Statistical downscaling for regional climate

Presented by

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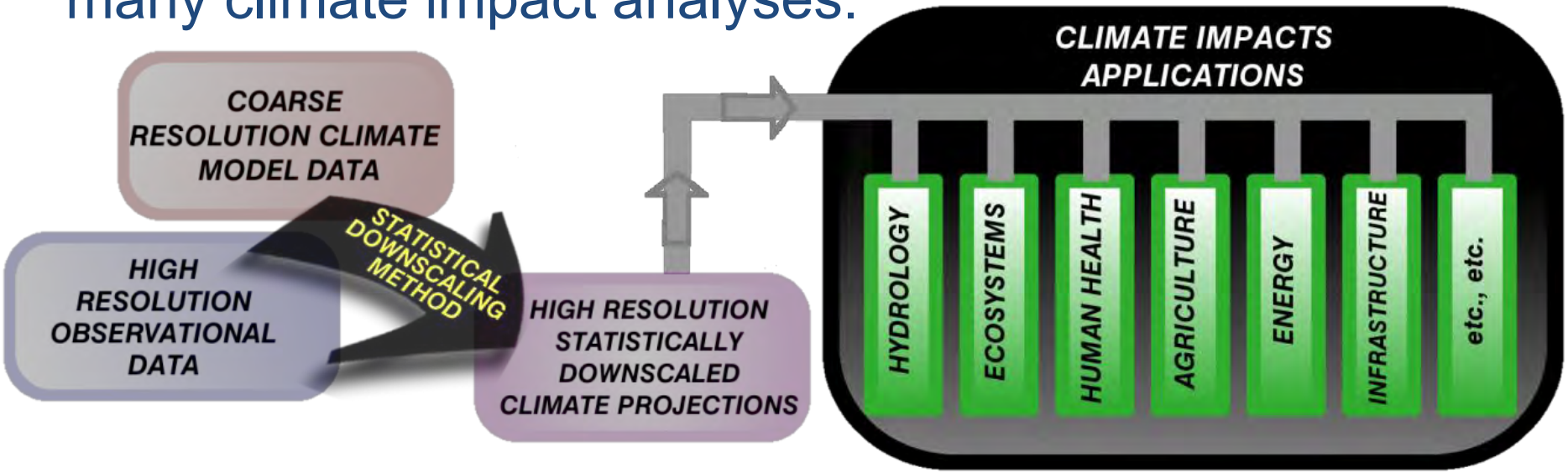
What is statistical downscaling?

(aka empirical statistical downscaling or ESD)

A statistical refinement of dynamical model output, informed by observations.

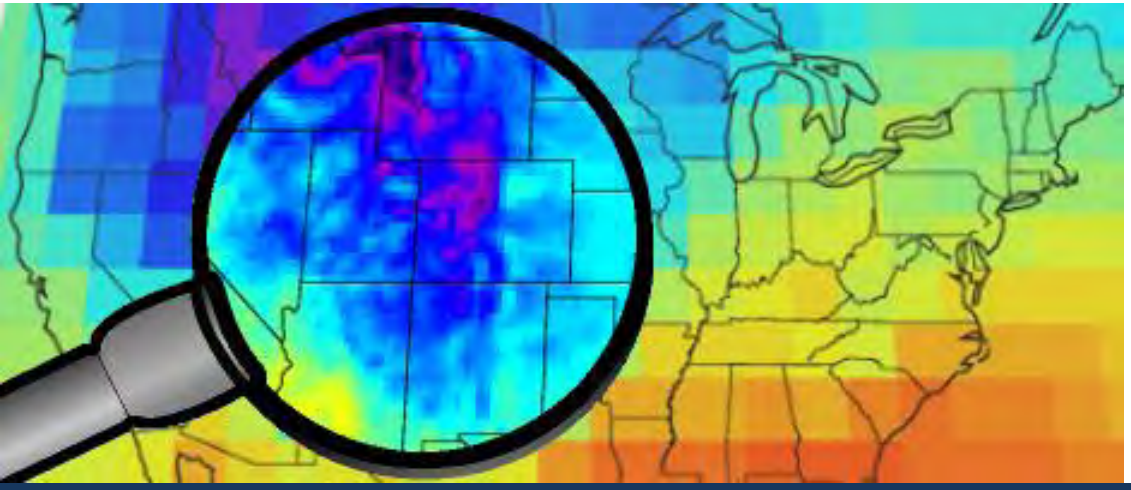
ESD-processed climate projections are generally considered to be “value-added” products & are used in many climate impact analyses.



Benefits of pursuing ESD at GFDL

- **Analysis of GCMs:** an ESD method challenges GCMs with observations, as it seeks to identify and address shortcomings in the GCM-simulated climate.

- **ESD Development:** our analysis framework has isolated weakness in some ESD methods, leading to improvements.



- **Stakeholders:** generating info & guidance on ESD methods used for decision-support.

Building ESD science & IT capacity

ESD-related research is relatively new at GFDL.

Pursued by building in-house expertise and via collaborations.

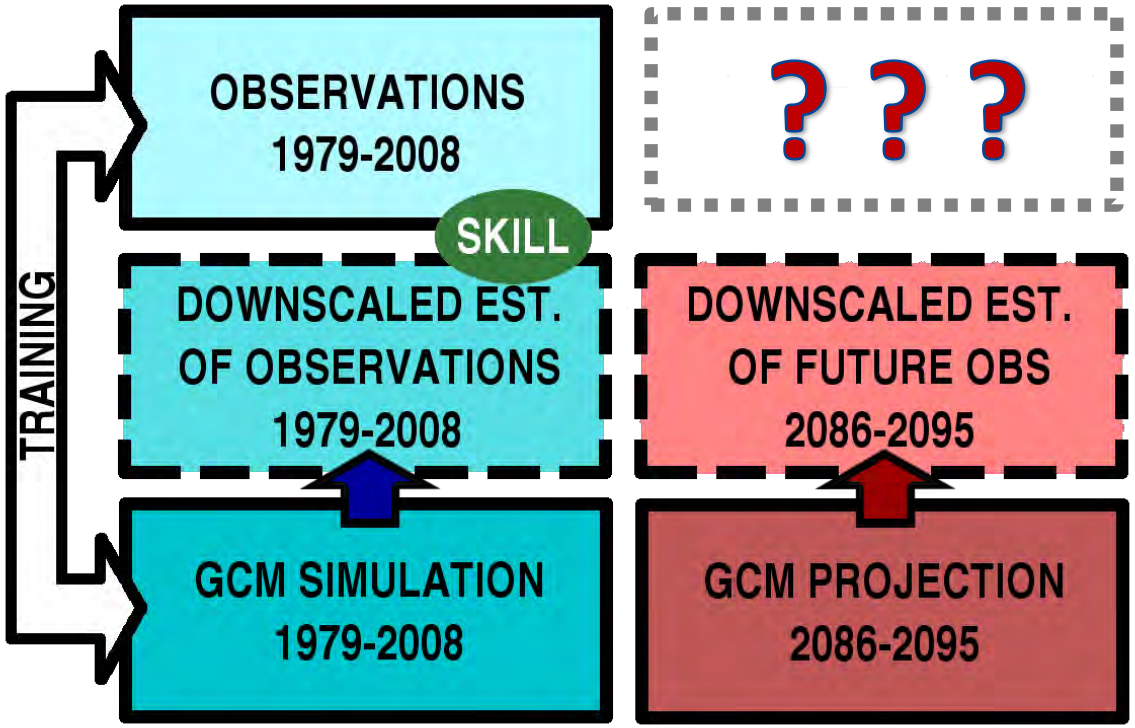
ESD research requires relatively modest compute power but software & data support is critical.

Univ. of Oklahoma & Texas Tech

Testing the ESD 'stationarity assumption'

Assumption: the statistical relationships between GCM output and observed climate data utilized by ESD techniques to produce downscaled projections remain constant over time.

Lack of future obs precludes straightforward testing.



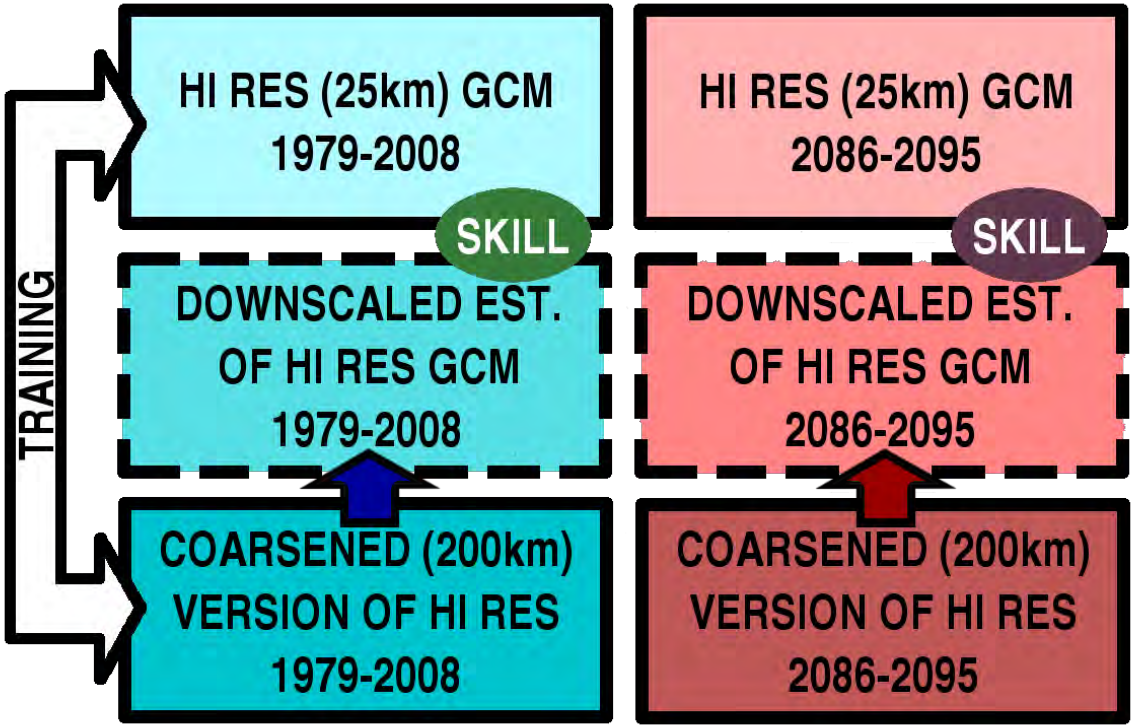
Testing the ESD 'stationarity assumption'

Our 'perfect model' experimental design allows for the quantitative testing of stationarity.

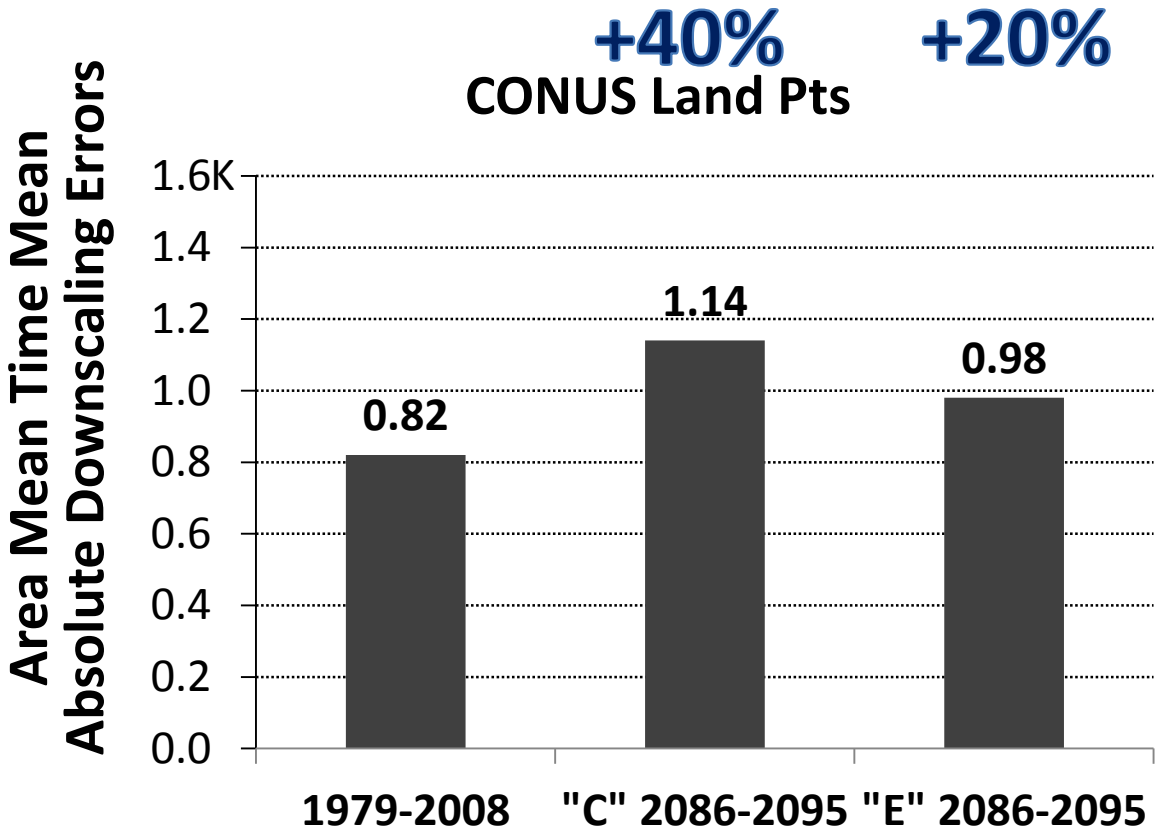
substituting HiRes GCM for Obs
(GFDL HiRAM C360)

&

substituting smoothed version of HiRes GCM for usual GCM output



An example of perfect model results

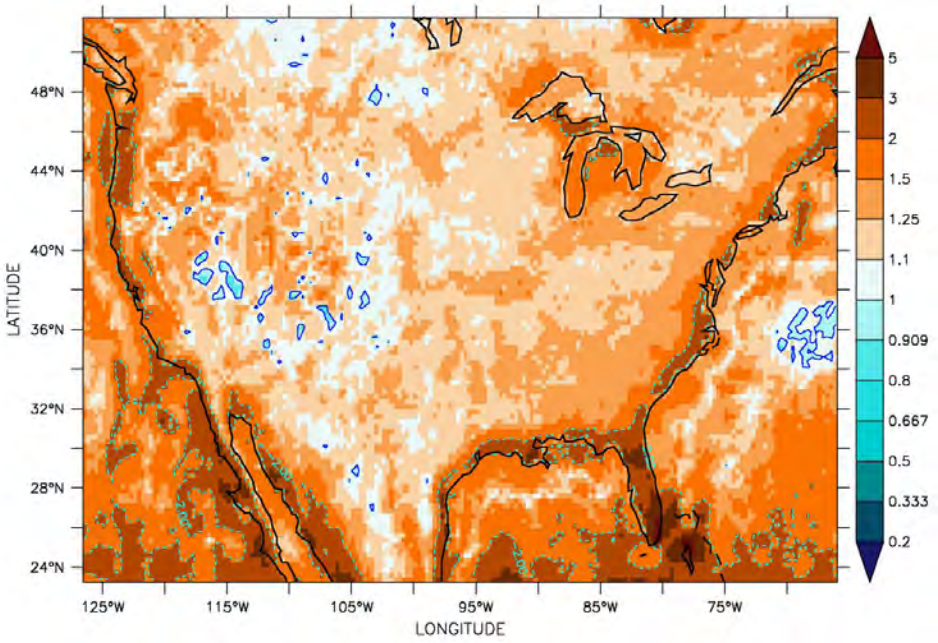


Averaged over the contiguous US, MAE for Tmax grows 20% for ~5K warming case and ~40% for ~7K warming case, for the ESD method shown here.

<u>Stationarity Assumption Does Not Hold:</u> ARRM method downscaling errors are larger for daily max temp at end of 21stC than for 1979-2008.

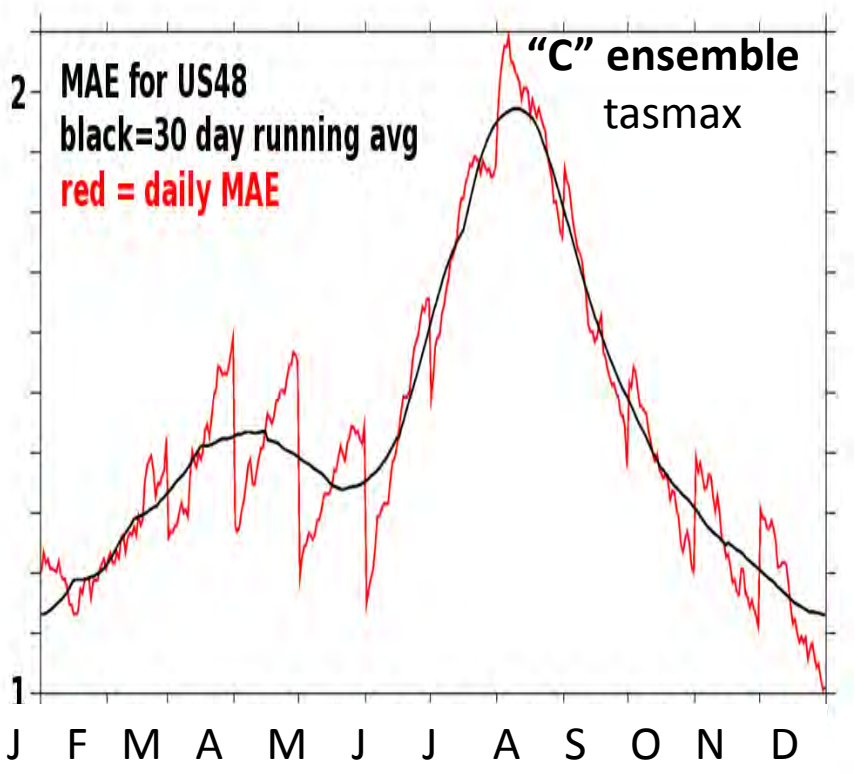
Also study variations by region, season, and variable of interest.

ESD performance varies by region & season



Ratio of the Mean Absolute Downscaling Error

$$\frac{\text{“C” 2086-2095 MAE}}{\text{1979-2008 MAE}}$$

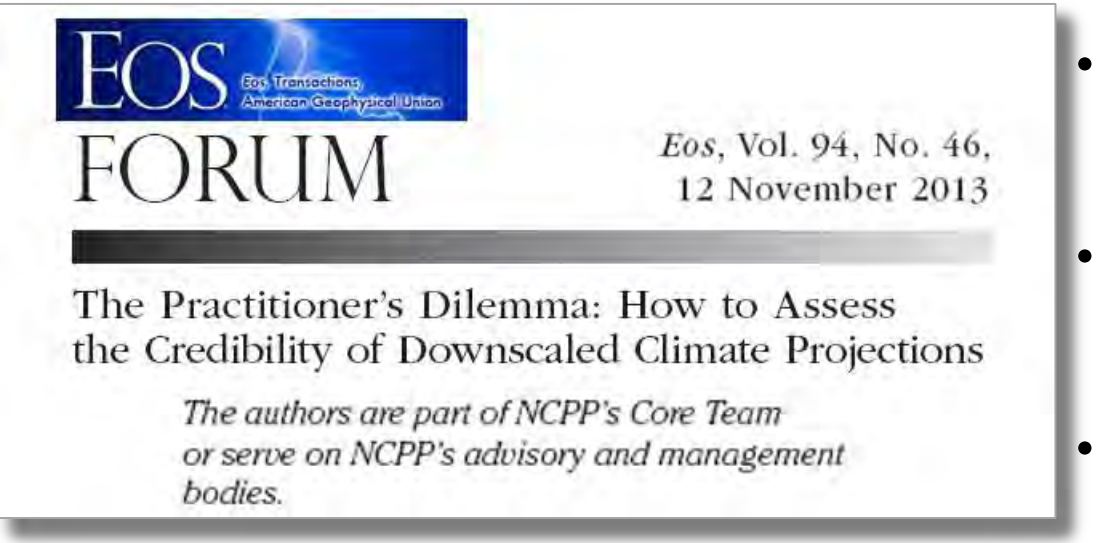


A clear intra-month MAE trend in some months

ARRM method downscaling errors are larger for daily max temp at end of 21stC than for 1979-2008; Larger along coasts and in summer.

Summary

- GFDL's relatively new statistical downscaling research effort aims to aid the analysis of GCMs, the development of ESD methods, & yield decision-support relevant guidance.
- Building a foundation based on a perfect model evaluation framework that tests a critical, but often overlooked assumption inherent to ESD products.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The Practitioner's Dilemma: How to Assess the Credibility of Downscaled Climate Projections

The authors are part of NCPP's Core Team or serve on NCPP's advisory and management bodies.

Next steps:

- Incorporate observation-based data sets into framework to test a range of ESD sensitivities.
- Address ESD method weaknesses exposed by perfect model evaluation.
- Apply to time scales from seasonal to multi-decadal.