Roles of Agroforestry in sustainable intensification of small farMs and food SEcurity for SocIetIes in West Africa

WP2 Ecosystem Services Task 2.2. Supporting & regulating services

D 2.2.4. Soilvegetationatmosphere transfers of energy, carbon, and water in a parkland (100% completed)

(by O. Roupsard)

Introduction

African eddy covariance, bioclimatology, ecophysiology, net primary productivity, agronomy, forestry ecosystem observatories are very scarce. Our recent (4 year-old, started in 2018) semi-arid, agro-silvo-pastoral, African subsaharian flux site is contributing to the Niakhar Observatory for Health, Demography and Environment (OPSE[1]-Niakhar) and to FLUXNET (registered as “Sn-Nkr”)[2].

The collected data will allow to evaluate concurrent ecosystem services and parameterize biophysical model of soilvegetation atmosphere transfers (SVAT) for energy, carbon, and water. For instance the one that is developed in WP3 (STICS) for pearl-millet.

The Ramses II project highly contributed to launching the collaborative “Faidherbia-flux”[3] observatory or living-lab.

Materials and methods

Site characteristics and instruments

D 2.2.4. data were collected from 2018 to 2022 at the collaborative “Faidherbia-flux” Niakhar-Sob observatory, located in the groundnut basin of Senegal. The system under study is an agro-sylvo-pastoral system. This system is characterized by a tree layer (dominated by the reversed phenology phreatophyte *Faidherbia albida*), a crop layer (annual rotation of pearl millet and peanut), soil (deep loamy sand), a water table contributing to tree water uptake and herds (cows, goats and sheep) (Fig. 1). The crop was millet in 2018 and 2020 and peanut in 2019 and 2021.

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[1] OPSE Niakhar : https://lped.info/wikiObsSN/?HomePage

[2] FLUXNET : Global network of micrometeorological tower sites that use eddy covariance methods: http://daac.ornl.gov/FLUXNET/fluxnet.shtml

[3] Web site Faidherbia-flux: https://lped.info/wikiObsSN/?Faidherbia-Flux

D 2.2.4. Soilvegetationatmosphere transfers of energy, carbon, and water in a parkland (99% completed)

General presentation, pictures, results and publications are available at https://lped.info/wikiObsSN/?Faidherbia-Flux.

Fig. 1a: Eddy covariance tower and meterorological instruments over an agro-sylvo-pastoral parkland dominated by *Faidherbia albida*. Photo by Alain Audebert, end of the dry season.

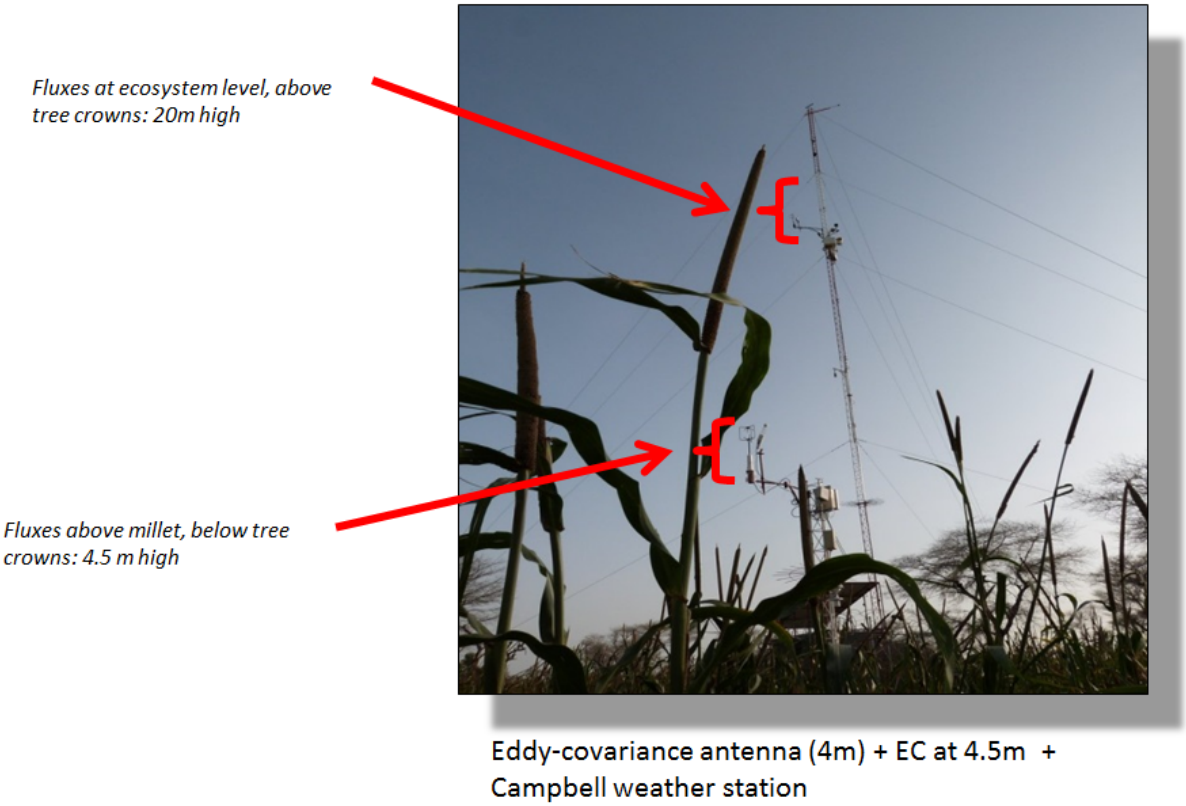


Fig. 1b: 2 Eddy covariance tower above and below tree canopies. Wet season with millet crop.

Footprint of the tall antenna

Most fluxes measured on the tall antenna at 20 m high originated from inside the main crop plot of interest (millet in 2018 and groundnut in 2019), whatever the season (Fig. 2). During the dry season, winds originated mostly from N and NE (mostly within 100 m of distance), but at that time, it can be assumed that the whole landscape is an equivalent source. During the wet season, fluxes originated from the W sector and very much closer to the antenna, mostly within 50 m of distance, i.e. mostly from the main crop plot of interest, with little contribution from the surrounding plots. Footprints were computed according to Kormann and Meixner (2001), using the FREddyPro R package (Xenakis, 2016). Plotted on QGIS.

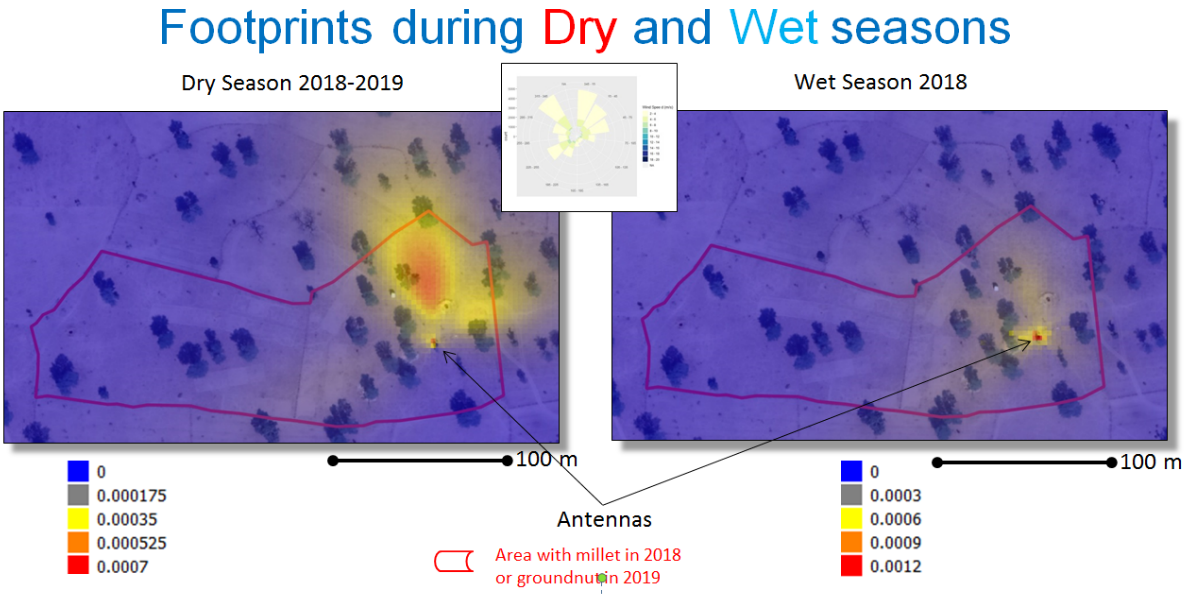


Fig. 2: Footprint of the tall antenna, according to the season

Results and Discussion

Tall Antenna: monitoring microclimate, radiation, CO2 and evapotranspiration

“Faidherbia-Flux” is equipped with 3 eddy covariance antennas. The tallest one (30 m high) is designed to monitor radiation, energy and CO_2, heat and evapo-transpiration fluxes over the whole ecosystem (Fig 1). A short antenna (4.5 m) is located underneath, in the same plot, to monitor the same variables but below the tree crowns, that is, only the fluxes from the soil and the crop (pearl millet or peanut). Another short antenna is placed over the other crop in a neighboring field. A refined weather station measures the classical variables, plus net radiation, NDVI, surface temperature (thermoradiometry), soil moisture + temperature + electrical conductance in full sun and under the shade trees (0-480 cm soil profiles) and water table depth (piezometry). The variables were averaged at the 30 min time-step and cumulated over the year since 2018. A total of 1200 variables are available since 2018 in the Faidherbia-Flux database.

From Fig. 3, the Net Ecosystem Exchange (NEE) of CO_2 (negative = uptake during the day; positive = release at night) is very weak during the dry season, where maximum photosynthesis (GPP) was ca. -7 µmolCO_2 m^{-2} s^{-1} and maximum ecosystem respiration (Re) around 1.5 µmolCO_2 m^{-2} s^{-1}. GPP was from *Faidherbia* trees only during the dry season. Just after the first rains, a large CO_2 burst was recorded with slow recession during more than one week or so. Other CO_2 peaks in July corresponded to smaller rain events. Early August, crop NDVI (green symbols) took off, followed by a large CO_2 uptake, but also large ecosystem respiration. After crop harvest, gas exchanges started to decline. Then the system resumed to dry season behavior again. Fluxes were filtered out for wet sensor, Planar-fitted, WPL and spectral corrected, quality checked. Gaps are due to power failure.

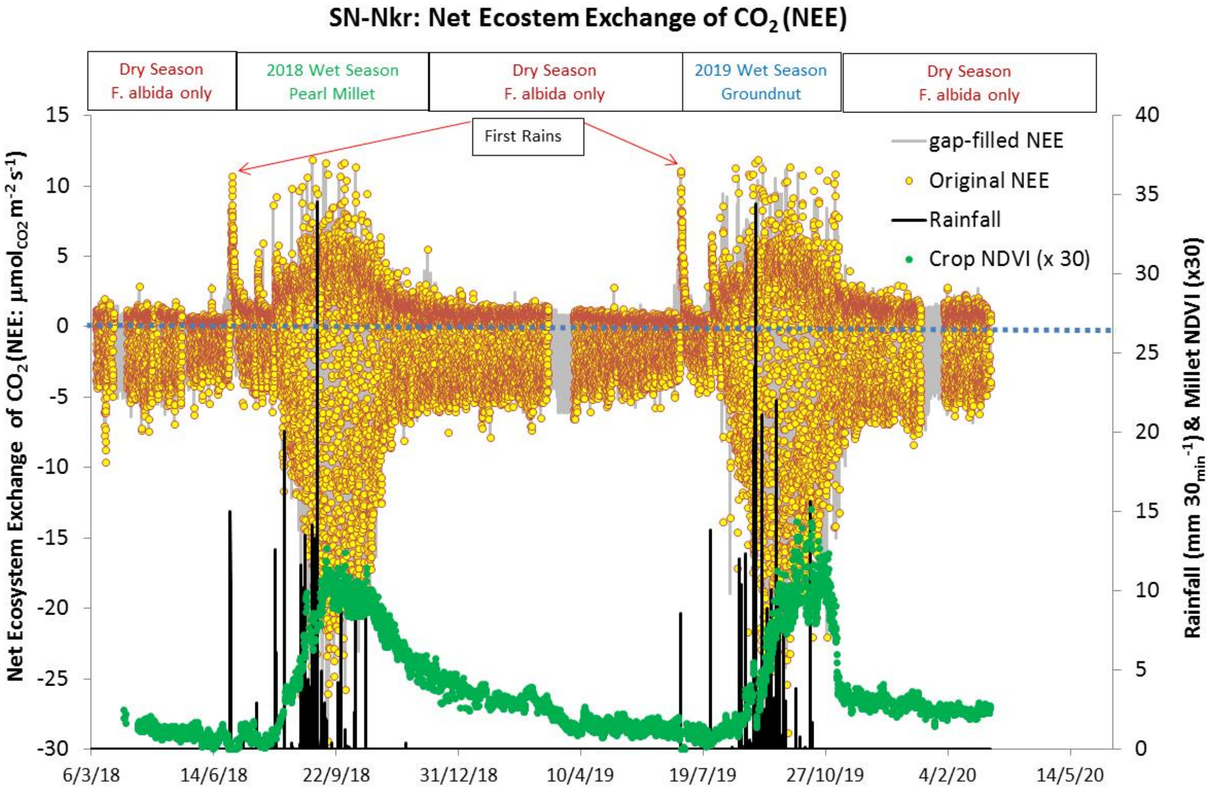
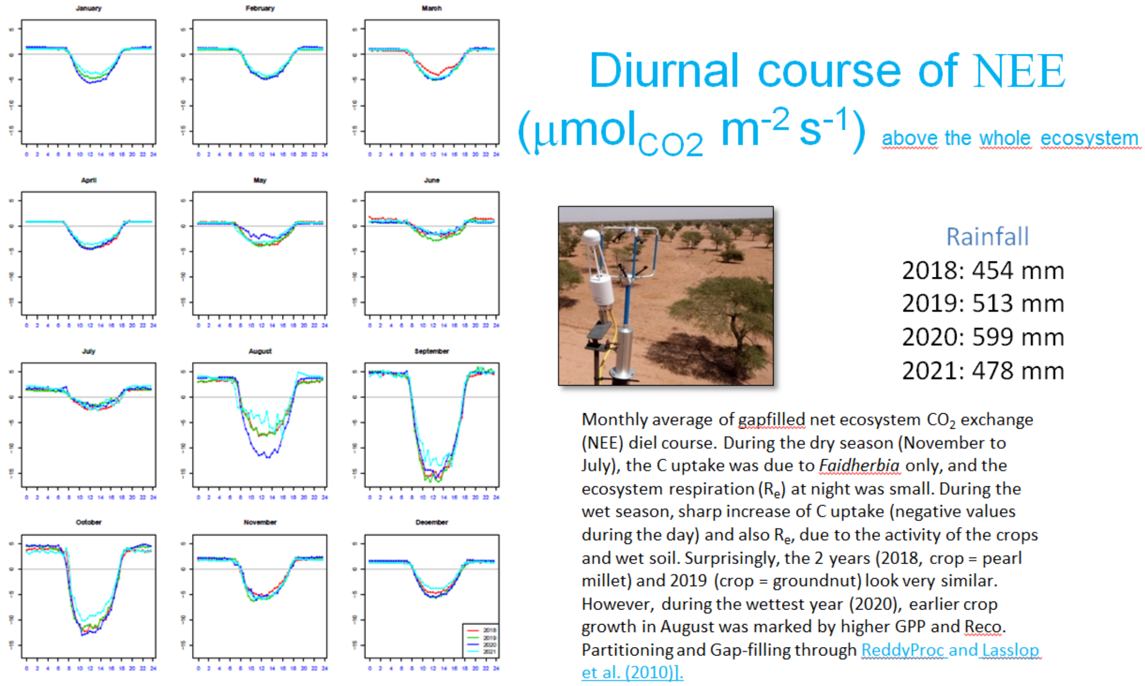


Fig. 3: Example of Net Ecosystem Exchange (NEE) of CO_2 (or C flux, negative = uptake during the day; positive = release at night) during 2 years (2018, millet and 2019 peanut) out of 4. Fluxes filtered out for wet sensor, Planarfitted, WPL and spectrally corrected, quality checked and gap-filled. Grey dots are from partitioning and gap-filling according to ReddyProc and Lasslop et al. (2010)]

Fig. 4 shows the infra-daily (centered on noon) fluxes, averaged for every month and during 4 years. During the dry season (November to July), the C uptake was due to

Faidherbia only, and the ecosystem respiration (R_e) at night was small. During the wet season, sharp increase of C uptake (negative values during the day) and also R_e, due to the activity of the crops and wet soil. Surprisingly, the 2 years (2018, crop = pearl millet) and 2019 (crop = groundnut) look very similar. However, during the wettest year (2020), earlier crop growth in August was marked by higher GPP and Reco.



Diurnal course of NEE ($\mu mol_{CO2}\ m^{-2}\ s^{-1}$) above the whole ecosystem

Rainfall
2018: 454 mm
2019: 513 mm
2020: 599 mm
2021: 478 mm

Monthly average of gapfilled net ecosystem CO_2 exchange (NEE) diel course. During the dry season (November to July), the C uptake was due to *Faidherbia* only, and the ecosystem respiration (R_e) at night was small. During the wet season, sharp increase of C uptake (negative values during the day) and also R_e, due to the activity of the crops and wet soil. Surprisingly, the 2 years (2018, crop = pearl millet) and 2019 (crop = groundnut) look very similar. However, during the wettest year (2020), earlier crop growth in August was marked by higher GPP and Reco. Partitioning and Gap-filling through ReddyProc and Lasslop et al. (2010)].

Fig. 4: Four years (2018-2021) of measurement of net ecosystem C balance at Faidherbia-Flux at 30 min time-step. Each single fig shows the average diurnal course of NEE during one month, with X axis showing hours of the day, and 4 colours represent the 4 successive years

Fig. 5 shows the net apparent ecosystem C balance for 4 years. In conditions where the canopy cover by *F. albida* is less than 10%, daily Net Ecosystem Exchange (NEE, Fig. 4. red line) remains slightly negative (net C uptake) all year-long, thanks to photosynthesis exceeding ecosystem respiration, by *F. albida* during the dry season and by crops during the wet season. Some rainy days express positive (emission) C balance though, when respiration dominates photosynthesis. It must be stressed that the overall C uptake by the system is only apparent here. Actually, C uptake by crops is mostly exported and released elsewhere and should be deducted from the C balance. Only C uptake by the trees contribute significantly to net C uptake on the long term.

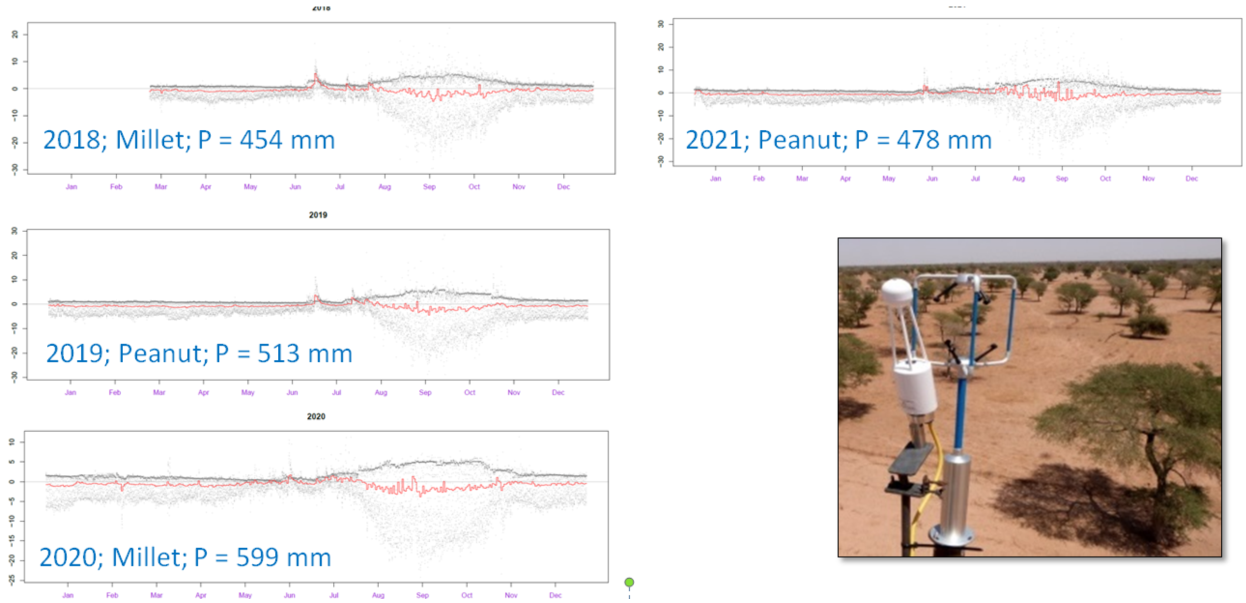


Fig. 5: Gapfilled instantaneous (grey dots) and daily sums of NEE (red line) during the dry season are negative (CO_2 capture), in conditions where the canopy of *Faidherbia* is active. Large CO_2 efflux after the first rains and small replicates during rain events. Net flux becomes more negative during the cropping season from August to October, during the wet season. The net balance is a CO_2 capture for most periods. Partitioning and Gap-filling through ReddyProc and Lasslop et al (2010).

Fig. 6 shows the energy balance for 2018 and 2019. Net radiation (Rn) peaks around 800 W m^{-2}. During the dry season, most of this energy (350 W m^2) is dissipated through sensible heat flux(H), given that the soil is bare (with exception to the *F. albida* trees). There is very little latent heat flux (evapotranspiration) then (λE: 50-100 W m^2), thus originating from *F. albida* trees mostly and from soil evaporation also during the beginning of the dry season. After the first rains each year, note the shift of H and LE fluxes (drop of the Bowen ratio) when crops cover the soil and soil is wet. Maximum LE is achieved in SeptOct, around 450 W m^2 then, a mix between crop transpiration and soil evaporation. Net radiation is well correlated (R^2 = 0.95) to the sum of H, λE and heat flux in the soil, G, at the semih time-step. The slope of 0.98 is only provisional, waiting for a final calibration of G. Overall, this proper energy balance closure indicates that the Eddy covariance system behaves reasonably.

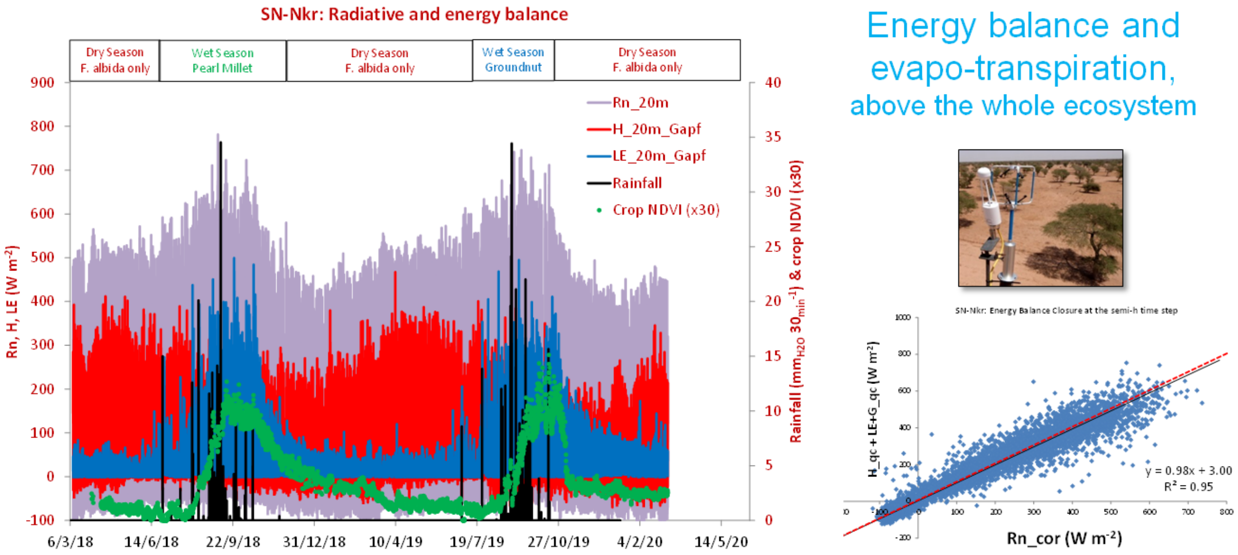
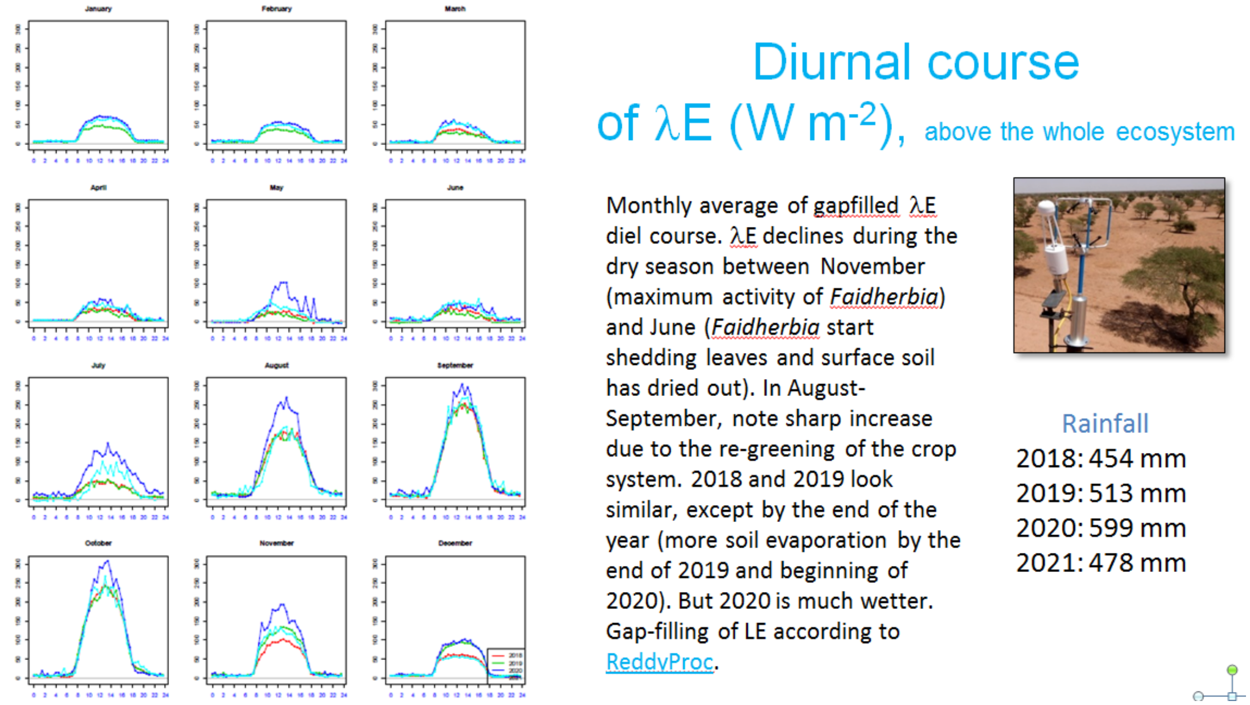


Fig. 6: Time course of Net radiation (Rn), sensible heat flux (H), latent heat flux (✦E), crop NDVI and rainfall for 2018 and 2019. Right graph, energy balance closure at the 30 min time-step, G not calibrated yet.

From Fig. 7, latent heat flux, or evapotranspiration (✦E) is much contrasting between the dry and wet seasons. ✦E is decreasing much from November until by the end of the dry season (June). However, even at the end of the dry season, when trees are much defoliated and no crops, there is still some residual soil evaporation, by around 50 W m^{-2}. Maxima of ✦E are achieved in September, with 350 W m^{-2} around noon. Higher values of maximal ✦E are expressed during the wettest year (2020).

Fig. 7: Diurnal course of latent heat flux, or evapotranspiration (✦E, W m^{-2}), above the whole ecosystem, for 4 years of measurements



Diurnal course of λE (W m^{-2}), above the whole ecosystem

Monthly average of gapfilled λE diel course. λE declines during the dry season between November (maximum activity of *Faidherbia*) and June (*Faidherbia* start shedding leaves and surface soil has dried out). In August-September, note sharp increase due to the re-greening of the crop system. 2018 and 2019 look similar, except by the end of the year (more soil evaporation by the end of 2019 and beginning of 2020). But 2020 is much wetter. Gap-filling of LE according to ReddyProc.

Rainfall
2018: 454 mm
2019: 513 mm
2020: 599 mm
2021: 478 mm

Small Antenna: monitoring CO2 and evapotranspiration

Fluxes were also recorded during 4 years below the tree crowns. These fluxes should correspond to the contribution of soil and crops only.

From Fig. 8, the behavior is similar during the wet season as compared to the tall antenna, as expected. During the dry season, the photosynthesis is less negative than measured at the tall antenna, but is not nil, indicating some residual contamination by the fluxes coming from the trees.

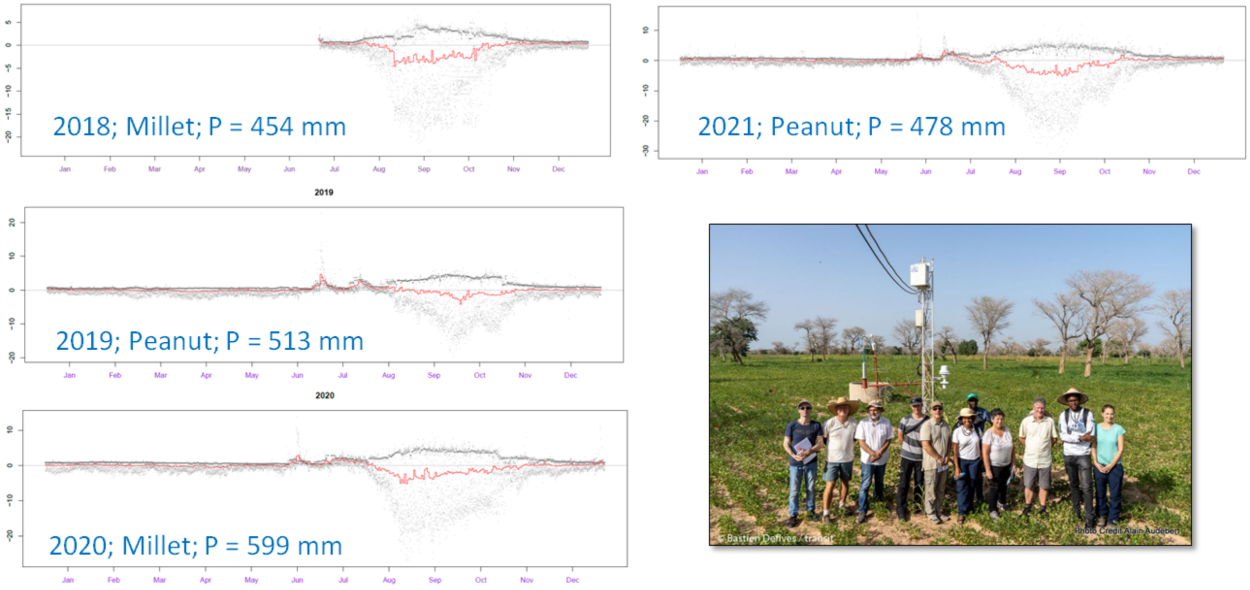
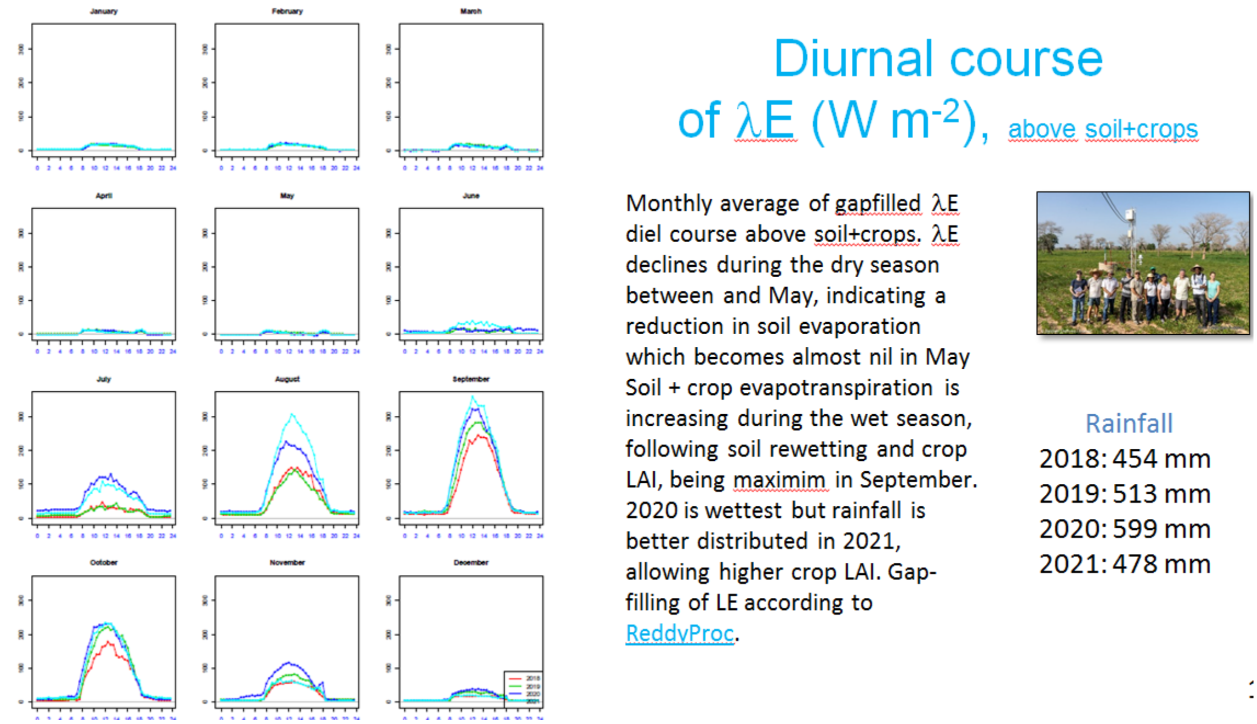


Fig.8: Small antenna. Gapfilled instantaneous (grey dots) and daily sums of NEE (red line) during the dry season close to nil, in bare soil conditions . Large CO2 efflux after the first rains and small replicates during rain events. Net flux becomes more negative during the cropping season from July to October, during the wet season. The net balance is a CO2 capture for most periods. Partitioning and Gap-filling through ReddyProc and Lasslop et al (2010).

From Fig. 9, small antenna latent heat flux, or evapotranspiration (✧E) is also much contrasting between the dry and wet seasons. ✧E is decreasing much from October until by the end of the dry season (June). At the end of the dry season, when trees are much defoliated and no crops, there is almost no residual soil evaporation left, which is clearly less than for the tall antenna which still expressed fluxes around 50 W m^{-2}. Maxima of ✧E are achieved in September, with 350 W m^{-2} around noon, similarly to the tall antenna results. Overall, the small antenna and tall antenna results appear to be consistent, indicating little contamination of the tree fluxes on the small antenna results.



Diurnal course of λE (W m^{-2}), above soil+crops

Monthly average of gapfilled λE diel course above soil+crops. λE declines during the dry season between and May, indicating a reduction in soil evaporation which becomes almost nil in May Soil + crop evapotranspiration is increasing during the wet season, following soil rewetting and crop LAI, being maximim in September. 2020 is wettest but rainfall is better distributed in 2021, allowing higher crop LAI. Gap-filling of LE according to ReddyProc.

Rainfall
2018: 454 mm
2019: 513 mm
2020: 599 mm
2021: 478 mm

Fig. 9: Small antenna. Diurnal course of latent heat flux, or evapotranspiration (λE, W m^{-2}), above the whole ecosystem, for 4 years of measurements

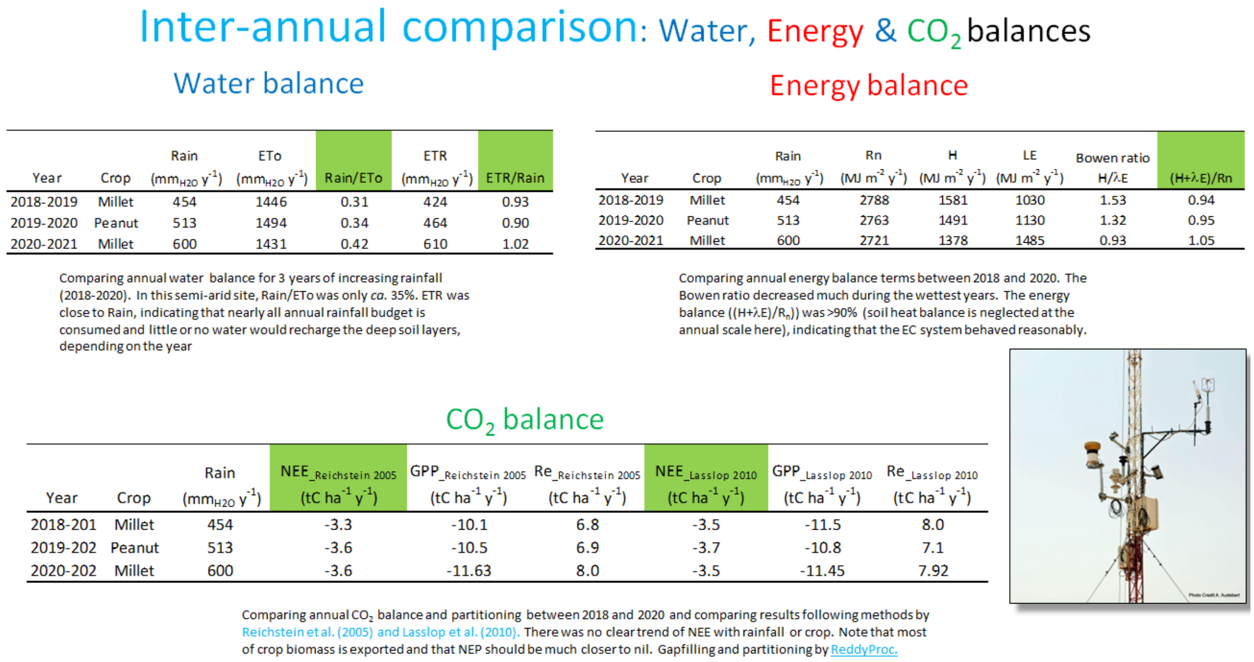
Inter-annual comparison : Water, Energy & CO2 balances

Comparing annual water balance for 3 years of increasing rainfall (2018-2020) (Table 1). In this semi-arid site, Rain/ETo (the potential evapotranspiration, FAO 1998) was only *ca.* 35% (Table 1a). ETR is increasing with Rainfall. ETR was close to Rain, indicating that the annual rainfall budget is almost fully evapo-transpired and little water (10% of Rainfall) would recharge the deep soil layers, through superficial and sub-superficial runoff and drainage.

The Bowen ratio decreased much during the wettest years (Table 1b). The energy balance (($H+\lambda E)/R_n$)) was >90% (soil heat balance, G, is neglected at the annual scale here), cinfirming that the EC system behaved reasonably.

Comparing annual CO_2 balance and partitioning between 2018 and 2020 and comparing results following methods by Reichstein et al. (2005) and Lasslop et al. (2010) (Table 1c). Apparent NEE was around 3.5 tC ha^{-1} yr^{-1}, whatever the year, the crop type or the computation method. Note that most of crop biomass is exported and that NEP should be much closer to nil after deduction of the C from the crops. Max GPP was 11.5 tC ha^{-1} yr^{-1} and max R_{eco} was 8.0 tC ha^{-1} yr^{-1}. Gapfilling and partitioning by ReddyProc.

Table 1: Inter-annual comparison of Water, Energy & CO2 balances



Inter-annual comparison: Water, Energy & CO_2 balances

Water balance

Year	Crop	Rain (mm_{H2O} y^{-1})	ETo (mm_{H2O} y^{-1})	Rain/ETo	ETR (mm_{H2O} y^{-1})	ETR/Rain
2018-2019	Millet	454	1446	0.31	424	0.93
2019-2020	Peanut	513	1494	0.34	464	0.90
2020-2021	Millet	600	1431	0.42	610	1.02

Comparing annual water balance for 3 years of increasing rainfall (2018-2020). In this semi-arid site, Rain/ETo was only *ca.* 35%. ETR was close to Rain, indicating that nearly all annual rainfall budget is consumed and little or no water would recharge the deep soil layers, depending on the year

Energy balance

Year	Crop	Rain (mm_{H2O} y^{-1})	Rn (MJ m^{-2} y^{-1})	H (MJ m^{-2} y^{-1})	LE (MJ m^{-2} y^{-1})	Bowen ratio H/λE	(H+λE)/Rn
2018-2019	Millet	454	2788	1581	1030	1.53	0.94
2019-2020	Peanut	513	2763	1491	1130	1.32	0.95
2020-2021	Millet	600	2721	1378	1485	0.93	1.05

Comparing annual energy balance terms between 2018 and 2020. The Bowen ratio decreased much during the wettest years. The energy balance ($(H+\lambda E)/R_n$)) was >90% (soil heat balance is neglected at the annual scale here), indicating that the EC system behaved reasonably.

CO_2 balance

Year	Crop	Rain (mm_{H2O} y^{-1})	NEE_Reichstein 2005 (tC ha^{-1} y^{-1})	GPP_Reichstein 2005 (tC ha^{-1} y^{-1})	Re_Reichstein 2005 (tC ha^{-1} y^{-1})	NEE_Lasslop 2010 (tC ha^{-1} y^{-1})	GPP_Lasslop 2010 (tC ha^{-1} y^{-1})	Re_Lasslop 2010 (tC ha^{-1} y^{-1})
2018-201	Millet	454	-3.3	-10.1	6.8	-3.5	-11.5	8.0
2019-202	Peanut	513	-3.6	-10.5	6.9	-3.7	-10.8	7.1
2020-202	Millet	600	-3.6	-11.63	8.0	-3.5	-11.45	7.92

Comparing annual CO_2 balance and partitioning between 2018 and 2020 and comparing results following methods by Reichstein et al. (2005) and Lasslop et al. (2010). There was no clear trend of NEE with rainfall or crop. Note that most of crop biomass is exported and that NEP should be much closer to nil. Gapfilling and partitioning by ReddyProc.

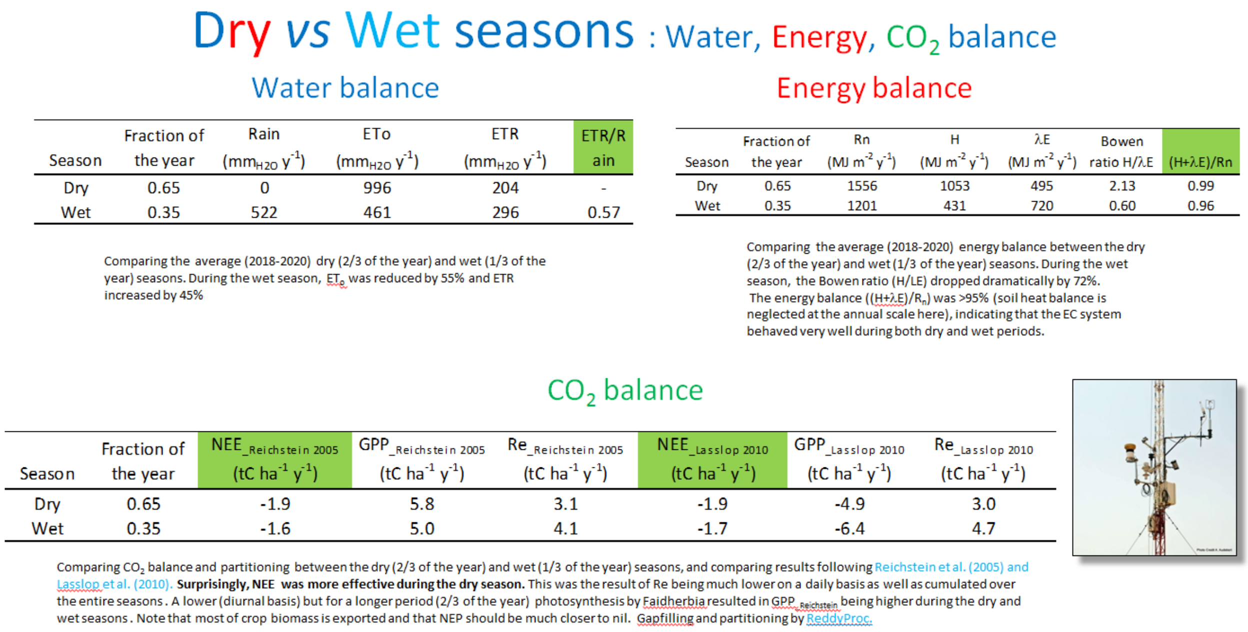
Season comparison: dry vs wet seasons

Comparing the average (2018-2020) dry (2/3 of the year) and wet (1/3 of the year) seasons. During the wet season, ET_o was reduced by 55% and ETR increased by 45% (Table 2a).

During the wet season, the Bowen ratio (H/✦E) dropped dramatically by 72%. The energy balance ((H+ ✦E)/R_n) was > 95% (soil heat balance, G is neglected at the annual scale here), indicating that the EC system behaved very well during both dry and wet periods (Table 2b).

Comparing annual CO_2 balance and partitioning according to dry vs wet seasons and comparing results following methods by Reichstein et al. (2005) and Lasslop et al. (2010) (Table 2c). Apparent NEE was around -1.8 tC ha^{-1} yr^{-1}, whatever the season or the computation method, indicating that *F. albida* is largely contributing to the ecosystem C balance. GPP and Reco were also comparable, whatever the season. Hence, a long (8 months) dry season is equivalently contributing to the C balance than a short wet season, thanks to the presence of *Faidherbia albida*. Note that most of crop biomass is exported and that NEP of the wet season should be much closer to nil after deduction of the C from the crops. Gapfilling and partitioning by ReddyProc.

Table 2: Season comparison of Water, Energy & CO2 balances



Dry *vs* Wet seasons : Water, Energy, CO_2 balance

Water balance

Season	Fraction of the year	Rain (mm_{H2O} y^{-1})	ETo (mm_{H2O} y^{-1})	ETR (mm_{H2O} y^{-1})	ETR/Rain
Dry	0.65	0	996	204	-
Wet	0.35	522	461	296	0.57

Comparing the average (2018-2020) dry (2/3 of the year) and wet (1/3 of the year) seasons. During the wet season, ET_0 was reduced by 55% and ETR increased by 45%

Energy balance

Season	Fraction of the year	Rn (MJ m^{-2} y^{-1})	H (MJ m^{-2} y^{-1})	λE (MJ m^{-2} y^{-1})	Bowen ratio H/λE	(H+λE)/Rn
Dry	0.65	1556	1053	495	2.13	0.99
Wet	0.35	1201	431	720	0.60	0.96

Comparing the average (2018-2020) energy balance between the dry (2/3 of the year) and wet (1/3 of the year) seasons. During the wet season, the Bowen ratio (H/LE) dropped dramatically by 72%.
The energy balance ($(H+\lambda E)/R_n$) was >95% (soil heat balance is neglected at the annual scale here), indicating that the EC system behaved very well during both dry and wet periods.

CO_2 balance

Season	Fraction of the year	$NEE_{\_Reichstein\ 2005}$ (tC ha^{-1} y^{-1})	$GPP_{\_Reichstein\ 2005}$ (tC ha^{-1} y^{-1})	$Re_{\_Reichstein\ 2005}$ (tC ha^{-1} y^{-1})	$NEE_{\_Lasslop\ 2010}$ (tC ha^{-1} y^{-1})	$GPP_{\_Lasslop\ 2010}$ (tC ha^{-1} y^{-1})	$Re_{\_Lasslop\ 2010}$ (tC ha^{-1} y^{-1})
Dry	0.65	-1.9	5.8	3.1	-1.9	-4.9	3.0
Wet	0.35	-1.6	5.0	4.1	-1.7	-6.4	4.7

Comparing CO_2 balance and partitioning between the dry (2/3 of the year) and wet (1/3 of the year) seasons, and comparing results following Reichstein et al. (2005) and Lasslop et al. (2010). **Surprisingly, NEE was more effective during the dry season.** This was the result of Re being much lower on a daily basis as well as cumulated over the entire seasons. A lower (diurnal basis) but for a longer period (2/3 of the year) photosynthesis by Faidherbia resulted in $GPP_{\_Reichstein}$ being higher during the dry and wet seasons. Note that most of crop biomass is exported and that NEP should be much closer to nil. Gapfilling and partitioning by ReddyProc.

Conclusions and perspectives

African eddy covariance sites are very scarce: our new (4 year-old) semi-arid, agro-silvo-pastoral, African subsaharian flux site is contributing to FLUXNET (registered as Sn-Nkr).

Fluxes are globally reasonable : few gaps in the data; footprint study indicates most of the fluxes originate from inside the main crop plot, thus EC data from tall and short antennas can be compared; energy balance (H+λE+G) is almost closed at the 30 min time-step (G waiting for calibration still) and also at the yearly time step (no G needed).

The net C balance is a capture for most periods. *F. albida* parkland associated to millet and peanut crops in rotation displays an apparent net annual CO2 uptake of ca. 3.5 tC ha^{1} yr^{1}, from which the exports should be substracted, however to yield the net ecosystem productivity(NEP). Unexpectedly, half of this uptake occurs during the dry season, owing to *F. albida* photosynthesis (carbon uptake) and a reduced soil respiration (carbon reject) and during this season. The ratio of evapotranspiration to rainfall is around 0.9, indicating that 10% of rainfall only is used for runoff or/and groundwater recharge.

The collected data will allow to parameterize the biophysical model of soilvegetation atmosphere transfers (SVAT) of energy, carbon, and water that is developed in WP3 (STICS).

References

Articles

***Diongue DML, Roupsard O, Do F, Stumpp C, Orange D, Sow S, Jourdan C, Faye S**. 2022. Evaluation of parameterization approaches for estimating soil hydraulic parameters with HYDRUS-1D in the peanut Senegal region. Hydrological Sciences Journal. Submitted 14 February 2022.*

***Duthoit M, Roupsard O, Créquy N, Sauze J, Van den Meersche K**. 2020. Conception d'un dispositif automatisé de chambres de mesures d'échanges gazeux du sol à fermeture horizontale. Le Cahier des techniques de l'INRA (2020, 102). https://www6.inrae.fr/novae/Les-Cahiers-parus/Les-N-reguliers/2020/Cahier-N-102/ Art4-ct102-2020, 19 pp.*

***Faye W, Fall AN, Orange D, Do F, Roupsard O, Kane A**. 2020. Climatic variability in the Sine-Saloum basin and its impacts on water resources: case of the Sob and Diohine watersheds in the region of Niakhar. Proc. IAHS **383**, 391-399. https://piahs.copernicus.org/articles/383/391/2020/.10.5194/piahs-383-391-2020.*

***Lembrechts JJ, Aalto J, Ashcroft MB, et al.** 2020. SoilTemp: A global database of near-surface temperature. Global Change Biology **26**, 6616-6629.https://doi.org/10.1111/gcb.15123.*

***Lembrechts JJ, van den Hoogen J, Aalto J, et al.** 2022. Global maps of soil temperature. Global Change Biology **n/a**.https://doi.org/10.1111/gcb.16060.*

***Rahimi J, Ago EE, Ayantunde A, et al.** 2021. Modeling gas exchange and biomass production in West African Sahelian and Sudanian ecological zones. Geosci. Model Dev. **14**, 3789-3812.10.5194/gmd-14-3789-2021.*

Communications

***Agbohessou Y, Delon C, Grippa M, Mougin E, Tagesson T, Roupsard O**. 2021. Modeling Greenhouse Gas Emissions from Sahelian Sylvo-pastoral Ecosystems. Poster presentation. AGU, New Orleans, USA 13-17 Dec 2021. Convention Center - Poster Hall, D-F USA.https://agu.confex.com/agu/fm21/meetingapp.cgi/Paper/809234.*

***Ba S, Roupsard O, Diongue D, Agbohessou Y, Serça D, Sambou B, Guerin F, Tagesson T, Lardy L**. 2021. Monitoring GHG balance in an agro-sylvo-pastoral ecosystem dominated by Faidherbia albida: comparing the soil and ecosystem scales (groundnut basin in Niakhar/Sob, Senegal). Conférence Intensification Durable (CID) 2021. Dakar, 23-26 nov. 2021: Senegal.*

***Ba S, Roupsard O, Lardy L, Diongue D, Agbohessou Y, Bouvery F, Guerin F, Tagesson T, Sambou B, Serça D**. 2022. Monitoring soil greenhouse gas (GHG) emissions in a Sahelian agro-silvo-pastoral parkland. EGU 2022, 3-8 April 2022, Vienna, Austria. Poster communication.*

***Diongue DML, Sow S, Faye W, Stumpp C, Roupsard O, Orange D, Jourdan C, Faye S, Do F**. 2021. Estimation of soil hydraulic parameters from a transient water flow field experiment in an agroforestry system of Central Senegal. Conférence Intensification Durable (CID) 2021. Dakar, Senegal, 23-26 nov. 2021. Oral communication.*

***Diongue DML, Stumpp C, Orange D, Jourdan C, Sow S, Faye S, Roupsard O**. 2022. Comparing the performances of simple Pedotransfer Functions with Hydrus 1D inverse parameters estimation in a deep cultivated sahelian soil. EGU 2022, 3-8 April*

2022, Session SSS6.7: Advancing soil parameterization in Earth system modelling. Vienna, Austria. Poster communication.

Roupsard O, Do F, Rocheteau A, et al. *2020. More C uptake during the dry season? The case of a semi-arid agro-silvo-pastoral ecosystem dominated by Faidherbia albida, a tree with reverse phenology (Senegal). Oral presentation Monday 4rth of May 11h45. Session BG3.30: Tropical landscapes and peatlands: Biogeochemistry, ecohydrology and land use impacts. https://meetingorganizer.copernicus.org/EGU2020/EGU2020-11203.html. EGU, Vienna, 3-8 May 2020, Session BG3.30 / Land use and climate effects on carbon, greenhouse gas and water dynamics in Africa / EGU2020-11203 / Austria.https://doi.org/10.5194/egusphere-egu2020-11203.*

Roupsard O, Gning Fatou; Sow Sidy; Diongue Djim M.; Malou Oscar; Sadio Khardiatou; Ba Seydina; Diedhiou Moussa; Siegwart Lorène; Diouf; K; Diatta; S.; Timouk Franck; Kergoat Laurent; Grippa Manuela; Delon Claire; Serça Dominique; Guerin Frédéric; Diaminatou Sanogo; Mame Sokhna Sarr; Ndienor Moussa; Saidou Nourou Sall; Serigne Faye; Ngom Daouda; Masse Dominique; Clermont-Dauphin Cathy; Pierre Caroline; Rajot Jean-Louis; Vezy Rémi; Le Maire Guerric; Valade Aude; Bertrand Isabelle; Seghieri Josiane; Manlay Raphael; Taugourdeau Simon; Salgado Paulo; Raebuild A.; Tagesson Torbern; Ardö Jonas; Fensholt Rasmus; Delaunay Valérie; Fleury Laurence; Lalou Richard; Montes Nicolas; Diedhiou Ibrahima; Telali Kader; Lesur Vincent; Leroy Nicolas; Vallee Martin; Laclau Jean-Paul; Chotte Jean-Luc; Cournac Laurent *2021. Faidherbia-Flux': a long-term Collaborative Observatory on food security, GHG fluxes, ecosystem services, mitigation and adaptation in a semi-arid agro-silvo-pastoral ecosystem (groundnut basin in Niakhar/Sob, Senegal. Video-Conference. AMMA-CATCH Scientific meeting 3-4 of March 2021. Oral presentation.: France.*

Sarr MS, Diouf K, Diedhiou I, Roupsard O, Jourdan C, Do F*. 2021. Water uptake by Faidherbia albida A. Chev. in an agroforestry parkland in Senegal. Conférence Intensification Durable (CID) 2021. Dakar, 23-26 nov. 2021: Senegal.*