

Super-Resolving Coarse-Resolution Weather Forecasts with Flow Matching

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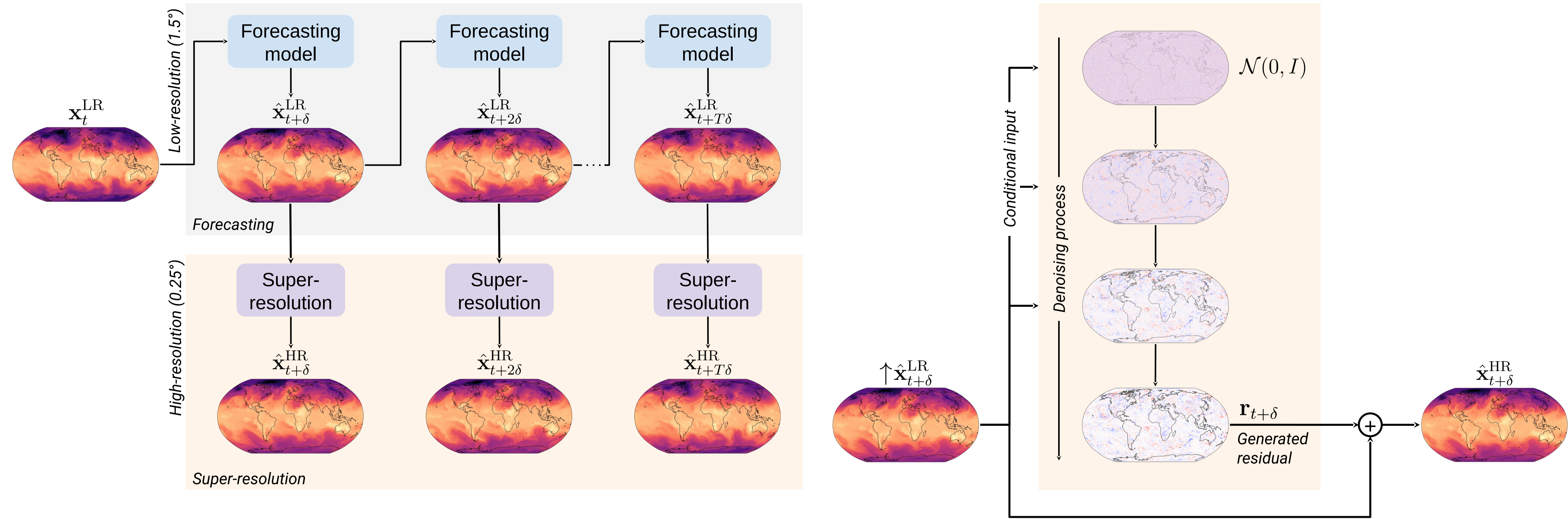
Forecasting and spatial resolution don't have to be solved together.

Why it matters

- Local impacts—heavy precipitation, strong winds, tropical cyclones—are governed by fine-scale structure that coarse models cannot resolve
- Training at high resolution remains out of reach for most research groups

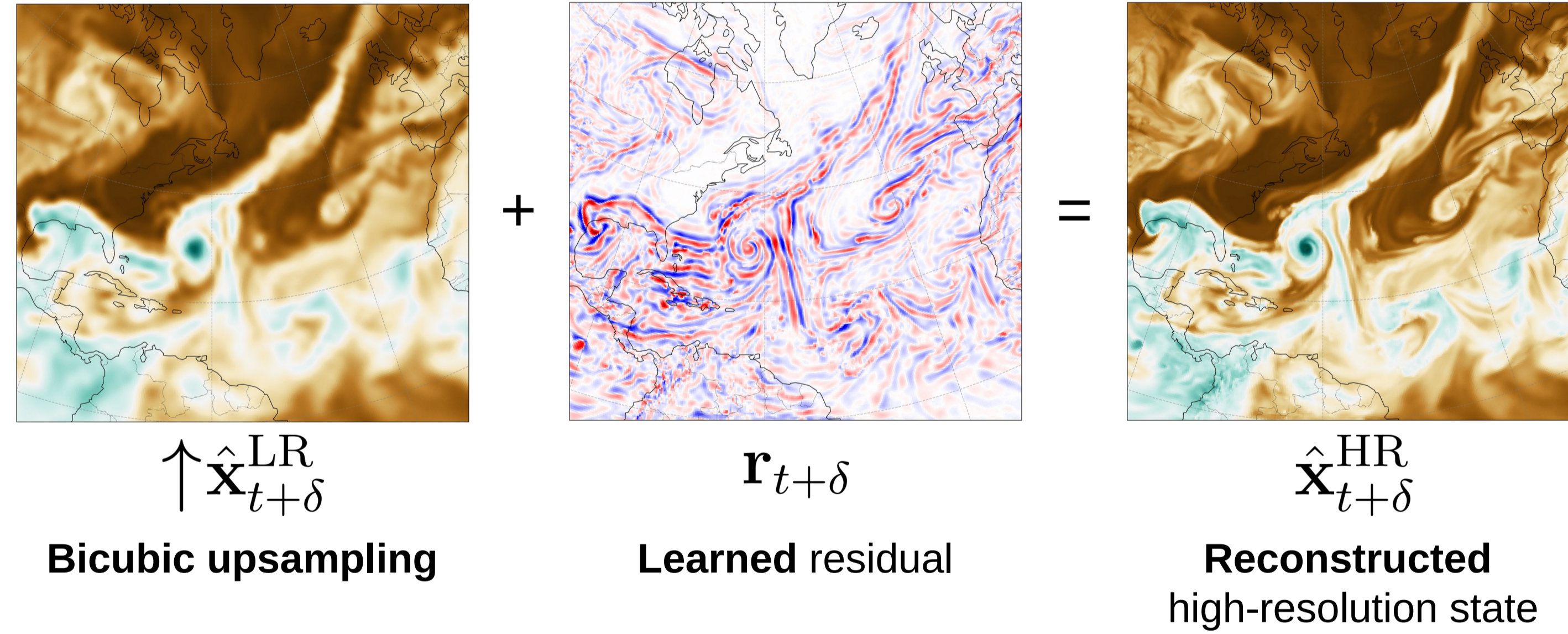
Highlights

- Trained on ERA5 only, zero-shot transfer to any physically coherent forecasting model
- Full pipeline trains in 30 A100-days; GenCast requires 480 A100-days at 0.25°
- Preserves the skill of the base forecasting model while reconstructing physically realistic fine-scale variability



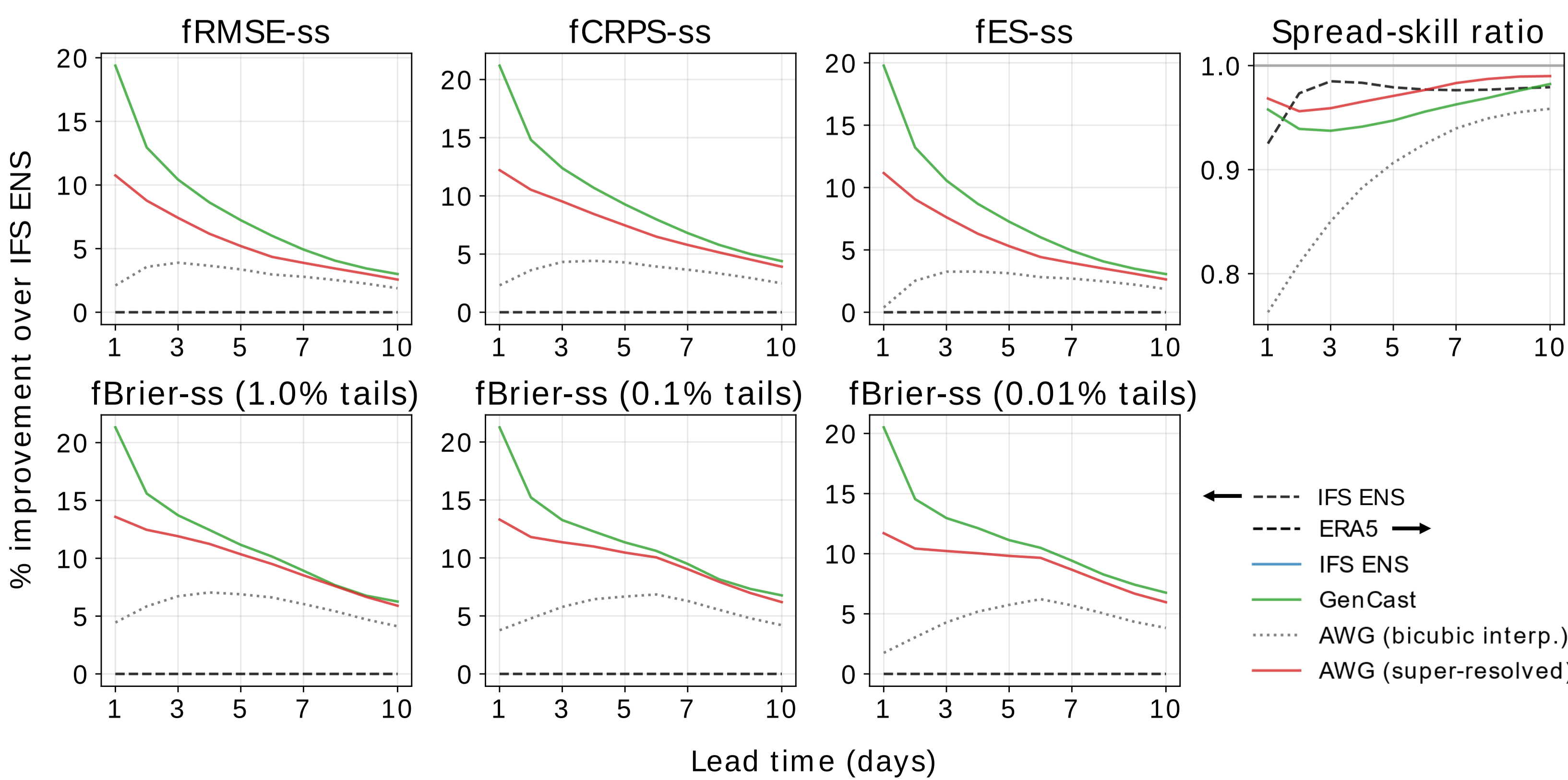
Problem formulation & method

Given a coarse trajectory \mathbf{x}_t^{LR} , reconstruct a high-resolution trajectory \mathbf{x}_t^{HR} . We model the residual via flow matching, learning $p(\mathbf{r}_t | \uparrow \mathbf{x}_t^{\text{LR}})$.



Weather forecast skill

Competitive probabilistic skill at 0.25°, at a fraction of the cost of end-to-end high-resolution training.



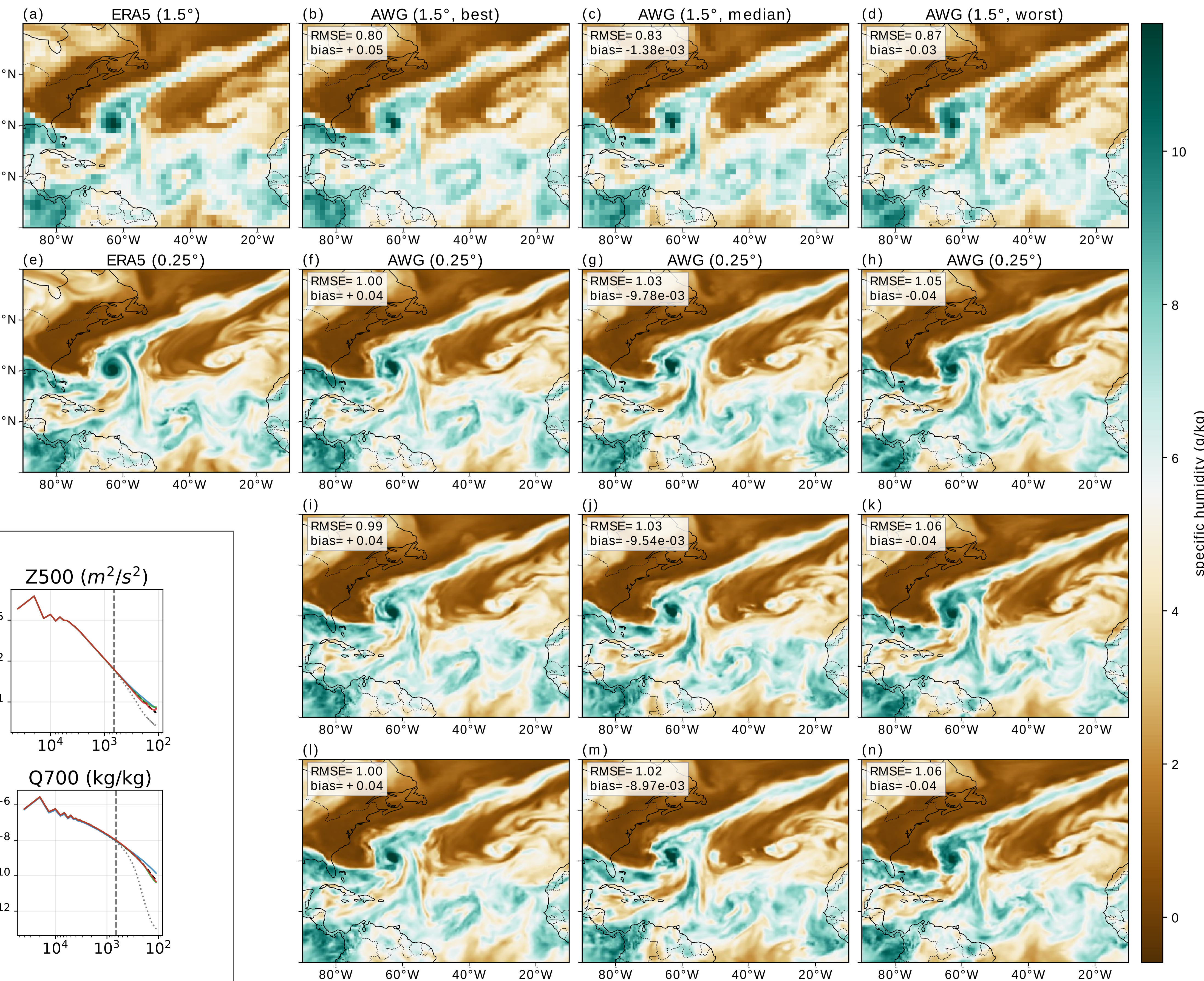
Code



Paper



Case study: Hurricane Teddy



Spectral analysis

Super-resolution introduces physically consistent subgrid scales while leaving the resolved-scales dynamics unchanged.

