Precipitation Forecast of the Z-Coordinate vs. the Terrain Following Version of LM over Greece

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1 Introduction

The Z-coordinate version (LM_Z) of LM (Refs. Steppeler, 2002, and others) was validated in a previous work (Ref. Avgoustoglou, 2006) against the standard terrain following version (LM_TF) for cloud cover and precipitation regarding moderate frontal activity over Greece. Motivated by the resulting preponderance of LM_Z over LM_TF in reference to observations and satellite pictures as well as the need to test a newer version of the LM_Z code, we considered another case with significantly stronger precipitation events in order to check the extent that this preponderance persists.

2 Case Study

The geographical domain of Greece is characterized by an almost equipartitioned land-sea mask interchange combined with a complex orography and a large number of mountainous islands providing a challenging candidate towards the relative evaluation of LM_Z against the terrain following coordinates operational version (LM_TF). In this study, the frontal development during the three day period of the 17^{th}, 18^{th}, and 19^{th} of November 2005 is investigated. From the synoptic analysis as well as the satellite pictures (Fig. 1), it can be seen that on November the 17^{th}, low pressures in the Adriatic and the North Balkans extended Southwards were associated with the relatively high pressures over Turkey. A barometric low associated with a cold front along West Greece was moving Eastwards leading to significant precipitation events over the country as well as strong to gale winds over Eastern Greece. This activity was paled down on November 18 but it was followed by a new frontal activity associated with low barometric pressures over North Italy and North Aegean Sea that affected Greece on November the 19^{th}. In relevance to our previous work (Ref. Avgoustoglou, 2006), the precipitation observations were overall significantly higher. Consequently, any important difference in the forecasted precipitation between LM_Z and LM_TF could be of interest from the operational standpoint.

In Figs. 2, 3, 4, we show the relative forecasted low, medium and total cloud cover for LM_TF and LM_Z respectively. We used boundary conditions from the Global Model of the German Meteorological Service (DWD) with analysis of 00 UTC for every date under consideration. Even though, the total cloud cover forecasted by LM_Z looks closer to the satellite pictures of Fig. 1, the agreement between the two versions of LM looks satisfactory.

However, there are rather significant differences between the forecasted low and medium cloud cover. This feature looks consistent with Fig. 5 where the 12-hour forecasted accumulated precipitation in LM_Z is overall downgraded and less dispersed in reference to LM_TF, particularly over the sea surface. Regarding observation, the measured values of the 12-hour accumulated precipitation over the local meteorological stations were compared to the forecasted values of the nearest grid point. By summing these values, it was found that the total forecasted precipitation for LM_Z was closer to the total precipitation measured (Table 1).

In Fig. 6, we depict with “R” the positions of the meteorological stations where the observed value for the precipitation was closer to LM_TF and with “Z” when this value was closer to LM_Z. The bullet sign corresponds to stations where precipitation was neither observed nor predicted by any version of LM. Within this context, it may be seen again that the forecasted values from LM_Z are relatively closer to observation.

	November 17 57 Stations	November 18 55 Stations	November 19 55 Stations
Observed: Total	615.4	26.0	358.1
Average	10.80	0.47	6.51
LM_TF: Total	1024.5	588.5	788.8
Average	17.97	10.7	14.34
LM_Z: Total	632.5	65.6	487.8
Average	11.10	1.19	8.87

Table 1: Total and average observed and forecasted precipitation height (mm)

3 Summary and Outlook

For the test case under consideration, LM_Z forecast shows relative preponderance over LM for the 12-hour accumulated precipitation as was the case in our previous work (Ref. Avgoustoglou, 2006). It should be noted, that a later version of LM_Z code was used. Indications are rising that LM_Z might be an important tool towards the forecast of quantitative precipitation. It might be worth to run the code in parallel with the operational LM for a continuous period of time in order to address its validity on a systematic fashion.

References

Steppeler J., H.-W. Bitzer, M. Minotte, L. Bonaventura, 2002: Nonhydrostatic Atmospheric Modeling using a z-Coordinate Representation. *Mon. Wea. Rev.*, **130**, 2143-2149.

Bitzer, H.-W., J. Steppeler, 2002: A Description of the Z-Coordinate Dynamical Core of LM. *COSMO Technical Report*, No. 6, Deutscher Wetterdienst (DWD), Offenbach.

Steppeler J., H.-W. Bitzer, 2002: The Z-Coordinate Version of the LM. *COSMO Newsletter*, No. 2, 111-112.

Steppeler J., H.-W. Bitzer and U. Schättler, 2003: New Developments Concerning the Z-Coordinate Version of the LM. *COSMO Newsletter*, No. 3, 177-178.

Steppeler, J., Z. Janjic, H.-W. Bitzer, P. Prohl and U. Schättler, 2004: The Z-Coordinate LM. *COSMO Newsletter*, No. 4, 151-154.

Steppeler, J., H.-W. Bitzer, Z. Janjic, U. Schättler, P. Prohl, J. Parfiniewicz, U. Damrath and E. Avgoustoglou, 2005: A Z-Coordinate Version of the Nonhydrostatic Model LM. *COSMO Newsletter*, No. 5, 149-150.

Steppeler, J., H.-W. Bitzer, Z. Janjic, U. Schättler, P. Prohl, U. Gjertsen, J. Parfiniewicz, L. Torrisi, E. Avgoustoglou, U. Damrath, 2006: Prediction of Clouds and Rain Using a z-Coordinate Nonhydrostatic Model. *Mon. Wea. Rev.* **134**, 3625-3643.

Avgoustoglou, E., T. Tzeferi, V. Tirli, I. Papageorgiou: Application of the Z-Coordinate Version vs. Terrain Following Version of LM Nonhydrostatic Model over Greece. *COSMO Newsletter*, No. 6, 74-80.

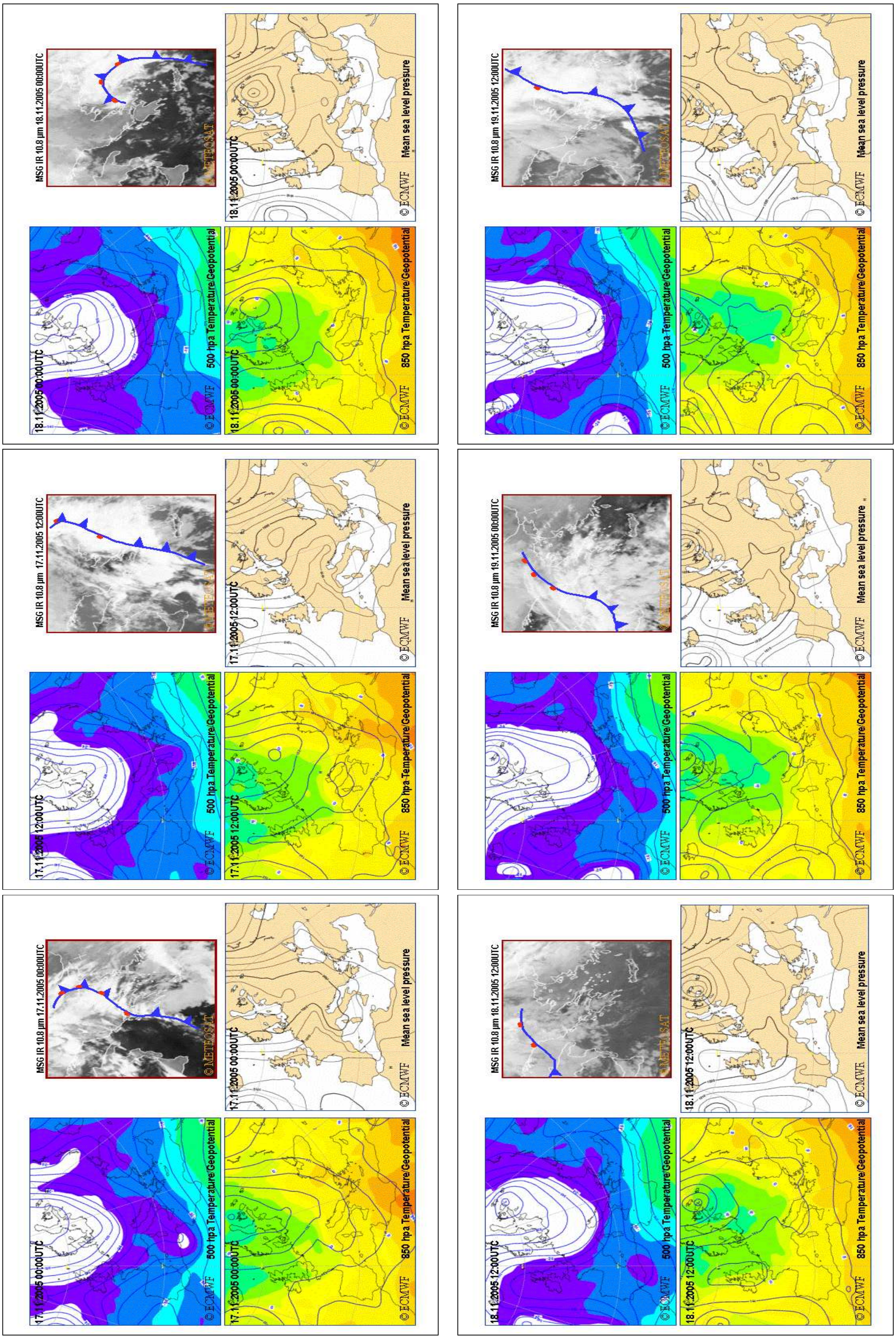

Figure 1: Satelite pictures and analysis charts for 17, 18 and 19 of November 2005.

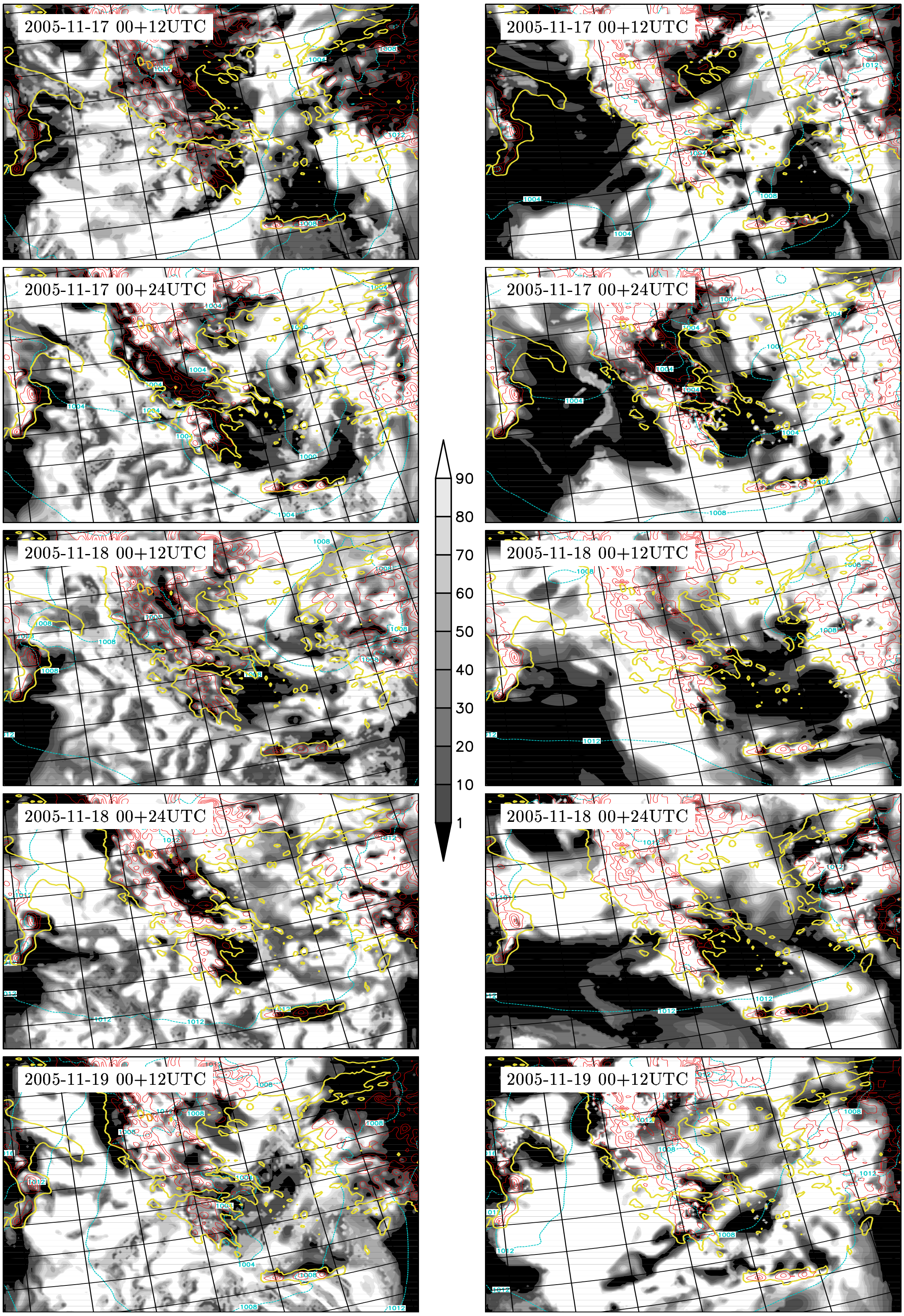

Figure 2: Low cloud cover forecast (%) and PMSL (HPa) from LM_TF (left column) and LM_Z (right column).

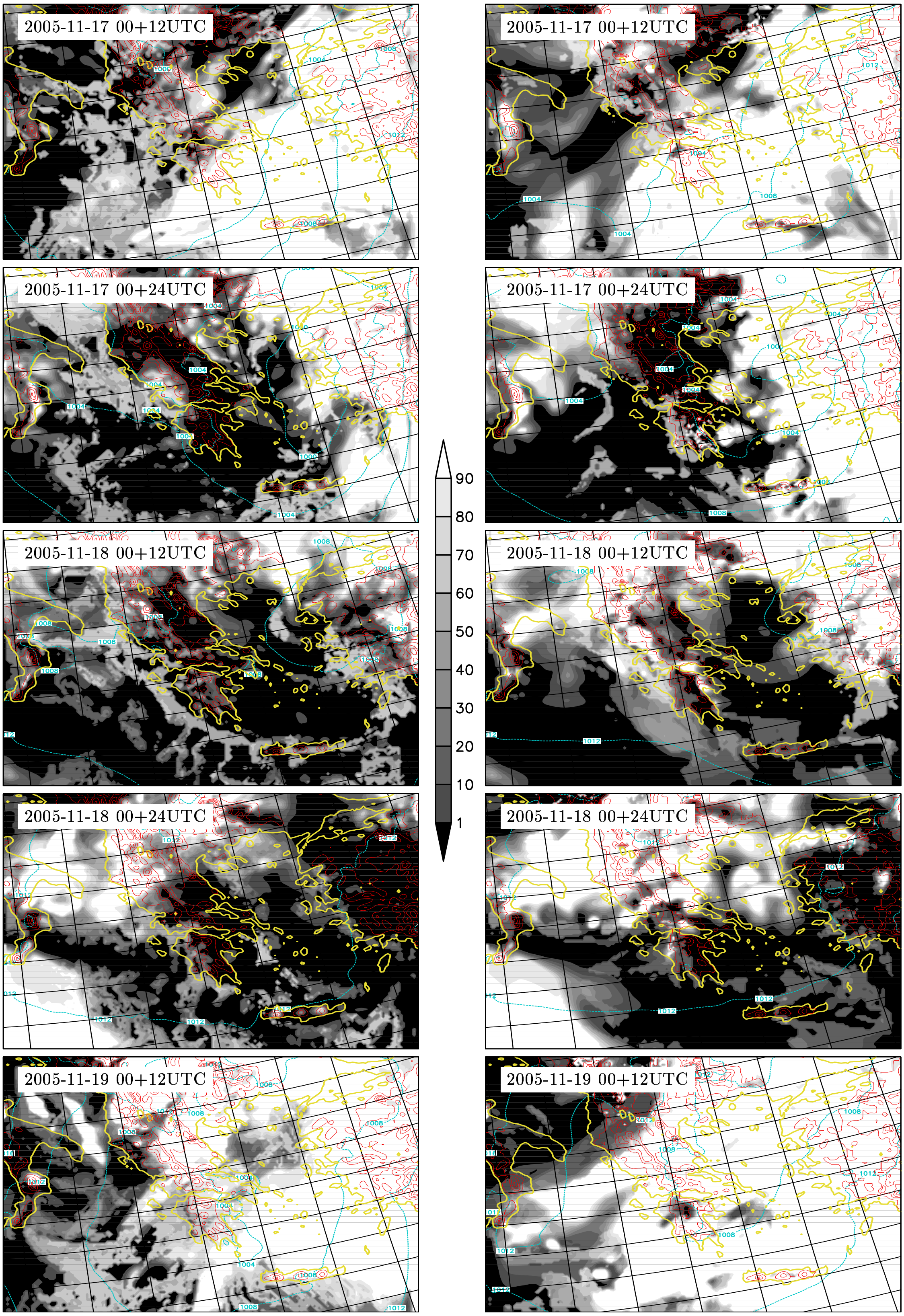

Figure 3: Medium cloud cover forecast (%) and PMSL (HPa) from LM_TF (left column) and LM_Z (right column).

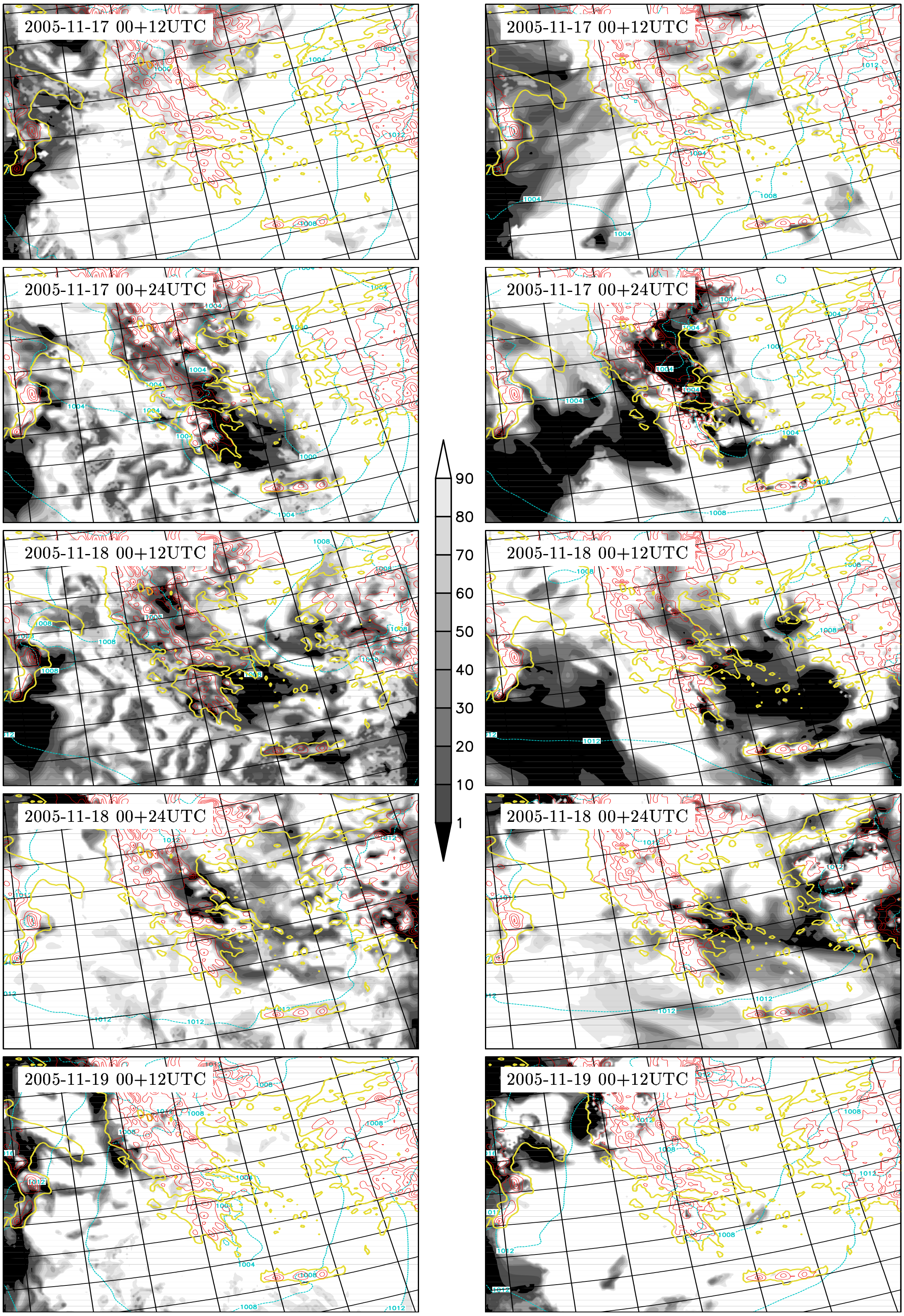

Figure 4: Total cloud cover forecast (%) and PMSL (HPa) from LM_TF (left column) and LM_Z (right column).

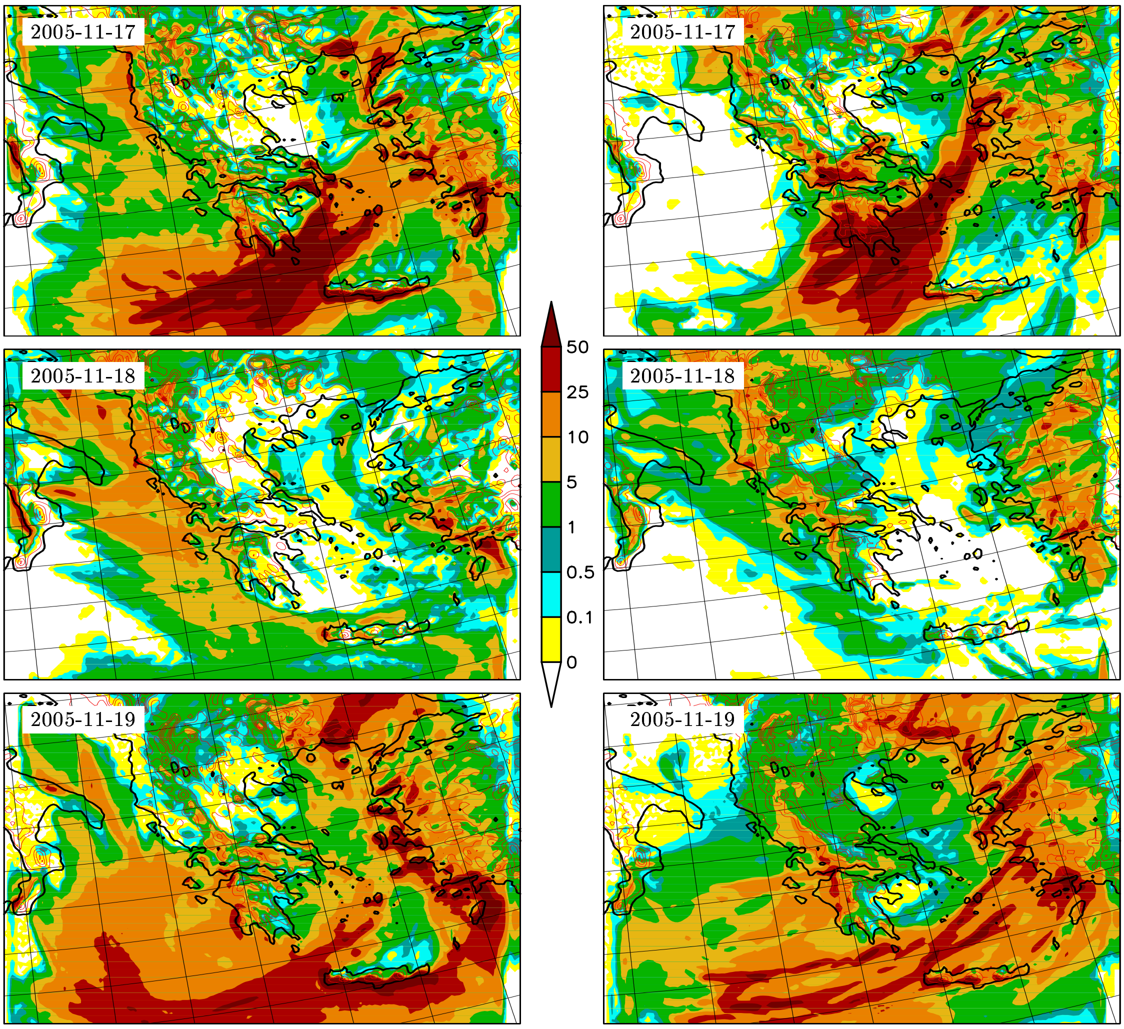

Figure 5: 12-hour accumulated precipitation (mm) from LM_TF (left column) and LM_Z (right column).

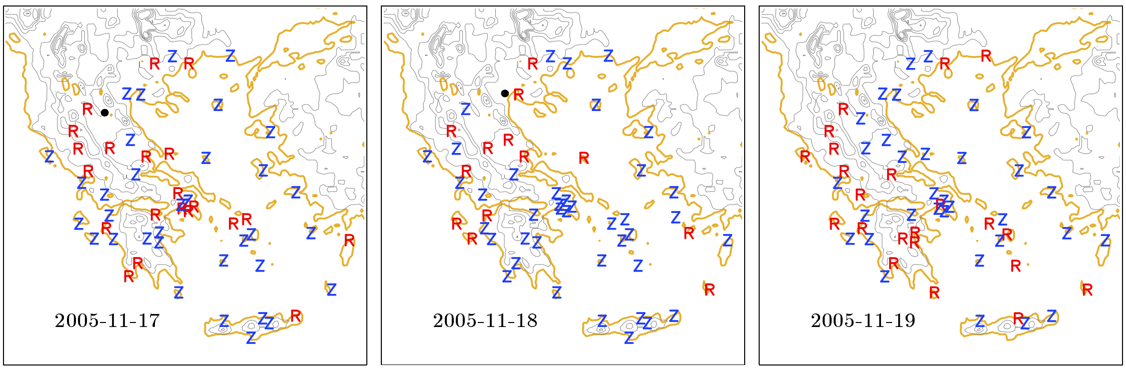

Figure 6: Represantation of the positions of the meteorological stations in reference to the relation of measured against the 12-hour accumulated precipitation; "R" and "Z" stand for stations where LM_TF and LM_Z forecast was closer to observation respectively. The "bullet" sign stands for stations where no precipitation was observed or forecasted by any version of LM.