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Display Materials

Emergence of multi-sectoral impacts of the global warming during the 21st century.

Focus on Western Africa

Audrey Brouillet[1*] and Benjamin Sultan[1]

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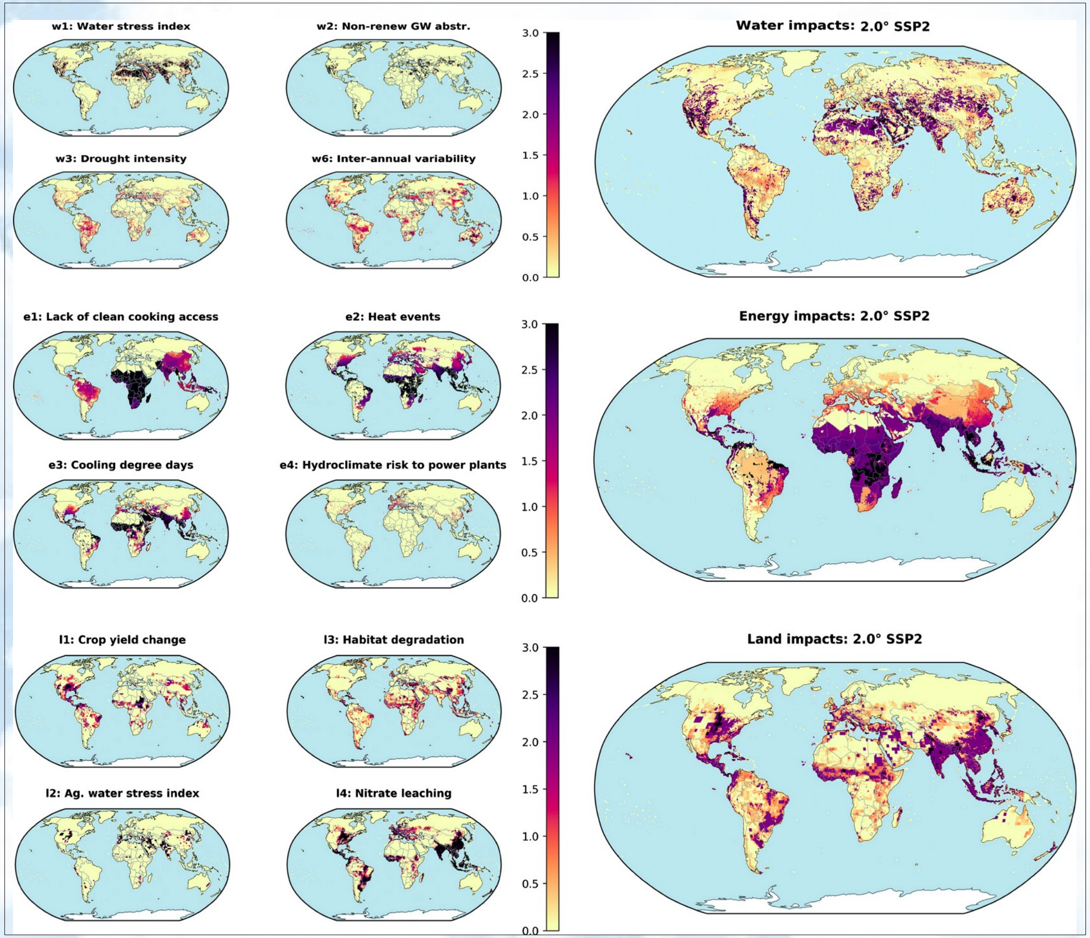
Previous studies: multi-sector (cumulated) impacts



DOI: 10.1088/1748-9326/aabf45

Byers et al. (2018) use a cumulative approach on quantified impacts (12-14 impacts illustrating 3 main sectors) using **ISIMIP Fast Track**.

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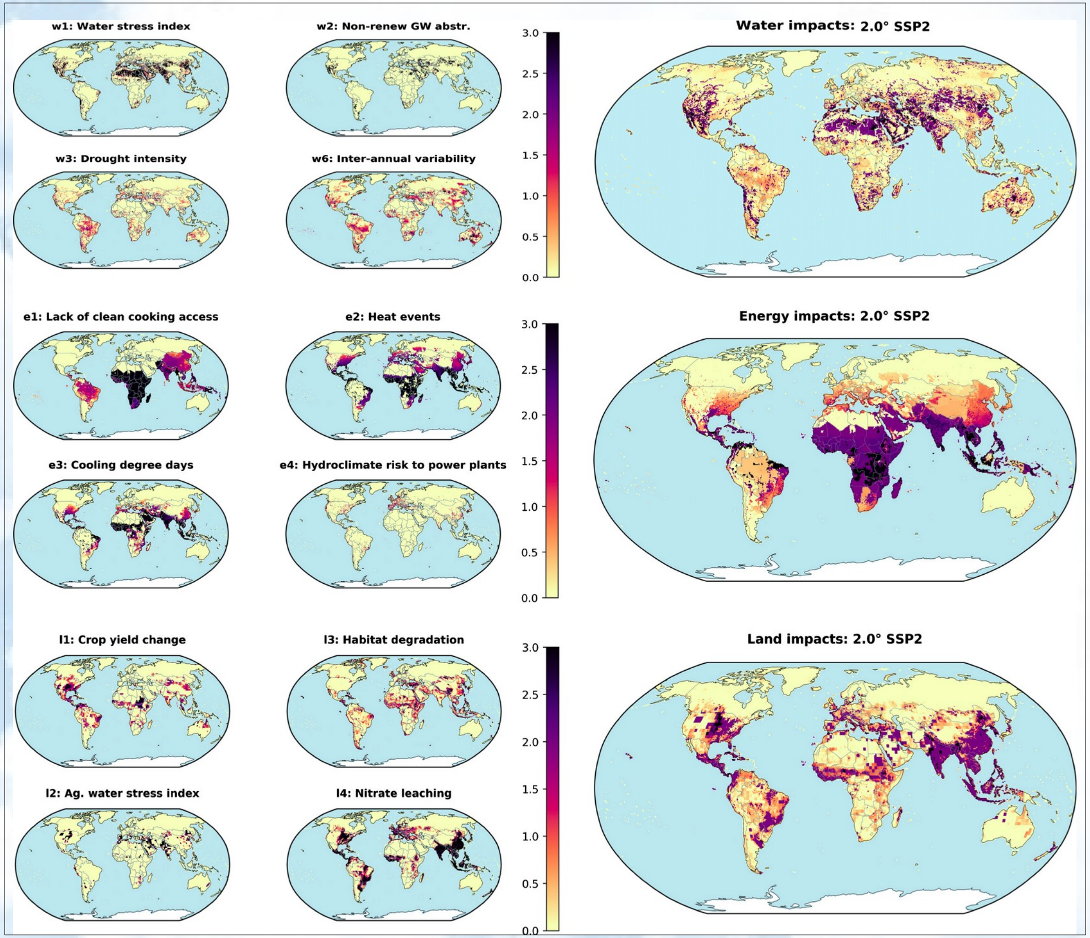

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Byers et al. (2018) use a cumulative approach on quantified impacts (12-14 impacts illustrating 3 main sectors) using **ISIMIP Fast Track**.

→ A ***multi-sectoral risk*** index is developed to assess the risk of a climate-change impacts overlapping. They further weight these risks with future population scenarios.

→ Global exposure to *multi-sector risks* approximately doubles between +1.5°C and +2°C warmings, and doubles again with +3°C.

→ The **risks are multiplied by 6 from best to worst cases** (i.e. depending on the RCP/SSP scenarios' combination). 85%-95% of global exposure falls to Asian and African regions.

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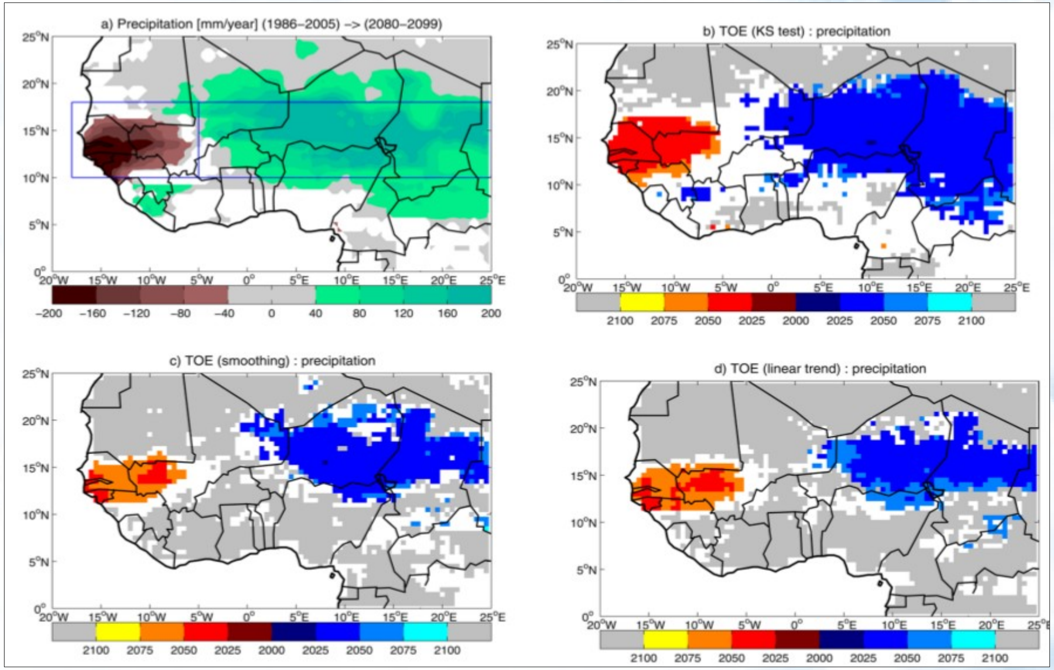
Previous studies: Time of Emergence

In *Gaetani et al. (2020)*, the TOE of precipitation change in West Africa is assessed for the first time using a set of 29 CMIP5 models.



DOI: 10.1038/s41598-020-63782-2

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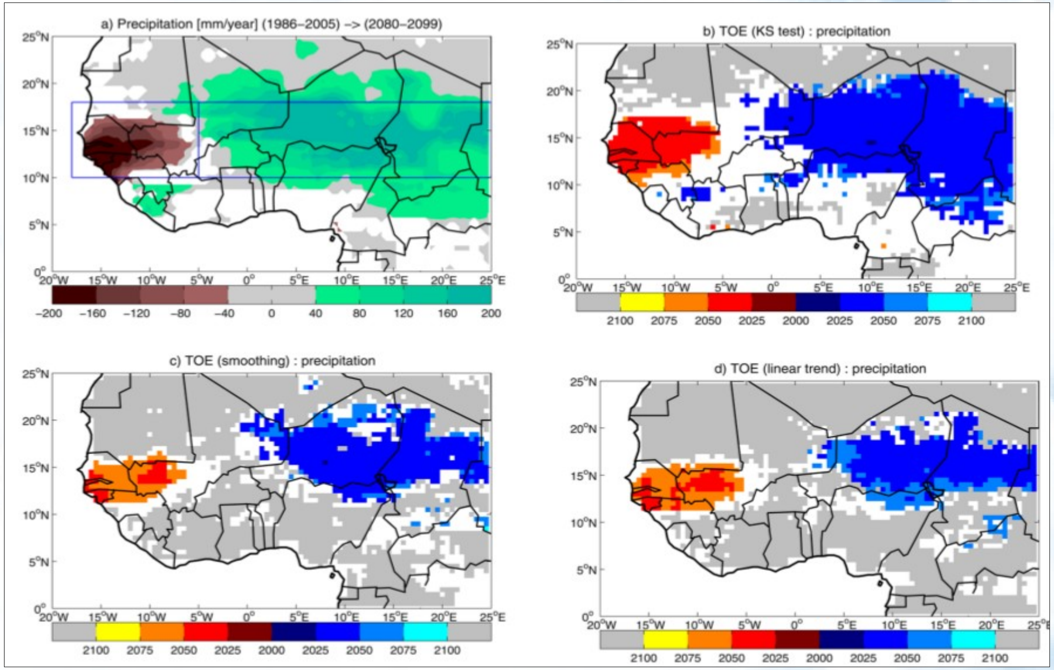
Previous studies: Time of Emergence

In *Gaetani et al. (2020)*, the TOE of precipitation change in West Africa is assessed for the first time using a set of 29 CMIP5 models.

→ In West Sahel, climate conditions characterized by reduced occurrence of wet days are likely to emerge before 2036, leading to the possible emergence of a dryer climate in 2028–2052.

→ In East Sahel, a wetter precipitation regime characterized by increased occurrence of very wet days is likely to emerge before 2054.

→ Although uncertainty in climate model projections still limits the robust determination of TOE at a local scale, this study provides reliable time constraints to the expected climate shift in West Africa at the sub-regional scale.



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Our approach

When will emerge combined and multi-sectoral impacts of the global warming during the 21st century ?

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Our approach

(1) <u>Data</u>

→ ISIMIP (Intersectoral Impact Models Intercomparison Project) data: Cross-sectoral simulations of different impacts of climate change. We use the <u>ISIMIP2b</u> protocol (*i.e. historical + future impact projections using 4 CMIP5 climate model inputs).* Different impact models are also compared when providing the impact (e.g. orchidee, visit, lpjml, clm45);

→ 10 CMIP5 climate models for “direct” climate variables/impacts;

→ Future scenario RCP8.5 displayed *(but RCP2.6 also analysed)*;

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→ 10 CMIP5 climate models for "direct" climate variables/impacts;

→ Future scenario RCP8.5 displayed *(but RCP2.6 also analysed)*;

(2) **Impact indicators**

HEATWAVES :
daily maximum temperature during AMJ *(not displayed)*
daily maximum temperature during JAS

HEALTH :
Annual days of severe heat stress (Thermal Heat Index)
annual Length Transmission Season of malaria *(not displayed)*

FLOODS :
annual wet extreme (98th percentile) precipitation
annual extreme (98th percentile) surface + subsurface runoff
very wet days (days with cumulated precipitations > 20mm)

DROUGHTS:
annual dry extreme (2th percentile) precipitation
dry days (days with cumulated precipitations < 3mm)

AGRICULTURE :
annual yields of soy under full irrigation *(not displayed)*
annual yields of maize under full irrigation
annual Leaf Area Index (gives information about breeding capability)

FIRES :
burntarea

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Our approach

(3) Time of Emergence

→ To detect the year when there is a significant statistical difference between a given window compared to a fixed reference known as the Time of Emergence (ToE), we use a **Kolmogorov-Smirnoff statistical test** (KS-test)

→ The KS-test compares two cumulative distribution functions and gives the maximum difference/distance (D) between these two continous distributions, independently from the shape of the distributions (*King et al., 2015; Gaetani et al., 2020*)

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→ The KS-test compares two cumulative distribution functions and gives the maximum difference/distance (D) between these two continous distributions, independently from the shape of the distributions (*King et al., 2015; Gaetani et al., 2020*)

→ Given a certain length of the distribution (N), the distance D is given at a confidence level/p-value (α). According to statistical tables, and for a distribution length of $20<N<30$ with a confidence level of 95 % (p-value ≤ 0.05), the critical distance above which the two compared distributions are different is 0.242:

→ In our study, we thus consider an emergence if the calculated D between each 20-year window sliding from 2006 to 2099 and the 1979-2005 reference is equal or above 0.242. We then pick the mid-20-years window of the first emergent 20-year window as the mean Time of Emergence.

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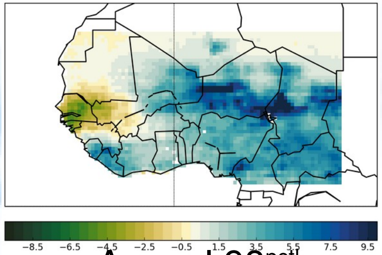
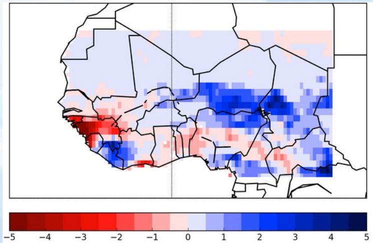
Multi-model mean future changes between 1979-2005 and 2074-2100 (RCP8.5)

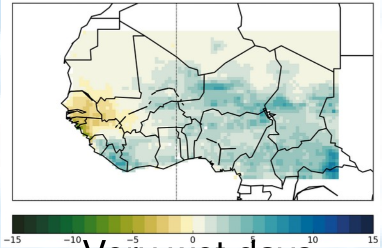
FLOODS



Annual 98pctl precipitations (mm/day)

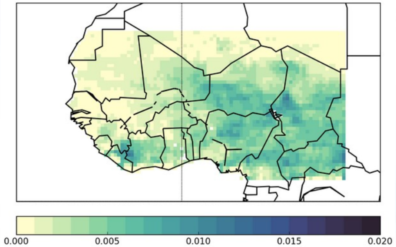


Annual 98pctl surface + surbsurface runoff (mm/day)

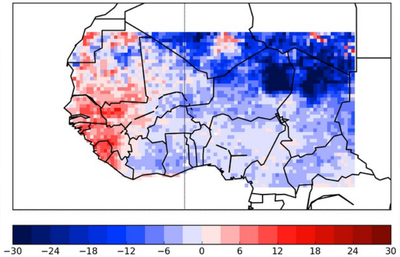


Very wet days (daily precip < 20mm)

DROUGHTS

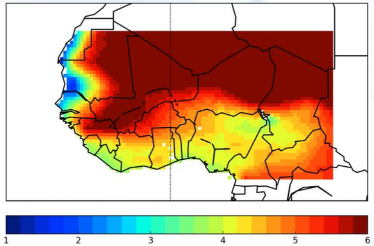


Annual 2pctl precipitations (mm/day)

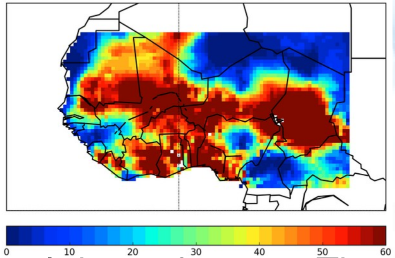


Dry days (daily precip < 3mm)

HEATWAVES

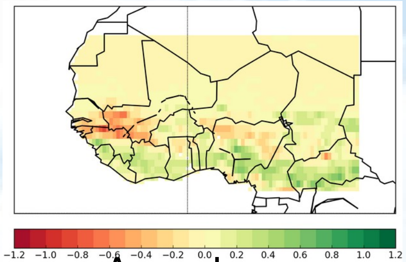


Maximum temperatures during summer (in °C)

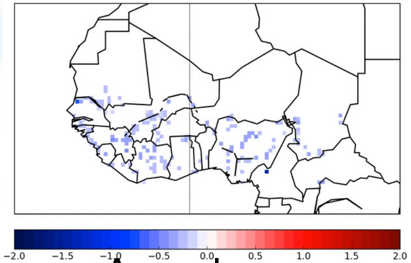


Annual days of severe Thermal Humidity Index (i.e. THI > 89)

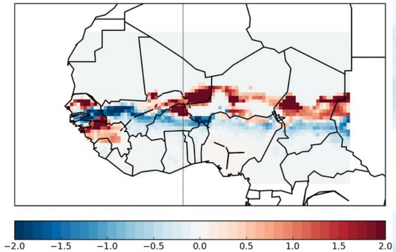
SOIL



Annual mean Leaf Area Index



Annual mean maize yields

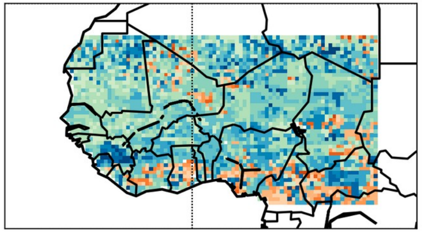


Burnt area (in %)

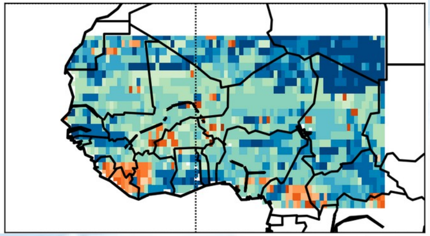
Emergences of the impacts must be considered with their corresponding trend

*Multi-model maximum Time of Emergence (RCP8.5) = **latest emergence***

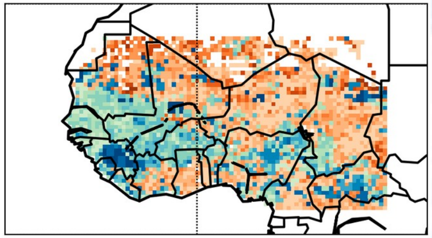
FLOODS



Annual 98pctl precipitations

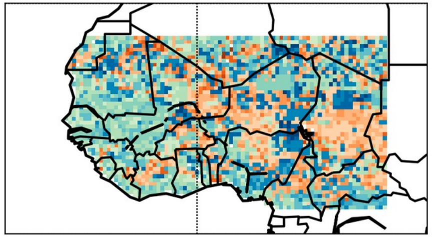


Annual 98pctl surface + surbsurface runoff

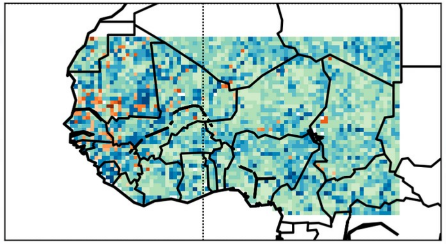


Very wet days (daily precip < 20mm)

DROUGHTS



Annual 2pctl precipitations



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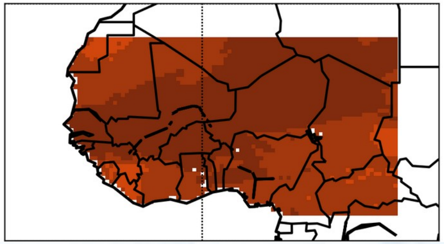
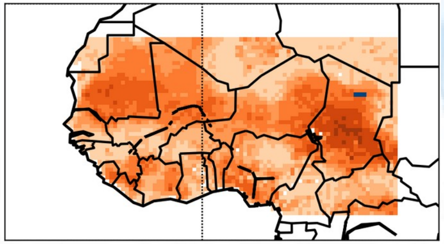


Maximum temperatures during summer



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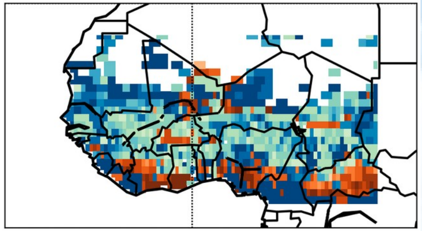
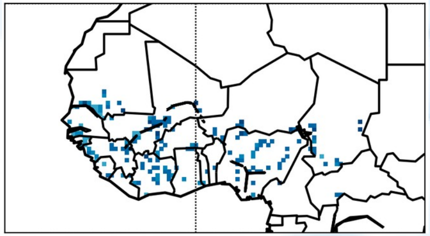
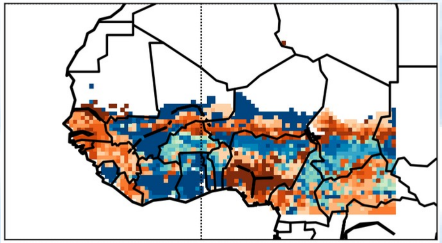


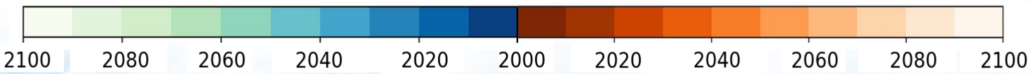
Annual mean Leaf Area Index



Annual mean maize yields

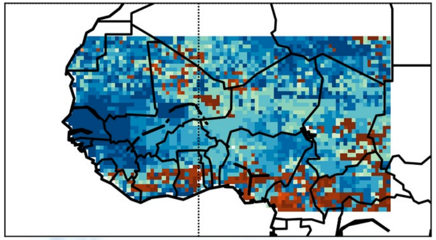


Burnt area

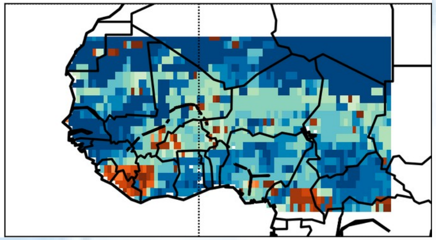


*Multi-model minimum Time of Emergence (RCP8.5) = **earliest emergence***

FLOODS



Annual 98^{pctl} precipitations



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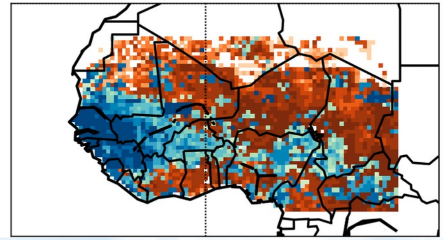

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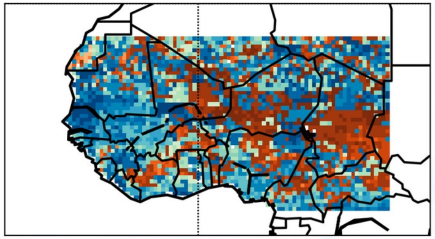
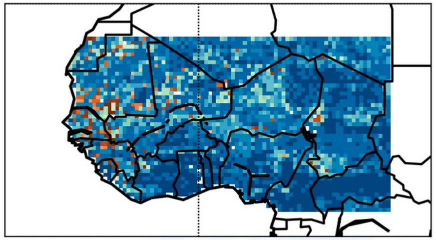
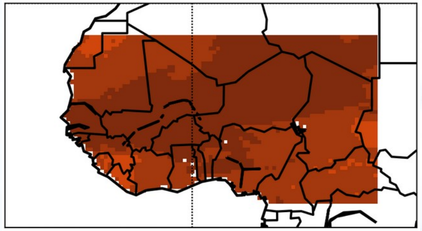


Annual 2^{pctl} precipitations

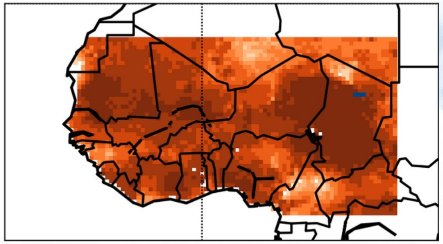


Dry days (daily precip < 3mm)

HEATWAVES



Maximum temperatures during summer



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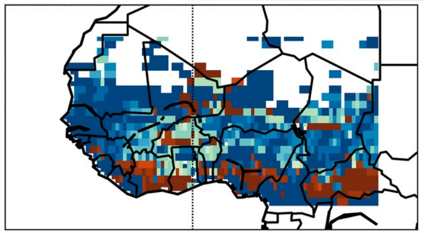
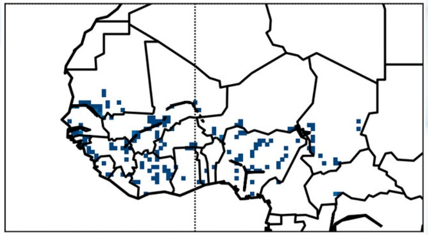
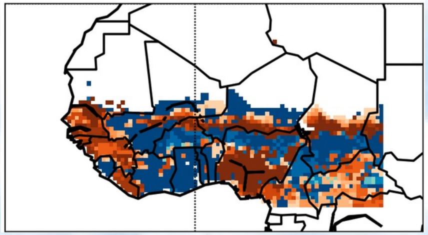


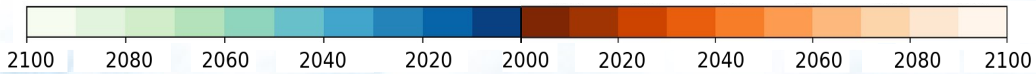
Annual mean Leaf Area Index



Annual mean maize yields



Burnt area



First interpretations

→ According to CMIP5 and ISIMIP2b projections, some locations could experience an emergence of multiple impacts covering different sectors. Some “hotspot” of particularly impacted regions could be highlighted using this approach.

→ Example of western West Africa (e.g. Senegal, Guinea): maximum multi-model Time of Emergence values exhibit an emergence of increasing dryest days, increasing daily maximum temperature, increasing burnt areas, decreasing leaf area index and decreasing maise yields **before** the 2040’s.

→ In these regions, even considering the latest projected emergence by the models, local populations could thus experience a “soon-coming” emergence of new climate regimes for at least 5 impacts.

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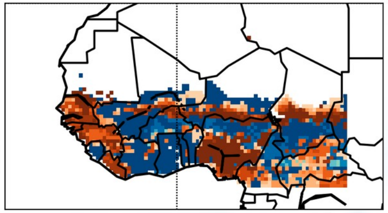
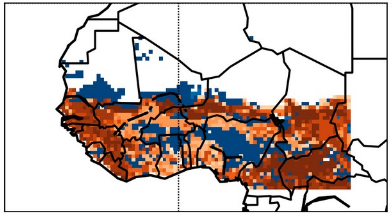
Current and next steps

Multi-model minimum
ToE – burnt area



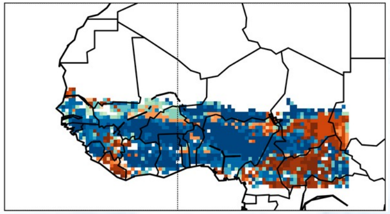
ORCHIDEE model



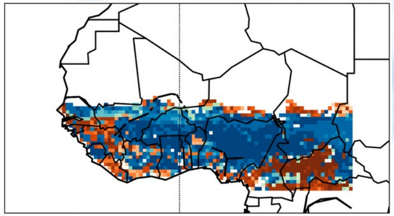
VISIT model

Impact models
uncertainties

Per model with VISIT impact
model ToE – burnt area



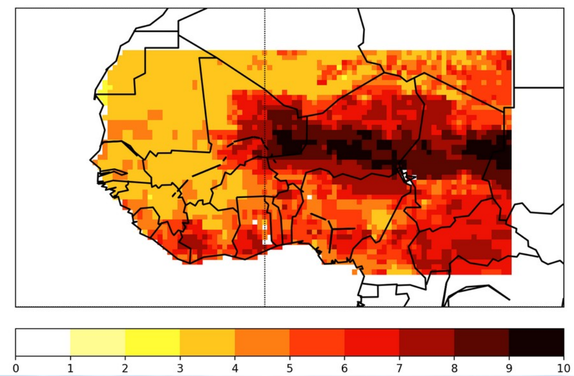
HadESM2-ES model



IPSL-CM5A-LR model

Climate models
uncertainties

Approach in a cumulative indicator using normalized definition for each indicator/associated timing



<u>Cumulated index of multi-impacts</u>. A value of 0 indicates that no impact exhibits a projected change superior to its corresponding historical variablity. A value of 10 indicates that the 10 impact changes are superior to their historical variability.

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