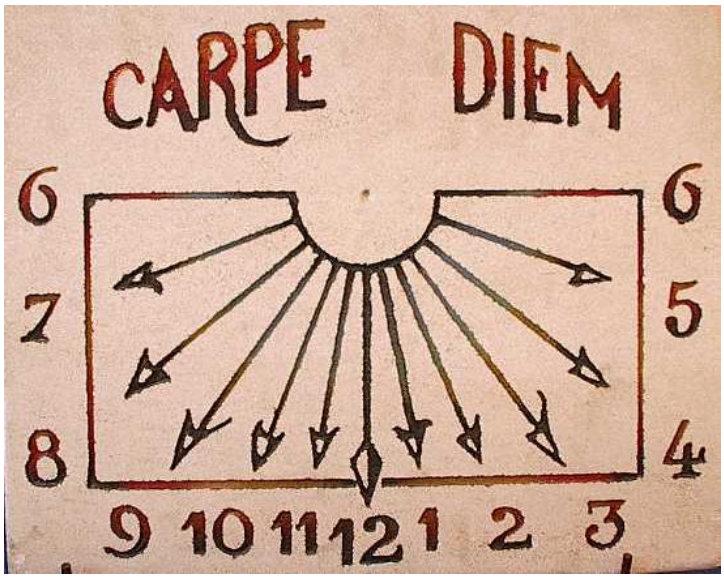
CARPE DIEM

Critical Assessment of available Radar Precipitation Estimation techniques and Development of Innovative approaches for Environmental Management



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1st Report of the Technical Steering Committee (TSC)

1 Introduction

The CARPE DIEM Technical Steering Committee (TSC) had its first meeting in the framework of the CARPE DIEM Kick-Off Meeting held 28-29 January 2002 in Herrsching, Germany. The TSC's task is to review the planning and progress of the project. The present report is the first deliverable requested of the TSC and contains its view on CARPE DIEM based on the project proposal (Description of Work), as well as the contributions to the Kick-Off Meeting.

2 General Comments

The overall focus of CARPE DIEM is placed on floods in small, medium, and urban catchments. It aims at developing integrated techniques for understanding their meteorological genesis and forecasting their occurrence. An important and novel aspect is the emphasis given to flood forecasting uncertainty, a complex quantity which is determined by a number of factors such as precipitation measurement, precipitation forecast, and soil conditions. Numerical Weather Prediction (NWP) is given a pivotal importance in CARPE DIEM's strategy. Assimilation of radar-derived mesoscale observations into the model's initial conditions are ultimately to produce more reliable precipitation forecast which then are fed into flood forecasting models, and to use model's results as an internally consistent background information, which can be used as a reference precipitation field for a better interpretation of measurements obtained from different sensors available in the integrated network. It is the opinion of the TSC that CARPE DIEM is:

- relevant in that it tackles an issue of extreme importance and a high damage potential;
- novel in that it pursues an integrated approach that aims at a coupled system consisting of a multi-sensor network and a NWP model;
- timely because most countries in the European Union have either deployed or are installing a network of surveillance weather radars;
- ambitious as:
    - the scales resolved by current-day NWP models are still relatively coarse for (*i*) the application to small and medium scale catchments, and (*ii*) the application to the interpretation of radar data,
    - the planning is tight for integrating the findings into an applicable strategy for flood forecasting,
    - it focuses on advanced issues while considering overcome some basic problems that still affect the technologies used in the project;
    - it aimes at integration of three different modelling components, namely assimilation of radar data, NWP model, and flood forecasting, each having its own challenges, which may enhance the difficulty of the linking exercise;
- applied in that it aims at and includes end user requirements from the very beginning of the project;

- generally well structured and planned;
- generally well linked to other projects, i.e. EURAINSAT, MUSIC, and Actions, i.e. COST-717, by members of the respective efforts that participate in CARPE DIEM;
- relevant to the community (e.g. COST-717, COSMO, HIRLAM);
- interdisciplinary in the sense that three distinct scientific communities collaborate towards an integrated strategy on flood forecasting;

A specific caveat the TSC wishes to make concerns the issue of common language between hydrologists, radar meteorologists, and NWP modellers, as technical terminology may differ substantially between the communities. This can give rise to misunderstandings along the way that may be harmful to the project's outcome. Nevertheless, the research teams are interdisciplinary, complimentary, highly qualified, and motivated. Keeping teams in focus is a challenge that the PIs will have to meet through regularly scheduled meetings and correspondence.

The PIs are commended for bringing early on a user group to help focus scientific activity toward operational utility. This is very important and equally so will be to define how the interaction between the users and scientists will proceed.

Finally, the TSC remarks that it may not be possible to achieve all the objectives in the time allotted to the project; nonetheless significant progress is expected on which further research would build.

3 Specific Comments

3.1 Hydrology

The study is declared to focus on small, medium and urban catchments. Unfortunately there is little indication about the characteristics of the catchment selected for the exemplary application simulating the operational use. The kick-off meeting was additionally not particularly highlighting in this respect. The project partners should therefore

- make an effort to identify the target catchments, which should be consistent with the overall goal of the project.

As the main thrust of the project is the integration of radar measurements and numerical weather predictions, to improve the flood forecasting models' ability to predict the flood hydrographaccurately and with considerable lead time, the

- catchment case studies should be selected with the purpose of understanding under which circumstances integrating radar, NWPs and a flood forecasting model is producing a significant benefit in terms of accuracy of the forecast or in terms of its lead-time

Accordingly a minimum number of catchments should be considered that are representative of the favourable conditions to the onset of flash-floods. Moreover, because flash-floods are generally generated by convective (or mainly convective) storm rainfall events, the ability of NWPs model to represent such events in terms of accuracy and scale should be adequately discussed. The complexity of the project is such that the suitability of the proposed forecasting approach could be investigated with the purpose of finding thresholds of both the

response time and catchment scale below which the procedure is too demanding with respect to the marginal improvement achievable in accuracy and lead-time. Coherently with the use of a distributed model, it is recommended that the catchments selection leads to basins where more than one discharge measuring station is available.

Being in general a good practice, the validation of the flood forecasting models based on internal validation criteria is particularly significant in the context of this project. Flood forecasting models should be extensively validated off-line against events of different nature, in order to assess their general performance. This is necessary to quantify the improvement due to the assimilation procedure and to the contribution of precipitation forecasts and separate it (signal) from the random fluctuations of the goodness of the flood model predictions (noise).

Finally, some accent (and more attention) should be put on the importance of the initial state of the catchment in terms of wetness conditions. This could be indeed (and generally regardless of the rainfall-runoff modelling approach) a major source of error. When testing the operational procedure (i.e. simulating the real-time) it is extremely important to have available accurate estimates (or measures) of the catchment wetness (soil moistur content) to minimise the noise that this source of uncertainty may introduce, thus masking the effect of the improvement due to the effectiveness of the meteorological forecasts and data assimilation.

3.2 Radar

Most operational radars in Europe have a 5 cm wavelength and use an R(Z) relation to obtaine rain rate. This raises the following issues that should be dealt with:

- Uncertainty in rainfall estimation due to variability of DSD, attenuation, calibration and many other sources that affect the classical R(Z) relation.
- A lack of mature procedures to obtain robust rainfall estimates from the few available polarimetric radars operating with the 5 cm wavelength.
- It has to be proven that assimilation of radar data into hydrologic models improve run off prediction before the same can be attemped with the NWP models.
- Tests of sensitivity to various data (i.e., spectral moments, polarimetric variables) and procedures need to be conducted to determine the best use of radar data.
- Target area(s) for experimental verification need to be establilshed, and a metric defined to make meaningful assesment of the radar data utility.
- To have valid radar data free of artefacts and contaminations requires extensive work including manual examination of select cases

3.3 NWP and Data Assimilation

Current-day operational NWP models have a horizontal grid resolution of the order of 10km allowing to resolve flow structures of the order of 30km. Direct application of model output seems insufficient for the requirements of CARPE DIEM. The following issues are considered as particular challenges:

- Precipitation forecast direct model output is not considered suitable for small and medium scale catchments, particularly not for convectively dominated

precipitation systems, as a typical grid meshsize is of the order of a small catchment size, i.e. 100km^2.

- An emphasis has been placed on quantifying uncertainty, and this the TSC considers as highly relevant, but little methodology has been proposed on how to actually achieve such a quantification.
- Uncertainty in mesoscale model precipitation forecast arises from a number of factors, i.e. model accuracy, initial conditions, boundary conditions of the driving (larger scale) model, and the atmospheric state. Even with well defined mesoscale initial conditions, which might be enhanced through the use of radar information, the representation of the synoptic scale flow has shown to be a major source of uncertainty when it comes to the location of precipitation maxima (Fehlmann and Quadri 2000).
- Integration of radar information into the initial conditions for an NWP model is a subject of current research. It is the focus of the ongoing COST-717 Action (e.g. Rossa 2000). This issue in itself constitutes a considerable challenge to which CARPE DIEM can make a substantial contribution in Europe. The issue of different scales (radar ~1km, NWP ~10 km) and of the considerable quantitative errors that still affect radar measurements should be however explicitely addressed, especially in view of application of this procedure to flash-flood dominated catchments, which are normally dominated either by strong convective activities and/or topographic process enhancements.
- The use of NWP model information to predict anomalous propagation of the radar beam may require more accurately resolved thermodynamic fields than presently available, where model resolution is only one part of the limitation, the other being the available humidity measurements. This is particularly stringent in the vicinity of the radar.

4 Final Remarks

In summary, the TSC considers CARPE DIEM to be very ambitious with a clear community added value once the goals are reached. In particular, the coupling of radar and NWP models is an important contribution to the development of next generation NWP models, and it is therefore pertinent to the aims of the COST-717 Action ‘use of radar observations in hydrological and NWP models’.