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Insights into the hydrology of the Congo peatlands through land surface modeling and data assimilation

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BG3.23 | Tropical peatlands: Past, Present, Uncertain Future
Tuesday, 25 April 2023, 08:45-08:55

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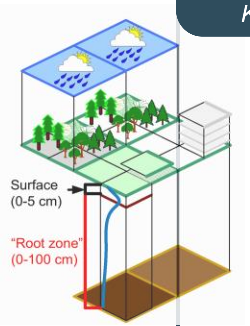
Development of a tropical peat-specific land surface model (LSM)



Catchment LSM

Koster et al. (2000)

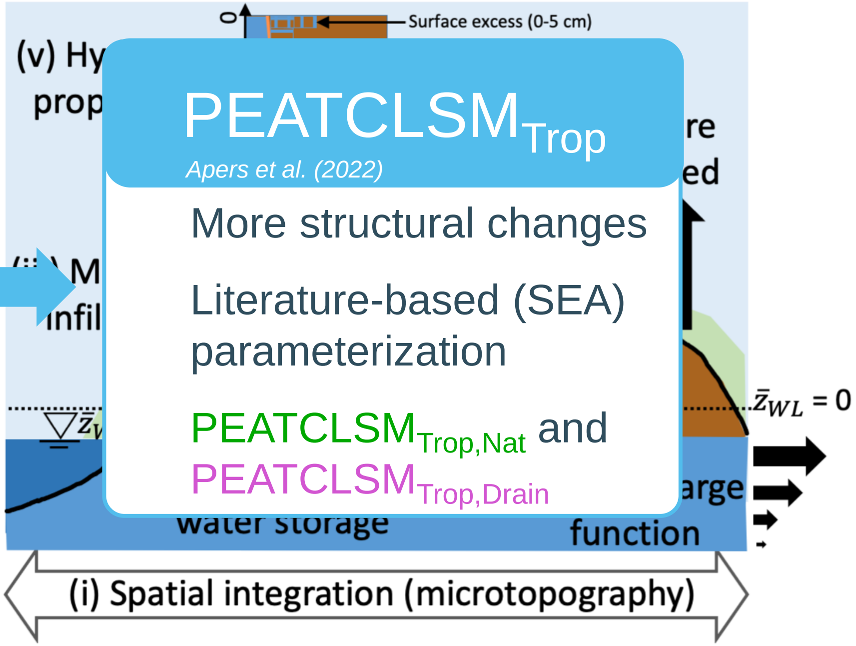
- LSM of operational products at NASA
- Water and energy balance modeling
- **Groundwater level**

PEATCLSM$_{North,Nat}$

Bechtold et al. (2019)

- Structural changes (i-vi)
- Literature-based parameterization
- Operational in NASA **SMAP L4_SM** product

Reichle et al.
EGU23-1419
Friday 16:57-17:07



PEATCLSM$_{Trop}$

Apers et al. (2022)

- More structural changes
- Literature-based (SEA) parameterization
- PEATCLSM$_{Trop,Nat}$ and PEATCLSM$_{Trop,Drain}$

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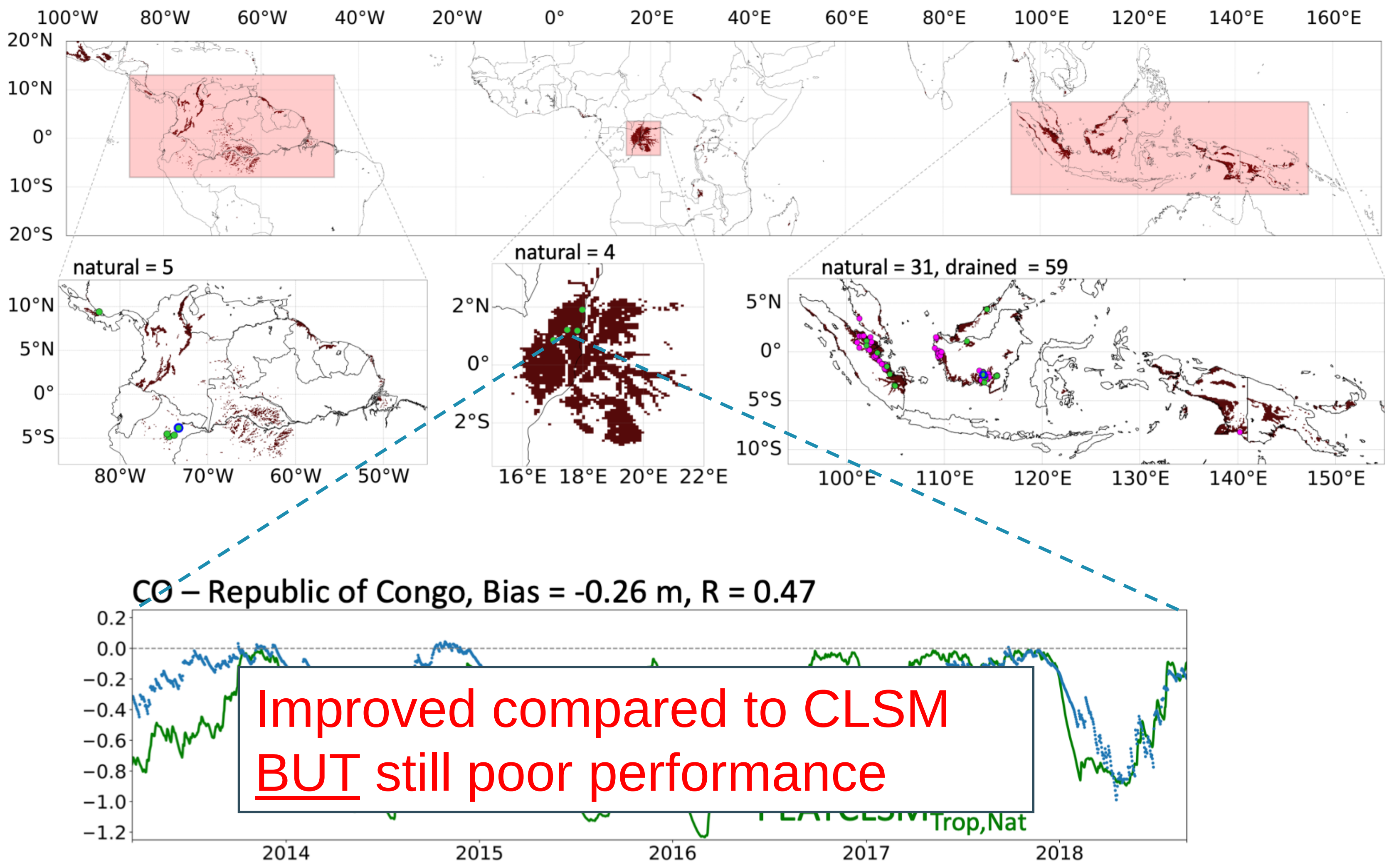
Evaluation of the tropical peat-specific LSM



Improved compared to CLSM
<u>BUT</u> still poor performance

$\text{PEATCLSM}_{\text{Trop}}$

Apers et al. (2022)

More structural changes

Literature-based (SEA) parameterization

$\text{PEATCLSM}_{\text{Trop,Nat}}$ and $\text{PEATCLSM}_{\text{Trop,Drain}}$

Further improve hydrological estimates over the Congo peatlands

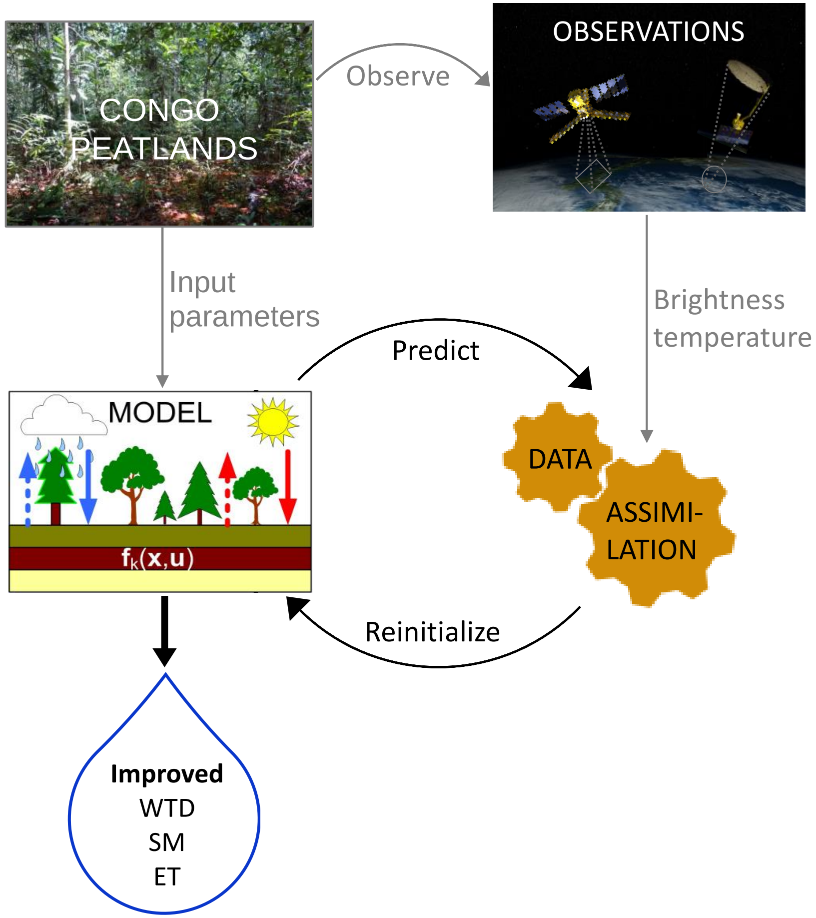
1. Adapt LSM structure and update input parameters

   → **PEATCLSM$_{\mathbf{CO,Nat}}$** development

2. Combine LSM with satellite observations

   → SMOS L-band **Tb data assimilation**

   2010-2022
   ~ 3-day revisit time
   43 km spatial resolution



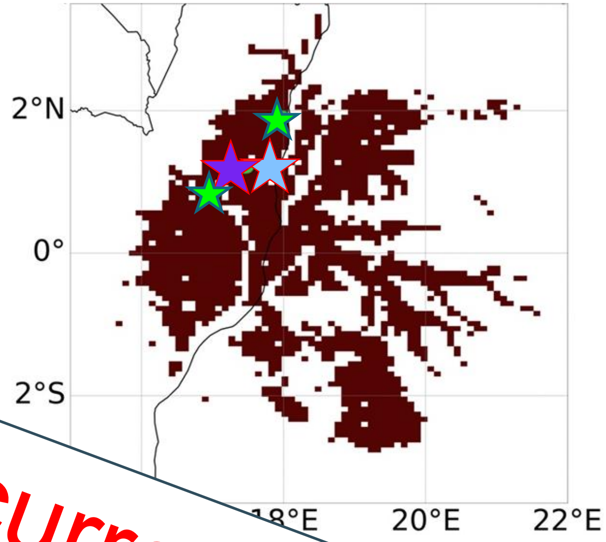
1. PEATCLSM$_{CO,Nat}$ development: scalar parametrization of water table dynamics

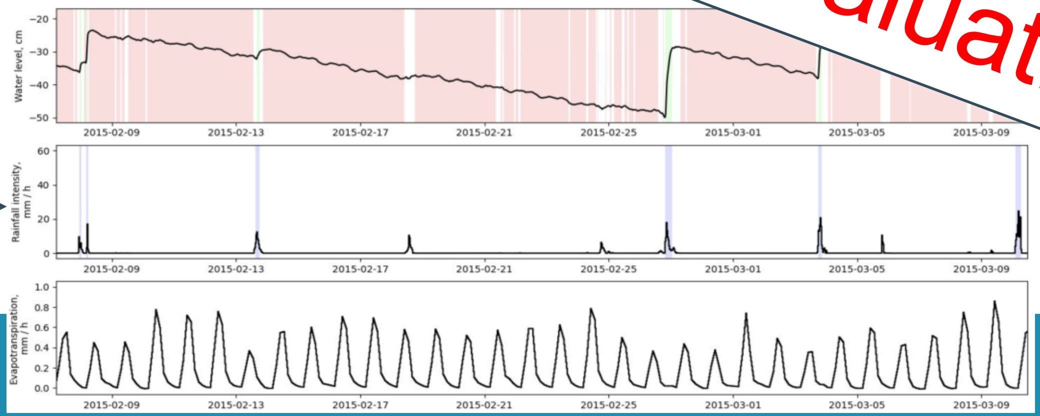
SPOWTD (Cobb et al., 2019): derive parameters that control sp... and discharge

Parame... ...angouma

1. In situ ...
2. Topographic ...
3. Evapotranspiration (...
4. Precipitation (IMERG_v6.0_F)

Rise and recession behavior





Ongoing development – currently unknown effect of new parameters on water level evaluation over Congo

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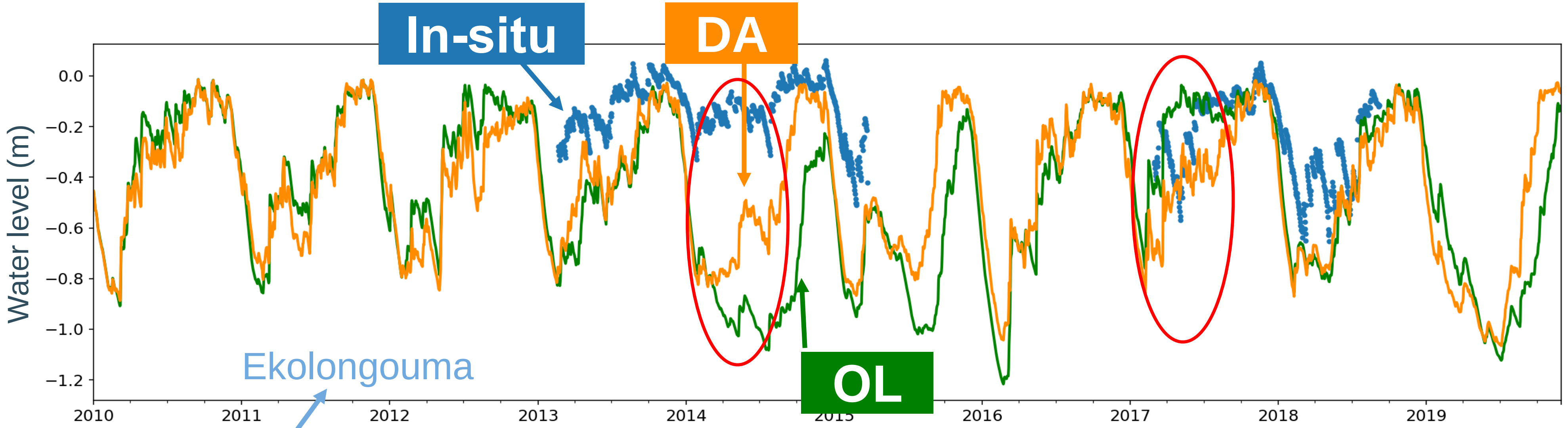
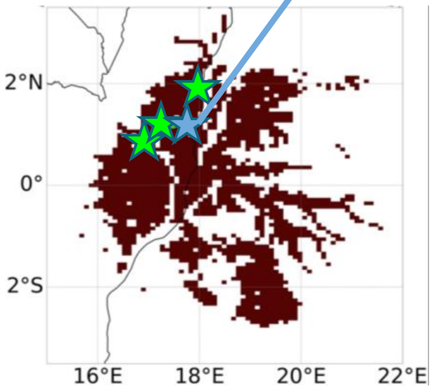
2. SMOS L-band Tb data assimilation with $\text{PEATCLSM}_{\text{Trop,Nat}}$





Four in situ sites:
(Dargie et al., 2017; CongoPeat project)

R_{OL}: 0.32 $Bias_{OL}$: -0.31 m
R_{DA}: 0.67 $Bias_{DA}$: -0.26 m

SMOS L-band Tb DA improves water level estimates

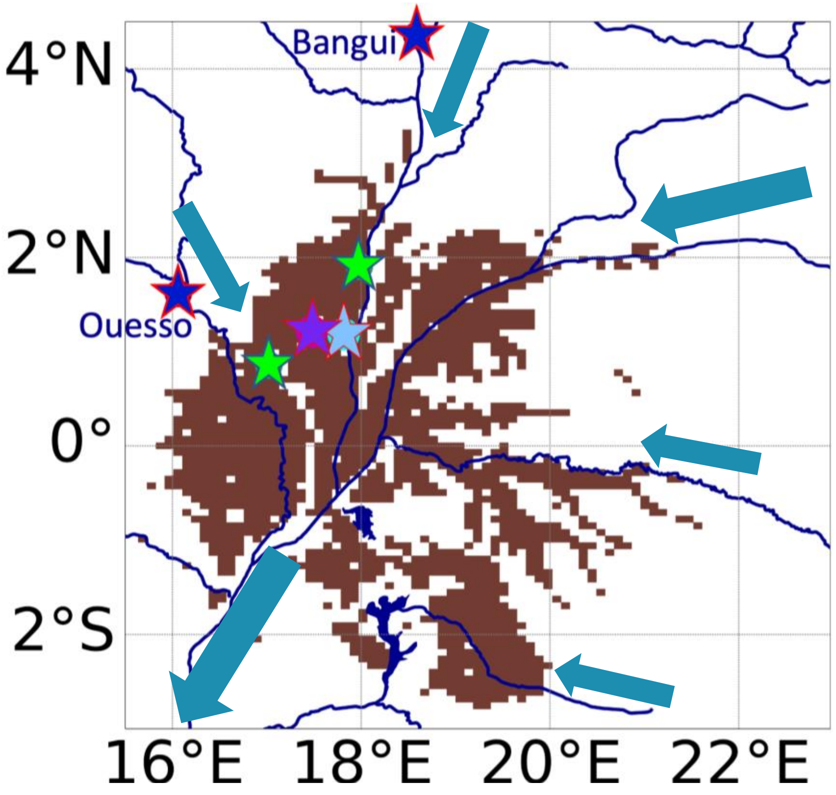
Upstream river water influence on the Congo peatlands water cycle

Hypotheses

- Upstream river water is an important process of the Cuvette Centrale peatlands water cycle

- PEATCLSM$_{Trop,Nat}$ does **not simulate influence of upstream river water**

  → Influence of river stage on peatland water level is ”seen” via assimilating SMOS L-band T_b ?



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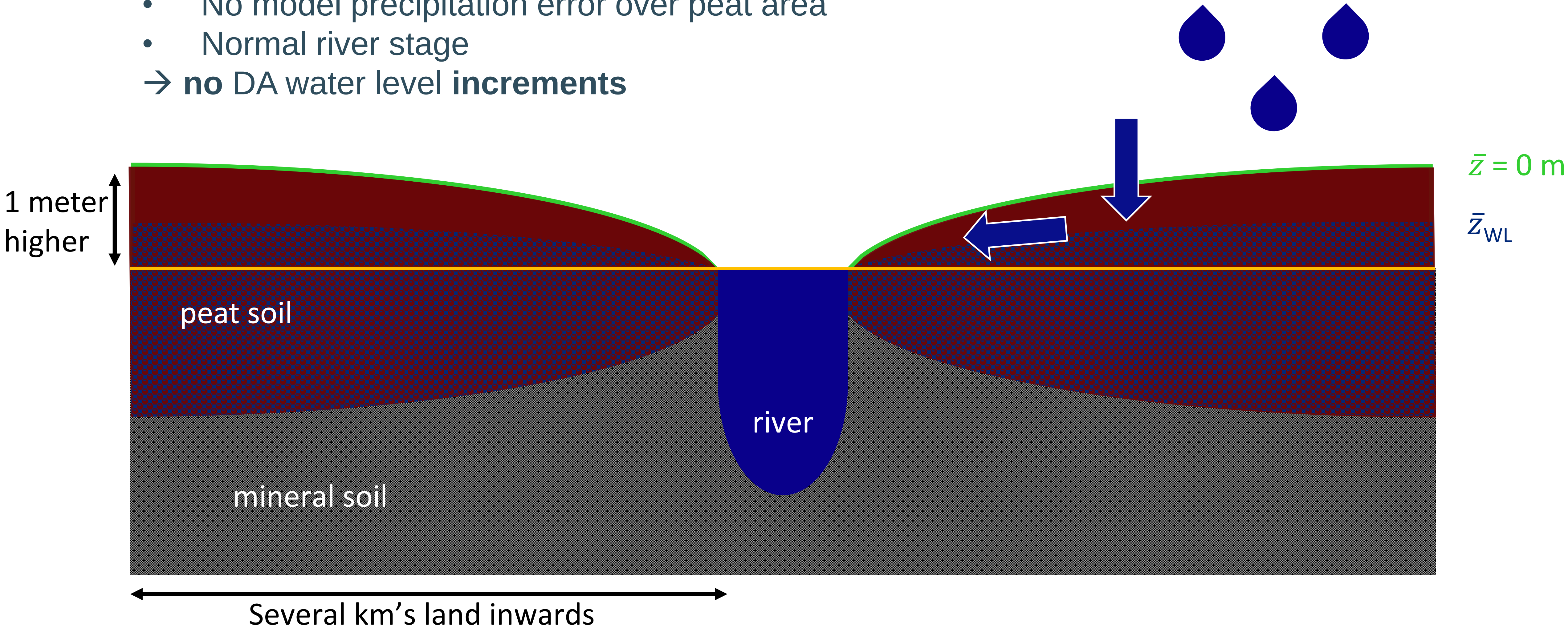
Case 1

- No model precipitation error over peat area
- Normal river stage

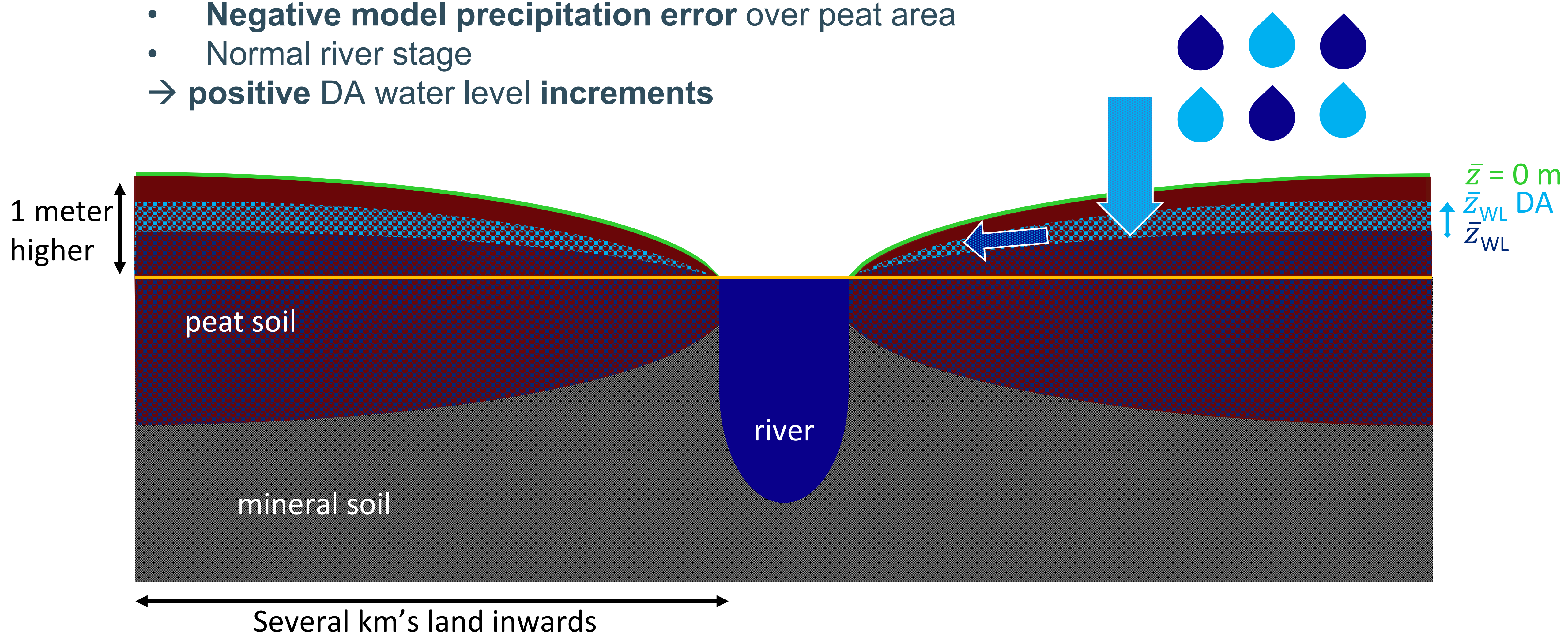
→ **no** DA water level **increments**



Case 2

- **Negative model precipitation error** over peat area
- Normal river stage

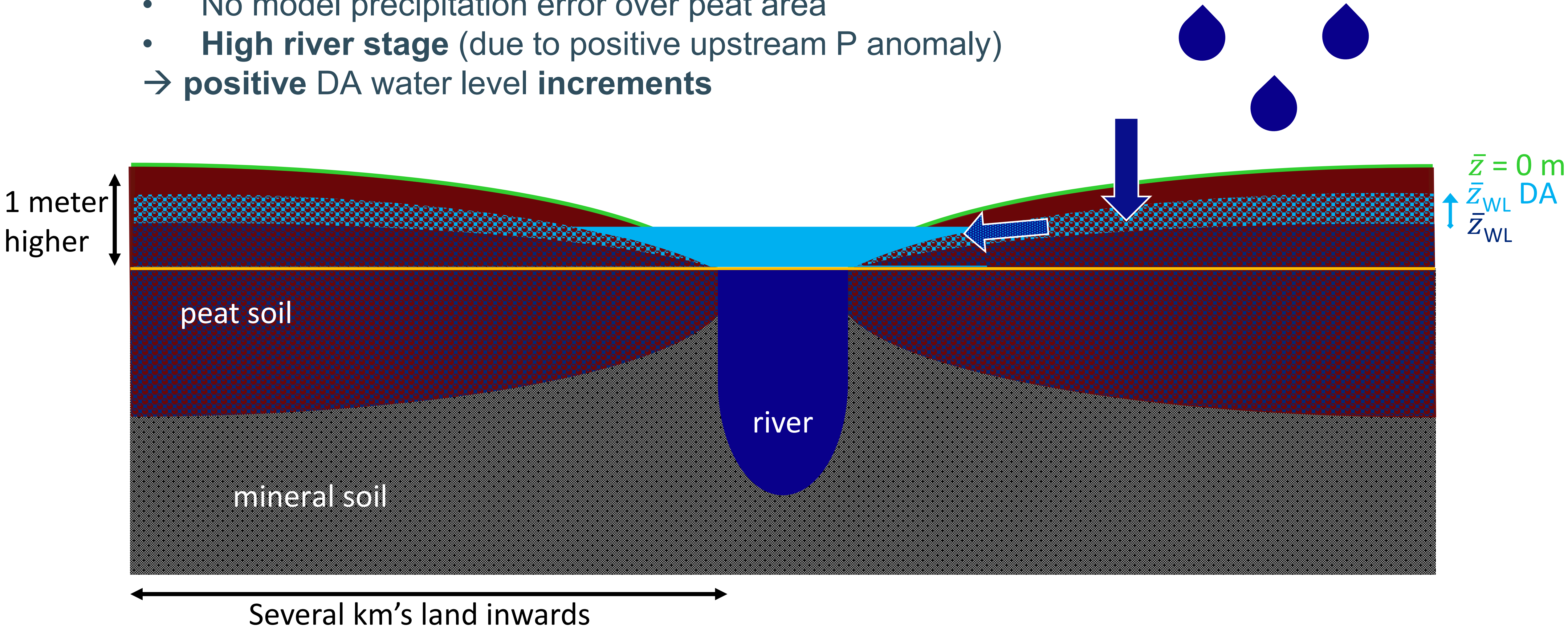
→ **positive** DA water level **increments**



Case 3

- No model precipitation error over peat area
- **High river stage** (due to positive upstream P anomaly)

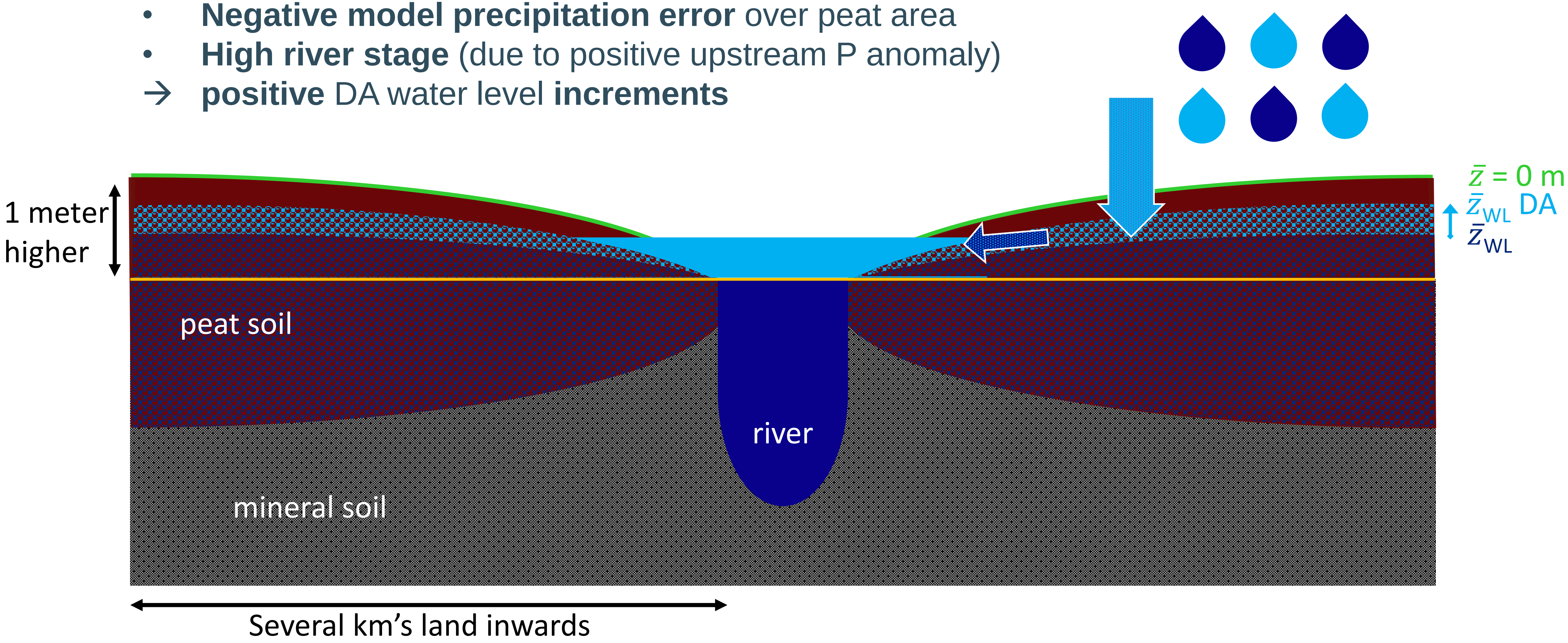
→ **positive** DA water level **increments**



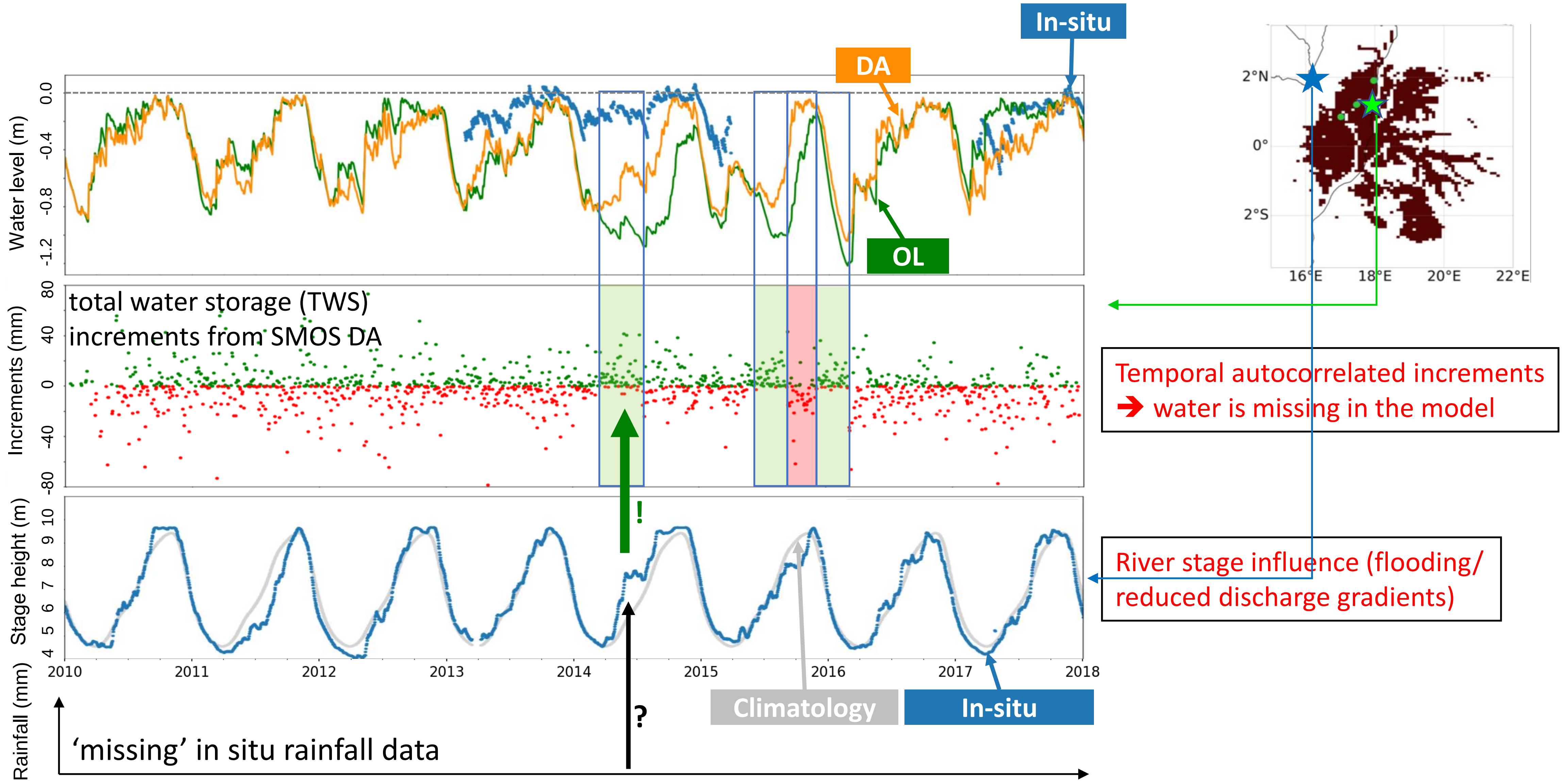
Case 4

- **Negative model precipitation error** over peat area
- **High river stage** (due to positive upstream P anomaly)

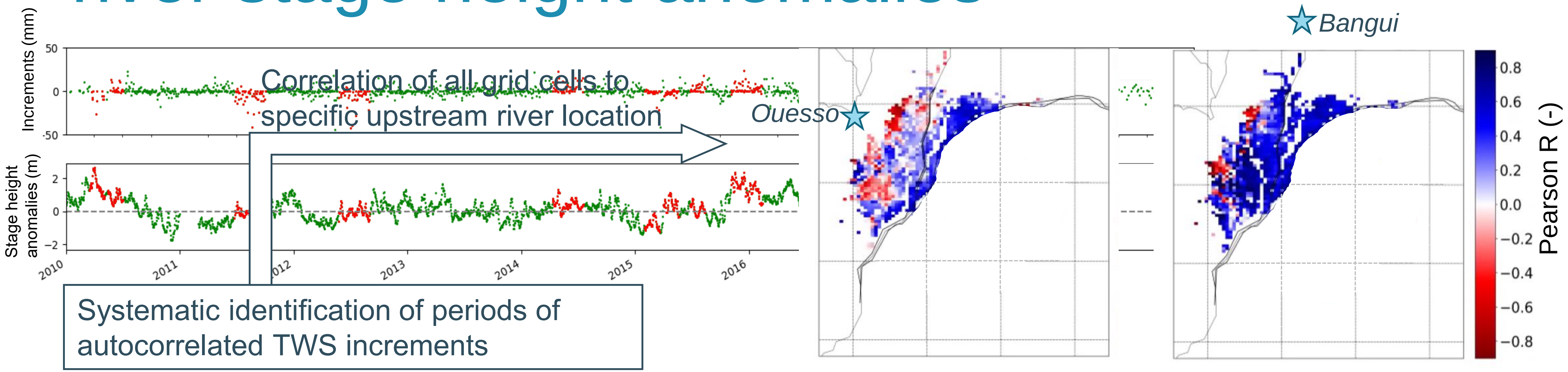
→ **positive** DA water level **increments**



Long periods of temporally-autocorrelated total water storage (TWS) increments



Positive correlation of TWS increments and river stage height anomalies

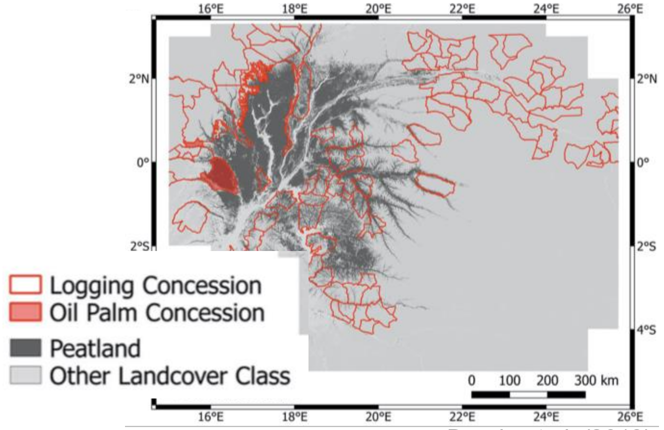


Systematic identification of periods of autocorrelated TWS increments

Conclusions

- Data assimilation (and likely LSM advancements) improve hydrological estimates over the Congo peatlands
- Data assimilation diagnostics indicates influence of river stage height on peatland water tables

→ In situ precipitation is key and missing for both approaches



Dargie et al. (2019)

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