Time Behavior of CO₂ and O₃ in the Lower Troposphere Based on Recordings from Neighboring Mountain Stations Between 0.7 and 3.0 km ASL Including the Effects of Meteorological Parameters

R. Reiter and H.-J. Kanter

With 15 Figures

Received November 30, 1981

Summary

The continuous recordings of CO₂ (1978–1980) and O₃ (1977–1980) from neighboring mountain stations at 0.7, 1.8, and 3.0 km sea level are analyzed. CO₂ recordings at 3.0 km have been started in late 1980. For O₃, about 1000 profile measurements are available achieved by means of the Zugspitze cable car telemetry system between 1.0 and 3.0 km. In the evaluation we derive first the mean monthly diurnal variations of the mentioned gases at the respective measuring station. Furthermore, for clarifying the most varied daily fluctuations at the different levels, additional parameters are included such as sunshine duration, global and diffuse radiation, temperature, air mass character.

For CO₂, the activity of the biomass dominates in the valley (0.7 km) while the anthropogenic contribution exists only in winter being very weak. At levels above 1.8 km in the almost entire absence of a daily variation, the global annual variation prevails.

The O₃ in the ground layer up to about 800 m above the valley floor appears to be produced photochemically by day through solar radiation whereas anthropogenic influences can be excluded.

At levels above 2 km the stratospheric ozone source is more effective but does not seem to be decisive for the O₃ level in the lower troposphere. In the O₃ parameterization, too, are considered temperature, radiation, and the atmospheric layer structure.

The research work was essentially supported by the U.S. Department of Energy, the Commission of the European Communities (Brussels) and the Umweltbundesamt (Berlin).

1 The research work was essentially supported by the U.S. Department of Energy, the Commission of the European Communities (Brussels) and the Umweltbundesamt (Berlin).
might be expected from the increase of dust and aerosol particles where especially volcanic eruptions could play an important role [6, 7, 8]. At any rate, Landsberg does not believe that the CO₂ problem would become critical over the next few decades but nevertheless continuation of well-founded research in this field should not be abandoned. This is also the result of a careful study carried out by the Oak Ridge National Laboratory [9]. The authors state that increased monitoring and a comprehensive research program are required for an understanding of the CO₂ flux between atmosphere and land, with special attention to the biomass, combustion processes, and other turnover processes of organic carbon. A conclusion, by the way, which recently has been confirmed again by the World Climate Conference of the WMO.

Worth mentioning appears to us also a basic study on energy and climate [10] containing an article by Revelle et al. [11] who are intensely engaged in problems of the CO₂ cycle in the biosphere. In extensive tables the net-photosynthesis of various kinds of the biomass in different countries on the earth is estimated and its consequences discussed. The equations used for the author's models are listed. This study may provide suggestions and bases for regional, locally confined budget studies of the CO₂ cycle. Special attention deserve furthermore the articles by H. Flohn, J. Williams, H. L. Wieser, C. Zimmermeyer, K. E. Zimen, H. Lieth, and G. M. Woodwell in [12]. The authors consider the CO₂ problem from various aspects, i.e. from the point of model detection of the CO₂ cycle, as well as from the standpoint of the climatologist, and finally in the light of measured values known so far and the resultant prognoses.

A recently published conference volume [13] is to be mentioned containing a series of articles on the problem of the CO₂ budget. They deal above all with concurring, equally significant trace gases as, for instance, the global cycle of nitrogen with its various compounds, especially N₂O. Finally, the volume contains models and predictions as to the behavior of climate including the effects of the different atmospheric constituents.

Interesting in this context are also the following reports:

a) A comprehensive description of the different sinks and sources of CO₂ including in particular industrial sources, seen from the point of view of the United States [14] where many well-documented tables can be found.
b) A series of recent workshop reports from the U.S. Department of Energy which consider the CO₂ problem from the following aspects: The importance of the ocean for the global CO₂ distribution [15]; the possible consequences of the increasing CO₂ concentration on the climate resulting in climatic change [16]; research of tree-rings and their content of stable isotopes to clarify preceding climatic changes [17]; the societal effects of a likely climatic change through CO₂ [18], and finally a survey with recommendations for the investigation of the global CO₂ concentration [19].