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CLIMATE MODEL DOWNSCALING AND UNCERTAINTY IMPLICATIONS FOR MODELLING

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INTRODUCTION:

Data from climate models (CM) are used in simulation model (SM) based climate change (CC) impacts, mitigation and adaptation studies. A key area of uncertainty is the utility of future projection weather data used as input to SM. Substantial differences exist in scale at which CC projection data is produced and at which SM studies are conducted. Downscaling may help resolve this issue. Uncertainties within CM estimates and evaluation of how uncertainties manifest themselves within SM need to be assessed and quantified in advance of their use.

METHODOLOGY:

1. Compare CM estimates for the 1960-90 period (hindcast) with observed data
2. Use differences to develop bias correction downscaling factors (DF).
3. Apply DF to hindcast data and re-compare with observed data.
4. Apply DF to future projections.
5. Run crop model simulations using observed, original CM hindcast and downscaled projection weather data.
6. Analyse differences in crop model estimates
7. Run crop model with downscaled future projection data and interpret results based on evidence in 6.

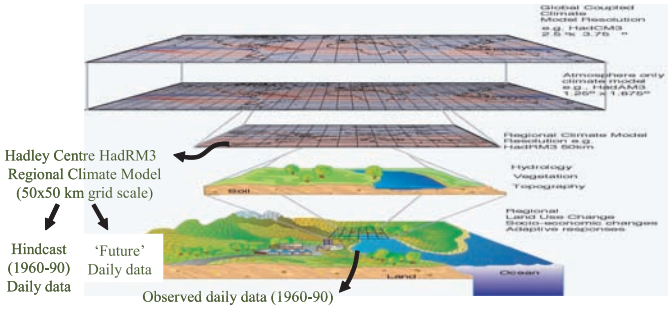

Fig 1. Downscaling method

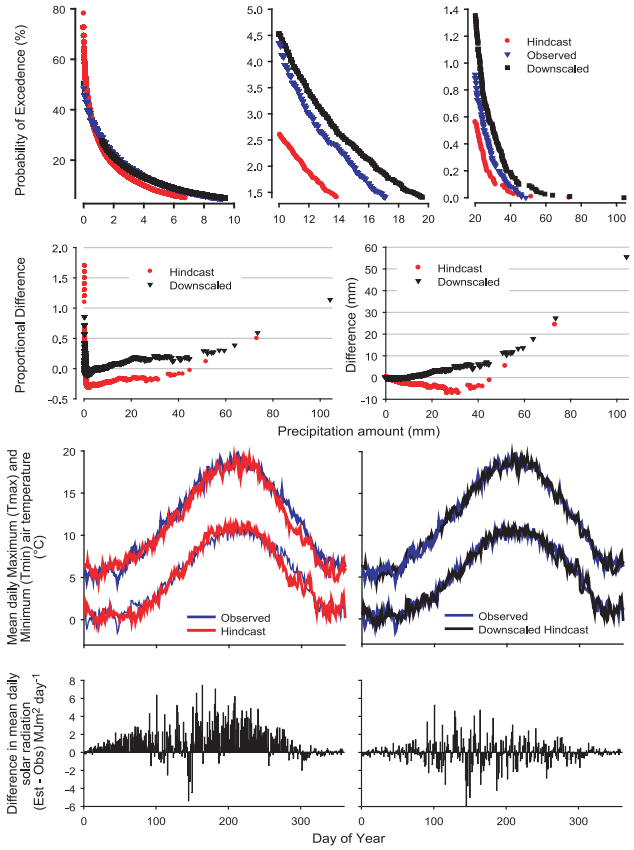

Fig 2. Assessment of data quality for original HadRM3 hindcast (red) and downscaled hindcast (black) against observed data for Mylnefield, Scotland.

	Yield differences (t/ha)								
	Observed (Obs)	Original hindcast (OH)		Downscaled hindcast (DsH)		Original Future (OFP)		Downscaled Future (DsFP)	
	Yield	Yield	Diff	Yield	Diff	Yield	Diff	Yield	Diff
Aberdeen	7.45	7.99	0.54	8.35	0.90	7.31	-0.14	7.83	0.38
Auchincruive	7.51	7.16	-0.35	7.70	0.19	7.38	-0.13	6.95	-0.55
Bracknell	6.66	7.61	0.95	7.13	0.47	6.15	-0.51	5.86	-0.80
Bush House	7.86	7.84	-0.02	8.38	0.52	6.64	-1.22	7.20	-0.66
Cawood	6.52	6.61	0.09	7.09	0.57	6.23	-0.29	6.50	-0.03
East Malling	6.40	6.38	-0.02	7.45	1.06	5.48	-0.92	6.13	-0.26
Everton	6.48	7.32	0.84	7.23	0.76	6.00	-0.48	5.90	-0.58
Galasheils	7.28	7.82	0.54	8.31	1.03	7.49	0.21	6.99	-0.29
Inverness	6.60	2.60	-4.00	8.35	1.76	3.08	-3.51	7.02	0.42
Mylnefield	7.17	2.49	-4.68	7.70	0.53	5.61	-1.56	6.88	-0.29
Rothamstead	6.97	6.99	0.03	7.49	0.53	5.85	-1.12	6.19	-0.78
Sutton Bonington	6.80	7.64	0.85	7.11	0.32	6.25	-0.55	5.89	-0.91
Wallingford	6.41	7.43	1.01	6.78	0.37	5.92	-0.50	5.51	-0.91
Mean	6.93	6.61	-0.32	7.62	0.69	6.11	-0.82	6.53	-0.40

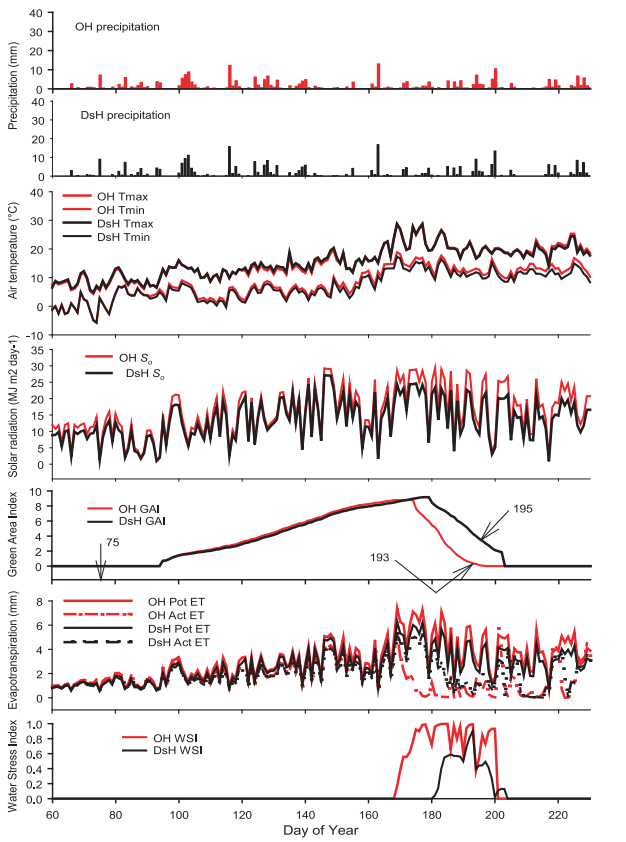

Fig 3. Comparison of weather variable inputs to crop model and estimates of Green Area Index (GAI), Potential (Pot ET) and Actual (Act ET) Evapotranspiration and a unitless Water Stress Index (WSI) from original HadRM3 hindcast and downscaled data for Mylnefield, Scotland.

CONCLUSIONS:

Downscaling improves the match between observed and modelled hindcast data, but this does not automatically translate into better match of crop model estimates. The original HadRM3 data were able to achieve a good match with crop model outputs derived from observed data, but this was a case of 'right results for the wrong reasons'. This illustrates that great care is required in utilising and interpreting simulation model estimates, to evaluate the impacts of CC, and how mitigation and adaptation can be best achieved.