

Establishment of management plan of UNESCO-designated sites through effective monitoring for abrupt climate changes

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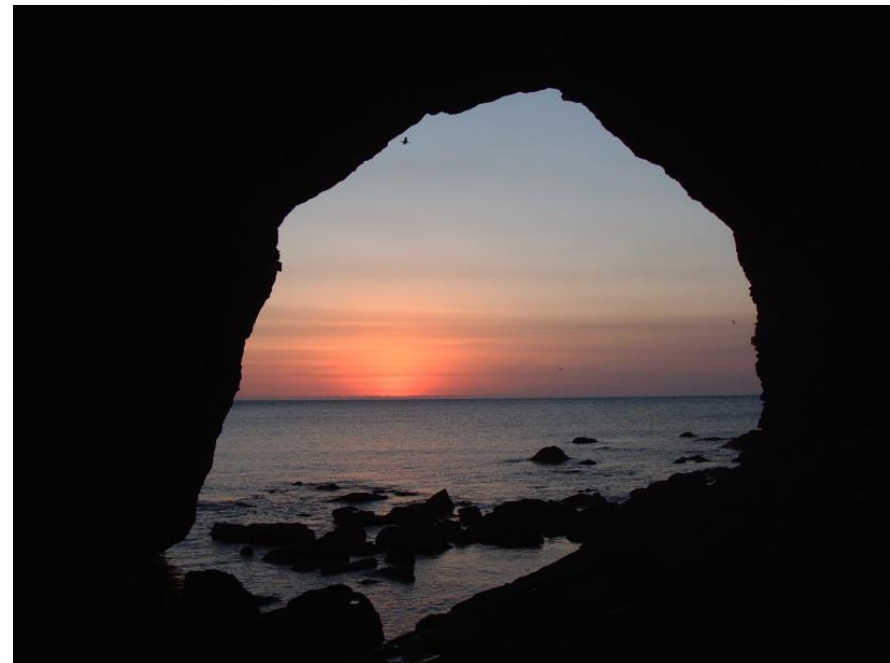
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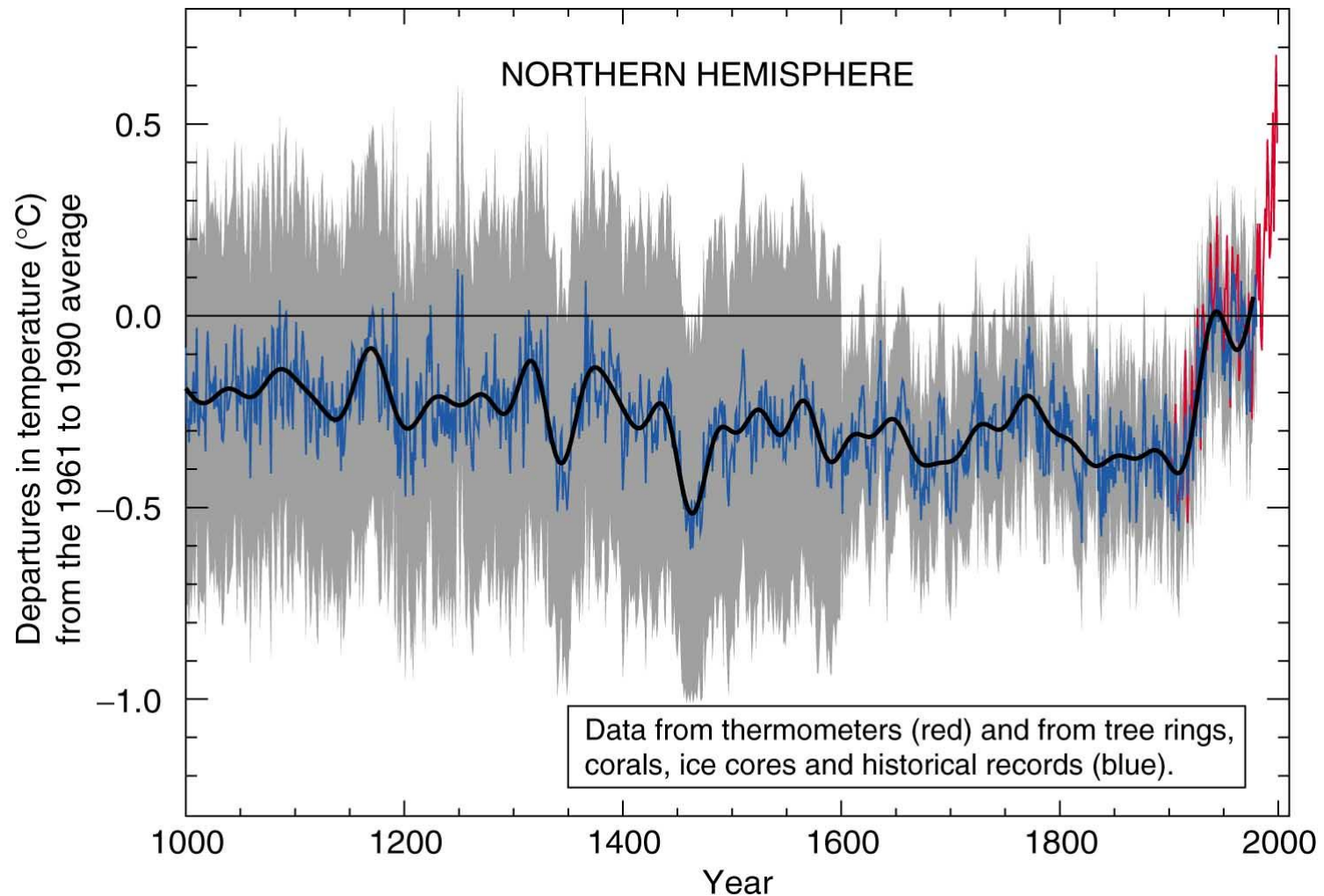
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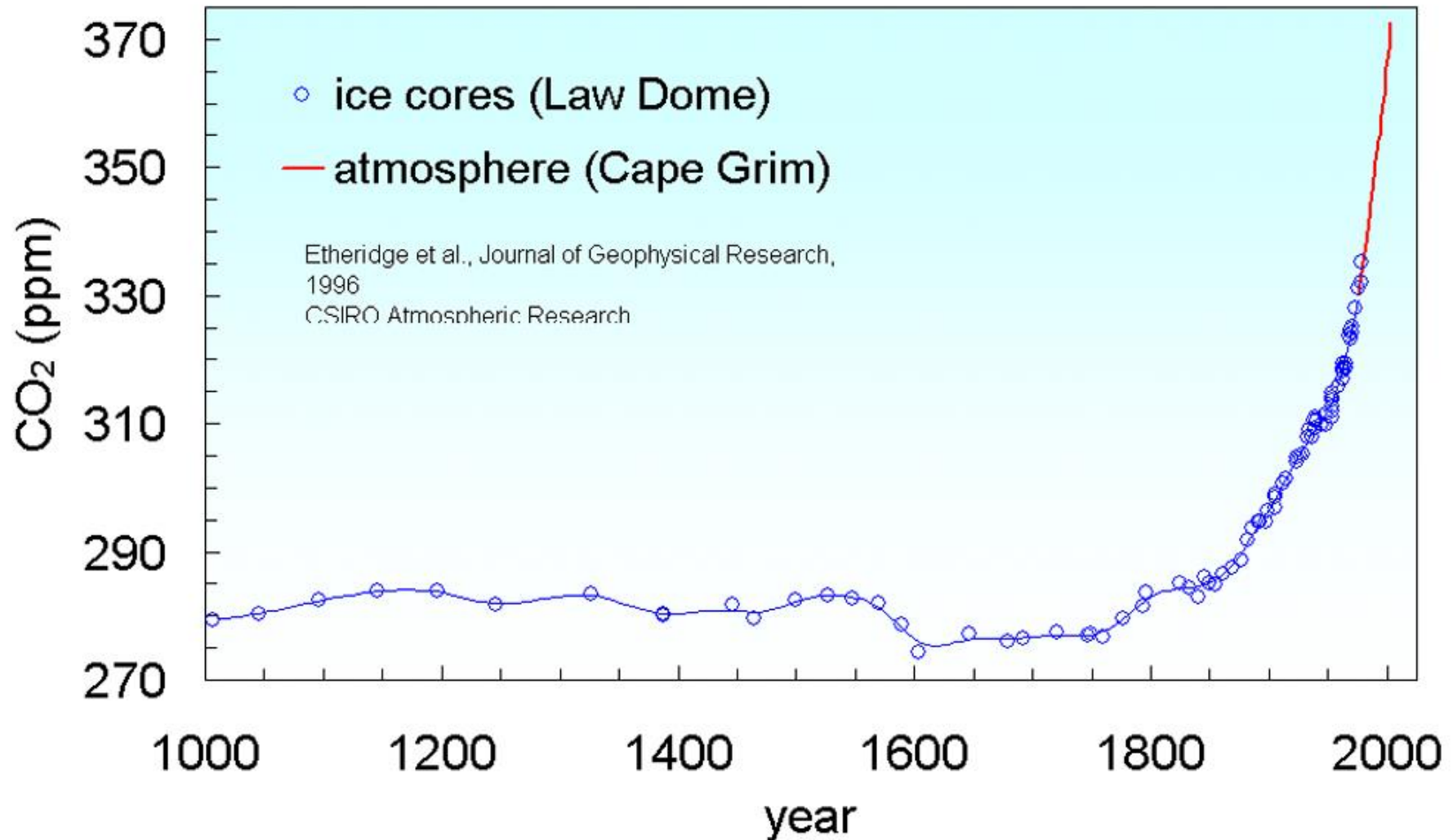
- Global warming & climate changes
- Their effects on UNESCO sites
- The role of monitoring for adaptation and mitigation
- Summary



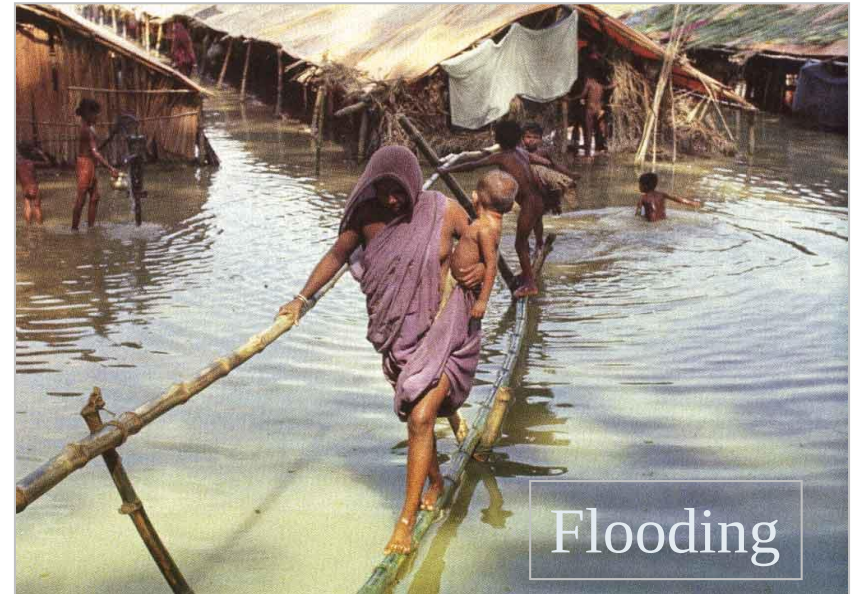
Variations of the Earth's surface temperature for the past 1,000 years - **Global Warming!**



Recent increase in CO_2 but also in CH_4 , NO_2 , etc.

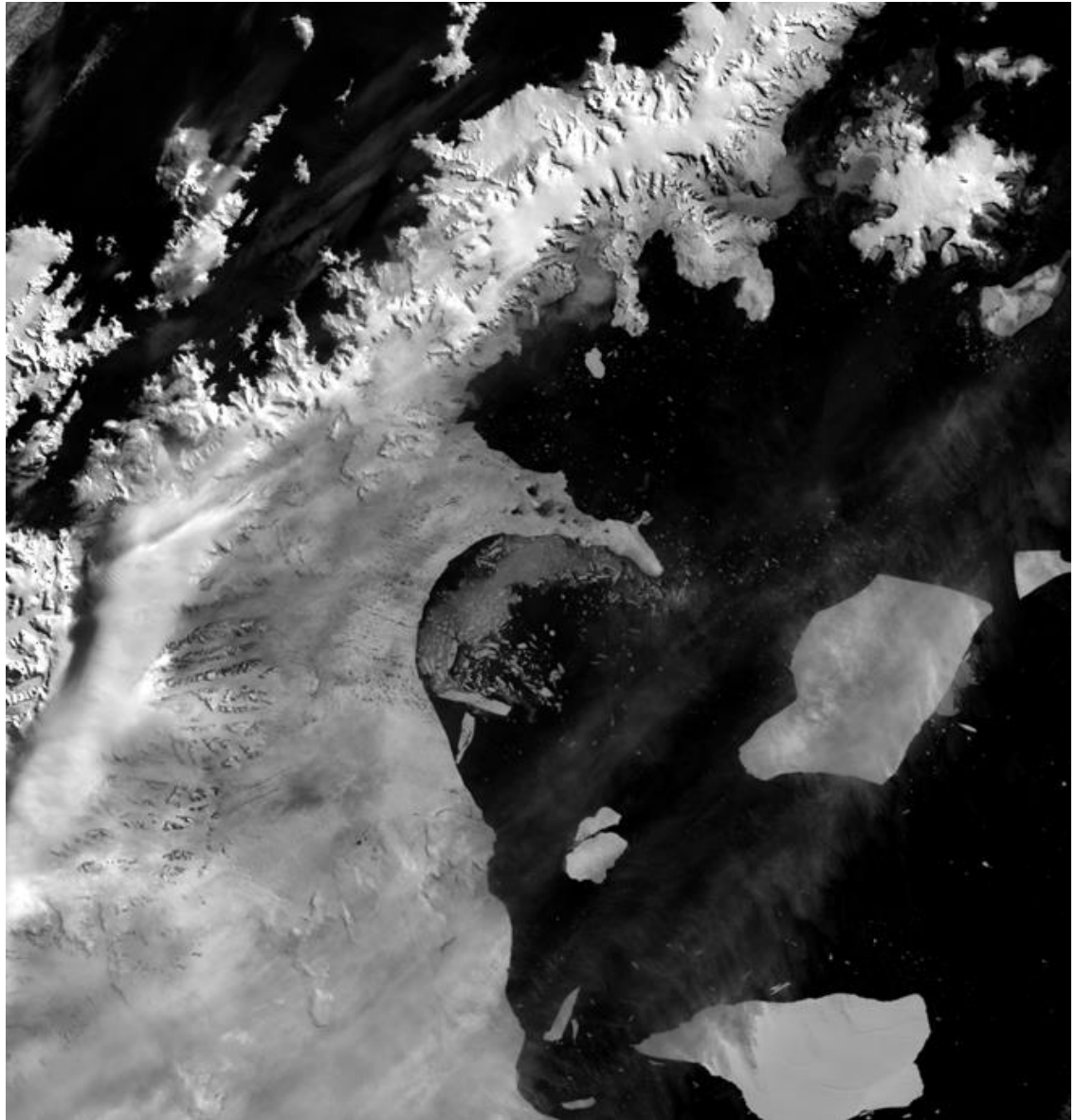


Natural disasters due to global warming?



Typhoon Maemi in Korea, 2003. 9

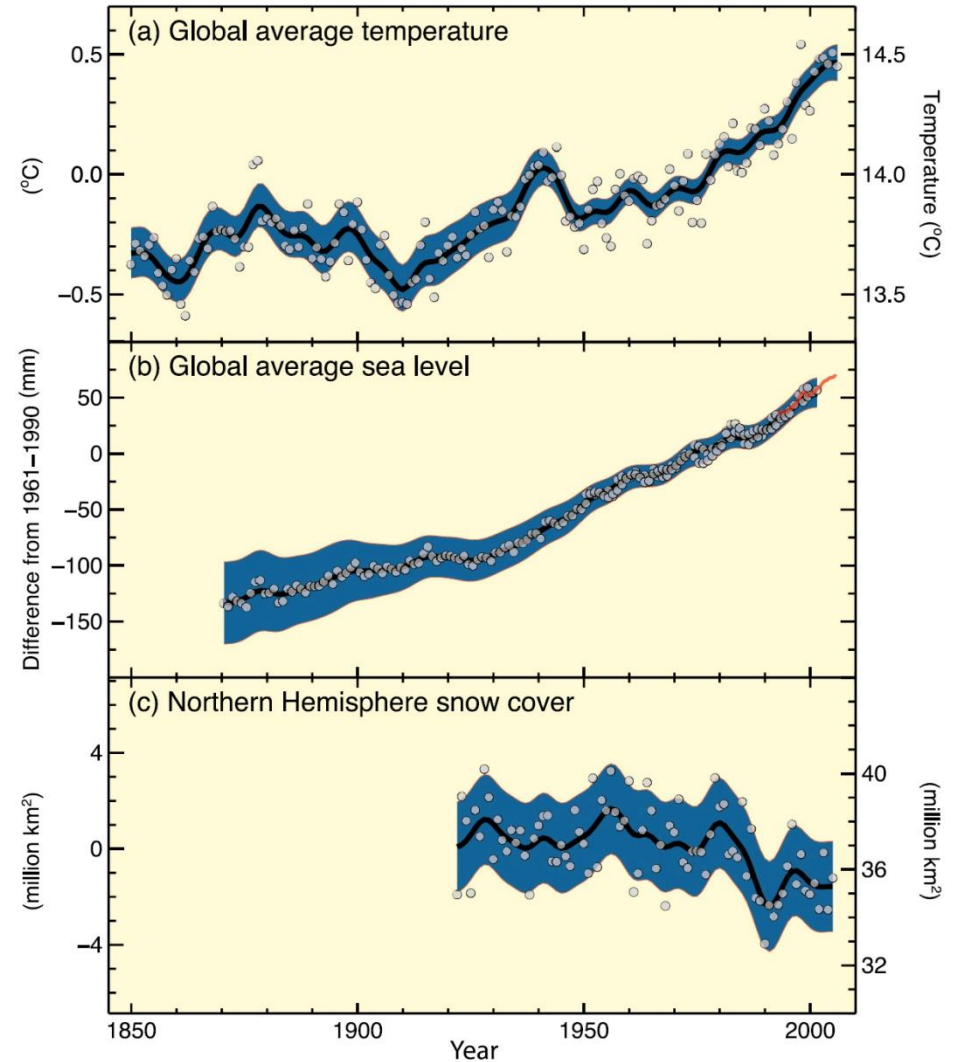
Melting of glacier in Antarctica



15 February 2002

Collapse
of Larsen Ice
Shelf-B

Global Sea Level Rise



Sensitive site? – coastal regions

- Destiny of the Maldives?



Sensitive site? – also polar regions

Melting of sea-ice in Arctic Ocean

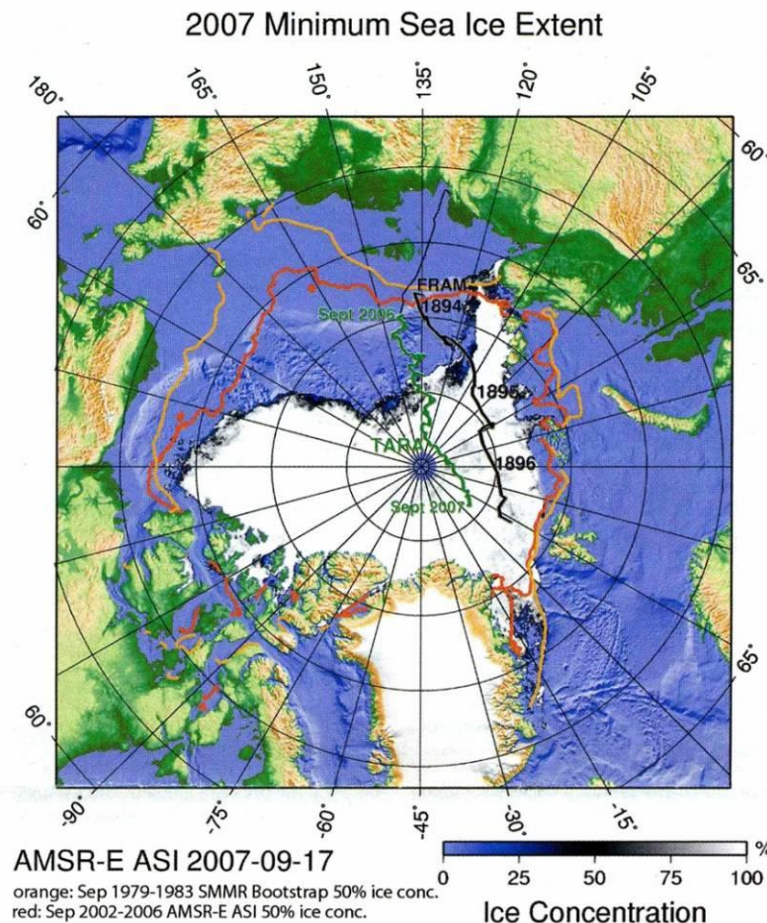


Fig. 1. The drift track of Ice Station Tara from September 2006 to September 2007 and the drift track of the Fram (1894-1896) are represented. The bottom topography is shown together with sea ice summer minimum extent in 2005 and 2007.

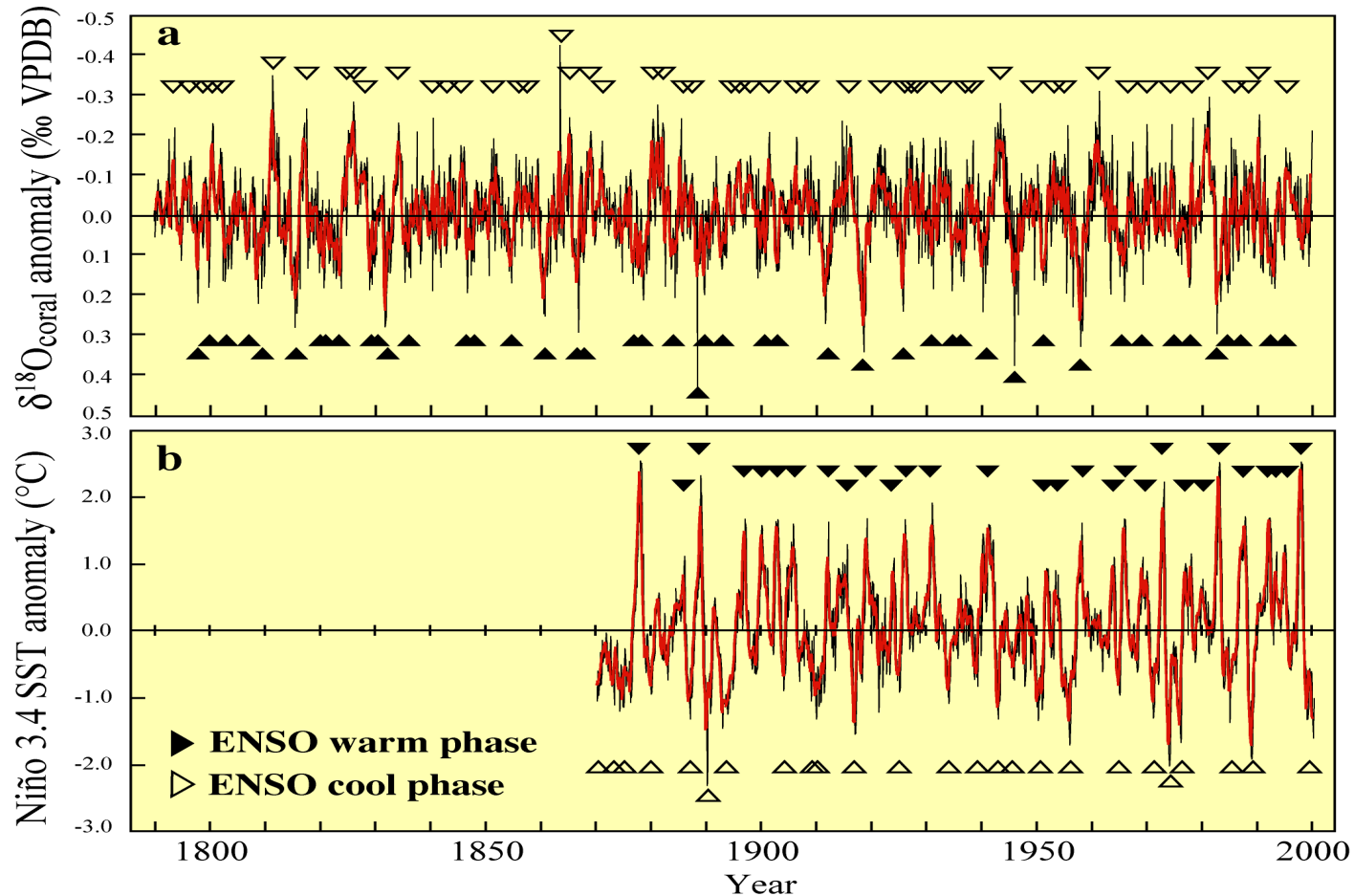
However in tropical regions

- The increase in sea surface temperature has resulted in bleaching of coral sea.
- So called ‘ocean acidification’ or ‘whitening’



El Nino : Natural disasters

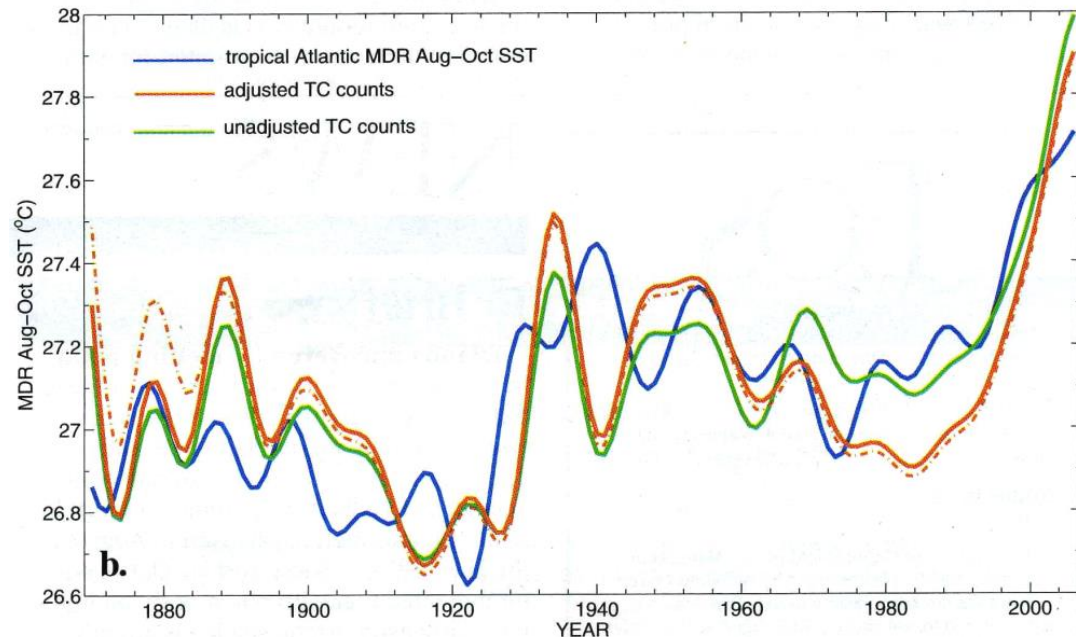
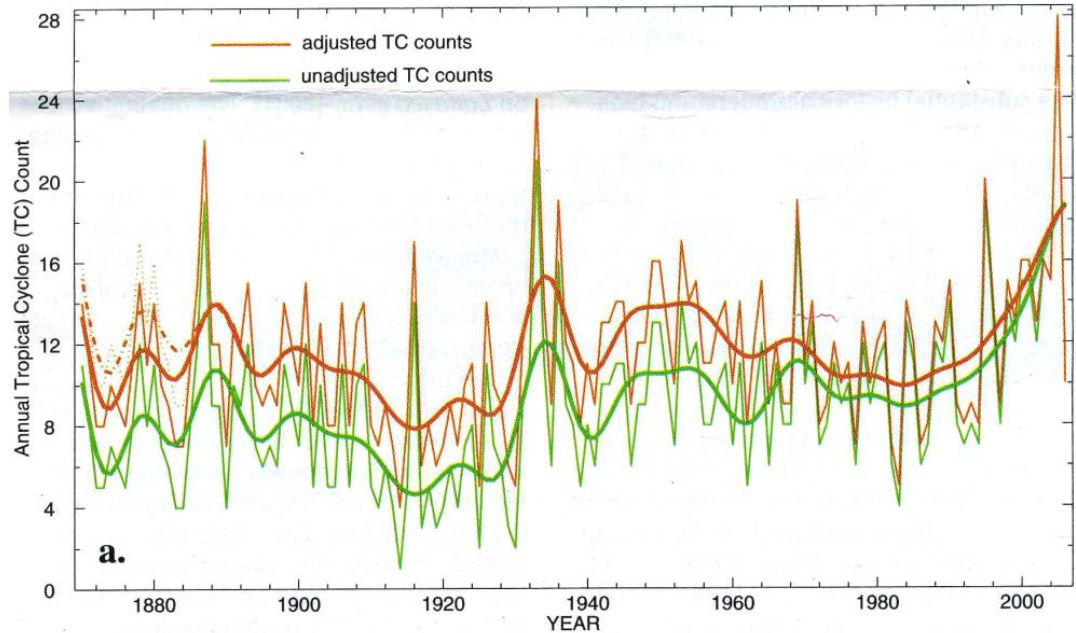
- not the frequency but the intensity



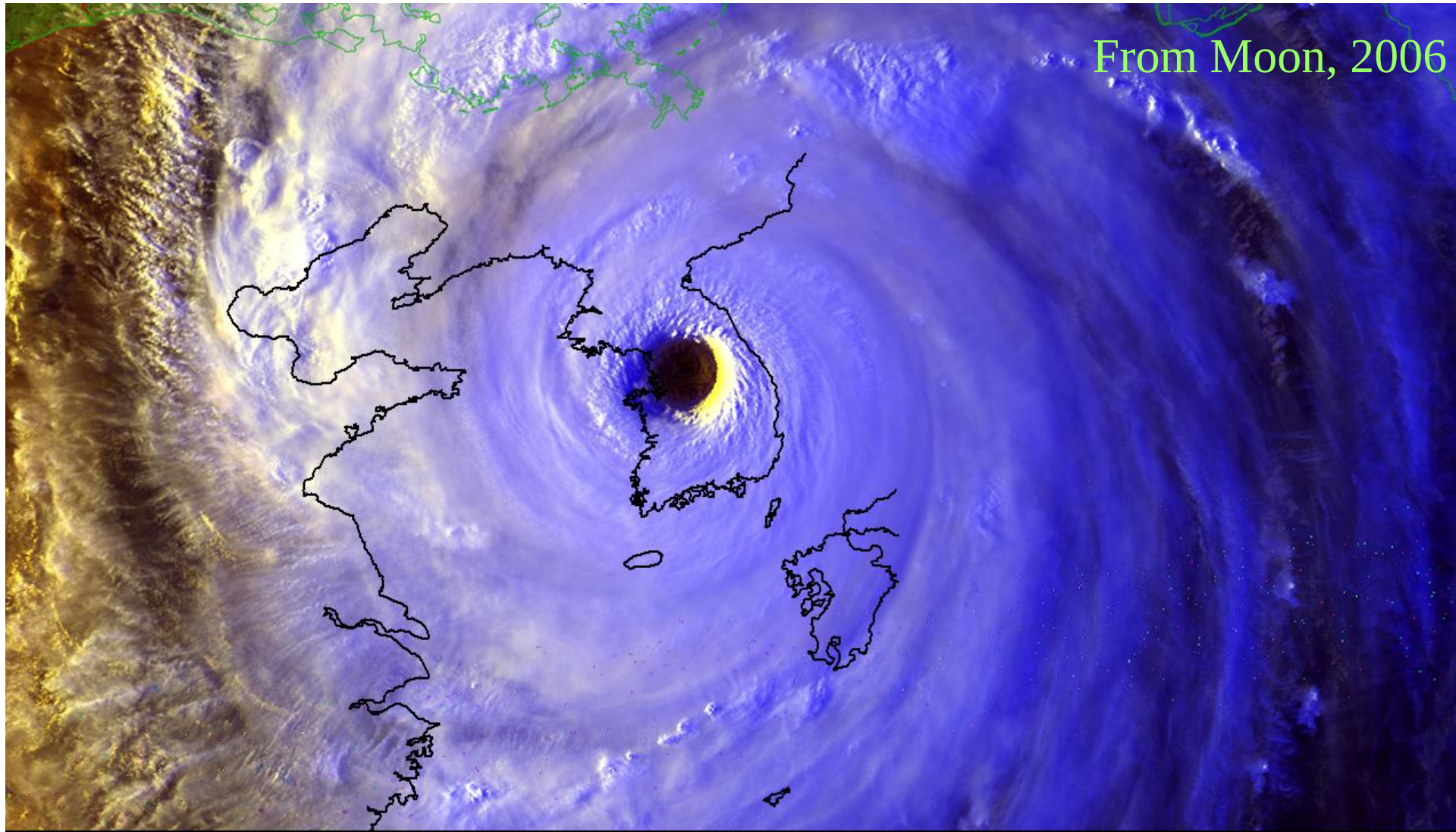
Atlantic Cyclones...

Also, not the
frequency
but the intensity

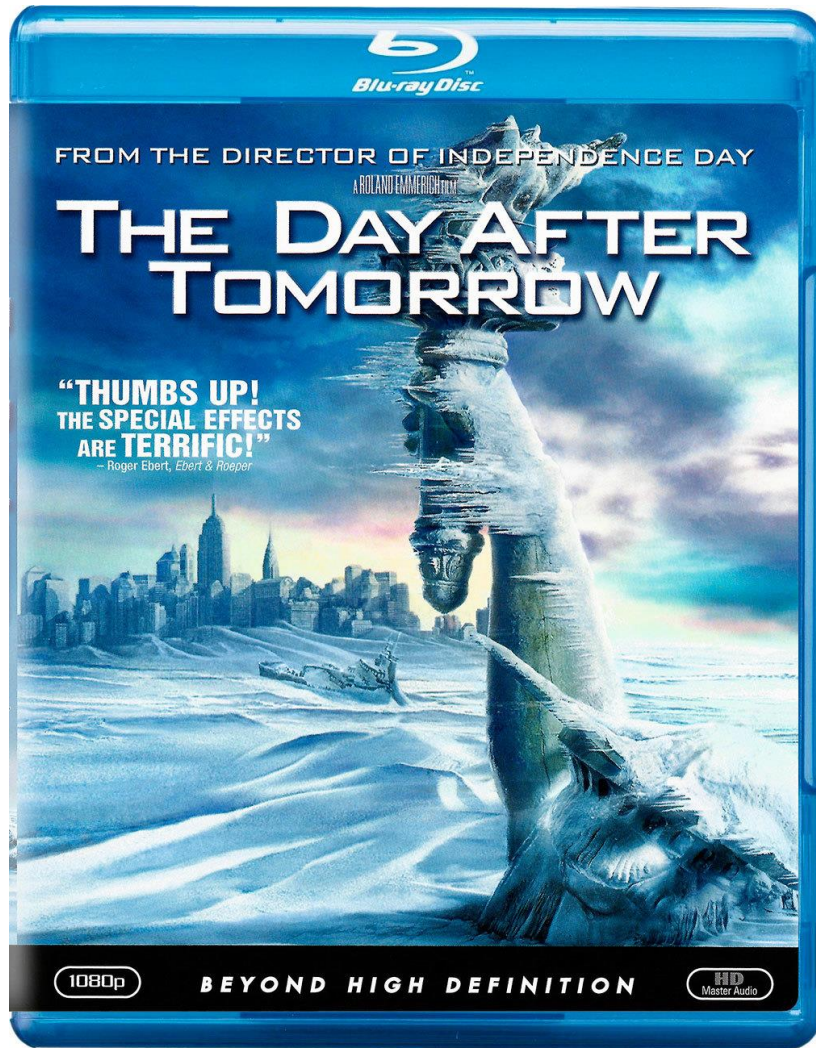
EOS, 2007



Super-typhoons in the future?



The day after Tomorrow - just a fiction?



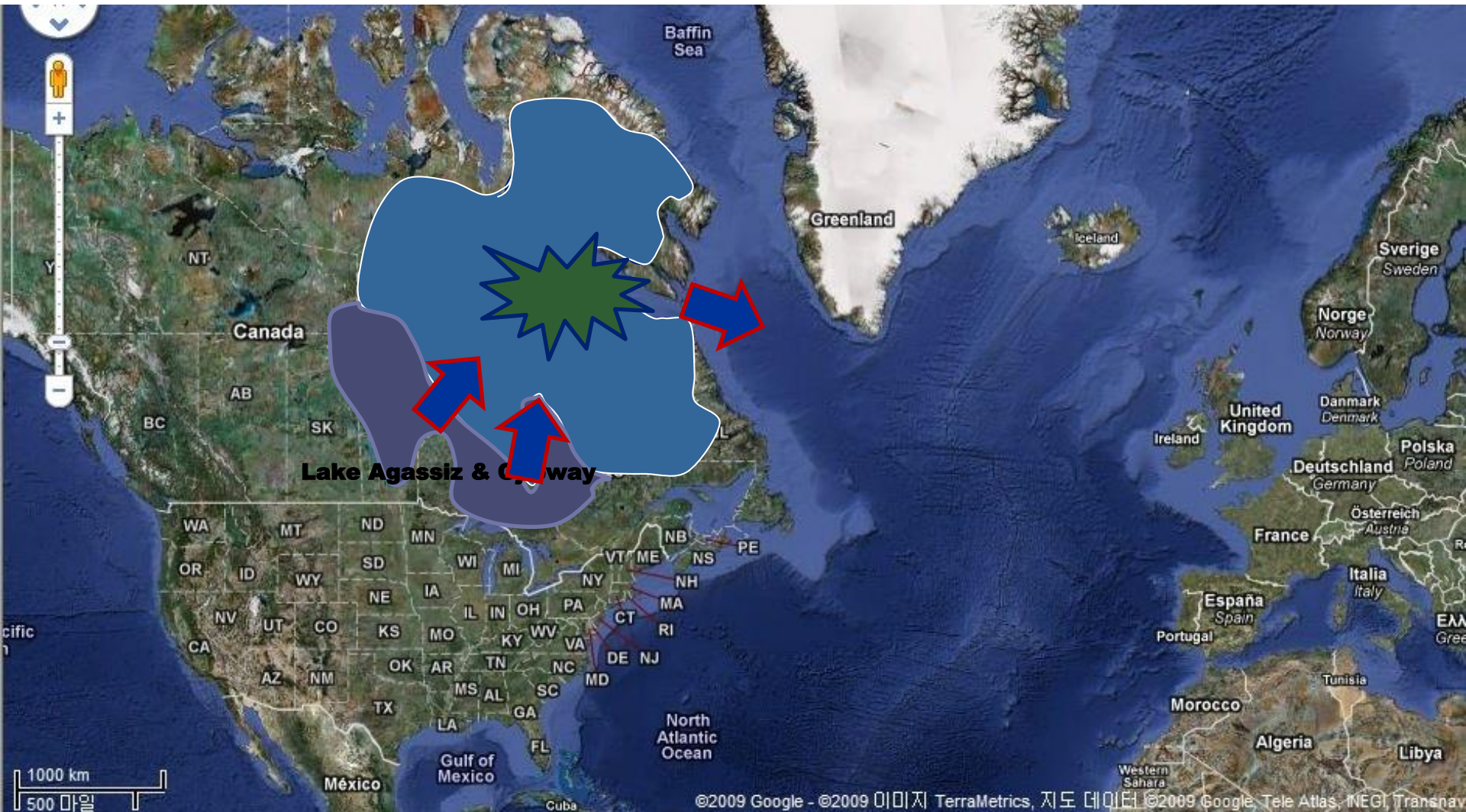
Based on the report by Andrew Marshal (2003): Now the Pentagon tells Bush: climate change will destroy us

- Britain will be 'Siberian' in less than 20 years
- Threat to the world is greater than terrorism

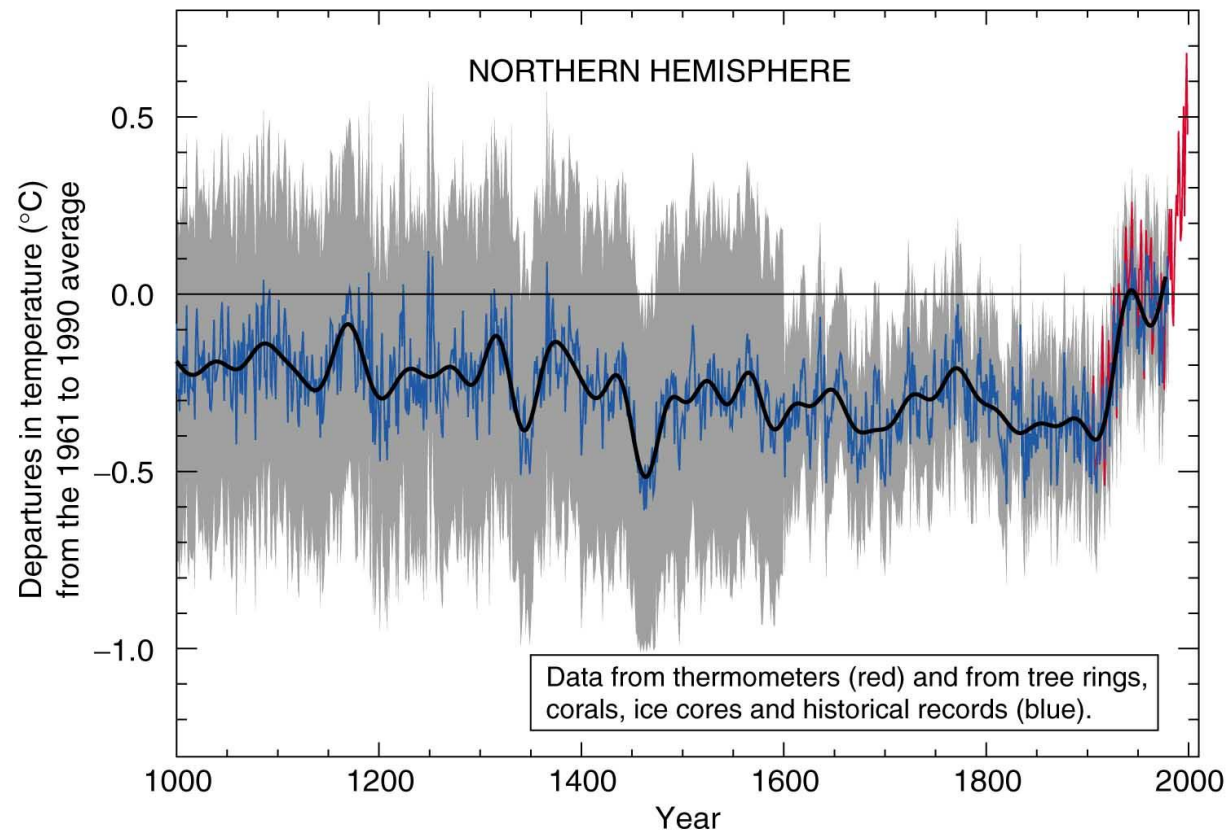
Is an Abrupt Climate Change possible in the future?

8.2 ka (8,200 years ago) event!

The glacial lake Agassiz and Ojibway (originally dammed by a remnant of the Laurentide ice sheet) drained catastrophically.



Is *global warming* a kind of ‘abrupt climate changes’?



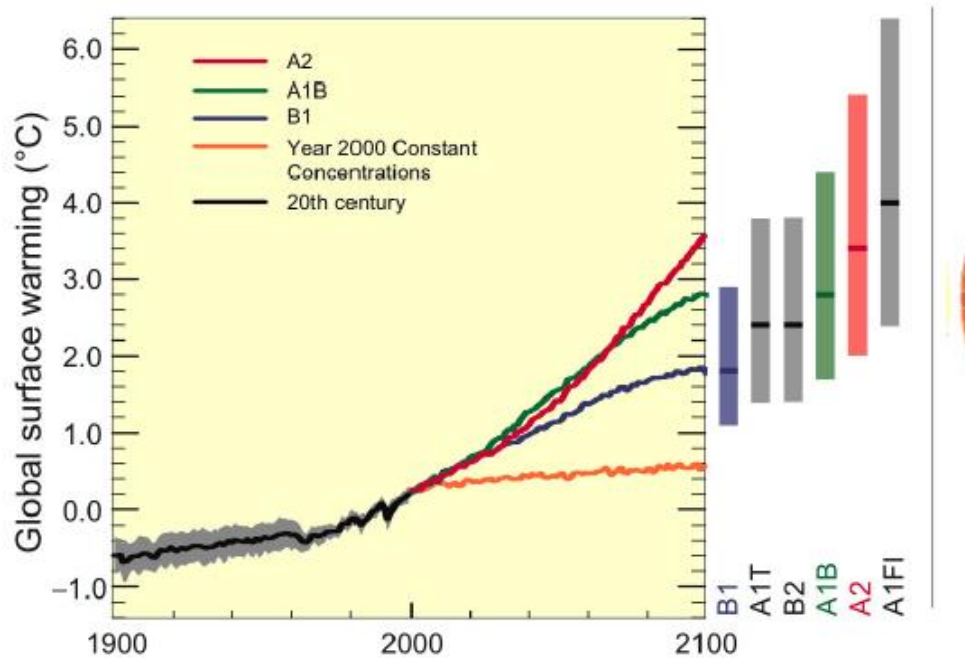
Effects of the ‘Future Abrupt Climate Change’?

- Rapid increase in atmospheric temperature
- Rapid increase in Sea Surface Temperature
- Rapid sea-level rise
- More intensive tropical cyclone
- Severe winter storm
- Others.....

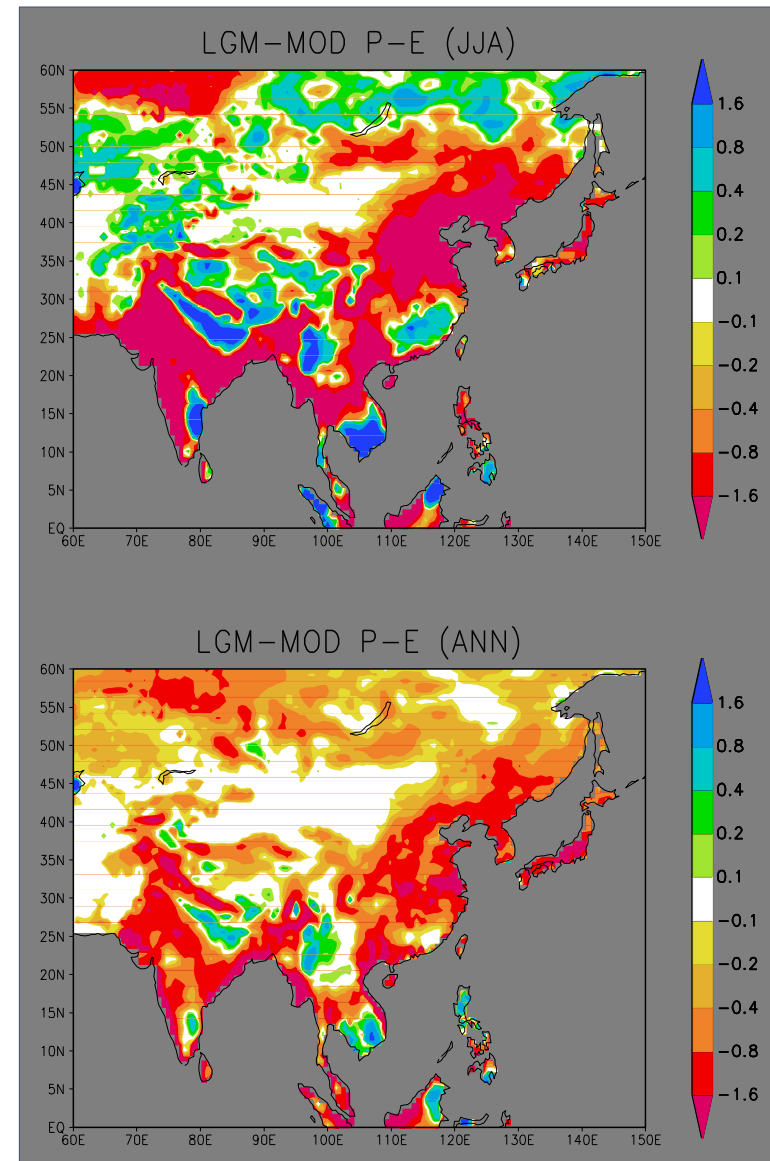


Prediction of climate change

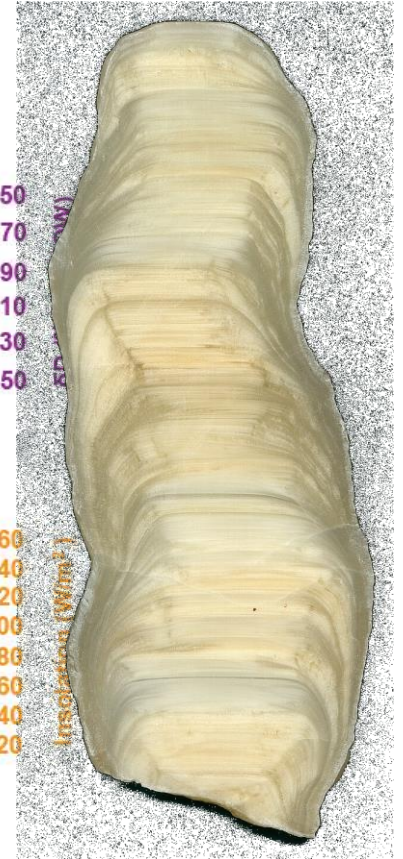
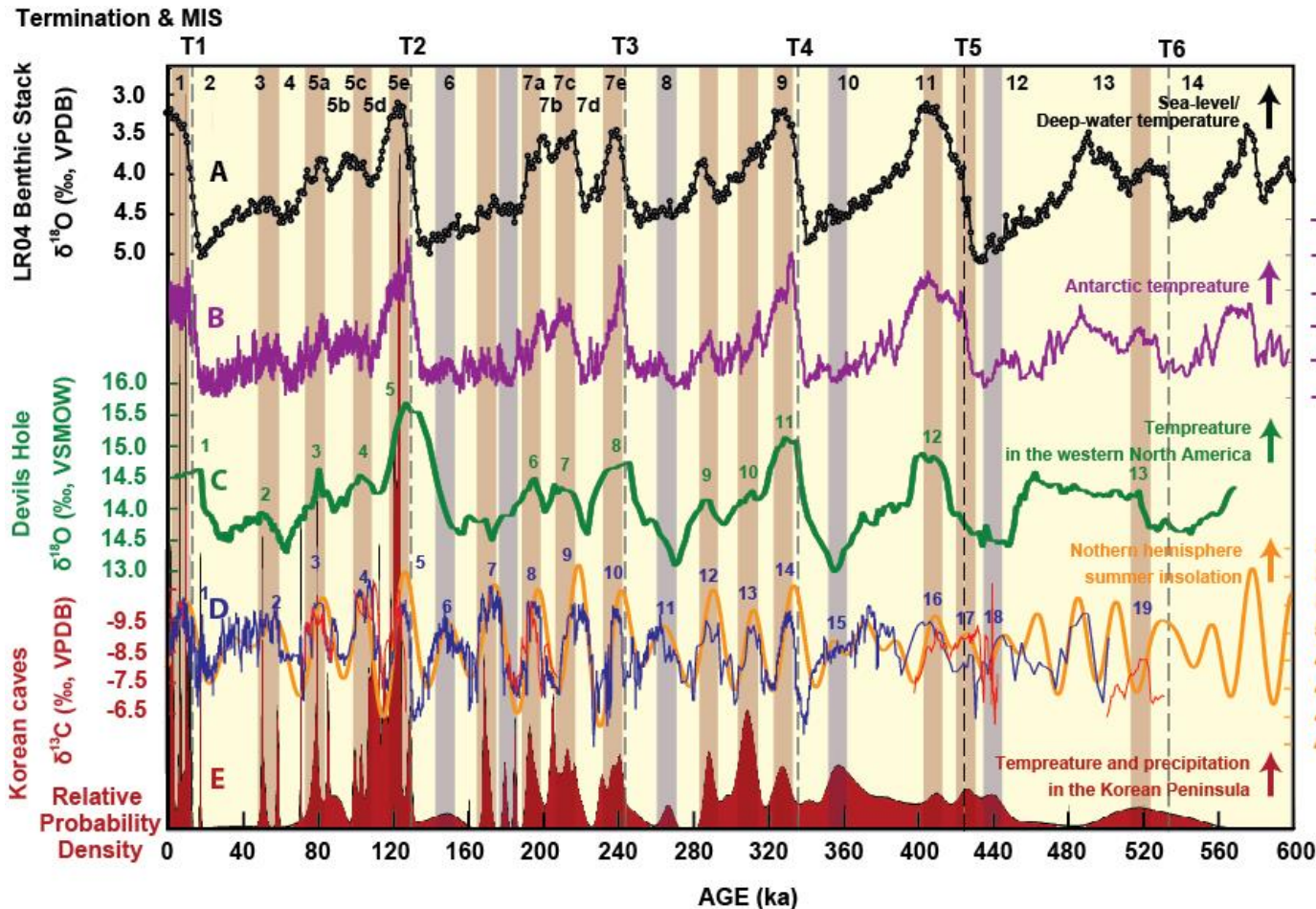
Projections of surface temperatures



IPCC, 2007



One way to solve the problem is to study climate changes in the past



Hydraulic seesaw in Mid-latitude regions (Jo et al., Nature, 2014)

What should we do?

- Understanding natural processes and past nature
- Do we?
- We just have less than 100 year meteorological record in the World
- Adaptation and mitigation can be only possible by proper monitoring
 - Daily, Weekly, Yearly, Decadal, Centennial



A large boulder in Okinawa - Tsunamite

Why is monitoring necessary?

- Safety of tourists
- Nature conservation

CO₂(ppm)

70,000~100,000

Intolerable to breathe for more than a few minutes

10,000~15,000

Dyspnea, Metabolic syndrome

1,000~2,000

Displeasure, Headache, Vomiting, Dizziness

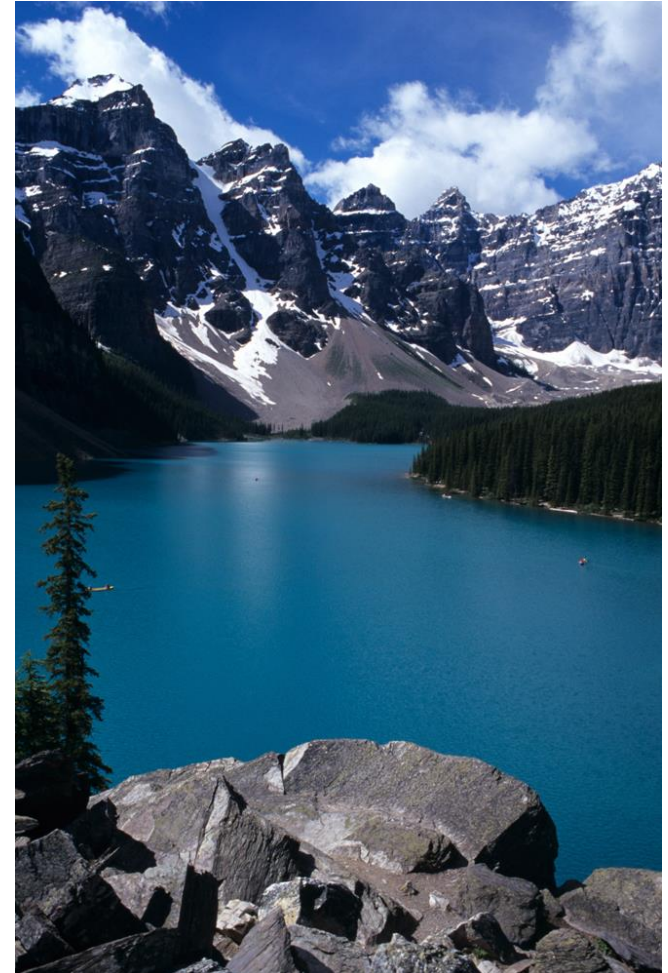
~1,000

Effect not noticeable



Monitoring indicators should be developed depending upon the location of the sites concerned.

- Consider **geographic locations** (mountain, river, sea coast, lake, cave, etc.)
- Consider all the elements to cause natural hazards and artificial contaminations



Banff National Park, Canada

Determination of monitoring sites

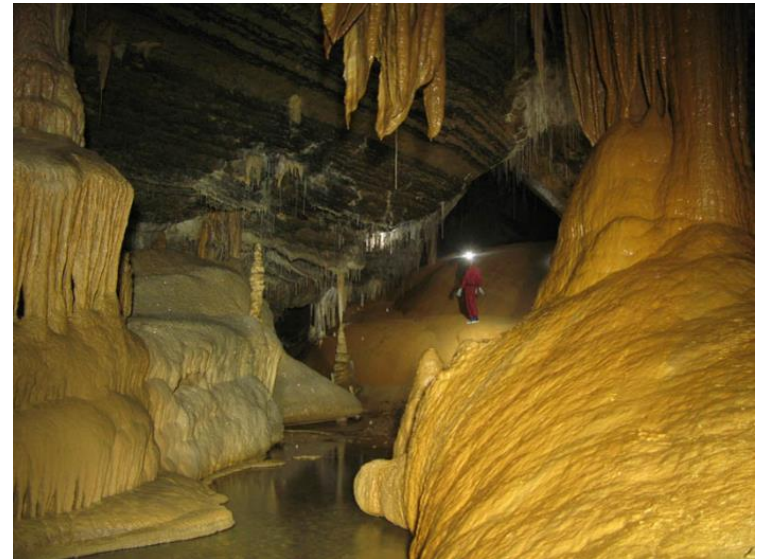
Shallow sea



Coast

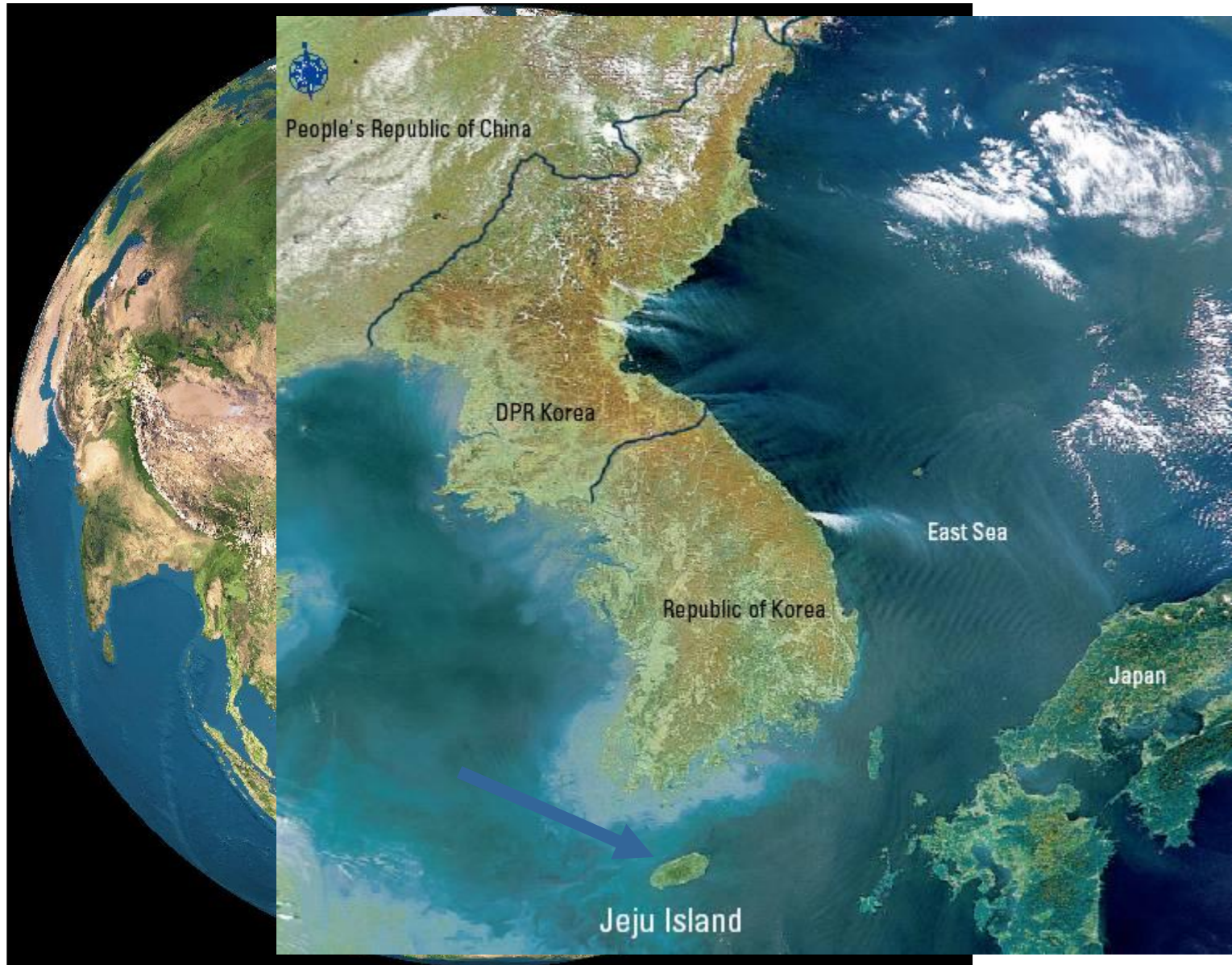


Inland fossil site

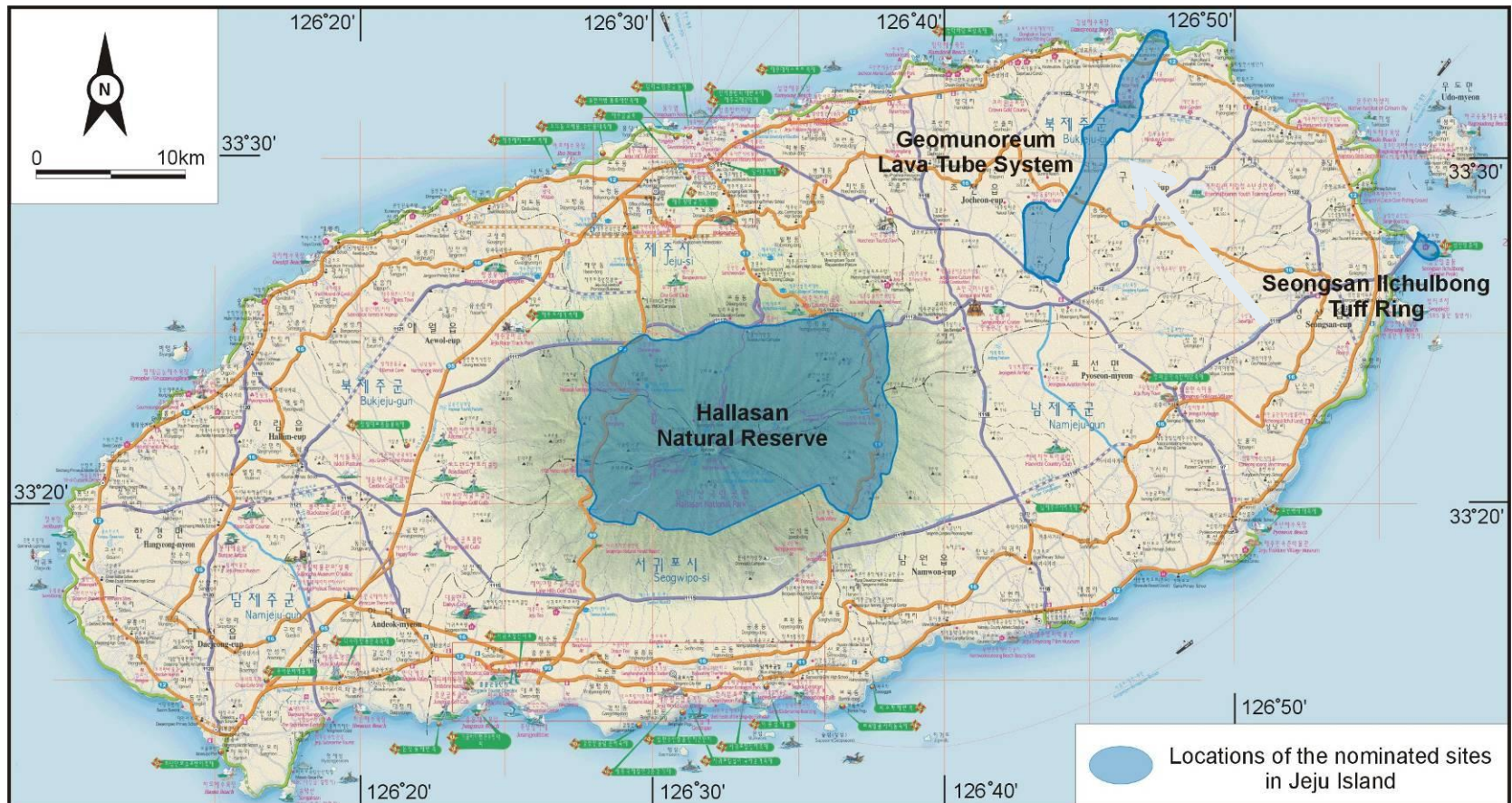


Cave

Location of Korea

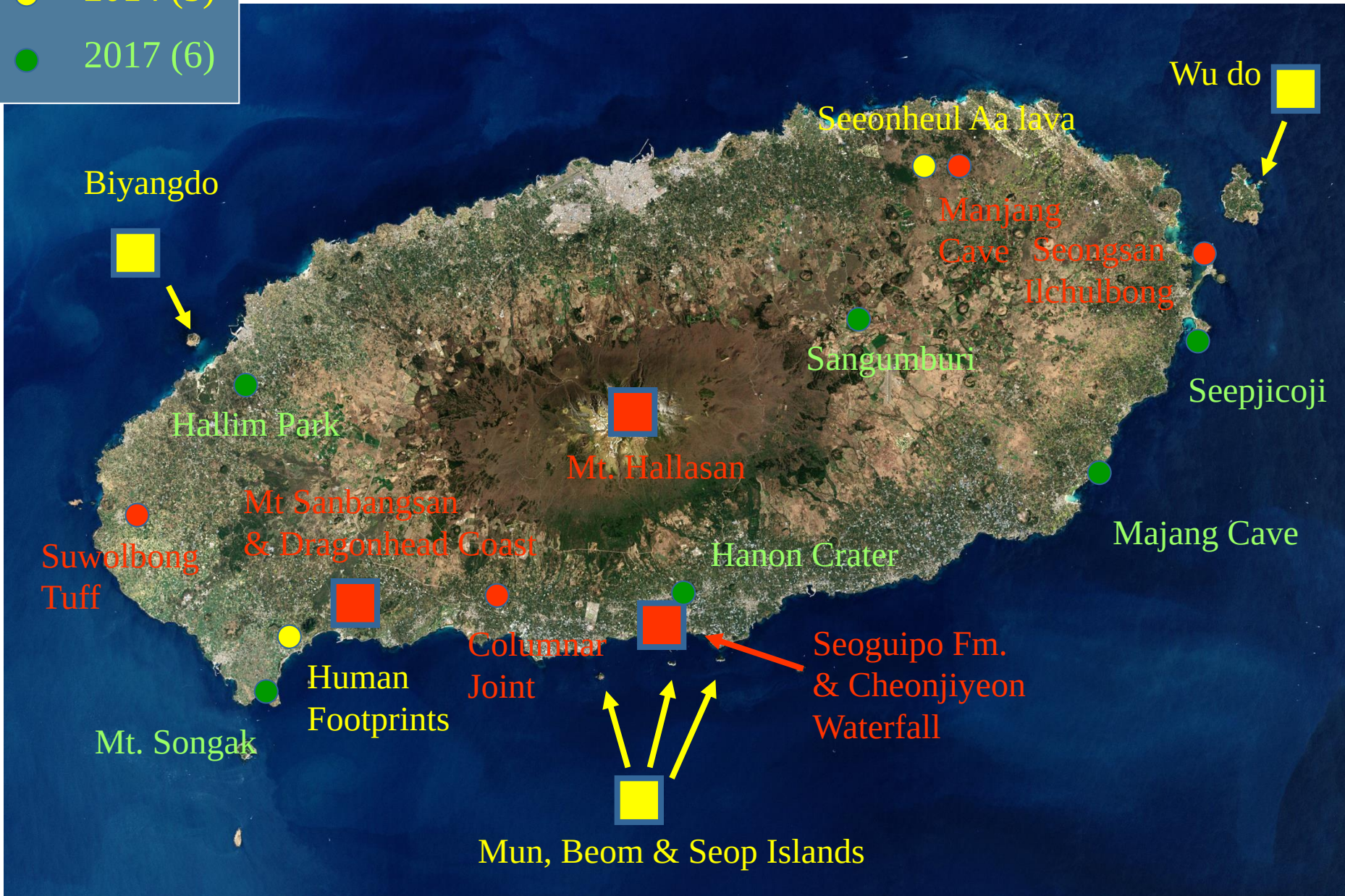


WH site in Jeju Island



Jeju Island Geopark geosites

- 2009 (7)
- 2014 (5)
- 2017 (6)



Inland geosites

- Damage of trails
- Rockfall
- Landform change
- Water level at the lake
- Water quality (color, smell)
- Rocks transported by stream
- Air monitoring
- Precipitation
- Snow depth
- Soil quality
- Valley erosion rate
- Volcanic activity
- Distribution of fauna
- Distribution of flora
- Slope failure
- Soil erosion & sedimentation
- Cliff retreat

Geosites along the coast

- Damage of trails
- Air monitoring
- Precipitation
- Snow depth
- Photomonitoring
 - Manmade landform
 - Natural landform
 - Collapse of vertical cliffs
- Soil & sediment accumulation
- Soil erosion
- Soil quality
- Seismicity
- Monitoring of vegetation
- Fossil conservation
- Erosion by wave action and typhoons

Monitoring of the Manjang Cave

- Pollution (lampenflora & dust)
- Lighting system
- Air monitoring
- Water monitoring
- Photomonitoring of speleothems and microtopography
- Safety controls
- Cave fauna
- 3D scan
- Crack checking
- Soil and sediments transported into the cave
- Seismicity
- Vibration by automobiles
- Outside vegetation

Photo-monitoring

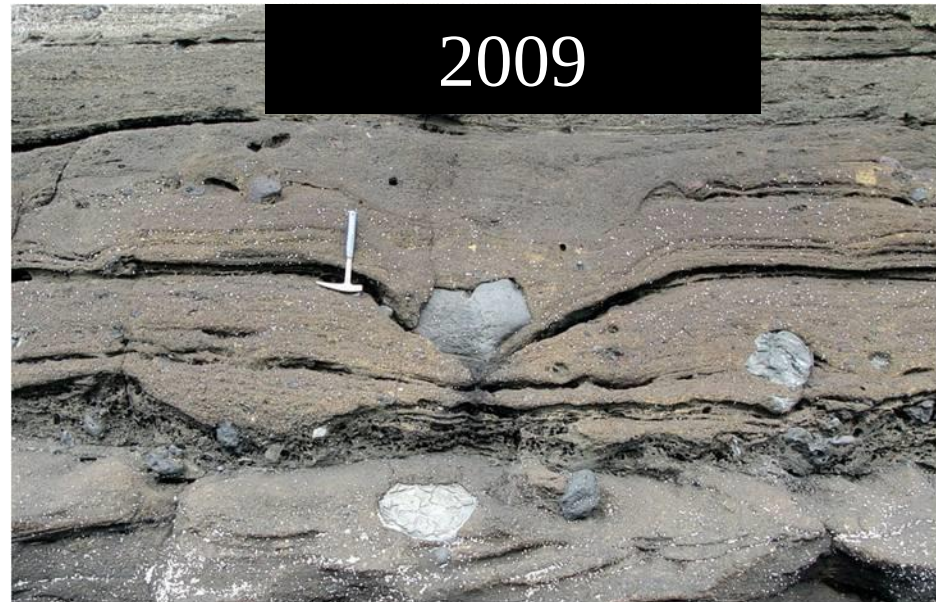
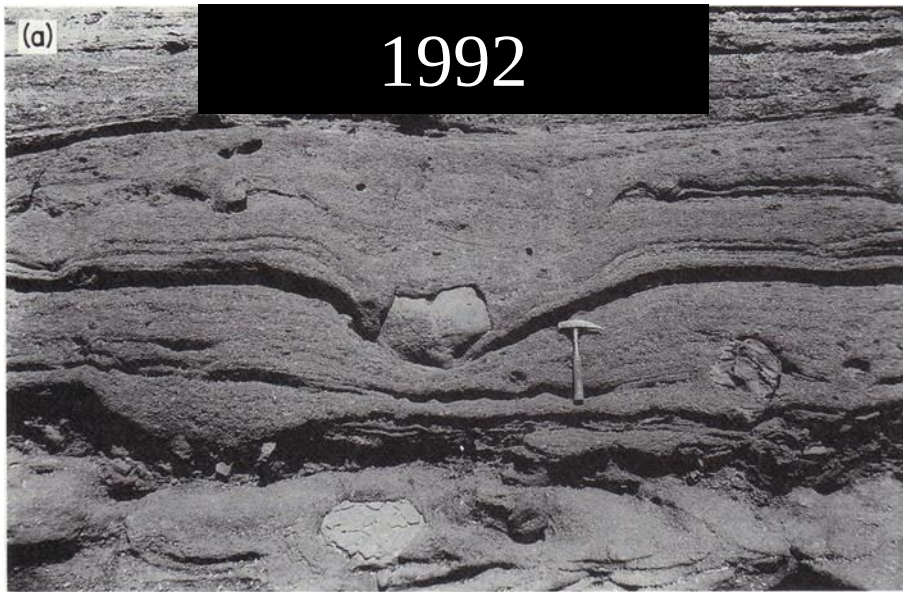
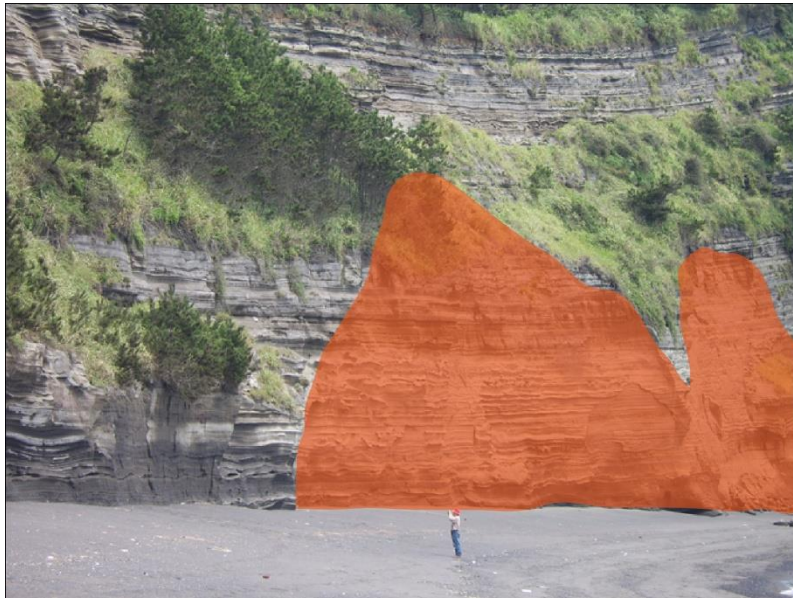


Photo-monitoring of Mt. Songaksan

- sensitive site along seashore
- composed of tuff deposits

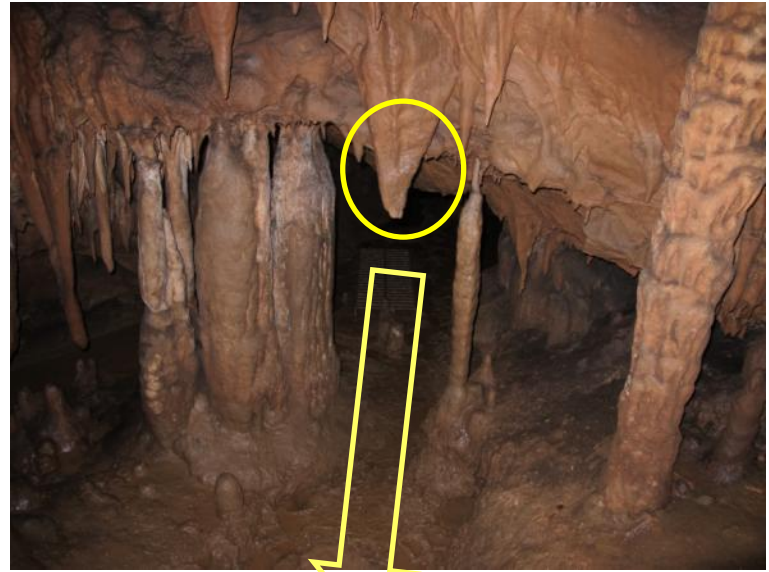
2005.09.10



2013. 04.02



Photo-monitoring



Monitoring of rock-fall



Monitoring of crack widening



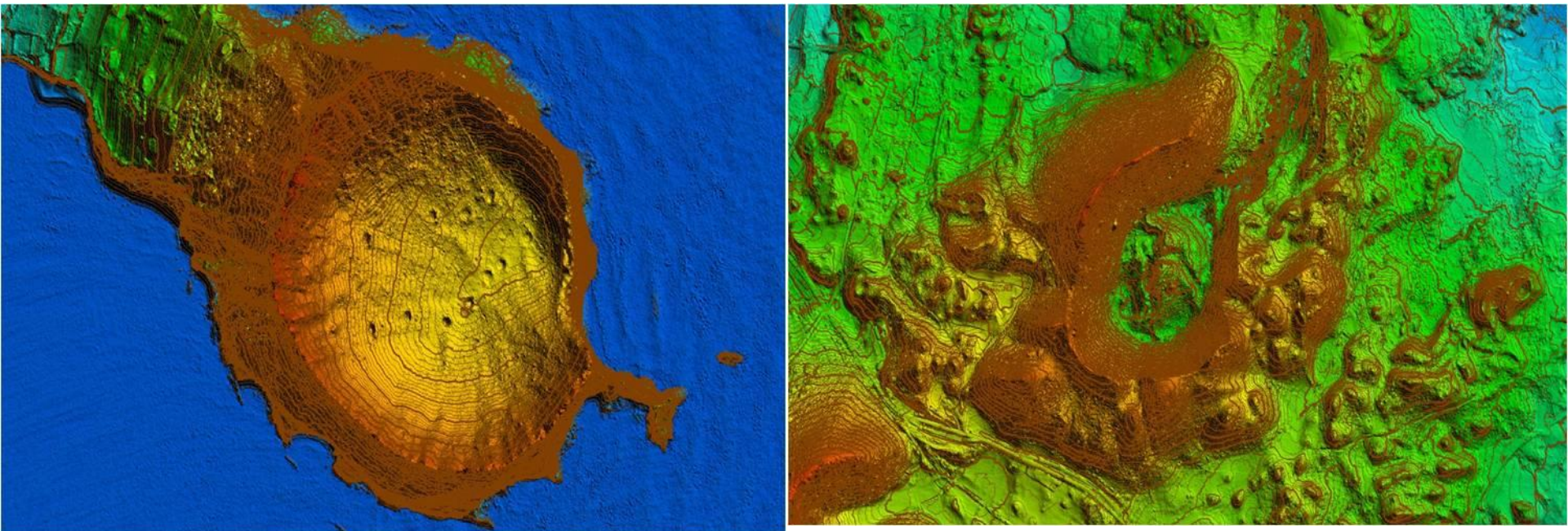
Air photo monitoring of coastal erosion

– Human footprint fossil site, Jeju Island

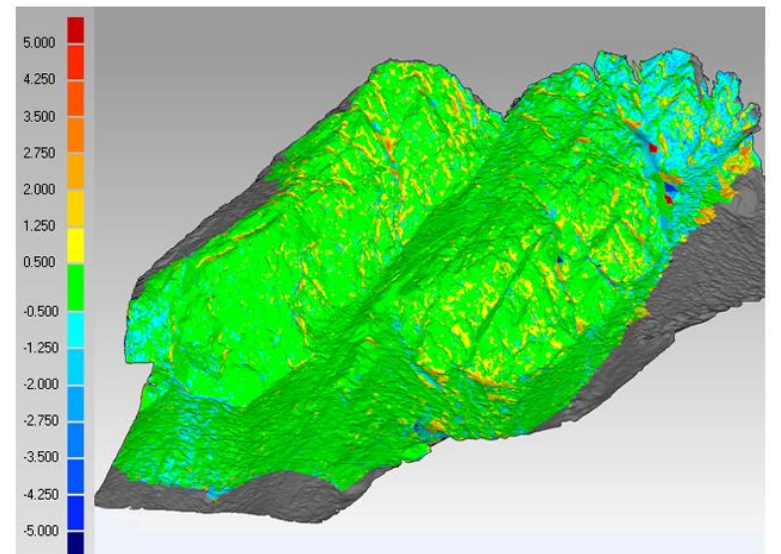
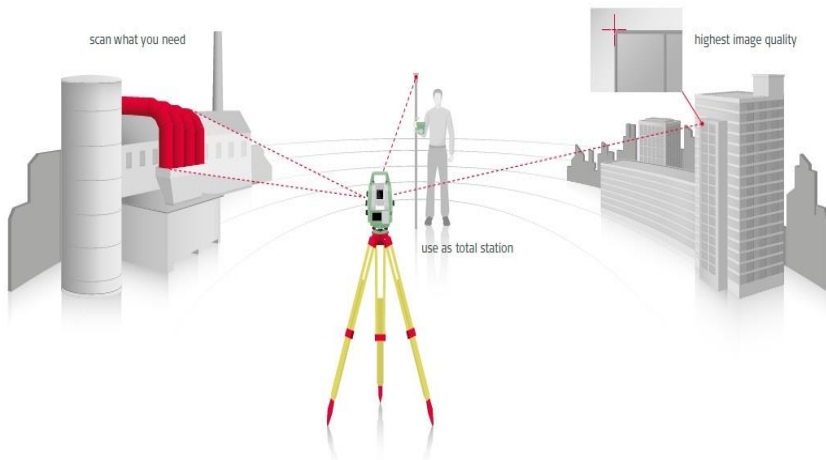


LiDAR monitoring of Seongsan Ilchulbong and Geomunoreum, Jeju Island, Korea

- Topographic map using 3D data by LiDAR (1 m-spaced contour lines)
 - Vertical error = ± 15 cm
 - Horizontal error = ± 50 cm



3D-scanning monitoring



Summary

- Global warming is a man-made disaster, but can be treated as a part of natural process on Earth.
- Natural disasters due to abrupt climate changes in WH sites, BR's and Global Geoparks cannot be avoided and prevented, but can be only adapted and mitigated by understanding natural processes and monitoring.
- Also, it is important that policy makers, managers of the sites and related stakeholders should have some knowledge and enough education about natural disasters related to global warming.

Thank you!

