Reports from Cal/Val Partners
Feedback to Cal/Val Partners from Rehearsal

Valencia (ES)

- University of Valencia, Spain / SMOS
  - Ernesto Lopez-Baeza, A. Coll, R. Fernández, P. Salgado-Hernanz, A. Benlloch, E. Carbo, F. Mora
- SMOS
  - J.-P. Wigneron, Y. Kerr, M. Schwank
- ESA
  - T. Casal, M. Drusch, S. Mecklenburg
- SMAP
  - A. Colliander, T. Jackson
- Spanish Hydro-Met Agencies
  - T. Estrela, A. Fidalgo, O. Gabalda, J. Tamayo
Contents

- Valencia Anchor Station
- SMOS/SMAP
  - SM Network
  - Modeling: SurfEx-ISBA
  - MELBEX
    - First Evaluation Simultaneous SMOS – ELBARA-II Observations
    - L-band Radiative Properties of Vines
    - Long-term Validation
  - SMAP Cal/Val Rehearsal Phase I
  - SMAP Cal/Val Rehearsal Phase II
- Conclusions
- Acknowledgment
Valencia & Alacant Anchor Stations

(Most?) suitable area in Europe for validation of low spatial resolution remote sensing data and products.

HR MERIS, 23 March 2002

Valencia Anchor Station

Alacant Anchor Station
accounting for non-homogeneities of the area
Modelled monthly mean values of soil moisture content (0-20 cm depth) (1940 – 2001) (SIMPA)

Annual Precipitation

UNESCO Climate Index P / ETP

Humid
Sub-humid
Semi-arid

Valencia Anchor Station
Alacant Anchor Station

(A. Fidalgo, Jucar River Basin Authority)
ESA will focus its efforts for the validation of soil moisture data on two key sites: the Valencia Anchor Station and the Upper Danube Catchment. The Valencia Anchor Station (below) is a typical Mediterranean sparse vegetation ecosystem, mainly characterised by bare soil and limited vegetation. The vegetation consists mainly of vineyards, pine trees and shrub and is thus comparatively uniform with regard to hydrological parameters. The site is well instrumented and has been the location of other field campaigns (Ernesto Lopez, Univ. Valencia).

The Upper Danube Catchment in contrast is a typical temperate continental ecosystem covering an area of 77 000 km² in Germany. The map shows overflight track (red) for the SMOS dress rehearsal campaign in spring 2008. Dots are measurement stations (Alexander Loew, Univ. Munich).
Free RFI over Spain ... and over the VAS!!!

(ESA, 2010)
Valencia Anchor Station
SM Network
ECOCLIMAP Land Use Map
Homogeneous Hydro-physiological Units

3 Different and Complementary Sampling Approaches for the 3 VAS Validation Campaigns

- 50 x 50 km² area
- 16 x 16 km² central area (SMOS 2008)
- CNES CAROLS’2009
- ESA/CNES CAROLS’2010

C. Antolin et al.
Modelling soil moisture at SMOS scale by use of a SVAT model over the Valencia Anchor Station

S. Juglea¹, Y. Kerr¹, A. Mialon¹, J.-P. Wigneron², E. Lopez-Baeza³, A. Cano³, A. Albitar¹, C. Millan-Scheiding³,⁴, M. Carmen Antolin¹, and S. Delwart⁵

Soil moisture modelling of a SMOS pixel: interest of using the PERSIANN database over the Valencia Anchor Station

S. Juglea¹, Y. Kerr¹, A. Mialon¹, E. Lopez-Baeza³, D. Braithwaite³, and K. Hsu³
SurfEx-ISBA 2011 -
Amparo Coll et al., 2013
MELBEX
Mediterranean Ecosystem
L-band Characterisation Experiment
SMOS MELBEX (Mediterranean Ecosystem L-band Characterisation Experiment)

MELBEX-I

Matorral and Shrubs


The SMOS Mediterranean Ecosystem L-band characterisation EXperiment (MELBEX-I) over natural shrubs

Aurelio Cano, Kauzar Saleh, Jean-Pierre Wigneron, Carmen Antolin, Jan E. Balling, Yann H. Kerr, Alain Kruszewski, Cristina Millán-Scheiding, Sten Schmidt Søbjerg, Niels Skou, Ernesto López-Baeza

Tasks programmed from 22nd September 2009:

- sky calibration measurements (3,1 Mb/day)
  - every day at 23:55
  - at 150°

- angular scan measurements (167 Mb/day)
  - every day, every hour at 0 and 30 min
  - at 30°, 35°, 40°, 45°, 50°, 55°, 60°, 65°, 70°

- fixed angle of 45° measurements (2,6 Mb/day)
  - every day, every hour at 5, 10, 15, 20, 25, 40, 45, 50 min
  - at 45°
Angular Scans

30°   35°   40°

45°   50°   55°

60°   65°   70°
Analysis of the footprint

Height of the beam waste above ground: \( h \approx 14 + 1 + 1.5 = 16.5 \) m

\( \alpha \) = observation angle relative to nadir
\( a \) = half axes of the footprint along the plane of incidence (direction from the tower to the wall)
\( b \) = half axes of the footprint perpendicular to the plane of incidence (direction approx. parallel to the wall)

\( D_{\text{min}} \) = min. distance from the root point of the antenna aperture (approx. end of tower) to the footprint ellipse

\( D \) = distance from the root point of the antenna aperture (approx. end of tower) to most sensitive part of the footprint (this does not correspond with the geometrical center of the footprint ellipse).

\( D_{\text{max}} \) = max. distance from the root point of the antenna aperture (approx. end of tower) to the footprint ellipse

\( A \) = area of the ellipse
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Grupo de Climatología Desde Satélites
Surface Roughness

\[ H_R = 0.06 \]
\[ Q_R = 0.0303 \]
\[ N_{RP} (p = H,V) = 0 \]

Values for 2012

(Miernecki et al., 2013)

\( H_R \) accounts for the decrease in reflectivity caused by soil roughness \((H_R \uparrow \Gamma_{GP} \downarrow)\)

\( Q_R \) accounts for polarization mixing effects \((Q_R \uparrow |\Gamma_{GV} - \Gamma_{GH}| \downarrow)\)

\( N_{RP} \) governs the change in the angular dependence of reflectivity caused by the rough surface
Leaf Area Index (LAI)

Figure 15. (a) LAI measurements (b) Measuring protocol
First evaluation of the simultaneous SMOS and ELBARA-II observations in the Mediterranean region

Jean-Pierre Wigneron a,*, Mike Schwank b, Ernesto Lopez Baeza c, Yann Kerr d, Nathalie Novello a, Cristina Millan c, Christophe Moisy a, Philippe Richaume d, Arnaud Mialon d, Ahmad Al Bitar d, Francois Cabot d, Heather Lawrence a, Dominique Guyon a, Jean-Christophe Calvet e, Jennifer P. Grant f, Tania Casal f, Patricia de Rosnay g, Kauzar Saleh h, Ali Mahmoodi i, Steven Delwart j, Susanne Mecklenburg j
High correlation between the ELBARA and SMOS L1C TB: $R^2 \sim 0.90$

Good general agreement between SMOS L1C $T_B$ and ELBARA $T_B$ data (July-Dec, 2010)

Comparing ELBARA and SMOS L1C $T_B$
Fig. 8. Comparison in the time variations in the soil moisture SM (m$^3$/m$^3$) retrieved from the EMBAR-II observations and in the measured in situ SM data from Theta probes (m$^3$/m$^3$) over the M-III vineyard. Precipitation data are represented by vertical lines (scaling factor 1/30). SM retrievals were carried out from TB observations made at 14:00 local time.

Fig. 9. Comparison in the time variations in the optical depth TAU ($\Delta$) retrieved from the EMBAR-II observations and in the 'smoothed' NDVI vegetation index computed from MODIS observations at 250 m spatial resolution over the M-III vineyard. Precipitation data are represented by vertical lines (scaling factor 1/30). TAU retrievals were carried out from TB observations made at 14:00 local time.
SMOS-L2 and ELBARA retrievals

- Good correlation (R² ~0.64)
- However: a large bias, especially in wet conditions (!)
L-band Radiative Properties of Vines (M. Schwank et al.)
Approximately 650m² of aluminum foil have been placed on the ground. The covered area comprises the -10dB footprints (> 95% of the signal) for the observation angles 30° - 60°.

Comparison between nadir optical depths from ELBARA II and estimates from in-situ data.

<table>
<thead>
<tr>
<th>Vegetation state</th>
<th>$\tau_{\text{NAD}}$ ELBARA II</th>
<th>VWC$_{\text{STOCK}}$</th>
<th>$\tau_{\text{NAD,Stock}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>0.101 - 0.112</td>
<td>0.33 - 0.5</td>
<td>0.033 - 0.06</td>
</tr>
<tr>
<td>Summer</td>
<td>0.160 - 0.177</td>
<td>1.63 - 1.8</td>
<td>0.163 - 0.216</td>
</tr>
</tbody>
</table>

Winter state:

\[
\tau_{\text{NAD ELBARA II}} = 2 \times \tau_{\text{NAD,Stock}} \quad \Leftrightarrow \quad b_{\text{ELBARA II}} = 2 \times b_{\text{lit.}}
\]

Summer state:

\[
\tau_{\text{NAD ELBARA II}} = \tau_{\text{NAD,Stock}} \quad \Leftrightarrow \quad b_{\text{ELBARA II}} = b_{\text{lit.}}
\]
Long-term ELBARA-II Assistance to SMOS Land Products and Algorithm Validation (M. Miernecki, R. Fernandez, et al.)
M. Miernecki et al., 2012
Elbara Brightness Temperature (K) (2010 - 2012) @ VAS

R. Fernandez et al. 2013
### T_B Correlation Statistics

#### 2010

- **Correlation Statistics**
- **V-POL**:
  - Year: 2010
  - N: 148
  - R: 0.60526
- **H-POL**:
  - Year: 2010
  - N: 148
  - R: 0.63055

#### 2011

- **Correlation Statistics**
- **V-POL**:
  - Year: 2011
  - N: 261
  - R: 0.6776
- **H-POL**:
  - Year: 2011
  - N: 261
  - R: 0.67297

#### 2012

- **Correlation Statistics**
- **V-POL**:
  - Year: 2012
  - N: 251
  - R: 0.87779
- **H-POL**:
  - Year: 2012
  - N: 251
  - R: 0.89258

---

**Precipitation**

- **2010**: 538.20 mm
- **2011**: 375.20 mm
- **2012**: 294.20 mm
### SM Correlation Statistics

<table>
<thead>
<tr>
<th>Orbit</th>
<th>2010 Ascending (5:30 am)</th>
<th>2010 Descending (6:30 pm)</th>
<th>2011 Ascending (5:30 am)</th>
<th>2011 Descending (6:30 pm)</th>
<th>2012 Ascending (5:30 am)</th>
<th>2012 Descending (6:30 pm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of measurements</td>
<td>77</td>
<td>102</td>
<td>164</td>
<td>166</td>
<td>135</td>
<td>143</td>
</tr>
<tr>
<td>Bias [m^3/m^3]</td>
<td>-0.29</td>
<td>-0.22</td>
<td>-0.16</td>
<td>-0.15</td>
<td>-0.11</td>
<td>-0.07</td>
</tr>
<tr>
<td>R</td>
<td>0.42</td>
<td>0.52</td>
<td>0.45</td>
<td>0.36</td>
<td>0.50</td>
<td>0.78</td>
</tr>
<tr>
<td>RMSE [m^3/m^3]</td>
<td>0.4</td>
<td>0.3</td>
<td>0.23</td>
<td>0.23</td>
<td>0.14</td>
<td>0.08</td>
</tr>
</tbody>
</table>

#### Precipitation

- 2010: 538.20 mm
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- 2012: 294.20 mm
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Grupo de Climatología Desde Satélites

ELBARA-II
TAU (2010 - 2012) @ VAS
ELBARA-II

TAU (2010 - 2012) @ VAS
**TAU Correlation Statistics**

<table>
<thead>
<tr>
<th></th>
<th>2010 Ascending (5:30 am)</th>
<th>2010 Descending (6:30 pm)</th>
<th>2011 Ascending (5:30 am)</th>
<th>2011 Descending (6:30 pm)</th>
<th>2012 Ascending (5:30 am)</th>
<th>2012 Descending (6:30 pm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of measurements</td>
<td>77</td>
<td>102</td>
<td>164</td>
<td>166</td>
<td>135</td>
<td>143</td>
</tr>
<tr>
<td>Bias</td>
<td>0.03</td>
<td>0.10</td>
<td>0.15</td>
<td>0.13</td>
<td>0.13</td>
<td>0.10</td>
</tr>
<tr>
<td>R</td>
<td>-0.03</td>
<td>0.16</td>
<td>0.08</td>
<td>0.24</td>
<td>-0.27</td>
<td>-0.10</td>
</tr>
<tr>
<td>RMSE</td>
<td>0.13</td>
<td>0.18</td>
<td>0.19</td>
<td>0.16</td>
<td>0.19</td>
<td>0.16</td>
</tr>
</tbody>
</table>

**Precipitation**

- 2010: 538.20 mm
- 2011: 375.20 mm
- 2012: 294.20 mm
Leaf Area Index (LAI) vs ELBARA-II TAU

P. Salgado et al. 2013
Datos de Elbara y Aquarius en el año 2012 junto con la Precipitación

A. Benlloch
SMAP Cal/Val Rehearsal Phase I
A. Colliander, SMAP
SMAP

Soil Moisture
Active Passive
Mission
SMAP
Cal/Val
Rehearsal
Phase 1

Wrap-Up
& Follow-Up
September 24, 2013

A. Colliander, SMAP
SMAP Cal/Val Rehearsal Phase II
SMAP

Land Uses 36-km Grid

Legend

- 36_nodes_UTM_ETRS89
- 36_corners_UTM_ETRS89
- Stations_UTM

**usos36_final**

- Bosque mixto
- Frutales
- Láminas de agua
- Matorral boscoso de transición
- Viñedos

1:200.000

Coordinate System: ETRS 1989 UTM Zone 30N
Projection: Transverse Mercator
Datum: ETRS 1989
Land Uses
09-km Grid

Legend
- 09_corners_UTM_ETRS89
- Stations_UTM
- Bosque mixto
- Frutales
- Láminas de agua
- Matorral boscoso de transición
- Viñedos

1:80,000
Coordinate System: ETRS 1989 UTM Zone 30N
Projection: Transverse Mercator
Datum: ETRS 1989
from SMOS to SMAP

50 km (SMOS)

36 km (SMAP)

9 km (SMAP)

Valencia Anchor Station
physio-hydrological units
Towards an accurate estimation of surface water balance

Campbell IRGASON

Eddy-Covariance
Recent Applications of SMOS Observations in our Region
<table>
<thead>
<tr>
<th>Rainfall</th>
<th>SMOS</th>
<th>SCS-CN</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Rainfall distribution - Isohyets" /></td>
<td><img src="image2" alt="SMOS observations" /></td>
<td><img src="image3" alt="SCS-CN output" /></td>
</tr>
<tr>
<td>Event: 28/09/2012 6:00 am Rainfall (input)</td>
<td>Event: 28/09/2012 6:00 am SMOS (input)</td>
<td>Event: 28/09/2012 6:00 am SCS-CN (input)</td>
</tr>
<tr>
<td><img src="image4" alt="Rainfall distribution - Isohyets" /></td>
<td><img src="image5" alt="Distribution of moisture - Isohyets" /></td>
<td><img src="image6" alt="SCS-CN output" /></td>
</tr>
</tbody>
</table>

Estimation of Surface Runoff from Storm Rainfall Data and SMOS Observations in the Jucar River Basin.
ERA-INTERIM vs SMOS Comparison (2011-2012)

Pau Benetó
Conclusions

• Capability of the Valencia Anchor Station for low-spatial resolution Cal/Val activities (GERB, CERES, SMOS, SMAP, SENTINEL-3)

• Core validation site for SMOS
  • land products
  • long-term validation with ELBARA-II
    • SM
    • TAU → VWC
    • SMOS Level 2 processor

• Contributing site for SMAP

• Singular validation site by combining ELBARA-II + eddy-covariance + appropriate network given the reasonable homogeneous characteristics of the area at that scale
Acknowledgment

- Spanish Research Programme on Space, Ministry for Economy & Competitiveness
- General Directorate for Climate Change, Dept. for Environment, Water, Town Planning and Housing, Regional Gov. of the Valencian Autonomous Community
- European Space Agency (ESA) (SMOS)
- National Aeronautics and Space Administration (NASA)
- Centre National d’Études Spatiales (CNES)
- Jucar River Basin Authority. Office for Hydrological Planning
- Irrigation Technology Service, Valencian Institute for Agricultural Research
- Spanish Meteorological State Agency of Spain (AEMet)
- Iranzo Wine Cellars, Caudete de las Fuentes
- Utiel Wine Cellars and Vineyards Utiel
- La Cubera Wine Cellar, Utiel
- Nicolas Guaita, Rafael Giménez, Roberto Garcia, Caudete de las Fuentes
thank you for your attention
backup