A New Metric to Quantify the Added Value of Regional Models

A Look at the Added Value Index (AVI) and an Application of the Intensity-Scale Technique

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The Motivation:

Often a visual inspection of skill (temporal correlation) for a regional downscaled model shows small areas of high skill surrounded by areas of poor skill. We have developed a metric to quantify the increase in area with high skill (as compared to the global model that forced the downscale run), without punishing the model for areas with low skill. This method is created so that it is ideal for comparing models of different resolutions.

Examples:

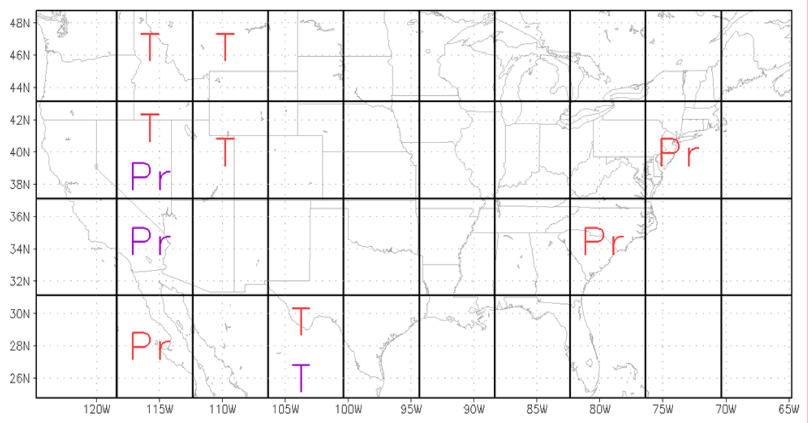
Two data sets were used to look at the AVI:

-a multi-model ensemble (70 members, 20 years) created from the Multi-Regional Downscale Project (MRED) forced by NCEP's CFS global model

-a 6 member, 50 year AMIP ensemble of the ECPC RSM forced by the ECPC GSM

Both data sets were downscaled over the US. The AVI and temporal correlation for precipitation and 2m temperature were computed for the JFM seasonal mean for each grid box shown to the right.

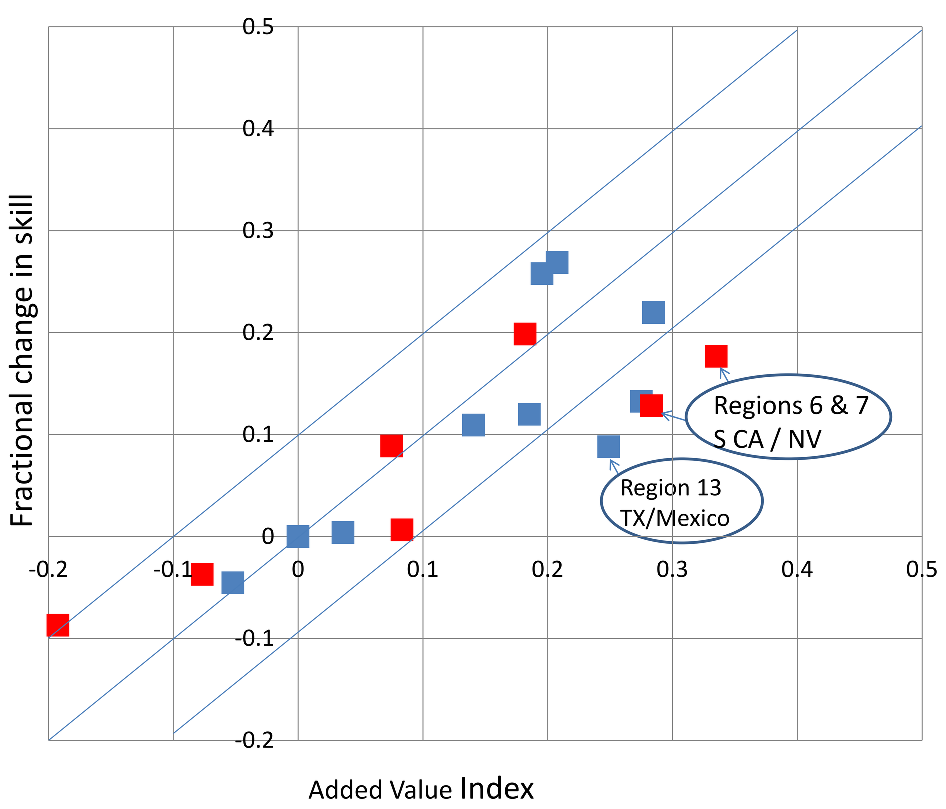
Regions used in computing AVI



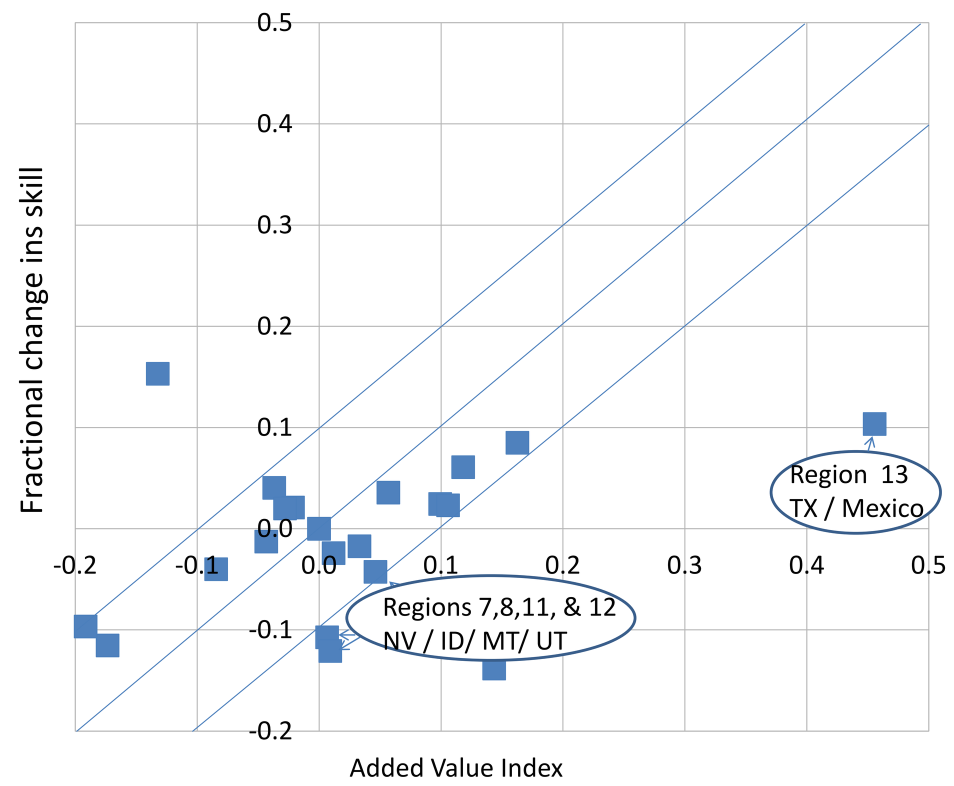
Regions with letters indicate the AVI is providing additional information to the area averaged temporal correlation. Purple is for the MRED run, red is for the AMIP run.

Comparison of AVI and Change in Temporal Correlation

MRED Multi-Model 2mT (blue) & Precip (red)



AMIP 2mT



The points between the upper and lower diagonal lines are regions where area averaged temporal correlation and AVI show similar results. The points below the lower line are from regions where the AVI shows a much greater increase in skill than temporal correlation. (Positive numbers indicate the downscale has greater skill than the forcing global model. Only regions with skill greater than 0.25 are shown).

MRED	fraction skill increase	AVI	X-point
Region 13 (2m T) TX / Mexico	0.13	0.28	0.55
Region 7 (precip) Nevada	0.13	0.27	0.51
Region 6 (precip) S California	0.08	0.25	0.6

The tables show details for the points of interest from the plot above. For example, in Southern California the area averaged skill from the MRED data shows an 8% improvement from downscaling. However, the AVI shows a 25% increase in skill when only considering skill levels > 0.6. Here, the AVI shows a very large added value that would not be seen from other skill measures.

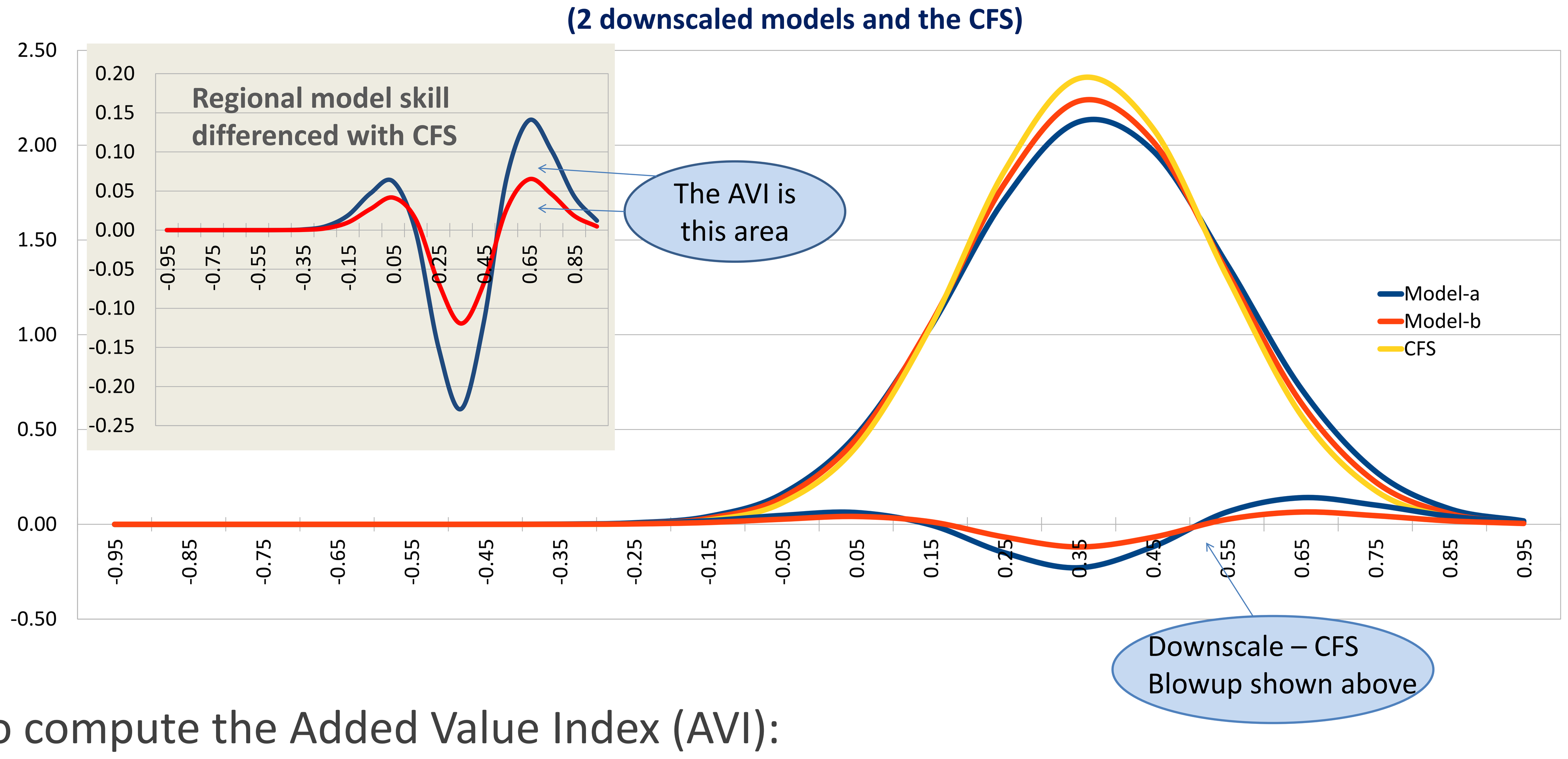
AMIP (2mT)	fraction skill increase	AVI	X-point
Region 7 Nevada	-0.11	0.01	0.63
Region 8 Idaho	-0.12	0.01	0.71
Region 11 Utah	-0.14	0.14	0.31
Region 12 Montana	-0.04	0.05	0.50
Region 13 TX / Mexico	0.10	0.46	0.53

From the AMIP data in Utah the AVI shows a 14% increase in skill with skill levels > 0.31, but a 14% decrease with area averaged skill. This suggests that when the global model has poor skill, the downscale decreases the skill, but the downscale improves the skill of skillful areas from the global forcing model.

How it works:

Example of Normalized Distribution of Skill

(2 downscaled models and the CFS)



To compute the Added Value Index (AVI):

-Find the distribution of skill (temporal correlation) over a given domain for each model.

-Fit a normalized curve to each distribution.

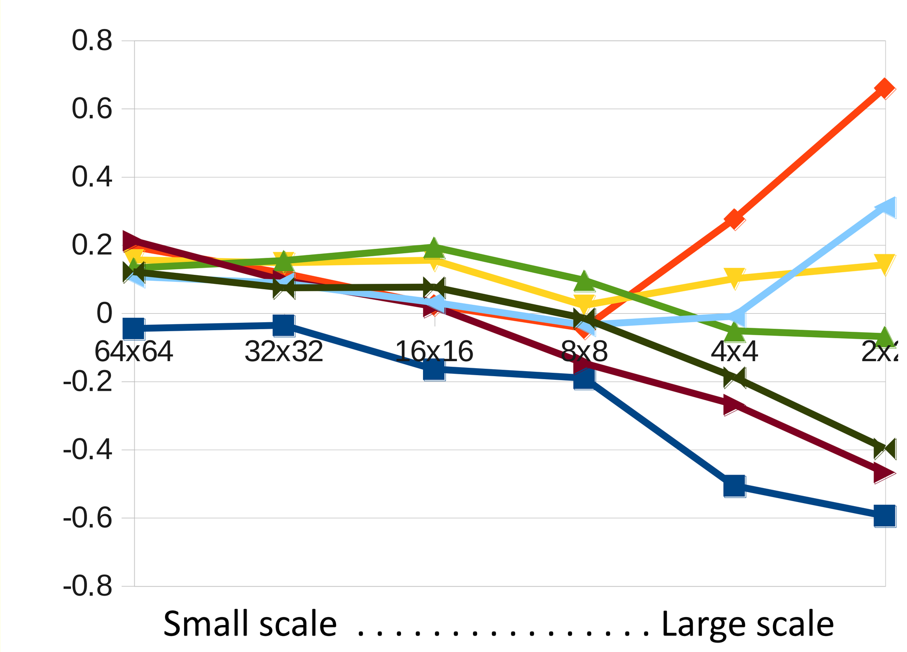
(These curves are shown for one large scale model (CFS) in yellow and 2 downscaled models in blue and red)

The AVI is given by the point where the 2 curves cross, and then the area between the curves to the right of the cross point. It can be interpreted as the percent increase (or decrease) in skill above the value of the cross point.

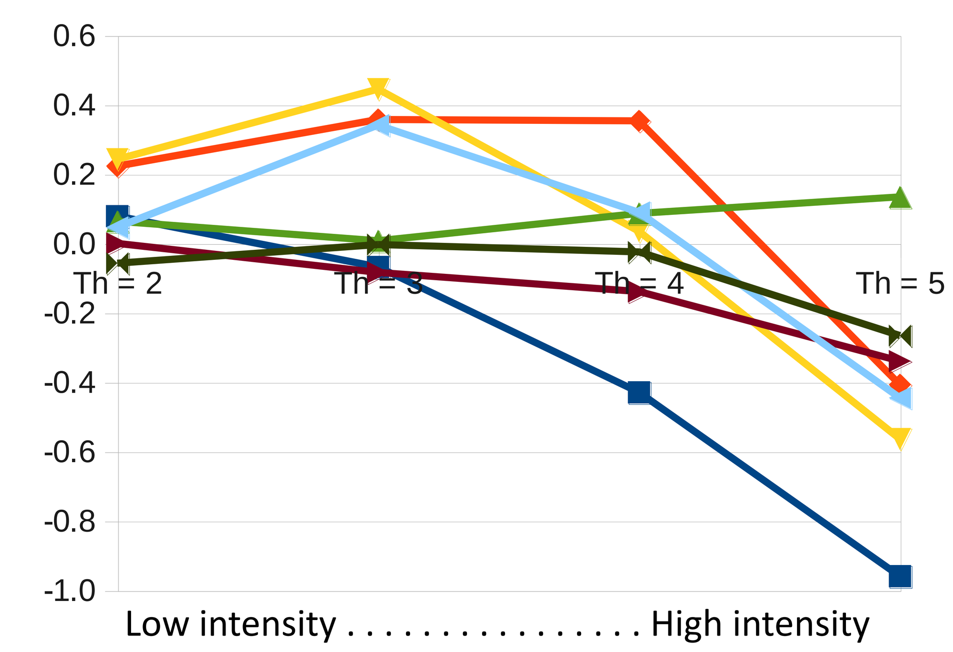
In the example, both downscaled models have fewer points than the CFS in the skill range of 0.15 to 0.5, and more points with skill above 0.5. The increase in points with skill above 0.5 is larger for model-a (blue) than model-b.

Using the Intensity-Scale Verification Technique for Downscaling

Mean Square Error Difference vs Scale



Mean Square Error Difference vs Intensity



These plots show the difference in Intensity-Scale mean square error between the 7 downscaled MRED models and the global forcing model for JFM precipitation. **Positive values mean the downscaled models have more error.** The results are for the eastern half of the US.

Another verification method that is useful for comparing the skill of a downscaled model with the global forcing model is the Intensity-Scale technique based on Casati (2010, *Weather & Forecasting*). In this method mean square error is computed as a function of both scale and intensity. The ability to look at scale separately makes it an ideal method for comparing models of different scales. The preliminary results here show little reduction in error with the downscale for most scales. However, there is a fairly consistent decrease in error at large precipitation intensities, suggesting the downscaled models are more skillful with convective precipitation.

Reference: Kanamitsu, M., and L. De Haan (2011), The Added Value Index: A new metric to quantify the added value of regional models, J. Geophys. Res., 116, D11106.

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