RESEARCH DEPARTMENT
MEMORANDUM

To:	D, DR, DO, HMD, HMAS, HMOS, RD Division and Section Heads, DA section	
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Subject:	**Use of new snow data from Sweden in IFS cycle 36r4**	

1 Introduction

Following the presentation of a document on 'Snow analysis' to the 42nd Session (in October 2010) of the ECMWF's Technical Advisory Committee (Document ECMWF/TAC/42-10-12), the Committee "supported the proposal that Member States and Co-operating States investigate and improve the availability of routine snow-depth observations from their country".

Since 20 December 2010 ECMWF receive new snow depth data from Sweden from more than 300 ground stations. This new data is provided once per day with an observation time at 06:00 UTC, in addition to SYNOP data. It is provided within the 14 hours cut-off time for the delayed cut-off analysis (in which the 06:00 UTC snow analysis is conducted). A new BUFR (Binary Universal Form for the Representation of Meteorological data) file template has been developed at ECMWF to encode this additional data. The BUFR file is more simple that the one used for SYNOP data as it contains only snow depth observations. A new BUFR message subtype has been defined with a value of 28, it is used for the additional snow data (instead of subtype 1 for SYNOP data).

In this memorandum we propose a change in operations in Integrated Forecasting System (IFS) cycle 36r4 to implement the use of the additional snow data in operations as soon as possible. Since the new snow data is a new observation subtype, substantial modifications were necessary to implement data in the assimilation system. The modifications in IFS cycle 36r4 are briefly described and results of early delivery data analysis experiments, conducted at operational resolution, are presented.

2 IFS cycle 36r4 modifications and experiments

The additional snow depth data received from Sweden has been continuously encoded in a new BUFR template specifically designed for additional snow depth data. New snow data BUFR files are archived in near real time on the ECMWF File Storage system, ECFS, in ec:/emos/CNOW.

Two analysis experiments have been conducted, to test the use and the impact of the new snow depth data provided by Sweden, on the snow analysis and on the forecast.

- Experiment fi28 is the control experiment. Its snow analysis uses SYNOP snow depth data and NESDIS snow cover information, as in operations (branch dap_CY36R4_name_of_branch is the default cycle 36r4 branch).

- Experiment fi29 is the test experiment. Its snow analysis uses SYNOP data and NESDIS, as well as new snow depth data from Sweden (dap_CY36R4_fix_use_news_now).

The two experiments were conducted using the latest version of IFS 36r4 (merged with dah_CY36R4_osuite on 17 March 2011), at high resolution (T1279) and in early delivery mode, ie similar to the operational assimilation suite. The initial date of the two experiments is 21 December 2010. Both experiments use initial conditions from operations. The first 4D-Var cycle is bit identical in the two experiments, as expected since snow analysis modifications only start to affect the upper air analysis from the second cycle.

In order to activate the use of the additional snow depth data in the analysis, substantial changes were necessary in the Fortran code, both for the BUFR to ODB (Observations Data Base) conversion, and for the use of the new data type in the analysis (new type of data using non-WMO station codes and adaptation to the absence of T2m with the report). The branch dap_CY36R4_fix_use_news_now, used for the experiment fi29, includes modifications that enable to activate the use of the new snow depth data. The following routines have been modified:
odb: bufr2odb/bufr2odbi_snow.F90 (new routine) and tools/Bufr2odb.F90
ssa: sub/fg2obs.F90 sub/oiupd.F90 sub/redundant_obs.F90 sub/scan_cma_odb.F90
scripts: gen/fetchobs.

3 Results

Figure 1 shows snow analysis and available snow depth observations on 07 January 2011 for the control experiment, on the top panel, and for the test experiment on the bottom panel. This presence of snow depth reports on the maps shows that the additional number of observations over Sweden is considerable. New snow data cover the entire area of Sweden, providing highly relevant information for the snow depth analysis. Therefore, after 18 days of using additional snow depth data in Sweden, the snow depth analysis is significantly modified in the test experiment fi29 (bottom panel) compared to the control experiment fi28 (top panel). Figure 2 shows the difference of snow depth analysis between the two experiments. Using the new snow data leads to larger values of snow depth in Sweden in the analysis, in better agreement with ground observations.

Figure 3 shows T2m forecast error (experiment forecast verified against operational analysis) difference between the experiment fi29 using the new data and the control experiment fi28 which do not use the new data from Sweden. This figure shows that using the additional new snow data leads to slightly decrease T2m forecast errors (green values) at steps 36 and 48. This indicates that using more snow data in Sweden has a slightly positive impact on T2m forecast.

Figures 4 and 5 show the impact of using the new snow depth data provided by Sweden on the general forecast scores, measured by the 500 hPa geopotential. It shows that although the impact is important in terms of snow depth in Sweden, it only has an insignificant but positive impact on the general forecast performance.

4 Conclusion

In 2010 the ECMWF TAC recommended the Member States to improve the availability of routine snow depth observations. Following this recommendation, Sweden has been providing ECMWF with near real time new snow depth data, since 20 December 2010. Data from more than 300 stations is provided at 06:00 UTC every day in near real time.

To enable the use of the new snow depth data a new BUFR template has been specifically defined and new snow data acquisition has been set up in Operations Department at ECMWF. The IFS 36r4 has been modified and developed by the Research Department to enable the activation of the use of the new data in the analysis.

The impact of using the new snow depth data in Sweden on analyses and the forecasts is presented in this memorandum, based on high resolution analysis experiments, similar to operations. Snow depth analysis and T2m forecast are improved when the new snow depth data from Sweden is used. Impact on the 500hPa geopotential height forecast scores is positive, but not significant. These results show that using additional snow depth data in Sweden provides valuable information which has an overall positive impact on surface parameter analyses and forecasts. Implementing changes in operations in IFS cycle 36r4 to activate the use of the new data in the analysis will enable to use of the new data from Spring 2011. The planned date for implementation of this change to the operational suite is Tuesday 29 March 2011.

Sweden is the first Member State to provide additional snow depth data. The positive results obtained with new Swedish snow depth data confirms the importance of improving the availability of routine snow depth information from the Member States.

Acknowledgements

ECMWF thanks Sweden for providing additional snow depth data on a routinely basis suitable for operational near real time use.

References

[Document ECMWF/TAC/42-10-12] TAC Topical Paper, 2010: Technical Advisory Committee, Topical paper on Snow Analysis. *ECMWF/TAC/42(10)12* , http://www.ecmwf.int/about/committees/tac/sessions/42nd/TAC42

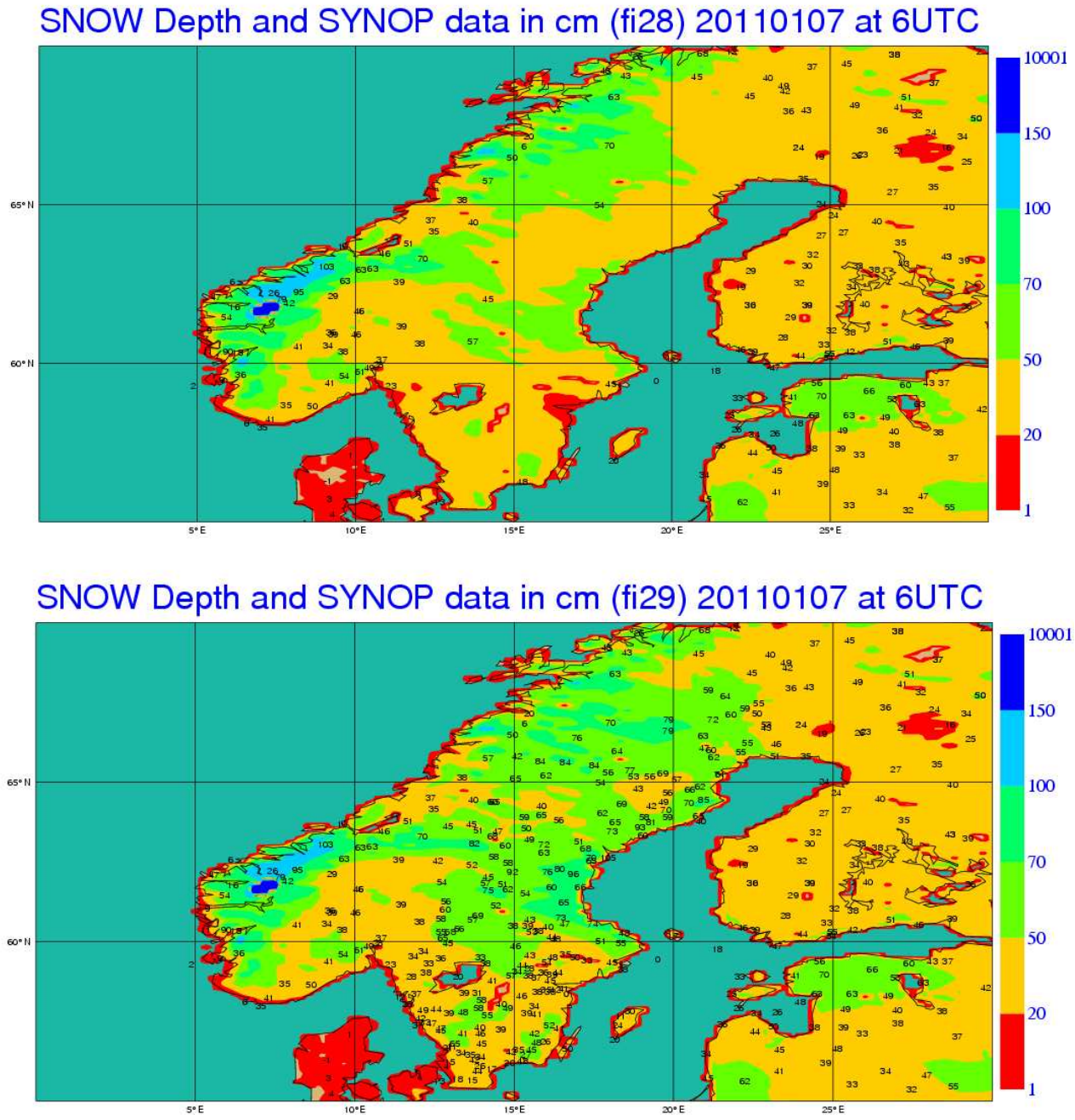

Figure 1: Snow depth (cm) Analysis at 06:00 UTC on 07 January 2011, in the control operational-like experiment (fi28, top panel) using SYNOP data only, and in the test experiment (fi29, bottom panel) using additional snow data provided by Sweden since 20 December 2010. The two experiments started on 21 December 2010. Numbers indicate values of snow depth (cm) observations available to the analysis.

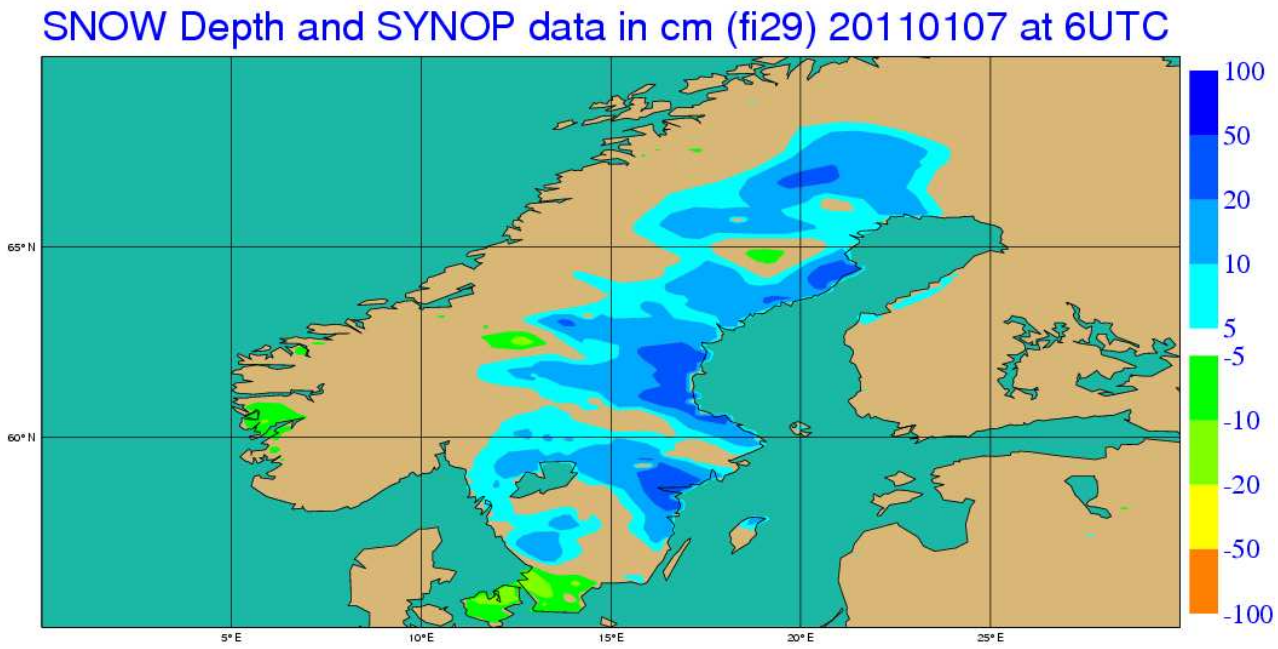

Figure 2: Difference in snow depth (cm) analysis at 06:00 UTC on 07 January 2011 between the test experiment (fi29) using additional snow data and the control experiment (fi28) using SYNOP data only.

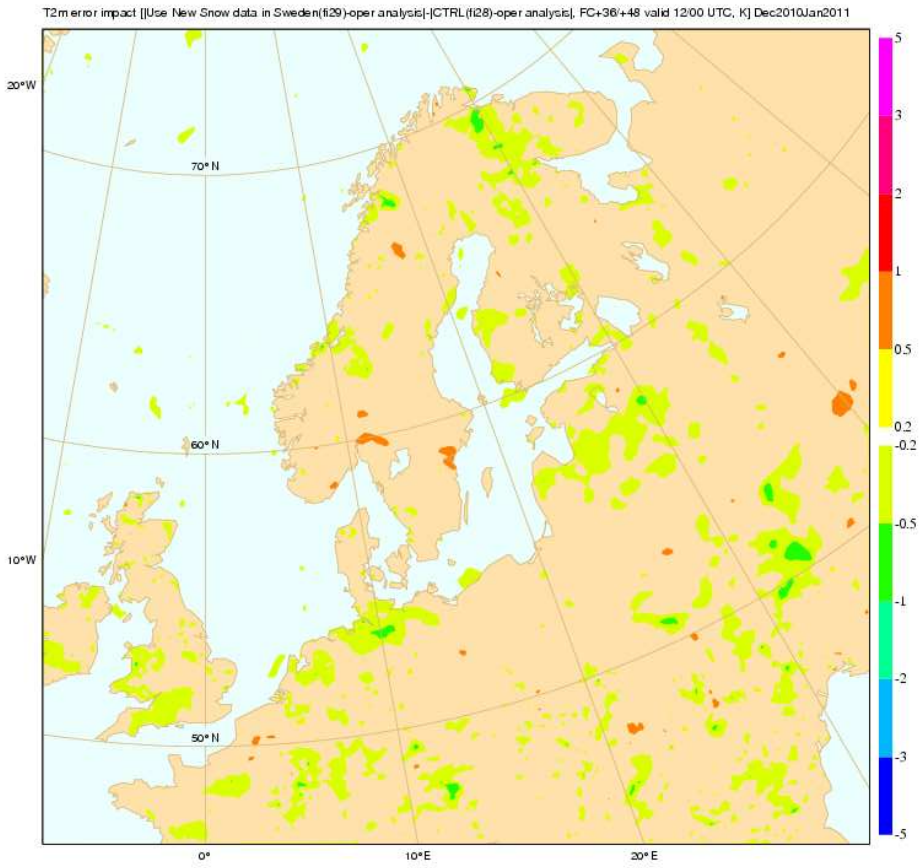

Figure 3: Impact of using the new snow depth data from Sweden on analysis of 2 meter temperature: difference of T2m forecast errors at steps 36 and 48 (experiment forecast minus operational analysis), between the test experiment using new data (fi29) and the control experiment fi28. It shows the impact of using more snow data on T2m forecast. Green values on the bottom panel show areas where T2m forecast error is reduced when the new snow depth data is used compared to the control which do not use the new snow depth data in Sweden.

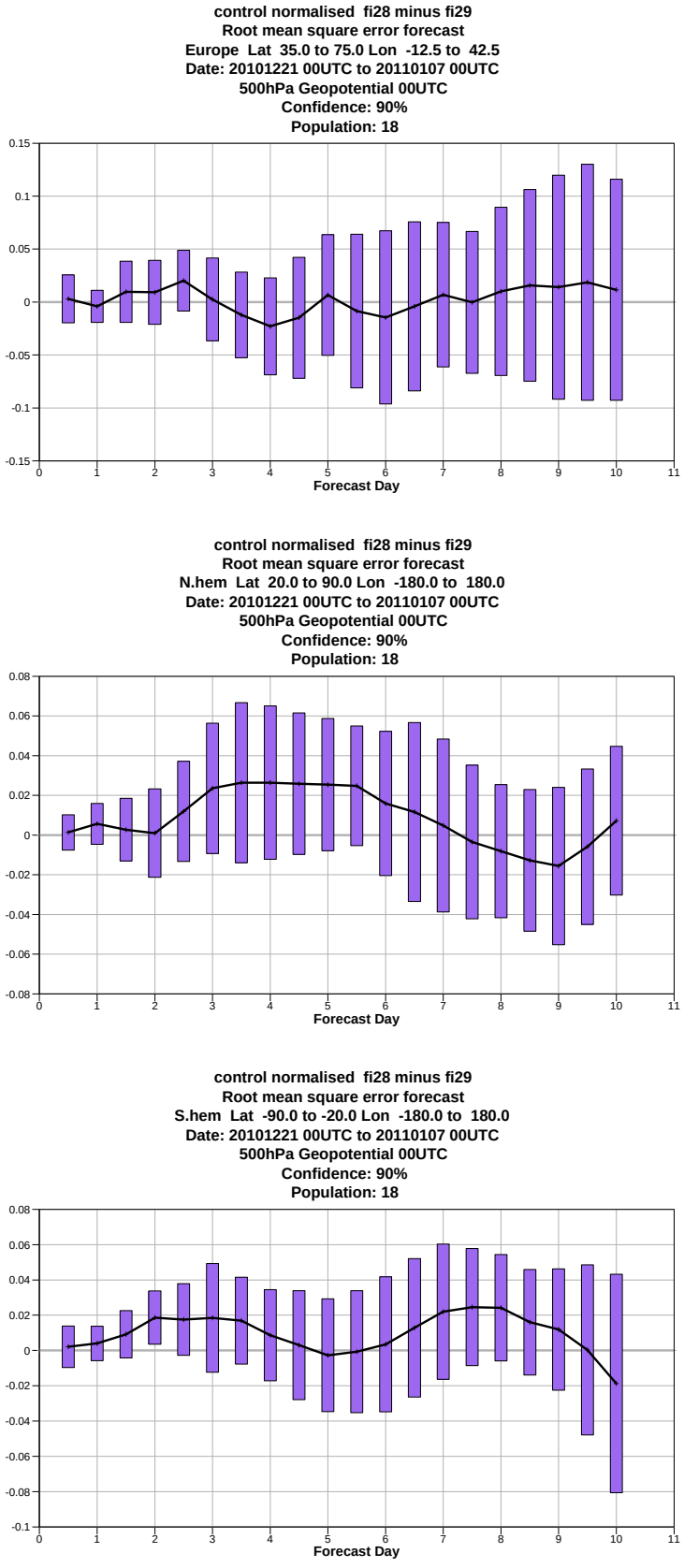

Figure 4: Impact of using the new snow data on the 500hPa geopotential height forecasts scores for Europe (top panel), North Hemisphere (middle panel) and South Hemisphere (bottom panel).

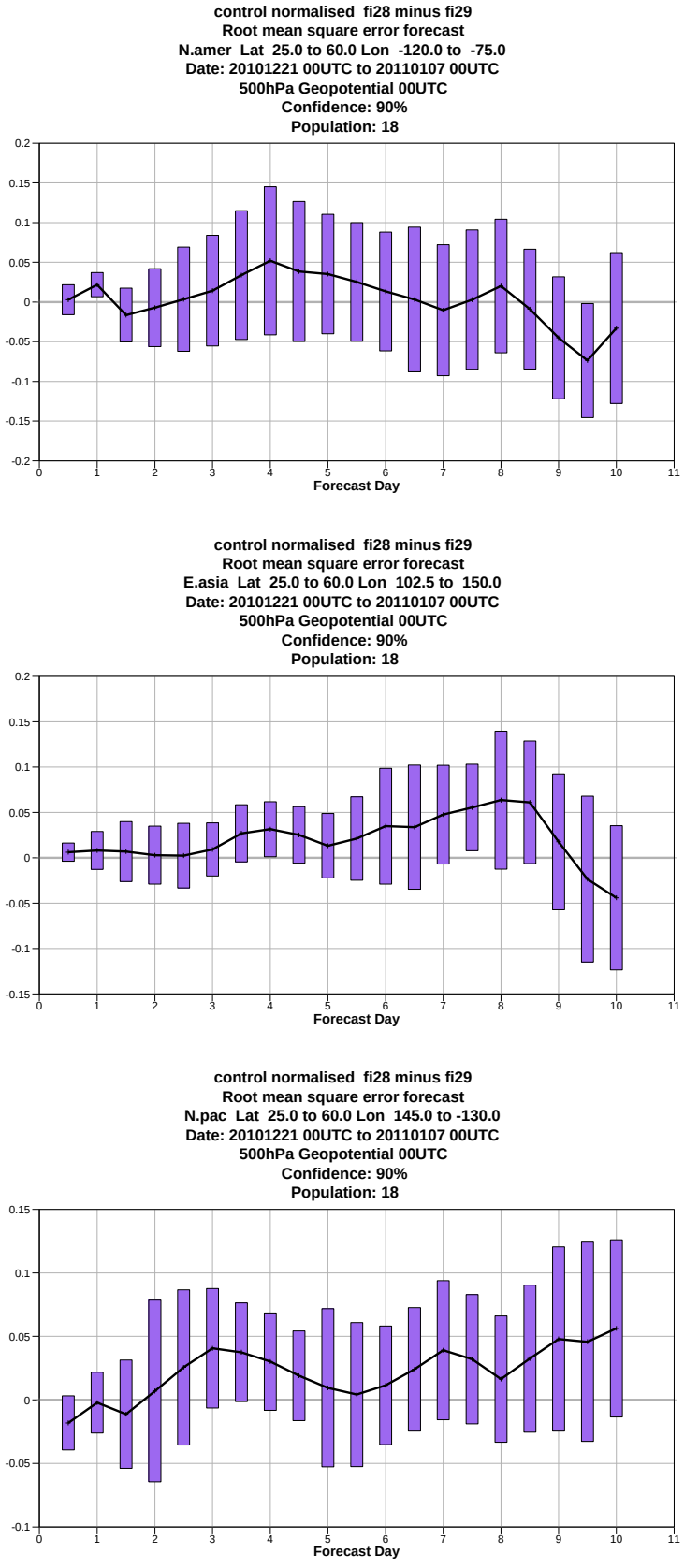

Figure 5: Same as Figure 4, but for North America (top panel), East Asia (middle panel) and North Pacific(bottom panel).