

How can climate models be improved over Africa?

Investigating global models with local knowledge



Rachel James, Richard Washington, Babatunde Abiodun, Gillian Kay, Joseph Mutemi, Wilfried Pokam, Neil Hart, Guleid Artan, Cath Senior

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Overview

Climate model evaluation for Africa

1. Context: the role of model evaluation
2. How should we best evaluate models to inform model development?
3. Examples of process-based model evaluation
4. A model evaluation “hub” for Africa?



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EVALUATING CLIMATE MODELS WITH AN AFRICAN LENS

RACHEL JAMES, RICHARD WASHINGTON, BABATUNDE ABIODUN, GILLIAN KAY, JOSEPH MUTEMI,
WILFRIED POKAM, NEIL HART, GULEID ARTAN, AND CATH SENIOR

Africa lags the rest of the world in climate model development. This paper explores the potential for region-specific, process-based evaluation to promote progress in modeling and confidence assessments.

In recent decades, there has been remarkable progress made in climate modeling (Gates et al. 1990; et al. 2014).¹ reference to

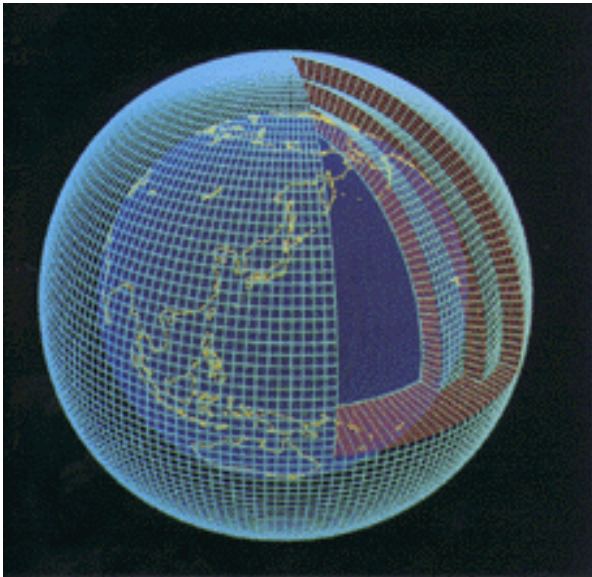
<https://doi.org/10.1175/BAMS-D-16-0090.1>



→ aiming to improve the availability and use of climate information on a 5-40 year timescale

How do we find out what might happen to climate in the next 5-40 years?

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Climate models!

Climate Modelling Research...

Alphabet Soup



Climate Modelling Research...

Alphabet Soup

GCM

RCM

SRES

RCP

ESM

CMIP3

CMIP5

CORDEX

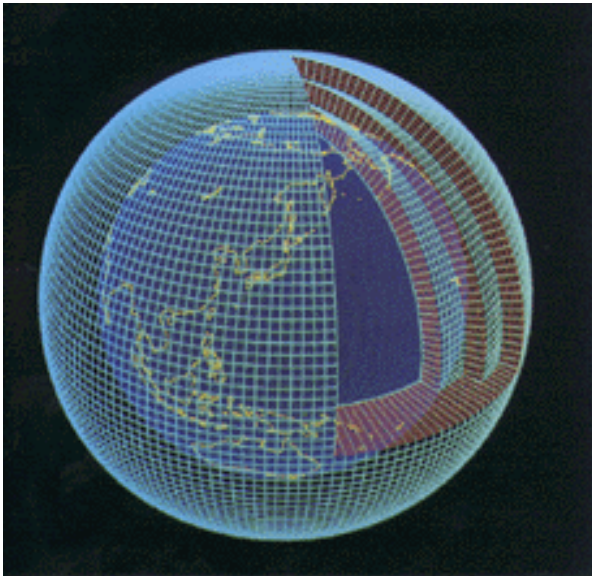
Climate Modelling Research...

Alphabet Soup

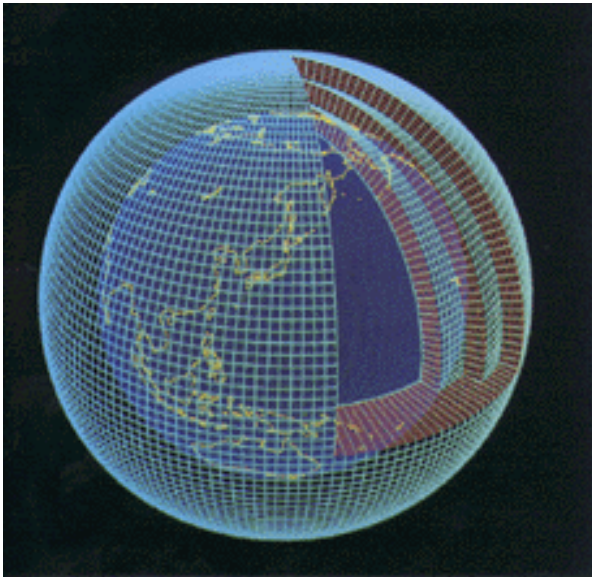
GCM

CMIP5

How do we find out what might happen to climate in the next 5-40 years?

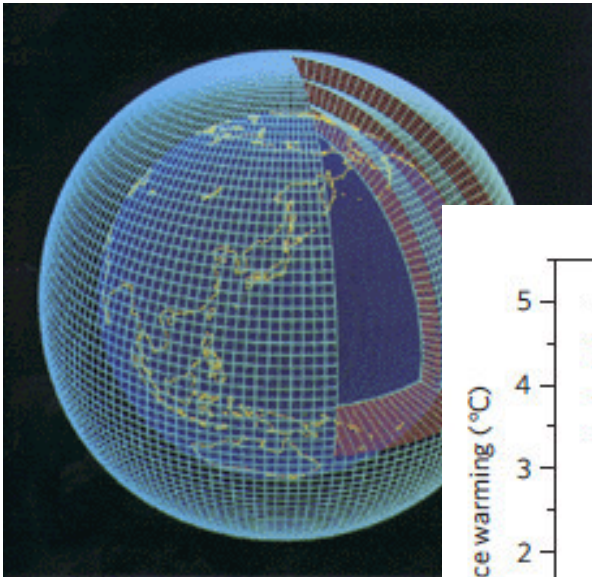


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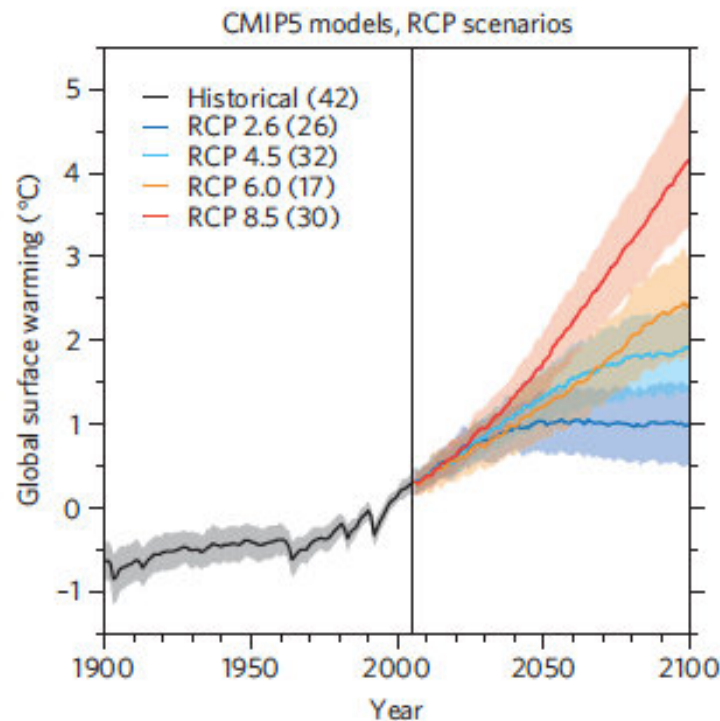


GCM

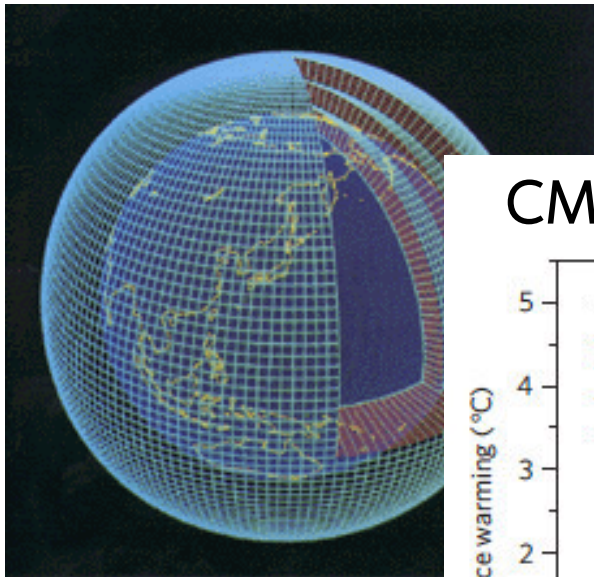
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GCM

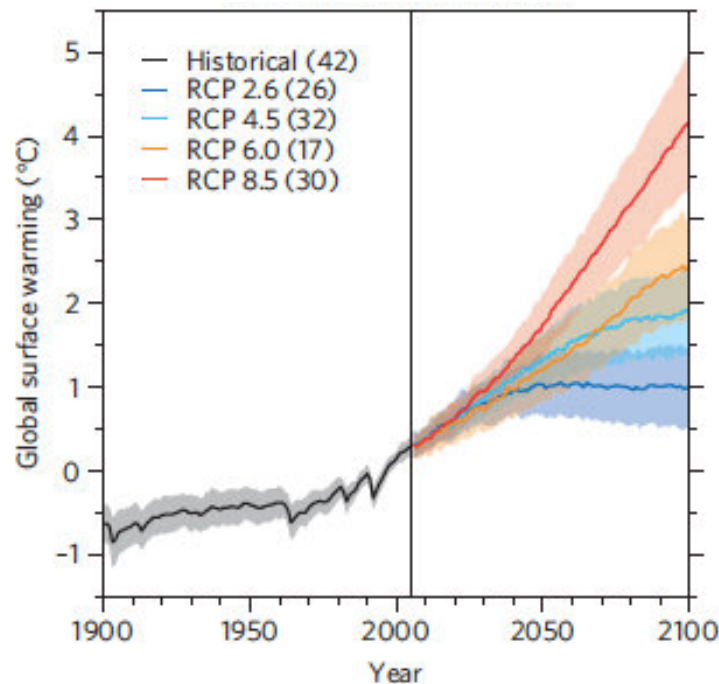


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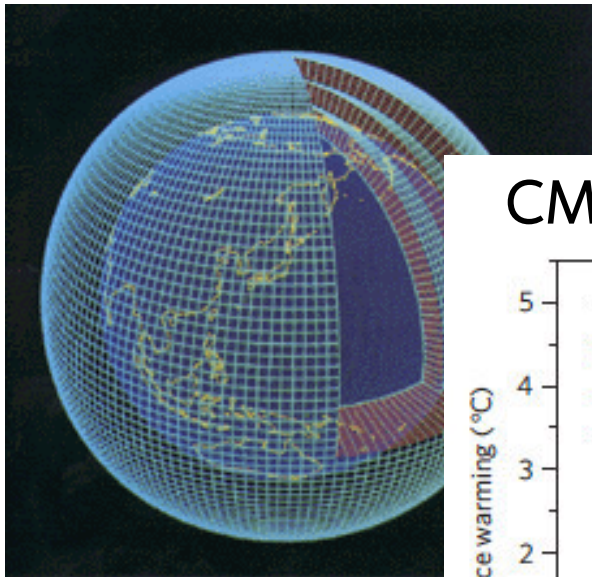


GCM

CMIP5 = many GCMs

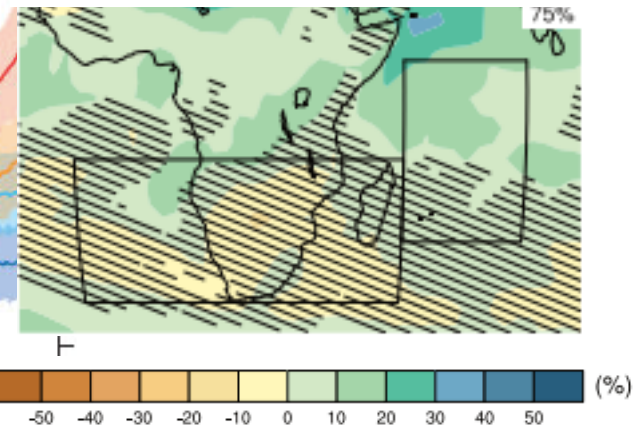
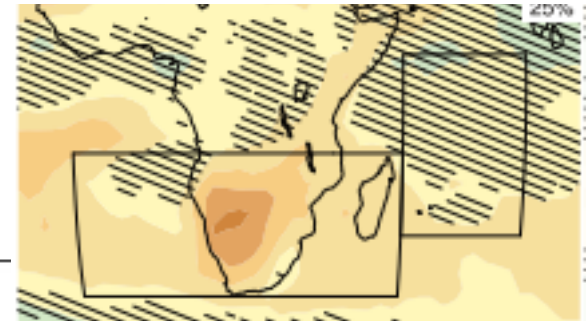
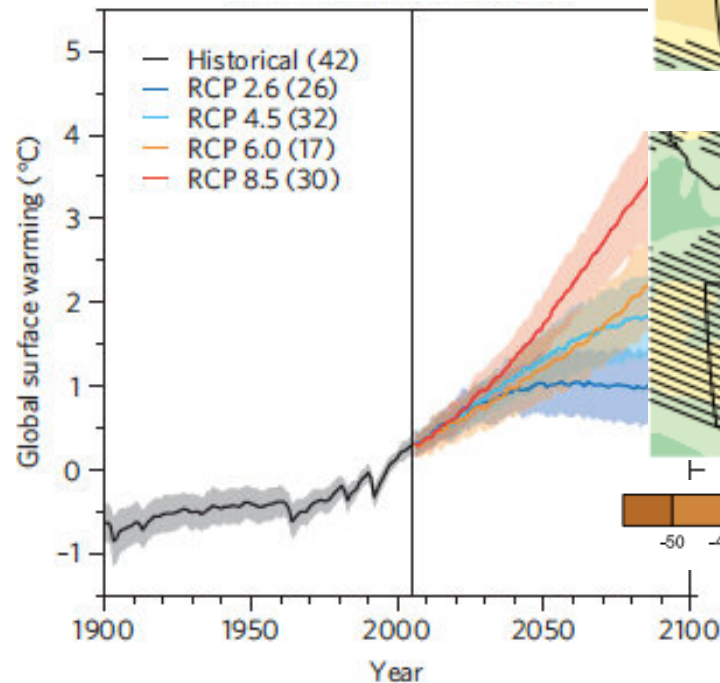


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Potential to deliver substantial improvement through model evaluation



Improving Model Processes for African cLimAte

A UK/African consortium led by
the Met Office



IMPALA Model Evaluation Team



Richard
Washington

Babatunde
Abiodun

Cath
Senior

Neil Hart



Joseph
Mutemi



Rachel James

Gillian
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Our mission:
to evaluate the Met Office global climate
model over Africa



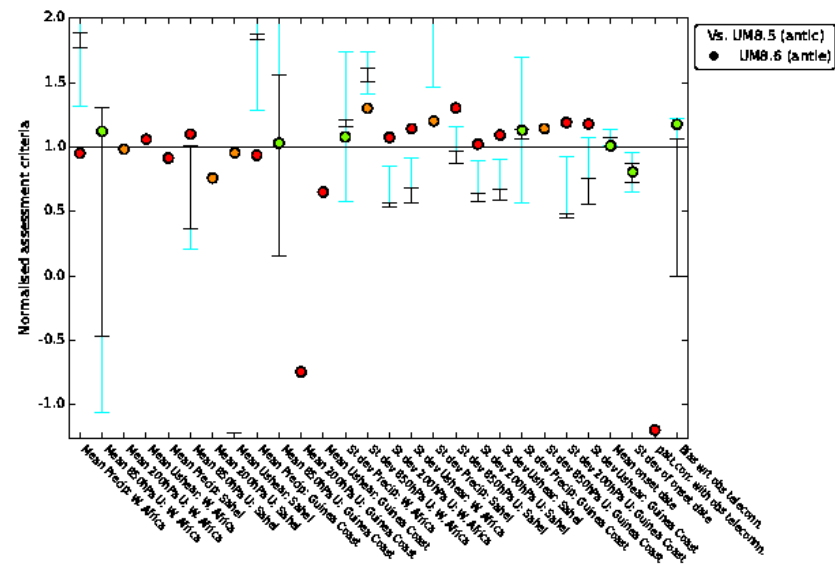
Rachel James

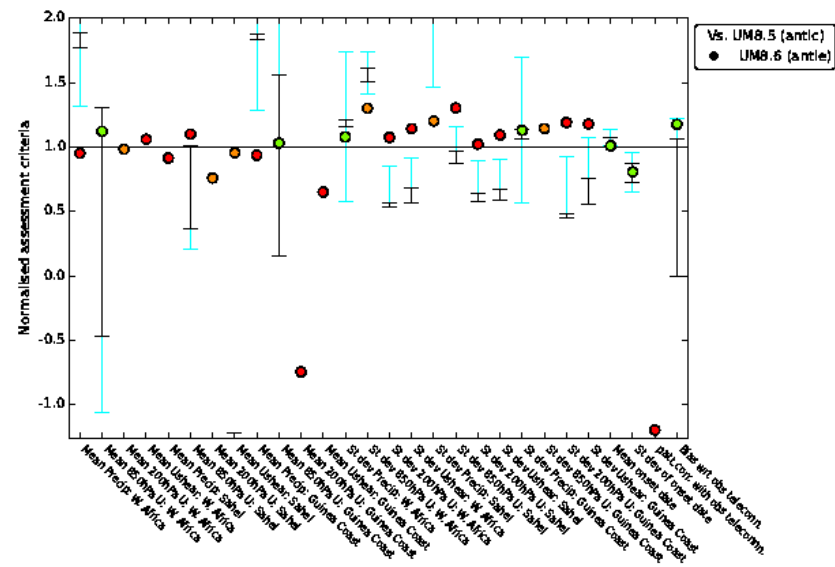
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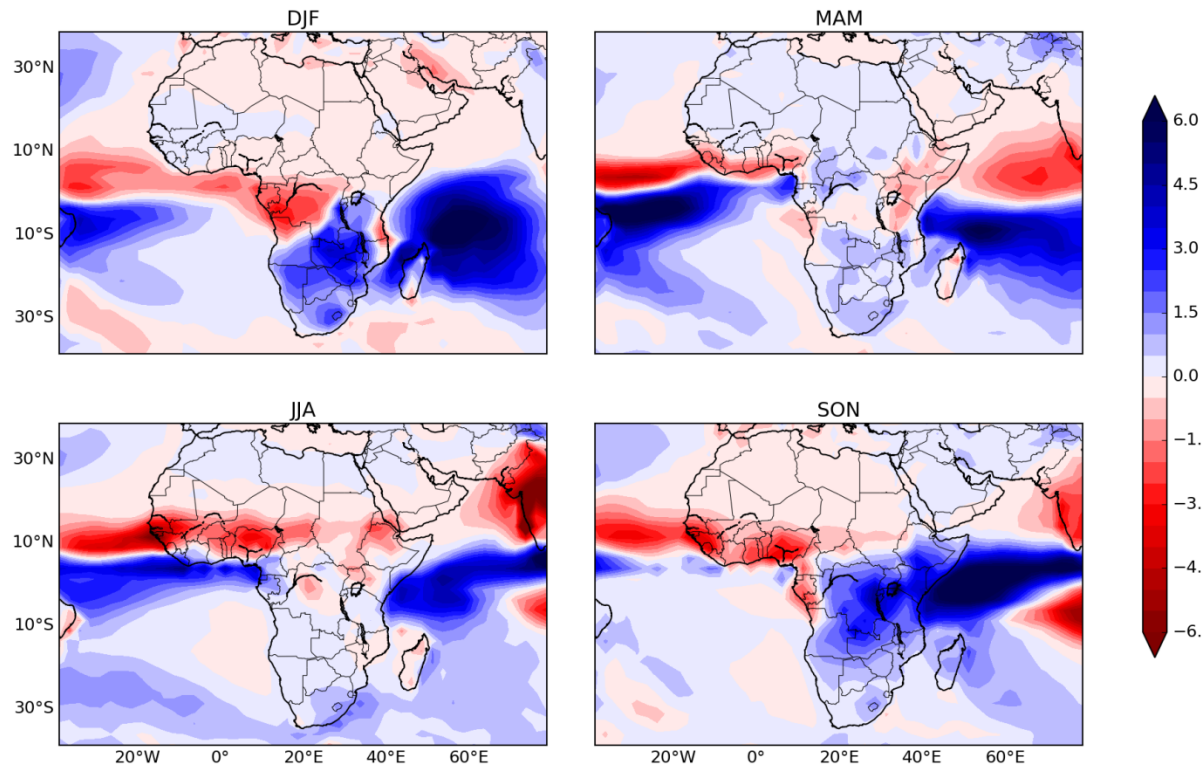


Existing evaluation infrastructure?



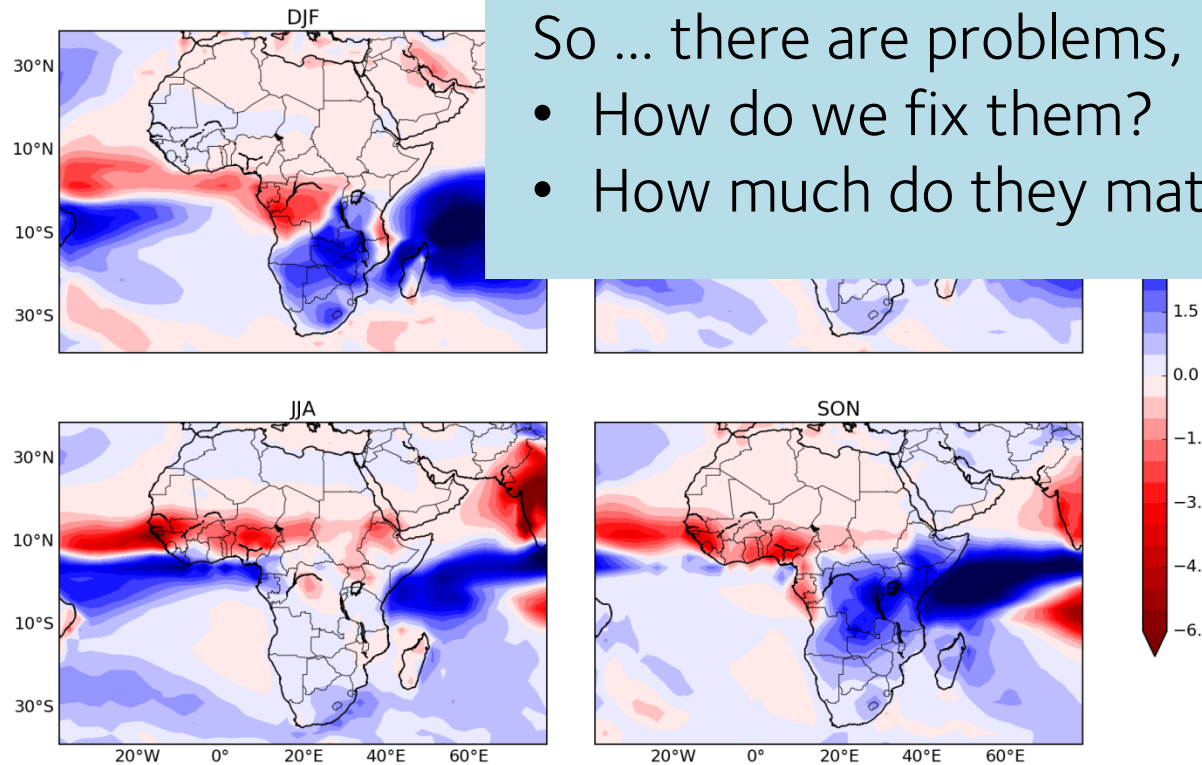


For Africa, automated evaluation is often limited to simple analysis of biases...



Precipitation biases in the Met Office model
(HadGEM3-GC2 r.t. GPCP)

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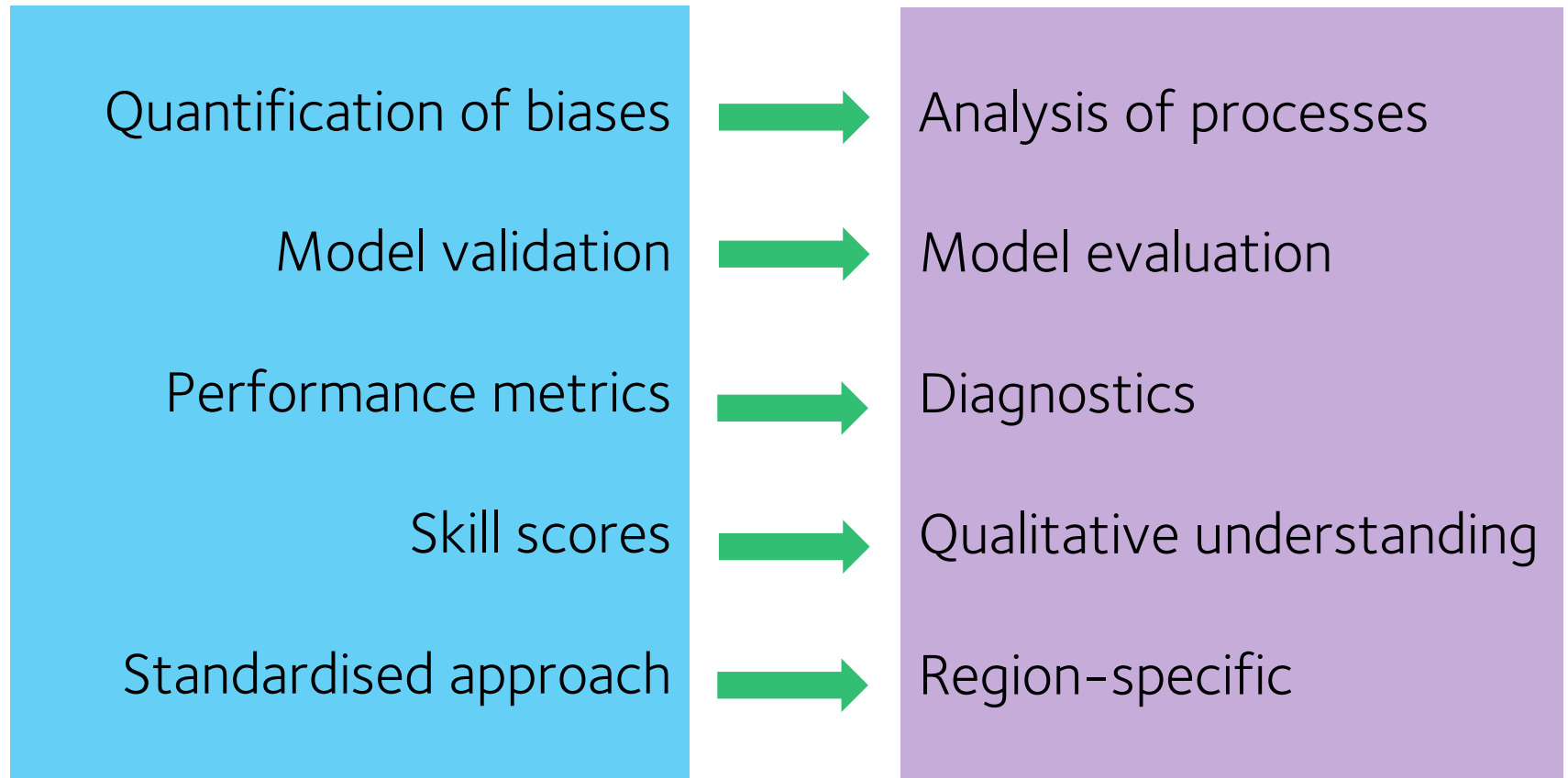


So ... there are problems, but:

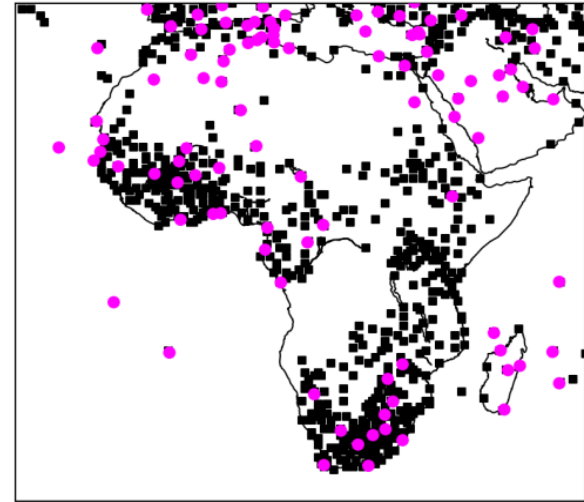
- How do we fix them?
- How much do they matter?

Precipitation biases in the Met Office model
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How can model evaluation better inform model development and confidence assessments?

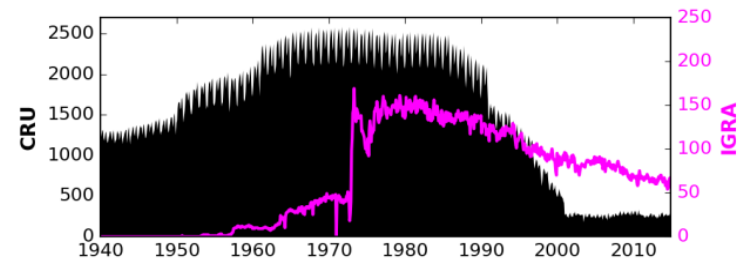


A focus on processes is also sensible given observational uncertainty...



Black: station data contributing to precipitation records

Pink: availability of radiosonde data (for u wind)



To improve climate models over Africa...

Need evaluation to be

process-based

& region-specific

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And... with feedback to model development

An opportunity for local evaluation with
global impact

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Plans for Routine Evaluation of CMIP
"DECK" Analysis Capability



An opportunity for local evaluation with global impact

Plans for Routine Evaluation of CMIP "DECK" Analysis Capability



Earth Syst. Dynam., 7, 813–830, 2016
www.earth-syst-dynam.net/7/813/2016/
doi:10.5194/esd-7-813-2016
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Earth System
Dynamics  Open Access

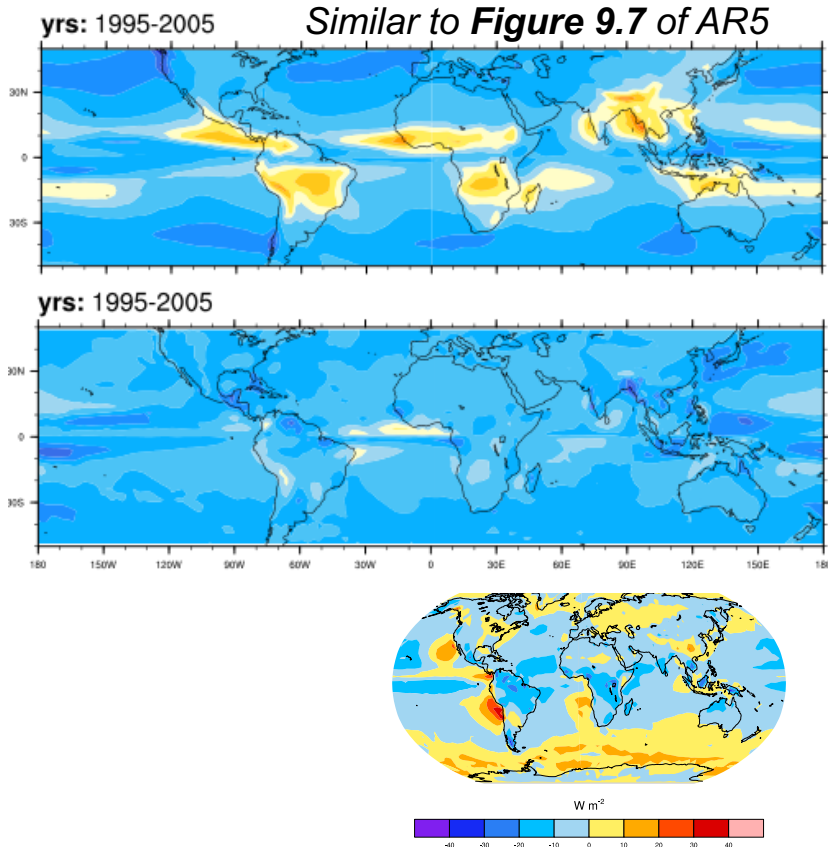
Towards improved and more routine Earth system model evaluation in CMIP

Veronika Eyring¹, Peter J. Gleckler², Christoph Heinze^{3,4}, Ronald J. Stouffer⁵, Karl E. Taylor²,
V. Balaji^{5,6}, Eric Guilyardi^{7,8}, Sylvie Joussaume⁹, Stephan Kindermann¹⁰, Bryan N. Lawrence^{8,11},
Gerald A. Meehl¹², Mattia Righi¹, and Dean N. Williams²

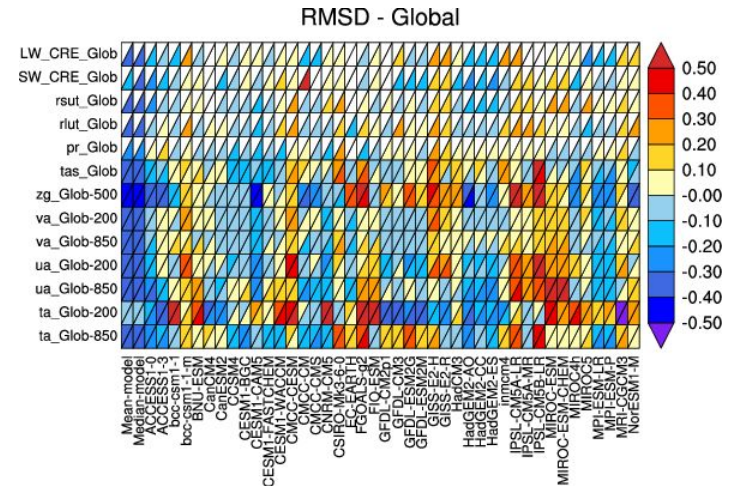
See paper by Eyring et al. 2016
Earth System Dynamics

An opportunity for local evaluation with global impact

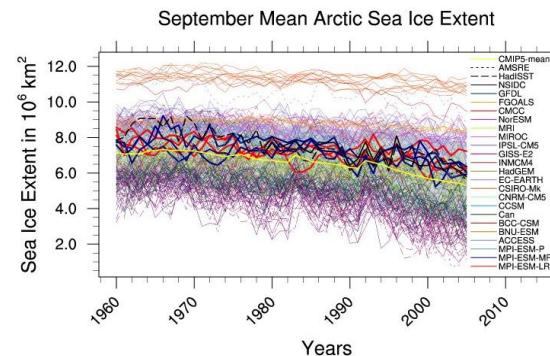
Plans for Routine Evaluation of CMIP "DECK" Analysis Capability



Similar to **Figure 9.5 of AR5**



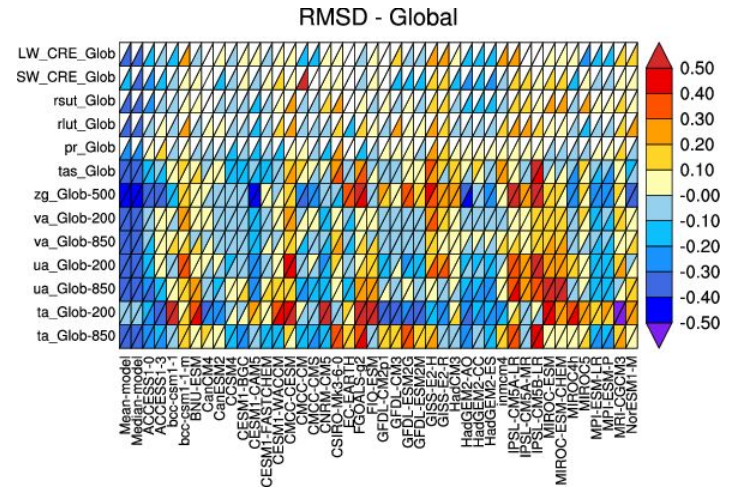
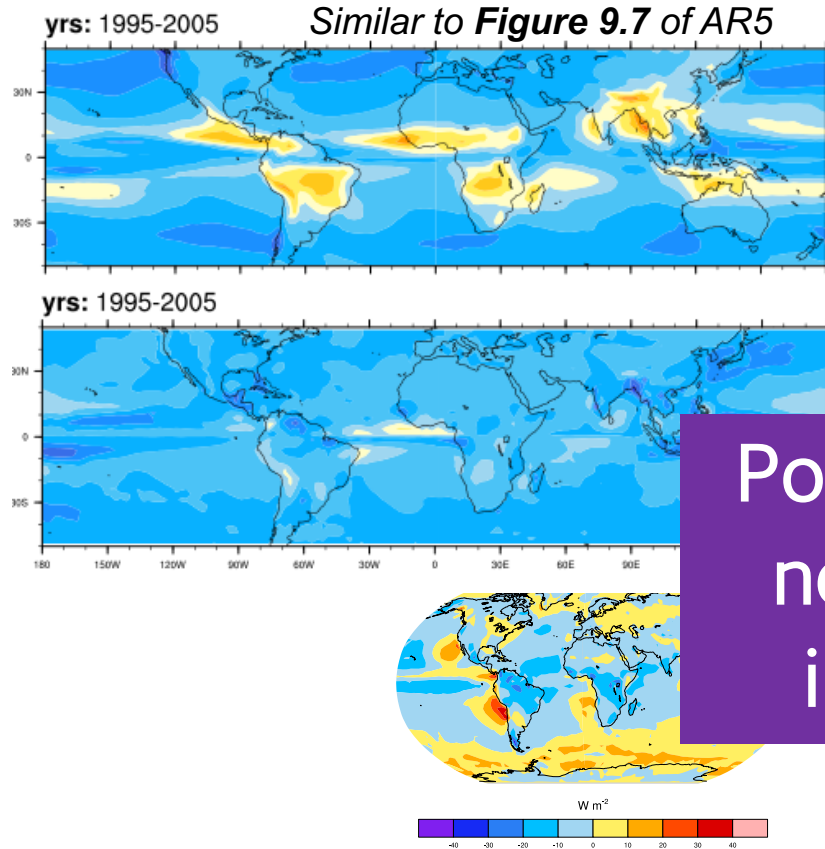
Similar to **Figure 9.7 of AR5**



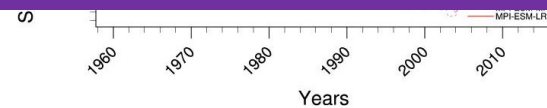
Similar to **Figure 9.24 of AR5**

An opportunity for local evaluation with global impact

Plans for Routine Evaluation of CMIP "DECK" Analysis Capability



Potential to contribute new evaluation tools including for Africa



Similar to **Figure 9.24** of AR5

*So which processes should we evaluate
and how?*

Evaluating Climate Models with an African Lens

*So which processes should we evaluate
and how?*

1. Introduction
2. Data
3. Approaches to process-based evaluation
 - a. Pan African
 - b. Central Africa
 - c. East Africa
 - d. Southern Africa
 - e. West Africa
4. Outlook

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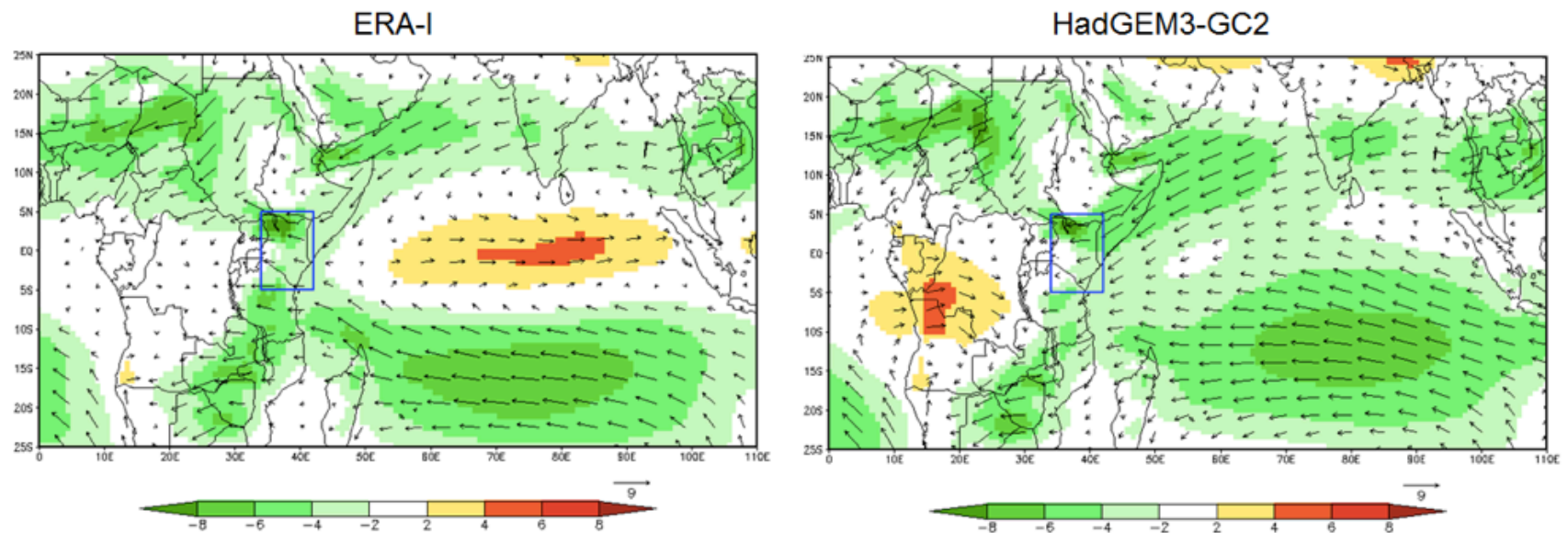
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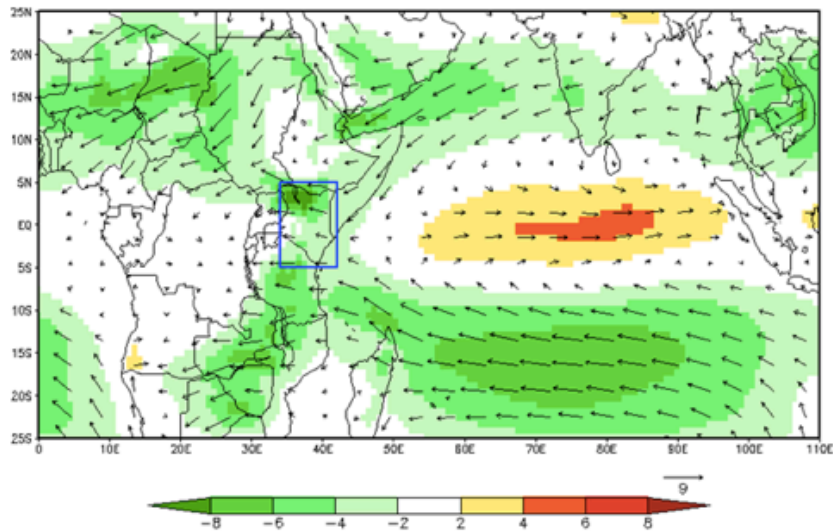
East Africa: winds in the short rains season



East Africa: winds in the short rains season

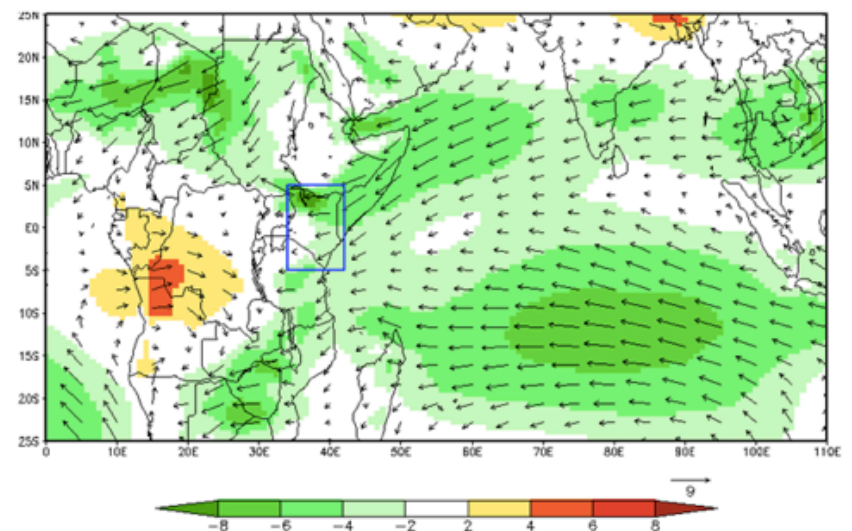
Reanalysis Data

ERA-I



Met Office model

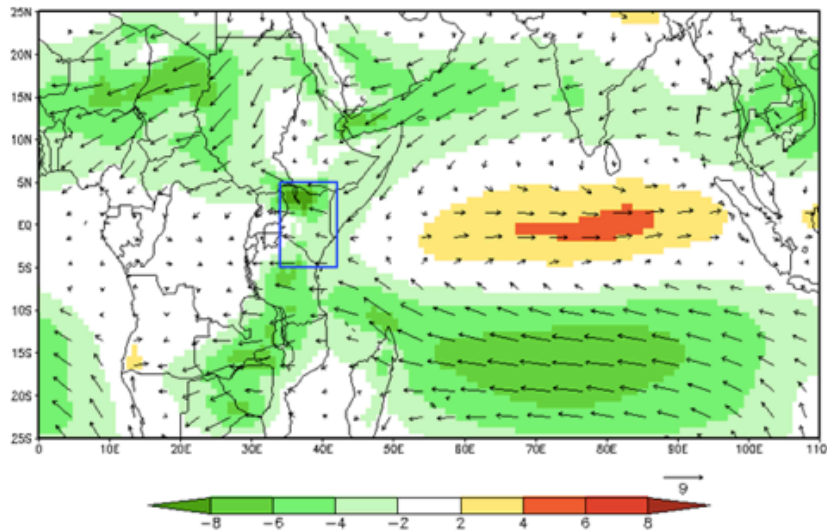
HadGEM3-GC2



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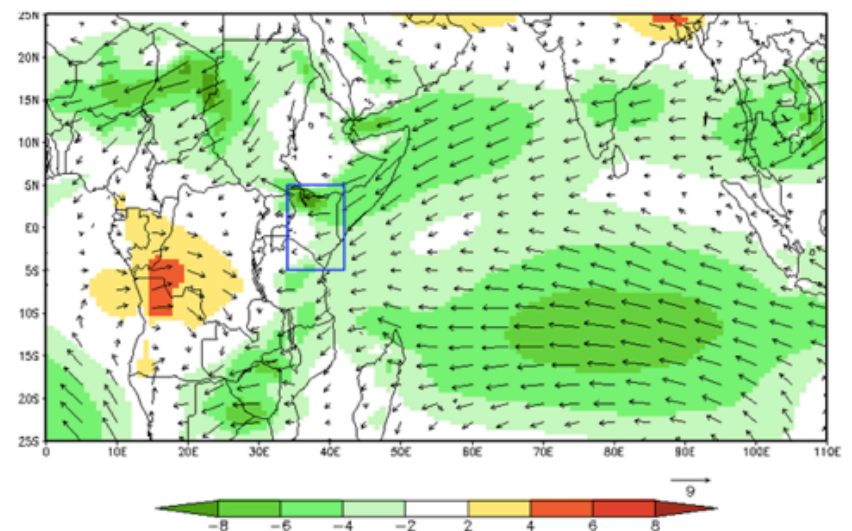
ERA-I



westerly

Met Office model

HadGEM3-GC2

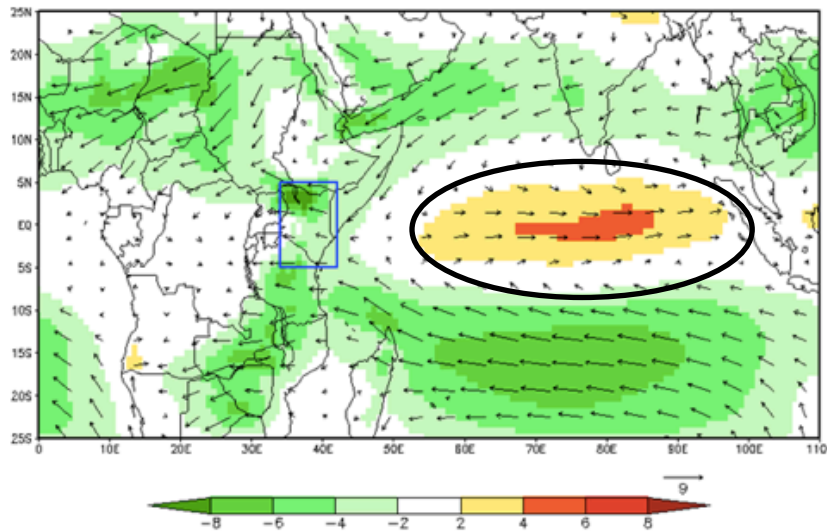


easterly

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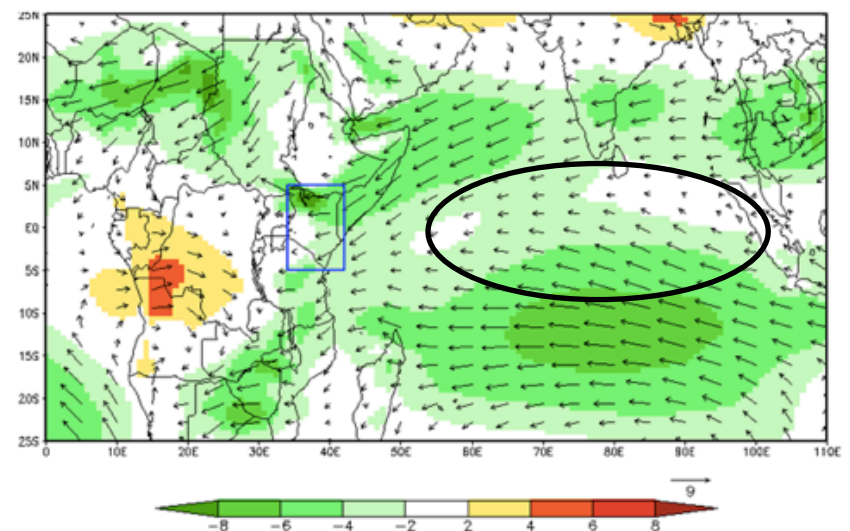
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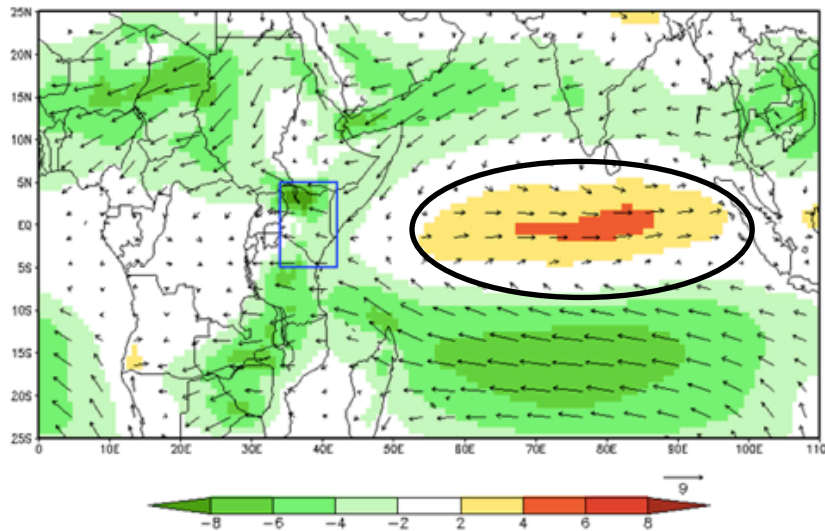


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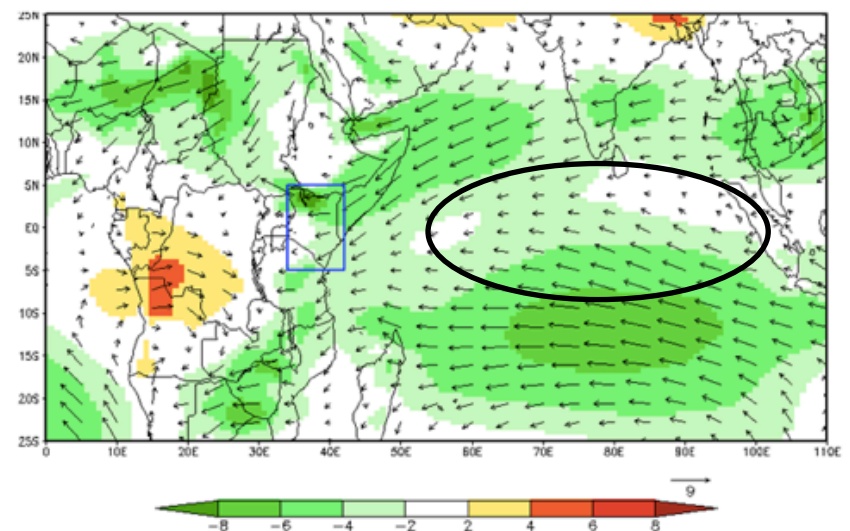
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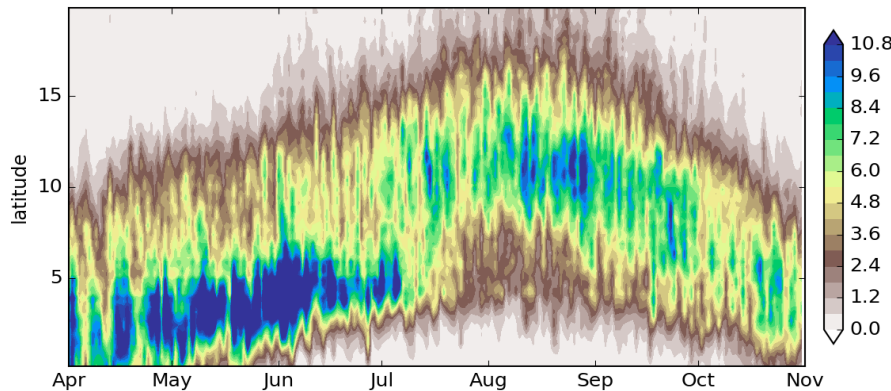


Focusing on the season that matters for East Africa led to new findings about the model

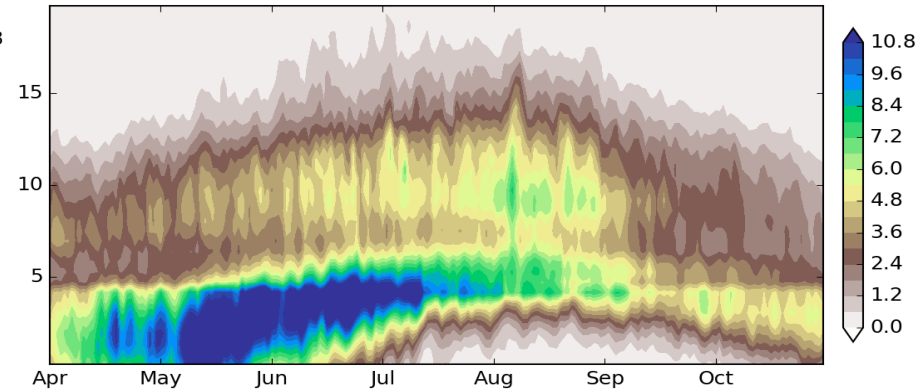
West Africa: simulation of the monsoon

PRECIPITATION

TRMM



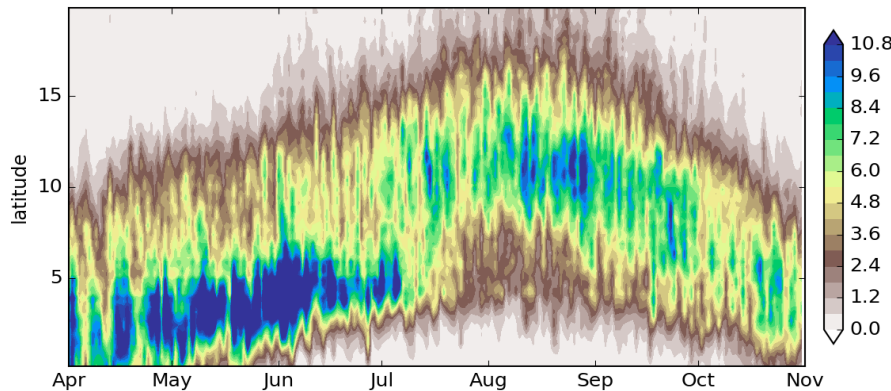
HadGEM3-GC2



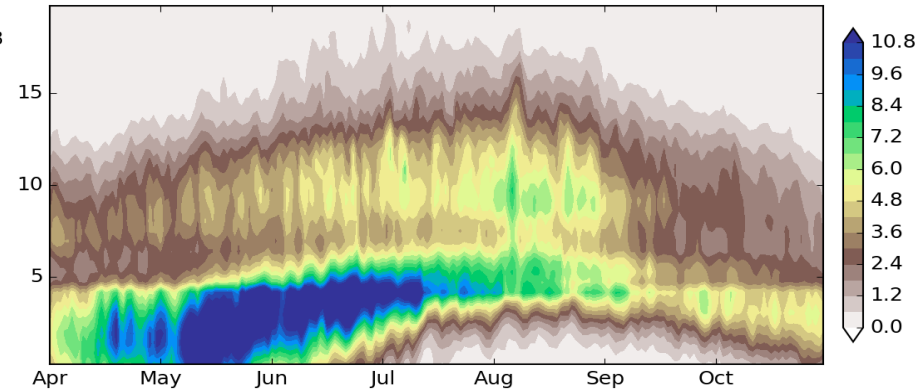
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PRECIPITATION

Satellite data
TRMM



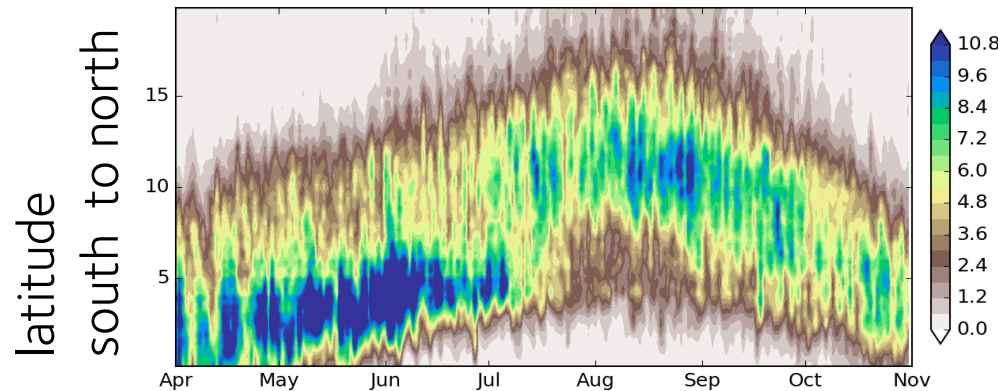
Met Office model
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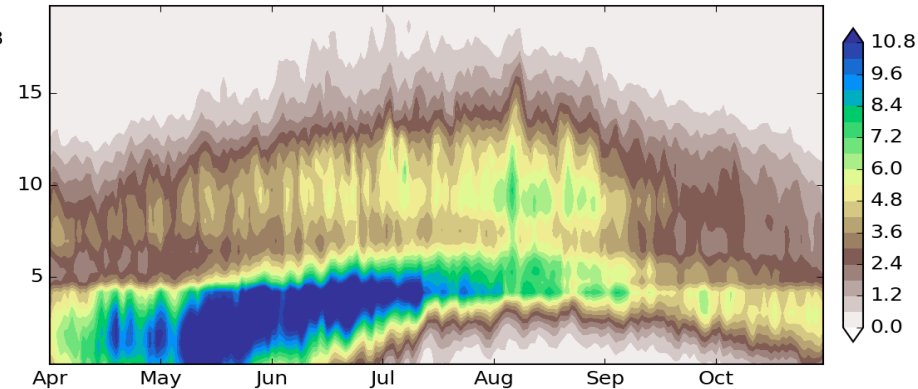
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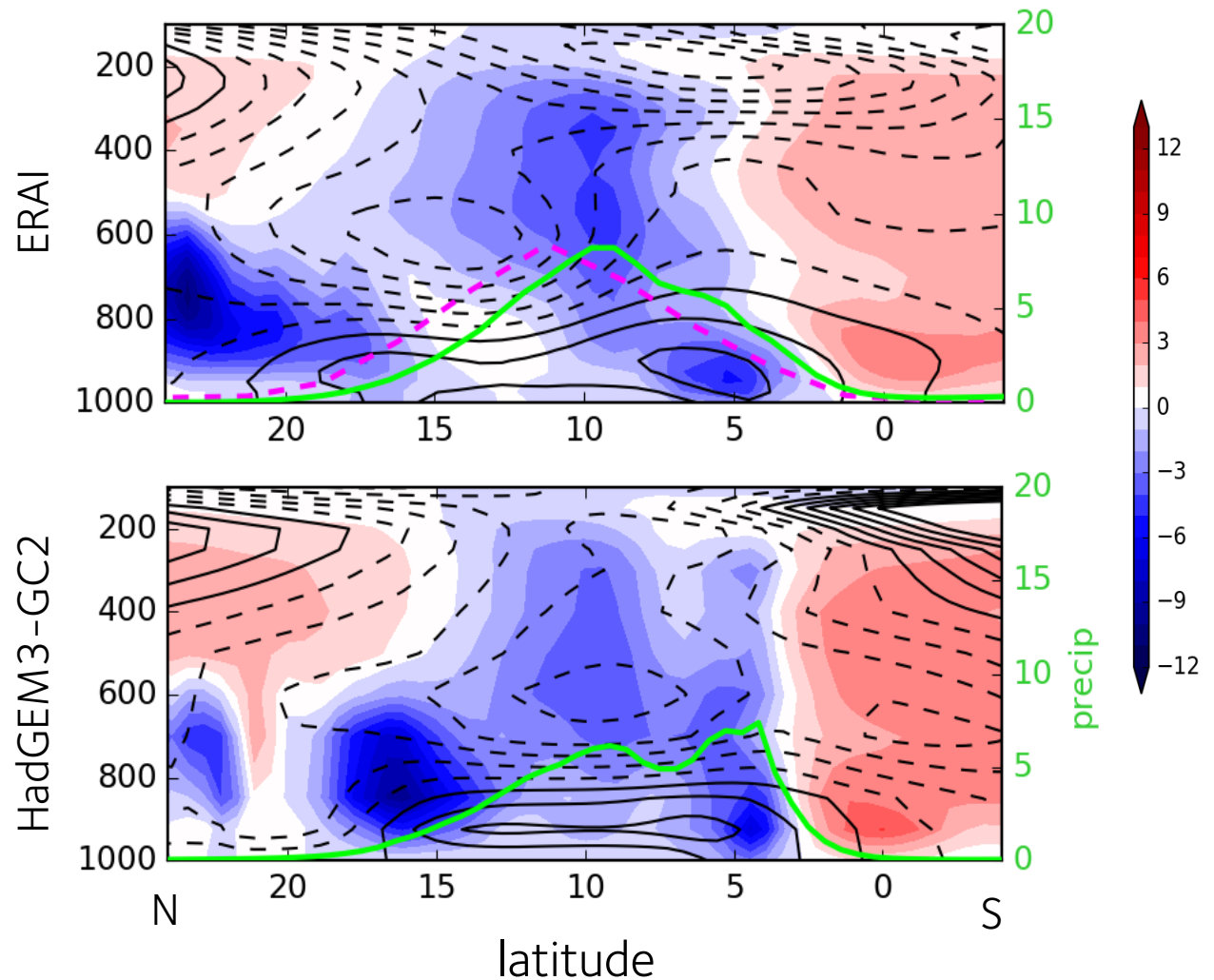
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evolution of the rainfall season

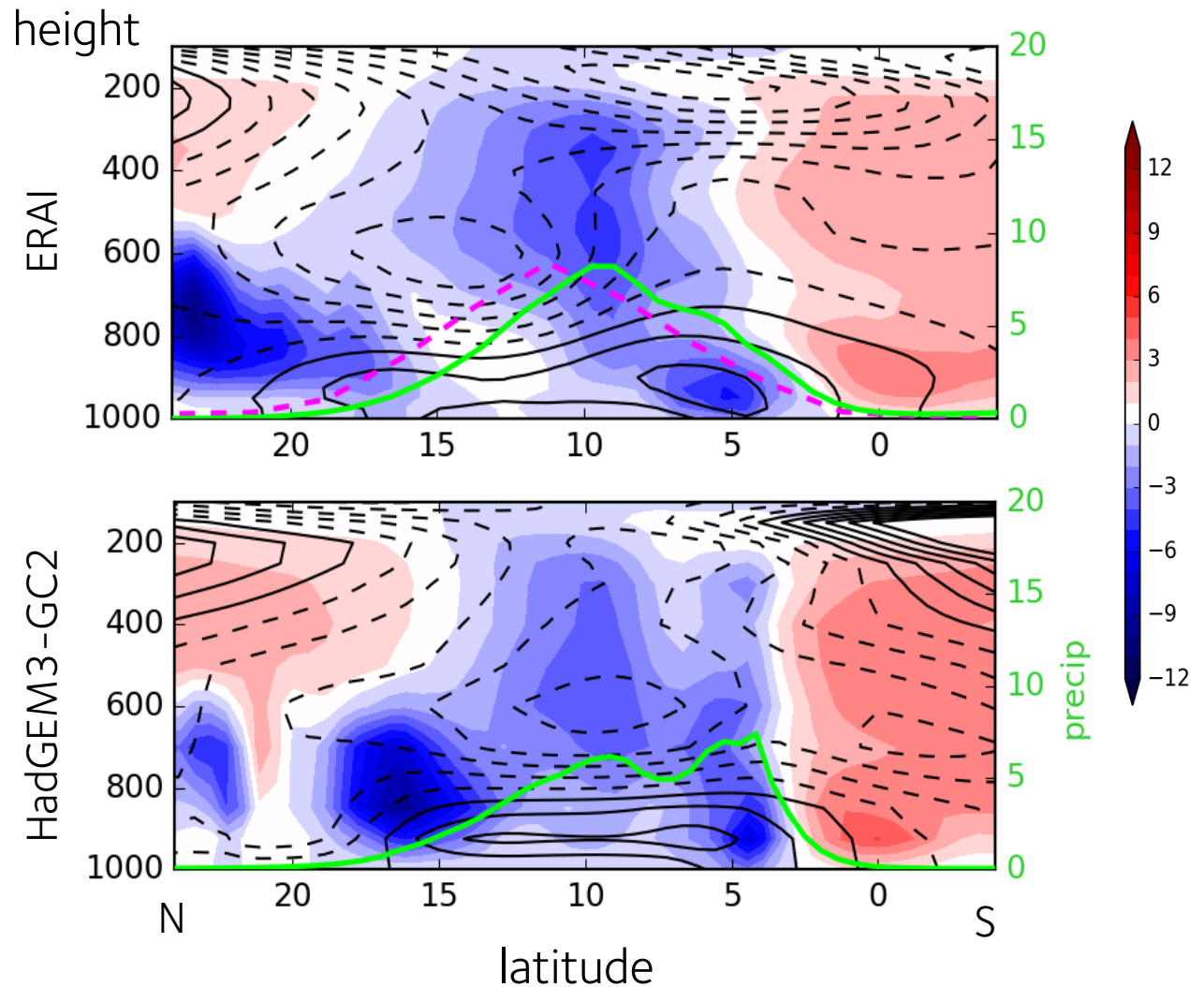
West Africa: simulation of the monsoon

PRECIPITATION, VERTICAL VELOCITY, and ZONAL WIND



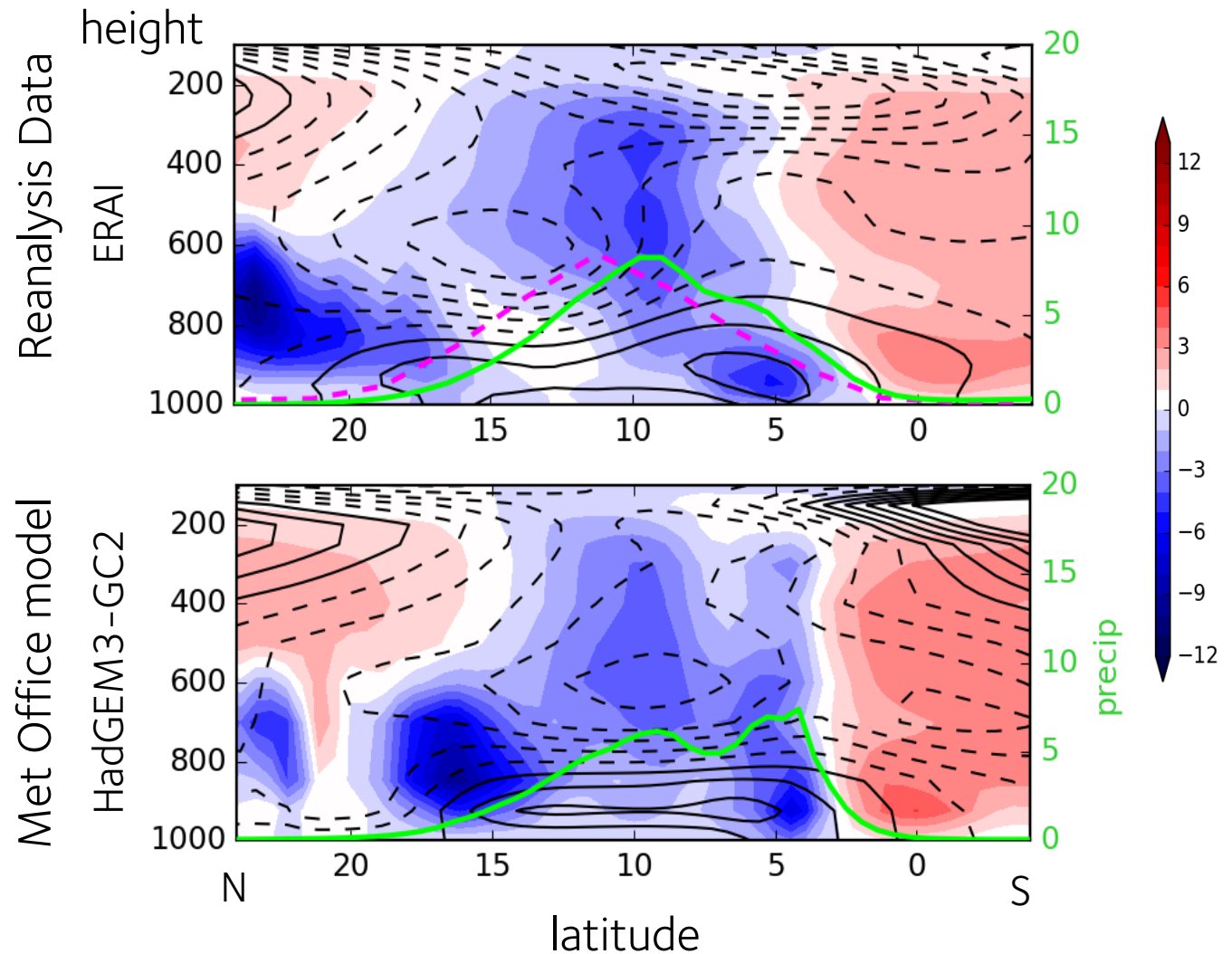
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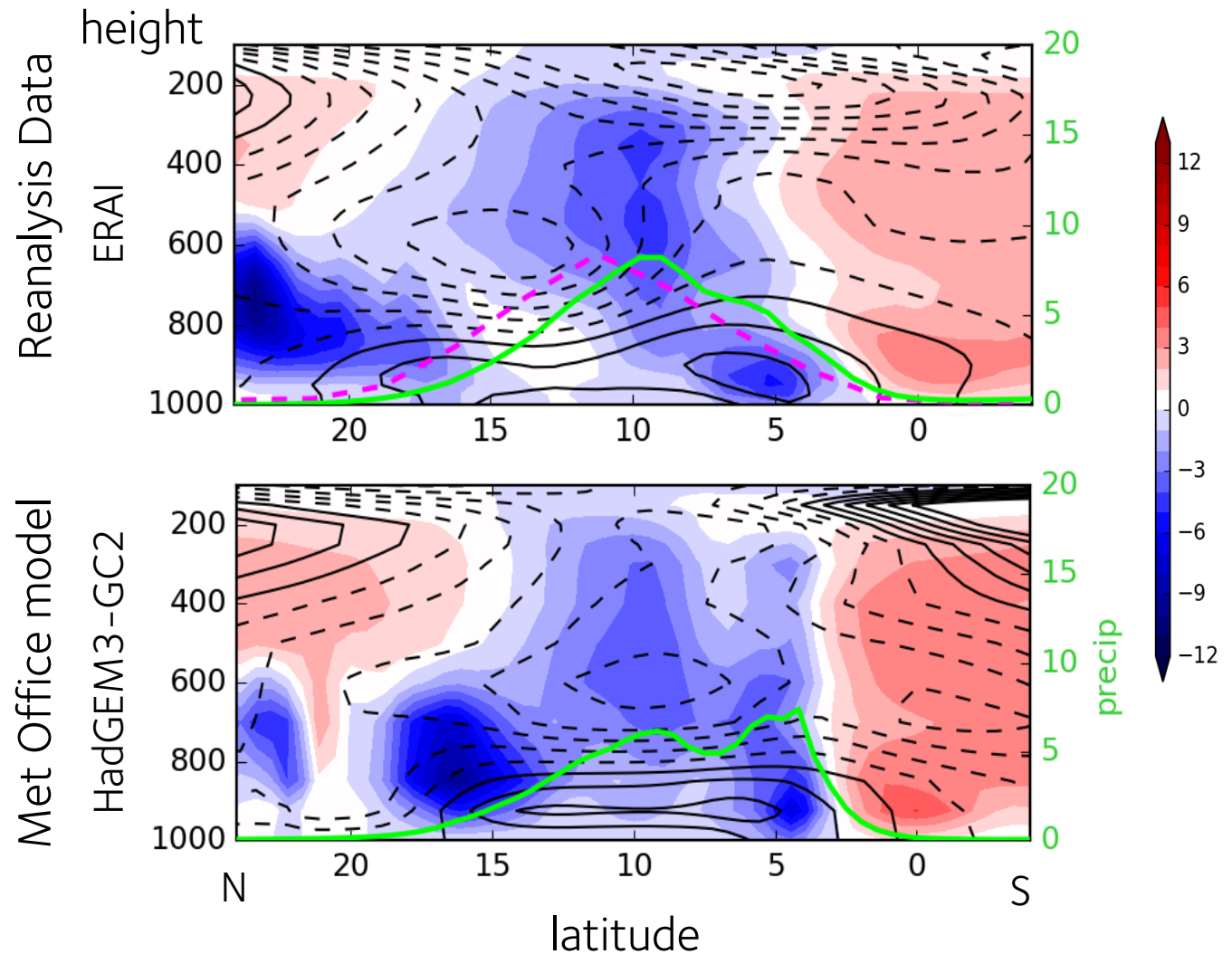
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green lines

blue to red shading

contour lines



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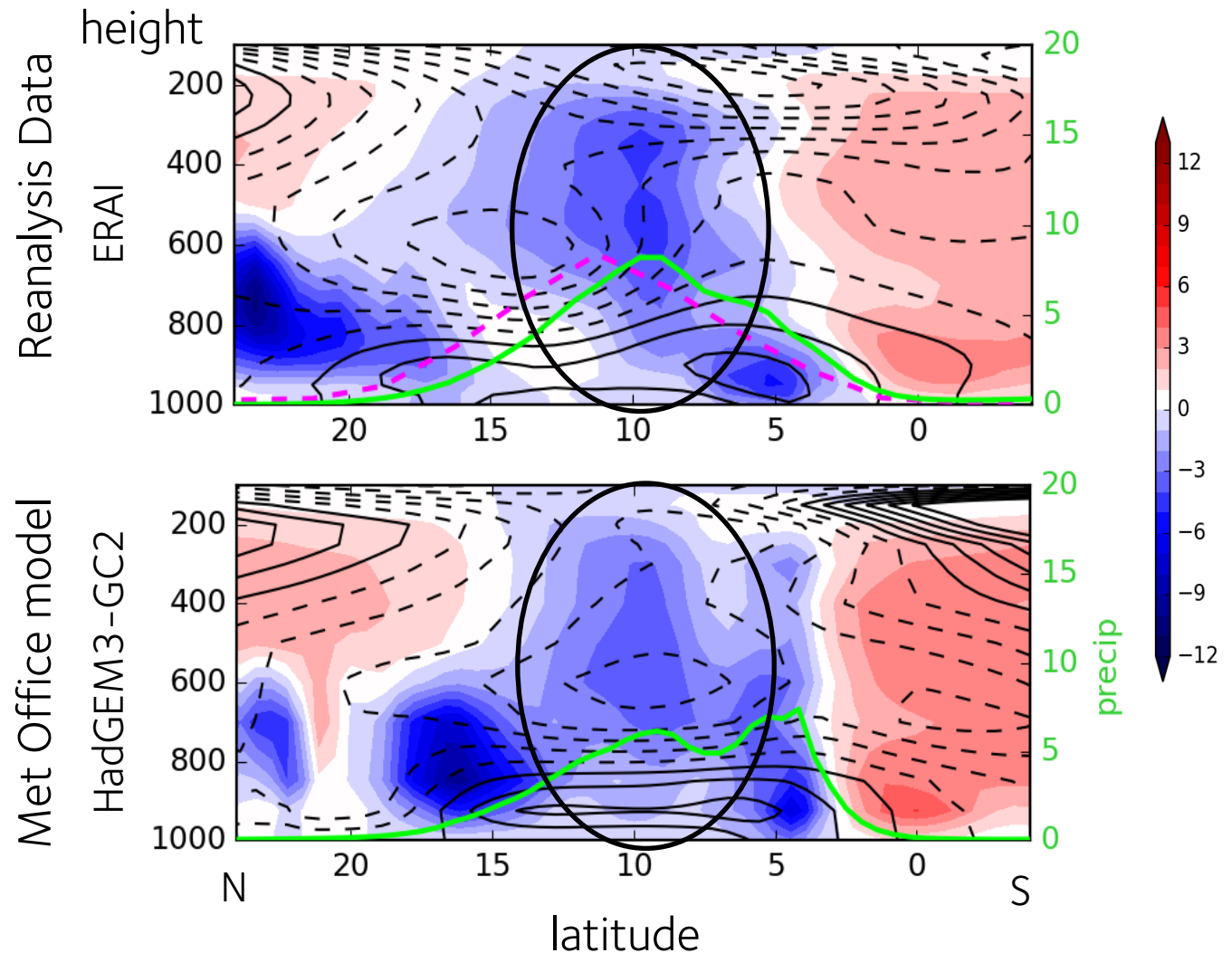
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contour lines

Differences
in main
region of
ascent



West Africa: simulation of the monsoon

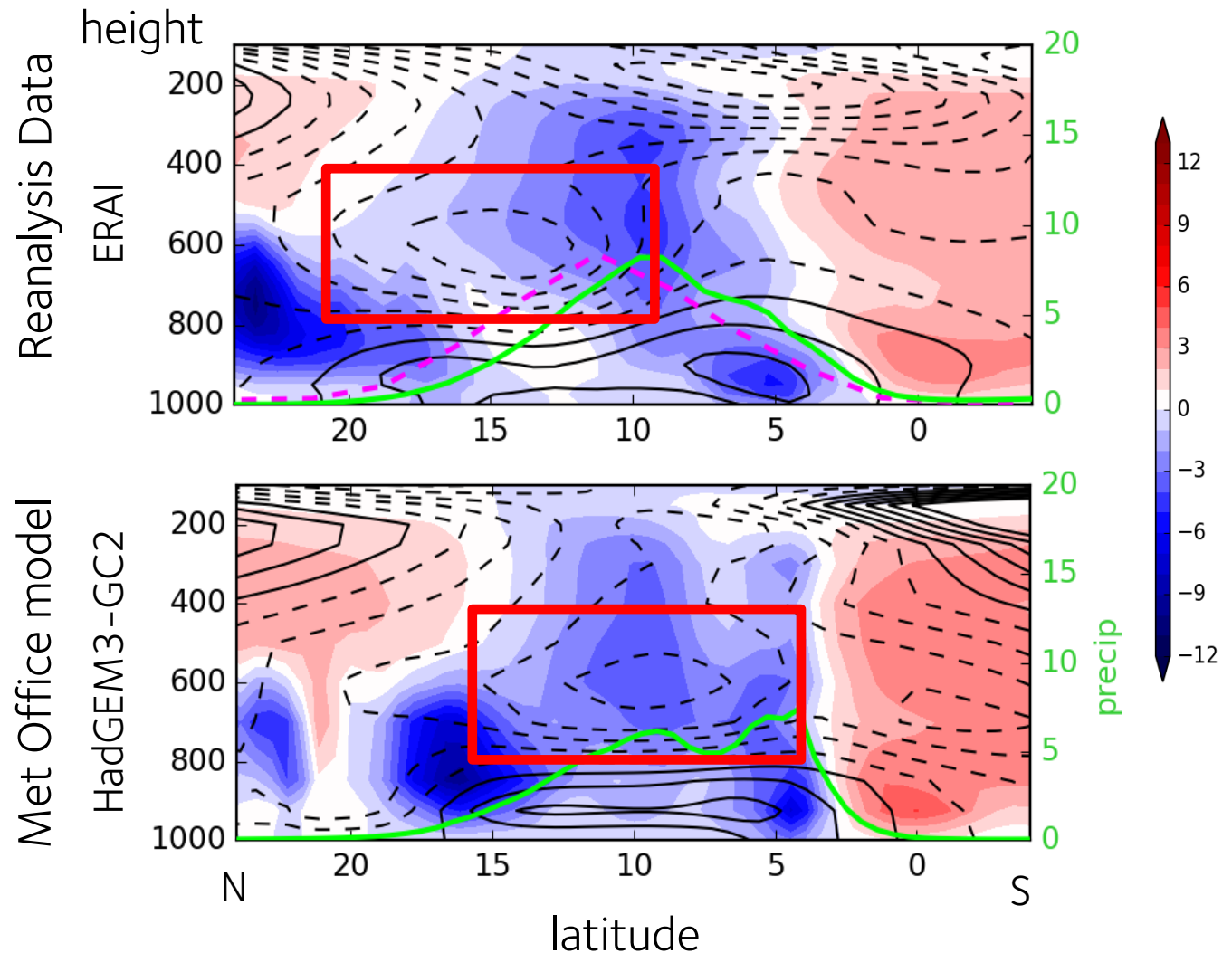
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green lines

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African
Easterly Jet
is further
south in
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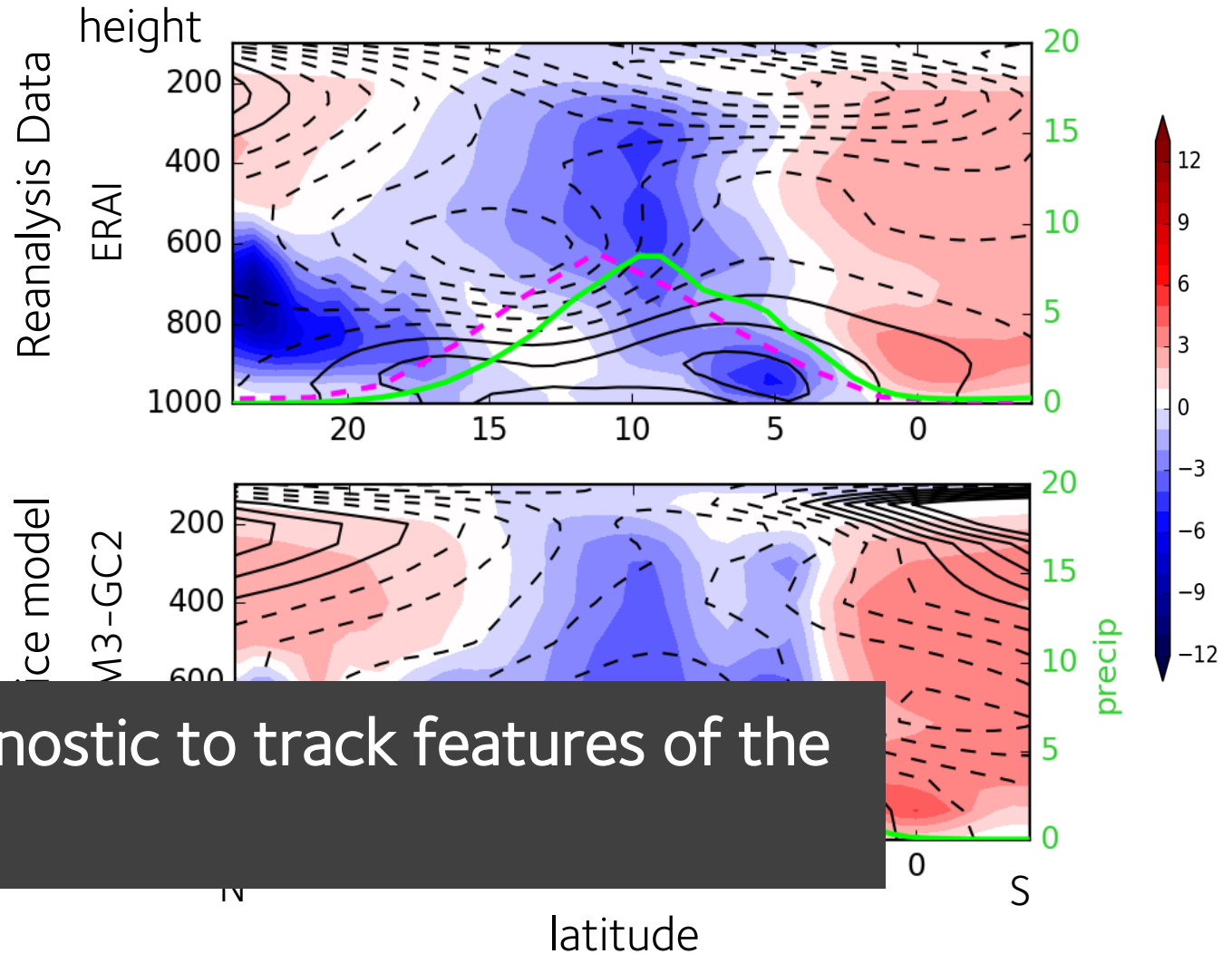
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A useful diagnostic to track features of the monsoon

A model evaluation “hub”?

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- Aims:
 - Collaboration between model developers and African climate scientists
 - Collectively identify priorities for evaluation
 - Share insights from model evaluation research
 - Develop diagnostics for the CMIP DECK analysis toolkit

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...a legacy of improved understanding of
climate models over Africa

What could a model evaluation hub look like?

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Who? How? Which institutions? ... Funding?

What could a model evaluation hub look like?

A potential vision:

- a people-centred hub
- workshops or conferences
- an online platform
- a git repository
- a list of priority diagnostics
- collaboration with programmers
- engagement with model development centres
- meetings to track progress at each CMIP phase

Summary

- Model evaluation has an important role to play in efforts to improve climate information over Africa
- So far, some really important efforts to understand regional processes and examine models, but this evaluation is not routine or linked to model development
- To improve climate models need routine evaluation which is:
 - Process based
 - Region specific
 - Guided by local expertise
- Our paper demonstrates some potential examples...
- ... a hub could embed Africa-focused diagnostics into CMIP infrastructure, promoting model development with an African lens

Thank you!
We welcome your input!



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