INTRODUCTION TO CLIMATE CHANGE SCIENCE AND IMPACTS ON URBAN AREAS

Febrauary16, 2015

TERI University, New Delhi

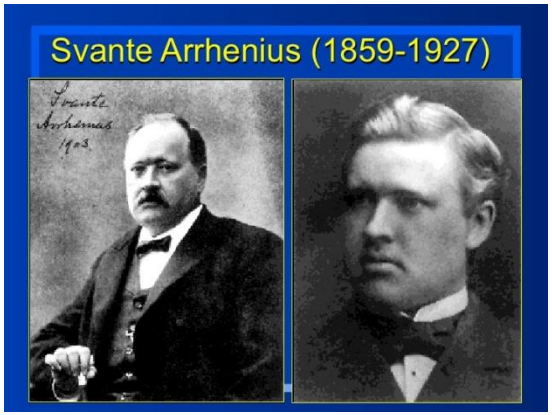
Aim of the lecture

To understand relationship between greenhouse gases and climate change

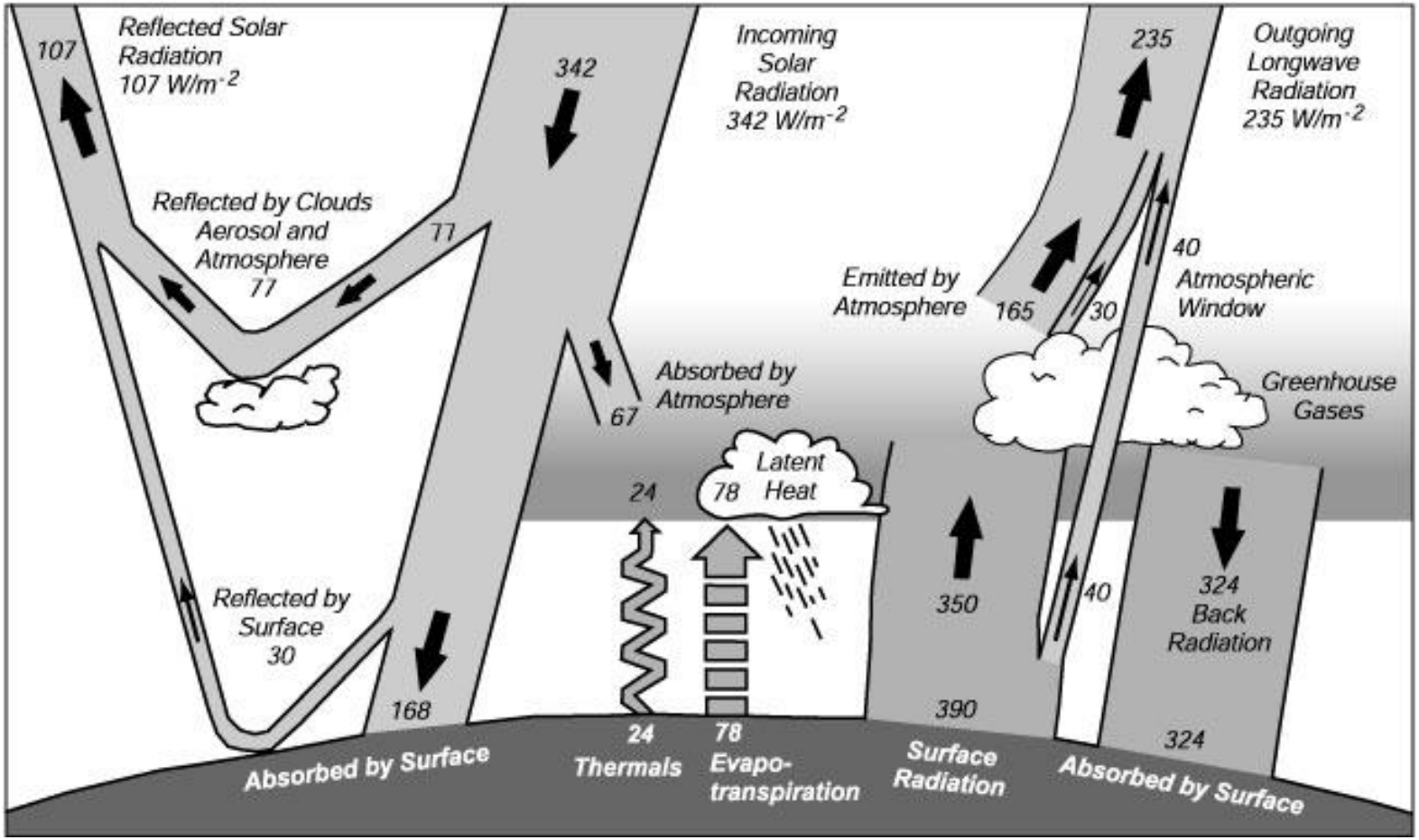
- Basic science which defines the global change
- What is earth's radiative balance and how greenhouse gases (GHG) affects it
- Concept of sources and sinks of GHG
- Further we will build on this basic science to explain our choices and other actions related to greenhouse gases in order to understand why, how, when at what pace we should be reducing emissions of greenhouse gases in order to stabilize the concentration of greenhouse gases at safe levels.

Jean-Baptiste-Joseph Fourier
(1768-1830)

John Tyndall
(1820-1893)

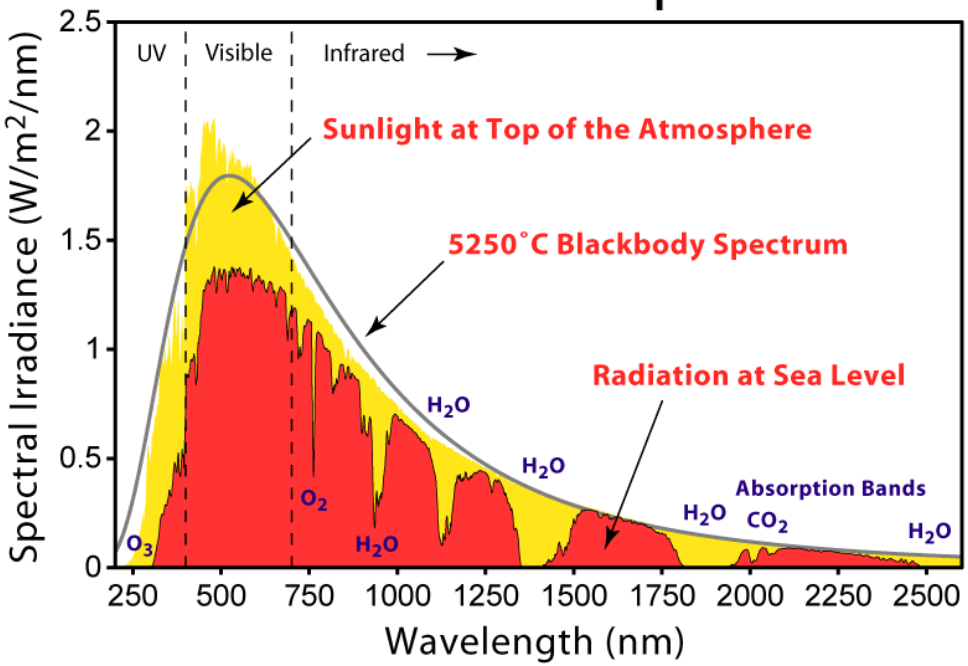


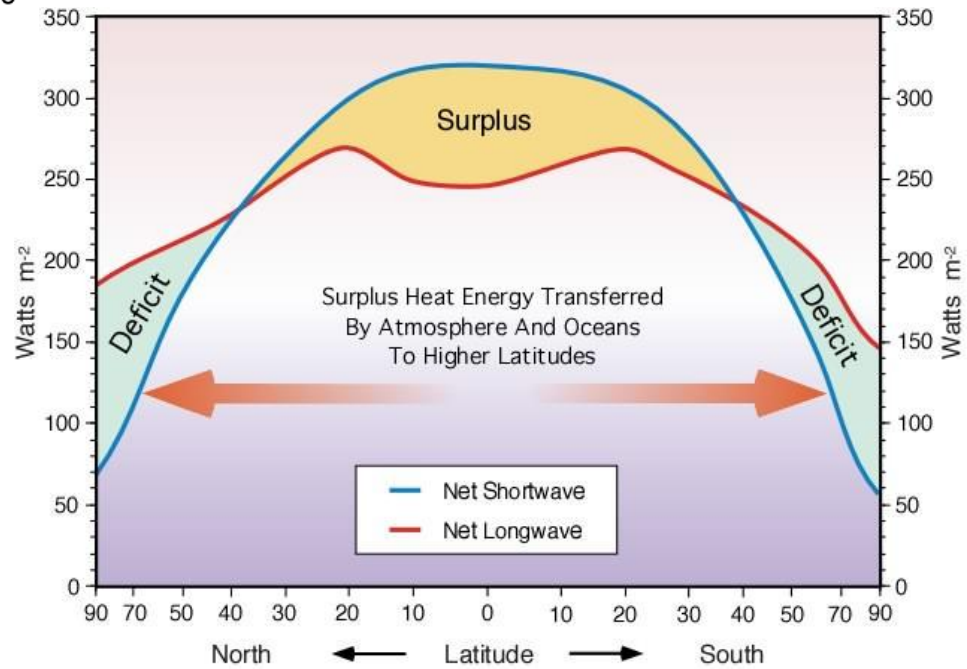
Earth's Radiation Balance



Source: Trenbreth et al, 2009

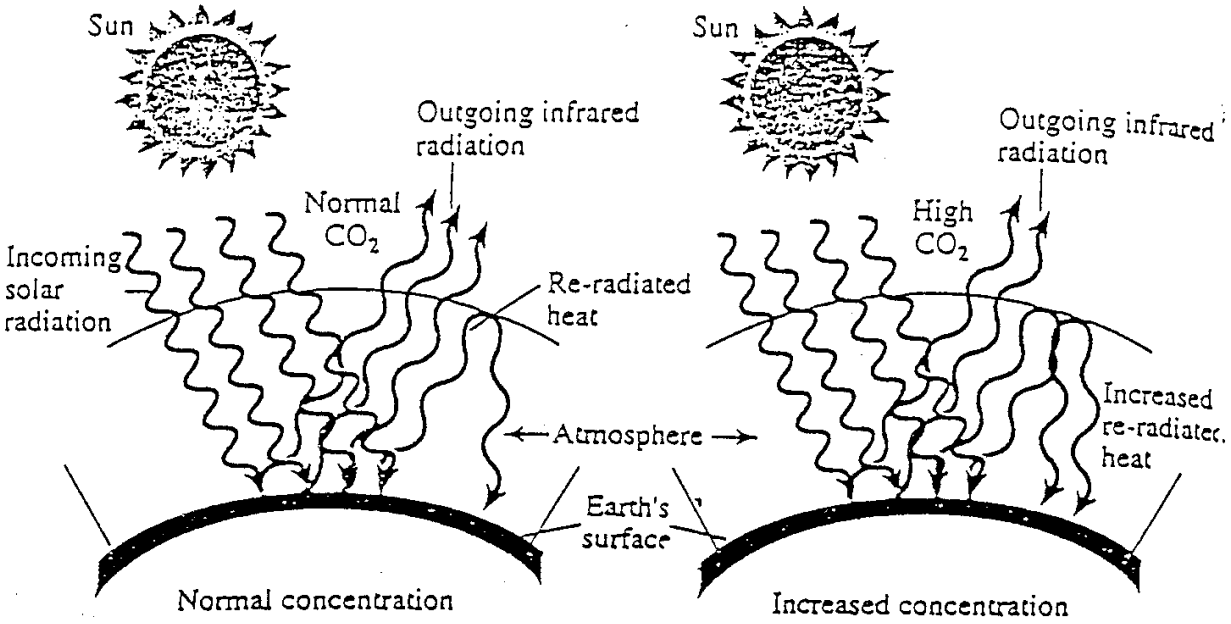
Solar Radiation Spectrum





Greenhouse gases

- H2O
- CO2
- CH4
- N2O
- O3
- CFCs
- SF6

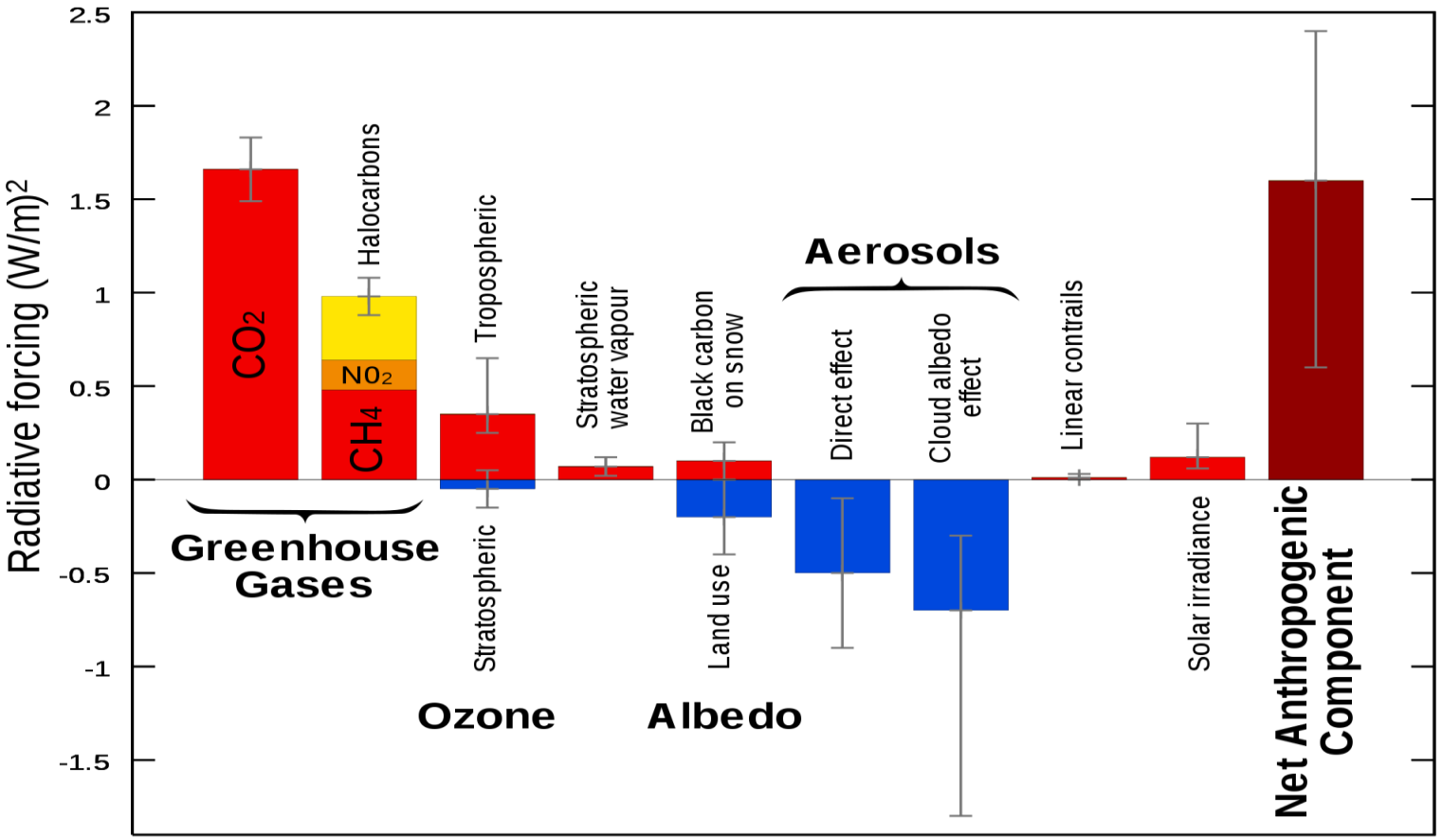


Enhanced greenhouse effect

Factors that determines the contribution of a greenhouse gas to global warming

- Concentrations
  - H2O and CO2 are the two biggest contributors to the atmospheric warming because of their higher concentrations.
- Lifetime
  - The longer-live a gas is, the higher the contribution. e.g. N2O contribution > CH4 because it has relatively high residence time
- Effectiveness as an infrared absorber
  - For example, CFC-11 and CFC-12 (based on chemistry and rotation)

Radiative Forcing Components



Black carbon emissions: product of incomplete combustion

- **The major component of PM from the Diesel Transportation Sector**
- **About 75% of PM from Diesel Mobile sources is BC**
- **The second largest contributor to global warming**
- **Contributes directly to melting of snow packs, glaciers, and sea ice**
- ***Biomass is fuel source for cooking/Heating for about 2.7Billion***
- ***Second largest source of Black Carbon; also CO/Methane/VOCs***

Ramanathan et al, 2013: CARB 08-323

Photo:Ramanathan, 2009

Health and air pollution in urban area

A Major New Study was released last year:

A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990—2010: a systematic analysis for the Global Burden of Disease Study 2010:

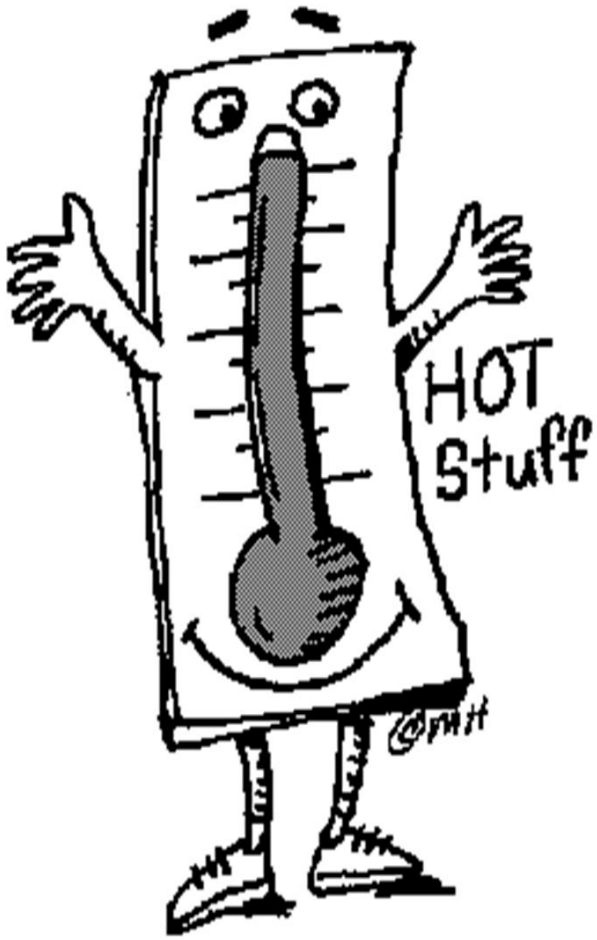
Lin et al, LANCET, 2013

Household air pollution from solid fuels accounted for 3·5 million (2·7 million to 4·4 million) deaths.

Ambient particulate matter pollution accounted for 3·1 million (2·7 million to 3·5 million) deaths

Climate change

- Long term average identifiable changes in climate variables is known as climate change
  - When due to natural processes, it is usually referred to as global climate variability
  - Usually refers to changes forced by human activities that change the atmosphere

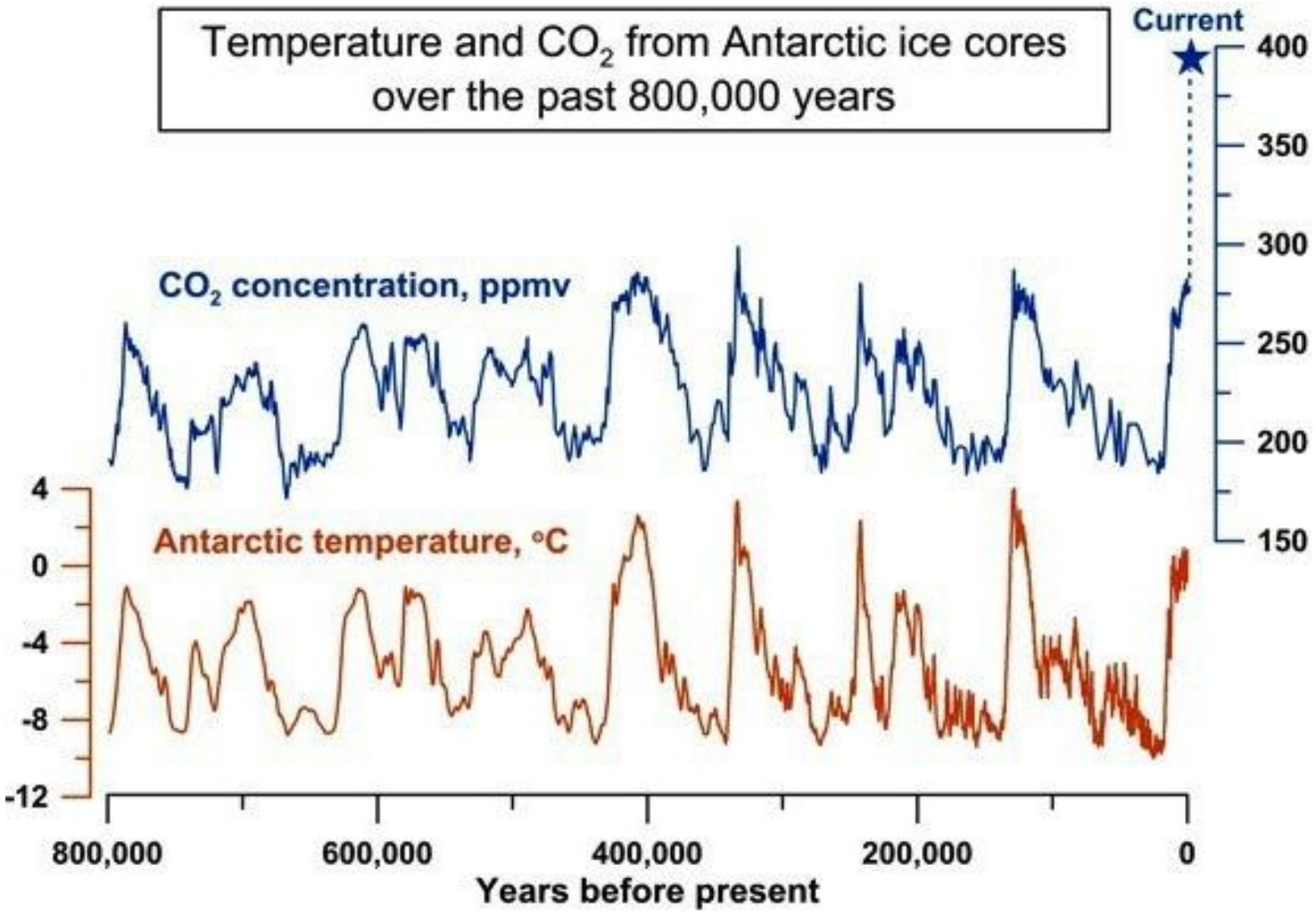


Causes of climate change

- Natural
- Natural processes
  - Volcanoes
  - Tectonic plate movement
  - Changes in the sun

- Anthropogenic
- Human activities – any activity that releases “greenhouse gases” into the atmosphere

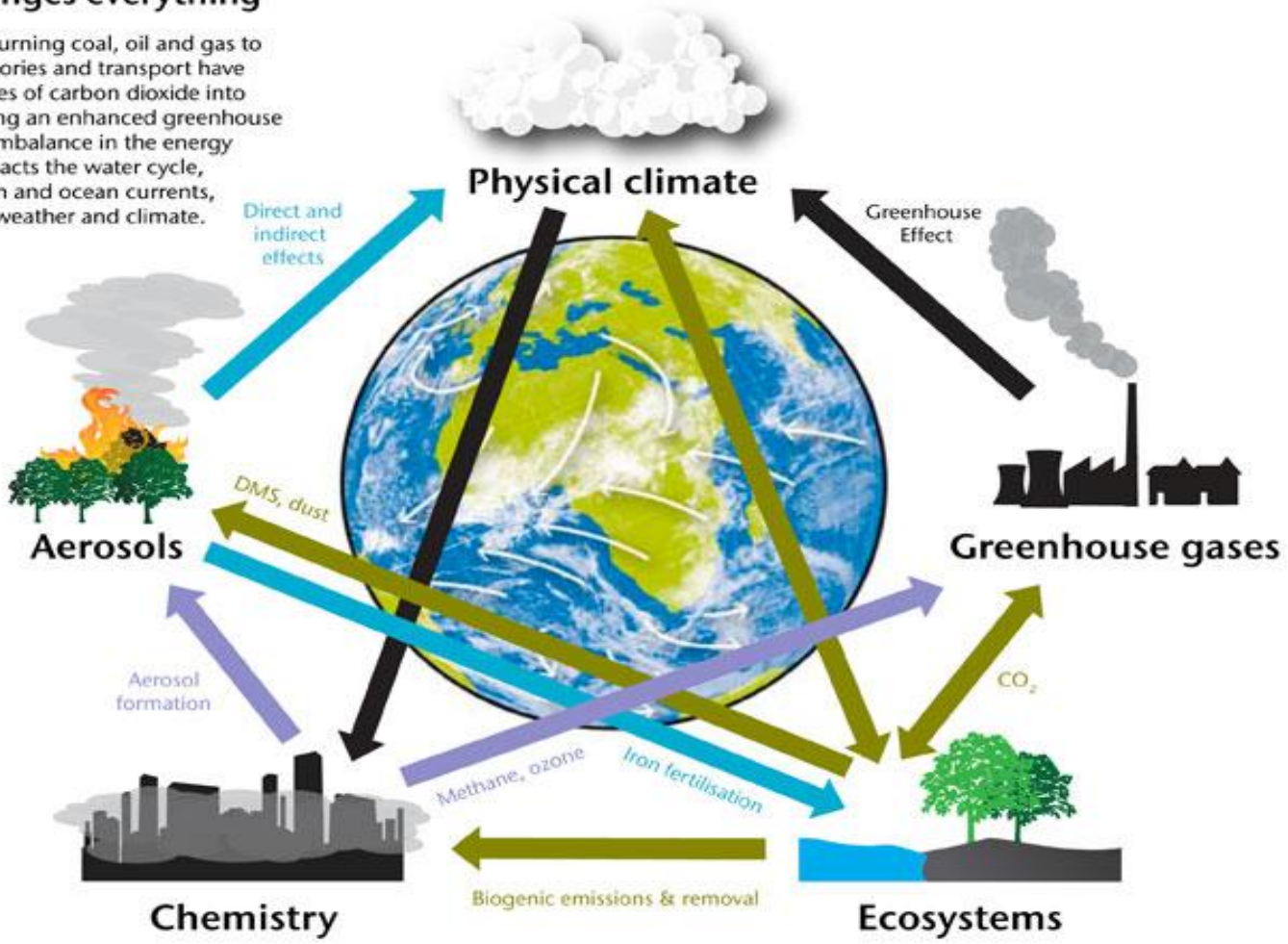
Evidences: Global change


Temperature and CO_2 from Antarctic ice cores over the past 800,000 years
Current
400
350
300
250
200
150
CO_2 concentration, ppmv
4
0
-4
-8
-12
Antarctic temperature, °C
800,000
600,000
400,000
200,000
0
Years before present

The Earth System

One thing changes everything

Human activities like burning coal, oil and gas to power our homes, factories and transport have released huge quantities of carbon dioxide into the atmosphere, causing an enhanced greenhouse effect. This causes an imbalance in the energy cycle that, in turn, impacts the water cycle, atmospheric circulation and ocean currents, leading to changes in weather and climate.

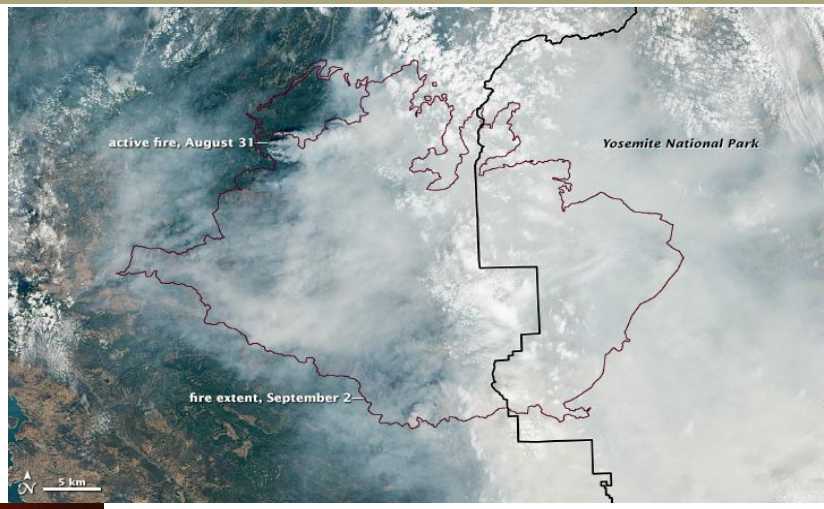


Phillipines, November 2013
Haiyan Typhoon

Flash Floods in-Himalayas 2012

Uttrakhand Monsoon Floods- June 2013

Yosemite, California
Rim Fire, August 2013

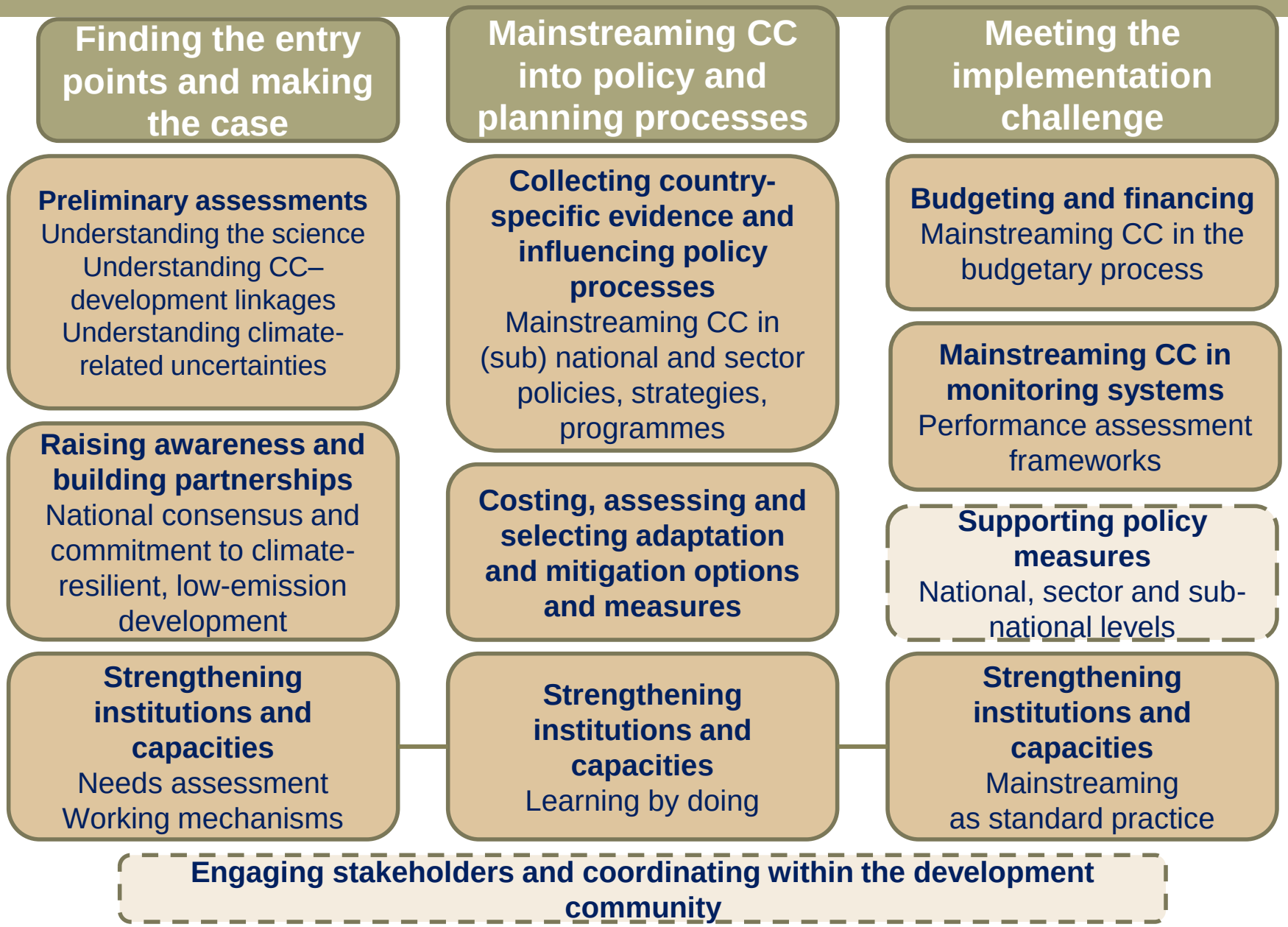


Towards a new development path

The **current path of development** has been characterized by high concurrent GHG emissions

Committing to alternative development paths requires **major changes** in a wide range of areas:

- Economic structure
- Urban design
- Transport infrastructure
- Consumption patterns
- Demography



Adapted from: UNDP-UNEP (2009)

Important learning:

- Climate change is a reality
- Radiation balance of earth can be disturbed by three ways:
  1. By changing the incoming solar radiation,
  2. by changing the fraction of solar radiation reflected
  3. By altering the long wave radiation return back to the space
  - Climate response directly or indirectly by different feedback mechanisms to such changes

Gandhi was once asked if he expected India to attain the same standard of living as Britain. He replied:

It took Britain half the resources of the planet to achieve this prosperity. How many planets will a country like India require!