Assessing the skill of seasonal rainfall outlooks for the Caribbean

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Outline

- Background – IRI and CIMH seasonal precipitation outlooks

- Why verifying the seasonal outlooks?

- How did we do it?

- Our findings

  - IRI / CIMH Forecast skill comparisons

  - Forecast skill variations

  - Take home messages

Operational seasonal rainfall forecasting

- **Reliable seasonal climate outlooks** form a regional cornerstone to the implementation of WMO's Global Framework for Climate Services (**GFCS**).

- Rationale: these outlooks help **mitigate substantial risks posed by climate variability**, thereby fostering sustainable development especially in highly vulnerable and hazard prone regions (such as the Caribbean).

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- Seasonal precipitation outlooks are mainly probabilistic forecasts usually presented in **tercile probabilities of 3-monthly rainfall sum**.

  - First tercile – below normal rainfall

  - Second tercile – normal rainfall

  - Third tercile – above normal rainfall
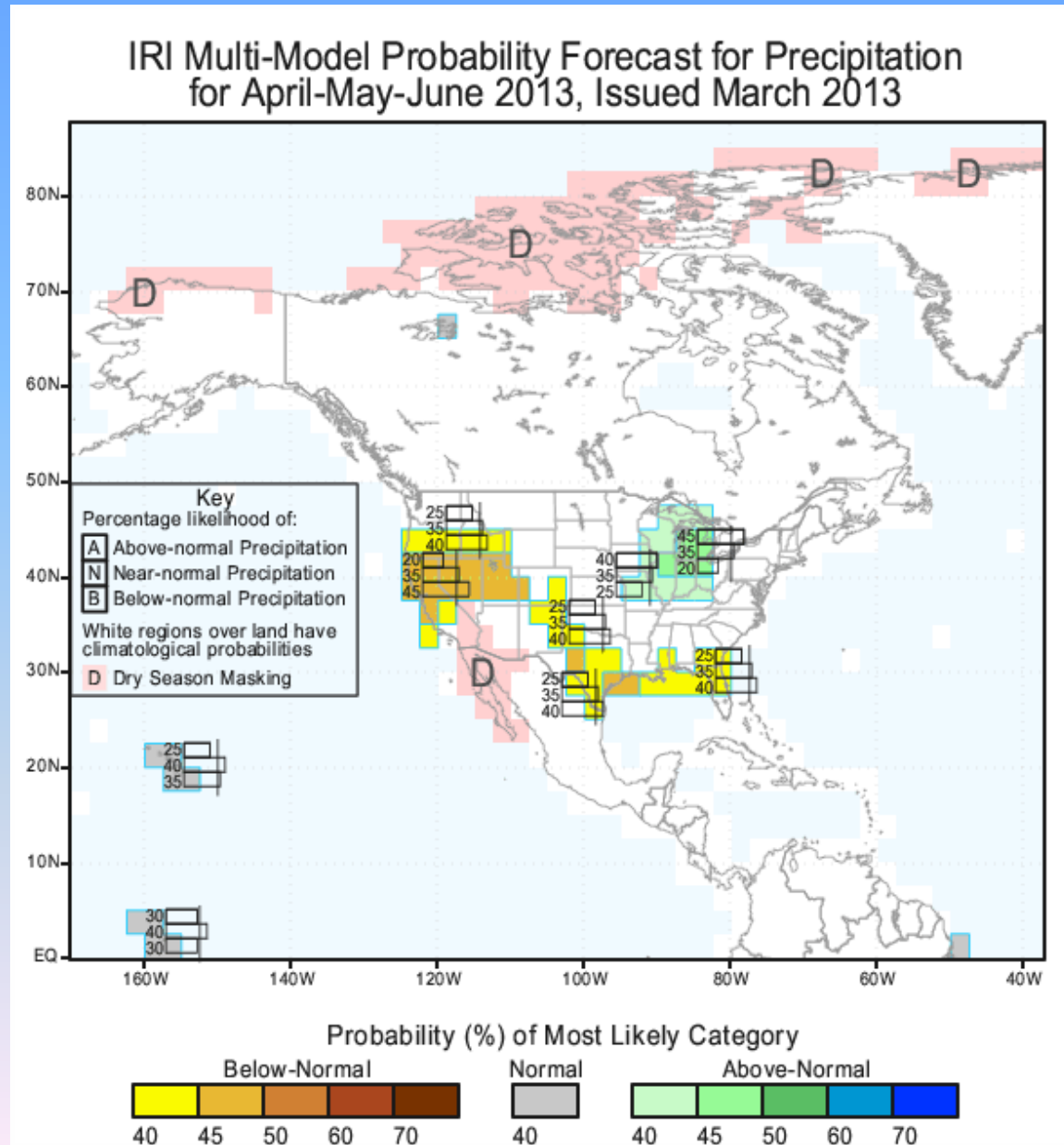
The IRI seasonal precipitation outlooks

- The **International Research Institute for Climate and Society (IRI)**'s prediction division has been producing **global operational seasonal forecasts** since 1997.

- 3-monthly tercile precipitation outlooks are produced each month using an **ensemble of dynamical climate models driven by observed sea surface temperature** (SST) anomalies. The rationale is that tropical SST patterns (such as El Niño) are the major driver of seasonal rainfall variability in the tropics.

Outlooks available at iri.columbia.edu/climate/forecast/net_asmt/

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- *NOTE: to support regional seasonal climate outlooks, IRI has developed the Climate Predictability Tool (**CPT**), a simple tool for **statistical forecasts** using methods such as Composite Correlation Analysis (CCA).*

Outlooks available at iri.columbia.edu/climate/forecast/net_asmt/

The IRI seasonal precipitation outlooks

IRI Multi-Model Probability Forecast for Precipitation for April-May-June 2013, Issued March 2013

The CIMH seasonal precipitation outlooks

- The Caribbean region – either *low lying coastal* or *Small Island* Developing States – is **particularly climate risk prone**. Given most territories are smaller than the resolution of most climate models, this warrants the production of **downscaled forecasts**.

- The **Caribbean Institute for Meteorology and Hydrology (CIMH)**, a regional WMO training and research institute for Meteorology, Hydrology and Climatology, has been producing downscaled tercile precipitation outlooks for the Caribbean since 2000.

Outlooks available at   www.cimh.edu.bb

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- Downscaling technique both subjective and objective:

  – Originally, **global model output** was only subjectively downscaled – on the basis of local climate expertise.

  – In most recent years, **CCA (with CPT)** has been used to add an objective component.
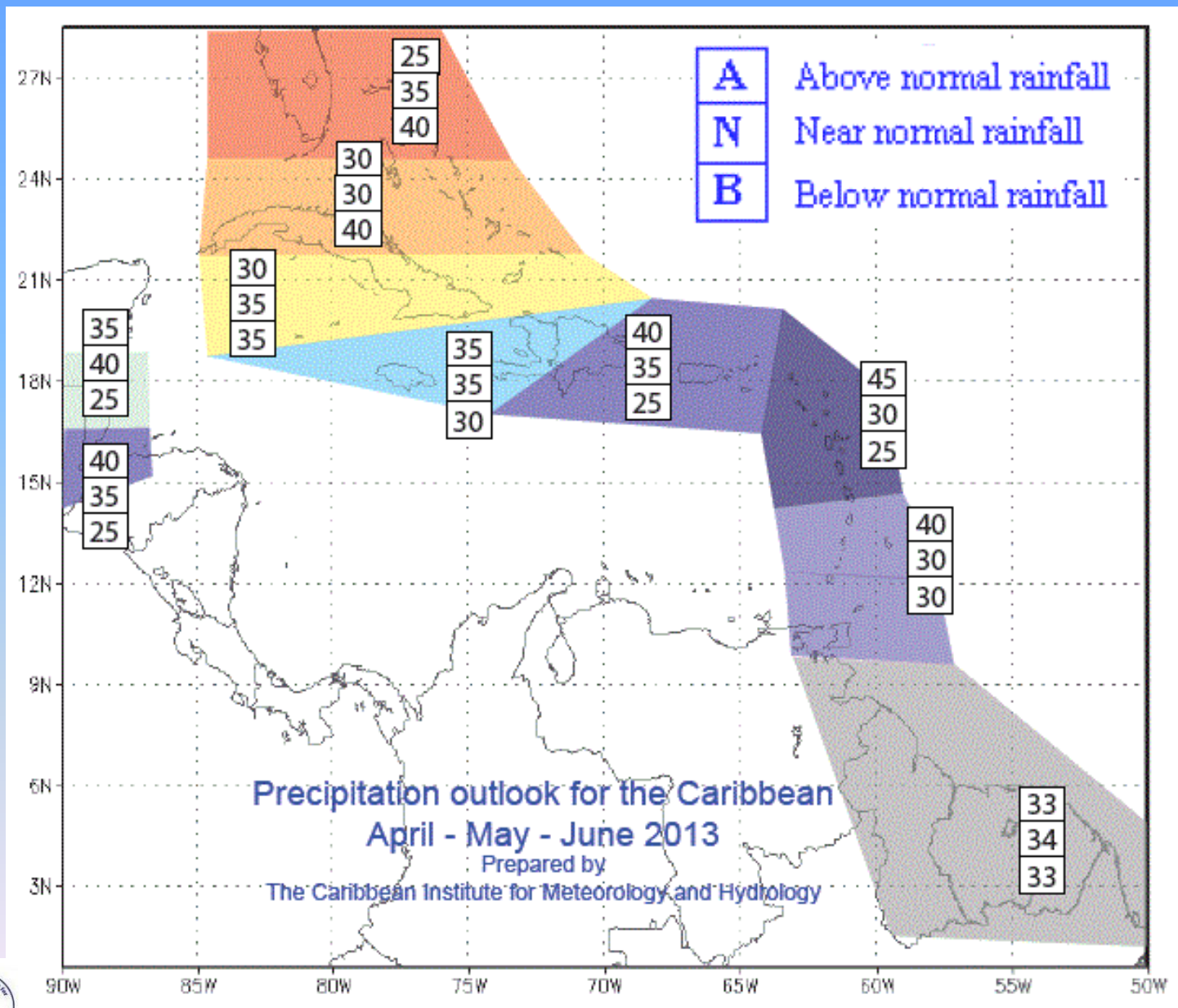
Outlooks available at   www.cimh.edu.bb

The CIMH seasonal precipitation outlooks

Verification – Why?

- CIMH's prediction system, is perceived to show limited reliability.

- Here, we present a quantitative assessment of the forecast skill of CIMH's and IRI's seasonal rainfall prediction systems as a first step in improving reliability and usefulness of the seasonal forecasts.

Verification – Why?

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- Here, we present a quantitative assessment of the forecast skill of CIMH's and IRI's seasonal rainfall prediction systems as a first step in improving reliability and usefulness of the seasonal forecasts.

- This assessment enables to answer below scientific questions:

1. (to what extent) does the perceived limited reliability of CIMH and IRI seasonal rainfall forecasts result from inherently low predictability?

2. (if not,) what improvements should be made?

Methods

- **Ranked Probability Skill Score (RPSS)** and **Heidke Skill Score (HSS)** were calculated for the IRI and CIMH forecasts to assess reliability across seasons and sub-regions.

  – The seasons: January-February-March (JFM), April-May-June (AMJ) and September-October-November (SON);

  – The sub-regions: Belize, the Greater Antilles, the Lesser Antilles and the Southern-most territories, comprising 19 Caribbean weather stations across 12 territories.

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- Skill scores were aggregated in four categories

  - **CAT 1** ≤ 0 -   negative skill

  - **CAT 2** $= 0 - 0.2$ -   poor skill

  - **CAT 3** $= 0.2 - 0.5$ -   good skill

  - **CAT 4** ≥ 0.5 -   very good skill

RESULTS

IRI and CIMH forecast skill – RPSS
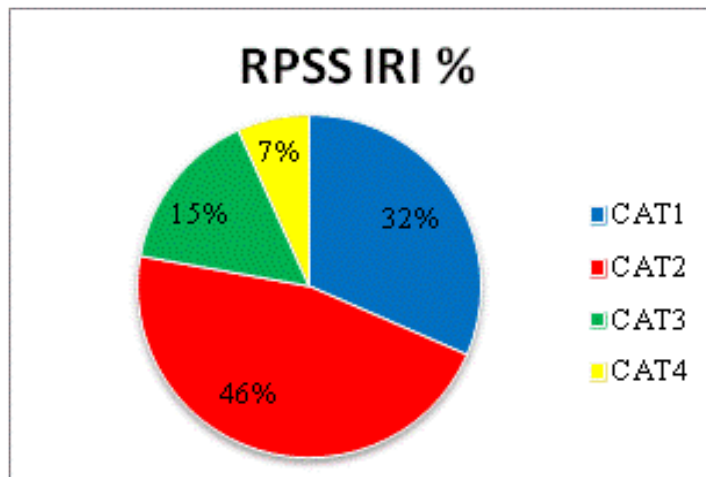
(a)
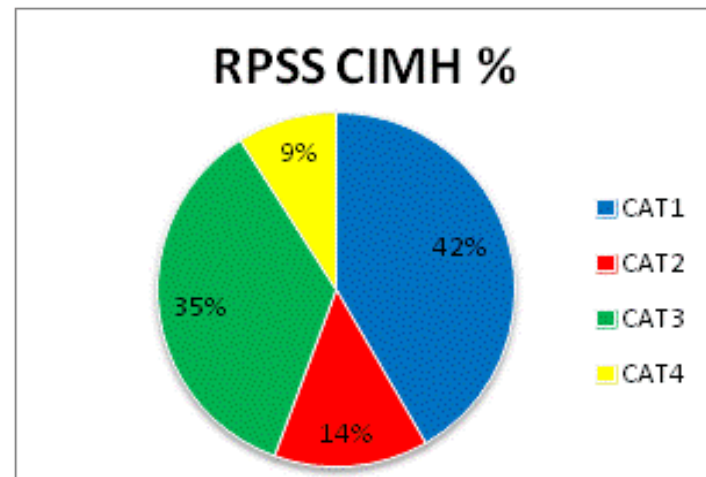
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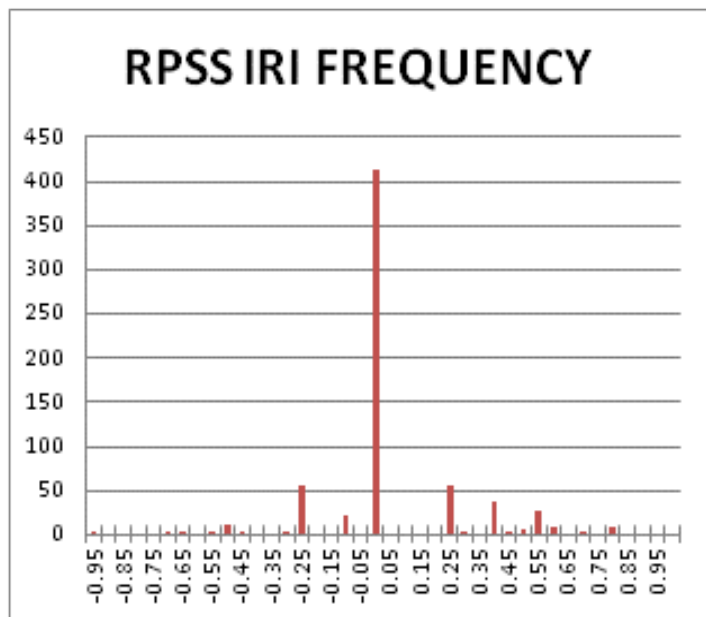
(c)
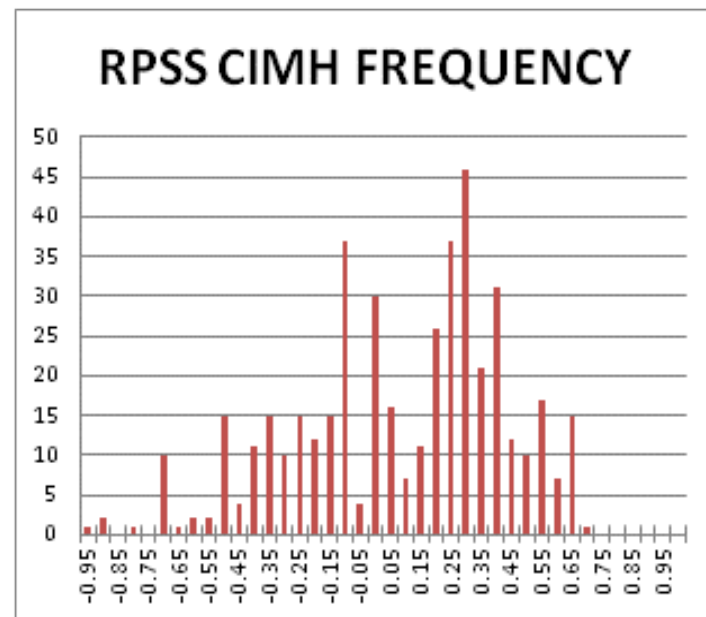
(d)
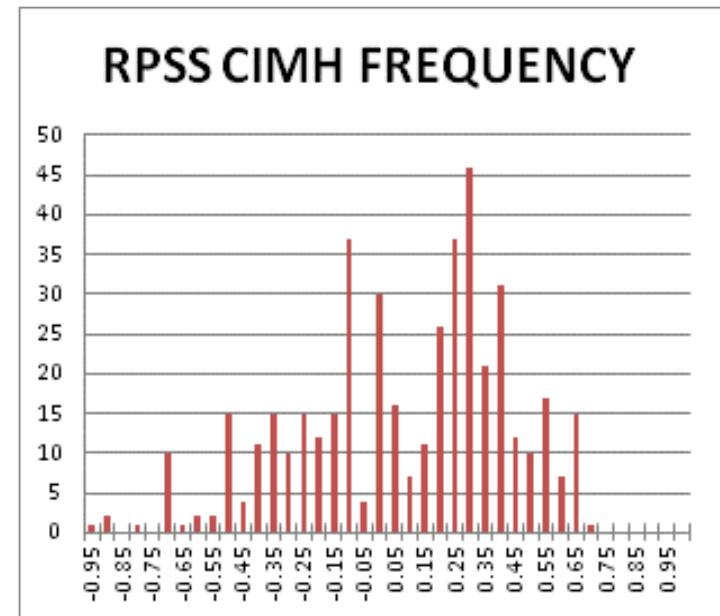
IRI and CIMH forecast skill – RPSS

22% good forecasts

RPSS IRI %

- CAT1
- CAT2
- CAT3
- CAT4

32%
46%
15%
7%

(a)

44% good forecasts

RPSS CIMH %

- CAT1
- CAT2
- CAT3
- CAT4

42%
14%
35%
9%

(b)

RPSS IRI FREQUENCY

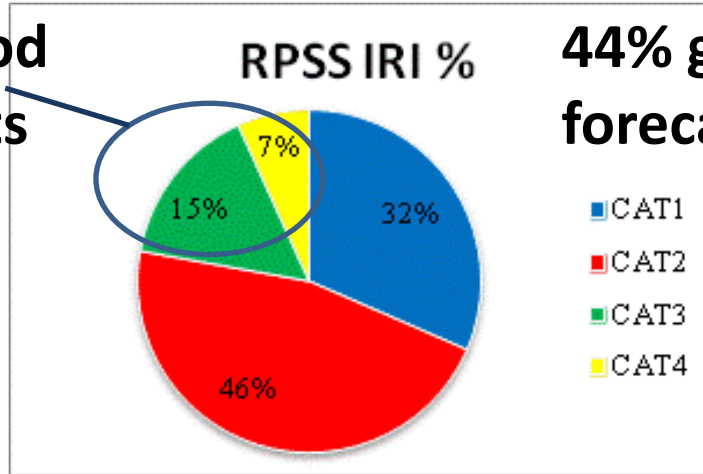(c)

RPSS CIMH FREQUENCY

(d)
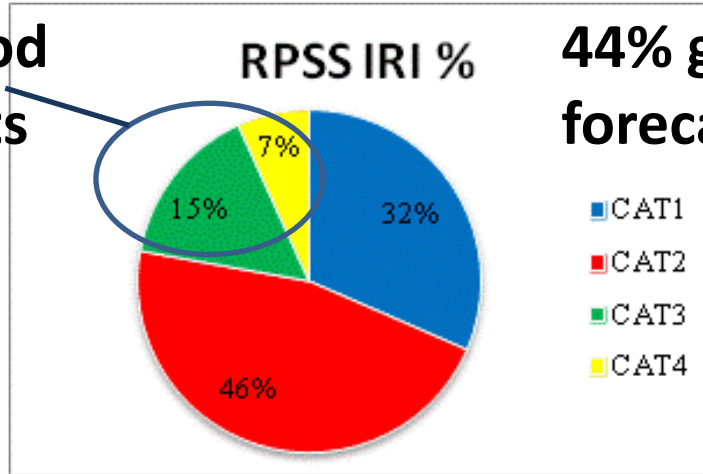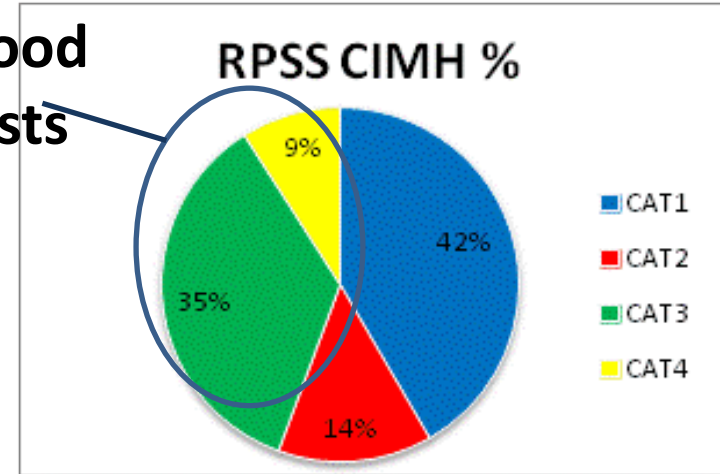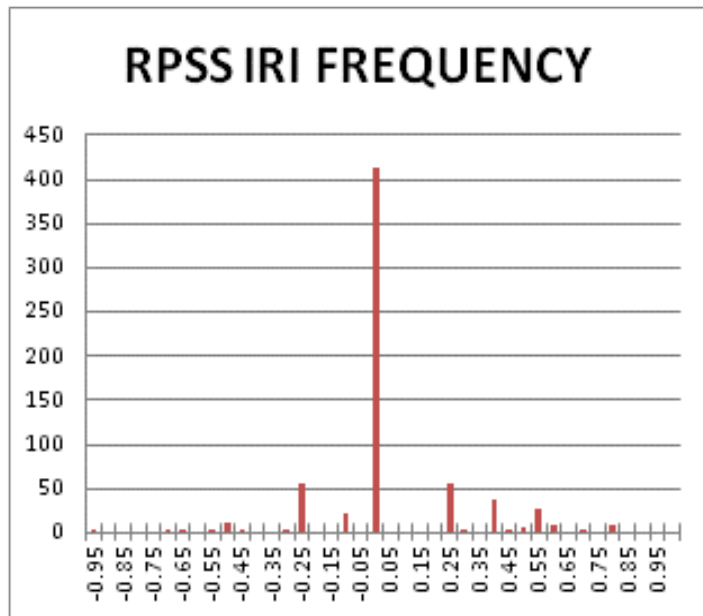
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22% good forecasts

44% good forecasts

RPSS IRI %

- CAT1 32%
- CAT2 46%
- CAT3 15%
- CAT4 7%

(a)

RPSS CIMH %

- CAT1 42%
- CAT2 14%
- CAT3 35%
- CAT4 9%

(b)
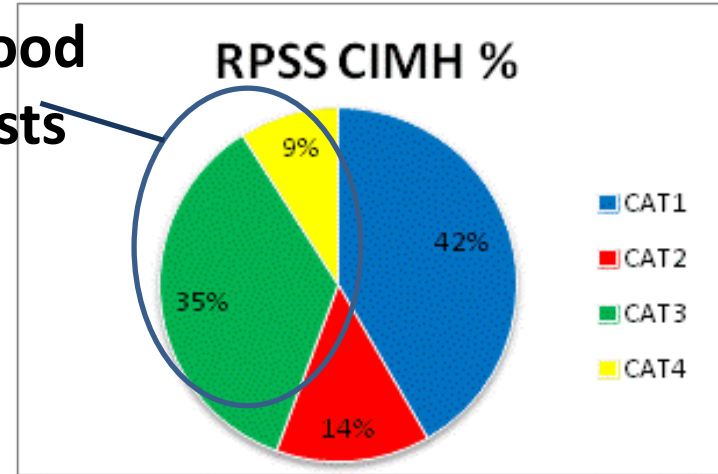
climatology forecasts (equal chance for each tercile)

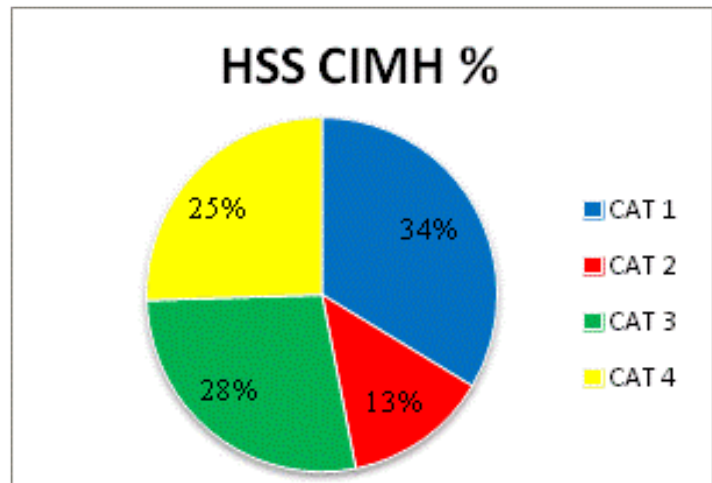**wider spread due to downscaling**
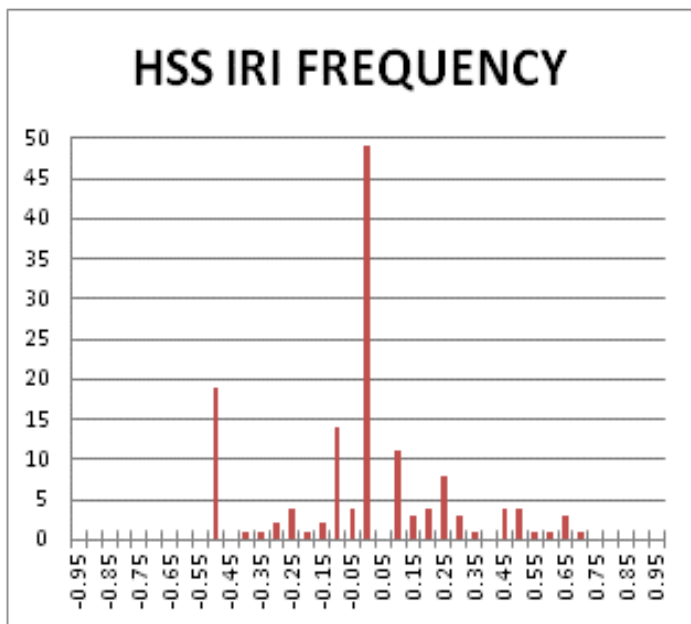
RPSS IRI FREQUENCY

(c)

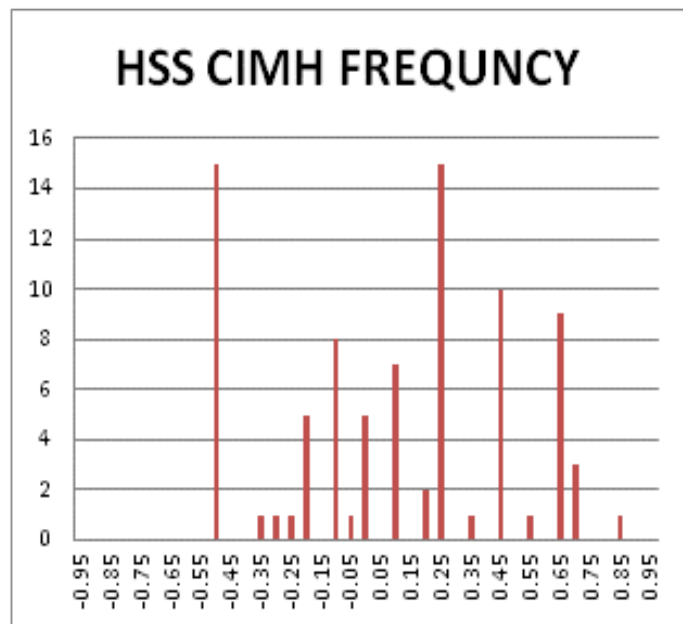RPSS CIMH FREQUENCY

(d)

IRI and CIMH forecast skill – HSS

(a)

(b)
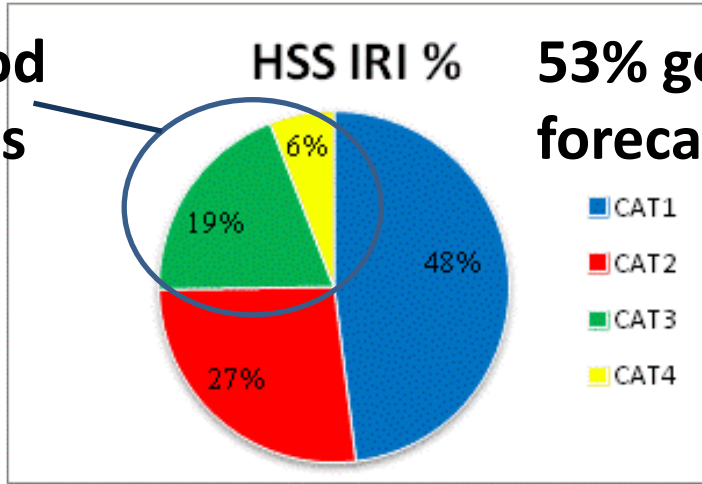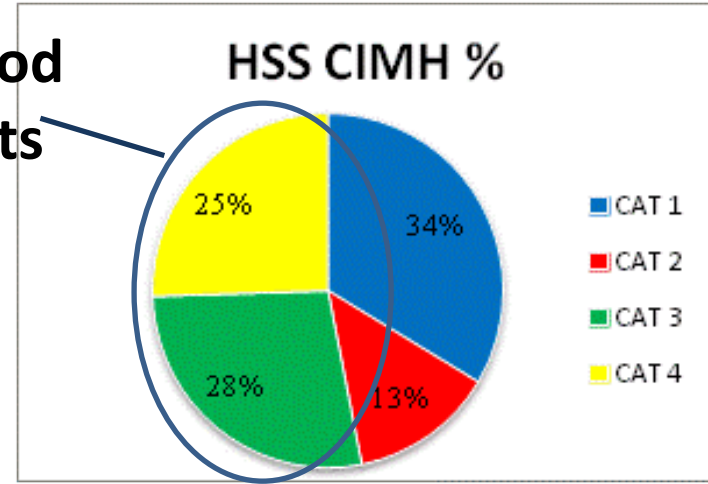
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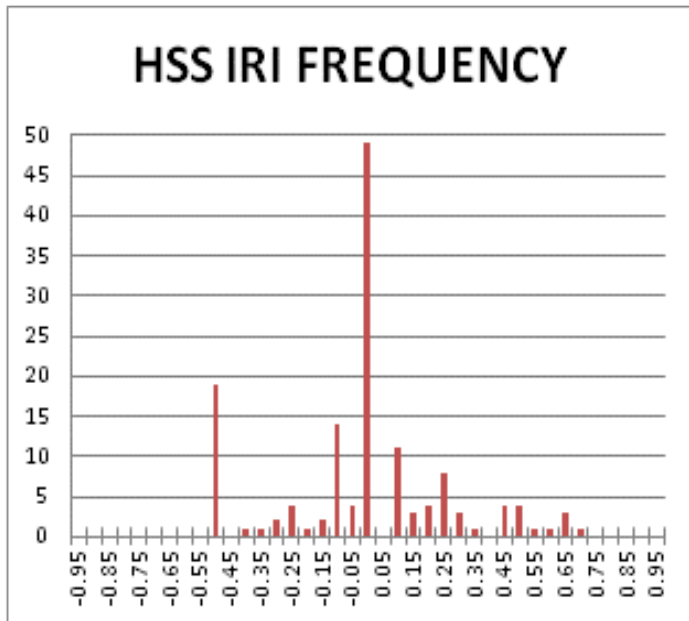# IRI and CIMH forecast skill – HSS

25% good forecasts

HSS IRI %

- CAT1 (blue) 48%
- CAT2 (red) 27%
- CAT3 (green) 19%
- CAT4 (yellow) 6%

(a)

53% good forecasts

HSS CIMH %

- CAT 1 (blue) 34%
- CAT 2 (red) 13%
- CAT 3 (green) 28%
- CAT 4 (yellow) 25%

(b)

HSS IRI FREQUENCY

(c)

HSS CIMH FREQUNCY

(d)

IRI and CIMH forecast skill – HSS

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HSS IRI %
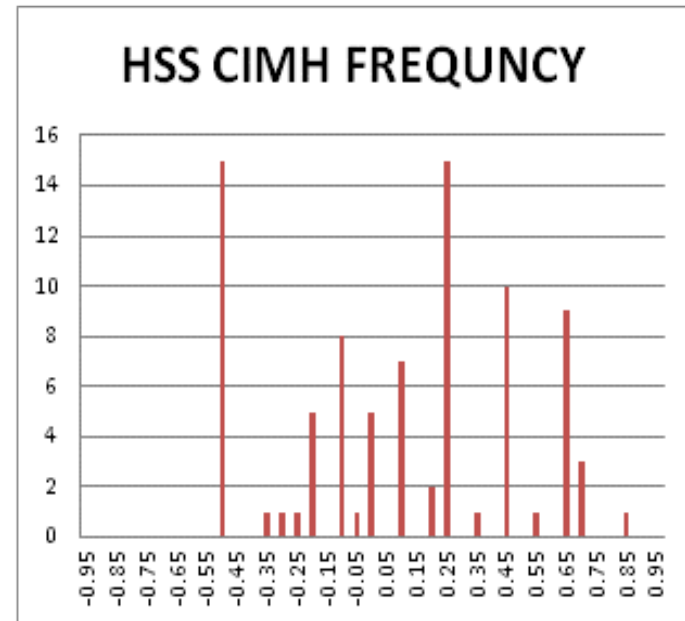- CAT1
- CAT2
- CAT3
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HSS CIMH %
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(b)

climatology forecasts (equal chance for each tercile)

HSS IRI FREQUENCY

(c)

wider spread due to downscaling

HSS CIMH FREQUNCY

(d)

CERMES
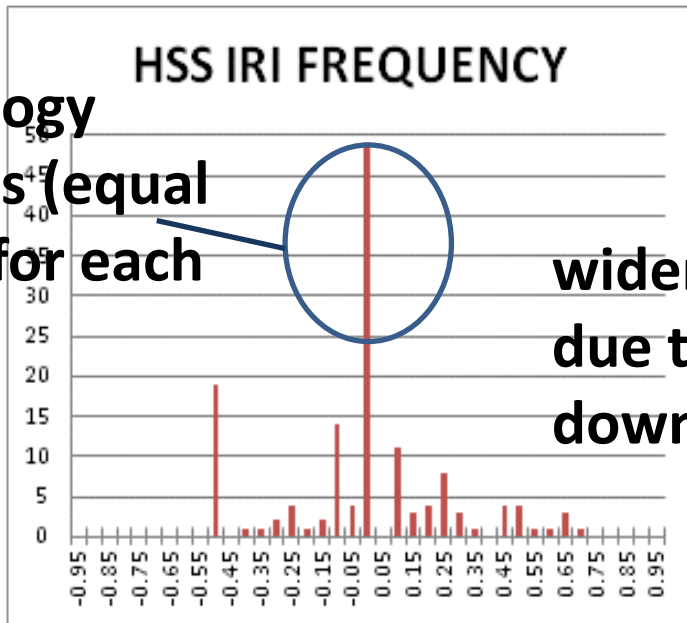
IRI and CIMH forecast skill – seasonal and regional variations

- The **most accurately forecasted season** was JFM for IRI, SON for CIMH.

- AMJ was poorly predicted by both.

- The Lesser Antilles formed the **best predicted sub-region** (mean RPSS score of ~0.1 by CIMH and ~0.05 by IRI.

- Skill was lower for the Greater Antilles and the Guianas, but virtually inexistent for Belize in either system.

Improving forecast skill through time
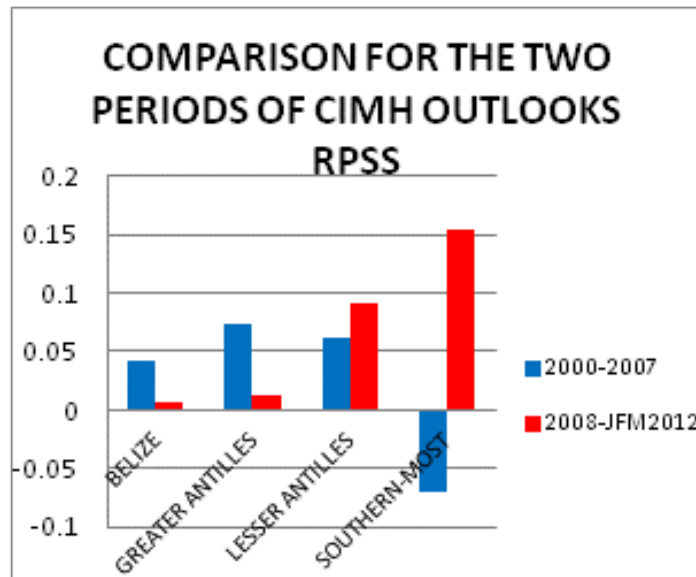
(a) RPSS
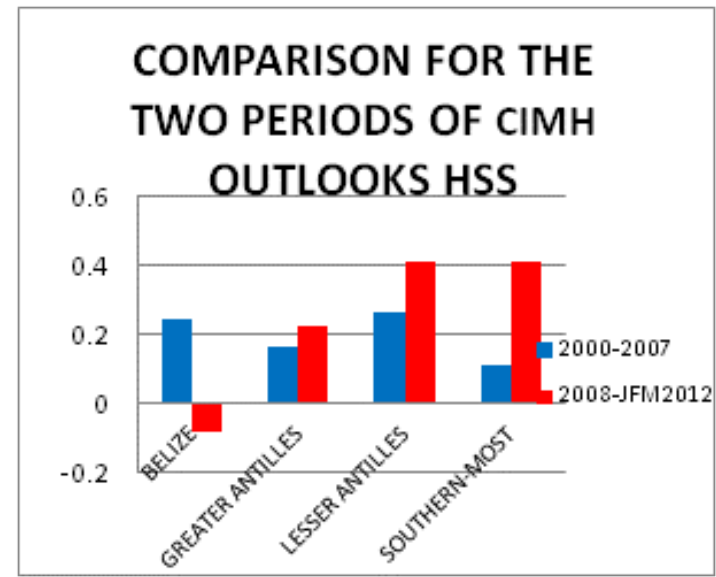
(b) HSS

Improving forecast skill through time

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(b) HSS
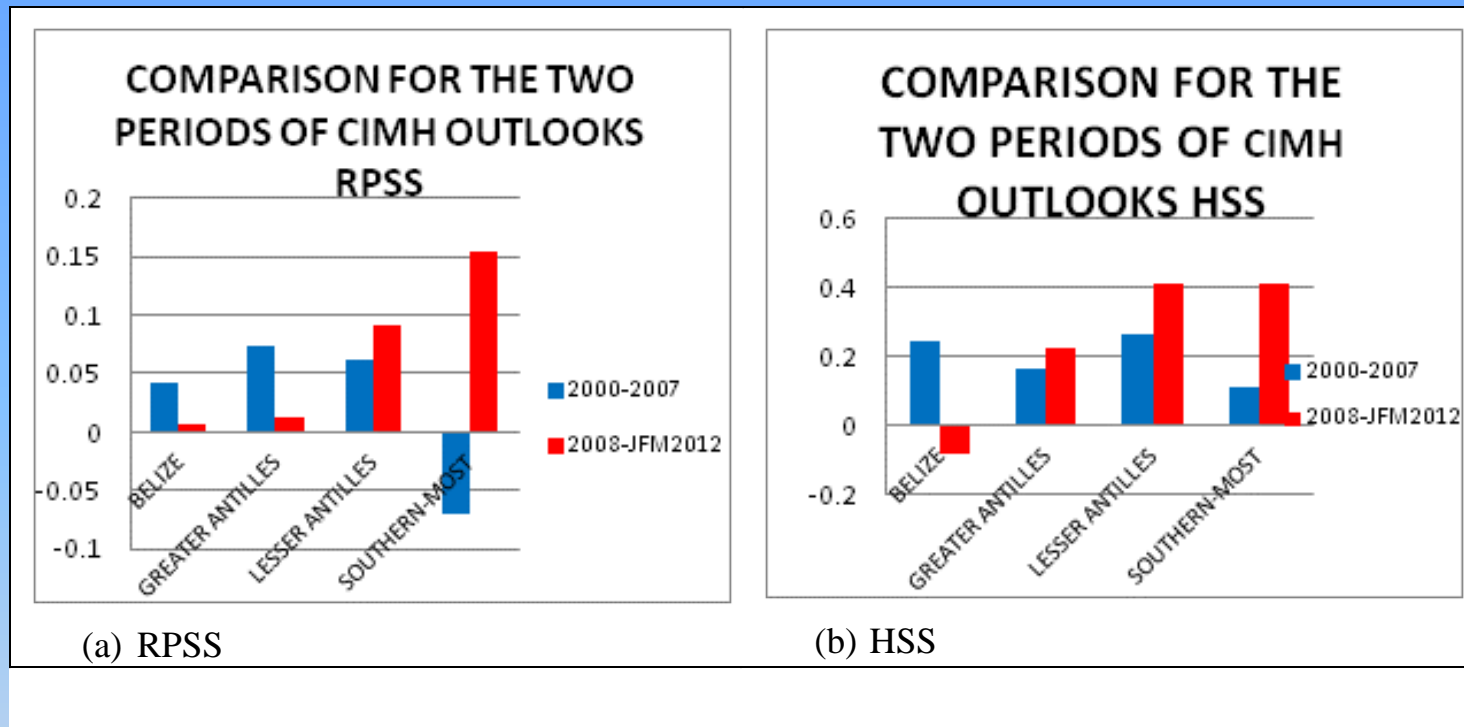
- Enhanced local climate expertise improved CIMH forecast **skill scores over time** for the Lesser Antilles and Southern-most territories.

Forecast skill   *v*   ENSO signal strength

Season	Corr. Co.t (IRI)	Cor. Co. (CIMH)
JFM	0.36	0.09
AMJ	0.03	-0.46
SON	0.24	-0.21

Groups	Corr. Co. (IRI)	Corr. Co.(CIMH)
Belize	0.09	-0.38
Greater Antilles	0.07	-0.33
Lesser Antilles	0.10	0.03
Southern-most Stations	0.45	0.29

Forecast skill *v* ENSO signal strength

POOR CORRELATION

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- **ENSO** often regarded as the main predictor for seasonal rainfall variability in the tropics.

- However, RPSS scores and ENSO signal strength are only significantly correlated over the **Southern-most territories**.

- We found a stronger relation to the North Atlantic Oscillation **(NAO)**, with **better scores** during **transitions** from positive to negative.

Take Home Messages

1. Higher skill scores in the Lesser Antilles are consistent with **a greater predictability of seasonal rainfall compared to other sub-regions.** However, forecasting accuracy lies well below a previously estimated 30%* inherent predictability.

2. Better forecasting skill should come with a larger ENSO signal. With low predictability and a small signal of ENSO during Apr-May-Jun, **AMJ rainfall was poorly predicted.** However, we found only a **weak correlation between RPSS scores and ENSO strength** altogether.

3. A strong relation was found between **NAO signal strength and forecasting skill** – whereas NAO is not directly included in the prediction systems. This suggests substantial improvement to reside in including **additional drivers of Caribbean seasonal rainfall** – such as NAO – **in the prediction systems.**

Thank you