

Current development of the remote sensing meteorological network and the fine grid weather forecast model for the nuclear power plants security in Switzerland

Bertrand Calpini, Yves Alain Roulet, Dominique Ruffieux and Philippe Steiner

Federal Office for Meteorology and Climatology, **MeteoSwiss**

E-mail : bertrand.calpini@meteoswiss.ch; Phone: +41 26 662 62 11

Abstract

Each of the four nuclear power plants in operation in Switzerland is currently equipped with one meteorological tower (up to 110 m height) and standard ground based instruments which yield the basic data input to a gaussian-dispersion model. The latter is being used as short term weather forecast tool in case of a power plant accident.

MeteoSwiss is currently in charge of upgrading this security tool. It is intended to use the advantage / peculiarity that the four nuclear power plants are all located on the Swiss Plateau at short distance each from another, and with wind fields channelled towards the NE to SW direction due to the presence of the Jura mountains on the NW and the Swiss Alps on the SE.

The new security tool is based on the development of a high resolution numerical weather prediction NWP model linked to a meteorological network instrumented with ground based and remote sensing equipment. The NWP will be used to forecast the dynamics of the atmosphere in the planetary boundary layer (e.g. up to 2 km above ground level) over the Swiss plateau, using remote sensing instruments such as wind profilers, passive microwave instrument for temperature profiling, and a sodar for low altitude wind field. The measuring sites of the network will be located in order to generate the ideal database, the latter being assimilated in real time as data input for the fine grid NWP model.

This decision making tool that includes the meteorological network and the fine grid NWP model will at any time (e.g. starting from the initial time of a nuclear power plant accident) give the best picture of the one day-evolution of air masses over the entire Swiss plateau. It will furthermore generate the necessary data input for the local dispersion model, the latter being specifically designed for each of the four nuclear power plants location respectively. The presentation will focus on the latest development in CN-MET, including the development of the ground based meteorological sites, the current test on the wind profilers and temperature passive radiometers systems of observation, and also the latest development in the fine grid aLMO2 forecast model.

The CN MET measurement network

A combination of surface measurements and ground-based remote sensing techniques will constitute the CN-MET observation network (see Figure 1). The following instrumentation is planned.

- Three low-tropospheric wind profilers combined with three microwave radiometers will provide a continuous observation of the Planetary Boundary Layer dynamics over the Swiss Plateau. These wind and temperature vertical profiles (see the time series in

Figure 2) will be located at three strategic locations in the domain: at the two main lateral boundary conditions of the domain, respectively corresponding to the in- and out-flow wind conditions over the Swiss Plateau, and one in the center of the domain for a direct validation of the model results. This center station will also give a realtime observation of the weather conditions in the direct surrounding of the nuclear power plants. A typical set of measurements from one of the three remote sensing site is reproduced in Figure 2.

- The aerological radiosonde station in Payerne (the station located at the south western part of the domain) will furthermore provide the state of the atmosphere four times a day: twice with pressure, temperature, humidity and wind and twice with wind only.
- At each nuclear power plant site (Mühleberg, Gösgen, Beznau, and Leibstadt), a ground based meteorological station will give the needed information about the local weather conditions. Each of these four sites will also include turbulence measurements at 10 m height (sonic anemometers). This turbulence measurement is a direct observation of importance for short scale dispersion model input.
- Four high towers in the surroundings of the nuclear sites (Stockeren, Bantiger, St.Chrischona, and Uetliberg) will be equipped with wind and temperature sensors, and bring an additional set of data for the control of the model results.

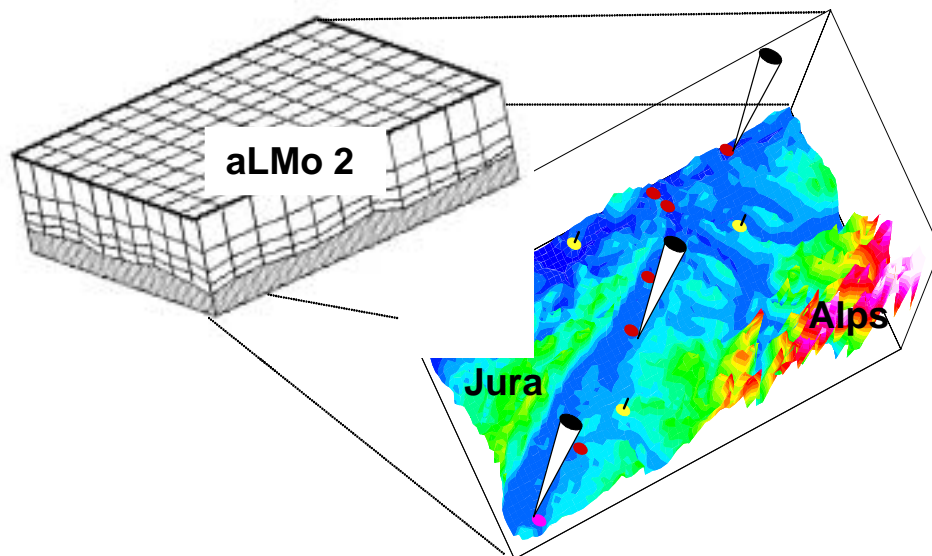


Figure 1. A schematic of the CN MET area, with the three remote sensing sites (wind field and temperature) located along the Swiss Plateau, at the “in-flow” resp. “out-flow” conditions of the domain. The Swiss Plateau is surrounded by the Jura mountains and the Alps. The Eulerian fine grid illustrates the use of the NWP aLMo2 for the security forecast in case of nuclear emergency.

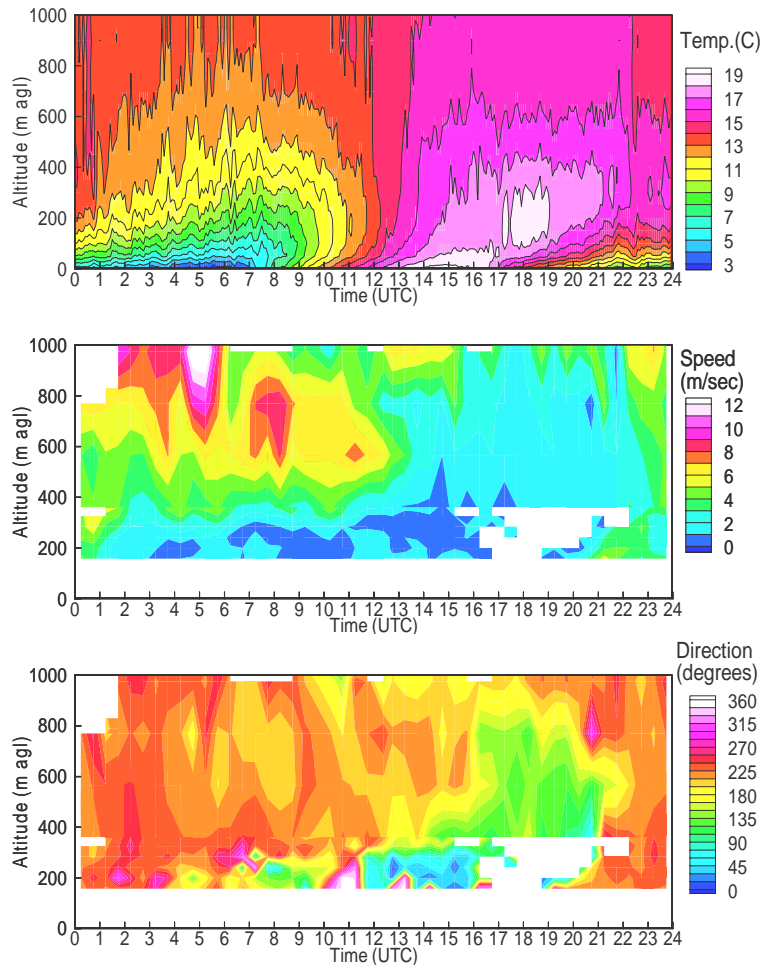


Figure 2. Typical set of vertical profiles time series as planned in CN MET: this example was measured in Payerne on March 17th 2004. Temperature is measured by passive microwave radiometer, wind speed and direction by low tropospheric wind profiler. This set of measurement will be obtained at each of the three remote sensing sites shown in Figure 1.

The CN MET fine grid NWP model

Within the COSMO consortium, there is a move towards improving the current horizontal resolution of the European Local Model (LM) from a grid of 7 km to a finer of ca. 2 km mesh. The new Swiss NWP aLMo/2 (aLpine Model) will be a nested grid of the 7 km LM centered over Switzerland, and encompassing the main alpine region. A rapid update cycle with quasi-real time data assimilation from the CN-MET network will be developed, and short term forecasts of up to 18 hours, renewed every 3 hours, will be provided.

The numerical results (Figure 3) from aLMo/2 will be used as a “now casting” tool over the Swiss Plateau, for the next few hours up to one day after a nuclear emergency. They will also be used as initial input data for the atmospheric dispersion model in operation at the Swiss Federal Nuclear Safety Inspectorate (SFNSI): in particular, a three-dimensional snapshot of wind field and turbulence will greatly enhance the quality of the SFNSI’s model output.

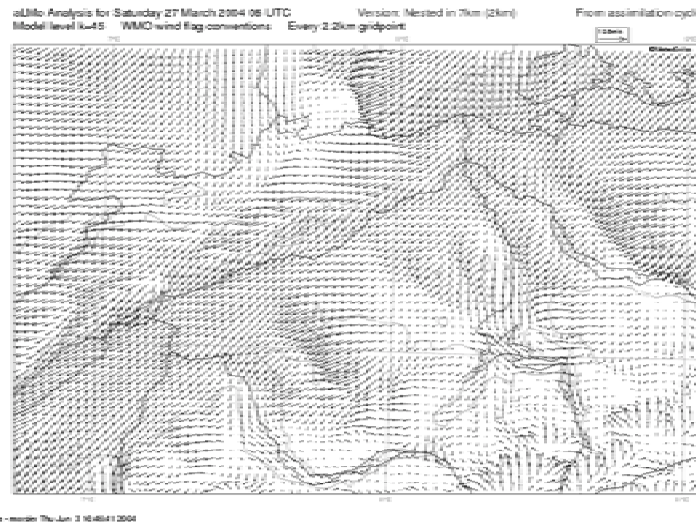
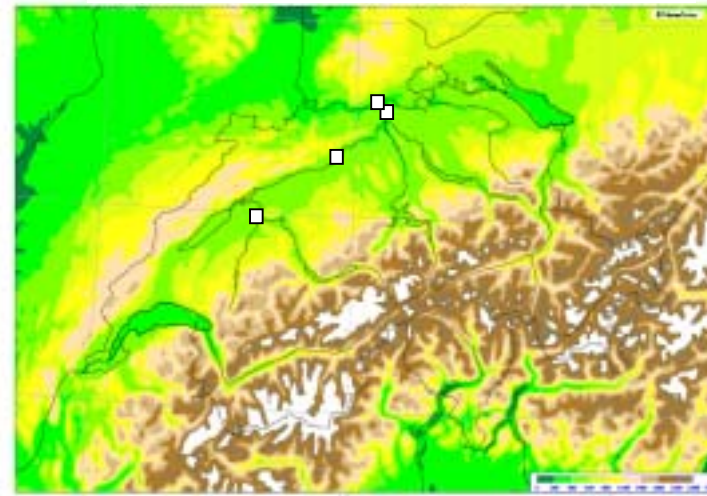


Figure 3. Orography and wind field in aLMO 2. The white squares represent the four nuclear power plants. The wind fields are shown for the 30m agl model result.

3 Conclusion

CN-MET is the combination of the aLMO/2 fine grid NWP model with an optimized network of meteorological observations, namely a network with observations at similar time and space resolution as the model resolution, designed as input and boundary conditions for the model. Instead of having meteorological towers located at each individual nuclear power plant, CN-MET is based on a “global network” of in-situ and ground-based remote sensing systems covering the three dimensions of the entire region. By combining the measurements with a high resolution non-hydrostatic NWP model, the meteorological information will be available at each point of the grid cell, including the nuclear power plants’ locations. Data from the observation network will be assimilated in real-time. Therefore, the model will provide a coherent image of the state of the atmosphere at and around the nuclear power plants and of its evolution in time and in space. A new “18 hours forecast” will be issued every 3 hours, with a temporal resolution of 30 minutes, over the entire domain of interest.