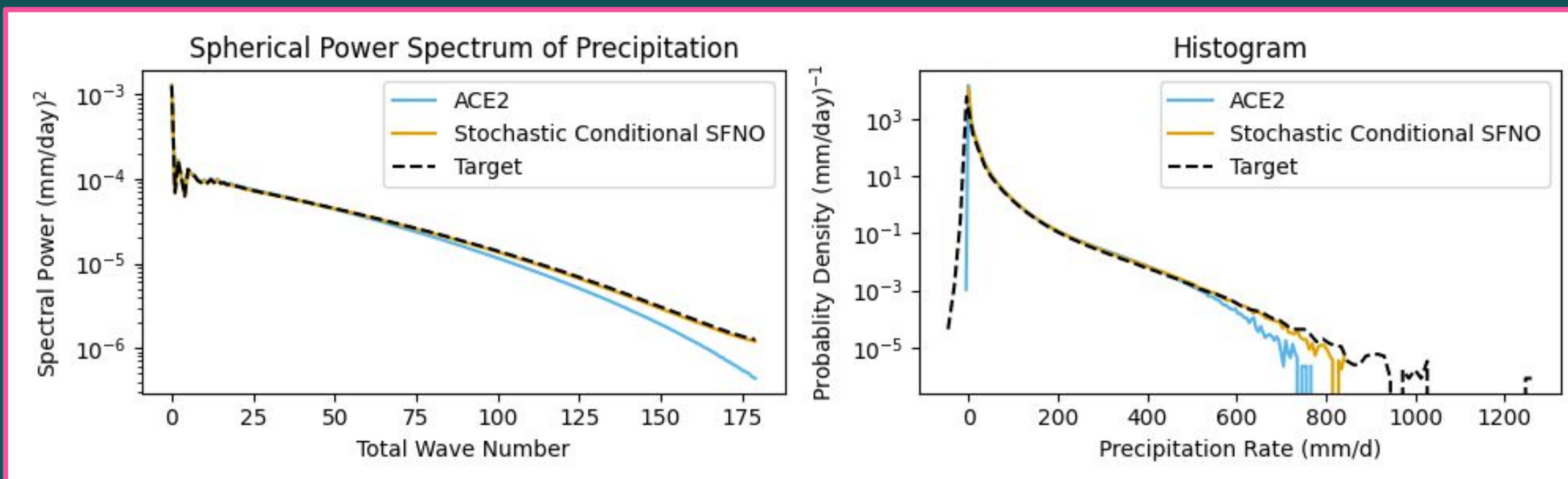


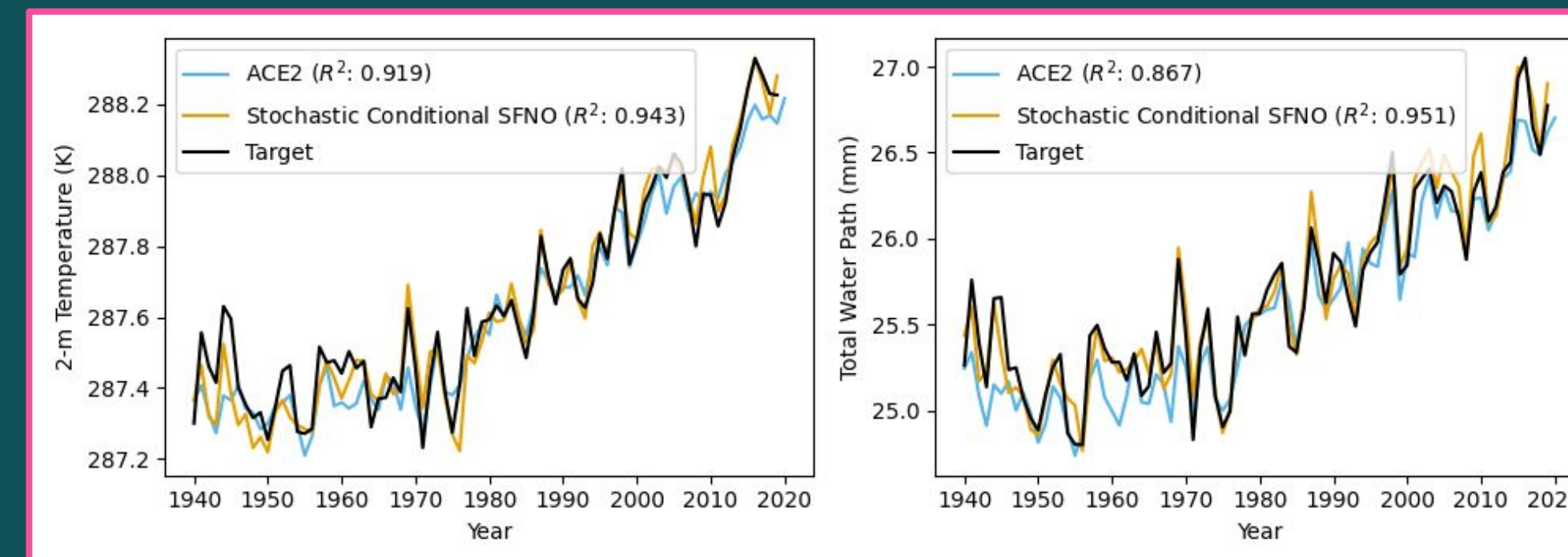


Emulating Climate Across Scales with Conditional Spherical Fourier Neural Operators

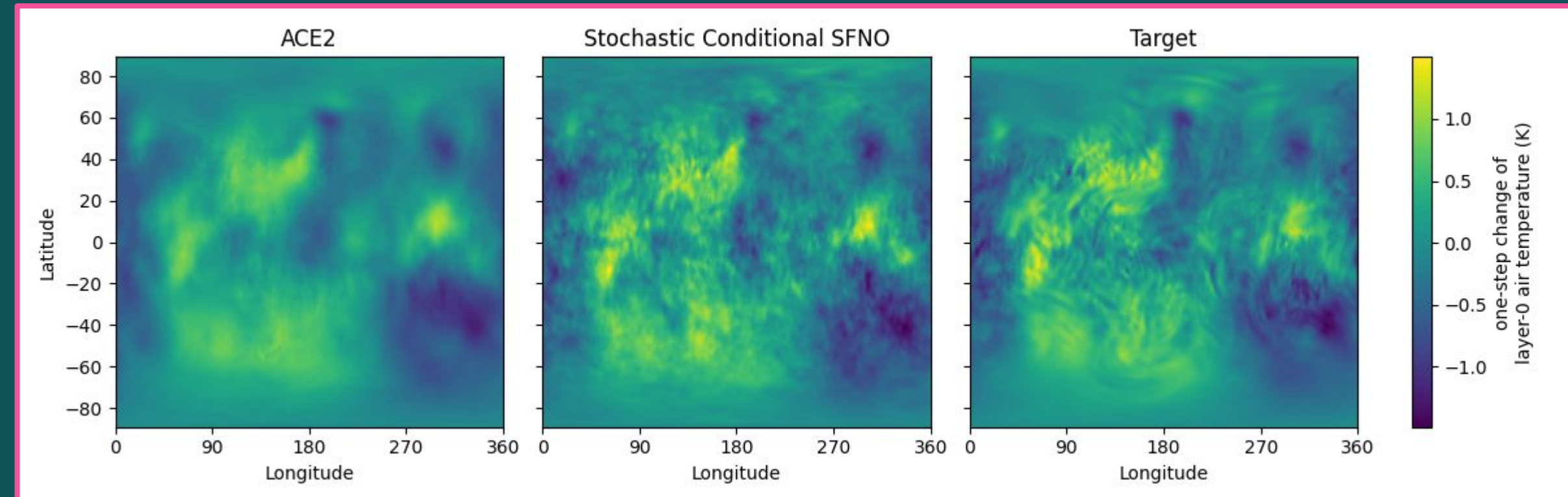
Correct 81-year small-scale power



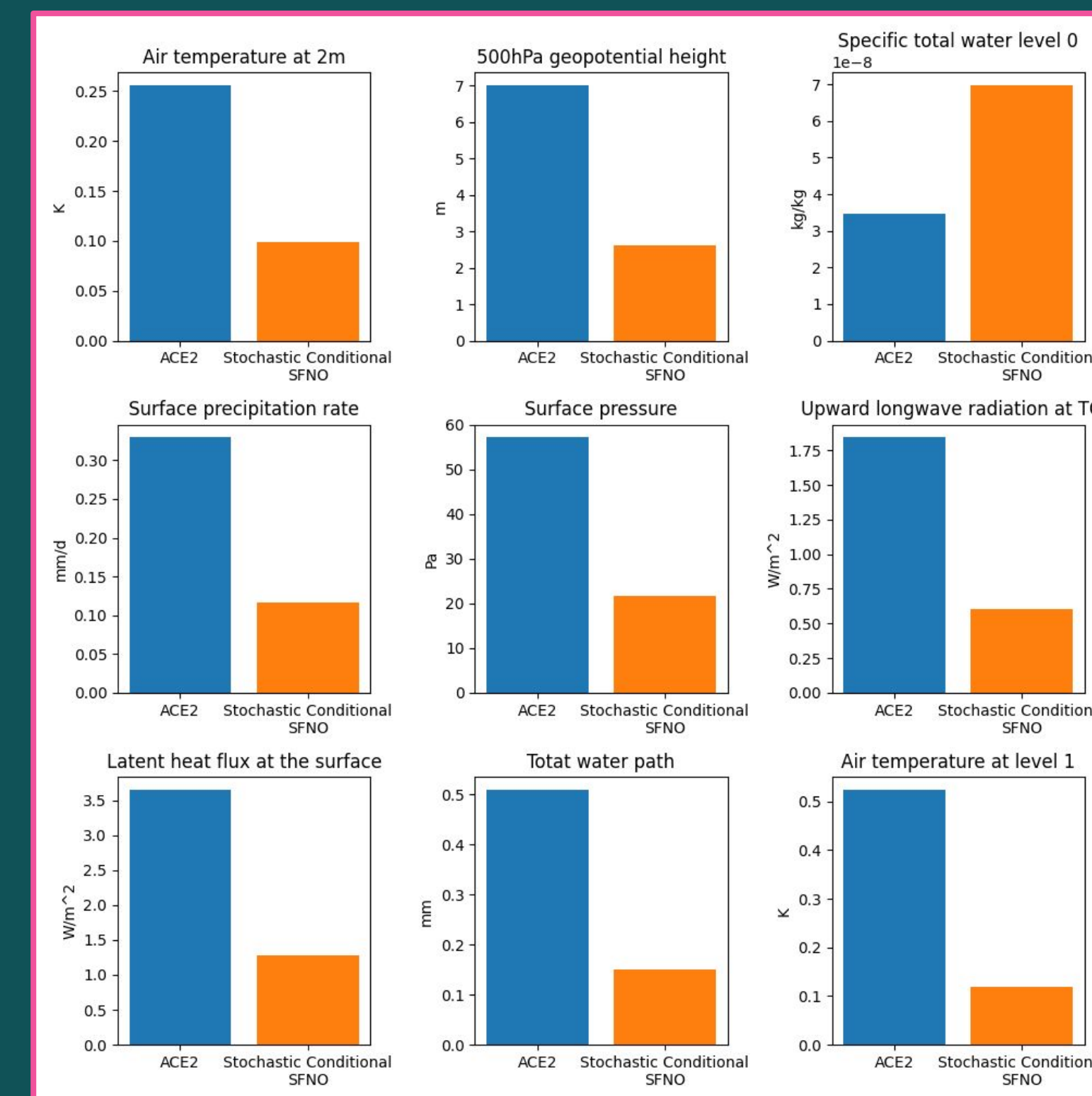
Better Interannual Variability



1-step Eyeball Check



Improved time-mean biases, RMSE of 81-year time-mean

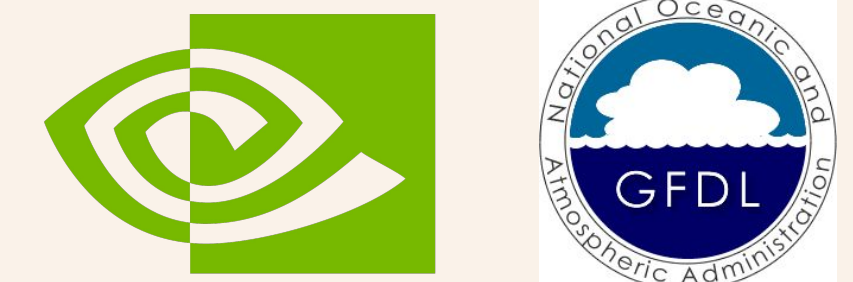


Stochastic Changes

- Instance Norm → Conditional Layer Norm
- Condition on isotropic noise inputs
- Loss: real CRPS + 2D energy score on spectral coefficients
- Train 1-step prediction for up to 20-steps lead time

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Elynn Wu,
Christopher S. Bretherton

with thanks to our collaborators



Stay tuned for
our downscaling
paper!

Comparisons are against ACE2-SHIELD, [Watt-Meyer et al. 2025](#),
an emulator of the SHIELD model forced using historical data.