REPORT

Coupling frequency – two time nesting

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Introduction

The horizontal domain of ALADIN can be divided in three zones as it is shown in Figure 1 Central zone (C) - region of meteorological interest, Intermediate zone (I) - the Coupling zone and Extension zone (E) - bi-periodic fields.
Central zone noted C, represents the region of meteorological interest, where the forecast is fully adapted to small-scale conditions.
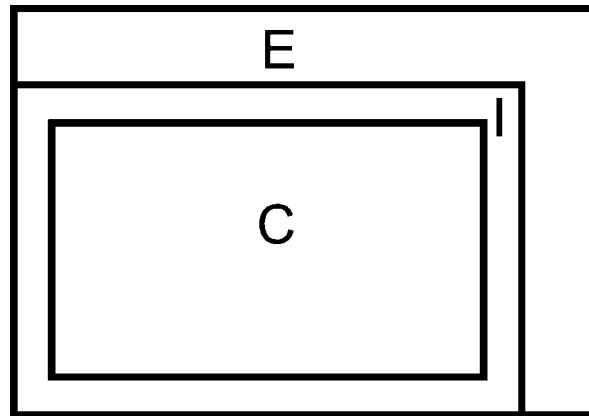

Figure 1   Zones in ALADIN

Any limited area model needs information about the state of the atmosphere outside of its integration domain. In order to solve this difficulty, one defines an Intermediate zone (Coupling) I where a large-scale solution computed with the ALADIN on LACE domain (12.2 km) is mixed with the solution resulting from the ALADIN integration (8 km). Smaller scale LAM uses large-scale solution only from I zone and only for the coupling date (usually only every 6 or 3 hours).
The use of spectral methods imposes for the fields similar boundary condition to those characterising the basis of function used for expansions i.e. the field must be periodic in the x and in the y directions (bi-periodic). An artificial zone, Extension zone E is defined like an outer belt only for this previously mentioned mathematical reason. Its size is chosen to avoid too sharp slopes at the boundaries of the domain.

Experiment with 1D model

Problem: fast cyclone enters LAM domain between coupling times and is not recognised by grid point (Davies) coupling. The cyclone propagates with very high velocity. On following Figures results from 1-D model experiments of Davies coupling are shown. On a left hand side results from coupling with 1 hour coupling frequencies are shown, and on a right hand side results from 3 hours coupling frequencies.
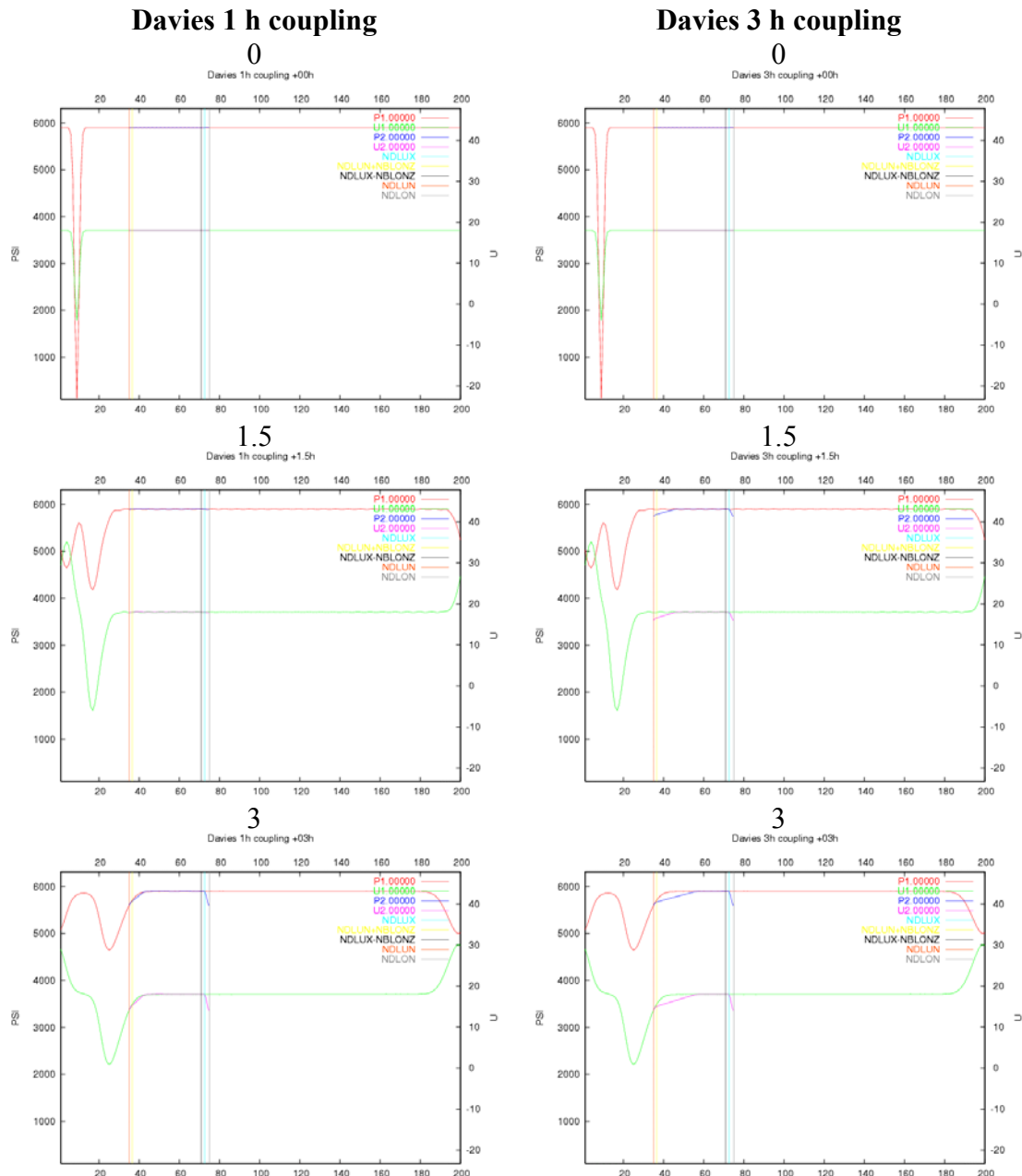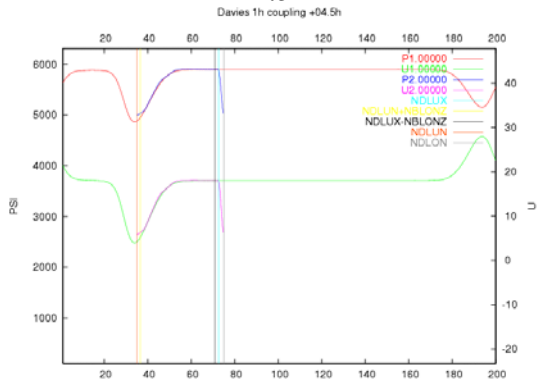
Davies 1 h coupling **Davies 3 h coupling**

Figure 2   Pressure and wind speed in driving model and coupled model for 1 hour and 3 hours coupling frequencies for forecast hours 0, 1.5 and 3
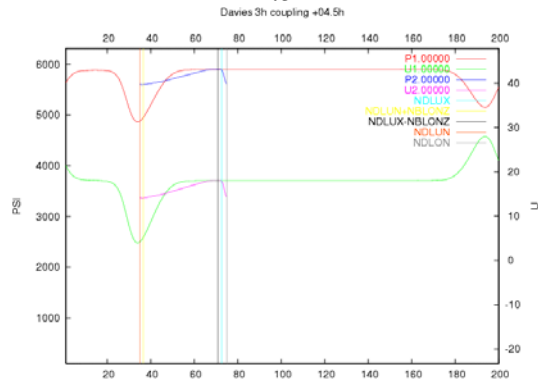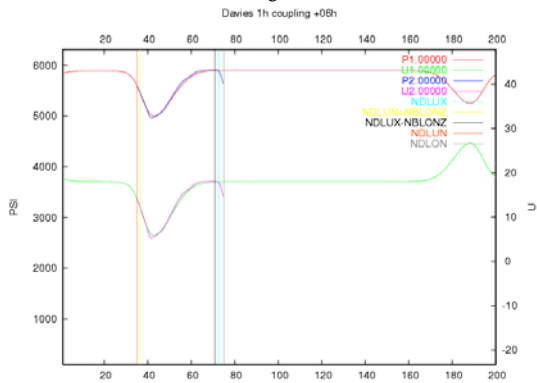
Davies 1 h coupling
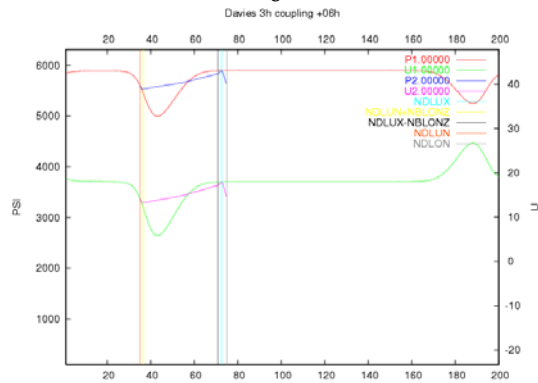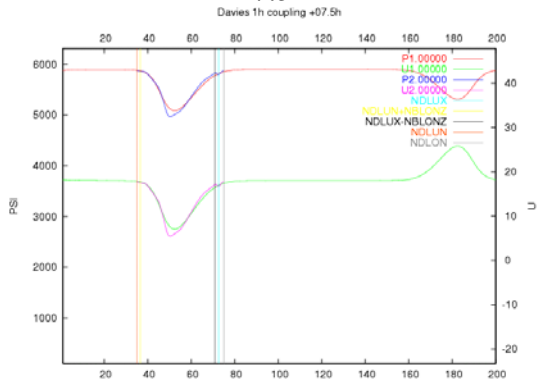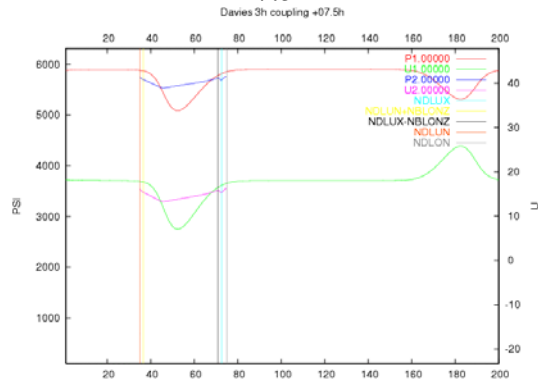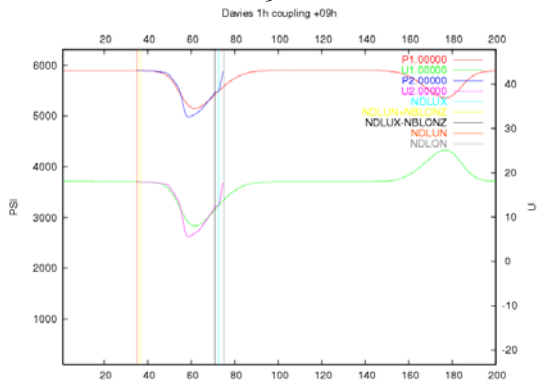
4.5

6

7.5

9

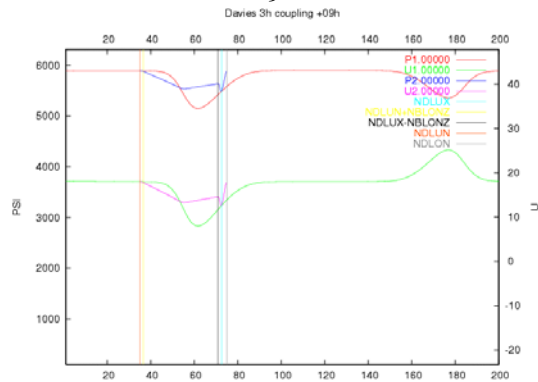**Davies 3 h coupling**

4.5

6

7.5

9

Figure 3   Pressure and wind speed in driving model and coupled model for 1 hour
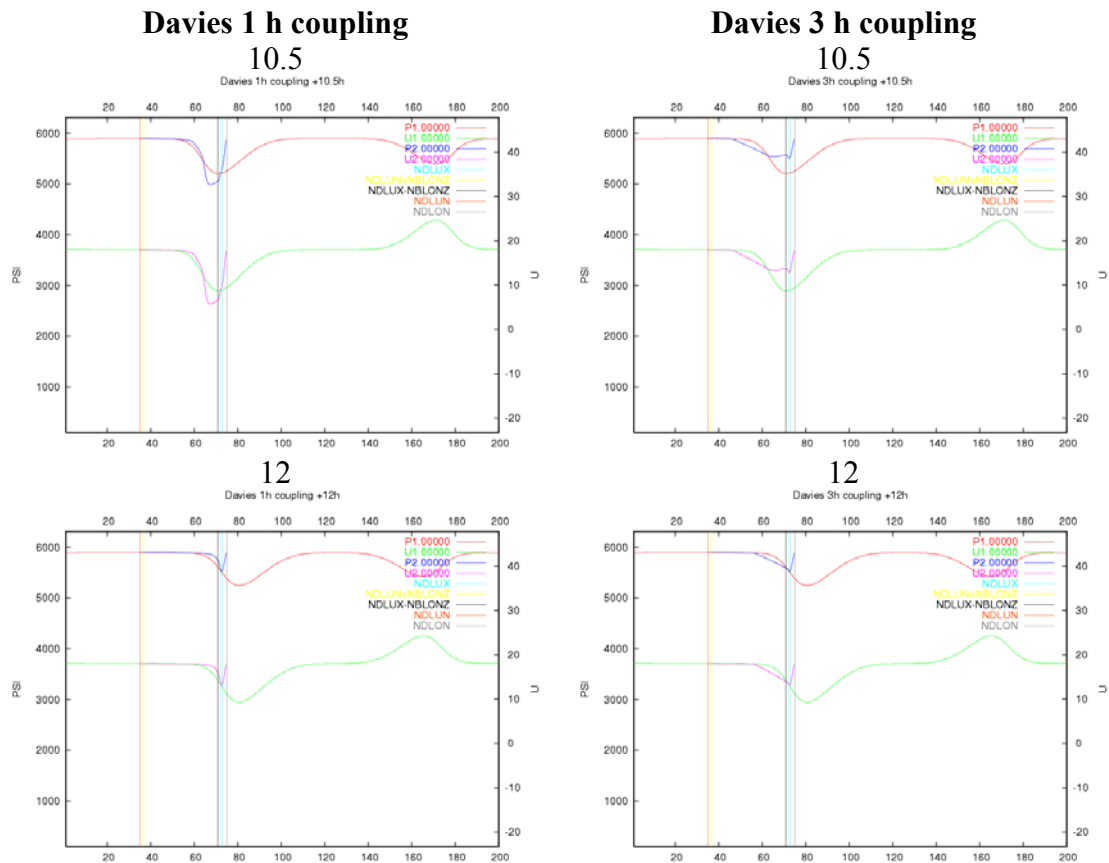and 3 hours coupling frequencies for forecast hours 4.5, 6, 7.5 and 9

Figure 4   Pressure and wind speed in driving model and coupled model for 1 hour and 3 hours coupling frequencies for forecast hours 10.5 and 12

In the 3 hour coupling experiment, cyclone is already in the domain for 1.5 hour forecast, while it should enter later, as it does in the 1 hour coupling experiment. Later, the cyclone in the 4.5 hour forecast is not deep enough and the wind speed is wrong. 1 hour coupling experiment exhibits only a small problem after 10.5 hour forecast when cyclone exits the domain, near the extension zone. In 1D model, cyclone is much better forecasted with 1 hour coupling experiment. That was a reason to start with testing of 1 hour coupling in 3-D ALADIN.

Model version and domains

Experiment was performed on operational Croatian domain with 8-km resolution. Driving model was ALADIN on LACE domain. Orography in LACE domain with borders of coupling zone in Croatian domain is shown bellow.
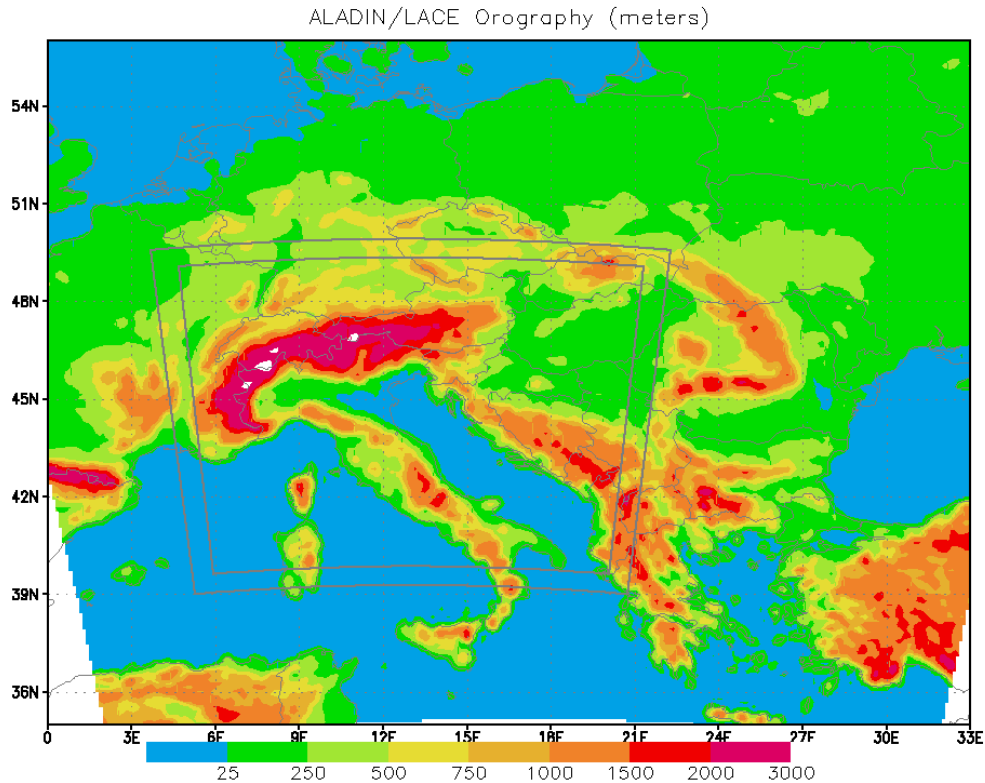

Figure 5   Orography in LACE domain and borders of coupling zone in Croatian domain

For all experiments operational version AL25T1_op2 was used.

Chosen dates for experiments

7 experiments for cases in the year 2003 were performed: February 4th, August 26th & 27th, September 2nd and October 5th, 14th & 15th 2003.

The difference in forecasted MSL Pressure between experiments with different coupling frequencies is usually less than 0.5 hPa. Cases with the difference larger than 0.5 hPa are February 4th and October 5th.
Results of experiments for those two days will be presented.

Case 4th February 2003 00 UTC run

During the 4th and 5th of February, cyclone is moving over Adriatic Sea and a few cyclones are moving near the right border of the domain. Absolute differences are highest over Adriatic Sea and Bosnia, more than 3 hPa.

MSL Pressure [2 hPa]

diff MSL Pressure 1h –3h coupl. [hPa]
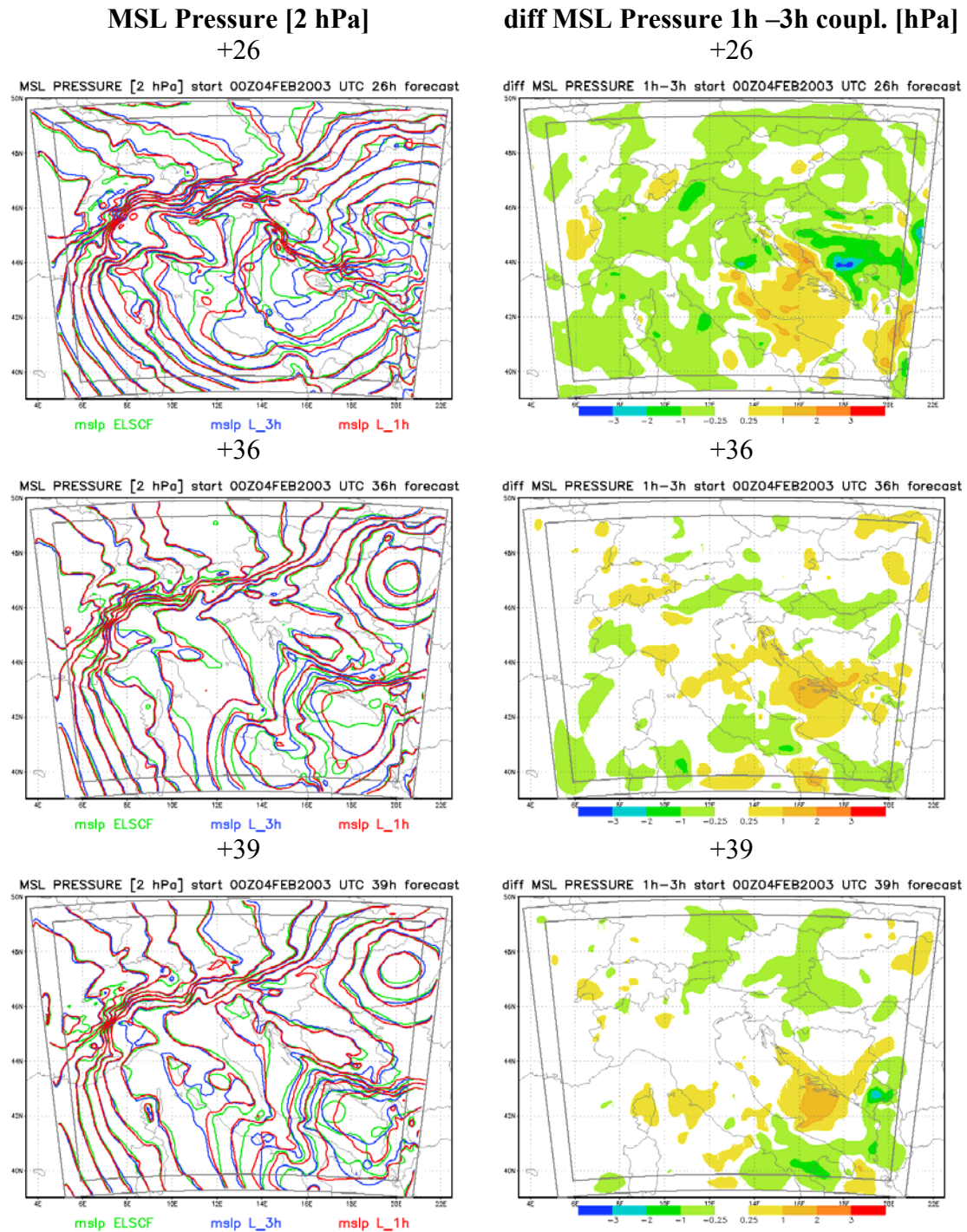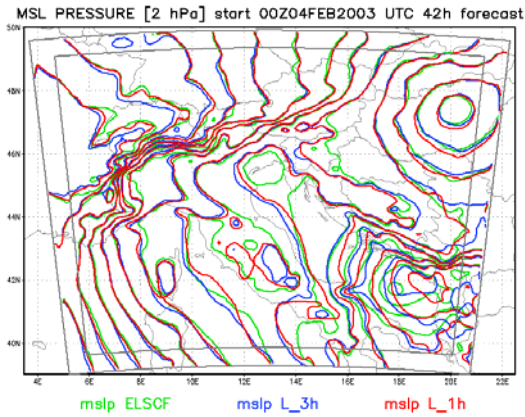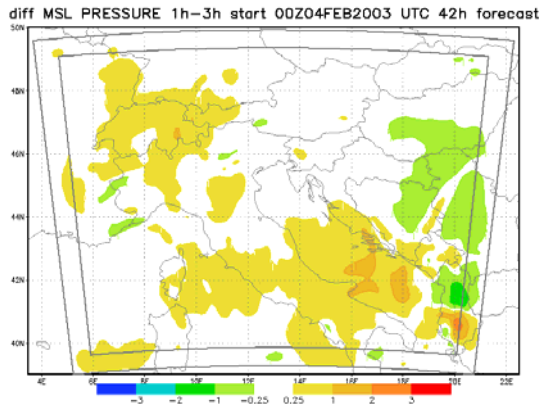
+26

+26

+36

+36

+39

+39

Figure 6   On a left-hand side: MSL Pressure interpolated from coupling files, MSL Pressure for 1 hour and 3 hours coupling frequencies, on a right-hand side: difference in MSL Pressure for 1 hour and 3 hours coupling frequencies, for 26, 36 and 39 hours forecasts
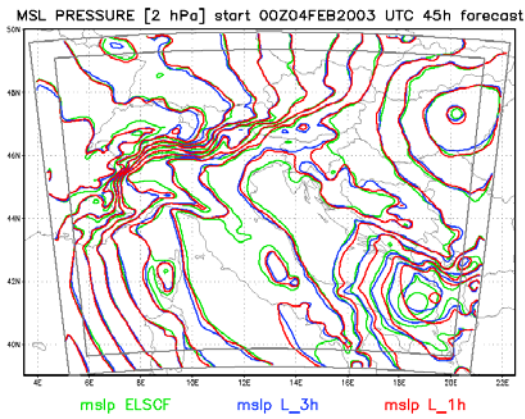
MSL Pressure [2 hPa]   **diff MSL Pressure 1h –3h coupl. [hPa]**
+42   +42
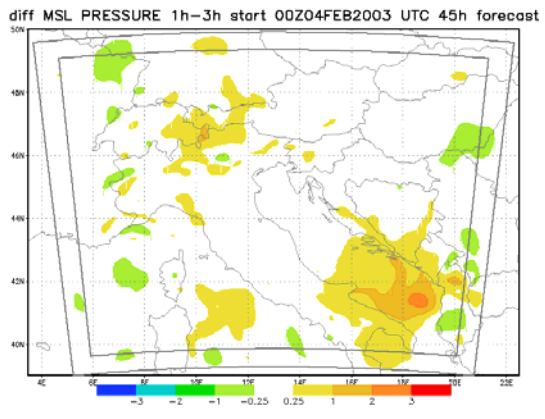

+45   +45

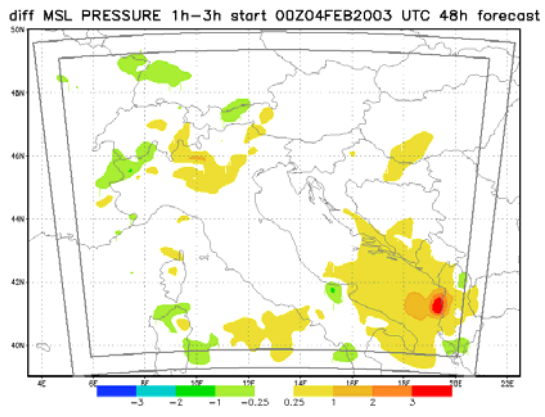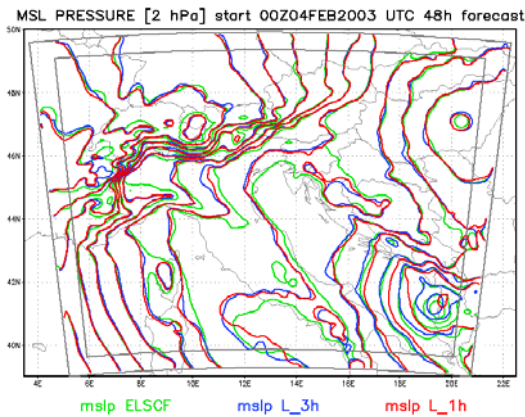+48   +48

Figure 7   On a left-hand side: MSL Pressure interpolated from coupling files, MSL Pressure for 1 hour and 3 hours coupling frequencies, on a right-hand side: difference in MSL Pressure for 1 hour and 3 hours coupling frequencies, for 42, 45 and 48 hours forecasts

MSL Pressure data from Croatian SINOP station are compared with model data. Just that data are compared because data over Bosnia are not available.
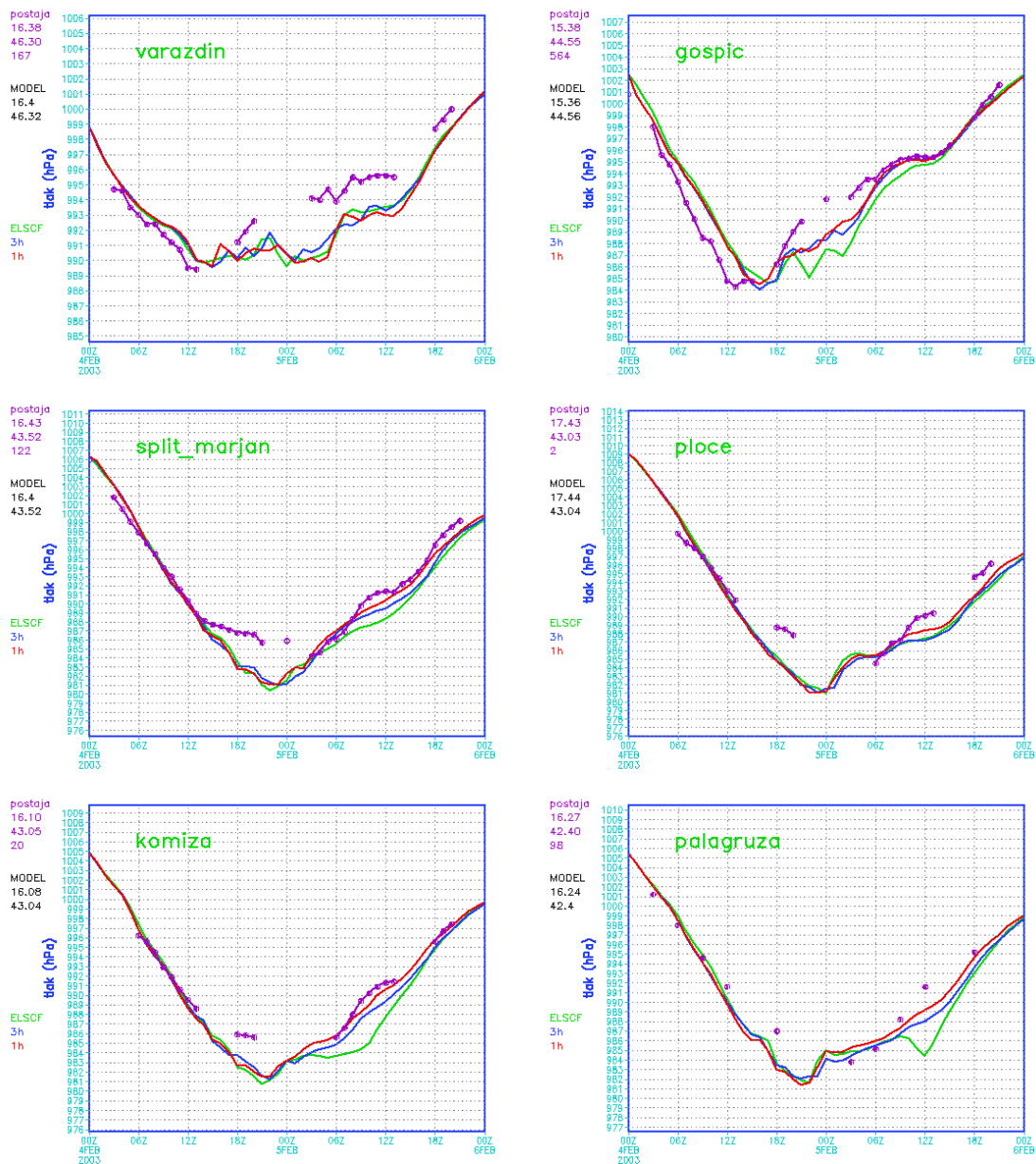

Figure 8   Comparison of SINOP data with coupling data and forecasts with different coupling frequencies, for 4 points in Croatia: Varaždin, Gospić, Split, Ploče, Komiža and Palagruža

In inland, Varaždin and Gospić, ALADIN with 8-km resolution for 1 and 3 hours coupling frequencies gives much better results than 12-km resolution. It is valid for coastal part to. For points on islands, Komiža and Palagruža, it look likes that 1hour coupling frequencies is the best one for this situation.

Case 5th October 2003 00 UTC run

Again a cyclone moves over the Adriatic Sea, but there is some impact inland too.

MSL Pressure [2 hPa]
+24

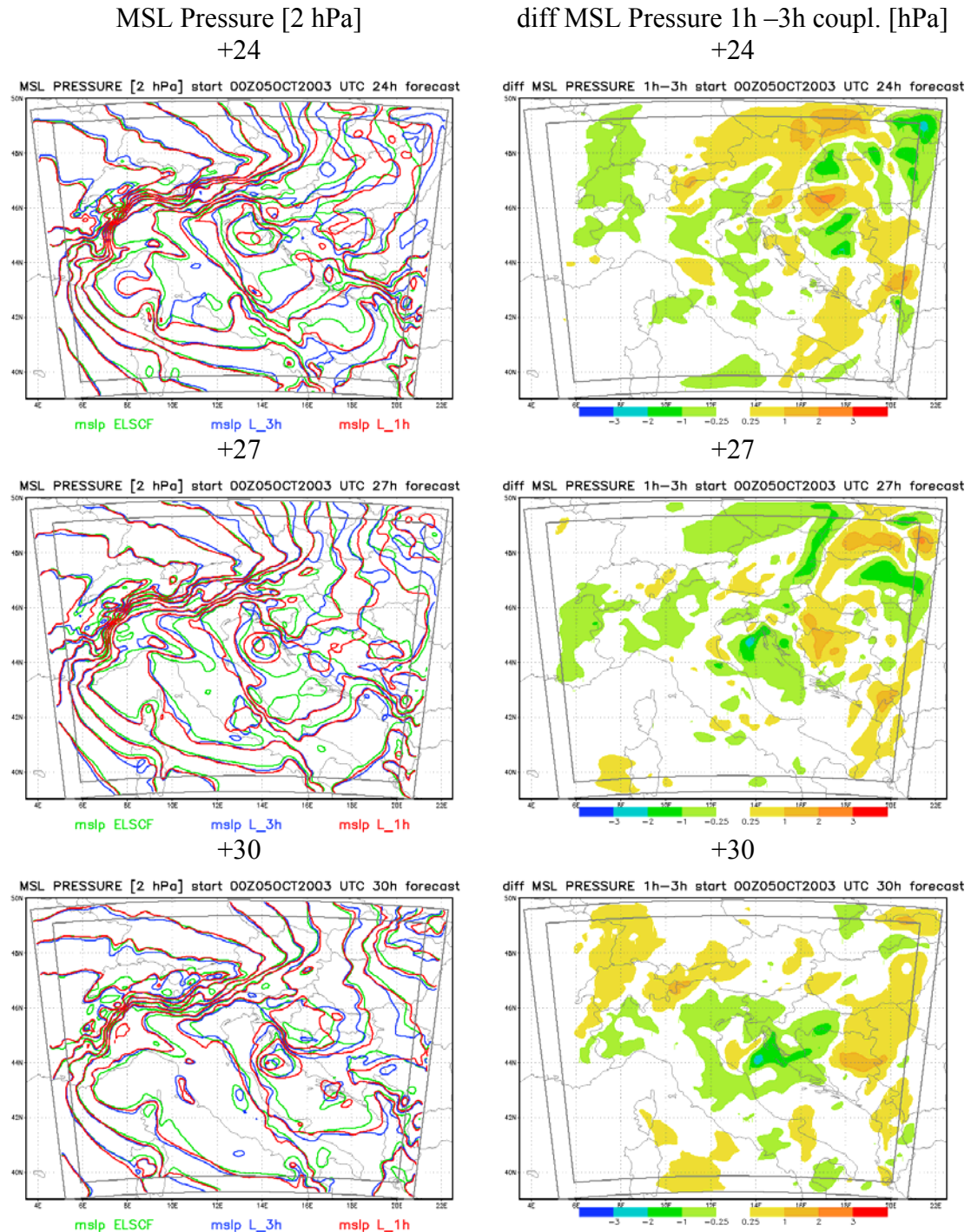diff MSL Pressure 1h –3h coupl. [hPa]
+24

Figure 9   On a left-hand side: MSL Pressure interpolated from coupling files, MSL Pressure for 1 hour and 3 hours coupling frequencies, on a right-hand side: difference in MSL Pressure for 1 hour and 3 hours coupling frequencies, for 24, 27 and 30 hours forecasts

MSL Pressure [2 hPa]

diff MSL Pressure 1h –3h coupl. [hPa]
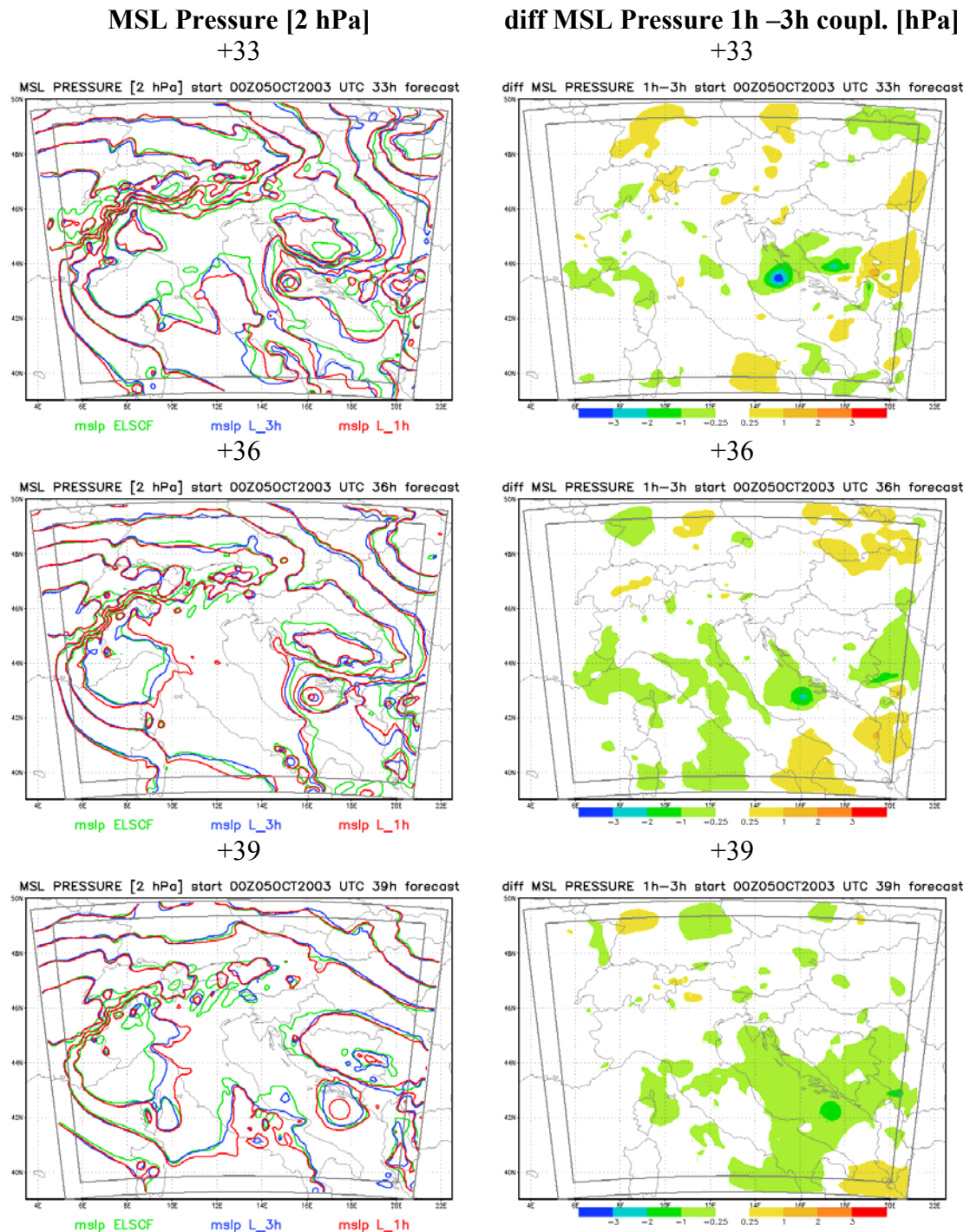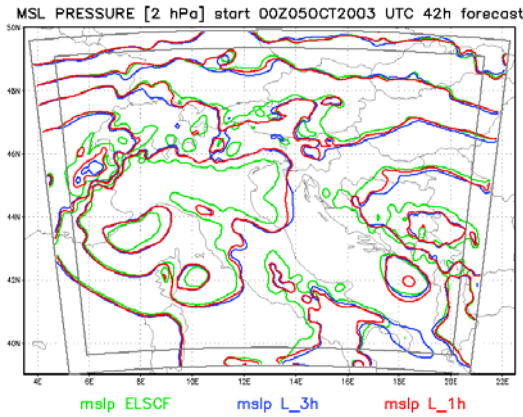
+33

+36

+39

Figure 10   On a left-hand side: MSL Pressure interpolated from coupling files, MSL Pressure for 1 hour and 3 hours coupling frequencies, on a right-hand side: difference in MSL Pressure for 1 hour and 3 hours coupling frequencies, for 33, 36 and 39 hours forecasts

MSL Pressure [2 hPa]   diff MSL Pressure 1h −3h coupling [hPa]
+42   +42

+45   +45

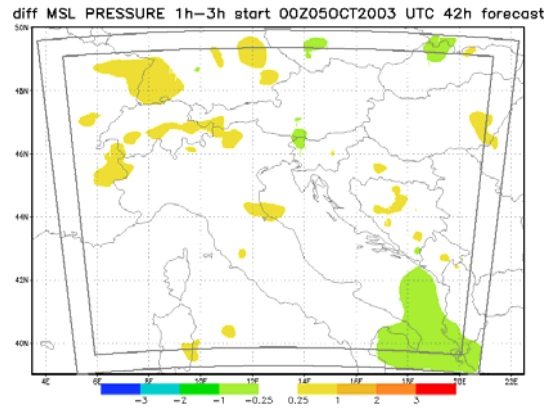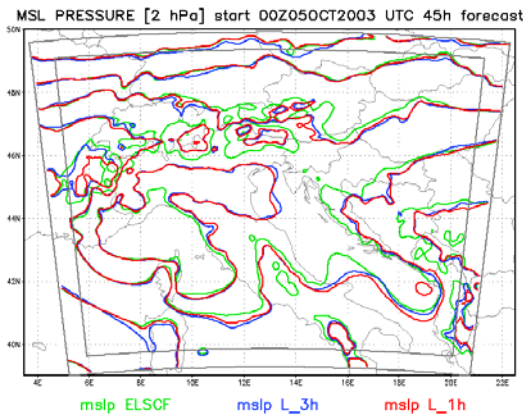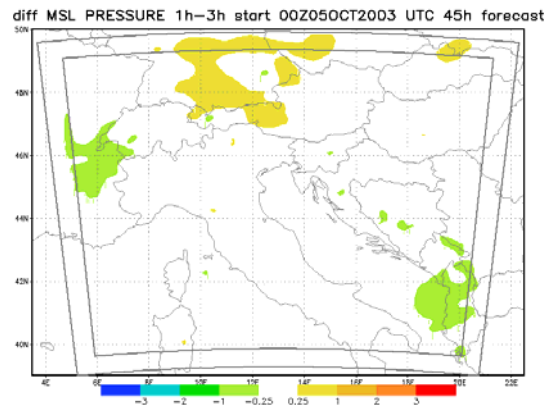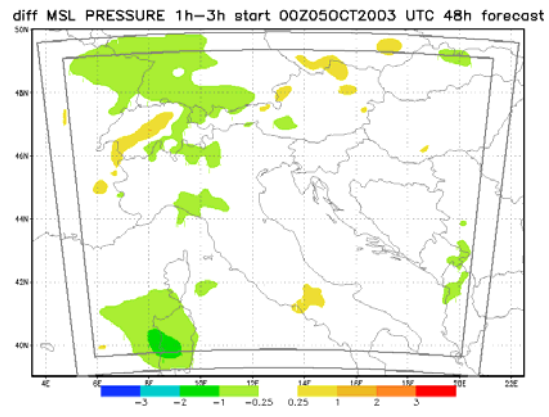
+48   +48
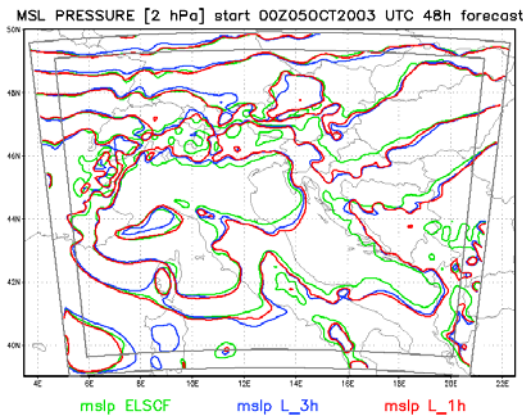

Figure 11   On a left-hand side: MSL Pressure interpolated from coupling files, MSL
Pressure for 1 hour and 3 hours coupling frequencies, on a right-hand
side: difference in MSL Pressure for 1 hour and 3 hours coupling
frequencies, for 42, 45 and 48 hours forecasts

Inland absolute differences are smaller than on Adriatic Sea. Differences are highest
above Adriatic Sea for 33 hours forecast.

Comparison of 33 hours forecasts MSL Pressure is shown on following figures.

1h coupling mspl=1004.31 hPa

3h coupling mslp=1006.85 hPa

ELSCF mslp=1007.29 hPa
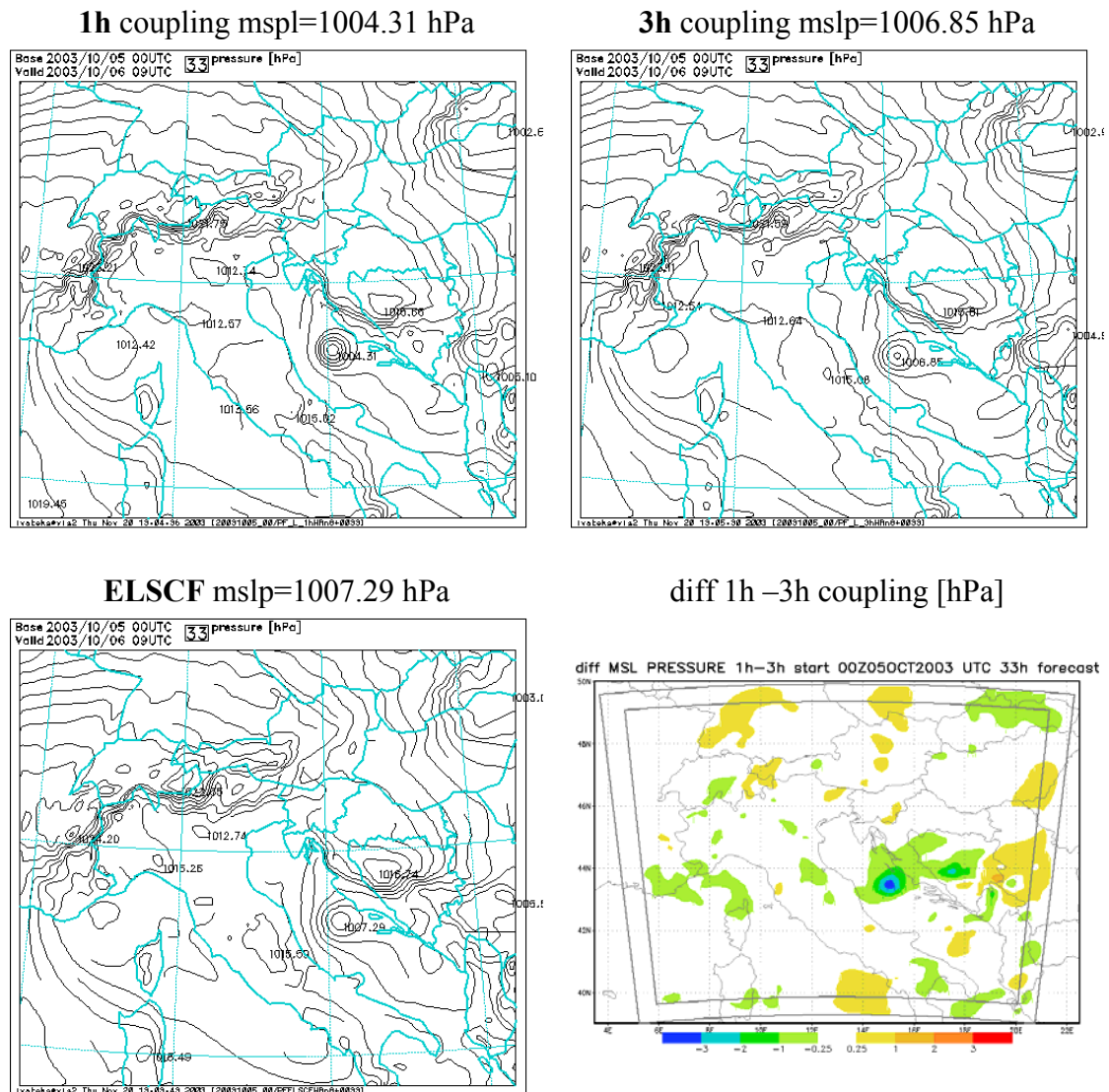

diff 1h –3h coupling [hPa]

Figure 12   MSL Pressure for 1 hour, 3 hours coupling frequencies and from coupling files and difference in MSL Pressure for 1 hour and 3 hours coupling frequencies, for 33 hours forecast

It looks like one more case of Adriatic storm, but this time cyclone was deeper for 1 hour coupling frequency experiment. Next day, cyclone was not forecasted, as it usually was for Adriatic storm cases. For this case, cyclone is deeper for higher resolution run.
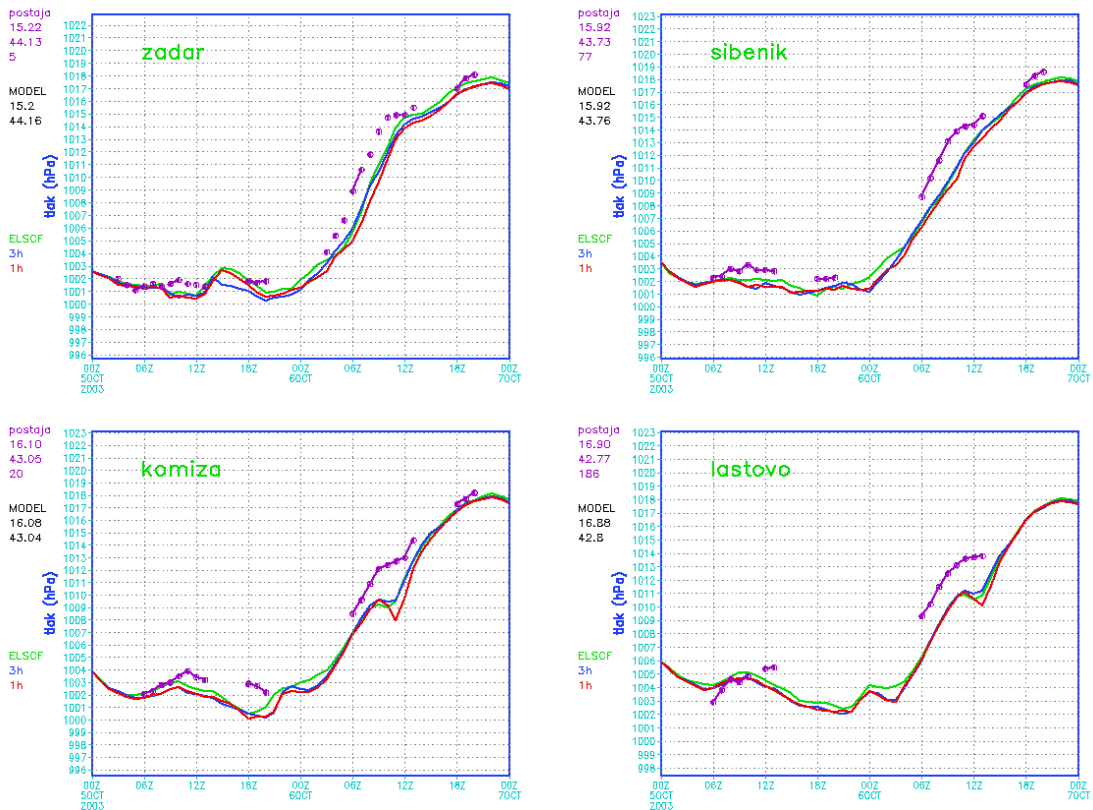
Figure 13   Comparison of SINOP data with coupling data and forecasts with different coupling frequencies, for 4 points in Croatia: Zadar, Šibenik, Komiža and Lastovo
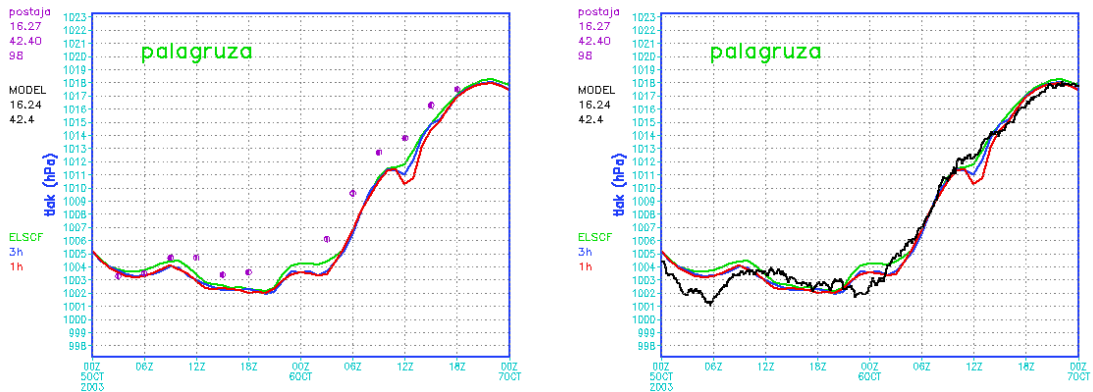

Figure 14   Comparison of SINOP data and data from automatic measurement station with coupling data and forecasts with different coupling frequencies, for Palagruža

On island stations; Komiža, Lastovo and Palagruža, 1 hour coupling low exists around 36 hours forecast. For 3 hours coupling frequency, MSL Pressure low does not exist or is less deep.

On Figure 14 comparison with SINOP data and 10-min average from automatic measurement station is shown. Low in MSL Pressure doesn't exist on this station.

Conclusion

Different coupling frequencies produce different Mean Sea level pressure. Absolute difference is usually less than 0.5 hPa. Largest differences were observed above the Adriatic Sea, sometimes more than 3 hPa.

Maybe it is not clear from this experiment, but for sure it is better to use 1 hour coupling frequency, perturbations from bigger domain are imported in smaller domain, what is not a case with 3 hours coupling frequency.