APEC Climate Symposium 2010

Climate prediction and applications: building adaptive capability to extreme climate events

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APEC Climate Center

Downscaling Approaches and Extreme Events

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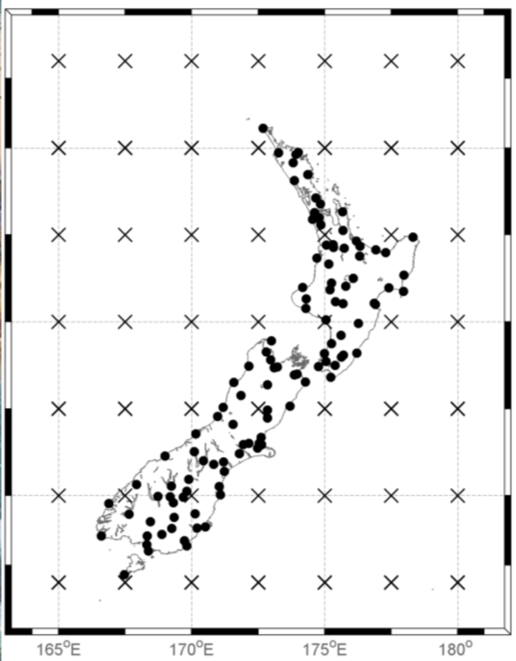
Statistical Downscaling



- From large scale to station scale
- Define a relationship between large and local scales
  - Regression, CCA, PLS, etc

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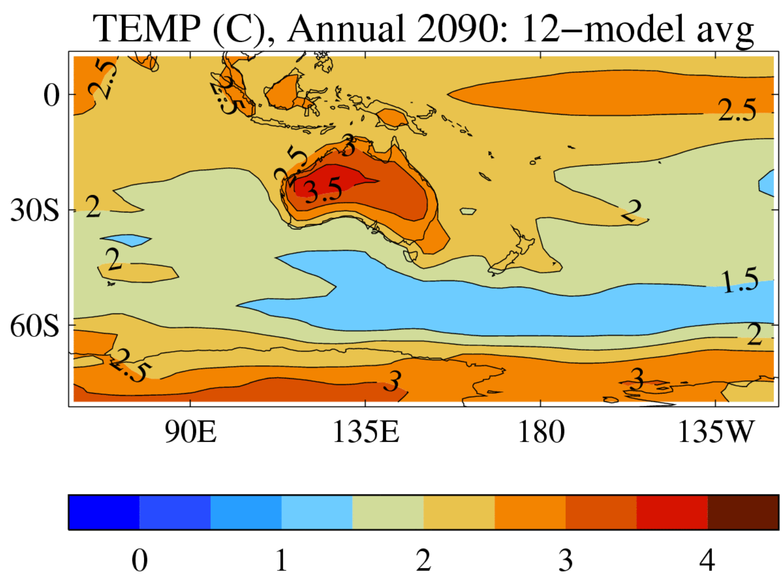
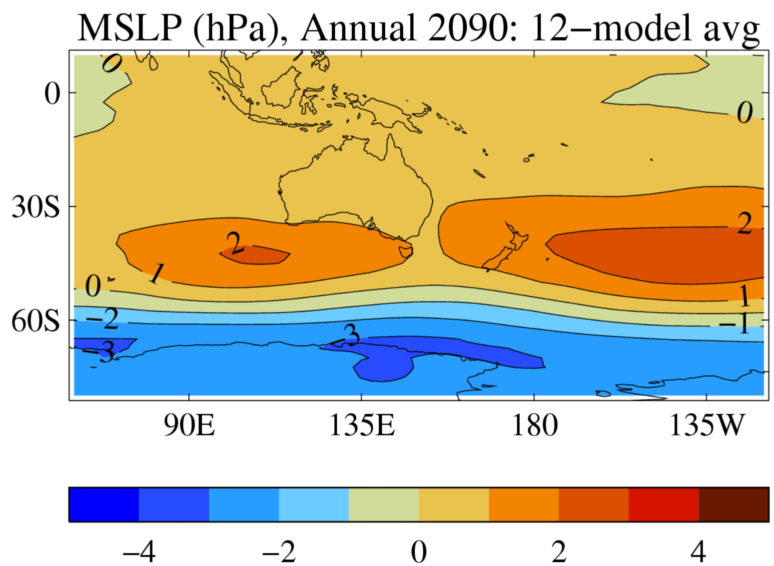
Projections – South Pacific/Australasia



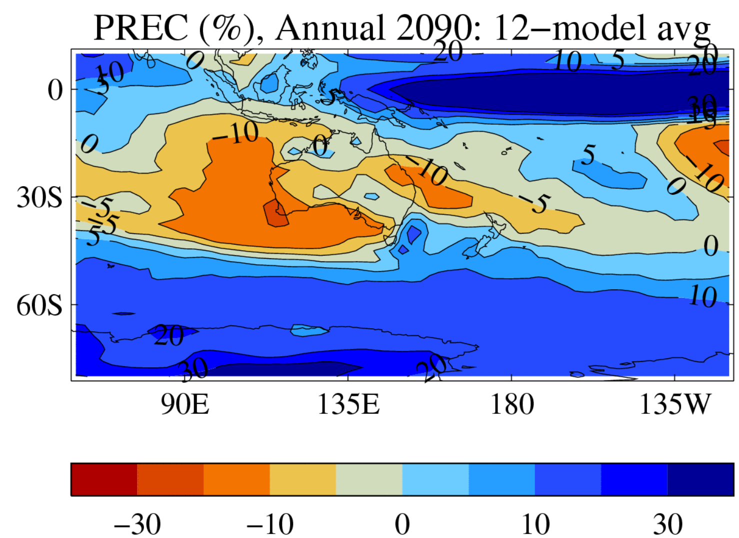


Annual mean changes for A1B scenario:

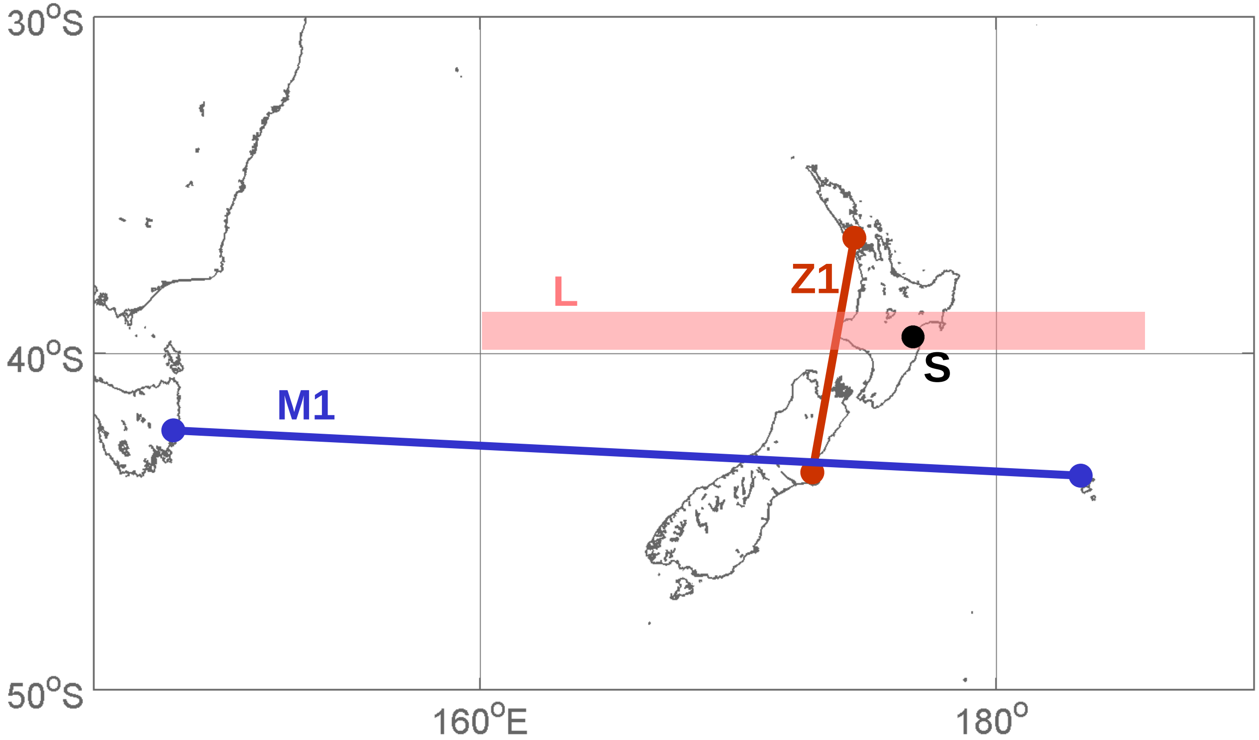
1) NZ temperature increase smaller than Australia (& 75% of global rate)

2) Higher pressures across N. Is. & increased westerlies across S. Is

3) Drier over N. Is. & wetter over S. Is. (at model grid-scale)



Simple Regression Downscaling



- $S - L = a + bZ1 + cM1$ (observed/reanalysis)
- ➔ $S = L + a + bZ1 + c\,M1$ (model)

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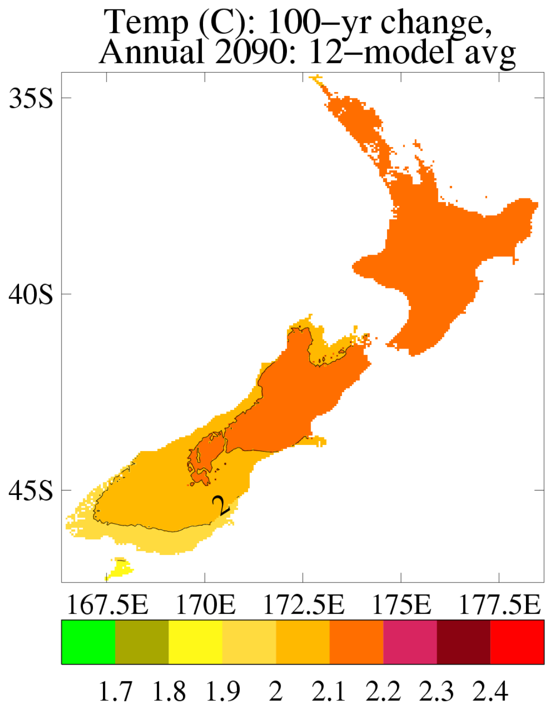
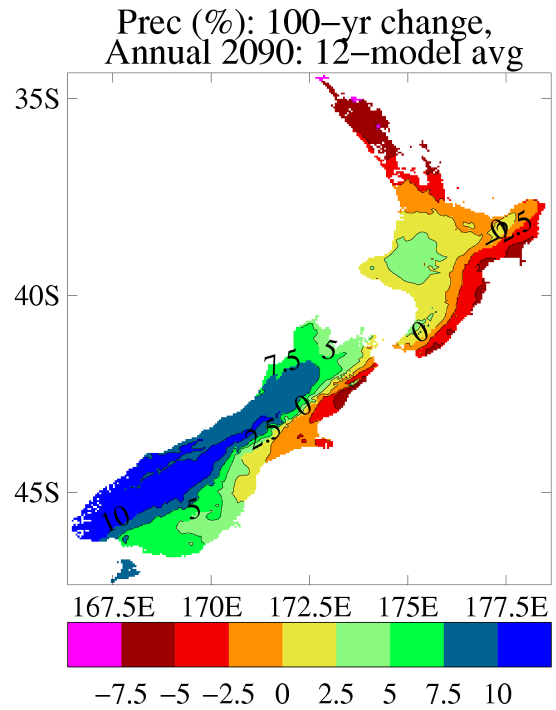
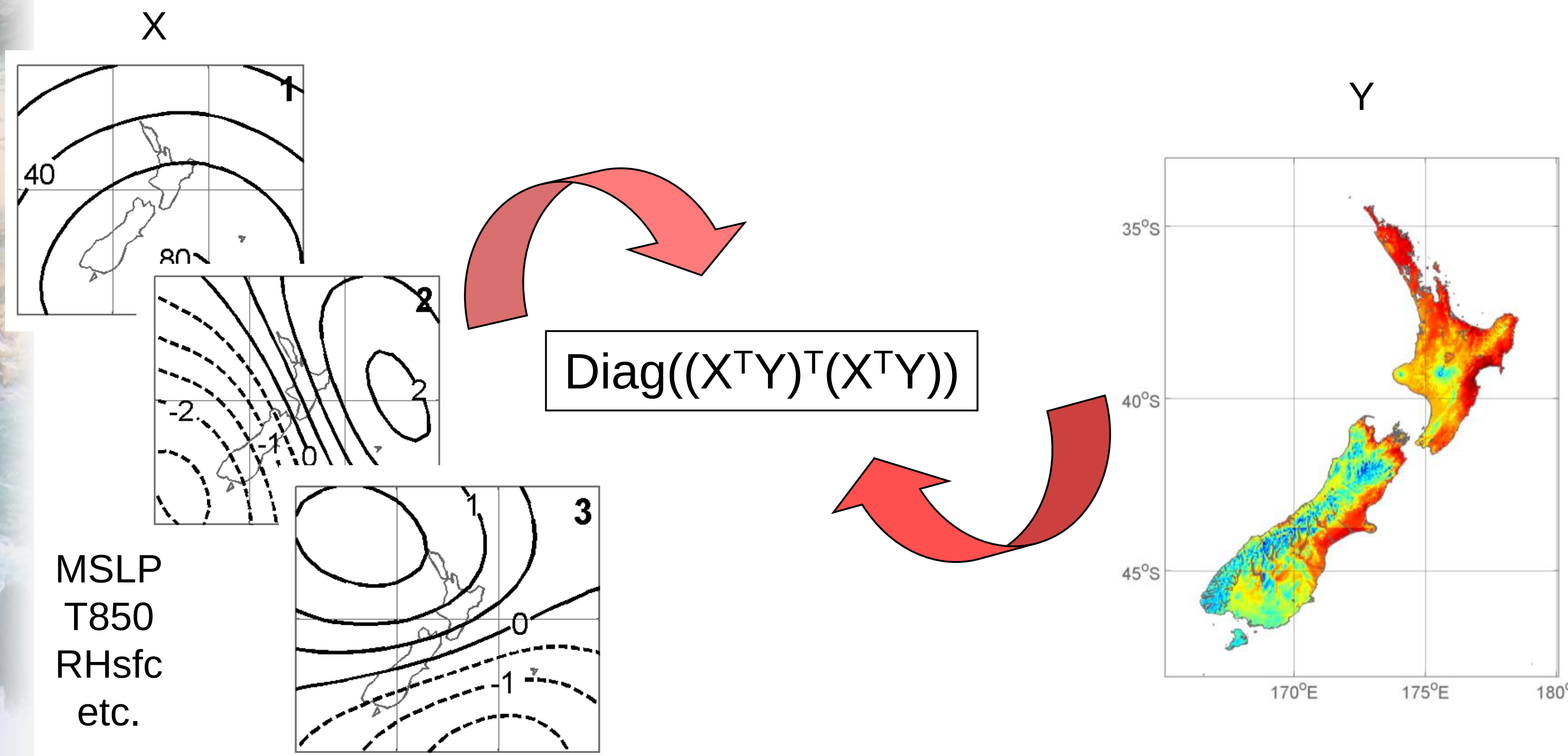
Projections – New Zealand





- Projected changes, 2090 relative to 1990
  - annual mean temperature (°C, left)
  - annual mean rainfall (%, right)
- Average over 12 GCMs for A1B emission scenario
  - Used for adaptation planning, drought risk etc.

PLS Regression Downscaling



- Diagonalise cross-covariance matrix
- Define predictor patterns and predictand response patterns
- Analogous to CCA, MCA/SVD

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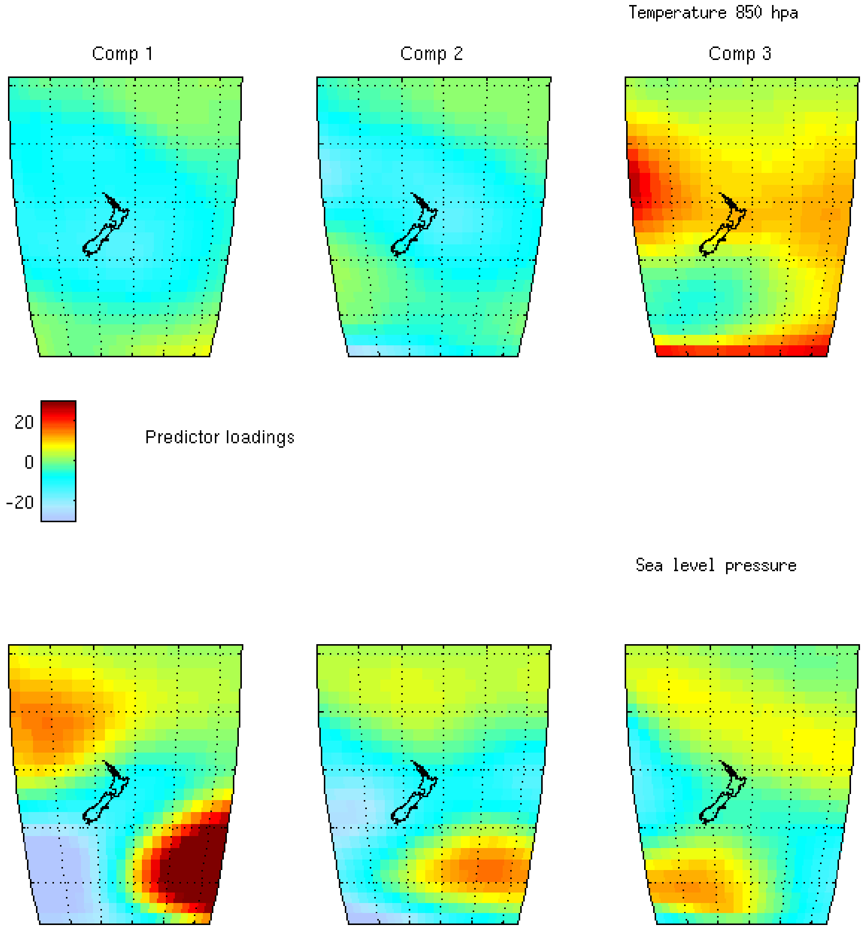
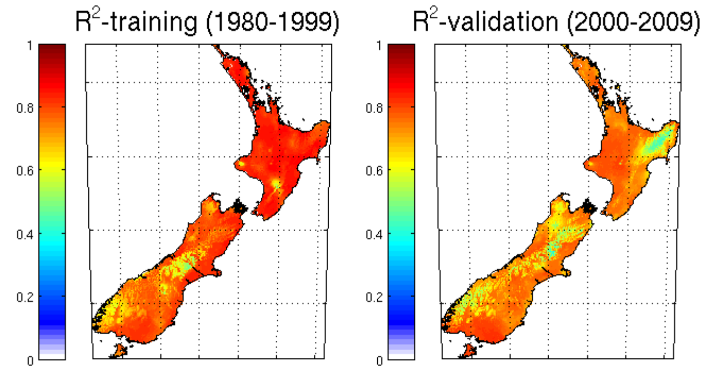
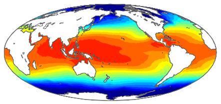
PLS Regression Downscaling







- Applied to temp, rain, wind, PET,…

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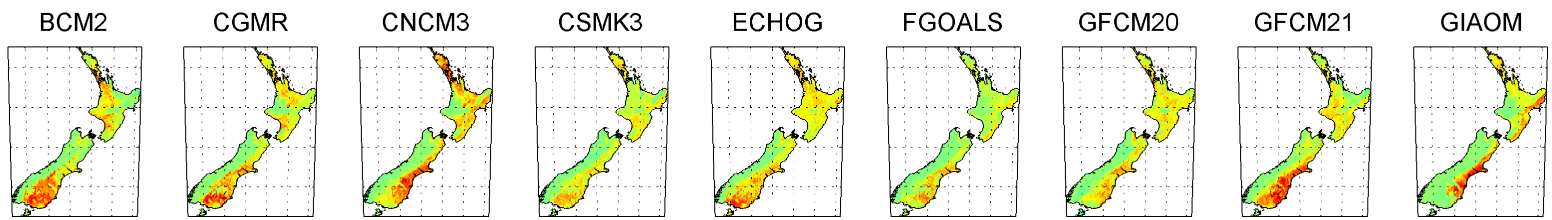
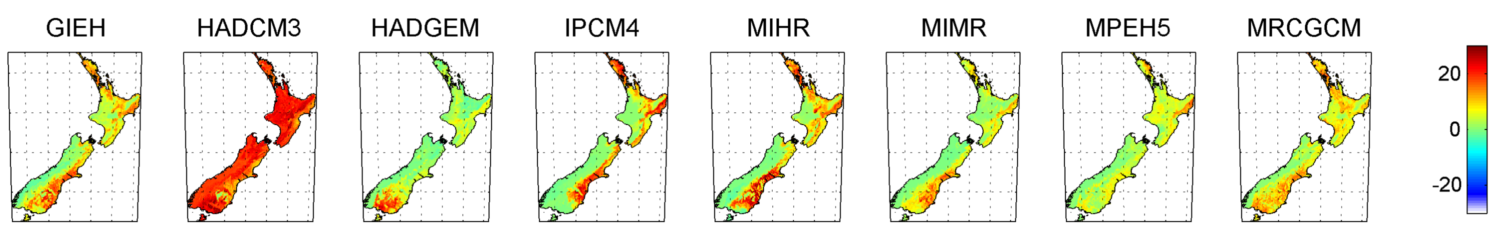
PLS Projections – New Zealand

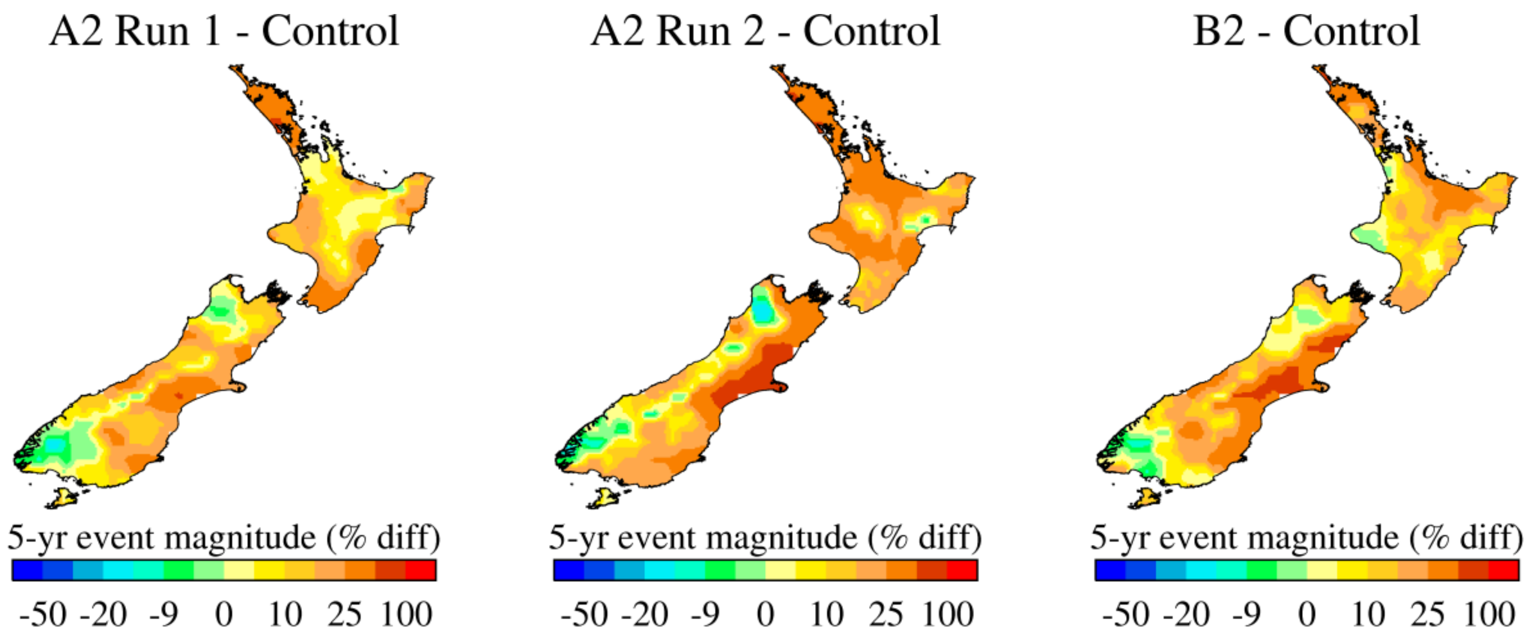


A1B Emission scenario
Change in drought probability
2040-2060 from 1980-99

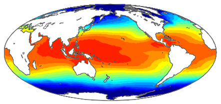


- Developing new guidance on changing drought risk

Changes in Extremes: Rainfall



- **Dynamical downscaling**
- 30-year RCM runs, 5-year ARI event magnitude
- Similar overall patterns but significant local differences
- Can estimate overall change in extremes but not local statistics
  - Thirty years of record too short to stably estimate 5-year ARI statistics
- Concentrate on regionally (country-wide) integrated statistics



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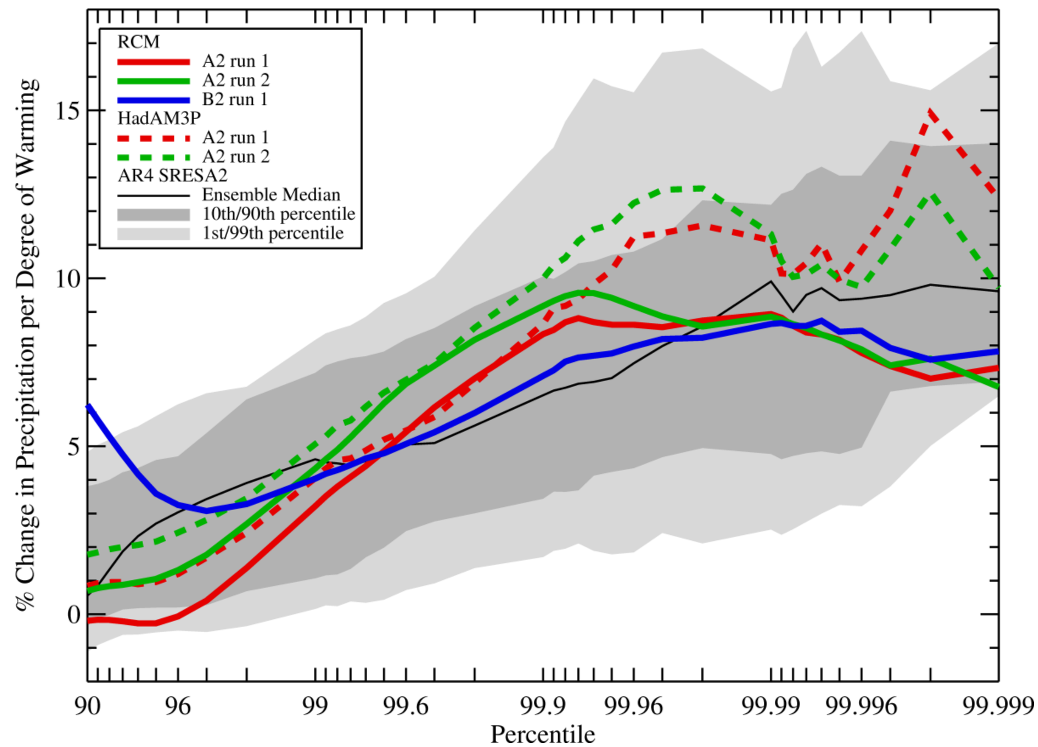
Extreme rainfall



- Integrate over New Zealand
- Percent change in precipitation (per degree warming), A2 scenario
  - RCM, parent GCM (HadAM3P) and ensemble of 16 CMIP3 climate models
- Change exceeds Clausius-Clapeyron constraint, beyond 99th percentile
  - Dynamical changes (moisture convergence) adds to purely thermal effect
- Analyse RCM statistically, and use output to modify statistical models

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Summary

- Statistical downscaling
  - Moving from simple to complex regression models
  - Aim to retain robustness but increase local detail
- Dynamical models crucial for extremes
  - Long time series required (ideally)
- Combination of dynamical and statistical methods most powerful
  - Statistical models of RCM output (extremes)
  - Dynamical model output to inform statistical models

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