Department of Earth Sciences

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Geohazards: Attempting to Predict the Unexpected

Dr Ken Amor

Our Perception of Time and Risk

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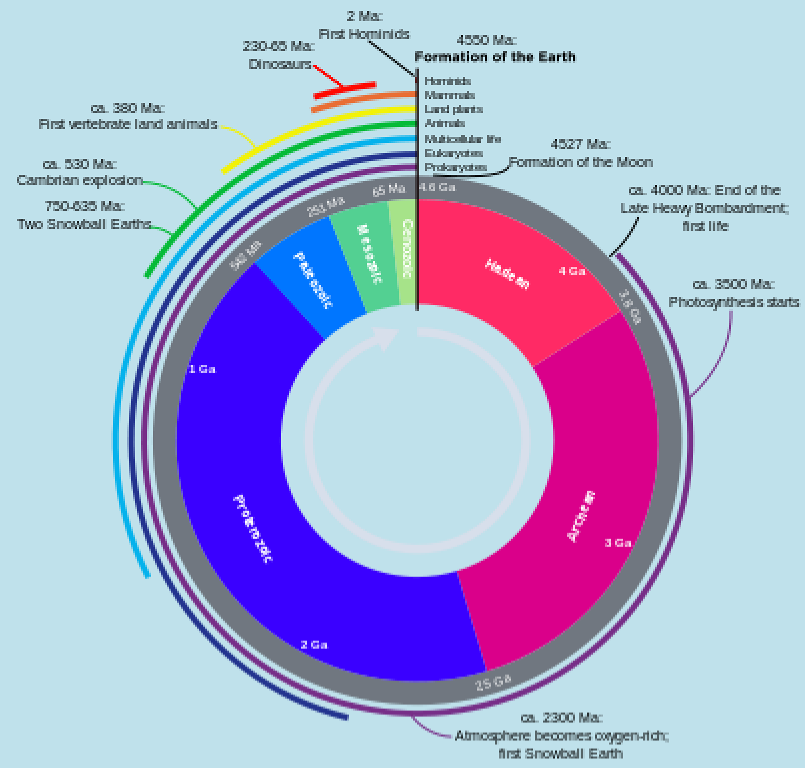
EON	ERA	PERIOD		EPOCH		Ma
Phanerozoic	Cenozoic	Quaternary		Holocene		0.01
Phanerozoic	Cenozoic	Quaternary		Pleistocene	Late	0.8
Phanerozoic	Cenozoic	Quaternary		Pleistocene	Early	1.8
Phanerozoic	Cenozoic	Tertiary	Neogene	Pliocene	Late	3.6
Phanerozoic	Cenozoic	Tertiary	Neogene	Pliocene	Early	5.3
Phanerozoic	Cenozoic	Tertiary	Neogene	Miocene	Late	11.2
Phanerozoic	Cenozoic	Tertiary	Neogene	Miocene	Middle	16.4
Phanerozoic	Cenozoic	Tertiary	Neogene	Miocene	Early	23.7
Phanerozoic	Cenozoic	Tertiary	Paleogene	Oligocene	Late	28.5
Phanerozoic	Cenozoic	Tertiary	Paleogene	Oligocene	Early	33.7
Phanerozoic	Cenozoic	Tertiary	Paleogene	Eocene	Late	41.3
Phanerozoic	Cenozoic	Tertiary	Paleogene	Eocene	Middle	49.0
Phanerozoic	Cenozoic	Tertiary	Paleogene	Eocene	Early	54.8
Phanerozoic	Cenozoic	Tertiary	Paleogene	Paleocene	Late	61.0
Phanerozoic	Cenozoic	Tertiary	Paleogene	Paleocene	Early	65.0
Phanerozoic	Mesozoic	Cretaceous		Late		99.0
Phanerozoic	Mesozoic	Cretaceous		Early		144
Phanerozoic	Mesozoic	Jurassic		Late		159
Phanerozoic	Mesozoic	Jurassic		Middle		180
Phanerozoic	Mesozoic	Jurassic		Early		206
Phanerozoic	Mesozoic	Triassic		Late		227
Phanerozoic	Mesozoic	Triassic		Middle		242
Phanerozoic	Mesozoic	Triassic		Early		248
Phanerozoic	Paleozoic	Permian		Late		256
Phanerozoic	Paleozoic	Permian		Early		290
Phanerozoic	Paleozoic	Pennsylvanian				323
Phanerozoic	Paleozoic	Mississippian				354
Phanerozoic	Paleozoic	Devonian		Late		370
Phanerozoic	Paleozoic	Devonian		Middle		391
Phanerozoic	Paleozoic	Devonian		Early		417
Phanerozoic	Paleozoic	Silurian		Late		423
Phanerozoic	Paleozoic	Silurian		Early		443
Phanerozoic	Paleozoic	Ordovician		Late		458
Phanerozoic	Paleozoic	Ordovician		Middle		470
Phanerozoic	Paleozoic	Ordovician		Early		490
Phanerozoic	Paleozoic	Cambrian		D		500
Phanerozoic	Paleozoic	Cambrian		C		512
Phanerozoic	Paleozoic	Cambrian		B		520
Phanerozoic	Paleozoic	Cambrian		A		543
Precambrian	Proterozoic	Late				900
Precambrian	Proterozoic	Middle				1600
Precambrian	Proterozoic	Early				2500
Precambrian	Archean	Late				3000
Precambrian	Archean	Middle				3400
Precambrian	Archean	Early				3800?

Two views of the Geological time scale



Faults and Earthquakes

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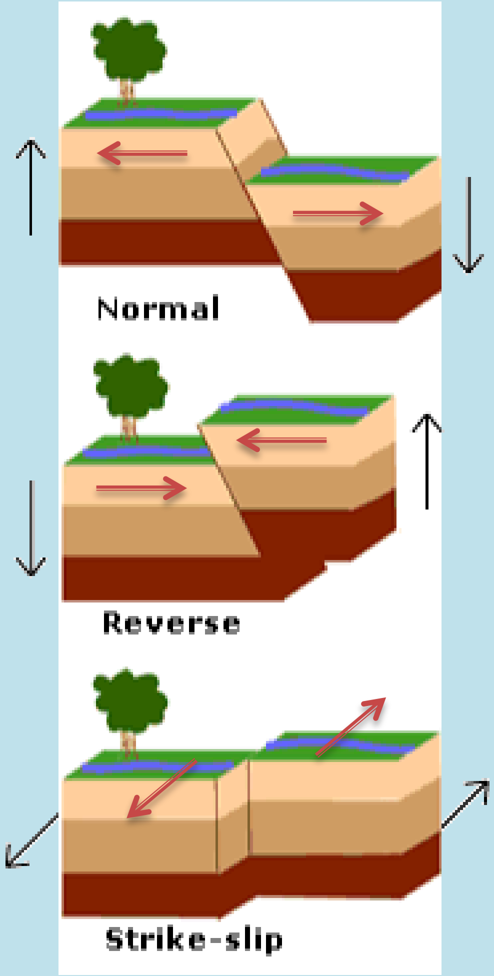
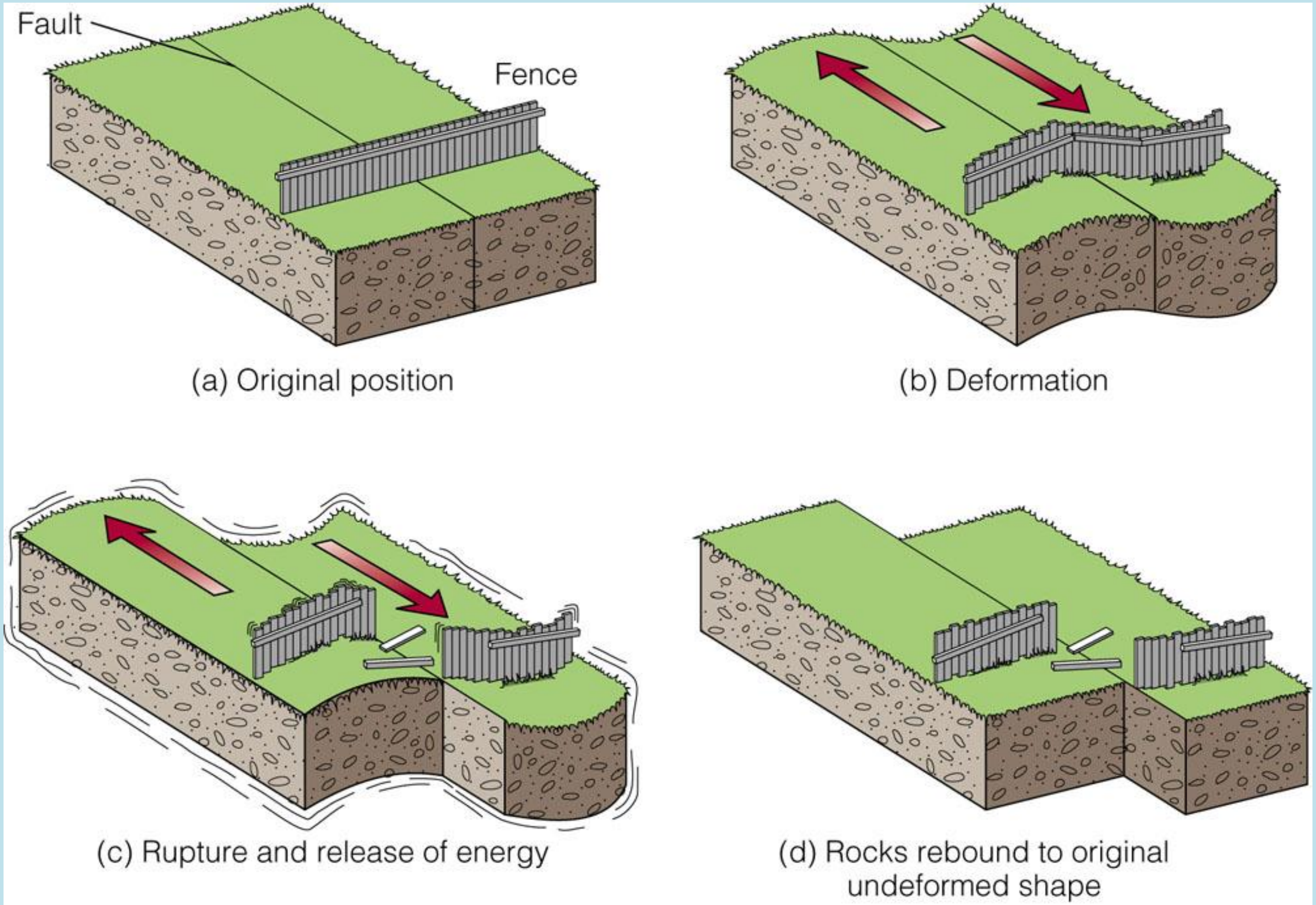
- Earthquakes occur at fault-planes (fractures in the Earth's crust)
- Crustal movement causes stress in rocks which deform elastically (rate of cm/yr)
- Earthquakes occur when internal strength of the rock is exceeded releasing enormous energy (elastic rebound theory)

Types of faults

- In a **normal fault**, rocks are under tension and move away from each other.
- A **reverse fault,** the fault blocks are moving towards each other (compressional forces)
- On **strike-slip faults** the blocks move laterally to each other e.g.San Andreas fault California



Rocks deform elastically



Rocks deform elastically

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Lulworth Cove, Dorset

An example of rocks behaving elastically under stress

Real Time Earthquake Map

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http://earthquake.usgs.gov/earthquakes/map/

Historical Data – Japanese Cultural context

The Great Wave off Kanagawa by Hokusai

Historical Data – Tsunami stone

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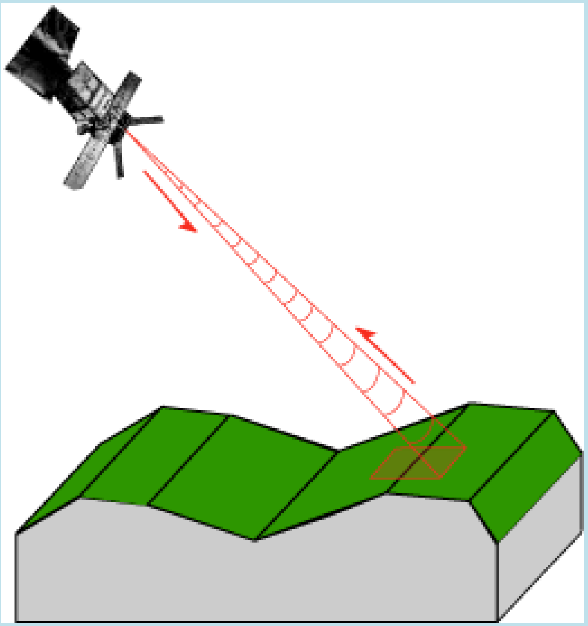
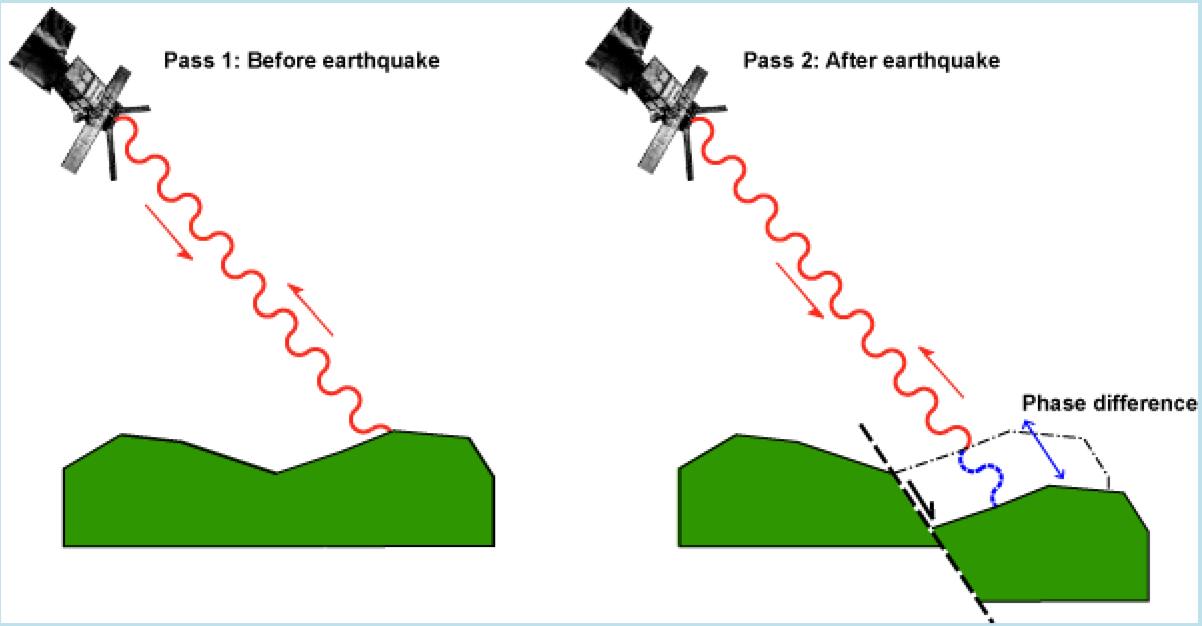
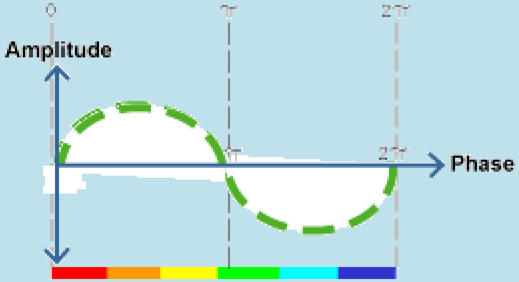
Japanese tsunami stones, dating back to the 15th Century.

"Do not build your homes below this point!"

Mapping crustal movements with INSAR



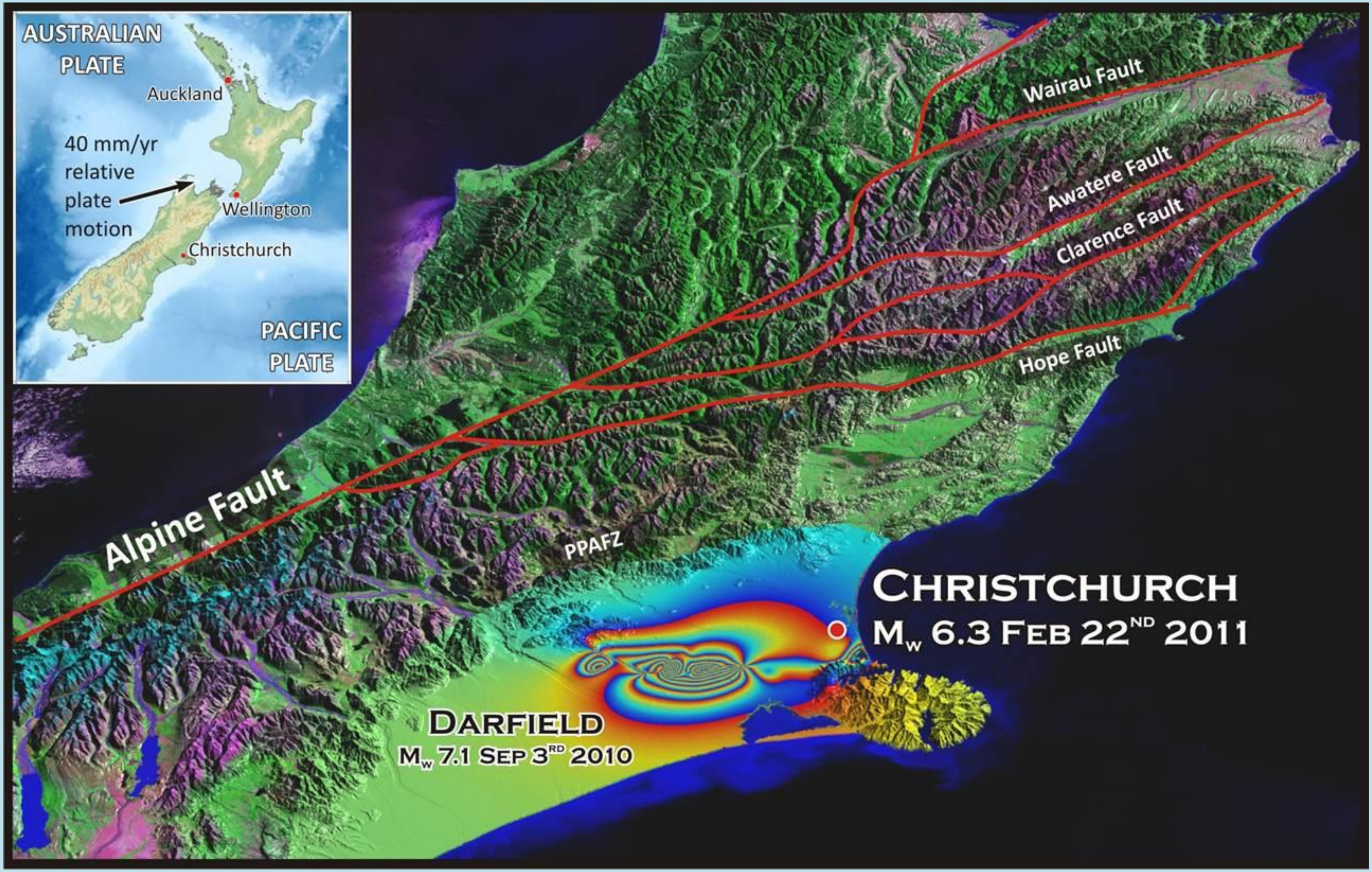




Radar satellites transmit electromagnetic waves illuminating an area of the Earth's surface.

They record the amplitude and phase of the waves that bounce back.

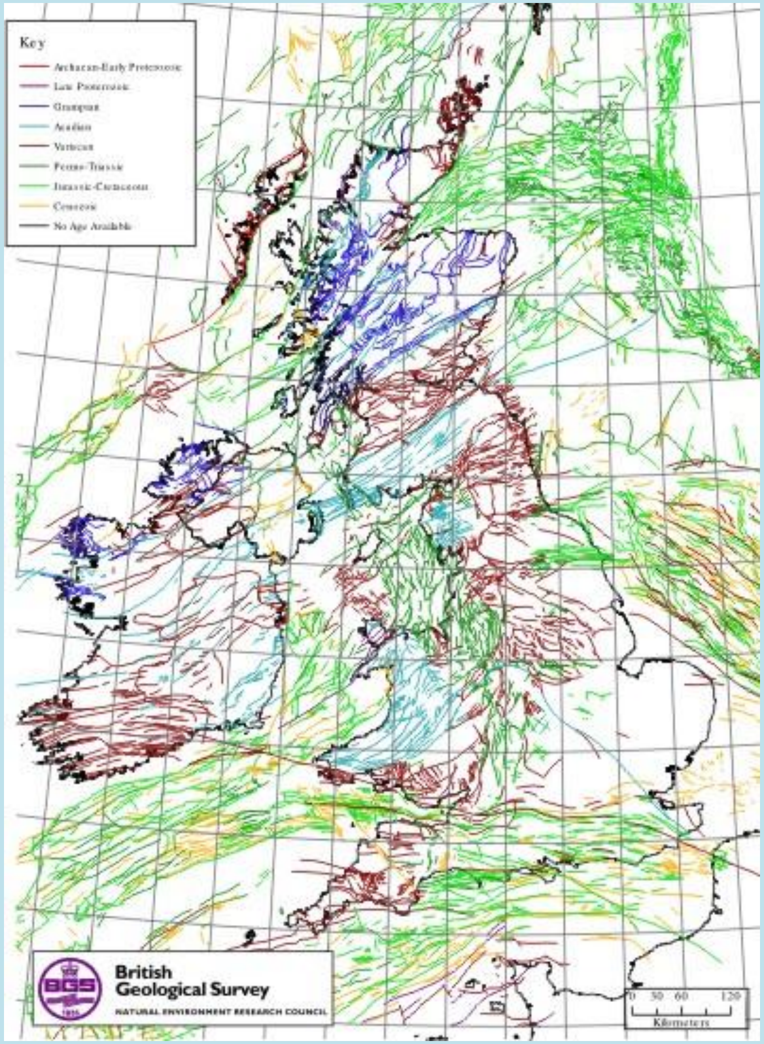
Mapping Crustal deformation



British Earthquakes

http://mapapps2.bgs.ac.uk/earthquakes/home.html

British Earthquakes



http://www.volcano.si.edu/index.cfm

Vesuvius and Pompeii AD 79

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Eruption of Vesuvius by William Turner

Vesuvius 1944 Eruption

Vesuvius and Naples - 2013

Mt Vesuvius today – Nasa earth observatory

Mapping volcanoes with INSAR

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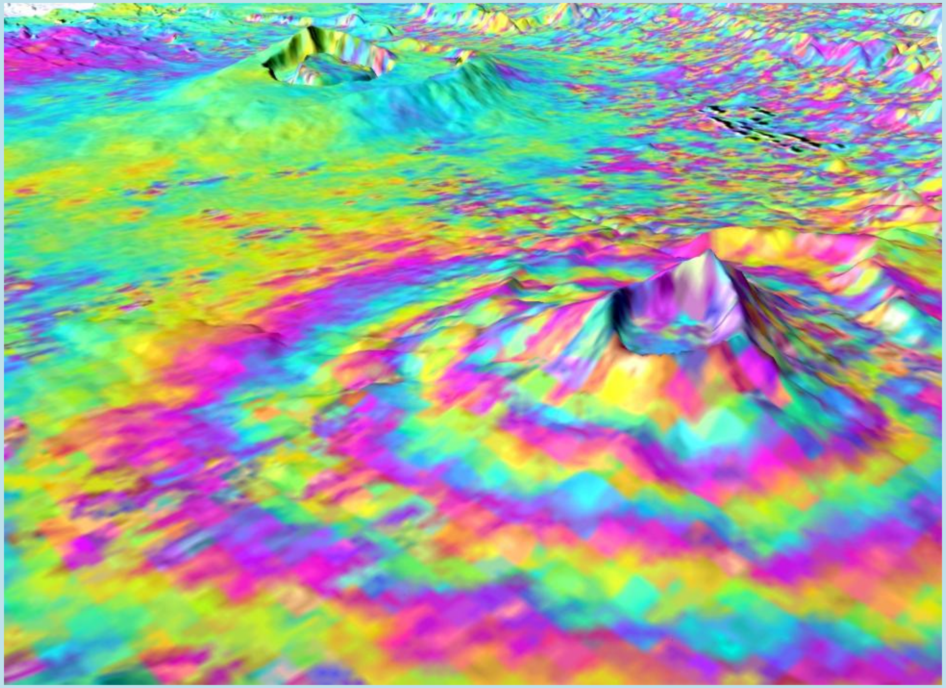
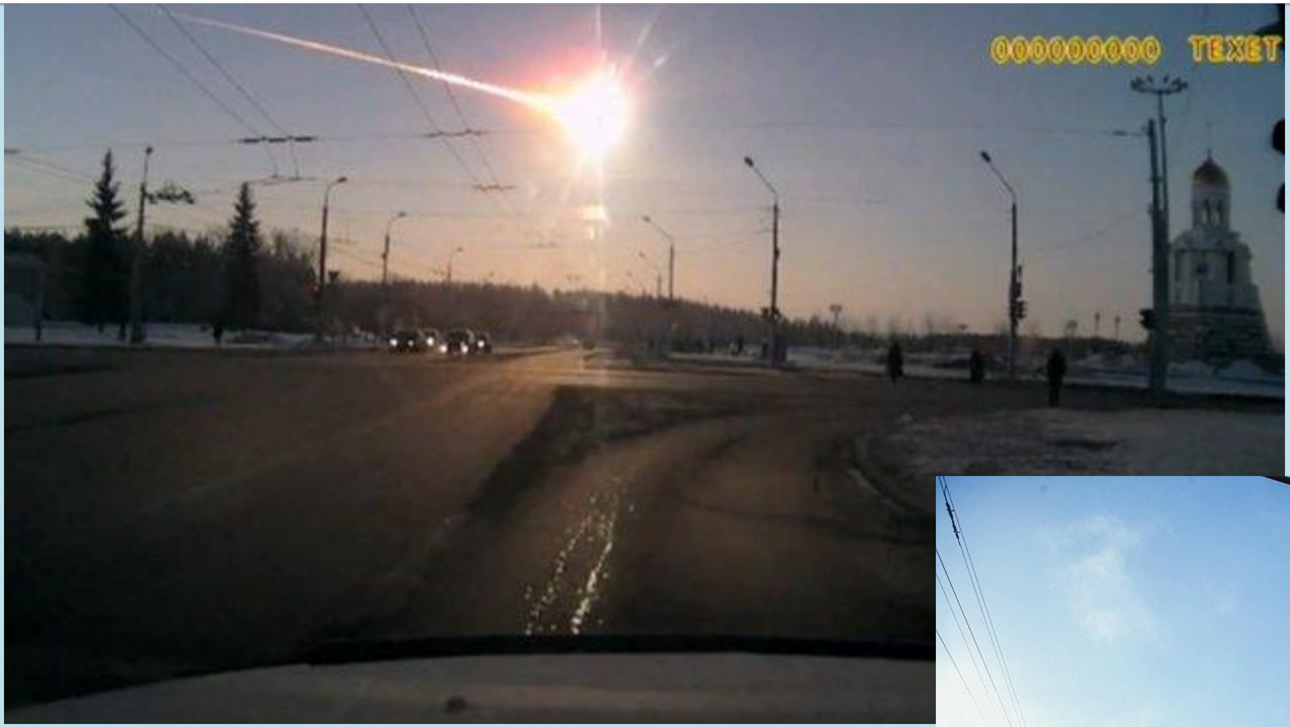


Small surface displacements (uplift of around 9 cm) of the Longonot Volcano, Kenyan Rift Valley.

The Suswa volcano in the background shows no such uplift at this time

Chelyabinsk Meteor



Dawn 15th Feb 2013 a 17m diameter asteroid enters the atmosphere

Chelyabinsk Meteor

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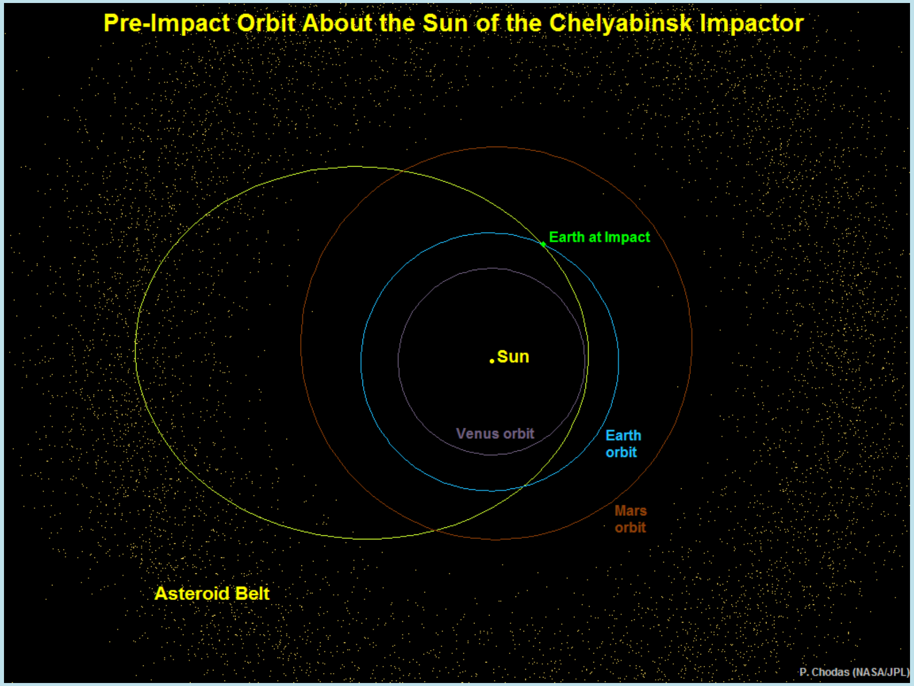
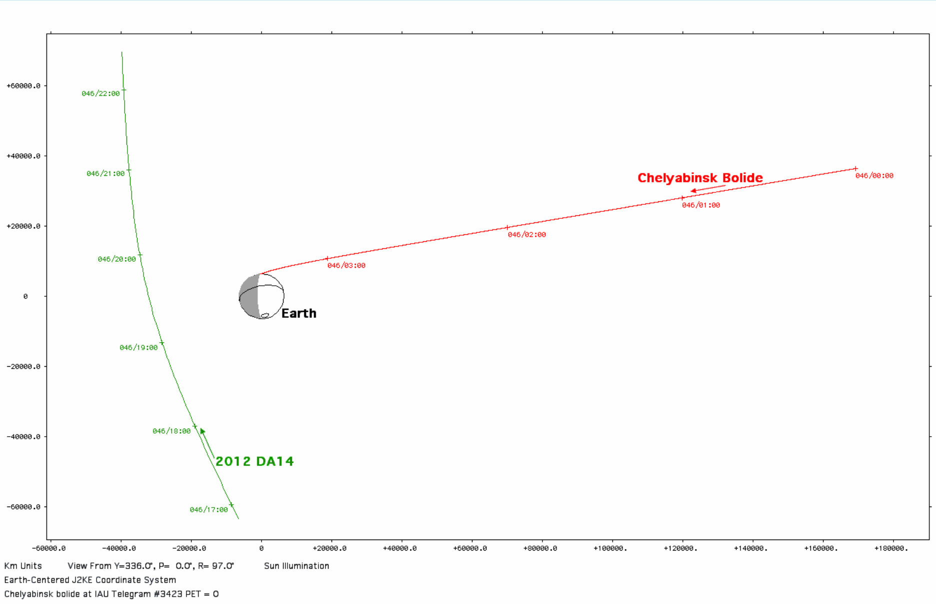


Unrelated to asteroid 2012 DA14 which passed 27,700km from the Earth



Tunguska – 30th June 1908

Exploded 8km above surface

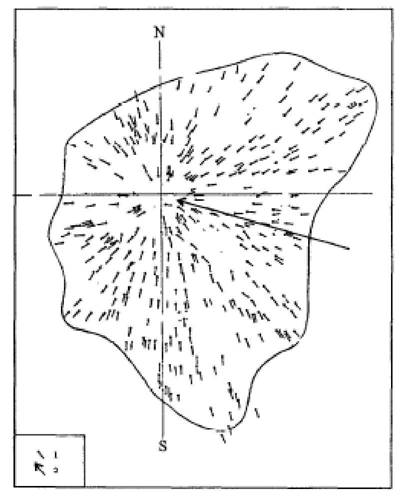


Fig. 4. Vector structure of the taiga devastation area caused by the TM shock wave (Fast, 1967a, b). (1) direction of fallen trees; (2) trajectory

Estimated diameter 50 – 100m
700 square miles of forest devastated

Amazon Rainforest – 13th August 1930

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Menace of Meteors Like Huge Bombs from Space

HURRICANE OF FLAME

BLAZING BOLTS FIRE FORESTS

MANKIND'S LUCK

Another colossal bombardment of the earth from outer space has just been revealed.

Three great meteors, falling in Brazil, fired and depopulated hundreds of miles of jungle.

NEWS of this catastrophe has only now reached civilisation because the meteors fell in the remote South American wilderness.

It was yet another lucky escape of mankind from an appalling and unrealised peril.

The last great meteor fell in Siberia in 1908, in a district so remote that only last year were details of its destruction given to the world.

Had either of these two meteor falls chanced to strike a city in a densely-populated country, frightful loss of life and damage would have been caused.

"A meteor," Mr. C. J. P. Cave, an ex-president of the Royal Meteorological Society, stated recently, "carries in front of it a mass of compressed and incandescent air.

"When it strikes the earth, this air 'splashes' in a hurricane of fire . . ."

The Brazilian meteors are reported (says the Central News) by Father Fidello, of Aviano, writing from San Paulo de Alivencia, in the State of Ama-

Peru Sept 2009

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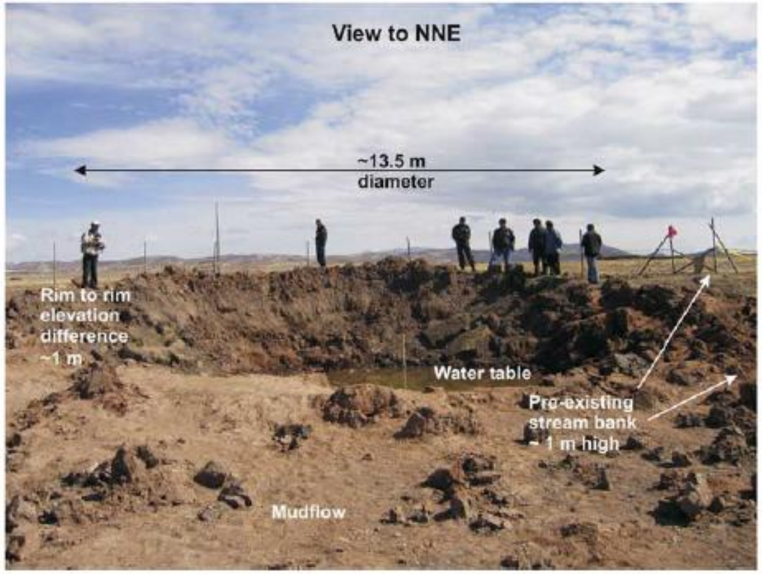

Figure 1. The crater 7 days after formation.

An ordinary chondrite survived the passage through the atmosphere.

Estimated diameter 2m

Fig. 2. Wide-field photo of the crater.

Frequency of meteorite strikes

A once in 100 year event
or
a once in 25 year event?

Asteroid map

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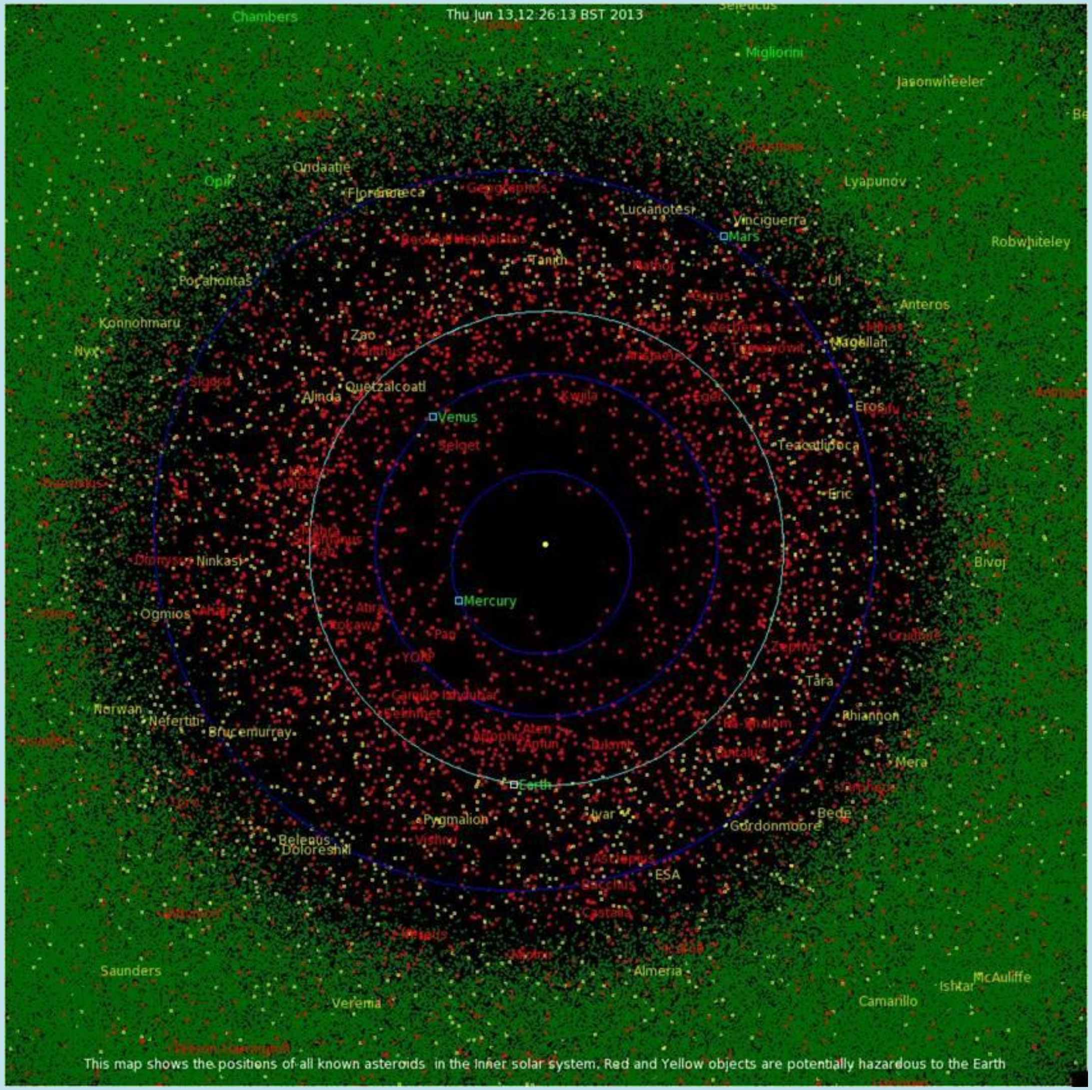
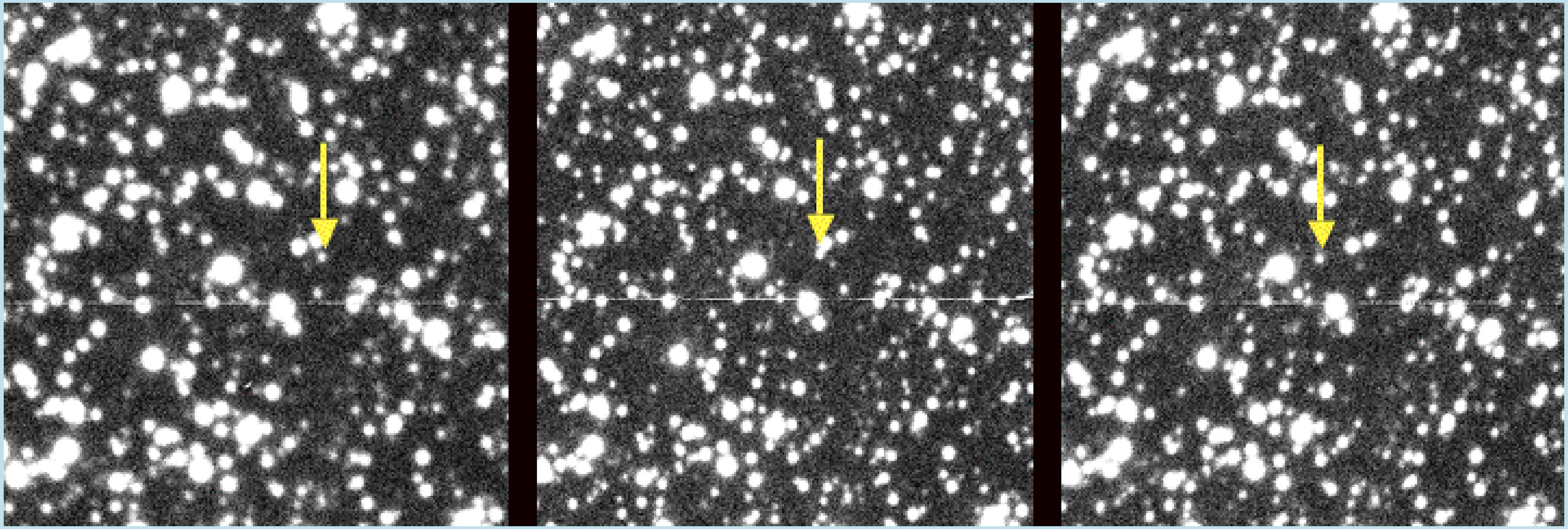
A crowded solar system!



Armagh observatory

Asteroid detection

Spotting the needle in the haystack



Impact effects calculator

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http://impact.ese.ic.ac.uk/

Climate Change Documentary

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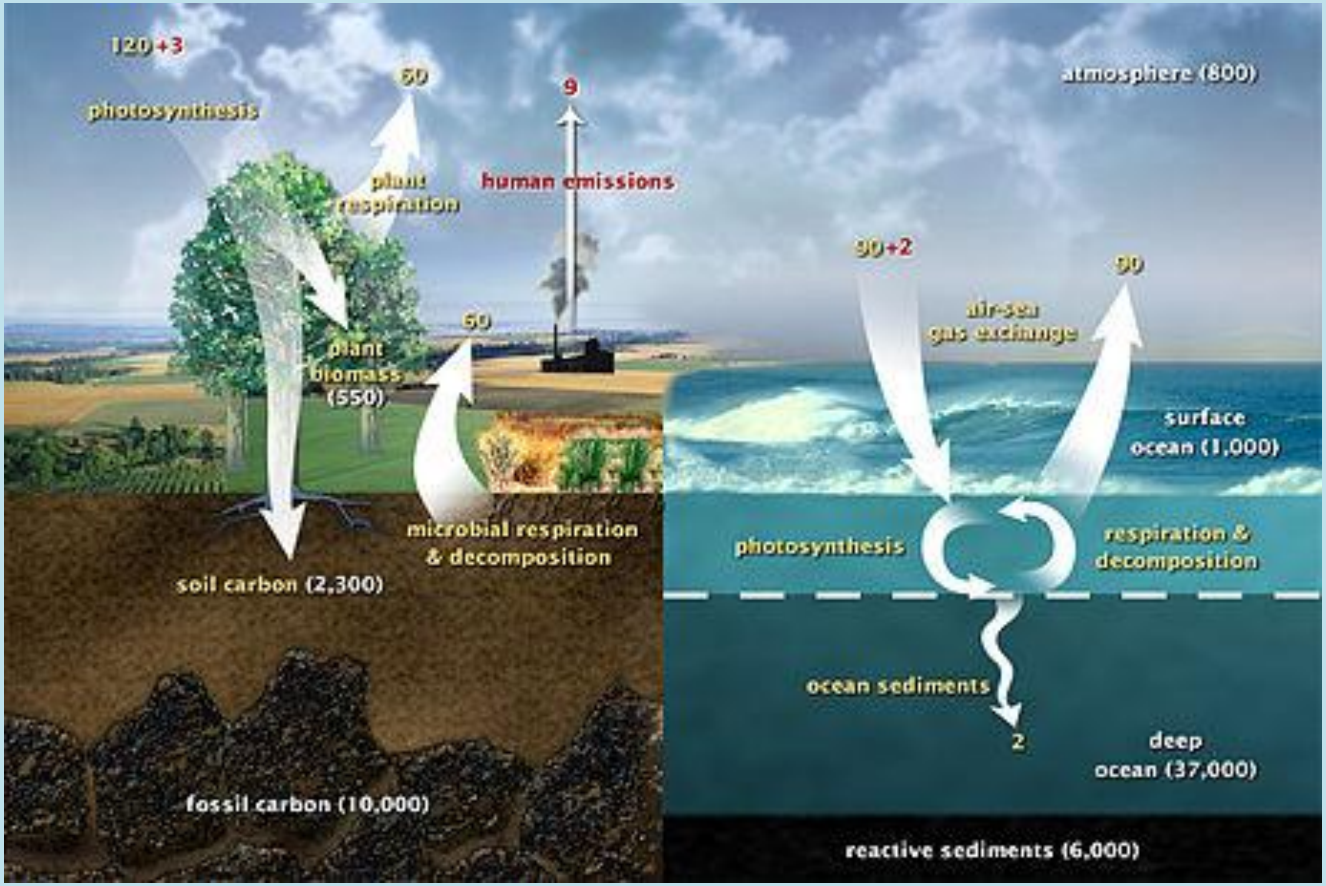
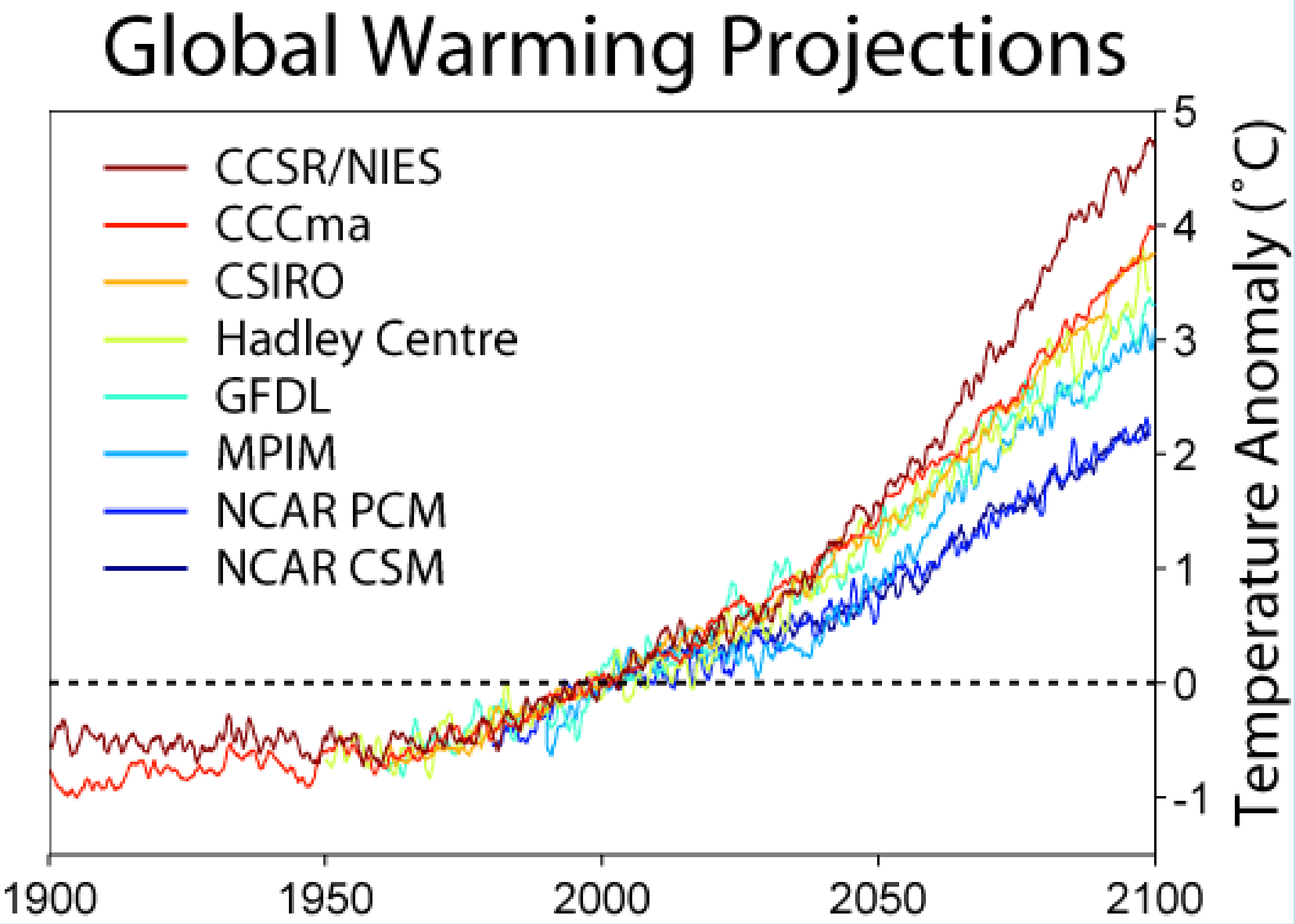
http://thiniceclimate.org/

CO_2 and the carbon cycle – its complicated



Climate projections



Historical weather data –

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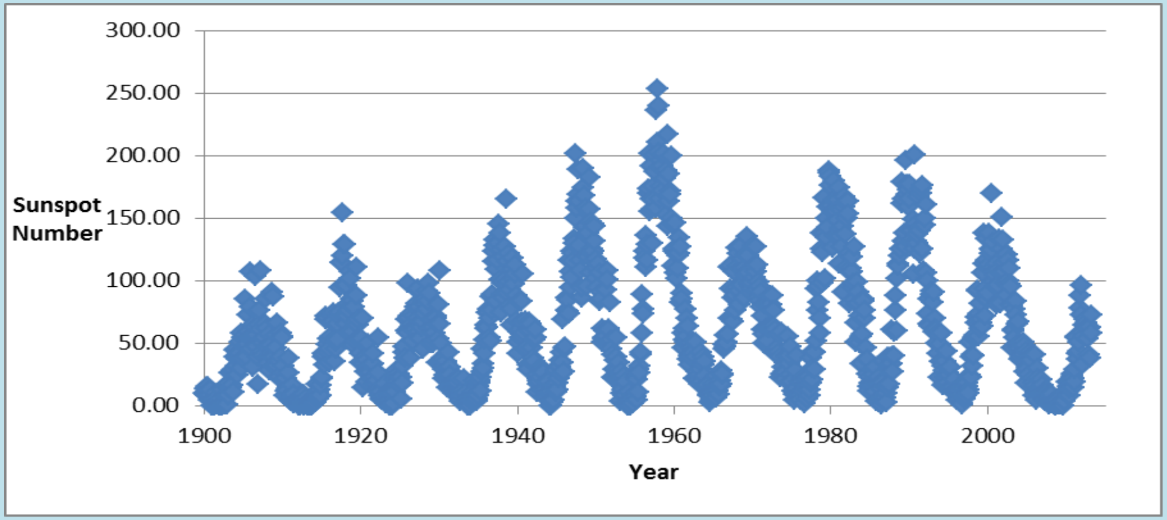
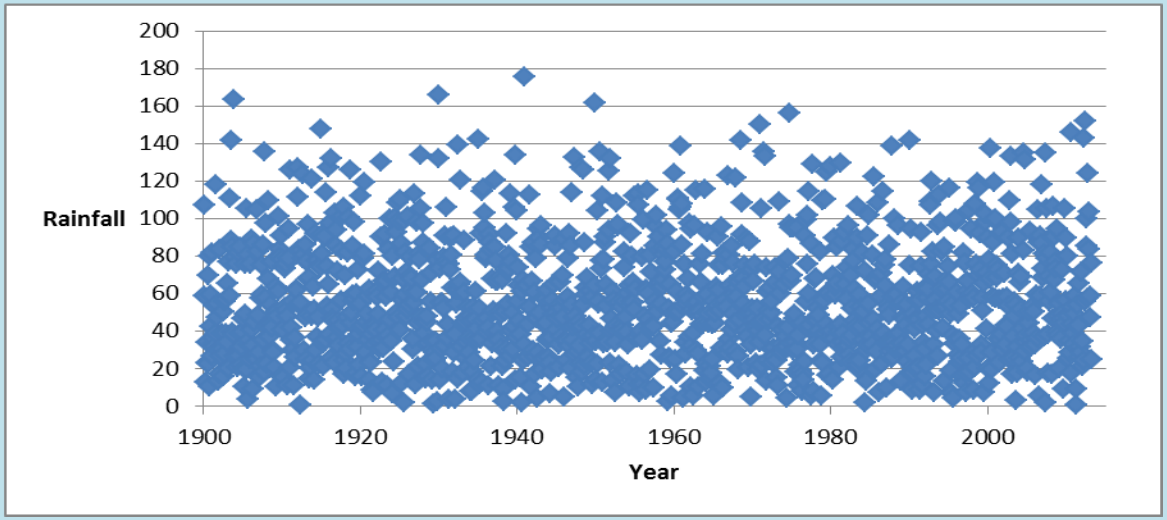
Data from Met office for Oxford

Testing the astronomical connection





Contact

- enquiries @ earth.ox.ac.uk

- www.earth.ox.ac.uk

- SCIENCE OPEN DAYS

  Wed 26th and

  Thurs 27th June 2013

  Fri 20th Sept 2013

Admissions requirements

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EARTH SCIENCES

- A2 Maths required for entry any year, PLUS EITHER Physics OR Chemistry for entry 2013 onwards
- Recommended A levels: Physics , Chemistry, Maths, Biology, Further Maths.
- A2 Geology NOT required.
- Typical offer A*AA or AAAA