DEDICATED MONITORING OF ATMOSPHERIC CO_2 IN WESTERN EUROPE
A CONCERTED ACTION IN AEROCARB

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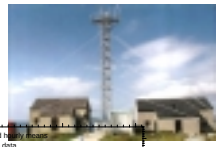
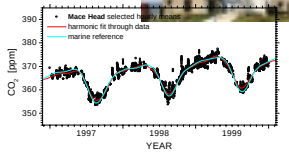
Aerocarb

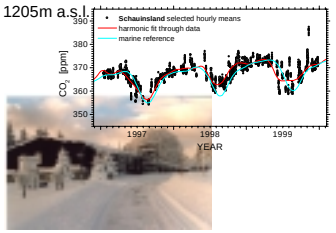
Mace Head
9.90°W, 53.33°N
5m a.s.l.





Mace Head station is situated at the western coast of Ireland. The CO_2 measurement program is run by the *Laboratoire de Sciences du Climat et de l'Environnement (LSCE, Gif-sur-Yvette, France)* (3). Air is sampled from a tower at a height level of 23 m above ground. Maritime background conditions (>6 m sec^{-1}, 200° to 300°) are selected according to Biraud et al. (2000).

Schauinsland
7.92°E, 47.92°N
1205m a.s.l.



Schauinsland station in the Black Forest, Germany, situated on a mountain ridge about 1000 m above the polluted Rhine valley, is run by the *German Environment Agency (Berlin, Germany)* (6). To avoid influences from these Rhine valley sources through upslope winds during the day, only night-time values (2200-0600 LT) and situations of high wind speed are selected. In addition, selection is based on concentration stability during one day (Schmidt et al., 1996).

References:

Apadula F., F. Rocchetti and C. Vannini, 2000."GreenInfo" web site, /monitoraggio/.

Biraud, S., P. Ciais, M. Ramonet, P. Simmons, V. Kazan, P. Monfray, S. O'Doherty, T.G. Spain and S.G. Jennings, 2000. *J. Geophys. Res.* 105D, 1351-1366.

Cundari, V., T. Colombo and L. Ciattaglia, 1995. *Il Nuovo Cimento* 18C, N1.

Haszpra, L. 1999. *J. Geophys. Res.* 104D, 26 953-26 960.

Hensen A., W.C.M. Van den Bulk, A.T. Vermeulen and G.P. Wyers, 1997. ECN, report ECN-C--97-032.

Globalview-CO2: Coop. Atmospheric Data Integration Project - Carbon Dioxide. Ftp.cmdl.noaa.gov, Path: ccg/co2/GLOBALVIEW, 2001

Levin, I., R. Graul and N.B.A. Trivett, 1995. *Tellus*, **47B**, 23-34.

Longhetto, A. C. Cassardo, S. Ferrarese, C. Giraud, F. Apadula, P. Bacci, P. Bonelli and A. Marzorati, 1997. *Advances in Atmospheric Sciences* **14**.

Schmidt, M., R. Graul, H. Sartorius and I. Levin, 1996. *Tellus*, **48B** (4), 457-473.

INTRODUCTION

Western Europe has a long tradition in monitoring CO_2 concentration in the continental atmosphere. However, the vicinity of most observational sites to the highly variable natural and anthropogenic CO_2 sources and sinks makes high demands on data selection and interpretation, but also on model investigations. On the other hand, a dense and well calibrated observational network in an area subject to about 15% of global anthropogenic emissions carries the potential to reliably assess the carbon budget, i.e. through inverse model investigations.

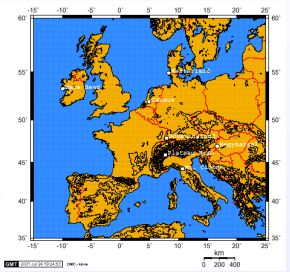


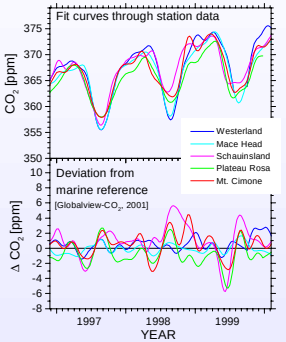
Figure 1

The EU-AEROCARB project aims at budgeting carbon emissions in Western Europe by a synergy of atmospheric observations, mesoscale atmospheric transport models, surface emissions data, and diagnostic models of land ecosystems carbon exchange. Our European network ranges from 55° to 44°N and from 10°W to 19°E with elevations from sea level up to 3480 m in the Alps (see Figure 1). Here we introduce our continuous monitoring sites and, for a first characterisation of the gradients to expected within the European network present pan-European CO_2 concentration gradients for a target period of 1997-1999.

Site descriptions show the individual selected hourly data for the target period together with harmonic fit curves through the data as well as, for comparison, the marine reference levels as given in Globalview-CO_2 (2001).

EUROPEAN GRADIENTS

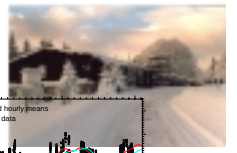
Amplitudes of seasonal cycles change by up to 5 ppm from marine stations to continental mountain sites. (Note that the respective change with latitude of the marine reference is only small, in the order of 2 ppm (Globalview-CO_2, 2001)). As expected, deviations from the marine reference level (lower panel of Figure 2) are small for the two marine sites with the Westerland winter time offsets being positive during winter. At the continental mountain sites, (Schauinsland, Mt. Cimone and Plateau Rosa) offsets are generally negative in summer and positive during winter.

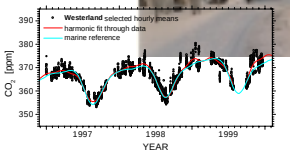


In particular, the summer time deviations from the marine reference level show large interannual variations, most probably due to interannual changes of the continental biospheric CO_2 uptake during summer. This finding indicates that long observational records are necessary to univocally determine mean carbon balances of continental regions. It is interesting to note that the Schauinsland and Plateau Rosa deviations compare well in 1997 and 1999. Both sites are only 200 km apart and obviously monitor similar air masses.

Acknowledgements
We wish to thank Ken Masarie for his tremendous work setting up the GLOBALVIEW-CO_2 data base and for data processing.

Westerland
8.32°E, 54.93°N
12m a.s.l.



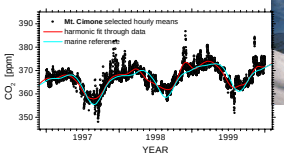


The northernmost site Westerland is situated at the German North Sea coast. The station is run by the *German Environment Agency (UBA, Berlin, Germany)* (6). Data selection is performed according to wind velocity (>7.5 m sec^{-2}) and concentration stability during one day (Levin et al., 1995)

Cabauw
4.93°E, 51.97°N

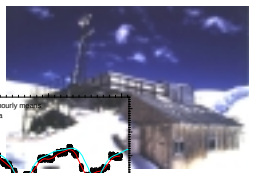
The Cabauw tower site in the Netherlands is run by the Dutch Meteorological Office with the *Energie-onderzoek Centrum Nederland (Petten, The Netherlands)* (8) being responsible for the CO_2 program (Hensen et al., 1997). Regular CO_2 measurements are performed at 4 height levels, 20, 60, 120 and 200 m above ground. Due to large maintenance of the tower, no CO_2 measurements are available for the target period.

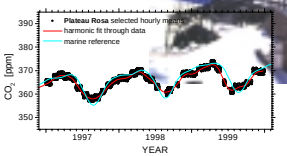
Monte Cimone
10.70°E, 44.20°N,
2165m a.s.l.



Mt. Cimone station in the Italian Apennines is located on a mountain top about 500 m above the tree line. Only some patches of vegetation are on the top of the mountain which during the winter half year is permanently snow covered. The CO_2 measurement program is run by the *Italian Meteorological Service (Sestola, Italy)* (5). To remove data affected by local vegetation during summer day-time values (0800-2000 LT) are rejected. In addition, for all months a selection based on concentration stability of hourly data is performed (Cundari et al., 1995).

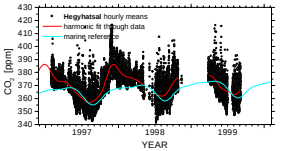
Plateau Rosa
7.70°E, 45.93°N
3480m a.s.l.





Plateau Rosa in the Italian Alps is the highest continuously monitoring station in Europe (Apadula et al., 2000). The surroundings of the site are permanently snow covered. The CO_2 measurement program is run by *CESI Business Unit Ambiente (Segrate, Italy)* (2) (Longhetto et al., 1997). Background data selection is mainly based on stability criteria applied to the half hourly data within one month.

Hegyhatsal
16.65°E, 46.95°N
248m a.s.l.



The Hegyhatsal tower in Hungary is located in a region of large agricultural activity as well as forests. The CO_2 measurement program is run by the *Institute for Atmospheric Physics (Hungarian Met. Service, Budapest, Hungary)* (7) (Haszpra , 1999). Selection of background data from a continental tower site is difficult due to the dynamics of the atmospheric boundary layer strongly influencing mixing ratios of trace substances with ground level sources and sinks. No data selection has been made.