# Development of a uniform model post-processing system of the ALADIN CHAPEAU model for education

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*Figure 8. Practical instruction of modeling in students lab*

## 1. Introduction

Several numerical weather prediction models have been run at the Department of Meteorology of the *Eötvös Loránd* University for air quality research, experimental weather forecast, wind energy estimation and educational purposes. Namely, the *NIRE* model from 1999, the *NCEP/Eta* model from 2005 and numerous versions of the Advanced Research *WRF*. Recently, in a cooperation with the Hungarian Meteorological Service (*HMS*) – the official weather bureau in Hungary – the *CHAPEAU/ALADIN* system has been installed and run on the facilities of the University. The latter two models have been implemented in the education of undergraduate students as well. Theoretical education of numerical weather prediction has always been taught in our institution, but practical instruction on modeling has not been given to our students before. In addition, a post-processing utility for the conversion of output *FA* files into standard *WMO grib* files has been developed in order to being able to visualize the outputs and compare them with other model outputs. Following the introduction of six case studies with the *CHAPEAU* model, we give a short description of the education of modelling and finally we define our near future targets on this field.

## 2. Installation of the *CHAPEAU/ALADIN* model at the *Eötvös Loránd* University

The model code has been provided by the *HMS* with a brief Users Guide written by *Daan Degrauwe*. It has been installed and run successfully on several different hardware platforms (including 32- and 64-bit *Intel Pentium* and *Xeon* architectures), and Linux OS' (including *Debian*, *Ubuntu* and *SuSe* distributions). The provided test case for the Netherlands of the 14 July 2007 has been used as reference, and has been followed by numerous test cases for the *Carpathian Basin*.
The output *FA* files were displayed with the open source *R* software extended by the *Rfa* package, however, minor difficulties have been experienced during it's installation and usage. In order to simplify the post-processing and ensure compatibility, with the aid of the *gribeuse* software, a conversion utility has been developed for the transition of *FA* files into one single (multi-level, multi-variable and multi-timestep) *grib1* file.

| Nr. | Date | Short name |
|---|---|---|
| 1. | 18 June, 2010 | Severe Thunderstorm |
| 2. | 1 July, 2010 | Summer Convection I. |
| 3. | 3 July, 2010 | Summer Convection II. |
| 4. | 24 July, 2010 | Slowing and Waving Cold Front |
| 5. | 5 August, 2010 | Arrival of a Squall Line |
| 6. | 10 September, 2010 | Case of Heavy Precipitation |

**Table I.** *Case study runs performed with the* **CHAPEAU/ALADIN** *model at the* **Eötvös Loránd** *University*

## 3. Short description of case studies

### *3.1 Severe thunderstorm*

Severe thunderstorms with heavy precipitation were experienced in the Southern part of Hungary at the 18th of June, 2010. The town of Mezőhegyes has been „destroyed" this day, where – besides significant damages – heavy personal injuries were happened. On the website of the HMS, meteorological analysis of the case is available titled "Destructive Thunderstorms".

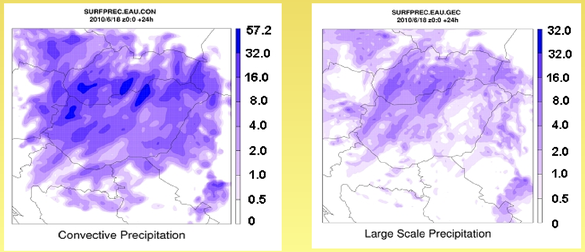


*Figure 1. Convective (left panel) and large scale (right panel) precipitation on the 18th June, 2010.*

### *3.2 Summer Convection I.*

Local Thunderstorms were developed especially in the central part of the country. In the vicinities of these cells, stormy wind gusts occurred.

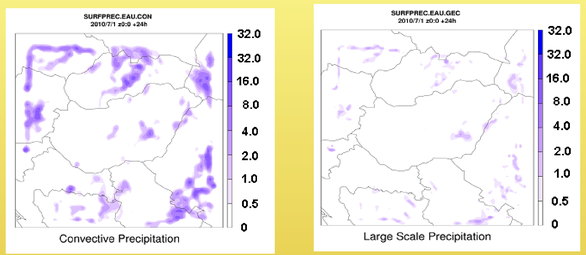


*Figure 2. Convective (left panel) and large scale (right panel) precipitation on the 1st July, 2010.*

### *3.3 Summer Convection II.*

Especially in the Eastern part of the country heavy thunderstorms were developed, mainly in the early afternoon hours.

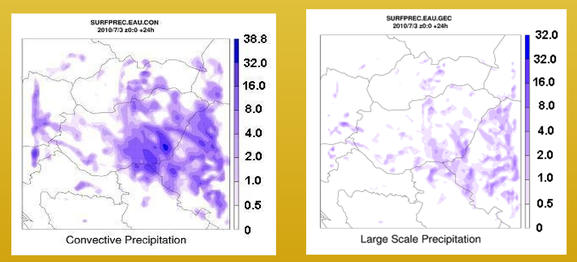


*Figure 3. Convective (left panel) and large scale (right panel) precipitation on the 3rd July, 2010.*

### *3.4 Slowing and waving cold front*

Northern wind dominated during the day 24th July, 2010. Many showers occurred in the Northeast, while in other parts of the country – after temporary improvement in weather conditions – subsequent precipitation activity begun. Until midnight, a significant amount of precipitation occurred in the Southwest.

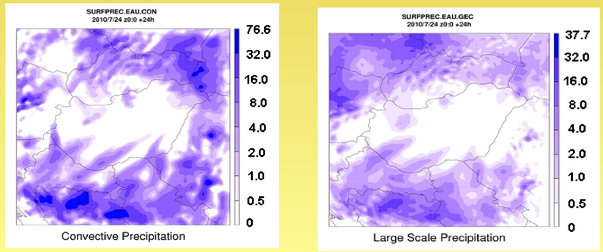


*Figure 4. Convective (left panel) and large scale (right panel) precipitation on the 24th July, 2010.*

### *3.5 Arrival of a Squall Line*

On the 5th August, 2010, some thunderstorms developed in the East, but the important weather phenomenon arrive in the first part of the night from the West. Significant amount of precipitation occurred until midnight.

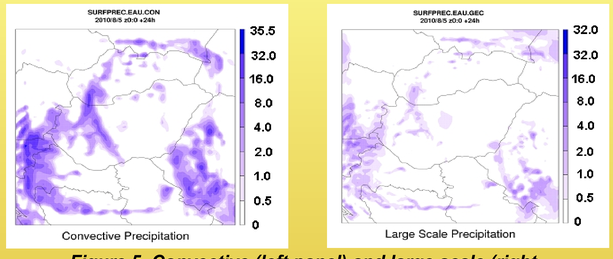


*Figure 5. Convective (left panel) and large scale (right panel) precipitation on the 5th August, 2010.*

### *3.6 Case of heavy precipitation*

Between the rivers Danube and Tisza about 60 mm precipitation was measured, but in some locations 90 mm occurred. This case has been compared to the model outputs from the WRF model (see figures in the frame below).

**CHAPEAU** **WRF**

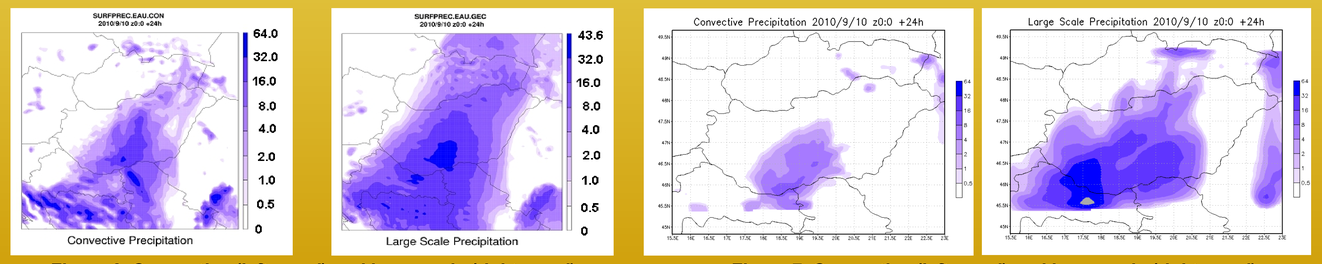


*Figure 6. Convective (left panel) and large scale (right panel) precipitation on the 10th September, 2010.*

*Figure 7. Convective (left panel) and large scale (right panel) precipitation on the 10th September, 2010.*

## 4. Practical education

Instruction of the application of the CHAPEAU/ALADIN model is being introduced to the education of undergraduate students at our University.

Syllabus of the short course on Practical Instruction of Numerical Modeling
13x 2 Lectures

Lecture 1 – 2
Introduction, historical review, the status of Numerical Modelling among the subjects of Meteorology. Introduction of the subjects of short students lectures. Short review of previous Numerical Modelling activity at the Department: introduction of the NCEP/MM4 (USA), the NIRE (Japan), the NCEP/Eta (USA) meso-scale meteorological models.

Lecture 3 – 7
Practical review of the WRF model, joint model integrations on workstations and projected by beamer. Possibilities of the post-processing and visualization of model outputs. Allocation of homework modeling projects. Consultation, discussion, referrals.

Lecture 8 – 11
Practical review of the CHAPEAU/ALADIN model, joint model integrations on workstations and projected by beamer. Possibilities of the post-processing and visualization of model outputs. Allocation of homework modeling projects. Consultation, discussion, referrals.

Lecture 12 – 13
Application of CFD solvers in Engineering Meteorology and in Meteorology projects. The Fluent and the OpenFoam software. Summary, consultation, discussion, referrals.

## 5. Future plans

Our aim is to develop an automated system for operational daily runs and the coupling of an air quality system for ozone application. This model development gives opportunity for the comparison of measured and computed surface energy budget components and fluxes .

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