Grid based Hydrological Model Calibration and Execution by gSWAT Application

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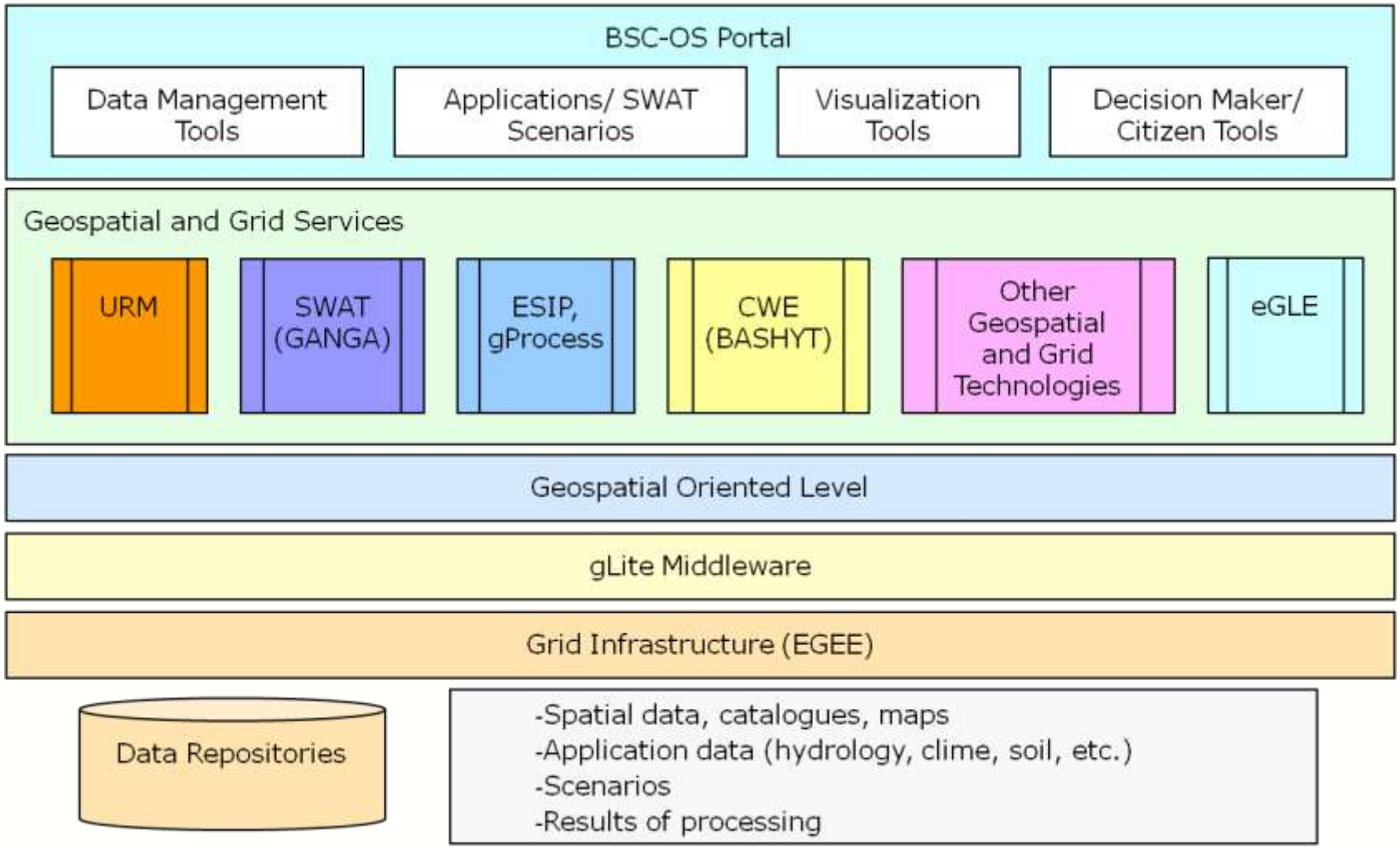
enviroGRIDS Project

- **enviroGRIDS** - Gridifying the Black Sea catchment to support its sustainable development (*http://www.envirogrids.net*)
- Founded by the European Commission FP7 framework (Theme 6: environment), April 2009 – March 2013, 27 partners, 7.9 mil EUR.
- Coordinator
  - University of Geneva, Switzerland
- Objectives:
  - Develop a SDI (Spatial Data Infrastructure) targeting the Black Sea catchment region
  - Use new international standards to store, analyze, process, and visualize important information regarding this area
  - Perform distributed spatially-explicit simulations of environmental changes

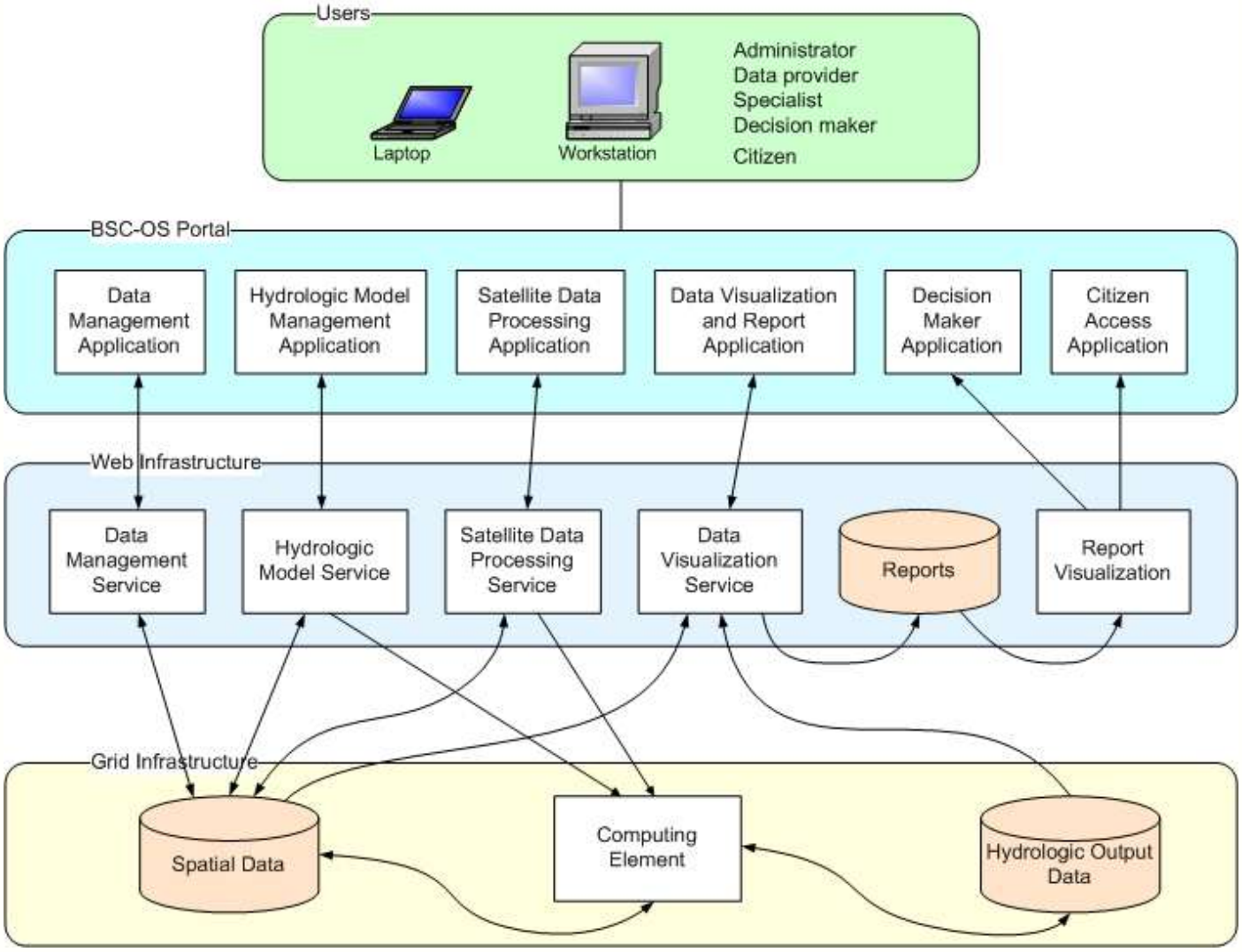
BSC-OS Portal

- Single way of the user to get into the enviroGRIDS system
- Exposes personalized tools for different category of users: data manager, earth science specialist, decision maker, citizen, and system administrator.
- Provide applications for:
  - data management
  - hydrologic models calibration and execution
  - satellite image processing
  - report generation and visualization
  - virtual training center
- Support interoperability between the Geospatial and Grid infrastructures on security, heterogeneous data access, distributed data processing
- EnviroGRIDS functionality gathers services provided by various technologies such as SWAT related modules, Collaborative Working Environment (CWE), Uniform Resource Management (URM), gProcess, ESIP, and eGLE platforms

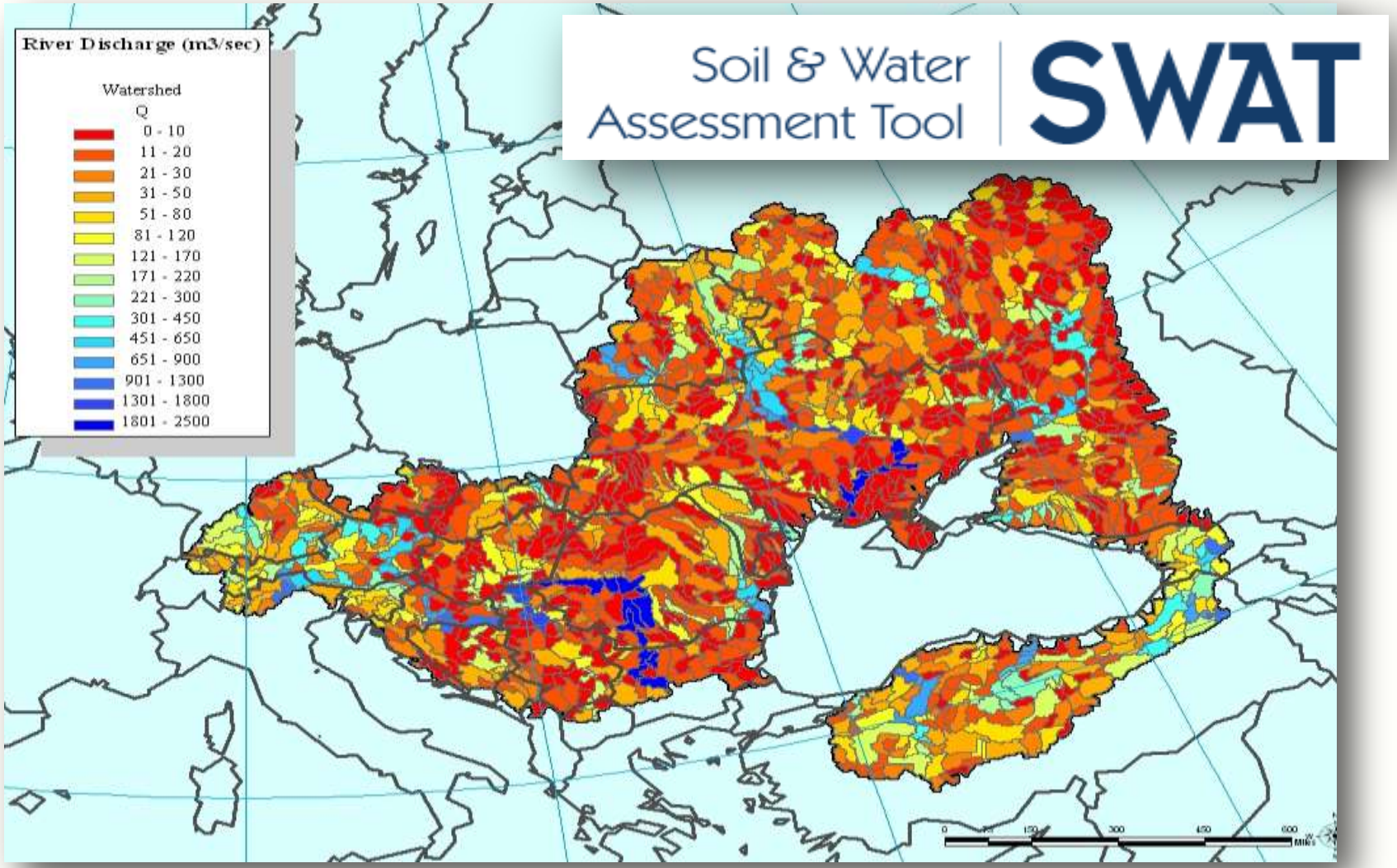
Portal Architecture



Data Flow Throughout the Portal



Black Sea Catchment Basin

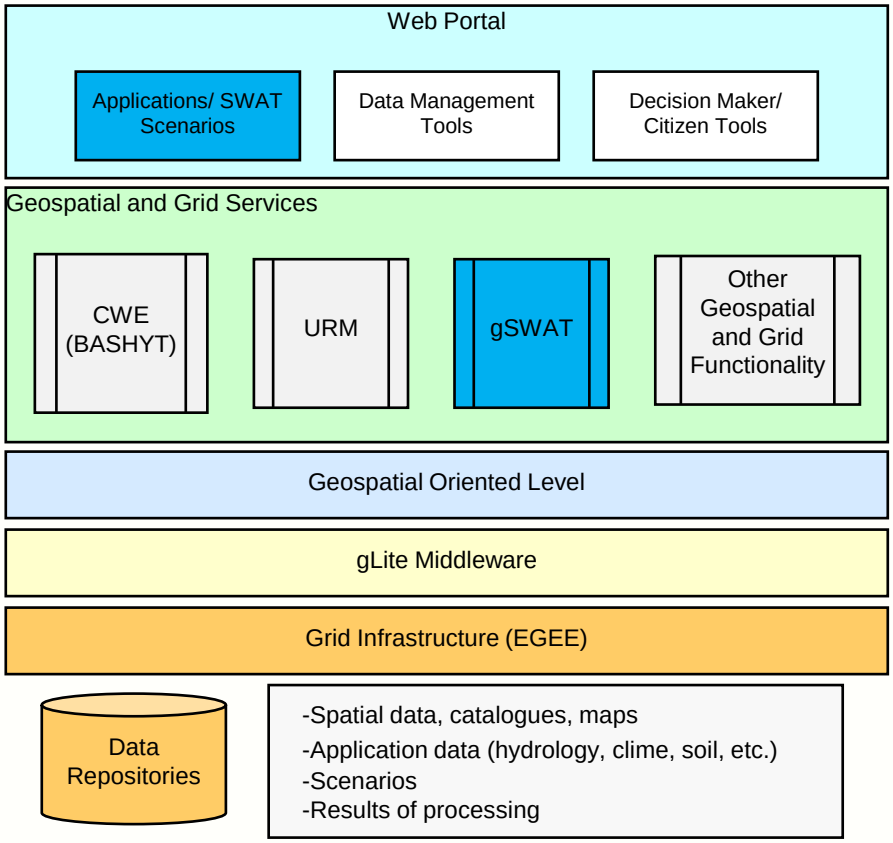


Specific Objectives

- Link, gather, store, manage and distribute key environmental data concerning the Black Sea Catchment Basin
- Large scale and high resolution distributed hydrological models
- Gridification of tools and applications
- Model and process huge spatial data over the Grid (e.g. hydrological models, satellite images, and maps)
- Develop early warning and decision support tools at regional, national and local levels

gSWAT Overview

- Main functionalities:
  - Calibration of the SWAT models (on GRID infrastructure)
  - Execution of scenarios based on a calibrated SWAT model (on GRID infrastructures)
- The calibration process uses the SUFI2 uncertainty analysis routine
- Web application



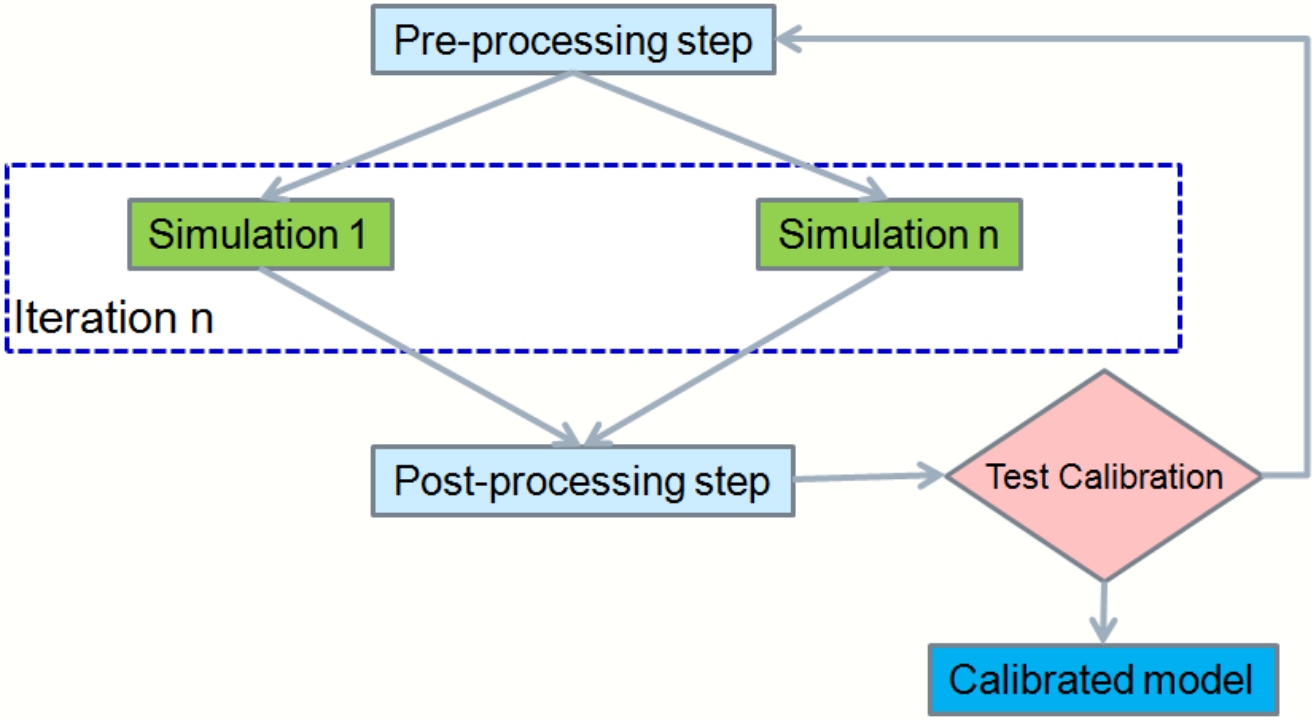
gSWAT Functionalities

- Management of the SWAT calibration projects
  - Create new project
  - Upload SWAT model
  - Delete project
  - Modify calibration parameters
- Management of the execution of the calibration iterations
  - Start and monitor iterations
  - Save and delete completed iterations
- Output visualization
  - Graphical visualization

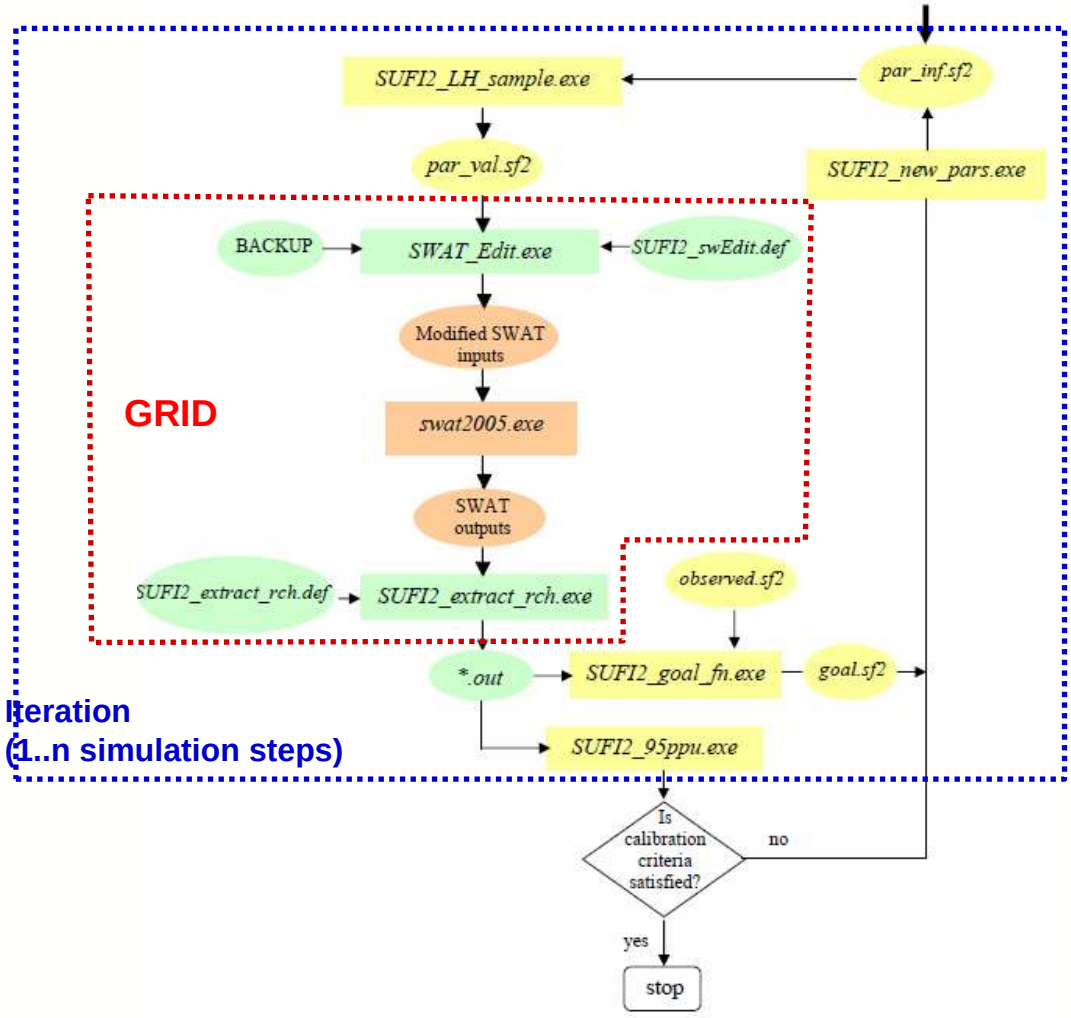
SWAT Calibration Process

- **The calibration process** - execution of several iterations until the calibration criteria is satisfied.
- Each **iteration** process is composed of a number of simulations.
- Each **simulation** is independent on the other simulations.
- The user can choose between several objective functions.
- After performing an iteration the user can change the type of the objective function to see the effect of this objective function.

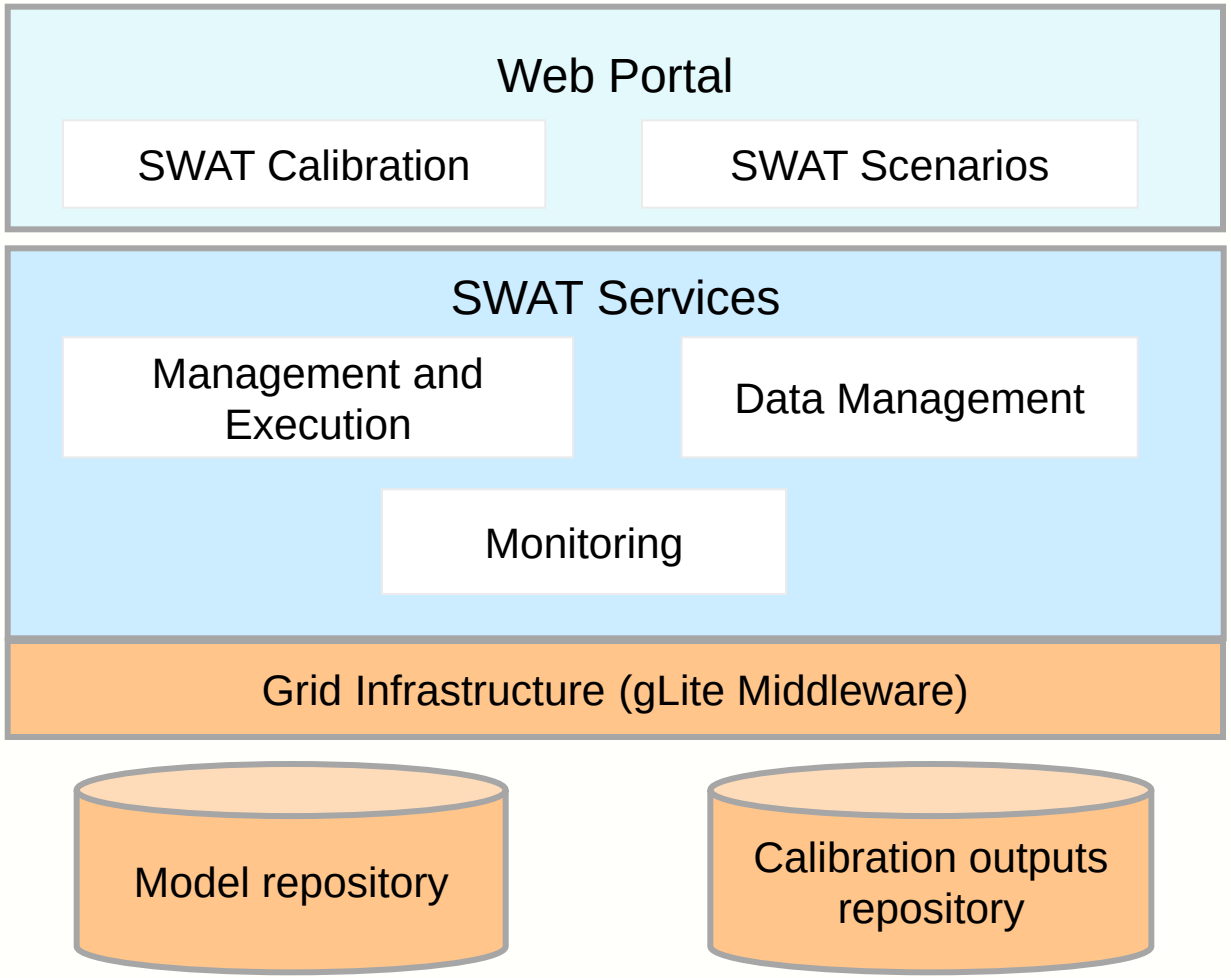
Processing steps



The calibration process



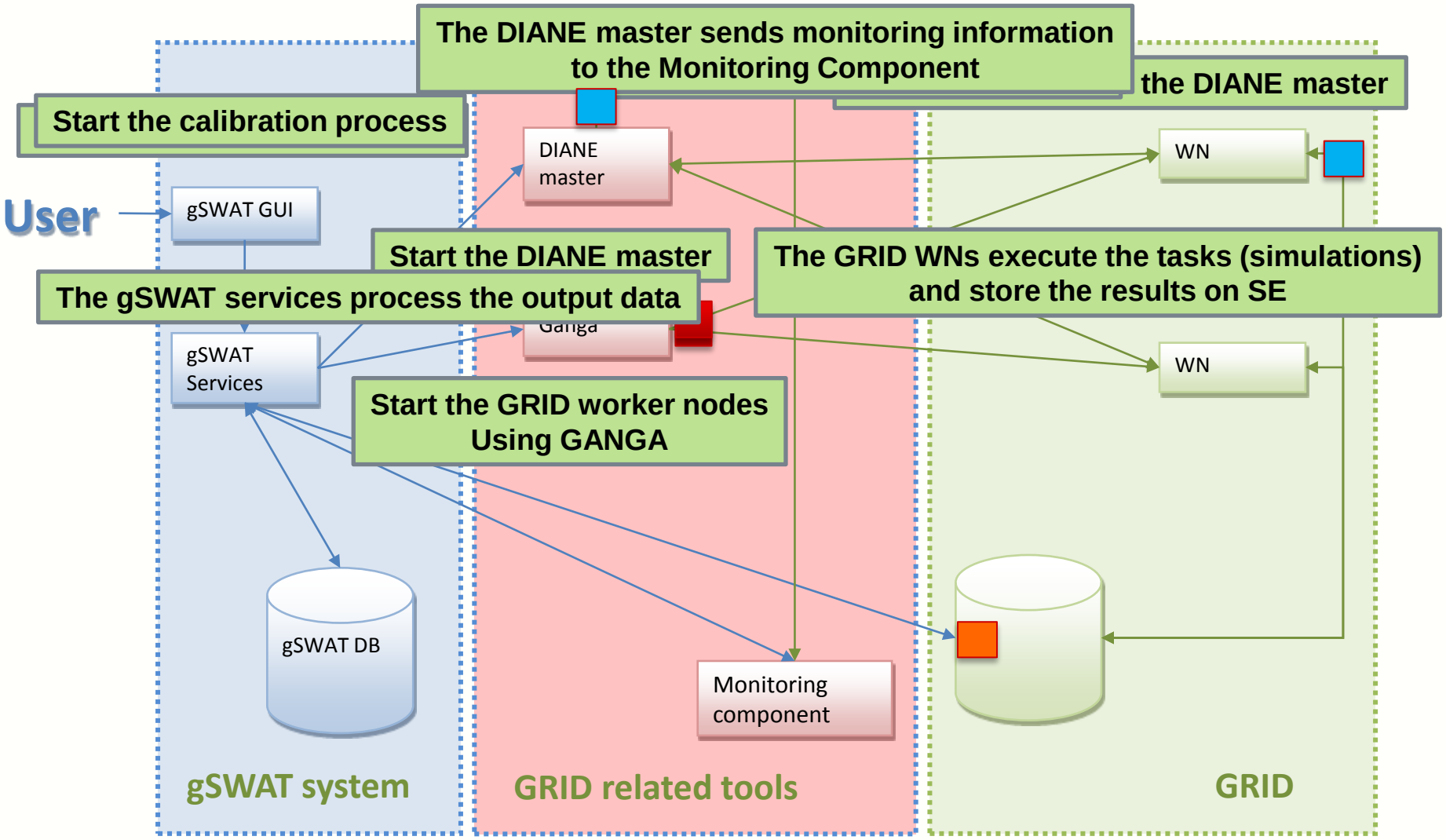
gSWAT Application - Architecture



gSWAT Execution Flow

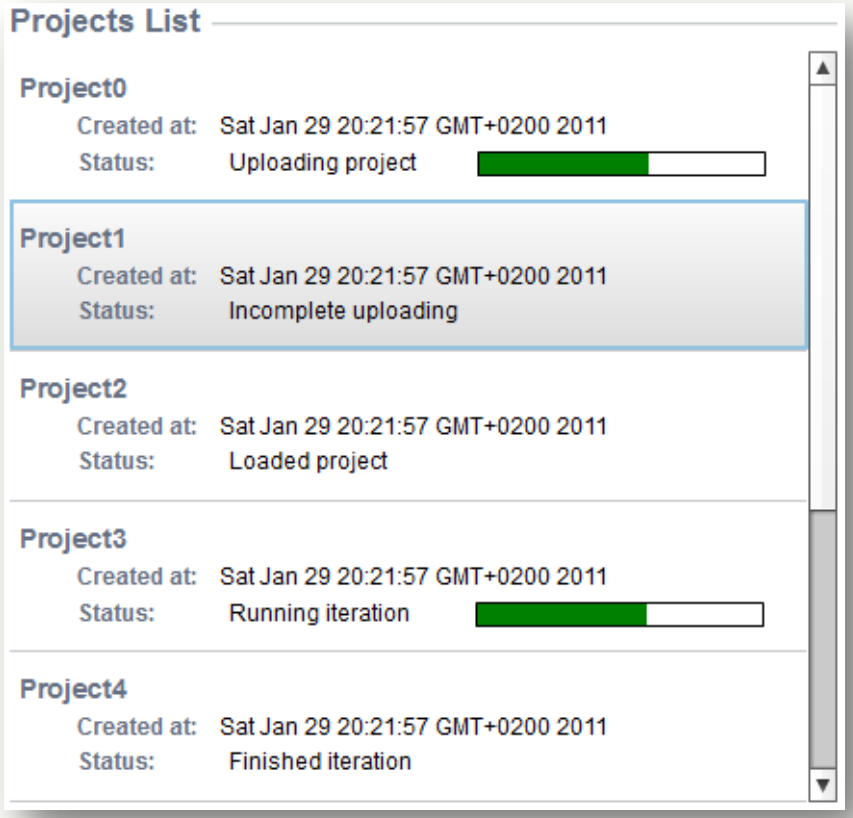
1. Create the job script
2. Create the DIANE script
3. Start the DIANE master
4. Start the Grid workers using GANGA
5. Monitor the execution of the tasks (simulations)
6. Download the output data

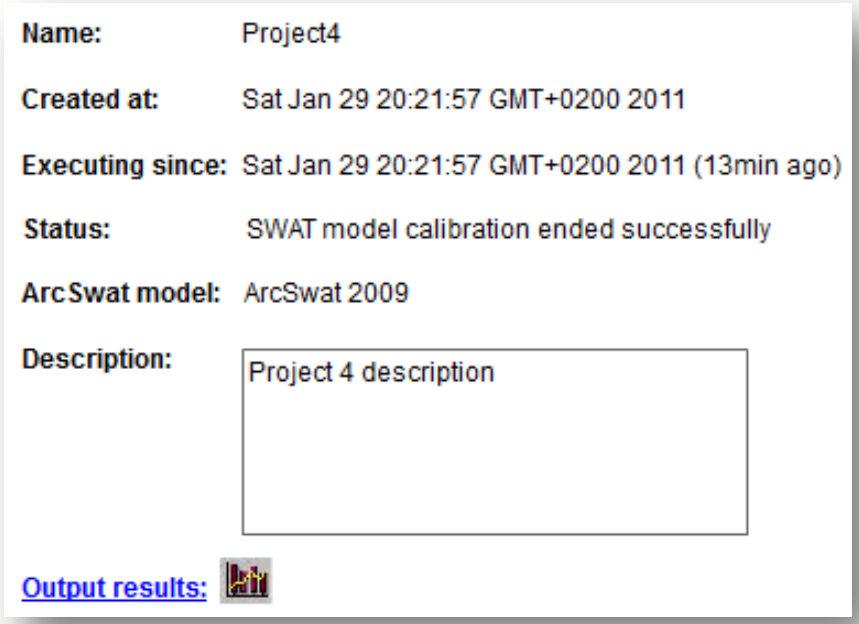
gSWAT Execution Flow



gSWAT User Interface

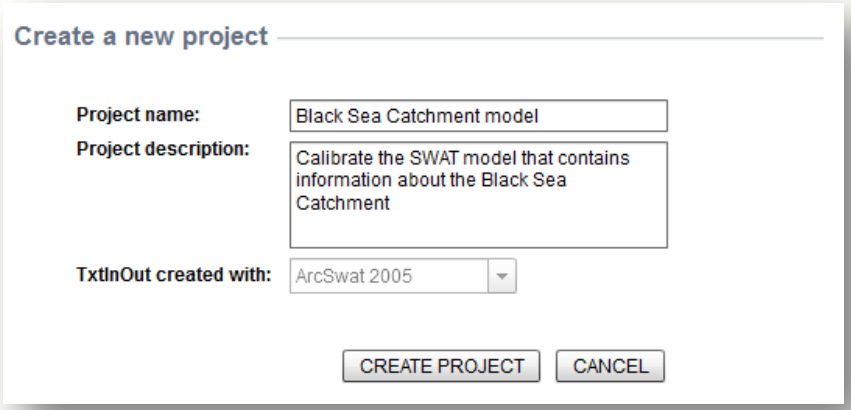
- Project list and detailed information on the selected project



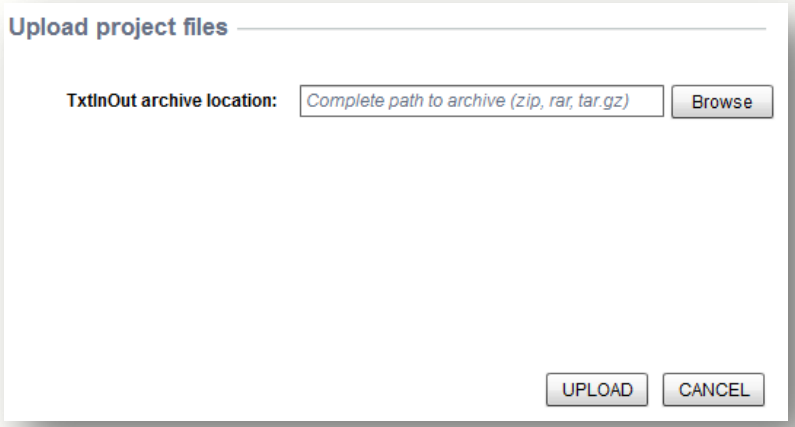


Create a new project

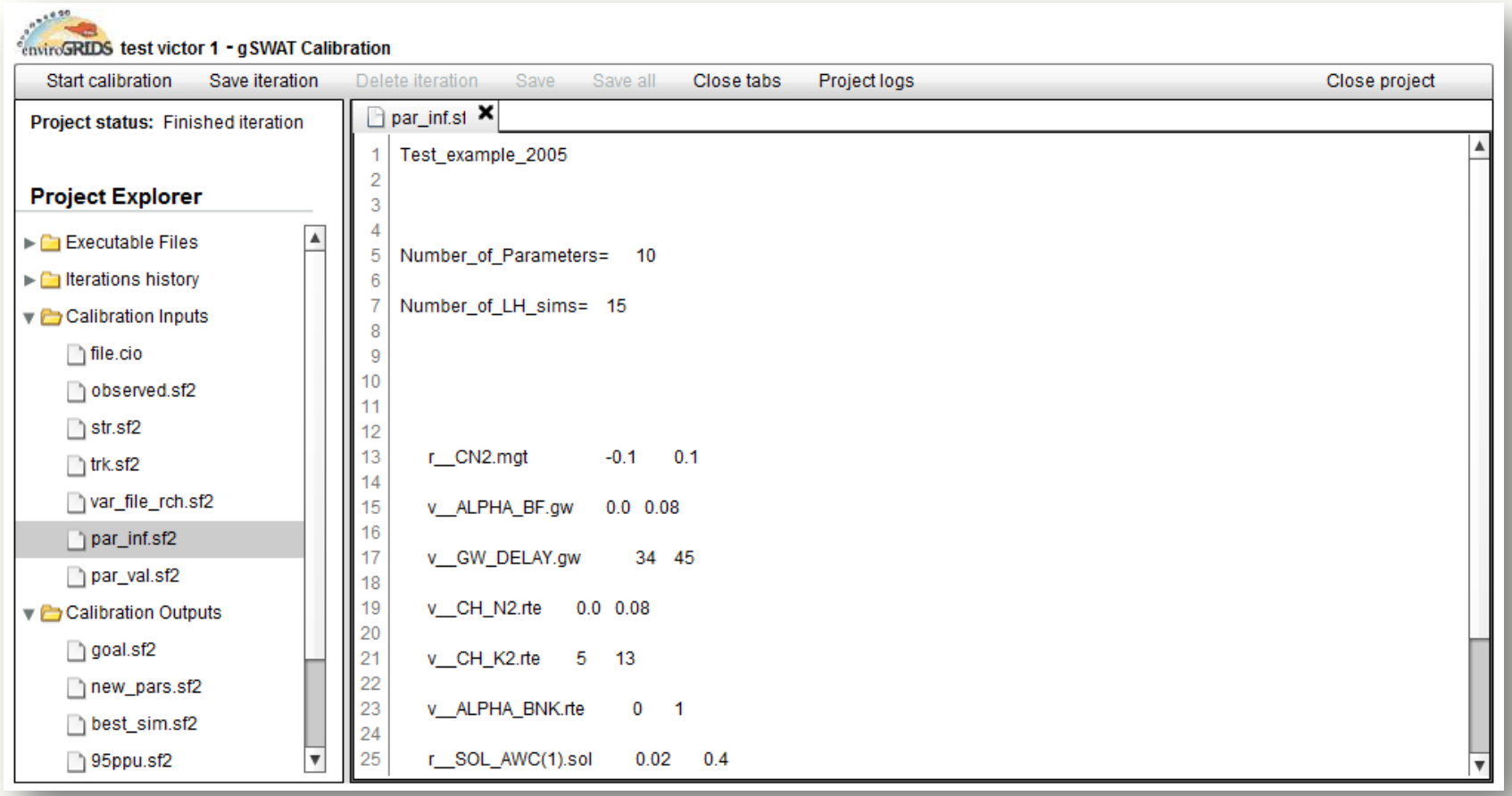
- Step 1: Define general project information



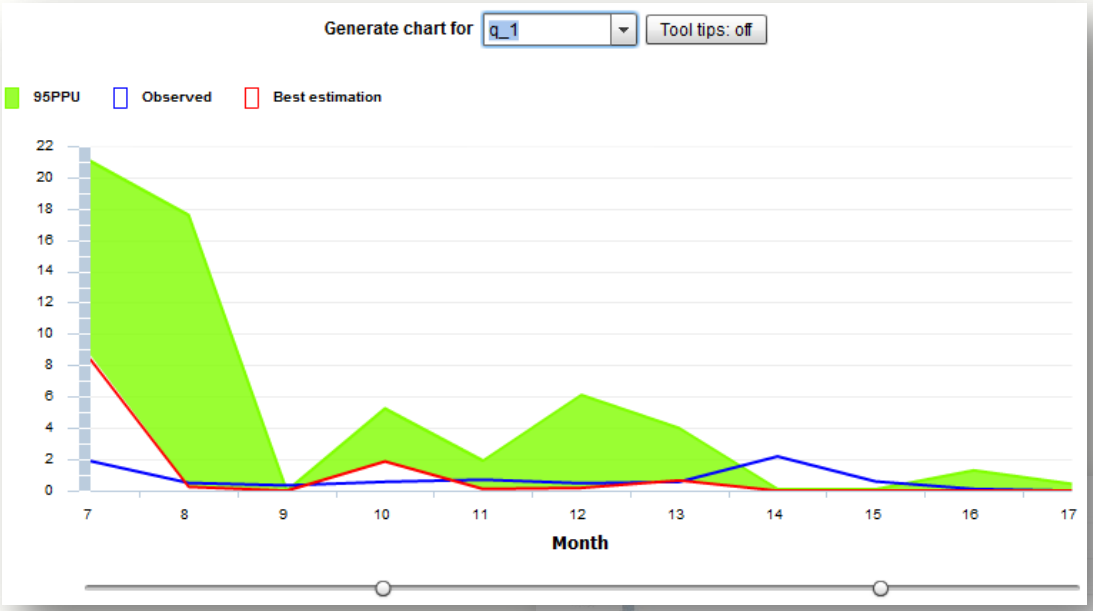
- Step 2: Select the SWAT model to be uploaded

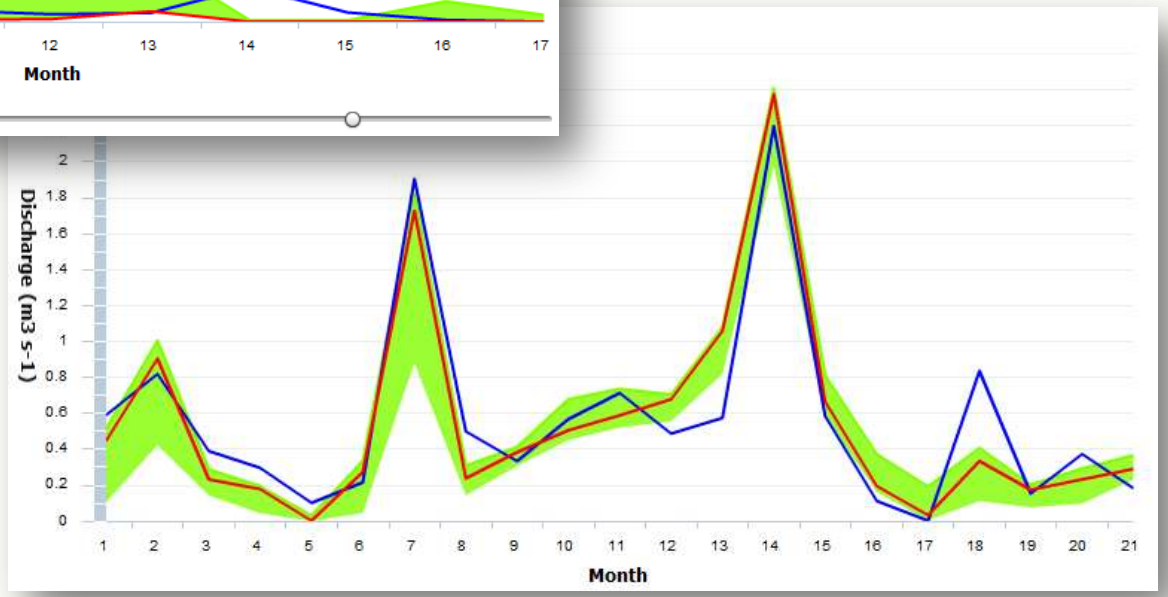


Modify SUFI2 calibration parameters

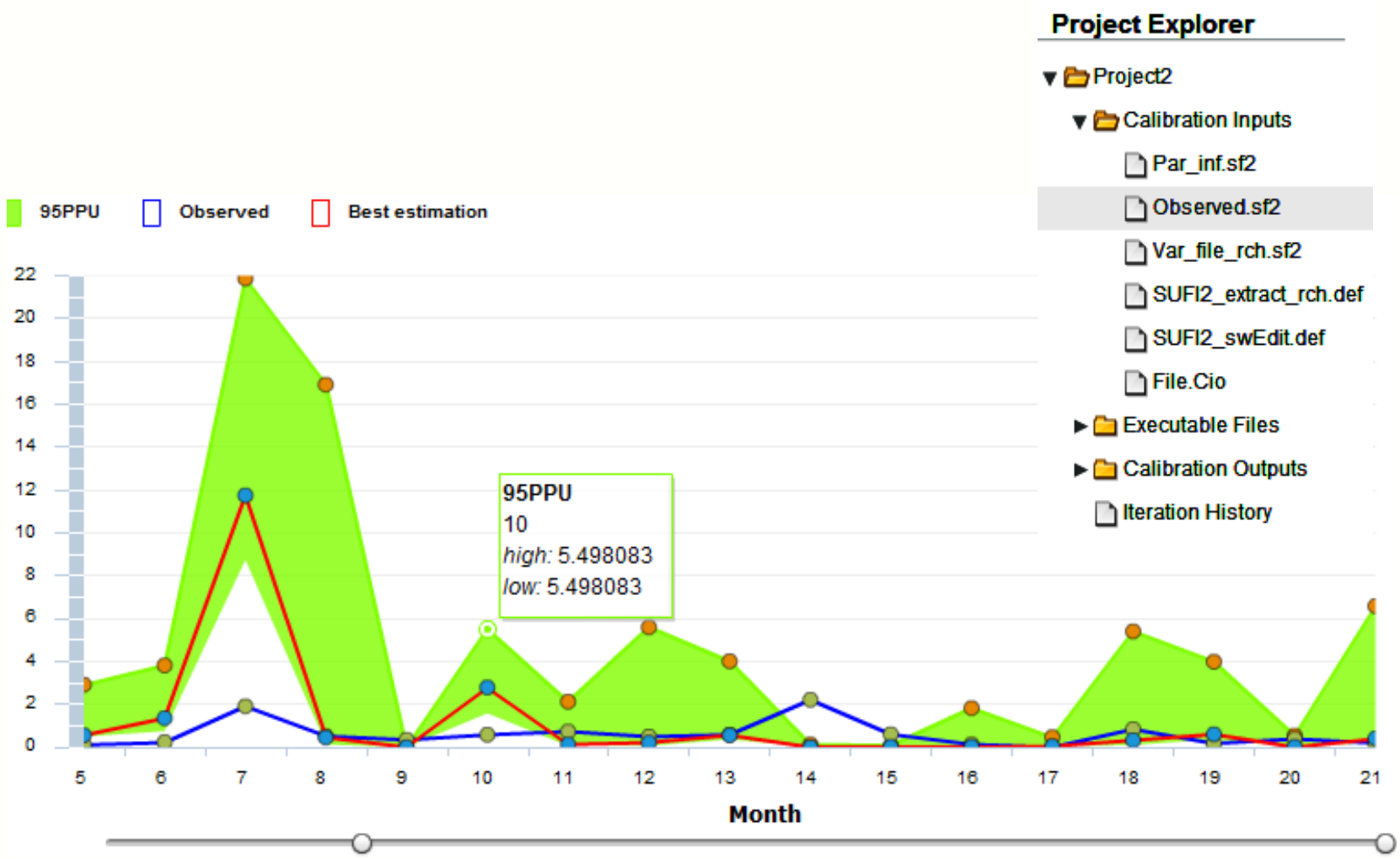


Calibration Output Visualization



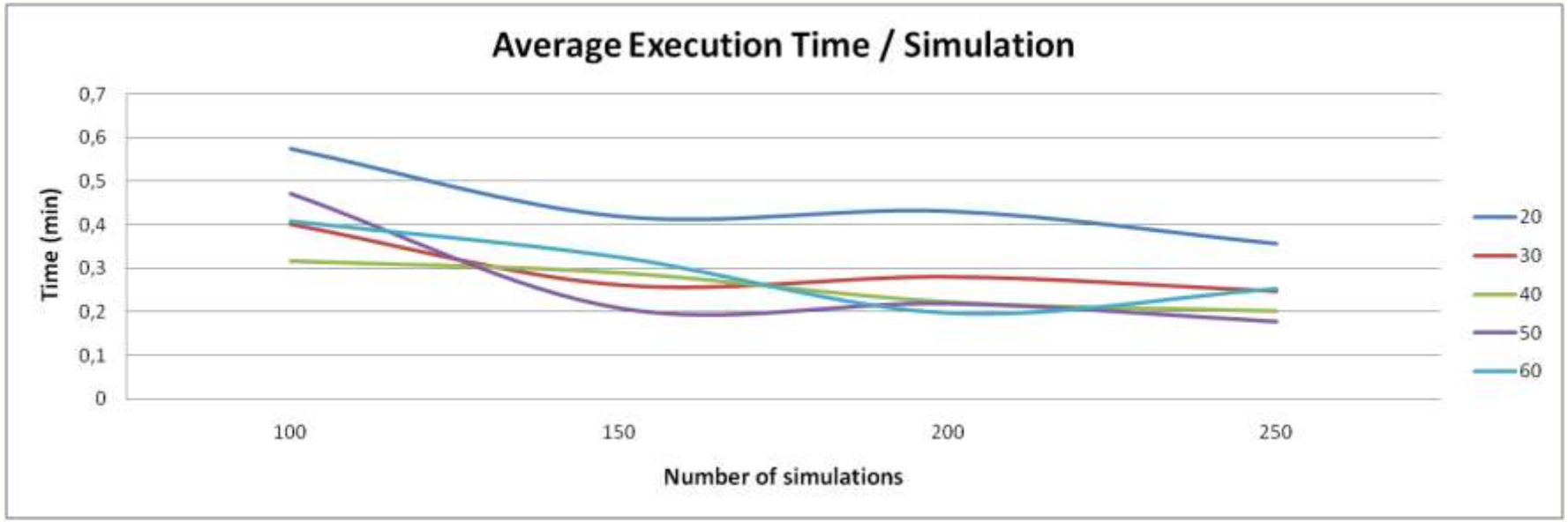


Calibration Output Visualization



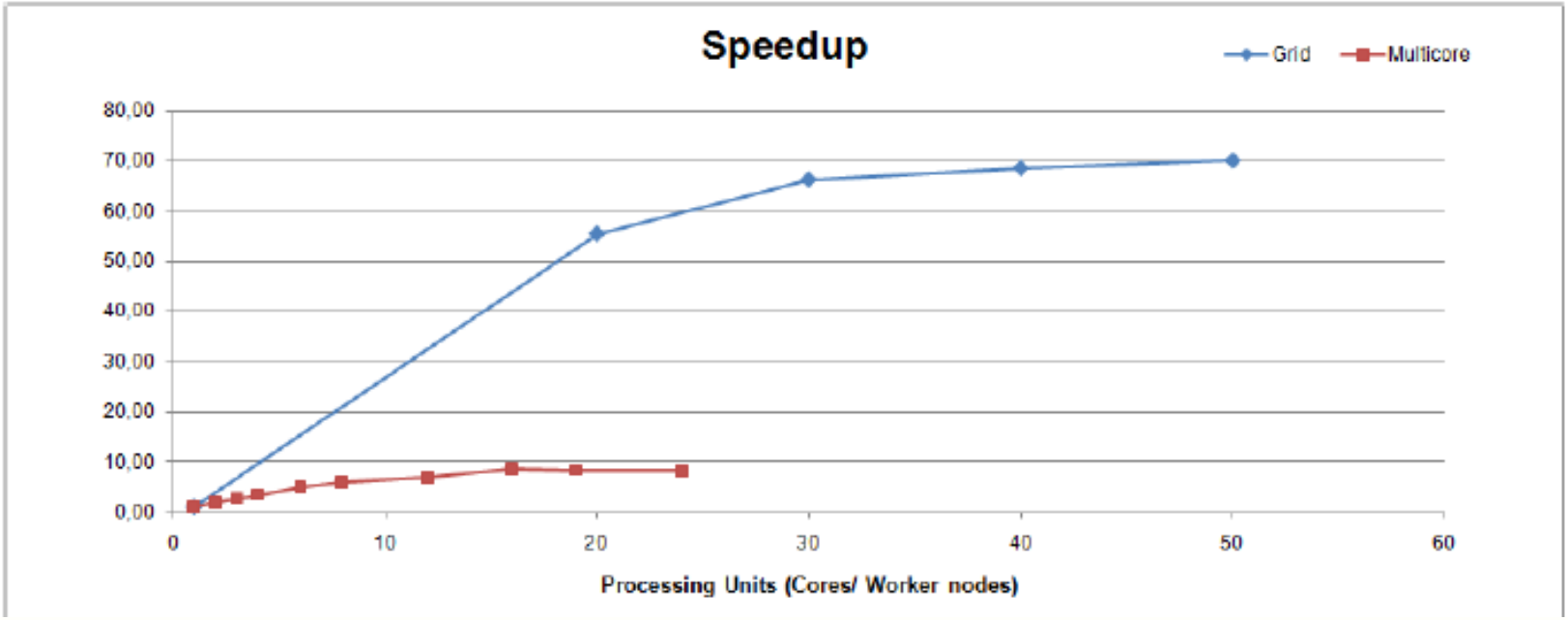
Performance

- vo.gear.cern.ch VO
- Variables:
  1. number of worker nodes
  2. number of SWAT simulations



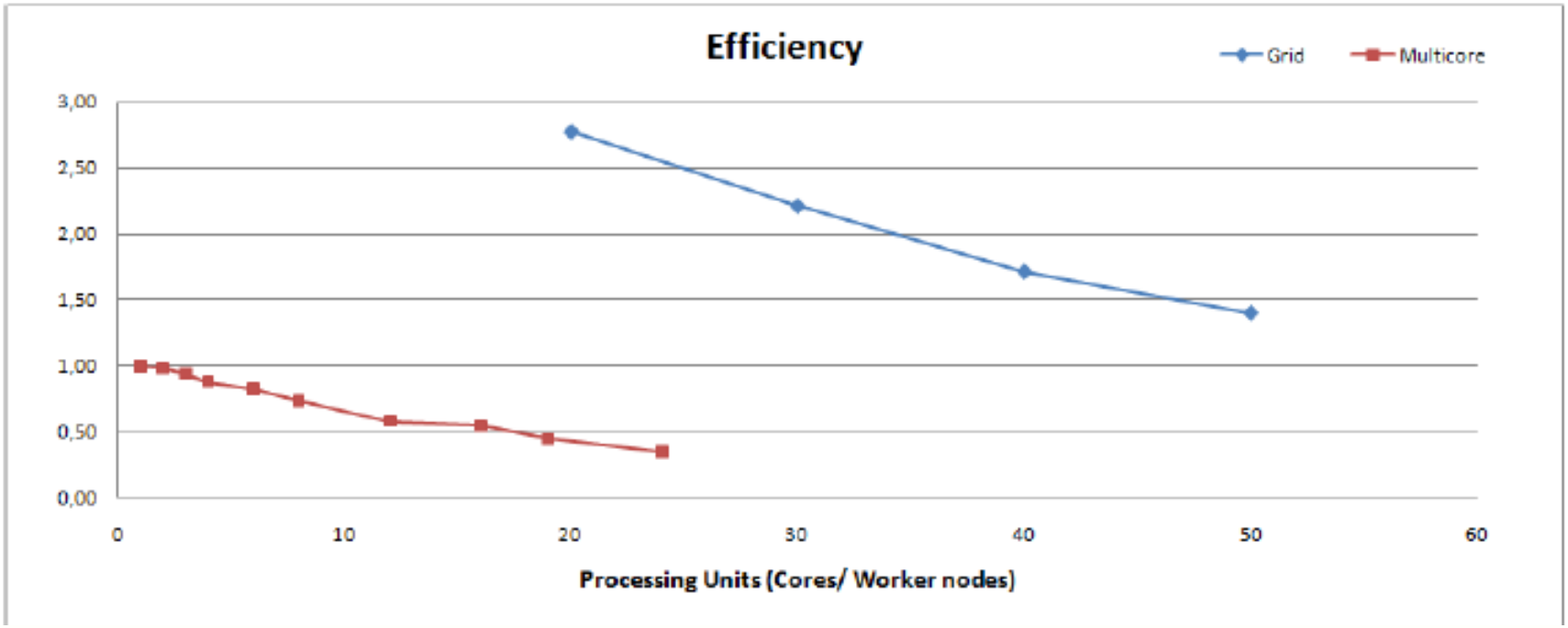
Comparative Multicore vs Grid Speedup

S(n) = T1/Tn



Comparative Multicore vs Grid Efficiency

E(n) = S(n)/n



Future work

- The possibility to define and run scenarios
- Export the calibrated SWAT model to other systems, such as BASHYT, for output visualization
- Parallel and distributed execution of the SWAT model on other platforms: Grid EMI, Cloud, Multicore, GPU based cluster

Thank you for your attention!

Questions?

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