Evaluating the JULES two-source energy balance

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Hydro-JULES

CEH Centre for Ecology & Hydrology
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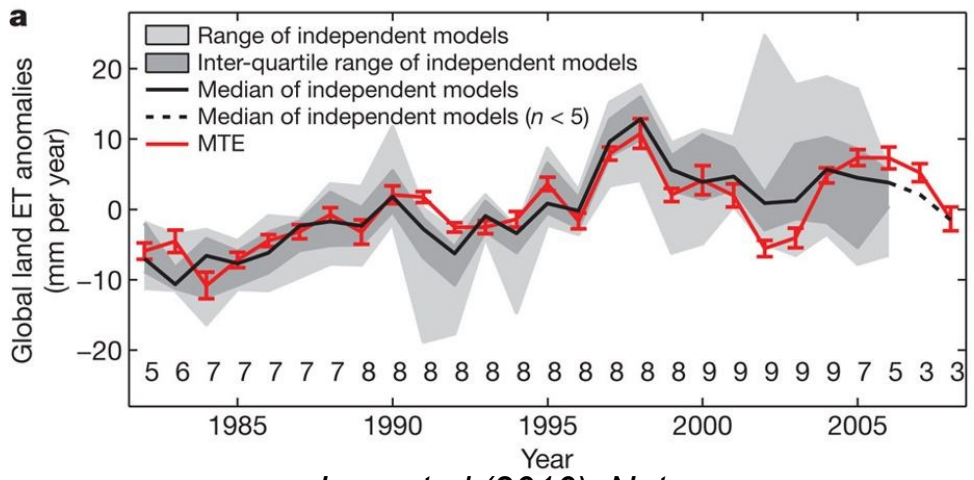
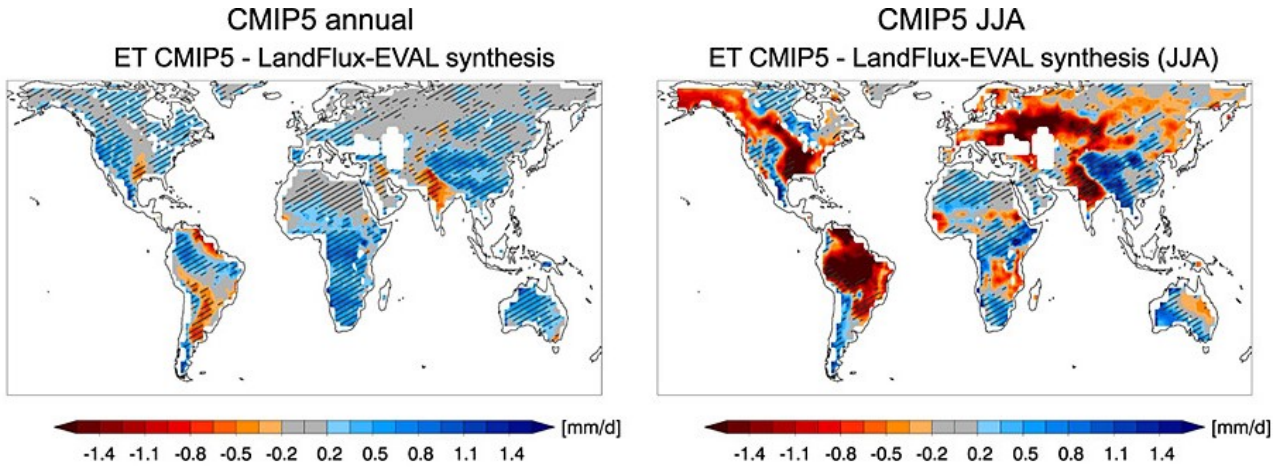
- Introduction
- Site study
- Global study
- Conclusions

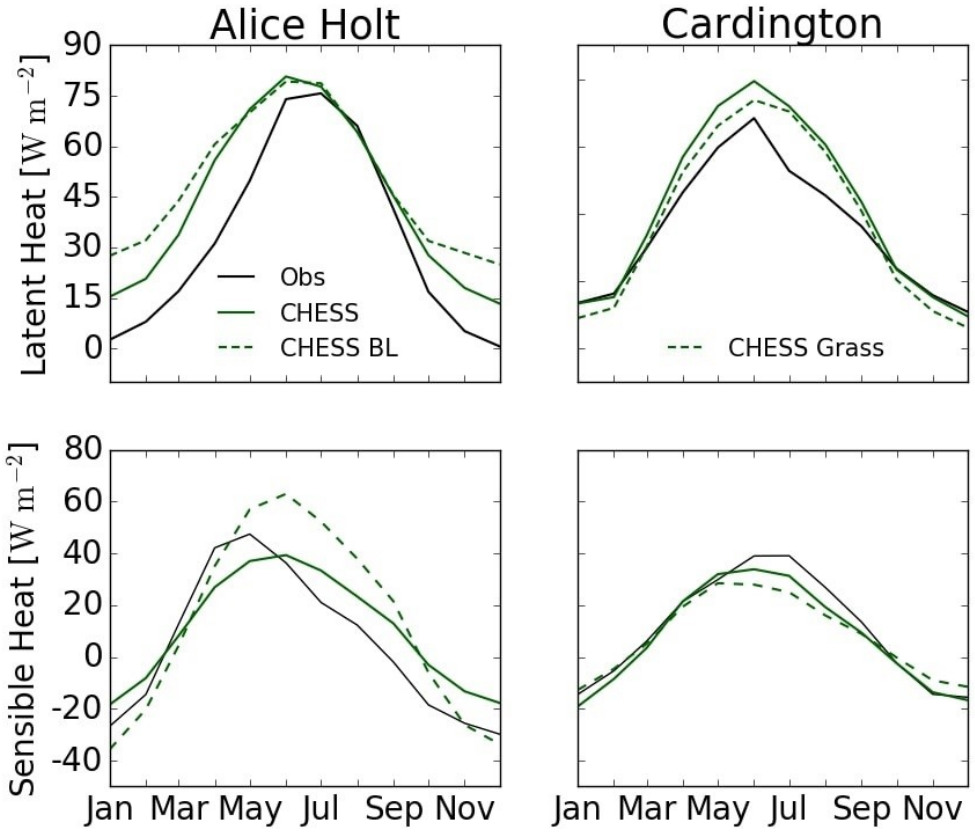
Introduction: Uncertainties in evapotranspiration



Jung et al (2010), Nature



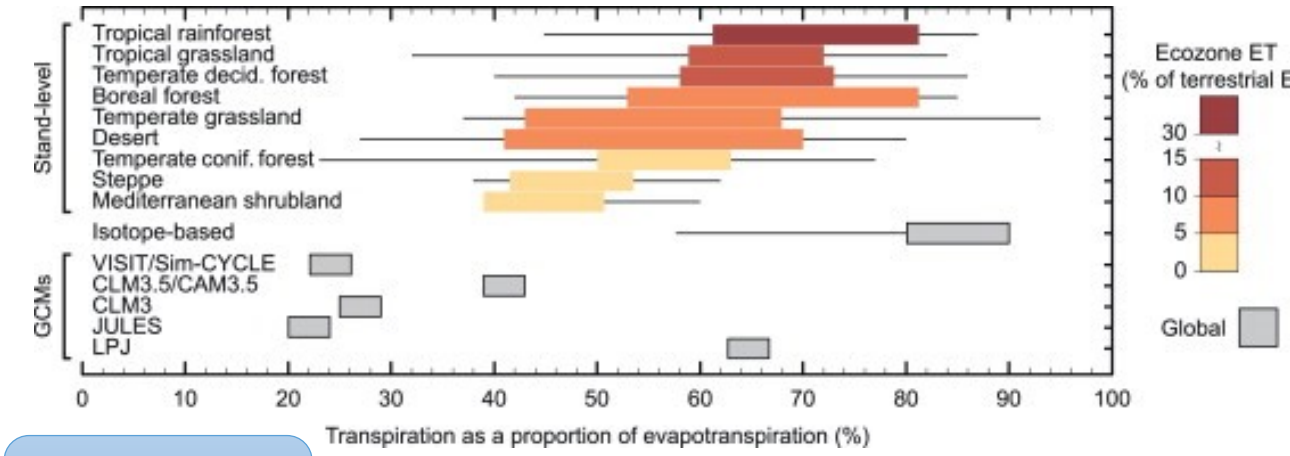
Mueller and Seneviratne (2014), GRL



Blyth, Martinez de la Torre and Robinson (2019), Progress in Physical Geography

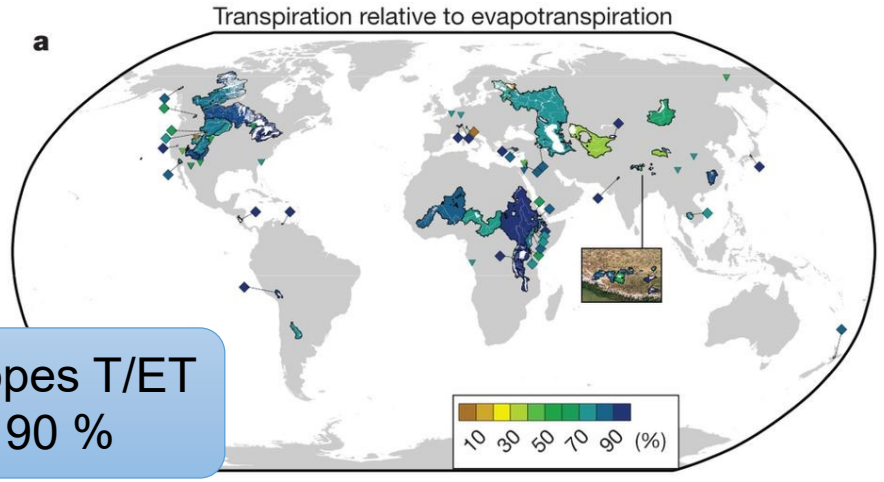
Introduction: Uncertainties in evapotranspiration components

Sites T/ET
39 – 61 %



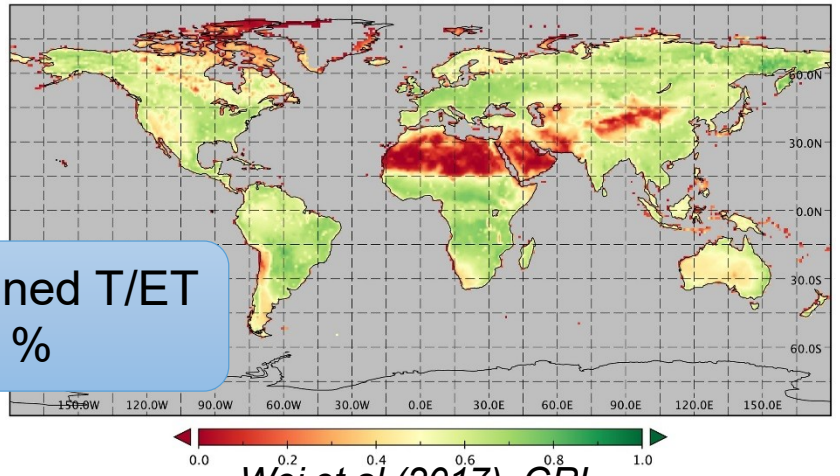
GCMs T/ET
20 – 67 %

Schlesinger and Jasechko (2014), Agr & For Met



Isotopes T/ET
80 – 90 %

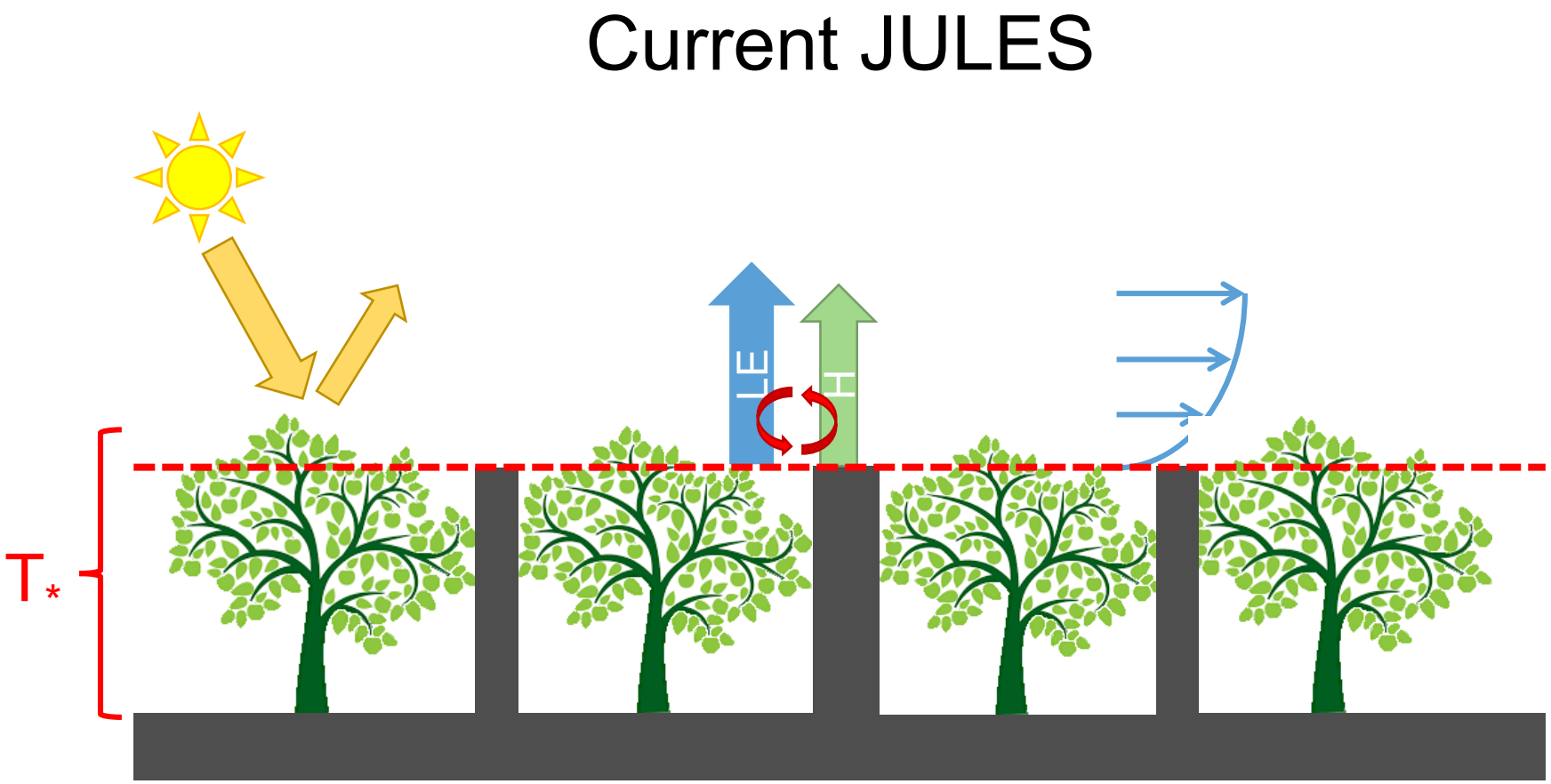
Jasechko et al (2013), Nature



Combined T/ET
57 ± 7 %

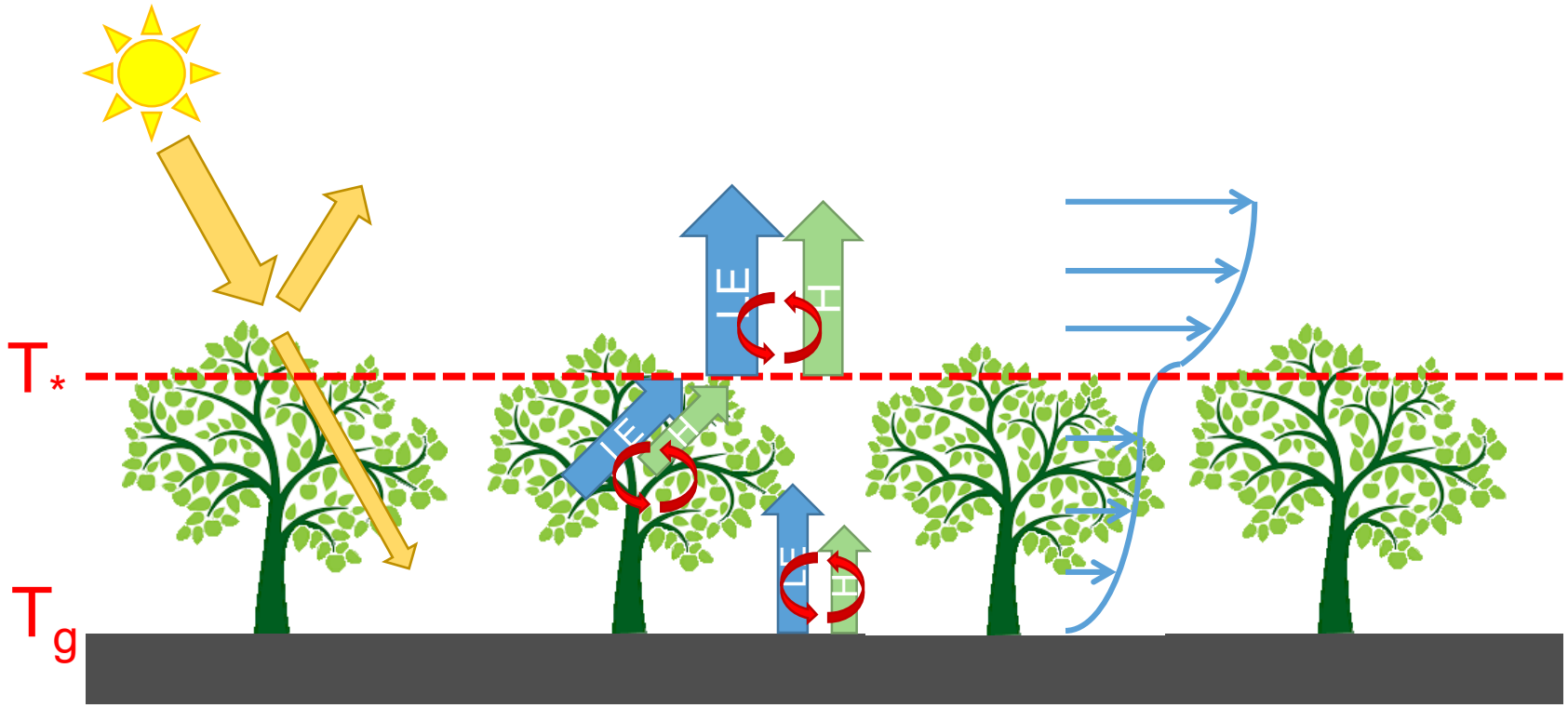
Wei et al (2017), GRL

Introduction: Why two-source modelling?



Introduction: Why two-source modelling?

Two-source JULES



Coded in JULES by Hiroshi Kusabiraki, Met Office/JMA

https://code.metoffice.gov.uk/trac/jules/browser/main/branches/dev/hiroshikusabiraki/vn5.1_twosrc

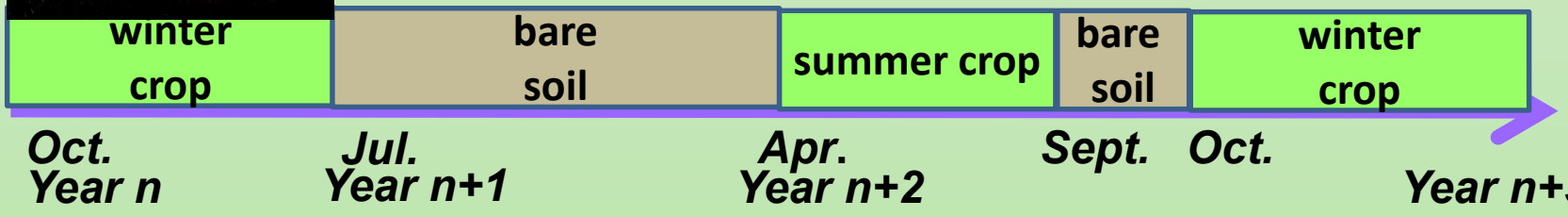
Evaluation over Mediterranean and semi-arid sites

Sébastien Garrigues

Evaluation over Mediterranean and semi-arid sites

Avignon site

- **Arable crop succession:** wheat, sunflower, maize, sorghum
- **Mediterranean climate**
- **Long period of crop succession 2001-2015 :** range of atmospheric and crop conditions



Garrigues et al., 2015,2018

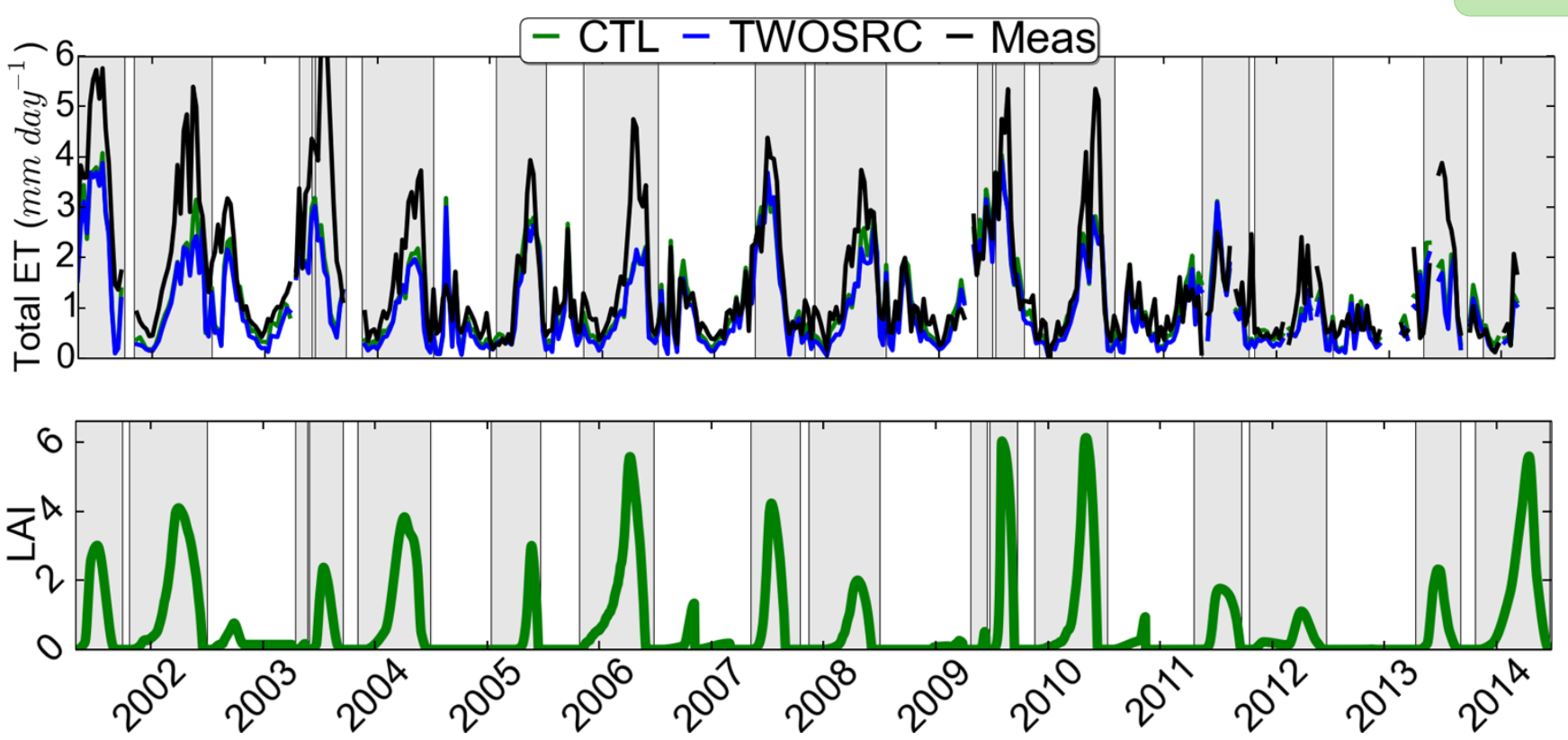
Agdal Irrigated Olive site (Morocco)

CESBIO, Caddi Ayad University, Marrakech – L.Jarlan, CESBIO

- **Irrigated olive orchard site** with large fraction of bare soil
- **Semi-arid climate**
- **1 year of observations** (2003)
- Measurement of plant transpiration (sap flow)
- SURFEX/ISBA simulations with different multi-source configurations

Evaluation of the temporal dynamics of ET over crop succession

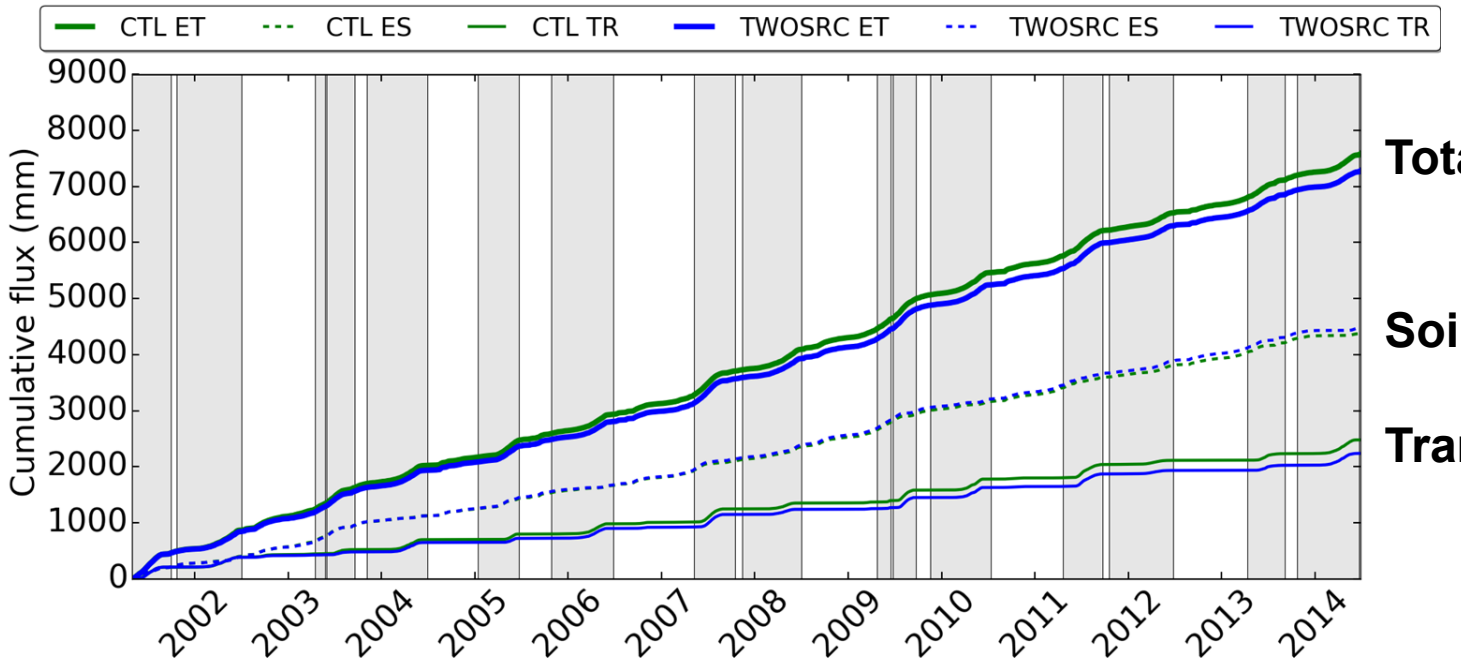
Avignon site



- Larger differences between model and measurement than between model configurations

Impact of the dual-source on ET partitioning

Avignon site



CTL
TWOSRC

Total ET🡻

Soil evaporation

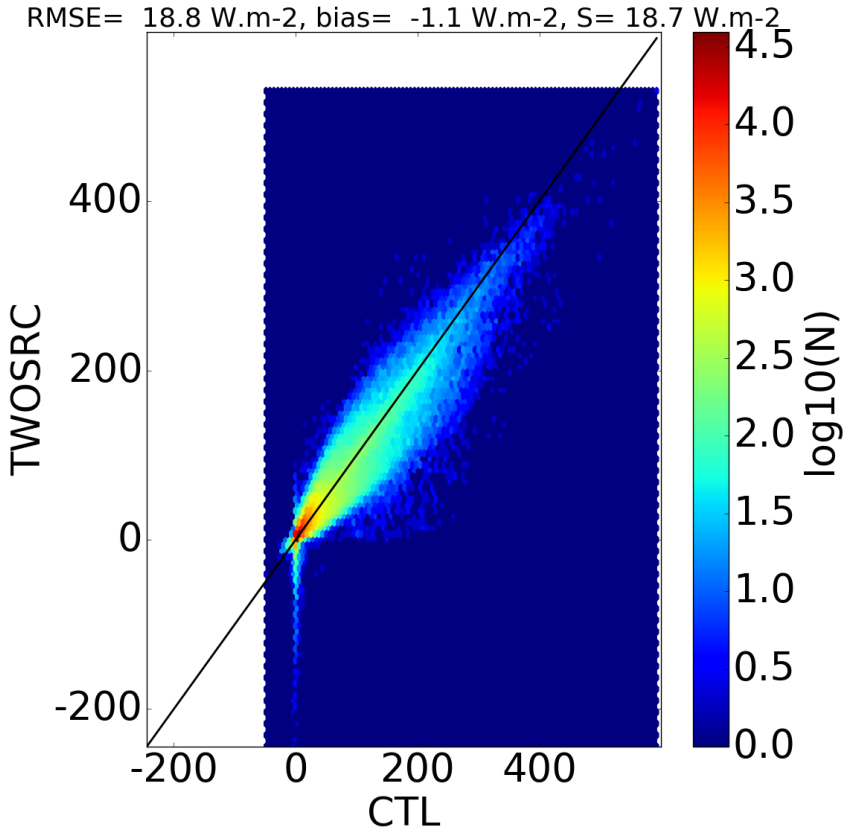
Transpiration🡻

- Low impact of the dual-source energy balance on ET partitioning between soil evaporation and plant transpiration

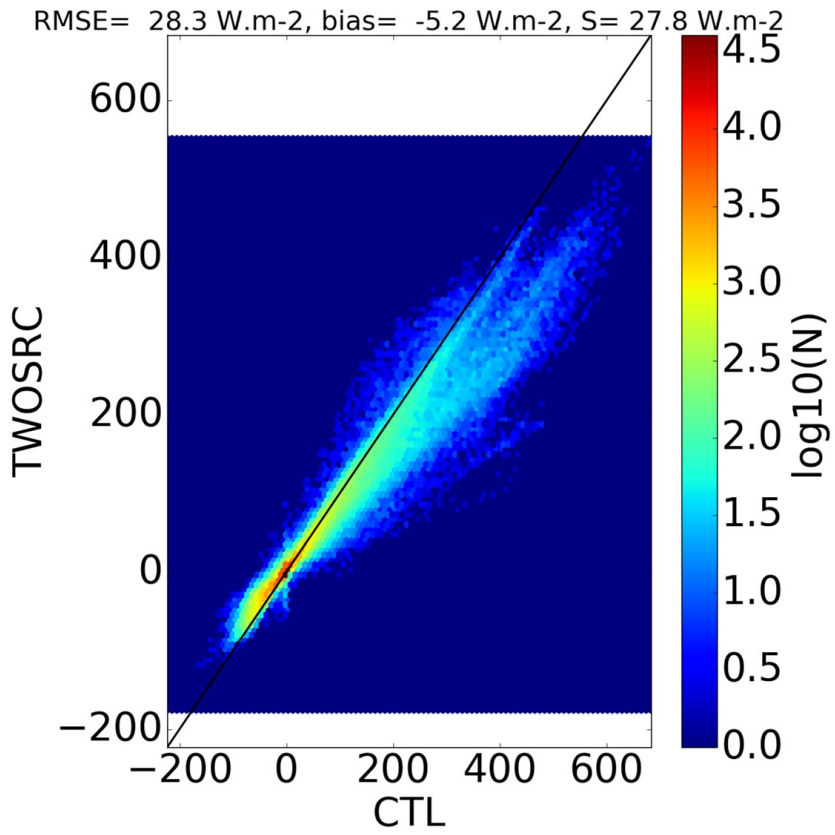
Impact on the energy budget

Avignon site

ET (W/m²)
RMSE=19, bias=-1



H (W/m²)
RMSE=28, bias=-5



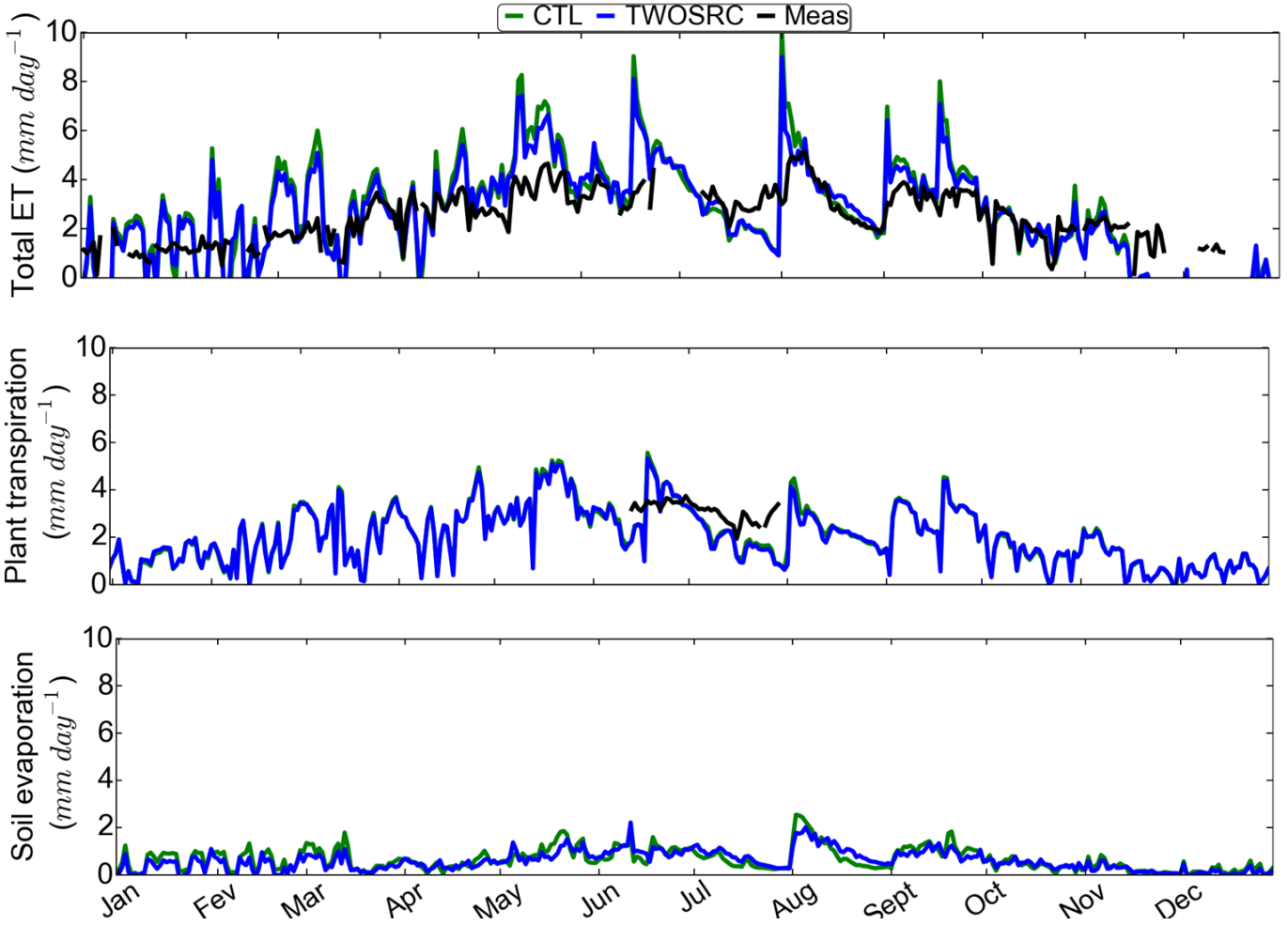
Larger impact of dual-source on H compared to LE

Impact on the temporal evolution of ET

Agdal site

Obs
CTL
TWOSRC

Total ET



- Overestimation of ET temporal variations

Transpiration

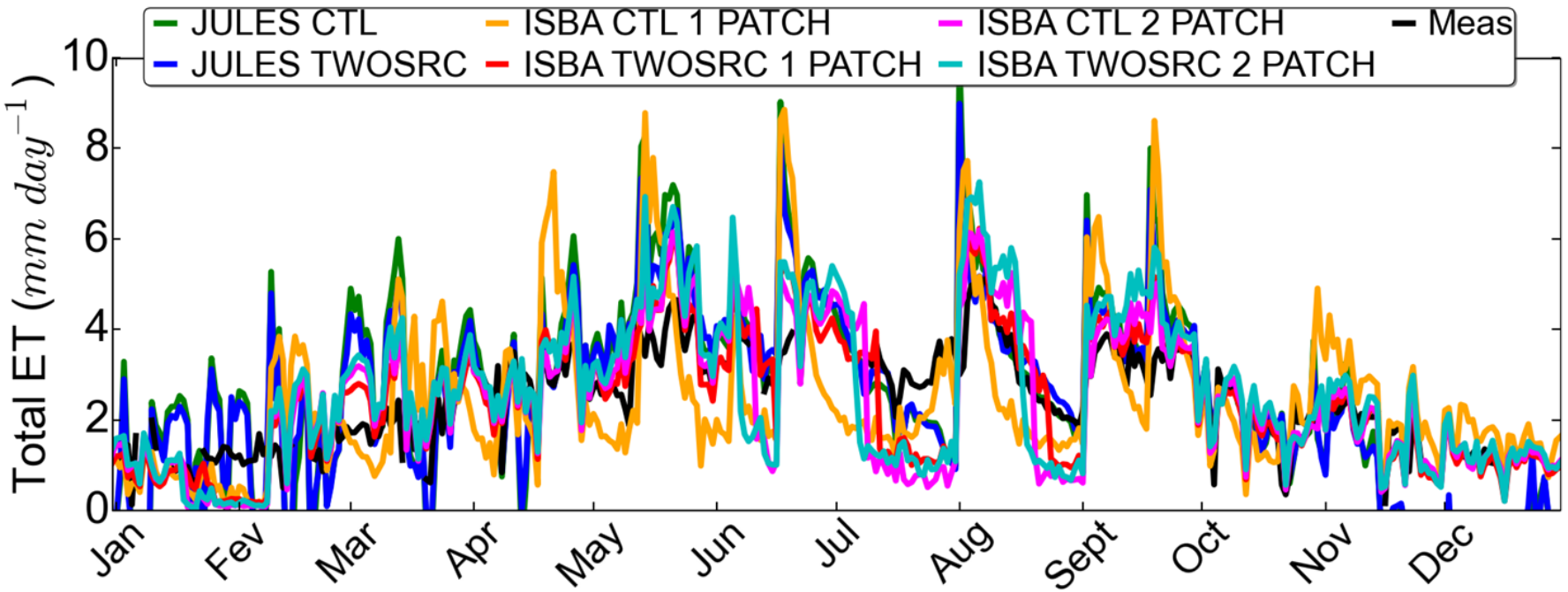
- No differences between CTL and TWOSRC transpiration

Soil evaporation

- Slight differences in soil evaporation

Comparison with the SURFEX/ISBA model

Agdal site

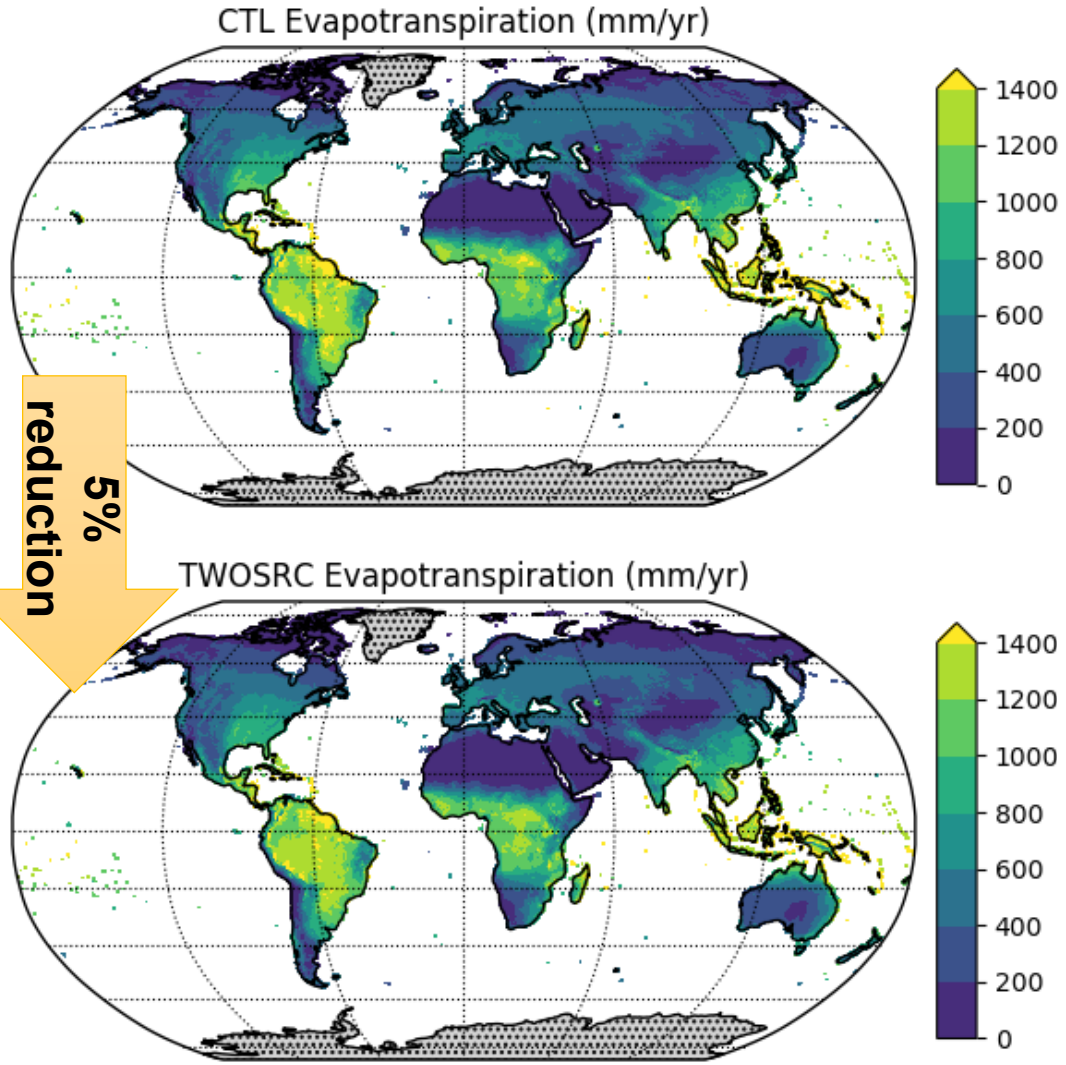


- Large discrepancies between models due to energy balance representation

Global evaluation

Emma Robinson

Global two-source modelling: ET

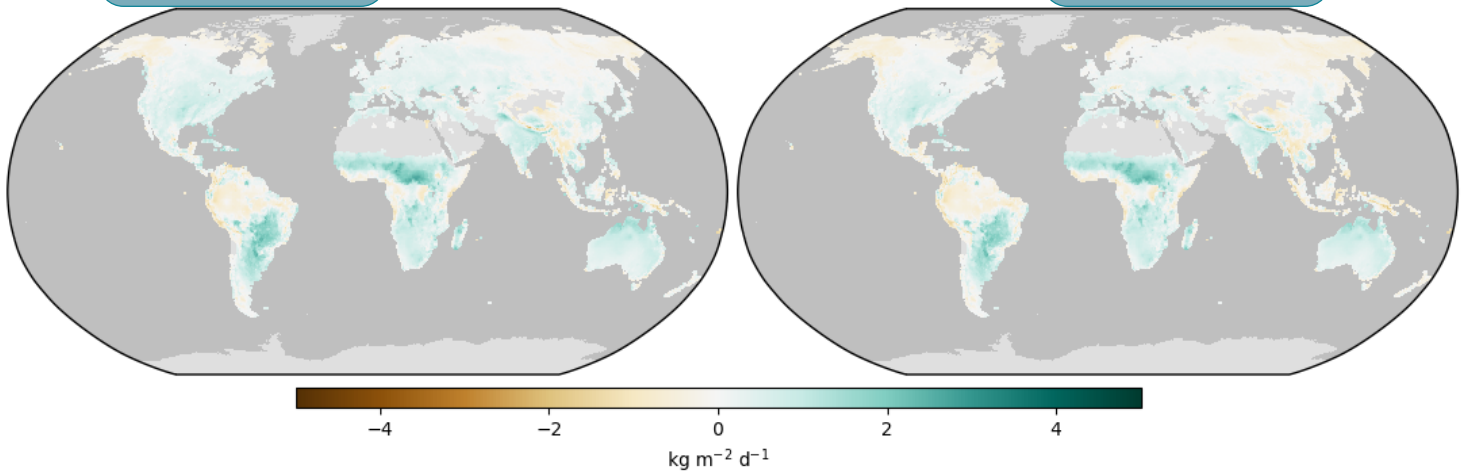


- WFDEI driving data
- 1979-2016
- GL8 configuration
- Rose suites:
  - u-be834 r110461
  - u-be834_twosrc r110376

CTL +20% bias

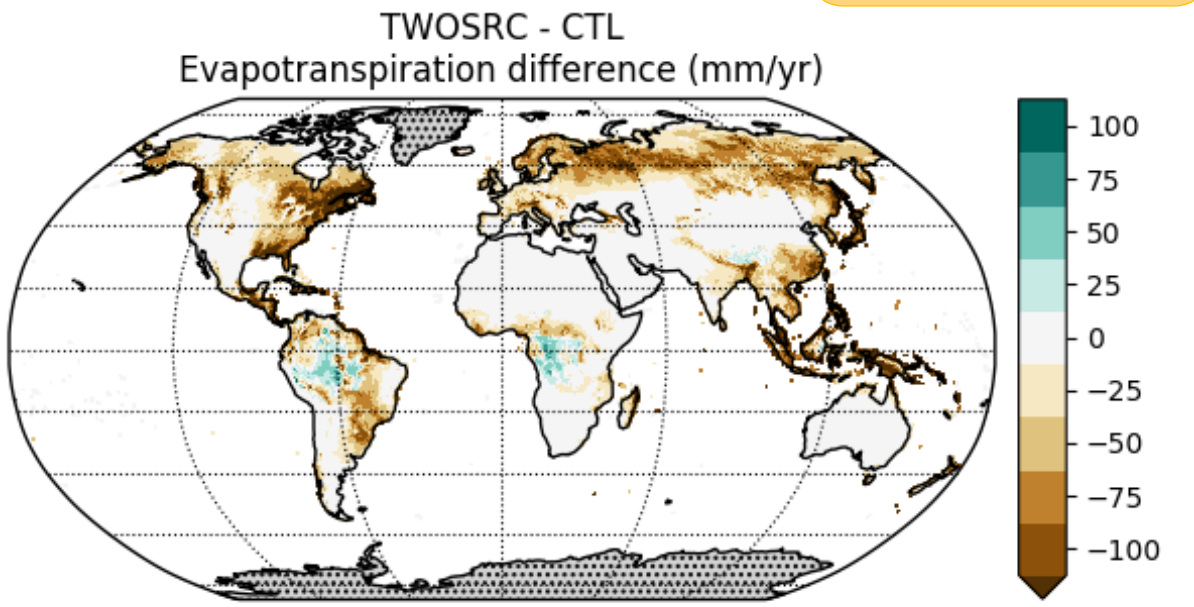
Comparison with MODIS

TWOSRC +15% bias

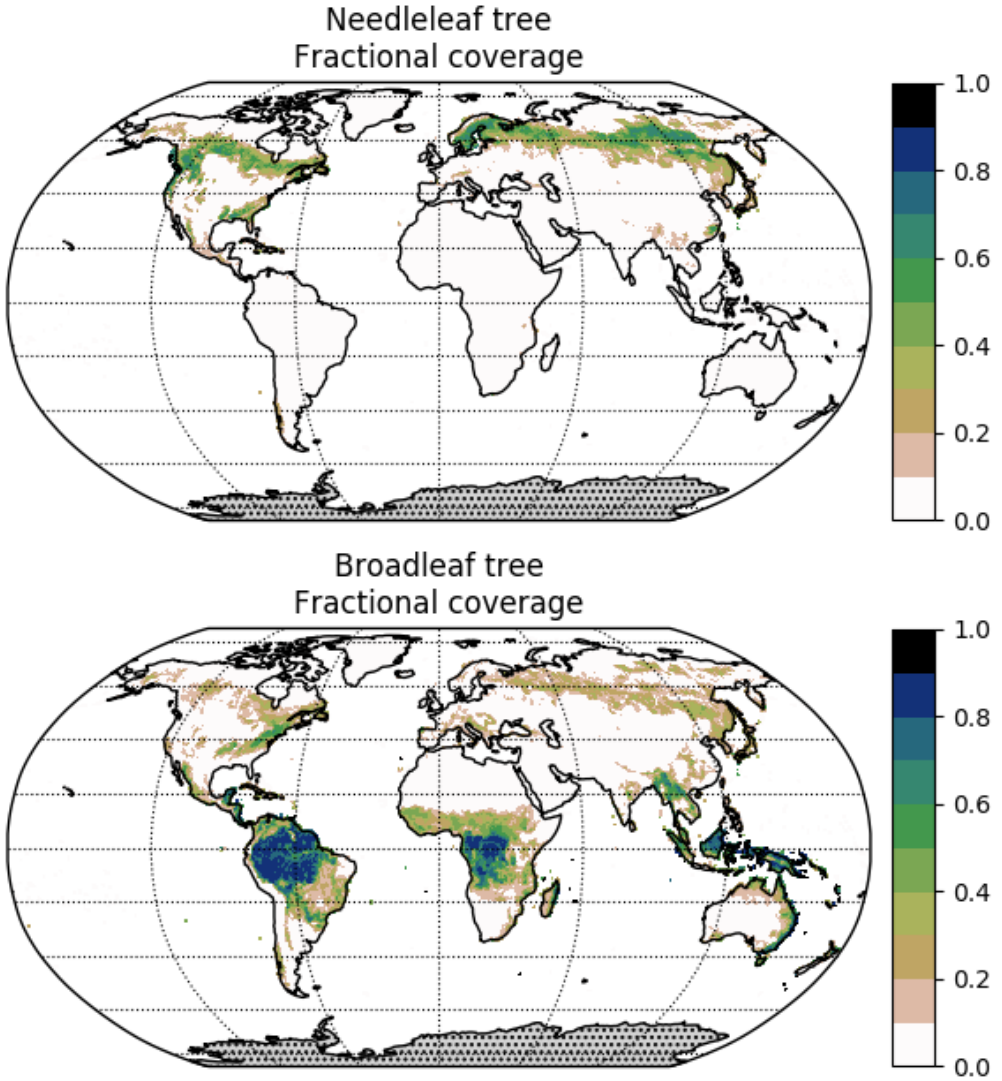


Regional differences

Decrease in ET for boreal needleleaf trees



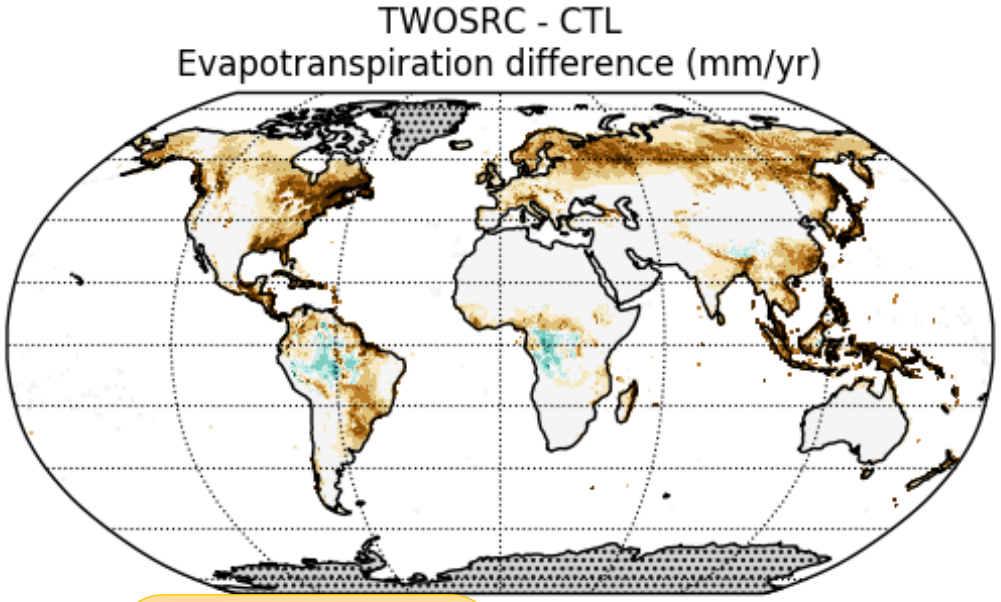
Increase in ET for tropical broadleaf trees

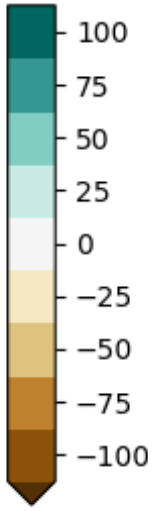


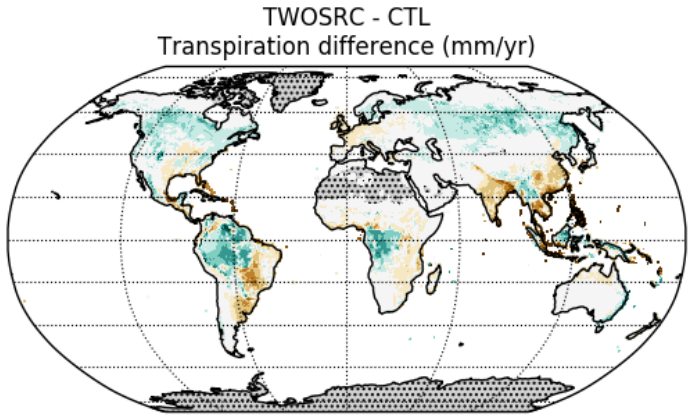
Components of ET

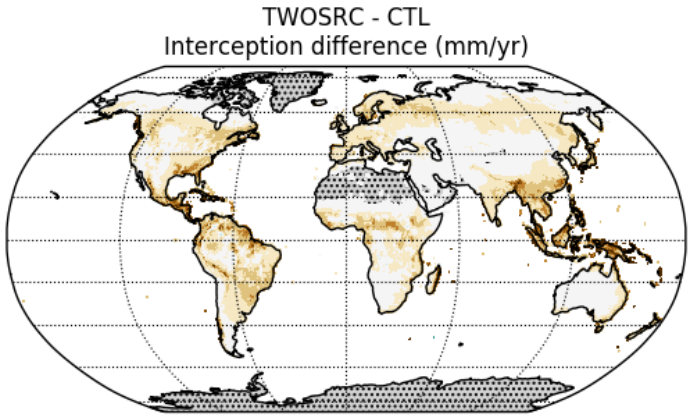
Increase in transpiration in both regions

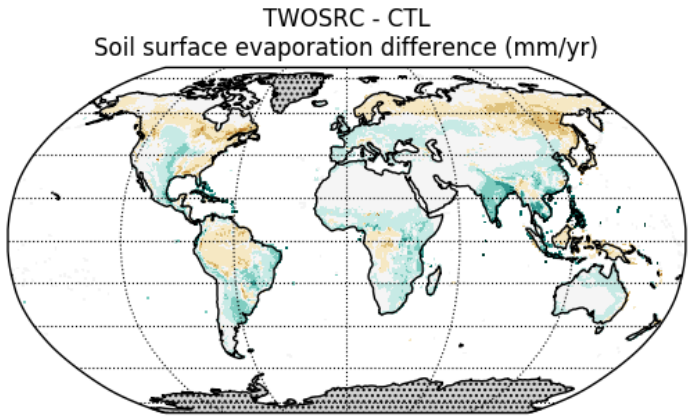
Small decrease in interception in both regions

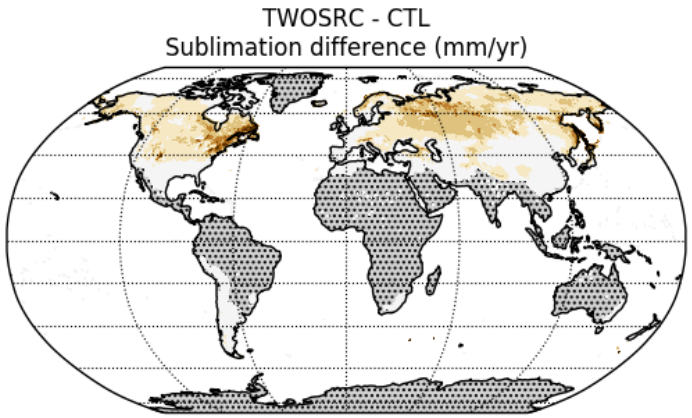












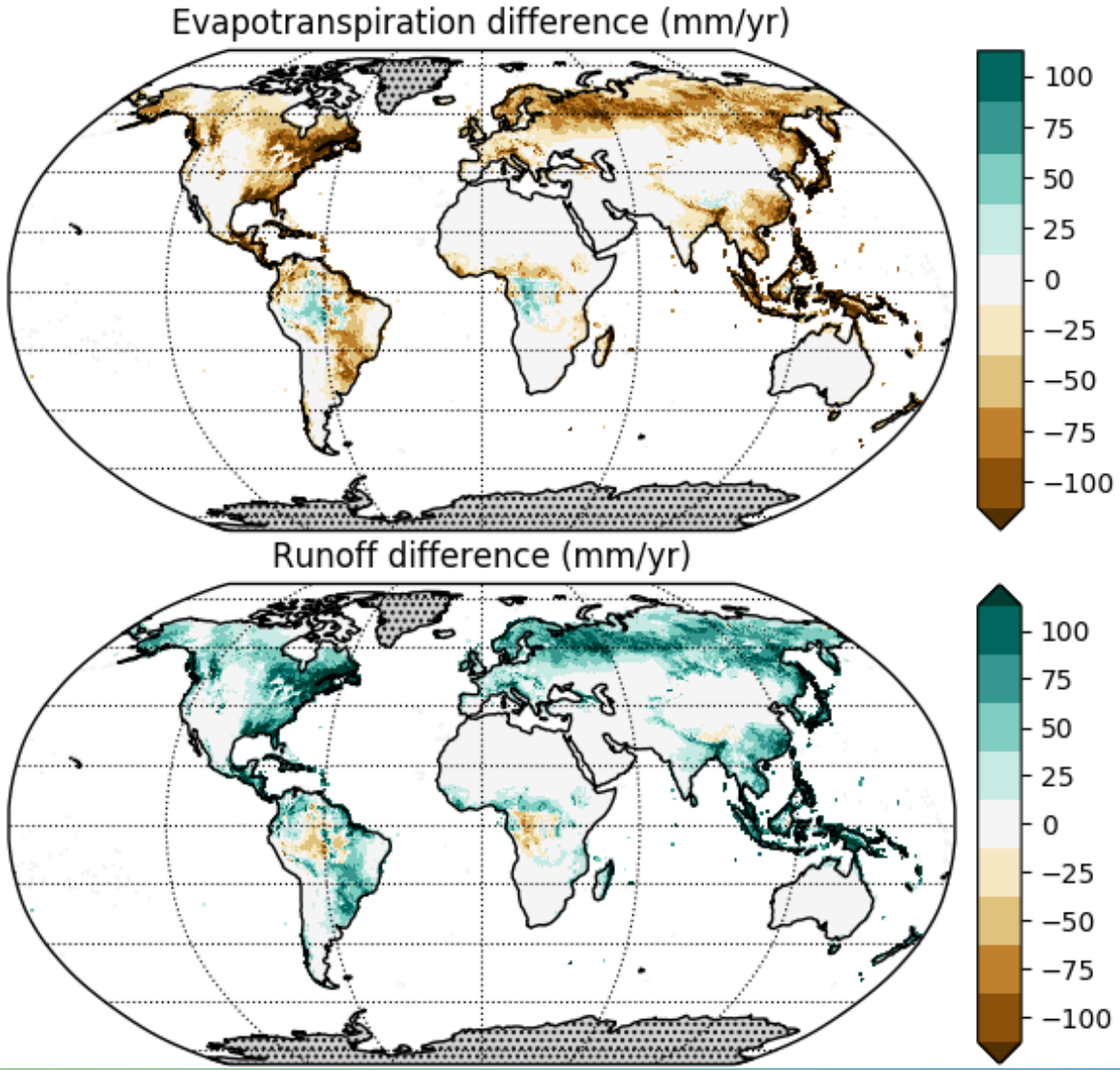
Decrease in soil surface evaporation in both regions

Decrease in sublimation in boreal regions

Implications for hydrology

5% reduction in total global ET

10% increase in total global runoff



Conclusions

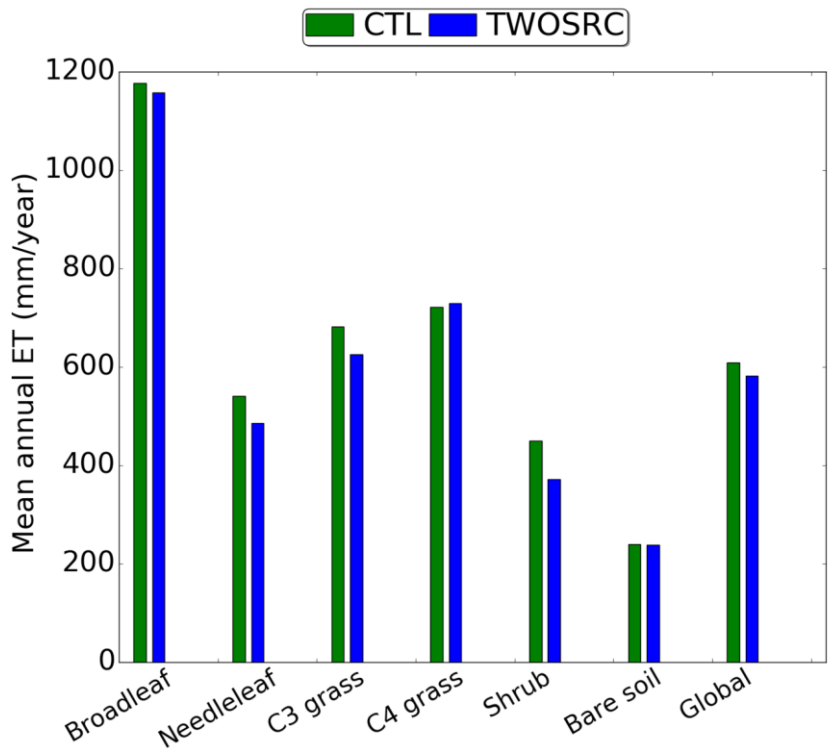
- Two-source model decreases ET over crop sites
- Larger effect on sensible heat flux

- Global 5% reduction in ET with two-source model
  - Transpiration: ↑ trees, ↓ grass
  - Soil evaporation: ↑ grass
- Significant reduction in sublimation in boreal regions

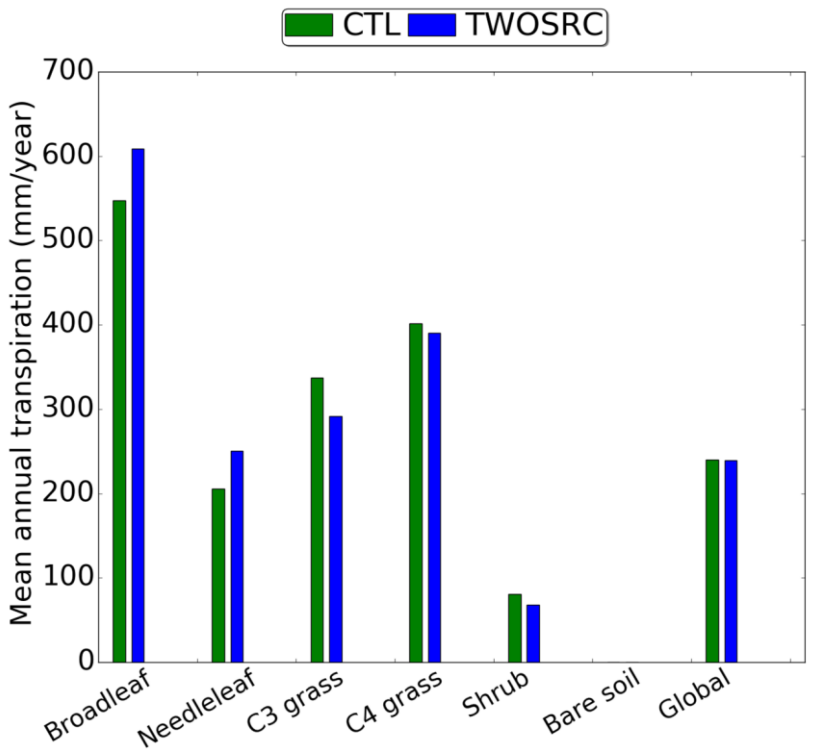
- Would multi-source be a further improvement…?

Sensitivity analysis by PFT

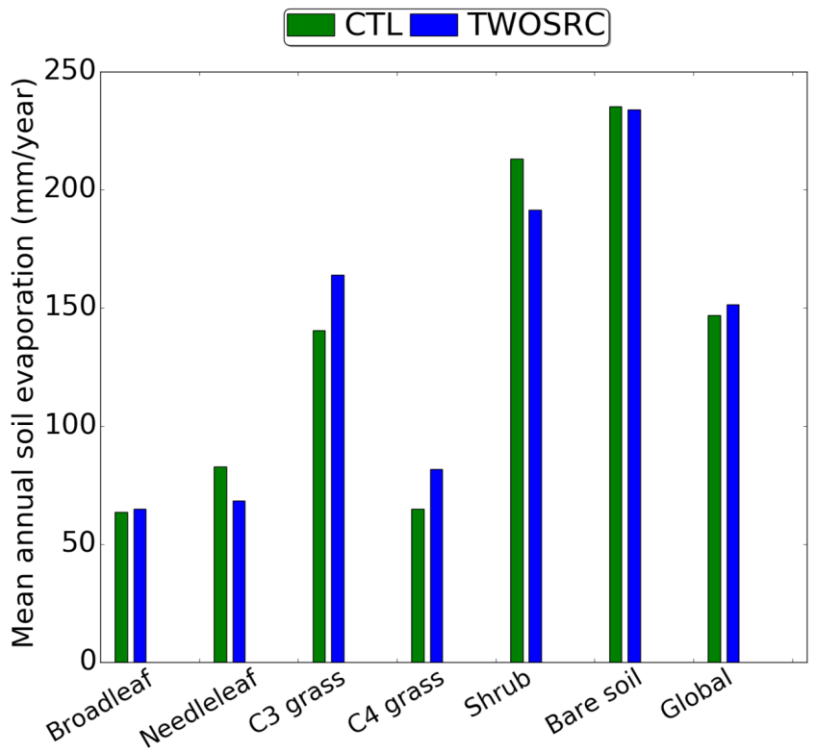
Total ET



Transpiration



Bare soil evaporation



- Small change in total ET
- Increase in transpiration over forests
- Increase in soil evaporation over grassland