氣象、氣候 –
一些科學常識和謬誤

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What is climate (氣候)? What is weather (天氣) ?

"Climate is what you expect; weather is what you get."
by Robert A. Heinlein

- Weather - day-to-day state of the atmosphere
- Climate - average of weather (normally 30 years)

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先談氣象

- 多一點接近大自然
- 多一些觀察，多一點好奇
- 大自然許多現象都有科學解釋
- 有些現象仍待研究發掘

大綱

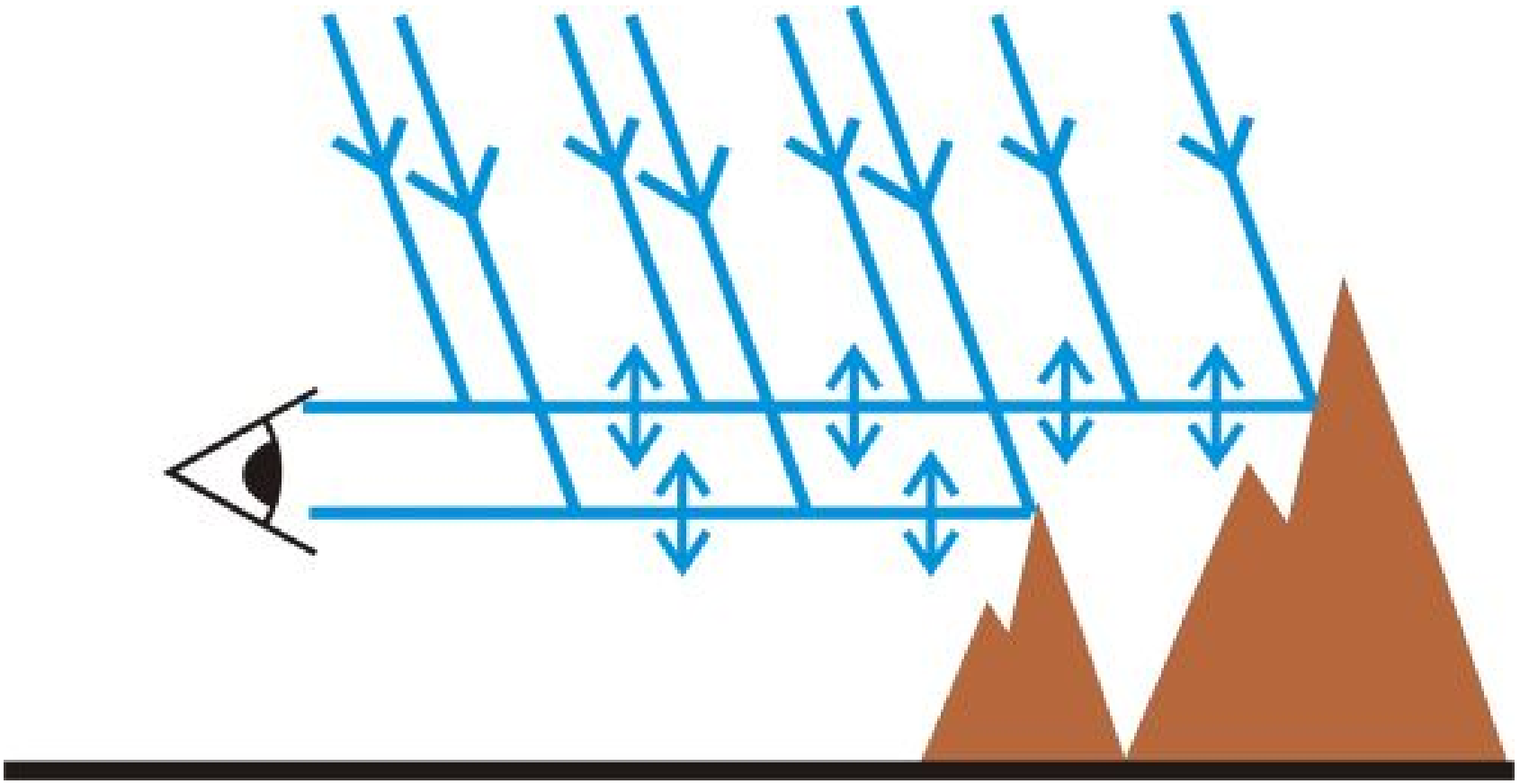
(1) 天

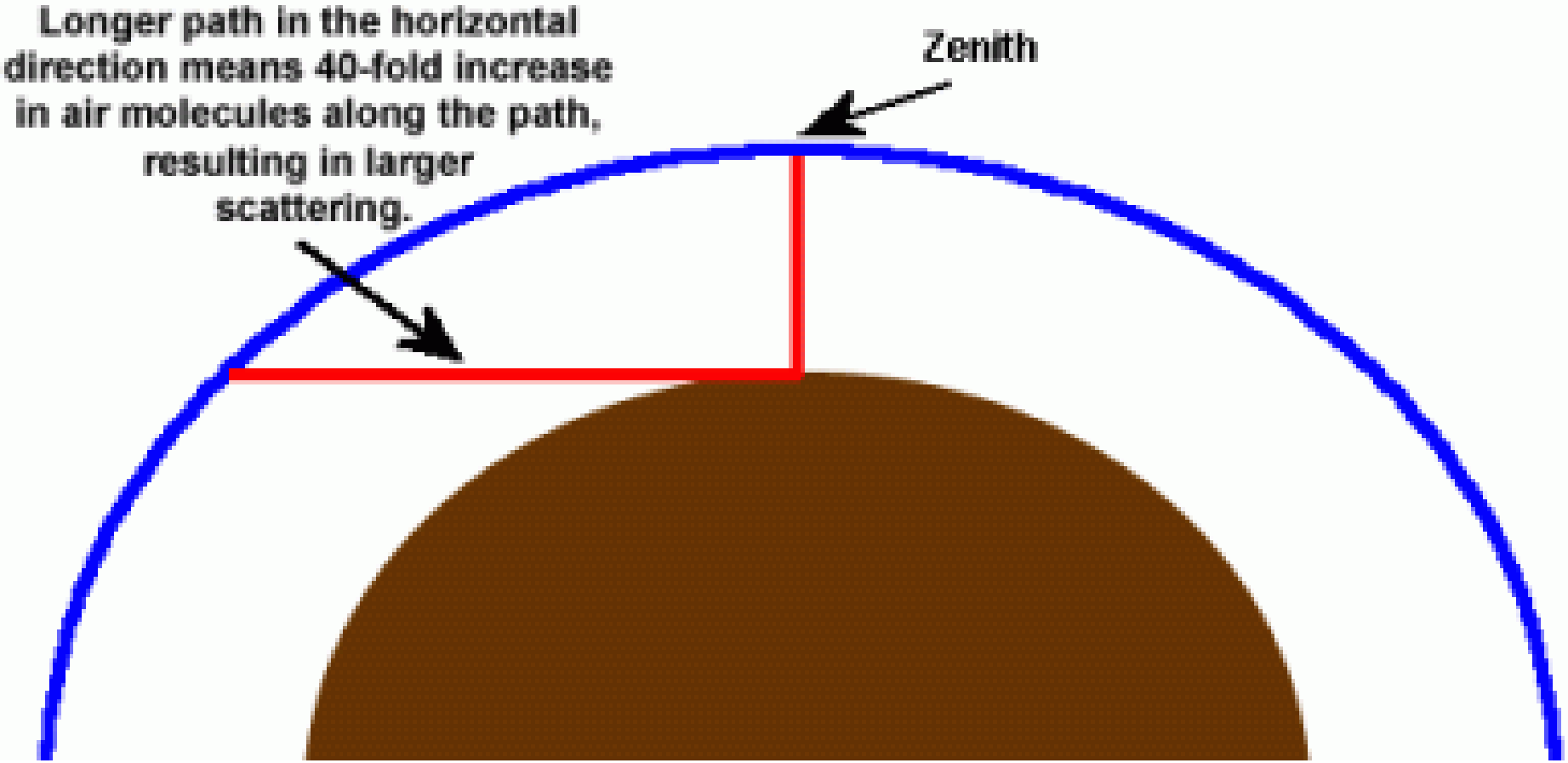
(2) 雲

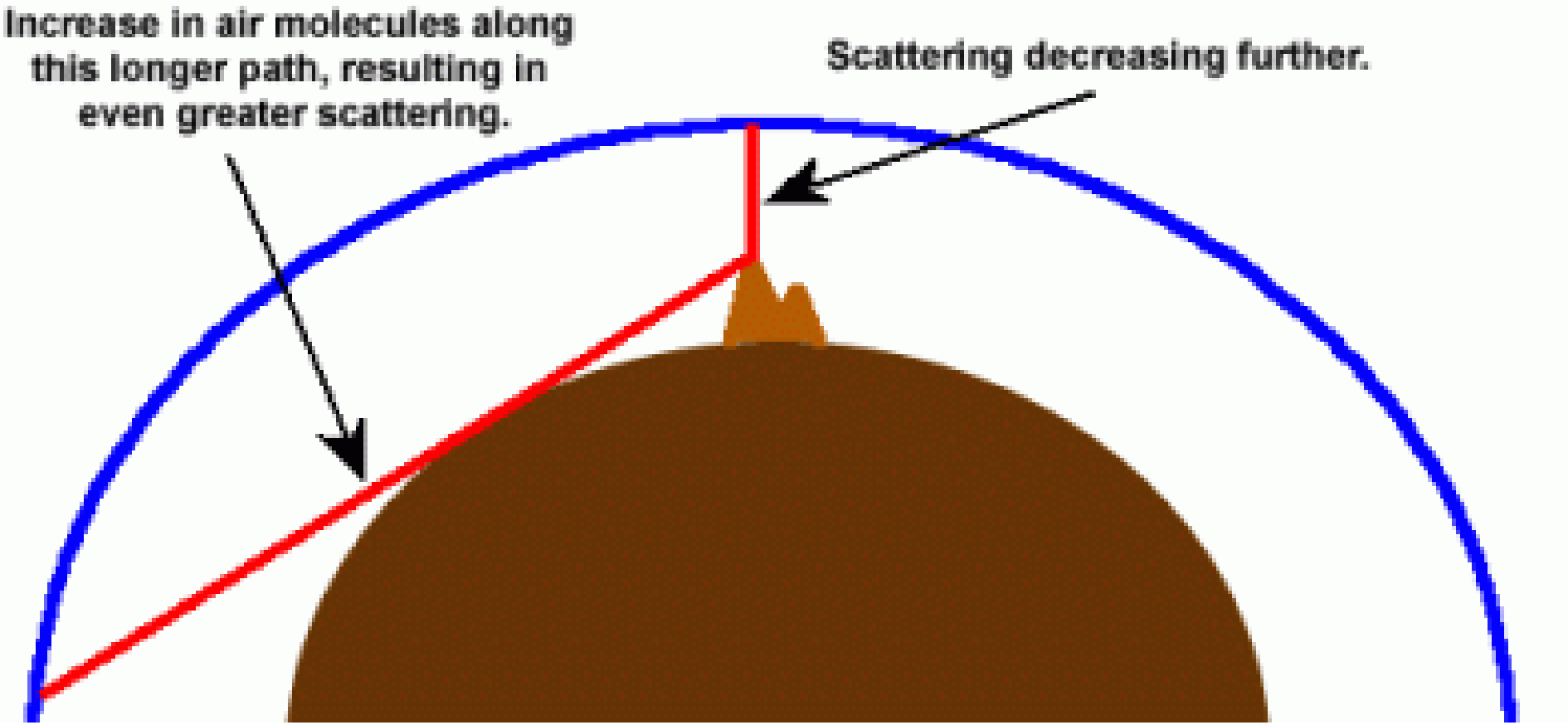
(3) 彩虹，暈，彩光環 .....

(4) 溫度

(5) 陽光





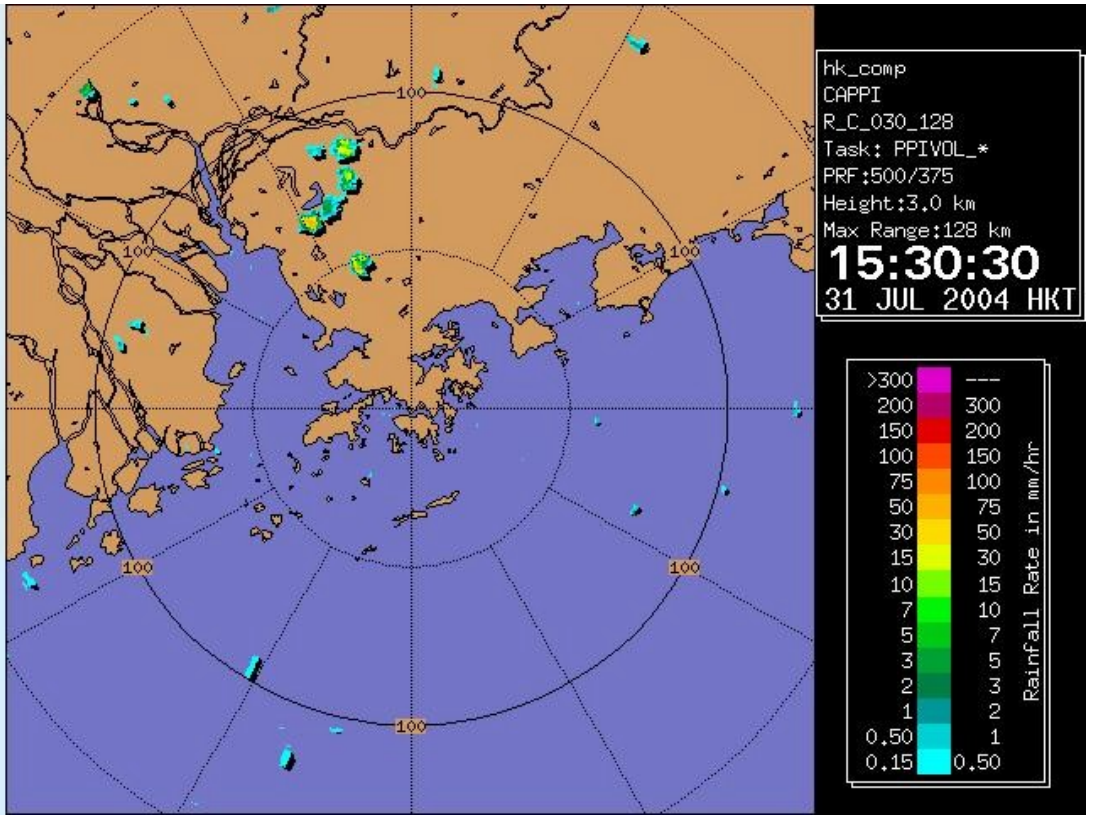



雲

巻雲


懸球状雲

積雨雲的發展



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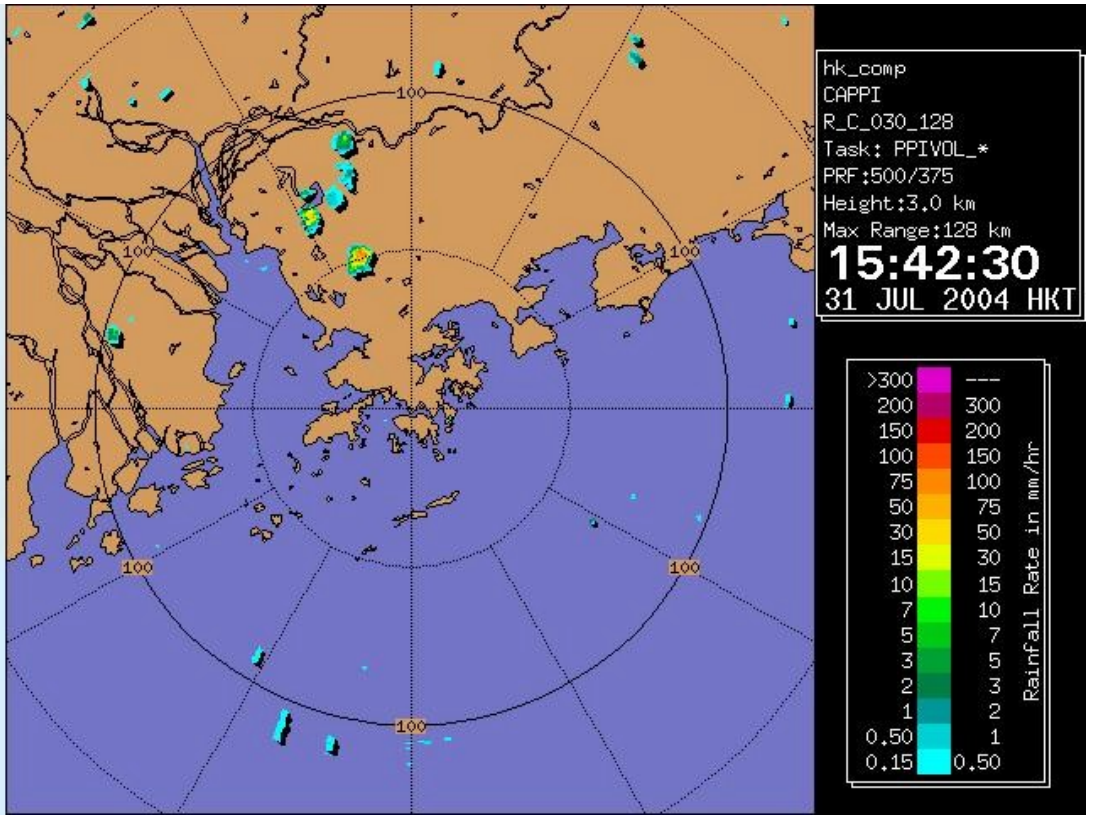

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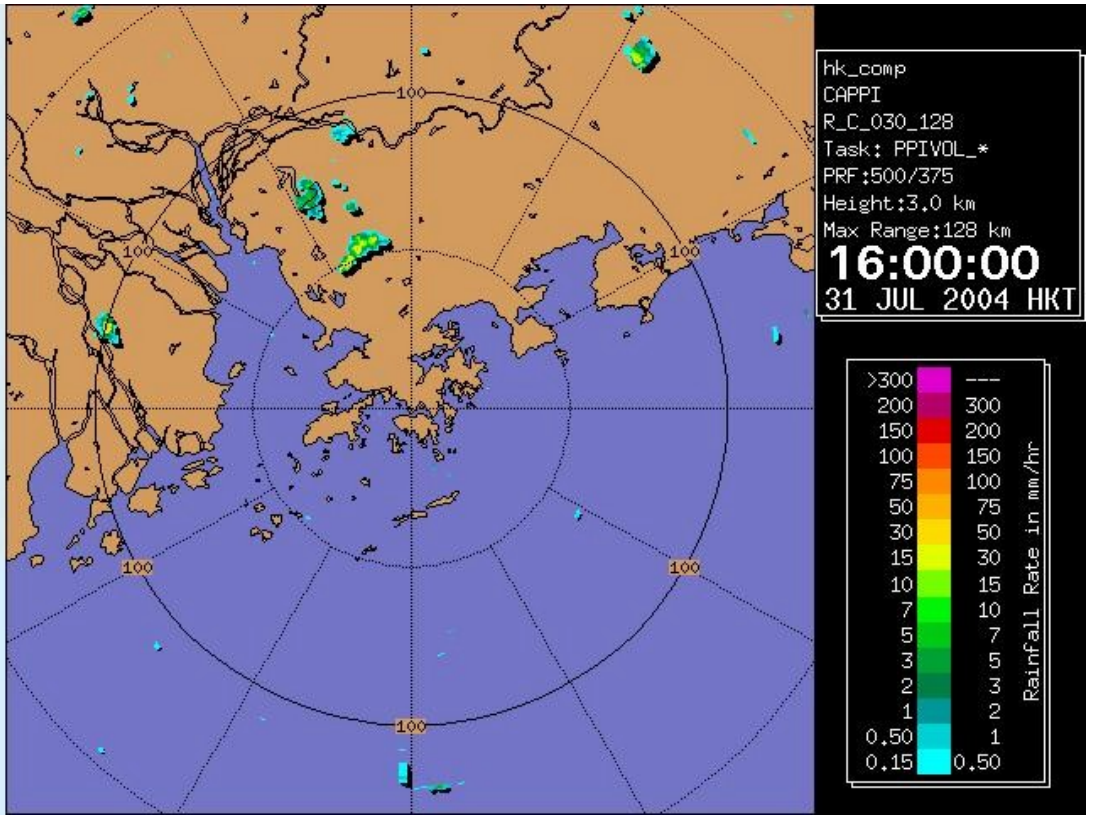

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凝結尾迹

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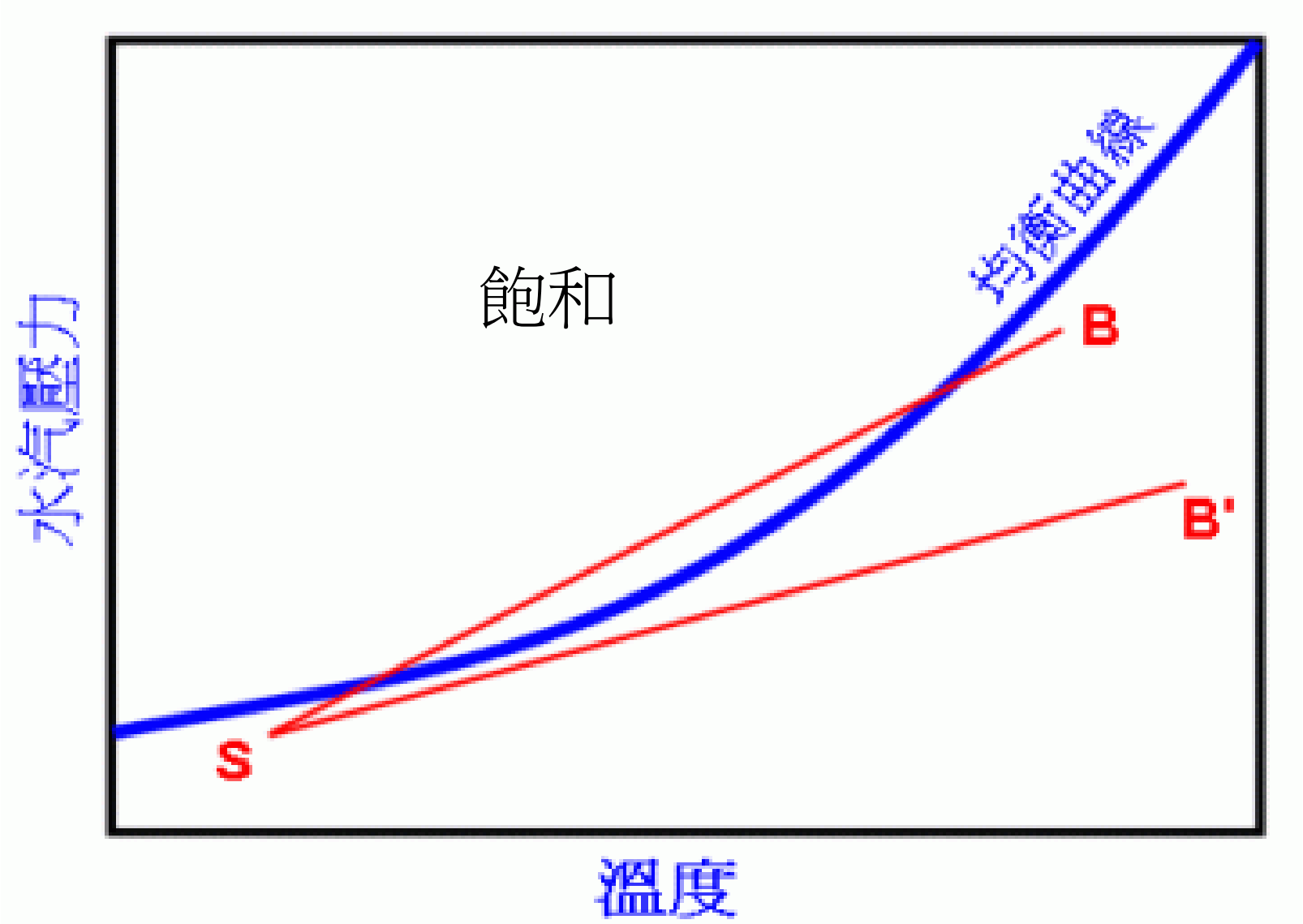

彩虹

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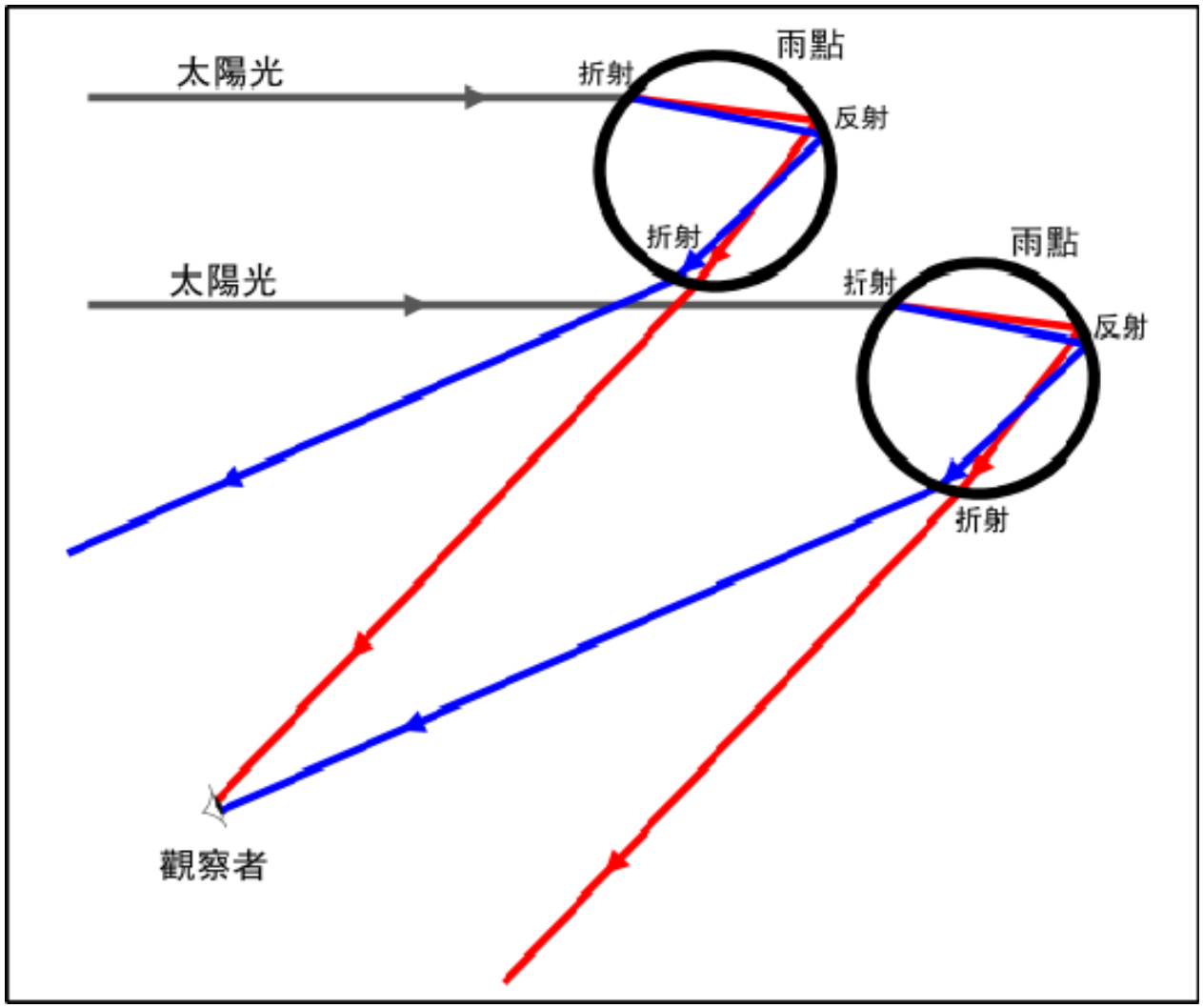
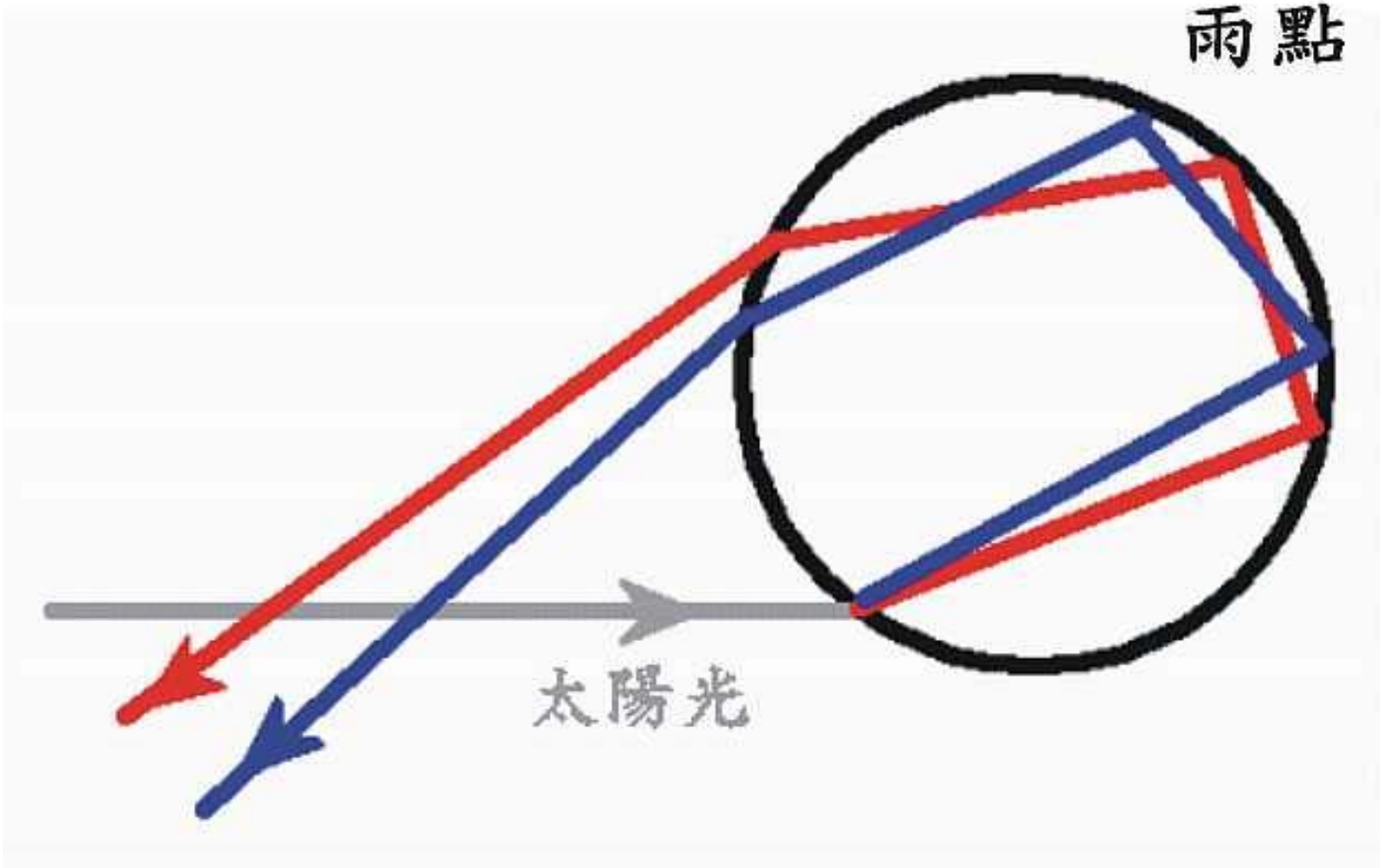


雙彩虹



暈

彩光環


3.7
Ta Kwu Ling
8.5
Lau Fau Shan
8.4
Tai Po
5.7
Sha Kong
9.7
Tuen Mun
10.6
Sha Tin
10.9
Sai Kung
10.8
Tsing Yi
11.0
Chek Lap Kok
10.1
King's Park
10.1
Tseung Kwan O
8.3
The Peak
7.1
Ngong Ping
11.2
Wong Chuk Hang
10.6
Cheung Chau
12.0
Waglan Island
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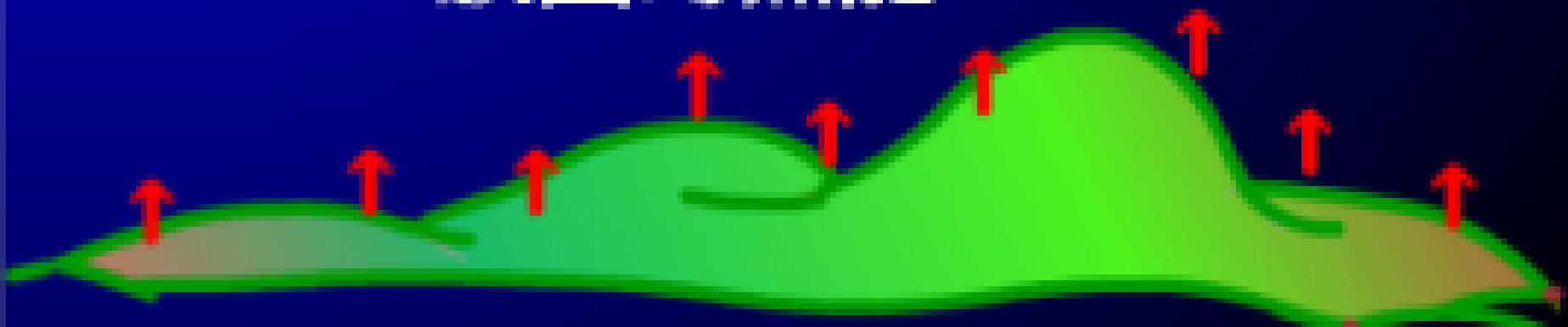
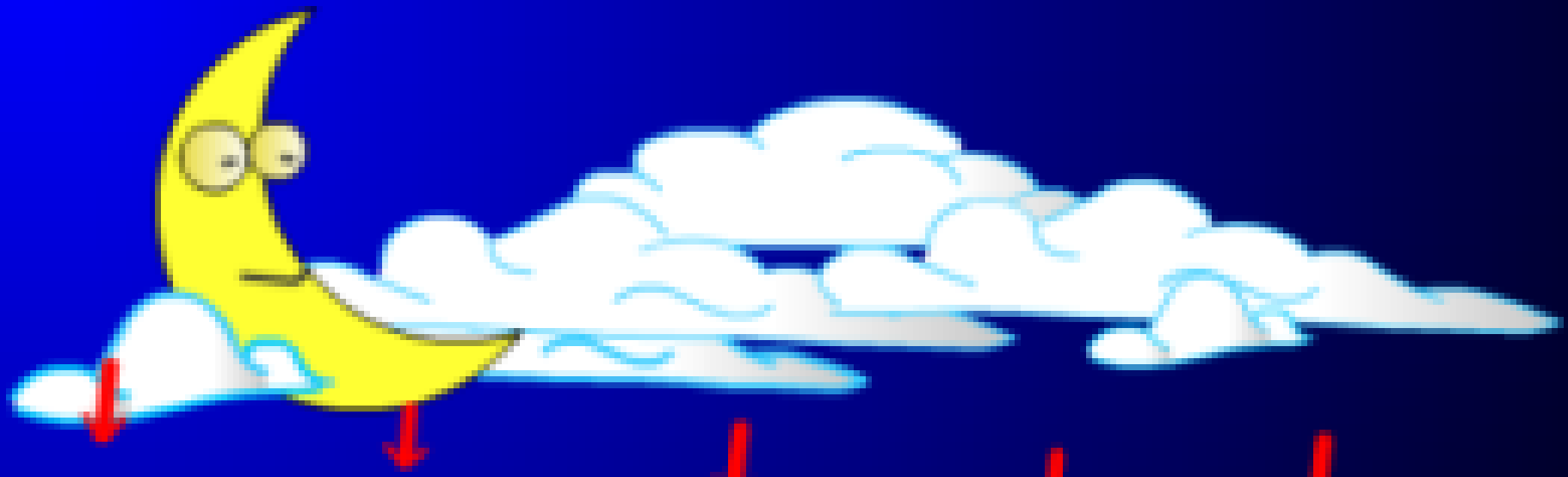
地面熱能減少，冷卻接近地面的空氣

放出的熱能

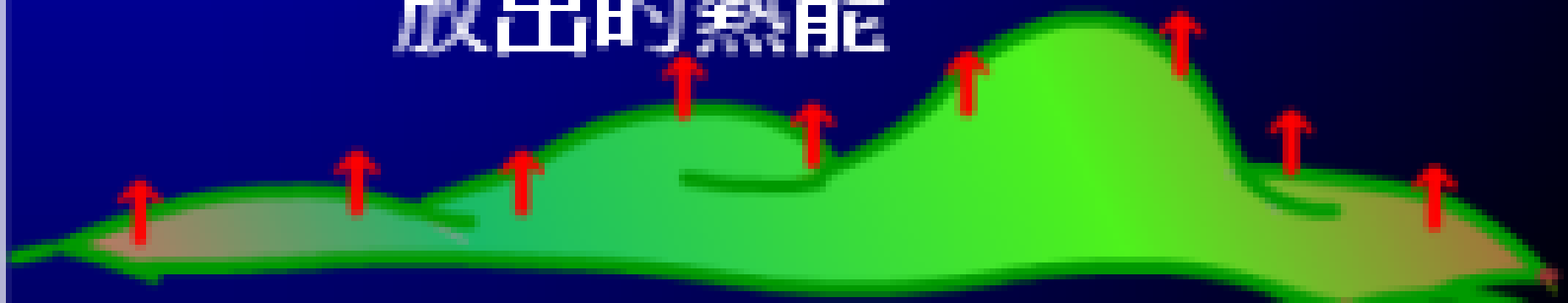


在多雲時的降溫幅度比天朗氣清時小



雲層把部份的熱輻射折回地面

放出的熱能



在天朗氣清、微風及乾燥的情況下，降溫是最大的

溫度

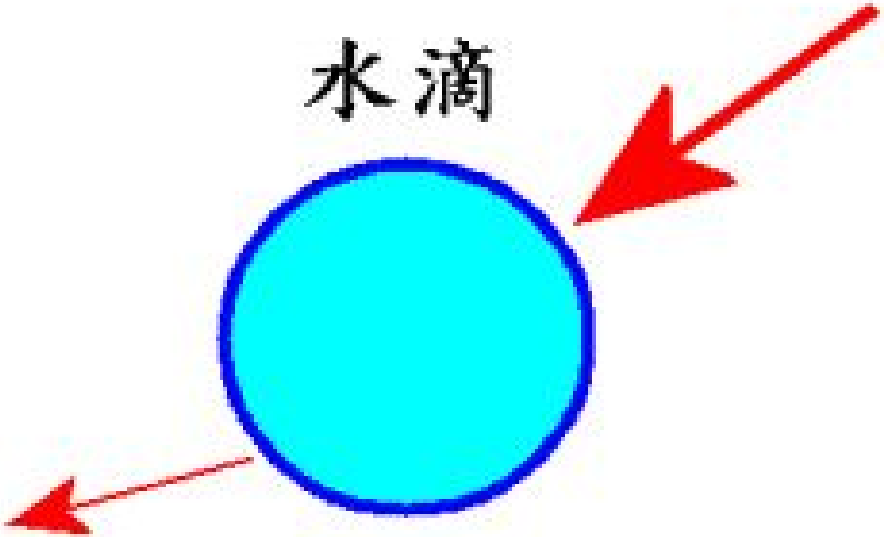
積溫　- 花卉

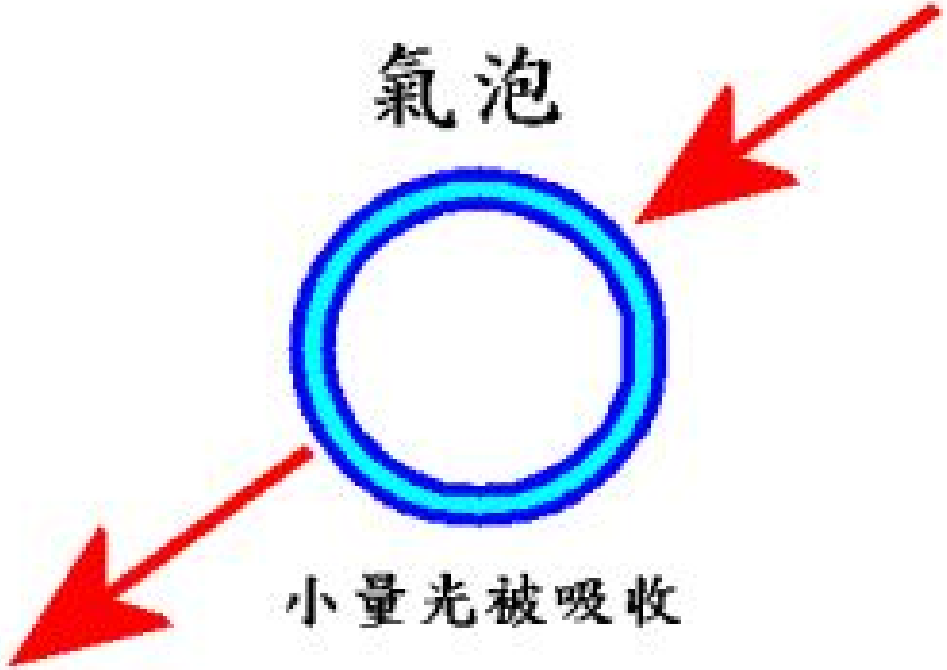
- 候鳥

防晒膏

- 什麼是 SPF ?
- SPF15 與 SPF30 有何分別?

- 爲什麼浪拍岸時總是與海岸平行？
- 爲什麼浪花是白色的？
- 水是無色透明的，但爲什麼濕沙總比乾沙深色呢？





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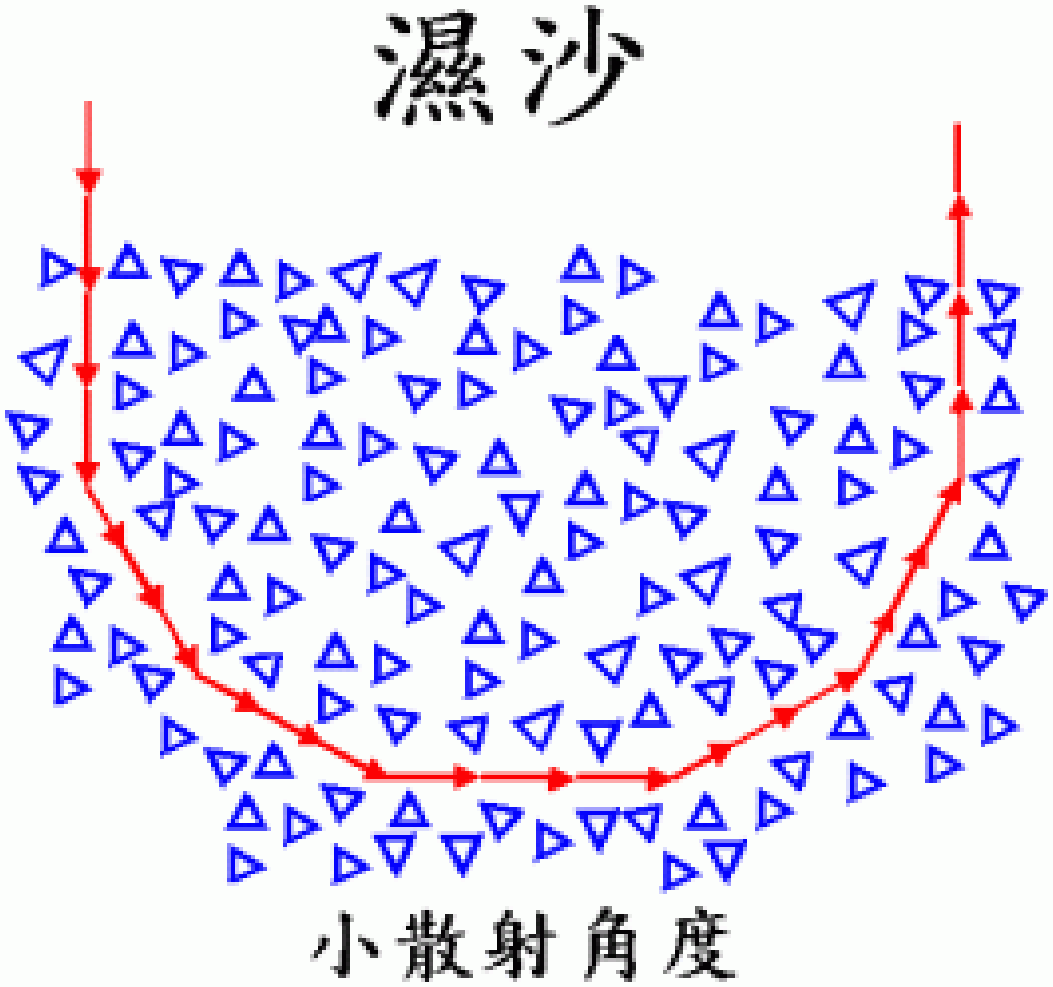

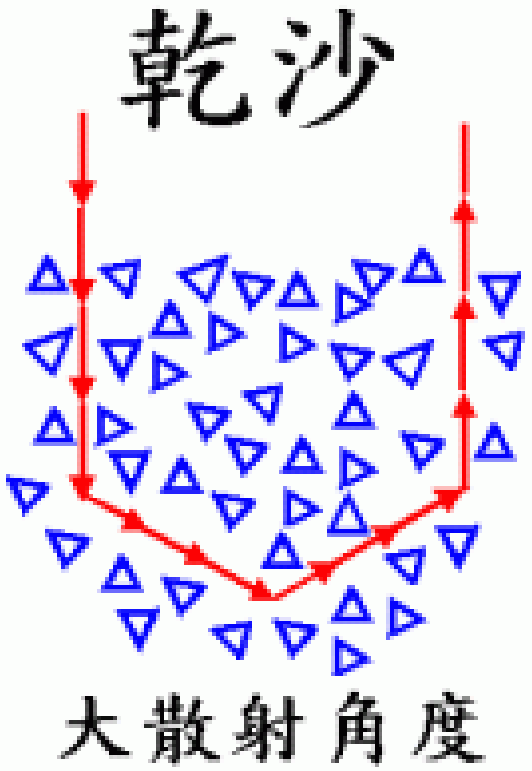

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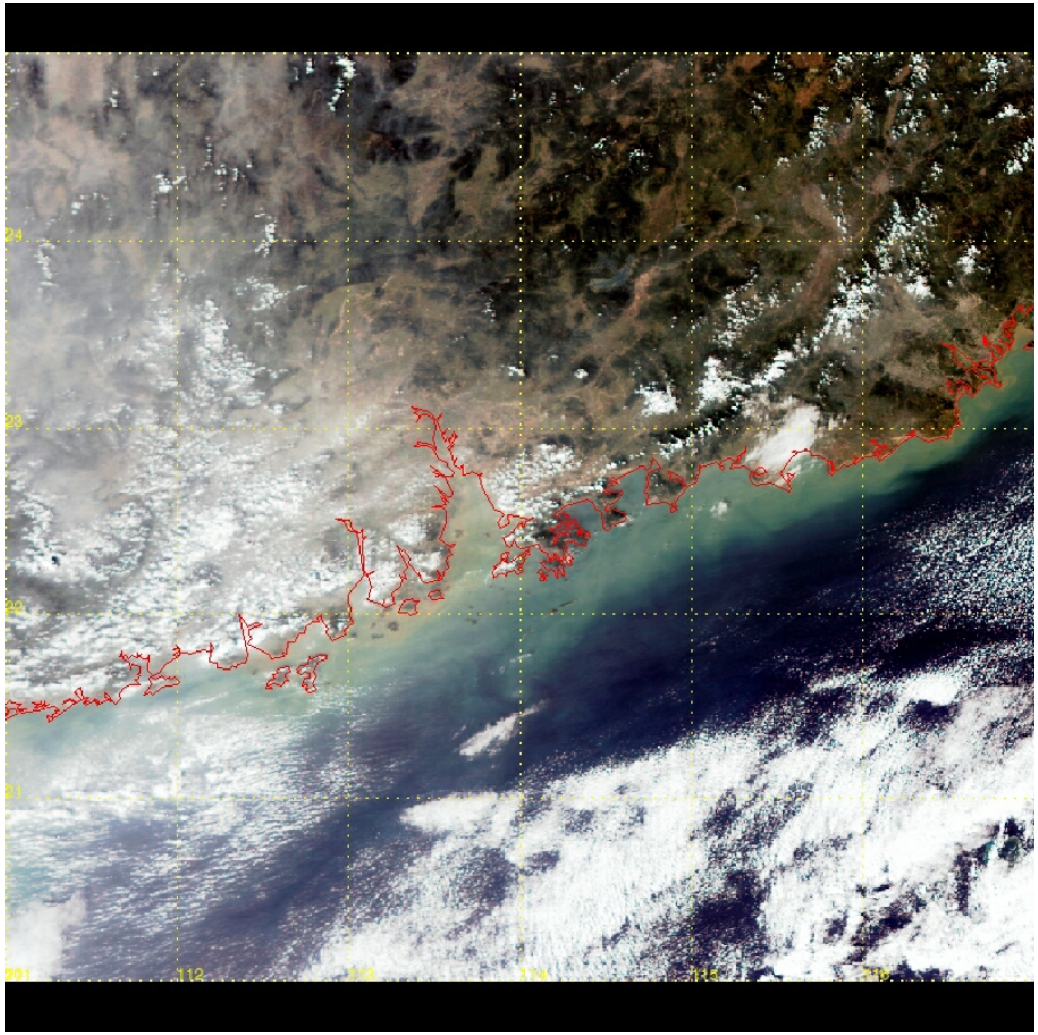
Sea breeze

- What causes sea breeze?



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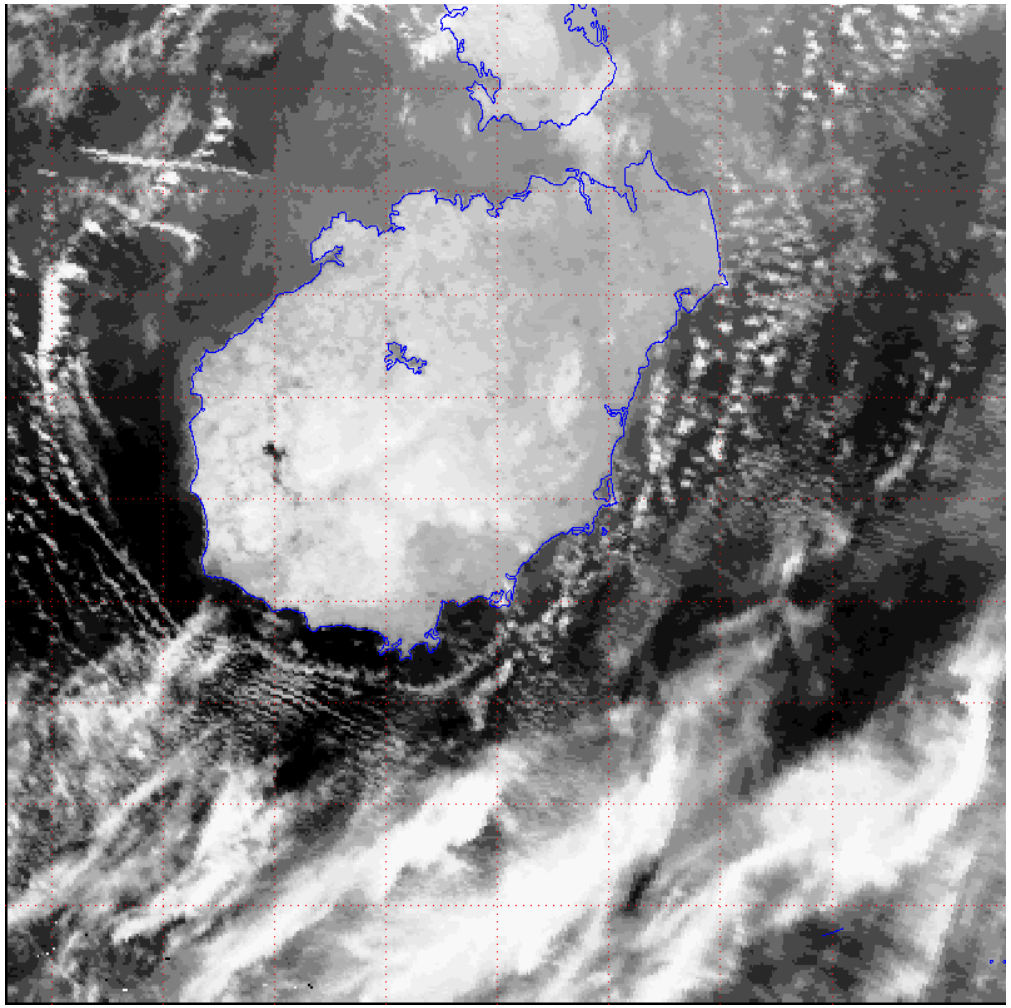
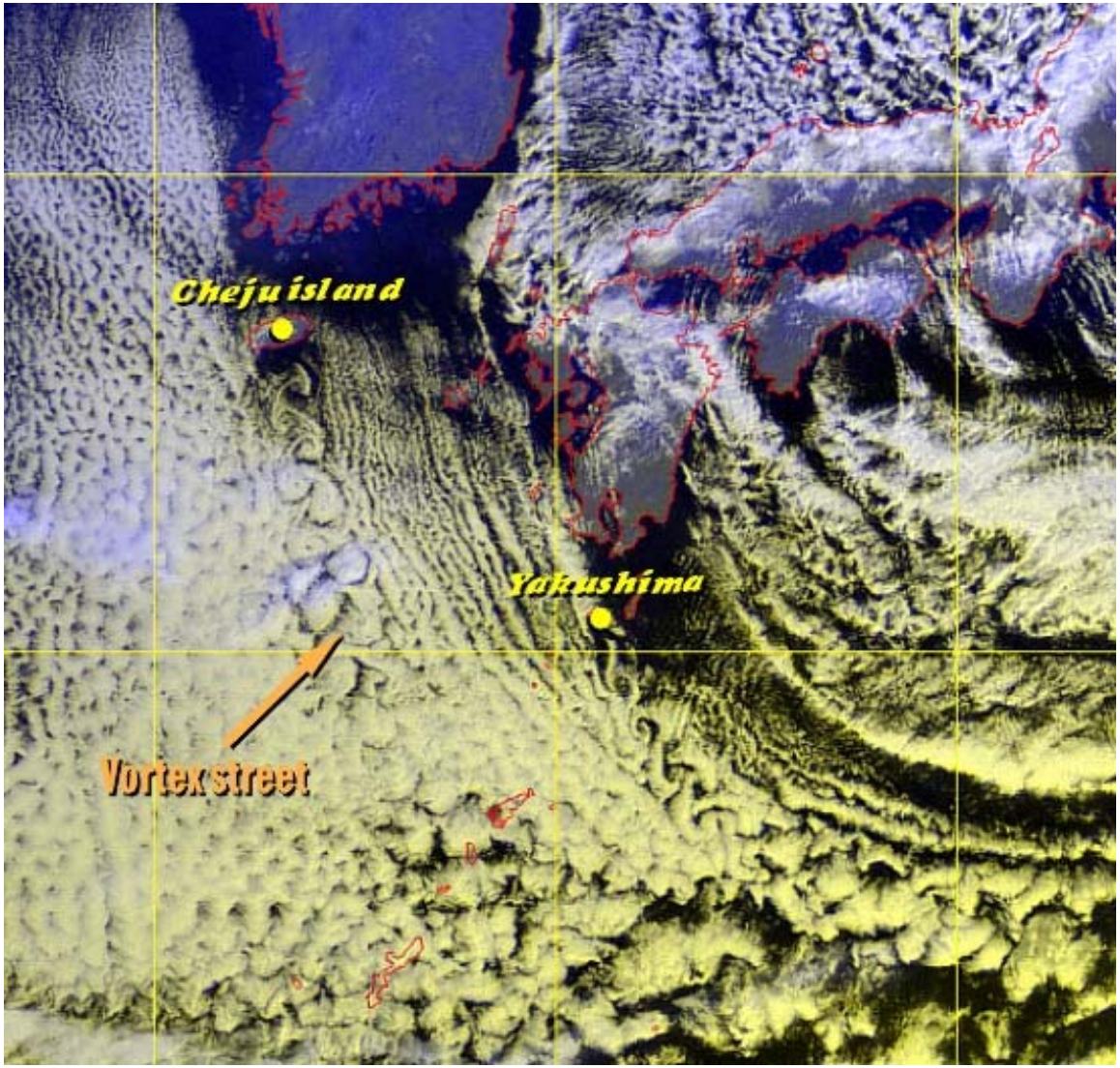
- And land breeze?



Wind

- Kelvin-Helmholtz waves

von Karman vortices



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What has temperature to do with the finance market?

- Short term – power consumption
  - heat wave
  - cold spell
- Long term – commodities
  - climate change
  - El Nino

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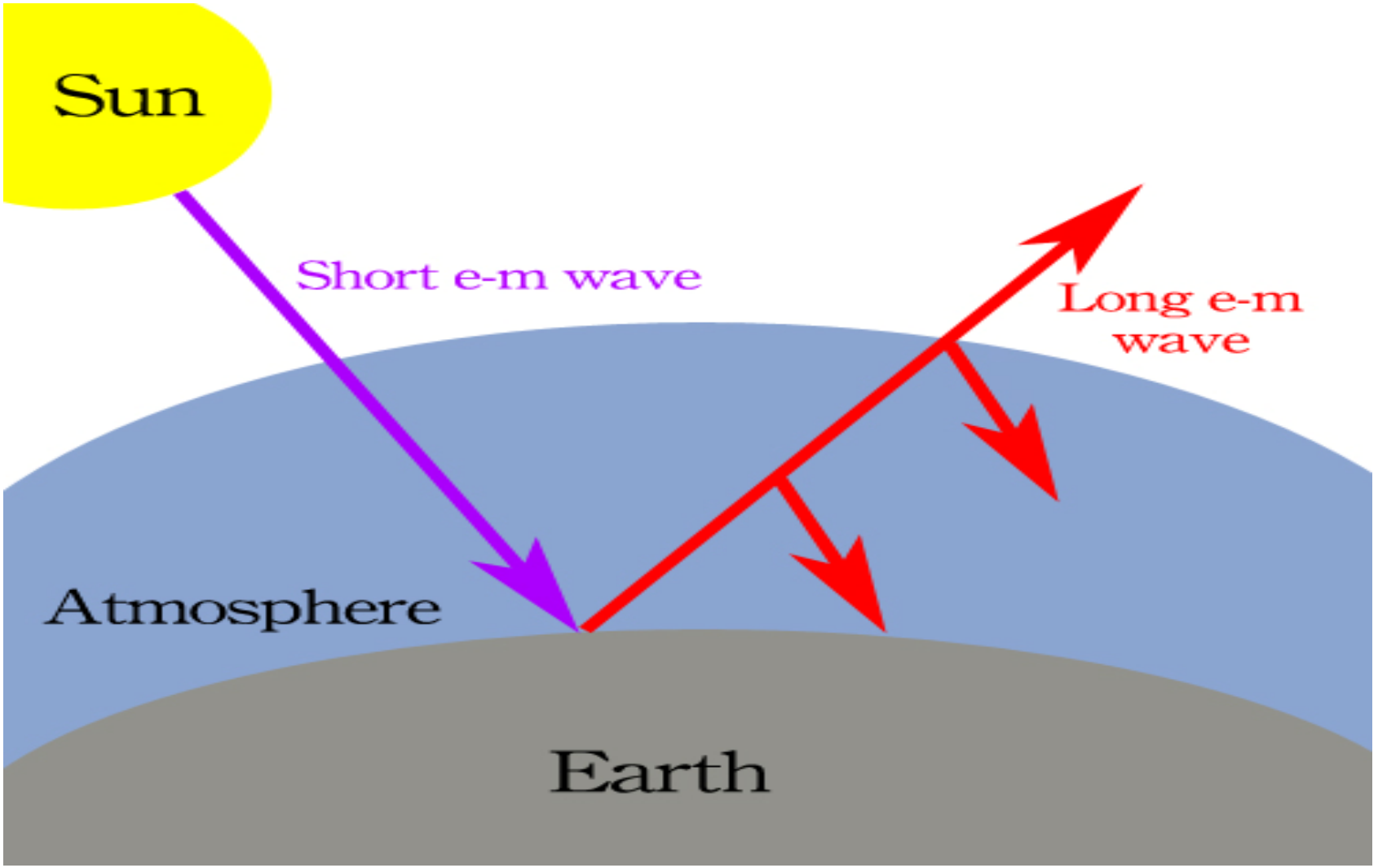
Climate（氣候)



Greenhouse gases: carbon dioxide, ozone, methane, water vapour …….

United Nations and Climate Change

World Meteorological Organization (WMO)

United Nations Environment Programme (UNEP)

The Intergovernmental Panel on Climate Change (IPCC)

- First Assessment Report of 1990
- Second Assessment Report of 1995
- Third Assessment Report of 2001
- Fourth Assessment Report of 2007
- Fifth Assessment Report (2013-14)

United Nations Framework Convention on Climate Change (UNFCCC) 1994

Kyoto Protocol 1997

Copenhagen 2009

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Global warming :

“The observed increase in globally-averaged temperatures since the mid-20th century is very likely due to the observed increase in man-made greenhouse-gas (GHG) concentrations”

(*United Nations Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007)*

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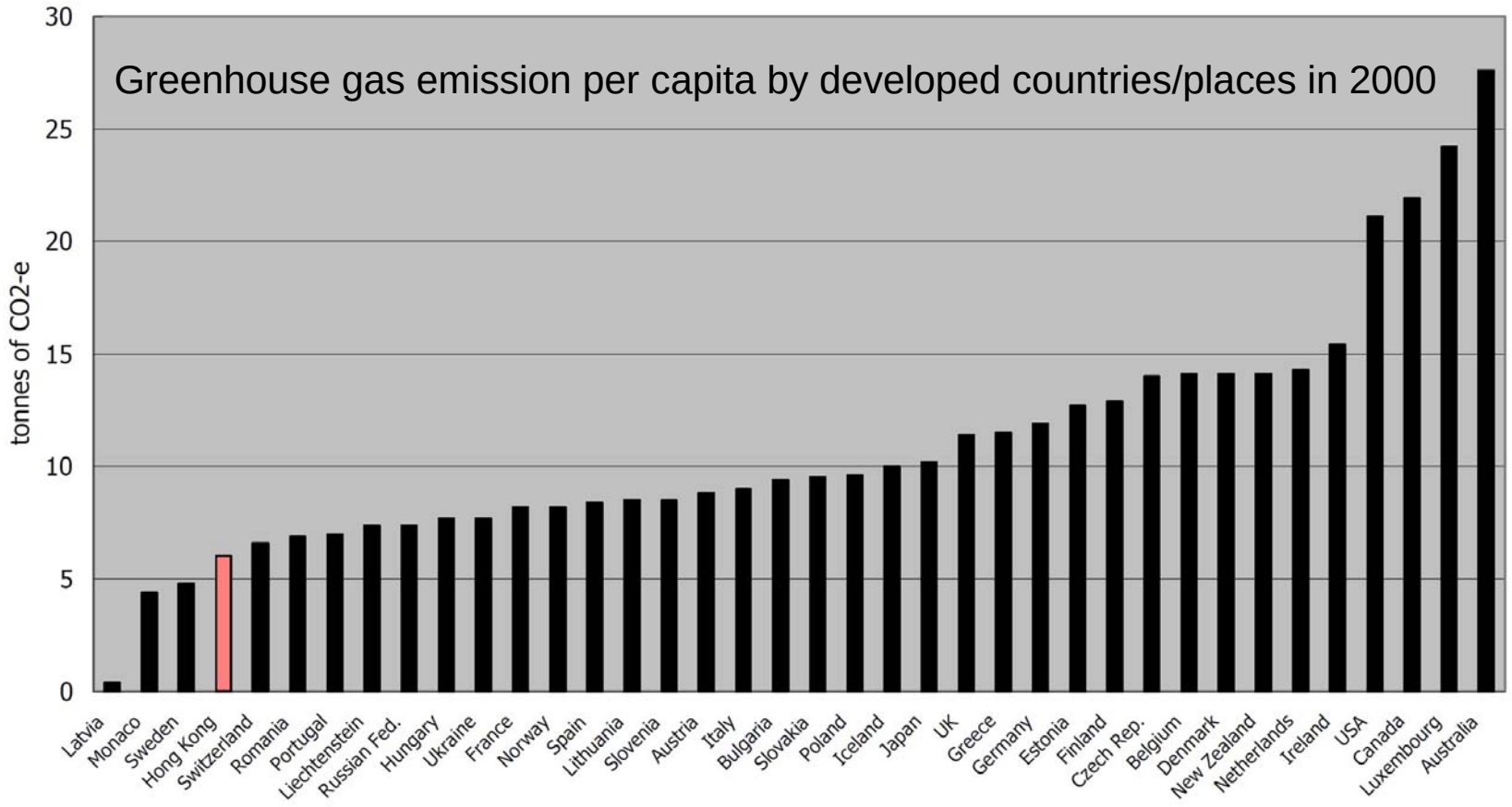
Carbon footprint

"The total set of greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product"

(UK Carbon Trust)



(Source : 1990-2000 Greenhouse Gas Emissions in the Hong Kong Special Administrative Region, L C Yu and K H Cheung, EPD)

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Weather model and climate model

Weather prediction

- higher resolution (20 km ~ 60km)
- forecast changes in weather
- forecast range : next few hours to two weeks

Climate prediction

- lower resolution (150 km ~ 500 km)
- simulate changes in climate (average weather)
- forecast range : season, year, decade, and century
- taking into account future changes in :

- *atmospheric composition (e.g. GHG emission)*
- *solar radiation (cloud amount, aerosols)*
- *sea surface temperatures*
- *snow cover and sea ice*
- *feedback effects*
- *……..*

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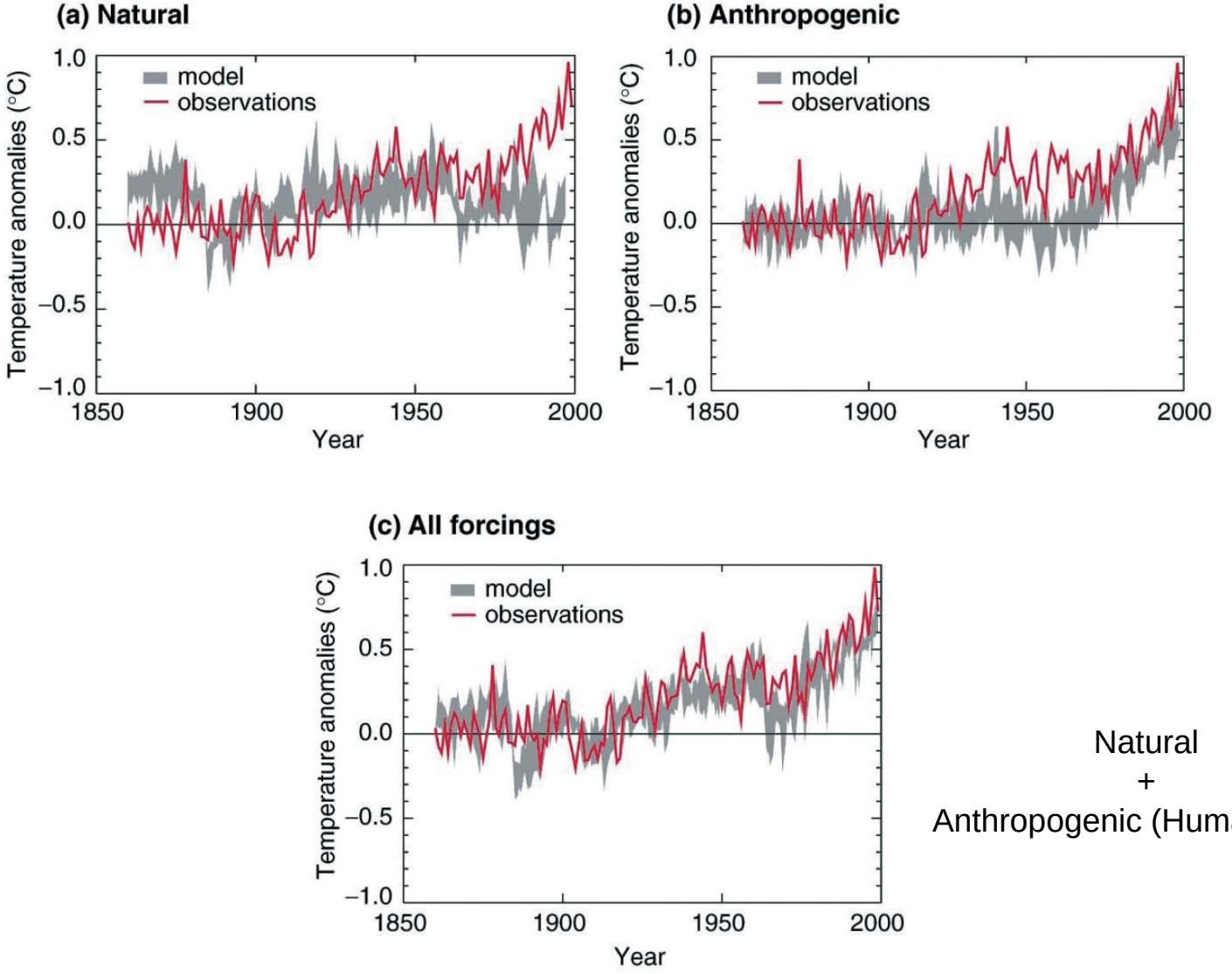
How good are the computer models ?

Simulated annual global mean surface temperature with Hadley Centre model



Natural
+
Anthropogenic (Human-made)

Source : Alan J. Thorpe, (2005). Climate Change Prediction : A challenging scientific problem, Institute of Physics

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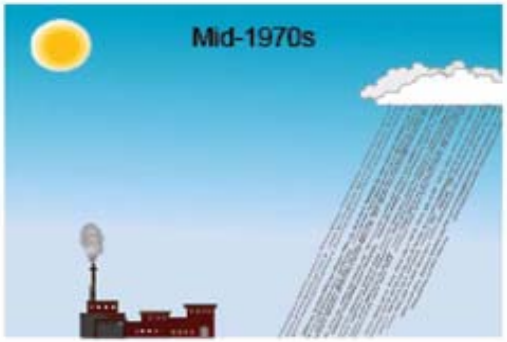
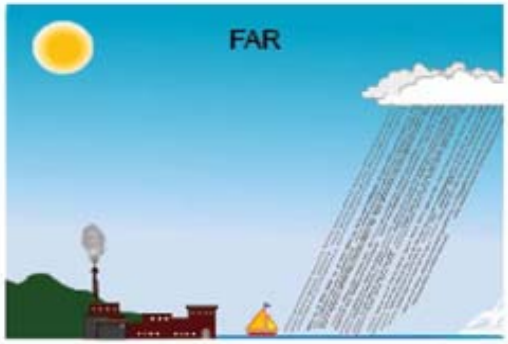
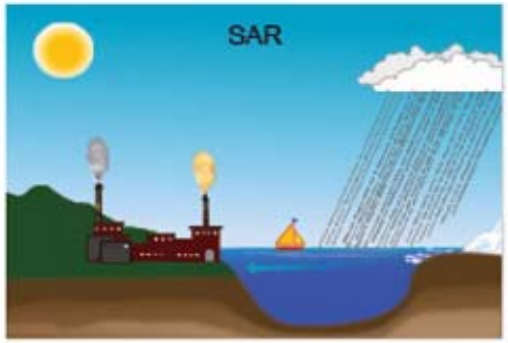
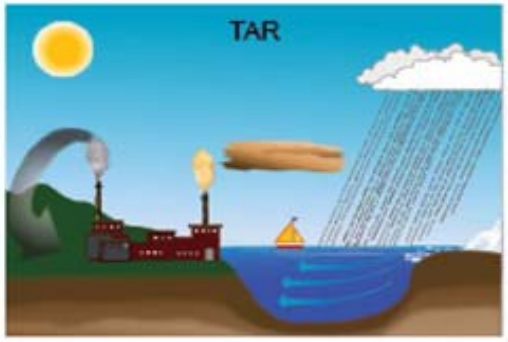
Evolution of global climate models

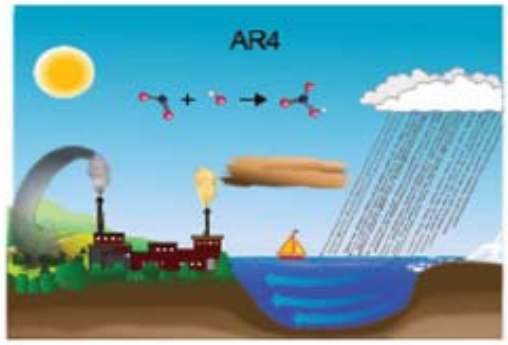






FAR – First Assessment Report
SAR – Second Assessment Report





TAR – Third Assessment Report
AR4 – Fourth Assessment Report

(Source : IPCC)

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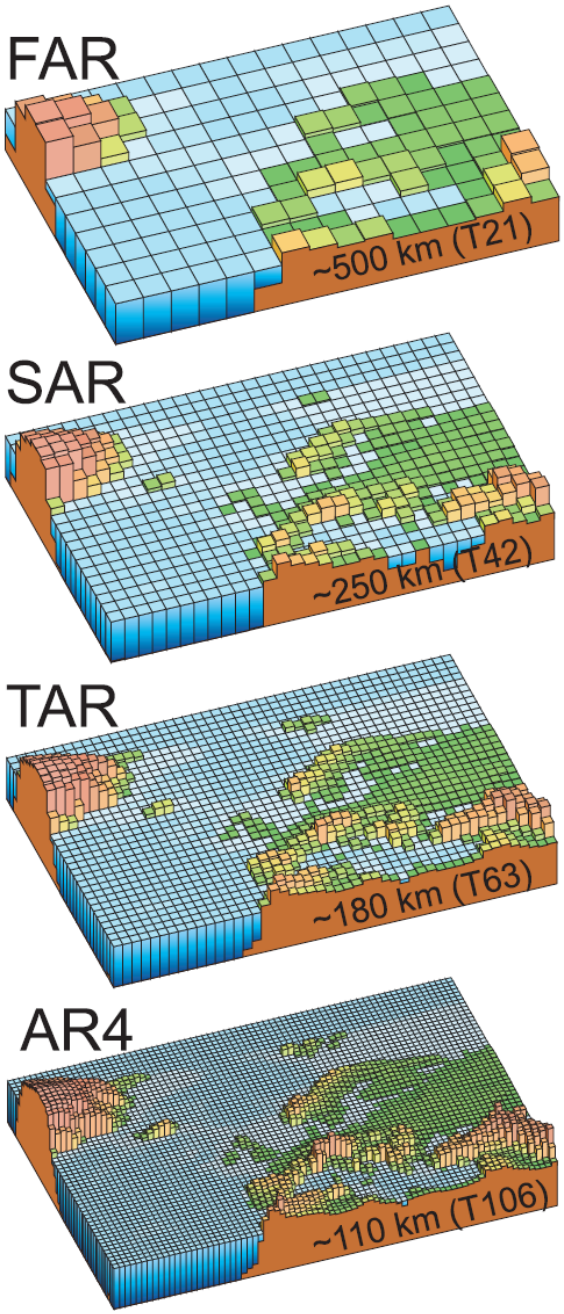
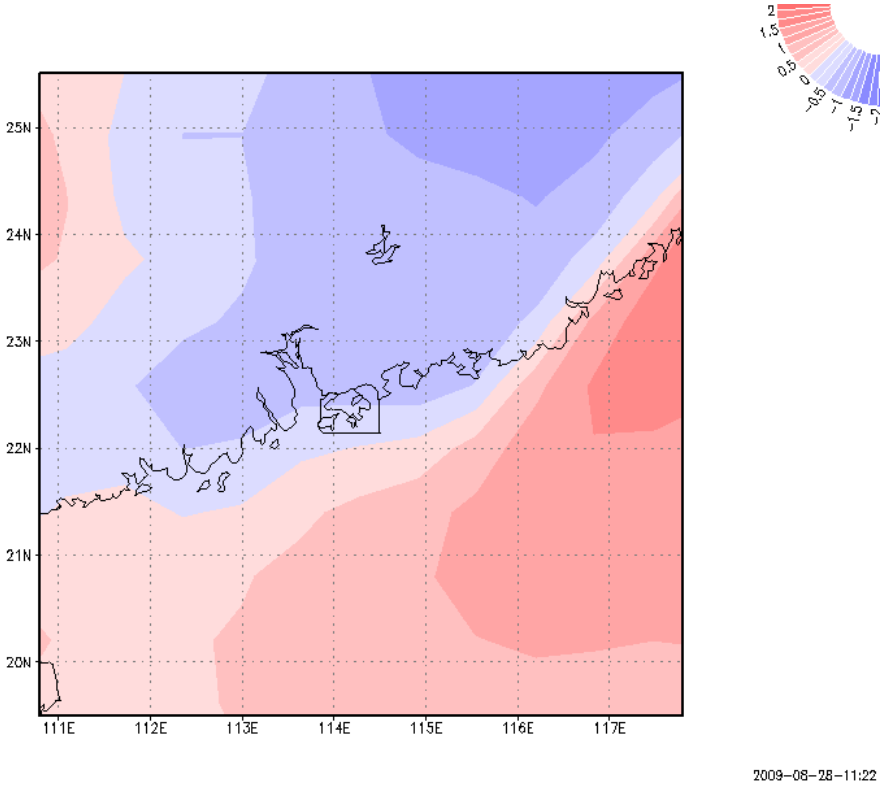


Future development of climate models

- finer spatial resolution (25 km or below)
- improved representations of the atmosphere
- improved representations of the connections between the atmosphere, the ocean, and the land
- better representations of the effects of greenhouse gases and aerosols on climate

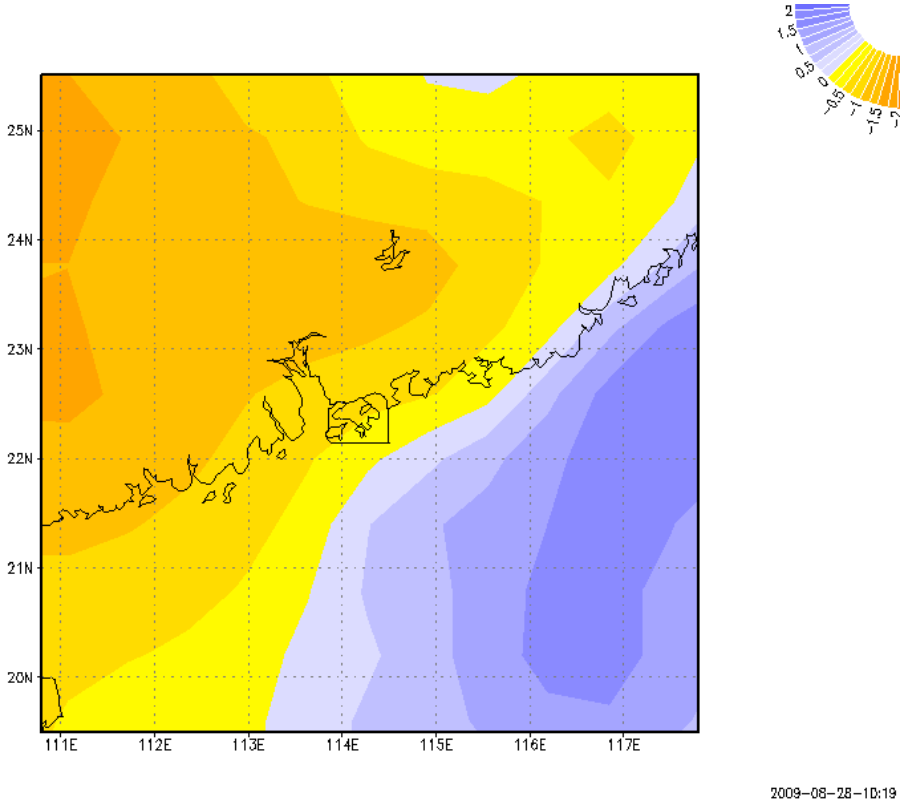
(Source : IPCC)

Regional climate model forecast (seasonal)



Temperature anomaly forecast

Red: +ve anomaly (above normal temperature)
Blue: -ve anomaly (below normal temperature)



Rainfall anomaly forecast

Blue: +ve anomaly (above normal rainfall)
Orange: -ve anomaly (below normal rainfall)

Unit expressed in standard deviation
±0.5 being classified as near normal

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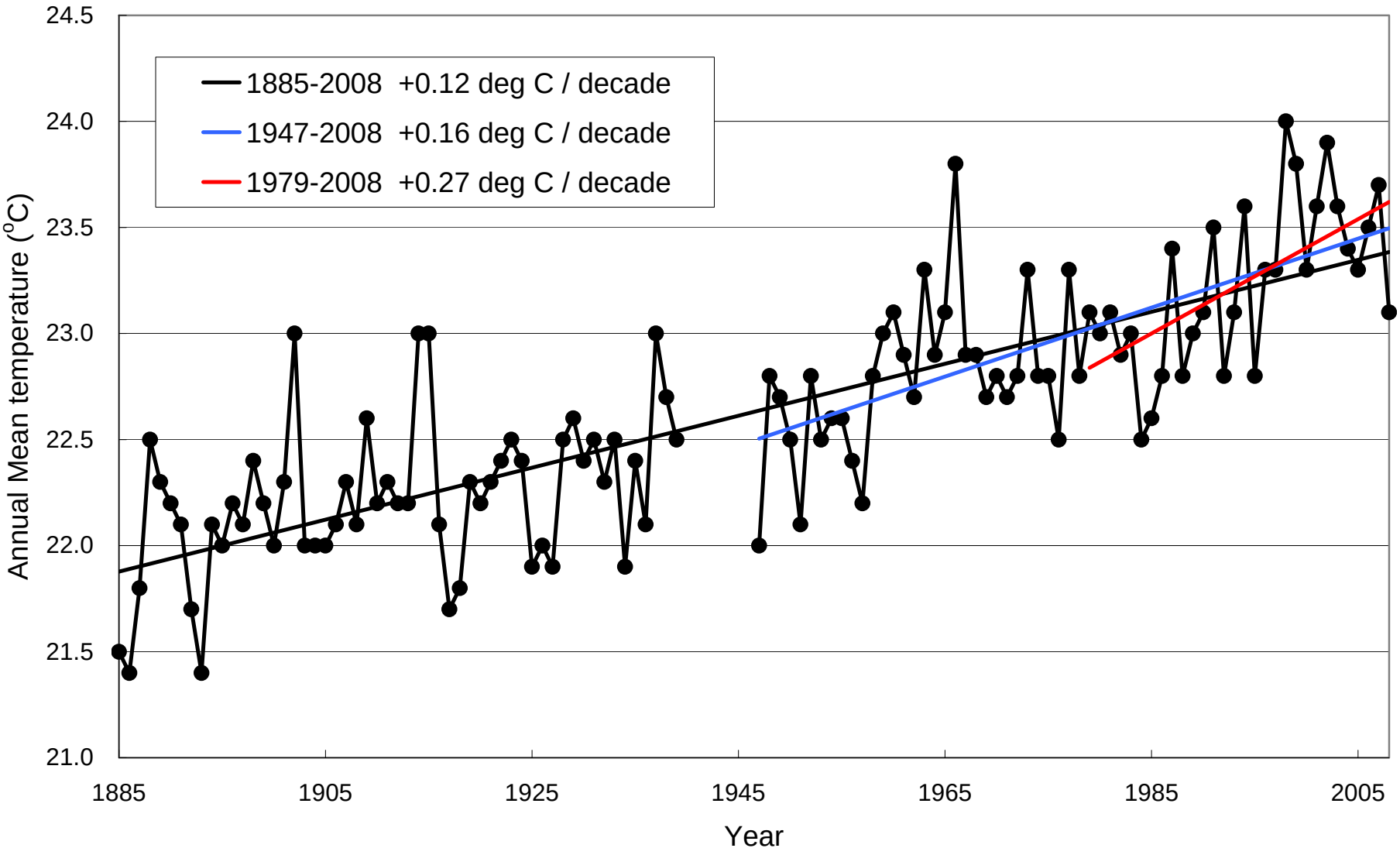
Temperature trend in Hong Kong



Annual mean temperature recorded at the Hong Kong Observatory Headquarters (1885-2008). Data are not available from 1940 to 1946.

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What can we do ?

(a) change in lifestyle (save energy, recycle, etc.)

(b) use renewable energy / alternative energy

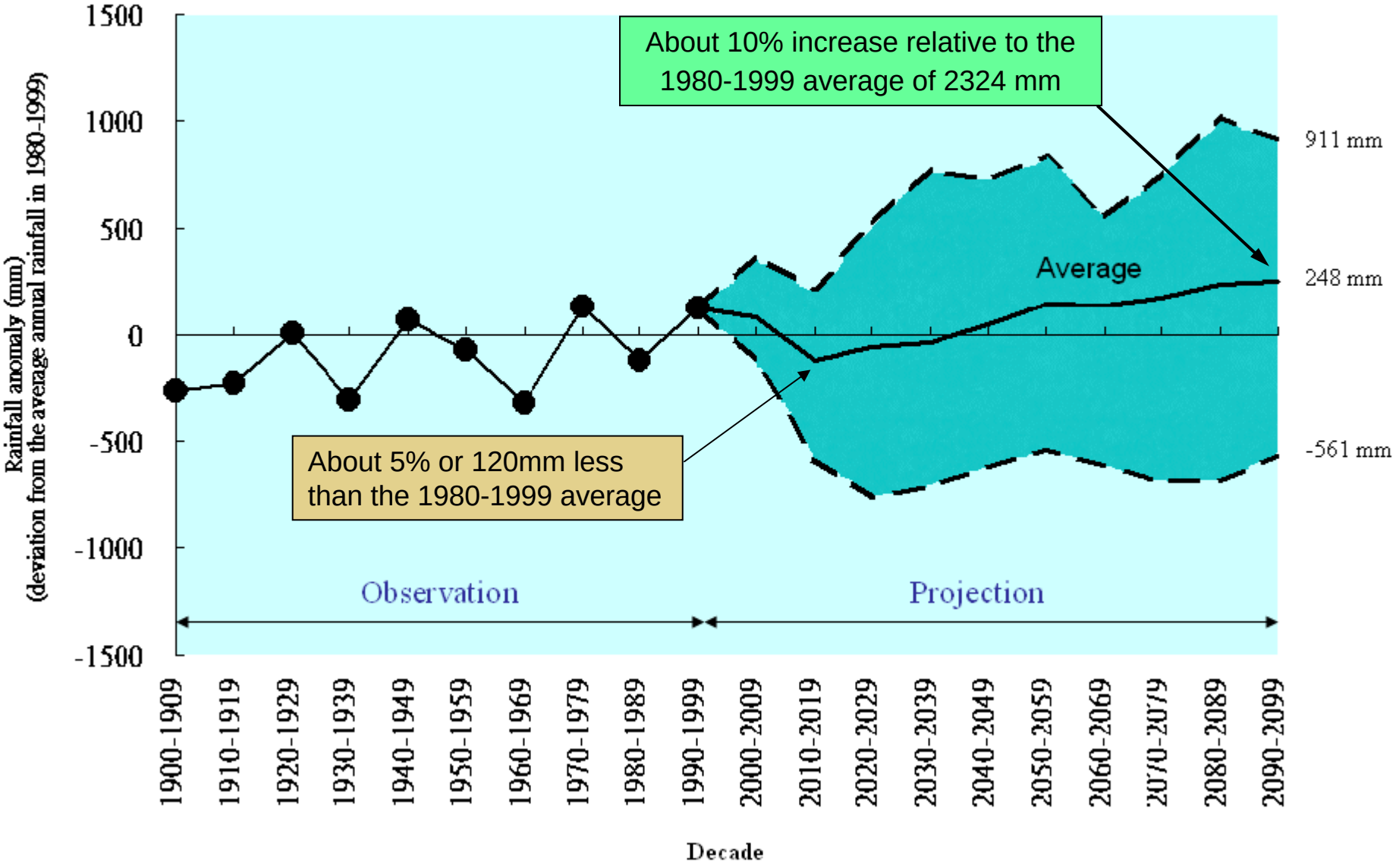
(c) green technology

(d) city planning and building design

(e) green roof

(f) ……

Past and projected change in annual rainfall for Hong Kong



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Water usage

Personally per capita	100 litres/day
Daily food consumption	2000-5000 litres
1 kg bolt of cloth	>10 000 litres
1 kg of beef	15 000 litres
1 kg of vegetable	2000 litres

(source : The Economist, 11 April 2009)

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What can we do ?

We currently collect only 10% of world's precipitation

(a) Collect more water (more reservoirs) **?**

(b) More dams **?**

(c) More recycling

(d) Change eating habits
(less meat, more vegetable)

(e) Enhance water efficiency, especially agriculture
(Agriculture currently uses up 75% of the world's water)

(f) ….

(source : The Economist, 11 April 2009)

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Sea level rise

Future projections :

(a) Melting of glaciers and ice caps

(b) Thermal expansion of ocean water

(c) Melting of the great ice caps of Greenland and Antarctic

IPCC (2007)	↑	0.2 to 0.6m	by 2100
But latest research :	↑	0.8 to 2 m	by 2100

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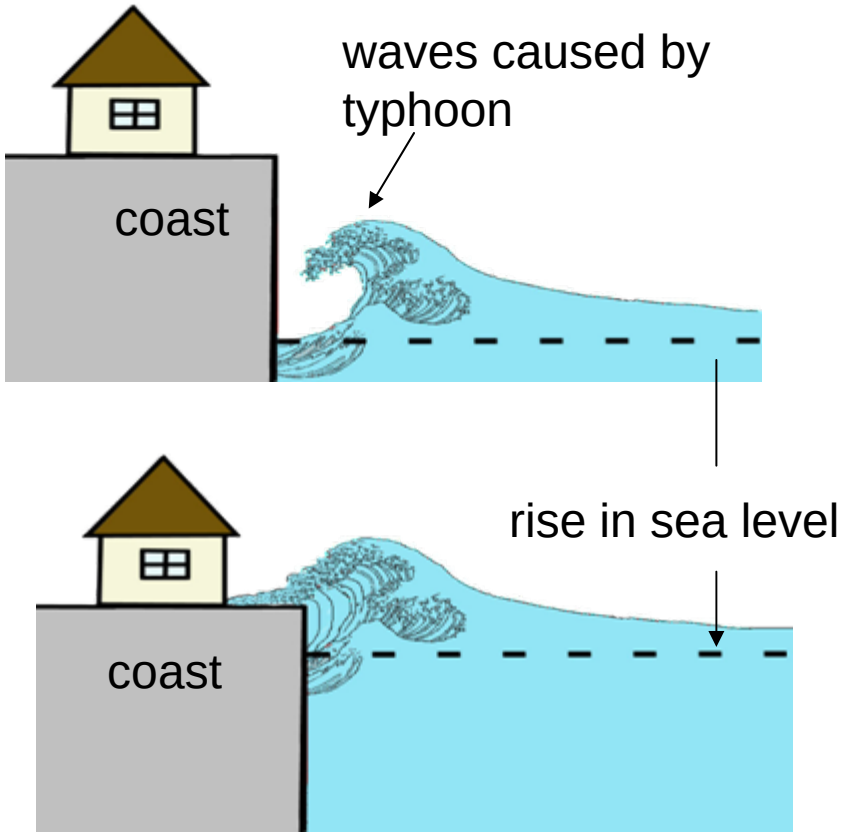
Sea level rise, plus storm surge



Flooding of the coastal areas becomes easier under tropical cyclone situations

Flooding in Tai O after Typhoon Hagupit
(September 2008)

(courtesy of TVB)

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How good is solar power?

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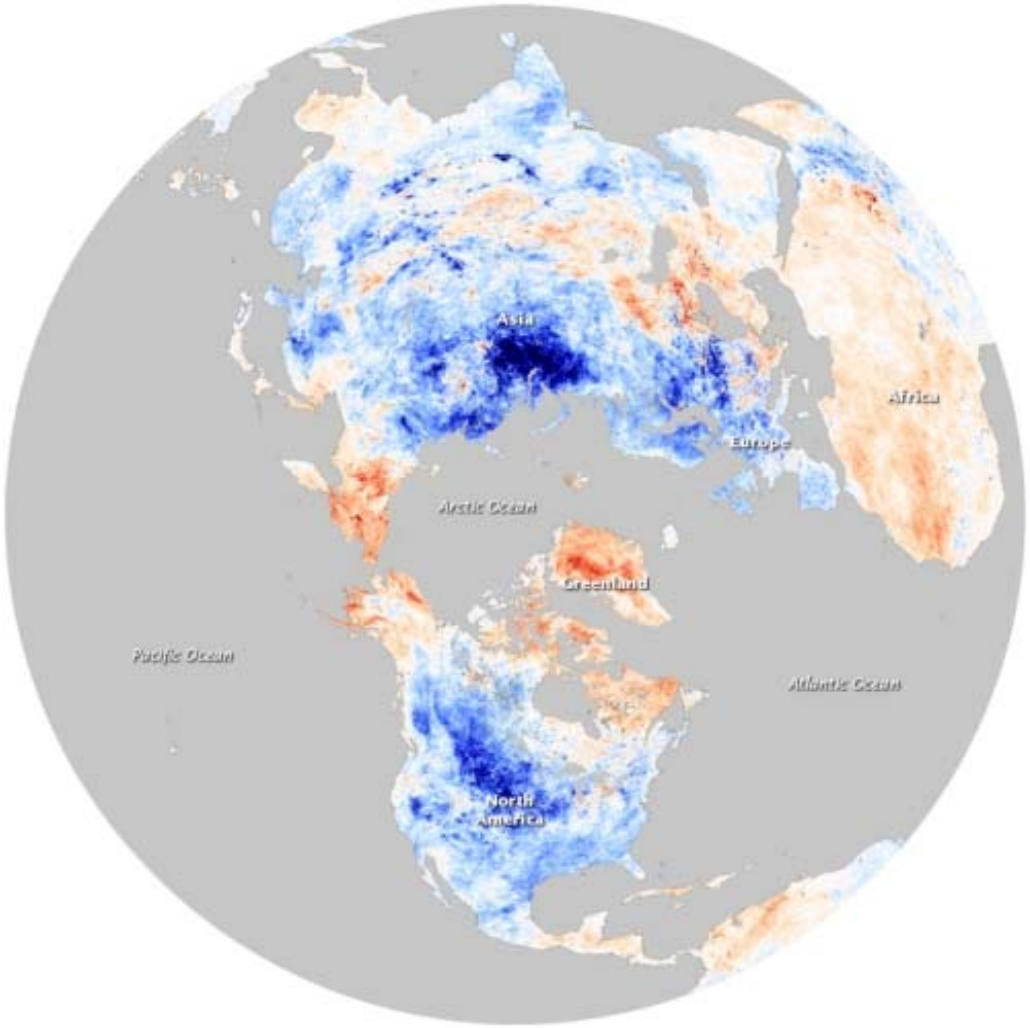
What about the weather elsewhere and the cold weather in Hong Kong?



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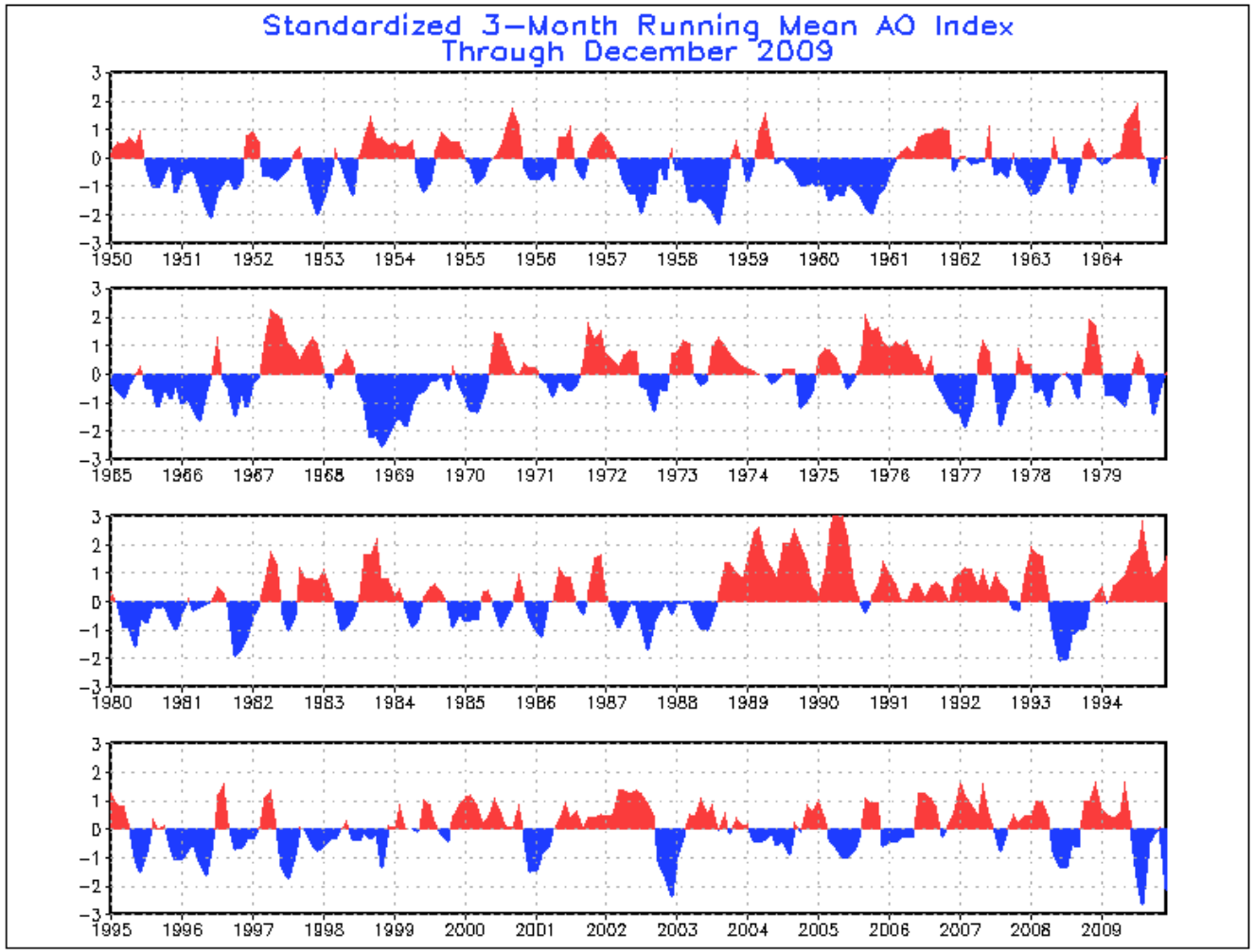
What are the causes of the cold weather?



3-month running mean of Arctic Oscillation Index from 1950 to 2009
(Source : Climate Predication Center, NOAA)

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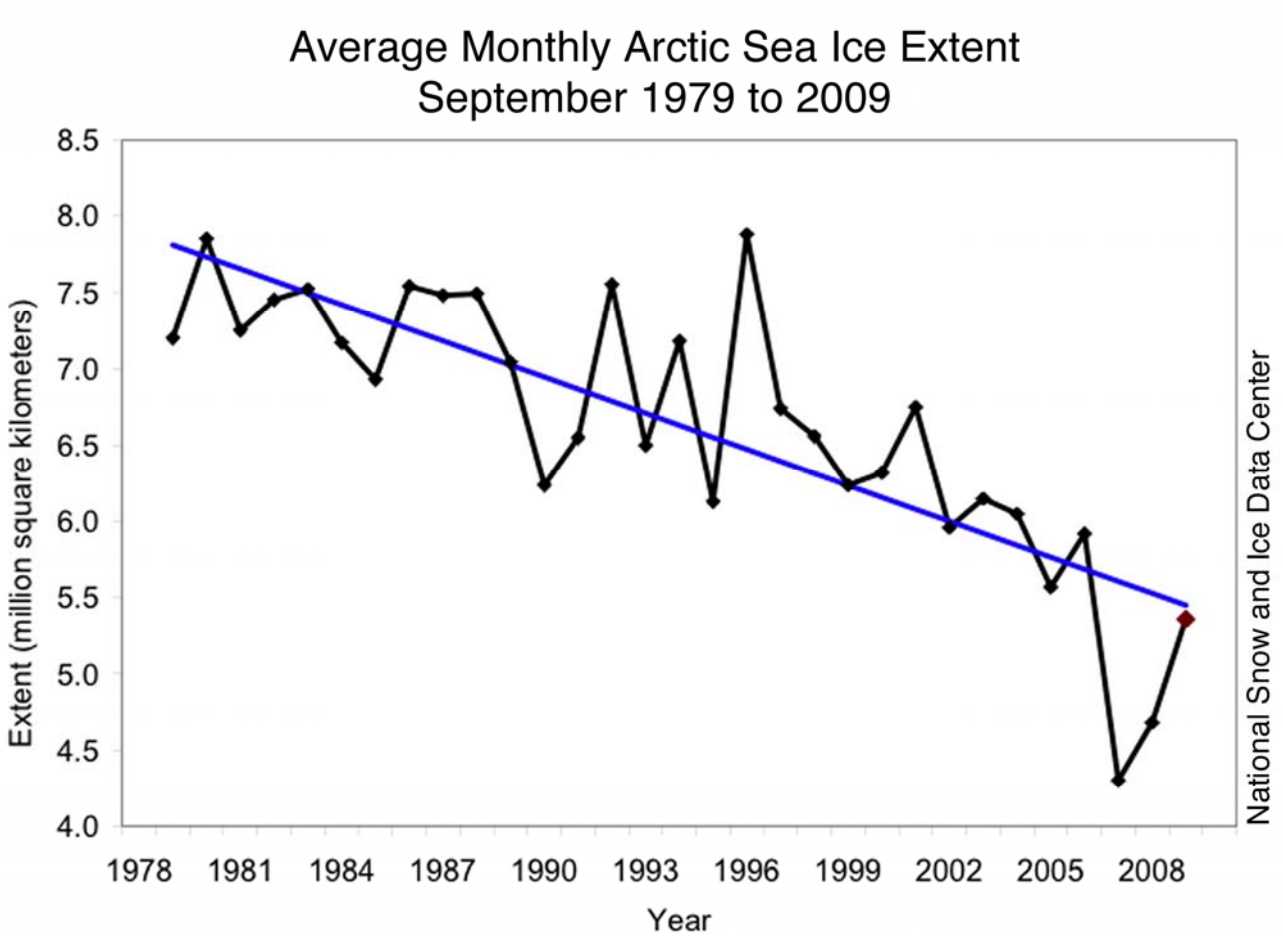
With global warming, how come there is recently a rise in sea ice coverage in the Arctic?



Average monthly arctic sea ice extent – summer (September) 1979 – 2009
(Source : U.S. National Snow and Ice Data Center)

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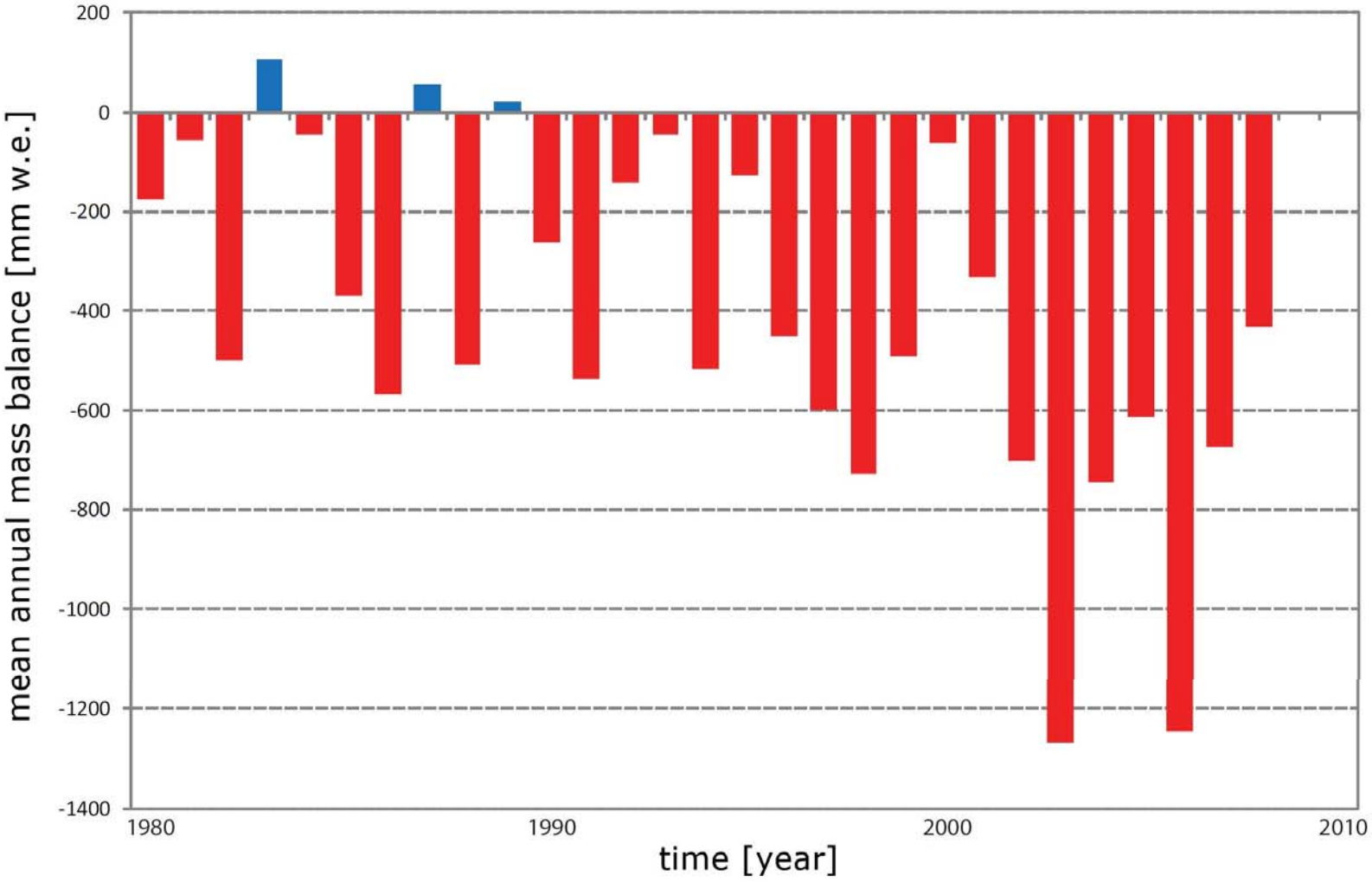
What about the melting glaciers in the Himalayas?



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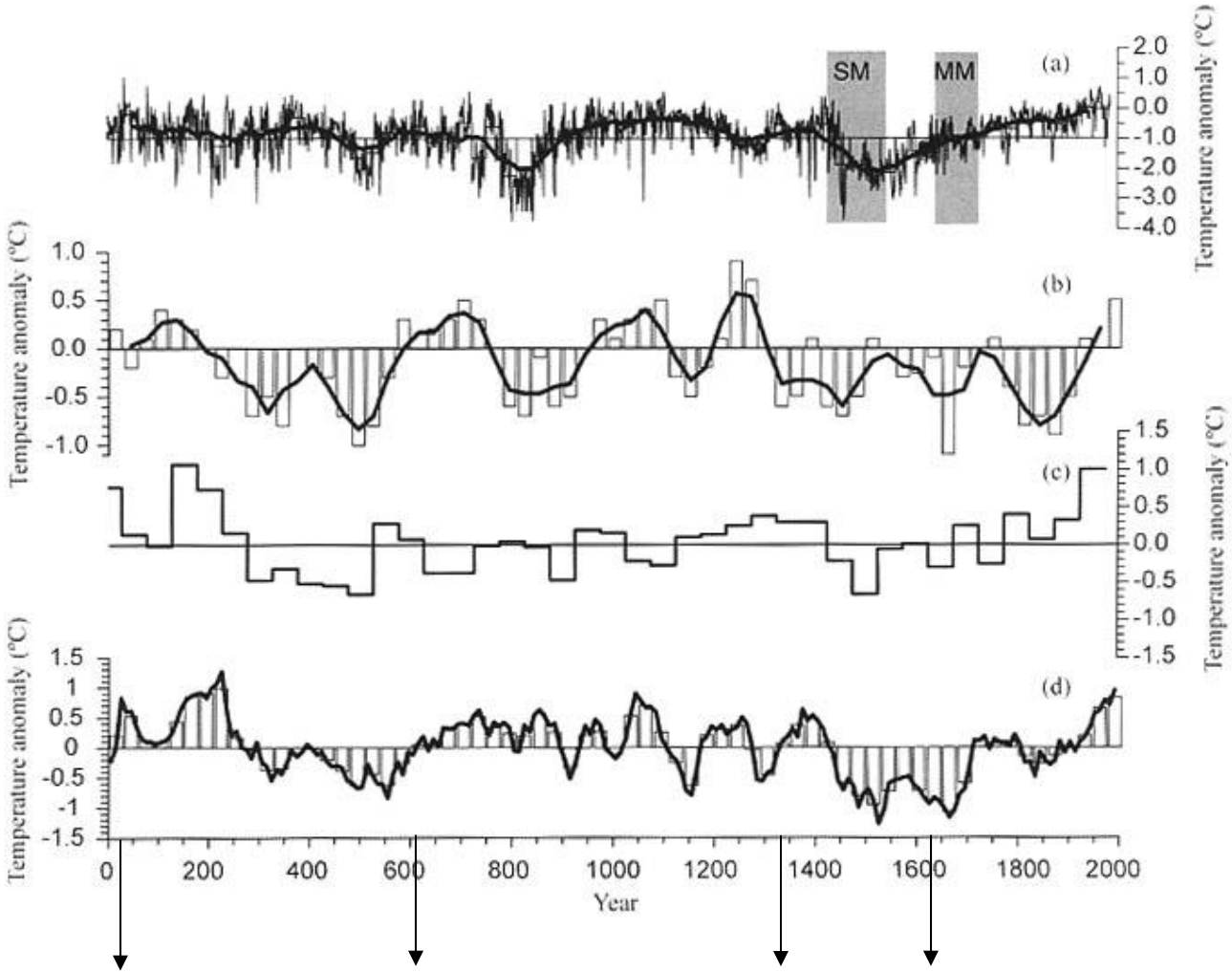

Eastern Han Dynasty (25 A.D.)

Tang Dynasty (618 A.D.)

Ming Dynasty (1368 A.D.)

Qing Dynasty (1644 A.D.)

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(*United Nations Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007)*

Very likely = 90%

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Thank you

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