Solar and thermal radiation profiles and radiative forcing measured through the atmosphere

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Abstract

Solar shortwave and thermal longwave radiation at the Earth's surface and at the top of the atmosphere is commonly measured at surface stations, from airplanes and from satellites. Here we show radiative flux profiles measured with radiosondes ascending from the Earth's surface to 35 km into the stratosphere. During two-hour flights solar shortwave and thermal longwave radiation are measured both downward and upward with four individual sensors. Daytime solar and thermal radiation is compared to nighttime measurements and 24-hour average radiation budget profiles are shown through the atmosphere. However, of even greater importance with regard to climate change are measured upward and downward longwave greenhouse radiation profiles. Their changes with temperature and water vapour enable direct measurement of radiative forcing through the atmosphere. Measurements during two cloud-free nights with different temperature and different water vapour amount, show an almost equal but opposite net longwave radiation change, or water vapour greenhouse forcing, downward to the surface and upward into space. Radiative flux profiles clearly illustrate the Earth's atmospheric greenhouse effect, and allow important investigations of clouds and other atmospheric constituents and their effects on shortwave reflection, as well as longwave emission towards the surface and into space.

Upper-Air Solar and Thermal Radiometry

A digital Meteolabor SRS-C34 radiosonde was used, which measures air temperature and humidity, and is equipped with additional channels measuring four thermopile voltages and several instrument temperatures of a Kipp & Zonen CNR4 net radiometer. The CNR4

consists of a pyranometer and a pyrgeometer measuring downward solar shortwave and thermal longwave radiation, and two identical instruments measuring upward radiation. All body and dome temperatures of the radiometers are measured with the same thermocouples as used for air temperature measurement on the SRS-C34.

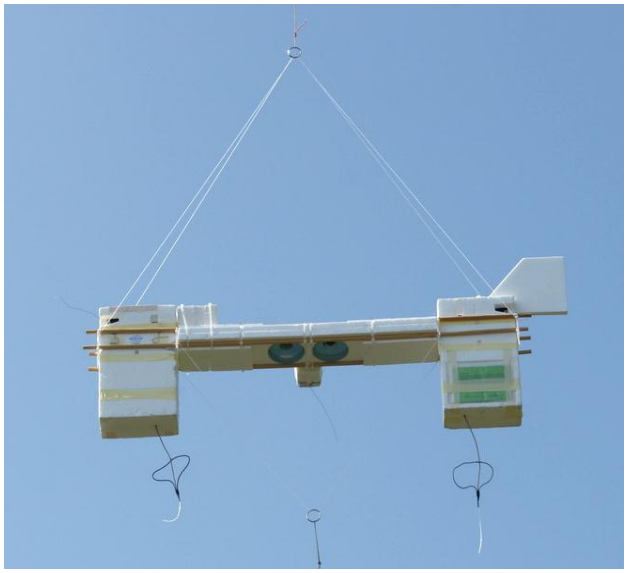

Figure 1: CNR4 and SRS-C34 Radiosondes

Figure 2: Double balloon technique

The CNR4 is mounted between two SRS-C34 radiosondes (Fig. 1). A new technique is used to lift the radiosonde package, consisting of two balloons and a GPS controlled mechanism which allows automatic release of the larger carrier balloon at a pre-set altitude (Fig. 2). The two balloons are inflated such as to lift the payload at a constant climbing rate of about 5 m/s from the aerological station in Payerne, Switzerland to above 30 km altitude. After the release of the carrier balloon, the sonde descends with the smaller parachute balloon.

Solar shortwave and thermal longwave radiation profiles during radiosonde ascents from the surface to 35 km altitude have been published in a paper in *Geophysical Research Letters*,

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