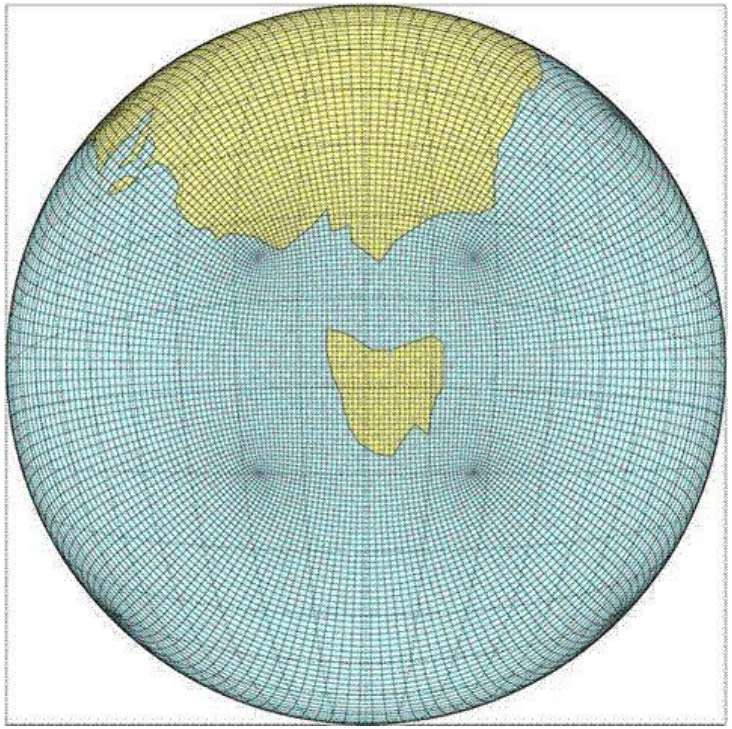


BUSHFIRE CONDITIONS UNDER A WARMING CLIMATE – THE VALUE OF REGIONAL CLIMATE MODELLING

CASE STUDY REGION: TASMANIA

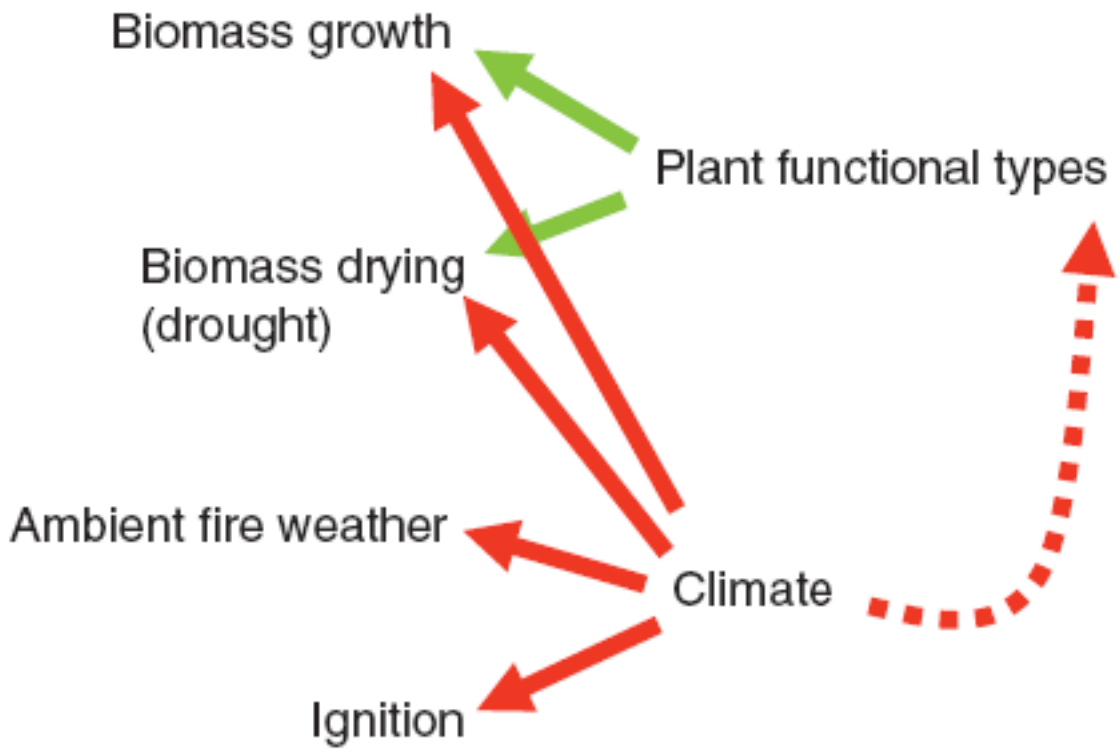
Michael Grose, Paul Fox-Hughes*, Nathan Bindoff

* Bureau of Meteorology

ANTARCTIC CLIMATE & ECOSYSTEMS CRC

MOTIVATION

Climate is an important factor in all aspects of fire danger except physical topography (e.g. slope)
A change in the climate may have profound effects

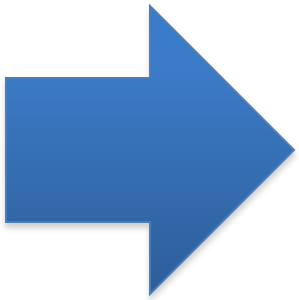


Graphic: NSW government report

MOTIVATION

Changes to *average* conditions of:

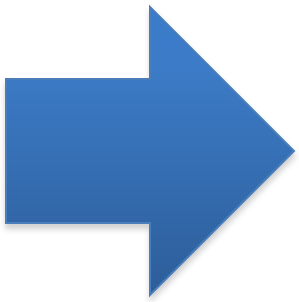
- Temperature
- Rainfall
- Evaporation
- Radiation (cloud)



Affects:
Fuel growth
Fuel drying

Change to *extremes* of:

- Temperature
- Wind
- Relative humidity



Affects:
Fire weather
Fire ignition
(and fuels)

CONTEMPLATING THE FUTURE

Guess

Expert judgment

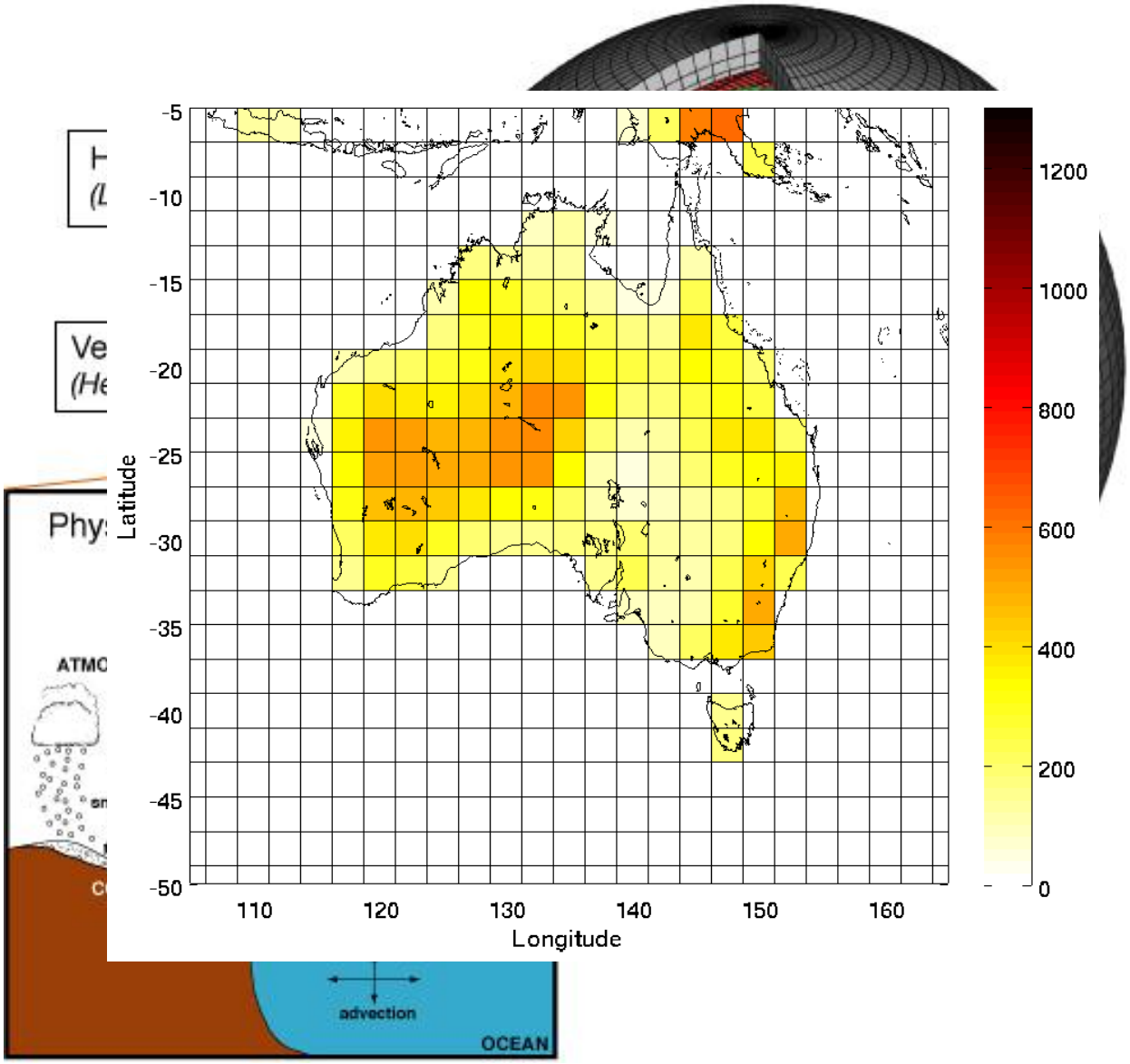
Global climate models + scenarios

- ‘Scale’ obs using Δ average
- Scale Δ average and Δ variability
- Adjust/correct bias from GCM output

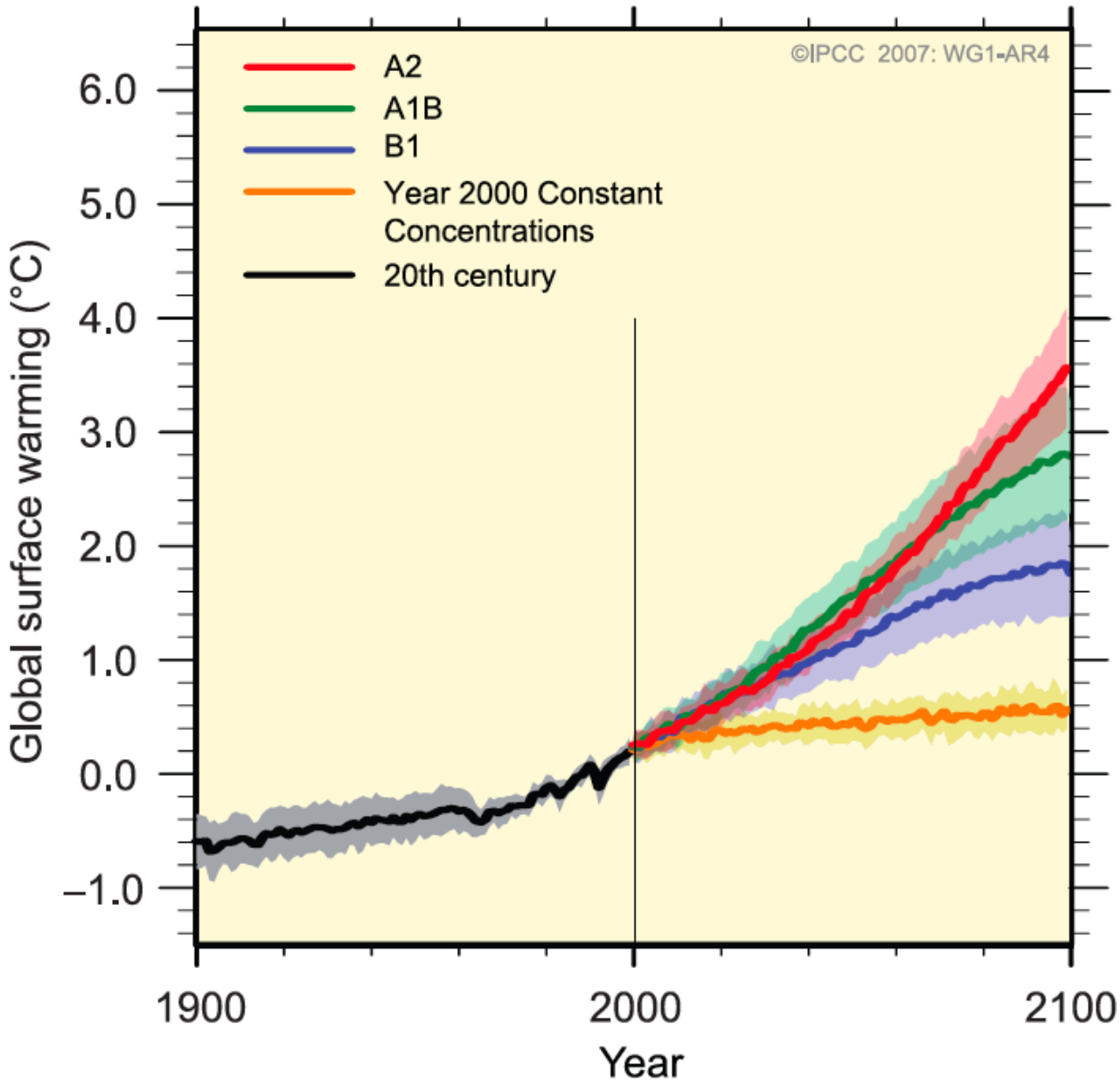
Go to the finer scale – Regional Climate Models (RCMs)

- Scale from this
- Adjust/correct if needed
- What is this and is there an advantage?

GLOBAL CLIMATE MODELS



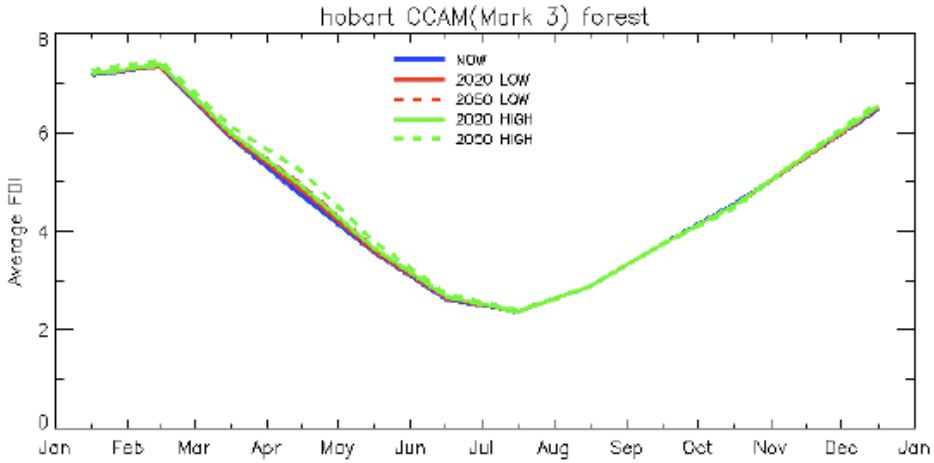
EMISSIONS SCENARIOS



CONTEMPLATING THE FUTURE

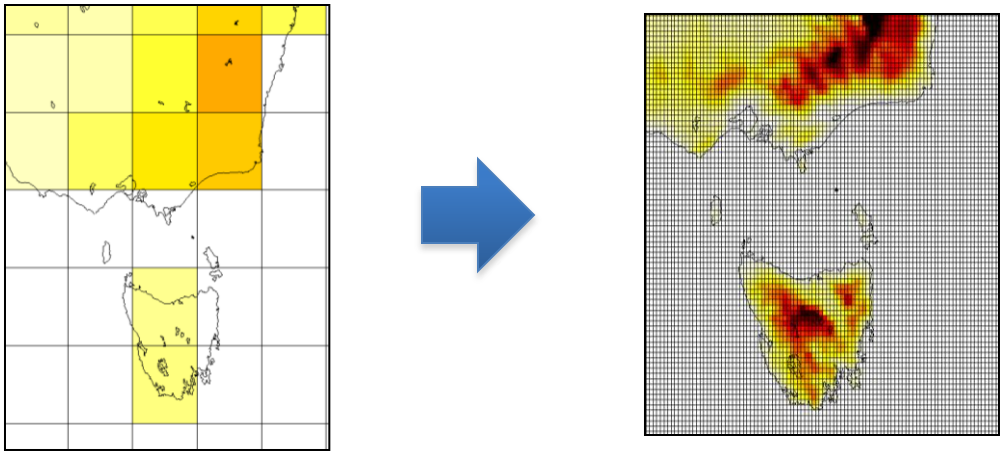
Tasmania's bushfire future:

Best view is something like Hennessy *et al*. (2005):
• Calculated trend in *mean* and *variability* of T, RH, Wind from models
• Applied this trend to observations, calculate fire danger
* Biases considered too large to use model data directly, or to correct



Hobart:
<1 or 2% change by 2050
(phew?)

RCMS



What RCMs offer:

Greater horizontal resolution – this study ~50km, then ~10 km
Greater temporal resolution – sub-daily outputs are useable
Greater fidelity of many meso-scale processes – doesn't "drizzle every day"

Remaining limitations:

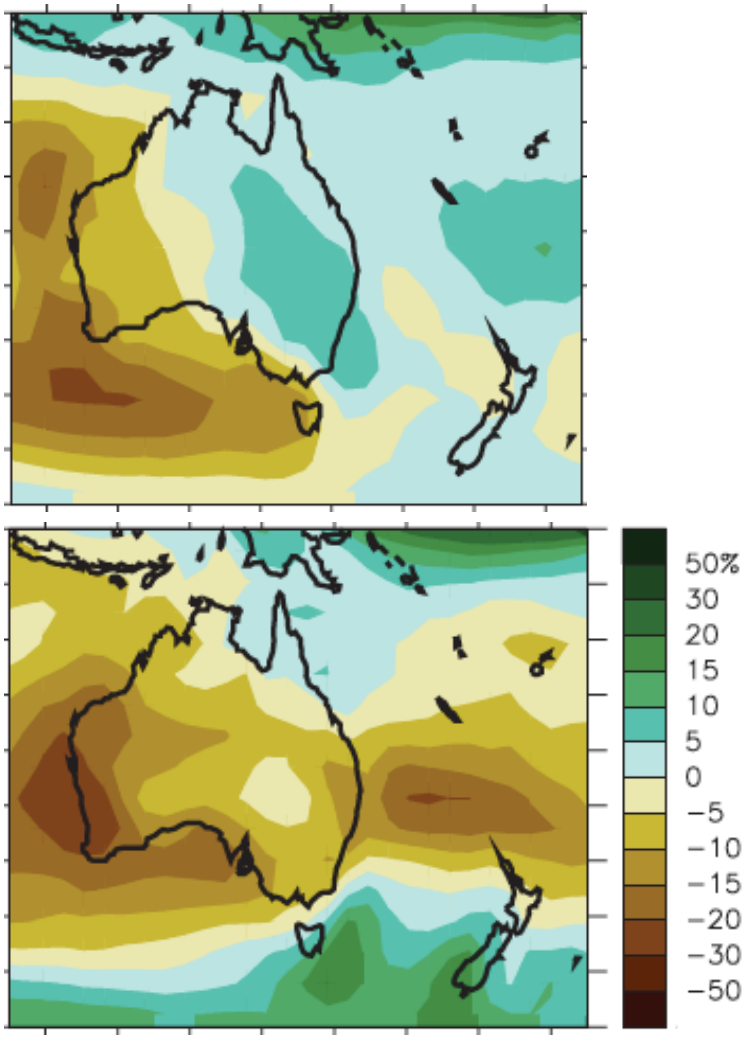
Spatial resolution is still not 'cloud resolving' or greater
Still requires parameterisations
Spatial resolution not the whole story
Some processes are classically poor in climate models – e.g. convection, cloud
Errors with mean circulation, oceans etc can remain

MOTIVATION

GCM trend in rainfall
End of century, A2 scenario

DJF

JJA



Climate averages affecting fuel growth and drying:

e.g. trend in mean rainfall

GCMs give a broad continental view

But
Trends can vary at a fine scale
Especially for places like Tasmania, eastern seaboard, alps region

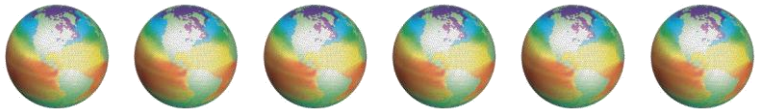
MOTIVATION

Black Saturday (wiki image)

Bushfire weather

- Fundamentally an issue of extremes (outside the norm)
- Average changes may not indicate the change in extremes
- Particular events, not just the coincidence of several factors (e.g. hot, dry winds brought by a particular system)
- Coarse scale GCMs may not give appropriate range or account for all the relevant processes

RCM METHODS

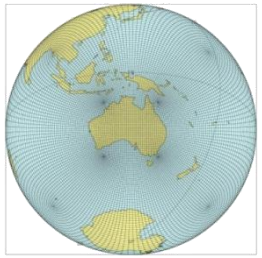


6 GCMs (Sea Surface Temperature)

SST only

Stage 1

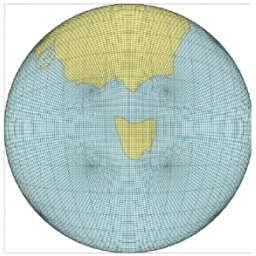
0.5° grid ~ 60 km



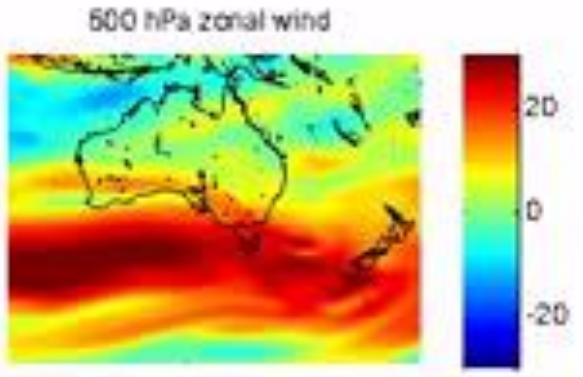
SST + nudging

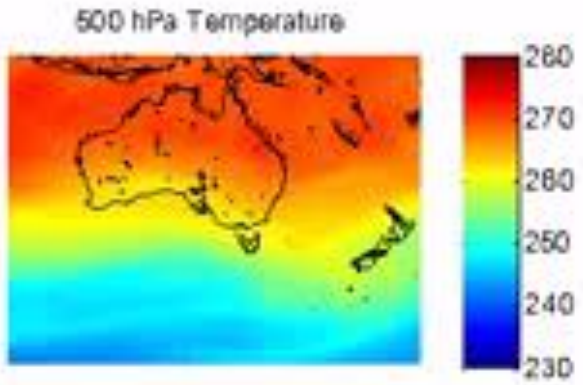
Stage 2

0.1° grid ~14 km



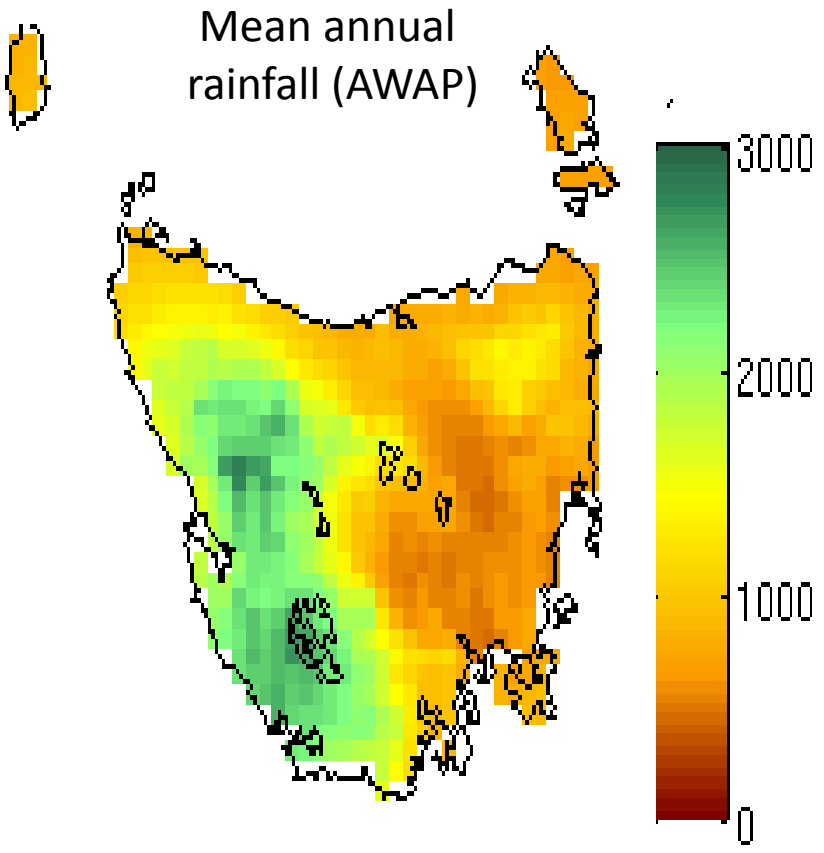
Conformal Cubic Atmospheric Model (CCAM)
A stretched-grid global model

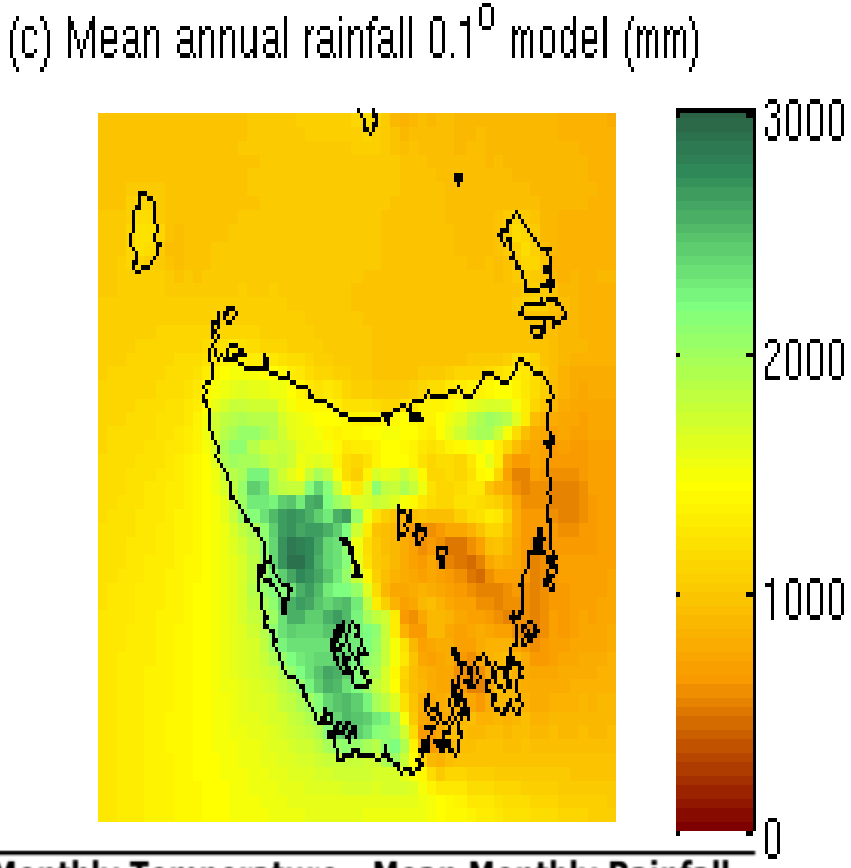




Methods: Corney *et al*. 2010

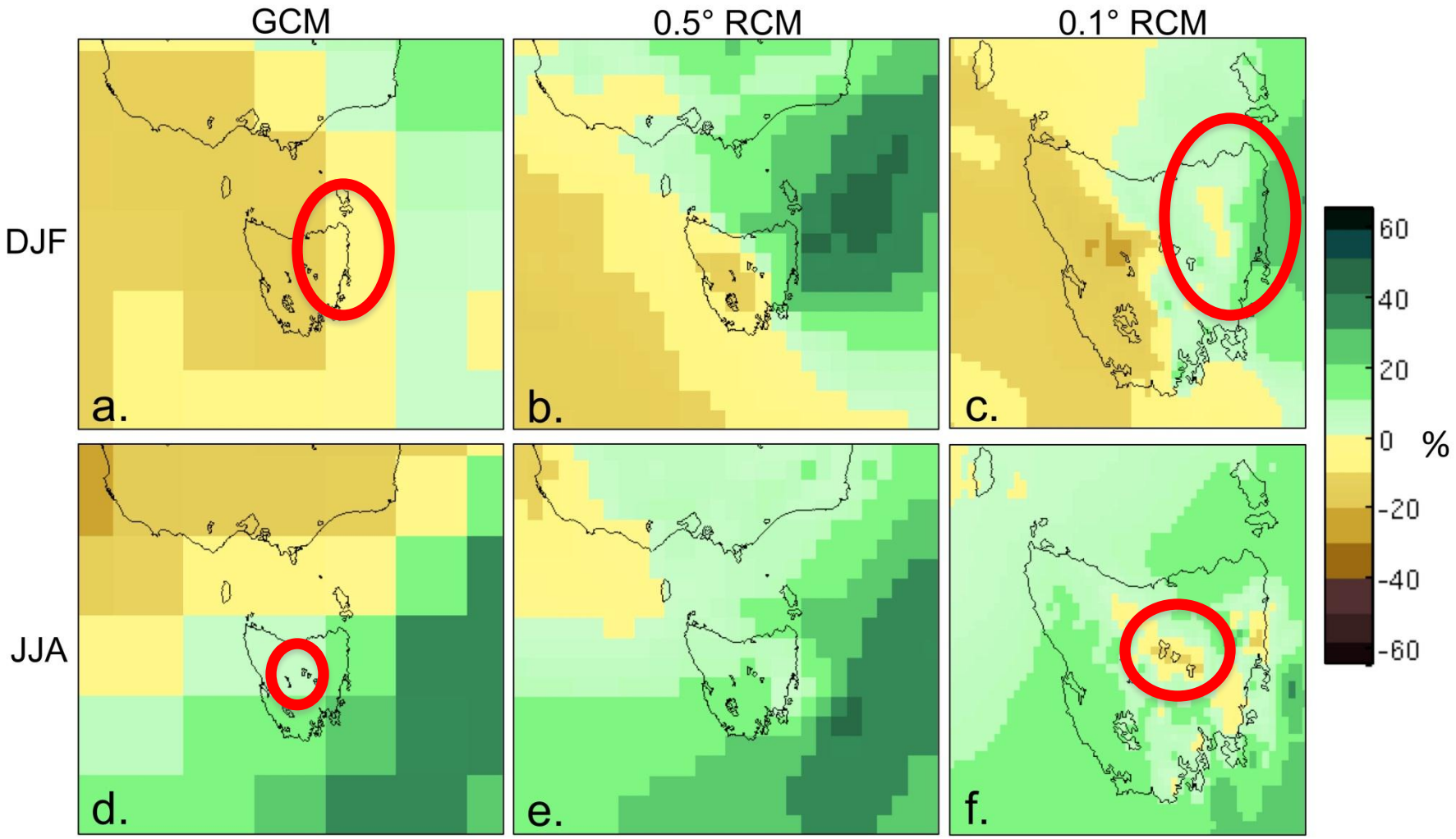
RCM METHODS





Model resolution	Mean Monthly Temperature	Mean Monthly Rainfall
GCM	0.45	0.28
0.5°	0.79	0.44
0.1°	0.93	0.63

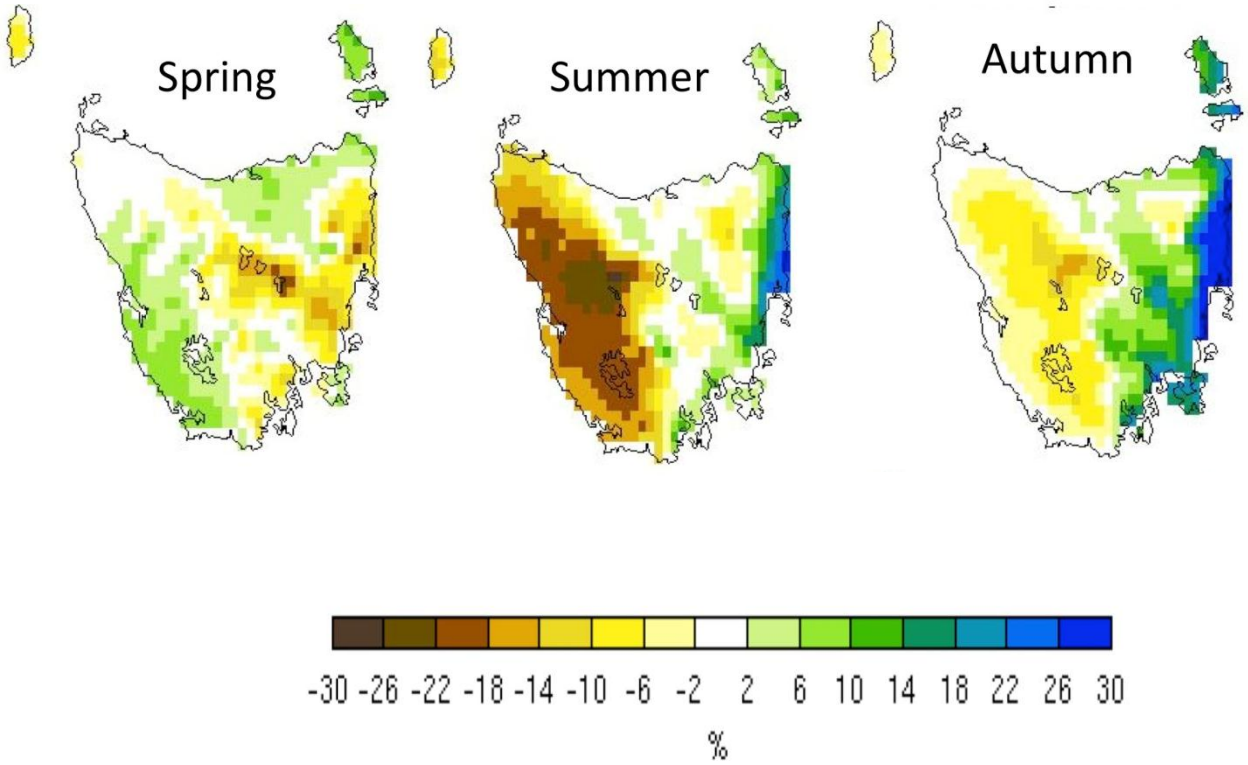
VALUE OF RCM - AVERAGES



Change over the entire 21st Century, A2 emissions scenario

VALUE OF RCM - AVERAGES

Finer resolution of projected change in average conditions
= better picture of likely changes to fuel growth and fuel drying
= use in modelling of biomass growth and even vegetation types(?)

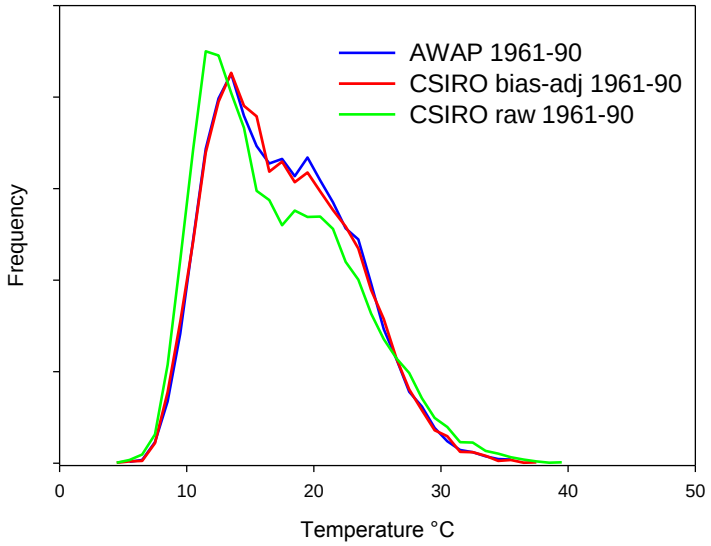


VALUE OF RCM – FIRE WEATHER

Events of high fire danger using direct model output (an audacious move)
But following some correction of biases of output
For this to work, biases must be small to start with (RCMs make it plausible)

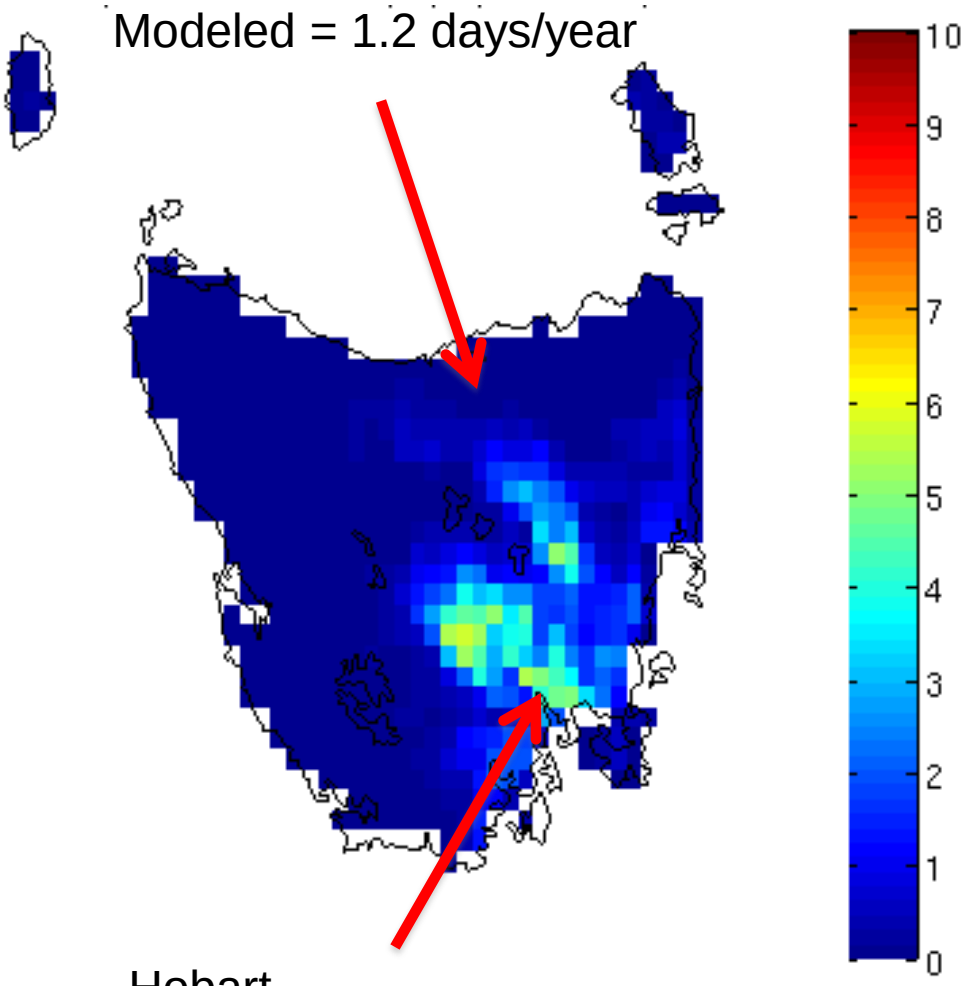
Bias-adjusted:
- Temperatures
- Rainfall

Not adjusted:
- RH (yet)
- Wind speed (no dataset)



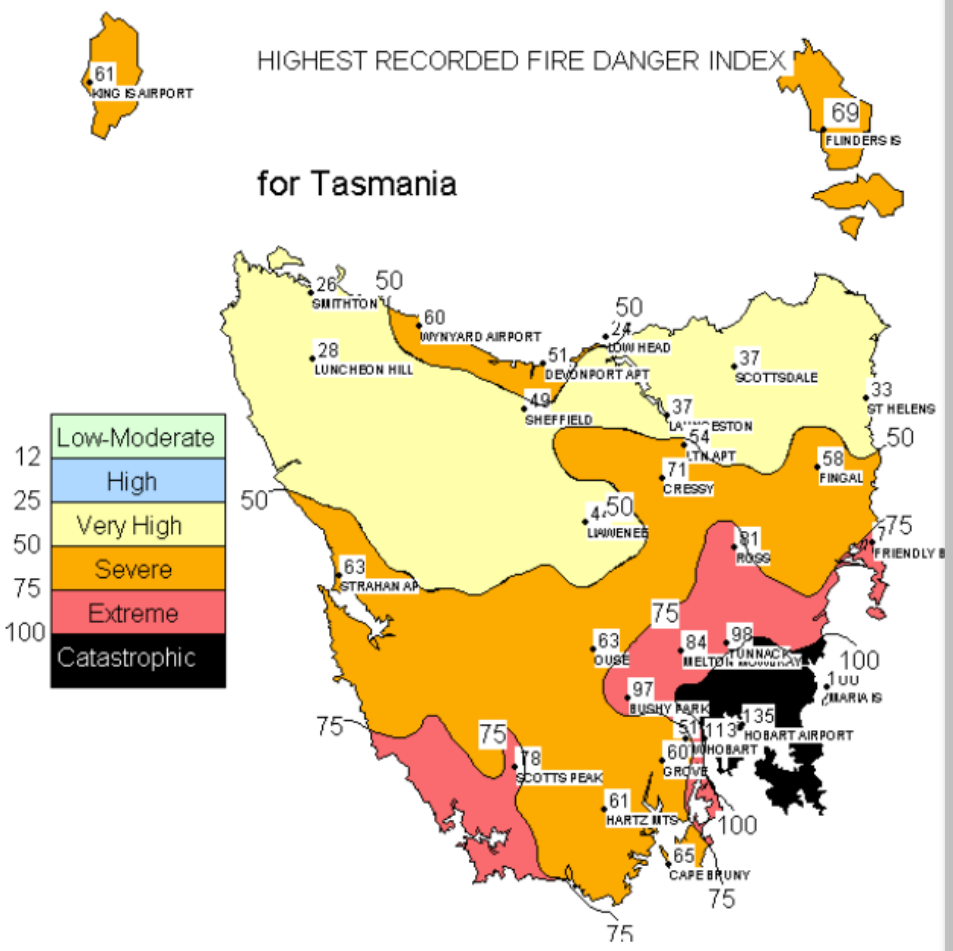
DAYS OVER FFDI 25 – CURRENT CLIMATE

Launceston
Obs = 1.5 days/year
Modeled = 1.2 days/year

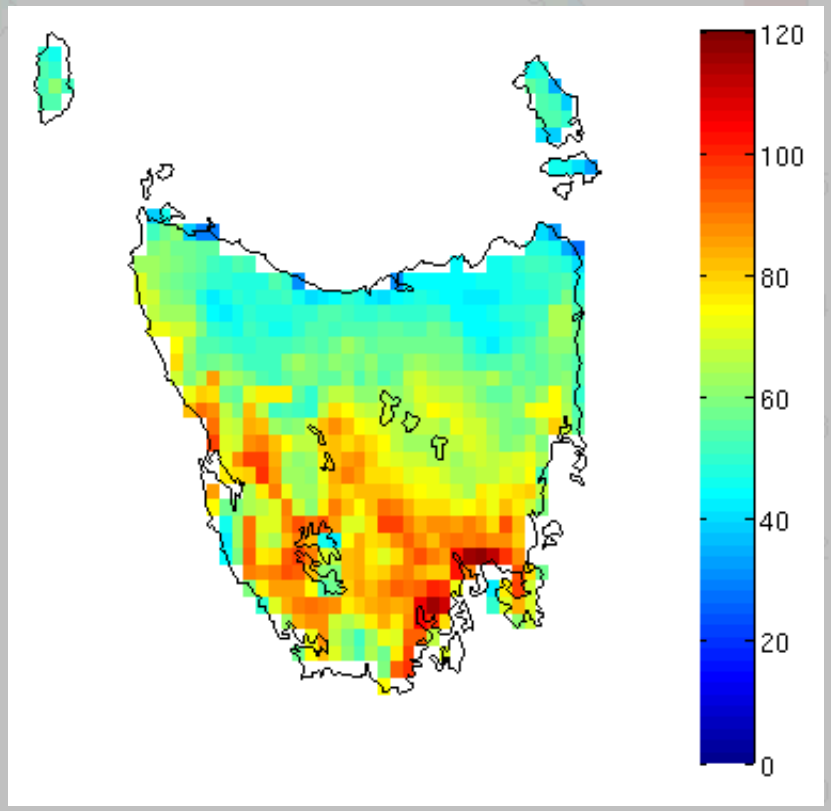


Hobart
Obs = 3.4 days/year
Modeled = 3.7 days/year

DAYS OVER FFDI 25 – CURRENT CLIMATE



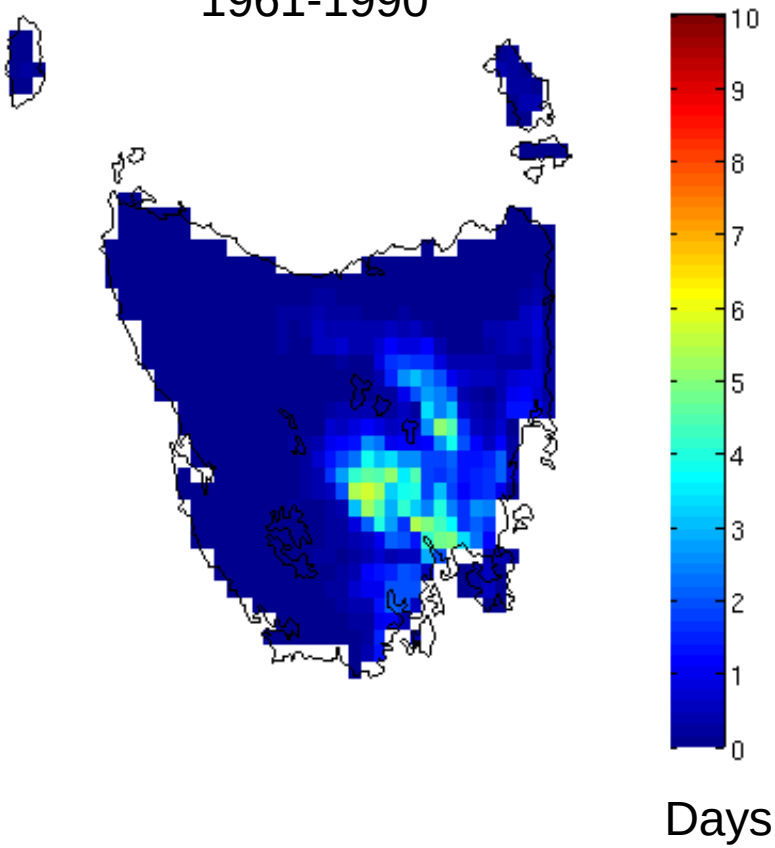
Observed



With DF = 10

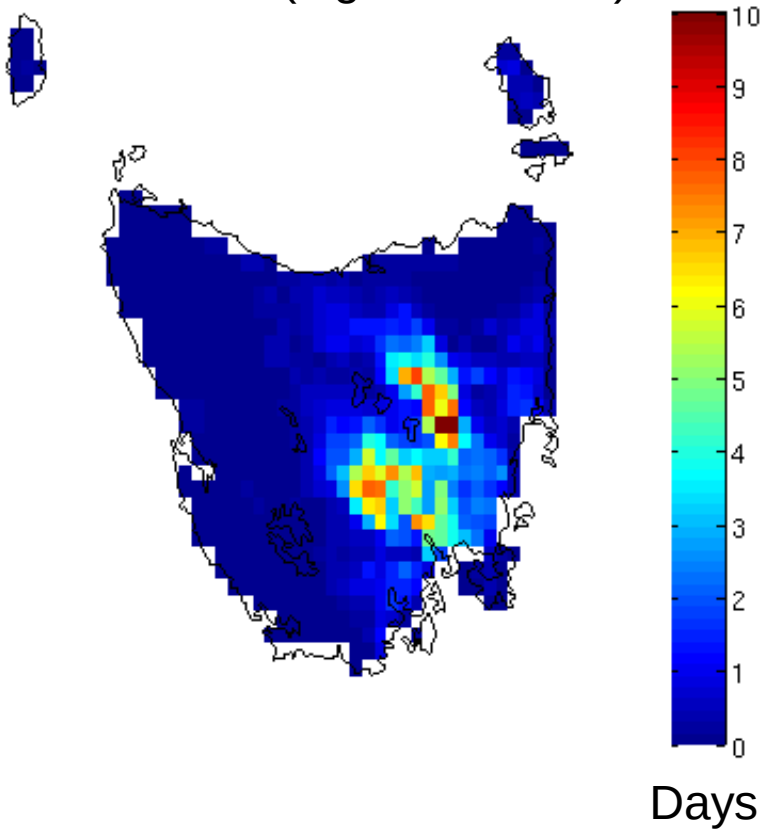
DAYS OVER FFDI 25 – CHANGE

1961-1990



Hobart = 3.7 days
Launceston = 1.2 days

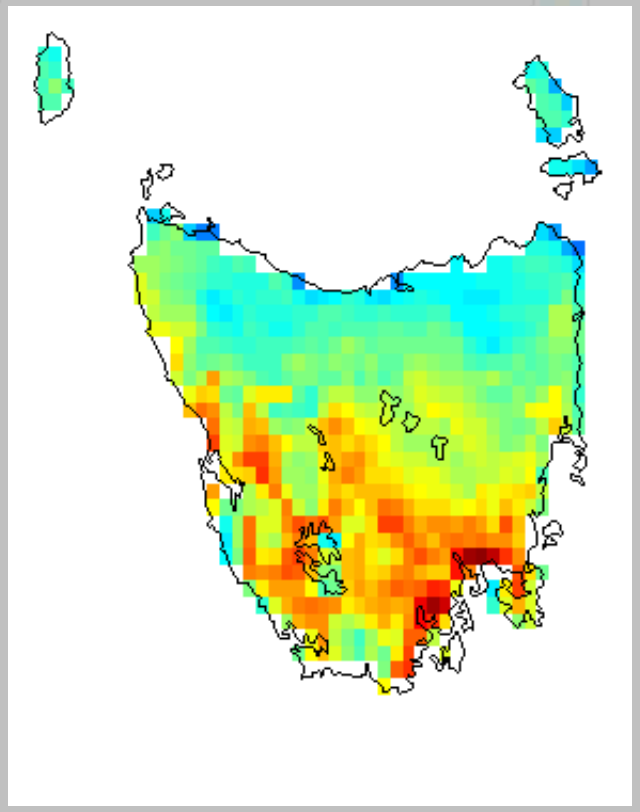
2090-2099
A2 scenario (high emissions)



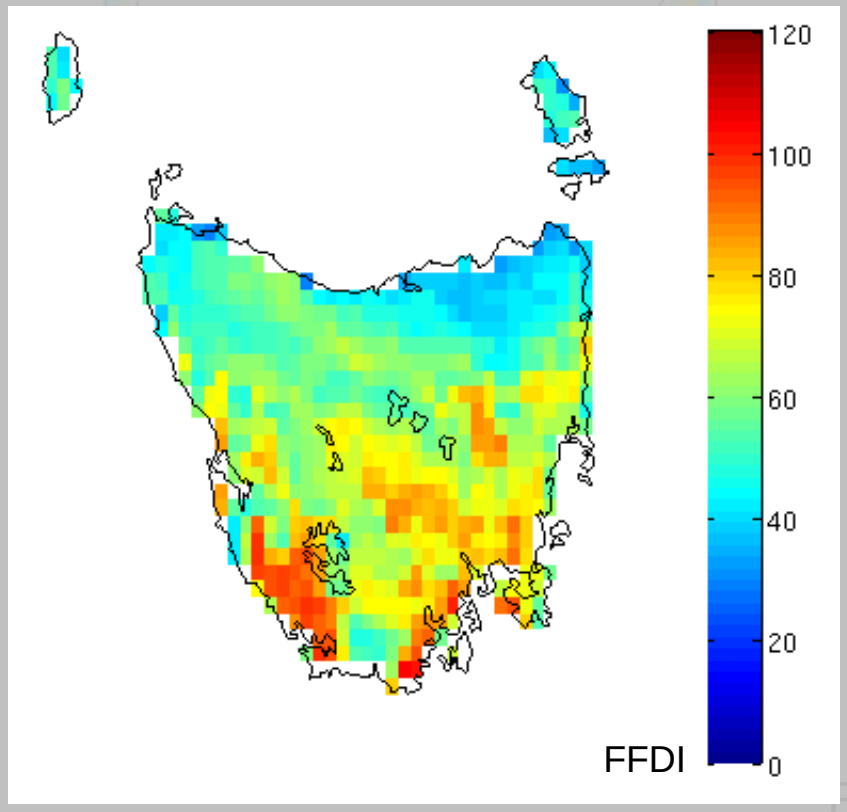
Hobart = 5.5 days
Launceston = 3.5 days

MAX FFDI – CHANGE

With DF = 10

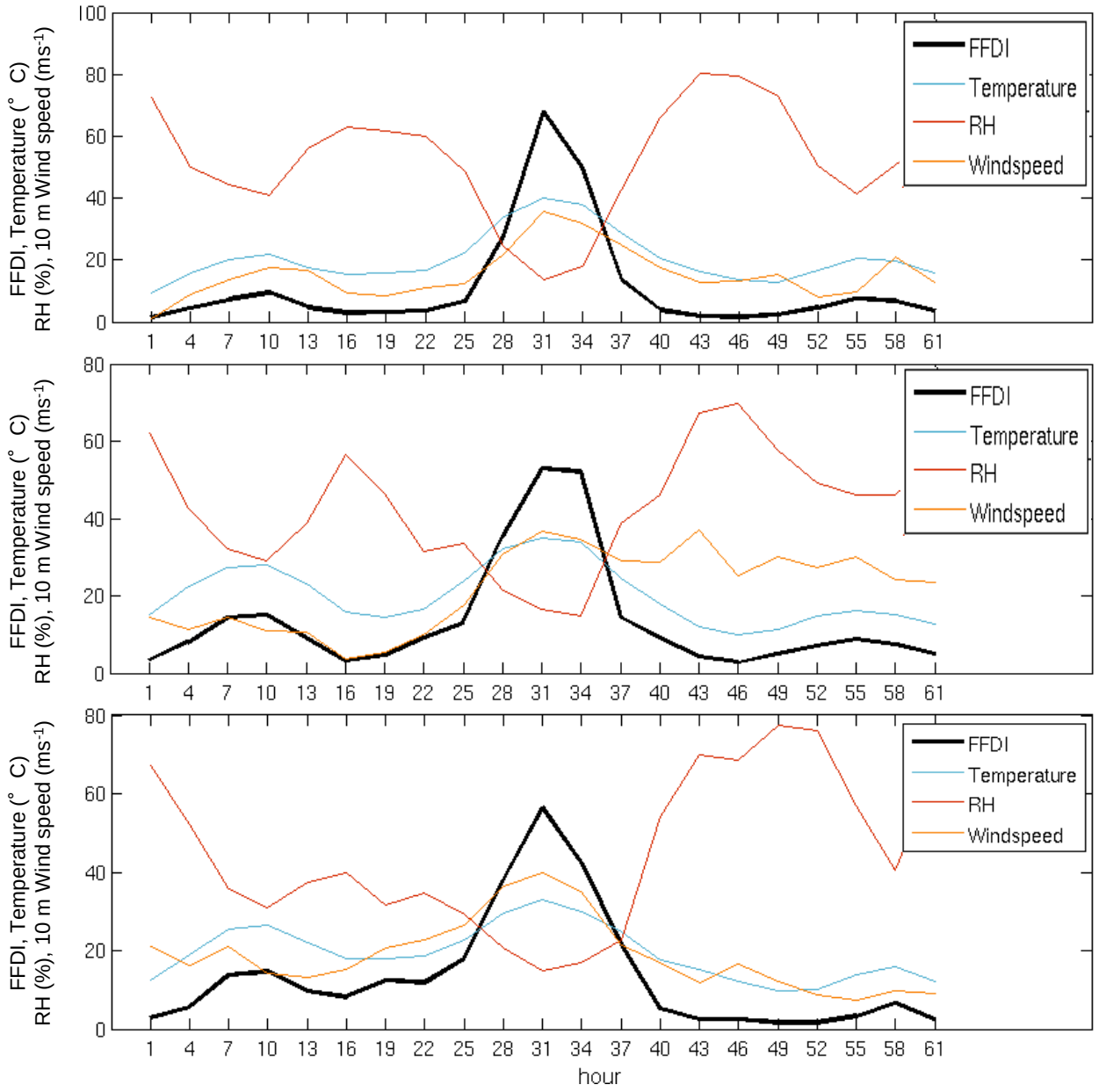


1961-1990



2090-2099
A2 scenario (high emissions)

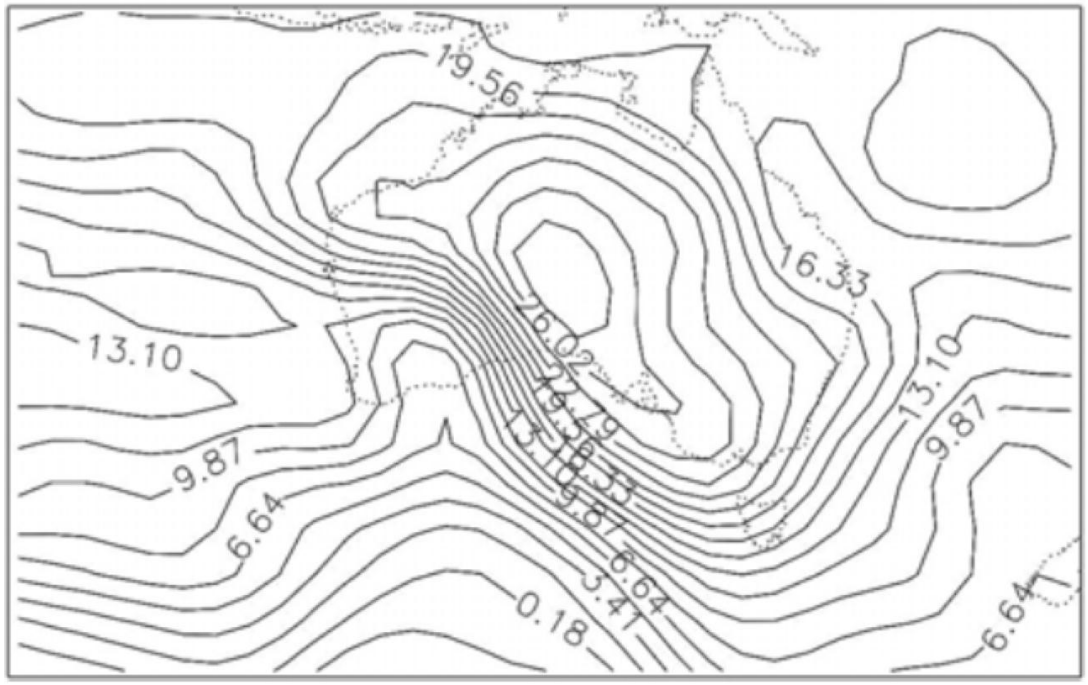
DYNAMICS OF EVENTS



FIRE WEATHER EVENTS - DYNAMICS

Example pattern:

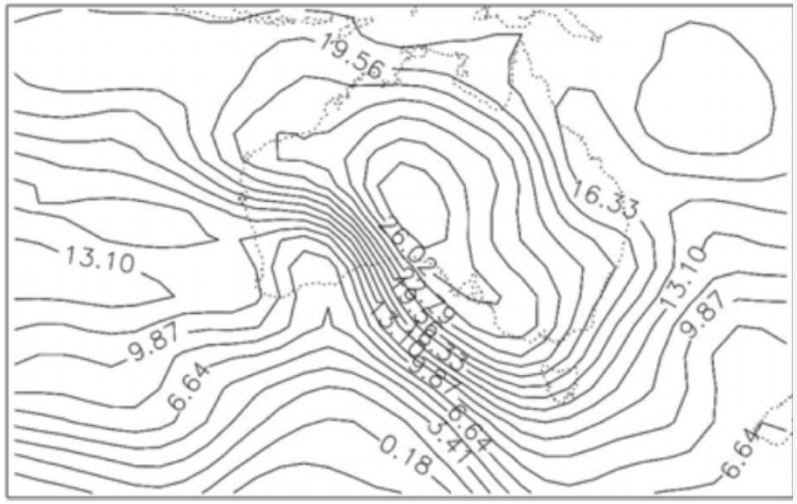
- Preceding a strong, deep cold front
- Strong and hot pre-frontal NW winds
- Indicated by strong thermal gradient at 850 hPa
- Analysis box over Victoria & Bass Strait (Mills 2005)
- Associated with many of the major fires (e.g. 1967, 1983 etc)



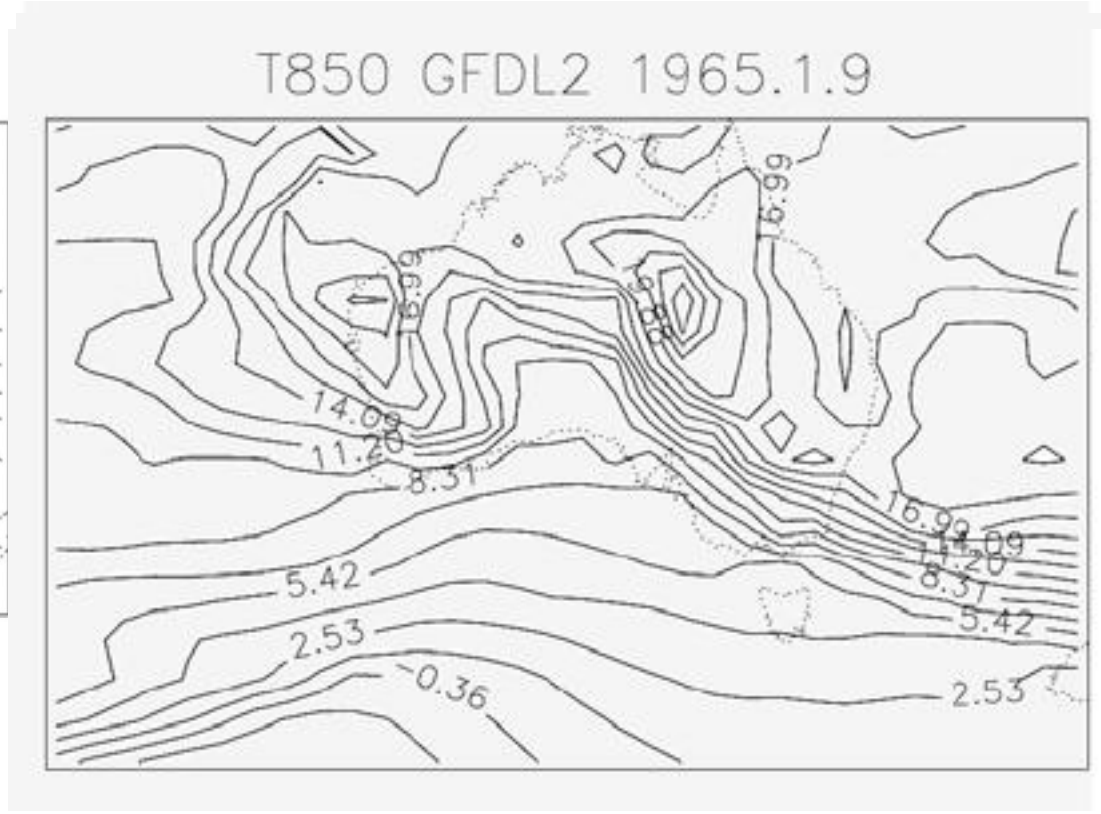
850 hPa Temperature, 16th February 1983 (Ash Wednesday)

FIRE WEATHER SYNOPTIC PATTERN

- Applying Mills method to GCM can be tricky
- Non-standard and coarse spatial resolution
- No sub-daily timescale
- Some latitudinal biases in climate models
- However, events are simulated with some success



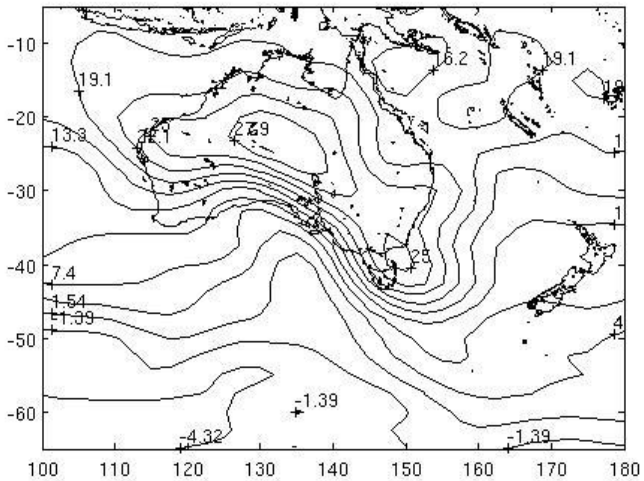
Extreme event - NCEP



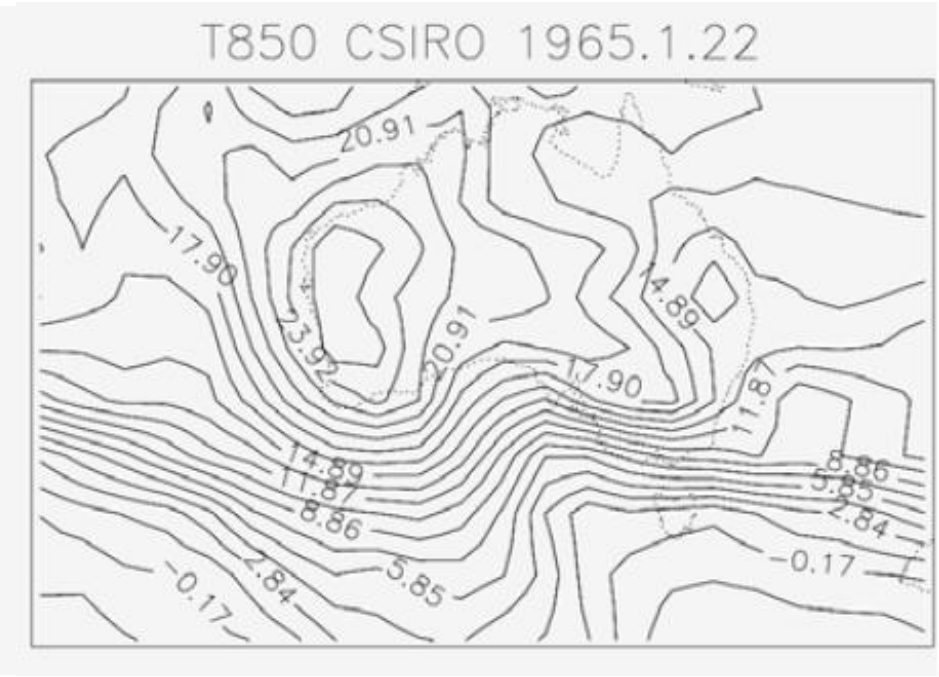
Extreme event – climate model

Hasson *et al*. 2008

FIRE WEATHER SYNOPTIC PATTERN

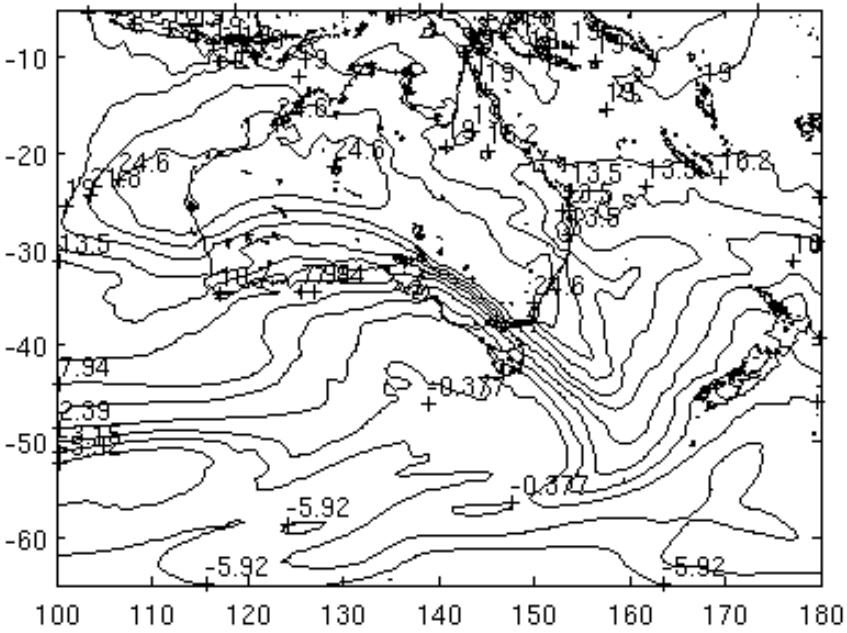


How does the RCM compare to GCMS?



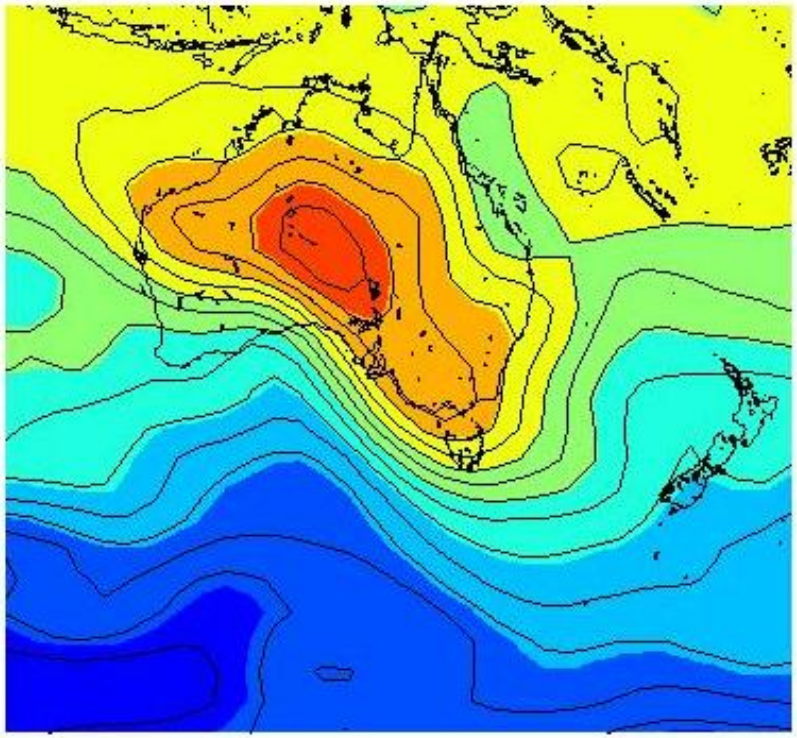
Timestep with strongest gradient

RCM equivalent

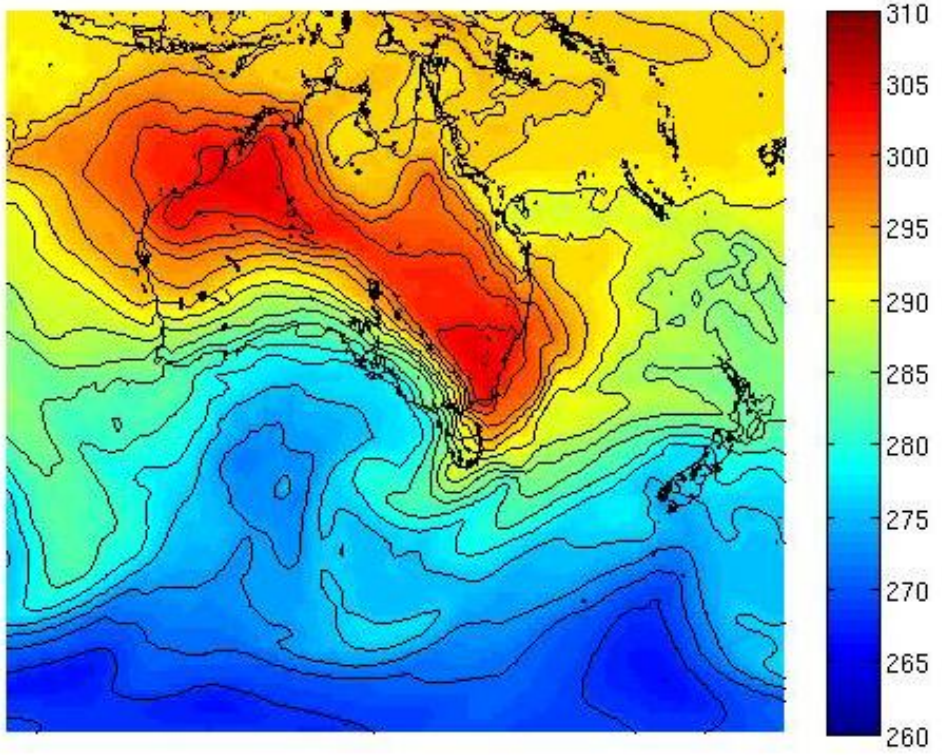


FIRE WEATHER SYNOPTIC PATTERN

- Events in an example RCM climate simulation
- Top 7 events from the recent 30 years shown

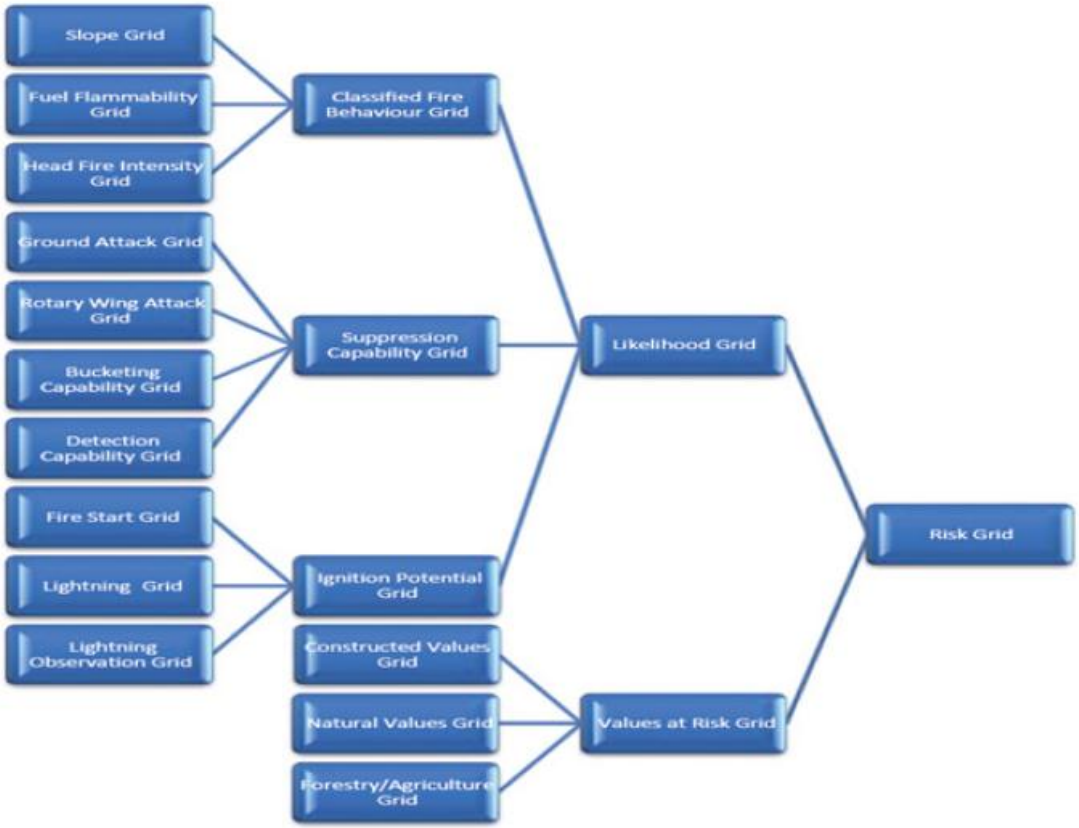


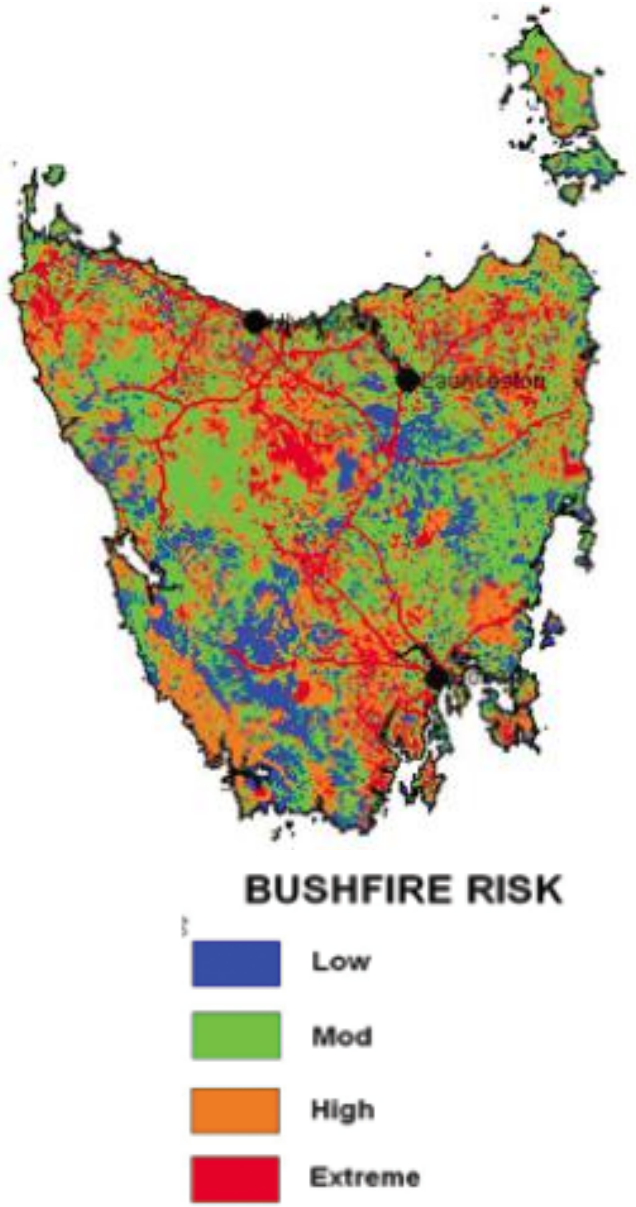
Ash Wednesday event for comparison
850 hPa Temperature, NCEP



850 hPa Temperature, CCAM simulation

OVERALL RISK - B.R.A.M





First test: weather only (FWI codes)
Plan to add fuels too

CONCLUSION

Regional climate models can be a useful tool in making projections:
- Assessing fuel growth and drying
- Examining changes to fire weather
- Analysing changes to fire dynamics

Can be teamed with existing Bushfire risk tools, e.g. BRAM
To give risk scenarios in the form that they are used

⇒ Provide useful scenarios to stimulate thinking on long-term planning

⇒ Still early days, ideas still coalescing – suggestions welcome

SES State Emergency Service - Tasmania

Australian Government
Attorney-General's Department

Emergency Management in Australia