Influence of Initial and Lateral Boundary Conditions on the Simulation of a Heavy Precipitation Event in the Western Mediterranean

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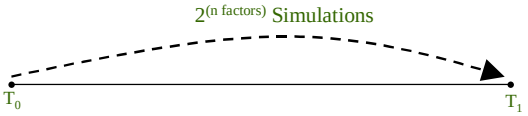
Objectives

- Establish a method to determine the effect of the Initial and Boundary conditions on a numerical meteorological simulation.
- Test the application of the Stein and Alpert (1993) factor separation technique along the time.
- Apply the factor separation technique with non-physical factors like IC and BC (following Alpert et al. 1996).
- Determine the effect of the IC and BC on a concrete simulation of a heavy rainfall event in the Western Mediterranean.
- Extend the study to several cases trying to obtain somehow a case independent conclusions.

Methodology

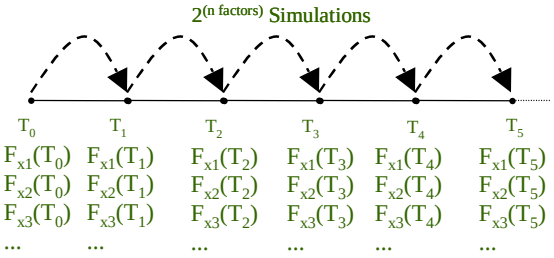
The technique

Factors separation technique is usually applied as:



Study event
- F_{x1}
- F_{x2}
- F_{x3}
- ...

A temporal evolution of the factors along the simulation can be obtained by:



$F_{x1}(t)$
$F_{x2}(t)$
$F_{x3}(t)$
...

Methodology

IC and BC factors. Particularities

- Initial and Boundary conditions are the 2 selected factors to apply the technique, so 4 simulations must be performed:

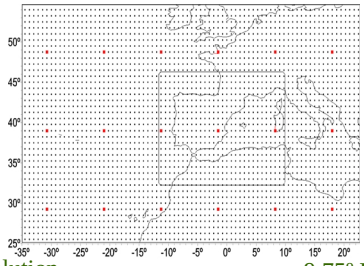
	Initial Conditions	Boundary Conditions
Control Simulation	Υ	Υ
IC Simulation	Υ	Ψ
BC Simulation	Ψ	Υ
00 Simulation	Ψ	Ψ

PROBLEM: How to turn off the IC or BC factors to perform the necessary simulations?

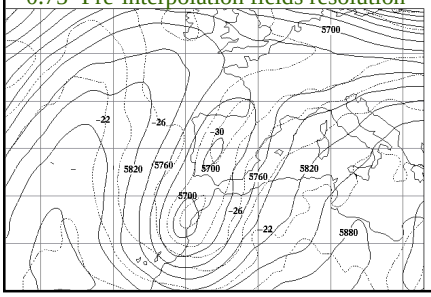
Methodology

Initial Conditions degrading

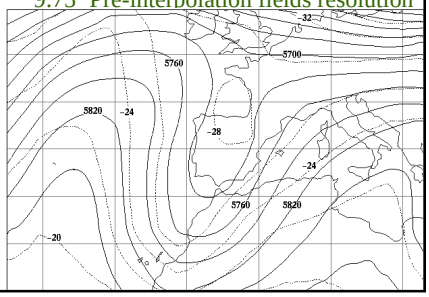
1 Initial Conditions: Degrading the information entering the model by decreasing the resolution of the pre-interpolation fields.



0.75º Pre-interpolation fields resolution



9.75º Pre-interpolation fields resolution



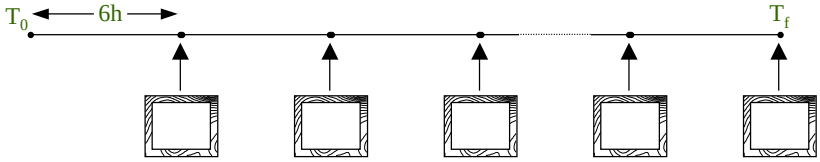
Geopotential and Temperature at 500 hPa. 28th September 1994 1200 UTC

Methodology

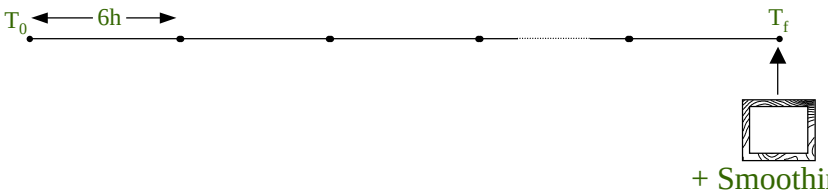
Boundary Conditions

2 Boundary Conditions: By non-updating the LBC until some time after the main event has finished:

Updating LBC:



Non-updating LBC:



+ Smoothing

Methodology

Factors' Meaning

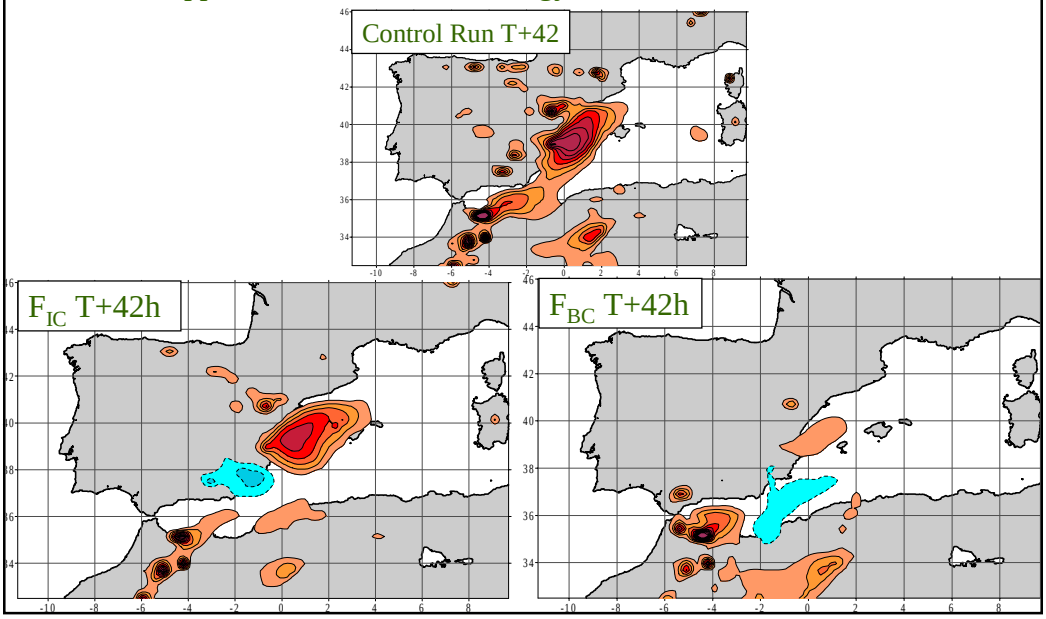
From the 'turning-off' process, an accurate interpretation of each factor must be done to avoid falling into wrong conclusions:

- IC: Structures of the pre-interpolation initial conditions fields eliminated in the degrading pre-process.
- BC: Information entered to the model through the 6h normal boundary update and non-smoothed final field.
- SY: Interaction between the two former factors.
- 00: Remaining structures after the 'turning-off' process of both IC and BC. This factor offers a self-checking procedure since as better the turning-off process is, as weaker this factor will be.

Results

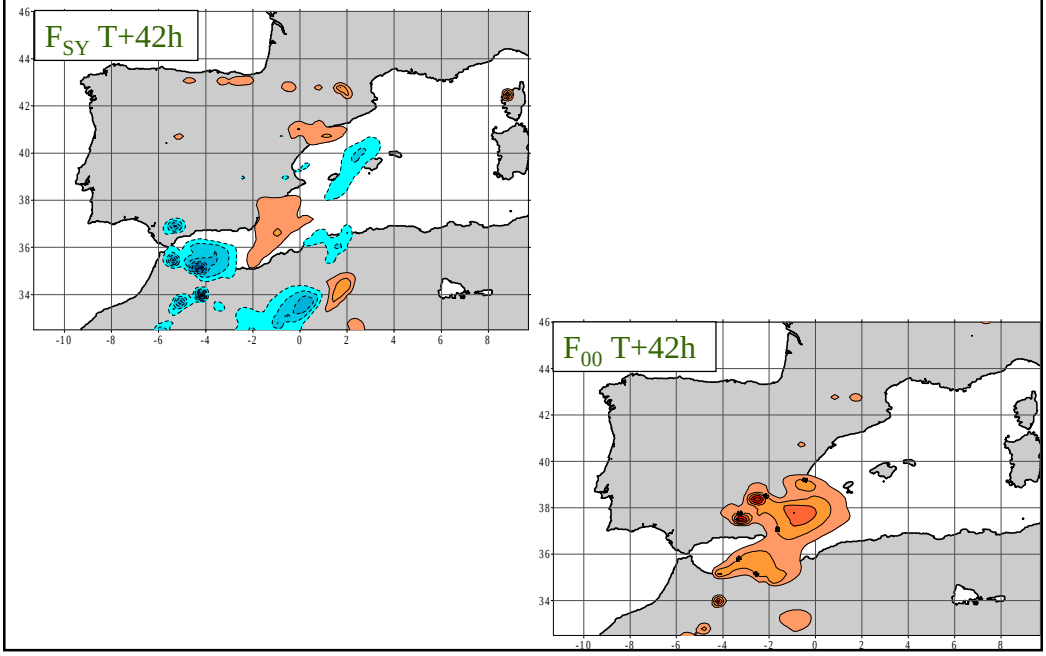
Total Accumulated Precipitation

The usual application of the methodology shows us:



Results

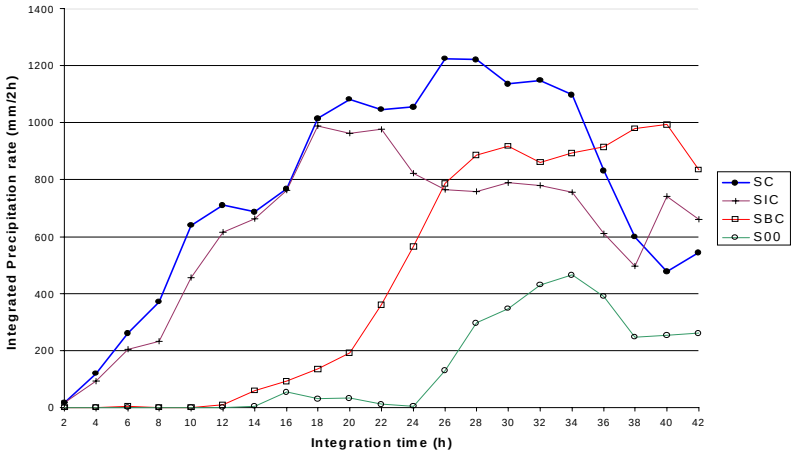
Total Accumulated Precipitation



Results

Precipitation rate

The crude simulations firstly reflect a temporal evolution of the factors influence:

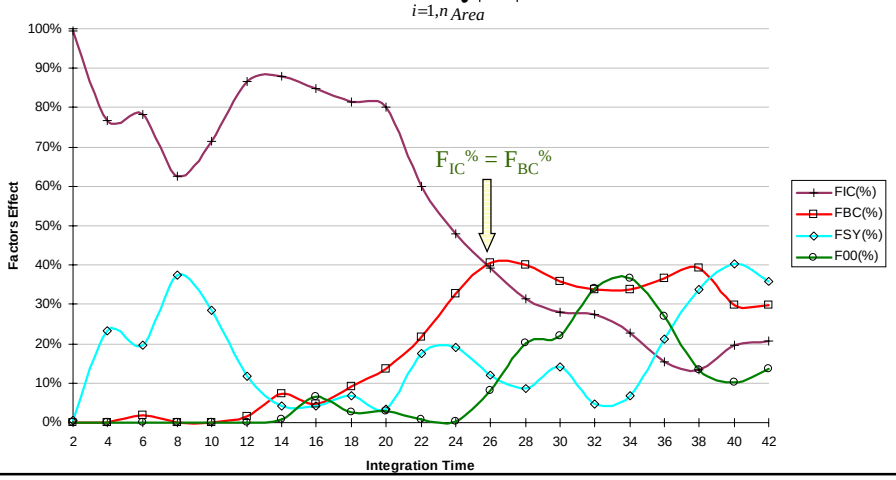


Results

Precipitation rate

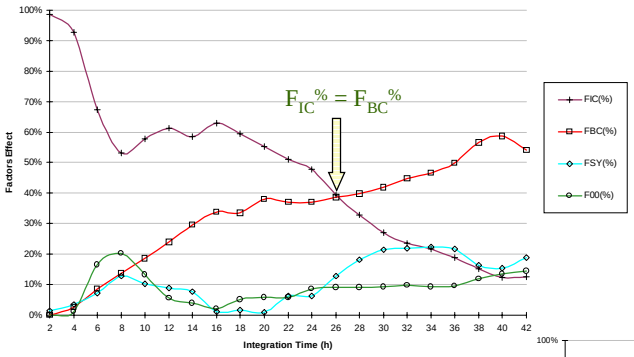
A relative factors' influence can be calculated as:

$$F_x^{\%} = \frac{\int |f_x|}{Area} \Big/ \sum_{i=1,n} \int |f_{x_i}|_{Area}$$



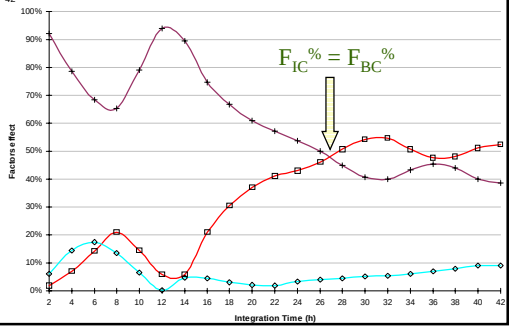
Results

Ground Relative Helicity and Sea Level Pressure



Ground Relative Helicity (1000-700 hPa)

Sea level pressure

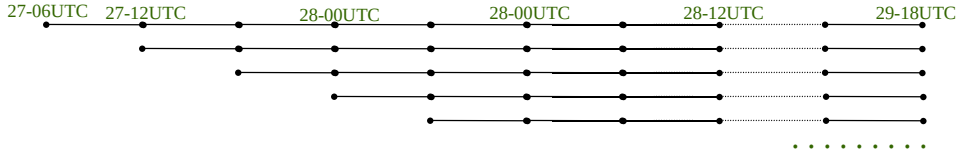


Methodology

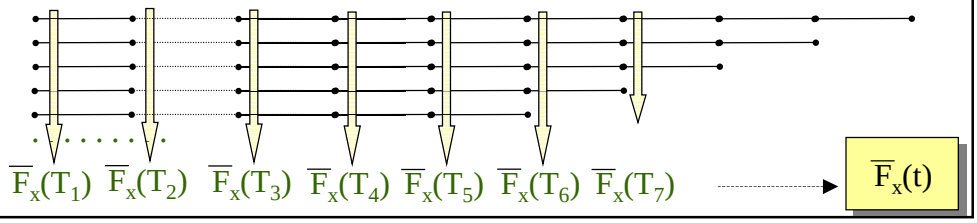
Average over different cases

These results are ‘case dependent’ and an average on different events must be done in order to obtain a coarse quantitative approximation to the $F_{IC}(t)$, $F_{BC}(t)$ and $F_{SY}(t)$ of the concrete model configuration:

A set of 4x9 simulations have been used

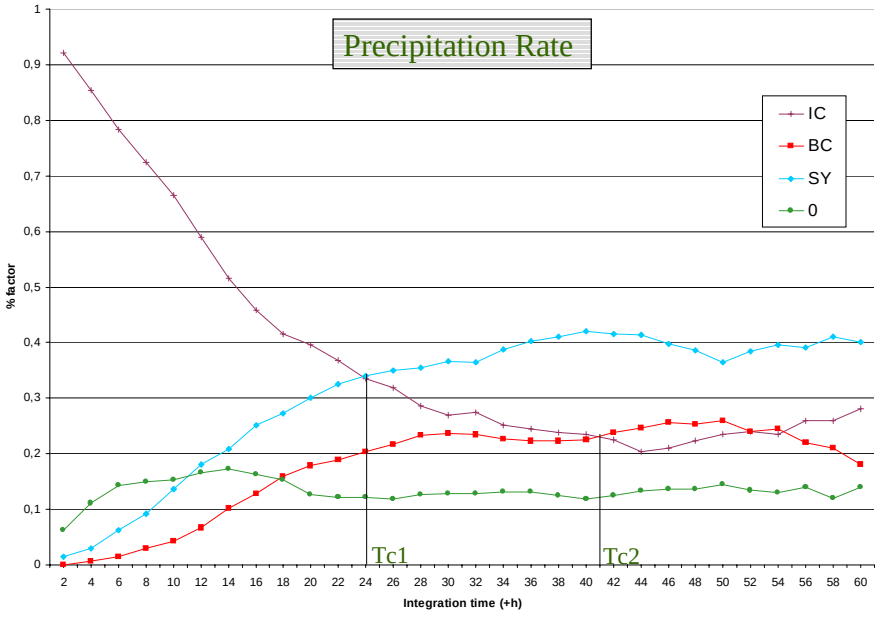


to make an average on ‘different cases’ every selected timestep:



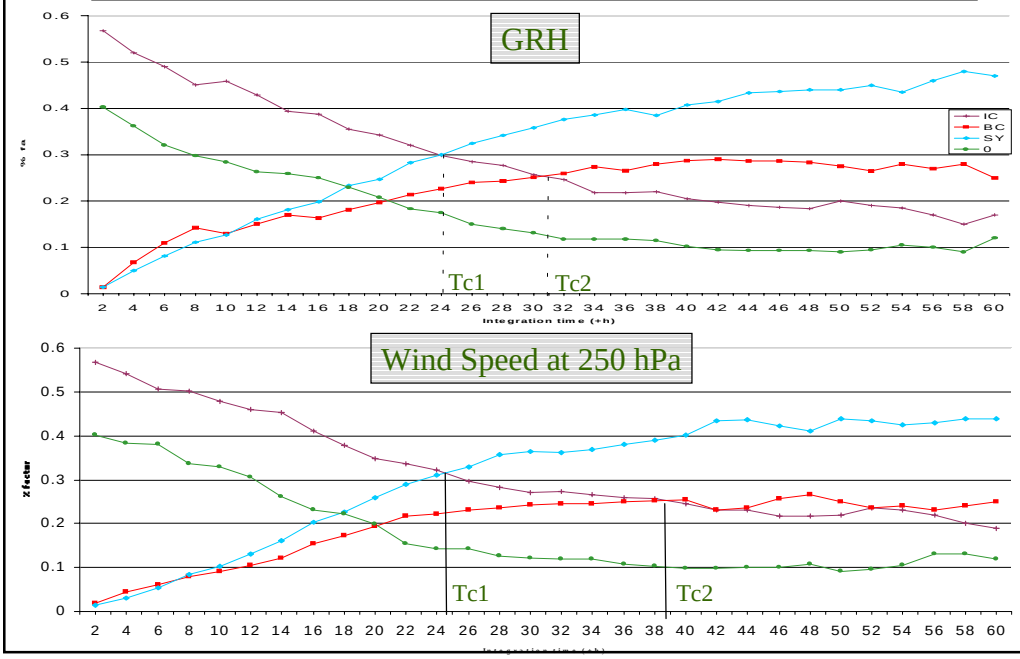
Results

Average over different cases



Results

Average over different cases



Conclusions

- A method to study the influence of IC and BC on the numerical simulation through the factors separation technique has been presented.
- Even non-trivial turning-off procedures must be applied, factor separation technique can be used with the IC and BC.
- Temporal evolution of the factors offers a useful information and shows the precise effect of each factor at every moment along the simulation.
- The application of the method over a simulation of a heavy precipitation event reveals the existence of a 'critical time' after which the BC become more important than IC.
- Averages over different cases show the existence of a second 'critical time' after which the synergism between the factors become more important than the IC.
- Further work will consist on apply the method over more case studies and try to determine Tc1 and Tc2 as a function of several parameters as the model domain, resolution, etc..