Consortium for Small-Scale Modelling

Michał Ziemiański

Consortia presentations
34th EWGLAM and 19th SRNWP meeting
8 October 2012, Helsinki

Outline

- **COSMO Organisation: News**
- **COSMO Model: Changes since last meeting**
- **COSMO Activities**

COSMO Organisation: News (1/2)

- Matthias Raschendorfer (DWD) is the new COSMO WG 3 (Physical aspects, upper air) Coordinator as of 15.9.2012
- Massimo Milelli (ARPA Piemonte) is the new COSMO WG 6 (Reference version and implementation) Coordinator as of 15.9.2012

- With the decision of the Steering Committee, COSMO WG Coordinators become the core members of respective SRNWP Expert Teams

COSMO Organisation: News (2/2)

- Five COSMO licences sold so far (United Arab Emirates, Brazil (INMET), Oman, Servei Meteorològic de Catalunya, Brazil (DHN))
- Three more licenses expected to commence in July 2013 (Botswana, Namibia, Turkmenistan)
  → Licence fees earned are spent for workshops / short-term missions / conferences / travelling.

- Free COSMO licence for low- and lower-middle-income economies (up to $4’036 GNI per capita) to allow migration from HRM to COSMO.

COSMO Model:
Changes since last meeting (1/3)

Recent changes aim at development of V5.0, unified for COSMO NWP, climat (CLM) and chemical (ART) communities

→ V5.0 expected in December 2012

- Version 4.21
  - Modified wind gust parameterization
  - Horizontal Smagorinsky diffusion
  - …
- Version 4.22
  - Modular nudging code
  - Radiation code for zenith angle correction
  - …

COSMO Model: Changes since last meeting (2/3)

- Version 4.23
  - Number of technical changes to accommodate further developments
  - CLM contributions (optimization of spectral nudging, new CO_2 scenarios, new diagnostics, restart and I/O changes, …)
  - …
- Version 4.24
  - New fast-wave solver (for increased stability)
  - Sub-hourly analysis update
  - …

COSMO Model:
Changes since last meeting (2/3)

- Version 4.25
  - 2-moment microphysics scheme
  - New tracer module (for microphysical species)
  - Optimization of asynchronous GRIB I/O
  - New asynchronous NetCDF I/O
  - Update of multi-layer snow model
  - IFS convection scheme for CLM community
  - …

COSMO Activities: Source Code Management

High priority due to:

- growing amount of software (COSMO, fieldextra, VERSUS, …)
- growing community contributing to the development of the software (COSMO-ART, COSMO-CLM, licensees, …)

Main recent developments:

→ update of the code management document (to clarify the process and better account for CLM and ART needs)

→ standard technical test suite (Python tool developed by the MeteoSwiss)

COSMO Activities

ET on data assimilation

- **Priority Project on Km-Scale Ensemble-Based Data Assimilation (KENDA)**
  PL: Christoph Schraff (christoph.schraff [at] dwd.de)

  → LETKF system implemented in CNMCA (Italy) on experimental basis since February 2012

  → see talk by Lucio Torrisi on Tuesday

COSMO Activities

ET on dynamics

- **Priority Project Conservative dynamical core (CDC)**
  PL: Michael Baldauf (michael.baldauf [at] dwd.de)

  → project ends in 2012 with a propotype of COSMO model employing anelastic dynamical core of EULAG

  → encouraging results for Alpine NWP-type simulations

  → see talk by Michael Baldauf on Tuesday

- **New Priority Project Operationalization of COSMO-EULAG (CELO)**
  PL: Zbigniew Piotrowski (zbigniew.piotrowski [at] imgw.pl)

  → project starts in 2012 with 3 year time-horizon

COSMO Activities

ET on physics

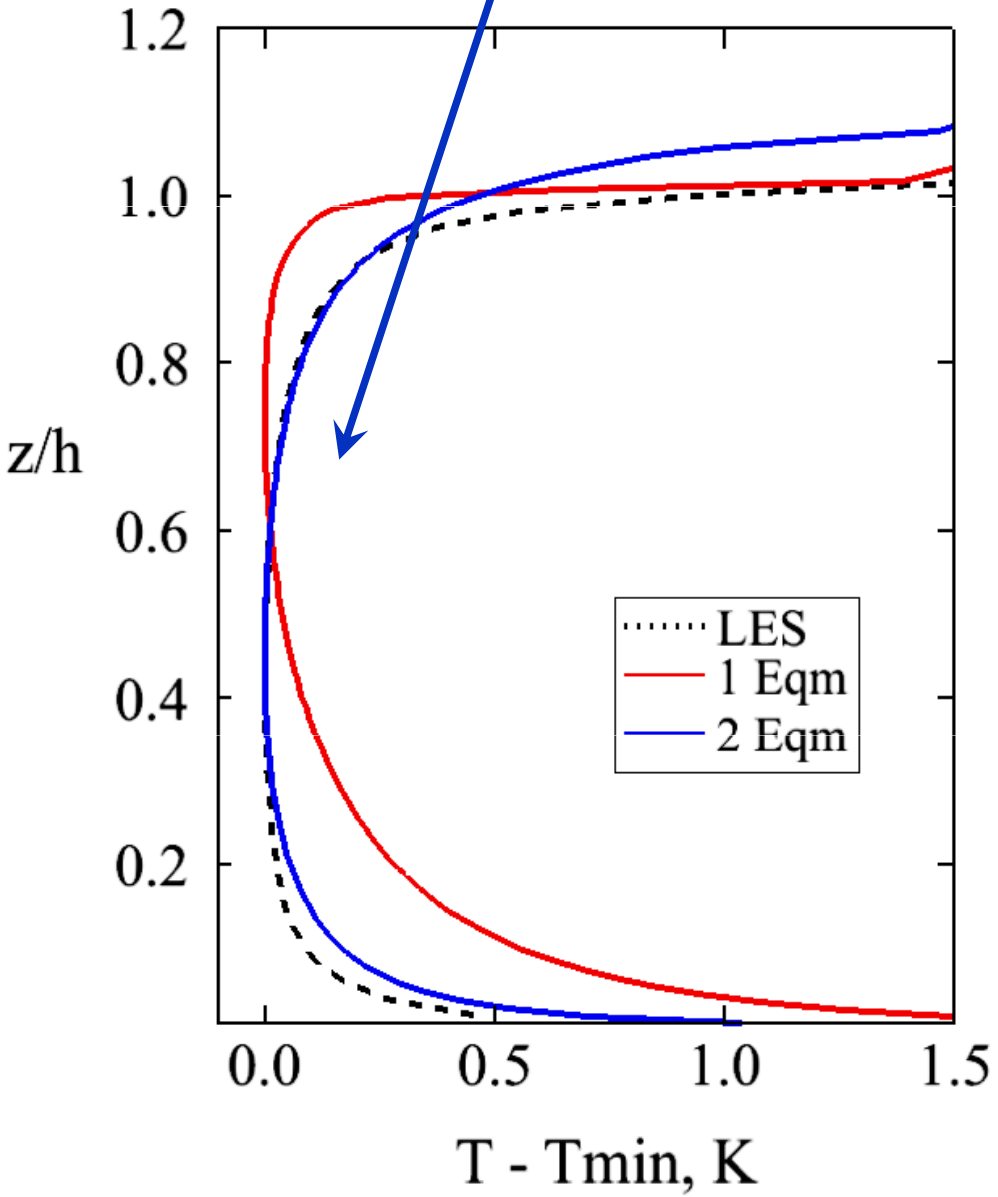
- **Priority Project Towards Unified Turbulence-Shallow Convection Scheme (UTCS)**
  PL: Dmitrii Mironov (dmitrii.mironov [at] dwd.de)

  → project ends in 2012 with, in between, a new TKE-Scalar Variance scheme carrying additional prognostic equations for the liquid water potential temperature variance, the total water specific humidity variance and the θ_l-q_t covariance

  → verification against observations indicate improvements as to e.g. fractional low cloud cover and 2m temperature and humidity

Task 1: 1D Results (cont'd)

Enhanced mixing, counter-gradient heat transfer

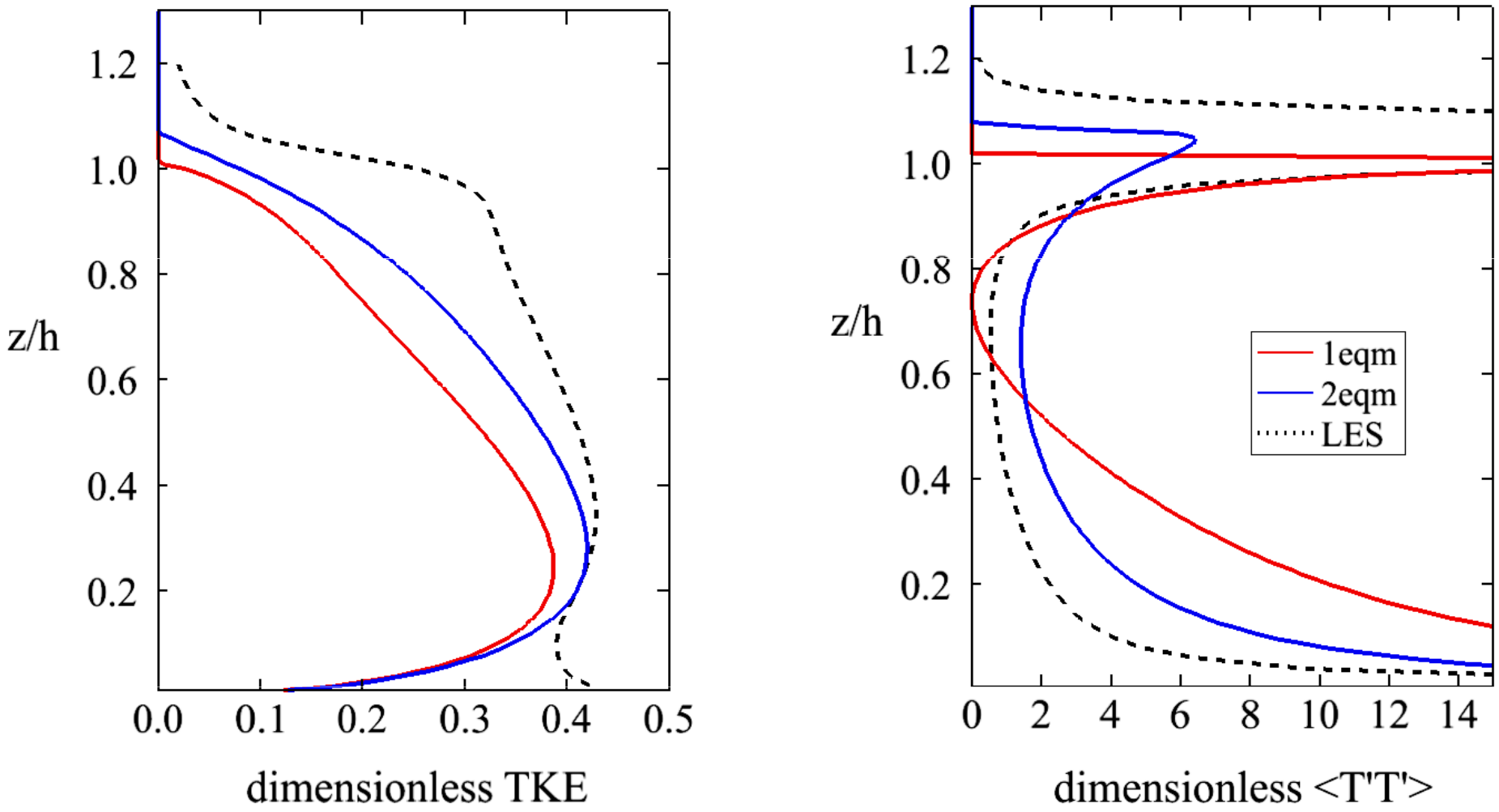


Mean Temperature in Convective PBL

TKE and TKESV Schemes vs. LES Data

Potential temperature minus its minimum value within the PBL. **Black dotted** curve shows LES data (Mironov et al. 2000), red – TKE scheme, blue – TKESV scheme.

Task 1: 1D Results (cont'd)



TKE (left panel) and $<\theta'^2>$ (right panel) made dimensionless with w_*^2 and θ_*^2, respectively **Black dotted** curves show LES data, red – TKE scheme, blue – TKESV scheme.

COSMO Activities

ET on physics

- **New Priority Project Calibration of COSMO Model (CALMO)**
  PL: Antigoni Voudouri (voudouri [at] hnms.gr)

  → project aims at automatic, multivariate, objective calibration of unconfined model parameters

  → based on Bellprat and Schär method for COSMO-CLM using a quadratic meta model in parameter space from Neelin et al. (2010)

  → reduction of model error of an expert tuned COSMO-CLM model by about 10%, optimal configuration close to the COSMO-EU one

COSMO Activities

ET on verification

- **Priority Project Verification System Unified Survey (VERSUS 2)**
  PL: Angela Celozzi (celozzi [at] meteoam.it)

→ the project focuses currently on conditional and EPS verification

→ see talk by Flora Gofa on Wednesday

COSMO Activities

ET on predictability and EPS

- **COSMO-DE-EPS** (2.8 km, 20 members) operational in DWD since 22 May 2012

  → provides early signals for severe weather; most beneficial for summer convection

  → see the talk by Detlev Majewski on Wednesday

- New Priority Project on convection-permitting EPS expected to start in 2013

COSMO Activities

ET on link with application

- **Priority Project Consolidation of Operations and Research results for the Sochi Olympic Games (CORSO)**

  PL: Gdaly Rivin (gdaly.rivin [at] mecom.ru) and Inna Rozinkina (inna [at] mecom.ru)

  → implementation and development of tools for deterministic and EPS modeling, and postprocessing

  → see the talk by Gdaly Rivin and Inna Rozinkina on Wednesday

  → see the additional talk by Pierre Eckert on detection of clear air turbulence on Wednesday

COSMO Activities

ET on system aspects

- **Priority Project on Performance on Massively Parallel Architectures (POMPA)**
  PL: Oliver Fuhrer (oliver.fuhrer [at] meteoswiss.ch)

  → aim at preparation of the proptotype model allowing for flexible computer architectures (including GPU)

  → design choice: C++, stencil library techique, DSEL (Domain Specific Embedded Language), GCL (General Communication Library based on MPI library)

  → new target: preoperational complete COSMO code based on new design

  → some of results:

Performance – COSMO vs. HP2C dynamics

Setup

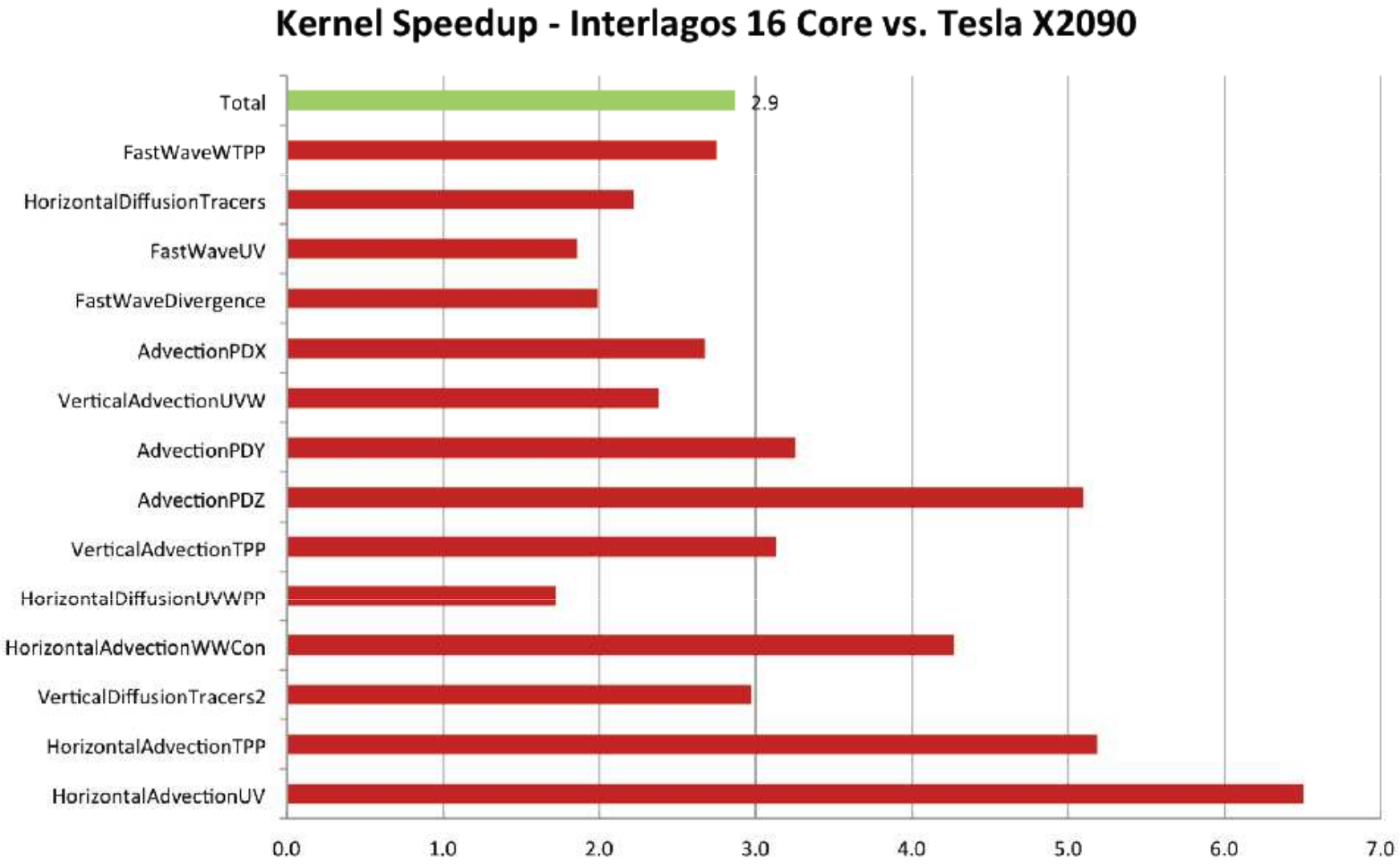
- CPU version
- Running 128x64 domain on one node of Cray XK6
- Timing of 11 time steps
- Use synchronous communication & GCL

Timings

	kernel [s]	comm [s]	copy [s]	total [s]
COSMO dynamics (MPI 4x4; OMP 1)	5.0	0.6	0.0	5.6
HP2C dynamics (MPI 2x1; OMP 8)	2.6	0.3	0.4	3.3
Speedup	**1.9**			**1.7**

Probably there is still to much communication done in case of the HP2C Dycore

Performance – CPU vs. GPU



Physics on GPU

	CPU runtime [s]	GPU runtime [s]	Speedup
Microphysics	17.9	2.6	**6.8**
Radiation	12.7	3.0	**4.3**
Turbulence	16.5	5.8	**2.8**
Soil	1.4	0.6	**2.4**
Copy (ijk) ↔ block	-	2.3	**-**
Total physics	48.5	14.3	3.4

- Convection scheme in preparation by CASPUR
- Meaningful subset of physics is ready!
- Ported using OpenACC (accelerator directives standard)

Xavier Lapillonne

What does that mean?

1 cabinet Cray XE6 (Production Machine)

144 AMD Opteron Magny-Cours (12-core)

Power = 45 kW

Price = 450 kCHF

GPU Server

O(10) GPUs

Power = 5 kW

Price = 50 kCHF

Thank you