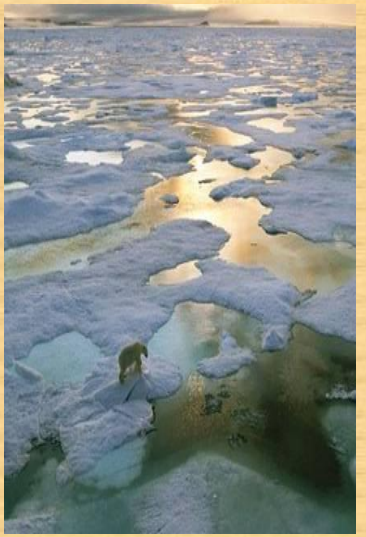


Overview of Global Warming and Climate Change

Presented by:

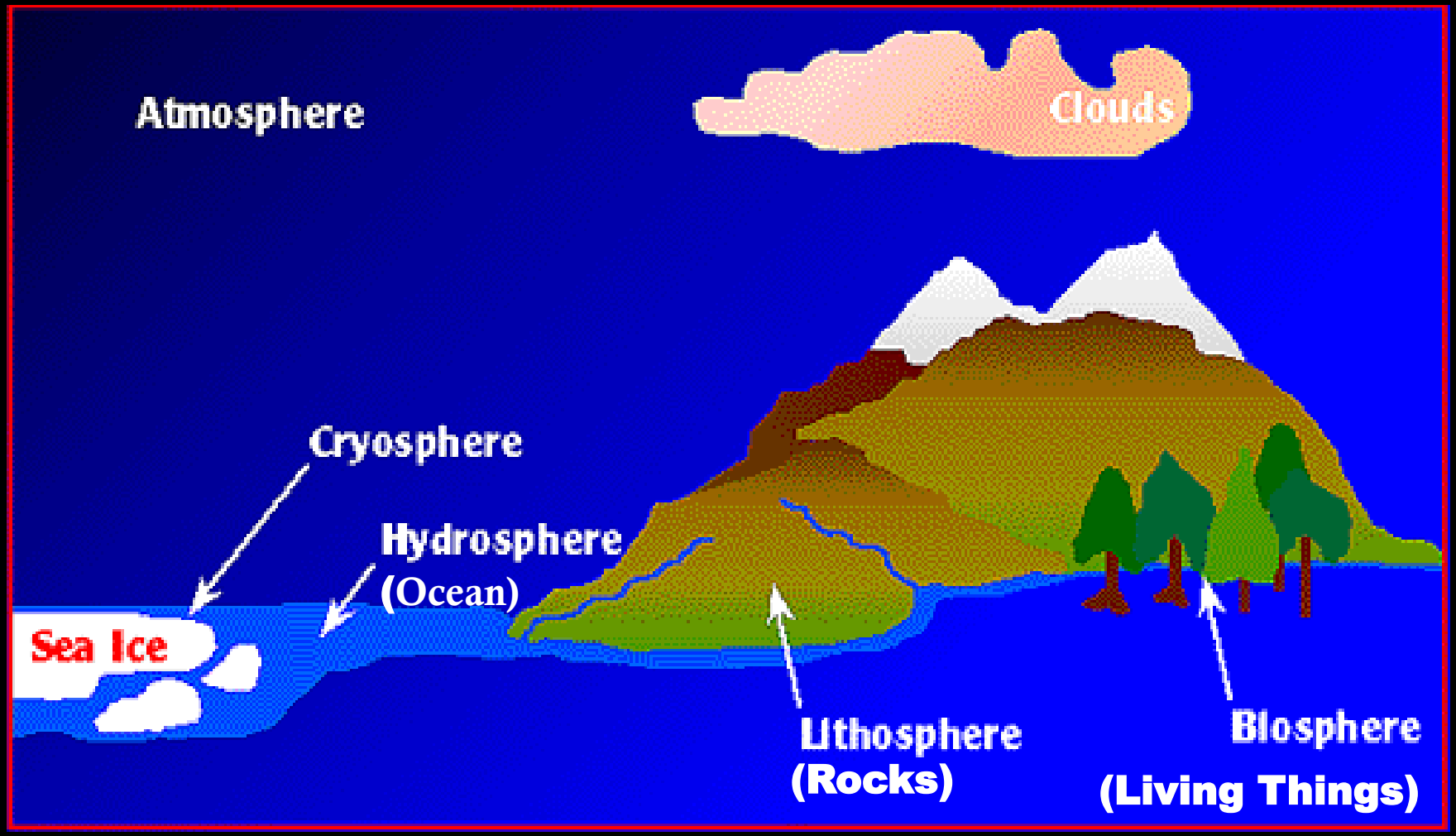
DAISY F. ORTEGA

Asst. weather Services Chief

PAGASA Regional Services Division- MINDANAO

DOST

The Climate System



The Earth has many different systems that interact with each other in different ways.

- So that climate is the state of the climate system

- It is affected by its latitude, terrain, altitude and nearby water bodies and their currents.

Climate

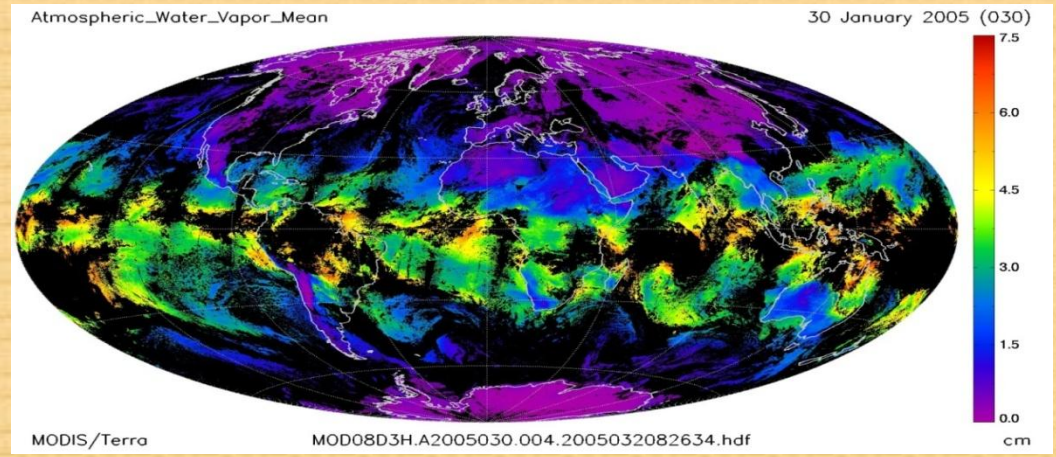
Is a measure of the average pattern of variation in:

- Temperature
- Humidity
- Atmospheric pressure
- Wind
- Precipitation and
- Other Meteorological variables in a given Region over a long periods of time.

What is Climate?

- Climate = the average and variations of weather over a long period of time (~30 years)

  (Describe the expected frequency and strength of weather condition)



Above: Global average for atmospheric water vapor.

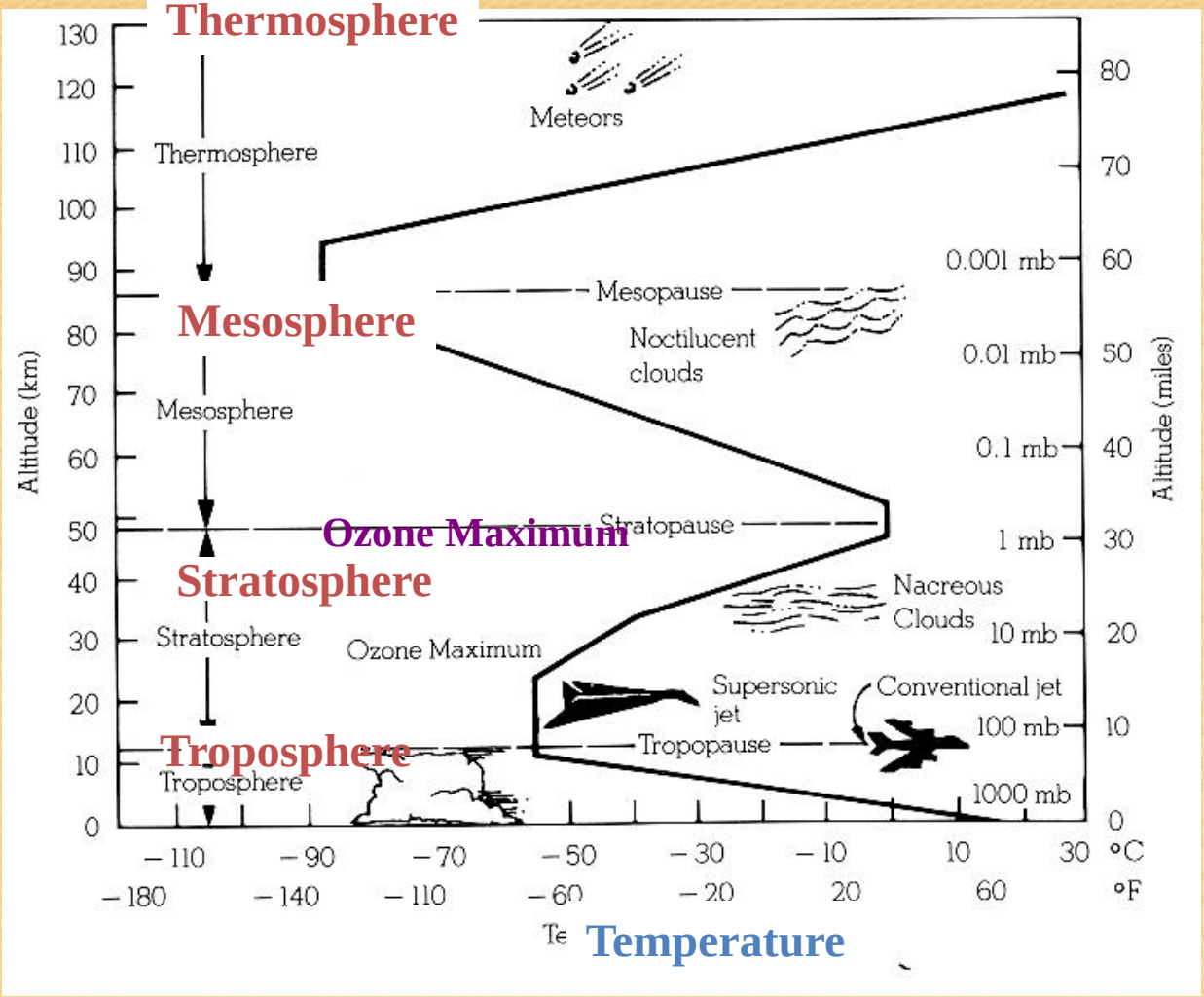
What is Weather?

- State of the atmosphere at a particular time and place. Describe by measuring its :

  temperature, air pressure, moisture,

  wind speed and direction, etc.

Structure of the Atmosphere



What is Global Warming?

Global warming refers to the increase in the earth's mean temperature due to the so-called enhanced greenhouse effect.

The Green House Effect and Global Warming

- How is energy distributed to the earth's surface?
- What are greenhouse gases and the greenhouse effect?
- Impact of an increase in atmospheric CO_2 on greenhouse effect
- Recent changes in greenhouse gas concentrations
- Relationship between the greenhouse effect and global warming

Why should we be concerned about Global Warming?

“Why should we be concerned about Global Warming?”

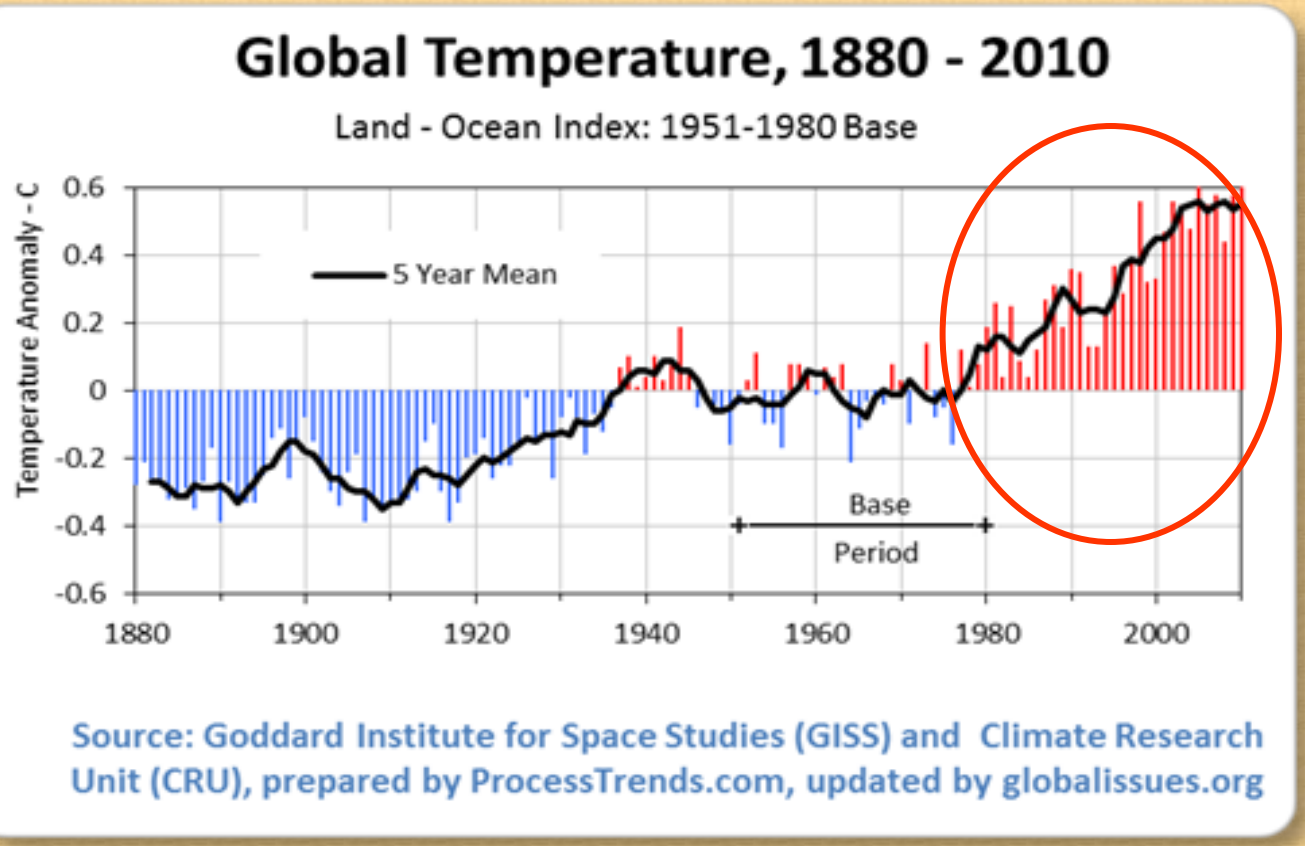
Many people consider that Global Warming is the greatest environmental threat of the 21st Century.

However, during the 80s and early 90s scientists argued about the causes and effects of global warming.

In the late 1990s scientists reached a consensus that global warming was a cause for concern.

So, why should you be concerned about global warming?

Collective Picture of a Warming World



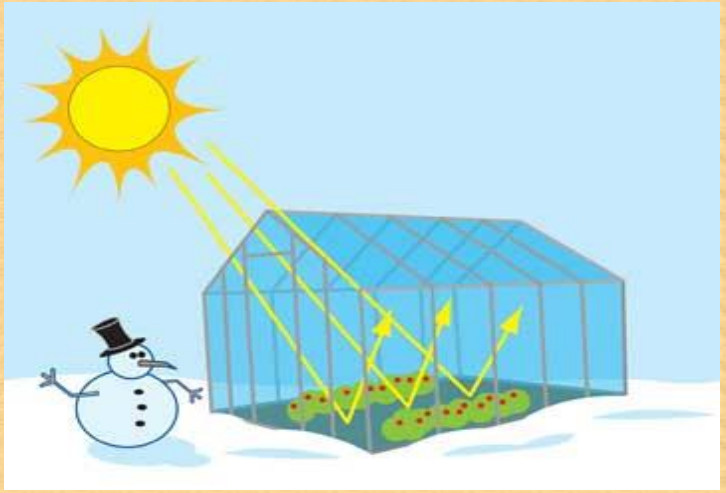
- global average air temperature increased by 0.74 ° C from 1906-2005
- Strong temperature increase since 1975 (unprecedented)

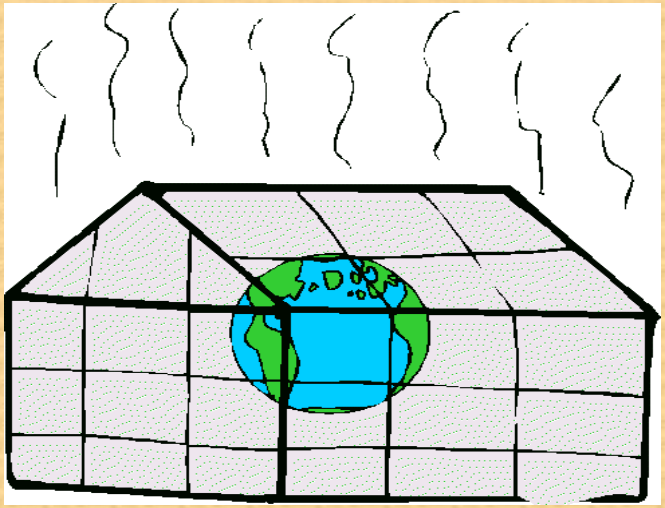
Earth's temperature depends on:

- The balance between energy entering and leaving the planet's system

- Many factors both natural and human can cause changes in earth's energy balance.
  including: - Changes in the greenhouse effect
  - Variations in the sun's energy reaching Earth
- Changes in the reflectivity of Earth's atmosphere and surface

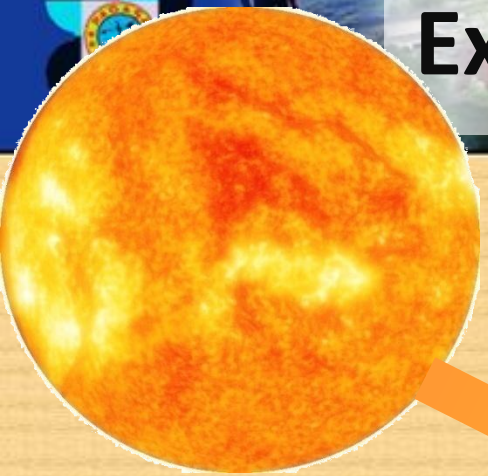
The Greenhouse Effect





- The greenhouse effect is a necessary phenomenon that keeps all Earth's heat from escaping to the outer atmosphere. Without the natural greenhouse effect it is certain that life on Earth would be difficult to sustain.

Example of the Greenhouse Effect



The Sun's energy passes through the car's windshield.

This energy (heat) is trapped inside the car and cannot pass back through the windshield, causing the inside of the car to warm up.

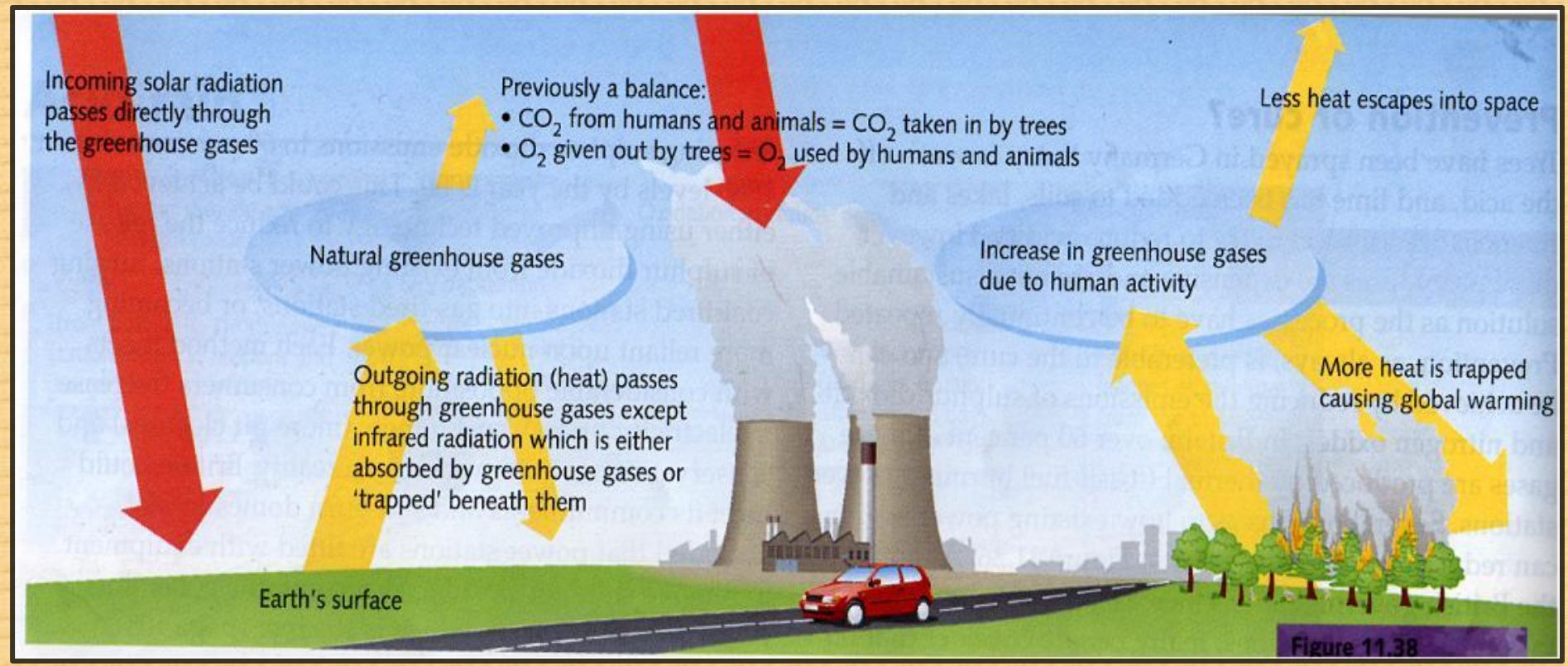
Without the natural Greenhouse effect,

The global average temperature of the earth would drop sharply 33 deg from its current 15 to -18C. The Earth would become an ice planet.

However, too many greenhouse gases in Earth's atmosphere could increase the greenhouse effect (enhanced greenhouse effect)

This could result in an increase in mean global temperatures as well as changes in precipitation patterns.

Explanation of the causes of global warming



78% nitrogen

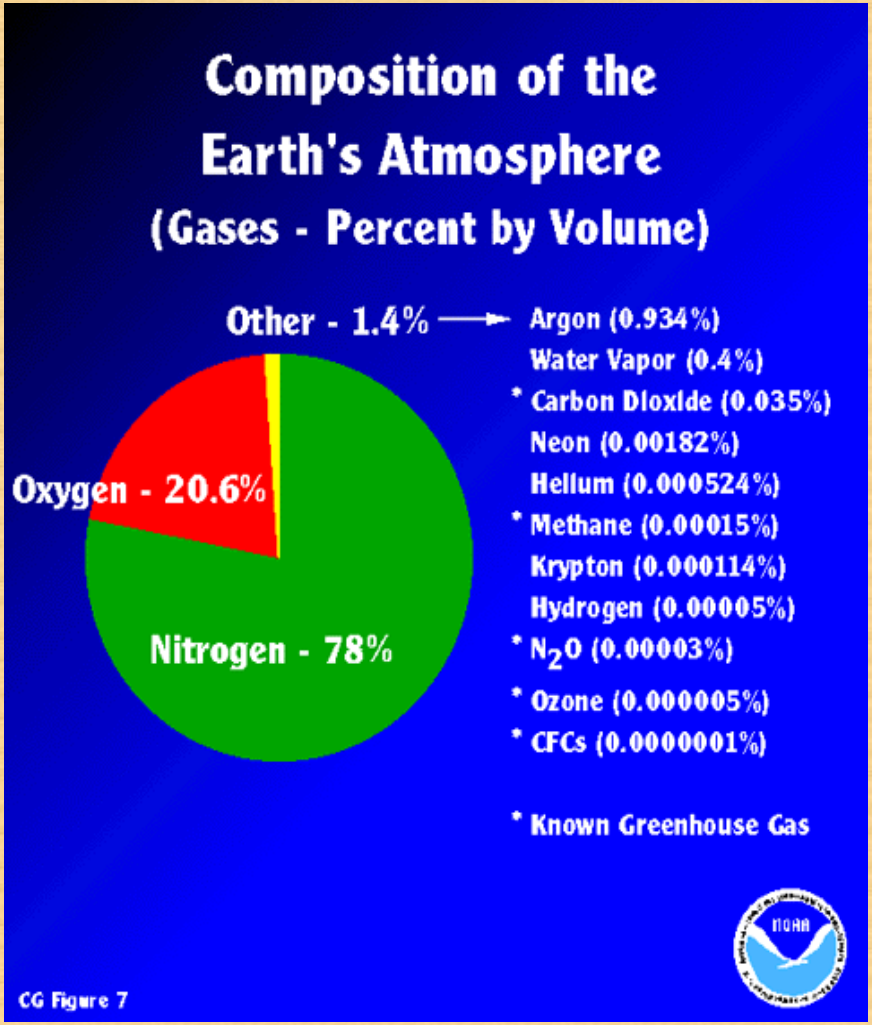
20.6% oxygen

< 1% argon

0.4% **water vapor**

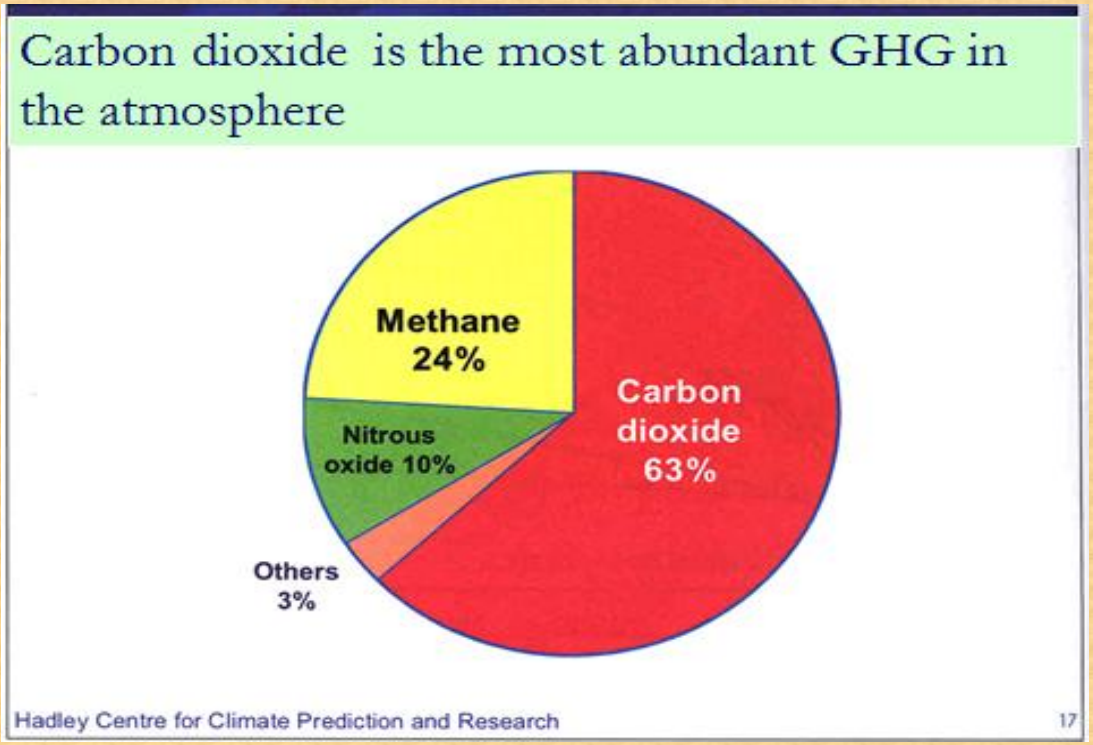
0.036% **carbon dioxide**

traces gases:
Ne, He, Kr, H, O_3
Methane, **Nitrous Oxide**



•The majority of Earth's atmosphere (N_2 and O_2) are not good greenhouse gas.

Global warming is mainly the result of CO_2 levels rising in the Earth's atmosphere



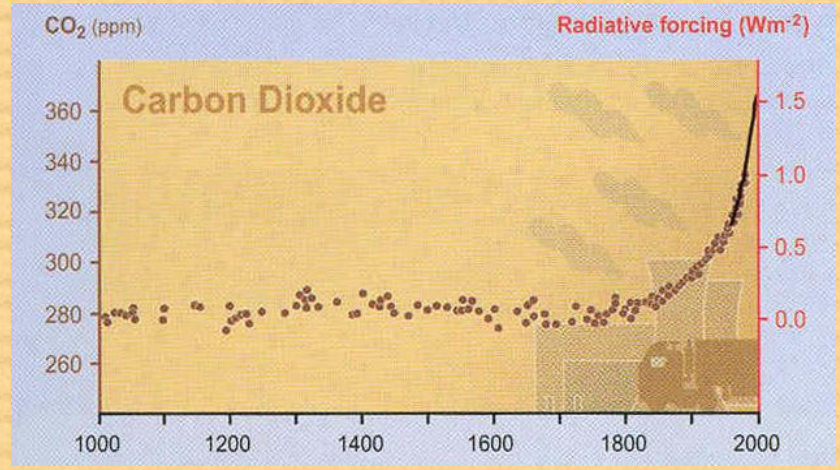
Carbon dioxide is the primary greenhouse gas that is contributing to recent climate change

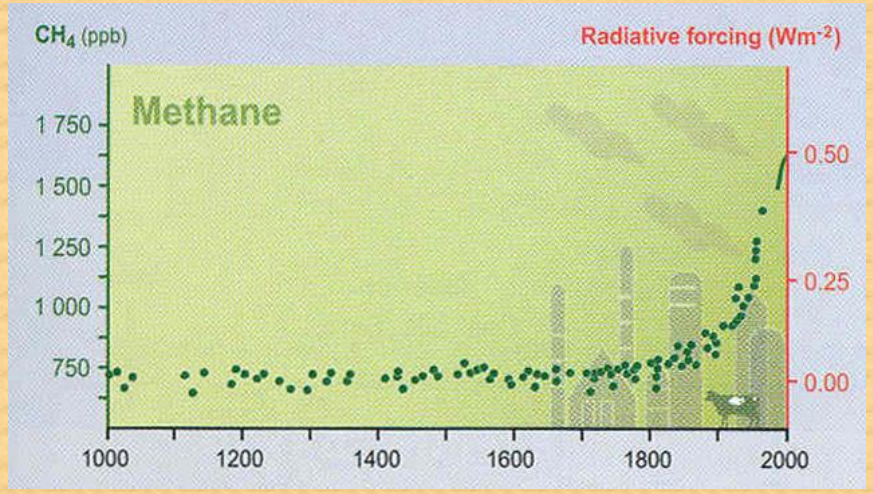
Selected Greenhouse Gases

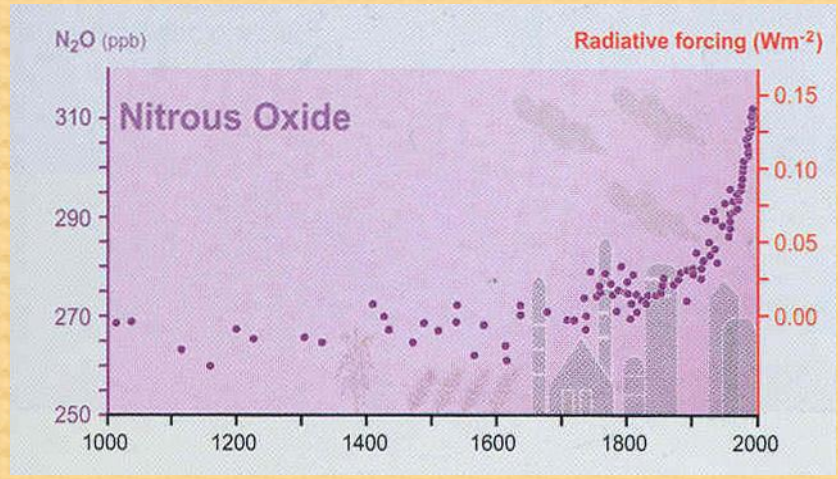
- **Carbon Dioxide (CO_2)**
  - Source: Fossil fuel burning, deforestation
  - Anthropogenic increase: **30%**
  - Average atmospheric residence time: **500 years**
- **Methane (CH_4)**
  - Source: Rice cultivation, cattle & sheep ranching, decay from landfills, mining
  - Anthropogenic increase: **145%**
  - Average atmospheric residence time: **7-10 years**
- **Nitrous oxide (N_2O)**
  - Source: Industry and agriculture (fertilizers)
  - Anthropogenic increase: **15%**
  - Average atmospheric residence time: **140-190 years**

Humans are increasing heat-trapping gases in the atmosphere = enhanced greenhouse effect

Recent changes in greenhouse gas concentrations

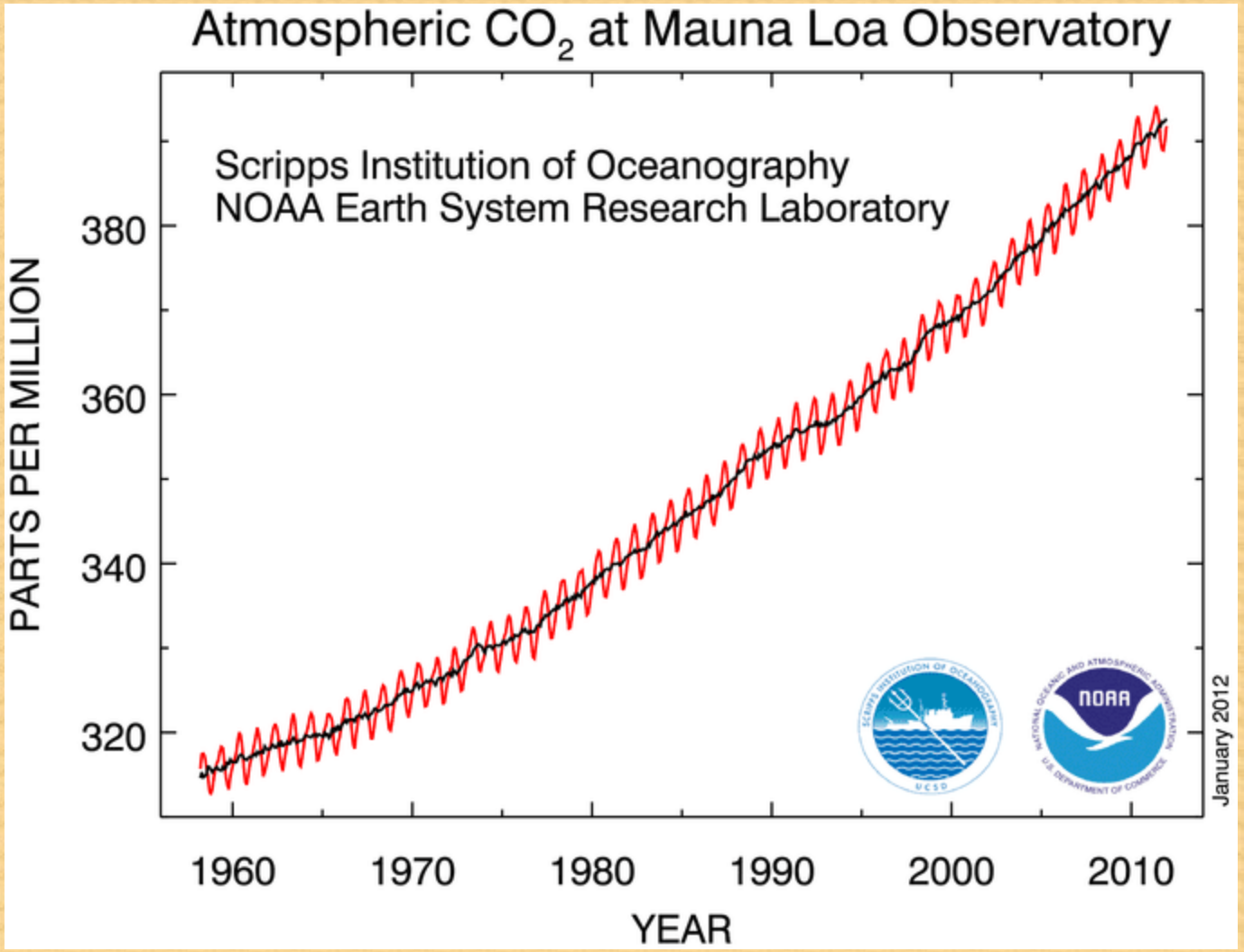






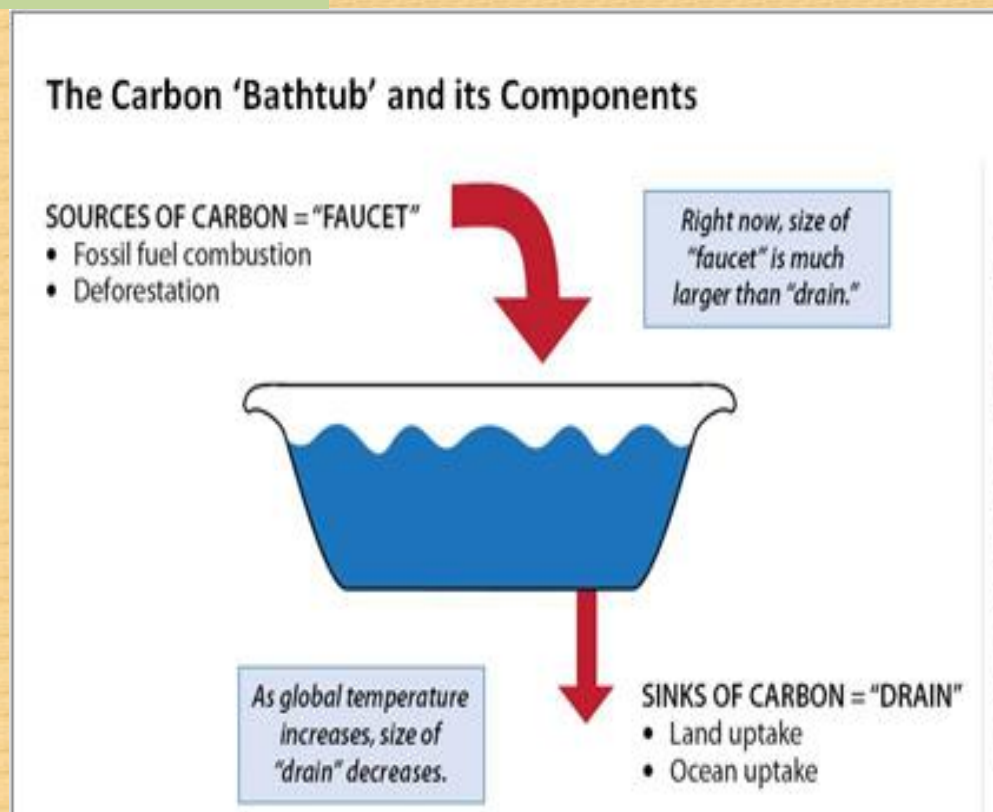
- Carbon dioxide: +**31%**
- Methane: +**151%**
- Nitrous oxide: +**17%**

'Thickening blanket'


Atmospheric CO_2 at Mauna Loa Observatory
Scripps Institution of Oceanography
NOAA Earth System Research Laboratory
PARTS PER MILLION
380
360
340
320
1960
1970
1980
1990
2000
2010
YEAR
January 2012

Simulation

The Climate challenge: Our Choices



If the amount of water flowing into a bathtub is greater than the amount of water leaving through the drain, the water level will rise. Carbon dioxide (CO_2) emissions are like the flow of water into the world's carbon bathtub. "Sources" of CO_2 emissions such as fossil fuel burning, cement manufacture, and land use are like the bathtub's faucet. "Sinks" of CO_2 in the ocean and on land (such as plants) that take up CO_2 are like the drain. Today, human activities have turned up the flow from the CO_2 "faucet", which is much larger than the "drain" can cope with, and the level of CO_2 in the atmosphere (like the level of water in a bathub) is rising.

The amount of carbon dioxide (CO_2) in the atmosphere is increasing. The world is getting warmer. If this continues, the ecosystems and economies of the world will be dramatically altered. What can be done about this?

Top 10 Countries Ranking 2009 Greenhouse Gas Emissions

Rank (Prev. Year)	Country	1990	2008	2009	Difference	real Changes	RE-Investments (CERINA-Plan 2009)
		CO_2 (mill. t)	CO_2 (mill. t)	CO_2 (mill. t)	2008 / 2009 (mill. t)	1990 – 2009 (%)	16€ / t CO_2 (bn. €)
	World	22682	31511	31098	-413	37	497.6
1. (1.)	China	2452	6810	7426	616	203	118.8
2. (2.)	USA	5461	6370	5951	-419	9	95.2
3. (3.)	Russia	2369	1688	1534	-154	-35	24.5
4. (4.)	India	626	1409	1529	120	144	24.5
5. (5.)	Japan	1179	1392	1225	-167	4	19.6
6. (6.)	Germany	1029	857	797	-60	-23	12.8
7. (7.)	South-Korea	257	664	664	0	158	10.6
8. (8.)	Canada	485	658	606	-52	25	9.7
9. (11.)	Saudi Arabia	242	491	544	53	125	8.7
10. (10.)	Iran	199	514	544	30	174	8.7

Source: IWR Research, BP Statistical Review, Bundesministerium für Wirtschaft

The six main greenhouse gases:

Name	Description
Water vapor	Is one of the most abundant gases in the atmosphere and builds up with the evaporation from water bodies on Earth.
Carbon dioxide (CO_2)	Is produced by the combustion of fossil fuels and from forest fires.
Methane (CH_4)	Animal husbandry, irrigated agriculture and oil extraction release important amounts of this potent greenhouse gas.
Nitrous oxide (N_2O)	Is a by-product of burning fossil fuels and is also released when ploughing farm soils.
Ozone (O_3)	Main element of the protective layer in the upper atmosphere, which shields the Earth from the sun's harmful ultraviolet radiation. Ozone is both a natural and a man-made gas. Produced in excess as a result of smog and severe air pollution, it becomes harmful to human health.
Chlorofluorocarbons (CFCs)	Chlorine-containing gas used for refrigerators, air conditioners, aerosol sprays propellants and cleaning agents. Chlorofluorocarbons cause depletion of the atmospheric ozone layer.

Natural Sources of Greenhouse Gases

CARBON DIOXIDE

METHANE

NITROUS OXIDE

- Bacterial Breakdown of Nitrogen in Soils and Ocean

Man-Made Sources of Greenhouse Gases

CARBON DIOXIDE - Burning of Fossil Fuels(Oil,Coal) by Powerplants, Industries and Vehicles

Man-Made Sources of Greenhouse Gases

Methane - Decomposition of Garbage and Agricultural Waste Materials, Leaks in Coal Mining and Natural Gas Production

Accounts for 20% of additional greenhouse effects

Where humanity's CO_2 comes from

91% 33.4 billion metric tonnes

Fossil Fuels & Cement 2010

9% 3.3 billion metric tonnes

Land Use Change 2010

Where humanity's CO_2 goes

50% 18.4 billion metric tonnes

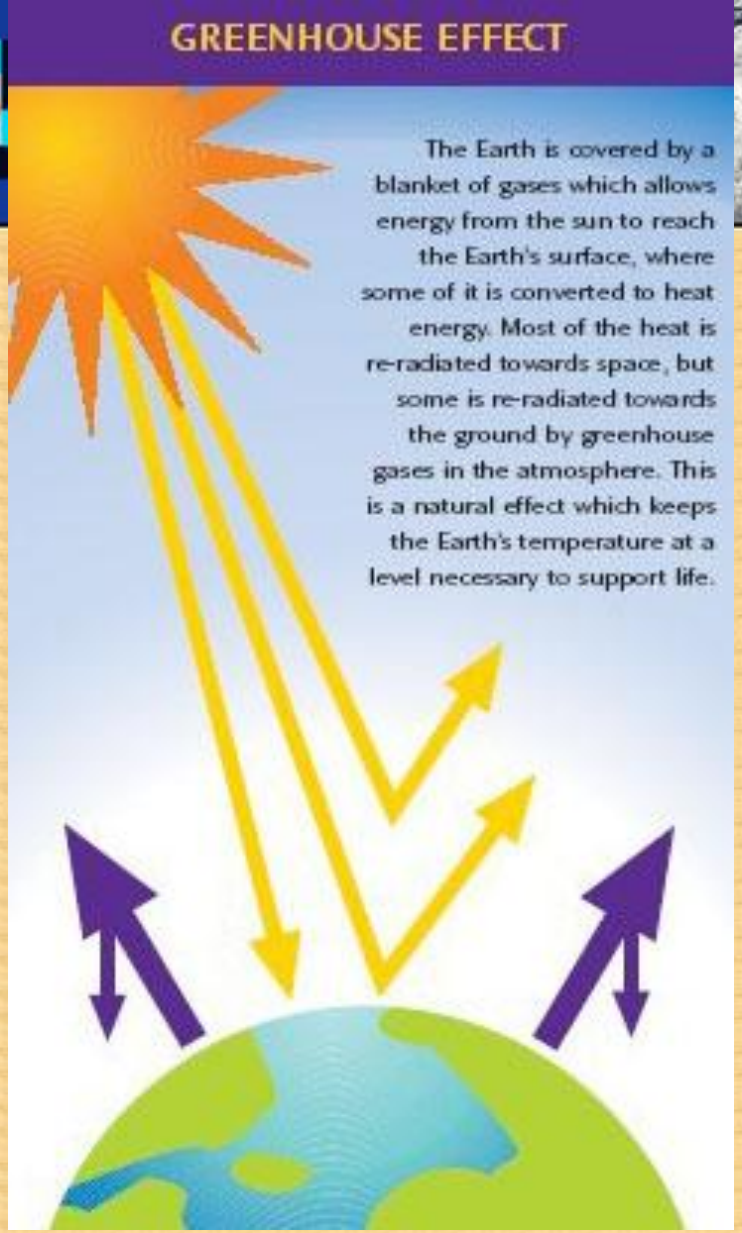
Atmosphere 2010

26% 9.5 billion metric tonnes

Land 2010

24% 8.8 billion metric tonnes

Oceans 2010



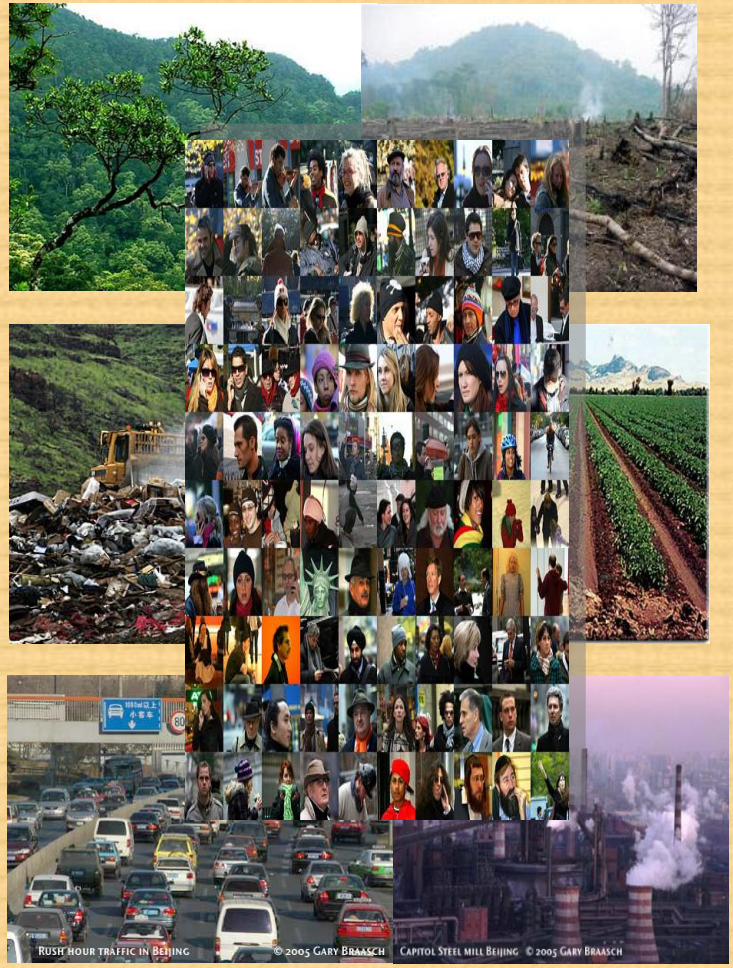
A diagram of the natural greenhouse effect on earth, where the Earth's temperature is kept constant to support life.

A diagram showing how additional greenhouse gases trap more heat in the Earth's atmosphere and raises the temperature.

Relationship between the greenhouse effect and global warming

- An increase in the ***concentration of greenhouse gases*** leads to an increase in the the ***magnitude of the greenhouse effect***. (Called enhanced greenhouse effect)
  - ➢ **This results in global warming**

What is Climate Change?



"**Change in the climate attributed directly or indirectly to human activities**, in addition to natural climate variability observed, over a comparable time periods" - **United Nations Framework Convention on Climate Change (UNFCCC)**

Increased use of fossil fuel → **Global Warming** → **Climate Change**

Consumption of fossil fuels increase
- 1.6 times over the last 4 decades

Global Warming

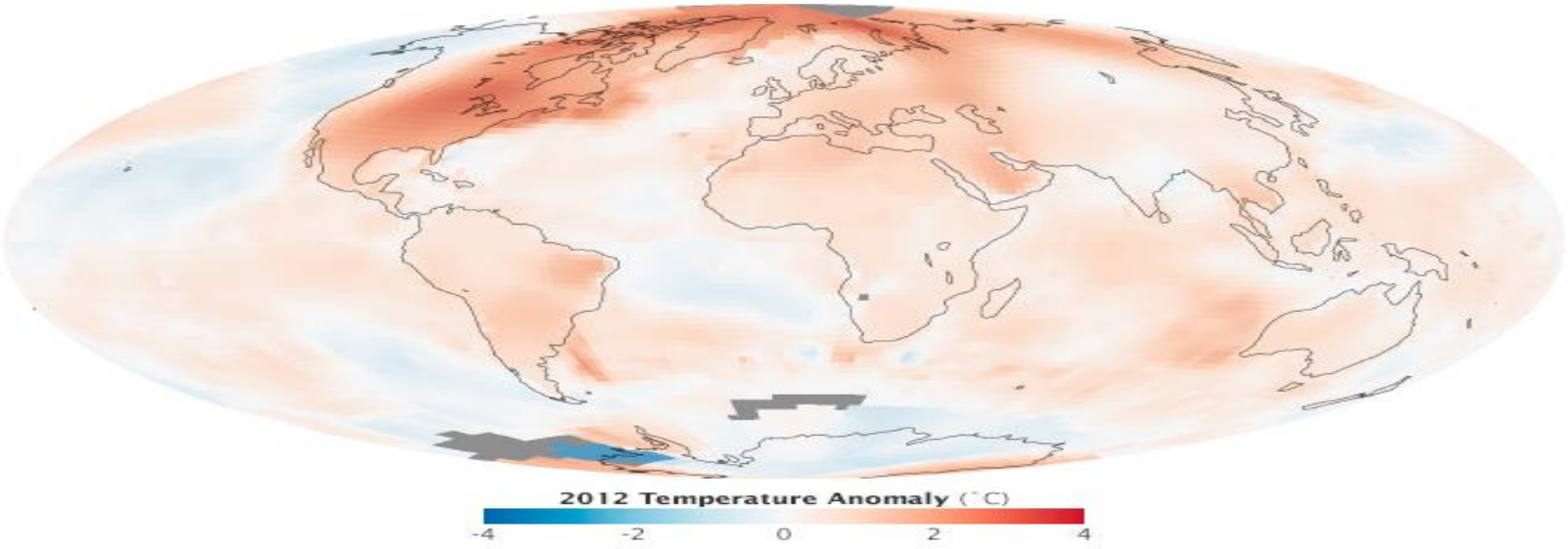
- Global average temperature rise: 0.74°C during the last 100 years

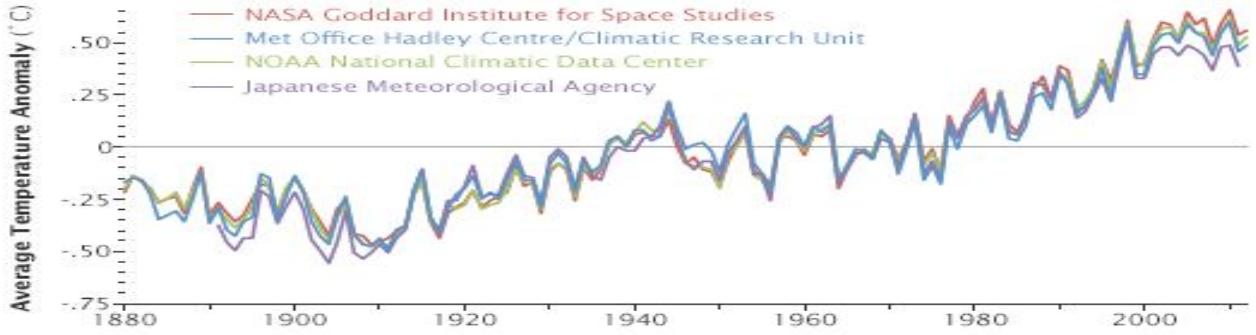
Seven of these indicators would be expected to increase in a warming world and observations show that they are, in fact, increasing. Three would be expected to decrease and they are, in fact, decreasing.

The Intergovernmental Panel on Climate Change Fourth Assessment Report

(IPCC AR4)

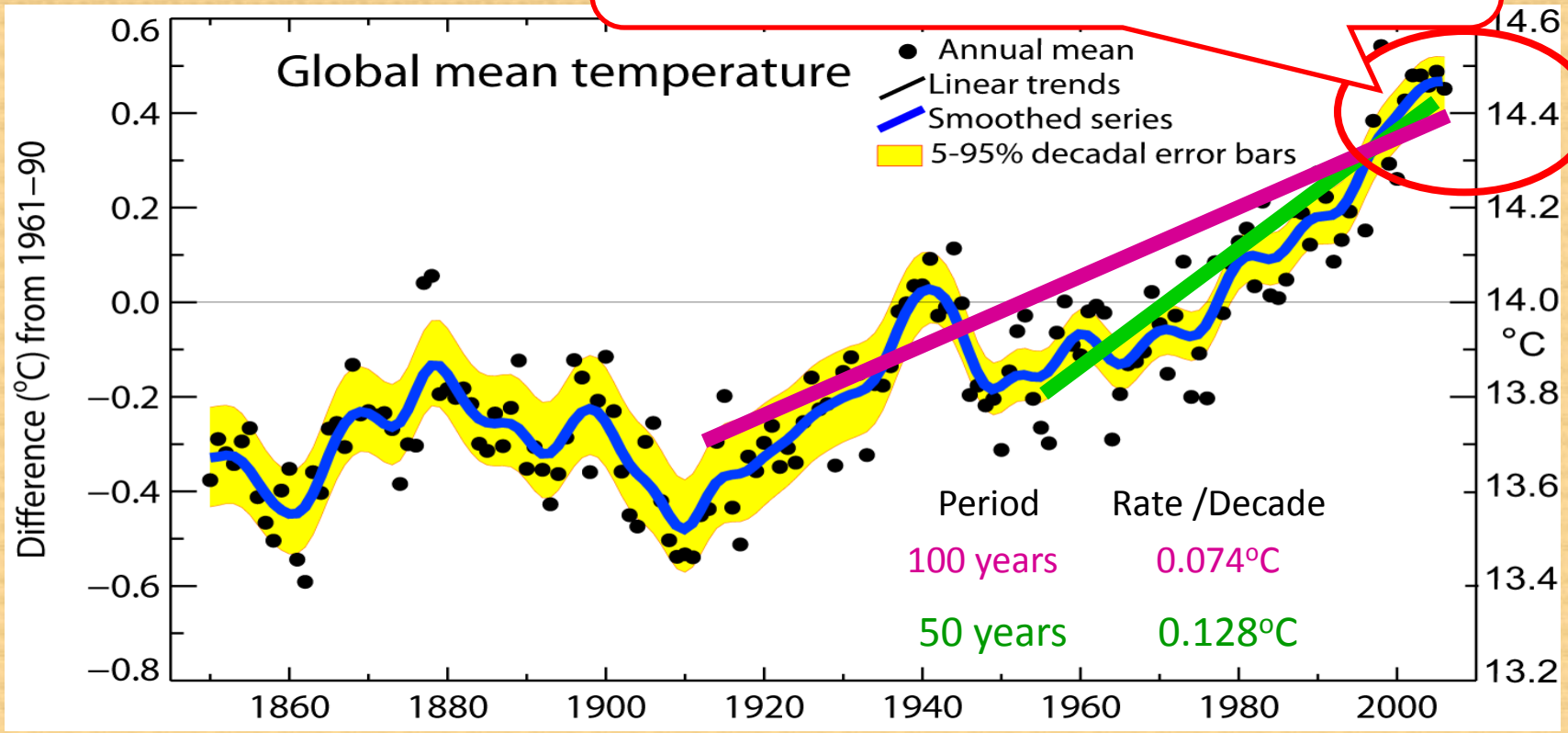
Warming of the climate system is **UNEQUIVOCAL!**


2012 Temperature Anomaly (°C)
-4
-2
0
2
4


NASA Goddard Institute for Space Studies
Met Office Hadley Centre/Climatic Research Unit
NOAA National Climatic Data Center
Japanese Meteorological Agency
Average Temperature Anomaly (°C)
.50
.25
0
-.25
-.50
-.75
1880
1900
1920
1940
1960
1980
2000

Change in global average surface temperature

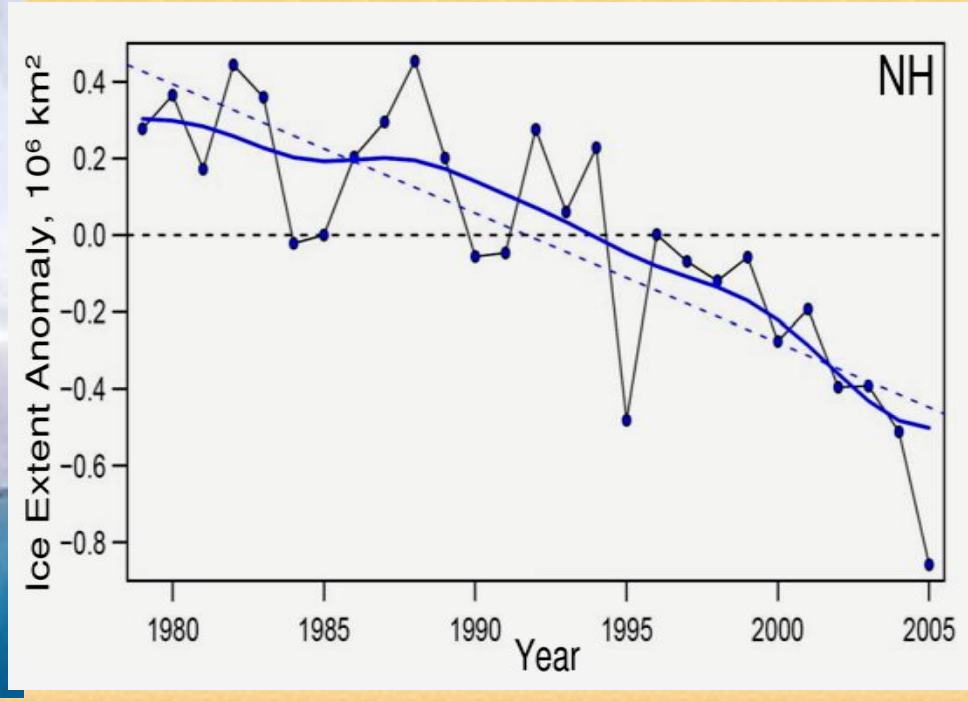
Warmest 12 years:
1998,2005,2003,2002,2004,2006,
2001,1997,1995,1999,1990,2000



Eleven of the last twelve years rank among the twelve warmest years in the instrumental record of global surface temperature

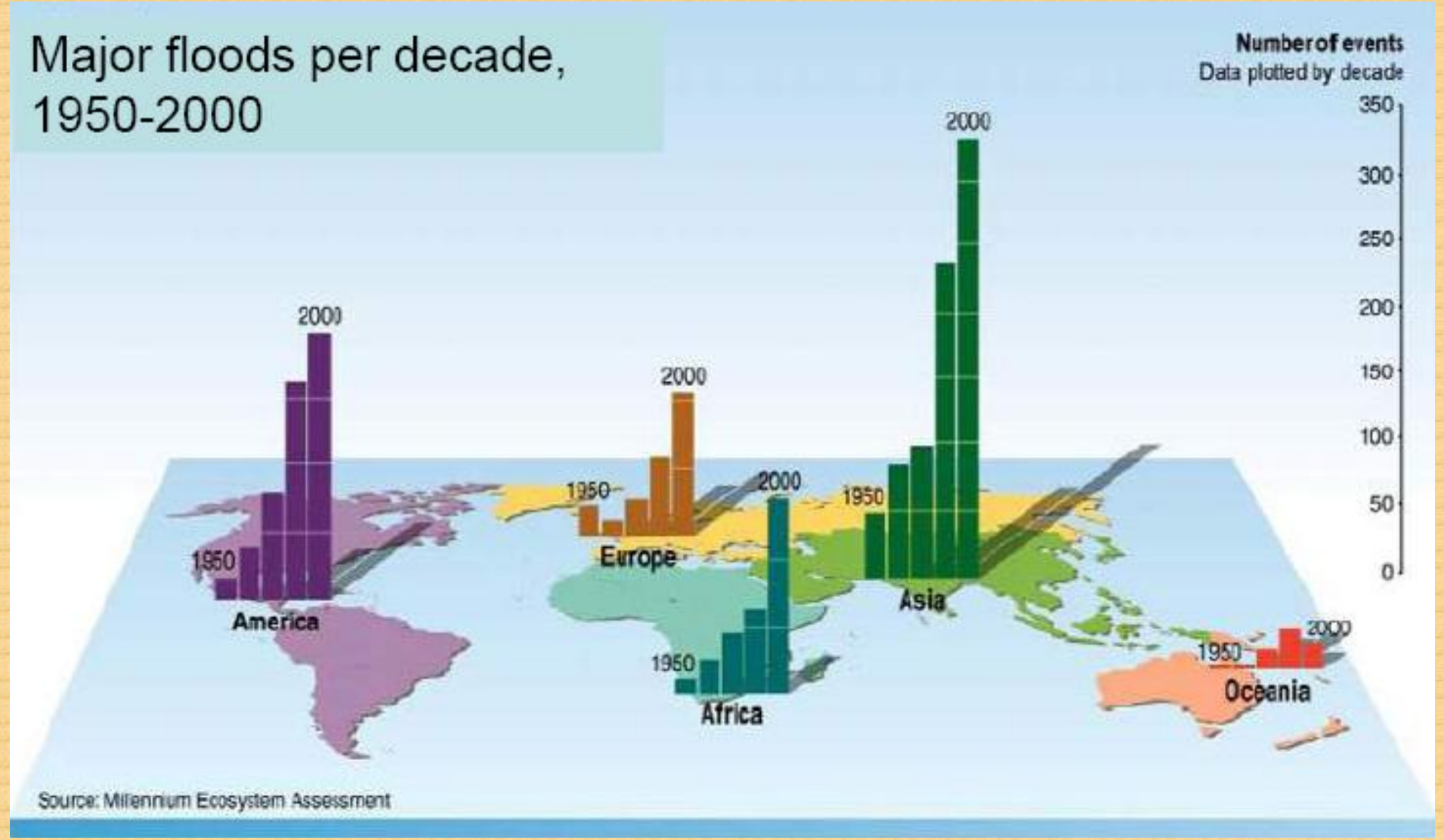
Manifestations of Climate Change …

Arctic sea ice area decreased by 2.7% per decade

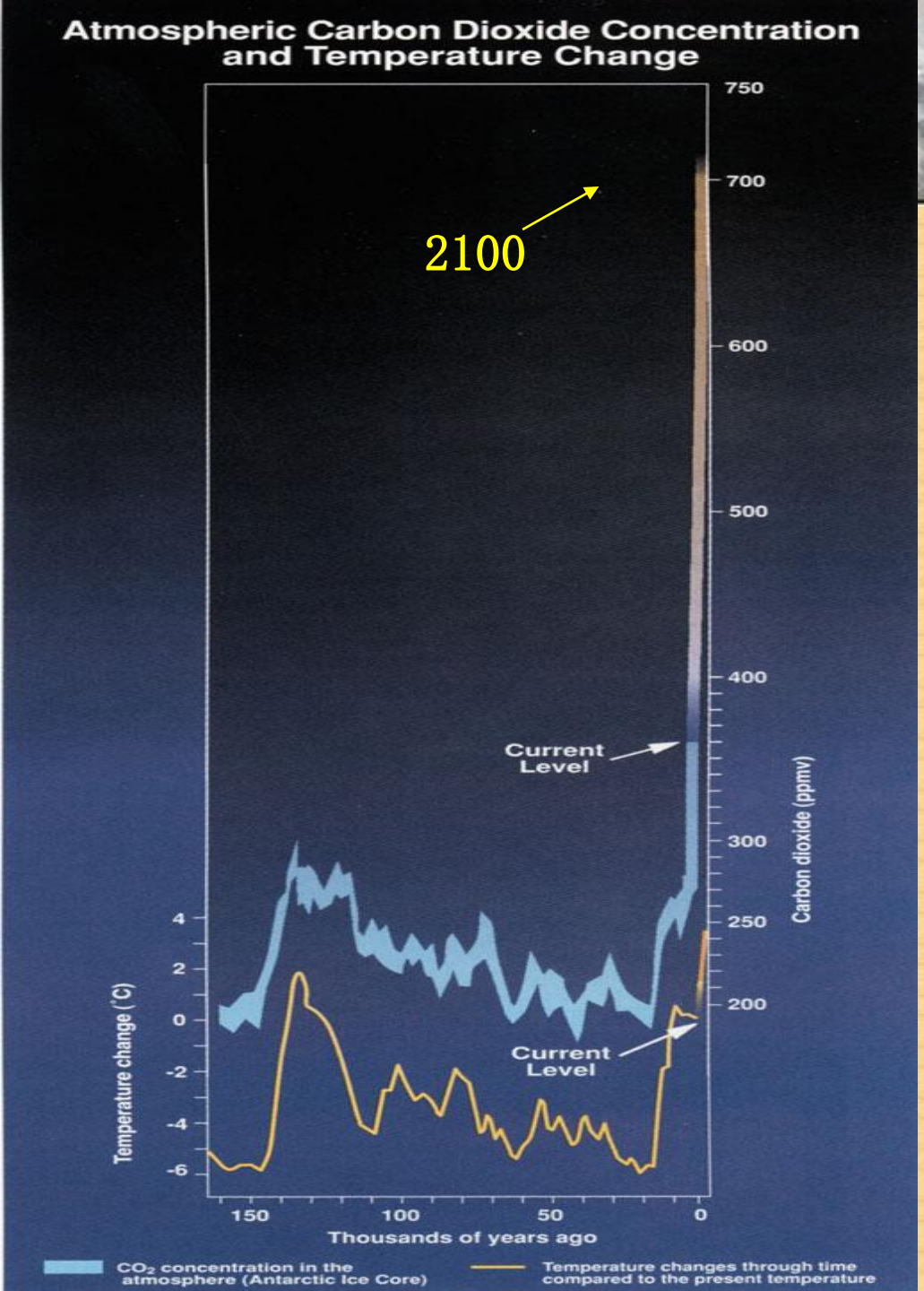


Melting of Glaciers

Frequency of Major Floods is Rising



Predictions of what might happen to the earth if subjected to change in climate



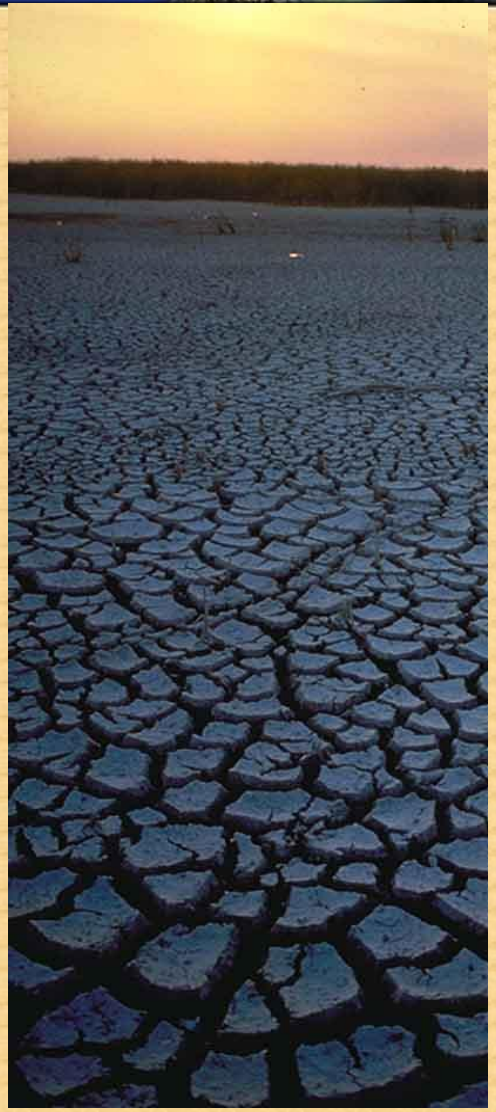
If nothing is done to slow these gas emissions. . .

CO_2 concentrations will likely be more than 700ppm by 2100

Global average temperatures are projected to increase by between (1.4-5.8 °C) by 2100

Source: OSTP

Projected Changes in Precipitation



- More frequent intense rainfall events; longer dry periods in between
- Drier in most coastal areas

Source:

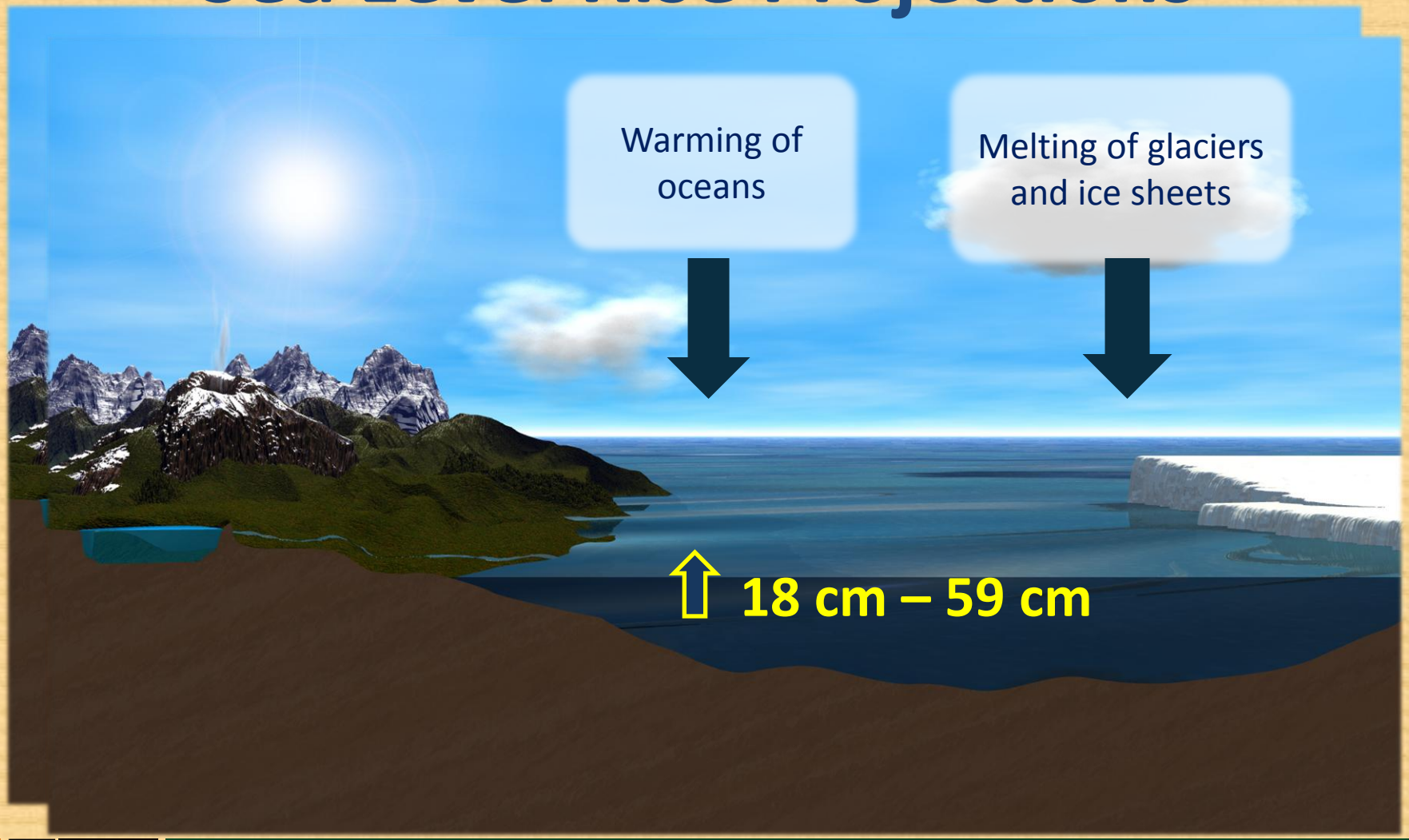
Hurricanes and Tropical Storms

With global warming: more intense hurricanes are likely, but changes in frequency are uncertain.

More intense El Niño-related droughts and floods in many different regions (medium confidence)

Human-induced warming and sea level rise would continue for centuries (highly certain).

Sea Level Rise Projections

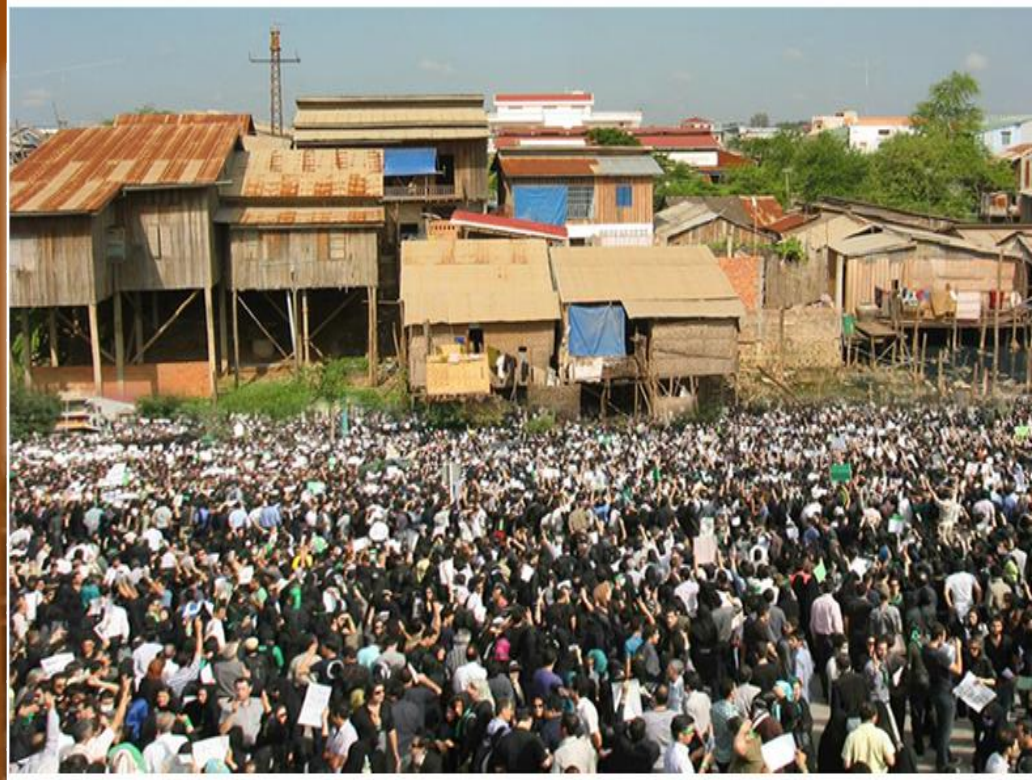


What does this all mean for the Philippines?

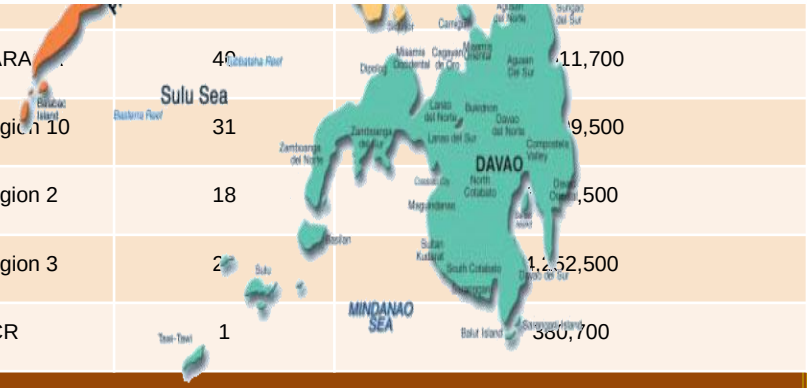
CLIMATE CHANGE H

- **DUE TO ITS GEOGRAPHIC FEAUTURES**
  - **Highly susceptible to flooding and inundations**
  - **Archipelagic- 7,100 islands with low lying areas**
  - **Highly susceptible to sea level rise**
  - **Among longest coastlines in the world with 32,400 kms (susceptible to storm surges)**
- LOW ECONOMIC DEVELOPMENT
- **POOR ACCESS TO RESOURCES**

REGIONS IN THE PHILIPPINES THAT ARE VULNERABLE TO A 1-METER RISE IN SEA LEVEL ***SOURCE:*** *Greenpeace Southeast Asia* *published at BBC NewsAsia*



12	CARA	40	11,700
13	Region 10	31	9,500
14	Region 2	18	,500
15	Region 3	2	52,500
16	NCR	1	380,700



REGIONS IN THE PHILIPPINES THAT ARE VULNERABLE TO A 1-METER RISE IN SEA LEVEL

SOURCE: *Greenpeace Southeast Asia published at BizNewsAsia*

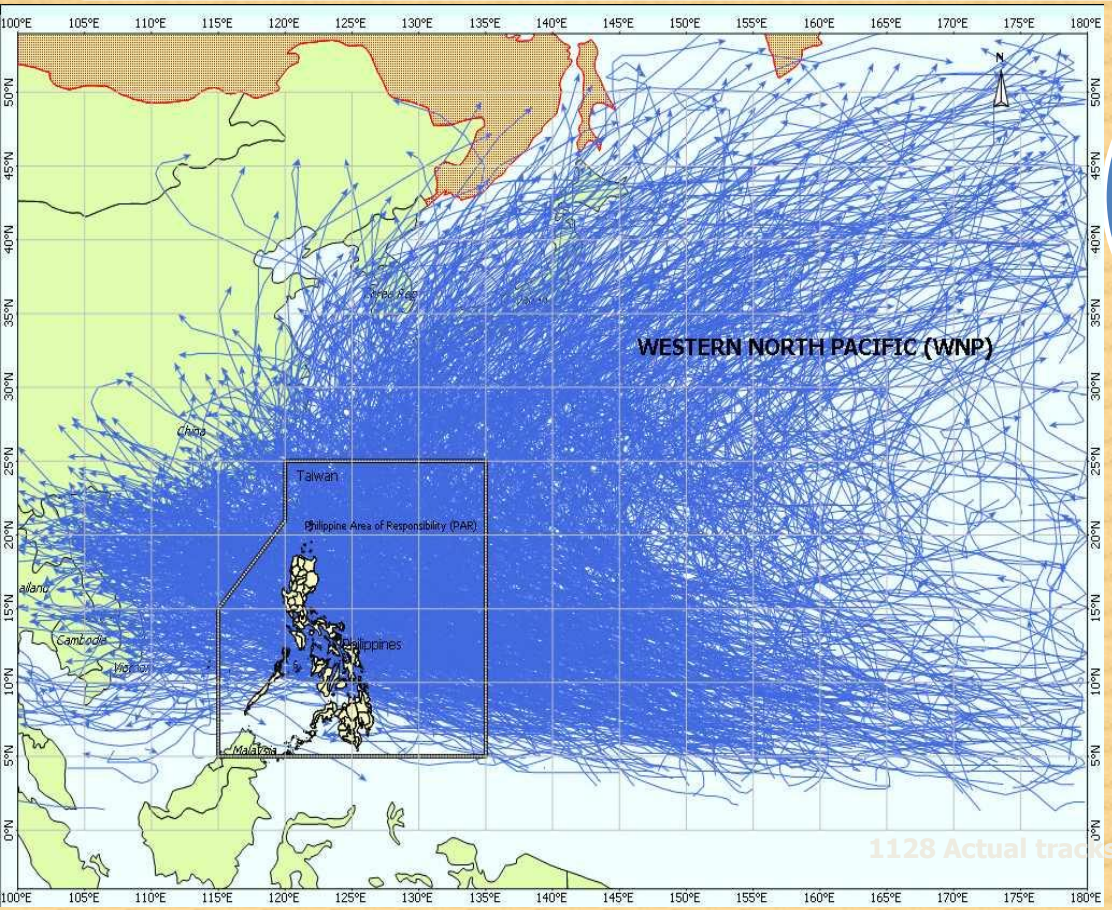
RANK	REGION	NUMBER OF MUNICIPALITIES	LAND AREA VULNERABLE TO 1 meter SLR (m^2)
1	ARMM	39	137,635,200
2	Region 9	40	81,129,600
3	Region 4B	64	75,807,900
4	Region 8	92	75,662,100
5	Region 5	86	74,277,000
6	Region 7	68	52,747,200
7	Region 6	68	38,118,600
8	Region 11	20	30,107,700
9	Region 4A	46	23,805,900
10	Region 1	48	20,322,900
11	Region 12	19	16,232,400
12	CARAGA	40	12,611,700
13	Region 10	31	12,109,500
14	Region 2	18	6,439,500
15	Region 3	23	4,252,500
16	NCR	1	380,700

HIGHLY SUSCEPTIBLE TO GROUND MOVEMENTS (LANDSLIDES, MUDSLIDES, ETC.)

MOUNTAINOUS TOPOGRAPHY WITH STEEP SLOPES

SITTING ALONG MAJOR FAULT LINES = FRACTURED ROCKS (GROUND EASILY SATURATED WITH WATER)

PHILIPPINE VULNERABILITY TO GLOBAL WARMING/ CLIMATE CHANGE



VISITED BY AVERAGE

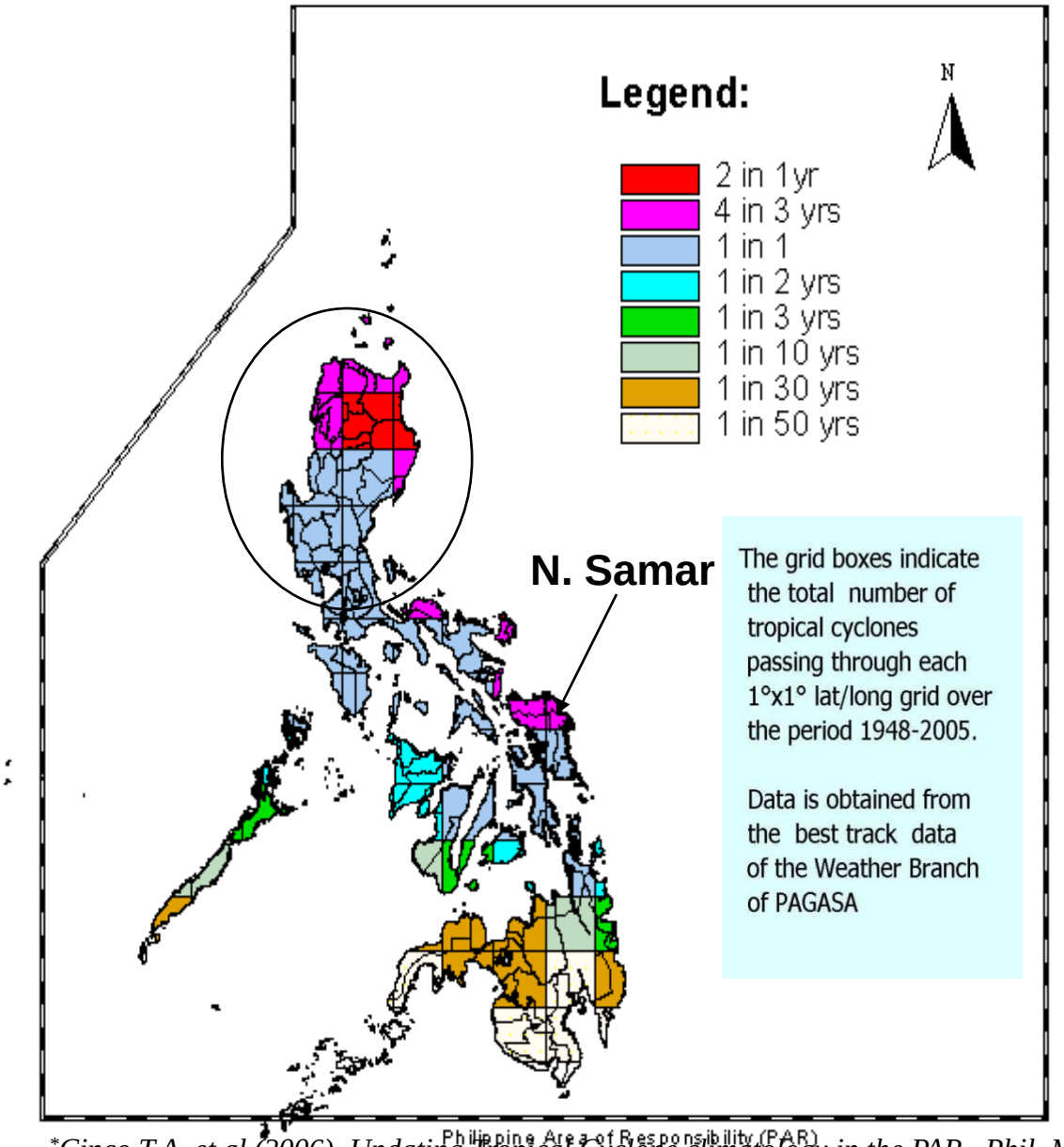
19-20 Tropical Cyclones

EVERY YEAR

With the projected increase in temperature this could mean much stronger and more intense tropical cyclones.

HIGHLY SUSCEPTIBLE TO TC's – LOCATED WITHIN PACIFIC TYPHOON BELT AREA

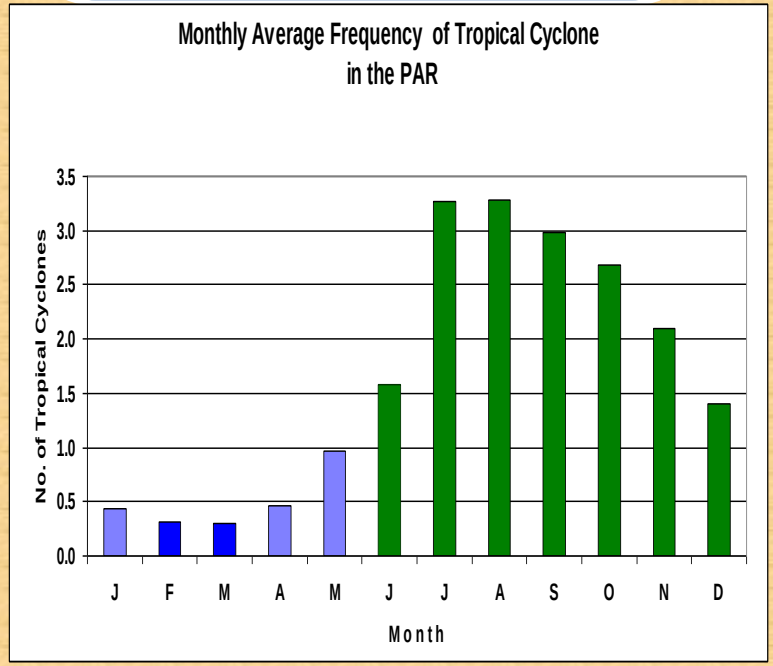
Frequency of Tropical Cyclones in the Philippines
Period: 1948-2005



The grid boxes indicate the total number of tropical cyclones passing through each 1°x1° lat/long grid over the period 1948-2005.

Data is obtained from the best track data of the Weather Branch of PAGASA

Northern Luzon is most frequently hit by tropical cyclones followed by Catanduanes and Northern Samar and least in the Mindanao area.

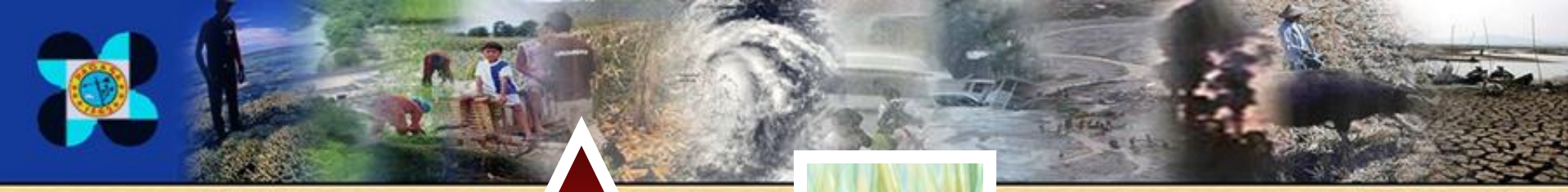


*Cinco,T.A.,et al.(2006). Updating Tropical Cyclone climatology in the PAR., Phil. Met-Hydro Congress 2006.

POTENTIAL IMPACTS OF GLOBAL WARMING/CLIMATE CHANGE

A 1 DEGREE INCREASE IN TEMPERATURE IN THE TROPICS

AGRICULTURAL YIELD DECLINE BY AS MUCH AS 10%

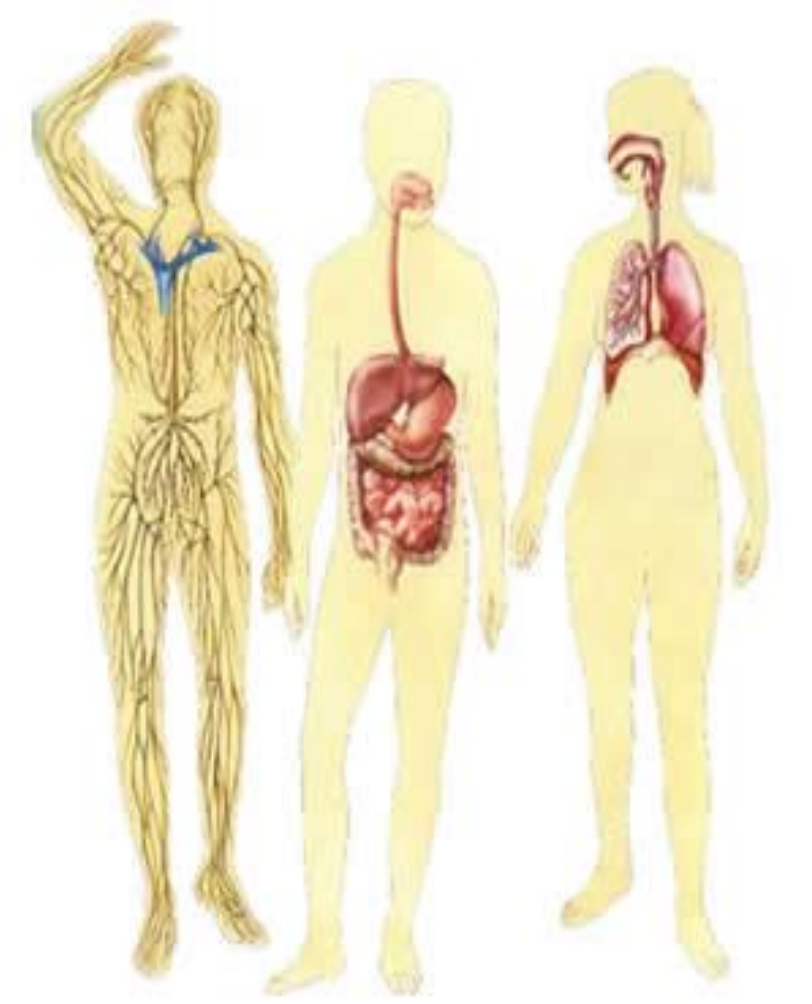


TEMPERATURE INCREASE BY 2-6 DEGREES

DECLINE OF 29%–60% IN PHIL AGRI PRODUCTION

WILL DIRECTLY THREATEN FOOD SECURITY, ESPECIALLY SINCE THE PHILIPPINES HAS ONE OF THE HIGHEST POPULATION GROWTH

Health & Global Warming



- Extreme temperatures can directly cause the loss of life (ex: 35,000 people died during heat wave in Europe, Aug‘03.)
- Warmer weather provides an ideal breeding environment for mosquitoes.

Tropical Diseases?

- Global Warming increases drought which lessens the supply of clean drinking water.
  - Cholera
- It increases temperature providing an ideal breeding environment for mosquitoes.
  - Dengue fever
  - Malaria
  - Yellow fever

Effect of Sea Warming on Coastal (Marine) Resources

- **The diversity of corals could be affected** with the branching corals (e.g., staghorn coral) decreasing or becoming locally extinct and the massive corals (e.g., brain corals) increasing (WGII TAR, 2001)
- **Massive coral bleaching in various reefs through- out the Philippines during the severe 1997-98 ENSO episode** (Arceo, H.O. et al., 2001)
- **Fish kills and high mortality of cultured giant clams, severe red tide outbreaks after strong El Niño periods.** The worst incidence of red tide in Manila Bay occurred in 1992, another El Niño period.

TS "Ondoy"
Sept 2009

- *Very likely* that extreme events will continue to become more frequent

"TY Pablo" The strongest tropical cyclone to ever hit the southern Philippine island of Mindanao Dec 2012

Cagayan de Oro city Flood

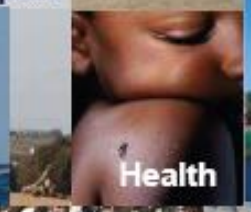
Photo 3. Brgy. Balulang, situated on the floodplain of Cagayan de Oro River, was devastated by flashfloods. Numerous houses once stood in this residential area.

Vulnerability analysis: River-basin Approach

Iligan city flood (Typhoon Sendong)

Orchid Pag-ibig Homes: Some engineered houses were not spared. Note location of the subdivision – at river-bend. Strict EIA compliance?

Increasing Risks under a Changing Climate



Strong Wind

Coastal Marine Hazards

Tropical Cyclones

Heavy rainfall / Flood

Heatwaves

Intensity

Frequency

Hazards' intensity and frequency are increasing

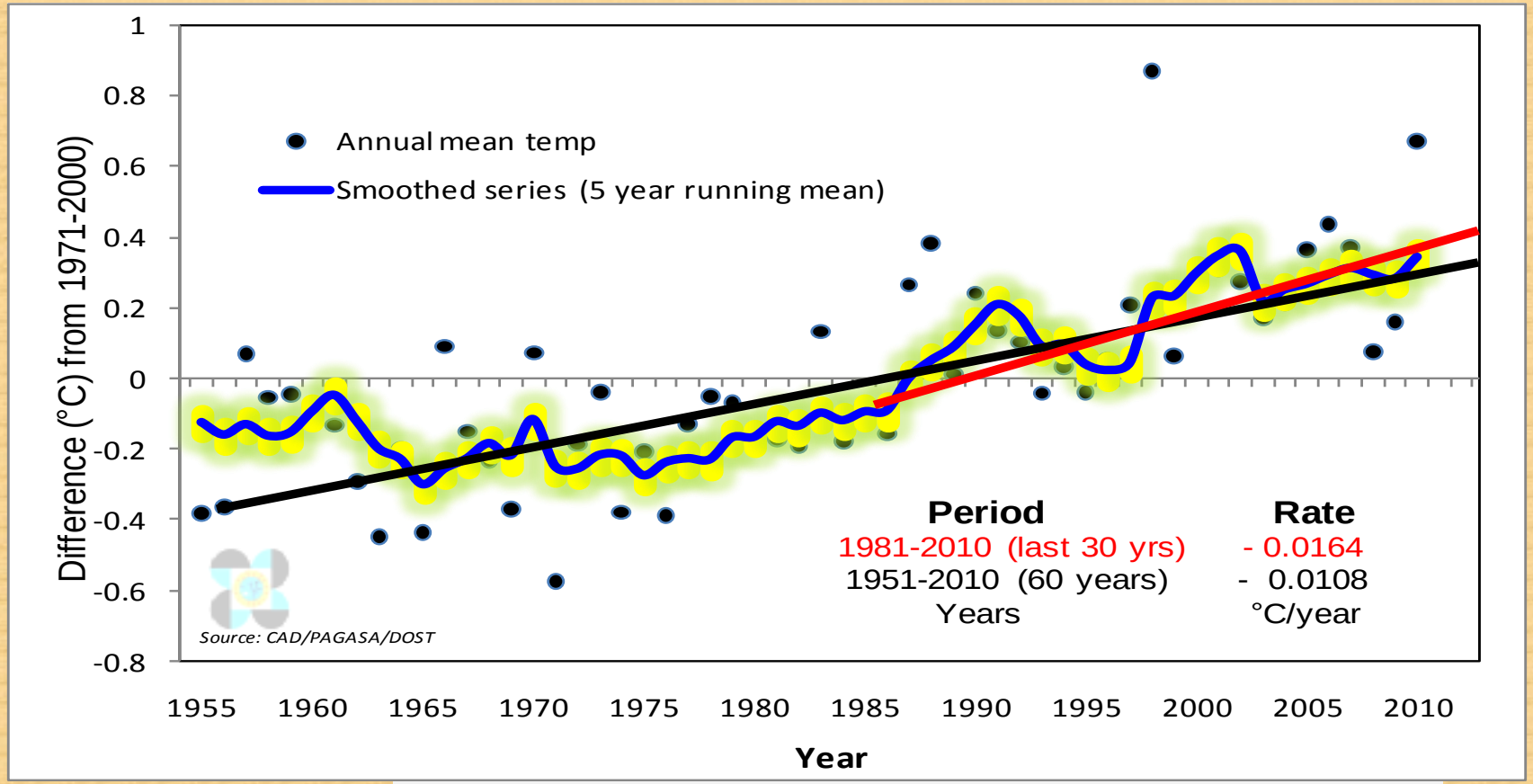
Exposure is increasing !

Need for disaster risk management

How is global warming manifested in the Philippines?

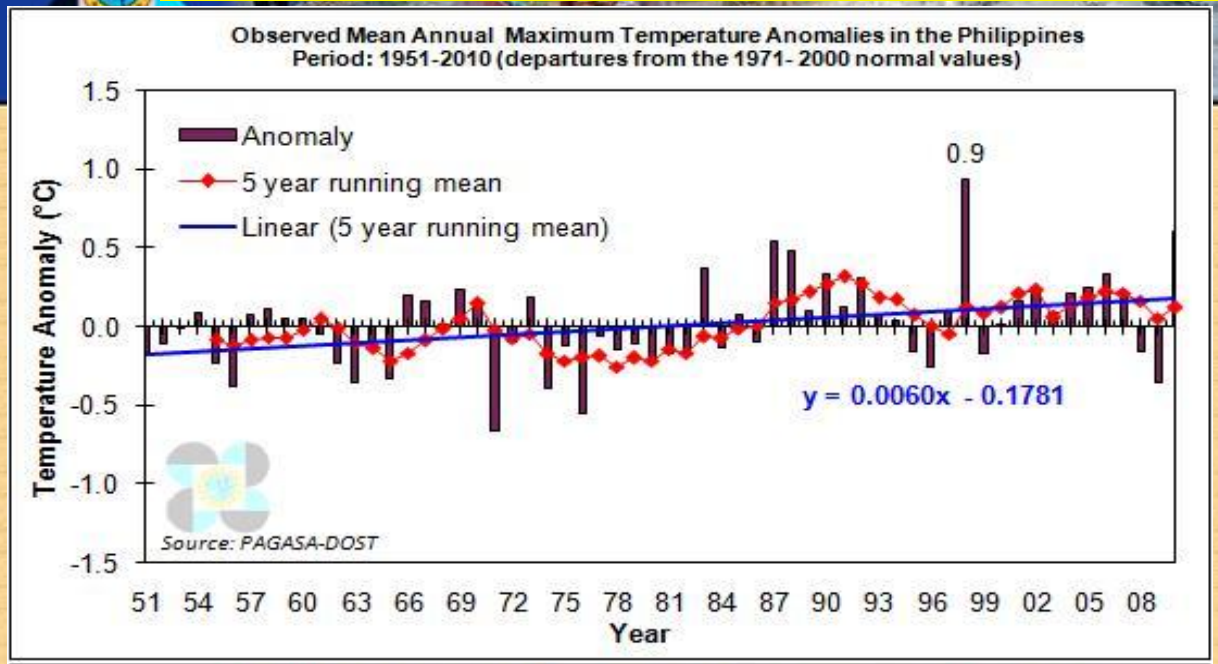
Philippines mean temperature

Observed Mean Temperature Anomalies in the Philippines (1951-2010)
Departures from 1971-2000 normal values



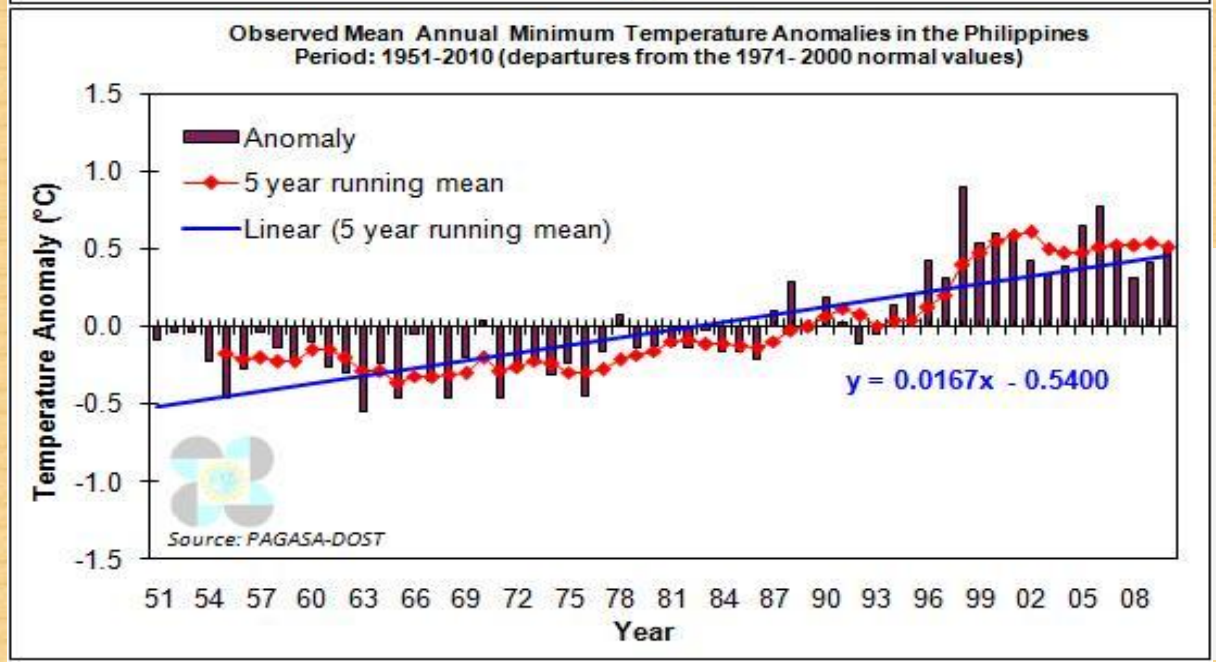
An increase of 0.65°C from 1951-2010 (60 years)

Maximum & Minimum Temperature



An increase of 0.36°C
from 1951-2010
(60 years)

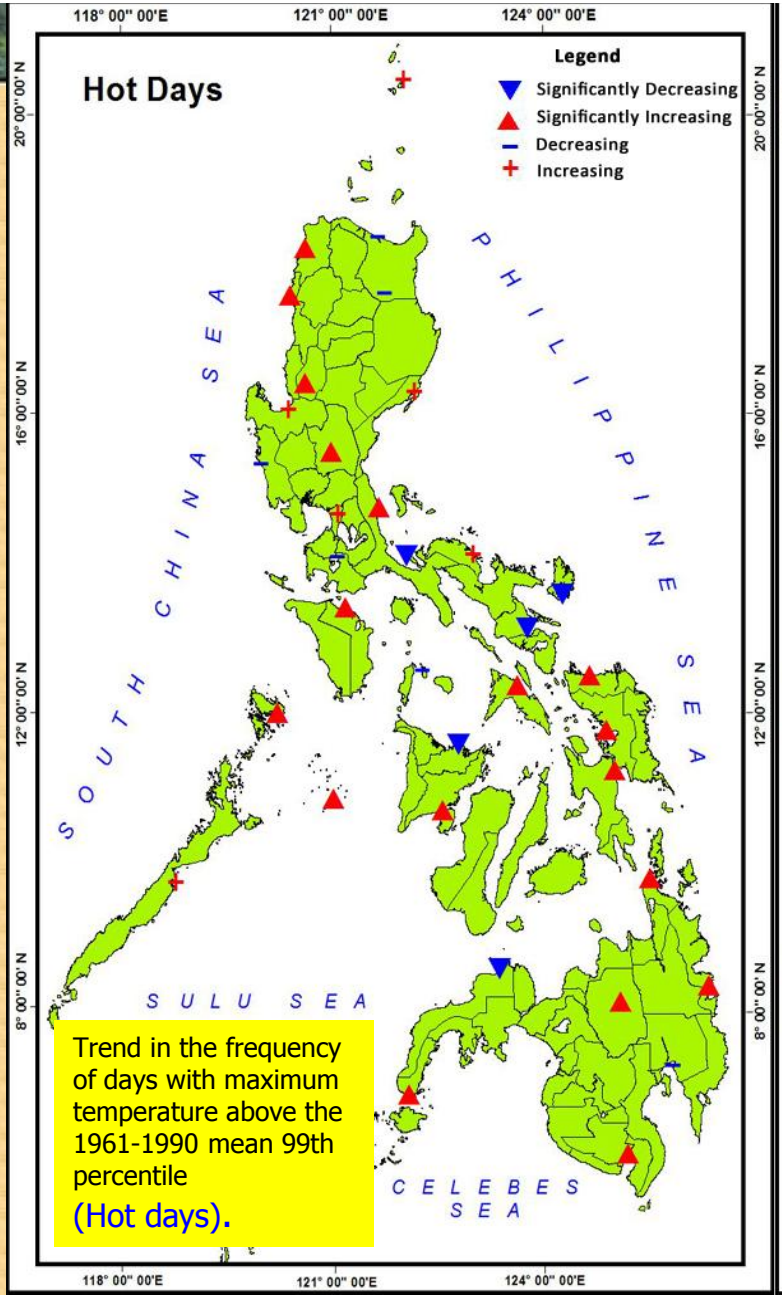
Rate of increase almost 3 times higher compared with the maximum temperature

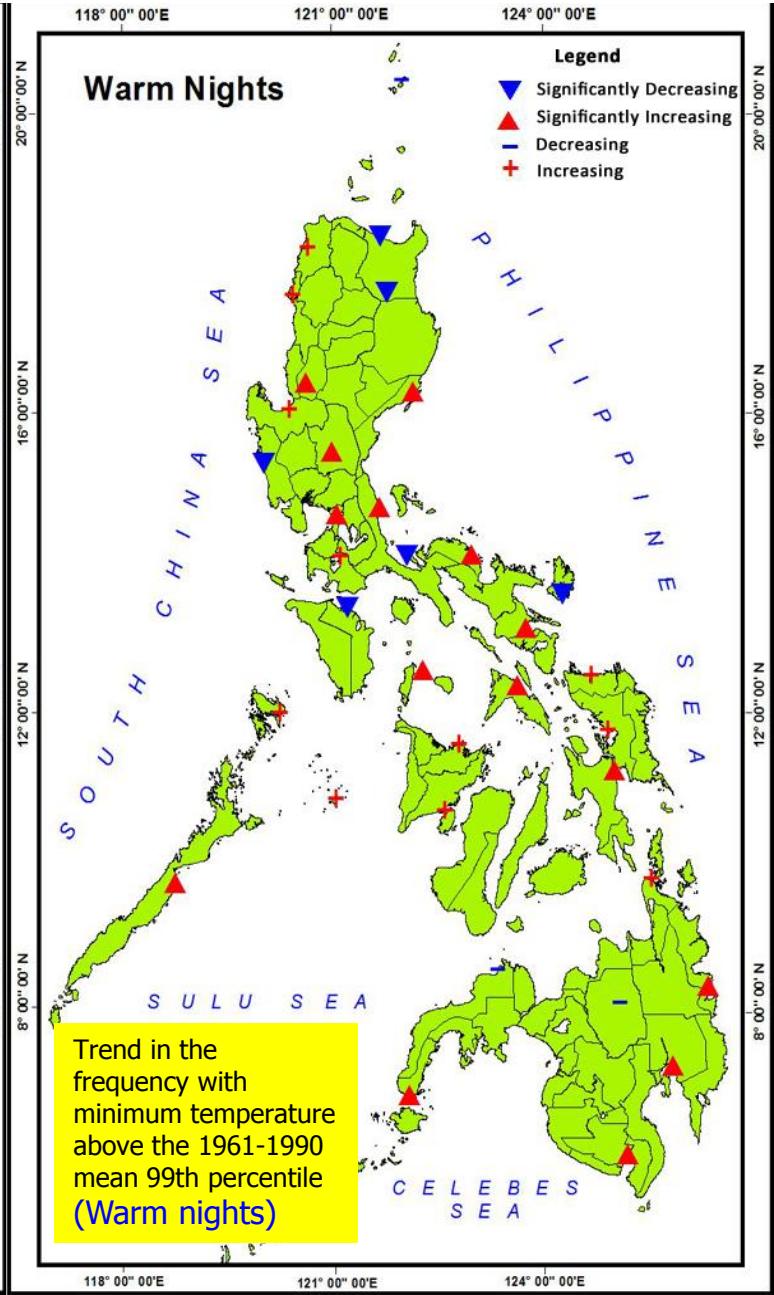


An increase of 1.0° C
from 1951-2010
(60 years)

Trends in Extreme Daily Temperatures in the Philippines Period: (1951 – 2008)

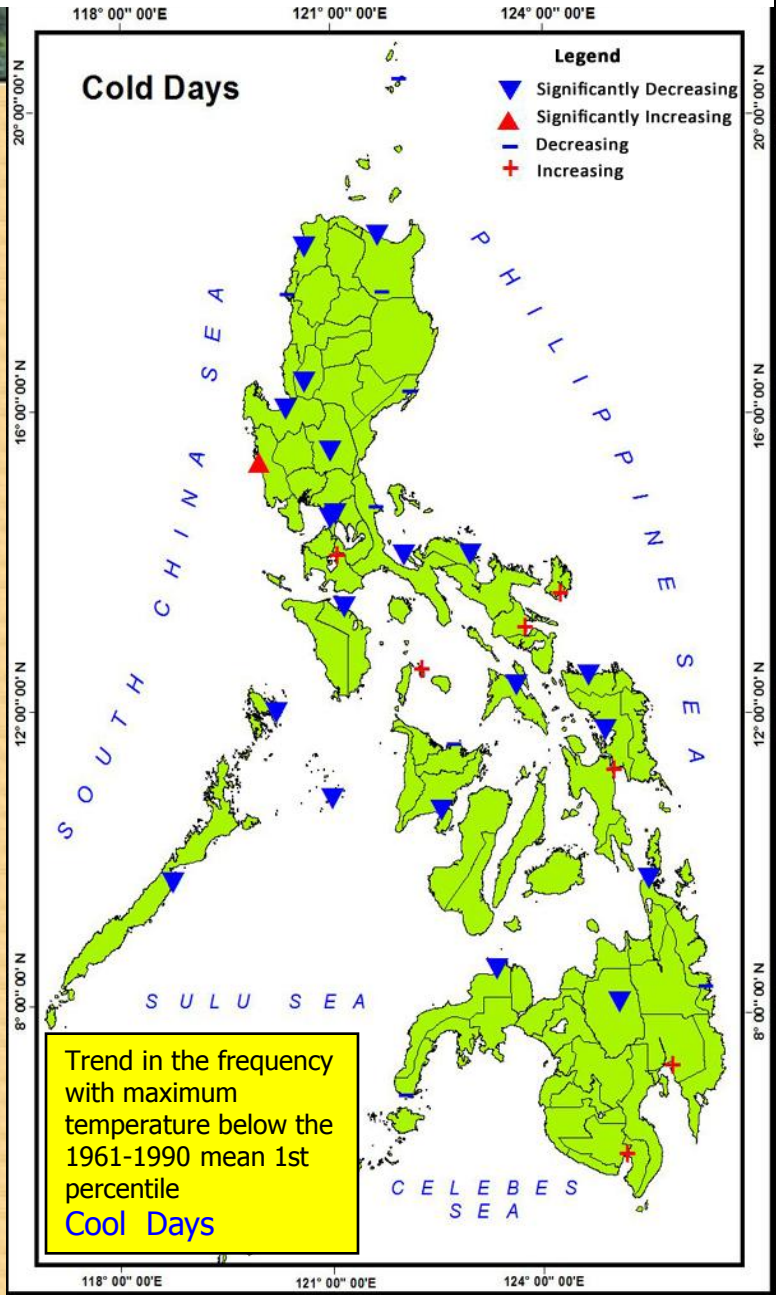
In most parts of the country, increases in the frequency of hot days and warm nights are Statically Significant

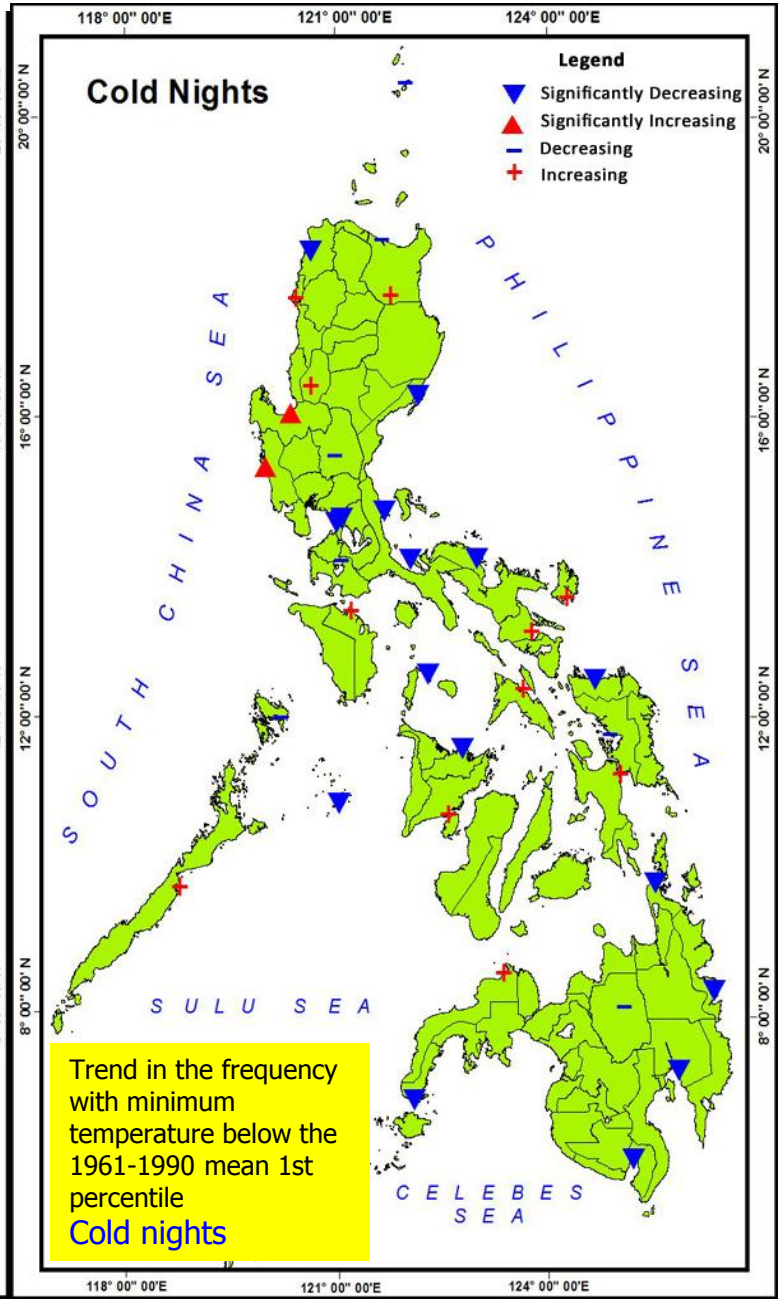




Trends in Extreme Daily Temperatures in the Philippines Period: (1951 – 2008)

In most parts of the country, Significant decreases in the frequency of Cool days and Cold nights

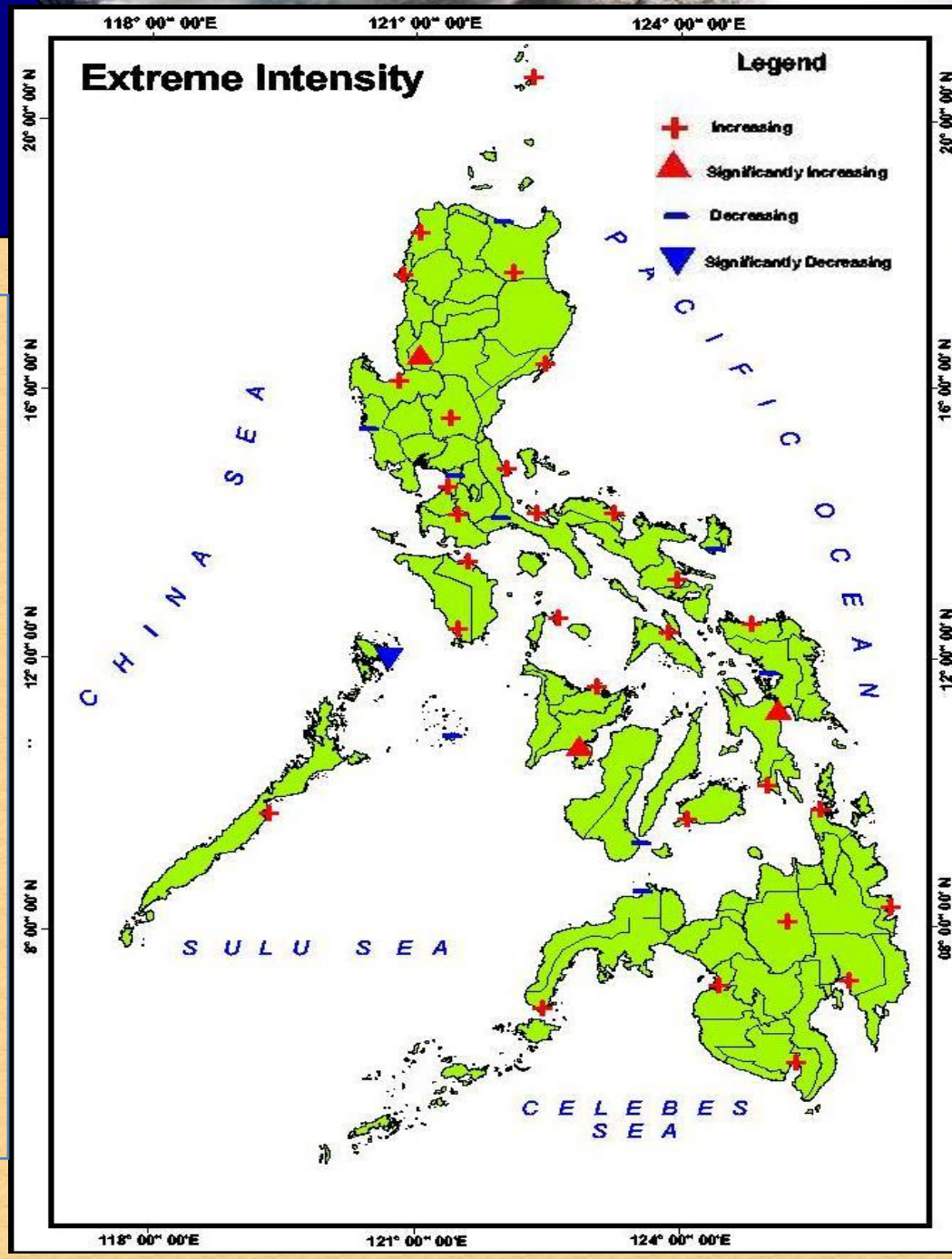




Rainfall

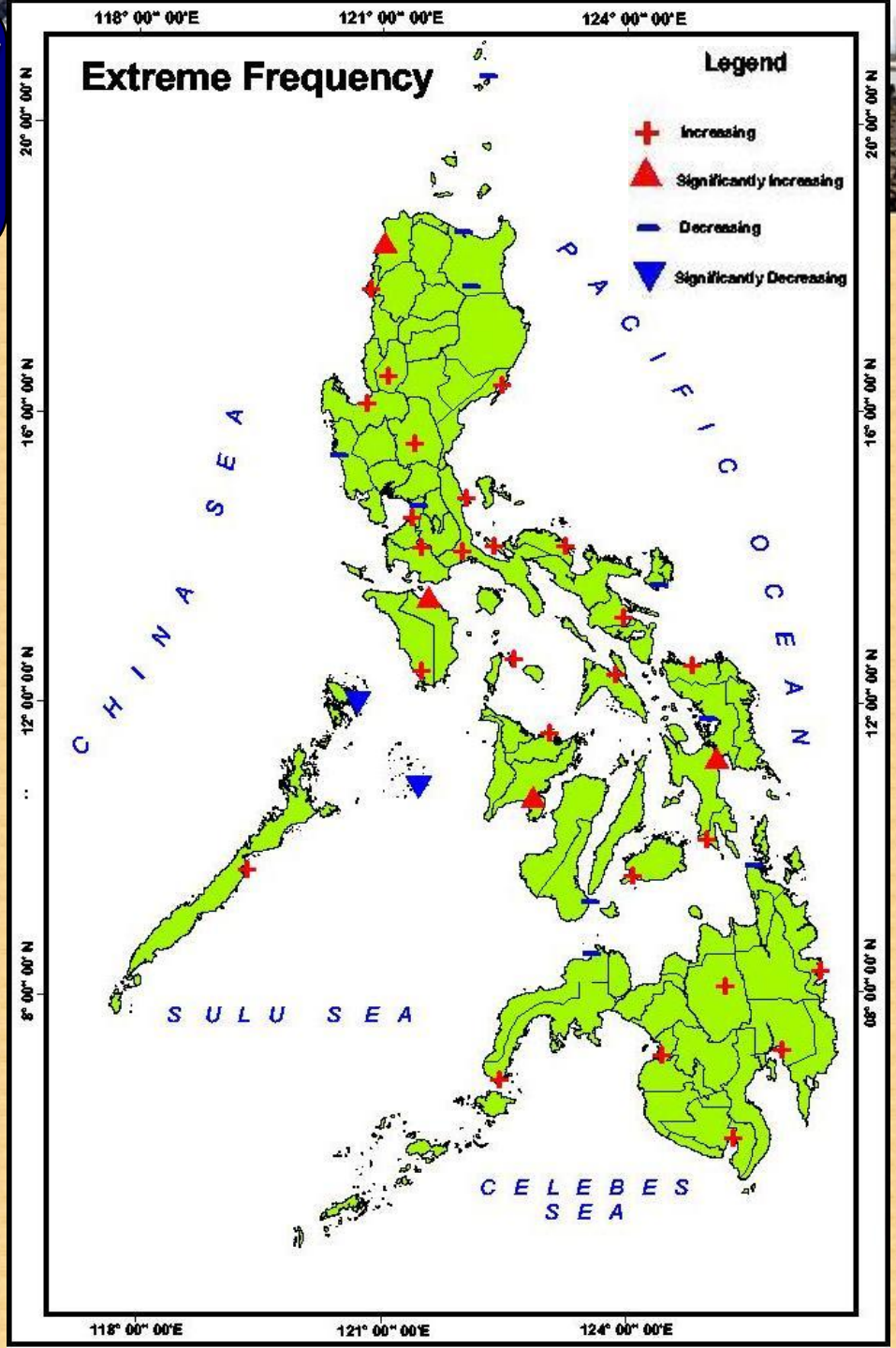
Trends in the Extreme Rainfall Intensity Philippines* (1951 – 2008)

- In most parts of the country, the intensity of rainfall is increasing but not all are statistically significant.
- Only in Baguio, Tacloban and Iloilo shows statistically significant increase in rainfall intensity.



Trends in the Frequency of Extreme Daily Rainfall in the Philippines* (1951 – 2008)

- Most parts of the country are generally increasing in trend but not all are significant.
- Only in Calapan, Laoag, Iloilo and Tacloban shows statistically significant increasing trend.
- While significantly decreasing trend is found in Palawan.

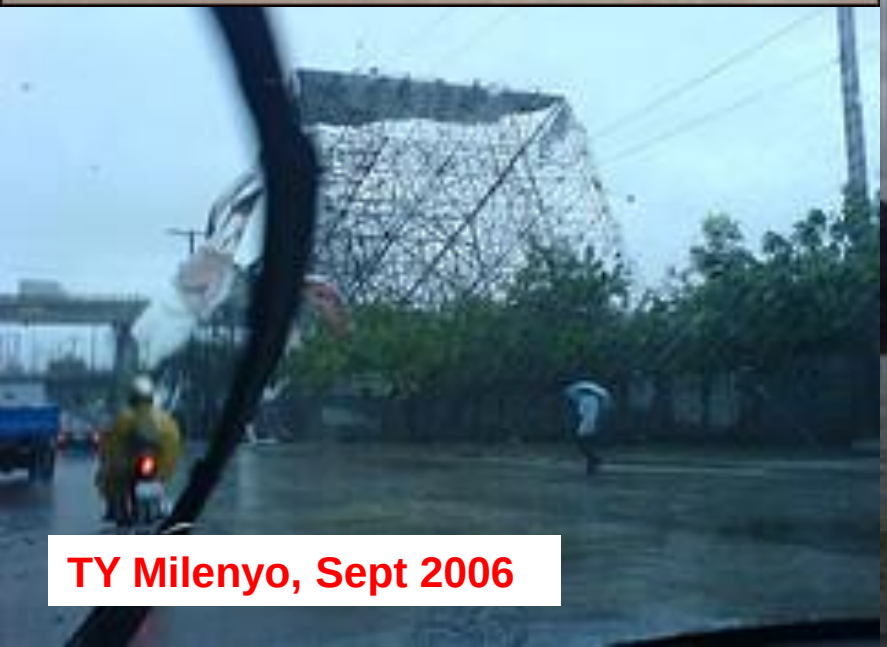


The Philippines has not been spared of the weather-related disturbances and disasters. The past typhoons have been unusually heavy and devastating to our country and our people.

Flooding in Metro Manila: Tropical Storm Ketsana"ONDOY" Sept. 24 - 27, 2009

Landslide :Ginsaugon, Feb 2006

TY Reming (DURIAN) 2006

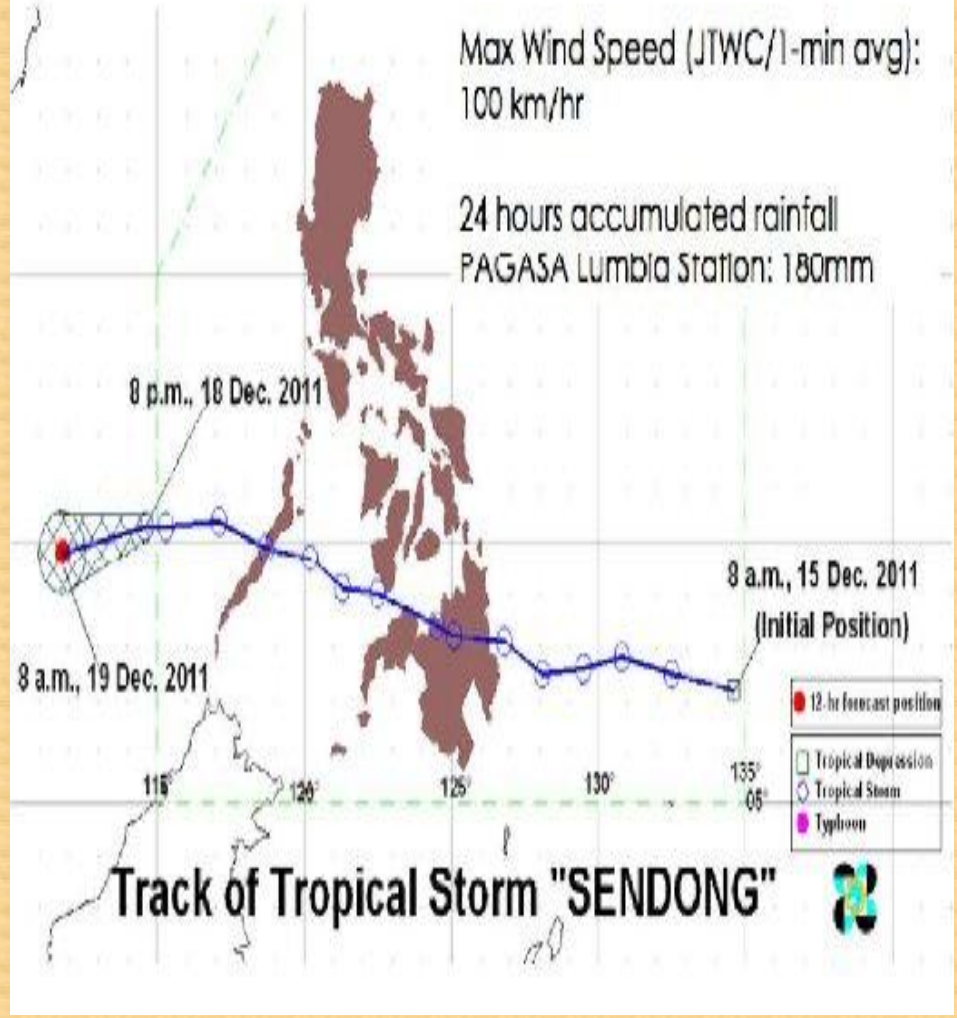


TY Milenyo, Sept 2006

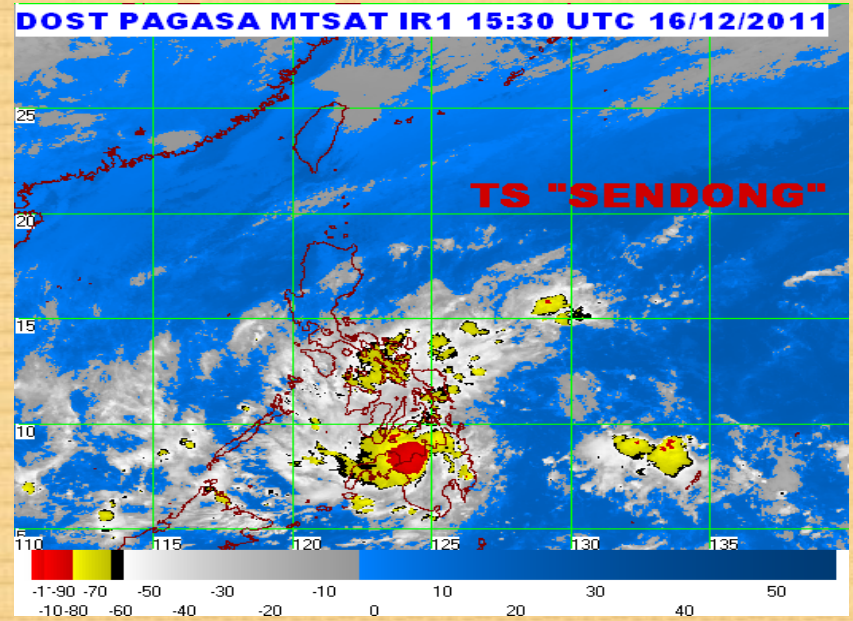
Typhoon Frank (Fengshen)

June 21, 2008. (MV Princess of the Stars)

TROPICAL STORM SENDONG



TS "Sendong" ranked No. 1 in the ten (10) most destructive TCs during 2011 with the most number of casualties totalling to 1,257 (as per NDRRMC report). Cagayan de Oro and Iligan suffered the most.

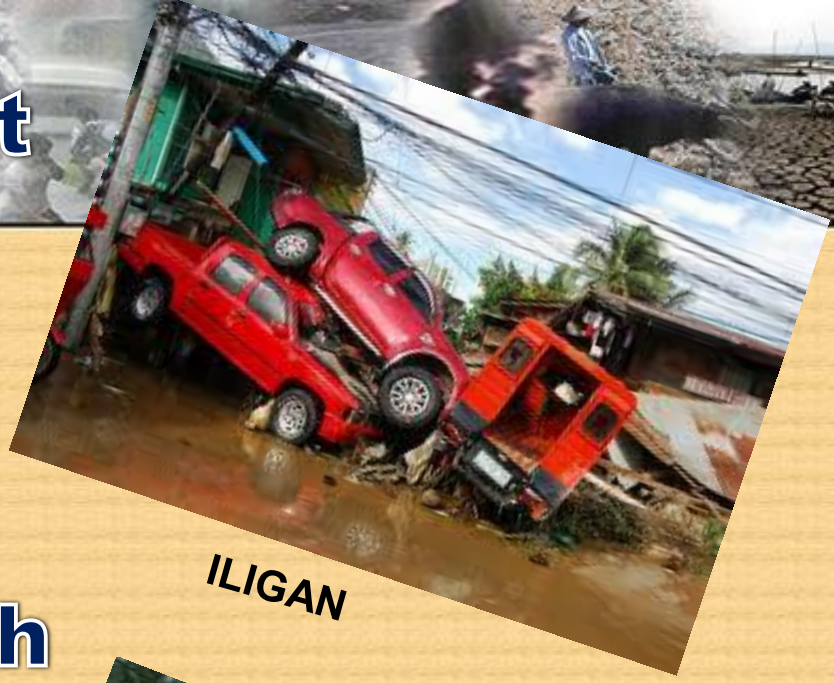


CAGAYAN DE ORO Tragedy

FLASH FLOOD

Effect of Flash Food

DUMAGUETE

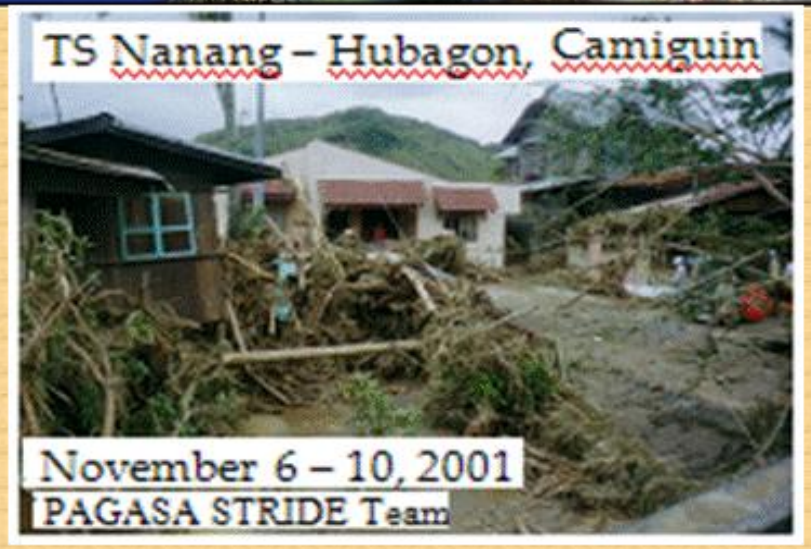


ILIGAN

ILIGAN

ILIGAN

Damaging Storms & Typhoons, Intense rainfall events



ORMOC FLASHFLOOD
November 1991

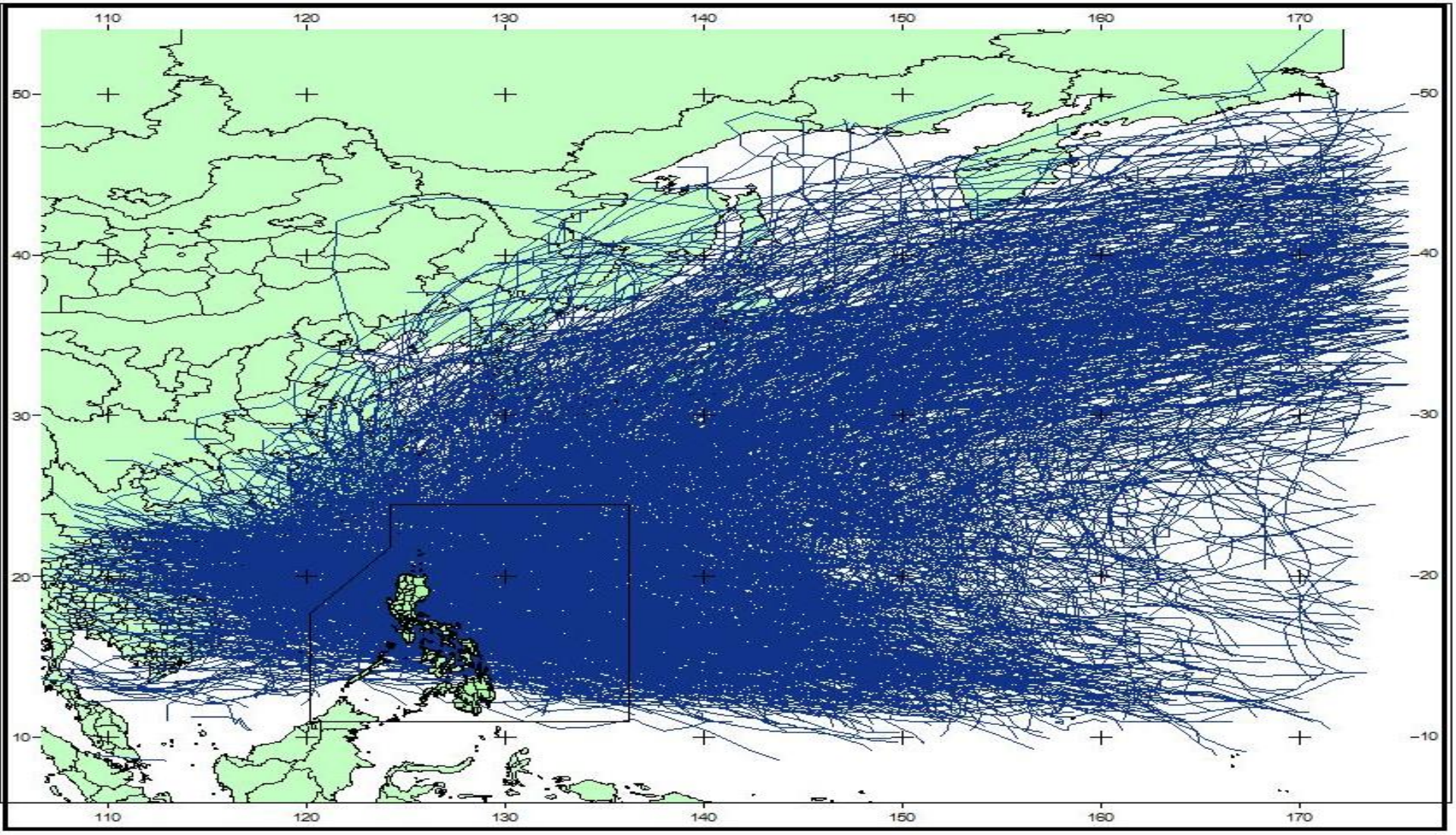
PANAON ISLAND
FLASHFLOOD
Dec 2003

INFANTA & AURORA
FLASHFLOOD
Dec 2004

ST. BERNARD
LANDSLIDE
Feb 2006

Tropical Cyclones Trends

Tracks of tropical cyclones in the Western North Pacific (1948-2010)



Tracks of tropical cyclones that formed in the Western North Pacific (WNP) during the period 1948-2010 (1641 TC and 1154 or 70% entered or formed in the Philippine Area of Responsibly (PAR) (Data used: JMA Data set)

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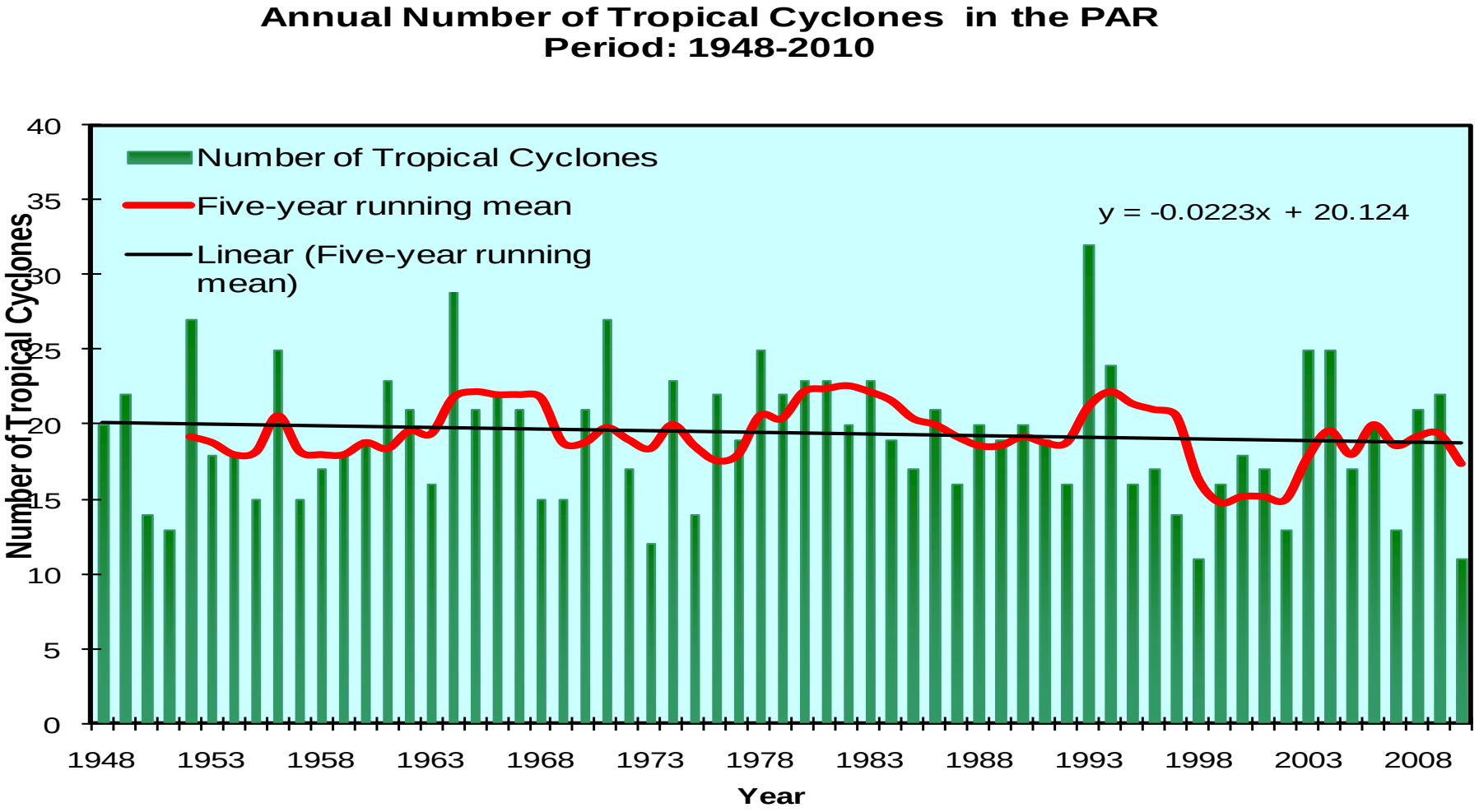
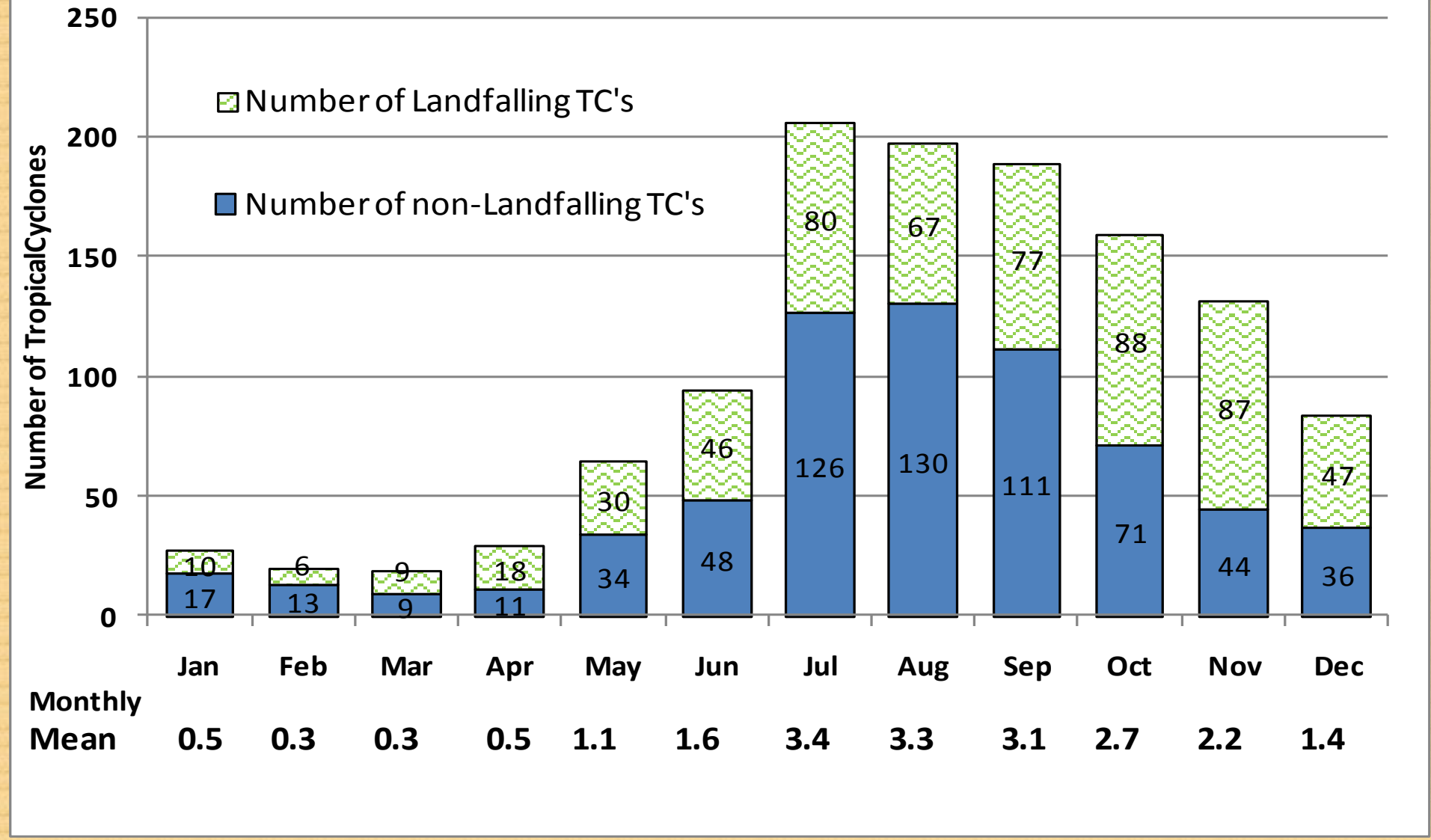
Trends of the number of tropical cyclone in the Philippines



*Cinco,T.A.,et al.(2006). Updating Tropical Cyclone climatology in the PAR., Phil. Met-Hydro Congress 2006.

Monthly frequency of T.C. entering the PAR and crossing the Philippines (1948-2010)



Responding to Climate Change: Mitigation and Adaptation

Mitigation

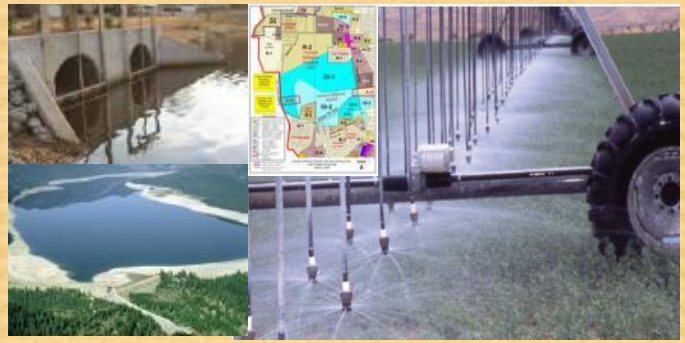
Measures to reduce the pace & magnitude of the changes in global climate being caused by human activities.

Focus on reducing emissions of greenhouse gases

Adaptation

Measures to reduce the adverse impacts on human well-being resulting from the changes in climate that do occur.

Focus on developing the capacity to manage the change that occurs



Mitigation

An anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases.

Adaptation

Practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change

Mitigation Actions

Improve technology

Regulations and standards

Use instruments

Change behavior and lifestyle

It's in our hands

Manage resources, especially forests in a sustainable way

Use renewable energy sources such as solar, wind or geothermal power.

Recycle as much as you can; you'll be saving energy and preserving natural resources.

MITIGATION

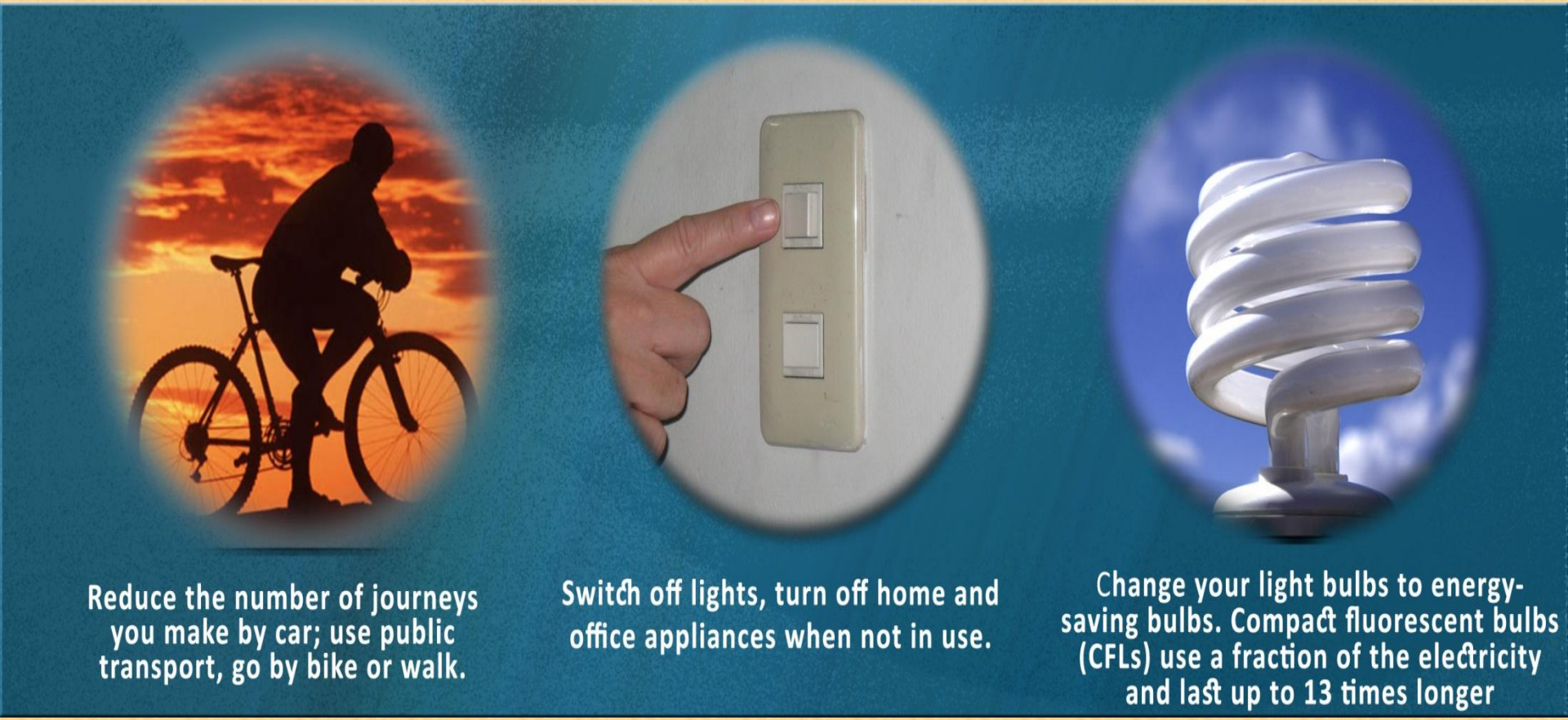
Plant a Tree

A single tree will absorb approximately one ton of carbon dioxide during its lifetime. During photosynthesis, trees and other plants absorb carbon dioxide and give off oxygen.

Reduce, Reuse, Recycle

- Recyclable products are usually made out of things that already have been used. It usually takes less energy to make recycled products than to make new ones. The less energy we use, the better.

- By recycling half of your household waste, you can save 1,200 kgs of carbon dioxide



MITIGATION – Change in behavior

Activities we can do to help:

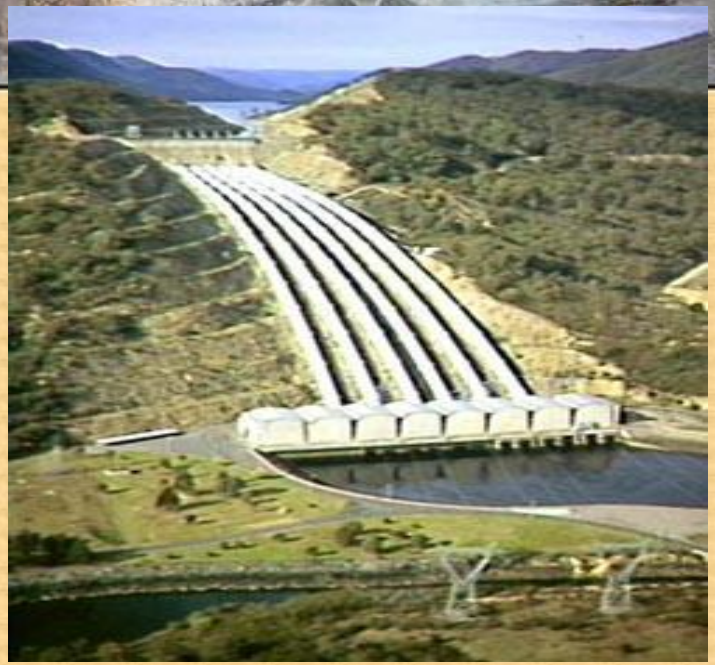
Drive Less and Drive Smart

Less driving means fewer emissions. Besides saving gasoline, walking and biking are great forms of exercise.

Change a Light Bulb

- **Replace regular light bulbs with compact fluorescent light (CFL) bulbs.**
- **Replacing just one 60-watt incandescent light bulb with a CFL will save you P1500 over the life of the bulb.**
- **CFLs also last 10 times longer than incandescent bulbs, and use two-thirds less energy.**

Activities we can do to help:



- If you are in a business that uses fuel, switch to renewable energy source
- Strive to have a more efficient production process
- Use efficient lighting and efficient use of electrical equipment.

PAGASA's Response	Activities
Enhancement of Observing systems and monitoring facilities for early warning system	• **Upgrading of surveillance radars/ Establishment of Doppler Radar** • **Upgrading of Satellite Facilities (NOAA, MTSAT)** • **Acquisition of MODIS Satelite** • **Upgrading of Upper Air Stations** • Buoys, wind profilers, AWS

Satellite Antenna at Weather and Flood Forecasting Center

Is climate change inevitable?

- We have pumped enough greenhouse gases into the atmosphere to warm the planet for many decades to come,
- The Earth's natural system will be affected for decades even if ghg emissions are reduced NOW.

Are there projections for further warming?

- There are projected increases of from 1.1°C to 6.4°C during the 21st century.
- For the next two decades a warming of about 0.2°C per decade is projected

GOVERNMENT RESPONSE

Government issued Administrative Order No. 171 creating the Presidential Task Force on Climate Change (PTFCC)

- TASKED TO ACT WITH AND RESOLVE THE URGENCY IN ADDRESSING THE ISSUE OF CLIMATE CHANGE
- MITIGATE ITS IMPACT
- ADAPT TO ITS EFFECTECT

Promote Pubic Awareness

- **Educate yourself, your family, your friends, your co-workers and everyone you meet.**
- **The more people are aware of the issues the more likely they are to make decisions that will be constructive!**
- **Be active - Speak up in a positive way in your local community and organization and help others to commit to reducing greenhouse gas emissions.**

Climate scientists say humanity has years, not decades, to stabilize CO_2 and other greenhouse gases.

Our failure to contain the emission of CO_2 and other greenhouse gases will have disastrous consequences for weather patterns, human settlements, agro-ecosystems, ecosystems, biodiversity etc.

Category Archives: Environmental Issues | In-depth

Thank You!

Tracking the sky…helping the country