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OBSERVING ACTUAL EVAPOTRANSPIRATION WITHIN A HILLY WATERSHED: CASE STUDY OF THE KAMECH SITE, CAP BON PENINSULA, TUNISIA

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http://*sciforum.net/conference/ecas2017*

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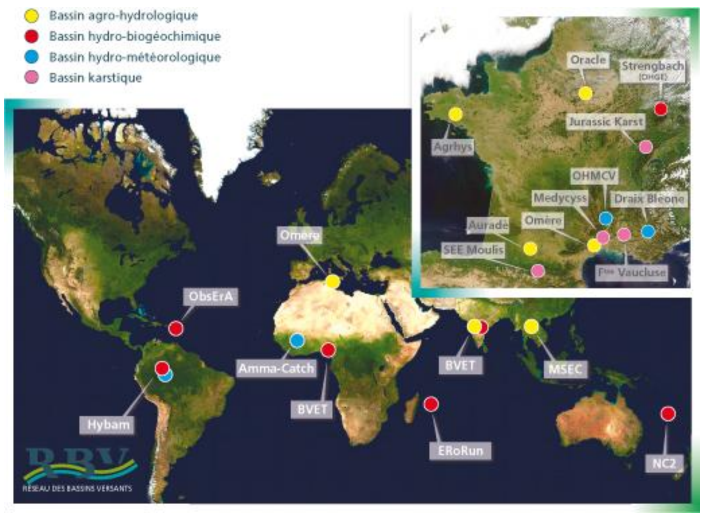
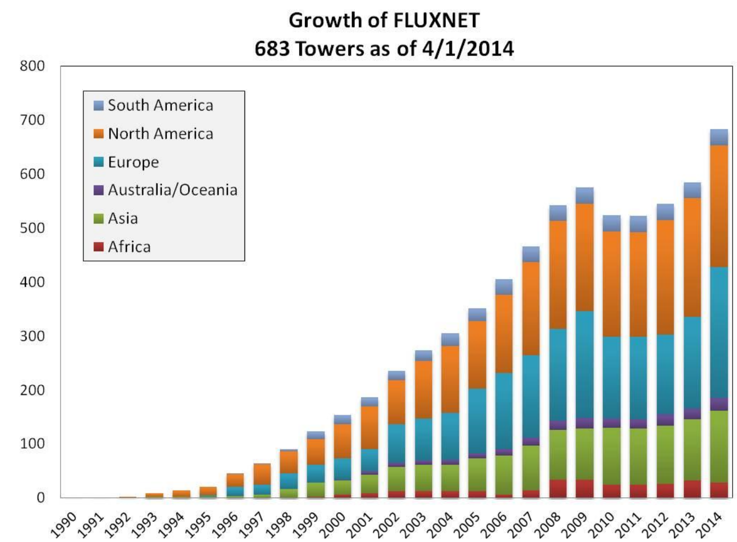
1.1 Actual evapotranspiration ETa

Water scarcity increases → Need to observe water cycle components in order to diagnostic processes and pronostic future trends



Hydrological observatories increases **but** ETa is rarely observed



Flux tower observatories increases **but** few are in agricultural system and under hilly topography

Agricultural hilly watersheds are widespread on Earth and allow intensification of agriculture

1.2 Long term series ETa under hilly topography

Eddy covariance (EC) techniques

permit continuous monitoring of land surface fluxes, including ETa

EC Missing data

sensor or power failures, maintenance and calibration procedures, improper weather conditions, and rejection of data induced by quality checks.

For hilly conditions

Necessary to adapt correction methods for EC measurements, or to account for footprint changes according to wind direction.

For long term series

Several gap filling techniques are proposed in littérature **but** existing gap-filling methods have not been examined over hilly cropping systems

2. Objective

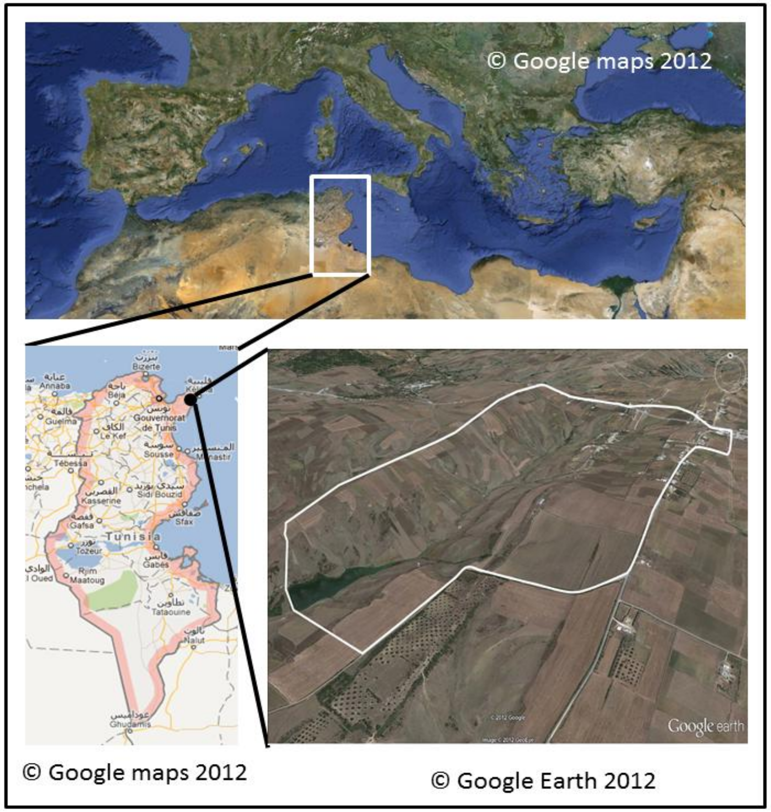
Obtaining continuous ETa time series from Eddy Covariance measurements collected within a small hilly watershed, which implied adapting gap-filling techniques to these particular conditions.

3. Experiments and methodology

3.1 Study site : Kamech agricultural watershed
3.2 Instruments : Flux tower
3.3 Flux calculations
3.4 Gap filling methods

3.1 Kamech agricultural watershed

http://www.obs-omere.org



OMERE
Observatoire Méditerranéen de l'Environnement Rural et de l'Eau

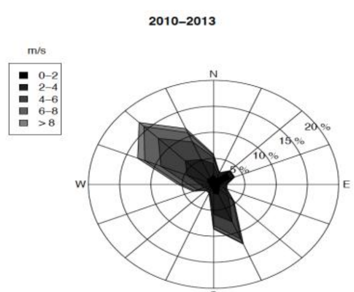
area of 2.45 km^2
Hilly totography
Rainfed

Crops

Cereals : Wheat/Oat/Barley
Legumes: Favabeans/ Chickpeas
Rangeland: natural vegetation

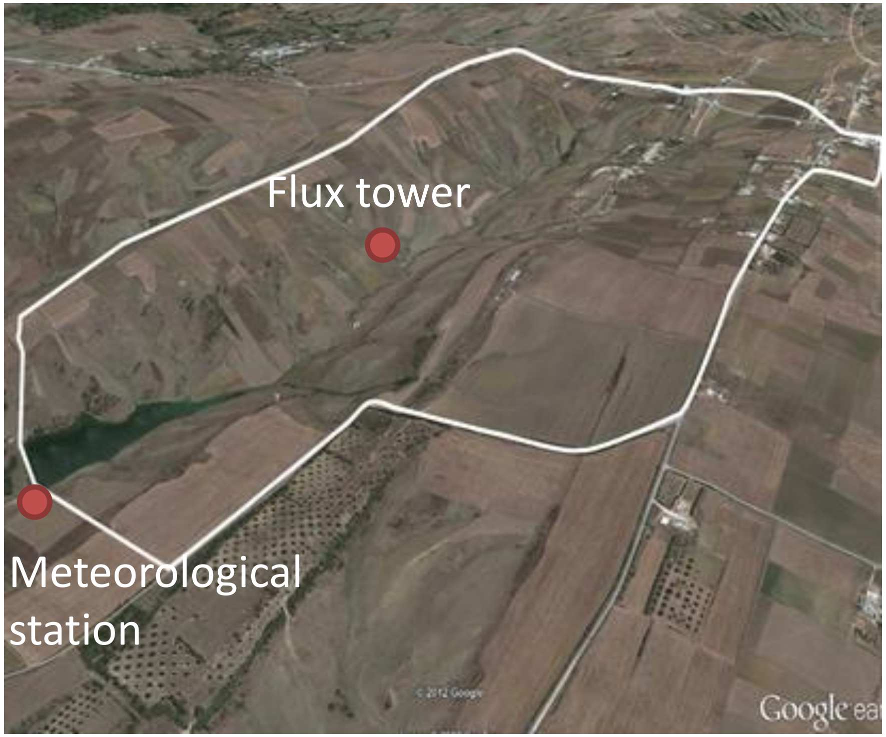
Climat

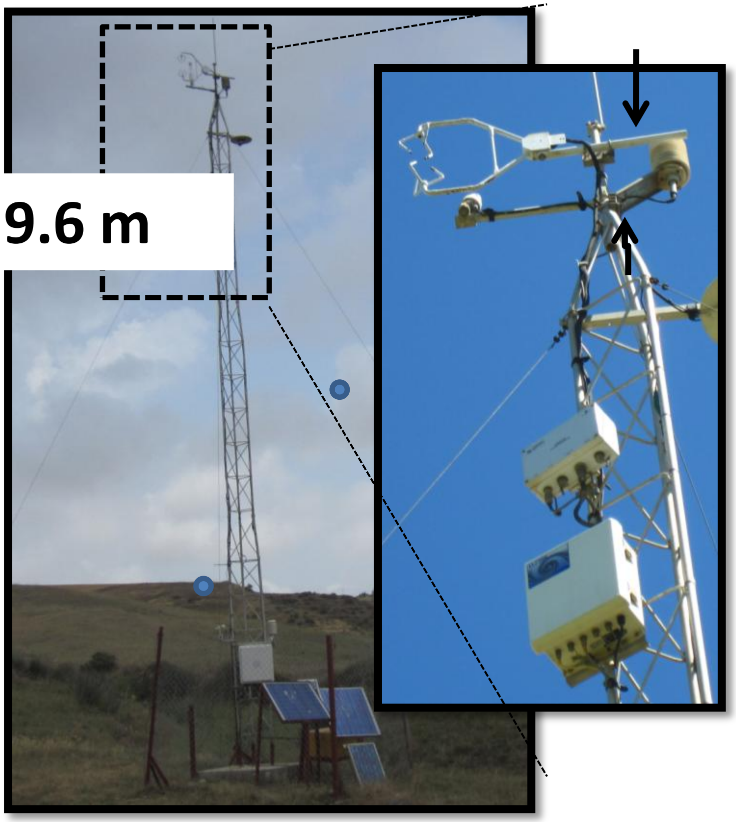
Annually averaged over the 2004-2014 pe
Precipitation 680 mm
Penman-Monteith reference
evapotranspiration 1366 mm



two dominant wind directions, that might interact with the hilly topography.

3.2 Eddy covariance flux tower





Data collected from:
04/2010 to 08/2013

Open path gas CO_2 / H_2O analyzer (LI-7500, LiCor Biosciences, USA)

3D anemometer (CSAT3, Campbell Scientific, USA

3.3 Flux calculations

Raw EC data: vertical wind speed, air temperature and humidity

20 Hz

Flux calculation and corrections

+

Contrôl quality

ECpack

ECpack library version 2.5.22

30 mn

Steady State test
Integral Turbulence characteristics test

Hourly convective fluxes
sensible heat (H) and latent (λE)

With missing data 53% for H and 78% for λE

30 mn

3.4 Gap filling

Model of Gap-filling

Reichstein et al. (2005)

REddyProc package

1

Original version (with all data)

H_{REP} and λE_{REP}.

2

Separation of wind direction

H_{RNS} and λE_{RNS}

Hourly data (λE and H) reconstructed

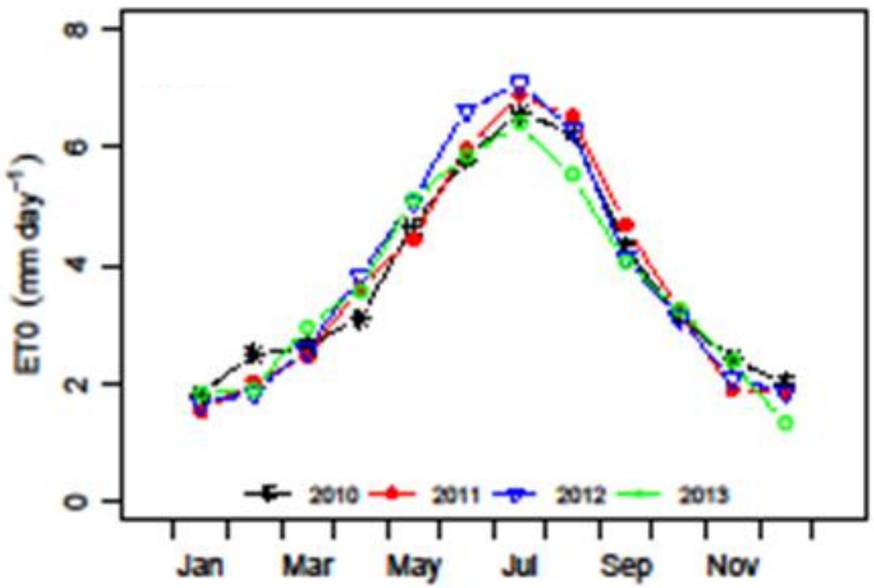
λE=ETa and H

24 h and monthly

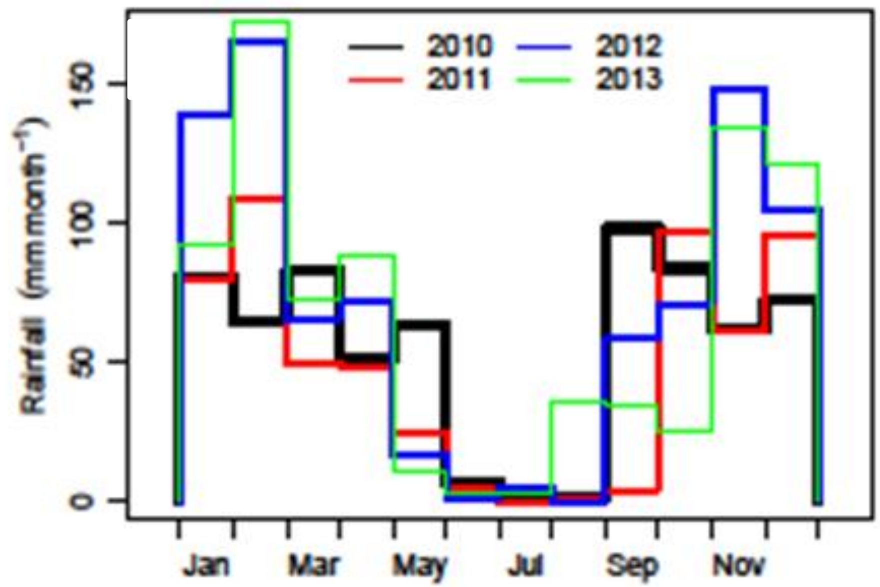
4. Results

4.1 Climatic conditions
4.2 Gap filling
4.3 Seasonal variations of daily surface fluxes
4.4 Monthly evapotranspiration

4.1 Climatic conditions



ET0 is almost similar between the four years of the experiment

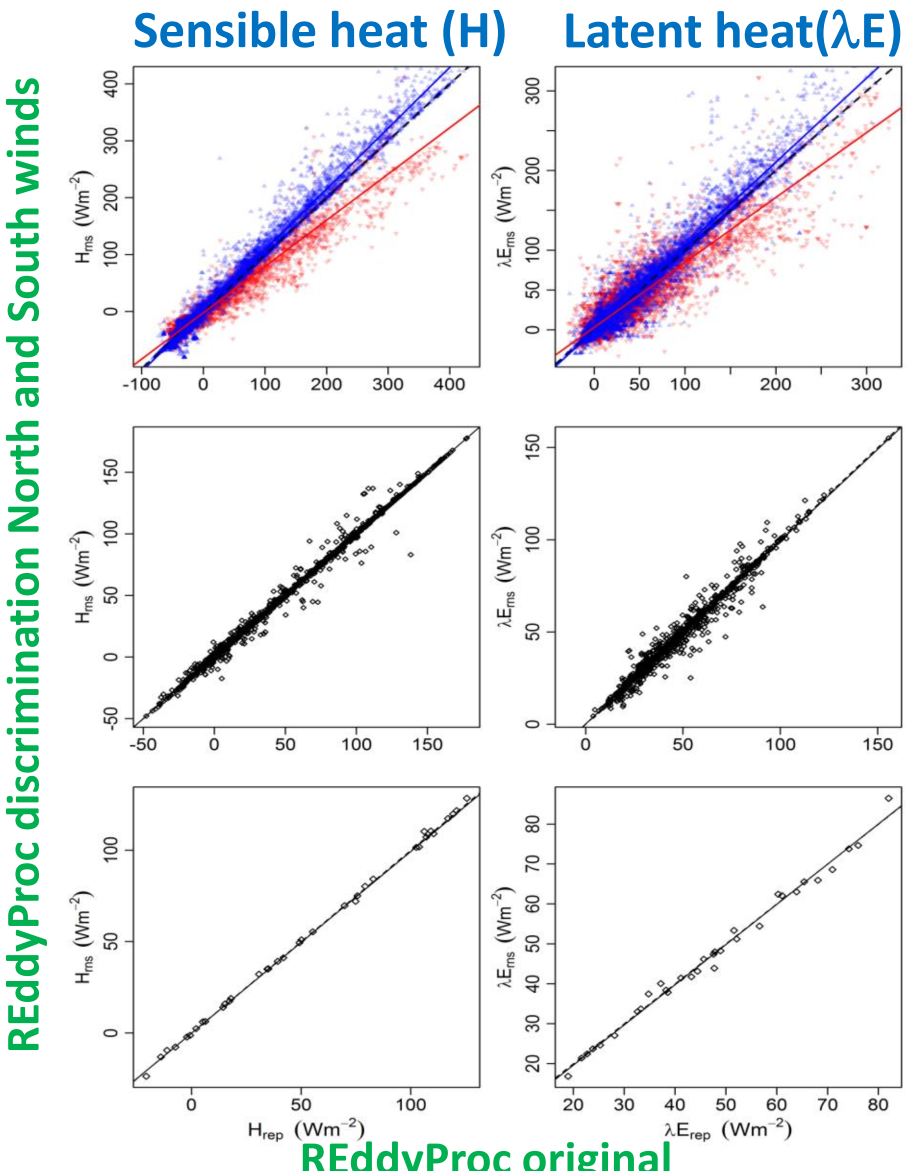


Rainfall shows differences during humid period but it is almost nul during summer

As a typical Mediterranean site, two contrating periods were clearly distinguished:

- a little evaporative demand (ET0) and available water (humid period) (from October to April)
- a high evaporative demand and dry period (from May to September).

4.2 Impact of taking into account the wind direction in REddyProc



Hourly

Differences observed when sdiscriminating wind direction for H and λE

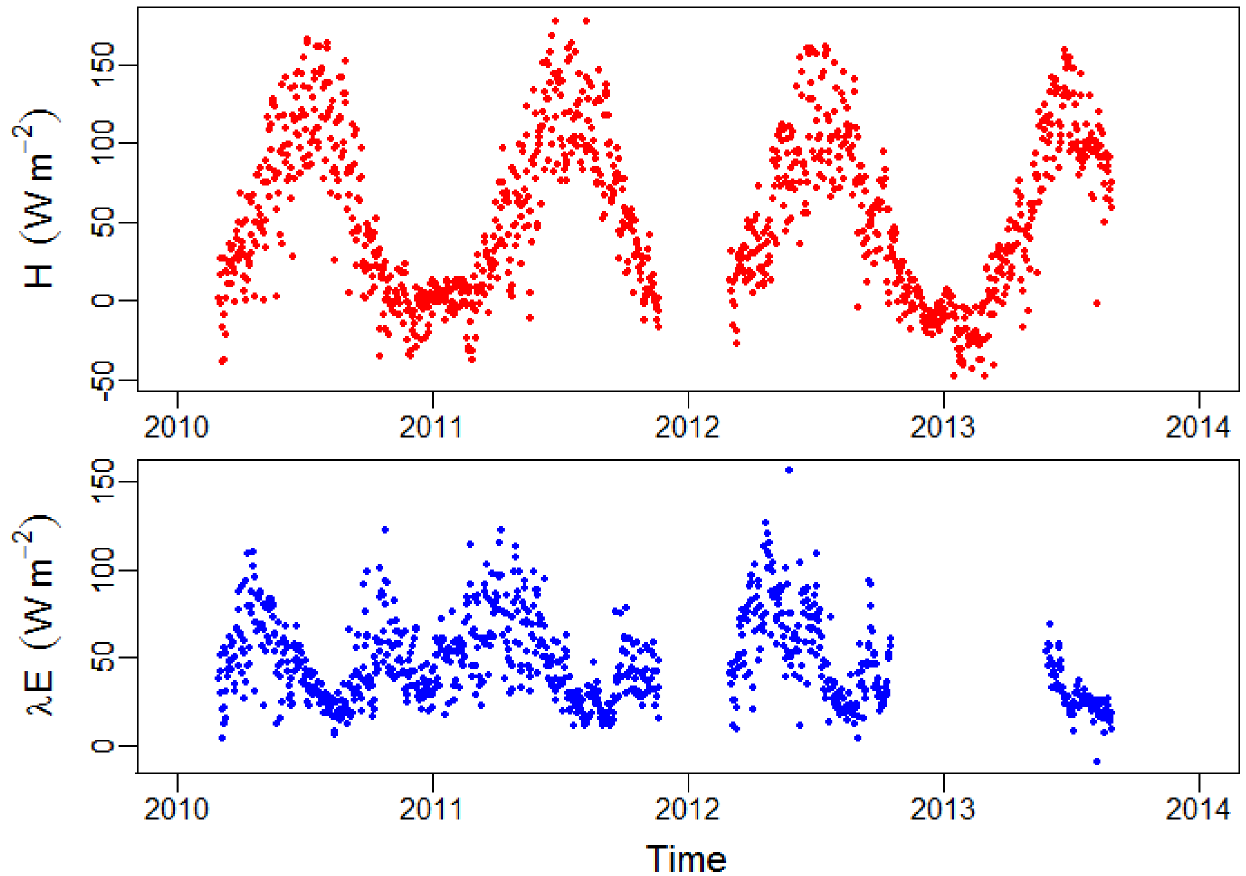
Daily

No differences observed

Monthly

No differences observed when discriminating wind direction for H and λ E

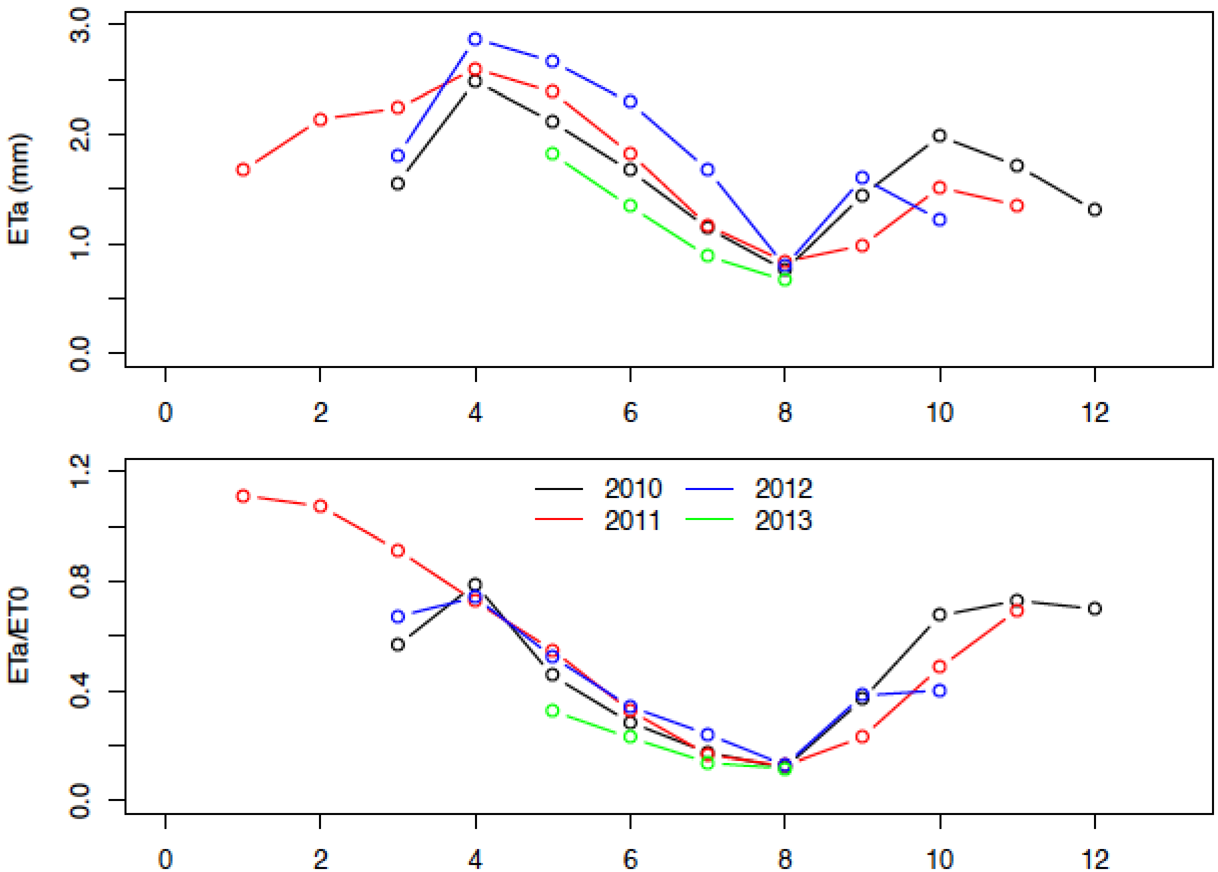
4.3 Seasonal variations of daily surface fluxes



REddyProc was able to gap-fill missing flux data most of the time, except when the duration of the periods with missing data were to long.

The time series of H and λ E emphasized the high consistency of the land surface fluxes obtained over this hilly watershed.

4.4 Monthly evapotranspiration



Maximum of Eta is reached on April, it is the maximum of vegetation growth for the rainfed crops of the watershed

In August, for bare conditions, Eta is 1 mm for the four years

ETa deduced from EC measurements exhibited a very good consistency for the four years

Clear and coherent seasonal variations of the ratio ETa/ET_0

5. Conclusion

5.1 Methodological conclusion

5.2 General conclusion

5.1 Methological conclusion

The REddyProc method was chosen to gap-fill the missing flux data, but was adapted to our particular conditions by separating the flux dataset between the two dominant wind directions.

It was demonstrated that at hourly timescale, it was necessary to discriminate between wind directions.

Conversely, the fluxes obtained with or without discriminating wind directions were very similar at daily and monthly timescales.

5.2 General conclusion

Our results gave great confidence in the observation of land surface fluxes by EC measurements over a small hilly watershed.

These flux time series could be further used for validating hydrological models, or for testing water management scenarios to mitigate the effect of global change.

Acknowledgments

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Thank you