Karlsruhe Institute of Technology

Bundesministerium
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The role of soil moisture-atmosphere interactions on the representation of Mediterranean weather extremes

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Extreme Weather in a Changing Climate

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Photo: Nick Moir

SMOS satellite
www.esa.int

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Content

1. Impact of extreme initial soil moisture (SM) on the representation of wet extremes

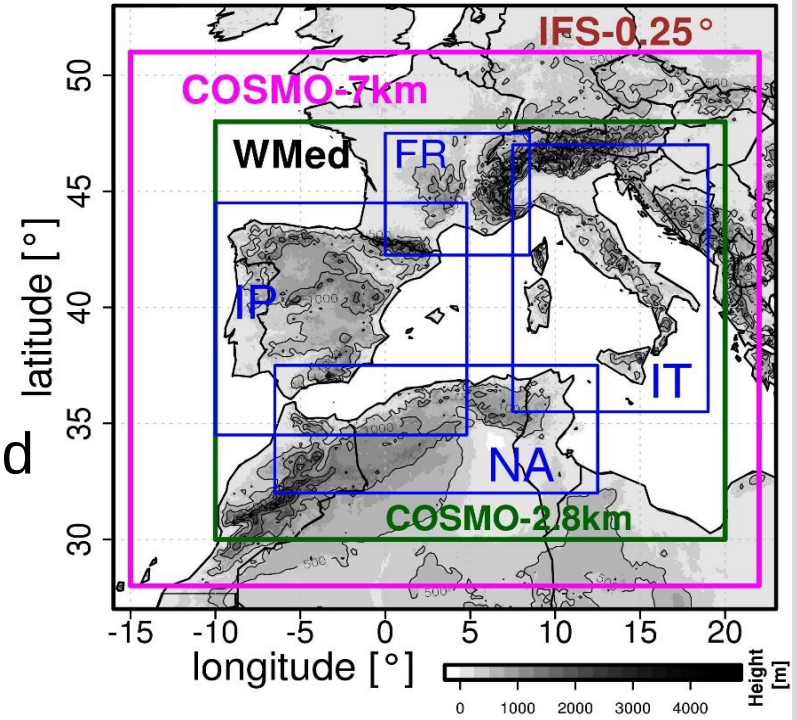
   ➡ **How relevant are SM-atmosphere interactions in the Mediterranean region?**

2. Realistic initialization with high-resolution satellite derived soil moisture data

   ➡ **What effect does realistic soil moisture initialization have on the prediction of wet extremes?**

Methodology: Data sources

- **Multiscale simulations with COSMO**
  - COSMO 5.01
  - **Horizontal resolution:** 7km to 2.8km
  - **Temporal resolution**: 2-3 days to years
  - **SVAT:** TERRA-ML model
- **SMOSL4:** High resolution downscaled SMOS soil moisture (SM) product
  - 1km resolution (“all weather” version)
- **Observational data**
  - **CMORPH** (CPC MORPHing technique) precipitation data (~8km,1/2h)
  - SM in situ networks



Description of SM sensitivity experiments

- **Extreme dry scenario (DRY)**

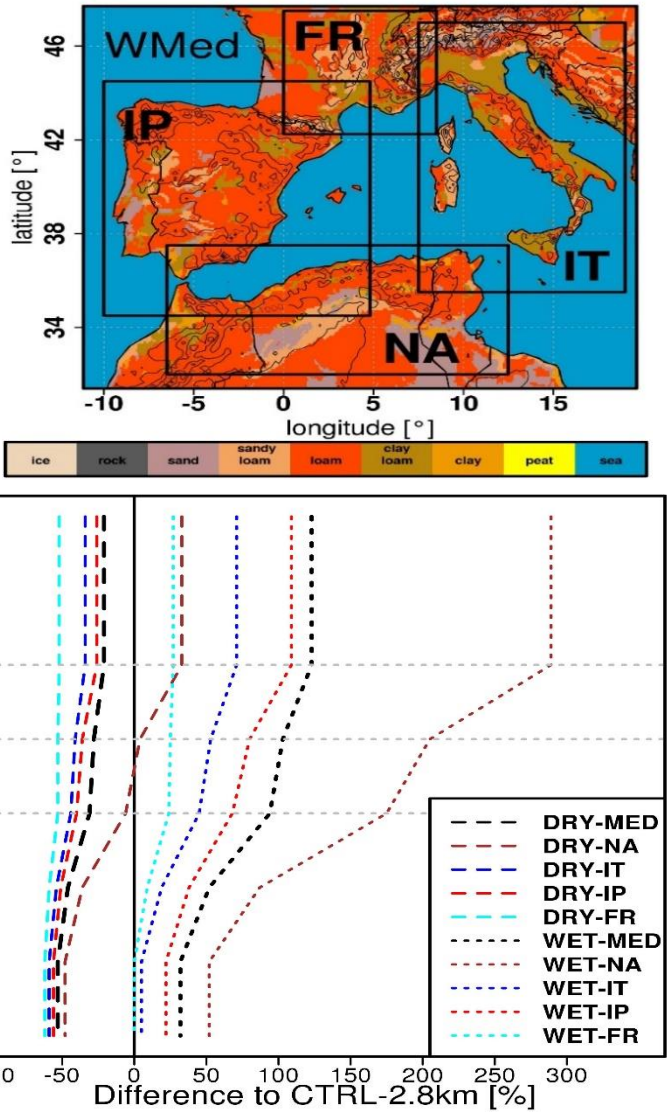
  initial SM ⇨ wilting point

- **Extreme wet scenario (WET)**

  initial SM ⇨ field capacity

- **Seasonal simulation (SON2012)**

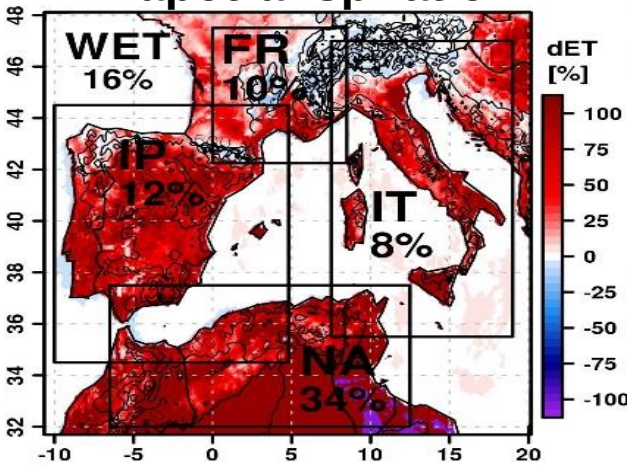
- **Initialization at 08.08.2012 00UTC (~1/2 month spin up)**



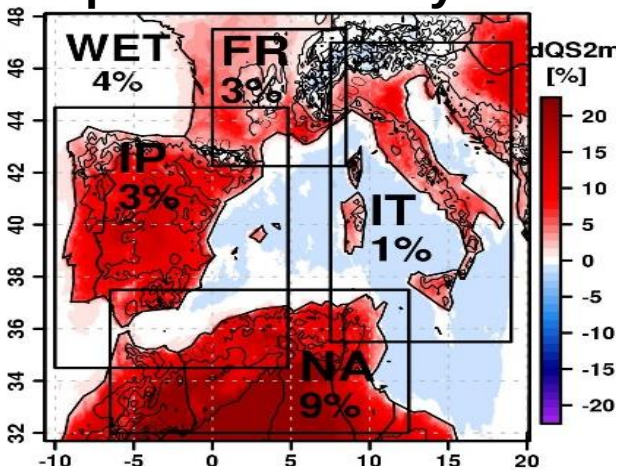
Impact on atmospheric conditions

Relative change (WET scenario) to mean value of SON 2012 (CLM2.8km)

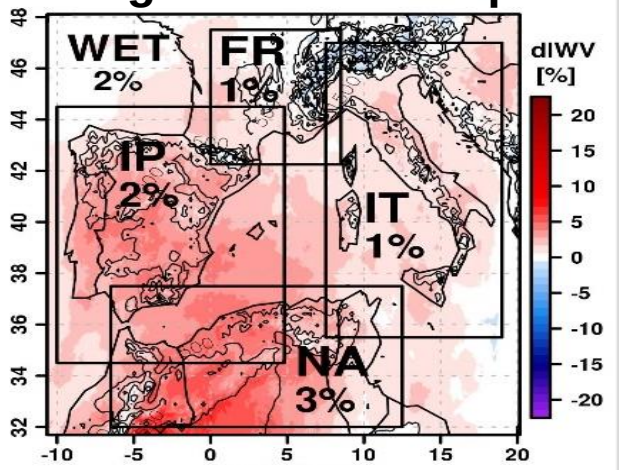
Evapotranspiration



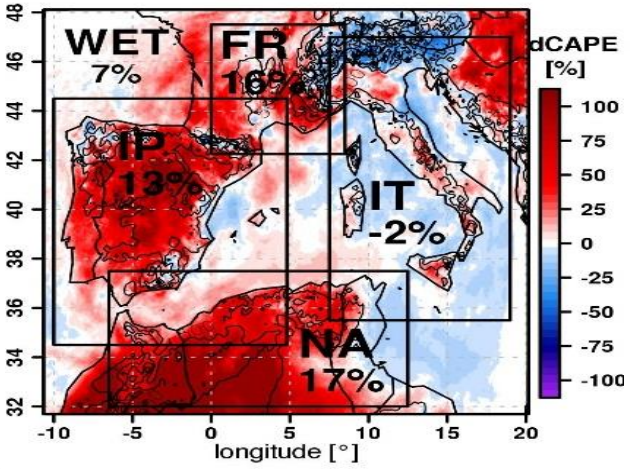
Specific Humidity 2m



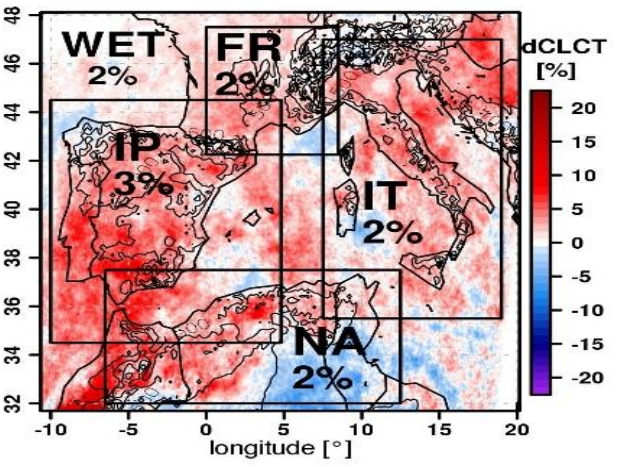
Integrated Water Vapor



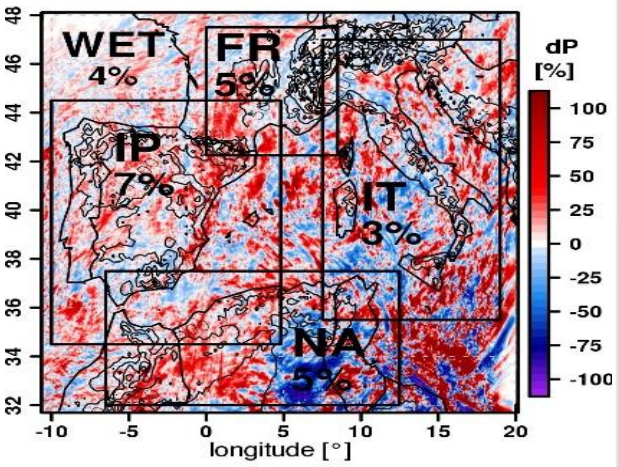
CAPE



Total Cloud Cover

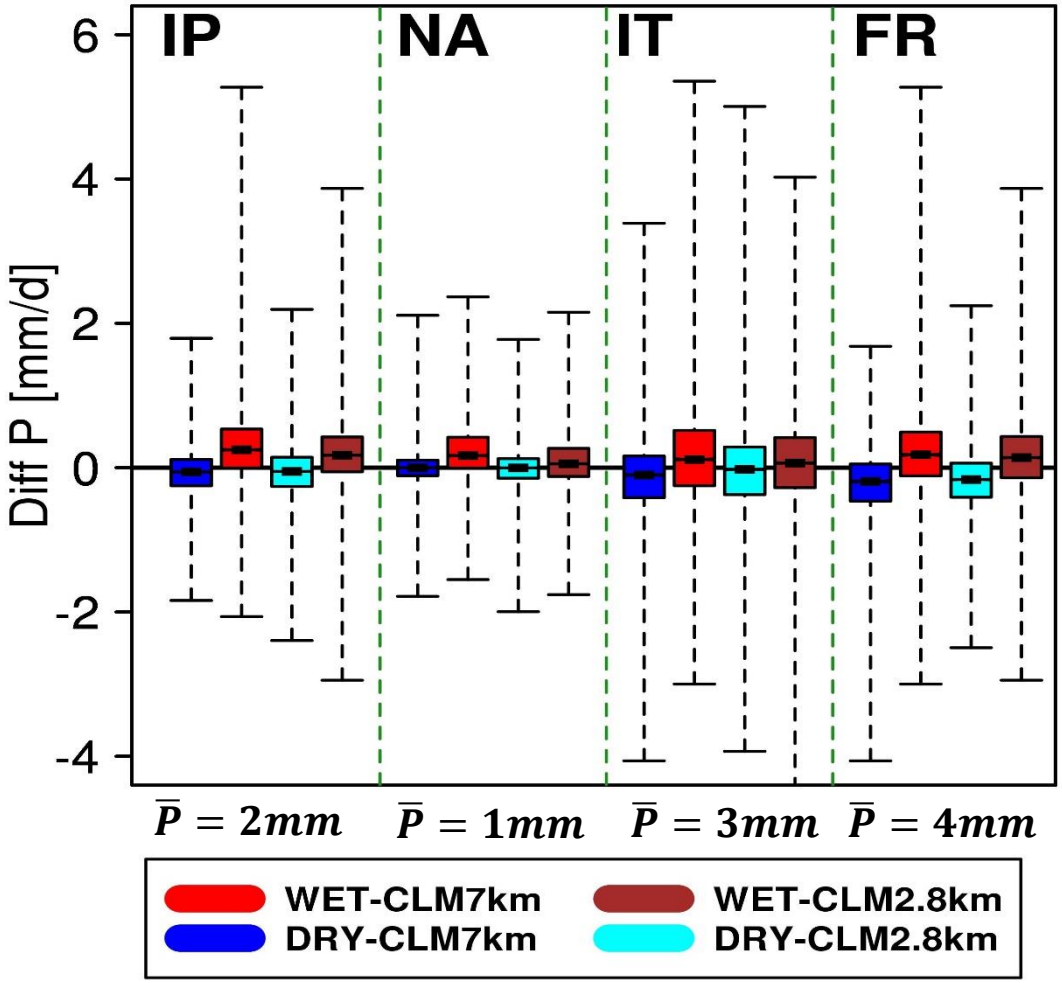


Precipitation



Changes in mean precipitation (SON 2012)

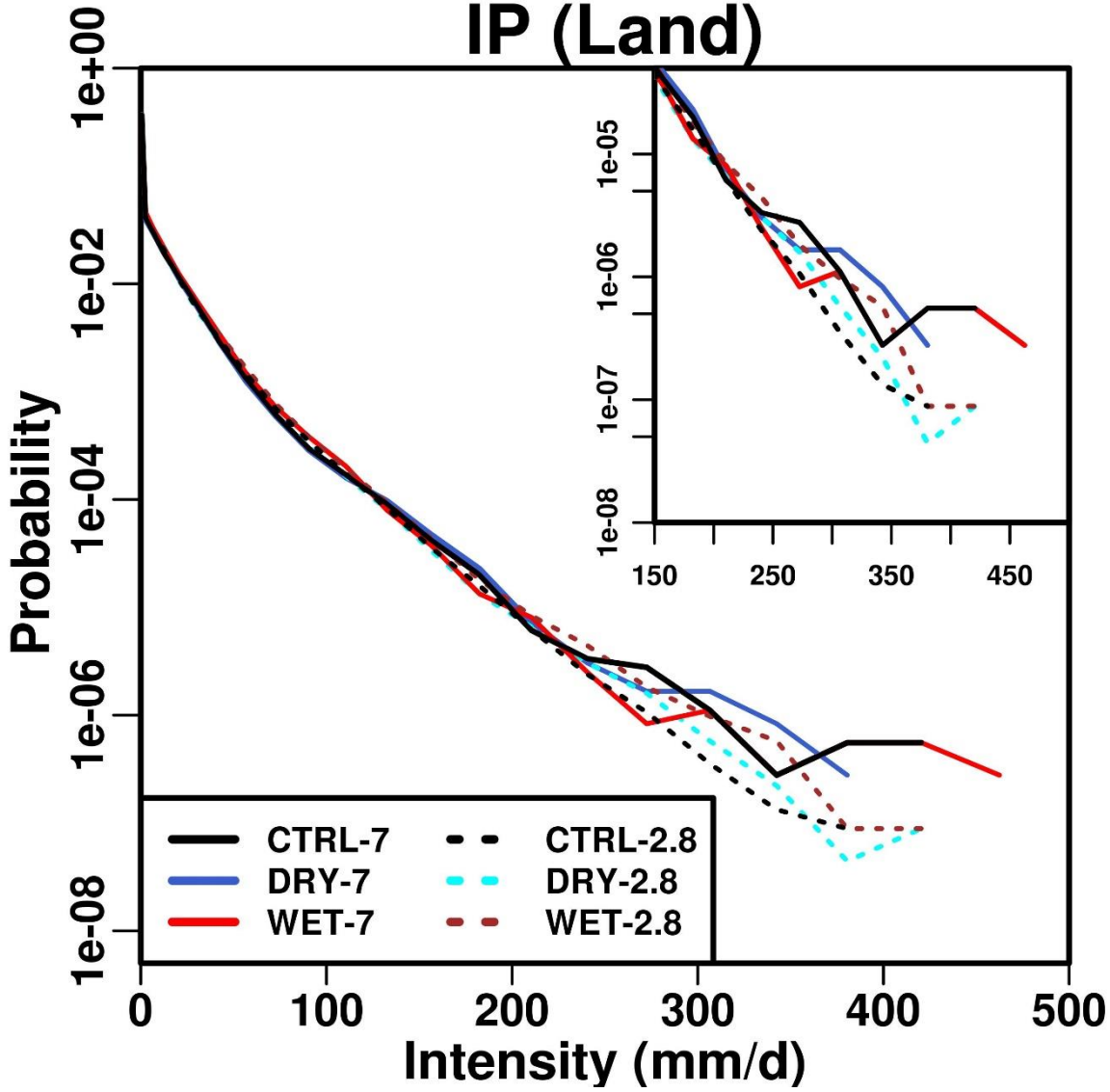
Convection-parameterized vs convection-permitting simulations



Target Area	DRY-7km (%)	WET-7km (%)
IP	-3	+11
NA	0	+20
IT	-4	+4
FR	-6	+6

Target Area	DRY-2.8km(%)	WET-2.8km(%)
IP	-2	+8
NA	-1	+5
IT	-1	+2
FR	-4	+4

Changes in extreme precipitation



Strategy of realistic SMOS initialization

SMOS-L4 "all weather"(V.3) product for IP (1km)

Piles et al. (2014, 2015)

1.Selection of SMOS-L4 product

2.Quality criteria data availability

3.CDF-matching of SMOS data

Koster et al. 2004

4.SM profile with exponential filter

Wagner et al. (1999), Albergel et al. (2008), Ford et al. (2015)

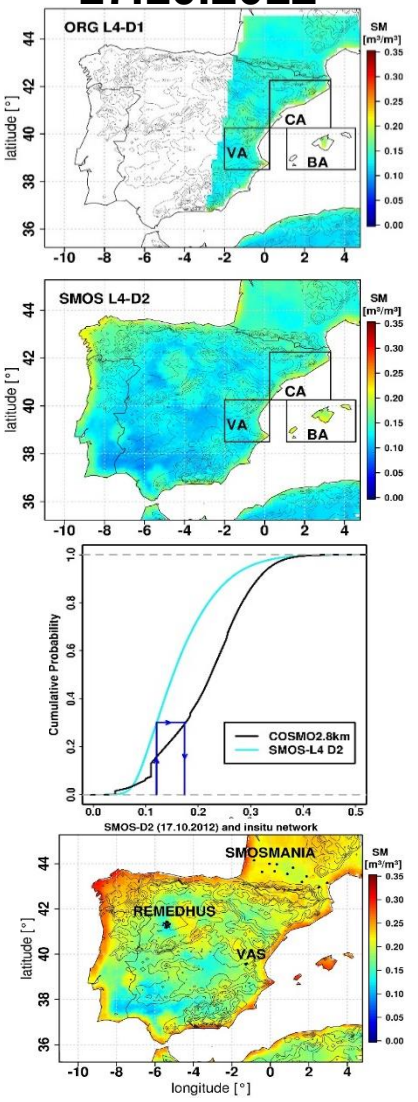
RM1

RM2 >50%

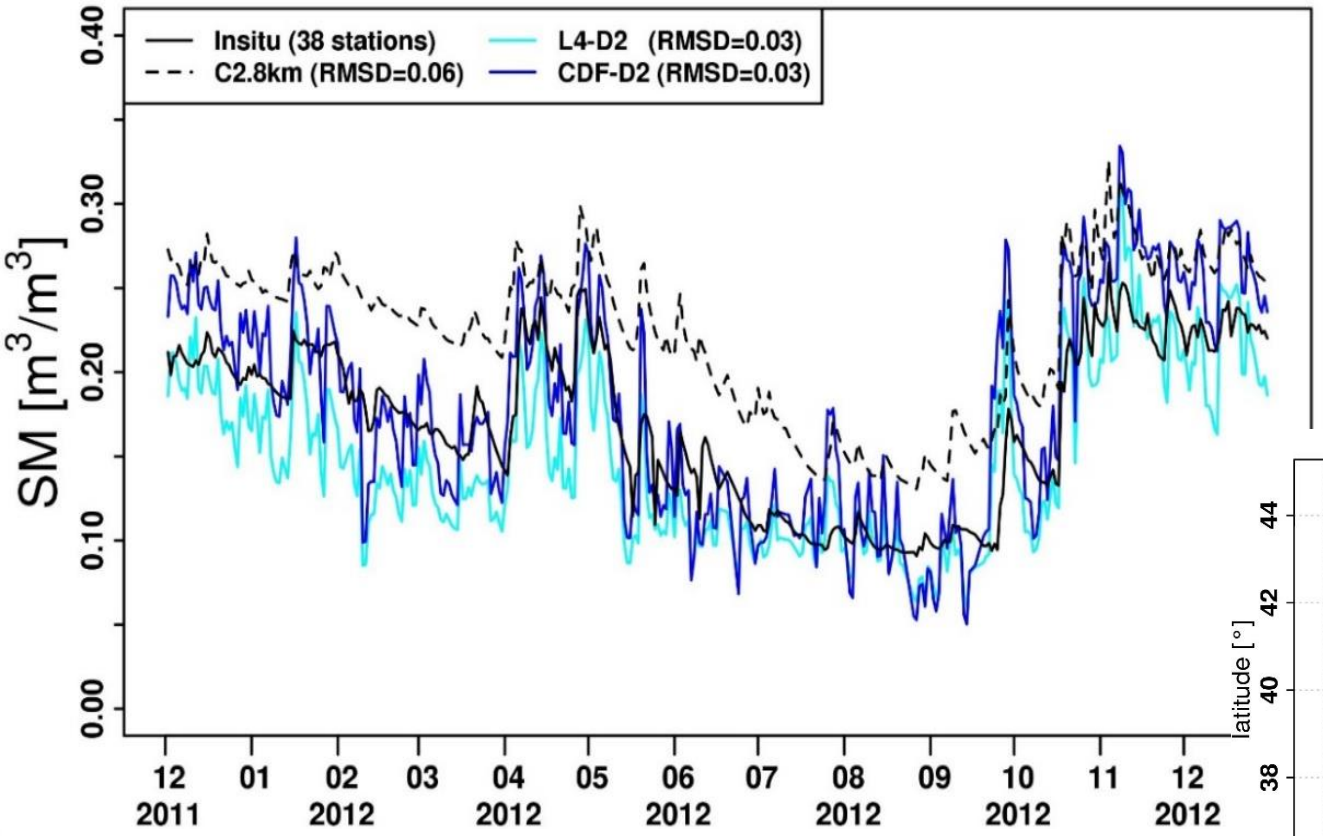
CDF

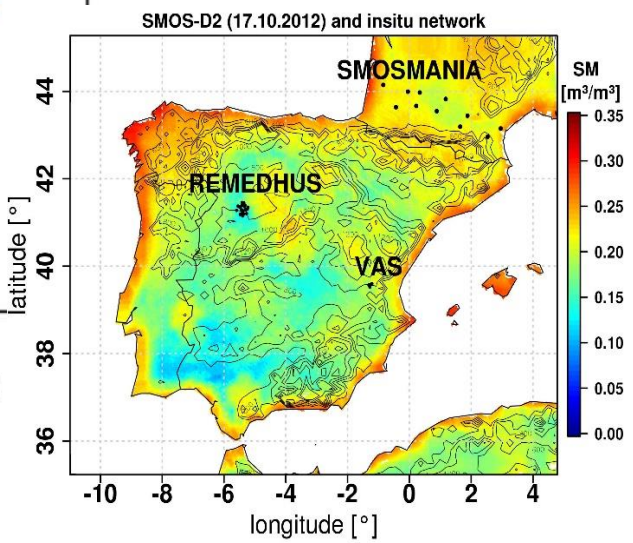
Expo filter

17.10.2012



Validation by SM in situ networks





The wet bias of COSMO model is improved and the accuracy of the original SMOS product is maintained

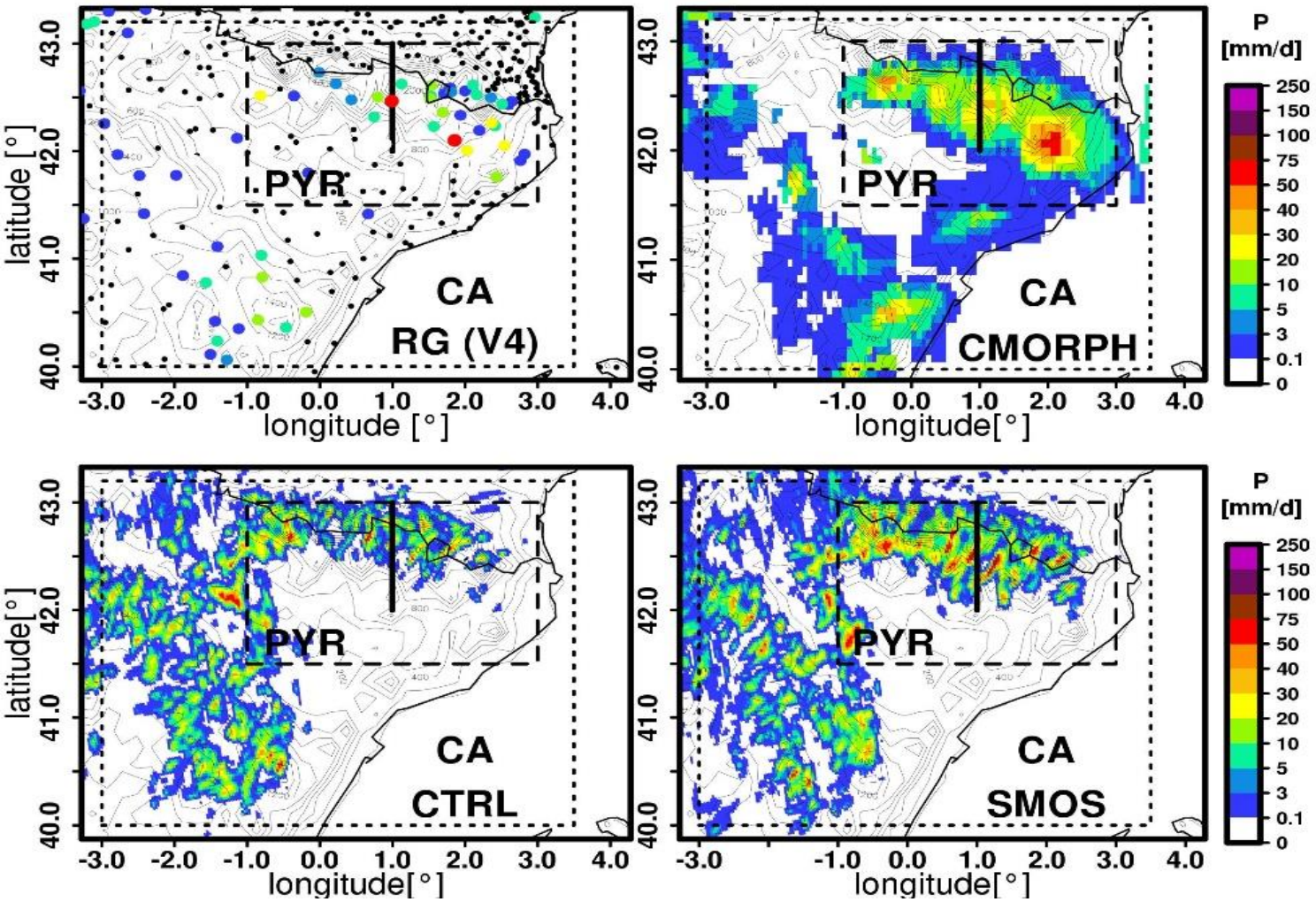
Convective precipitation event

Example for simulation with SMOS SM initialization (09.09.2012)

Observation Daily P

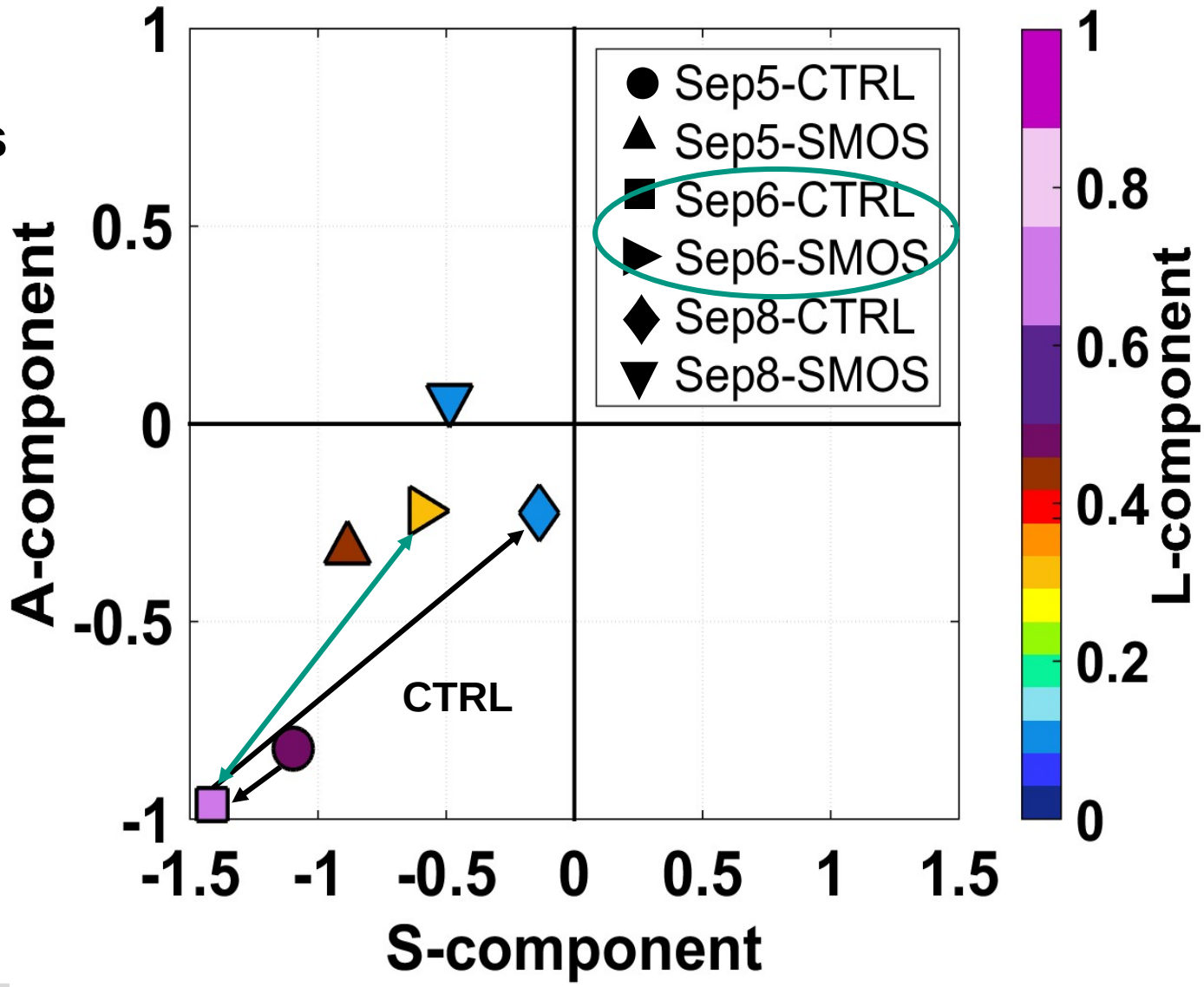
SM-Initialization 6.Sep 2012 (+3day)

COSMO-2.8km



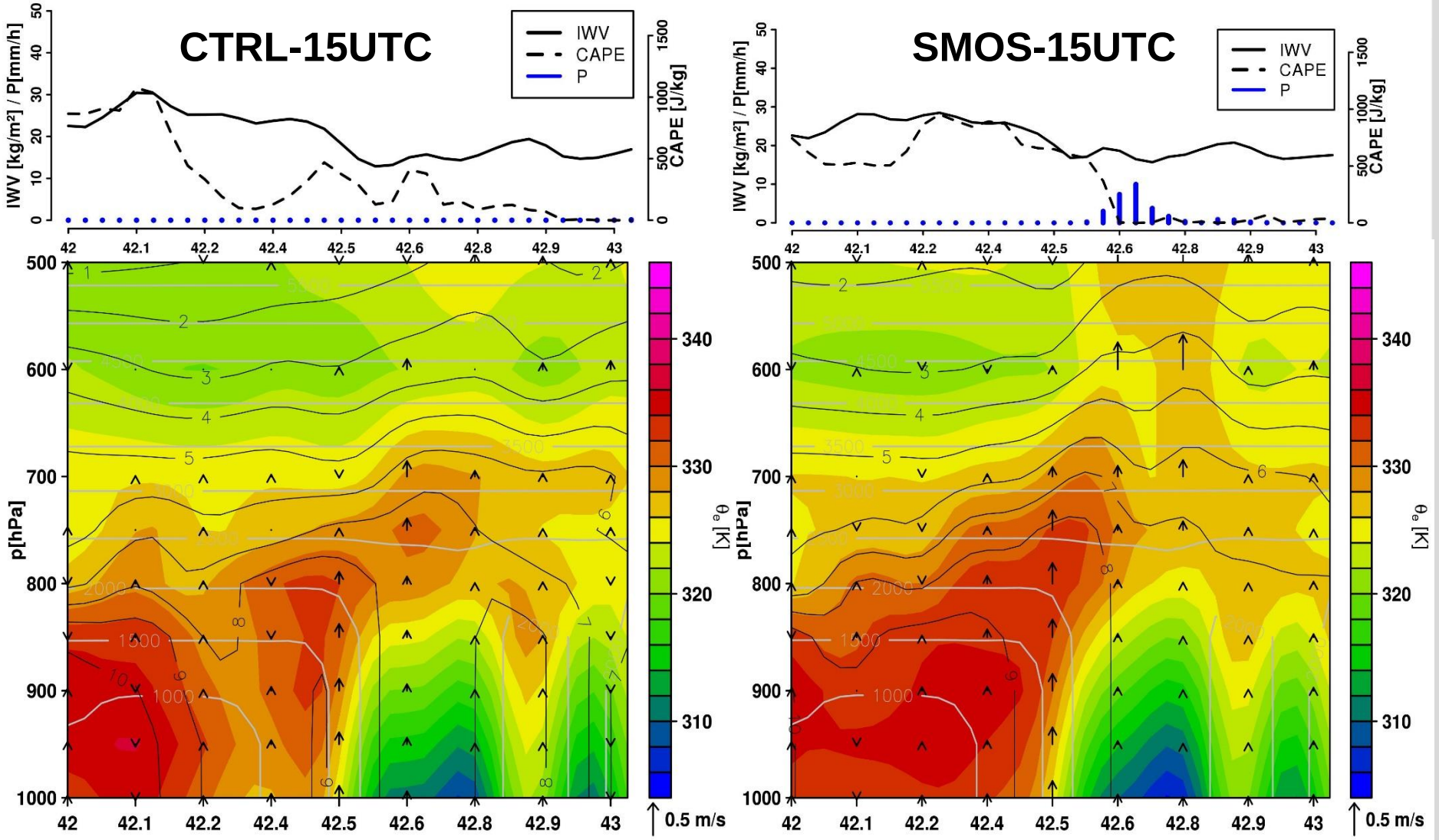
Verification of precipitation forecast

SAL Pyrenees -Area (09.09)



Atmospheric vertical profile (9.Sep)

Cross section along the latitude 42°- 43°



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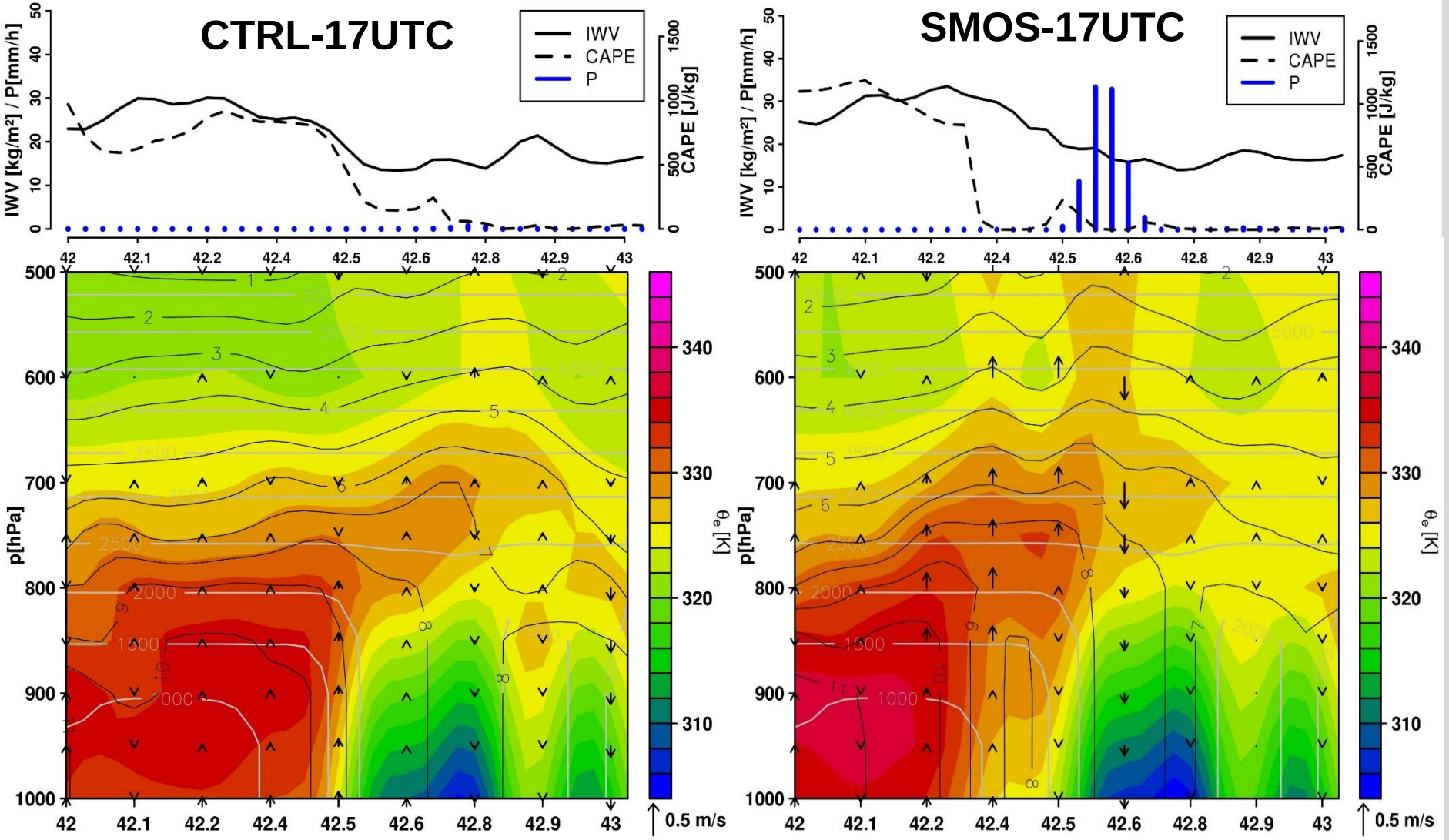

Conclusions

- **Soil moisture-atmosphere interactions** play an **important role** on the representation of wet extremes in the WMed autumn season
- **SM-precipitation feedback is positive** in convection-parameterized simulations as well as in convection-permitting simulations
- The 7km-simulations show a stronger feedback with **up to 20% more precipitation** in semi-arid regions
- Our **bias-corrected SMOS-SM profile product** for COSMO initialization shows a **good agreement with SM in situ** measurements
- The application of this **realistic SMOS initialization** revealed an **improvement of the prediction of convective precipitation**