6 Working Groups

COSMO's scientific and technical activities are organized in *Working Groups* (WG) which cover the main research areas related to a NWP-system. Each Working Group is headed by a *Work Package Coordinator* (WPC), who is responsible for the consistency of the execution of the work packages and for the coordination, planning, and supervision of the scientific and technical activities related to the work packages in his group.

This section gives an overview on the current personnel composition of the WGs. All scientists contributing actively to the work packages are included in the lists, also those from outside COSMO member institutions. For each WG, the main research activities from the recent COSMO period (Oct 2002 - Oct 2003) are briefly summarized and a short note on the planned activities for the present period (Oct 2003 - Oct 2004) is given. The work plan lists as well as a detailed description of each work package within a WG, are available at the member area of our web-site.

6.1 Working Group 1: Data Assimilation

This working group considers various aspects of 4-dimensional assimilation of observation data using the nudging analysis technique. For soil moisture and some surface fields, a set of 2-dimensional intermittent analysis schemes is applied in addition. The group is headed by Christoph Schraff (DWD) as WPC. The following scientists are members of this group.

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- A main focus was on the assimilation of radar-derived precipitation by means of latent heat nudging (LHN). Sensitivity experiments have been performed both in an OSSE framework for an idealised supercell storm and in real-case studies on a 7 km and 2.8 km resolution. Better results are obtained when convection is simulated explicitly rather than parameterised, and when the humidity is also adjusted (see *Assimilation of Radar Data in the LM at DWD* by S. Klink and K. Stephan in Section 9). In the real cases, the positive impact of LHN disappears after 3 to 6 hours of free forecast.

- The work on the assimilation of ground-based GPS-derived total precipitable water (PW) ceased in early 2003. It included the conduction of parallel assimilation cycle and forecast experiments for several periods. In one period, a bias correction was applied to account for a summerly diurnal wet bias of the observed PW relative to the model forecasts. This decreased a tendency to overestimate precipitation. While the statistical impact of the GPS data was found to be neutral to positive, except for cloud cover in low status periods, there were also individual cases with distinct negative impact on precipitation forecasts. A key factor to these problems is the vertical distribution of the PW information. It requires further efforts (or imposing restrictions) before operational use of the GPS data.
- Work has started to derive retrievals of temperature and humidity profiles from NOAA polar orbiting satellite data by means of a 1DVAR package from NWP SAF. Yet in the first place, this is done to be used in a 3D-PSAS data assimilation for lower-resolution HRM applications.
- Work has also started to derive statistically based vertical and horizontal correlation or weight functions for the nudging-type scheme by means of radiosonde observations.

In 2004, the development work to use satellite data will be intensified, partly with some delay to original plans. The 1DVAR approach will be applied also to MSG data and in the framework of the nudging-type scheme for the LM. Cloud information based on satellite data as well as conventional data will also be striven to be assimilated. Some effort can be redirected to the use of GPS-derived PW, and the other work packages mentioned above will be continued. Furthermore, the variational soil moisture analysis scheme will be extended, the temporal nudging weights tuned, and the snow analysis improved.

(Christoph Schraff, DWD)

6.2 Working Group 2: Numerical Aspects

The WG on numerical methods and basic model dynamics is headed by Jürgen Steppeler (DWD) as WPC. Currently, the following scientists are members of this group.

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The main research activities of WG 2 for the period Oct 2002 - Sep 2003 and the planned activities for the current year are summarized below.

- Experiments done using the two time level Version of LM indicate that the introduction of a prognostic precipitation scheme, which takes account of the horizontal advection, reduces the systematic error of the precipitation forecast considerable. It is planned to use the prognostic precipitation within the current three time-level scheme. In order to be useful it is planned to develop the operational scheme rather fast, in order that it has a useful production time before the LM will change to a high order two time level scheme.

- It is planned to develop a high order discretization scheme for LM. Order 3 in time and probably order 5 in space are planned. This development will be based on the third order Runge Kutta time discretization scheme. With high resolution applications of LM this scheme is expected to give a sufficient amount of accuracy in order to be able to forecast the interesting scales with enough reliability.

- The Z-coordinate version of LM is expected to give better forecasts of a horizontally stratified atmosphere. High fog and orographically induced winds should be forecasted better than with terrain following models. For the current year key developments are the harmonising of the semi Lagangian and Euler Z-LM as well as the beginning of realistic tests of the z-concept. The aim of these tests is to show that the Z-LM has advantages and no disadvantage as compared to the terrain following LM. Questions of operational efficiency will be followed in a large time frame. For these the semi-Lagrangian version could turn out to be essential.

- Questions of the performance of LM in the tropics are still open and will be followed in the current year.

- Further questions to be investigated are the LM performance on large domain size, questions of vertical discretization abd alternative formulations of the dynamic equations.

(Jürgen Steppeler, DWD)

6.3 Working Group 3: Physical Aspects

The main effort of this working group is to develop new physics packages for future operational applications and to improve existing parameterisations. The WG on physical processes, which is coordinated by Marco Arpagaus (MeteoSwiss), has grown substantially since the publication of the last Newsletter and currently consists of the following scientists:

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During the last COSMO period, the following topics were of major importance:

- Work continued on the new turbulence scheme based on a prognostic treatment of turbulent kinetic energy (TKE) as well as on the new surface layer scheme. Both schemes are operational at DWD, ARPA-SMR, and IMGW, and are expected to become operational at MeteoSwiss soon. A technical report on parts of this work package ("Evaluation of Empirical Parameters of the New LM Surface-Layer Parameterisation Scheme") can be obtained on the COSMO web-site at http://www.cosmo-model.org/cosmoPublic/technicalReports.htm.

- The new multi-layer version of the soil model TERRA, which includes freezing and melting of soil layers and a revised formulation of the snow model, has been thoroughly tested and is currently undergoing final pre-operational testing. A technical report describing the changes to TERRA ("The Multi-Layer Version of the DWD Soil Model TERRA_LM") is available on the COSMO web-site at http://www.cosmo-model.org/cosmoPublic/technicalReports.htm. Additionally, work has started on the development of a new lake model, which is expected to lead to first experimental results by the end of the current working period.

- Implementation work on the Kain-Fritsch convection scheme continued. Tests show promising results, but rigorous validation is still pending and the code eventually needs substantial re-writing to improve the performance on vector machines. Therefore, alternative implementations of the Kain-Fritsch scheme are also being looked at.

- A cloud-ice scheme has been developed and implemented into both LM and GME. The scheme is running operationally at all member states except MeteoSwiss since September 2003, and is planned to become operational in Switzerland in the first half of 2004.

- Implementation and adaptation of a 3D turbulence formulation is under way, and will be followed by extensive testing, especially at higher resolutions.

The plan for 2004 includes further work on most of the schemes mentioned above. For the new turbulence scheme, this consists of parameter tuning, further extension of the scheme as well as writing up a documentation. The soil model mainly awaits operational implementation, and the implementation of the Kain-Fritsch convection scheme is "work in progress".

New packages for the work plan of 2004 include the parameterisation of boundary layer clouds (either within the new turbulence scheme or an entirely new package) and sub-grid scale cloudiness, inclusion of graupel in the microphysics scheme as well as testing of different aspects of LM runs at 2.8 km or even smaller grid-spacing.

(Marco Arpagaus, MeteoSwiss)

6.4 Working Group 4: Interpretation and Applications

The main effort of this working group is to develop methodologies and tools for the interpretation of high-resolution direct model output, including model applications to limited area ensemble prediction and various postprocessing methods. The WG on interpretation and applications is coordinated by Pierre Eckert (MeteoSwiss). The following scientists are members of the group:

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The efforts of WG4 have one side been devoted to the COSMO LEPS. This technique consisting of a downscaling of the ECMWF ensemble with the help of the LM has been implemented semi-operationally and runs on a daily basis since November 2003. Several probabilistic products are disseminated to the member states. New parameters like instability indices and zero degree level have been proposed. The verification based on the Italian high density precipitation network has been carried out, but the statistics for the time being is to poor to draw conclusions. Benchmark verifications based on statistical methods (pattern recognition by artificial neural networks) and the ECMWF EFI (Extreme Forecast Index) are available.

Two workshops have been organised, one in May together with WG5 and the other in September, in which decisions on future operations and research have been taken. The ensemble should be raised to 10 members, alternative clustering regions and parameters

should be tested, a set of test cases should be defined to be used not only by the COSMO LEPS project, but also to test new versions of the LM code.

As regards the LM postprocessing, the following activities have been carried out at DWD. Implementation of the neighbourhood method, probabilistic verification of this method, calibration, tests with stochastic physics on the LM. On the other side, computation and evaluation of various instability indices is in development at MeteoSwiss, the results should be available in 2004. Finally, links to dispersion models, ozone models and hydrology have been investigated at the polish meteorological service.

(Pierre Eckert, MeteoSwiss)

6.5 Working Group 5: Verification and Case Studies

This Working Group takes care for the verification of operational model forecasts, for the development of new verification methods and diagnostical tools as well as for case studies with the LM. The WG was coordinated till September 2003 by Carlo Cacciamani (ARPA-SMR) and since then ad interim by Francis Schubiger (MeteoSwiss).

The following scientists are members of this group:

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The main activities of WG 5 for the period Oct 2002 - Sep 2003 covered the following points.

- Operational verification of surface parameters, using SYNOP stations and also regional high resolution networks. Results are summarised in verification reports which are distributed on a quarterly basis on the COSMO website.

- Operational verification of upper-air parameters, using TEMP stations. As in the case of surface verification, results are summarised in reports distributed on a quarterly basis on the COSMO website.
- High resolution verification of precipitation, using available high resolution dense non-GTS surface data. Consolidation of a common data set of non-GTS daily precipitation data.
- Verification of precipitation using radar composites.
- Verification of model cloudiness with Meteosat VIS channel at 12 UTC.
- Verification of integrated water vapour content using GPS data.
- Weather regime verification of vertical profiles and precipitation using radar composites.
- Verification of radiation budget with measurements at Payerne (shortwave and longwave radiation, sensible heat and albedo).
- Verification of runoff over river basins in Poland.
- Verification at MeteoSwiss of aLMo with IFS boundary conditions (instead of GME; results presented at COSMO General Meeting 2003).
- Exchange of two charts per day (precipitation and sea surface pressure) of each operational LM running on the COSMO website for subjective verification (comparison) purposes.

An internal meeting on the verification was held on 26-27 May 2003 in Geneva (CH) together with the the Working Group 4. The presentations covered (1) the COSMO LEPS project, especially the verification aspects of these ensemble forecasts and (2) the actual state of the verification developments at the different centres, namely at DWD a verification of (a) wind gusts and (b) multi-level aircraft measurements vs TEMPs and LM-vertical profiles and at MeteoSwiss the verification of a test chain with IFS lateral bounday conditions.

The major workpackages for 2004 include a continuation of the current operational verification of surface and upper air using SYNOP and TEMP stations. High-resolution dense non GTS-data as well as radar composite data will be used for verification of QPF. Cloudiness will be verified using Meteosat VIS data, integrated water vapour content using GPS data. At ECMWF a common verification package will be installed for the verification of new LM versions.

(Francis Schubiger, MeteoSwiss)

6.6 Working Group 6: Reference Version and Implementation

The WG on code maintenance, reference version, documentation and implementation is headed by Ulrich Schättler (DWD) as WPC. The following scientists contribute to the work of this group:

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In the period Oct. 2002 - Oct. 2003 the following work was done by WG 6:

- Updates of the GME2LM and LM have been programmed, tested and implemented at all sites. See Section 5 for the program updates and Section 4 for the changes in the operational applications in the COSMO centres.
- A working group on code optimization and portability has been formed and guidelines for the work have been set up. This working group should be a platform to exchange and centralize information. Most important for the work is the "portable optimization".
- A template for describing the operational applications of all COSMO partners has been developed and a first prototype web page has been implemented.
- A page with the list of available software tools for exchange within COSMO has been set up on the private pages of the Web Site.
- Two parts of the restructured documentation have been released (I: Numerics and Dynamics; III: Data Assimilation).
- For the LM Nesting and the different interpolation programs (IFS2LM, LM2LM) only further tests could be made. No activities for an operational coding could be started.

Ongoing activities of WG 6 are the maintenance and the update of the COSMO software and the web site. New versions of the programs will be implemented and tested at all sites. The update procedure for the Reference Version will be installed and the Common Verification Package will be used for testing the new Reference Version. More documentation has to be put to the Web-Site (Update histories of COSMO software; description of the Working Groups) and work on restructuring the (offline) documentation has to go on.

(Ulrich Schättler, DWD)