URD_10

Title of the doctoral program

Urban and regional development

Title of the research activity

Physical Exchange Processes in the Soil and the Surface Boundary Layer

Short description of the research activity

The parametrizations of physical exchange processes between soil and atmosphere and water fluxes into the soil have been measured and simulated in our studies. Some examples of our research activities are:

- The interpretation of field measurements of water retention were analyzed in relation to hysteresis phenomena. Experimental data sets from three different field soils were used to clearly demonstrate how the lack of hysteresis knowledge can lead to an inconsistent and incorrect interpretation of the retention data, and therefore to the incorrect estimation of soil hydraulic parameters. By using a hysteresis model to interpret this same data set, it was shown that consistent and reliable estimates of soil retention parameters could be obtained (Canone et al., 2008).
- A TDR probe for loose materials water content measurements was developed. The probe ensure optimum working conditions in terms of ease of insertion into the porous medium, contact with the surrounding porous medium, and homogeneity and confinement of electrical energy storage. The performance of the probe was tested on three porous media: a sandy soil and decomposed and undecomposed litter taken from four different sources of forest material (Canone et al., 2009).
- Micro-basins for the harvesting of rainfall and runoff water built out of earth and stones on hillslopes around cultivated trees were analyzed. Measurements were taken in a hilly region of Central Tunisia. The time domain reflectometry technique was used to measure soil moisture inside and outside the micro-basins to assess their effect on soil water retention (Previati et al., 2010).
- Larch wood (Larix decidua Mill.) logs at different degradation levels were analyzed by surveying their water content with the time domain reflectometry (TDR) technique. The laboratory analysis was performed to calibrate the water content measurements performed by TDR with those obtained with the gravimetric method. Three field campaigns were conducted in three different check dams built between 1950 and 2003. The TDR calibration curve allowed for the determination of the volumetric wood water content with satisfactory accuracy. Finally, we found an operative way to relate the wood water content to the wood degradation level (Previati et al., 2012).
- Soil water dynamics at a midlatitude test site were analyzed by employing three box models in a regularly monitored experimental site in northwestern Italy. The models include increasingly complex representations of leakage and evapotranspiration processes. The models were forced with the local rainfall, and the model parameters were determined with a least-square minimization procedure. summer and annual dynamics were separately studied. The models were tested both in simulation mode, estimating their parameters from the same data used to verify them, and in forecast mode, determining the model parameters from one period, and using them to forecast soil water dynamics in a different period. The results indicated that simple box models can estimate soil water dynamics at midlatitudes, using rainfall as the only meteorological driver (Baudena et al., 2012).
- The parametrizations of physical exchange processes in the surface boundary layer involving vegetation, bare soil, snow, ice and water surfaces and related to the radiative budget, the energy and hydrological budgets have been analyzed and implemented in a numerical model. The original version of this model was called LSPM (acronym of Land Surface Process Model) and was regularly updated and improved by adding new processes, parameterizations and algorythms. The first stable version of the LSPM was obtained in the 1994 and publshed one year later ([Cassardo et al., 1995]). The dependence on the initialization has also been investigated [Cassardo et al., 1998].

- The snow parameterization was considered in the 1998, and tested using 6 years of Russian observations carried out in Siberia [Cassardo and Balsamo, 1999]. The question of the initialization was again investigated some years later, due to its influence in the results quality ([Cassardo et al., 2002]). One of the output variables tested by an intercomparison with observations was the leaf wetness ([Cassardo et al., 2003]). Again, a sensitivity analysis [Cassardo et al., 2005] was performed on the LSPM in order to check the dependence of the results (namely, energy and hydrological budget components) from the initial conditions (namely, soil temperature and moisture) on the synoptic scale; the results were used to identify the minimum spinup time of the model. The last documented version of the LSPM is the 2006 ([Cassardo, 2006]).
- At the January 2010, the LSPM changed its name in UTOPIA, acronym of the University of TOrino land surface Process Interaction model in Atmosphere. Despite the change of its name, there is a continuity between the two models, and the UTOPIA can be considered as the evolution of the old LSPM. The last documented version of the UTOPIA is the 2011 ([Cassardo, 2011]).

Scientific responsible (name, surname, role, email)

Stefano Ferraris, Associate Professor, stefano.ferraris@unito.it
Claudio Cassardo, Associate Professor, claudio.cassardo@unito.it
Davide Canone, Assistant Professor, davide.canone@unito.it

Number of vacancies for XXXI cycle (3 years program)

2

Specific requirements (experiences, skills)

Knowledge in hydraulics, hydrology, meteorology or climatology.

Website of the research group (if any)