Remote sensing data and land surface flux aggregation modelling

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Satellite remote sensing provides a detailed and accurate mapping of land surface parameters with a reasonable time resolution. However the information is only useful for weather forecasting (and climate modelling) and other large-scale application under the condition that the fine-scale information is quickly and reliably averaged to grid-averaged values. The grid averaged-values are those that enter the larger scale model. These grid-values are also often called effective values. Averaging to grid-cell resolution is readily done for parameters where non-linear effects are insignificant (e.g. albedo) whereas for parameters such as aerodynamic roughness and surface temperature this is not the case. A micro-scale surface flux aggregation method has been developed and it has been tested and validated for several landscape types. The aggregation routine is based upon a physical description of turbulent atmospheric flow over inhomogenieties in the landscape, i.e. abrupt changes in land cover type, roughness, surface temperature and LAI. The atmospheric flow adjusts itself to every new surface characteristic downwind from a transition. The relaxation time (and distance) towards full equilibrium with the new surface is typically longer than the distance to the next step change within typical landscapes. The non-linear turbulent responses are a function of the flow and the upwind history (the flow 'remembers' the past surface conditions) and this is included in the aggregation scheme. The aggregation model is capable of providing the effective values of the roughness for momentum, the roughness for scalars, the surface momentum flux and the surface sensible heat flux. The model is also able to 'downscale' from larger grid values to the local surface. This downscaling is linked to every physical point in the two-dimensional domain mapped from the satellites pixels. The flow model is based on balancing the terms of the advection term and the diffusion term, and the flow equations are linearized and solved by Fast Fourier Transform. This makes the model computationally fast. Results from the aggregation model are successfully compared to other model data and to field observations of roughness, momentum flux and sensible heat flux at various sites within Europe including rural areas in the Rhine Valley (D), the Alpilles (F), Foulum (DK) and forested/rural area in Sodankyla (FIN). For Denmark grid-averaged values of roughness for momentum has also been verified at two other sites (Boerglum and Tystofte) and then tested successfully in the HIRLAM weather forecasting model using meteorological observations from the Danish Meteorological Institute stations within Denmark. The above work is related to projects: RS-model, SAT-MAP-CLIMATE, EU-WINTEX, EU-WATERMED and EU-TRACT. Current collaboration include USDA (USA) using remote sensing data from the SMACEX 2002 experiment in Iowa, aiming for testing the results in the operational ALEXI/DISALEXI model at University of Wisconsin (USA).