The Caribbean Modelling Initiative

- Why?
- CMI Genesis
- Some Results
- Legacy
- Lessons

Michael A. Taylor
Climate Studies Group, Mona
Department of Physics
University of the West Indies, Mona

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Why?

1. The Caribbean has an inherent climate sensitivity…

Location gives rise to distinct dry and wet seasons around which live has evolved and revolves. E.g. Planting seasons, holidays, disease cycles, recreation

Size and topography: E.g. Hilly backbone, limited landspace, infrastructure few miles from coast.

Economic activity and water resources strongly depndent on climate. E.g. Tourism, agriculture, fishing

Why?

2. The Caribbean therefore has 'built in' vulnerability…

Changes in climate (short term or long term) can and do alter Caribbean existence.

Droughts and floods; Hurricanes; Hot days, nights, Long term climate change etc.

Because sensitivity pervades all areas of Caribbean existence, **Impact of climatic changes similarly felt throughout all areas of Caribbean life directly or indirectly:**

Agriculture, Health, Water,Tourism, Disaster Management/Infrastructure, Sport, Finance

Why?

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2. The Caribbean therefore has 'built in' vulnerability…

Event	Year	Country	(Millions of US Dollars)		
			Housing	Education	Agriculture
Hurricane Luis	1995		7.57	0.52	2.90
Hurricane Luis & Marilyn	1995	St. Kitts &	10.00	12.00	35.00
Hurricane Keith	2000		34.30	1.51	124.40
Floods and Landslides	2001		4.80	0.44	11.52
Hurricane Ivan	2004		517.22	73.40	37.60
Hurricane Ivan	2004		180.06	13.01	138.04
Hurricane Frances & Jeanne	2004		71.90	21.82	45.00
Earthquake and Landslide	2004		2.20	3.50	21.00
Hurricane Emily	2005		51.90	4.44	13.30
Floods	2005		275.60	1.90	54.50
Floods	2006		0.40	0.00	22.10
		Total	**1,155.95**	**132.54**	**505.36**

Source: CDERA. OECS; UN/ECLAC
Note: Jamaica 2001 Flood Rains and Landslides were in association with Hurricane Michelle
2006 Flood damage cost to Education Sector was approximately US$5.3(Thousands)

Why?

3. Recognition of need to build climate resilient societies…

Early 2000s : Clear Mandate to Caribbean science community.

Climatic information that enables planning.

(1) At Scale
(2) Long Term Change

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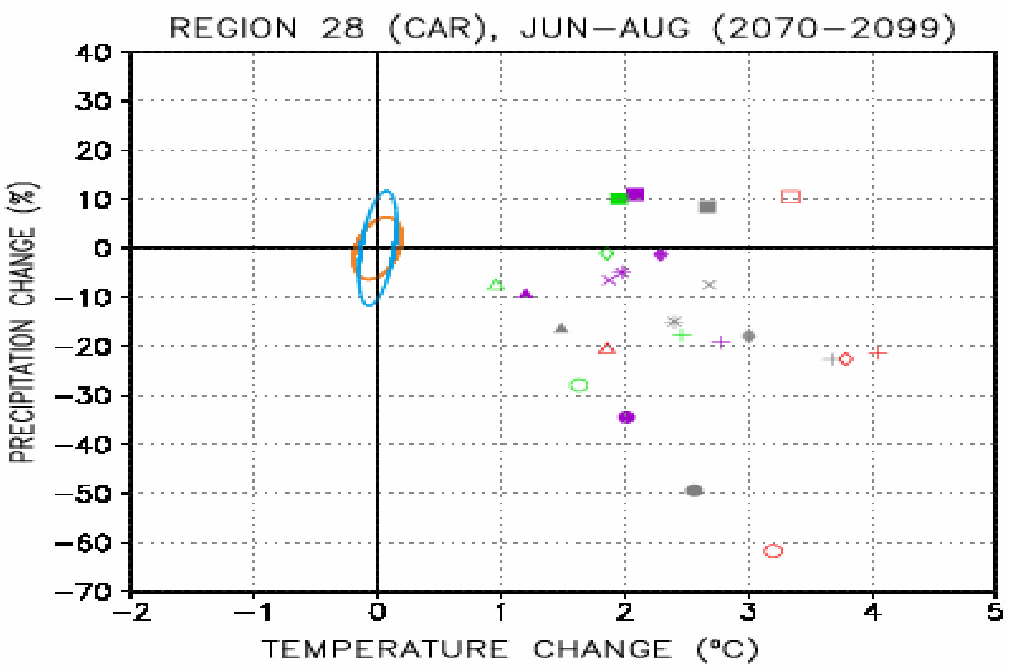
Info existed on future climate for Caribbean from GCMs….

…but scale too coarse!



Model-simulated temperature/ precipitation response to forcing scenario. Scenario is depicted by colour of the point (A1FI - red, A2 - grey, B1 - green and B2 - violet). Ovals show 95% Gaussian contour ellipses of the natural internal tridecadal variability.

Caribbean Modelling Initiative (CMI)

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Some Results
Legacy
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In 2003 a group of Caribbean climate scientists got together in Havana Cuba.

- Gathering facilitated by a World Bank sponsored Caribbean project: MACC
- **4 Countries**: Jamaica, Cuba, Barbados, Belize
- **4 Institutions**: University of the West Indies (UWI-Cave Hill), University of the West Indies (UWI-Mona), Instituto de Meteorologia (INSMET), Caribbean Community Ckimate Change Centre (CCCCC)
- **Adaptation efforts must be premised on climate change projections <u>for</u> the Caribbean <u>at the scale of</u> the Caribbean.**

Caribbean Modelling Initiative

In 2003 a group of Caribbean climate scientists got together in Havana Cuba.

•Deliberate collaborative effort to produce quickly Caribbean climate projections at scale of Caribbean.

• Premised on shared workload to get results out quickly.

• Premised on building of capacity in the region.

•Multiple components to the strategy, but concentrate on a major one.

Caribbean Modelling Initiative

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Chose a MODEL

PRECIS - Providing **RE**gional **C**limates for **I**mpact **S**tudies
- Hadley Centre, UK

- Dynamical Downscaling Model (RCM)
- Can be used for any part of the Globe
- Has a resolution of up to 25km
- Driven by full suite of physics
- Multiple variables on multiple levels in atmosphere.
- Forced at its boundaries by other GCMs - the HADAM3P GCM and ECHAM.
- Built by UK Hadley Centre but run locally

PRECIS Modelling

- Complex but computationally less expensive than a GCM.
- Requires a Desktop Standard Desktop Pentium 4 Processor
- Could be run locally

Caribbean Modelling Initiative

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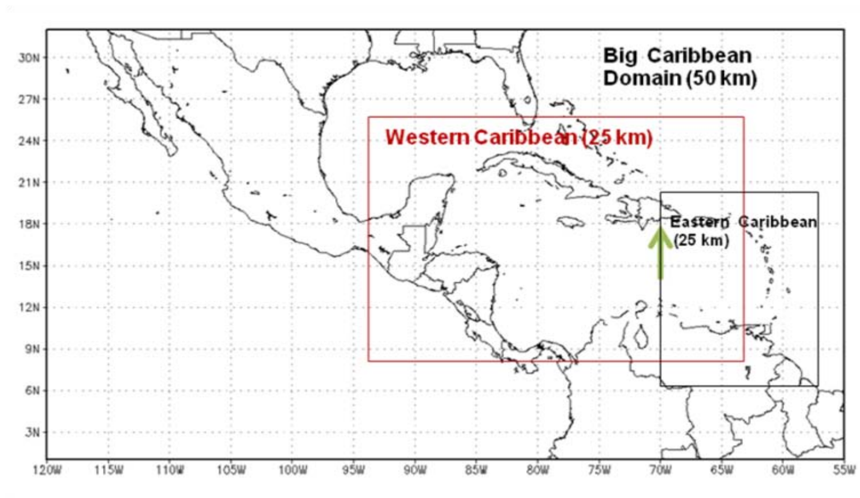
Chose a DOMAIN

• Big Domain including all Caribbean, Central America, southern USA and northern South America. Run at 50 km

•Two smaller domains:
- •Western Caribbean at 50 km
- •Eastern Caribbean at 25 km



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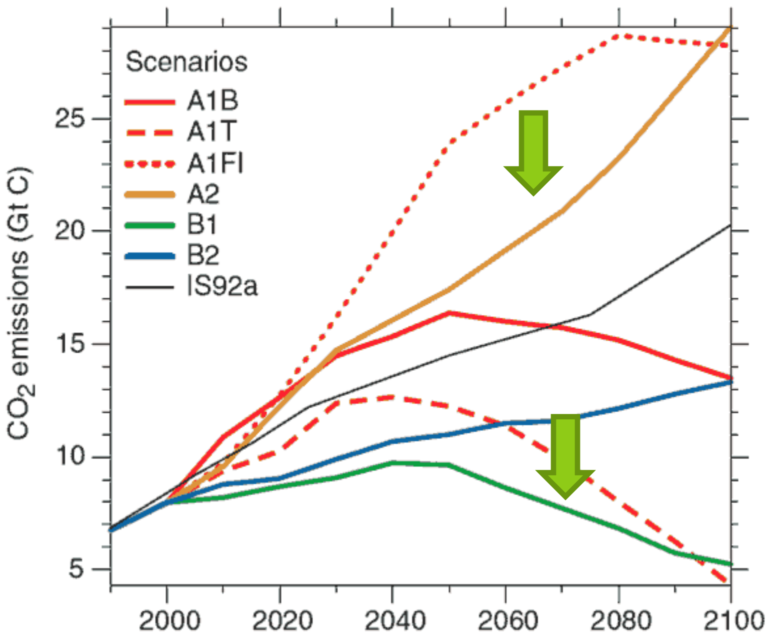
Chose SCENARIOS

•IPCC Special Report on Emissions Scenarios i.e. SRES scenarios.

•Scenarios are storylines of future development. Divided into families (A,B) which emphasize different pathways of development.

•Associated with scenarios are CO_2 concentrations

•A2 (high emissions) and B2 (low emissions)



Caribbean Modelling Initiative

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Chose Methodology - Divided up the runs

- Considered capacity – manpower, technical, time
- Considered available computing power, some help in acquiring computers.
- Considered interest

Cuba (INSMET)	Carib basin 50 x 50 km	B1 (30 yrs) & A2 (30 yrs) Baseline (30 yrs) Reanalysis (15 yrs)
Jamaica – UWI (Mona)	Carib Basin 50 x 50 km	A2 (30 yrs) & B2 (30 yrs) Baseline (30 yrs)
Barbados – UWI (Cave Hill)	Eastern Caribbean 25 x 25 km	A2 (30 yrs) & B2 (30 yrs) Baseline (30 yrs)
Belize - 5C's	Caribbean and Eastern Caribbean	Multiple runs

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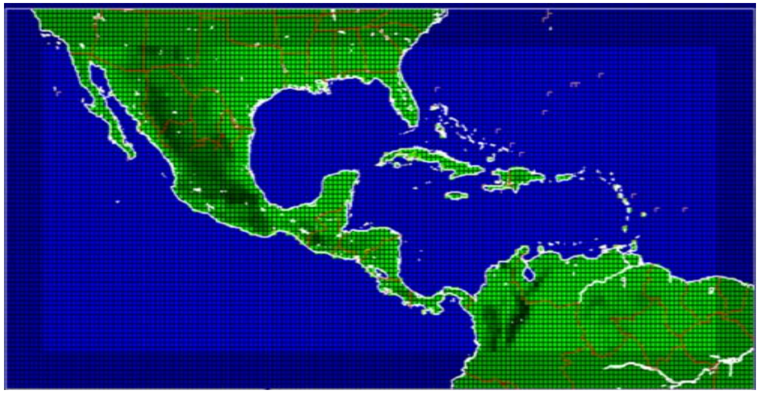
Chose Methodology – Time slice approach

•Simulate historical conditions (e.g. 1970-present)
•Simulate future conditions under scenarios (end of century)
•Determine absolute or percentage change between future and present.



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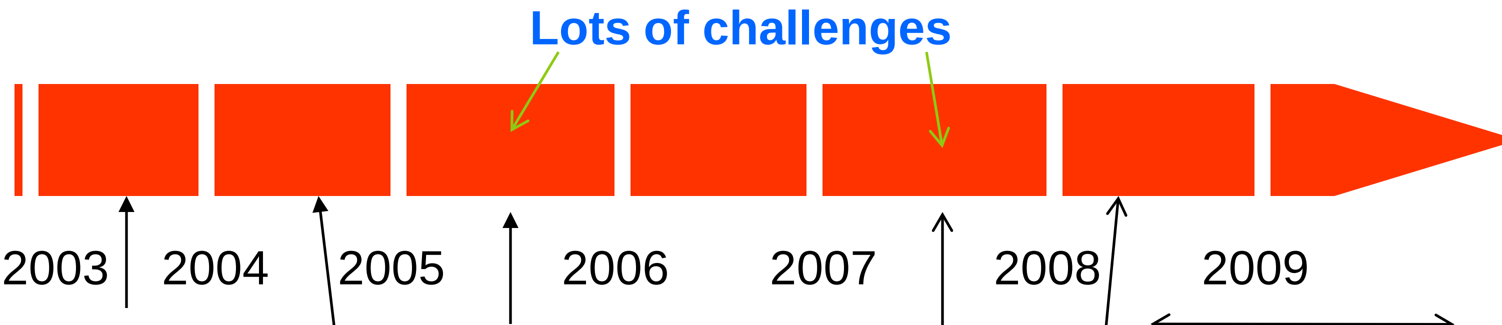
PRECIS Project Timeline



Sept: Initial Cuba meeting

Apr: Runs restarted
Dec: Space limitations noted

Analysis and publications

New runs begun

Sept: Computers purchased.
Oct: Runs initiated
Nov: Start of computer woes

Aug: All initial runs completed. Analysis begun

Caribbean Modelling Initiative

Runs eventually done

No.	Driving conditions		Domain	Resolution	Period
	GHG Scenario	LBCs Data			
1		ERA15	Big Caribbean	50 km	1979-1983
2		ERA40	Big Caribbean	50 km	ongoing
3		HadAM3H	Big Caribbean	50 km	1961-1990
4	SRES A2	HadAM3H	Big Caribbean	50 km	2071-2100
5	SRES B2	HadAM3H	Big Caribbean	50 km	2071-2100
6	SRES A2	ECHAM4	Big Caribbean	50 km	1961-2100
7	SRES B2	ECHAM4	Big Caribbean	50 km	1961-2100
8	SRES A2	ECHAM4	Eastern Caribbean	25 km	1961-2100
9	SRES B2	ECHAM4	Eastern Caribbean	25 km	1961-2100
10	SRES A2	ECHAM4	Western Caribbean	25 km	1961-2100
11	SRES B2	ECHAM4	Western Caribbean	25 km	1961-2100

Value added

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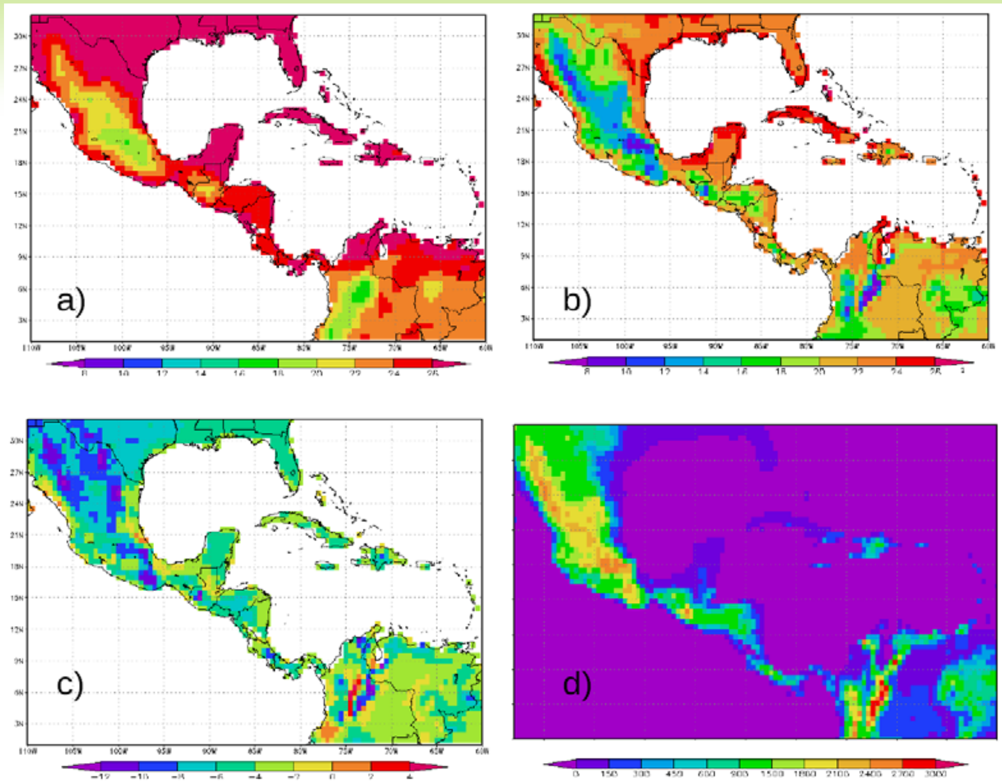

Added value mirrored coastline and topography and coastal gradients.

30-years mean summer 1.5m temperature (^oC) simulated by GCM a) and PRECIS b). Panel c) shown the differences between PRECIS and GCM (PRECIS-GCM) and d) orography height (m) distribution in PRECIS RCM.

Validation

- Why?
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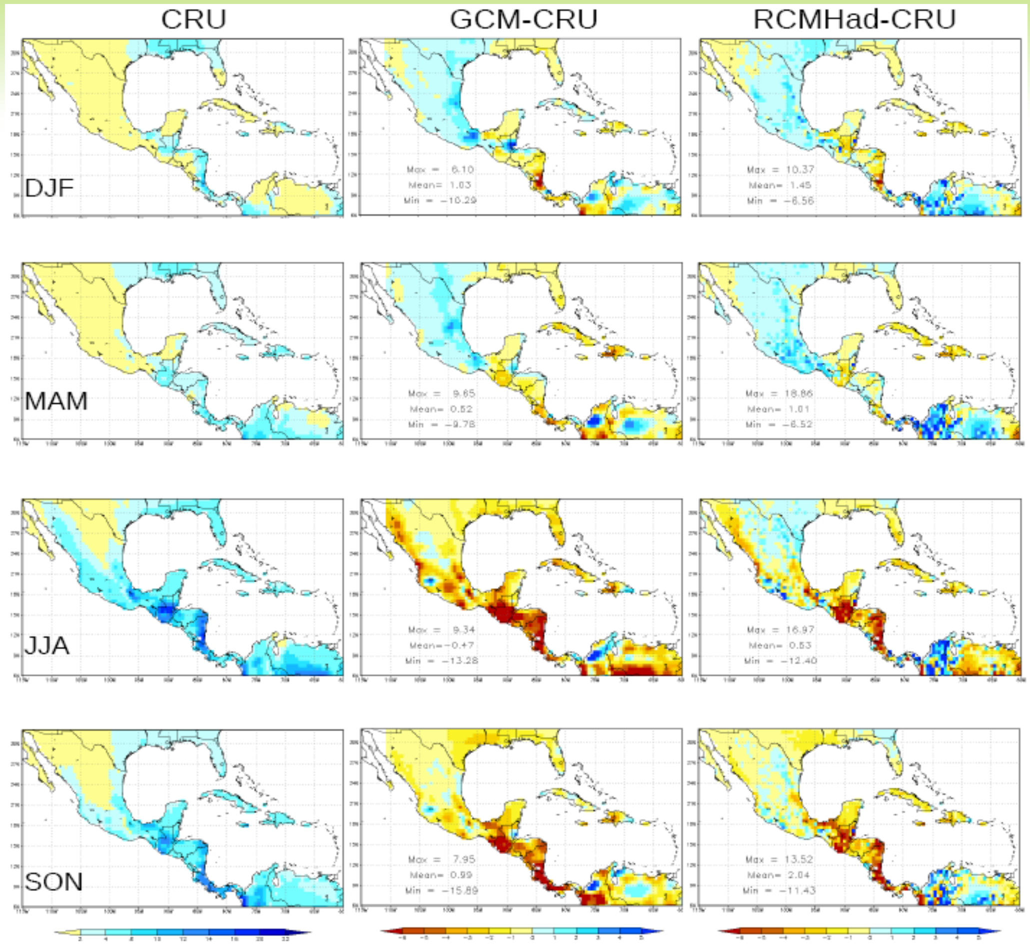

29-years mean seasonal precipitation (mm/days) over land areas. Observed CRU climatology (first column) and the differences between simulations and CRU (second and third columns are GCM, RCM_Had, respectively). Maximum, Mean and Minimum area bias values are indicated in each bias map.

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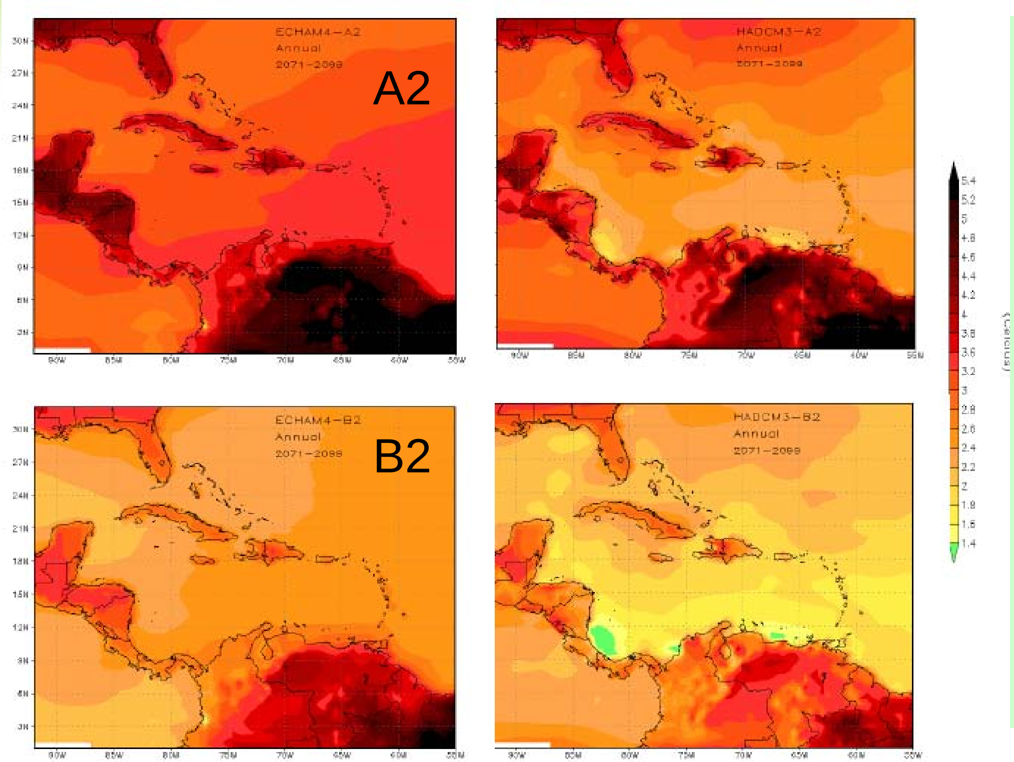
Projections -Temperatures



Irrespective of scenario the Caribbean expected to warm.

Warming between 1 and 5°C

Warming greater under A2 scenario.

Warming consistent with projections for other parts of globe.

Warming far exceeds natural variability

Mean changes in the annual mean surface temperature for 2071-2099 with respect to 1961-1989, as simulated by PRECIS_ECH and PRECIS_Had for SRESA2 and SRESB2.

Projections -Temperatures

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Legacy
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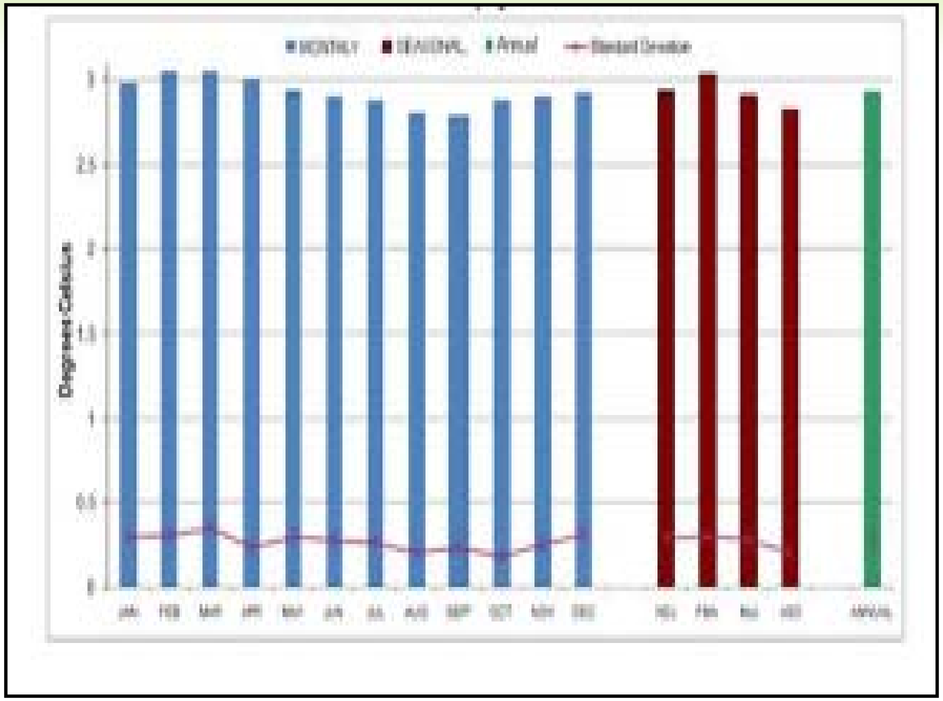

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Projections - Rainfall

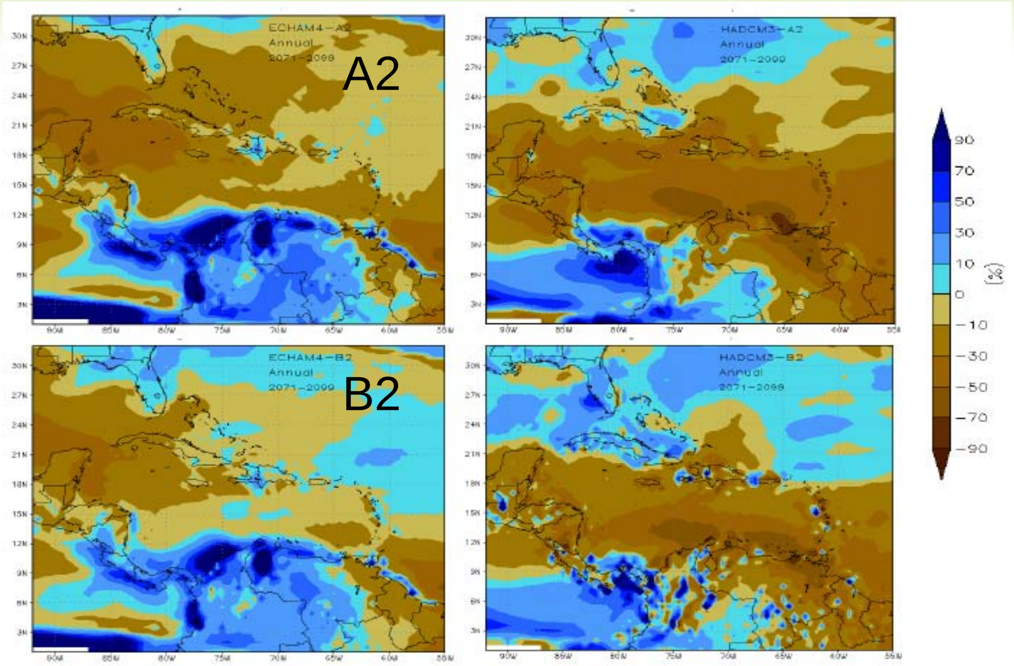
Why?

CMI Genesis

Some results

Legacy

Lessons



General tendency for drying (main Caribbean basin) by end of the century.

Drying between 25% and 30%

Possibly wetter far north Caribbean NDJ and FMA.

Drying exceeds natural variability June-October – wet season dryer!

Mean changes in the annual rainfall for 2071-2099 with respect to 1961-1989, as simulated by PRECIS_ECH and PRECIS_Had for SRESA2 and SRESB2.

Projections- Rainfall

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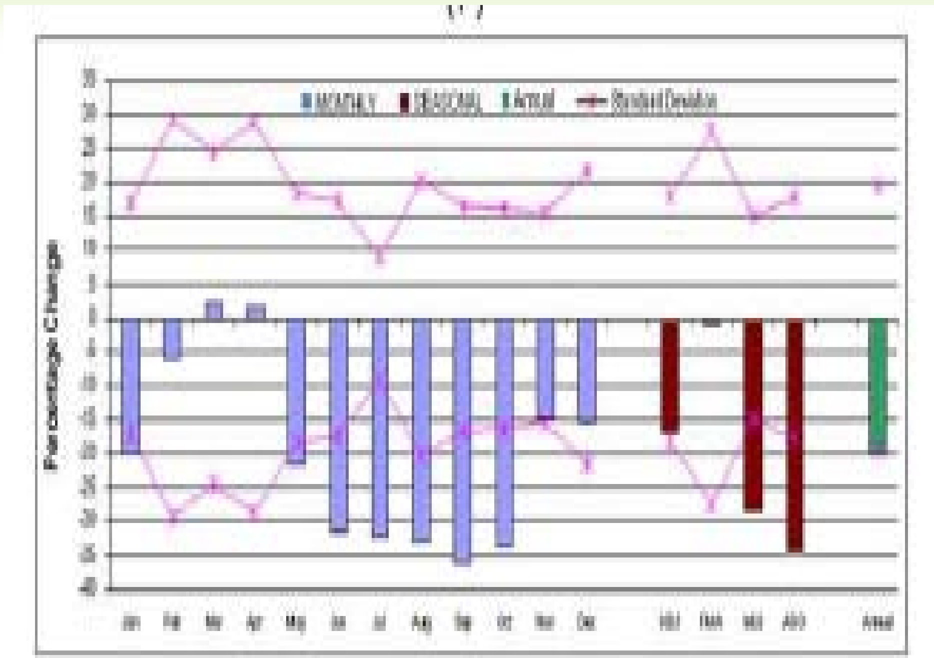

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How certain?

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- Legacy
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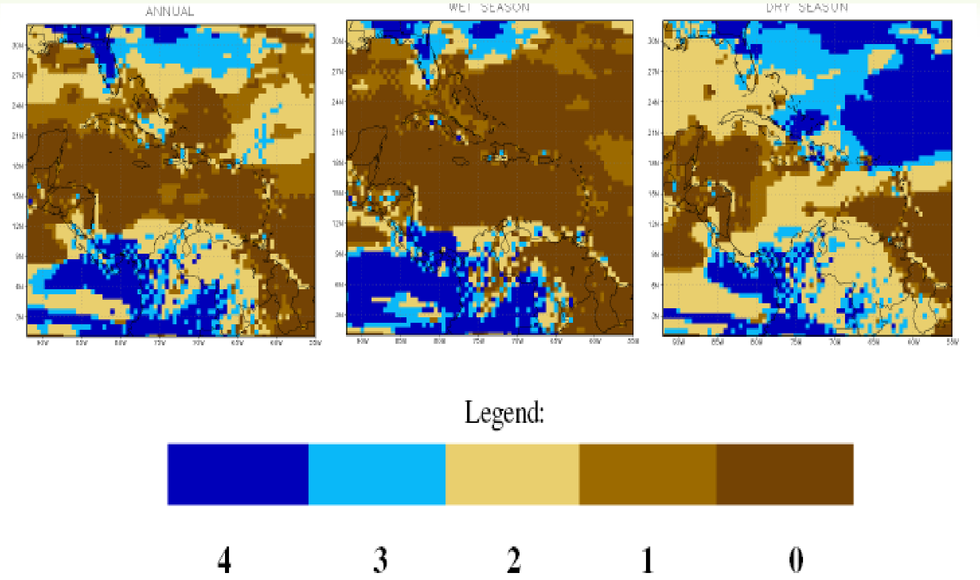


Multiple uncertainties in models

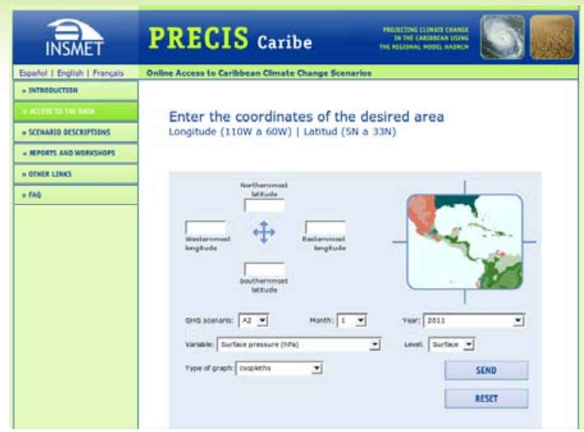
Consensus diagrams useful

In some regions, all scenarios predict drier.

In some regions all simulations predict wetter.

Number of simulations projecting precipitation increase for 2080s.

Data



http://precis.insmet.cu/Precis-Caribe.htm

User friendly website

All results

User specify desired variables and future period.

Multiple plot types available.

Use of the Data

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<u>Reporting Purposes</u>

Compiling projections for use in 2nd National Communications:

Antigua

St. Lucia

St. Vincent

Grenada

Jamaica

British Overseas territories

St. Lucia

	RCM
	2070s
JAN	1.6 - 1.9
FEB	1.8 - 2.3
MAR	1.9 - 2.5
APR	1.9 - 2.8
MAY	2.2 - 2.7
JUN	2.1 - 2.7
JUL	1.9 - 2.5
AUG	1.9 - 2.2
SEP	2.0 - 2.2
OCT	1.9 - 2.3
NOV	1.8 - 2.1
DEC	1.8 - 2.1
ANNUAL	1.9 - 2.4

Temps

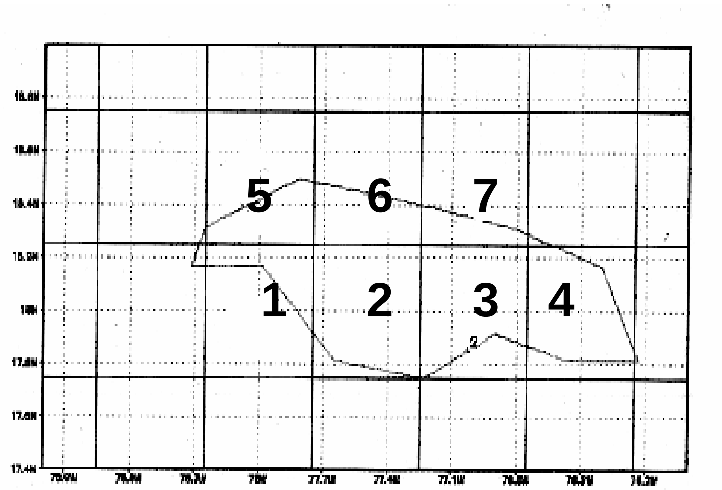
	RCM
	2070s
JAN	-46.91 --25.90
FEB	-78.37 - -50.04
MAR	-86.14 - -50.95
APR	-81.80 - -57.79
MAY	-69.91 - -47.49
JUN	-77.10 - -47.26
JUL	-57.86 - -29.02
AUG	-36.29 - -21.95
SEP	-39.94 - -21.95
OCT	-33.13 - -3.76
NOV	-30.37 - +18.58
DEC	-48.69 - -8.32
ANNUAL	-57.21 - -27.94

Rainfall

Use of the Data – Impact Studies

Impact Studies

E.g. Analysis of impact of climate change on water sector in Jamaica



Average of A2 and B2 projected changes in streamflow at Great River and precipitation at Sangster and in region 5 for 2015s, 2030s, 2050s and 2080s.

Publications

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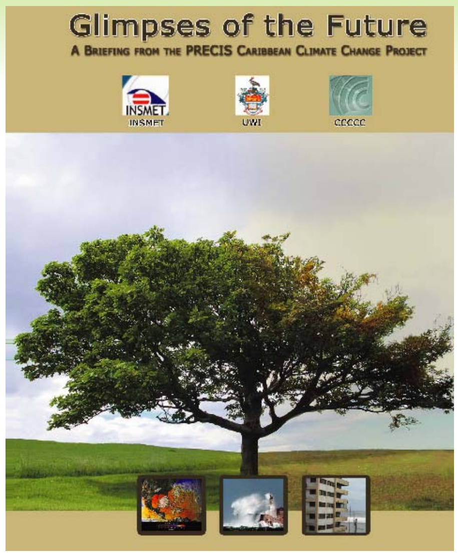

Taylor MA, A Centella, J Charlery, I Borrajero , A Bezanilla, J Campbell, R Rivero, TS Stephenson, F Whyte, R Watson, 2007. *Glimpses of the Future: A Briefing from the PRECIS Caribbean Climate Change Project*, Caribbean Community Climate Change Centre, Belmopan, Belize.

Campbell J, MA Taylor, TS Stephenson, RA Watson, FS Whyte, 2010: Future Climate of the Caribbean from a Regional Climate Model. Int J Climatol DOI: 10.1002/joc.2200.

Cashman, A., L. Nurse, and J. Charlery. 2010. Climate change in the Caribbean: The water management implications. The Journal of Environment & Development 19(1): 42-67.

Charlery, J., and L. Nurse. 2010. Areal downscaling of global climate models: an approach that avoids data remodelling. Clim Res 43: 241–249. doi: 10.3354/cr00875.

Collaborations

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Japanese Earth Simulator

WB sponsored visit to Japan

Earth Simulator climatic Dataset relevant to Caribbean acquired

Expertise gained

Beginning analysis – using for study of hurricane like features.

"…to see what appeared to be a hurricane over the Atlantic with the correct flow pattern, lasting for five days before moving out of the domain. Just a cursory glance at the daily data showed what appeared to be migratory fronts into the Northern Caribbean from the northwest in the early months up to June. The dominant northeasterly flow pattern dominates from June up until about November, the ITCZ is also clearly visible…"

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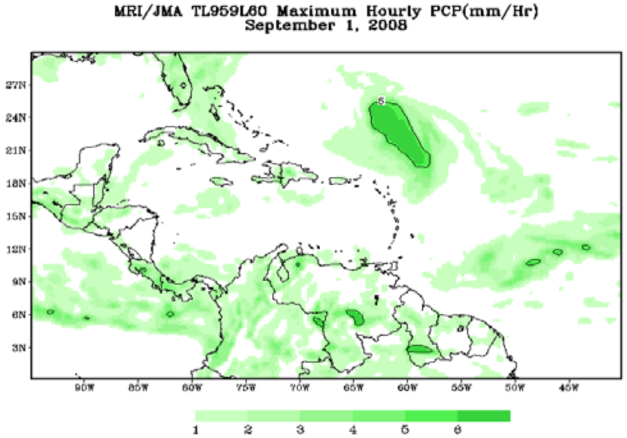

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CARIBSAVE is a partnership between the Caribbean Community Climate Change Centre (CCCCC) and the University of Oxford. The CARIBSAVE Partnership addresses the impacts and challenges surrounding climate change, tourism, the environment, economic development and community livelihoods across the Caribbean Basin, using an integrated and holistic approach.

Capacity

Consortium of Caribbean Modellers

1. Caribbean Community Climate Change Centre (CCCCC)	Belize
2. Caribbean Institute of Hydrology and Meteorology (CIMH)	Barbados
3. Instituto de Meteorología de la Republica de Cuba	Cuba
4.Anton de Kom University	Suriname
5.University of the West Indies-Cave Hill	Barbados
6.University of the West Indies, Mona-CSGM	Jamaica

Modelling and Research Agenda for the Caribbean

Task 1: Further determination of the value of Regional Modeling

Activities

- Complete inventory of existing PRECIS Data
- Conducting model analysis of PRECIS output along research lines indicated above
- Analysing Precipitation and Temperature (2m) for the eastern Caribbean at 25 km versus 50 km
- Determining spatial bias (if any) of value added
- Varying resolution and domain and the conducting of sensitivity analysis with the new limits
- Hosting stakeholder consultations to discuss new results

Deliverables

- Completed analysis of the existing PRECIS data for all existing domains
- Reports on: Spatial Bias of value added and the sensitivity analysis of varying scales and domains
- New model outputs, including maps and graphs differentiating the results of the western and eastern Caribbean
- At least one publication on the PRECIS Modeling Effort in the Caribbean
- An improved version of the user friendly website to facilitate the dissemination of the results.

Modelling and Research Agenda for the Caribbean

Task 2a : Analysis of Caribbean Climate Extremes

Activities

•Data collection for temperature and climatological rainfall

•Determination of climate extreme indices representative of droughts, floods, temperature anomalies, etc. using Caribbean meteorological data

•Determination of climate extreme indices representative of droughts, floods, temperature anomalies, etc. using current and future data simulated by PRECIS

•Awareness raising and capacity building sessions of regional experts

Deliverables

•Completed down-scaled analysis of climate extremes, including characterization of current and future extremes under climate change

•Maps and graphs of climate variables and extreme indices including the frequency of consecutive wet days and dry spells, maximum 5-day rainfall accumulations, Simple daily Precipitation Index (SDII), and maximum and minimum temperatures

•Framework for conducting new impact and sectoral studies using new outputs

•Increase in number of regional experts in analysis of extreme events

Modelling and Research Agenda for the Caribbean

Task 2b: Analysis of Droughts

Activities

•Data collection for temperature, rainfall, evapotranspitation, wind speed and other relevant climate variables
•Determination of drought indices representative of meteorological drought using Caribbean meteorological data
•Determination of meteorological and agro meteorological droughts using current and future data simulated by at least PRECIS and RegCM
•Awareness raising and capacity building sessions of regional experts

Deliverables

•Completed database of down-scaled regional projections of drought, including characterization of current and future under climate change
•Maps and graphs of climate variables and drought indicators
•Framework for conducting new impact and sectoral studies using new outputs
•Increase in number of regional experts in analysis of meteorological and agro meteorological drought.

Modelling and Research Agenda for the Caribbean

Task 2c: Analysis of Hurricanes

Activities

•Testing of methodology to detect tropical cyclone vorticities
•Validating methodology used to detect hurricane like features in Caribbean using reanalsysis datasets with known hurricanes.
•Determining the impact of domain size and resolution on hurricane genesis in the PRECIS model.
•Data gathering for periods of known hurricane activity in the Caribbean
•Conducting trend analysis of hurricanes in current and future periods.
•Statistical and dynamic analysis of favourable genesis conditions including wind-shear, and other parameters of interest.
•Host stakeholder consultations and capacity building seminars and training

Deliverables

•Increased regional capacity for hurricane projections and adaptation planning
•Validated methodology for detecting and forecasting tropical cyclones in the Caribbean.
•Increase in number of regional experts in analysis of tropical cyclones from regional models.
•Scientific publications of methodologies and results.

Modelling and Research Agenda for the Caribbean

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Task 3a: Expanding the range of Regional Models

Activities

•Source new climate models: PRECIS model, RegCM, CCSM, WRF, PCM
•Data collection for input data, including selected inputs from GCMs
•Perform testing and validation of new regional climate models
•Perform inter-model comparisons and do model agreement analysis
•Carry out inter-regional comparison with other regional climate models of CORDEX
•Participate in CORDEX meetings, workshops and conferences.
•Conduct training of regional experts with use and application of new models
•Publish results and host stakeholder consultations

Deliverables

•Tested and validated new Regional models
•Multi-model projections of climate change at the scale of the Caribbean
•Analyses of inter model and inter regional comparison of climate change including assessment of model agreement and uncertainties
•At least two publications on regional modeling in the Caribbean
•New capacities built among regional experts in regional modeling.

Modelling and Research Agenda for the Caribbean

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Task 3b: Expanding the range of Scenarios

Activities

•Accessing new scenarios.

•Undertaking simulations using new IPCC emission pathways

•Engaging with CORDEX.

•Training and Capacity Building

Deliverables

•New climate projections based on additional (new) scenarios and a variety of climate models

•Publications on applications of regional climate modeling in the Caribbean

Modelling and Research Agenda for the Caribbean

Task 3c: Expanding the range of forcing GCMs

Activities

•Access to different GCM boundary data e.g. ECHAM5 or other
•Objective selection of a subset of perturbed parameter experiment to run PRECIS
•An assessment of the impacts using different perturbed experiments as well as different GCMs as ECHAM5
•Determination of tropical cyclones, drought and temperature/precipitation pattern for current and future climates.

Deliverables

•New climate projections based on additional (new) scenarios and a variety of climate models
•New analysis of tropical cyclones, drought, temperature and precipitation for current and future climate
•Publications on uncertainties in future regional climate in the Caribbean

Valuable Lessons about Collaboration…

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Collaborations work

when…

Collaborators own the problem

Collaborators are willing to share a piece of the problem.

Collaborators are equipped to solve their piece of the problem.

There is joint ownership of the results amongst collaborators.

Collaborators do not lose sight of the wider purpose for their work.

Foundation for more work...

More Partnerships

Too difficult, time consuming for any one country or institution.
Collaboration heightens efficiency for producing usable results.
Builds synergies/support groups across institutions.
Collaborate with non-English speaking Caribbean

Thank You