Decadal Surface Temperature Predictions in the North Atlantic region in CMIP6

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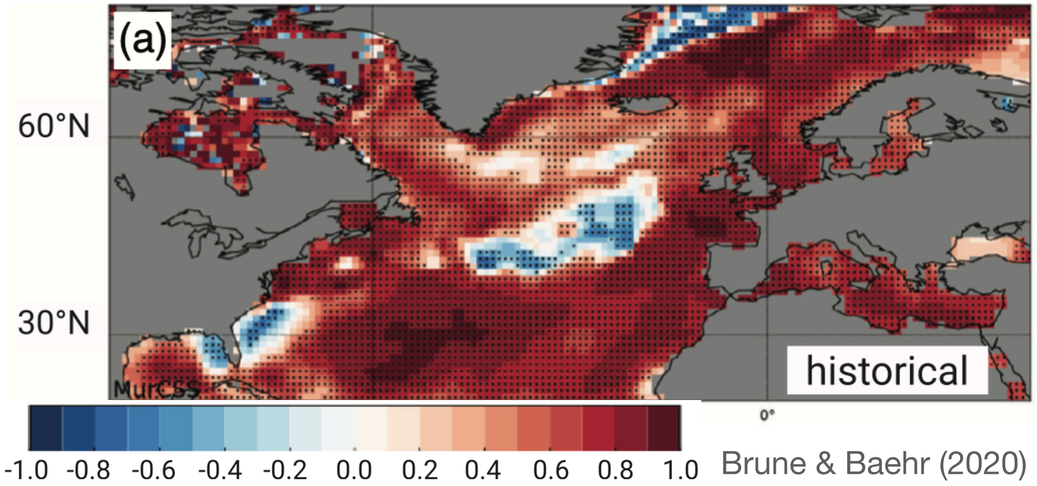
EUCP
European Climate Prediction system

Decadal Predictions & the North Atlantic

- North Atlantic sea surface temperature is recognised as decadal prediction “hot spot” (e.g. Yeager & Robson, 2017)
- Observed SST variability is “misrepresented” in historical simulations (i.e. the forcing)
- Ocean circulation (AMOC) related to SST variations -> internally generated?

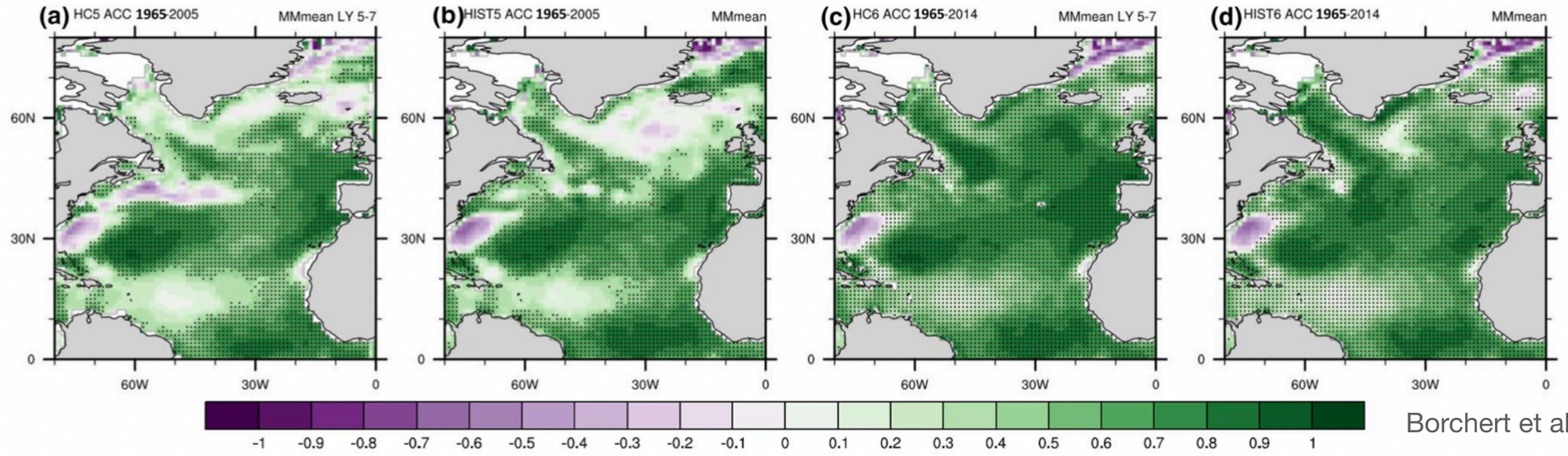


Brune & Baehr (2020)

- These findings are based on CMIP5
  - CMIP6: larger ensembles, improved models, new forcing

Predictions in CMIP6 - Ocean

- 5 multi-model ensemble mean of CMIP5 models: correlation skill (ref: HadISST) improvement with initialisation in subpolar North Atlantic (LY 5-7)
- 6 multi-model ensemble mean of CMIP6 models: correlation improvement in subpolar North Atlantic strongly reduced
- Higher correlation (skill) in CMIP6

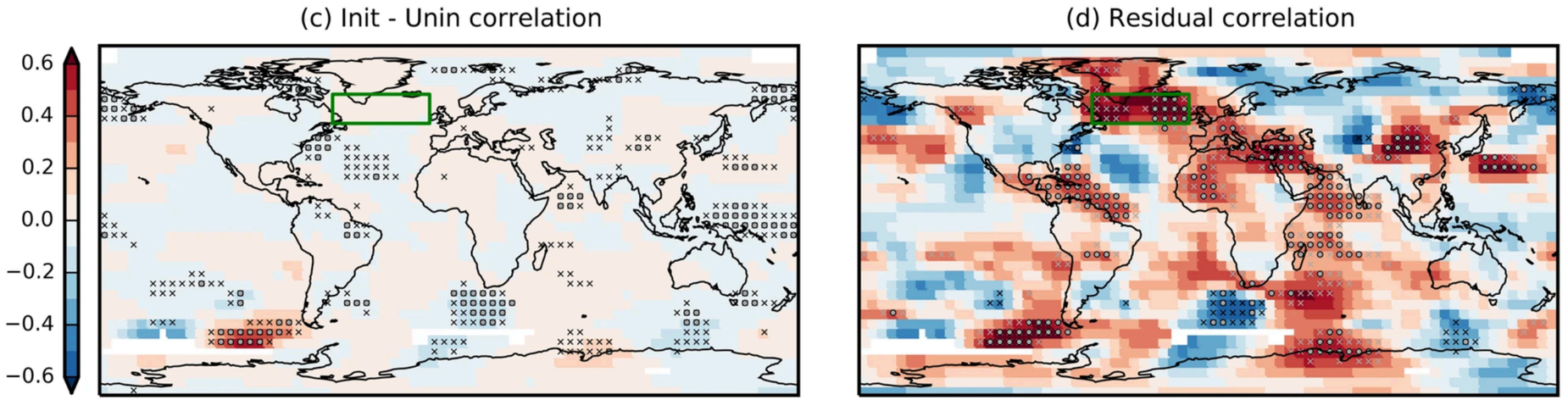


Borchert et al. (2021a)

Predictions of European summer temperature

- Over Europe: prediction more difficult than for SST
- Unforced predictions are particularly tricky (e.g. Smith et al., 2019)

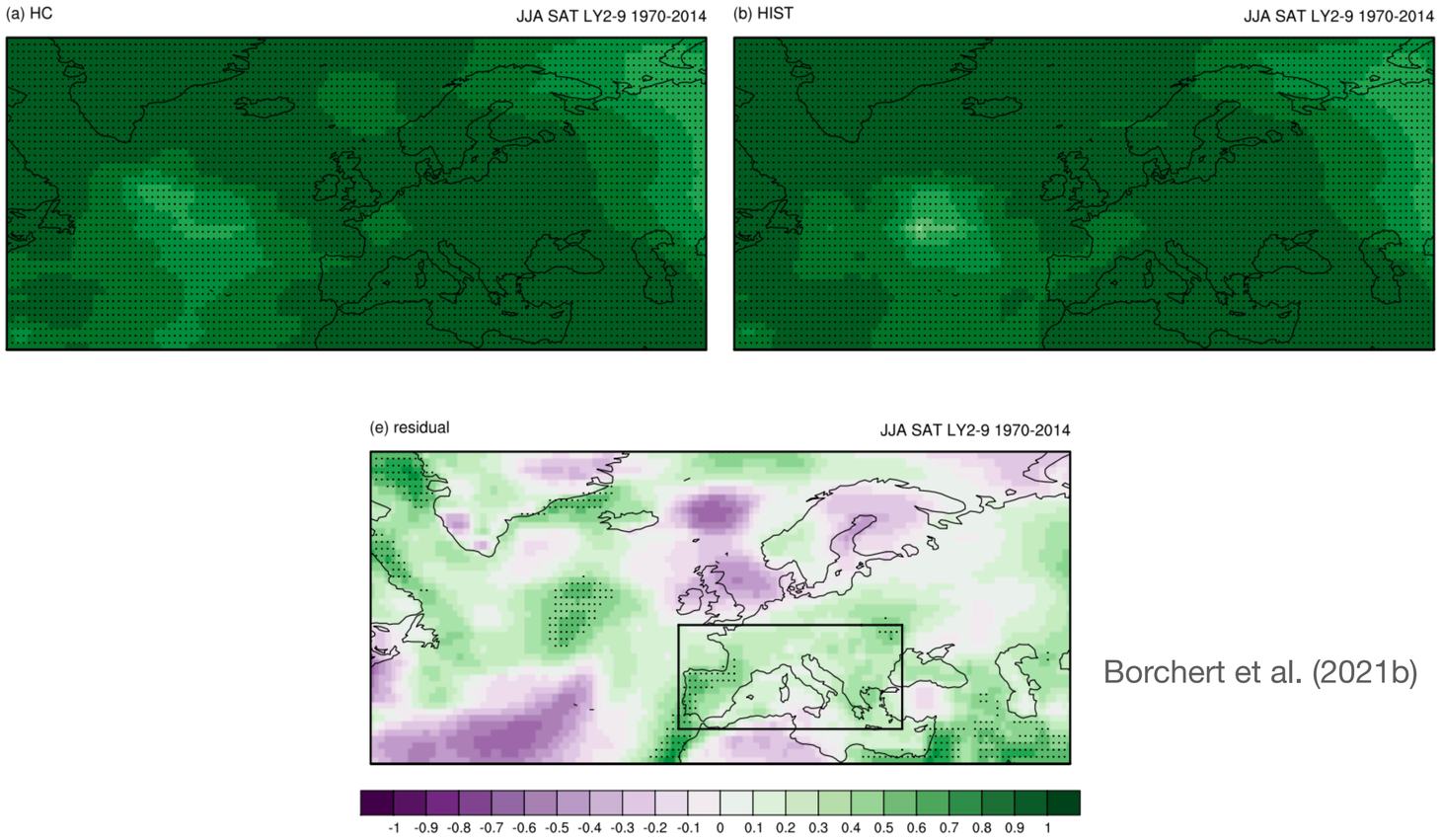
- Re-assess with CMIP6



Smith et al. (2019)

Predictions in CMIP6 - EUST I

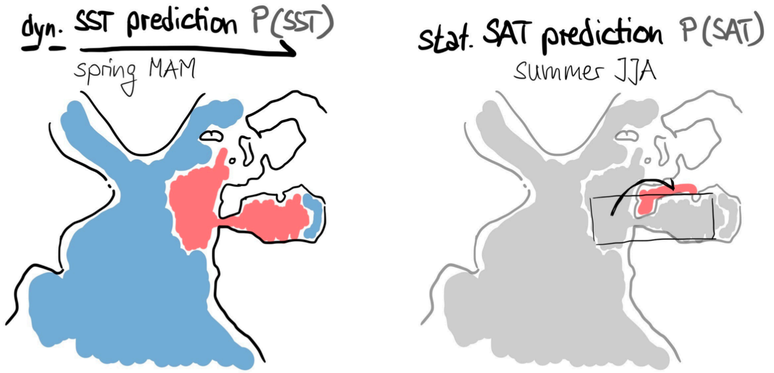
- Summer temp, 8-model multi-model ensemble, against HadCRUT, LY2-9
- High skill
- “Residual” (Smith et al., 2019) shows low skill
- Can this be improved?

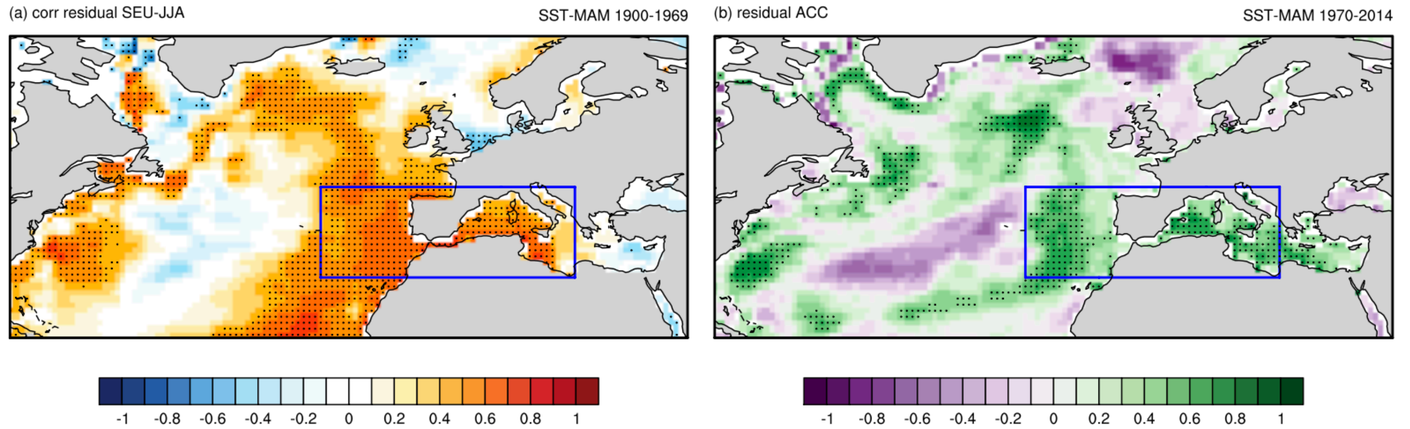


Borchert et al. (2021b)

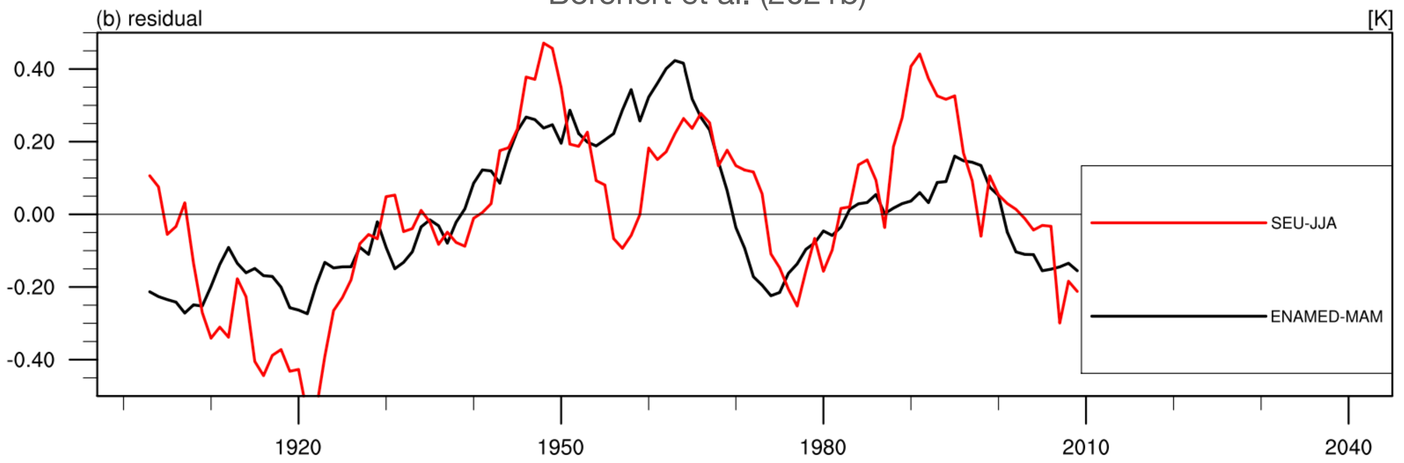
Predictions in CMIP6 - EUST II

- Hybrid dynamical-statistical predictions: use dynamical SST predictions plus a statistical model (Wu et al., 2019; Simpson et al., 2019)
- Observed connection (training) + skilful SST prediction targeting Southern European summers
- Significant for spring SST in Mediterranean & Eastern North Atlantic
- Use this for dyn-stat prediction?



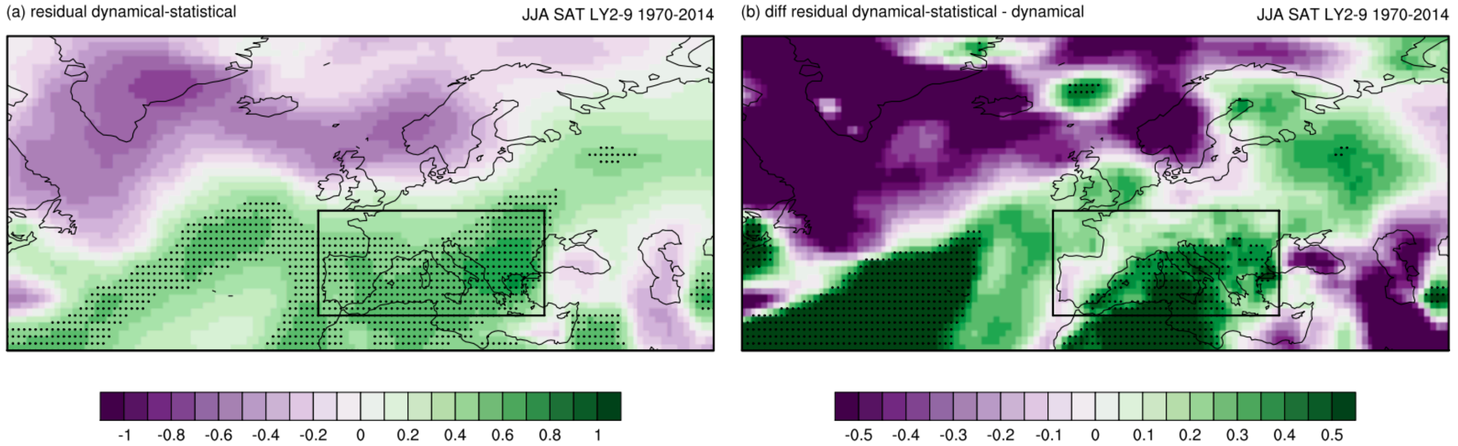


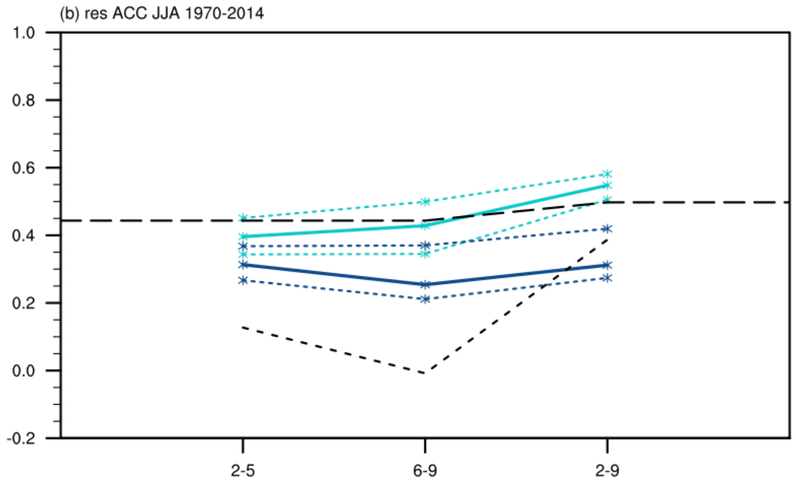
Borchert et al. (2021b)



Predictions in CMIP6 - EUST III

- Dyn-stat predictions: significant residual skill in southern Europe
- Partly significant skill increase
- Unforced skill is only significant for long time-averages (2-9 lead years)
- At decadal time averages, dyn-stat models can hold significant skill for unforced southern European summer temperature

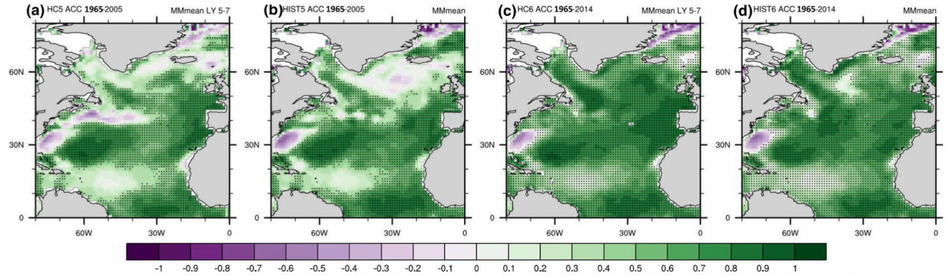




Borchert et al. (2021b)

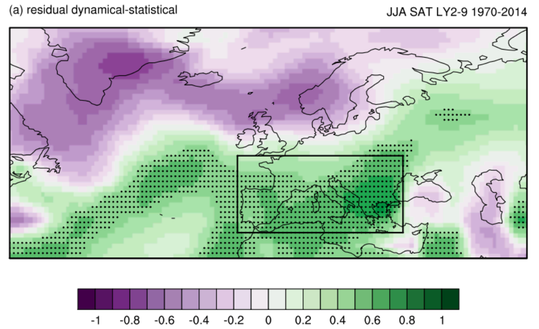
Take Home Messages

- CMIP6 models significantly predict decadal North Atlantic subpolar gyre SST variations
- A large portion of this skill is related to natural forcing (volcanoes?)



Borchert et al. (2021a) Improved decadal prediction of North Atlantic subpolar gyre SST in CMIP6. GRL. https://doi.org/10.1029/2020GL091307

- Unforced summer temperature variations in southern Europe are not directly skilfully predictable in CMIP6
- Invoking a dyn-stat model based on observed SST-SAT connections enables skilful summer temperature prediction



Borchert et al. (2021b) Skillful prediction of unforced southern European summer temperature variations. ERL. https://doi.org/10.1088/1748-9326/ac20f5

Supplement

- Predictions are more skilful after ~1980 in HIST and HC
- Value of initialisation particularly low during that time
- Related to which forcing? -> DAMIP simulations (9 model MME)
- Natural forcing contributes most strongly after 1980