

**Reducing Risk and Enhancing
Sustainable Socio-Economic in the
Caribbean – the Role of the Caribbean
Meteorological Organization**

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Evolution of Climate Data Gathering in the Caribbean

- Historically primarily precipitation data were collected by the agricultural community
 - 24-hr rainfall datasets can still be found in most countries.
 - Fairly good spatial distribution of measuring stations.
 - Remaining data often on paper records.
- National Meteorological and Hydrological Services often manage few stations with often poor spatial resolution.
 - Underfunding often limits the temporal resolution of these datasets.
 - Much of the historical data is in the form of paper records.
 - Several meteorological parameters measured
 - Data often of sufficient quality to be entered into global climate databases
 - Quality management systems weak.
- Miscellaneous Stakeholders
 - National Ministries
 - Private companies
 - Systems of set up for specific purposes which limits the use of the data
 - Data often difficult to get a hold of

Challenges to Sustainable Development in the CMO Member States

- Small climate sensitive economies that often lack significant diversity and are susceptible to economic shocks;
 - Agriculture and service based economics with the exception being Trinidad and Tobago which has a petroleum based economy
- Inter-related economies;
- Many small island states with small populations that are predominantly coastal;
- Many states have low GDPs and small tax bases
- Several water scarce islands
- Complex inter-related natural hazards and highly vulnerable populations
 - Hazards include extreme weather and consequences (e.g., hurricane, drought, flood and landslides etc), earthquake and tsunami among others
- Youthful populations
- Susceptibility to climate change and climate variability

Challenges to Sustainable Development in the CMO Member States

- Over the last three decades, the Caribbean region has suffered direct and indirect losses estimated at between USD 700 million to USD 3.3 billion due to extreme weather events;
- The World Bank in a 2009 report determined that the cumulative annual impact of future climate change on all CARICOM Member and Associate Member States by ca. 2080 will be approximately USD 11.2 billion which represents 11.3 percent of the projected cumulative GDP of USD 99.3 billion (all estimates referenced to 2007 USD prices);
 - The most significant contributors to the future annual cost of impacts are expected to be direct losses due to climate change related disasters USD 4.9 billion (of which USD 2.6 billion are expected to result from wind storm damage, USD 363.2 million from flood damage and USD 447 million from loss in tourism revenues) and loss of tourist expenditure due to temperature rise which is expected to be approximately USD 4 billion.
- ***Supporting risk reduction and supporting sustainable socio-economic development must be an important focus of the Caribbean Meteorological Organization (CMO)***

Evolution of a Regional Meteorological Structure

- British Caribbean Meteorological Service (1951)
- Caribbean Meteorological Service (1962)
- Caribbean Meteorological Organization (1973) – Special Agency with functional autonomy

Caribbean Meteorological Organization

Objective

“The Organization shall have as its objectives the promotion and co-ordination of regional activities in the fields of meteorology and allied sciences.”

Caribbean Meteorological Organization

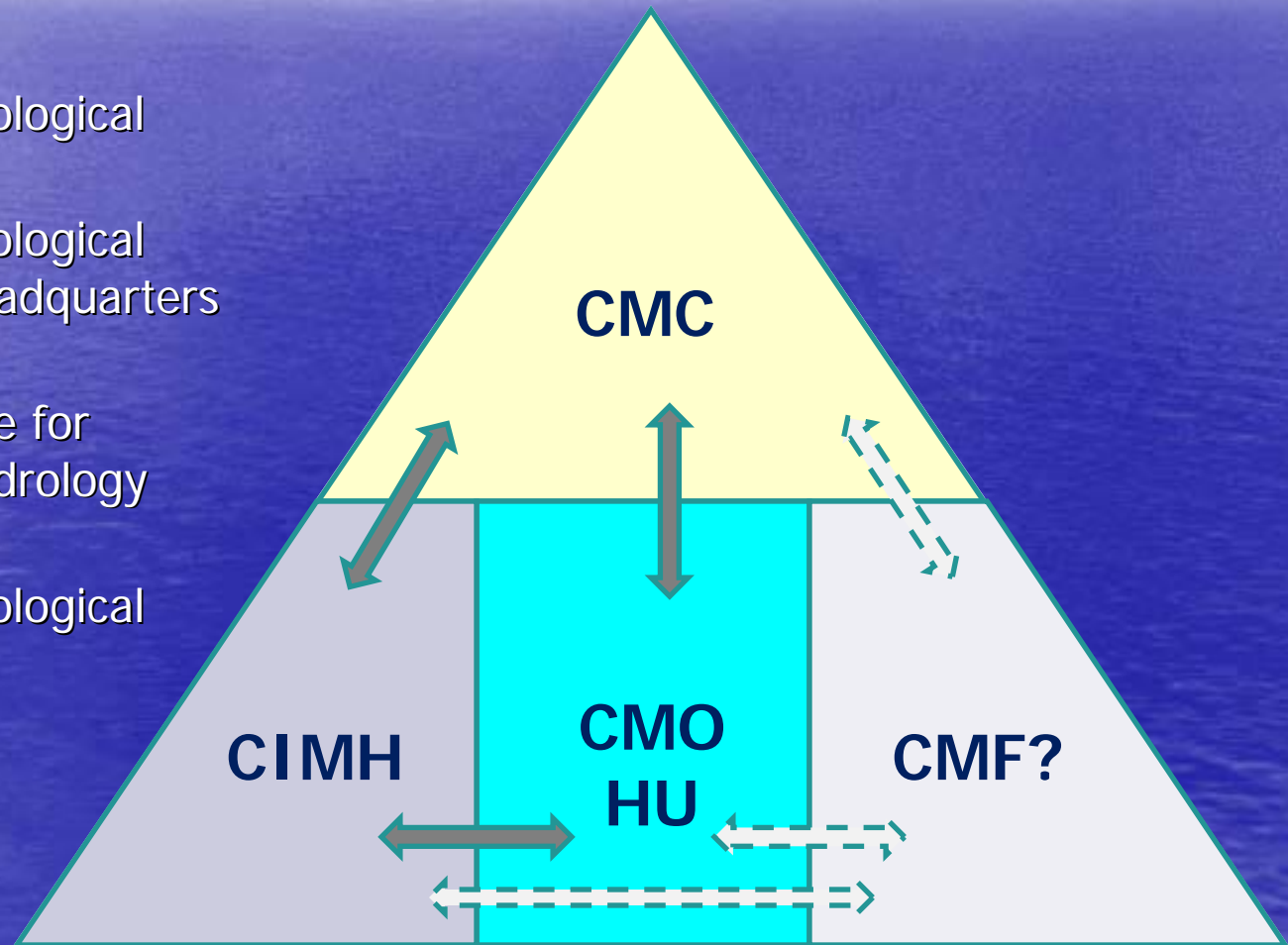
The functions of the Organization include:

- Provision of meteorological services to civil aviation ;
- Co-operation with other services to provide an efficient hurricane warning system;
- Provision of meteorological information and advice to Member States ;
- Collection and analysis of all relevant meteorological data available and publication of results;
- Co-operation with meteorological services;
- Execution of basic scientific observations in keeping with its objectives;
- Participation in the work of the appropriate international organizations particularly the World Meteorological Organization and the International Civil Aviation Organization ;
- Participation in work in applied meteorology, agricultural meteorology, hydrology and associated research of direct interest to the Region
- Co-operation with all relevant scientific institutions

Caribbean Meteorological Organization

Organs

- Caribbean Meteorological Council (CMC)
- Caribbean Meteorological Organization – Headquarters Unit (CMO-HU)
- Caribbean Institute for Meteorology & Hydrology (CIMH)
- Caribbean Meteorological Foundation (CMF)



Caribbean Meteorological Council (Functions & Powers)

- The Council may issue directions of a general or special character as to the policy to be pursued by the Organization and any organs, institutions or bodies of the Organization, and effect shall be given to any such directions.
- The Council shall be the final authority for the conclusion of agreements on behalf of the Organization and for entering into relationships between the Organization and other Organizations and States. The Council may however delegate this authority in any particular case.
- Subject to the provisos to Article 8 (6) the Council shall take decisions for the purpose of maintaining the final arrangements necessary for meeting the expenses of the Organization and shall be the final authority on questions arising in relation to the financial affairs of the Organization.
- **The Council may determine the operation of regional programmes in meteorology and allied sciences to achieve the objectives of the Organization.**
- The Council may at the request of any Member State make provision for the representation of that State by the Organization on any constituent body of the World Meteorological Organization.

Caribbean Meteorological Council (Functions & Powers)

- The Council may generally do all such acts and things as may be requisite in order to fulfill the objectives of the Organization, and may in particular-
 - appoint officers and staff to the Organization upon such terms and conditions as the Council may decide;
 - establish and designate such institutions, bodies and committees as it sees fit for achieving the purposes of carrying out the objectives of the Organization ;
- The Council may delegate to any of its representatives or to any organ of the Organization or to any officer or member of staff of the Organization, or to any other person or body, such of its powers and functions as it may decide from time to time, under the terms and within the limits laid down by the Council

Caribbean Meteorological Organization Headquarters Unit (Structure)

- The Commonwealth Caribbean Regional Secretariat shall be recognized as the Secretariat of the Organization. The principal office of the Secretariat in relation to this Agreement shall be the Headquarters Unit which shall be situated in Trinidad and Tobago unless the Council otherwise determines;
- The Headquarters Unit shall enjoy functional autonomy and shall comprise a Co-ordinating Director and such other staff as may be determined by the Council ;
- The Co-ordinating Director shall be the principal administrative and technical officer of the Headquarters Unit.

Caribbean Meteorological Organization Headquarters Unit (Functions)

- Undertaking and carrying out of the decisions of the Council;
- Advising and assisting Member States, in particular, those States without national meteorological services;
- Formulating and co-ordinating applications and requests for technical assistance from non-Member States and international agencies for regional projects ;
- Representing those Member States which so desire at sessions of the Congress of the World Meteorological Organization as determined by the Council;
- Attending meetings if appropriate, of the International Civil Aviation Organization (ICAO), especially the Regional Air Navigation Meetings;
- Initiating projects, studies and other programmes of a regional nature in the field of meteorology and allied sciences;
- Attending to such other matters relating to the fields of meteorology and allied sciences as may be referred to it by the Council.

Caribbean Institute for Meteorology & Hydrology (Functions)

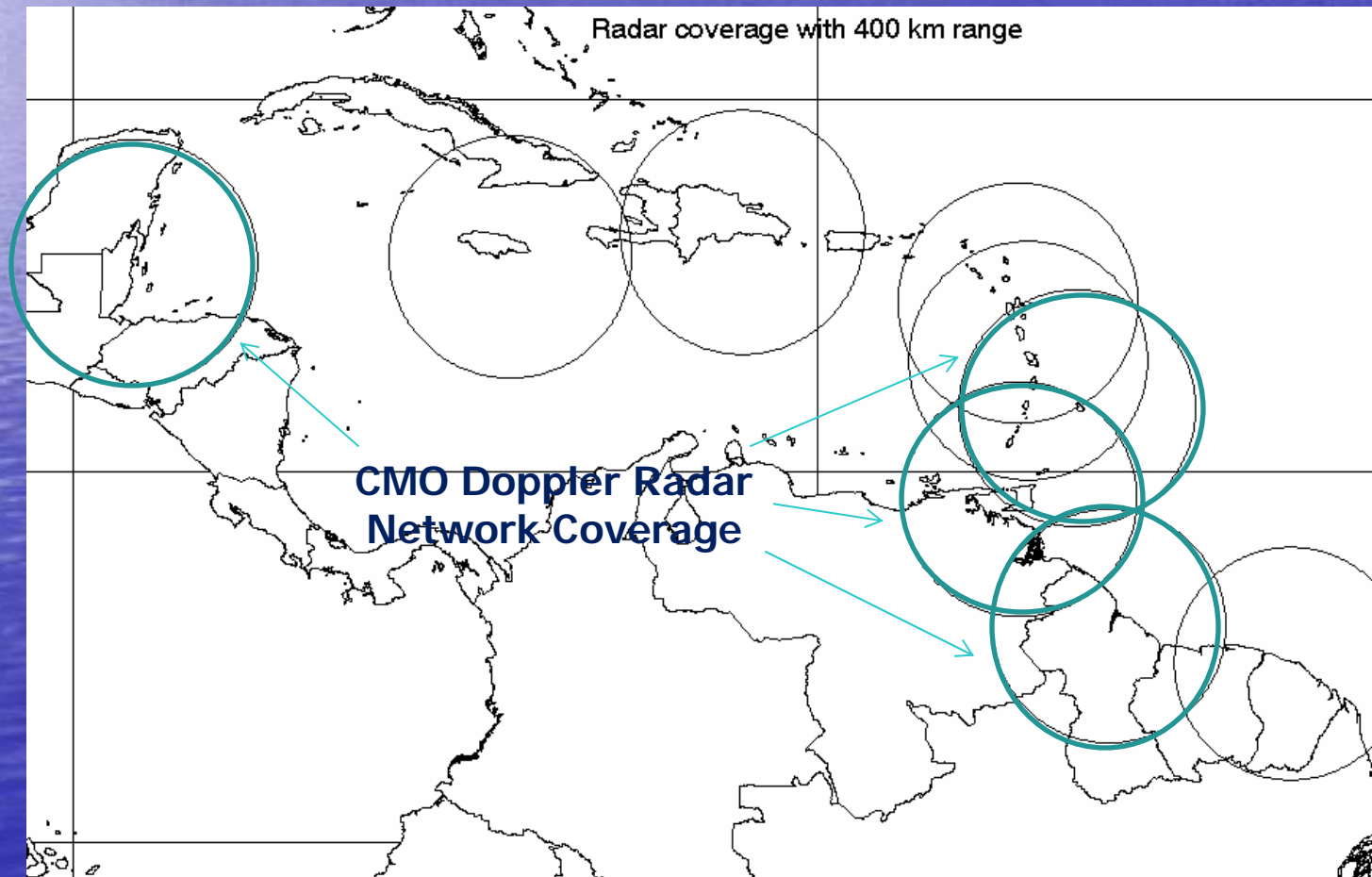
- The Institute shall provide training and conduct research in meteorology and allied sciences;
- The Institute shall provide facilities to Member States for the repair and maintenance of meteorological equipment. It shall undertake the processing and dissemination of climatological data and shall provide advice to Member States on request;
- The Institute shall, when appropriate, co-operate with national, regional or international organizations or other bodies concerned with the development of meteorology and allied sciences;
- The Institute shall also deal with such other matters relating to meteorology and allied sciences as may be referred to it by the Council

Caribbean Meteorological Foundation (Functions)

- Charitable organisation with the objective of promoting through the CIMH the study of, and research in, meteorology, hydrology, and associated sciences. One of the main functions of the Foundation is the soliciting, receiving, and disbursing of funds, donations, and research contracts in pursuance of the above objective.

Caribbean Meteorological Organization Headquarters Unit

Lead the installation of 4 new Doppler radars in 4 CMO Member States.
Proposed mosaic for the region also shown.



Caribbean Meteorological Organization Headquarters Unit

New CMO Doppler Radars



Belize



**Trinidad &
Tobago**



Guyana



Barbados

Radars will enhance disaster risk reduction across the region by supporting early detection and tracking of adverse weather. Information from the system will also support scientific research and development in areas that will support the goal of disaster risk reduction.

CIMH MANDATE

"... to assist in improving and developing the Meteorological and Hydrological Services as well as providing the awareness of the benefits of Meteorology and Hydrology for the economic well-being of the CIMH member states. This is *achieved through training, research, investigations and the provision of related specialized services and advice*".

CIMH HISTORY

- Caribbean Meteorological Institute (CMI) established August 23, 1967 under special funding from UNDP and WMO
 - 16 Caribbean States that comprise the Caribbean Meteorological Council were entrusted with the responsibility of managing CMI
- CMI becomes affiliated with UWI in 1973
 - B.Sc. in Meteorology established in Faculty of Natural Sciences
- CMI designated by WMO as a Regional Meteorological Training Centre in 1978 (new designation RTC)
- Caribbean Operational Hydrology Institute (COHI) established in 1982 and located at CMI ... COHI subsequently brought under CMI in 1987
- Name of CMI changed to Caribbean Institute for Meteorology & Hydrology in 1999

CMC MEMBER STATES

- Anguilla, Antigua and Barbuda
- Barbados
- Belize
- British Virgin Islands
- Cayman Islands
- Dominica
- Grenada
- Guyana
- Jamaica
- Montserrat
- St. Kitts/Nevis
- St. Lucia
- St. Vincent and the Grenadines
- Trinidad and Tobago
- Turks and Caicos Islands

PRIMARY FUNCTIONS

- Train various categories of meteorological and hydrological personnel
- Operate as a centre of research in meteorology, hydrology and associated sciences
- *Data collection, storage, & dissemination*
- Maintain, repair, and calibrate meteorological & hydrological instruments
- Advise regional governments on matters related to meteorology & hydrology
- Provide consulting services to industry



METEOROLOGY TRAINING PROGRAMMES

- WMO professional programmes
 - Entry Level Technician (6 months)
 - 2 courses conducted per year
 - 11 persons trained in 2006
 - Mid Level Technician (8 months)
 - 1 course per year
 - On-going course has 3 students
 - Senior Level Technician (18 months)
 - 1 course every two years
 - On-going course has 2 students
 - Next course starts in January 2008
 - *Applications of Meteorology*
 - Provides joint training in agrometeorology, hydrology, and climatology

METEOROLOGY TRAINING PROGRAMMES

- *B.Sc. Degree (joint with the University of the West Indies)*
 - Students in this programme are fully registered at the University but receive instructions in meteorology from staff of the Institute.
- *M.Sc. Natural Resource and Environmental Management specializing in Applied Meteorology (joint with CERMES, University of the West Indies)*
 - The programme provides students with training in advanced techniques suitable for the analysis of meteorological and hydrological data and their application in various sectors of the regional economy.

HYDROLOGY TRAINING PROGRAMMES

- *Hydrological Observers*
 - Four week course designed to train technicians on applications of hydrology databases, basic hydrometeorology observation techniques, and field activities.
- *General Technicians*
 - Six month course with students being trained in the fundamentals of surface water hydrology and hydrogeology. The course also covers water quality monitoring, basics of surveying, and instrument maintenance.
- *Higher Technicians*
 - This is an eighteen months course and is designed to allow personnel with several years experience to gain further knowledge in hydrology
- **M.Sc. Natural Resource and Environmental Management**
specializing in Water Resources Management (*joint with CERMES, University of the West Indies*)
 - The programme provides students with training in advanced techniques suitable for addressing a broad range of water resources issues.

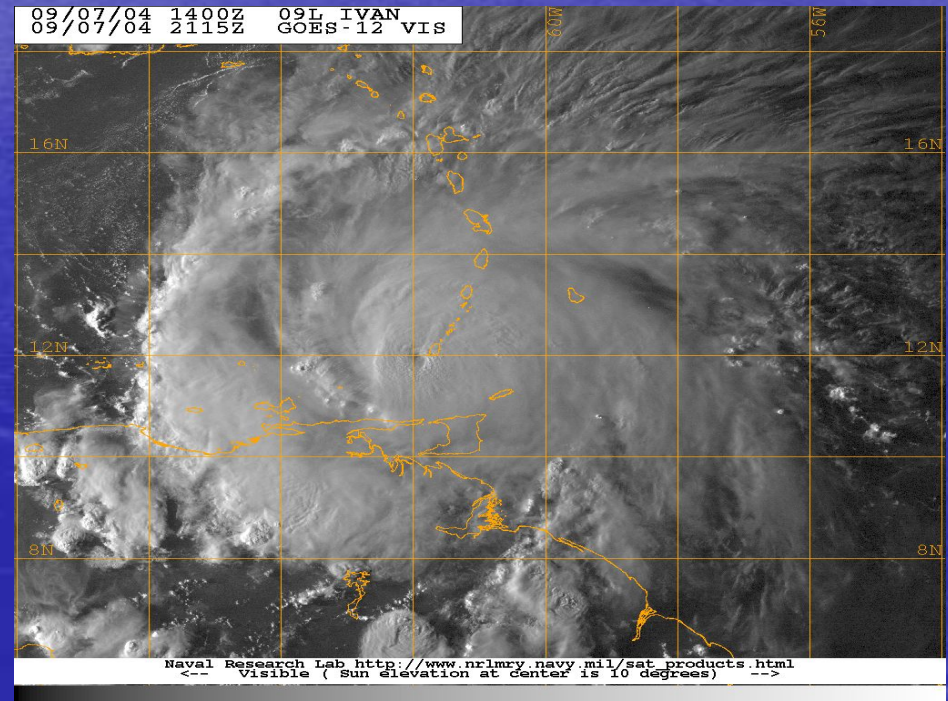
Instrument Calibration and Maintenance

- Regional Instrument Calibration Laboratory
 - Establishment of the instruments calibration lab established in 2007
- Sea Level Monitoring and Equipment Maintenance
 - CIMH currently involved in redevelopment of sea level monitoring stations across the Caribbean
 - CIMH will be responsible for maintenance of several of these stations
- Support for International Research and Development Projects (NASA, U. Miami, Max Planck Institute and CCCCC)
 - Instrument installation (lidar and small radar systems)
 - Monitoring and Maintenance
- Regional Maintenance/Support
 - CIMH continues to support requests from regional meteorological office and governments
- Research and Development
 - Developed a data-logger and rain gauge recording system (hardware and software customizable to client needs)

RESEARCH & DEVELOPMENT

Satellite & Marine Meteorology

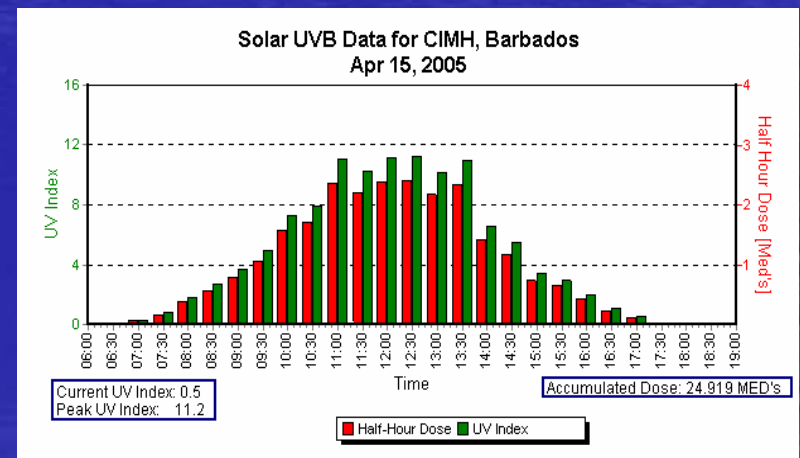
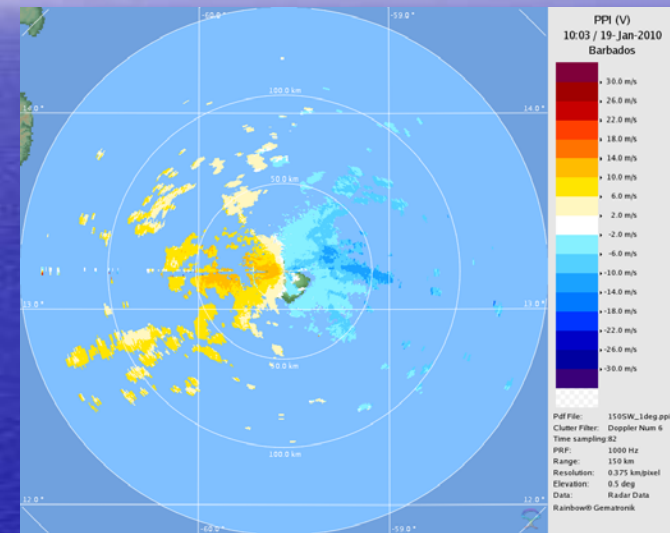
- Satellite meteorology
 - RAMSDIS
 - COROBOR
- Other satellite products are available
- Storm surge modeling
- Planning underway to expand marine meteorology products



RESEARCH & DEVELOPMENT

Physical Meteorology

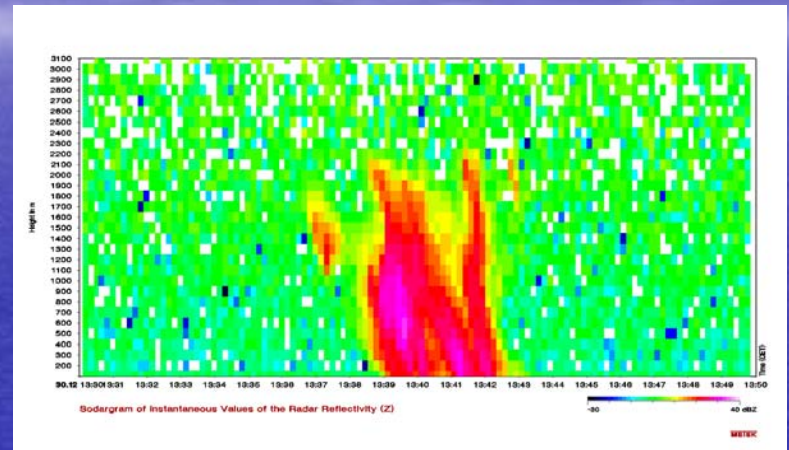
- Radar Meteorology
 - Access to outputs from the CMO Doppler Radar recently installed in the Caribbean
 - Access to data from a new Micro-Rain Radar installed at CIMH ... additional systems to be installed across Barbados
 - Development of packages to support real-time and short-term forecasting
 - Integration of radar output with numerical modeling output to improve forecasts
- UV Studies
 - Supply of solar radiation data to the World Radiation Data Center, Russia
 - Measurement and analysis of UVB radiation levels for Barbados
 - Study of some of the factors which affect UV radiation levels



RESEARCH & DEVELOPMENT

Physical Meteorology

- Cloud Development and Rainfall Genesis Studies
 - International collaboration with the Max Planck Institute Hamburg (Meteorology Research Section) and the University of Miami
 - Cloud, rainfall and dust monitoring systems to be in place in 2010
- Aerosol Monitoring
 - Greater participation in the U. Miami aerosol monitoring programme along the east coast of Barbados (40-year aerosol and climate dataset acquired)
 - Participation in the new 2010 field campaign which will include aircraft flights
 - CIMH 2010 Atlantic dust transport modeling studies



Micro-Rain Radar image over CIMH (2009)

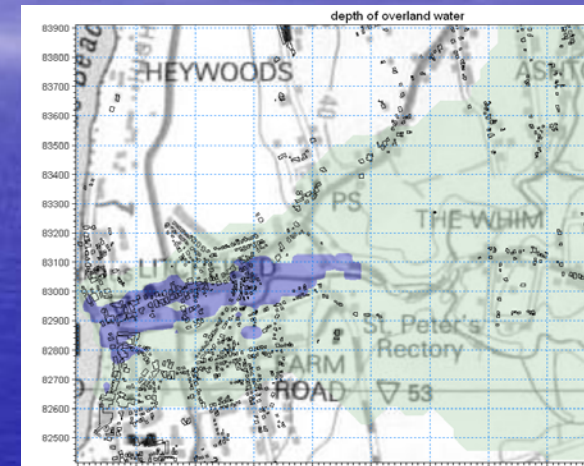


Aerosol monitoring on Barbados (BACEX 2010)

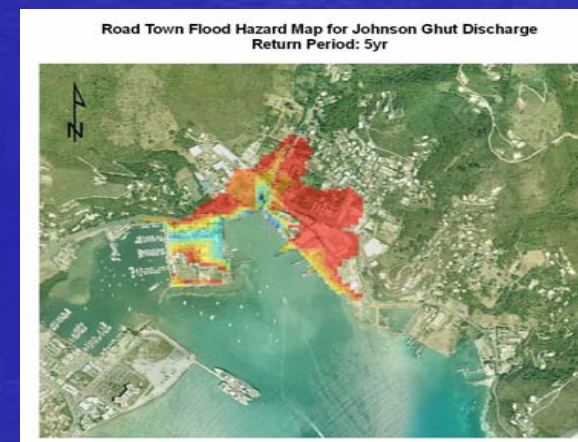
RESEARCH & DEVELOPMENT

Hydrometeorology, Water Resources Management & Site Investigations

- Caribbean Water Initiative (CARIWIN)
 - Joint initiative with McGill University, Canada funded by Canadian International Development Agency (CIDA)
 - Supports water resources management training from the national scale to the community scale
 - Installation of rain gauges and stream flow meters that support disaster management
- Improved flood forecasting
 - Weather forecasting model (WRF)
 - Hydrologic model
 - 48hr rainfall forecast from WRF
 - Coupled surface water and groundwater flow simulation
 - Flood forecasts provided with significant lead times (24-48 hours)
 - Accuracy dependent on catchment characterisation (DEM, K's, etc.)



Dynamic flood modeling on Barbados

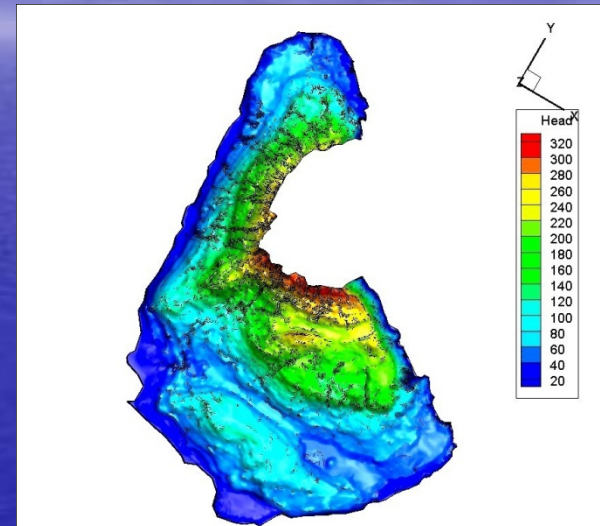


Flood hazard modeling at Johnson Ghut, BVI

RESEARCH & DEVELOPMENT

Hydrometeorology, Water Resources Management & Site Investigations

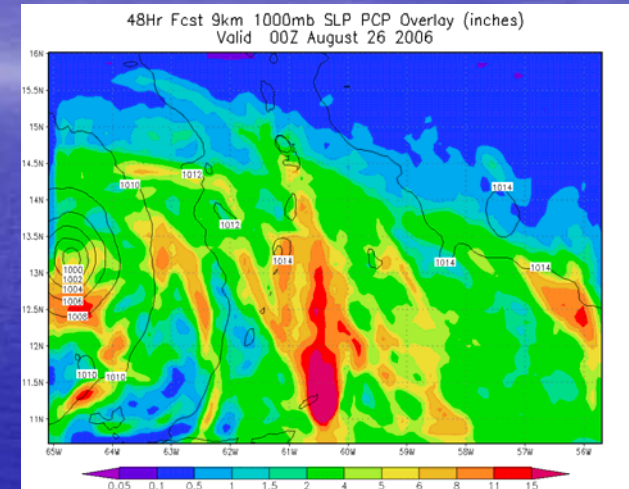
- Hydrometeorology
 - Floodplain mapping to support international projects within the region (JICA CADM Phase I and II)
 - Storm surge modeling (TAOS)
 - Stream flow modeling
 - Real-time monitoring
- Hydrologic Site Characterization
 - Application of geophysical methods to characterize and monitor aquifer systems and construction sites (including proposed radar site on Barbados)
- Groundwater & solute transport modeling (Water Resources Management)
 - Seawater intrusion modeling to support sustainable groundwater management of karst aquifers
 - Pollution migration assessment



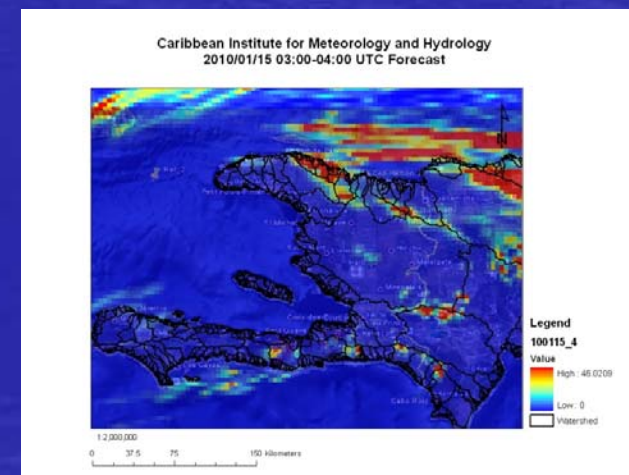
RESEARCH & DEVELOPMENT

Computational Meteorology & Climatology

- Computational Cluster
 - Primary computational cluster 16 nodes with 36 cores
 - CCRIF flood risk cluster 3 nodes with 24 cores
 - UWI Cray CX1
 - Smaller quad core systems used for daily runs
- Application of Mesoscale Models to Support Meteorological Forecasting
 - MM5V3 and WRF ver 2 & 3 used to support work
 - Model validation ongoing
 - Integration of modeling results into disaster management will commence this year
 - Student interns are involved in this activity
- Climate Change Modeling
 - Use of the PRECIS model to support analysis of climate change and climate variability across the Caribbean (MACC project)
 - Use of WRF to perform regional climate runs
 - Introduction of Max Planck's REMO model in 2010
 - Outcomes being used to support sectoral analyses (e.g., impact of climate change on agriculture)



Model outputs associated with Hurricane Deane

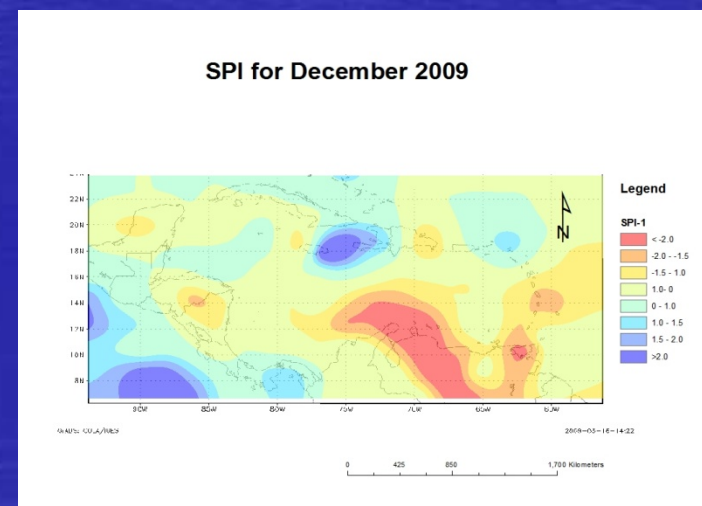
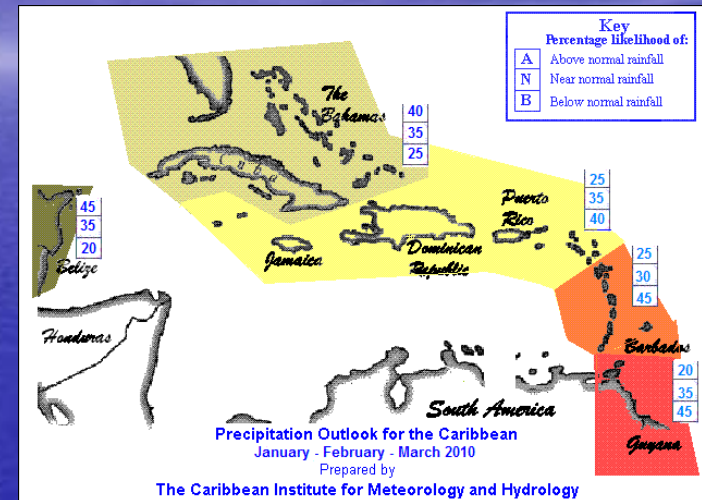


Rainfall simulation over Haiti (post 12/01/2010)

RESEARCH & DEVELOPMENT

Applications of Meteorology

- 3-month Precipitation Outlook
 - Caribbean basin product produced using global databases and model outputs
 - Percentage likelihood for 3 scenarios provided (above average, average and below average rainfall)
 - Outputs useful for sectoral planning
 - Product being revised to improve usefulness
- Caribbean Drought and Precipitation Monitoring Network
 - Concept was borne out of the need to mitigate and respond to the creeping nature of drought the onset of which may go undetected
 - Regional and national monitoring scales
 - Several indices used SPI, Deciles, PDSI, CMI
- Monthly Weather Summary
 - Climate data for most Caribbean islands



RESEARCH & DEVELOPMENT

Applications of Meteorology

- Caribbean Agrometeorology Initiative
 - Provision of specialized training to National Meteorological Services and the agricultural community to reduce risk and enhance productivity
 - Funded by the European Union's ACP Science and Technology Programme (Euro 720,000)
 - Partnership between CIMH (Applicant), WMO, CARDI, Ten Meteorological Services
- Parametric Risk Insurance
 - Determine the technical feasibility for establishing a parametric insurance mechanism for catastrophic flood risk as an additional product under the Caribbean Catastrophe Risk Insurance Facility (CCRIF)
 - Development of a comprehensive database of flooding
 - Development of an Excess Rainfall parametric insurance model

The History of Climate Change Adaptation in the Caribbean

- The Barbados Plan of Action (BPoA), which resulted from the 1994 Global Conference on the Sustainable Development of Small Island Developing States held in Barbados, focused on sustainable development through adaptation to climate change.
- In response to BPoA, OAS and CARICOM organized national and regional workshops to facilitate maximum stakeholder consultation on climate change issues.
- The result was a proposal for the Caribbean Planning for Adaptation to Climate Change (CPACC) project, which was submitted for funding to the Global Environment Facility (GEF) and received USD 5.6 million.

Regional Climate Efforts Involving CMO (Caribbean SIDS Project)

- Implemented in the 1990's
- Provided institutional strengthening for national meteorological services
 - Climate monitoring equipment
- Provide institutional strengthening for CIMH
 - Training
 - Storm surge modeling
 - Climate monitoring equipment
 - Data rescue

Overview of the CPACC Project (1997-2001)

- Regional projects executed under CPACC included:
 - Design and establishment of a sea level/climate monitoring network;
 - Establishment of databases and information systems;
 - Inventory of coastal resources;
 - Use and formulation of initial adaptation policies.
- Pilot projects executed under CPACC included:
 - Coral reef monitoring for climate change (Bahamas, Belize, and Jamaica);
 - Coastal vulnerability and risk assessment (Barbados, Guyana, and Grenada);
 - Economic valuation of coastal and marine resources (Dominica, Saint Lucia, and Trinidad and Tobago);
 - Formation of economic/regulatory proposals (Antigua and Barbuda, and St Kitts and Nevis);
 - National communications (St Vincent and the Grenadines).

Selected Achievements of the CPACC Project

- Establishment of a sea level and climate monitoring system – A total of 18 monitoring systems, along with the related data management and information networks, were installed in 12 countries.
- Improved access and availability of data – An integrated database for the monitoring of climate change effects was established through the Inventory for Coastal Resources and the institutionalization of coral reef monitoring.
- Articulation of national climate change adaptation policies and implementation plans – Such policies and plans were formulated in 11 participating countries.
- Increased appreciation of climate change issues at the policy-making level

Overview of the ACCC Project (2001-2004)

- Designed to sustain activities initiated under CPACC and to address issues of adaptation and capacity building not undertaken by CPACC, thus further built capacity for climate change adaptation in the Caribbean region
- Activities included:
 - Project design and business plan development for a regional climate change centre;
 - Integration of climate change into a physical planning process using a risk management approach to adaptation to climate change;
 - Strengthening of regional technical capacity, in partnership with the Caribbean Institute for Meteorology and Hydrology (CIMH), the University of the West Indies (Scenario Projection and Establishment of Climate Change Master's Programme), and the Caribbean Environmental Health Institute

Overview of the ACCC Project (2001-2004)

- Activities included:
 - Integration of adaptation planning in environmental assessments for national and regional development projects;
 - Implementation strategies for adaptation in the water sector;
 - Formulation of adaptation strategies to protect human health;
 - Adaptation strategies for agriculture and food;
 - Fostering of collaboration/cooperation with non-CARICOM countries.
- Selected outcomes:
 - Political endorsement (by CARICOM) of the business plan and establishment of the basis of financial self-sustainability for the Caribbean Community Climate Change Centre (CCCCC);
 - Successful launch of a Master's Programme in climate change (the first set of graduates, in 2003)
 - Statistically downscaled climate scenarios development for Jamaica, Trinidad and Tobago, and Barbados;

Overview of the ACCC Project (2001-2004)

- Selected outcomes:
 - Staff training and development at the Caribbean Institute for Meteorology and Hydrology (CIMH) in climate trend analysis in order to strengthen climate change capacity;
 - Implementation of pilot projects on adaptation studies in the water health and agricultural sectors.

Overview of the MACC Project (2004-2009)

- The project's main objective is to mainstream climate change adaptation strategies into the sustainable development agendas of the small island and low-lying states of CARICOM.
- Builds on the progress achieved in these past projects.
- Major components of MACC:
 - Building capacity to identify climate change risks – Among other things, this will include strengthening networks to monitor impacts on regional climate, downscaling global climate models, and developing impact scenarios;
 - Building capacity to reduce vulnerability to climate change;
 - Building capacity to effectively access and utilize resources to minimize the costs of climate change;
 - Public education and outreach;
 - Project management.
 - Data collection through reestablishment of sea level monitoring stations.

Overview of the MACC Project (2004-2009)

- Expected outcomes:
 - The mainstreaming of adaptation to climate change into national and sectoral planning and policies through the use of climate models developed and customized through the project;
 - A strong public education and outreach (PEO) program and a comprehensive communications strategy including all stakeholders in the Caribbean mass media;
 - The creation of an environment conducive to the implementation of measures for adaptation to climate change.
 - Continuous strengthening of regional institutions involved in climate studies (e.g., CIMH, UWI, INSMET)

Overview of the SPACC Project (2007-2011)

- Main objective of this USD 2.1 million project is to support efforts by Dominica, Saint Lucia and St. Vincent and the Grenadines to implement specific (integrated) pilot adaptation measures addressing the impacts of climate change on the natural resource base of the region, focused on biodiversity and land degradation along coastal and near-coastal areas.
- Objective of the project will be achieved through: (i) the detailed design of pilot adaptation measures to reduce expected negative impacts of climate change on marine and terrestrial biodiversity and land degradation; and (ii) the implementation of pilot adaptation investments.

Overview of the SPACC Project (2007-2011)

- Reducing these impacts will primarily result in protection of biodiversity and prevention of land degradation but will also induce economic benefits in the tourism, fisheries, agriculture and forestry sectors, help maintain the resource base upon which these economic activities rely and promote climate resilient sustainable development.

Climate & Environmental Change Monitoring & Agreement Verification

- Demonstration of agreement of compliance with multilateral and bi-lateral climate mitigation agreements will require sophisticated climate and environmental monitoring agreements which could include expansion of existing networks and development of new techniques.
- For resource limited developing and least developed states in the Caribbean, history indicates that achieving and sustaining such sophistication will be challenging and is prone to failure without political will and the assistance of regional and international institutions.