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MODELLING THE SUBSIDENCE RISK IN FRANCE TAKING INTO ACCOUNT THE EFFECTS OF CLIMATE CHANGE

Insurance Data Science Conference, 16 - 18 June 2021

16 JUNE 2021

«Drought induced» soil subsidence

Soil subsidence is the damage on buildings due to ground movement resulting from the shrinkage and swelling of expansive soils (mainly clay) after episodes of unusual drying and rehydration.

It is the second most costly hazard to be compensated after flooding in France.

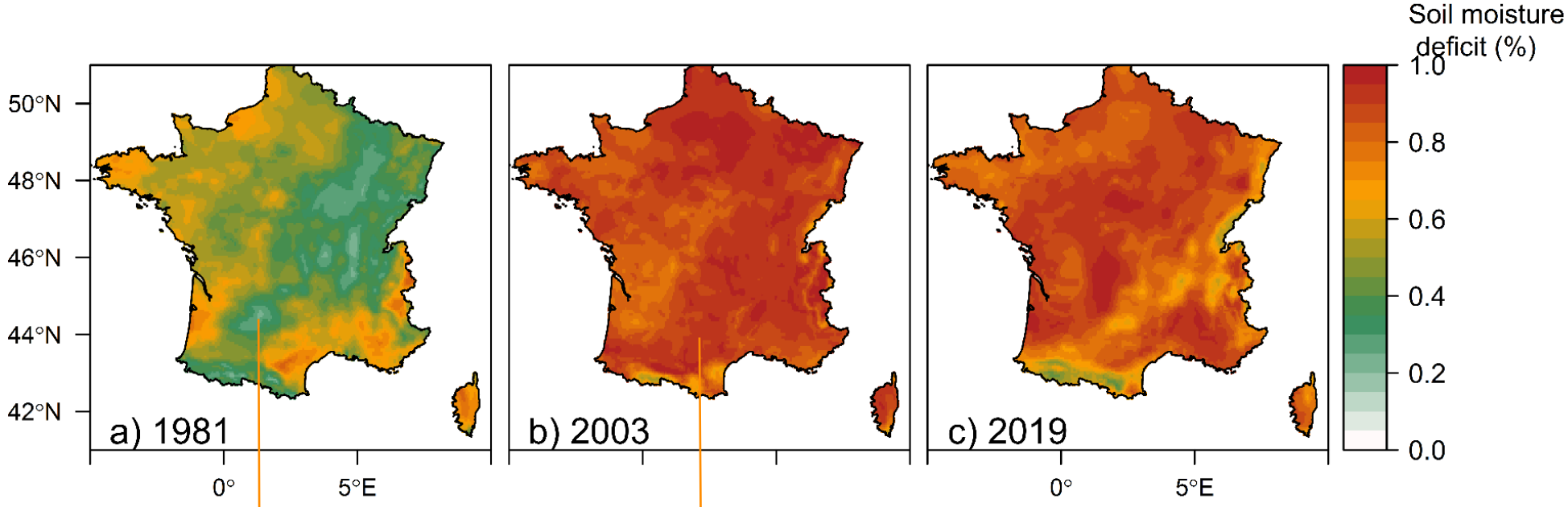
- **Soil geology**: Presence potentially expansive soils (inorganic clays of high plasticity, such as montmorillonite).
- **Structural vulnerability**: Inappropriate foundation depth and / or structure not designed to resist the shear stresses and moments generated by the differential swelling.
- **Land use:** Presence of trees & vegetation in the vicinity of the building, built density, rainwater collecting systems, manmade water table variations.
- **Soil water content fluctuations**: Caused by a sequence of abnormally dry and wet periods.
  - Climate change?

https://en.wikipedia.org/wiki/Subsidence

Soil moisture deficit

ERA5 Land reanalysis

- **Annual soil moisture deficit**, d (%), as the annual difference between the maximum and minimum soil moisture within a year.



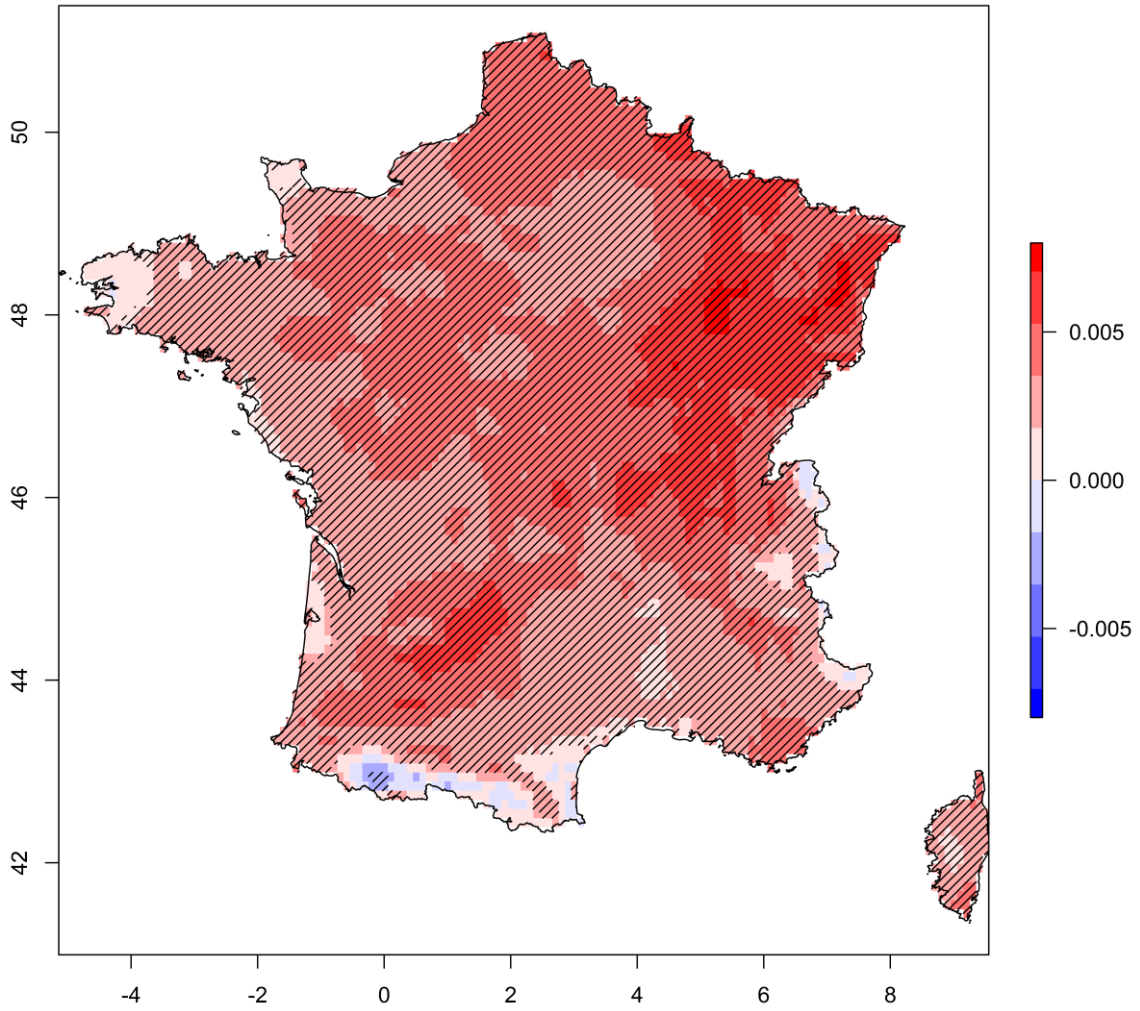
d → 0
Approaching soil moisture saturation

d → 1
Approaching complete soil dryness

Annual soil moisture deficit trends

- Trend:
  - Positive
  - Negative
- Significant at the 0.05 level: ///
- Significant upward trends in soil moisture deficit, almost everywhere during the last 40 years.

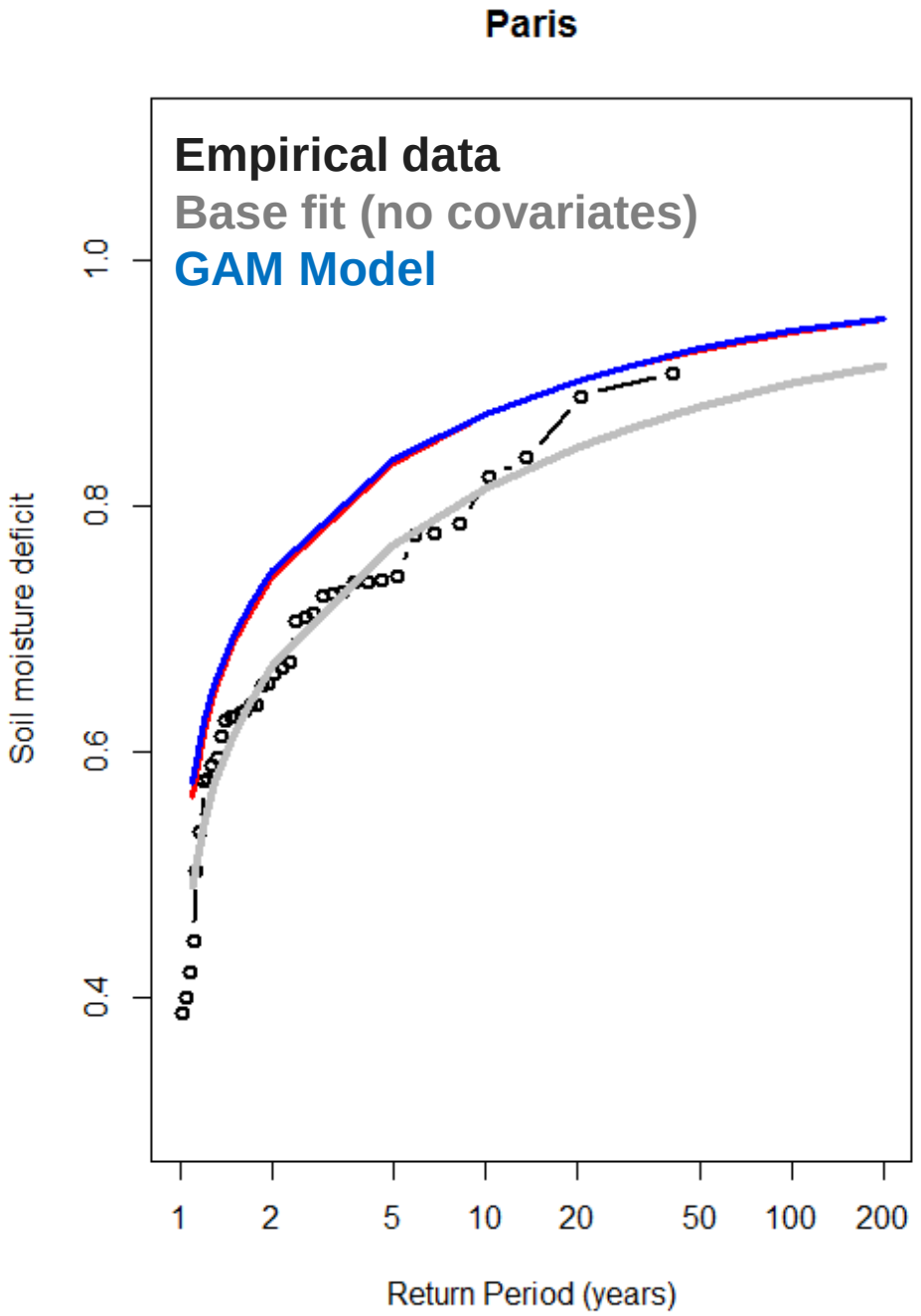
Linear trend (1981-2020)



Model

- **Generalized Additive Model (GAM):**
  - 1-inflated Beta regression model with year as covariate.
    - $\mu(t) = \mu_0 + f(year)$
    - where f represents a *cubic spline*
    - (in R using the gamlss package)

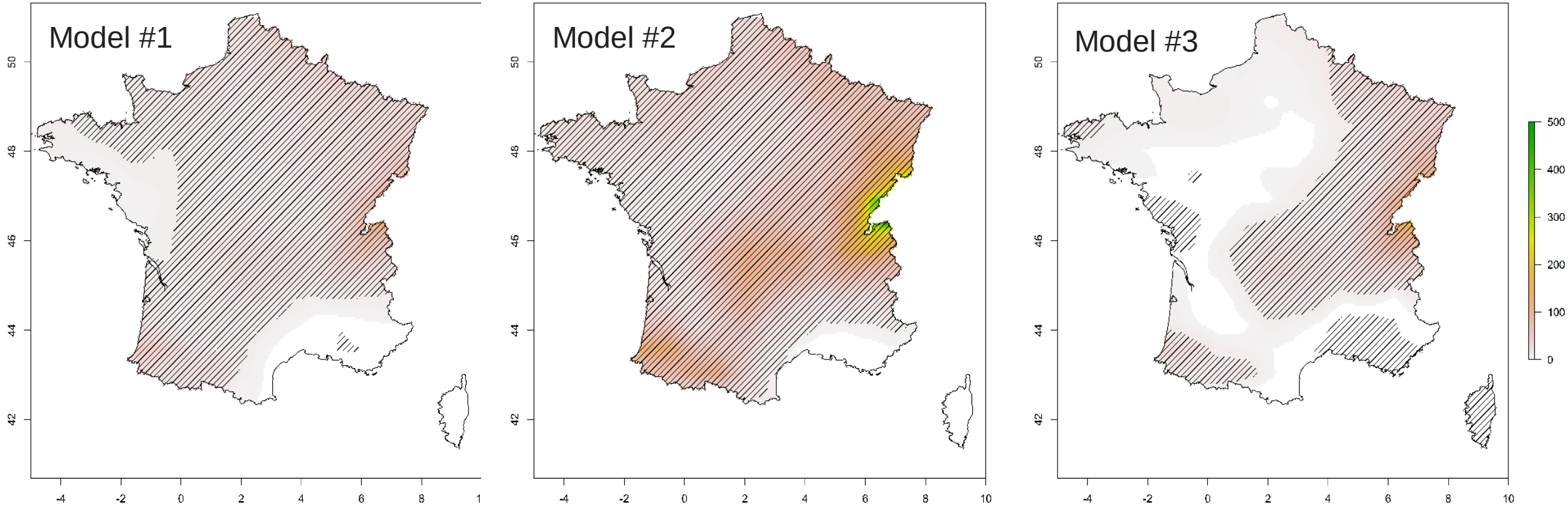
- The maximum soil moisture deficit experienced represents now a **25-year RP** (instead of 1 in 40 year event empirically).



Future climate

- Use **climate models** to estimate the soil moisture deficit in the future climate.
- Different trends between models (although on average always positive).

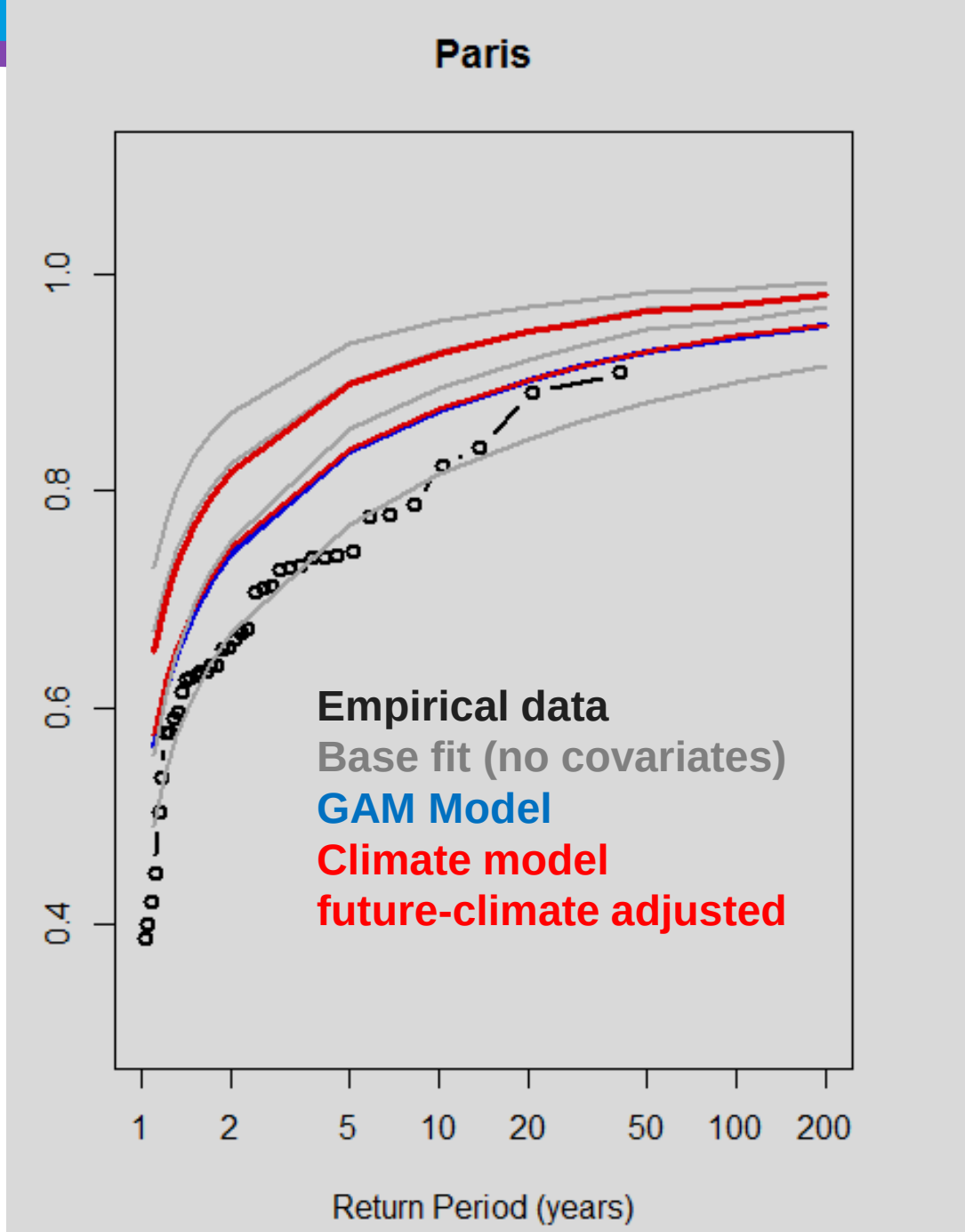
% change between 1981-2019 vs. 2021-2059



Future climate

- The maximum soil moisture deficit experienced reduces to **10 year RP** for the future climate (2040s with an RCP85 scenario).

- Different results between models.

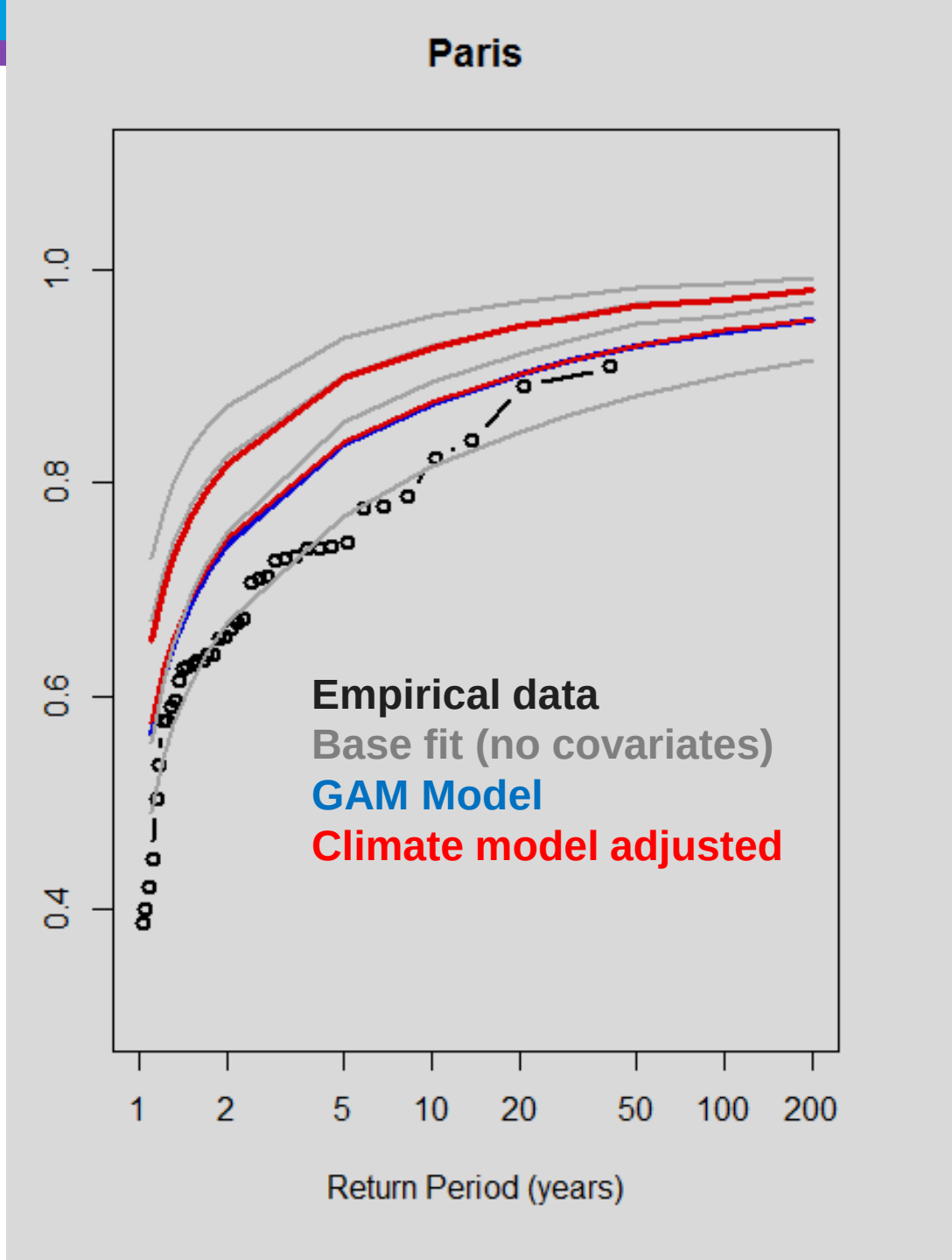


Future climate

- The maximum soil moisture deficit experienced reduces to **10 year RP** for the future climate (2040s with an RCP85 scenario).

- Different results between models.

- Thank you!



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