Report from work on subject

Physics - Dynamics Interface for Predictor - Corrector Scheme

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The assignment can be divided into three parts:

0. To run diabatic model with PC scheme correctly.
1. Under LPC_FULL=TRUE, during corrector part, trajectories are recomputed and values at origin points are re-interpolated. First, the impact of the new origin point should be evaluated. The physics tendency is calculated in the origin point. Therefore the physics tendency should be re-interpolated into the new origin point.
2. In ALADIN, total physics tendency is evaluated at the origin point. To use half the physics tendency evaluated at the origin point time t and half evaluated at the arrival point time t+dt.
3. To take the physics tendency contribution from stratiform precipitation parameterisation at the arrival point time t+dt and the rest at the departure point time t.

0. The purely technical part

The PC scheme was coded in a following way: if the physics package was called, the physics tendencies were calculated, the accumulated and instantaneous fluxes were diagnosed, but the variables were never updated with physics tendencies. This lead to a strange situation, for example for precipitation, the precipitation water was never subtracted from the moisture in the air. Therefore, it was raining, but the moisture was not removed from the 3D moisture fields.

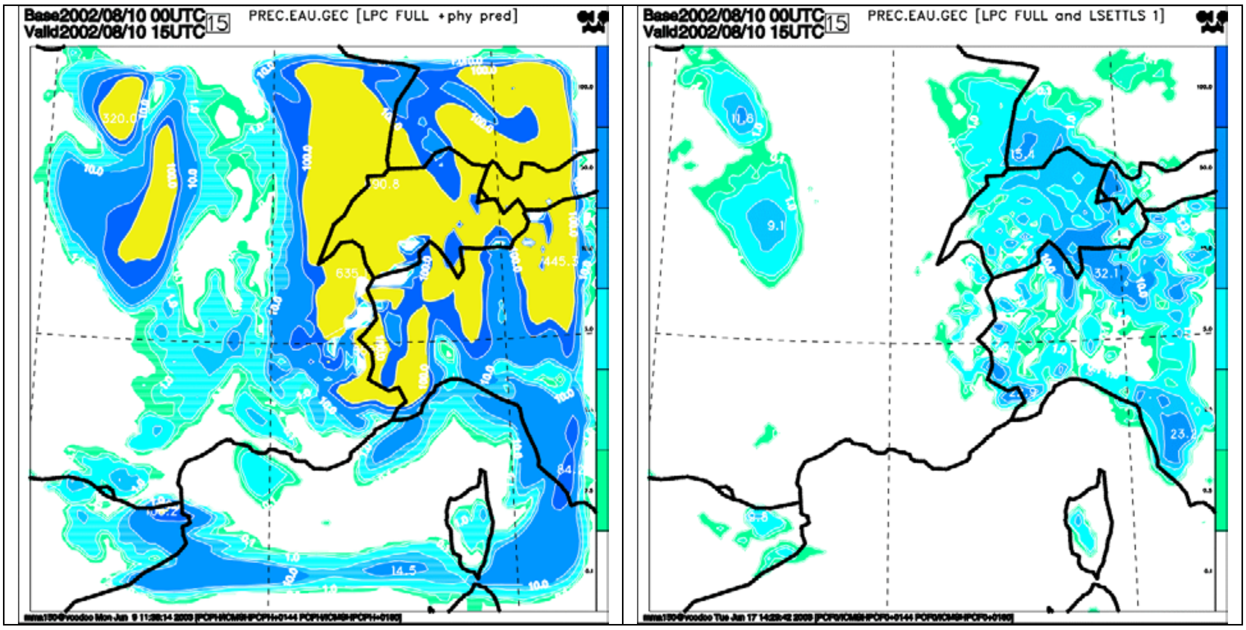

Figure 1. 3 hourly accumulated large scale precipitation forecasted by PC scheme with reiteration of trajectories and physics for Aug 10th 2002, before (left) and after (right) introduction of the correct treatment of physics tendencies into LPC_FULL.

To use physics tendencies during PC scheme properly, the following code changes are introduced:

Physics tendencies are transferred using GT9 buffer. The size of GT9 buffer is increased in sudim2. PCXPTT9 arrays contain tendency of variable X after the call to physics and are stored in GT9 buffer. In this way, physics tendencies are transported from predictor to corrector and the final values are updated with physics tendencies. The scheme works in a way that if the trajectories are re-calculated, physics tendency values are re-interpolated.

During predictor:

In cpg, after the call to diagnostics, pt2gt9 stores the tendencies from physics to PCXPTT9 array, these arrays are written to GT9 buffer in cpg_end using sc2wrt.

During corrector:

GT9 buffer is read by sc2rdt9 called from cpg_gp and PCXPTT9 arrays are filled. If the physics package is not called, gt92pt is called from cpg, the physics tendencies are obtained by copying PCXPTT9 arrays into the physics tendency arrays.

modified routines: adiab/cpg.F90, adiab/cpg_gp.F90, adiab/cpg_end.F90, setup/sudim2.F90, utility/sc2rdt9.F90, utility/sc2wrt9.F90
new routines: adiab/gt92pt.F90, adiab/pt2gt9.F90
branch with the modified source code is in Prague: Arp_mma150_CY25t2_PCphy

Model was run on ALPIA, with 10, 5 and 2.5 km resolution. Hydrostatic 2TLSISL, nonhydrostatic 2TLSISL and nonhydrostatic PC scheme model configurations were used, with and without physics. Different extrapolation schemes were tested too; LSETTLS and Robert for all 3 set-ups, and non-extrapolating scheme with PC only.

1. Impact of the new O point

Using the current code, only the reiteration of the tendencies from physics is possible when using the LPC_FULL key. However, when the previously mentioned problem was tackled, first solution was hardcoded. This one does not re-interpolate the tendency from physics to the new origin point.

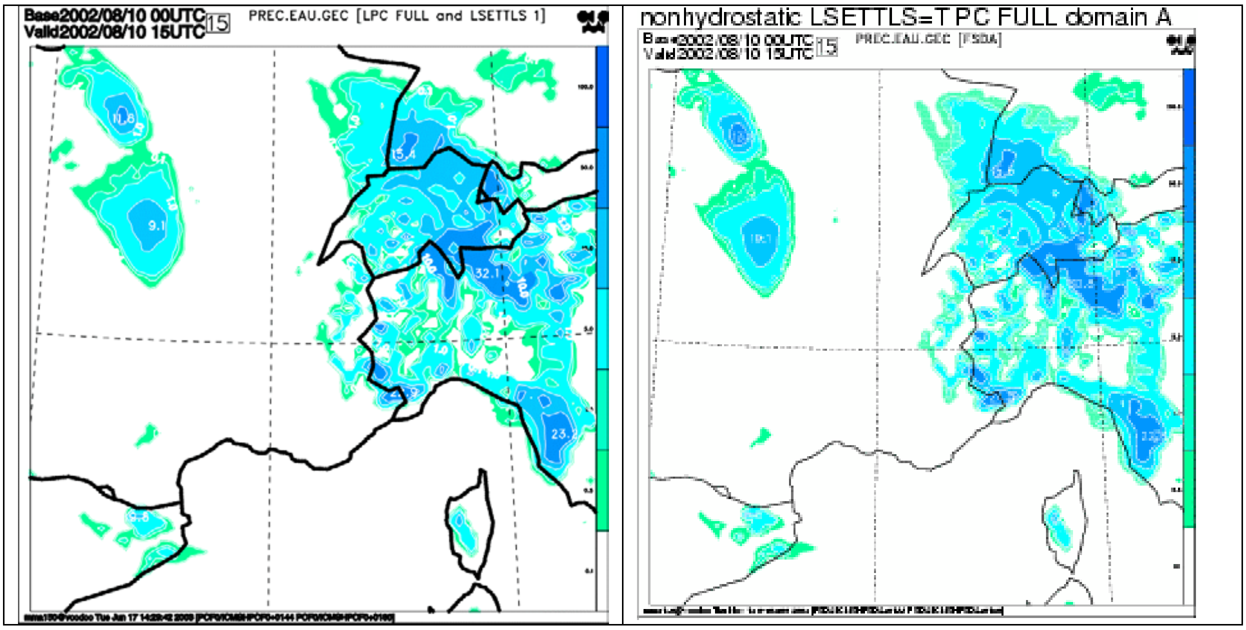

Figure 2. 3 hourly accumulated large scale precipitation forecasted by PC scheme with reiteration of trajectories and physics for Aug 10th 2002, when tendencies from physics are not reinterpolated (left) and when they are (right).

The difference in forecasted precipitation fields is so small that it may be ignored. However, since the non-re-interpolated version was hardcoded, some more reliable evaluation is desirable.

The other two parts of the assignment are not yet finished. Due to considerable changes in the data flow of the model that are introduced into the new cycle, new solution for the correct treatment of physics tendencies into LPC_FULL had to be developed. These two parts will be tested with the new version of the code, soon, hopefully.

1.1 Impact of the PC scheme

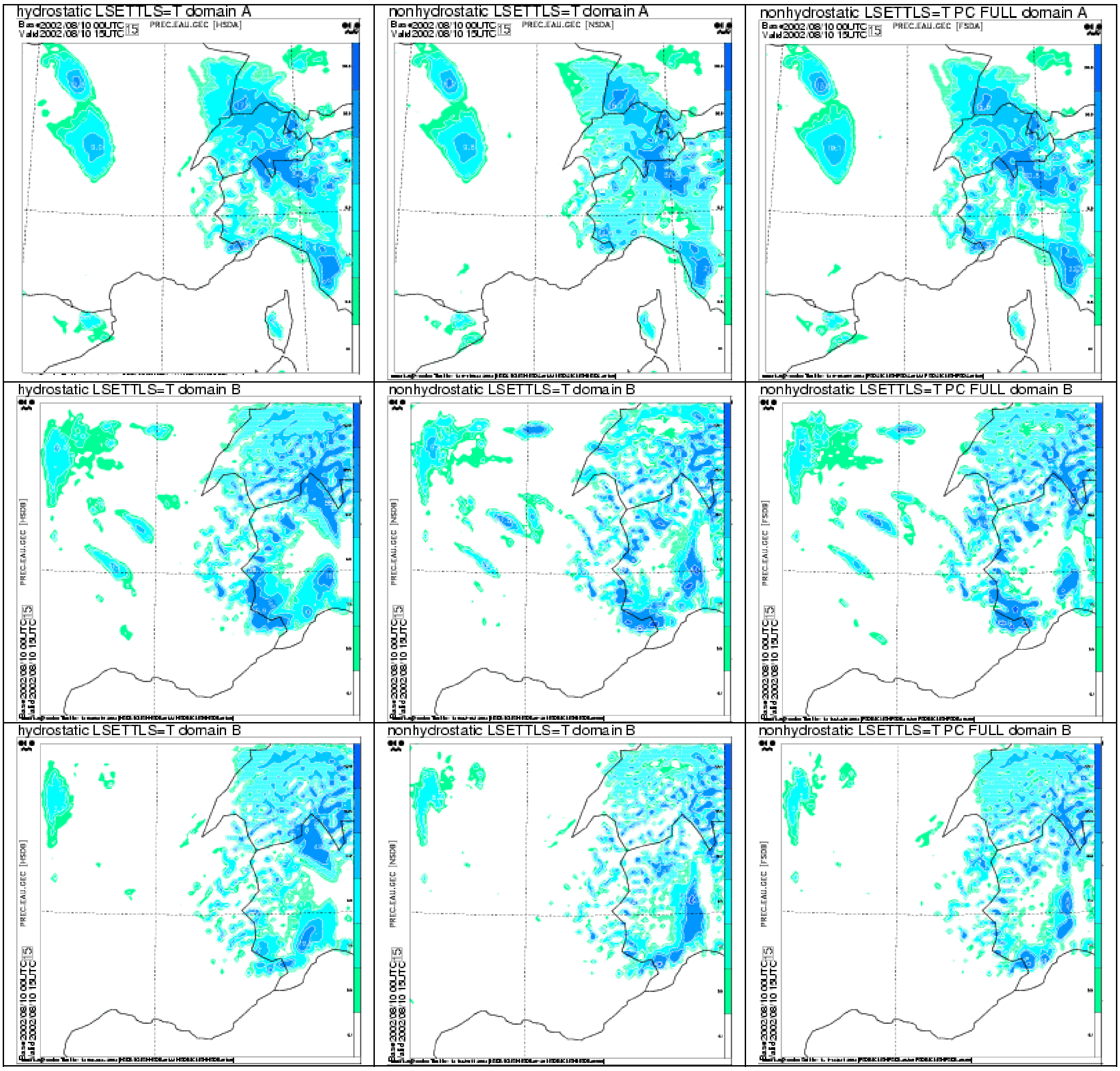

Figure 3. 3 hourly accumulated large-scale precipitation forecasted by hydrostatic (left), non-hydrostatic (middle) and PC scheme with reiteration of trajectories (right), with 10 km (top row) and 5 km resolution without convection (middle row) and with convection (bottom row) for Aug 10th 2002.

All model configurations were run with 300 sec time-step on 10-km resolution.
Hydrostatic was running with 300 sec time-step on 5 and 2.5 km resolutions (without convection).
Nonhydrostatic model ran with 60 sec time-step on 5 km resolution, but blew up with U wind too strong for 90 (for adiabatic run too).
Nonhydrostatic model with PC ran with 90 sec time-step on 5 km resolution, but blew up with U wind too strong for 150 (for adiabatic run too).

1.2 Impact of different trajectory extrapolation schemes

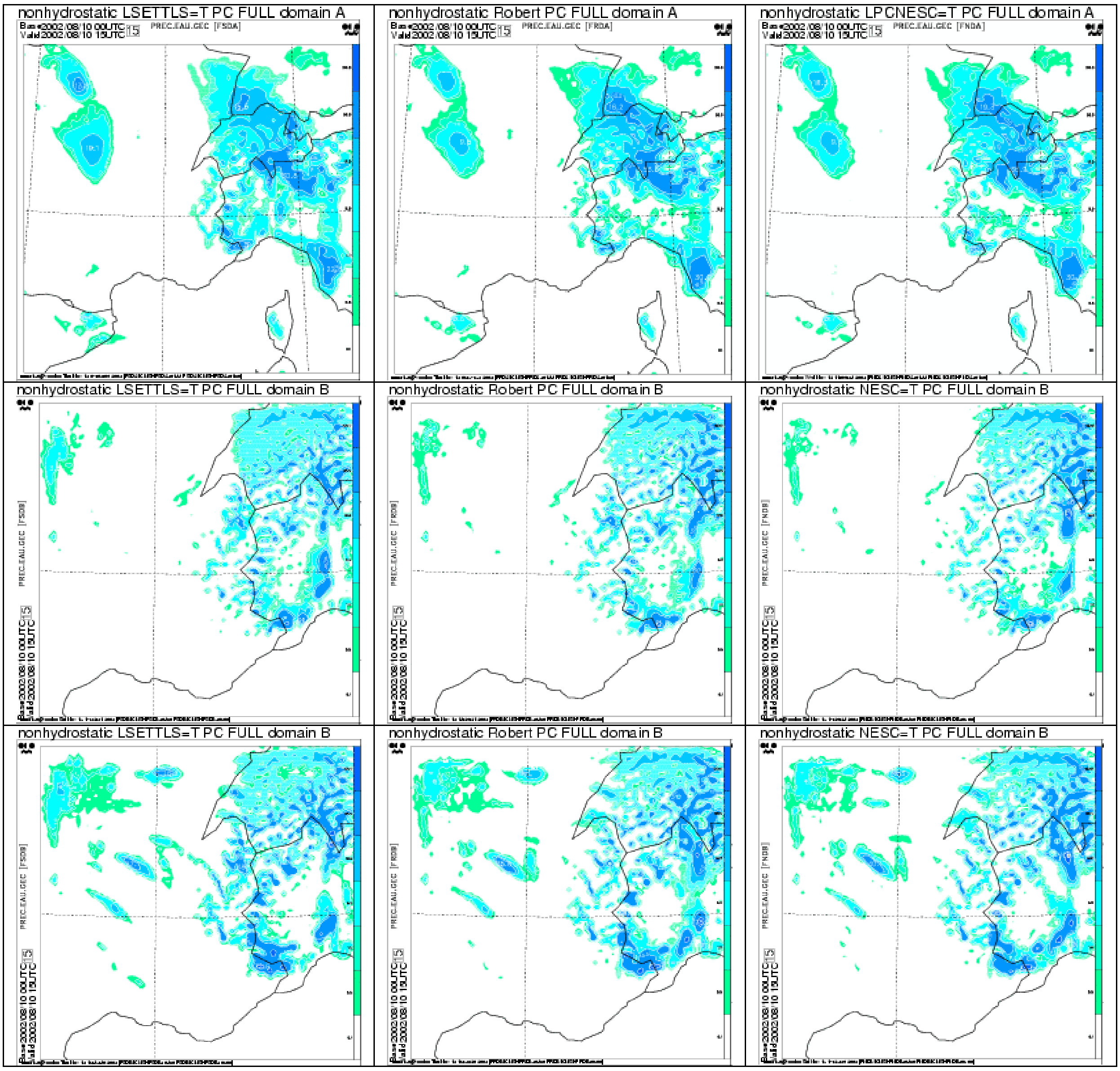

Figure 4. 3 hourly accumulated large-scale precipitation forecasted by PC scheme with reiteration of trajectories and LSETTLS (left), Robert (centre) extrapolations and scheme without extrapolations (right), with 10 km (top row) and 5 km resolution with convection (top row) and without convection (bottom row) for Aug 10th 2002.

1.2 A few preliminary conclusions

Not all figures are shown here. The figures show only the distribution of large scale liquid precipitation. The figures of the differences between the fields can be misleading since a small displacement of the maximum produces large differences, although the fields are very similar. The overall picture for the 10-km resolution tests may be drawn as follows. Precipitation maximum is higher in hydrostatic than in non-hydrostatic configurations, it is also stronger for LSETTLS than for other extrapolation schemes. As expected, more significant differences may be observed later in the run. In hydrostatic and PC runs, there is a secondary maximum in the large scale precipitation field (21 and 24 hour forecast) close to Genoa bay that is much weaker in the SI NH run. The same maximum is stronger in PC with Robert extrapolation and without extrapolation than when LSETTLS is used. The effect of different extrapolation schemes seems negligible in hydrostatic and SI NH experiments. PC with LSETTLS gives a bit different distribution of rainfall than other schemes and is more similar to the hydrostatic distribution.

5-km resolution is in the so-called grey zone. So the two sets of experiments were run – with and without convection. In the areas with extreme rainfall, the maximum is stronger in NH than in hydrostatic. However, the experiments were performed with different time-steps.

2.5-km resolution experiments for hydrostatic runs were running with 300 sec time-step for LSETTLS and 150 for Robert extrapolation. NH runs completed with 30 sec time step, while PC runs aborted with 45 sec time-step.