RESEARCH DEPARTMENT MEMORANDUM

ECMWF

To:	HR, RD Division and Section Heads, HO, HMD, HMOS, HMAS	
Copy:	RD	
From:	Drasko Vasiljevic, Patricia de Rosnay, Jan Haseler	
Date:	April 3, 2009	File: R43.2/PdR/0920
Subject:	**New structure of the surface analysis for cycle 35r3**	

1 Summary

A new surface analysis structure is proposed for implementation in IFS cycle 35r3 to replace the current operational surface analysis. The new surface analysis and the upper air analysis are separated so they can be run in parallel. The surface analysis in not any more in the critical path, opening thereby the possibility to increase the surface analysis elapse time significantly. This new surface analysis constitutes an essential step in the ongoing developments of the surface analysis in the IFS. By removing the surface analysis tasks from the time critical path, it will enable us to implement the Extended Kalman Filter soil moisture analysis (Drusch et al. 2008). Modifications of the surface analysis structure have been performed in cycle 35r2 and proposed for cycle 35r3. They are briefly described in this research memorandum. Since the new surface analysis is using first guess input fields (for 10 m wind components) and persistent analysis (for albedo), instead of analysis fields, some evaluation is presented on model performances.

2 Background

Currently (cycle 35r2) the surface analysis is performed after the upper air analysis (except for the final trajectory). There are two main reasons for that:

- Surface analysis gets observations by using the upper air analysis ODB (ECMA.conv).
- Some of the surface analysis input fields (10m wind components and albedo) are the upper air analysis output fields.

Hence, the surface analysis has to wait for the upper analysis to complete. As a consequence the surface analysis is performed in the time critical path, however this has never been an issue because of its very short elapse time. In the near future, surface analysis elapse time is expected to increase significantly with the implementation of the EKF surface analysis end of 2009. For this reason it would be beneficial if the surface analysis could be performed outside the critical path and thereby separate completely the upper air analysis and the surface analysis. In order to achieve that, both the observational and the field dependencies need to be removed in the new surface analysis.

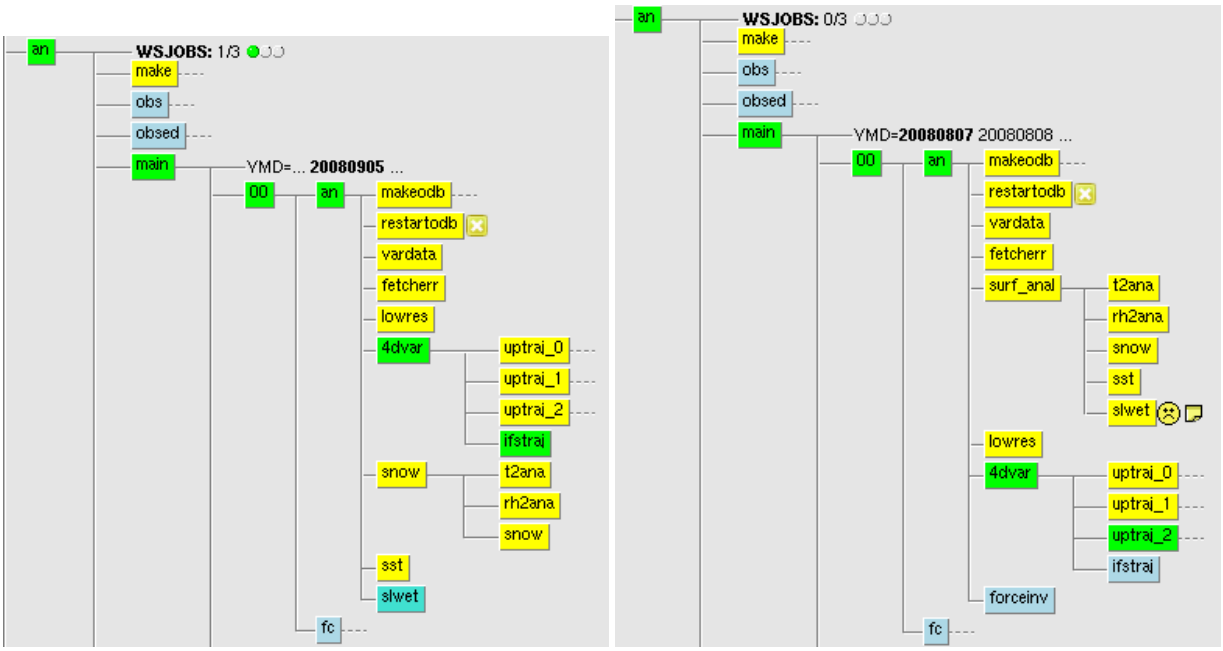


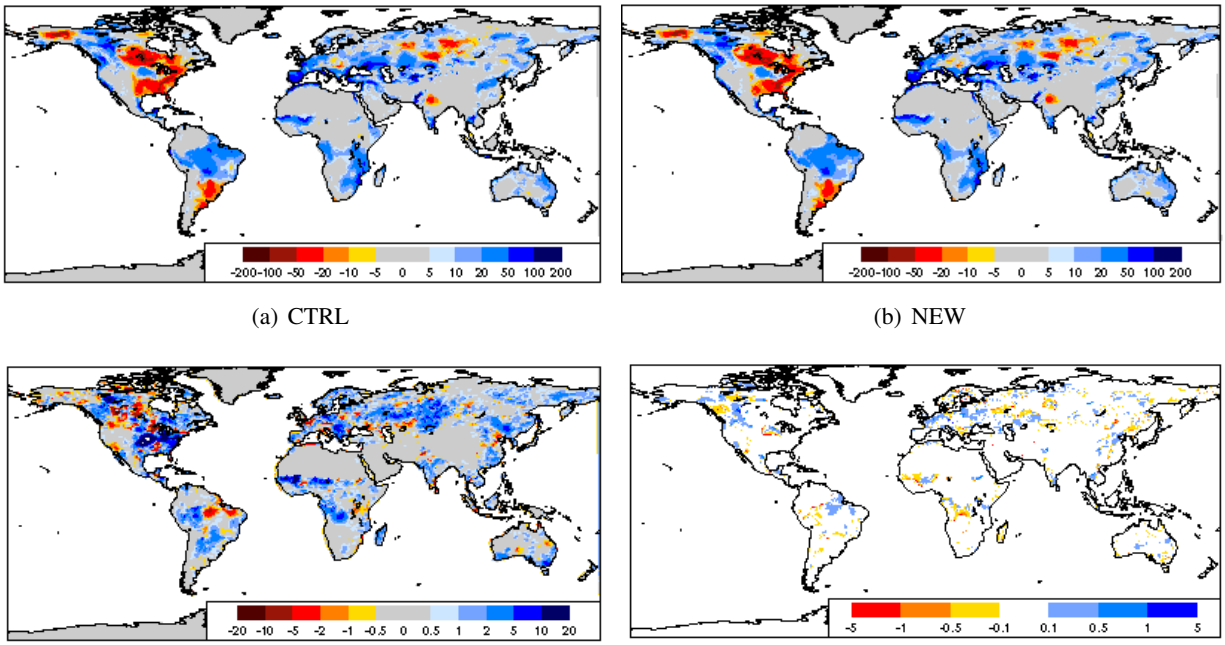
Figure 1: SMS structure of the surface analysis in cycle 35r2 (left) and proposed for cycle 35r3 (right). In the new structure, surface analysis tasks are independent of the upper air analysis. They are organised in a new surf_anal family. The new task FORCEINV aims at replacing the invariant fields.

3 Dependency issues

The observational dependency is resolved by creating a new surface analysis dedicated ODB (ODB.conv_surf) at the same time as the ODB.conv is created. Furthermore, in the current operational IFS the ODB.conv is accessed by the surface analysis in read-only mode, so we do not update it (surface feedback) at all. The only update of the ODB.conv is done by the upper air analysis (upper air feedback). Thus, not only will the new ODB.conv_surf resolve the observational dependency issue, it will also enable us for the first time to update and store this valuable diagnostics surface feedback. This observational dependency modification does not have any impact on the upper air analysis nor on the surface analysis results.

The field dependency issue mentioned above is resolved in the new surface analysis by using the first guess fields of wind components and persistent analysis albedo instead of the upper air analysis output fields. In contrast to observational dependency modifications, the proposed field dependency change will have an impact, although only to a small extend, on the surface analysis but not on the upper air analysis results.

In addition to resolving the dependency issues, it turns out that there are a couple of other changes that were needed to complete the modifications of the surface analysis structure. Firstly, in the soil wetness analysis step (at the very end of scripts/gen/soilana) there is in the current CY35R2 a task which is replacing all the invariant fields by the climate ones. This is fine as long as the soil wetness analysis is the last step of the analysis, which is the case in the current operational IFS cycle 35r2. However in the new surface analysis approach proposed for cycle 35r3, that will not be the case anymore. Therefore, this soil wetness task is now taken out and a new step (FORCEINV) is introduced with a single purpose to replace the invariant fields by the climate ones. This new step is dependent on both the surface analysis and the upper air analysis completion. Secondly, in the current system final trajectory is dependent on the surface analysis completion. This is because of the post-processing



(a) CTRL (b) NEW

(c) NEW - CTRL (d) (NEW - CTRL)/CTRL

Figure 2: Accumulated root zone (0-1m) soil moisture analysis increments (mm) for 7 August to 5 September 2008, obtained from the control f5b3 experiment (a, CTRL), from the f4s5 experiment (b, NEW) and their absolute (c) and relative (d) differences.

reasons. As these post-processing reasons are not present in the new surface analysis approach anymore, this dependency has been simply removed.

Figure 1 shows the current SMS structure in cycle 35r2 (left panel) and that of the new surface analysis proposed for cycle 35r3 (right panel). Surface analysis tasks are organised in the SURF_ANAL family. The FORCEINV task is performed at the very end of the analysis, after SURF_ANAL and IFSTRAJ have been completed.

4 Model performances

As indicated above, field dependency issue between upper air analysis and surface analysis is resolved by:

- Using 10 m wind components from the previous forecast instead of from the upper air analysis,
- Using albedo from persistent analysis instead of upper air analysis.

There is no direct impact on the upper air analysis, but this modification has a small impact on the surface analysis results. As a consequence, the modified surface analysis results are not identical to the default version of cycle 35r2. When it is used in an assimilation experiment the upper air fields will be affected from the second cycle and onwards. The impact is still small.

The control (CTRL) experiment used here is f4b3 which uses the IFS cycle 35r2 default version without the back-fixes included in the recommanded f4no experiment. The experiment using the new surface analysis

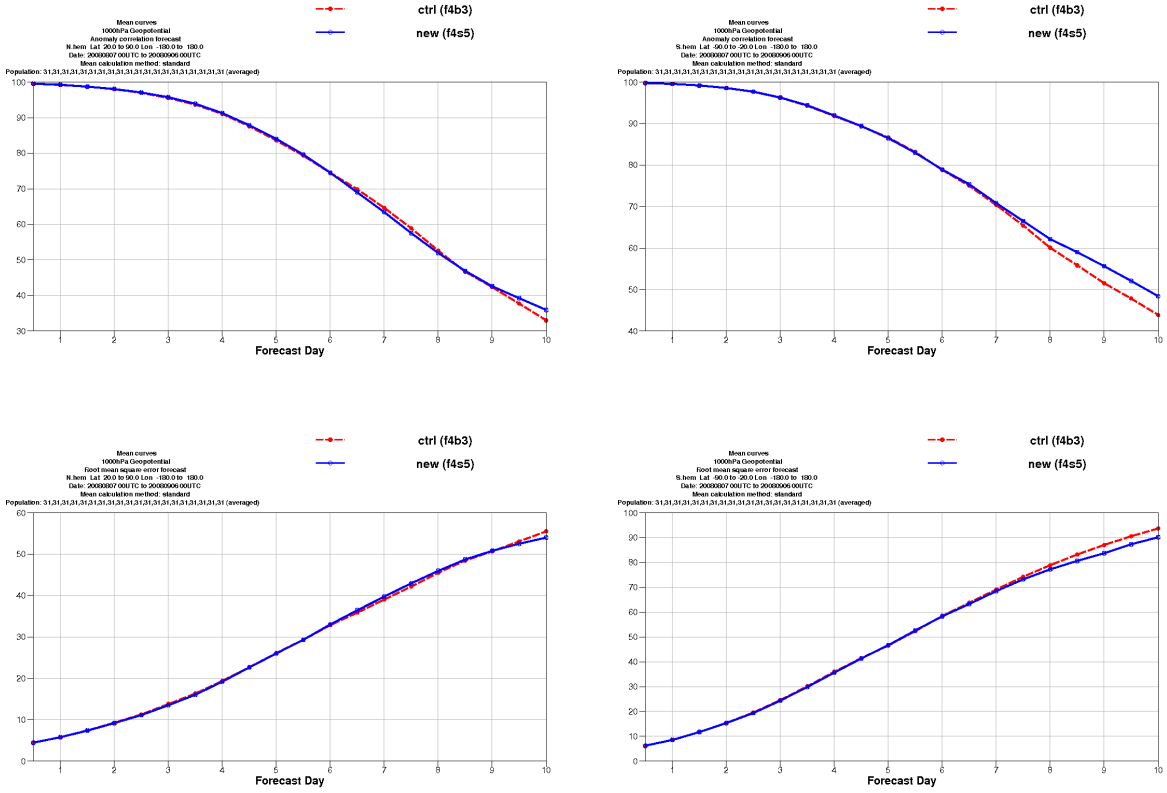
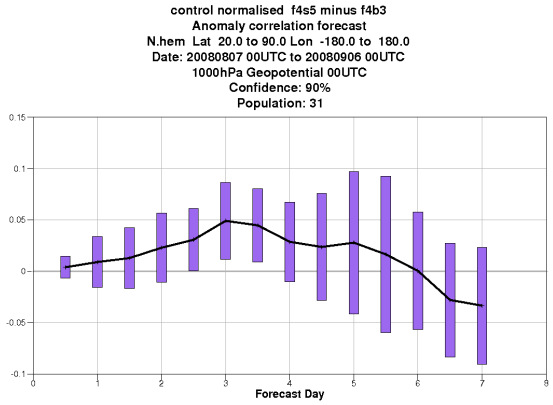
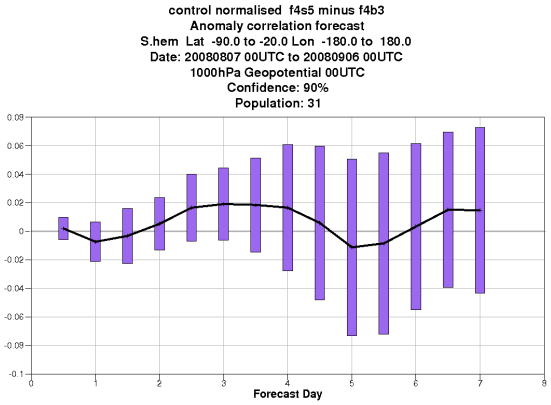


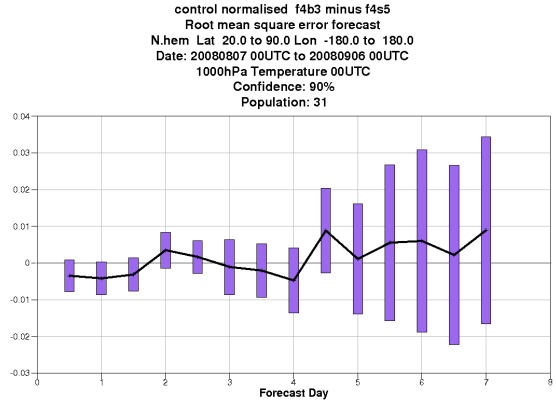
Figure 3: Anomaly correlation forecasts (top panel) and root mean square error forecasts (bottom panel) for 1000 hPa geopotential fields, for f4b3 and for the new analysis experiment f4s5. Left panel is for Northern hemisphere extra-tropics and right panel is for Southern hemisphere extra-tropics.



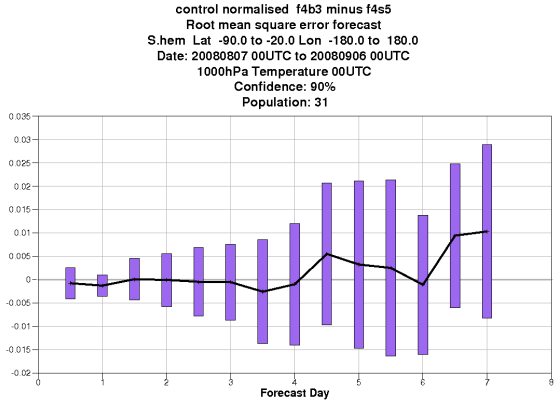
(a) North Hemisphere Z



(b) South Hemisphere Z



(c) North Hemisphere T



(d) South Hemisphere T

Figure 4: Score differences showing the impact of using the new surface analysis (f5b3) compared to the CTRL experiment f4b3, for geopotential at 1000 hPa (top) and air temperature at 1000 hPa (bottom), for Northern hemisphere extra-tropics (left) and Southern hemisphere extra-tropics (right). The experiment was for 31 days 7 August 2008 - 6 September 2008).

(NEW) is f4s5. It uses the IFS cycle 35r2 (also without the back-fixes) with the proposed new surface analysis. The assimilation was performed at operational resolution in early delivery mode.

Figure 2 shows the accumulated root zone soil moisture increment from 7 August 2008 to 5 September 2008 for the two experiments and their differences. Very similar soil moisture increment values are obtained between the two experiments in both the summer and winter hemispheres.

Figure 3 shows the anomaly correlation and root mean square error forecasts averaged over 31 days for the two experiments for the 1000 hPa geopotential, for the northern hemisphere and for the southern hemisphere. This figure shows that, as expected, the new surface analysis impact on the forecast model performances is rather neutral. Figure 4 shows the differences of performances obtained between the CTRL and NEW experiments for the geopotential at 1000 hPa, and air temperature at 500 hPa. Apart from a slightly positive impact on day 3 in the southern hemisphere, the impact is rather neutral.

5 Conclusion

A new surface analysis is proposed for cycle 35r3. It relies on completely independent surface analysis and upper air analysis during the analysis step. The forecast step will start from the combined surface and upper air fields, like it is done in cycle 35r2. The observational dependency and field dependency between surface and upper air analysis have been removed in the new surface analysis. The new surface analysis is shown to have a neutral impact on the forecasts performances.

This new surface analysis structure is a first step toward a more advanced surface analysis. It will be followed by the operational implementation of the Extended Kalmam Filter surface analysis at the end of 2009. In addition, the new surface analysis structure is a preliminary step towards a fully decoupled “Surface Analysis Suite” in which the surface analysis will be able to run without performing the upper air analysis. This future stand alone suite will be of high interest because it enables us to perform consistent long re-analyses. They can quickly be used for climatology and initial states of surface fields for seasonal and monthly forecasts.

References

[Drusch et al. 2008] Drusch, M., K. Scipal, P. de Rosnay, G. Balsamo, E. Andersson, P. Bougeault, and P. Viterbo, 2008 : Exploitation of satellite data in the surface analysis. *ECMWF Technical Memorandum - 576, October 2008*.