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# Changes in extreme weather

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# Talk outline

- **IPCC assessment**
- **Available data for Australia**
- **Extreme temperature**
- **Extreme rainfall**
- **Hail**
- **Extreme wind**
- **Fire weather**
- **Tropical cyclones**
- **Extreme sea level**

# IPCC assessment

- The type, frequency and intensity of extreme events are expected to change as Earth's climate changes, and these changes could occur even with relatively small mean climate changes
- Increased risk of more intense, more frequent and longer-lasting heat waves
- Fewer frost days
- More intense precipitation and flooding due to the greater water-holding capacity of a warmer atmosphere
- Dry extremes become more severe in areas where mean precipitation is projected to decrease
- Fewer tropical cyclones globally due to the increased stability of the tropical troposphere in a warmer climate, characterised by fewer weak storms and greater numbers of intense storms

# Available data for Australia

- There is limited information about projected changes in extreme weather over Australia for a 4°C global warming
- Most information is available for a warming of < 4°C because
  - projections tend to be based on simulations for the A2, A1B and B1 emission scenarios, rather than A1FI
  - many projections are focussed on the period 2030 to 2070, rather than 2090 and beyond
- In the following projections, the emission scenarios and years are noted, along with the approximate global warming

# Extreme temperatures

- **Changes in the number of days over 35°C have been estimated by CSIRO and BoM (2070) for 15 sites for 2030 and 2070**
- **The warmest scenario considered was for A1FI emissions in 2070, which has a global warming range of 1.7 to 4.6°C**
- **The 90<sup>th</sup> percentile regional warming for this scenario is 4-5°C over most of Australia**

# Annual average no. days over 35°C

**GW ~ 4°C**

Site	Present	2070*
Adelaide	17	47
Alice Springs	90	182
Brisbane	1	21
Broome	54	281
Cairns	3.8	96
Canberra	5	26
Darwin	11	308
Dubbo	25	87
Hobart	1.4	3.4
Melbourne	9	26
Mildura	32	76
Perth	28	67
St George	47	135
Sydney	3.5	12
Wilcannia	63	129

## More hot days

\* 90<sup>th</sup> percentile regional warming for the A1FI emission scenario

CSIRO & BoM (2007)

# Annual average no. days over 40°C

**GW ~ 3°C**

Site	Present	2070*
Adelaide	2.3	6-12
Alice Springs	16	44-85
Brisbane	0	0-0.6
Broome	2.8	16-28
Cairns	0.1	0.5-0.8
Canberra	0	0.1-4.3
Darwin	0	0.1-0.2
Dubbo	2	2-29
Hobart	0	0.3-0.6
Melbourne	1.3	4-8
Mildura	6	15-28
Perth	4	12-21
St George	4.6	5-59
Sydney	0.3	0.7-3.1
Wilcannia	15	27-54

**More extremely hot days**

\* 4 climate models for the A1FI emission scenario

Hennessy et al (2011)

# Annual average no. days below 0°C

GW ~ 3°C

Site	Present	2070*
Alice Springs	17	1-3
Bathurst	57	16-29
Canberra	59	24-33
Charleville	12	0.3-2.5
Dubbo	22	3-10
Hobart	1	0
Launceston	33	6-9
Melbourne	0.2	0
Mildura	6	0.3-.08
Rutherglen	44	14-20
St George	1	0
Wagga	24	5-10
Wilcannia	5	0.3-0.6

Fewer cold days

\* 4 climate models for the A1FI emission scenario

Hennessy et al (2011)

# 1-in-20 year daily rainfall intensity **GW ~ 2.5-3.7°C**

**Percentage change in intensity for 2080-2099 A2, relative to 1980-1999**

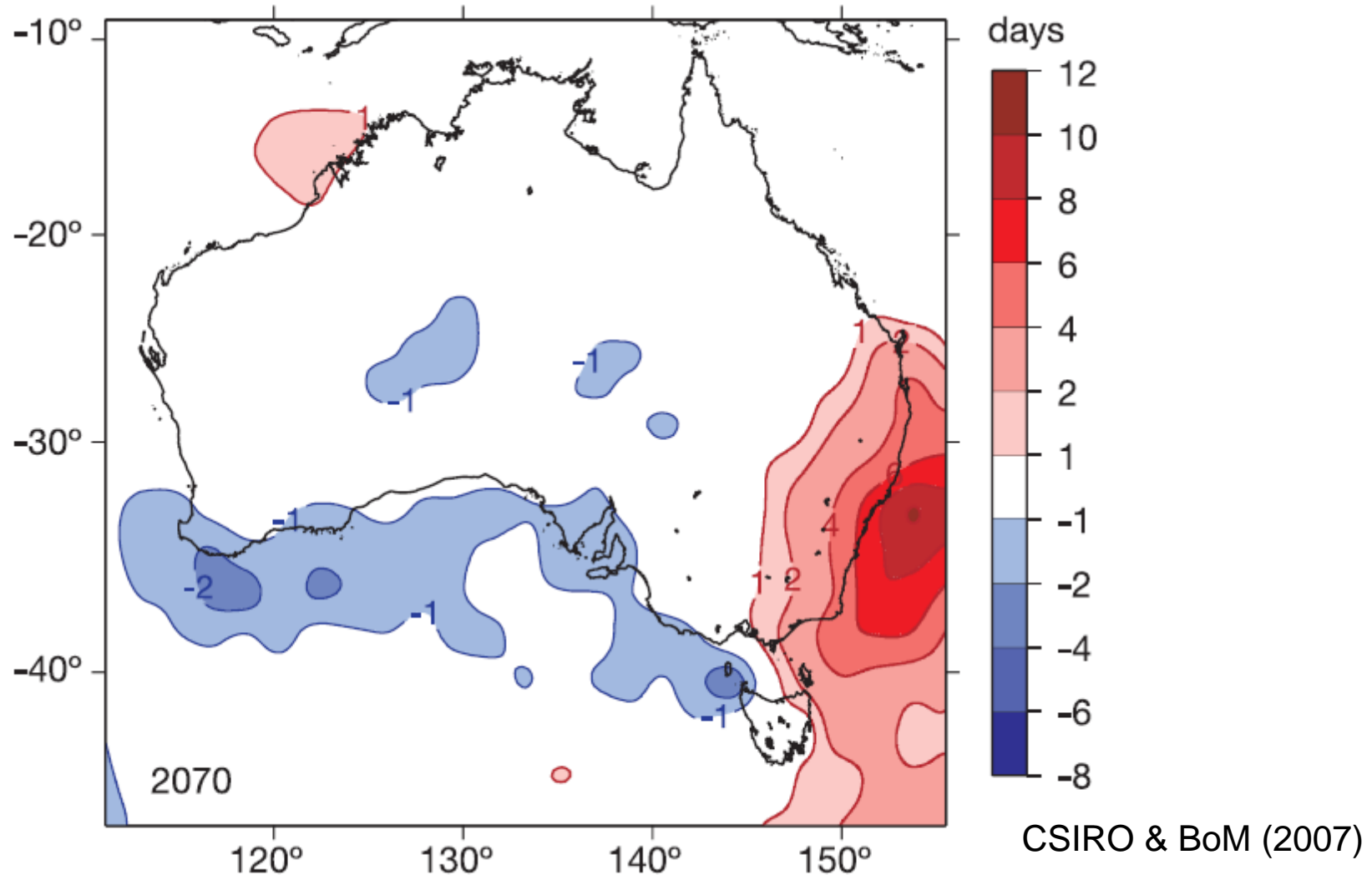
Region	CNRM	CSIROMk3.0	CSIROMk3.5	MIROC-M	ECHO-G	ECHAM5	MRI	CCSM	HADCM3
Northwest	26	17	44	10	13	0	-2	4	17

**Extreme rainfall intensity tends to increase**

Rafter & Abbs (2009)

# Hail

GW ~ 3°C



**Projected changes in large hail risk (2 cm diameter hail-days per year) for 2070 from the CSIRO Mk3.5 model for the A2 emission scenario**

# Hail in Sydney

GW ~ 1°C

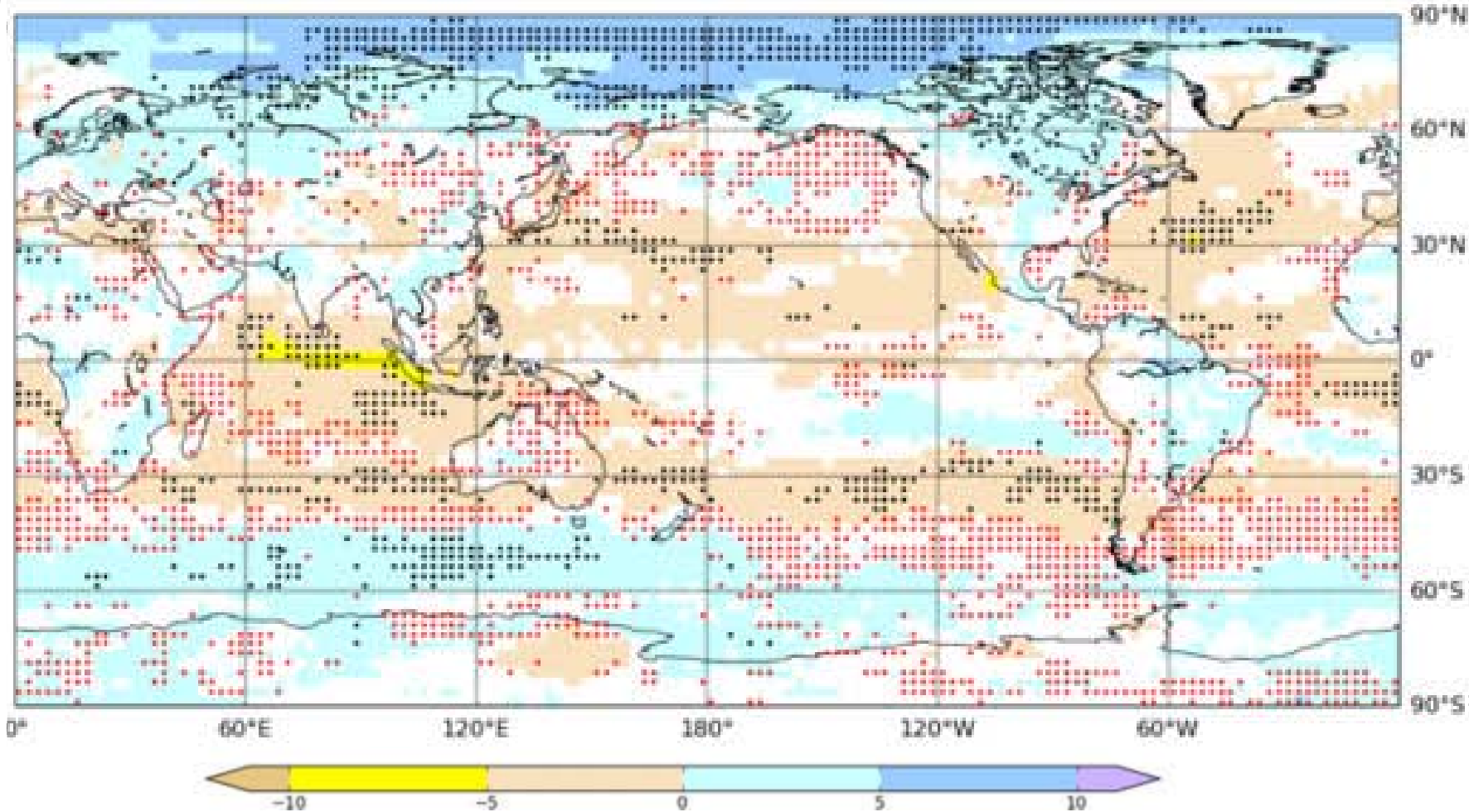
Hail diameter	Current climate	1991-2050
4 cm or greater	1.4 years	1.2 years
6 cm or greater	8 years	5 years
8 cm or greater	28 years	19 years
10 cm or greater	51 years	28 years

**Average recurrence intervals for hail events with diameters of 4 cm or greater, for current climate (1990-2002) and 2001-2050 for the A1B emission scenario**

Leslie et al (2008)

# Extreme wind speed

GW ~ 1.7-4.4 °C



**Percentage change in annual 99th percentile wind speed for 2081–2100 relative to 1981–2000 for A1B where > 66% of the models agree on the sign of the change (black = 90%, red = more than 66% of models agree on a change of  $\pm 2$  %). From McInnes et al (2011).**

# Fire weather

Percent changes in the number of days with very high and extreme fire-weather - 2020 and 2050, relative to 1990

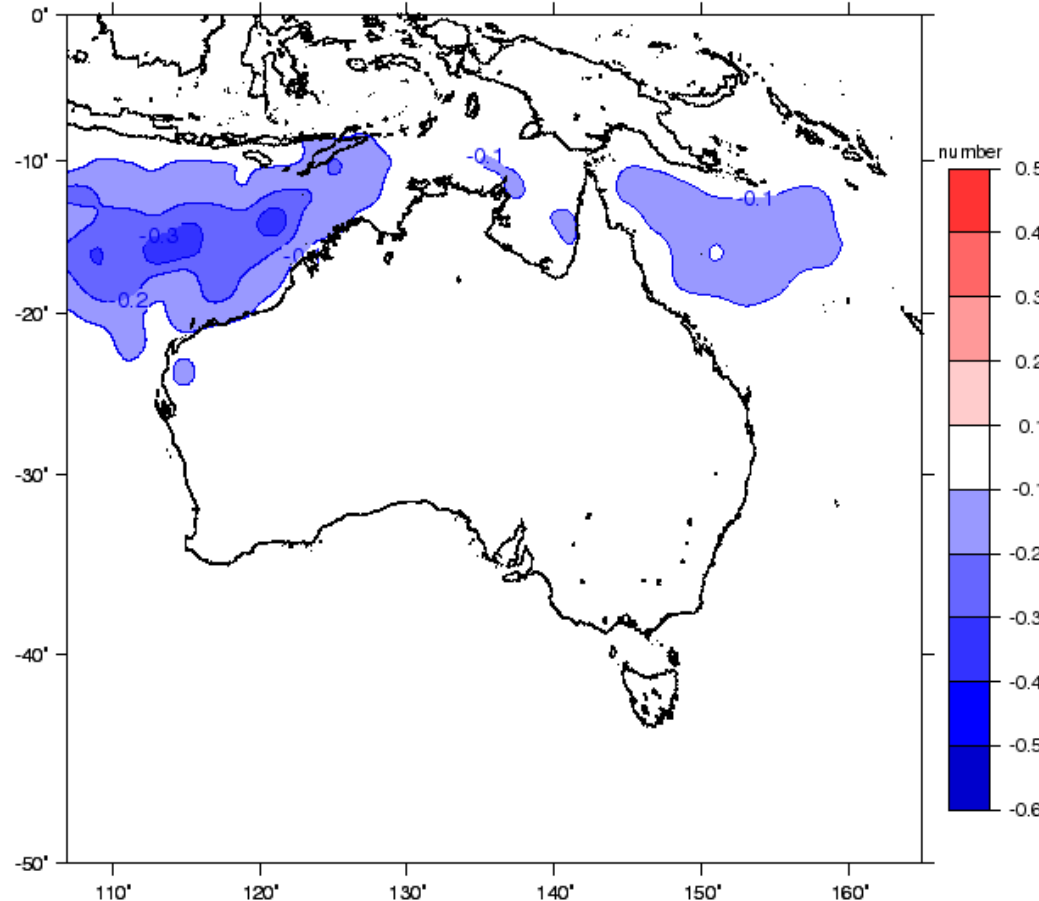
	2020		2050	
	Low global warming (0.4°C)	High global warming (1°C)	Low global warming (0.7°C)	High global warming (2.9°C)
Very high	+2-13%	+10-30%	+5-23%	+20-100%
Extreme	+5-25%	+15-65%	+10-50%	+100-300%

Lucas et al (2007)

# Tropical cyclones

GW ~ 0.8-2.2 °C

Projected changes in the annual number of cyclone-like vortices for 2046-2065, relative to 1971-2000, based on A2 results from 12 climate simulations



Fewer cyclones are likely in future near Australia

Intensity of severe (Category 3-5) cyclones increases

Abbs (2010)

# Tropical cyclones

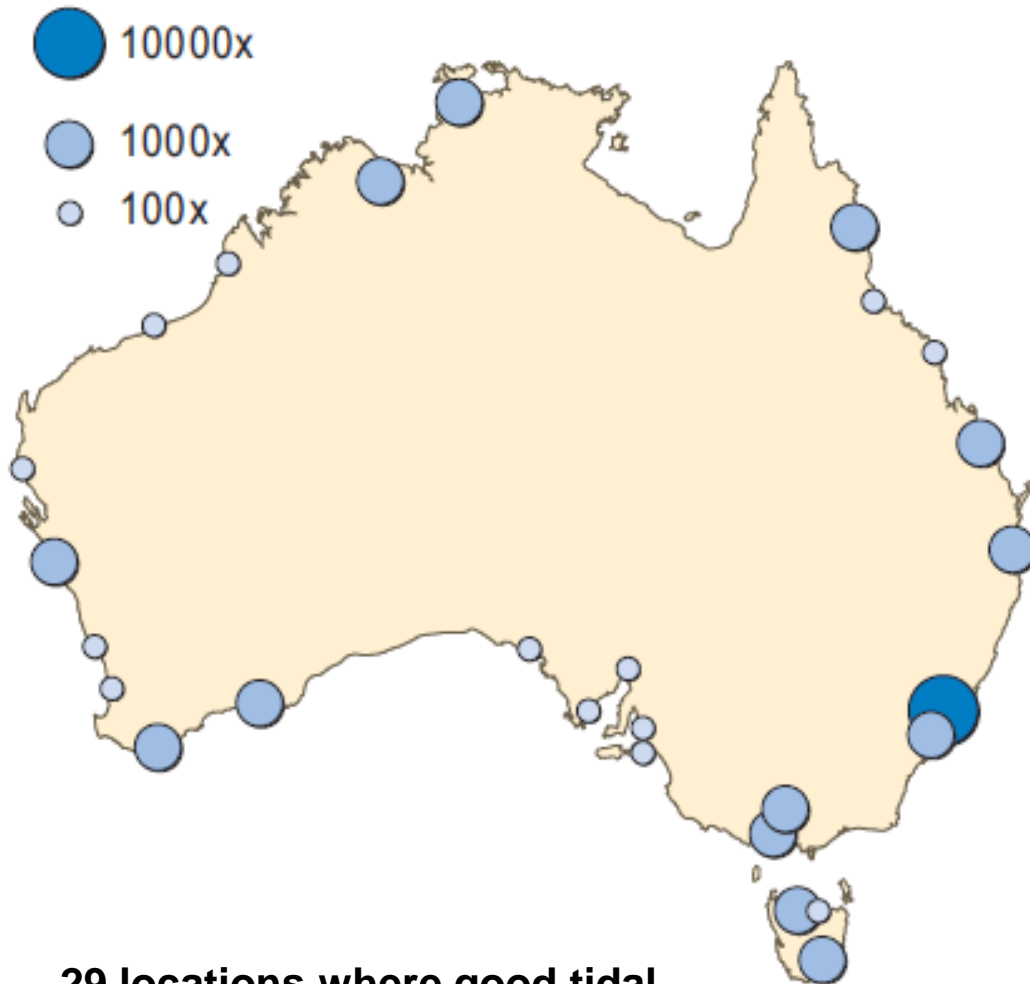
GW ~ 1.3-3.6 °C

	Australia				
	Number	Days	Duration (days)	Genesis (deg lat)	Decay (deg lat)
<i>ECHAM5</i>	-58%	-59%	-0.4	-1.1	-1.3
<i>GFDL CM2.0</i>	-53%	-55%	-0.3	-0.8	-1.1
<i>GFDL CM2.1</i>	-40%	-52%	-1.0	-1.4	-1.2
<i>MIROC3.2(medres)</i>	-68%	-73%	-0.8	-1.1	-2.0
<i>CSIRO Mk3.5</i>	-39%	-44%	-0.2	-0.5	-0.2
<i>UK HADCM3</i>	-50%	-47%	0.2	-0.7	-1.7
<i>CSIRO Mk 3.0</i>	-28%	-23%	0.2	-0.8	-1.9
<b>Ensemble Average</b>	<b>-48%</b>	<b>-50%</b>	<b>-0.3</b>	<b>-0.9</b>	<b>-1.3</b>

*7 GCM simulations, downscaled using CCAM to 65 km grid spacing, for the period 2051-2090, relative to 1971-2000*

# Extreme sea level

GW ~ 5 °C



29 locations where good tidal records exist that are longer than 30 years

Estimated increases in the frequency of extreme sea level events (indicated by the diameters of the circles) caused by a mean sea level rise of 50 cm

Events that happen every few years now are likely to occur every few days if mean sea-level rises by 50 cm

DCC (2009)

# Conclusions

**A global warming of up to 4°C is likely to lead to increases in**

- **extremely high temperatures**
- **extreme rainfall**
- **extreme fire weather**
- **large hail on the east coast**
- **tropical cyclone intensity**
- **extreme sea level events**

**However, decreases are likely in**

- **extremely low temperatures**
- **cyclone frequency**
- **extreme wind**
- **large hail in southern Australia**

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Thank you

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