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Characterisation of the Jucar River Basin Hydrological Climatology with ERA-Land Reanalysis. Consistency with In-Situ and SMOS Soil Moisture Products

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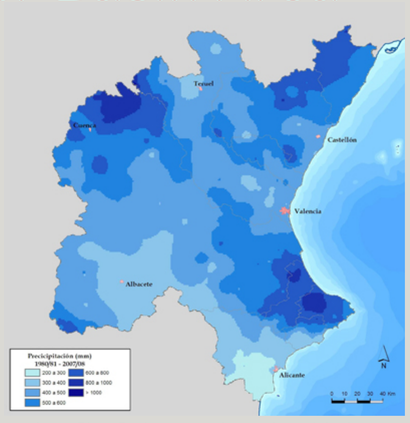
Jucar River Basin Area

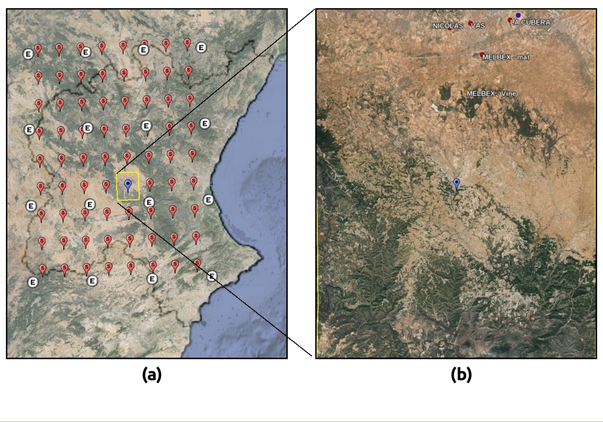
- Typical Mediterranean climate
- Hot summers, mild winters
- Annual temperatures between 14 and 16.5ºC
- Annual precipitation around 500 mm
- Large spatial variability. Scarce in water in S regions and much more abundant in the N and in some SE regions as shown
- Temporal variability. More abundant in October and November (usually short and intense precipitation episodes of cut-off low type).



Jucar River Basin averaged annual precipitation map. *Jucar River Basin Authority* (CHJ, 2014)

in this study:

- ERA-Land SM (0-7 cm) estimations were compared with SMOS L3 SM for the period 2011-2013
- ERA-Land SM (0-7, 7-28, 28-100, and 100-289 cm) were used to establish a SM climatology for the period from 1979-2010



- Comparison of SMOS level-3 and ECMWF ReAnalysis ERA-Interim/Land products for the period 25th Oct 2011 to 31st Oct 2013 through statistical metrics
- ERA-Interim/Land reanalysis provides an improved set of land-surface parameters as compared to those of ERA-Interim
- SMOS data for the period Oct 2011 - Oct 2013 was correlated at the pixel scale with in-situ measurements from the Valencia Anchor Station (VAS) network, where calibration and validation activities are currently being undertaken along the SMOS mission
- Comparison of SMOS level-3 and ERA-Land products covering all the Jucar River Basin for the same period
- Jucar River Basin soil moisture climatology characterised using ERA-Land products (four soil layers) for the term 1979-2010

SMOS L3 Product

3 periods of reprocessed data:
- 25 Oct to 28 Mar 2012
- 29 Mar 2012 to 23 Jun 2013
- 24 Jun 2013 to 31 Oct 2013
- ascending (06:00 h)
- descending (18:00 h)
- geolocated data on the original EASE-Grid (Equal-Area Scalable Earth Grid)

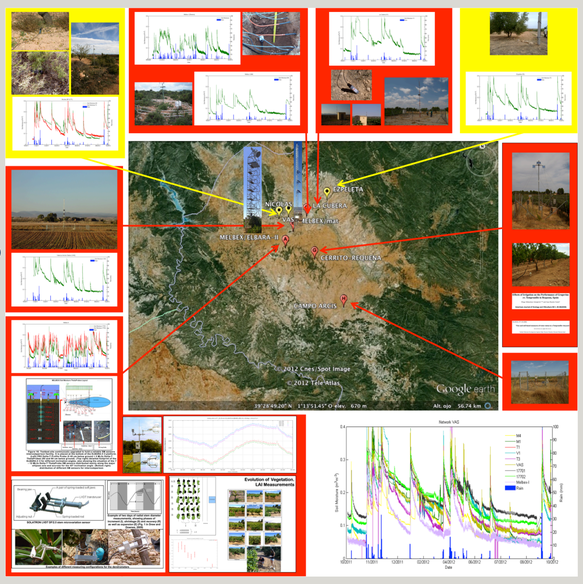
ERA-Land Product

- ERA-interim is a reanalysis of the atmosphere at global scale covering data since 1979 and continuing in near-real time around 80 km resolution
- Started in 2006 with the objective of improving key aspects of ERA-40 (representation of the hydrological cycle, quality of the stratospheric circulation, handling of biases and changes in the system)
- ERA-Interim reanalyses are available four times per day at 00, 06, 12 and 18 UTC.
- Soil moisture is obtained for four different layers at depths of 0-7, 7-28, 0.28-100, and 100-289 cm, respectively, and given in volumetric SI units (m^3m^{-3})
- ERA-Interim/Land reanalysis (ERA-Land)
  - improved hydrology
  - significantly increased spatial variability compared to ERA-Interim reanalyses, and closer to in-situ observations (Balsamo et al., 2013)

In-situ data from the Valencia Anchor Station network

- To validate the SMOS soil moisture product
- 5 stations were used over different land-use types
  - Valencia Anchor Station
  - MELBEX-vine (two different probes for two different vine conditions)
  - La Cubera (vineyards)
  - MELBEX-mat (shrubs)
  - NICOLAS with two probes (fruit trees and shrubs)
- Precipitation for quality control

Station name	Point ID	Latitude	Longitude
MELBEX - Vine	MELBEX - TestBed - 177 - 01	39.521997°N	1.292000°W
	MELBEX - TestBed - 177 - 02	39.521997°N	1.292000°W
MELBEX - Mat	MELBEX - Shrub - M4	39.548074°N	1.277302°W
Valencia Anchor Station	VAS - SM	39.570715°N	1.288220°W
LA CUBERA	La Cubera - Vine - V1	39.573329°N	1.251367°W
NICOLAS	NICOLAS - Shrub - M1	39.567311°N	1.307384°W
	NICOLAS - Olive - T1	39.567311°N	1.307384°W



Statistical Comparison Metrics

- SMOS L3 vs ERA-Land
- SMOS L3 vs ground observations over the reference pixel

most common statistical metrics
- Pearson's correlation coefficient, R
- Root mean-square-difference, RMSD
- Bias

ref indicates the value taken as reference in the comparison under study and *product* indicates the evaluated value in the comparison under study

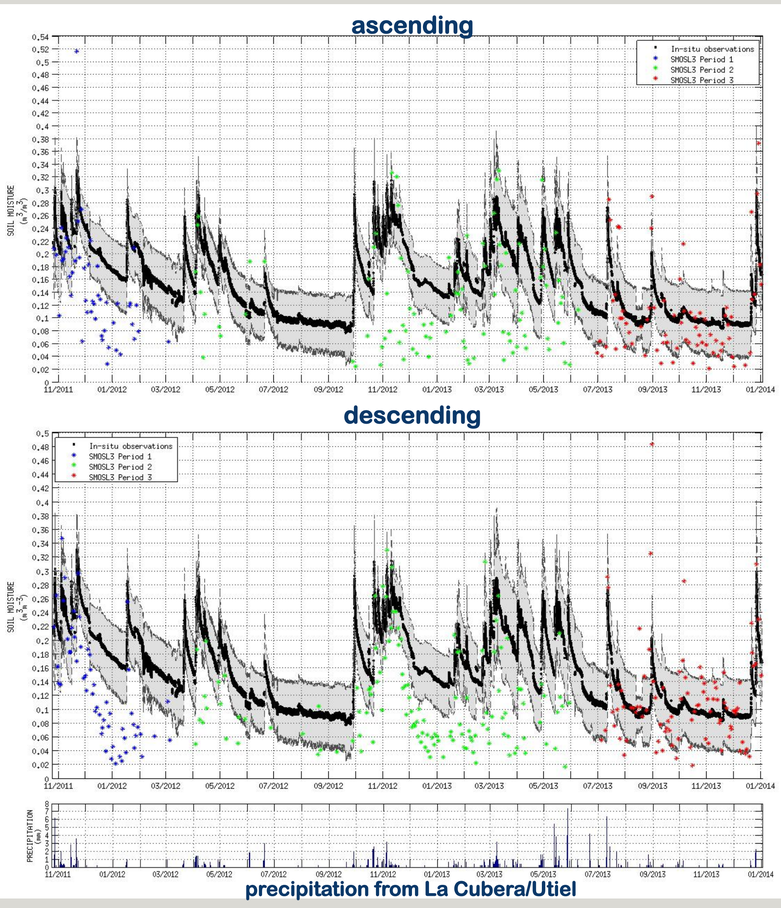
$$R=\frac{\sum_{i=1}^{n}(SSM_{ref\,(i)}-\overline{SSM_{ref}})(SSM_{product(i)}-\overline{SSM_{product}})}{\sqrt{\sum_{i=1}^{n}(SSM_{ref\,(i)}-\overline{SSM_{ref}})^2\sum_{i=1}^{n}(SSM_{product(i)}-\overline{SSM_{product}})^2}}$$

$$RMSD=\sqrt{(SSM_{product}-SSM_{ref})^2}$$

$$Bias=(SSM_{product}-SSM_{ref})$$

Local validation

SMOSL3 SM retrievals compared to averaged in situ observations.



Orbit	Period 1			Period 2			Period 3		
	R	RMSD	Bias	R	RMSD	Bias	R	RMSD	Bias
ASC	0.75	0.092	0.069	0.41	0.102	0.070	0.80	0.053	0.009
DES	0.81	0.096	0.078	0.65	0.093	0.077	0.54	0.063	-0.002

- Better correlation for A orbits, periods 1 (R=0.75) and 3 (R=0.80), as compared to period 2 (R=0.41)
- Better correlation in period 1 for D orbits R=0.81, lower for periods 2 (0.65) and 3 (0.54)
- Descending SMOSL3 SM correlates better than ascending in periods 1 and 2, oppositely to period 3 where ascending retrievals correlate significantly better than descending ones

Consistency of In-situ Data

- A qualitative quality control was applied to in-situ soil moisture observations using precipitation from two rain gauges in the area and ECMWF operational soil moisture estimations over the station network.
- Even though some punctual inconsistencies were observed and discarded, in general, the measurements showed a good correspondence both with precipitation and ECMWF operational soil moisture.
- Thus, averaged soil moisture was calculated using measurements from all 5 stations used in the comparison with SMOSL3 product.

Pixel	Orbit	Period 1			Period 2			Period 3		
		R	RMSD	Bias	R	RMSD	Bias	R	RMSD	Bias
1	ASC	0.52	0.213	0.210	0.49	0.217	0.175	0.37	0.145	0.127
	DES	0.81	0.189	0.187	0.64	0.183	0.175	0.37	0.105	0.077
2	ASC	0.56	0.210	0.205	0.12	0.231	0.219	0.01	0.173	0.146
	DES	0.84	0.169	0.166	0.55	0.179	0.169	0.30	0.128	0.110
3	ASC	0.60	0.153	0.146	0.31	0.155	0.143	0.02	0.123	0.093
	DES	0.85	0.125	0.122	0.61	0.121	0.112	0.18	0.103	0.062
4	ASC	0.37	0.209	0.204	0.48	0.228	0.221	0.54	0.101	0.083
	DES	0.76	0.195	0.192	0.62	0.206	0.200	0.62	0.080	0.063
5	ASC	0.31	0.201	0.195	0.39	0.210	0.201	0.34	0.109	0.088
	DES	0.72	0.180	0.175	0.59	0.180	0.172	0.47	0.087	0.062
6	ASC	0.46	0.133	0.125	0.58	0.140	0.131	0.37	0.072	0.055
	DES	0.34	0.132	0.124	0.53	0.124	0.114	0.40	0.076	0.054
7	ASC	0.70	0.184	0.181	0.68	0.188	0.181	0.72	0.087	0.079
	DES	0.80	0.165	0.161	0.75	0.149	0.140	0.60	0.068	0.050
8	ASC	0.69	0.133	0.125	0.74	0.120	0.108	0.78	0.043	0.029
	DES	0.66	0.128	0.118	0.74	0.098	0.083	0.60	0.042	0.012
9	ASC	0.75	0.046	-0.001	0.65	0.064	-0.027	0.66	0.091	-0.083
	DES	0.64	0.051	0.003	0.70	0.066	0.040	0.47	0.094	-0.087

Limited Amount of data? Topography?

Lower variation Dryer areas

Comparison ERA-Land & SMOS. ERA-Land pixel scale

On average for all pixels (pixels 2 and 3 for period 3 discarded)
- A orbit: R=0.55 (period 1), R=0.49 (period 2) and R=0.54 (period 3)
- D orbit: R=0.71 (period 1), R=0.64 (period 2) and R= 0.50 (period 3)
- Generally, D SMOSL3 product tend to be better correlated to ERA-Land estimations than A retrievals for periods 1 and 2
- However, A orbit values are better correlated for period 3, although correlation differences between A and D orbits are low.

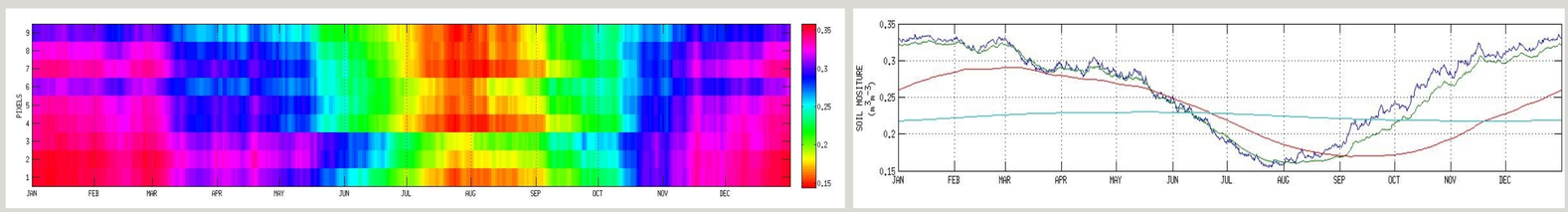
Comparison ERA-Land & SMOS. Jucar River Basin scale

Orbit	Period 1			Period 2			Period 3		
	R	RMSD	Bias	R	RMSD	Bias	R	RMSD	Bias
ASC	0.68	0.157	-0.154	0.61	0.151	-0.141	0.65	0.070	-0.060
DES	0.78	0.141	-0.138	0.71	0.120	-0.109	0.51	0.062	-0.040

In general, ERA-Land estimations appear to be better correlated to SMOSL3 reprocessed data from period 1 for both A and D orbits. D SM retrievals show better correlation in periods 1 and 2, in contrast to A orbit retrievals. However, the correlation between SMOSL3 and ERA-Land products is higher for the A orbit rather than for the D one in period 3

Climatology of the Jucar River Basin

- for the period from 1979 to 2010 using ERA-Land soil moisture estimations
- Daily averaged soil moisture was obtained over each ERA-Land pixel from the first layer along the studied period
- Generally, soil moisture shows the same dynamics over every pixel of the ERA-Land product, being higher during winter, particularly in Dec and Jan, and lower during summer, especially in Jul and Aug.
- However, the variation range of soil moisture depends on ERA-Land pixels location clearly distinguishing dryer from wetter areas.



- Averaged SM over the whole Jucar River Basin (blue, green, red and light blue for layers 1, 2, 3 and 4, respectively), showing SM variations and differences between wet and dry seasons.

Conclusions

- SM study variation in different zones for the period 1979-2012 using ERA-Interim reanalysis data.
- Similar variation of SM has been observed for most of the pixels.
- Direct relationship between precipitation and SM has been proved with SMOS data.
- SMOS shows higher variation than ERA-Interim, although both of them show the same dynamics.

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