LAND EC V MONITORING THROUGH MICROWAVE SATELLITE SENSORS

Microwave Remote Sensing Group
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The MRSG has been active since 1980 in the field of experimental and theoretical active and passive microwave remote sensing of land.

**Research programs and activities**

- **Instrumentation (IROE)** polarimetric multifrequency microwave airborne radiometer (L to Ka bands)
- **Experimental campaigns** on land and sea with microwave sensors
- **Electromagnetic modelling** Coherent/incoherent scattering and emission from soil, vegetation and snow
- **Retrieval algorithms for estimating** Soil Moisture, Snow Depth, and Water Equivalent, Vegetation biomass (AGB)
**International programs**

- **2014-2015: ESA SAOCOM** (TEC-EEP / 2014-92/NF) to consolidate the understanding of the L-band bi-static SAR signal (radiometry and phase) over land surfaces in the SAOCOM CS configuration.

- **2014 – 2015: ESA GNSS-Bio** (AO/2-1610/14/NL/CVG) to demonstrate the use of GNSS signals for the estimation of forest above-ground biomass (AGB).

- **2014-2015: EUMETSAT SCA Cross Polarization** (ITT 14208518) to evaluate the potential of the cross-polarization channel of SCA (heir of ASCAT) in improving soil moisture retrievals.


- **2010-2011: ESA – SENTINEL** (AO/1-6320/09/NL/MP) GMES Sentinel-1 Soil Moisture Algorithm Development.

- **2010-2012: ASI – HYDRO-COSMO** (AO 1720) for the retrieval and monitoring of Land Hydrological parameters for Risk and Water Resources Management using Cosmo SKYMED.

- **2010-2011: ASI – SIASGE** (ASI-SXL) project for defining SAR derived products at X and L+X bands supporting SIASGE (Sistema Italo Argentino Satellitare per la Gestione delle Emergenze).

- **2008-2010: ASI – PROSA** (Products of Satellite Observations for the Meteorological Alert), to provide products from Earth Observation data to be used by the Italian Civil Protection.

- **2008-2009: ESA – LEIMON** (AO/1-5830/08/NL/AF) to investigate the potential of navigation signals as a tool for remote sensing of soil moisture and vegetation.

- **2008-2011: Regione Toscana – C-TOTUS** for improving the existing competences for developing and using sensors and methods for the Earth monitoring from space.

- **2003-2006: EC – FloodMan** (EVK1-2001-00237) aimed at developing a system for Near real time flood forecasting, warning and management system based on satellite radar images, hydrological and hydraulic models and in-situ data.

**PROPOSED ACTIVITIES IN CCI**

### New R&D on ECVs that were started in CCI

- **Soil Moisture**: Research activity for implementing innovative algorithms for estimating SM using **microwave sensors** in combination with optical data.

### Developing ECVs that were not started in CCI

**Research activities** for exploiting the potential of microwave sensors and implementing dedicated algorithms for estimating

- **Snow**: extension and status (Wet/Dry), Snow Depth/Water Equivalent
- **Vegetation biomass** (AGB) of Agricultural vegetation (and Forests?)

<table>
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<th>ECV</th>
<th>Satellite data</th>
<th>Characteristics</th>
<th>Cooperations</th>
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<tr>
<td>Soil Moisture</td>
<td>Sentinel-1, SMAP+AMSR2, ASCAT/SCA</td>
<td>Coverage: regional to global</td>
<td>CNR-IRPI/TU Wien, EURAC/JPL/MIT</td>
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<tr>
<td>Vegetation Biomass (AGB)</td>
<td>Sentinel-1, CSK +AMSR2, SMOS+SMAP/ALOS, (BIOMASS?)</td>
<td>Resolution: 100m – 10 Km (depending on the sensors)</td>
<td>JAXA/DLR/…</td>
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<tr>
<td>Snow Cover (SCA+SD/SWE)</td>
<td>CSK, Sentinel-1 +AMSR2 optical Sentinel-2 (PRISMA?)</td>
<td>Revisiting: 1 -10 days (depending on the sensors)</td>
<td>EURAC, RADI (Chinese Academy of Sciences)</td>
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INNOVATIVE ASPECTS:

- Use of **advanced forward e.m. models** for simulating scattering and emission from bare, vegetated and snow-covered soils (Numerical models, AIEM, I²EM, discrete RT, DMRT - Bicontinuous approach -, SFT, ...)

- Integration of data from different sensors in several spectral bands, by combining (also with **data fusion** techniques) **microwave** (Radiometric and SAR) and **optical data** (Sentinel-2, hyperspectral → PRISMA)

- Implementation of new techniques for **increasing the spatial resolution** in order to compare sensors at different spatial resolution

- Implementation of retrieval algorithms based on **Machine learning approaches** (ANN and SVR) for estimating ECV variables by using innovative training based on measured and simulated datasets
INTERNATIONAL FRAMEWORK

➢ ADDED VALUE:
The proposed research is aimed at filling some gaps in the ECV variables currently available (SM, SD/SWE and AGB) and at enhancing the spatial resolution and accuracy of the existing products.

➢ COOPERATIONS

**SMC → JPL/MIT** (Entekhabi) in developing a method for merging SMAP/AMSR2 and S-1 data for SMC retrieval

**TUW** in developing advanced algorithms for SM retrieval from EUMETSAT SCA

**CNR IRPI** in developing a new SMC product over Italy from AMSR-E/AMSR2 at enhanced spatial resolution and accuracy

**AGB → JAXA** in developing an algorithm based on AMSR2 data for retrieval of Biomass of Agricultural Vegetation

**SNOW → EURAC** for evaluating the CSK/TSX potential for SWE/SD monitoring and setting up a dedicated retrieval algorithm

**RADI** (Chinese Academy of Sciences) for prosecuting the DMRT model refinement
POTENTIAL FEEDBACK IN ITALY

- Networking with other research institutions by taking advantage of different competences (e.g. for applying to EC Calls)
- Assimilation of ECV variables obtained from remote sensing sensors in process models (e.g. SM and AGB in evapotranspiration or erosion or landslide models)
- Applications to Risk forecasting and mitigation, providing timing information to local authorities (e.g. Regional departments) and Civil Protection
- Applications to water resources management for more rational water use and distribution providing indications to ‘consorzi di bonifica’ and irrigation networks
- Providing timely information to precision farming consortia
- Use of CSK data for civil purposes
MICROWAVE REMOTE SENSING GROUP - EXPERIENCE

Relevant publications 2010 → present


