National level products generation including calibration aspects

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May 30 – June 1, Barcelona, Spain

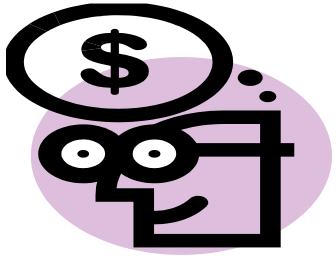
Forecast Value

Forecast quality

- Do the forecasts correspond well with the observations?

  Speaks to: **goodness of forecasts**

Forecast value



- Do the forecasts enable beneficial decisions?

  Speaks to: **usefulness of services**

Hagedorn, R., and L. A. Smith, 2008: Communicating the value of probabilistic forecasts with weather roulette. *Meteor. Appl.*, DOI: 10.1002/met.92.

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Increasing the value of climate forecasts at the national level

What attributes?

- **Good forecasts:**
  - **Accurate**
  - **Reliable** (= well calibrated)
  - **Sharp** (= limited uncertainty/very high probabilities)

- **Useful forecasts:**
  - **Timely**
  - **Understandable**
  - **Salient** (= relevant)
  - **Contextualised** (= previous + usual climatological context and climate impacts)

- **Manageable operations:**
  - **Cost-effective**
  - **Sustainable**

Ideas on priorities for operational climate prediction services at the national *vs* regional *vs* global scale

	National (NMHS/NCC)	Regional (RCC)	Global (GPC)
Goodness	**3**	**2**	**1**
Usefulness	**2**	**1**	**2**
Manageability	**1**	**3**	**3**

Ideas on priorities for operational climate prediction services at the national *vs* regional *vs* global scale

	National (NMHS/NCC)	Regional (RCC)	Global (GPC)
Goodness	**3**	**2**	**1**
focus	How to provide prediction services that correctly distinguish the observed outcome from other outcomes, with minimum uncertainty?	How to develop a minimum, common standard across NMHSs that strike the best balance between cost-effectiveness and goodness?	How, using the best available science, to produce state of the art operational prediction products?
Usefulness	**2**	**1**	**2**
Manageability	**1**	**3**	**3**

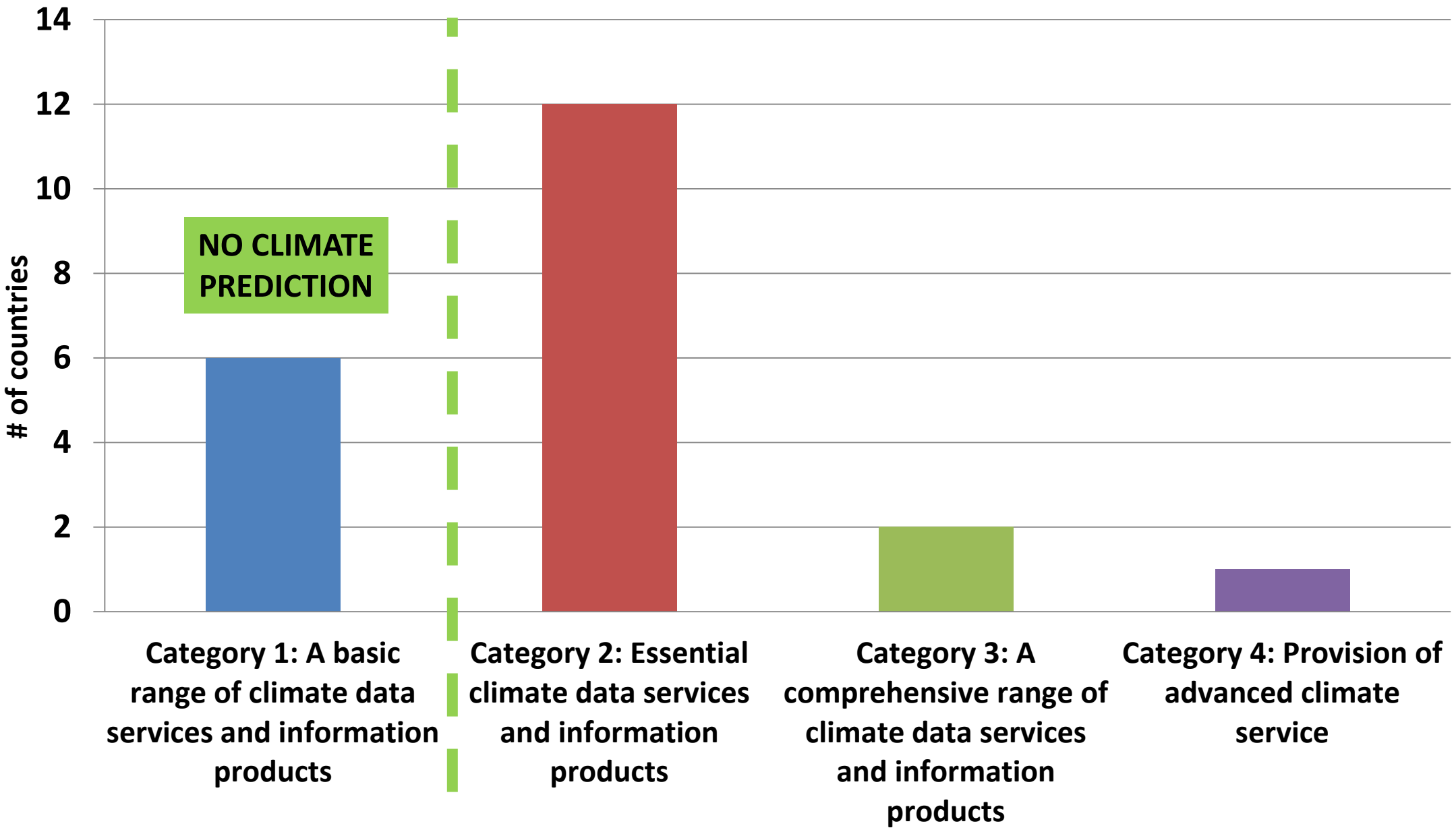
Ideas on priorities for operational climate prediction services at the national *vs* regional *vs* global scale

	National (NMHS/NCC)	Regional (RCC)	Global (GPC)
Goodness	3	2	1
focus	Reduce uncertainty → **need for techniques for sharper forecasts**	Common standard	State of the art prediction
Usefulness	**2**	**1**	**2**
focus	How to tailor the format of services to meet sectoral user needs?	What climate capacity is necessary at the national scale to provide (context to) forecasts?	What climate variables do RCCs and NMHSs require predictions for?
Manageability	**1**	**3**	**3**

Ideas on priorities for operational climate prediction services at the national *vs* regional *vs* global scale

	National (NMHS/NCC)	Regional (RCC)	Global (GPC)
Goodness	**3**	**2**	**1**
focus	Reduce uncertainty → **need for techniques for sharper forecasts**	Common standard	State of the art prediction
Usefulness	**2**	**1**	**2**
focus	Tailored information needs → **Need for tailored presentation formats**	Climate capacity needs	Climate variables
Manageability	**1**	**3**	**3**
focus	Given user needs, what can we sustainably provide and at what timescales?	What tools are needed within the NMHSs? And, if too resource demanding, what services to provide regionally?	How to optimise infrastructural, technical and human resource capacity?

Capacity of Caribbean NMHSs to deliver Climate Services



CIMH

CariCOF
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Need for automation

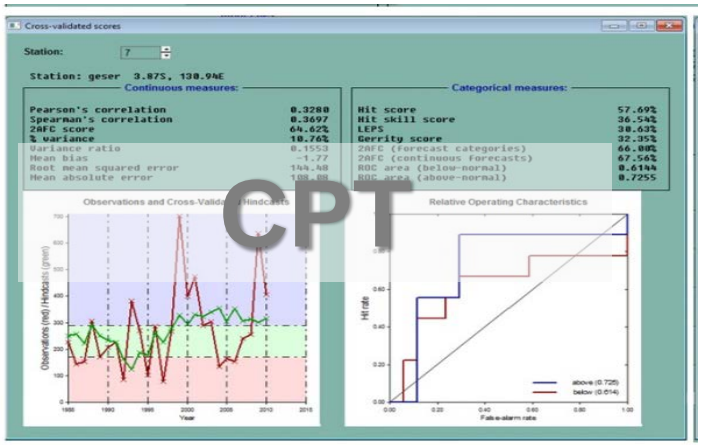
Automation of climate forecast generation

- Automation for Category 1 and 2 NCCs/NMHSs should:
  - help alleviate their limited **human and procedural capacity** in climate prediction;
  - build a **common standard methodology** for calibrated, objective seasonal forecasting within the context of Regional Climate Outlook Forums (RCOFs);

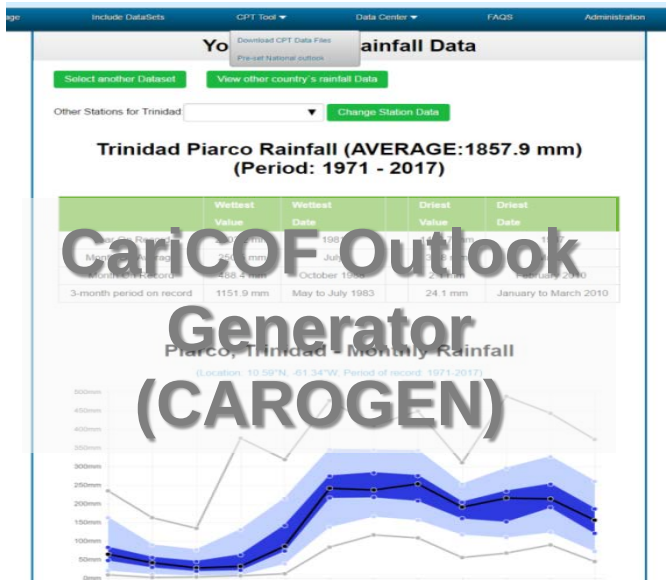
- By adopting a common standard methodology across NMHSs and their RCC, an NMHS can:
  - strive for an optimal balance of **accuracy, reliability and sharpness** of forecasts;
  - ensure **comparability** of results between countries;
  - maximise the potential of **peer-to-peer learning and support** between climate prediction providers;
  - **reduce biases** arising from different personnel issuing different outlooks;
  - enhance the **authority of the provider**.

Automation and standardisation of Climate Outlooks for Caribbean NMHSs: CAROGEN & CPT

- CAROGEN is a platform for Caribbean NMHSs and the Caribbean RCC to **generate and visualise forecasts** that drive seasonal climate outlooks, developed by the Caribbean RCC.



- CAROGEN adopts CariCOF's methodological standards of objective seasonal forecasts.
- It utilises the **Climate Predictability Tool (CPT)** to make ensemble-based forecasts based on Canonical Correlation Analysis.
- In addition, CAROGEN allows:
  - NMHSs to submit and **access historical temperature and precipitation** data;
  - **public access** to climatological norms, summary climate statistics, and monitoring tools for rainfall and temperature for all weather stations.

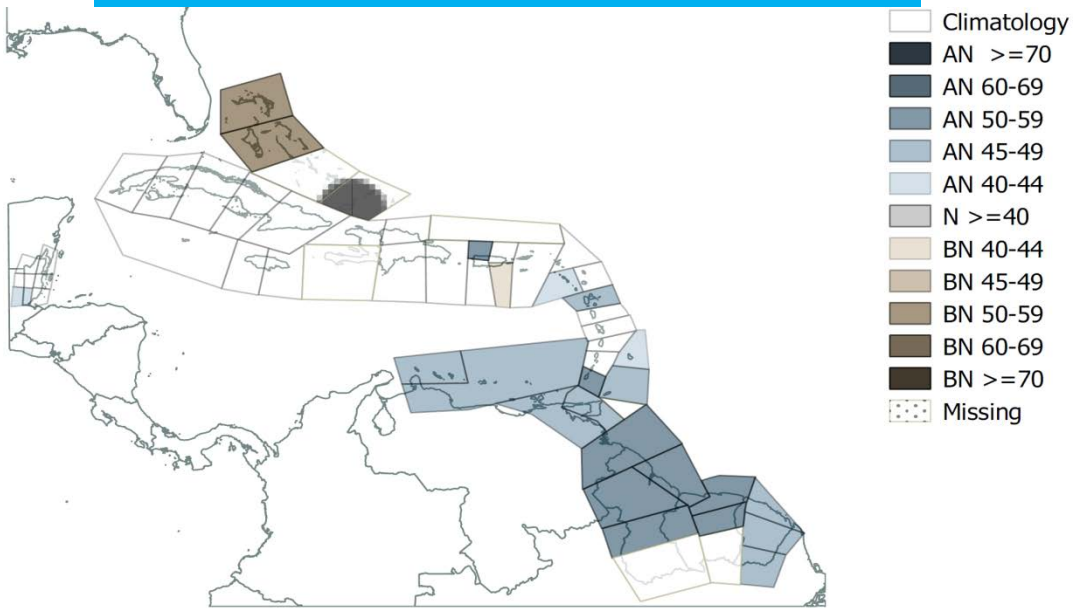


- CAROGEN has **reduced the time** required to produce seasonal forecast products by 70%.

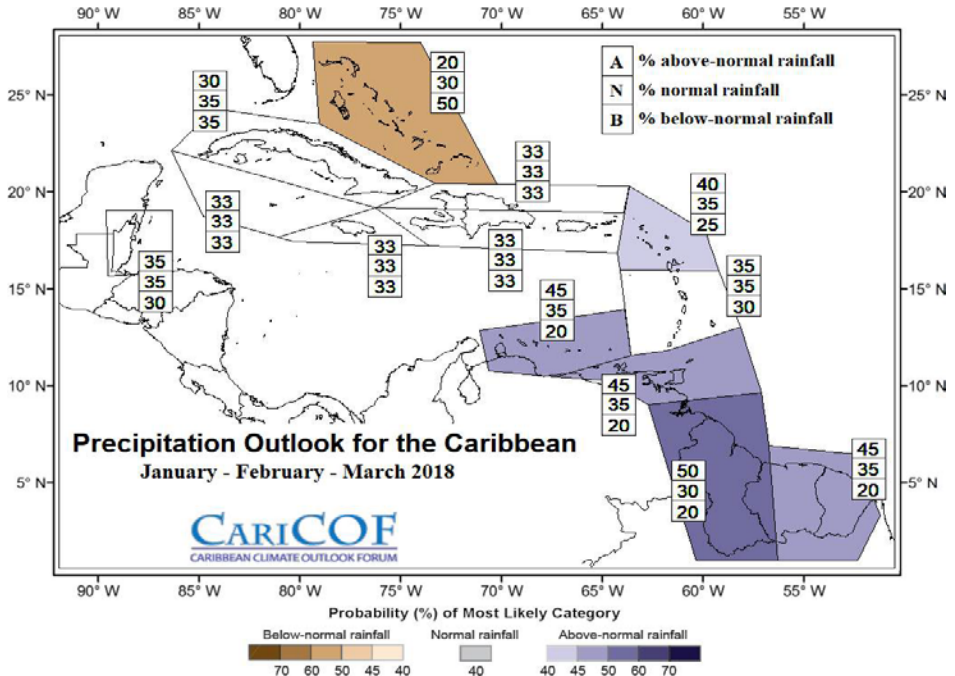
Calibrated climate forecasts facilitated by automation

- Automation allows for **consistent ensembles** to feed into climate outlooks
  - making ensemble forecasts (with members built with a variety of largely independent predictors) gives a more realistic rendition of forecast uncertainty;
  - given the adoption of a common standard between NMHSs and RCCs, **RCOF type consensus-based climate outlooks** can then be produced **largely objectively**.

Area-averaged ensemble mean three-month precipitation forecast



CariCOF three-month precipitation outlook

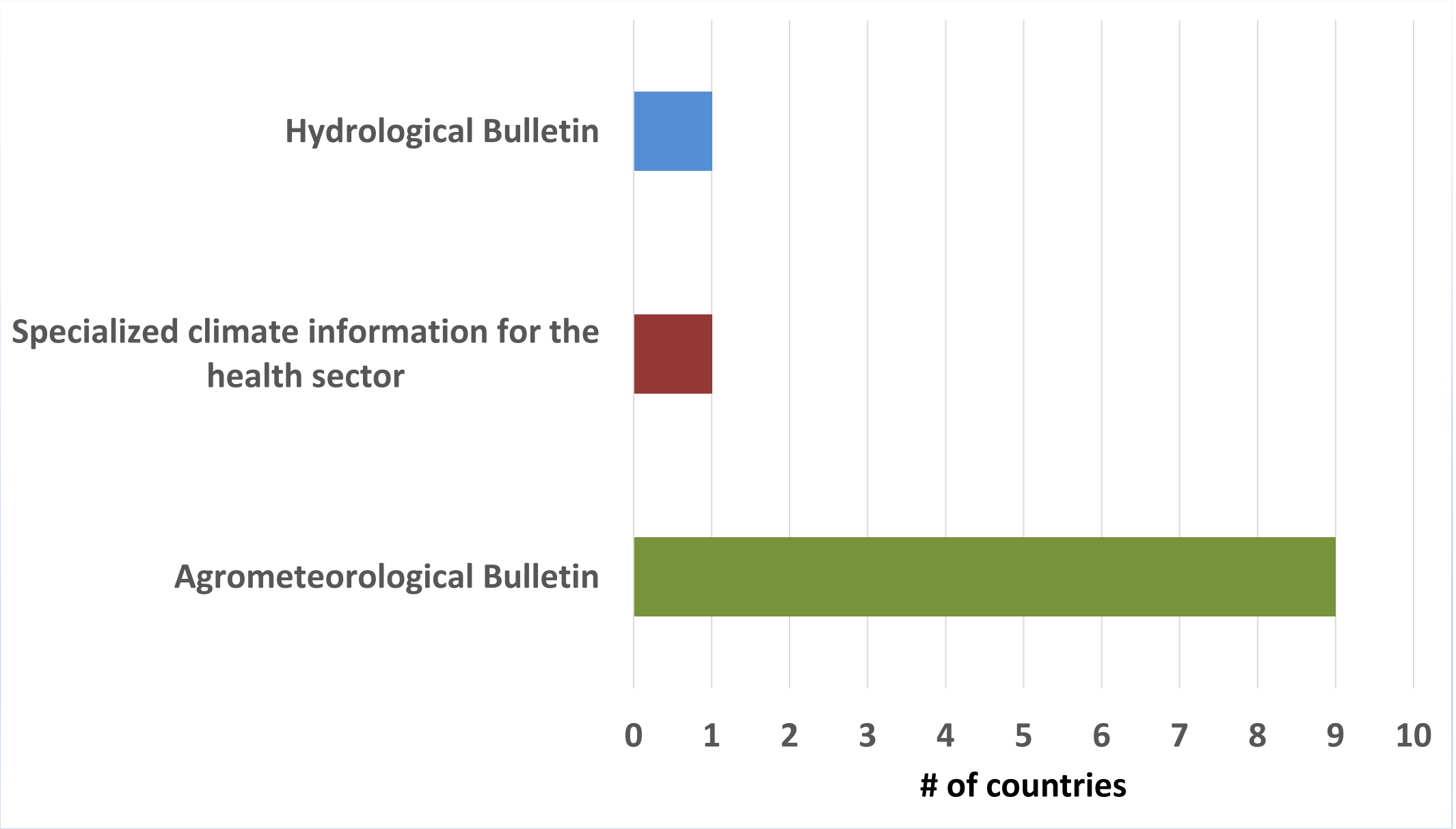


Need for tailored presentation formats

Need for tailored presentation formats

- Traditionally, seasonal climate forecasts are presented using tercile-based probabilities (i.e. Pr.(AN), Pr.(NN), Pr.(BN)) of seasonal averages or totals of climate variables
- … but:
  1. users more interested in **hazard probabilities** (e.g. drought level *vs.* precipitation totals);
  2. little correspondence between terciles and **impact thresholds**, reducing the relevance of outputs to decision makers;
  3. users require **contextualisation** of the forecasts to foresee potential implications.
- Alternatively, climate forecasts can be:
  - **hazard-specific** → focusing e.g. on drought risk levels, probability of extreme rainfall, numbers of heatwaves or dry spells, etc.
  - **contextualised** → including climate monitoring, historical climatology and climate impacts information
  - **sector-specific** → focusing e.g. on packaging existing information relevant to sector outcomes, and/or producing impact-based forecasts

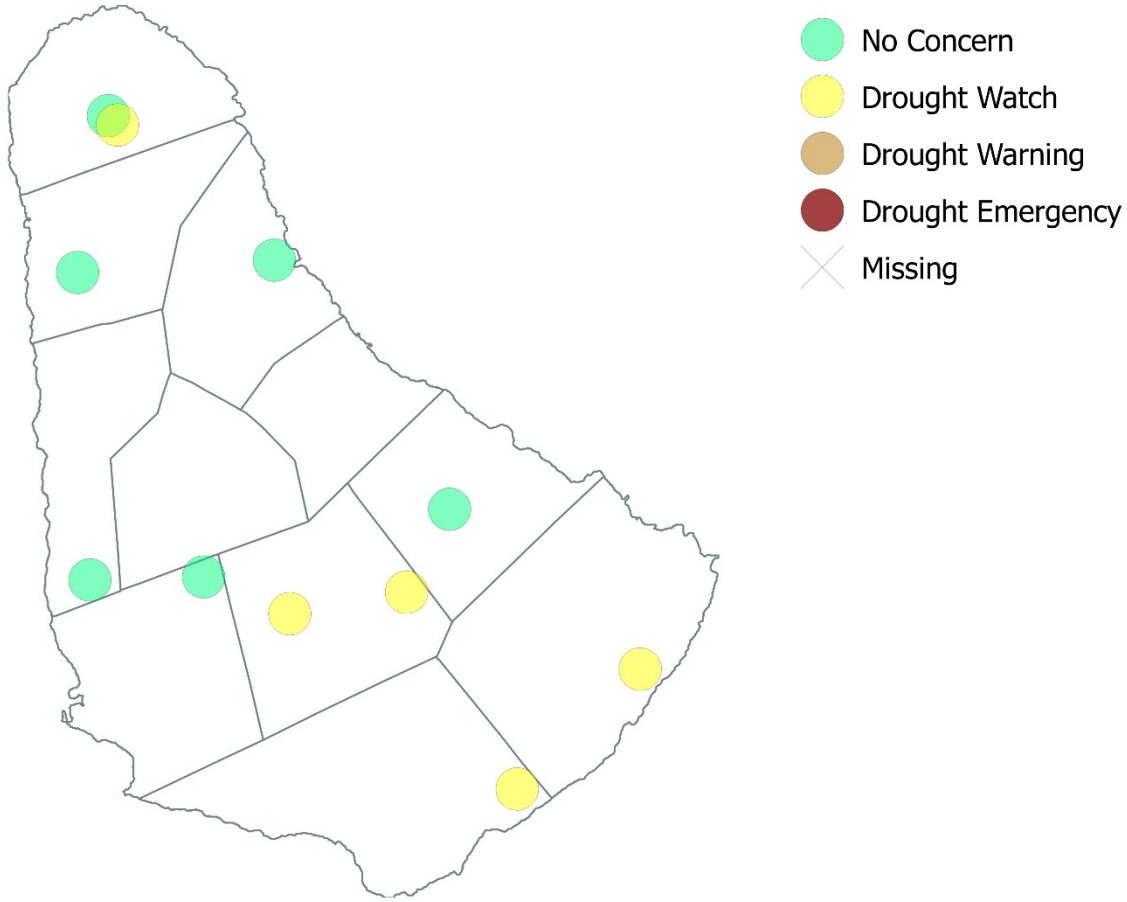
Lack of specialised climate products in many Caribbean NMHSs



n=22

Hazard-specific products - National Drought Outlook

Short-term drought situation in Barbados by the end of August 2018:

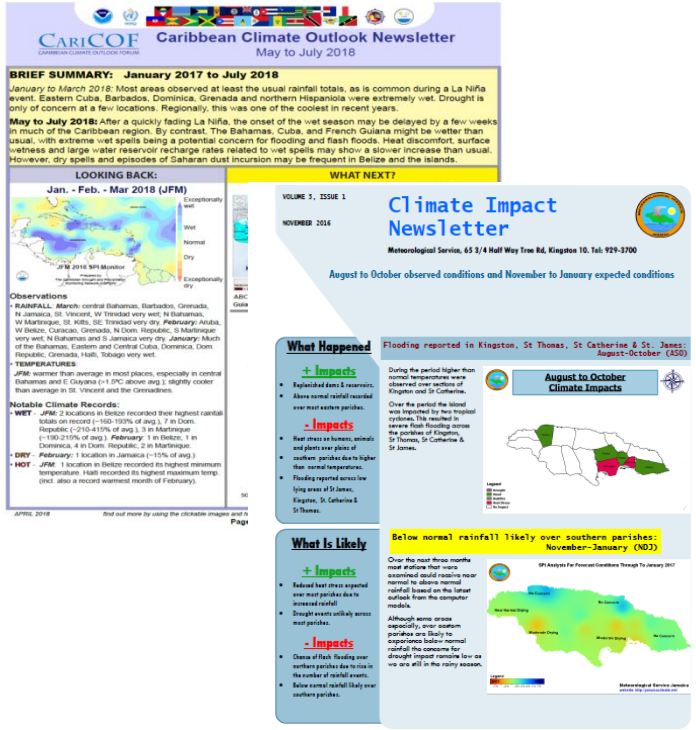


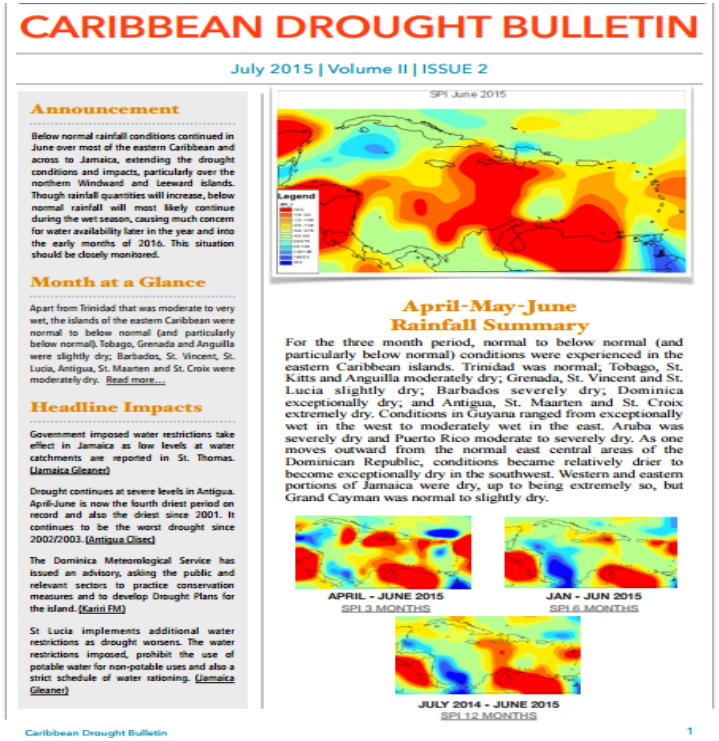
Forecast:
Drought might possibly develop in Christ Church, St. George and St. Phillip. **However, major impacts are unlikely**.

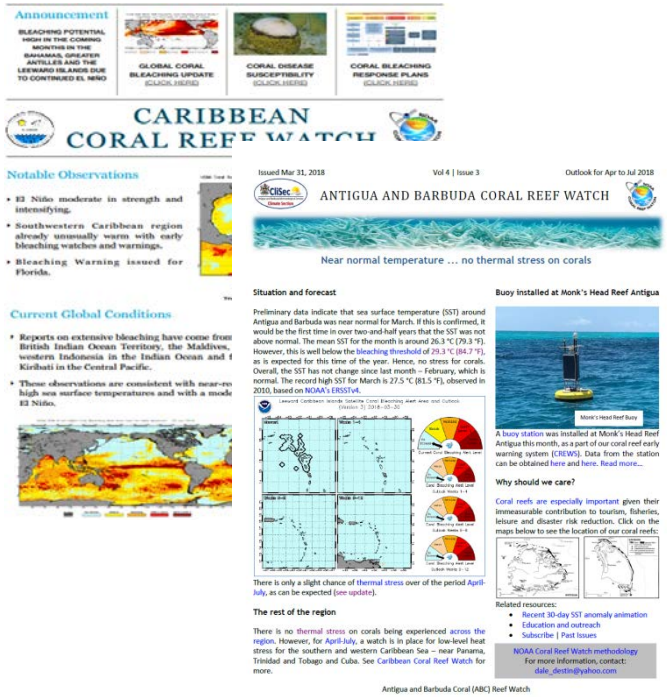
Action level:

- ✓ Protect resources and conserve water
- ✓ Implement management plans
- ✓ Response training
- ✓ Monitor and repair infrastructure

Contextualised information - Newsletters/Bulletins







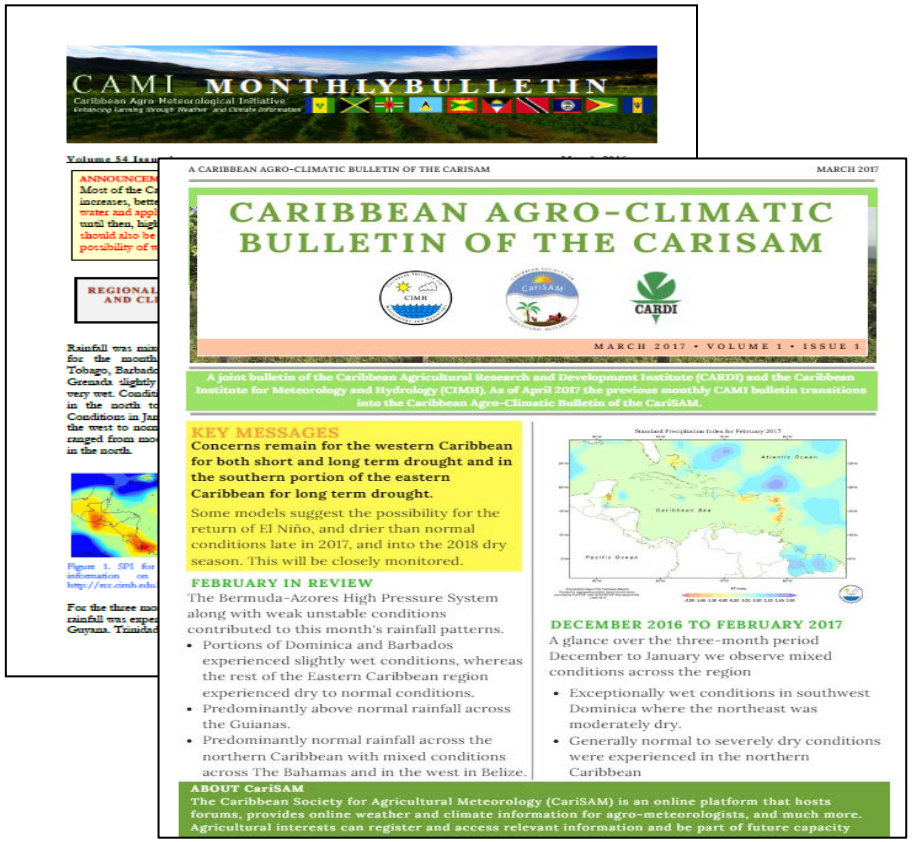
Climate newsletters

Drought bulletin

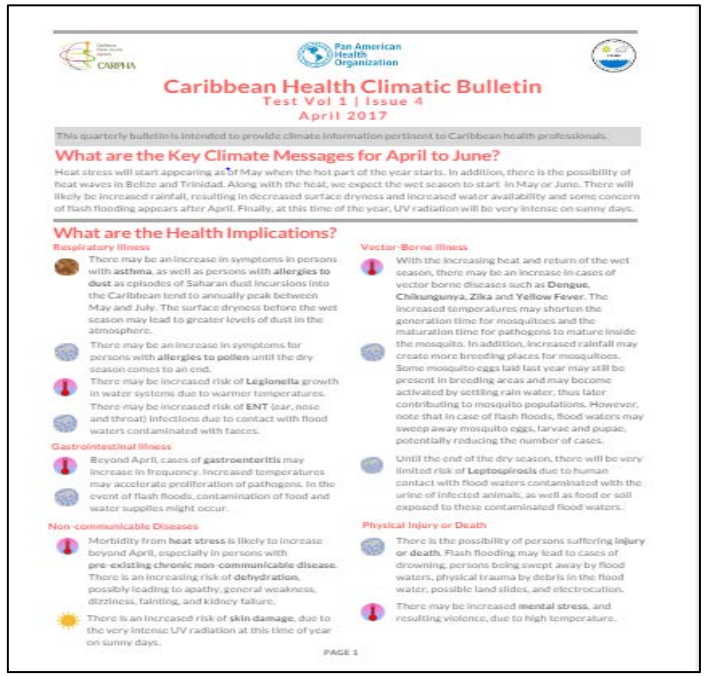
Coral Reef Watches

Partnering with NOAA, USA

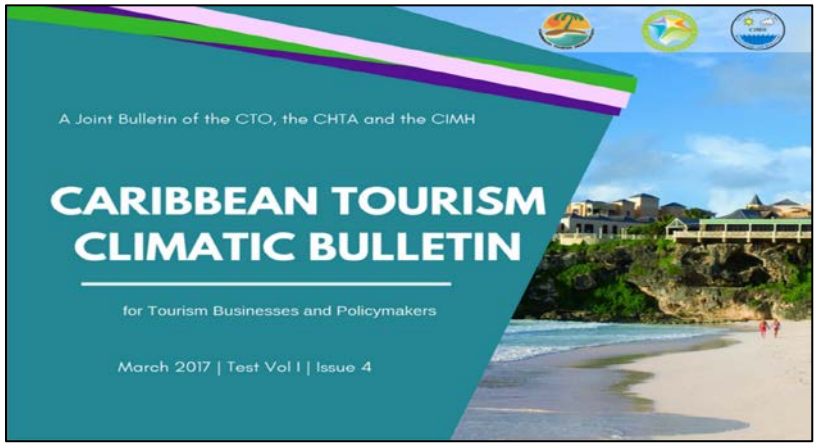
Sector-specific climate bulletins in the Caribbean



Regional CAMI Bulletin (since 2011), now the Caribbean Agro-Climatic Bulletin of the CariSAM



New Health-Climatic Bulletin (since May 2017)



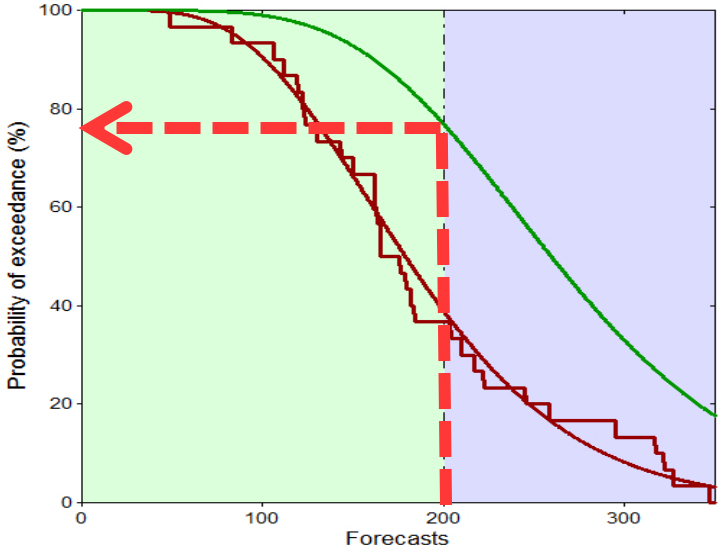
New Tourism-Climatic Bulletin (since May 2017)

- Key messages – quick information
- Recent related news and weather and climate related impacts
- Climate Smart Advisories – implications of the climate information – how to reduce risk of loss and disaster
- to be developed – national bulletins

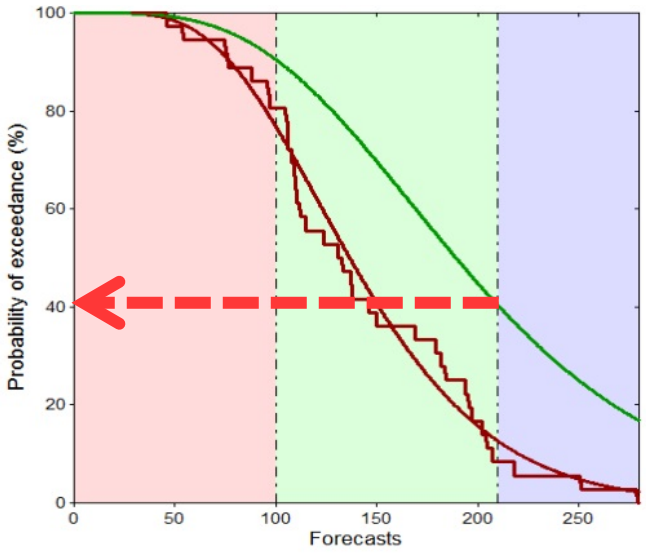
Sector-specific impacts-based forecasts

- **Exceedance probabilities** relate to impact levels, because thresholds are sector outcome specific.
- For example, precipitation exceedance forecasts can speak to the risk level of **crop water requirement** not being met during critical periods of the growing season.

Probability of meeting water demand for sweet potato



Probability of meeting water demand for sugar cane



Need for techniques for sharper forecasts

Need for techniques for sharper forecasts

- Traditionally, seasonal climate forecasts are presented using tercile-based probabilities (i.e. Pr.(AN), Pr.(NN), Pr.(BN)) of seasonal averages or totals of climate variables.

- This format offers several advantages:
  - succinct way of expressing the **probabilistic nature** of climate forecasts;
  - identify the **confidence** of the forecaster w.r.t. the expected outcome;
  - **large expertise base** within WMO at the global, regional and national levels.
- … but:
  1. users more interested in **hazard probabilities** (e.g. drought level *vs.* precipitation totals)
  2. little correspondence between terciles and **impact thresholds**, reducing the relevance of outputs to decision makers;
  3. tendency to "**hedging**" of forecasts, such that probabilities are not really tied to confidence;
  4. even if 1, 2 and 3 are not a problem, **probabilities are often too low** to support different user decisions;
  5. such climate forecasts are **anomaly forecasts**, which remove the climatological seasonality in events such as dry spells or heat waves.

- Problems 3, 4 & 5 can be addressed by adopting novel techniques that improve sharpness.

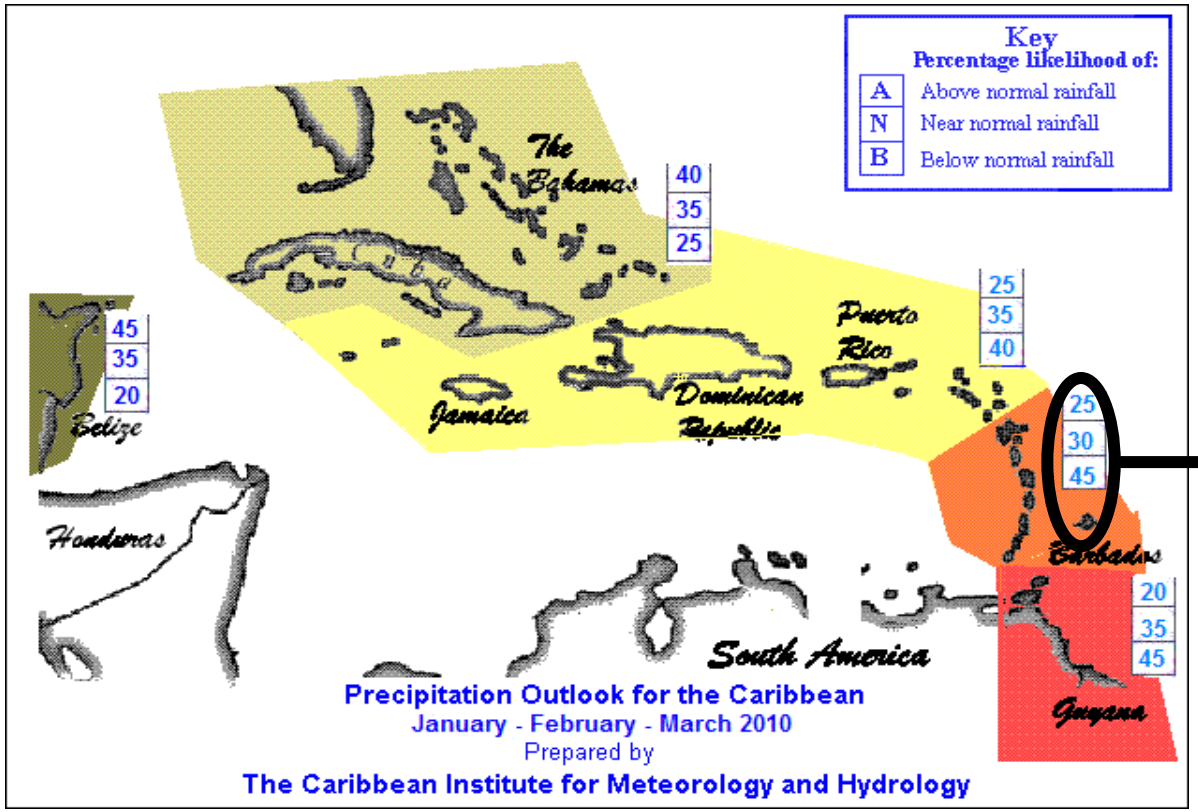
A few techniques for sharper forecasts

- For slow onset hazards, such as drought, the climate anomaly can be monitored before becoming impactful.
- Adding persistence = adding certainty to an uncertain forecast of **slow onset** events

- For fast onset hazards, such as flash floods, forecasting the occurrence of rainfall is easier than to forecast rainfall totals.
- Forecasting occurrence = reducing the uncertainty of **extreme rainfall** forecasts

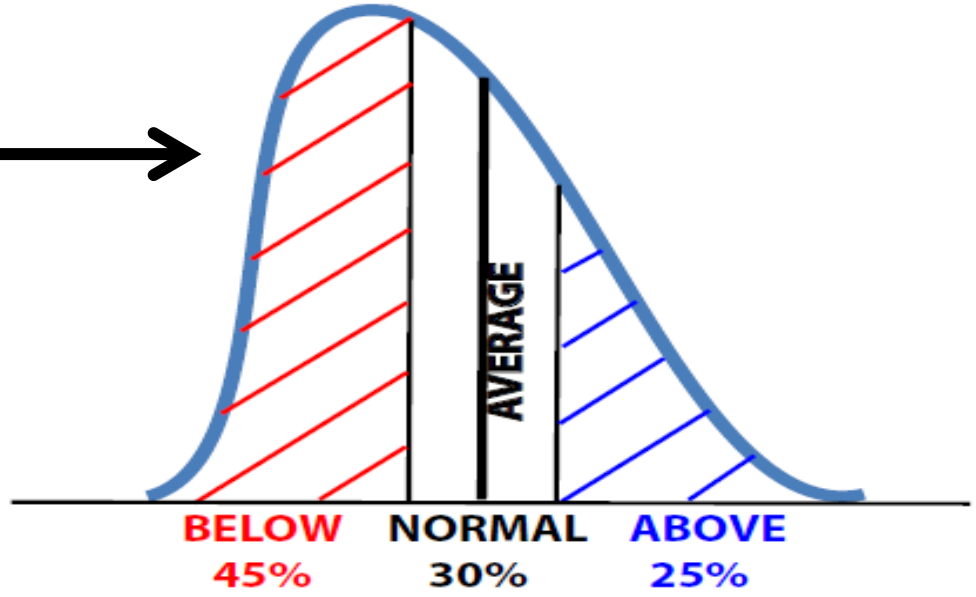
- Forecasting **frequency ranges** of events within a period, such as the number of hurricanes, heatwaves or dry spells, within a season reduces the uncertainty by including the climatological seasonality.

Adding persistence - example: drought forecasts



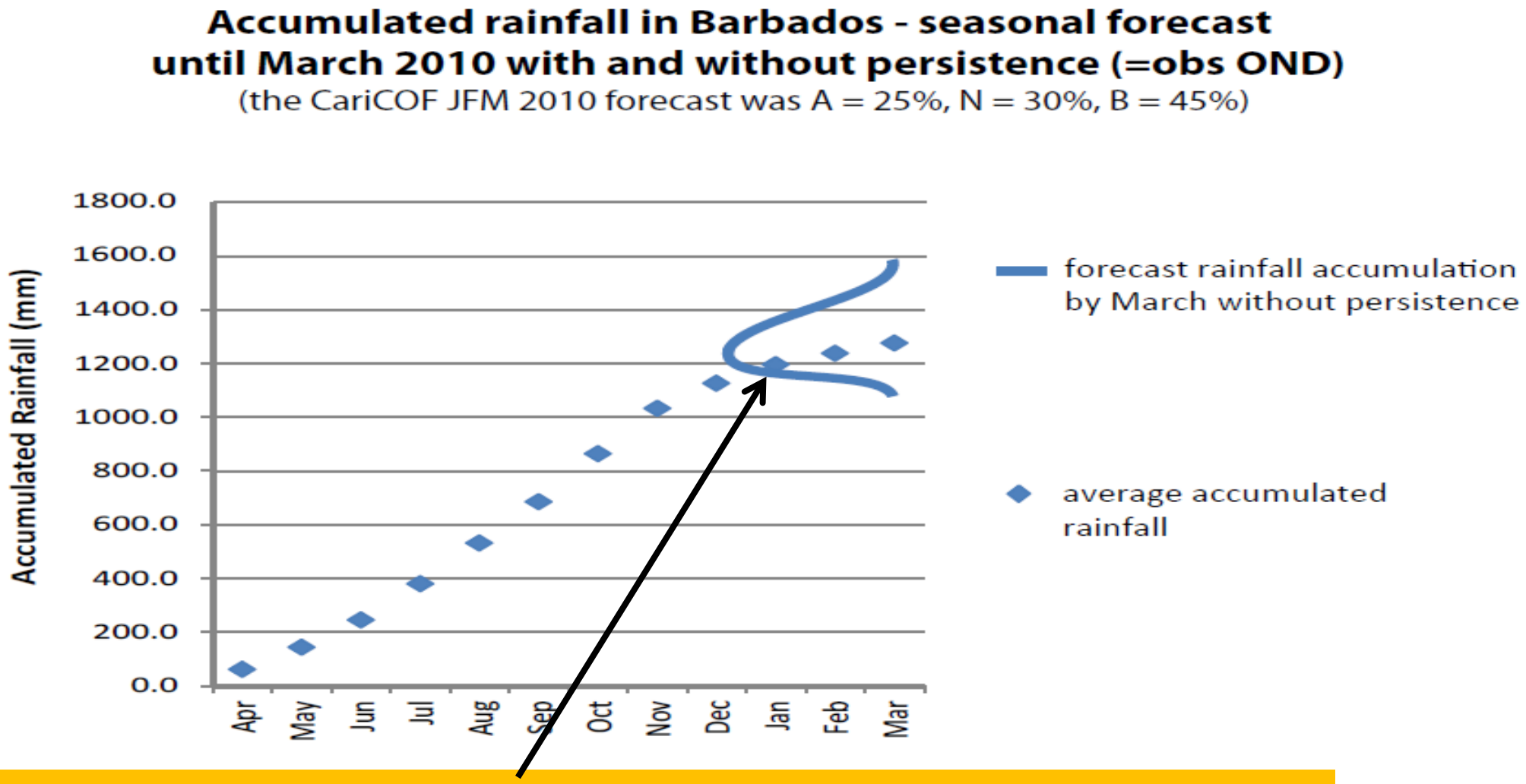
CIMH seasonal forecast for Barbados for January-February-March 2010

(A = 25%, N = 30%, B = 45%)



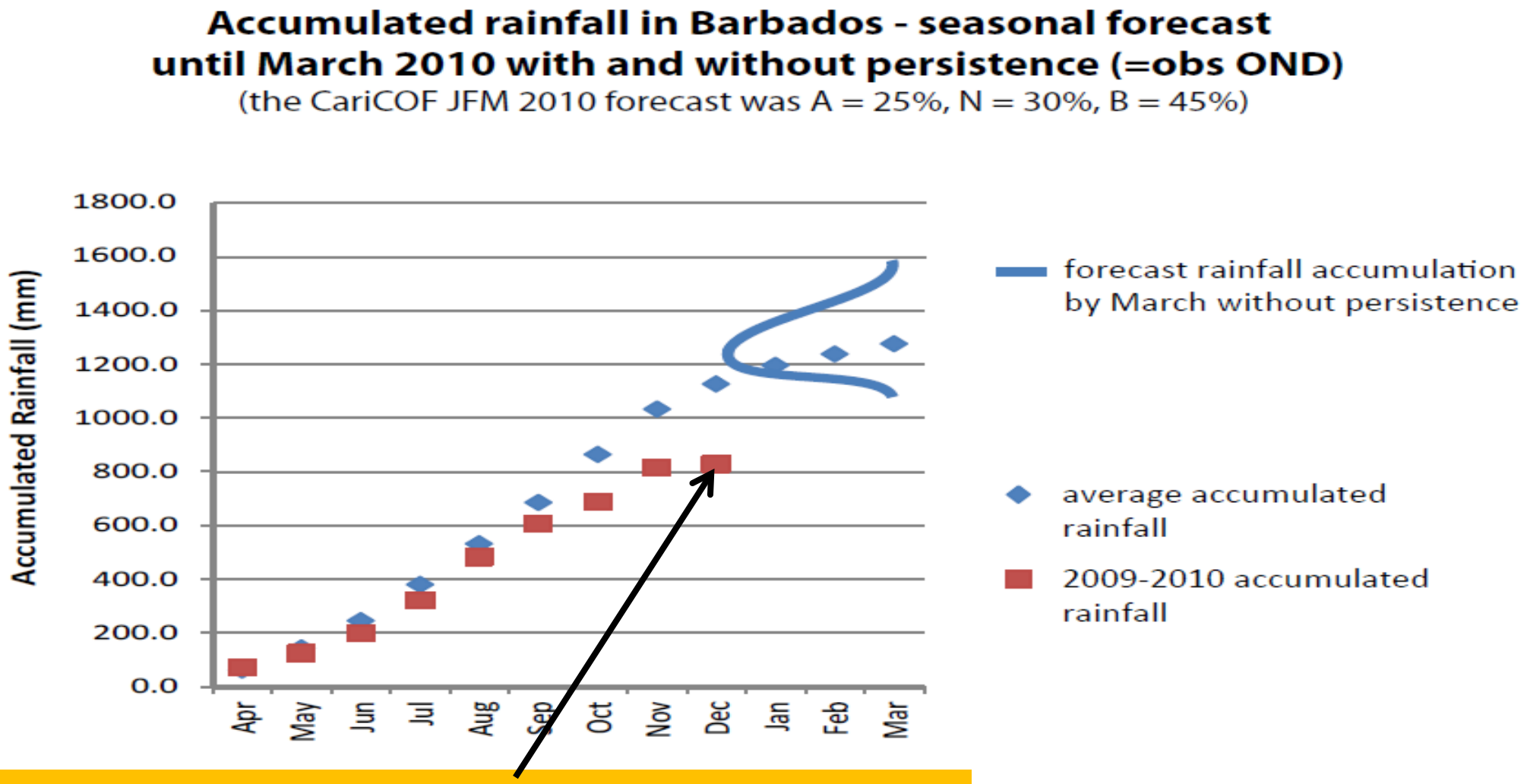
HOW MUCH RAINFALL WE EXPECTED IN JFM

Adding persistence - example: drought forecasts



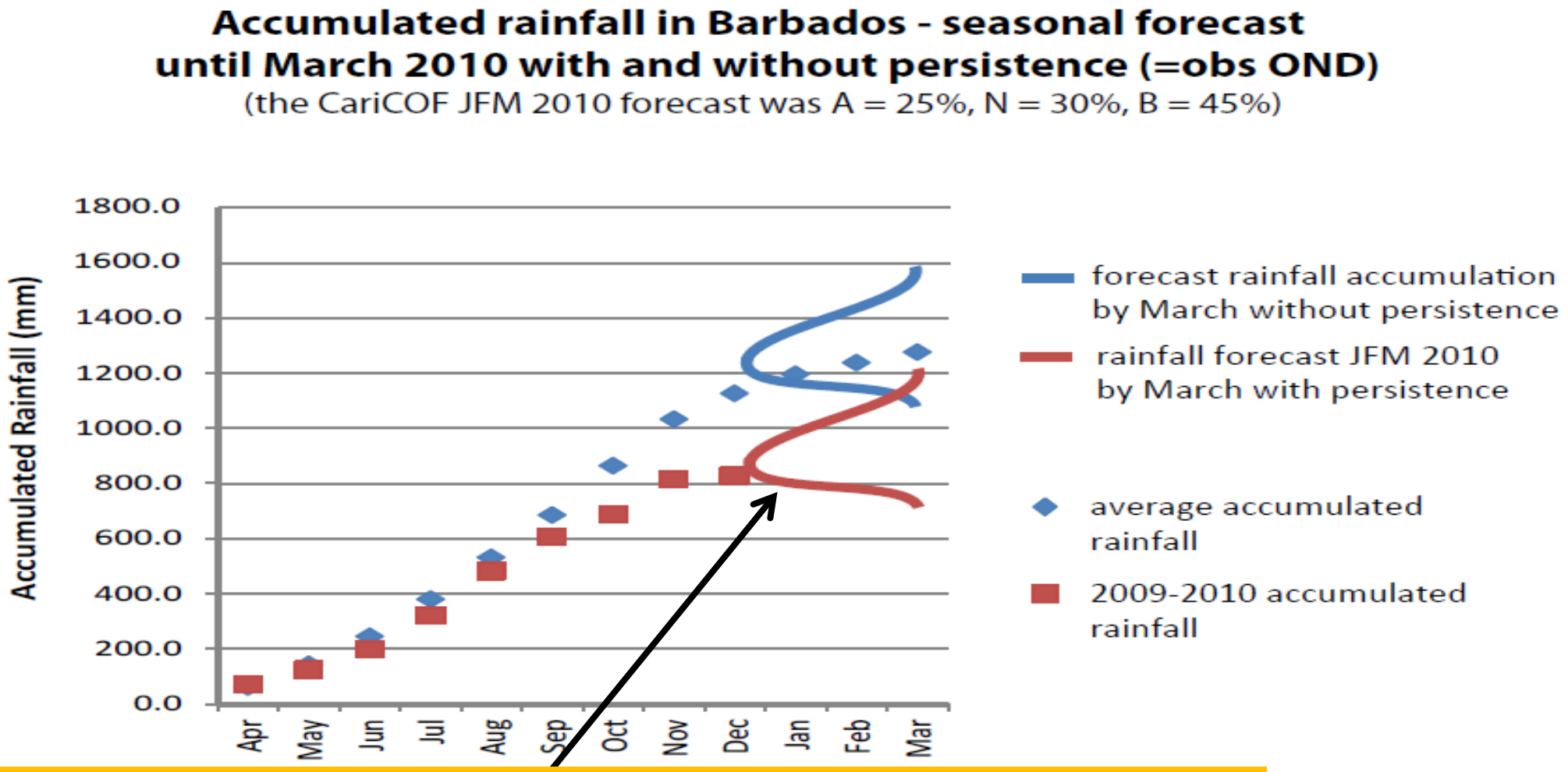
TRADITIONAL SEASONAL RAINFALL OUTLOOK

Adding persistence - example: drought forecasts



HOW MUCH RAIN FELL SO FAR?

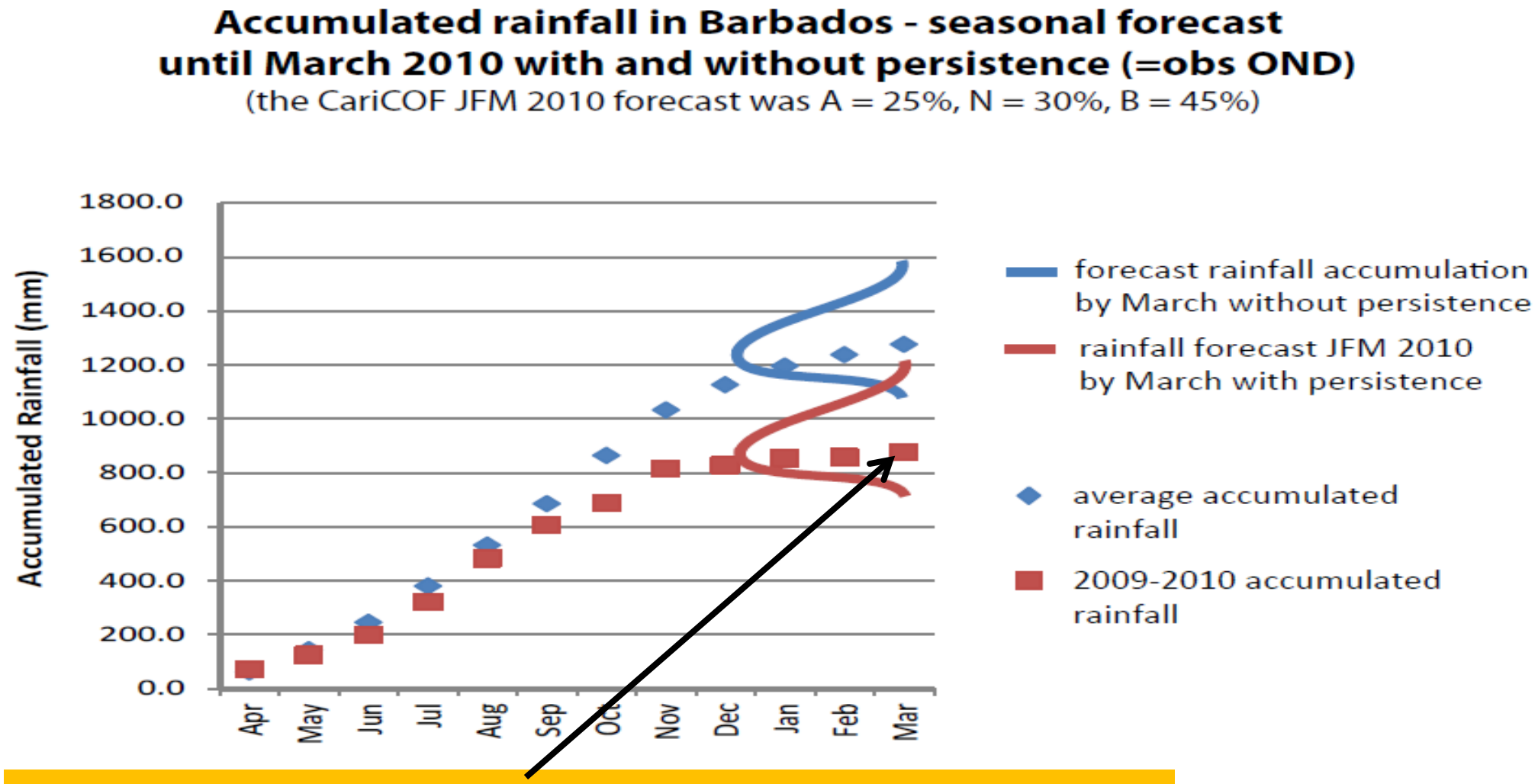
Adding persistence - example: drought forecasts



SAME SEASONAL RAINFALL FORECAST …

but adding in observed rainfall surplus/deficit

Adding persistence - example: drought forecasts

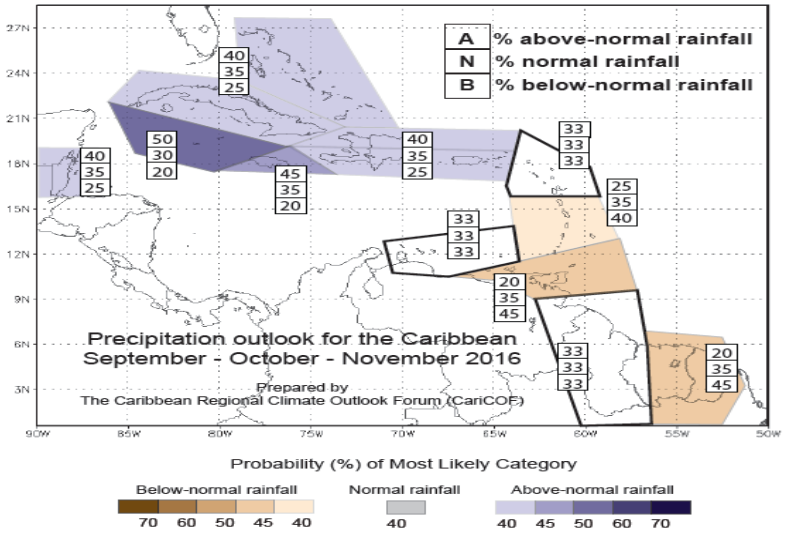


THIS IS WHAT ACTUALLY HAPPENED!!

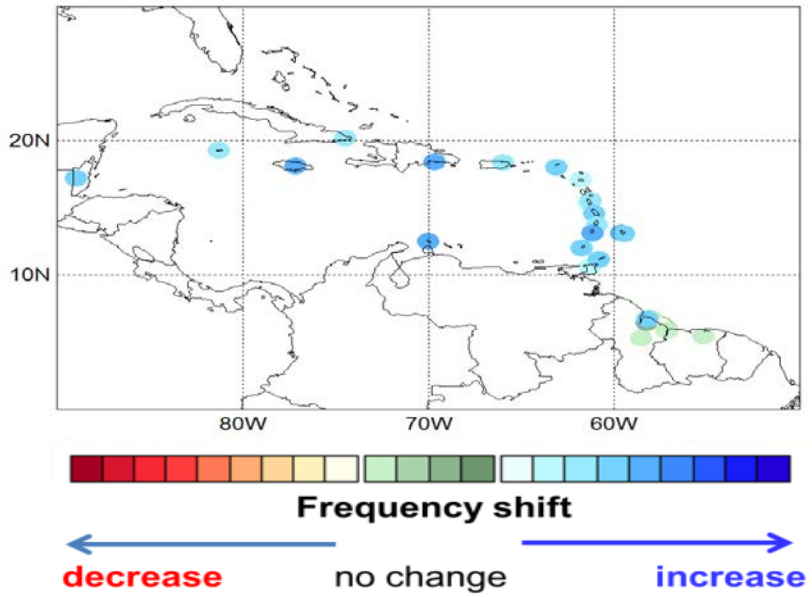
Forecasting wet spell occurrence

- Forecasting occurrence = reducing the uncertainty of **extreme rainfall** forecasts
- Forecasting **frequency ranges** of events within a period, such as the number of hurricanes, heatwaves or dry spells, within a season reduces the uncertainty by including the climatological seasonality.
- Forecasting occurrence of dry or wet spells within a season **adds detail/context** to a seasonal precipitation forecast.

Sep. – Oct. – Nov. 2016 Precipitation Outlook



Sep. – Oct. – Nov. 2016 forecast frequency of *extreme (top 1%)* **3-day wet spells**



Ideas on priorities for operational climate prediction services at the national *vs* regional *vs* global scale

	National (NMHS/NCC)	**Regional** (RCC)	**Global** (GPC)
Goodness			**TOP PRIORITY?**
focus	Reduce uncertainty → **need for techniques for sharper forecasts**	Common standard	State of the art prediction
Usefulness	**TOP PRIORITY** (*once operations are sustainable*)	**TOP PRIORITY**	
focus	Tailored information needs → **Need for tailored presentation formats**	Climate capacity needs	Climate variables
Manageability	**TOP PRIORITY** (*to get started*)		
focus	Sustainable provision → **Need for automation**	Tools provision Regional services needs	Resource optimisation

Thank you

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