

## **CZECH REPUBLIC**

### **INTRODUCTION**

In the Czech Republic (CR) monitoring and research of ozone and UV-B solar radiation are mostly carried out in the Czech Hydrometeorological Institute (CHMI). Scientific activities are performed also by the Institute of Atmospheric Physics of the Czech Academy of Science and by the Department of Meteorology of the Charles University in Prague. While the monitoring is fully funded by the CHMI the research projects are supported also by grant agencies or by EC programmes. In recent years the extensive assistance has been provided by CHMI experts to the ozone part of the Global Atmosphere Watch Programme (GAW) of WMO.

### **OBSERVATIONAL ACTIVITIES**

#### **Column measurements of ozone**

Daily observations of total ozone (DS and ZS) have been performed with the Dobson and Brewer spectrophotometers collocated at the Solar and Ozone Observatory of CHMI in Hradec Kralove (SOOHK) since 1962 and 1994, respectively. The observations are stored in the ozone database of CHMI and submitted to partner institutions. Both total ozone data series have been re-evaluated and re-deposited into WOUDC in 2005 [1], [2].

#### **Profile measurements of ozone**

Balloon-borne ECC ozone sondes are launched three times per a week in January - April at the Aerological Observatory (AOPH) of CHMI in Prague. The vertical profiles of ozone are stored in the ozone database of CHMI, WOUDC and NDSC, as well.

#### **UV measurements**

##### ***Broadband measurements***

The broad-band UV Solar Light-Biometers are operated at three CHMI stations (Hradec Kralove, Kosetice and Labska Bouda) that are located in typical climate and geographical regions of CR (lowlands, rural land and mountains). The observations are used for the UV public information system and for research activities - see next parts of this Report.

##### ***Narrowband filter instruments***

No narrowband UV radiometers are currently operated in CR.

##### ***Spectroradiometers***

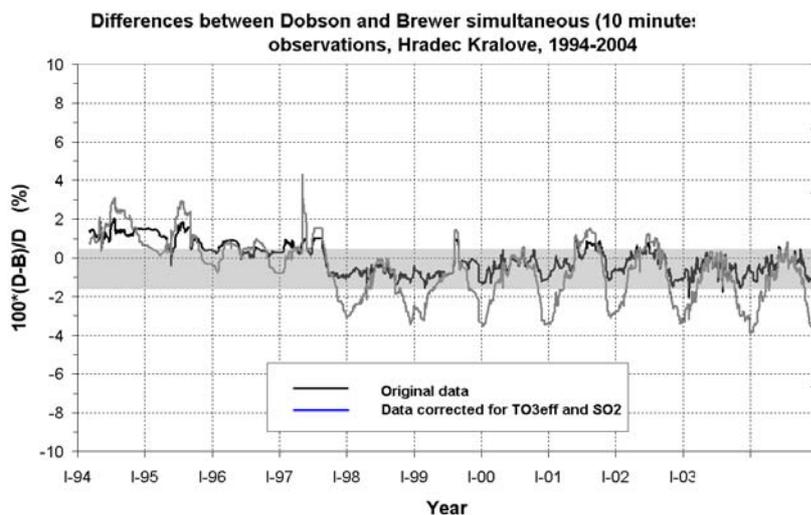
Spectral measurements of UV-B solar radiation (298-325 nm) and calculation of erythema DUV irradiances have been performed with the single (MKIV) and double (MKIII) Brewer spectrophotometers at SOO-HK since 1994 and 2004, respectively. The observations are accompanied by measurements of other auxiliary radiation fluxes (global, diffuse, reflected).

#### **Calibration activities**

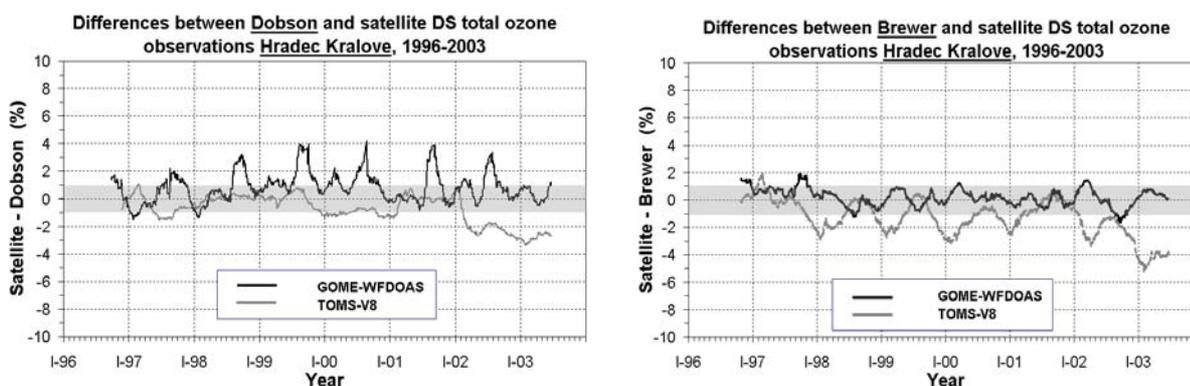
The above mentioned instruments are regularly calibrated towards regional or world standards of the GAW calibration centres (RDCC-E, Hohenpeissenberg, MSC/IOS Brewer Triad) and they are operated according to SOPs defined in GAW manuals. Therefore the data sets are consistent with observations from other GAW stations and they are given in relevant world calibration scales.

## RESULTS FROM OBSERVATIONS AND ANALYSIS

The observations taken at SOO-HK have been used for data quality assessment, estimation of long-term ozone trends and analyses of relation between ozone and UV in the territory of CR in several recent and current international research projects joined by Czech teams - see the paragraph 5. Attention is paid mainly to investigation of relation between simultaneous Dobson and Brewer total ozone observations and between ground and the latest satellite data sets (TOMS-8, GOME/WFDOAS). The results show significant seasonal variations of differences that exceed 1% calibration accuracy of the spectrophotometers and thus they could influence the estimation of ozone trends if combined or non-homogenized data series are used - see Figures 1, 2 and [2], [3]. The quality assessment of UV spectral measurements taken with Brewers confirmed that the UV scans need to be filtered and correct (e.g. for spikes) before they are deposited into data bases and used for statistical analyses.



**Figure 1: Differences between simultaneous DS Brewer and Dobson total ozone observations in Hradec Kralove - original data and data corrected for ozone effective temperature and total SO<sub>2</sub>.**

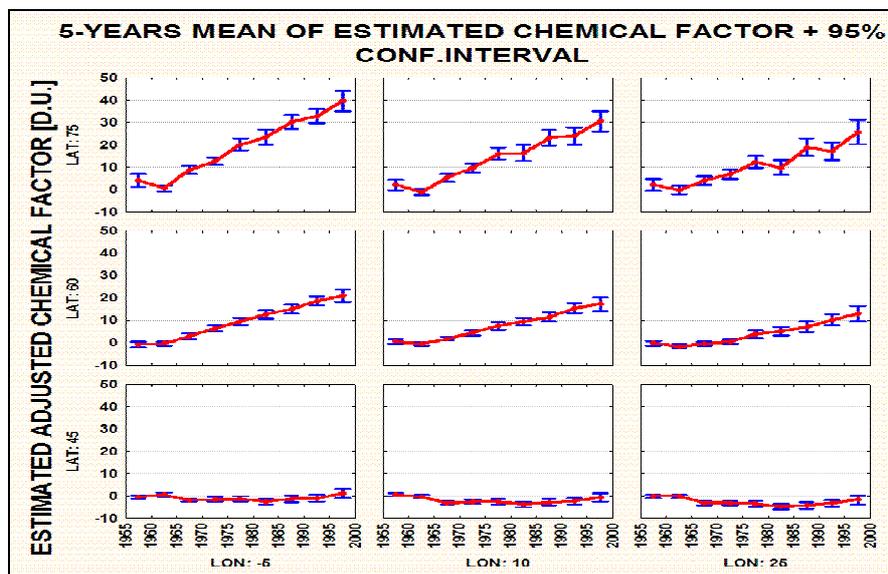


**Figure 2: Relative differences between simultaneous DS Brewer, Dobson and satellite (TOMS-8, GOME/WFDOAS) total ozone observations in Hradec Kralove.**

## THEORY, MODELLING, AND OTHER RESEARCH

Neural technologies have been used to simulate long-term ozone and UV changes by specialists from CHMI. The chemically induced part of the decadal ozone change was estimated by the neural model that was developed within the project CANDIDOZ and run with ERA-40, solar flux, circulation indices and AOD proxies in the European region [4]. The results showed that the magnitude of the chemical component of ozone losses has been increasing since the early sixties in the region but it depends on the latitude - see Fig. 3. While in the southern part (45° N) of the region its influence is almost negligible in high latitudes (over 50° N) the ozone losses have

reached 30-40 DU (8-12%) during last four decades. Similar neural model has been developed to simulate UV spectral irradiances and UV erythemal doses by total ozone, clearness indices and AOD at Hradec Kralove. The model is now tested by re-evaluated total ozone data series from SOO-HK and it is to be used for estimation of the UV climatology in the territory of CR during last five decades - see the project COST-726



**Figure 3: Time evolution of the estimated chemical component of decadal total ozone change in the European region - simulation with the neural model of CHMI, EC project CANDIDOZ [5].**

## DISSEMINATION OF RESULTS

### Data reporting

All ozone observation taken in CR are regularly submitted into the WOUDC, Toronto and also to other partner institutions and projects - e.g. the Ozone Mapping Centre of MSC, NDSC data base, GAW cooperating stations in Central Europe, MATCH campaigns and satellite validating teams. UV observations that have been carried out under projects funded by EC (COST-713, COST-726, SUVDAMA, EDUCE, SCOUT) are reported to the European UV data base maintained by FMI.

### Information to the public

A public ozone and UV information system has been implemented and operated by CHMI since 1999. Reports on actual and forecasted UV Indices and variation of ozone are issued for the territory of CR and disseminated to mass media daily. The system is supported by information campaigns that are also joined by medical experts [5]. The internet component of the system that is linked with international centres (e.g. TEMIS/KNMI the Netherlands and ECUVF/DWD, Germany) is located at the address: <http://www.chmi.cz/meteo/ozon/hk-e.html>.

### Relevant scientific papers

- [1] Vanicek K.(2003), *Calibration History of the Dobson 074 and Brewer 098 ozone spectrophotometers*, Publication of the Czech Hydrometeorological Institute, Prague, 2003, ISBN:80-86690-08-3
- [2] Vaníček., Dubrovský M. and Staněk M., *Evaluation of Dobson and Brewer total ozone observations from Hradec Králové, Czech Republic, 1961-2002 (2003)*, Publication of the Czech Hydrometeorological Institute, Prague, 2003, ISBN: 80-86690-10-5
- [3] Vanicek K. (2005), *Results of the Work Task 4. The final Report of the CANDIDOZ Project*, Brussels - in print.

- [4] Metelka L., Kliegrova S. and K. Vanicek (2005), *Application of Neural Models for Simulation of Total Ozone in the European Region, Deliverable 12 of the CANDIDOZ Project, Publ. of the Czech Hydrometeorological Institute, Prague, ISBN:80-86690-30-X*
- [5] Vaníček, K. , Janouch M. a K. Ettlér (2001): *UV-Index for the Public. Deliverable of the COST-713 Project, Publ. of the Czech Hydrometeorological Institute, Praha (in Czech)*
- [6] Koehler U.H. and K. Vanicek (2000): *The new European Dobson Calibration Center at Hohenpeissenberg and Hradec Kralove. Proceedings of the Quadrennial Ozone Symposium, Sapporo, NASDA Publ., July 2000, p.483*

## PROJECTS AND COLLABORATION

The Czech scientific community is involved in several research and development projects that are focused mainly on analyses of ozone and UV observations taken by national monitoring facilities and their relations to external data sets. Attention is also paid to modeling of UV radiation with the aim to the ozone change and regime of cloudiness. The long-term cooperation is pursued between CHMI and the GAW Programme of WMO. Following are the chief ongoing collaborations and projects that should be mentioned.

### CANDIDOZ

“Chemical and Dynamical Influences on Decadal Ozone Change”. EC FP-5, 2002-2005. Experts from CHMI and from the Department of Atmospheric Physics of the Czech Academy of Sciences investigate:

- Differences between simultaneous total ozone data sets originated with different instruments (Dobson, Brewer, satellite - TOMS-8, GOME/WFDOAS) and their impacts on ozone trends
- Estimation of the chemical component of ozone changes in the European region using neural-models and ERA-40 proxies.
- Relation between occurrence of ozone laminae and trends in ozone profiles in NH mid latitudes.

### SCOUT-O3

“Stratospheric-Climate Links with Emphasis on the UTLS”. EC FP-6, 2004-2009. The CHMI specialists are involved in its UV part. High-quality UV spectral and broadband measurements taken at Czech stations are provided to SCOUT partners. Development and tests of a CHMI’s neural UV model and its application on reconstruction of the UV climatology in CR are the goals of the Czech team. The activities follow up the previous participation of CHMI in the project EDUCE.

### COST-726

“Long term changes and climatology of UV radiation over Europe”. The EC coordinated, 2004-2008. Definition of the climatology of UV radiation and selected biologically effective UV radiation doses in the territory of CR by UV models are the chief tasks of the Czech scientists in the project. The models will be tested and applied to derive UV radiation data for long time period and places without UV measurements.

### GAW Ozone

For a decade experts of CHMI contribute to maintenance of the GAW ozone monitoring network. The activities are focused mainly on implementation of new technologies and calibration of instruments at stations in developing countries (Capacity Building) and on cooperation with GAW central facilities. The following missions and achievements have been realized in the recent years.

- Technical service on ozone spectrophotometers (WMO IC in Dahab, Egypt, 2004)
- Re-installation and upgrade (semi-automation) of ozone spectrophotometers at GAW stations (Botswana, Egypt, Kenya, South Africa in 2004/2005)
- Training of operators from ozone stations - annual campaigns (15 trainees in 2003-2005)
- Assistance in realization of calibration campaigns of the Regional Dobson Calibration Centre - Europe, Hohenpeissenberg, Germany  
<http://www.chmi.cz/meteo/ozon/dobsonweb/eurdcc.htm>
- Assistance in establishment of the Regional Brewer Calibration Centre - Europe, Izana, Spain
- Maintenance of the Dobson Web  
Site:<http://www.chmi.cz/meteo/ozon/dobsonweb/welcome.htm>
- Donation of the software packages for Dobson and Brewer data management at GAW stations
- Participation in GAW scientific groups (SAG-Ozone, Dobson and Brewer Committees)

Currently the above activities are mostly sponsored by the Czech governmental project: "Maintenance of the Network for Monitoring the Ozone Layer in Developing Countries" established by the Ministry for Environment of CR for the period 2004-2006.

## **FUTURE PLANS**

- The long-term monitoring of ozone and UVB radiation will be pursued in CR as specified above. Attention will be paid mainly to maintenance of calibration condition of the instruments and to implementation of updated SOPs, so that observations from the Czech facilities keep the highest achievable quality. Further establishment of new stations is not planned.
- Participation in the ongoing projects mentioned in this Report will continue. Future activities will be focused on the Czech contribution to building up the IGACO system in the regional scale. This includes the assistance to the Regional Dobson and Brewer Calibration Centres and on testing new technologies for Brewer spectrophotometers, above all.
- The UV simulation model developed at SOO-HK will allow CHMI experts to reconstruct the UV climatology of the last 5-6 decades. The results are expected to be applied in Czech and international integrated environmental projects.

## **NEEDS AND RECOMMENDATIONS**

- Quality of assimilated ozone observations from the integrated ozone monitoring system should generally reach the calibration accuracy of the ground system so that recovery of the ozone layer is reliably identified and documented in the future.
- Accuracy of ground and satellite ozone observations in high latitudes needs to be better understood and improved through analyses of available records or by experimental missions.
- Analyses and modeling of the Arctic ozone losses and their relation to the stratospheric dynamics should get the highest priority in research projects in order to estimate a possible influence of the climate change on the state of the ozone layer.
- The WMO/GAW Programme and the UNEP should continue their key role in the capacity building and in the international coordination of ozone monitoring and research.
- Sustainable quality of UV spectral measurements in the global network requires establishment of global/regional references and implementation of standard calibration procedures for particular types of UV radiometers.

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