The AquiFR hydrogeological modeling platform

Evaluation of the 1958-2017 long-term simulation for the main regional multilayer aquifers in France

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**Introduction**

- Gathering **hydrogeological models** developed over **France** inside a **single numeric tool** for operational and research purposes.

<table>
<thead>
<tr>
<th>Year</th>
<th>Time Frame</th>
<th>Description</th>
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<tbody>
<tr>
<td>1958</td>
<td></td>
<td>Long-term simulation</td>
</tr>
<tr>
<td>Present</td>
<td>10 days</td>
<td>Short-term forecast</td>
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<tr>
<td></td>
<td>3-6 months</td>
<td>Seasonal Forecast</td>
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<td></td>
<td>&gt;= 2050</td>
<td>Climate impact studies</td>
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- CERFACS
- brgm
- GEOsciences Rennes
- Agence Française pour la Biodiversité
- Mines ParisTech
- METEO FRANCE
- Laboratoire d'Hydrologie et de Géochimie de Strasbourg
- Metis UMR 7619
Implemented softwares

SAFRAN atmospheric reanalyses

Rainfall, Temperature, Wind, PET…

SURFEX Land surface model

Surface runoff, Groundwater recharge

EROS lumped model for karsts

Spatially distributed hydrogeological model

MARTHE

EauDyssée

Karst discharges

Piezometric heads

Fontaine de Vaucluse (GARDÉNIA)

Surface runoff, Groundwater recharge
Map of the models

MARTHE distributed models
EauDyssée distributed models
EROS lumped models

Seine-Oise
4 layers

Seine-Eure
1 layer

Basse-Normandie
10 layers

Poitou-Charente
8 layers

Somme
1 layer

Nord-Pas de Calais
10 layers

Alsace
3 layers

Marne-Oise
2 layers

Marne-Loing
3 layers

Seine
6 layers

Karsts
23 basins

Loire
3 layers
Example of a spatially distributed model
Jurassic-Poitou Charentes model

- Regular grid with 1-km resolution with 8 layers
- Coupling between surface water and groundwater
- Pumping for agriculture, drinking water or industry
  - 1850 groundwater pumpings
  - 100 surface water pumpings
- Initially calibrated on the 2000-2007 period

Models recalibrated with the SURFEX surface runoff and recharge (except the Seine and Loire models)

Area of the model
19 200 km²
Evaluation of the 1958-2017 long-term simulation

Why?

- Models **recalibrated using the SURFEX surface runoff and recharge**
- Validate the approach on a long-term period with observations for future long-term climate study
- Initial states for hindcasts

Characteristics

- Daily simulation from 1st August 1958 to 31st July 2017
- Initial state: 1st August 2006
- Outputs:
  - Monthly piezometric head maps (unconfined aquifers)
  - 580 daily piezometers levels and 23 karst discharges
  - Groundwater-surface water exchanges
RMSE of piezometric heads

580 piezometers

- 80% < 9 m
- 70% < 6 m
- 41% < 3 m

RMSE (m)

- 0.0 - 3.0
- 3.0 - 6.0
- 6.0 - 9.0
- 9.0 - 12.0
- > 12.0
The Standardized Piezometric Level Index (SPLI)

- Indicator to compare groundwater time series
- Based on the Standardized Precipitation Index for meteorological drought
- Used in France in the Monthly Hydrological Summary for a set of chosen piezometers

SPLI daily evolution

OBS  SIM

HUMID  DRY
Evaluation of the Standardized Piezometric Level Index (SPLI)

Nash Coefficient

- 47 % > 0.5
- 84 % > 0
- 16 % < 0
Example of SPLI maps – August 2016
Example of karst system: La Fontaine de Vaucluse

- Lumped model
- Basin Area: 1317 km²
- Calibrated over 24 years (1990-2013)
- Gauging station: river Sorgues

Daily Nash

Accumulated distribution of Nash

[Nash vs. % of the 23 gauging stations graph]

m³/s

Groundwater-surface water interactions

**Somme Model**

Spatial sum of daily groundwater recharge

- $Q > 0$: river to aquifer
- $Q < 0$: aquifer to river

Spatial average of monthly piezometric head

- 1959 to 1969
- 1979 to 1989
- 1999
- 2009
Groundwater-surface water interactions

**Alsace Model**

- Spatial sum of daily groundwater recharge
- 80% of the recharge to the aquifer provided by the river

Spatial average of monthly piezometric head:

- m: 225.5 to 226.5
Conclusions

- AquiFR gathers **11 distributed models** and **23 lumped models** for karsts in a single tool
- **Consistent results** on the 1958-2017 long-term simulation
- Potential to produce **water resource indices** for operational purposes and climate services
  - Example: Standardized Piezometric Level Index for extreme events

Perspectives

- Add new models
- Analyze river discharge outputs
- Seasonal forecast up to 6 months
- Make outputs available to users for water resource management