Global Gravity-Based Groundwater Project: a cross-ECV approach to global groundwater monitoring

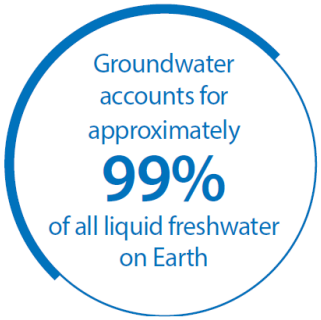
Pasik, A. (presenter), Ruz-Vargas. C. (author), Güntner, A., Haas, J., Sharifi, E., Dorigo, W., Jäggi, A. et al.

1st Space4Water Stakeholder Meeting,
27-28 October, Vienna.

www.g3p.eu

Horizon2020

Groundwater: an introduction



- Groundwater accounts for 33% of the global water withdrawals
- More than two billion people depend on groundwater as primary water resource
- It ensures ecosystem stability, energy and food security.
- Main pressures: overexploitation & climate change

Groundwater monitoring is limited: poor **in-situ monitoring** capabilities in many regions, **sparse and un-representative** groundwater monitoring networks, inaccessibility of data, etc.

Spatially quantification of groundwater storage changes may contribute to fill the monitoring gap, especially at large scales. This can be achieved through satellite technologies

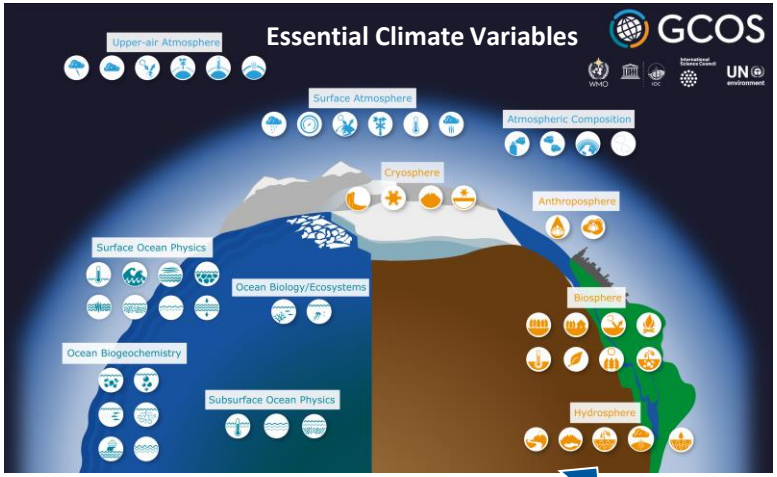
The Global Groundwater Monitoring Network: https://ggis.un-igrac.org/view/ggmn

Source: WWDR 2022, https://www.unesco.org/reports/wwdr/2022/en

G3P
Horizon2020

G3P motivation

GCOS (the Global Climate Observing System) defined **groundwater** as one of the **Essential Climate Variables** (ECVs)



ECV Groundwater

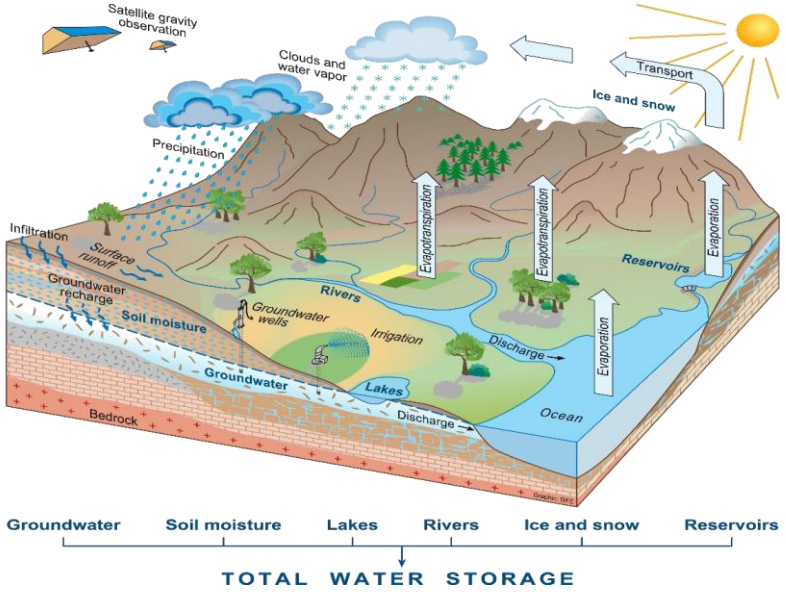
- Copernicus Services provide many ECV data sets
- **But:**
  no product yet for
  the ECV Groundwater

Horizon2020

A new product: The Global Gravity-based Groundwater Product (G3P)

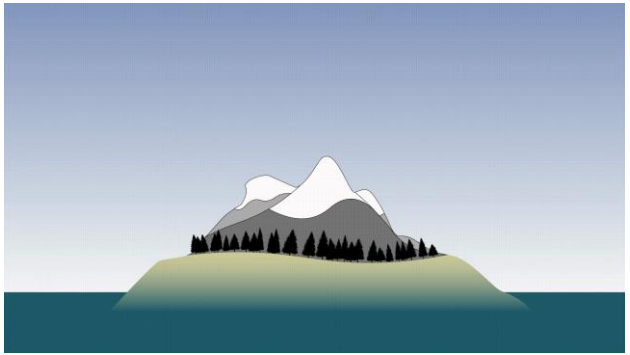
Development of a product of groundwater storage variations

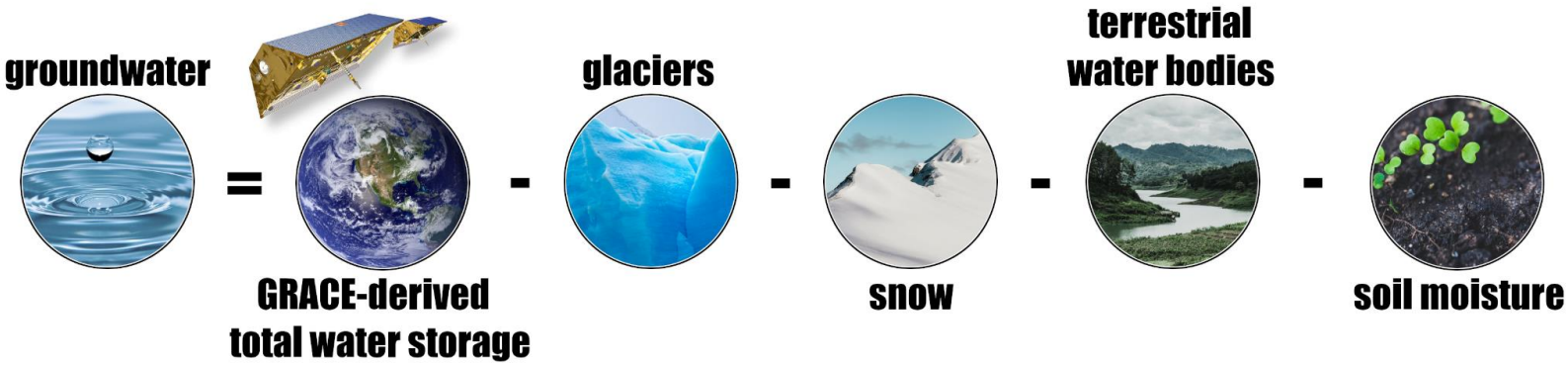
- by a cross-cutting combination of GRACE / GRACE-FO satellite gravity data with water storage data based on existing Copernicus services
- global coverage
- 0.5° spatial resolution
- from 2002 until present
- monthly temporal resolution
- for later operational implementation into the Copernicus Climate Change Service (C3S), Lot *Land hydrology & cryosphere*



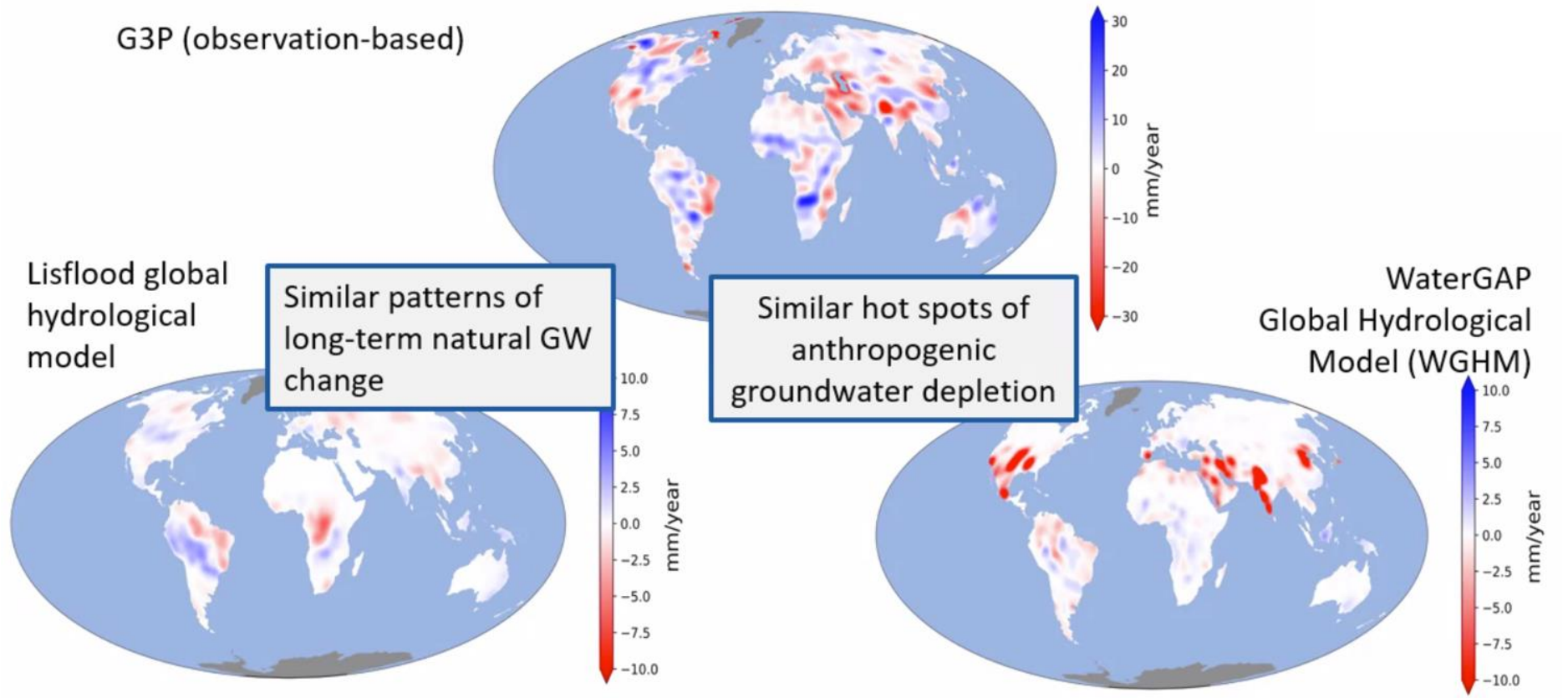
How does G3P work?

The data from the German-American Gravity Recovery and Climate Experiment (**GRACE**) and **GRACE-Follow On (FO)** satellites are used to estimate total water storage (TWS).



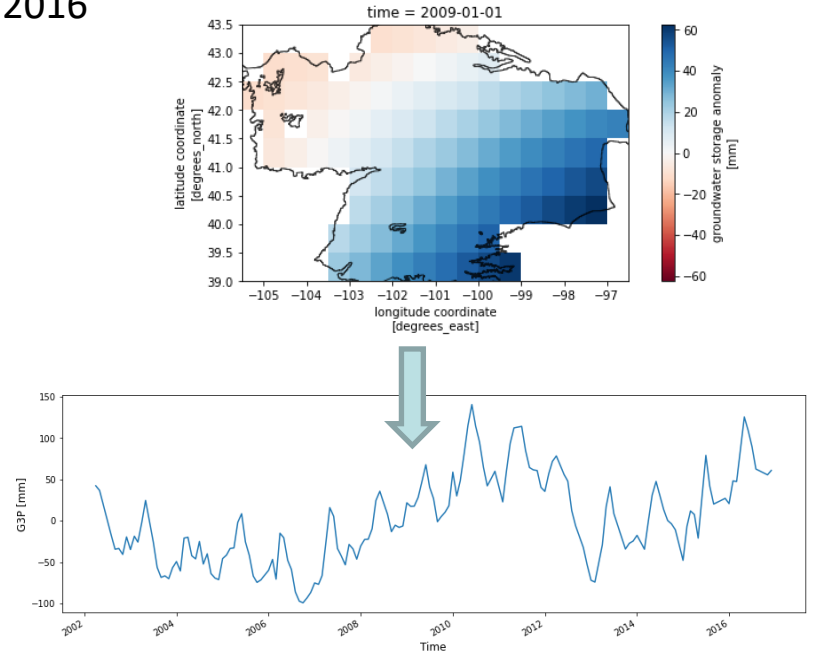


G3P – Preliminary results – Groundwater storage trend 2002-2016



Comparing G3P with GWSA using in-situ values

- From the **G3P product** → Extracted the area average time series of GWSA from 2002 to 2016



- From the **in-situ measurements** → Calculate the Groundwater Storage Anomaly using groundwater heads and specific yield.
- In the absence of geological data, the signal of the groundwater level anomalies (GWLA) was used instead.

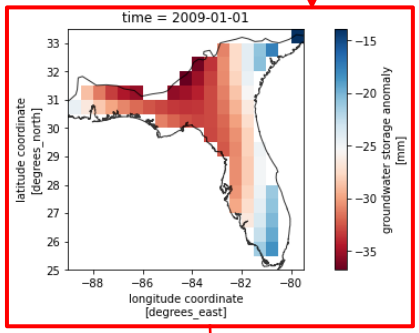
Conceptualization:

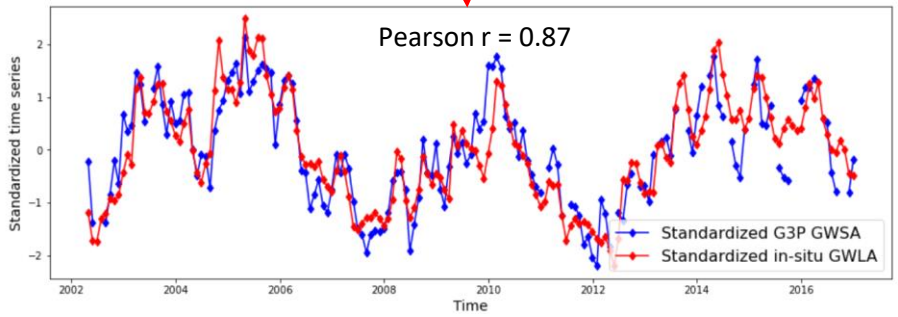
1. GWSA = $\sum(h_{anomaly} * \text{area} * SY / \text{Total Area})[mm]$

$h_{anomaly}$ = Head values relative to mean head value on each site
area = Thiessen polygon area per available borehole
SY = Specific yield corresponding to the thiessen polygon area

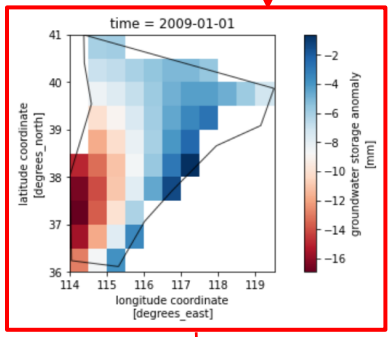
2. GWLA = average($h_{anomaly}$)[mm]

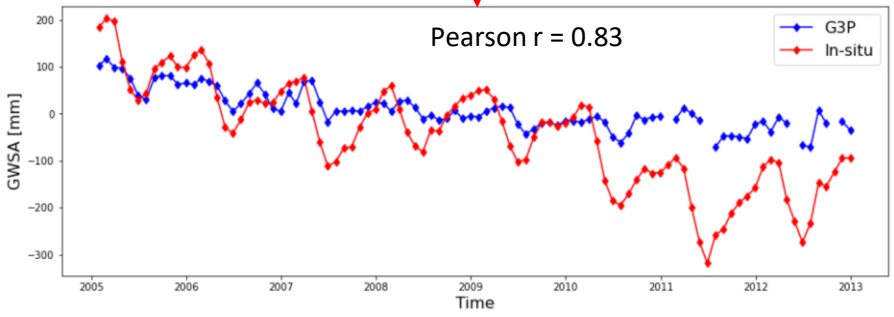
Floridan aquifer



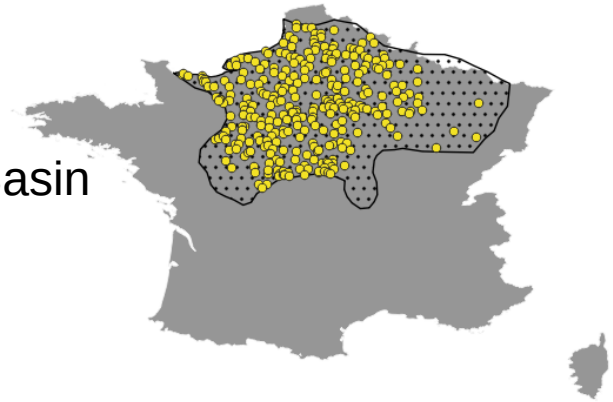


North China aquifer system

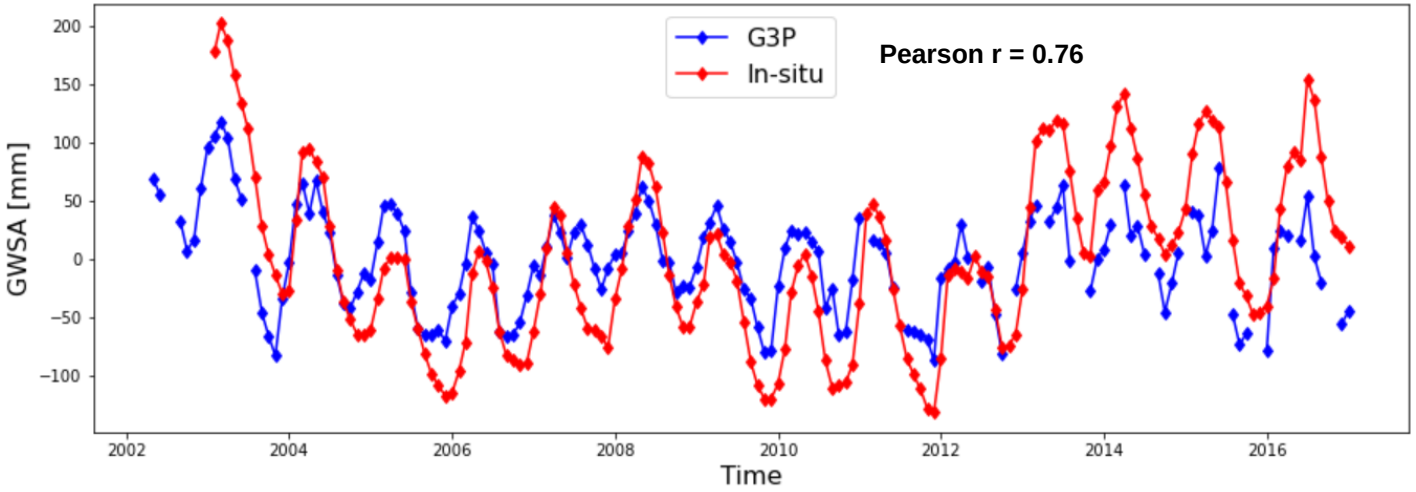




Seine aquifer and Paris Basin



- Evaluation with 215 boreholes **[1]**



[1] Hsu, K.-H., Eicker, A., Longuevernge, L., Güntner, A.: High-resolution groundwater storage data set in France (in preparation)

Horizon2020

G3P – User survey

Types of organisations

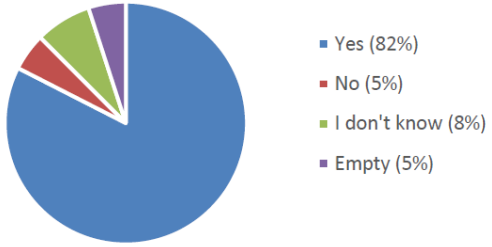
- Geological survey & national institutes (32%)
- European commission (5%)
- Research institute/university/project (27%)
- UN Agency and affiliated centers (11%)
- Intergovernmental entity (4%)
- Charity/NGO/development agency (9%)
- Private company (4%)
- Individuals (5%)
- Empty (3%)

132 individuals were contacted, and 80 answered forms were collected

16 questions in total, including ones about preferred:

- Spatial and temporal resolution
- Ways of presenting uncertainty
- Alternative ways of sharing data

Percentage of respondents that think that they will be able to use G3P in their current position



- Yes (82%)
- No (5%)
- I don't know (8%)
- Empty (5%)

If you answer "Yes" to the previous questions, please indicate how would you use the groundwater product. If you answer "No", please let us know why, or if we can do something to make it more useful to you (open field).

- For advocacy/awareness raising; science-policy interface; management (17 a.)
- In combination with models (13 a.)
- For monitoring/forecasting (10 a.)
- Groundwater assessment (6 a.)
- General answer (e.g. “I will use it for research”) (6 a.)
- To compare with/complete other datasets (5 a.)
- In Managed Aquifer Recharge (MAR) projects (2 a.)
- Not applicable/other (4 a.)

https://www.g3p.eu/fileadmin/user_upload/G3P_survey_report.pdf

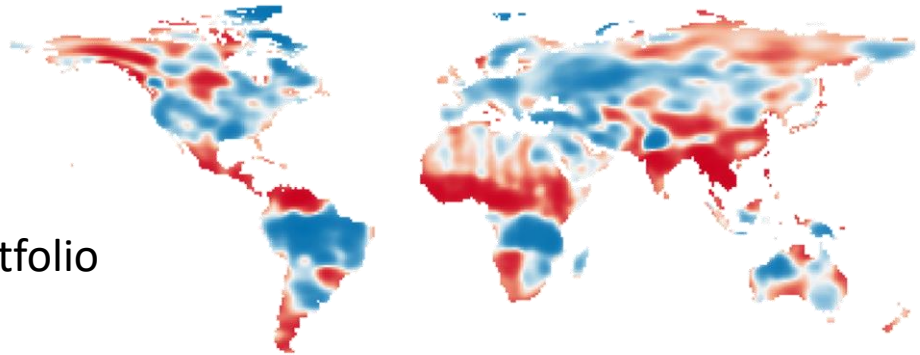
Conclusions and final thoughts

- G3P is an innovative tool that contributes to a better understanding of groundwater changes on a large scale.

- G3P has the potential to support water resources management activities, as well as raising awareness on the pressures that the resource is increasingly facing.

- Promising validation results

- G3P is largely based of existing Copernicus C3S services and aims for future integration into the C3S portfolio



01/04/2002 ~ -300,+300 mm

Thank You!

G3P is funded in response to the Earth observation call

LC-SPACE-04-EO-2019-2020
“**Copernicus evolution – Research activities in support of cross-cutting applications between Copernicus services**”

As part of the H2020-SPACE-2018-2020 activity
“**Leadership in Industrial Technologies - Space Part**”

https://www.g3p.eu/

@G3P_EU