# SPECIAL PROJECT PROGRESS REPORT

All the following mandatory information needs to be provided. The length should *reflect the complexity and duration* of the project.

| | |
|---|---|
| **Reporting year** | 2020 |
| **Project Title:** | Operationalization of SPP and further improvements of EDA, boundary and surface perturbation in MEPS |
| **Computer Project Account:** | spseandr |
| **Principal Investigator(s):** | Ulf Andrae |
| **Affiliation:** | SMHI |
| **Name of ECMWF scientist(s) collaborating to the project** (if applicable) | None |
| **Start date of the project:** | 2020-01-01 |
| **Expected end date:** | 2022-12-31 |

## Computer resources allocated/used for the current year and the previous one

(if applicable)

Please answer for all project resources

| | | Previous year | | Current year | |
|---|---|---|---|---|---|
| | | Allocated | Used | Allocated | Used |
| **High Performance Computing Facility** | (units) | | | 16M | 5.7M |
| **Data storage capacity** | (Gbytes) | | | 30000 | >60000 |

## Summary of project objectives (10 lines max)

The aim of the project is to improve various components such as model uncertainty, initial perturbations and the best usage of ECMWF IFSENS or EDA boundaries in the MetCoOp ensemble system MEPS. In the first part we have focused on the possibility to derive new background error statistics for our 3DVAR setup using ensemble members from MEPS and the sensitivity to different components in the perturbation chain.

## Summary of problems encountered (10 lines max)

ECFS is very often very slow.

## Summary of plans for the continuation of the project (10 lines max)

- Continued investigations of background error sensitivity to different perturbations
- Longer runs and sensitivity studies with Stochastically Perturbed Parameterizations scheme (SPP)
- Improvements of surface perturbation aspects as outlined in the project application.

## List of publications/reports from the project with complete references

None

## Summary of results

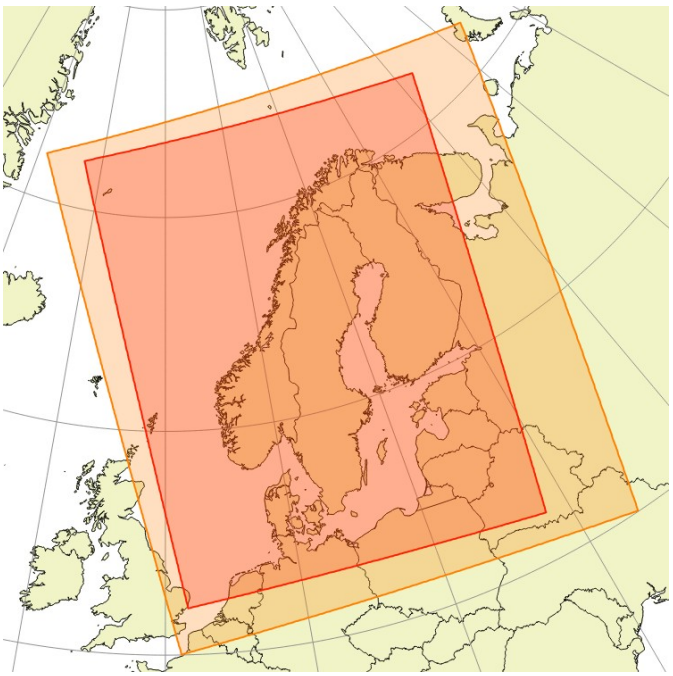

Figure 1: New operational domain for MEPS(orange) and domain used for experiments described (red).

A redesigned setup for MEPS was introduced in operations in February 2020. The new ensemble is based on an Ensembles of Data Assimilation (EDA), using members from IFSENS on the

boundaries and is running in a continuous mode as described in Andrae et.al. (2020). The upgrade also involved a new larger domain, figure 1, improving mainly precipitation forecasts for systems propagating from south or south east. The larger domain requires a new set of background error statistics (BES) for the data assimilation and it is normally a costly procedure to generate representative statistics for all seasons. A lot could be gained if (pre) operational data from the ensemble forecasts could be used and it would also allow us to explore a more continuous update of statistics representing "errors of the day". The old statistics were derived using a four member ensemble driven by the ECMWF EDA system on the boundaries as compared to IFSENS for MEPS. Another noticeable difference is the use of surface perturbations in MEPS which introduces initial perturbations with a horizontal scale of 150km in soil state variables and SST.

BES derived from 6h forecasts using 348 cases over the period of 14th of May to 29th of November 2019 is presented and compared with old BES in figure 2. It's clear from this figure that the new BES contains more energy on larger scales which is undesirable as it will introduce analysis increments with larger scales and thus prevent the resulting analysis to represent smaller scale features.

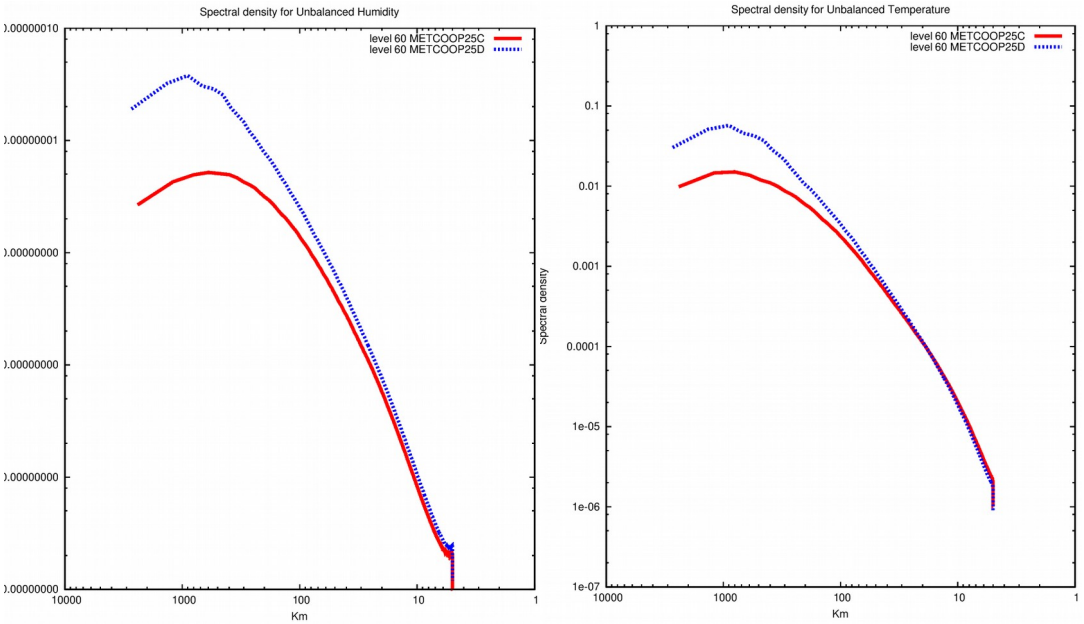


Figure 2: Spectral energy density for humidity(left) and temperature(right) for the old (red) and new (blue) background error statistics.

Based on this result an sensitivity study was initiated investigating the following aspects:

1. The sensitivity to surface perturbation length scales
2. The impact of using IFSENS or IFS EDA boundaries
3. The impact of not using LSMIX, a method to relax the large scale field of the first guess to ECMWF data.

A set of experiments, as outlined in table 1, have been performed on cca for August 2019. The experiments are not identical to the operational setup but share the important aspects. At the time of writing none of them have been fully completed. However, in figure 3 we see some preliminary results for the the impact of boundaries. It's clear that there are less energy on the larger scales for EDABD as compared to ref for both humidity and temperature. There are a number of differences in the usage of IFSENS or EDA boundaries such as their update frequency, temporal resolutiona and how perturbations are generated in IFS. At this stage it is unclear to what extent these differences plays any important role but ECMWF experts have been contacted for further discussions.

Table 1: Experiments run

| **Experiment name** | **Characteristics** |
|---|---|
| REF | Model domain as showed in red in figure 1<br>3h cycling 3DVAR using perturbed observations<br>Conventional observations only<br>Surface perturbation with a length scale of 150km<br>IFSENS boundaries every 1h<br>Large scale mixing of IFS forecasts |
| SP_50km | As REF but with<br>Surface perturbation with a length scale of 50km |
| EDABD | As REF but with<br>IFS EDA (MARS STREAM=ELDA) boundaries every 6h<br>6h cycling |
| NOLSMIX | As REF but without mixing of IFS data |

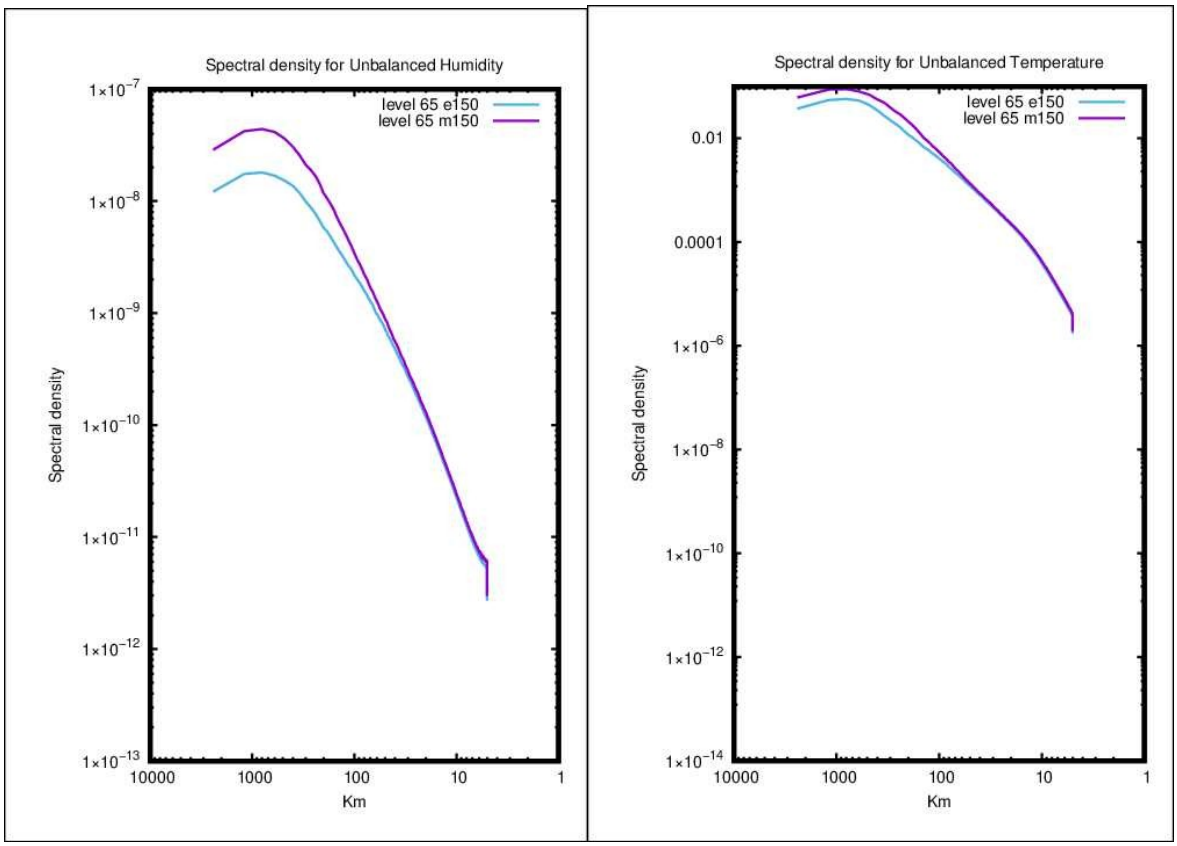


Figure 3: Spectral energy density for humidity(left) and temperature(right) for background error statistics generated with IFS EDA (blue) and IFSENS (magenta) boundaries respectively.

References:

Andrae, U. et.al, 2020, A continous EDA based ensemble in MetCoOp, ALADIN-HIRLAM Newletter Nr 14, 189-198