Climate Risks, the merging of finance, risk and climate science

Key Messages

*Our climate is changing and the change is happening now

*the impacts will occur through both climate extremes events and change in mean state

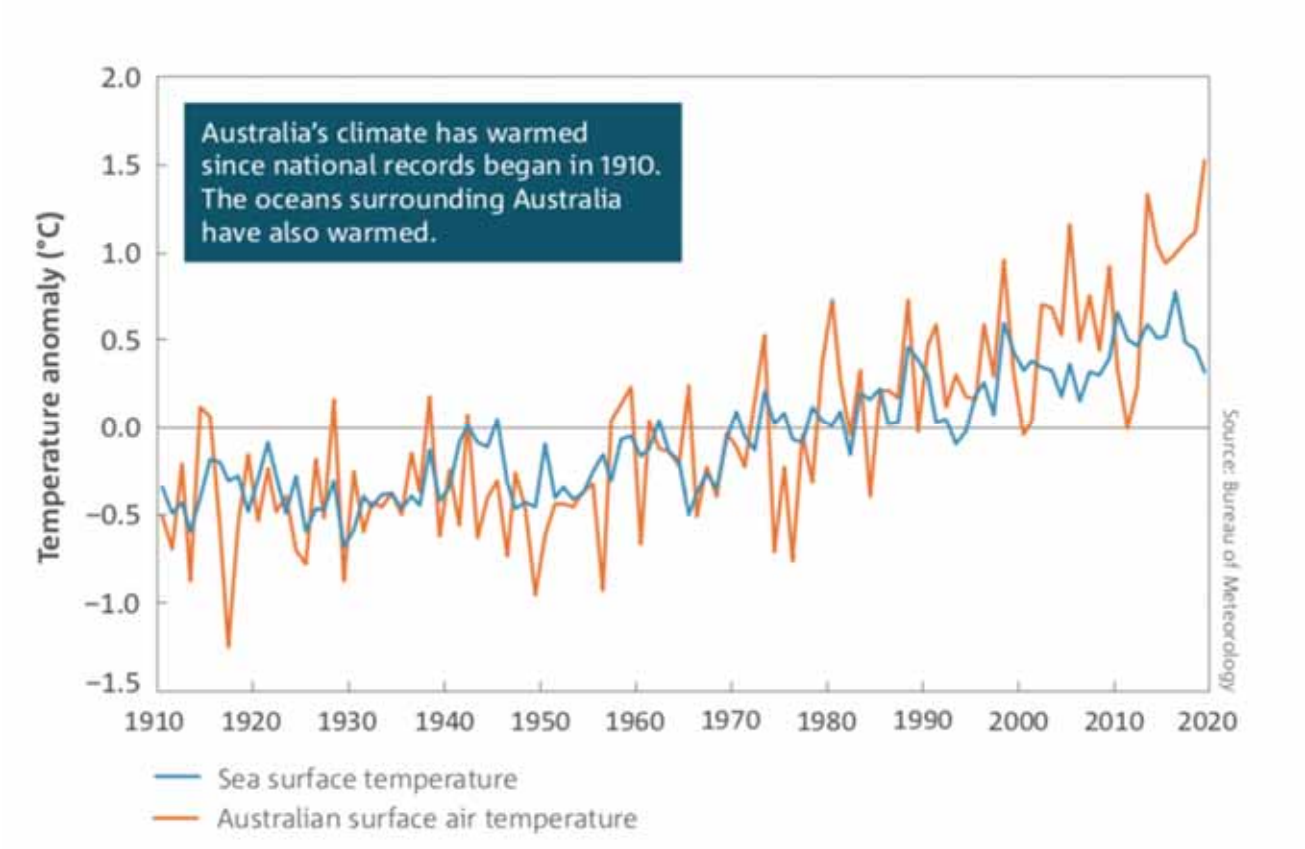
*move to quantitative assessing climate risk

Richard Matear | Climate Intelligence Portfolio Lead, Climate Science Centre
O&A Business Unit
OCEANS AND ATMOSPHERE

Outline

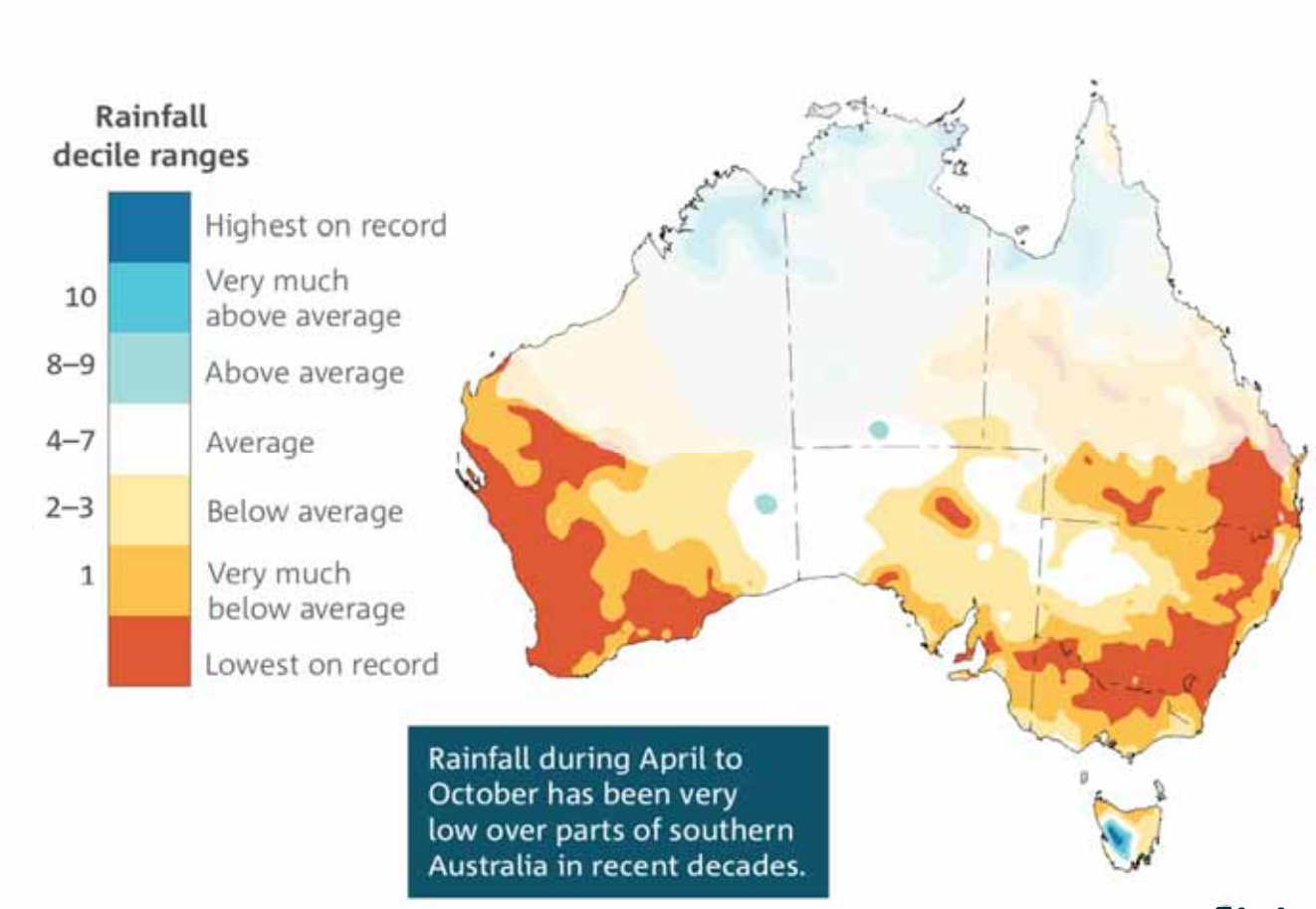
- Historical and Future Climate Trends
- Climate Risk -Energy Sector Climate Information Project
  - Case study approach
- A Climate Service – multi-agency proposal to deliver the authoritative climate hazard information from multi-week to multi-decade
- Climate Resilient Enterprise – CSIRO initiative
- Summary and where to next

Australia's Mean Temperature Anomaly



- **State of the Climate, 2020**

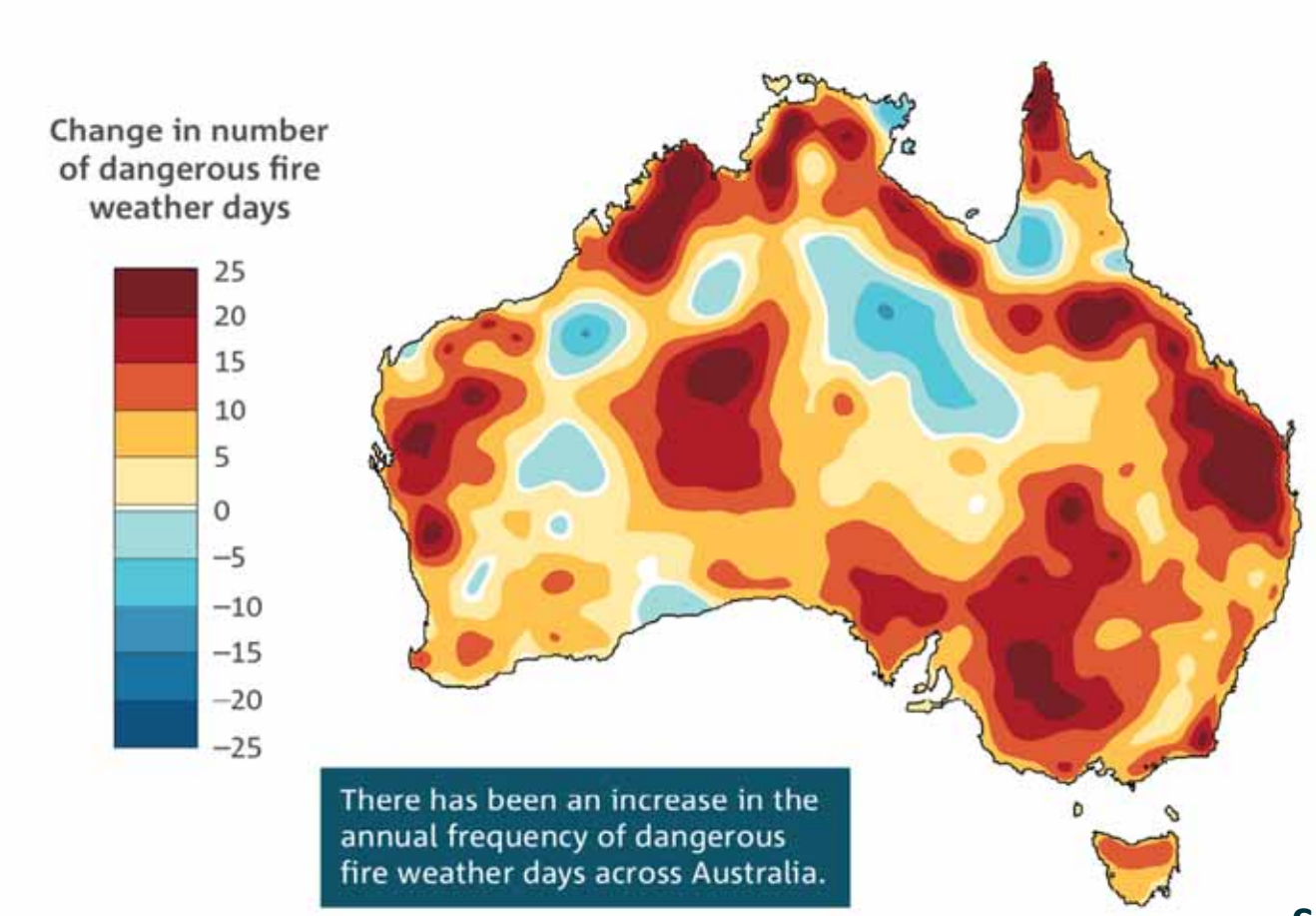
Winter (Apr-Oct) Rainfall last 20 years compared to 1900-2019



April to October: In 17 of the last 20 years, monthly rainfall in southern Australia has been below average

- **State of the Climate, 2020**

Fire weather: 2019-1985 vs (1950-1985)



*Climate change affects the dryness and amount of fuel, through changes in rainfall and air temperature and atmospheric moisture content that exacerbate landscape drying.
*CO2 impacts plant growth too.

- **State of the Climate, 2020**

Need to better manage climate variability and extremes:

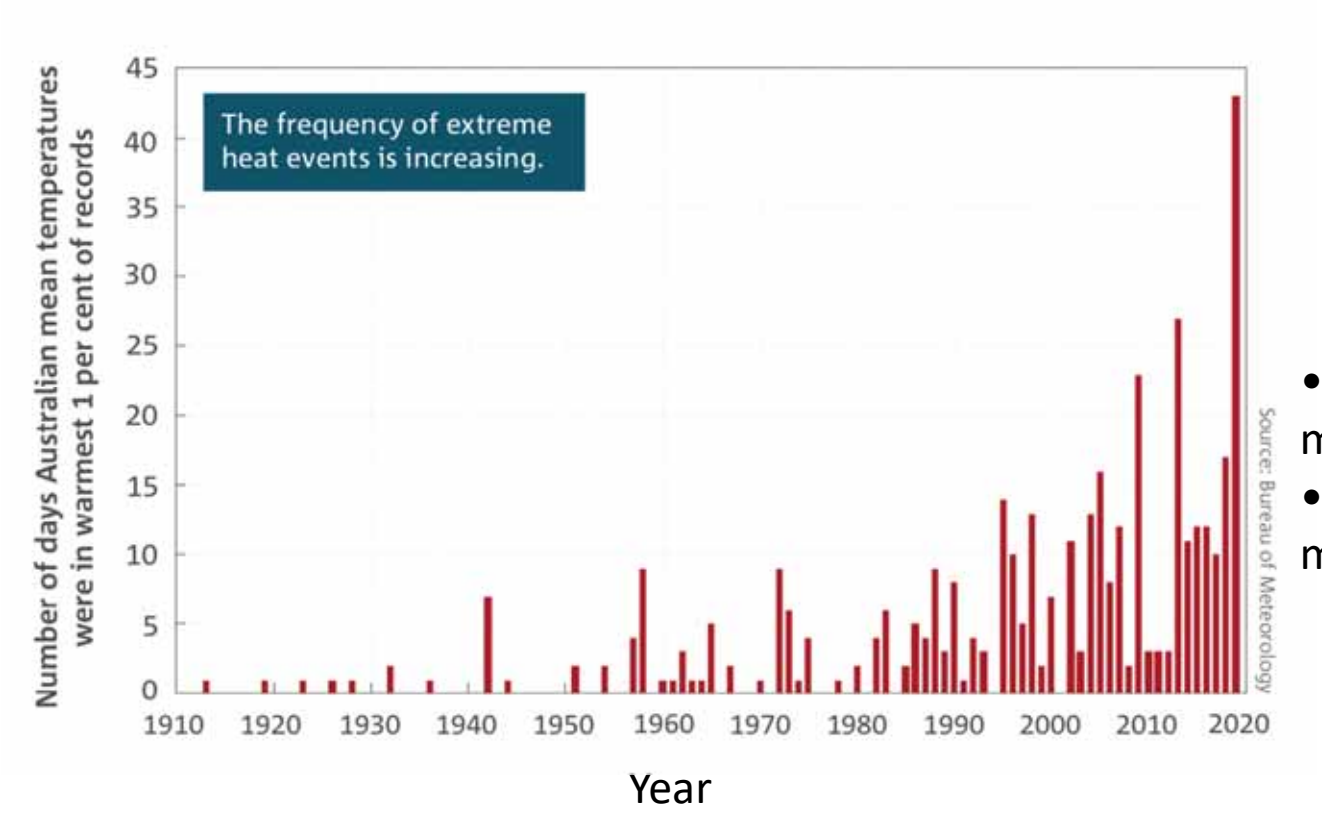
The Guardian

Floods, fire and drought: Australia, a country in the grip of extreme weather bingo

Amid record temperatures, severe flooding and devastation of wilderness, the political message from the government is business as usual

Australian Climate Trends: Heat events

- **State of the Climate 2020**



- Climate is changing with more and stronger extremes
- Applies to rainfall, floods, marine heatwaves

Australian Climate Trends

Hazards: Informing priorities

Table 4: Peril types ranked by insurance loss caused, 1967-2020 (54 years of record)
Data from ICA's Historical Catastrophe Database

Rank	Peril	Sum insured	%
1	Hail	$28,932,650,727	28.6%
2	Flood	$26,939,437,924	26.7%
3	Cyclone	$17,286,685,083	17.1%
4	Bushfire	$13,781,863,112	13.6%
5	Storm	$8,733,886,947	8.6%
6	Earthquake	$4,666,906,311	4.6%
7	Tornado	$470,015,900	0.5%
8	Landslide	$238,071,172	0.2%
	TOTAL	$101,049,517,175	100.0%

Table 6: Peril types ranked by fatalities caused, all time periods (ranked by the 1967-2020 **period**)
Data from Risk Frontiers' PerilAUS database

Rank	Hazard	1788-2020		1900-2020		1967-2020		1990-2020	
		Deaths	%	Deaths	%	Deaths	%	Deaths	%
1	Heatwave	5634	42.4%	4857	47.8%	1202	39.9%	909	46.6%
2	Flood	3115	23.4%	1953	19.2%	565	18.8%	328	16.8%
3	Bushfire	1033	7.8%	1015	10.0%	557	18.5%	305	15.6%
4	Gust	284	2.1%	346	3.4%	264	8.8%	219	11.2%
5	Cyclone	2018	15.2%	1216	12.0%	206	6.8%	55	2.8%
6	Lightning	1012	7.6%	593	5.8%	111	3.7%	59	3.0%
7	Landslide	101	0.8%	96	0.9%	65	2.2%	63	3.2%
8	Earthquake	17	0.1%	17	0.2%	14	0.5%	0	0.0%
9	Tornado	55	0.4%	53	0.5%	13	0.4%	3	0.2%
10	Rain	22	0.2%	18	0.2%	11	0.4%	8	0.4%
11	Dust storm	3	0.0%	3	0.0%	3	0.1%	3	0.2%
12	Hail	4	0.0%	3	0.0%	1	0.0%	0	0.0%
	All hazards	13,298	100.0%	10,170	100.0%	3012	100.0%	1952	100.0%

Credit: Risk Frontiers, 2021

Climate-Related Financial Risk

Physical risk

Acute physical risks:

- Tropical cyclone
- East coast lows
- Extreme rainfall and riverine floods
- Extreme sea level events
- Large hail
- Extreme bushfire events

Chronic physical risks:

- • Average temperature and extreme heat events
- • Average rainfall
  • Sea level rise
  • Drought

Transition risk

Acute physical risks:

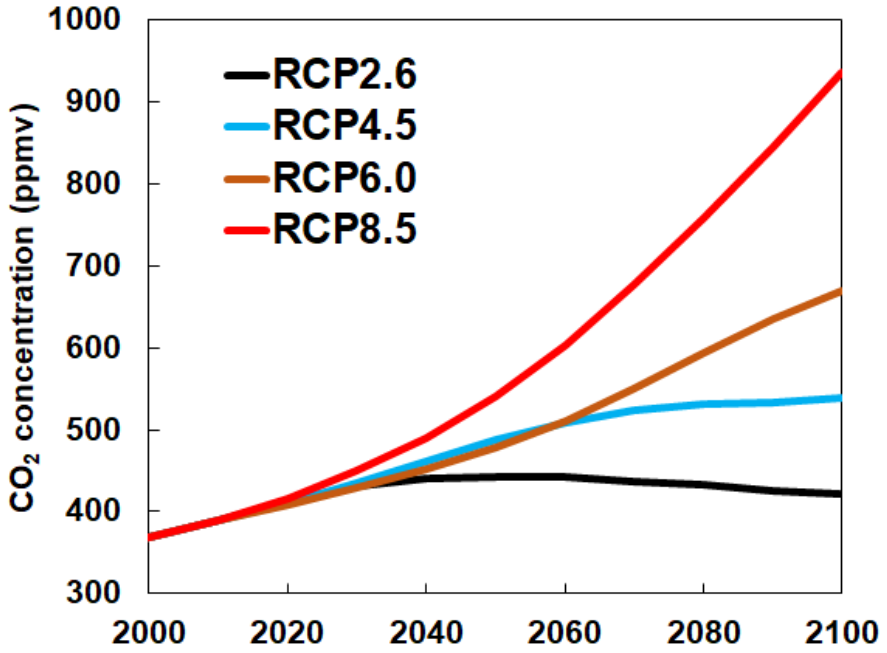
- Storm surge and coastal flooding

Transition risks:

- Technology
- Policy and legal
- Market
- Reputation

Climate Measurement Standards Initiative
Task Force on Climate-Related Financial Disclosures (TCFD)

Future Pathways (TCFD consistent)



Certainly exceed Paris, 3-5 °C

2/3 chance of meeting 2 °C limit (Paris)

Climate Measurement Standards Initiative
Task Force on Climate-Related Financial Disclosures (TCFD)

Earth Systems and Climate Change Hub

Projections for chronic hazards (confidence)

Chronic hazards (changes in average conditions) - projected ranges given for the 3 periods, 4 regions, with confidence ratings:

- Temperature – increase (*Very High confidence*)
- Rainfall – drier in south (*High)* and east *(Low-Medium)* uncertain in the north
- Sea level – increase (*Very High)*
- Time in drought – increase in most regions (*Low-Medium)*

Climate variable	Observed change and attribution	2030 relative to 1986-2005	2050	2090	Confidence rating
Annual average temperature	Around +1.4 °C since 1910 (strong)	+0.6 to 1.4 °C	+0.5 to 1.5 °C	+0.5 to 1.5 °C	Very High
			+1.5 to 2.5 °C	+2.5 to 5.0 °C	

2/3 chance of meeting 2 °C limit (Paris)

Certainly exceed Paris, 3-5 °C

Climate Measurement Standards Initiative
Task Force on Climate-Related Financial Disclosures

Acute Hazards: Projected Changes

Climate Measurement Standards Initiative
Task Force on Climate-Related Financial Disclosures

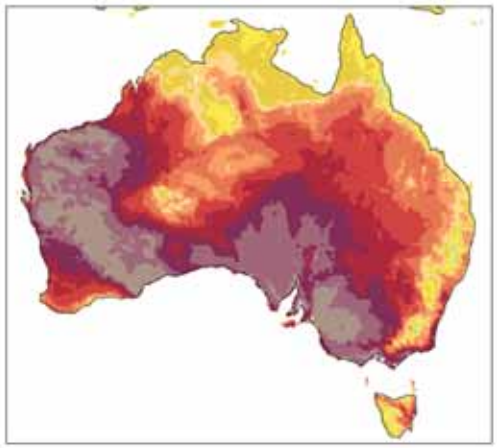
Electricity sector hazards

Hazard	Electricity System Exposure
Temperature	• Reduces generator and network capacity, and increases failure rates while simultaneously increasing customer demand for cooling load. • Increases the rates of electrical asset deterioration, increasing failure rates or maintenance/replacement costs.
Bushfire	• Poses a threat to all assets, with a particularly high operational risk to transmission lines due to smoke and heat. • Requires consideration in line route selection and design.
Wind	• Affects wind generation output, plant profitability and design specifications. • Requires consideration for network capacity assessments, design specifications and failure rates.
Precipitation / Dam inflows	• Reduces water available for hydro generation and cooling water for thermal coal plants. • Increases requirement for desalination loads.
Extreme and compound events	• Widespread impacts on all assets • Vulnerability is time-dependent: during, aftermath, recovery

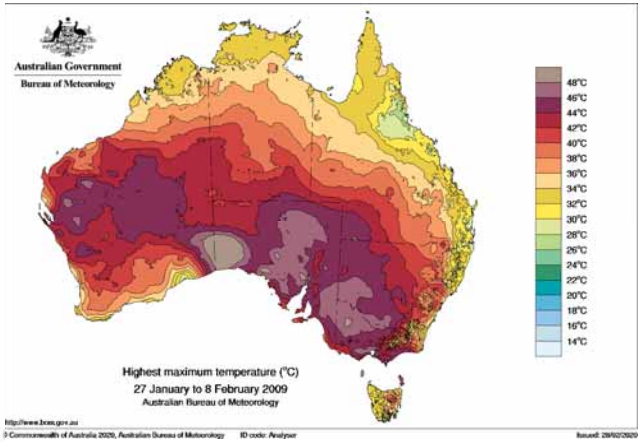
Overview of future scenario: hypothetical heat event in January 2045

Highest maximum temperature – comparison to historical events

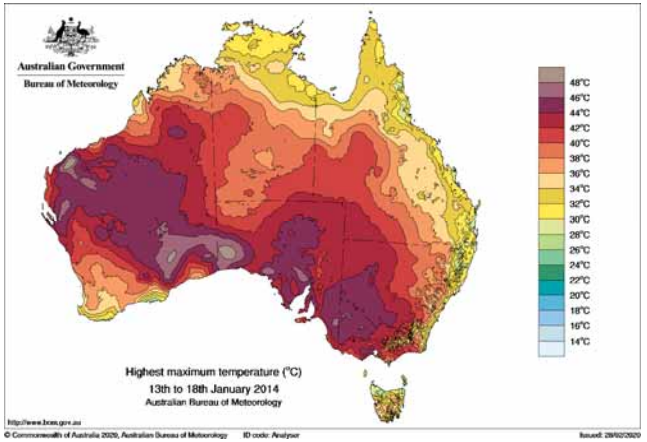
"2045"



2009



2014

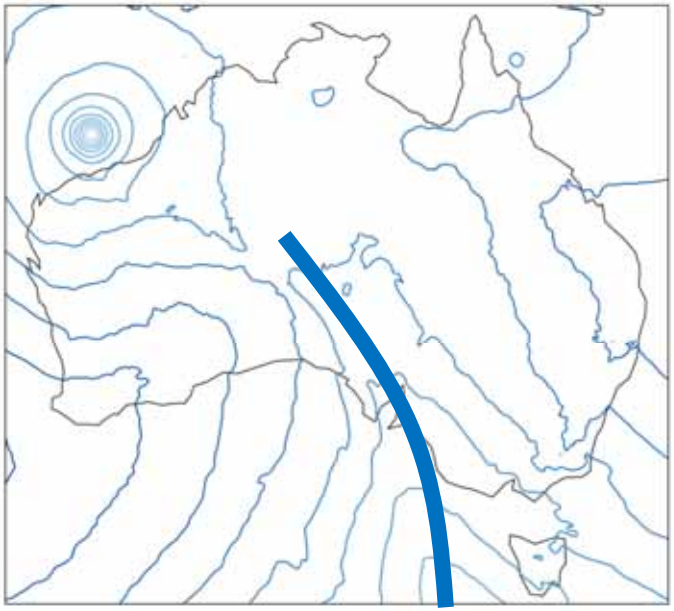


The highest maximum temperatures modelled during the "2045" case event are similar (or warmer than) temperatures recorded in significant historical heatwave events. Note the very hot conditions along the eastern seaborn during the "2045" event (i.e., impacting a number of major demand centres simultaneously).

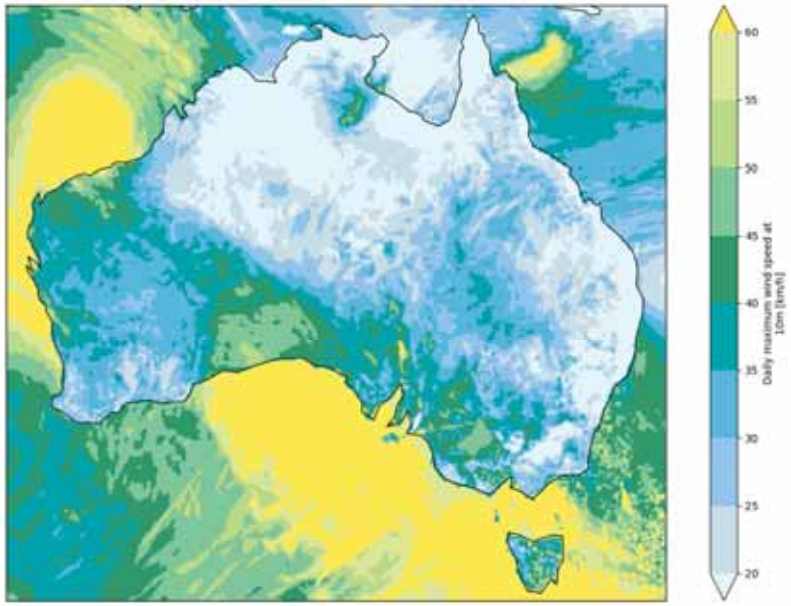
Overview of future scenario: hypothetical heat event in January 2045

Strong Frontal System – passing southeast Australia on 25th January "2045"

Synoptic Chart: 25 Jan "2045"



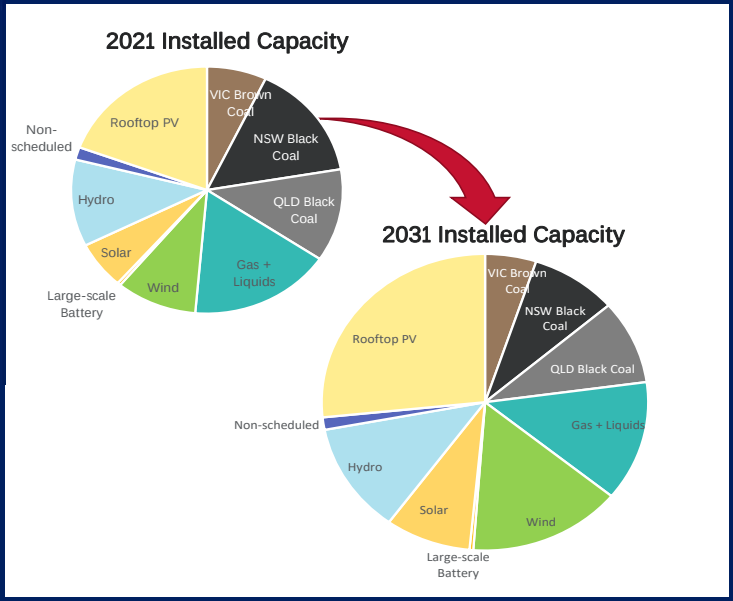
Maximum wind speeds: 25 Jan "2045"

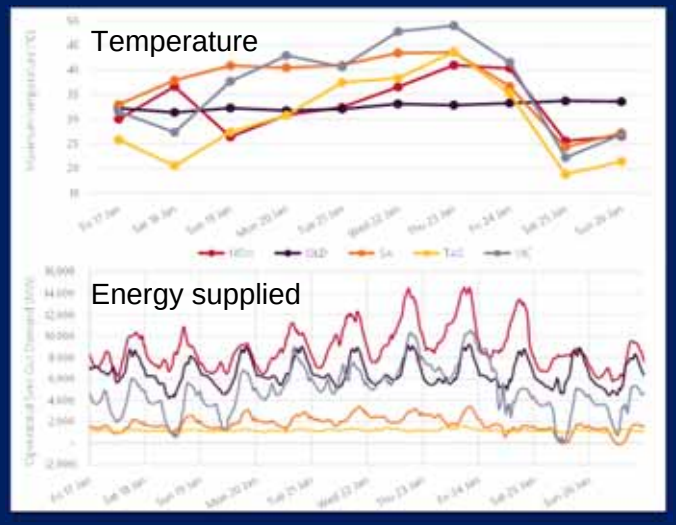


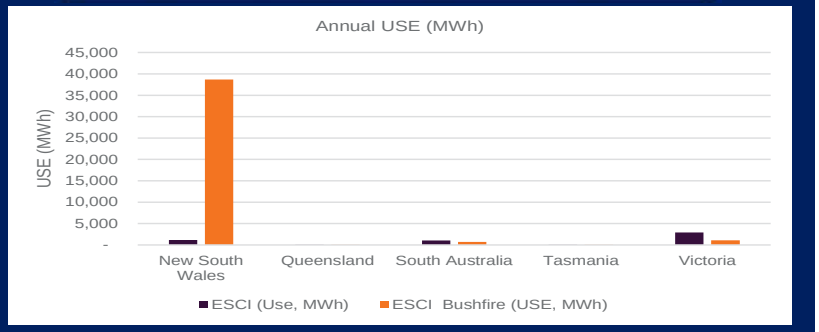
The frontal system passing Southeast Australia in "2045" is at least as strong as the systems associated with significant historical fire weather events – e.g., Black Saturday and Ash Wednesday.

AEMO use of extreme event case study

1. Understand context
2. Identify climate risk
3. Analyse climate risk
4. Evaluate climate risk
5. Risk treatment







AEMO is very concerned about extreme events

High Impact Low Probability events are increasing in likelihood and magnitude:

- Climate change is increasing the frequency and magnitude of weather hazards
- Cyber hazards are increasing risks
- … and then there are exceptional events such as a pandemic

Energy system resilience is in decline:

- Generation sources are increasingly located in stringy, weak parts of the system
- These generation sources are inherently more vulnerable to extreme hazards
- System control services are increasingly complex, manual and reactive
- Societal services are increasingly interconnected

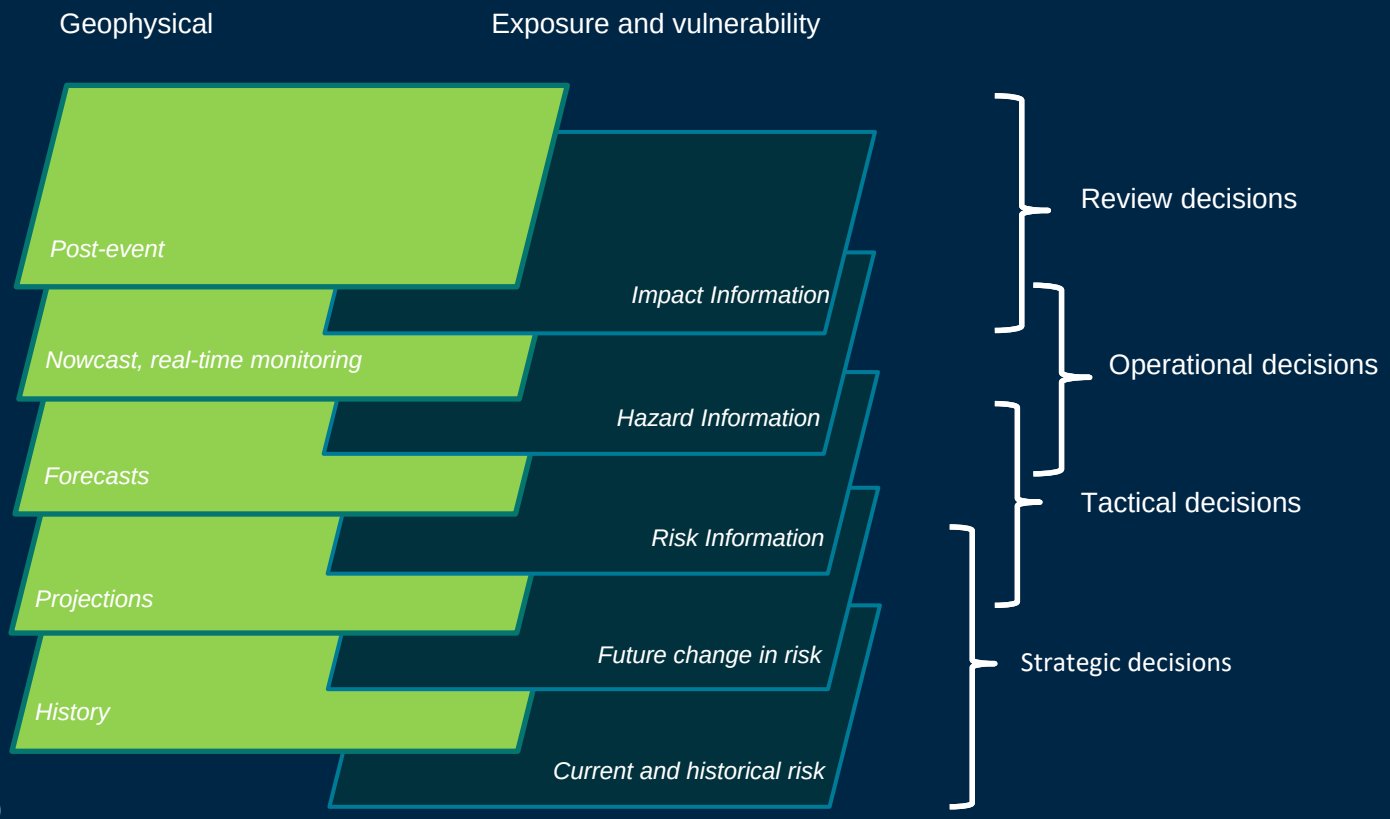
Source: 2020 ISP, Appendix 8

A different future requires a different approach

As the Energy Sector work shows there is a need to focus on high impact low probability of events

- High resolution simulations
- Large number of simulations of the future state to quantify the likelihood of high impact low probability events

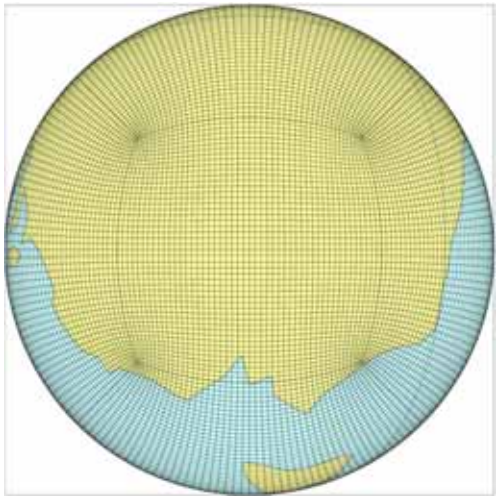
Multi-agency approach for Climate information - Seamless delivery of information across time horizons



Regional Climate Modelling- climate downscaling

- Example Approach:

Spectral nudging of Atmospheric fields (e.g. winds



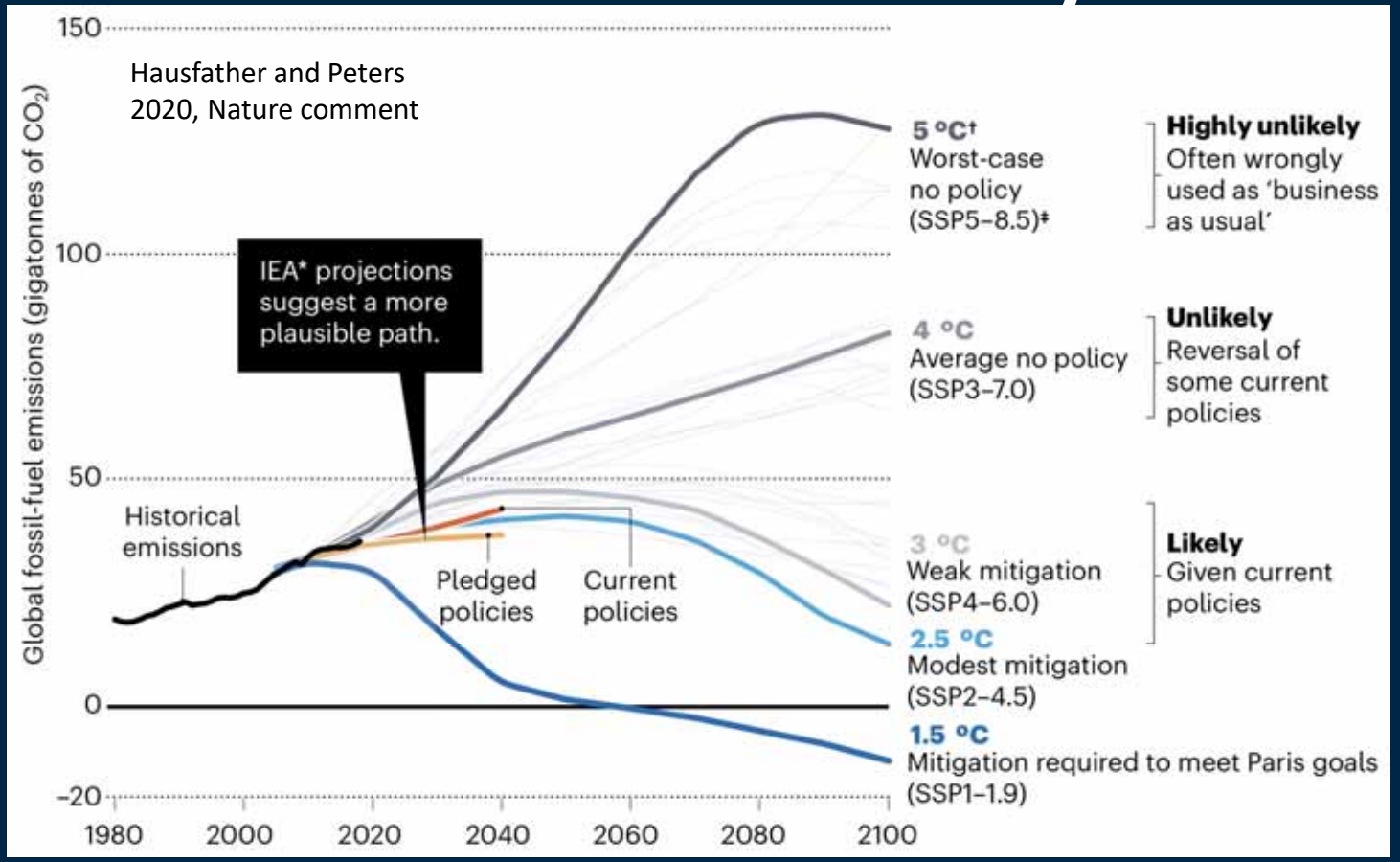
Host Global Climate Model

Regional simulation for SE Australia (Conformal Cubic Atmospheric Model, CCAM)

SSPs – Shared Socioeconomic Pathways

Regional Climate Model Simulationss:
SSP3-7.0
SSP1-2.6

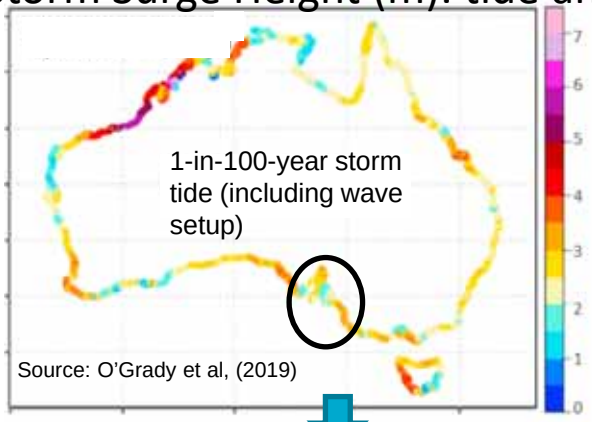
Comms challenge:
People expect we are on the highest scenario and the low option is impossible



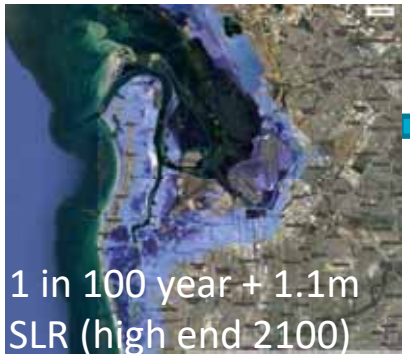
22

Coastal Inundation projection: Adelaide

Storm Surge Height (m): tide and wave setup



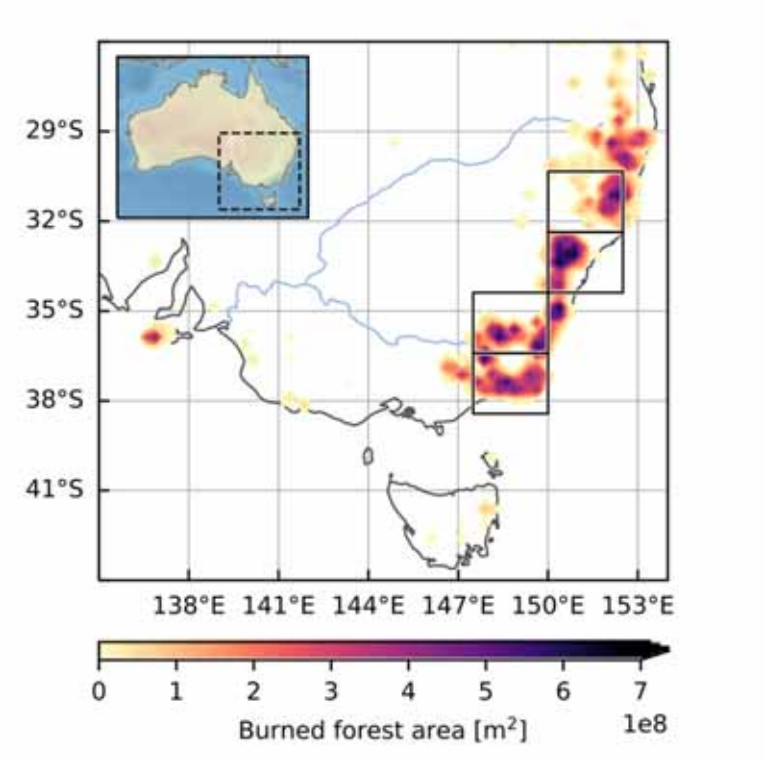
Bathtub infill: pragmatic for national rollout but high resolution hydrodynamic modelling may be required for high priority locations

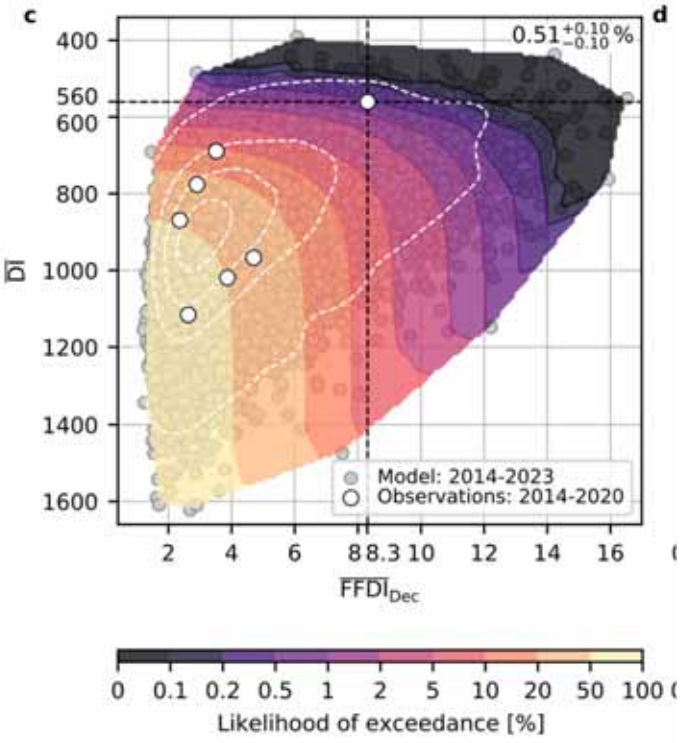


*Integration with exposure and vulnerability data

- Properties affected per post code
- Length of roadways affected per postcode area
- Depth and duration of inundation above building floor height
- Flow velocity and duration of inundation***

Extreme Fire Weather – probability estimated from a large ensemble of the present-day climate (13300 years)





Squire et al., 2021 submit to Nature Geosc.

Where to next:

Climate Resilient Enterprise (CRE)

an initiative to help assess climate risks

Build a national climate risk capability for industry by 2025. It will enable Australian industry to disclose and respond to climate risk, whilst identifying adaptation and transition options; thereby building resilience across the economy

Expected outcomes

Climate ready enterprise, investment and new industry

- Climate risk and resilience. Minimise hostile analytics risk.
- Transitioning industries and new industries built around climate risk
- National capability built around provenance, trust, credibility
- Minimise cost of compliance ($250Bn drag, most self imposed)

Activities

Innovation Hub: develop

- Incubator - complex problems and develop solutions with private sector, ensuring user needs met
- Elevating users into the governance and delivery
- Co-design/developed products and services

Climate Intelligence Marketplace: deliver

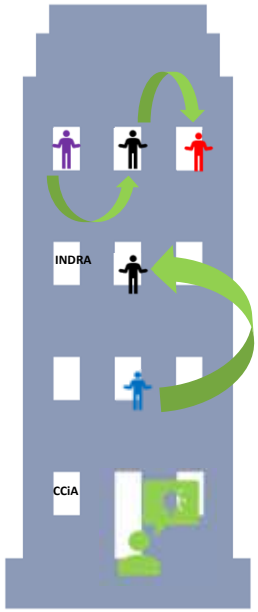
- CI platform with concierge capability for end-to-end climate risk & resilience services
- Interoperable, scalable, tradeable
- Powered by CSIRO/Microsoft and partners

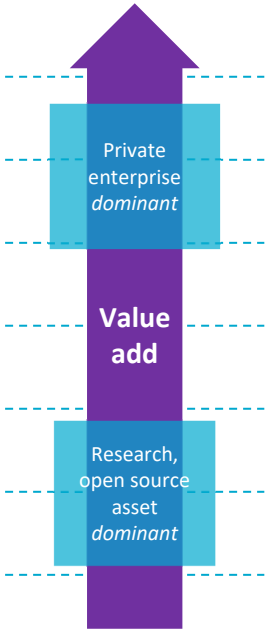
Summary:

- Our climate has changed and will continue to change, hence the physical climate risks both acute and chronic hazards will change
- New initiative to better characterise our future physical climate risks through large ensemble of climate simulations is proposed
- New initiatives to bring merge our climate understanding with risk methods to assess the financial impacts of the changing physical risks
- Climate variability provides an opportunity to test climate mitigation strategies and help us to our changing climate

ESCI Climate risk assessment framework

Climate risk marketplace: user centric, science informed
No *black-box* core: provenance, replicability, credibility. Internally consistent.





- Adaptation and transition tools, services
- Climate risk, climate-economy services, supply chain and materiality analyses
- Climate risk enhanced, bespoke services, TCFDs. Decision workflows.
- Climate risk digitised, replicable domain knowledge, product builders
- Sectoral information
- Climate Projections, Hazards
- Data – e.g. Ensemble of Regional Climate model simulations of the future

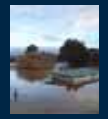
A different future requires a different approach

More large-scale heatwaves and record-high temperatures

Longer fire season, more extreme fire danger days

Prolonged high ocean temperatures

Reduced average rainfall, more time spent in drought



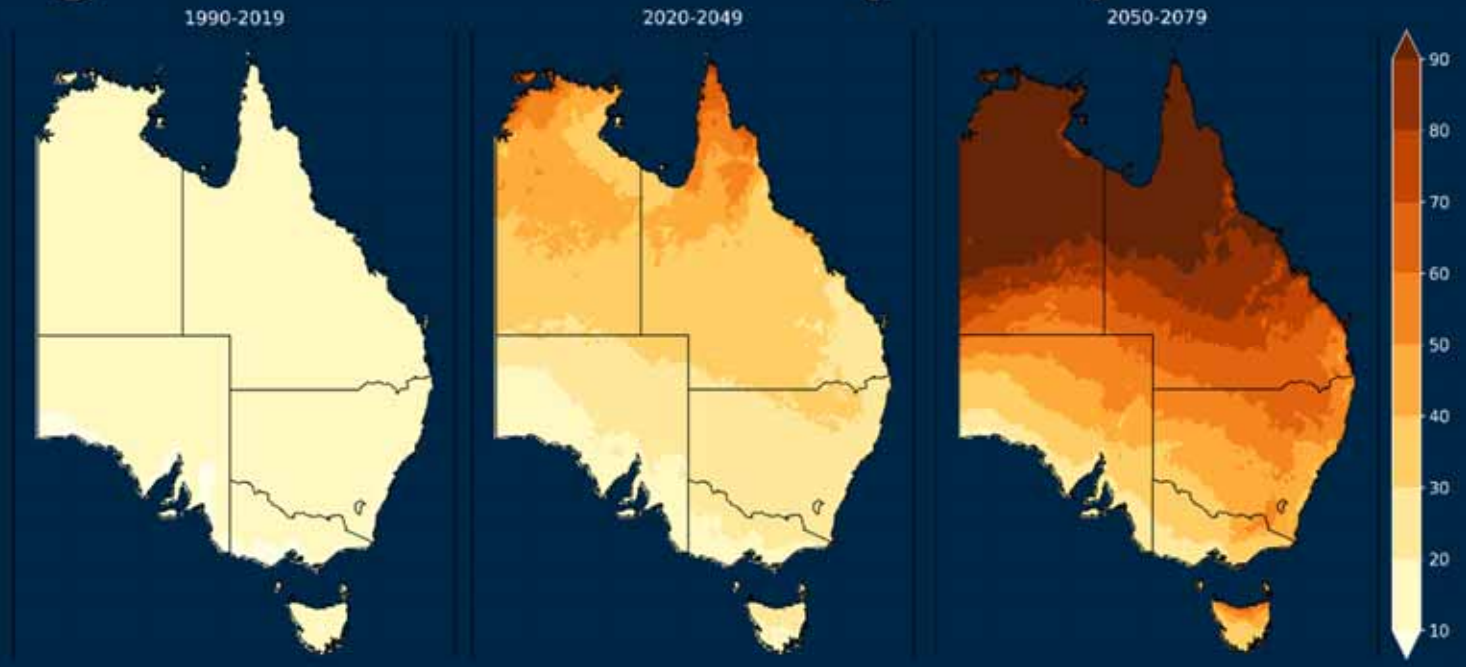
Increase in heavy rainfall

Increased frequency of coastal storm surge inundation

Now

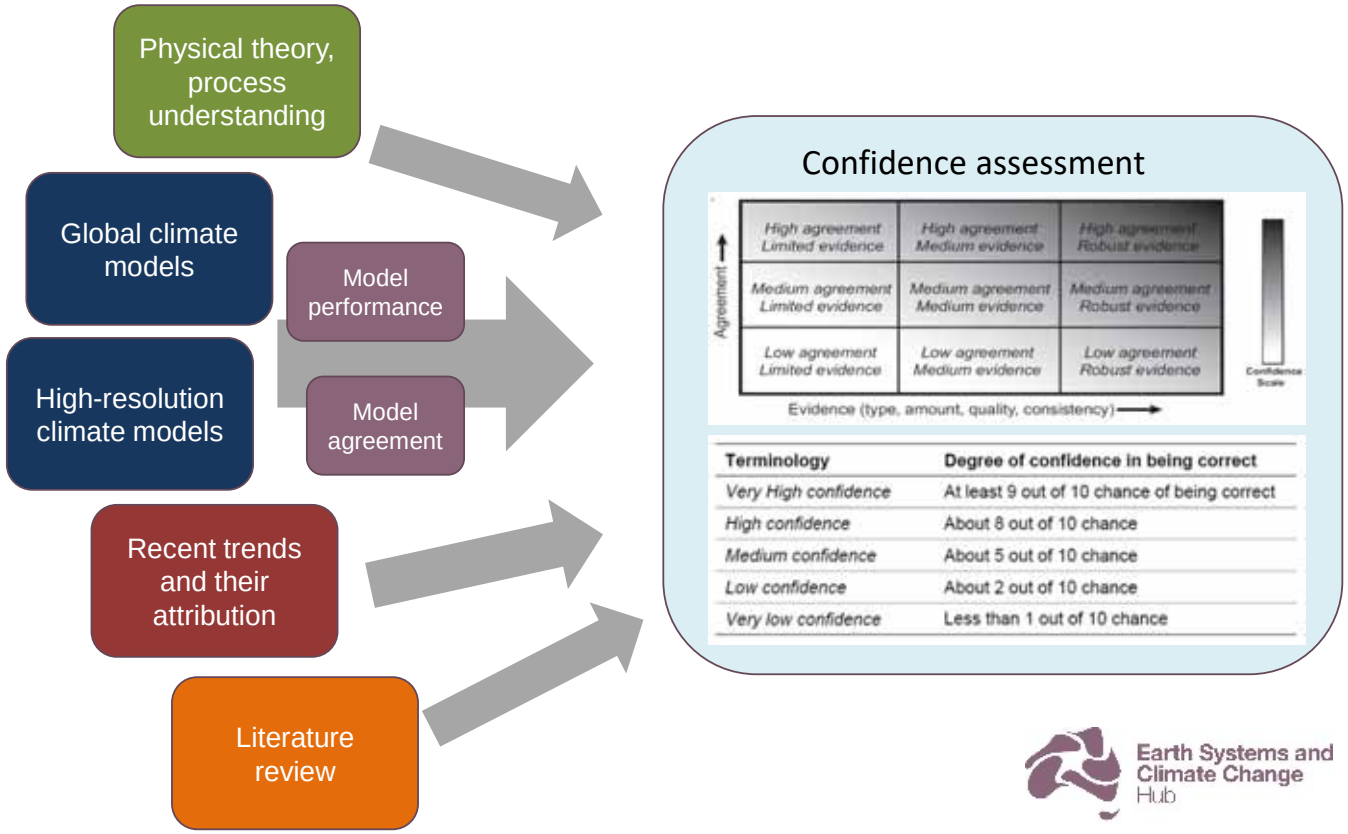
Emerging threat

Changes in Heatwave frequency



The annual frequency of heatwave days (as measured by the Excess Heat Factor) for various time periods: 1990-2019 (left), 2020-2049 (centre) and 2050-2079 (right).

Multiple lines of evidence

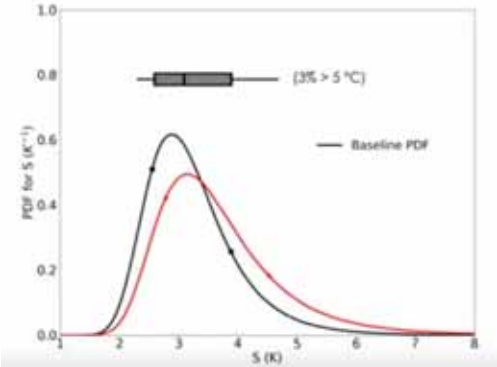


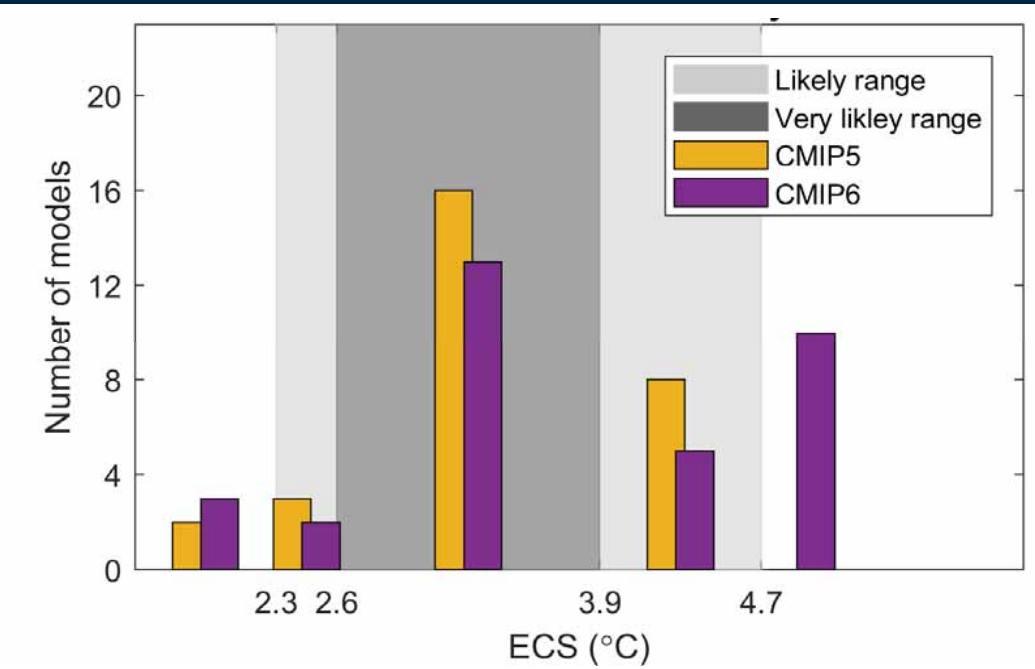
Earth Systems and Climate Change Hub

CSIRO

CMIP6 – new important issue – climate sensitivity

- Wider and more uneven spread in ECS than CMIP5
- Three models low, two very low ECS
- 15 models in ‘unlikely but possible’ high range
- 10 models in ‘very unlikely but possible’ high range





Upcoming CLEX/NESP Technical Note – Grose, Sherwood + others
Range from: Sherwood et al. (2020) review

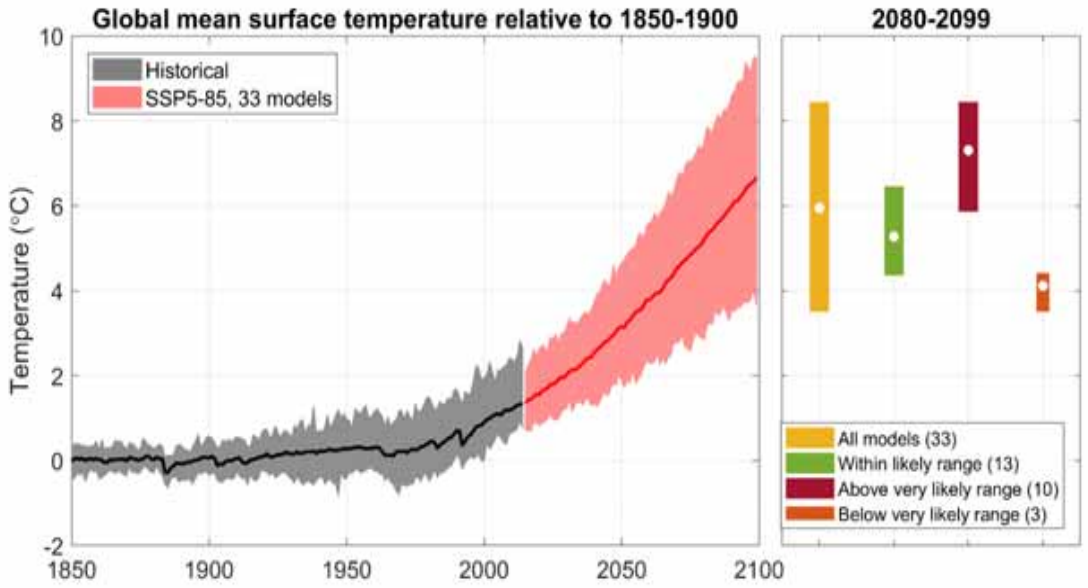
CMIP6 sensitivity – what to do about it?

So model range we report matches assessment of likelihood:

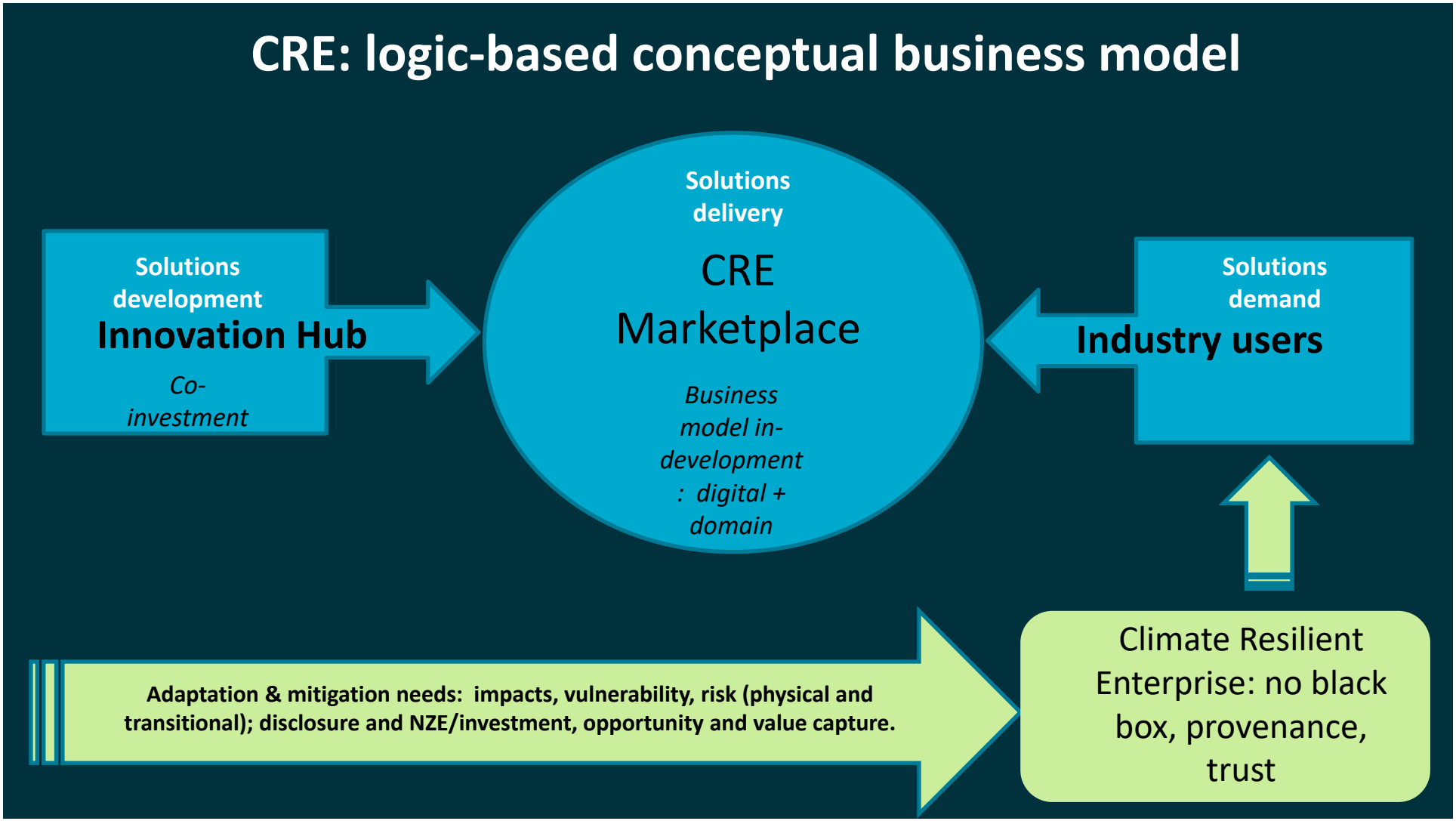
- Discount or weight models – studies already advocating
- Present models by groups
- Focus mainly on warming levels rather than timeframes – then bring timeframes in based on independent assessment

How to sample for downscaling?

- Only use one 'hot' model?
- Avoid cold models?
- Use warming levels?



Upcoming CLEX/NESP Technical Note
Range from: Sherwood et al. (2020) review


CRE: logic-based conceptual business model
Solutions development
Innovation Hub
Co-investment
Solutions delivery
CRE Marketplace
Business model in-development : digital + domain
Solutions demand
Industry users
Adaptation & mitigation needs: impacts, vulnerability, risk (physical and transitional); disclosure and NZE/investment, opportunity and value capture.
Climate Resilient Enterprise: no black box, provenance, trust