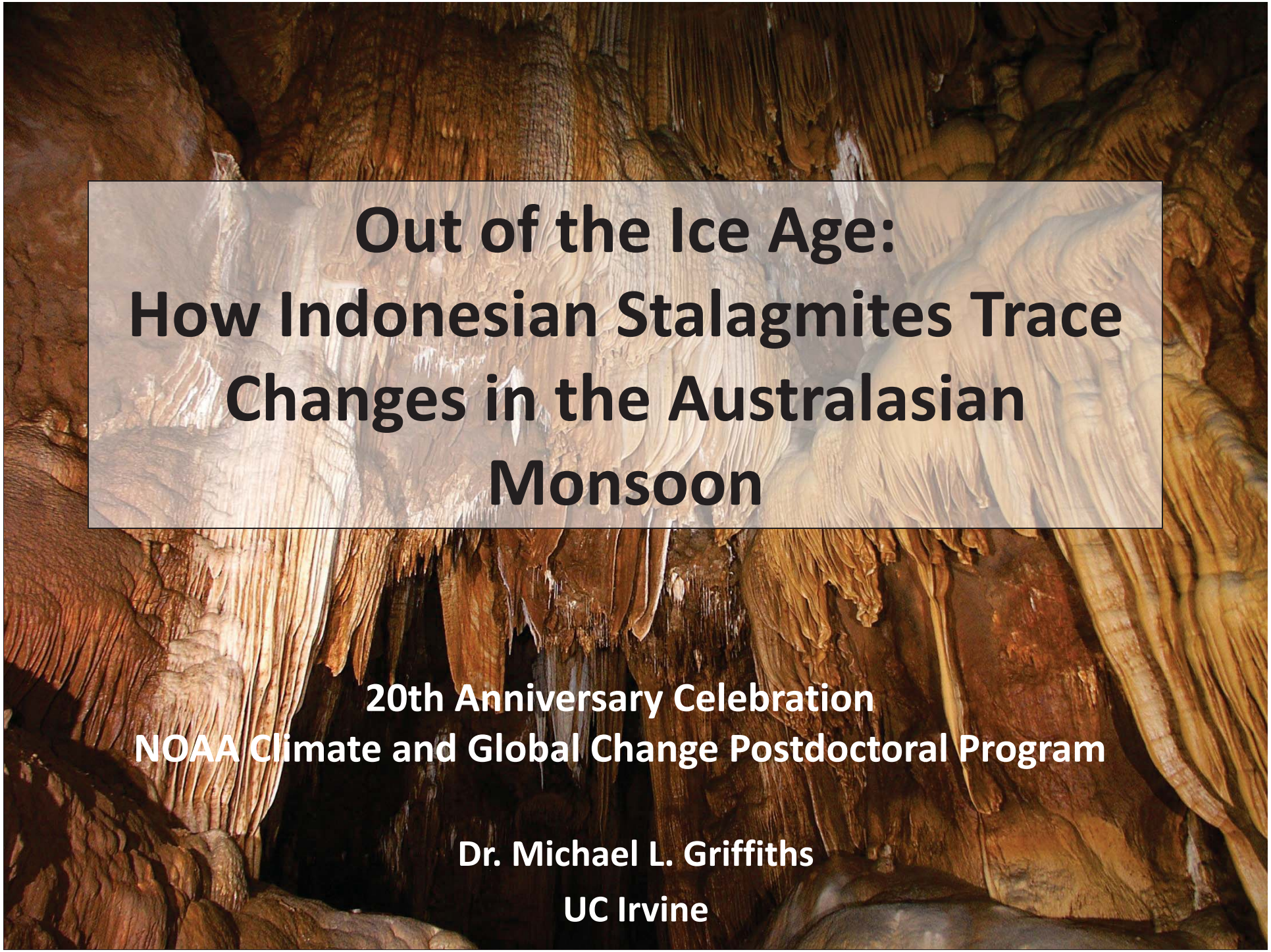
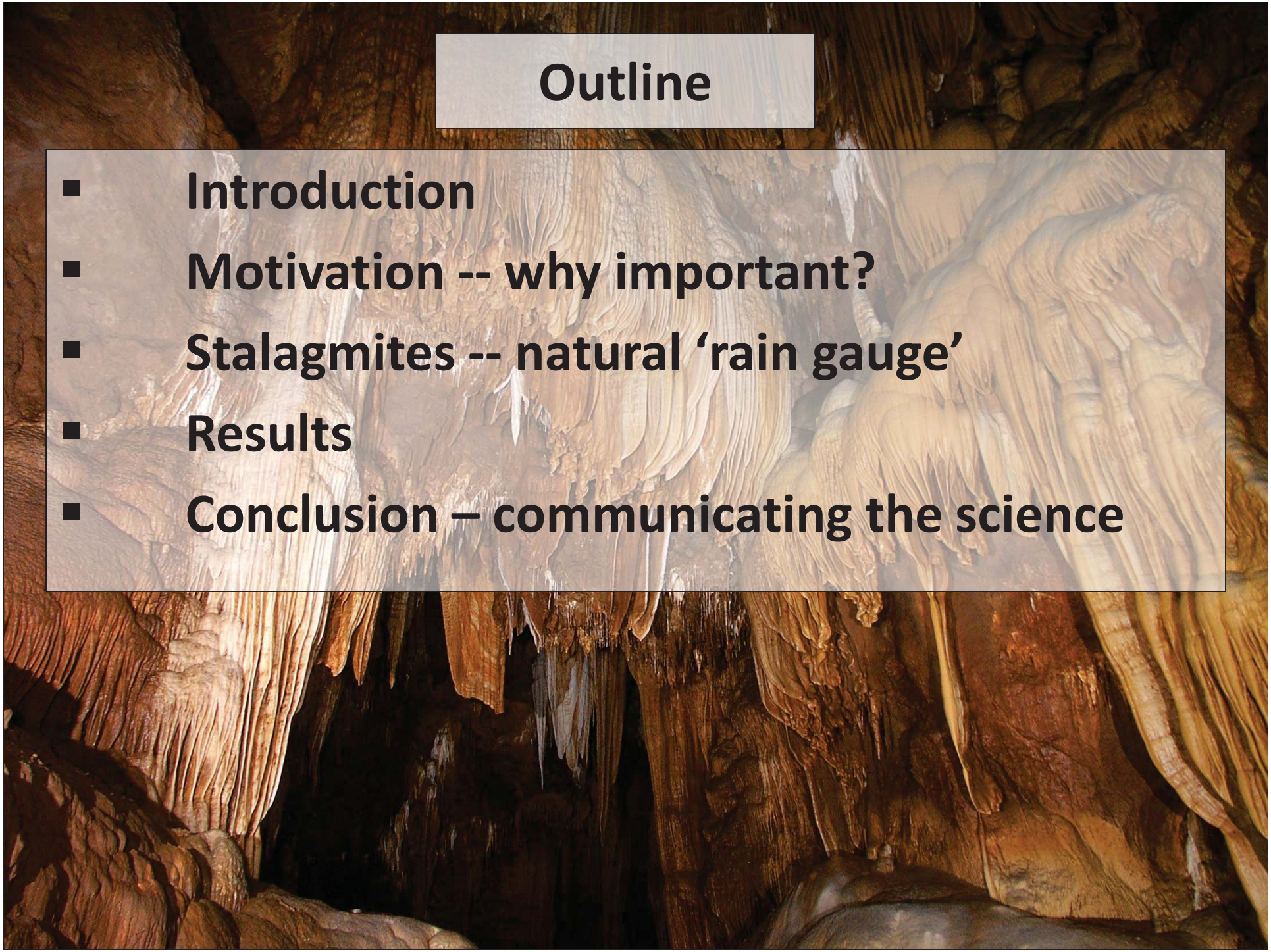


Out of the Ice Age: How Indonesian Stalagmites Trace Changes in the Australasian Monsoon

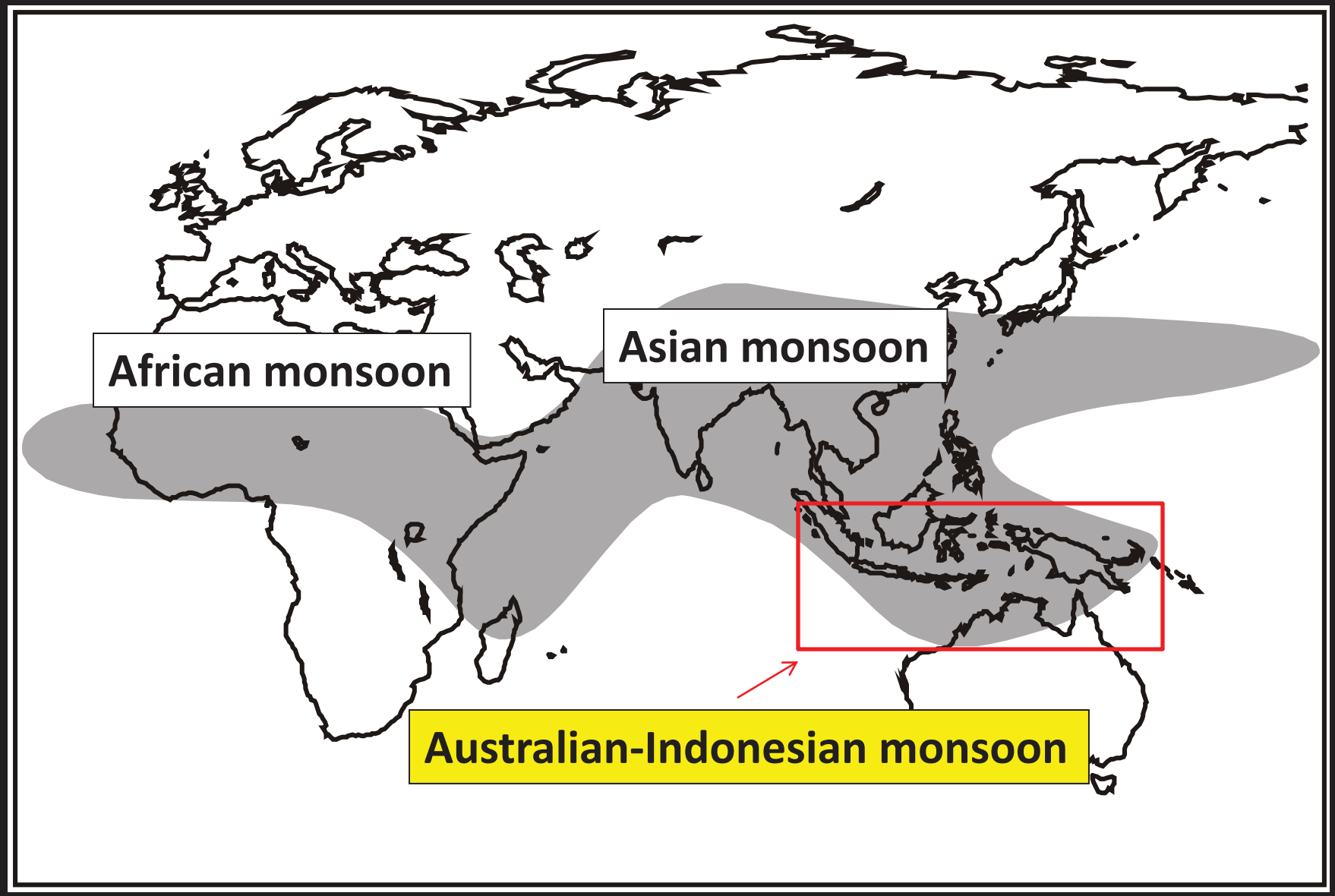
20th Anniversary Celebration
NOAA Climate and Global Change Postdoctoral Program

Dr. Michael L. Griffiths
UC Irvine



Outline

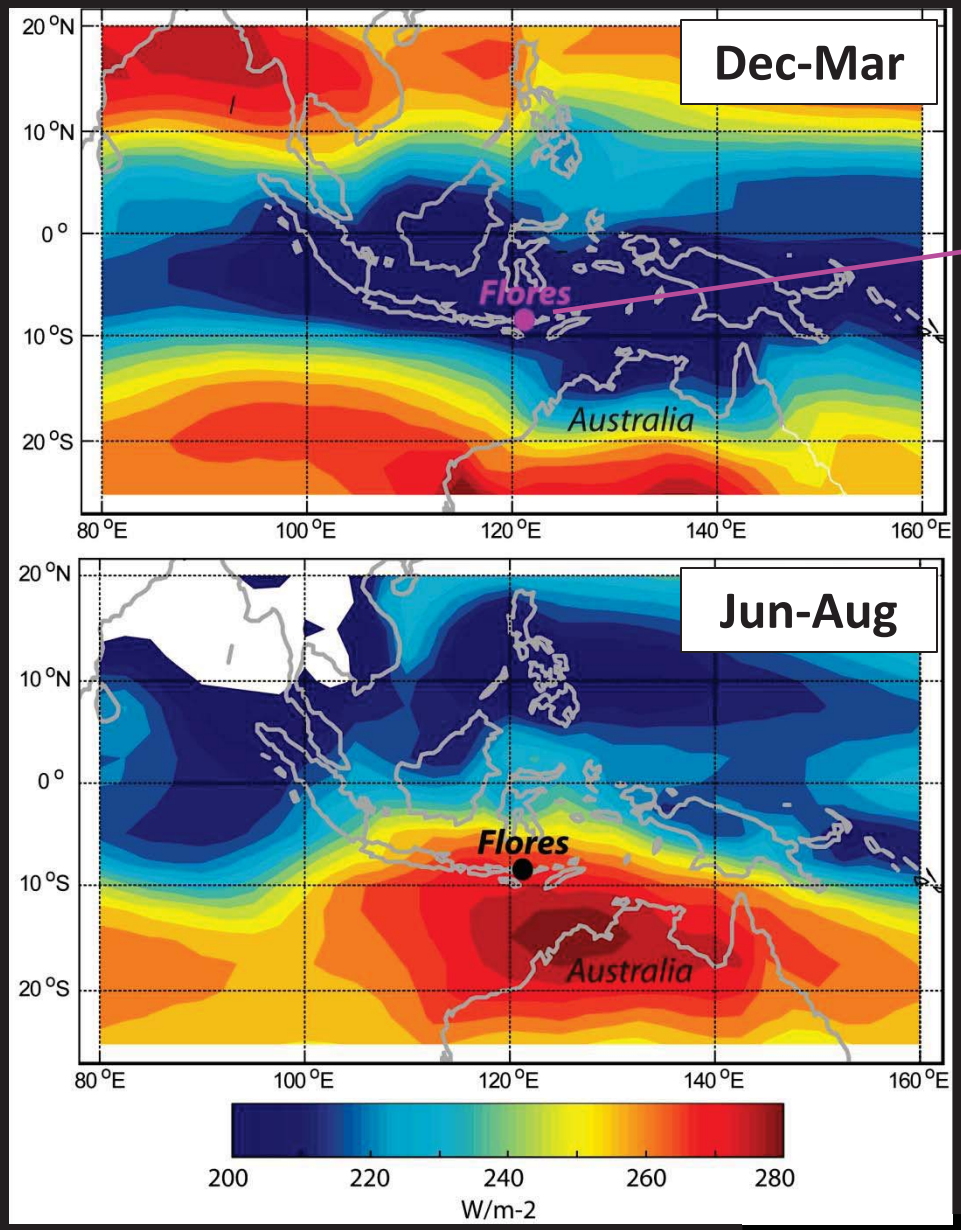
- Introduction
- Motivation -- why important?
- Stalagmites -- natural ‘rain gauge’
- Results
- Conclusion – communicating the science



(Mitchell et al., 1994)

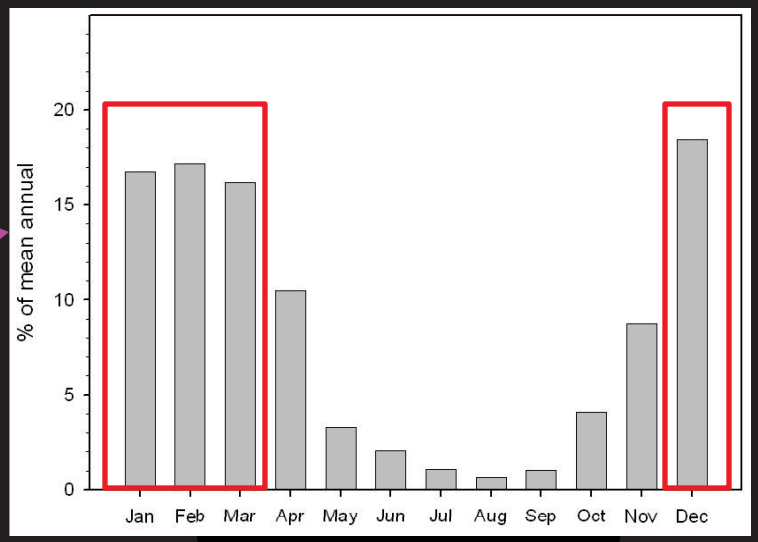
Australian-Indonesian monsoon

Outgoing Longwave Radiation composites



Wet ← → Dry

Average monthly rainfall (Flores)



(Source: NASA TRMM)

~70 % of annual rain occurs between Dec and Mar

(Source: NCEP/NCAR reanalysis)

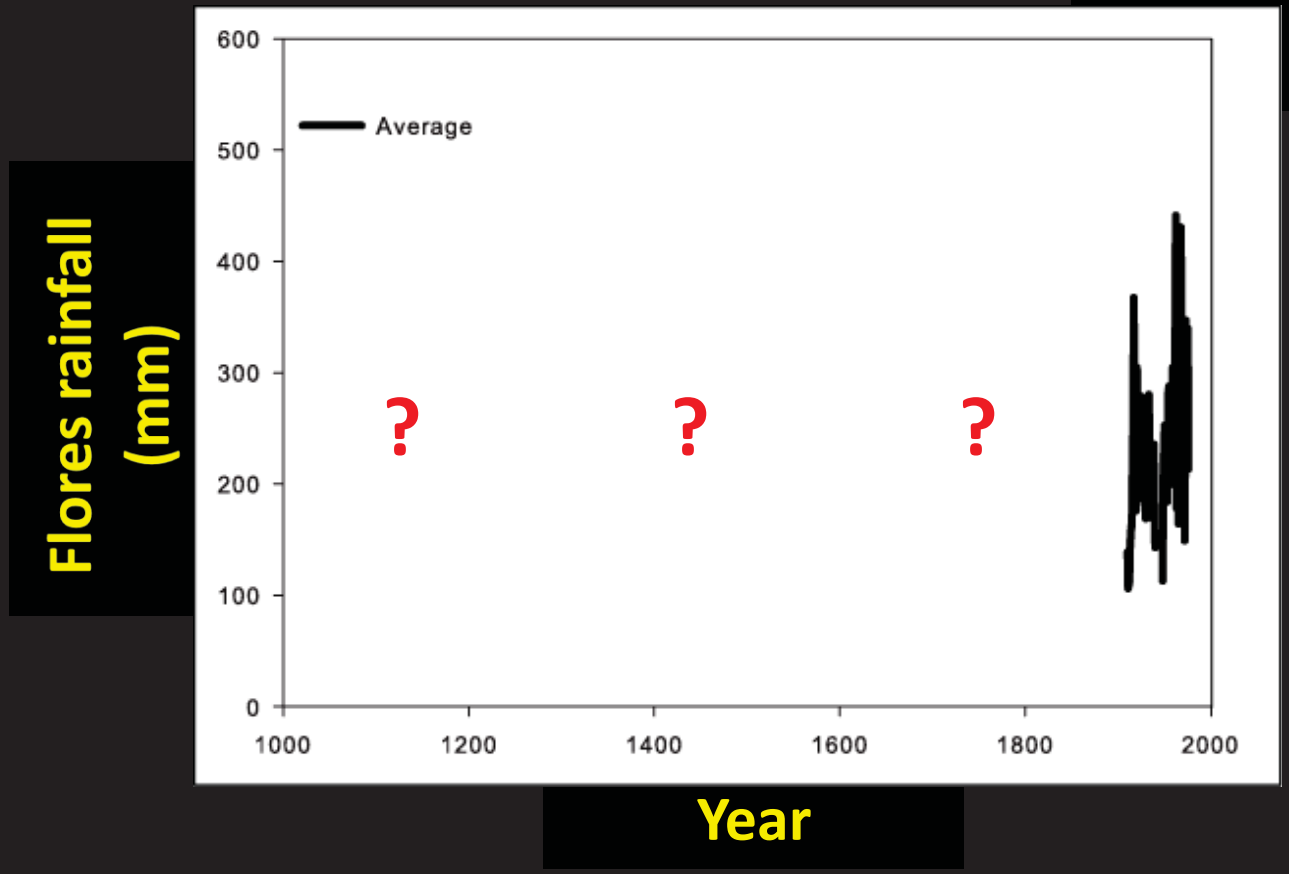
Motivation – why important?

Indonesia:

- Monsoon accounts for ~70% of annual precipitation
- Fourth most populous country - home to an est. population of 237 million
- Any slight variations in the strength and/or timing can have adverse effects on agriculture and industry

Vital that we gain a clearer understanding of how the monsoon has changed in the past, in order to help us make better predictions into the future

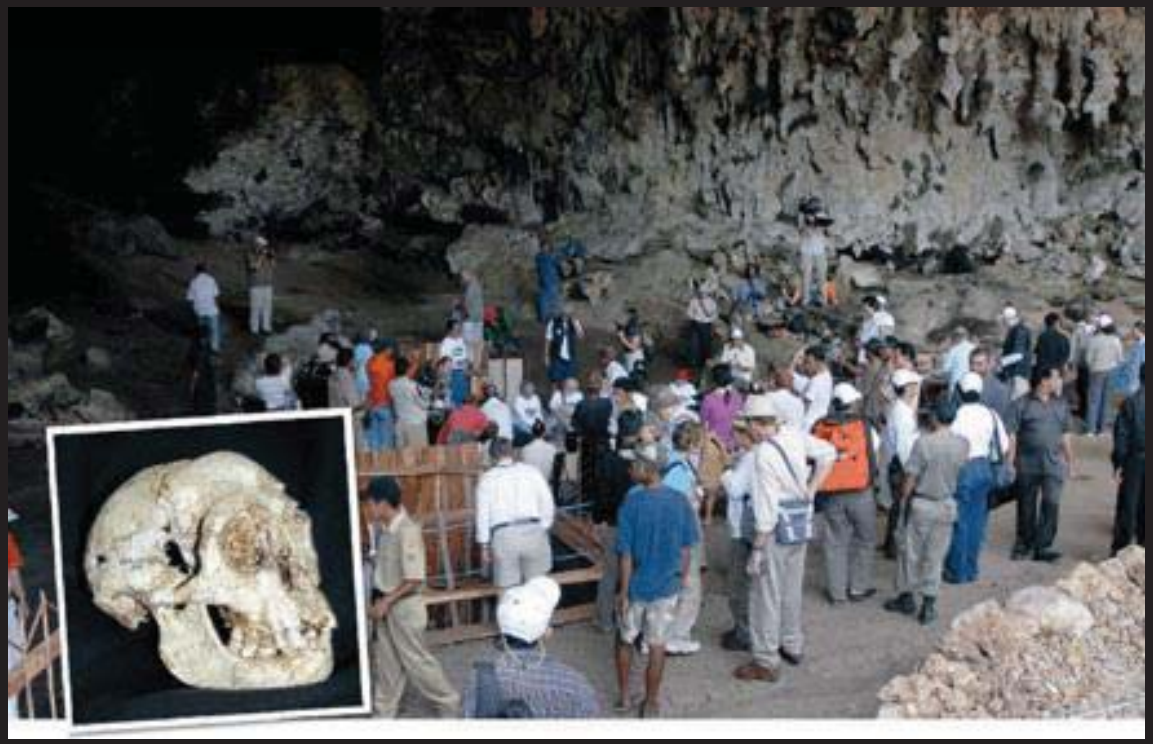
Motivation – why important?



(Source: Global Historical Climatology Network)

- Instrumental records only go back to beginning of last century
- We do not have a clear picture on how the monsoon has changed over longer time-scales
- Therefore, we must rely on natural archives to ‘extend’ the instrumental record back through time

Indonesian caves are significant environments for preserving records of past human and faunal occupations….



Liang Bua, Flores, Indonesia (Morwood et al. 2004 Nature)

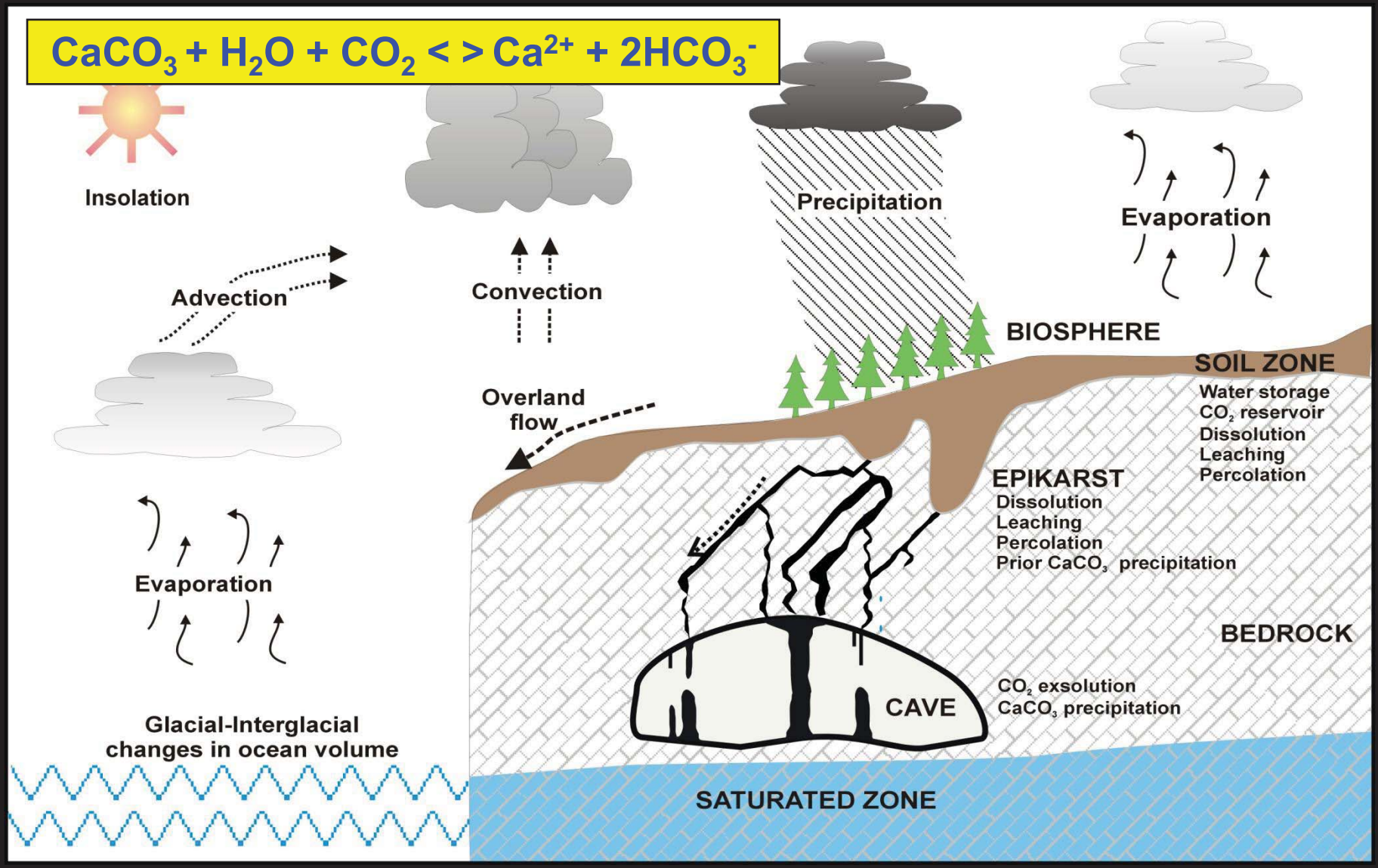
Image of *homo floresiensis* (the "Hobbit")

..but they also contain carbonate deposits (called stalagmites) that have yielded vital information on Earth's climate over the last 500 ka

Drilling flowstone cores in Liang Luar Cave, Flores, Indonesia

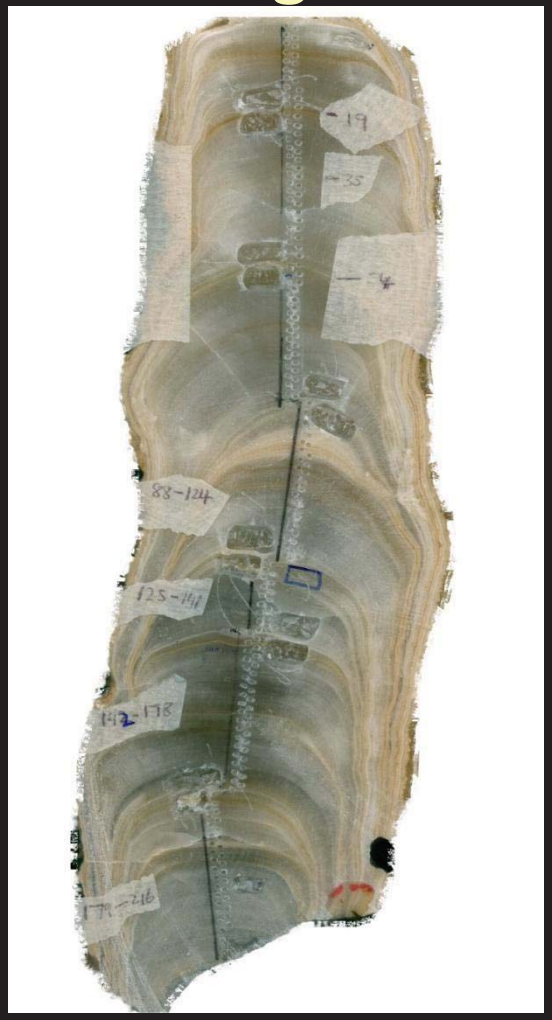
Cross section of two ~90,000 year old stalagmites from Liang Luar Cave, Indonesia (Griffiths et al. *in prep*)

Karst processes and stalagmite formation



Why are stalagmites useful in global change research?

Stalagmite

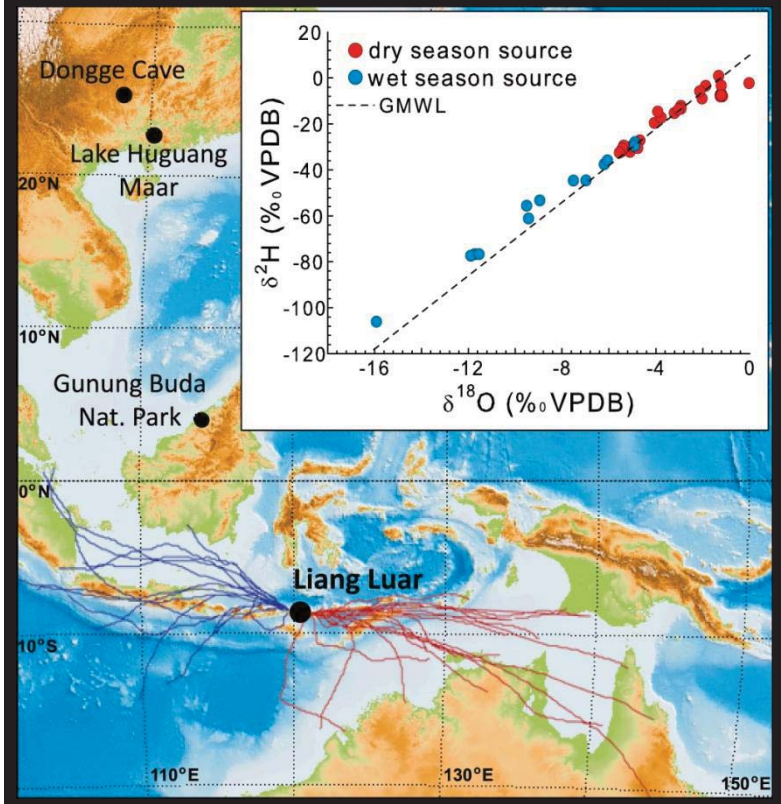


- Sensitive to climate-driven environmental processes
- Dated with great precision back to about 500 ka using $^{234}U/^{230}Th$ technique:
  - typical uncertainty @ 100 ka is: +/- 1 ka
  - some labs can produce uncertainties 5x-10x better
- Depositional environment well protected from weathering
- Long, continuous records

What climatic information can we extract from speleothems?

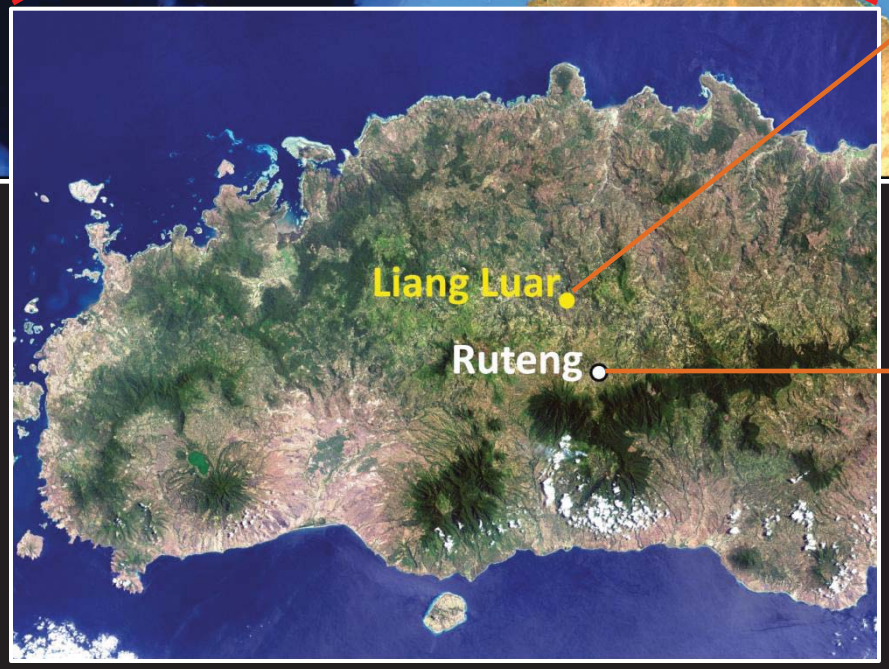
Oxygen isotopes

$$\delta^{18}O\ (‰) = \frac{\left({}^{18}O/{}^{16}O_{sample} - {}^{18}O/{}^{16}O_{std}\right)}{{}^{18}O/{}^{16}O_{std}} \times 1000$$



- During water phase changes, one isotope is favored over the other
  - Change in $^{18}O/^{16}O$ tells us something about air-mass transport
- Oxygen isotopes in stalagmites dependent upon drip-water composition, in turn dependent upon rainfall composition
- Controls on oxygen isotopes of rainfall (longer time-scales):
  - changes in the $\delta^{18}O$ of the oceanic source region ("ice-volume effect")
  - changes in moisture sources or storm tracks
  - changes in seasonality of precipitation (winter/summer)
  - amount of rainfall ("amount effect")
    - Lower $\delta^{18}O$ = Higher rainfall

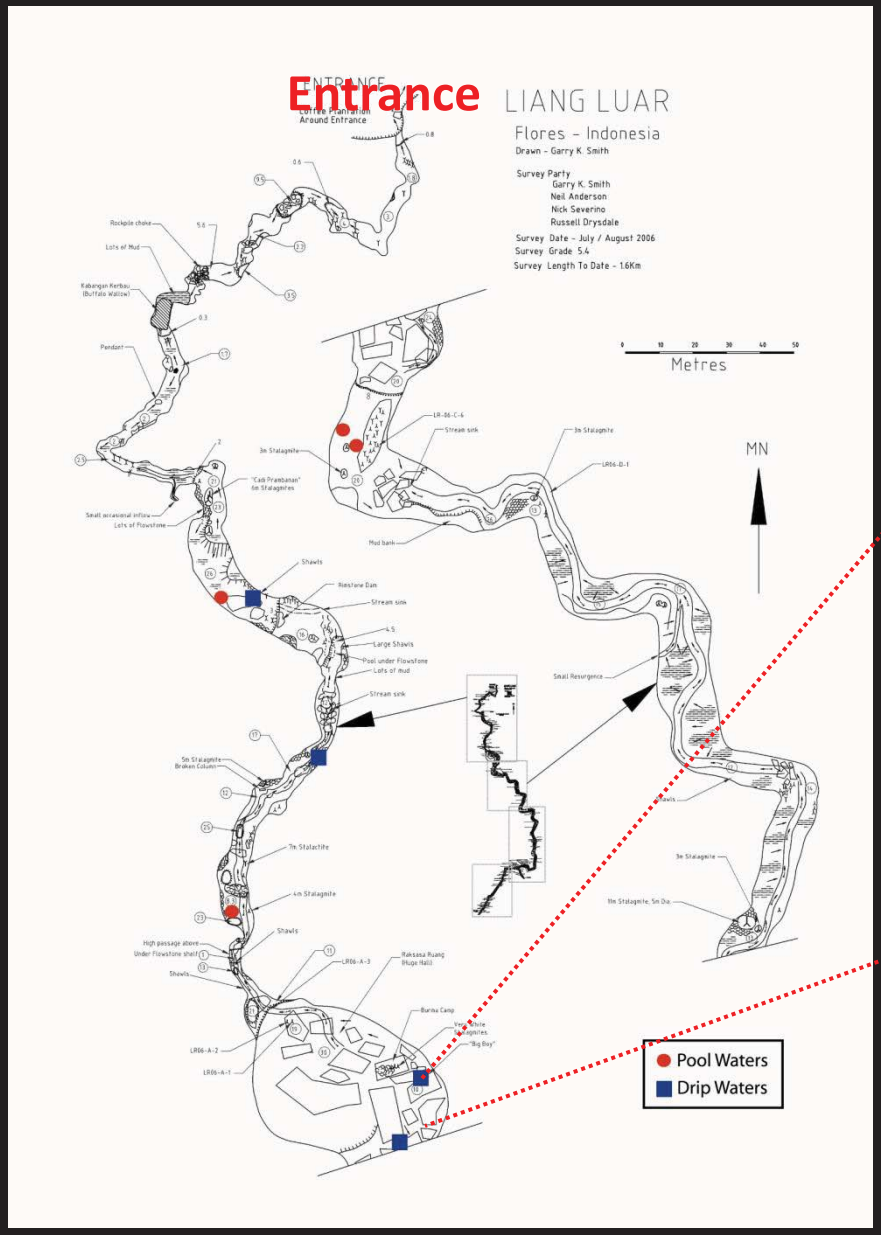
Study Site: Flores, Indonesia



Flores:

- 8°- 9° S ; 120°-123° E
- Extends over length of 360 km NW of Australia
- Liang Luar Cave located 25 km from north coast in central west region of island

Study Site: Liang Luar Cave

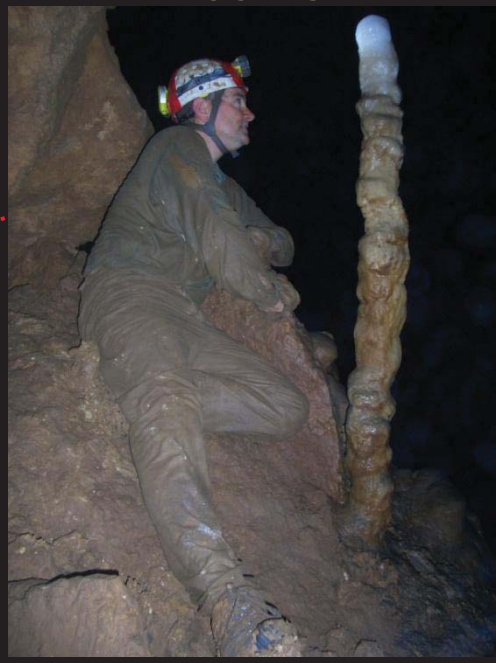


LR06-B1

Liang Luar Cave

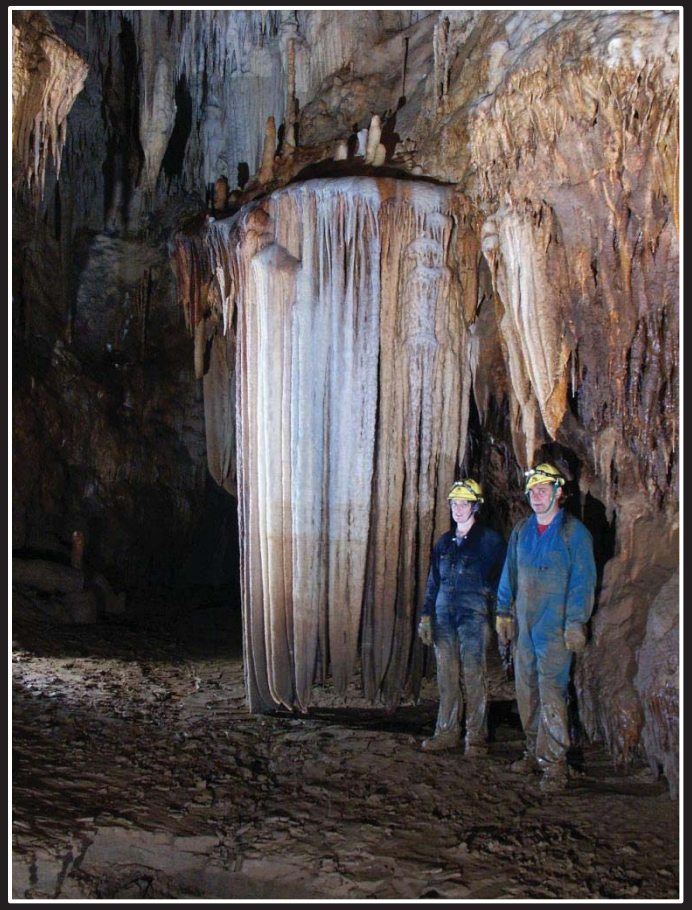
- ~2 km in length
- Cave temp: ~26°C
- 100% humidity

LR06-B3



B1 and B3: ca. 800m from entrance

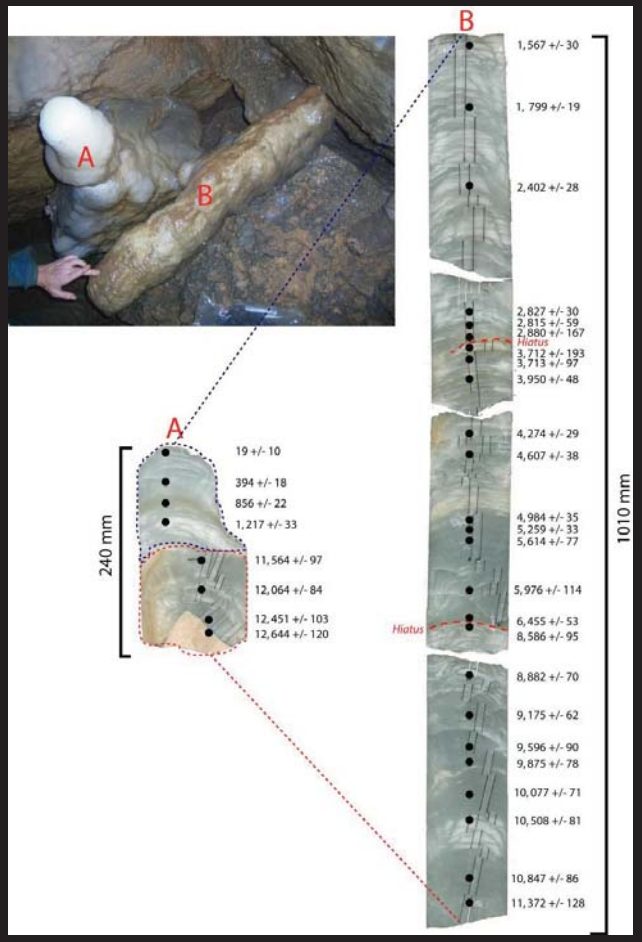
Study Site: Liang Luar Cave



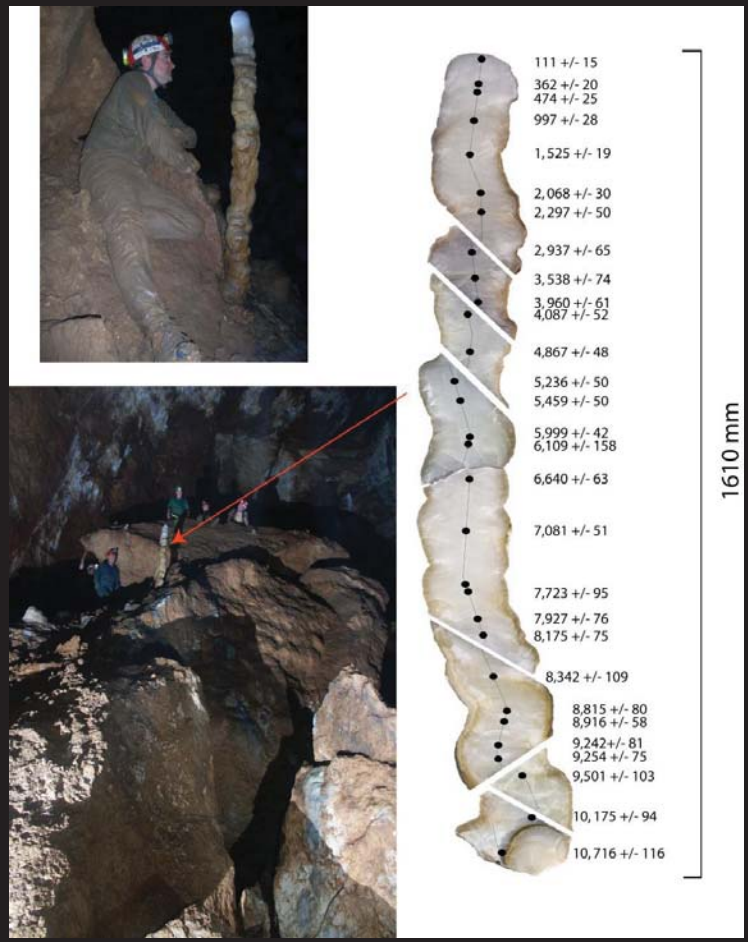
Several speleothems collected in May/June 2006, 2007

Two speleothems collected in 2006

LR06-B1



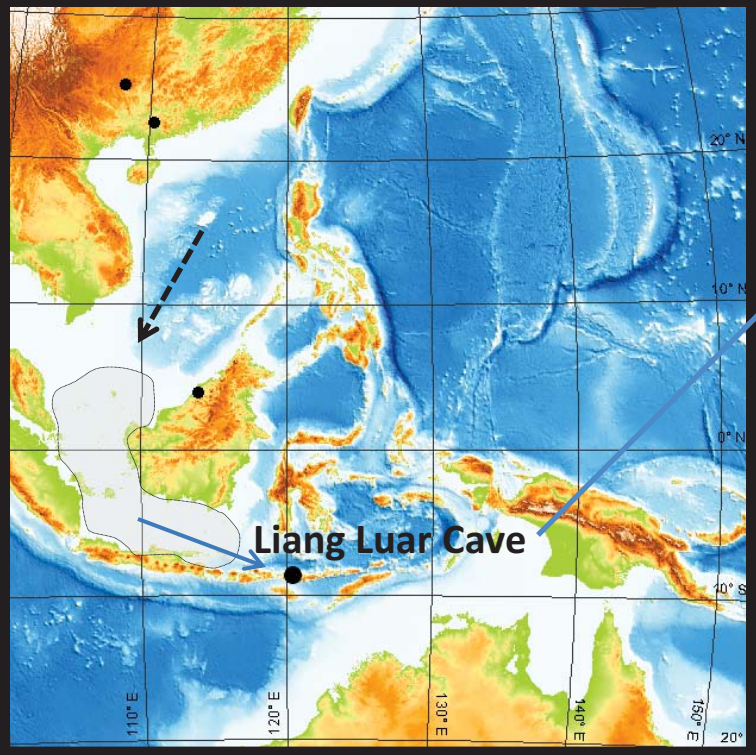
LR06-B3



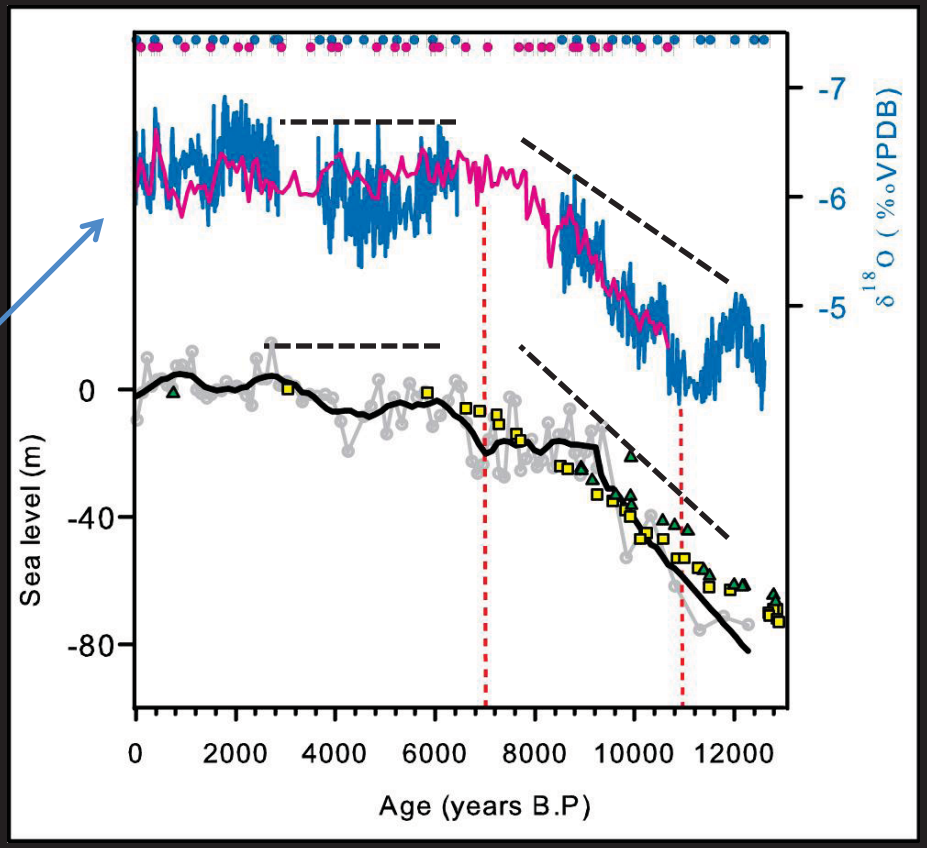
- Total of 62 U/Th dates
- Indicates a period of growth from 12,600 years ago to present day
- Total of 1399 oxygen isotope measurements (equating to approx. 7 yr resolution per sample)

(Griffiths et al., 2009, Nature Geoscience)

Palaeomonsoon reconstruction using oxygen isotopes



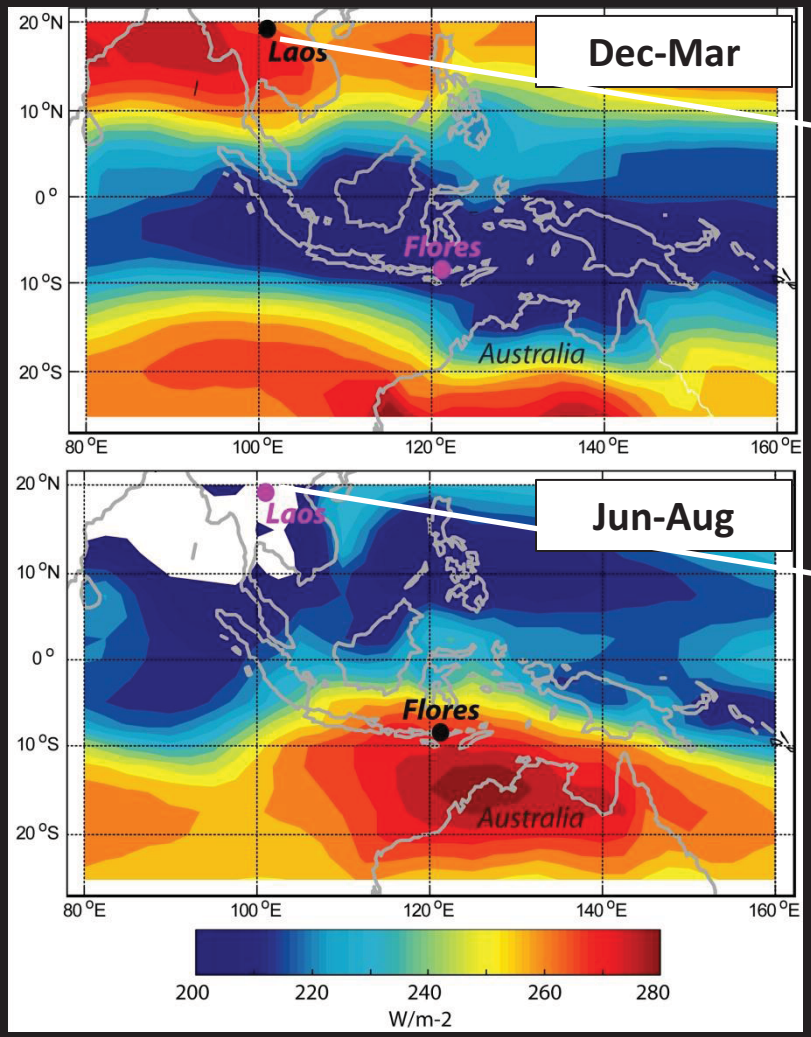
Lower $\delta^{18}O$ = Higher rainfall



- Sharp decline in Liang Luar $\delta^{18}O$ from 12-7 thousand years ago
- Propose sea-level to have been dominant forcing during the end of the last deglaciation
- Two possibilities to explain sea-level influence:
  - Monsoon trajectory occupied by land
  - Incursion of warm waters from the South China Sea as the sea-level rose resulted in higher evaporation over the source region

(Griffiths et al., 2009, Nature Geoscience)

Next stage of research: Looking at greater Australasian monsoon



Fieldwork 2010, 2011 with Dr. Kathleen Johnson - UC Irvine

Challenges/Strategies communicating science

Challenges

- What I do is scientifically specialized - trying to explain this to the general public can be difficult.
- How to convert data-intensive results into a 'user-friendly' fashion (i.e. a format that the non-scientific person can understand)?
- Overcoming the "so what" factor: who cares if you know what the climate was like in the past?

Successes

- Because my study area so interesting to look at physically, much easier to catch people's attention – good place to start conversation.
- Once I have explained how we can use stalagmites to look in to the past, people are generally fascinated.

Bottom line: Not only about improving ways in which we can simplify the science BUT ALSO about improving the ways in which we can communicate it.

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