Flash Floods Applications

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Outline

Can Grid Technology enhance Civil Protection functioning such as Flash Flood crisis management ?

- **Outline**
- Flash-Flood
- Existing System
- CP Requirements
- Grid Adoption
- Conclusion

Introduction: Flash flood crisis management context

Part I : Technological and organizational existing

Part II : Hazard monitoring requirements

Part III : In progress developments and researches

Conclusion: Research perspectives

"Episode Cévenols" phenomena

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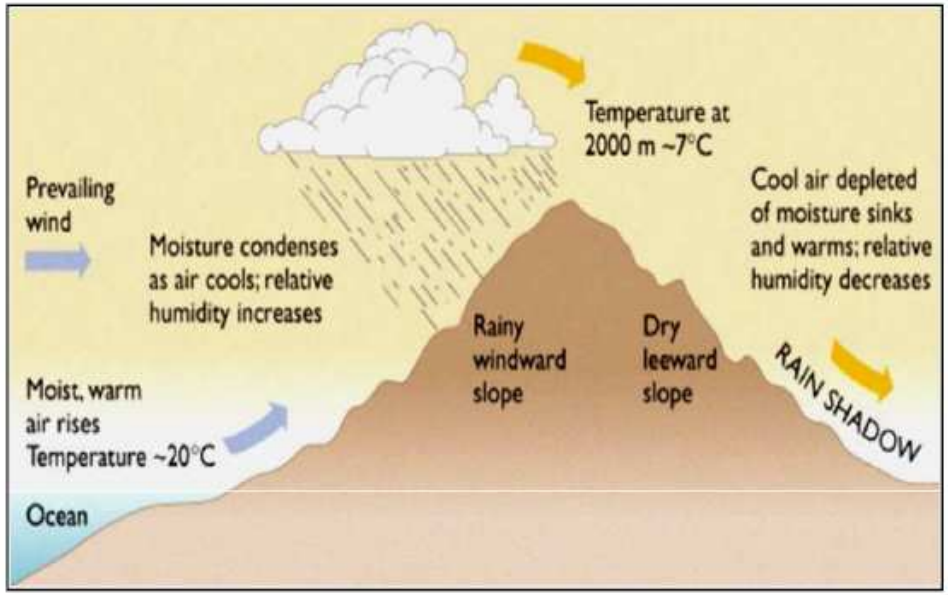

- Orographic effect
- Intense local rainfall events
- Rapid respond of catchments (types, size and slopes)

Rough rise of water flow

Today, rainfall intensity and hydrologic complexity make hydrologic modeling very complexe and not reliable

Models don't suit operationnal management needs for precision

The 8 & 9 September 2002
An extreme flash flood

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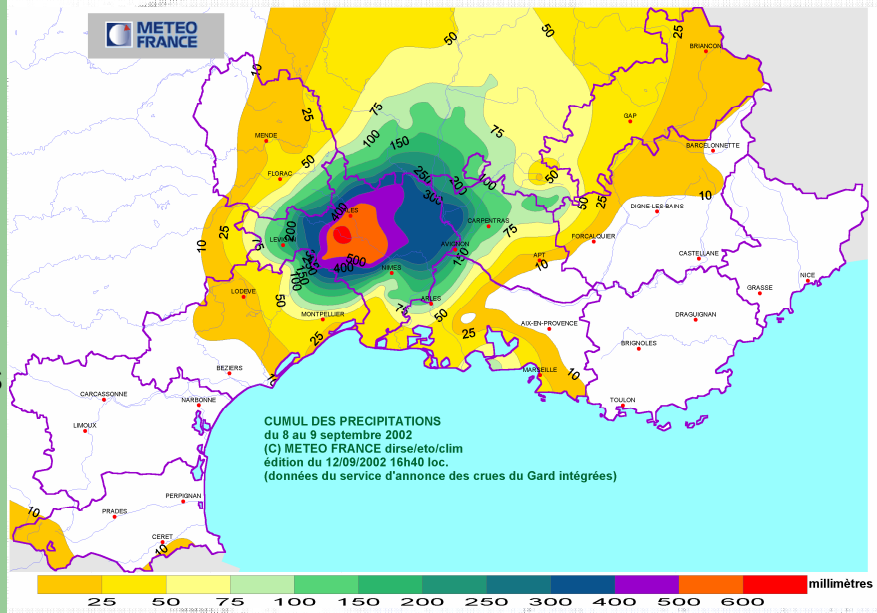

Rainfall situation

1. **Rapid phenomena**

⇒ less than a half of day

2. **Important accumulation**

⇒ about 600mm

3. **Large extent**

⇒ About 5000 km2

⇒ **High rainfall spatial variability**

⇒ **Many different hydrologic situations to modelize**

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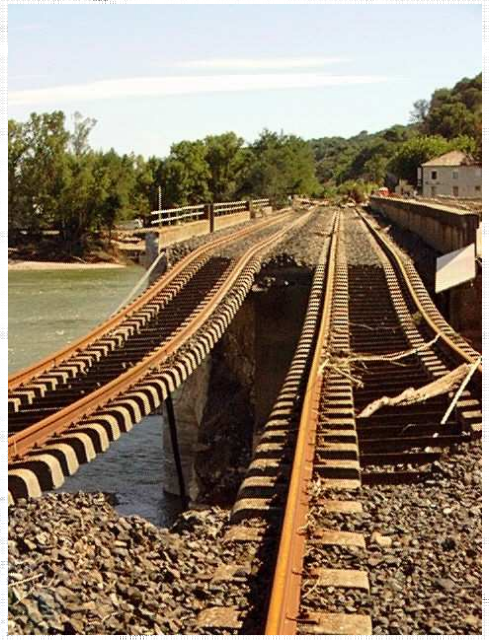

Some damages examples …

Flash Flood Cyclops use-case

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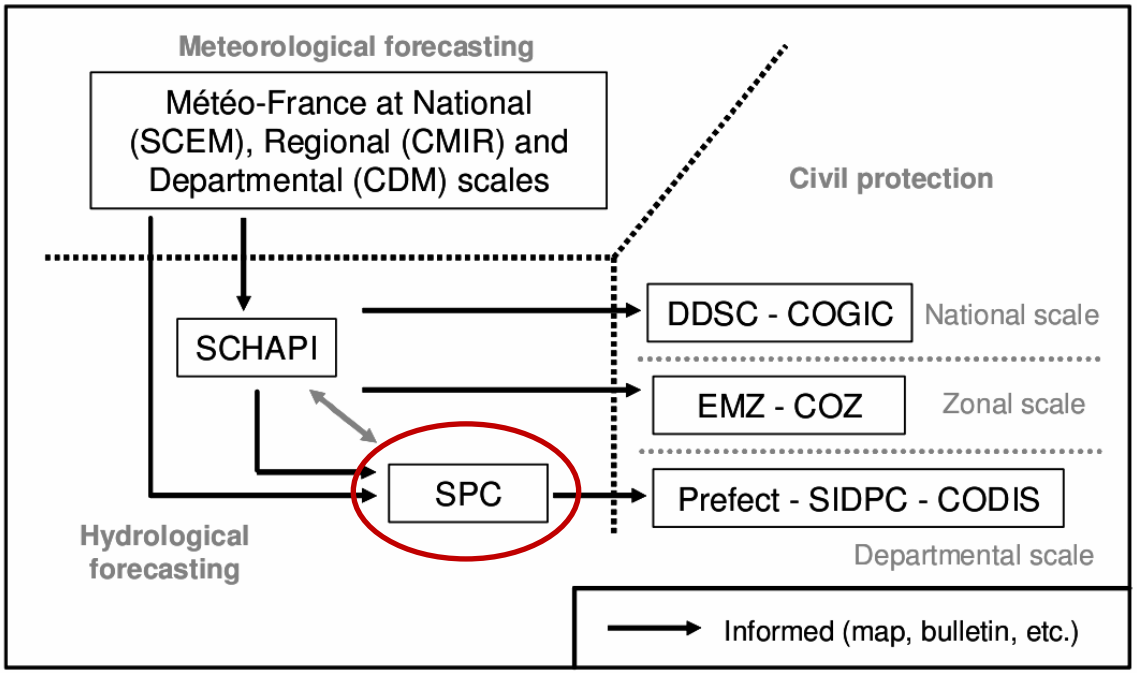

Multi-scales Organization

Multi-partners organization

Cyclops use-case have to focus on Flood Forecasting Service (SPC)

Grand Delta
Flood Forecasting Service (SPC-GD)

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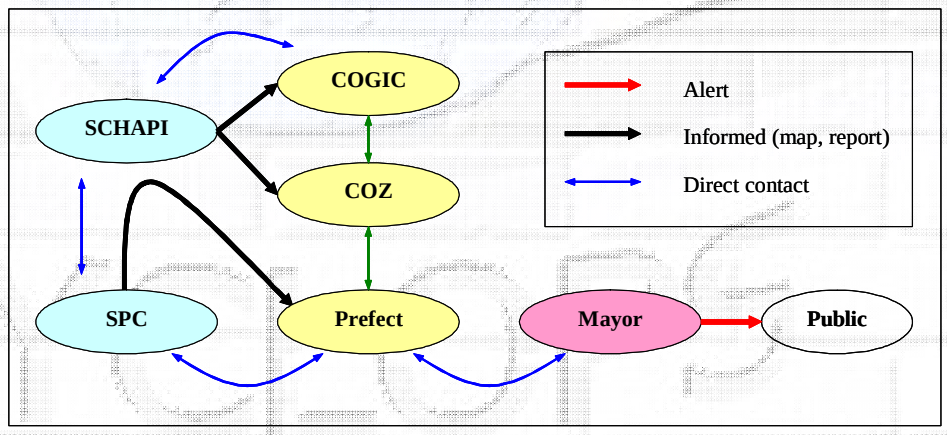
Objectives:

- Knowledge on **watersheds functioning**
- Work in **collaboration** with hydrological central service (SCHAPI)
- **Better anticipation and spatialization** of hydrological hazard
- Flood **forecasting** and monitoring in **real-time**
- **Use efficiently existing hydrological model**



Grand Delta
Flood Forecasting Service (SPC-GD)

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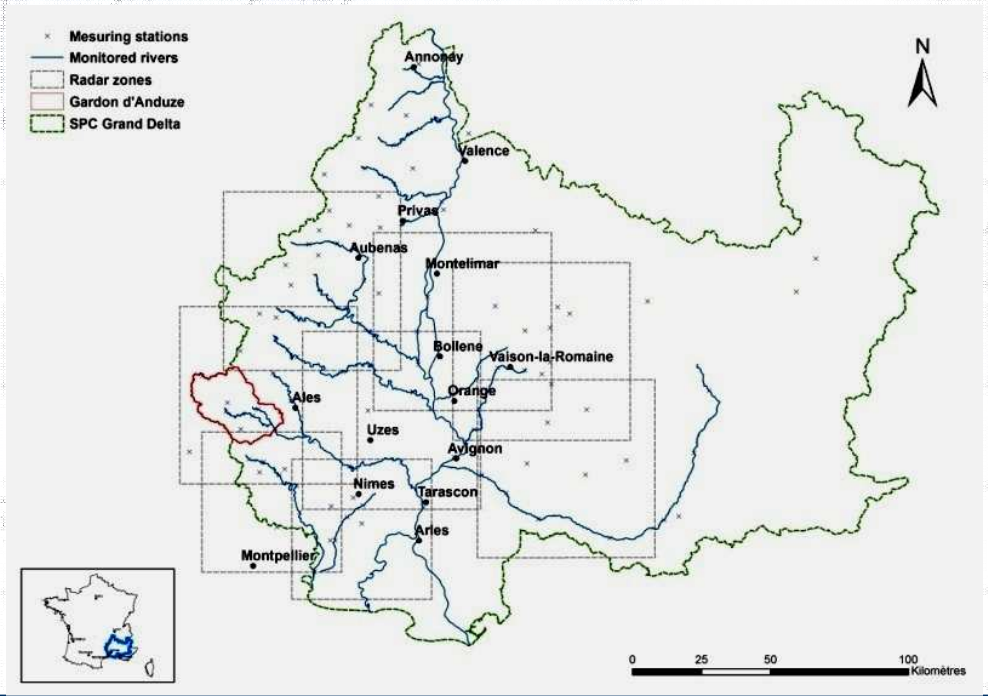
Means :

- Hydrological experts
- 170 sensors (rainfall and water level gauges)
- Radar observation system (Meteo-France)
- Information system (chain of rainfall-hydrological tools)



SPC-GD Global functionning

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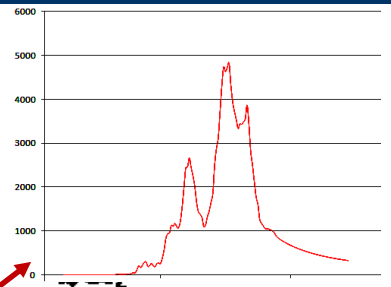
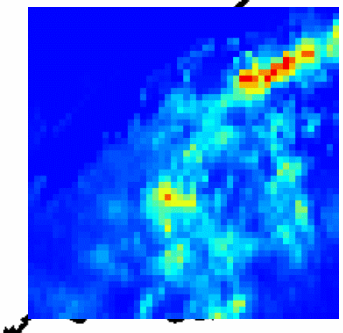
One of territories modelised with AHLTAÏR



X 170 stations and 20 watersheds



X 10 Zones (64 x 64 km)

Alès
Anduze
Uzès
Bagnols sur Cèze
Remoulins
Nîmes
Sommières

Mediterranean sea

100 km

SPC-GD Information system

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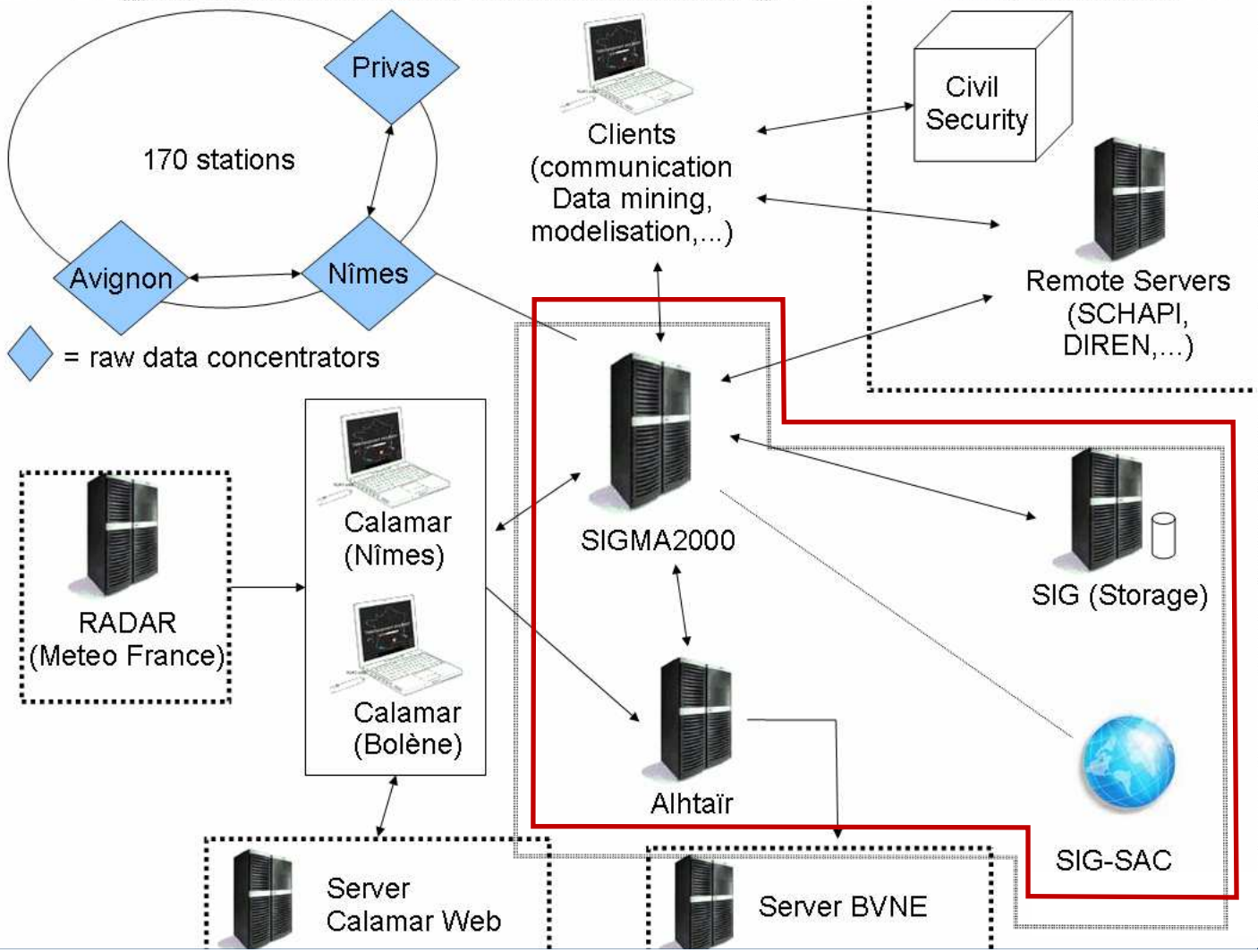

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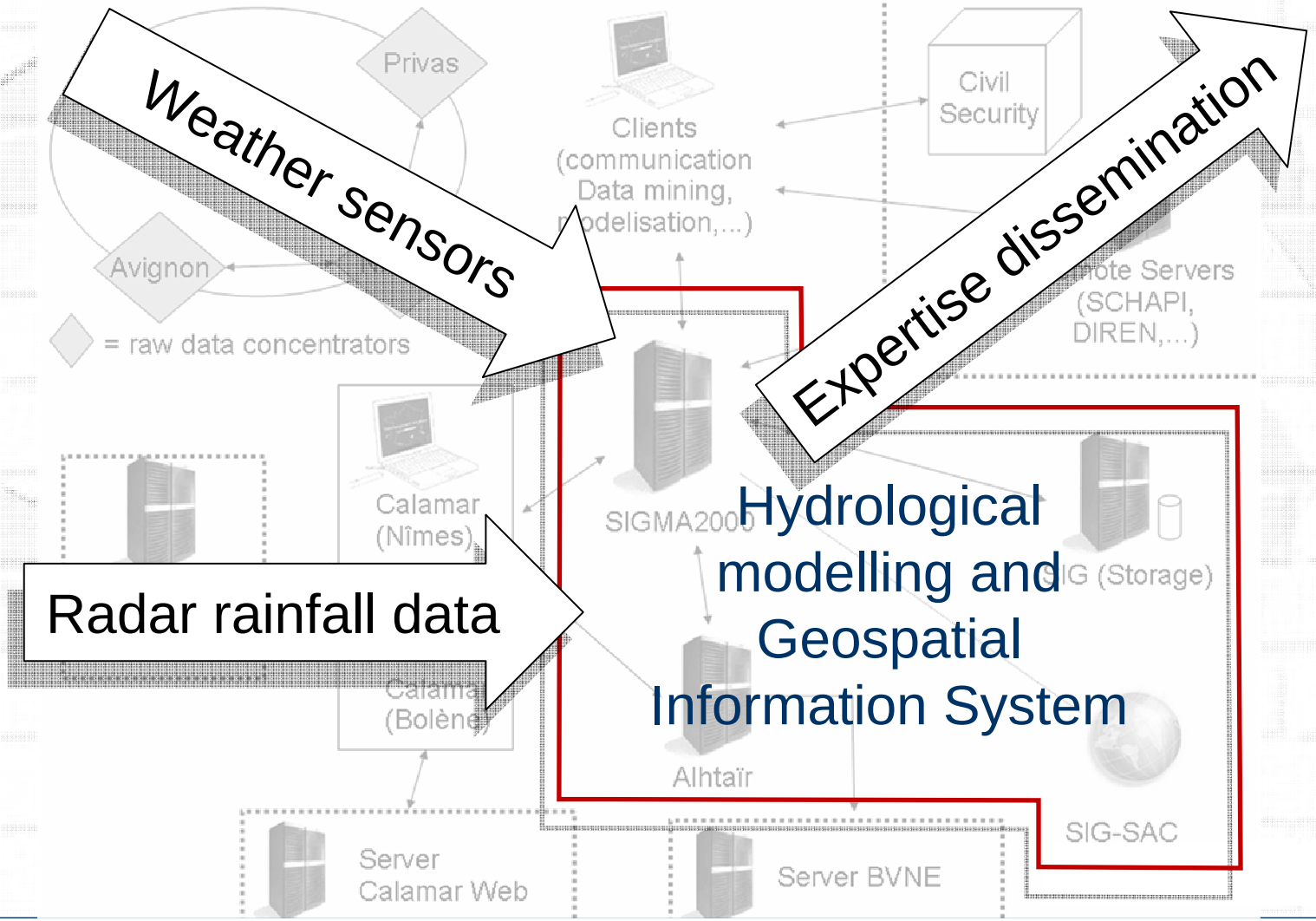

Lessons learnt from past events

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- an integration and mutualization of all observation networks
- a simplification of hydrological report creation and diffusion
- a better reliability in raw data retrieving and managing to ease models data input
- the use of geospatial data and geomatic tools to efficiently spatialize hydrological phenomena
- **an optimization of models results to really assist forecasters**
- **up-to-date information on rainfall and hydrological phenomena**

Civil Protection Requirements

Main Work Package 3 results

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1. Functional requirements

   - ❑ Geospatial information access and publishing
   - ❑ Authentification and Authorization
   - ❑ Files replica
   - ❑ Higher resolution processing

2. Non-functional requirements

   - ❑ Computational power
   - ❑ Time of response / Bandwidth
   - ❑ Quality of service negotiation
   - ❑ Interoperability
   - ❑ Storage capacities

Why Grid technology adoption ?

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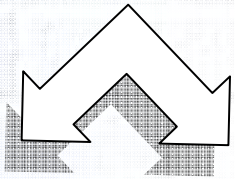
Grid Technology ⇔ Flash-Flood use-case



Computational Power

1. Calibration models in post and real-time
2. Monitoring and forecasting large-scale hydrological situation in crisis phase
3. Design a real-time hydrological modelling platform for models inter-comparison

Storage capacities

1. A Virtual Organization for all Civil Protection actors
2. Improve geospatial services to a better reliability of the crisis management
3. Integrate the whole of data and information for lessons learnt process (operational and scientific aspects)

SPC-GD new functioning

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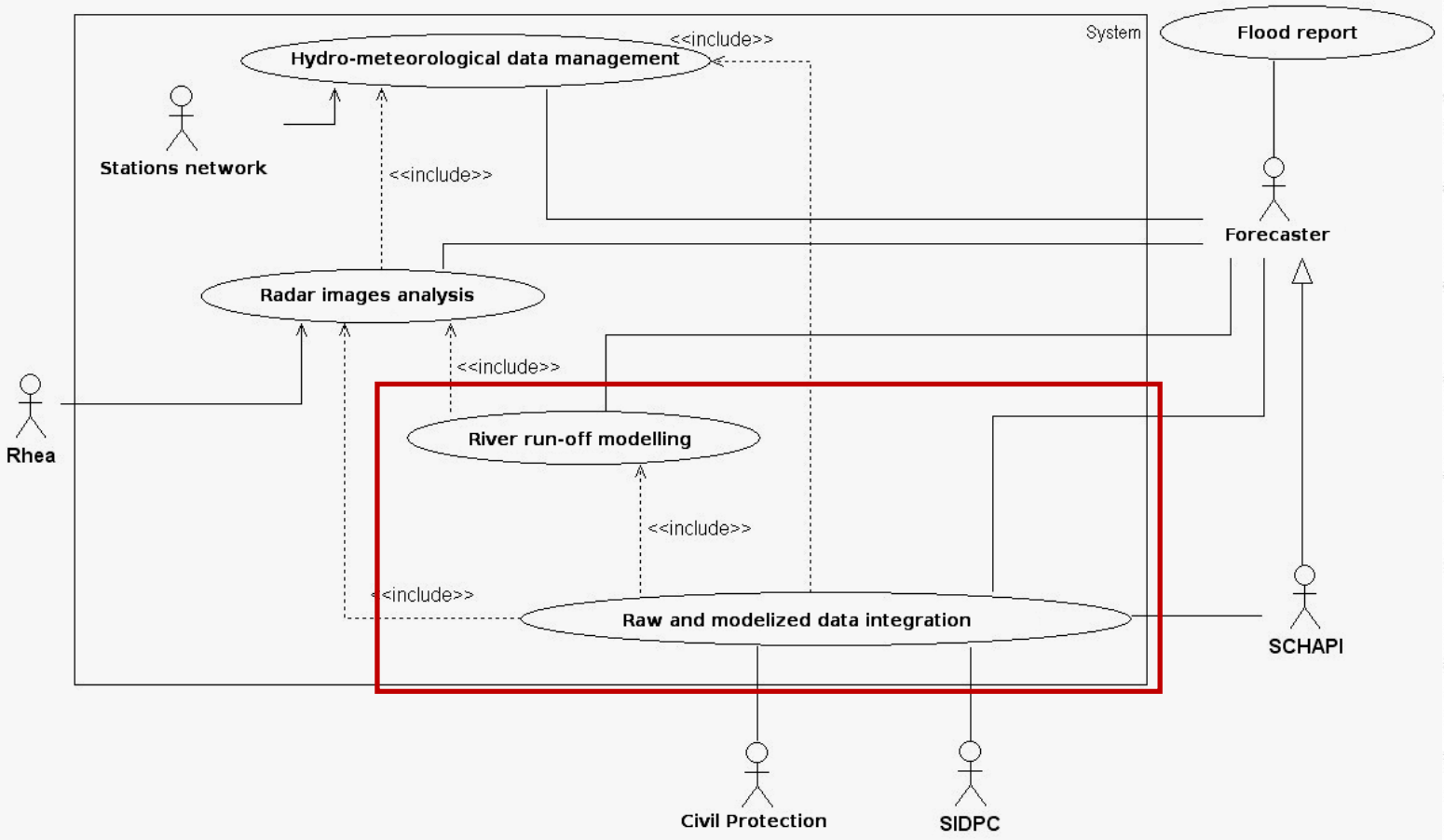
UML use-cases diagram for SPC-GD new functioning



A new Worflow for Grid technology adoption

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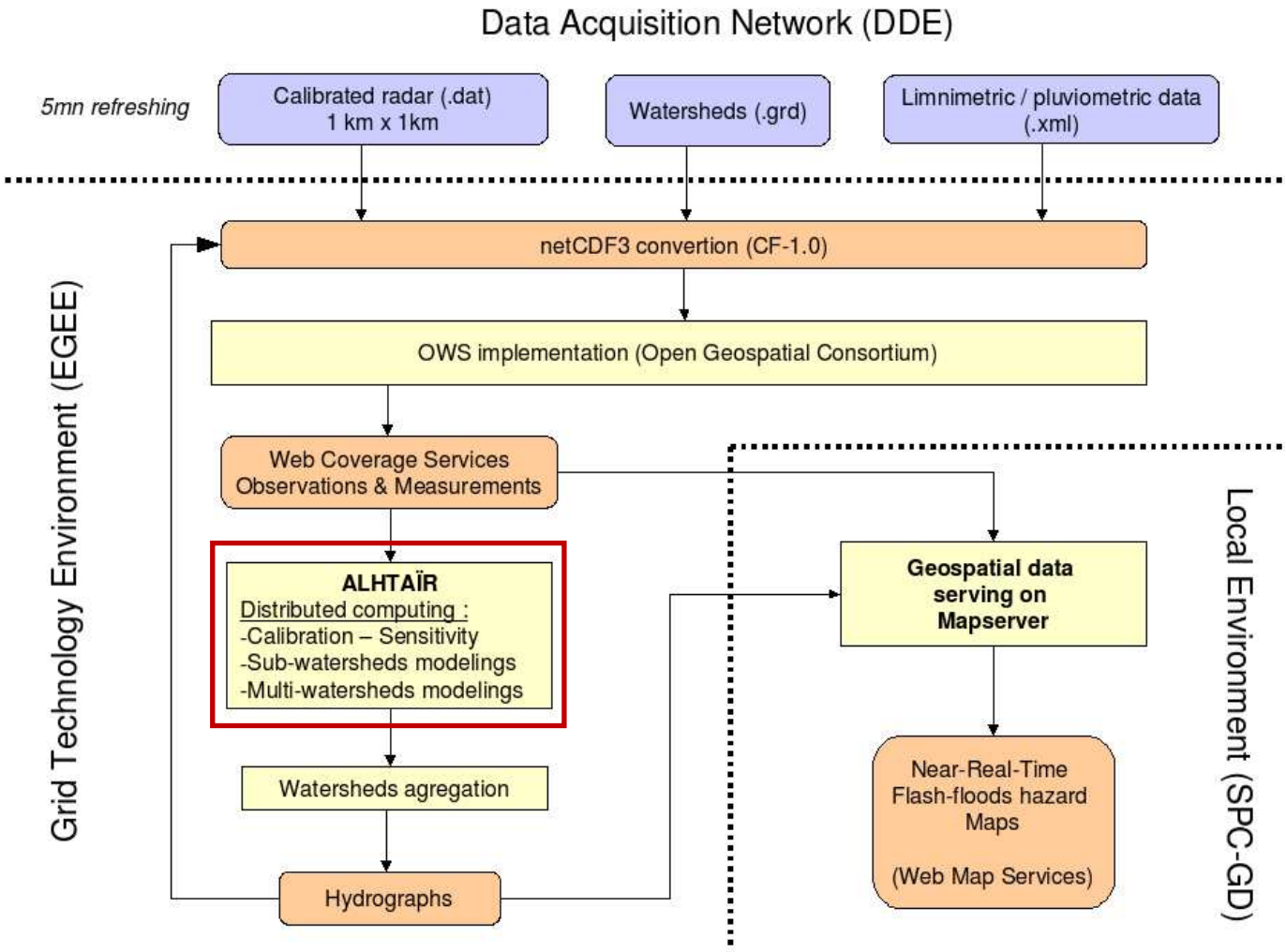

UML activity diagram

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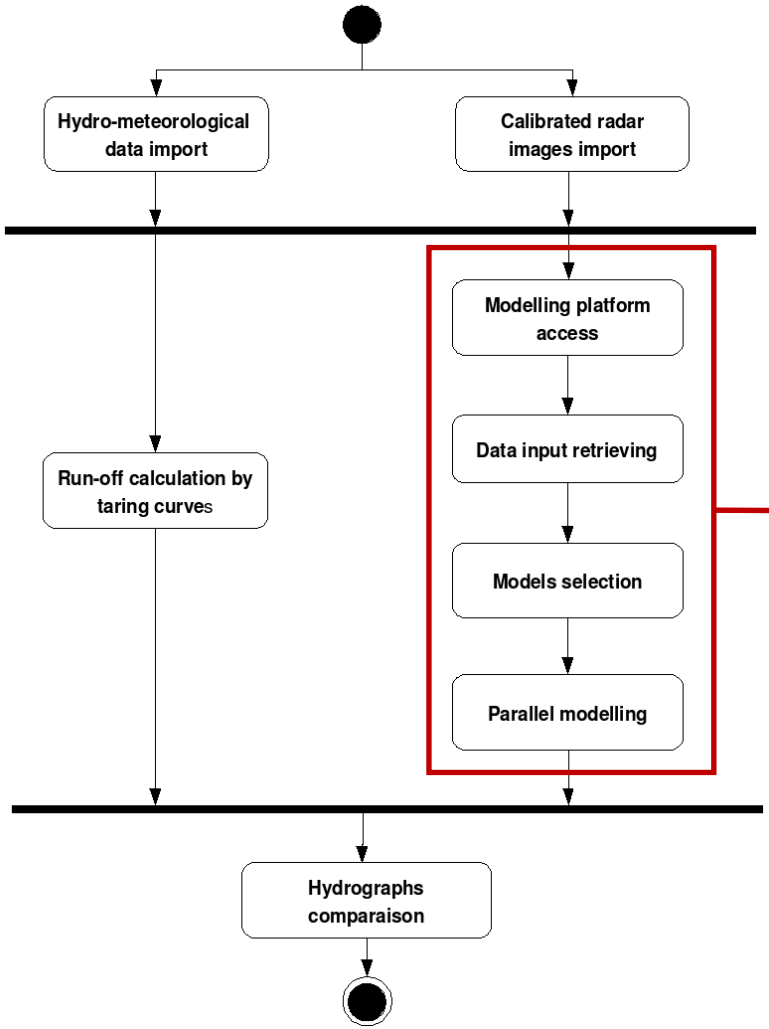

Grid task implementation for:
- Modelling
- Calibration
- Sensitivity

Modelling improvements

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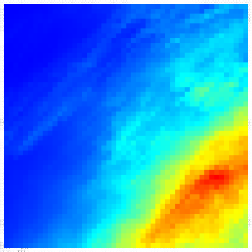
Grand Delta Flood Forecasting Service

Measuring stations Network

+



Radar imagery (Météo-France)

⁘

Rainfall-Runoff model Alhtaïr

1. The calibration and sensitivity tests during hydrological event or in prevention stage to respectively improve modelling performances and assess models effectiveness in real-time,
2. the simultaneous watersheds modellings, in using one grid job submission per watershed-model couple,
3. the sub-watershed modelling thanks to parallelization process potentially permitting a better run-off calculation and spatialization

ALHTAIR Functioning: Horton Law

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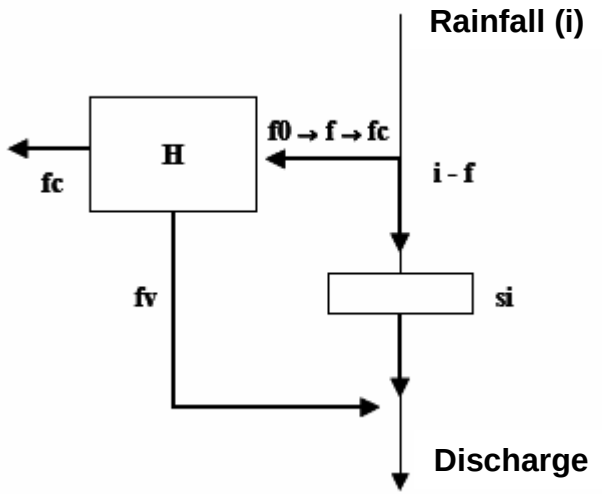
- Production step:

  From rainfall to cell discharge taking in account soil infiltration capability and soil surface roughness (6 parameters)

  => one discharge per watershed cell



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- Production step:

  From rainfall to cell discharge taking in account soil infiltration capability and soil surface roughness (6 parameters)

  => one discharge per watershed cell

- Transfer step: $V = (1 + \frac{(p-1)}{9}) \times L^{0,25}$

  Based on an information matrix giving water transfer time to reach the watershed outlet (1 parameter)

  => sum of discharges for cells having the same transfer time

Real-time runoff calculation
based on a physical model initially coded with WINDEV©

Modelling improvements

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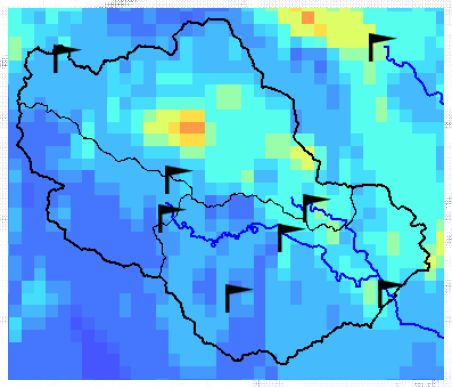

« In real-time, in crisis management context, the modelling client-server architecture is crashing … »

❑ **Modelling improvement:**

1.Several watersheds simultaneous modelling

2.Production calculation grouping based on transfert time thresholding: a job submission per group of cells (WPS)

❑ **Modelling potential gains:**

1.Free SPC-GD local environment storage and computational power

2.Ease calibration stage (7 production parameters variation)

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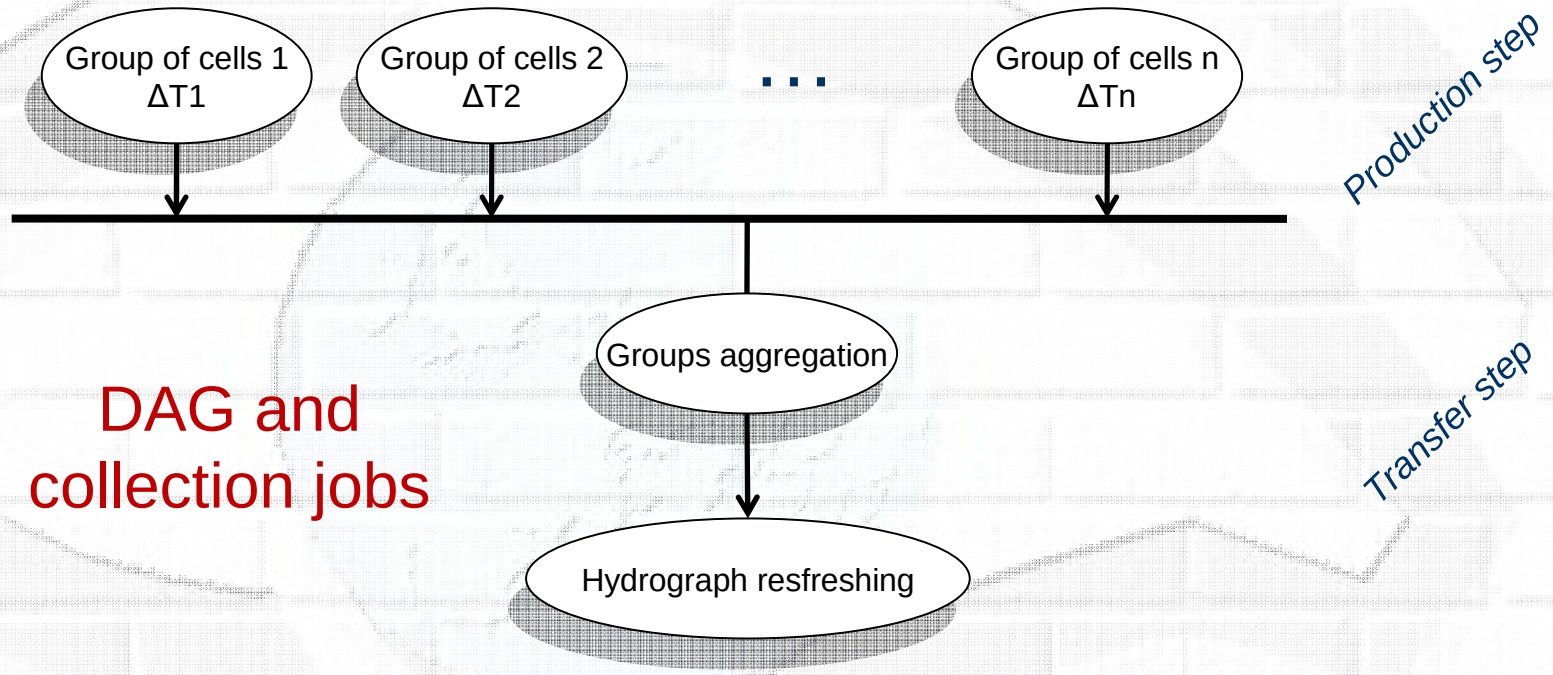
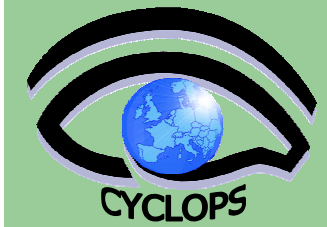


DAG and collection jobs

=> This workflow has to be run for each existing watershed



In progress activities

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The main (model) component implementation:

1. Alhtair Object-oriented Python algorithm recoding
2. Simple algorithm porting
3. Design DAG and Collection jobs to perform parallelization

Technical problems:

1.Initial WINDEV implementation specific for Windows

2.Python different version between local and Worker node architecture

3.Matrix Python library using and set up : Numpy

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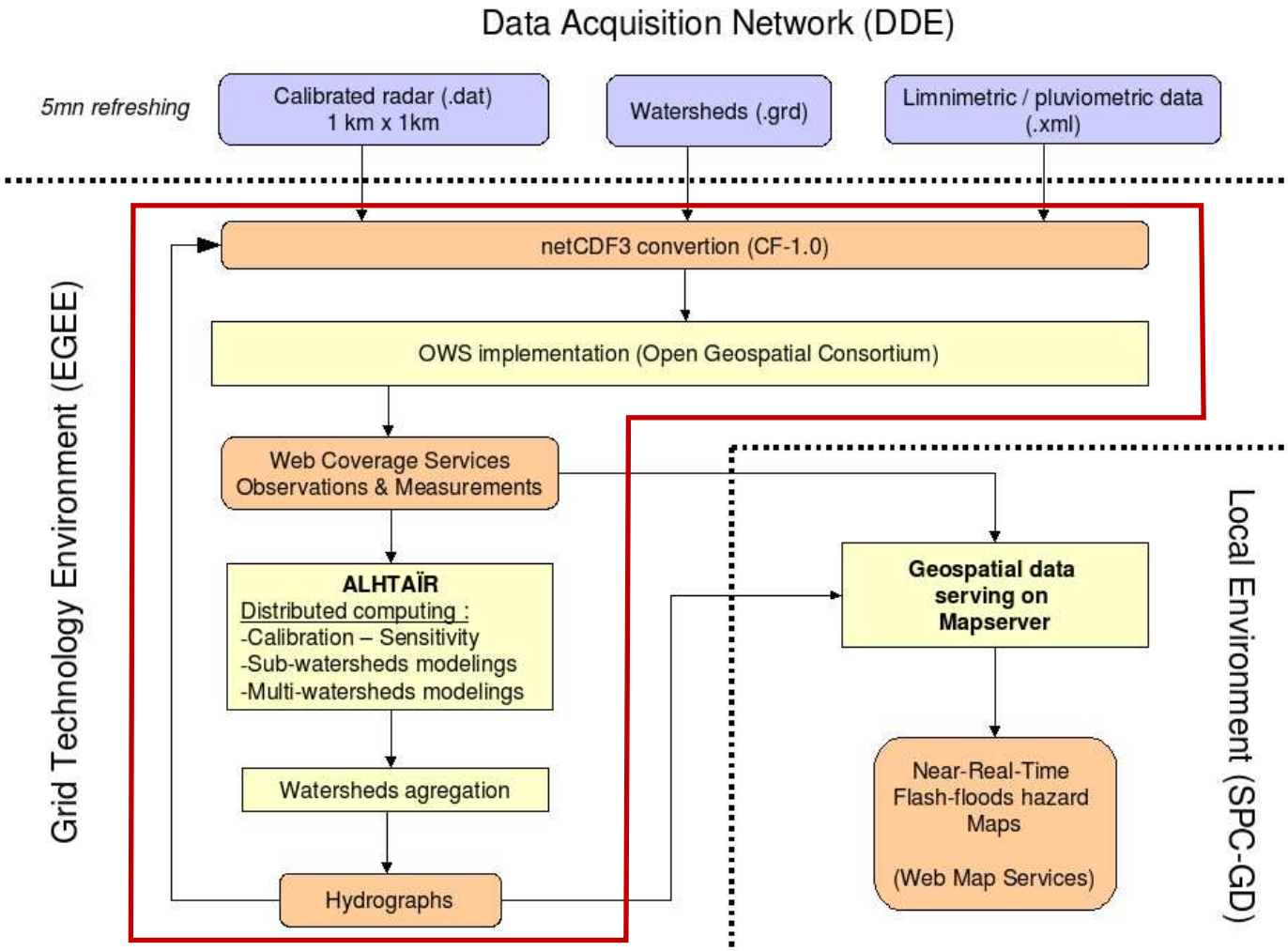

Data-processing improvements

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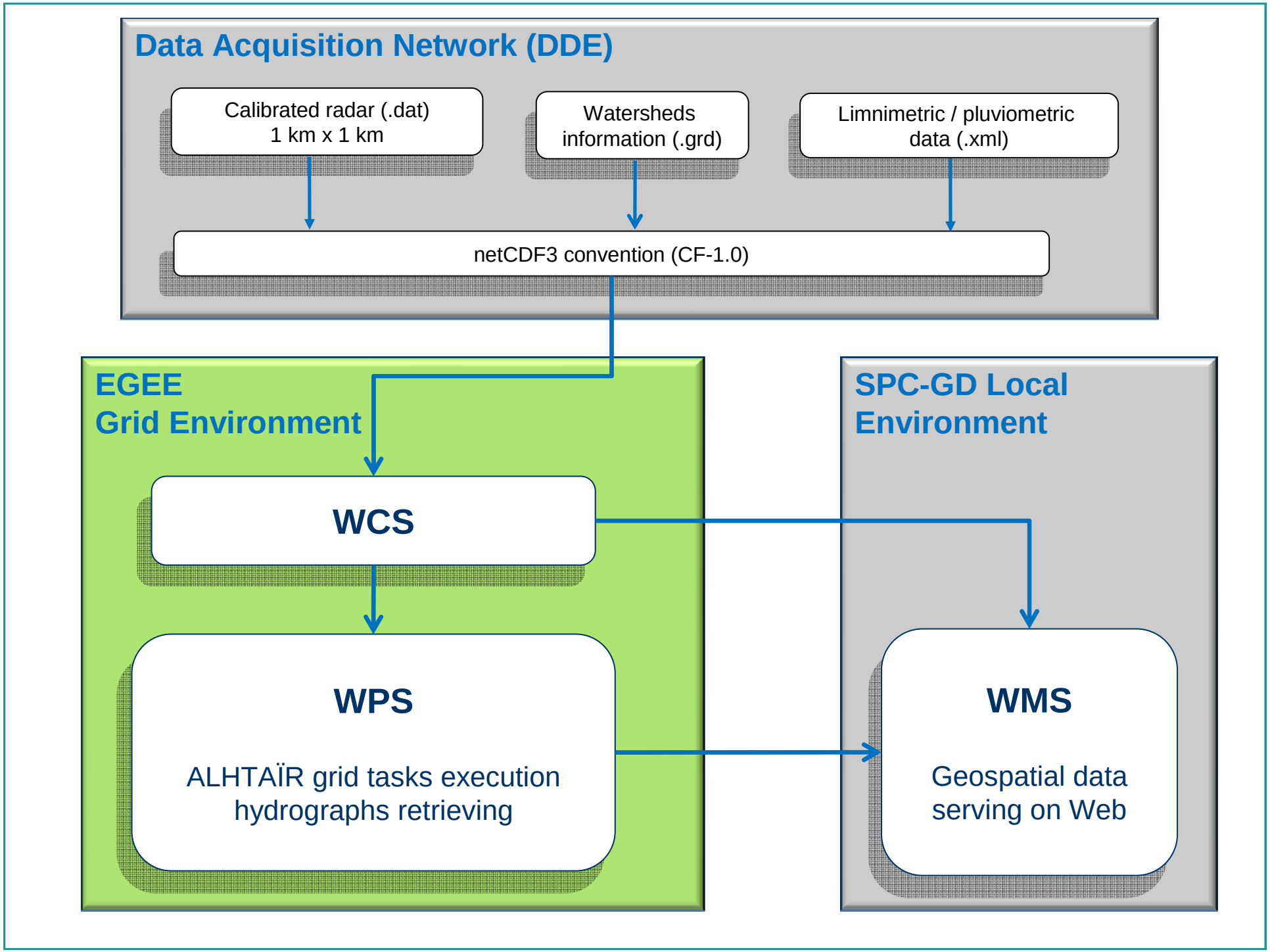
G.RISICO OWS Grid implementation experience :

1. Web Coverage Service (WCS) to access calibrated radar images already stored in standard format (NetCDF)

2. Web Processing Service (WPS) to manage Grid processing in
   - ❑ activating various independent data access services
   - ❑ distributing an adequate number of jobs on the grid
   - ❑ being responsible for the execution of the ALHTAÏR algorithm

The final objective is the design of **Flash Flood Spatial Decision Support System** implemented on Grid platform to ease and integrate hydrological expertise among flood hazard experts and to disseminate it to the overall partners involved in the crisis management, enabling a more integrated communication.


Data Acquisition Network (DDE)
Calibrated radar (.dat)
1 km x 1 km
Watersheds
information (.grd)
Limnimetric / pluviometric
data (.xml)
netCDF3 convention (CF-1.0)
EGEE
Grid Environment
WCS
WPS
ALHTAÏR grid tasks execution
hydrographs retrieving
SPC-GD Local
Environment
WMS
Geospatial data
serving on Web

Future rearches

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1. Hydrological issue
   - ❑ Calibration and Sensitivity
   - ❑ Multi-models platform designing (SCS, Neural Networks)
   - ❑ Use of Message Passing Interface
   - ❑ Integrated watershed delineation
   - ❑ Sensors data grid integration

2. ICT issue
   - ❑ Civil Protection operations (OWS)
   - ❑ GPS data grid integration
   - ❑ Geoprocessing tasks

Thanks for your Attention

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