

Comparison of actual maize evapotranspiration simulated by the CROPWAT model with the estimated data from satellite images

Dr. Adriana MARICA & Dr. Gheorghe STANCALIE
ROMANIA



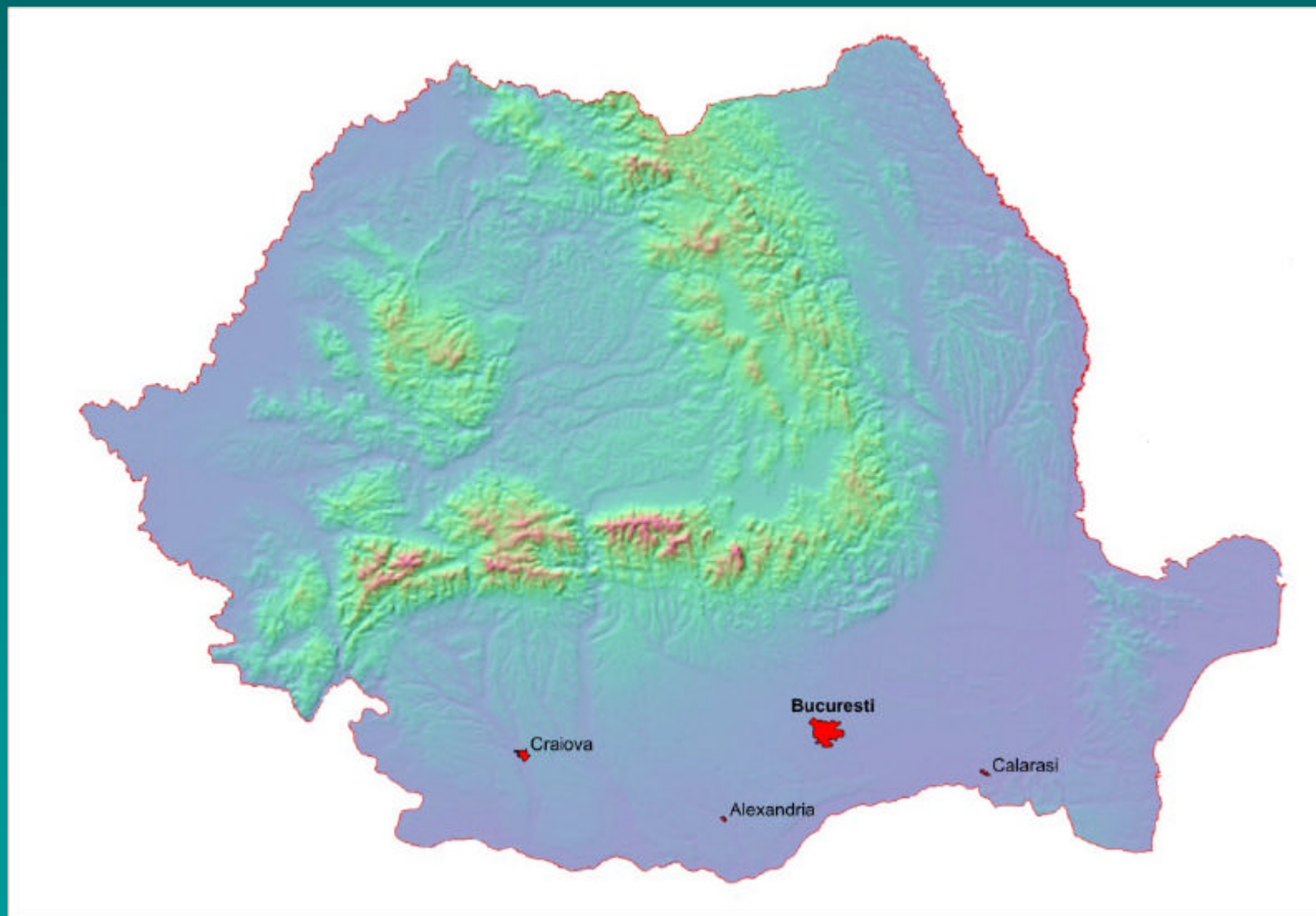
COST Action 718 – WG 1.1 & WG 2
Research Centre Foulum , DK, 25-26 of September 2003



Objectives

- **Analyze the possible use of satellite information as input for CROPWAT model;**
- **Estimate daily evapotranspiration during maize growing season from climatic data by using CROPWAT model;**
- **Calculate daily actual evapotranspiration from satellite images based on the surface energetic balance;**
- **Analyze and compare the model results with satellite estimations on test areas in the Romanian Plain .**

Test-areas in the Romanian Plane



CROPWAT model

DATA	INPUT	OUTPUT
Climatic	<ul style="list-style-type: none">• Eto measured or calculated with Penman-Monteith• rainfall data	<ul style="list-style-type: none">• crop water requirement• irrigation requirement
Crop	<ul style="list-style-type: none">• Kc, crop description, max. rooting depth, % area covered by plant	<ul style="list-style-type: none">• actual crop evapotranspiration
Soil	<ul style="list-style-type: none">• initial soil moisture condition and available soil moisture	<ul style="list-style-type: none">• daily soil moisture deficit• irrigation scheduling
Irrigation	<ul style="list-style-type: none">• irrigation scheduling criteria	<ul style="list-style-type: none">• estimated yield reduction due to crop stress

Input data used for CROPWAT model

Climatic data:

? Monthly means of: minimum temperature (?C), maximum temperature (?C), air relative humidity (%), sunshine duration (hours), wind speed at 2m high (m/s)

? Monthly Rainfall

Crop data:

- sowing date: 20 / 25 April 2000
- crop coefficient (Kc): standard
- crop description: according to the observed crop phenology

Soil data:

- initial available soil moisture: 86/75 mm
- maximum root infiltration rate: 40 mm/day
- maximum rooting depth: 1m

Scheduling criteria: rainfed conditions

Use of EO data in the CROPWAT model

The CROPWAT model operates in two modes:

- computing the evapotranspiration using climatic parameters;
- using directly the evapotranspiration measurements values.

The possibilities of the use of the satellite-based data as input into the CROPWAT model are limited, because this model was not considered to directly use of satellite-derived information.

This information can be useful for comparison/validation procedures of some model input/output data, like evapotranspiration, precipitation, sunshine duration.

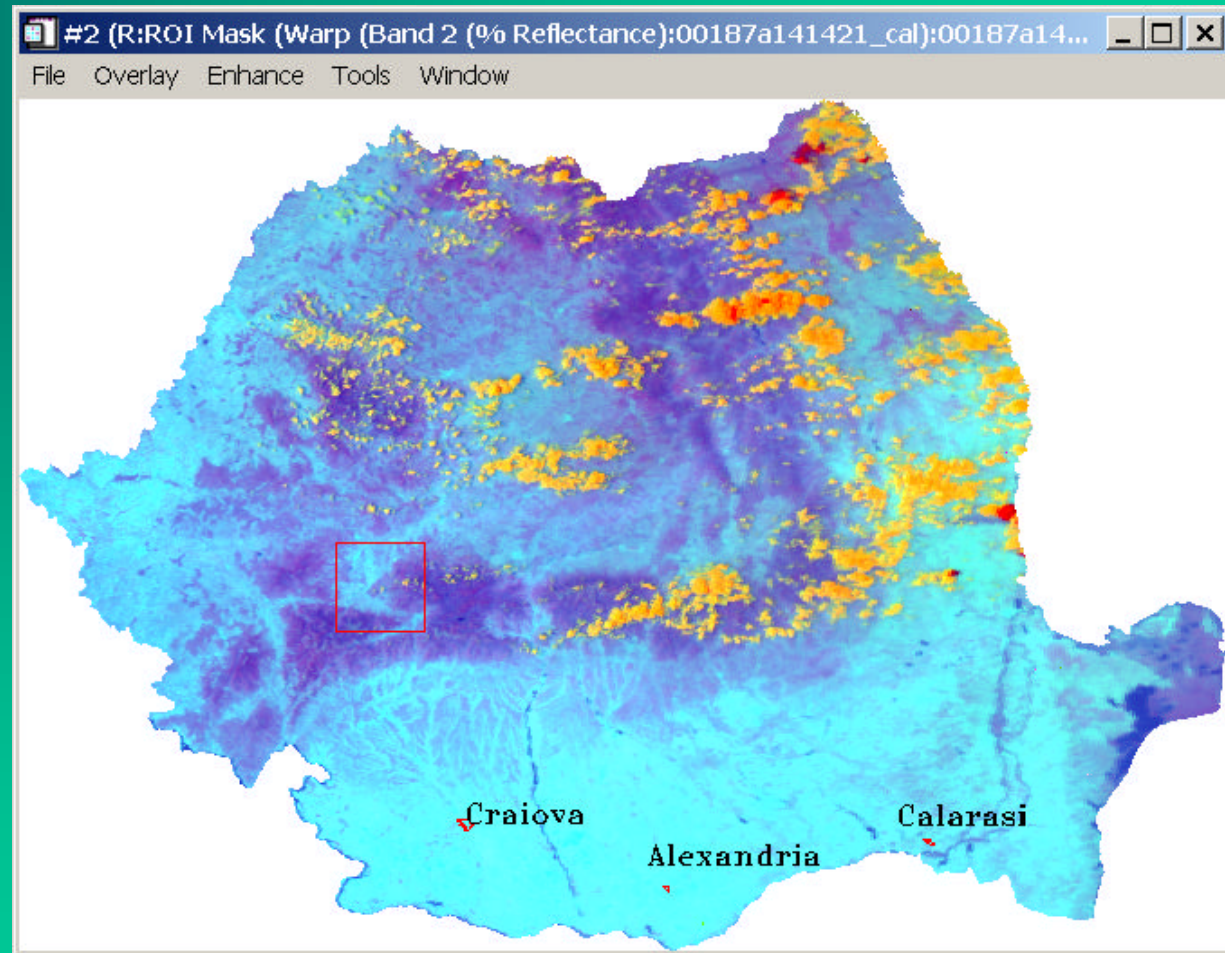
Use of EO data in the CROPWAT model

The CROPWAT model can use the satellite-derived information in different ways:

- ✍ the measured evapotranspiration could be replaced with estimation derived from satellite data, for comparison and validation procedures;
- ✍ the satellite-derived evapotranspiration values could bring a better accuracy for the spatialisation of the punctual computing values;
- ✍ the satellite information can be used for the assessment of the some reference parameters of the actual evapotranspiration (e.g. land surface temperature, vegetation indexes, etc)

Satellite data

- NOAA-AVHRR archive images for the year 2000;
- 23 images for clear patterns for the Romanian territory, especially for the Romanian Plain) associated to the following data from the maize vegetation period: 7.04, 12.04, 13.04, 3.05, 4.05, 8.05, 11.05, 17.05, 22.05, 23.05, 24.05, 25.05, 26.05, 28.05, 4.06, 5.07, 6.07, 7.07, 3.08, 4.08, 5.08, 8.08, 9.09.2000.



NOAA/AVHRR image of 6July 2000 - color composite (2,3,4)

Method for the assessment of the crop actual evapotranspiration using satellite data

- ✍ The method used in this study for the computation of daily actual crop evapotranspiration, (ET_{c_j}), is based on the surface energetic balance expressed in two simplified versions.
- ✍ The method uses the connection between evapotranspiration, net radiation and the difference between surface (T_s) and air (T_a) temperature measured around 1400 hrs. L.T. – the time of the satellite passage.
- ✍ The air temperature around local noon is well approximated by the daily maximum air temperature (T_{amax})

Method for the assessment of the crop actual ET – version 1

The **version 1** of the method used a simplified linear relationship of the form:

$$ET_{cj} - R_{nj} = A - B \times (T_s - (T_{amax}))$$

where: R_{nj} is the daily net radiation;

T_s and T_{amax} is the surface and air maximum temperature

A , B are coefficients which depend on the surface type and the daily mean wind speed.

- Coefficients A and B could be determined either analytically, on the basis of the relationships given by Lagouarde and Brunet (1991) or statistically.
- The A and B coefficients are stable in the case of mature crop vegetation cover and for clear sky conditions.
- Especially the B coefficient vary considerably, function of the land vegetation cover percent.

Method for the assessment of the crop actual ET – version 2

In case of soil with great thermal inertia, the heat flux changed by conduction at the soil-atmosphere interface, can be neglected and the computing relationship for daily actual crop evapotranspiration can be expressed in a **version 2** of the proposed method:

$$ET_{cj} = R_{nj} - B'.(T_s - T_{amax})$$

where:

$$B' = 0.0253 + [1.0016/\log_2(2/z_h)].v$$

with: v – the daily average wind speed and z_h being expressed by the relationship:

$$z_h = [1 - \exp(-LAI)].[\exp(-LAI/2)]$$

where: z_h is the vegetation roughness and LAI the foliar index;

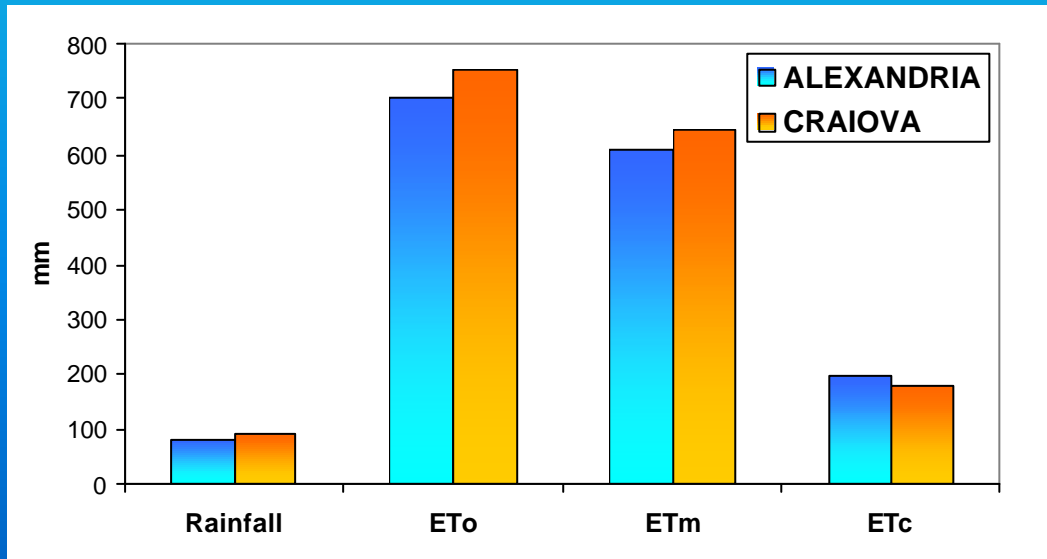
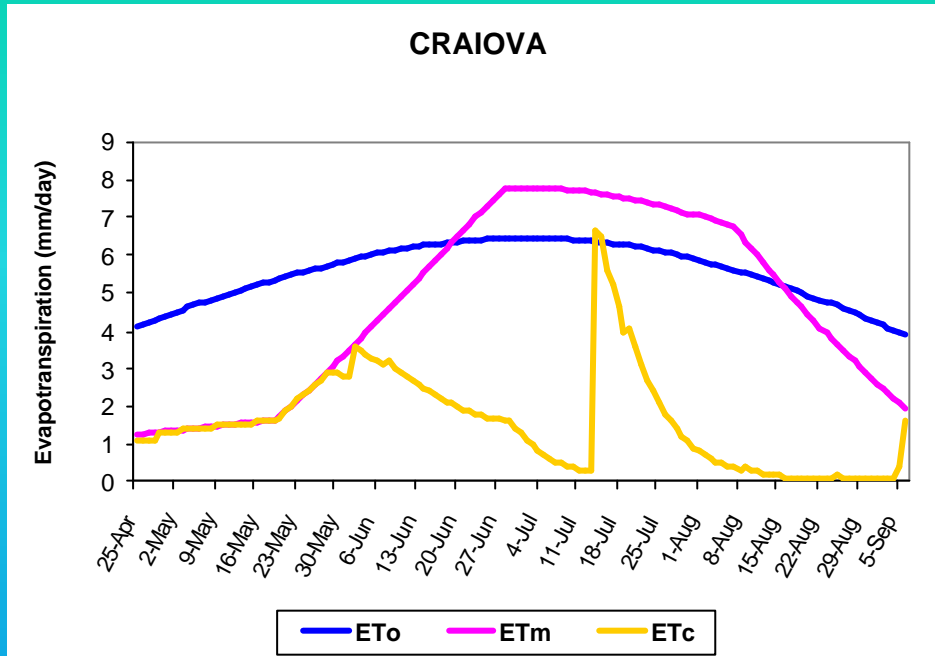
Results

Example for Craiova site

Daily evolution of:

- reference evapotranspiration (ET_o),
- maximum evapotranspiration (ET_m)
- actual crop evapotranspiration (ET_c)

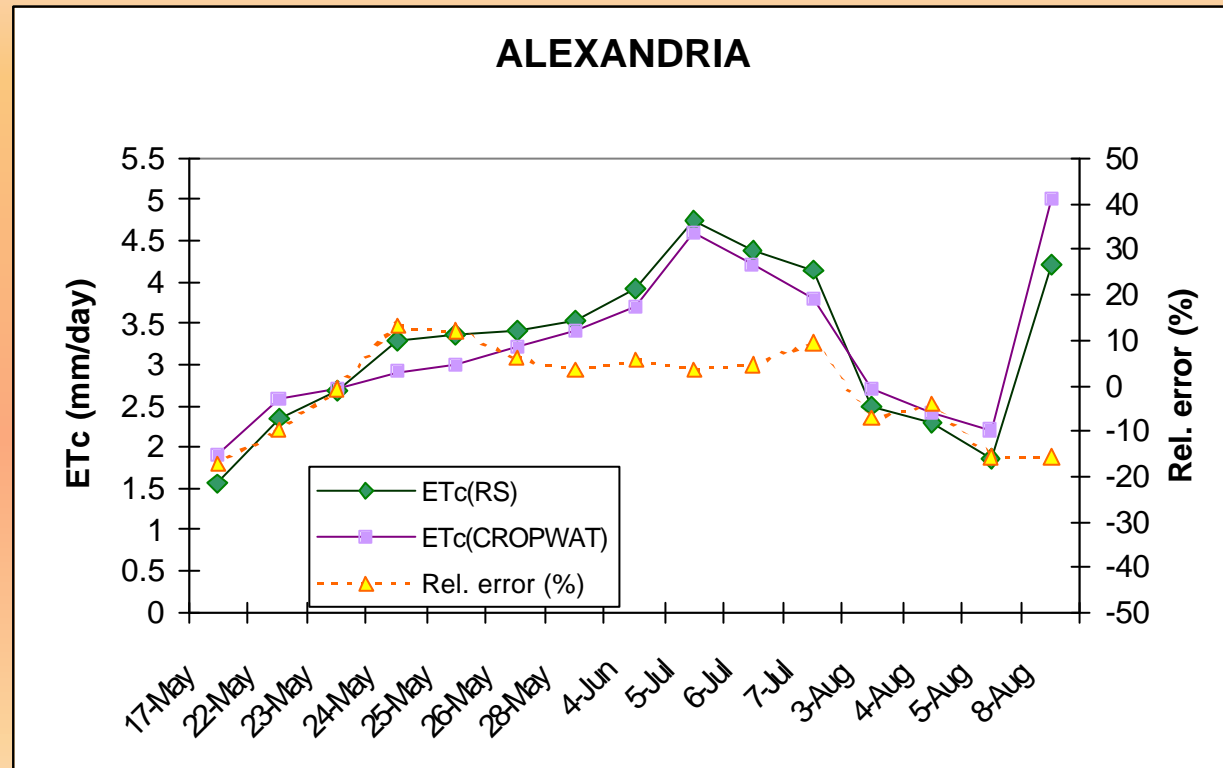
simulated with CROPWAT model during maize growing season



Cumulative values of maize variables simulated with CROPWAT model, on the whole vegetation period at both test - sites, in the weather conditions of year 2000

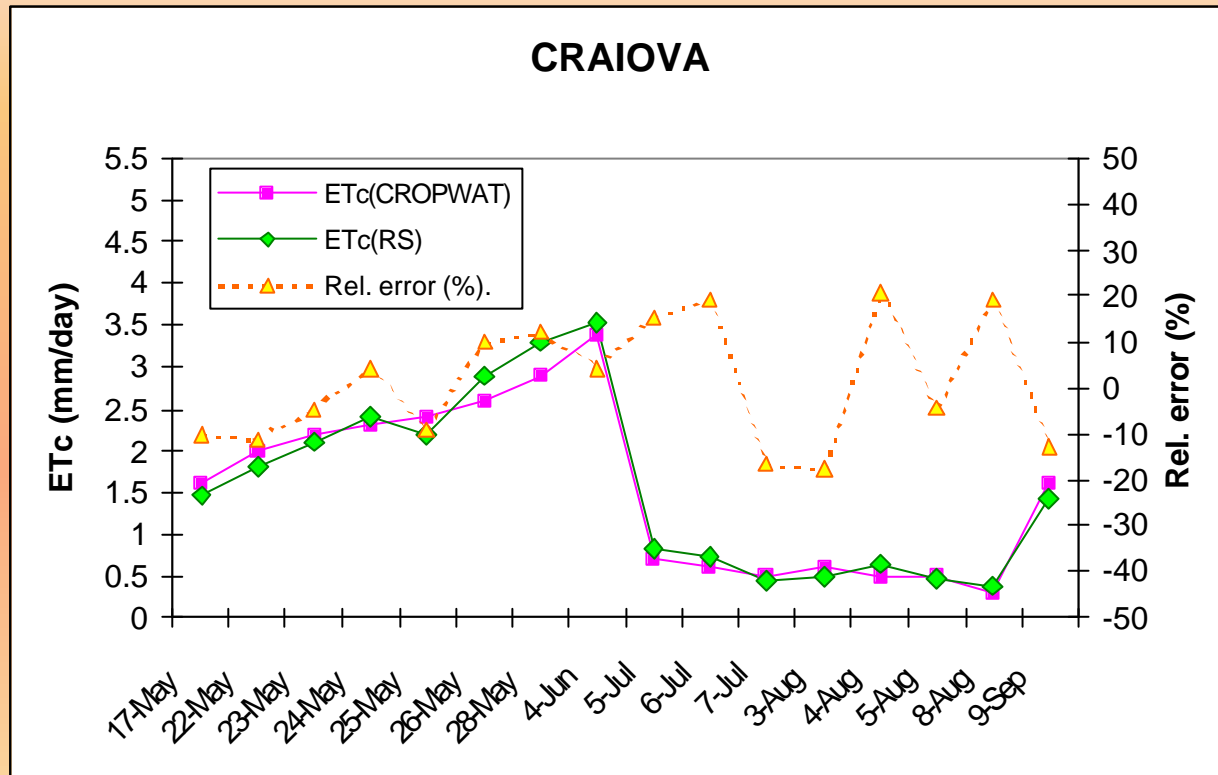
Results

Comparison between daily actual maize evapotranspiration values computed by the CROPWAT model and by the energy balance method (v. 1) using remotely sensed data at the Alexandria station



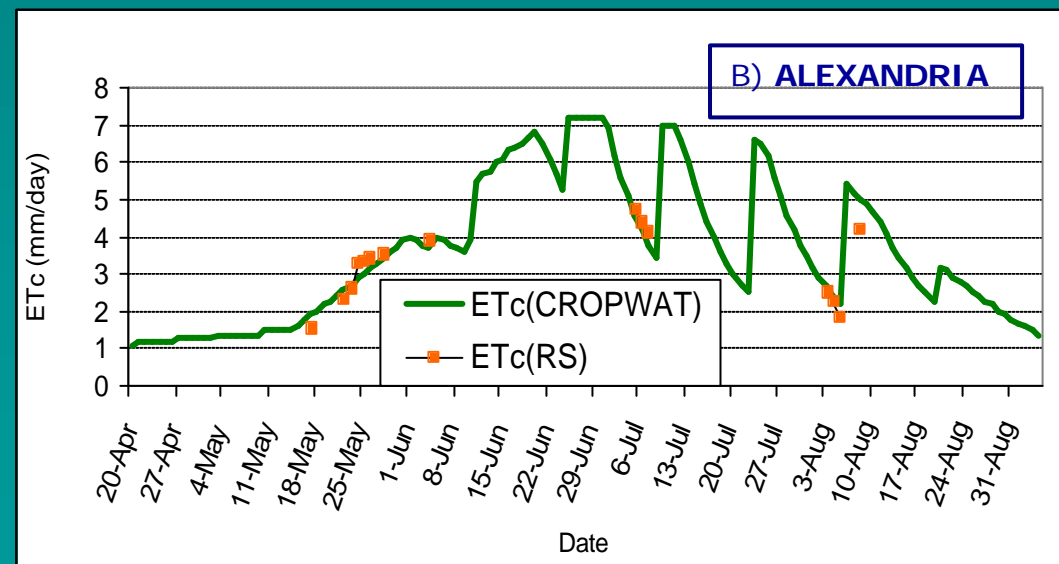
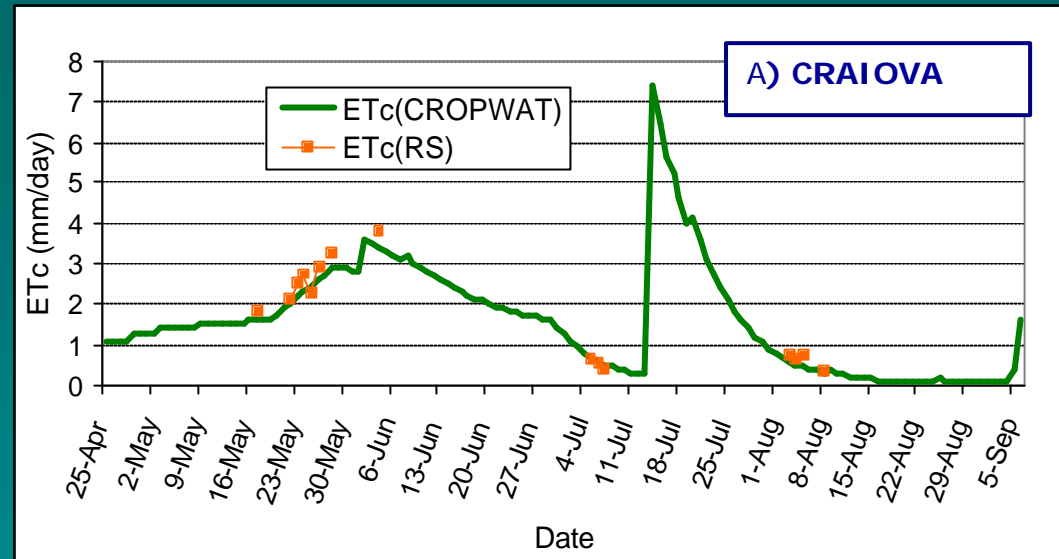
Results

Comparison between daily actual maize evapotranspiration values computed by the CROPWAT model and by the energy balance method (v. 1) using remotely sensed data at the Craiova station



Results

Comparison between daily actual ET values computed by the CROPWAT model and by the energy balance method – v.2 using EO data, at the Craiova (A) and Alexandria (B) agrometeorological stations, for the maize vegetation period in 2000.



Conclusions

- The satellite data could bring an important contribution for comparisons and validation of the model outputs for some parameters, like the actual crop evapotranspiration.
- Analysis of model results concerning comparison of daily actual crop evapotranspiration (ET_c) calculated by using climatic data vs. satellite estimations based on the surface energetic balance showed that generally ET_c values from satellite information are higher than those simulated by the model, the differences being by +0.45 and -1.9 mm/day.
- The preliminary results emphasized a good correlation between the simulated values (CROPWAT) and those derived from the satellite data, with relative errors of ? 10%-20%.