ANALYSIS OF LOW-LEVEL JETS ASSOCIATED WITH IOP 2B CASE

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Abstract: The different methods of the numerical analysis of the small-scale features observed during MAP IOP cases are compared. The products from the MAP ECMWF Re-analysis are compared with the other analysis products. The properties of downscaling of MAP ECMWF Re-analysis to the meso-beta resolution are examined. The "blending initialisation method" developed under the ALADIN Project is applied as the initialisation technique. MAP IOP2 case has declared as the most intensive and complex event during MAP IOP period. The strong south flow intrusion into the Rhone valley on 20 September 1999 at 00 UTC has been measured by Lyon radiosonde. The tests describe how the analysis of low-level jet has been improved by the "blending initialisation method".

Keywords - *blending initialisation method, mid-latitude cyclone inducted low-level jet, ALADIN, ARPEGE, MAP ECMWF Re-analysis, MAP IOP2b*

1. INTRODUCTION

The meso-scale meteorological features could be analysed either by meso-scale data analysis or meso-scale features can be introduced into numerical weather prediction model initial state by some other techniques. Blending initialisation method provides the meso-scale type of analysis, by the combination of a global model data analysis initial state and the small-scale features that are introduced from the meso-scale model first-guess state. Low-level jets (LLJ) are an intensive but very topography dependant phenomena. The paper describes how the improved analysis of mid-latitude cyclone inducted LLJ could influence the advection of the humidity and distribution of precipitation during the MAP IOP2b case.

2. NUMERICAL ANALYSIS DATA AND BLENDING INITIALIZATION

The first requirement for the numerical analysis is to provide the realistic and stable initial condition for the numerical weather prediction models. Analysis is realistic if it describes the meteorological features that correspond to the resolution of the analysis. Thus the global model data assimilation (GM-DA) is not able to analyse a meso-scale meteorological features, while the downscaling of GM-DA products could, very often, create the artificial small-scale features that should be treated as the "noise" of the downscaling method. Here we describe the tests that have been performed on the products from two GM-DA data sets for MAP IOP2b:

a) ARPEGE 3D-Var DA data, from 1999, that has been operational during the MAP SOP campaign,
b) ECMWF MAP Re-analysis, from 2003, that has introduced the SOP extra measurements.

The blending initialisation by incremental digital filter (Brožkova at al., 2001) has been introduced at ALADIN project as the tool for the "meso-scale analysis without the measurements". The idea of the "Blending type" initialisation method relies on assumption that the analysis of the coupling numerical models provides the correct large scale waves, but the short wave features are artificial and leads to the unbalanced initial state. In order to provide the more correct small-scale features blending initialisation uses incremental digital filter, as the toll that filters out the artificial small-scale waves from GM-DA. Afterwards the large-scale waves from GM-DA are blended with the correct small-scale waves, coming from the meso-scale model first guess. The new blended initial state has been balanced by incremental digital filter, as well.

The experiments have been performed with ALADIN LAM model. At **test a** ARPEGE DA products have been down-scaled to the 9km mesh size, by dynamical adaptation technique and by the blending initialisation technique. At **test b**, coming from the fact that IFS model and ALADIN model have the different surface parameterisation, the prior relaxation of ECMWF Re-analysis data to the ARPEGE-ALADIN environment has been performed. Afterwards the relaxed ECMWF data have been downscaled to ALADIN/MFSTEP, 9.5km mesh size, by dynamical adaptation technique and blending initialisation technique.

3. MAP IOP2B LOW LEVEL JET OVER THE RHONE VALEY

In this paper we describe the influence of the blending initialisation method on the properties of cold front and associated forefront cyclone inducted low-level jet that entered the Alpine area on 20th of September 1999, on the second day of the MAP IOP 2b. The event is the most dominant MAP "wet" episode that brings the warm and the moist air from the Mediterranean sea to the Alps, lifted it up to the ridges of the Alpine area, and caused the heavy precipitation over the western and southern slopes of Alps.

ALADIN model run on 19th September 1999 predicted the occurrence of LLJ ahead of the cold front that passes over Rhone valley close to 00 UTC on 20th September 1999, as it is shown at time cross-section of forecasted horizontal wind fields for the prognostic period up to the +48 hours (Fig 1a). The time-cross section, that corresponds to the series of the radiosonding measurements for Lyon station gives us the real intensity of the LLJ event (Fig 1b).

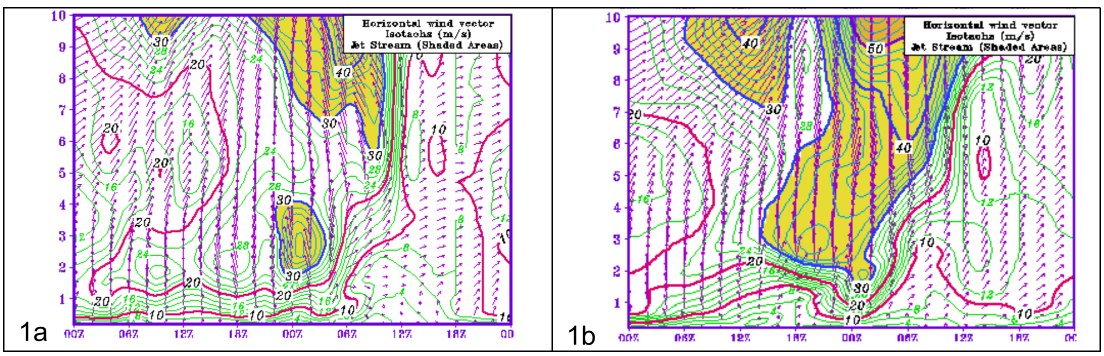

Figure 1. LLJ over Rhone valley, grid point Lyon, time cross–sections of horizontal wind:1a) ALADIN–start on 19.09.1999. 00 UTC; 1b) Time series from Lyon radiosondings 19.09. 00UTC - 21.09. 1999 00 UTC.

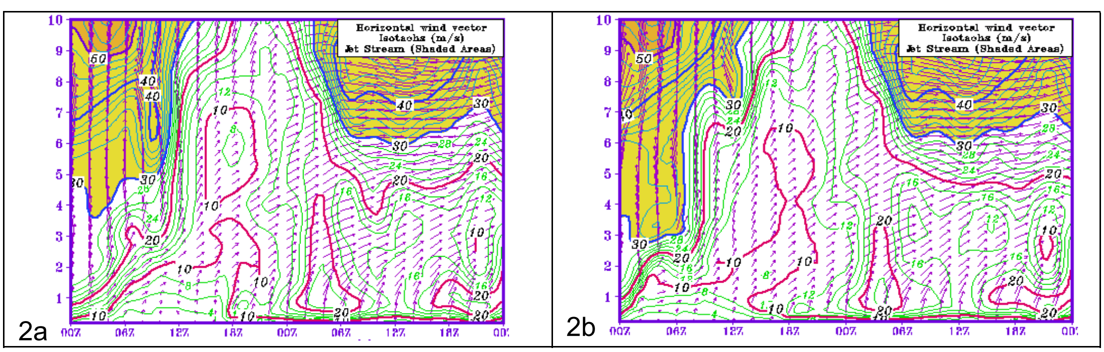

Figure 2. Low level jet over Rhone valley, grid point Lyon, time cross–sections of horizontal wind, the comparison of ALADIN forecast for 20th September 1999 00 UTC run: 2a) ALADIN based on dynamical adaptation initialisation; 2b) ALADIN based on **blending type of initialisation.**

The comparison of ALADIN forecast for 20th September 1999 00 UTC run. ALADIN forecast based on dynamical adaptation downscaling predicted the strong jet event over the mid troposphere, but the LLJ is not analysed and predicted within first few hours of model integration due to the lack of the analysis of the meso-scale features in the global model data assimilation (Fig 2a). The size of Rhone valley, where LLJ occurred, is too narrow to be properly described by the global models analysis. The blending type of initialisation that introduced the small-scale circulation via first guess of the previous run of ALADIN model is able to describe a realistic intensity and duration of LLJ (Fig. 2b).

The blending type of initialisation was able to improve the initial state of the wind circulation for the both experiments. At the blending initialisation, test a based on ARPEGE initial sate, LLJ entered the Rhone valley even at the 925 hPa model level, as it is shown at Figure 3. Moreover the deep LLJ over Genova bay enforced the advection of the moistures that rapidly transport the moist and warm air toward the North-east. The strength of LLJ enlarged the precipitation area at first 6 hours of integration at the slopes of Maritime Alps.

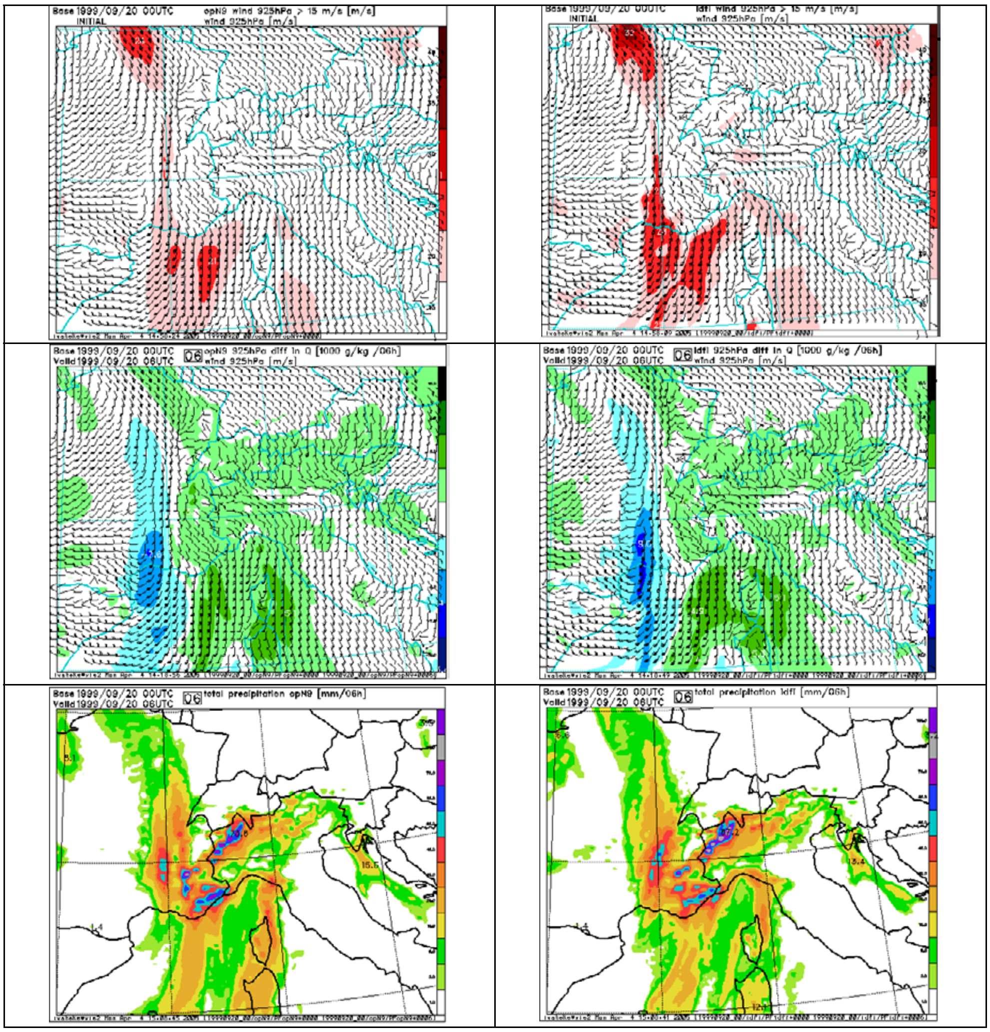

Figure 3: ALADIN initial conditions, based on ARPEGE 3D-Var initialisation, set-up from 1999 SOP period: Left side charts performed by dynamical adaptation initialisation, right side charts performed by blending type of initialisation. The first row: wind field at 925 hPa (wind bars) and LLJ intensities (dashed), second row: wind field at 925 hPa and advection of humidity in first 6 hours of integration (dashed), third row: the first 6 hours forecast of precipitation.

At the test b, with the ECMWF MAP re-analysis data, the blending type of initialisation brings the benefits at the 850 hPa level (Fig 4), where the LLJ is introduced. The flow pattern is the similar but the moist air is transported more toward the north. The stronger LLJ provides extra push of the warm and humid air and gives the fuel for occurrence of severe weather. At Fig 4 the difference between the participation fields over the Rhone valley is clearly noticed.

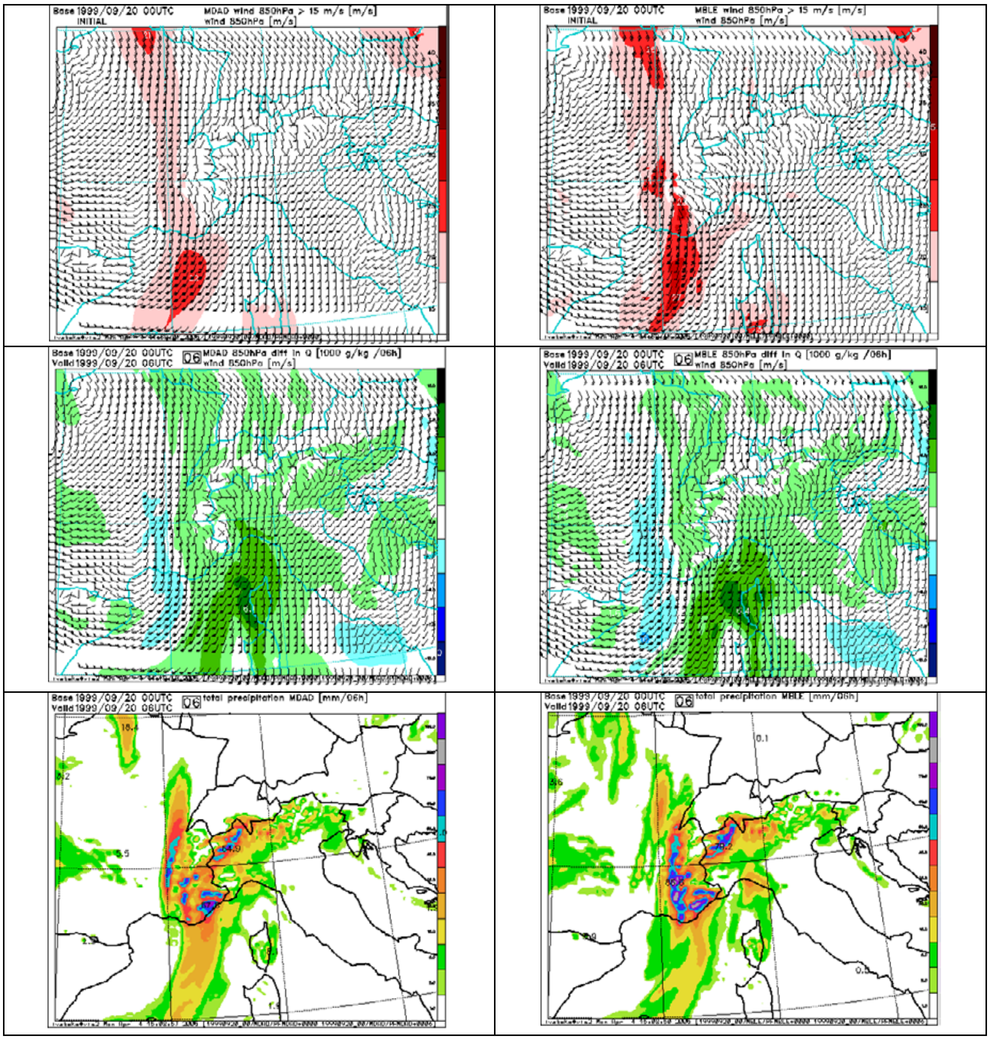

Figure 4: ALADIN initial conditions, based on MAP ECMWF Re-analysis: <u>Left side charts</u> dynamical adaptation initialisation, <u>right side charts</u> blending type of initialisation. The <u>first row</u>: wind field at 850 hPa (wind bars) and LLJ intensities (dashed), <u>second row</u>: wind field at 850 hPa and advection of humidity in first 6 hours of integration (dashed), <u>third row</u>: the first 6 hours forecast of precipitation.

4. CONCLUSION

The proper analysis of LLJ has the significant role in the numerical meso-scale predictions. The realistic LLJ flow pattern could improve the way in which LAM predicts the distribution of precipitation in the first few hours of model integrations. At the both tests, blending type of initialisation of meso-scale features brings the benefit in the analysis of LLJ. The blending initialisation techniques are already introduced into several ALADIN operational applications.

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