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Synergistic Use of ASAR AP Data and Crop Growth Model for Yield Map Estimates

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This study investigates the possibility to forecast wheat yield maps at watershed scale by means of the synergistic use of multi-temporal and multi-polarisation ENVISAT ASAR data and crop growth models, such as CERES-Wheat.

The potential of CERES-Wheat for estimating the crop growth and the final production is hampered by the numerous input parameters, rarely available with a sufficient accuracy at the requested high spatial resolution. In this context the radar information can give a strong support to crop model. ASAR data, in particular the HH/VV backscatter ratio acquired at about 40° incidence angle, are able to provide multi-temporal information, concerning above ground biomass and leaf area index, that can be assimilated into the crop model leading to large improvements in the accuracy of their estimates.

Experimental data, exploited for the calibration of the CERES-Wheat model and the validation of the assimilation technique, were collected over the Matera site (located close to Matera city in Southern Italy and included in a subcatchment of the Bradano basin) during a measurement campaign carried out from 2003 to 2005 and co-funded by the European Space Agency and the Italian Space Agency. In situ measurements of soil and agronomical quantities were gathered over four wheat fields from tillering to harvesting coincidentally to 15 ENVISAT ASAR alternating polarisation acquisitions. Moreover climatic daily data and information on soil chemical and hydrological properties were acquired. At the end of the season the yield was evaluated for all the fields.

Using the ASAR HH/VV backscatter ratio, multi-temporal LAI maps of the subcatch-

ment (in particular of the wheat fields) were retrieved. Then the LAI information was assimilated into CERES-Wheat crop model, applying a model re-initialisation technique. This technique consists of determining the optimum set of input parameters which enable to force the model LAI state variable to match the multi-temporal radar-retrieved LAI and to correct the performance of the model over the whole season. Applying this methodology, wheat yield maps of the 2004 and 2005 seasons were estimated over the test area and then validated over the fields monitored during the experimental campaign.

The results, which will be shown in this paper, point out that the assimilation of radar data into the crop model improves the model estimates and leads to wheat yield maps with an accuracy of approximately 3 q/ha. This promising result may be extremely useful for the early forecast of wheat yield at regional scale.