Variations of Atmospheric Carbon Dioxide Concentration and Greenhouse Effect at Syowa Station (69°00′S, 39°35′E), Antarctica

Qu Shaohou (曲绍厚)
Institute of Atmospheric Physics, Chinese Academy of Sciences, 100029 Beijing, China

and Takashi Yamanouchi (山内恭)
National Institute of Polar Research, Tokyo, Japan

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ABSTRACT

On the basis of the analysis of atmospheric carbon dioxide concentration variations and the annual mean air temperature at Syowa Station, Antarctica in the period of 1984–1988, the following results are easily obtained:


The seasonal variations are observed and the maximum concentration is in spring and the minimum one is in late-summer or early-autumn.

2. The increasing tendency of the concentration of the atmospheric carbon dioxide is consistent with that of the air temperature.

I. INTRODUCTION

Now the climatic variation and climatic anomaly is an important topic in the researches of the earth change (Qu Shaohou, 1989). Scientists and governments of many countries have paid attentions to the greenhouse effect of the global scale induced by emissions of greenhouse gases i.e., carbon dioxide, methane, nitrous oxide and chlorofluorocarbon etc.. The increase of atmospheric carbon dioxide concentration is associated with exploiting burning of fossil fuels.

Since 1958 monthly average carbon dioxide concentration observed continuously at Mauna Loa, Hawaii shows that it has increased by 40 ppmv over the past 30 years(Keeling et al., 1989), the increasing yearly rate was about 0.4% and for various years it is obviously different.

At Pre–Industrial Revolution the atmospheric carbon dioxide concentration of 280+10ppmv was almost maintained (Houghton et al., 1990). For the past 100 years from 1985 the air temperature increasing had reached to 0.3–0.6°C by greenhouse effect.

According to present emission of greenhouse gases, the increasing rate of temperature in the next century will be about 0.3°C per decade (with uncertainty range of 0.2°C to 0.5°C per decade), and the global mean temperature will raise about 1°C by the year of 2025 and 3°C by the end of next century. If it is so, global mean sea surface will be risen about 6 cm per decade at the next century (with uncertainty range of 3–10 cm per decade) mainly due to thermal expansion of the oceans and melting of some land ice.

The predicted rise is about 20 cm for the global mean sea level by the year of 2030, and
Now there are approximately 40 ground stations around the world including Antarctica and Arctica to monitor the variations of atmospheric carbon dioxide (Pearman et al., 1980). Aircraft measurements of atmospheric carbon dioxide concentration over Japan, initiated January 1979, had been continued to May 1985 by Tohoky University et al. (Tanaka et al., 1987). The results show that the average rate of annual increase of atmospheric carbon dioxide concentration was about 1.3 ppmv/yr.

In the period of March 1979–June 1985, the measurements of atmospheric carbon dioxide concentration at Mt. Ckmone (2165 m m.s.l.), Italy, had been carried out by Italian Air Meteorological Service (Ciattaglia et al., 1987). The average rate of annual increase during the period was about 1.7 ppmv/yr.

Systematic measurements of the atmospheric carbon dioxide concentration are currently made at several places in the Antarctic region, either by continuous sampling with an analyzer in situ or by discrete flask sampling with subsequent laboratory analysis (Keeling et al., 1976; Beardsmore et al., 1984; Komhry et al., 1985).

Syowa Station (69°00′S, 39°35′E) used a flask sampling technique firstly in January 1983 and then operated the continuous measurement system since February 1984. Based on the analysis of observational data of atmospheric dioxide carbon concentration at the station in the period of 1984–1988, this paper gives the annual mean concentration, the interannual variations, the annual increase rates and the seasonal variations of atmospheric carbon dioxide. Besides, it also describes the correlation relation between the concentration of atmospheric carbon dioxide and the mean annual air temperature.

II. SYOWA STATION (SAMPLING SITE) AND MONITORING INSTRUMENT

Syowa Station (69°00′S, 39°35′E) is located in East Ongul Island of Lutzow-Holm Bay (see Fig. 1). Being separated from continent by the Ongul Strait which is about 4km wide, the Ongul Island is about 11 km² in area and 29 m above the sea level. The Ongul Strait is usually frozen throughout the year but since 1980 open water has been occasionally observed in summer to autumn. The surface of the island is composed of naked rocks with some lichen growth in summer and covered with snow and ice in other seasons. Since the station is isolated from vegetated lands and industrial regions it is an excellent site monitoring the variations of atmospheric carbon dioxide concentration.

Fig. 1. Location of Syowa Station and its surrounding area.