DHMZ

# Evaluation of the ability of progressively finer MNWP models to reproduce wind regimes in complex terrain
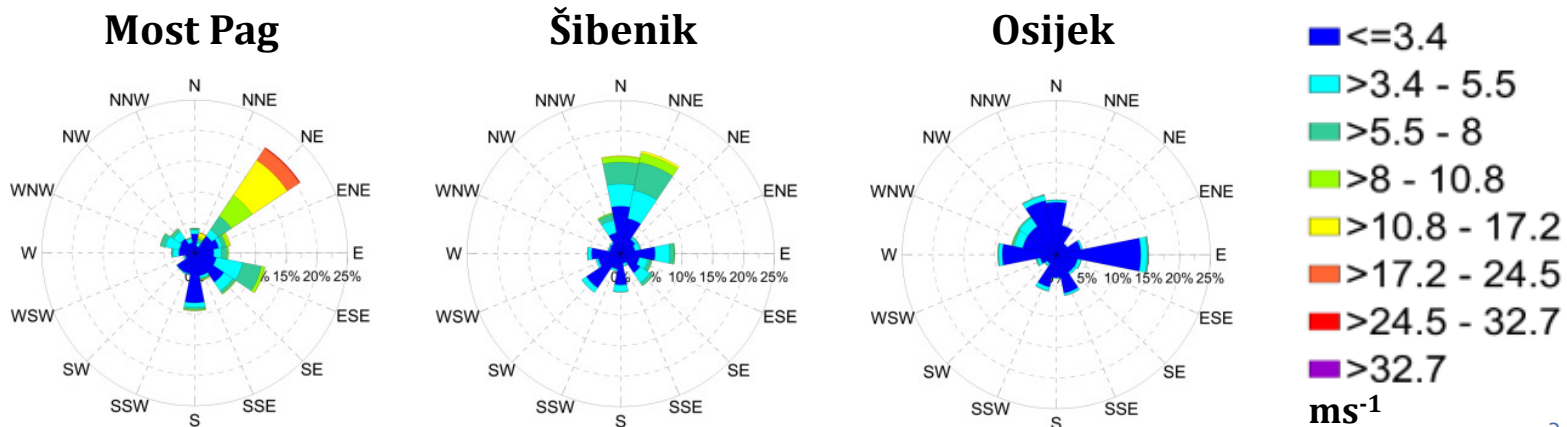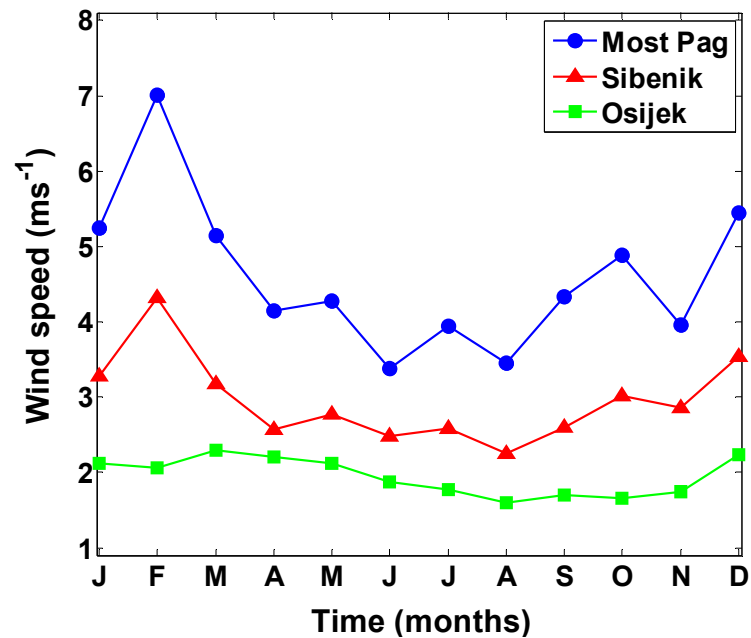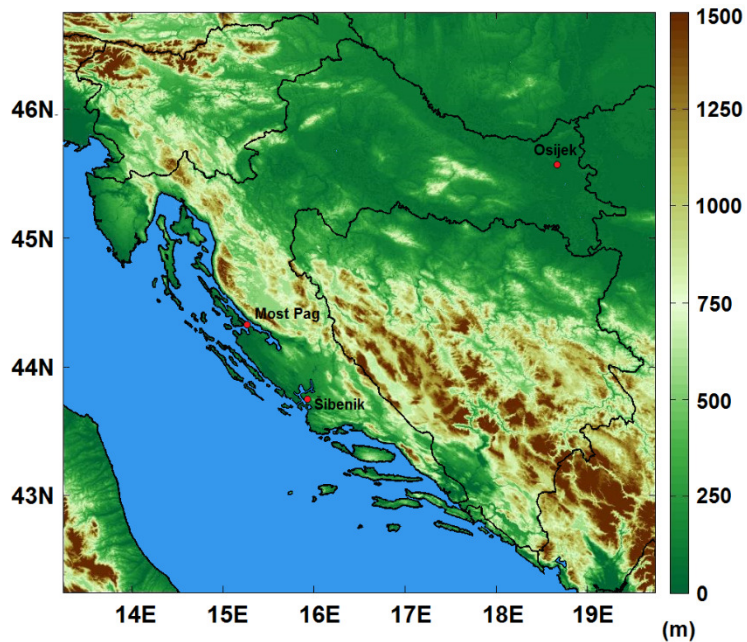
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Workshop on advances in meso- and micro-meteorology
Jezerčica thermae, Donja Stubica, Croatia
4. November 2014.,

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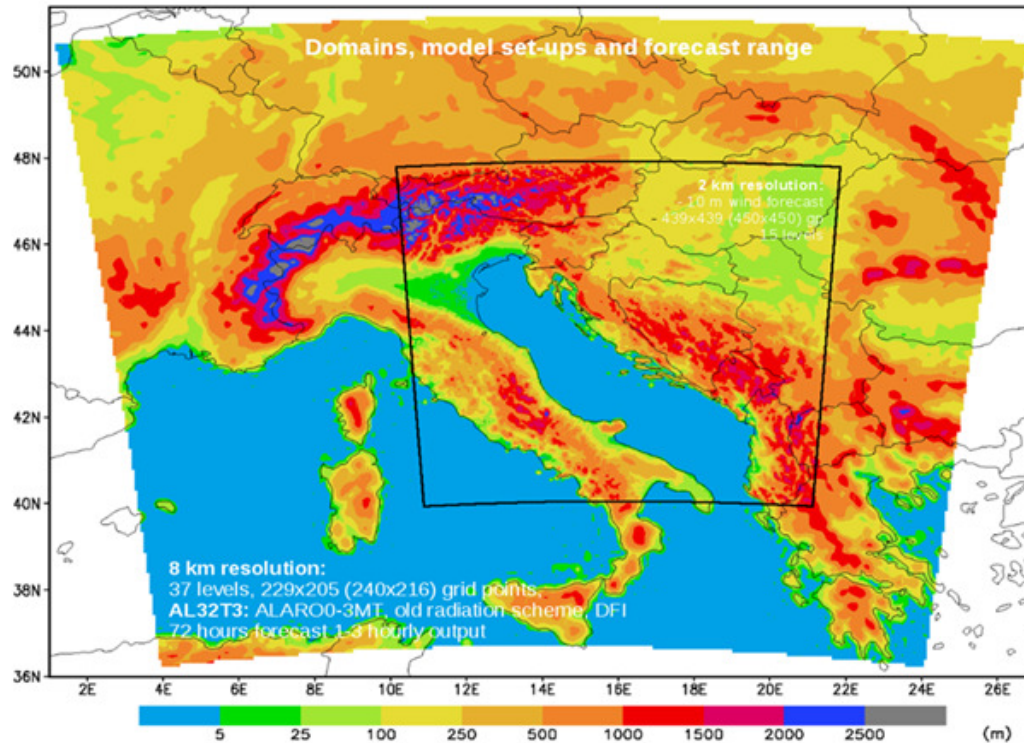
- Introduction

- Data and methods

- Results

- Conclusion

# Introduction





### Most Pag



### Šibenik



### Osijek

# Introduction

- Objectives:

  1) to evaluate the overall model performance and to quantify among different sources of errors

  2) to provide the scale dependent measure of model performance

# Data and methods



Domains, model set-ups and forecast range

8 km resolution:
37 levels, 229x205 (240x216) grid points,
AL32T3: ALARO0-3MT, old radiation scheme, DFI
72 hours forecast 1-3 hourly output

- Covered period: 2010-2012.
- 10 min wind speed time series
- Modeled series with 1-3 hours output

## ALADIN 8 km:

- 37 levels
- 240 x 216 grid points
- 72-hourly forecast
- 3 hours output
- hydrostatic
- initialized at 00 UTC

## DADA 2 km:

- 15 levels
- 450 x 450 grid points
- 72-hourly forecast
- 3 hours output
- hydrostatic
- initialized at 00 UTC

## ALADIN 2 km:

- 37 levels
- 450 x 450 grid points
- 24-hourly forecast
- 1 hours output
- non-hydrostatic
- Initialized at 06 UTC

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# Data and methods

- Statistical verification: MBIAS, RMSE and MAE (monthly averaged)

- RMSE decomposition:

$$\overline{(f - o)^2} = (\bar{f} - \bar{o})^2 + (\sigma_f - \sigma_o)^2 + 2\sigma_f \sigma_o (1 - r_{fo})$$

$\quad\quad\quad$ RMSE$^2$ $\quad\quad\quad$ BM$^2$ $\quad\quad\quad$ BSD$^2$ $\quad\quad\quad$ PHE$^2$

- Spectral decomposition in wavenumber and frequency domain

- PSD in spectral ranges (model and measurements):

  ➢ Larger than diurnal (LTD) → 26 hours – 7 days

  ➢ Diurnal (DIU) → 22 - 26 hours

  ➢ Sub-diurnal (SUB) → 6 – 22 hours
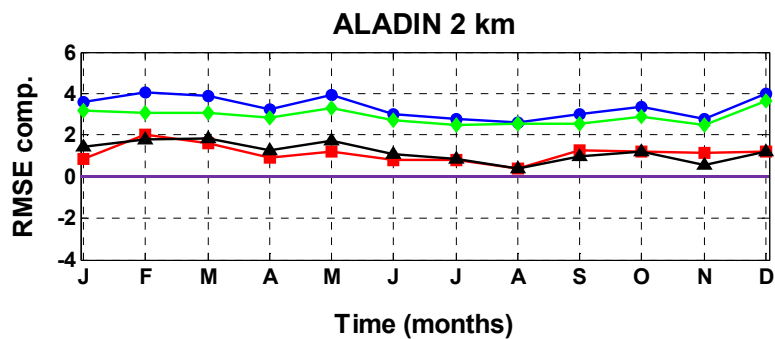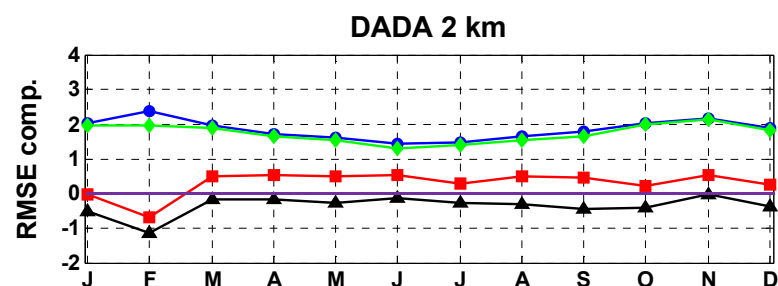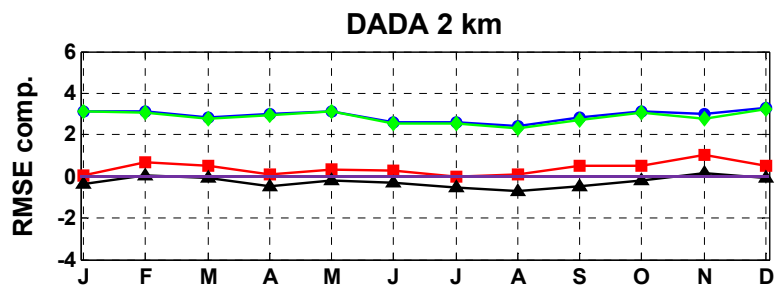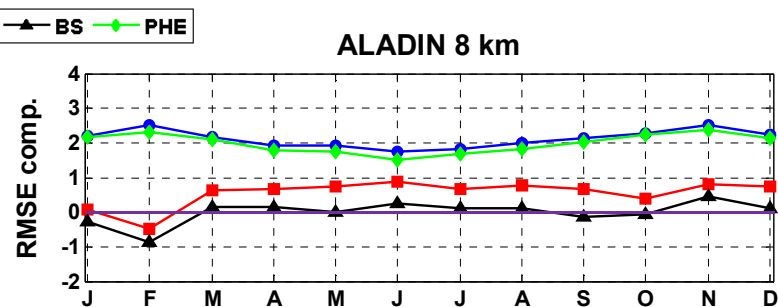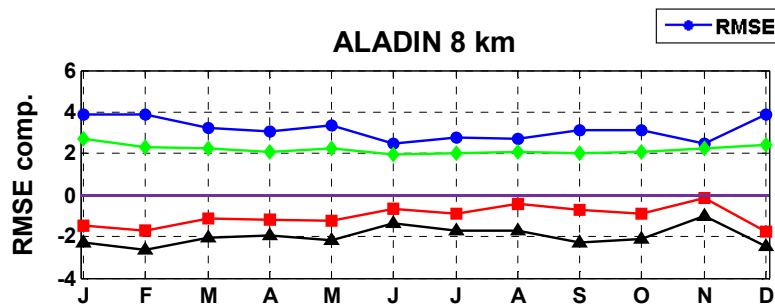
# Results – Statistical verification
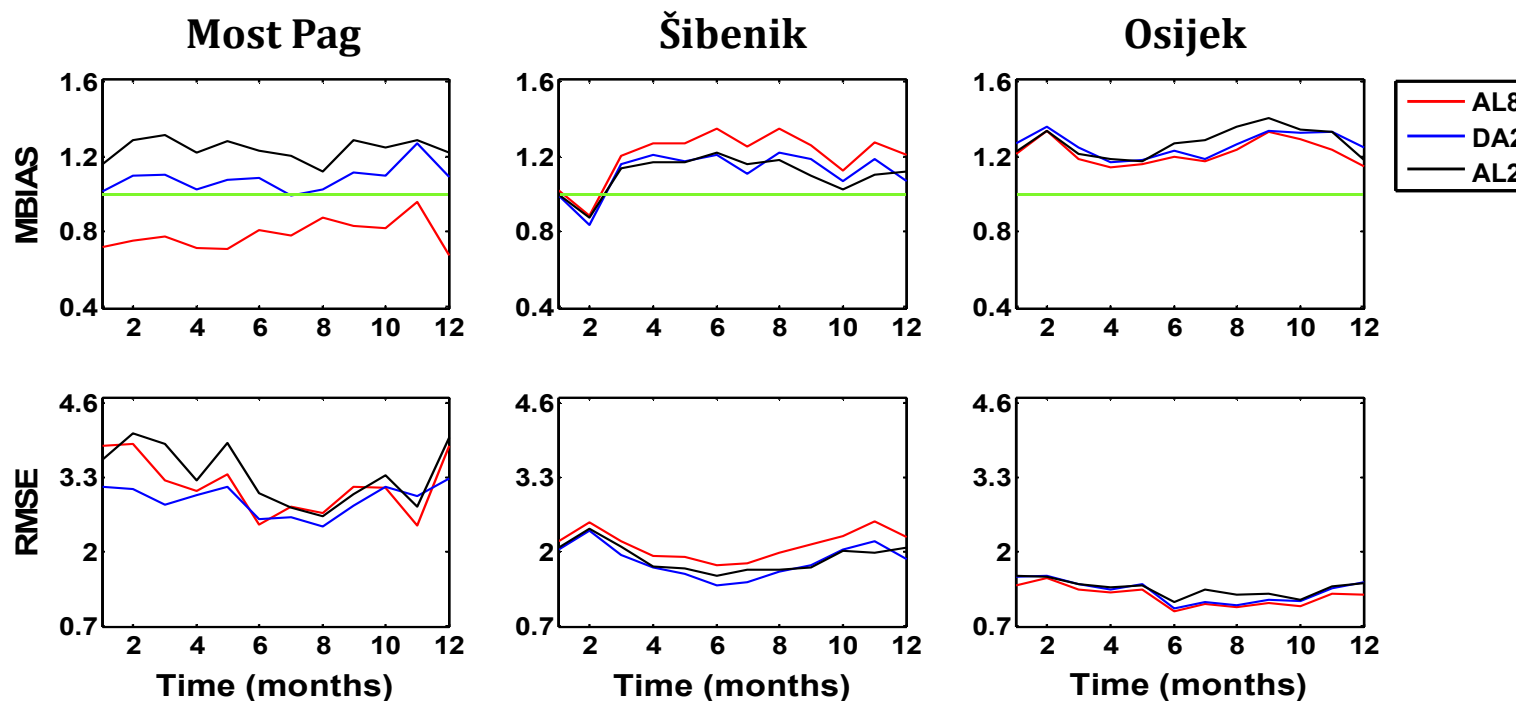


Table1. 2010-2012. period average continuous statistical scores at Most Pag, Šibenik and Osijek stations

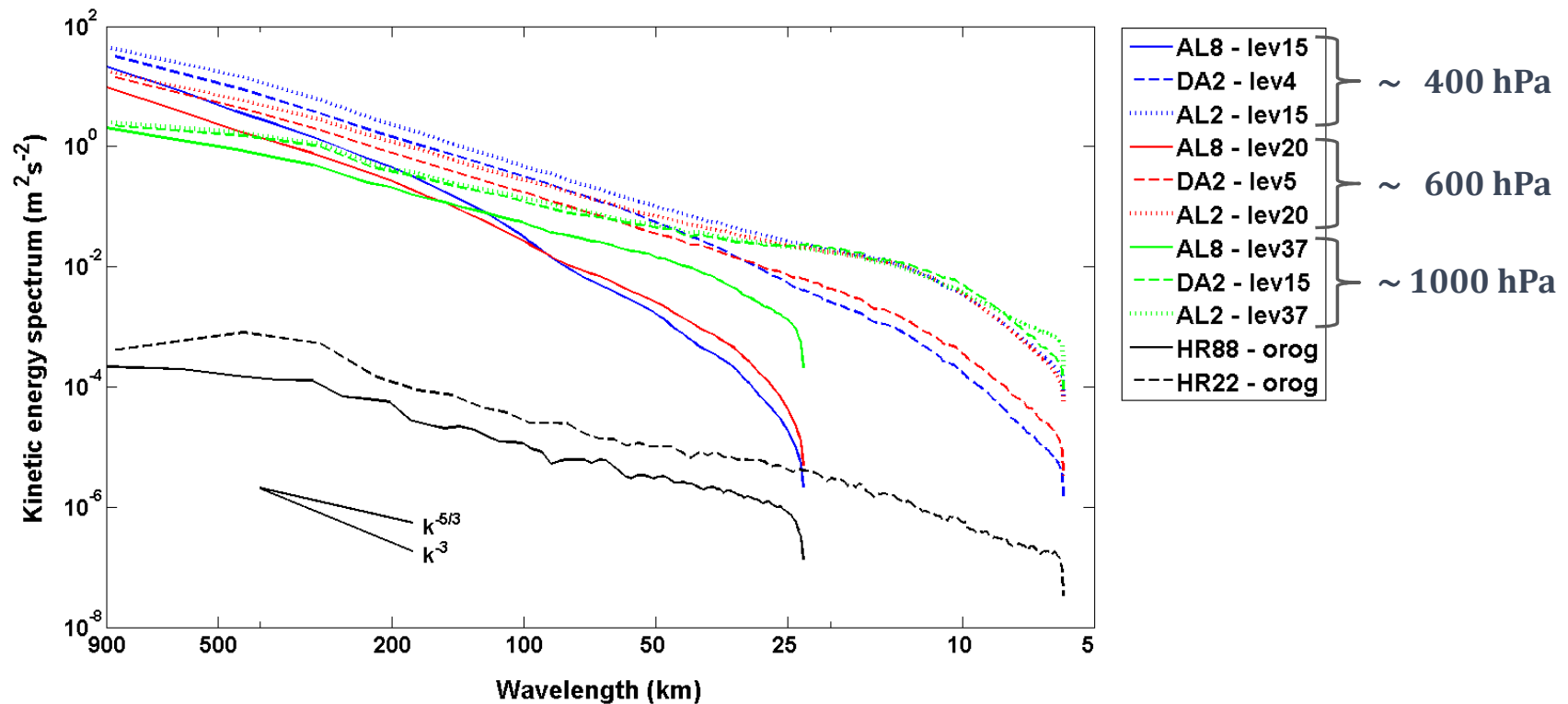| | MBIAS | | | RMSE | | |
|---|---|---|---|---|---|---|
| | Mpa | Šib | Osi | Mpa | Šib | Osi |
| AL8 | 0.78 | 1.21 | 1.22 | 3.16 | 2.12 | 1.22 |
| DA2 | 1.08 | 1.12 | 1.26 | 2.92 | 1.84 | 1.31 |
| AL2 | 1.24 | 1.10 | 1.28 | 3.36 | 1.90 | 1.26 |

# Results – RMSE decomposition
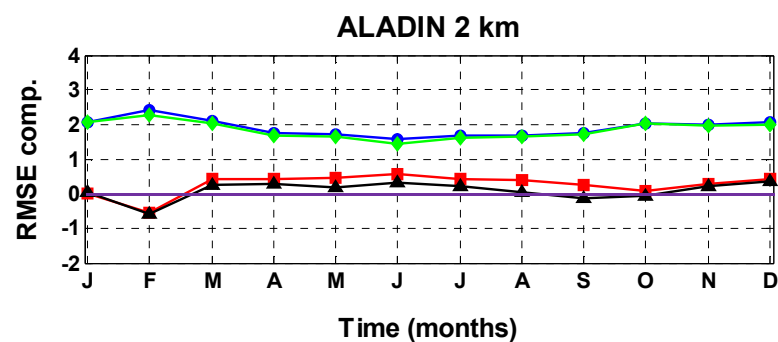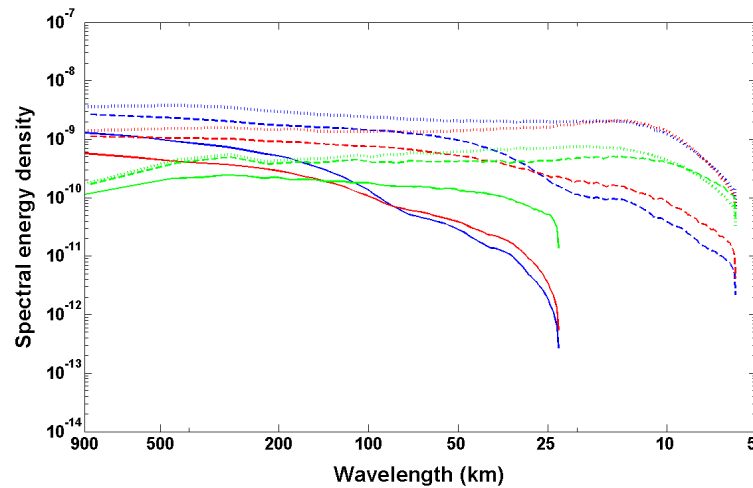


**Most Pag**

**Šibenik**

# Results – Kinetic energy spectra

- Qualitative tool for model evaluation
- Large scale spectra $\sim k^{-3}$, 'turbulent' spectra $\sim k^{-5/3} \rightarrow$ mesoscale (?)
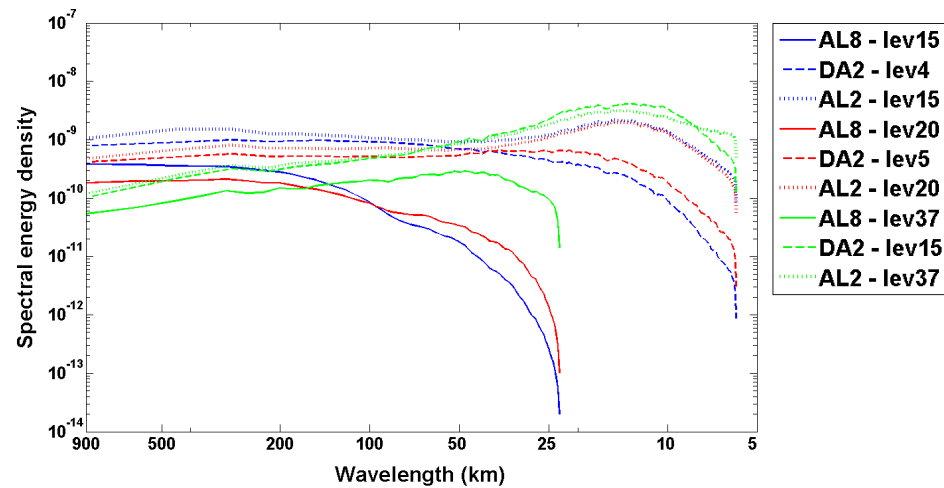- Effective resolution $\approx$ 4-5 $\Delta$x

# Results – Vorticity and divergence spectra

- All spectra comparable for scales larger than 200 km

- Vorticity is more energetic for scales > 200 km

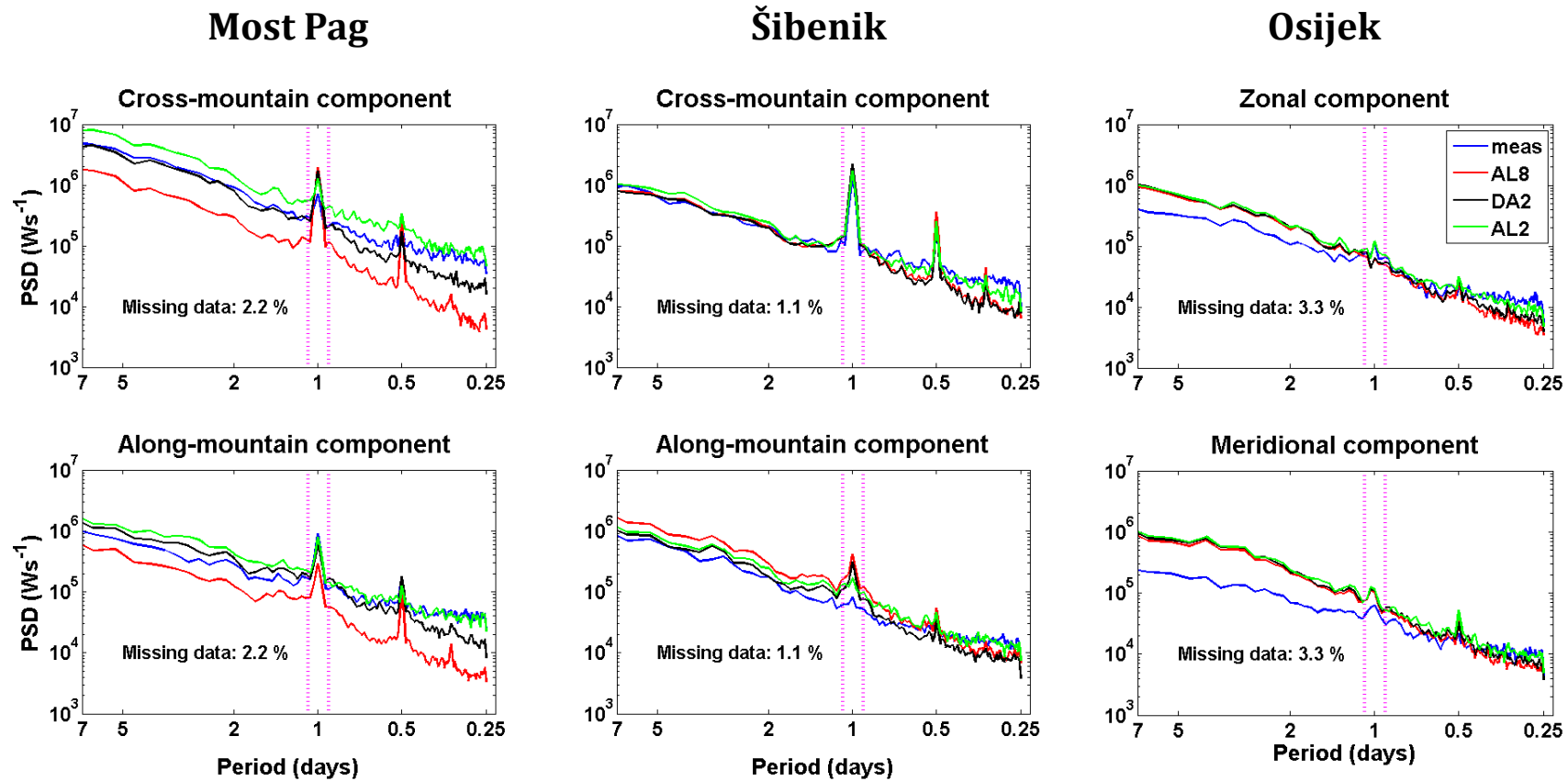- Divergence domintes for scales < 100 km



**Vorticity**

**Divergence**

Legend:
- AL8 - lev15
- DA2 - lev4
- AL2 - lev15
- AL8 - lev20
- DA2 - lev5
- AL2 - lev20
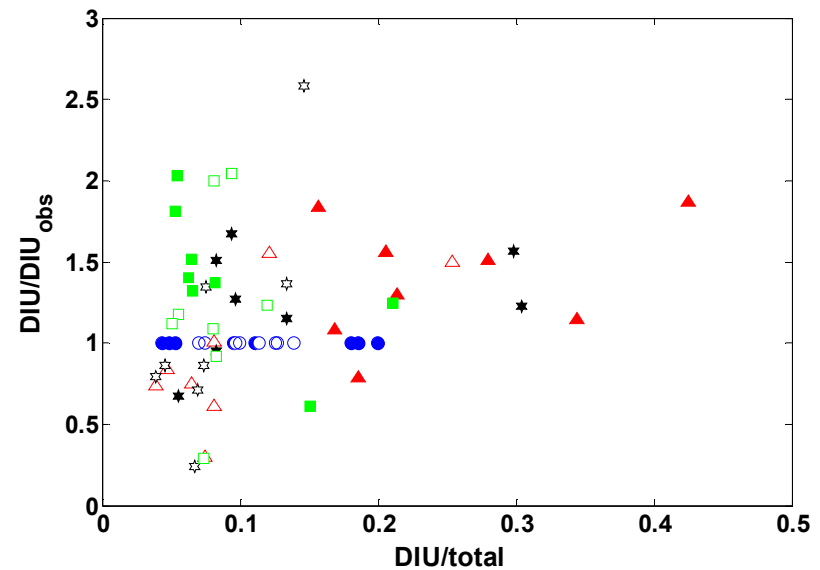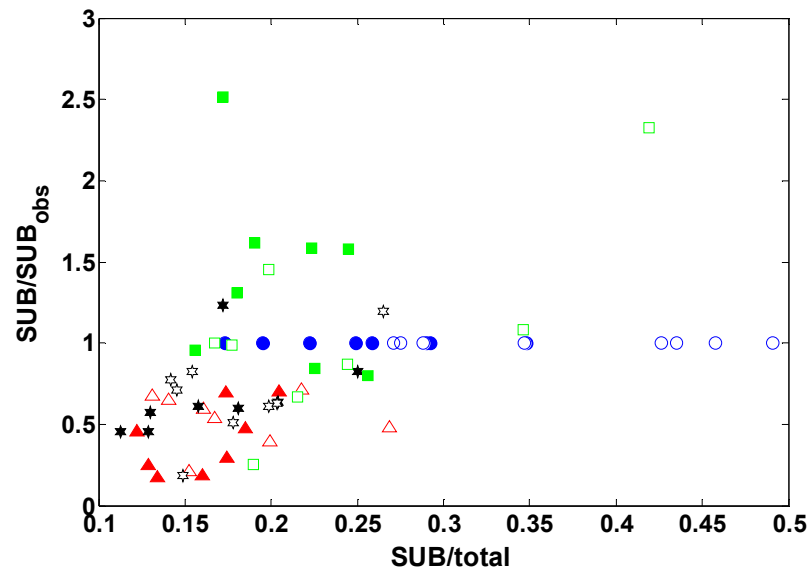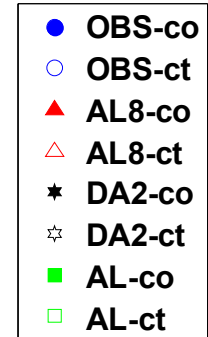- AL8 - lev37
- DA2 - lev15
- AL2 - lev37

# Results – Power spectral density

- Spectra of components rather than of wind speed

- ALADIN 2 km forecasts improve simulation of DIU and SUB motions

# Results – PSD in spectral ranges

- Zonal and cross-mountain components

- Major improvement for DIU and SUB cross-mountain motions

- Along-mountain SUB motions not adequatly resolved

# Conclusions

- ALADIN 8 km model is sufficient for wind forecast in continental part of Croatia

- In coastal part forecast generally improves with increasing the model resolution

- The largest portion of errors can be atributed to phase errors

- KE spectra follow the $k^{-3}$ at larger scales in upper troposphere and flatten towards the surface

- The most significant increase of accuracy was found for diurnal periods of motions in cross-mountain direction
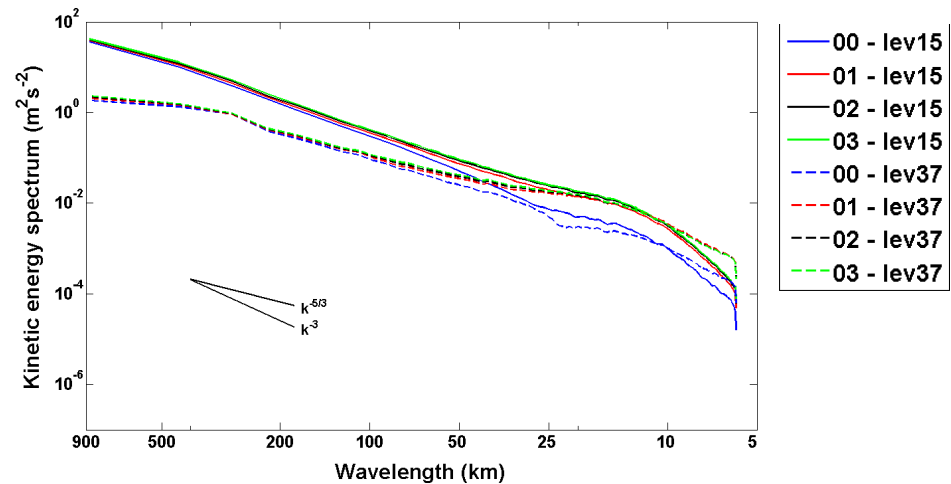
# Apendix – A
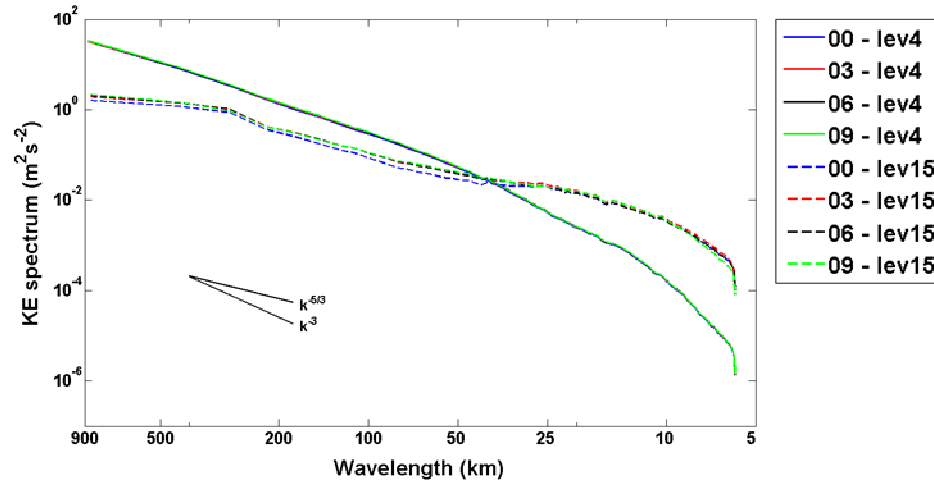
**DADA 2 km**



- ME builds up faster in the upper troposphere
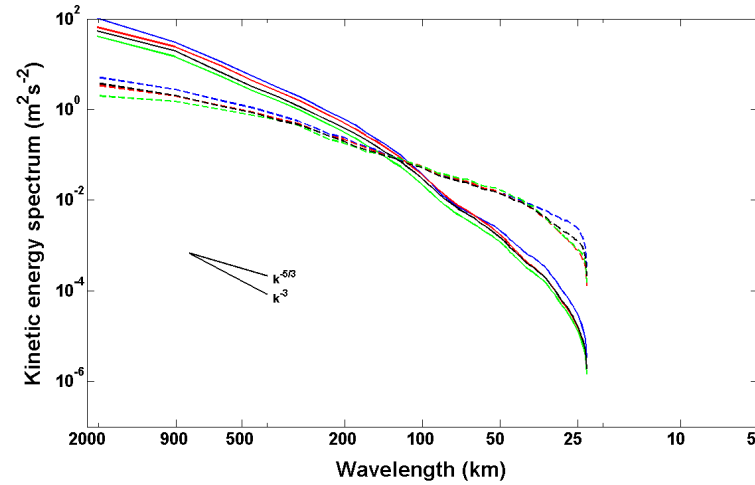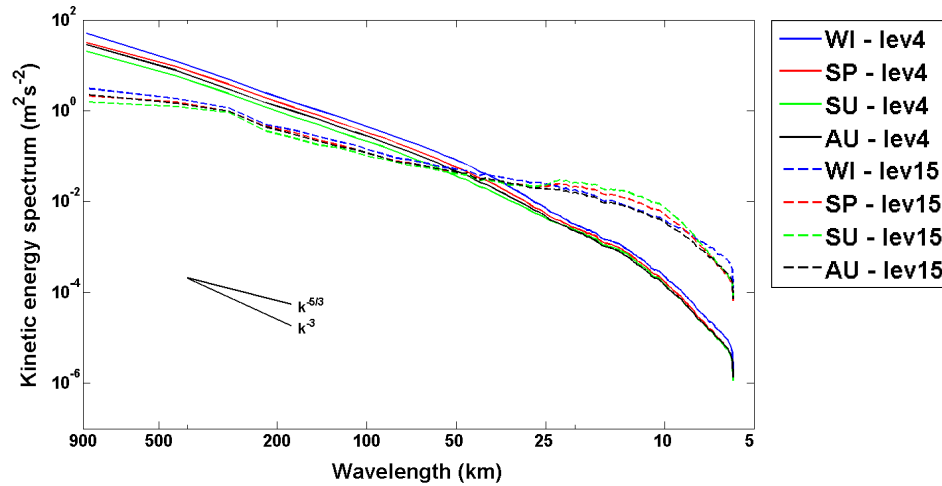- spin up time is shortest for ALADIN 2 km model
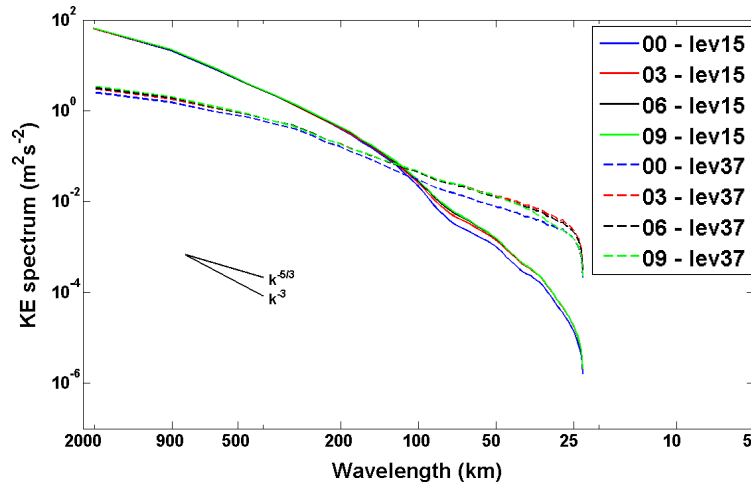


**ALADIN 8 km**



**ALADIN 2 km**
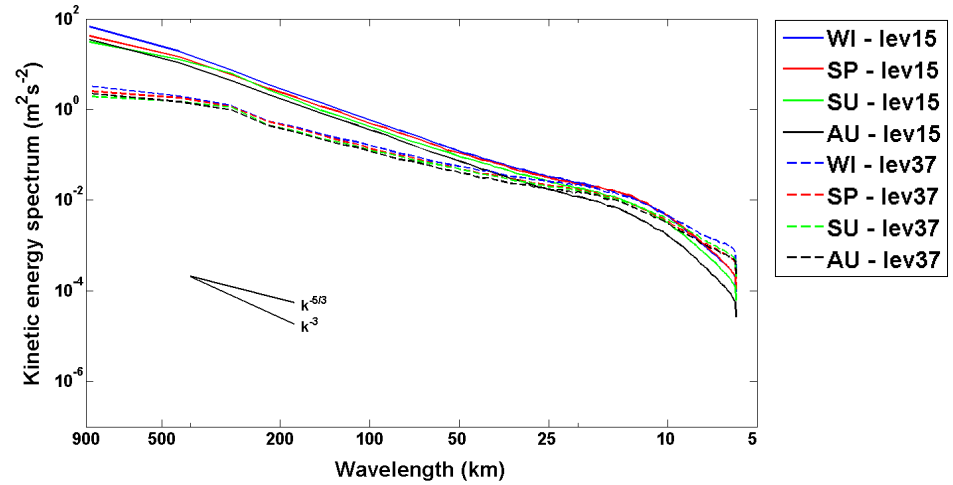
# Appendix - A

**ALADIN 8 km**

**ALADIN 2 km**



**DADA 2 km**

# Appendix-B

# Appendix-C