CARPE DIEM

Critical **A**ssessment of available **R**adar **P**recipitation **E**stimation techniques
and
Development of **I**nnovative approaches for **E**nvironmental **M**anagement

Contract N° EVG1-CT-2001-00045

30th Month – Management Report
January 1st, 2004 – June 30th, 2004

Section 1

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SECTION 1: MANAGEMENT AND RESOURCE USAGE SUMMARY

1.1. Objectives of the reporting period

Objectives of the reported period were mainly the following:

1.1.1. WP 1 - Project Management

- Organisation of project meetings;
- Reporting on project status;
- Organisation of the 2st project workshop;

WP 2 - Extraction of information from Doppler Winds

- Dual-Doppler data set
- Analysis of Dual Doppler wind field
- Set-up of super-observations dataset;
- Extraction of Dual-Doppler wind retrieved over some representative cases;

WP 3 - Data Assimilation

- Implementation of observation operator for radar radial wind variational assimilation.
- Impact studies of radar radial winds on limited area NWP and an assessment of suitability of radar radial wind measurements for use in operational NWP
- Implementation of continuous assimilation based on nudging technique;
- Test of implemented techniques over representative case studies;
- Set-up of inter-comparison experiment.

WP 4 - Assessment of NWP model uncertainty including models errors

- Development of software modules for ML/SKF approach.
- Development of software modules for KF/IIP

WP 5 – Assessment of improvements in NWP

- Analysis of MAP IOPs 14 and 15;
- Production of quick look analyses for the intercomparison experiment.
- Test of very short range forecasting chain

WP 6 – Anomalous propagation

- Use of LAM outputs to predict ANAPROP effects of radar images;
- Development of visualisation software;
- Analyses of ANAPROP cases over Catalonia.
- Integration of application to provide image products.

WP 7 – Advanced surface radar-based rainfall estimate applying NWP model data

- Operational test and validation of VPR correction methodology in a radar network, based on radar and sounding data
- Development of software to read 3D HIRLAM real time fields from the FMI database into the 3D radar composite grid;
- Set-up of classification schema to classify the hydrometeor types;
- Automatic operational real quality control check of each measured VPR

WP 8 – Use of polarimetric data to improve the radar rain estimate

- Review of polarimetric techniques for radar rain estimate
- Analysis of the variations in Z-R at different spatial and temporal scales of model input obtained by ΦDP method

WP 9 - Assessment of the Bias, Spatial Pattern and Temporal Variability of errors in the different sources of areal precipitation estimates.

- Data collection on the Irish and Swedish catchments;
- Precipitation estimate assessment based on the different techniques abd data sources available (radar, gauges, LAM, satellite).
- Comparison of flood estimates and forecasts using a semi-distributed model, a lumped model and a complex distributed model.

WP 10 - Optimal use of radar, NWP and raingauge data in precipitation forecasts for improving flood forecasts in urban and rural catchments

- Set-up of methodology to make the best use of radar, NWP and gauges data within an hydrological model;
- Test of methodology to make the best use of radar, NWP and gauges data within an hydrological model;

WP 11 – END-USERS' level of service requirements

- Organisation and run of the end-user workshop
- Contacting end-user panel
- End-user assessment

WP 12 – Project results dissemination

- Project web-site
- Project promotion activity towards end-users, scientists and decision-makers.

1.2. Scientific/Technical progress made in different work packages according to the planned time schedule:

1.2.1. WP 1 - Project Management

The 2nd end-users workshop was held on 23rd June in Helsinki as part of the "European Workshop on New tools for Flood Forecasting and Warning" held in the Unitas Conference Centre from 22nd to 23rd June. The overall objective was to report and discuss the achievements of the CARPE DIEM, MANTISSA and MUSIC European Projects. At the 1st end-users discussions, in Düsseldorf (27th and 28th May 2003) a large, formal meeting of end-users and researchers was arranged. In this, all of the research teams made formal presentations of their progress and results to the end-users.

The objectives of the 2nd end-users' workshop were:

- To have a substantial dialogue between project researchers and end-users.
- To produce conditions that facilitate this dialogue and especially for participants not
- accustomed to speaking at large meetings.
- To especially promote contributions and feedback from actual or potential end-users.

The topic for discussion at the round-table sessions was the very general theme of the meeting "Flood forecasting and warning". Any issue of concern to either the end-users or researchers in each group could be raised at each discussion. However, as an aid to the Rapporteurs in focusing their groups (or starting a discussion if the group was slow to start) a number of sub-themes/keywords had been identified as important, they were

1. Current Problems / Solutions
   - Technical: Data / Modelling
   - Operational
2. Dealing with uncertainty and risk
   - How to present uncertainty / tools needed to deal with it?

- Warning levels
- False Alarm Rate vs. Probability of detection
- Public attitude to risk

3. Future Requirements

- New instrumentation / New technology
- Specifications, resolution, accuracy, timing
- Training / Education

The round table format provided a forum in which the concerns, comments and suggestions of end-users could be discussed and recorded. The number and character of the resulting suggestions and comments listed above confirm that, despite current progress, much remains to be done in all aspects of flood warning and especially in ensuring operational use of research outputs. I think that participants emerged from these discussions with a broader knowledge of not only the problems, but also the range of potential practical uses for the technical outputs of the research projects involved.

Following the decision done in Dublin, at the end of the second year, the project coordinator present a draft idea for the organisation of the final meeting. The aim of such school is to provide an advanced training on the multi-disciplinarily components that have to be considered in the hydrogeological risk prevention and management work. The school will be organised over a three year period, and this is a clear result of the project out of its life, in order to cover the different topics related to the hydrogeological risk prevention and management.

In each school session a particular aspect will be treated.

Session one – Meteorological aspects – To be held in 2004

Session two – Hydrological and geological aspects – To be held in 2005

Session three – Risk management and prevention – To be held in 2006

Attendance is open to all professional people involved in hydrogeological risk prevention and management. Young scientists, Ph.D students as well post-graduates who still are in their training process are also welcome in order to improve their knowledge of the multi-disciplinarily problems and operational aspects.

The first session of the school is titled: Rainfall estimation and forecast.

This session will focus on the different aspects of precipitation estimation and precipitation forecast.

The relative skill of the different “sources” of rainfall data will be analysed and discussed in order to understand potentials and limits of the measurement tools used and of the techniques described. Fundamentals of numerical modelling at different time scales, as well as all different aspects that contribute to the rain forecast will be analysed.

An overview of hydrological modelling aspects and their interaction with the rainfall input field will be discussed.

<u>Status of the project</u>

According with the time-table the project is on its last year and we need to focus our work in the next months on the reporting activity. A general survey of CARPE DIEM shows that the project is well in track, except only part of the work of WP8 that is now in recovering and preparing the deliverables according with the new timetable presented at the end of the second year.

Some workpackages have anticipated the work, one have reshuffle its time-plan and few problems have delayed few workpackages.

1.2.2. Area 1 – Data assimilation and NWP improvements (WP 2, 3, 4, 5)

The work in Carpe Diem Research Area 1 makes progress in accordance with the plan. An additional component, an atmospheric model and data assimilation inter-comparison study has been added to the plan.

1.2.2.1. WP 2 - Extraction of information from Doppler Winds

A digital terrain map has been examined with regard to suitability for dual doppler radar wind retrievals with data from the radar stations in S. Pietro Capofiume and Gattatico in Northern Italy. A retrieval area has been selected - this area also makes retrievals including data from a third radar at Monte Grande possible. (University of Essex). Data on a representative case study have been acquired from this radar and are now under analysis.

The software DARWin (Doppler Analysis and Retrieval of Wind Information) is now ready to read SMR data (Bologna & Gattatico), convert data from radar grid point to a common cartesian grid place in the Dual-Doppler area, produce graphic visualisation both 2-D (PPI, RHI, VAD) and 3-D (Velocity vectors), retrieve the dual Doppler wind and save the fields in ASCII format. Some case studies have been presented.

Major outcomes are:

- Analysed a few more new cases.
- All the derived wind fields have been checked by comparing with original measurement and calculating relative deviation of "along-track" component.
- Made initial attempts on triple-Doppler analysis, but need more time to understand Teolo data.

The software for generation of radar wind super-observations, to be applied in variational data assimilation, has been further developed. The sensitivity to the spatial scale of the super-observation has been examined. Furthermore, a new algorithm for de-aliasing of radar radial wind data has been developed. The new algorithm has proven to perform satisfactory for radar wind data from Sweden and Finland. (SMHI).

1.2.2.2. WP 3 - Data Assimilation

The observation operator used in the variational data assimilation of radar radial wind super-observations has been further developed. Taking into account the effects of refractivity gradients on the vertical propagation of the radar beam as well as the broadening of the radar beam have proven to contribute to an improved fit between observed radar data and model-data. The impact of these refinements on the assimilation and forecast remain to be checked. (FMI and SMHI).

Results of the intercomparison experiment carried out, by SMHI and ARPA, are summarised :

- too large scale of the HIRLAM background errors (developed for 0.4°/ 0.4° grid)
- analysis increments on model levels questionable in steep orography
- dfi initialization not ideally tuned for this resolution and such a small area
- long integration (cdd) without D.A. skilful, but D.A. improves the quality

- ARPA and cdc analyses and forecasts generally quite similar
- HIRLAM has stronger (too strong?) 10 metre winds
- HIRLAM warmer night, cooler day in the Alps than ARPA (6 November)
- HIRLAM cooler night and warmer day over Spain than ARPA (6 November)
- 850 hPa analysis differences due to orography and post-processing differences

The data assimilation scheme based on nudging for initialisation of the regional MASS forecast model has been further developed by enhancement of humidity initial data based on radar and satellite data. Case studies have indicated significant improvements of short-range precipitation forecasts. (University of Barcelona). A comparison between nudging and IAU initialisation schemes have been carried out.

Conclusions:

- 3-hour assimilation frequency minimizes the RMSE.

- IAU tends to overestimate the total amount of precipitation while nudging gives a bias closer to zero.
- There are not any significant differences on the forecast precipitation field when assimilating surface pressure.
- Assimilating all meteorological fields or the combination of wind and humidity produces the best impact on the precipitation field.
- The bias is not so affected by the combination chosen.

1.2.2.3. WP 4 - Assessment of NWP model uncertainty including models errors

Two approaches for online estimation of forecast error statistics, to be applied in atmospheric data assimilation, are investigated – A Maximum Likelihood Estimation approach and a Kalman Filter approach. The first approach will be applied to the estimation of forecast error standard deviations in a full-scale limited area model (HIRLAM), while the second approach will be applied to a simplified model with emphasis on baroclinic developments. Software development and data exchange between the partners have started. (PROGEA and SMHI)

First results on the use of Kalman filtering (KF) and Maximum Likelihood (ML) approach, as suggested by Dee, for Hirlam data assimilation have been presented. The main idea is the estimation of innovation and background error covariance.

The work done cover the following points:

- Set algorithm ML to estimate covariance parameters
- Calculation of weight factors for optimal interpolation
- Application for some types of observations (ex. geopotential and temperature)

It is clear, from the results presented till now, that a different behaviour is associate with the different quantities analysed.

1.2.2.4. WP 5 – Assessment of improvements in NWP

Following the ad-hoc meeting, held in Bologna 29-30 April 2003, for the inter-comparison some MAP IOP's have been examinated.

IOP 14

- The run with data assimilation provides an improvement of precipitation forecast over North-Western Italy (when compared to the control run), although a maximum not observed is also predicted.
- The nudging assimilation scheme has a negligible impact on the forecast of temperature and wind fields

IOP 15

- The run with data assimilation has a non-negligible impact on the forecast of precipitation, but does not bring a substantial improvement.
- The use of the nudging assimilation scheme does not have an appreciable impact on the forecast of temperature fields; on the other hand, it allows the generation of different structures in terms of wind forecast.

1.2.3. Area 2 – Improve radar products by using NWP results (WP 6, 7, 8)

1.2.3.1. WP 6 – Anomalous propagation

Essex and Barcelona have liaised over terrain data and have now implemented a high resolution 30 m terrain elevation map, and also land coverage data. Essex have been developing software to interpolate data to radar coordinates, and to generate suitably smoothed radial terrain profiles, so that it will be possible to model the reflection and diffraction effects of terrain through anaprop and blockage. They have also been developing new algorithms for the fast calculation of the phase integrals for the Huyghens-Frenel approximation to the terrain scattering, by evaluating the orthotomic locus of the source reflection point. In addition, they have also been working on the display aspects for the anaprop modelling application, so that radar, anaprop predictions and terrain information can be simultaneously displayed.

The methodology developed within the project to assess the beam blockage occurrence is now applied in the quality check of SMC and ARPA.

1.2.3.2. WP 7 – Advanced surface radar-based rainfall estimate applying NWP model data

An update of work-package was given. As the first results that need to be raise at the attention of the partnership is that the VPR network correction scheme will be, in the next months, implemented in the NORDRAD network.

Examples of how the melting layer changes its height with time have been given. To solve this problem the scheme use, now, the forecasted height from HIRLAM, while the radiosounding data play a backup role.

1.2.3.3. WP 8 – Use of polarimetric data to improve the radar rain estimate

Work at DLR on WP8 has been significantly delayed as a result of the refurbishment of the radar and significant changes to both the hardware and software. As agreed at the end of the second project year the original workplan has been reorganised.

POLDIRAD has been unavailable throughout course of project due to delays in refurbishment of the radar. It has instead been necessary to use data collected by the S-POL radar during the MAP campaign. Two main disadvantages are:

- Radar operates at S-band. KDP less sensitive to rainfall rate.
- No control over scan strategy. Necessary to use spatial rather than temporal filtering.

Data examined covers IOPs 2, 4, 7, 8 and 14. Examples shown are from IOP 2 which featured the heaviest rainfall, and where the strongest effects likely to be evident. Other cases were predominantly lower intensity stratiform rainfall. In both examples, radar is scanning a sector to the North-West. Terrain is mountainous, hence a relatively high elevation angle being used.

Analysis focussed on a area 64km square. This could represent a model grid or an idealised river catchment.

The deliverable 8.2 is ready.

1.2.4. Area 3 – Flood forecasting (WP 9, 10)

1.2.4.1. WP 9 - Assessment of the Bias, Spatial Pattern and Temporal Variability of errors in the different sources of areal precipitation estimate

The assessment of the bias, spatial pattern and temporal variability in the different sources of areal precipitation have been carried out separately over the different testing-domain.

Partner 4 have compared over a “quite” large catchment, the precipitation estimate dome with raingaues, radar and NWP output. The major characteristic of the different sources are:

Interpolated station observations (PTHBV)

- Based on all available stations, corrected for observation losses.
- Optimal interpolation.
- Frequencies of wind direction and wind speed included in the description of the topographic influence.
- Spatial resolution 4x4km^2. Temporal resolution 24 hours.
- Period with data 1961-2002.
- Radar estimates
- Spatial resolution 2x2 km^2. Temporal resolution 3 hours.
- Evaluation so far only made for accumulated 24 hour precipitation.
- Period with data 2000-2002.Hirlam forecasts
- Spatial resolution 22x22 km^2. Temporal resolution 6 hours.
- Evaluation so far only made for accumulated 24 hour precipitation (6-30hours).
- Period with data 2002.The results could be summarised as follows:
- Comparison of radar and interpolated station data 2000-2002
  - Higher spatial resolution and realistic spatial variability for single days in radar data
  - Technical problems cause non-realistic local spatial gradients in radar data.
  - Systematic deviations both spatially and temporally - could be explained by technical problems and/or physiographic factors.
- Comparison of HIRLAM forecasts and interpolated station data 2002
  - No obvious systematic deviations.
  - Higher spatial variability in HIRLAM forecasts.
  - Hirlam tends to generate small rainfall events during dry periods

In summary, in terms of rainfall amounts HIRLAM tend to overestimate spring precipitations while the radar overestimate the autumn season. In term of discharge HIRLAM overestimate the spring response while all others sources give a similar results.

The testing of the rapid update (RU) blended PMW-IR satellite rainfall estimation technique of the Naval Research Laboratory (NRL) started at ISAC-CNR (Partner 8). The RU was applied to events relevant for the project, including rainfall-induced flood events. In particular, the method was applied to intense storms affecting Northern Italy (the November 2002 intense precipitation episode over Liguria and Lombardia) and the Mediterranean basin. In some cases the rapid onset of intense precipitation events gave rise to flood (as for the November 2001 Algerian flood). Previous applications of the method were mainly devoted to the production of rainfall accumulations on a 6 to 48 hours basis or more, but the prediction of rainfall induced floods requires the assessment of the reliability of the method in producing instantaneous rain rate maps. PMW based rainfall algorithms, due to their intrinsic poor time-space coverage, cannot supply the required source of remotely sensed data for the present scope. The PMW rainfall algorithm adopted in the NRL algorithm is the NOAA-NESDIS operational algorithm. It derives rain rates at the A-scan resolution of the SSM/I instrument (~25 km) by means of non-linear relationships involving the instrument channels (vertical and horizontal polarization) that have been calibrated using large sets of ground reference data collected by several radar networks. The physical basis of such relationships are the scattering of MW radiation due to large ice particles above the freezing level occurring in precipitating clouds, and the emission due to liquid water. This latter phenomenon can be sensed only above oceanic surfaces, due to high and largely unknown emissivity of land surfaces in the MW spectral range. Relying on PMW measurements only (no need of large input data-base of physical properties) and on simple but well founded relationships, this algorithm is very robust and lends itself to global applications.

The analysis of the results highlighted the following aspects. The over-land part of the algorithm misses a relevant fraction of precipitation (in terms of raining area) when the event is characterised by a sudden onset of precipitation, orographic complexity of the terrain, and/or the vicinity to the coast. In such environments large errors and biases arise in PMW rainfall retrieval algorithms. Moreover, if the considered event has a short overall duration, the geographical zone is imaged only a few times by PMW instruments. In such unfavourable conditions, RU techniques are a powerful instrument to follow the evolution of the rain field.

To try to mitigate the deficiencies of the algorithm in gauging the rain over land, Partner 8 received and installed on UNIX-Linux machines the new Version 6 of the Goddard Profiling algorithm (GPROF6), which presently works on data from the TRMM Microwave Imager (TMI) and is being adapted to the SSM/I. After careful comparison of GPROF5 rain rate estimates with ground validation data, GPROF6 has been tailored for a better matching of precipitation radar and ground observations. Moreover, it includes an improved classification of stratiform–convective precipitation. On a global scale, GPROF6 eliminates the high bias with respect to gauges. The space-time coincident Precipitation Radar (PR) measurements available from the Tropical Rainfall Measuring Mission (TRMM) platform allow a direct comparison of rainfall data derived from PMW (TMI radiometer) with reference data. It has to be stressed that the use of improved PMW algorithms cannot avoid the depression of rain rate fields due the smoothing process involved in the NRL method. In particular, modifications of the screening techniques for non-precipitating pixels over land were completed and this translates into an overall improvement of rain detection.

1.2.4.2. WP 10 - Optimal use of radar, NWP and raingauge data in precipitation forecasts for improving flood forecasts in urban and rural catchments

The TOPKAPI model, developed at the University of Bologna, is now installed at NUID, a calibration have been performed and the base-flow component it is added now. An analysis and integration of archived radar data over the **Partner 9** catchment is now commenced as well as the use of operational NWP data (HIRLAM).

Major advancements are:

- The collection of hydro-meteorological data, which started at the early stages of the project, has continued (rainfall, water levels, radar measurements). ??
- Manual flow measurements and automatic (ultrasonic) measurements on the Dargle have continued to further refine the discharge water level rating curves.. (WP 9 & 10).

In addition the following activities have begun:

- NWP (HIRLAM) forecasts of precipitation have been acquired from Met Eireann. These are hourly forecasts up to 24 hours lead-time, done 4 times per day at two different grid lengths. This means we now have a data set of overlapping periods of NWP forecasts, radar rain estimates, gauge rain data and river discharges.
- We have begun the task of analyzing this data set and of investigating optimal forecast methods.
- We have two hydrological models calibrated for the data set a distributed model {TOPKAPI (with the help of partner 4)} and a lumped conceptual model {SMARG, (originally proposed by O'Connell & Nash) and implemented by a team (which included Bruen) at UCG } and have some preliminary comparisons.

Modelling report (lumped & distributed) at drafting stage, some conclusions presented at workshop. Suggest wait for a full year of independet validation data before finalising.

1.2.5. WP 11 – END-USERS' level of service requirements

The second workshop of the project has been organised together with the EU projects Music and Mantissa. The objectives of the workshop were the reporting on the results and achievements of CARPE DIEM, MANTISSA and MUSIC European Projects and discuss them in the context of future flood research and development in Europe.

The workshop has been arranged at Helsinki, Finland, with common efforts between FMI, as local organiser, and ARP consortium for workshop management.

Up to 84 participants attend to the event. The workshop has been organised over five sessions:

- Session 1: The European Context
- Session 2: Observation Techniques
- Session 3: Meteorological and Hydrological modelling
- Session 4: End Users round table
- Session 5: End Users Needs, Applications and Perspective

With a great total of 20 presentations.

A summary of the discussions and results outcomes from the End Users time table has been prepared by Micheal Bruen and will be available on project web site soon, as well as the CD with the proceedings of the workshop is under preparation and it will be distributed to all participants within September.

1.2.6. WP 12 – Project results dissemination

Partner 7 continue the updating and managing of the project web-site (http://carpediem.ub.es).

1.2.7. Original Gantt chart

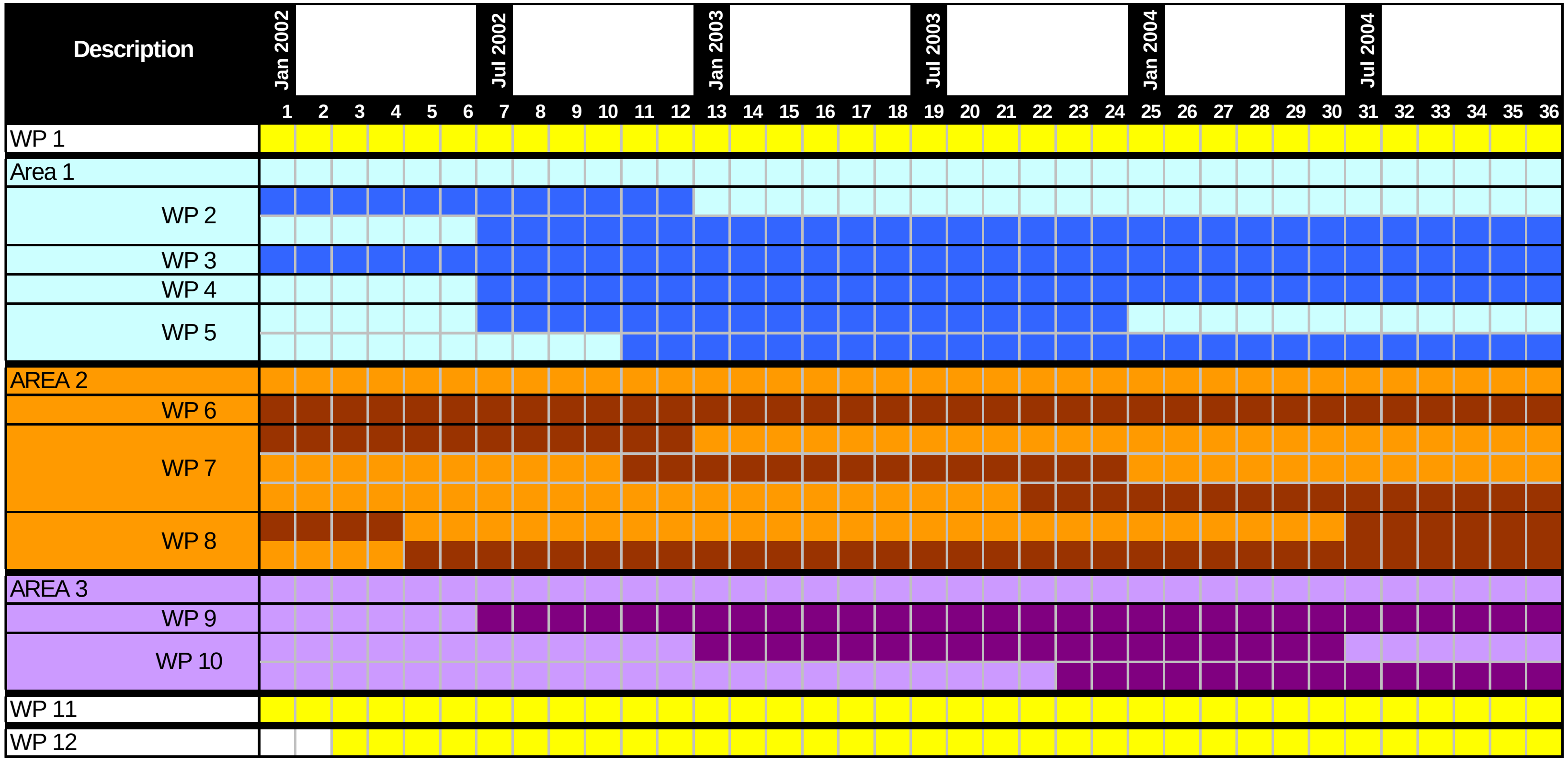

TABLE 1 – ORIGINAL GANTT CHART OF THE DISTRIBUTION OF THE WORK AMONG THE DIFFERENT WPS.

1.2.8. Modified Gantt chart

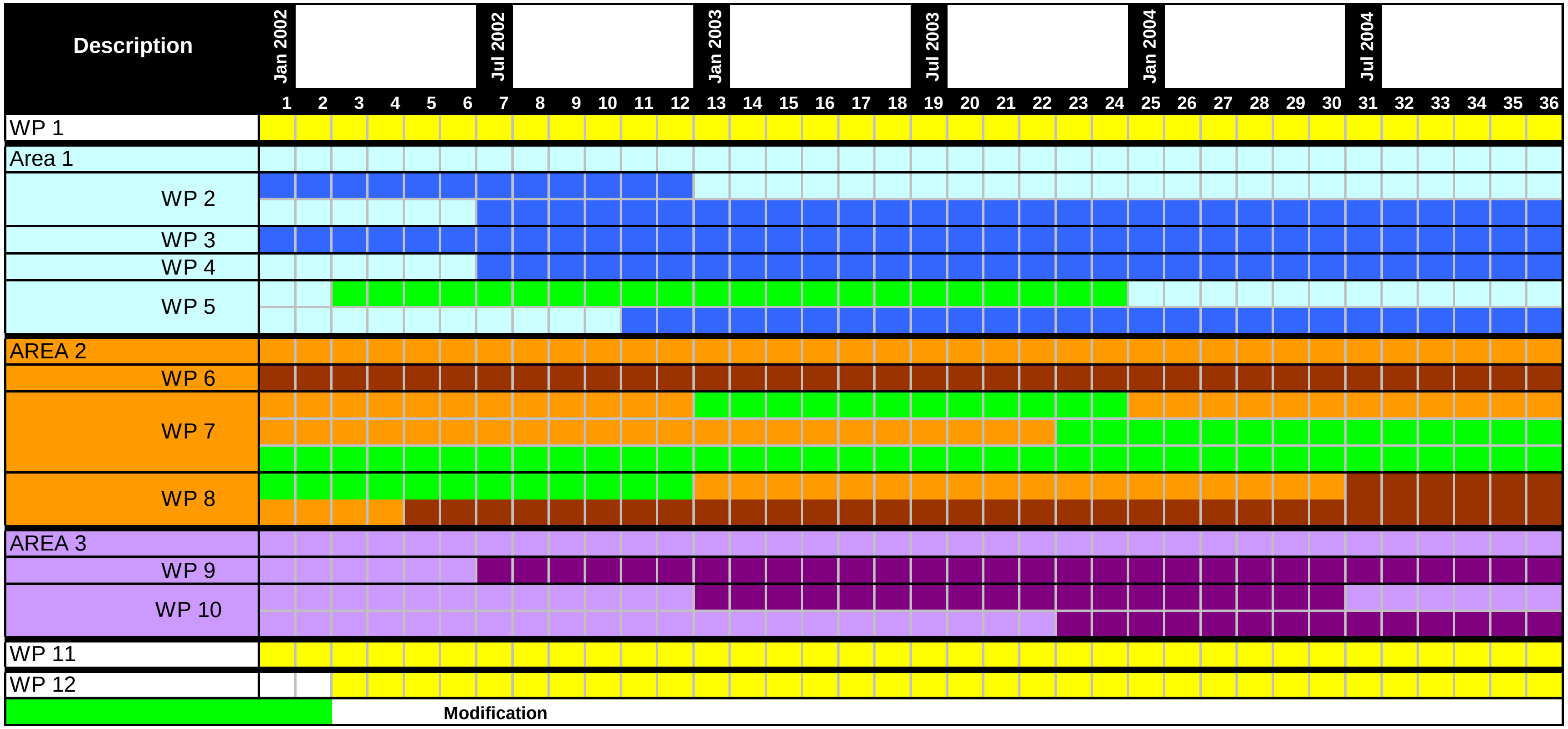

TABLE 2 – MODIFIED GANTT CHART OF THE DISTRIBUTION OF THE WORK AMONG THE DIFFERENT WPS.

1.2.9. Planned and Used Manpower

WP	ARPA-SMR		PROGEA		DLR		SMHI		FMI		UE		UB		CNR-ISAC		NUID		WP TOTAL	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P
1	2,6	1,0	0,3	0,2	0,0	0,0	0,3	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,1	1,7
2	1,0	0,4	0,0	0,0	0,5	2,2	0,8	0,0	0,0	0,0	3,4	1,7	0,0	0,0	0,0	0,0	0,0	0,0	5,7	4,3
3	0,0	0,0	0,0	0,0	0,0	0,0	8,8	4,5	0,0	1,72	0,0	0,0	5,0	5,5	0,0	0,0	0,0	0,0	13,8	11,7
4	0,0	0,0	3,0	4,0	0,0	0,0	1,0	1,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,0	5,0
5	14,4	5,4	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	3,8	3,4	0,0	0,0	18,2	8,8
6	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,8	3,4	4,0	3,5	0,0	0,0	0,0	0,0	10,8	6,9
7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,4	5,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,4	5,0
8	0,0	0,0	0,0	0,0	5,0	2,0	0,0	0,0	0,0	0,0	1,5	0,7	0,0	0,0	0,0	0,0	0,0	0,0	6,5	2,7
9	0,0	0,0	1,0	1,0	0,0	0,0	0,3	0,0	0,0	0,0	0,0	0,0	0,0	0,0	2,2	1,9	1,0	1,0	4,5	3,9
10	5,1	1,9	2,5	1,2	0,0	0,0	2,5	2,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	6,0	8,0	16,1	13,6
11	0,4	0,2	0,0	0,0	0,0	0,0	0,5	0,5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,5	1,0	1,4	1,7
12	0,5	0,2	0,2	0,1	0,5	0,5	0,0	0,0	0,0	0,0	0,3	0,2	0,5	1,0	0,0	0,0	0,5	1,0	2,5	2,9
Partner Total	24,0	9,0	7,0	6,5	6,0	4,7	14,2	9,0	6,4	0,0	12,0	6,0	9,5	10,0	6,0	5,3	8,0	11,0		
TOTAL																			93,1	68,2

TABLE 3 – PLANNED AND USED MANPOWER RESOURCES BY WORKPACKAGES AND PARTNERS.

1.2.10. Planned and Used Financial Resources

WP	ARPA-SMR		PROGEA		DLR		SMHI		FMI		UE		UB		CNR-ISAC		NUID		WP TOTAL	
	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P	U	P
1	5597	4472	2625	1750	0	0	2158	4317	0	0	0	0	0	0	0	0	0	0	10380	10539
2	2239	1789	0	0	5061	22271	6907	0	0	0	14274	10322	0	0	0	0	0	0	28481	34382
3	0	0	0	0	0	0	75979	38853	0	9466	0	0	15671	14782	0	0	0	0	91650	63101
4	0	0	26250	35000	0	0	8634	8634	0	0	0	0	0	0	0	0	0	0	34884	43634
5	31341	25044	0	0	0	0	0	0	0	0	0	0	0	0	21067	22056	0	0	52408	47101
6	0	0	0	0	0	0	0	0	0	0	28799	20825	5224	5900	0	0	0	0	34023	26725
7	0	0	0	0	0	0	0	0	45824	27452	0	0	0	0	0	0	0	0	45824	27452
8	0	0	0	0	50616	20246	0	0	0	0	6261	4527	0	0	0	0	0	0	56877	24773
9	0	0	8750	8750	0	0	2849	0	0	0	0	0	0	0	11850	12407	2612	2051	26061	23208
10	11193	8944	21875	10500	0	0	21585	21585	0	0	0	0	0	0	0	0	15670	16404	70323	57433
11	933	745	0	0	0	0	4317	4317	0	0	0	0	0	0	0	0	1306	2051	6556	7113
12	1018	813	1750	875	5061	5061	1281	1281	0	0	1366	988	400	944	0	0	1306	2051	12182	12013
Partner Total	52320	41809	61250	56875	60738	47578	123710	78987	45824	36918	50700	36663	21295	21626	32917	34463	20894	22557		
TOTAL																			469648	377475

TABLE 4 – PLANNED AND USED FINANCIAL RESOURCES BY WORKPACKAGES AND PARTNERS.

1.3. Milestones and deliverables obtained

1.3.1. Milestones

M 0.1. Start of activities
M 0.2. 1st TSC meeting

M 1.1. Basic end-Users requirements
M 1.2. Web site established
M 1.3. Critical review of polarisation techniques

M 2.1. Pre-processing of radar data
M 2.2. Data quality assessment
M 2.3. Definition of multiple Doppler analysis
M 2.4. Overview for software modules to be applied for assimilation of radar and satellite data.
M 2.5. Descriptions for ingestion of satellite and radar data.
M 2.6. Description of observation operators, including tangent-linear and adjoint versions, for radar radial winds in 3D-Var.
M 2.7. Results from first tests using simulated data in 3D-Var
M 2.8. Implementation of fast Hybrid Parabolic Equation model
M 2.9. Incorporation of terrain elevation data
M 2.10. Implementation of the program which produces the VRP correction over the whole radar network
M 2.11. Verification on the improvement in radar derived surface precipitation using VPR correction

M 3.1. Implementation of the observation operator for 4DVAR
M 3.2. Assessment of errors in the input of hydrological models
M 3.3. 1st workshop, End-Users panel meeting
M 3.4. 2nd TSC meeting
M 3.5. End-users Assessment document

M 4.1. Implementation of continuous assimilation based on nudging
M 4.2. Development and test software modules for ML/SKF approach
M 4.3. First results of assimilation
M 4.4. Implementation of the VSRF system
M 4.5. Overhanging precipitation correction, statistics of overhanging precipitation
M 4.6. Delivery of a report on precipitation estimate assessment
M 4.7. First results on flood forecasting improvements

M 5.1. Sensitivity studies
M 5.2. Impact of Doppler wind on the 4DVAR
M 5.3. Assessment of impact of radar wind in assimilation
M 5.4. Software modules for KF/IIP
M 5.5. Test of VSRF system
M 5.6. Integration of application to provide image products
M 5.7. Implementation of the program which produces the VRP correction over the whole radar network.
M 5.8. Flood estimation and forecasting assessment
M 5.9. Methodology for optimal use of radar, NWP and raingauge data

1.3.2. Deliverables

W.P.	Deliverable	Deliverable title	Planned delivery date	Expected delivery date	Status
1	1.01	Set-up of Technical Steering Committee	2		
1	1.02	Report of the kick-off Meeting	2		
1	1.03	1st TSC report	2		
8	8.01	Critical review of present state of the art multi-polarisation rainfall estimation techniques	4		
11	11.01	Basic End-Users requirements	6		
12	12.01	web site	6		
2	2.01	Super-observation dataset	12		
2	2.02	Maps of the partner 1 region detailing those areas accessible to dual-Doppler analyses, and any accessible to three Doppler radars.	12		
5	5.01	Analysis of severe weather situations	12,24		
5	5.02	Set-up of VSRF procedure	12		
8	8.02	Climatology of variations in Z-R at different spatial and temporal scales of model input obtained by FDP method	12	27/30	
7	7.01	Diagnosis of hydrometeor liquid water fraction in 3D radar volumes, based on NWP model fields	13		
2	2.03	Multiple Doppler dataset	18	27	
4	4.01	Software modules for ML/SKF approach	18	27	

W.P.	Deliverable	Deliverable title	Planned delivery date	Expected delivery date	Status
6	6.01	PC-based application producing predicted images of terrain or sea clutter caused by anaprop effects based on mesoscale NWP model products	18		
9	9.01	Comparison of precipitation estimates with mesoscale analysis and stochastic model.	18		
11	11.02	End-Users Assessment document	18,36	18,36	
12	12.02	Workshops	18,36	18,36	
1	1.04	2nd TSC report	20		
2	2.04	Analysis of Multiple Doppler wind field	24		
2	2.05	Extraction of clear-air wind	24	36	
3	3.01	Software modules for 4-dimensional assimilation	24		
7	7.02	3D diagnosis of overhanging precipitation based on NWP model fields	24	36	85 %
7	7.03	Improvement of radar derived surface precipitation using integrated OP correction from a radar network and from a NWP model	24	36	60 %
9	9.02	Comparison of flood estimates and forecasts using the semi-distributed model in the Swedish catchment	24	27	
9	9.03	Comparison of flood estimates and forecasts using the simpler lumped models in the Irish catchment	24	27	

W.P.	Deliverable	Deliverable title	Planned delivery date	Expected delivery date	Status
9	9.04	Comparison of flood estimates and forecasts using the more complex distributed model in the Irish catchment	24	30	
10	10.01	Methodology for optimal use of radar, NWP and raingauge data	24,36	24,36	
7	7.04	Improvement of radar derived surface precipitation using integrated VRP correction from a radar network and from a NWP model	36	36	80%
3	3.02	Impact studies of radar radial winds on limited area NWP and an assessment of suitability of radar radial wind measurements for use in operational NWP	30	30	
4	4.02	Software modules for KF/IIP	30	30	
5	5.03	Verification of the forecasted field coming from the VSRF procedure	30	30	
6	6.02	Real-time application combining the first application with radar data assimilation, and display diagnostics	30	30	

Legend					
completed	Partially available	Work continuously in progress	Cancelled	Anticipated	Delayed

1.4. Deviations from the work plan or /and time schedule and their impact to the project

A number of deviations, as to be considered as: reorganisation, added topics and delay, from the original plan and time schedules have taken place:

It has been agreed during the Kick-off meeting that a data assimilation and model inter-comparison experiment based on MAP data will be carried out with participation of **Partner 1**, **Partner 4** and **Partner 7**. This in response to a comment by the Carpe Diem Technical Steering Committee, a planning meeting was held in April 2003 to organise the intercomparison experiment. This experiment is now under analysis, first results are briefly discussed previously.

Due to the anomalously dry 2003 summer the data collection and data providing for multiple Doppler analysis has been extended and works are now continuously run. As a consequence the deliverables **2.03** and **2.04** are extended too. This gives the possibility to provide a more complete dataset and analysis tool.

As reported in the previous reports there has been some re-ordering of tasks within Work Package 7, this cause the anticipation of the **Deliverable 7.4 - Improvement of radar derived surface precipitation using integrated VRP correction from a radar network and from a NWP model** and the delay of **Deliverable 7.1**.

Following the rescheduling of WP 8 the work is now carried out in time. The first deliverable, i.e. 8.2, is now available.

1.5. Co-ordination of the information between partners and communication activities

1.5.1. Meetings

A project meeting have taken place during the reporting period. Details and presentations can be found in the restricted area of the project's web site (http:carpediem.ub.es/partners_only).

The second project workshop has been anticipated in order to co-organise it together with two other EU projects (MUSIC and MANTISSA).

1.5.2. Co-ordination of the information between Partners

For the time being, all the information among the partners were exchanged via e-mail.

The CARPE DIEM web site, developed at **Partner 7**, is available since project's inception, also allowing a direct link with each partner Institution.

1.6. Difficulties encountered at management and co-ordination level and proposed/applied solutions

No dramatically difficulties have been encountered during the reporting period. We have experienced only a problem with funds transferring between EU and the coordinator. This was due to a late registration of the bank account form. The situation is now fixed and the funds have been transferred to the partnership during august.