Near-term climate predictions: Part I

Outline

- Introduction of Near-term climate predictions (Part I)
- Example 1: Hybrid prediction of Atlantic tropical cyclones (Part II)
- Example 2: NAO and blocking
- Challenges in near-term climate predictions (Part III)

Near-term climate predictions

- Near-term climate predictions (NTCP) operate on the multi-year to decadal time scales. NTCP bridge the gap between seasonal forecasting and century-scale climate projection and provide useful information on climate adaptation and resilience (Kushnir et al. 2019).
- Different from climate change projections, which focus on the response of the climate system to external forcing, NTCP draw skill from both the external forcing and internal climate variability. The climate predictions thus need to be properly initialized.

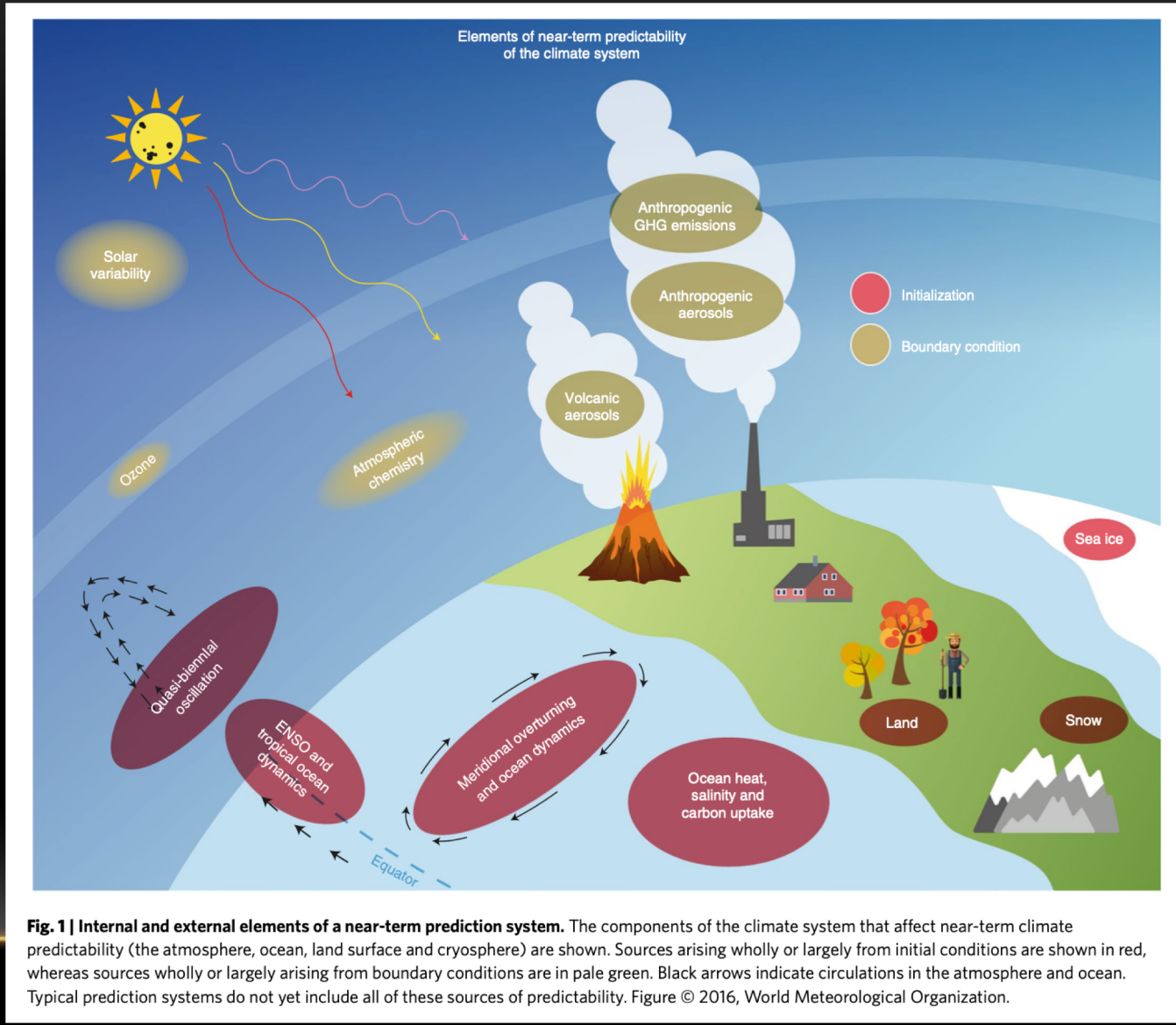

Fig. 1 | Internal and external elements of a near-term prediction system. The components of the climate system that affect near-term climate predictability (the atmosphere, ocean, land surface and cryosphere) are shown. Sources arising wholly or largely from initial conditions are shown in red, whereas sources wholly or largely arising from boundary conditions are in pale green. Black arrows indicate circulations in the atmosphere and ocean. Typical prediction systems do not yet include all of these sources of predictability. Figure © 2016, World Meteorological Organization.

Kushnir et al. 2019

Skill of NTCP (ACC between prediction and obs)

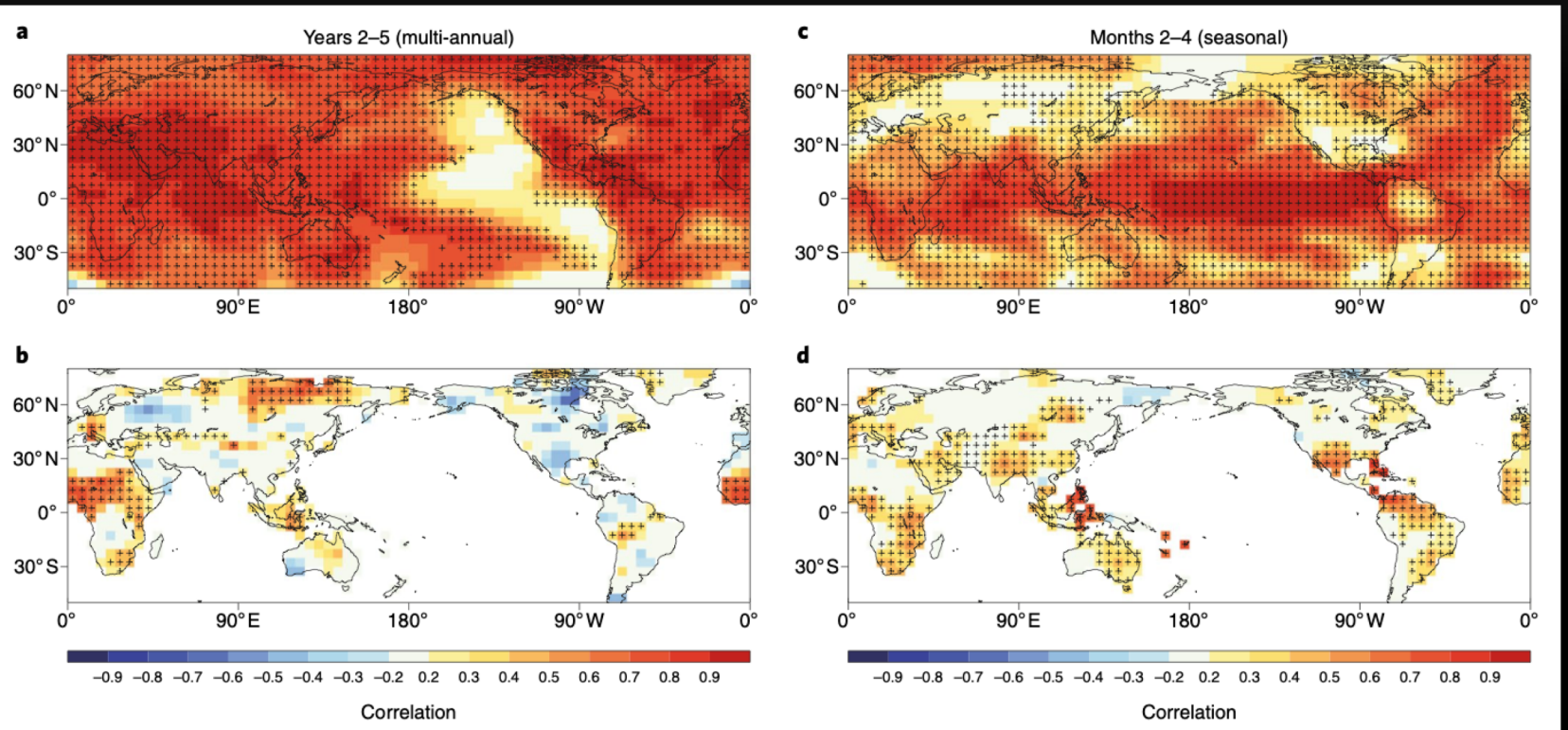

Fig. 2 | Near-term (decadal) forecast skill, compared with the skill of operational seasonal forecasts. a, The correlation between the years 2–5 average of predicted surface air temperature and observations. **b**, The same as **a** but for precipitation. **c**, Correlation between the seasonal forecast for months 2–4 of surface air temperature and observations. **d**, The same as **c** but for precipitation. The near-term forecast skill in **a** and **b** was calculated from hindcasts performed by the UK Meteorological Office decadal prediction system DePreSys[8], between 1960 and 2005. The seasonal forecast skill in **c** and **d** was calculated from operational forecasts that were issued by one of the 12 Global Producing Centres of the WMO[14].

- The skill of NTCP of temperature and precipitation is comparable to operational seasonal forecasting in terms of ACC.
- The temporal resolutions of these predictions, however, are different: the skill of multiyear averages is assessed for NTCP, whereas the skill of seasonal predictions is assessed using multi-month averages.

Kushnir et al. 2019

Benefits of NTCP for preparedness and adaptation

- Examples of NTCP benefits are relatively limited, primarily due to low awareness in the user community.
  - Skillful prediction of multiannual tropical cyclone frequency can provide useful information to the re-insurance industry.
  - NTCP, employing large ensembles, were used to inform the UK government of flooding risk in 2016.
  - NTCP can be used to calibrate climate change projections and develop users' confidence in climate prediction/projection since NTCP and climate projections often use the same coupled climate models and observational data are available to validate NTCP hindcasts.

Kushnir et al. 2019

Decadal Prediction Initialization

- Internal climate variability can only be predicted skillfully when it is initialized at its correct phase.
- Ocean processes play an important role in decadal/multidecadal variability.
- Ocean initialization is thus critical for the skillful prediction of internal variability and is at the heart of the decadal prediction/predictability problem.
  - For example, the initialization of the AMOC is critical for the skillful prediction of the AMV and its associated impacts.
- Challenges to initialize a coupled GCM:
  - Subsurface ocean observations are sparse.
  - Models may drift from the observation to their preferred biased climatology, which leads to biases in forecasts. In some cases, the model drift occurs rapidly after initialization, which is called ” initialization shock”.

References

- Athanasiadis, P.J., Yeager, S., Kwon, YO. et al. Decadal predictability of North Atlantic blocking and the NAO. Nature npj Clim Atmos Sci 3, 20 (2020). https://doi.org/10.1038/s41612-020-0120-6
- Chang, C., & Wang, Z. (2020). Multiyear Hybrid Prediction of Atlantic Tropical Cyclone Activity and the Predictability Sources, *Journal of Climate*, *33*(6), 2263-2279.
- Eade, R., D.M. Smith, A.A. Scaife, E. Wallace, N. Dunstone, L. Hermanson and N. Robinson, 2014: Do seasonal to decadal climate predictions underestimate the predictability of the real world? Geophys. Res. Letts., 41, 5620-5628, DOI: 10.1002/2014GL061146
- Kushnir, Y. et al., 2019: Towards operational predictions of the near-term climate. Nature Climate Change, Vol 9, pp 94-10
- Smith et al. 2019: Robust skill of decadal climate predictions, Nature npj Climate and Atmospheric Science (2019)2:13 ; https://doi.org/10.1038/s41612-019-0071-y
- Smith, D. M., et al, 2020, North Atlantic climate far more predictable than models imply, Nature, 583, 796-800, doi:10.1038/s41586-020-2525-0