Can we use the operational MetCoOp ensemble to generate background error statistics?

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Background and motivation

- To make an analysis we need background error statistics that tells how e.g. a change in temperature affects wind, humidity and pressure.
- Tedious process to derive these statistics and in MetcOop we use statistics derived for an old model version and a smaller domain…
- The setup is similar to the operational ensemble, although with some important differences in the details (as we will see).

Can we use data from the operational ensemble to generate new statistics for free, and more often?

A continuous EDA based ensemble in MetCoOp

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Figure 1. Current and future domain

MEPS perturbation and assimilation characteristics

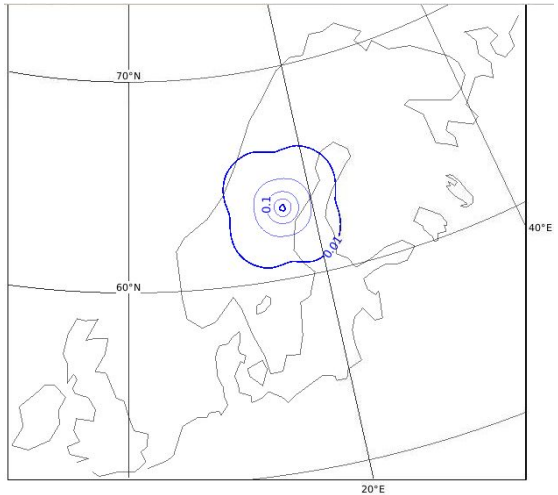
- We use the first 28 ECMWF **IFSENS** members in MEPS whereas the ECMWF EDA suite (**ELDA**) is used for BG-error generation
- Mixing of ECMWF large scale information, from the IFSENS/ELDA member used, on T/U/V is done prior the analysis (**LSMIX/BlendVAR**)
- Each member runs their own 3DVAR with perturbed observations (**EDA**)
- The initial atmospheric state is further perturbed by adding a scaled difference between the used IFSENS member and control (**PertAna**)
- Soil temperature, SST, Z0 and albedo is perturbed after the surface analysis (**PertSFC**) with a pattern having a 150km length scale characteristic

First trial with MEPS pre-operational data from May - Nov 2019

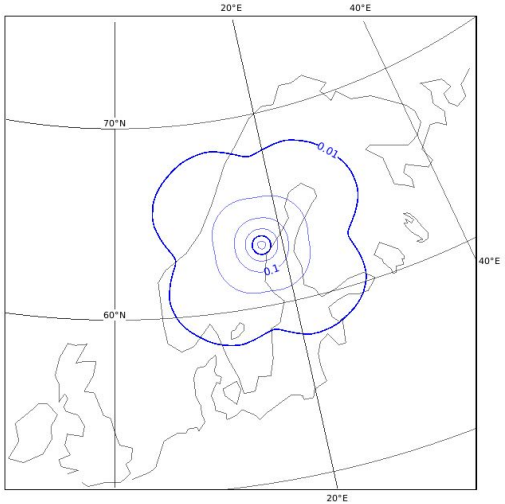
single observations : magnitude and spread of analysis increments (analysis minus background)

- one single temperature observation 1K warmer than the corresponding background value and with an observation error standard deviation of 1K placed in the center of the domain at 500 hPa (lev=24)

Operationally used statistics



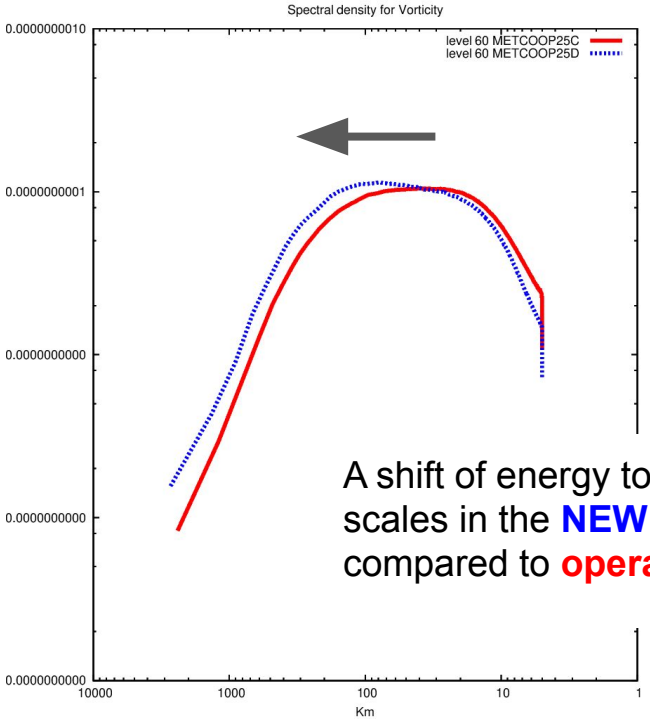
New statistics



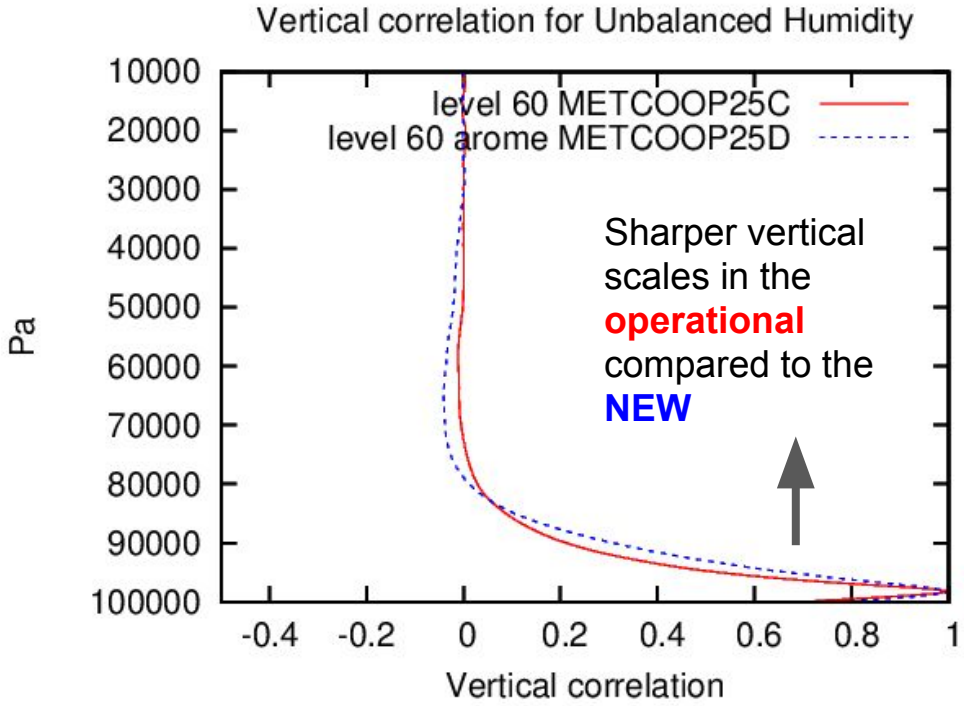
The new statistics give increments with larger scales which means a smoother analysis losing e.g. sub synoptic scale features

Courtesy Rohollah Azad, MET Norway

Diagnostics of the statistics using MEPS
(New vs Operational)



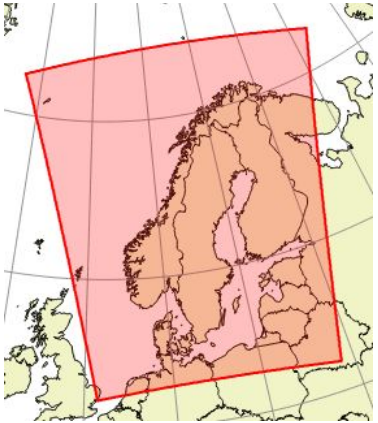
A shift of energy to larger scales in the **NEW** as compared to **operational**



Courtesy Rohollah Azad, MET Norway

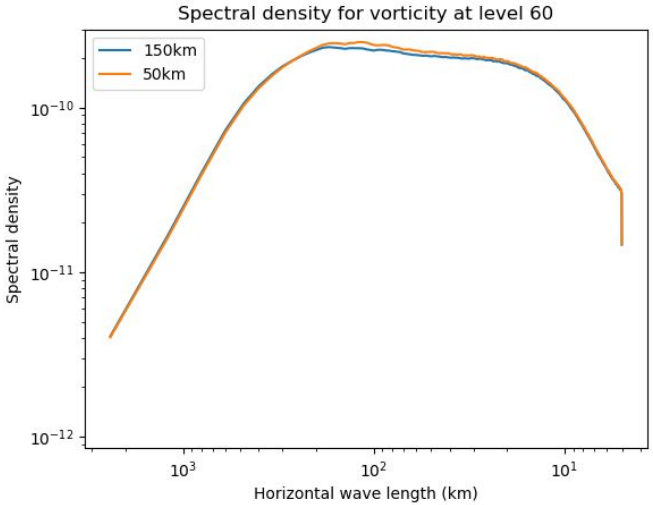
EDA setup for August 2019, over METCOOP25B domain using release-43h2.1.rc1 using 4 members

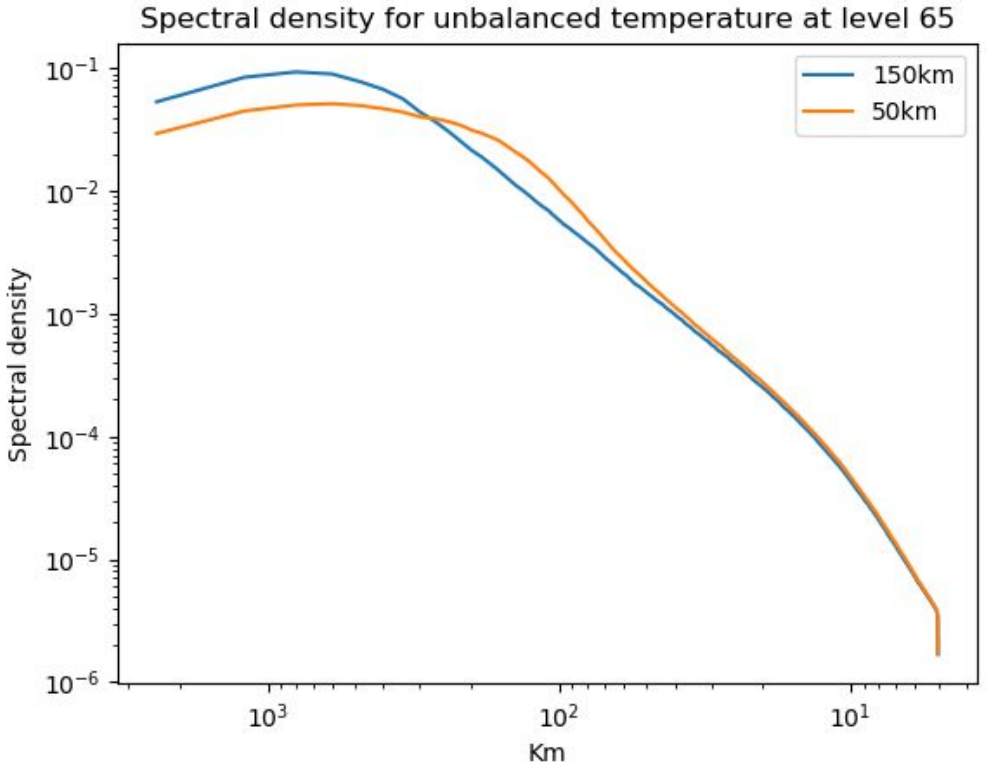
	Boundaries	PertAna	LSmix	Surfpert scale
Operationally used	IFS ELDA	No	No	0km (off)
ELDA, no PertAna, no LSMIX	**IFS ELDA**	**No**	**No**	150km
ELDA boundaries	**IFS ELDA**	Yes	Yes	150km
MEPS like	IFSENS	Yes	Yes	150km
No PertAna	IFSENS	**No**	Yes	150km
No LSMIX, no PertAna	IFSENS	**No**	**No**	150km
50km surface pert	IFSENS	Yes	Yes	**50km**
No LSMIX	IFSENS	Yes	**No**	**50km**



Impact of surface scales: 150km <-> 50km

The scale of the surface perturbations affects mainly the lowermost levels where smaller scale perturbations also shifts energy to the smaller scales.

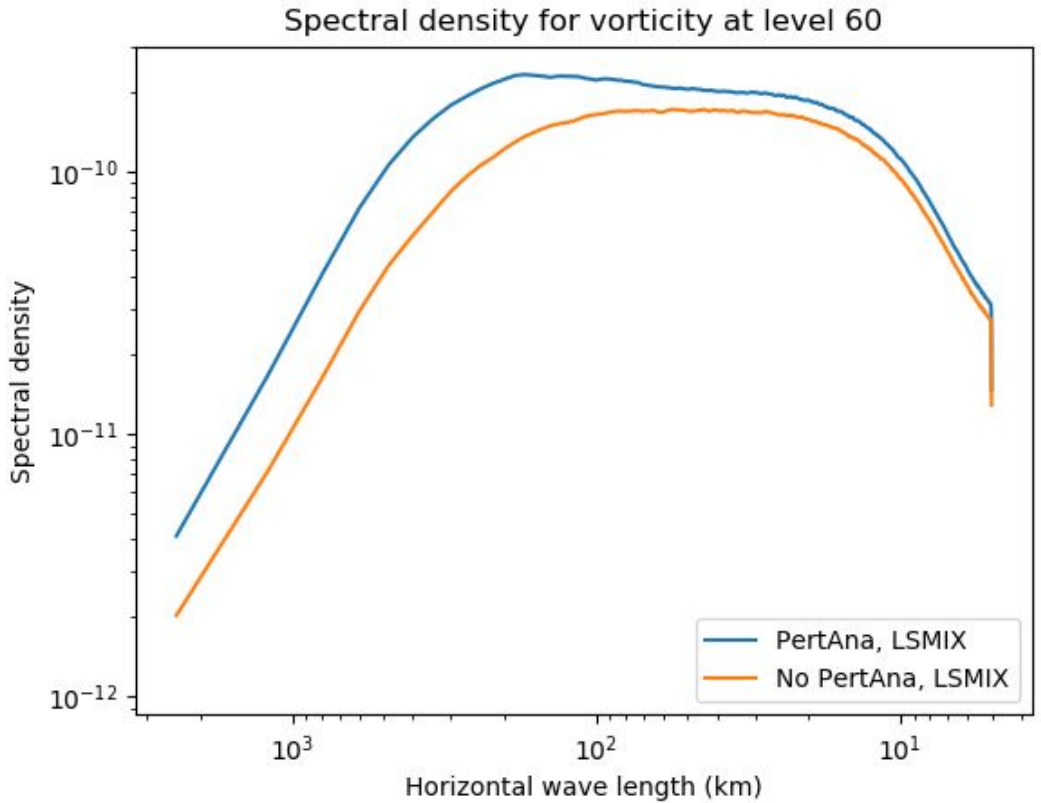




What's the contribution from the various components?

IFSENS boundaries unless stated

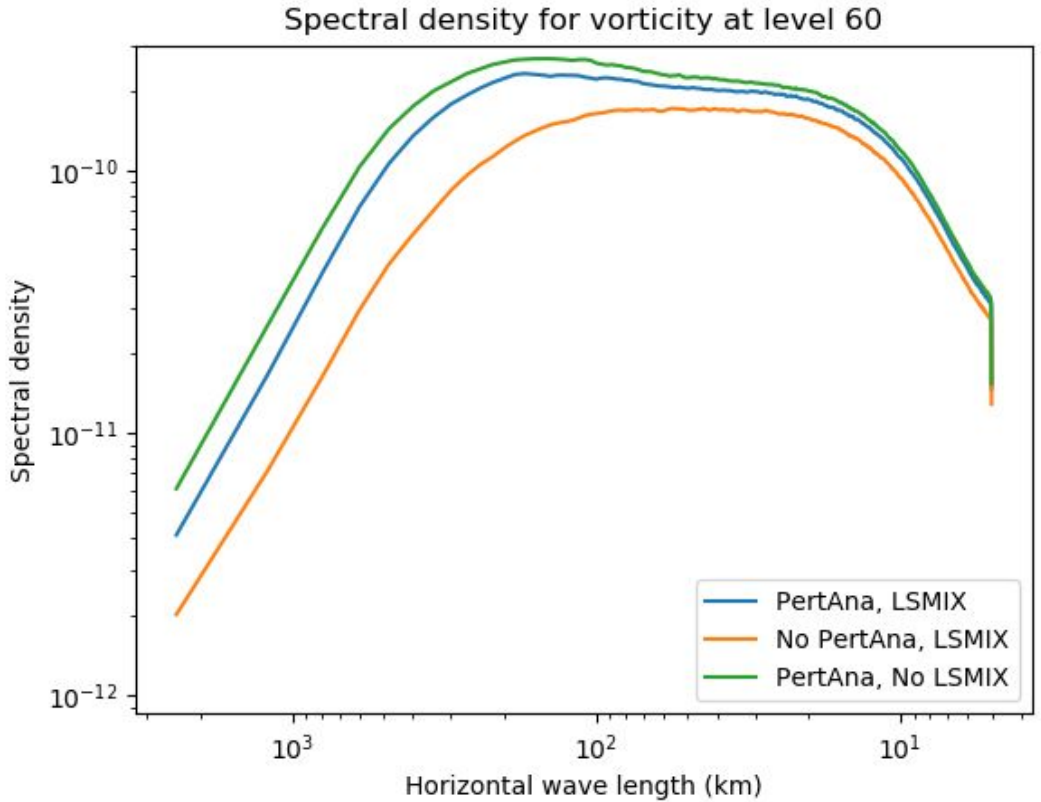
- **PertAna** is contributing to more energy on the larger scales
- We have indications from elsewhere that it is efficient for the ensemble spread but may introduce noise.



What's the contribution from the various components?

IFSENS boundaries unless stated

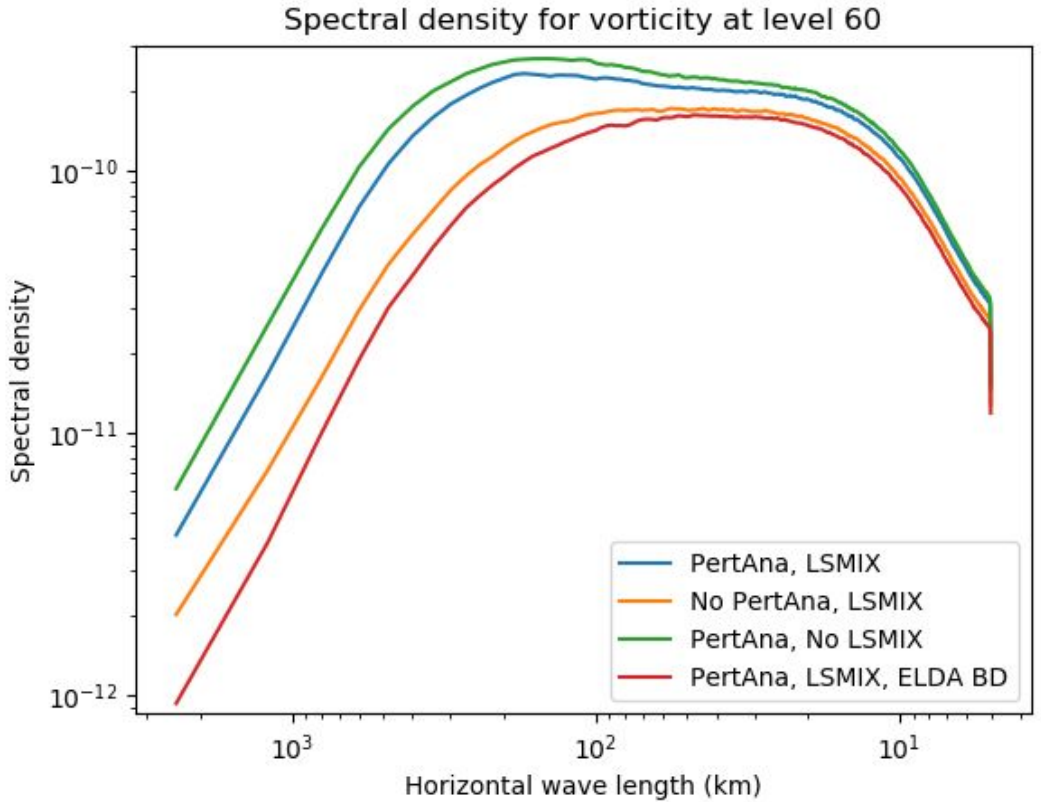
- PertAna is contributing to more energy on the larger scales
- Switching **off LSMIX** constraints the model less and allows even more energy



What's the contribution from the various components?

IFSENS boundaries unless stated

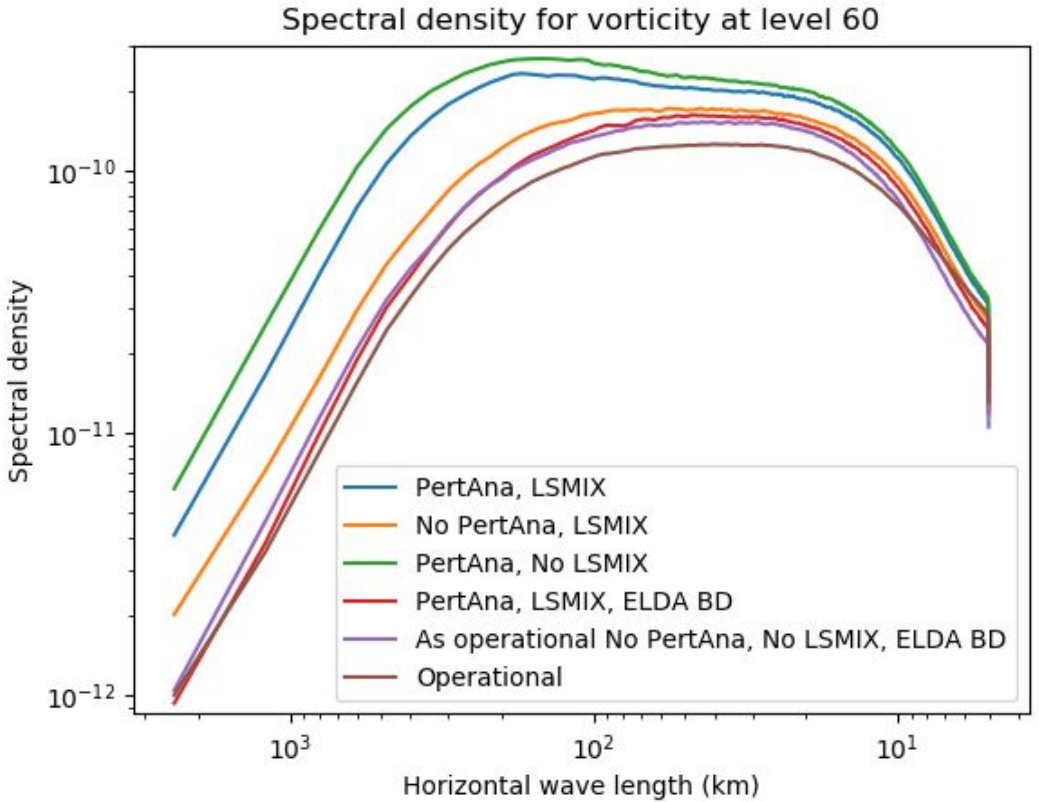
- PertAna is contributing to more energy on the larger scales
- Switching off LSMIX constraints the model less and allows even more energy
- Using **ELDA** (ECMWF EDA) boundaries instead of IFSENS gives less energy on the larger scales



What if we try to run like “operational”

IFSENS boundaries unless stated

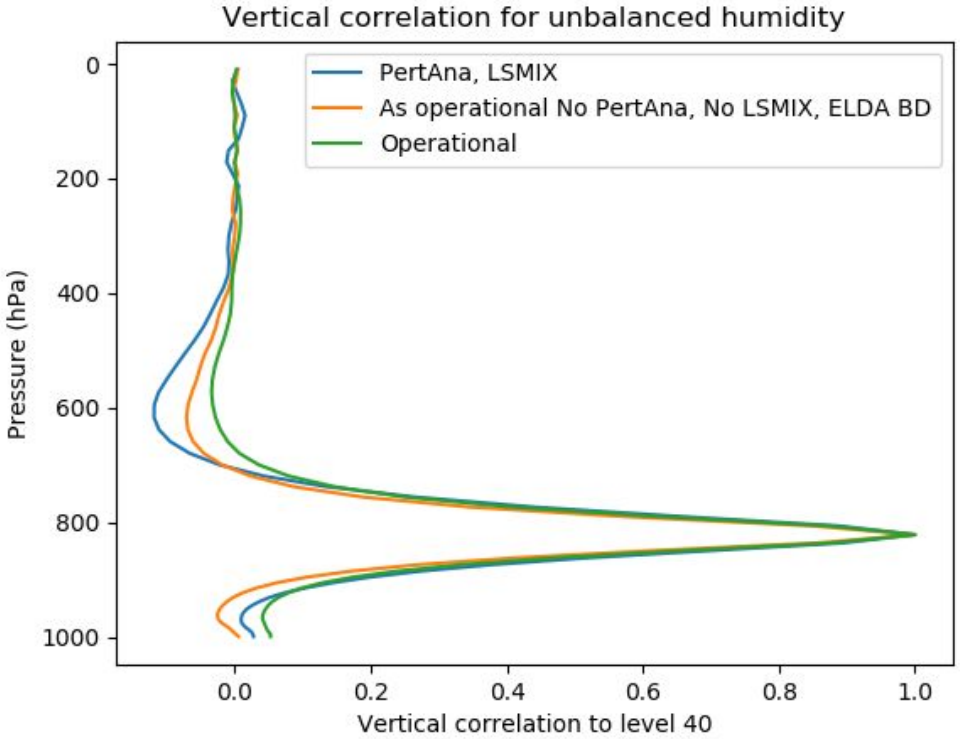
- PertAna and LSMIX makes a much smaller difference with ELDA BD
- IFSENS also has additional perturbations like singular vectors and SPPT
- **Operational** still smaller but based on different periods and more cases



Impact of IFSENS boundaries and switching off PertAna

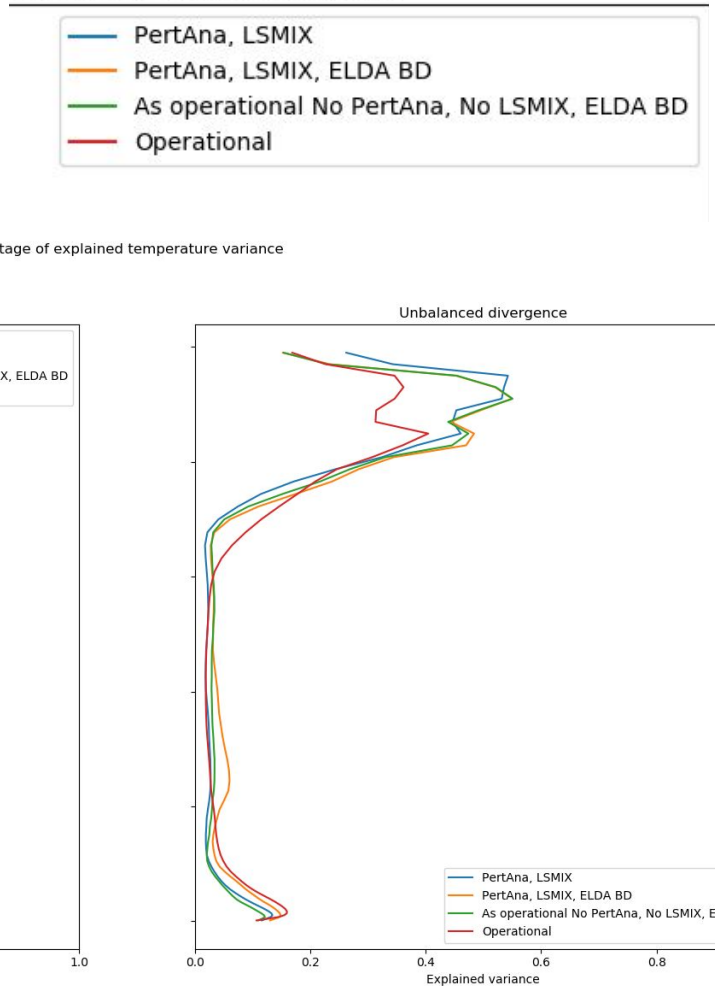
Sharper vertical structure with **ELDA**

Note that IFSENS has 91 levels and ELDA has 137 levels which allows finer vertical structures. Will change in a month with CY47r2!



Comparing the balances

- More balanced field, larger scales with IFSENS boundaries compared to EDA



The current configuration of MEPS cannot be used to derive background error statistics, but we've learned a few things:

- PertAna when combined with IFSENS introduces too large scales
  - PertAna is efficient for initial spread in the ensemble but apparently has some side effects. Introduces noise if not reduced.
  - We need a better balance between EDA and PertAna, or other initial perturbation methods
- IFSENS gives larger scales than ELDA boundaries
  - Targeting for DA purposes and good EPS scores does not combine well, yet.
- Should we adjust MEPS settings, introduce an extra suite for background errors, or wait for some hybrid setup?
- Note that we miss a representation of model uncertainty but SPP is on the way!


Thanks for your attention, questions?