Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
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Societal responses to political and climatic changes in Babylon in the First Millennium BCE

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CL3.2.6: Climate extremes, biosphere and society: impacts, cascades, feedbacks, and resilience
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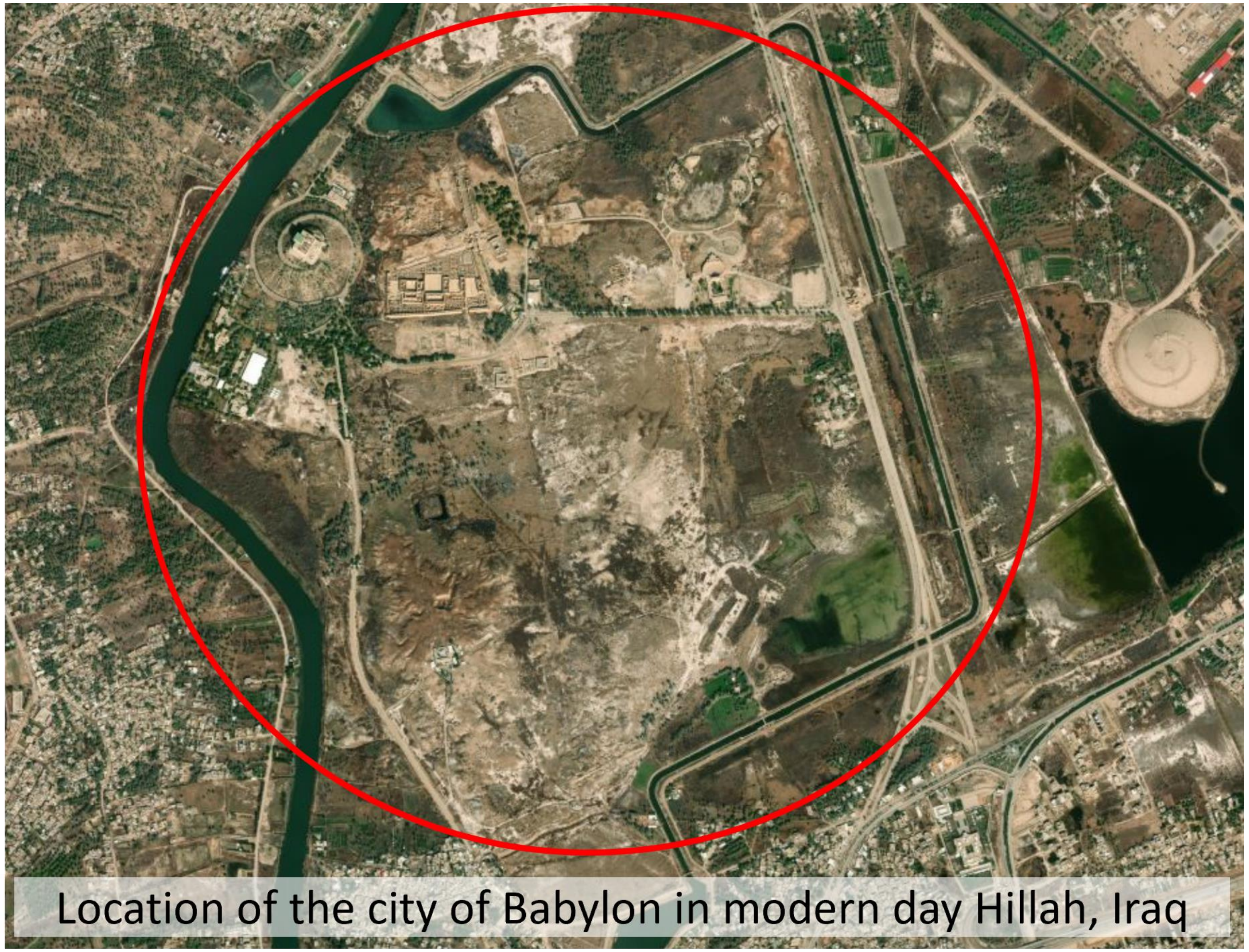
Trinity Centre for Environmental Humanities
SCHOOL OF HISTORIES AND HUMANITIES

IRISH RESEARCH COUNCIL
An Chomhairle um Thaighde in Éirinn

Research supported by an Irish Research Council Laureate Starting Award

Location

Babylon, Iraq


Location of the city of Babylon in modern day Hillah, Iraq

The Ancient city of Babylon is situated in modern-day Hillah in Iraq, it is roughly 80 kilometers south of Baghdad. The city and the kingdom went through many dynasties and social changes throughout its lifetime. Through a need to record administration data (ownership, taxes, historical events), as well as recording astronomical phenomena with the aim of successfully predicting the future, the Babylonian scribes used cuneiform writing on clay tablets.

Cuneiform

Reed tip being pressed into clay (top), result shown (middle), combinations of shapes (bottom).
Finkel & Taylor, 2015

Cuneiform is a complex script constructed from a variety of wedge and line shapes produced by pressing the tip of a reed into wet clay. It is through the choice of medium that we can still study this ancient language today. Clay hardens over time, and it is one of the few mediums that benefits from fires. Many clay tablets that may have been discarded, survived by accident, allowing us to delve into the time capsule each tablet provides. In fact, many of the tablets were excavated accidentally, when workmen were searching for well baked bricks to build with.
(Abraham Sachs, 1948:44)

First map of the world
92687, British Museum, 2022

The Astronomical Diaries and Related Texts from Babylonia

Tablet from the *Astronomical Diaries and Related Texts from Babylonia* series, 141BCE. British Museum, 2022

K.2039, British Museum 2022

The *Astronomical and Related Texts from Babylonia* are a series of tablets that comprise sub-daily resolution of astronomical and meteorological data, monthly (and sometimes sub-monthly) resolution of Euphrates River level heights, market price value for six commodities (barley, dates, mustard, cress, sesame and wool), and records of historical events.

Volume	Content	Published
1 - Diaries from 652-262BC	Systematic daily observation of lunar, planetary and meteorological phenomena along with monthly river heights, economic data for five commodities, and historical information for the years 652-262BC.	1988
2 - Diaries from 261-165BC	Systematic daily observation of lunar, planetary and meteorological phenomena along with monthly river heights, economic data for five commodities, and historical information for the years 261-165BC.	1989
3 - Diaries from 164-61BC	Systematic daily observation of lunar, planetary and meteorological phenomena along with monthly river heights, economic data for five commodities, and historical information for the years 164-61BC.	1996
4	Undatable fragments	Not yet published
5 - Lunar & Planetary Texts	Monthly observations of lunar and planetary data from 747-10BC	2001
6 - Goal Year Texts	Contains “raw materials for the prediction of planetary and lunar phenomena for a given year” (Sachs, 1948: 282)	2006
7 - Almanacs & Normal Star Almanacs	Contains astronomical almanacs from the 3rd to the 1st century BC.	2014

These tablets have been transliterated, translated, dated and published into a seven-volume series. The first three contain the weather data and are therefore the focus of my research, which aims to reconstruct the climate of the region in the First Millennium BCE. The series span 652-61 BCE, with the majority of data falling in the years 390-61 BCE.

Evidence of volcanoes recorded in the diaries

"The disk of the sun looked like that of the moon"

Pale sun due to volcanic particulates from Eyjafjallajökull eruption, Iceland; Photo taken in Leiden by Marco Langbroek, 18 May 2010

5′ [.... Night of the 13th, beginning of the night, the moon was x]+½ cubits [below β Geminorum,] the moon being ½ cubit back to the west; all night clouds were in the sky, ... [....]

6′ [....] the north[?] wind blew; in the morning watch, rain DUL. The 14th, sunrise to moonset: 4°, measured (despite) clouds [....]

7′ [....] were in the sky[?], the north wind blew; in the morning, heavy fog. The disk of the sun was like [....]

8′ [.... Night of the 17th, last part of the night, the moon was] 7 cubits [below ϑ Leo]nis, the moon having passed a little to the east; the moon was surrounded by a halo, [it billowed] very [much ....]

11 [....] .... the west wind blew; the cold became severe; last part of the night, overcast. The 2[2nd[?], clouds were] in the sky; in the morning, small hail fell; all [day ....]

12 [.... the co]ld became severe. Night of the 25th, clouds crossed the sky, the north wind [which was set to the west side] blew; the cold became very severe [....]

13 [....] clouds were in the sky, a little fog, the north wind which was set to the west side blew; cold. Night of the 27th[?], ... [....]

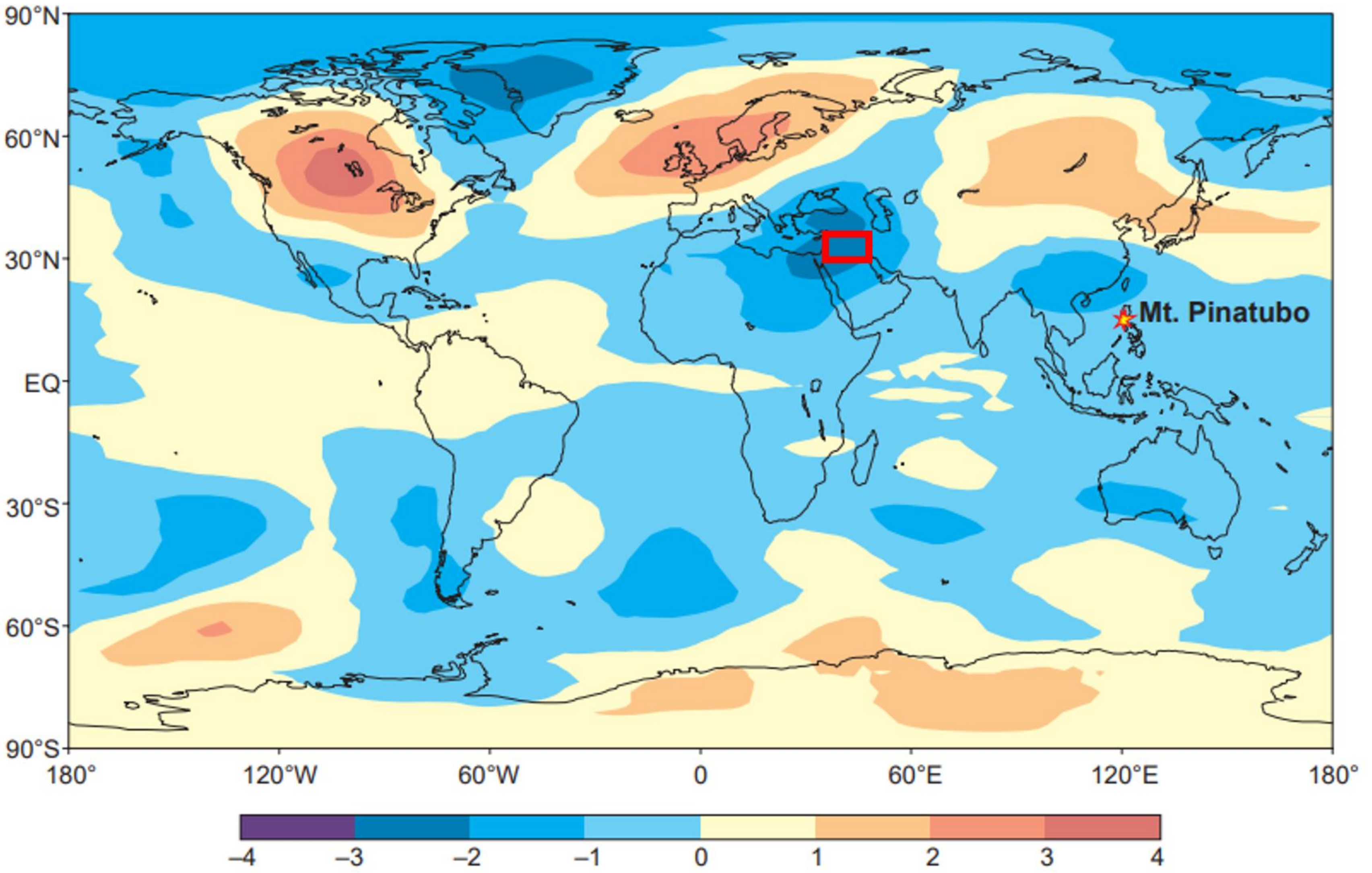
14 [.... Night] of the 28th, the north wind which was set to the west side blew; cold; last part of the night, [clou]ds were in the sky. The 28th, moonrise to sunrise: 13° 10′, cl[ouds ....]

The diaries contain an abundance of evidence from the climatic impacts of explosive volcanism. "The disk of the sun looked like that of the moon" is a phrase found in the diaries that indicates the presence of a volcanic dust veil. The image below of a diminished sun, was taken in 2010 in Leiden in the Netherlands following the Eyjafjallajokull eruption in Iceland. This is the type of paler sun the Ancient Babylonians saw when recording "the disk of the sun looked like that of the moon".

Volcanic eruptions are a known natural forcing on climate including causing a reduction in global surface temperature (Colose *et al.*, 2016; Swingeduow *et al.,* 2017; Khodri *et al.,* 2017). When a reference to the disk of the sun is recording alongside a period of cold, we mark it for potential volcanic evidence, to be examined following coding and cataloguing of the weather data.

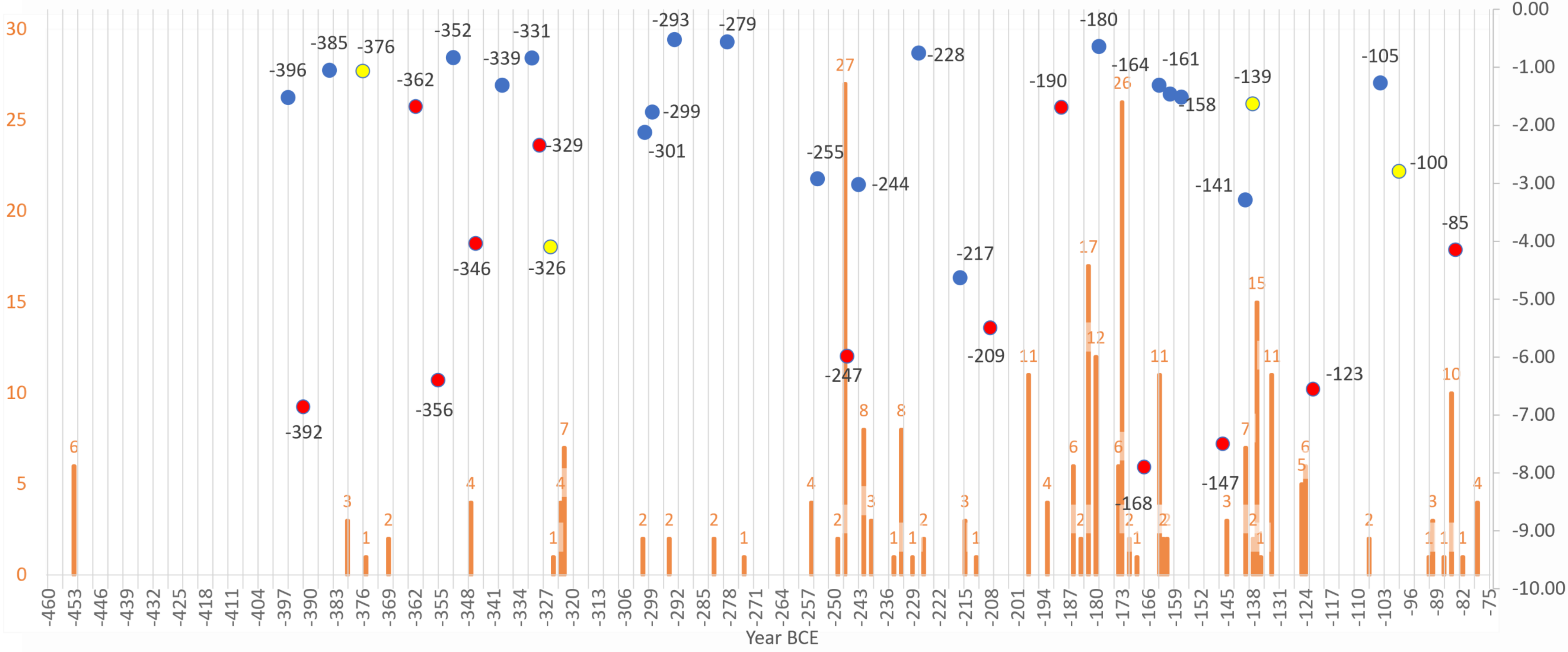
The Climatic Aftermath, Alan Robock, 2002

Alan Robock highlights the typical temperature anomalies that occur following a tropical eruption in his 2002 work *The Climatic Aftermath*, which compared the non-volcanic years of 1984-1990 with the year of the Mount Pinatubo eruption in Indonesia of 1991. This was the second largest eruption of the twentieth century. While some locations see a rise in temperature, the troposphere over Iraq sees a decrease of two to three degrees (area outlined in red in the chart below).



After the eruption. Lower tropospheric temperature anomalies for the Northern Hemisphere winter (December 1991 to February 1992) after the 1991 Mount Pinatubo eruption. This pattern is typical after large tropical eruptions, with warming over North America, Europe, and Siberia and cooling over Alaska, Greenland, the Middle East, and China. Data from Microwave Sounding Unit Channel 2R, updated courtesy of J. Christy and now called Channel 2LT (*3*). The nonvolcanic period of 1984–90 was used to calculate the mean.

The extraction of weather data from the diaries has resulted in over 230,000 rows of data, each row representing an individual data point. Within this there are a total of 177 observations referring to temperature. All these reference cold. Using a Likert scale for intensity, we can outline periods of significant cold. Thanks to the revised chronology by Michael Sigl *et al.* (2015) for volcanic sulphur deposits on the polar ice, we can line up the global volcanic forcing alongside the Likert scale for cold and see what crossover of data we have.



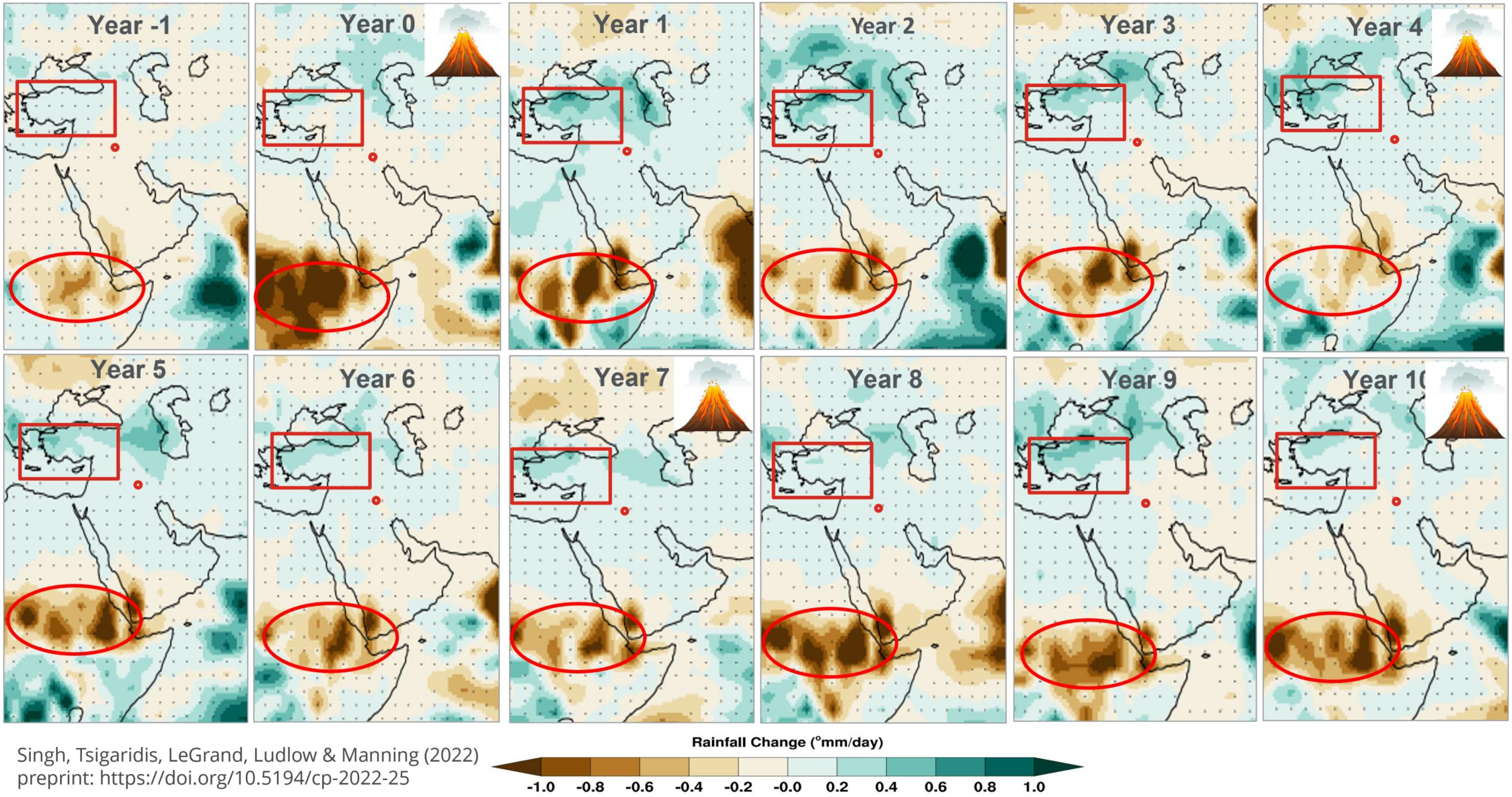
The chart shows the volcanic forcing from known volcanoes in coloured dots, red for tropical eruptions, blue for northern hemisphere and yellow for southern hemisphere. This data is from the polar ice cores and is available in the supplementary data with this paper from Sigl *et al.*, 2015. The axis for this part of the graph is on the right-hand side and starts with zero at the top working all the way down to a forcing of ten in minus watts per meter squared, globally. The most extreme volcano within this time frame is the tropical eruption of 168 BCE with a forcing of -7.9 watts per meter squared. Singh *et al.* have calculated that this eruption is ~30% greater than that of Pinatubo in 1991 (2022: 36).

The axis for the cold measured with a Likert scale for intensity is on the left of the chart (in orange) going from zero at the lower end to thirty at the top of the vertical axis. The coldest recordings we have are for the years 247 and 173 BCE. There is a tropical eruption in 247 BCE and the impact of this is mostly likely reflected in these decreased and severe temperatures. We also have strong evidence in the diaries with the disk of the sun looking like the moon observed and recorded, alongside haziness and severe cold for over a week. On the other hand, however, there is no known eruption in 173 BCE and the cold here could be a result of another, yet to be analysed, climatic forcing. The next stage of research will see an interrogation of other variables that may also be perturbed as a result of volcanic eruptions.

Climate Modelling Data

One of the benefits of working in a centre of interdisciplinarity is a cross over of projects, which enables collaborations among colleagues across the world. One such colleague, Ram Singh, kindly shared his climate modelling work that informed his most recent paper.

From this climate modelling we saw a disparate connection between levels of precipitation from Babylon to Egypt.



Singh, Tsigaridis, LeGrand, Ludlow & Manning (2022)
preprint: https://doi.org/10.5194/cp-2022-25

This climate simulation was conducted on the NASA GISS ModelE Earth system model and was set up to imitate the volcanic eruptions of the 160s BCE. In this decade there was a tropical eruption in 168, and Northern Hemisphere eruptions in 164, 161, and beyond the decade in 158 BCE. The data shown in the chart above displays the model simulations for the year prior to the first eruption of 168 BCE (year 0), all the way through each year until the final eruption in 158 BCE (year 10). The results presented in green and brown are statistically significant at the 95% confidence interval.

The approximate location of Babylon is indicated with a red circle. The Anatolian Highlands are demarcated with a red rectangle, and the Ethiopian Highlands with a red oval. The Euphrates water originates in the Anatolian Highlands while the Nile obtains it waters from the Ethiopian Highlands. The implication of this simulated model is that there is an imbalance between Babylon and Egypt, which has a knock-on impact of crop growth and therefore food security (Manning et al, 2017). Following an eruption, the Egyptians (Babylonians), experiencing reduced (increased) precipitation into the Nile (Euphrates), or "Nile Failure", would have experienced reduced (increased) crops. This would have impacted on their societies in many complex ways.

Political & Societal Change, and Adaptive Capacity

The Parthians were a nomadic people, who were nowhere near in contention to be one of the most powerful empires of the day. But somehow, the volcanoes of the 160s decade intervened and lent a fateful hand to the opportunistic Parthians. Both societies in Babylon and Egypt used the river to irrigate crops, which helped them prosper. In fact the Egyptians knew when the summer floods were due as it was aligned with the Sirius or dog star in the sky. This provided them with a specified time in the year to assess how their crop growth, and therefore food stability, would unfold. As one of the top exporters of grain in the Ancient world, word would spread when the harvest was poor in Egypt. War in the Ancient world was seasonal. Armies had to be fed, and for that, the

rulers had to wait for harvest. Taking advantage of stable, and presumably, abundant crop growth in Babylon, the Seleucids made an attack on Egypt leaving Babylon more or less unprotected.

Being opportunistic, the Parthians moved into Babylon and sought to expand their footing in the Ancient world. This was the beginning of the Parthian Empire, which grew out of an ability to adapt to change. The Parthians proved their adaptive capacity (Adger & Vincent, 2005; Brooks *et al.*, 2005; Engle, 2011), not just through taking advantage of opportunities as they arose, but also by adapting methods of rule. Rather than impose on the regions they colonised; the Parthians brought people along with them. Incorporated cultural practices. The result of their ability to adapt when required, meant that their empire became quite vast by the turn of the Millennium and beyond (Overtoom, 2019).

Image on the right is the approximate extent of the Parthian Empire in the First Century (CE).

Image by Delphine Smittarello - Sunrise at Piton de la Fournaise https://imaggeo.egu.eu/view/14594/

The complexities of this region in this time frame are under current study by many scholars (Medenicks, 2022, Singh, *et al.*, Ludlow *et al.*, forthcoming). Examining events such as the climatic forcing from multiple volcanoes in the 160s BCE from various angles and with different lenses will enable us to obtain a more "rigorous understanding of societal responses to climate change" (Degroot *et al.*, 2021) and we will continue to interrogate the research in this manner.

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Thank you for your attention

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