



LITTLE ICE AGE

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Physical Sciences

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[Watch Introductory Video from BBC](#)

What is an Ice Age?

Geological period of **long-term** reduction in the temperature of the Earth's surface and atmosphere, resulting in an expansion of **continental ice sheets**, **polar ice sheets** and **alpine glaciers**.

RARE PHOTO FROM THE LAST MAJOR GLACIATION:



What is an Ice Age?

The “last ice age” refers to the most recent colder period that peaked at the Last Glacial Maximum **approximately 20,000 years ago**, in which extensive ice sheets lay over large parts of the North American and Eurasian continents.

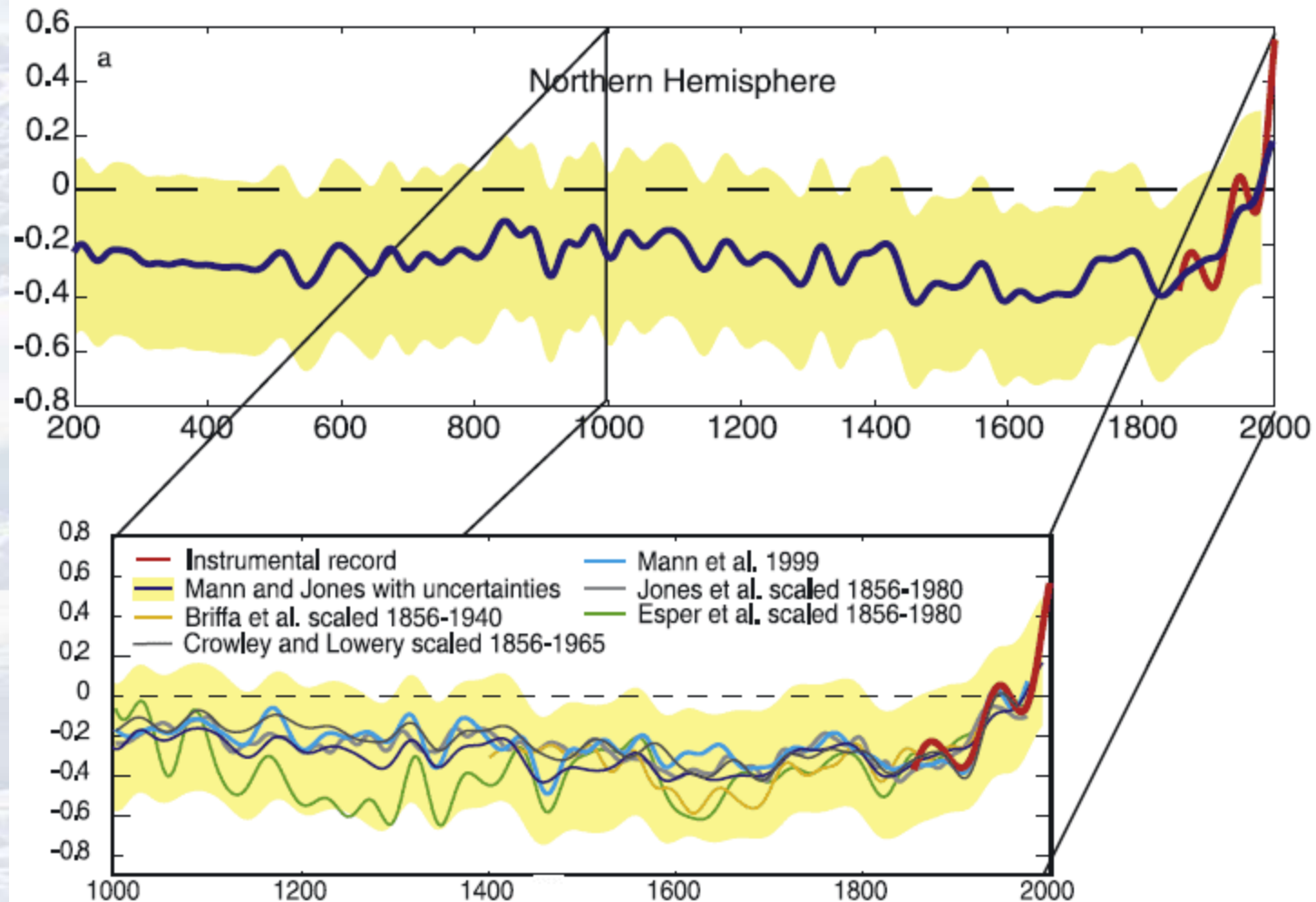


The LIA was not an ice age by definition.

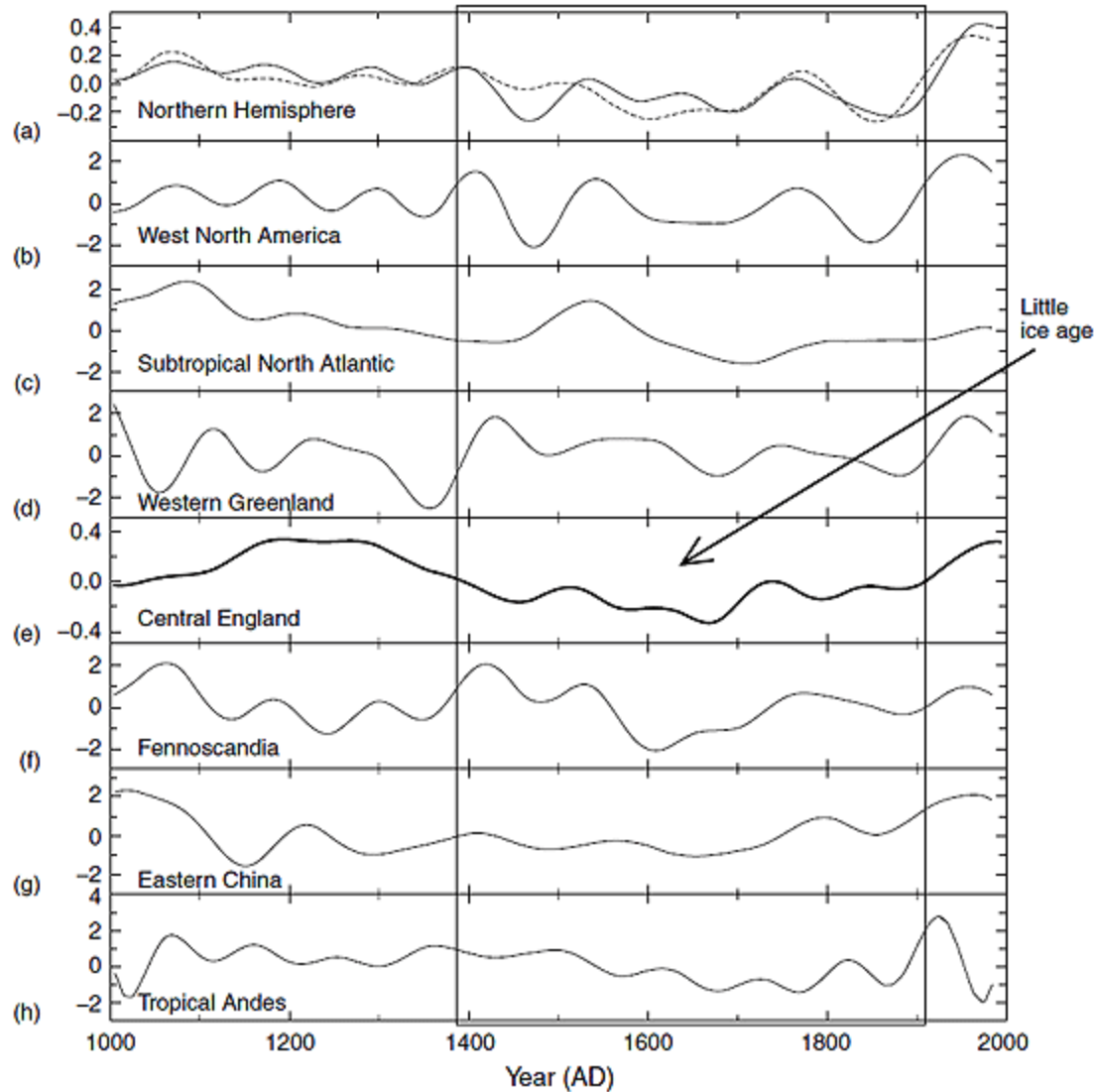
When Did the LIA Occur?

- General cooling of the climate between the years 1150 and 1460
- Very cold climate between 1560 and 1850
- Not every year was cold. Some years were warm but most were colder than normal.
- Ended after 1850 (Industrial Revolution)

When Did the LIA Occur?



When Did the LIA Occur?

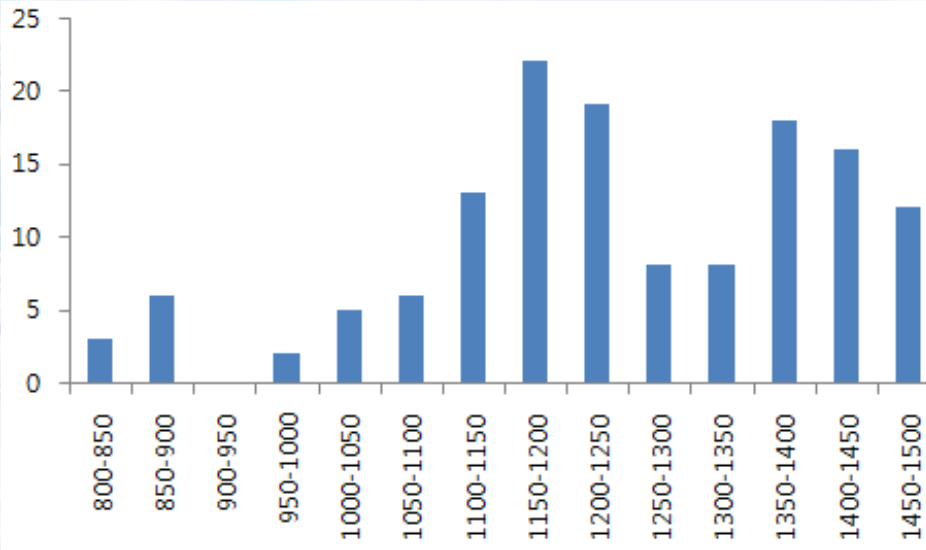


When Did the LIA Occur?



Frost Fairs on Thames River, England (Last Freeze: 1816)

Increased Storms



- At least four **sea floods of the Dutch and German coasts in the thirteenth century** were reported to have caused the **loss of around 100,000 lives**.
- Storms that caused greater than 100,000 deaths were also reported in 1421, 1446, and 1570.
- Large **hailstorms that wiped out farmland** and **killed great numbers of livestock** occurred over much of Europe
- Due to severe erosion of coastline and high winds, **great sand storms developed** which **destroyed farmlands and reshaped coastal land regions**.

Hail Damage to Crops



Advancing Glaciers



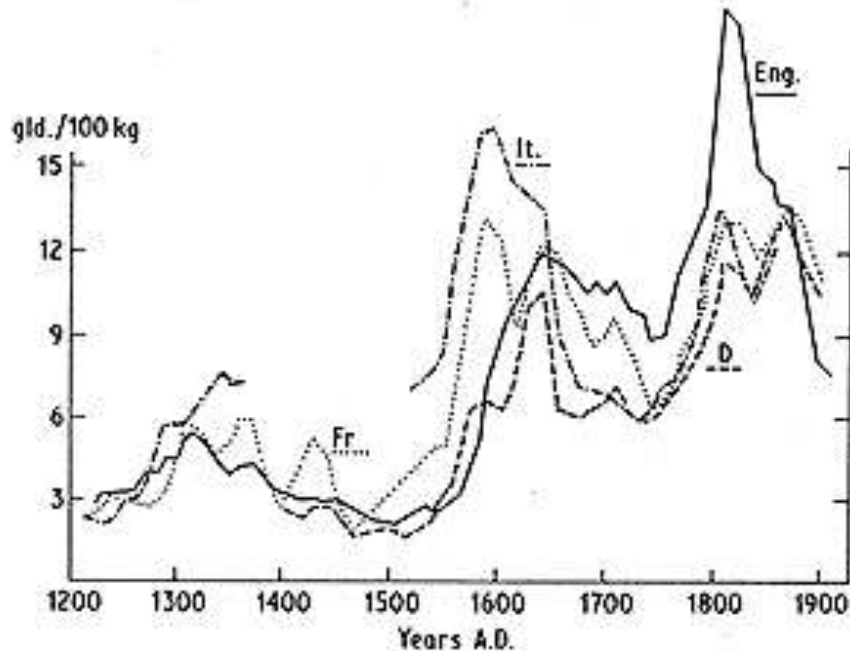
Chamonix - 1850



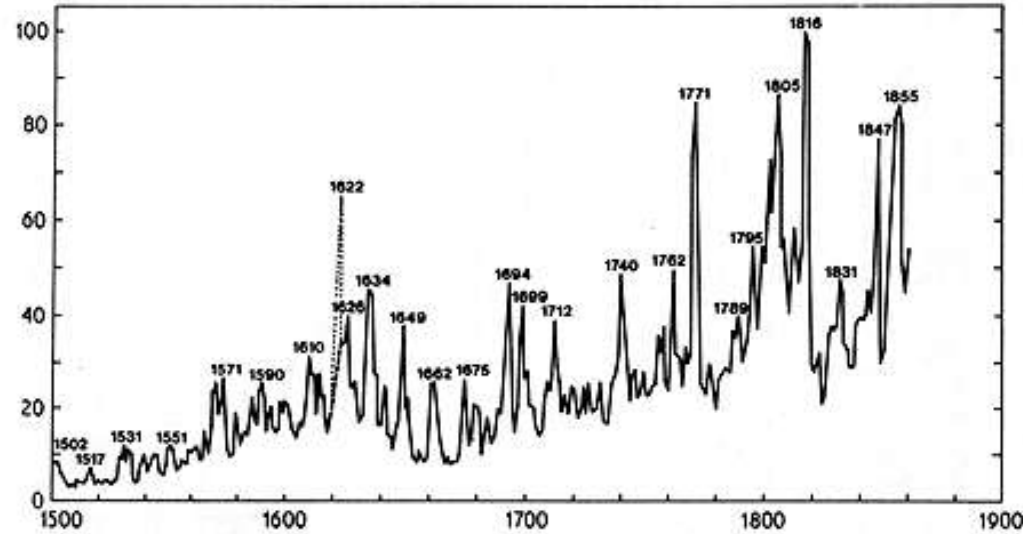
Chamonix - Today

- **Glacial advances** throughout Europe **destroyed farmland** and caused **massive flooding**.
- On many occasions **bishops and priests were called to bless the fields** and to pray that the ice stopped grinding forward.
- Various **tax records show glaciers over the years destroying whole towns** caught in their path.

Impact on Agriculture



Prices of wheat expressed in Dutch guilders per 100 kg. in various countries vs. time.



Price of rye in Germany vs. time expressed as an index.

- **Growing season changed by 15 to 20 percent** between the warmest and coldest times of the LIA.
- During the coldest times of the LIA, **England's growing season was shortened by one to two months** compared to present day values.
- The availability of **varieties of seed today that can withstand extreme cold or warmth, wetness or dryness**, was not available in the past. Therefore, climate changes had a much greater impact on agricultural output in the past.
- **1816 – “Year Without a Summer”**

Impact on Agriculture

- In **Norway**, many farms located at higher latitudes **were abandoned** for better land in the valleys. By 1387, **production and tax yields were between 12% and 70%** of what they had been around 1300. In the 1460s it was being recognized that this change was permanent. As late as the **year 1665**, the **total Norwegian grain harvest is reported to have been only 67 - 70% of what it had been about the year 1300.**
- The Electors of Burgundy, sent a protest to the King in 1662 which stated that:
“famine this year has put an end to over seventeen thousand families in your province and forced a third of the inhabitants, even in the good towns, to eat wild plants.’ The chronicle even alleged that ‘Some people ate human flesh”. Ten years earlier “the people of Lorraine and other surrounding lands are reduced to such extremities that, like animals, they eat the grass in the meadows...and are black and thin as skeletons.”
- One of the worst famines in the seventeenth century occurred in France due to the **failed harvest of 1693**. **Millions of people in France** and surrounding countries were killed.

Impact on Agriculture



Normal grain



Snow mold damage

- The effect of the LIA on Swiss farms was also severe. Due to the cooler climate, snow covered the ground deep into spring. A parasite, known as *Fusarium nivale*, or **snow mold**, which thrives under snow cover, **devastated crops**.
- Additionally, due to **the increased number of days of snow cover**, the stocks of hay for the animals ran out so **livestock were fed on straw and pine branches. Many cows had to be slaughtered.**

Impact on Health



Witch hunts



Black Death

- Cool, wet summers led to outbreaks of an illness called **St. Anthony's Fire**. Whole villages would suffer convulsions, hallucinations, gangrenous rotting of the extremities, and even death. Grain, if stored in cool, damp conditions, may develop a fungus known as **ergot blight** and also may ferment just enough to **produce a drug similar to LSD**. (In fact, some historians claim that the **Salem, Massachusetts witch hysteria was the result of ergot blight**.)
- Malnutrition led to a weakened immunity to a variety of illnesses. In England, malnutrition aggravated an **influenza epidemic of 1557-8** in which whole families died. In fact, during most of the **1550's deaths outnumbered births**.
- **The Black Death (Bubonic Plague) was hastened by malnutrition** all over Europe in 1300s.

Impact on Economics

- Due to famine, storms, and growth of glaciers, **many farmsteads were destroyed**, which resulted in **less tax revenues** collected due to decreased value of the properties.
- **Cod fishing greatly decreased**, especially for the Scottish fisherman, as the cod moved farther south.
- In the Hohe Tauern mountains of the Austrian Alps, advancing glaciers closed the gold mines of the **Archbishop of Salzburg who was one of the wealthiest dukes in the empire**. The succession of two or three bad summers where the miners could not rely on work in the mines caused them to find employment elsewhere, which resulted in an **abrupt end to the mining operations**.
- The fertile fishing grounds of the present day **Newfoundland Banks** were thought to have been found by fisherman in the late 1400s who were looking for the fish stocks that had deserted their former grounds as the result of the movement of colder waters from the north.
- English fisherman **benefited** by the southern movement of herring normally found in the waters off Norway. This increase in deep-sea fishing helped to **build the maritime population and strength** of the country.
- The failure of crops in Norway between 1680 and 1720 was a prime reason for the great **growth of merchant shipping** there. Coastal farmers whose crops failed turned to selling their timber and to constructing ships in order to transport these timbers themselves.

Impact on Art & Literature



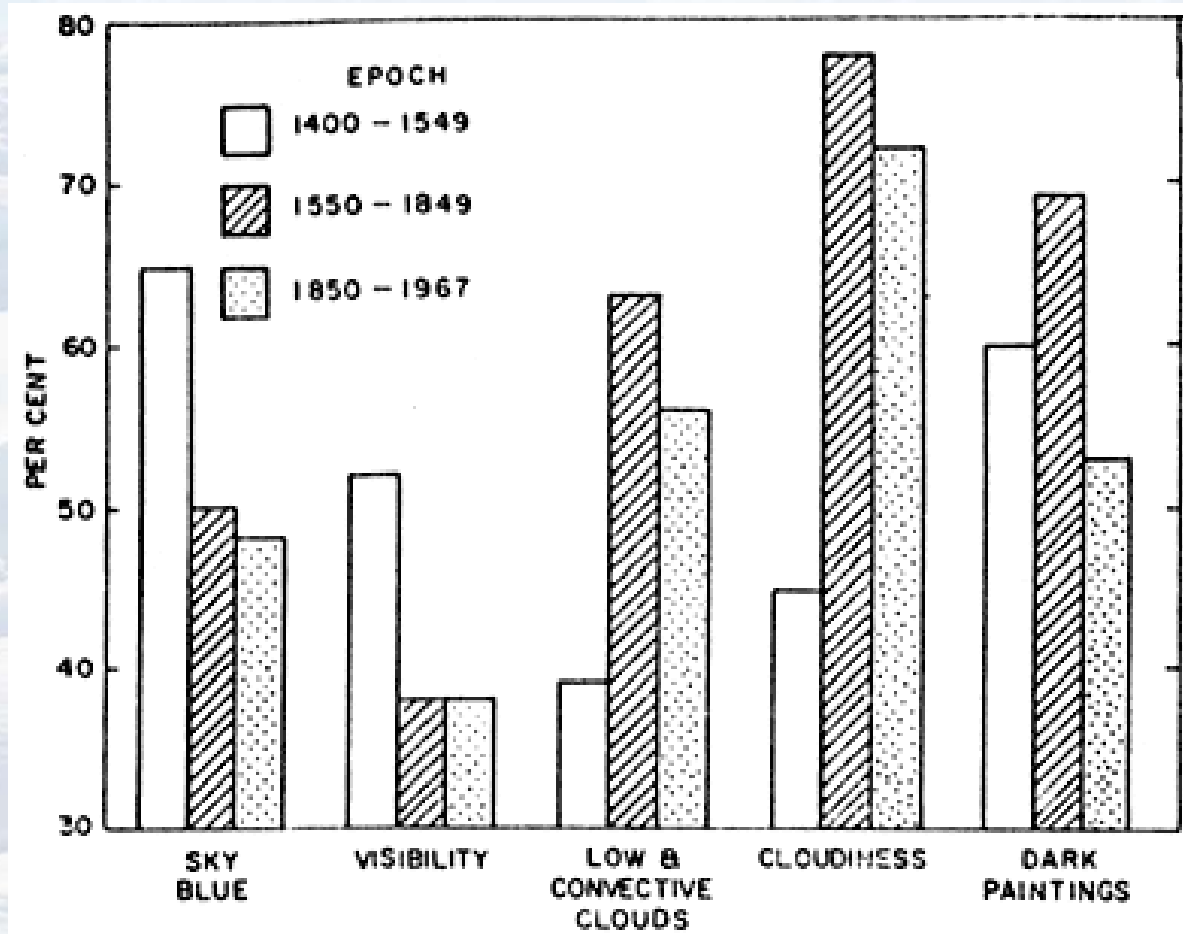
Hunters in the Snow - Pieter Bruegel (the elder)



Frankenstein

- In **1816**, many Europeans **spent their summers around the fire**. Mary Shelley was inspired to write **Frankenstein**, and Polidori, *The Vampire*. Both authors, together with Byron and Percy Shelley, were in Switzerland, near Lake Geneva where Byron said "*We will each write a ghost story.*" Percy Shelley also referred to a glacier in his poem "*Mont Blanc*" when he wrote "*...and wall impregnable of beaming ice. The race of man flies far in dread; his work and dwelling vanish...*"
- Neuberger (1970) studied more than 12,000 paintings in 41 art museums in the United States and eight European countries to test his hypothesis that paintings would accurately reveal the climate record. These paintings covered the period from 1400 to 1967.

Impact on Art & Literature



Epochal changes in various painting features

Social Unrest During LIA

- The winter of 1709 killed many people in France. Conditions were so bad, a priest in Angers, in west-central France, wrote:

"The cold began on January 6, 1709, and lasted in all its rigor until the twenty-fourth. The crops that had been sewn were all completely destroyed.... Most of the hens had died of cold, as had the beasts in the stables. When any poultry did survive the cold, their combs were seen to freeze and fall off. Many birds, ducks, partridges, woodcock, and blackbirds died and were found on the roads and on the thick ice and frequent snow. Oaks, ashes, and other valley trees split with cold. Two thirds of the vines died.... No grape harvest was gathered at all in Anjou.... I myself did not get enough wine from my vineyard to fill a nutshell."

- The occurrence of cattle raids on the Lowlanders by Highlanders who were stressed by the deteriorating climate. **In 1436, King James I of Scotland was murdered** while hunting on the edge of the Highland region near Perth. The clan warfare grew so bad that it was decided that no place north of Edinburgh Castle was safe for the king so **Edinburgh became the capital of the country.**

Social Unrest During LIA



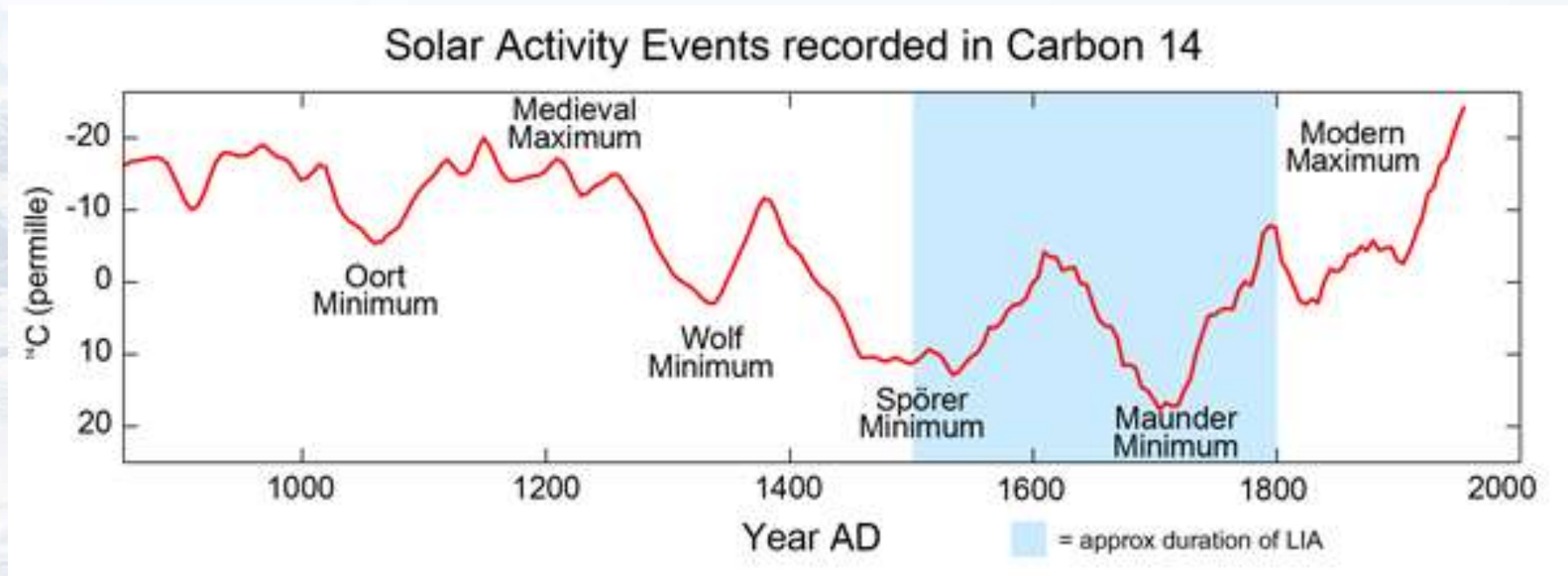
- In northern France in 1788, after an unusually bad winter, May, June, and July were excessively hot, which caused the grain to shrivel. On July 13, just at harvest time, a **severe hailstorm** (which typically occurs when there is very cold air aloft) **destroyed what little crops were left.**
- From that bad harvest of 1788 came the **bread riots of 1789** which led to Marie Antoinette's alleged remark "*Let them eat cake,*" and the **storming of the Bastille.**
- The staple food of the French peasantry and the working class was **bread, absorbing 50% of their income, as opposed to 5% on fuel;** the whole topic of bread was therefore the result of obsessional national interest.

Witch Hunts

- One group in particular suffered from the poor conditions - people thought to be **witches**.
- **Weather-making** was thought to be among the **traditional abilities of witches** and during the late fourteenth and fifteenth centuries many saw a great witch conspiracy.
- Extensive witch hunts took place during the most severe years of the LIA, as people looked for scapegoats to blame for their suffering.

[She's a Witch Video](#)

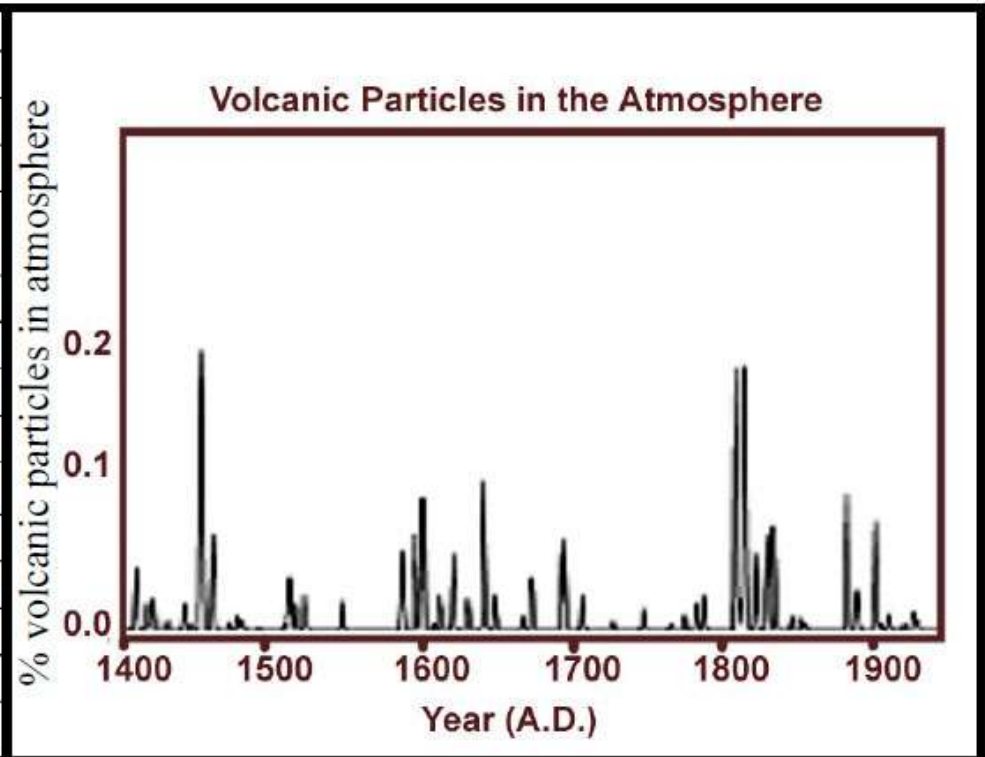
Possible Causes of LIA



- Spörer Minimum and Maunder Minimum
- **Fewer** sun spots = **less** solar output = **cooler** climate

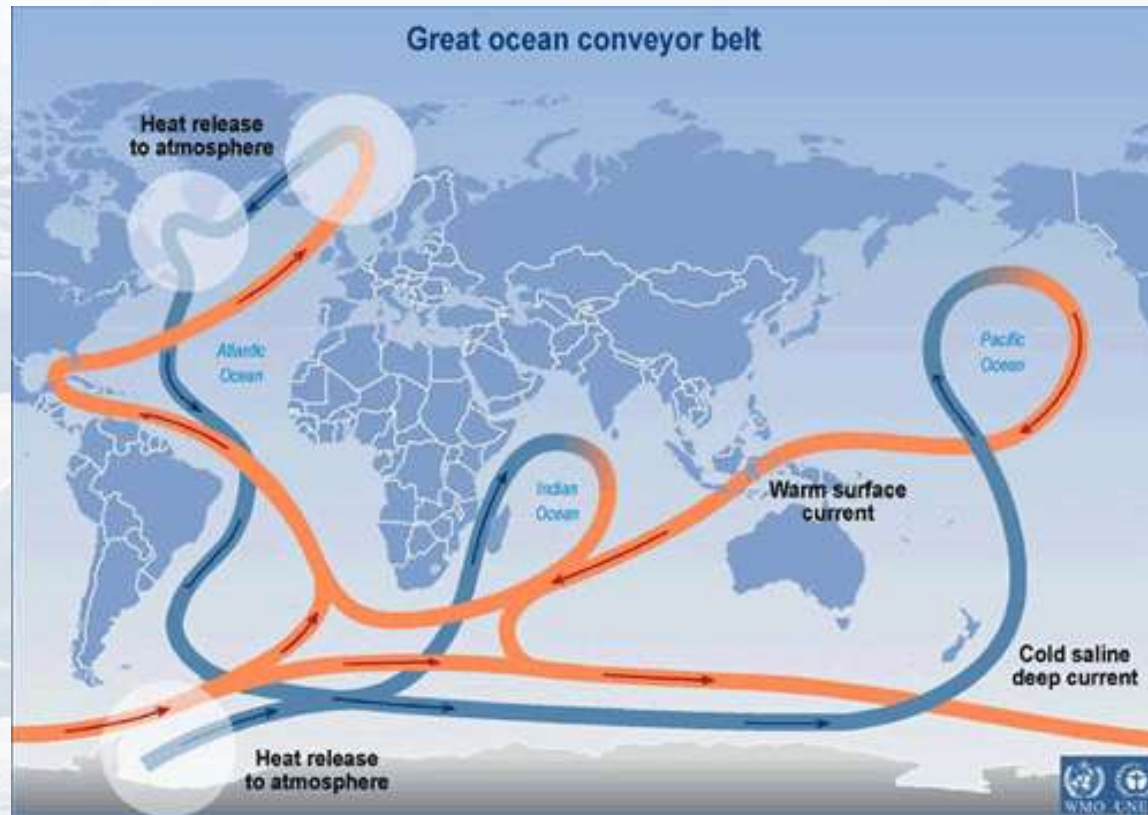
Possible Causes of LIA

Date	Volcano
1452	Kuwaae, Vanuatu, SW Pacific
1480	St. Helens, Washington, US
1482	St. Helens, Washington, US
1580	Billy Mitchell, Bouganiville, SW Pacific
1600	Huaynaputina, Peru
1641	Parker, Philippines
1660	Long Island, New Guinea
1680	Tongkoko, Sulawesi
1815	Tambora, Lesser Sunda Island
1883	Krakatau, west of Java
1902	Santa Maria, Guatemala
1912	Novaraupta (Katmal), Alaska
1980	St. Helens, Washington, US
1991	Pinatubo, Philippines



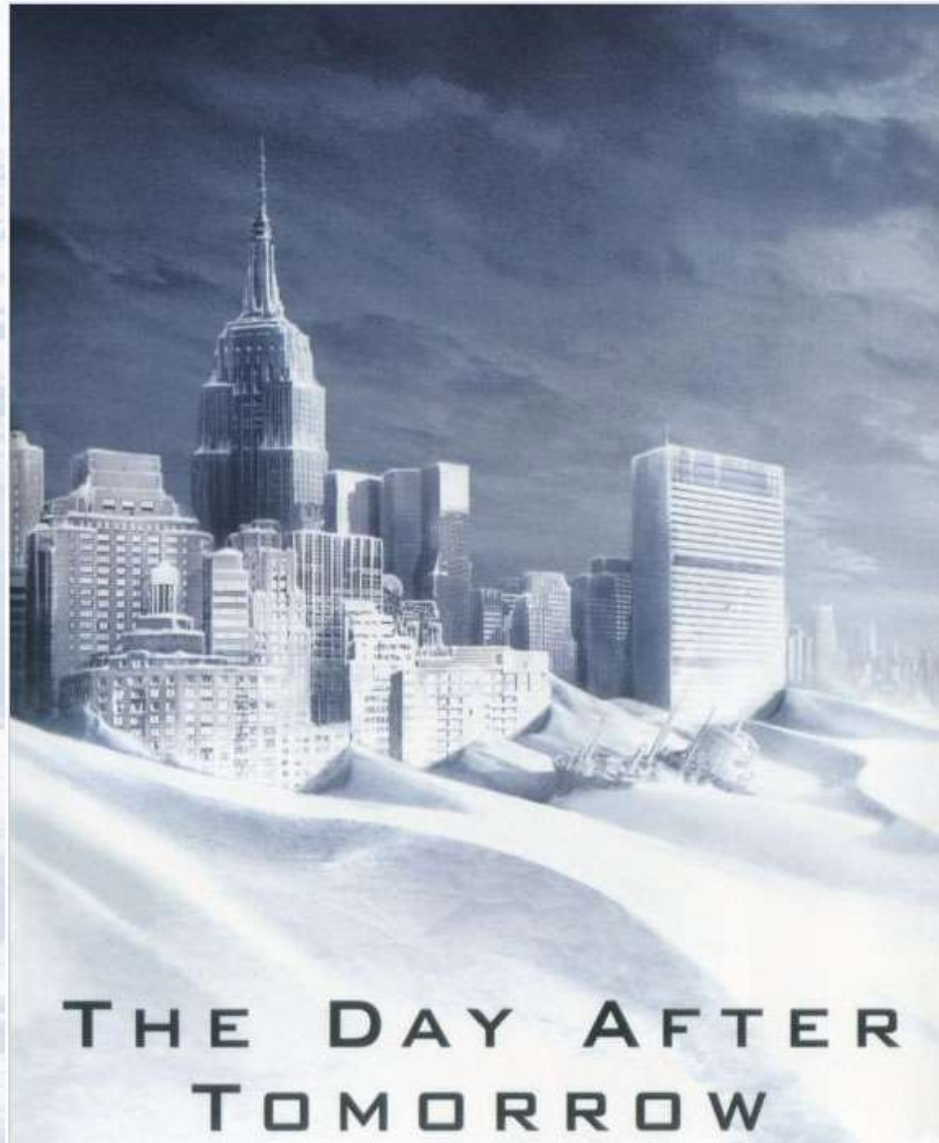
- Greater **volcanic eruptions** blocks incoming sunlight = **cooler** climate
- Tambora (1815) - 1816 called *“Year without a Summer”*

Possible Causes of LIA



- **Weakened ocean conveyor belt** caused less heat to be moved northward toward Europe.

Could It Happen Again?



Could It Happen Again?

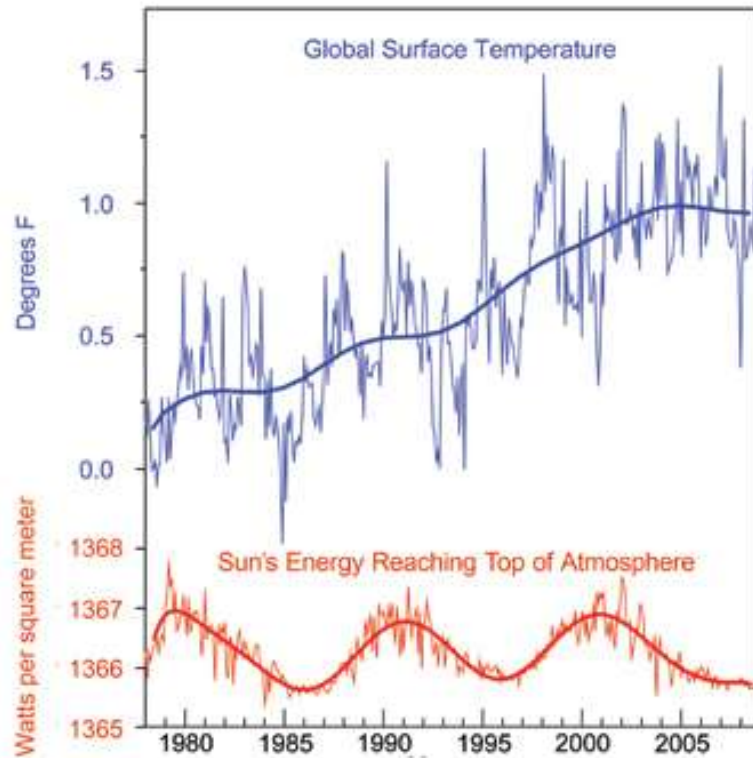
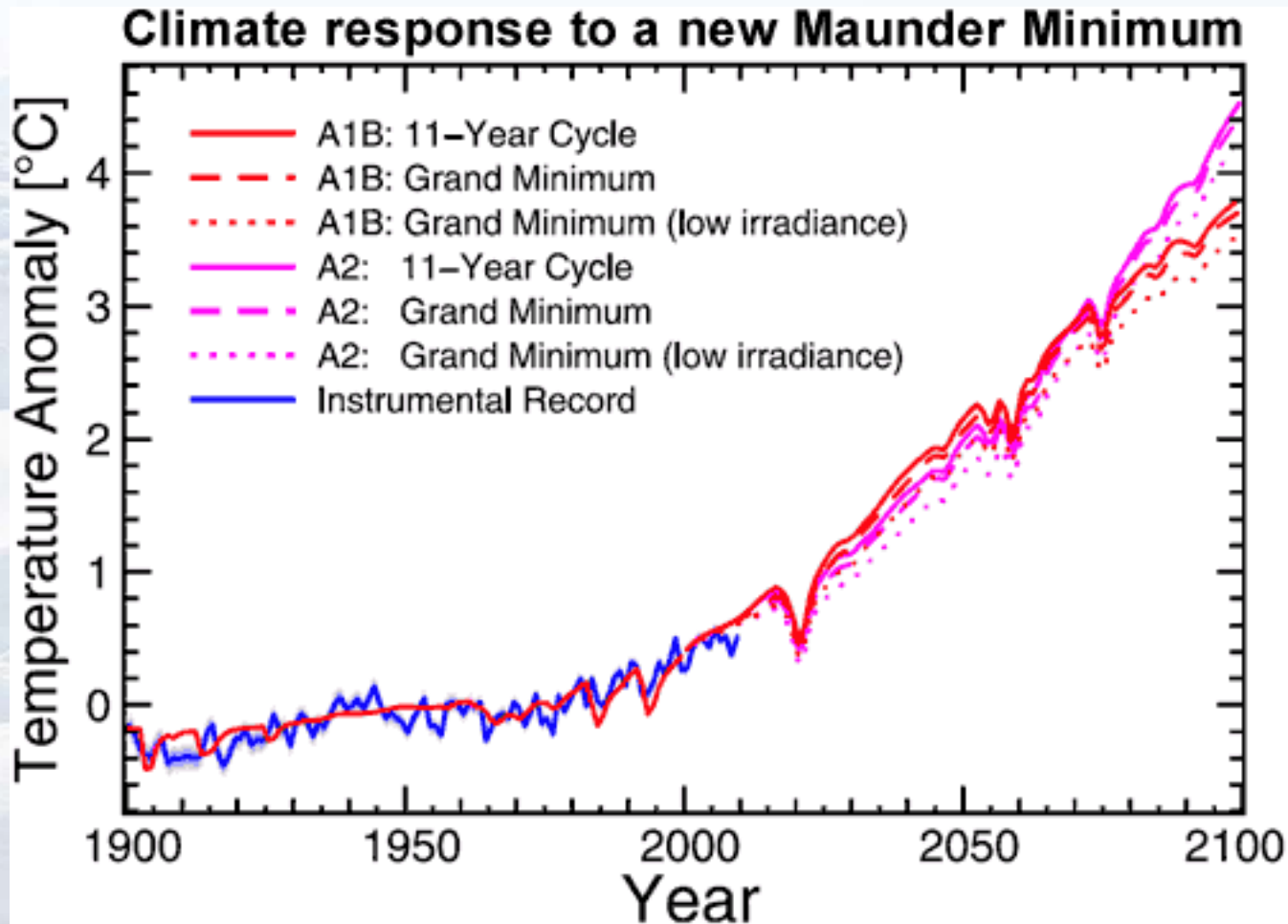


Figure 2. Satellite observations show no increasing trend in solar output. The 11-year solar cycle is evident, but this cannot be driving the overall increase in global average temperatures. (GCRP, 2009, p. 20)

- The sun is quite “cool” right now and yet climate is setting **record warmth!**

Could It Happen Again?

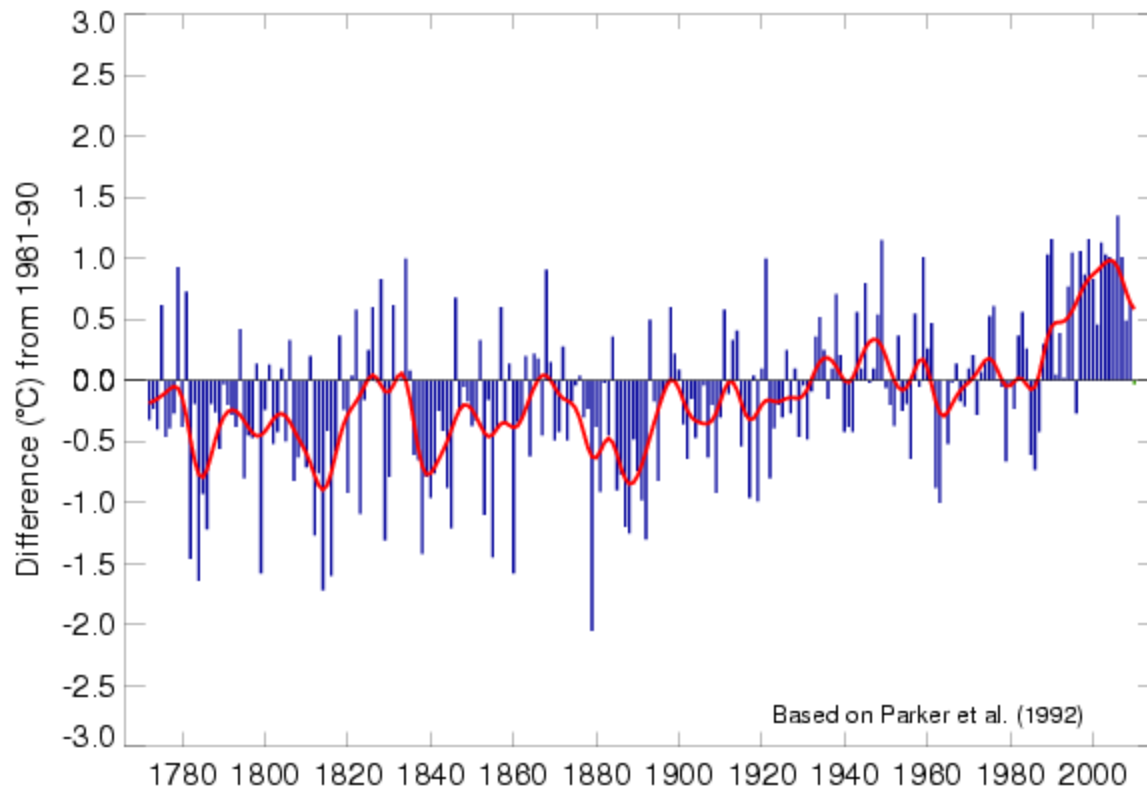


- Another “Maunder Minimum” just **slightly offsets** major global warming!

Day After Tomorrow?



Mean Central England Temperature
Annual anomalies, 1772 to 14th Sep 2010



- The Ocean Conveyor Belt is slowing yet **England temperatures are climbing!**

Man-Made Global Warming

Global Warming Web: http://www2.sunysuffolk.edu/mandias/global_warming

Global Warming Blog: <http://profmandia.wordpress.com>

Facebook Group Global Warming Fact of the Day:

<http://www.facebook.com/group.php?gid=336682515937>

Twitter: @AGW_Prof http://twitter.com/AGW_Prof

Special Topics: Global Climate Change - 26483 - MET 295 - 100

The impact of global climate change is far-reaching, both for humanity and the environment. This 3 credit science elective course will provide students with the scientific background to understand the role of natural and human-forced climate change so that they are better prepared to become involved in the discussion. Students will learn how past climates are determined and why humans are causing most of the observed modern day warming. The technical and political solutions to climate change will also be addressed. Offered on: A / 3 cr. hrs.

Associated Term: Spring 2011

Registration Dates: No dates available

Levels: Undergraduate

Attributes: LASC-Lab Science, LIBA-Liberal Arts, MET-Meteorology, SCI-Science, UNRE-Unrestricted Elective

Instructors: Scott A. Mandia (P)

Ammerman (A) Campus

Special Topics Schedule Type

Traditional on campus Instructional Method

3.000 Credits

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Scheduled Meeting Times

Type Time	Days Where	Date Range	Schedule Type	Instructors
Class 12:30 pm - 1:45 pm TR	Amm-Smithtown Science Bldg	15 Jan 24, 2011 - May 17, 2011	Special Topics	Scott A. Mandia (P) 

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