Climate Change

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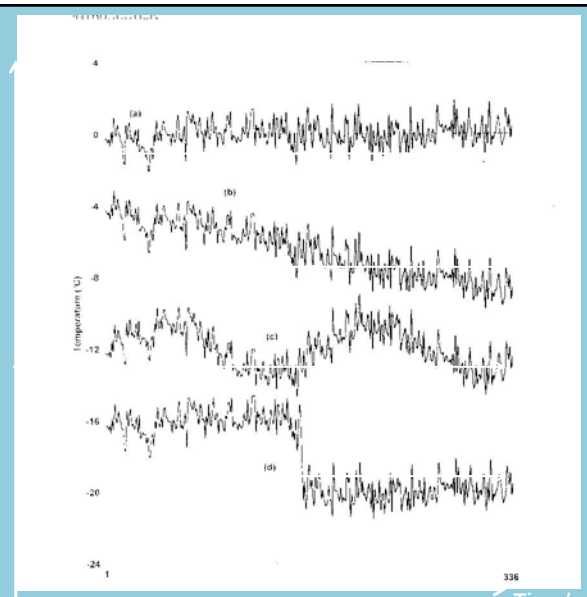
Weather Climate

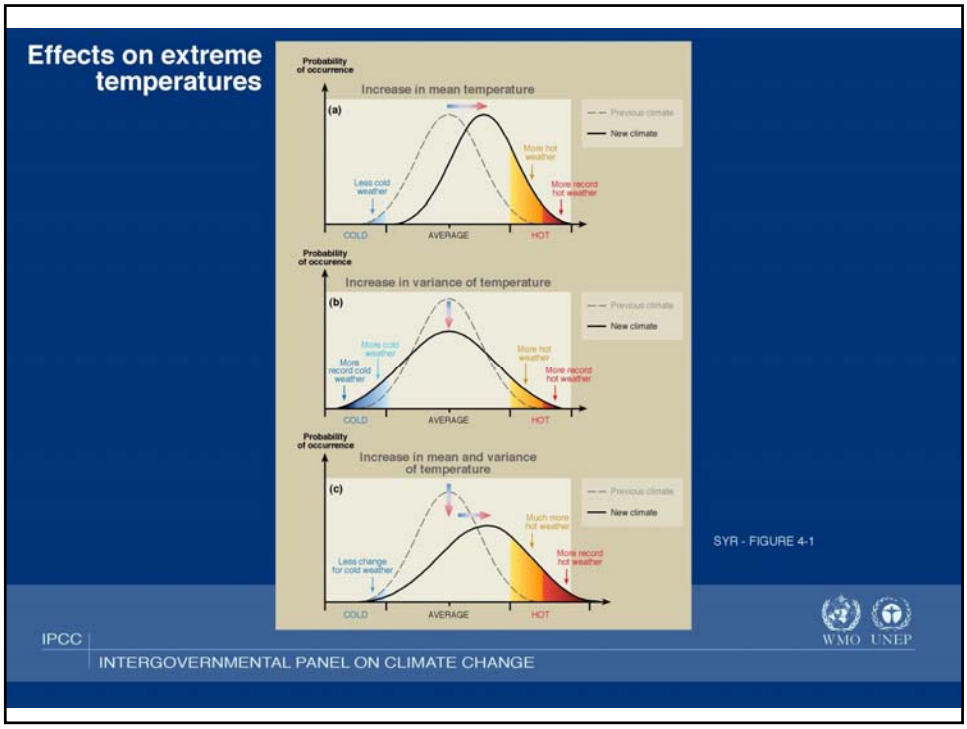
Climate - average weather
It includes patterns of temperature, precipitation (rain or snow), humidity, wind and ….

Climate patterns shape natural ecosystems,

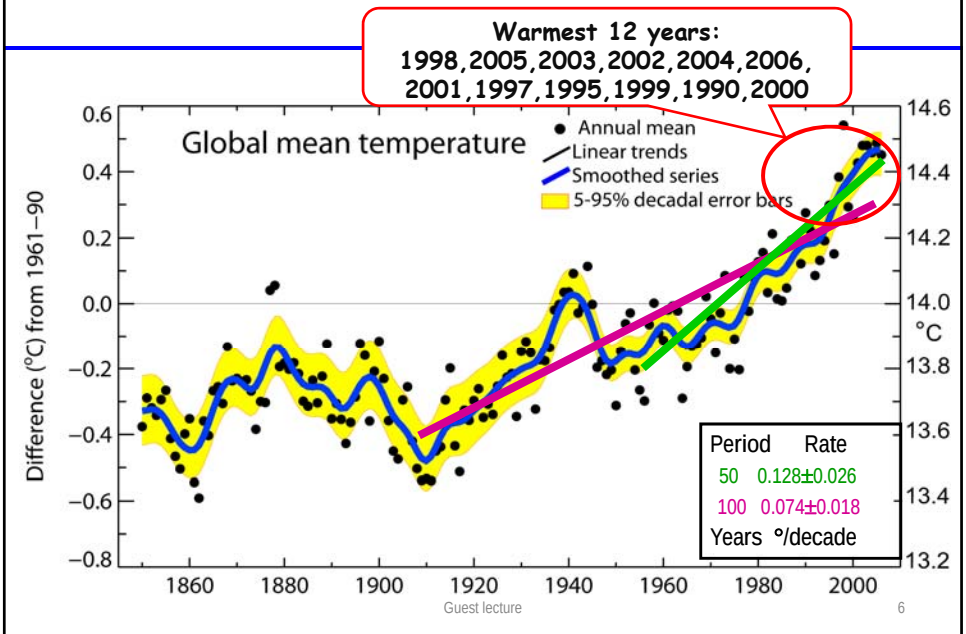
- Our climate is rapidly changing with disruptive impacts
- faster than any seen in the last 2,000 years
- progressively worsening impacts.

- Climate is the average weather at a given point and time of year, over a long period (typically 30 years).
- We expect the weather to change a lot from day to day, but we expect the climate to remain relatively constant.
- If the climate doesn't remain constant, we call it climate change.
- The key question is what is a significant change – and this depends upon the underlying level of climate variability

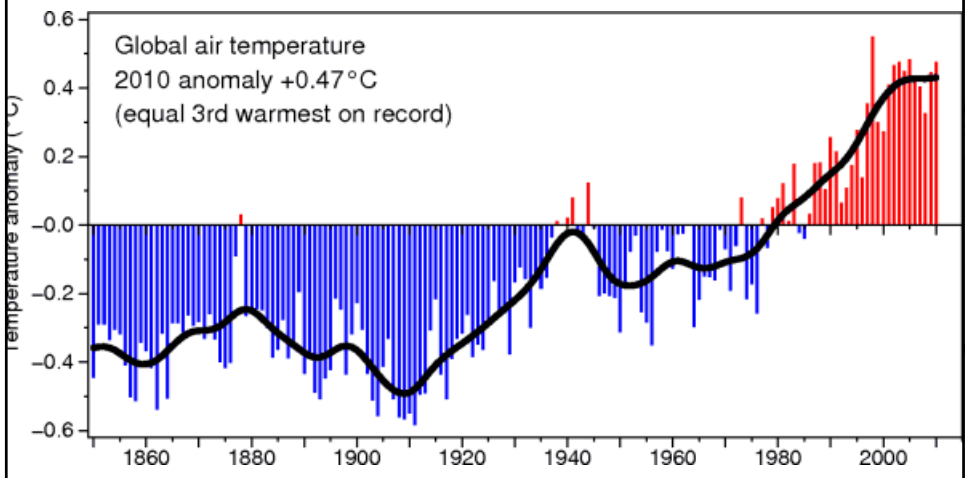




Global mean temperatures are rising faster with time

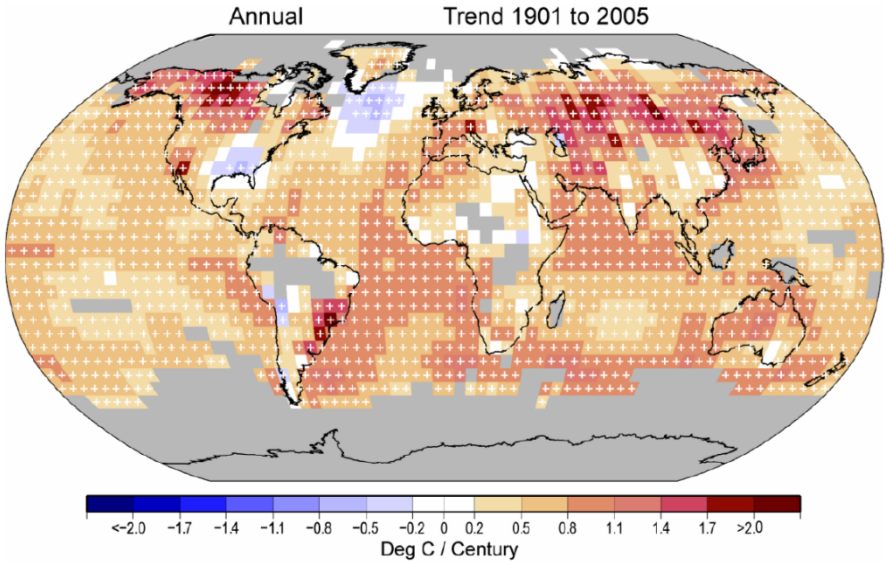


Global surface temperature 1855-2010



How is this curve calculated?

Observed surface temperature trend

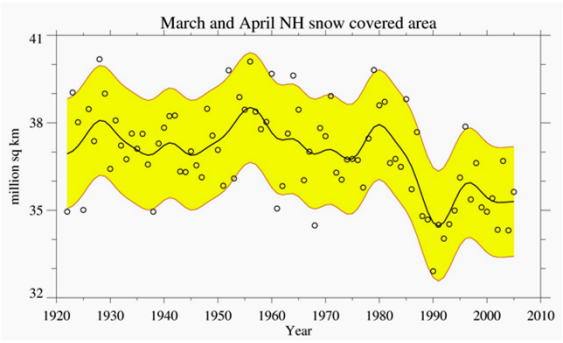


Trends significant at the 5% level indicated with a '+'. Grey: insufficient data

Other evidence of Climate Change

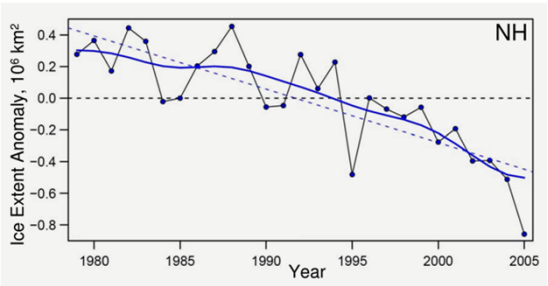
Glacier retreat

1875 2004



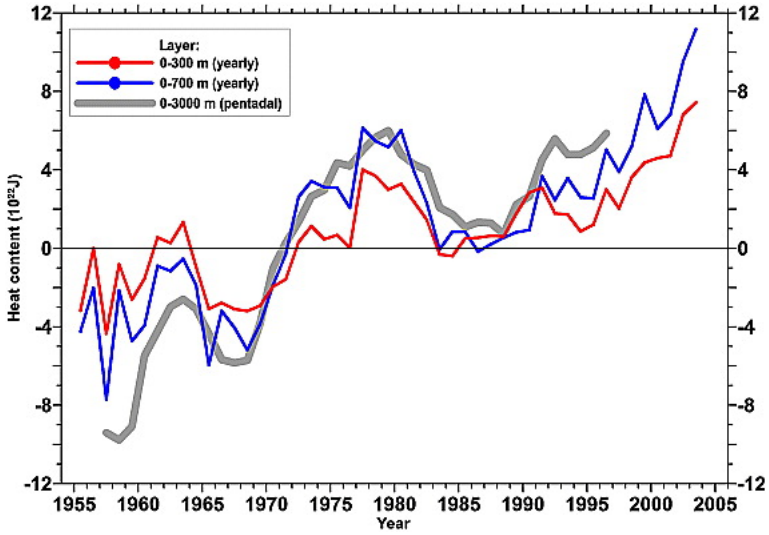
Snow cover and Arctic sea ice are decreasing

Spring snow cover shows 5% stepwise drop during 1980s



Arctic sea ice area decreased by 2.7% per decade

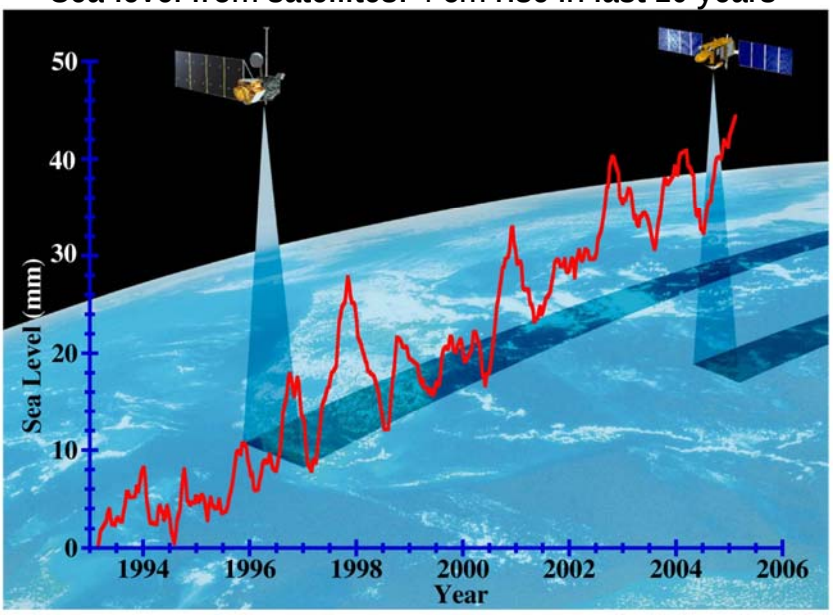
Rise in global ocean heat content 1955-2005

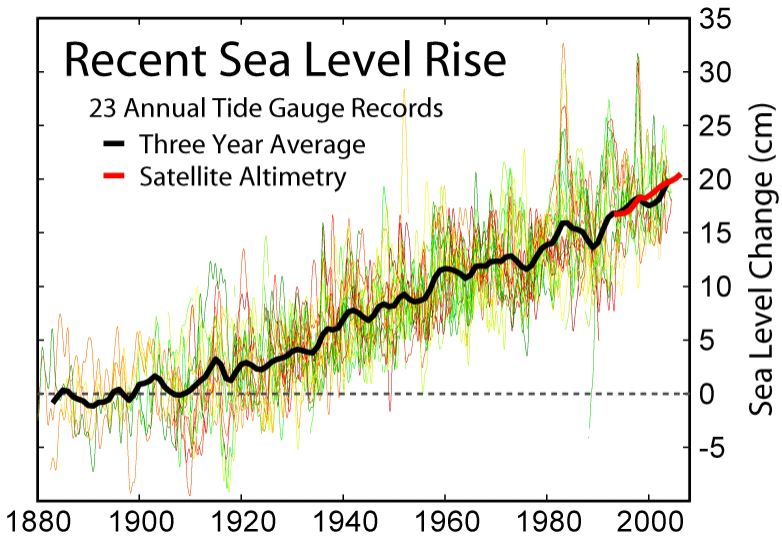


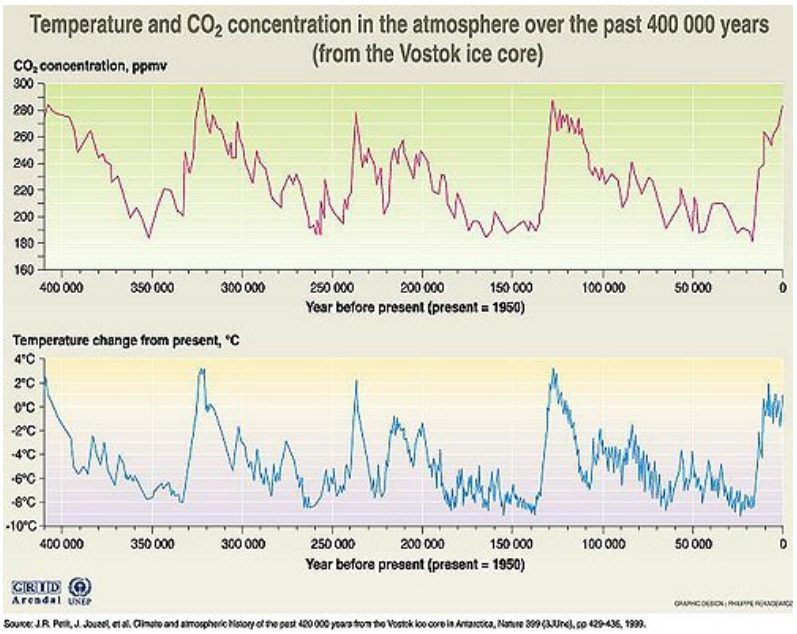
Some ups and downs, but clear overall increase

Levitus et al., 2005, GRL

Sea-level from satellites: 4 cm rise in last 10 years

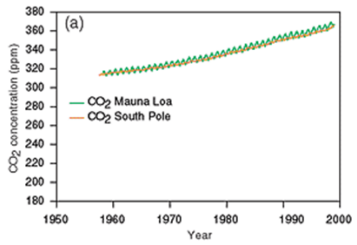


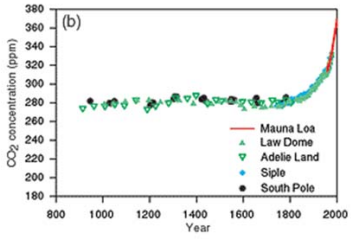




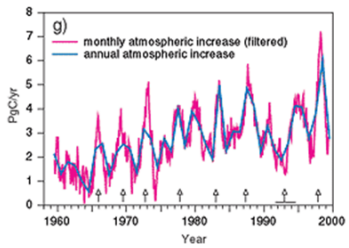
Source: J.R. Petit, J. Jouzel, et al. Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3JUne), pp 429-436, 1999.

Variation of CO2 in different time scales



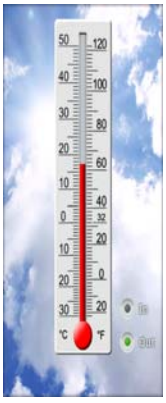


Rate of increase of CO_2 in the atmosphere



Measurements

Thermometers

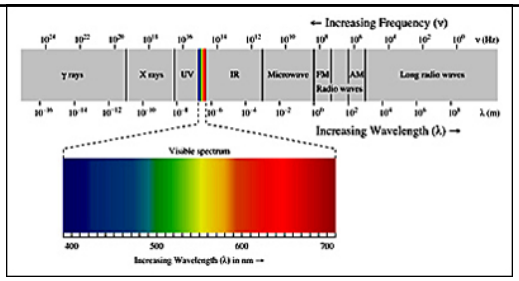


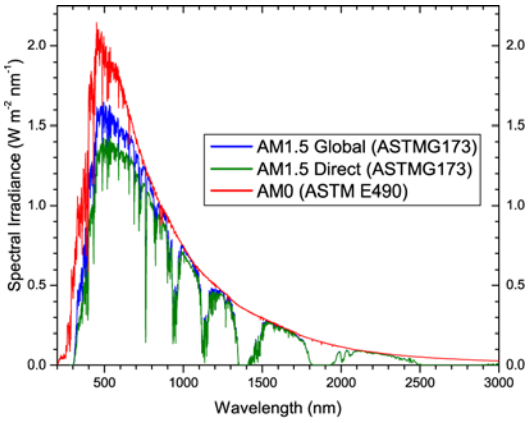
A **thermometer** has two important elements:

- ➢a temperature sensor (bulb on a mercury-in-glass thermometer)
  ✓some physical change occurs with temperature
- ➢some means of converting this physical change into a numerical value

Measurements

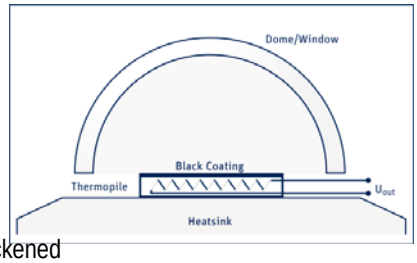
Solar Spectrum





Measurements

Pyranometers



thermoelectric detection

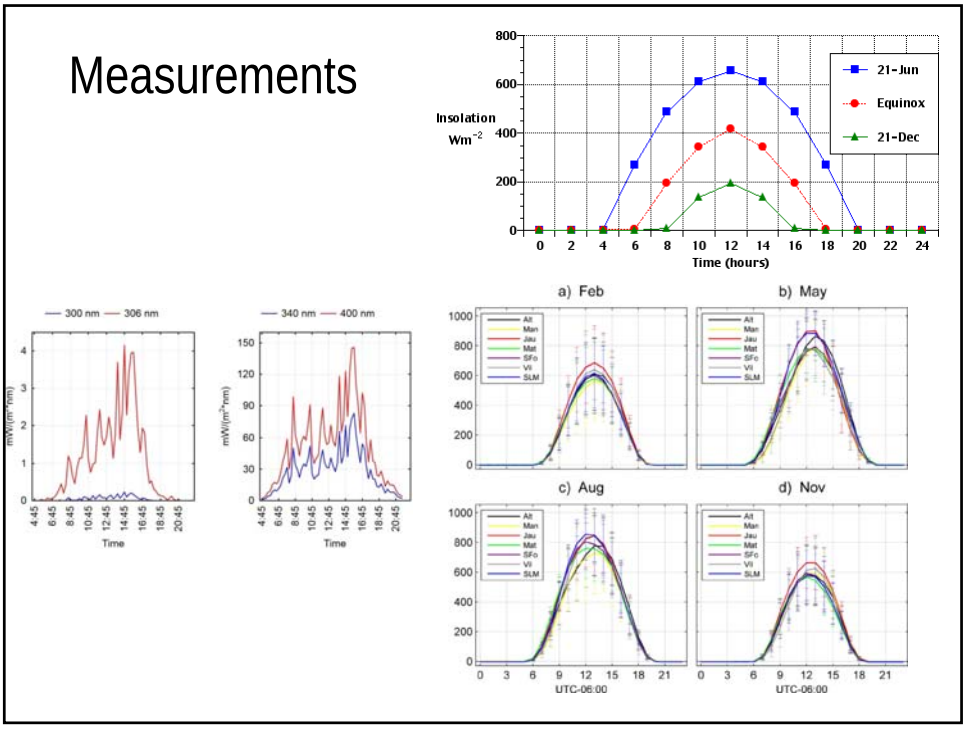
incoming radiation - absorbed by a horizontal blackened surface

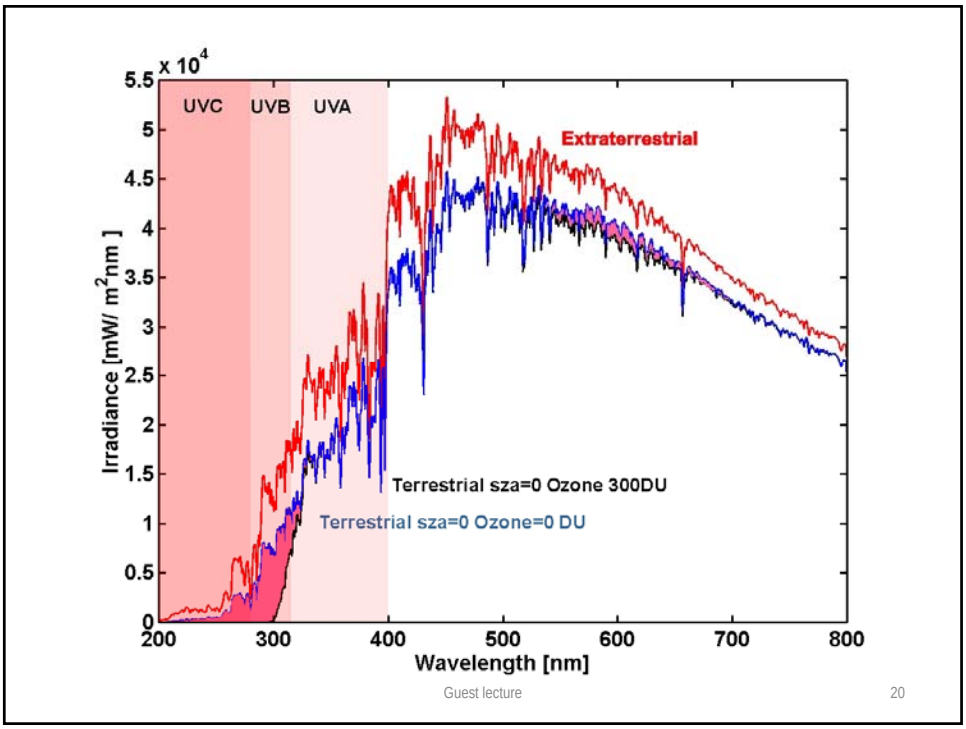
resulting increase of temperature is measured through thermocouples connected in series or series-parallel to make a thermopile

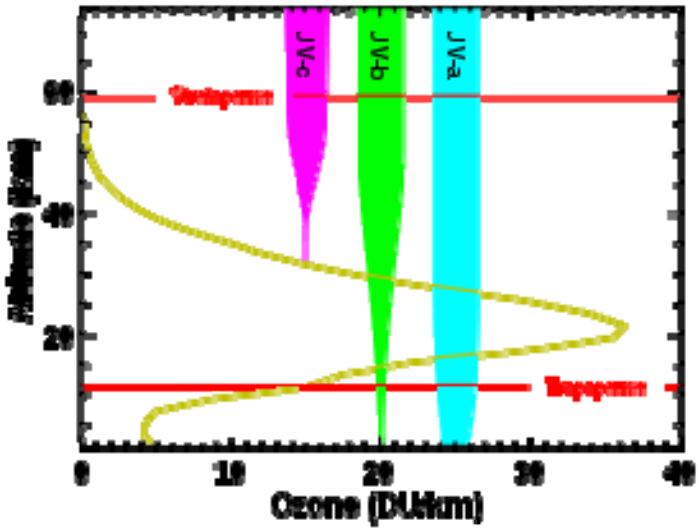
active (hot) junctions beneath the blackened receiver surface are heated by the radiation absorbed in the black coating

passive (cold) junctions of the thermopile are in thermal contact with the pyranometer housing, which serves as a heat-sink.

Measurements







New unit for UV: UV index number from 0 - 20

Solar spectrum [W/m²nm]

Multiplied (weighted)

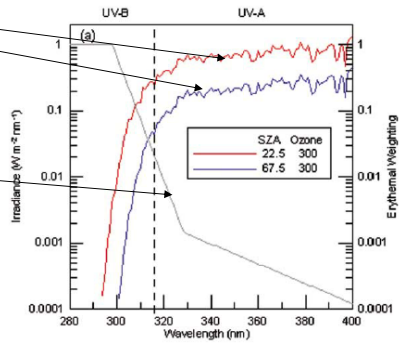
CIE's biological weighting function (≈ erythemal action spectrum)

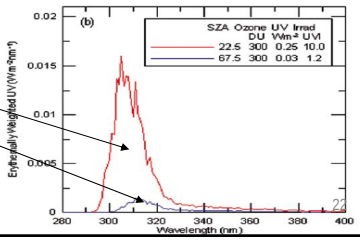
Mathematical well defined

Area below the weighted spectrum is multiplied by 40

The number gives the UV index

a number 0 - 20

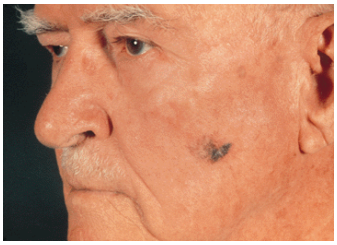


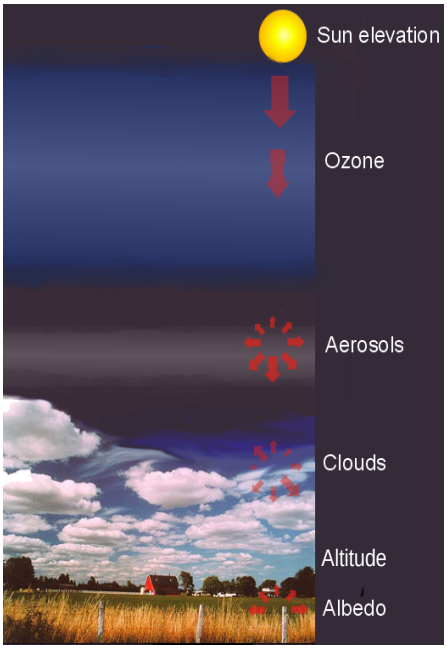


Short term -
Erythemal damage in the skin,
Cataract in the eye

Long term -
Skin cancer

Ocular effects





Solar Energy influencing parameters

Measurements

UV meters

NILU UV meters

Five channels: 305, 312, 320, 340, 380

Plus PAR

Measurements

Aerosol meters

340nm, 380nm, 440nm, 500nm,
675nm, 870nm, 936nm, and 1020nm

Some review questions….

1. What is climate change? How is it quantified?
2. How is the solar spectrum look like? What does it indicate?
3. What is a pyranometer? Discuss its working.
4. What is solar UV? What are their positive and negative effects?
5. Is it possible to forecast solar UV? What will be its benefit to the society?
6. What is attenuation of solar energy? How is it attenuated in earth's atmosphere?

Climate Change

continuation------

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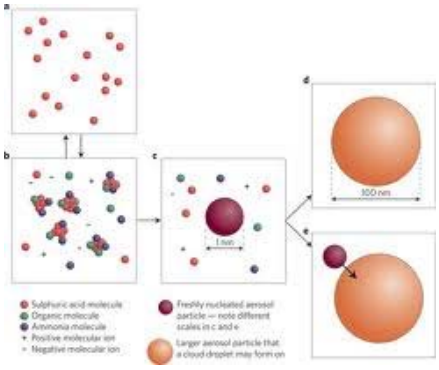
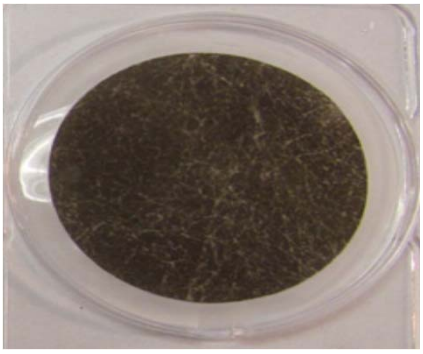
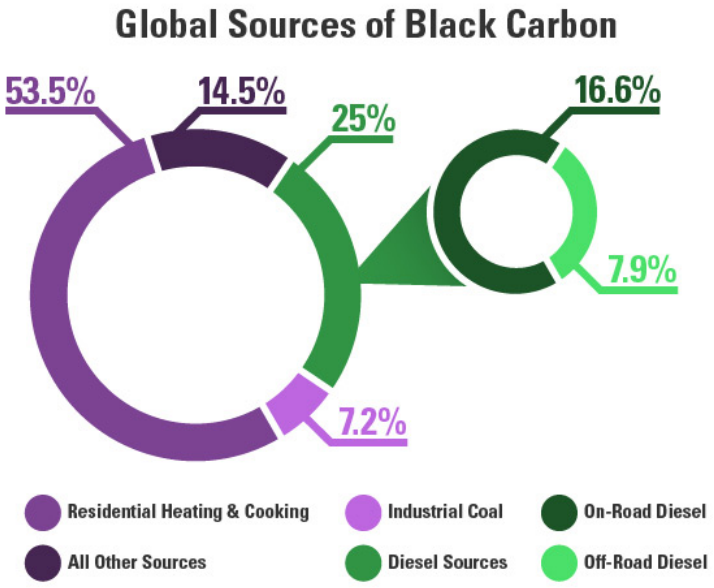
Aerosols





- Black carbon (BC) is most effective form of PM, its mass fraction in atmospheric aerosol is typically less than 10 percent
- Black carbon emissions originate from a variety of sources



Guest lecture 31

BC emissions can remain in the atmosphere for several weeks to a month or more

The sources of BC emissions vary by region depending on lifestyle and the types of fuel used.

BC effects

melting of ice

warming of atmosphere,

diming at surface

Atmospheric brown clouds,

Guest lecture 32

Elements in particulate matters are generated from different sources

Burning of fossil fuels V, Co, Mo, Pb, Ni and Cr

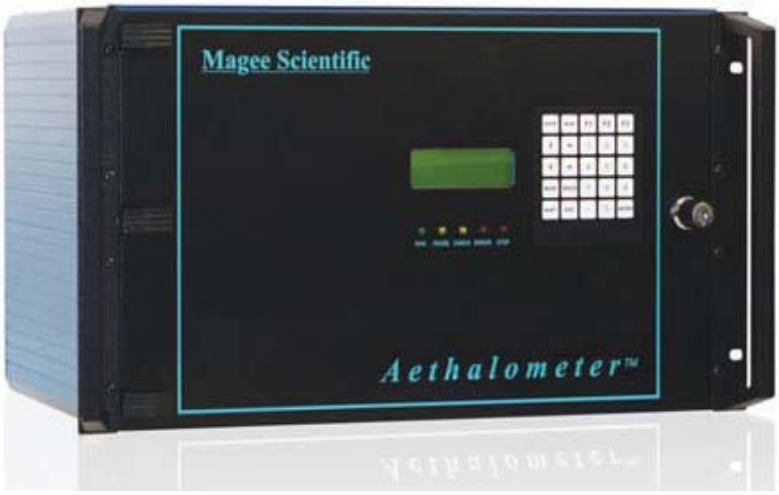
Metallurgical processes As, Cr, Cu, Mn and Zn

Traffic pollution Fe, Ba, Pb, Cu, Zn, and Cd

Instruments

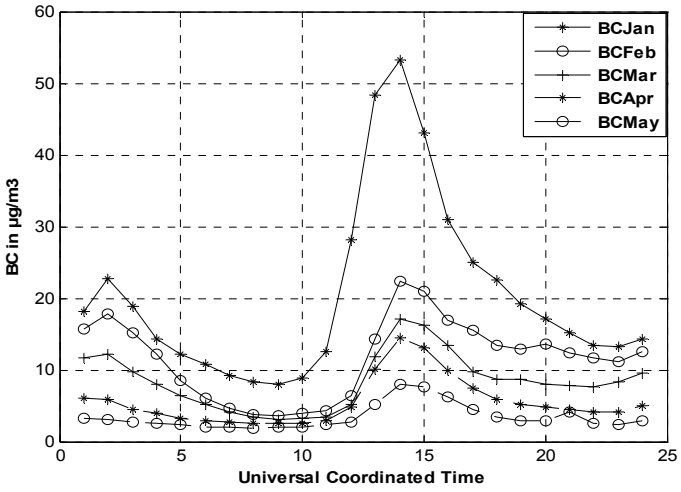
Ambient Air sampler

Aerosol Spectrometer

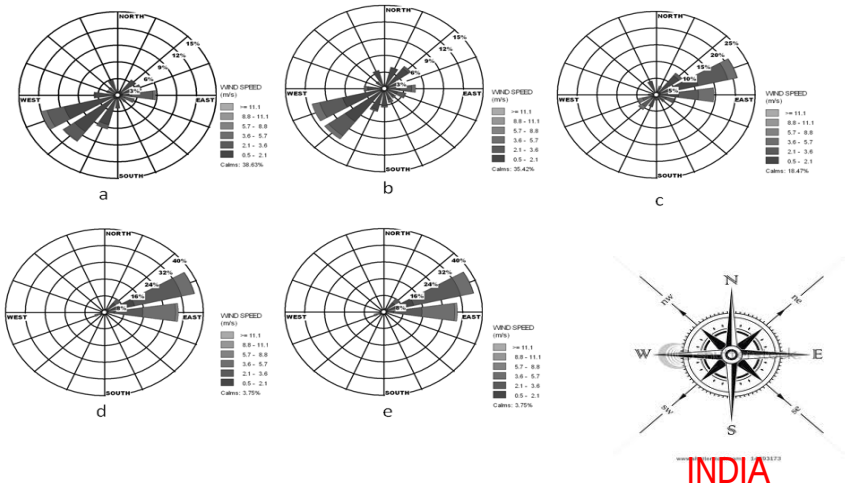


Aethalometer

Diurnal variation of BC in Biratnagar

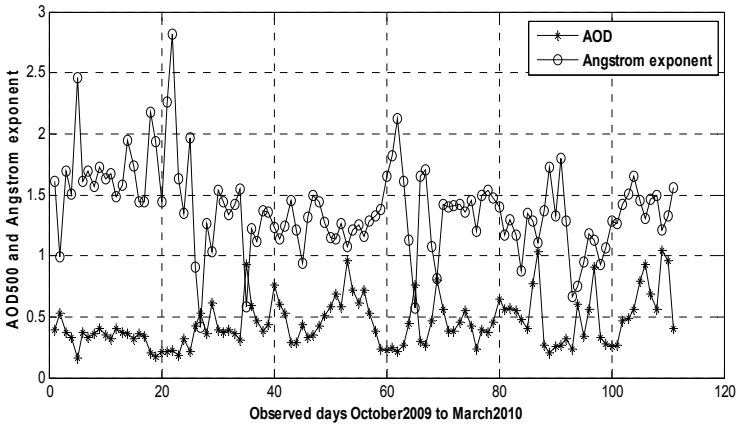


Wind rose for Biratnagar



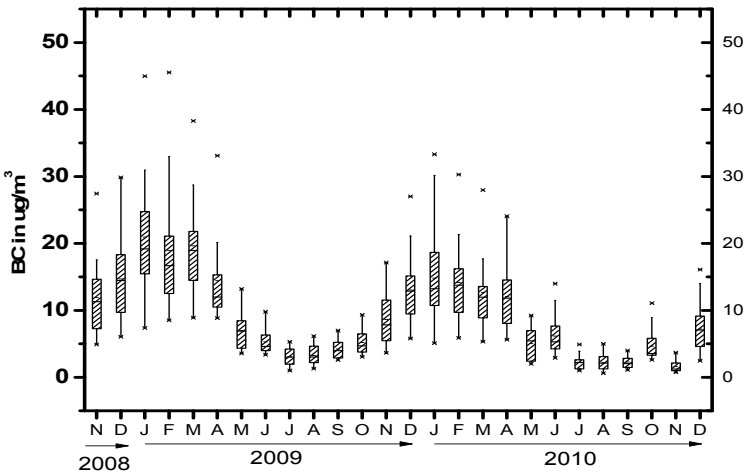
Wind rose diagram a-e (January to May)

AOD and Ångström exponent α



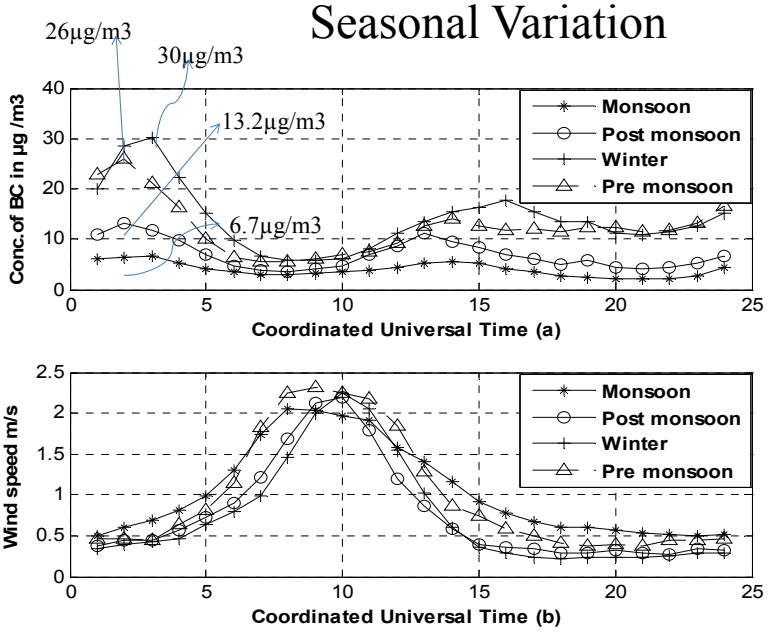
Locations	AOD 500 Values
Hanle	0.05-0.09
Nainital	0.059-0.157
Kullu	0.24-0.27
Kathmandu	0.2-1.0

Monthly variation of BC

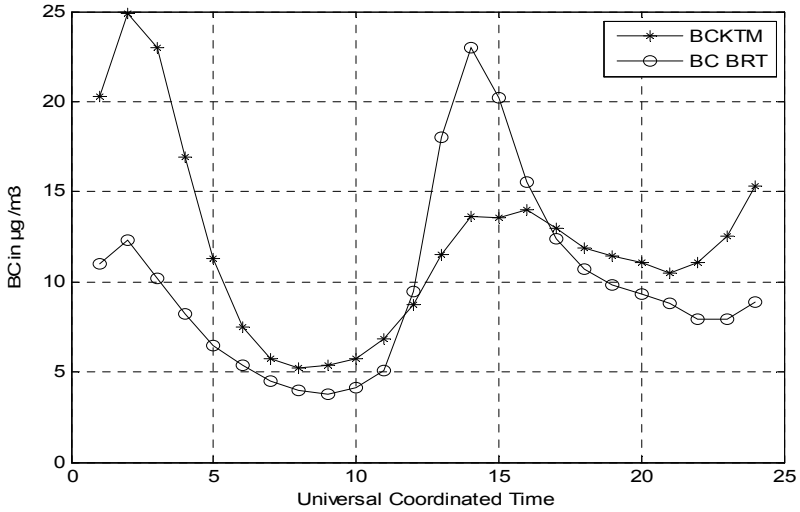


2008/2009 Winter	0 mm water
2009/2010 Winter	31.0 mm recorded

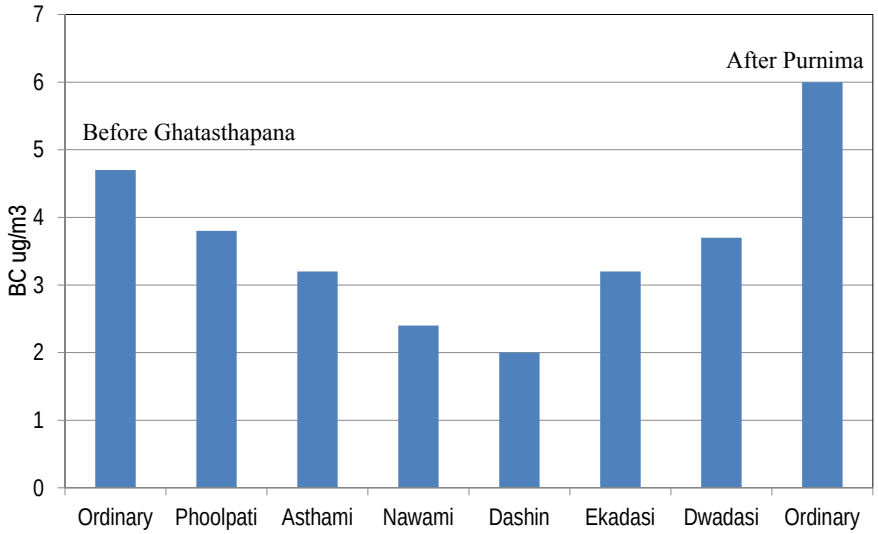
Seasonal Variation



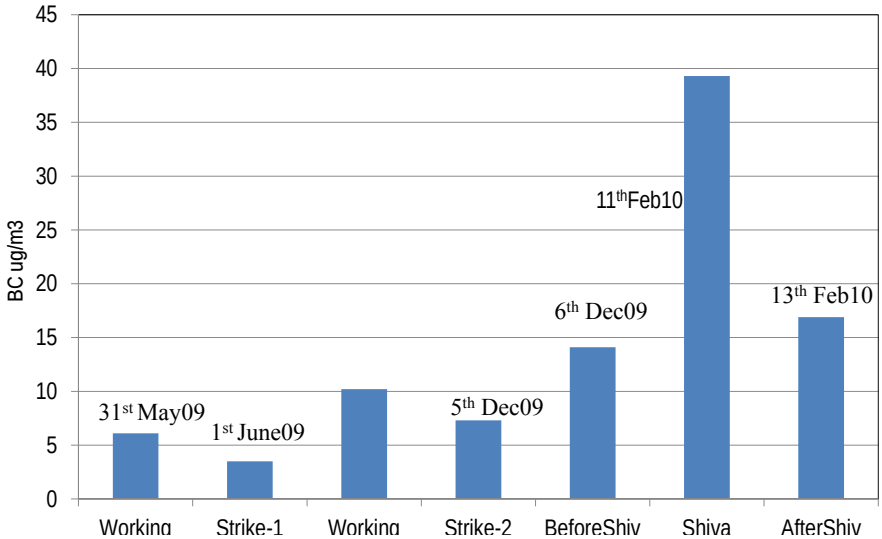
Diurnal Variation of BC in KTM and BRT



Dashain Festival



Influence of local events on BC



Most of the time Angstrom exponent value was ≥1($\alpha_{340-675}$) shows domination of small particles, originated from urban pollution and biomass burning

Monthly average EC, BC and solar radiation shows a fairly anti-correlation.

r=- 0.91 for EC

r=- 0.90 for BC

Comparison of AOD_{500} and carbonaceous aerosols analysis shows the highest values of EC and BC when AOD_{500} value exceeds 0.5

About 50 % BC of KTM is contributed by vehicles and industries

Air pollution is a major environmental risk to health and is estimated to cause approximately 2 million premature deaths worldwide per year.

Guest lecture 47