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improving methods of crop monitoring with envisat data

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The main objectives of this project focus on two issues: crop yield estimation and new crop identification and crop acreage estimation methods based on ENVISAT data.

Based on the difference of the water requirement of crop in different stages, the crop growing season was divided into several periods for crop biomass estimation. In each period, multi-year time-series ET data estimated with ETWatch was used to get the maximal ET value, which approximately equals to potential ET. And the water stress scalar was calculated for crop biomass estimation. HI was simulated by the ratio of NDVIpre (the average value of NDVI form emergence to anthesis) and NDVIpost (the average value of NDVI from anthesis to maturity). With the estimated crop biomass and HI, crop yield can be calculated by the follow expression : YIELD = BIOMASS * HI.

For crop identification, the fusion data of Envisat ASAR VV polarization backscatter data and HJ satellite multi-spectral data was investigated using different classifiers. Results indicated that fusion data can take full advantage of spectral information of HJ multi-spectral data and the structure sensitivity feature of ASAR VV polarization data. The fusion data enlarges the spectral difference among different classifications and improves crop classification accuracy. Crop classification accuracy with fusion of HJ and ASAR was improved by 5 percent compared to the single HJ CCD data.

Crop classification with support vector machine (SVM) classifier using multi-configuration SAR data including ENVISAT ASAR and TerraSAR-X was also investigated in our project. Multi-configuration SAR data achieved satisfactory classification accuracy (best overall accuracy of 91.83%) in the North China Plain. ASAR performed slightly better than TerraSAR data acquired in the same time span for crop classification, while the combination of C- and X-band data was better than the multi-temporal C-band data. Two temporal ASAR data acquired in late jointing and flowering periods achieved sufficient classification accuracy.

Crop acreage estimation using ENVISAT MERIS and CBERS-02B CCD data of 2008 was investigated in our project. Firstly, adaptive maximum likelihood classification of CBERS-02B CCD images based on ground survey provided reliable maize area fraction image (AFI). CBERS derived AFIs (as reference AFI) were used to train a 3-layer back-propagation neural network, this was then used to the whole MERIS data to generate MERIS AFIs (AFIe). To estimate maize acreage, the maize AFI from MERIS was masked with cropland dataset and maize acreages were estimated by zonal statistic of maize AFI at district level. This reliable method can not only be applied to MERIS and CBERS-02B data. Classification results of multi-configuration SAR data or fusion data of ASAR and HJ data can be used to get crop area fraction image (AFI). This method is valuable for wide-scale, regional crop acreage estimation at the early stage of growing season by combination of high resolution data and moderate-resolution data.

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基于ENVISAT数据的作物监测方法改进研究

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此项目的主要研究内容包括以下两个方面：基于ENVISAT数据的作物单产估算、作物识别及作物种植面积估算方法研究。

根据不同作物在不同生长阶段需水量的不同，将作物的整个生长季划分为若干生长阶段。在不同的生长阶段依据ETWacth监测获取的多年时间序列的ET数据求取最大值来模拟该生长阶段的作物潜在蒸散量，进而确定其水分胁迫因子，进行作物生物量的估算。作物收获指数是通过开花期到成熟期之间的NDVI累积值与开花之前的NDVI累积值模拟得到的。综合利用作物地上生物量与收获指数，作物单产可以通过公式：单产=生物量*收获指数来估算。

对于作物识别与分类，利用ENVISAT ASAR VV极化数据与环境星多光谱数据进行融合，并采用不同分类方法进行农作物分类研究。结果表明，融合之后的影像充分利用了环境星数据的多光谱信息和ASAR VV极化数据对于地物结构敏感的特征，不但增强了不同地物之间的光谱差异，而且提高了作物分类精度。ASAR与环境星数据融合后的影像作物分类精度比仅利用环境星多光谱数据的分类精度提高了约5%。

在项目执行期间，还研究分析了利用多频率SAR数据（包括ENVISAT ASAR数据和TerraSAR-X数据）对作物分类的效果。研究表明，利用多频率SAR数据对华北平原的作物识别精度较高（最高总体分类精度为91.83%）。对同一时期的数据，ASAR数据的作物识别效果比TerraSAR稍好，C波段与X波段组合的作物识别精度优于多时相的C波段数据。利用拔节后期及开花期的两景ENVISAT ASAR数据就可以获取另人满意的作物分类精度。

本研究还利用ENVISAT MERIS及CBERS-02B CCD数据相结合对作物种植面积进行估算。首先，基于地面调查数据，利用最大似然法对CBERS-02B CCD影像进行分类，可靠有效地获取了各像元玉米种植比例。将CBERS-02B CCD影像导出的玉米种植比例数据作为三层后向反馈神经网络模型的训练样本，然后利用经过训练的神经网络模型估算MERIS影像各像元玉米种植比例。为了进一步估算玉米种植面积，利用耕地掩膜对MERIS数据导出的玉米种植比例影像进行非耕地去除，然后利用区域统计估算各行政区划的玉米种植面积。这种可靠的种植面积估算方法不仅限于ENVISAT MERIS及CBERS-02B CCD数据的结合，多频率SAR数据分类结果、SAR数据与环境星数据融合后的分类结果均可用于神经网络模型的训练。这种利用高分辨率影像与中分辨率影像相结合的面积估算方法对于大范围作物种植面积的估算具有重要意义，即使在作物生长早期也具有较高的估算精度。

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