

Annual Technical Progress Report on the Global Data Processing System

Switzerland

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1 SUMMARY OF HIGHLIGHTS

Skills of MeteoSwiss forecasts for the general public reached in 2003 an all-time high. A major project for server and storage consolidation has been completed in 2003. Many parts of the computer system have been replaced by the latest equipment.

2 EQUIPMENT IN USE

In 2003, MeteoSwiss replaced many parts of its central computer equipment. Today, the main computer is a SunFire 6800 with 4 domains running Solaris 8. One domain is used as fileserver controlling the NAS (Network Attached Storage) and the backup/recovery tapes. A second one is used as database server (Oracle) of our climatological database. Another domain is for producing meteorological and climatological products and the last one is scalable to increase the availability of the system. At the regional offices, the configuration is basically the same as in Zurich, however with smaller computers (SunFire V880).

The servers for the message handling system (MHS) had been replaced by SunFire V880 machines too. At the same time the radar servers have been integrated into these machines. For EUMETSAT-MSG data reception (DVB), we installed a PC system running Windows 2000. The Limited Area Forecasting Model (aLMo) is processed at the Swiss Center for Scientific Computing (CSCS) in Manno.

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	12'700
TEMP Part A+B	1'960
PILOT Part A+B	200
METAR	44'000
TAF short/long	13'000
AIREP/AMDAR	3'200
GRIB	31'400
T4-charts	460

BATHY/TESAC
DRIFTER

265
1'670

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. Bulletin failing this check are routed to operators workplace for manual correction if possible. Currently SYNOP and TEMP/PILOT for region VI will be corrected as well as OPMET data for indicators L/// and E///.

6 MONITORING OF THE OBSERVATION SYSTEM

Surface observations are monitored on the national level. Currently a computer aided automatical and manual system is used. For future enhancement see chapter 9.

7 FORECASTING SYSTEM

7.1 System run schedule and forecast ranges

Medium and extended range forecasting are based on external NWP sources, but MeteoSwiss runs its 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. All time critical forecast products are available in less than 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 Centre for Scientific Computing (SCSC, 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 SCSC (on the other side of the Alps!).

7.2 Medium range forecasting system (4-10 days)

MeteoSwiss does 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, 2m humidity, 10m wind for stations below 100 m above msl), temp/pilot (wind, temperature and humidity profiles) and airep/amdar (wind, temperature). A typical 24 h 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 vapor 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 and the liquid water content. There are options for additional prognostic variables (cloud ice, turbulent kinetic energy, rain and snow water content) 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.

7.3.3 NUMERICAL WEATHER PREDICTION PRODUCTS

A suite of post processing modules are 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 SCSC; 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 radio-active 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 contributes also to the development of a limited-area ensemble prediction system based on the COSMO Local Model and on ECMWF ensemble forecast. Pre-operational products are already available, in the form of probability maps.

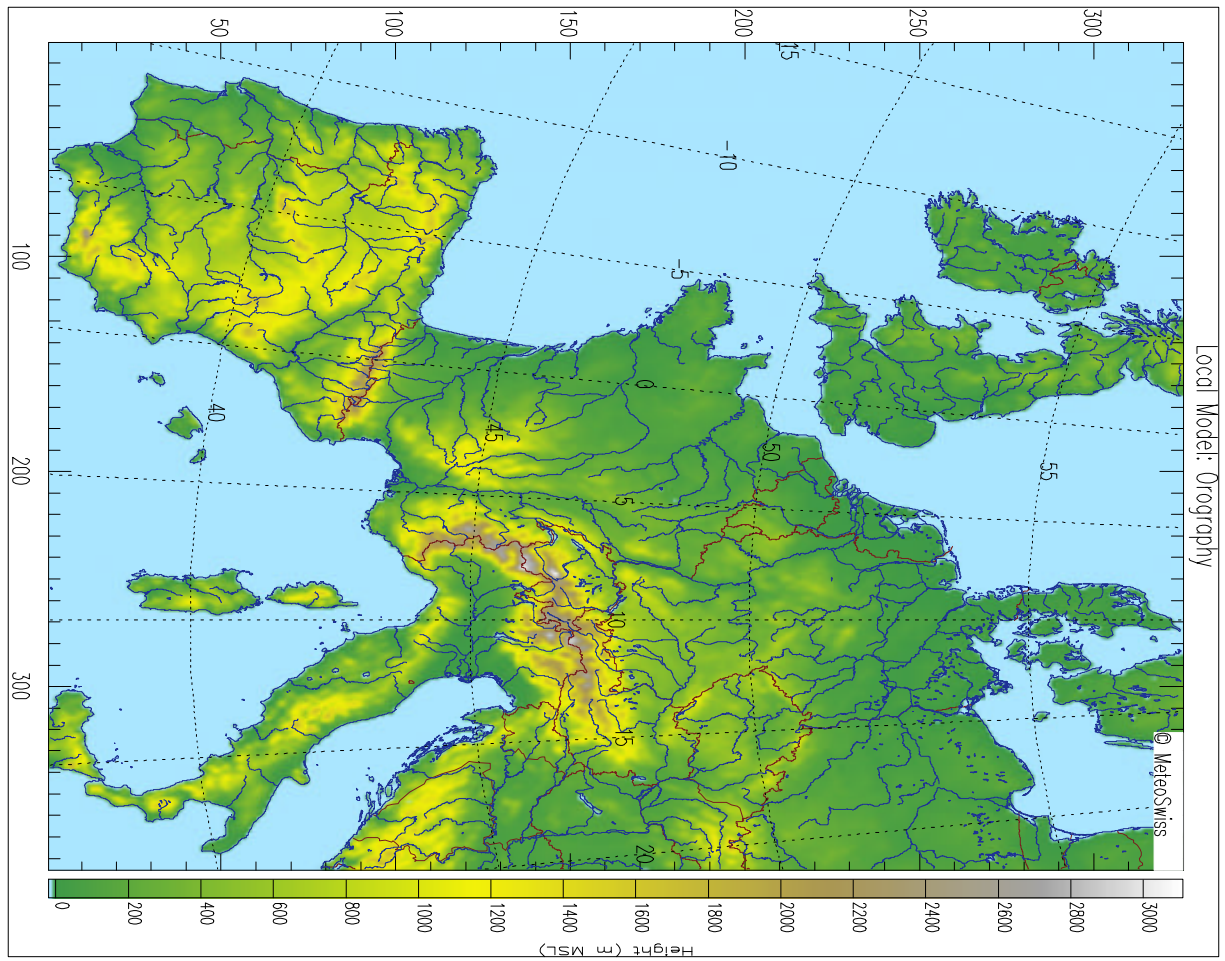


Fig. 7.1 Operational domain and orography of aLMo (filtered orography, highest point: 3109m)

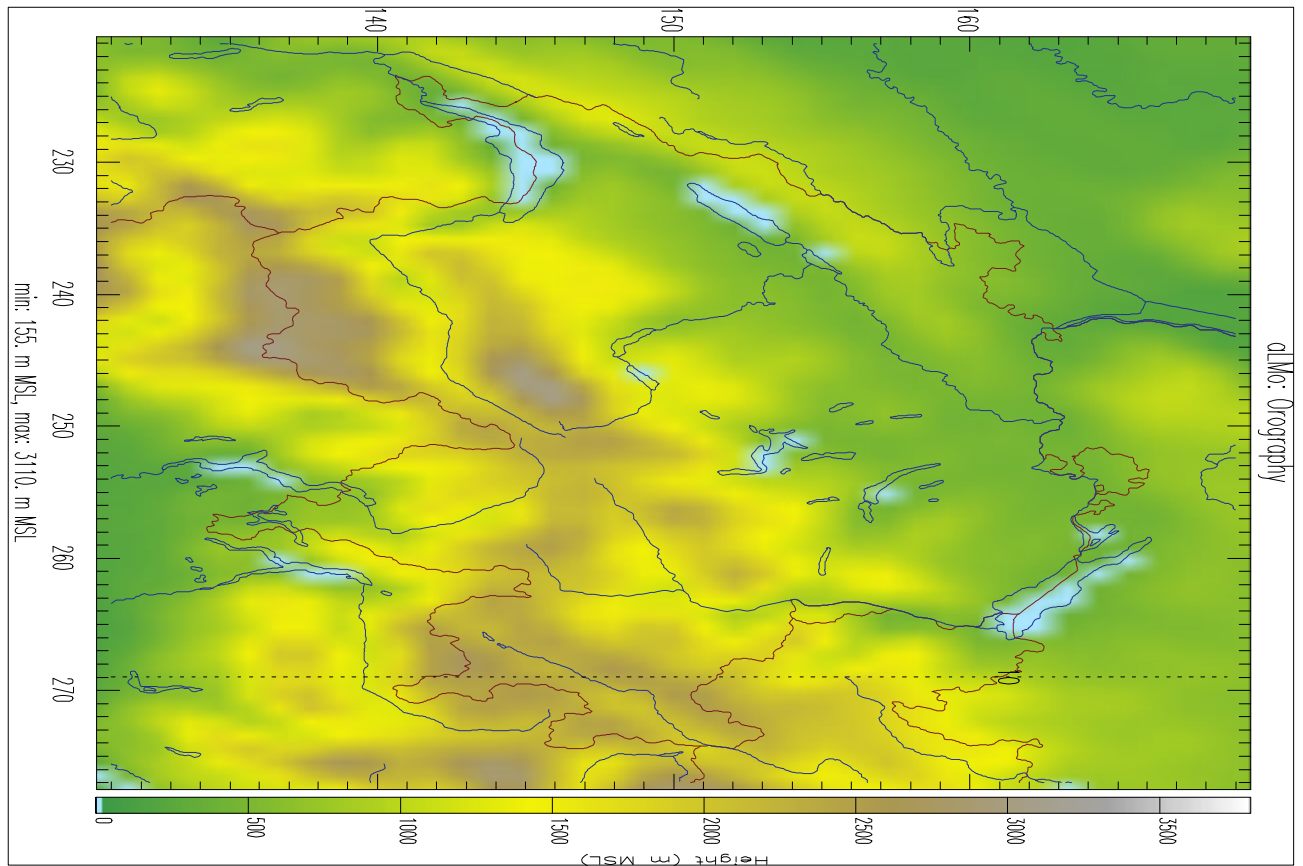


Fig. 7.2

7.4 Specialized Forecasts

Not available

7.5 Extended Range Forecasts

Not available

7.6 Long Range Forecasts

MeteoSwiss uses the ECMWF seasonal forecast system 2 to issue forecasts to a selected number of customers. The probabilistic forecasts make use of all 40 ensemble members and focus on the 2m temperature and precipitation. On a quasi-operational basis, the forecasts are visualized using the in-house developed Klimagram. The Klimagram shows the temporal evolution of monthly means in a probabilistic manner and in reference to the hindcast climatology. Further, various charts are produced and consolidated on an in-house web-page. The skill of the forecasts is analyzed globally on a grid point basis for 2m temperature for various lead times based on a modified ranked probability skill score taking into account the limited number of ensemble members.

8 VERIFICATION OF PROGNOSTIC PRODUCTS

For decades MeteoSwiss has assessed the quality of its forecasts. 19 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 issues forecasts in three languages for the general public through 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 will be taken into account. This means the measured time in relation to the maximum sunshine possible, the later changing daily according to the shape of horizon. The difficulty with this method is the conversion of terms describing sunshine or degrees of cloudiness to 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 amounts of precipitation are coded according to clear and binding regulations. The same applies to wind in cases where gusts of more than 25 knots are expected. This is 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 2003 show the following scores:

Central and eastern part of Switzerland	86%
Western part of Switzerland and Valais	87%
Southern part of Switzerland and Engadine	84%
The whole of Switzerland	86%

This is the best result since the verification of the official forecasts with the method OPKO is in use. The forecast analysis of 19 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

We will continue to use the described method for the moment. However, there are deficiencies. We cannot compare for example our results with those of other weather services. We are currently analyzing other verification methods with a view to introducing an improved method in the future.

9 FUTURE PLANS

In 2000 MeteoSwiss has started a project to renew the ground based monitoring system. From 2004 to 2008 the currently operated observing systems will be replaced using the developed new infrastructure. In the end a total of about 130 sites will be automatically operated. The data processing and quality control system will be performed as described in the GDPS-report 2002 (Chap. 9). Actually, the described data processing system is set up on the existing observing systems. It will be adapted station by station using the new network SwissMetNet in near future.