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Federal Department of Home Affairs FDHA

Numerical Weather Prediction at MeteoSwiss

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Swiss implementation of the COSMO-Model

Prognostic variables: pressure, 3 wind components, temperature, specific humidity, cloud water, cloud ice, rain, snow, turbulent kinetic energy (TKE), COSMO-2: also graupel

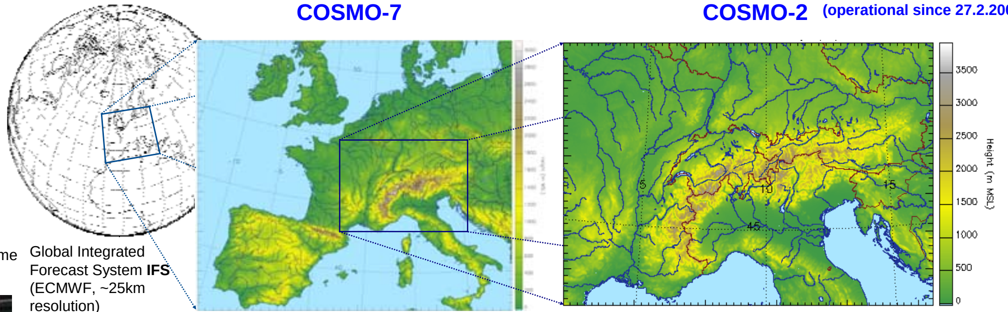
Coordinates: general terrain-following height-based vertical levels, Lorenz staggering; Arakawa-C, rotated Lat/Lon horizontal grid

Dynamics: 2-timelevel 3rd order Runge-Kutta

Physics: bulk microphysics for atmospheric water content, multilayer soil module, COSMO-7: Tiedtke mass flux convection scheme COSMO-2: explicit deep convection

Computer:

Cray XT4, 447 dual-core processors; 390 Gflops sustained on 816 processors, 9% of peak
Fail-over: Cray XT3, 1664 processors
Swiss National Centre for Supercomputing (**CSCS**), Manno



Global Integrated Forecast System **IFS** (ECMWF, ~25km resolution)

COSMO-7 domain (maximum height at 3122m). COSMO-2 domain (maximum height of 3950m).

	COSMO-7	COSMO-2
Mesh size	3/50°, **~6.6km**	1/50°, **~2.2km**
Domain	393 x 338 x 60 = 7'970'040 grid points	520 x 350 x 60 = 10'920'000 grid points
Forecasts	+72h at 00 and 12 UTC	+24h every 3h, first one at 00 UTC
Boundary conditions	Updated every 3h from IFS	Hourly updated from COSMO-7
Initial conditions	Newtonian relaxation (nudging) to surface and upper air observations, intermittent cycle of 3h assimilation	Same as COSMO-7, but with use of radar data over Switzerland (latent heat nudging)

D-PHASE (Demonstration of Probabilistic Hydrological and Atmospheric Simulation of flood Events in the Alpine region)

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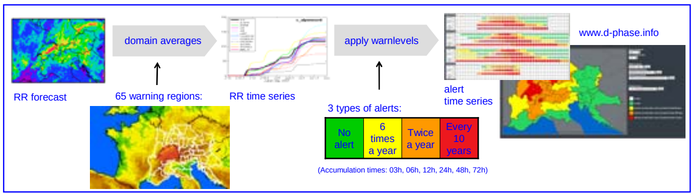
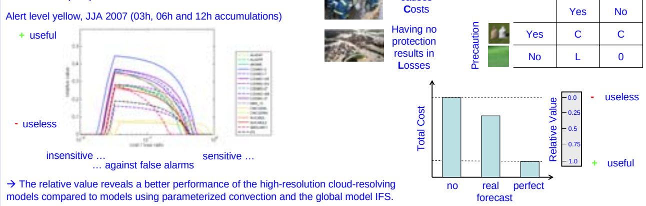
D-PHASE is a Forecast Demonstration Project (FDP) within the World Weather Research Programme (WWRP) of the WMO. It mainly aims at demonstrating the ability of forecasting heavy precipitation and related flooding events in the Alpine region resulting from the achievements of the Mesoscale Alpine Programme (MAP). The D-PHASE Operations Period (DOP) has been from 1 June to 30 November 2007. The project has set up a real-time end-to-end forecasting system, which addresses the entire forecasting chain, including observations, 7 ensemble and 23 deterministic models (including 13 cloud-resolving models) for the atmosphere as well as 7 hydrological models and various real-time nowcasting tools. Warnings are issued as the potential flooding event approaches, allowing forecasters and end users (civil protection authorities, water management and hydrological agencies, etc.) to alert and make decisions in due time. All alerts for predefined warning levels are made available in real-time on an internet-based centralised visualisation platform (www.d-phase.info). On request of many end users, the platform is still up and running and continues to provide information from 13 atmospheric and 3 hydrological models on an experimental basis.



The **relative value R** gives the fraction of savings that can be achieved scaled by perfect forecast information (R=1) and no forecast data (R=0).

Alert level yellow, JJA 2007 (03h, 06h and 12h accumulations)



→ The relative value reveals a better performance of the high-resolution cloud-resolving models compared to models using parameterized convection and the global model IFS.

The model results for the DOP are stored in a central data archive in the World Data Center for Climate in Hamburg. They provide a huge amount of data which is well suited to investigate the use of atmospheric/hydrological models for flood forecasting in mountainous regions. Various methods are applied to get an objective verification of the model forecasts, like e.g. fuzzy verification techniques based on the Swiss radar composite, and to evaluate the warnings for target regions. From an economic point of view, the cost-loss ratio is a crucial parameter to issue most effective warnings based on inherently uncertain forecasts. For a low cost/loss ratio the high resolution models are the best choice to rely on. However, model calibration should be used to optimize the "relative value" for a specific application.

Statistical Postprocessing for building climate

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Local weather forecasts are becoming more and more interesting for the industrial sector. This motivates the development of statistical adaptation methods in order to provide sufficiently accurate weather predictions at point locations. The research project OptiControl (www.opticontrol.ethz.ch) investigates the potential of using weather forecasts for predictive control of building indoor climates for various building types, technical installations, locations and comfort requirements.

Local corrections have been developed for three parameters that have large impact on the energy balance of buildings: 2m air temperature, 2m dewpoint temperature (both based on the Kalman filter) and global radiation (using time dependent splines). Here, we report first results of a comparative simulation study for the application "Integrated Room Automation" (IRA). Other applications as well as different control strategies are being investigated in the course of the project.

The IRA control task is to maintain the room temperature and the luminance level in a single building zone within suitable given comfort ranges. The control variables considered here were heating power delivered by radiators via a heat pump; cooling power delivered by a cooled ceiling via a mechanical chiller, or via a wet cooling tower in free cooling operation; blind position; and artificial lighting power. The system's annual total primary energy consumption (PEC) was estimated by means of multi-year, hourly time step simulations with a dynamical building model. The control variables were updated every hour based on a control algorithm that incorporated weather forecasts for 32 hours ahead. The algorithm optimized in particular the use of blind position and free cooling usage (associated with low PEC).

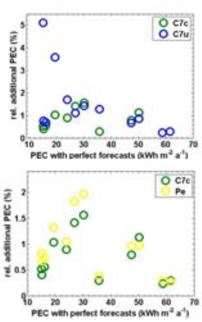
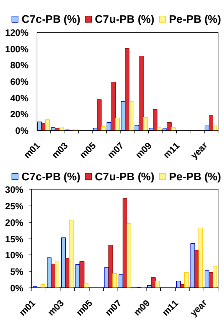


Fig.7: Summary of all simulations for the three different forecasts compared to the perfect prediction scenario. The absolute PEC with perfect forecasts and the relative additional PEC are highly dependent on the type of control and building. Pe is persistence, C7u is COSMO-7 DMO and C7c is COSMO-7 corrected. The two cases with PEC ≈ 60 kWh m^{-2} a^{-1} are insensitive to the weather forecasts.



Considered were four building types and one technical installation at the sites Kloten, Basel and Marseille, resulting in 12 cases for the year 2006. The meteorological parameters used were global radiation (on the vertical orientations of the building), wet-bulb temperature and 2m air temperature. The lowest possible PEC values (Performance Bound, PB) were estimated in each case by assuming perfect knowledge of the building's dynamics as well as the availability of perfect weather and internal gains forecasts. The results of the PB simulations were then compared with those from simulations using COSMO-7 direct model output (C7u, height correction only); COSMO-7 statistically corrected output (C7c); and a persistence forecast (Pe, "same weather as past day").

Fig. 8: Monthly resolved PEC increments for office rooms with "Swiss average" thermal insulation levels and south orientated façades at sites Marseille (upper panel) and Kloten (lower panel). It can be seen that the monthly PEC increments depended strongly on location. A distinct annual cycle was typical for all cases (not shown).

COSMO-7 outputs need to be corrected statistically in order to achieve a forecast quality which brings benefits for the IRA application.
The COSMO-7 predictions can be expected to give a larger benefit for applications that depend on longer prediction horizons (e.g. storage management, systems with limited energy supply).