First look at the MC2 peformance for finescale forecasting during the MAP SOP (a WG-NUM report)

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Introduction

The configuration of the MC2 model for MAP, featuring a 3-km window over the entire Alps, described in (Benoit et al., MAP NL 11, 1999), has been run succesfully during MAP to provide special guidance to the research aircrafts, to test the explicit convection modeling, and to establish a database for mesoscale process studies over the Alps. A website was established to record the day-by-day analysis of the model forecasts by the MC2 desk crew (RPN, ETHZ and MeteoSwiss) at the MOC in Innsbruck: now at www.geo.umnw.ethz.ch/research/map_mc2/.

From Sep. 7, 1999 until Nov. 15 1999, the model was run on a continuous basis on *gottardo*, the NEC SX-4 supercomputer at the Swiss Centre for Super Computing (SCSC/CSCS); results were archived for all days and all graphical products (about 1000 images per day) are online at the MAP Data Centre. The full 27 h 3-km simulation takes 4.5 h CPU time in a dedicated mode on 10 processors at a sustained speed of approximately 10 Gflops (50% of peak theoretical performance). During the MAP field phase, this computation represents the largest computational task that was conducted in Switzerland on a daily basis.

The full suite consisted of 14-3-1 km nested runs, with the 1-km targeting (~150 km moveable domain) crucial (mostly for the GWB project, P6) aircraft missions scheduled to take place the next morning.

A first look at the results

The topography chosen for the 3-km model (Fig. 1), rather smooth, ensured un-noisy and reliable runs (not a single failure during the period): very subtle features (e.g. detailed timings of the foehn or gapflow onset) have been be simulated.

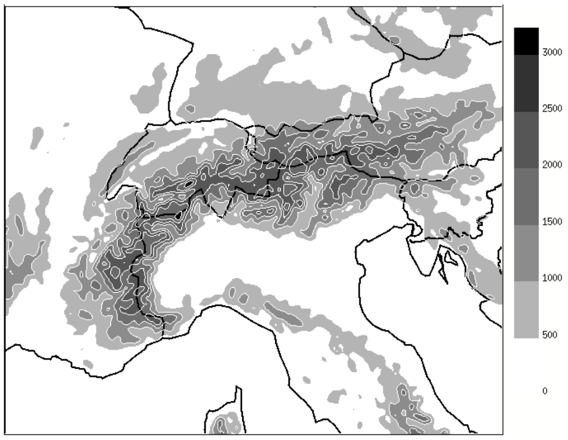

Figure 1: Topography and domain of MC2-3km

The explicit modeling of convection with 3-km instead of 2-km as initially planned, appears to have been able to catch properly only the heavy precipitation zones, while underestimating the smaller amounts, resulting in a quite large areal bias. A comprehensive evaluation of the MC2 precipitation is being carried out in collaboration with MeteoSwiss, as part of an overview paper (Benoit et al., 2001); Fig. 2a compares the mean hourly precipitation at *all* ANETZ stations (over Switzerland) with that of the MC2 corresponding points. The timing of the precipitation was well predicted, with some underestimation of the precipitation intensity.

The planned hydrologic realtime simulations (driven by the MC2 rain) really took place with the collaboration of Nick Kouwen (Waterloo, Canada). Fig. 2b shows the hydrographs for the Toce and Ticino during the SOP. There were three significant events during the MAP SOP: September 20 during IOP-02, September 26 during IOP-03 and October 21 during IOP-08. The first rainfall event that resulted in a very good flood forecast. The second rainfall was centered on the Ticino river above Bellinzona and was not predicted by MC2 for the Ticino River. The third event was a snowfall event with precipitation amounts that would have produced significant flows if it were rain instead of snow.

It took the 1-km final MC2 adaptation to fully capture the amplitude of the intense gravity waves, such as shown on Fig. 3, for the IOP15. The model predicted approximately the right wave amplitudes (with peak values of 4.2 and 3.6 m/s, respectively). Apart from IOP 2b, no GWB false alarms were raised by the MC2.

Outlook

A complete MC2-MAP archive (1 TeraByte) has now been established at RPN that contains all of the MC2 gridded output as well as the driving boundary files: scientists interested in using parts of this MAP data are invited to enquire to the author. The adequacy of 3-km for explicit convection will be further examined, as well as the question of the proper terrain definition.

A second MC2 suite, at 14 km, with 75 levels and a higher lid at 35 km, out to T+72h, driven by the ECMWF model, was also run on a DLR SX-4 machine and is not described here.

References

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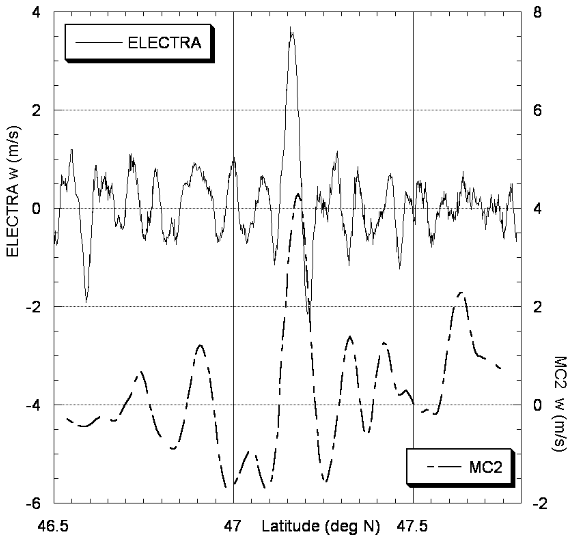

Figure 3. Vertical velocity observed by Electra (in solid line) at altitude of 6400 m ASL, and simulated by MC2-1km (dashed line) at an altitude of 6500 m ASL for IOP 15. Abscissa is latitude of flight track and model points.

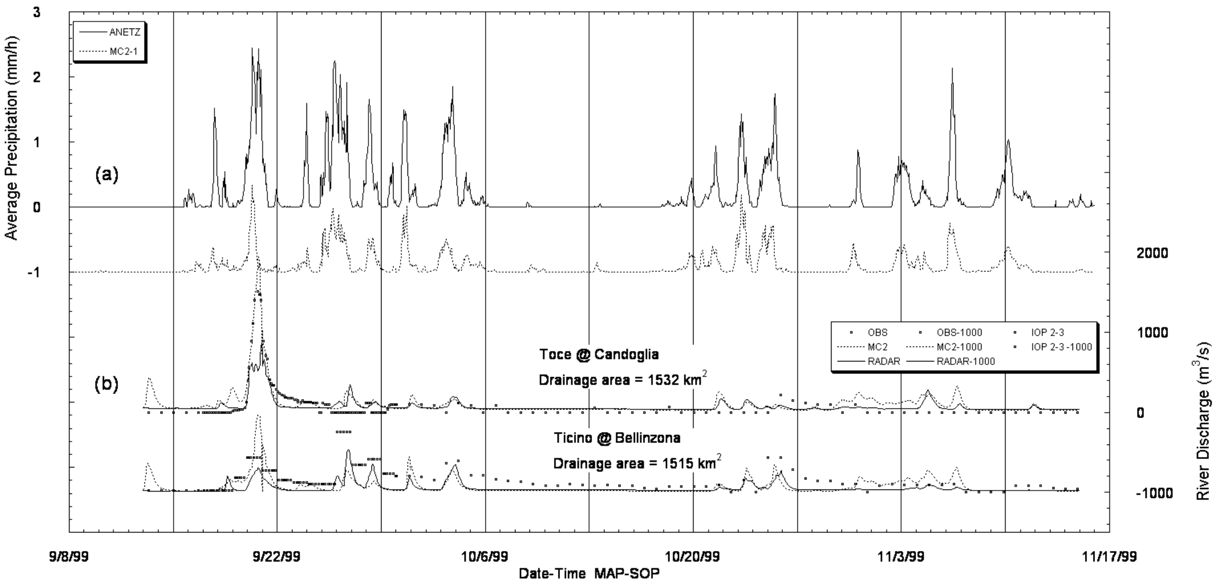

Figure 2, (a): Averaged hourly precipitation observed by the ANETZ stations and predicted by MC2-3km (shifted down by 1 mm/h on plot). (b): Observed and modelled streamflow for the MAP–SOP for the Toce and Ticino (shifted down by 1000 m^3/s) Rivers. One model driven by MC2 forecasts and the other, driven by radar observations (extracted from the Alpine radar composite imagery). Hydrometric observations shown at higher density during the wet episode of IOP 2-3 (17-29 September 1999).