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ROMANIA

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ACCOUNTING FOR TERRAIN SLOPE-ASPECT INFLUENCE ON AIR TEMPERATURE.

A DETERMINISTIC APPROACH

METHODOLOGY

• **Identification of a statistically significant relationship between air temperature and some potential causal factors**: altitude, latitude and longitude by *stepwise multiple regression*

• **Application of a correction coefficient to account for the influence of terrain slope and aspect**:

$$t_c = t_n \, (R_{ns\text{-}c} / R_{ns\text{-}n})$$

– t_c : corrected (radiant) air temperature;

– t_n : non-corrected air temperature, estimated by regression;

– $R_{ns\text{-}c}$: corrected incoming net radiation;

– $R_{ns\text{-}n}$: non-corrected incoming net radiation.

• **Estimation of the non-corrected incoming net radiation ($R_{ns\text{-}n}$)** using the *Angstrom* formula and albedo values:

$$R_{ns-n} = (1-a) \cdot R_a \left[0{,}25 + 0{,}5 \frac{n}{N} \right]$$

– Ra : extraterrestrial radiation;

– n/N : ratio of actual number of sunshine hours over astronomically possible sunshine hours;

– a, b : coefficients expressing the qualitative structure of the global radiation;

– a : albedo.

METHODOLOGY

• **Estimation of the corrected incoming net radiation.** Accounting for slope influence on northern and southern orientations:

$$R_{ns-c} = (1 - a) \cdot R_a \left[0{,}25 + 0{,}5 \frac{n}{N} \frac{\sin(h_m \pm \alpha)}{\sin(h_m)} \right]$$

- α : slope angle of land surface (+ for southern orientations and – for northern orientations;

- h_m : mean daily sun angle estimated using latitude (φ) and number of day in the year (J):

$$sin(h_m) = sin[0{,}85 + 0{,}3\ \varphi\ sin(2\pi\ J/365 - 1{,}39) - 0{,}42\ \varphi^2]$$

• **Transformation of the aspect values**, initially ranging from 0^o to 360^o, into values ranging from 0^o (N) to 180^o (S) and division by 180 in order to obtain *weighting coefficients* (*c*) ranging from 0 to 1.

• **Estimation of the corrected incoming net radiation**. Accounting for overall slope-aspect influence:

$$R_{ns} = R_{ns}\text{-}N + c\ (R_{ns}\text{-}S - R_{ns}\text{-}N)$$

- R_{ns}-S, R_{ns}-N : incoming net radiation for southern and northern orientations

STUDY REGION AND INPUT DATA

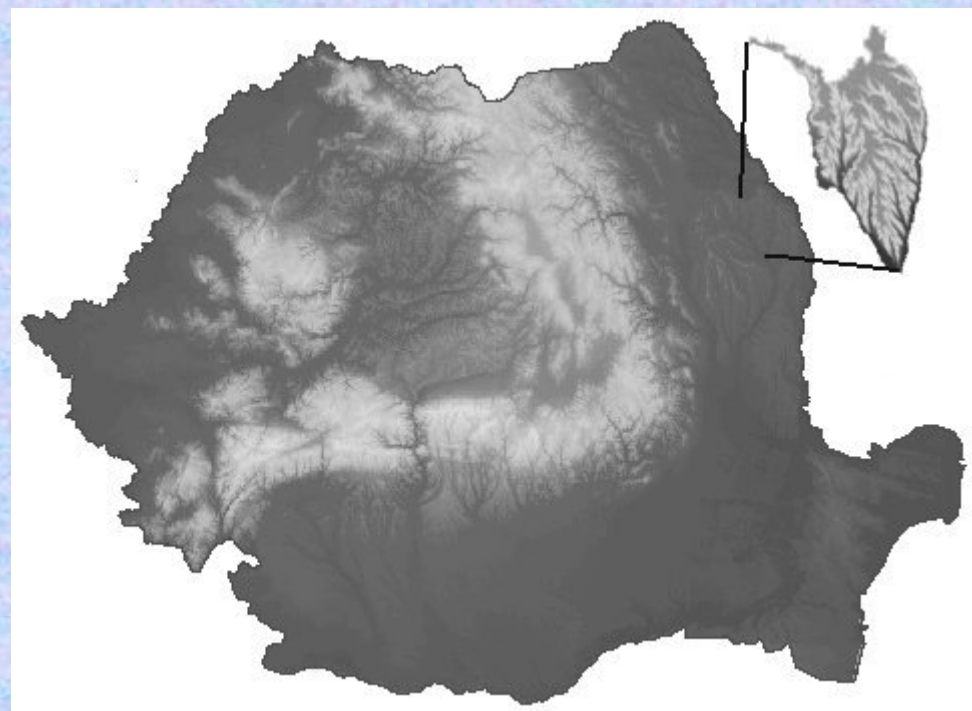
- **Study region:**

  - 47^{o}N of latitude, eastern Romania

  - in the central part of the Central Moldavian Plateau

  - surface: about 930km^2

  - altitude range: 95m to 416m, generally decreasing from north to south.



- **Input data:**

  -mean annual temperature from 12 stations situated in the larger area of the Moldavian Plateau

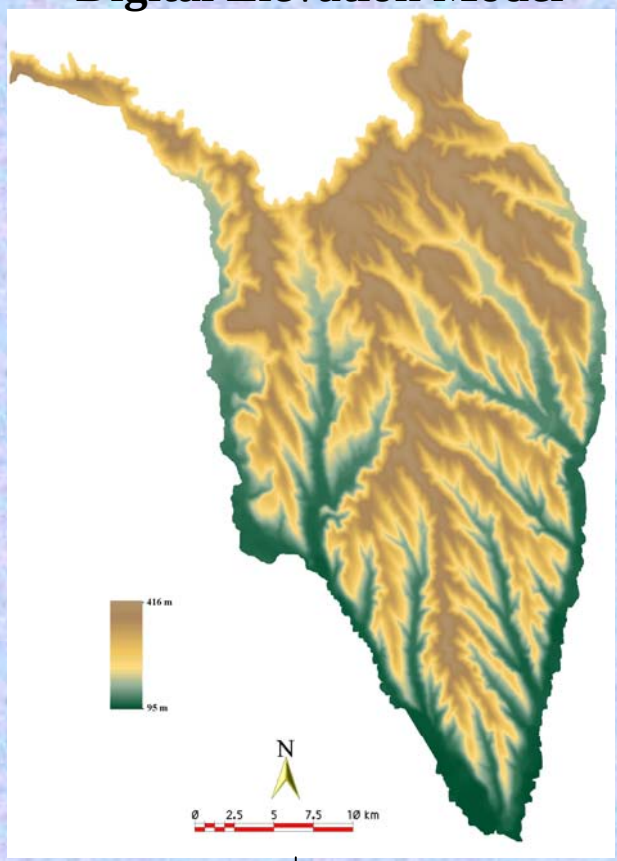
  -Mean annual actual number of sunshine hours

  -Mean annual albedo values

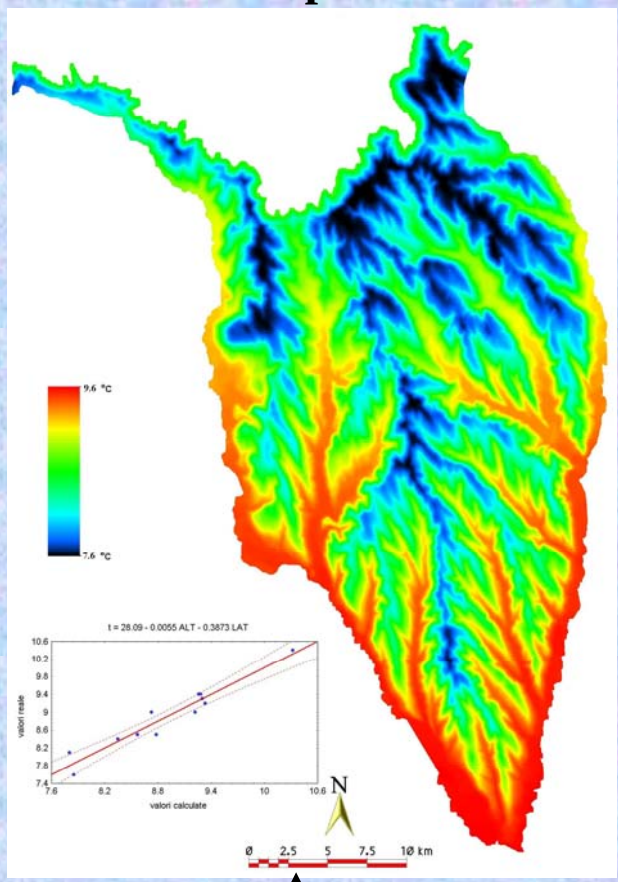
  -Digital Elevation Model

RESULTS

Digital Elevation Model



Non-corrected mean annual air temperature



First step:

$t_{an} = 10,03 - 0,0069ALT \pm 0,32$

$p < \quad 0,01 \qquad 0,01$

$R = 0,91 \rightarrow R^2 = 0,82$

The second step:

$t_{an} = 28,09 - 0,0055ALT - 0,3873LAT \pm 0,22$

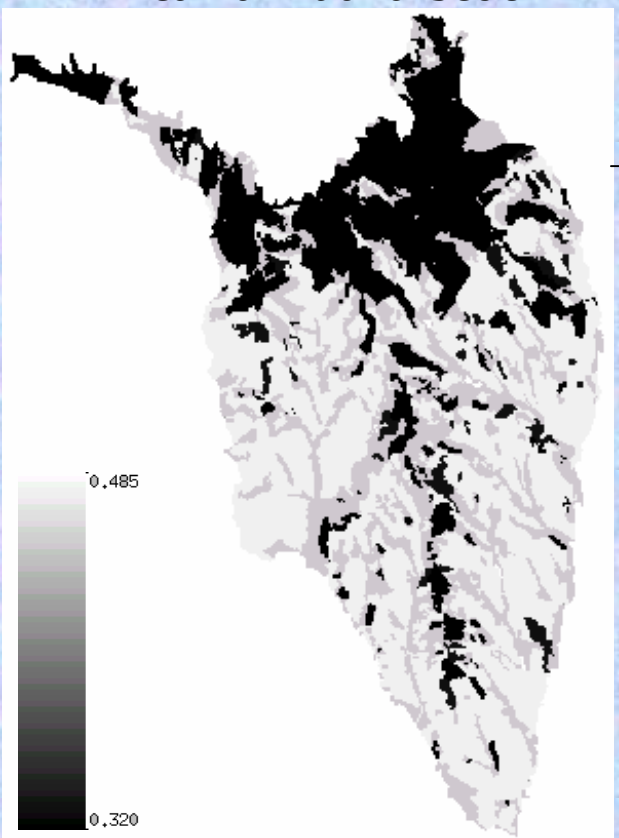
$p < \quad 0,01 \qquad 0.01 \qquad 0.01$

$\beta \qquad\qquad -0,72 \qquad -0,37$

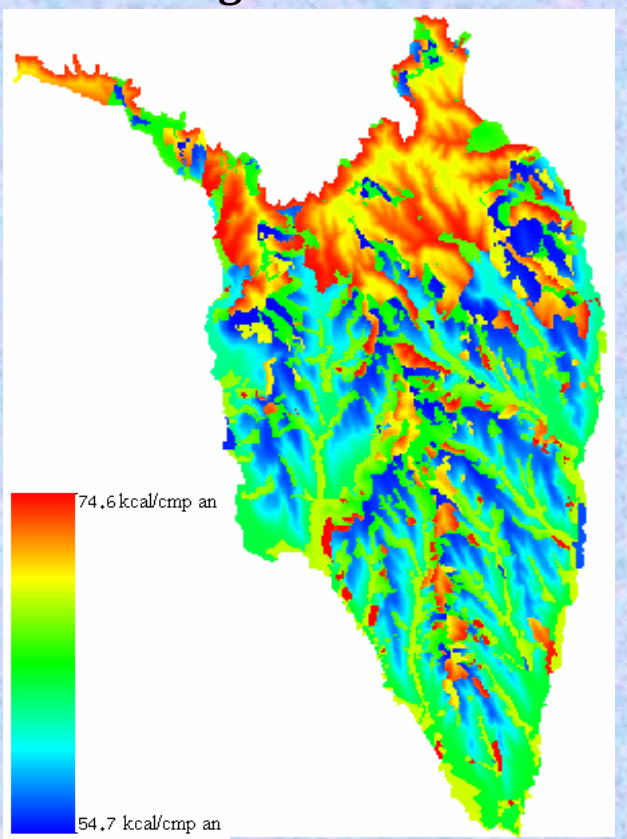
$R = 0,96 \rightarrow R^2 = 0,93$

RESULTS

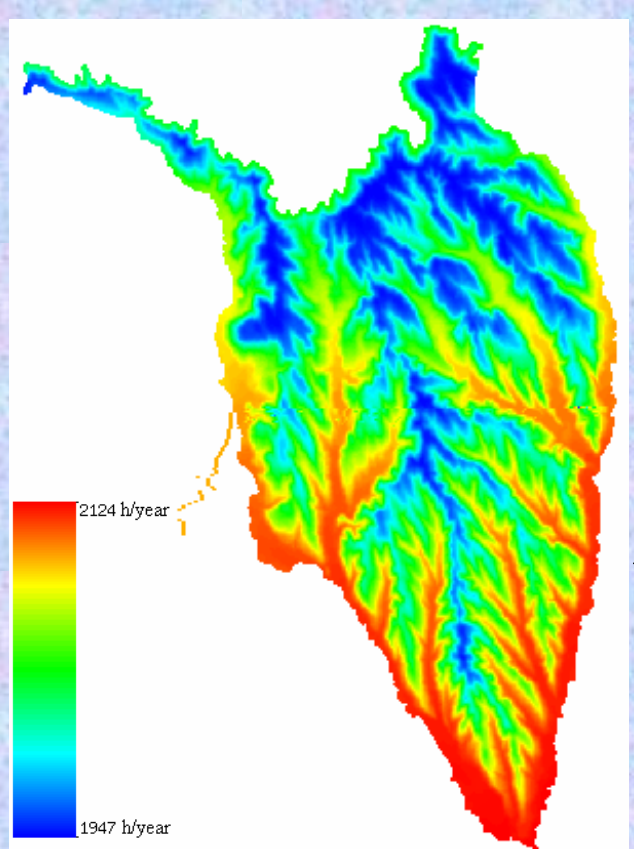
Mean annual albedo



Mean annual non-corrected incoming net radiation

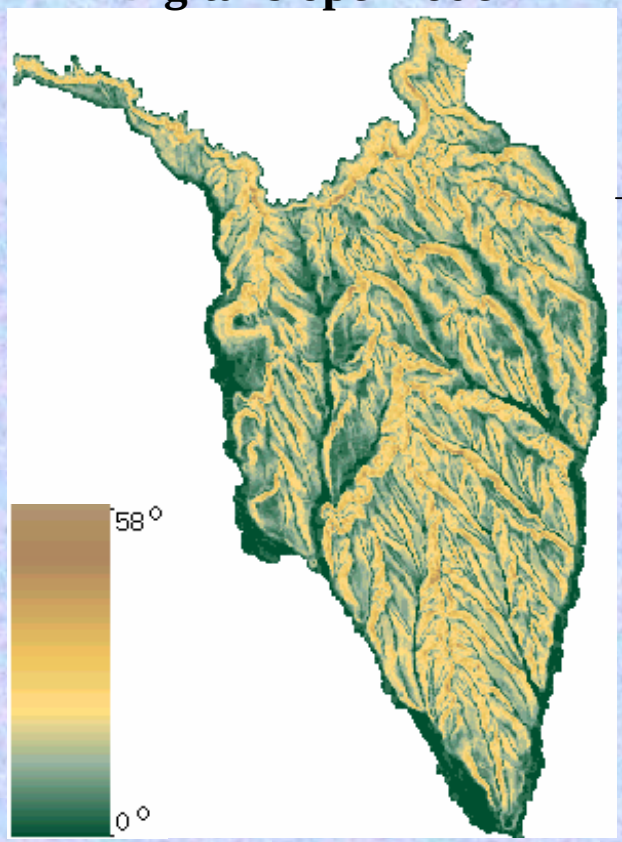


Mean annual sunshine hours

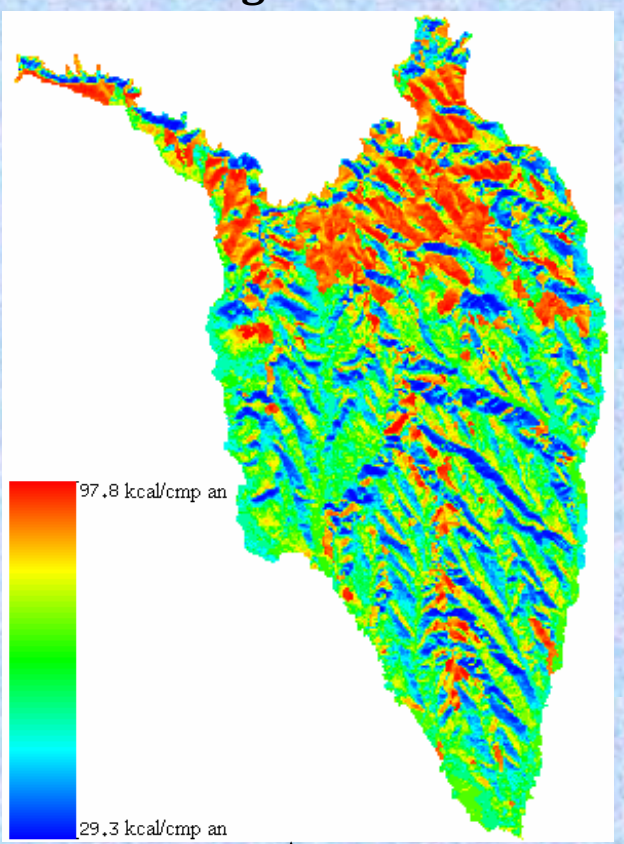


RESULTS

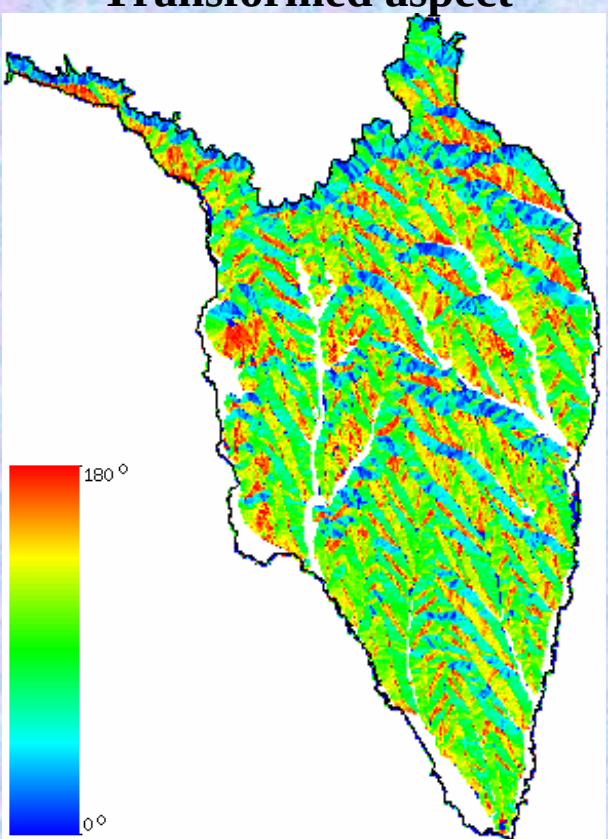
Digital slope model



Mean annual corrected incoming net radiation

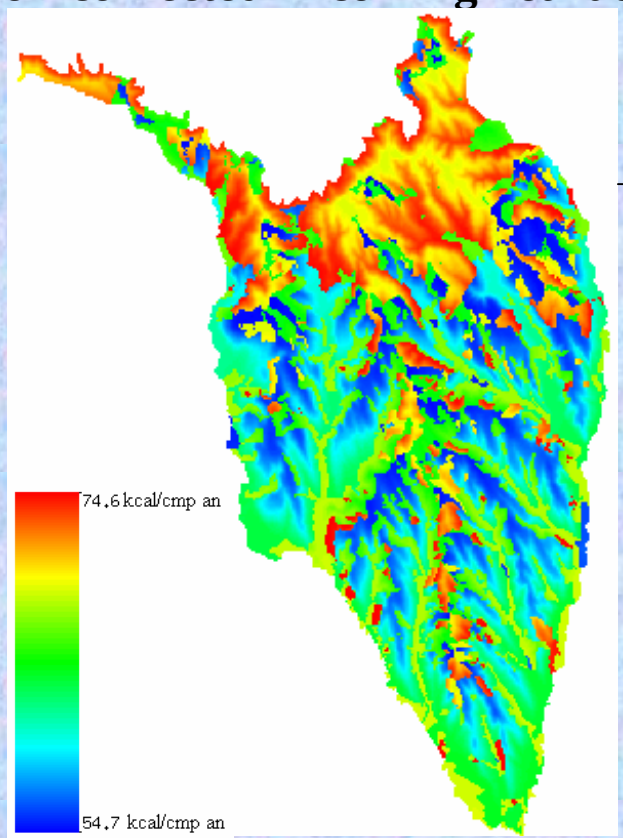


Transformed aspect

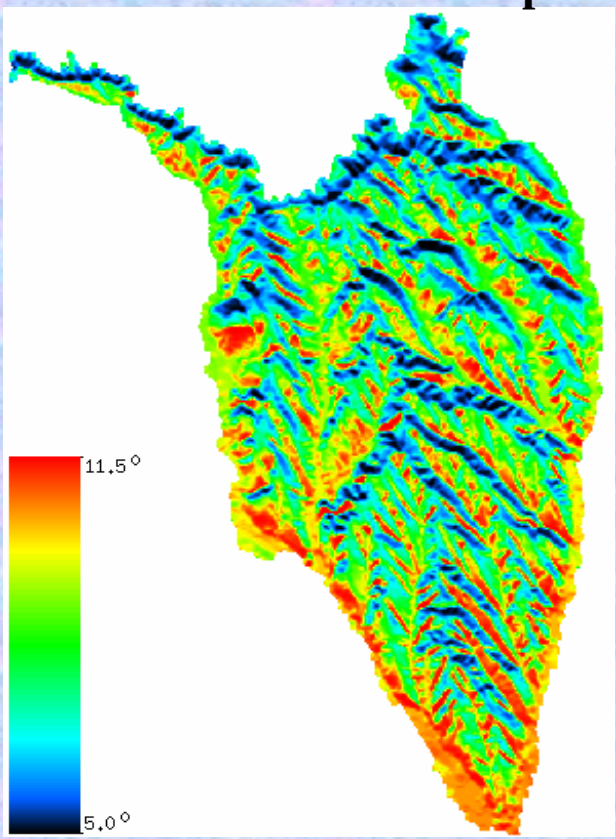


RESULTS

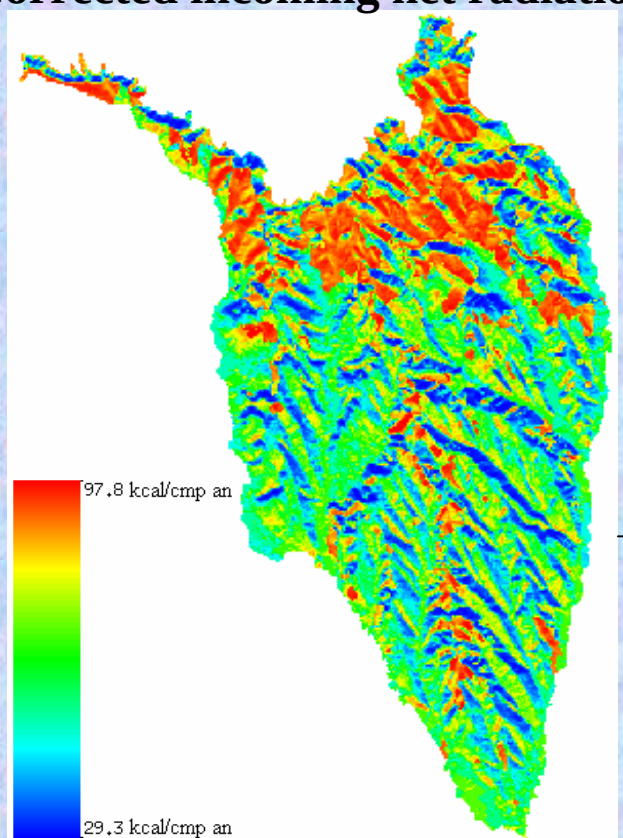
Non-corrected incoming net radiation



Corrected mean annual temperature



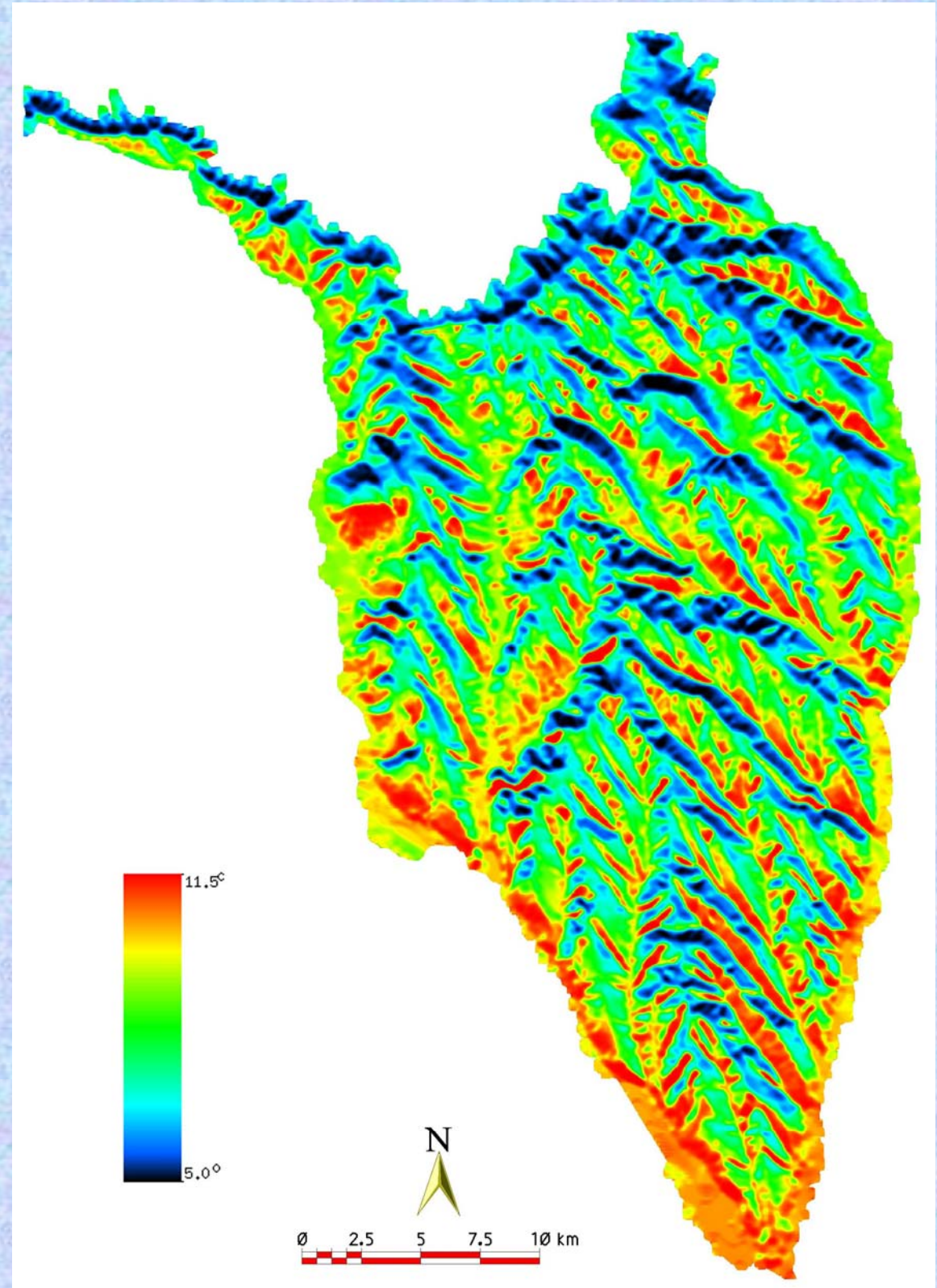
Corrected incoming net radiation



RESULTS

Corrected mean annual temperature.

Accounting for terrain slope-aspect influence



CONCLUSIONS

•The approach could be seen as **a first step** the process of deriving a more realistic spatial estimation of air temperature

• It could constitute the **deterministic component of a residual kriging system**

• **Further research** should focus on:

-Integration of *other predictors* in the regression system (such as, terrain energy, orientation-width of valleys etc.)

-Integration of the *smoothing effect of turbulent heat transfer*

-Accounting for *the temperature differences between eastern and western orientations*

-Deriving *a finer spatial distribution of the albedo* (for example, using visible satellite images such as Spot)

-*Validating* the estimated temperature (for example, by correlation with the thermal-infrared Landsat images).