

Statistical Downscaling

Statistical Downscaling: Methods

- Different statistical downscaling methods (Wilby and Wigley 1997; Schoof 2013)
 - 1) scaling methods
 - 2) regression-based approach
 - 3) weather pattern-based approach
 - 4) analogue forecasts
 - 5) weather generators

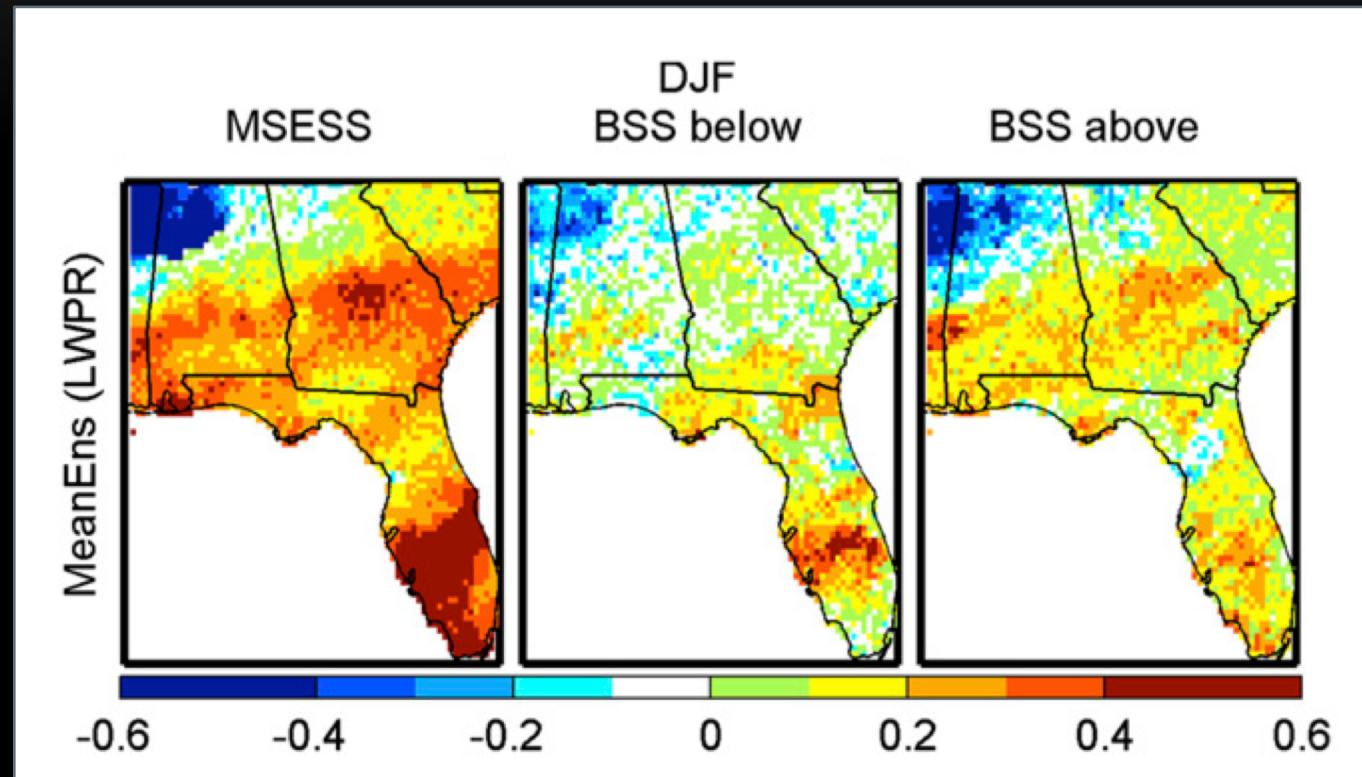
2) Regression Based Approach

Some examples:

- Multi-linear regression: predictors can be the grid-point values of variables from a coarse-resolution model or the principal components (PCs) of a field variable from a coarse-resolution model.
- Artificial neural networks can be used when the predictor–predictand relationship is nonlinear.
- The generalized linear modeling framework provides a flexible technique when the predictand is non-Gaussian.

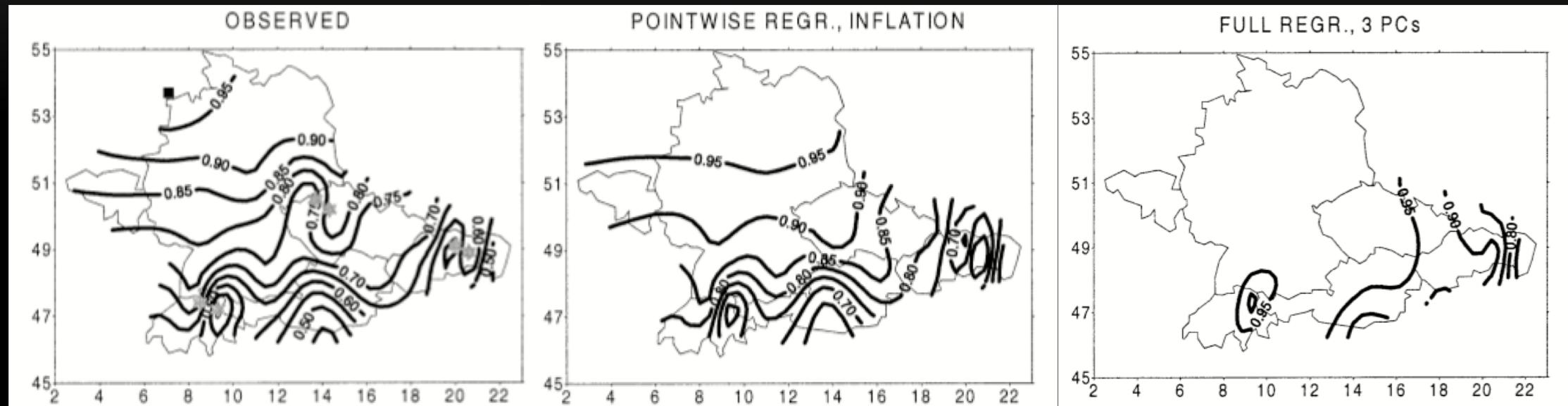
Example 1: Prediction of Precipitation Using a Climate Mode Index

- Tian et al. (2014) predicted local-scale precipitation over the southeastern US using the forecasts of the Niño3.4 SST from the North American Multimodel Ensemble (NMME).
- Regression models were first trained using the observed Niño-3.4 SST and the observed precipitation for each season and each grid point, and then these trained models were applied to the bias-corrected SST prediction to predict precipitation.



The mean squared error skill score (MSESS) and the Brier skill score (BSS) of DJF precipitation prediction. The model shows positive skill over Southeast U.S. (Fig. 13 in Tian et al. 2014)

Example 2: Pointwise vs. PC-based Regression



Spatial correlations with the station of Norderney (square in the left panel) for obs and different downscaling methods. Huth (2002) © American Meteorological Society. Used with permission

- Huth (2002) tried different multi-linear regression models: (i) stepwise screening of PCs of the predictor field(s), and (ii) stepwise screening of gridded values (“pointwise regression”). The potential large-scale predictors include 500-hPa heights, sea level pressure, 850-hPa temperature, and 1000–500-hPa thickness.
- In observations, T correlation gradually decreases with an increasing distance and is modulated by elevation. In PC-based regression, correlation decreases too slowly with an increasing distance because of a dominance of one PC and little effect of other PCs. This performance, however, may be different for other predictions.

3) Weather-pattern Based Approach

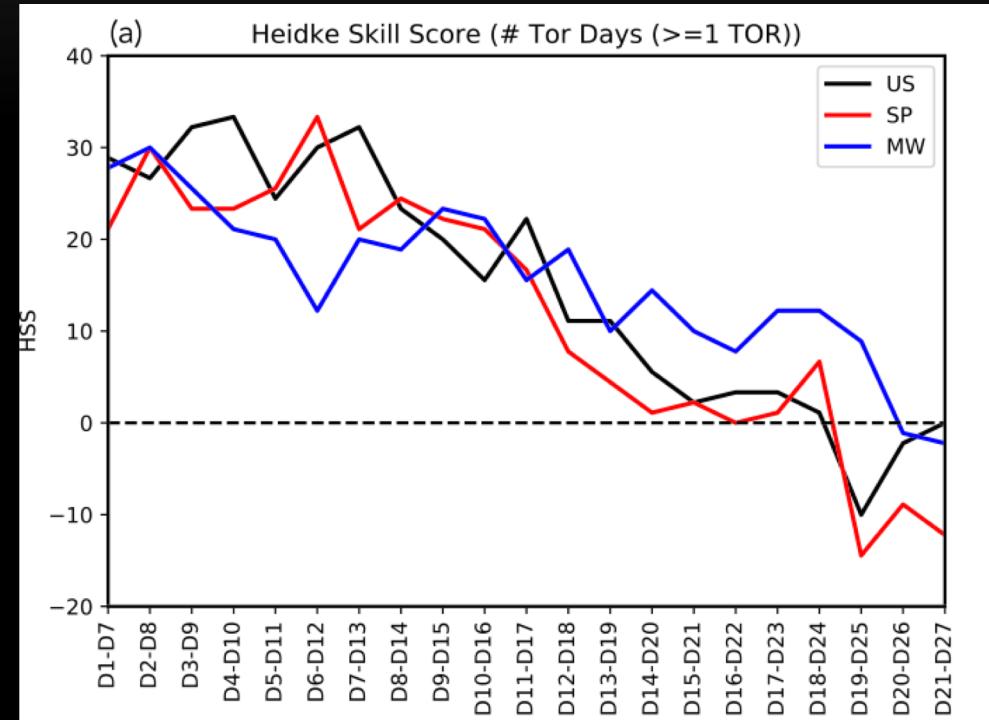
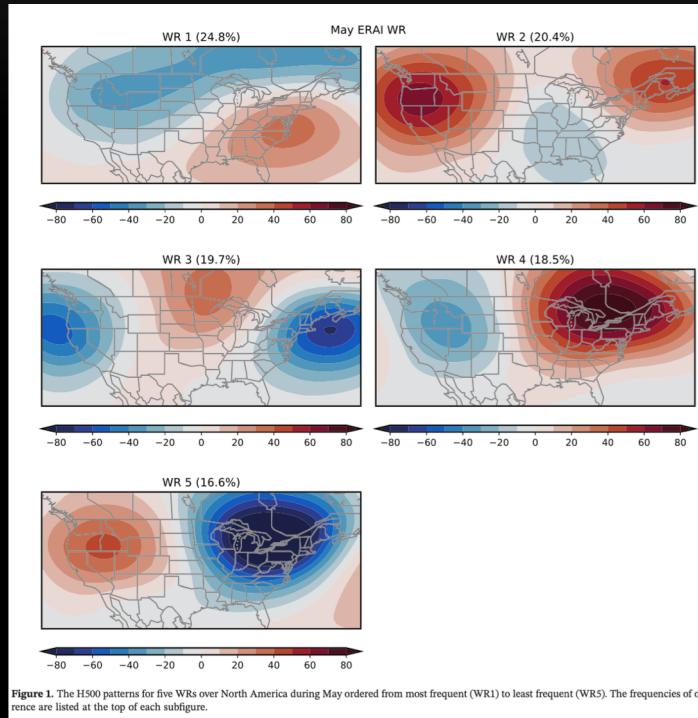
- Weather classification methods group days into a finite number of discrete weather types or “regimes” according to their synoptic similarity. The weather type information is then used as predictors to predict regional climate information or mesoscale phenomena that are not well represented by global models.
- Strengths:
 - yields physically interpretable linkages to surface climate
 - can be applied to various regional climate variables
- Weaknesses:
 - Circulation-based schemes can be insensitive to future climate forcing (thermodynamic conditions also matter)
 - May not capture intra-type variations in surface climate.

3) Weather-pattern Based Approach (cont'd)

Some specific methods:

- Analog methods: the historical record is searched for a pattern matching the climate simulated pattern. The observations of the predictand during the historical analog are then used to estimate the predictand.
- Weather-regime based methods: weather regimes are identified from the climate model prediction and are used as predictors. Self-organizing maps have also been applied within a downscaling context.

Example: Weather-regime Based Downscaling



Miller et al. (2020) used the model predicted weather regime frequency to predict weekly tornado activity. Skillful predictions are achieved out to Week 3 for the United States and the subregions analyzed.

References

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