Dieter Kranzlmüller
LMU & LRZ Munich

www.drihm.eu
DRIHM Objectives

- **To support** the development and deployment of a **HMR e-Science environment**

- **To promote** the establishment and diffusion of a **service-oriented culture** (involving specialist scientist users, members of public services, members of the general public)

- To provide **integrated HMR services**

- To design and deploy **user-friendly interfaces**

- To provide HMR e-Science **support centres** and corresponding **training activities**

- To support hydro-meteorological **forecasting chains**
DRIHMS History

DRIHMS Consultation Process

HMR Hot Topics

A Roadmap for HMR e-Science

Conceptual view of the data points, meteorological problems, and forecasting chains.

Notable points related to the HMR hot topics are:
- Respondents perceive data management as very important but they do not see significant progress in the next years.
- High Performance Computing is perceived important and they expect significant progress within the next years.
- Workflow management is perceived important but no significant progress is expected even short term.
- Protocols and user interfaces are perceived important and the existing solutions seem to fulfill most of the requirements already.
- Virtual Organization (VO) management is perceived to be less important but sufficiently mature already.
Why DRIHM?

• Forecasting severe storms and floods is a key topic in HMR/early warning

• Storms do not respect country boundaries – a pan-European approach to data access and modeling is necessary

Satellite cloud liquid water composite (week ending 5/11/2011) clearly shows the cyclone track from USA east coast to Mediterranean.
Why DRIHM?

- The FLASH project estimated over 29 billion euros the material damages produced by floods in the Mediterranean region during the 1990-2006 period.
- The total number of casualties has been estimated over 4,500, concentrating in the Mediterranean African countries especially...
Experiment Suites

- **Experiment Suite 1**: Rainfall
- **Experiment Suite 2**: Discharge
- **Experiment Suite 3**: Water Level, Flow & Impact

Diagram details:
- NWP Multi-model Ensemble
- Stochastic Downscaling
- Observation Datasets
- Hydrological Drainage Model
- Hydraulic Open Channel Flow Model
- Impact
  - Pluvial Flooding (from Runoff)
  - Fluvial Flooding (from River)
  - Groundwater Flooding
DRIHM e-Science environment

Resources accessible through the Grid: require valid Grid Certificate + DRIM VO user

- IGI
- Grid nodes
- EGI
- Grid Test Bed
- Other Grid resources

Resources available out of the Grid

- Dedicated nodes
- Data repository
- PRACE
- Visualization nodes
- Cloud services
- Windows nodes
- Web services
DDCI Ideal Architecture

WPS and critical case data repository

Serious run for meteo models

HMR Linux-based Models

Citizen Scientists and proprietary software

Testbed

HMR Windows Models

HMR
The DRIHM Models

Meteorologic
- Cb-TRAM (DLR)
- Arome EPS (CNRS)
- Meso-NH (CNRS)
- WRF-ARW (CIMA)
- PhaSt (CIMA)
- WxFUSION (DLR)
- Rad-TRAM (DLR)
- WRF-NMM (RHMSS)
- RainFARM (CIMA)
- COSMO-Model (CIMA)

Hydrologic
- Contiuum (CIMA)
- DRIfT (CIMA)
- HBV (RHMSS)
- RIBS (UPM)
- HYPROM (RHMSS)
- MASCARET (HR Wallingford)
- SOBEK-FLOW (Deltares)
- TELEMAC-2D (HR Wallingford)
- RFSM (HR Wallingford)
- Delft3D-FLOW (Deltares)
- Inundator (CIMA)

Impact
- SISYPHE (HR Wallingford)
- Property Damage (HR Wallingford)

Hydraulic
HRM chains are usually clumsily stitched together so that it is ONLY model $i$ (of level 1) and model $j$ (at level 2) and model $k$ (at level 3) that fit together because somebody worked for many years to get it together.

Adding another data set, replacing model $j$ by model $j2$, finding out sensitivities etc is tedious and thus hampers progress.

DRIHM wants to make it possible to work in a modular environment.

DRIHM will provide an e-science environment for this goal.
Identification of HMR critical cases

1. Rain episode of June 22nd – July 5th 2010 in Serbia
2. Period of October-November 2011 in the north-western Mediterranean area
3. Rain episode of November 1st – 8th 2011 in Catalunya
4. Flash flood episode on 4th of November 2011, Genoa, Italy

Flash flood of the Genoa town center. Top right corner: the similar event of 1970
DRIHM Model Chains

“Large” Scale Meteorological
- RHMSS
  - WRF-NMM
- CIMA
  - COSMO-Model
- CNRS
  - Arome EPS
- CNRS
  - Meso-NH

“Small” Scale Meteorological
- RHMSS
  - WRF-NMM
  - RainFARM
- Deterministic Ensemble

Hydrologic
- HBV
  - Flag
- HYPROM 2D
- DRiFt
- RIBS

Hydraulic
- HRW
  - TELEMAC-2D
  - HYPROM 1D
- Deltares
  - SOBEK-FLOW
  - Delft3D-FLOW

Impact
- Property Damage

Deterministic Ensemble

UPM
- Measured Rainfall
Baseline version of experiment suites 1 & 2

- WRF
- RainFARM
- Meso-NH
- Arome
- Raingauge observations
- DRiFt
- RIBS
- Streamflow observations

Direct, hard-wired coupling

Gridded data
Point series data
DRIHM Unified Interface Concept:
using tools like those developed within the SCI-BUS project
Advanced version of experiment suites 1 & 2

- WRF
- RainFARM
- Meso-NH
- Arome
- Raingauge observations

- netCDF-CF

- DRiFt
- RIBS

- Streamflow observations

- WaterML 2

- Gridded data
- Point series data
## Summary of model setups

<table>
<thead>
<tr>
<th>Rain source</th>
<th>Description</th>
<th>Ensemble members</th>
<th>Resolution (km)</th>
<th># DRiFt runs</th>
<th># RIBS runs</th>
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<tr>
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<td>0.5</td>
<td>10</td>
<td>300</td>
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<tr>
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<td>0.5</td>
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</table>
Meteorological scenarios

- More than 30 high-resolution, multi-model scenarios
- 3 different ensembles from 2 different ensemble prediction systems
- In the same format (netCDF-CF)
- Allowing processing by many free, off-the-shelf post-processing and visualization softwares (here the NCAR Command Language – NCL)
- Directly comparable with WaterML 2.0 observations
Comparison of rainfall time series

Rainfall time series averaged over the Bisagno catchment

Rainfall time series for raingauge observations and different simulations

Ensembles

Rainfall time series for raingauge observations and Meso-NH ensemble (DRI5X)

Rainfall time series for raingauge observations and Arome ensemble
Comparison of model fields
Full hydrometeorological chains

Summarizing all the information produced by a chain in one plot

RIBS(mesonh DRI57-7408):20111104-20111105

- Rain For (mesonh DRI57)
- Rain Obs (future)
- Rain Obs (past)
- Time Now (11/04:16)

Observed Discharge
Sim Discharge (Obs)
Sim Discharge (Obs+For)
Time Now (11/04:16)
Comparison of different rainfalls

**DRiFt** driven by **Arome** ensemble member #6

**DRiFt** driven by **Meso-NH** ensemble member DRI54
Upper panel: satellite cloud liquid water composite (week ending 5/11/2011) clearly shows the cyclone track from USA east coast to Mediterranean. Lower left panel: snowstorm impacts example on USA east coast. Lower right panel: Genoa city (Italy) under massive flash-flood event.
Main components of our multi-layer design and the interactions between collaborating projects in the US and Europe, in particular as organized under DRIHM2US and its US counterpart, SCIHM (Standards-based CyberInfrastructure for HydroMeteorology). The two projects overlap in their reliance on open community standards developed for high performance resource management and for domain services and catalogs, and on joint use of the data and services infrastructure, as well as parallel institutional development and community engagement.
Schematic showing the suite of multi-physics options available for experimentation in the SCIHM use cases from WRF-Hydro (left) or from DRIHM (right).
Dieter Kranzlmüller
kranzlmueller@mnm-team.org