CONSORTIUM FOR SMALL SCALE MODELING

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Impact of soil moisture perturbation in a complete ensemble system

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COSMO/CLM/ART User Seminar – Offenbach – 2-6 March 2015

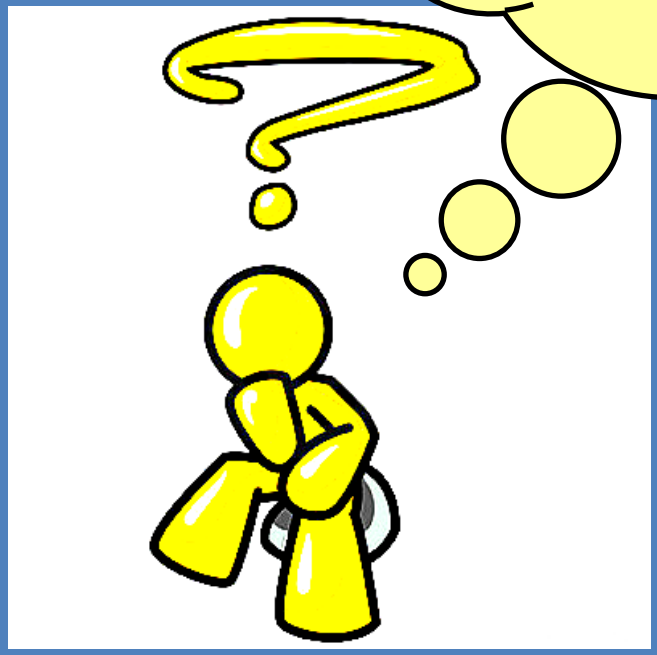
Introduction

- A well-known problem with ensemble forecasts is their lack of variability between members, typically worse near the surface rather than higher in the troposphere.
- Previous studies (COSMO newsletter n. 14 – 2014; COSMO newsletter n.15 submitted) demonstrated the sensitivity of high resolution convection permitting COSMO model to different surface initializations and to different perturbation techniques.

Previous study main findings

- stronger spread in the spring/summer case studies with convective conditions, weaker in autumn season and less appreciable in stable winter conditions.
- impact to spread on upper level atmospheric prognostic variables.
- spread comparable with the one coming from an ensemble system with perturbed atmospheric initial and boundary conditions (COSMO-LEPS).

What about a complete perturbed ensemble system (soil IC and atmosphere IC / BC perturbed)?



Aim of this study

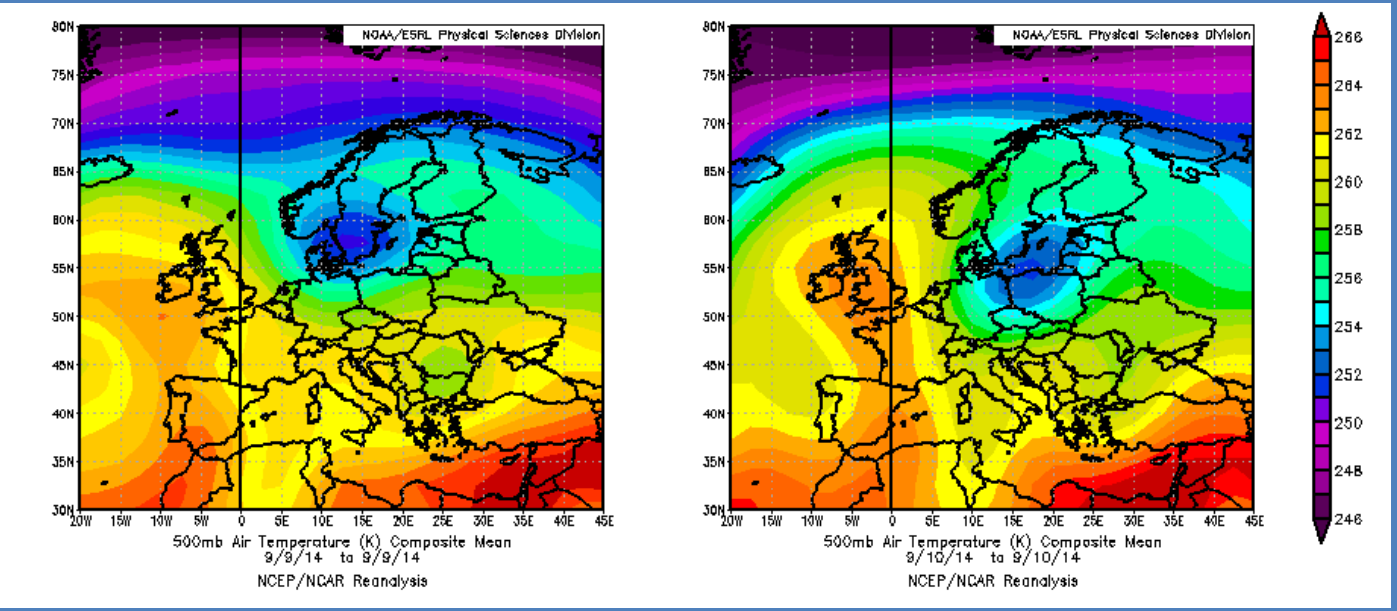
Develop and compare the results of different test suites:

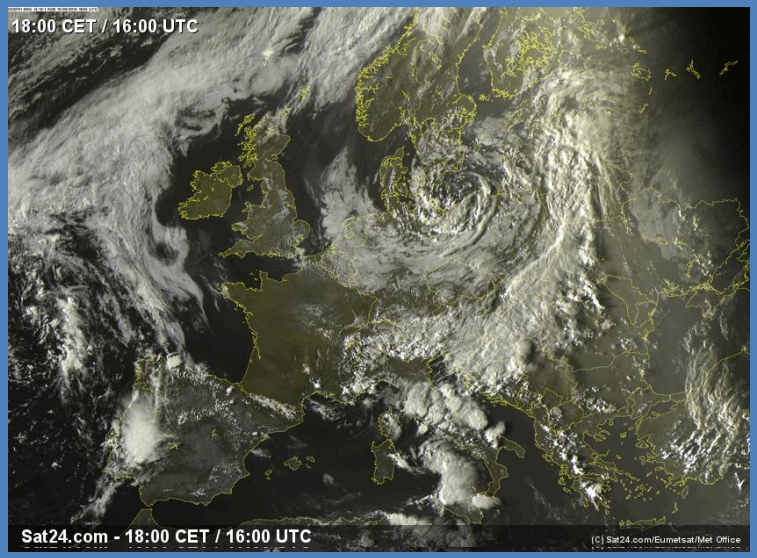
SUITE	PERTURBATION			
	ATM IC	ATM BC	SOIL IC	PHYSICS
(1) EPS	X	X		
(2) SOIL			X	
(3) EPS-SOIL (ECMWF)	X	X	X	
(4) EPS-SOIL (COSMO-EU)	X	X	X	
(5) EPS-PHYSICS	X	X		X
(6) EPS-SOIL-PHYSICHS	X	X	X	X

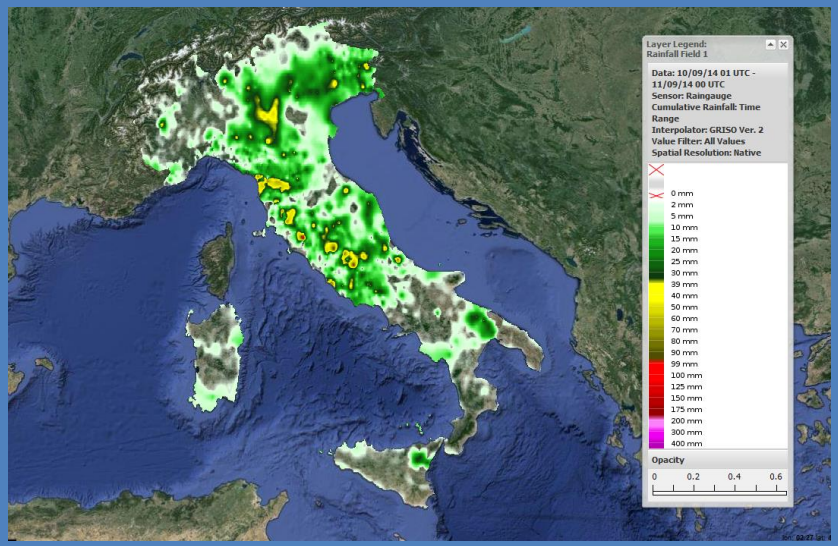
SPITSOIL – ECMWF special project

Case studies

CS1 - 09-09-2014 Typical late summer convection

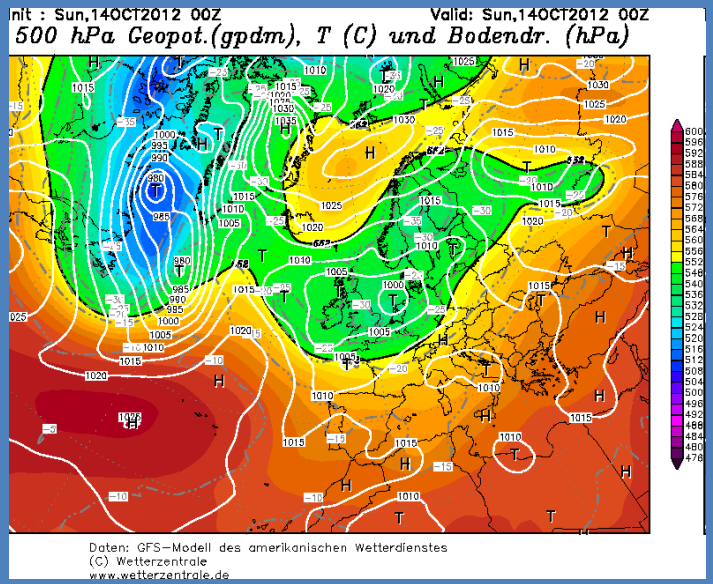


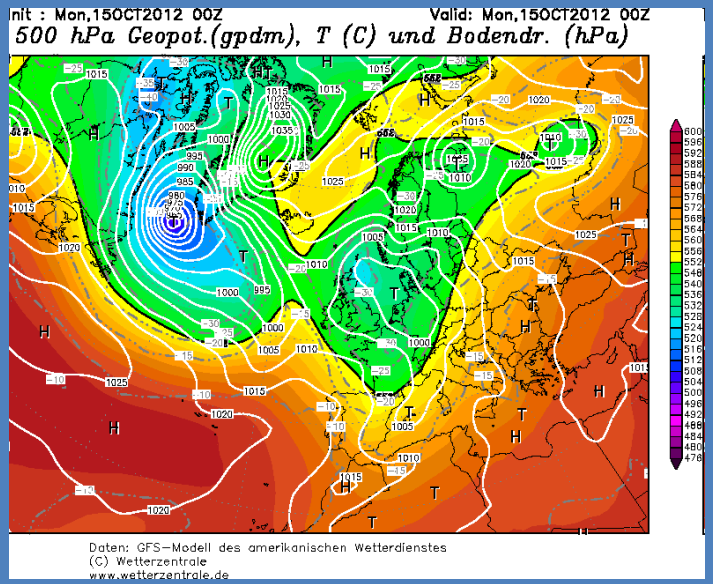


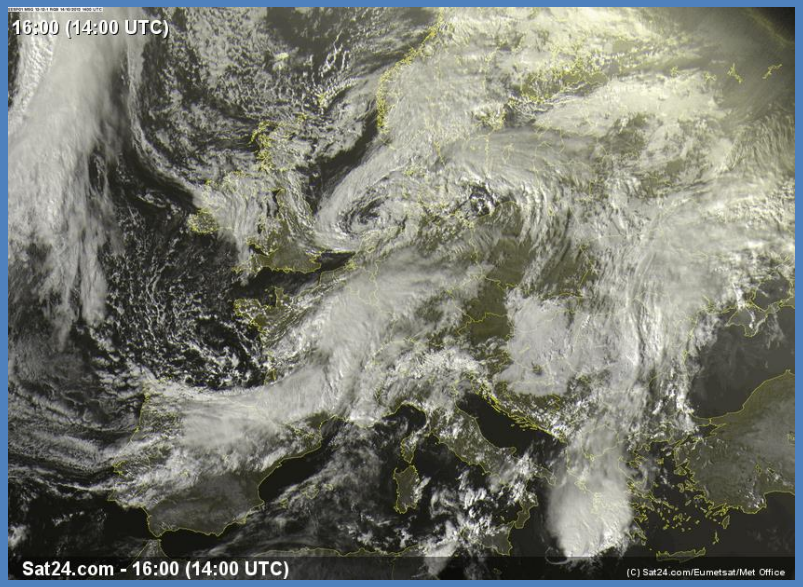


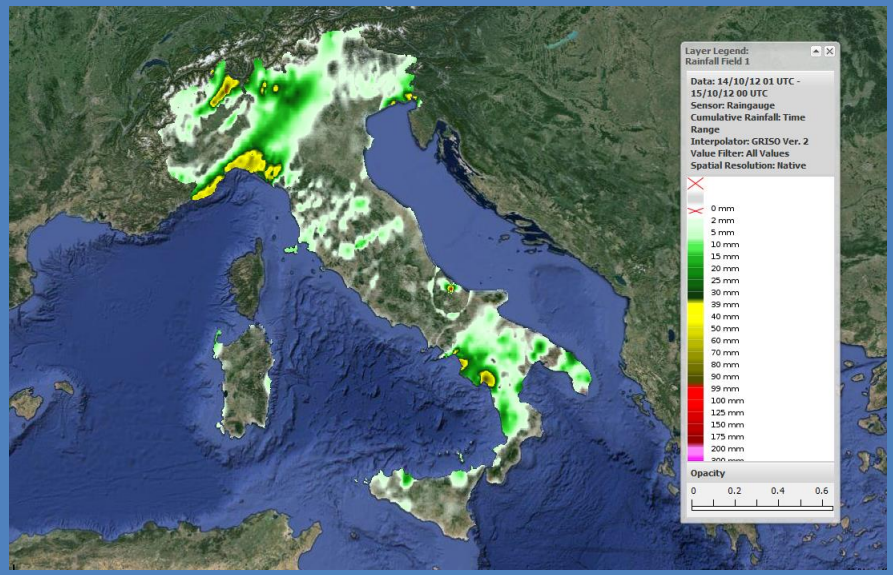
Case studies

CS2 - 14-10-2012 Typical fall convection









Simulations

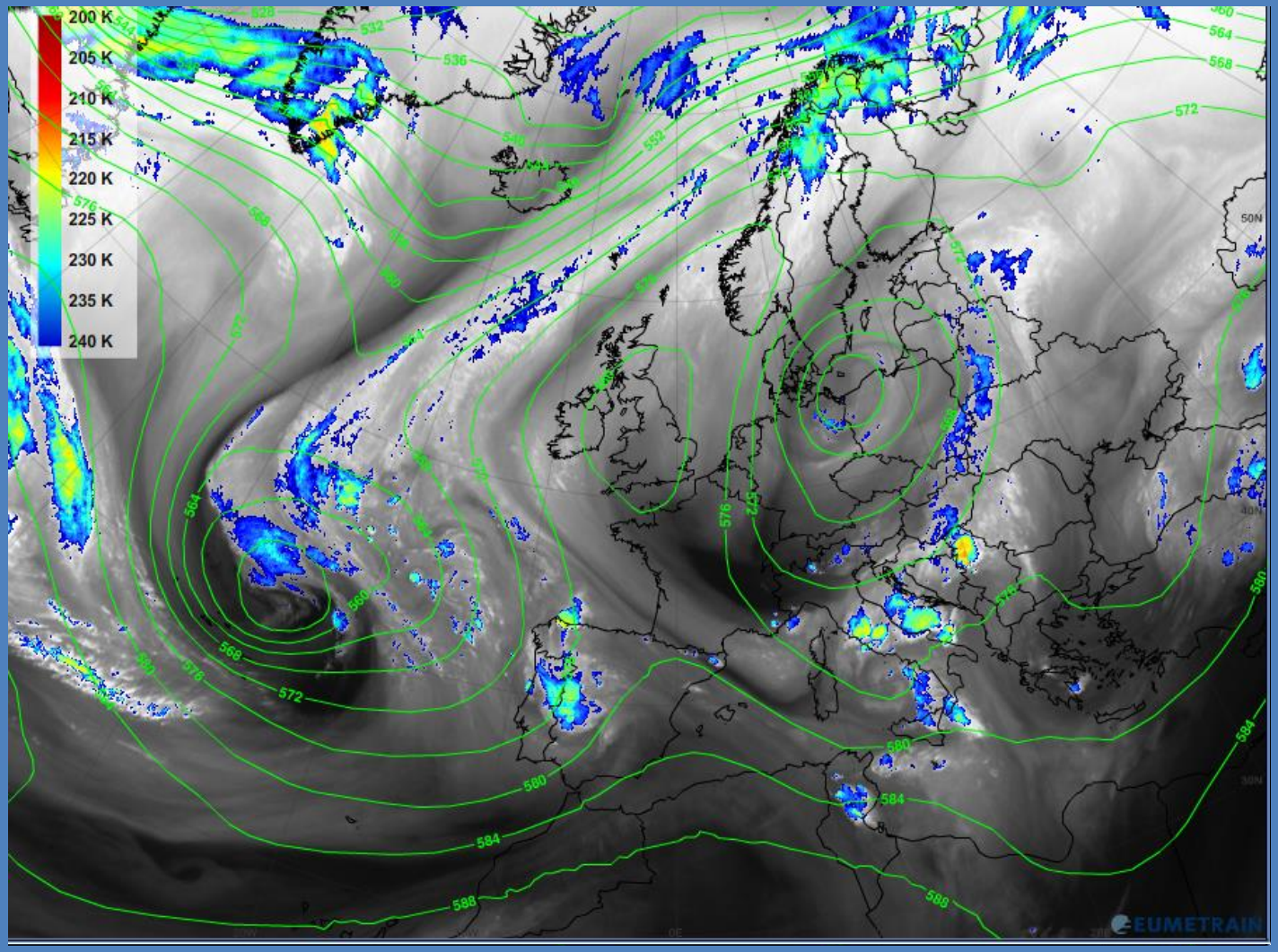
- Being 2 the case studies considered, 2 the different soil moisture analyses (ECMWF and COSMO-EU) and 6 the available suites, we obtained 120 different COSMO runs for each CS (each ensemble constituted of 10 members).
- COSMO model version 5.0 was used with an horizontal resolution of 0.025° (about 2.8 km).
- The variables that we opted to analyze for each case study are: 2 m temperature and dew point, 10 m wind speed (module), precipitation.

Results

- Temporal evolution of the spread averaged over the whole domain
- Spatial distribution of spread at a chosen time of the forecast

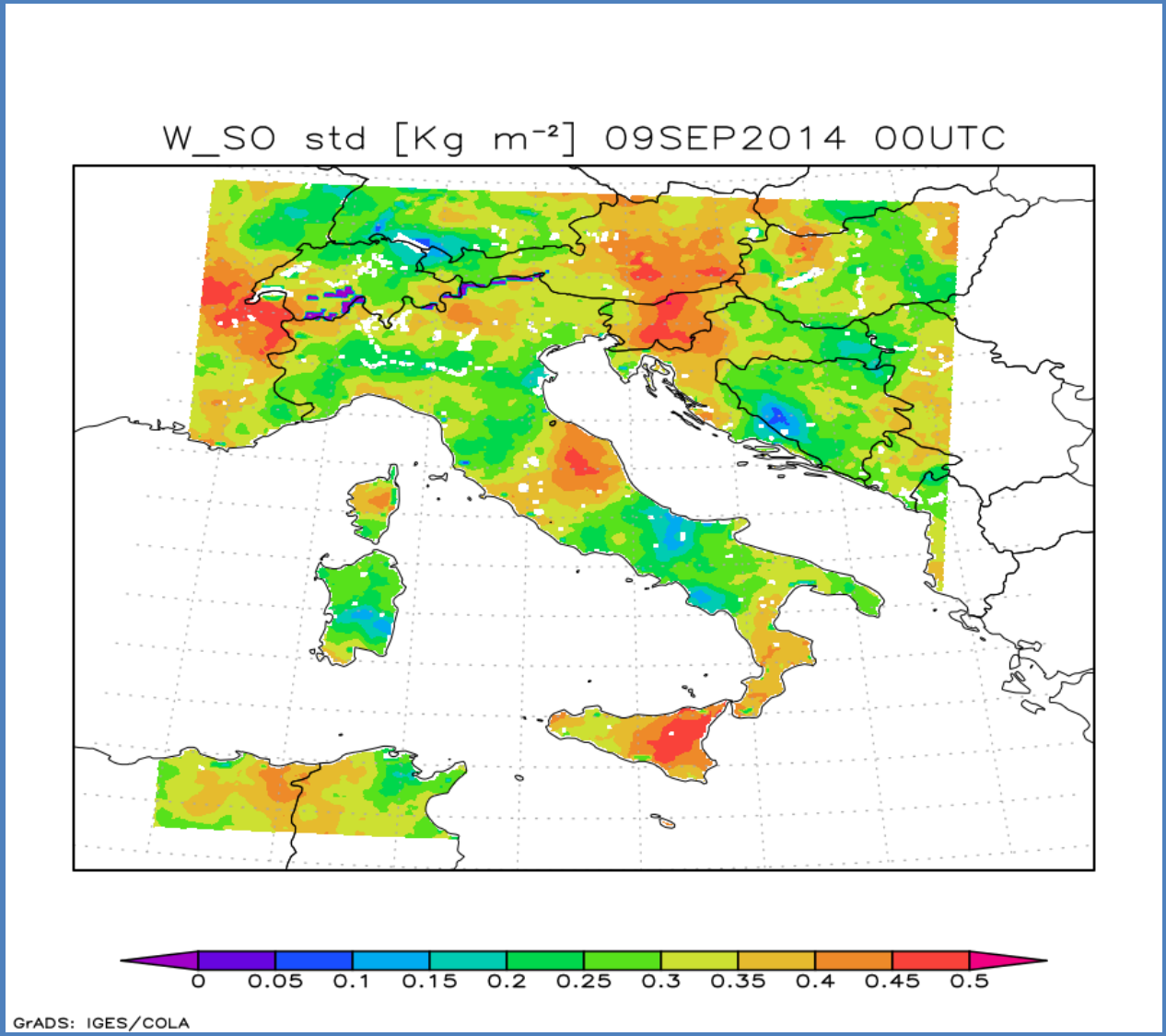
CS1 summer forcing: upper level through moving Southward from Northern Europe

SYNOPTIC FORCING



CS1 summer forcing: upper level through moving Southward from Northern Europe

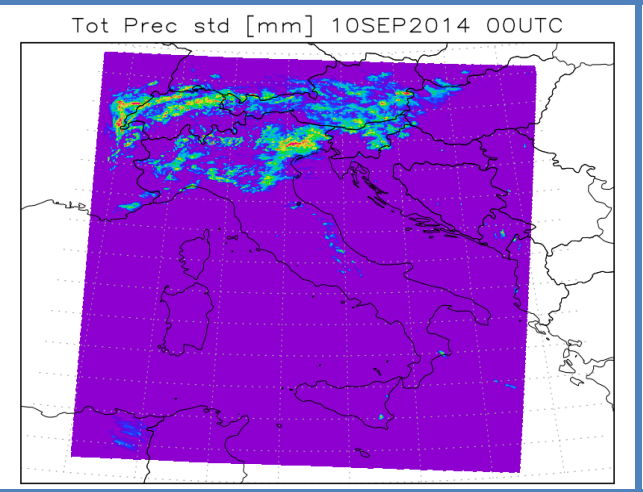
1° layer soil moisture spread [kg m^{-2}] (1 cm depth)



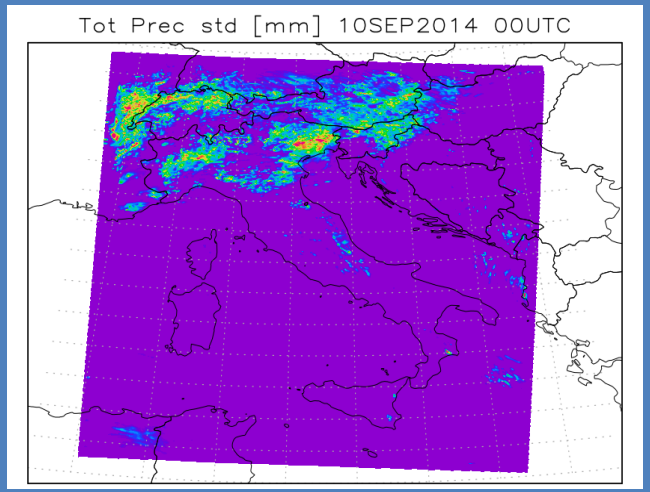
CS1 – DAY 1

Spatial distribution of spread - Precipitation

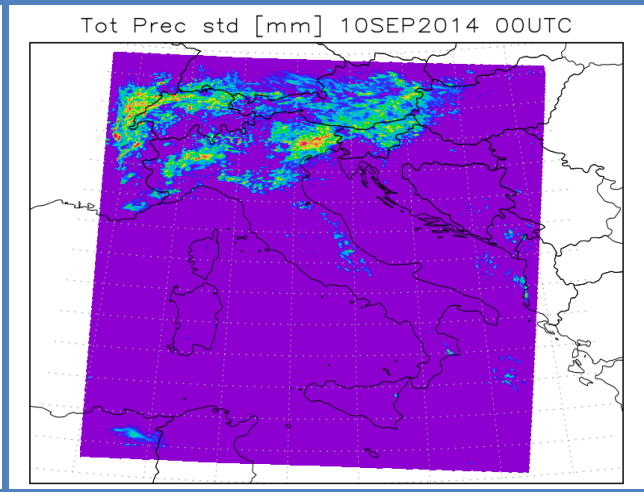
SUITE SOIL



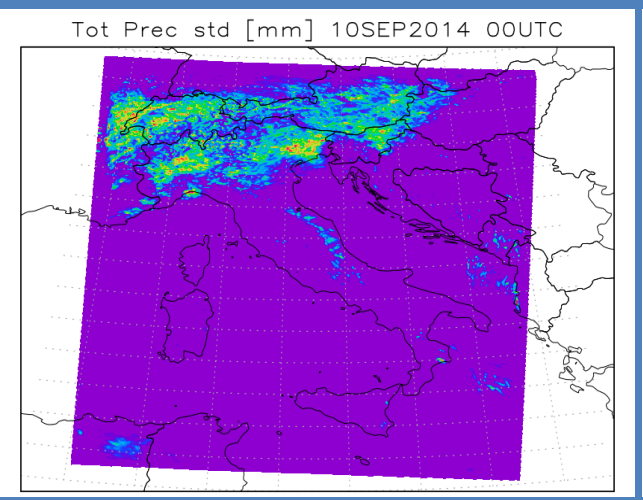
SUITE EPS



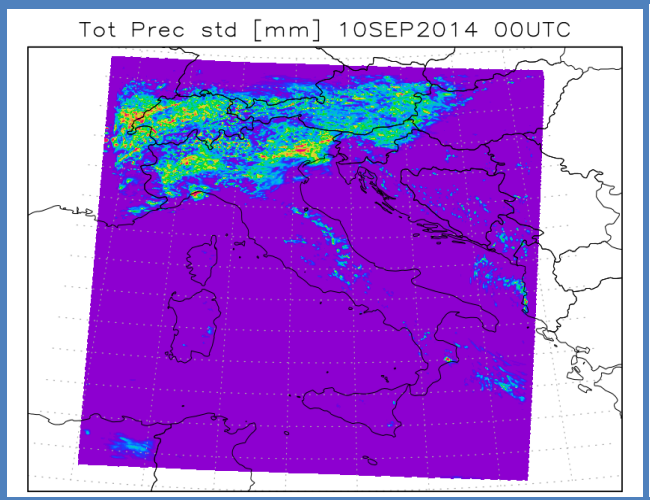
SUITE EPS-SOIL



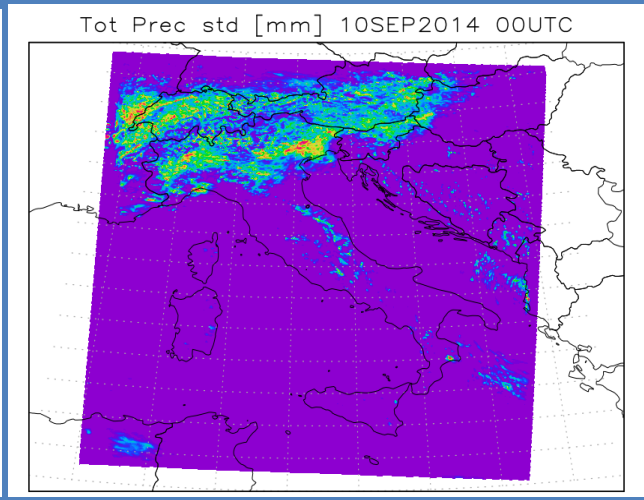
SUITE EPS-SOIL COSMOEU

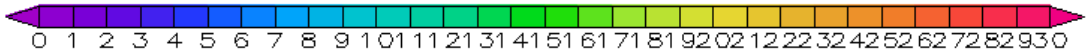


SUITE EPS PHYSICS



SUITE EPS-SOIL-PHYSICS

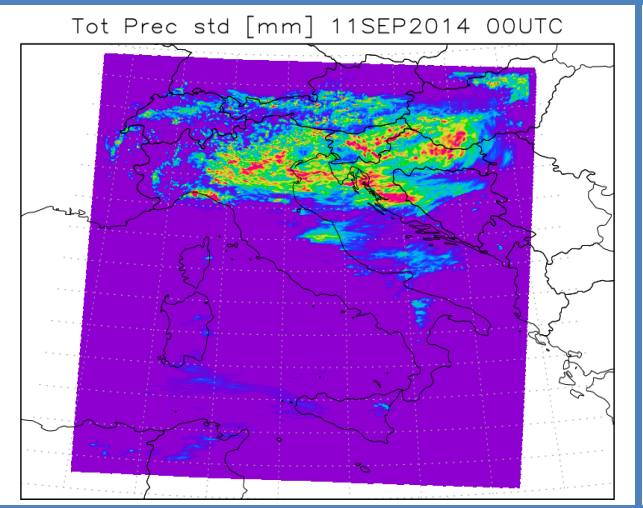




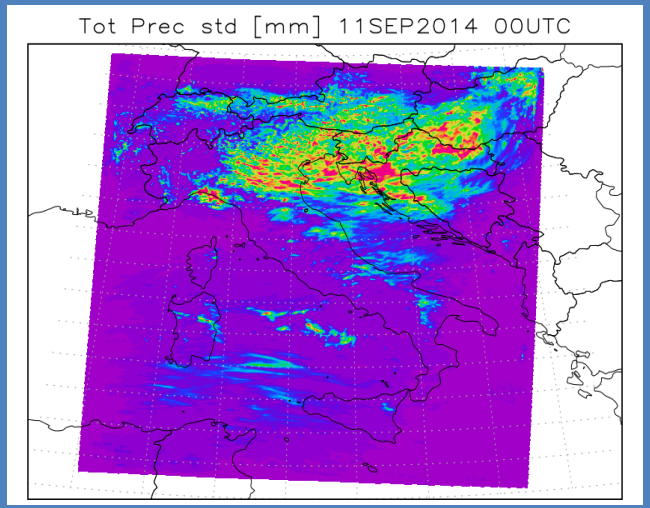
CS1 – DAY 2

Spatial distribution of spread - Precipitation

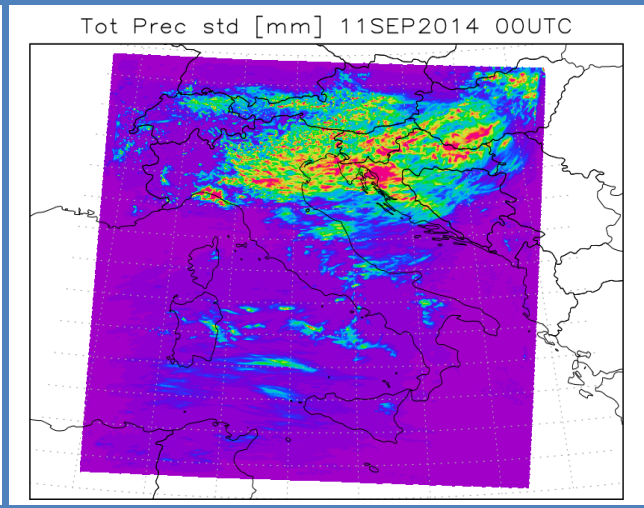
SUITE SOIL



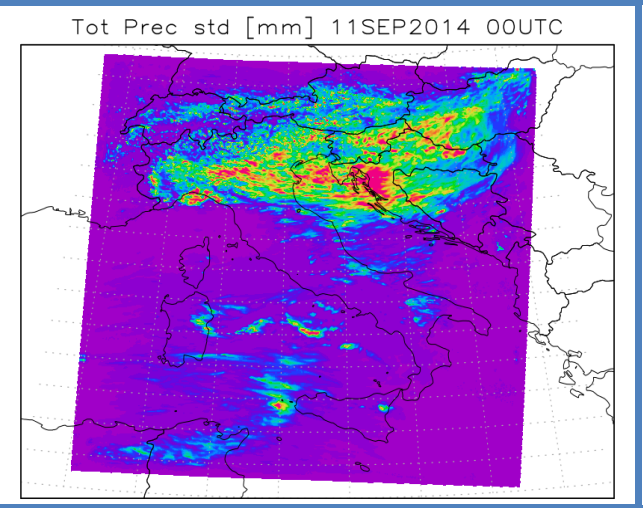
SUITE EPS



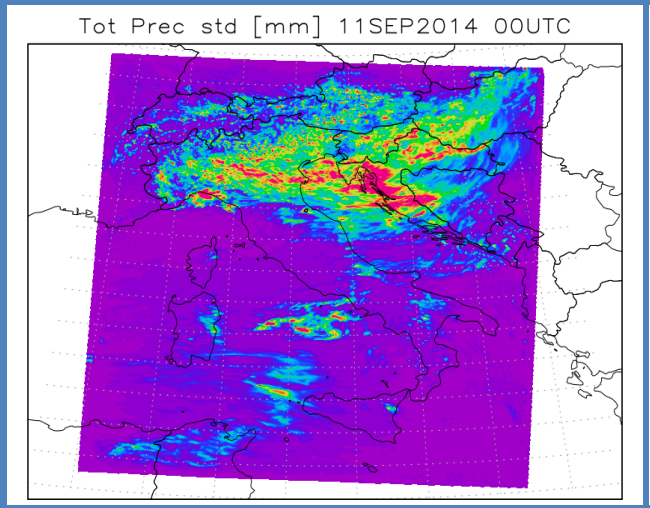
SUITE EPS-SOIL



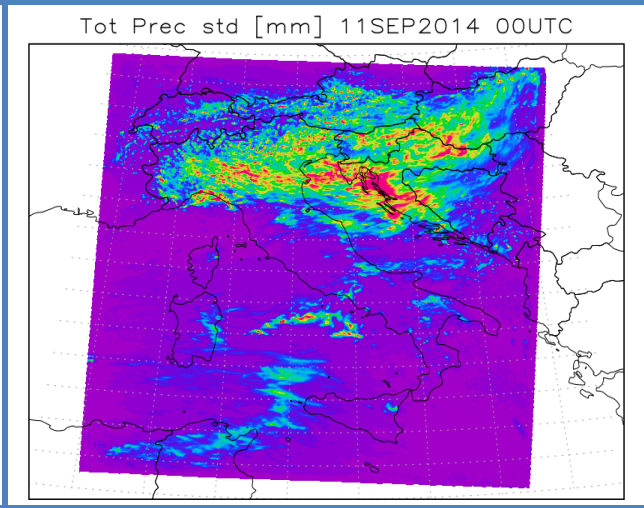
SUITE EPS-SOIL COSMOEU

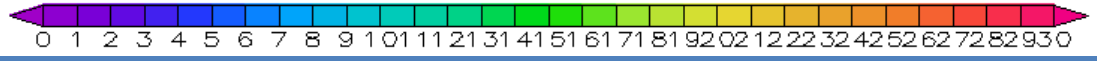


SUITE EPS PHYSICS

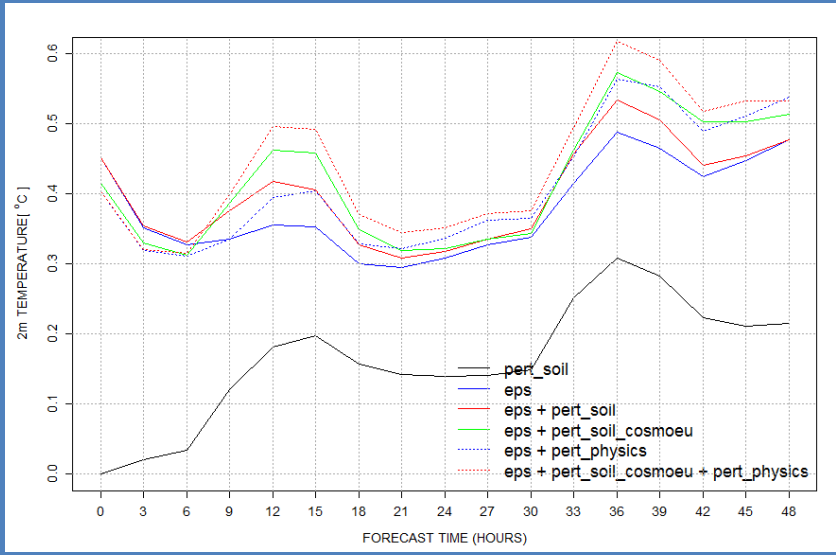


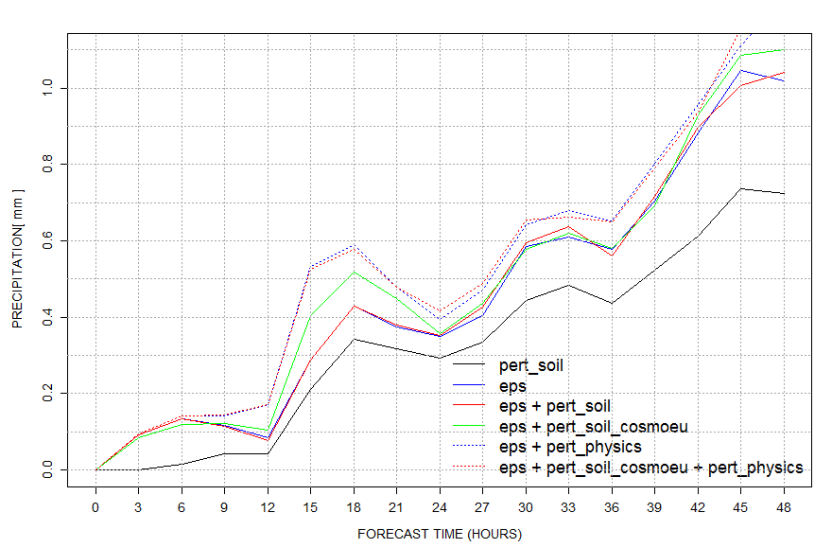
SUITE EPS-SOIL-PHYSICS

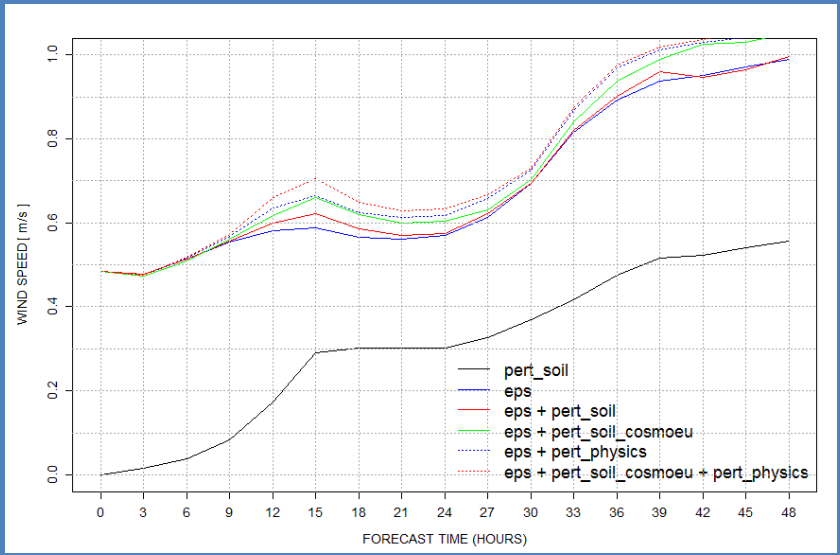


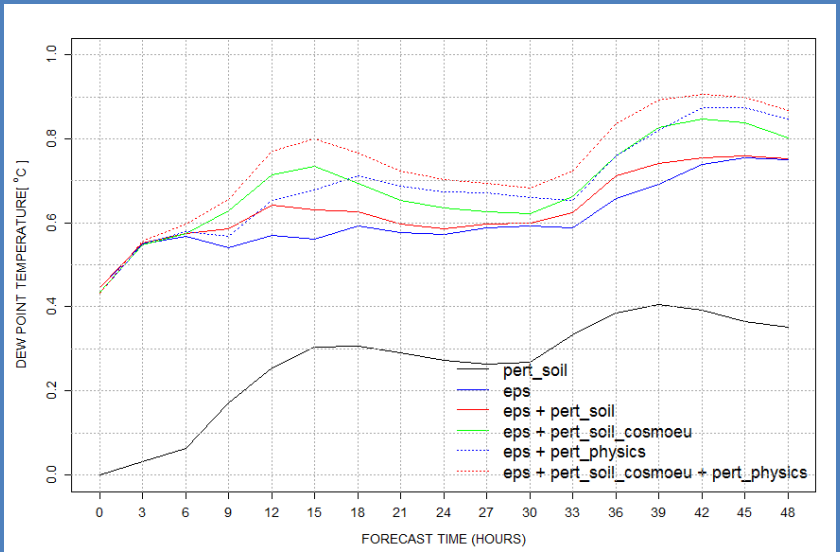


CS1 summer forcing: upper level through moving westward from Western Europe



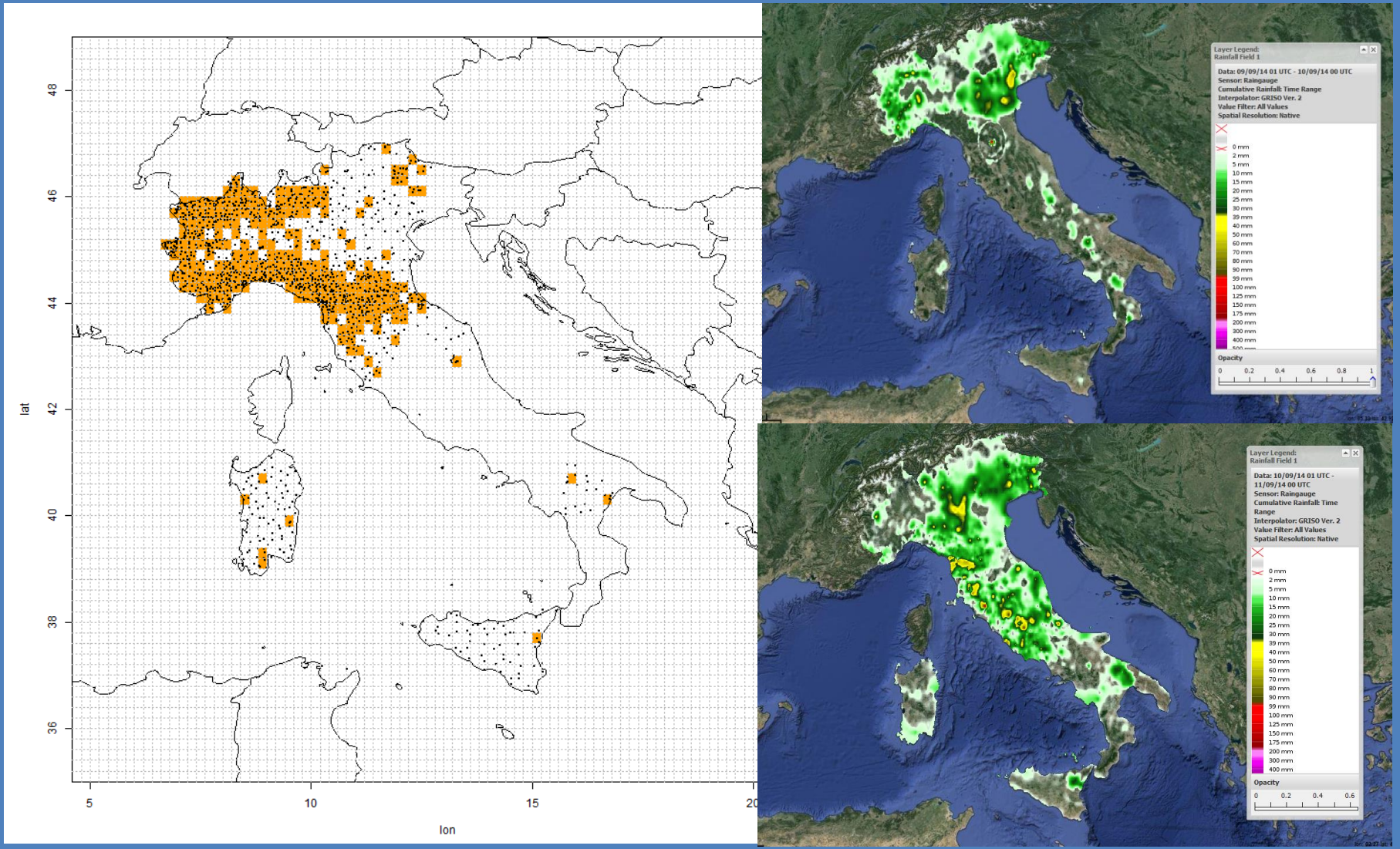






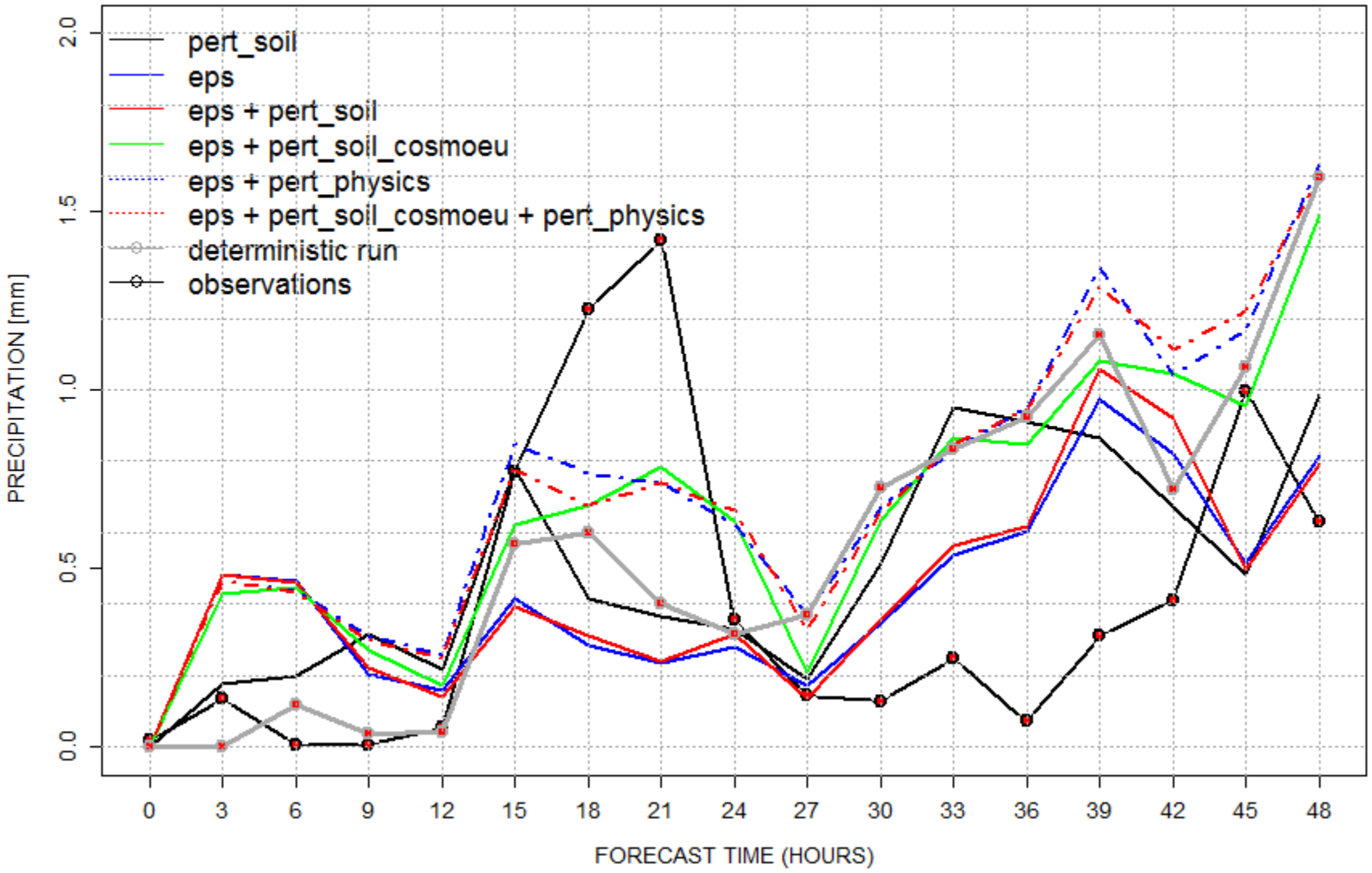
CS1 summer forcing: upper level through moving westward from Western Europe

VERIFICATION



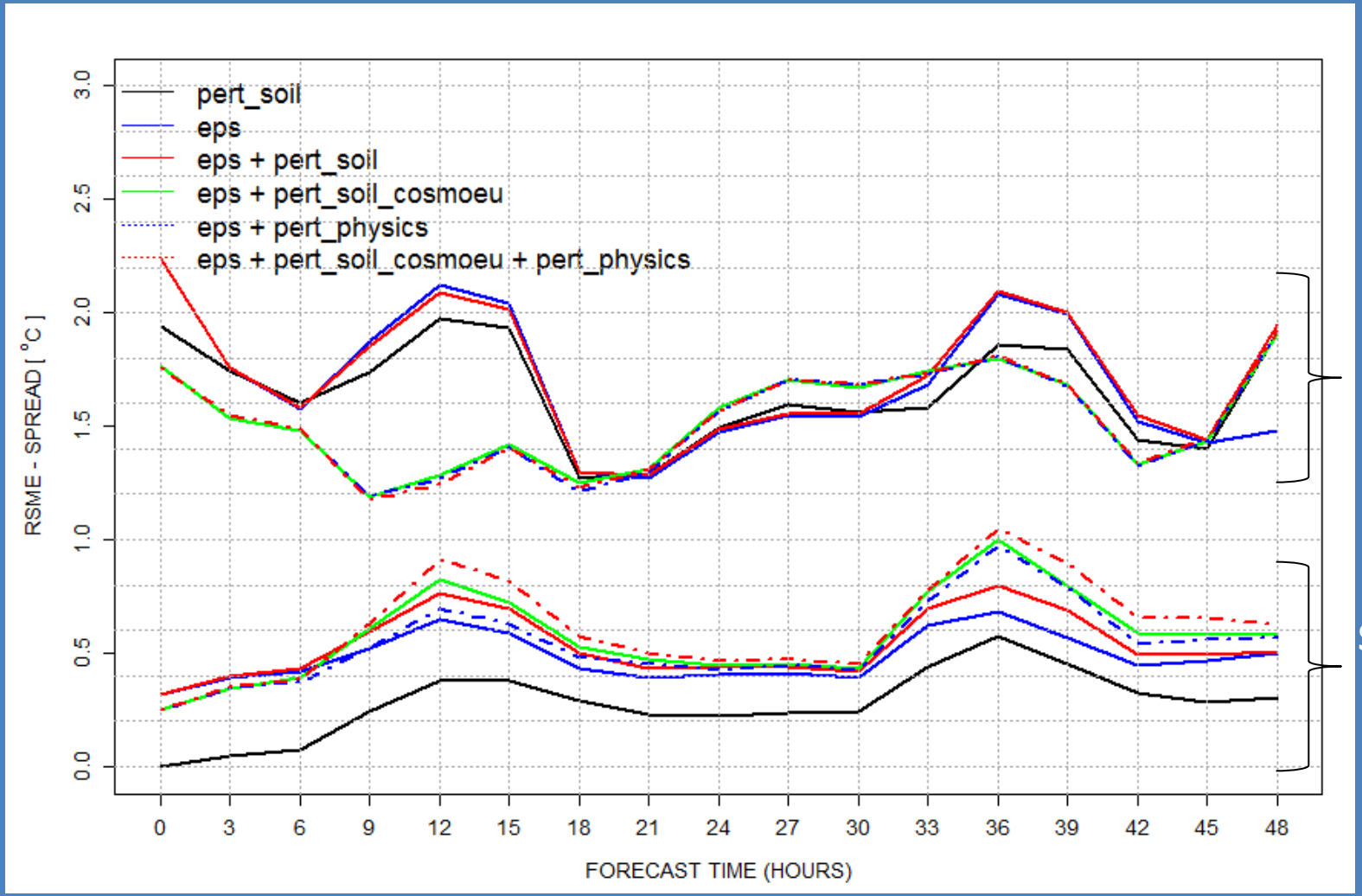
CS1 summer forcing: upper level through moving westward from Western Europe

PRECIPITATION VERIFICATION



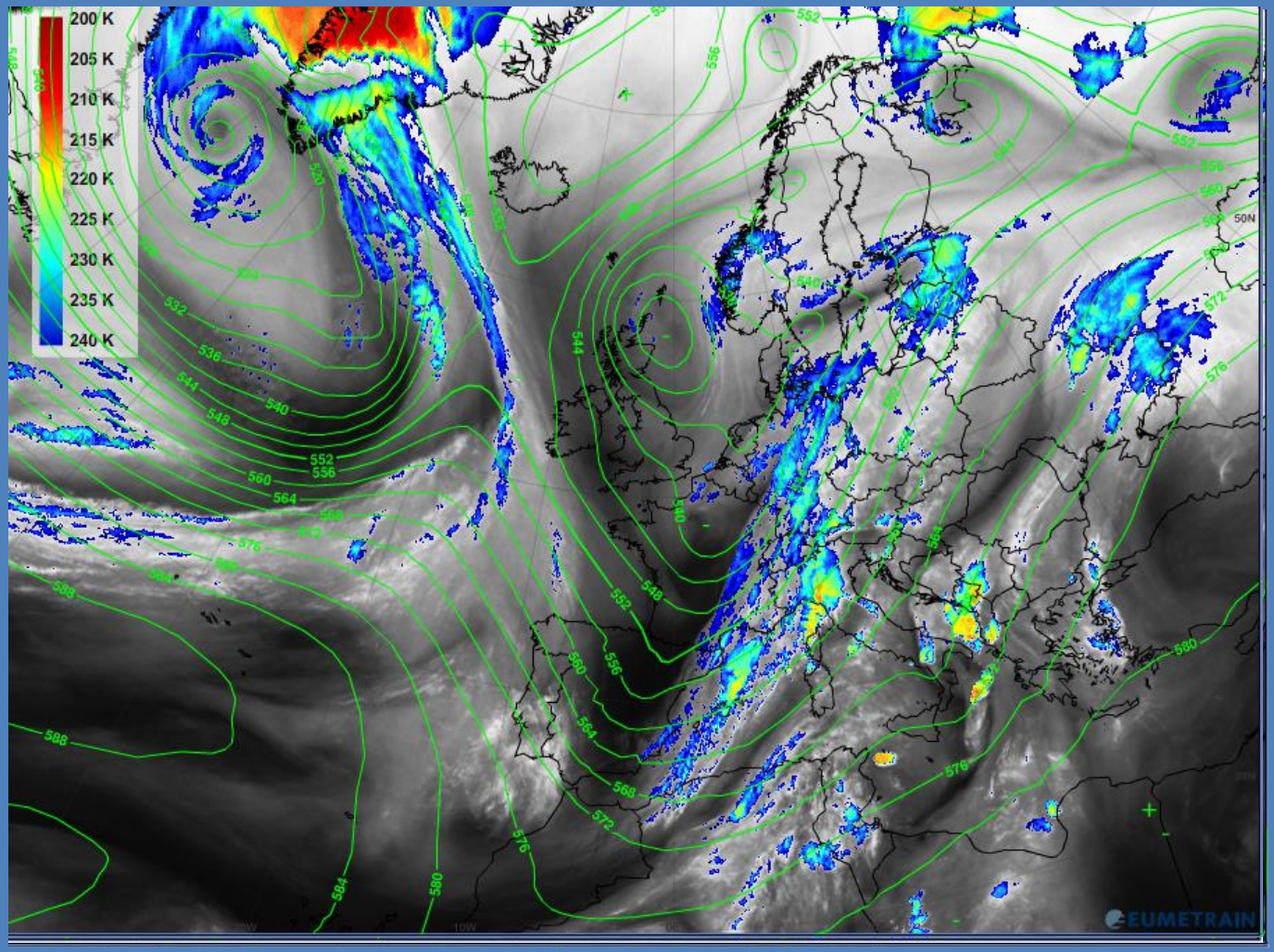
CS1 summer forcing: upper level through moving westward from Western Europe

2m TEMPERATURE VERIFICATION – SPREAD SKILL RELATIONSHIP

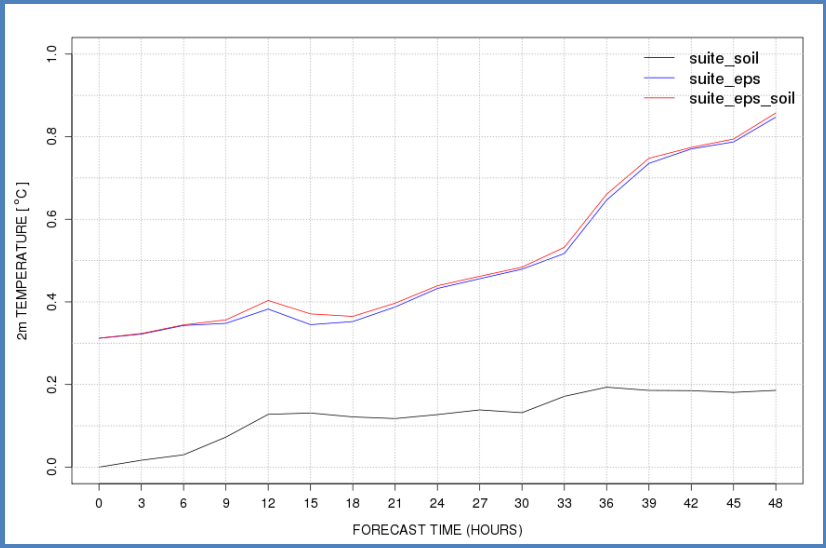


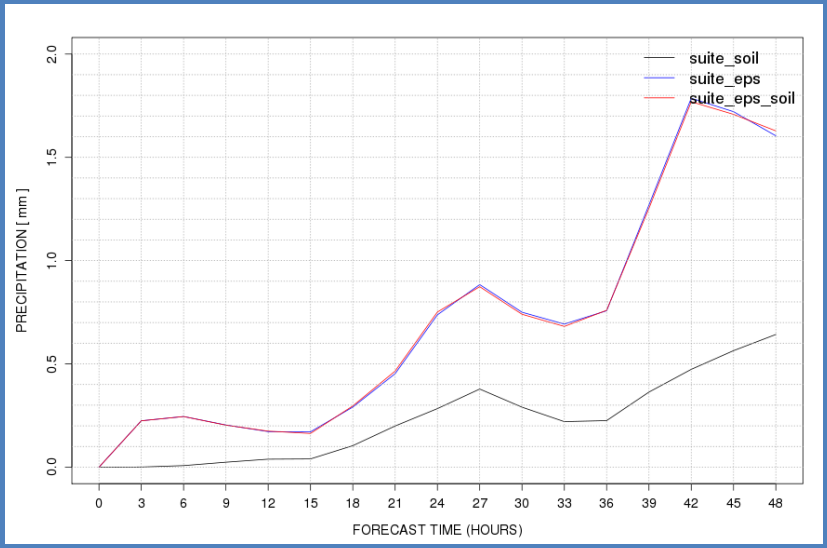
CS2 fall forcing: low level convergence over Liguria, convection over Southern Italy

SYNOPTIC FORCING



CS2 fall forcing: low level convergence over Liguria, convection over Southern Italy





Conclusions

- In this study we performed a comparison among six different ensemble suites ran with high resolution COSMO-I2 model.
- According with a previous analysis, the obtained spread of different near surface variables is increasing whenever IC of soil moisture is taken into account.
- Including the soil perturbation in a more complex ensemble system have benefits generating spread.
- This spread is larger when COSMO-EU soil moisture analysis is used as surface field to perturb with SPG technique.
- Verification gives interesting results, even if more data would benefit the statistics

Future developments

Verification and ensemble technique

1. Increase the simulation lead time in order to have a better and more appropriate statistic
2. Set up a COSMO-IT-EPS implementing results from KENDA

Acknowledgments

Chiara Marsigli, Andrea Montani — ARPA SIMC (ITALY)

Dmitriy Gayfulin, Michael Tsyrulnikov — HydroMetCenter (RUSSIA)

Thank you for your attention!

Aim of this study

Develop and compare the results of different test suites:

SUITE EPS

Classic ensemble system: Atmospheric IC and BC from 10 random ECWMF EPS members, soil IC from ECMWF or COSMO-EU soil moisture analysis

SUITE SOIL

10 members made by perturbing soil moisture IC (from ECMWF or COSMO-EU soil moisture analysis) using Stochastic Pattern Generator (SPG)

SUITE EPS-SOIL (ECMWF)

"Completely" perturbed: SUITE EPS + SUITE SOIL – Soil moisture analysis from **ECMWF**

Aim of this study

Additional test suites:

SUITE EPS-SOIL (COSMO-EU)

"Completely" perturbed: SUITE EPS + SUITE SOIL – Soil moisture analysis from COSMO-EU

SUITE EPS-PHYSICS

SUITE-EPS + physics perturbation

SUITE EPS-SOIL-PHYSICS (COSMO-EU)

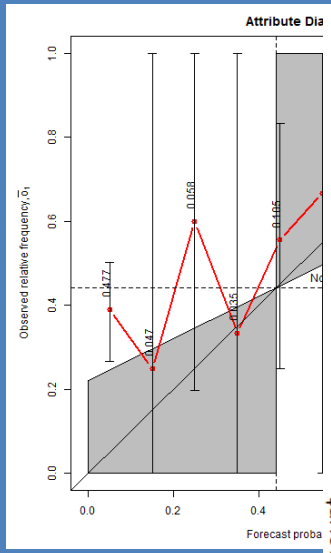
"Completely" perturbed: SUITE EPS-SOIL (COSMO-EU) + physics perturbation

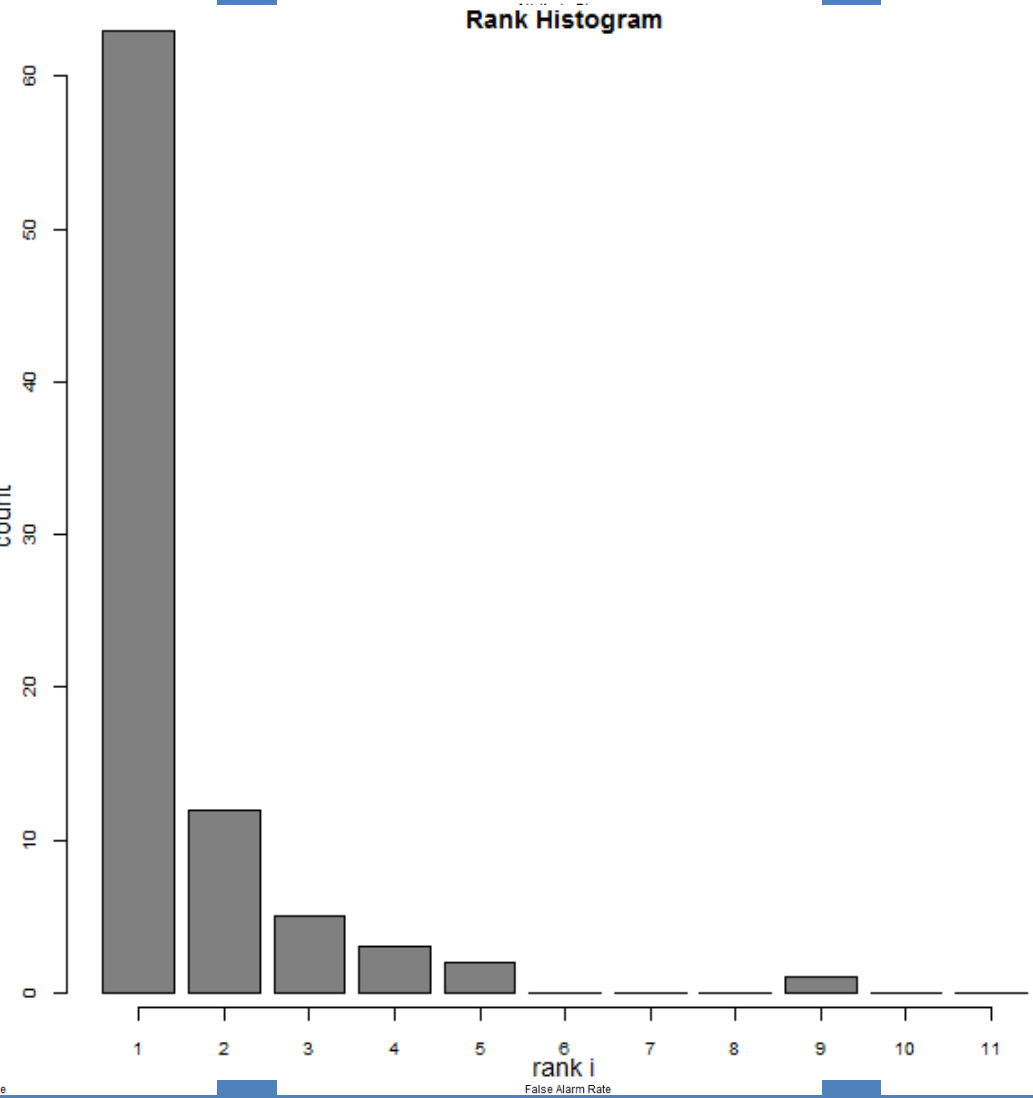
SPITSOIL – ECMWF special project

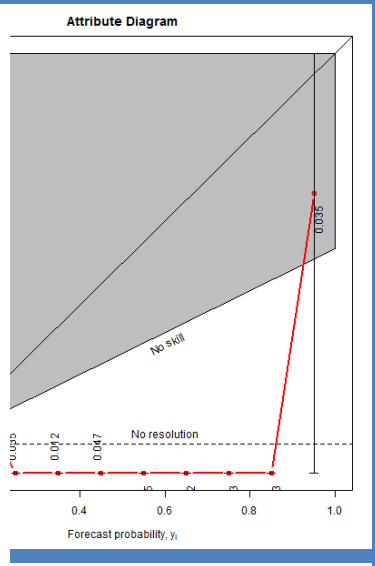
CS1 summer forcing: upper level through moving westward from Western Europe

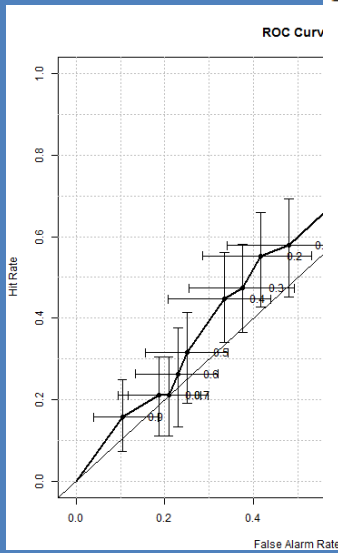
PRECIPITATION VERIFICATION

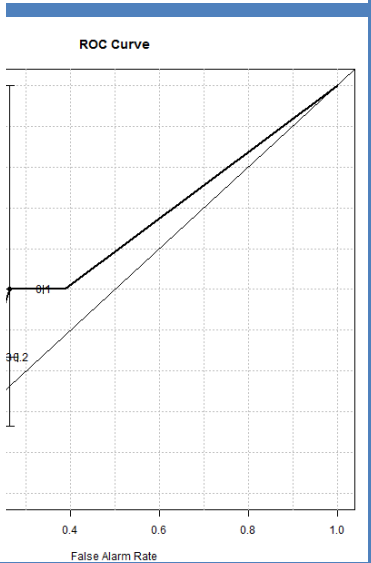
5 mm | **10 mm** | **25 mm**





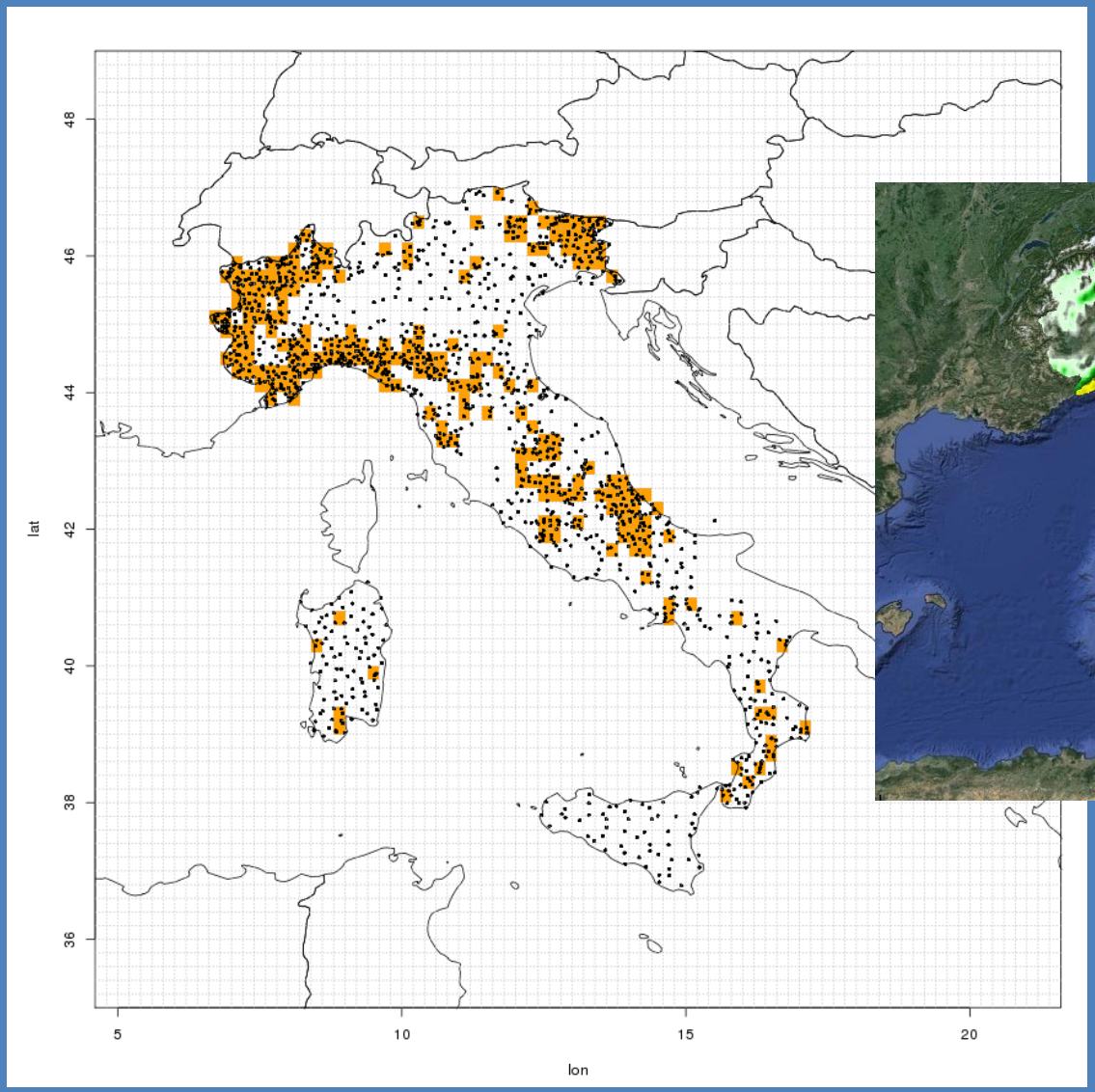


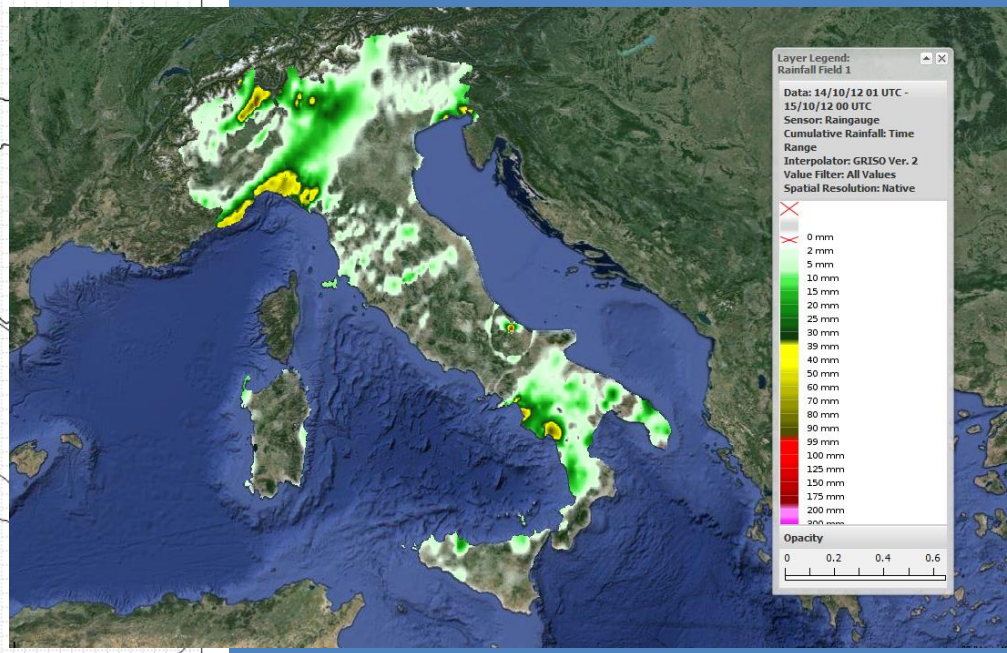




CS2 fall forcing: low level convergence over Liguria, convection over Southern Italy

VERIFICATION





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