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. The WGC normally meet twice a year to discuss the status of the work packages and to prepare the work plans for the next period. The plans are then elaborated in detail during the COSMO General Meeting

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 2003 - Sep 2004) are briefly summarized and a short note on the planned activities for the present period (Oct 2004 - Sep 2005) 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, especially 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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During the last COSMO period, the following topics were of major importance:

- The assimilation of European wind profiler data has been introduced operationally (at DWD) after that some profilers have been blacklisted and an impact study showed slight positive impact.
- A main focus continued to be on the assimilation of radar-derived precipitation by means of latent heat nudging (LHN). Sensitivity experiments in an OSSE framework for an idealised supercell storm indicate that errors in the ambient low-level humidity affect mainly the rain amounts, while wind errors may distort the dynamincal structures and precipitation distributions. Effects of prognostic treatment of precipitation (including drifting) limit the validity of the basic assumption of LHN, and this is found to adversely affect LHN in real-case studies on 2.8 km resolution compared to runs with diagnostic precipitation (see *Latent Heat Nudging and Prognostic Precipitation* by S. Klink and K. Stephan in Section 9). Efforts are devoted to diagnose, better understand and reduce these problems.
- Deriving 3D wind retrievals with a simple variational adjoint method provides another approach to use both radar reflectivity and radial velocity. Preliminary results indicate that the method is very sensitive to the pre-processing of the radar data, and spurious wind patterns may be obtained.
- Some further case studies on the assimilation of ground-based GPS-derived total precipitable water (PW) have basically confirmed earlier results, that although these data do have a potential to improve precipitation forecasts, the incorrect vertical distribution of the PW information has a significant negative impact in some cases. A feasibility study has been performed on GPS tomography which in principle could solve this problem by providing vertical humidity profiles. While this has worked reasonably well in some cases, problems in other cases indicate the need for much more work to be done on this method.
- The work has been continued on retrieving temperature and humidity profiles from NOAA polar orbiting satellite data by 1DVAR and assimilating them in a 3D-PSAS scheme for lower-resolution HRM applications. However, the effort has been extended to use these data also in the framework of the nudging-type scheme for LM and to apply the 1DVAR approach to MSG data.
- Using 2-m humidity observations in the 2D variational soil moisture analysis (SMA) in addition to 2-m temperature data has not shown any positive impact.

In 2005, the work on the above topics will continue along the lines described, except that it will probably not be possible to allocate any resources to the use of ground-based GPS data. The variational soil moisture analysis will be extended from the current 2-layer soil model to the new multi-level soil model. Further plans relate to tuning issues in the nudging scheme, the use of cloud information, and the incorporation of satellite information in the snow analysis.

(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 2003 - Sep 2004 and the planned activities for the current year are summarized below.

Apart from smaller work, which is described on the private part of the COSMO web-site, there are two important lines of work, which are the development of the Runge-Kutta time integration and the Z-coordinate. Both developments are contiued from the 2003/2004 period. A preliminary version of the RK-scheme was developed by September 2004 and the z-coordinate version had a preliminary physics interface and realistic runs were possible with the Euler version of the LM_Z. Also, the Semi-Lagrangian version of LM_Z was integrated in the same program library.

For 2004/2005 it is planned to develop the RK-scheme further by developing further versions and finding a suitable version using a series of tests, which in addition to realistic integrations involve convergence tests in idealised situations. For the z-coordinate, it is planned to develop the Semi-Lagrangian into three dimensions and to do realistic tests using the Eulerian version. This should include a refinement of the physics interface. The condensation should be computed on the z-levels.

(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 parameterizations. The WG on physical processes, which is coordinated by Marco Arpagaus (MeteoSwiss), consists of the following scientists:

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Most of the tasks of this working group are fairly big, and hence topics typically stay on the agenda for a few years. This is also true for most of the main work packages of the last COSMO period:

- Work continued on the new turbulence scheme based on a prognostic treatment of turbulent kinetic energy (TKE) as well as on the new surface transfer scheme. Both schemes are operational at DWD, ARPA-SIM, IMGW and HNMS, 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 in *Publications* > *Technical Reports*.
- 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 also available on the COSMO web-site in *Publications* > *Technical Reports*. Additionally, work on the development of the new lake model FLake continued.

- Implementation work on the Kain-Fritsch convection scheme continued, although very slowly. 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 three-category ice scheme has been developed and implemented into the LM. Tests, including comparison with a two-moment microphysics scheme, are ongoing.

- 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 2005 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 an extended 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 2005 include the intercomparison of soil models with respect to soil moisture, the development of a shallow convection scheme to be used for LM runs at 2-3 km grid-spacing, sensitivity studies concerning boundary layer clouds and testing of different sub-grid scale cloudiness approaches as well as testing of different aspects of LM runs at 2-3 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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(Pierre Eckert, MeteoSwiss)

6.5 Working Group 5: Verification and Case Studies

The activities of this group focus on an administrative point of view, in order to have some objective measures of how well LM forecasts are performing, and on an scientific viewpoint, in order to have detailed assessment of the strengths and weaknesses of the model. Thus, at the moment, the main activities of the working group deal with the following issues:

- The verification of operational model forecasts,
- The verification with feedback on the physical parameterizations (which means verification of new LM versions on a set of test cases)
- The development of new verification methods and diagnostic tools
- The collection of LM case studies.

The WG was coordinated ad interim from September 2003 to September 2004 by Francis Schubiger (MeteoSwiss), and now by Patrizio Emiliani (CNMCA, Italy).

The following scientists are members of this group:

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The main activities of WG 5 for the period Oct 2003 - Sep 2004 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. Like in the case of surface verification, results are summarized in reports distributed on a quarterly basis on the COSMO website.

- Exchange of LM maps (24hrs cumulated precipitation and MSLP) of each operational LM running on the COSMO web-site.

- 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.

- Daily cloudiness verification at 12 UTC with the Meteosat VIS channel.

- Verification of integrated water vapour content using GPS data.

- Validation of near-surface boundary layer processes and radiation budget from operational weather prediction runs (LM, GME, aLMo) at selected observatory measurement sites with different land surface properties.

- Weather regime type verification of vertical profiles and precipitation using radar composite network.

- Verification of precipitation forecast using radar composite network.

- Realization of a common Verification Package;

- Verification of runoff over river basins.

A WG4/WG5 workshop was held on 5-6 May 2004 in Geneva. Besides presentations of recent developments in the different services and preliminary results of the common verification package at ECMWF, the main topic of this joint workshop was a sessin named *how to present verification results to forecasters and feedbacks from forecasters to WG4 and WG5.* Presentations were given both from forecasters and scientists of the COSMO community. The discussion will lead into a document *LM Guidelines for forecasters.*

The work plan for 2005 includes new ideas and packages like verification on high resolution and with new techniques (like CRA (Contiguous Rain Area) verification, or by using fuzzy logic), verification of near surface boundary layer processes, conditional verification of new LM versions on a predefined set of test cases, implementation and installation of the Common Verification Suite at ECMWF and WGs 3-5 joint workshop in March 2005.

(Patrizio Emiliani, CNMCA-Italy)

6.6 Working Group 6: Reference Version and Implementation

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In the period Oct. 2003 - Oct. 2004 the following work was done by WG 6:

- Updates of the GME2LM (Versions 1.18/1.19) and LM (Versions 3.6-3.12) 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. No new Reference Version has been defined, so the update procedure for the reference version has not been activated.
- Due to the support of the Olympic Games in Athens, there were problems with the availability of the official COSMO web-site. Updating of the site could only be done in Manno. Therefore, many pages are rather old now and have to be updated.
- There was progress in updating the LM Documentation. Besides *Numerics and Dynamics* (Part I) and the *Data Assimilation* (Part III) there are drafts available now of the *Physical Parameterizations* (Part II) and the *User Guide* (Part VII).
- The common interpolation program INT2LM has been implemented as a test version. It includes GME2LM, IFS2LM and LM2LM and will, after a testing phase, replace these programs.
- There was little work on the Nesting Version of LM. Some more bugs were found and could be solved, but there still is no operational implementation in sight.

Activities on the maintenance and the update of the COSMO software will go on as usual in the next period. More emphasis will be put on updating the web-site, because this is a very important tool for information inside and also outside of COSMO. Also work on updating the whole LM documentation is going on. Some Grib related issues are investigated at MeteoSwiss and a comparison between the Nesting Version and the new INT2LM (LM2LM-part) is done at HNMS.

(Ulrich Schättler, DWD)