Class Projects & Assignments
The project topics

Natural Climate Changes
1. Chicxulub and the death of dinosaurs
2. Volcano eruptions and the consequences for global temperature
3. Sahara in pre-historic times
4. The role of the Amazon jungle for global climate
5. Noah’s Flood and human migration
6. The little ice age and consequences for medieval life
7. The expansion of the Sahel zone
8. Isotope Geology and the mapping of Earth’s climate

Anthropogenic Climate Changes
1. The Gilgamesh epos and agriculture in Mesopotamian cultures
2. The abandonment of Maya cities
3. The large Midwest forest clearing
4. Industrial revolution and the impact on global climate
5. Nuclear testing and the impact on the atmosphere
6. Tropical deforestation of the Amazon, Congo, Indonesia
7. Urban heat islands
8. Soviet irrigation and the Aral Sea disaster
9. Climate and human development and history
Requirements and expectations

15-20 minute power-point presentation (15%)

• Provide background and explain the topic or situation
• Provide or dismiss evidence for influence of climate conditions
• Discuss preventive measures (for anthropogenic cases)
• Compare with present situation

1 page concept due before mid-term break
5 page write-up due at the end of the semester (15%)
Alternative: development of JAVA based climate simulation
1. Asteroids and Climate

Catastrophic events are often associated with drastic geological changes. The best known example is correlated with the end of the Cretaceous period. This change is correlated with the sudden extinction of the Dinosaurs as well as with the disappearance of 60-80% of the existing marine species. Common explanation, impact of a large asteroid which caused dust eruption and long term decrease of global temperature.
Chicxulub and the death of dinosaurs
FREQUENCY OF IMPACTORS:

- Pea-size meteoroids - 10 per hour
- Walnut-size - 1 per hour
- Grapefruit-size - 1 every 10 hours
- Basketball-size - 1 per month
- 50-m rock that would destroy an area the size of New Jersey - 1 per 100 years
- 1-km asteroid - 1 per 100,000 years
- 2-km asteroid - 1 per 500,000 years

A "nemesis" parabolic comet impactor would give us only a 6-month warning.
2. Volcano eruptions and the consequences for global temperature

On April 5, 1815, Mount Tambora, a volcano on the Indonesian islands started to rumble with activity. Then it erupted for four months ejecting 150 billion cubicmeters of debris into the atmosphere, the largest eruption known in recorded history. This resulted in the coldest winter known in Europe, causing famine and economic downturn.
More recent past, Krakatau 1883

Scattering effects of photons on sub-micron sized particles in the dusty stratosphere & troposphere

Significant drop in temperature due to sunlight absorption in emitted dust and aerosols!

Sulfuric acid emission; evidence in Greenland and Antarctic ice cores

Economic costs: more than $2B (Mt. St. Hellen)
3. Sahara in pre-historic times

The Sahara has been once upon a time a wetter and greener place, including one interlude between 130,000 to 170,000 years ago, when river channels flowed with water and people cultivated the lands. Deep underground water reservoirs still point to that period. Describe the evidence for the warmer past and the climate changes which let to today’s desert conditions.
Water in the Sahara

- Water resource & reservoirs
- Rivers, canyons, and wadis
- Water composition
- Water age
4. The Amazon Rainforest

The Amazon Rainforest covers over 3.7 million square miles and is the largest forest in the world. Explain why the Amazon is often called the “Lungs of the World” and describe its impact on the overall global climate pattern.
Biological infrastructure & topography

The evergreen woodland Rainforest infrastructure is distinguished by a continuous leaf canopy interwoven into tropical forest layers. Rainforests have a very small percentage of overall topography worldwide, yet they hold the highest number of plant and animal species in the world by far. Tropical Rainforests are home to an estimated 50 to 70 million different unique life organisms.
The Amazon Basin is characterized by a widespread, interwoven system of rivers, wide swamp areas and steep waterfalls. Describe the impact on local and global climate patterns!
5. Noah’s flood
Climate Change and Migration

- Identify post-glacial lakes
- Fate of post-glacial lakes
- Evidence of flood theory
- Mummies in Takla Makan
Triggered by climate change consequences for climate

Raising water level in Mediterranean with decreasing level in Lake Euxine caused flood. Bosporus break through formed Black See ~ 7500-7000 BC (radiocarbon dating of shells)
Climate Change and Migration
Mummies
6. The little Ice Age

After a warm period during the high mediaeval ages, the European climate is characterized by much colder temperatures, which caused long winters, bad harvests, famine, and hunger. Describe the phenomenon and consequences of the little ice age. Was it a global or regional European event and what have been the likely causes?
Scientific evidence

Reconstructed Temperature

Temperature Anomaly (°C)

-1 -0.8 -0.6 -0.4 -0.2 0 0.2 0.4 0.6 0.8

Little Ice Age

Medieval Warm Period

2004

-
7. The Sahel Region

- Causes for change
- Migration and conflict issues
- Adaptation of population
Desertification – expansion of Sahara Desert

EXTENT OF THE SAHARA

1984

1991

Desert

Increasing vegetation cover

Vegetation
Isotope ratios are important carriers of geological and anthropological information; $^{16}$O and $^{18}$O is related to water $\text{H}_2\text{O}$, isotope ratios change as function of precipitation, evaporation and other climatic conditions.

$^{86}$Sr and $^{87}$Sr is related to calcium, since it behaves chemically similar!
King of Stonehenge, a German immigrant?

The Daily Express expressed the opinion. "This is as shocking as the discovery that the first cricket players wore leather pants and ate Bratwurst with their tea."
9. The Decline of Early Mesopotamia

The Gilgamesh Epos, the earliest known literary text, describes how Gilgamesh has to travel far to reach the Cedar forests which have been disappearing from the agricultural expansion of the early Sumerian cities in Mesopotamia. Gilgamesh fights and kills the protector of the forests, Humbaba. Gilgamesh fells the trees and brings ecologic catastrophe upon the country by the revenging Sumerian head of gods Enlil.
Civilizations of the past
Approximately 4700 years ago in Uruk, a city-kingdom in southern Mesopotamia, Uruk's ruler Gilgamesh sought to ensure his immortality through the greatness of his city. He wanted large amounts of timber to accomplish his plans, and he set his sight on the cedars of Lebanon. Extending before Gilgamesh lay an area of land so large its exact size was not known. An almost unbroken forest flourished near southern Mesopotamia, in the hills and mountains surrounding the Fertile Crescent. The forest was so dense that the sun's light barely penetrated through its foliage.

The chief Sumerian deity Enlil protected these glorious forests by entrusting the ferocious demigod Humbaba to protect the interests of nature against the desires of civilization. Enlil understood the unlimited appetite of civilization, and predicted that once humans would enter the forest, they would remove all the gods' beautiful garden of trees; they would destroy the divine beauty where "the cedars raise aloft their luxuriance."

After a moment of enjoying the glory and awe of the magnificent, virgin cedar forest, Gilgamesh began destroying the "abode of the gods." They cut the cedars, chopped their branches and trunks into transportable sizes. A fight erupted between the intruders and the mighty forest demigod... the greed of civilization won; the forest's guardian lost his head; and the cedars wailed with fear now that Gilgamesh was master of the forest. The trees were correct to cry, for the men stripped the "mountains of their cover," leaving bare rock. When Enlil, who forever must watch over the well-being of the earth, learned of the destruction of the cedar forest, he sent down a series of ecological curses on the offenders: "May the food you eat be eaten by fire; may the water you drink be drunk by fire."

**The Cedars of Lebanon:**
**Significance, Awareness and Management of the Cedrus Libani in Lebanon**
Rania Masri
What caused the Maya tribes to abandon their cities and villages in the Yucatan around 1000-1200 AD and change their way of life?
Continued discoveries in jungle areas

What do the isotope signatures tell the researcher about the Maya migration and re-settlement?
Continuing Reconstruction
11. The large Midwest forest clearing
Clear Cut America

- What are the ecologic and economic consequences of cutting nearly 50% of the US forest within only 50 years?
- Estimate the consequences for the temperature and overall climatic conditions in the Midwest
- Is there evidence in observational data in terms of CO₂ emission or isotope distribution?
12. Industrial revolution and global climate

- Determine industry and traffic related CO\textsubscript{2} production.
- Evaluate its impact on IR absorption and the consequences for climate.
- Propose ways to reduce CO\textsubscript{2} exhaust.
13. Nuclear testing and the impact on the atmosphere

- Distribution by high altitude winds
- Alteration of the atmospheric chemistry
- Modification of global radioactivity level
The Tsar Bomb
Discuss the overall impact of the US/USSR test program on the radioactivity level in the atmosphere.
Discuss the distribution mechanism of high altitude winds including the wind mechanism
Analyze possible impact on climate development
Describe the concept of Nuclear Winter
Right: A false-colour Landsat image of deforestation in Brazil. The colours have been chosen to highlight the destruction of the rainforest: the dark green of the natural forest contrasts with the pale green and pinks of the areas that have been cleared. Latest estimates based on Landsat images suggest that this deforestation is damaging some 2.5–3.5 million hectares (6.4–9 million acres) of forest in the Amazon basin each year.
Rapid Progress

- Determine impact of deforestation of the remaining jungle areas on the CO₂ production and balance.
- Evaluate the impact of deforestation on IR absorption and the consequences for climate.
- Consider the consequences for rainfall and water distribution.
15. Urban Energy Production

Light pollution indicates high population & industrial density
Heat losses are associated with infrared emission
Urban Heat Islands

City environment generate localized higher temperature regions
16. Implication of Climate on Human Development and History

Methods, techniques and reliability of Dendrochronology

Sources

Year (BC/AD)
Describe the methods, techniques, and uncertainties of dendrochronology

Try to find correlation between dramatic climate changing events and historical developments