

# Consequences of Climate Change in the Caribbean

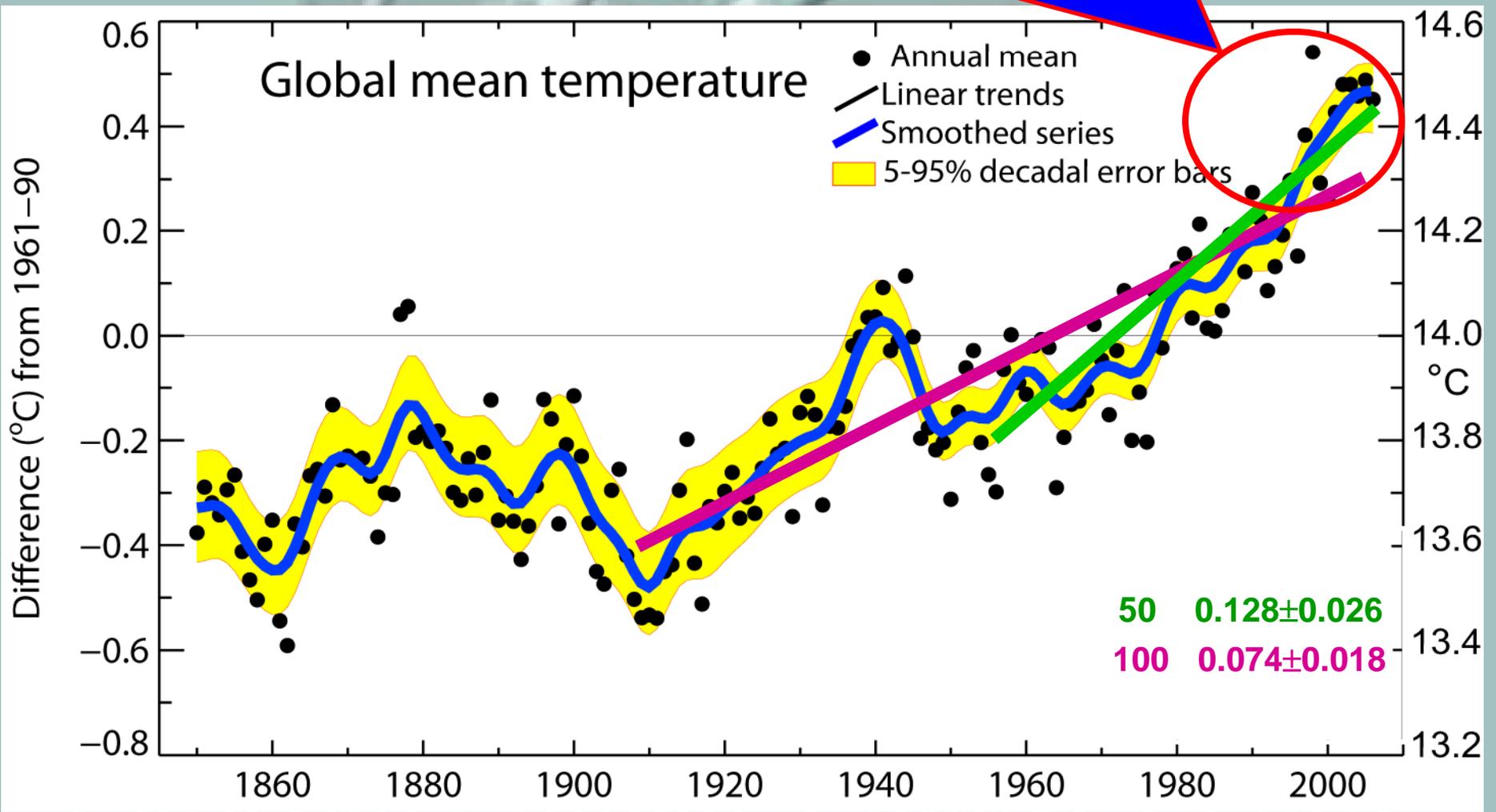
**Climate Change in the Caribbean  
2011: Puerto Rico and the U.S.  
Virgin Islands**

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# Global mean temperature (IPCC AR4)

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

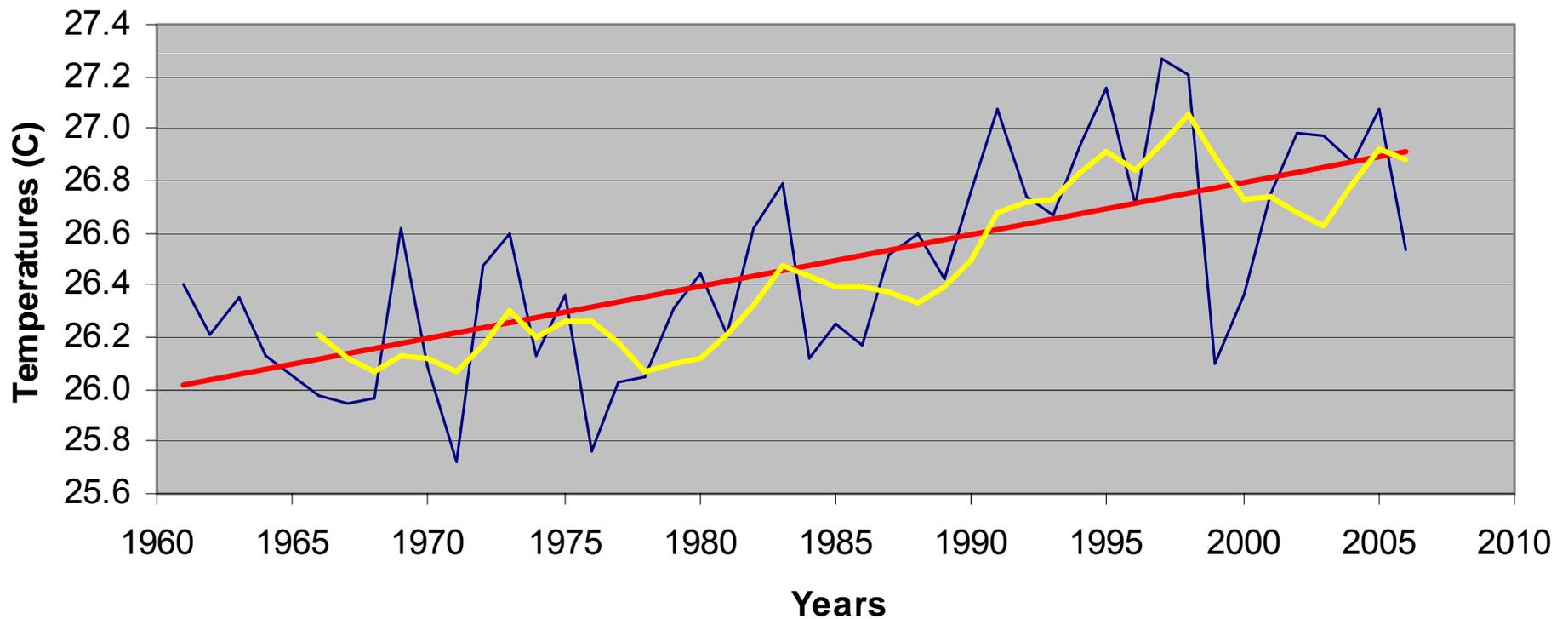


# Temperatures are rising in the Caribbean

- IPCC rate of rise of global average temperature is  $0.13^{\circ}\text{C}$  per decade in past 50 years and  $0.18^{\circ}\text{C}$  in past 25 years
- In Belize temperatures along the coast have risen by  $0.9^{\circ}\text{C}$  while inland, it has risen by  $1.0^{\circ}\text{C}$ .
  - International Airport
  - Central Farm
- Rate of increase in Belize for past 40 years is  $0.22^{\circ}\text{C}$  per decade along the coast and  $0.25^{\circ}\text{C}$  in the interior, exceeding both the global 50 and 25 year trends.
- The two warmest decades in Belize were the 2000s and 1990s.

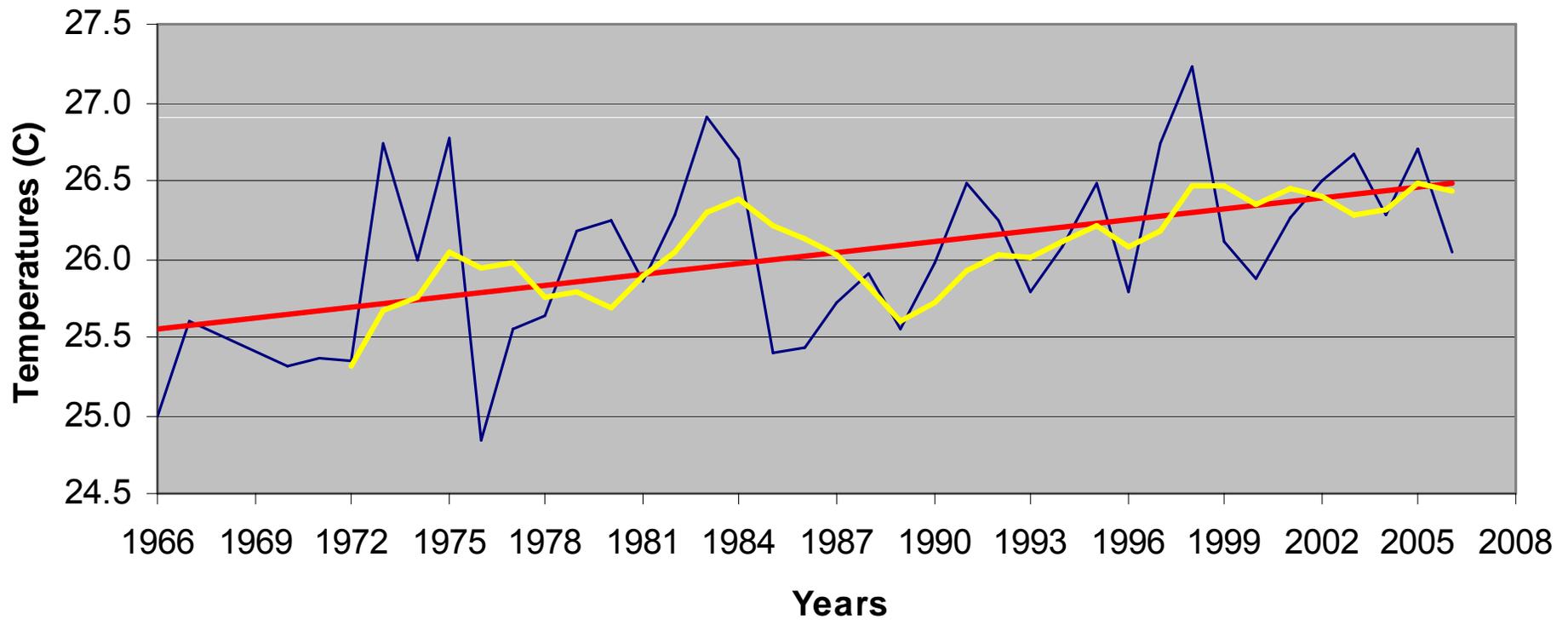
# Temperatures at Belize International Airport

**PGIA Average Temperatures**



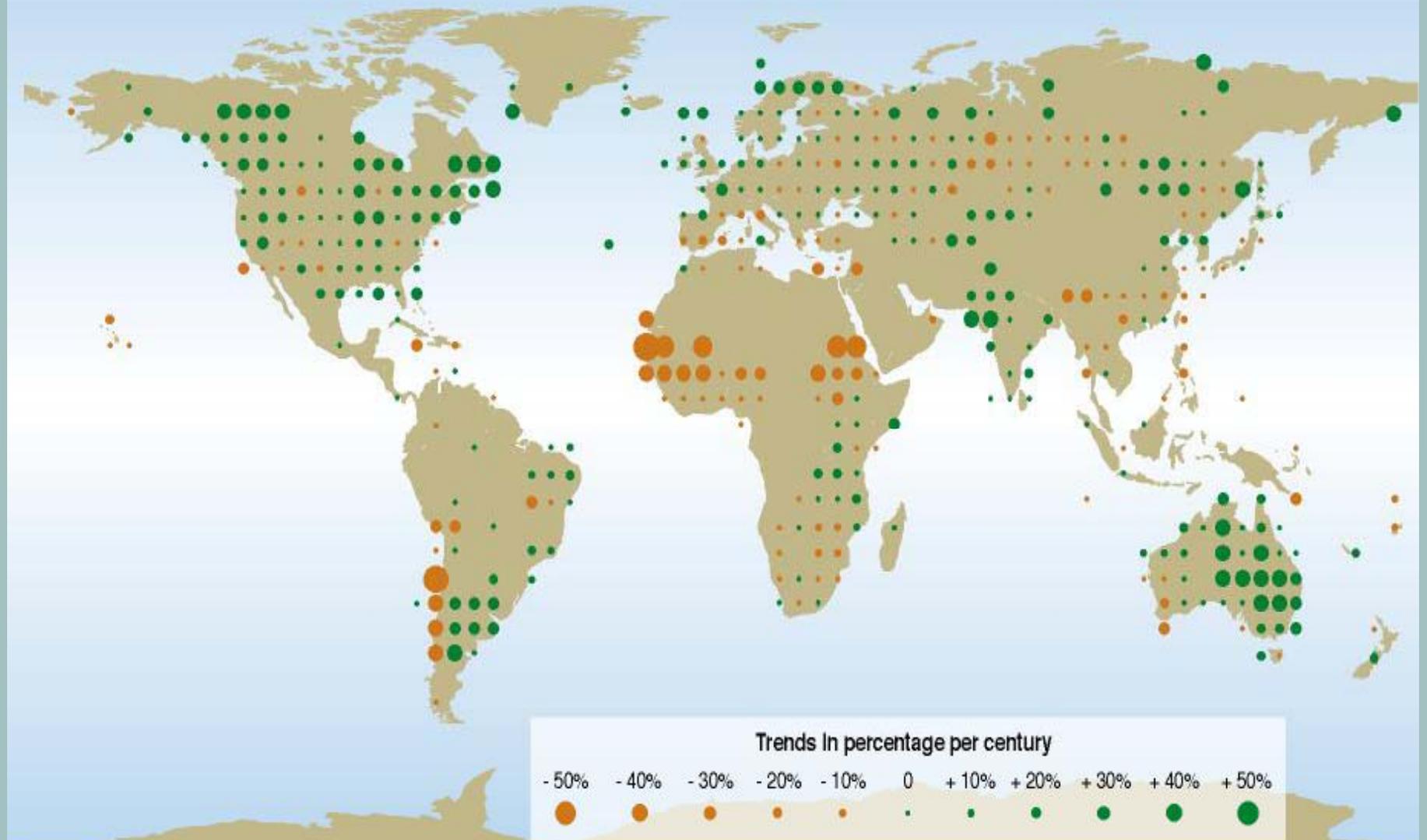
# Temperatures at Central Farm

Average Temperatures Cent Farm



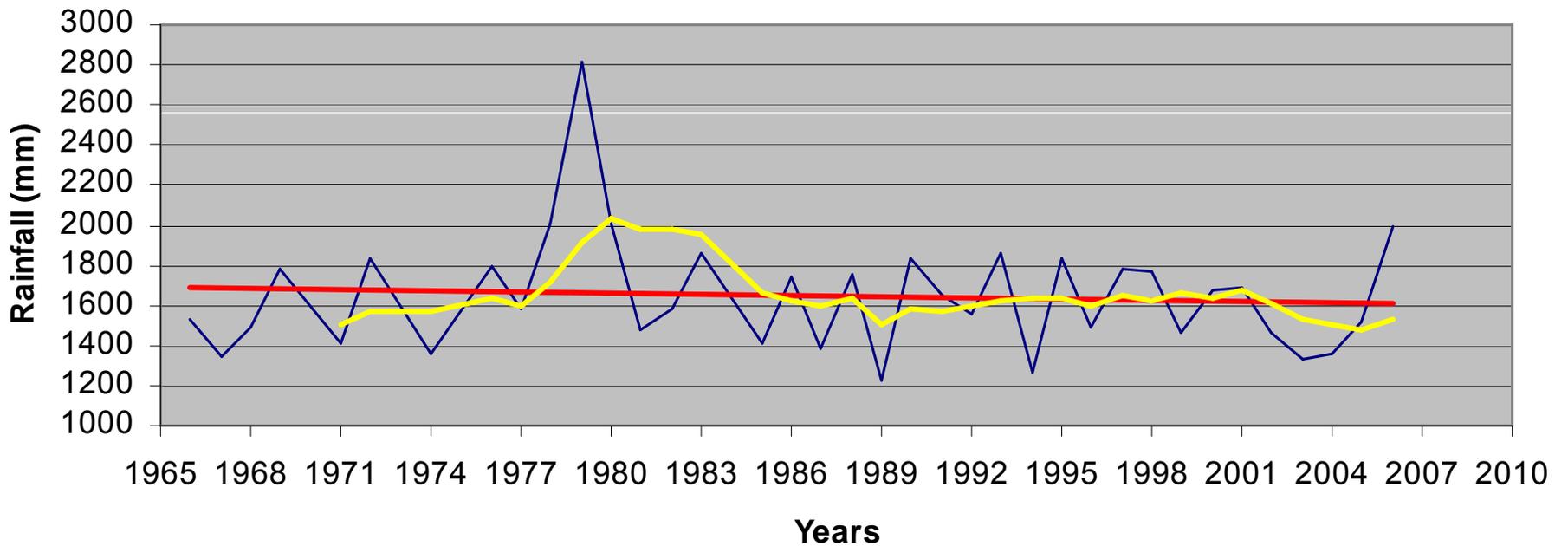
# Precipitation patterns have changed (IPCC TAR)

Annual precipitation trends: 1900 to 2000



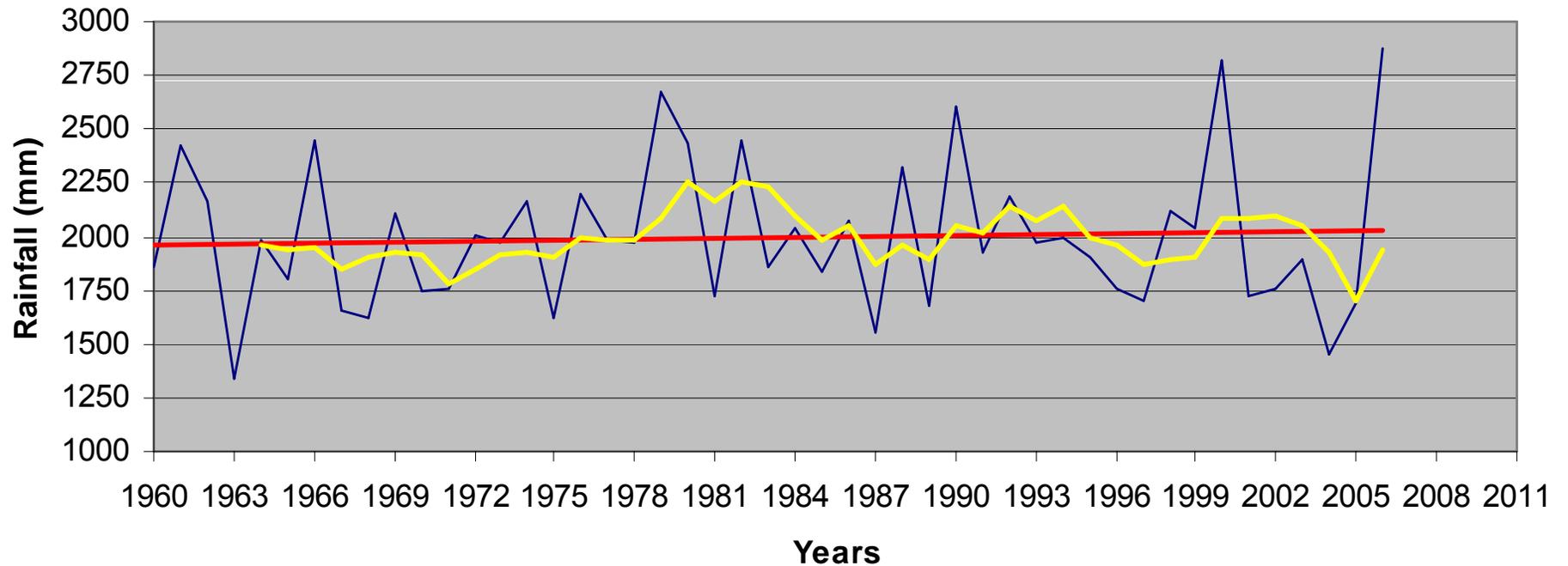
# Rainfall in Belize

**Cent Farm Annual Total Rainfall**



# Rainfall in Belize

**PGIA Annual Total Rainfall**



# Rainfall Intensity

- IPCC AR4 notes increases in heavy precipitation events around the world even where there has been a reduction in total annual precipitation.
- Belize
  - Increase in daily precipitation
  - Increase in 5-day totals
  - Increase in number of very wet days
  - Floods in November 1995, October 2000, June 2002, January 2006, August 2007, May to June 2008, and October 2008

# Droughts

- IPCC AR4 notes more intense and longer droughts have been observed globally
- Belize:
  - More consecutive dry days and less consecutive wet days
  - Two major droughts in 1975 and 2004-2005

# Guyana

- Temp increase of 1°C from 1909 to 1998
- Sea level rise is 5 times greater than global avg.
  - 10.2 mm per year from 1951-1979
- Rainfall patterns abnormal
  - More intense rainfall and longer dry spells



**Loss of Biodiversity**

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Branching coral



Brain coral



**Coral bleaching events have increased**

# Forestry in Belize

- 1999-2000
- Pine bark beetle infestation
- 75% of pine forest destroyed
- High temperatures & high humidity
- Poor management
- Climate change signal?
- Impacts on timber industry and biodiversity
- Contributes to emissions
- Increased erosion – poor water quality (rivers and sea)

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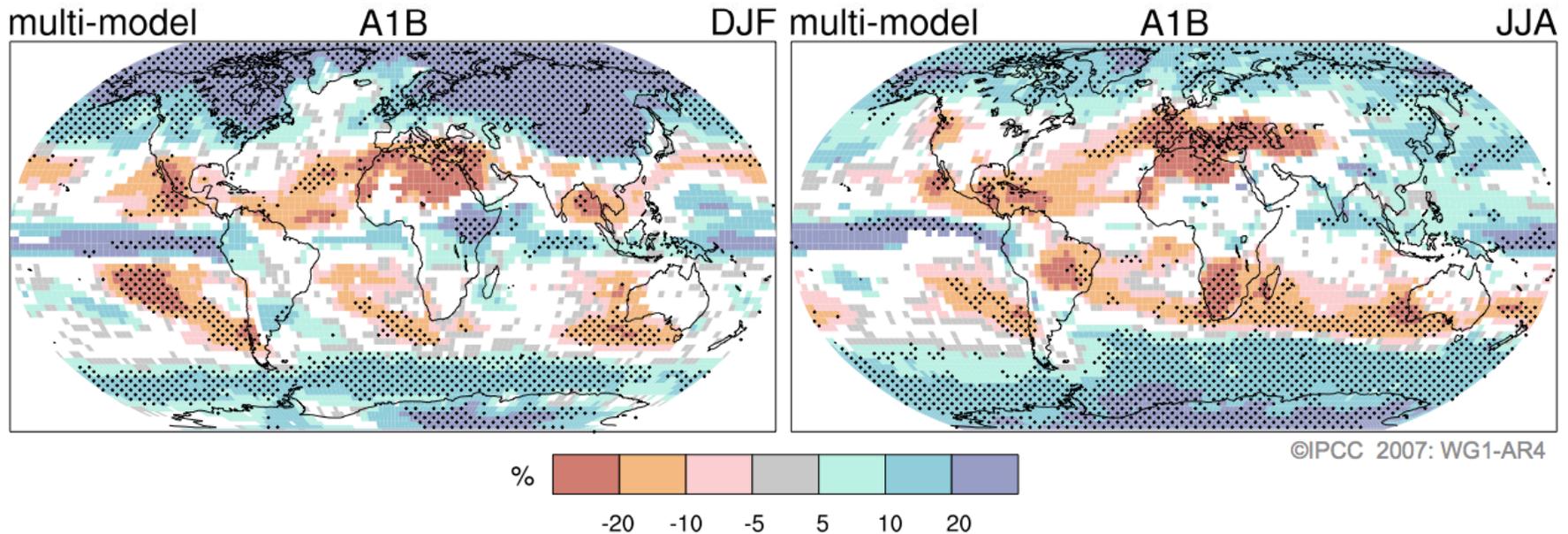
# Vulnerability Study on Health in Belize

- 2008
- Dr. Errol Vanzie, Former Director of Health Services
- Dengue
- Country highly vulnerable to outbreak of dengue
- Study interrupted to advise Ministry of Health to issue dengue alert in four villages
  - Emergency averted as a result of remedial measures

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# Projections of Future Changes in Climate

## Projected Patterns of Precipitation Changes

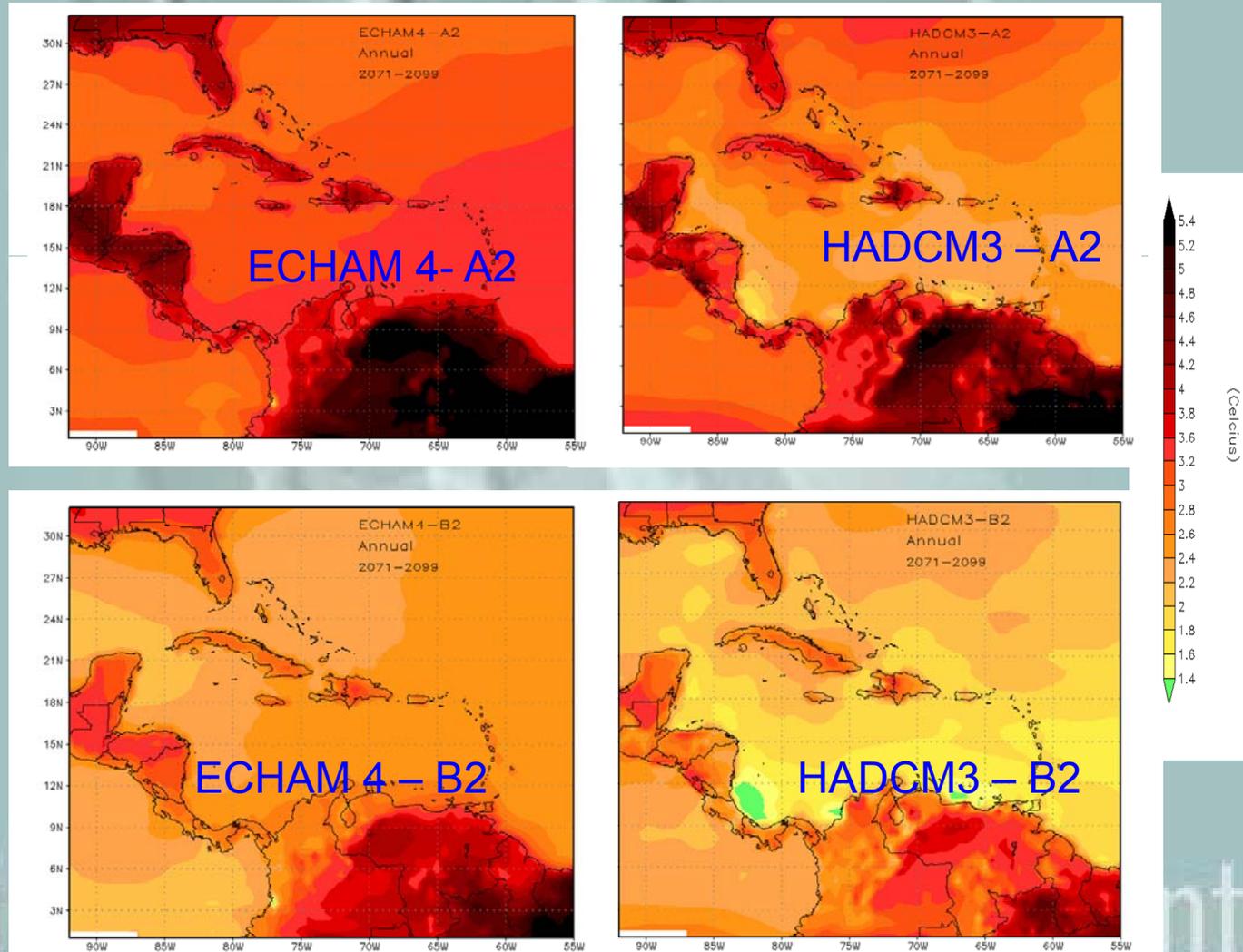


Precipitation **increases** *very likely* in high latitudes

**Decreases** *likely* in most subtropical land regions

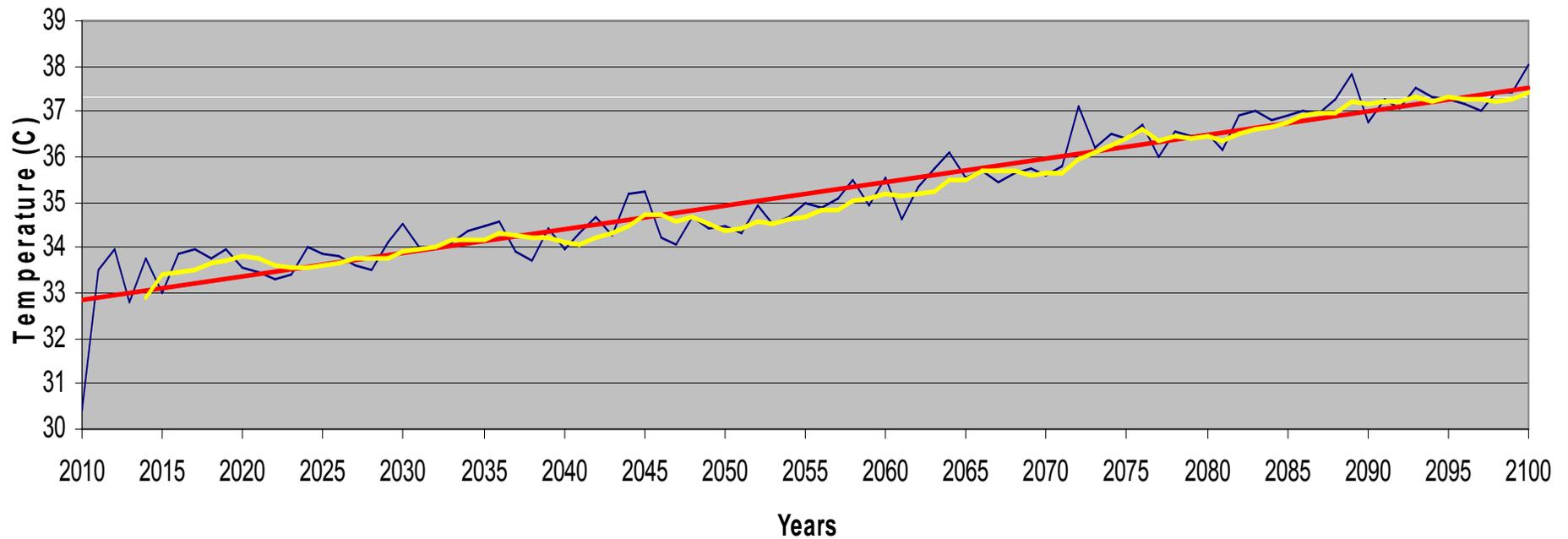
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# Mean changes in the annual surface temperature for 2071-2099 period



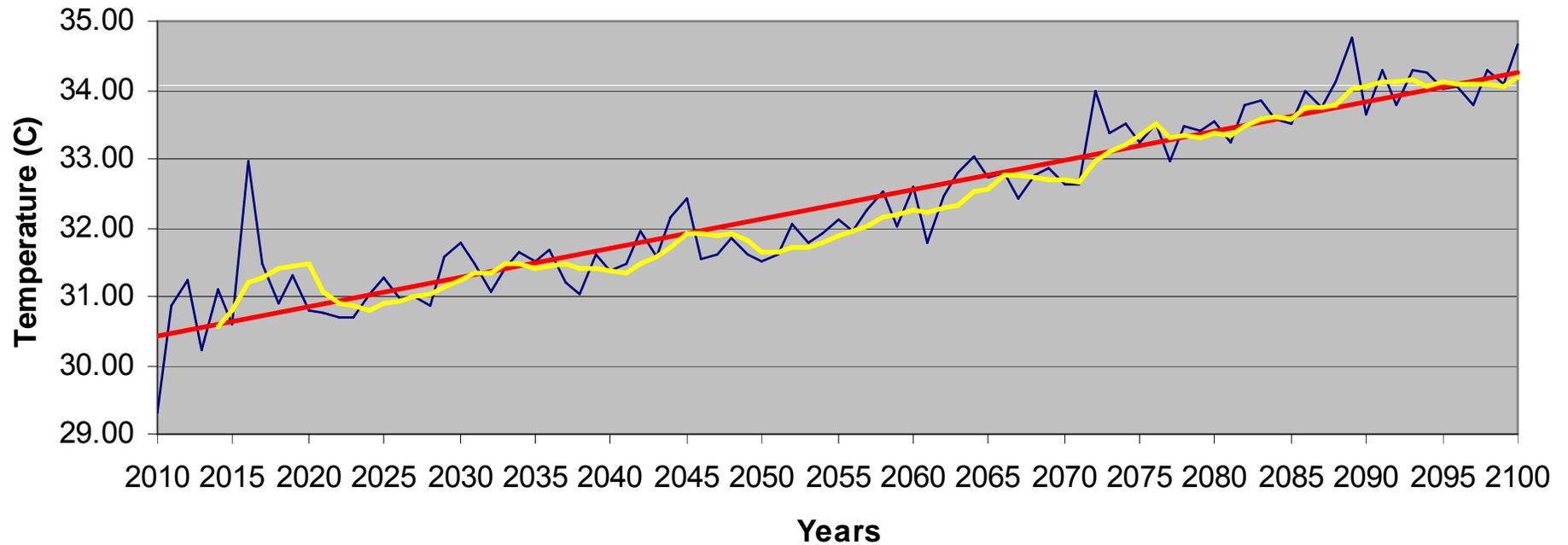
# Central Farm Scenario

Temperature Projections (Cent Farm)



# International Airport Scenario

**PGIA Average Yearly Temperature Projecton**

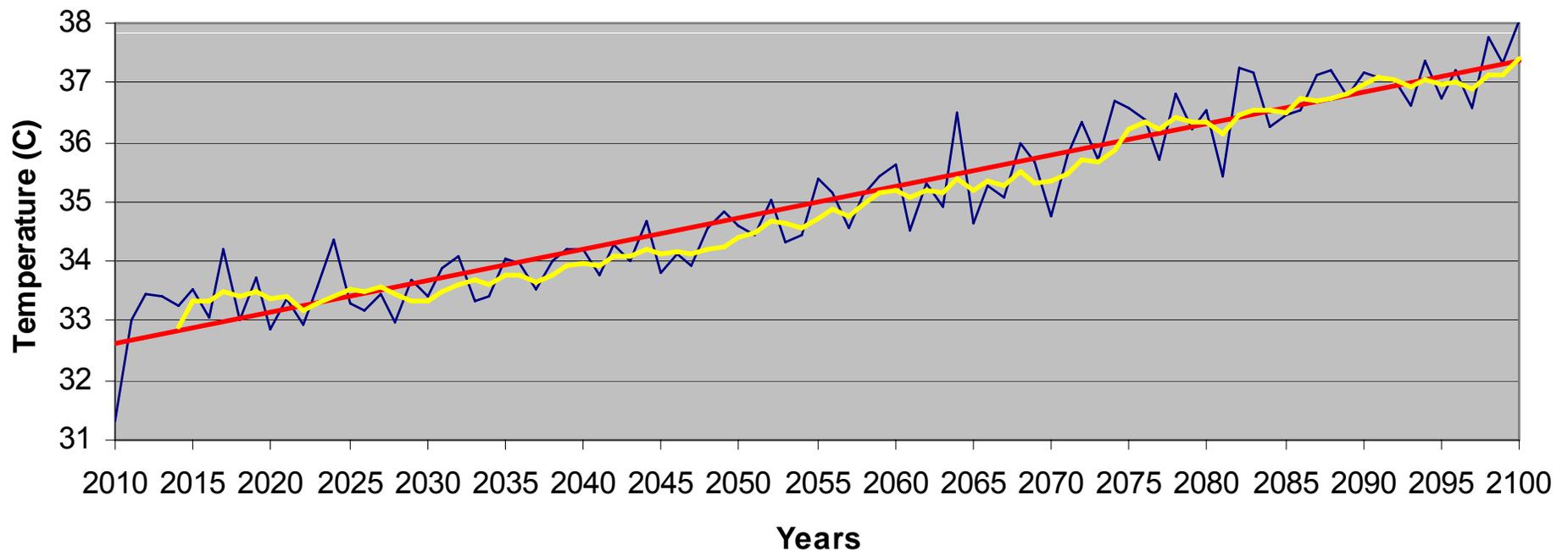


# Scenarios

- In coastal Belize temperatures projected to rise by  $0.83^{\circ}\text{C}$  by 2020,  $2^{\circ}\text{C}$  by 2050 and  $3.11^{\circ}\text{C}$  by 2100.
- In the interior, temperature rise will be  $1.72^{\circ}\text{C}$  by 2020,  $3.23^{\circ}\text{C}$  by
- Rise in temperature will not be uniform throughout the year or during the century.
  - Moderate warming during the winter months along the coast during this decade.
  - This will more than double during the dry season and the first part of the rainy season
  - Will more than triple during the last quarter of the year.
  - By the 2050s the rise in temperature will still be greater during the later part of the year but the increase will be closer to  $0.16^{\circ}\text{C}$  per quarter. This gap is further lowered by the end of the year.

# Central Farm Scenario (Sep – Nov)

**Cent Farm Average Temperature Projections (SON)**



# Temperature rise not Uniform

- In the interior the rise in temperature during the dry season will not be as great as the rise during the other three quarters. The greatest rise in temperature will occur during the first and last quarters of the year. The greatest rise in temperature will occur in the interior from September to November when temperatures are projected to rise by 13 degrees Fahrenheit by 2100.

# Guyana projections to 2100

- Temperature rise of 1.2°C – 4.2 °C
- Sea level rise of 0.40 – 0.61 metres
- Drier but more intense rainfall and longer dry spells

# AVVA Vulnerability Analysis

- Entire coastline videotaped and analyzed in 1995
- Sea level rise of 4, 30 and 50 cm.
- Time periods of 25, 50 and 100 yrs.
- Little impact in 25 yrs
- 50-100% of beaches lost in 100 yrs

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# Sea Level Rise

- Erosion
- Coastal flooding
- Inundation
- Saltwater intrusion
- Mangroves
- Tourist destinations
- Human settlements
- Water supply
- Agriculture
- Aquaculture
- Fisheries



# Vulnerability Studies on Agriculture in Belize

- 1995
- DSSAT
- Beans, corn and rice
- 1-2°C rise in temp
- $\pm$  10-20% change in precipitation
- Result: 10-20% decline in yields

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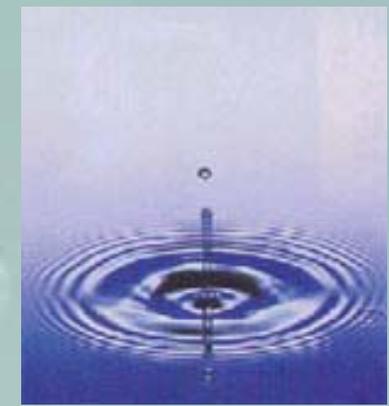
## Impact of 2°C rise on Agriculture

Crop	Temperature Change (°C)	% Change in Precipitation	Yield (kg/ha)	Change in Yield
Rice	0	0	3356	
	+2	+20	3014	-10%
	+2	-20	2888	-14%
Beans	0	0	1354	
	+2	+20	1164	-14%
	+2	-20	1093	-19%
Maize	0	0	4511	
	+2	+20	3737	-22%
	+2	-20	3759	-17%

# Vulnerability Studies on Agriculture in Belize

- 2008
- **PRECIS, DSSAT4 and Cropwat**
- Sugarcane and Citrus
- 2028 & 2050
- 1 & 2.5°C rise in temp
- $\pm$  12 & 20% change in precipitation
- Result: 12-17% decline in yields for sugarcane
- Result: 3 – 5% decline in yields for citrus

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- Water Security:**
- Salt water intrusion
  - Less rainfall
  - More evaporation



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# Water Supply

- San Pedro
  - Desalination plant
- Placencia
  - Piped across lagoon
- Caye Caulker
  - Desalination plant
- Belize City
  - Supply located 17 miles inland
  - During drought in 1995, pumping limited to high tide
  - Salt water intrusion?



## **Fisheries**

### **Threatened:**

**-Loss of habitats  
mangroves, reefs**

**-Species migrate**

**-Water quality changes**



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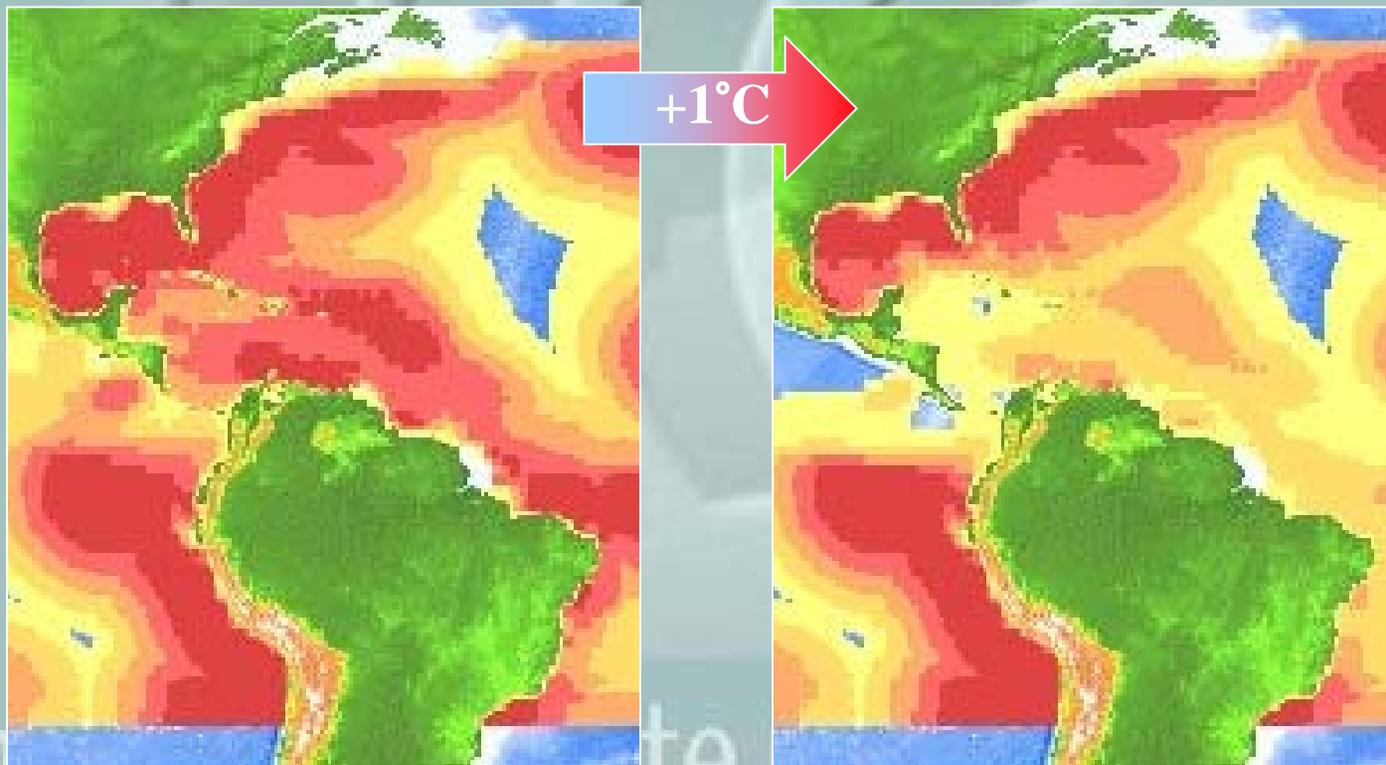
Dolphin fish

*Coryphaena hippurus*

Conséquences du réchauffement sur la biodiversité marine exploitée et impacts sur les pêcheries

**Fabian BLANCHARD**, Chercheur écologue halieute - Institut Française de Recherche pour l'Exploitation de la Mer (IFREMER - Guyane)

Habitat becomes less favourable



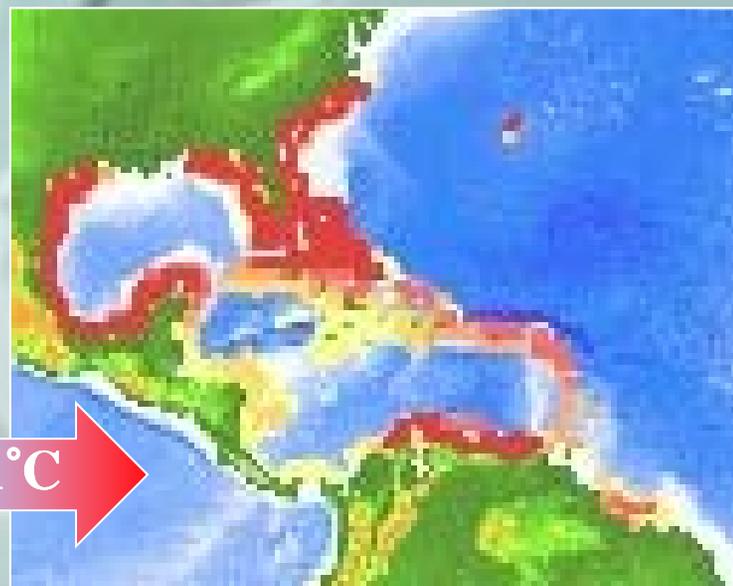
# Yellow tail

*Ocyurus chrysurus*



Conséquences du réchauffement sur la biodiversité marine exploitée et impacts sur les pêcheries  
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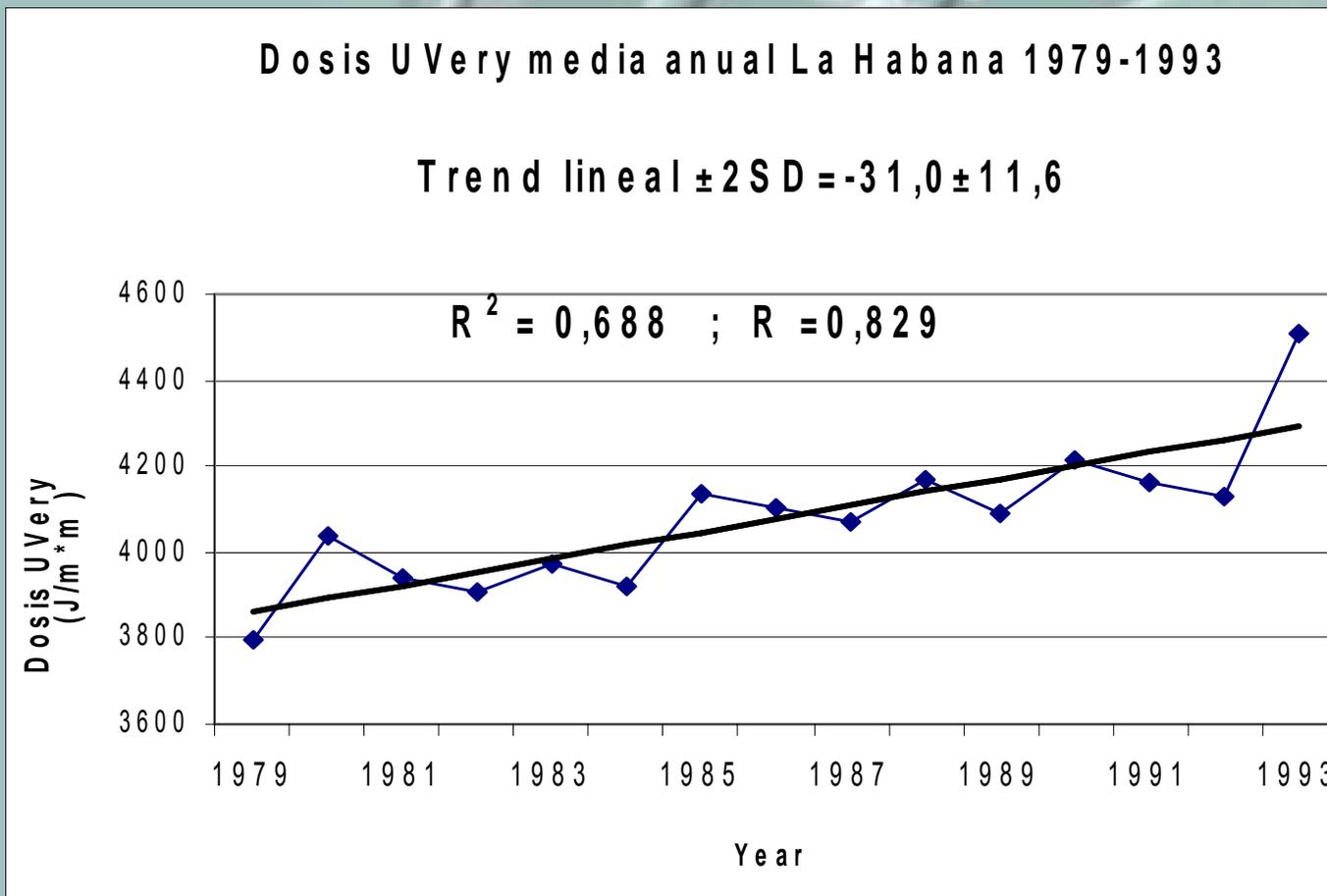
+1°C

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## The high priority diseases identified in the small island states.

- Disease Identified: malaria, dengue, diarrhea disease/typhoid, heat stress, skin diseases, acute respiratory infections, viral hepatitis, varicella (Chicken pox), meningococcal disease and asthma, toxins in fish and malnutrition.
- The possibility of dust-associated diseases with the annual atmospheric transport of African dust across the Atlantic, is unique to the Caribbean islands.
- In addition to weather and climate factors, social aspects such as culture and traditions are important in disease prevalence.

# Variability and trend of average yearly UV incidence due to cloud cover and total ozone changes in Havana during the period 1979-1993



Average annual UV increased significantly in agreement with the trend of decrease in cloud cover. This results are consistent with the observed trends by satellite in the region during 1979-1998

# Threats to Belize

- Population: 320,000
- Growth: 2.8% per annum
- Mean Scenario: Population will double in 27 yrs
- Projection: 1 million by 2100
- Population density would increase from 8.2/km to 41/km
- Population retreat from coast (sea level rise)
- Compete with agriculture

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# Threats to Belize

- Food security threatened: mainland and marine
- More marginal land used for agriculture
- Water security compromised
- Competing users for water resources: hydropower, agriculture, municipal, tourism, navigation
- Migration from other countries facing worse conditions
- Health risks increase

## Contact Information

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