

IPCC氣候變遷第五次評估報告(第一工作小組)導讀講座

IPCC CLIMATE CHANGE 2013: THE PHYSICAL SCIENCE BASIS

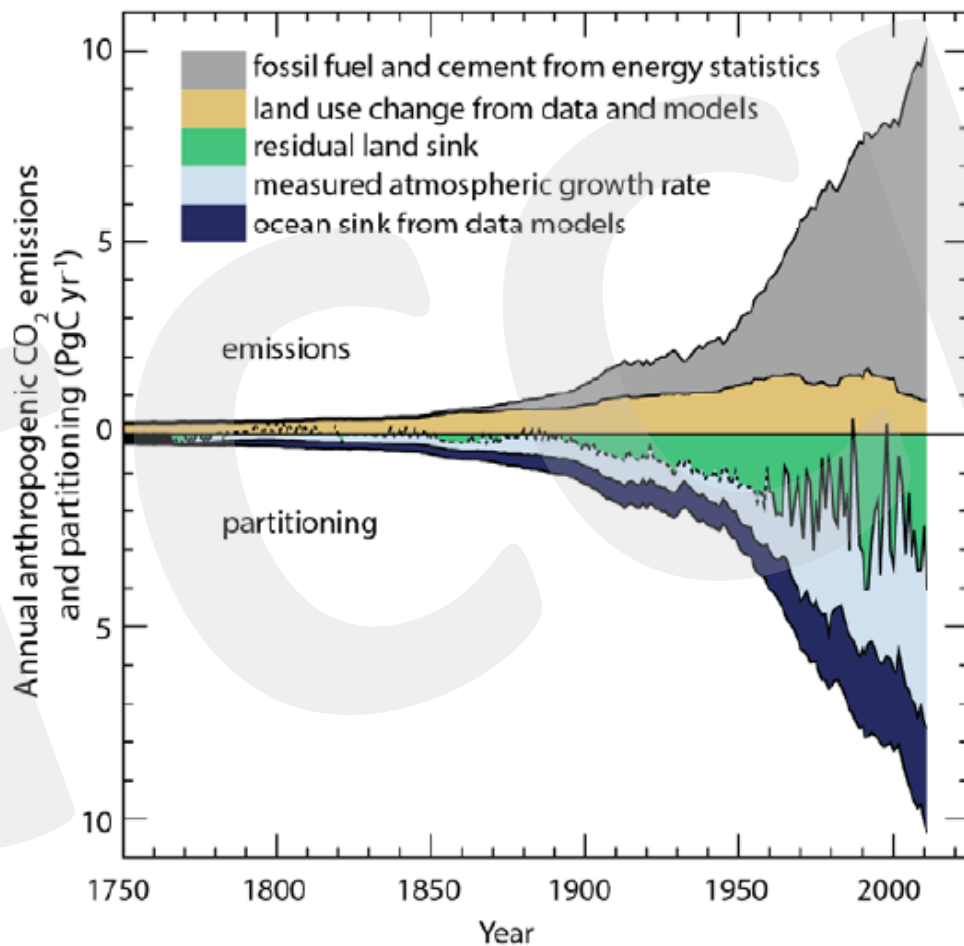
# 議題二 人為與自然對氣候的輻射驅動力 氣候模式 氣候變遷偵測與歸因

國科會臺灣氣候變遷推估與資訊平台計劃 (TCCIP)  
臺灣師範大學地球科學系暨海洋環境研究所 陳正達



# 人為與自然對氣候的輻射驅動力

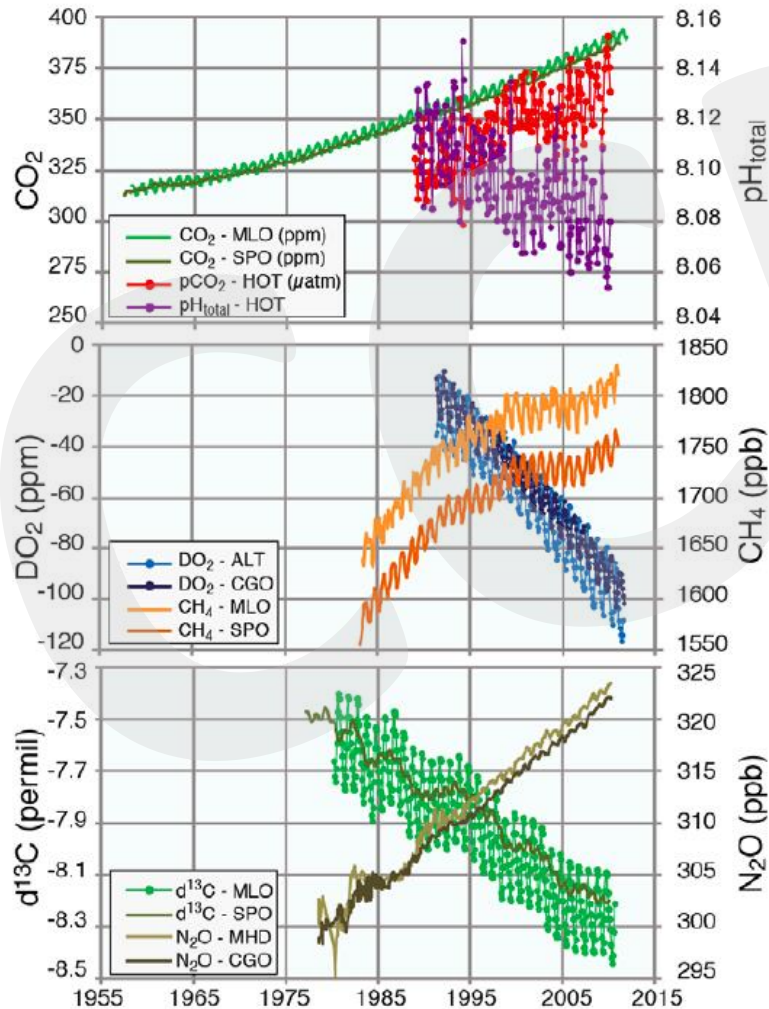
## 人為排放的二氧化碳去哪裡？



引用自「IPCC氣候變遷第五次評估報告」  
技術摘要

# 人為與自然對氣候的輻射驅動力

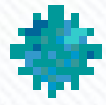
## 觀測的主要溫室氣體變化



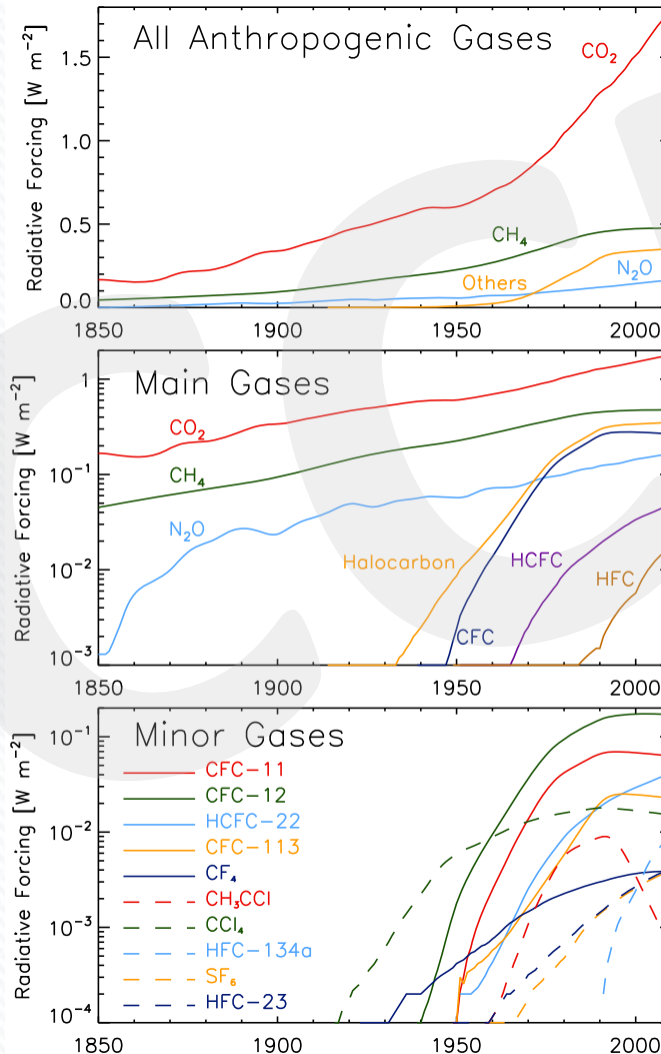
引用自「IPCC氣候變遷第五次評估報告」  
技術摘要



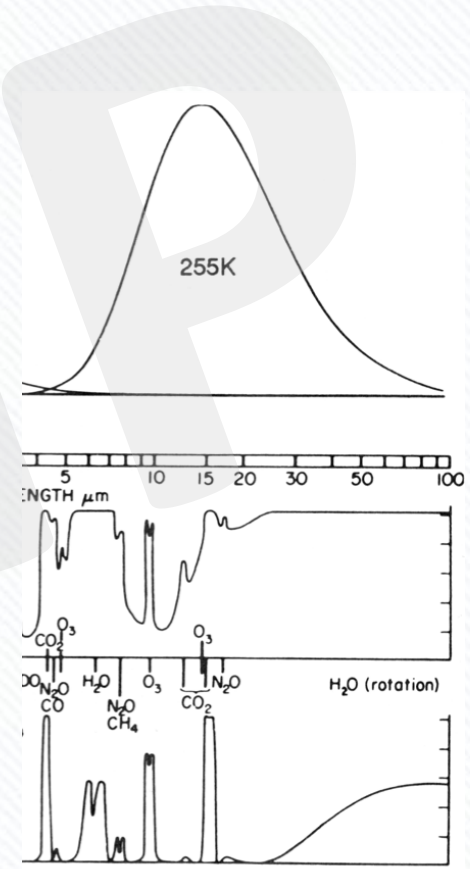
# 人為與自然對氣候的輻射驅動力



## 人為溫室氣體增加所造成的輻射驅動力



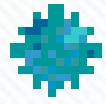
引用自「IPCC氣候變遷第五次評估報告」



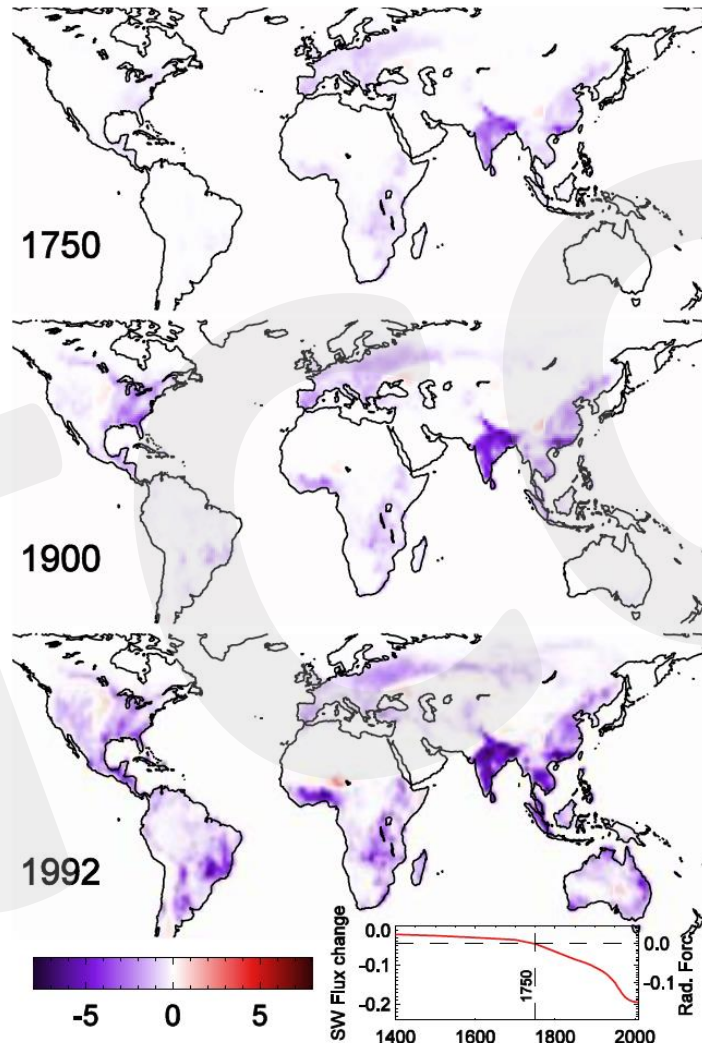
Goody and Yung (1989)



# 人為與自然對氣候的輻射驅動力



## 人為土地利用變化所造成的輻射驅動力



### Deforestation



### Urbanization



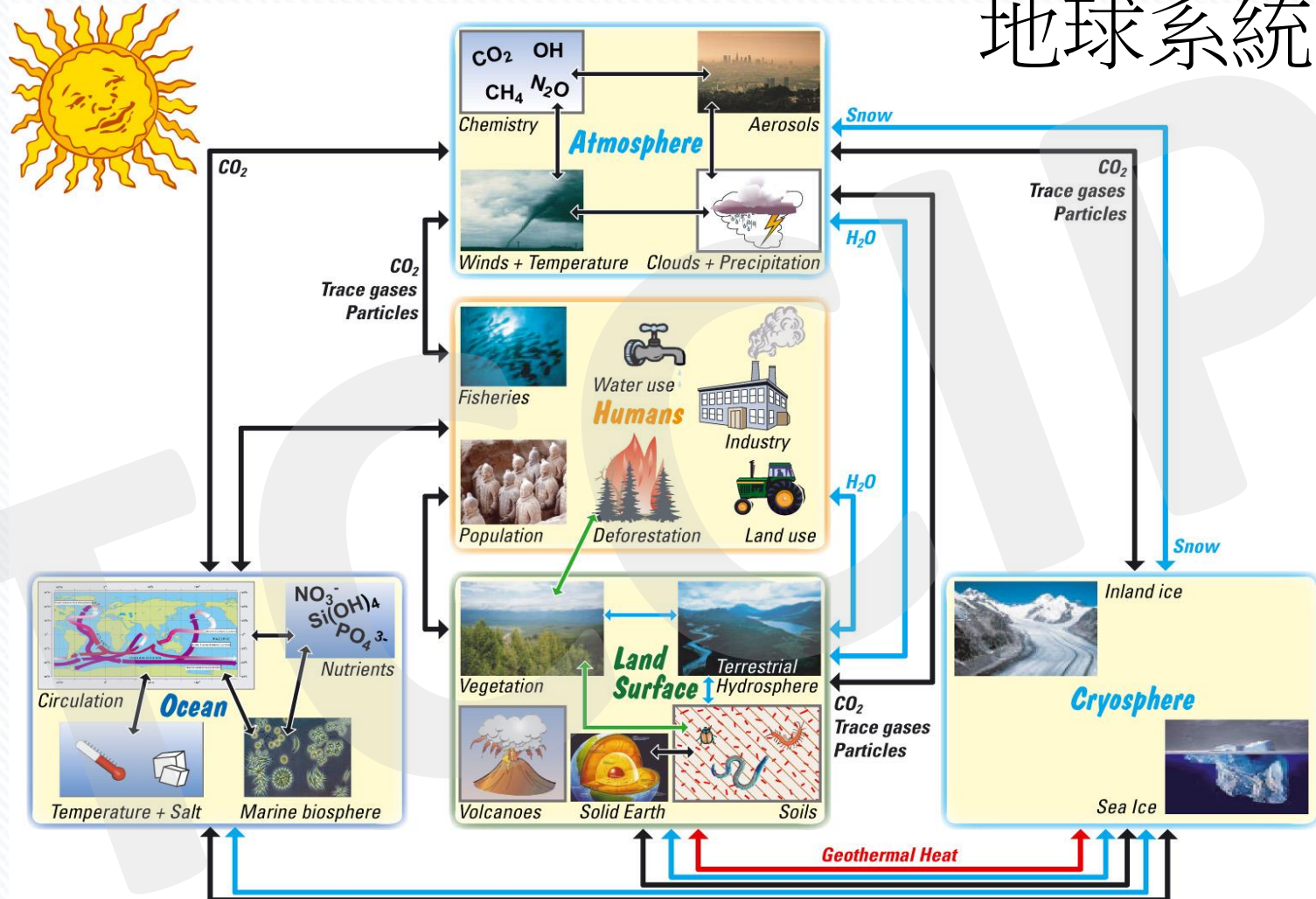
### 地表反照率改變

引用自「IPCC氣候變遷  
第五次評估報告」



# 氣候模式

## 地球系統

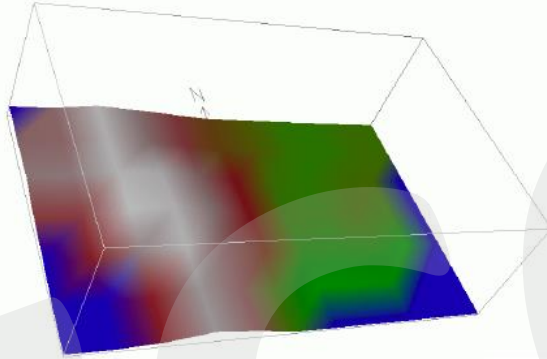


Conceptual diagram from  
Max Planck Institute for Meteorology

# 氣候模式

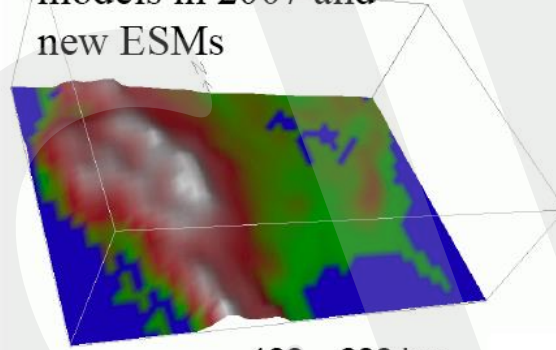
## 氣候模式的解析度

Climate Models circa early 1990s



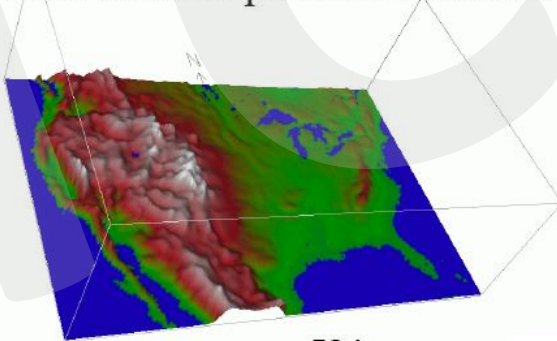
~500 km

Global coupled climate models in 2007 and new ESMs



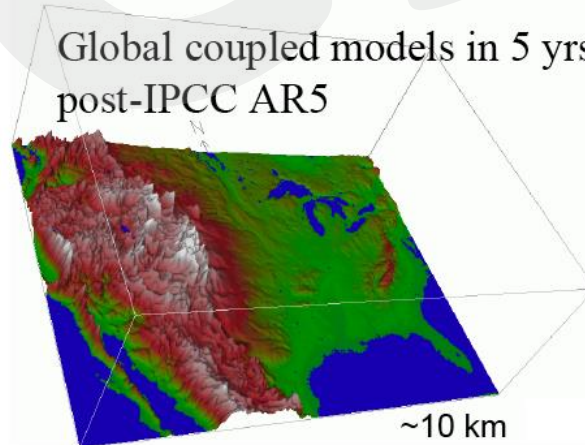
~100 – 200 km

New decadal prediction models



~50 km

Global coupled models in 5 yrs post-IPCC AR5



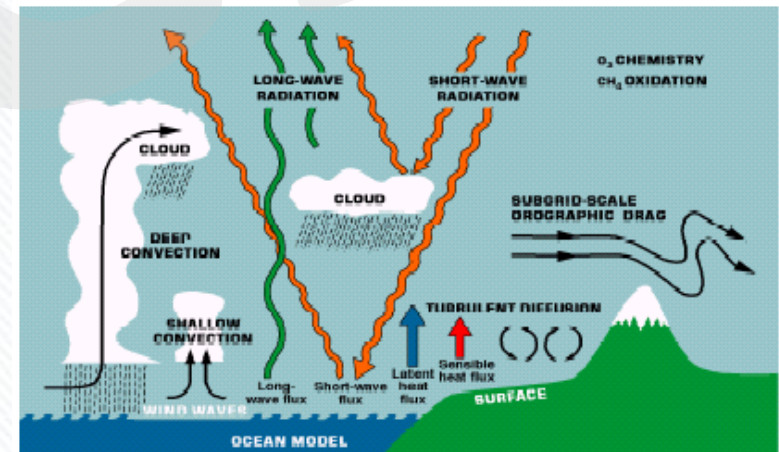
~10 km



# 氣候模式

## Physical Parameterizations 物理參數化

- Processes not explicitly represented by the basic dynamical and thermodynamic variables in the equations (dynamics, continuity, thermodynamic, equation of state) on the grid of the model need to be included by parameterizations (3 kinds).
  - Processes on smaller scales than the grid not explicitly represented by the resolved motion;**
    - Convection, boundary layer friction and turbulence, gravity wave drag
    - All involve the vertical transport of momentum and most also involve the transport of heat, water substance and tracers (e.g. chemicals, aerosols)
  - Processes that contribute to internal heating**
    - Radiative transfer and precipitation
    - Both require cloud prediction
  - Processes not included**
    - (e.g. land surface processes, carbon cycle, chemistry, aerosols, etc)





# 氣候模式

## What are we trying to parameterize?

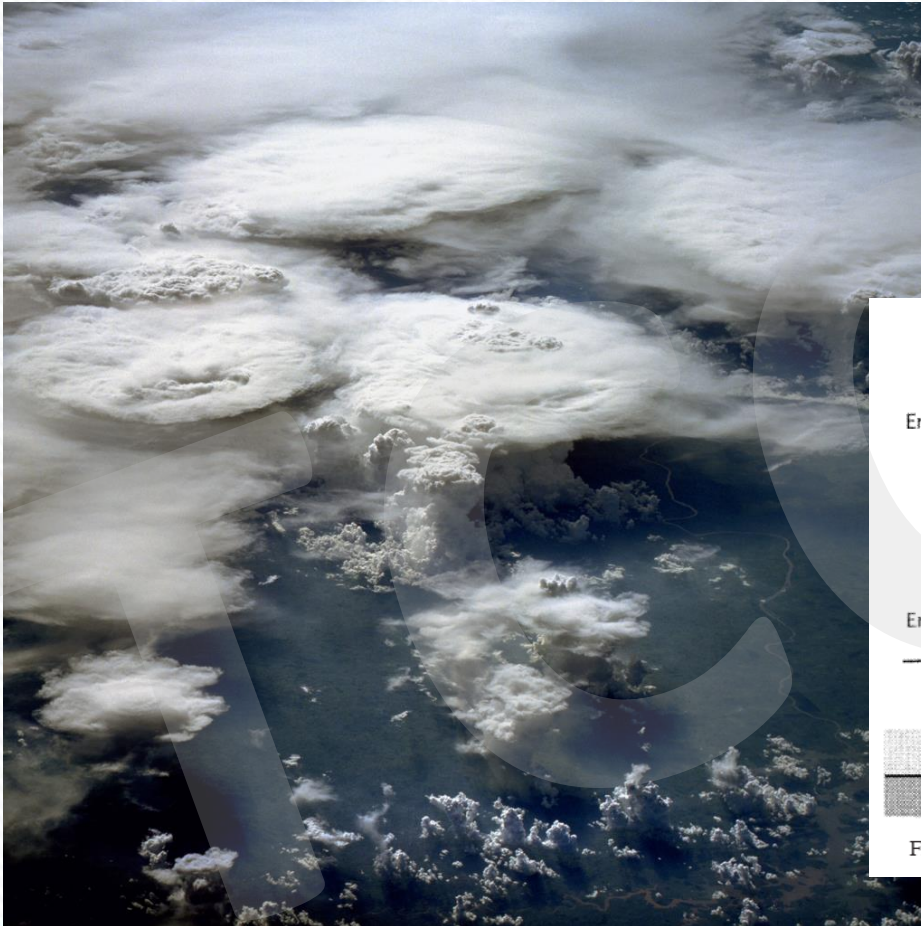


Photo from NASA

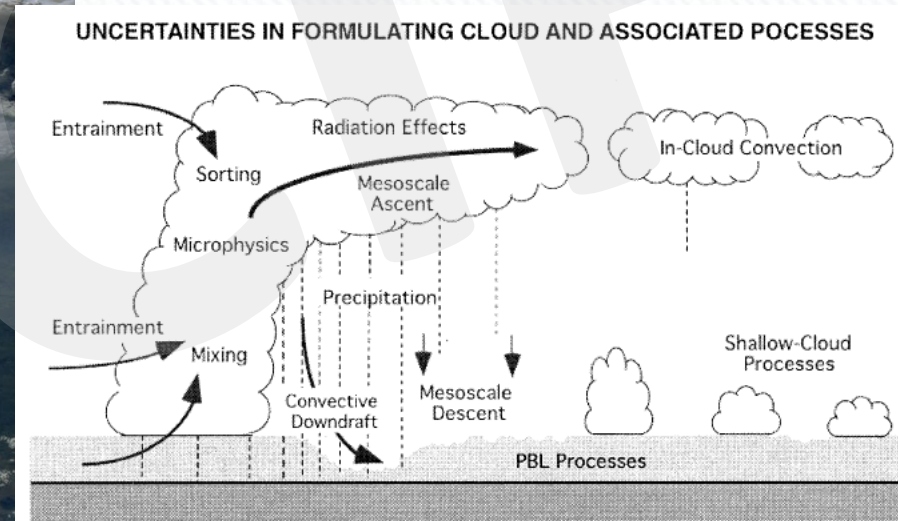


FIG. 2. Cloud and associated processes for which major uncertainties in formulation exist.

Courtesy of B. Stevens



# 氣候模式

Gridcell



## Subgrid Structure of the Land Model

Landunits



Glacier



Wetland



Vegetated



Lake



Urban

Columns



Soil Type 1

Plant Functional Types

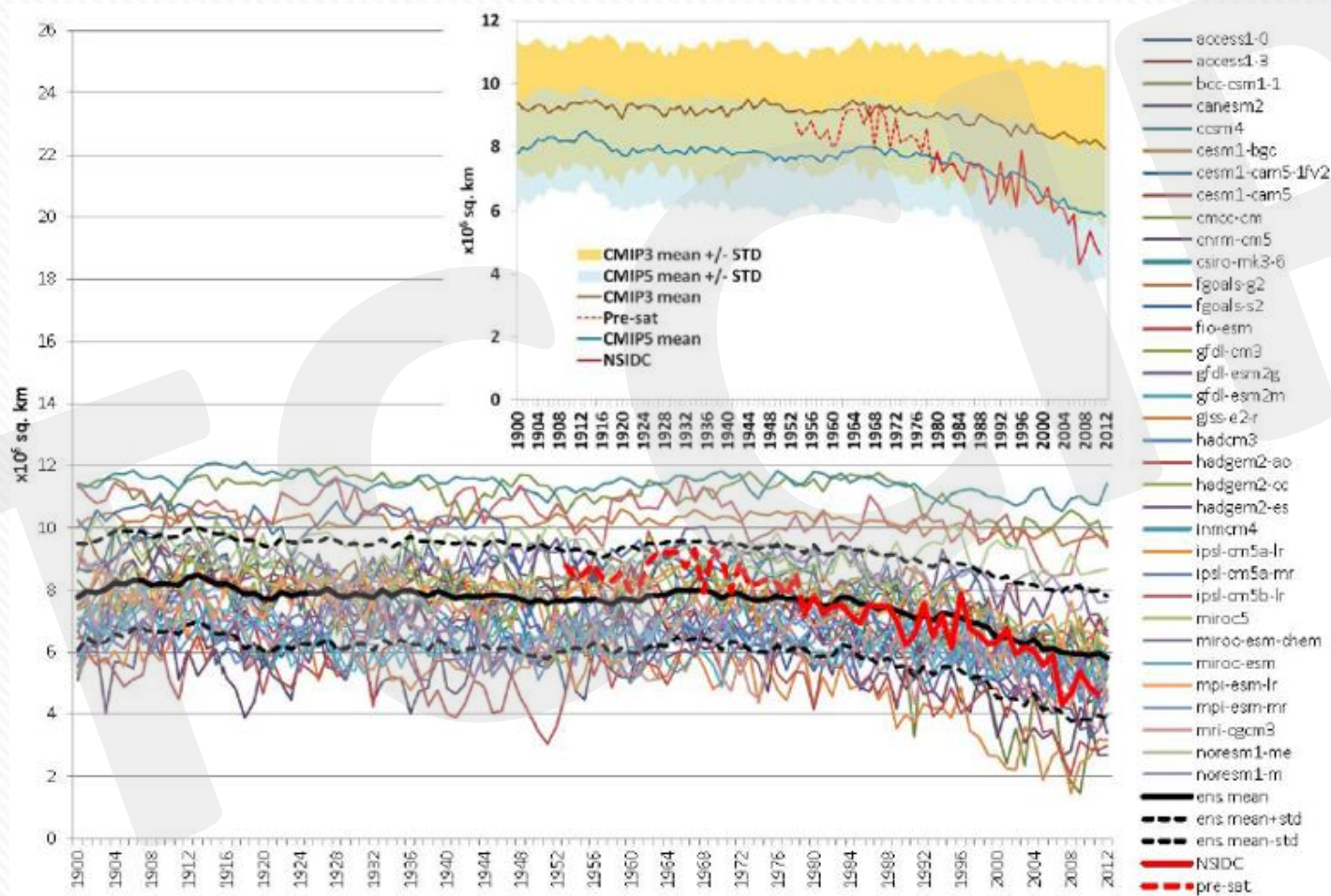


Courtesy of P. Lawrence  
CLM in CESM



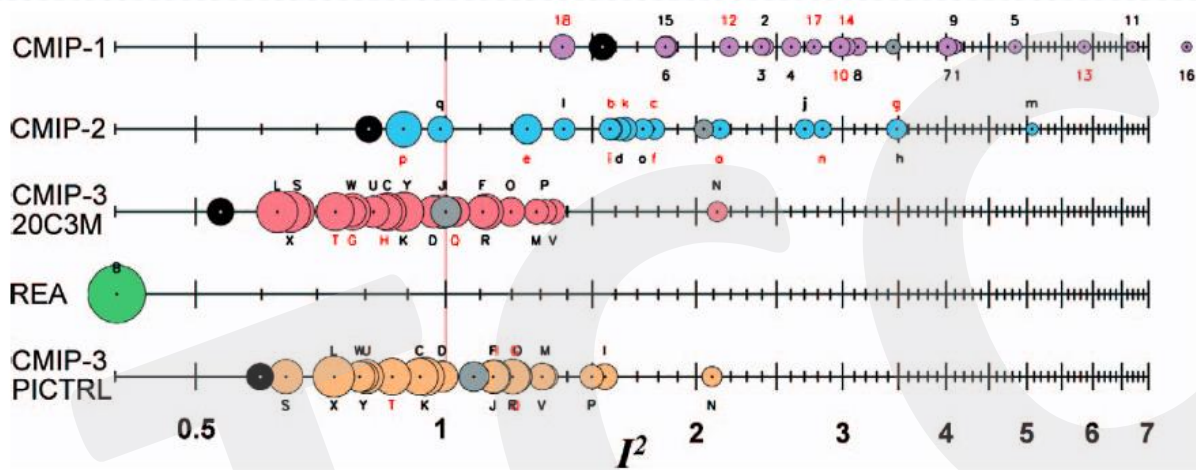
# 氣候模式

## 氣候模式所模擬北極海冰變化

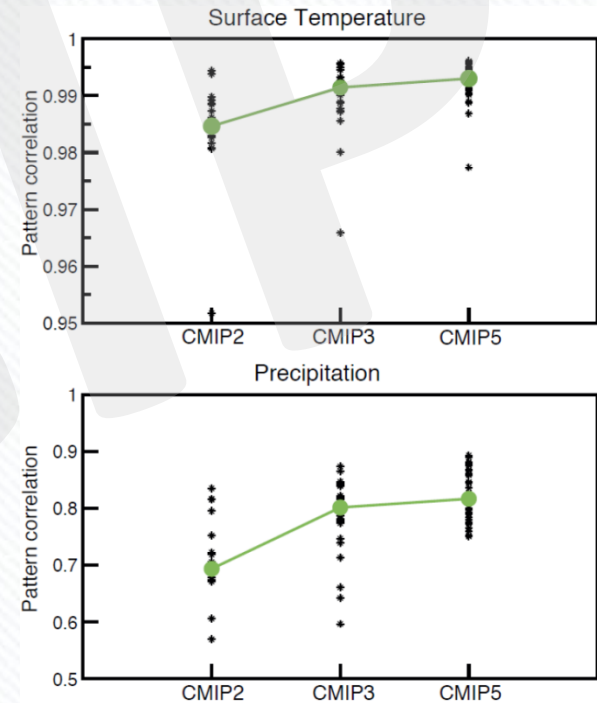


# 氣候模式

## Are climate models getting better?

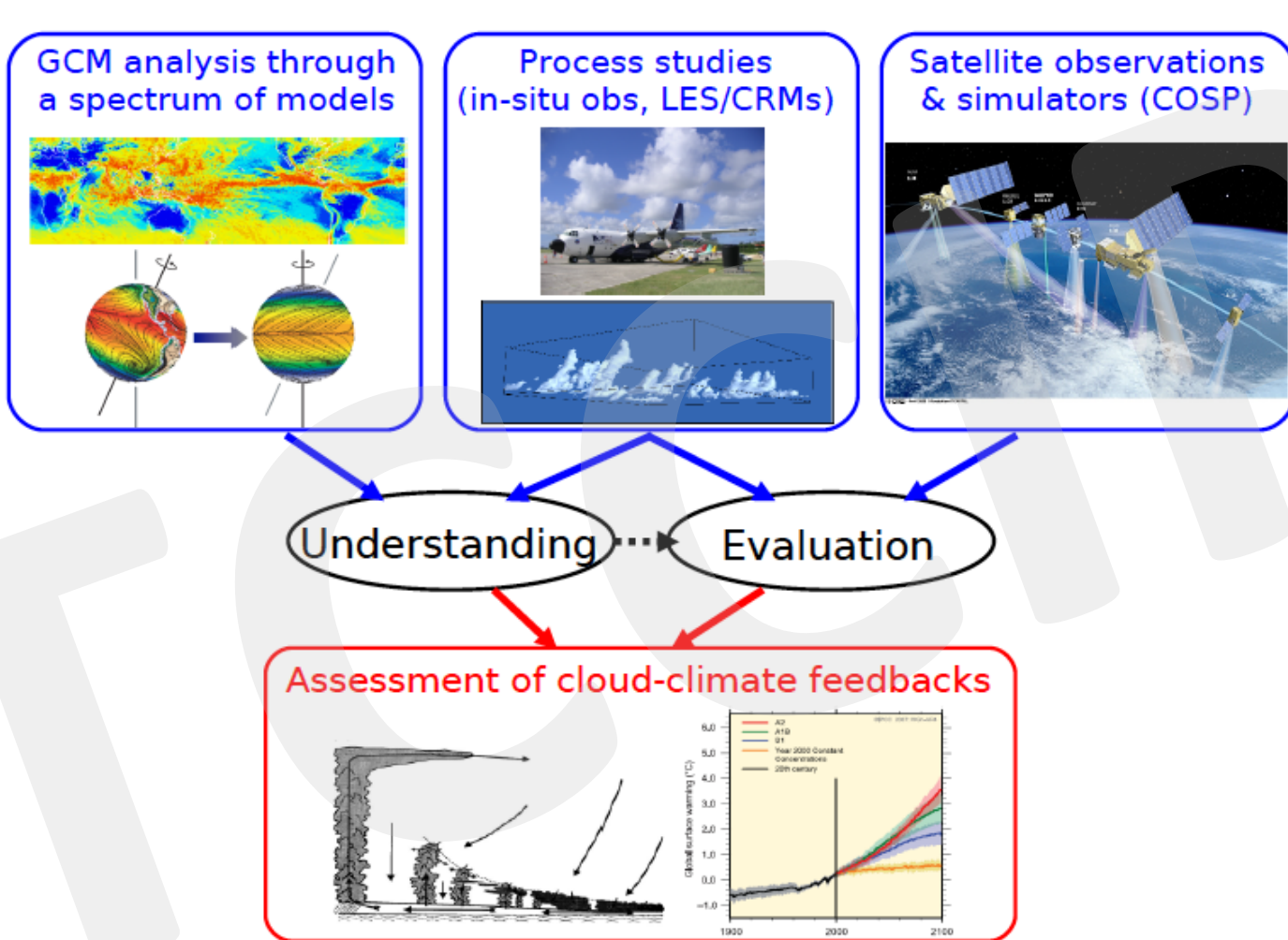


Reichler and Kim, BAMS (2008)



引用自「IPCC氣候變遷第五次評估報告」

# 氣候模式



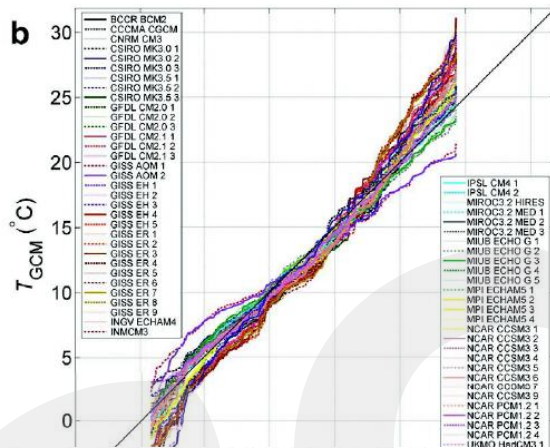
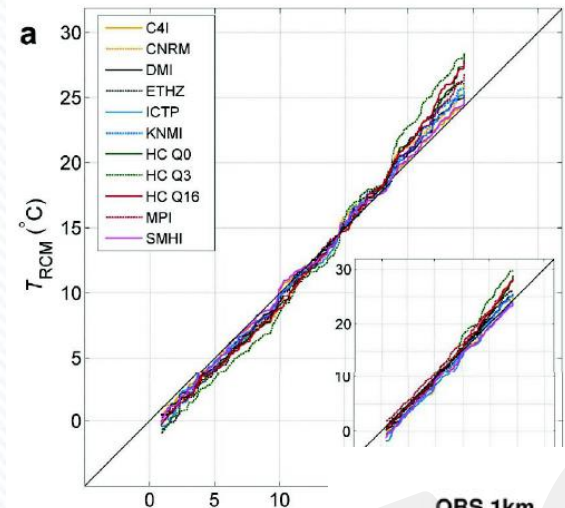
CFMIP (Cloud Feedback Model Intercomparison Project)

# 氣候模式

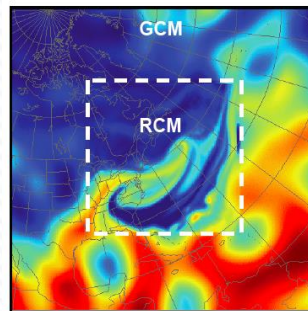
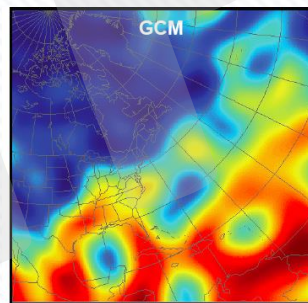
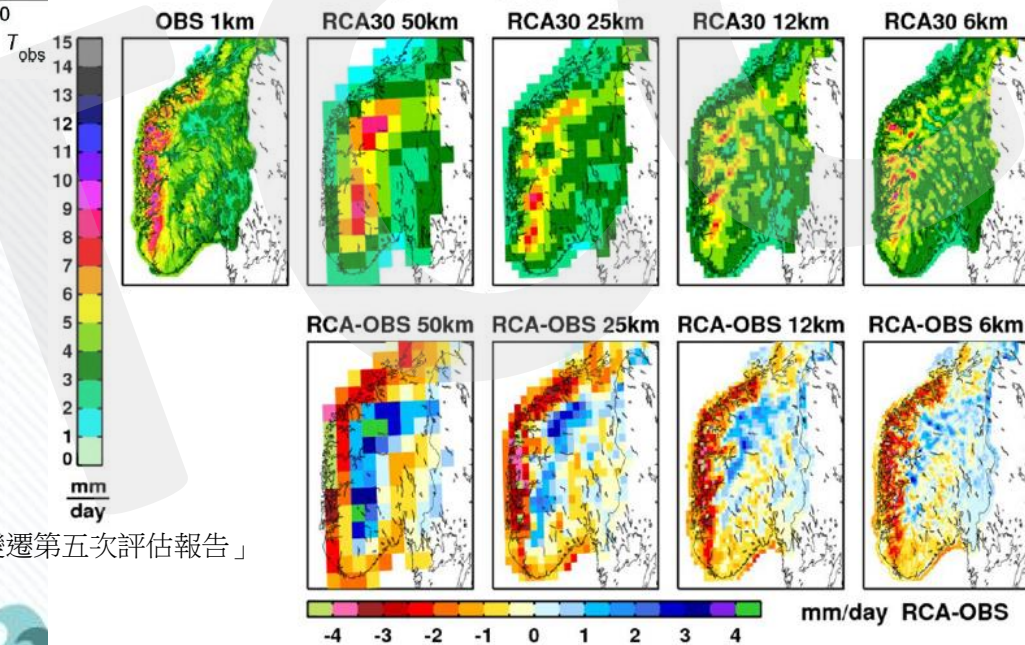
## 區域氣候模式

## 全球氣候模式

區域高解析度氣候模式  
可以改善全球氣候模式  
所模擬的區域氣候特徵



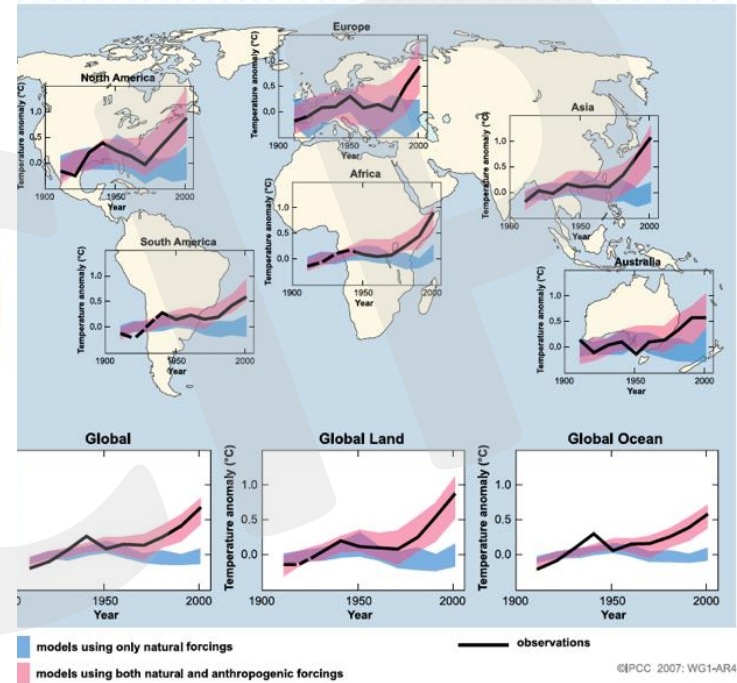
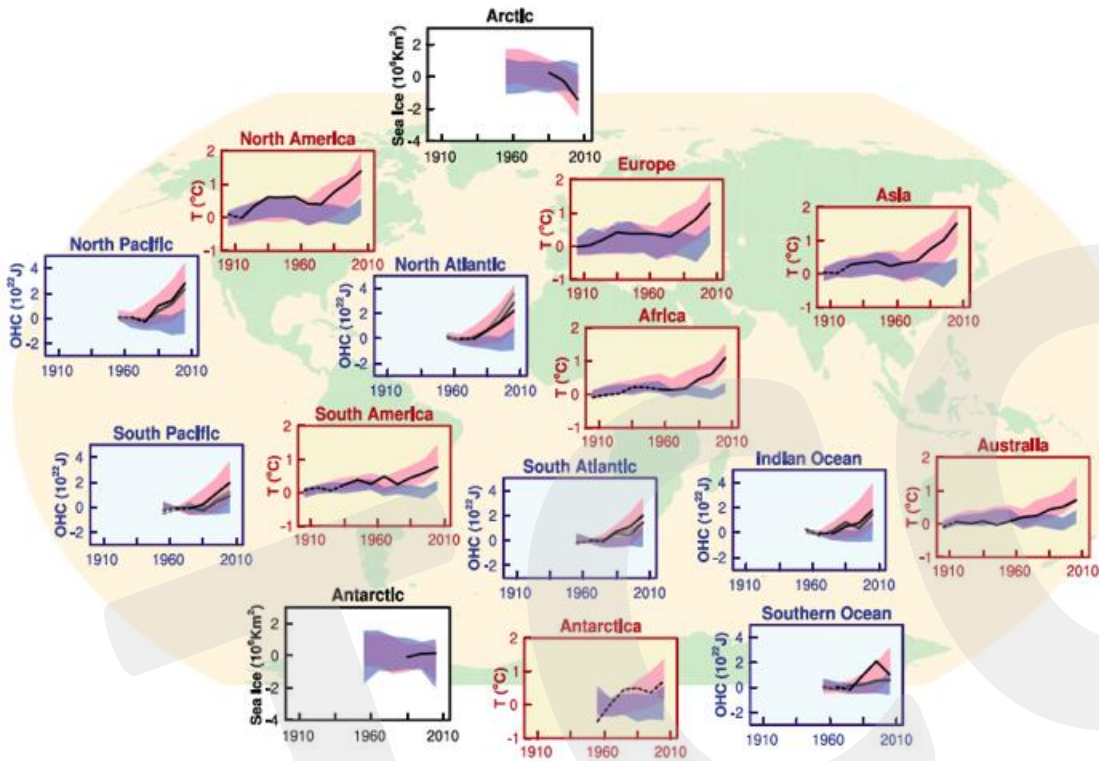
Precipitation (pr) | JJA | 1987-2008



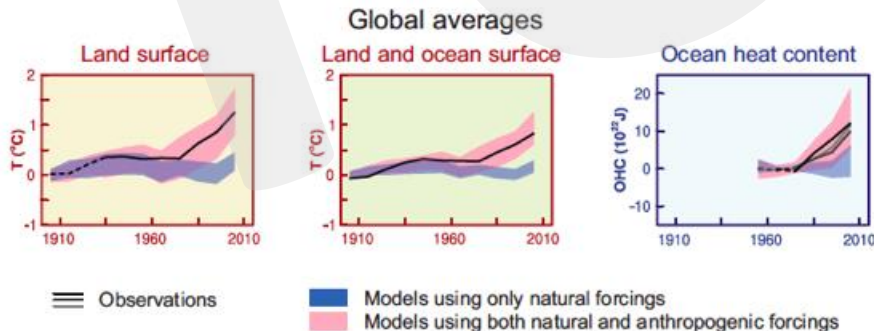
(Georgi 2013)



# 氣候變遷偵測與歸因



©IPCC 2007: WG1-AR4

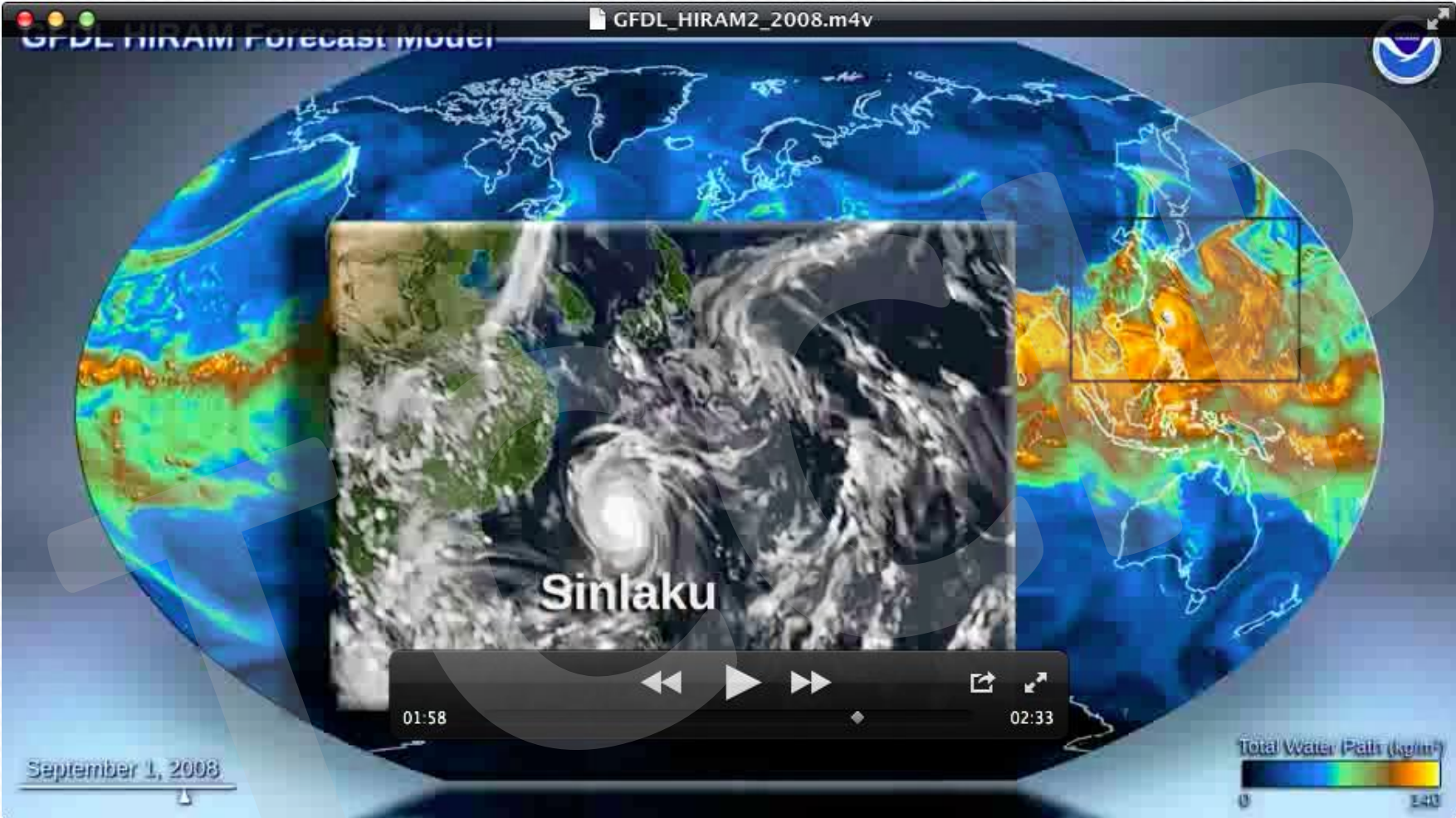


## IPCC AR4

引用自「IPCC氣候變遷第五次評估報告」



# GFDL HiRAM2 Model Simulation



Courtesy of S. J. Lin and GFDL