Regional climate model projections for Africa and implications for food security

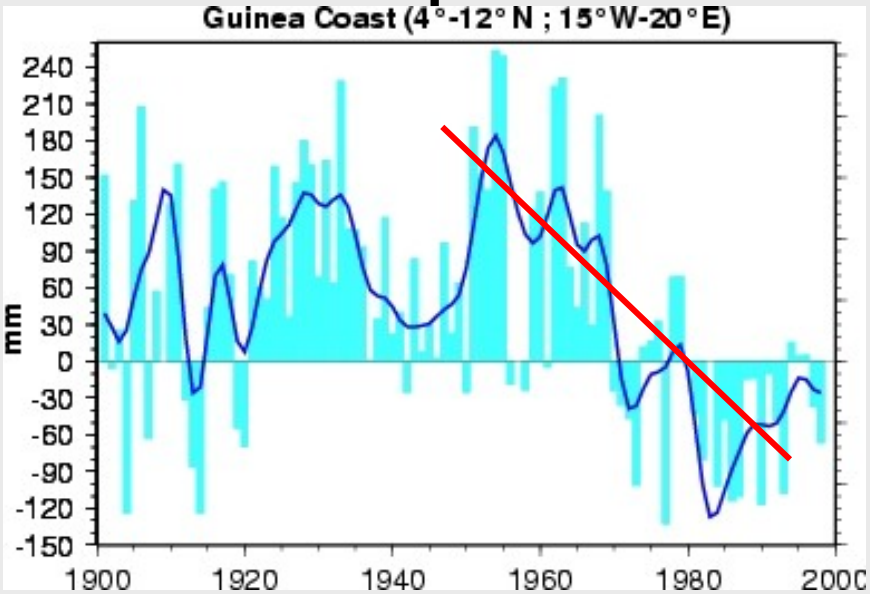
Heiko Paeth, *Institute of Geography, University of Wuerzburg*

Conference on African Drought, Trieste 2008

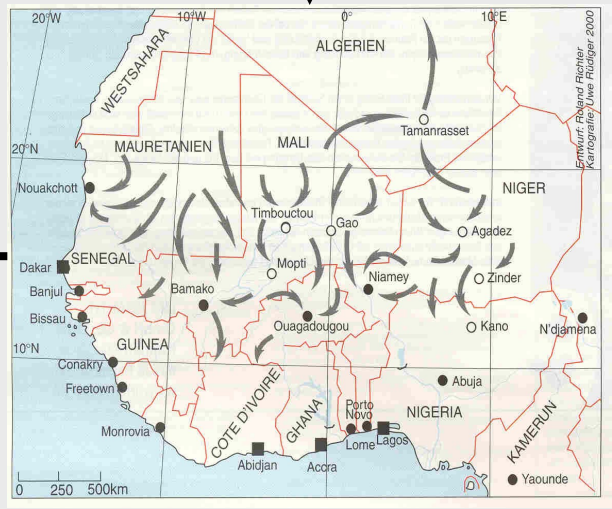
Learning from the past …

hunger

climate change



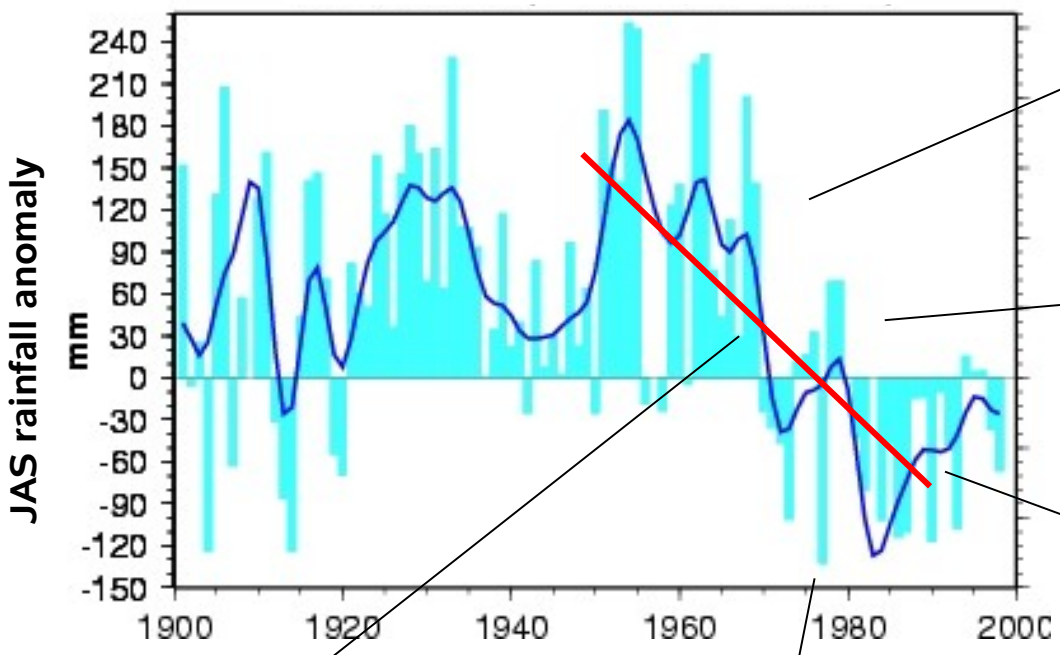
migration



civil war ?

Motivation

What has caused the Sahelian drought?



decadal trend

seasonal anomaly

Relevant time scales

Driving forces

oceanic forcing ?

greenhouse forcing ?

feedbacks with land surface / land degradation ?

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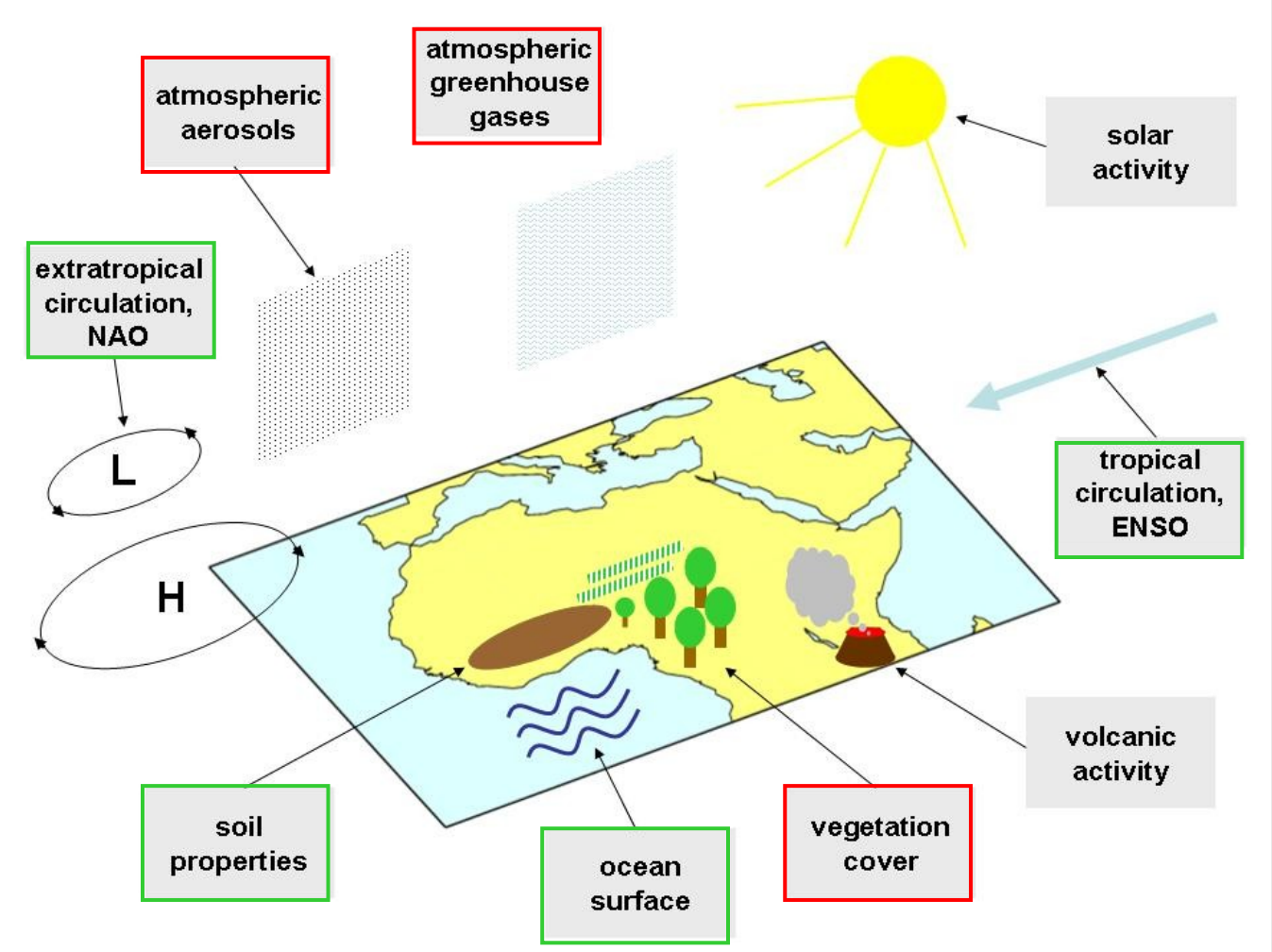
Key factors in African climate



possible anthropogenic forcings

possible feedbacks to anthropogenic forcing

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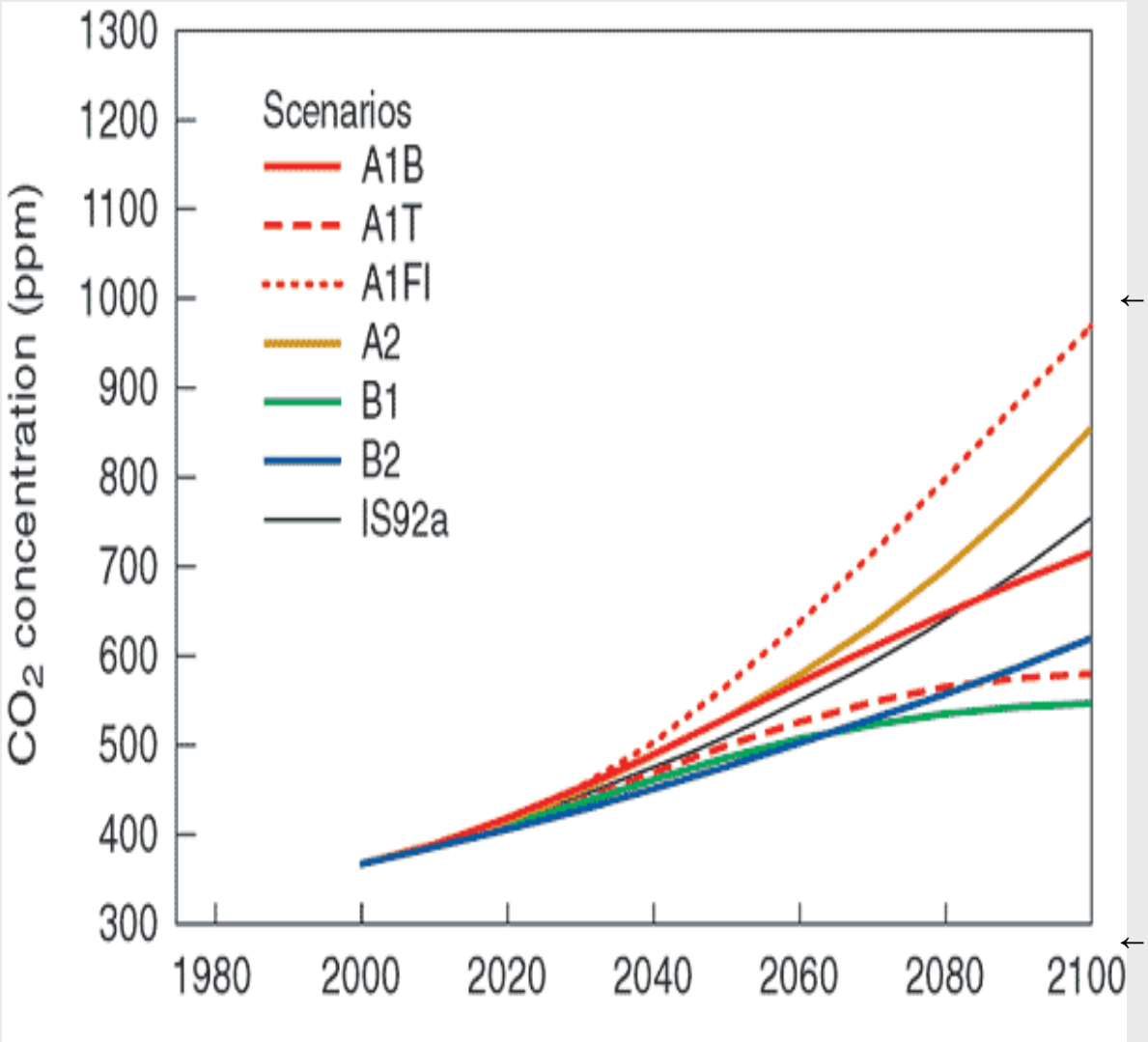
Classical IPCC view



noticeable differences between scenarios from 2030 onward

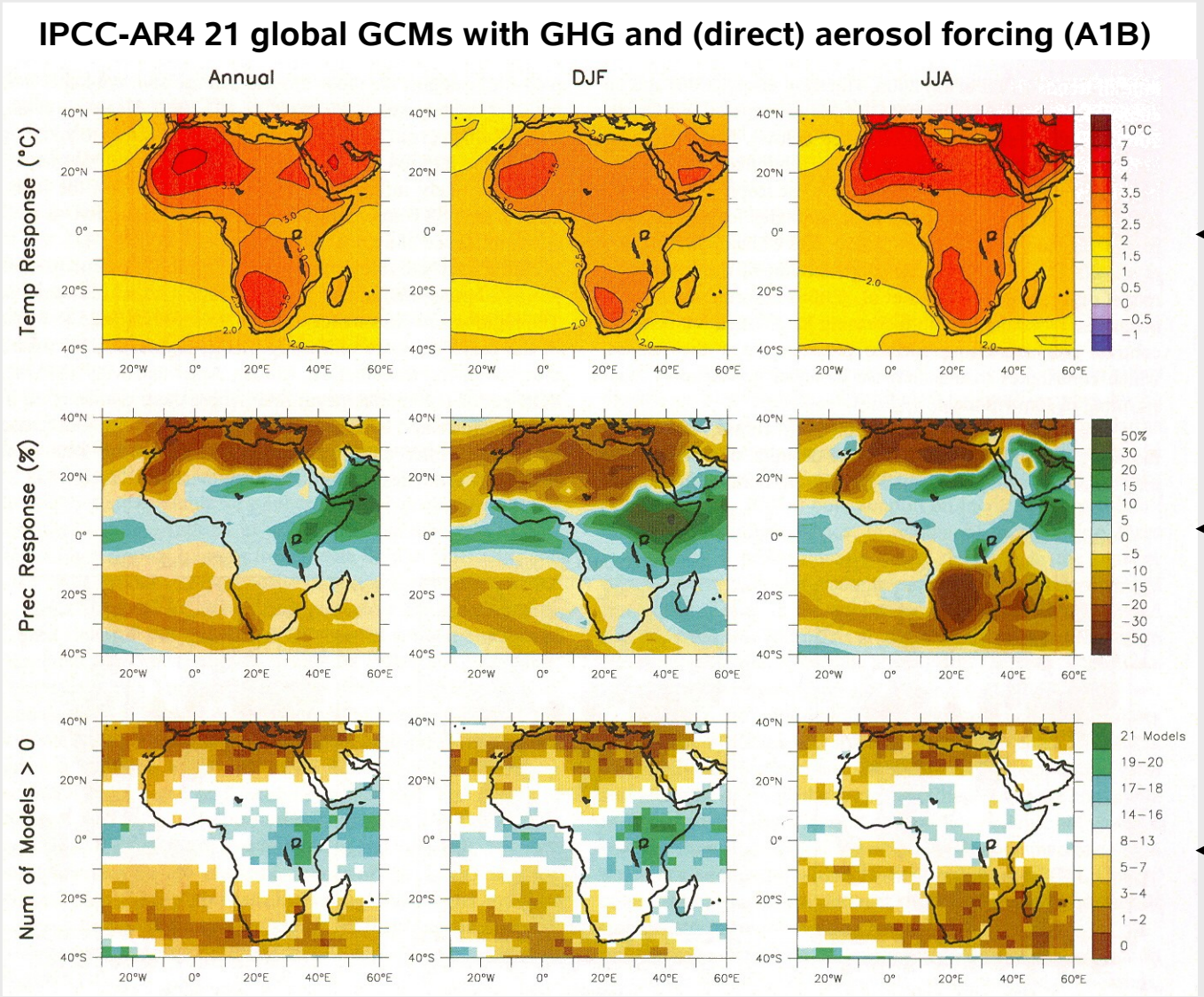
← **1000 ppm: Mesozoic**

250 years

65 Mio. years

← **280 ppm: pre-industrial**

Classical IPCC view



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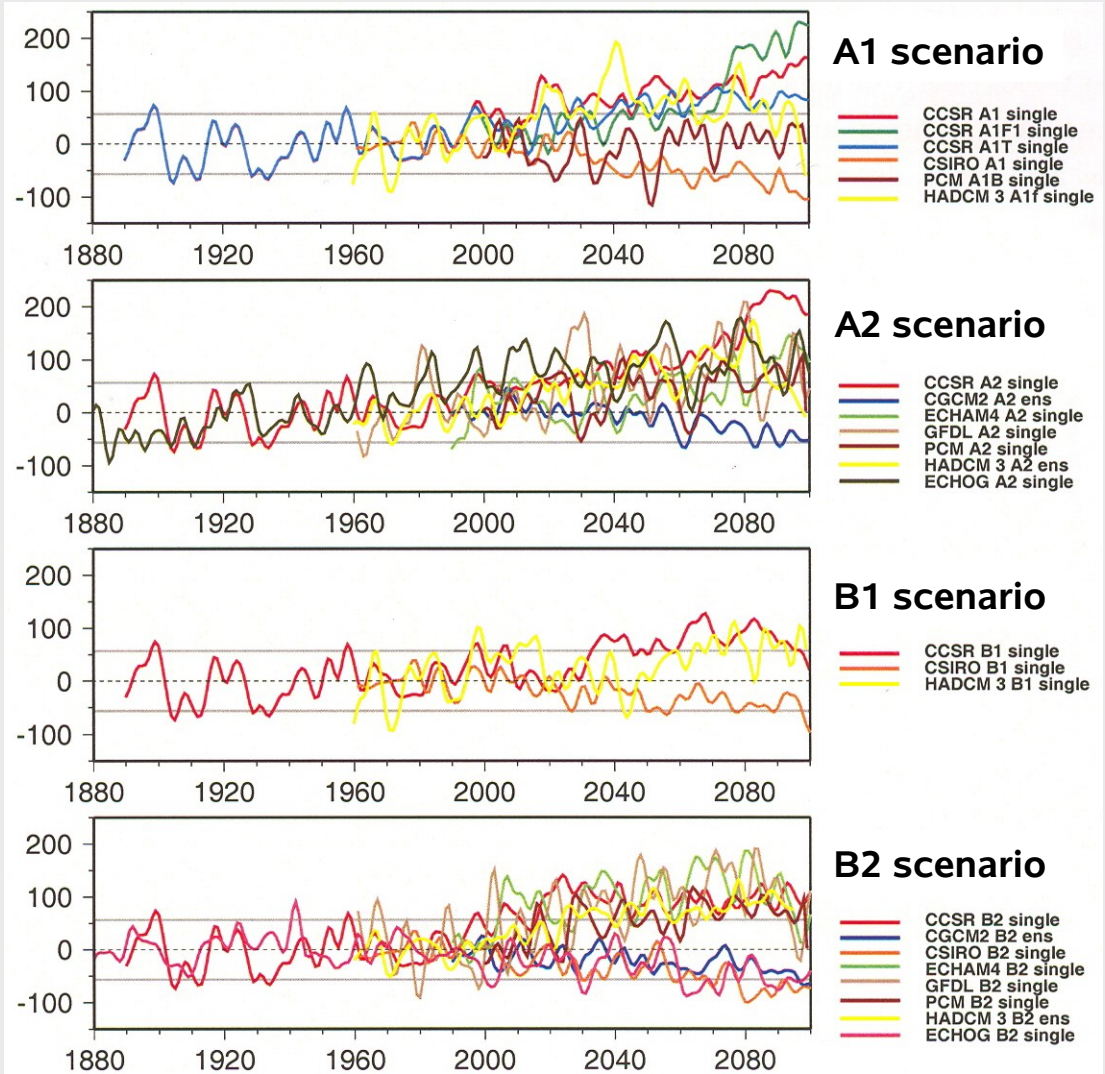
Classical IPCC view

Time series of the West African summer monsoon rainfall from CMIP2 runs:

even qualitatively uncertain



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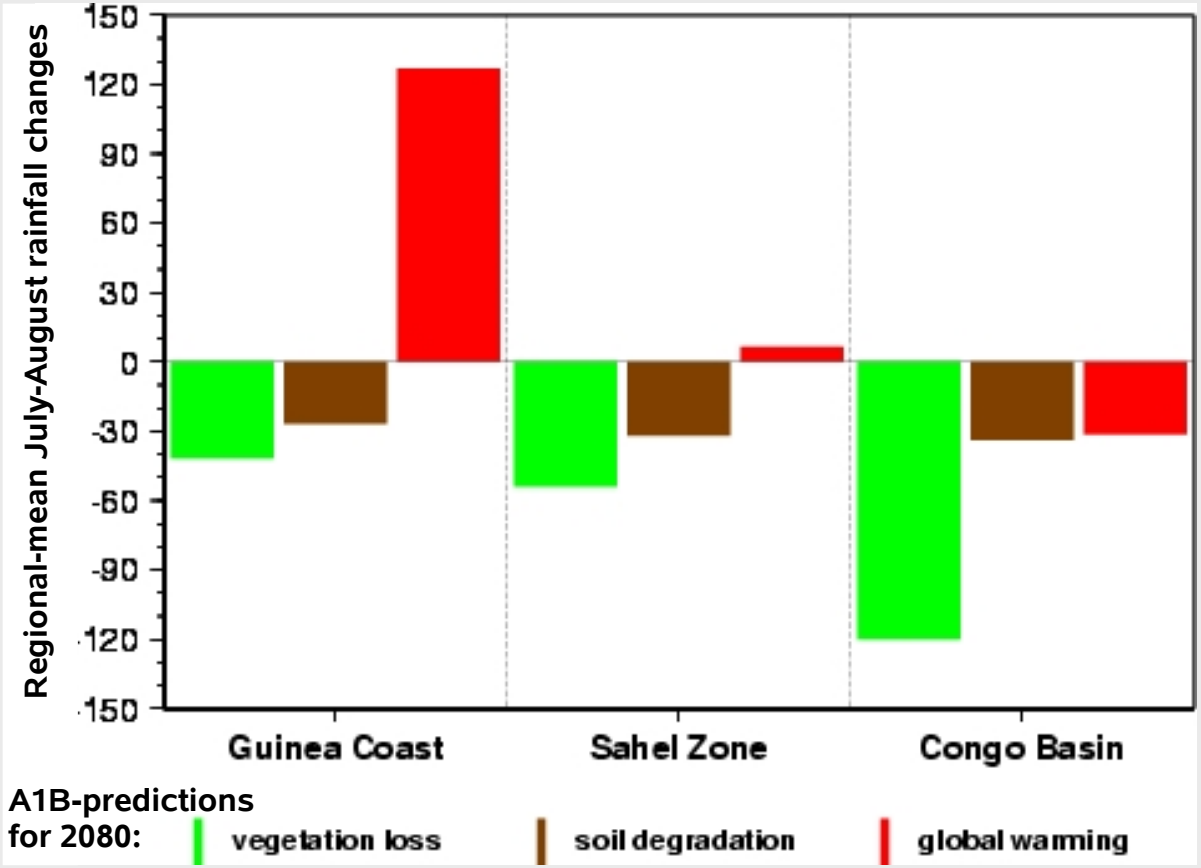
Additional forcings



⇒ land degradation is a key factor in African climate change

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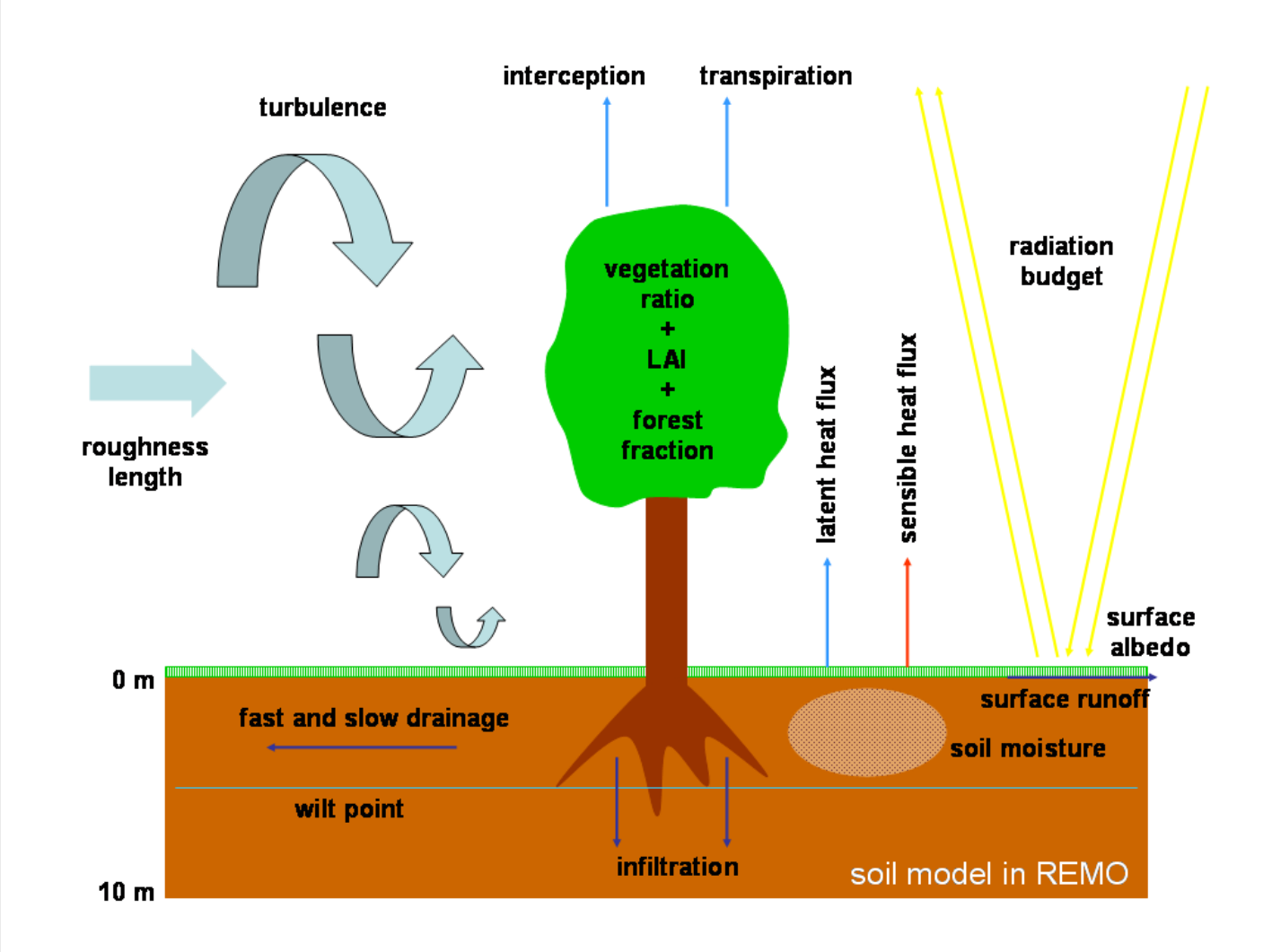
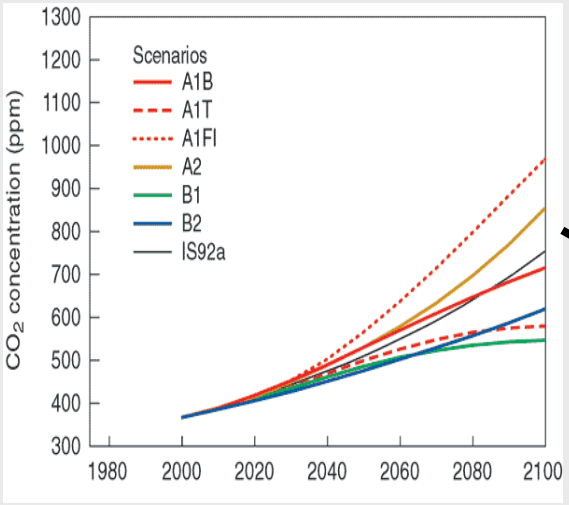
Effects of land degradation

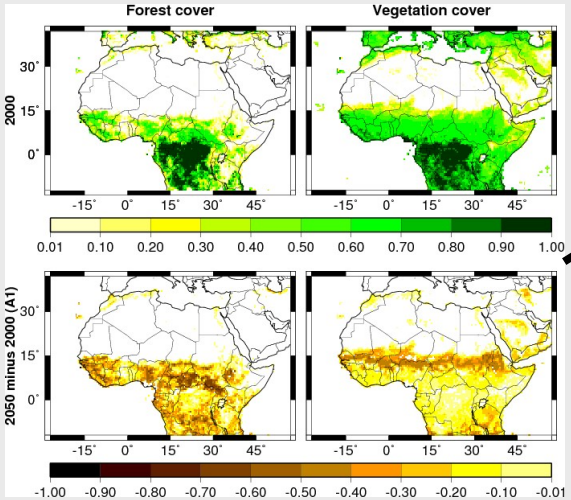


New transient scenarios

greenhouse forcing

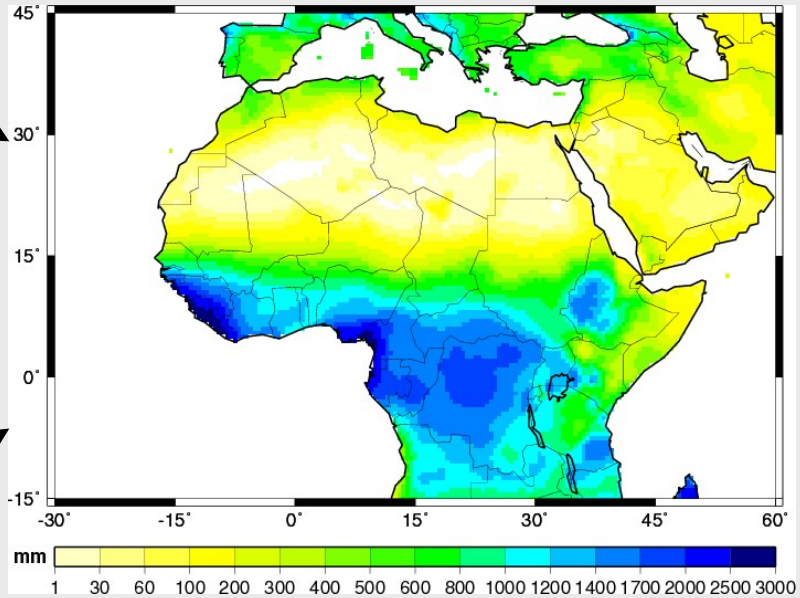


land degradation



A1B
+
B1

REMO 0,5° , 1960-2050



(nested in ECHAM5-MPI-OM model)

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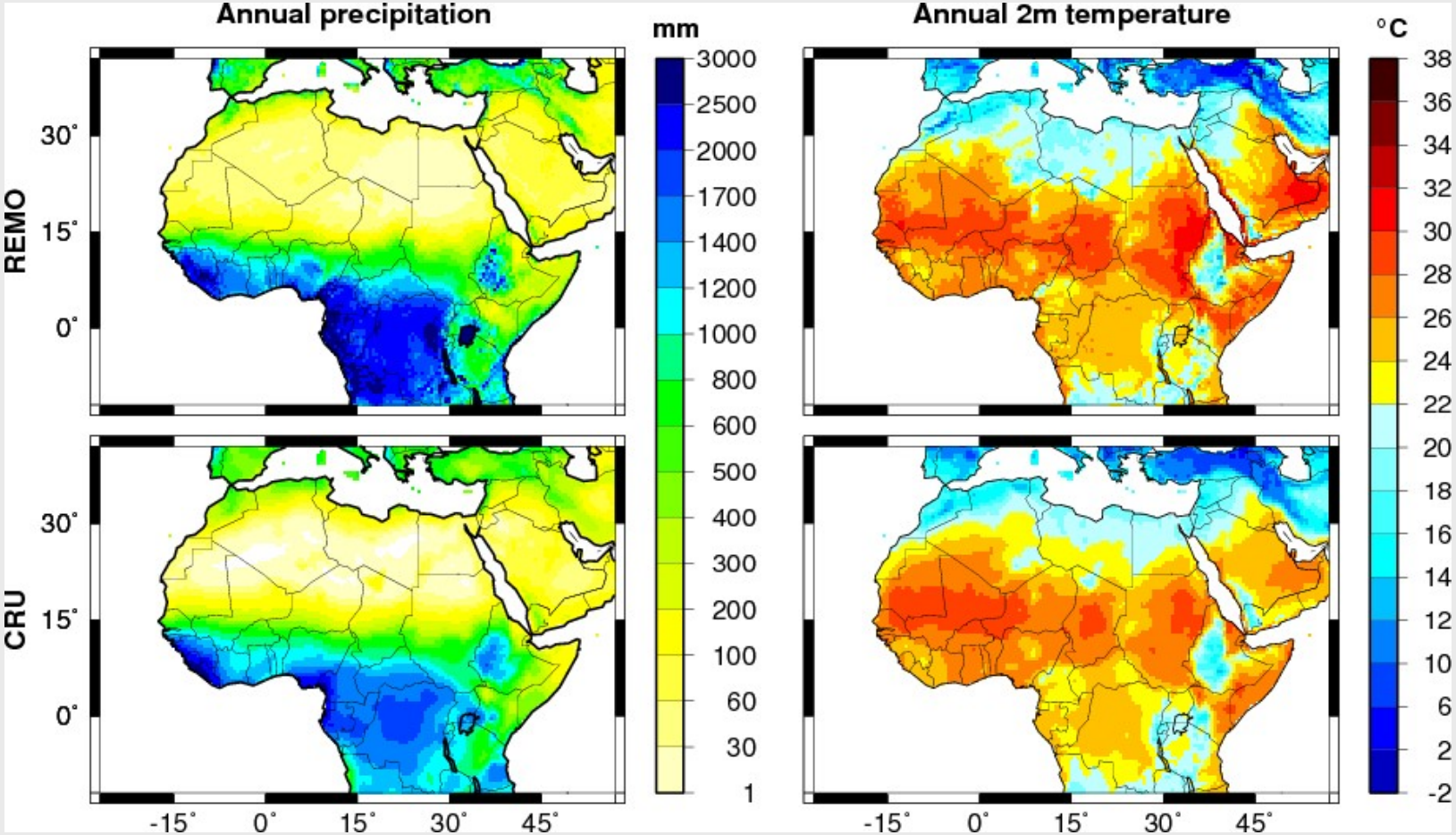
Model versus observations



⇒ realistic simulation of the main features

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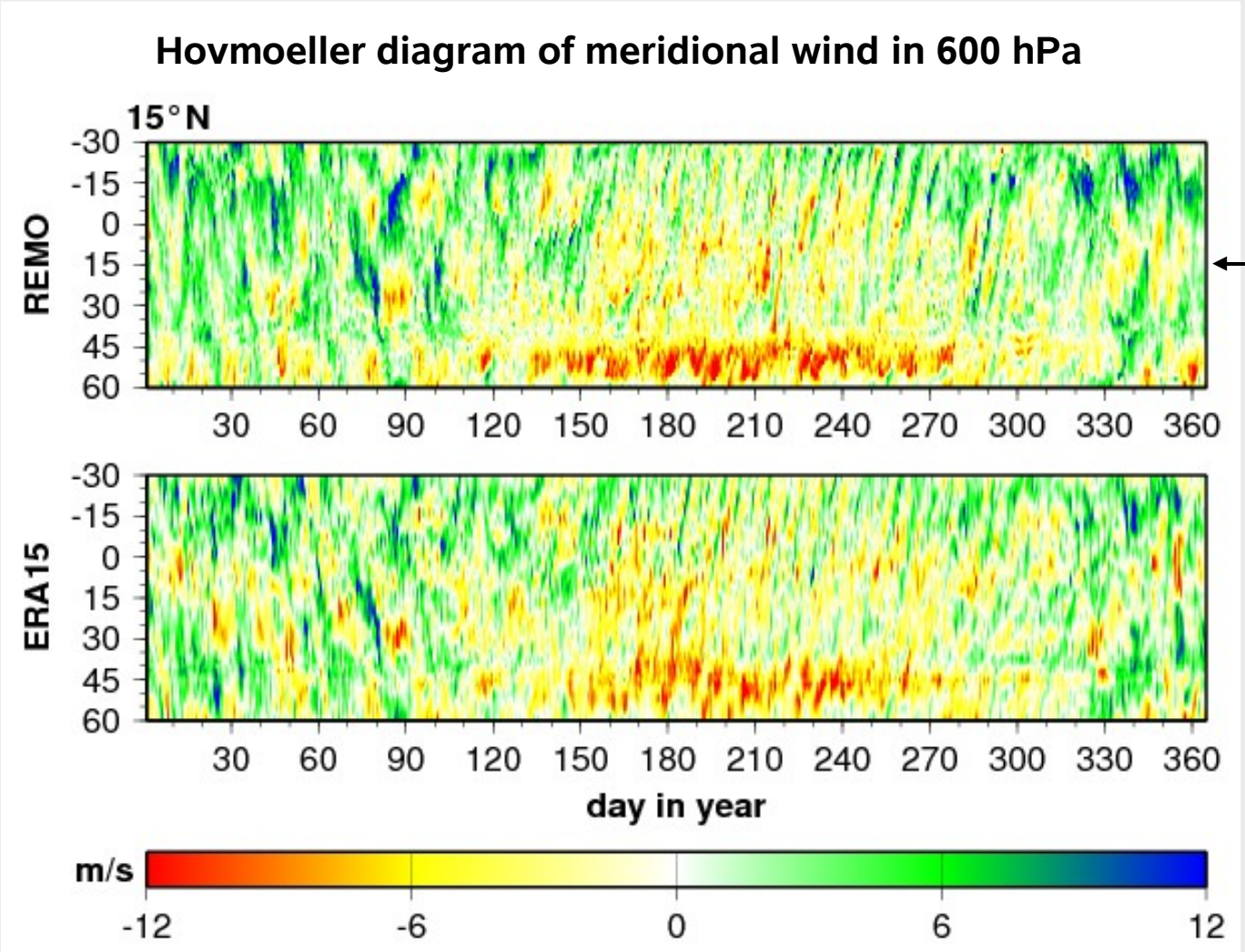

African Easterly Waves well reproduced by REMO

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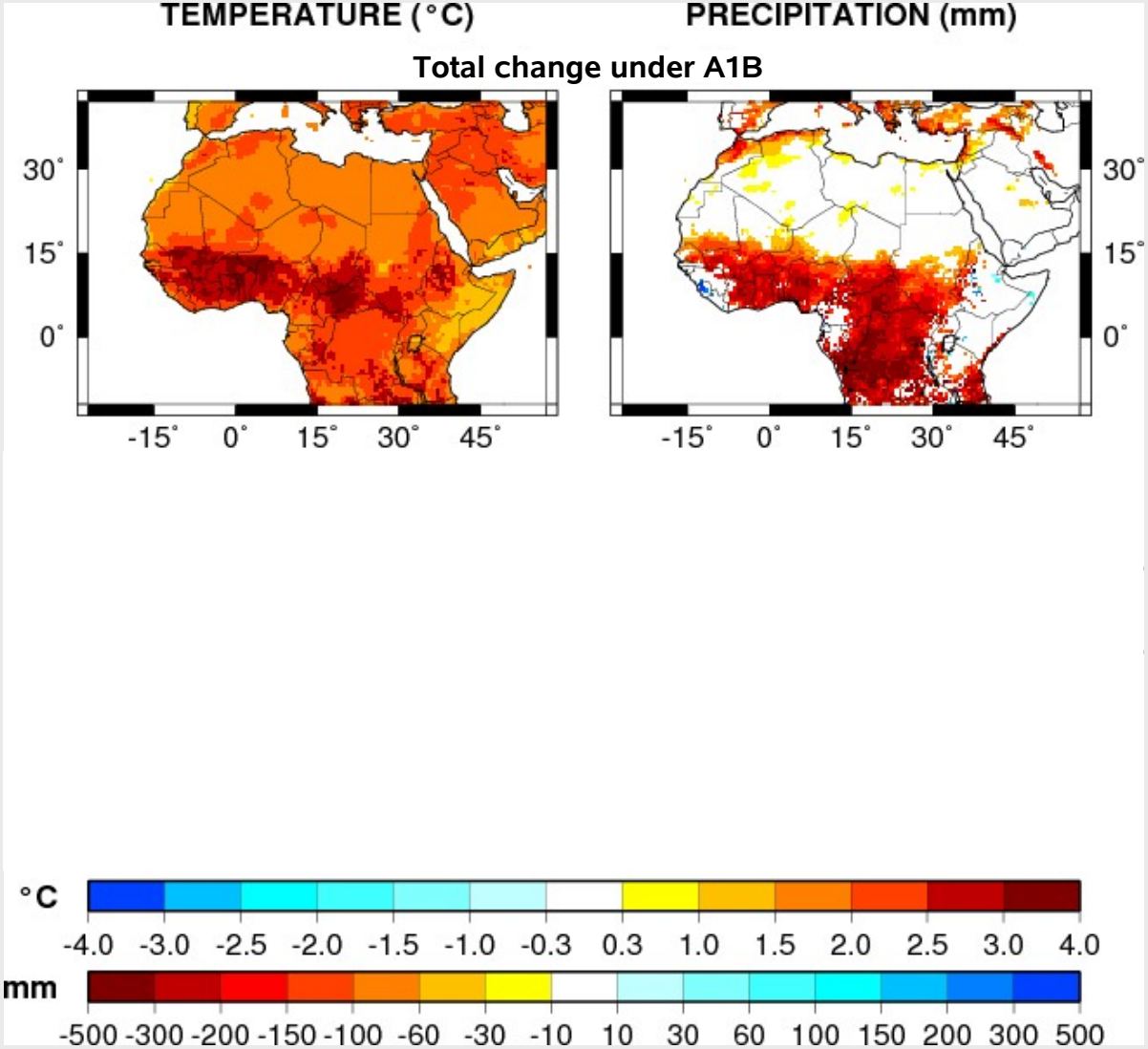
Model projections



⇒ **prominent warming and drying in sub-saharan Africa**

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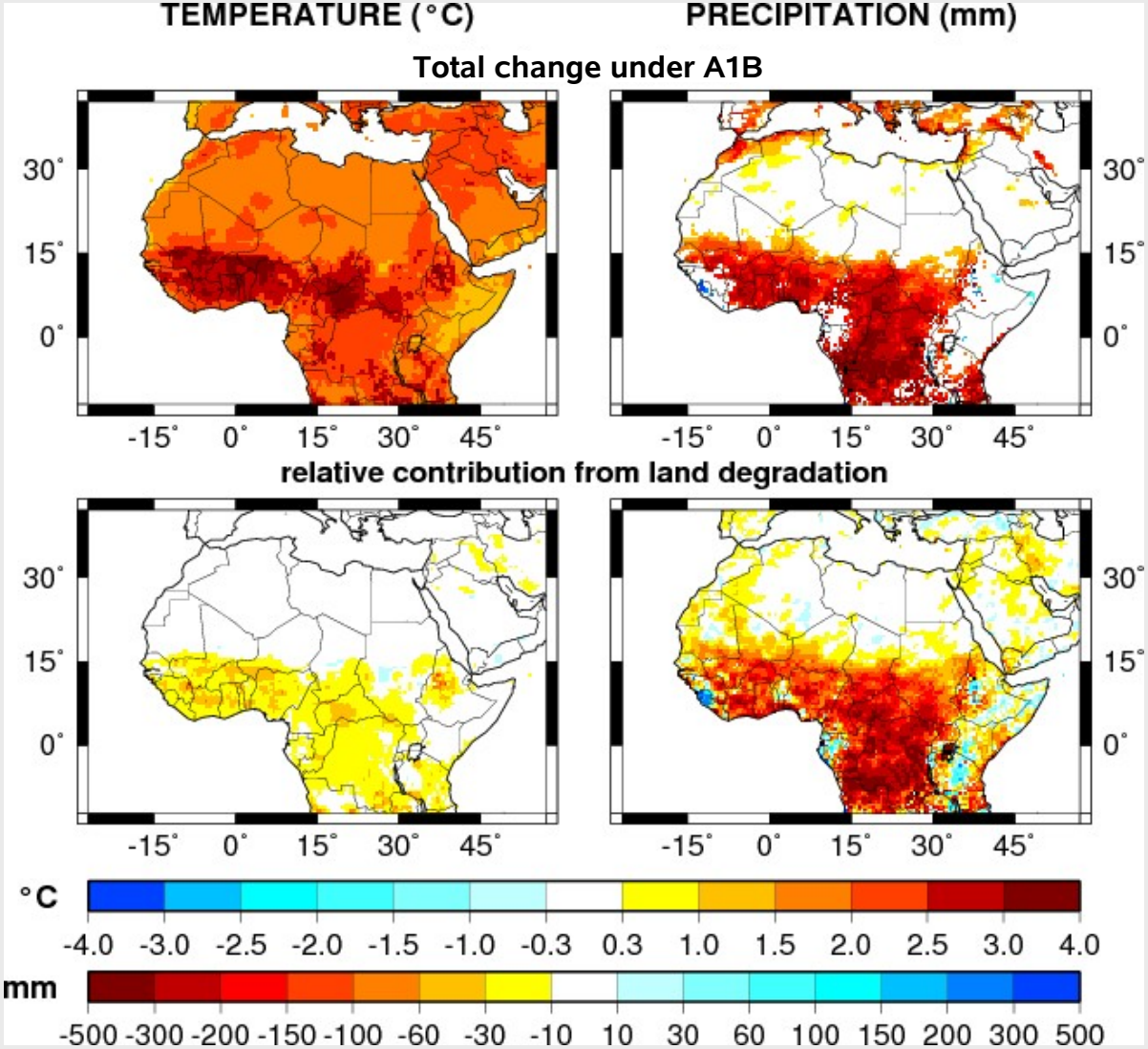
Model projections



⇒ prominent warming and drying in sub-saharan Africa

⇒ land degradation is primarily responsible for the drying

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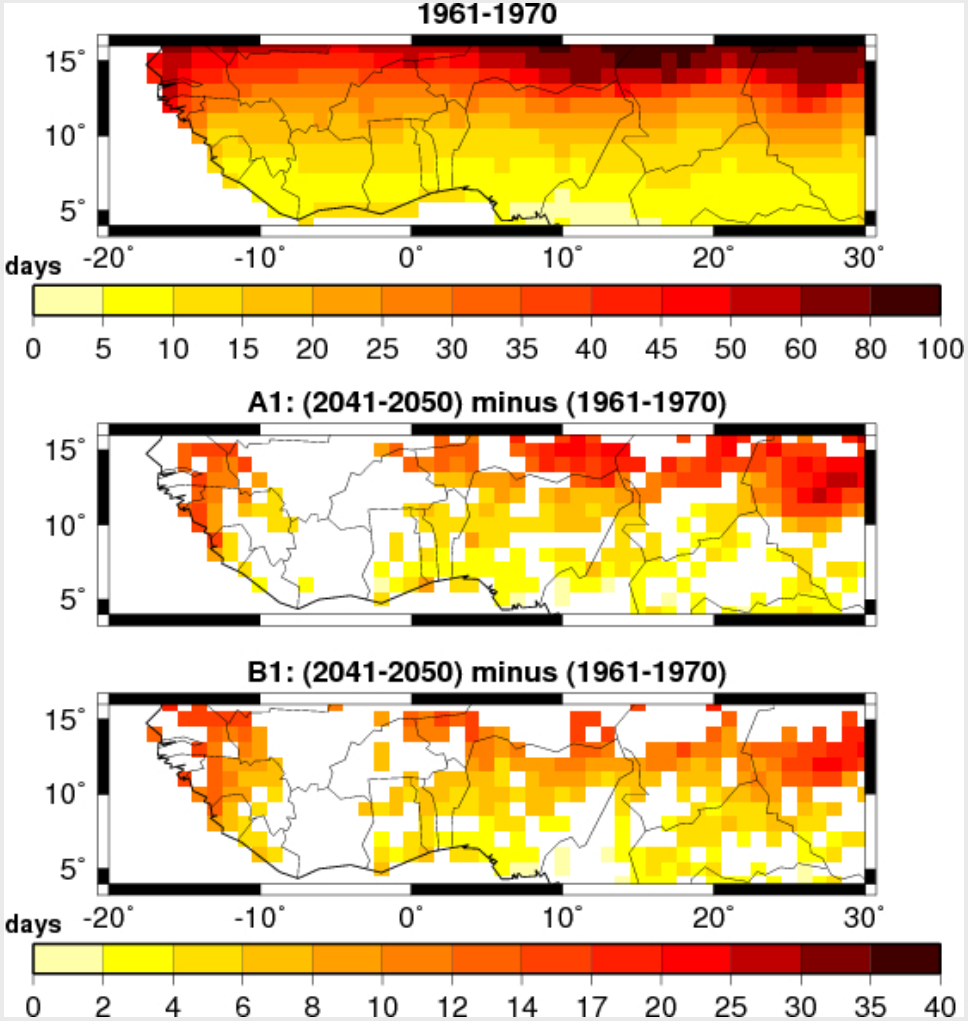
Model projections



⇒ extent of the time length of monsoon breaks

⇒ retreat of the natural boundaries of agriculture without irrigation

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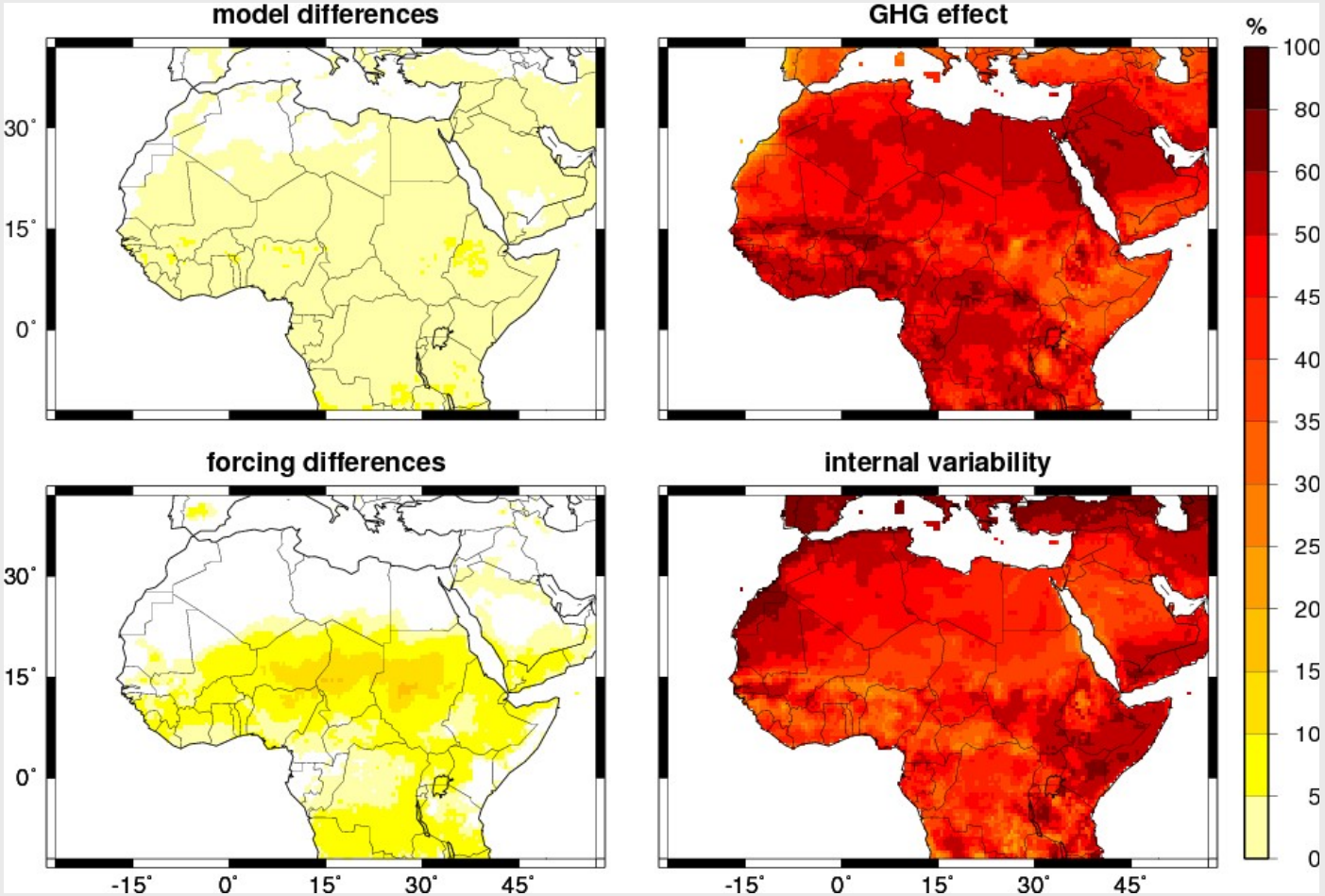
Signal-to-noise ratio

TEMPERATURE



⇒ the combined external forcing accounts for up to 60 % of total variability
⇒ different scenarios have a statistically significant effect on the heating rate

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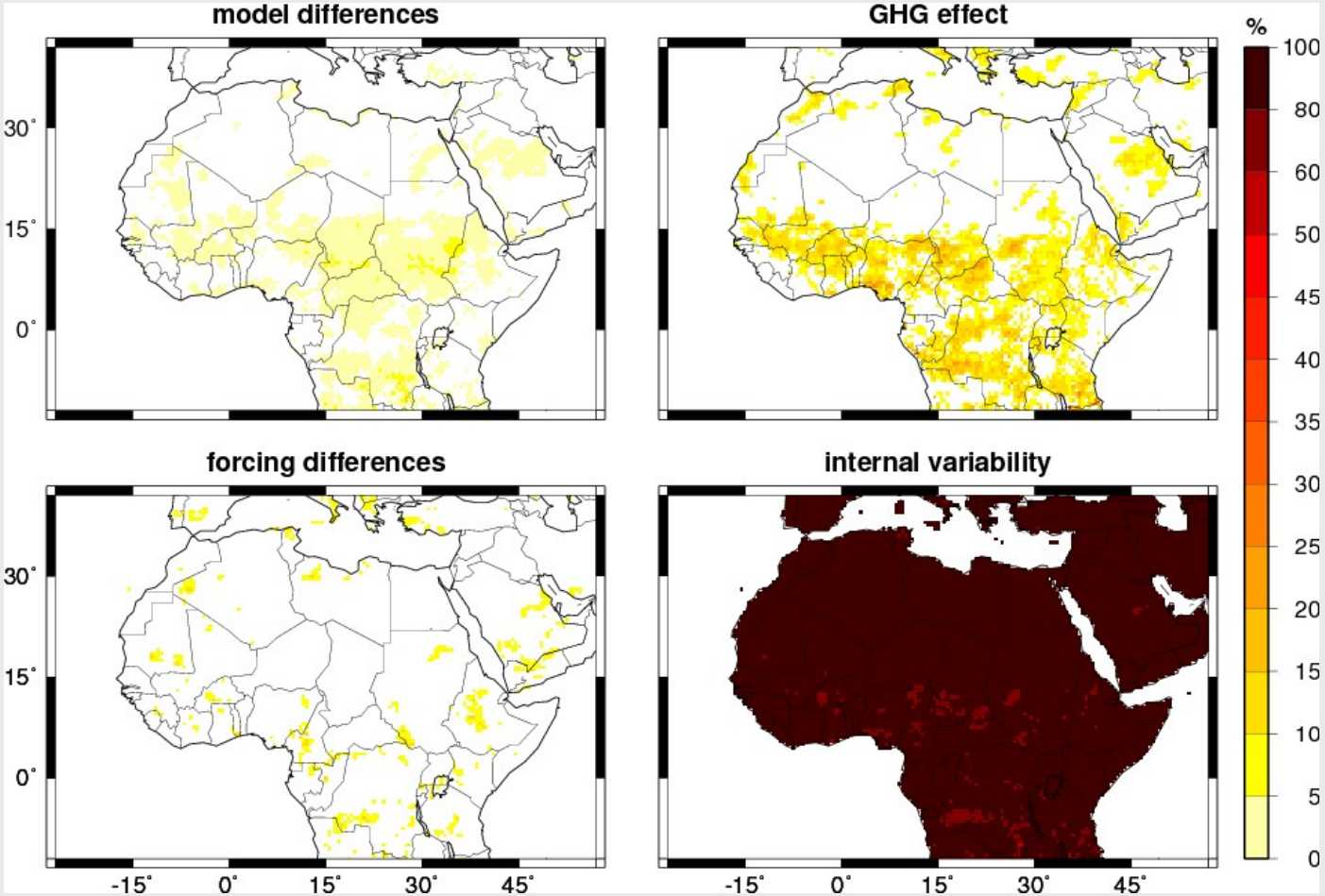
Signal-to-noise ratio

PRECIPITATION



⇒ even for precipitation, the external forcing stands out at the regional scale
⇒ the A1-B1 difference is less apparent with respect to the hydrological cycle

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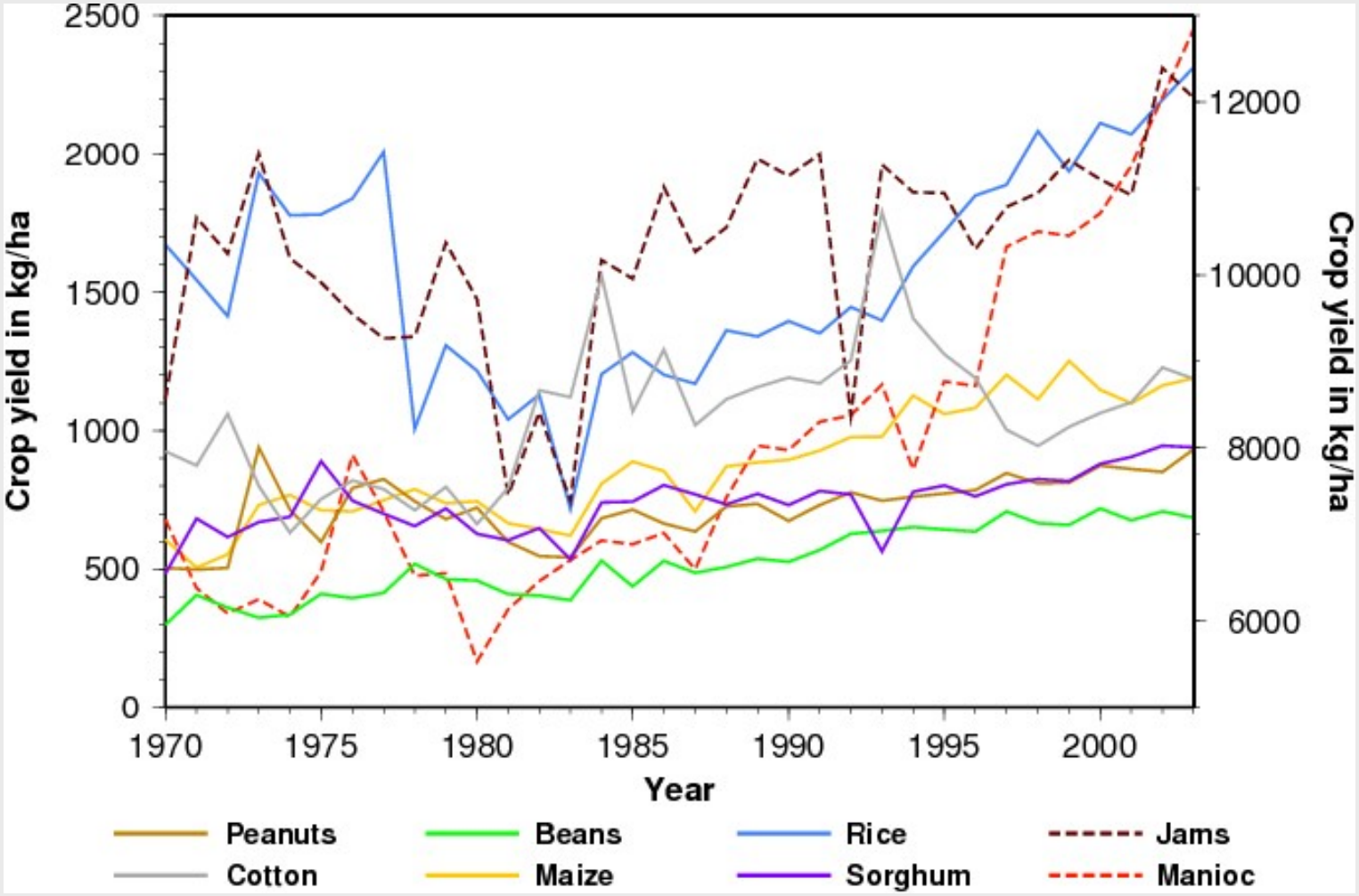
Variability of crop yield in Benin



⇒ green revolution plus interannual variability

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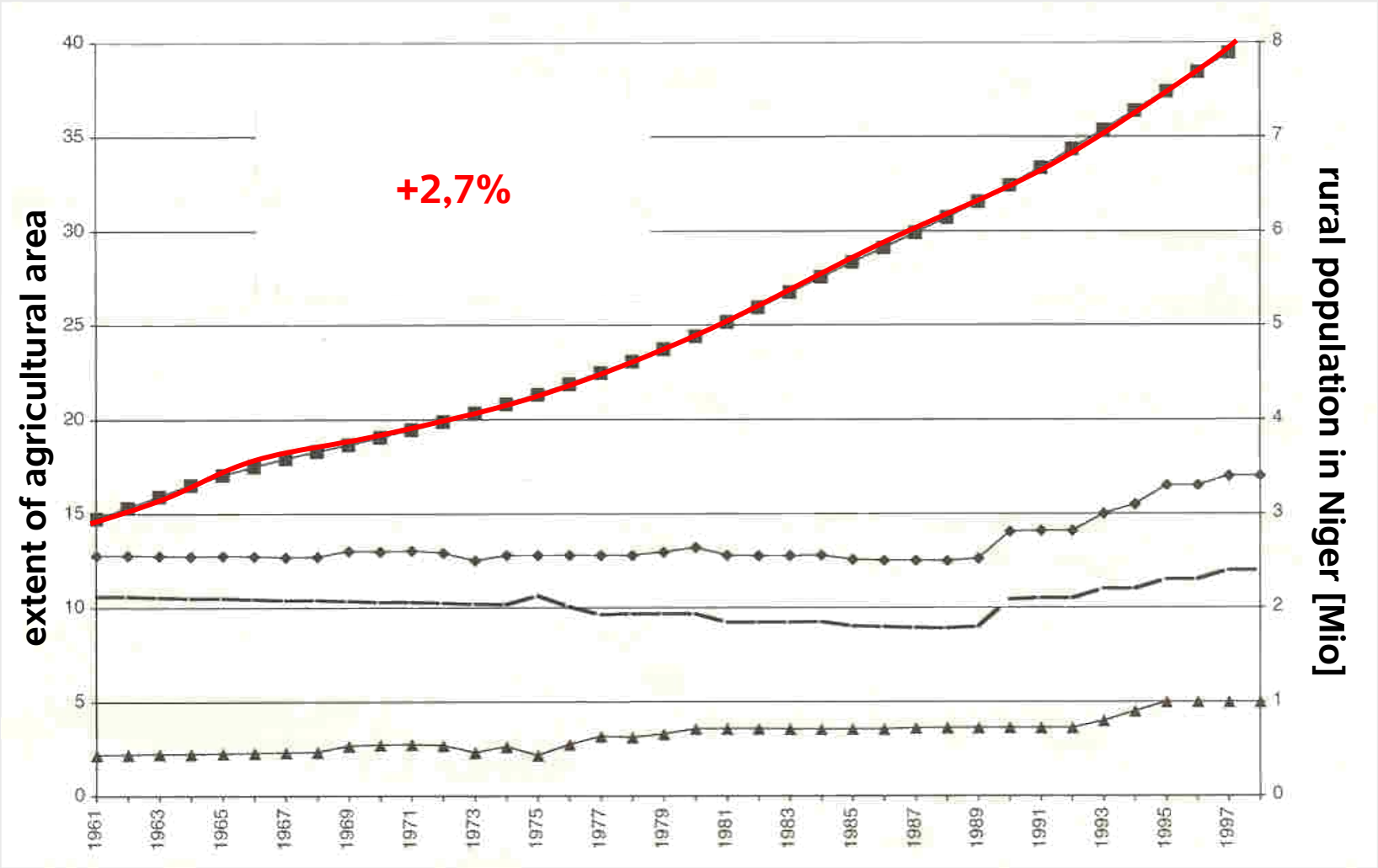
Population growth



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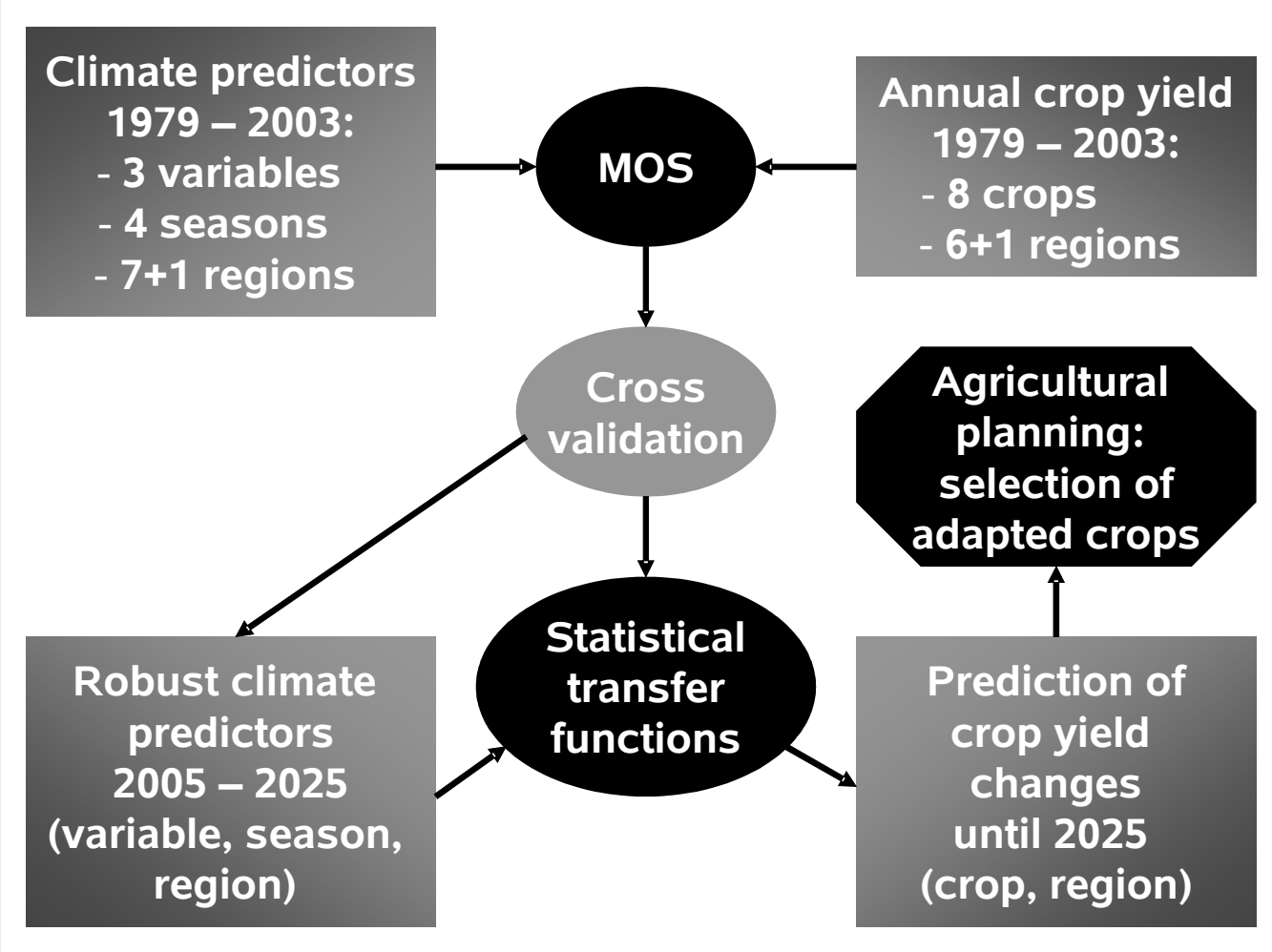
Statistical model for crop yield



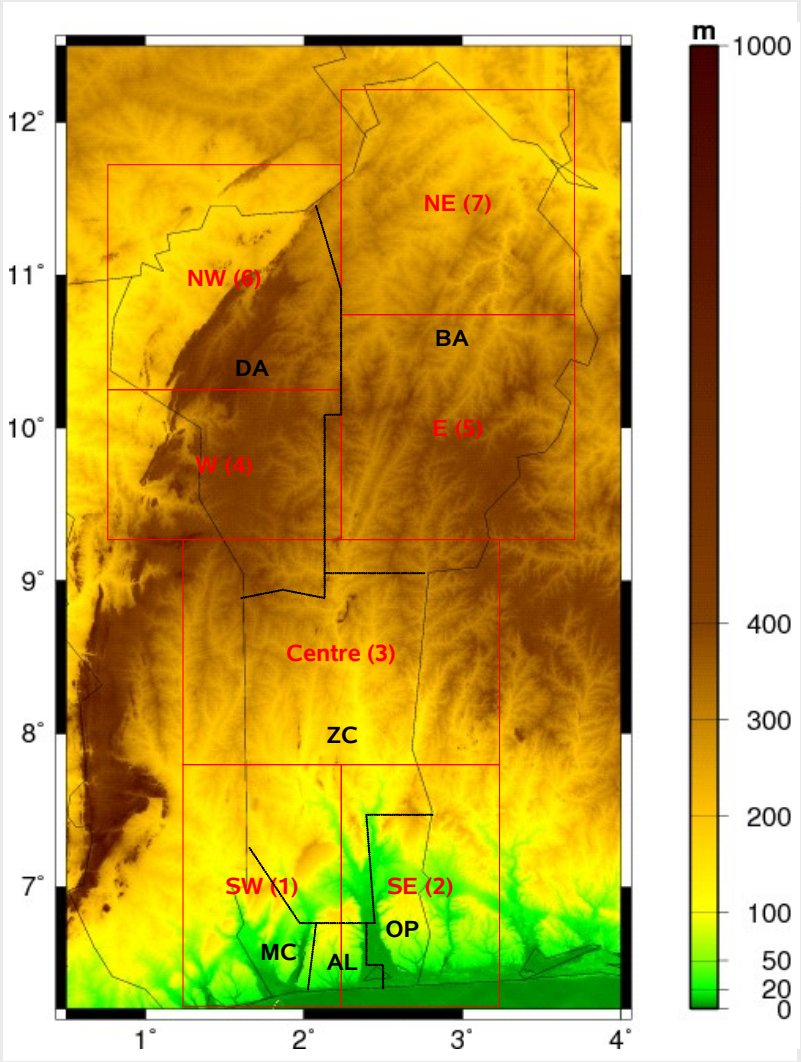
Predictors and predictands

3 atmospheric variables: precipitation
temperature
relative humidity

seasonal time series

7 agro-climatological units over Benin

plus Benin average



8 crops

annual time series

6 departments

plus Benin total

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Statistical transfer functions

Crop	Explained Variance (dependent)	Explained Variance (independent)	Predictors		
			Variable	Season	Region
Peanuts	79.2	47.2	3	3	7
Cotton	58.0	20.3	1	2	1
Beans	53.9	25.4	3	3	7
Jams	85.2	42.3	3	3	8
Maize	52.4	27.8	3	3	7
Manioc	72.5	30.2	1	1	7
Rice	73.4	53.3	3	3	7
Sorghum	72.9	43.6	3	3	7

strong relationship

robust relationship

rel. humidity is best predictor

JAS is best predictor (forecast potential?)

Northeast climate is best predictor

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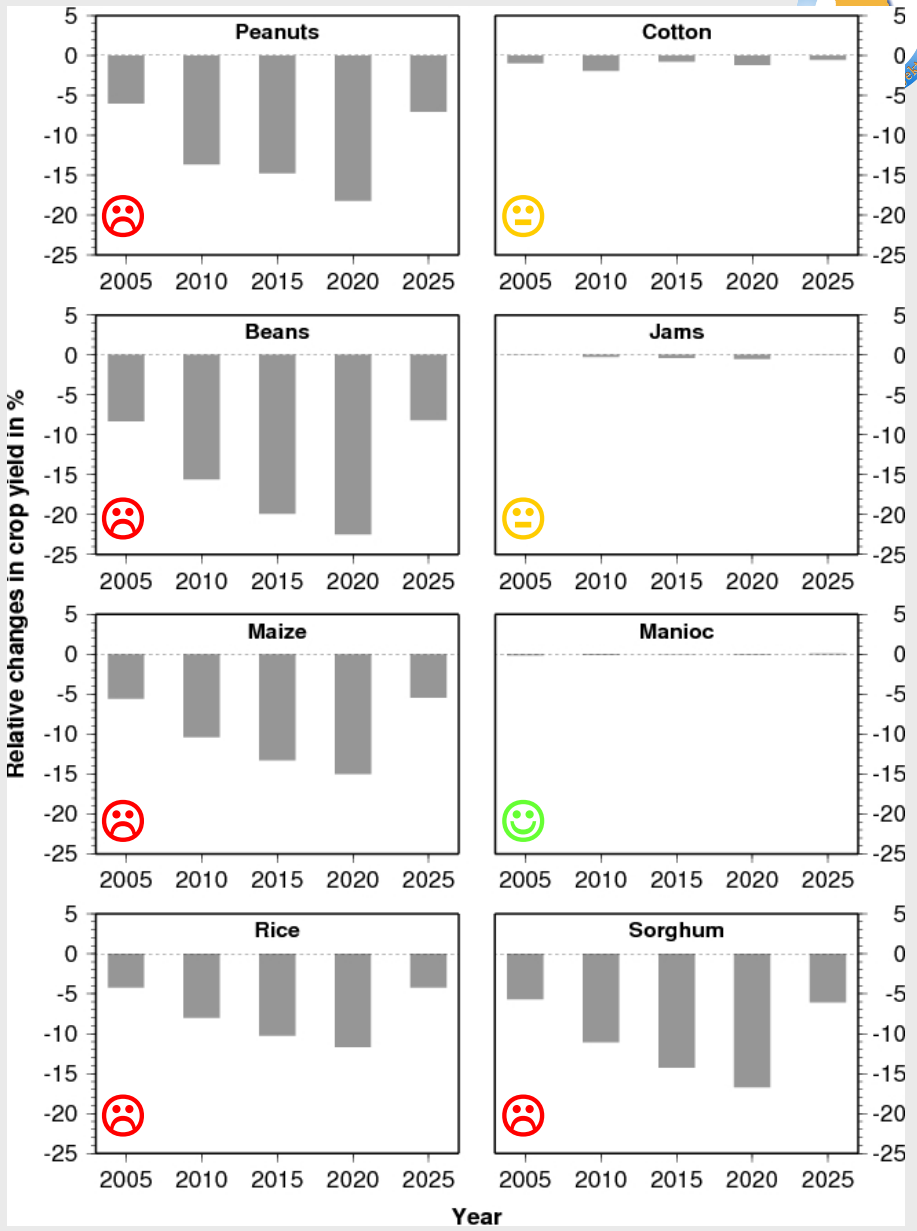
Future changes in crop yield

⇒ **Winners:** Manioc

⇒ **Insensitives:** Jams
Cotton

⇒ **Loosers:** Peanuts
Beans
Maize
Rice
Sorghum



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Summary

⇒ **Regional climate model simulations project a warmer and dryer climate in tropical Africa under the influence of human activity.**

⇒ **The expected climate change may lead to a reduction in crop yield, in particular alimentary crops, of up to 20 % until 2025.**

⇒ **Statistical and dynamical models in climate impact research together with realistic climate projections are required in order to support decision making in the light of climate change.**

⇒ **This may include the cultivation of less sensitive crops.**

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