

# Comparative analysis and validation of remotely sensed estimation of actual evapotranspiration in cotton ecosystems of Middle Asia

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A satellite image of the Earth's Northern Hemisphere, showing clouds, landmasses, and ice caps. The image is partially cut off at the bottom right corner.

Knowledge for Tomorrow



# Outline

1. Introduction

2. ET Modelling

3. Results and validation

4. Outlook

- Comparative analysis
- Soil moisture implementation



# 1. Introduction: Aral sea development - Past



July – September, 1989



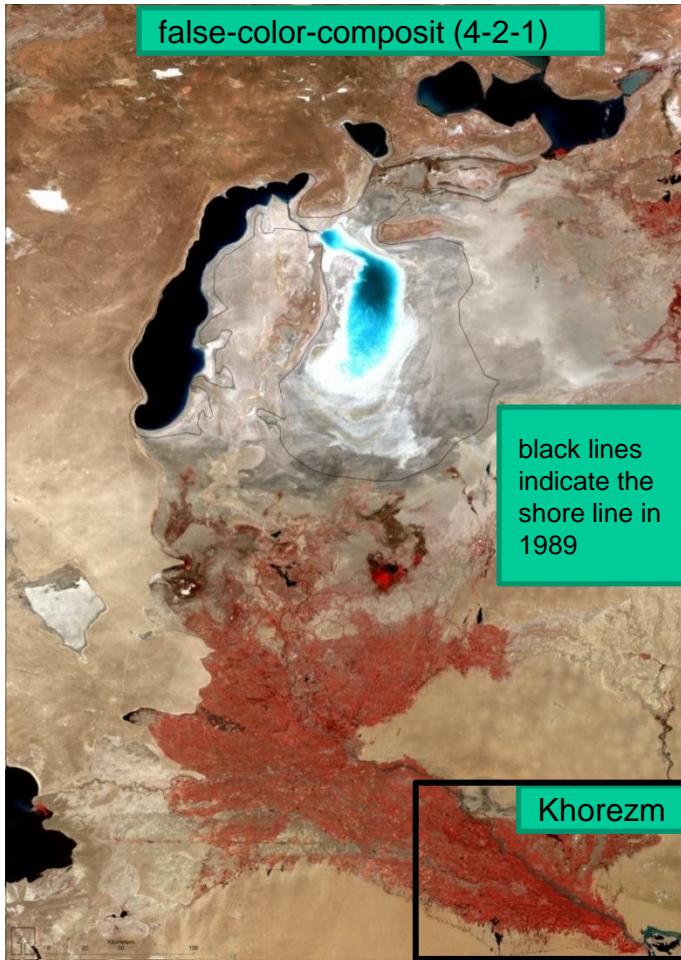
August 12, 2003



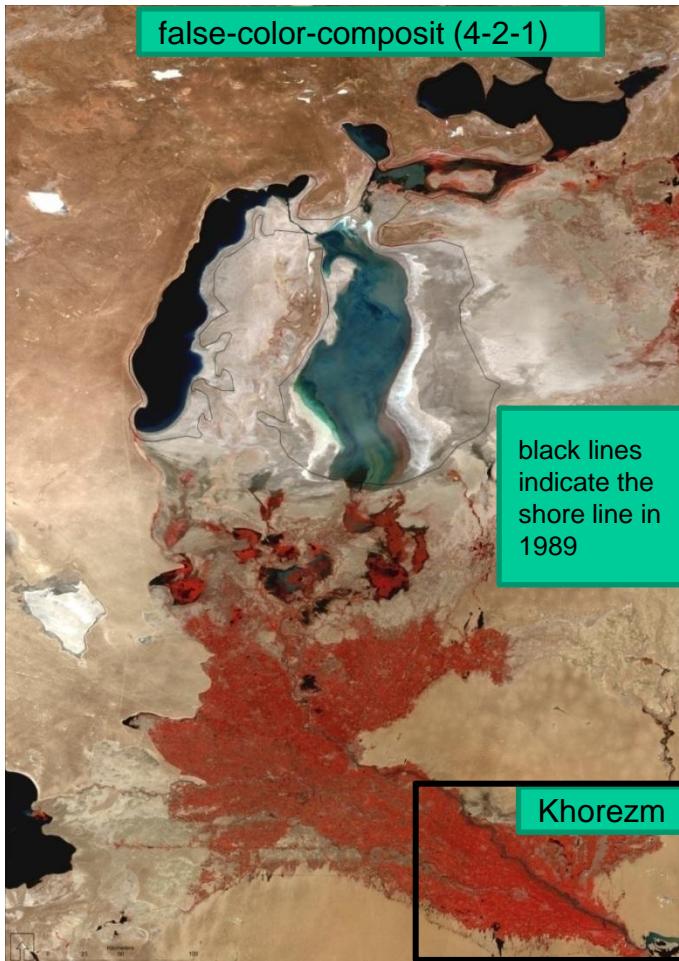
August 16, 2009



# 1. Introduction: Aral sea development - Present



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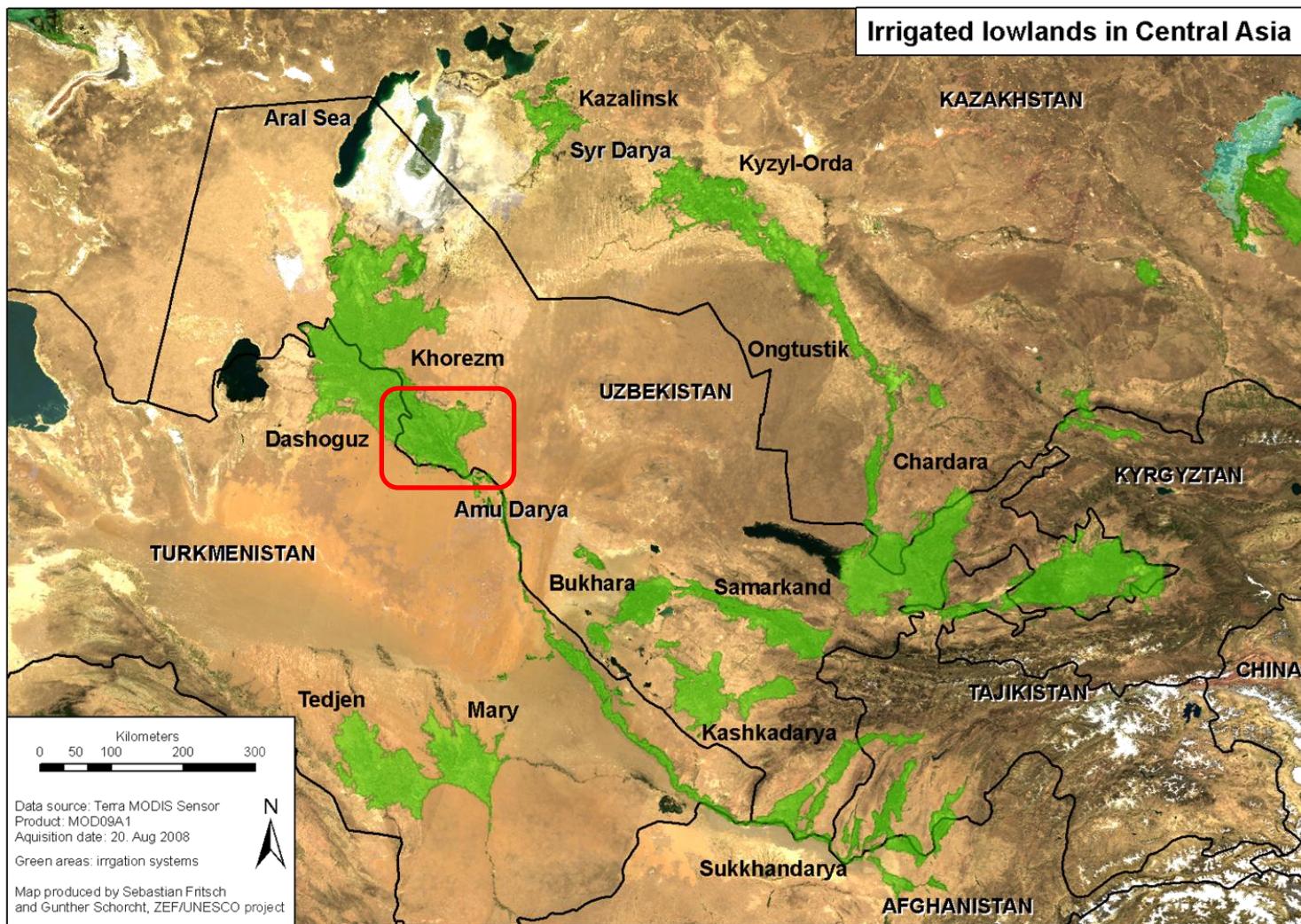
# 1. Introduction: Aral sea development

- More water reached the Aral Sea and the deltas of Syr Darya and Amu Darya than in the past 18 years
- The irrigated area in the deltas show higher vegetation intensity than 2009 (NDVI)

	Year	Plan [million m³]	Actual [million m³]	% (Plan – Actual)
Amu Darya	2008	3990	972	25.3
	2009	4200	2733	93.2
	2010	4200	200000	476
	2011	4200	1456	36.4
Syr Darya	2008	4175	3193	76.5
	2009	3939	4989	126.7
	2010	4931	8294	168.2
	2011	4279	4861	113.6



# 1. Introduction – Study area





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Irrigation agriculture in the aral sea basin is facing serious problems, like:

- unsustainable land and water usage,
- insufficient data about water user needs for water distribution,
- soil salinization due to high groundwater levels,
- glacier melting, and
- increasing population, etc.



Unpredictable water availability

Uncertainties for irrigation management and expected crop yield



## Need for analysis and evaluation of water management system

here: remote sensing can provide large scale input data like potential and actual evapotranspiration, land use classification or yield estimations.



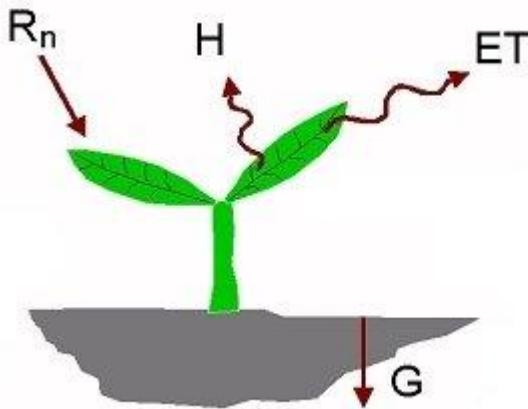
## 2. ET Modelling

SEBAL (Surface Energy Balance Algorithm for Land, [Bastiaanssen et al.1998])

- Approach to quantify actual evapotranspiration based on remote sensing data
- Solves the surface energy balance equation to estimate latent heat flux (ET)
- Originally developed for Landsat, in this study MODIS data is used.

Site specific adaptions:

- Semi - automated selection of anchor points
- Multi temporal approach.



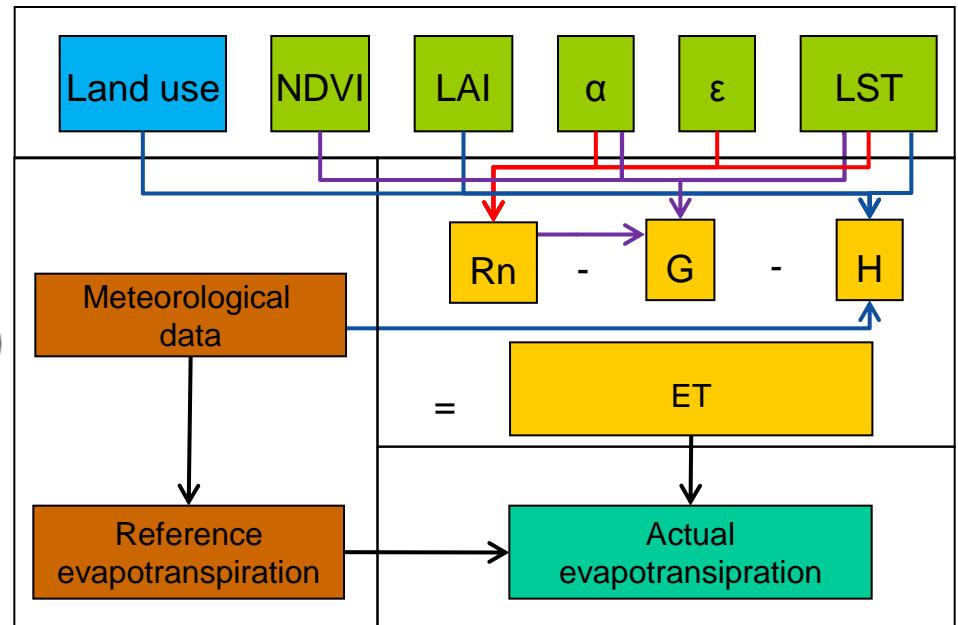
## 2. ET Modelling

SEBAL (Surface Energy Balance Algorithm for Land, [Bastiaanssen et al.1998])

$$R_n = (1 - \alpha)R_S + \varepsilon R_L - R_{Le}$$

$$\frac{G}{R_n} = \frac{LST}{\alpha} (0,0038 + 0,0074\alpha)(1 - 0,978NDVI^4)$$

$$H = \frac{\rho_{air} * c_p * dT}{r_{ah}}$$

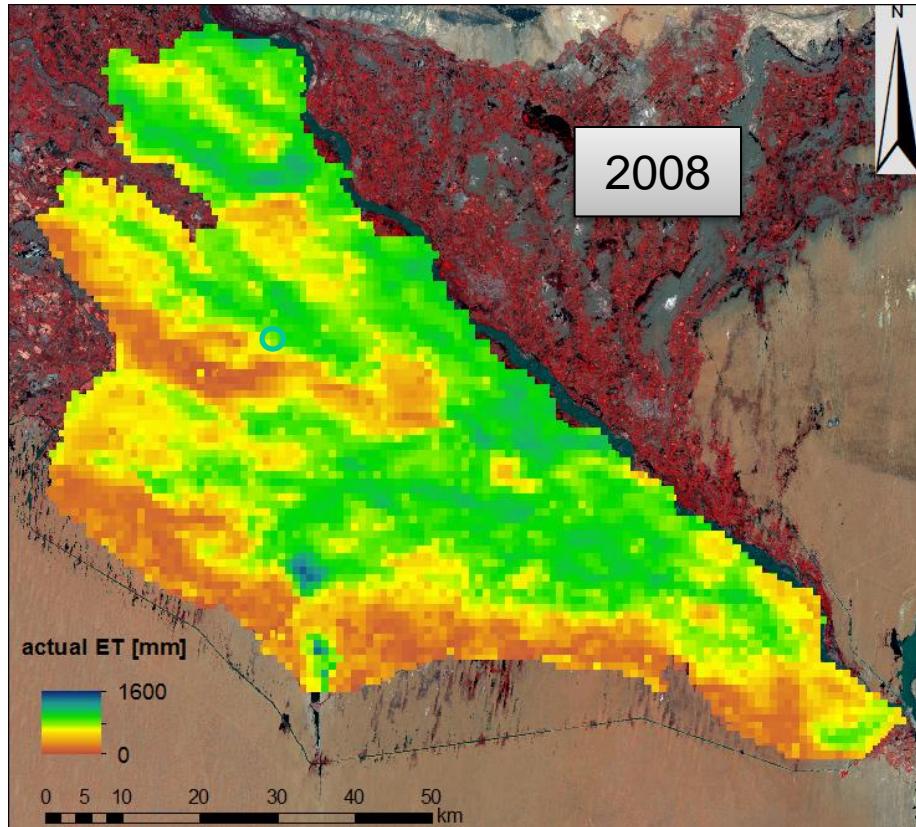


## 3. Results and validation

An eddy covariance station was build at the end of year 2008.

For this location the model validation was performed using the stations data.

The station is measuring the turbulent heat fluxes and meteorological information.



source: Landsat data (July 2009)

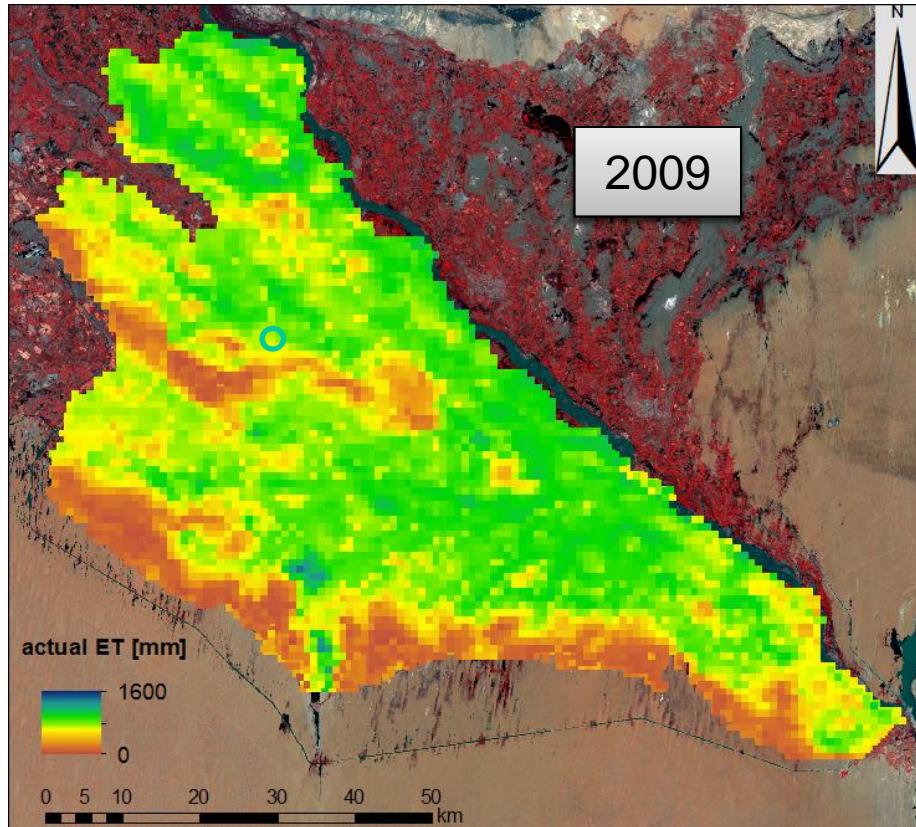


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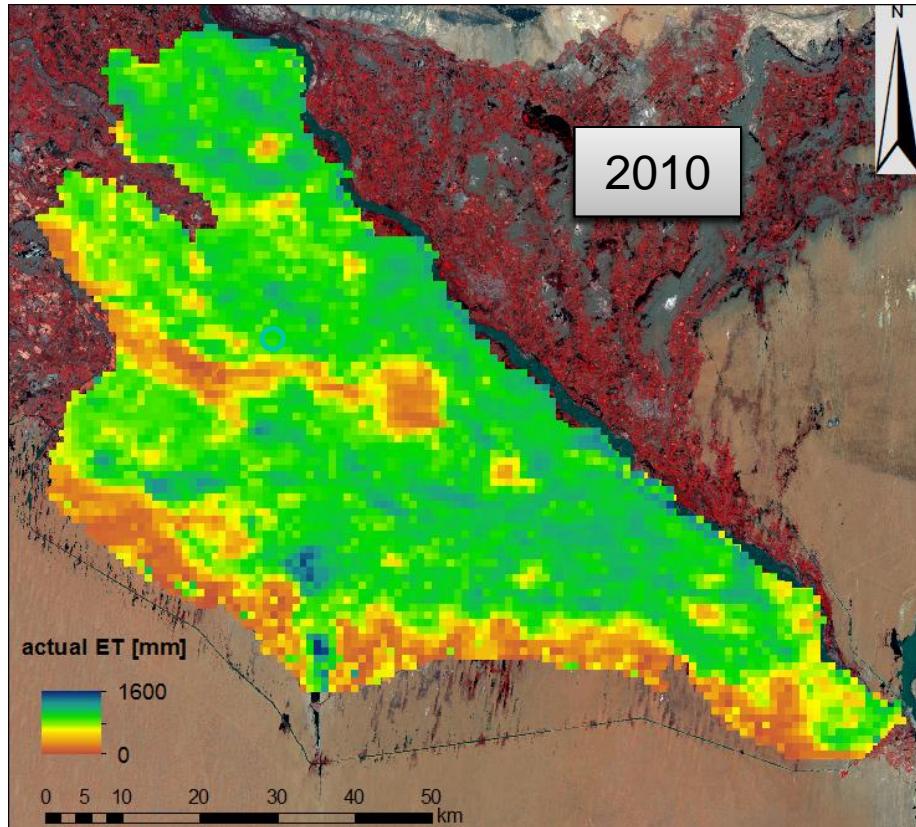


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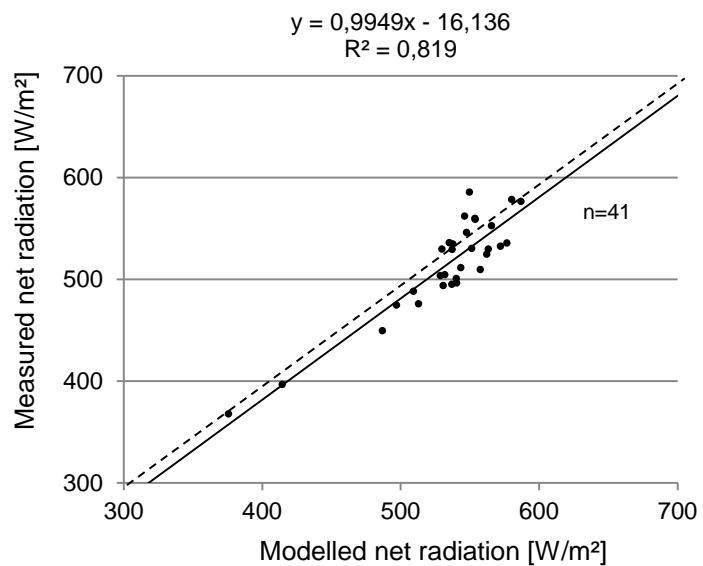


source: Landsat data (July 2009)



### 3. Results and validation – Net radiation

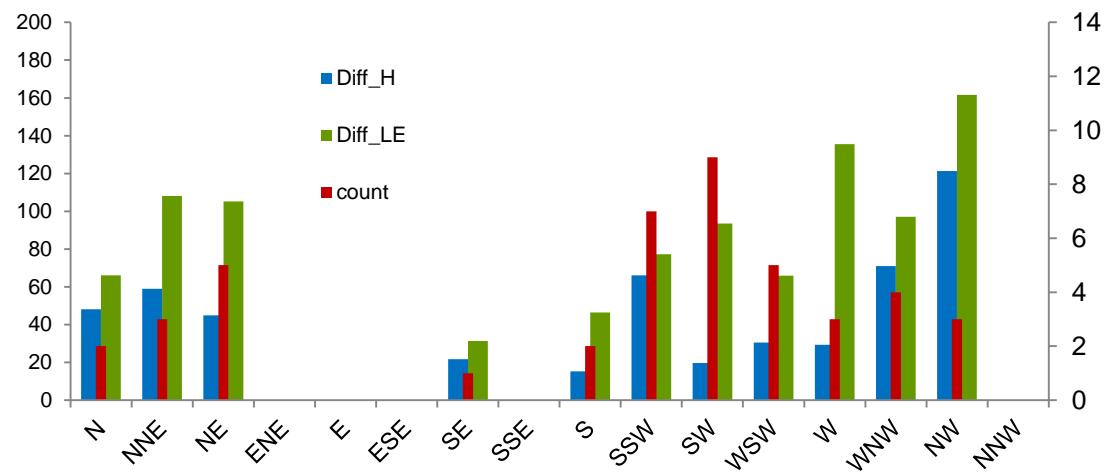
Net radiation is showing strong correlation between measured and modelled values.



### 3. Results and validation - Footprint analysis

A footprint analysis was performed. In order to determine the days of valid measurements (where the fluxes came quite likely from the ecosystem of interest, in this case: cotton ecosystem)

Prevailing wind direction is SSW to WSW.

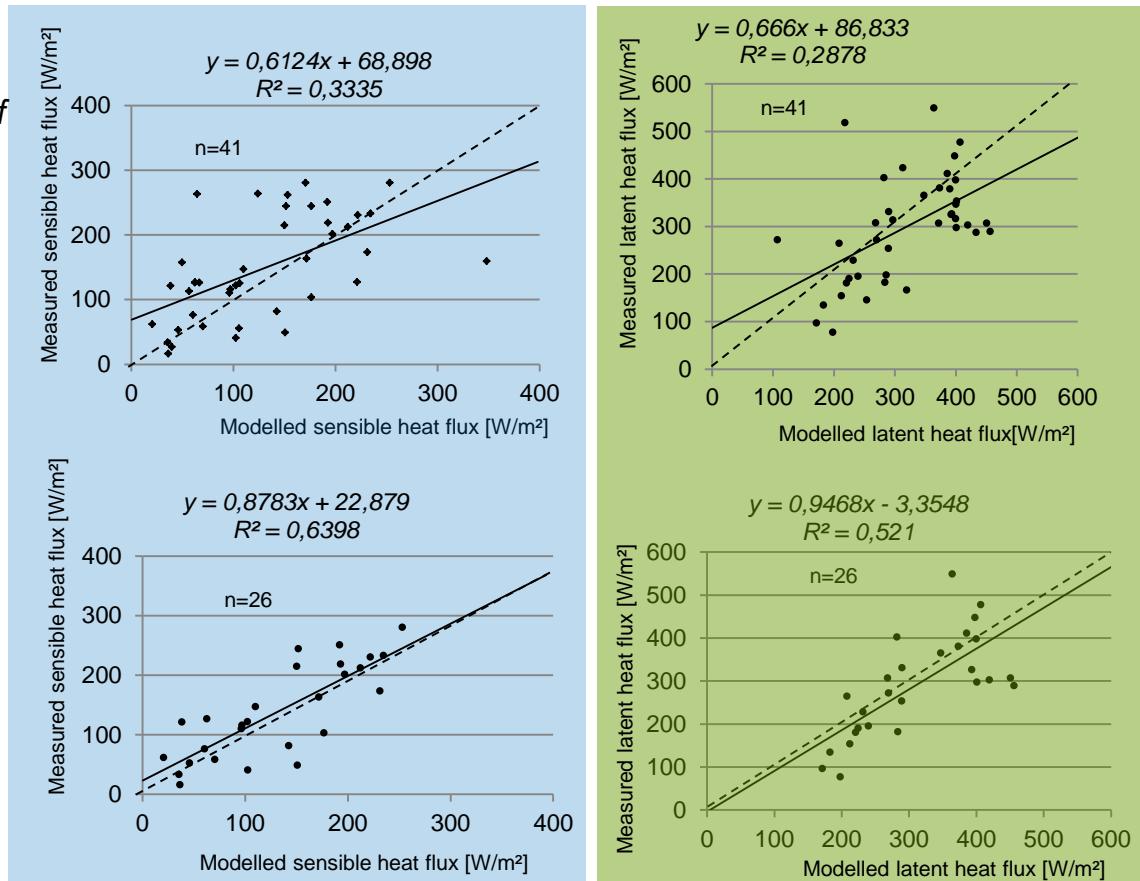
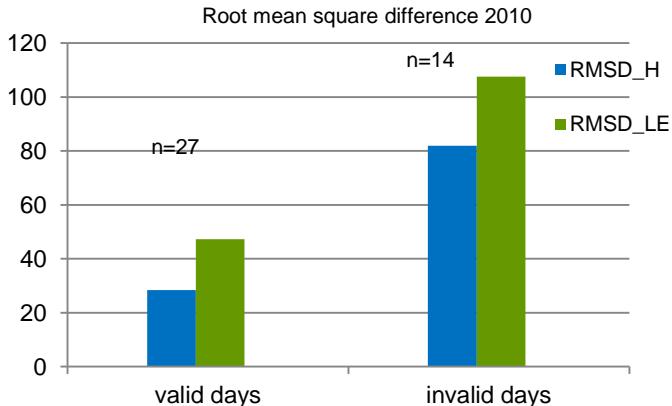


### 3. Results and validation - Footprint analysis

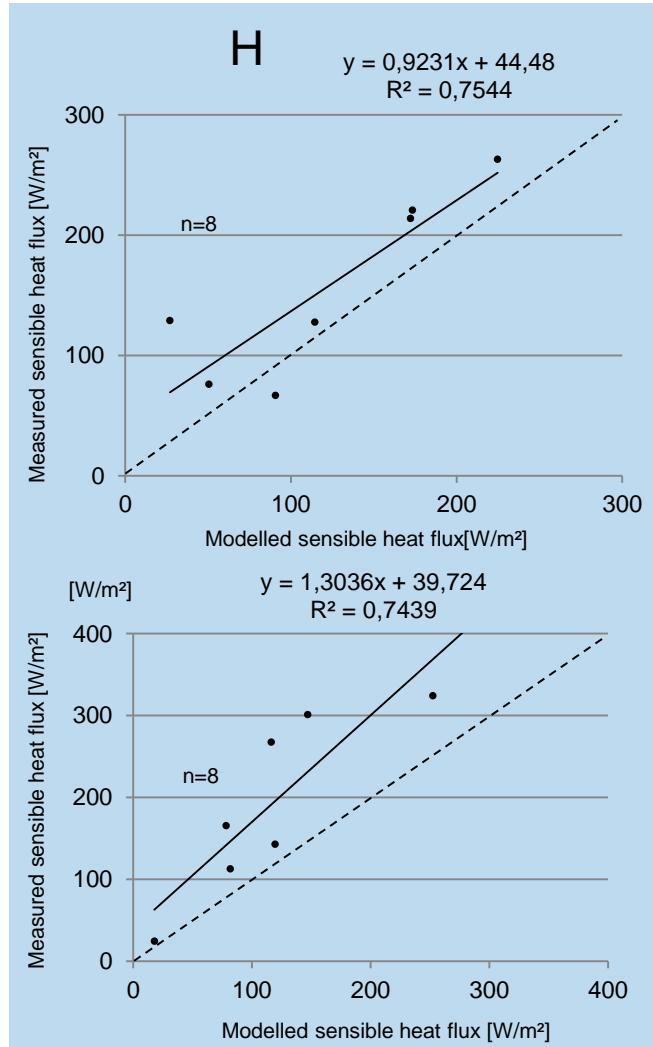
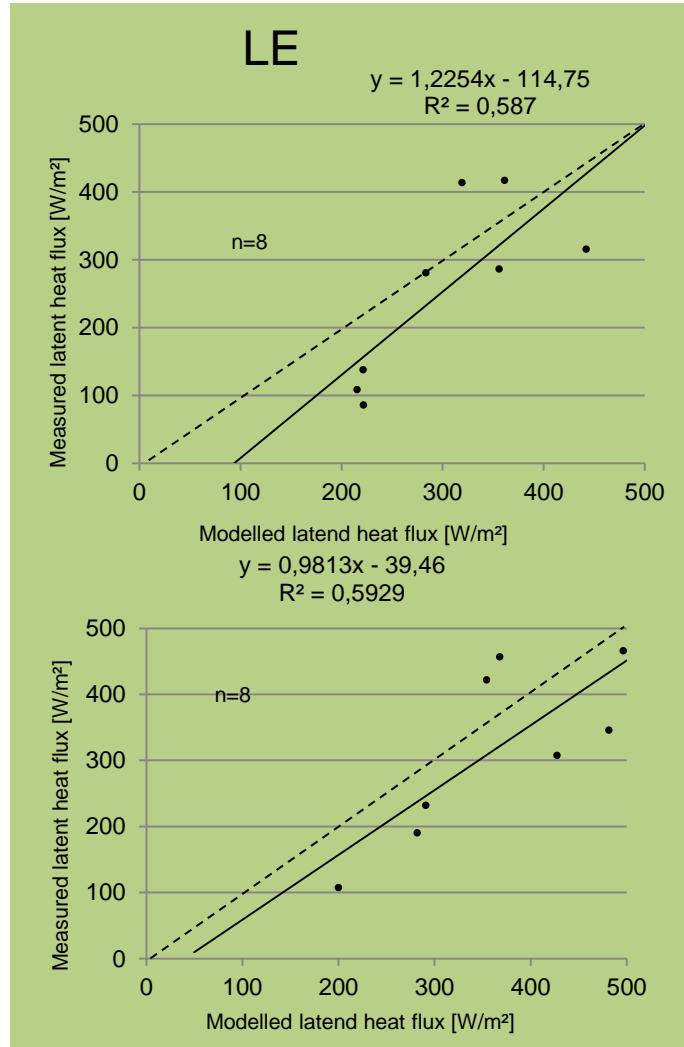
*Performing a footprint analysis leads to lower RMSD compared to the RMSD of all days where a model run was performed.*

*Correlation of model results and measurements show weak correlation without footprint analysis .*

*After footprint analysis the correlation chances to be stronger correlated.*



## 4. Outlook – Comparative analysis



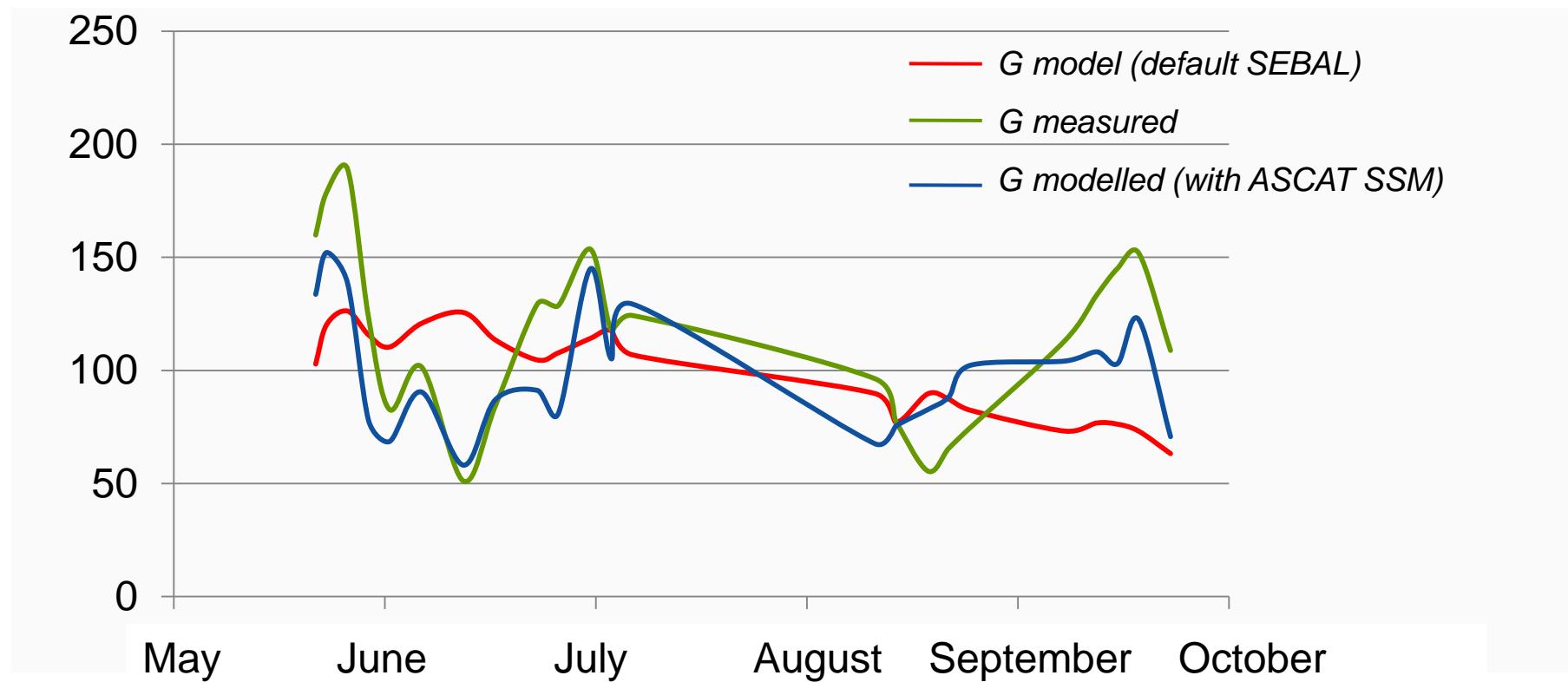
MODIS

Landsat

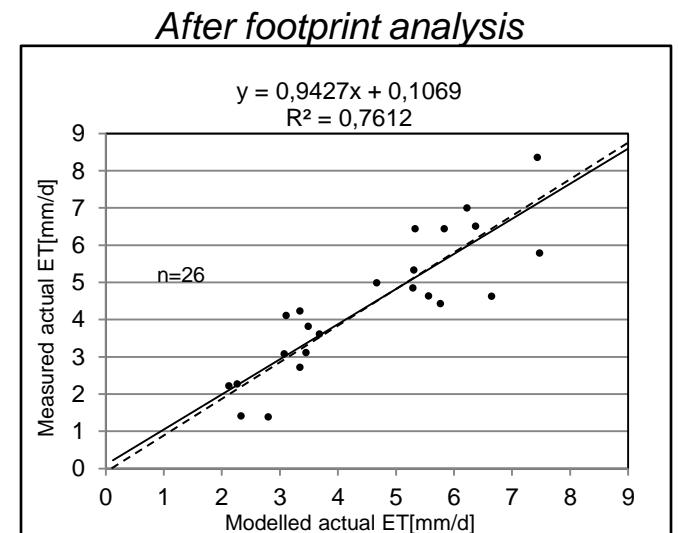
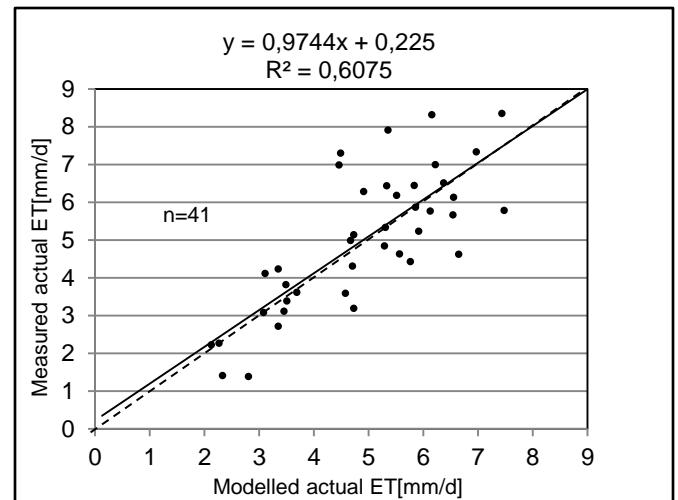
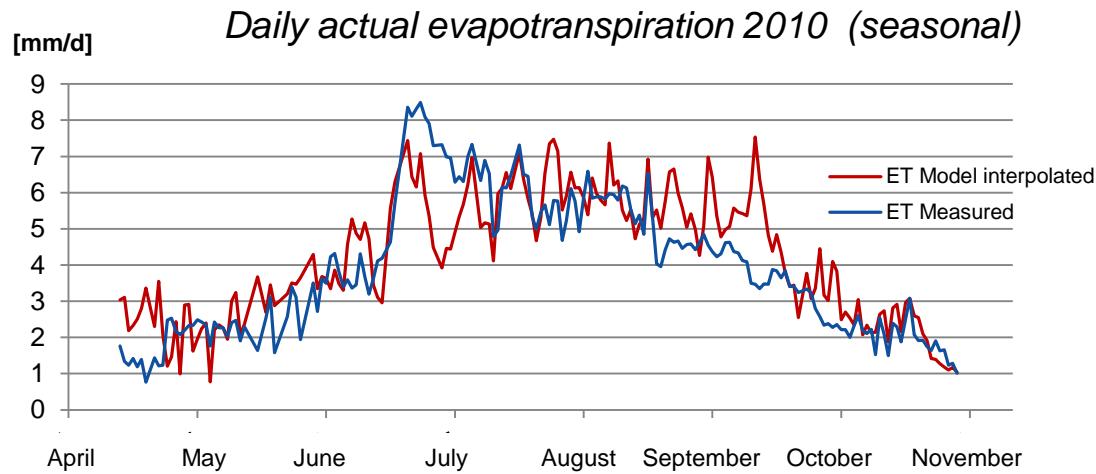
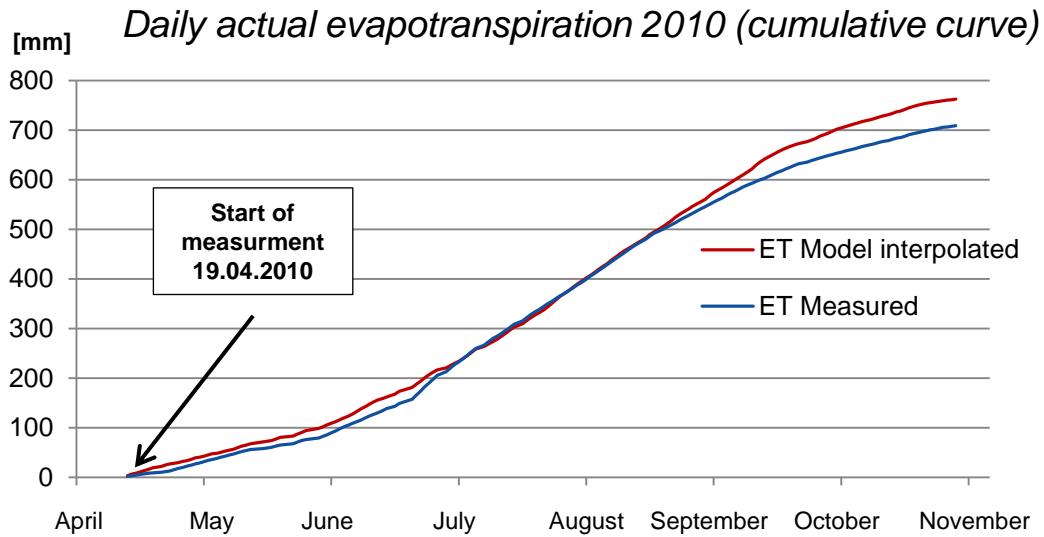


## 4. Outlook - Soil heat flux validation

[W/m<sup>2</sup>]

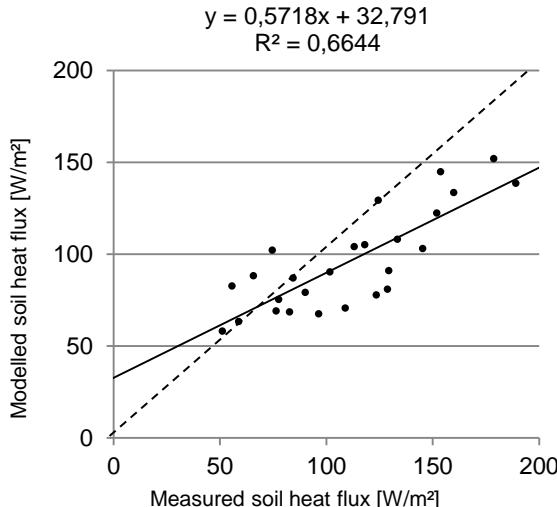
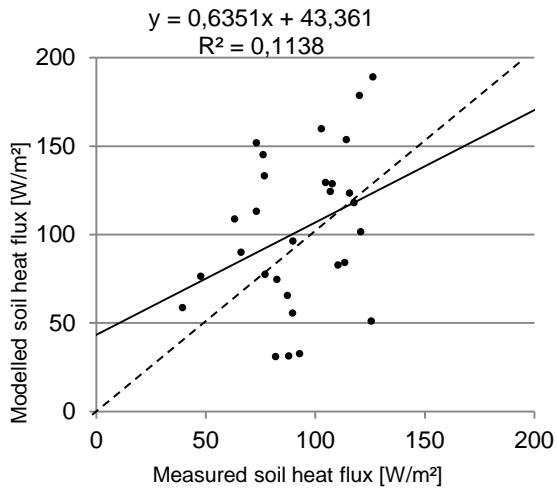


### 3. Results and validation - Footprint analysis



## 4. Outlook - Soil moisture approach

*Using the ASACT SSM information improves the estimation of the soil heat flux and increases the correlation from weak correlation to stronger correlation.*





# Summary

- Model results showing acceptable results for net radiation, sensible and latent heat flux after a footprint analysis.
- Implementation of soil moisture could improve the estimation of soil heat flux.
- Closer look on the comparative analysis between MODIS and Landsat.



# Thank you for your attention

