

<http://waseda2.t.u-tokyo.ac.jp/~waseda>  
waseda@naoe.t.u-tokyo.ac.jp

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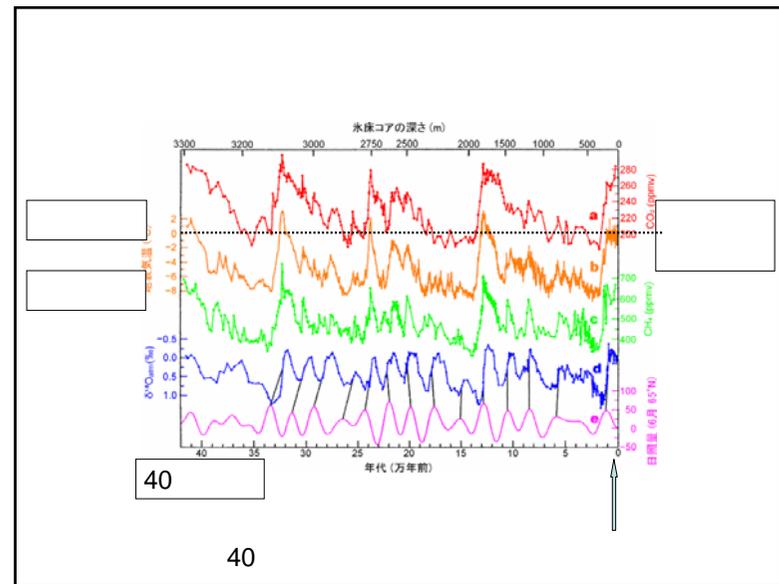
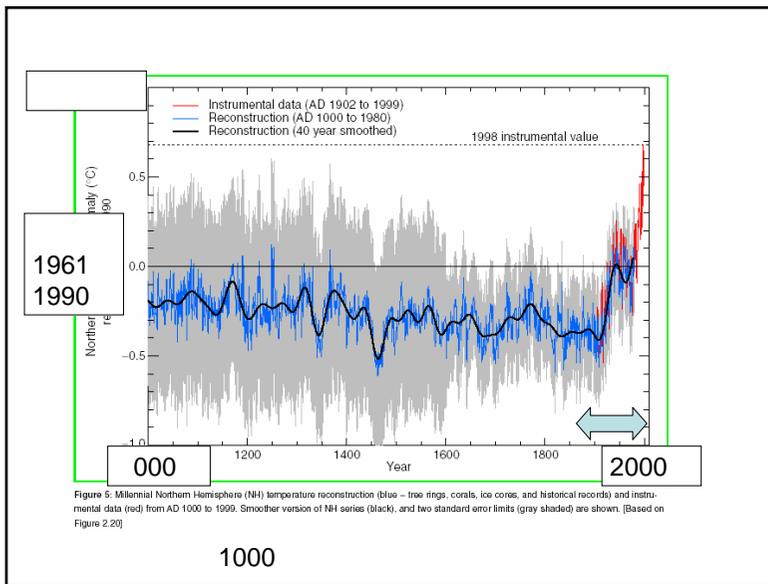
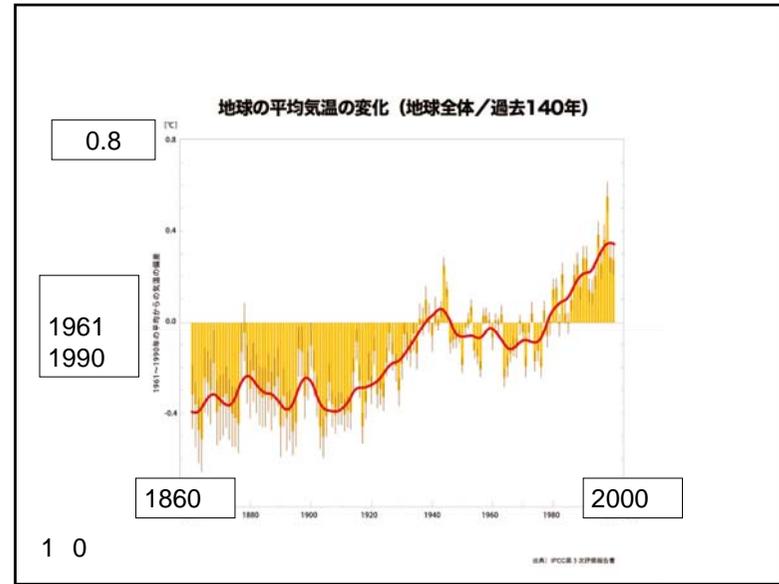
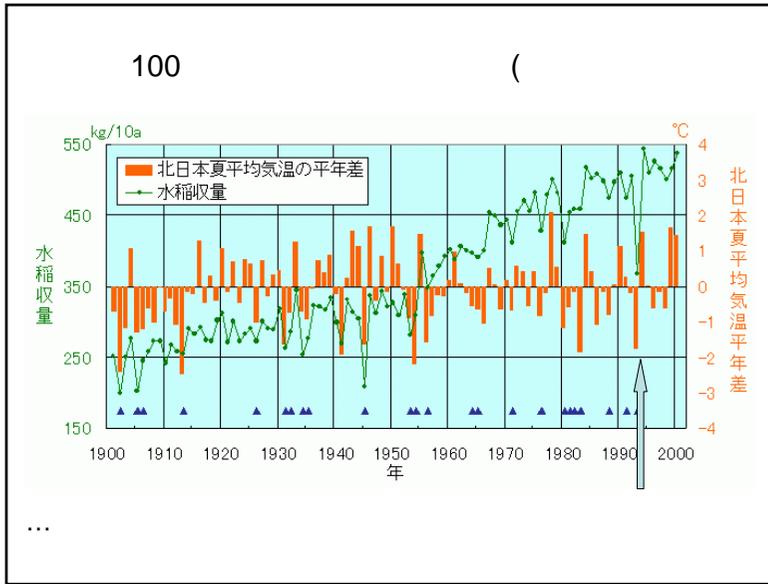
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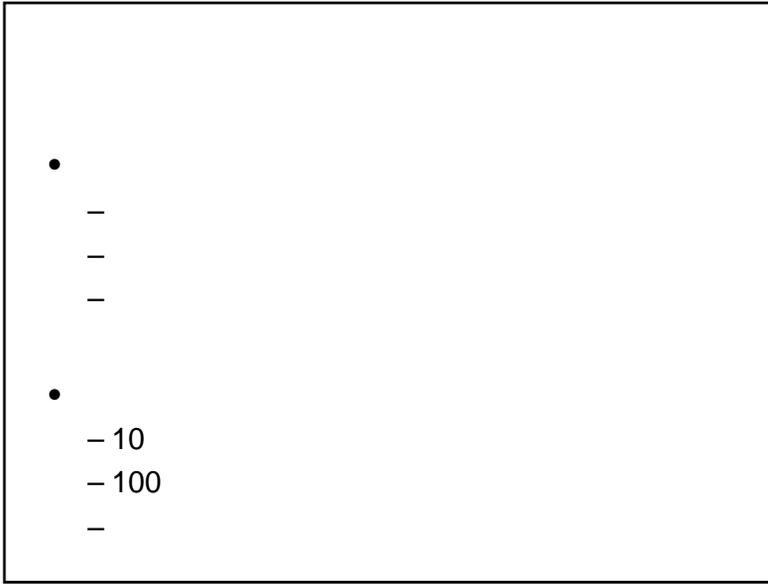
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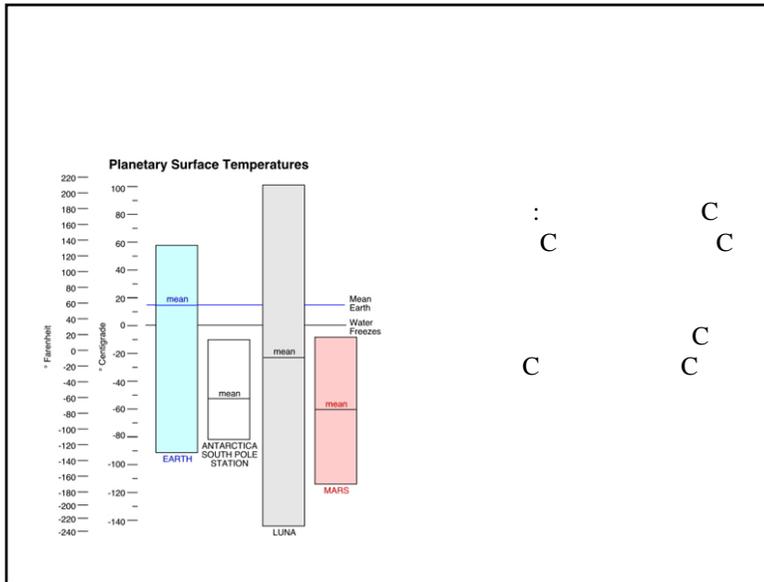
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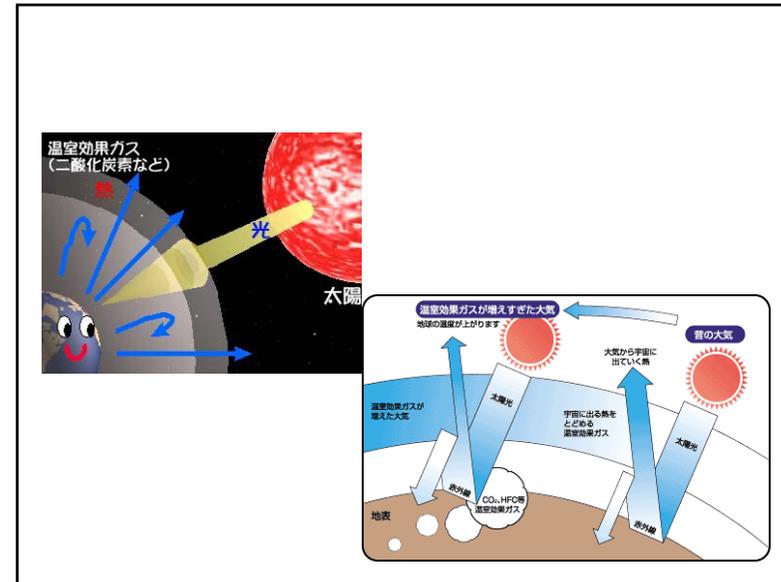
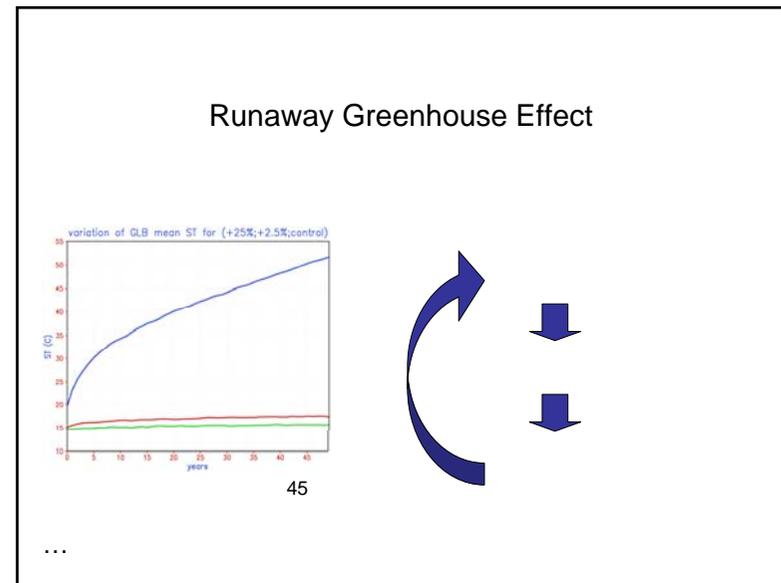
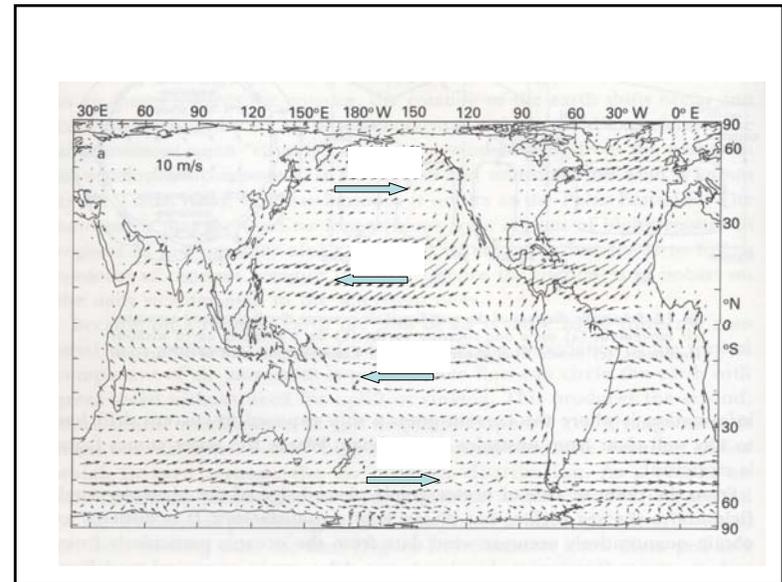
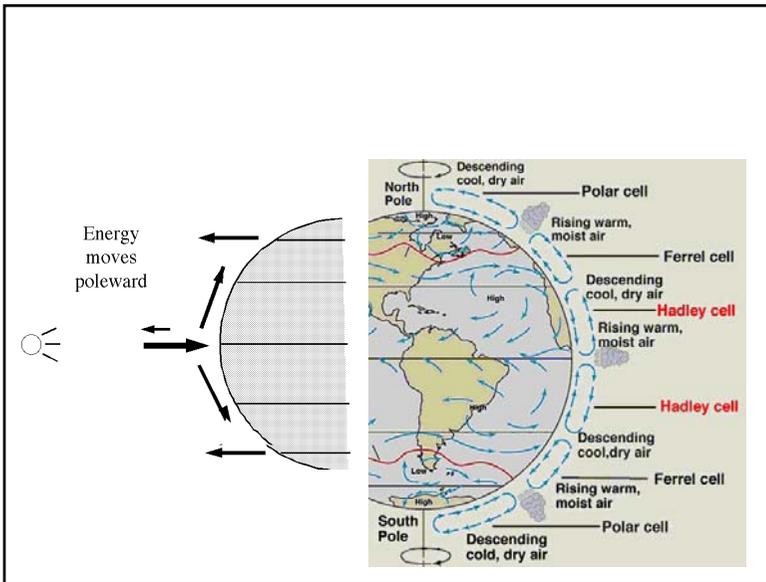
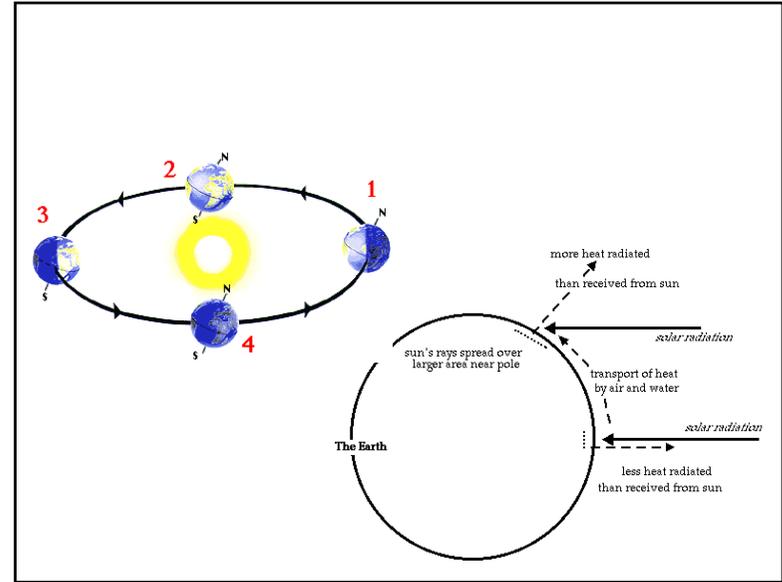
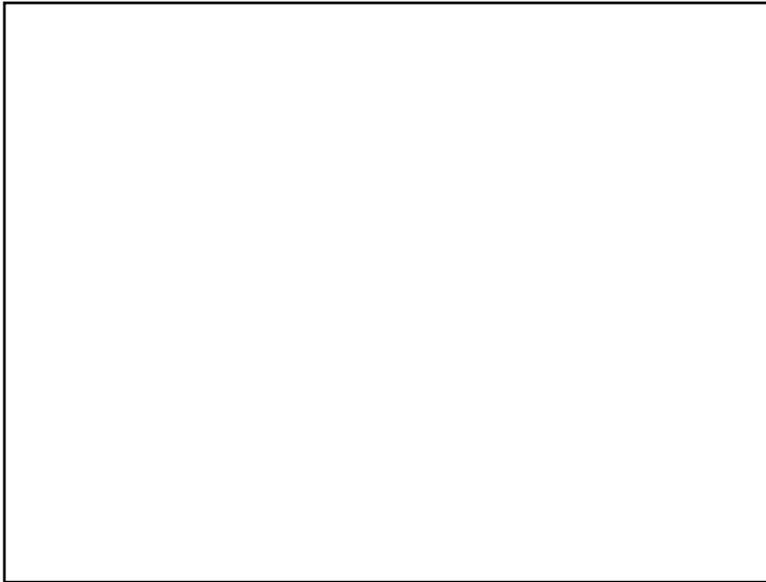
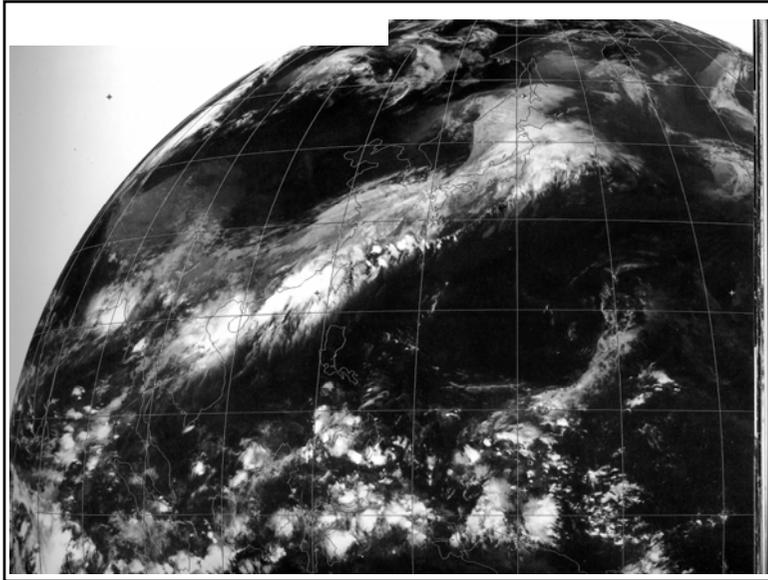
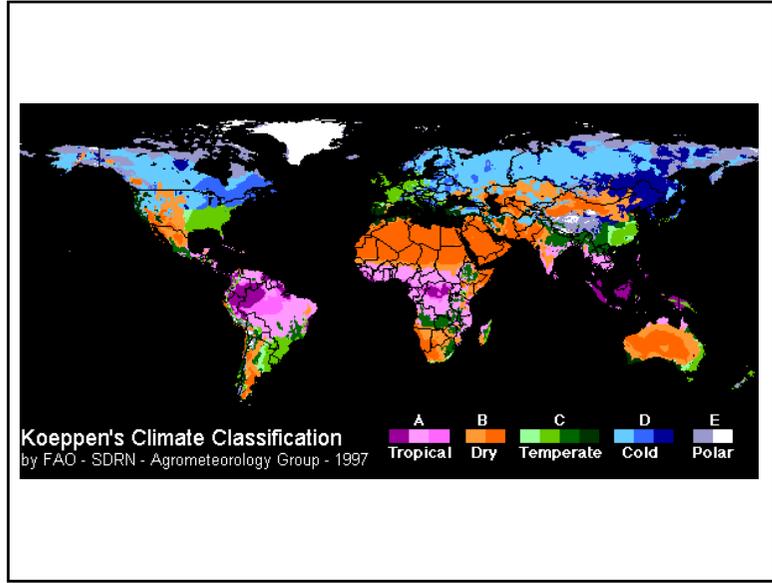
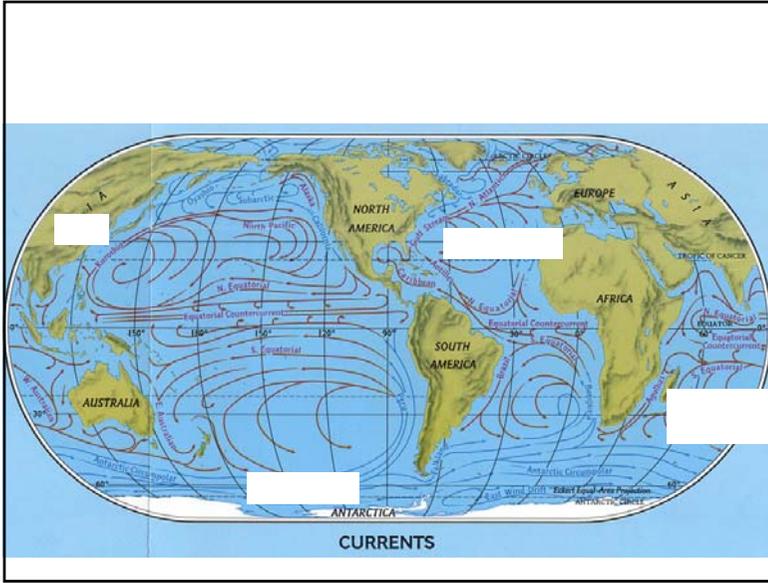


Table 1.2. *The greenhouse gases*

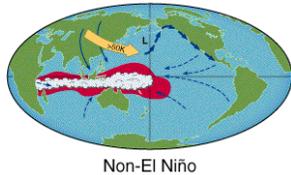
Gas	Basic absorption wavelengths ( $\mu\text{m}$ )	Contribution
Water vapour ( $\text{H}_2\text{O}$ )	2.66, 2.74, 6.27	55-70%
Carbon dioxide ( $\text{CO}_2$ )	4.26, 7.52, 14.99	25%
Chlorofluorocarbons (CFCs)	typical bonds: 9.52, 13.8, 15.4	11%
Methane ( $\text{CH}_4$ )	3.43, 6.85, 7.27	5%
Nitrous oxide ( $\text{N}_2\text{O}$ )	4.50, 7.78, 16.98	2%
Ozone ( $\text{O}_3$ ), sulphur dioxide ( $\text{SO}_2$ ), other oxides of nitrogen, carbon monoxide (CO), etc.		<1% each



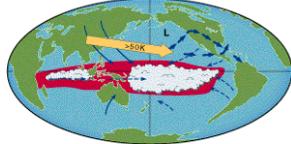




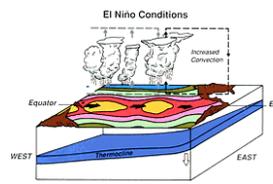
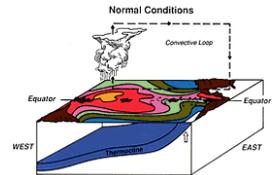
# El Nino and La Nina



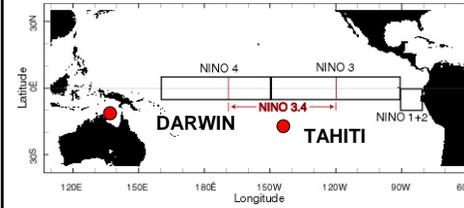
Non-El Niño



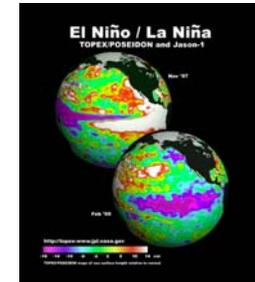
El Niño



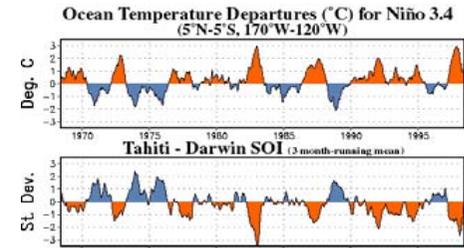
# Signatures of El Nino and La Nina



# ENSO CYCLE



NiNO  
Darwin Tahiti  
Southern Oscillation



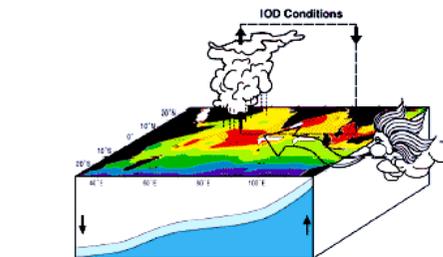
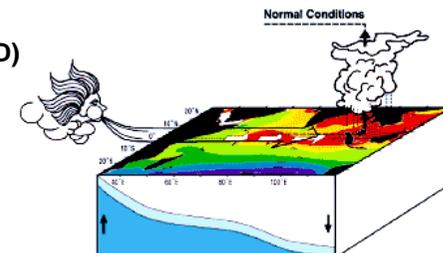
# Teleconnection



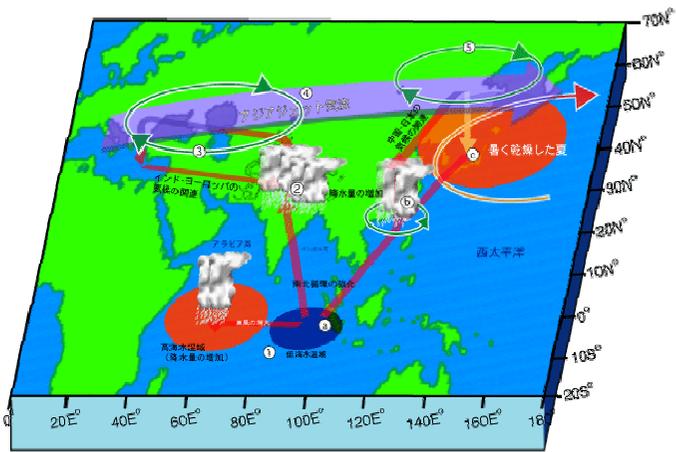
図4-15 PJテレコネクションパターンの模式図(Nitta, 1987)  
西太平洋域で海面水温が高く、対流活動が活発な、いわゆるラ・ニーニャ期間中の夏季に出現しやすいパターン。

La Nina  
El Nino

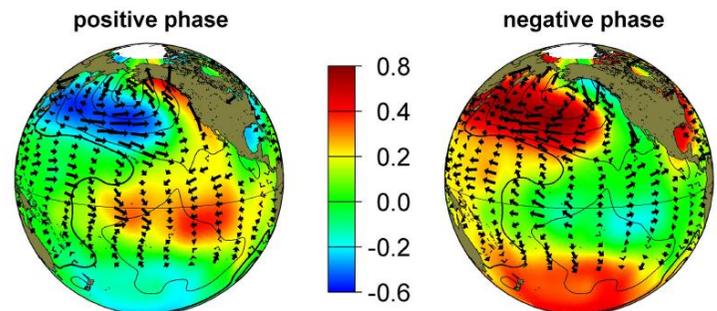
# Indian Ocean Dipole (IOD)



**Teleconnection**

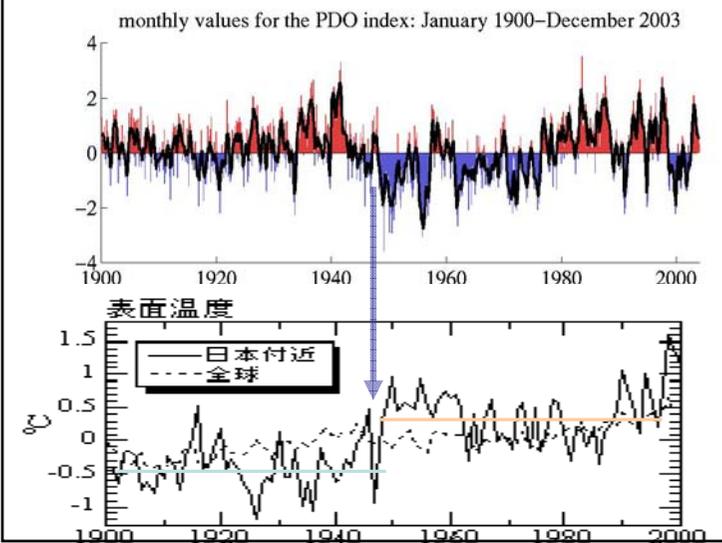


**Pacific Decadal Oscillation**

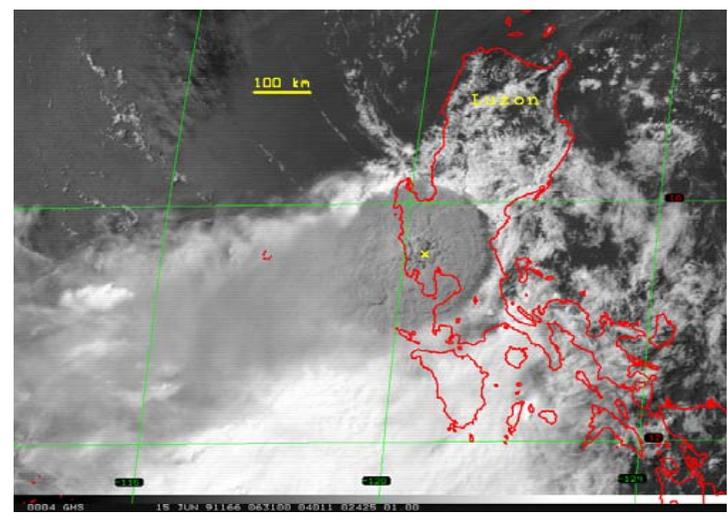


**Color: SST; Contour: sea level pressure; Arrow: wind**

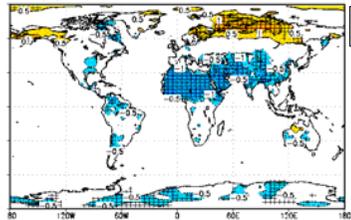
**Regime shift – associated with Pacific Decadal Oscillation**



**– Mt. Pinatubo**

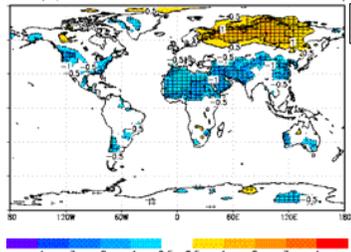


$\Delta T_s$  (K) AQ – QBO ensemble avr, DJF 91/92

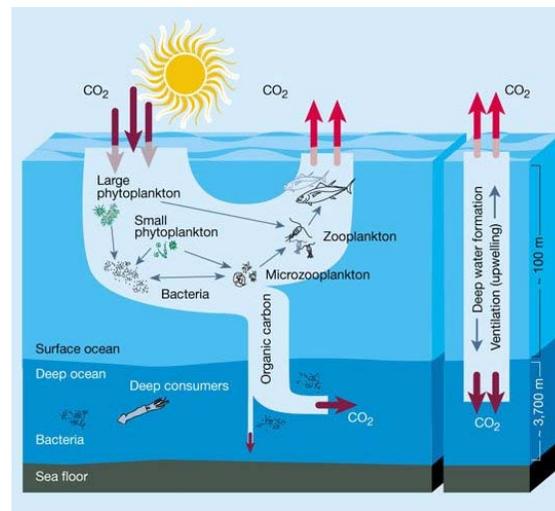


Pinatubo

$\Delta T_s$  (K) AQ – QBO ensemble avr, DJF 92/93

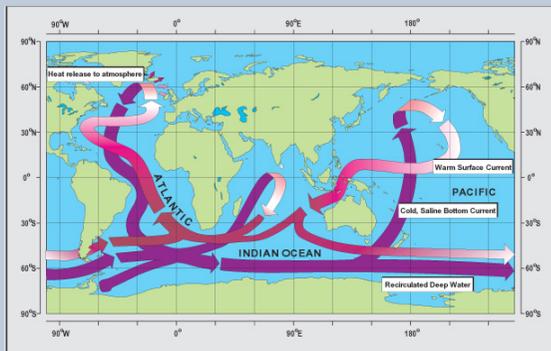


### Biological Pump



### The Atlantic Thermohaline Circulation

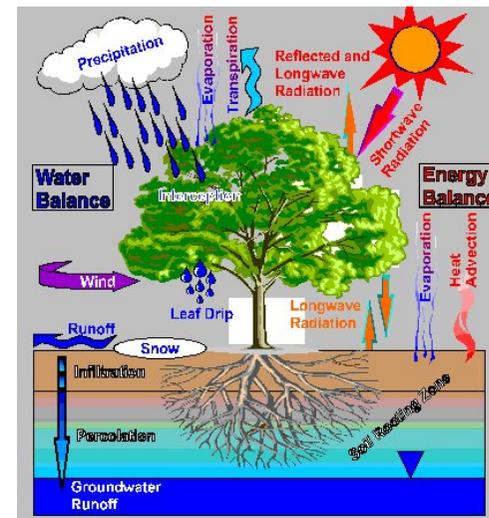
- A Key Element of the Global Oceanic Circulation -

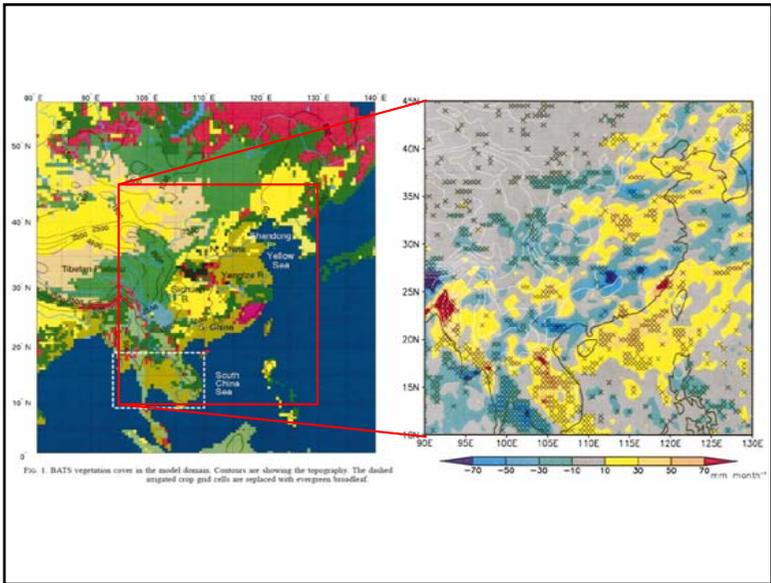
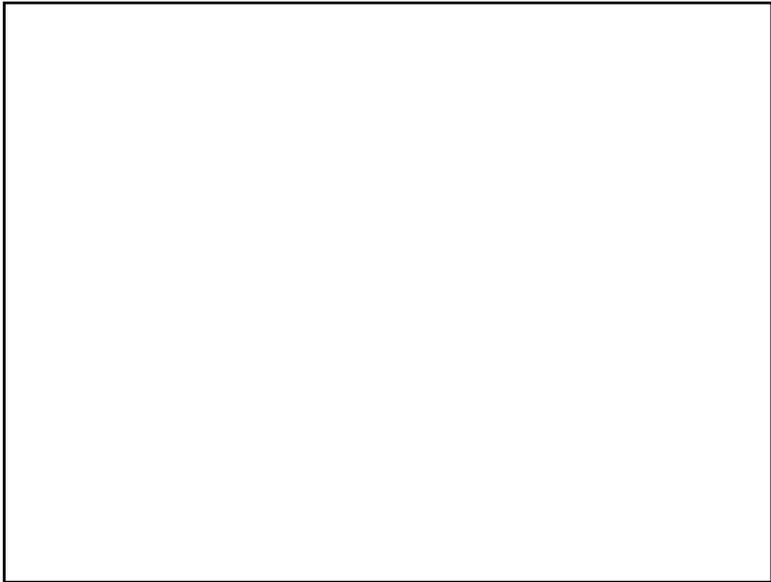
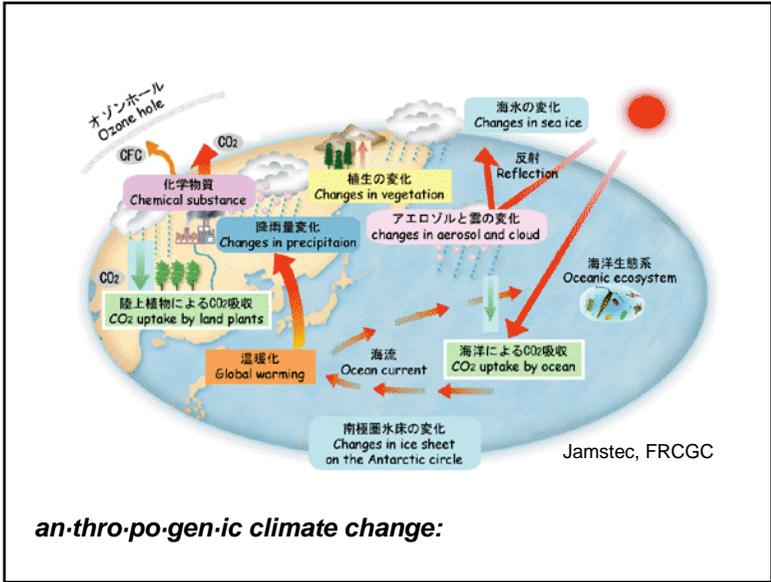


Schematic diagram of the global ocean circulation pathways, the 'conveyor' belt (after W. Broecker, modified by E. Maier-Reimer).

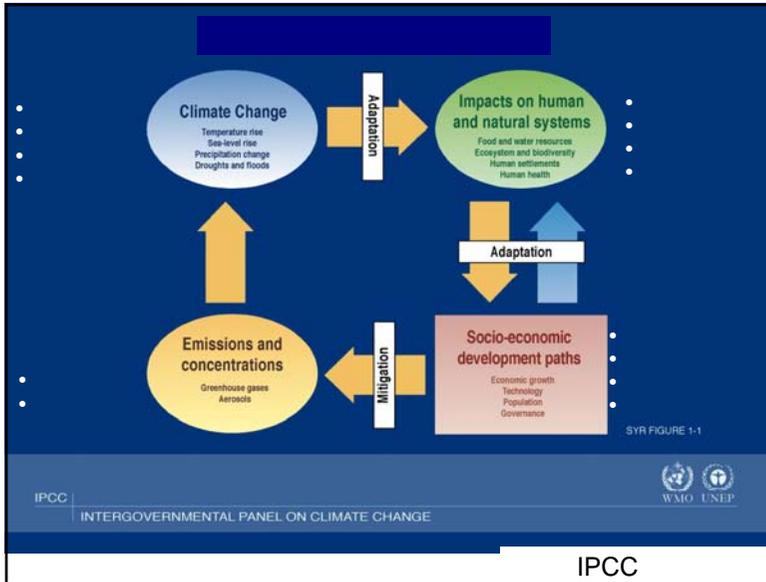
AV/D3/99-2

### Land surface processes





		World Climate Research Program (WCRP)
	Callendar	IPCC (Intergovernmental Panel for Climate Change)
	Moller	IPCC
	<b>Manabe&amp;Wetherald</b>	IPCC
<b>CO2</b>	Mercer	IPCC
	<b>Manabe</b>	<b>CO2</b>



### IPCC Emission Scenarios

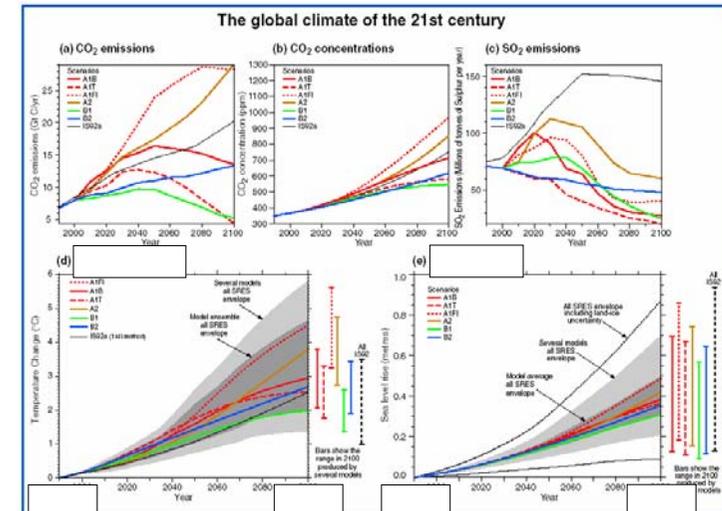
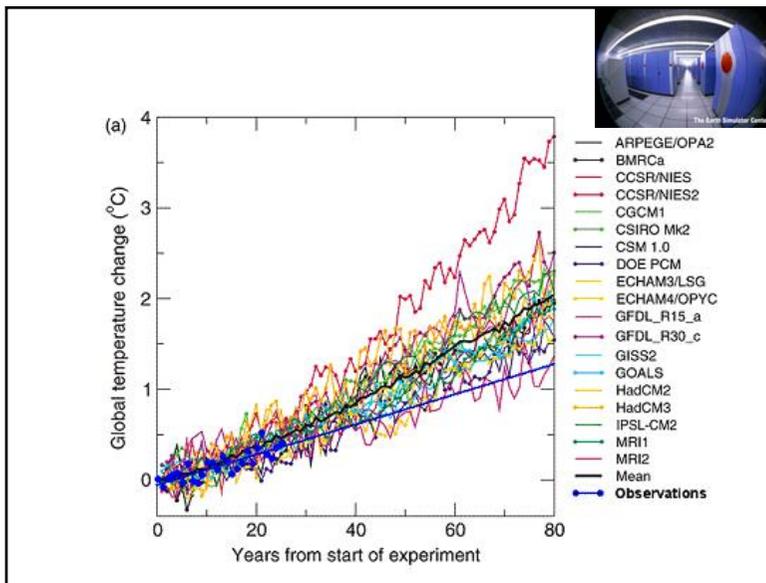
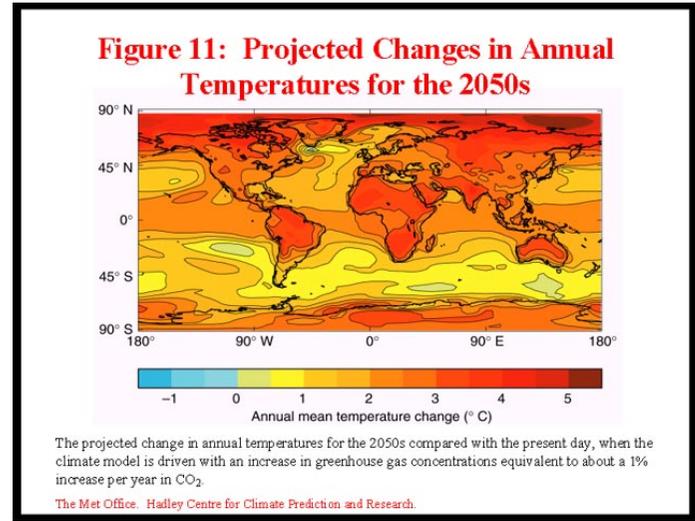


Figure 5: The global climate of the 21st century will depend on natural changes and the response of the climate system to human activities.

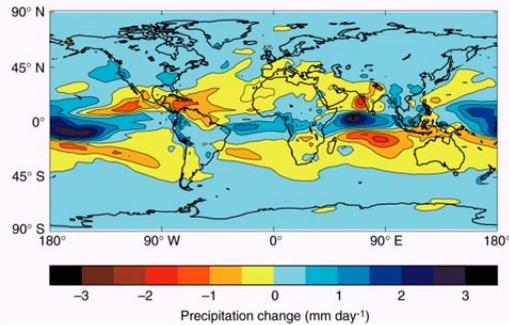


### Impacts of global warming <http://www.ipcc.ch/press/sp-cop6.htm>



Impacts of global warming <http://www.ipcc.ch/press/sp-cop6.htm>

**Figure 12: Projected Changes in Annual Precipitation for the 2050s**

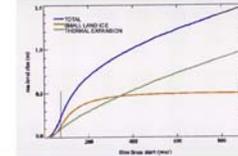


The projected change in annual precipitation for the 2050s compared with the present day, when the climate model is driven with an increase in greenhouse gas concentrations equivalent to about a 1% increase per year in CO<sub>2</sub>.

The Met Office - Hadley Centre for Climate Prediction and Research

Impacts of global warming <http://www.ipcc.ch/press/sp-cop6.htm>

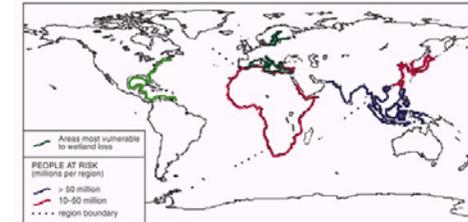
**Figure 13: Sea Level Rise Commitment**  
Thermal expansion and land ice melt after an initial 1% increase in CO<sub>2</sub> for 70 years



The Met Office - Hadley Centre for Climate Prediction and Research

**Figure 18: People at Risk from a 44 cm sea-level rise by the 2080s**

Assuming 1990s Level of Flood Protection



Source: R. Nicholls, M&E Research University in the U.K., Meteorological Office 1997, *Climate Change and its Impacts: A Global Perspective*.

Impacts of global warming <http://www.ipcc.ch/press/sp-cop6.htm>

**Figure 17: Vector (insect)-borne Diseases**

Disease	Vector	Population at risk (millions)	Present distribution	Likelihood of altered distribution with warming
Malaria	mosquito	2,100	(sub)tropics	✓✓
Schistosomiasis	water snail	600	(sub)tropics	✓✓
Filariasis	mosquito	900	(sub)tropics	✓
Onchocerciasis (river blindness)	black fly	90	Africa/Latin America	✓
African trypanosomiasis (sleeping sickness)	tsetse fly	50	tropical Africa	✓
Dengue	mosquito	unavailable	tropics	✓✓
Yellow fever	mosquito	unavailable	tropical South America & Africa	✓

Likely ✓  
Very likely ✓✓

Source: Modified WHO, as cited in Stone (1995).

