# Annual WWW Technical Progress Report on the Global Data Processing and Forecasting System (GDPFS) 2004

## SWITZERLAND

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## 1. Summary of highlights

MeteoSwiss have made significant progress in a number of fields during 2004. This includes the consolidation of the IT infrastructure and the preparations for the installation of a new powerful graphical forecast production system called 'NinJo'. The MeteoSwiss Data Warehouse is now fully operational and provides the backbone for an automated data input system for the surface component. aLMo, the MeteoSwiss implementation of the COSMO Local Model, operational at MeteoSwiss since April 2001, is now running with IFS frames provided by the ECMWF boundary condition special project. Its operational suite is controlled by a sophisticated set of scripts, which accounted for a very high reliability of the system, with less than 3% of the forecast requiring manual intervention.

## 2. Equipment in use

Last year, further progress has been made on consolidation and renewing of the central information technology infrastructure. As an important milestone, a second central computer unit in Zurich could be taken into operations. The new unit is expected to cover the additional capacity requirements for the various ongoing projects and guarantees - along with the first unit - a substantially higher availability of business critical applications. In addition, the refurbishment of the Wide-Area-Network (WAN) based on Internet Protocol Services Switch (IPSS) technology was initiated and is currently in progress. With IPSS the flexibility and scalability of network data communication is greatly enhanced and will allow to fulfill the requirements expected from the new meteorological forecast system 'NinJo'. The Local-Area-Networks (LAN) of various sites of MeteoSwiss have been upgraded accordingly for the use with 'NinJo'. In the same regard, new powerful Windows-based PC-Workstations for 'NinJo' were purchased and are currently staged and tested within a preproduction phase of 'NinJo'.

## 3. Data and products from GTS in use

At present nearly all observational data from GTS are used. Further in use are GRIB data from Bracknell, Washington and Offenbach as well as T4-charts from Bracknell and Washington. Additionally most of MOTNE and OPMET data are used as well.

Typical figures on message input for 24 hours are:

| | |
|---|---|
| SYNOP, SYNOP Ship | 12'200 |
| TEMP Part A+B | 1'200 |
| PILOT Part A+B | 120 |
| METAR | 34'500 |
| TAF short/long | 10'900 |
| AIREP/AMDAR | 2'750 |
| GRIB | 24'500 |
| T4-Charts | 550 |
| BATHY/TESAC | 0 |
| DRIFTER | 1'620 |

## 4. Data input system

A fully automated system is used. A bulletin entering the Message Handling System (MHS) is stored, after some format validation and, related on this, some automatic format error correction, to the database. SYNOP, TEMP/PILOT and some national station reports are decoded on MHS for further distribution to related systems or customers. METAR and TAF are formatted back to old code format (removing keyword METAR/TAF) from every station report) for internal use and national customers.

## 5. Quality control system

Quality control is done format based for ASCII coded bulletins on input and can be switched off or on for every bulletin type desired. Bulletins failing this format check are routed to operators' workplace for manual correction if possible. Currently SYNOP and TEMP/PILOT will be corrected as well as OPMET data for indicators LSSW.

METAR are checked on errors of data and format in the editing tool of the observers.

Automatically measured data are checked in the SYNOP encoder, before the SYNOP Bulletin is generated. The monitoring of the quality of the observations is done on the national scale.

## 6. Monitoring of the observing system

Surface observations are monitored on the national level. A computer aided network monitoring is used for the automatic surface weather stations. For the manual weather stations a semiautomatic system is used for the monitoring.

Upper-Air observations are monitored on the national level.

## 7. Forecasting systems

### 7.1 System run schedule and forecast ranges

Medium and extended range forecasting are based on external NWP sources, but MeteoSwiss run their own short-range forecasting system. The core of this system is the non-hydrostatic Local Model developed by COSMO (the Consortium for Small-Scale Modelling, currently composed of the national weather services of Germany, Switzerland, Italy, Greece and Poland – see cosmo-model.cscs.ch).

aLMo, the Swiss implementation of the COSMO Local Model, is operational at MeteoSwiss since April 2001, originally with lateral boundary conditions provided by the GME and, since September 2003, by IFS frames provided by the ECMWF BC special project.

A continuous assimilation cycle has been implemented, currently ingesting conventional observations only. A main assimilation suite has been defined with a cut-off time larger than 4 hours, implemented with 3-hour assimilation runs; an additional short cut-off suite is also calculated to provide initial conditions for the operational forecasts and for other near-real time requirements. Two daily 72 hours forecasts are calculated, based on the 00 and the 12 UTC analyses, with a 90 minutes cut-off time. The time critical forecast products are available in about 70 minutes.

A sophisticated set of scripts controls the whole operational suite, and allows for a very high reliability of the system, with less than 3% of the forecast requiring manual intervention. This same environment is also used to run parallel suites, to validate proposed modifications to the system, and to facilitate experimentation by the modelling group.

The computing resources and expertise is provided by the Swiss National Supercomputing Centre (CSCS, see www.cscs.ch). aLMo is calculated on a single node 16 processors NEC SX-5, and achieved a sustained performance of 29 GFlops, or more than 25% of the peak performance of the machine. Pre- and post-processing needs are covered by a 8 processors SGI O3000 platform; a large multi-terabytes long term storage is used for archiving purposes, and a 10 MBit/s link connects the MeteoSwiss main building with the CSCS (on the other side of the Alps!).

### 7.2 Medium range forecasting system (4-10 days)

MeteoSwiss do not run a medium range forecasting system.

### 7.3 Short-range forecasting system (0-72 hrs)

#### 7.3.1 Data assimilation, objective analysis and initialization

Data assimilation with aLMo is based on the nudging or newtonian relaxation method, where the atmospheric fields are forced towards direct observations at the observation time. Balance terms are also included: (1) hydrostatic temperature increments balancing near-surface pressure analysis increments, (2) geostrophic wind increments balancing near-surface pressure analysis increments, (3) upper-air pressure increments balancing total analysis increments hydrostatically. A simple quality control using observation increments thresholds is in action.

Currently, only conventional observations are assimilated: synop/ship/buoys (surface pressure, 2 m humidity, 10 m wind for stations below 100 m above msl), temp/pilot (wind, temperature and humidity profiles) and airep/amdar (wind, temperature). A typical 24 hours assimilation at MeteoSwiss ingests about 180 vertical soundings, about 7000 upper-air observations and about 25000 surface observations. Options to use wind profiler data and GPS derived integrated water vapour are also available, but not yet used. A radar based 2-dimension latent heat nudging scheme is being developed.

The snow analysis made by the German Weather Service is used in aLMo; it is based on a simple weighted averaging of observed values. All other surface and soil model fields are obtained by interpolating IFS analysis. These fields are updated twice daily by direct insertion in the assimilation cycle. Finally, the ozone and vegetation fields are based on climatic values. Effort is currently under way to derive some surface parameters from NOAA and MSG satellites.

In addition to the MARS retrieving system, the full ECMWF decoding, quality control and database software have been installed on out front end machine (SGI Origin 3000). The cut-off time for the main assimilation cycle is at least 4 hours, and the oldest lateral boundary conditions are 3 hours old. Based on this main cycle, additional short cut-off cycles (90') are calculated to produce the initial conditions for the operational forecasts.

### 7.3.2 Model

A thorough description of the Local Model itself can be found on the COSMO web site at cosmo-model.cscs.ch. aLMo is a primitive equation model, non-hydrostatic, fully compressible, with no scale approximations. The prognostic variables are the pressure perturbation, the cartesian wind components, the temperature, the specific humidity, the liquid water content, cloud ice, rain and snow. There are options for additional prognostic variables (e.g. turbulent kinetic energy) which are currently not used at MeteoSwiss.

The model equations are formulated on a rotated latitude/longitude Arakawa C-grid, with generalized terrain-following height coordinate and Lorenz vertical staggering. Finite difference second order spatial discretization is applied, and time integration is based on a 3 time levels split explicit method.

Fourth order linear horizontal diffusion with an orographic limiter is in action. Rayleigh-damping is applied in the upper layers. Boundary conditions from GME (DWD), from IFS (ECMWF - both full fields and frames) and from the Local Model itself (1- and 2-ways nesting) are supported. The initial conditions are defined by Newtonian relaxation (nudging) to the observations.

At MeteoSwiss aLMo is calculated on a 385x325 mesh, with a 1/16° mesh size (about 7 km), on a domain covering most of Western Europe (see figure 7-1). In the vertical a 45 layers configuration is used; the vertical resolution in the lowest 2 km of the atmosphere is about 100 m. The main time step is chosen to be 40 seconds.

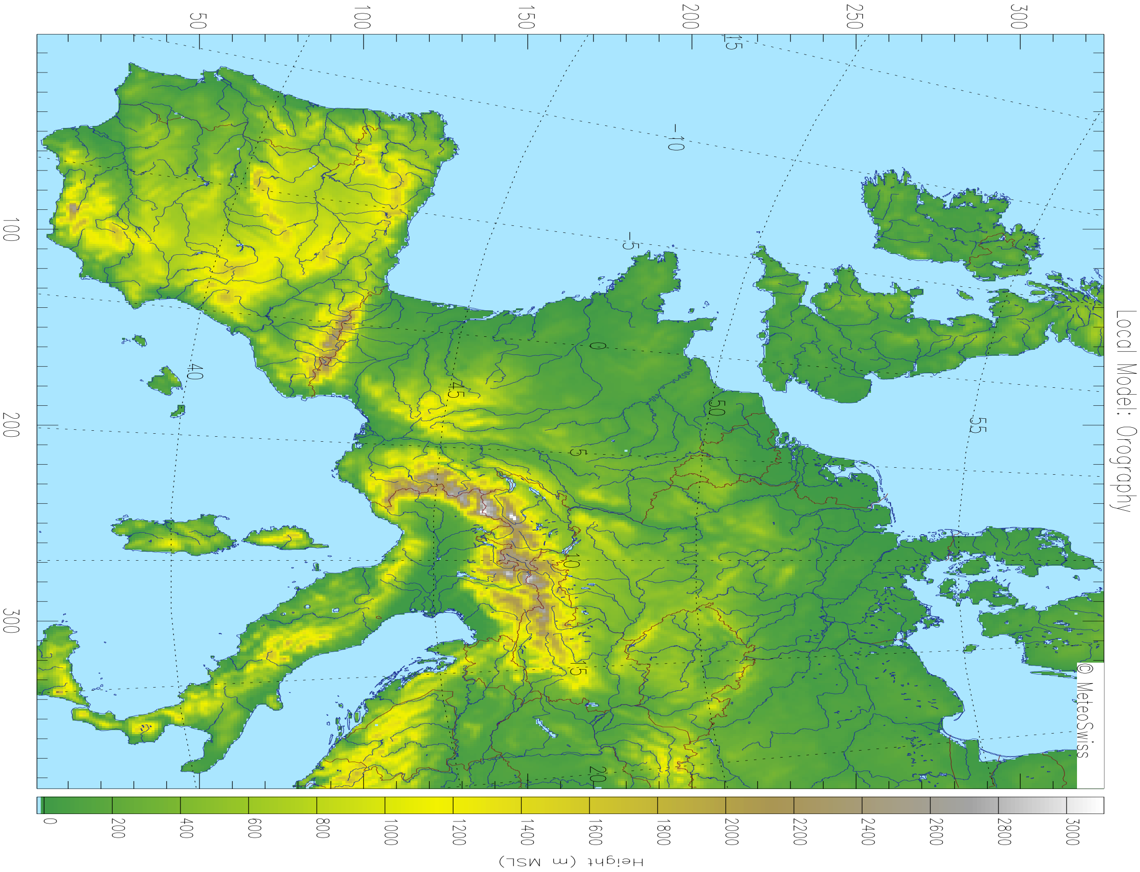


**Fig. 7-1** Operational domain of aLMo.

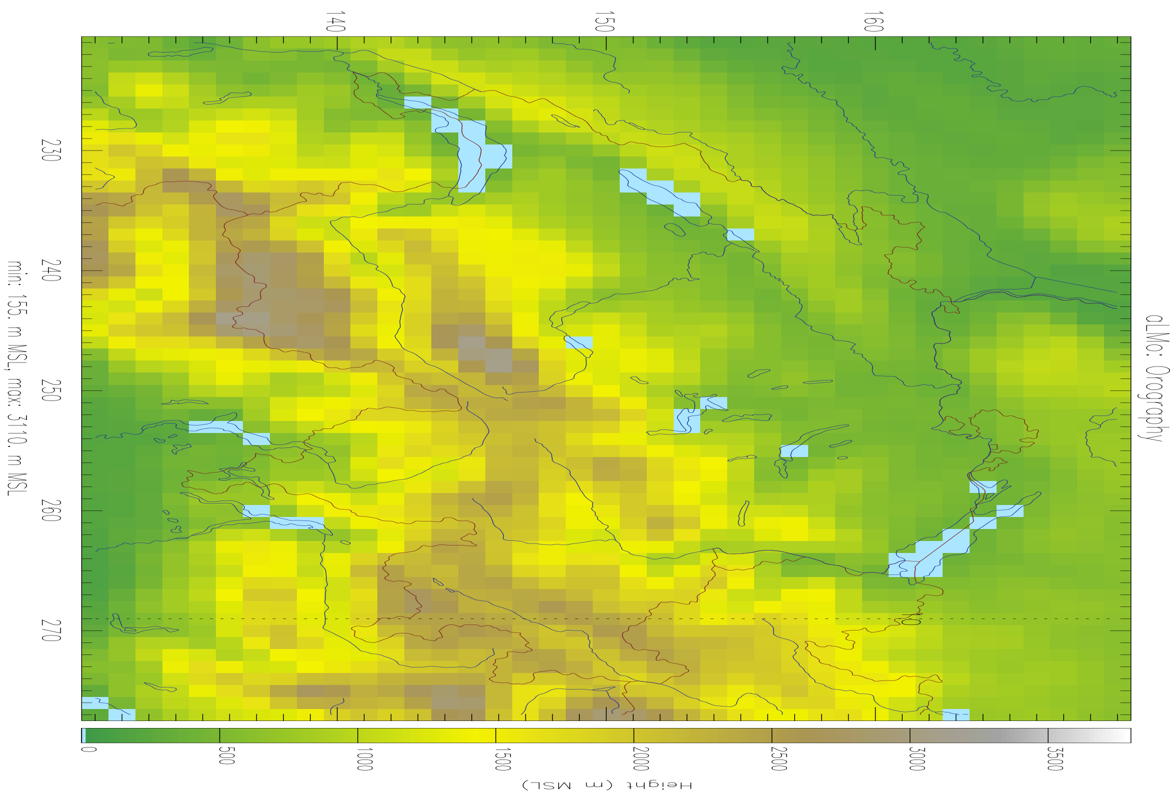


**Fig. 7-2** Orography of aLMo (filtered orography, highest point 3109 m)

### 7.3.3 Numerical weather prediction products

A suite of post processing modules is available:

- Kalman filtering of model output for 2 meter temperature and dew point temperature;
- visualization software based on the ECMWF MetView package and on in-house developments at MeteoSwiss and at CSCS; static maps, 2- and 3-dimensional loops with texture based flow visualization are created;
- a trajectory model providing guidance on transport route (hot air balloons, pollutants);
- a lagrangian particle dispersion model to calculate dispersion and deposition of radioactive materials.

Based on these modules, a standard set of products is provided to the MeteoSwiss bench forecasters, and are used as guidance for short-range forecasts. In case of necessity the two last modules can be run by the on-duty forecasters at any time (on-demand mode).

Besides that a large quantity of tailor made products, based on direct model output, are disseminated to internal and external clients.

MeteoSwiss contribute to the improvement of the limited-area ensemble prediction system COSMO-LEPS based on global ECMWF Ensemble forecasts and on the COSMO Local Model. COSMO-LEPS has been developed at ARPA-SIM, Bologna, and runs in a quasi-operational mode since November 2002 at the ECMWF. It makes probabilistic high-resolution short to early-medium range forecasts available at MeteoSwiss, visualized in the form of probability maps and meteograms for various parameters. The probability maps complement the deterministic aLMo products while the meteograms combine the output from both systems. Figure 7-3 shows an example of such a meteogram as derived from COSMO-LEPS and the aLMo output in terms of precipitation and 2m temperature.

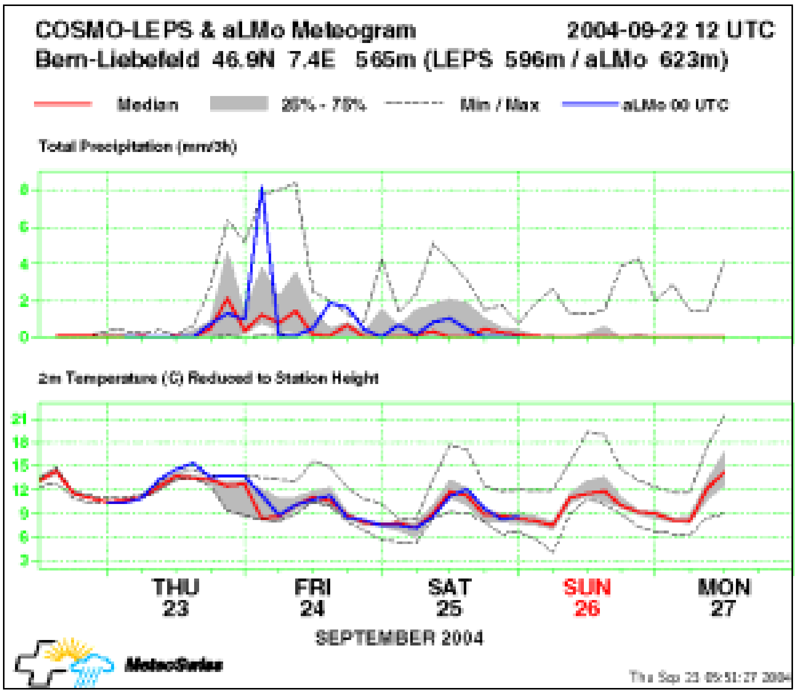


**Fig. 7-3** Meteogram with precipitation and 2 m temperature as derived from the COSMO-LEPS and the aLMo output. Example for Berne from a forecast starting on 22 September 2004. Red lines: median of the 10 COSMO-LEPS members; grey shaded area: the middle two quartile (25 to 75% probability of occurrence); dashed lines: the highest and lowest values, respectively; blue line: the operational deterministic model at MeteoSwiss, aLMo.

### 7.4 Specialized Forecasts

Not available

### 7.5 Extended Range Forecasts

Within the framework of the NCCR climate programme, MeteoSwiss have established access to the data from ECMWF monthly forecasts. Postprocessing and visualization procedures have been developed and are operated on an operational basis. Products include weekly forecasts of probability maps over various regions. The developments profit from the experience from seasonal forecasts. In particular, calibration and visualization techniques are applied in an equivalent manner.

### 7.6 Long Range Forecasts

MeteoSwiss issue long range forecasts on the basis of the ECMWF seasonal forecast system 2. Research results from the NCCR Climate project optimized the calibration of the forecasts. Further, verification of grid point and large scale climate mode forecasts were conducted. The operational postprocessing suite was further developed and automated. The presentation on the password protected webpage was optimized to ease the interpretation of the products, e.g. Climagrams and probability charts.

## 8. Verification of prognostic products

For decades MeteoSwiss has assessed the quality of its forecasts. For 20 years the method OPKO (ObjektivePrognosenKOntrolle) has been in use. The verification method of the official forecasts will be described in the following paragraph. The available results will be presented and commented according to different criteria.

**Method**

Several times a day MeteoSwiss issue forecasts in three languages for the general public trough its regional centers. These forecasts are assessed on a regular basis. First of all the texts have to be coded. The verbal contents are transferred into numerical codes according to precise regulations. This is quite easy with temperatures, but becomes a little more difficult with other meteorological data.

To assess the cloudiness, the relative sunshine time is taken into account. The difficulty with this method is the conversion of terms describing sunshine or degrees of cloudiness into a code number. We have determined the corresponding categories on the basis of a public opinion poll and our forecasters are obliged to write their texts according to these binding categories.

Also the precipitations are coded according to clear and binding regulations. The same applies to wind in cases where gusts of more than 25 knots are expected. Altogether quite a demanding, time-consuming job, which is still carried out manually for the time being.

The forecasts are assessed taking into account the measurements of our automatic network. 67 stations are used, however the temperatures of mountain-stations are not considered. The measured values are compared with the coded weather data. Fixed scores quotients are used to evaluate the results.

**Results**

The overall forecast results for the climatological year 2004 show the following scores:

| | |
|---|---|
| Central and eastern part of Switzerland | 84% |
| Western part of Switzerland and Valais | 85% |
| Southern part of Switzerland and Engadine | 83% |
| The whole of Switzerland | 84% |

The forecast analysis of 20 years with this same method shows in the beginning results around 80% and now around 85%. The results in flat areas are generally better, because forecasting in mountain regions is more difficult.

**Outlook**

The above described method will continue to be used for the moment. Deficiencies are known, especially because we cannot compare our results with those of other weather services. We are currently analysing other verification methods with a view to introducing an improved method in the near future.

## 9. Plans for the future

The development of a high resolution model will start in 2005. This model will have a mesh size about 2km, will get its boundary conditions from the actual aLMo and produce 8 times a day 18 hours forecasts. It is planned to be pre-operational in 2007 and operational in 2008.

2005 the first automatic weather stations of the ground based monitoring system will be renewed. A new tool for the observers will be implemented, which helps to get a better quality of the observations. The renewing will be done station by station and should be finished 2008. At the end a total of about 130 sites will be automatically operated. With the first new station a new network monitoring will be in operational use as well.

In 2005 MeteoSwiss will implement a new production system for SYNOP messages including an extensive quality check module and a completely revised encoder software.