

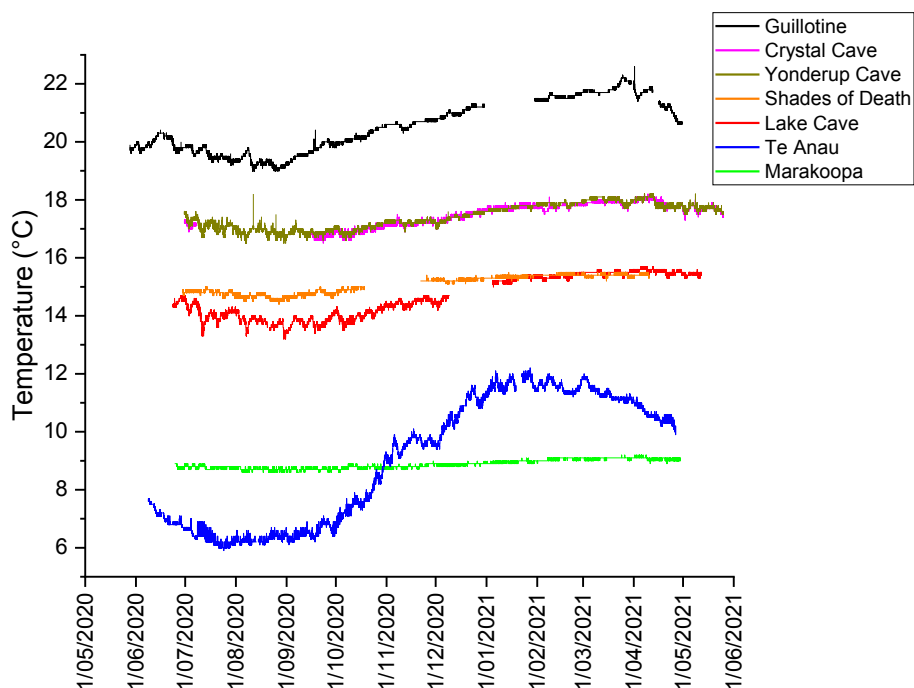
Is the temperature of your cave constant?

'The ACKMA Cave Climate Team'

The temperature of a tourist cave is often something that is displayed at the cave or interpreted as part of a tour. Now that we have almost a year of cave temperature data from the ACKMA Cave Climate Project, here is some information that might help you think again about cave temperature.

Is cave air temperature constant?

The answer is "rarely". However, cave temperature is less variable than the temperature outside the cave. Almost all caves have some temperature variability through the year. Here are some examples from some of the participating caves (you can see all the data at <http://www.ackma.org/CaveClimate/index.asp>).



What sort of annual temperature variation do we see at the participating caves?

At Capricorn Caves, the relatively open 'Cathedral' varies by 11.8 °C between highest and lowest cave temperatures. The variability is so great we have not shown it on the graph, but we do show the more enclosed 'Guillotine' location which varies by 3.2 °C (black line in the graph). Most of the participating caves have a temperature variability of a few degrees Celsius or less. For example, Marakoopa Cave (light green line on the graph) varies by just 0.6 °C over a year.

| | COLDEST CAVE TEMPERATURE | | WARMEST CAVE TEMPERATURE | | ANNUAL TEMPERATURE RANGE |
|-----------------------|--------------------------|---------|--------------------------|---------|--------------------------|
| Capricorn, QLD | | | | | |
| Cathedral | 5 July | 13.4 °C | 7 December | 25.2 °C | 11.8 °C |
| Guillotine | 25 August | 19.0 °C | 25 March | 22.2 °C | 3.2 °C |
| Te Anau, NZ | 24 July | 5.9 °C | 27 January | 12.2 °C | 6.3 °C |
| YANCHEP, WA | | | | | |
| Yonderup Cave | 31 August | 16.5 °C | 11 April | 18.2 °C | 1.7 °C |
| Crystal Cave | 23 September | 16.5 °C | 9 April | 18.2 °C | 1.7 °C |
| Marakoopa, Tas. | 30 August | 8.6 °C | 2 April | 9.2 °C | 0.6 °C |
| Lake Cave, WA | 31 August | 13.2 °C | 7 April | 15.7 °C | 2.5 °C |
| Shades of Death, Vic. | 27 August | 14.4 °C | 21 March | 15.5 °C | 1.1 °C |

As you can see, there is no relationship between how variable the cave temperature is and the external climate and whether it is hot or cold. It is all about the cave morphology and the amount of ventilation that is possible. Caves with large entrances, or multiple entrances, are more likely to allow air exchange between the cave and the outside. The greater the amount of exchange between the outside air and the cave, the more variable the cave temperature.

For example, Lake Cave (images below) has a steeply descending passage and a relatively small entrance (shown on the right) which is situated at the base of a very large doline (shown on the left). This morphology limits the extent of ventilation possible here.

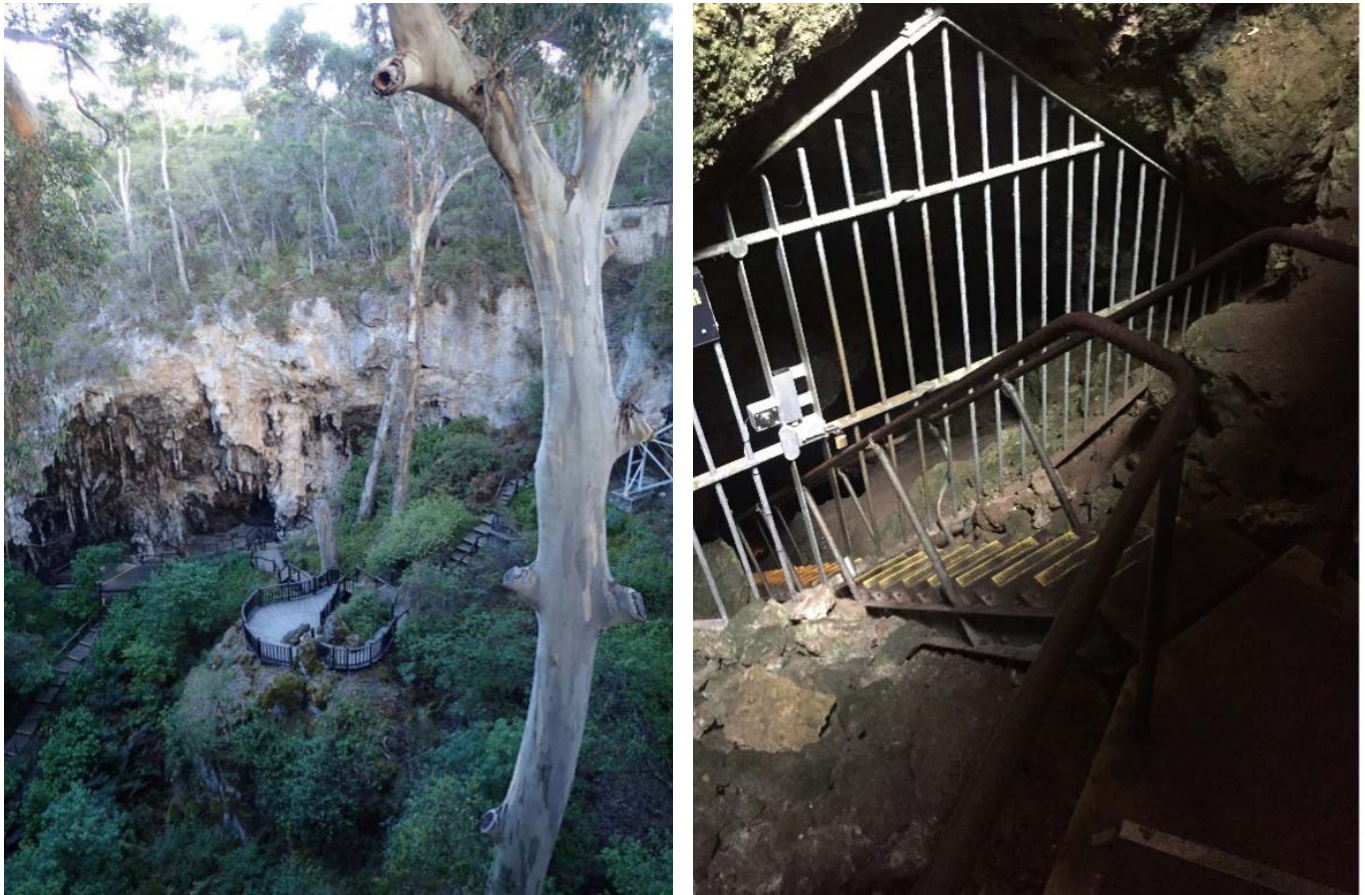


Figure: Lake Cave, WA, with the cave entrance, shown right, at the base of the doline shown on the left. (Photo credits: Mark Delane, David Gillieson)

At what time of year is my cave likely to have the warmest air temperature?

You can see from the table that most caves are warmest in late summer to autumn. In summer, the cave air is cooler and denser than outside air, which means it is trapped within the cave. This cave air is slowly warmed through the summer by the conduction of heat through the rock from the surface. This conduction is a slow process, which is why the warmest temperatures in the cave are after the warmest months on the surface. Most caves will only start to cool after the night time temperatures become colder than the cave air temperature. The warmer cave air then becomes buoyant and can escape the cave, being replaced by cooler, denser outside air. The cooling of the cave air temperatures has thus begun.

‘Summer time’ in your cave is likely to be in autumn – check <http://www.ackma.org/CaveClimate/index.asp> to find out for a particular cave)

And the coldest?

For most caves this is late winter to spring. The processes are the same as for summer, just happening in the reverse order. Ventilation in winter draws in cooler external air and that cools the cave. Conduction of cooler surface temperatures through the rock takes time to reach the cave. That can further cool the cave air temperature. As soon as outside temperatures start to warm, ventilation becomes less possible and the air in the cave becomes trapped there. Eventually it will start to warm again due to conduction of heat through the rock from the surface.

‘Winter time’ temperatures in your cave are likely to be in spring.

You say most caves. What are the exceptions?

No two caves are identical, and this is certainly true for cave climate.

One exception is at Capricorn Caves, where the ‘Cathedral’ temperatures change at the same time as outside temperatures. That is because this part of the cave is so open to the outside air through large entrances on both sides of the limestone tower as well as other, smaller openings. Its climate changes rapidly.

And you can see Te Anau has its coldest and warmest months only slightly after the surface coldest and warmest months. With entrances at different altitudes, and a cave stream as an additional source of heat energy to cool or warm the cave, Te Anau's climate is unique to the participating caves in the study.

Anything else?

The cave temperature variability observed in Australia and New Zealand is not unique and is likely to occur elsewhere. But bear in mind that the closer to you get to the equator, the surface temperature is less variable. And if the surface temperature doesn't vary across the year, the cave temperature won't vary either. So what we observe will be typical for caves in mid to high latitudes, but not for low latitudes.

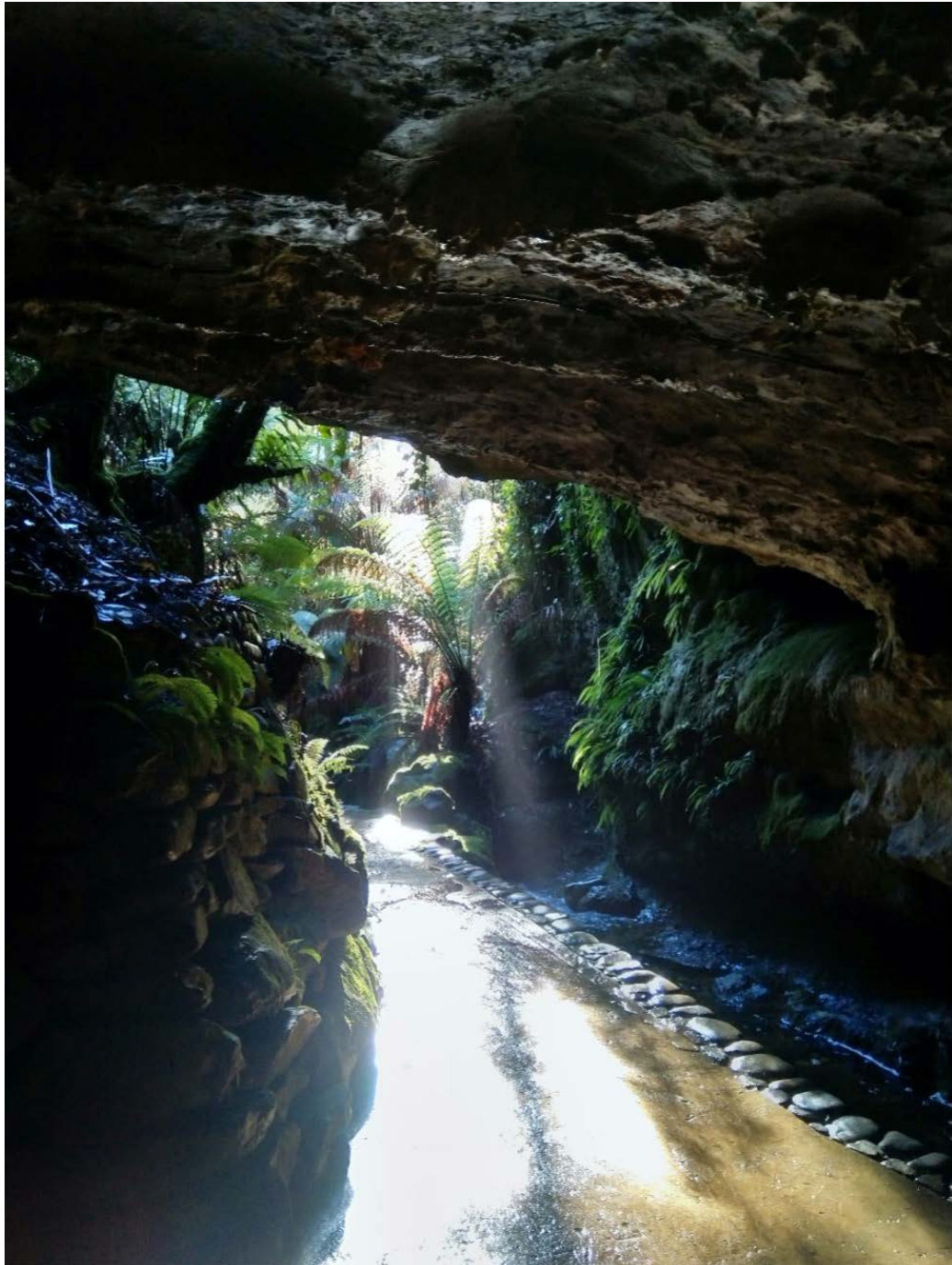


Image: Marakoopa Cave entrance. Photo credit: Renee Larcher