P1.19 A SINKHOLE FIELD EXPERIMENT IN THE EASTERN ALPS

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1. INTRODUCTION

Sinkholes represent an excellent natural laboratory to study the formation, the maintainance, fluctuations and the dissipation of temperature inversions during fair weather episods with undisturbed radiative conditions. Several locations are known worldwide, preferably in lime stone mountain areas, where sinkholes exist. One of the first sinkhole meteorological observations in history were made at a place in the Northeastern Austrian limestone Alps, called Gstettner Alm or Gruenloch, see e. g. Schmidt (1930), or Sauberer and Dirmhirn (1954). It was known from that early observations, that the air temperature at the bottom of the sinkhole may decrease to values some 30 degrees (Centigrade) or more below the ambient temperature at the same level, leading to the lowest temperatures in Central Europe known so far (around –57 deg C). Such extreme events can only occur when a snow cover is existing, which minimizes the surface heat flux. During the recent few years, other experiments in sinkholes have been carried out in the USA, see, e. g. Clements et al (2002).

2. THE INSTRUMENTAL SETUP OF THE FIELD EXPERIMENT IN THE WINTER OF 2001/2002

In a joint transcontinental effort of several institutions it was agreed upon, to carry out a field experiment at the Gstettner Alm sink hole (see fig. 1) during the winter season of 2001/2002, to document the formation, the maintainance, fluctuations and the dissipation of inversions in better detail than some decades ago, due to a more modern instrumentation. In the Autumn of 2001 a large number of automatic temperature sensors (a total of 58! Stations) and a few fully instrumented (temperature, humidity, wind, global radiation) automatic weather stations were set up in the doline and its surrounding, in an area of little more than 1 square kilometer. An intensive observing period (IOP) during a few fair weather days was planned in late Autumn, after a first snow cover has formed. Unfortunately, the winter season of 2001/2002 was very extreme in the sense, that after a long period of fair weather without snow cover several weeks followed with heavy snow fall events. This created an early snow cover of such a depth (up to 2,5 m! already early December) which did not allow the access to the sink hole with the additional instruments and equipment. Hence, the IOP had to be postponed towards Spring.

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Due to the deep snow cover, several temperature sensors, mounted on posts 1,5 to 2 m above ground level, were below the snow surface for a while. Some instruments were even damaged due to the forces of creeping snow.
Nevertheless, most of the data during the winter season could be saved due to several tedious and risky expeditions to the sinkhole. During the IOP in Spring 2002, special measurements with additional instrumentation are being carried out. Besides mobile equipment for temperature, humidity and wind observations, vertical profiles of temperature and humidity are being retrieved with the aid of 10 meter masts and tethered balloon soundings. Special attention is being drawn to long wave radiation measurements, to study the significance of radiative flux divergences.

3. SOME PRELIMINARY RESULTS

The evaluation phase of the data is currently being under way. An example of a daily temperature series at several observing points along a profile from the bottom of the sink up to a level somewhat above the level of the outflow is shown in fig. 2. The complete data set will be used to make comparisons with results of models of different complexity. It is hoped that an answer will be obtained on how important mass fluxes as a response to thermally driven circulations are versus radiative flux divergences. This is vital to further improve the simulation of the mass and wind field over complex terrain by high resolution models.

4. REFERENCES

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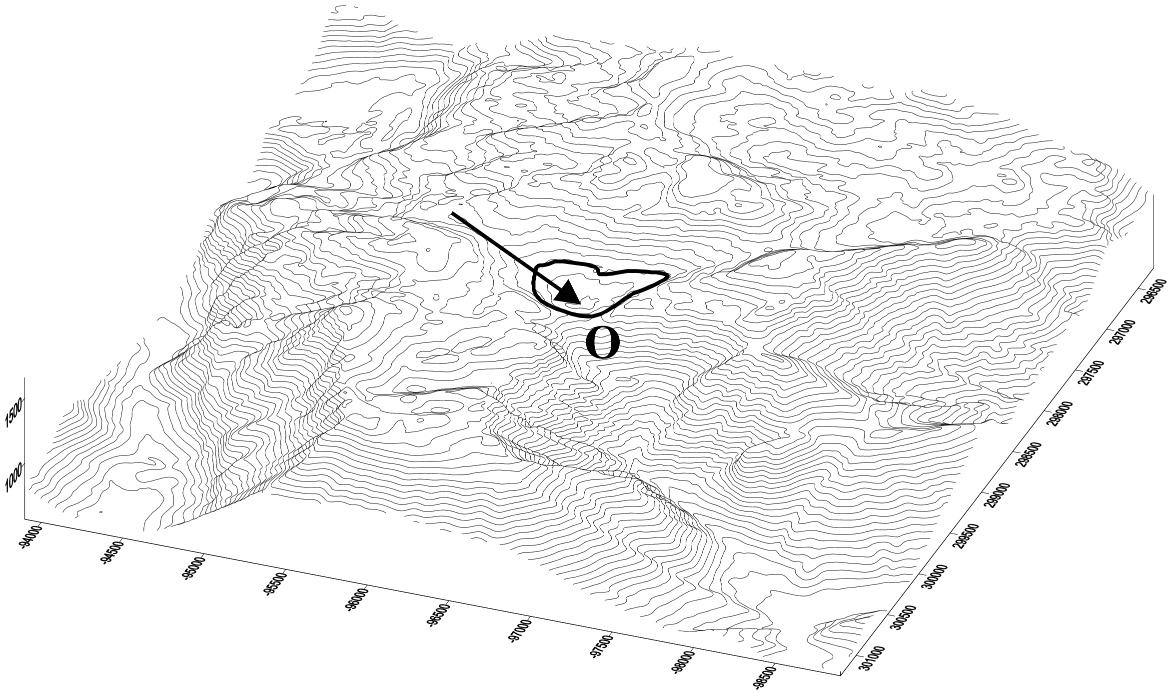

Fig.1: 3D plot of the 5x5 square kilometers area surrounding the Gstettner Alm sinkhole (arrow). The view is towards South-East. Contour lines are plotted at 20m intervals. The bold line shows the highest contour line surrounding the sinkhole.

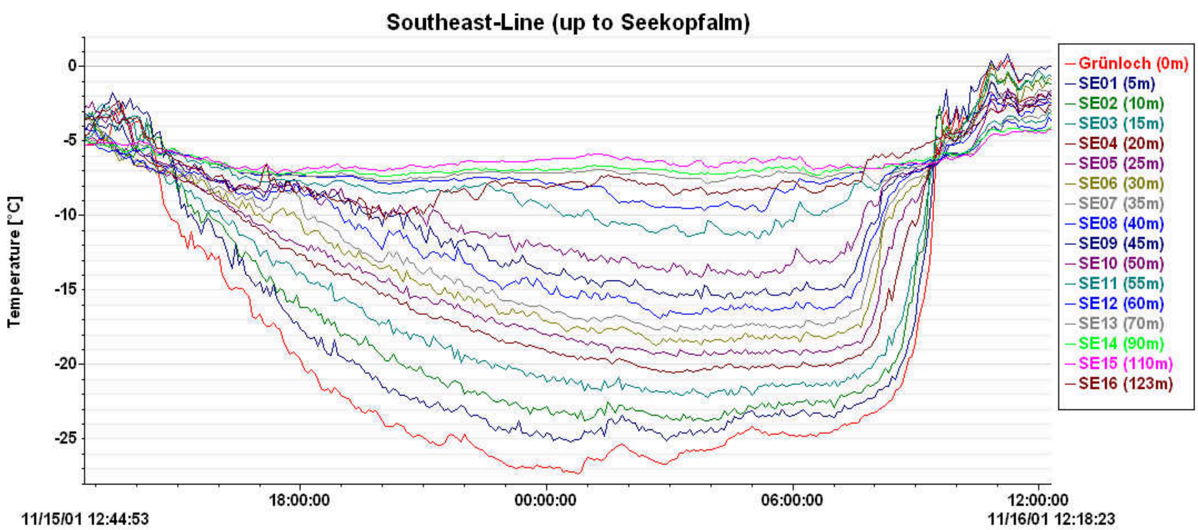

Fig. 2: Time series of the temperature in the sinkhole Gstettner Alm between November 11, noon and November 12, 2001, noon. The stations are located in an array from the base of the sinkhole (coldest overnight temperature) in steps of 5 meters vertically up to the level of outflow (in the Northwest, denoted by “O” in Fig. 1), some 50 meters above the base. Six further locations are above the level of outflow, along a gentle slope to the southeast, approximately along the arrow of fig. 1.