

ICT IN CLIMATE CHANGE RESEARCH

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- ⊙ What is Climate Change?
 - ⊙ What is Climate & Climate Change
 - ⊙ How is Climate Change investigated
- ⊙ Some ICT Requirements in Climate Change Research
 - ⊙ ICT as seen in Climate Research
 - ⊙ Global Example
 - ⊙ Regional/Local Example

WHAT IS CLIMATE & CLIMATE CHANGE

⊙ **Climate**

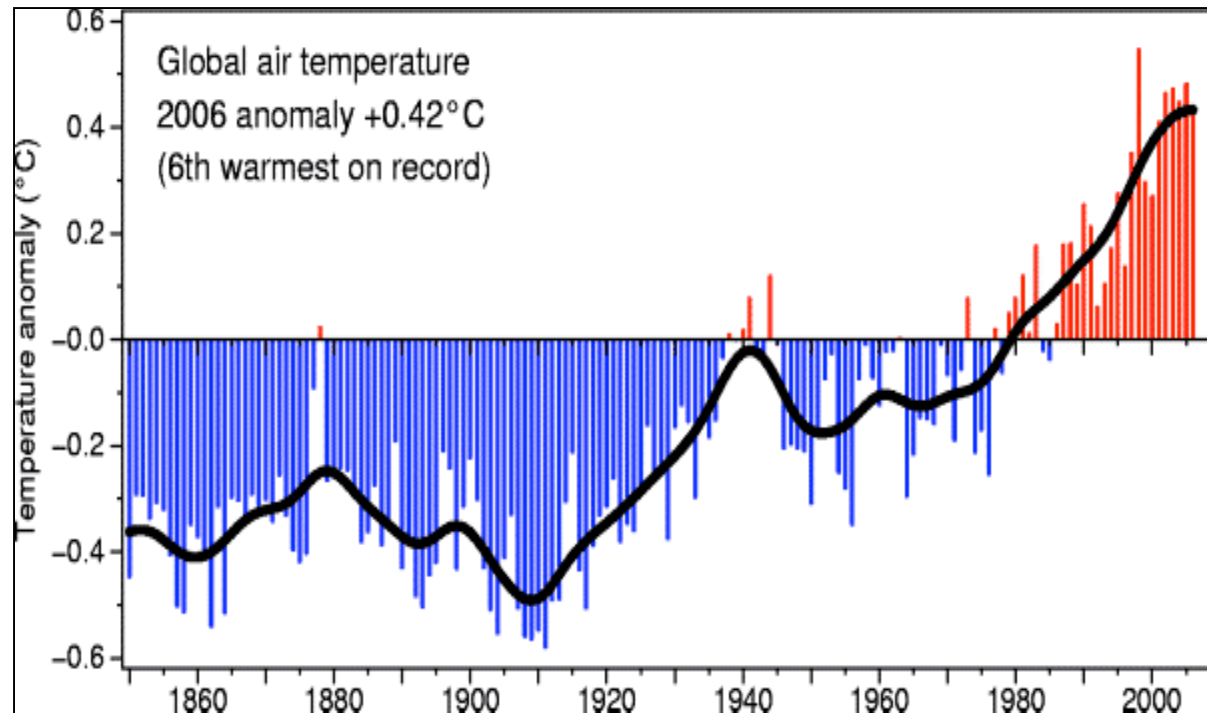
- ⊙ Commonly defined as the “average weather” with a classical period of 30 years (WMO).
- ⊙ Statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years.

⊙ **Climate Change**

- ⊙ Term used to describe a significant change from one climatic condition to another. The changes may be due to natural or anthropogenic forcings.

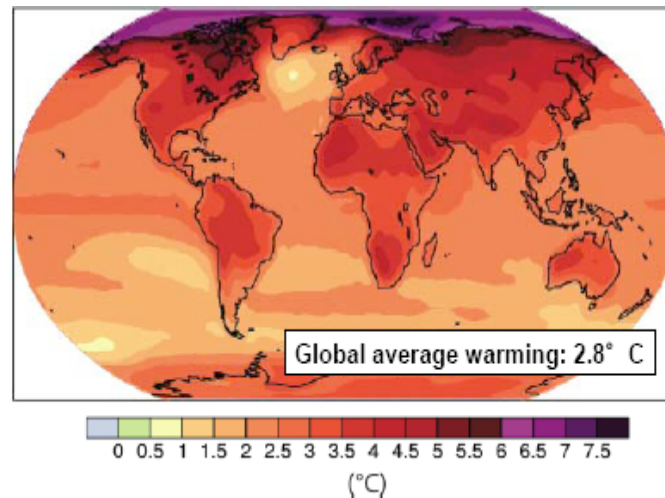
WHAT IS CLIMATE & CLIMATE CHANGE

🕒 Climate Change – up until now



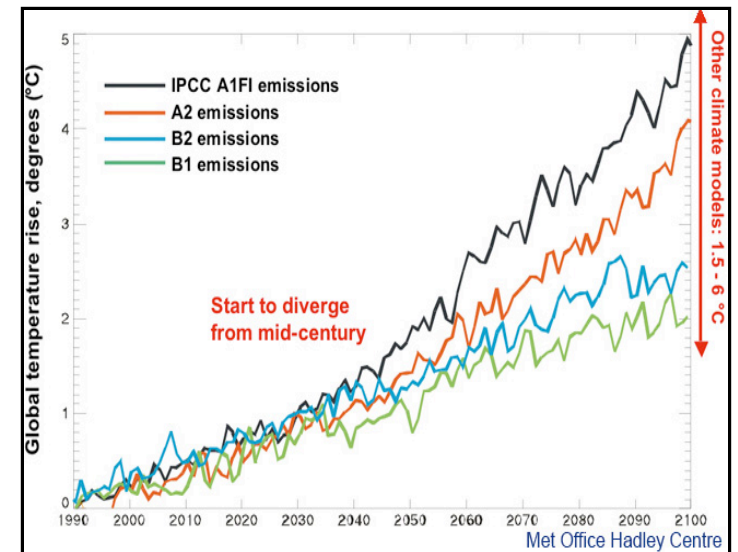
WHAT IS CLIMATE & CLIMATE CHANGE

🎯 Climate Change – by century's end



But how do we know?

2 – 5 degrees warmer



INVESTIGATING CLIMATE CHANGE

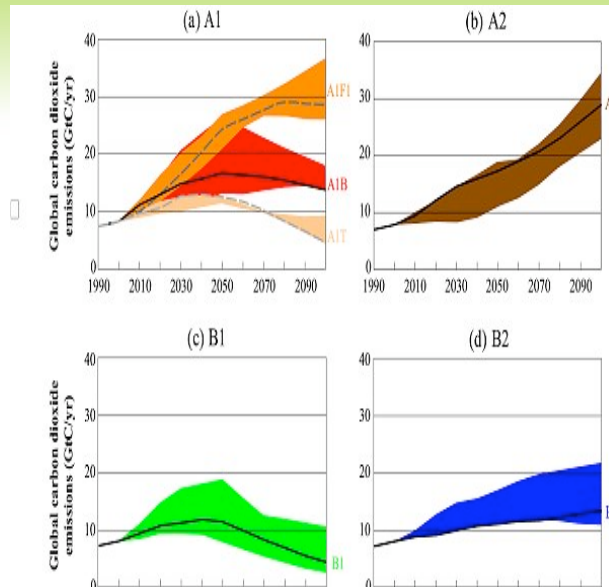
⊙ **Climate Model**

- ⊙ A set of specialized thermo-hydrodynamic equations with usually prescribed boundary and initial conditions and specified schemes of parameterization
- ⊙ Computer model – Simply

⊙ **Types**

- ⊙ General Circulation Models – GCM's
- ⊙ Regional Climate Models – RCM's

INVESTIGATING CLIMATE CHANGE



Total global annual CO₂ emissions from all sources (energy, industry, and land-use change) from 1990 to 2100 (in gigatonnes of carbon (GtC/yr) for the families and six SRES scenario groups (Nakicenovic et al., 2000).

☉ Climate Scenarios

- ☉ It is a reference to a plausible future climate that has been constructed for explicit use in investigating the potential consequences of anthropogenic and natural climate changes
- ☉ There are different types – Our focus Special Report on Emissions Scenarios (SRES)

ICT - AS SEEN IN CLIMATE RESEARCH

- ◎ ICT - *A generalized definition as used in the study of climate*
- ◎ all technologies used in the manipulation and or communication of information
- ◎ ICT is not limited to Information Communication Technology but also entails any:
 - Medium that records information - magnetic tape, optical disks , etc
 - Technology to broadcast information - radio, television, etc
 - Computing hardware - Desktops, Servers, etc
 - A wide range of application software

ICT & CLIMATE CHANGE RESEARCH

⊙ **Data**

- ⊙ Self Generation from Models
- ⊙ Digital Libraries
- ⊙ Access & Dissemination - Online / External Source

⊙ **Modelling**

- ⊙ Model Design - Programming, Efficiency, etc ..
- ⊙ Modelling Environment - Robustness, Cost, UI, etc ..
- ⊙ Specialized Software – Visualization, Analysis, etc..

ICT & CLIMATE CHANGE RESEARCH

- ⊙ **Communication**
 - ⊙ Access & Dissemination of Results - Online / External Source
 - ⊙ Decision Management Tools
 - Example – Early Warning Systems
 - ⊙ End User Format for ease of use

ICT & CLIMATE CHANGE- GCM EXAMPLE

⊙ **Data**

- ⊙ Produces climate data for the entire globe.
- ⊙ Peta-Bytes (PB's) of Data produced Monthly or Daily

⊙ **Modelling**

- ⊙ Requires a Supercomputer
- ⊙ Example – Japan's Meteorological Agency (JMA) MRI Global Model
 - ⊙ Ran on Earth Simulator
 - ⊙ 640 Processor Node
 - ⊙ Terra-flops in Processor Speed

⊙ **Communication**

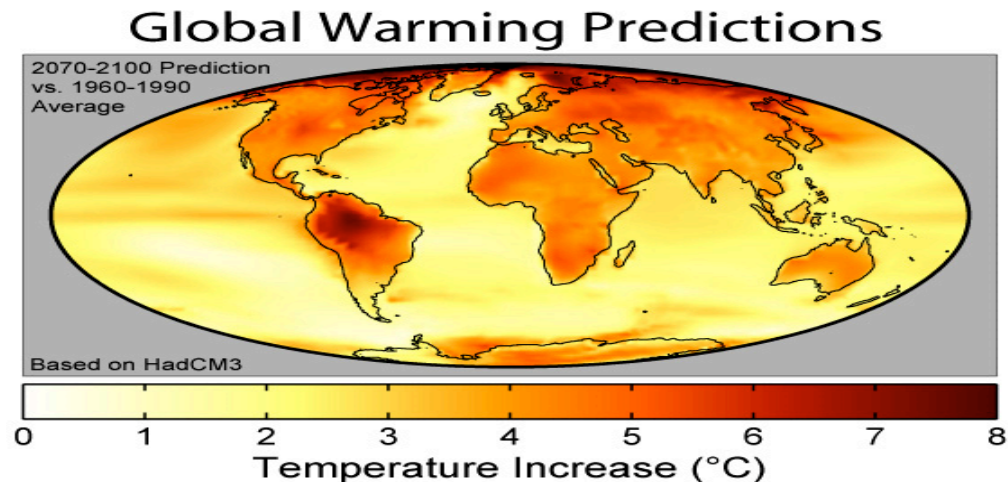
- ⊙ Data are freely available for download and analysis

ICT & CLIMATE CHANGE- GCM EXAMPLE

- ⊙ Challenges – Data & Communication
 - ⊙ Moving TBs of data across a 10 MB shared connection
 - ⊙ Storing vast amount of data generated
 - ⊙ Analyzing large datasets

CLIMATE MODELS - GCM

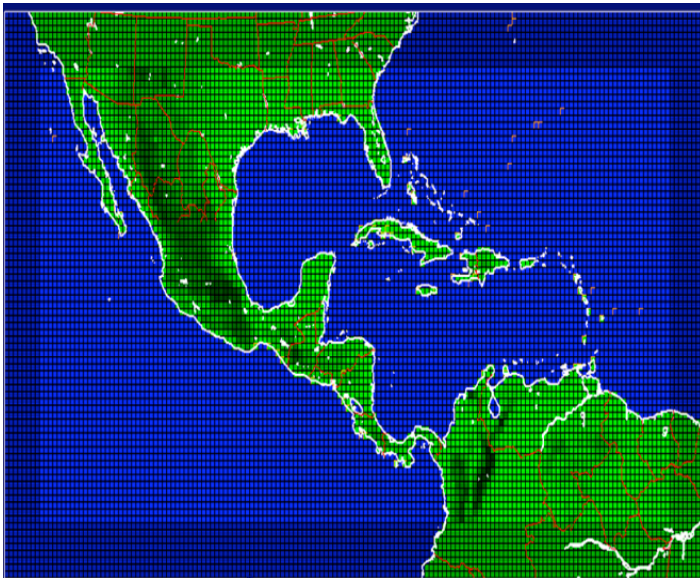
- ⊙ Challenges - Modelling
 - ⊙ Complex and Computationally expensive
 - ⊙ Resolution too coarse in detail to accurately capture the small island states of the region



Can you identify any islands of the eastern Caribbean?

ICT & CLIMATE CHANGE- RCM EXAMPLE

- Several available
- P.R.E.C.I.S – *Used in the Caribbean*
 - Providing **RE**gional **C**limates for **I**mpacts **S**tudies
 - Dynamical Downscaling Model – RCM
 - Driven by the HADAM3P GCM and can be forced at its boundaries by other GCM's
 - Has a resolution of up to 25km
 - Built by UK Hadley Centre but run locally
 - Can be used for any part of the Globe



ICT & CLIMATE CHANGE- RCM EXAMPLE

⊙ Data

- ⊙ Generates Gigabytes of Data (~300 GB per scenario)
- ⊙ Boundary Data (~200GB)
- ⊙ Data Storage
 - ~500GB was required to store converted data in a format that it could be analyzed - this was per Scenario
 - Each had to be backed up of Tape Drives

ICT & CLIMATE CHANGE- RCM EXAMPLE

- ⊙ Modelling
 - ⊙ Complex but computationally less expensive
 - ⊙ Requires a Desktop
 - **PRECIS** Work done at UWI Mona, Jamaica, in collaboration with UWI Cave Hill, Barbados, INSMET Cuba and 5 C's in Belize.
 - ⊙ Standard Desktop
 - ⊙ Pentium 4 Processor
- ⊙ Produces High Resolutions Data for the Region (Never available previously)

ICT & CLIMATE CHANGE- RCM EXAMPLE

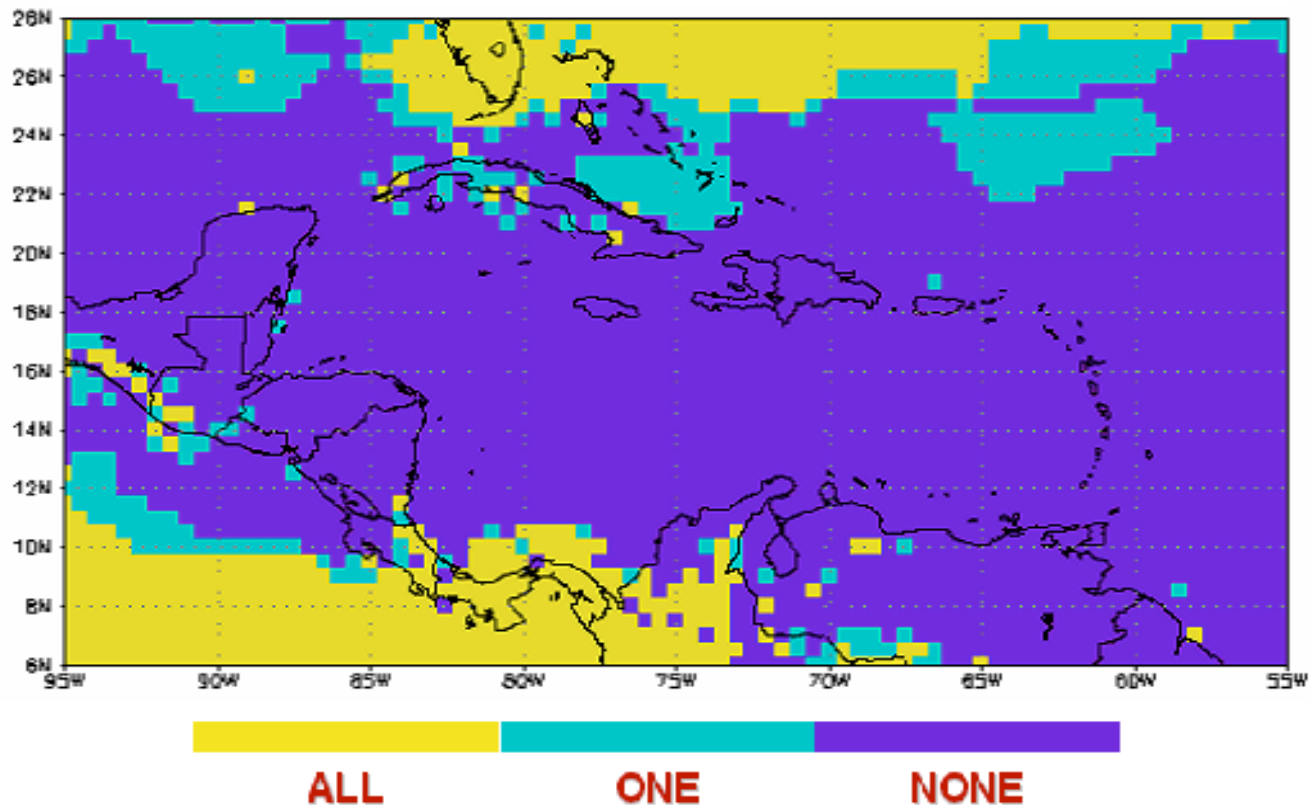
- ◎ The Specialized Computer Software
 - ◎ PRECIS – freely available
 - ◎ Other Analysis Tools – freely Available

ICT & CLIMATE CHANGE- RCM EXAMPLE

- ⊙ How were PRECIS Experiments were conducted
 - ⊙ Jamaica, Barbados & Cuba – 3 Stand-a-lone experiments each(average or 6 to 8 months to complete)
 - ⊙ Belize learning from above – Parallel processing,
(halved the run time) but required more computers (~20)

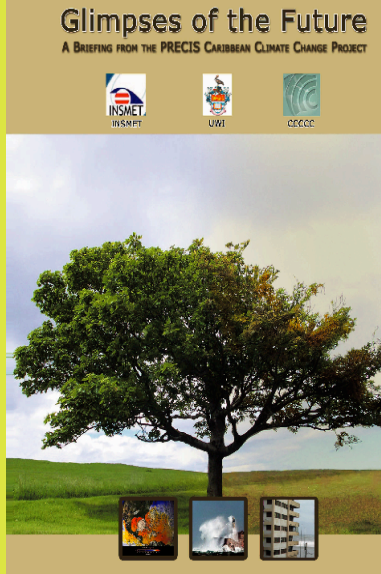
ICT & CLIMATE CHANGE- RCM EXAMPLE

Annual precipitation consensus diagram



No experiments project an overall increase in precipitation for the Caribbean Basin by 2080's

ICT & CLIMATE CHANGE- RCM EXAMPLE



Communication

- ⊙ Written Publications
 - **Glimpses of the Future** : *A Briefing from the PRECIS Caribbean Climate Change Project.*
- ⊙ Online Data Access – publicly available @ <http://precis.insmet.cu/eng/datos.html>
- ⊙ Challenges
 - ⊙ Of 12 – 15 Scenarios only 4 have been done
 - Data Storage an obvious limitation

PRECIS PROJECT - ICT REQUIREMENTS

- ⊙ Challenges for completion of PRECIS Project
 - ⊙ **Data & Communication**
 - ⊙ 40 TB of Storage
 - ⊙ RAID Array
 - ⊙ Multiple/Simultaneous connections
 - ⊙ Fire-wire or Greater Speeds
 - ⊙ 100 MB or greater internet connection
 - ⊙ Download Observed Data available online
 - ⊙ Virtual Network with Cuba, Barbados and Others
 - ⊙ **Modelling**
 - ⊙ At least 25 Computers – Duo Core or Greater
 - ⊙ Other RCMS

FINAL THOUGHTS

- ⊙ Strong ICT considerations in climate change research
- ⊙ How further developments in ICT will impact climate change research, especially in the Caribbean :
 - ⊙ Build Capacity
 - Modelling Capabilities to answer regional science questions
 - ⊙ Facilitate/ Enhance Collaborative ventures
 - PRECIS Project Model - multi-country simulations to address common problem
 - ⊙ Facilitate / Enhance Data & Results Dissemination
 - Key for the development of decision making tools for the perceived impacts of climate change