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Satellite data and distributed hydrological model for water resources assessment in the Upper Yangtze River basin

Mancini, Marco[1]; *Li, Jiren*[2]; *Corbari, Chiara*[1]; *Xin, Jinfeng*[2]; *Zhang, Jianli*[2]; *Zhang, Xingnan*[3]; *Zhang, Xiaoxiang*[3]; *Su, Bob*[4]; *Sobrino, Josè A.*[5]; *Menenti, Massimo*[6]; *Li, Jia*[7]

[1]*Politecnico di Milano;* [2]*China Institute of Water Resources and Hydropower Research;* [3]*Hohai University;* [4]*University of Twente;* [5]*University of Valencia;* [6]*Delft University of Technology;* [7]*Alterra insitute*

The main objective of the project “Application of remote sensing and other space technology to hydrology and water resources (ID 5281)” is to assess water resources availability under human and natural pressure on the Yangtze River basin combining remote sensing data with distributed hydrological models. Chinese and ESA satellite images and ground measurements have been analysed in order to provide the necessary dataset to the modelling. Specific numerical codes were written in order to properly compare satellite data and model state variables and also for satellite data assimilation into the hydrological models. The model algorithm solves the system of energy and mass balances in terms of a representative equilibrium temperature (RET) that is the land surface temperature that closes the energy balance equation and so governs the fluxes of energy and mass over the basin domain. This equilibrium surface temperature, which is a critical model state variable, is comparable to LST as retrieved from operational remote sensing data (MODIS and AATSR). So a new methodology for the calibration of distributed hydrological models at basin scale is proposed by constraining an internal model variable. Soil hydraulic and vegetation parameters are then calibrated in each pixel of the domain according to the comparison between observed and simulated land surface temperature minimizing the differences. A traditional “trial and error” calibration procedure is also applied by comparing only discharge measurements in the available cross section. The distributed hydrological energy water balance model (FEST-EWB - Flash–flood Event–based Spatially–distributed rainfall–runoff Transformation-Energy Water Balance) has been implemented for the Upper Yangtze River basin with an extent of about 1,000,000 Km2 at spatial resolution of 5km and temporal resolution of 1 hour. Results are provided in terms of hourly evapotranspiration, soil moisture and land surface temperature maps for the period between 2000 to 2004 where ground and satellite data are available for engineering and environmental applications as parsimonious irrigation, real time flood forecast, and quantitative water resources availability. The model accuracy was controlled from the comparison with traditional discharge daily data series and also from the comparison between model and satellite land surface temperature used as a proxy of evapotranspiration fluxes. Another main result from the project deals with the possibility of computing the hydrological water balance components at monthly scale using only satellite data and ground discharge measurement. Remote sensing data provide, infact, an alternative to in situ data, with observations that are, in some cases, at a higher spatial and temporal resolution than those available from traditional ground sources. In the last few years there was an improvement in availability and quality of satellite products for all the main variables of the water cycle. In this work, the water balance equation is solved using: precipitation retrieved from TRMM, water storage from GRACE satellite and ground discharge. Evapotranspiration is then computed as a residual term of the water balance equation. Satellite data will be then compared with ground data to understand to what extent remote sensing observations can be used to improve estimates of the terrestrial water balance at regional to continental scales and to better represent the variability of water cycle components in space and time.

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基于遥感和水文模型的长江流域上游水量和水质评价

Mancini, Marco1; Li, Jiren2; Corbari, Chiara1; Xin, Jinfeng2; Zhang, Jianli2; Zhang, Xingnan3; Zhang, Xiaoxiang3; Su, Bob4; Sobrino,Josè A.5; Menenti, Massimo6; Li, Jia7
1Politecnico di Milano; 2China Institute of Water Resources and Hydropower Research; 3Hohai University; 4University of Twente;5University of Valencia; 6Delft University of Technology; 7Alterra insitute

"遥感和其它空间技术在水文水资源中应用"项目的主要目的是通过遥感与分布式水文模型结合的途径对在自然和人类活动作用下长江流域上游的水量和水质进行评价。项目对中国和欧空局的遥感影像和地面资料进行了分析以提供模拟所必需的资料。进行了专门的数值编码以比较遥感资料和模型状态变量，同时也是为了将遥感资料融合到水文模型中。模型算法结合能量平衡方程的代表性平衡温度（RET），从而控制了流域范围内的能量和水量通量。这个平衡地表温度是模型状态变量的临界值，可与从遥感资料（MODIS和AATSR）反演的LST比较，通过限制一个中间模型变量，提出了一个流域尺度的分布式水文模型的新的率定方法。 然后，通过实测的和模拟的地表温度的比较并使之最小化的方法，对每个像元率定土壤水力学特性和植被参数。传统的试算法仅用于比较测量断面的流量。分布式水热平衡模型（FEST-EWB：瞬时-次洪-空间分布-降雨径流转换-水热平衡）已用于长江上游一百万平方公里的流域，空间分辨率为5公里，时段长为一小时。结果包括2000年到2004年每小时的蒸散发量、土壤含水量和地表温度分布图。该流域有用于工程和环境，如灌溉、实时洪水预报和水量的遥感及地面资料。模型精度通过传统的日流量系列以及用作为蒸散发通量之代表的模拟的和遥感的地表温度比较来控制。另一个主要结果是项目试验了仅用遥感资料和地面实测流量来计算月水量要素的可能性。事实上，提供了一个用较高时空分辨率的遥感资料替代传统的从地面获取实测资料的方案。近年来，有关水循环所有主要变量的遥感产品及其质量有了改善。在此项工作中，水量平衡可用TRMM反演降水量、用GRACE卫星资料和地面流量资料解决蓄水量，蒸散发用水量平衡方程的残余项计算。然后对遥感资料和地面资料进行比较，从而了解遥感在多大程度上可以用来改善从区域到大陆尺度的水平衡估算以更好地表达水循环要素在时空上的变化。

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