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Land-atmosphere exchanges of water and energy in space and time over a heterogeneous land surface

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In order to advance our understanding of land-atmosphere exchanges of water and energy in space and time over heterogeneous land surfaces, an intensive field campaign was carried out at the Barrax agricultural test site in Spain in the period 12–21 July involving multiple field, satellite and airborne instruments for characterizing the state of the atmosphere, the vegetation and the soil from visible to microwave range of the spectrum. Part of the experimental area is a core site of a 25 km^2 area within which numerous crops are grown - on both irrigated and dry land - alongside fields of bare soil. This campaign formed part of the preparatory study for a proposed ESA Earth Explorer mission called SPECTRA (Surface Processes and Ecosystem Changes Through Response Analysis) of the European Space Agency, thus was named as SPARC-2004 (SPECTRA Barrax Campaign-2004) in combination with the EU 6FP EAGLE Project.

Used for the first time during SPARC-2004 was the new Airborne Hyperspectral System (AHS), operated by Spain's Instituto Nacional de Técnica Aeroespacial (INTA). The AHS has a total of 80 spectral channels available in the visible, short wave infrared and thermal infrared. A total of 16 multiangular acquisition flight lines were obtained over Barrax with spatial resolutions varying from 2.5 to 6.8 m. Several satellite sensors, including the Compact High Resolution Imaging Spectrometer (CHRIS) on the Proba spacecraft, with two days of consecutive multiangular acquisitions over the campaign site, as well as sensors from several other satellites (ENVISAT, TERRA, MSG) were deployed for image data acquisition.

A large number of ground based instruments were also deployed including lidars and balloon-based radio sondes to sample atmospheric variables, sun photometers to measure sky radiance and sensors mounted on mobile towers to record local vegetation characteristics. Several mobile instrument towers, including four eddy correlation devices and two scintillometers, were deployed in the field to monitor the individual components of the energy, water and carbon dioxide flux exchanged between land and the atmosphere. In addition to CHRIS data, two ENVISAT overpasses enabled acquisitions from that spacecraft's Medium Resolution Imaging Spectrometer (MERIS) and Advanced Along Track Scanning Radiometer (AATSR), as part of parallel ENVISAT data product validation activities. Data from the Spinning Enhanced Visible and InfraRed Imager (SEVIRI) instrument aboard MSG-1 (Meteosat Second Generation) were acquired during the campaign as part of the validation activities for MSG vegetation products, alongside data from Landsat and also

the Moderate Resolution Imaging Spectroradiometer (MODIS) and Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on Terra, collected to complete the SPARC dataset.

In the CHRIS configuration available to the SPARC-2004 campaign, 62 spectral bands were available for five angular acquisitions with 34 m spectral resolution. The higher resolution data, in combination with data from other sensors (spatial resolution from 90 m of ASTER, 300 m of MERIS, to 1 km of AATSR and MODIS, and to over 3 km of MSG data) provide unprecedented opportunity for studying of the scaling behavior of the land-atmosphere exchanges of water and energy.

A total of 80 people from 21 different institutions in five different countries were involved in the SPARC-2004 activity, with around 50 people directly participating in the daily field measurements. Participants included Spanish teams from Universities in Valencia, Albacete and Castellon along with national research institutes (INTA, INM, CSIC, CIEMAT, CEDEX, ITAP and CECAF), French teams from LURE-Paris, INRA-Avignon and the University of Strasbourg, Italian teams from the University of Naples and the National Research Council and a large team from the Netherlands involving Alterra, Wageningen University, ITC and the University of Utrecht, plus ESA participants. A team from the University of Washington in Seattle also took part in the campaign, as part of a NASA project related to validation of Terra/ASTER data over the Barrax site. The SPARC-2004 activity has been funded by ESA and the European Commission with additional contributions from Eumetsat and national projects.

The in-situ data relevant to land-atmosphere exchanges included the following measurements:

- Turbulence, H_2O, CO_2 fluxes and CO_2 concentrations using an eddy correlation system (Gill 3D sonic + closed path Licor gasanalyser: CO_2 and H_2O + nitrogen reference gas +pneumatic mast + dataloggers);
- Soil heat flux, soil temperatures (two levels), air temperature and humidity
- Leaf temperatures (thermal couples);
- Radiation balance (shortwave and longwave incoming and outgoing radiation, wind, air temperature, radiometric surface temperature) and sensible heat flux (using two scintillometer systems);
- Photosynthesis, conductance and transpiration measurements at leaf level (using a CIRAS from PP systems);
- Radiometric surface temperature measurements using a hand-held radiometer (Everest);
- Roughness measurements using stereo photogrammetry with the NEar Sensing CAmera Field Equipment (NESCAFE);
- Emissivity measurements with the "two-lid box method";
- LAI measurements with hemispherical photographs, which will be processed with WinPhot*.

Digital photos are taken to document the actual field situations. These data and part of the satellite data have undergone preliminary analysis in space and time, the results and findings will be presented at the workshop.

*http://www.bio.uu.nl/~herba/Guyana/winphot/wp_index.htm