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CONTRIBUTIONS OF THE REMOTE SENSING TECHNIQUES FOR THE ESTIMATION OF THERMAL FIELD

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Abstract: *Frost damage is a serious concern for many types of temperate climate crops. Frost may damage leaves and fruit, impact on plant health and cause death, depending on the severity of a frost and the susceptibility of a particular plant. Frost is generally divided into radiation frost, i.e. created in cloudless, calm conditions by the long wave radiative cooling of near-surface air, and advective frost, which is caused by large-scale cold air masses moving into an area in windier condition.*
Key words: *remote sensing, MODIS, MSG, frost*

1. INTRODUCTION

Romania has a temperate continental climate with cold winters and hot summers. During spring time occurs numerous episodes of cooling ground frost. Average date of last spring frost calculated for the period 1961-2000 in the plains and hills is generally in the second decade of April.

Climate scenarios for the country projected average temperature increases, which will cause an early development of vegetation and therefore greater sensitivity to cold. In the context of climate change with many uncertainties concerning the intensity and frequency of freezing phenomenon, shaping the spatial scale of minimum temperatures will allow accurate estimation of the consequences of climate change and planning for adapted methods (use of plants less sensitive are more likely to experience frost Spring).

The main objective of this study is to develop frost risk maps of measured data from weather stations and the satellite data and presenting a case study in Romania (March 2009)

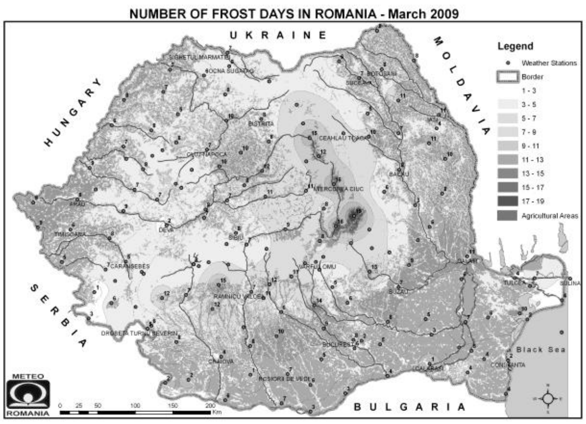

Fig. 1. Number of frost days in Romania, March 2009

2. METHODOLOGY

Analysis of weather data minimum soil temperature and minimum air temperature shows a large variability and large spatial variability of frost damage caused phenomena (Tait & Zheng, 2003). Protect plants from the effects of low temperatures is a matter of considerable importance in agricultural and horticultural production of fruits and vegetables. Accurate forecasting and monitoring of the phenomenon of frost is needed and knowing of areas most likely to be affected.

Degree and specific type of frost damage depends on several factors: the type of crop, its variety, maturity, tissue, culture size, phenological stage, temperature decrease rate and the time during which the culture is exposed to lower temperature. Plant species differ greatly in terms of susceptibility to damage caused by cold and points of freezing are different to each other.

Remote sensing offers unique opportunities in this regard by the channel thermal infrared satellite images that allow spatial mapping of soil surface temperature (Stancalie, 2005).

In this context, estimating a minimum temperature scale in specific situations, spring frost is the main objective of this study. A mapping is presented as a result of spatial interpolation of data coming from the network of weather stations and thermal infrared satellite imagery of MODIS and MSG.

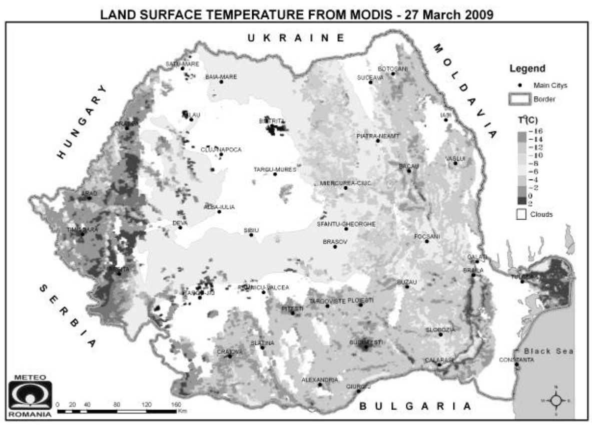

Fig. 2. Land surface temperature from MODIS, March 2009

The MODIS instrument provides high radiometric sensitivity (12 bit) in 36 spectral bands ranging in wavelength from 0.4 µm to 14.4 µm. Land surface temperature is one of the MODIS Land products. Emitted spectral radiance L at wavelength λ from a surface at thermodynamic temperature T_s is given by multiplying the Planck function by spectral emissivity $\varepsilon(\lambda)$ (Zhengming, 1999).

$$L(\lambda, T) = \varepsilon(\lambda) B(\lambda, T_s) \quad (1)$$

In general, azimuthally depended radiance in an absorbing, emitting, and scattering layer is governed by the monochromatic radiative transfer equation (Caselles et al., 1997).

Land surface temperature is one of the main quantities governing the energy exchange between surface and atmosphere. LST based on MSG-SEVIRI measurements is an operational product of the Land Surface Analysis – Satellite Application Facility (LSA-SAF)

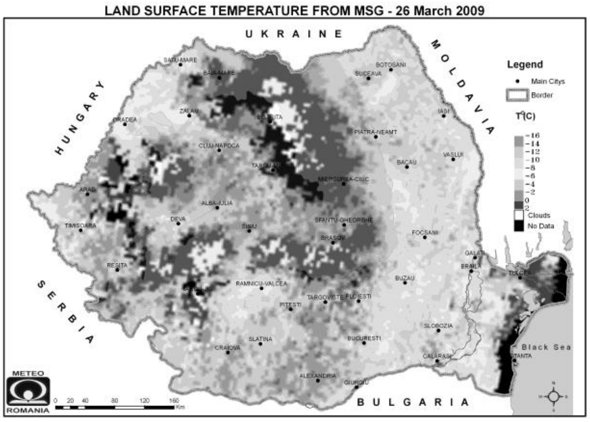

Fig. 3. Land surface temperature from MSG, March 2009

In case of satellite measurements, the surface associated with a pixel is not in thermal equilibrium and is composed of areas with different characteristics of reflectance and emissivity.

A surface temperature is well defined for homogeneous surfaces at thermal equilibrium. Remote sensing sensors for determining the temperature related parameters, such as brightness temperature, Tb, radiation temperature, Tr, Radiometric temperature T. Brightness temperature is the temperature of a blackbody having the same radiation emitted from a given area. Radiometric temperature depends on surface temperature distribution, of its emissivity and the spectral range to be measured (Stancalie et al., 2006)

To achieve frost risk map, interpolation of LST data was performed, data obtained from weather stations, processing of satellite images, consisting of georeferencing (bringing images in stereo70 projection), redesign, mosaic and calculating pixels values in ENVI 4.5 software. Eventually we realized the correlation between meteorological and satellite data to observe and interpret the results.

3. RESULTS

Using weather data daily minimum soil temperature were made frost risk maps for March with thresholds of 0, -1, -2, -3 ° C.

To analyze the cooling of March 2009, minimum soil temperature maps were made and satellite images were processed: MODIS, MSG and SPOT VEGETATION.

Minimum soil temperature data from 26 and March 27, were measured at 130 stations and were interpolated and compared with soil surface temperature product from MODIS satellite images, and MSG. MODIS images have spatial

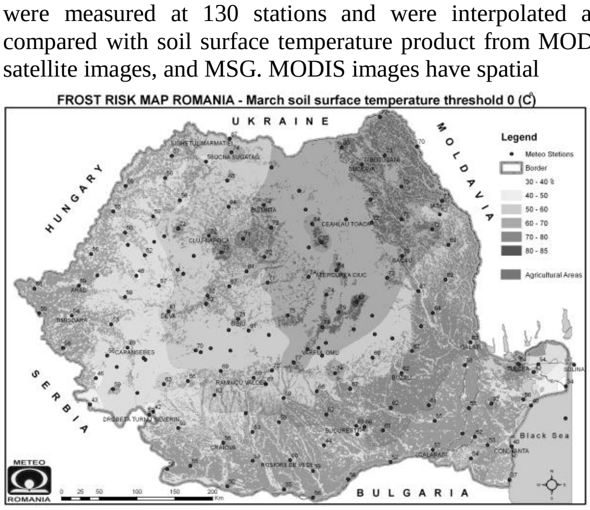

Fig. 4. Frost risk map, March 2009

resolution of 1km and are daily. MSG images have a spatial resolution of 4 km and 15 minutes temporary resolution that allows a synthesis and obtaining an image without clouds. To estimate the effect of low temperatures on vegetation development were used images SPOT VEGETATION NDVI, FPAR and FVC. The images were processed and integrated into a GIS environment.

4. CONCLUSION

The role of satellite data to determine the thermal field has become particularly important given the development of remote sensing systems and products generated by them.

Due to temporary good resolution (15 min.), land surface temperature from MSG, allow an image synthesis without clouds.

Land surface temperature from MODIS images allows estimation of temperature surface for each pixel of 1x1 km.

Data obtained from satellite imagery can be used for numerical forecasting models.

It can be seen much better spatialization of information, making comparison between data obtained from weather stations and data from satellite imagery. Data from weather stations provide information in one point and does not cover a large area while satellite imagery provides more detailed information, a value on each pixel of 1x1 km, in case of MODIS images.

The analysis of meteorological data shows a high spatial variability for the low temperatures as well as damages due to frost events. Indeed, important differences in the temperatures of weather stations as close as a few kilometres apart, sometimes records coming from the same hill side, are observed. These contrasts are accounted for by numerous factors, the main ones being the atmospheric conditions, the topography and soil state. In this context, an estimate of minimum temperatures at a fine scale using remote sensing data in spring frost situations is useful.

Because of spatial resolution of 1 km (MODIS) and 4 km (MSG), the results of research on smaller areas may be inaccurate. The next step of research will be used of other satellite images, for example Landsat 7 (band 6 thermal infrared) with spatial resolution of 60m.

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