Drought and water resources science team

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with contributions from the HyMeX Drought & Water Resources Science Team

GEWEX/GLASS Panel Meeting
May 15th, 2016
Tokyo, Japan

Science Questions

HyMeX SQ related to the DWR ST

- WG2-SQ1: How to **quantify the water cycle components** over the Mediterranean basin through an improved hydro-meteorological framework?
- WG2-SQ2: Can we better understand the specificities of the **hydrological processes** in the Mediterranean?
- WG2-SQ3: How will the continental hydrological cycle evolve in relation to **global change**?
- WG5-SQ4: How can we define plausible scenarios (land use, economy,...) to quantify the **impact of global change on** the Mediterranean **hydrological cycle and extremes**?

In April 2016 we organized a workshop in Zaragoza, (Spain), in order to enhance our activity.

- GEWEX was present through (A. Boone and Jan Polcher).

In July 2017 we will meet again in Barcelona (HyMeX Workshop).

HyMeX's objectives respond to WRCP, GEWEX and GLASS questions.

GLASS

GLASS coordinates the evaluation and intercomparison of the new generation of Land Surface Schemes (LSSs) and their applications to scientific queries of broad interest on both local and global scales.

WCRP Grand Challenges

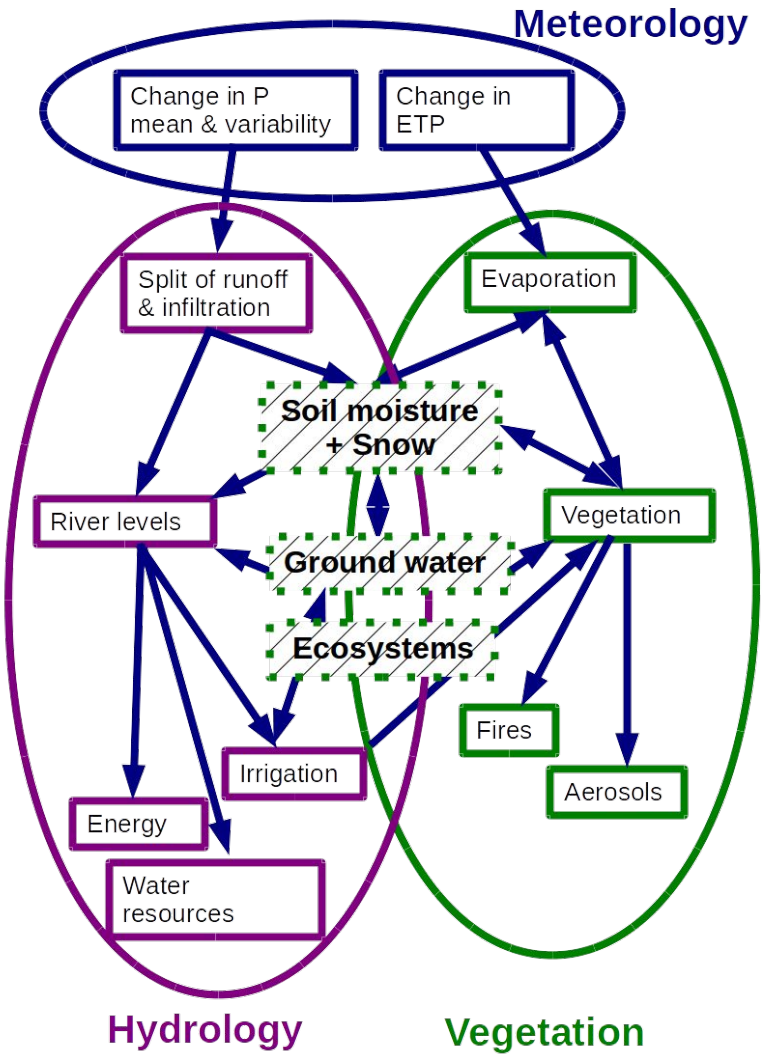
- Melting Ice and Global Consequences
- Clouds, Circulation and Climate Sensitivity
- Carbon Feedbacks in the Climate System
- **Weather and Climate Extremes**
- **Water for the Food Baskets of the World**
- Regional Sea-Level Change and Coastal Impacts
- **Near-Term Climate Prediction**

GEWEX Science Questions

1. **Observations and Predictions of Precipitation**: How can we better understand and predict precipitation variability and changes?
2. **Global Water Resource Systems**: How do changes in land surface and hydrology influence past and future changes in water availability and security?
3. **Changes in Extremes**: How does a warming world affect climate extremes, esp. droughts, floods, and heat waves, and how do land area processes, in particular, contribute?
4. **Water and Energy Cycles and Processes**: How can understanding of the effects and uncertainties of water and energy exchanges in the current and changing climate be improved and conveyed?

HyMeX Drought and Water Resources Science Team

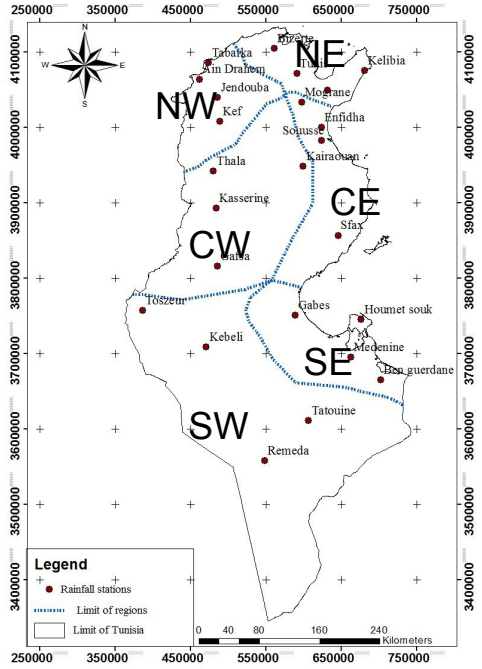
- Description of Mediterranean droughts:
  - Datasets, models and societal impacts of past droughts
- Understanding of drought processes:
  - Drought propagation within the system, feedbacks, interactions with climate change and water resources, aerosols, vegetation, etc.
- Predicting drought:
  - Data assimilation, seasonal forecasting, model improvement, impacts of climate change, and links with policy.



In the following slides we present an update on the recent developments related to this DWR Science Team.

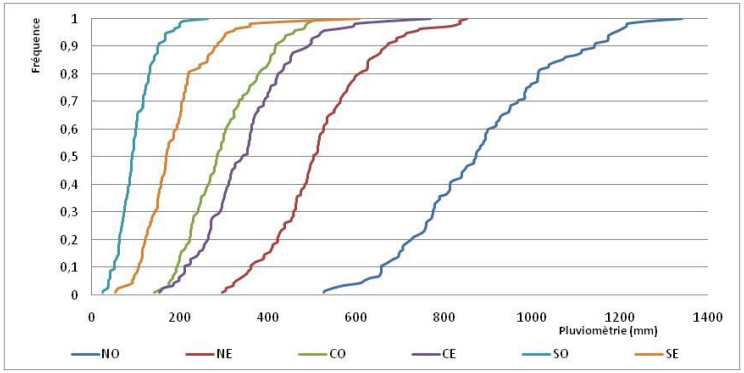
Drought description

We should aim at applying such methods at the Mediterranean scale in order to have a coherent description of Mediterranean drought.

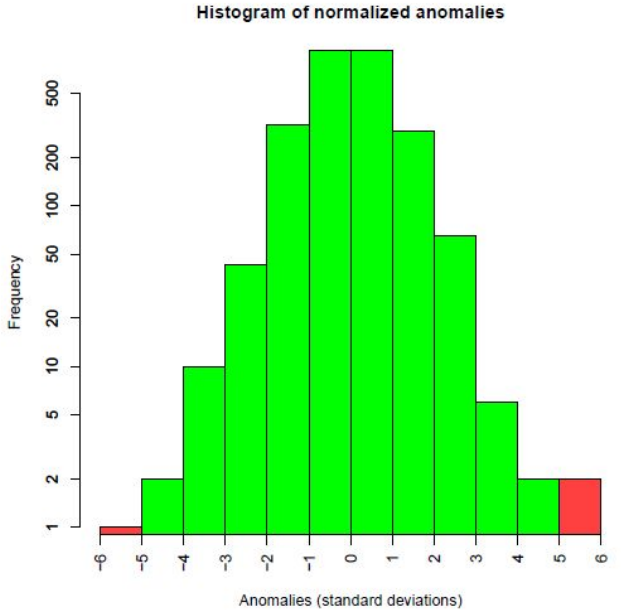


Touati et al. have studied and quantified **drought occurrence in Tunisia** using Markov chains.

A better knowledge of drought statistics in a region is useful for planning.



José A. Guijarro has improved his **data homogenization software** package CLIMATOL in order to allow the homogenization of daily series (or any other time scale if synchronous data is available).



Reconstruction of past droughts

Caillouet et al. (2016).

~ 50 years of streamflow data in data rich countries → Too short for extremes!

Daily 140-year ensemble reconstructed streamflow dataset for near-natural catchments in France.

Based on a probabilistic **downscaling of the Twentieth Century Reanalysis** over France and a continuous **hydrological model**.

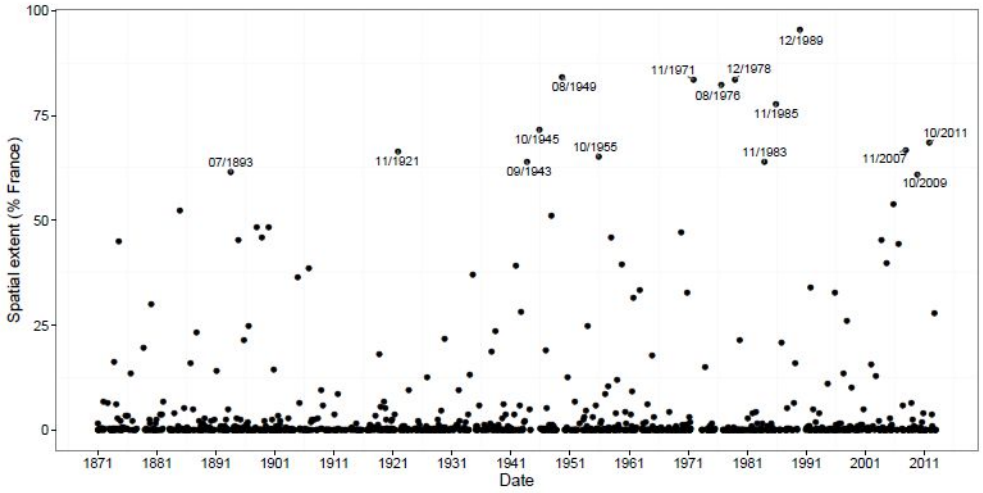
Results bring forward older and relatively forgotten events.

The worst events often belong to the pre-1950 period.

Our current worst case scenarios might be too optimistic.

This work has an important impact on adaptation strategies.

Can our LSMs reproduce such extreme drought events?



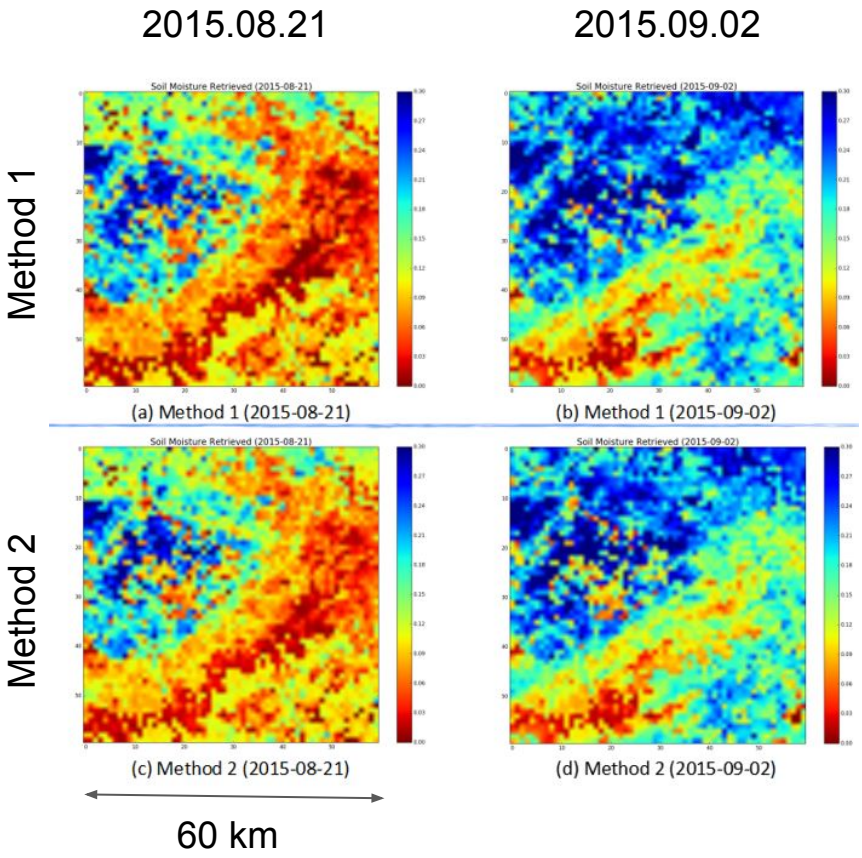
Remote sensing

Soil moisture data is crucial for improvements in land-surface processes.

New missions, new possibilities.

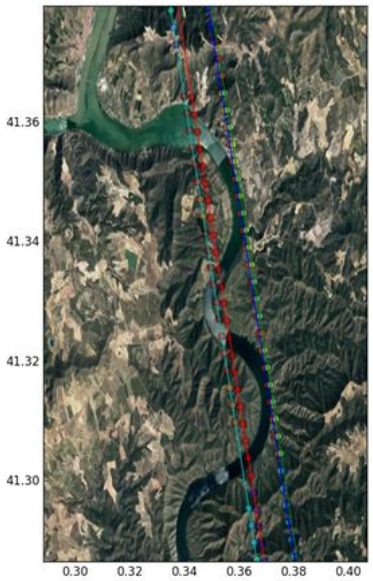
Qi Gao et al. (2017) Soil Moisture Retrieval from Sentinel-1 and MODIS NDVI Synergy.

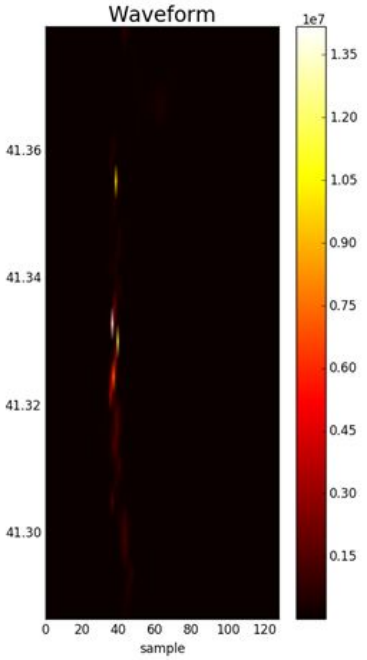
- Synthetic Aperture Radar give possibility to retrieve the surface soil moisture with a **high spatial resolution**.
- Two methodologies.
- Methods validated in a site (in NE Spain), with an RMS error about 0.08 for method 1 and 0.07 for method 2 in volumetric moisture.



New remote sensing high resolution soil moisture datasets will be very useful for model improvement.

Remote sensing





Qi Gao et al. are currently working on the estimation of the **level of small water bodies**.

- Surface Height is retrieved from Sentinel-3 data over Ebro River.
- The brighter color in the waveform indicates where the signal is reflected from water.

The objective is to obtain data of small dams and irrigation ponds in areas where the data is not available.

- These data are necessary if we aim at introducing anthropic processes in models.

Clara Linés is describing drought by means of remote sensing data, with a focus on **decision making support** (Ebro river basin).

- Cross-correlation of remote sensing datasets against reported drought impacts.

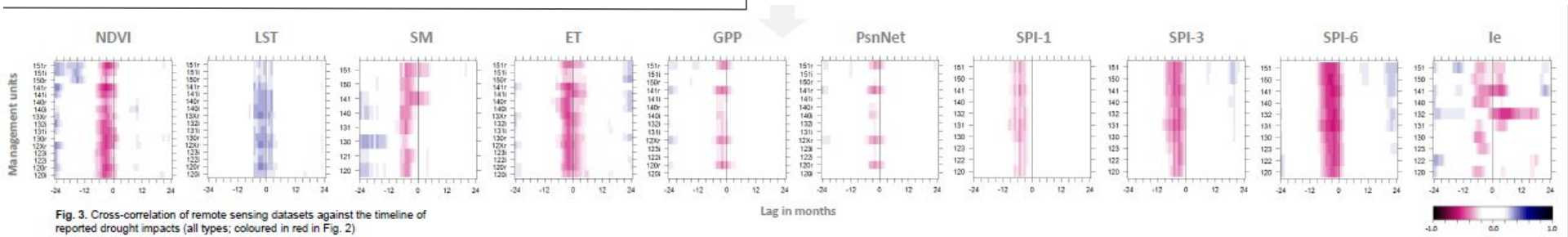
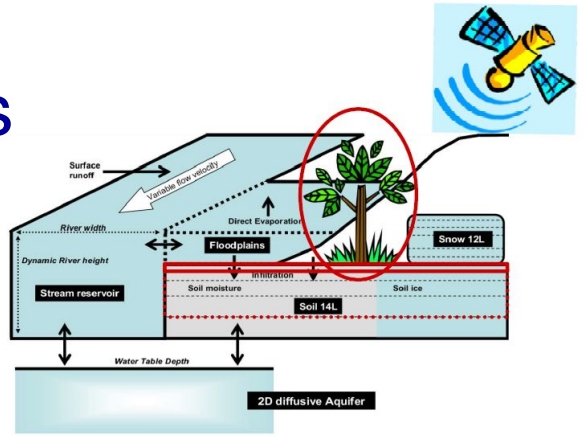


Fig. 3. Cross-correlation of remote sensing datasets against the timeline of reported drought impacts (all types; coloured in red in Fig. 2)

Assimilation of satellite data in LSMs



Albergel et al.

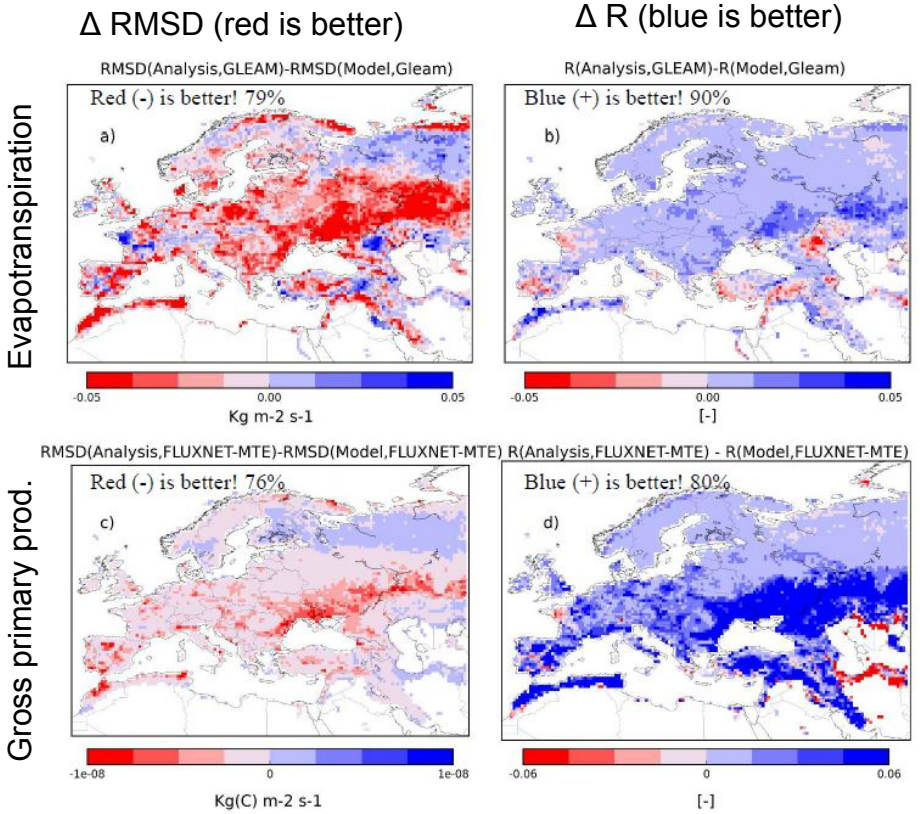
LDAS-Monde: SURFEX with fully coupled to hydrology.

The only system able to sequentially assimilate vegetation products such as LAI together with SSM observations.

Positive impact on Evapotranspiration, Gross Primary Production and aboveground Biomass.

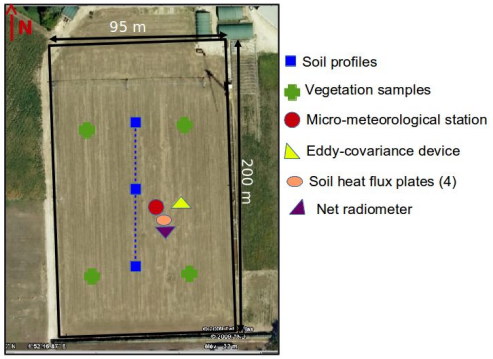
Neutral to positive on river discharge.

Data assimilation is having a relevant impact on the Mediterranean area.



Representation of crop succession

Instrumented plot

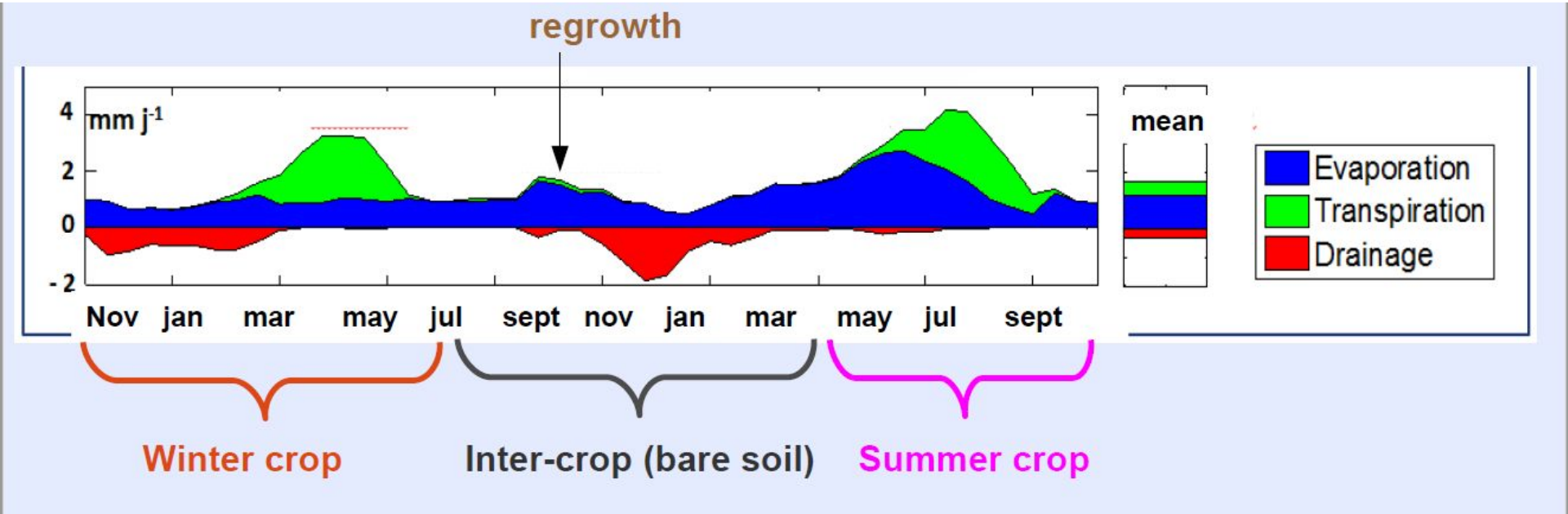


Sébastien Garrigues is studying the representation of crop successions using a LSM (SURFEX) on an instrumented site.

Explicit representation of crop succession in the simulation.

- Succession of crops and bare soil.

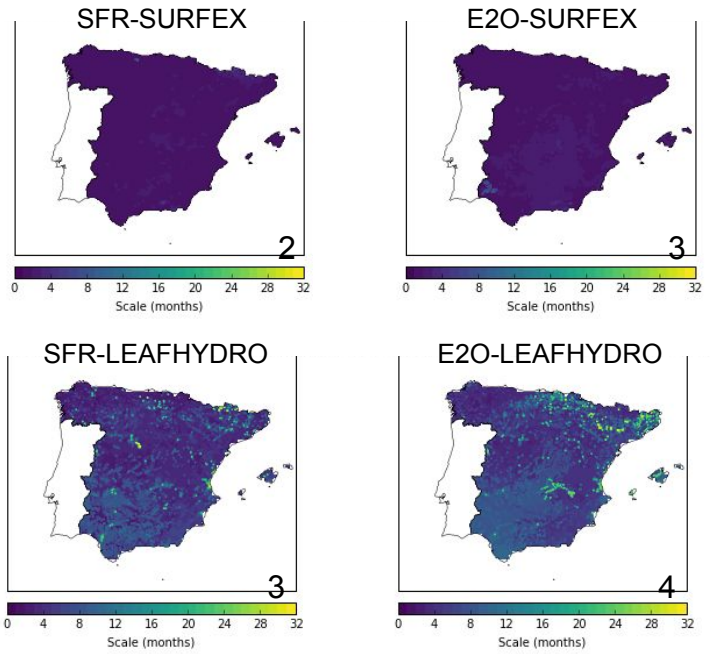
This work is allowing to understand in great detail the different sources of uncertainty.

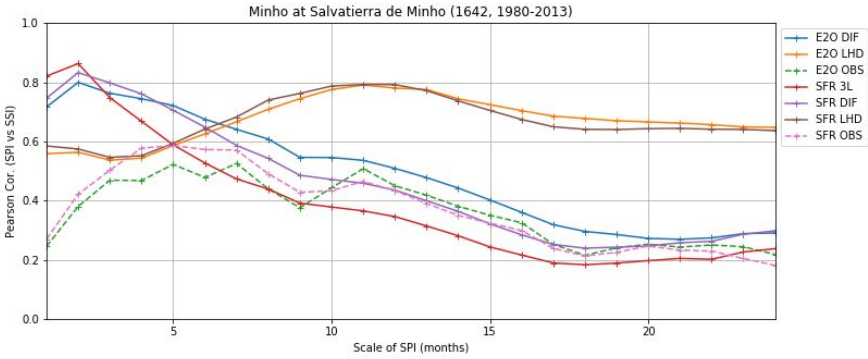


Drought propagation in LSMs

Quintana-Seguí et al. (eartH2Observe project) are studying how LSM models propagate drought through the system (from precipitation to soil moisture and streamflow), using standardized indices.

1. **Forcing**: When forced by a global low resolution dataset, LSMs propagate drought to soil moisture more slow (compared to local high resolution forcing).
2. **Model structure**: Drought propagation to soil moisture and streamflow is very dependant on model structure.
   a. The comparisons performed until now show large differences between models.
   b. This is an indicator of problems in how our models simulate some processes.





Inclusion of underground water in SURFEX LSM

J.C. Sánchez Perrino et al. are introducing underground water processes in SURFEX using the LEAFHYDRO methodology.

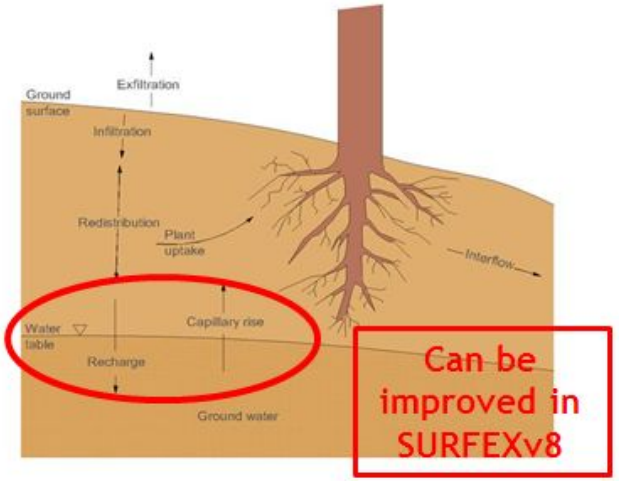
- More realistic than current method!
- Better closure of the water balance.

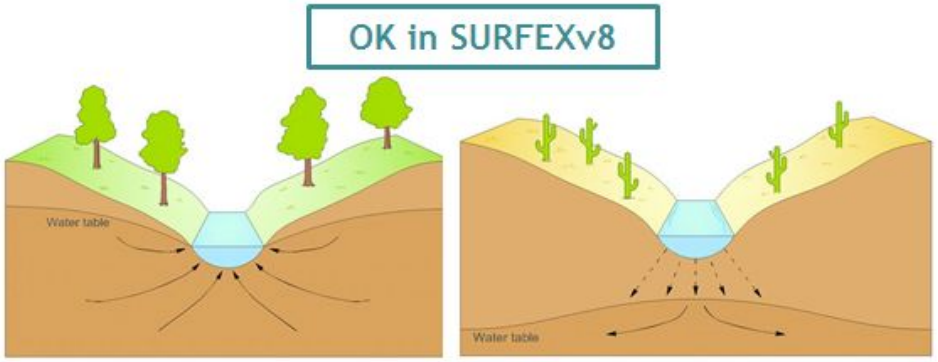
LEAFHYDRO allows a 2-way coupling

1. underground water and soil moisture
2. underground water and river.

The first results are encouraging.

Once implemented in SURFEX, it will be very easy to apply to the whole Mediterranean.





Underground water is essential for many processes, including anthropic processes (water extraction)

Estimation of freshwater inputs in the Mediterranean

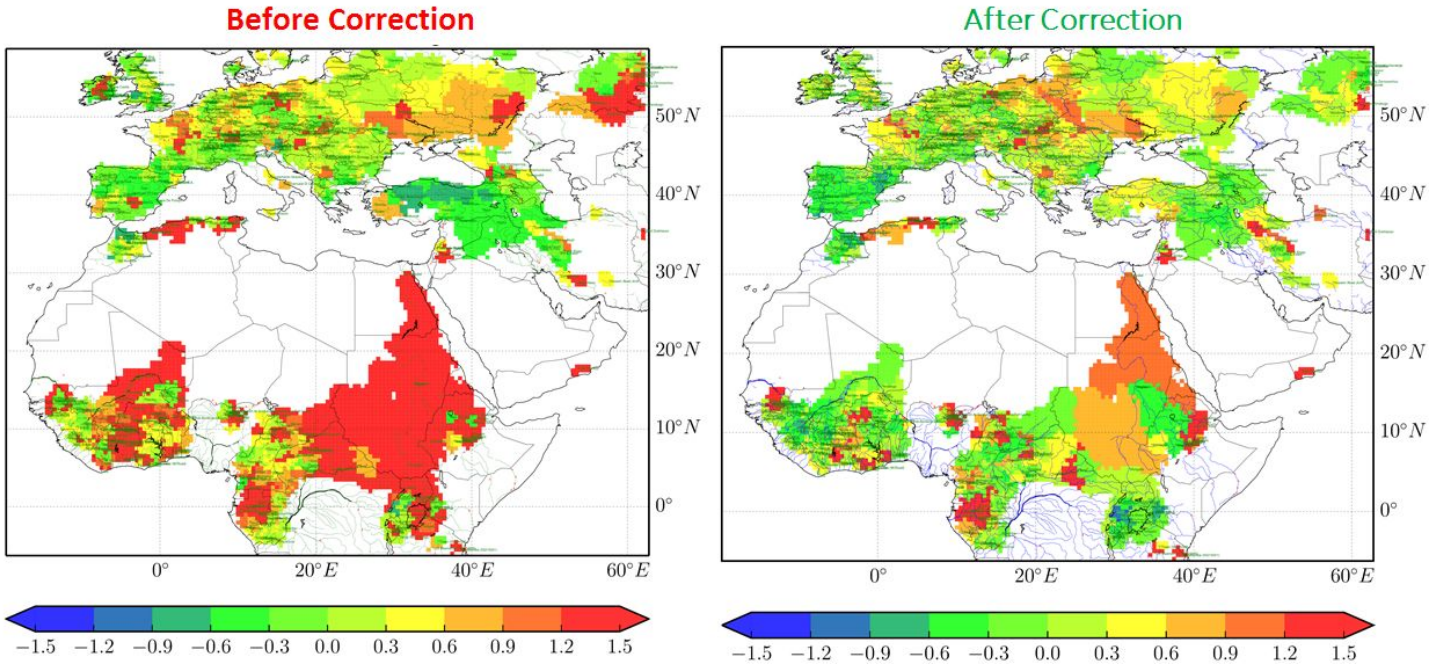
Wang and Polcher are improving their estimations of riverine freshwater inputs in the Mediterranean by means of LSM simulations (ORCHIDEE).

- LSMs allow higher temporal resolution than simpler water-balance methods.

Assimilation of GRDC streamflow data.

- No LSM parameters are modified → no impacts on other fluxes.

Streamflow Biases are reduced.



Seasonal forecasting

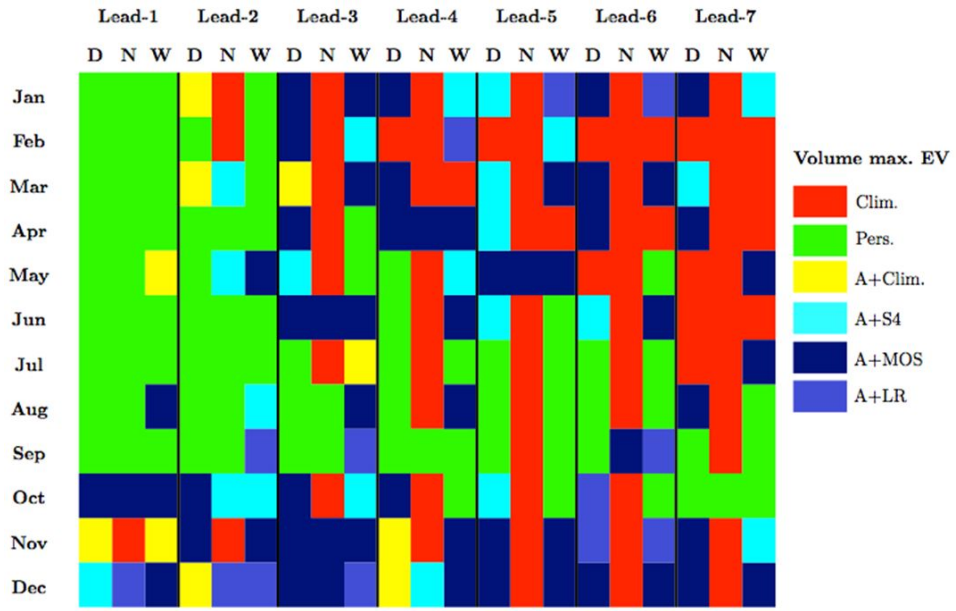
R. Marcos et al. (2016) have shown that seasonal forecasts have economic value:

- Small mediterranean basin.
- Dam levels.
- Simple statistical model.

Better land-atmosphere processes may lead to improvements in seasonal forecasting.

Potentially high impact on water management, agriculture, etc.

- Within the FP7 SPECS project, some work has been done with this aim.



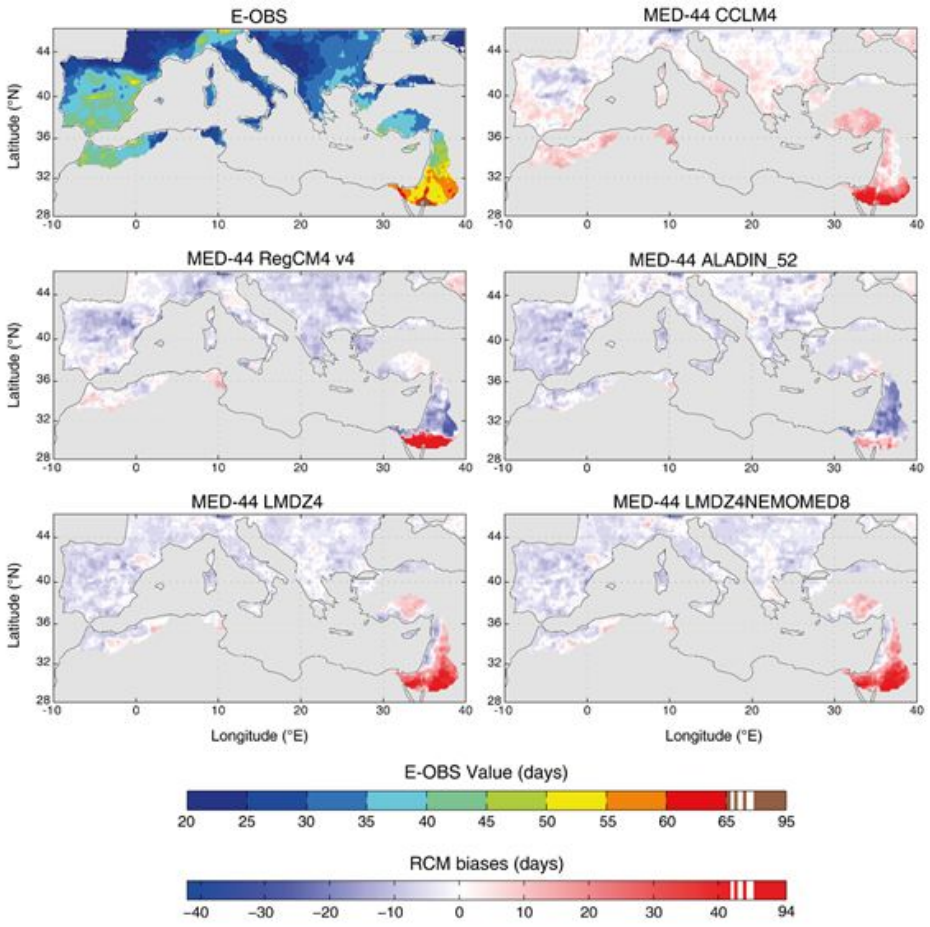
Long dry spells in RCMs

F. Raymond et al. are working on the detection of **very long dry spells** (1957-2013, E-OBS and NCEP-NCAR) and also are evaluating how Med-CORDEX simulations are reproducing these.

A small number of VLDS events is detected (76 events) for the 1957-2013 period

- Strongly anticyclonic conditions mainly explain the VLDS events presence in almost all the Mediterranean Basin, except to the Middle-East ;
- Models strongly overestimate the length of 80th centile value in the South of the Middle East compared to the E-OBS data:

Model capacity to reproduce the 80th centile value



Priorities for model improvement

In order to study drought and water resources in the Mediterranean using LSMs we need to improve in the following areas:

1. Irrigation and dam schemes.
2. Land-use and land-cover changes.
3. Physical processes relevant in the Mediterranean: snow, semi-arid areas, extremes, etc.
4. Feedbacks between the human influence and the natural system.

GEWEX GLASS-GHP Workshop in Gif-sur-Yvette, "Water Management in Large-Scale Models" (2016)

LIAISE

is a very good opportunity to progress on this topics.

→ Next presentation by Aaron Boone.



Conclusions

The **HyMeX DWR** community is making progress on many fronts.

- New studies are performed to **describe droughts** in the Mediterranean at different scales and with different approaches (precipitation, low flows, …).
- Work is done to **improve our models** and **understanding** of key **processes** (underground water, drought propagation, …).
- **Remote sensing** offers new opportunities, which are being exploited (new datasets, data assimilation).
- We are also active in **seasonal forecasting** and **climate change**.

Federating efforts and extending methodologies to the Mediterranean scale could lead to **future improvements.**

Projects

- Many of our current projects are ending this year (eartH2Observe, MARCO, REMEMER, SPECS, …).
- New proposals are to be submitted at national and international levels.
- This new generation of projects should allow us progress towards our objectives.
  - **LIAISE and related national projects.**

Coordination with GEWEX GLASS and GHP

- Our work is a contribution to GLASS and GHP and are targeted towards the GHP SQ and WRCP GC.

Book on Climate Change in the Mediterranean

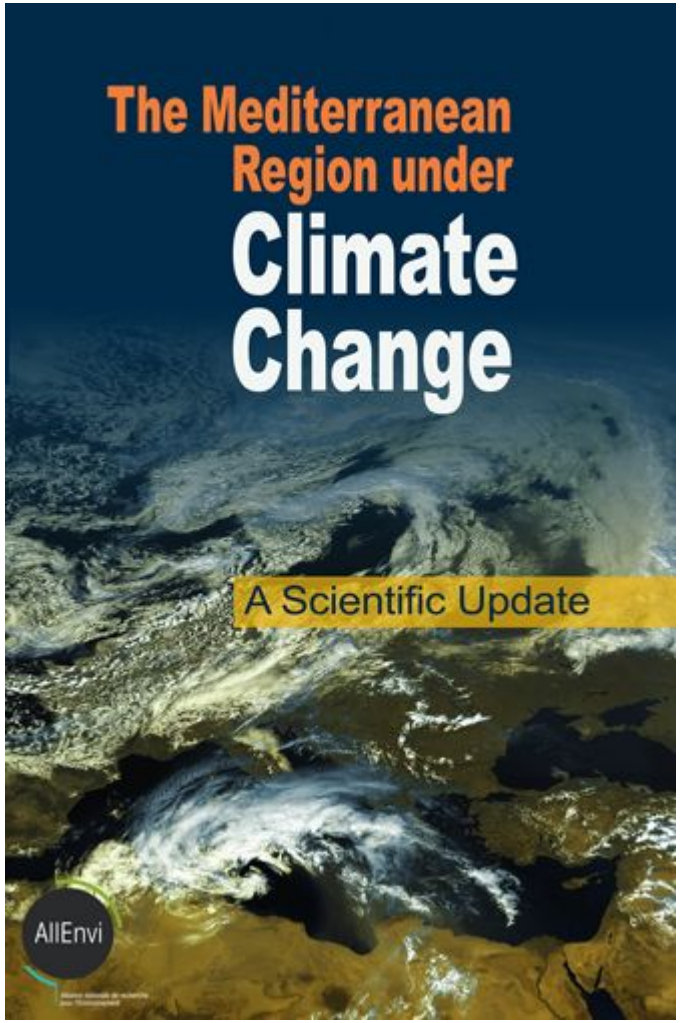
Book promoted by the French community for the COP22 (Marrakesh).

Contributions from researchers all over the Mediterranean.

Many contributions from the HyMeX community.

- Chapter on drought (Drought: observed trends, future projections).

ISBN: 978-2-7099-2219-7



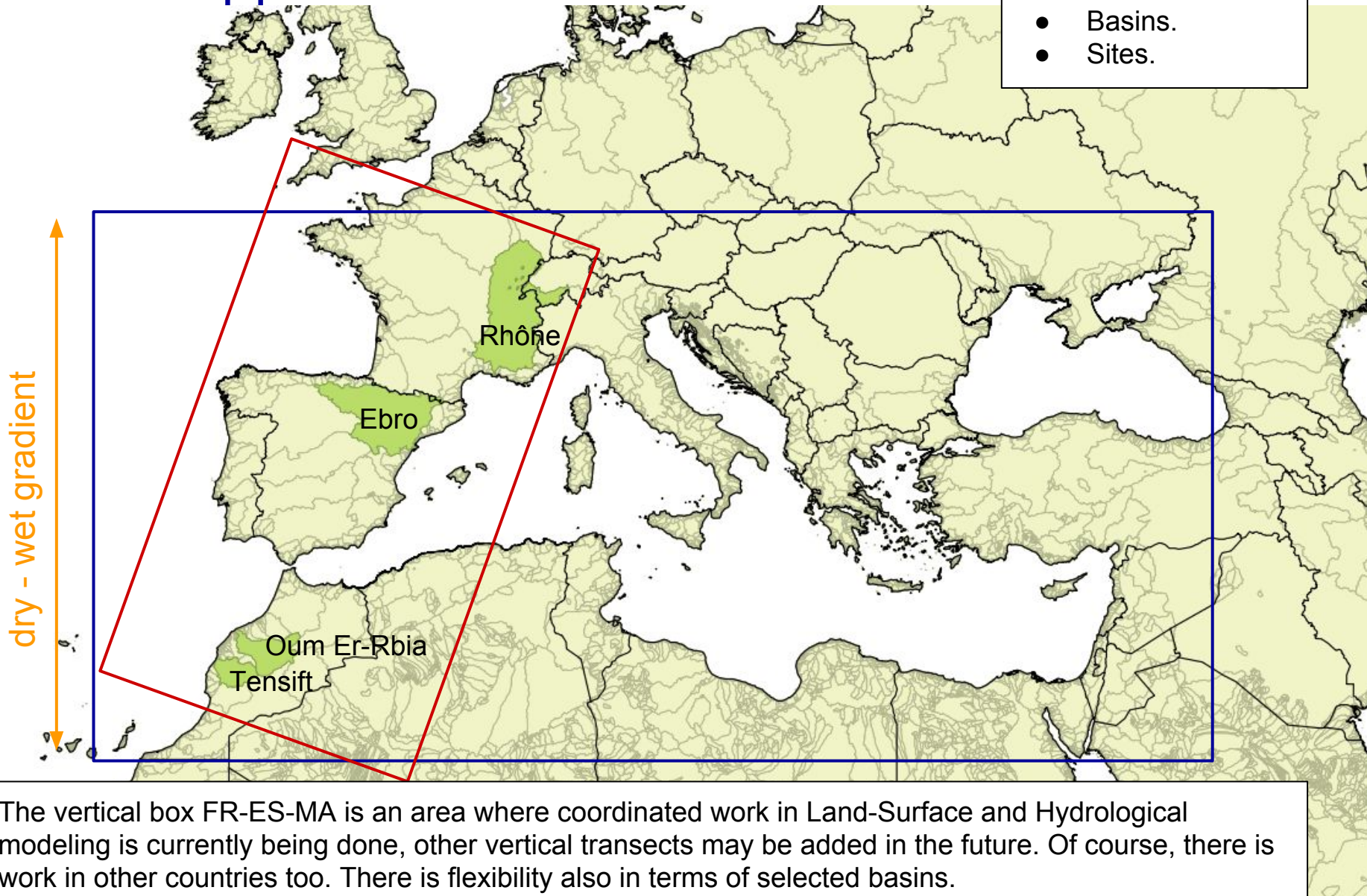
Thanks

This presentations has contributions from (in random order):

- Clara Linés Díaz (UNESCO-IHE).
- Florian Raymond (U. Bourgogne).
- Fuxing Wang (LMD).
- Clément Albergel (CNRM).
- José A. Guijarro (AEMET).
- Jean-Philippe Vidal (IRSTEA).
- Juan Carlos Sánchez Perrino (AEMET).
- Raül Marcos (BSC-CNS).
- Sebastien Garrigues (INRA).
- Qi Gao (isardSAT, U. Ramon Llull, CESBIO).
- Taoufik Hermassi (INRGREF)
- Aaron Boone (CNRM).
- and the rest of the **HyMeX DWR ST**.

Nested approach

Four levels:
- Mediterranean.
- Countries.
- Basins.
- Sites.



The vertical box FR-ES-MA is an area where coordinated work in Land-Surface and Hydrological modeling is currently being done, other vertical transects may be added in the future. Of course, there is work in other countries too. There is flexibility also in terms of selected basins.