3rd Land Surface Analysis SAF Workshop
Lisbon, 4 - 6 June 2008

EUMETSAT

LSA-SAF Estimates of Reference Crop Evapotranspiration

Henk de Bruin[1], Isabel Trigo[2], Maria Pat González Dugo[3], Pedro Gavilan[3] and Eva Rubio[4]

[1]) Formerly at Wageningen University, The Netherlands
[2]) Instituto de Meteorologia, Lisbon, Portugal
[3]) IFAPA. CIFA Alameda del Obispo. Avd. Menéndez Pidal s/n 14080 Cordoba, Spain
[4]) IDR-University of Castilla-La Mancha 02071 Albacete, Spain

Background:

- About 80% of available fresh water is used for agriculture, i.e. irrigation in semi-arid regions
- In order the estimate **Crop water requirements** the **FAO** developed a semi-empirical method (Allen et al., 1998):

$$ET_c = K_c ET_0$$

crop factor

reference crop evapotranspiration

Problem:

- In FAO guidelines ET_0 refers to ***hypothetical*** well-watered grass with given albedo, aerodynamic and surface resistance, etc., grown in large fields

- ET_0 is evaluated with a FAO-version of the Penman-Monteith equation using weather data to be collected over large well-watered grass fields.

- **BUT.....In real-life in semi-arid regions such weather stations are very rare!!!!**

Objective

- To develop **weekly ET_0 maps** for agricultural applications in irrigated regions using existing LANDSAF products,
- i.e. to develop a **virtual network of ET_0 stations** with a grid distance that equals the **LANDSAF pixel size**

Approach:

- In literature it has been shown that radiation based estimates of ET_0 might be a fair alternative for the full FAO procedure, notably the formulas proposed by **Makkink and Priestley-Taylor**, using shortwave or net radiation and air temperature as input only
- The current LANDSAF products includes shortwave radiation, while the temperature is available through the LANDSAF software

In 1957 **Makkink** proposed

$$ET_{well-watered\ grass} = a_M \frac{s}{s+\gamma} \frac{DSWR}{L_v} = a_M f(T) DSWR$$

DSWR = Down-welling Short-Wave Radiation at the (horizontal) surface

Experiments in NL and Mexico: $a_M = 0.7$

Priestley-Taylor (1972):

$$ET_{well-watered} = a_{PT} \frac{s}{s+\gamma} \frac{Q^*}{L_v} = a_{PT} f(T) \frac{Q^*}{L_v}$$

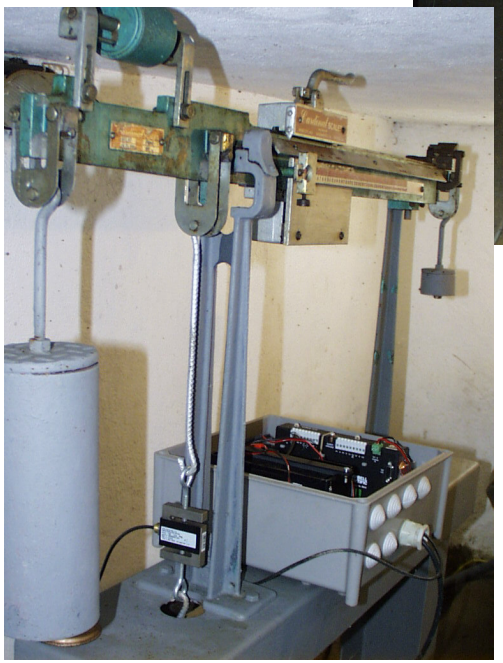
Q^* = net radiation

a_{PT} = *1.3 many experimens*

First Results

For recent 14 days we tested the **Makkink** approach using ground-truth data of 2 lysimeter sites in Spain, notably near Cordoba and Albacete.

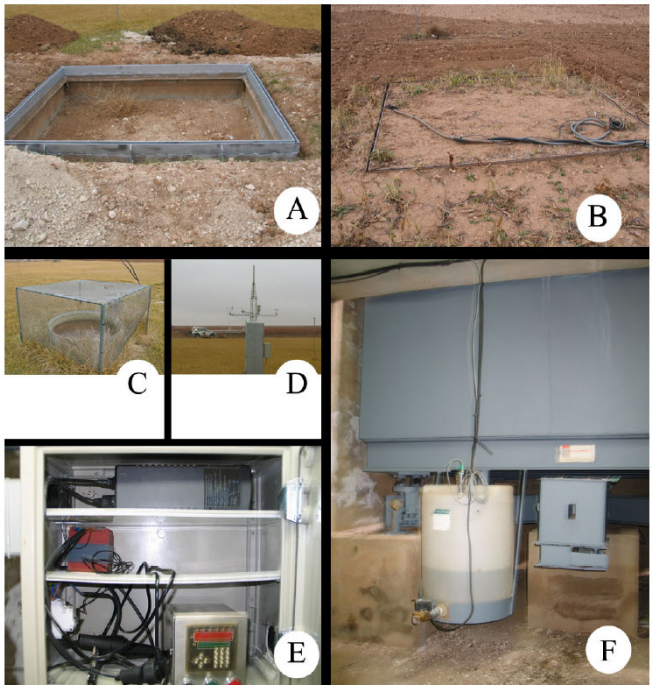
Cordoba Lysimeter Site



Cordoba Lysimeter Site from space

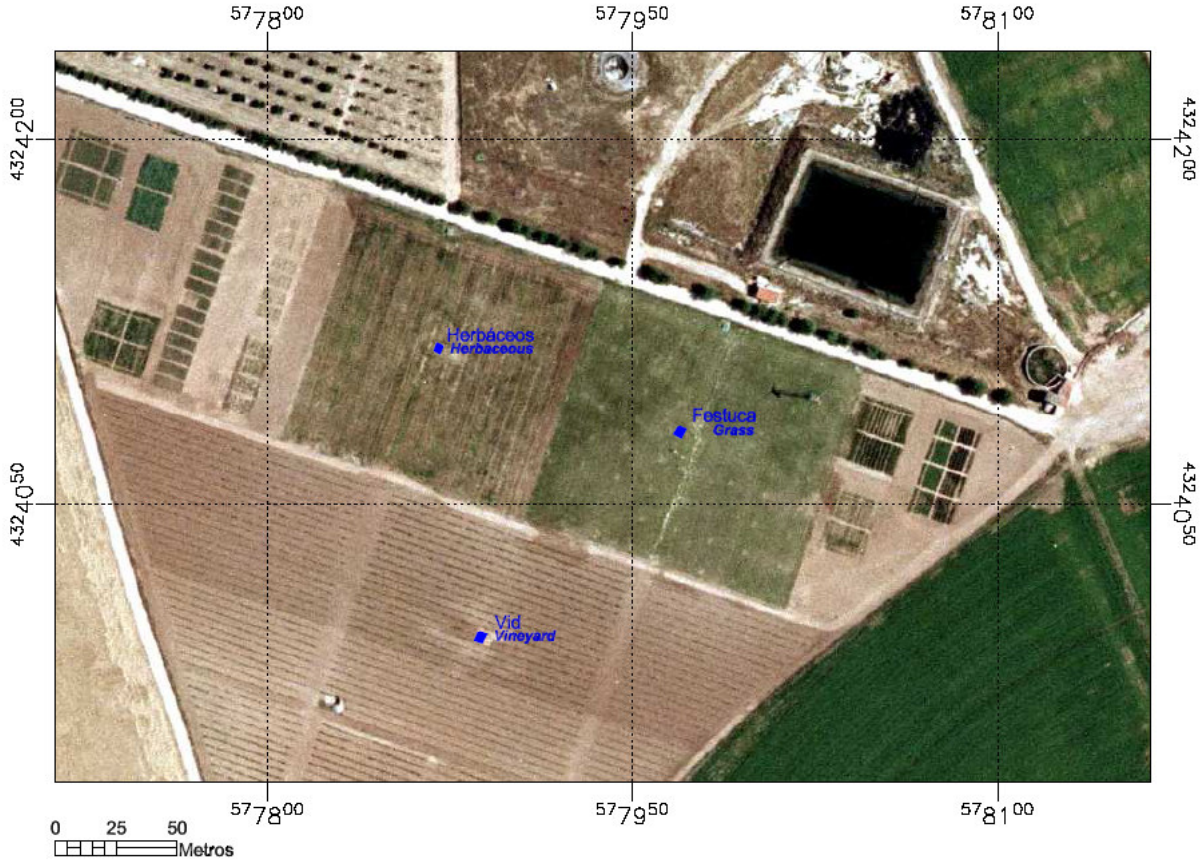
3rd Land Surface Analysis SAF Workshop
Lisbon, 4 - 6 June 2008

EUMETSAT

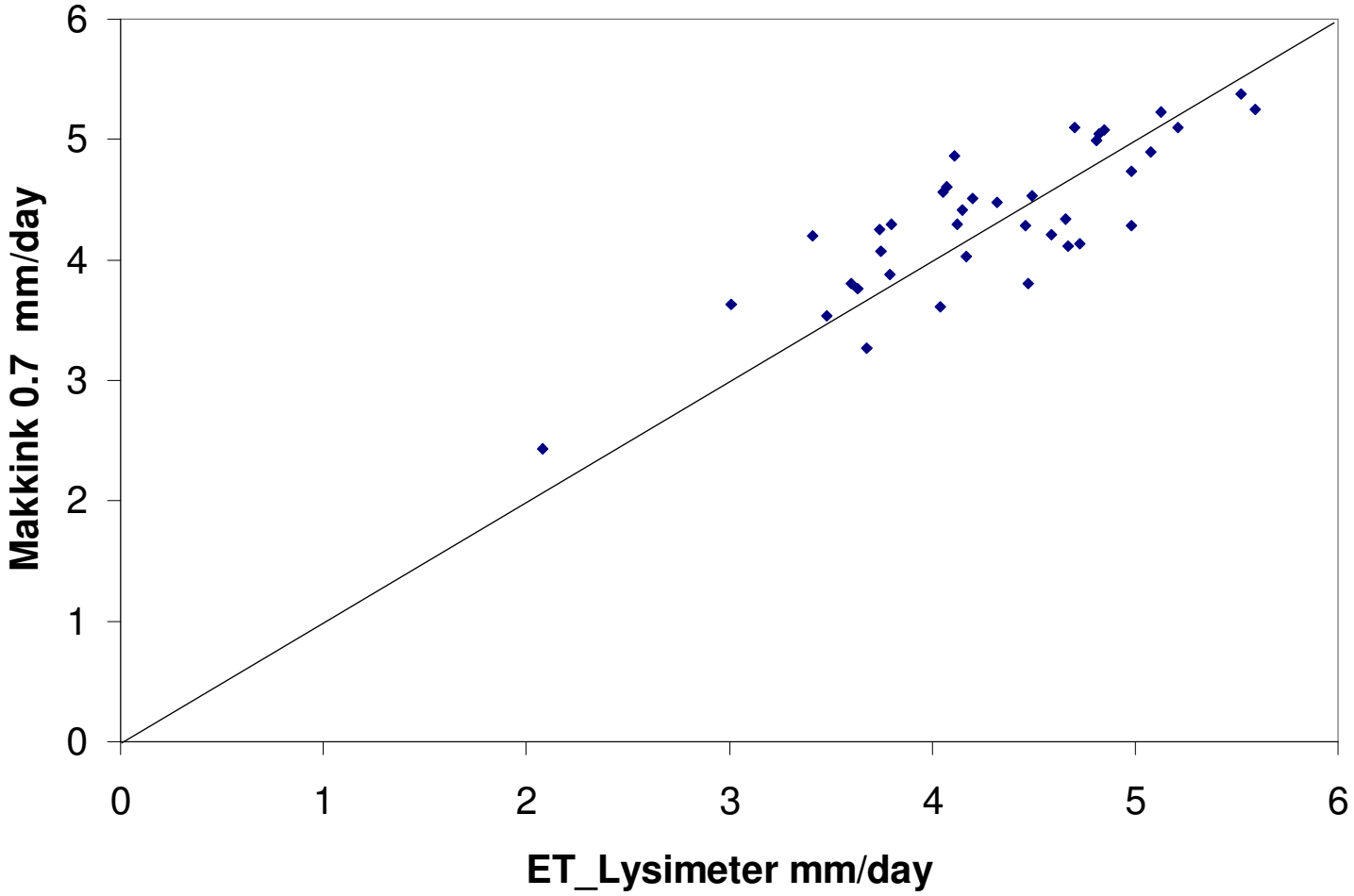


Las Tiesas (near Albacete) Lysimeter Site

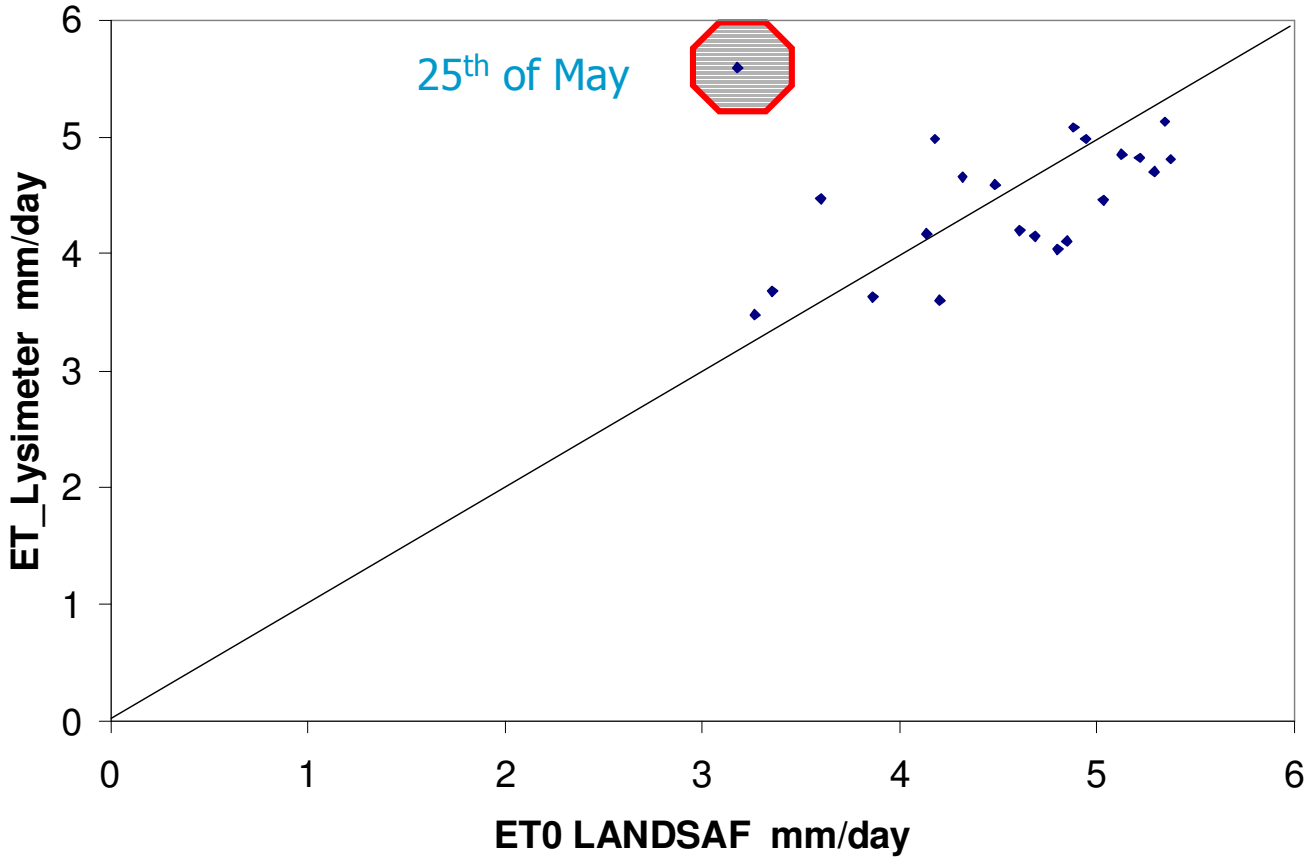
Las Tiesas, (near Albacete) Lysimeter Site from space



First results for Cordoba: 'ground-truth' test of Makink
2 weeks in May 2008, daily values



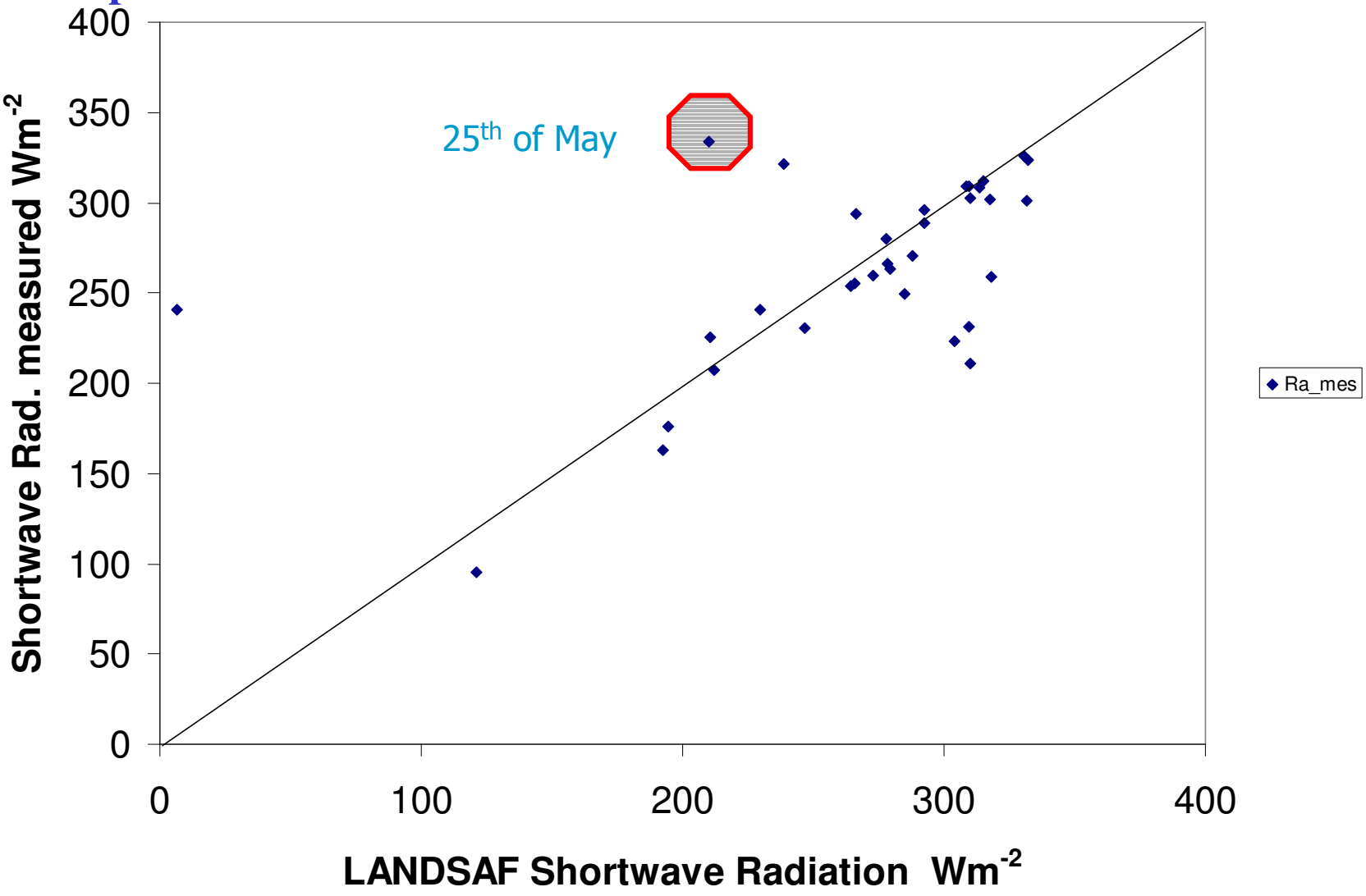
Comparison ET_0 LANDSAF and ET-Lysimeter for Cordoba daily values



3rd Land Surface Analysis SAF Workshop
Lisbon, 4 - 6 June 2008

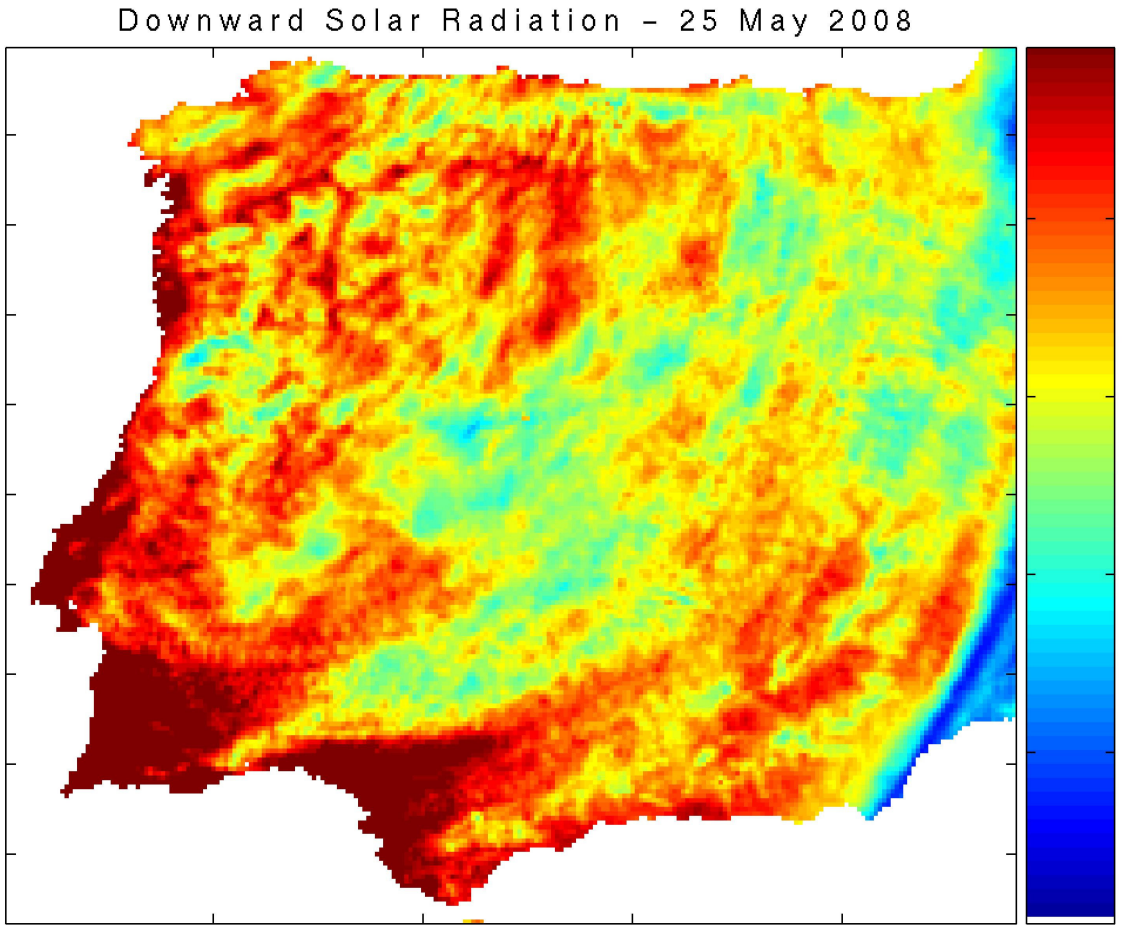
EUMETSAT

Comparison *SWR* LANDSAF and *SWR measured* at Cordoba



3rd Land Surface Analysis SAF Workshop
Lisbon, 4 - 6 June 2008

EUMETSAT



232 Wm^{-2}

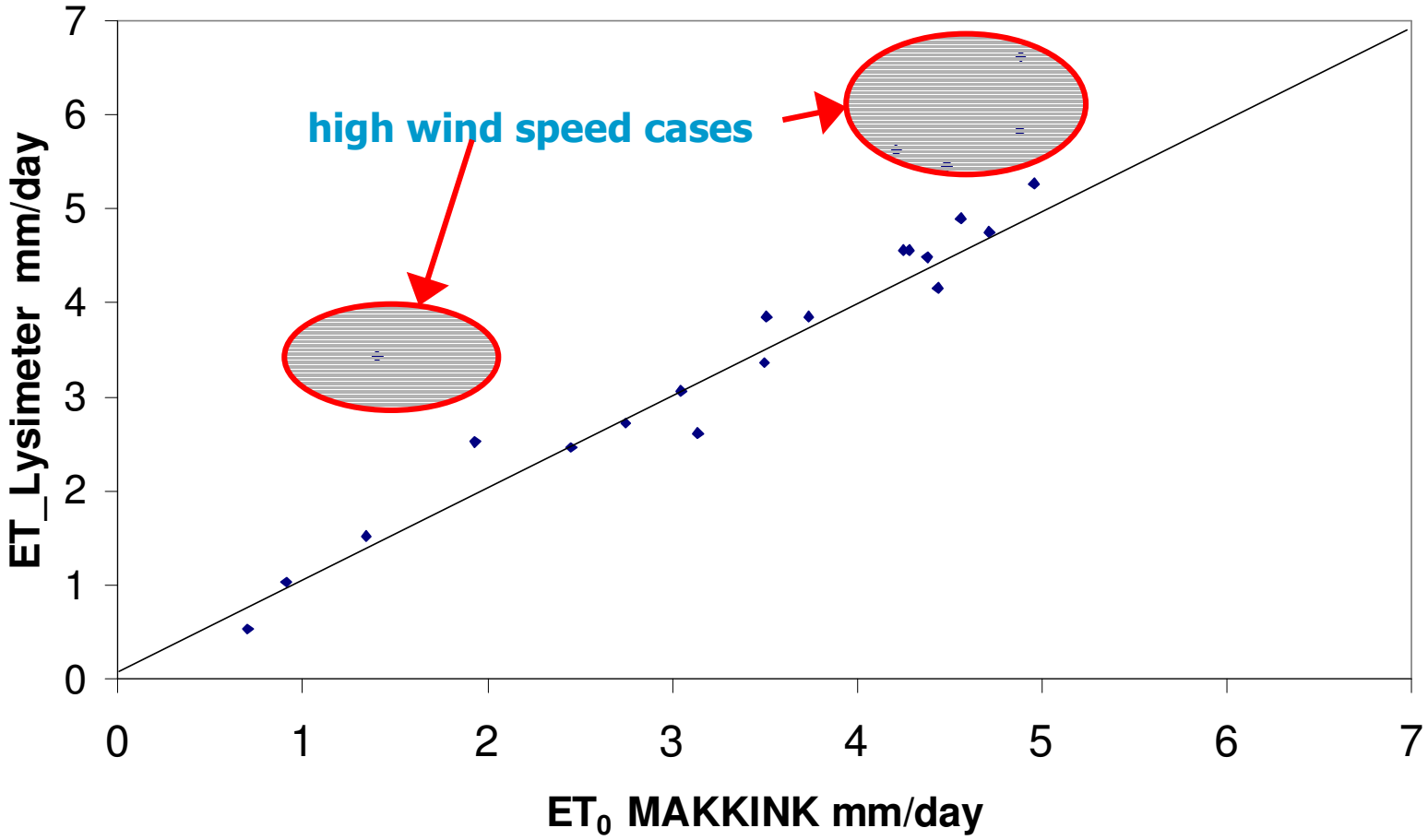
174 Wm^{-2}

116 Wm^{-2}

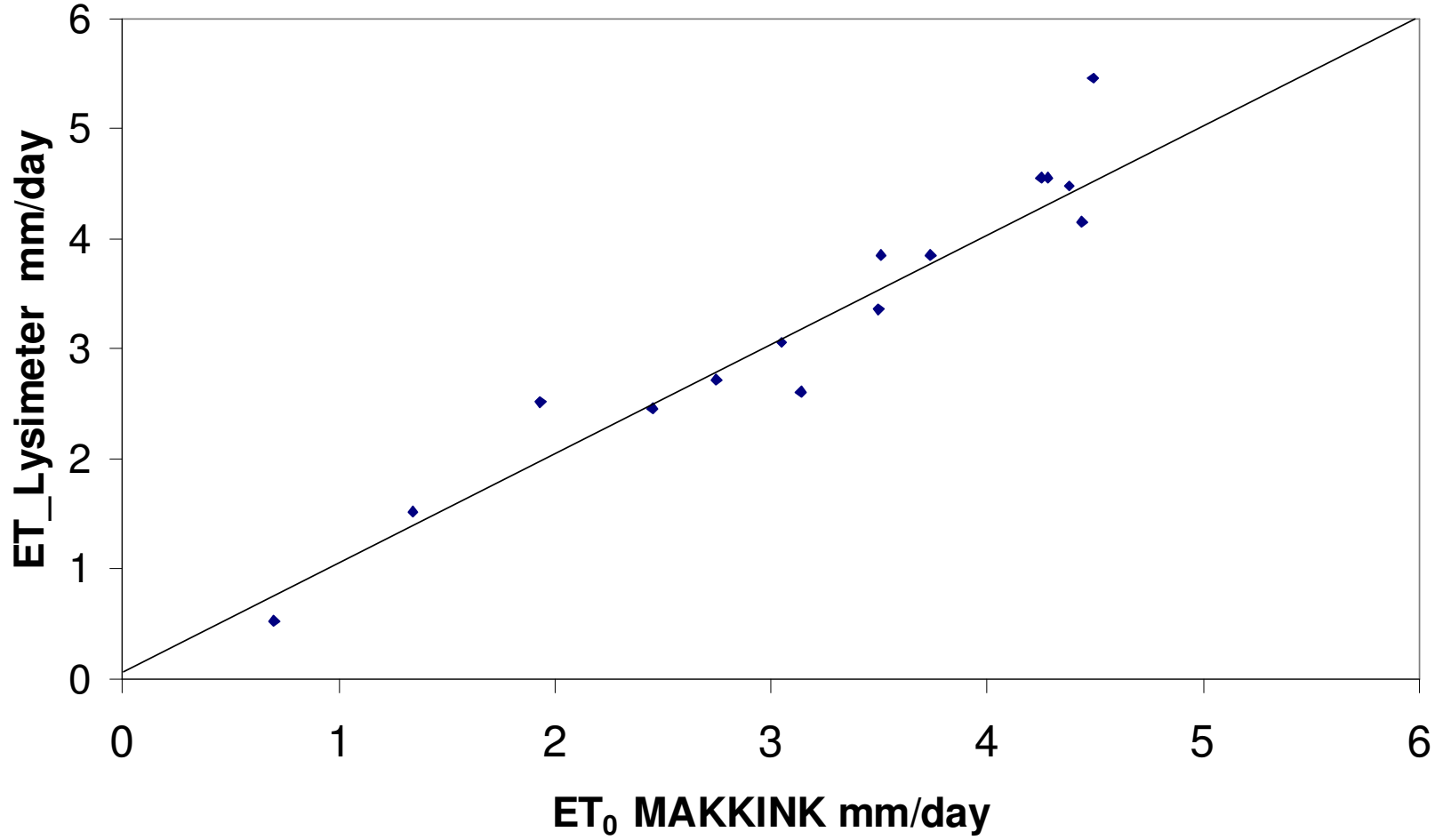
58 Wm^{-2}

Down-welling Solar Radiation on 25 May

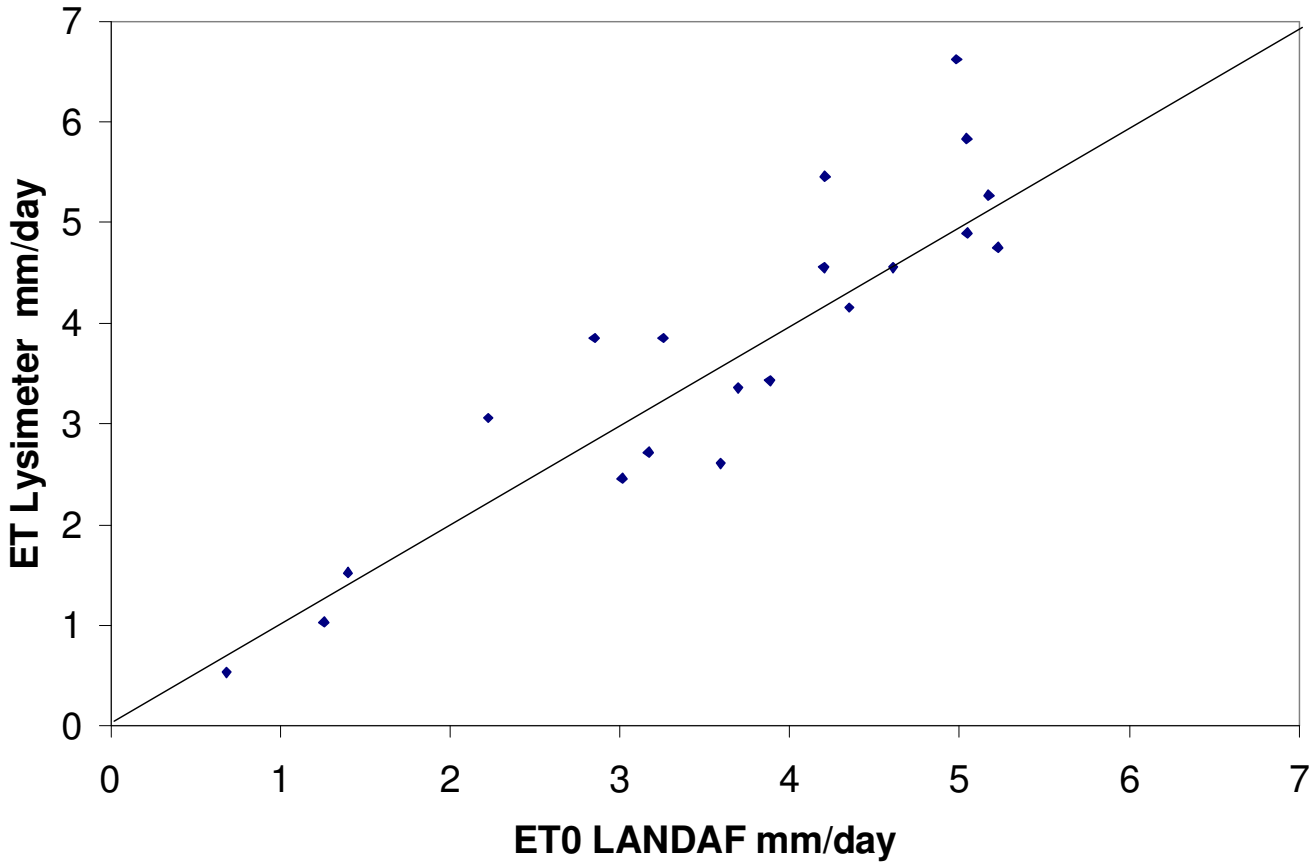
Las Tiesas (Altitude 700 m) lysimeter: test of Makink
2 weeks in May 2008, daily values



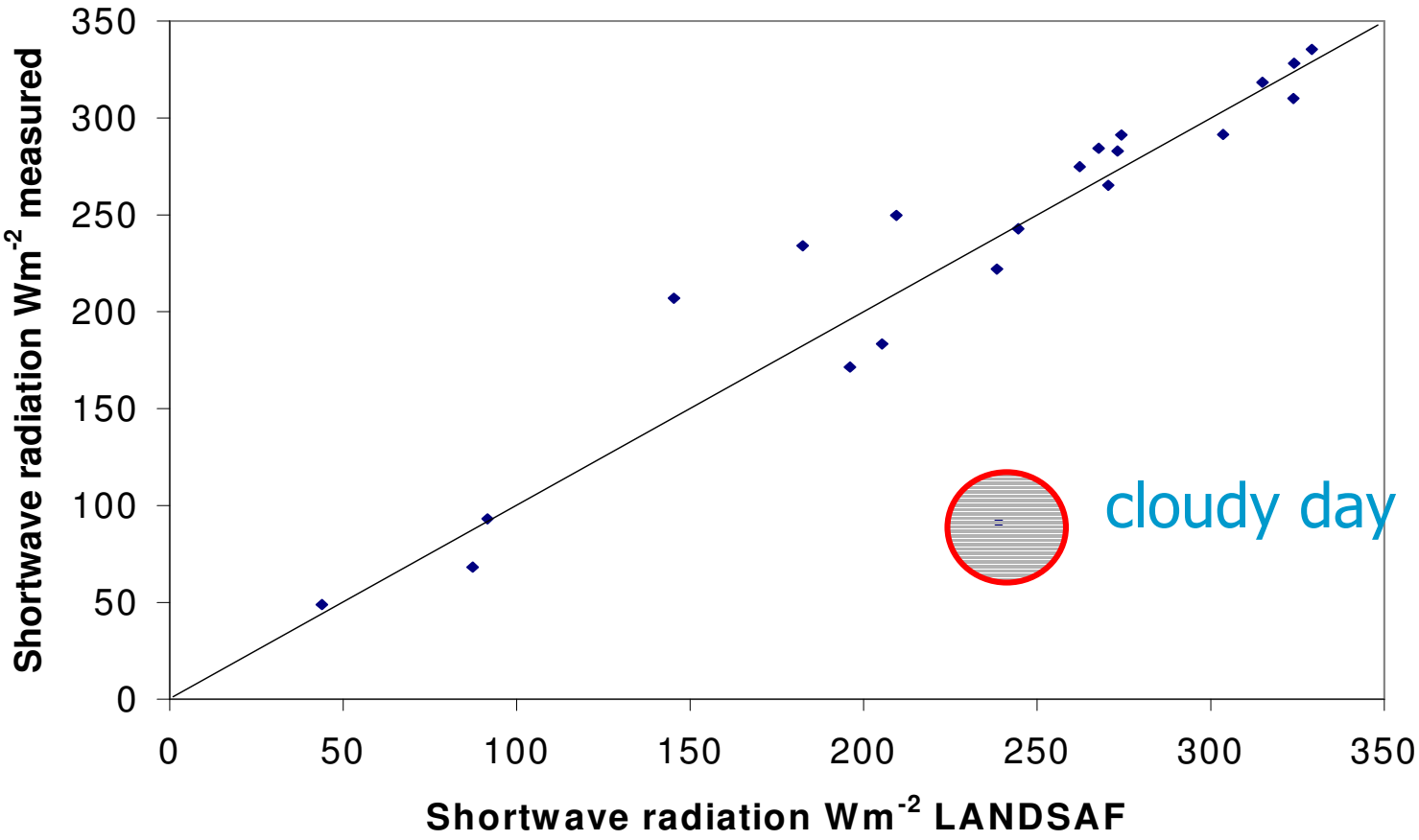
Albacete : test of Makink wind speed less than 3 m/s



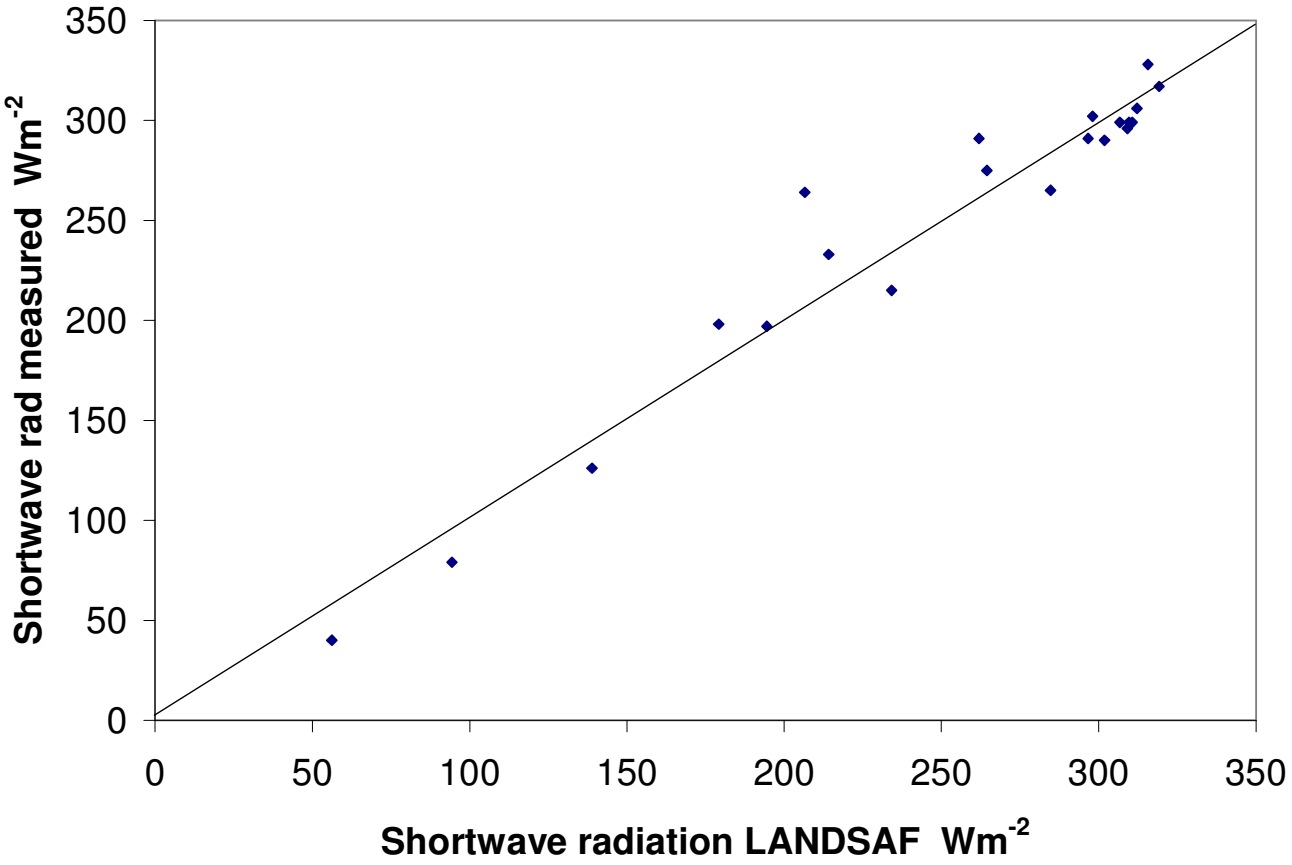
Comparison ET_0 LANDSAF and ET-Lysimeter for Las Tiesas psychrometer constant for altitude 700m, daily values



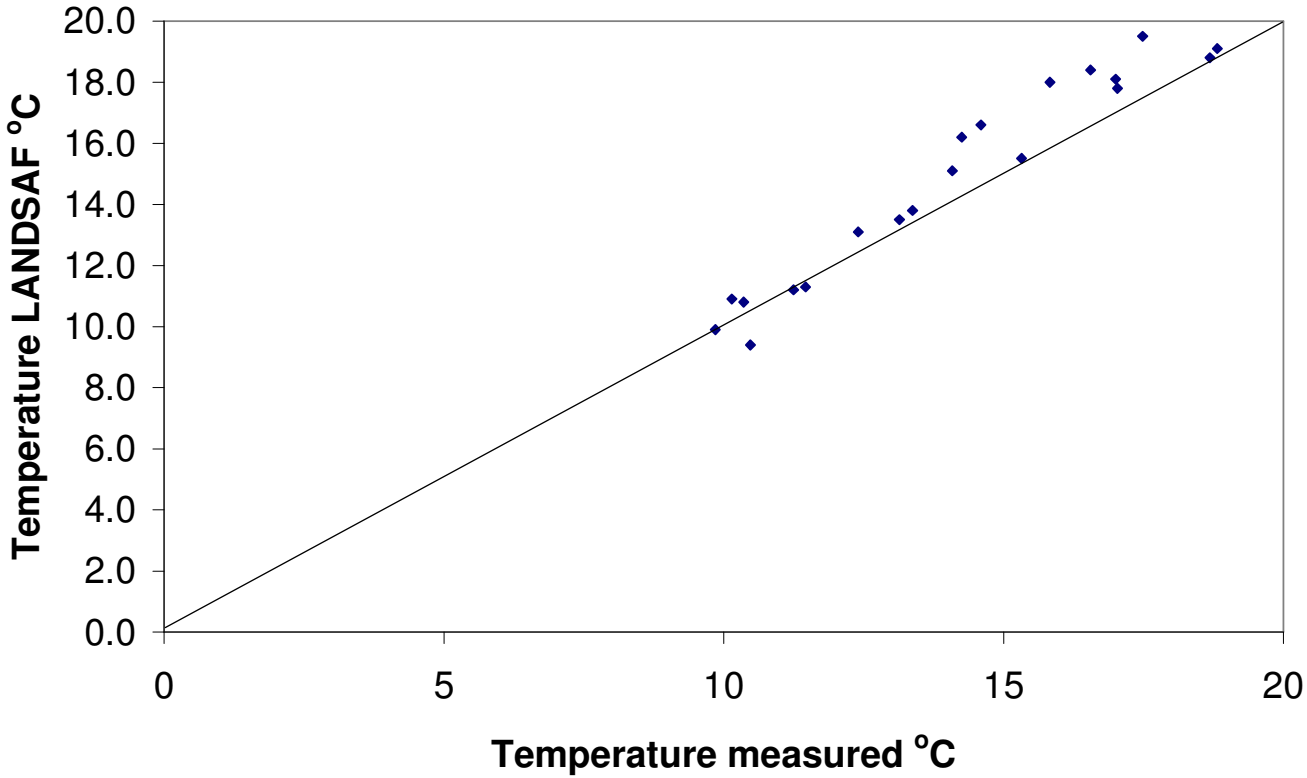
Comparison *SWR* LANDSAF and *SWR* for Las Tiesas



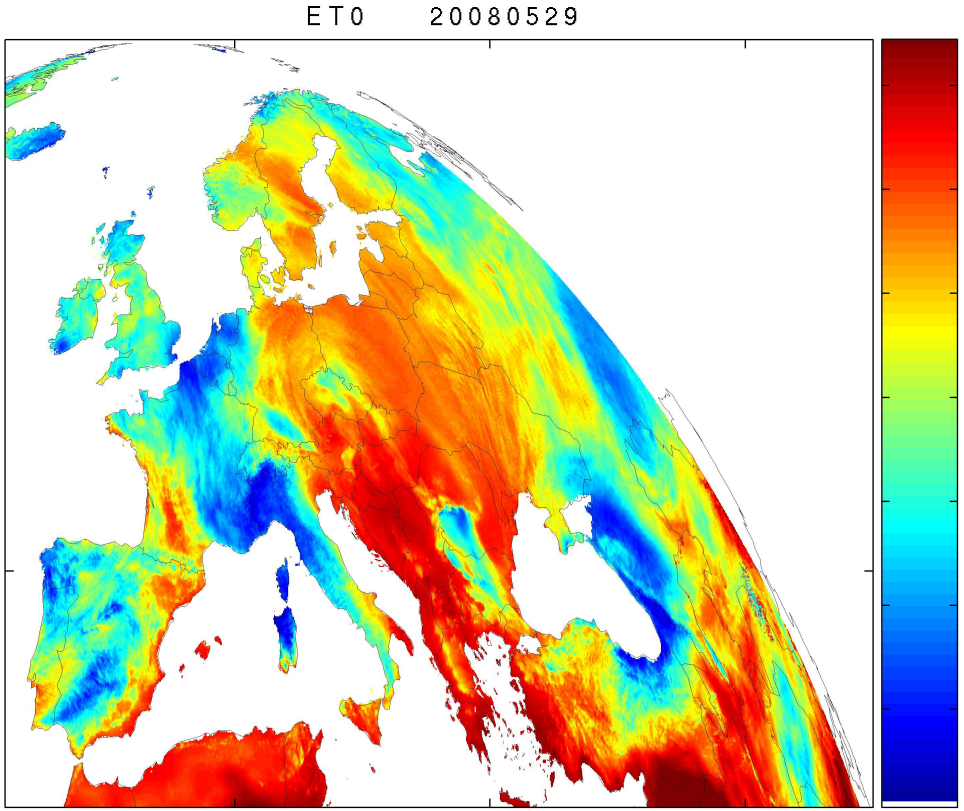
Comparison *DSWR* LANDSAF and *DSWR* for Wageningen 'Northern Europe', 52 N, daily values



Comparison *temperature* LANDSAF and for Wageningen 'Northern Europe', 52 N



LANDSAF - Makkink – ET_0 approach is in fact 'operational'



6.2 mm/day

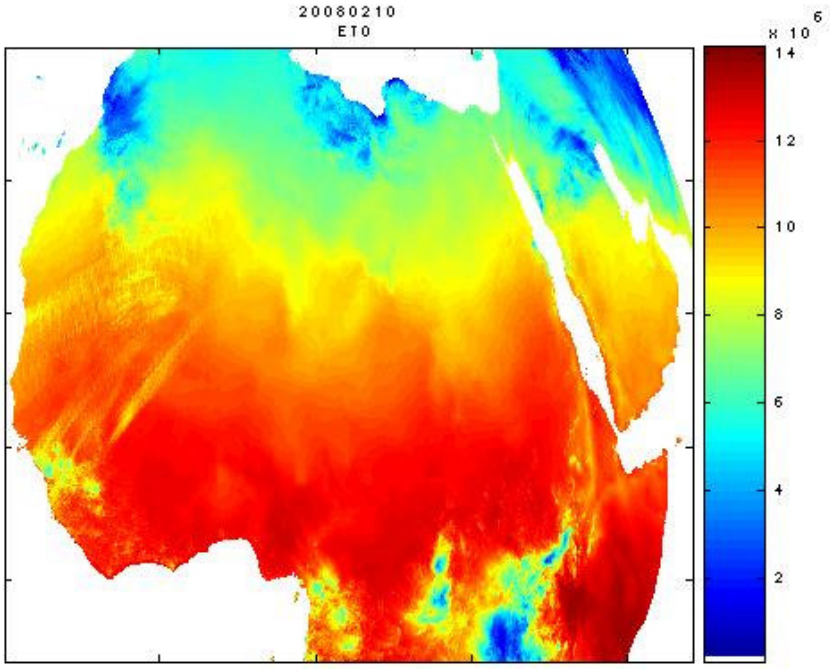
4.4 mm/day

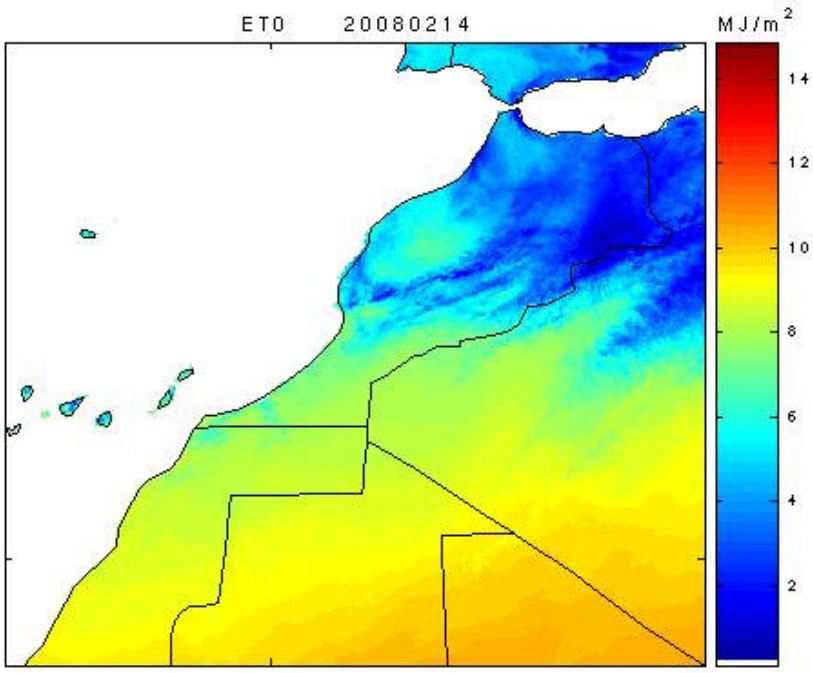
2.6 mm/day

0.9 mm/day

3rd Land Surface Analysis SAF Workshop
Lisbon, 4 - 6 June 2008

EUMETSAT





Results so far:

First results of LANDSAF Makkink approach are very promising, considering the limitations of the approach:

- semi-empirical nature of Makkink
- we considered daily values, whereas weekly values are needed in practice
- comparison with entirely independent lysimeter data
- point value versus LANDSAF pixel size
- measuring errors
- no tuning of parameters,

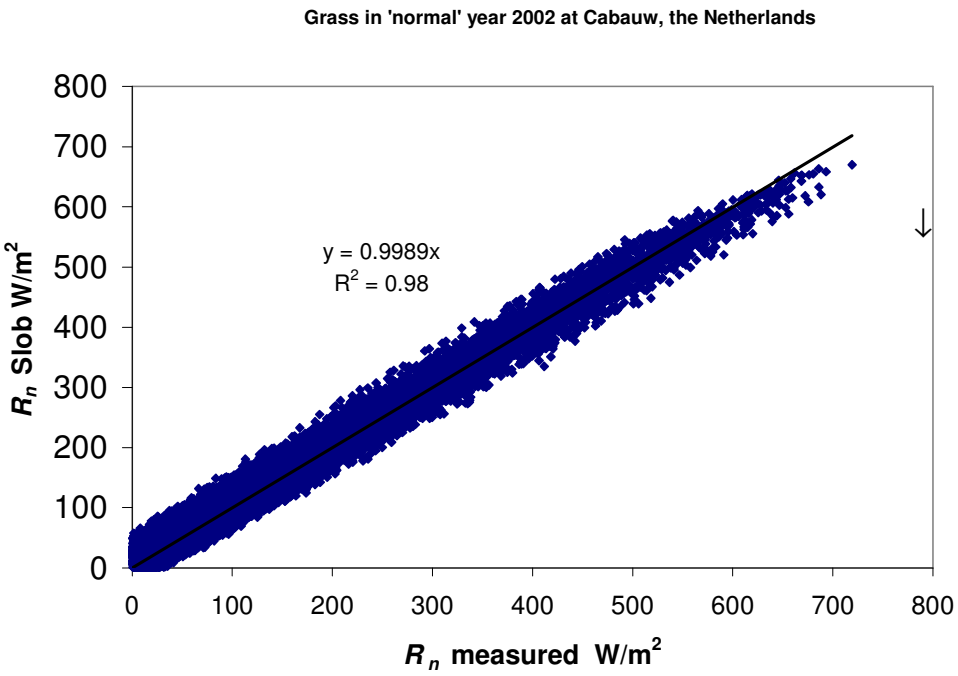
but..... more work has to be done

Future Work:

A test of the Makkink approach for more stations and, at least for a full growing season in Mediterranean countries as well in countries in the Mid-Latitudes, which special attention for *windy conditions* and *advection*.

A test of the Slob method to determine net radiation of well-watered grass from global radiation (not dealt with here)

Towards ET_0 - Priestley-Taylor



Slob (see de Bruin, 1981):

$$R_n = (1-0.23)DSWR - c\frac{DSWR}{DSWR_{ext}}$$

c = 150 for 30 min values

Future Work, continued:

To select the most suitable approach and, next, to test this in an operational water management system used by end-users.

This will be done in collaboration with of members of the EU-project group

PLEIADeS

Final product: operational weekly ET_0 maps for these end-users

Thanks for your attention