Downscaling : a perspective from Australia

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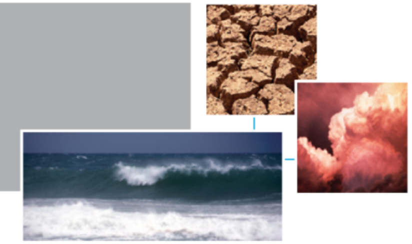
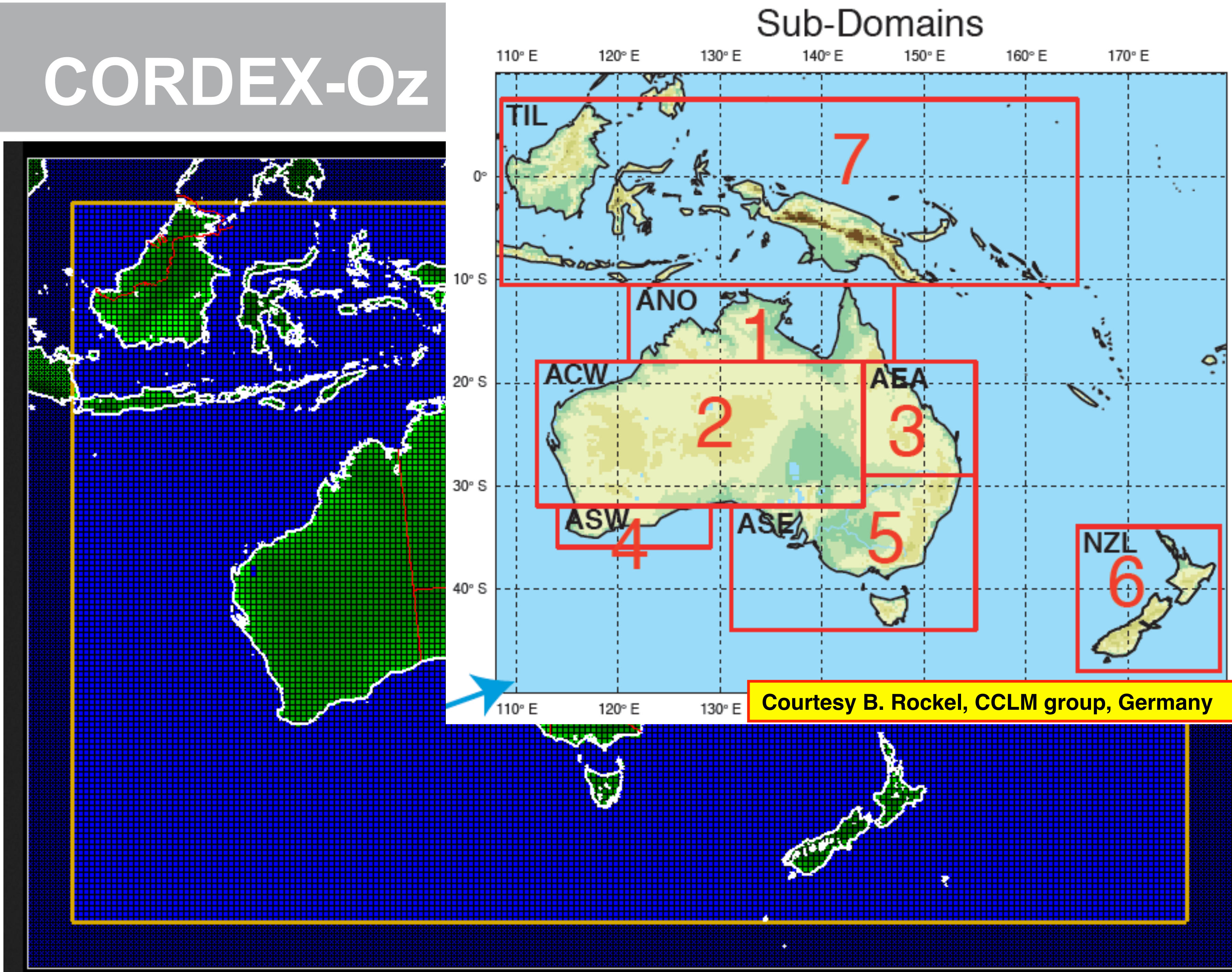
Australian Bureau of Meteorology

Presentation overview

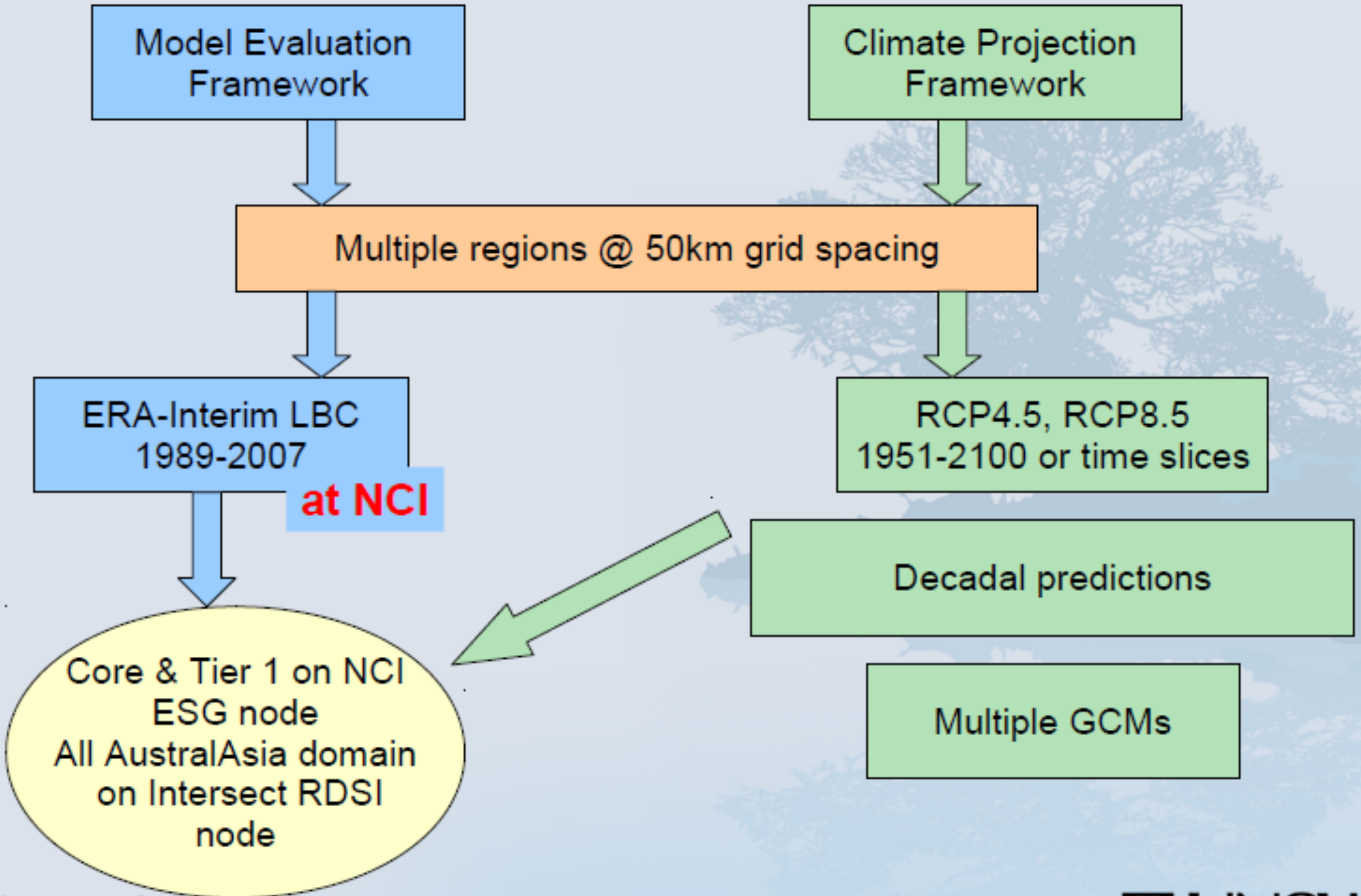


- Update on activities in CORDEX-AustralAsia domain
- General perspectives on SDM (in respect to RCM)
- A perspective from on-going work in Australia on
  combining SDM and RCM projections
  to enhance understanding about future climate

CORDEX-Oz


Sub-Domains
110° E
120° E
130° E
140° E
150° E
160° E
170° E
0°
10° S
20° S
30° S
40° S
TIL
7
ANO
1
ACW
2
AEA
3
ASW
4
ASE
5
NZL
6
Courtesy B. Rockel, CCLM group, Germany

CORDEX-Oz experimental set-up



Climate Change Research Centre

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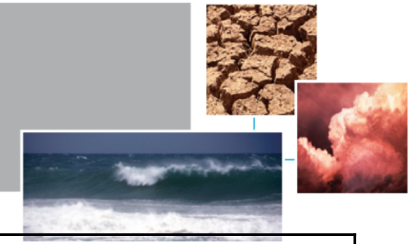
CORDEX-Oz update



	RCM (group)			
GCM	COSMO-CLM (Institute of Coastal Research HZG, Germany)	CCAM (CSIRO, Australia) [& Queensland government]	WRF (3-member multi-physics ensemble) (Uni. of New South Wales, Australia)	BoM-SDM (Bureau of Met., Australia) Statistical technique Australian continent R, T_{max}, T_{min} only
ERA-Interim				
MPI-ESM-LR				
EC-Earth				
HadGEM2-ES				
CNRM-CM5				
ACCESS 1.0				
CCSM4				
NorESM1-M				
GFDL-CM3				
ACCESS 1.3				
An other 15 GCMs				

CORDEX-Oz wikipage

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Welcome to CORDEX AustralAsia wikipage

This is the RCM users wikipage that includes information about the CORDEX (COordinated Regional climate Downscaling Experiment) project over the AustralAsian region.

- Further information about the CORDEX project can be found here
- The main CORDEX data archive can be found here

If you would like to contribute RCM simulations to CORDEX-AustralAsia please contact Daniel Argueso to join this wikipage.

CORDEX Australasia has a now a mailing list. If you want to join it, please click the link below:
https://groups.google.com/d/forum/cordexaustralasia

page revision: 17, last edited: 31 Jan 2013, 01:23 (469 days ago)

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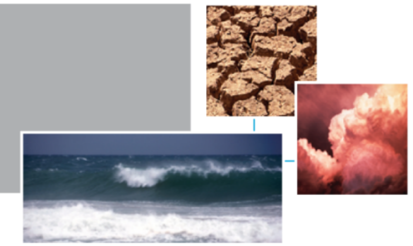
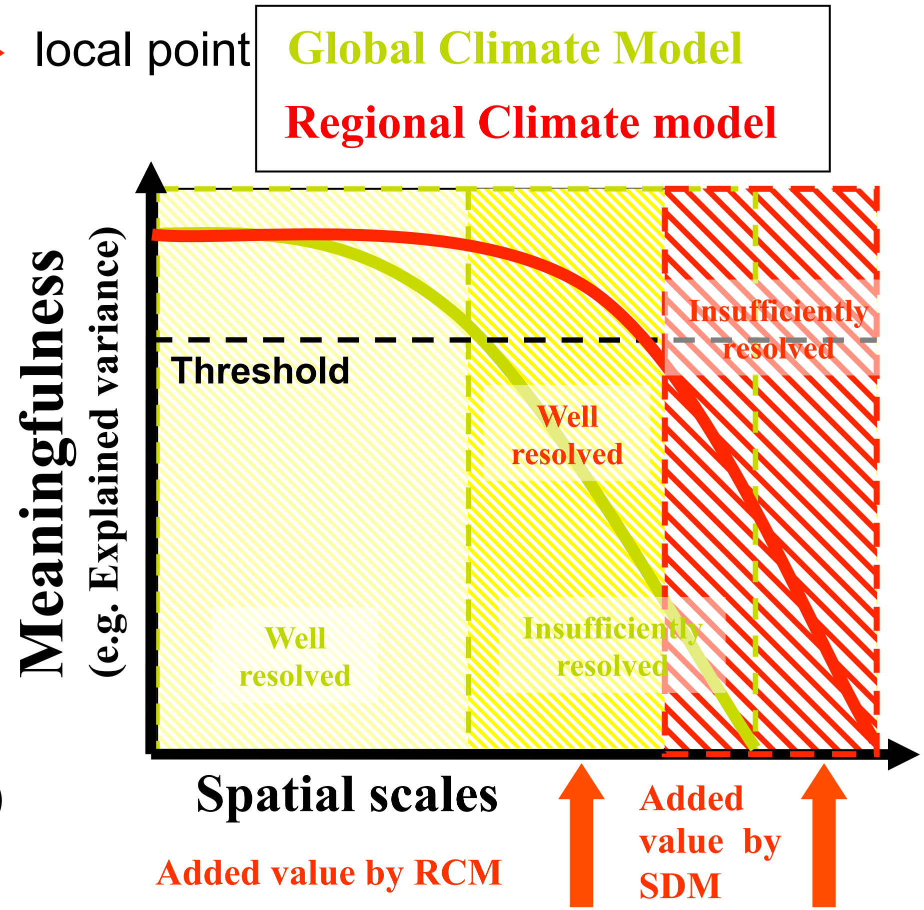
The Centre for Australian Weather and Climate Research
A partnership between CSIRO and the Bureau of Meteorology

CSIRO

The scaling issue:



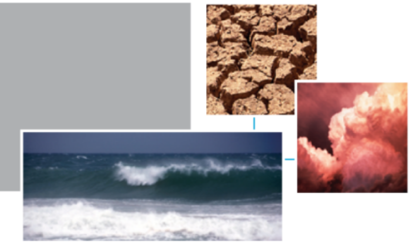
Broadly two approaches:
- Dynamical: regional climate models
- Statistical: linkage large-scale → local point



Both are:
- dependent on GCMs
- able to cascade forward uncertainties

Differences:
- computing cost
- target variables (grid vs. point)
- physical consistency
- pros & cons ("horses for courses")

A large range of techniques



- <u>Weather Generator:</u>
  - Random generation of number for local predictands
  - Matching observed characteristics of the series
  - Driven by large-scale atmospheric states
  - E.g.: Conditional Probability, Markov Model

- <u>Transfer Function:</u>
  - Direct quantitative relationship is build
  - Some form of regression (linear or not)
    - multi using single predictor values
    - spatially distributed predictors
  - E.g.: MOS, PC, EOF, CCA, SVD, ANN

- <u>Weather typing:</u>
  - Classic synoptic climatology concept
  - Relate an atmospheric state to locale climate
  - Can introduce some form of dynamical approach (hybrid: dyn-sta)
  - E.g.: Analogues, clusters, airflow indices, CART

Method→ ↓Feature	GCM	RCM	Scaling Mean	Multi	M. Decile	Stat. Downscaling W.G.	Anal.	NHMM
No bias in current climate means	Can be badly biased	Usually less biased	No bias	No bias	No bias	No bias	No bias	No bias
Represents changes in mean – coarse scale	Yes	Yes	Yes	Yes	Yes	Yes	Yes, but predictor dependent	Yes, but predictor dependent
Represents changes in mean – fine scale	No	Yes	No	No	No	No	Yes	Yes
Monthly variability realistic	Can be badly biased	Usually less biased	Yes	Yes	Yes	Yes	Yes	Yes
Monthly variability *changes* represented	Yes	Yes	Any change not captured	Any change not captured.	Yes	Yes	Yes	Yes
Daily variability realistic - Temperature	Can be badly biased	Usually less biased	Yes	Yes	Yes	Yes	Yes	Yes
Daily variability *change* represented - Temperature	Yes	Yes	Any change not captured	Any change not captured.	Yes	Yes	Yes	Yes
Daily variability realistic - Precipitation	Can be badly biased	Usually less biased	Yes	Yes	Yes	Yes	Yes	Yes
Daily variability *change* represented - Precipitation	Yes	Yes	Change not captured	Change not captured	Changes captured?	Yes	Yes	Yes
Inter-variable physical consistency	Yes	Yes	Yes	Not necessarily	Yes	Yes	Not sure	Not sure

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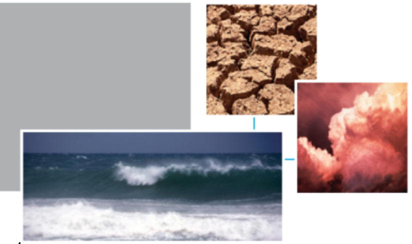
Courtesy Penny Whetton CAWCR, CSIRO

Assumptions made for SDM



- **Relies on large-scale predictors for which Climate System Models are most skilful:**
  - **Several grid lengths**
  - **Tropospheric variables (away from the surface)**
  - **Dynamic variables (geopotential, wind, temperature)**

- **The transfer function must remain valid in different climate conditions:**
  - **Hard to demonstrate**
  - **Can be evaluated by comparison with other approaches**

- **The predictors must encompass the entire climate change signal:**
  - **Importance of testing several predictors**
  - **Uncertainties related to the choice of predictors**

Predictors → Predictands

• Large scale fields which drive the local climate
• Variables well represented by Climate Models

<u>Statistical model validation:</u>

• Data quality
• The length of the dataset
• Stability in time
• Re-analyses: NCEP, ERA

• Applying the SM: Coupled GCMs Control and Transient simulations

• Daily local observations
• Good quality measurements
• Long record (few decades)
• Variables influenced by the weather

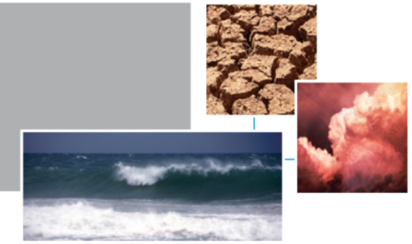
WMO network:

• Rainfall
• Tmax
• Tmin
• Others

Non meteorological variables:

• Hydrological variables
• Agriculture index
• Public health (HDD, pollution)

Context for current work

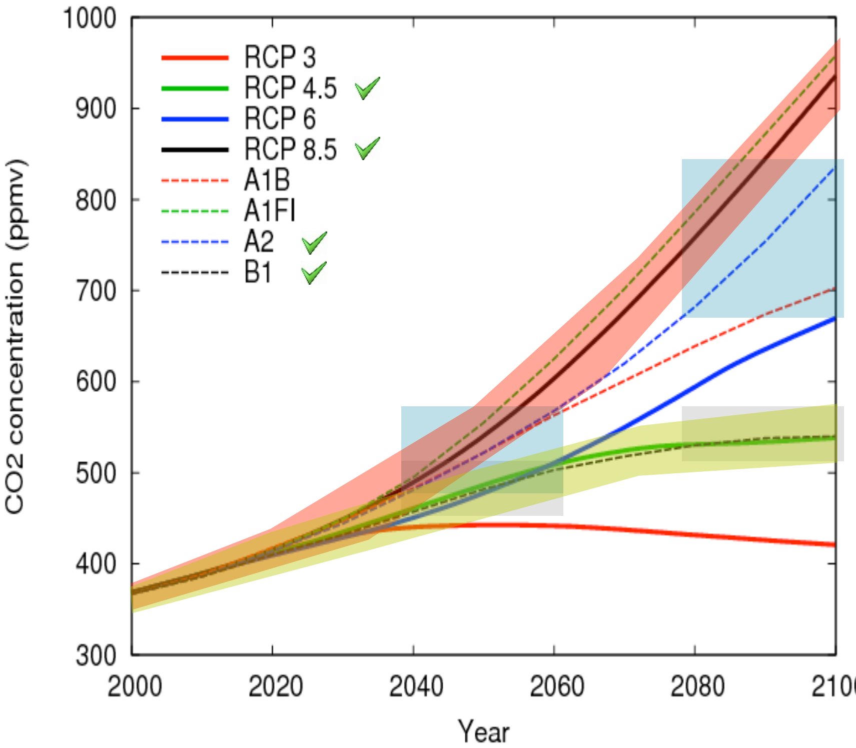


- Delivery of a new set of national climate change projections across the Australian continent
- To be released in 2014 (superseding 2007 projections)
- Application ready datasets
- Downscaling is part of the mix (dynamical & statistical)
- Well defined user-needs (NRM groups)

- Planning (risk management and opportunities)

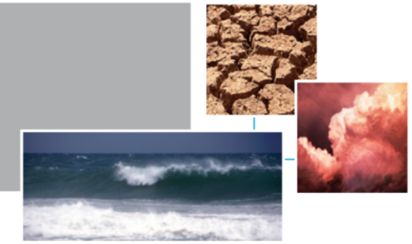
Statistical Downscaling

- Well used and developed technique (based on daily meteorological analogues)
- 20th century (1950-2005)
- RCPs 4.5 & 8.5 only (2006-2100)
- Continuum from 1950 to 2100
- 22 CMIP5 GCMs available
- Downscaled variables: daily for Rainfall Tmax Tmin



- Australia-wide on a grid (BoM operational 0.05º resolution)

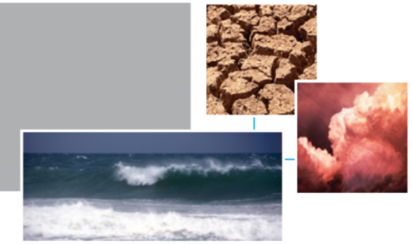
3 obvious challenges



- Size of dataset:
  - SDM outputs increase 50.000 times between CMIP3 and CMIP5 crop of outputs
  - Application "ready" dataset (!)
- Limitations on predictands available
  - Well observed (length, completeness) variables
  - User needs are broader (full Atmo-LS coupling)
- Station observation vs. grid
  - Real observation = ground truth
  - Heavy reliance on stations in climate impact applications
  - Gridded data provides the spatial coverage

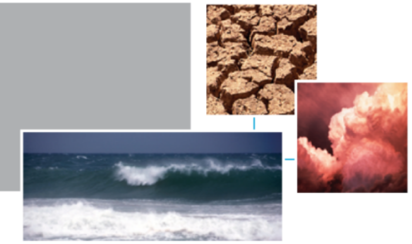
ESD outputs morphing into RCM comparable products

Large-scale predictor



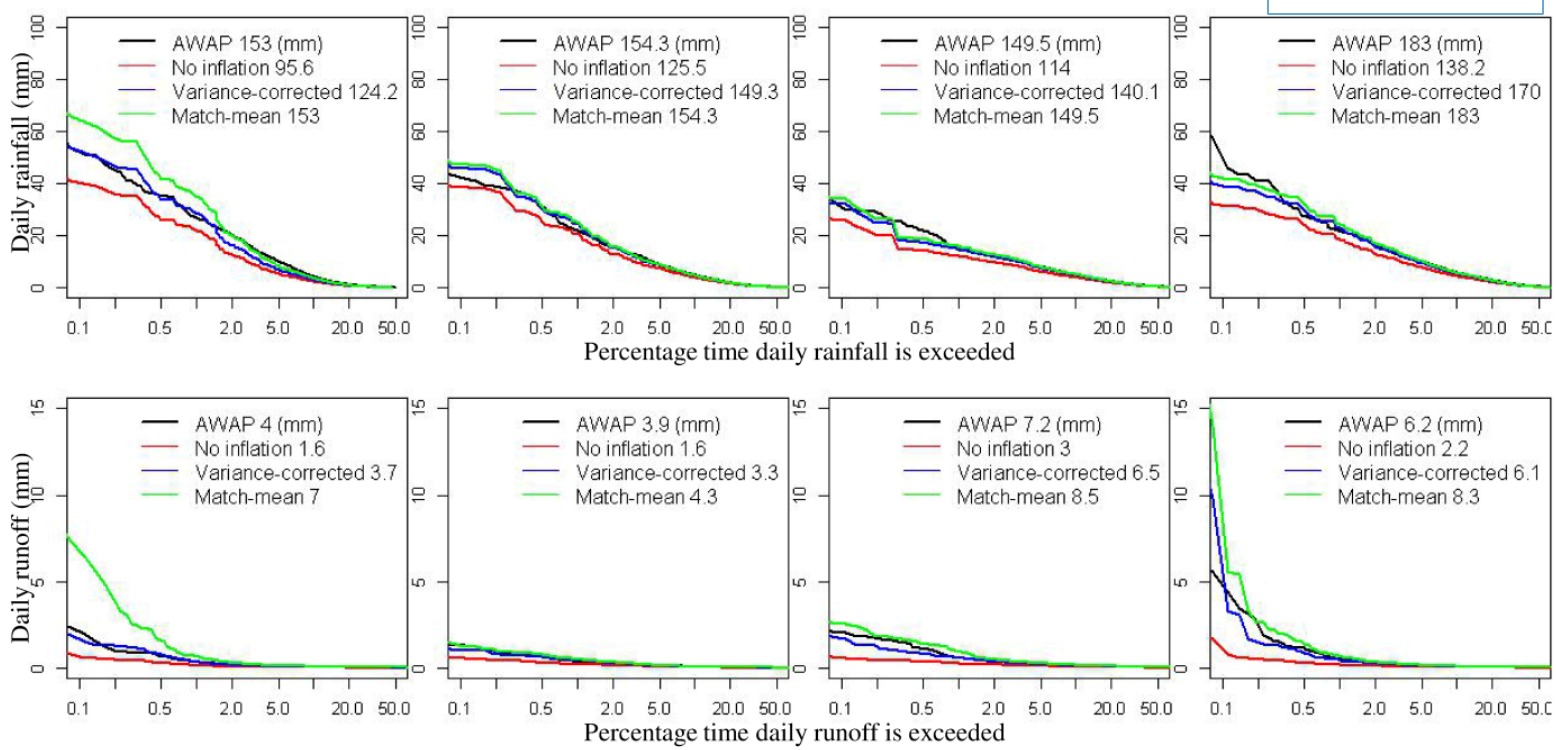
- Growth in reanalysis products
  - NCEP 1/2, ERA40, ERA-interim, JRA, MERRA, CSFR, 20th century RA
  - Choices and trade-offs
  - Length vs. accuracy & resolution
  - Increased resolutions (CMIP5 vs. CMIP3)
- Choice of Predictors limited by GCMs
  - Processes well represented ("General Circulation")
  - Data availability (daily data needs)
    - CMIP3: 12 models / 26 ; CMIP5: 22 models / 59

Climate Data Marketplace

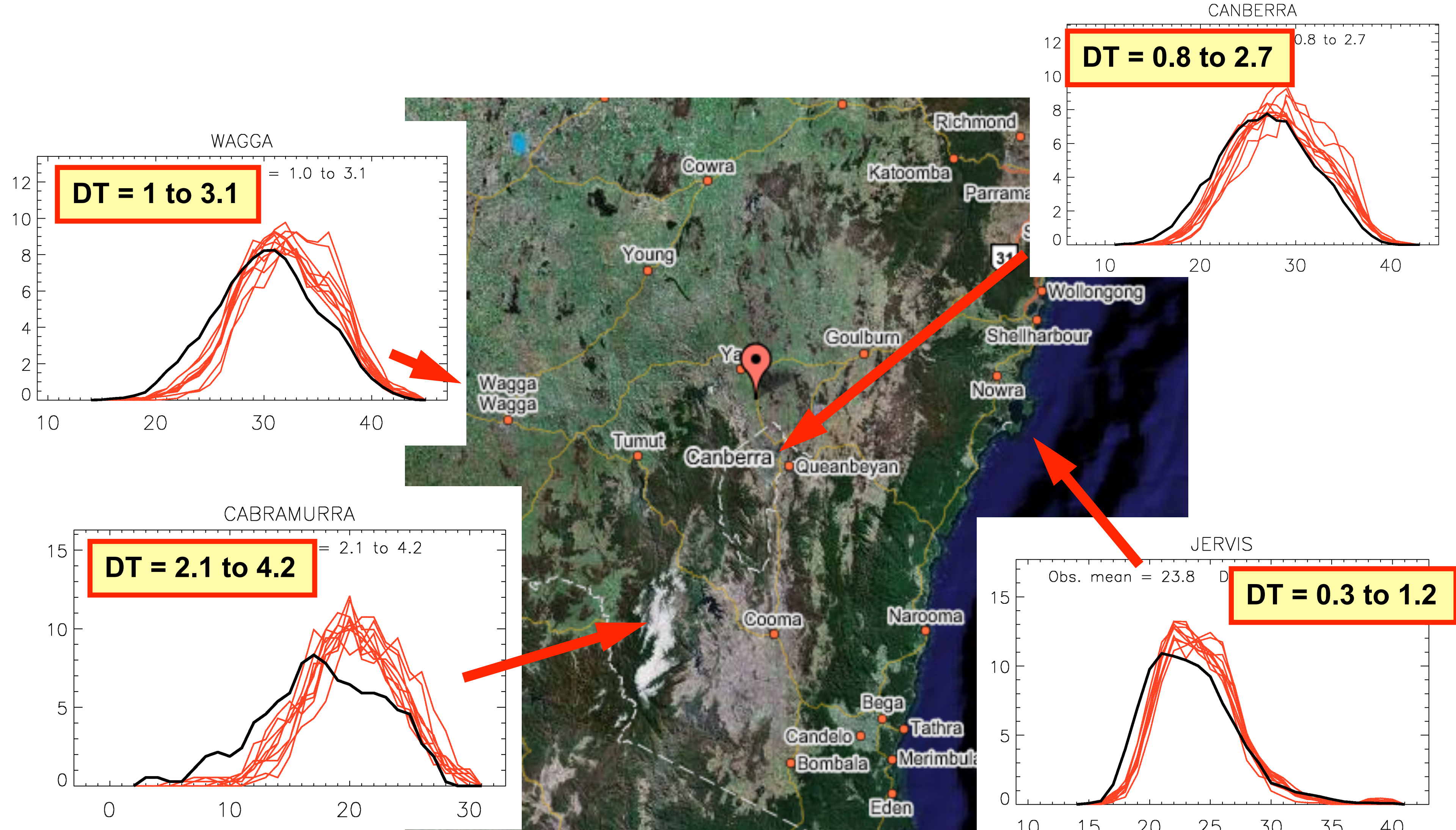


- Application "ready" dataset
  - Direct model (GCM) outputs & scaling factors
  - RCM & SDM dataset
  - Need for post-processing and bias corrections

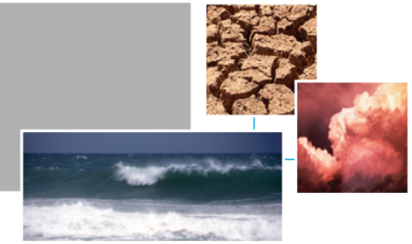
Teng et al., J. of Hydro., 2012



Limitation of scaling approach



Added value of Downscaling



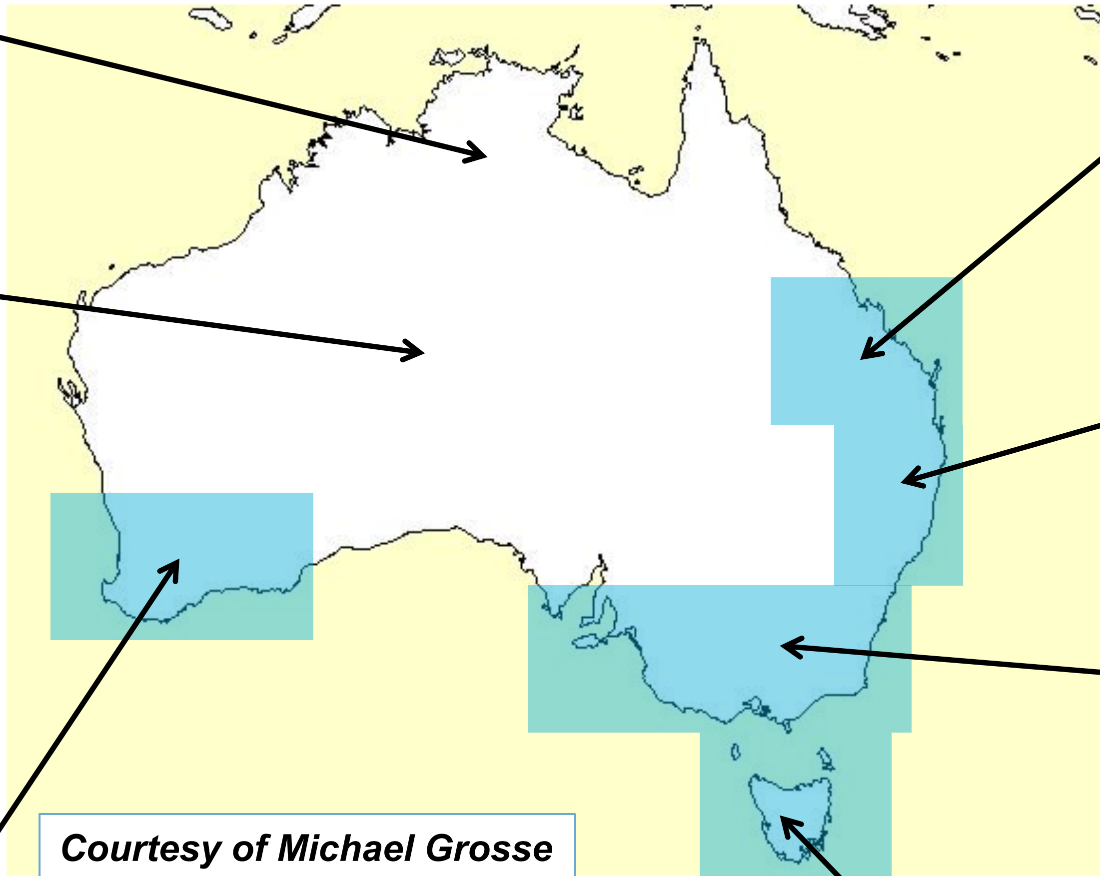
Tropics??

"Just another model"?

SE Qld
- Topography
- Coast
- Urban

NSW
- Topography
- Coast
- Land use & urban

SE Aus and Alps
- Topography, coast
- Snow
- Urban



Courtesy of Michael Grosse

SW WA
- Land use
- Coast

Tasmania
- Topography
- Coast

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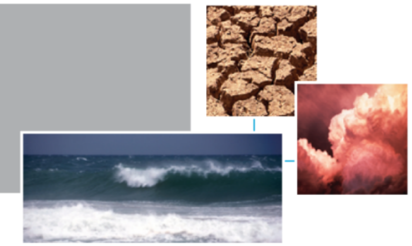
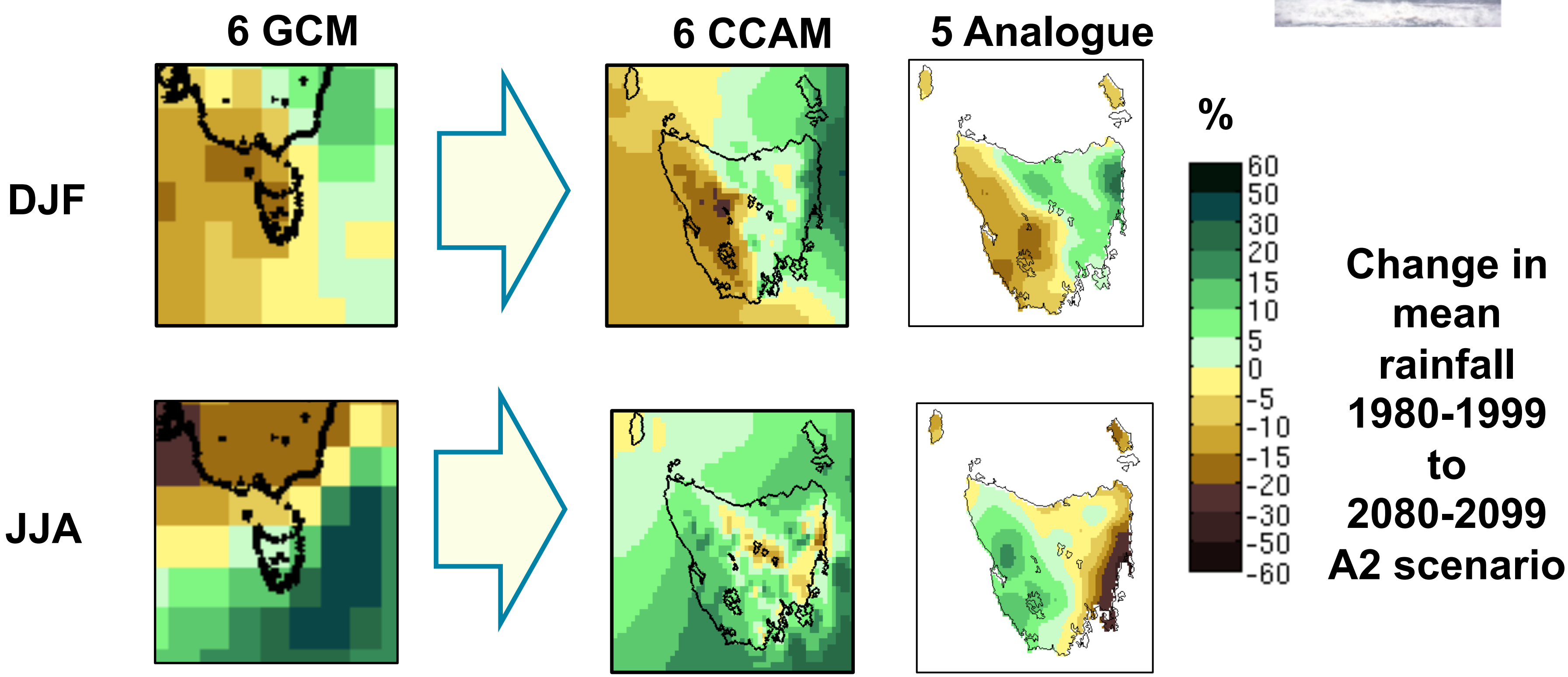
Convergence btw methods





- Comparison of different downscaling approaches
  - Understand the convergences (airflow against orography)
  - And the divergences (SDM= translation; RCM = independence)

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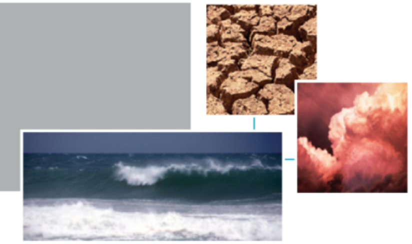
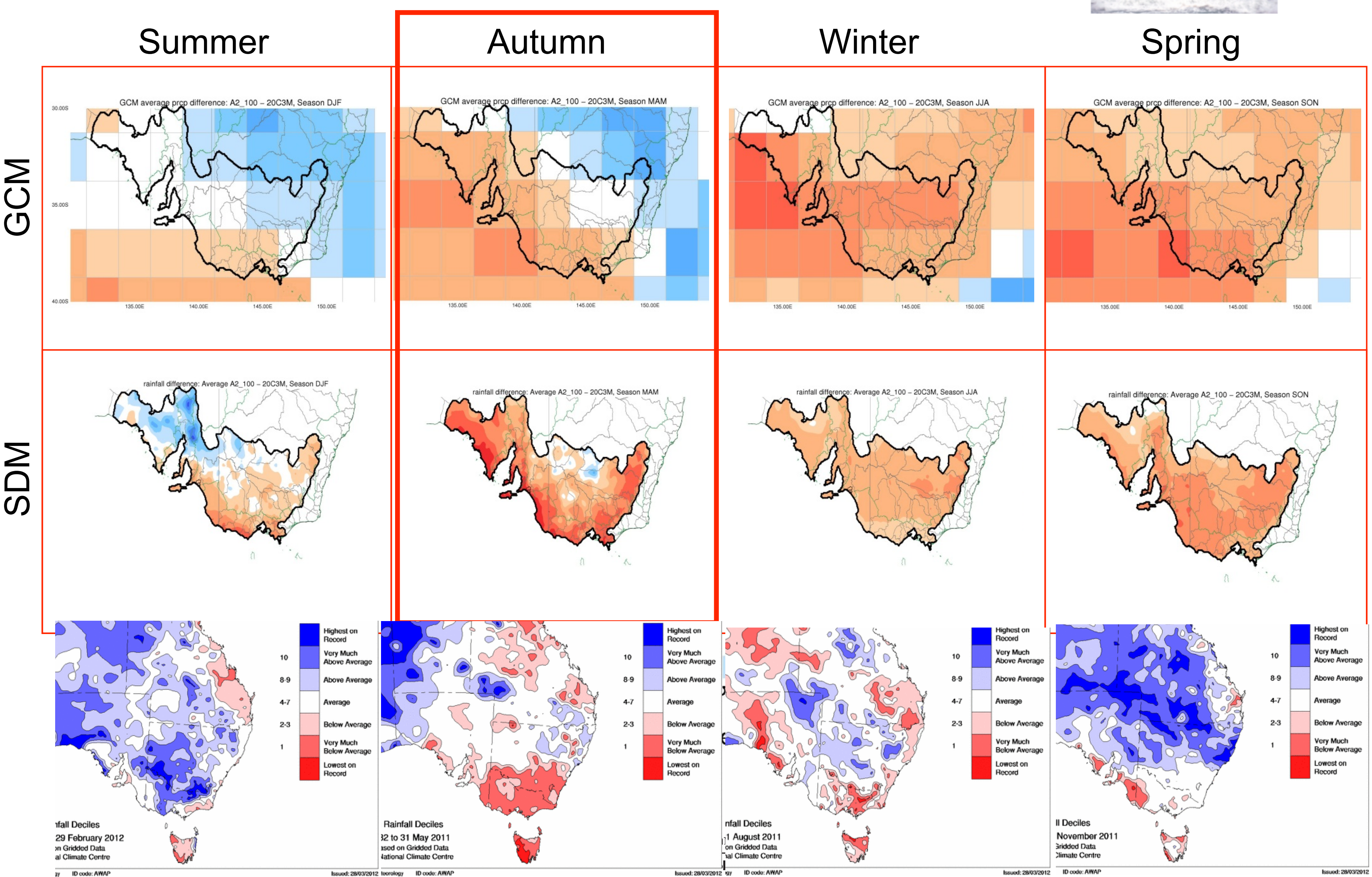
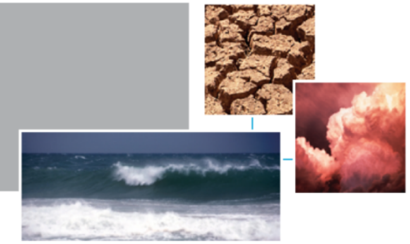
Convergence with obs. trends





Presentation summary



- CORDEX-Australasian domain: you can contribute!!
- A range of SDMs exist as a complement to RCM approaches
- Our perspective from developing Australia-wide projections with application ready dataset:
  - Hard to displace "old habits": users love scaling approaches
  - Downscaling is not required everywhere
  - Need to guide users through the various options (implications)
  - Combining SDM and RCM provides additional in-sight
  - Required to fully describe the uncertainty space