

Project "Hydrology / Remote Sensing"

Modeling of water and nitrogen fluxes at the land surface using remote sensing

Project period: 01.01.2001 - 31.12.2008

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Brief Description:

The major scope of the project "Hydrology and Remote Sensing" is the realistic and physically-based description of the radiation budget and the water and nitrogen fluxes at the land surface in mesoscale watersheds. A spatially distributed, mesoscale hydrologic object für the Upper Danube has been developed. As part of the integrated modelling system DANUBIA, it simulates the energy and water fluxes in the soil-plant-vegetation system and the nitrogen transformation and transport in the soil root zone on a 1 km² modeling grid. The project-team is in charge for the development of the sub-models *RadiationBalance* (for the modelig of the radiation balance and the radiation distribution in the canopy), *Surface* (for the simulation of water and energy exchange directly at the land surface), and *Soil* (for the modeling of runoff formation, groundwater recharge and nitrogen transformation in the soil root zone). These models, along with the model components *Biological* and *Snow*, are embedded in the *Landsurface*-object. The functioning of the respective objects is secured by means of sensitivity analyses, and the validation against point measurements as well as regional and sub-watershed based water balance calculations. Furtherly, the sub-model *AtmoStations* has been developed, providing spatially distributed meteorological parameter fields derived from historic point measurements provided by the national weather services. For the implementation in the DANUBIA system, direct interfaces have been established to the respective objects of the sub-projects Meteorology (*Atmosphere*), Groundwater (*GroundwaterFlow*), Surface Waters (*RiverNetwork*) and Actors (*Household*, *Tourist*, and *Farming*).

Land surface parameters are retrieved from high- to medium resolution remote sensing sensors, especially from the TERRA and ENVISAT system. These informations are required for the initialization, validation and regionalization of the developed model algorithms. Emphasis is given to vegetation parameters, such as LAI and biomass, and to the disaggregation of statistical data onto the model grid.

Based on available sub-scale information, derived from remote sensing imagery, conventional station recording or field sampling of geo-factors such as topography, land use and soil, strategies have been developed to upscale hydrologically relevant information from the micro- to the mesoscale. The technique is utilizing sub-scale parameterizations, Geocomplexes, by assigning typical topograhny and

soil characteristics to each land-cover class in a 1km² spatial model unit, and hence considerably reduces the uncertainty associated to mesoscale hydrologic simulation.

Publications

- Ludwig, R., Mauser, W., Niemeyer, S., Colgan, A., Stolz, R., Escher-Vetter, H., Kuhn, M., Reichstein, M., Tenhunen, J., Kraus, A., Ludwig, M., Barth, M., Hennicker, R. (2003) „Web-based modeling of water, energy and matter fluxes to support decision making in mesoscale catchments – the integrative perspective of GLOWA-Danube“. In: *Physics and Chemistry of the Earth* 28, S. 621-634
- Ludwig, R., Probeck, M., Mauser, W. (2003) : “Mesoscale water balance modelling in the Upper Danube watershed using sub-scale land cover information derived from NOAA-AVHRR imagery and GIS-techniques“. In: *Physics and Chemistry of the Earth* 28, S. 1351–1364
- Mauser, W., A. Becker, P.Speth, P.Vlek (2001): Integrated River Basin Management – the GLOWA projects; 1st Global Change Open Science Conference, Amsterdam, July 10-13, 2001 “Challenges of a Changing Earth”, Abstract of Oral Presentation, (www.sciconf.igbp.kva.se), p.54
- Mauser, W., A. Becker, J. Tenhunen, K. Schneider (2001): Water in Complex Landscapes: Recent Achievements by German Research Groups, in: D. Heinen et.al.(Edts): Contributions to Global Change Research, A Report by the German National Committee on Global Change Research, pp. 54-59
- Mauser, W., Ludwig, R. (2002): GLOWA-DANUBE – A research concept to develop integrative techniques, scenarios and strategies regarding global changes of the water cycle. In: Beniston, M. (ed), Climatic Change: Implications for the Hydrological Cycle and for Water Management. Advances in Global Change Research, 10. Kluwer Academic Publishers, Dordrecht and Boston, pages 171-188
- Mauser, W., R. Ludwig, R. Stolz, T. Vogel, S. Dabbert, T. Winter, S. Herrmann (2002): Integrative Techniken, Szenarien und Strategien zum Globalen Wandel des Wasserkreislaufs am Beispiel des Einzugsgebiets der Oberen Donau, in: R. Böcker (Hrsg.): Globale Klimaänderung und Ernährungssicherung, 34. Hohenheimer Umwelttagung 2002, S.157-163, Verlag Günter Heimbach
- Mauser, W., Colgan, A., Ludwig, R., Niemeyer, S., Probeck, M., Reichert, D., Stolz, R. (2002): GLOWA-Danube - Werkzeuge zum Integrativen Einzugsgebietsmanagement der Oberen Donau. Münchener Geographische Abhandlungen A52, pp. 275-285
- Mauser, W., Ludwig, R., Niemeyer, S. (2003): GLOWA-Danube – Integrative hydrologische Modellentwicklung zur Behandlung von Global Change Szenarien beim Einzugsgebietsmanagement – erste Erfahrungen. Tagungsband "Tag der Hydrologie", Universität Freiburg, S. 235 - 242
- Niemeyer, S., Mauser, W., Ludwig, R., Stolz, R. (2002): “GLOWA-Danube: Integrative Techniques, Scenarios and Strategies regarding the Global Change of the Water Cycle“. In: *21st Conference of Danube Countries on Hydrological Forecasting and Hydrological Bases of Water Management. Bukarest, Sept. 2-6, 2002*
- Niemeyer, S., Ludwig, R., Mauser, W. (2002): “Integrative Modelling in the Upper Danube catchment – GLOWA-Danube and the DANUBIA Decision Support System.“ In: *Proc. Int. Conference on Policies and Tools for Sustainable Water Management in the EU. Venedig, Italien, Nov. 21-23, 2002*
- Probeck, M., Ludwig, R., Mauser, W. (2003): Spectral unmixing of sub-scale land cover from multitemporal NOAA-AVHRR imagery using a combined GIS- and fuzzy logic approach. Proceedings of the 2nd International Workshop on the Analysis of Multitemporal Remote Sensing Data (MultiTemp-2003). Ispra, Italy 16-18 July 2003 (in print)
- Probeck, M., Ludwig, R., Mauser, W. (2004): “Fusion of NOAA-AVHRR imagery and GIS-techniques to derive subscale land cover information for the Upper Danube watershed.“ In: *Hydrologic Processes*, (in print)
- Reichert, D., Ludwig, R., Mauser, W. (2003): Subskalige Modellierung hydrologischer Prozesse in mesoskaligen Einzugsgebieten. In: Hennrich, K. et al. (Hrsg.): Flußgebietsmanagement – 6. Workshop zur Großskaligen Modellierung in der Hydrologie, Magdeburg 2002. Kassel University Press, S. 21-32.
- Reichert, D., Ludwig, R., Mauser, W. (2004): Flächenverteilte Modellierung der Wasserflüsse in einem mesoskaligen Einzugsgebiet – Ergebnisse mit dem Skalierungsansatz „Geokomplexe“; In: Ludwig, R. (Hrsg.): Neue methodische Ansätze zur Modellierung der Wasser- und Stoffumsätze in großen Einzugsgebieten – 7. Workshop zur Großskaligen Modellierung in der Hydrologie, München 2003.

Workshops/Events

- *Workshop „Advances in Global Change Research“*, Wengen (CH), 09/2000
Presentation: "GLOWA-Danube – Integrative Techniques, Scenarios and Strategies regarding the Global Change of the Water Cycle" (Mauser)
- *ATV-DVWK „Tag der Hydrologie“*, München 22./23.03.2001
Presentation: „Integrative, transdisziplinäre Ansätze in GLOWA-Danube“ (Ludwig)
- *XXVI General Assembly of the European Geophysical Society*, Nizza, 23.- 27.3.2001
Presentation: "Integrative Techniques, Scenarios and Strategies regarding the Water Cycle in the Upper Danube Watershed" (Ludwig)
- *Jahrestagung des AK Hydrologie der Dt. Geogr. Gesellschaft*, Trier, 04/2001,
Posterpresentation (Ludwig)
- *Jahrestagung des AK Hydrologie der Dt. Geogr. Gesellschaft*, Berlin, 10.- 12. März 2002
Presentation: „Fusion of NOAA-AVHRR imagery and GIS-techniques to derive subscale land cover information for water balance modelling in the Upper Danube “ (Probeck)
- *XXVII General Assembly of the European Geophysical Society*, Nizza, 21.- 26.4.2002
Presentation: "Water balance modelling in the Upper Danube using subscale land use information derived from fuzzy based GIS-techniques and remote sensing" (Ludwig)
Presentation: "Network based modeling of mesoscale catchments – The land surface perspective of GLOWA-Danube" (Ludwig)
- *GLOWA-Status Conference*, Munich, 08.-10.5.02
Presentation: „Land Surface Processes within GLOWA-Danube“ (Niemeyer)
Posterpräsentationen: „The Landsurface-Object“ (Teilprojekte Landsurface)
- *Ecosystem Management in Cultural Landscapes*. Berchtesgaden, 23.-24.5.02, Training Course, (Niemeyer)
- *21st Conference of Danube Countries on the Hydrological Forecasting and Hydrological Bases of Water Management*. Bukarest, Rumänien, 2.– 6.9.02
Presentation: „GLOWA-Danube: Integrative Techniques, Scenarios and Strategies regarding the Global Change of the Water Cycle “ (Niemeyer)
- *International Conference on Policies and Tools for Sustainable Water Management in the EU*. Venedig, Italien, 21.-23.11.02
Presentation: " Integrative Modelling in the Upper Danube catchment – GLOWA-Danube and the DANUBIA Decision Support System " (Niemeyer)
- *Workshop zur großskaligen Modellierung in der Hydrologie*, Magdeburg, 28./ 29.11.02
Presentation: „Fernerkundung und fuzzy logic basierte GIS-Methoden zur Modellierung des Wasserhaushalts in mesoskaligen Einzugsgebieten“ (Ludwig)
Presentation: „Modellierung hydrologischer Prozesse in mesoskaligen Einzugsgebieten“ (Reichert)
- *ATV-DVWK „Tag der Hydrologie“*, Freiburg, 20./21.3.2003
Presentation: „GLOWA-Danube – Integrative hydrologische Modellentwicklung zur Behandlung von Global Change Szenarien beim Einzugsgebietsmanagement“ (Mauser)
- *XXVIII. Joint Assembly of the EGS and the American Geophysical Union*, Nizza, April 2003
Presentation: "Distributed modeling of water and energy fluxes in mesoscale catchments using the concept of Geocomplexes" (Ludwig)
- *2nd International Workshop on the Analysis of Multi-Temporal Remote Sensing Images*, Ispra, Italien. 16./18.07.2003
Presentation: "Spectral unmixing of sub-scale land cover from multitemporal NOAA-AVHRR imagery using a combined GIS- and Fuzzy Logic approach" (M.Probeck)
- *7. Workshop zur großskaligen Modellierung in der Hydrologie*, München 27./28.11.2003
Presentation: „Flächenverteilte Modellierung der Wasserflüsse in einem mesoskaligen Einzugsgebiet – Ergebnisse mit dem Skalierungsansatz „Geokomplexe“ (Reichert)“
Presentation: „Mesoskalige Modellierung der Wasserflüsse im Einzugsgebiet der Oberen Donau – Implementierung des Integrationskonzeptes in GLOWA-Danube am Beispiel des Objektes Soil“ (Ludwig)
- *First General Assembly of the European Geosciences Union*, Nizza, April 2004
Presentation: "Impacts of agricultural management on groundwater recharge and nitrogen leaching in an agrarian mesoscale watershed" (Ludwig)
Poster: "Sub-grid hydrological catchment modelling using Geocomplexes" (Reichert, Ludwig)