Modèle SurfAtm

Fiche de présentation

SurfAtm en quelques mots

SurfAtm is a model of pollutant exchange between the biosphere and the atmosphere. It is a bi-directional two-layer resistive model for heat and pollutant. This model distinguishes the soil and the plant layers: it describes the exchanges in terms of adsorption to leaf cuticles and bi-directional transport through leaf stomata and soil. SurfAtm combines a resistive approach for the energy balance and is implemented for ammonia (NH3) ozone (O3) and pesticides. Regarding NH3, it incorporates a compensation point for both stomata and litter or soil, and a cuticular pathway. It has been validated for a grassland. Regarding O3, it includes stomatal, cuticular and soil deposition pathways whatever the canopy development, and is currently validated for maize and wheat. Regarding pesticides, it calculates the pesticide volatilisation just after application, integrating the cuticle penetration and photodegradation of the pesticide.

Laboratoire de développement : UMR 1091, Environnement et Grandes Cultures, INRA/AgroPArisTech

Site internet : http://www6.versailles-grignon.inra.fr/egc/Productions/Logiciels-Modeles/The-Surfatm-model

Contact : Erwan Personne (erwan.personne@agroparistech.fr)

Description détaillée

The resistance approach is schematised in Figure 1 (reprint from Personne et al. 2009).

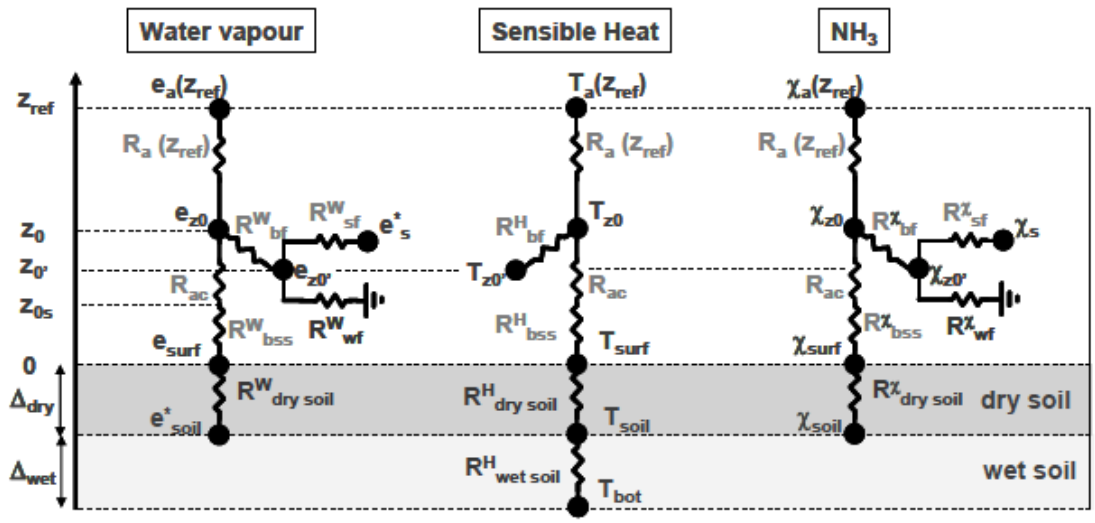

Figure 1. Resistive scheme for water vapour, heat, and pollutant exchange models, where z is the height above ground; e, T and c refer to the water vapour partial pressure, the temperature and the pollutant concentration respectively; Ra, Rac, Rbf, Rbs, Rdry soil, Rwet soil, Rsf and Rwf are the aerodynamic resistance, the canopy aerodynamic resistance, the leaf boundary layer resistance, the soil boundary layer resistance, the soil dry resistance, the soil wet resistance, the stomatal resistance and the cuticular resistance, respectively; indexes ref, a, z0, z0', z0s, s, surf, soil, and bot, refers to reference, atmospheric, canopy roughness height for momentum, canopy roughness height for scalars, soil roughness height, soil boundary, soil surface, dry/wet boundary in the soil, and bottom of the wet boundary in the soil, respectively, Ddry and Dwet are the heights of the dry and wet soil compartments respectively.

At the field scale, Surfatm calculates every 30 minutes:

- the energy balance of the soil and plant surfaces;
- the temperatures of soil surface, air inside the plant canopy, and foliage surface;
- the soil water balance;

- the heat fluxes (latent and sensible) above the canopy;
- the pollutant fluxes above the canopy;
- the partition of the heat and pollutant fluxes between the soil and the plant layers.

Initialisation, paramètres ajustables, variables d'entrée / forçages

SURFATM requires as input, the soil characteristics, the vegetation stand structure, and the meteorological data and the concentration at a reference height zref every 30 minutes:

- Meteorological forcing at a reference height zref:
  - air temperature (Ta),
  - relative humidity (RH),
  - net radiation and (Rn),
  - wind speed (U),
  - precipitation (P).
- Soil characteristics:
  - soil density and porosity
  - field capacity,
  - wilting point
  - dry soil humidity in order to define thesoil water availability for plants.
  - thermal conductivity for wet and dry soil
- Vegetation stand structure:
  - single sided leaf area index (LAI)
  - height of the canopy (hc).

Concerning the stomatal regulation, it integrates a multiplicative model that describes leaf stomatal conductance as a function of plant species and environmental variables (leaf temperature, photosynthetically active radiation, leaf-to-air vapour pressure deficit and soil water potential). The leaf stomatal resistance is calculated following Emberson et al. (2000) and Tuovinen et al. (2004) (see the "EMEP" parameterisation).

Caractéristiques techniques

- Logiciel pré-requis : no
- Langage informatique : « C »
- Système d'exploitation : Windows or Linux

Variables de sortie principales

Surfatm outputs the following data:

- Energy balance
  - H, LE, G (sensible heat, latent heat and soil conduction fluxes)
  - a repartition between the soil and vegetation surfaces.
- Temperatures and humidity:
  - at the soil surface,
  - at the leaf surface,
  - within canopy.
- Concentrations (NH3, O3, or pesticides):
  - at the soil surface,
  - at the leaf surface,
  - within the canopy.
- Fluxes
  - above the canopy,
  - at the soil surface,
  - across the stomata,
  - at the leaf surface (cuticle).

Couplage

SurfAtm est couplé avec :

- Volt'Air
- FIDES-SurfAtm
- NITROSCAPE…

Utilisateurs

* Network for students (Master of Sciences, AgroParisTech engineer)

* Tested for comparisons and understanding of processes by UMR EGC (FR), EPA (US), SEI (SE), ECLAIRE community (EU project), NOAA PhD student

Publications - Références

Personne, E., Loubet, B., Herrmann, B., Mattsson, M., Schjoerring, J. K., Nemitz, E., Sutton, M. A., and Cellier, P.: SURFATM-NH3: a model combining the surface energy balance and bidirectional exchanges of ammonia applied at the field scale, Biogeosciences, 6, 1371–1388, doi:10.5194/bg-6-1371-2009, 2009.

P. Stella, E. Personne, B. Loubet, E. Lamaud, E. Ceschia, P. Béziat, J. M. Bonnefond, M. Irvine, P. Keravec, N. Mascher, and P. Cellier: Predicting and partitioning ozone fluxes to maize crops from sowing to harvest: the Surfatm-O3 model , Biogeosciences Discuss., 8, 6701-6741, 2011.

Lichiheb N., Personne E., Bedos C., Barriuso E., 2014. Adaptation of a resistive model to pesticide volatilization from plants at the field scale: Comparison with a dataset. Atmospheric Environment, 83, 260-268.