Research on Balloon-borne Whole Air Sampling System for Studying Stratospheric Minor Constituents

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The thesis deals with the research and development of two types of stratospheric whole air samplers onboard scientific balloons for studying minor constituents in the staratosphere. One is a grab sampler, which is simple and lightweight, to use under difficult experimental conditions like Antarctica, and which can complete all the in-flight sequence automatically by using an onboard computer and a GPS receiver. Another is a cryogenic sampler to collect more than 20 LSTP of stratospheric air at 12 different altitudes. It has been realized to analyze many kinds of trace gases and isotope rations more precisely. The system utilizes liqued helium as a cryogen, which is easy to obtain, and is a unique one in the world. Major research subjects, including thermal design of a cryogenic system, preparation method of contamination-free sample cylinders, and a reliable onboard computer system are described in detail. Since the first flight in 1980, stratospheric air samples have successfully been recovered in most balloon experiments. Air samples are analyzed in the precision of 0.01 ppm, 1 ppd and several ppt for CO_2, CH_4 and CFCs, respectively. It is also shown that change of CH_4 concentration has proved to be less than 5 ppb after 10-year storage. Through the analysis of samples collected between 10 km through 35 km altitude, the CO_2 concentration trend, the condensation of an oxygen isotope ratio in CO_2, altitude profiles of various CFCs, for example, are observed. Such results have proved the outstanding capability of the sampling systems.