6.3 Working Group 3: Physical Aspects

The main responsibility of this working group is to develop new physics packages for future operational applications and to improve existing parameterisation schemes. The WG is coordinated by Marco Arpagaus (MeteoSwiss). The work packages of this group are splitted into various sub-themes, such as planetary boundary layer, microphysics, clouds, convection, radiation, and soil processes. The detailed annual status reports for each work package can be obtained from within the member area of the COSMO web-site. Short summaries of some selected topics of the last COSMO period are given below:

Planetary boundary layer: 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. The main effort went into setting up a 1-d version of the model to be able to make thorough validation studies. Writing an extended documentation of the new scheme was another priority of last years work. — 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`.

Microphysics: A three-category ice scheme has been developed and implemented into the LM. After extensive testing, the scheme is now the default option of the test-suites for the 2.8 km LM version 'LMK' running at DWD.

Clouds: First tests with the statistical cloud scheme (which is part of the new turbulence scheme) have been done and showed encouraging results. More tests and systematic studies are certainly needed, and the work will be continued within the framework of the new priority project *Towards a Unified Turbulence Shallow Convection Scheme (UTCS)* (see below).

Convection: The high resolution versions of LM (e.g. LMK, aLMo2) treat deep convection explicitly. However, to prevent the boundary layer from becoming too wet (the transport across the boundary layer top due to vertical mixing alone seems to be insufficient), a shallow convection scheme is needed also for grid-spacings of 2.8 km or 2.2 km. Tests with a stripped-down version of the Tiedtke cumulus parametrisation scheme showed satisfactory results, and is being used for the test-suites of LMK and aLMo2. However, a physically more appealing description of the moisture transport in and across the boundary layer top is part of the new priority project *Towards a Unified Turbulence Shallow Convection Scheme (UTCS)* (see below).

Radiation: First attempts towards a (poor-man's) three-dimensional radiation scheme have been made by applying correction factors to the solar and thermal radiation budgets at the surface due to shadowing, terrain inclination and orientation, reduced sky-view, etc.

Soil processes: 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 finally been put into operational service at DWD in autumn 2005 (LME). A technical report describing the changes to TERRA is available on the COSMO web-site at `http://www.cosmo-model.org/cosmoPublic/technicalReports.htm` ("The Multi-Layer Version of the DWD Soil Model TERRA_LM").

According to the new organisational structure of COSMO, introduced at the last COSMO meeting in Zurich (September 2005), there are now priority projects in addition to the work packages already known from earlier years. The two priority projects associated to WG3 (but explicitly not restricting their focus to physical aspects only) and starting as of March 2006 and December 2005, respectively, are *Towards a Unified Turbulence Shallow Convection Scheme (UTCS)* and *Tackle deficiencies in quantitative precipitation forecasts*.

Towards a Unified Turbulence Shallow Convection Scheme (UTCS):

Representation of shallow convection and boundary-layer turbulence in numerical models of atmospheric circulation is one of the key unresolved issues that slows down progress in numerical weather prediction. The goal of this project is to make a step forward in this area. The project is aimed at (i) parameterising boundary-layer turbulence and shallow non-precipitating convection in a unified framework, and (ii) achieving a better coupling between turbulence, convection and radiation. Boundary-layer turbulence and shallow convection will be treated in a unified second-order closure framework. Apart from the transport equation for the sub-grid scale turbulence kinetic energy (TKE), the new scheme will carry at least one transport equation for the sub-grid scale variance of scalar quantities (potential temperature, total water). The second-order equations will be closed through the use of a number of advanced formulations, where the key point is the non-local parameterisation of the third-order turbulence moments.

Tackle deficiencies in quantitative precipitation forecasts:

This project aims at looking into the LM deficiencies concerning precipitation by running sensitivity experiments on a series of well chosen cases which have verified very poorly. If successful, the outcome of these sensitivity experiments will be a more effective set of LM namelist or model parameters for quantitative precipitation forecasting, or a clear idea of what parts of the model need to be reformulated and improved most urgently to obtain better quantitative precipitation forecasts.

The working plan for the next COSMO period includes — additionally to the priority projects just described — further ongoing or new work related to the parameterisation schemes dealing with the planetary boundary layer, microphysics, clouds, convection, radiation, and the soil processes. Examples for such work packages are the revision of the surface transfer scheme to improve the daily cycle of 2m temperature, a detailed comparison of the (fast) radiation scheme with an elaborate line-by-line code, and the implementation of the new lake model FLake.