

Attributing land water storage trends from satellite gravimetry to long-term wetting and drying conditions with global climate models

Laura Jensen¹, Annette Eicker¹, Henryk Dobslaw²

- 1) HafenCity University Hamburg
- 2) Helmholtz Centre Potsdam, German Research Center for Geosciences (GFZ)

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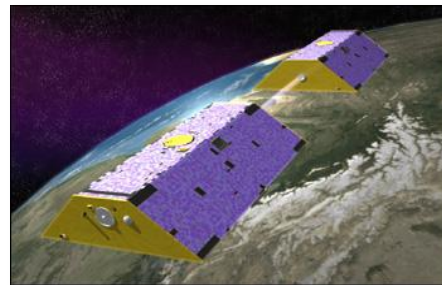
May 27, 2022

Global coupled climate models



Coupled Model Intercomparison Project

Satellite gravimetry

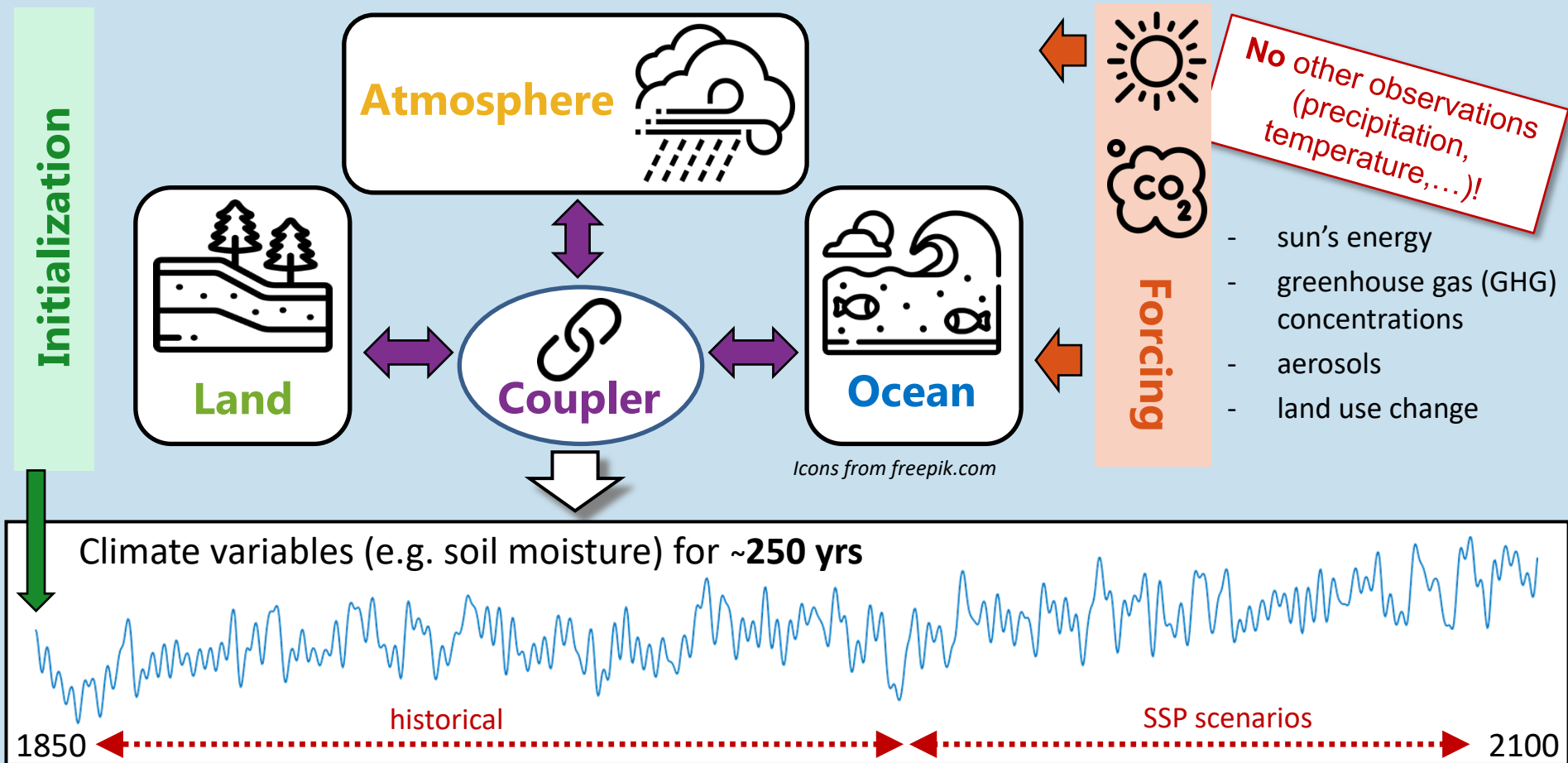


GRACE
GRACE-FO
MAGIC

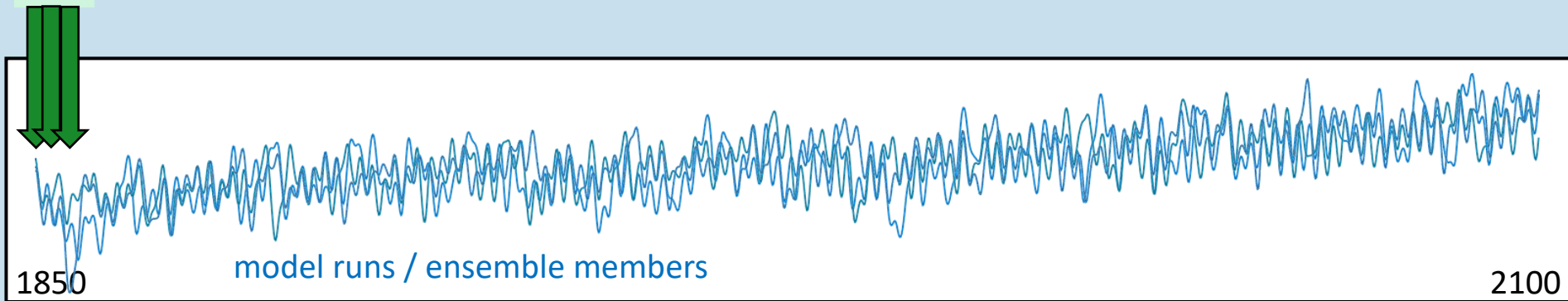
...

(How) can we use satellite gravimetry to evaluate climate models*?

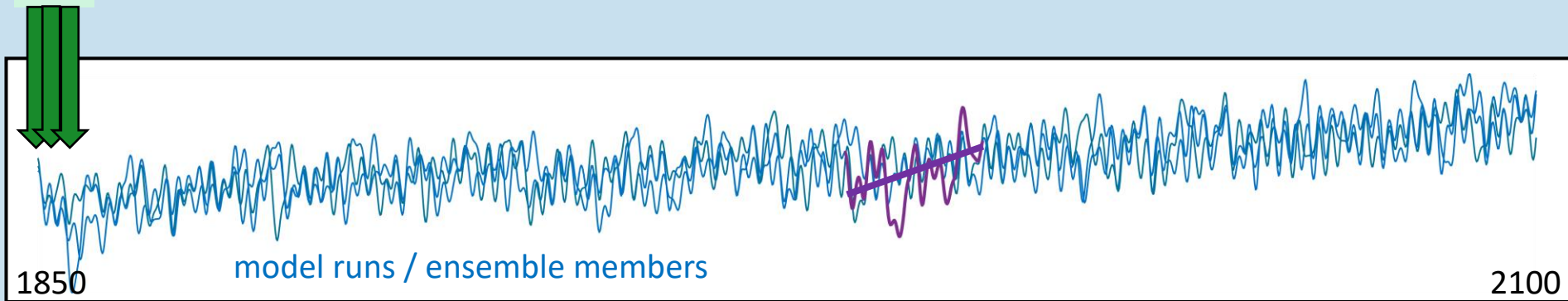
* regarding **land water-storage** related variables



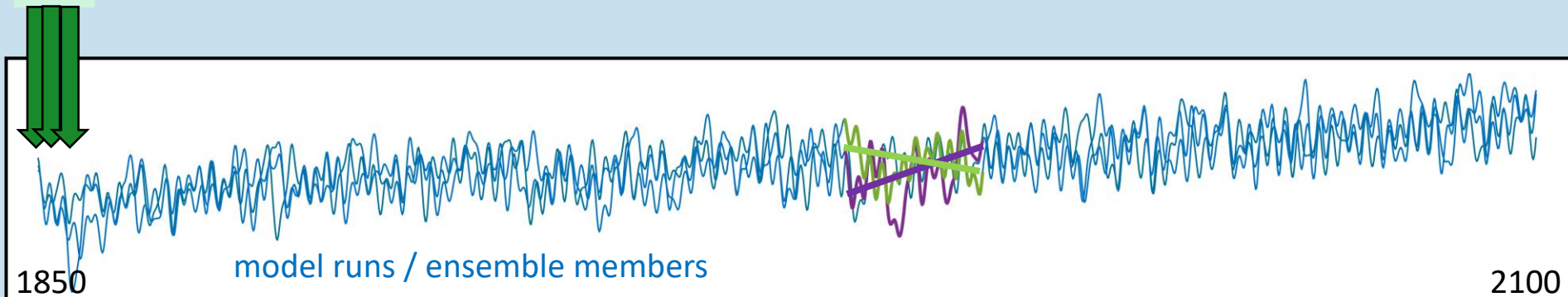
Initialization

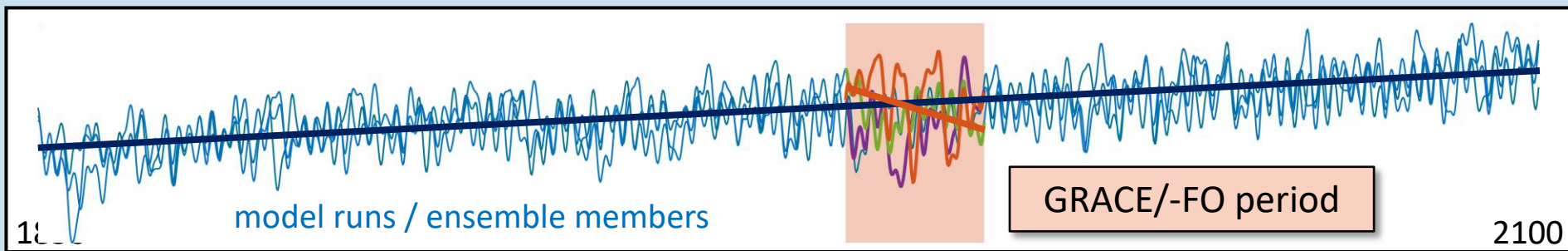


Initialization



Initialization

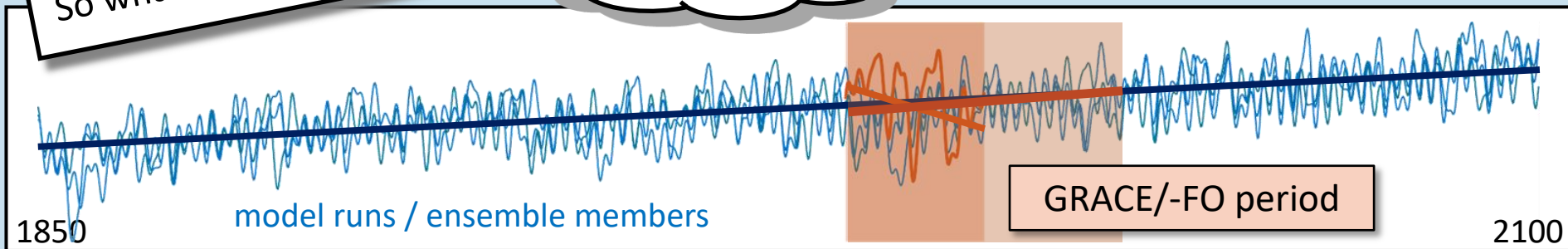




Try to identify **hot spot regions** where GRACE/-FO already sees climate related wetting or drying trends.

So what can we do?

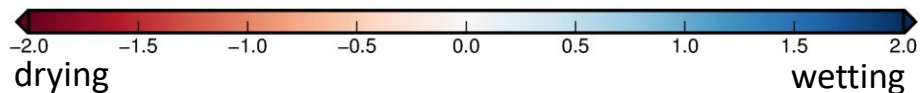
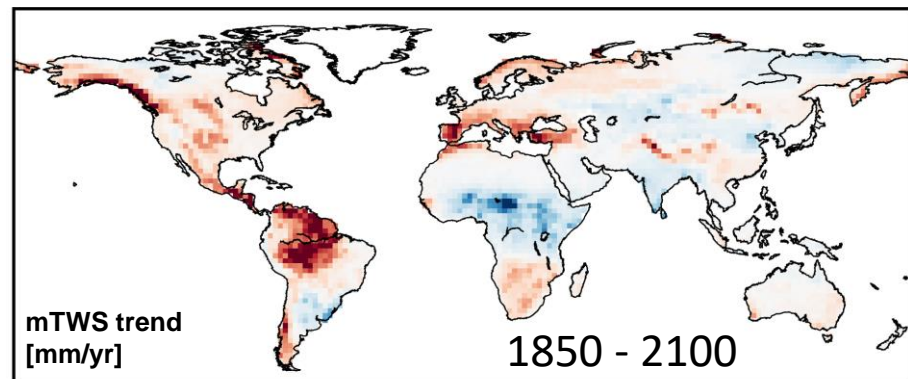
Observe longer...



Long-term linear trends

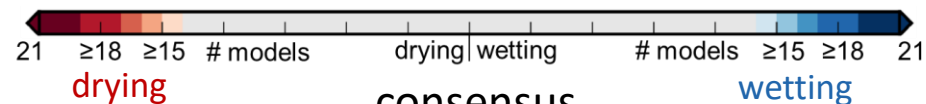
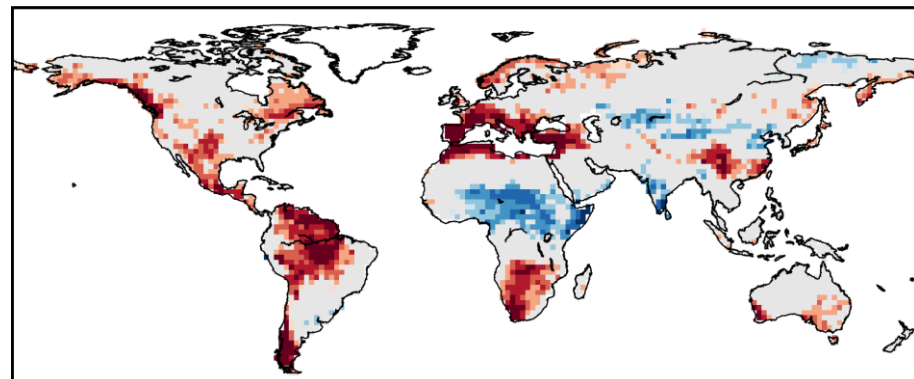
Drying or wetting?

Jensen, L., Eicker, A., Dobslaw, H., Stacke, T., & Humphrey, V. (2019). Long-term wetting and drying trends in land water storage derived from GRACE and CMIP5 models. *Journal of Geophysical Research: Atmospheres*, 124(17-18), 9808-9823.

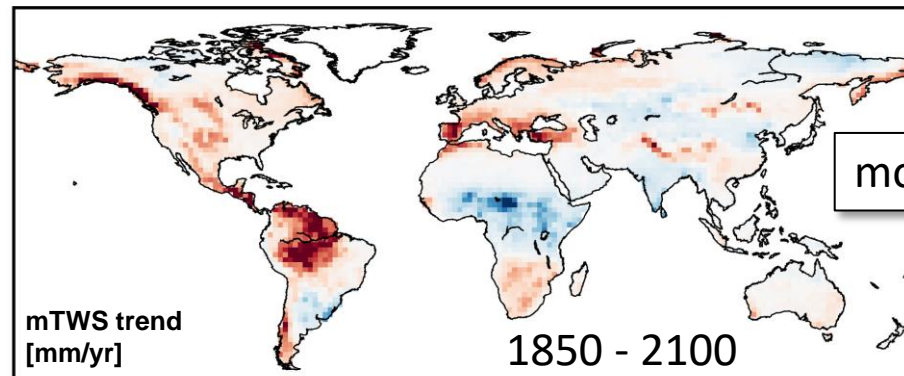


Multi-model median (MMMEd) trend
of 17 CMIP6 models

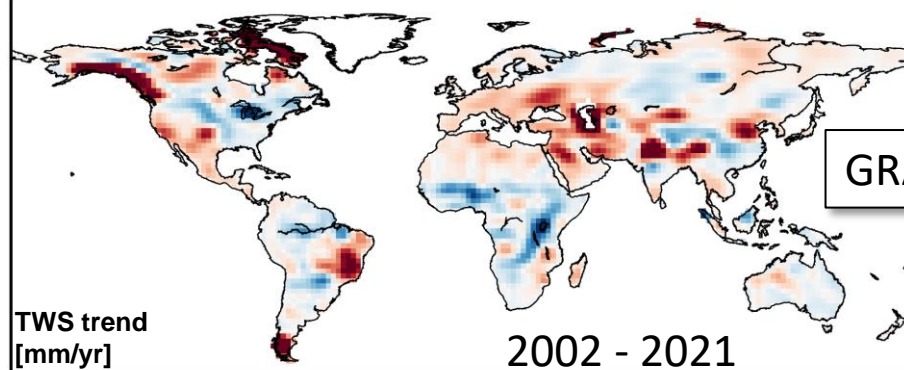
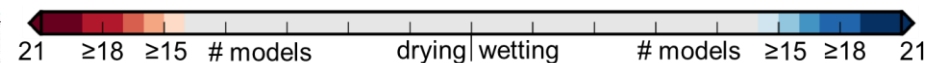
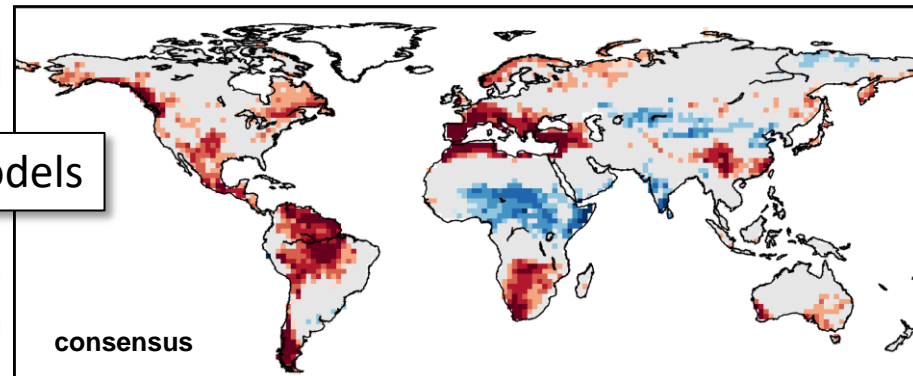
But: Large inter-model differences!



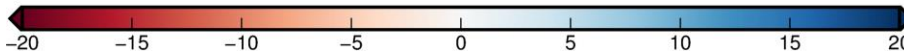
= number of models agreeing on **sign** of trend



models

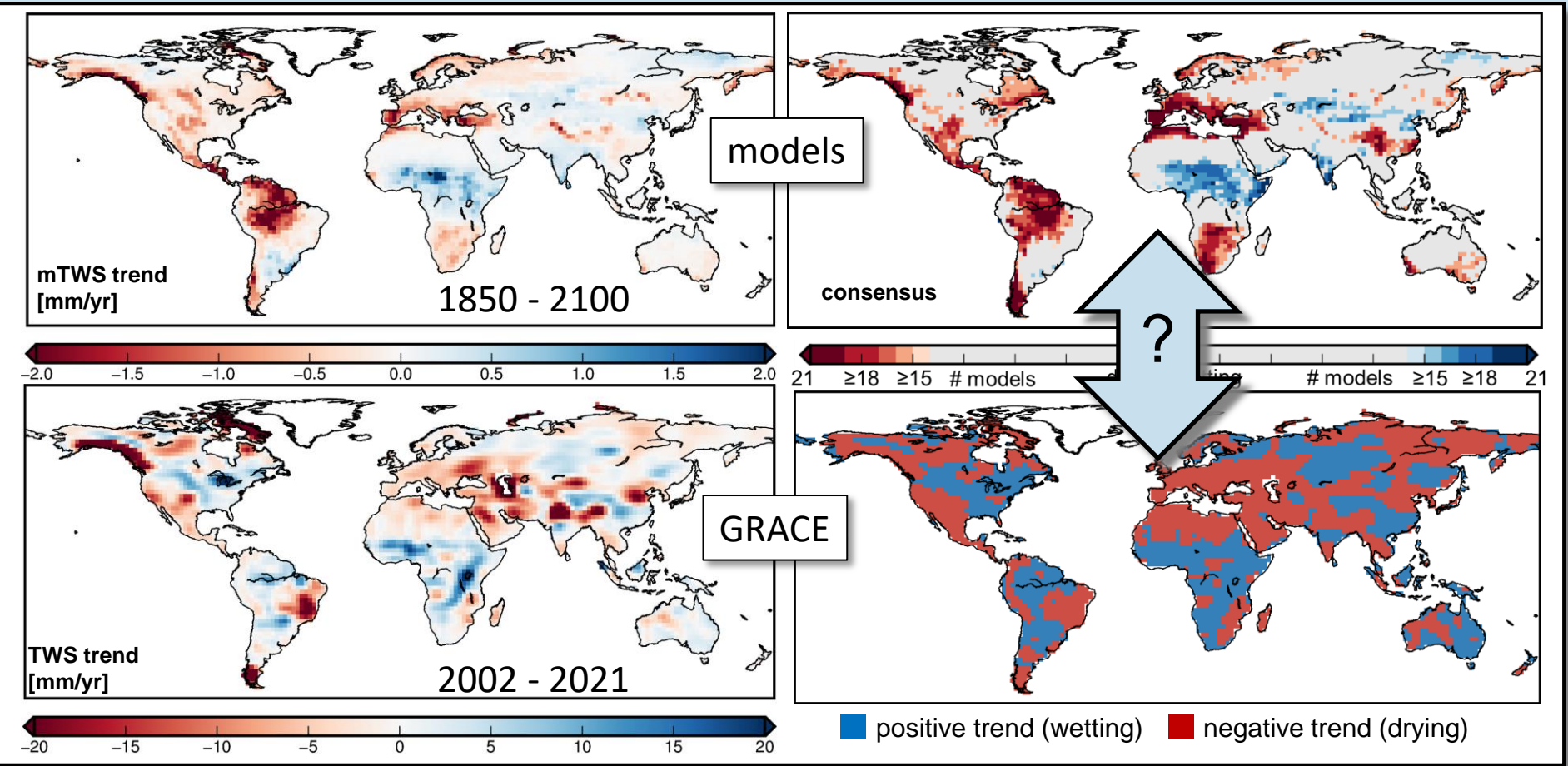


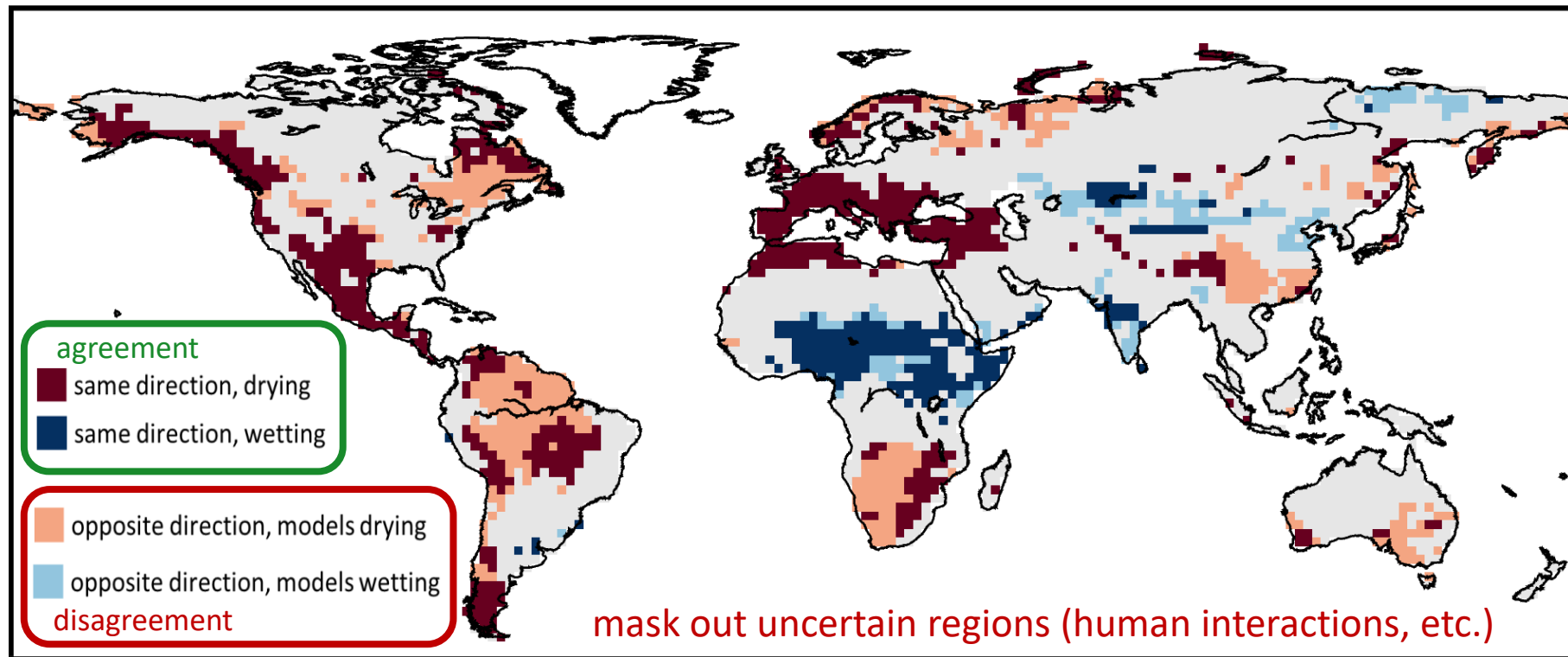
GRACE



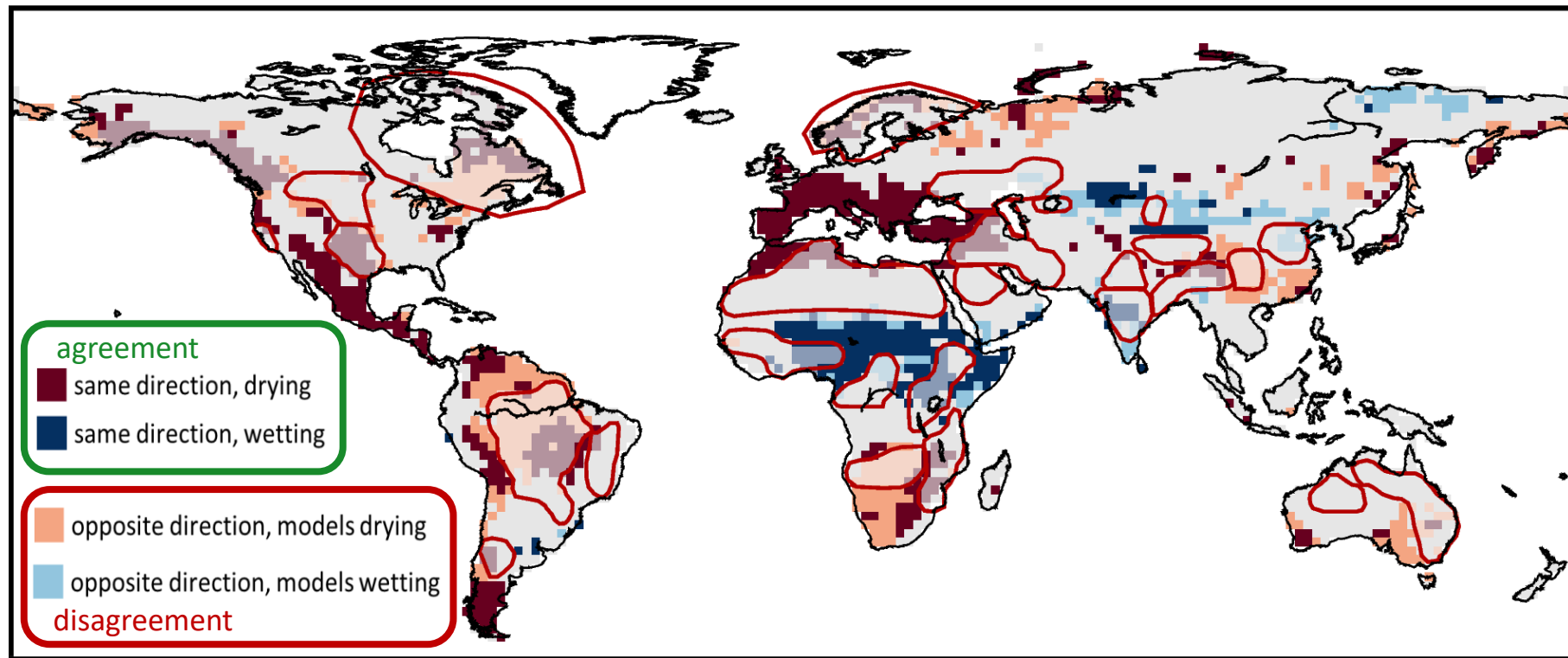
**Agreement on
wetting or drying?
(sign of the trend)**

Comparison of long-term trends

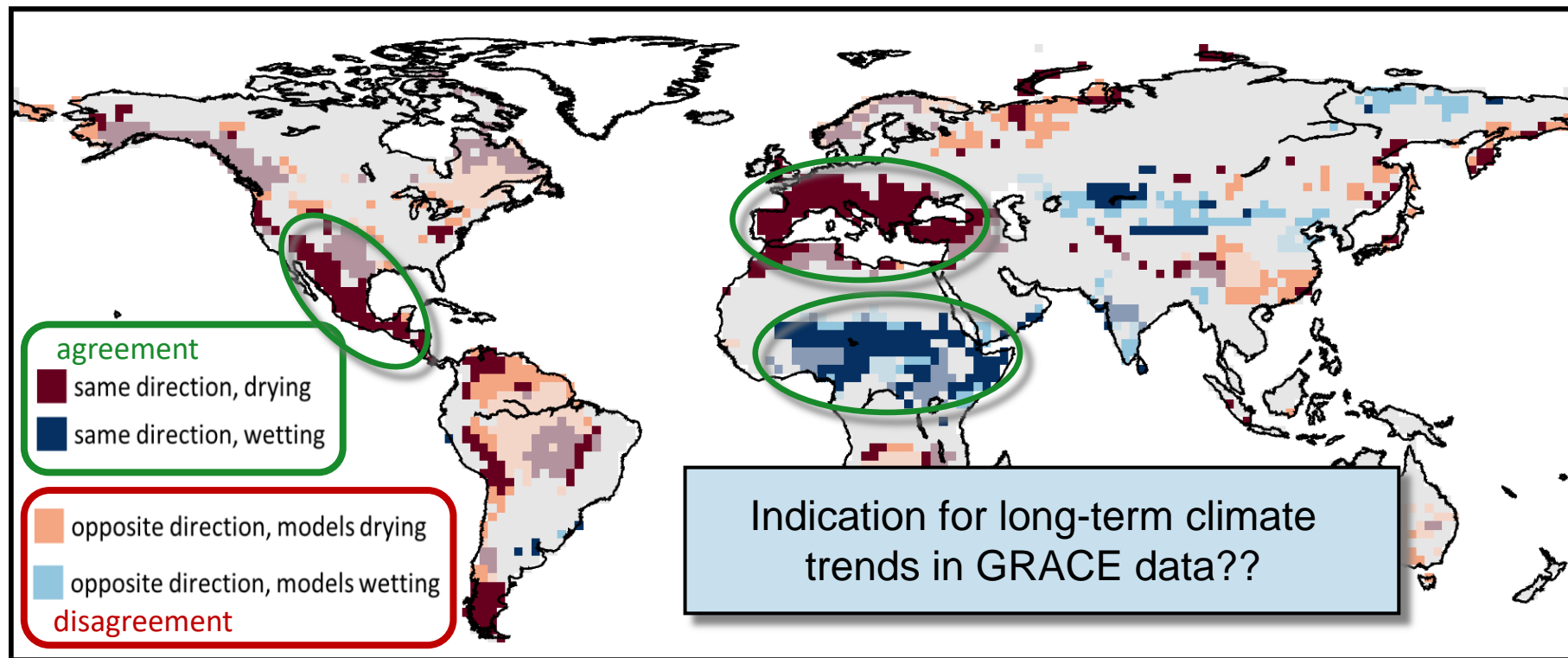




agreement/disagreement of trends from **GRAVIS v4** (2002/04 - 2021/11) and **CMIP6** models

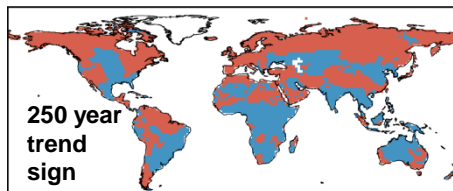
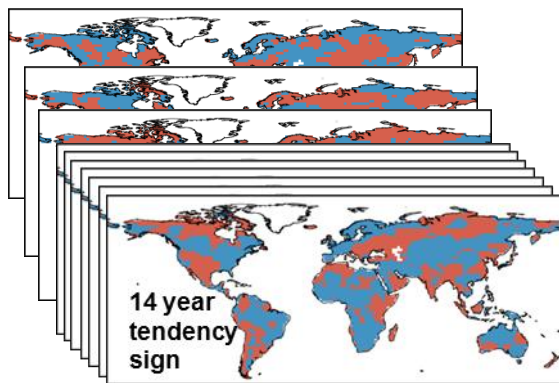


agreement/disagreement of trends from **GRAVIS v4** (2002/04 - 2021/11) and **CMIP6** models



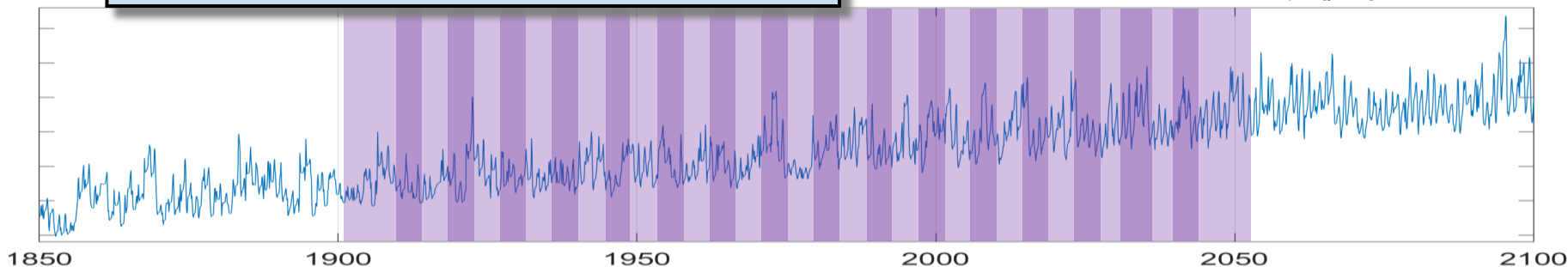
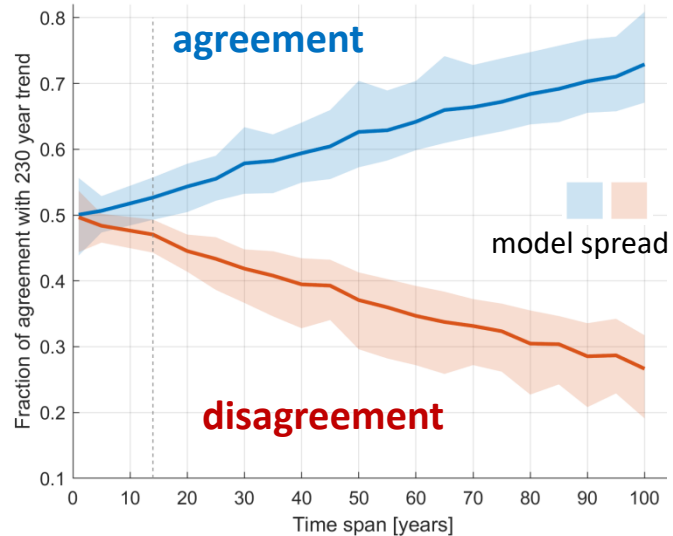
agreement/disagreement of trends from **GRAVIS v4** (2002/04 - 2021/11) and **CMIP6** models

Influence of interannual variations



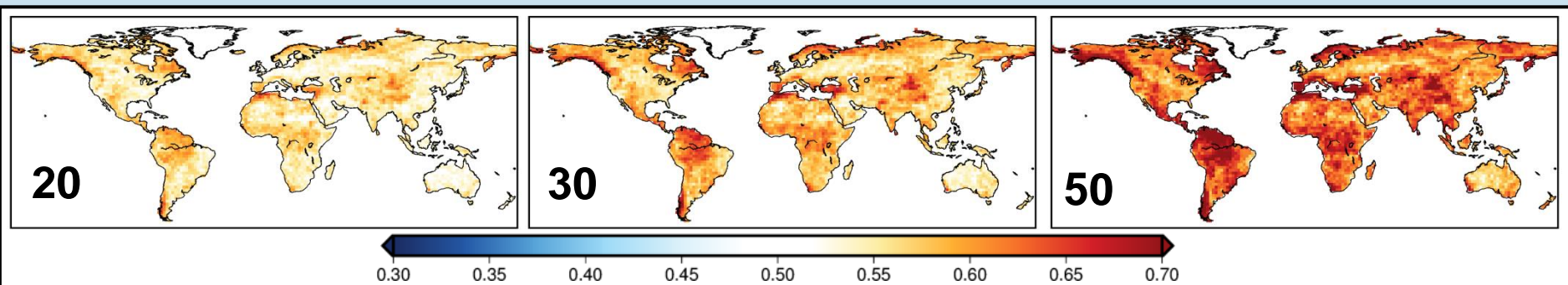
Count number of
grid cells where sign
of trend agrees with
sign of 250 yr trend

Are there regions with a good
temporal consensus on trends?

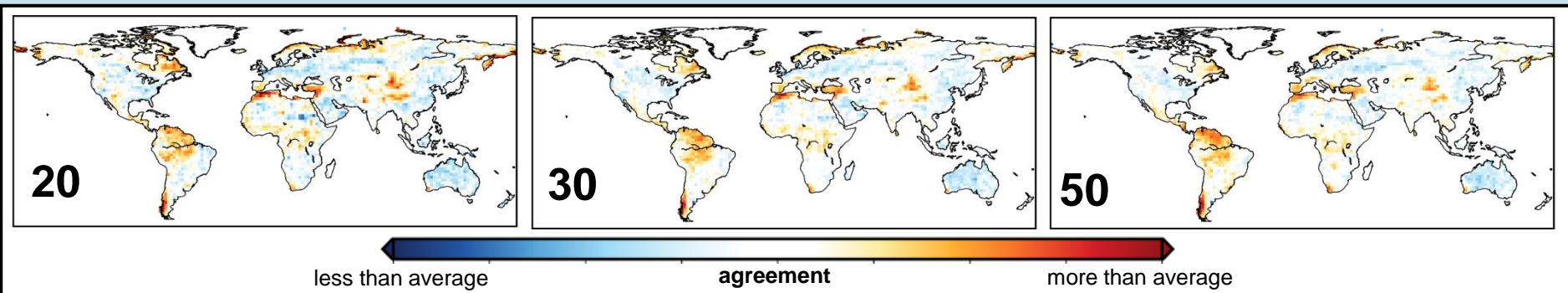


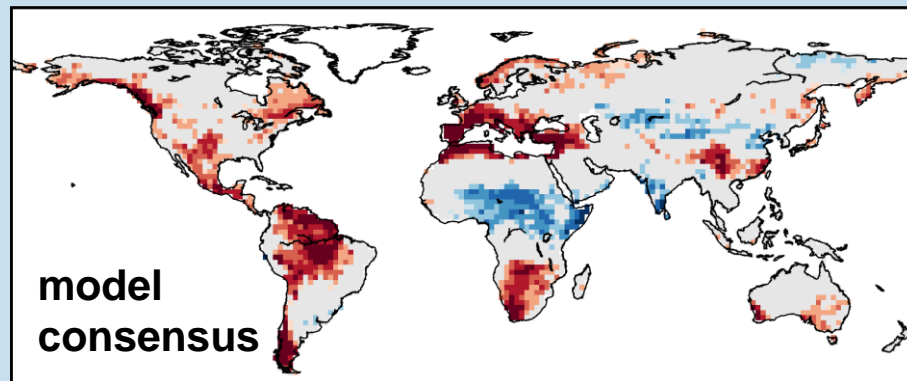
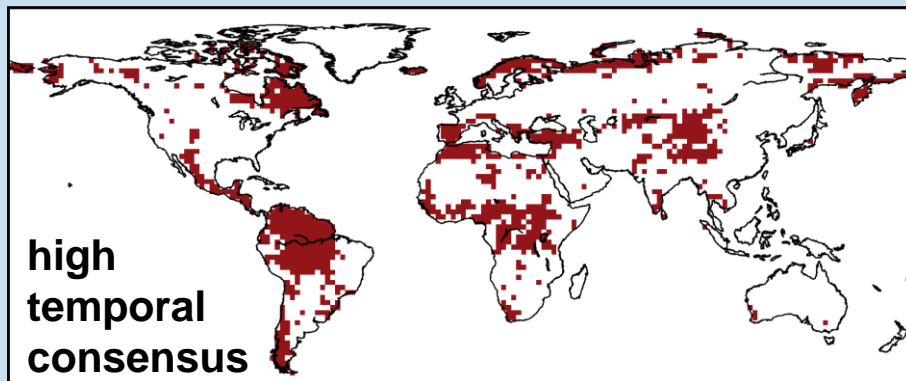
Regional analysis of temporal consensus for trends

percentage of agreement between x-yr trend and 250-yr trend
(using slices of 5 yrs distance, from 17 models)

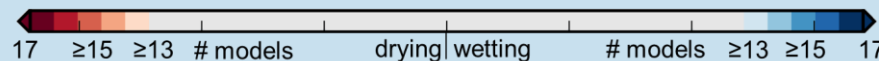
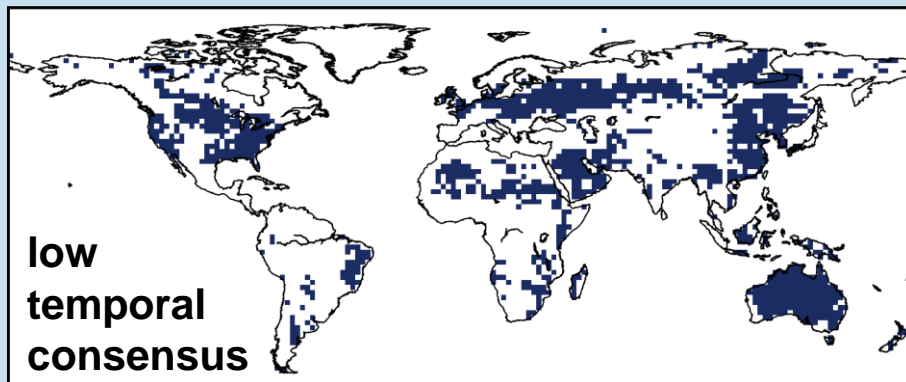




removing the global mean agreement → similar pattern for different time spans



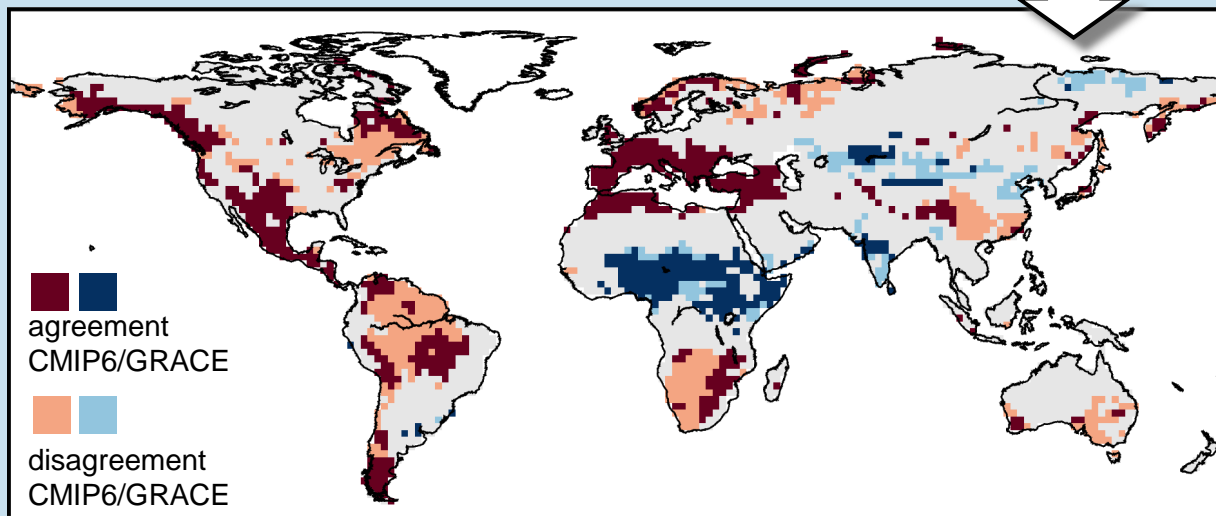
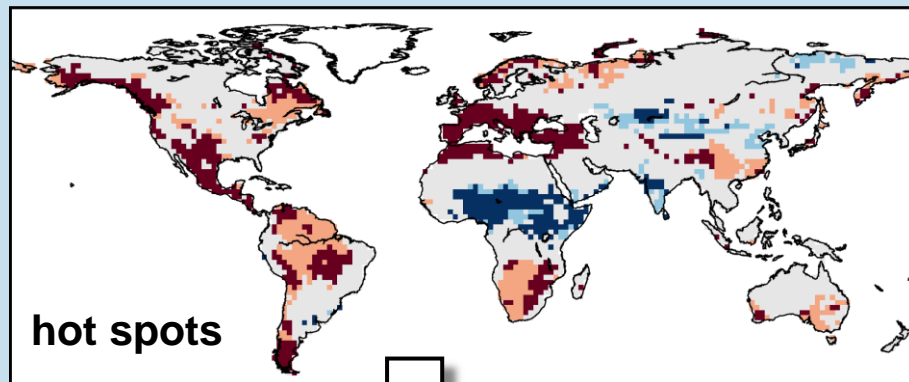
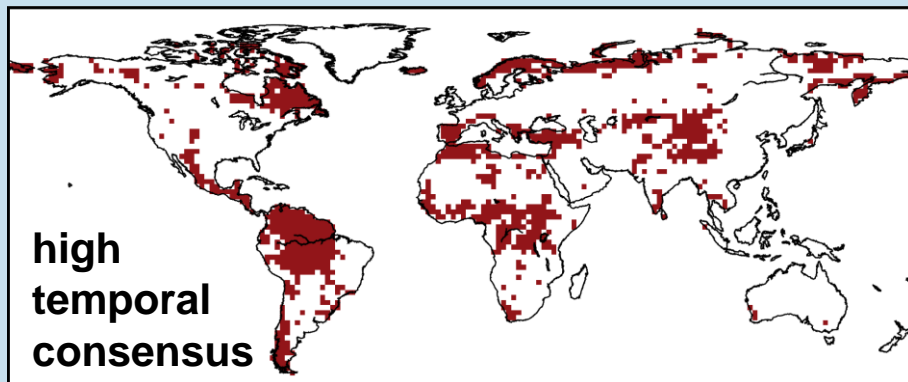


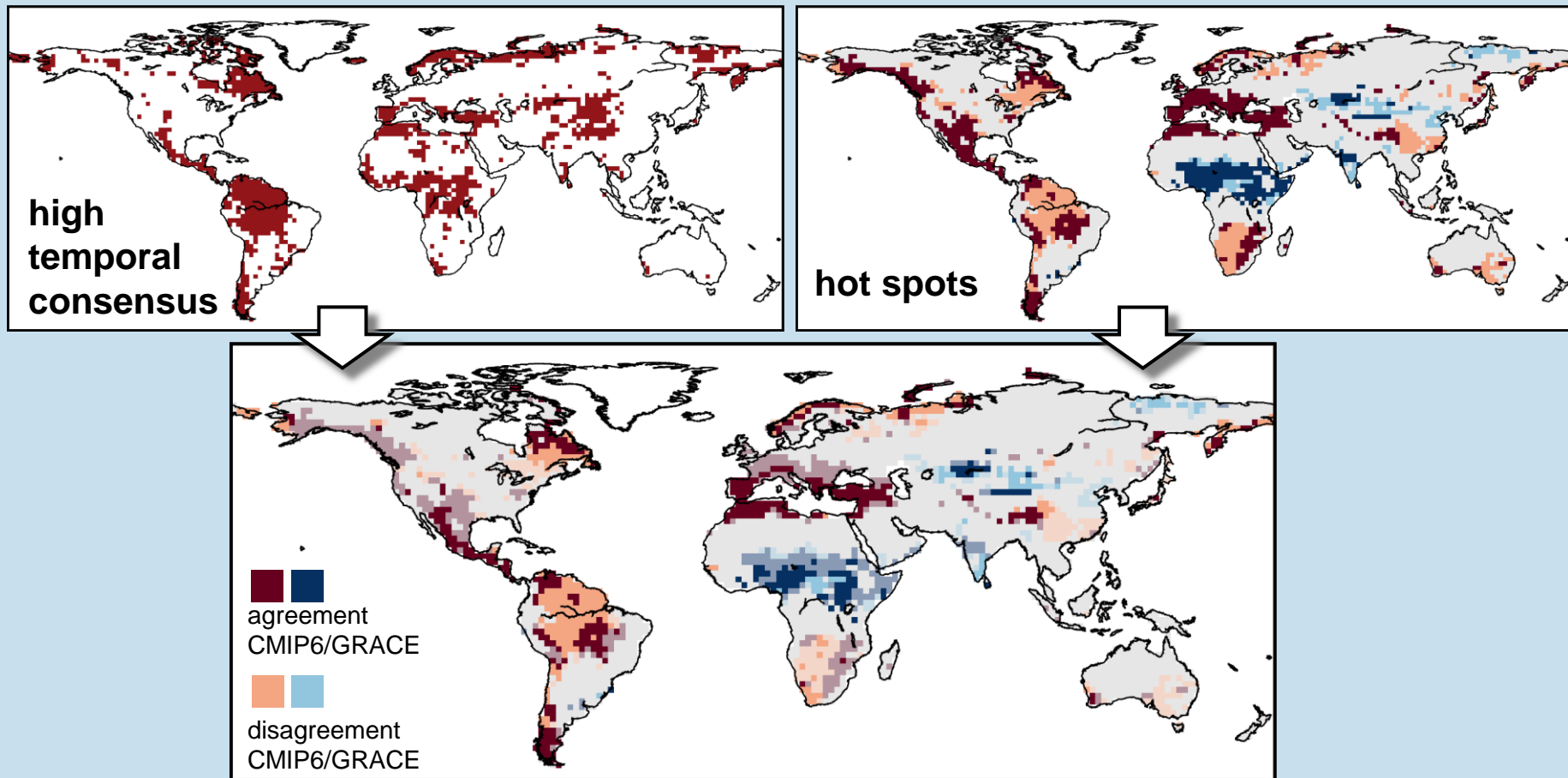
20, 25, 30, 35, 40, 45, 50 years

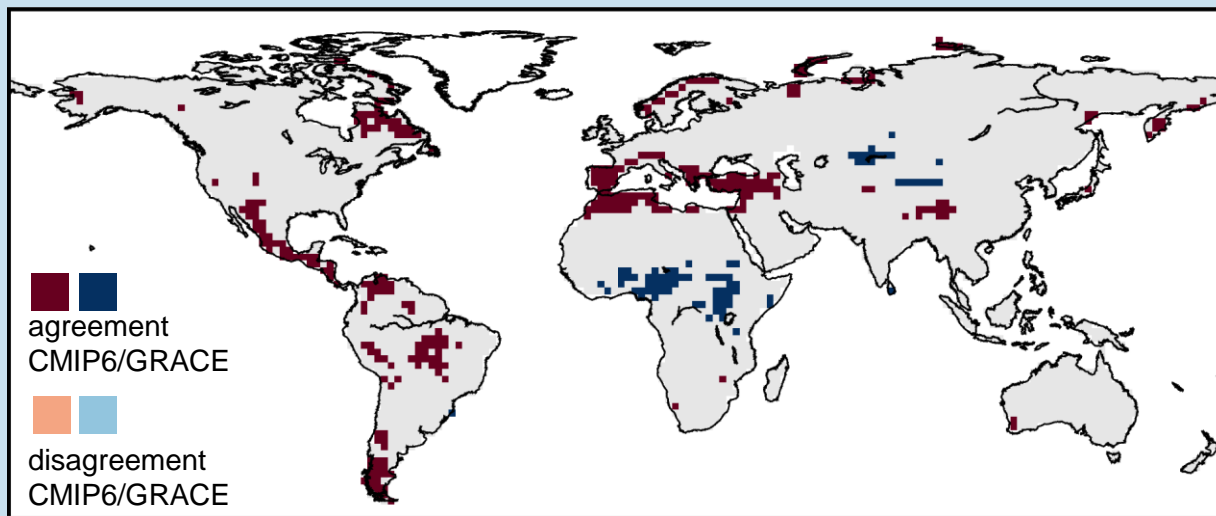
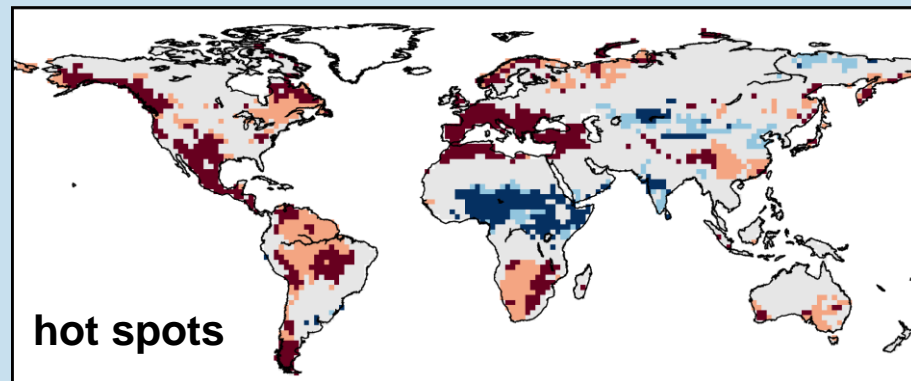
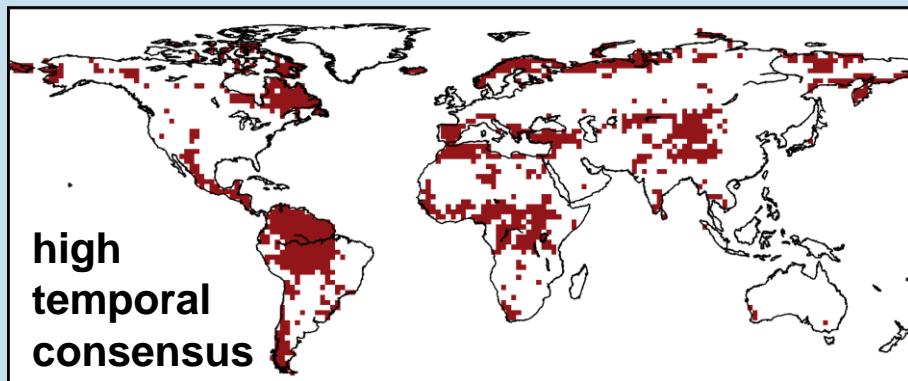


-  **more than average** trend agreement for all time spans = high temporal consensus
-  **less than average** trend agreement for all time spans = low temporal consensus

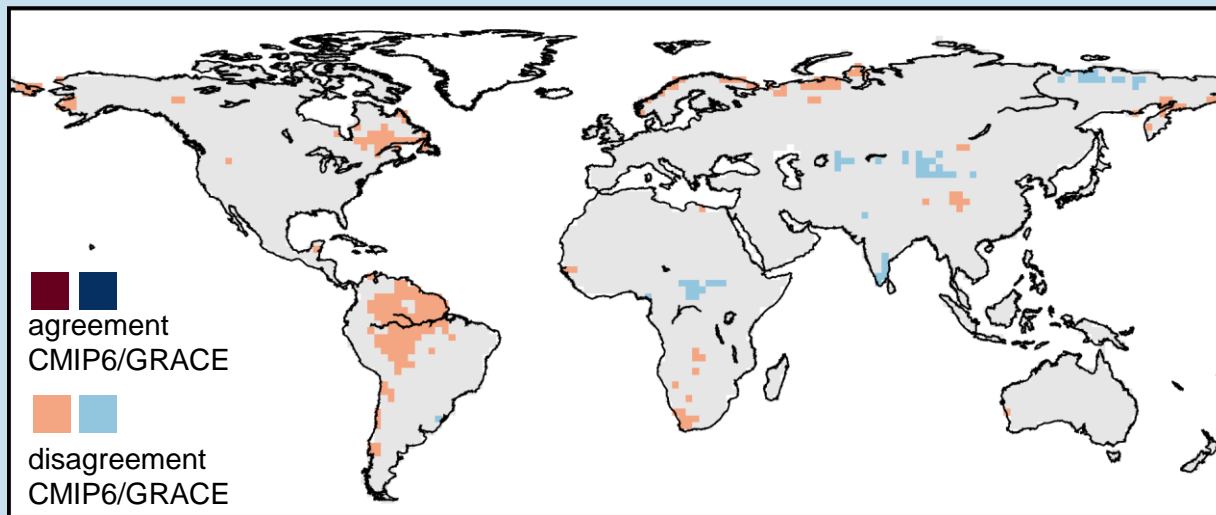
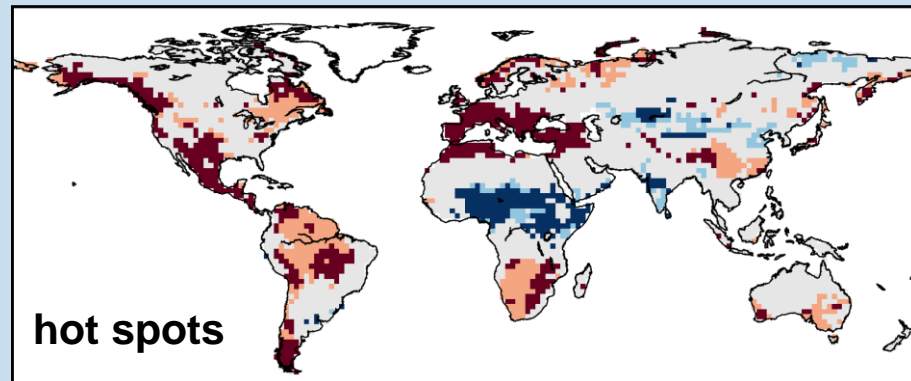
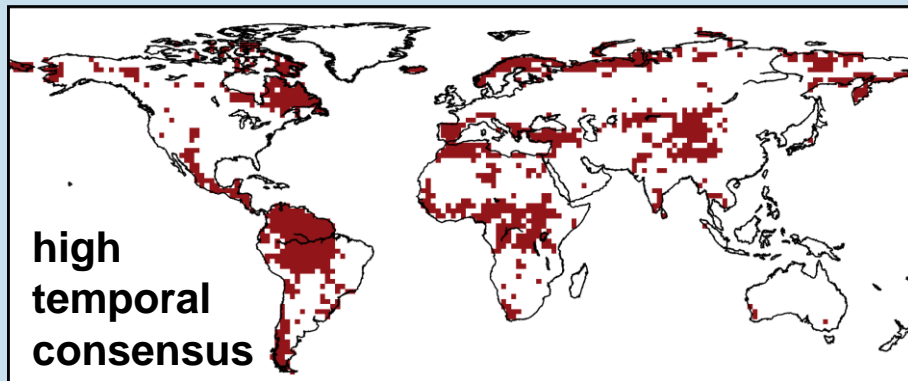
similarities between temporal and model consensus



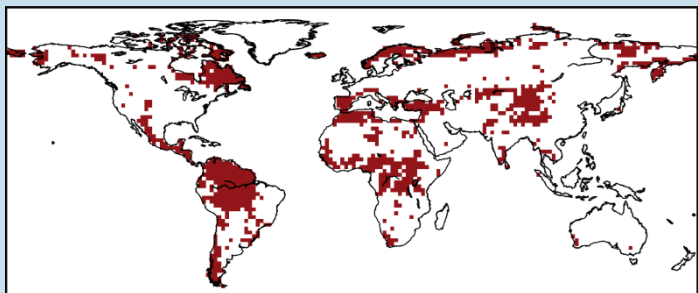




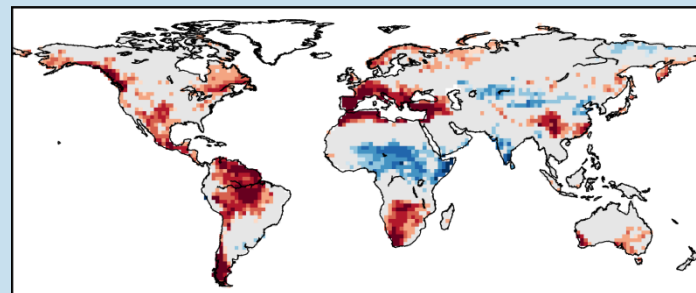
high temporal
and model
consensus
and
agreement
with
GRACE/-FO



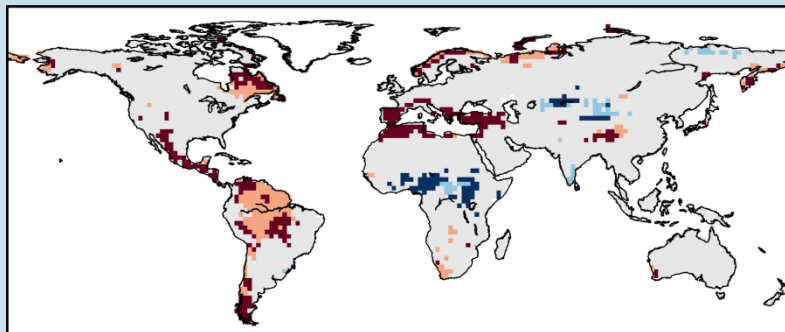
high temporal
and model
consensus
but
disagreement
with
GRACE/-FO



high temporal
consensus
+
high model
consensus



+
agreement/
disagreement
with GRACE/-FO



=
hot spots of climate related
wetting/drying trends
= supported by observations
& indications of
discrepancies between
models and observations

Challenging task but great potential for satellite gravimetry!
Model evaluation would largely benefit from:
longer observational time series & higher spatial resolution