INFLUENCE OF THE CO_2 LATITUDINAL GRADIENT ON THE OBSERVATIONS AT THE MEDITERRANEAN ISLAND OF LAMPEDUSA

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ABSTRACT

Measurements of CO_2 concentration are carried out on a weekly basis since 1992 on the island of Lampedusa (35.5°N, 12.6°E), in the Mediterranean. Measurements are based at the Station for Climate Observations, which rests on a rocky plateau (45 m asl) on the North-Eastern coast of the island, and are made with a NDIR analyzer. World Meteorological Organization (WMO) reference standards are used for calibrations. Continuous measurements were started in 1998; they were interrupted in early 2003, and activated again in 2005. The continuous observations show evidence of a small daily cycle (amplitude < ±1 ppm) only during the months of June, July, and August. Mean annual cycles derived from weekly flask measurements show a dependency on the wind origin: the annual cycle and the annual CO_2 mean are smaller for winds originating from the Southern sectors, than for winds from Northern sectors. The continuous measurements were combined with daily backward airmass trajectories to identify the dependency of the CO_2 amount on the airmass origin. Trajectories provided by National Oceanic and Atmospheric Administration / Air Resources Laboratory (Hysplit) are used. During winter, low CO_2 is generally connected to Southern/South-Eastern airmasses. In summer airmasses from North often display lower CO_2 content, due to the influence of the European sink.

INTRODUCTION

Measurements of CO_2 concentration are carried out on a weekly basis since 1992 at Lampedusa (35.5°N, 12.6°E), in the Mediterranean. The island of Lampedusa is small, rocky, and far from relevant pollution sources. Measurements are based at the Station for Climate Observations of the National Agency for New Technologies, Energy, and Environment (ENEA) of Italy. The station is located on a rocky plateau (45 m asl) on the North-Eastern coast of the island. In the period 1992-1998 air samples in glass flasks were collected weekly at Lampedusa and shipped to Rome, where the CO_2 concentration was determined with a NDIR Siemens Ultramat 5E analyzer. In 1998 the measurement system was moved to Lampedusa, and continuous measurements were started at the same site. Weekly flask samplings have also been continued. Details on the measurement system and a description of the weekly observations throughout the period May 1992 – March 2002 are given by *Chamard et al.* [2003]. Data are routinely submitted to the WMO-World Data Centre for Greenhouse Gases, as part of the Global Atmosphere Watch network. Continuous observations were interrupted in March 2003 and restarted in 2005. In this study the continuous observations are related to the origin of the airmasses reaching Lampedusa, and some exemplificative cases are shown.

RESULTS

The Mediterranean is the largest inland sea in the world, enclosed between densely populated, highly industrialized regions in the North, and less populated, more desert regions in the South. The island of Lampedusa is located in the Southern sector of the central Mediterranean. Prevalent winds are from NW, and airmasses originating from Africa are also frequent. The CO_2 behavior at Lampedusa is essentially determined by long range transport. The alternation of African and European airmasses leads to a modulation in the CO_2 concentration generally on a timescale of few days. The CO_2 concentration of European airmasses is influenced by large sources and sinks, due to the presence of industrialized regions and forests. African airmasses, conversely, are dominated by the influence of the Sahara desert. The observations at Lampedusa are also influenced by the large scale latitudinal CO_2 gradient.

The CO_2 average concentrations over 10-minute intervals are stored during routine acquisition. From these values, hourly CO_2 averages and standard deviations are calculated. To reduce the possible influence of local sources, data with hourly CO_2 standard deviation > 1 ppm are discarded. This selection leads to the elimination of about 8% of the data. The monthly average diurnal cycle is calculated from the dataset on a yearly basis. No evident CO_2 diurnal cycle is discernible throughout the year; monthly averages of the daily variations are always smaller than ±1 ppm, suggesting that the local scarce vegetation has a negligible impact on the CO_2 concentration.

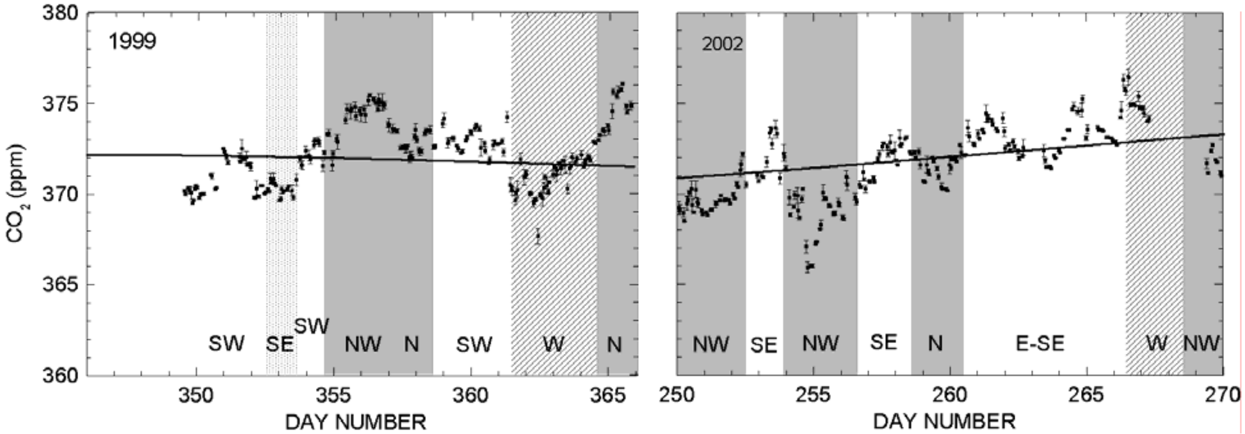

Fig. 1. Evolution of hourly CO_2 concentration and standard deviation in two selected periods of winter 1999 (left graph), and summer 2002 (right graph). The solid lines are sinusoidal curves including a semiannual and an annual oscillation fitted to the yearly data. The airmass origin sector is indicated in the vertical shaded or white areas. The ticks on the x axis mark the beginning of each day.

Day-to-day variations are related to airmass trajectories. One back-trajectory per day, arriving at 00 UT at the Station altitude, is calculated by means of the HYSPLIT Dispersion Model [*Draxler and Rolph*, 2003]; the employed model version uses NCEP/NCAR reanalysis data and includes vertical wind. Figure 1 displays the evolution of the measured hourly average CO_2 concentration in two periods, the first in winter 1999, and the second in summer 2002. The effect of the CO_2 latitudinal distribution is evident in winter, with peak CO_2 values measured in airmasses from North and North-West. This behavior generally reverses in summer, with higher CO_2 concentration in airmasses originating from Southern sectors than in airmasses from North. This behavior is attributed to the presence of the European vegetation sink, that shows diurnal and seasonal cycles. Consequently, the summer CO_2 evolution is more complex in summer than in winter, when the European sink is less effective.

In 1998-2003 period CO_2 peaks often correspond to airmasses coming from Northern Italy, in particular from the Po valley, and/or from the Balkans.

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