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# Sensitivity of the SARRA-H crop model to the climate forcing

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**<u>Aim</u>: in order to use climate simulations from the IPCC AR4, define the most useful climatic input data for a crop model.**

**Climatic input data** used to compute the reference evapotranspiration ($ET_o$) and to estimate crop yields, at daily time step:

- rainfall (mm),
- minimum, maximum and mean humidity (%),
- insolation (h),
- minimum, maximum and mean temperature (°C)
- wind speed ($m.s^{-1}$),
- solar radiation ($W.m^{-2}$)

"$ET_o$ is a climatic parameter and can be computed from weather data. $ET_o$ expresses the evaporating power of the atmosphere at a specific location and time of the year and does not consider the crop characteristics and soil factors." (FA0 56, 1998)

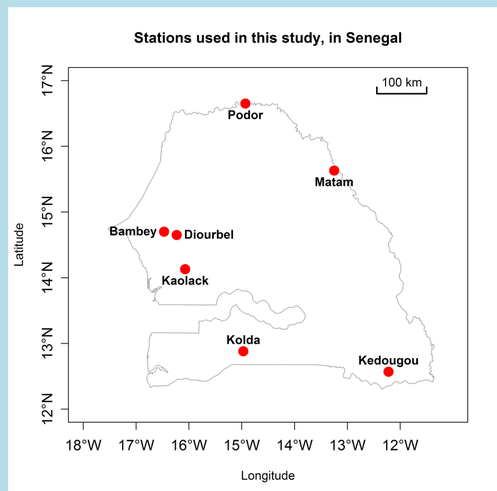
**Crop variety**: 3 millet genotypes, HK (55-60 j), Souna III (65-70 j) and MTDO (110-120 j)

**Datasets**:

- daily observations in 7 stations of Senegal (1961-2000),
- daily NCEP/NCAR Reanalysis (1961-2000),

→

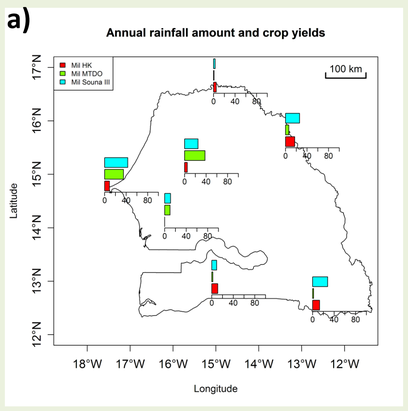
- rainfall,
- minimum temperature,
- maximum temperature,
- solar radiation



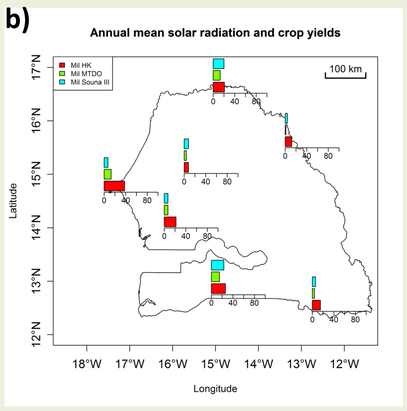

## Impact of observed annual rainfall and mean solar radiation

First, determine how rainfall and solar radiation affect crop yields.

a)




b)

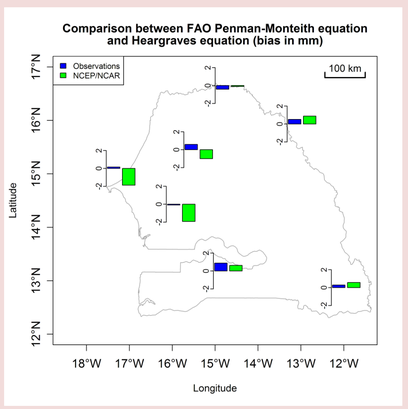



a) rainfall amount is particularly important for Souna III genotype (medium cycle), then for MTDO (long cycle), with geographical differences (more important in the west, less important in the east),

b) solar radiation seems to be important for HK (short cycle) → need for energy during a short period. Same geographical differences than in a)

## Accuracy of Heargraves $ET_o$ (H-$ET_o$)

Due to the lack of some weather data in IPCC AR4 simulations, we considered an alternative equation for ETo computation. This equation only use temperature (minimum, maximum and mean), and extraterrestrial radiation.

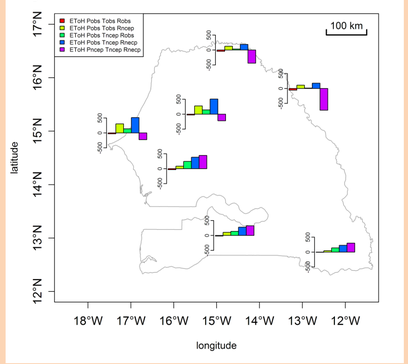



-H-ETo computed with observations is generally greater than FAO $ET_o$, with biases less than 1 mm,

- H-ETo computed with NCEP/NCAR reanalysis is greater than FAO $ET_o$ in the eastern Senegal,

- but in the west part of the country, H-$ET_o$ is underestimated -> maybe due to inaccurate data?

a)

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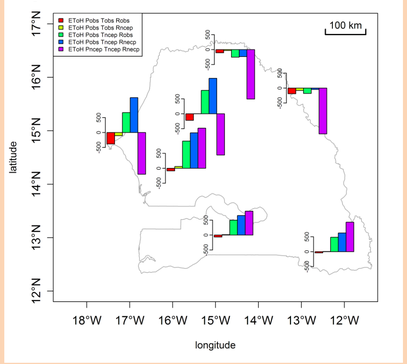
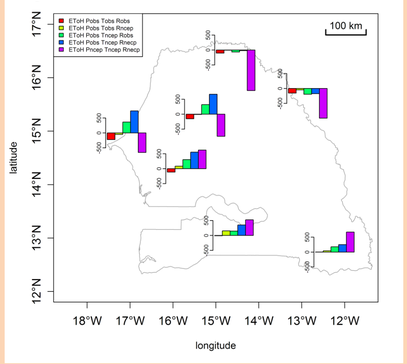


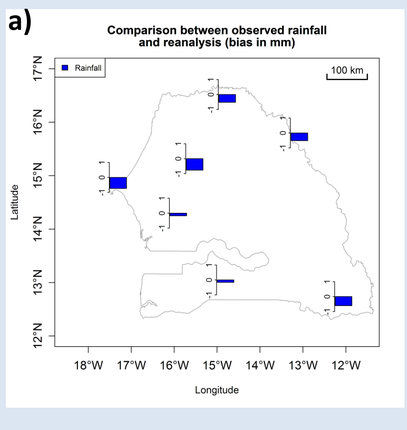

c)



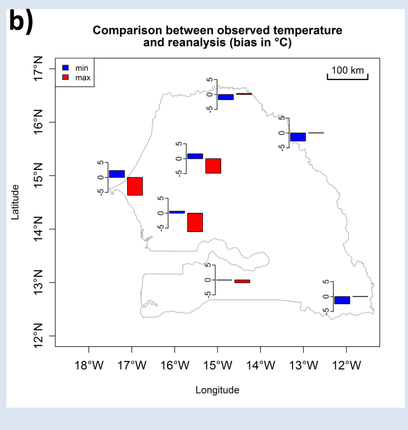

## Accuracy of NCEP/NCAR Reanalysis

Rainfall, temperatures and solar radiation from NCEP/NCAR Reanalysis are compared to observations, to evaluate their accuracy.

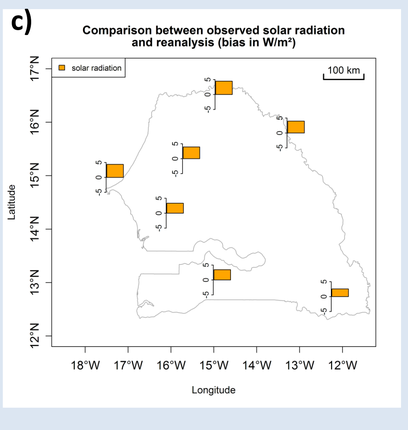
a)




b)




c)




a) daily rainfall in NCEP/NCAR are lower than observed rainfall., but it rains every day → weak biases. In fact, the succession of dry and wet spells, important for crop yield quality, is not well reproduce,

b) daily minimum (maximum) temperatures are greater (lower) than observed minimum (maximum) temperatures, with more inaccuracy for maximum temperatures (particularly in the west of Senegal) → introducing biases in Heargraves $ET_o$ computation,

c) daily solar radiation is more important than observed data → too much energy at the surface (biases between +3 and +5 $W.m^{-2}$).

## Different climate forcing scheme

Observations and reanalysis are combining in order to test the sensivity of the crop model to different climate forcing:

- crop yields weakly underestimated (~100 kg/ha) when Heargraves ETo is used, except for Souna III at Diourbel

- with short cycle millet (a), too strong solar radiation may cause overestimated yields, because of too much energy available. But it doesn't affect medium (b) and long (c) cycle,

- inaccurate rainfall may cause underestimated yields in the northern part of the country (>500 kg/ha for Souna III (b)).

- in the south, $ET_o$ overestimation and better accuracy of reanalysis can explain overstimation of yields.

**<u>Conclusions</u>**:

- Heargraves $ET_o$ can be used to simulate crop yields → only 3 parameters needed (minimum and maximum temperatures, and extraterrestrial radiation) → only mean temperatures are available in simulations→ require an estimation of minimum and maximum temperatures from mean

- But for better crop simulations, need for accurate rainfall (amount, frequencies…) and solar radiation.

**<u>Perspectives</u>**:

- use two scenarios A2 and B1 (simulations of temperatures, rainfall and solar radiation) to give trends in future yields in the next century and to quantify uncertainties in the simulated future yields.

- to use simulations, downscaling informations from GCM grid cell to stations