Quantifying the overall added value of dynamical downscaling and the contribution from different spatial scales

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Motivation of the study

- An essential requirement for RCMs is that they improve the representation of the climate compared to the global driving data (GDD), i.e., RCMs produce **added value (AV)**.

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Open question

- Which of these two situations (improvement/deterioration) is more dominant ?
- Do RCMs produce in general a substantial **overall** improvement over the driving data ?

Objectives of the presentation

1. To **evaluate the overall AV** of an ensemble of RCM simulations and its dependence on a variety of factors.
2. To decompose the AV according to the **contribution of different spatial scales** :
   - **large scales :** scales common to both the GDDs and the RCMs
   - **small scales :** scales only represented in the higher resolution RCMs
3. To explore how much of the AV can be attained using **simpler postprocessing methods**.

Two "Added Value" metrics

1. **Mean square error :** relative performance in terms of absolute values :

$$\begin{aligned} AV_{MSE} &= \overline{(X_{GDD} - X_{OBS})^2} - \overline{(X_{RCM} - X_{OBS})^2} \\ &= MSE_{GDD} - MSE_{RCM}. \end{aligned}$$

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- Metrics are **normalized** to allow for comparisons across regions, seasons, etc.
- Quantities vary between -1 and 1 with positive values suggesting that there is some AV.

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1) dx (RCM)	ES	2	10 and 50-km grid spacing
2) RCM	ES	4	R1, R2, R3, ensemble mean
3) GDD	ES	3	NNRP, CCCMA3.1, ECHAM5

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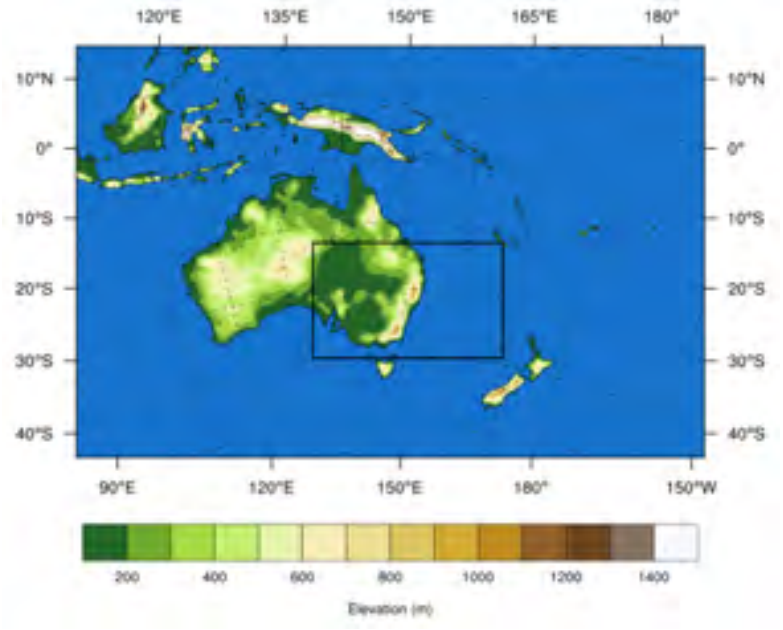
RCM domains

- 50-km over Australasia
- 10-km over south-east Australia



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5) Region	CS	3	coastal, topography, flat
6) Variable	CS	3	Tmin, Tmax, precipitation
7) Measure	CS	3	mean, stddev, 99^{th} percentile

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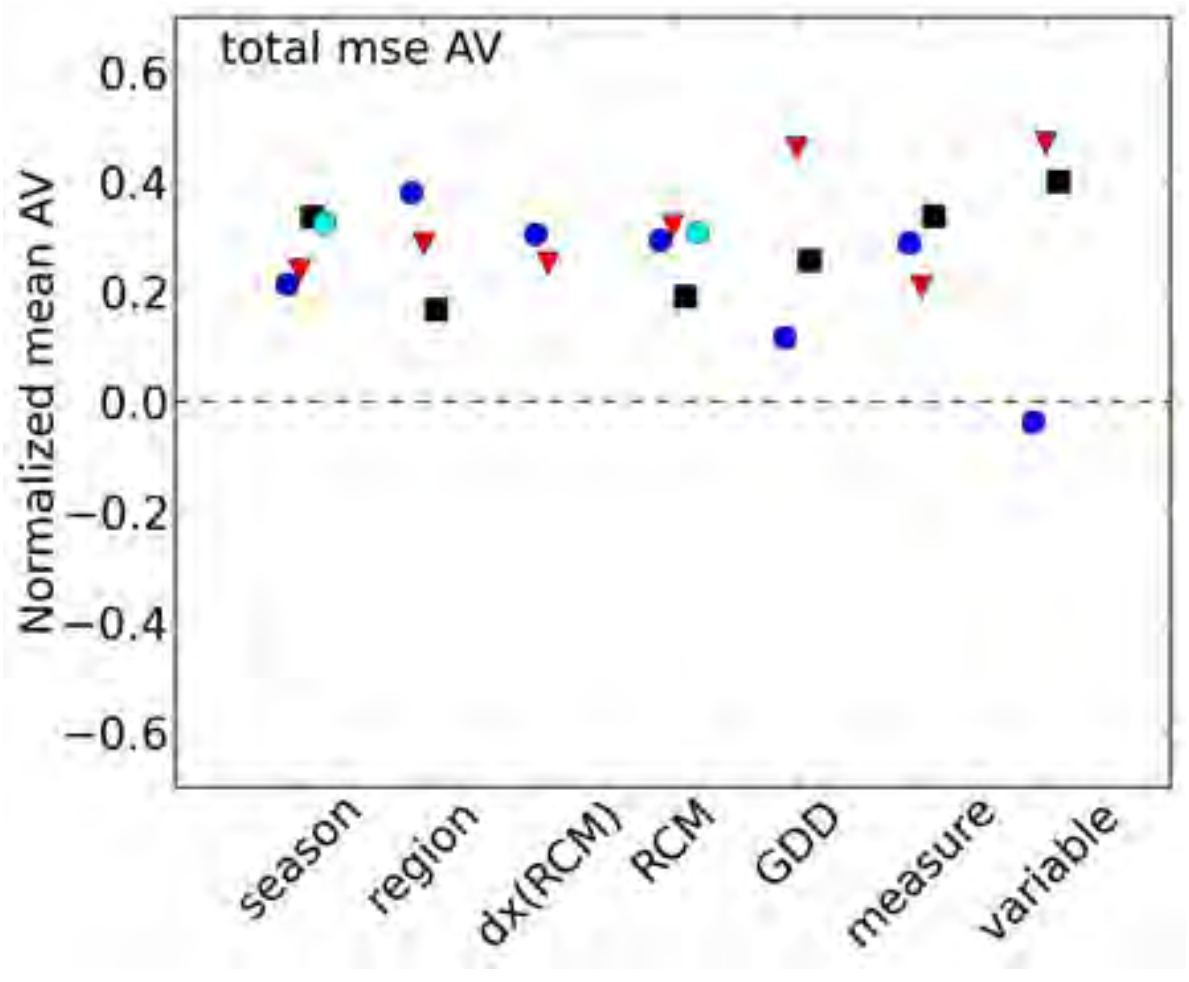
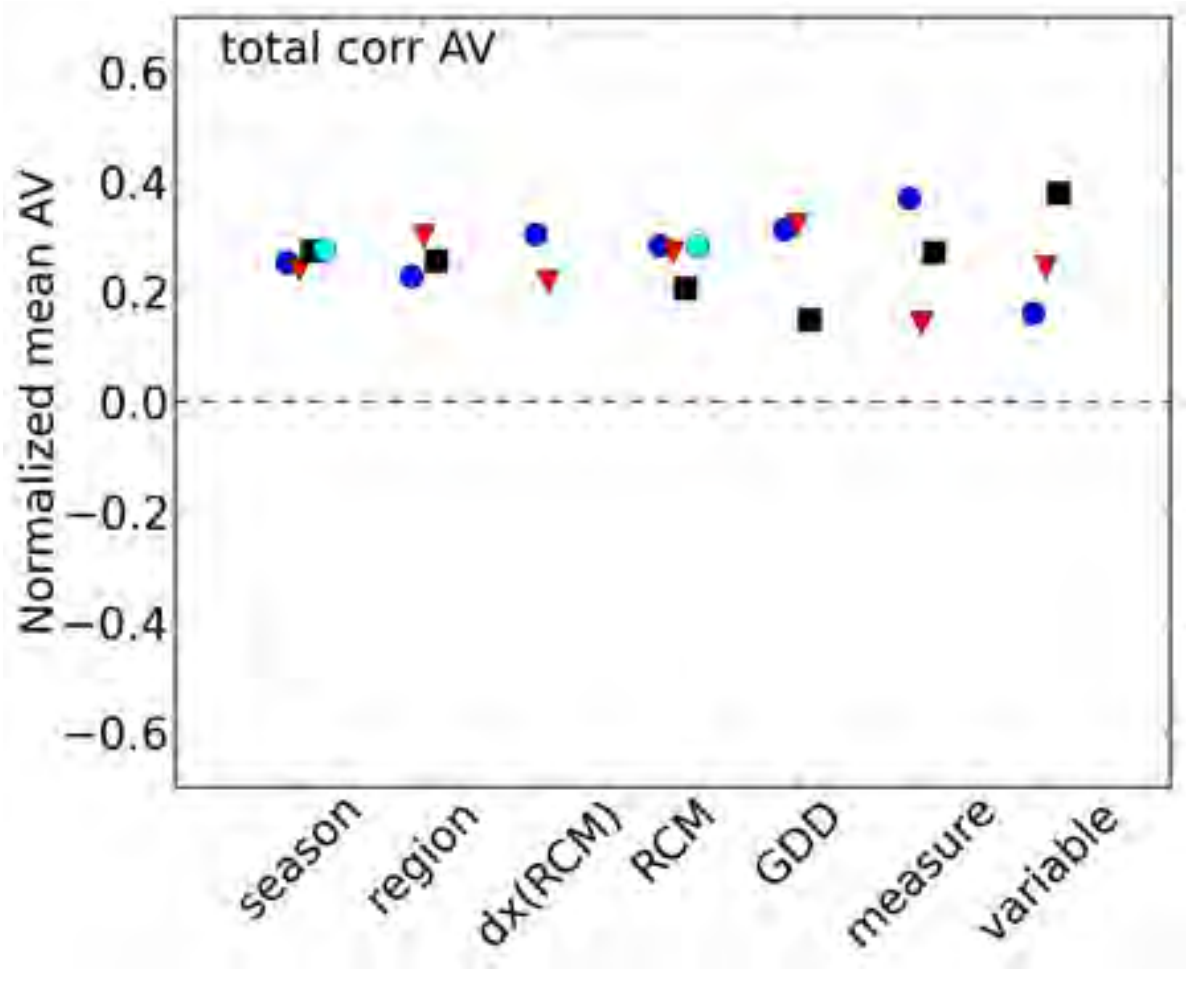
TOTAL NUMBER OF AV ESTIMATIONS : 2592

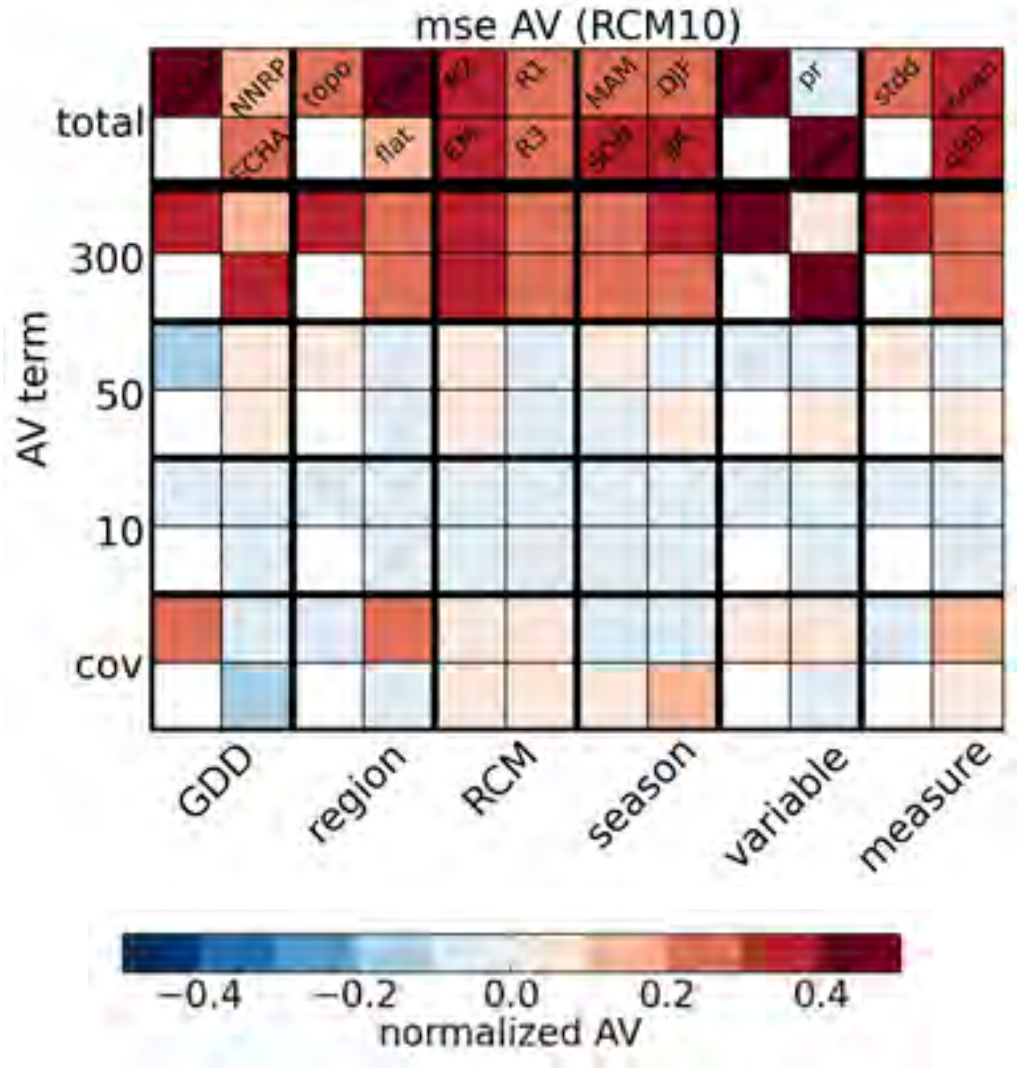
mean square error : $AV = (MSE_{GDD} - MSE_{RCM})/errors_{sum}$



spatial correlation : $AV = (corr(RCM, OBS) - corr(GDD, OBS))/errors_{sum}$



AV as a function of spatial scales



- The AV of MSEs is dominated by the **large scale** term.

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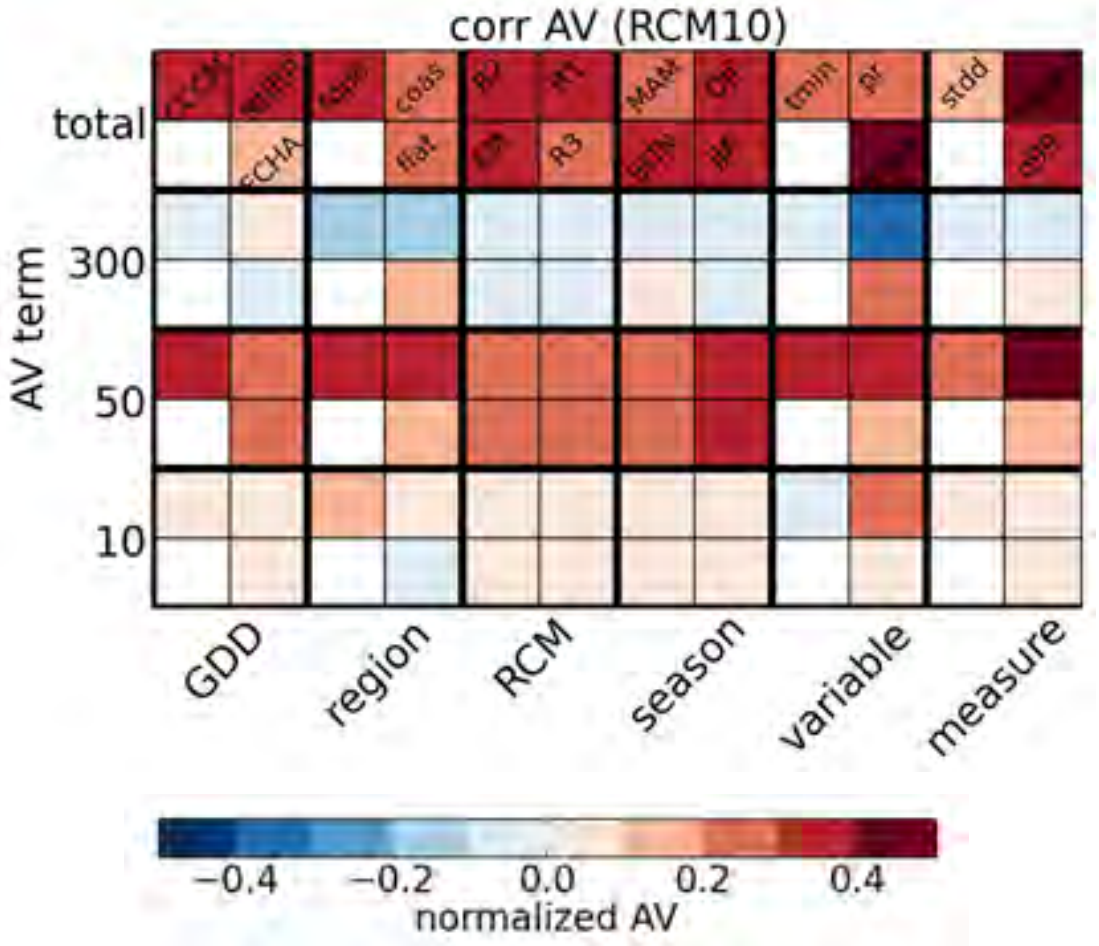

- The AV of MSEs is dominated by the **large scale** term.
- The AV of spatial correlations is dominated by the **small scale** term.

AV with simple GCM-postprocessing : T_{min}

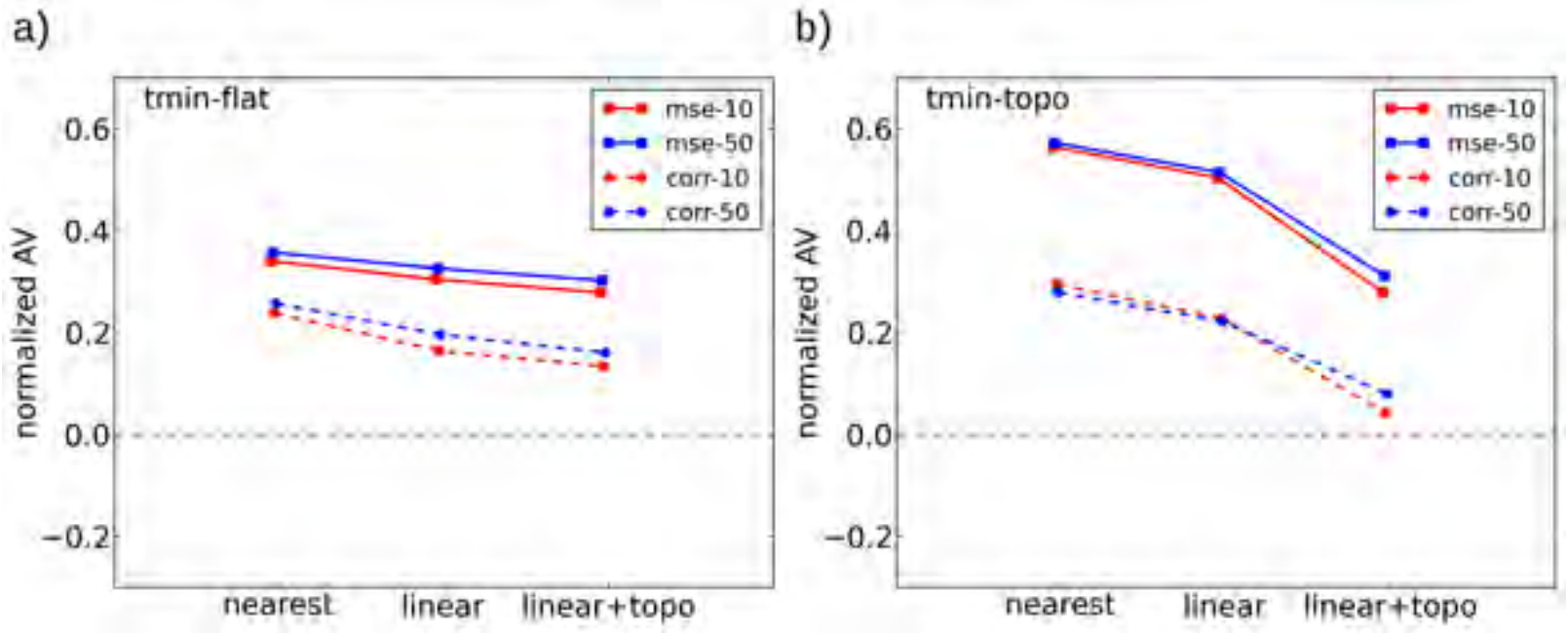

FIGURE : Overall AV for minimum temperature calculated using three different methods to interpolate GCM data.

- In general, about half of the AV in temperature variables can be obtained using simpler postprocessing.

Summary

- For both AV metrics, the overall performance of RCMs is generally superior compared with the corresponding driving data :
  - AV higher and more robust for spatial correlation metric.
- $AV_{MSE} \approx AV_{MSE}^{large\ scales}$
- $AV_{correlation} \approx AV_{correlation}^{small\ scales}$
- A significant amount of the overall AV in temperature variables was shown to be **attained using simpler post-processing** methods.

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Are these results dependent on the specific ensemble used in this study ?

References

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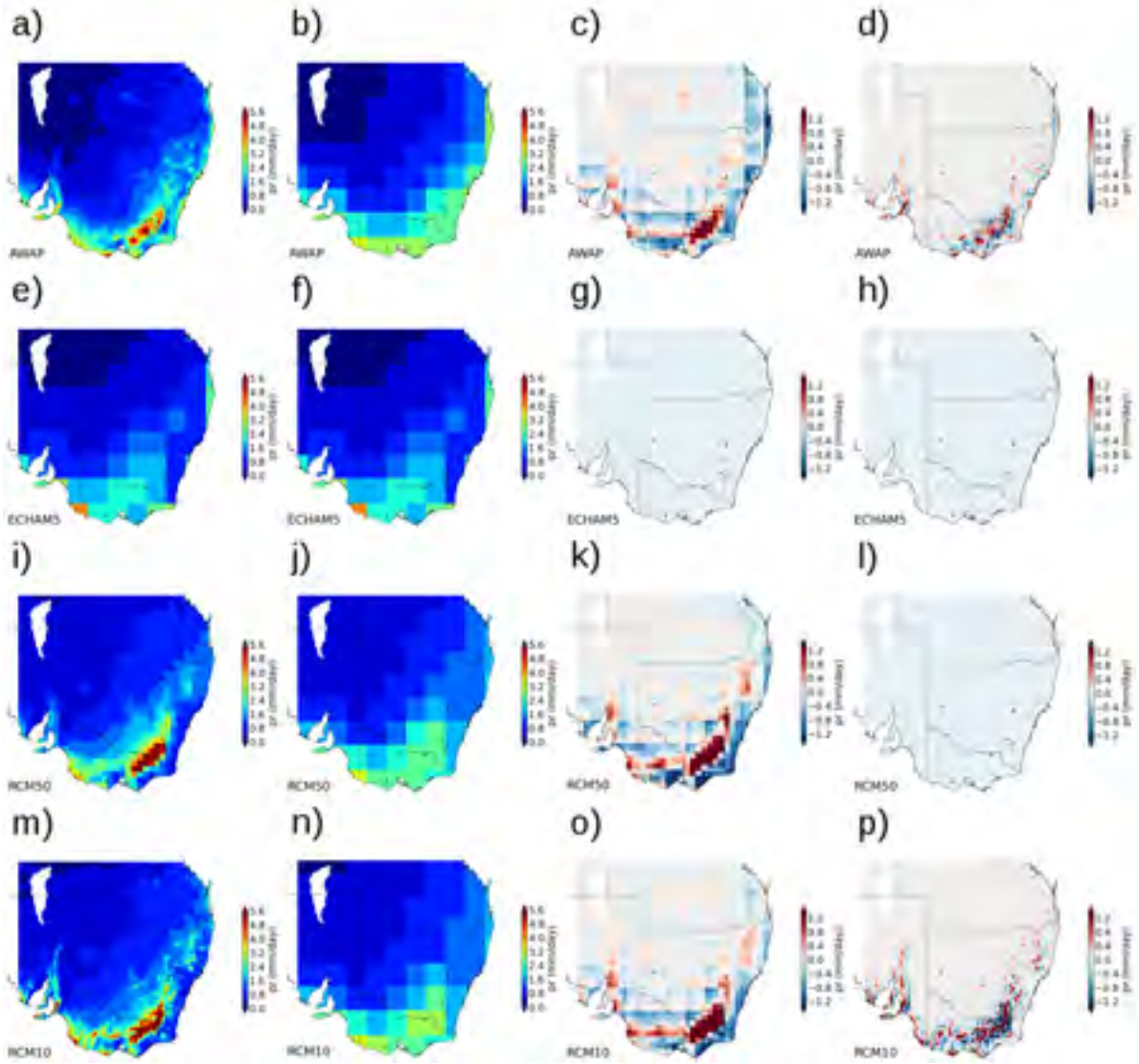
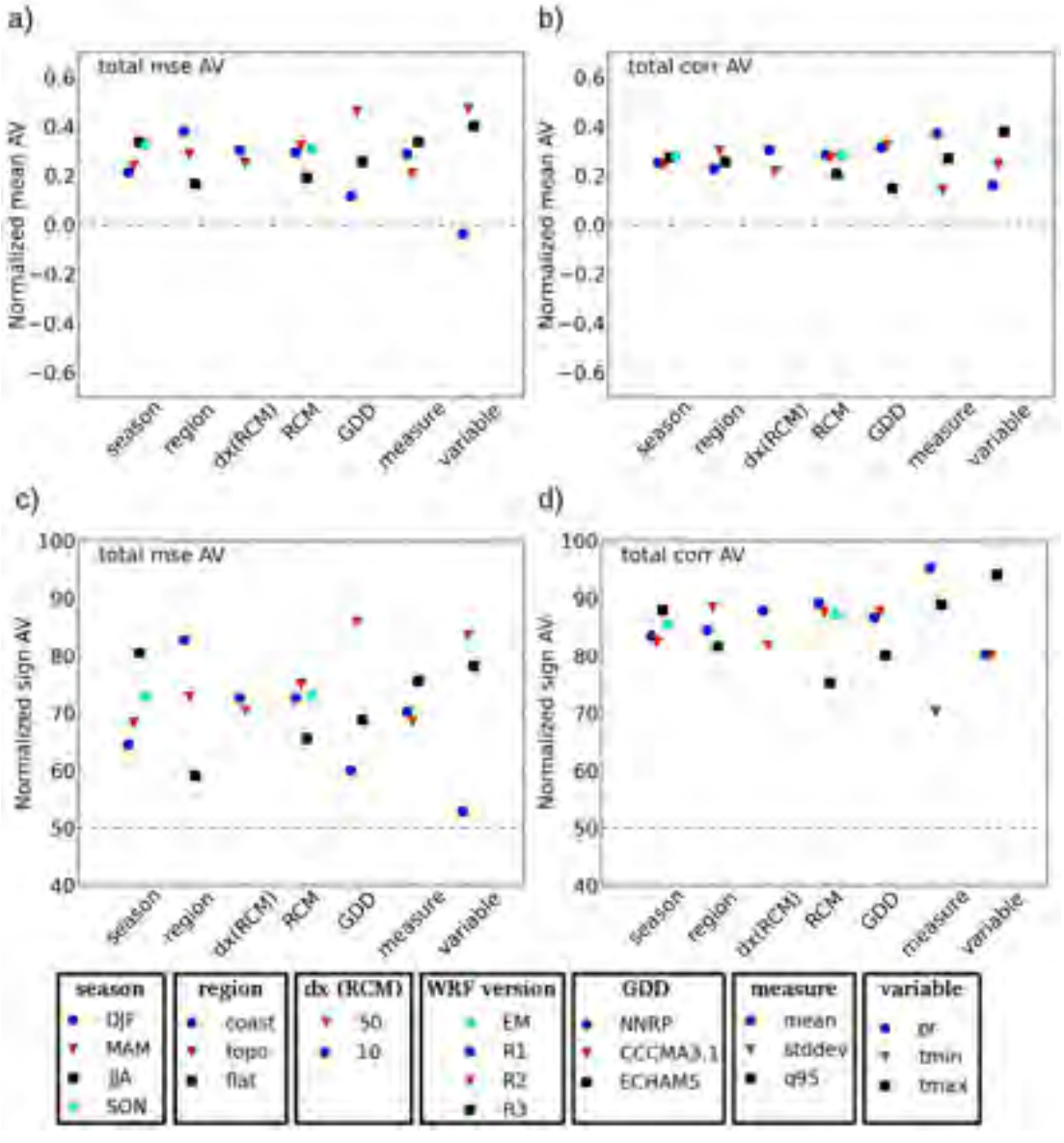
THANKS FOR YOUR ATTENTION!!!

QUESTIONS? COMMENTS?

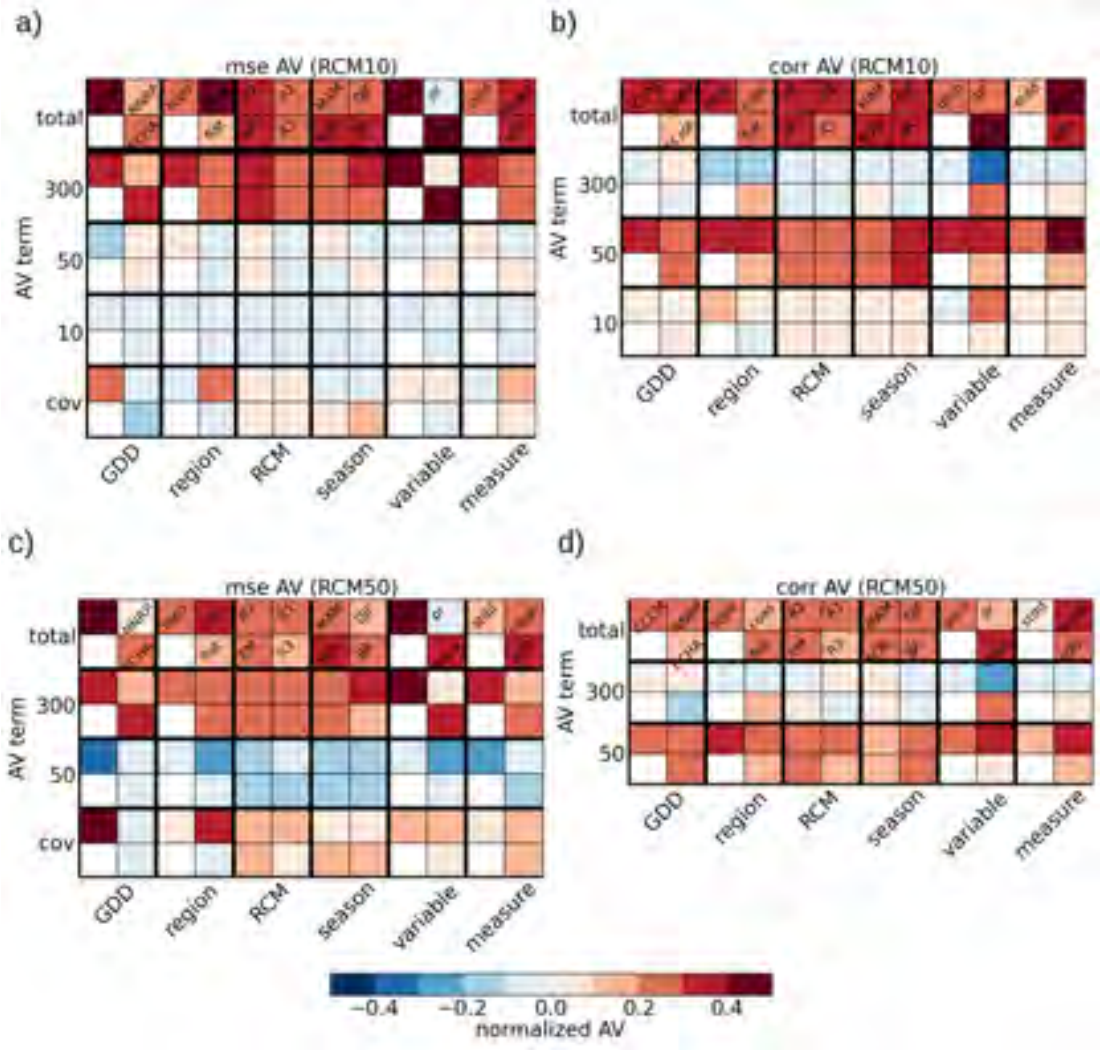
Spatial scale decomposition method



AV measures : mean Vs sign



AV as a function of spatial scales



10-km RCM vs 50-km RCM

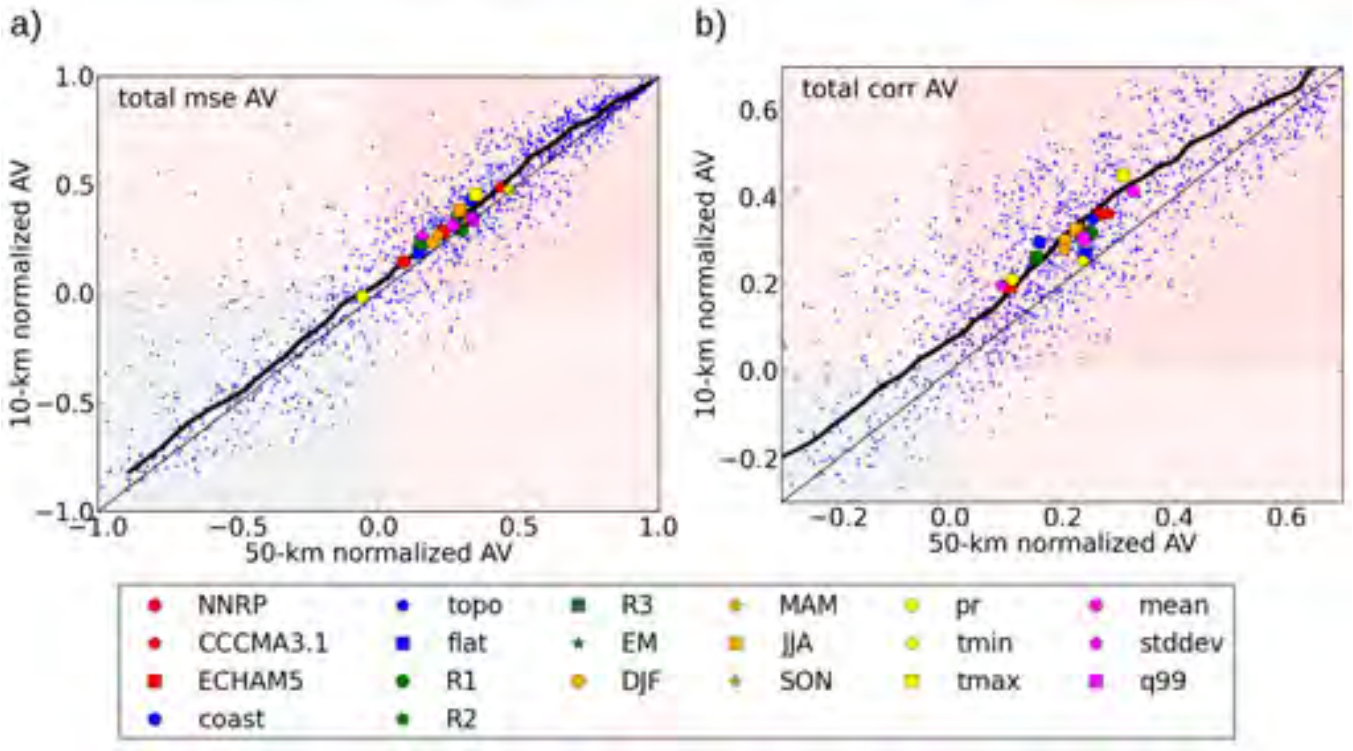


FIGURE : AV values for the **50-km RCM** simulations compared with the global driving data for different spatial scale terms.

Raw Vs. Corrected : minimum temperature

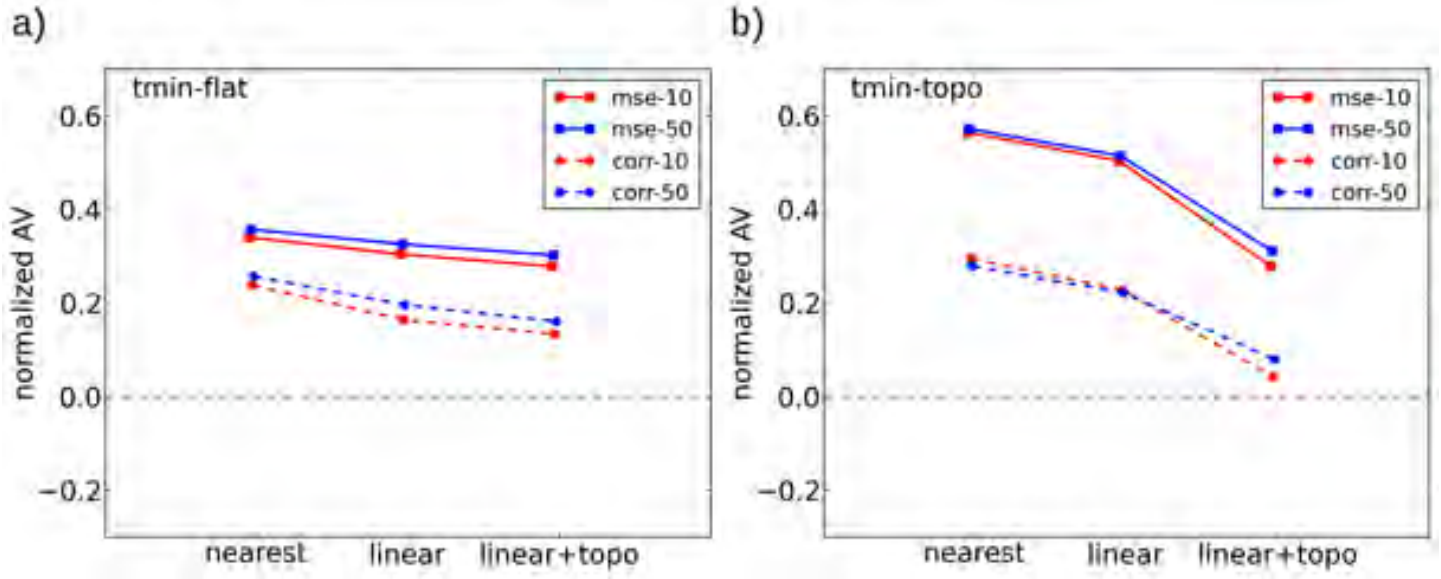


FIGURE : Overall AV for minimum temperature calculated using three and different interpolation : nearest neighbor, bilinear and bilinear plus topographic correction.

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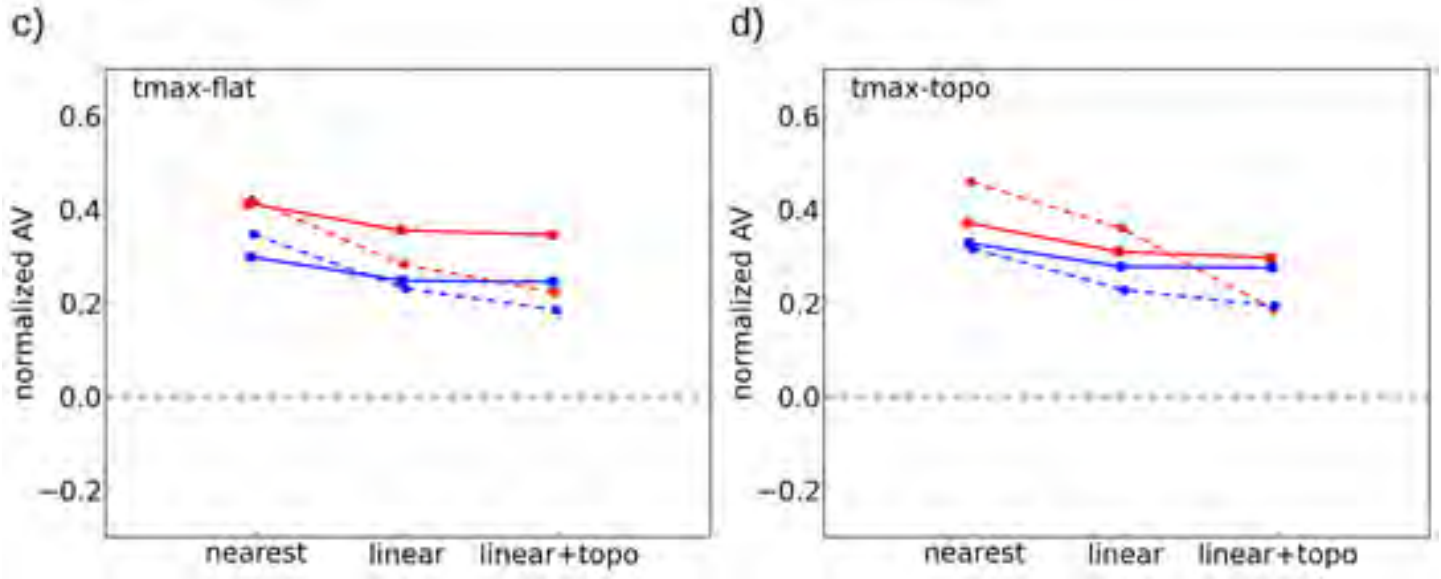

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