Regional modelling and assessment of atmospheric particulate matter concentrations at rural background locations in Europe

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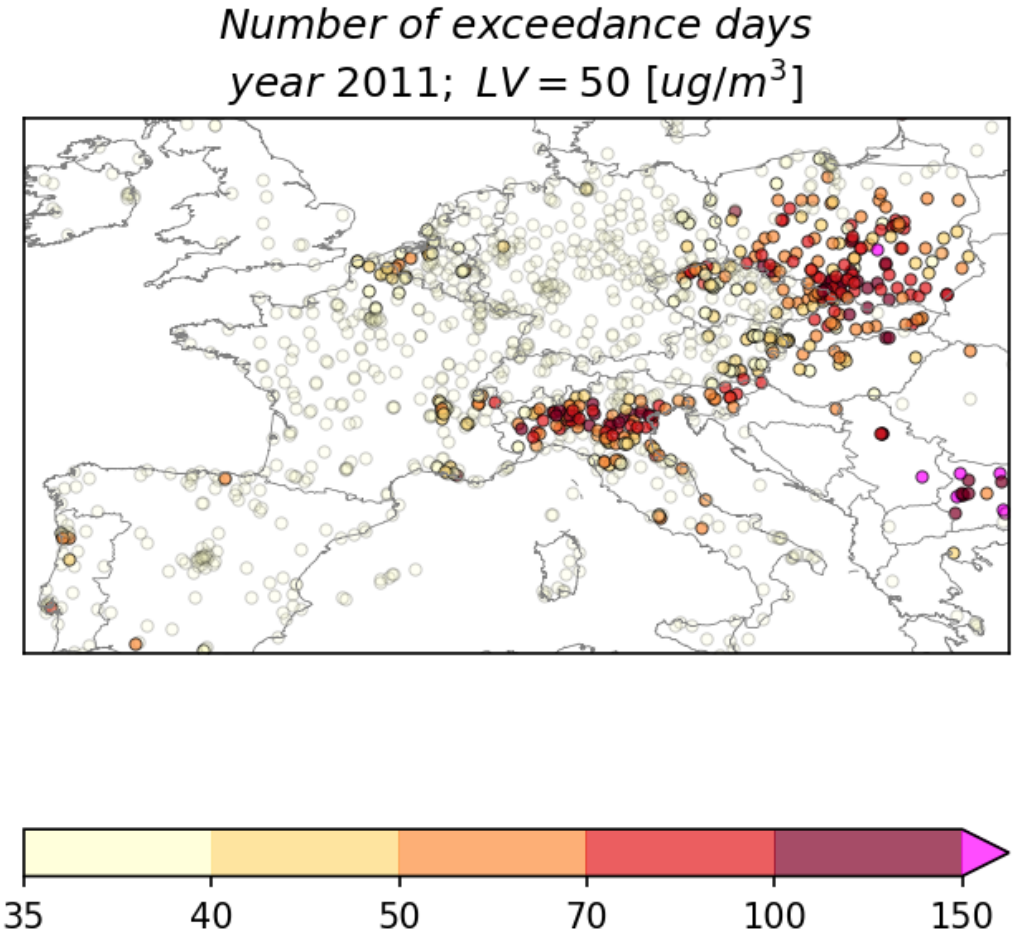
Challenges in meteorology 6
15 – 16 November, Zagreb, Croatia

Related conducted research ..

- The increased concentrations of particulate matter (PM) - associated with **significant impact on human health** (Anderson, 2009; Heal et al., 2012; Jeričević et al, 2016; Samet et al., 2000; Samoli et al., 2005; Peters et al., 2001; Pope et al., 2002).
- The elevated PM concentrations in the atmosphere - **effect on the ecosystem** (acidification, eutrophication) and visibility (Putaud et al., 2010).

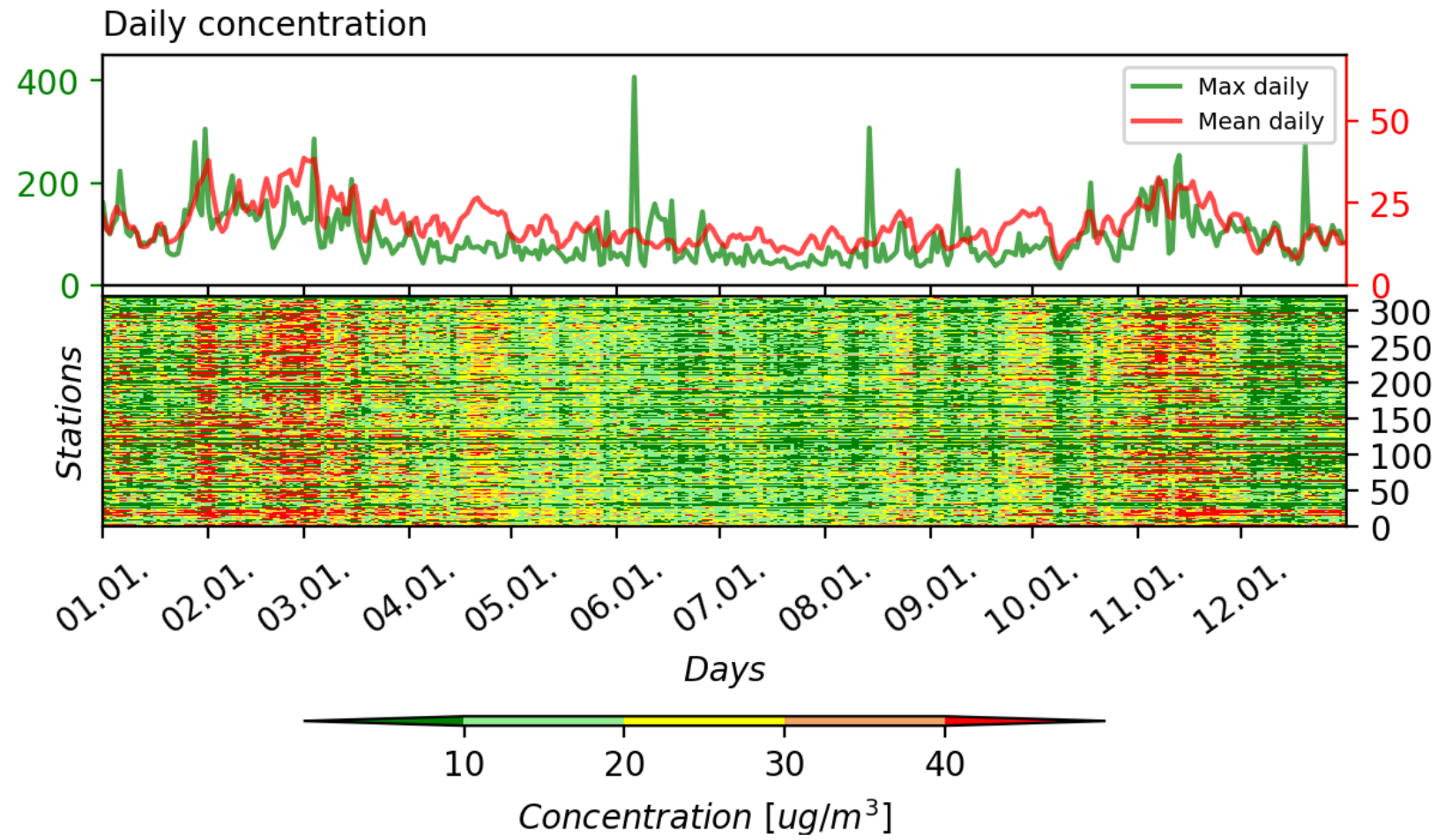
  Conseqently – affect **on cloud formation, radiation** -> strong climate forcer
- Influence on **Earth's balance** - radiative effects and cloud processes (Prank et al, 2016)
- **Air quality models - significant role** in the assessment and management (Ritter et al, 2012)
- Variety of AQ models: EMEP, LOTOS, SILAM, CMAQ, CAMx, WRF-Chem, … etc
- General **underestimation of PM** mass with large scale models (Vautard et al, 2007).
- **WRF-Chem** good comparison with measurements (Tucella et al, 2012), overestimation of wind speed -> underestimation (AQMEII)
- **EMEP** – general underestimation, improvementst in ic/bc (Techincal report 1/2016)

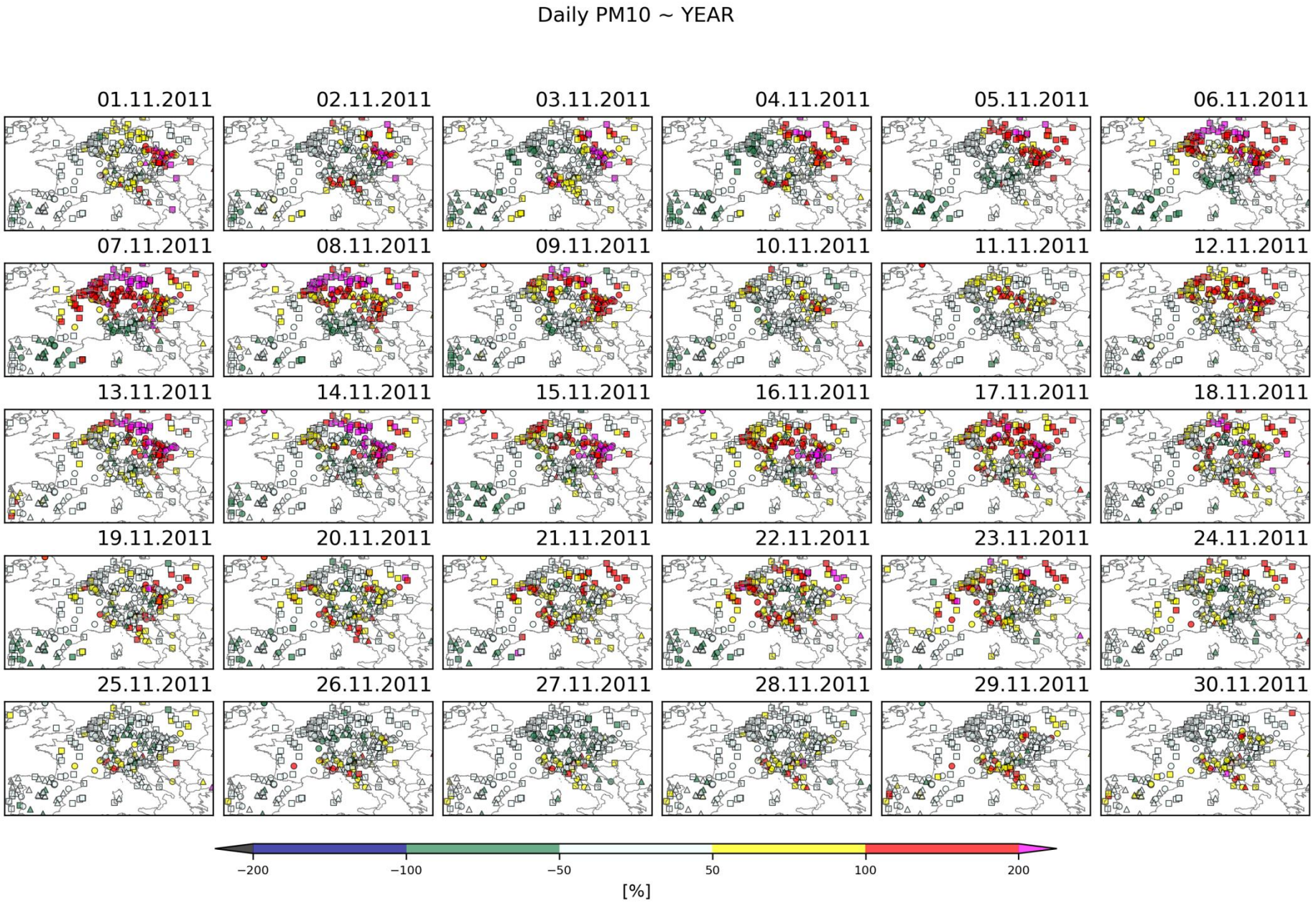
Monitoring data



320 rural background stations

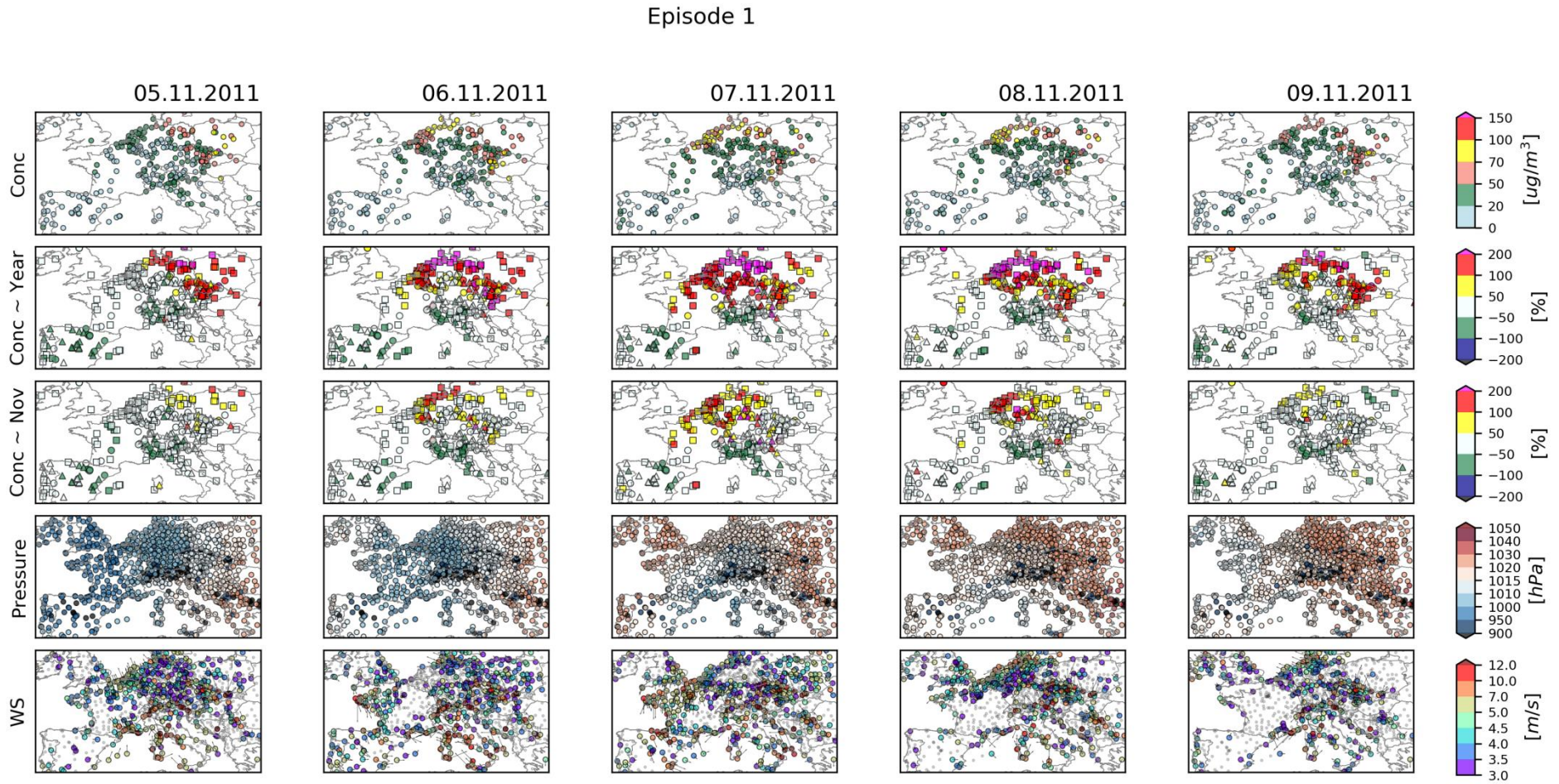
Monitoring data




Daily PM10 ~ YEAR
01.11.2011
02.11.2011
03.11.2011
04.11.2011
05.11.2011
06.11.2011
07.11.2011
08.11.2011
09.11.2011
10.11.2011
11.11.2011
12.11.2011
13.11.2011
14.11.2011
15.11.2011
16.11.2011
17.11.2011
18.11.2011
19.11.2011
20.11.2011
21.11.2011
22.11.2011
23.11.2011
24.11.2011
25.11.2011
26.11.2011
27.11.2011
28.11.2011
29.11.2011
30.11.2011
−200
−100
−50
50
100
200
[%]

Monitoring data

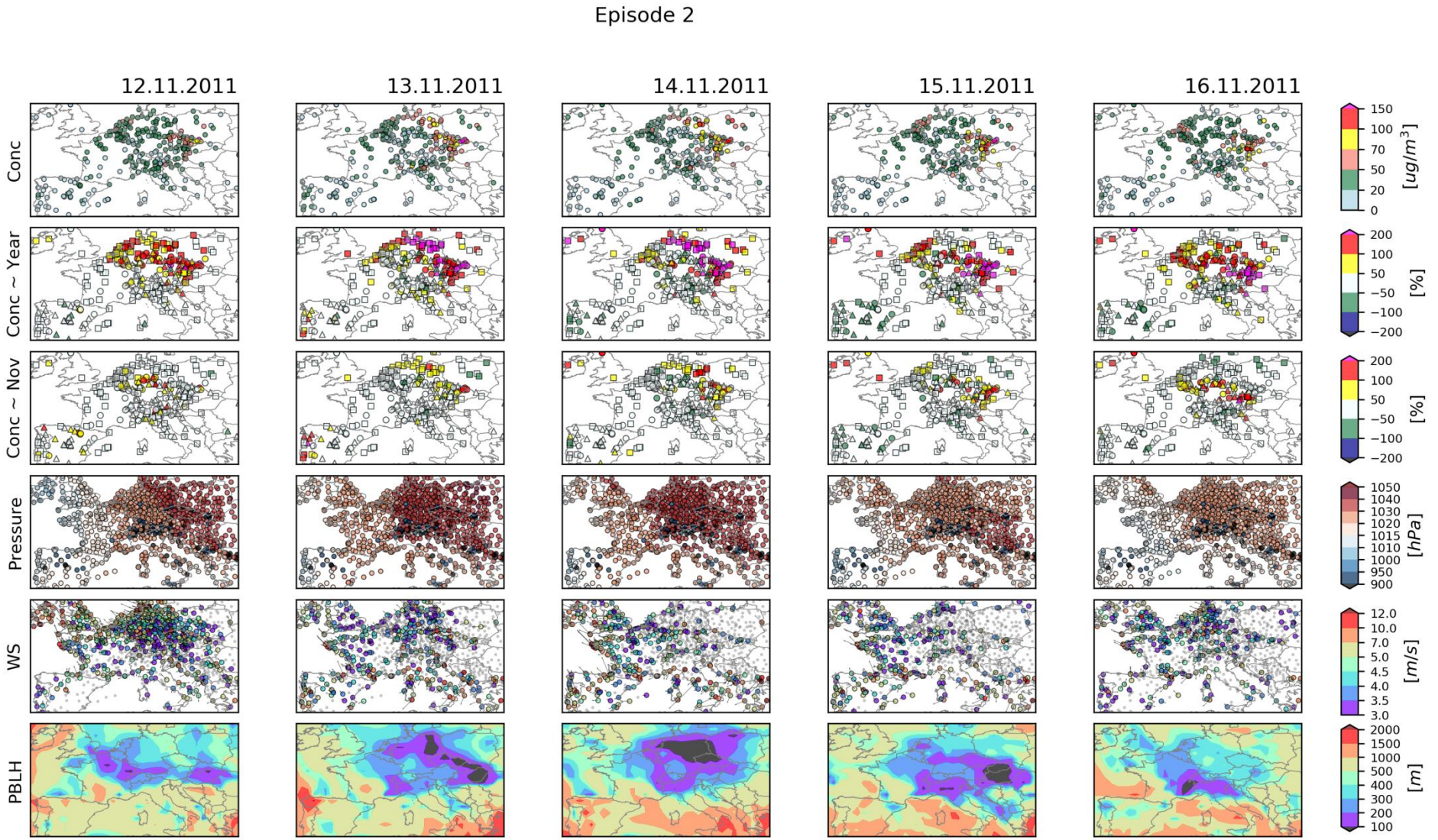
EPISODE 1: 5 – 9 Nov



920 meteo stations

Monitoring data

EPISODE 2: 12 – 16 Nov

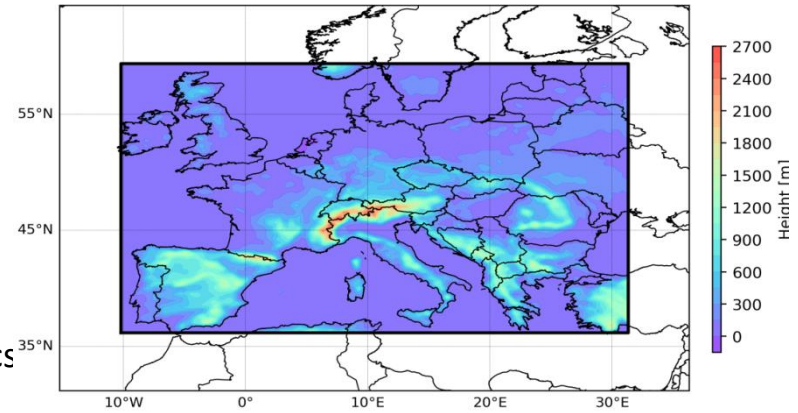


AQ modeling

- **WRF-Chem model** *Weather Research and Forecasting with Chemistry module*
- Domain properties

  SETUP: **18x18km** 01.10. – 30.11.2011.

  IC/BC- FNL (GFS) reanalysis 1°x1°; dt=6h
- EMISSIONS
  - Anthropogenic - EDGARv4
  - Initial/boundary conditions : from previous runs
  - Setup: Morrison double-moment cloud microphysics

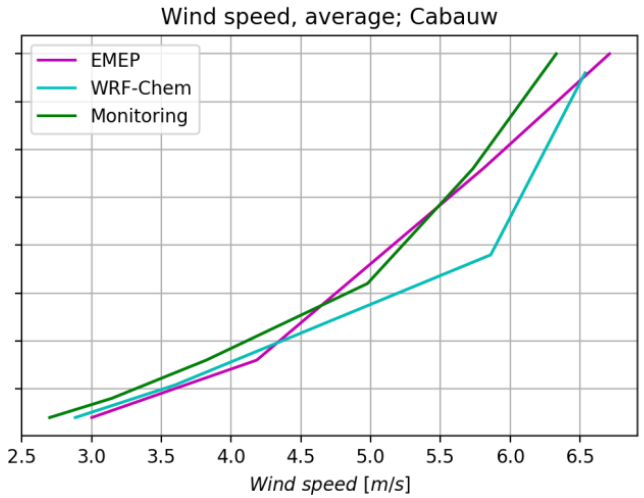


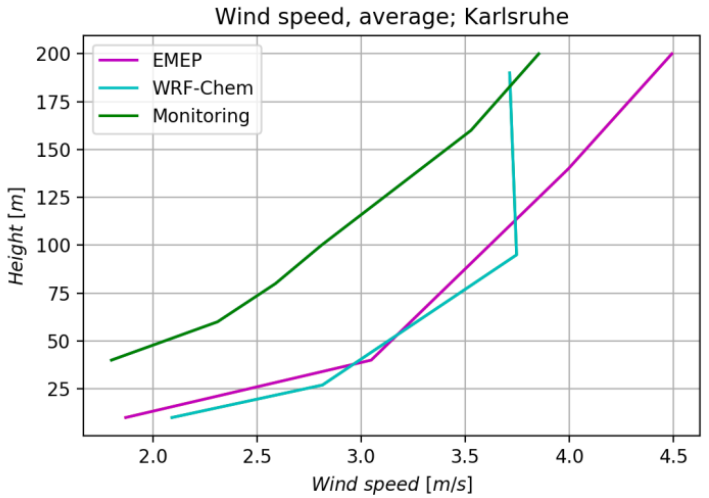
- **EMEP model**
- **ECMWF** meteorology data (Integrated Forecast System);

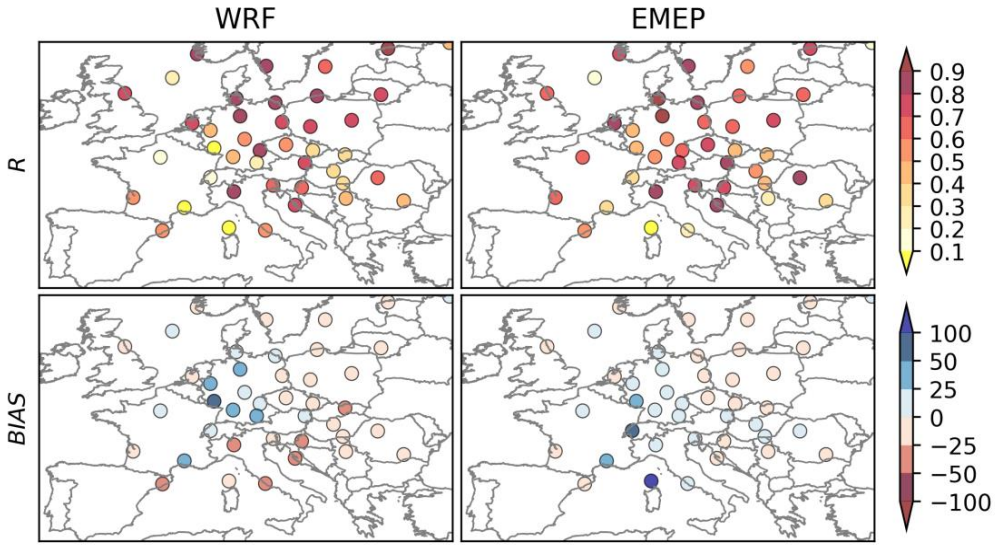
  SETUP: dt = 3h; vertical levels = 20 levels; dx,dy=**50km**
- EMISSIONS
  - Anthropogenic (aircraft, shipping, VOC, SO2, NOx, CO, PM)
  - Biogenic (calculated from landuse) – NMVOC, DMS, Lightning, Volcanoes

AQ modeling

VALIDATION







AQ modeling

Station categories

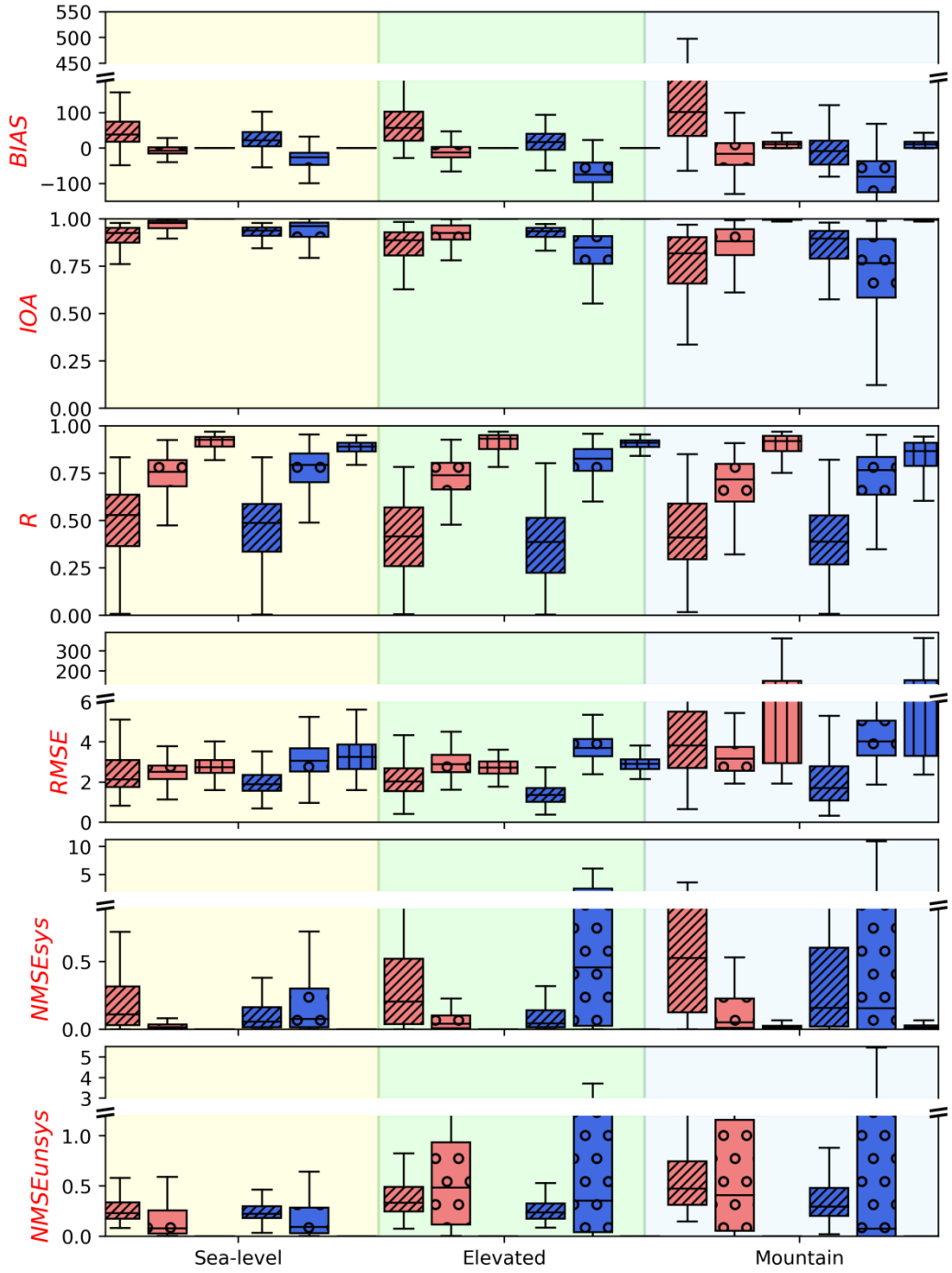
- < 200 m **Sea – level (Flat)**
- 200 < 500 m **Elevated (Moderate)**
- 500 < m **Mountain (Complex)**

// - wind speed

°° - temperatrure

|| - surface pressure

WRFChem EMEP



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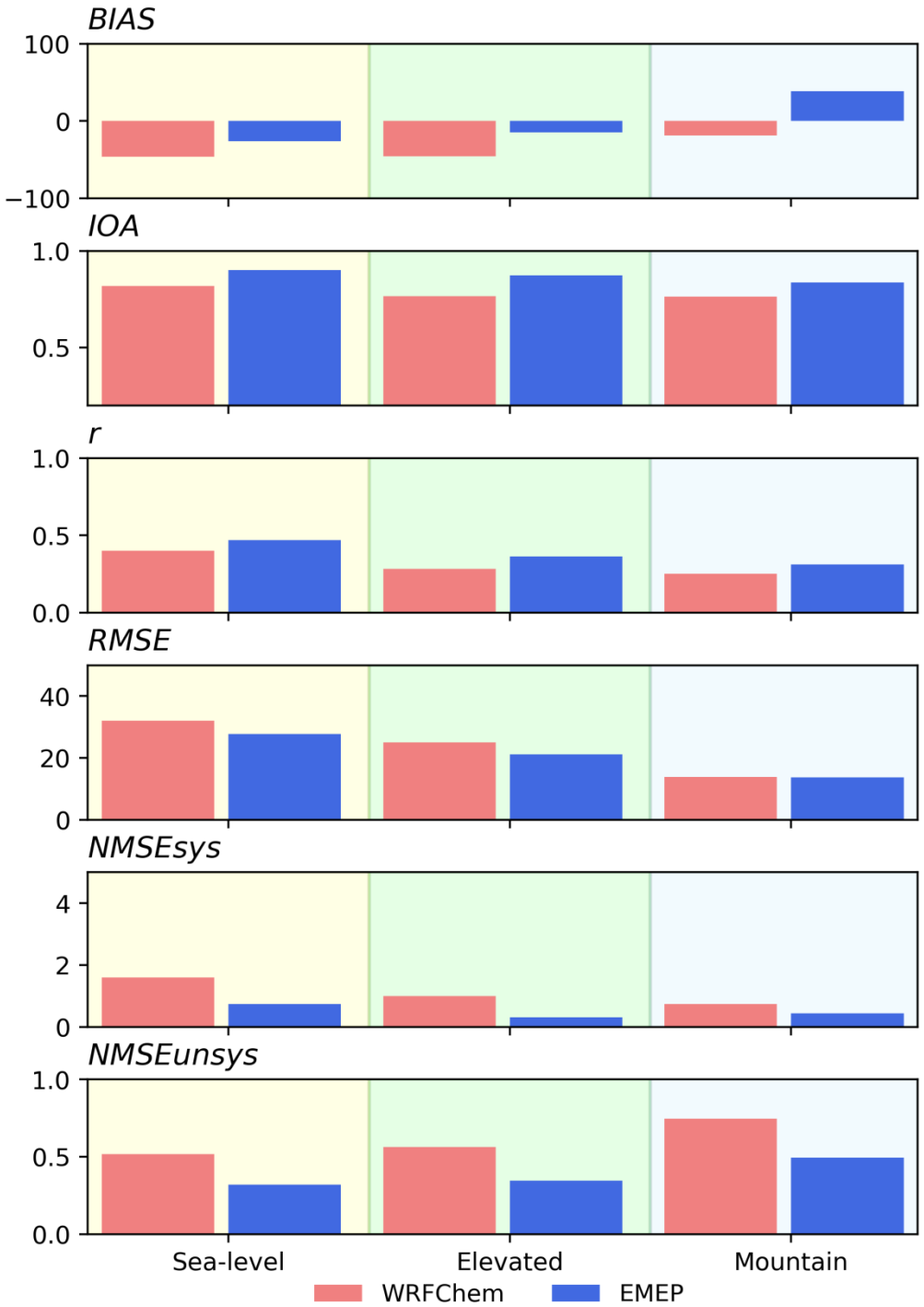
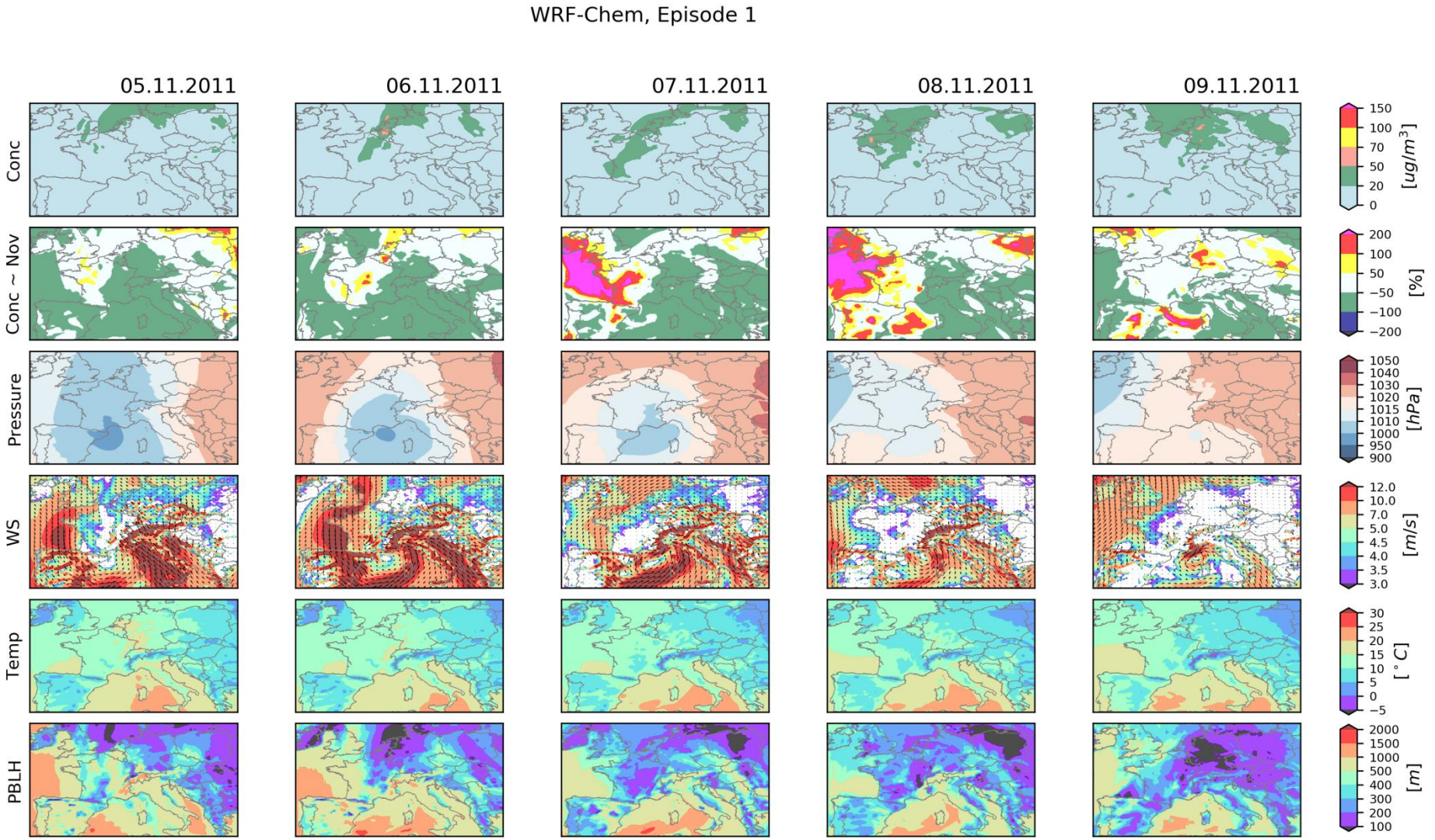


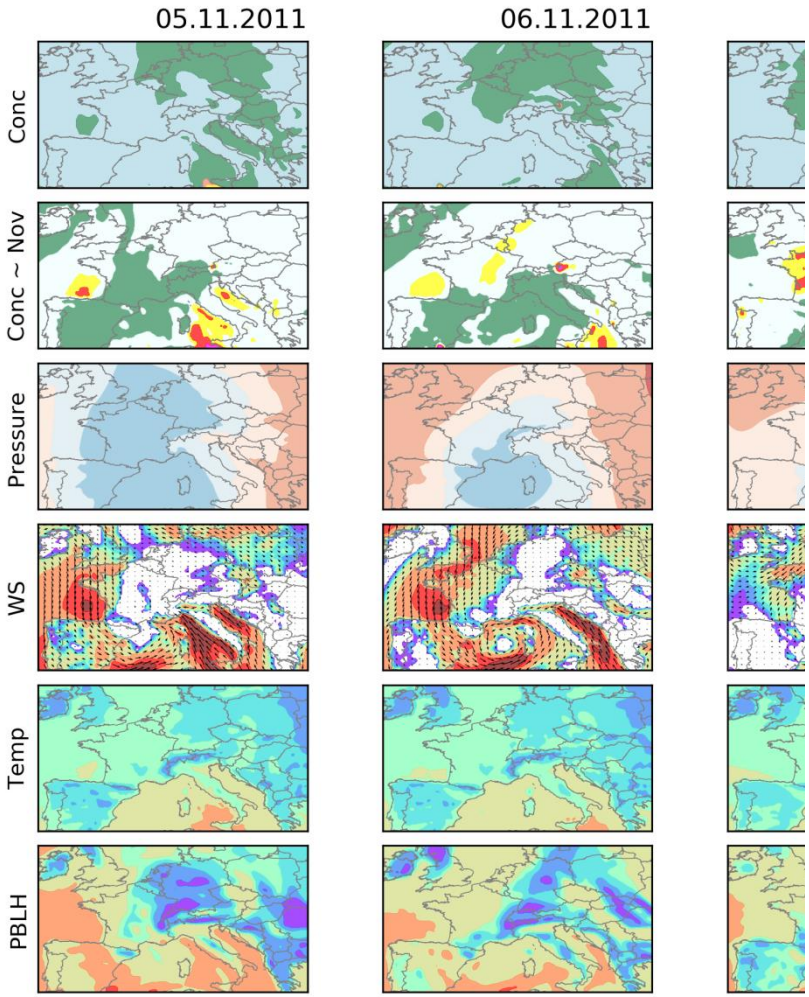
AQ modeling

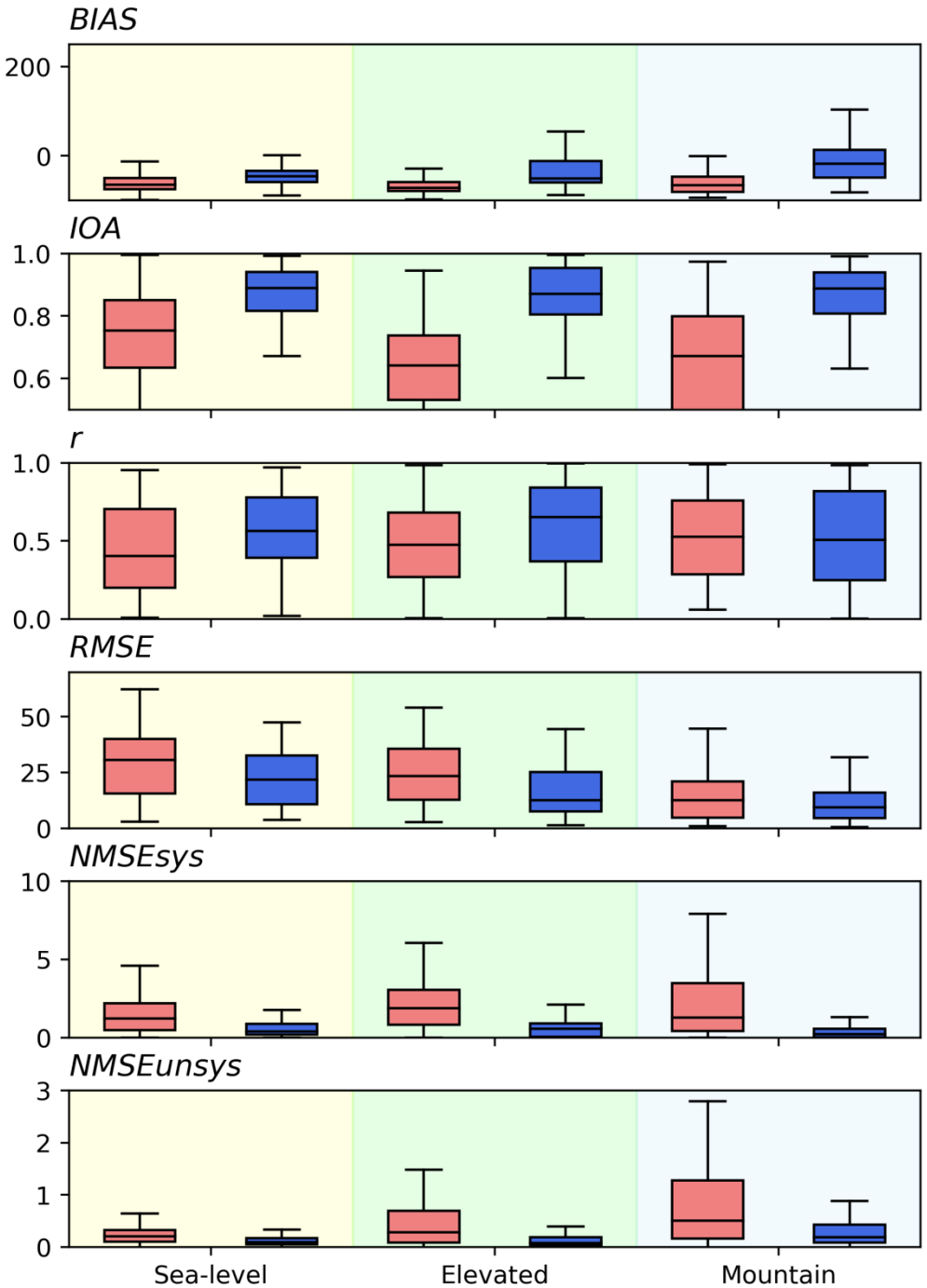
EPISODE 1



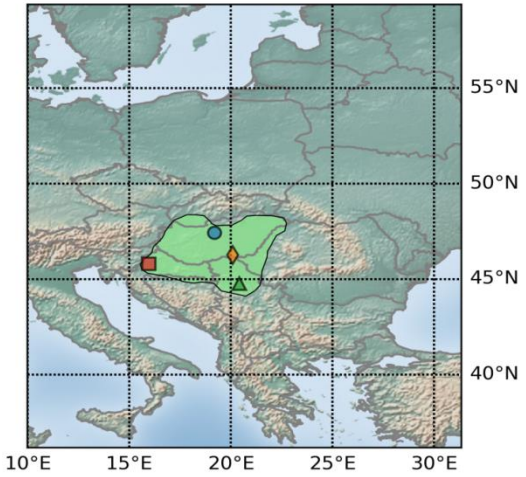
AQ modeling

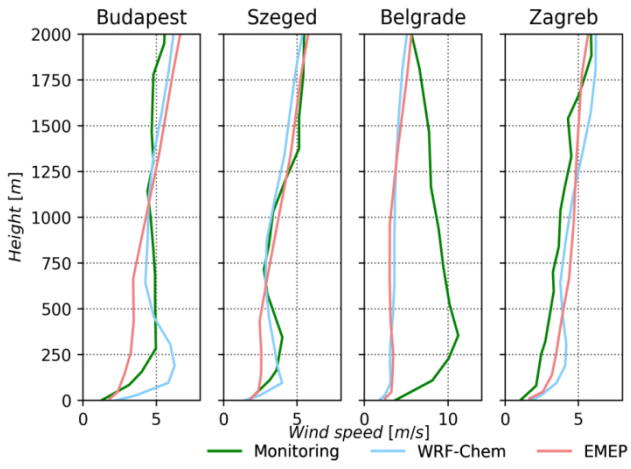
EMEP,



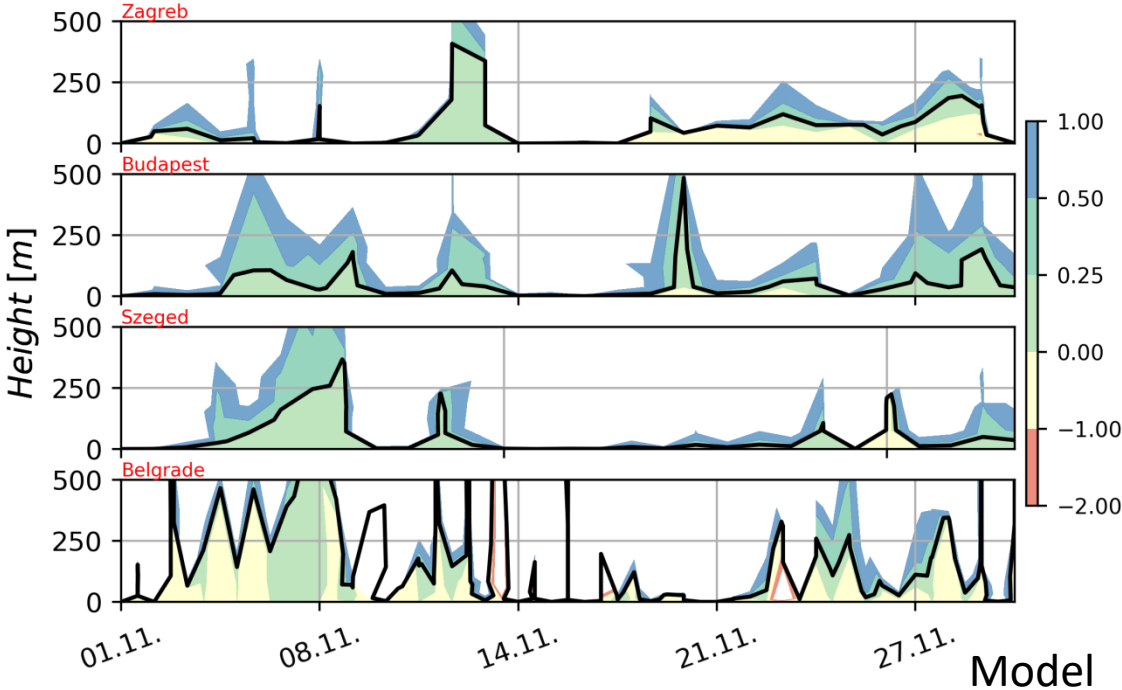


AQ modeling

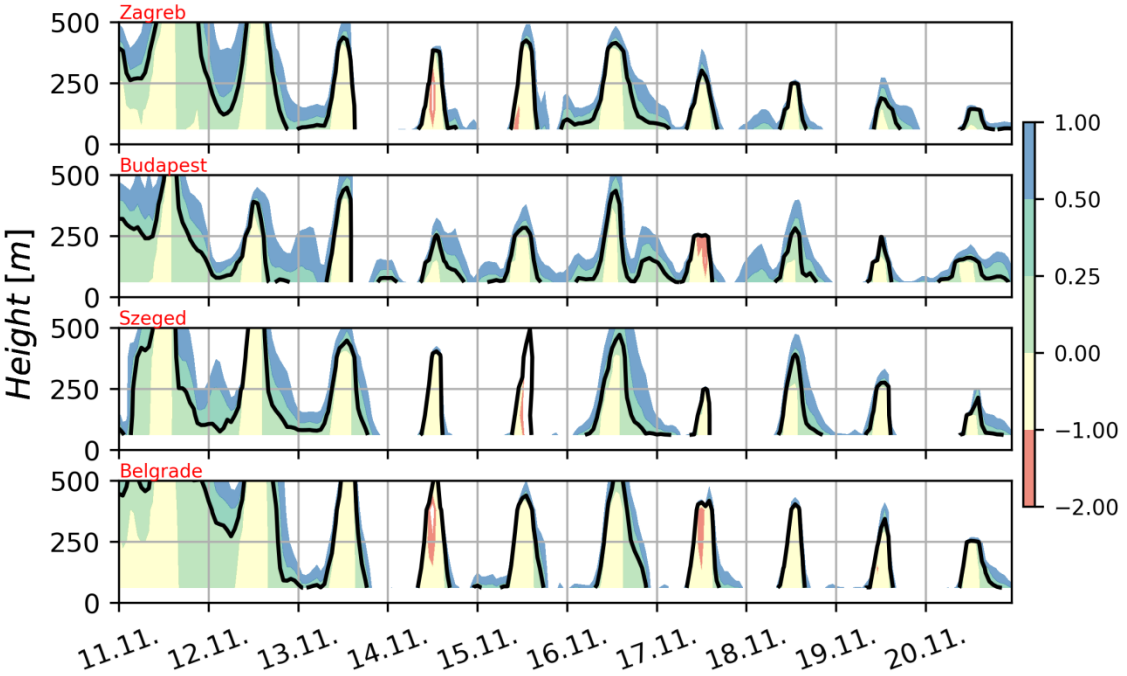




Measurements



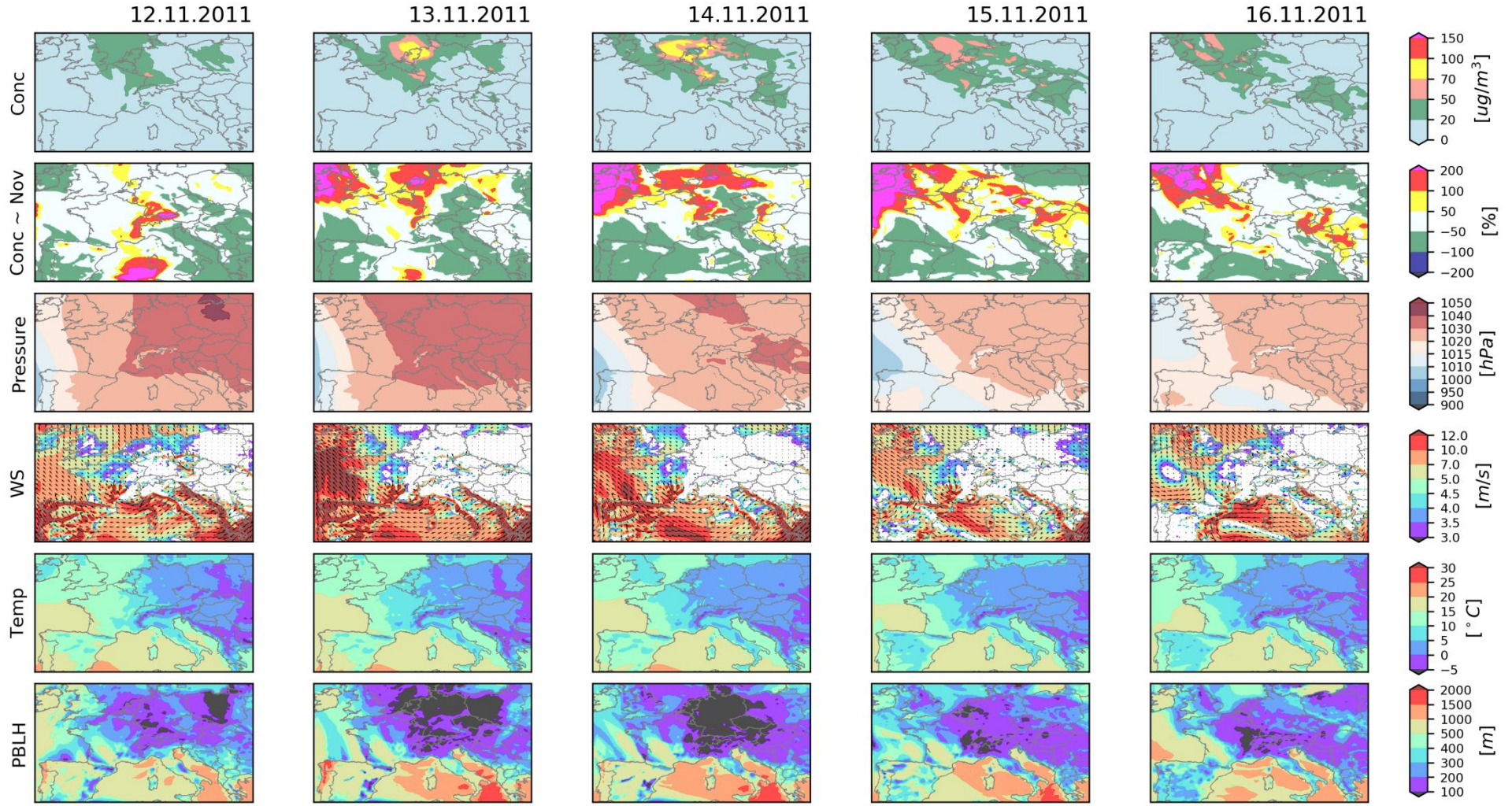
Model



AQ modeling

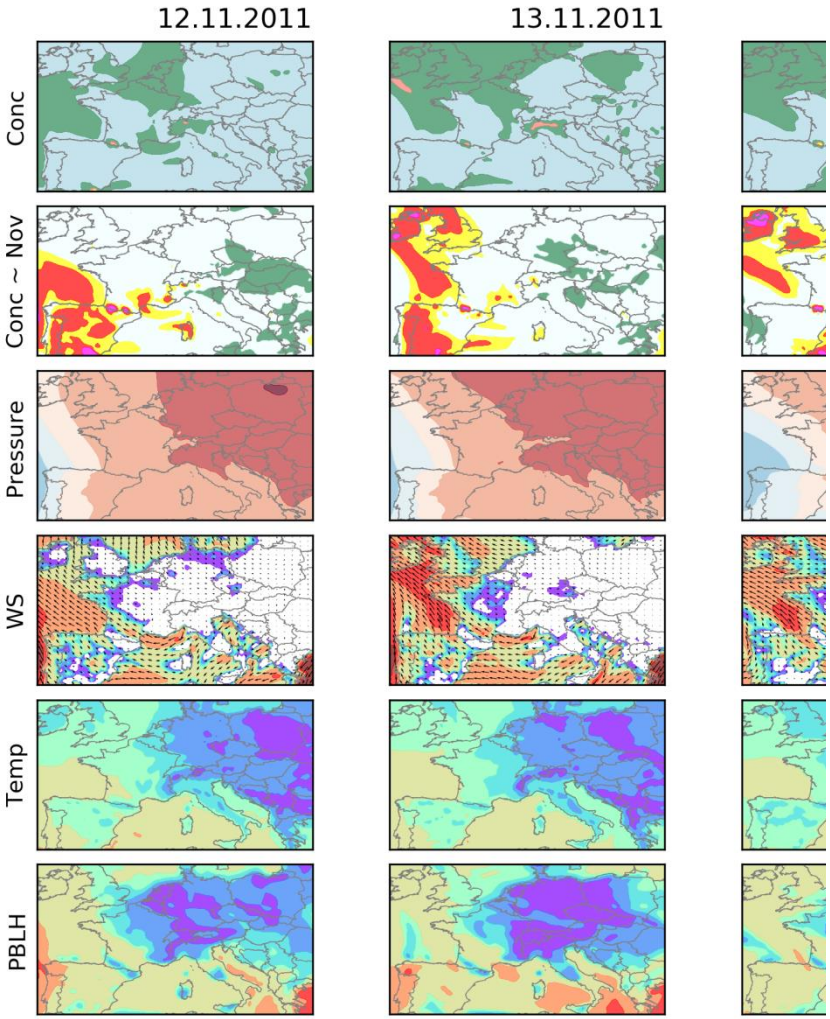
EPISODE 2

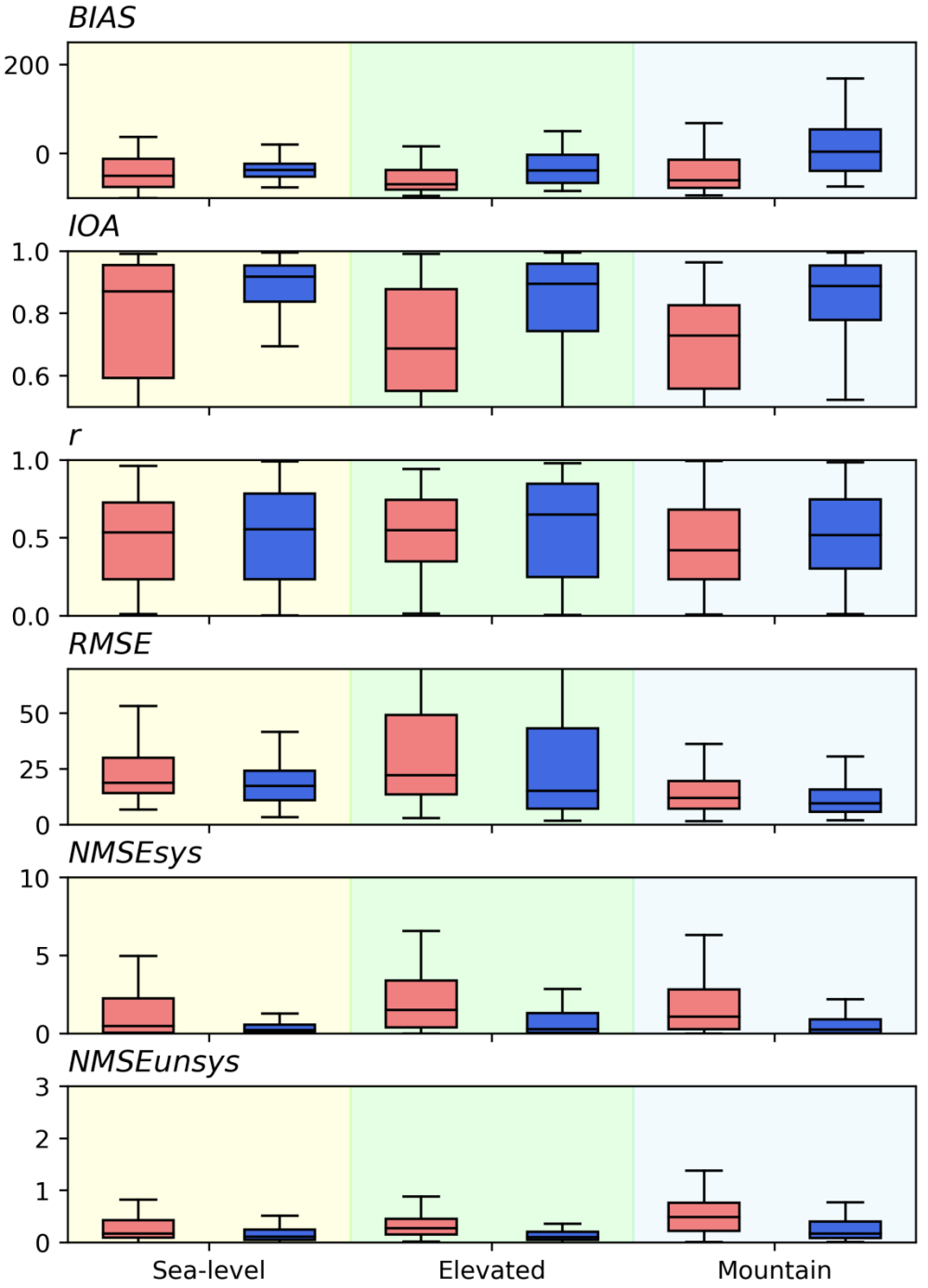
WRF-Chem, Episode 2



AQ modeling

EMEP,





Summary

AQ models

- Significant underestimation of background PM mass concentrations
- Station differentiation according to station height was found (Tørseth et al, 2012)
- Decrease of model performance with the height (AQ, meteo)
- Overall, better performance in terms of all analysed statistical parameters obtained with the EMEP model
- Notable differences in wind speed and temperature (IC/BC)
- Differences in PBL dynamics between model (PBLH)
- Wind speed higher in WRFChem model
- Horizontal resolution – impact on spread of surface concentrations -> statistical performance

Future work

- longer periods of simulations for both models in order to make a comparison in various meteorological conditions.
- simulations with WRF-Chem will include **more accurate emission inventory** on **higher resolution**.
- model intercomparison focus on other species (NOx, SOx, PM compounds, O_3, etc)