Towards a Multi-Source Remote Sensing Data Assimilation System in the Heihe River Basin

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The general objective of project 5322 in the Dragon 2 programme is to quantitatively retrieve key eco-hydrological parameters by using remote sensed data and to develop a multi-source remote sensing data assimilation system which can eventually produce a high resolution and spatiotemporally consistent hydrological and ecological data set of the Heihe River Basin. In this presentation, we will report the up to date progresses on the retrieval of eco-hydrological parameters and the development of a catchment scale land data assimilation.

(1) Retrieval of eco-hydrological parameters

Snow water equivalent (SWE) and snow depth (SD) were derived using airborne K (18.7 GHz) and Ka (36 GHz) -bands microwave radiometers. The microwave emission model of layered snowpacks (MEMLS) was adopted to simulate the brightness temperature of snow cover for each measurement point. And, an empirical method was used to derive SD and SWE. Hyperion images were used to retrieve the snow albedo and snow grain size in mountainous areas. Soil freeze/thaw status was captured by the airborne/track-mounted radiometer observations. Correspondingly, algorithms for the classification of different soil status based on the radiative transfer models and decision tree were developed. Ground penetrating radar measurements were carried out to obtain the heterogeneities of soil moisture at the field scale and frozen/thaw penetration depth.

In forest hydrology experiment region, digital surface model (DSM) and digital elevation model (DEM) were derived from airborne light detection and ranging (LIDAR) observations. On this basis, canopy height model and the height of trees can be estimated. Forest biomass was inverted by combining using SPOT, ALOS-PALSAR and ancillary data sets. And, leaf area index (LAI) was retrieved by the multispectral canopy imager observations.

In order to acquire accurate evapotranspiration (ET) estimates, two parameterization schemes were proposed for the estimation of surface heat fluxes over heterogeneous landscapes in arid regions based on a two-layer surface energy balance model and surface energy balance index by using multi-angular thermal infrared remote sensing data, which were provided by the airborne Wide-angle infrared Dual-mode line/area Array Scanner (WiDAS) instrument. Algorithms on the estimation of canopy resistance were also improved by the correction of some resistance calculation methods, such as Penman-Monteith equation. Besides, the components of flux energy were estimated by using the surface energy balance system (SEBS) model and obtained reliable results.

In addition, from airborne observations, land surface parameters classification was realized based on the amplitude of received signals by LIDAR observations. Chlorophyll and chlorophyll fluorescence properties were evaluated from the multi-spectral operational modular imaging spectrometer-II data. Moreover, bi-directional reflectance, albedo, effective LAI, vegetation coverage, land surface temperature and drought index were derived from WiDAS observations through improved retrieval algorithms and models. Retrieval of soil moisture from airborne multi-angular TIR images (WiDAS) was also attempted.

For the application of satellite remote sensed data, a two-step retrieval scheme was proposed to acquire surface roughness and soil moisture based solely on multi-angular ENVISAT-ASAR data without ancillary information. Based on the hybrid canopy reflectance model, a new hyperspectral directional second derivative method (DSD) was proposed by using PROBA-Chris data. DSD can remove the effect of soil background effectively. Additionally, this method can estimate LAI accurately through analyzing the canopy anisotropy. And, gross primary production was derived from MODIS data based on the vegetation photosynthesis model.

(2) Catchment scale land data assimilation system

Under the support of WATER, we have developed Heihe data assimilation system (HDAS) to make use of the multi-source watershed observations within a land data assimilation framework. It aims to obtain improved estimates of the hydrologic and land surface states such as soil moisture and temperature, evapotranspiration, surface runoff, snow water equivalent and other principle components of the water cycle which will be able to benefit the watershed management activities. The spatial resolution is 1 km and the temporal resolution is 1 hour. HDAS includes seven sub-components: (1) Integrated Watershed Model; (2) Radiative Transfer Model; (3) Model Driver Module; (4) Data Assimilation Platform; (5) Integrated Watershed Observation System; (6) Database Management System; (7) Interoperability.