

Stories Told By Grottes de Bétharram Speleothem Records

VICTORIA GONZALEZ, JESSICA PAN



Motive



- By analyzing the isotopic/trace element composition and thicknesses of speleothem rings, we may find high-frequency cycles in precipitation and temperature over a timescale of a century.
- This analysis can predict future changes in France's climate by providing ancient records and looking at past cycles.

Hypothesis



- Natural cycles (rainfall) can be detected in speleothem rings
- Layer thickness of speleothems increases with an increase in rainfall
- d_{18O} of speleothems decreases with an increase in rainfall

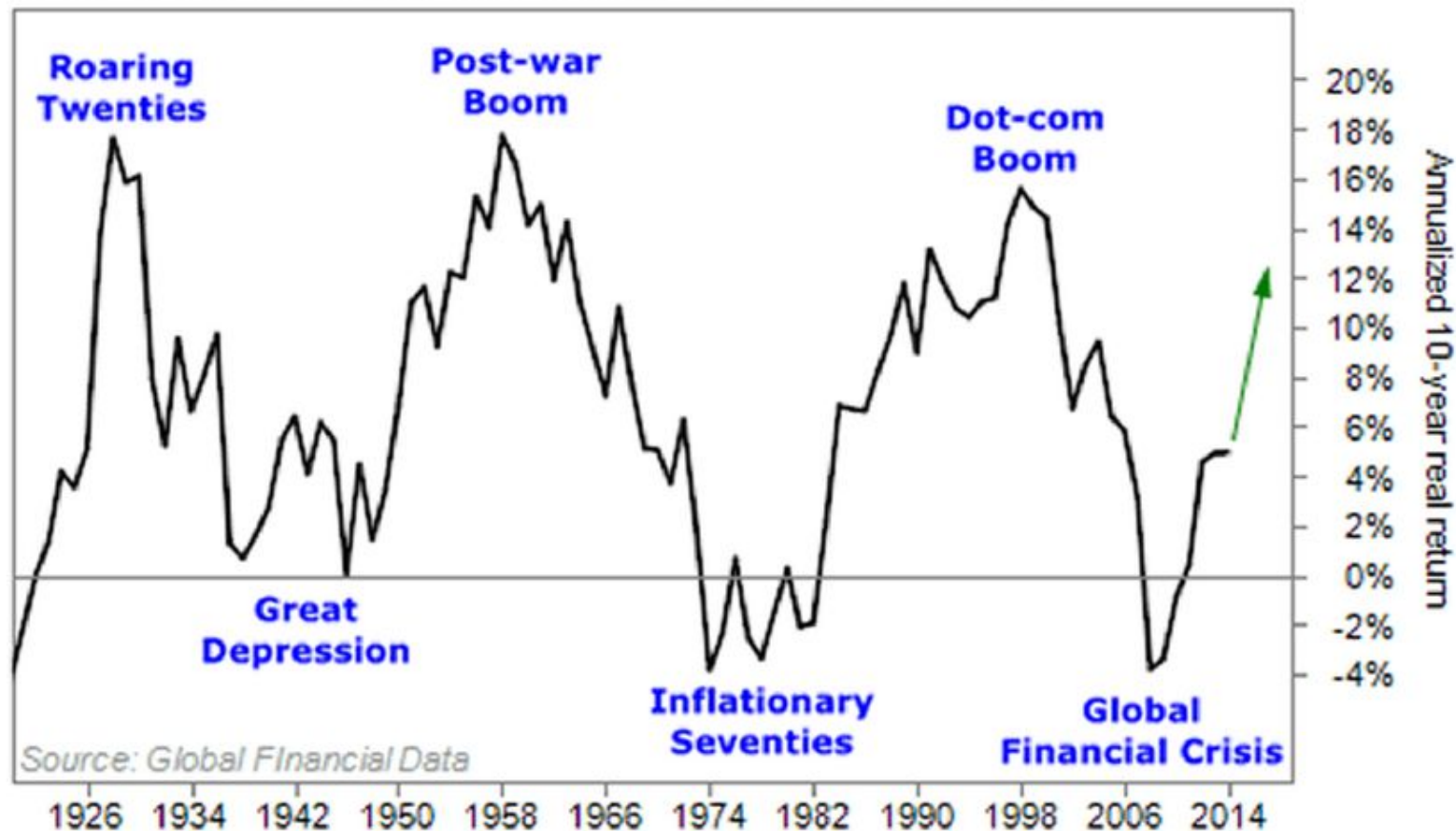
Overview

Introduction



Why are cycles important?

S&P 500 10-Year Real Return, Annualized



Grottes de Bétharram

446

Meters above
sea level

80

Meters deep

14

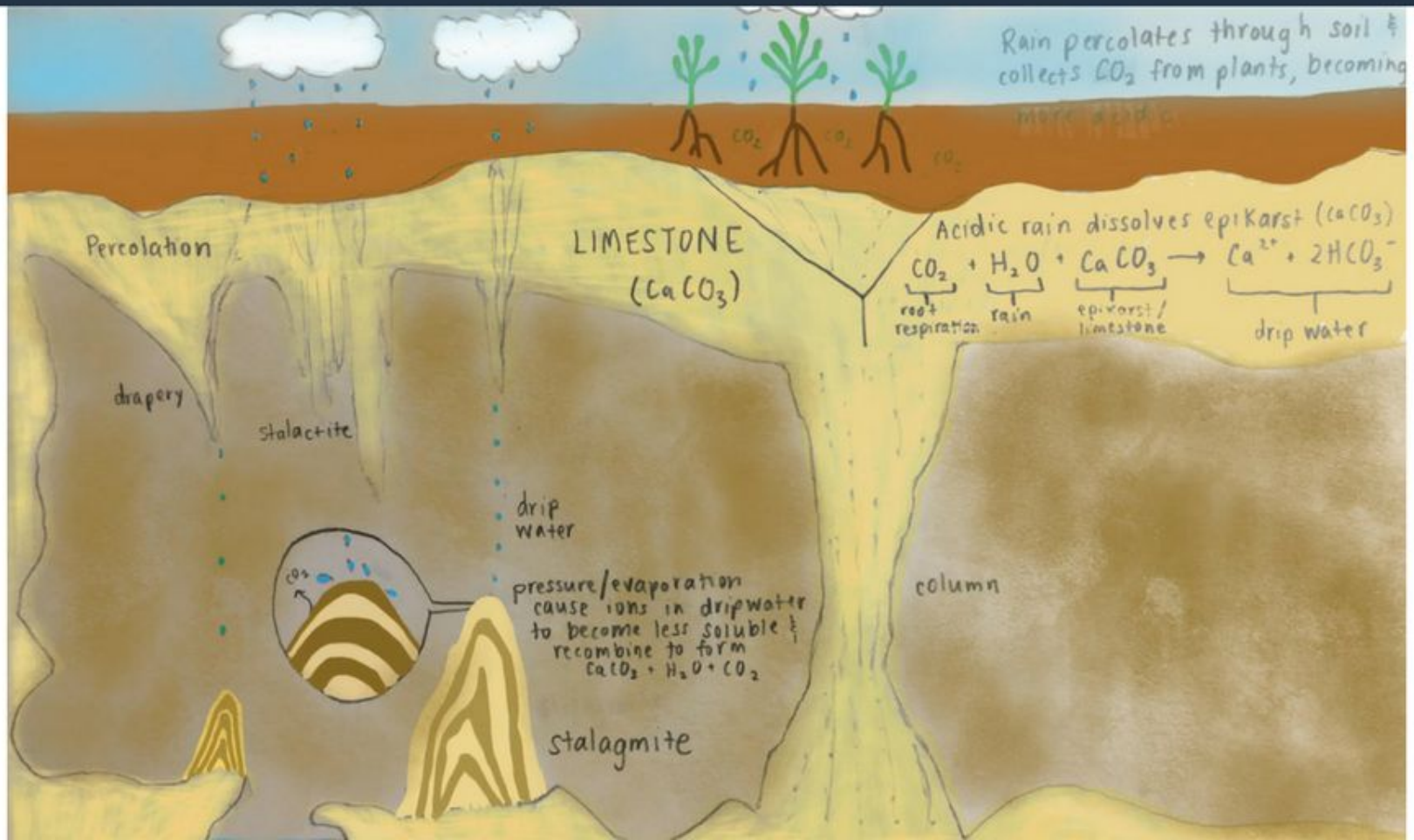
Degrees Celsius
internal cave
temperature

What are speleothems?

Cave formations caused by minerals precipitating out of rainwater as it percolates through the cave



Speleothem Formation

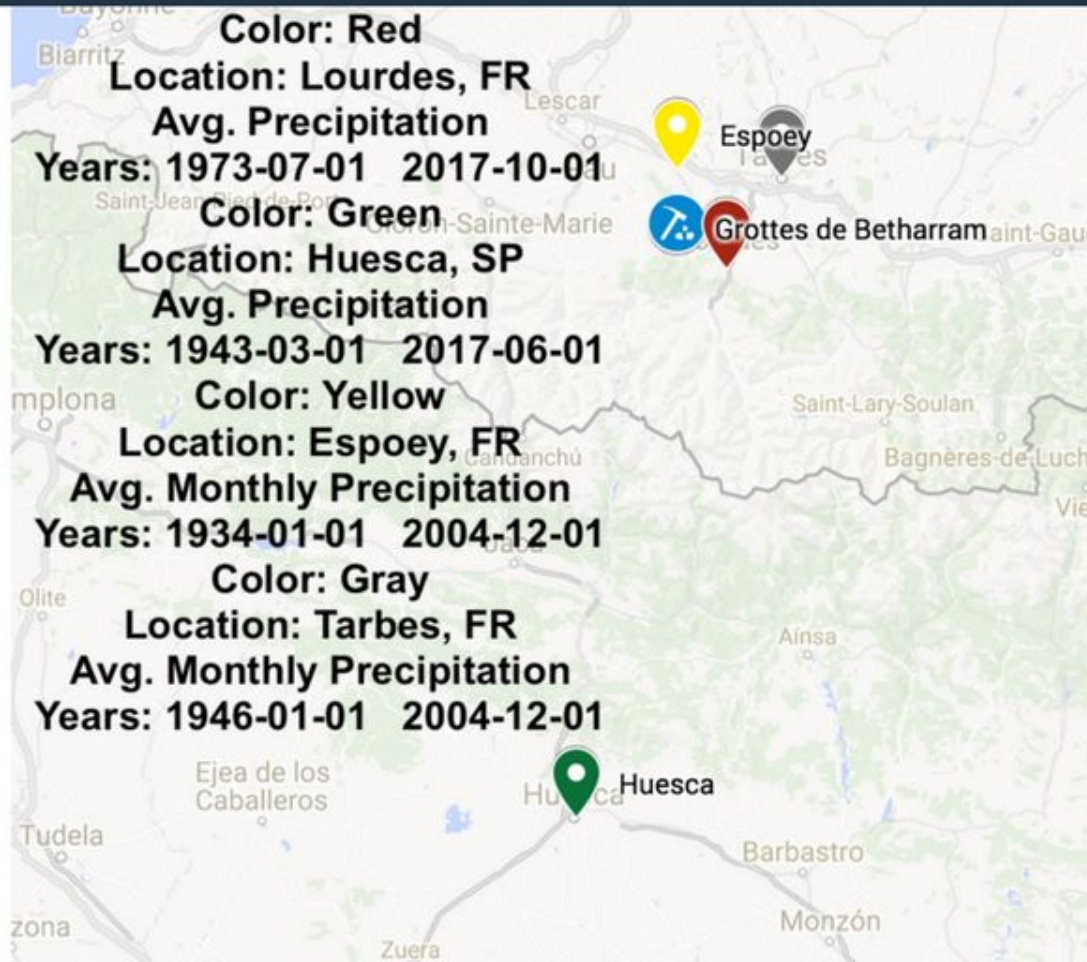


Overview

Methodology

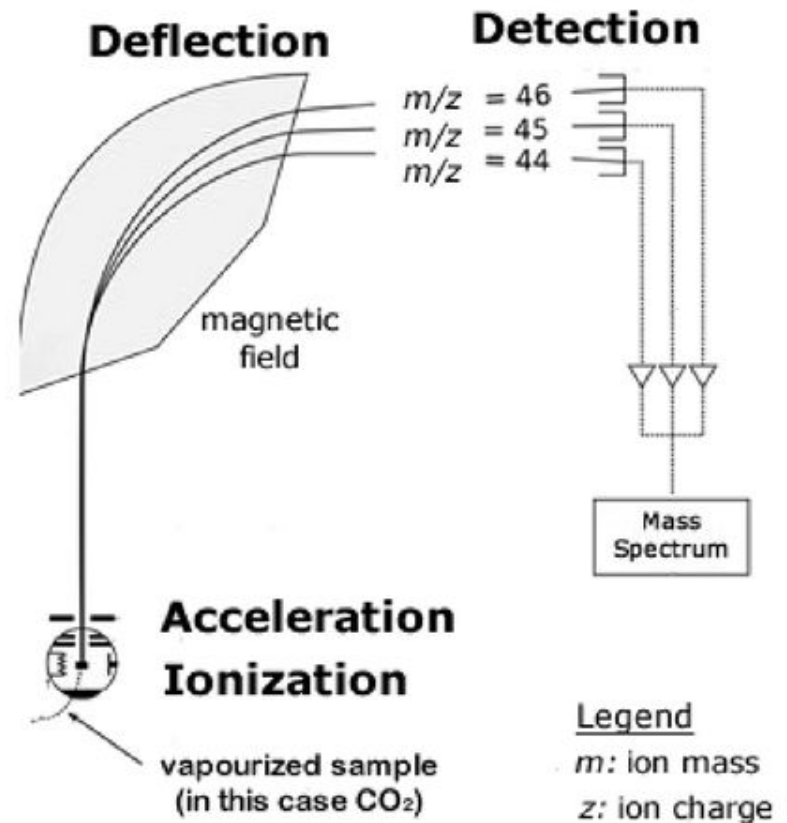


Weather Stations



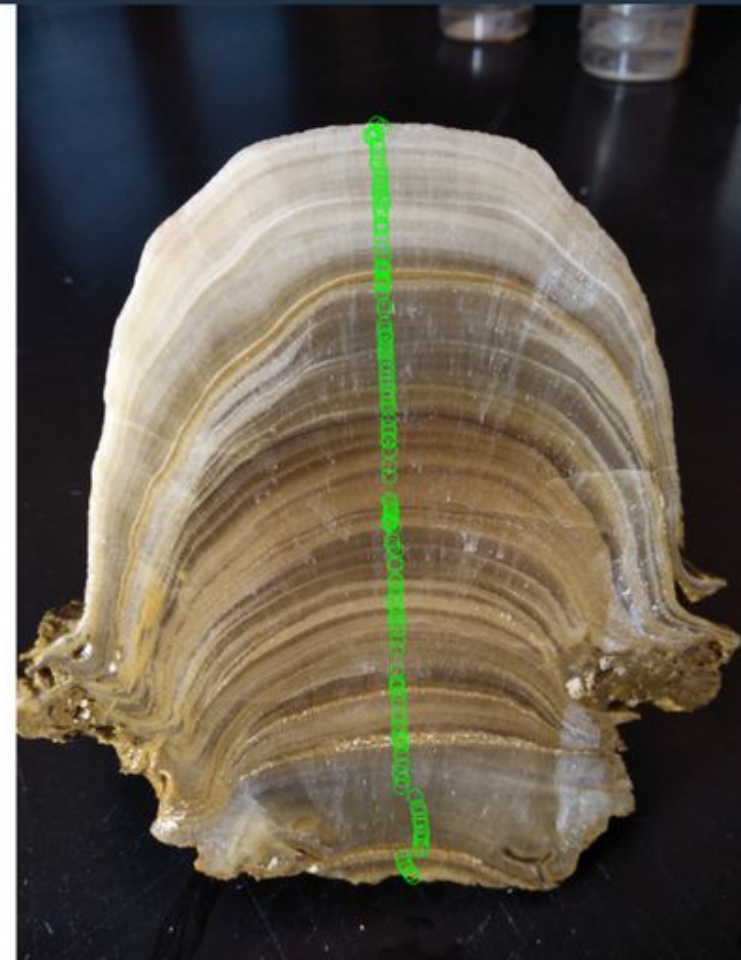
IRMS

- Used to determine isotopic concentrations
- Detects ions determined by their mass to charge ratio
- Ions move under influence of magnetic or electrical field



Layer Counting and Sampling

- Counted layers starting from the bottom of the speleothem
- 3 transects going up the speleothem
- Isotopic equilibrium at time of deposit?
- Hendy test

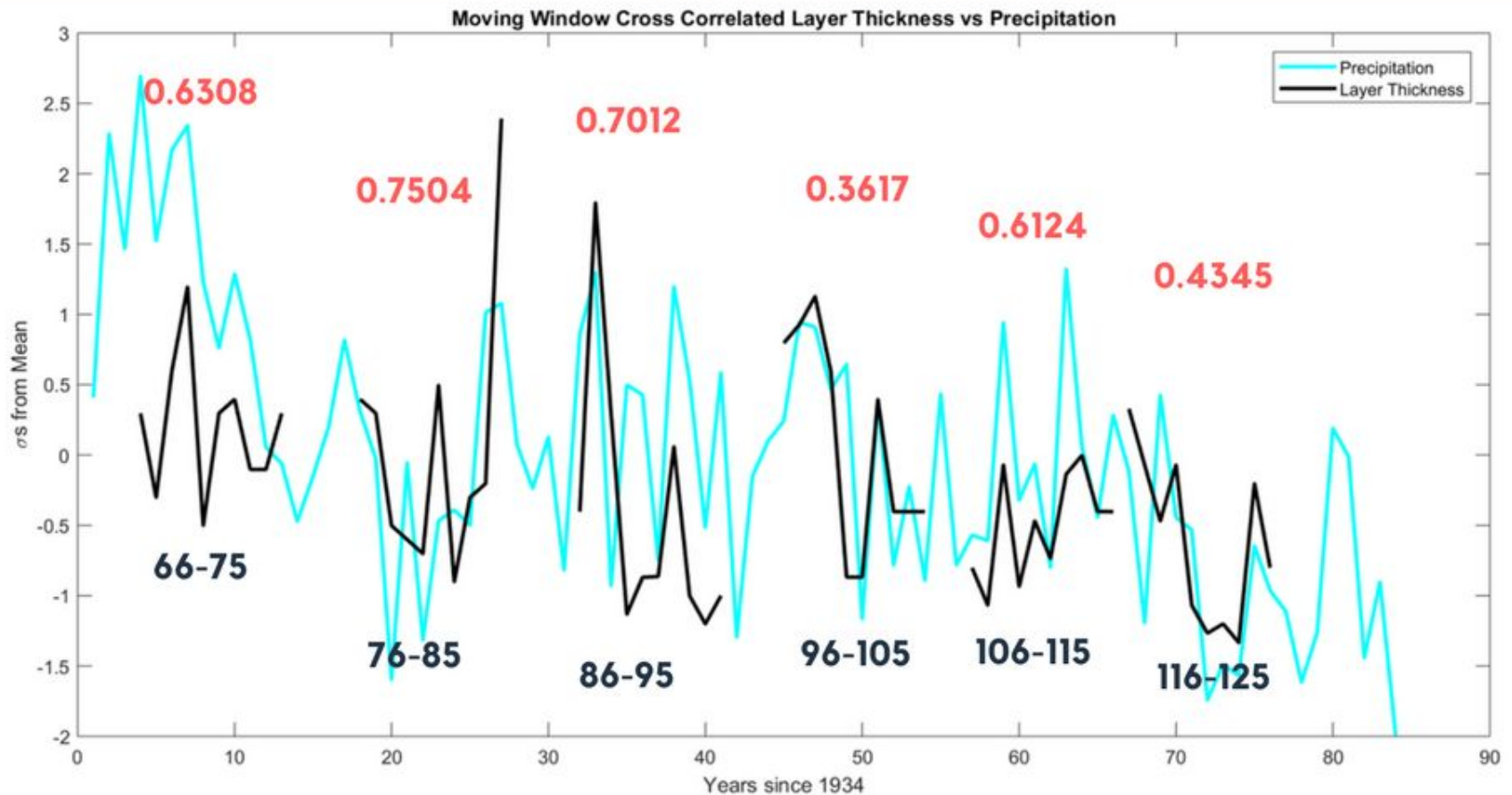


Overview

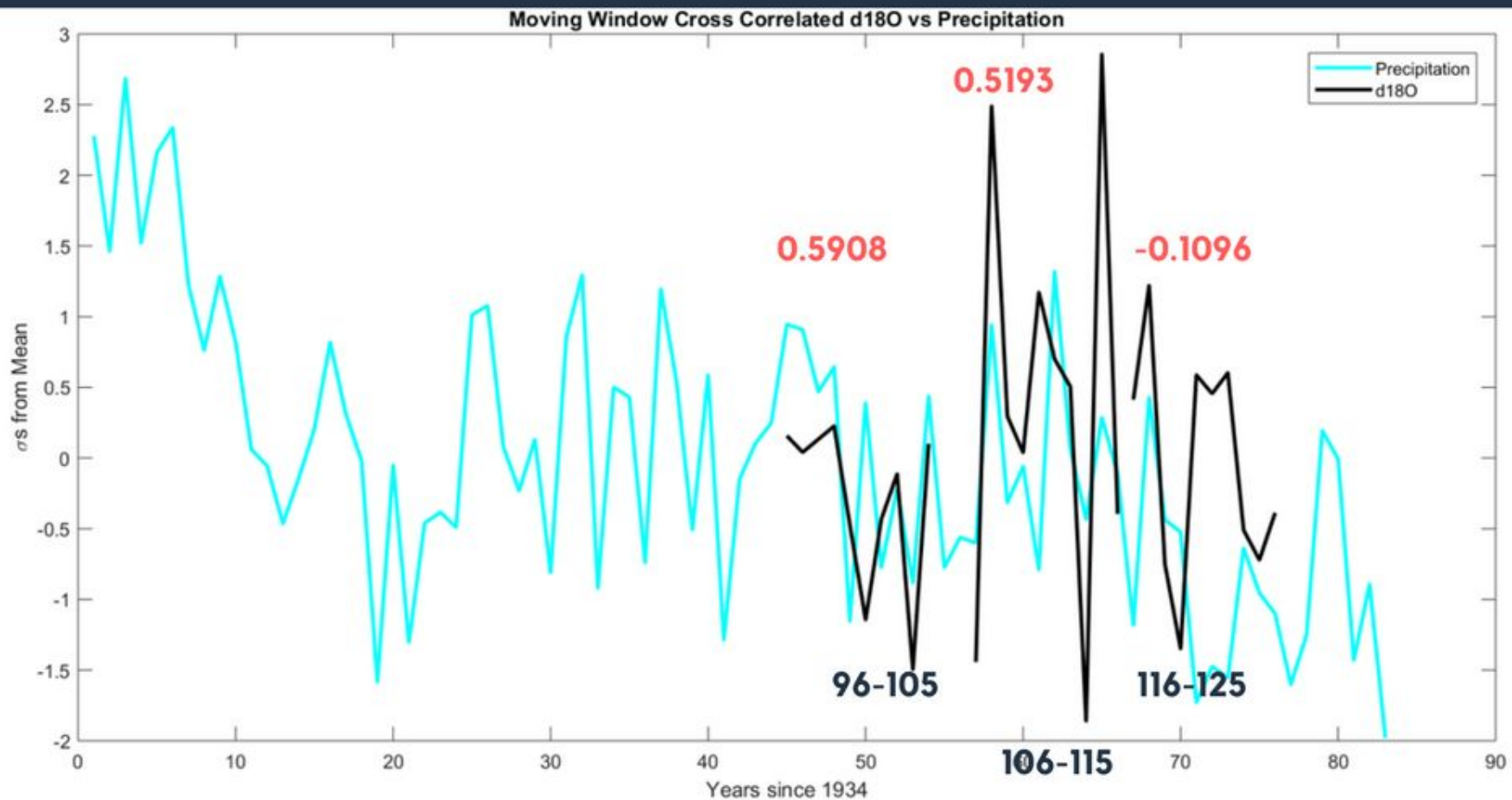
Results



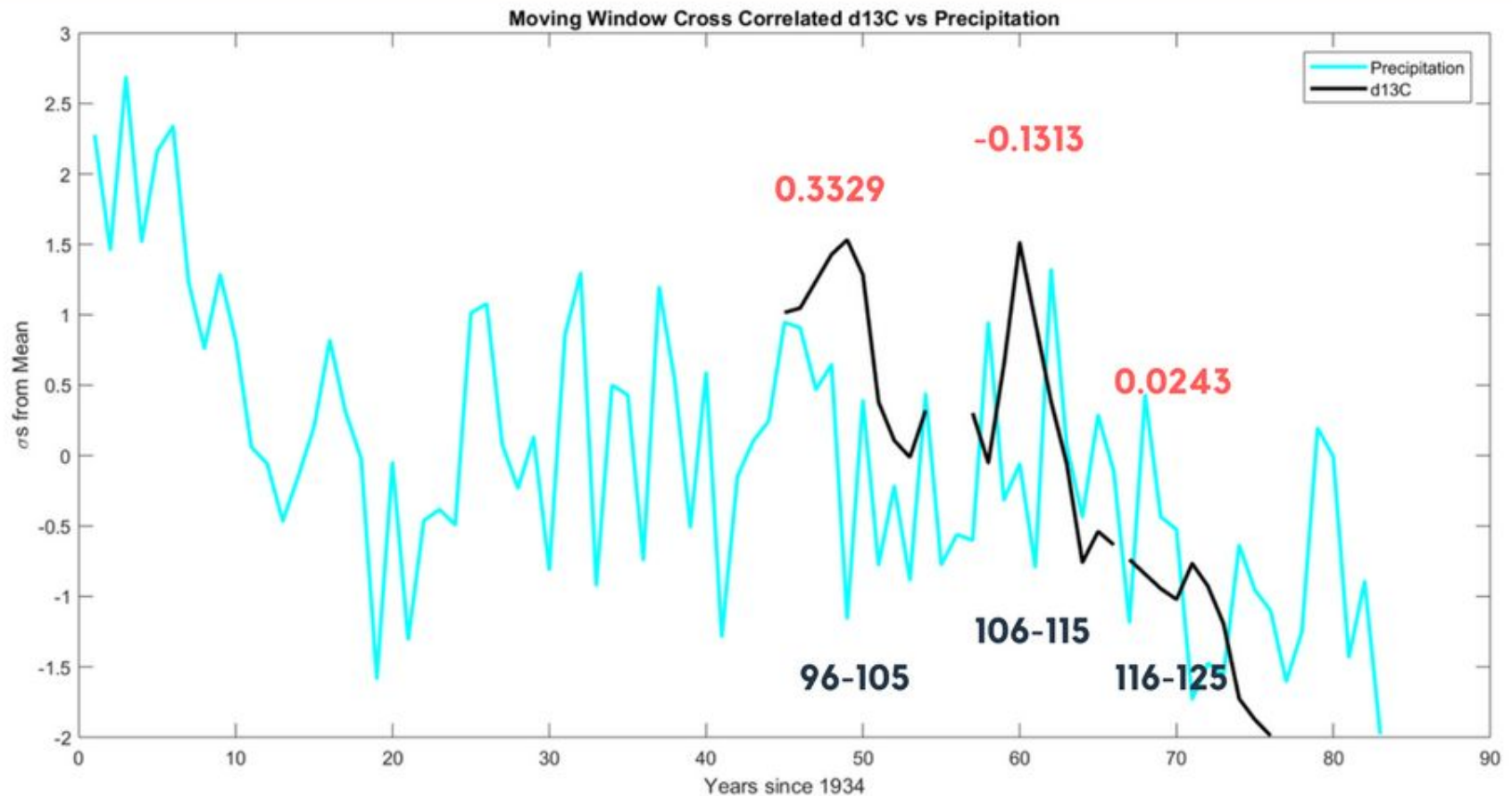
Moving Window Cross Correlation



Precipitation vs d18O

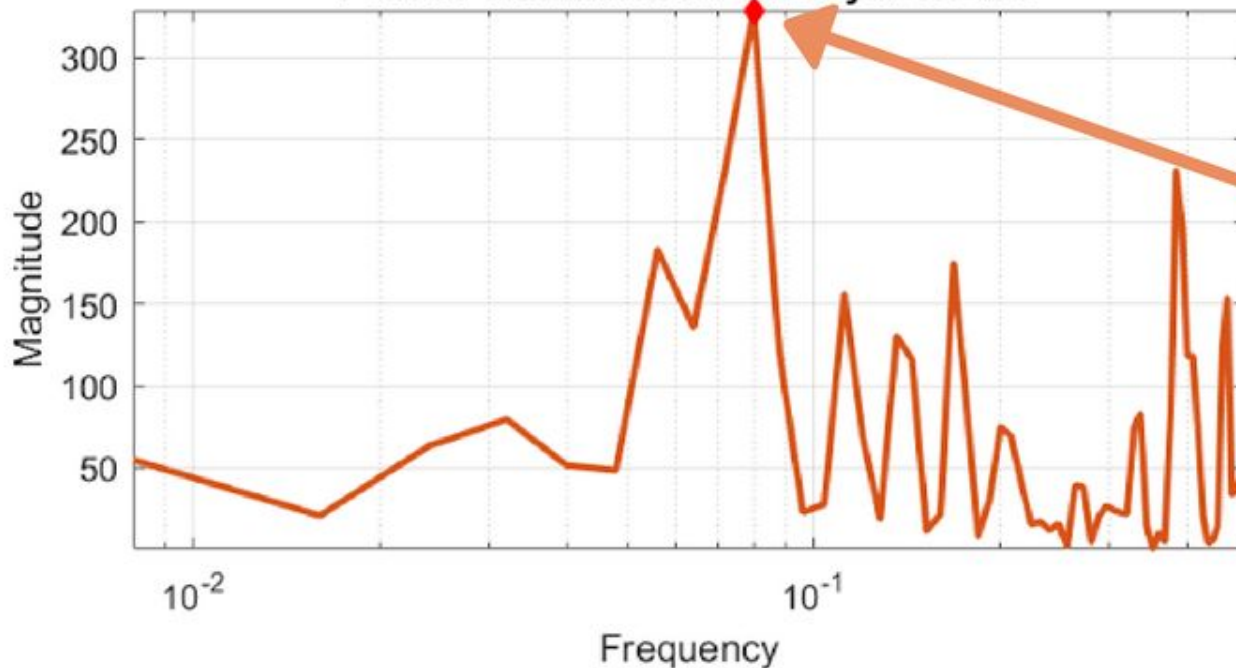


Precipitation vs d13C



Fourier Transform of C2 Speleothem Layer Widths

Fourier Transform for C2 Layer Widths



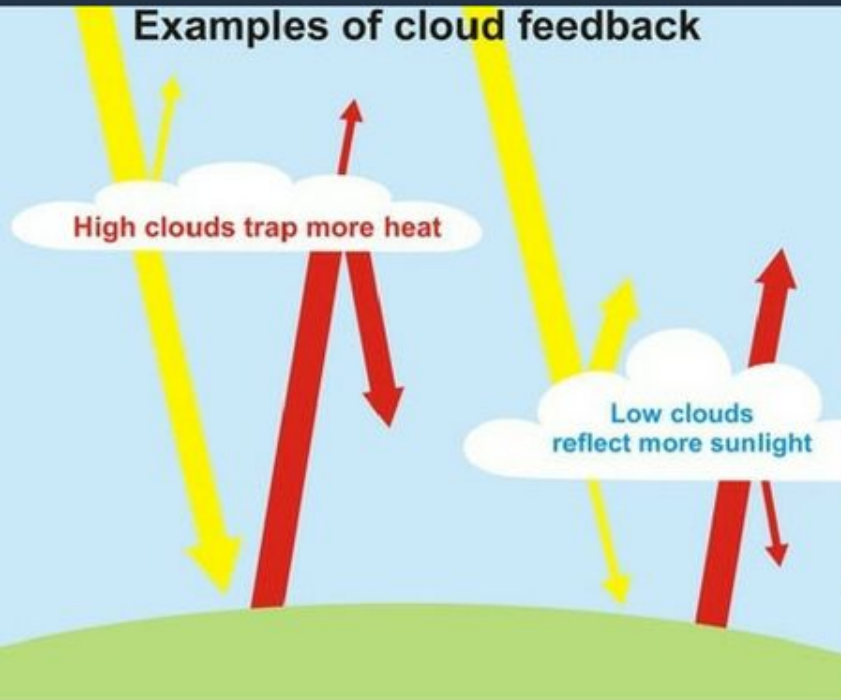
- Peak at period of 12.5 years
- Sun spot cycles (11-year changes in Sun's level of solar radiation)

Sun Spot Cycles

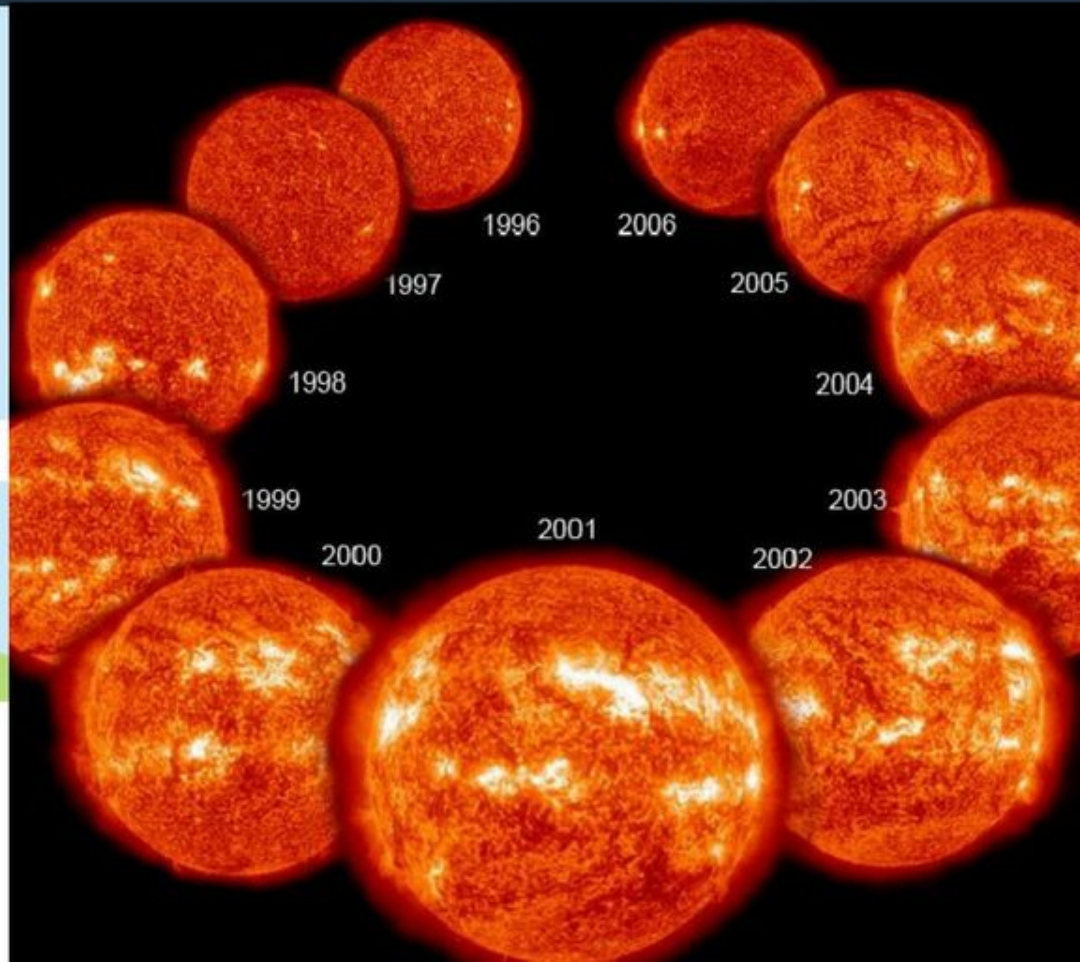
Examples of cloud feedback

High clouds trap more heat

Low clouds reflect more sunlight



<https://qph.ec.quoracdn.net/main-qimg-4774e668d558044b97595842688e8edf-c>
https://www.nasa.gov/images/content/506263main_sorce1.jpg



Conclusions

- More rainfall corresponds to a smaller abundance of $\delta^{18}\text{O}$
- There is no correlation between rainfall and $\delta^{13}\text{C}$

- As precipitation increases, lamina thickness increases

- Sunspot cycles (which correlate to annual precipitation) can be seen in speleothem ring width

Acknowledgements

SPECIAL THANKS TO ADAM MALOOF, FREDERIK SIMONS, EMILY GEYMAN, DISHA OKHAI, AKSHAY MEHRA AND OUR FELLOW CLASSMATES IN FRS 135 FOR HELPING US COLLECT/CARRY ROCKS, RUN SAMPLES, CODE IN MATLAB, USE LATEX, AND PROVIDE ADVICE AND FINANCIAL SUPPORT.

thank you for
your time

TEAM SPELEO

