# Are baseflow separation methods suitable for assessing shallow alluvial aquifers' contribution to streamflow?

**Juan Pablo** García Montealegre[1,2], **Yvan** Caballero[2], **Manuel** Del Jesus Peñil[1]
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## Why Baseflow separation?

- **Groundwater's crucial role**

Groundwater sustains streamflow, especially during dry periods, playing a key role in maintaining river networks and ensuring water availability for both human commmunities and ecosystems.

- **The quantification challenge**

Accurately measuring the exchange between aquifers and rivers remains difficult due to limited data, spatial complexity, and the need for specialized 3D models.

- **Baseflow separation: A practical alternative**

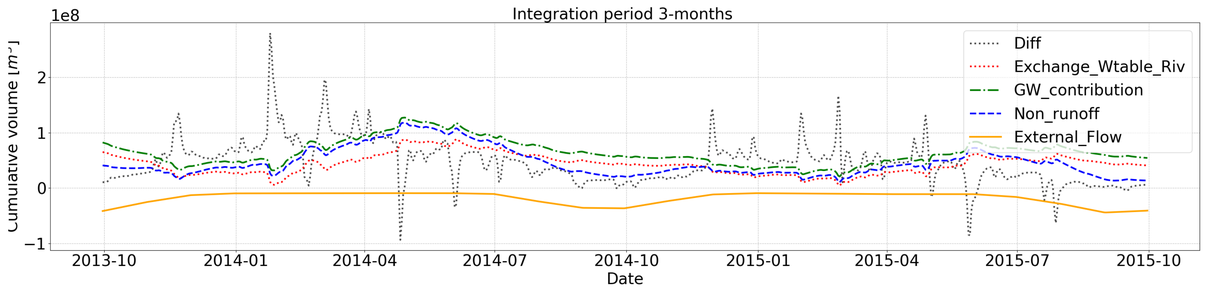
Baseflow separation methods offer a simplified approach that requires fewer data inputs; but questions remain about their reliability and accuracy.

## The approach:

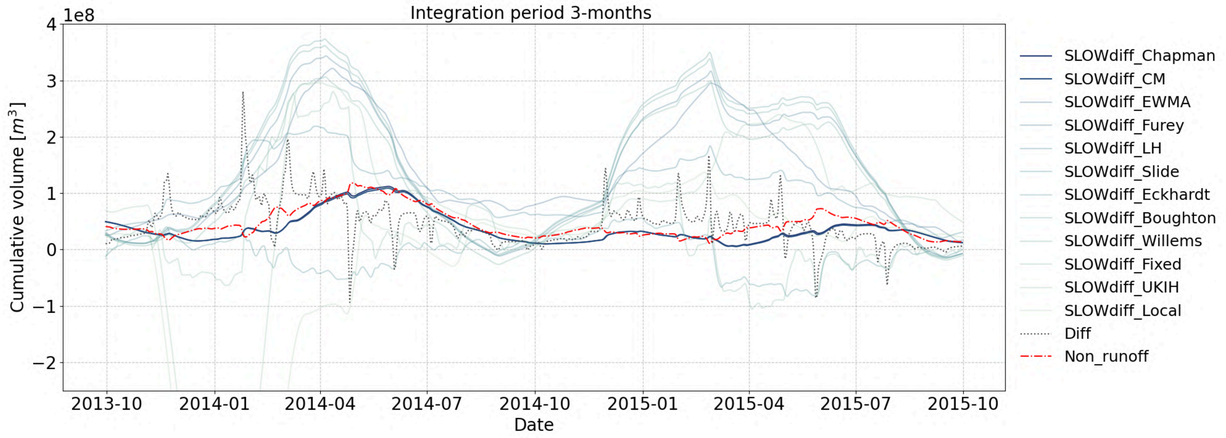
**Alluvial aquifer system** at the **Tarn–Aveyron–Garonne** river confluence, **France**

- 3D hydrogeological model (MARTHE software, BRGM).
- Tested 12 baseflow methods:
  Graphical (e.g., UKIH, HYSEP variants).
  Filtering (Chapman, Maxwell, Eckhardt, etc.).
- Evaluated across 4 time integrations: 3mo, 6mo, 1y, 2y.

## The river-aquifer water balance




## How did They perform?




## What did We learn?

- **Short integration periods** (e.g., quarterly) **better capture rapid changes** in aquifer–river exchange, such as seasonal variability and flow reversals during floods.
- **Longer integration periods** (e.g., annual or biannual) **provide more stable estimates** of total groundwater contributions, minimizing short-term noise.
- **External inputs** like water withdrawals, irrigation returns, or canal diversions **can distort baseflow estimates**, especially when not accounted for in separation filters.
- **Chapman and Chapman-Maxwell methods** consistently **outperformed others;** achieving $R^2 > 0.8$ for integration periods longer than six months, making them the most reliable in this study.

Baseflow separation methods **can approximate** aquifer-river cumulative water exchanges, **but only** when the **system is well-characterized**

# Supplementary material - Are baseflow separation methods suitable for assessing shallow alluvial aquifers' contribution to streamflow?

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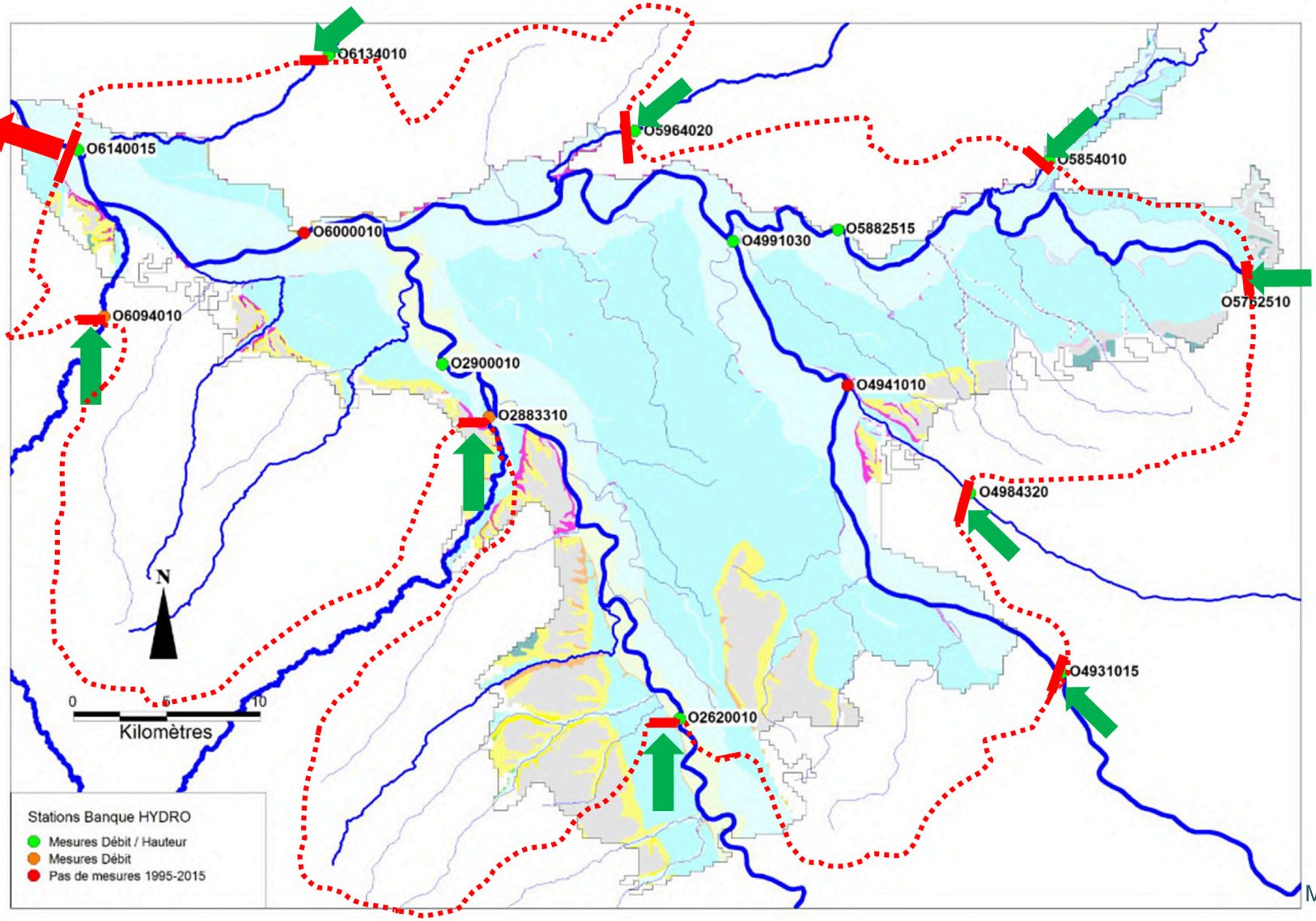


## Study Zone

**Alluvial aquifer system** at the **Tarn–Aveyron–Garonne** river confluence, **France**

**Zone 1 (Whole):** Garonne, Tarn & Aveyron

- Output at station O6140010 La Garonne à Lamagistère.
- Entries at study area boundaries.

**Gauging station - Output**

**Gauging station - Input**

**Drainage area border**

Modified by the authors. **Source:** BRGM/RP-65583-FR, 2016

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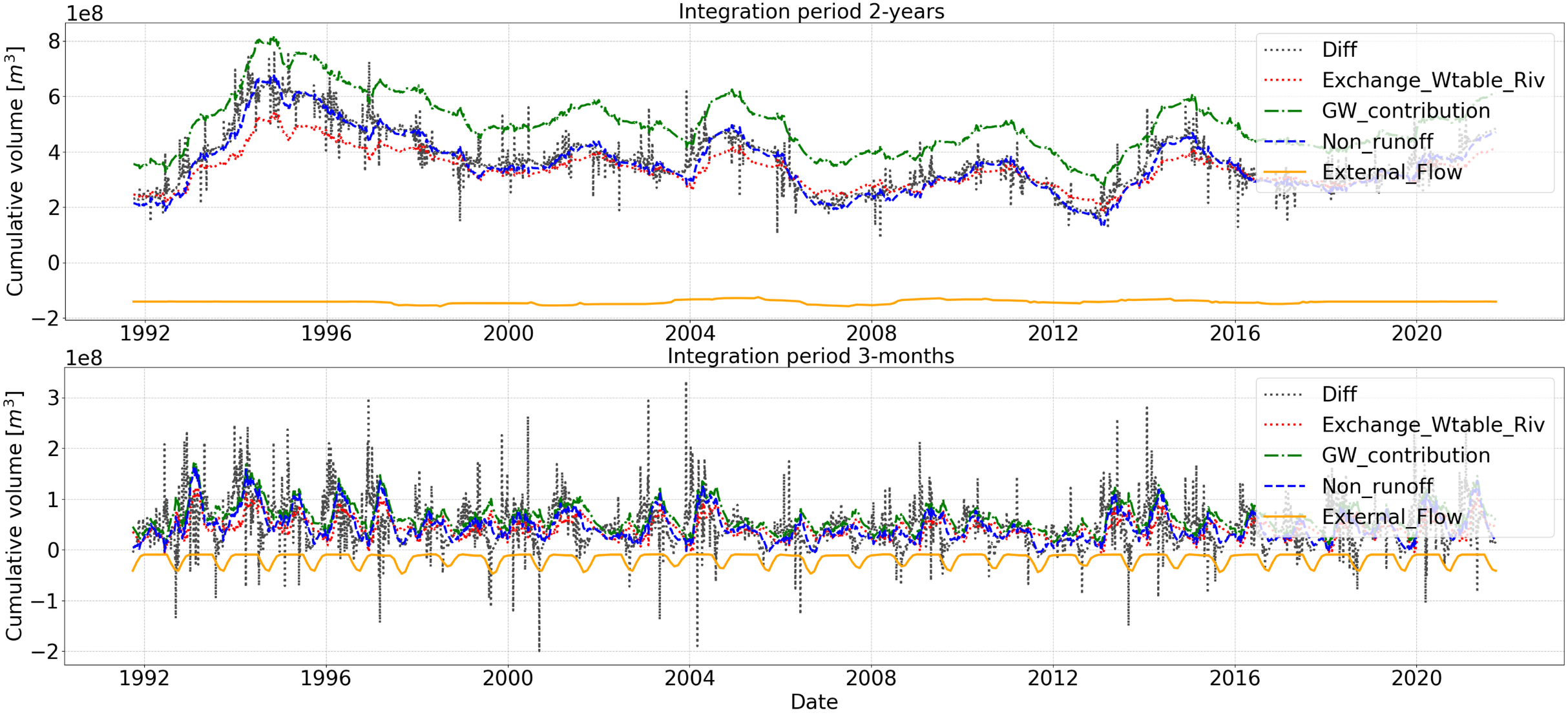
## The river-aquifer water balance: 2-years vs 3-months - Integration period (30-years time serie)



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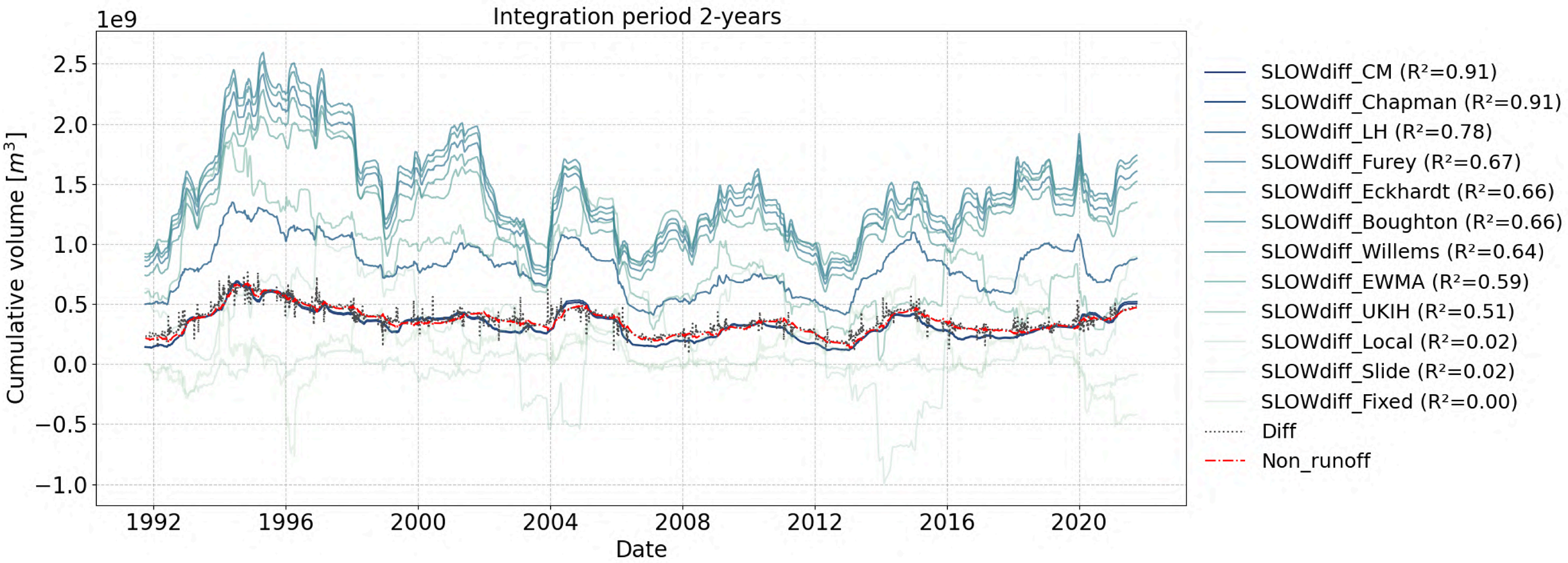
## Results: Cumulative volumne time series - 2-years integration period (30-years time serie)



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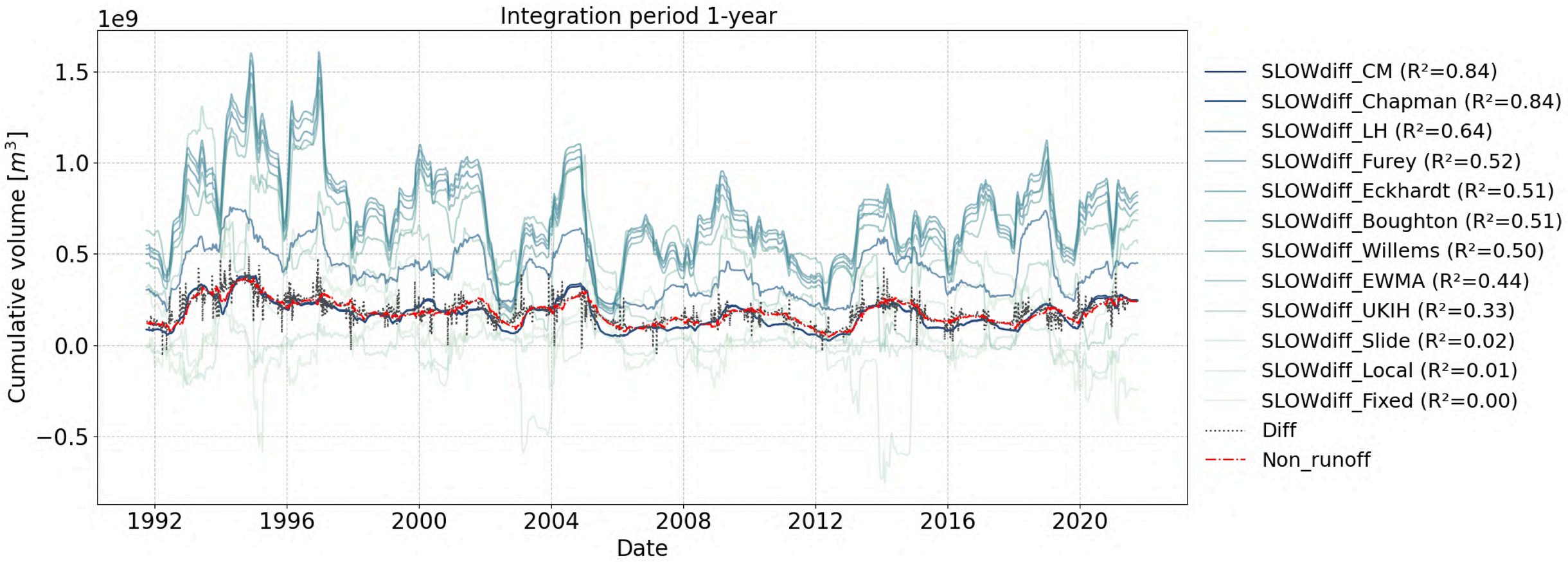
## Results: Cumulative volumne time series - 1-year integration period (30-years time serie)



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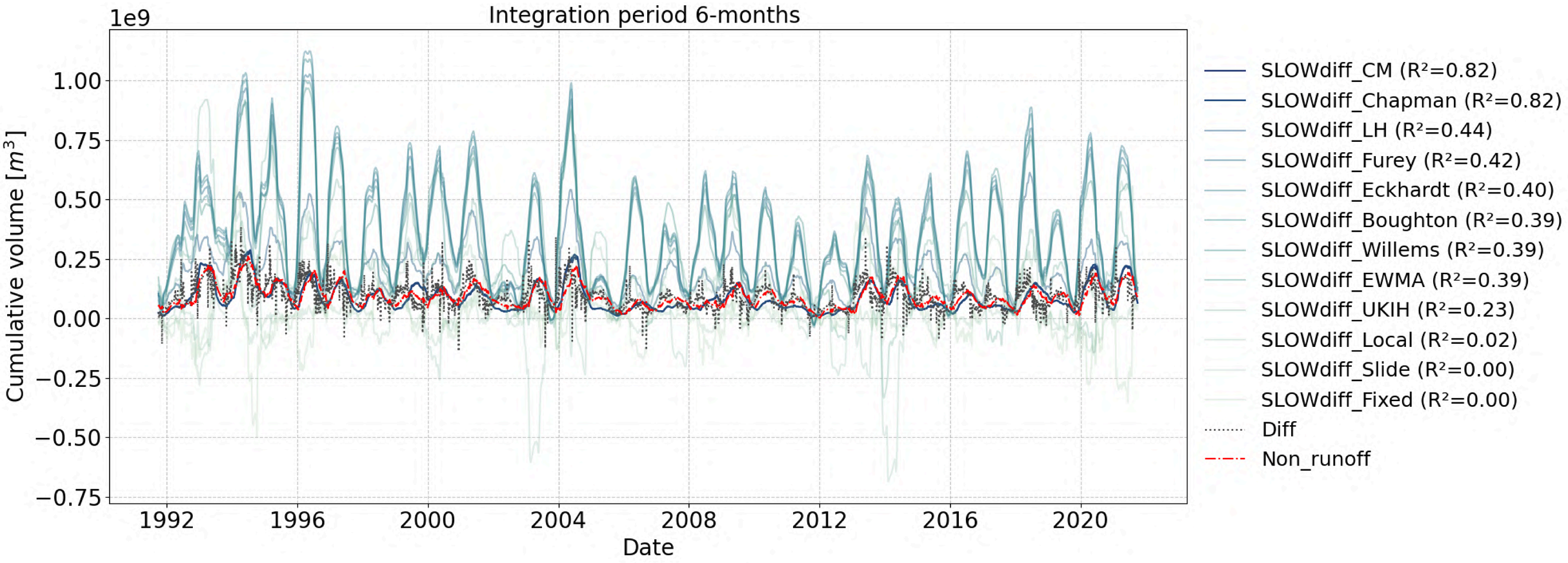
## Results: Cumulative volumne time series - 6-months integration period (30-years time serie)



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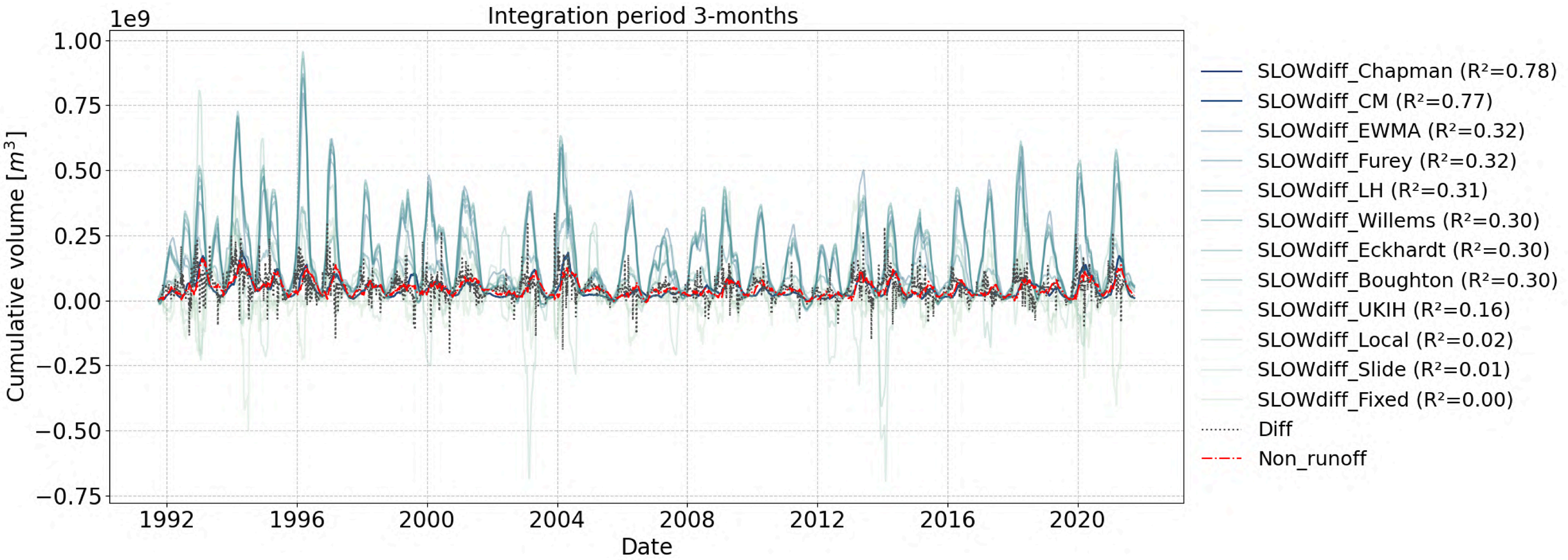
## Results: Cumulative volumne time series - 3-months integration period (30-years time serie)



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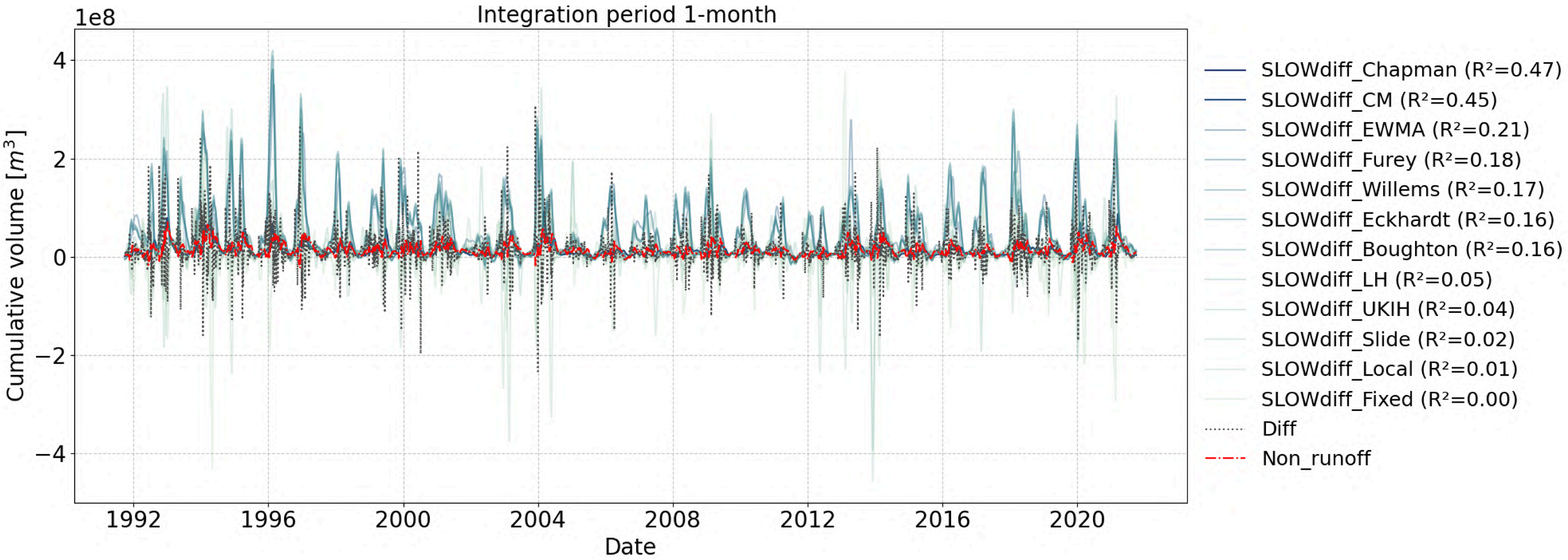
## Results: Cumulative volumne time series - 1-month integration period (30-years time serie)



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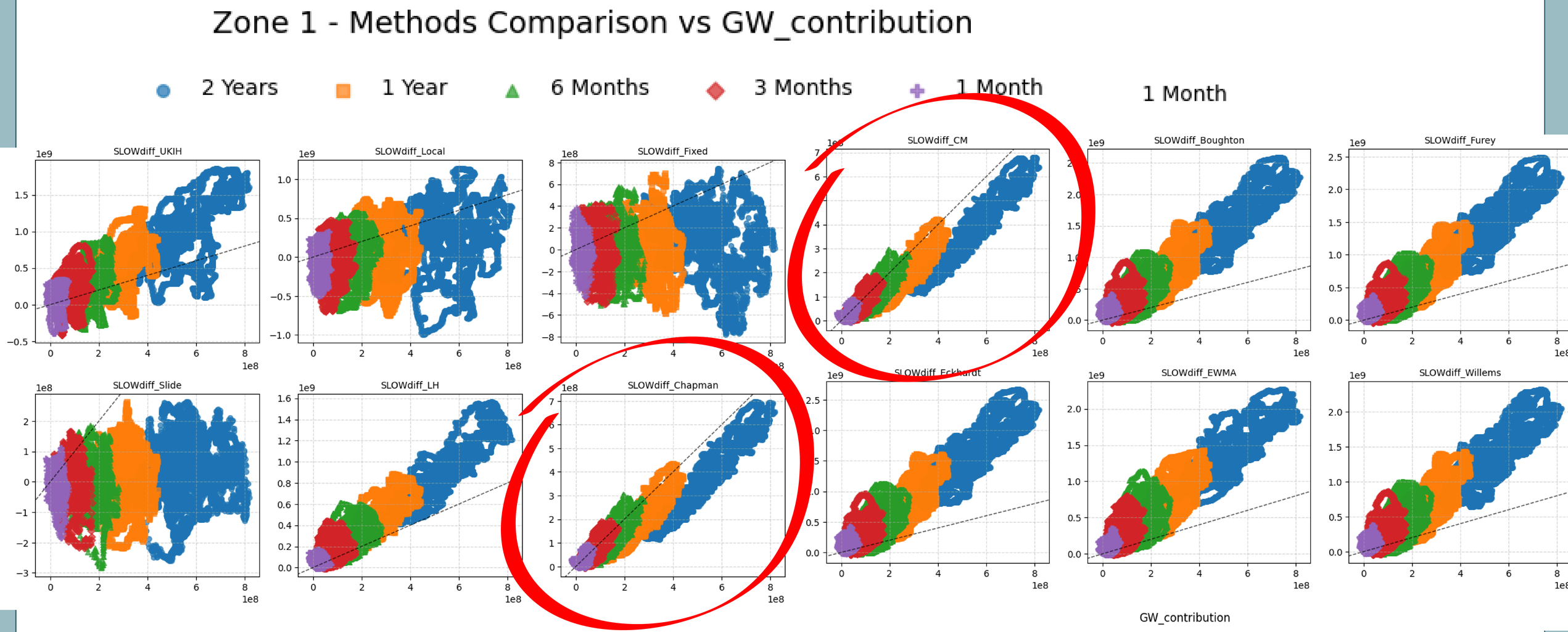
## Results: All Inteagration periods, all methods comparison vs GW contribution (3D -model)



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## Results: All Inteagration periods, all methods comparison vs Non runoff (3D -model)