

Robustness of precipitation Emergent Constraints in CMIP6

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WHAT's an Emergent Constraint (EC)?

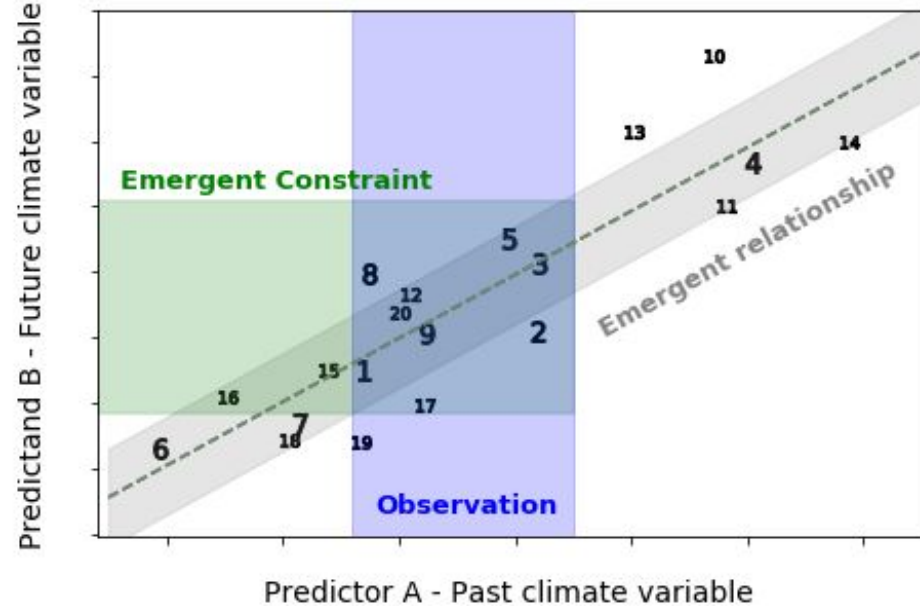


Physically explainable relationship between:

- PREDICTOR (past)
- PREDICTAND (future)

in an ensemble of simulations performed by different models

Idealized example



Precipitation

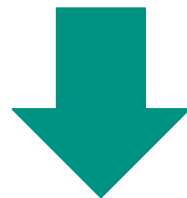


- Important variable
- affected by relevant uncertainty in climate models
- very few precipitation EC exist already
- none tested with CMIP6

Our study

Test previously documented precipitation EC:

- CMIP5 models
- CMIP6 models



are they still ROBUST?

CASE STUDIES

SUMMARY OF RESULTS

Acronym	Predictor	Predictand
ECG (O’Gorman, 2012)	Extreme tropical precipitation scaled over temperature increase in tropical ocean	Extreme tropical precipitation scaled over temperature increase in tropical ocean
ECL (Li et al., 2017)	Western Pacific mean precipitation	Indian Summer Monsoon rainfall change
ECT (Thackeray et al., 2018)	Global-mean precipitation over degree of global warming	Extreme precipitation normalized by global mean warming
ECB (Borodina et al., 2017)	Rx1day scaled over global-land temperature increase	Rx1day scaled over global-land temperature increase

CMIP5	CMIP6
YES	YES
NO	NO
YES	NO
YES	NO



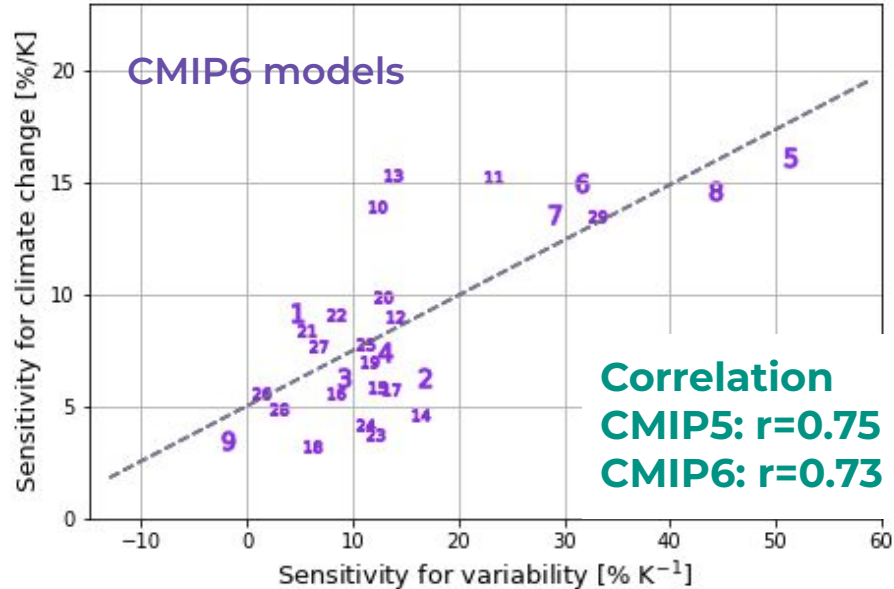
CASE STUDIES

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ECB (Borodina et al., 2017)	Rx1day scaled over global-land temperature increase	Rx1day scaled over global-land temperature increase	YES	NO



ECG - O'Gorman (2012)



Predictor: 99.9th tropical precipitation percentile scaled with temperature increase in tropical ocean

Predictand: 99.9th tropical precipitation percentile scaled with temperature increase in tropics



Predictor and predictand are described by the same subgrid parameterization in models

Strong physical basis for EC

ECT

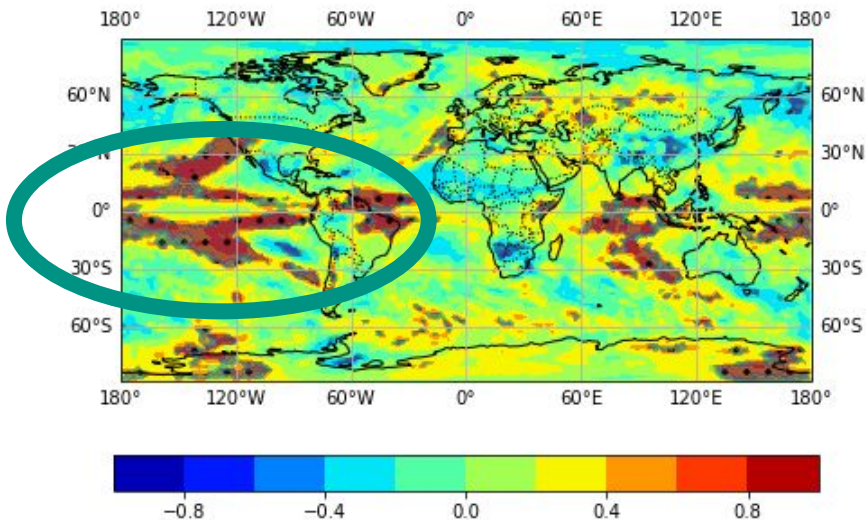


Thackeray et al.
(2018)

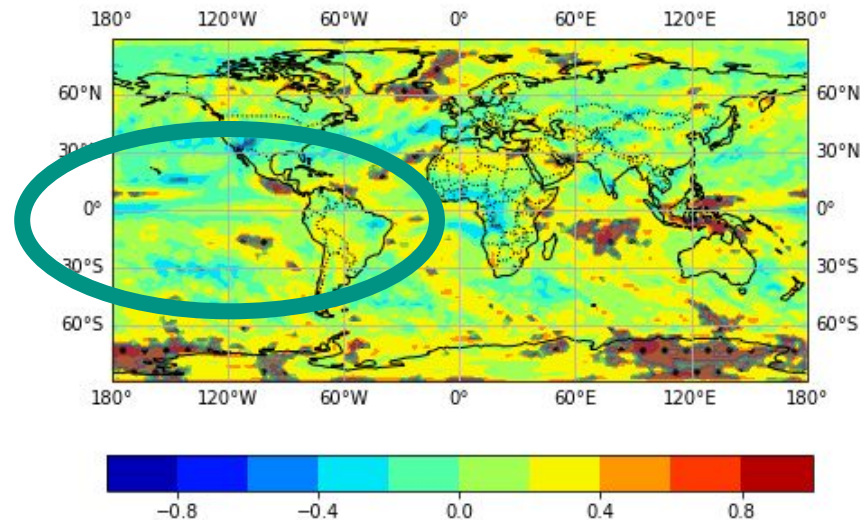
Predictor: Global mean precipitation change normalized by global-mean surface warming

Predictand: 99th percentile of precipitation change normalized by global mean temperature increase

CMIP5 models



CMIP6 models



Correlation maps between
predictor and predictand

**The correlation between predictor and predictand
in the tropical Pacific ocean disappears**

ECT

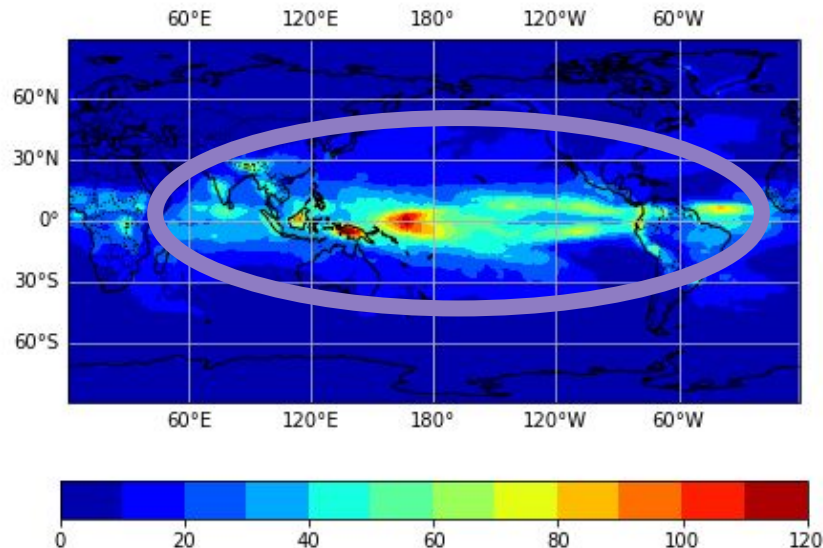


Thackeray et al.
(2018)

Predictor: Global mean precipitation change normalized by global-mean surface warming

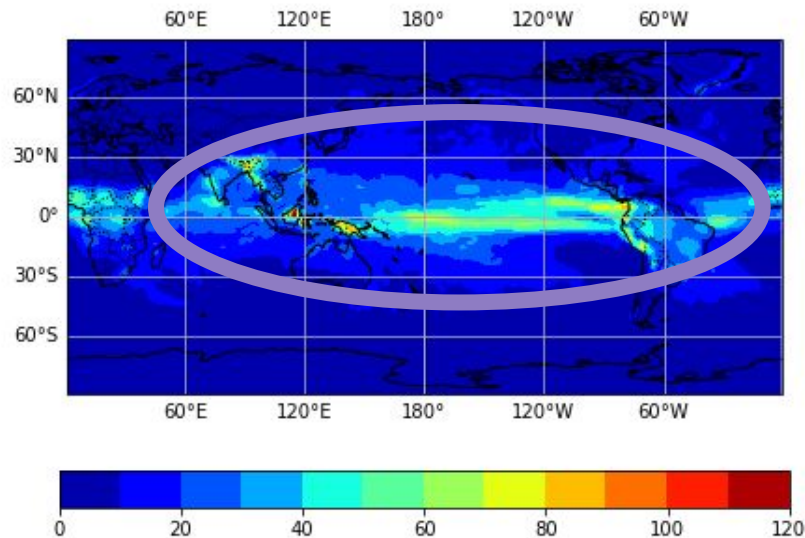
Predictand: 99th percentile of precipitation change normalized by global mean temperature increase

CMIP5 models



Maps of model ensemble standard deviation of the predictand

CMIP6 models



Inter-model spread in projections of extreme precipitation is narrowed from CMIP5 to CMIP6

CONCLUSIONS

- **Three of the four precipitation EC that I have analyzed are not robust with CMIP6**
- **Without a strong physical explanation, EC could be just spurious correlation**
- **More convincing tests to assess the validity and robustness of EC must be performed**

THANK you for your attention!

Ferguglia, O. et al., 2022, Robustness of precipitation Emergent Constraints in CMIP6, submitted to Climate Dynamics

References

Borodina, A., Fischer, E.M., and Knutti, R., 2017, in Journal of Climate, 30

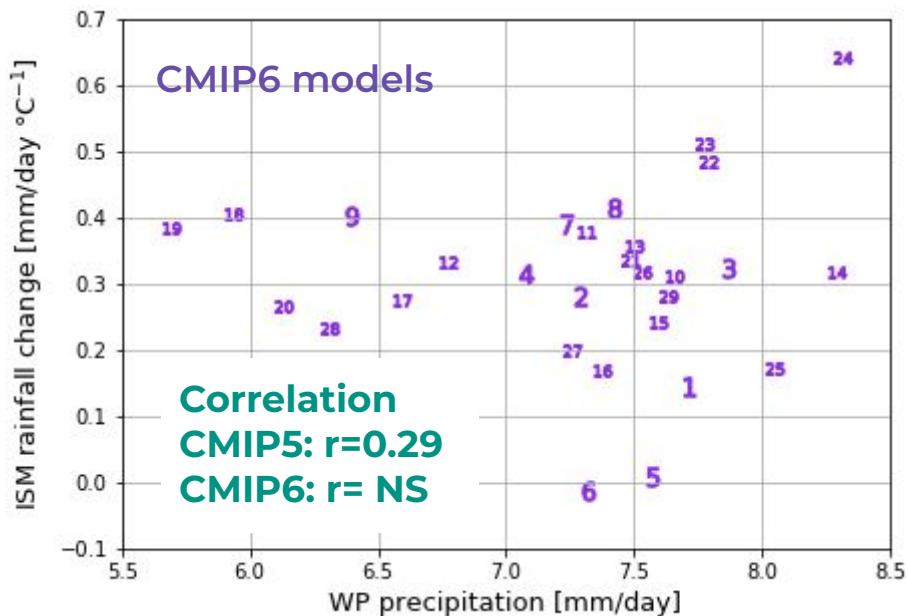
Li, G., Xie, S. P., He, C., and Chen, and Z. S., 2017, in Nat. Clim. Change, 708-712;

O' Gorman, P. A., 2012, in Nature Geoscience, 697-700;

Thackeray, C. W., De Angelis, A. M., Hall, A., et al., 2018, in Geophysical Research Letters, 45

Backup slides

ECL - Li et al. (2017)



Predictor: Mean Western Pacific precipitation
Predictand: Indian Summer monsoon rainfall change normalized by global-mean precipitation increase



EC not robust with both CMIP5 and CMIP6

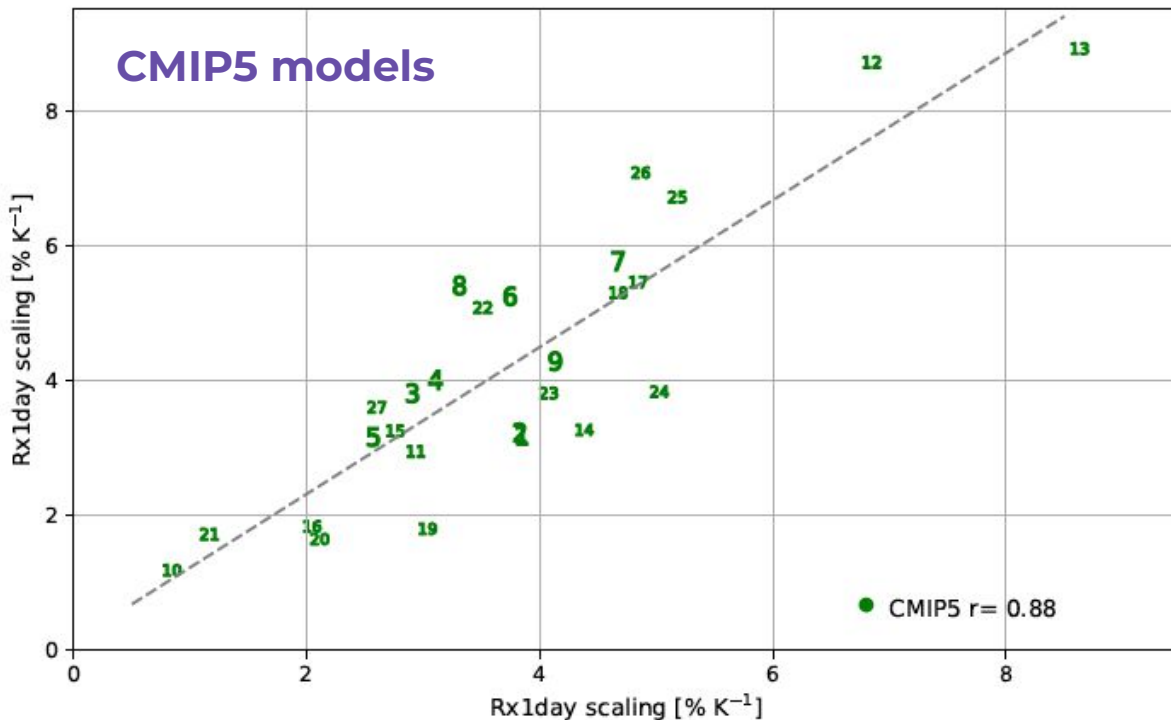
Another predictor must be found

ECB



Borodina et al.
(2017)

Predictor: Rx1day scaled over global land temperature increase - past
Predictand: Rx1day scaled over global land temperature increase - future

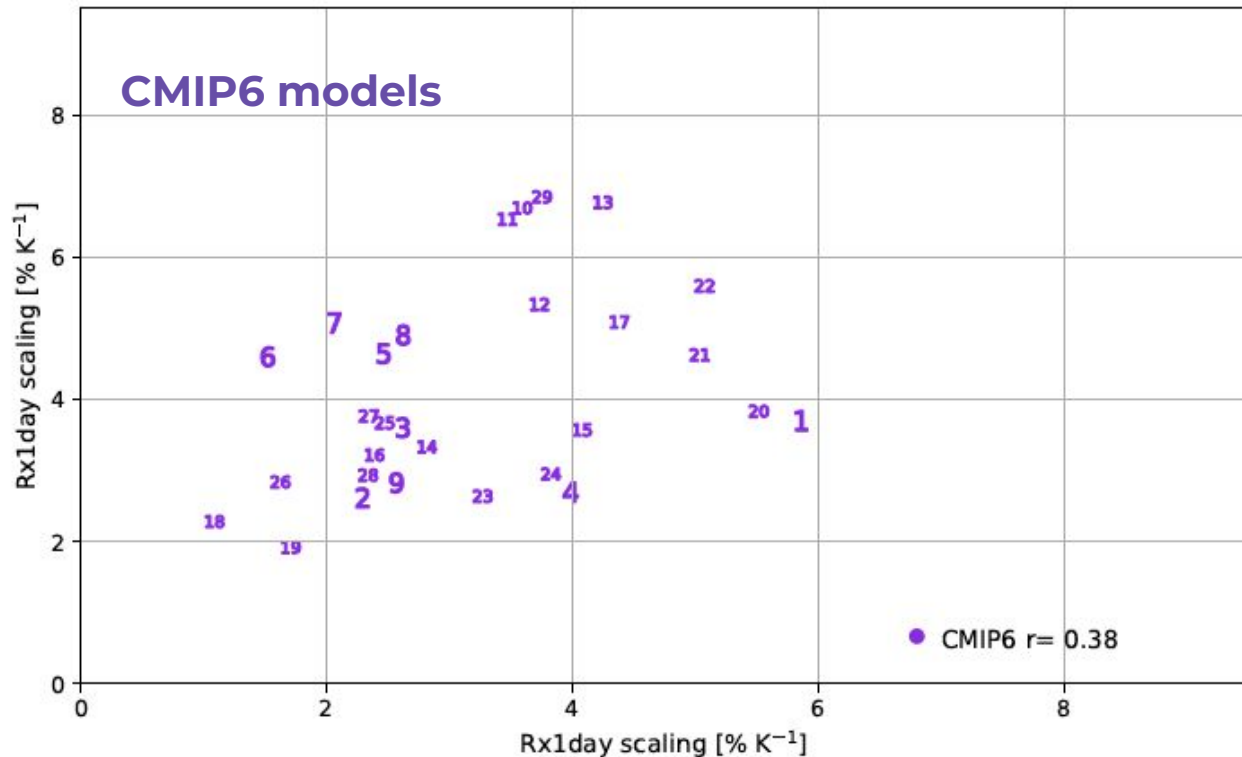


ECB



Borodina et al.
(2017)

Predictor: Rx1day scaled over global land temperature increase - past
Predictand: Rx1day scaled over global land temperature increase - future



The correlation
between predictor
and predictand in
the tropical Pacific
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