

Real-time control of irrigation by assimilating measured soil moisture contents into CLM: a case study in Spain.

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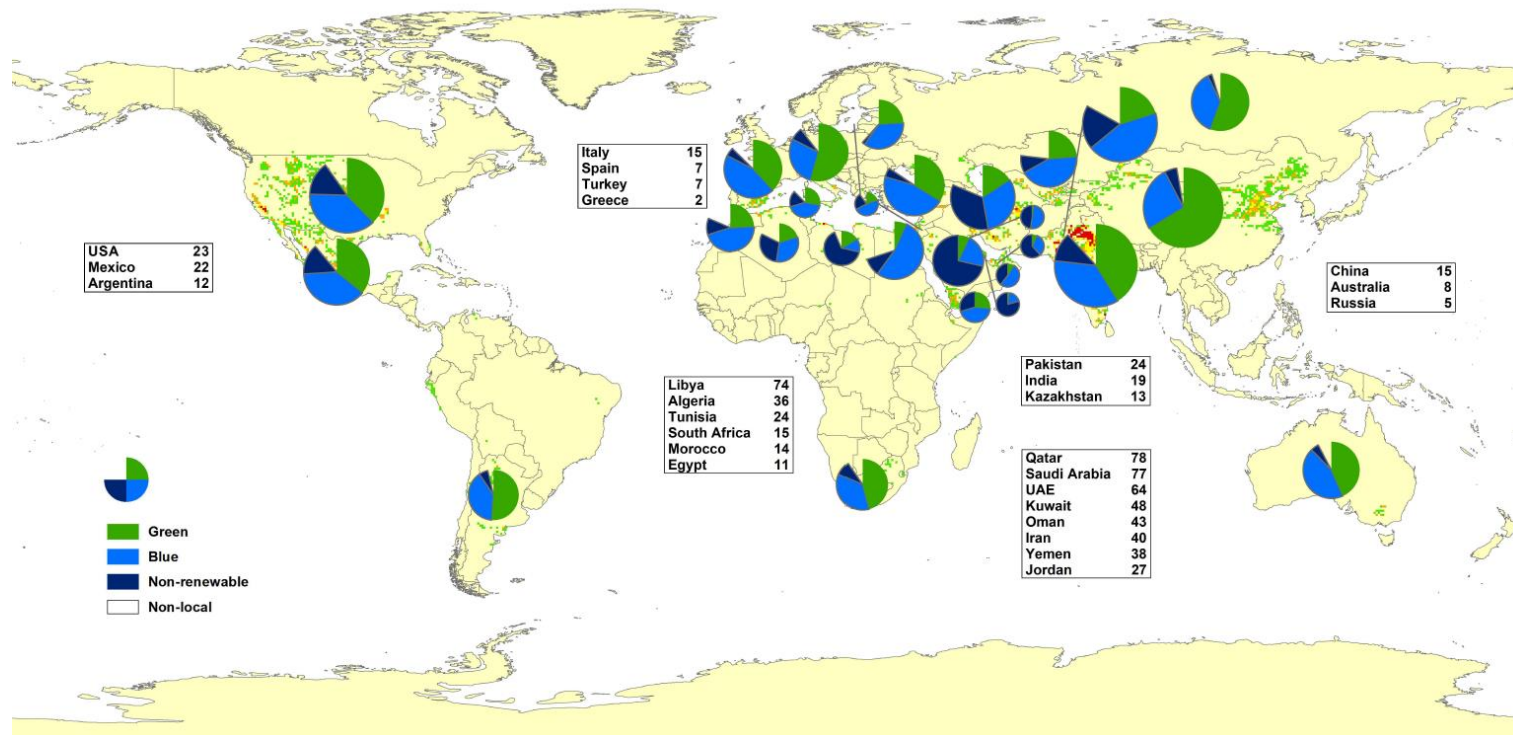
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- Large regions with agricultural production are affected by water stress.
- Irrigation results in non-sustainable groundwater depletion in many regions.



From: Wada (2012)

- Our approach to optimize irrigation has five components:
 - Soil moisture data from in situ probes.
 - Ensemble meteorological forecasts.
 - Land surface model to predict soil moisture evolution.
 - Data assimilation to update model predictions with data.
 - Optimization of needed irrigation.

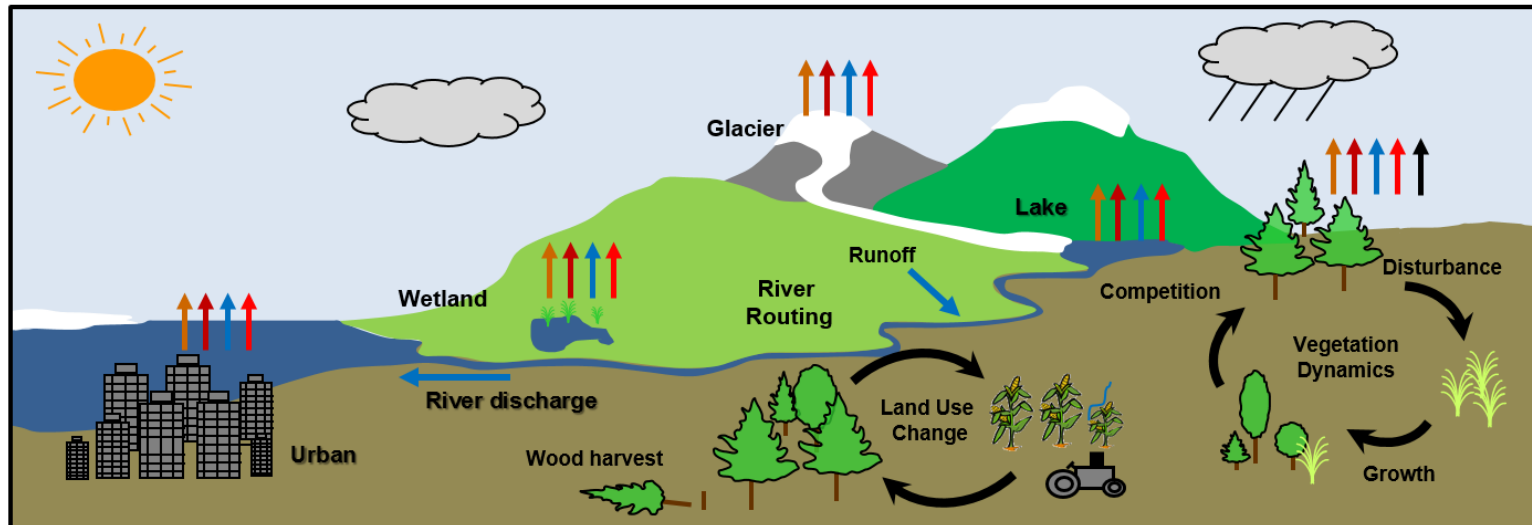
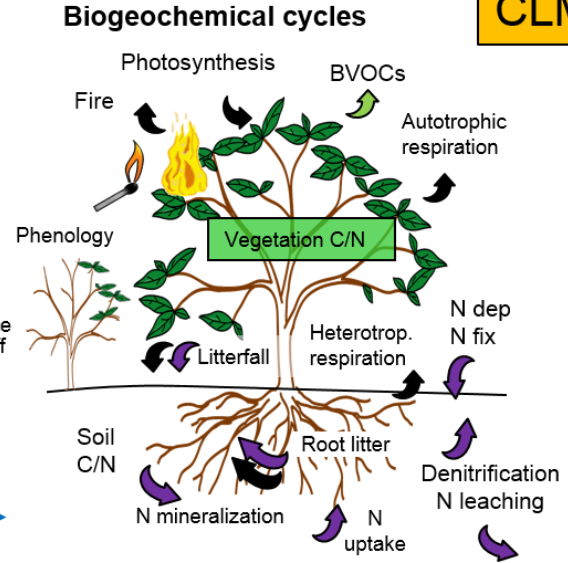
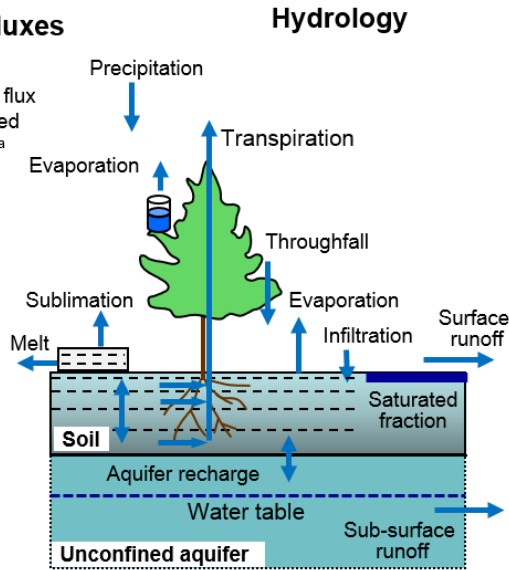
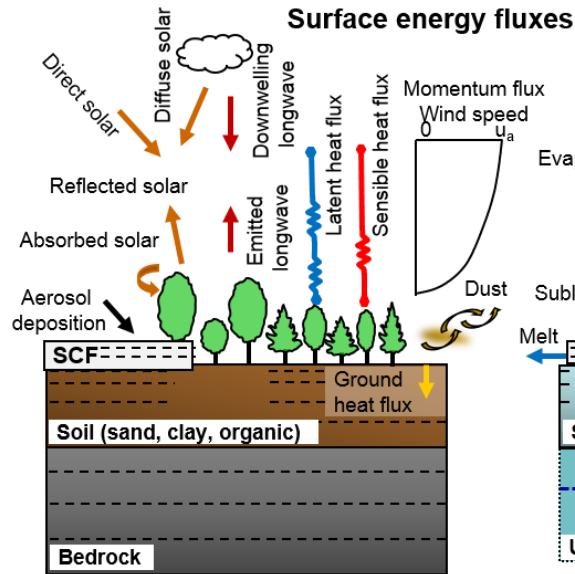
- Operational application and test: Picassent area, Spain.



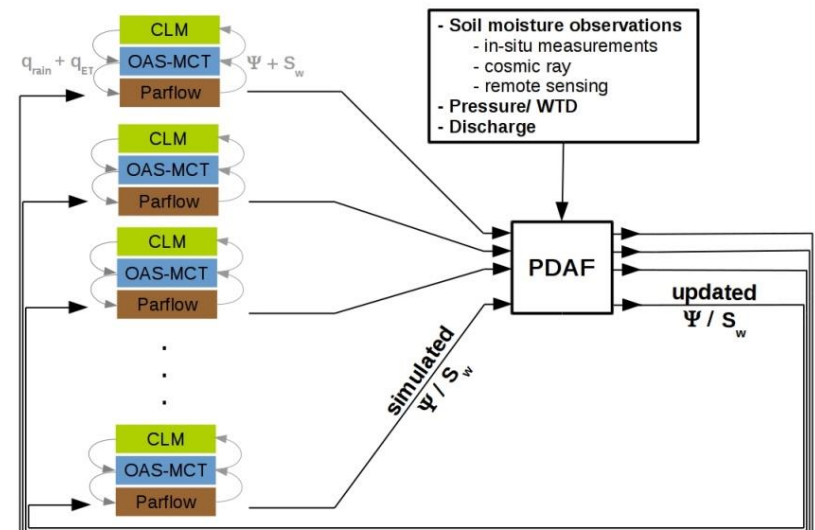
Soil capacitance sensors



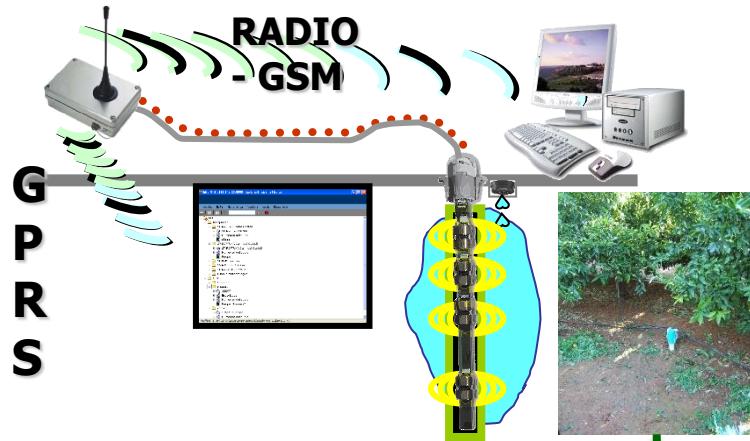
Cosmic ray probe



- CLM4.5 in combination with LETKF (Xujun Han et al.):
 - Multivariate (brightness temp, land surface temp, neutron counts, latent heat flux, and others).
 - Parameter estimation possible.
 - Bias estimation possible.
- Current development (Kurtz et al.):
 - EnKF with TerrSysMP.
 - Massive parallel computing.
 - Good scaling for 8192 proc.
 - **See poster!**



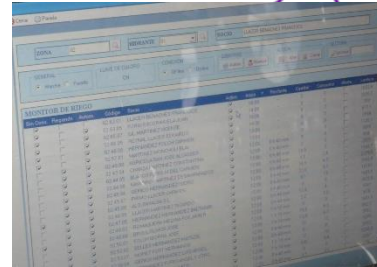
AGADAPT: Overview approach



Real-time Measurement

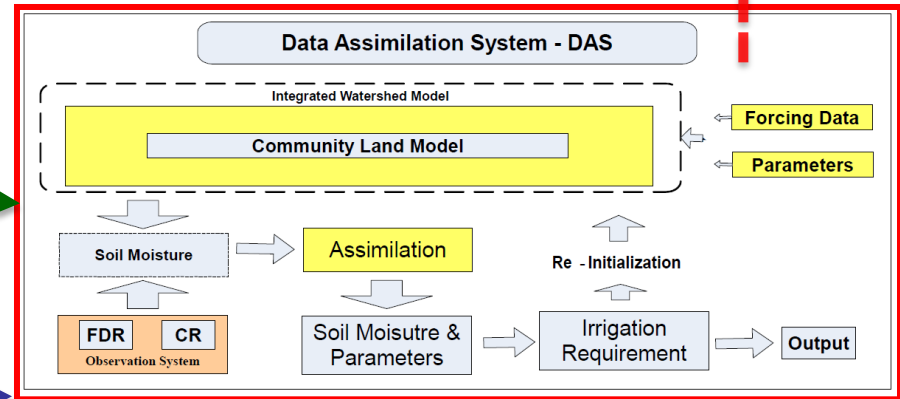


Real-time Weather Forecast



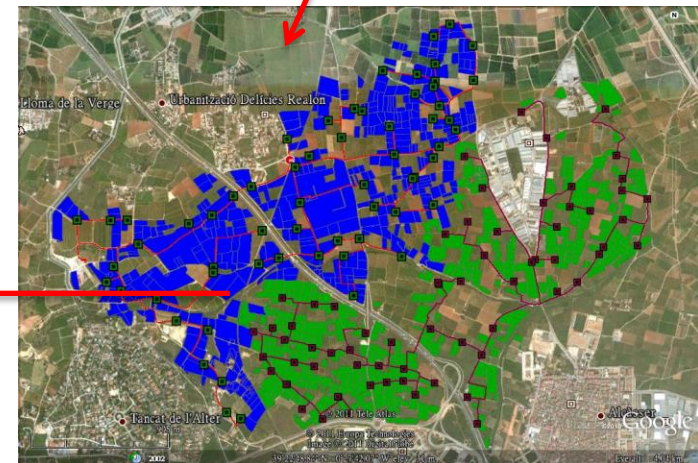
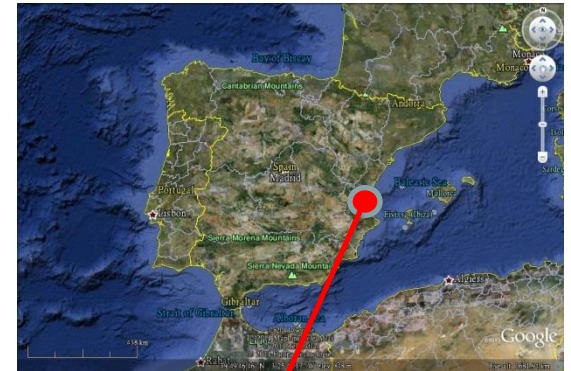
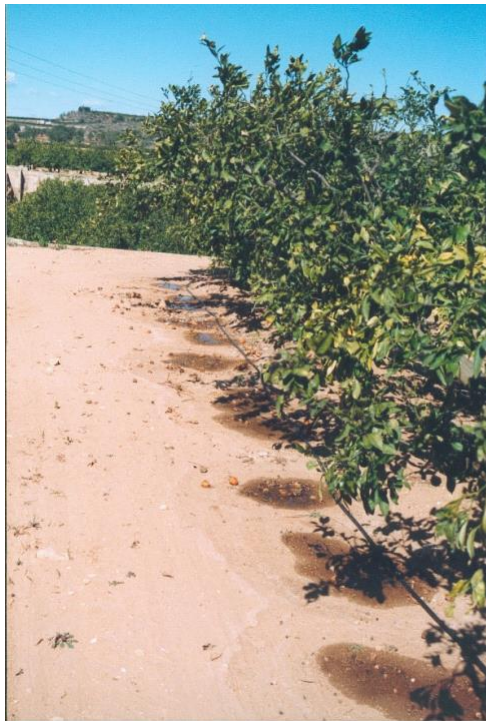
Irrigation time setting system (SCADA)

Irrigation Time Estimation

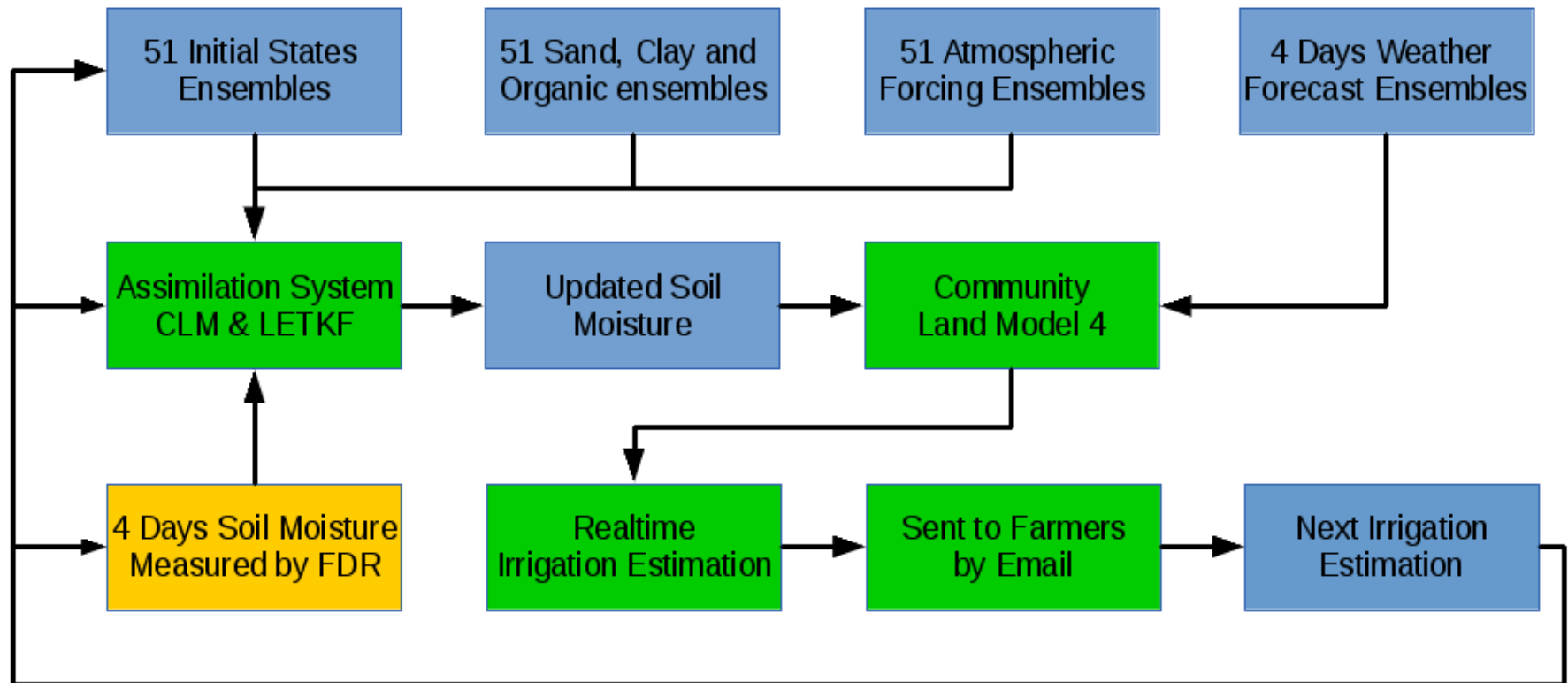


Model and Assimilation System

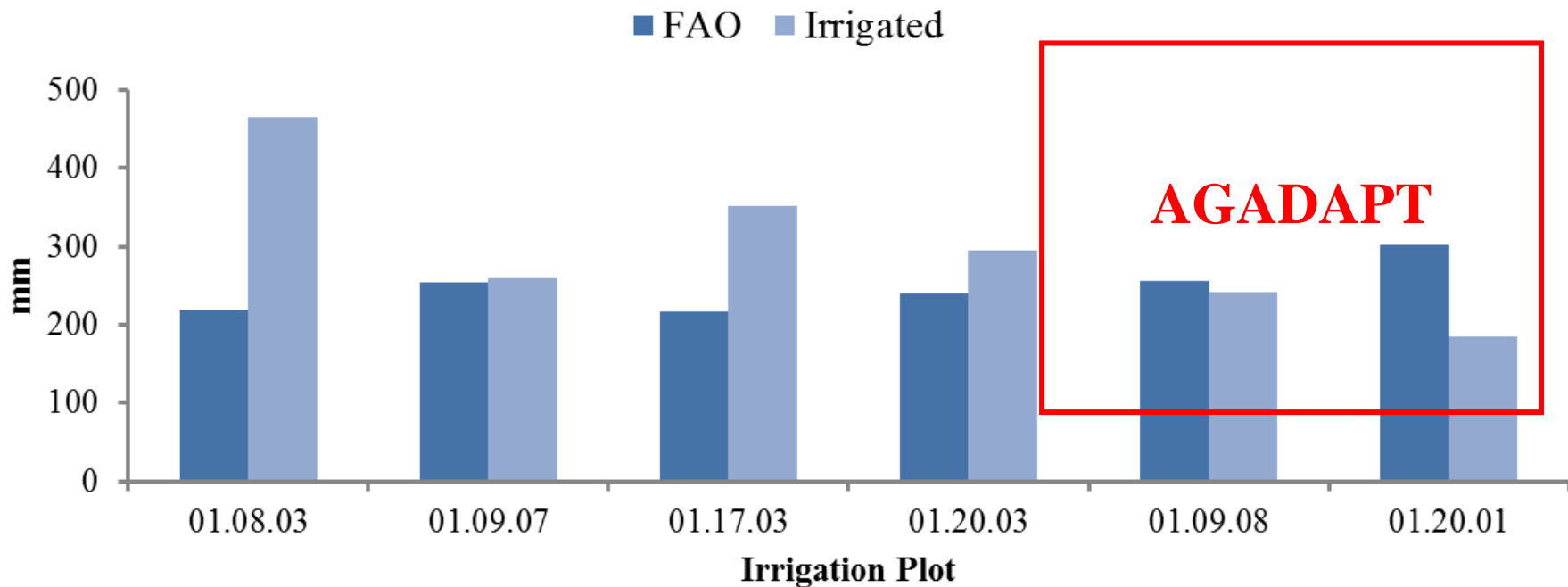
Crop type: Citrus - Picassent



- Real-time, operational scheduling of irrigation for the year 2013.
- Three fields traditional FAO-based irrigation, three fields CLM-based irrigation.
- Each field equipped with one capacitance probe (four depths), used for DA four times per day. Soil moisture measured at 10cm and 30cm assimilated.
- Ensemble weather forecast (51 members) used for next days (Meteo France).
- Operational approach: automatic data delivery, automatic model runs/optimization, automatic sending of optimization results.
- Water board in Spain implements optimized amounts, but includes logistic/hydraulic constraints.



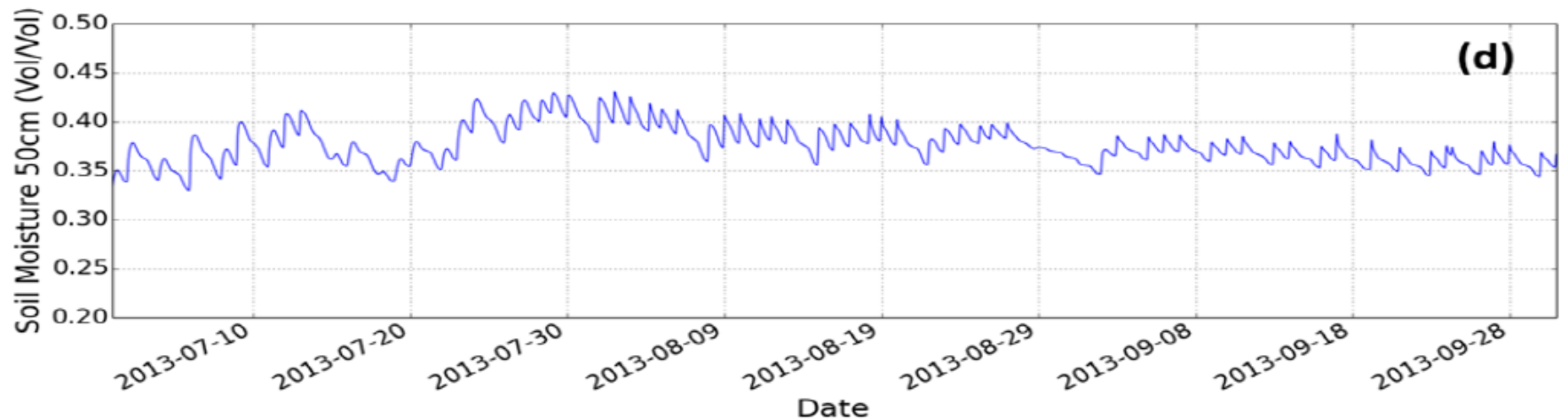
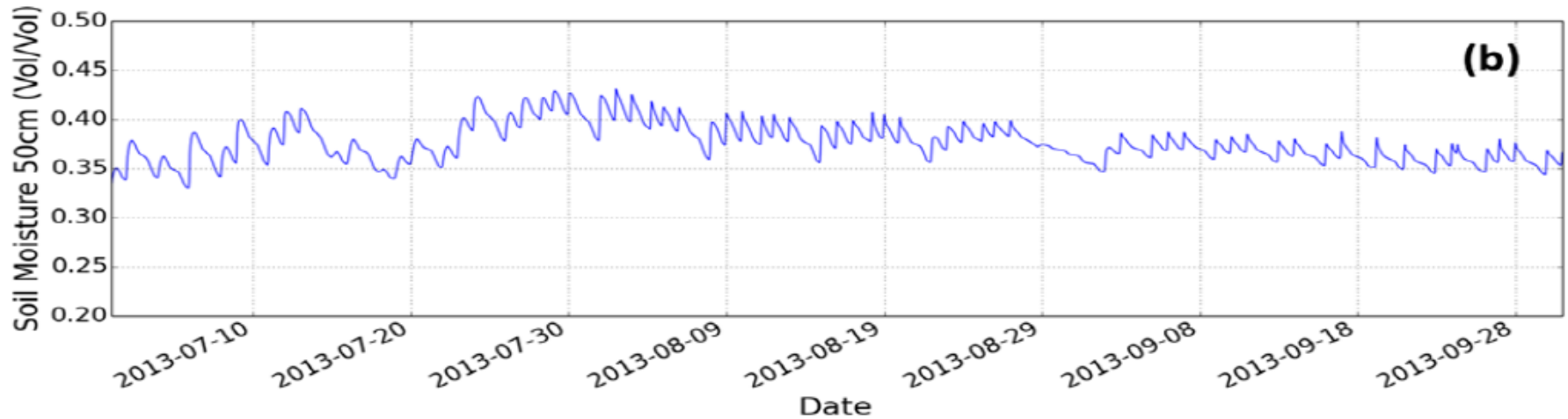
- Predicted soil moisture contents for next 1-4 days at sensors have errors of 0.02-0.07 cm³/cm³.

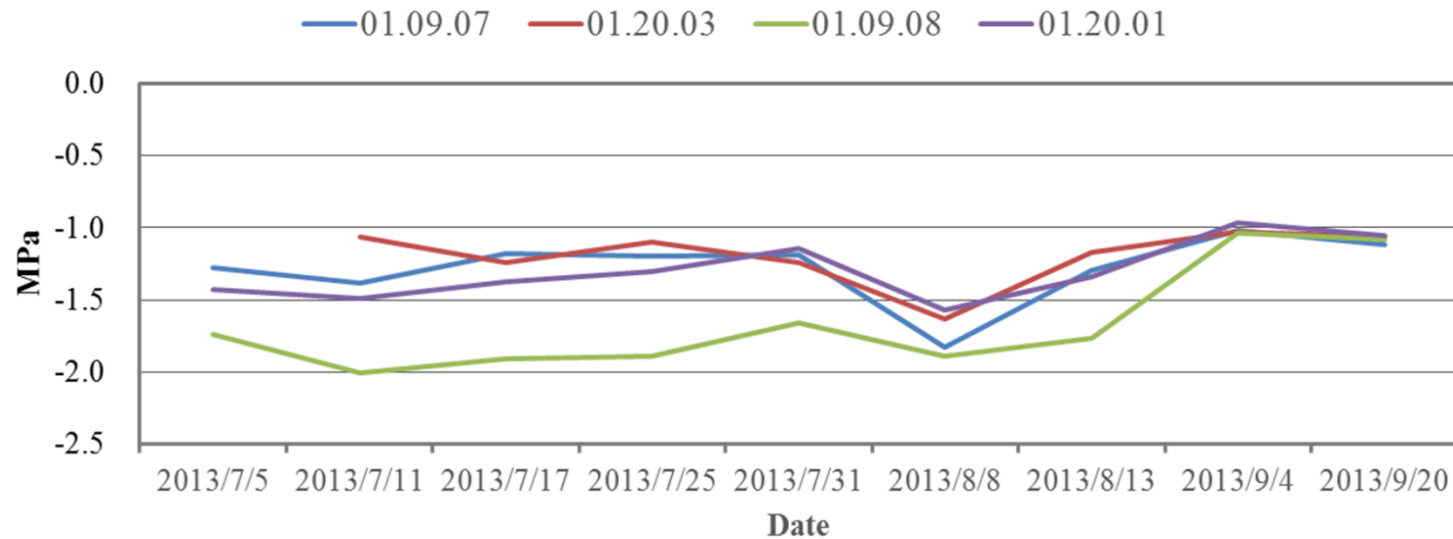


CLM-fields: ca. 30% less irrigation.

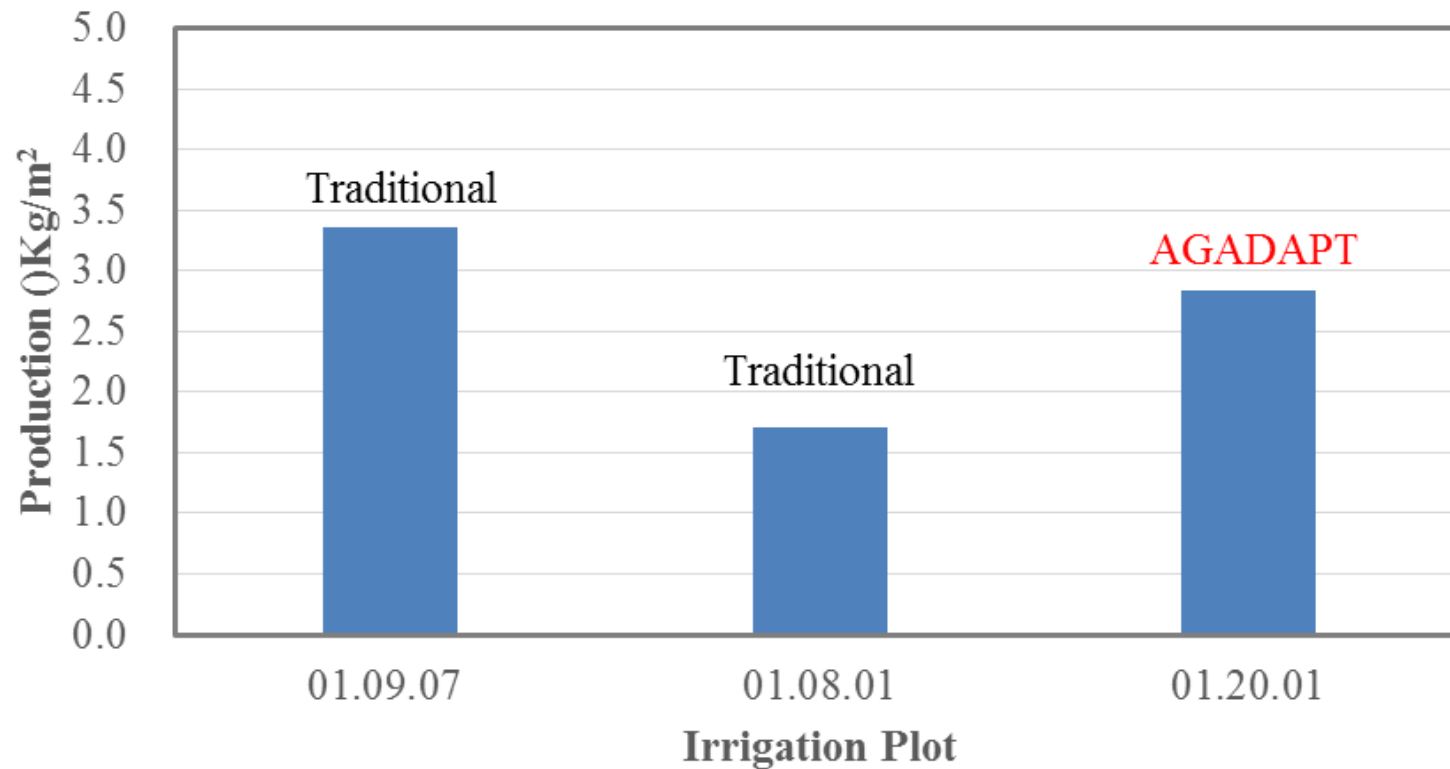
- Soil moisture data, also at 50cm and 70cm depth.
- Stem water pot meas, clear sky noons, 52-56 trees in total, 9 campaigns Jul-Sep.
- Production evaluated at end of season.

Evaluation: Soil moisture 50cm depth

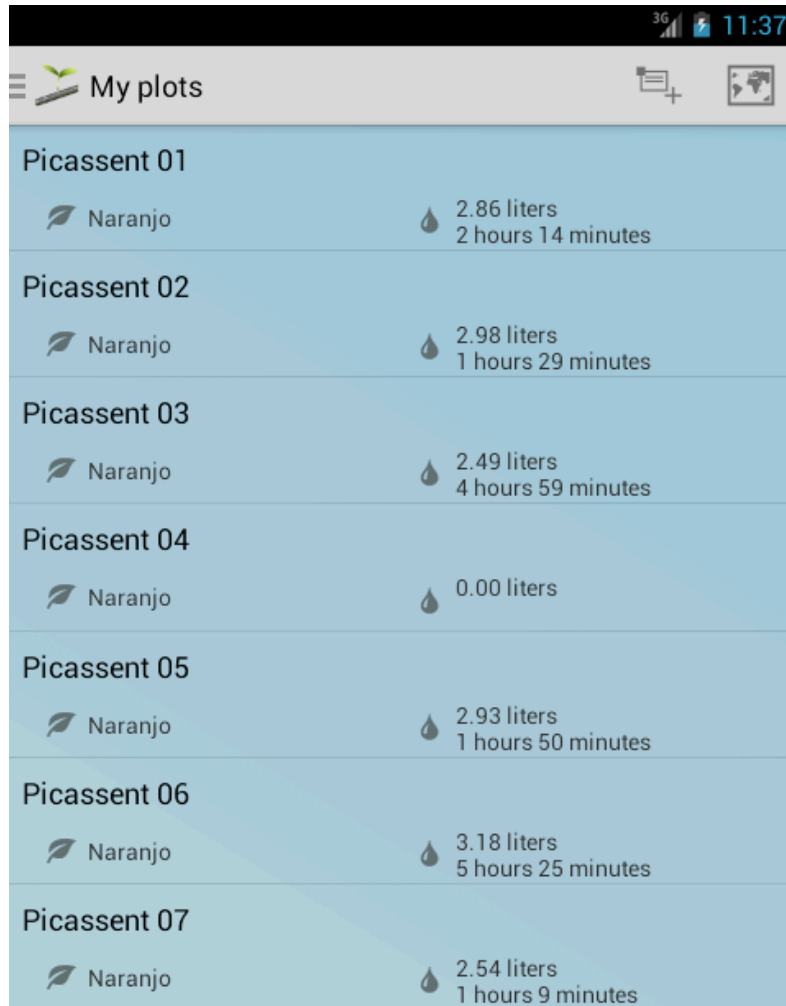




Measurement at end of season for only three out of six plots.

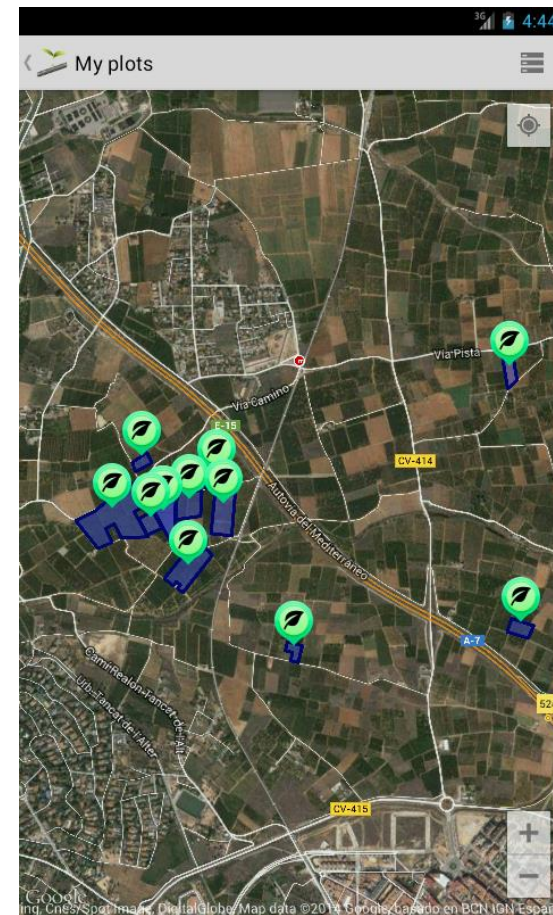


Application at parcel with real-time information (e.g., irrigation amount)



The screenshot shows a mobile application interface titled "My plots". It displays a list of seven plots, each with a leaf icon, the name "Naranjo", and irrigation data. The data includes the amount of water in liters and the time taken in hours and minutes.

Plot ID	Plant	Irrigation Amount (liters)	Irrigation Time
Picassent 01	Naranjo	2.86	2 hours 14 minutes
Picassent 02	Naranjo	2.98	1 hours 29 minutes
Picassent 03	Naranjo	2.49	4 hours 59 minutes
Picassent 04	Naranjo	0.00	
Picassent 05	Naranjo	2.93	1 hours 50 minutes
Picassent 06	Naranjo	3.18	5 hours 25 minutes
Picassent 07	Naranjo	2.54	1 hours 9 minutes



- Potential of optimization of irrigation scheduling with data assimilation shown.
- Operational framework was developed and shown to work.
- Significant water saving possible.
- Experimental data from 2013 not conclusive, further tests needed/ongoing.
- Outlook: Cosmic ray probe: large scale soil moisture. Potential for additional improvement.
- Web application will be further developed.

Thanks for your attention!