Blending by digital filter - an alternative tool for DA

maria.derkova@shmu, martin.bellus@shmu.sk

Outline

- What is blending?
- Blending algorithm
- Examples/plots
- Conclusions

Note: no surface blending will be explained

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

Blending is an alternative empirical algorithm to prepare the initial state that combines:

- large scales <u>analysed</u> by a driving/global model
- small scales resolved (<u>forecasted</u>) by LAM

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

Blending is an alternative empirical algorithm to prepare the initial state that combines:
- large scales <u>analysed</u> by a driving/global model
- small scales resolved (<u>forecasted</u>) by LAM

Short-wave part of the LAM signal contains more reliable information on meso-scale than the corresponding mathematically interpolated part of the global model spectra.

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

Blending is an alternative empirical algorithm to prepare the initial state that combines:
- large scales <u>analysed</u> by a driving/global model
- small scales resolved (<u>forecasted</u>) by LAM

Short-wave part of the LAM signal contains more reliable information on meso-scale than the corresponding mathematically interpolated part of the global model spectra.

The scale selection is done by the means of the digital filter technique with empirical tuning based on models analysis and forecasts resolutions (<u>blending truncations and ratio, DFI settings</u>).

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

Blending is an alternative empirical algorithm to prepare the initial state that combines:

- large scales <u>analysed</u> by a driving/global model
- small scales resolved (<u>forecasted</u>) by LAM

Short-wave part of the LAM signal contains more reliable information on meso-scale than the corresponding mathematically interpolated part of the global model spectra.

The scale selection is done by the means of the digital filter technique with empirical tuning based on models analysis and forecasts resolutions (<u>blending truncations and ratio, DFI settings</u>).

The algorithm is based on existing and widely used model configurations (DFI, ee927, e001).

What is blending?

Downscaling mode: initial state is a mathematical interpolation of the driving model analysis into the target model grid => **??** high resolution part of spectra?

Blending is an alternative empirical algorithm to prepare the initial state that combines:
- large scales <u>analysed</u> by a driving/global model
- small scales resolved (<u>forecasted</u>) by LAM

Short-wave part of the LAM signal contains more reliable information on meso-scale than the corresponding mathematically interpolated part of the global model spectra.

The scale selection is done by the means of the digital filter technique with empirical tuning based on models analysis and forecasts resolutions (<u>blending truncations and ratio, DFI settings</u>).

The algorithm is based on existing and widely used model configurations (DFI, ee927, e001).

No direct use of observations! => pseudo-assimilation (upper air)

Blending algorithm (1)

$$I^{BLEND} = G^{ALD}$$

Blending algorithm (1)

$$I^{BLEND} = G^{ALD}_{low}$$

Blending algorithm (1)

$$I^{BLEND} = A^{ARP} \quad G_{low}^{ALD}$$

Blending algorithm (1)

$$I^{BLEND} = A_{low}^{ARP} \quad G_{low}^{ALD}$$

Blending algorithm (1)

$$I^{BLEND} = \widetilde{A^{ARP}_{low}} \quad \widetilde{G^{ALD}_{low}}$$
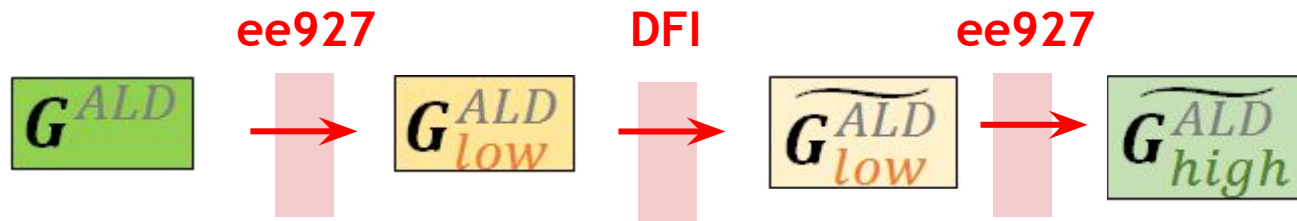
Blending algorithm (1)

$$I^{BLEND} = (\widetilde{A_{low}^{ARP}} - \widetilde{G_{low}^{ALD}})_{high}$$

Blending algorithm (1)

$$I^{BLEND} = G^{ALD} + (\widetilde{A^{ARP}_{low}} - \widetilde{G^{ALD}_{low}})_{high}$$

Blending algorithm (2)

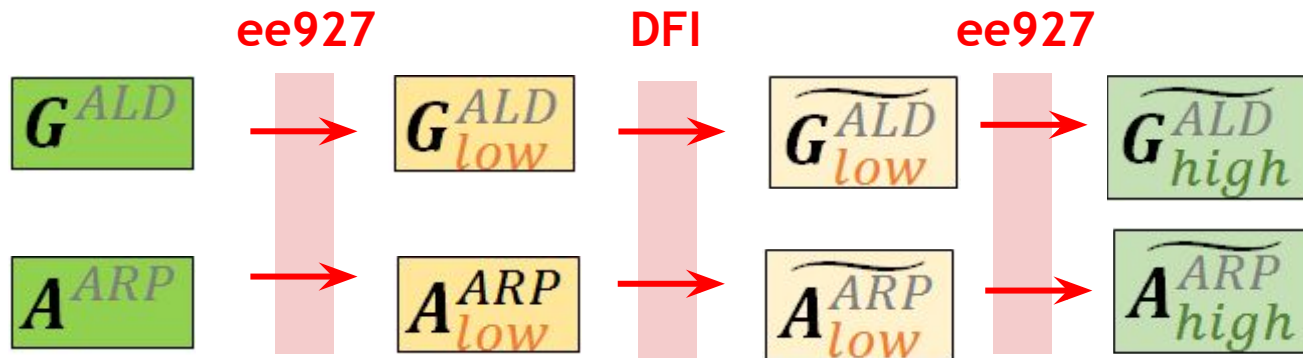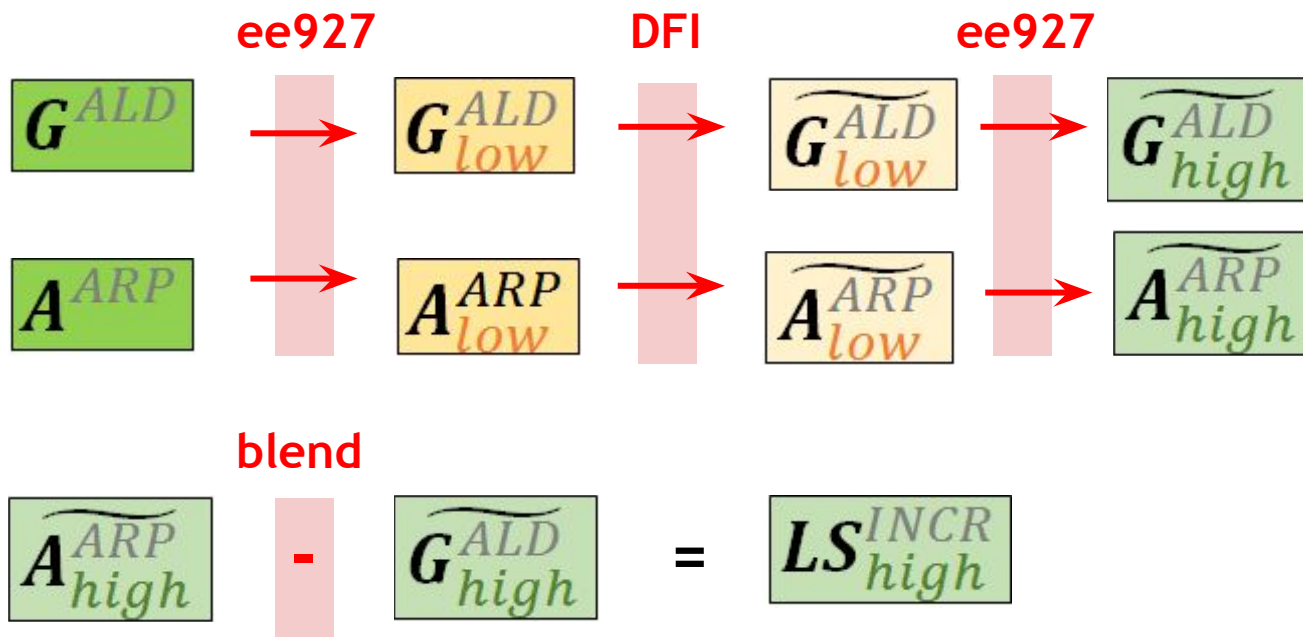$$I^{BLEND} = G^{ALD} + (\widetilde{A_{low}^{ARP}} - \widetilde{G_{low}^{ALD}})_{high}$$

Long waves   Transition zone

Short waves

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + \left(\widetilde{A_{low}^{ARP}} - \boxed{\widetilde{G_{low}^{ALD}}} \right)_{high}$$

G^{ALD}

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + (\widetilde{A_{low}^{ARP}} - \widetilde{G_{low}^{ALD}})_{high}$$

ee927

G^{ALD} $\rightarrow$ G_{low}^{ALD}

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + (\widetilde{A_{low}^{ARP}} - \widetilde{G_{low}^{ALD}})_{high}$$

ee927   **DFI**

G^{ALD} → G_{low}^{ALD} → $\widetilde{G_{low}^{ALD}}$

Blending algorithm (3)

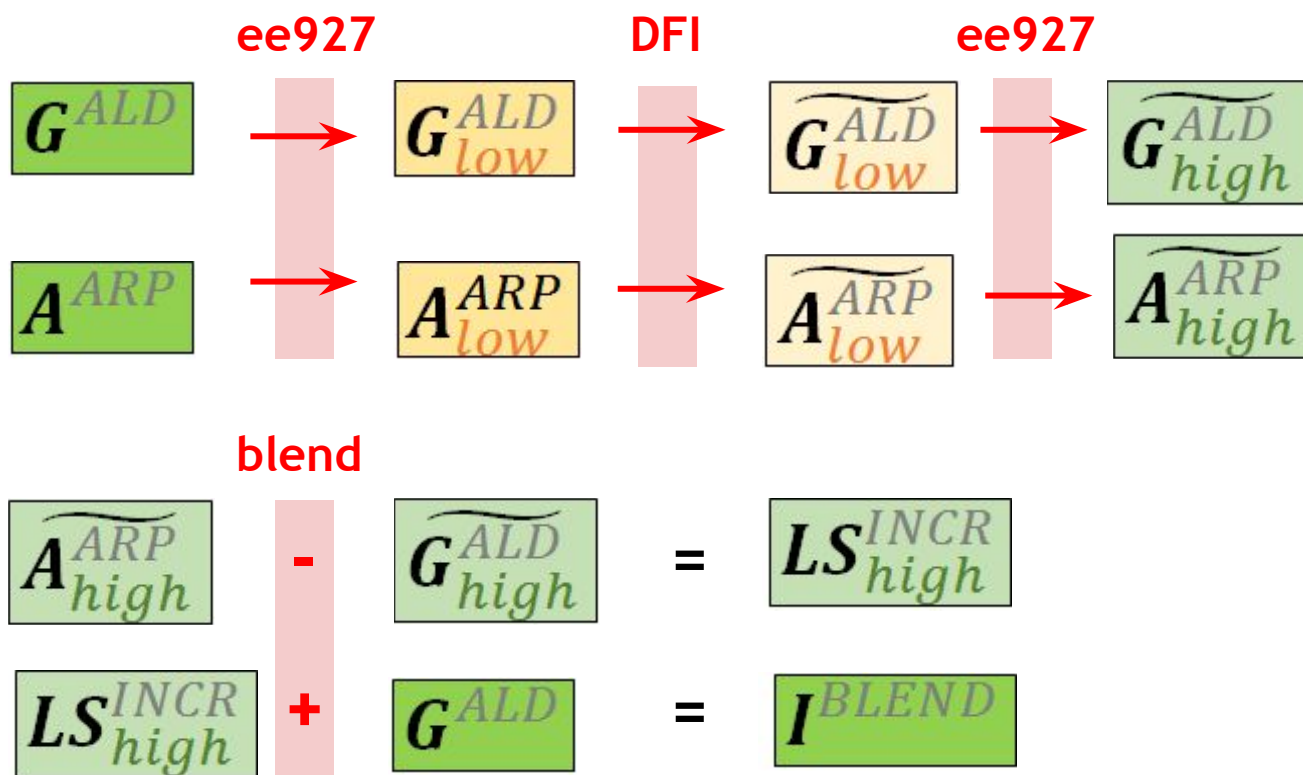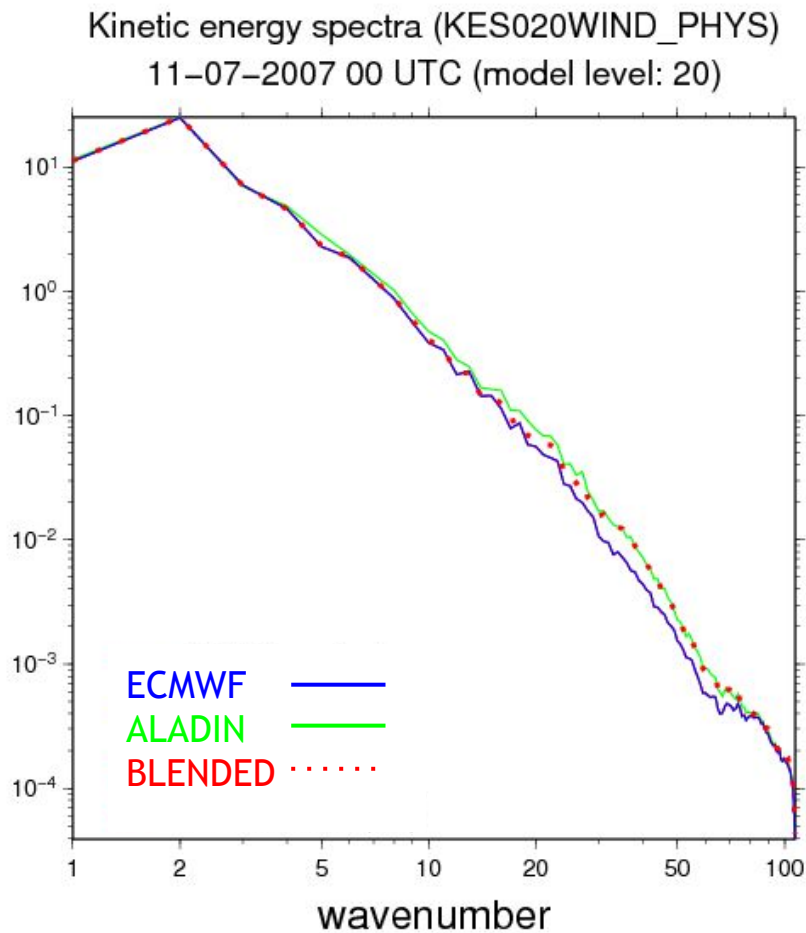$$I^{BLEND} = G^{ALD} + (\; \widetilde{A_{low}^{ARP}} \; - \; \widetilde{G_{low}^{ALD}})_{high}$$

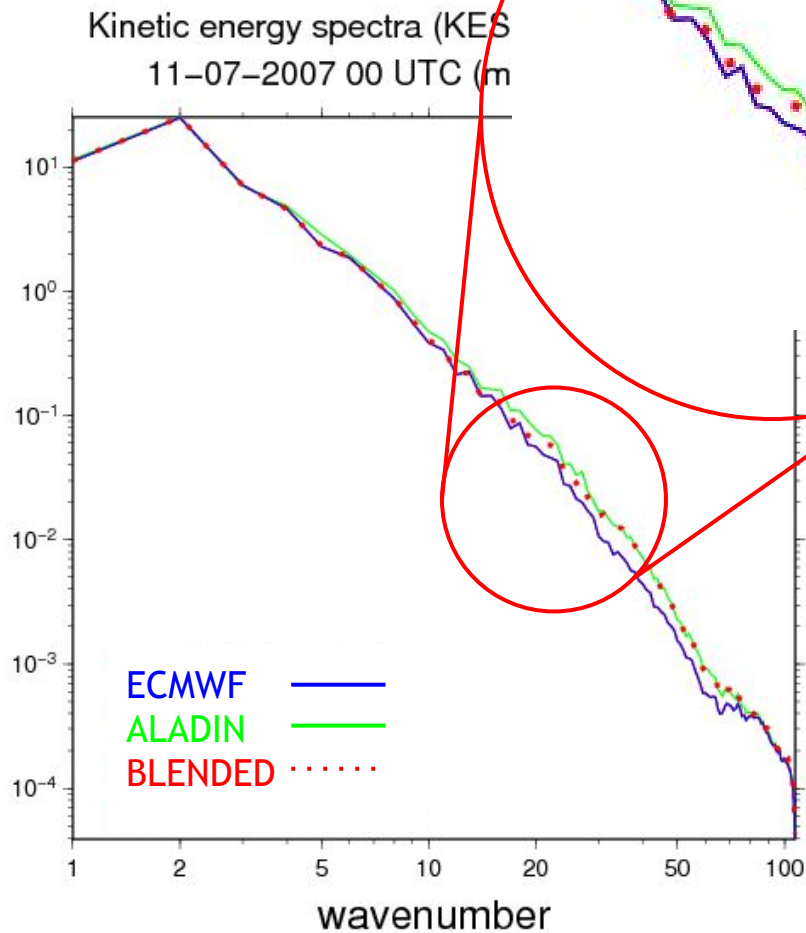**ee927**   **DFI**   **ee927**

G^{ALD} → G_{low}^{ALD} → $\widetilde{G_{low}^{ALD}}$ → $\widetilde{G_{high}^{ALD}}$

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + (\boxed{\widetilde{A^{ARP}_{low}}} - \widetilde{G^{ALD}_{low}})_{high}$$

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + \left(\widetilde{A^{ARP}_{low}} - \widetilde{G^{ALD}_{low}} \right)_{high}$$

Blending algorithm (3)

$$I^{BLEND} = G^{ALD} + (\widetilde{A_{low}^{ARP}} - \widetilde{G_{low}^{ALD}})_{high}$$

ee927 **DFI** **ee927**

$G^{ALD} \rightarrow G_{low}^{ALD} \rightarrow \widetilde{G_{low}^{ALD}} \rightarrow \widetilde{G_{high}^{ALD}}$

$A^{ARP} \rightarrow A_{low}^{ARP} \rightarrow \widetilde{A_{low}^{ARP}} \rightarrow \widetilde{A_{high}^{ARP}}$

blend

$\widetilde{A_{high}^{ARP}}$ - $\widetilde{G_{high}^{ALD}}$ = LS_{high}^{INCR}
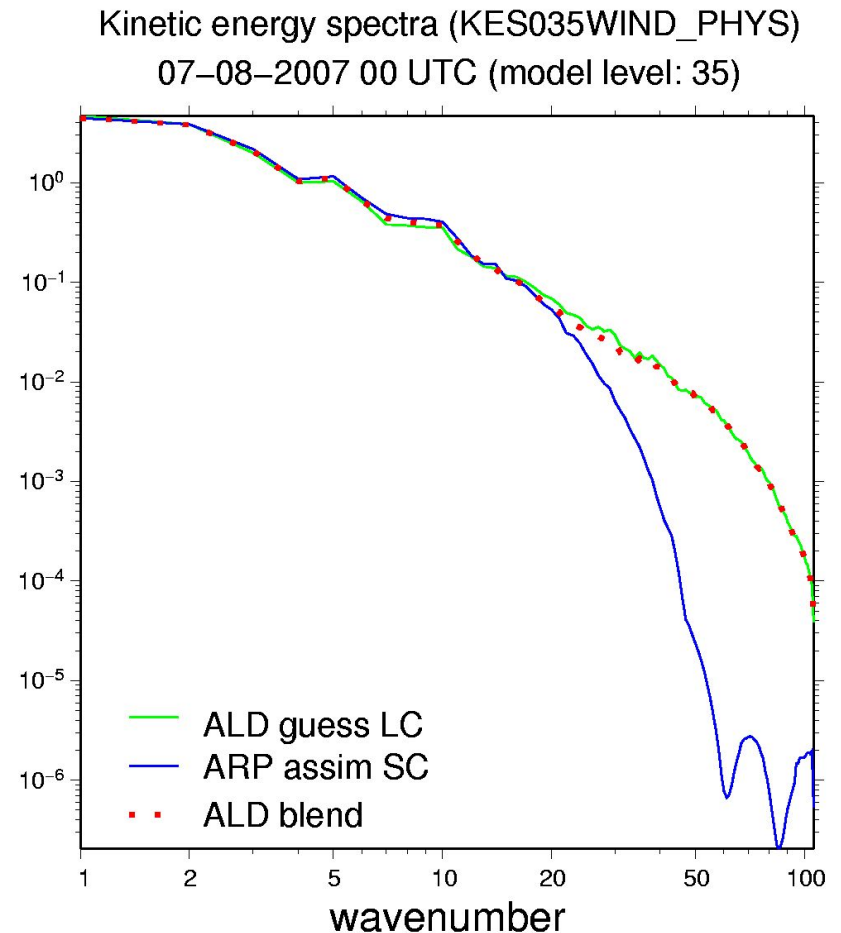
LS_{high}^{INCR} + G^{ALD} = I^{BLEND}

Blending plots: spectra

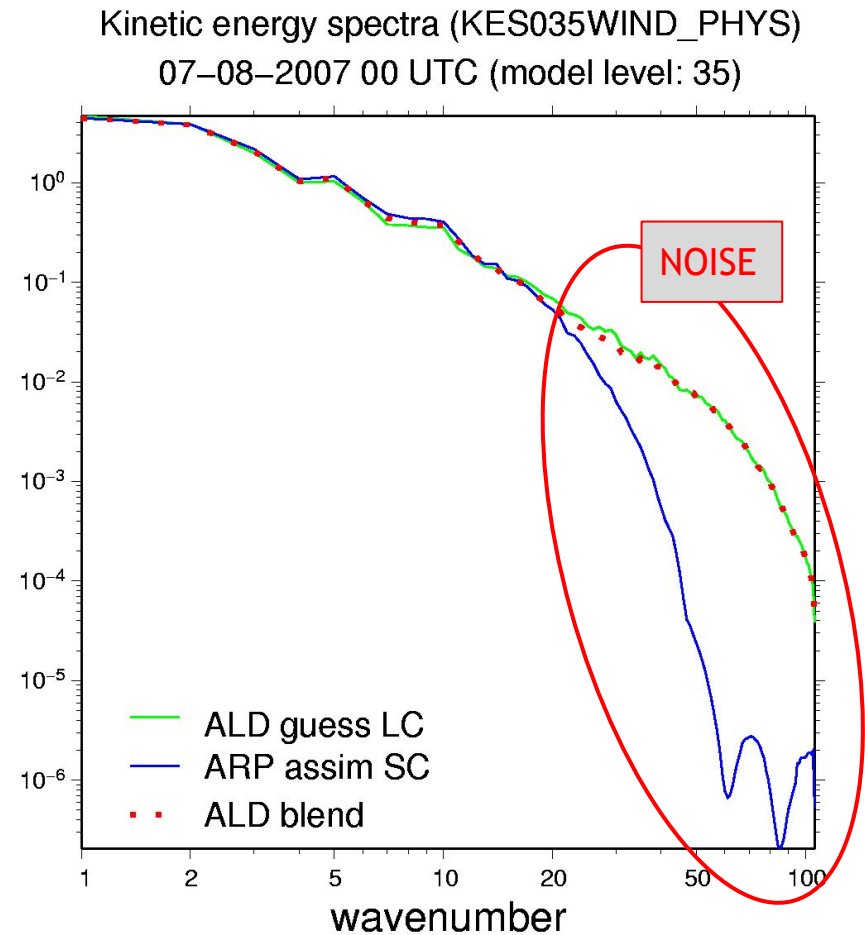ECMWF KE lev20

Blending plots: spectra

ECMWF KE lev20

Kinetic energy spectra (KES
11–07–2007 00 UTC (m

ECMWF ——
ALADIN ——
BLENDED ······

wavenumber

Blending plots: spectra

Kinetic energy spectra (KES020WIND_PHYS)
11–07–2007 00 UTC (model level: 20)

ECMWF ——
ALADIN ——
BLENDED ······

Kinetic energy spectra (KES035WIND_PHYS)
07–08–2007 00 UTC (model level: 35)

ALD guess LC
ARP assim SC
ALD blend

Blending plots: spectra

Kinetic energy spectra (KES020WIND_PHYS)
11–07–2007 00 UTC (model level: 20)

ECMWF ⎯⎯
ALADIN ⎯⎯
BLENDED ······

Kinetic energy spectra (KES035WIND_PHYS)
07–08–2007 00 UTC (model level: 35)

NOISE

ALD guess LC
ARP assim SC
ALD blend

Blending plots: precipitation forecast

1h precipitation field from operational suite, e-suite with blending and INCA analysis
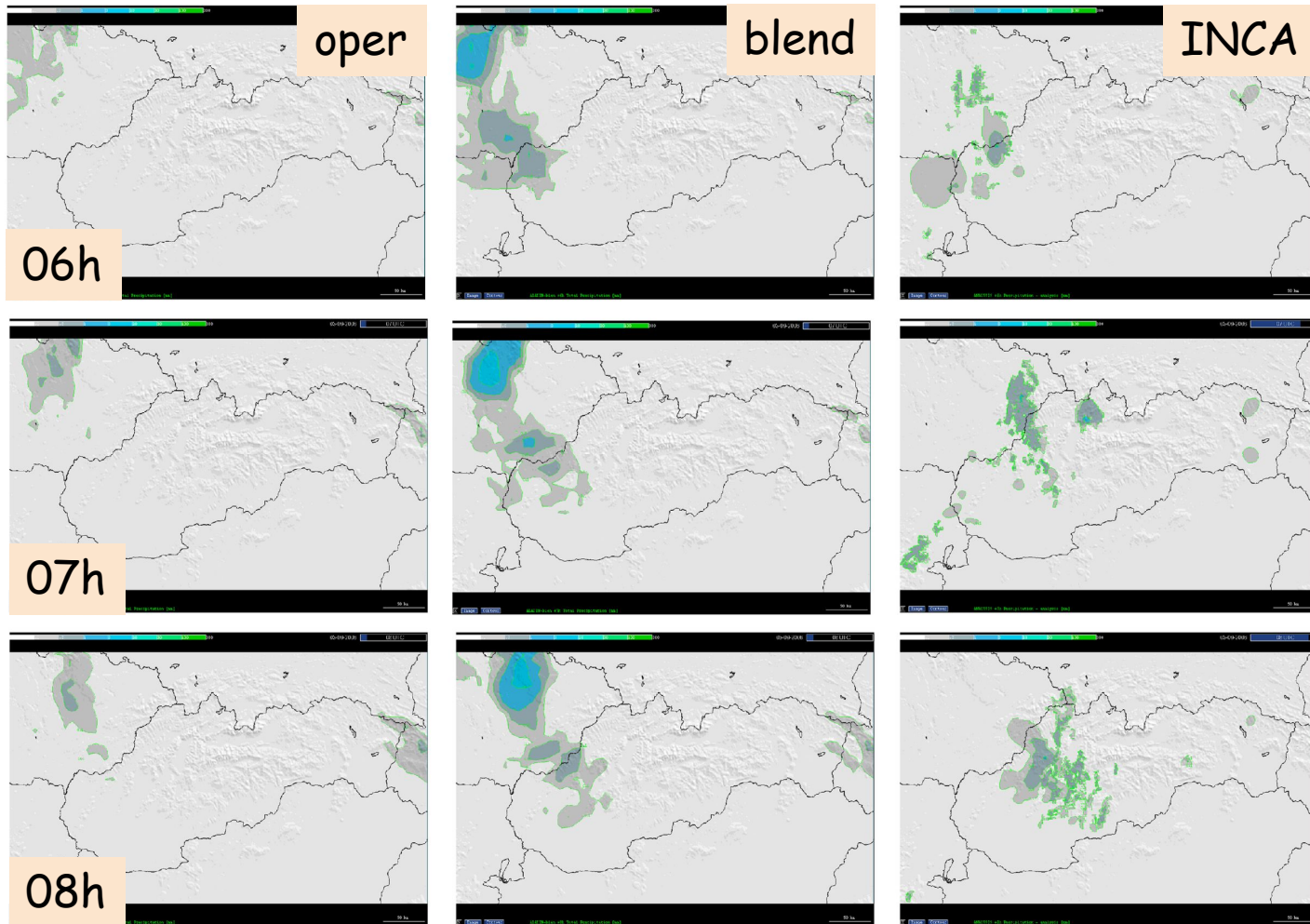
Blending plots: wind initial state

Initial state of the 10m wind field from a reference experiment and after blending: local effects (induced by orography) better described. MFSTEP project, case 24/08/2006 06UTC.
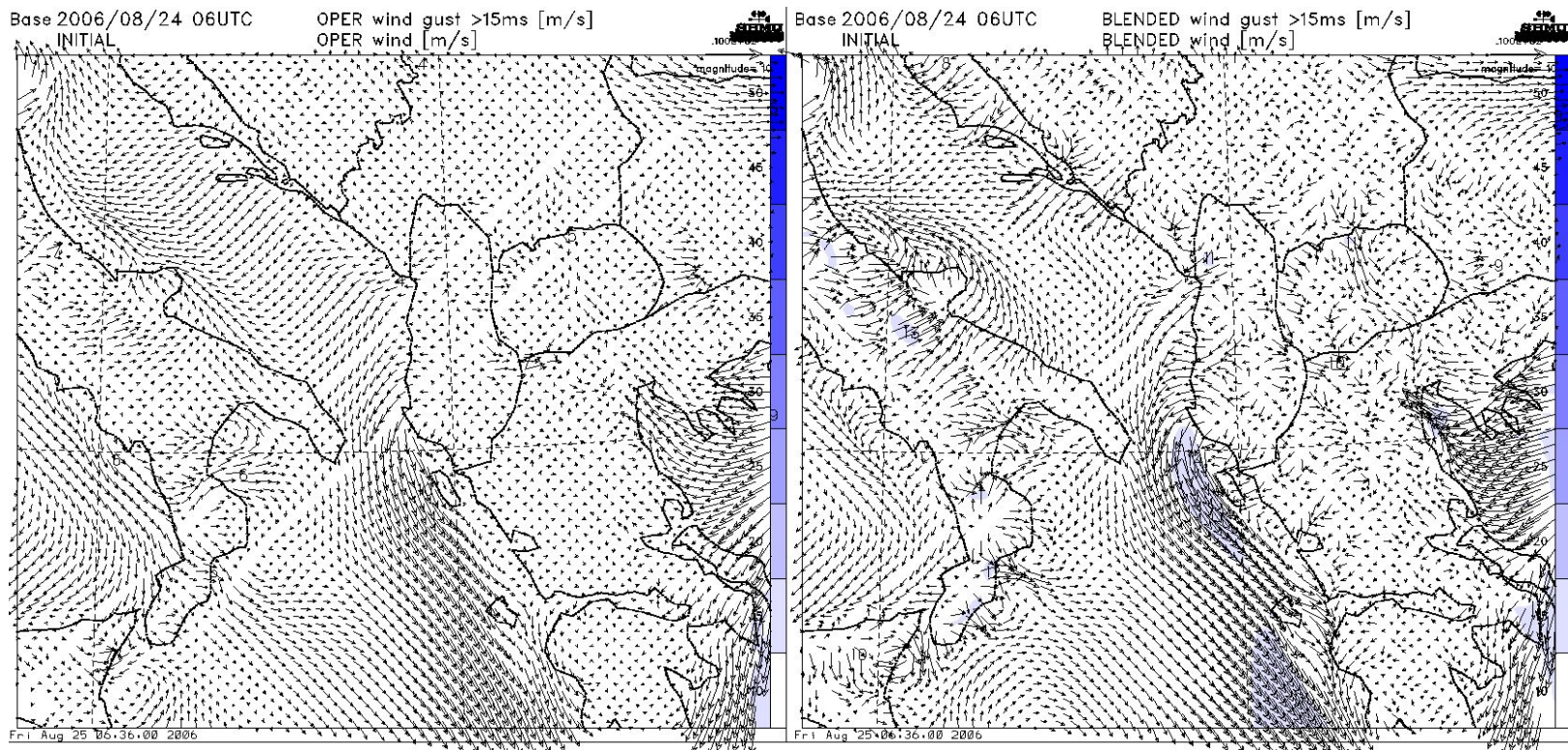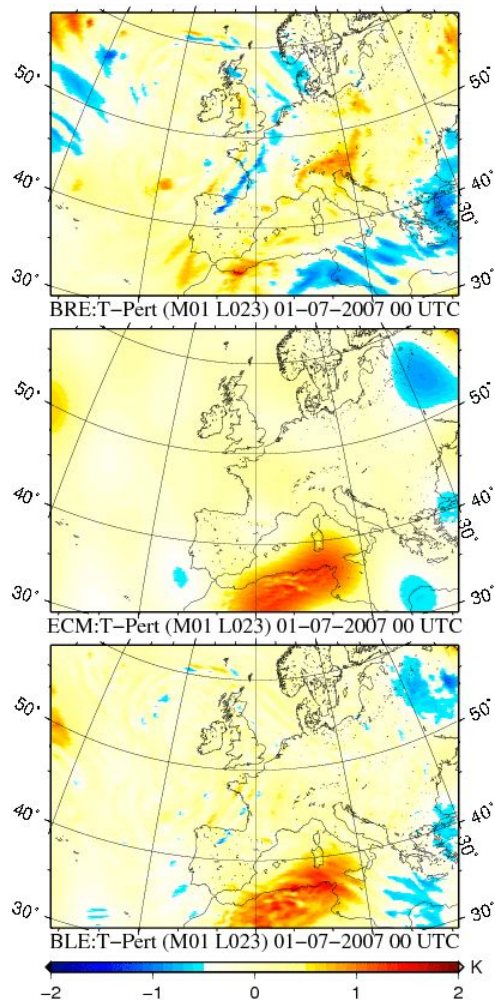
Blending plots: cloudiness initial state

Initial state of the cloudiness field from a reference experiment and after blending compared to the MSG view: more small scale details are present in the blended state (24/08/2006 06UTC).
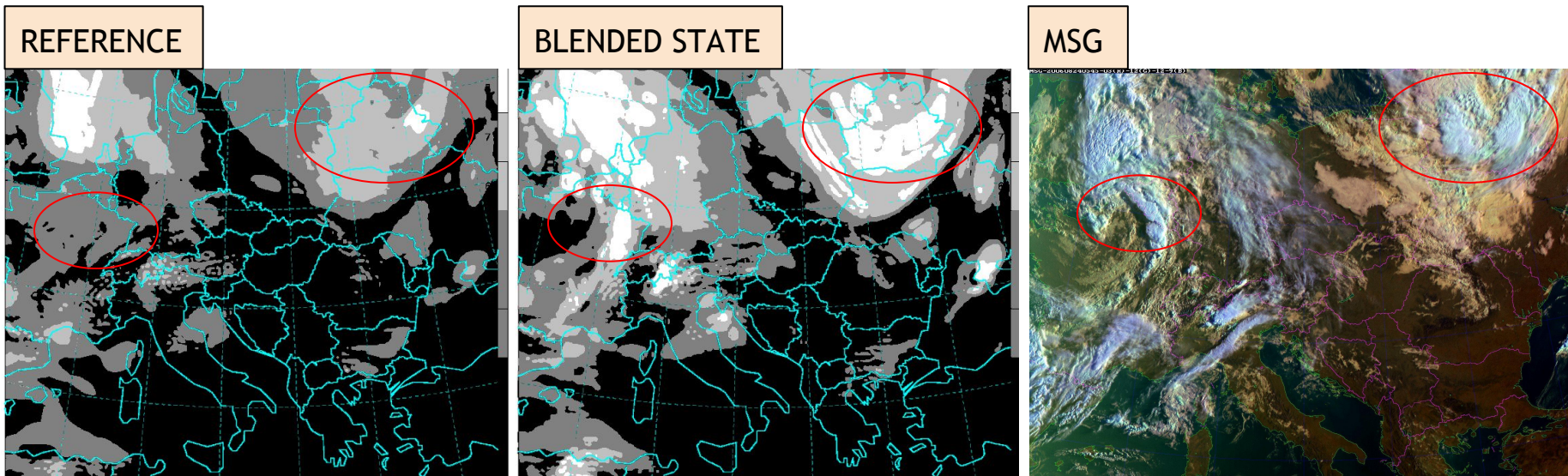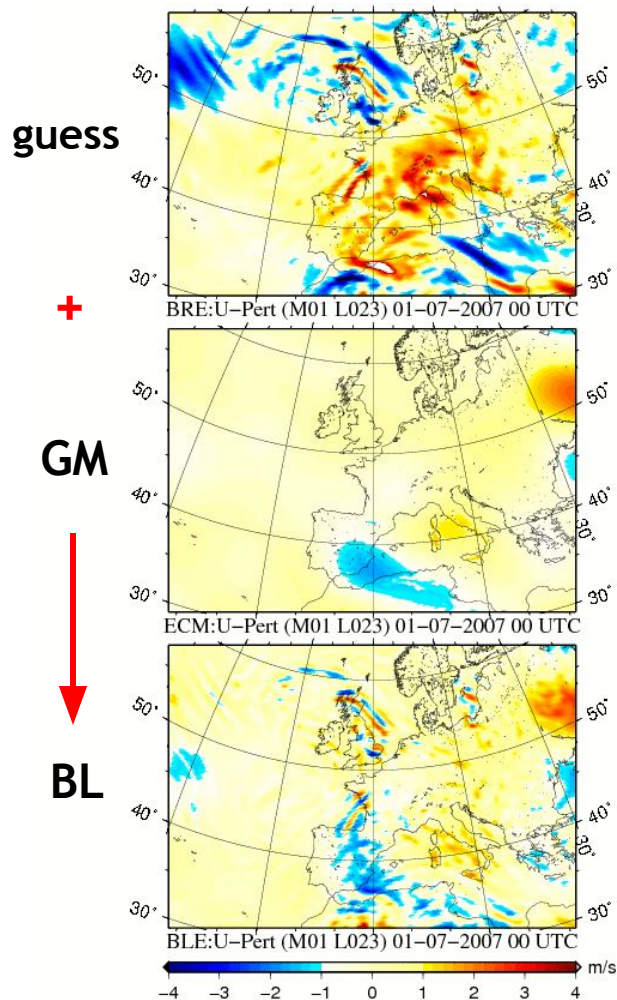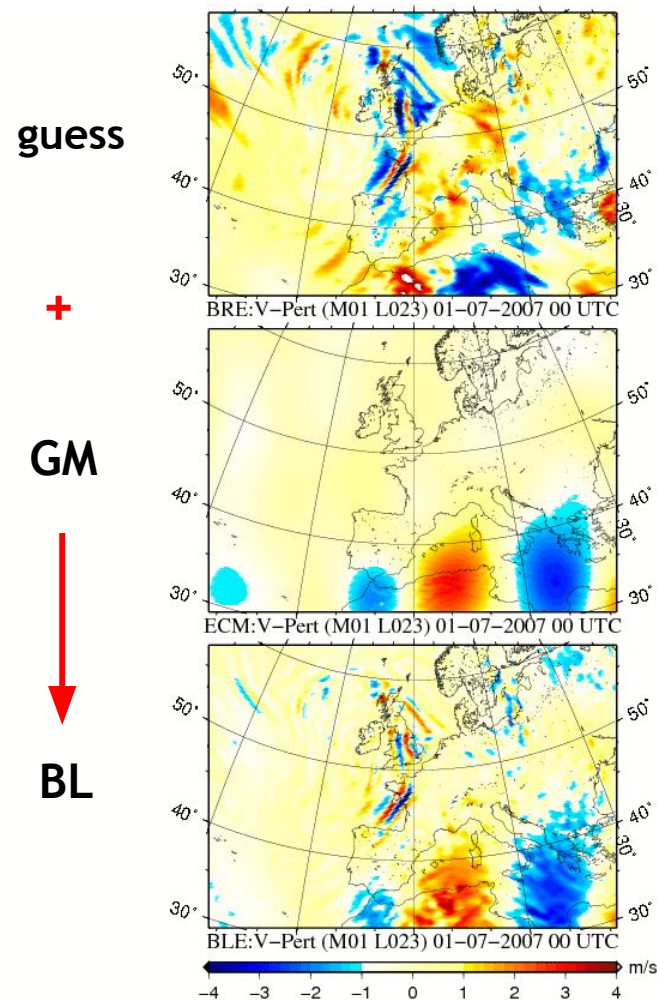
Blending plots: LAEF 850 hPa INIT

Conclusions

- Blending is an alternative tool for (*pseudo-*)assimilation (no observation used!)

- Numerical noise (from spatial interpolation into the finer grid) is replaced by physically meaningful signal

- Small scale features are preserved in pseudo-assimilation cycle

- Blending is quite complicated and costly procedure but definitely it has some impact (although no scores shown)