Topic 2 – Numeric Weather Prediction

NWP modelling course in the frame of Serbia for Excell Summer School was held from June 27th to July 1st 2016 in Novi Sad, Faculty of Agriculture.

Intention of NWP modelling course was to train students to install, run and present results of Weather Research and Forecast numerical weather prediction model. We choose WRF as a state-of-the-art atmospheric modelling system designed for both meteorological research and numerical weather prediction. WRF has a large worldwide community of registered users (over 30,000 in over 150 countries).

Some of the students didn't have any knowledge and experience in numerical modeling. It was necessary to introduce the topics like software packages, libraries and Linux basics that are needed for the installation, running and presentation of the model products.

Comprehensive step-by-step documentation with description of necessary libraries and installation procedure was prepared in advance and distributed to the students. Students had individual questions that we were solving during training course. They discussed practical issues about how to run the model, where to download the data, how to read and plot model products.

Lateral boundary conditions for actual dates where provided and students had an opportunity to run the model and interpret their own forecast.

Final student's discussion and presentation convinced us that all of them finished installation and running of the model and that they understood and learned NWP fundamentals. After this summer school all students are capable to install and run WRF on their own. This can be a starting point for their further research in providing meteorological forecast for crop modelling purposes.

Serbia for Excell

H2020-TWINN-2015

Parameterisation of processes in soil-vegetation-atmosphere transfer schemes: Water and energy balance

Branislava Lalić

[a] Faculty of Agriculture, University of Novi Sad, Serbia

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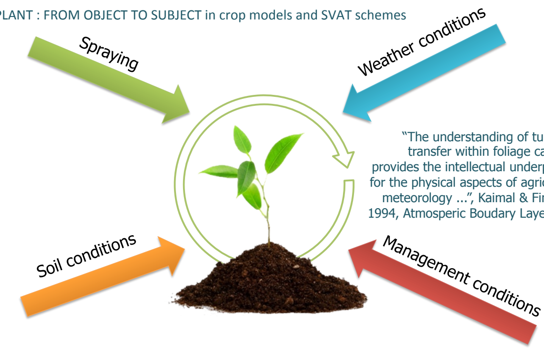
AgMnet INTERNATIONAL SUMMER SCHOOL IN AGROMETEOROLOGY AND CROP MODELLING

27 June – 01 July 2016
Novi Sad, SERBIA

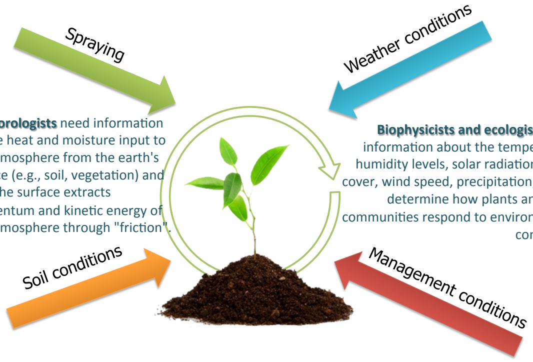
SVAT – Soil – Vegetation - Atmosphere Transfer Schemes

PLANT : FROM OBJECT TO SUBJECT in crop models and SVAT schemes



"The understanding of turbulent transfer within foliage canopies provides the intellectual underpinning for the physical aspects of agricultural meteorology ...", Kaimal & Finnigan, 1994, Atmosperic Boudary Layer flows

Penman, H. L. and Long, I. F. (1960), Weather in wheat : An essay in micro-meteorology. *Q.J.R. Meteorol. Soc.*, 86: 16–50.



Meteorologists need information on the heat and moisture input to the atmosphere from the earth's surface (e.g., soil, vegetation) and how the surface extracts momentum and kinetic energy of the atmosphere through "friction".

Biophysicists and ecologists need information about the temperature, humidity levels, solar radiation, cloud cover, wind speed, precipitation, etc. to determine how plants and plant communities respond to environmental conditions

SVAT – Soil – Vegetation - Atmosphere Transfer Schemes

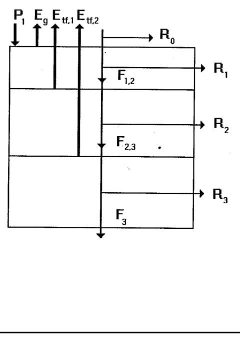
Used to more accurately describe how soil, vegetation, and water surfaces exchange fluxes with the atmosphere

Meteorologists and climatologists need information on the heat and moisture input to the atmosphere from the earth's surface (e.g., soil, vegetation, water bodies) and how the surface extracts momentum and kinetic energy of the atmosphere through "friction".

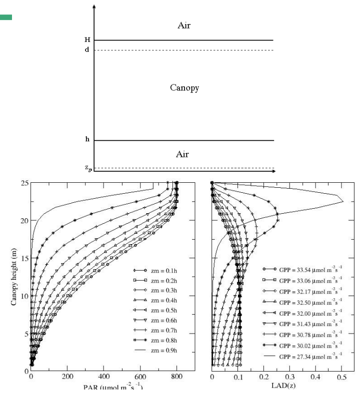
Biophysicists and ecologists need information about the temperature, humidity levels, solar radiation, cloud cover, wind speed, precipitation, etc. to determine how plants and plant communities respond to environmental conditions

SVAT: Soil and Vegetation Model

- Soil – three layer model



- Vegetation - single layer model



LAPS: Radiation Module

Governing equations

The net radiation absorbed by the

canopy
$$R_{nc} = \lambda E_c + H_c + C_c \frac{\partial T_c}{\partial t}$$

soil
$$R_{ng} = \lambda E_g + H_g + C_g \frac{\partial T_g}{\partial t}$$

partitioned into sensible heat, latent heat, and storage terms

Deep soil temperature

$$\frac{\partial T_d}{\partial t} = 2(R_{ng} - H_g - \lambda E_g)/(C_g\sqrt{365\pi})$$

Mihailovic et al. (1992, 1993, 1995), J. App. Meteor

LAPS: Radiation Module

Sensible and latent heat flux partitioning

- Sensible (H_c) and latent (λE_c) heat flux from vegetation to canopy air space

$$H_c = \rho c_p \frac{2(T_c - T_a)}{r_b} \qquad \lambda E_c = (e_*(T_c) - e_a)\frac{\rho c_p}{\gamma}\left(\frac{W_c}{r_b} + \frac{1 - W_c}{r_b + r_c}\right)$$

- Sensible (H_g) and latent (λE_g) heat flux from ground to canopy air space

$$H_g = \rho c_p \frac{2(T_g - T_a)}{r_d} \qquad \lambda E_g = \frac{(\alpha_s e_*(T_g) - e_a)}{r_b + r_d}\frac{\rho c_p}{\gamma}$$

- **Sensible (H) and latent (λE) heat flux from canopy air space to reference level**

$$H = H_c + H_g = \rho c_p \frac{(T_a - T_r)}{r_a} \qquad \lambda E = \lambda E_c + \lambda E_g = \frac{\rho c_p}{\gamma}\frac{(e_a - e_r)}{r_a}$$

LAPS: Hydrological Module

Governing equations

Water stored on the canopy

$$\frac{\partial w_f}{\partial t} = P_f - E_{wf}/\rho_w$$

The volumetric soil water content

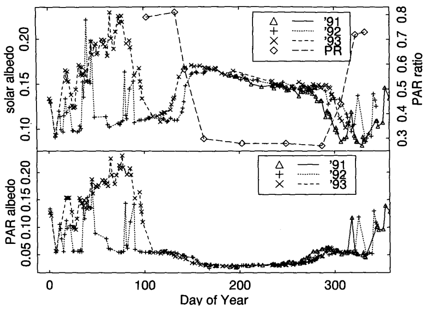
$$\frac{\partial w_1}{\partial t} = \frac{1}{D_1}\left\{P_i - F_{1,2} - \frac{E_g + E_{tf,1}}{\rho_w} - R_0 - R_1\right\}$$

$$\frac{\partial w_2}{\partial t} = \frac{1}{D_2}\left\{F_{1,2} - F_{2,3} - E_{tf,2}/\rho_w - R_2\right\}$$

$$\frac{\partial w_3}{\partial t} = \frac{1}{D_3}\left\{F_{2,3} - F_3 - R_3\right\}$$

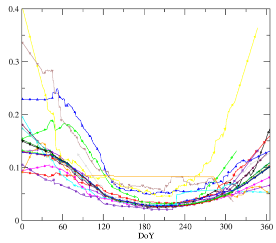
LAI ⇄ ALBEDO

"The Hitchhiker's Guide to the Galaxy"

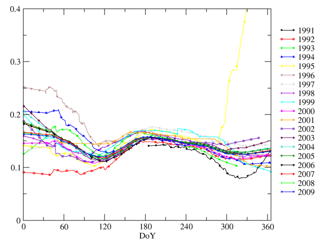


Moore, K. E., D. R. Fitzjarrald, R. K. Sakai, M. L. Goulden, J. W. Munger, S. C. Wofsy, 1996: Seasonal Variation in Radiative and Turbulent Exchange at a Deciduous Forest in Central Massachusetts, *Journal of Applied Meteorology*, 35 (1), 122-134.

Energy balance – IMPACT OF PLANTS ON ENERGY BALANCE



PAR albedo 1991-2009



Solar albedo 1991-2009

Lalic, B., Fitzjarrald, D.R., Firanj Sremac, A., 2016: "Climatology" of Radiative and Turbulent Exchange at a Deciduous Forest in Central Massachusetts (manuscript in preparation)

Energy balance – IMPACT OF PLANTS ON ENERGY BALANCE

Fig. 2.3 Observed diurnal energy balance over a dry lake bed at El Mirage, California, on June 10 and 11, 1950. [After Vehrencamp (1953).]

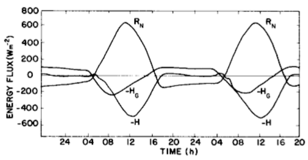
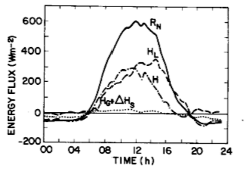


Fig. 2.5 Observed energy budget of a Douglas fir canopy at Haney, British Columbia, on uly 23, 1970. [From Oke (1987); after McNaughton and Black (1973).]



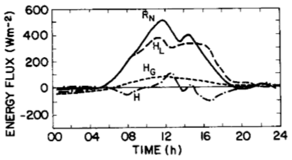
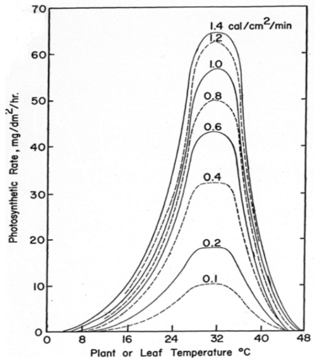


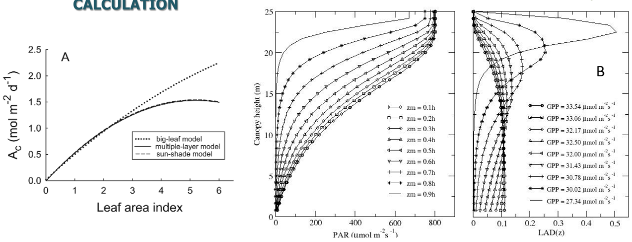
Fig. 2.4 Observed diurnal energy budget of a barley field at Rothamsted, England, on July 23, 1963. [From Oke (1987); after Long *et al.* (1964).]

Energy balance – IMPACT OF "ENERGY BALANCE" ON PLANTS



LAI ⇄ PHOTOSYNTHESYS CALCULATION

"The Hitchhiker's Guide to the Galaxy"

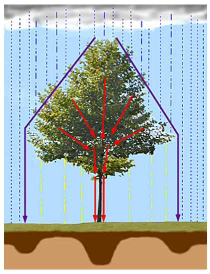


Predictions of canopy-level CO_2 assimilation rate (Ac) as a function of LAI (panel A) and GPP as a function of LAD (panel B). Ac was predicted using the biochemical models of Farquhar and von Caemmerer (1982) coupled to three different types of canopy flux models; a big-leaf model, a multiple layer model, and a sun/shade big-leaf model.

Monson, R., Baldocchi, D., 2014: *Terrestrial Biosphere-Atmosphere Fluxes*. Cambridge University Press, pp. 518.
Firanj, A., Lalic, B., Podrascanin, Z., (2014) The Impact of Forest Architecture Parameterization on GPP simulations. *Theoretical and Applied Climatology*, 121, 3, 529-544

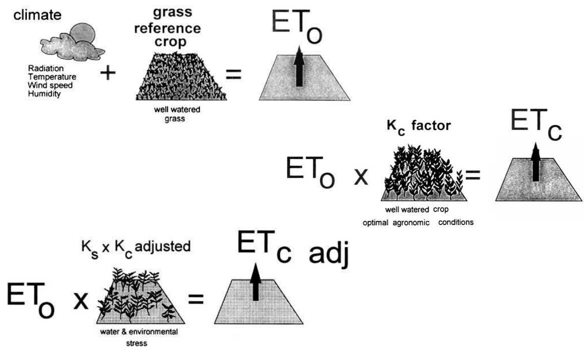
Water balance – IMPACT OF PLANTS ON WATER BALANCE

Vegetation can intercept up to 50% of the rain that falls on its leaves. The leaves of deciduous trees commonly intercept anywhere from 20 to 30% of the falling rain.



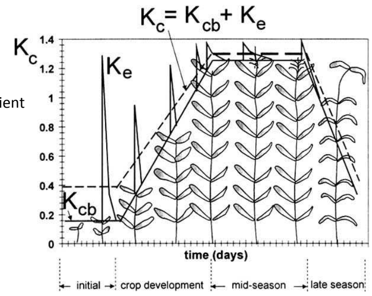
Modification of falling precipitation by vegetation The relative quantity of precipitation entering the soil is indicated in dark brown

Water balance – IMPACT OF "WATER BALANCE" ON PLANTS

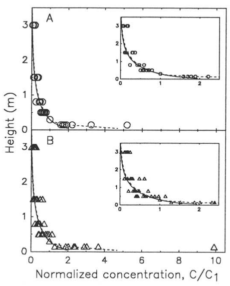


Water balance – IMPACT OF "WATER BALANCE" ON PLANTS

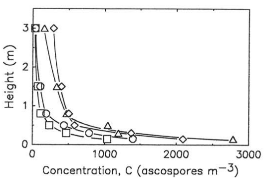
Evapotranspiration coefficient



Air flow - IMPACT OF AIR FLOWS ON PLANTS



$$U(z)\frac{\partial C(x,z)}{\partial x} = \frac{\partial}{\partial z}\left[K(z)\frac{\partial C(x,z)}{\partial z} + v_S \cdot C(x,z)\right] - G(z)\cdot C(x,z)$$



TURBULENT DIFUSION ⇄ Venturia inaequalis spatial distribution

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Summer school lessons about building SVAT models

Dragutin T. Mihailović

Lesson 1

Epistemological features

Problems in building SVAT models

a) How we see the object of interest?
b) How to make proper approximations?
c) Mathematical problems
d) Scalling problems

Problems in building SVAT models

a) How we see the object of interest?
b) ……………………………………………………
c) ……………………………………………………
d) ……………………………………………………

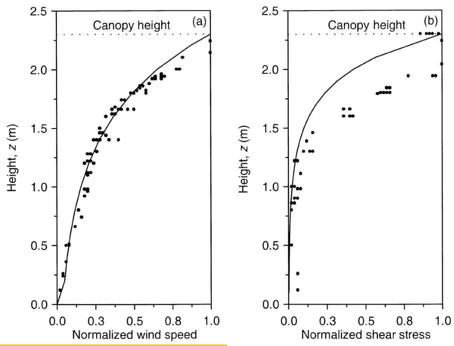
People "naively" say:

Model is the only way to approach to reality!

NO!

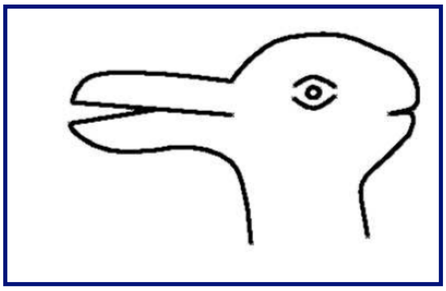
Formalization of theory cannot be older than the theory itself!!

Model is the only way to simulate a reality!



Mihailović et al., 2006, *J. App. Meteorol.*

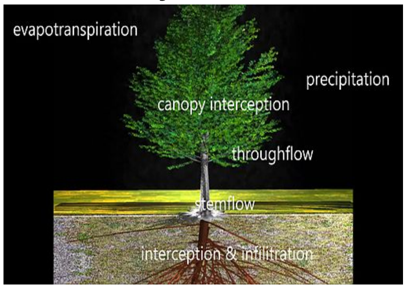
Mihailović, D.T., I. Balaž and D. Kapor, 2016: **Time and methods in modelling environmental interfaces: personal insights**. *Elsevier,* Amsterdam (in publishig dept.)



What we see as a reality?

Is it a:
1)duck
2)rabbit
or
3) both

Our reality



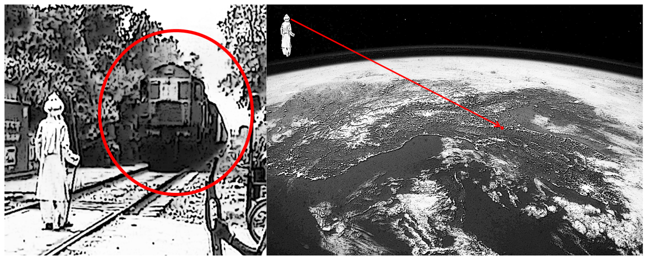
Minimum of processes

Evapotranspiration
Precipitation
Canopy interception
Throughflow
Stemflow
Interception& inflitration

Problems in building SVAT models

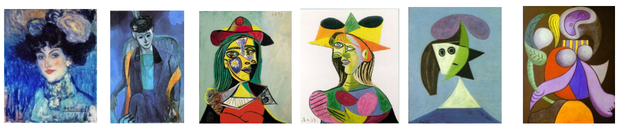
a) ....
b) How to make proper approximations?
c) ....
d) ....

The most famous approximation – material point



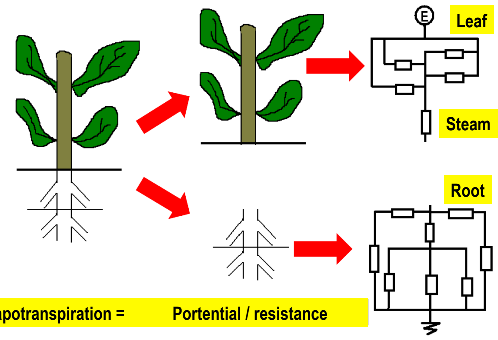
seen by bugs

bird's-eye view



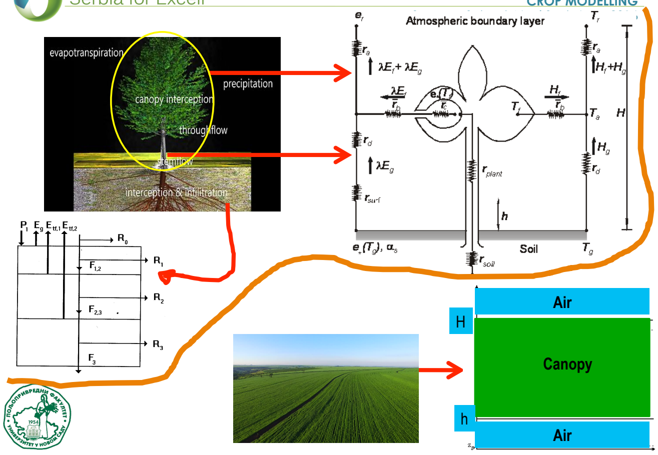
How Picasso “saw” a women 1901-1968?

How we can “see” a tree in SVAT models?

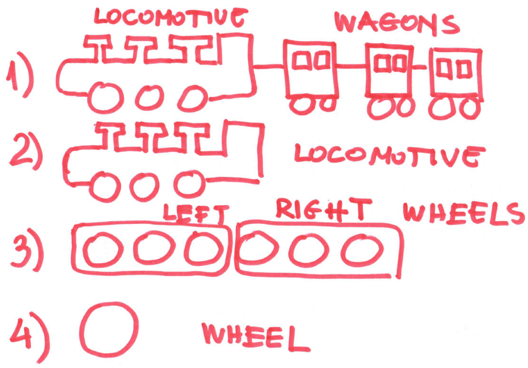


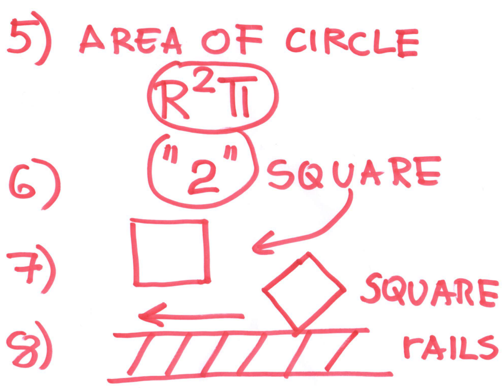
Evapotranspiration = Portential / resistance

Analogy to electronic circuit



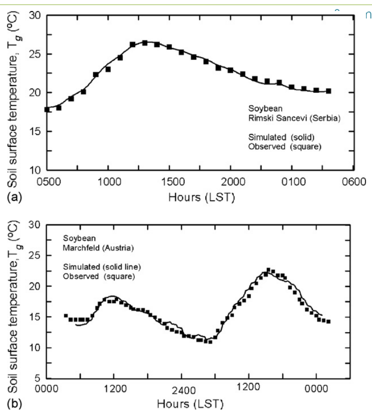
Why does a train clatter when it's moving along the tracks?



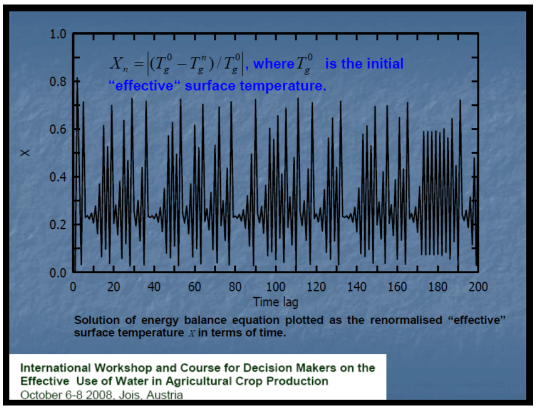


Problems in building SVAT models

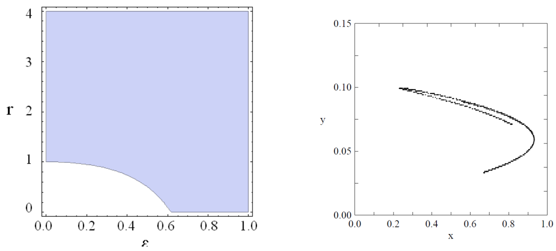
a) ....
b) ....
c) Mathematical problems
d) ....



Mihailović and Eitzinger, 2007, *Ecol. Modelling*



Chaotic behaviour of model surface variables



$$x_{n+1} = r x_n (1 - x_n) + \varepsilon y_n \qquad (6.27a)$$

$$y_{n+1} = \varepsilon (x_n + y_n) \; . \qquad (6.27b)$$

Mimić and Mihailović, 2013, *Modern Phys. Lett.*

Problems in building SVAT models

a) ....

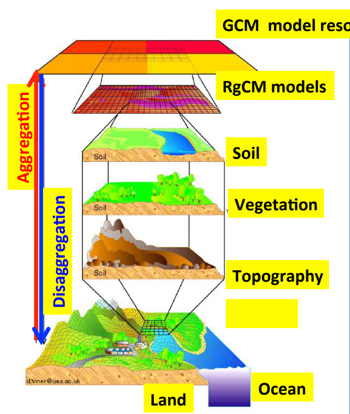
b) ....

c) ....

d) Scaling problems

Scalling problem is one of the major concern in building SVAT models

It is the lack of information on how one can aggregate and/or disaggregate various surface fluxes (heat, momentum and water vapor) from one scale to another.



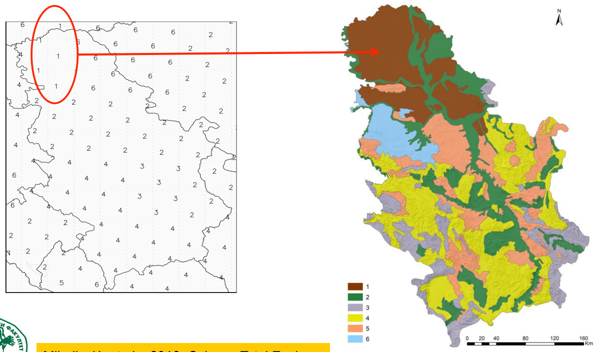
GCM is run on the coarse grid

while

LSS on the finer subgrid

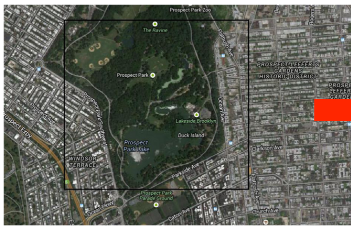
input parameters to LSS needs to be disaggregated

Disggregation of fluxes



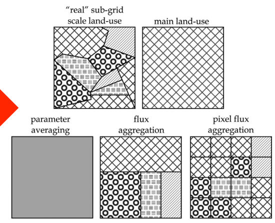
Mihailović et al., 2016, *Science Total Enviro.*

Aggregation of fluxes (Schmidt's paradox)



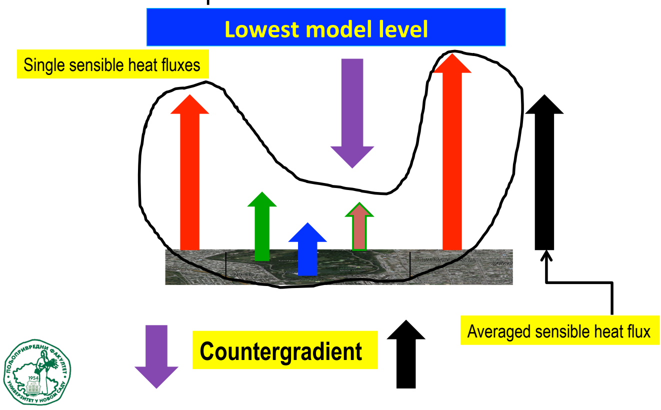
The grid-box over the Prospect park NY, USA illustrating the heterogeneous grid-box used in environmental model simulations.

Mihailović et al., 2015, *App. Math. Comp.*



Schematic diagram illustrating how the sub-grid scale surface patch-use classes are treated within the different parameterization scheme

Schmidt's paradox



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Faculty of Agriculture, University of Novi Sad, Serbia

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Lesson 2

An example with the LAPS scheme

Content

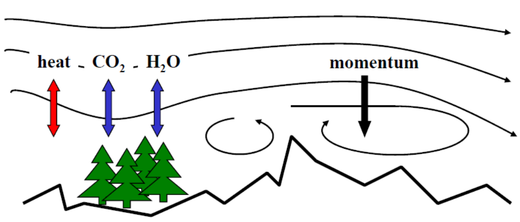
a) Introduction
b) The main features of the LAPS scheme
c) Comment of outputs
d) Uncertainities in modelling procedure

Content

a) Introduction
b) ....
c) ....
d) ....

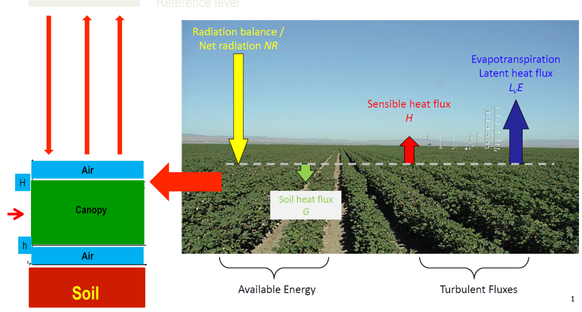
Surface Processes

The energy exchange is only but one of the possible links between the hydrosphere/biosphere/cryosphere/pedosphere and the atmosphere. Other interactions include:



- the exchange of water;
- the exchange of trace constituents (CO_2, CH_4, N_2O, ...);
- the exchange of momentum (friction!)

How LSS works?



Serbia for Excell

CROP MODELLING
Summer School, Novi Sad, June 2016

Content

a) ....
b) The main features of the LAPS scheme
c) ....
d) ....

LAPS: Soil-Vegetation-Atmosphere-Transfer model

Forcing data

- Air temperature
- Short wave radiation
- Long wave radiation
- Humidity
- Wind speed
- Precipitation
- Initial conditions
- Aerodynamic ch.
- Morphological ch.

→ L A P S →

Prognostic variables

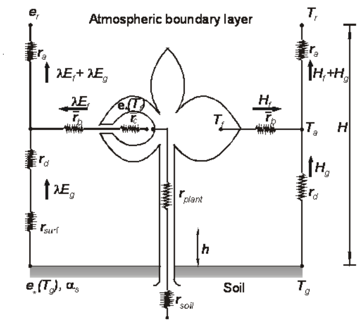
Temperatures:
leaf, ground and deep soil temperature
- Soil moisture content at three soil layers
- Leaf wetness

Main outputs

Sensible and latent heat fluxes
vegetation - canopy air space
ground - canopy air space
canopy air space - reference level
- Momentum flux
- Wind within the canopy

Serbian-French Project Meeting, 23 June 2008, Avignon (France)

LAPS: resistance representation



- Mihailovic et al. (1992), J. App. Meteor.
- Mihailovic et al. (1993), J. App. Meteor.
- Mihailovic (1994), Workshop, McQuary Univ., Sydney
- Mihailovic et al. (1995), J. App. Meteor.
- Mihailovic (1996), Global and Planetary Chang.
- Mihailovic and Kallos (1997), Bound. Layer Met.
- Mihailovic et al. (1999), Bound. Layer Met.
- Mihailovic et al., (2006), J. App. Meteor.

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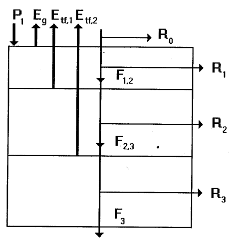
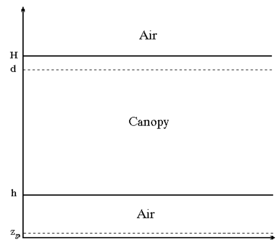
LAPS: submodels used

- **Soil – three layer model**
- **Vegetation-single layer model**





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Governing equations in the LAPS

The net radiation absorbed by the canopy and soil is assumed to be partitioned into sensible heat, latent heat, and storage terms, as

$$R_{nf} = \lambda E_f + H_f + C_f \frac{\partial T_f}{\partial t} \quad (1)$$ Prognostic

$$R_{ng} = \lambda E_g + H_g + C_g \frac{\partial T_g}{\partial t} \quad (2)$$ Prognostic

Deep soil temperature

$$\frac{\partial T_d}{\partial t} = 2\left(R_g^{net} - H_g - \lambda E_g\right)/\left(C_g\sqrt{365\pi}\right)$$

(3) Prognostic

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Governing equations in the LAPS

Water stored on the canopy

$$\frac{\partial w_f}{\partial t} = P_f - E_{wf}/\rho_w$$ Prognostic

The volumetric soil water content

$$\frac{\partial w_1}{\partial t} = \frac{1}{D_1}\left\{P_l - F_{1,2} - \frac{E_g + E_{tf,1}}{\rho_w} - R_0 - R_1\right\}$$

$$\frac{\partial w_2}{\partial t} = \frac{1}{D_2}\left\{F_{1,2} - F_{2,3} - E_{tf,2}/\rho_w - R_2\right\}$$

$$\frac{\partial w_3}{\partial t} = \frac{1}{D_3}\left\{F_{2,3} - F_3 - R_3\right\}$$ Prognostic

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Content

a) ....
b) ....
c) Comment of outputs
d) ....

Outputs

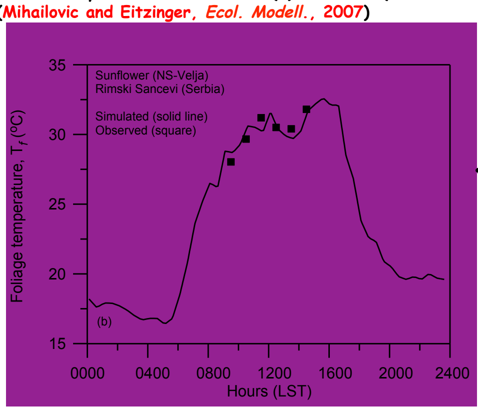
Ground surface temperature T_g

Leaf temperature T_l

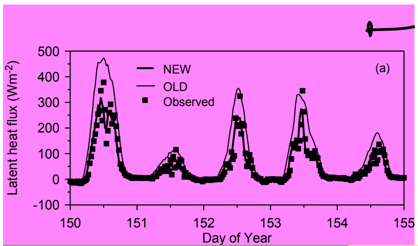
Water intercepted by leafes W_l

Soil moisture content in three layers W_l, W_2 and W_3

Daily variations (19 July 1998) of the sunflower foliage temperature: (1) simulated by the LAPS model and (2) measured (Rimski Sancevi, SERBIA) (Mihailovic and Eitzinger, *Ecol. Modell.*, 2007)



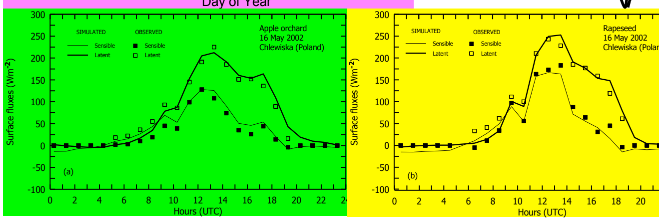
NCEP
LAPS



Temporal variation of latent heat flux and obtained by the LAPS scheme compared with the observations over a soybean field in Caumont site (France) during its growing season in 1986 (*Mihailovic et al., 2006, J. App. Meteor.*)

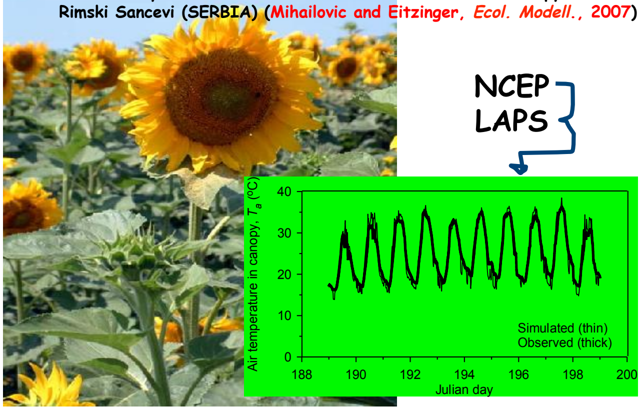
Diurnal variations of latent and sensible heat fluxes over (a) apple orchard, (b) rapeseed in Chlewiska (Poland) for 16 May 2002 (*Mihailovic et al., Ther. App. Climat. - in revision*)

Measured values provided by the Poznan Agric. University Group



Ten-day variation (8-17 July 2002) of within-canopy air temperature simulated by the LAPS and observed inside a sunflower canopy at the Rimski Sancevi (SERBIA) (Mihailovic and Eitzinger, *Ecol. Modell.*, 2007)

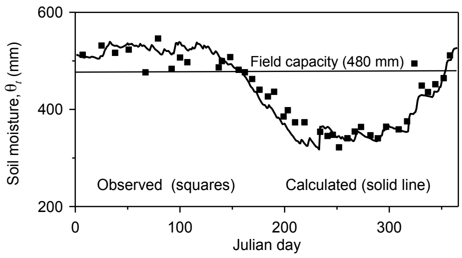
NCEP
LAPS



Water transfer modelling: Soil

(WRF Modelling System - NMM) + LAPS
(forcing data)

Daily averages of total soil water content (mm) over a depth of 1.6 m simulated by the LAPS and observed beneath a soybean canopy in HAPEX experiment at the Caumont (France) (Mihailovic et al., 1998, *J. Hydrol.*)



Serbia for Excell

CROP MODELLING

Summer School, Novi Sad, June 2016

Content

a) ……………………………………………………

b) ……………………………………………………

c) ……………………………………………………

d) Uncertainities in modelling procedure

The energy balance equation is valid on LOCAL and GLOBAL scale (Rosenberg, 1983)

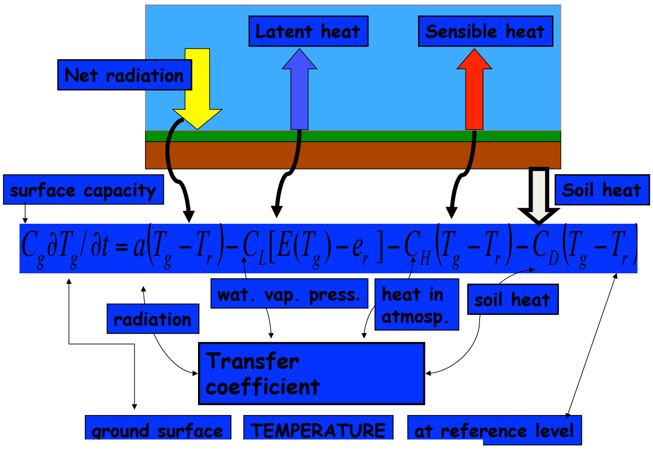
In order to calculate surface temperature T_s we can use one of the following methods

1) solving this transcendental equation for T_s

2) solving this equation in F.D. form

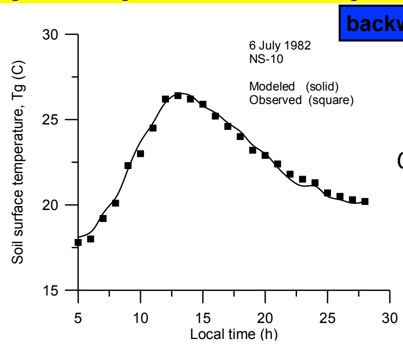
$$R_n(T_s) + S(T_s) + LE(T_s) + PS(T_s) + M(T_s) = 0$$

$$C_g\, \partial T_s / \partial t = R_n(T_s) - S(T_s) - LE(T_s) - PS(T_s) - M(T_s)$$



$$T_g^{\,n+1} = T_g^{\,n} + F^n / (\Delta t / C_g + (\delta F^n / \delta T_g^{\,n}))$$

backward scheme in time

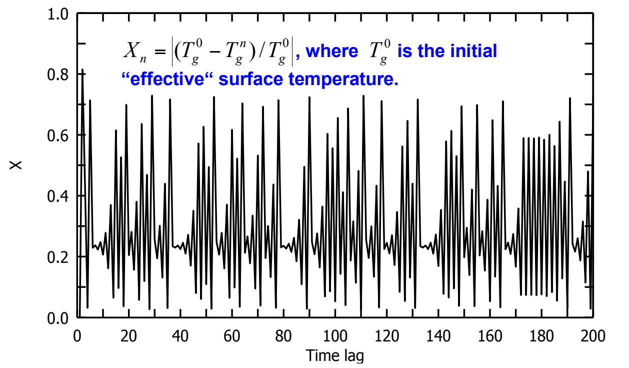


in this form

n time level

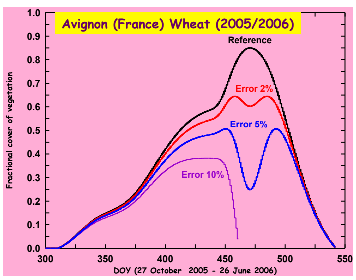
Δt time step solution

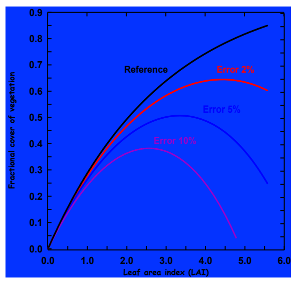
(Mihailovic and Lalic, 1995)



Solution of energy balance equation plotted as the renormalised "effective" surface temperature x in terms of time.

Error in estimation of vegetation fractional cover



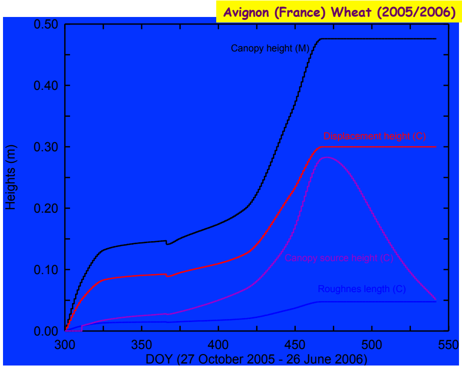


$\Delta\sigma = (1-\exp(-k*LAI*r))/\exp(k*LAI)$

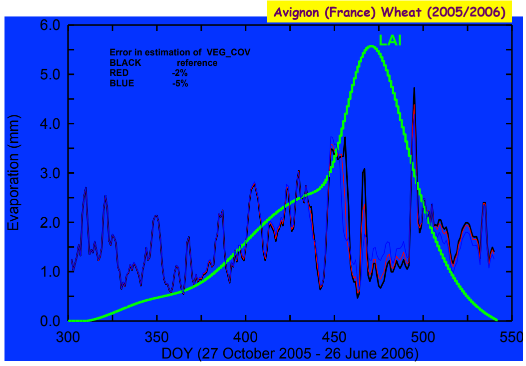
$K=0.34$

$r = \Delta LAI/LAI$

Error in estimation of vegetation fractional cover

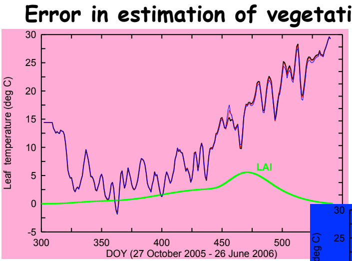


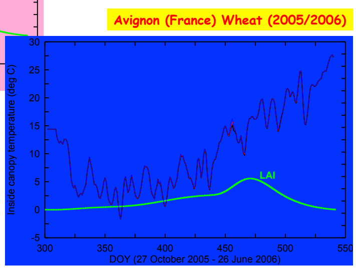
Error in estimation of vegetation fractional cover



International Workshop and Course for Decision Makers on the Effective Use of Water in Agricultural Crop Production
October 6-8 2008, Jois, Austria

Error in estimation of vegetation fractional cover





Calculation performed according to LAPS scheme

(Theor.App. Clim., Mihailovic et al., 2008)

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Poljoprivredni fakultet Univerzitet u Novom Sadu
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Università degli Studi Firenze
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BOKU
European Commission
Horizon 2020

AgMnet INTERNATIONAL SUMMER SCHOOL IN AGROMETEOROLOGY AND CROP MODELLING

27 June – 01 July 2016
Novi Sad, SERBIA

Serbia for Excell
H2020-TWINN-2015

Summer school lessons about building SVAT models

Dragutin T. Mihailović

Faculty of Agriculture, University of Novi Sad, Serbia

Summer school lessons about building SVAT models

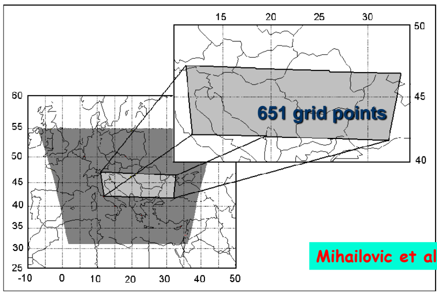
Dragutin T. Mihailović

Lesson 3

Links with other models

UFPA Universidade Federal do Pará

Regional climate 3- D simulations



Mihailovic et al., 2004, JAM

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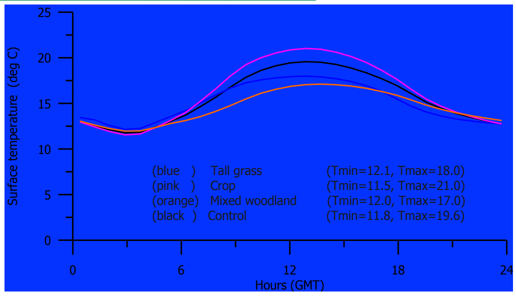
UFPA Universidade Federal do Pará

Surface temperature

Sensitivity of mean surface temperature to cover type. The hourly means were made using all grid points in the domain of interest.

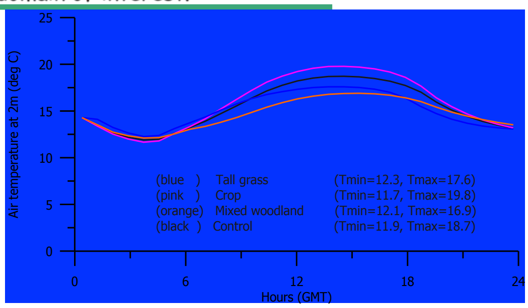


Mihailovic, D. T., 2003: Implementation of Land-Air Parameterization Scheme (LAPS) in a limited area model. Final Report, The New York State Energy Conservation and Development Authority, Albany, NY, 110 pp.

Air temperature at 2m

UFPA Universidade Federal do Pará

The hourly means were made using all grid points in the domain of interest.



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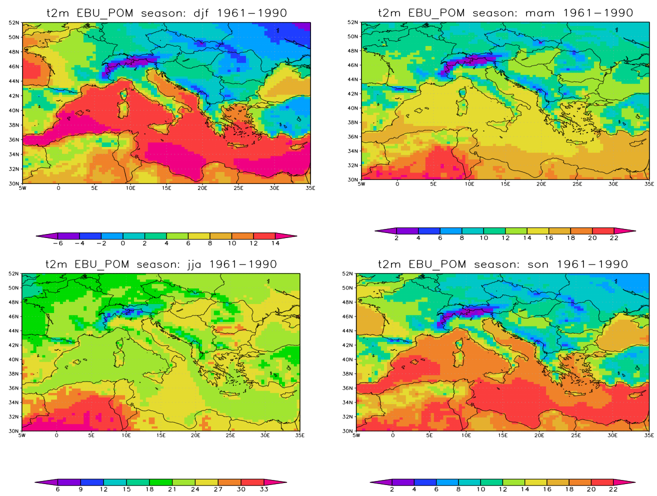
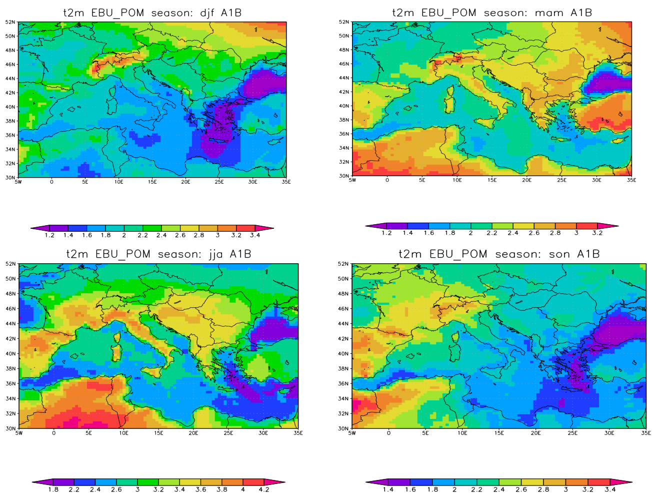


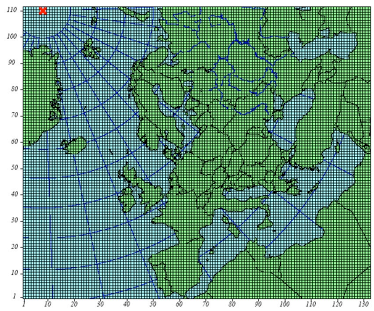


3) Chemical Transport Models

Chemical transport models

While related general circulation models (GCMs) focus on simulating overall atmospheric dynamics (e.g. fluid and heat flows), a CTM instead focuses on the stocks and flows of one or more chemical species

5th International Summer School
"Renewable Energy & Energy Efficiency in South East Europe"
10 – 21 August 2009, Fojnica, Bosnia and Herzegovina



Domain of integration

iEMSs 2006
July 9-13, 2006
The Wyndham Hotel, Burlington, Vermont, USA
Page 10

5th International Summer School
"Renewable Energy & Energy Efficiency in South East Europe"
10 – 21 August 2009, Fojnica, Bosnia and Herzegovina

- ♥ The Unified EMEP model (UNIT-ACID, rv2_0_9) with no photochemistry - Berge and Jacobsen [1998].
- ♥ The model uses the same horizontal and vertical grid as the meteorological data (Simpson et al. [2003])
- ♥ Polar-stereographic projection
- ♥ The lowest level located nearly 92 m in depth
- ♥ The horizontal grid of the model is the Arakawa C grid
- ♥ The Unified EMEP model uses 3-hourly resolution meteorological data from the dedicated version of the HIRAM
- ♥ The horizontal winds are given on a staggered grid (this is also the case with the vertical wind component. All other variables are given in the center of the grid. Linear interpolation between the 3-hourly values is used to calculate values of the meteorological input data at each advection step.
- ♥ The time step used in the simulation was 600 s. We performed the runs for the following years: 1999, 2001 and 2002.

Mihailović et al., *Environ. Sci. Poll. Res. Int.* (2008, 2009)
To activate EMEP with new meteorology
(advection, surface processes and boundary layer)

5th International Summer School
"Renewable Energy & Energy Efficiency in South East Europe"
10 – 21 August 2009, Fojnica, Bosnia and Herzegovina

5 Transboundary Fluxes in 2002

5.1 Oxidised sulphur deposition

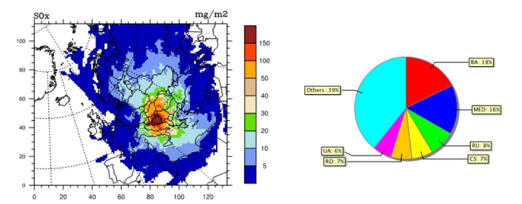
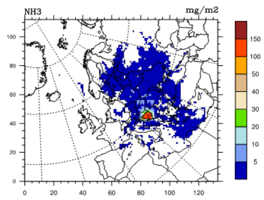


Figure 4: Contribution of emissions from Bosnia and Herzegovina to oxidised sulphur deposition in Europe. Units: mg(S)/m^2. Pie chart shows the six main receptor areas of oxidised sulphur deposition from Bosnia and Herzegovina. Units: (%).

5.3 Reduced nitrogen deposition



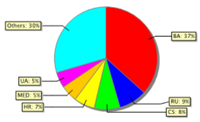


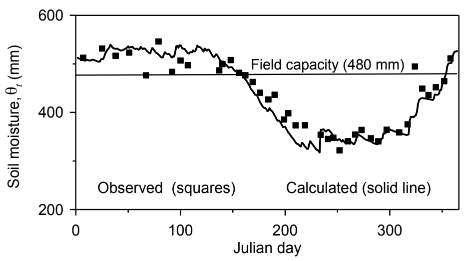
Figure 8: Contribution of emissions from Bosnia and Herzegovina to reduced nitrogen deposition in Europe. Units: mg(N)/m^2. Pie chart shows the six main receptor areas of reduced nitrogen deposition from Bosnia and Herzegovina. Units: (%).

6) Hydrological Models

Water transfer modelling: Soil

(WRF Modelling System - NMM) + LAPS (forcing data)

Daily averages of total soil water content (mm) over a depth of 1.6 m simulated by the LAPS and observed beneath a soybean canopy in HAPEX experiment at the Caumont (France) (Mihailovic et al., 1998, *J. Hydrol.*)

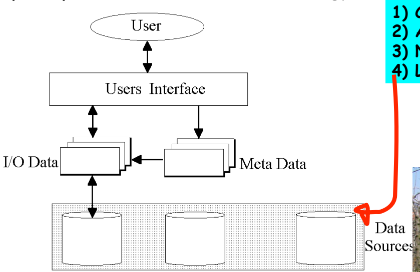


7) Forecasting the Occurrence of Plant Diseases

BAHUS

biometeorological system for predicting the occurrence of diseases in plant production (Center for Meteorology and Envoronmental Predictions)

1) Clamatological data
2) Automatic weather station
3) NCEP outputs (mesoscale)
4) LAPS surface scheme



Venturia inequalis
Ervinia amylovora
Plasmopra vitiocola

(Mihailovic et al., *Envir. Modell. Soft.*, 2001)

FP6 project ADAGIO

8) Modelling of the UV radiation

NEOPLANTA computes the:

1) solar direct and diffuse UV irradiances under cloud free conditions for the wavelength range 280–400 nm and UV index
2) effects of O3, SO2, NO2, aerosols, and nine different ground surface types on UV radiation are included.
3) instantaneous spectral irradiance for a given solar zenith angle
4) UV index for the whole day at half-hour intervals from sunrise to sunset

Modelling details:

5) atmosphere is divided into several parallel layers (maximum 40) in the model
6) it is assumed that the layers are homogeneous with constant values of meteorological parameters
7) vertical resolution of the model is 1 km for altitudes below 25 km and 5 km above this height.
8) upper boundary of the highest layer in the model is 100 km
9) model uses standard atmosphere meteorological profiles
10) there is also an option of including the real-time meteorological data profiles from the **high-level resolution mesoscale**

(WRF Modelling System - NMM) + LAPS
(forcing data)

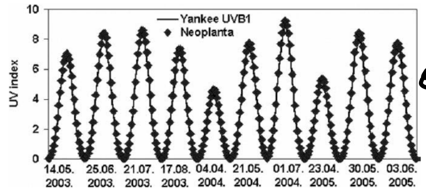


FIG. 1. Variation of the UVI obtained by the NEOPLANTA model in comparison with the observations in Novi Sad for cloudless days.

NEOPLANTA: A Short Description of the First Serbian UV Index Model **Authors:** Malinovic, S., Mihailovic, D.T., Kapor, D., Mijatovic, Z., Arsenic, I.D., **Publication:** Journal of Applied Meteorology and Climatology, vol. 45, Issue 8, p.1171-1177