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MeteoSwiss

The Swiss Network for the Meteorological Monitoring of Nuclear Power Plants

In the event of a nuclear accident a radioactive cloud might be released into the atmosphere. Such a cloud would travel and disperse in the three dimensions of the atmosphere: in time it would move horizontally, but also vertically. It is therefore vital that meteorological monitoring takes all these dimensions into consideration and does not rely solely on meteorological measurements on or near the ground.

The Swiss network for the meteorological surveillance of nuclear power plants, CN-MET, is an innovative tool that combines local measurements with a high-resolution numerical weather prediction model in order to provide analyses and forecasts of the state of the atmosphere with a high degree of precision. The tool has been operational since 2010 and it shows an availability rate of over 95%, providing high-quality meteorological information.

Three sites have been built: Payerne in the south-west, Schaffhausen in the north-east and Grenchen in the centre of the Swiss Plateau. These sites are equipped with automatic ground-based weather stations as well as with automatic systems for establishing wind and temperature profiles. All this information is integrated in real time into the numerical model COSMO-1 (until 2016 COSMO-2) run by MeteoSwiss. The obtained data enable the exact calculation of wind conditions in the regions that might be affected by a possible release of radioactive matter and they make it possible to forecast the dispersion of the cloud in the hours following the accident.

In order to follow wind and temperature developments both in time and space, two types of innovative instruments are being used:

- the wind profiler is an active remote sensing system operating from the ground: it emits a series of electromagnetic pulses into the atmosphere and registers the pulses that are returned. The automatic analysis of the back-scattered signal enables – thanks to the Doppler effect – the establishing of vertical profiles of wind speed and direction, from 100m above ground to several kilometres above the measuring device;

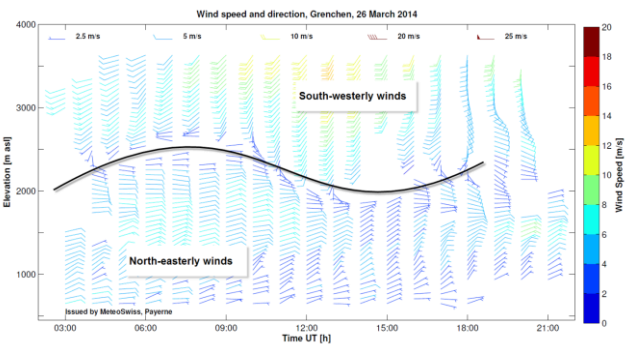

Figure 1
Wind speed and direction profiles measured by the wind profiler. The transition of north-north-easterly to south-westerly winds over the course of the day is clearly visible (black line).

- the micro-wave radiometer is a passive remote sensing system, operating from the ground, which « listens » to the radiation emitted by oxygen molecules present in the atmosphere, in a frequency range of 51 to 59 GHz. An automatic temperature profile above the measuring site is obtained through a complex analysis of this information.

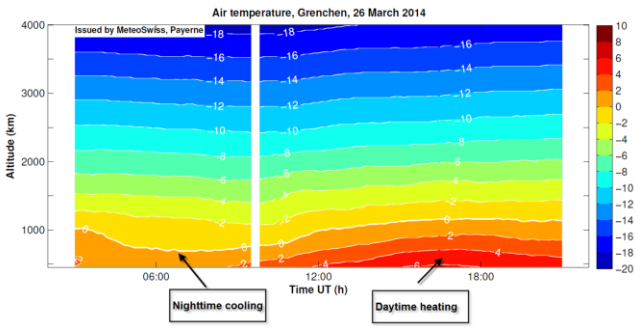

Figure 2
Temperature profiles, measured by micro-wave radiometer. The transition from night temperatures (cooling) to day temperatures (heating) is clearly displayed.

These observation data are integrated in real time into a numerical, high-resolution numerical weather prediction model which is used with the aim of calculating wind paths in the event of a nuclear accident. Such a model describes the changes in time and space of meteorological parameters which can be predicted (wind, temperature, humidity…) based on the laws of physics. In this way weather phenomena of varying scale are represented, such as storm, Föhn wind, the presence of stratus cloud, snow and many other phenomena. Before one can calculate the future development of the atmosphere one has to know the present state. The observation network provides the input for determining the initial conditions of the numerical model. This model in turn can then calculate forecasts which help in the estimation of what the extension and the trajectories of a possible radioactive cloud might be.

The numerical model in use takes the complex topography of Switzerland into account, and its high spatial and temporal resolution allows for a precise forecasting of wind paths in all spatial dimensions.

The combination of an automatic network for monitoring the atmosphere on the Swiss Plateau with a high-performance forecasting model of the latest generation thus provides an essential tool for strategic decision-making in the event of a nuclear accident: it projects an image, typically for the following 24 hours, of the development in time and space of the contaminated air mass.

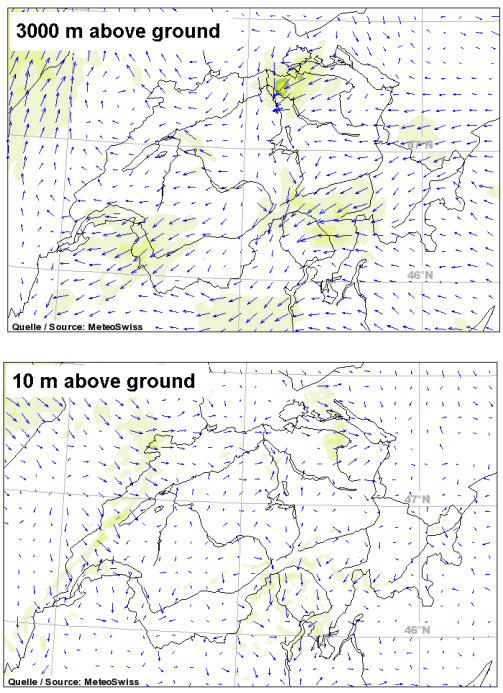

Figure 3 et 4
On 3 June 2008 at 22.00 COSMO-2 calculated wind fields over Switzerland at an elevation of 10m above ground and 3,000m above ground.

On the Swiss Plateau, close to the ground, a north-westerly wind blew with wind speeds below 10m/s.

At the same time, at Alpine altitudes, there were winds present at speeds over 20m/s and in east-north-easterly direction.
Only this numerical result in three dimensions and relating to time can forecast with great accuracy such a « stratification of the atmosphere », in this case, an air mass which traveled in different directions and at varying speed depending on the altitude.

Additional Information
www.meteoswiss.ch

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