

**GE1301**

**Climate Change and Extreme Weather**

Course Outline & Learning Methods

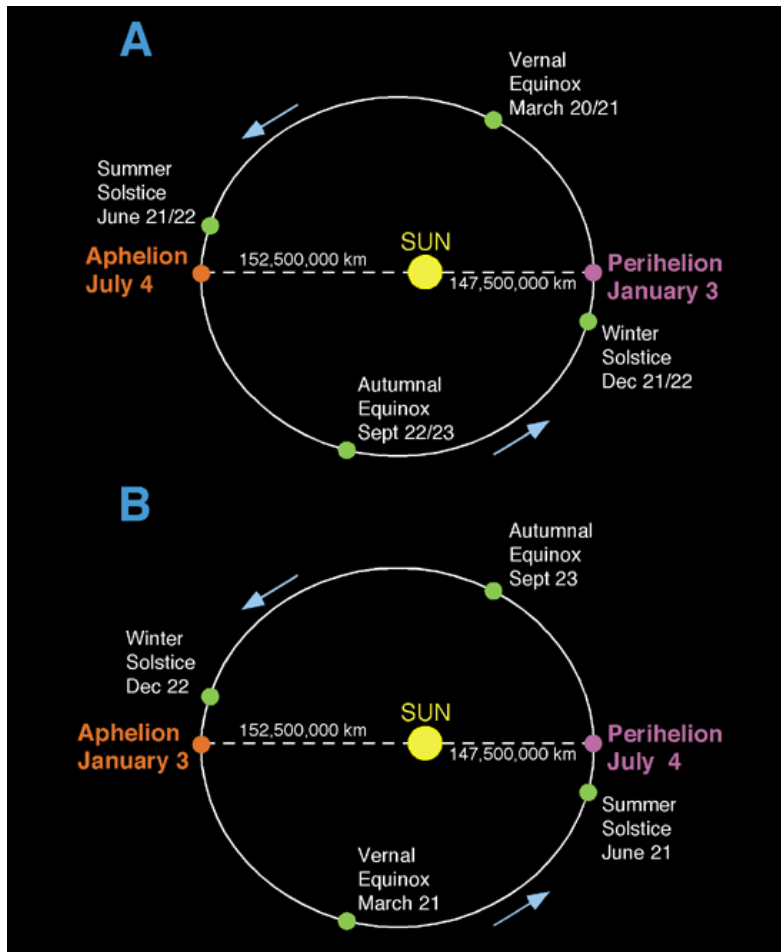
Contact: Dr. Wen ZHOU

([wenzhou@cityu.edu.hk](mailto:wenzhou@cityu.edu.hk))

# Course Objective

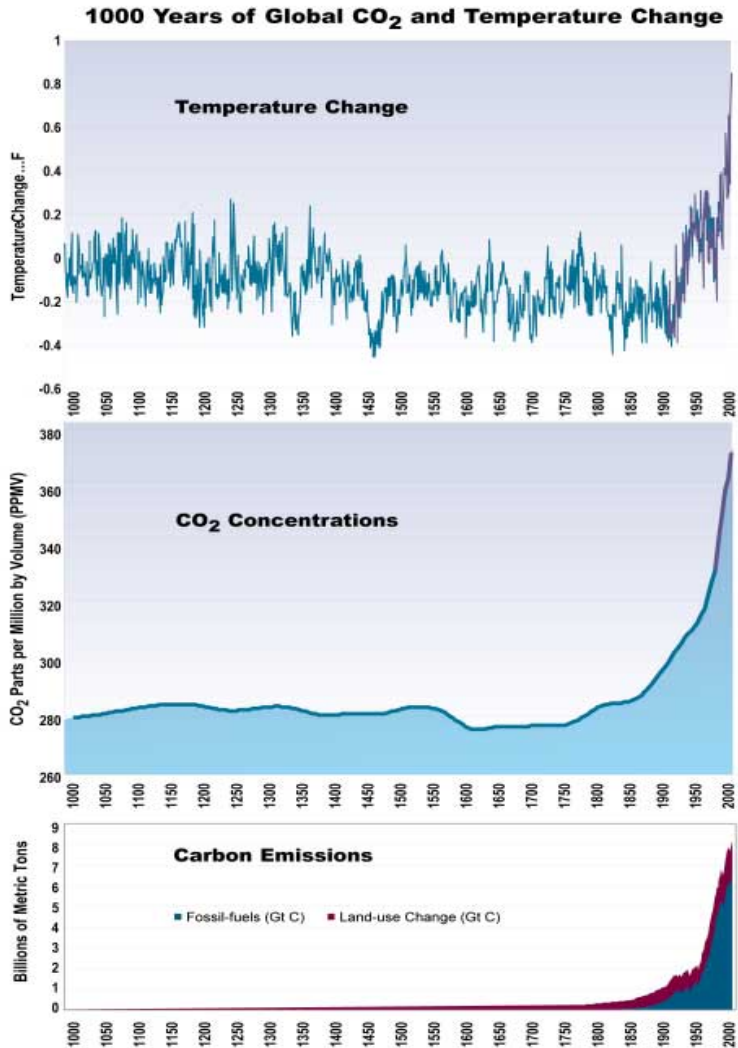
- to provide students with an understanding of contemporary climate issues;
- to raise his/her awareness of extreme weather in the changing world;
- to connect the scientific world with daily life; and
- to help students become better informed citizens and decision makers.

# How Does the Earth's Tilt Affect the Climate?



- The third cyclical variation is related to the changes in the tilt of the Earth's axis of rotation over a 41,000 year period. During the 41,000 year cycle the tilt can deviate from approximately  $22.5$  to  $24.5^\circ$ .
- At the present time, the tilt of the Earth's axis is  $23.5^\circ$ . When the tilt is small, there is less climatic variation between the summer and winter at middle and high latitudes. Winters tend to be milder and summers cooler.

# Our Changing Climate History

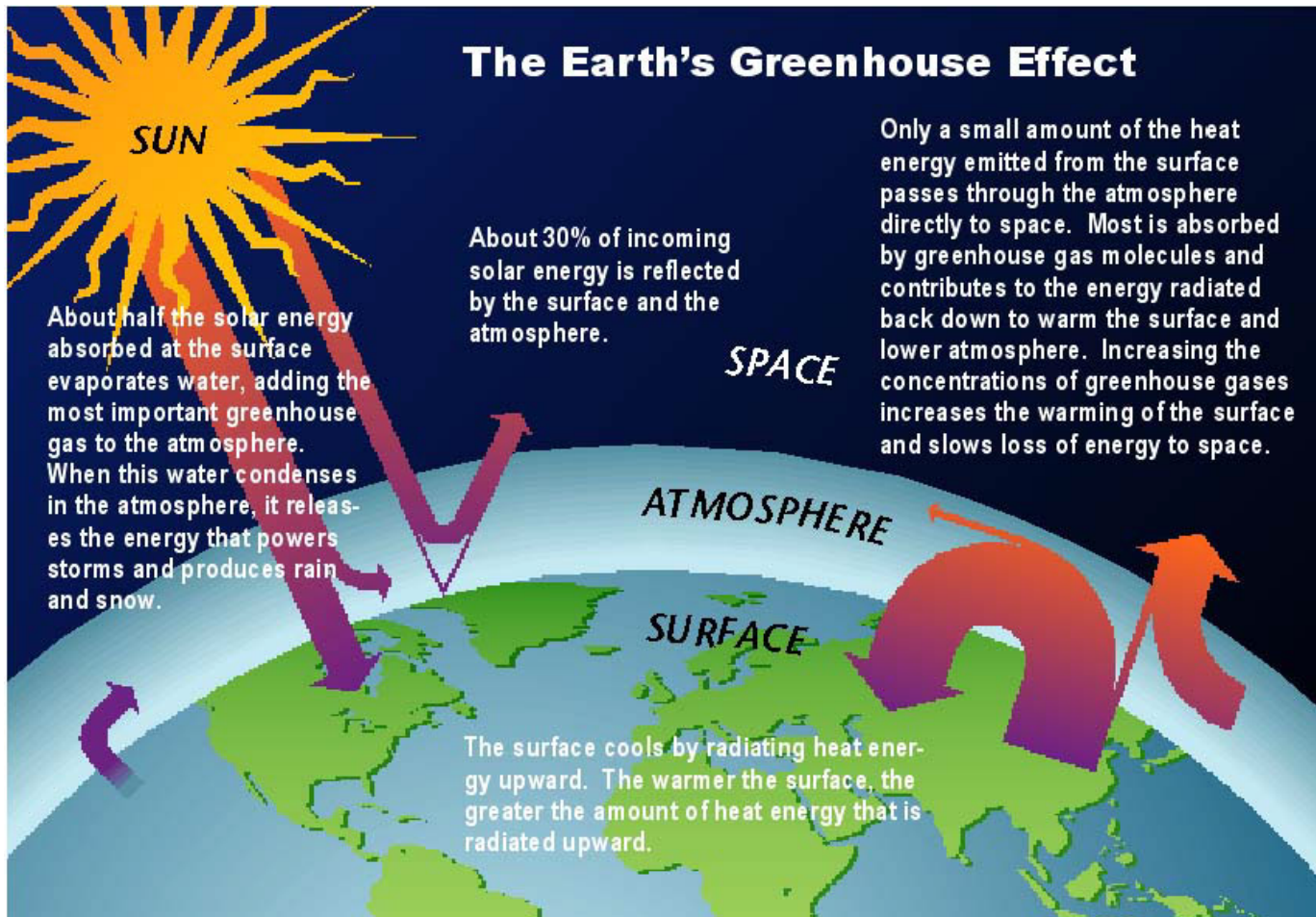


- **Temperature Change:** reconstruction of annual-average Northern Hemisphere surface air temperatures derived from historical records, tree rings, corals (blue), and air temperatures are directly measured (purple).

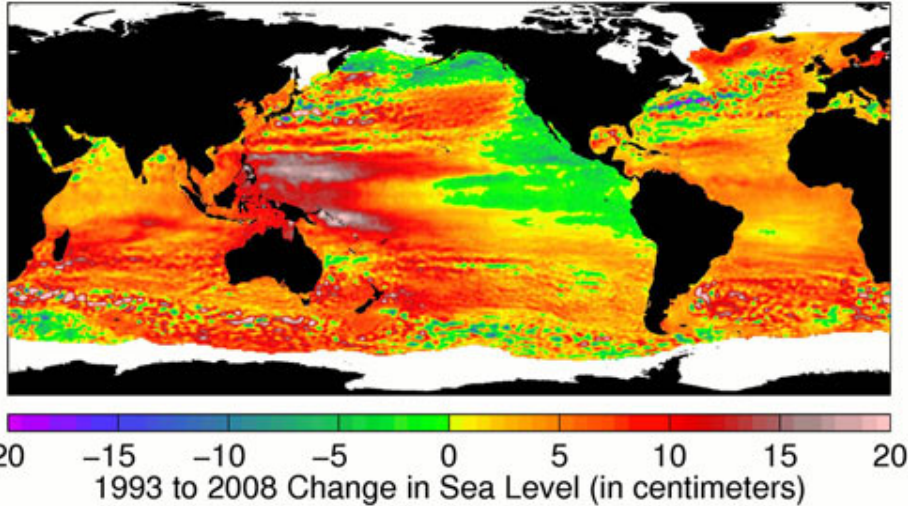
- **CO<sub>2</sub> Concentrations:** record of global CO<sub>2</sub> concentration for the last 1000 years, derived from measurements of CO<sub>2</sub> concentration in air bubbles in the layered ice cores drilled in Antarctica (blue line) and from atmospheric measurements since 1957.

- **Carbon Emissions:** reconstruction of past emissions of CO<sub>2</sub> as a result of land clearing and fossil fuel combustion since about 1750 (in billions of metric tons of carbon per year).

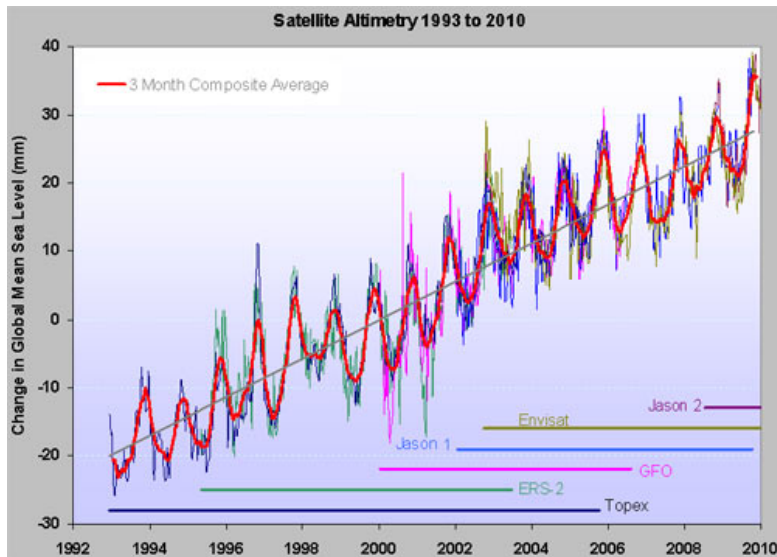
# Greenhouse Effects



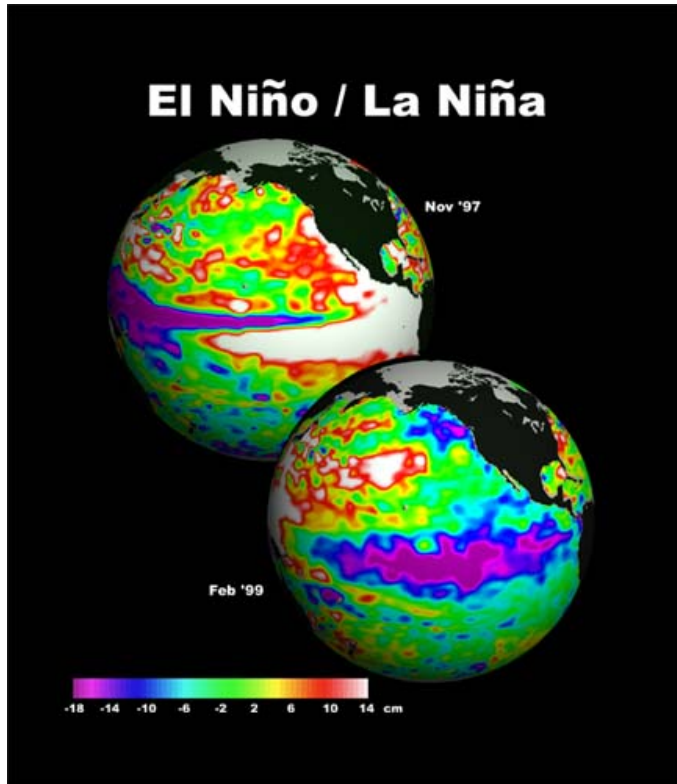
# Sea Level Rise and Our Future



- Sea level changes between 1993 and 2008 from TOPEX/Poseidon, Jason-1 and Jason-2 satellite altimeters.
- The oceans are colour coded for changes in mean sea level. Yellow and red regions show rising sea level, while green and blue regions show falling sea level. White regions are missing data during parts of the year.
- On average, the global sea level is rising, but complex regional variations are superimposed on this.



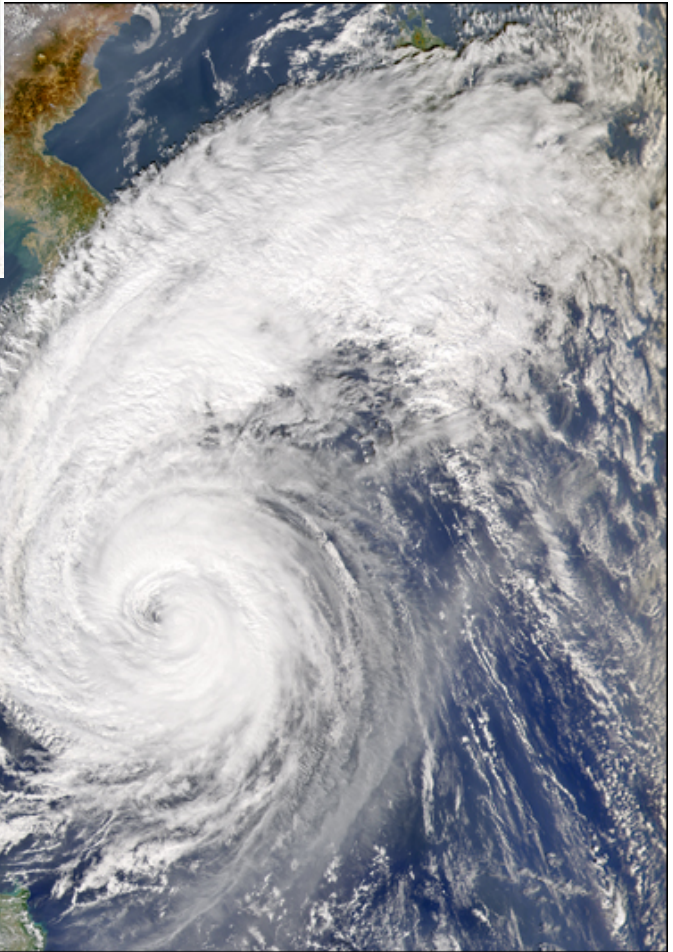
# ENSO and Disastrous Climate



- ENSO is composed of an oceanic component, called El Niño (or La Niña, depending on its phase), which is characterized by warming or cooling of surface waters in the tropical eastern Pacific Ocean, and an atmospheric component, the Southern Oscillation, which is characterized by changes in surface pressure in the tropical western Pacific.
- The two components are coupled: when the warm oceanic phase (known as El Niño) is in effect, surface pressures in the western Pacific are high, and when the cold phase is in effect (La Niña), surface pressures in the western Pacific are low.



# Tropical Typhoon v.s. Global Warming





# Carbon Footprint



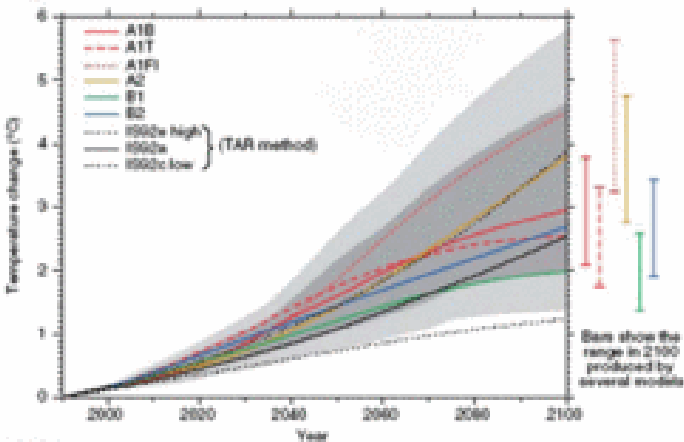
- **To calculate your full carbon footprint (the part of your lifestyle you are most interested in, e.g. your flights. ).**
- **To offset / neutralize your emissions through one of our climate-friendly projects.**



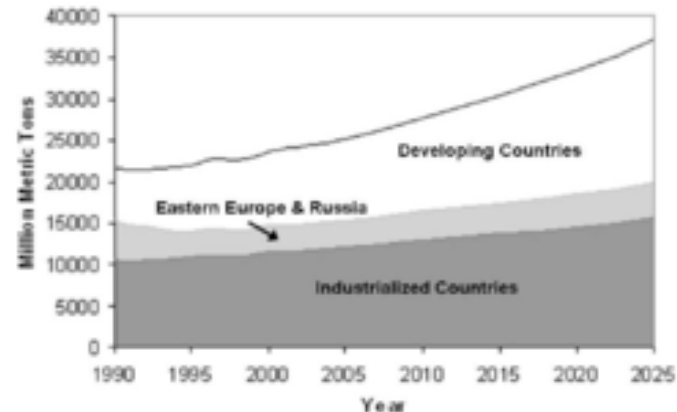
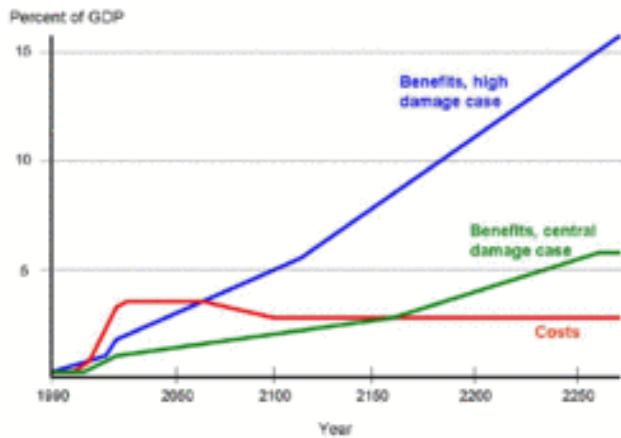
- **Sources of our calculations**
- The calculations for primary emissions are based on conversion factors sourced from:
- Department for Environment, Food and Rural Affairs (DEFRA) - UK
- World Resource Institute (WRI) Greenhouse Gas (GHG) Protocol
- Vehicle Certification Agency (VCA) - UK
- US Environmental Protection Agency (EPA) - USA
- US Department of Energy (DOE) - USA
- Green House Office - Australia
- Standards Association (CSA) GHG Registries - Canada



# Carbon Taxes



- Climate change differs from any other problem that, as collective humanity, we face today. If it goes unchecked, the consequences are likely to be catastrophic for human life on Earth.
- Political action and intervention, at local, national and international levels, are going to have a decisive effect on whether or not we can limit global warming, as well as how we adapt to that already occurring (e.g. Alternative Carbon Taxes on Fossil Fuels )



# Recommended Reading

- **Reference Book(s):**

- The Greenhouse Effect, Diana Falloon (NSW, 1993)
- Meteorology Today: An Introduction of Weather, Climate, and the Environment, C. Donald Ahrens (Brooks/Cole, 6th edition, 2000)
- An Introduction to Atmospheric Physics, D G Andrews (Cambridge U Press, 2000)
- An Introduction to Dynamic Meteorology, J R Holton (Academic Press, 3rd edition, 1992)
- Fundamentals of Atmospheric Physics, M L Salby (Academic Press, 1996)
- The Physics of Atmospheres, J T Houghton (Cambridge, 3rd edition, 2002)
- Understanding Weather and Climate, E Aguado and J E Burt (Prentice Hall, 2001)

- **Online Resources:**

- <http://weather.cityu.edu.hk/>
- <http://www.co2science.org/subject/e/ensoew.php>
- <http://www.cityu.edu.hk/gcacic/index.htm>
- <http://www.hko.gov.hk/contente.htm>
- <http://www.aerospace-assault-on-planet-earth.com/>
- <http://www.koshland-science-museum.org/exhibitgcc/index.jsp>
- <http://www.cdc.noaa.gov/>

# Scheduled Activities

- 1.5 hrs lecture + 1.5 hrs tutorial including team projects (hands-on experiments), group presentations and group assessment exercises.
- The maximum class size is 60.
- Lectures: Introduction of basic concepts, ideas, and arguments.
- Group discussions/presentation: Students are required to work out well argued and defensible positions of their own through a process of collaboration.
- Pop quiz: designed to test and enhance students' grasp of basic concepts and arguments.
- Hands-on experiments:
  - 1. analysis of sea level rise in Hong Kong
  - 2. analysis of each student's carbon footprint
- Assignment: Students are required to write a report on extremes events of their choice.

# Keyword Syllabus:

- Weather and climate in our lives
- Our changing climate history
- Sea level rise and our future
- El Niño events and disastrous climate
- Carbon footprint for a sustainable living
- Response to climate change