The influence of cover cropping on carbon sequestration and water use efficiency in an irrigated Mediterranean olive agrosystem

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Why is this important?

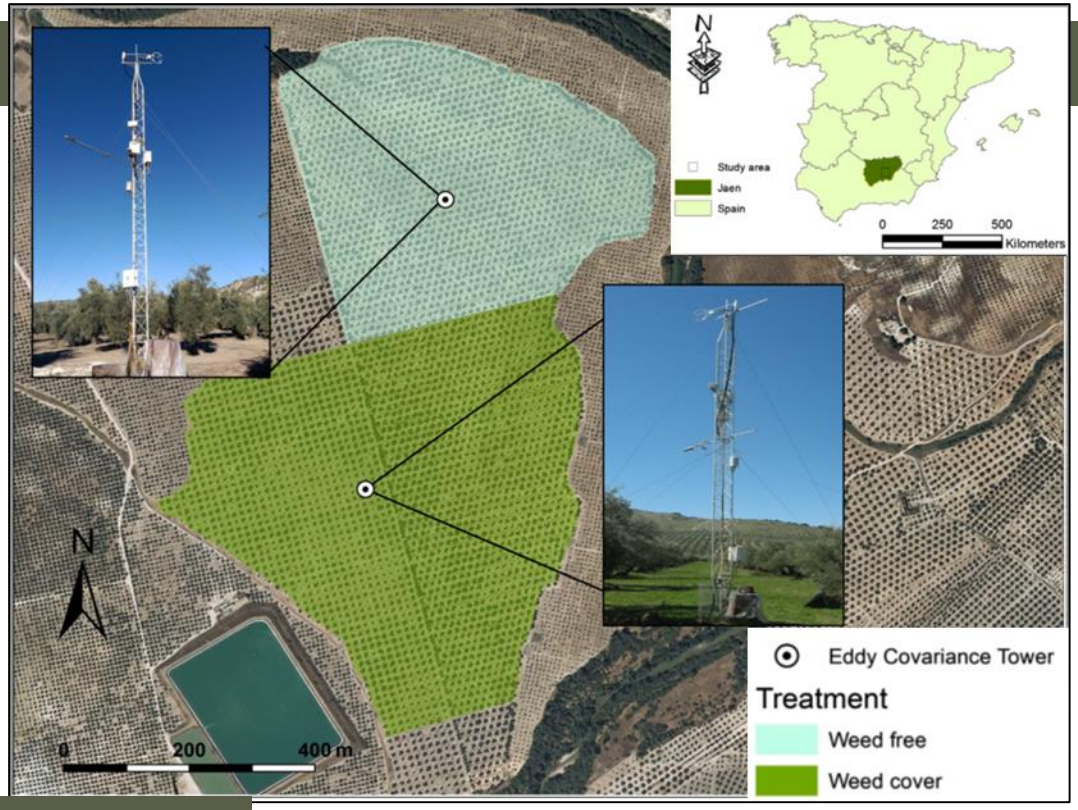
- 98% of the world's olive cultivation area is within the Mediterranean basin
- Inadequate conventional soil-management practices (intensive tillage) cause **high runoff rates** and **soil fertility loss**
- Conservation practices such as **cover crops** benefit soil physicochemical properties, storage of rainfall water, soil fertility and biodiversity but **little is known** about their effect on **carbon sequestration, evapotranspiration and ecosystem-scale water use efficiency** (WUE)

Materials & Methods

- Soil texture: Clay loam
- Soil organic matter content: 1.7 %
- Olive trees: 80 years old; 204 trees/ha
- Drip irrigation and fertilization from February to October (32 L h^{-1} per tree for 8 h, 3 times a week and 0.156 g NPK L^{-1} water, every irrigation night)
- Flux data shown here correspond to gap-filled data using marginal distribution sampling technique.
- Time resolution → half-hourly meteorological and flux data.

In our study, **cover crop** means maintenance of spontaneous resident vegetation cover in the alleys from autumn to spring, when these are mechanically whacked and left on the surface to avoid excessive water consumption and water competition with trees during summer.

More info: Chamizo et al. 2017



Meteorological conditions over the study period

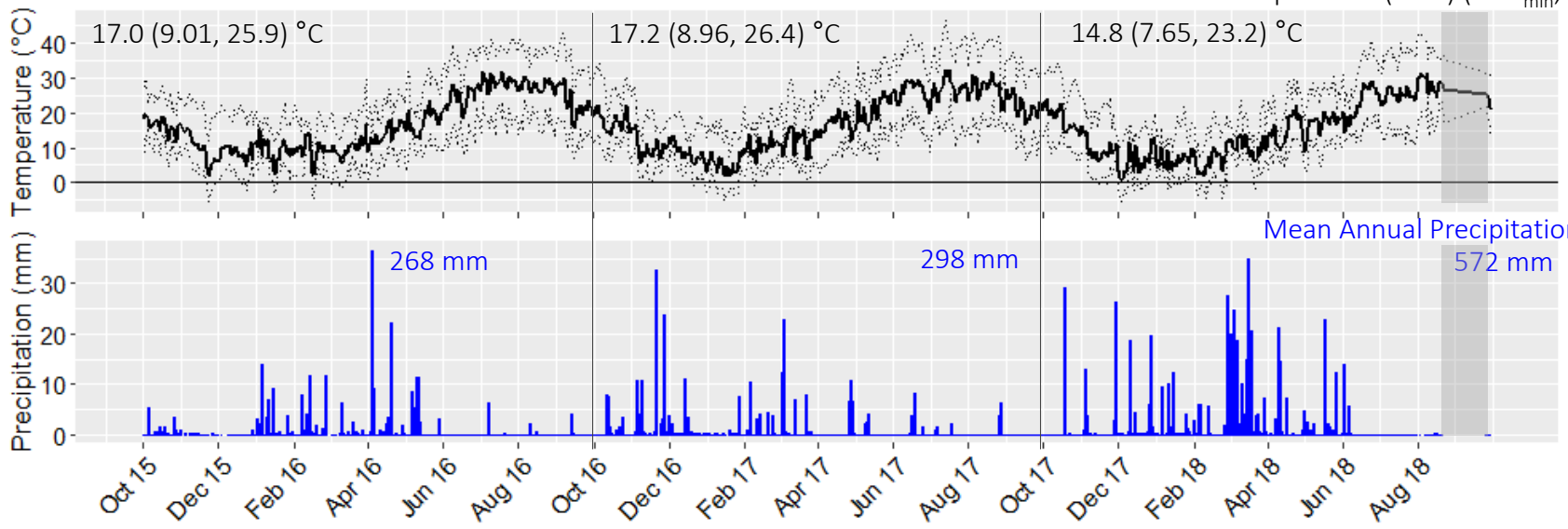


Fig. 1

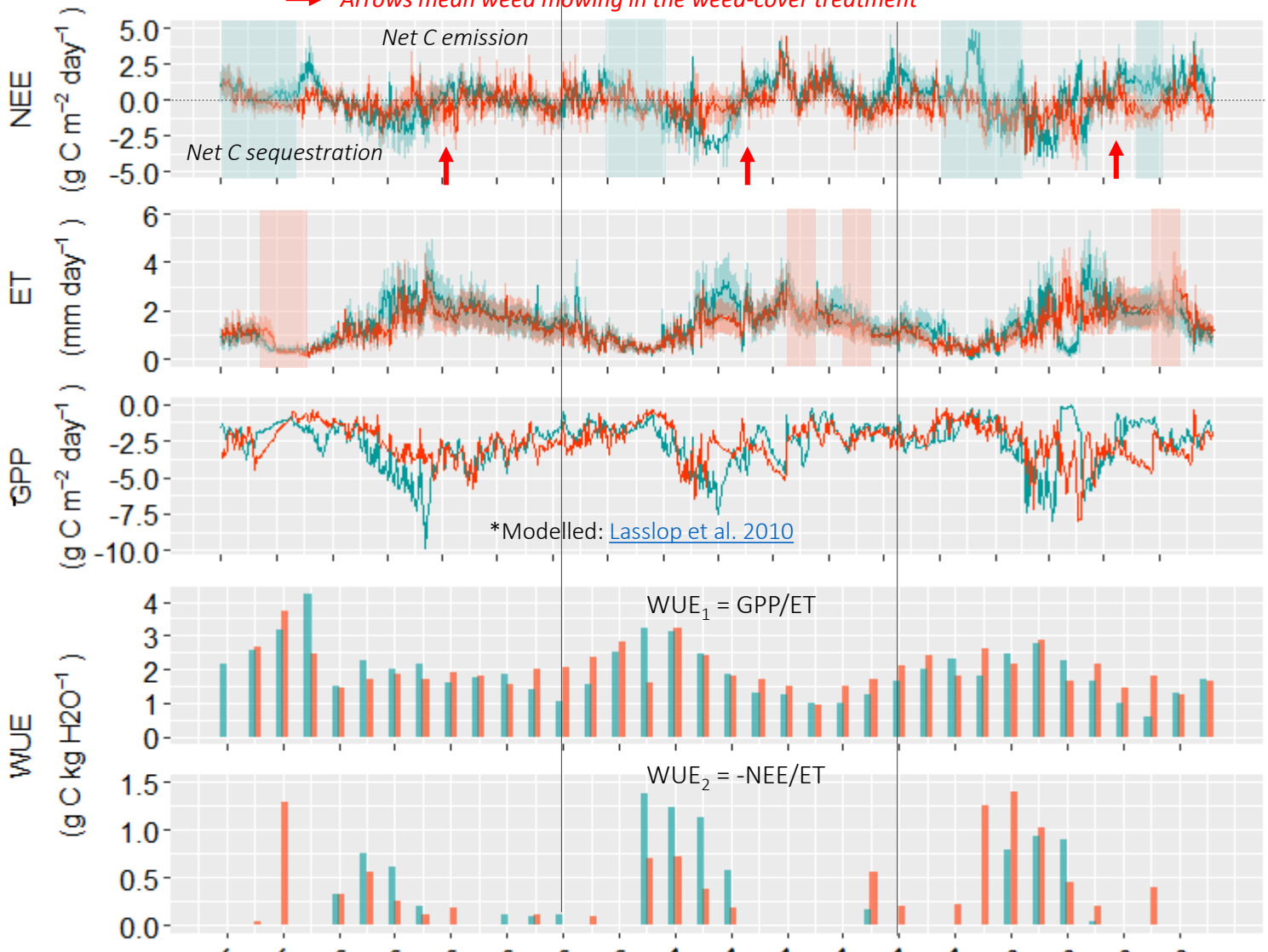
Shaded areas represent data gaps

Ecosystem-scale Carbon and water fluxes and Water Use Efficiency

Weed-cover Weed-free

Shaded areas *represent monthly NEE and ET* ***data gaps*** *> 50% for each treatment station*

Arrows mean weed mowing in the weed-cover treatment



Spring net carbon sequestration is higher in the **weed-cover treatment** for all hydrological years.

The presence of cover crops led to an **increased water loss** via higher evapotranspiration in the weed-cover treatment during spring months.

Gross Primary Production (GPP) estimates and **gap-filled NEE seem not very reliable**, especially over periods with important data losses. Accordingly, **Water Use Efficiency estimates** (WUE_1 & WUE_2) **might be biased**. However, **April WUE_1 estimates were 15, 6 and 61% higher in the weed-cover treatment** for the three hydrological years of the study, respectively.

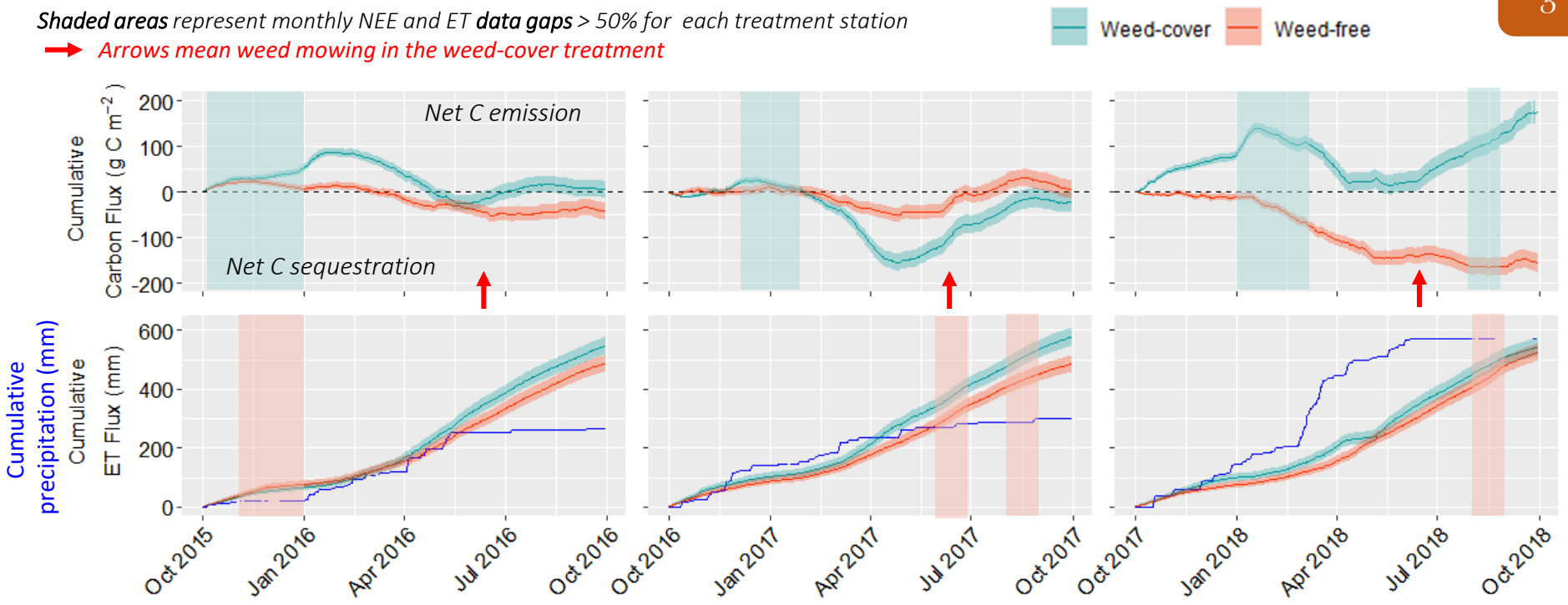
Fig. 2

Annual Carbon & Water Balances

Fig. 3

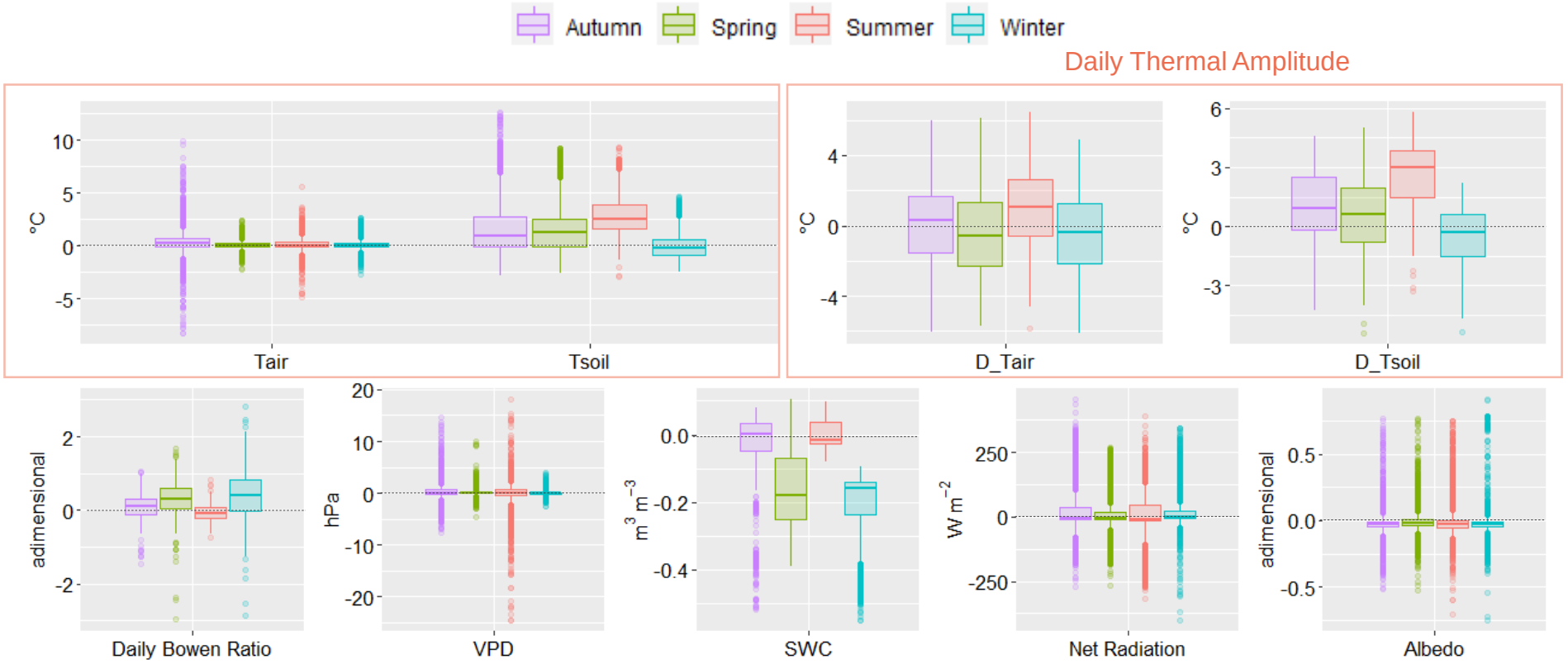
Shaded areas *represent monthly NEE and ET* ***data gaps*** *> 50% for each treatment station*

Arrows mean weed mowing in the weed-cover treatment



- In the studied **olive agrosystem**, there is a **remarkable inter-annual variability in annual carbon balances** estimated for the three hydrological years. In contrast, **cumulative annual evapotranspiration shows similar pattern** over the study period.
- During the **first two years** of the study, **both treatments where close to carbon neutrality**. However, **annual carbon balance differed substantially between treatments over last hydrological year**, when **higher winter and summer C emissions** were estimated for the **weed-cover treatment**. However, we must <u>be cautious</u> in the interpretation and take into account the data gaps.
- Despite being an irrigated system, our results suggest that **precipitation quantity and distribution may affect net carbon exchange** since the wettest hydrological year (2017-2018) showed a different pattern compared to the other two years.
- **Annual evapotranspiration was 12, 19 and 3% higher in the weed-cover treatment** over the **three hydrological years** of the study.

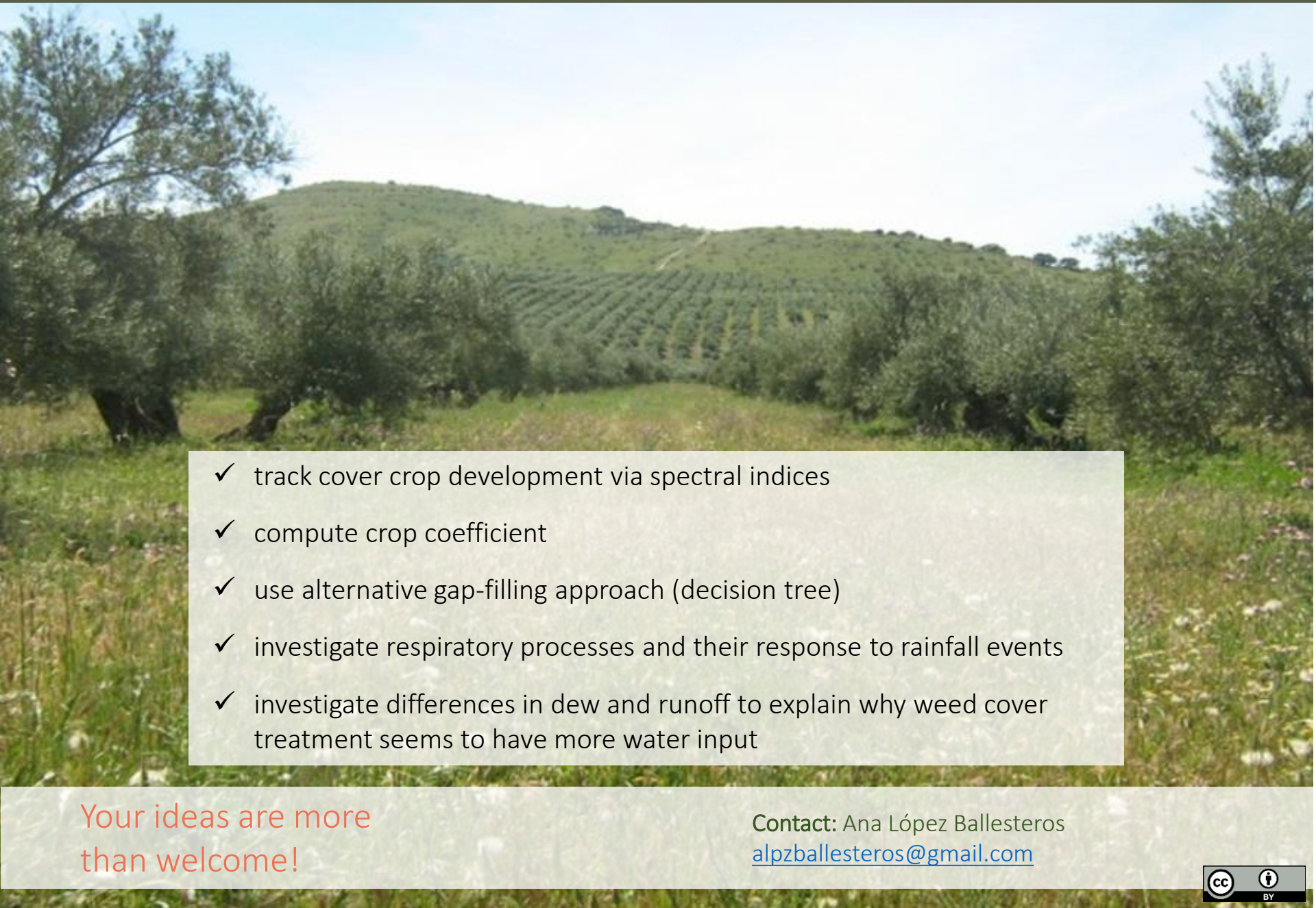
Difference in microclimate due to cover cropping: Weed-free minus Weed-cover



- Microclimatic conditions substantially differed between treatments.
- **Soil Water Content (SWC) was substantially enhanced during** spring and winter (~0.2 m^3 m^{-3} higher).
- **Milder temperatures were registered in the weed-cover treatment during summer**, when daily soil and air thermal amplitude during summer was 1 and 3 degrees higher in the weed-free treatment during summer.
- **Daily bowen ratio was higher in the weed-free treatment** over autumn, spring and winter.

Fig. 4

Future work



- ✓ track cover crop development via spectral indices
- ✓ compute crop coefficient
- ✓ use alternative gap-filling approach (decision tree)
- ✓ investigate respiratory processes and their response to rainfall events
- ✓ investigate differences in dew and runoff to explain why weed cover treatment seems to have more water input

Your ideas are more than welcome!

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