cm^{-3} (12-06), con un valore medio stagionale pari a 30.0 cm^{-3}. Tale valore è inferiore a quello climatologico (36.9 cm^{-3}).

Il valore massimo giornaliero della concentrazione di **particelle grossolane** è stato registrato il 24-06 (1.2 cm^{-3}). Le medie semi-orarie variano da 0.005 cm^{-3} (01-06) a 2.3 cm^{-3} (04-07), con un valore medio stagionale pari a 0.23 cm^{-3}. Tale valore è in linea con quello climatologico relativo agli ultimi 12 anni (0.26 cm^{-3}).

Il picco giornaliero del **coefficiente di scattering dell'aerosol a 550 nm** è stato osservato il 12-06 (74.2 Mm^{-1}). Le medie sui 30-minuti oscillano tra un minimo di 0.11 Mm^{-1} (30-07) e 120.1 Mm^{-1} (12-06), con un valore medio stagionale di 12.67 Mm^{-1} che risulta essere considerevolmente inferiore al valore medio climatologico relativo agli ultimi 7 anni (41.56 Mm^{-1}).

Il massimo giornaliero di **HFC-134a** è stato registrato il 12-07 (123.1 ppt): valori relativamente elevati sono stati osservati dal 15-07 al 18-07. La concentrazione minima (78.2ppt) è stata registrata il 24-06, durante un periodo (dal 23-06 al 27-06) di condizioni di fondo (valore medio: 83.6 ppt) durante un evento di trasporto di sabbia dal Sahara.

La concentrazione massima di **Benzene** è stata registrata il 12-07 (74.3 ppt), mentre il minimo (23.8 ppt) è stato osservato il 06-07.

Il valore massimo della **quantità colonnare di biossido di azoto** è stato registrato il 9-07 ($6.57 \cdot 10^{15}$ mol/cm^2) per il tramonto, e il 31-07 ($5.54 \cdot 10^{15}$ mol/cm^2) per l'alba. Il valore minimo della quantità colonnare di biossido di azoto è stato registrato il 19-07 ($4.66 \cdot 10^{15}$ mol/cm^2) per il tramonto, e il 25-08 ($3.75 \cdot 10^{15}$ mol/cm^2) per l'alba.

Daily **air temperature** peak was recorded on 09-06 (15.5°C), minimum on 16-06 (3.6 °C). 30-minute average values ranged from a minimum of 0.8 °C (01-06) to 19.8 °C (08-06), with an average seasonal value of 9.5 °C, which is lower than the seasonal climatological value (10.6 °C).

Daily **relative humidity** minimum was recorded on 09-06 (49.8%). 30-minute average values ranged from a minimum of 19.2 % (23-06) to a maximum of 100.0 % (observed on 14 days), with an average seasonal value of 84.4 %. This value is higher than the average climatological summer value obtained from the last 18 years (75.7 %).

Daily **atmospheric pressure** peak was recorded on 03-07 (799.6 hPa), the lowest value on 10-07 (783.6 hPa). 30-minute average values ranged from a minimum of 781.7 hPa (10-07) to 800.4 hPa (03-07), with an average seasonal value of 791.7 hPa, comparable with the average climatological summer value obtained from the last 18 years (792.7 hPa).

Daily **wind speed** peak was recorded on 29-06 (17.3 m s^{-1}). 30-minute average values ranged from a minimum of 0.9 m s^{-1} (30-06) to a maximum of 22.1 m s^{-1} (26-08), with an average seasonal value of 7.0 m s^{-1}. This value is higher than the climatological summer value (6.4 m s^{-1}).

Wind direction was prevalently from SW (42.2 % of 30-minute data). This is similar to the climatological analysis over the last 18 years.

Daily **solar radiation** highest average daily value was recorded on 08-06 (377.4 W m^{-2}), while the lowest average value (46.5 W m^{-2}) was observed on 23-08.

A similar trend was also observed for **UV-B radiation**: the highest value was observed on 08-06 (0.6 W m^{-2}).

Il valore massimo giornaliero della **temperatura** è stato registrato il 09-06 (15.5 °C), il valore minimo il 16-06 (3.6 °C). Le medie semi-orarie variano da 0.8 °C (01-06) a 19.8 °C (08-06), con un valore medio stagionale pari a 9.5 °C ed inferiore a quello climatologico di 10.6 °C.

Il valore minimo giornaliero dell'**umidità relativa** è stato registrato il 09-06 (49.8 %). Le medie semi-orarie variano da 19.2 % (23-06) a 100 % (osservato in 14 giornate), con un valore medio stagionale pari a 84.4 %. Tale valore è superiore a quello climatologico relativo agli ultimi 18 anni (75.7 %).

Il valore massimo giornaliero della **pressione atmosferica** è stato registrato il 03-07 (799.6 hPa), il valore minimo il 10-07 (783.6 hPa). Le medie semi-orarie variano da 781.7 hPa (10-07) a 800.4 hPa (03-07), con un valore medio stagionale pari a 791.7 hPa, simile a quello climatologico relativo agli ultimi 18 anni (792.7 hPa).

Il valore massimo giornaliero della **velocità del vento** è stato registrato il 29-06 (17.3 $m\ s^{-1}$). Le medie semi-orarie variano da 0.9 $m\ s^{-1}$ (30-06) a 22.1 $m\ s^{-1}$ (26-08), con un valore medio stagionale pari a 7.0 $m\ s^{-1}$. Tale valore è superiore a quello climatologico ottenuto dalle misure realizzate negli ultimi 18 anni (6.4 $m\ s^{-1}$).

La **direzione del vento** osservata nell' estate 2014 è stata prevalentemente da Sud-Ovest (42.2 % dei dati semi-orari), in linea con quanto osservato negli ultimi 18 anni.

La **radiazione solare** mostra il valore giornaliero più elevato il 08-06 (377.4 $W\ m^{-2}$), mentre il minimo giornaliero (46.5 $W\ m^{-2}$) osservato il 23-08.

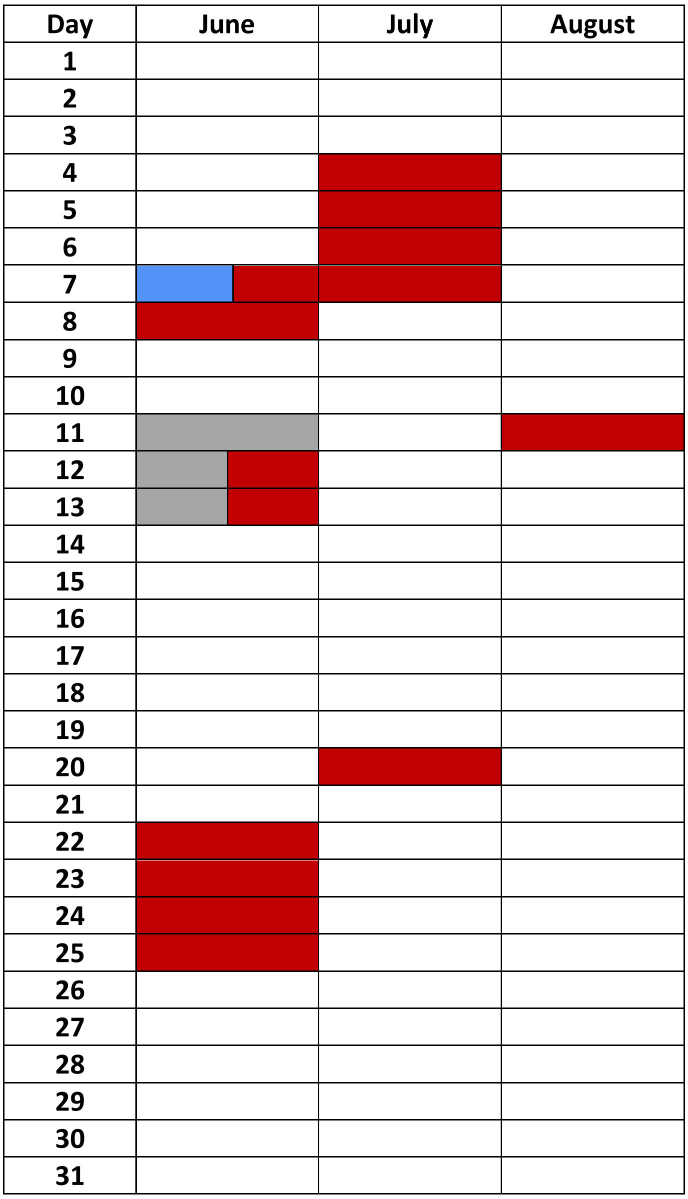
Anche la **radiazione UV-B** mostra un andamento simile nel corso della stagione, con il valore massimo (0.6 $W\ m^{-2}$) osservato il 08-06.

Special events

In this paragraph, we present a detailed overview of "special events" which have been detected at the ICO-OV during the reference period, namely:

- **Mineral Dust transport**
- **Stratospheric intrusions;**
- **Pollution transport.**

<u>It must be noted that the event selection methodologies are executed on 30-minute basis, thus, for the same day, different classes of special events can be observed.</u>



LEGEND

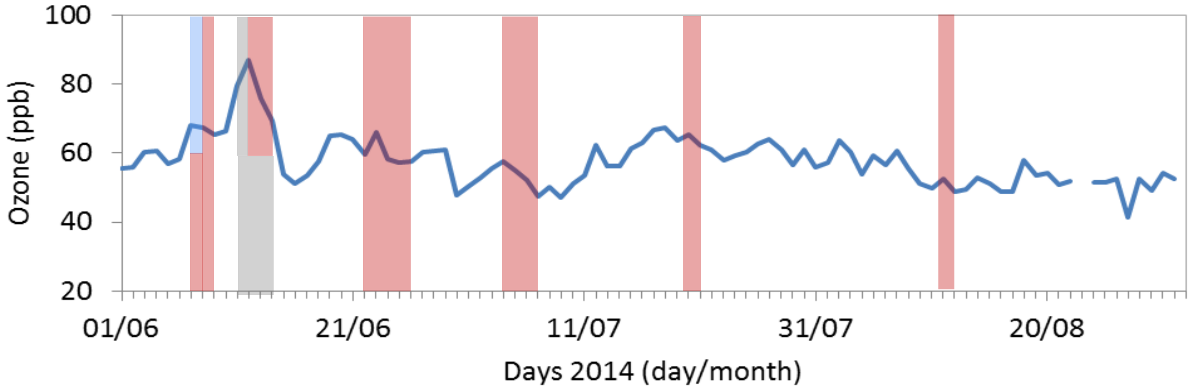
Mineral dust Stratospheric intrusions Pollution transport

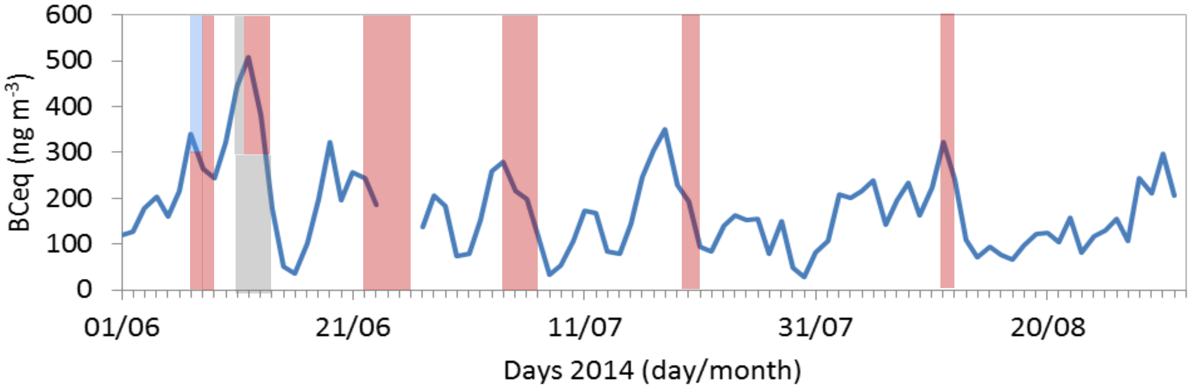
Eventi speciali

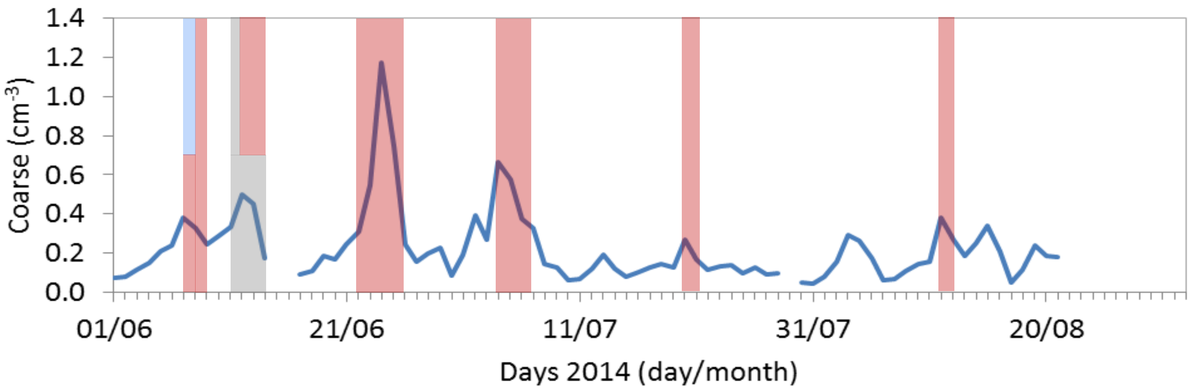
In questo paragrafo viene presentato l'elenco degli "eventi speciali" che sono stati registrati presso il sito di misura durante il periodo analizzato:

- **Trasporto di polveri minerali;**
- **Intrusioni stratosferiche;**
- **Trasporto di inquinanti**

Va notato che le metodologie di selezione degli eventi sono calcolate a partire dai dati a 30-minuti, quindi, per lo stesso giorno, possono essere osservate diverse tipologie di evento.







LEGENDA

Polveri minerali | Intrusioni stratosferiche | Trasporto di inquinanti

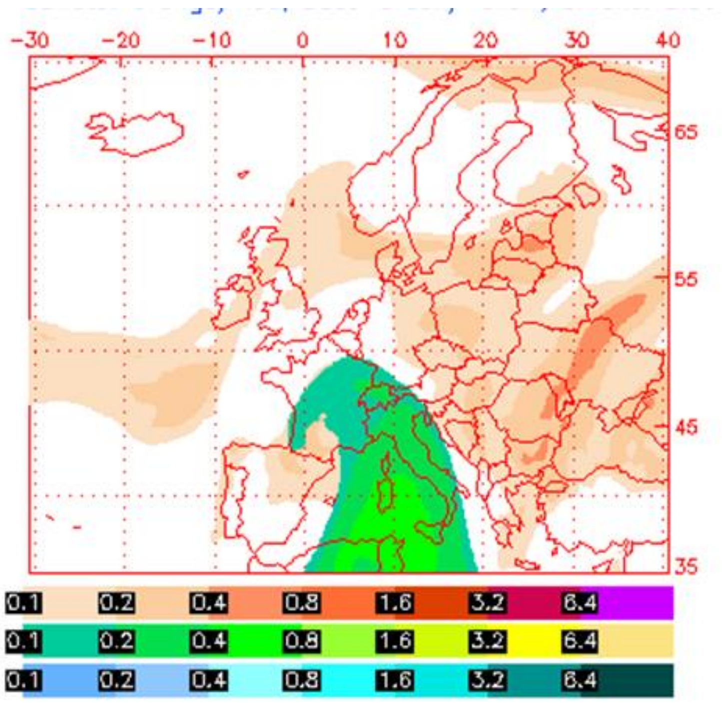
Mineral dust transport

The presence of mineral dust in the atmosphere plays direct and indirect role in affecting climate variations. Moreover, mineral dust can seriously affect air quality in regions downwind of desert areas, contributing to PM_{10} levels. Sahara desert exports more mineral dust than any other area of the world, injecting into the atmosphere millions of Tons of dust particles. Mt. Cimone represents one of the first mountain ridges that Saharan dust meet along their tracks towards Italy and Europe.

> *Selection methodology:* we detected a Saharan dust event when the atmospheric concentration of coarse particles (particles with diameter 1 µm ≤ Dp≤ 20 µm) significantly increased with air-masses coming from North Africa, as deduced by three-dimensional air-mass back-trajectories and transport model outputs.

SUMMER 2014:

- **14 days were characterized by the transport of mineral dust from northern Africa (20.7 % of the period).**
- **3/6 Saharan dust events (7th - 8th June, 12th – 13th June, 4th- 6th July) were associated to anticyclonic circulation over central Mediterranean basin, while the remaining events were tagged to the presence of a pressure trough over west Europe (e.g. June, 23rd).**
- **The most important dust event occurred from July 4th to July 7th, when the coarse particle reached the concentration of 2.3 cm^{-3}, on 4th July 2014.**



Dust transport event simulation by NAAPS model (4th July 2014).

Simulazione dell'evento di trasporto di polveri minerali osservato il 4 Luglio 2014 (modello NAAPS).

http://www.nrlmry.navy.mil/
Courtesy by NRL/Monterey Aerosol Modeling.

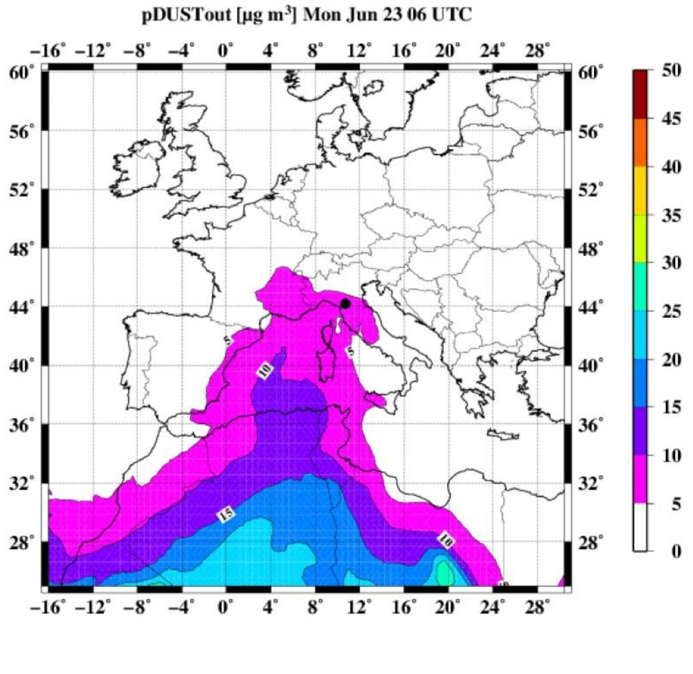
Trasporto di polveri minerali

La presenza di aerosol (polveri) minerali nell'atmosfera può influenzare il clima attraverso effetti diretti ed indiretti. Esse possono inoltre alterare in modo significativo la qualità dell'aria in regioni prossime alle aree di emissione o soggette a fenomeni di trasporto, influenzando le concentrazioni di PM_{10}. Masse d'aria ricche di polveri minerali possono essere trasportate dal deserto del Sahara, la più importante sorgente al mondo di polveri minerali, verso l'Italia e l'Europa. Mt. Cimone rappresenta uno dei primi rilievi montuosi che queste masse d'aria incontrano durante il loro movimento verso nord.

> *Metodologia di selezione:* gli eventi di trasporto di polveri sahariane sono stati identificati quando la concentrazione delle particelle grossolane (1 µm ≤ Dp ≤ 20 µm) è aumentata in modo significativo con l'arrivo di masse d'aria provenienti dal nord Africa, come indicato da analisi di retro-traiettorie tri-dimensionali delle masse d'aria e da modelli di trasporto.

ESTATE 2014:

- **14 giorni sono stati caratterizzati dal trasporto di polveri minerali proveniente dal Nord Africa (20.7 % del periodo).**
- **3/6 eventi di trasporto dal Sahara (7 - 8 giugno, 12 - 13 giugno, 4 - 6 luglio) sono stati associati a condizioni anticicloniche sul bacino del Mediterraneo. Mentre i restanti eventi sono stati favoriti dalla presenza di saccature sull'Europa occidentale. (es. 23 giugno)**
- **L'evento più significativo è stato osservato dal 4 al 6 di Luglio, quando è stata registrata la concentrazione massima di particelle grossolane per l'estate 2014 (2.3 cm^{-3}, il 4 Luglio 2014).**



Dust transport event simulation by WRF-CHIMERE model (23th June 2014). The colored scale represents the aerosol concentration expressed as µg m^{-3}.

Simulazione dell'evento di trasporto di polveri minerali osservato il 23 giugno 2014 (modello WRF-CHIMERE). La scala colorata rappresenta la concentrazione di aerosol minerale in µg m^{-3}.

Stratospheric intrusions (SI)

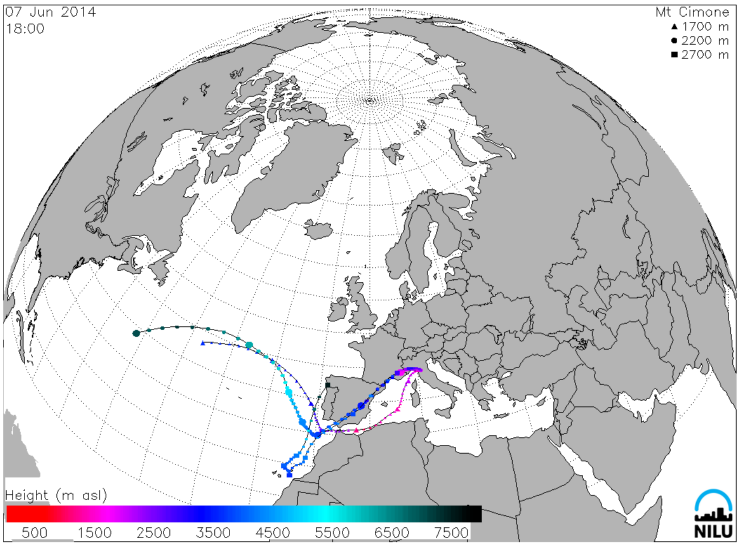
Stratospheric intrusions (SI) can be considered as a specific aspect of stratosphere–troposphere exchange (STE): the irreversible downward transport of stratospheric air relatively deep into the troposphere. Such phenomena are highly episodic and can be favored by a number of different mechanisms, acting on different geographical and temporal scales: tropopause folding and cut-off lows at upper levels, and fronts or high-pressure systems at the surface.

Even though it has been assessed that nowadays the greatest contribution to tropospheric ozone concentrations comes from photochemical production, the contribution from STE is far from negligible, in particular in the free troposphere. For these reasons, at ICO-OV the frequency of SI and its contribution to ozone is assessed.

> *Selection methodology:* at Mt. Cimone, we identified days probably affected by air-mass transport from the stratosphere or from the upper free troposphere by selecting the measurement periods characterized by at least 8 hours of relatively dry conditions (RH<60%) with low levels of anthropogenic pollution (CO<90 ppb) together with analysis of air-mass three-dimensional back-trajectories corroborating the origin of the air masses.

SUMMER 2014:

- **During summer 2014, the selection methodology was able to detect only a single event on June 7th. During the event ozone increase to 71 ppb, while RH decreased to 30% (well below the seasonal average value).**



120 h air-mass back-trajectories describing the path of air-masses to Mt. Cimone on 7th June 2014. The color code represents the air-mass height (expressed as pressure level). The dark green points represent air-mass at altitude exceeding 7500 m a.s.l.

Courtesy by Andreas Stohl (NILU).

Retro-traiettorie tridimensionali a 120 ore che descrivono il moto in atmosfera delle masse d’aria che hanno raggiunto Mt. Cimone il 7 giugno 2014. Il colore verde scuro rappresenta masse d’aria originatesi a quote superiori a 7500 m slm.

Elaborazione: Andreas Stohl (NILU)

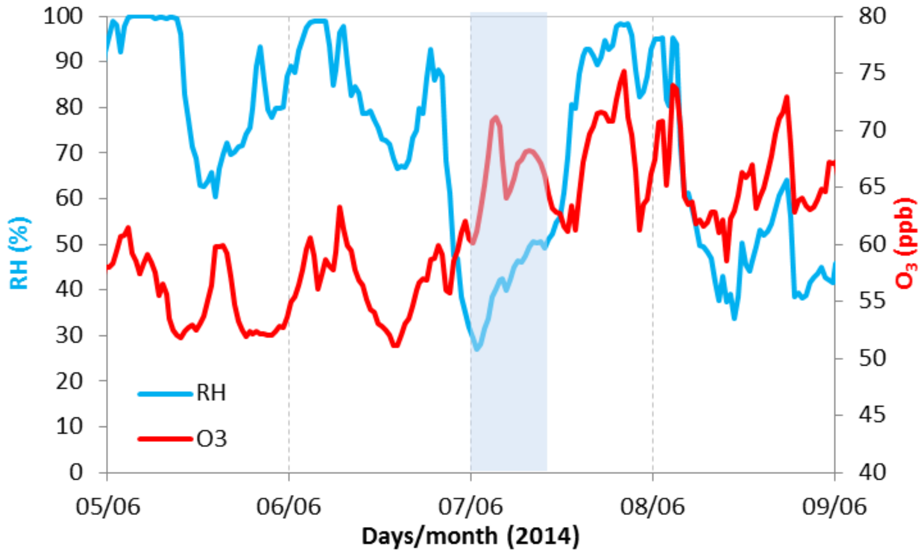
Intrusioni stratosferiche (SI)

Le intrusioni stratosferiche (SI) possono essere considerate un aspetto specifico degli scambi stratosfera-troposfera (STE). Tali fenomeni, che avvengono in maniera episodica, possono essere favoriti da processi dinamici e meteorologici caratteristici che agiscono su differenti scale spazio-temporali: ripiegamento della tropopausa, cut-off low, sistemi frontali o aree di alta pressione. Sebbene il processo più importante che influenza la variabilità dell'ozono in troposfera sia oggi rappresentato dalla produzione fotochimica, il contributo dei processi STE è tutt'altro che trascurabile, in particolare nella libera troposfera. Per queste ragioni, presso l'ICO-OV viene effettuata l'identificazione e lo studio di questa classe di fenomeni.

Metodologia di selezione: a Mt. Cimone, sono stati identificati gli eventi di trasporto di masse d'aria dalla stratosfera o dalla parte superiore della libera troposfera come i periodi caratterizzati per almeno 8 ore dalla presenza di masse d'aria relativamente secche (RH<60%) e bassi livelli di inquinamento antropico (CO<90 ppb). Retro-traiettorie tridimensionali delle masse d'aria, sono state utilizzate per corroborare l'origine degli eventi.

ESTATE 2014:

- **Nel corso dell'estate 2014, la metodologia di selezione ha messo in evidenza un solo evento chiaramente ascrivibile al trasporto di masse d'aria dalla stratosfera. Durante questo evento, l'ozono ha superato 71 ppb mentre l'umidità relativa è diminuita sotto al 30% (ben al di sotto della media stagionale).**



Relative humidity (blue) and ozone (red) behaviors at CMN during June, 5th-8th 2014. The blue area indicates the period probably affected by SI.

Andamento dell'umidità relativa (azzurro) ed ozono (rosso) nel periodo 5 – 8 giugno 2014. L'area azzurra indica il periodo probabilmente influenzato dall'evento di SI.

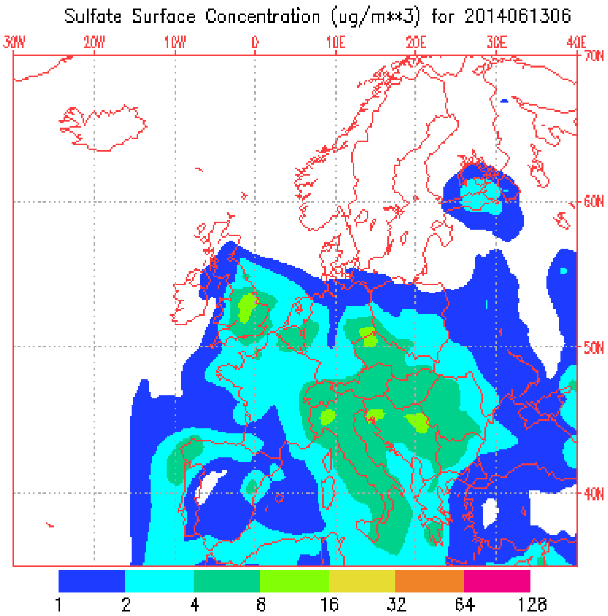
Pollution transport

The Mediterranean region represents a global hot-spot in terms of climate change and atmospheric composition variability while the Po Basin on which Mt. Cimone leans out, is considered one of the major polluted European regions. In particular during the summer seasons, when the high solar irradiance characterized these areas, many anthropogenic pollutants, including photochemically produced ozone can affect the lower troposphere. With the goal of better evaluating the influence of these processes on the atmospheric composition variability, polluted air-mass transport phenomena are systematically identified and investigated at ICO-OV.

Selection methodology: at Mt. Cimone, days possibly affected by polluted air-mass transport are identified by selecting periods characterized by at least 8 hours of relatively high ozone, black carbon and carbon monoxide concentrations (higher than the 75th percentile of the seasonal values observed from the start of the respective measurement programmes). **This identification methodology points out those "significant" pollution events that significantly alter the typical seasonal values of atmospheric compounds.**

SUMMER 2014

- **3 days, related to a single event, were characterized by significant transport of polluted air masses (3.2% of the period).**
- **This event was associated with increasing concentration of pollutants (CO, NO_2, BC, fine particles) starting since June, 10th. The transport at regional/synoptic scales from East Europe (e.g. June, 12th) could contribute to the event occurrence.**
- **June 12th was the most polluted day of the season (O_3: 87.1 ppb; CO: 140.3 ppb;, NO_2: 0.52 ppb, BC:508.6 ng m^{-3}; fine particles: 266.9 cm^{-3}; aerosol scattering: 120.1 Mm^{-1})**



Pollution transport event simulation by NAAPS model (13th June 2014). The colored scale represents the sulfate aerosol concentration expressed as μg m^{-3}.

Simulazione dell'evento di trasporto di inquinamento osservato il 13 giugno 2014 (modello NAAPS). La scala colorata rappresenta la concentrazione dei solfati (aerosol) in μg m^{-3}.

http://www.nrlmry.navy.mil/

Courtesy by NRL/Monterey Aerosol Modeling

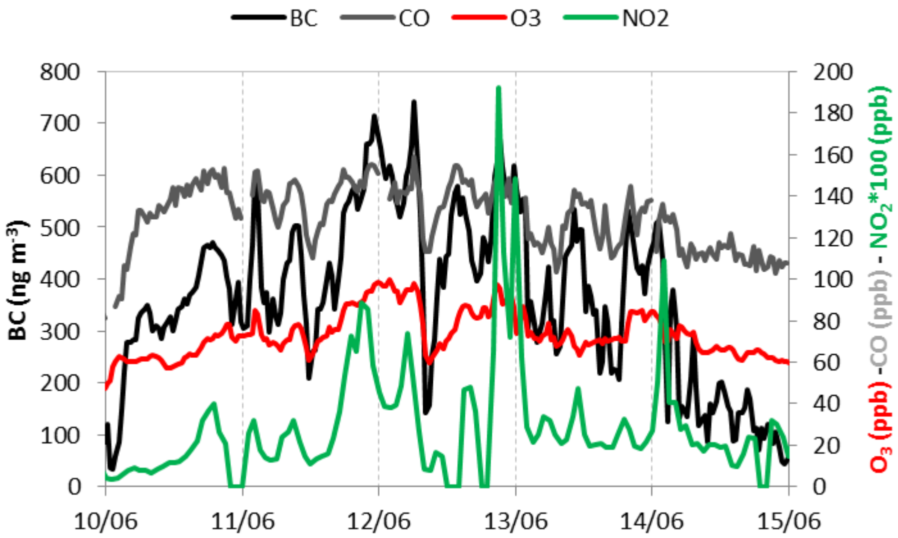
Trasporto di inquinanti

Il bacino del Mediterraneo rappresenta un “hot-spot” globale per quanto riguarda i cambiamenti del clima e della composizione dell’atmosfera, mentre la Pianura Padana rappresenta un’importante area sorgente di inquinamento antropico. In particolare durante l’estate, a causa dell’alto irraggiamento solare che caratterizza queste regioni, esse sono interessate da intensi eventi di produzione fotochimica e di ozono nella bassa troposfera. Con lo scopo di valutare l’influenza di tali eventi sulla composizione dell’atmosfera, i fenomeni di trasporto di masse d’aria inquinate sono sistematicamente identificati e studiati a Mt. Cimone

Metodologia di selezione: a Mt. Cimone, sono stati identificati i giorni possibilmente affetti da trasporto di masse d’aria inquinate selezionando i periodi caratterizzati per almeno 8 ore da concentrazioni elevate di ozono, black carbon e monossido di carbonio (maggiori del 75^{esimo} percentile dei valori osservati stagionalmente dall’inizio delle rispettive misure). **Questo metodo di identificazione permette di identificare gli episodi “acuti” di inquinamento che alterano in maniera significativa la composizione atmosferica tipica stagionale.**

ESTATE 2014

- **3 giorni, ascrivibili ad un unico evento, sono stati caratterizzati dal trasporto di masse d’aria inquinate (3.2% del periodo).**
- **L’evento è associato ad un incremento delle concentrazioni degli inquinanti (CO, NO_2, BC, particelle fini) a partire dal 10 giugno. Fenomeni di trasporto a scala regionale/sinottica dall’Europa dell’Est possono aver avuto un ruolo importante nello sviluppo dell’evento (es. 12 giugno).**
- **Il 12 giugno è stato il giorno più inquinato dell’estate 2014 (O_3: 87.1 ppb; CO: 140.3 ppb;, NO_2: 0.52 ppb, BC: 508.6 ng m^{-3}; particelle fini: 266.9 cm^{-3}; aerosol scattering: 120.1 Mm^{-1}).**



BC, ozone, CO,and NO_2 behaviors at Mt. Cimone from 10 to 15 June 2014.

Andamento delle concentrazioni di BC, ozono, CO ed NO_2 a Monte Cimone (10 – 15 Giugno 2014).

Surface ozone

Why is ozone so important?

Ozone (O_3) is one of the most important Short-Lived Climate Forcers and Pollutant (SLCF/P), being a powerful greenhouse gas at regional scale. Due to its chemical properties, O_3 is also a dangerous secondary pollutant in the lower troposphere. Its tropospheric mixing ratios are also affected by natural processes, e.g. stratospheric intrusions and lightning production. Being the precursor of oxidizing substances like OH radical and NO_3, O_3 is one of the key agents determining the oxidation capacity of the troposphere.

Instrumentation and calibration

Surface ozone is measured by using a UV-absorption analyser (Thermo Tei 49i). Intercomparisons with the laboratory standard (Dasibi 1008 PC #6506, traced back to SRP#15 at the World Calibration Centre for surface ozone at WCC-EMPA of Zürich) are carried out every 3-months.

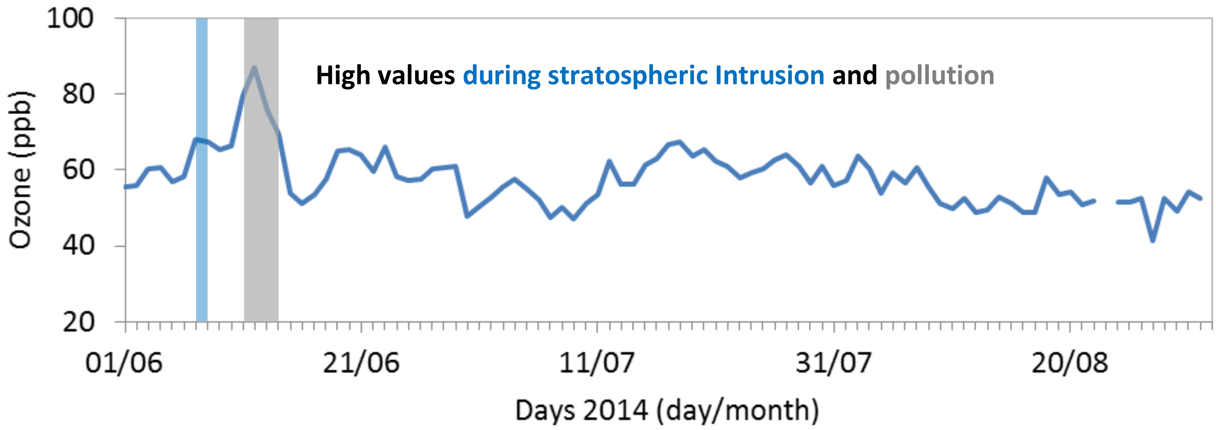
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (ppb)	25^{th} Percentile (ppb)	50^{th} Percentile (ppb)	Average mean value (ppb)	75^{th} percentile (ppb)	Max value (ppb)
98.8	32.2	52.2	57.5	57.9	62.8	102.5

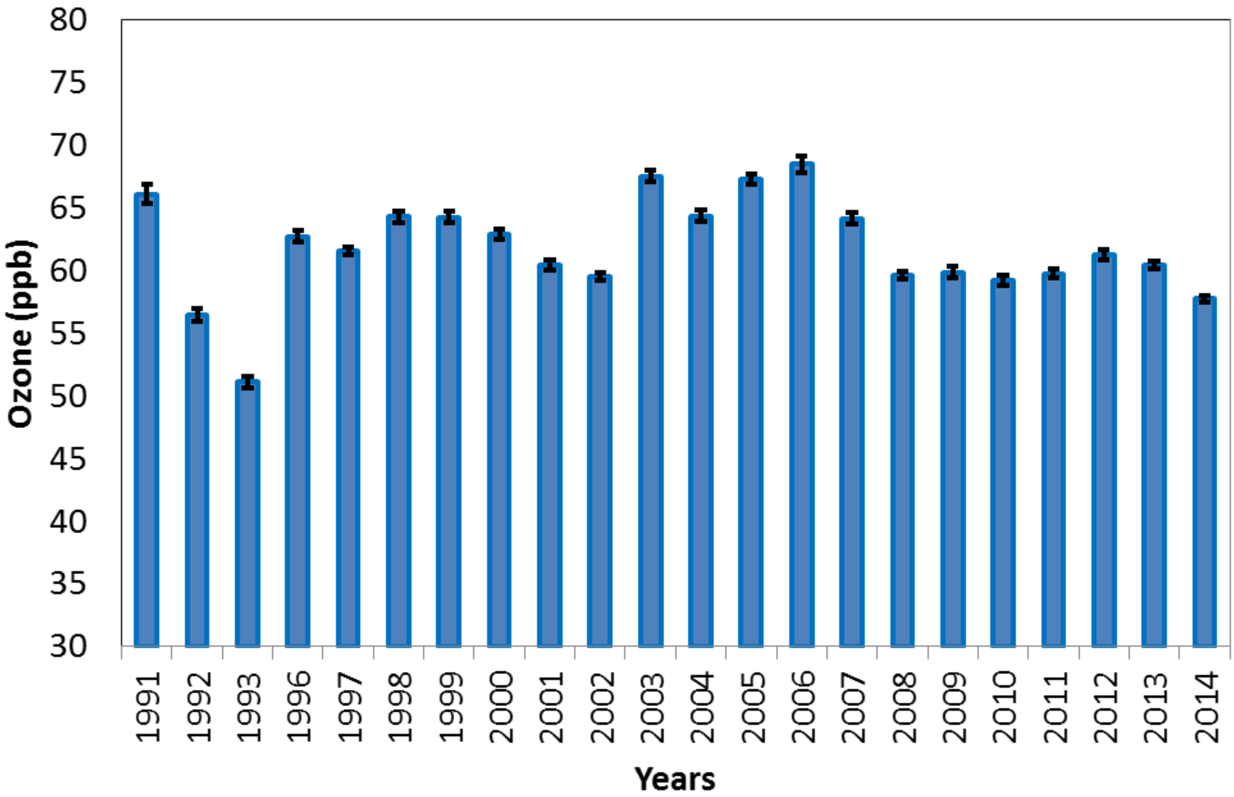
Time series of daily mean values

Ozone concentrations during summer 2014 were below the climatological seasonal value (62.4 ppb) for the 81% of the period. High values were recorded on **June 11 – 13**, when an acute pollution event were recorded at Mt. Cimone.



Comparison with historical data-set

The **2014 summer average mean value of O_3 is 57.9 ppb, lower than the climatological mean value of 62.4 ppb**. This condition also characterized other anthropogenic pollutants (i.e. CO, NOx, SO_2, BC, fine particle) during summer 2014. It was related to the relatively clean conditions which characterized July and August due to the occurrence of meteorological conditions not favorable to the accumulation of pollutants within the PBL and their vertical transport to the free troposphere.



Carbon monoxide (NDIR)

Why is carbon monoxide so important?

Carbon Monoxide (CO) plays an important role in the oxidation/reduction chemistry of the atmosphere and it participates in the reactions of photochemical O_3 production. CO has an indirect radiative forcing effect by influencing atmospheric mixing ratios of O_3 and methane. Through natural processes in the atmosphere, CO is eventually oxidized to CO_2. CO represents a tracer for combustion emissions (biomass burning, residential, traffic,...).

Instrumentation and calibration

Carbon monoxide is measured by using a non-Dispersive Infrared (NDIR) analyzer (Thermo Scientific TEI 48C-TL). A CO working standard (approx. 10 ppm, synthetic air, Messer Italia) is used to calibrate the instrument with a dilution system. On a monthly basis, these working standards were compared against secondary standards from NOAA-CMDL.

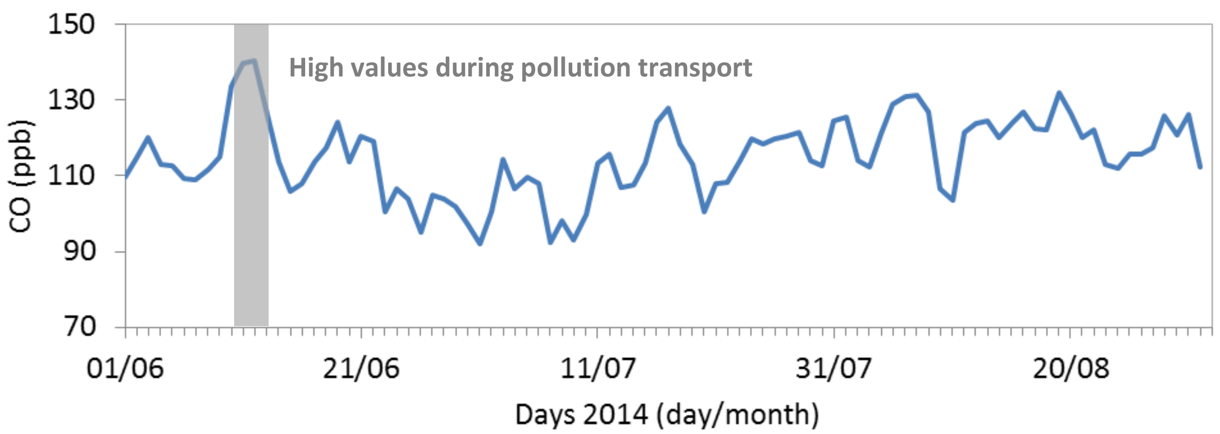
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (ppb)	25th Percentile (ppb)	50th Percentile (ppb)	Average mean value (ppb)	75th percentile (ppb)	Max value (ppb)
92.5	68.7	106.4	115.4	115.0	124.2	158.7

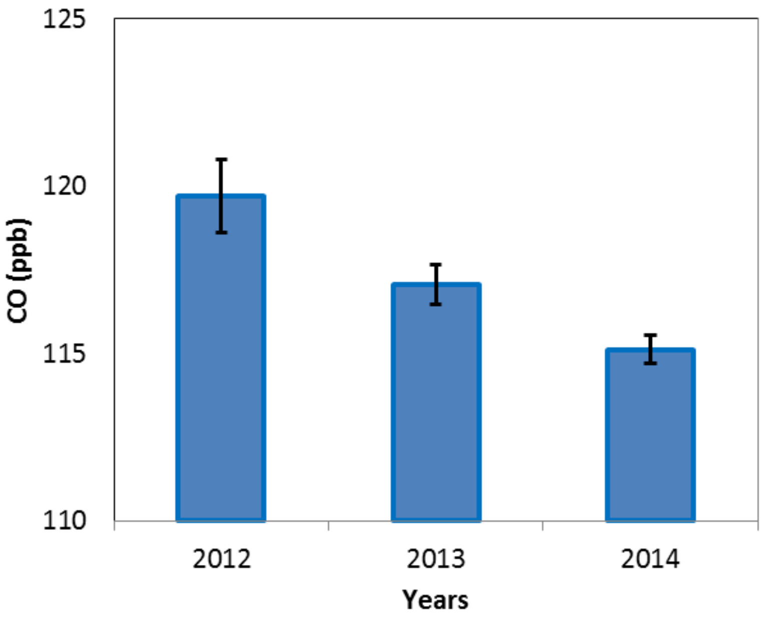
Time series of daily mean values

Similar to O_3 the highest CO concentration was observed on **June 12nd** (158.7 ppb), during the acute pollution event.



Comparison with historical data-set

The **2014 summer average mean value of CO was 115.0 ppb which is slightly lower than the average mean value of 118.3 ppb obtained from the last two summers.** This is the result of the occurrence of lower than average values during the last ten days in June and the first two weeks in July.



Nitrogen oxides

Why are nitrogen oxides so important?

Nitrogen oxides (NO_x) encompasses nitric oxide (NO) and nitrogen dioxide (NO_2). NO is naturally produced by lightning. Anthropogenic contributions are related to combustion processes and agricultural fertilization. NO_x are key elements of atmosphere chemistry influencing a number of atmospheric compounds with roles on climate, air-quality and ecosystem threats, e.g. sulphur dioxide, halocarbons, methane, tropospheric ozone, secondary aerosols.

Instrumentation and calibration

Nitrogen oxides ($NOx=NO+NO_2$) are measured by using a Chemioluminescence analyser (Thermo 42i-TL), equipped with a photolityc converter (Blue Light Converter) for NO_2 determination. Every 48 hours, zero and span checks are carried out for NO by using an external zero air source (dry compressed air scrubbed with active charcoal and Purafill) and dilution of certified NO standard (5 ppm +/- 2%). GPT is used to determine the conversion efficiency of the NO_2 converter.

Basic statistical parameters

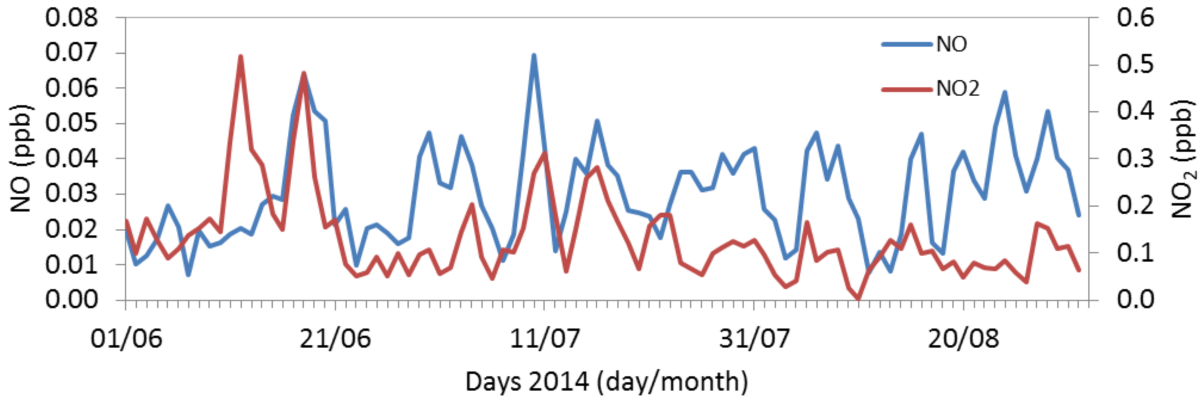
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (ppb)	25^{th} percentile (ppb)	50^{th} percentile (ppb)	Average mean value (ppb)	75^{th} percentile (ppb)	Max value (ppb)
NO 94.8	UDL	UDL	UDL	0.03	0.04	0.25
NO_2 94.4	UDL	UDL	0.10	0.13	0.17	1.92

UDL: under detection limit

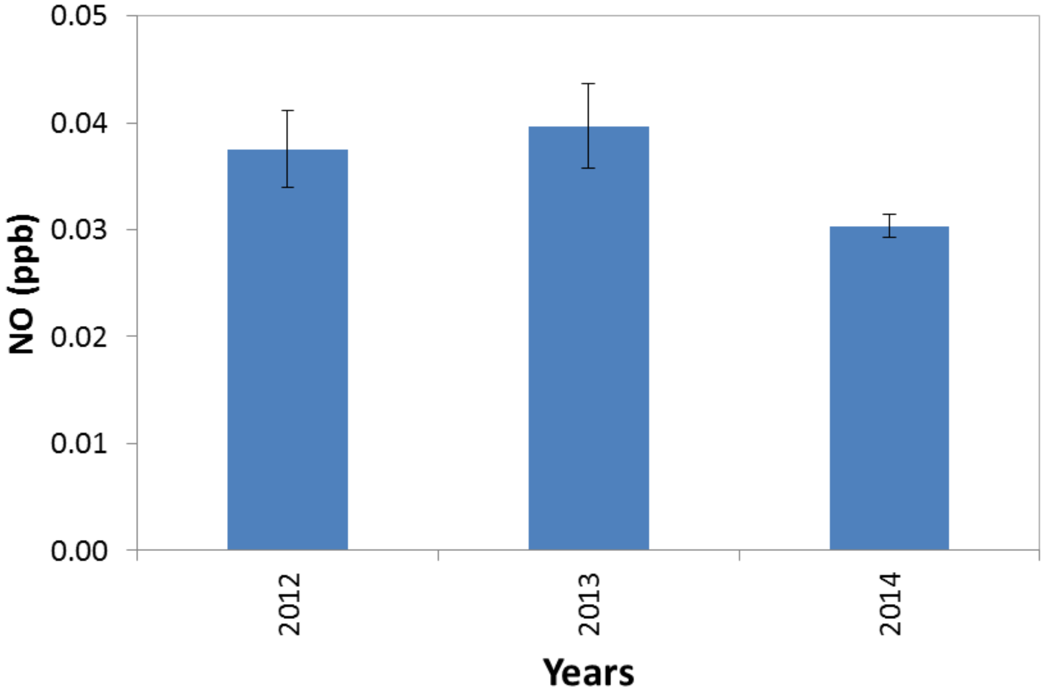
Time series of daily mean values

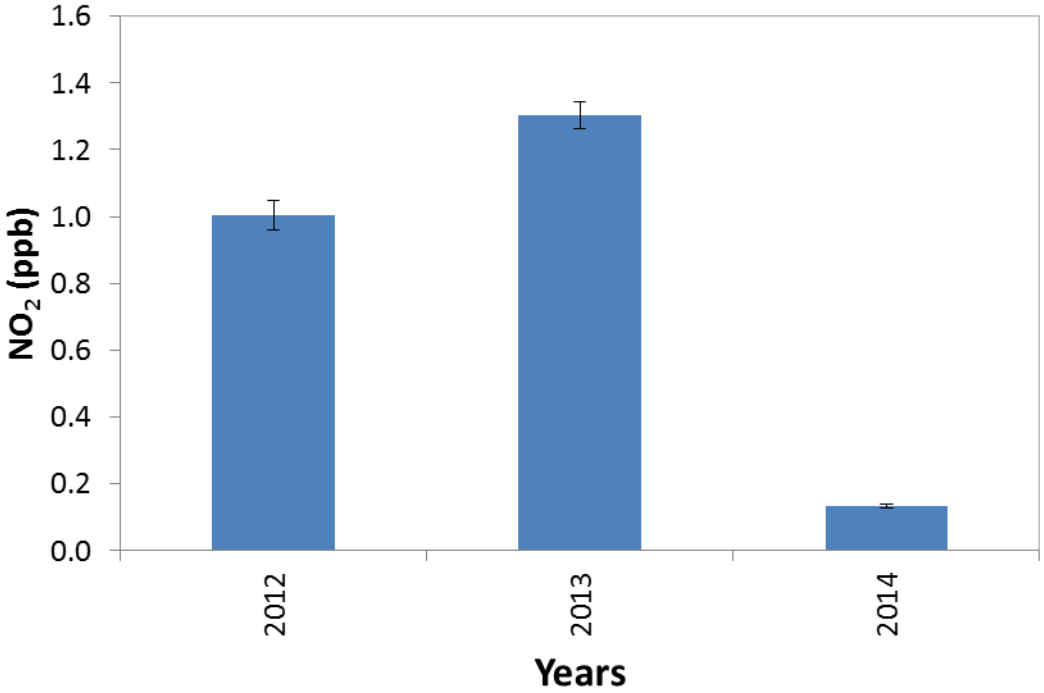
The highest NO value (0.25 ppb) was observed on **June 18th**, while the highest NO_2 value (1.92 ppb) was observed on **June 12th**. Low NO_2 concentrations were observed from the second half of June. Values under DL were observed for 51% of the period for NO and 15% for NO_2, respectively.



Comparison with historical data-set

The **2014 summer average mean value of NO (NO_2) was 0.03 ppb (0.12 ppb) which is comparable (lower) with the average 2013 summer mean value of 0.04 ppb (1.30 ppb)**. The NO_2 lower average value is dependent on the "clean" conditions observed from the latter half of June.





Sulphur dioxide

Why is sulfur dioxide so important?

Sulfur dioxide (SO_2) is the main precursor to the sulphate aerosol which exerts a large influence on climate and air quality. It is a well know precursor for acid rains. SO_2 is also one of the main tracers for detecting the occurrence of ash plumes from volcanic eruption. In Europe, during the last years, SO_2 concentrations have been declining due to efficient restrictions on emissions.

Instrumentation and calibration

Sulphur dioxide is measured by using a UV-fluorescence analyser (Thermo 43i-TLE). Daily zero check are executed by using an external zero air source (scrubber with active charcoal), while daily span check are performed using a permeation tube with set point at 48 ppb. Detection limit for 1-minute average is estimated to be 0.11 ppb

Basic statistical parameters

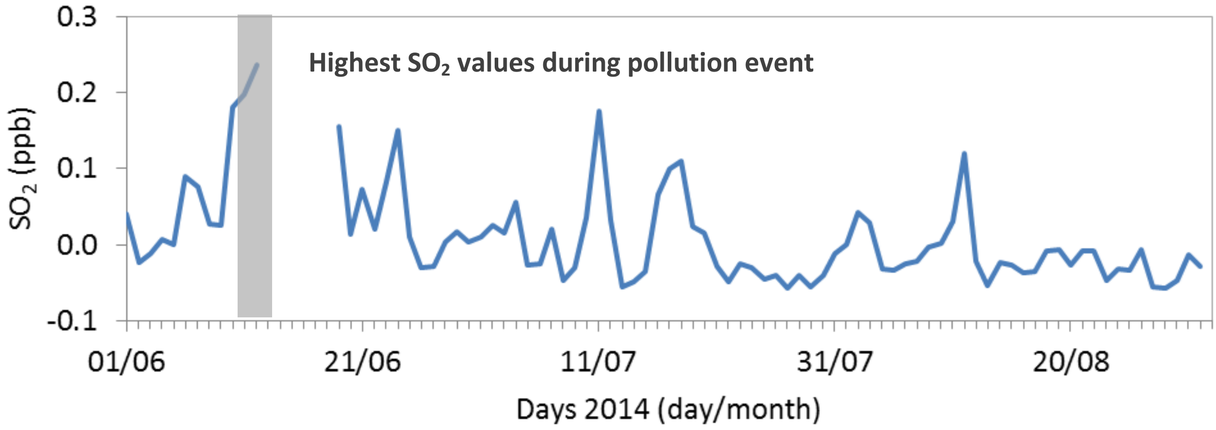
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (ppb)	25^{th} percentile (ppb)	50^{th} percentile (ppb)	Average mean value (ppb)	75^{th} percentile (ppb)	Max value (ppb)
97.5	UDL	UDL	UDL	UDL	UDL	1.11

UDL: under detection limit

Time series of daily mean values

During summer the average SO_2 concentration (0.02 ppb) was lower than the detection limit. The highest SO_2 daily mean value (0.24 ppb) was observed on **June 12th**, during the acute pollution event. The highest 30 minute average was instead observed on **July 11th**, when the 1-minute data reached 1.59 ppb.



NOTE: Negative values in the graph represent "under detection limit" conditions, common in a remote, high altitude, free troposphere measurement site.

Black carbon

Why is black carbon so important?

Black carbon (BC) is a primary aerosol resulting from incomplete combustion processes. Its main sources are fossil fuel combustion (anthropogenic) and biomass burning (natural and anthropogenic). BC, a Short Lived Climate Forcer and Pollutant, strongly absorbs solar radiation and it has been recognized as a driving factor of global warming: the magnitude of the direct radiative forcing due to BC can exceed that due to methane.

Instrumentation and calibration

Equivalent black carbon concentration is measured by a Multi Angle Absorption Photometer (MAAP, Model 5012 – Thermo Electron Corporation). Detection limit was measured as 3σ of 12 h measurement of free particle air. Calibration of sampling flow and internal temperature-pressure sensors are conducted every 6 months.

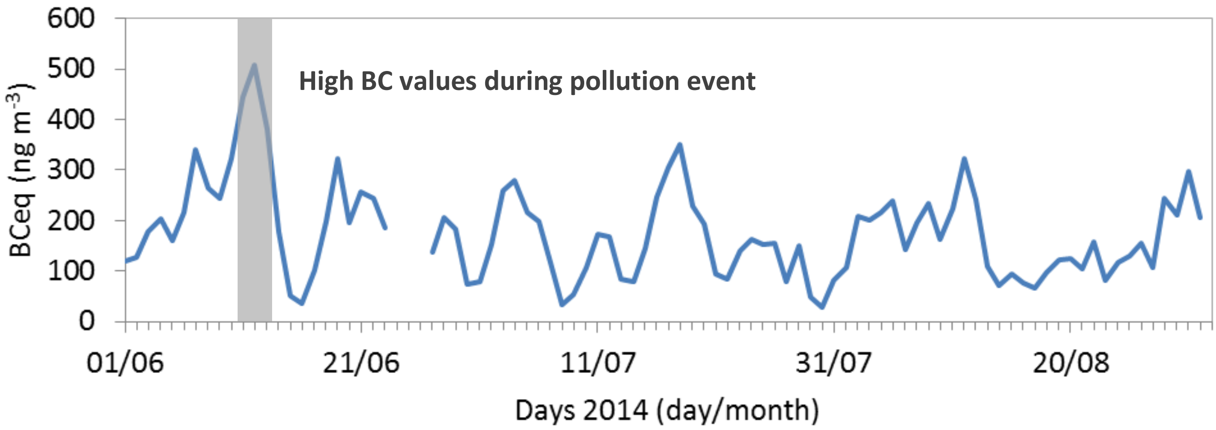
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (ng m^{-3})	25th percentile (ng m^{-3})	50th percentile (ng m^{-3})	Average mean value (ng m^{-3})	75th percentile (ng m^{-3})	Max value (ng m^{-3})
95.9	10.7	87.5	154.0	175.1	237.9	741.3

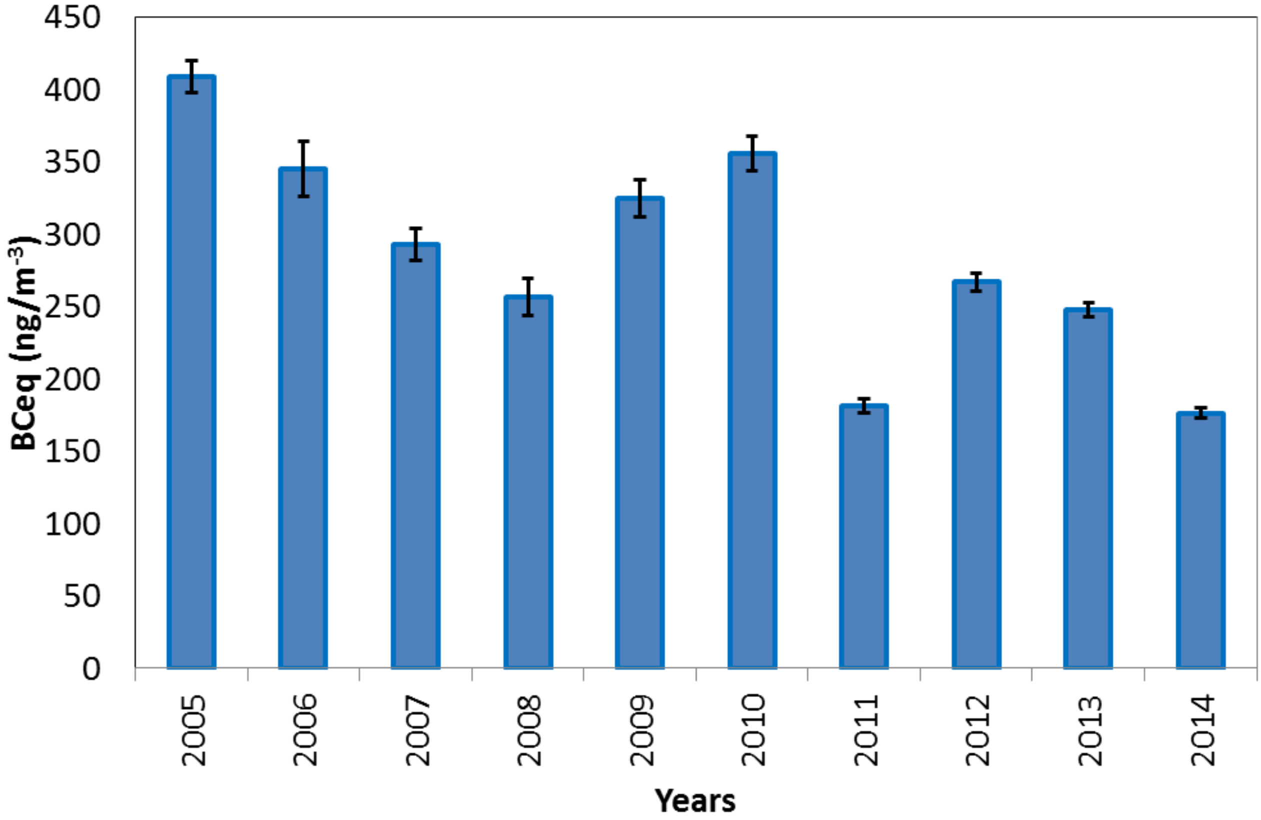
Time series of daily mean values

As was observed for the other pollution tracers, the highest concentration was observed on **June 12th**. Lower atmospheric concentrations were observed from the end of the identified pollution event until the end of the season.



Comparison with historical data-set

The 2014 summer average mean value of BC is 175.1 ng m^{-3}, which is considerably lower than the climatological mean value (297.8 ng m^{-3}). This behavior is the result of low concentrations observed for the majority of the season, thanks to the occurrence of weather conditions not favorable to the accumulation and transport of pollution at local/regional scales



Aerosol light scattering coefficient

Why is aerosol light scattering coefficient so important?

Aerosol light scattering coefficient variability is an important parameter in deriving quantitative information on the optical properties of atmospheric aerosols, which are used to determine the direct effects of aerosols on the earth radiation balance (and therefore their impact on climate change). Moreover, information on the extinction coefficient, which is related to visibility in the atmosphere, is also an important parameter in many atmospheric applications.

Instrumentation and calibration

Starting from March 2014 a new three wavelength TSI Integrating nephelometer 3563 measures the aerosol light scattering coefficient at red (700 nm), green (550 nm), and blue (450 nm) wavelengths. A calibration on site with low span gas (filtered air) and high span gas (filtered carbon dioxide) is performed every 3 months.

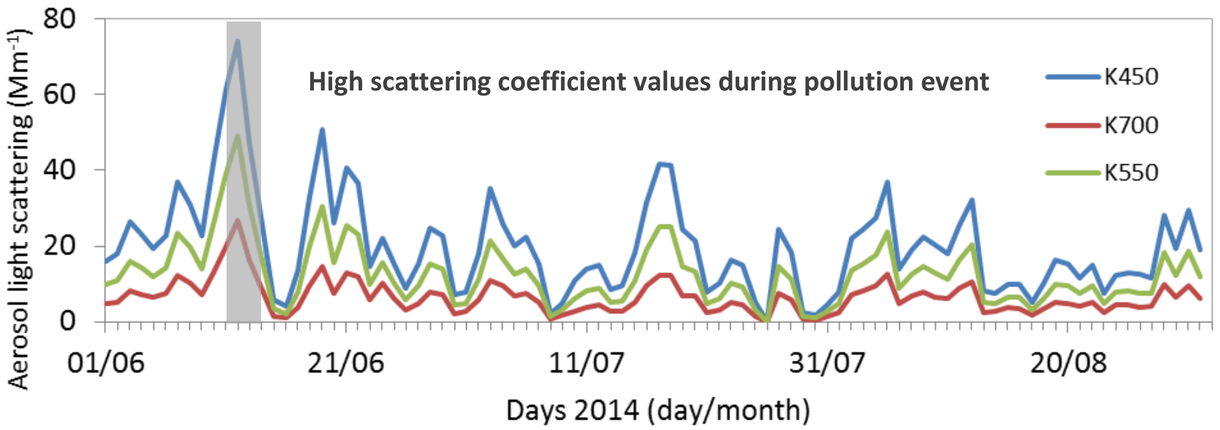
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (Mm^{-1})	25th percentile (Mm^{-1})	50th percentile (Mm^{-1})	Average mean value (Mm^{-1})	75th percentile (Mm^{-1})	Max value (Mm^{-1})
700 nm 97.6	0.03	2.63	5.46	6.60	9.01	51.29
550 nm 97.6	0.09	5.02	10.26	12.67	16.91	85.25
450 nm 97.6	0.11	8.19	16.38	20.26	27.26	120.10

Time series of daily mean values

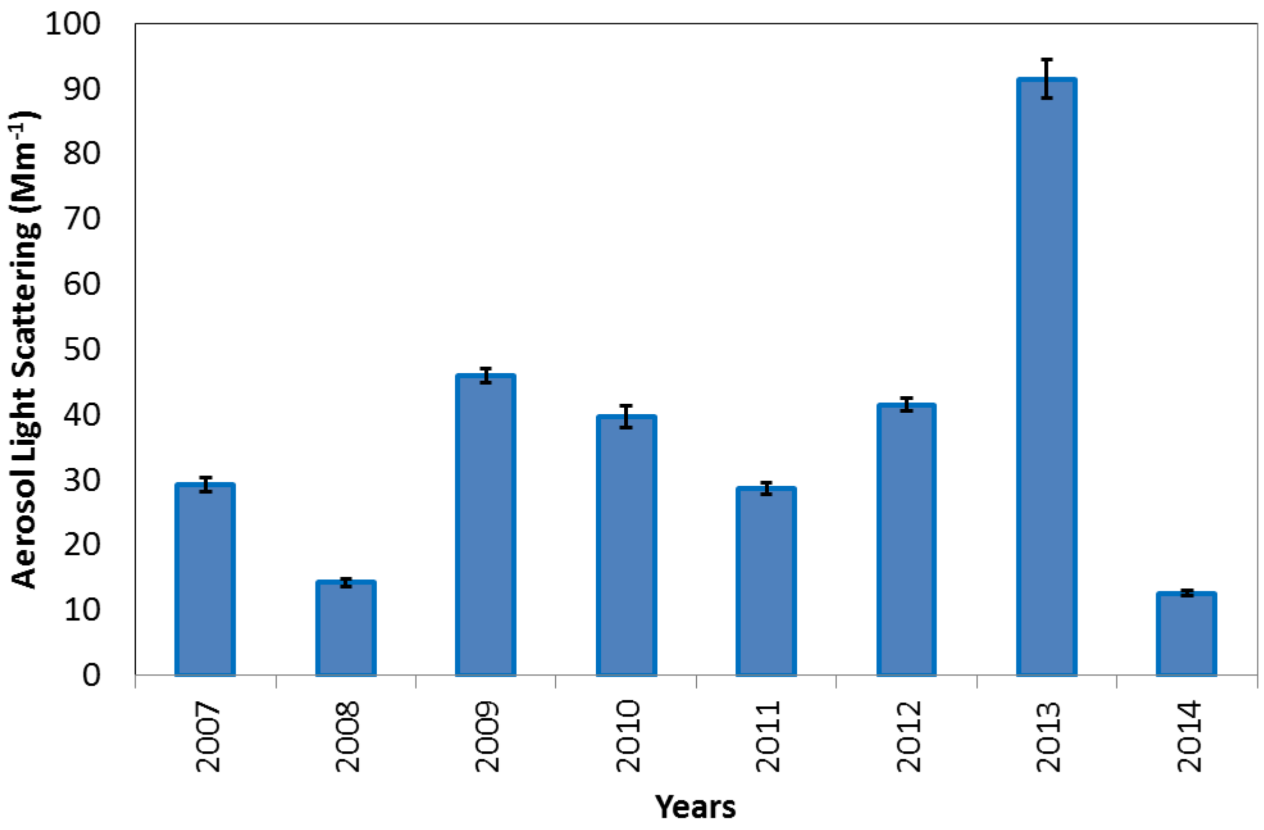
The highest daily mean value of the scattering coefficient at all three wavelength (450, 550, 700 nm) has been observed on **June 12th**, during the identified pollution episode (respectively 74.2, 49.2 and 26.9 Mm^{-1}).



Comparison with historical data-set

The 2014 summer average mean value of at 550 nm is 12.67 Mm^{-1}, which is lower than the climatological mean value (41.56 Mm^{-1}). The behavior is similar to what have been observed for all the other aerosol parameters, related to the presence of lower than average values starting from the latter half of June.

It should be noted that aerosol scattering data were obtained by a M9003 integrating nephelometer (ECOTECH) during summer seasons 2007 - 2013.



Aerosol number concentration (fine)

Why are fine particle so important?

Fine particles are highly effective in modifying the radiation field by absorbing and scattering solar and thermal radiation, thus impacting radiative transfer through the atmosphere. Additionally, aerosols act as cloud condensation and ice nuclei, thus influencing cloud properties. Aerosols also help to control the concentrations, lifetime and the physical as well as the chemical behavior of many important trace gases by providing reaction sites and serving as carrier and/or sink for many atmospheric species. Moreover, fine particles strongly contribute to air pollution, representing a main fraction of PM_1.

Instrumentation and calibration

Aerosol concentration and size distribution of particles with optical diameter between 0.3 and 20 µm have been continuously recorded in 15-size channel by using an OPC Mod. GRIMM 1.108. These measurements allow the continuous measurement of the fine mode (0.3 µm ≤ Dp ≤ 1 µm) particle number. The instrument is based on the quantification of the 90° scattering of light by aerosol particles

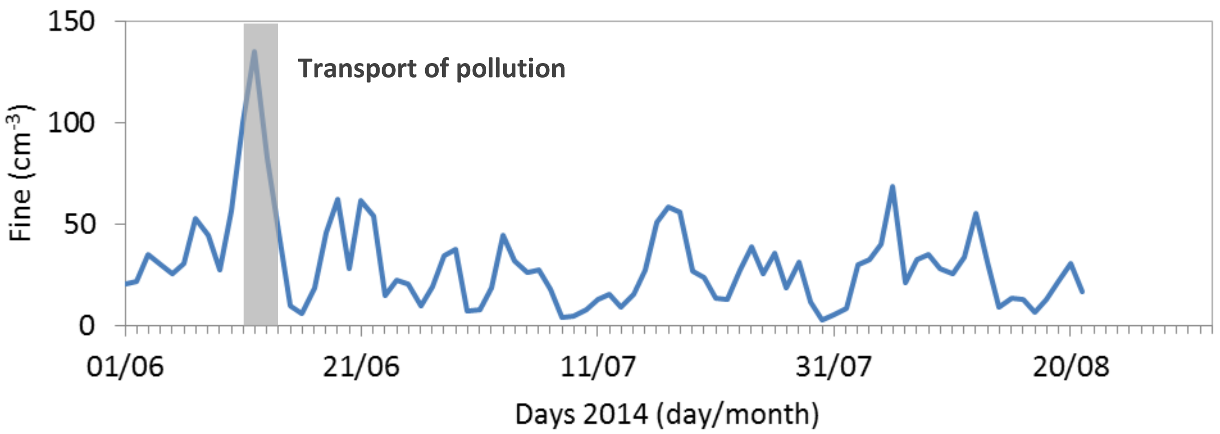
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability %	Min value (cm^{-3})	25th percentile (cm^{-3})	50th percentile (cm^{-3})	Average mean value (cm^{-3})	75th percentile (cm^{-3})	Max value (cm^{-3})
89.7	0.0	10.8	22.3	30.0	38.9	266.9

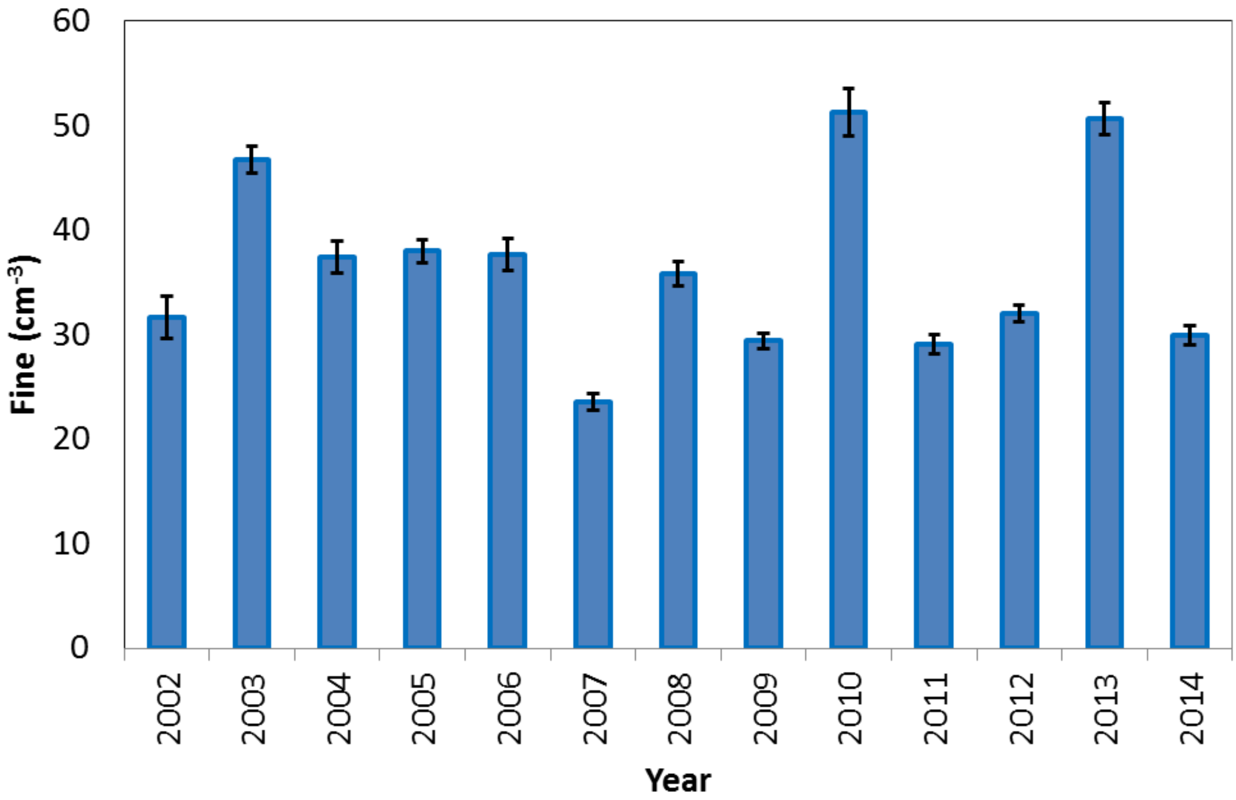
Time series of daily mean values

The highest fine particles mean value (266.9 cm^{-3}) has been observed on **12th June**, while lower values have been observed from the latter half of June with daily values which never exceeded 50 cm^{-3}.



Comparison with historical data-set

The 2014 summer average mean value of fine particles is 30.0 cm^{-3}, and is lower than the seasonal climatological value (36.9 cm^{-3}). While July and August 2014 (average value: 22.9 cm-3 and 27.8 cm^{-3}) were characterized by average values significantly lower than the climatological ones, June (38.7 cm^{-3}) was significantly higher due to the occurrence of the pollution event on 11st – 13th June.



Aerosol number concentration (coarse)

Why is this research so important?

Coarse particles measured in background conditions represent a good tracer for mineral dust or marine aerosol transport. They play a significant role in radiation budget by absorbing and especially scattering solar radiation and can act as condensation and ice nuclei. Coarse particles can represent one of the major contributors to the overall PM_{10} variability. Moreover, mineral dust contributes in determining the chemical behavior of many important trace gases (e.g. ozone) by way of heterogeneous-phase chemistry. Coarse particles strongly influence PM_{10} concentrations.

Instrumentation and calibration

Aerosol concentration and size distribution of particles with optical diameter between 0.3 and 20 µm have been continuously measured in 15-size channel by using an OPC Mod. GRIMM 1.108. These measurements permit the determination of the coarse (1 µm ≤ Dp≤ 20 µm) particle number. The instrument is based on the quantification of the 90° scattering of light by aerosol particles.

Basic statistical parameters

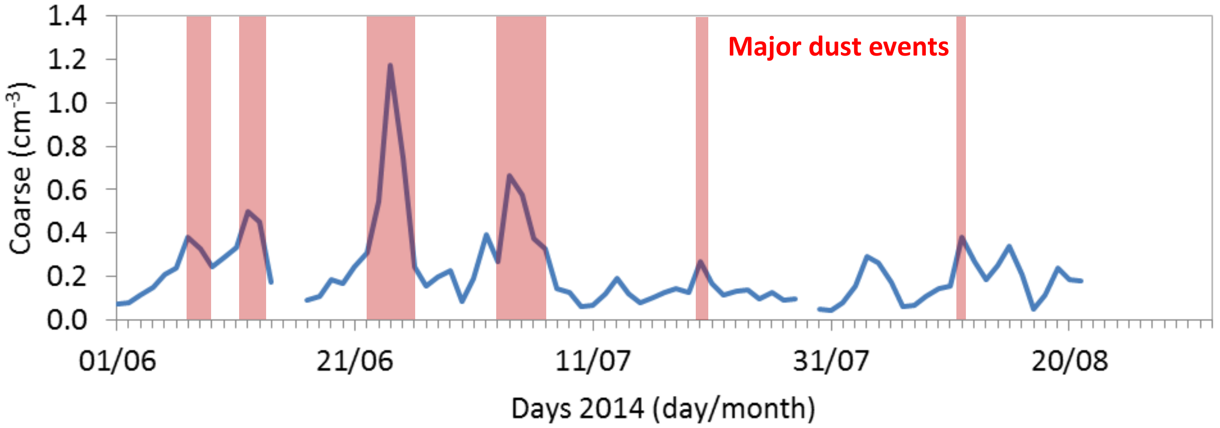
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability %	Min value (cm^{-3})	25th percentile (cm^{-3})	50th percentile (cm^{-3})	Average mean value (cm^{-3})	75th percentile (cm^{-3})	Max value (cm^{-3})
77.6	0.00	0.09	0.16	0.23	0.28	2.29

UDL: Under Detection Limit

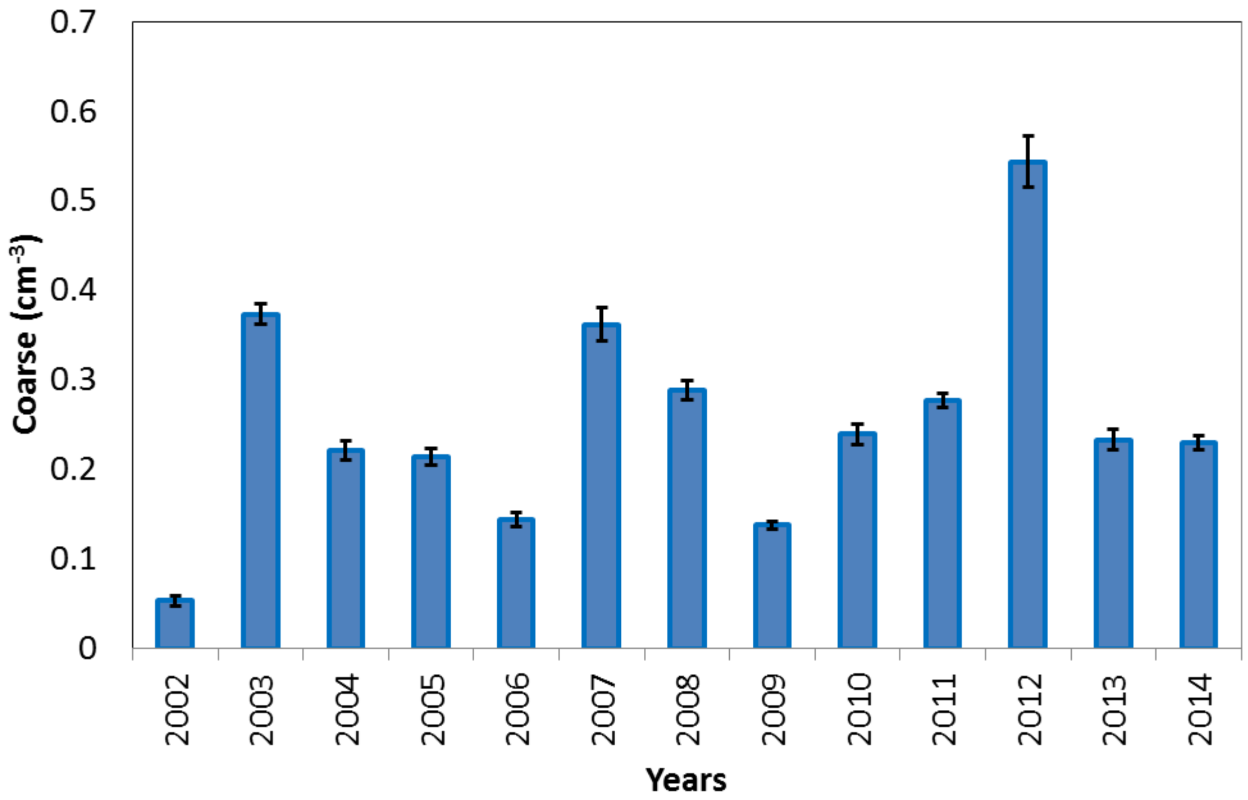
Time series of daily mean values

The highest daily mean value (1.2 cm^{-3}) has been observed on **June 24th** when a major Saharan dust transport affected the Mediterranean basin and Mt. Cimone. 3/6 Saharan dust events (7th -8th June, 12th – 13th June, 4nd – 6th July) were associated to high-pressure conditions at Mt. Cimone, indicating anticyclonic circulation over central Mediterranean basin.



Comparison with historical data-set

The summer 2014 average mean value of the coarse particles (0.23 cm^{-3}) is comparable to the climatological value (0.26 cm^{-3}). In respect to the previous years, we observed a comparable frequency of Saharan dust transport.



Halogenated gases

Why is this research so important?

Halogenated gases are both stratospheric ozone depleting substances and powerful greenhouse gases and SLCF/P. High-frequency long-term measurements of halogenated gases are used in order to detect atmospheric trends and to verify emission inventories. The measurements conducted at Monte Cimone are used in order to ascertain the compliance to the International Protocols on a European scale.

Instrumentation and calibration

Thirty halogenated gases have been continuously measured (one sample every two hours) via gas chromatography-mass spectrometry since 2001. The GC-MS instrument (Agilent 6850–5975) is equipped with an auto-sampling/pre-concentration device (Markes International, UNITY2-Air Server2) to enrich the halocarbons on a focussing trap filled with four different adsorbing materials.

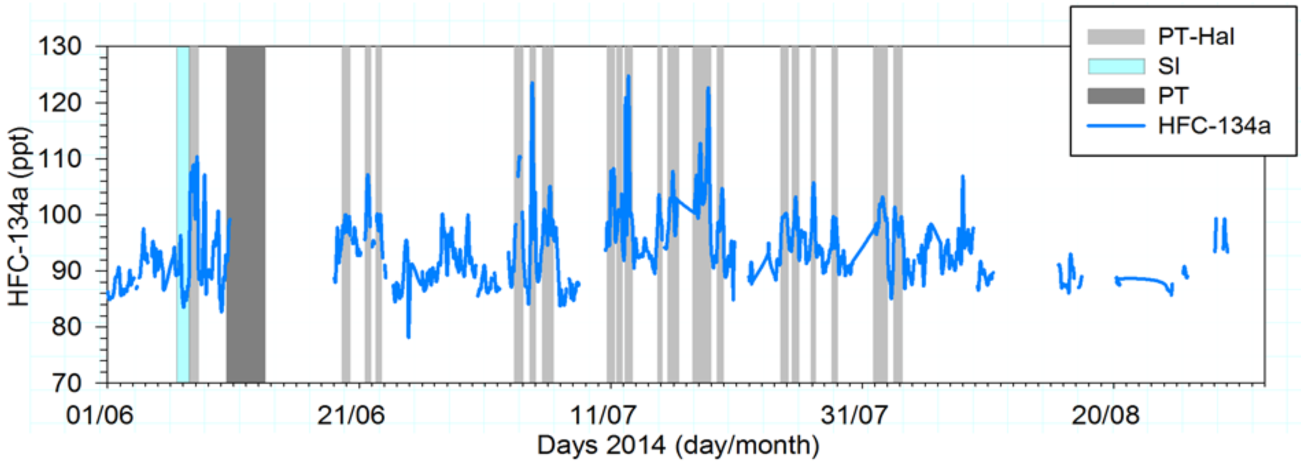
Basic statistical parameters

We report as an example the basic statistical parameters of HFC-134a, a Kyoto gas mainly used in refrigeration sealed systems, such as industrial refrigeration, car and in-house air conditioners, domestic fridges. Statistical parameters are calculated based on bi-hourly measurements from June to September 2014.

Data availability %	Min value (ppt)	25th percentile (ppt)	50th percentile (ppt)	Average mean value (ppt)	75th percentile (ppt)	Max value (ppt)
74	78.1	89.7	92.4	93.5	96.7	123.3

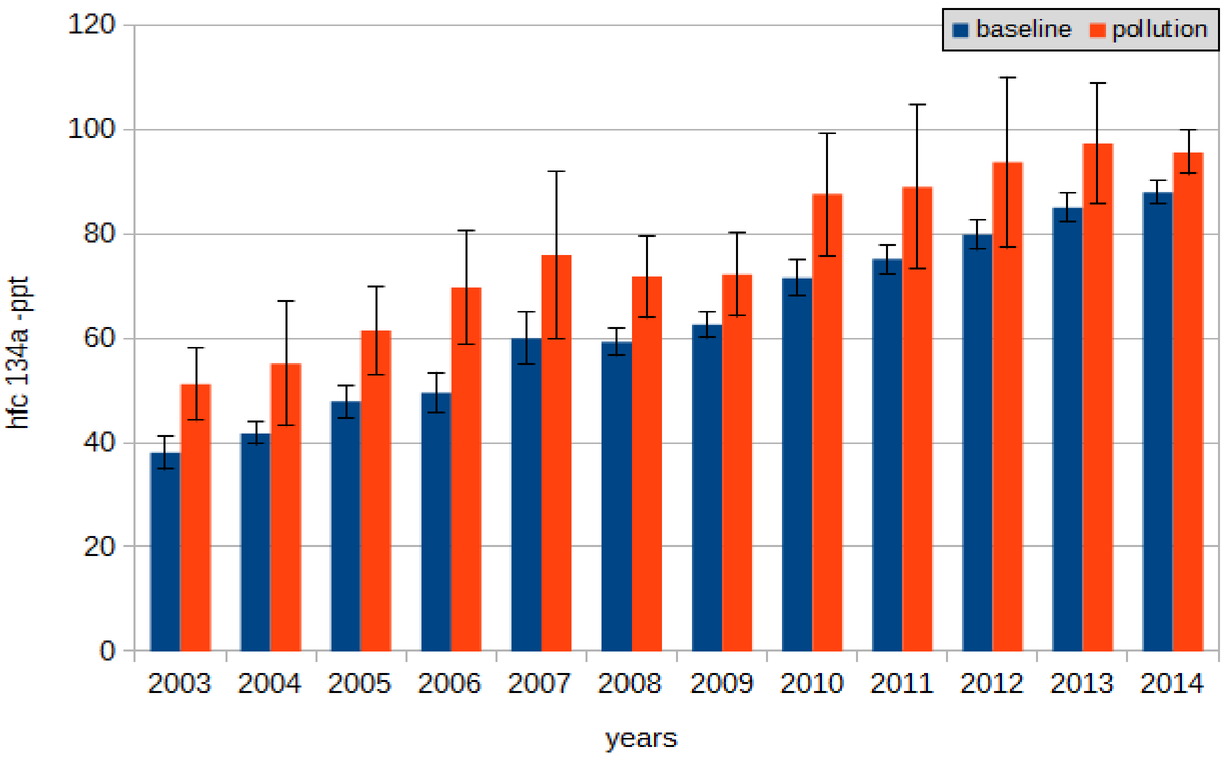
Time series of daily mean values

The summer season is characterized by lower concentrations during June and August while during July (especially the central two weeks) higher concentrations (as high as 123.3ppt, **12-07**) were observed. An high number of pollution transport episodes were identified through the analysis of the halogenated markers (PT-Hal on the graph, gray bars), while only a single major event was detected by other tracers (O_3, CO and BC).



Comparison with historical data-set

Both baseline (blue) and polluted data-set (orange) summer-averages show a continuous and uninterrupted increase of atmospheric concentration. Summer observations show a large difference between the two data-set, due to the typical increase in the use of refrigeration equipment during the hot season but also owing to the typical advection of air-masses from the lower troposphere.



** At CMN, the following halogenated gases are continuously monitored: CFC-11, CFC-12, CFC-114, CFC-115, H-1211, H-1301, HCFC-22, HCFC-142b, CH3Br, CH3CCl3, CCl4 (Montreal Gases); PFC-218, SO2F2, HFC-32, HFC-125, HFC-134a, HFC-143a, HFC-152a, HFC-227ea, HFC-236fa, HFC-245fa, HFC-365mfc; CH3Cl, CH3I, CH2Cl2, CHCl3, CH2Br2, CHBr3, TCE, PCE.

Volatile organic compounds (VOCs)

Why is this research so important?

Voatile organic compounds (VOCs) of anthropogenic origin play a significant role as precursors of both particular matter and tropospheric ozone. In situ continuous measurements of VOCs are used also for inferring the OH radical concentration. Furthermore, correlations among the different species are used In order to identify the main anthropogenic sources of these compounds.

Instrumentation and calibration

13 VOCs have been continuously measured (one sample every two hours) via gas chromatography-mass spectrometry since 2008. The GC-MS instrument (Agilent 6850–5975) is equipped with an auto-sampling/pre-concentration device (Markes International, UNITY2-Air Server2) to enrich the VOCs on a focussing trap filled with four different adsorbing materials.

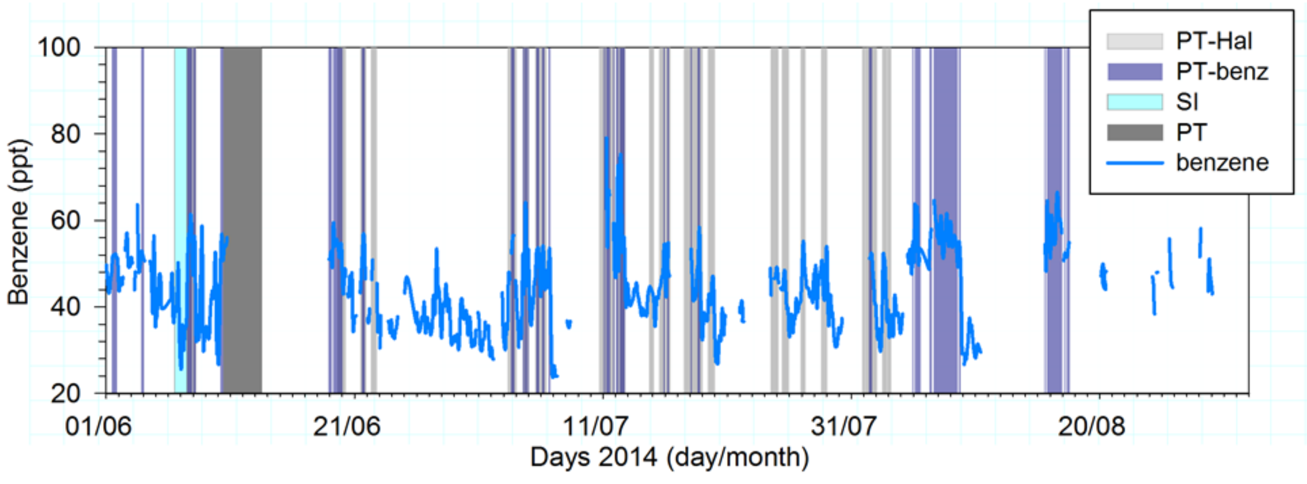
Basic statistical parameters

We report results for Benzene, as an example of all the VOCs measured. Benzene is a constituent of crude oil, is widely used worldwide in chemical industries as an intermediate and in the recent past was regularly added to gasoline to increase the octane number. The benzene atmospheric concentration is mainly due to exhausts from motor vehicles, from evaporative losses from petrol, incomplete combustions (wildfire) and industrial emissions/leakages. Statistical parameters are calculated based on bi-hourly measurements from June to September 2014.

Data availability %	Min value (ppt)	25th percentile (ppt)	50th percentile (ppt)	Average mean value (ppt)	75th percentile (ppt)	Max value (ppt)
55	23.8	36.7	43.6	43.7	50.8	79.1

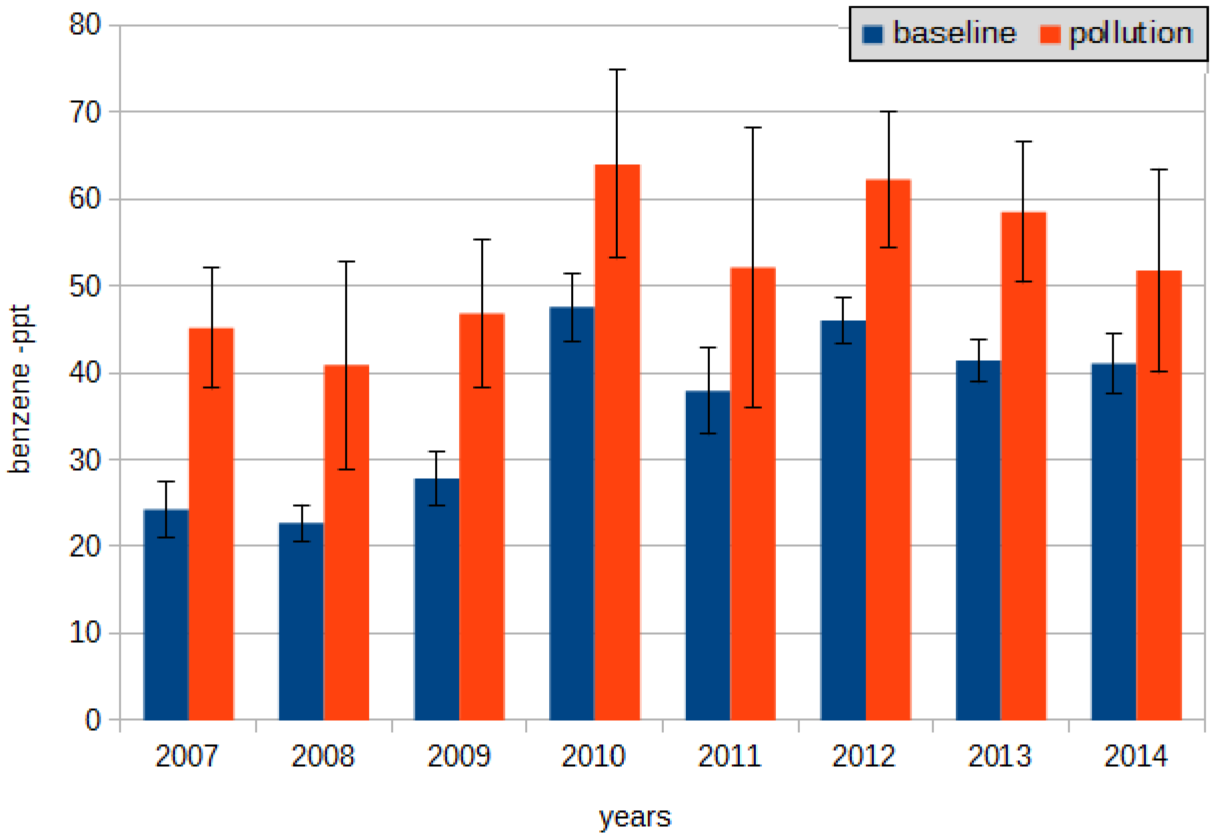
Time series of daily mean values

The summer benzene concentrations were characterized by the presence of higher values during middle June (79.1 ppt, **11-07**) and first half of August (65.9 ppt, 17-08), similarly to what have been observed for HFC-134 (both clear anthropogenic pollutants).



Comparison with historical data-set

Benzene, as far as most of the VOCs, is characterized by a short atmospheric lifetime (10 days, year average). As a consequence, its concentration shows a large range of variation over the years and within seasons. The discrepancy between baseline and polluted data during summer season, for which reactivity is larger and life time is shorter than during winter time, is an evidence of the transport of polluted air masses from local to mid-range source regions.



** At CMN, the following VOC are continuously monitored: ethyne, propane, propene, i-butane, n-butane, i-pentane, n-pentane, c-propane, benzene, toluene, ethyl-benzene, m+p-xylene, o-xylene

Stratospheric nitrogen dioxide

Why is stratospheric nitrogen dioxide so important?

Nitrogen dioxide, in the stratosphere, acts both as an ozone destroying substance and as a buffer against halogen catalysed ozone loss (formation of chlorine and bromine nitrates). The main source of nitrogen oxides in the stratosphere is N_2O coming from soil emissions. The diurnal, seasonal, and latitudinal variation of NO_2 is dominated by the equilibrium between NO_x (NO_2+ NO) on one hand and the reservoir substances (mainly N_2O_5, HNO_3, $ClONO_2$) on the other hand.

Instrumentation and calibration

Nitrogen dioxide is measured by means of an UV-Vis spectrometer (GASCOD) which collects diffuse solar radiation each day at sunset and sunrise. Its columnar value is measured each day at sunset and at sunrise, giving the two value called AM and PM.

Basic statistical parameters

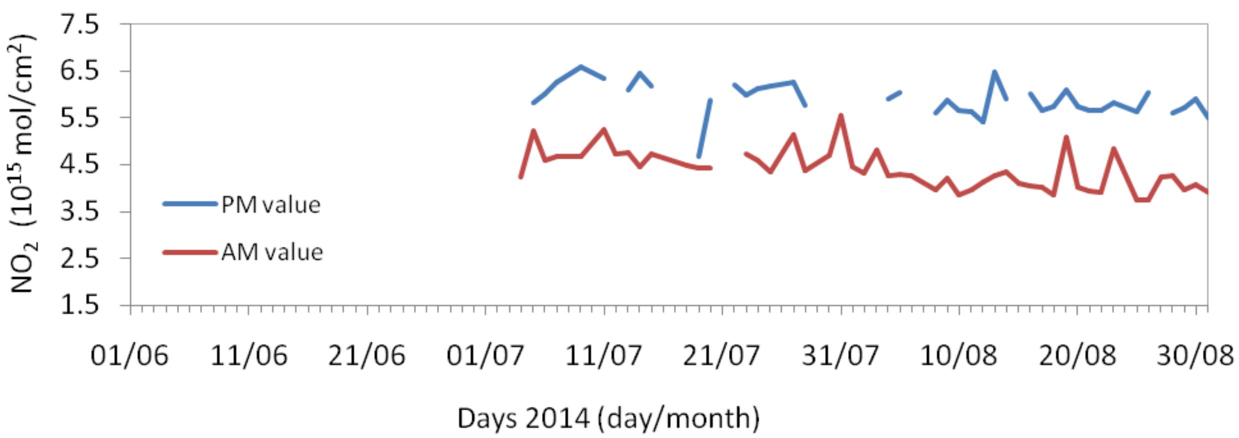
Statistical parameters are calculated basing on 1 data per day from June 2014 to September 2014.

Data availability (%)	Min value (mol/cm^2)	25^{th}percentile (mol/cm^2)	50^{th}percentile (mol/cm^2)	Average mean value (mol/cm^2)	75^{th} percentile (mol/cm^2)	Max value (mol/cm^2)
AM (54.3)	3.75	4.06	4.32	4.38	4.68	5.54
PM (46.7)	4.66	5.69	5.87	5.88	6.09	6.57

UDL: under detection limit

Time series of daily mean values

Data were available starting from July 1st 2014. During the month of June the GASCOD data are not available. The time series follows the typical climatologic trend.



Air Temperature

Why is air-temperature so important?

Temperature data are useful to detect the occurrence of summer heat waves, during which photochemical smog episodes and transport of pollution from the boundary layer to the free troposphere can be favoured. The measurement of meteorological parameters at ICO-OV is a fundamental activity for the analysis of other measurements such as trace gases and aerosols.

Instrumentation and calibration

The basic meteorological data (temperature, relative humidity and atmospheric pressure) are measured above the ICO-OV terrace using instrumentation in compliance with WMO recommendations (IRDAM WST7000 and Rotronics thermo-hygrometer).

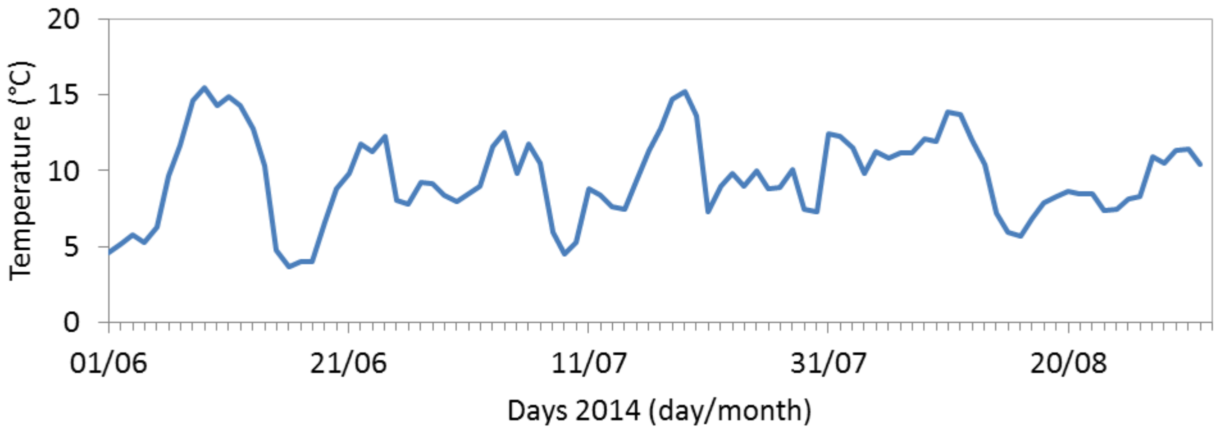
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability %	Min value (°C)	25th percentile (°C)	50th percentile (°C)	Average mean value (°C)	75th percentile (°C)	Max value (°C)
100.0	0.8	7.2	9.4	9.5	11.6	19.8

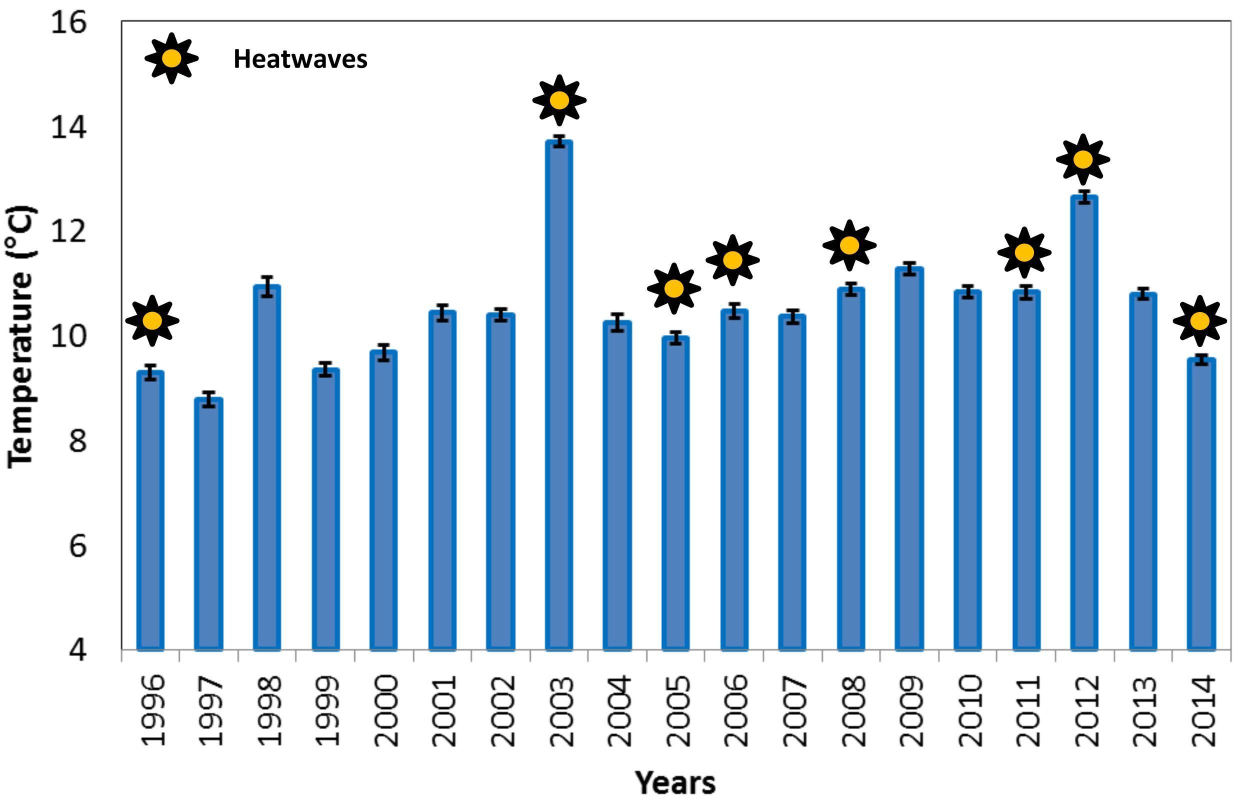
Time series of daily mean values

The highest daily mean value (15.5 °C) has been observed on **9th June**, after a Saharan dust transport event and during the only summer HW, even though high values were also observed during 16th - 20th July and 9th - 12th August 2014, when high pressure conditions affected Mt. Cimone.



Comparison with historical data-set

The **summer 2014 average temperature (9.5 °C) is lower than the seasonal climatological value (10.6 °C):** it constitutes the 4th lower seasonal value observed at ICO-OV from the beginning of the measurement programme. This results from 59 days characterized by below average temperature even if **an heatwave was observed at ICO-OV on 8th -13th June 2014.**



Heathwaves identification

To unambiguously identify HWs which affected the north of Italy, we analysed the time series of daily mean and maximum temperature at ICO-OV and at low-land locations (Verona: 45°23'N 10°53'E; Milano: 45°26'N 9°17'E; Bologna: 44°32' 11°18'). In particular, we categorized as being influenced by HWs the warm periods (when simultaneously identified by the following WMO and ECA&D (European Climate Assessment and Dataset) selection methodologies:

(1) ECA&D: a period of at least 6 days with daily mean temperature above the upper tenth percentile of the temperature distribution for each of the calendar days;

(2) WMO: : a period of at least 6 days with the daily maximum temperature greater than 5°C above the climate normal (CliNo) maximum temperature.

Relative humidity

Why is relative humidity so important?

Relative humidity is a key parameter to identify the occurrence of dry meteorological conditions (RH<60%), usually associated with stratospheric intrusions or air-mass transport from the free troposphere. During summer, afternoon-evening RH increases can trace transport of air-masses from the boundary layer.

Instrumentation and calibration

The basic meteorological data (temperature, relative humidity and atmospheric pressure) are measured above the ICO-OV terrace using instrumentation in compliance with WMO recommendations (IRDAM WST7000 and Rotronics thermo-hygrometer).

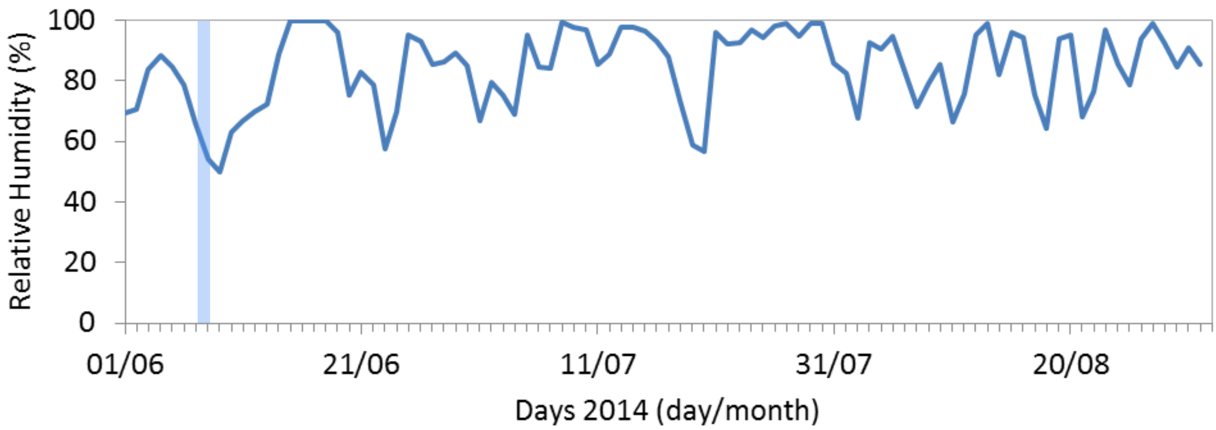
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (%)	25th percentile (%)	50th percentile (%)	Average mean value (%)	75th percentile (%)	Max value (%)
100.0	19.2	72.7	90.5	84.4	99.0	100.0

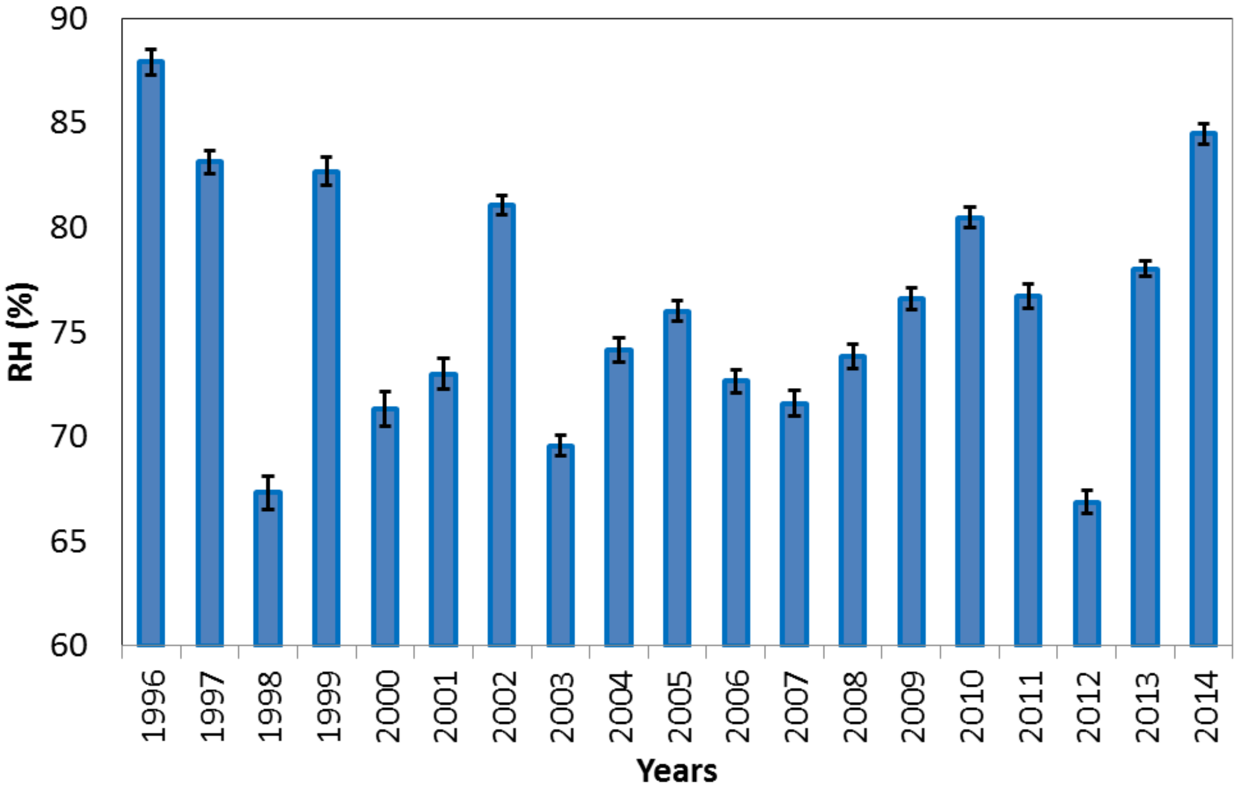
Time series of daily mean values

The daily mean RH values ranged from 100% to 49.8%. 27% of days showed average value higher than 95%. Periods characterized by relatively dry conditions (mean daily values lower than 60%) were observed only in conjunction with high pressure conditions during the **HW**, **air-mass transport from North Africa and one stratospheric intrusion event** affected ICO-OV.



Comparison with historical data-set

The summer 2014 average relative humidity (84.4%) was higher than the seasonal climatological value (75.7%). This can be related to the occurrence of bad weather conditions during summer 2014, except that during the detected summer HW . Only for four days, all of them occurred during period of high atmospheric pressure conditions, average daily values below 60% were observed at ICO-OV.



Atmospheric pressure

Why is atmospheric pressure so important?

Pressure is a key parameter to investigate the variability of weather conditions at the ICO-OV. As an example, heat waves periods are characterized by the occurrence of high pressure values, while sudden pressure variability can be used to identify the passage of synoptic-scale disturbances possibly related to stratospheric intrusions.

Instrumentation and calibration

The basic meteorological data (temperature, relative humidity and atmospheric pressure) are measured above the ICO-OV terrace using instrumentation in compliance with WMO recommendations (IRDAM WST7000 and Tecnoel barometer).

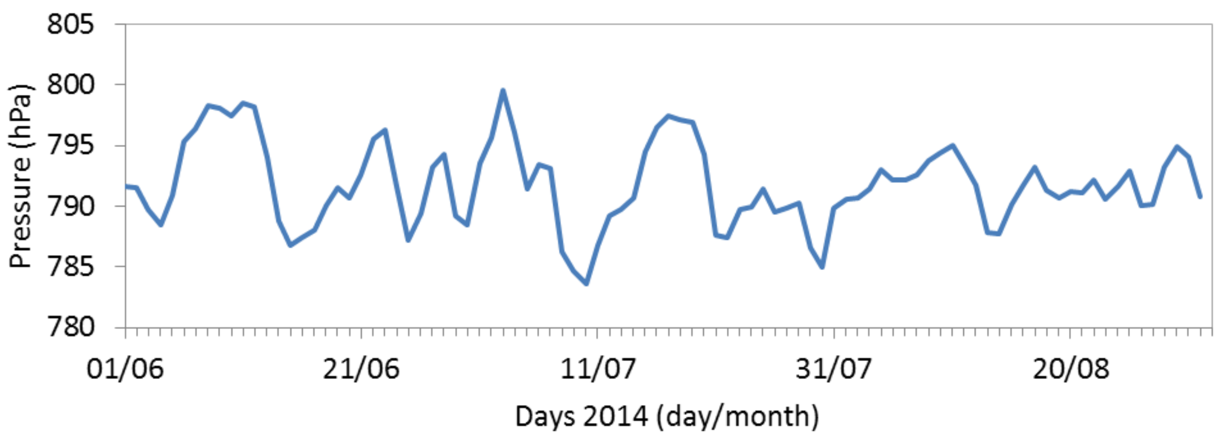
Basic statistical parameters

Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (hPa)	Min value (hPa)	25th percentile (hPa)	50th percentile (hPa)	Average mean value (hPa)	75th percentile (hPa)	Max value (hPa)
100.0	781.7	789.6	791.5	791.8	794.1	800.4

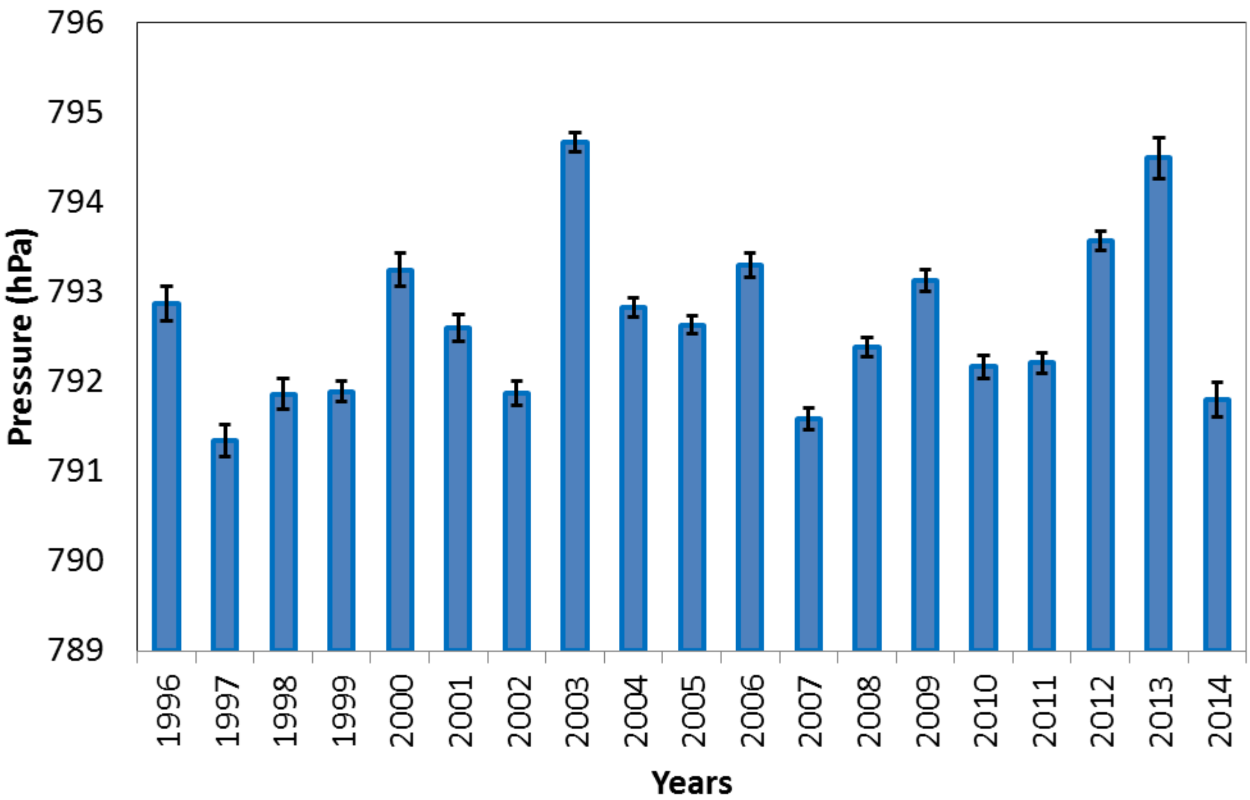
Time series of daily mean values

The daily mean pressure values was characterized by **high variability: pressure drops alternated with pressure increases**, indicating the occurrence of unusual summer conditions. The highest daily value (800.4 hPa) occurred on **3rd July**, the lowest daily value (783.6 hPa) on **10th July**. A period of prolonged high pressure conditions characterized the June HW (8 – 13 June).



Comparison with historical data-set

The **summer 2014 averaged atmospheric pressure (791.7hPa) ranked as the third lowest value observed at ICO-OV since 1996.** As deduced by the analysis of the time series of daily values, this can reflect the frequent occurrence of pressure minima associated with the presence of synoptic atmospheric disturbances.



Wind speed and direction

Why is wind so important?

Wind speed and direction are used to identify the air mass circulation and therefore the transport of polluted air-masses from the near Po basin, as well as to identify the passage of surface fronts and the development of thermal wind circulation.

Instrumentation and calibration

Wind measurements are carried out at 5 m and 3 m high above the roof of the station, by using an integrated weather station IRDAM WST7000 and a sonic anemometer Vaisala WS425, respectively.

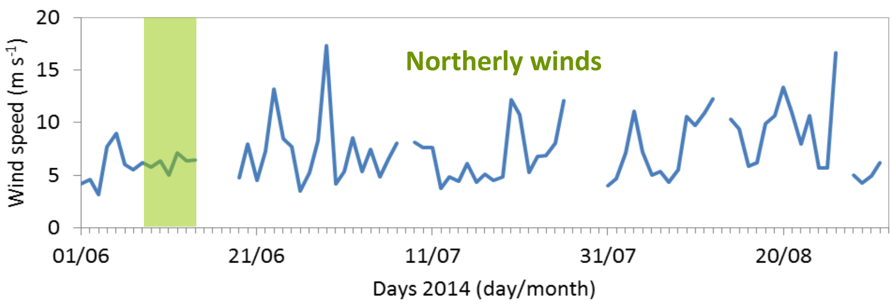
Basic statistical parameters of wind speed

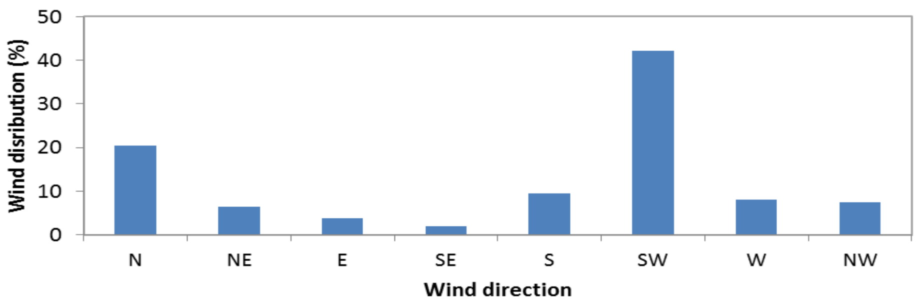
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014. Due to technical problems affecting the primary anemometer (Vaisala 425), IRDAM WST700 data were used. Wind speed data recorded for RH>95% were not considered due to the large instrumental uncertainty during foggy conditions.

Data availability (%)	Min value (m/s)	25^{th} Percentile (m/s)	50^{th} Percentile (m/s)	Average mean value (m/s)	75^{th} percentile (m/s)	Max value (m/s)
57.0	0.9	4.1	6.1	7.0	9.3	22.1

Time series of daily mean values

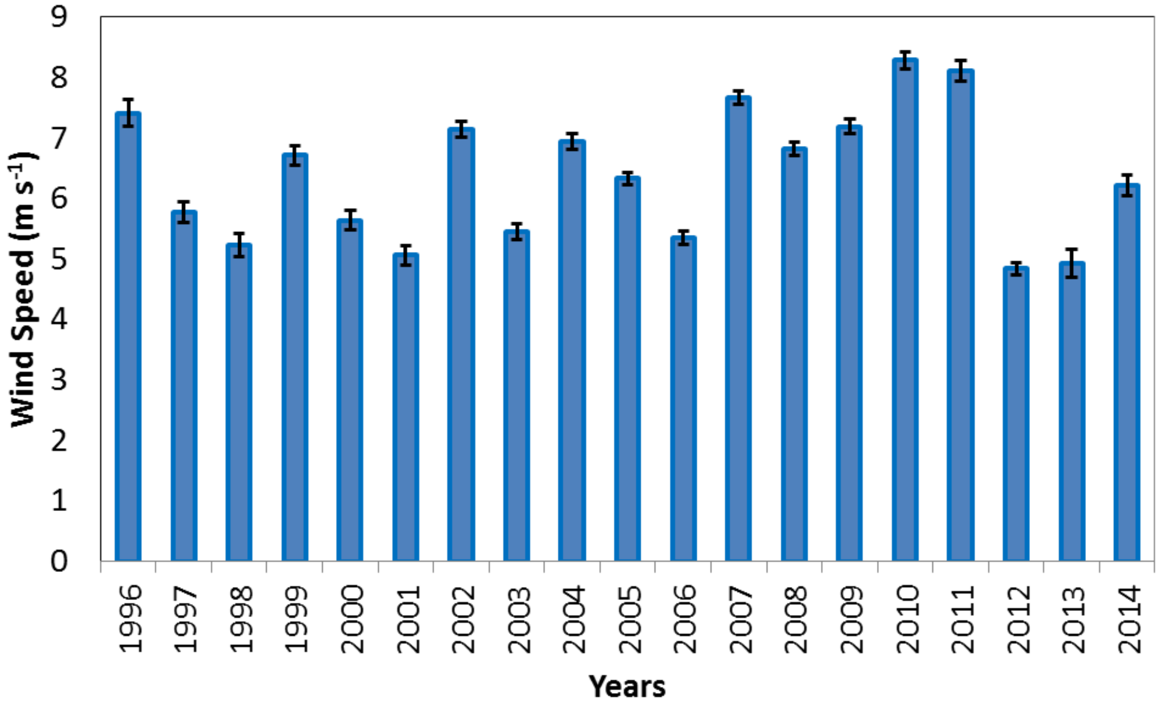
Although the summer 2014 is characterized by a predominance of SW winds, a clear predominance of N winds of relatively low speed was observed from June 8^{th} till June 15^{th}, during the June HW and the only episode of pollution observed at the measurement site, possibly indicating the Po Valley as the source of the pollutants.

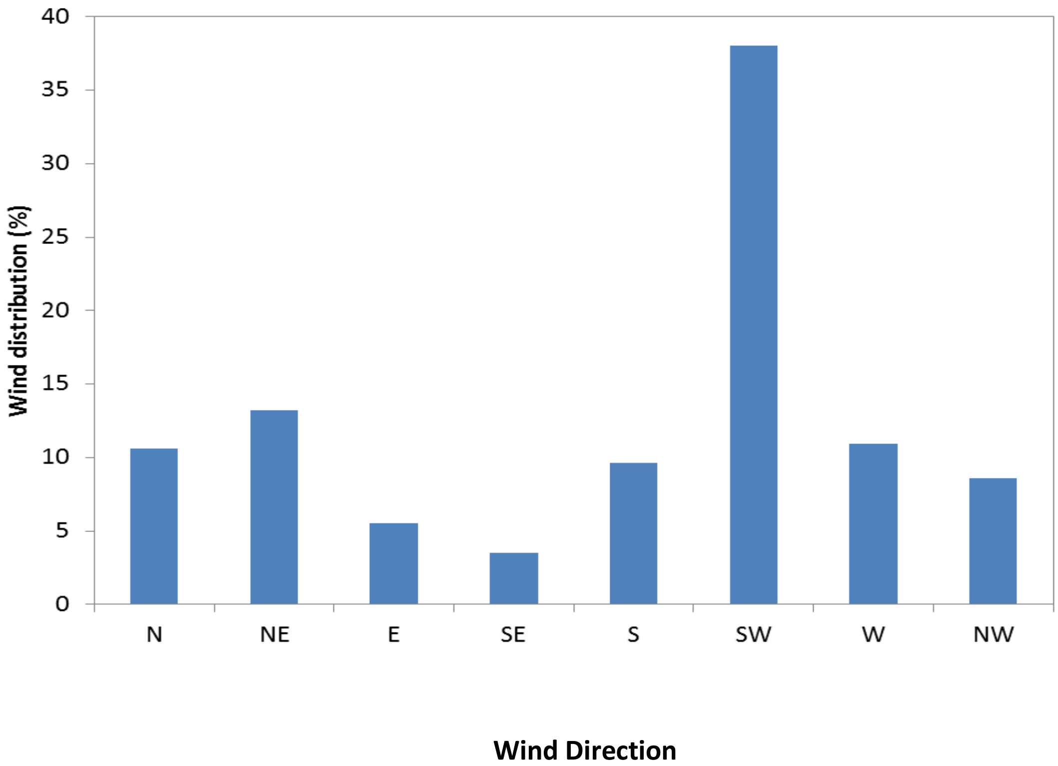




Comparison with historical data-set

The summer 2014 showed an average wind speed (7.0 m/s) **that is slightly higher than the climatological summer value** (6.4 m/s). Rather high wind speeds (> 10 m/s) have been observed on a daily basis, mostly in connection with atmospheric pressure minima and thus testifying the passage of synoptic disturbances. The seasonal wind direction is similar to the climatological one, with a prevalence of south-westerly winds (44.2 %).





Solar radiation (short-wave and UV-B)

Why is solar radiation so important?

Solar radiation is a key parameter in studying climate change and also play a role in defining the chemical properties of the troposphere, triggering photochemical reactions of important compounds (like O_3). Moreover, UV-B radiation is fundamental in determining the oxidative properties of the troposphere by leading O_3 photo-dissociation and thus determining OH levels.

Instrumentation and calibration

Solar radiation (wavelength: 350 – 1100 nm) and UV-B (wavelengths: 280-315 nm) are respectively measured by a commercial silicon cell pyranometer (Skye SKS110) and a silicon photodiode (Skye SKU 430). Calibrations were performed by factory against a WMO secondary standard pyranometer (for Skye SKS110) and against the National Physical Laboratory UK reference standard lamp (for Skye SKU 430).

Basic statistical parameters (Solar radiation)

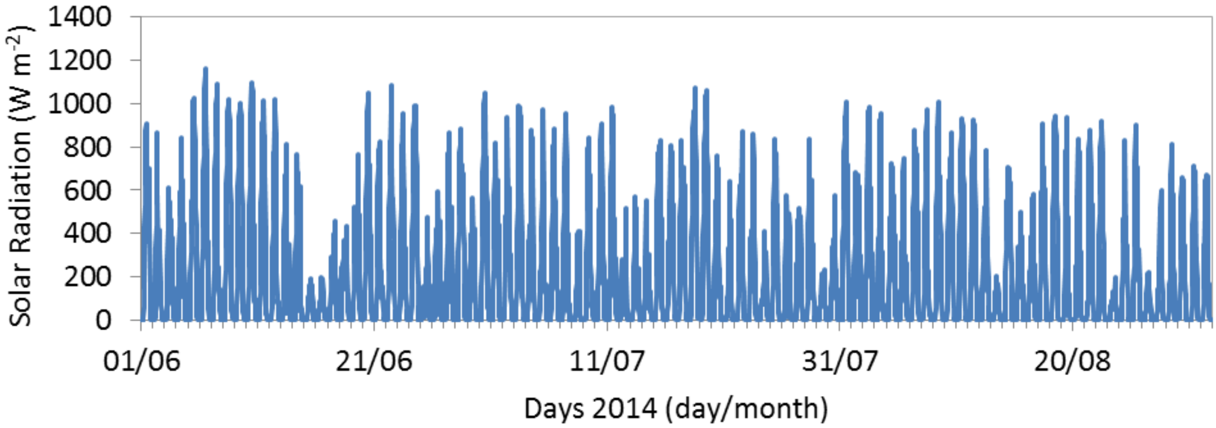
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (W/m^2)	25th Percentile (W/m^2)	50th Percentile (W/m^2)	Average mean value (W/m^2)	75th percentile (W/m^2)	Max value (W/m^2)
100.0	UDL	1.2	76.7	216.0	367.6	1161.0

UDL: under detection limit

Time series (Solar radiation)

Summer 2014 was characterized by frequent cloudy conditions, as deduced by the severe drops in solar radiation fluxes occurring on 15th,16th, 25th June, 12th, 24th ,28th July, 13th, 23th and 26th of August. This drops are associated with minima in atmospheric pressure and temperature values (possible influence of synoptic disturbances). The highest daily value was observed on June, 8th (377.4 W m^{-2}) while the highest 30 minute mean value (1161.0 W m^{-2}) was observed on June, 6th.



Basic statistical parameters (UV-B)

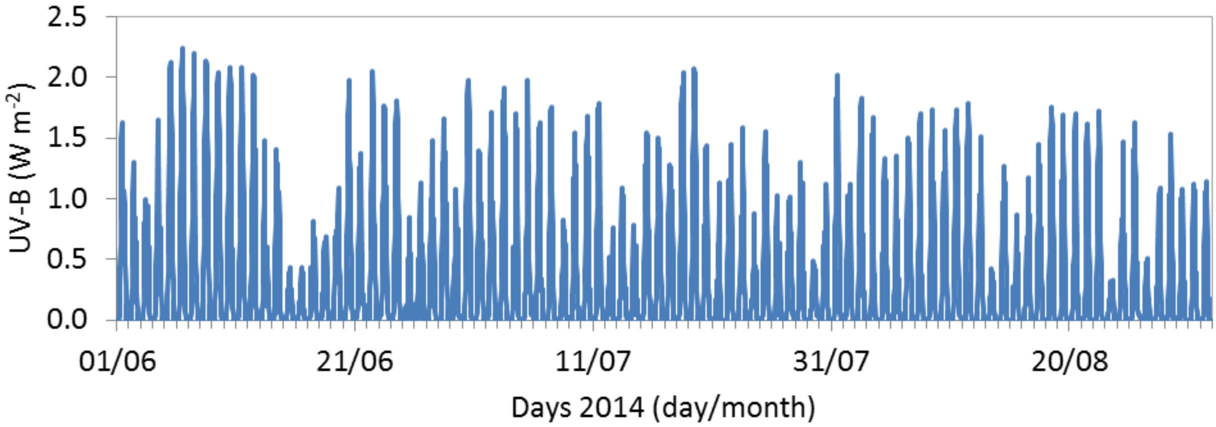
Statistical parameters are calculated basing on 30-minute aggregated values from June 2014 to August 2014.

Data availability (%)	Min value (W/m^2)	25^{th} Percentile (W/m^2)	50^{th} Percentile (W/m^2)	Average mean value (W/m^2)	75^{th} percentile (W/m^2)	Max value (W/m^2)
100.0	UDL	UDL	0.07	0.34	0.54	2.24

UDL: under detection limit

Time series (UV-B)

The UV-B solar fluxes day-to-day variability is almost the same of solar radiation. The highest daily average (0.6 W m^{-2}) and 30 minutes average (2.2 W m^{-2}) values were observed on June, 6^{th}.



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Research Projects

GAW (Global Atmosphere Watch) The Global Atmosphere Watch (GAW) programme of WMO is a partnership involving 80 countries, which provides reliable scientific data and information on the chemical composition of the atmosphere, its natural and anthropogenic change, and helps to improve the understanding of interactions between the atmosphere, the oceans and the biosphere.

NextData The Project of Interest NextData will favour the implementation of measurement networks in remote mountain and marine areas and will develop efficient web portals to access meteoclimatic and atmospheric composition data, past climate information from ice and sediment cores, biodiversity and ecosystem data, measurements of the hydrological cycle, marine reanalyses and climate projections at global and regional scale.

SHARE (Station at High Altitude for Research on the Environment) Share is an integrated project funded by EV-K2-CNR Committe comprising an international climate and atmospheric monitoring network, researches in environmental and geophysical sciences and new technology development for monitoring activity in high mountain regions. Working in synergy with projects run by UNEP and WMO, data from the SHARE initiative benefit the international scientific community as well as decision makers.

ACTRIS (Aerosols, Clouds, and Trace gases Research InfraStructure Network) ACTRIS is a European Project aiming at integrating European ground-based stations equipped with advanced atmospheric probing instrumentation for aerosols, clouds, and short-lived gas-phase species. ACTRIS will have the essential role to support building of new knowledge as well as policy issues on climate change, air quality, and long-range transport of pollutants. ACTRIS is building the next generation of the ground-based component of the EU observing system by integrating three existing research infrastructures EUSAAR, EARLINET, CLOUDNET, and a new trace gas network component into a single coordinated framework. ACTRIS is funded within the EC 7th Framework Programme under "Research Infrastructures for Atmospheric Research" and started on 1 April 2011 for a period of 4 years.

MACC-2 (Monitoring Atmospheric Composition and Climate - Interim Implementation) is the current pre-operational atmospheric service of the European GMES programme. MACC provides data records on atmospheric composition for recent years, data for monitoring present conditions and forecasts of the distribution of key constituents for a few days ahead. MACC-II combines state-of-the-art atmospheric modelling with Earth observation data to provide information services covering European Air Quality, Global Atmospheric Composition, Climate, and UV and Solar Energy.

EUSAAR (European Supersites for Atmospheric Aerosol Research) The objective of EUSAAR UE-funded project is the integration of measurements of atmospheric aerosol properties performed in a distributed network of 20 high quality European ground-based stations. This integration contributes to a sustainable reliable operational service in support of policy issues on air quality, long-range transport of pollutants and climate change.

EUROHYDROS The aim of EUROHYDROS has been the initialisation of a European Network for observations of molecular Hydrogen based on 12 continuous measurements sites which allow a wide range of observation, from clean air stations for measurements of atmospheric background to moderately polluted and urban. This in order to improve the understanding of hydrogen in the global background atmosphere and of the impact of European emissions on the present day atmosphere.

CIRCE (Climate Change and Impact Reserach: the Mediterranenan Environment) The general project objectives are to predict and to quantify physical impacts of climate changes in the Mediterranean area; to evaluate the consequences of climate changes for the society and the economy of the populations located in the Mediterranean area; to develop an integrated approach to understand combined effects of climate change; to identify adaptation and mitigation strategies in collaboration with regional stakeholders.

AGAGE-Advanced Global Atmospheric Gases Experiment AGAGE and its predecessors (the Atmospheric Life Experiment, ALE, and the Global Atmospheric Gases Experiment, GAGE) have been measuring the composition of the global atmosphere continuously since 1978. The AGAGE is distinguished by its capability to measure over the globe at high frequency almost all of the important gases species in the Montreal Protocol (e.g. CFCs and HCFCs) to protect the ozone layer and almost all of the significant non-CO2 gases in the Kyoto Protocol (e.g. HFCs, methane, and nitrous oxide) to mitigate climate change.

CEOP HE (Coordinated Energy and Water Cycle Observation Project - High Elevation) CEOP HE is a component of 'regional focus' within the Coordinated Energy and Water Cycle Observation Project (CEOP) of the Global Energy and Water Cycle Experiment (GEWEX), under the WCRP of WMO. CEOP HE aims to further knowledge on physical and dynamic processes in high elevation areas, contributing to global climate and water cycle studies by providing rare but crucial information from high elevations. This initiative was launched and is coordinated by the Ev-K2-CNR Committee.

ACCENT (Atmospheric Composition Change - The European Network of Excellence) The overall goals of the UE-network ACCENT are to promote a common European strategy for research on atmospheric composition sustainability, to develop and maintain durable means of communication and collaboration within the European scientific community, to facilitate this research and to optimise the interactions with policy-makers and the general public.

AEROCLOUDS (Climatic Effects of Aerosol and Clouds) AEROCLOUDS is a project funded by the Italian Ministry for University and Research to improve our knowledge of the role of aerosol and clouds in the climate system. Four research lines have been investigated: 1) Radiative properties of aerosols ("direct" climatic effects); 2) Aerosol-Cloud interactions ("indirect" climatic effects); 3) Climatic effects of clouds and precipitation; 4) Regional and global modelling of the aerosol effects on climate.

SOGE (System for Observations of Halogenated Greenhouse Gases in Europe) SOGE is an integrated system for observation of halogenated greenhouse gases in Europe. The project was funded by UE and builds on a combination of observations and modelling. The observations are partly surface in situ data collected continuously at four background stations as a part of national or international measurement programs. For some species(PFC, SF6), for which high-frequency measurements are not yet fully developed, such capacity will be developed as a part of SOGE.

POLPO (Pollution Hot Spot Monitoring from GOME Applied to the Po-basin) POLPO investigated the feasability of applying satellite data for monitoring large pollution plumes. The prototype service demonstrated the application of GOME data for case studies. Users as, e.g., environmental agencies, who have to rely on ground-based measurements, found the added value satellited data provide together with its limitations in the feasability study.

QUILT (Quantification and Interpretation of Long-Term UV-Vis Observations of the Stratosphere)
The general aim was to use the existing ground-based, satellite and balloon borne UV-visible data as well as 3D atmospheric modelling tools for quantifying ozone loss in the past, to monitor its development in the present and to investigate its relation to active halogen and nitrogen species.

TOR-2 (Tropospheric Ozone Research - 2) The overall aim of TOR-2 was to quantify crucial processes in the atmosphere in order to improve the scientific background for the development of effect-based control strategies for photochemical oxidants over Europe.

STACCATO (Influence of Stratosphere-Troposphere Exchange in a Changing Climate on Atmospheric Transport and Oxidation Capacity) EU-project STACCATO is a comprehensive study of stratosphere-troposphere exchange (STE) processes and their effect on atmospheric chemistry. STE is a key factor controlling the budget of ozone, water vapour and other substances in both the troposphere and lower stratosphere.

MINATROC (Mineral Dust and Tropospheric Chemistry) Problems to be solved this EU-project focuses on the transformation of atmospheric pollutants from Europe in the presence of mineral dust over South Europe and Africa. Intensive field campaigns, experimental laboratory investigations and modeling studies were conducte dti evaluate the influence of mineral dust on troposphere oxidazing properties.

VOTALP-2 (Vertical Ozone Transport in the Alps - 2) The EU research project VOTALP II investigated the enhanced vertical exchange above the Alps as well as other processes which might be relevant for increased ozone concentrations. The role of stratospheric intrusions for mountain peaks and of horizontal advection of polluted air for the foothill area causing a high ozone abundance has been quantified for selected locations.

VOTALP (Vertical Ozone Transport in the Alps) The EU research project VOTALP investigated transport and formation of ozone in the Alps, focusing on processes which can cause increased ozone concentrations, namely stratospheric intrusions, horizontal advection of polluted air, and in-situ production of ozone due to emissions in Alpine valleys.

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