Object-based COSMO-DE verification using Meteosat observation

Fabian Senf[1,2], Martin Rempel[1]

[1] Leibniz Institute for Tropospheric Research, Leipzig

[2] Hans Ertel Centre for Weather Research,
Atmospheric Dynamics and Predictability Branch

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Tropospheric Research

Outline

(1) Motivation

(2) Data

(3) Cell Statistics

(4) Diurnal Cycle

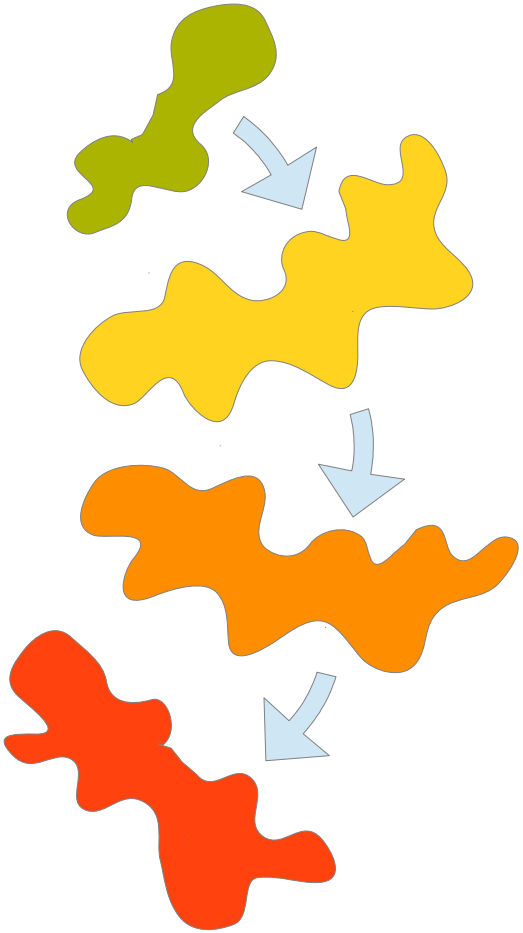
(5) towards Meteosat-based SAL verification

(6) Conclusions

Motivation

What is an object?

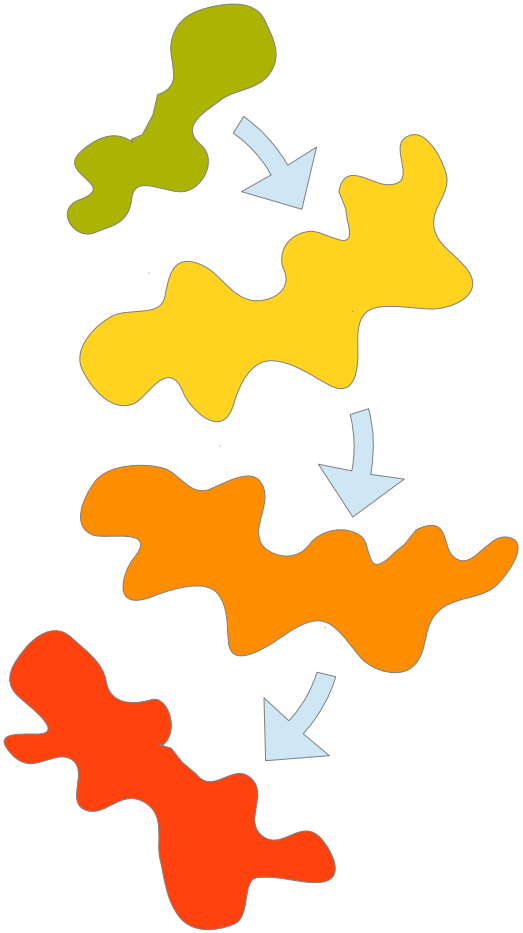
- **coherent structures** in space and time
- with properties **temporally persistent** compared to observation or model output time (to enable labelling and tracking)
- **causal relationship** in time between different spatial structures



Motivation

Object-based Methods

- often used in nowcasting applications
- usually consists of
  - object **identification**
    (e.g. threshold and clustering techniques)
  - object **tracking**
    (e.g. cross-correlation, overlap)
  - temporal **extrapolation**
    (e.g. linear displacements, typical life cycle)
- examples:
  - DWD KONRAD based on Radar Reflectivities
  - NWCSAF RDT based on Meteosat images



Motivation

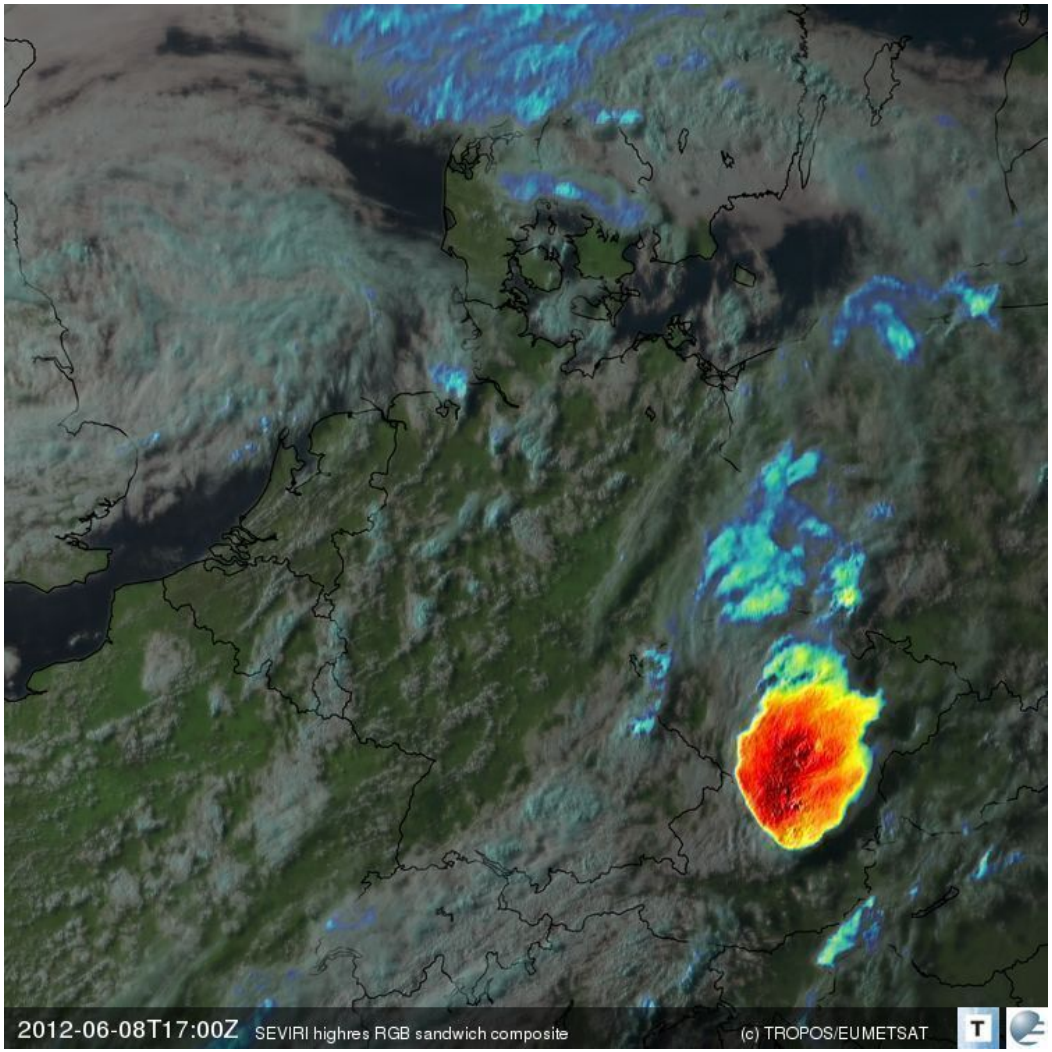
Objectives

How do operational COSMO-DE simulations forecast cloud properties in convective situation?

- comparison based on Meteosat observations
- forecasting location and timing of convective initiation is challenging
  - ➔ Can COSMO-DE forecasts reproduce at least the statistics of observed convective cells?
  - ➔ How does the observation of the diurnal cycle of convective development compares with model forecasts?
- object-based verification techniques are mainly developed for precipitation forecasts:
  - How can we adapt existing methods to cloud observations from Meteosat?

Data

Observations: Meteosat Rapid Scan (each 5 min, pix ~ 3 x 6 km²)



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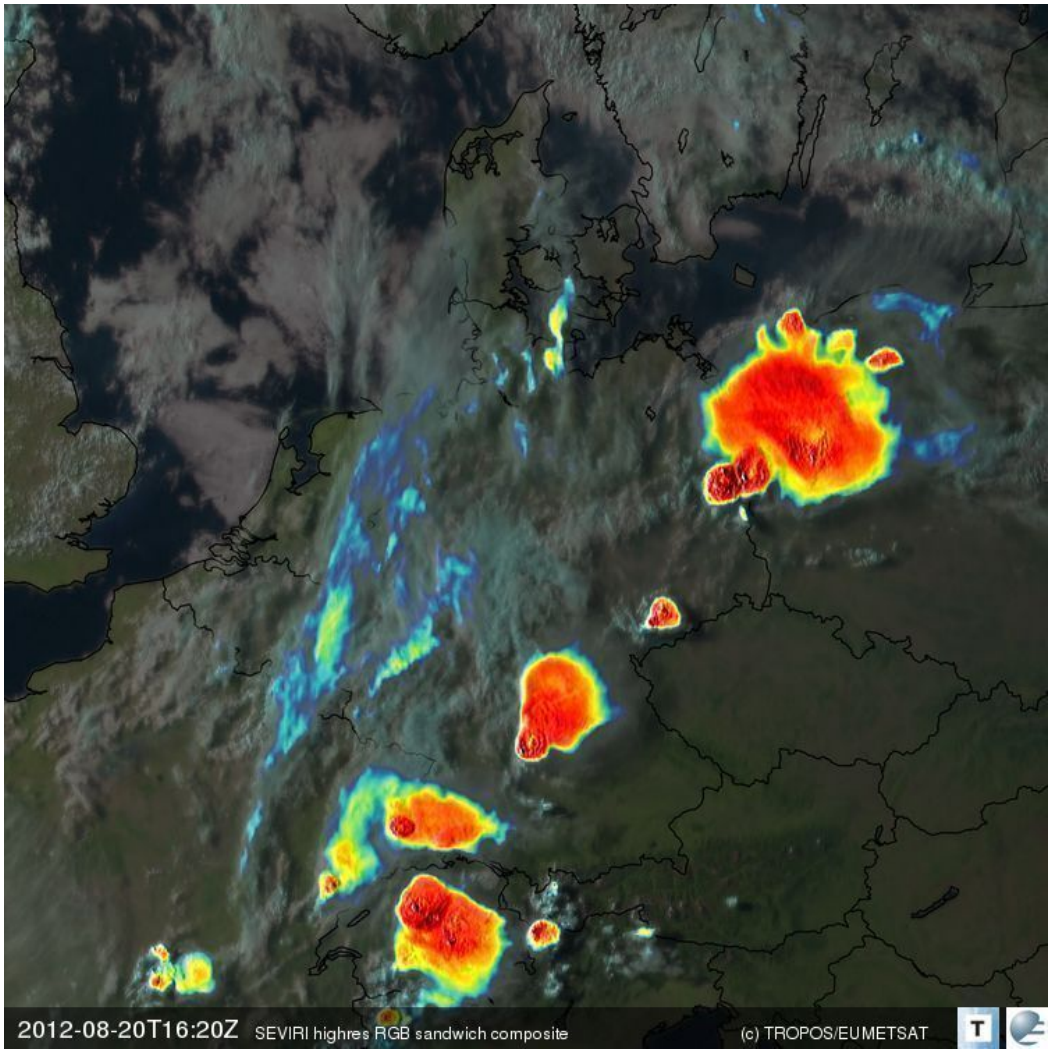
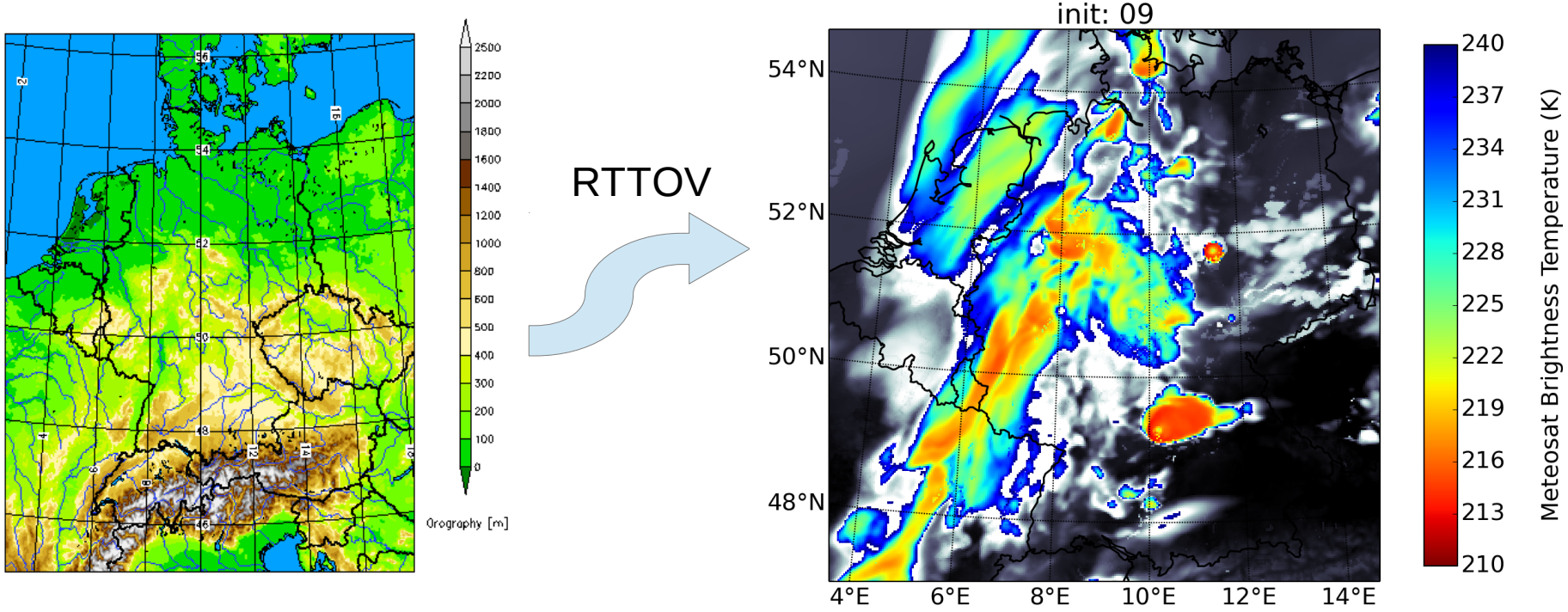


Data

Forecast: Synthetic Satellite Data from COSMO-DE



Results

Cell Size Statistics

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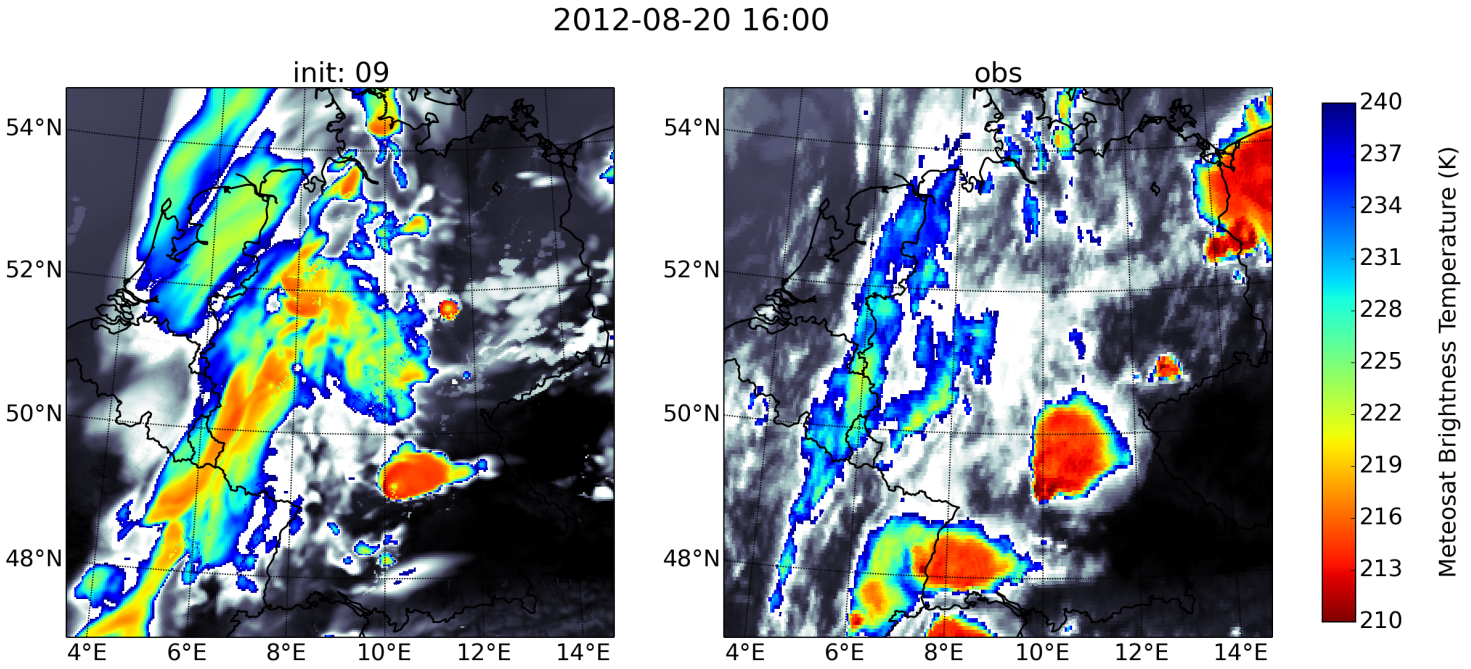
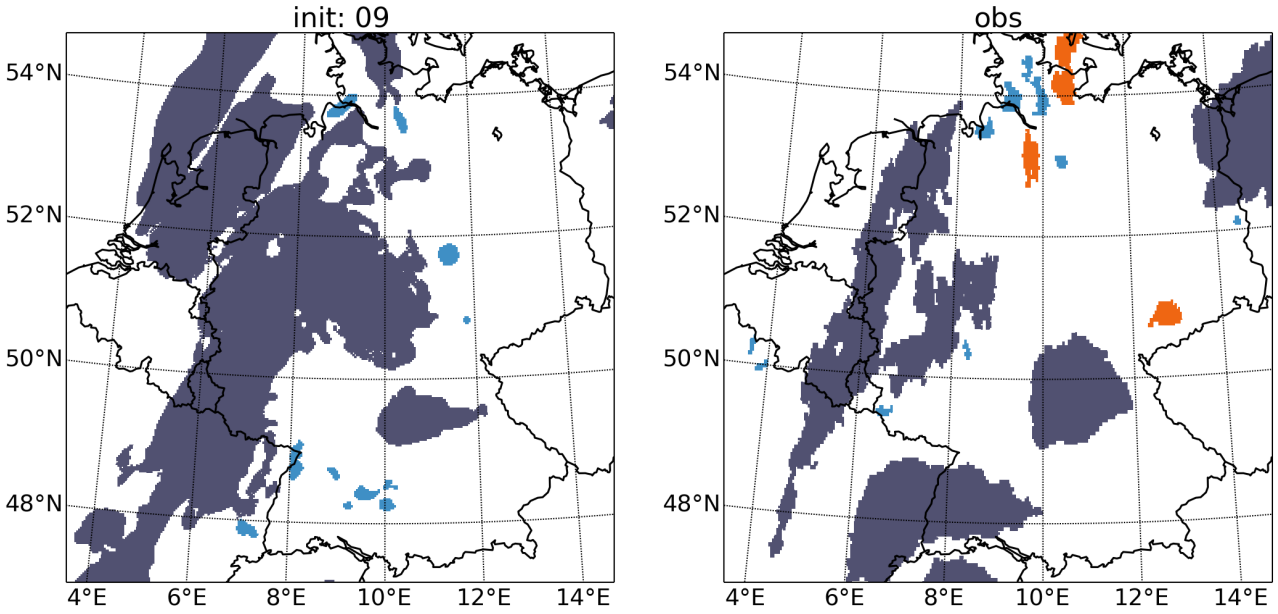


- comparison of forecast and observation using MSG SEVIRI 10.8 µm brightness temperature

Results

Cell Size Statistics

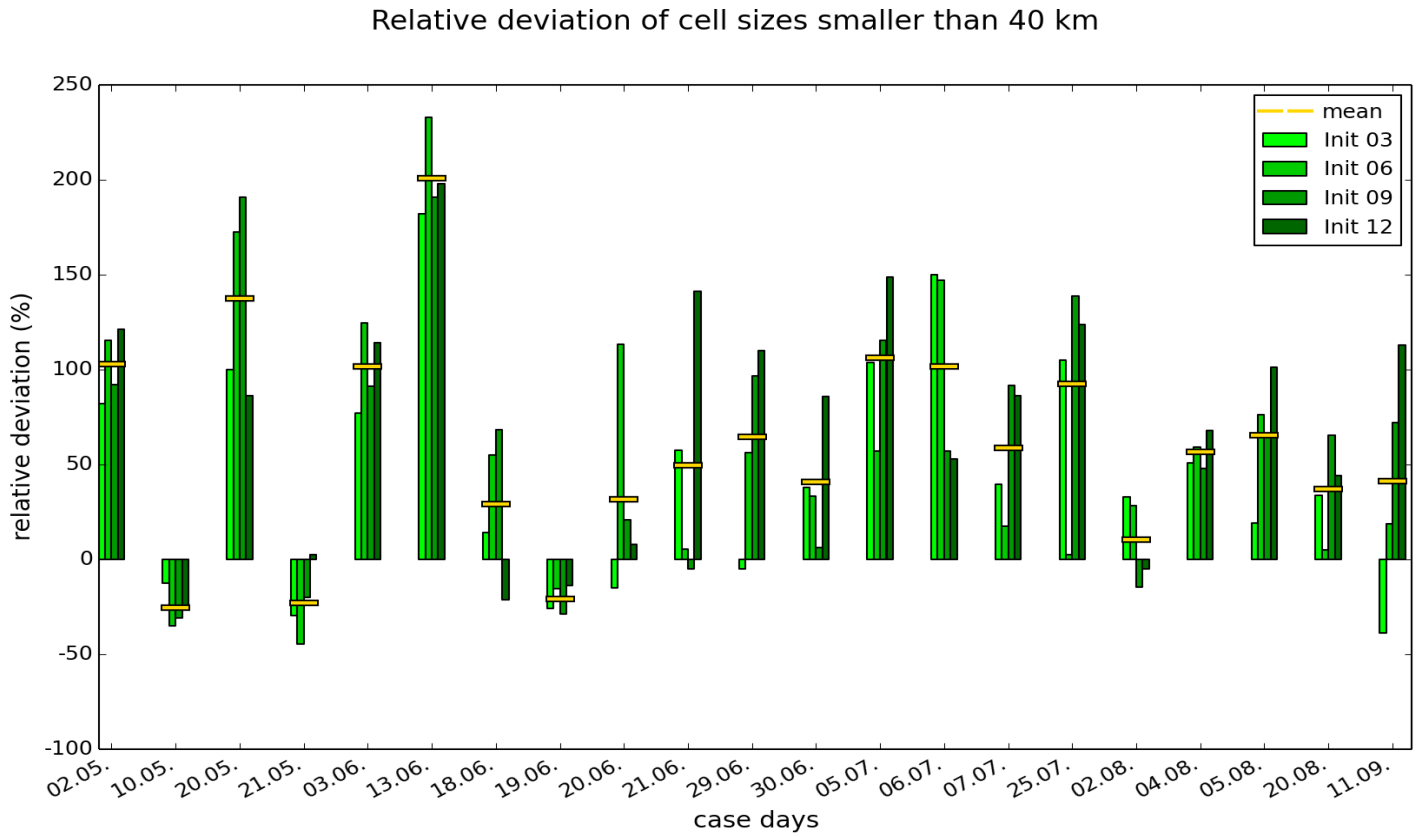
2012-08-20 16:00



- masked for brightness temperature smaller than 240 K
- cloud objects as connectivity clusters and classified for different size categories
  - object diameters: **< 40 km**, **40 km – 80 km**, **> 80 km**

Results

Cell Size Statistics



- COSMO forecasts overestimated the number of convective cells in 2012 with 66 out of 84 forecasts having more small cells
- 50 % of forecasts show between 5 % and 100 % overestimation (median: 50%)

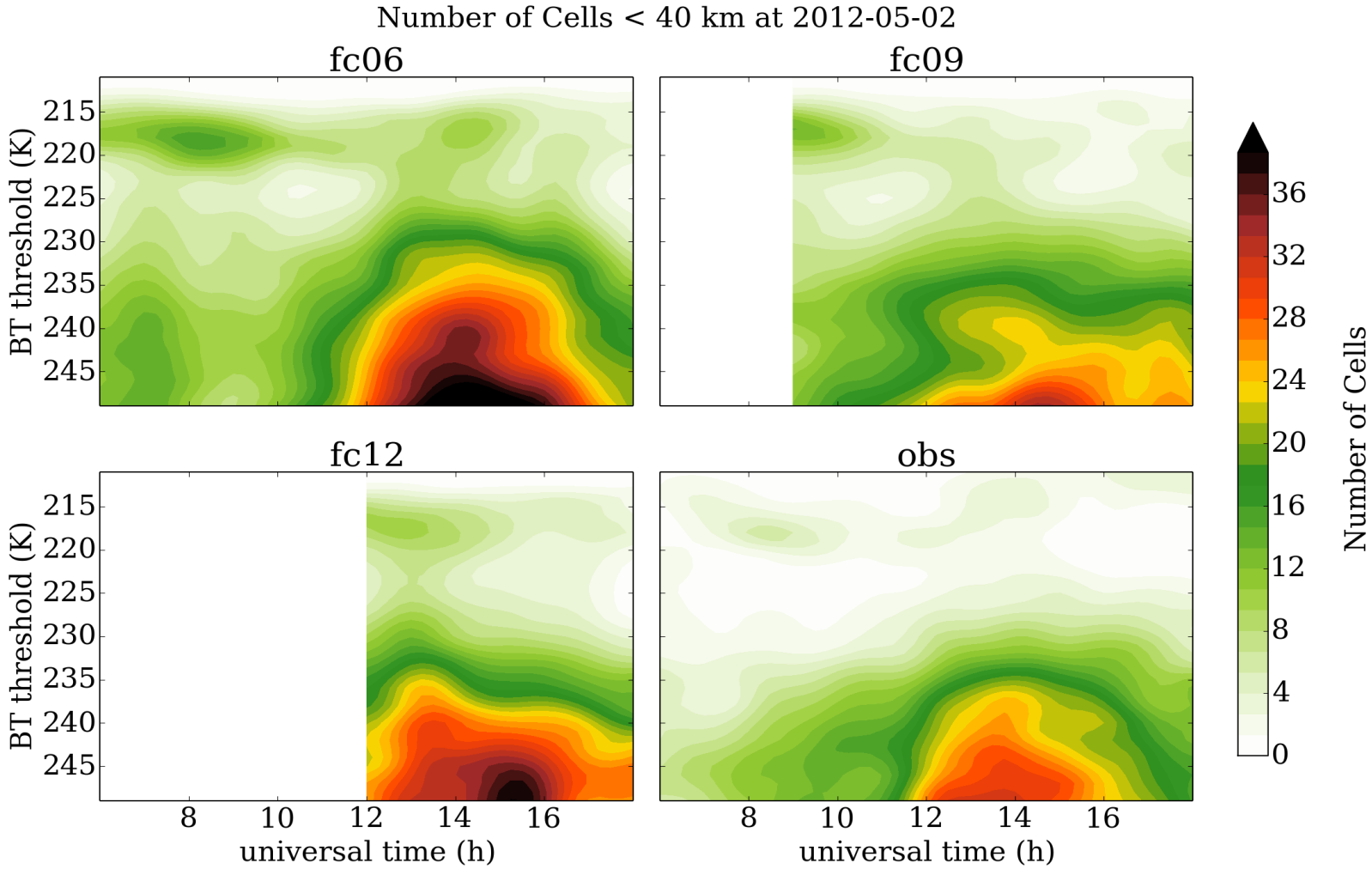
Results

Diurnal Cycle

Results

1 case

Diurnal Cycle



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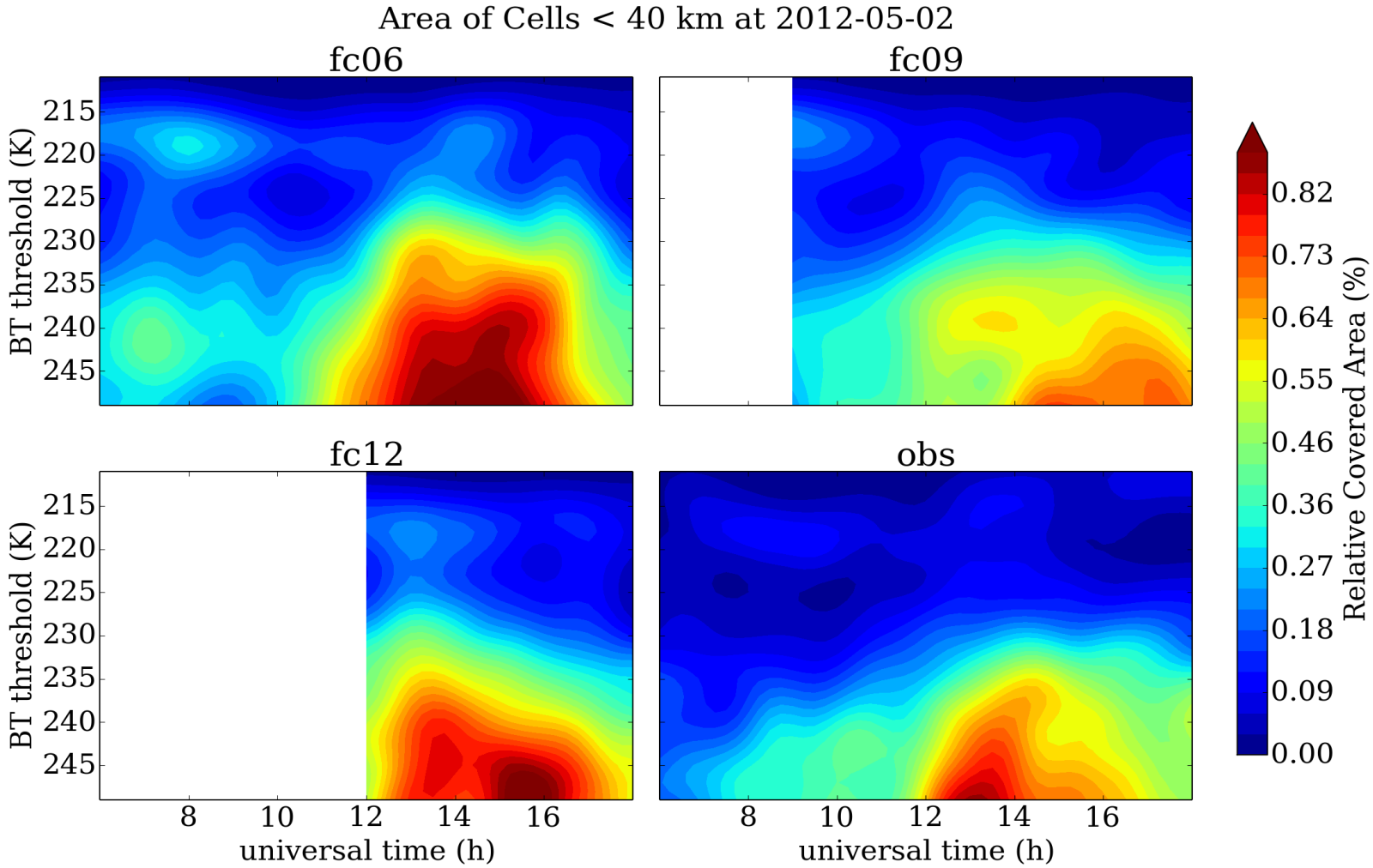

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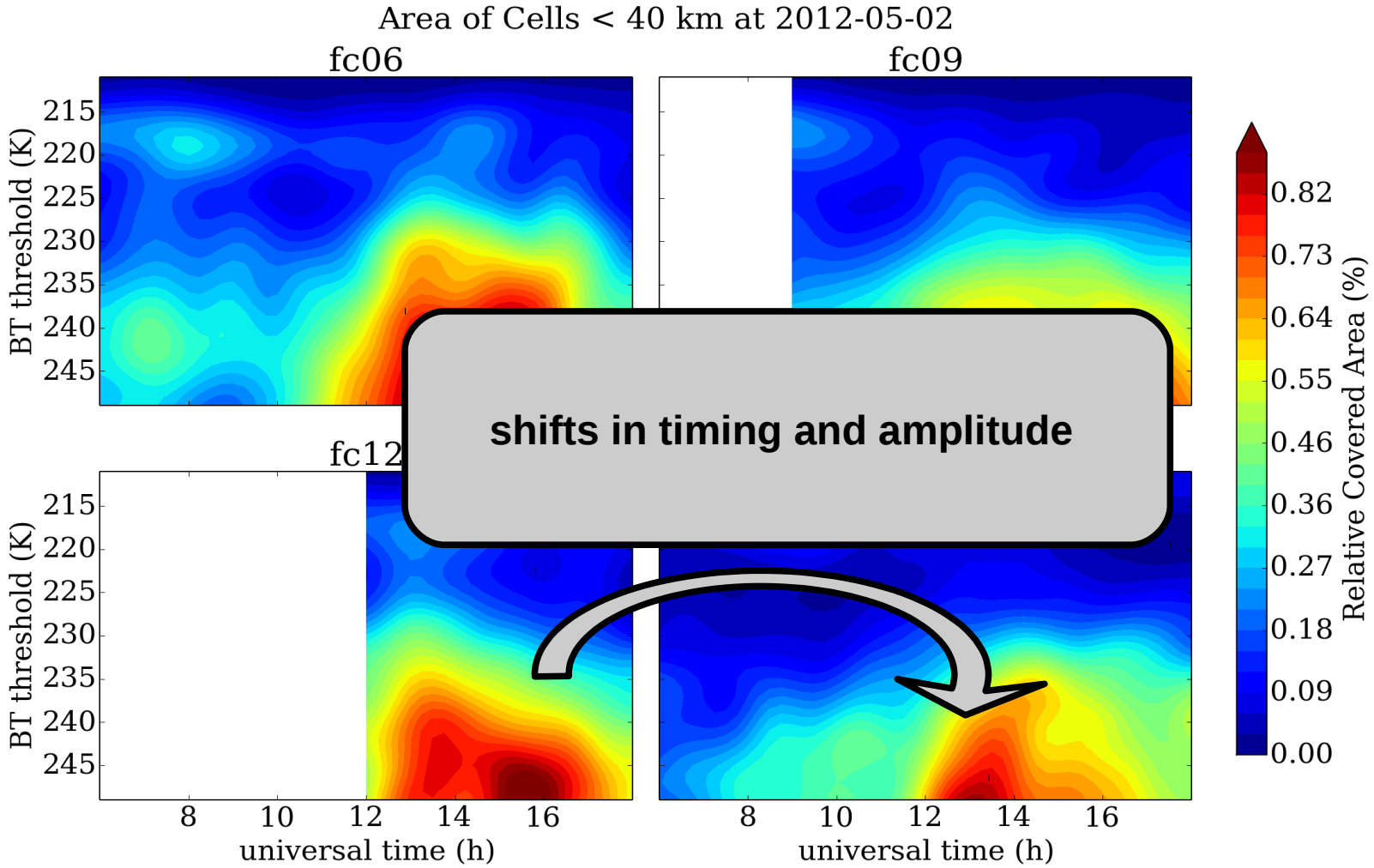
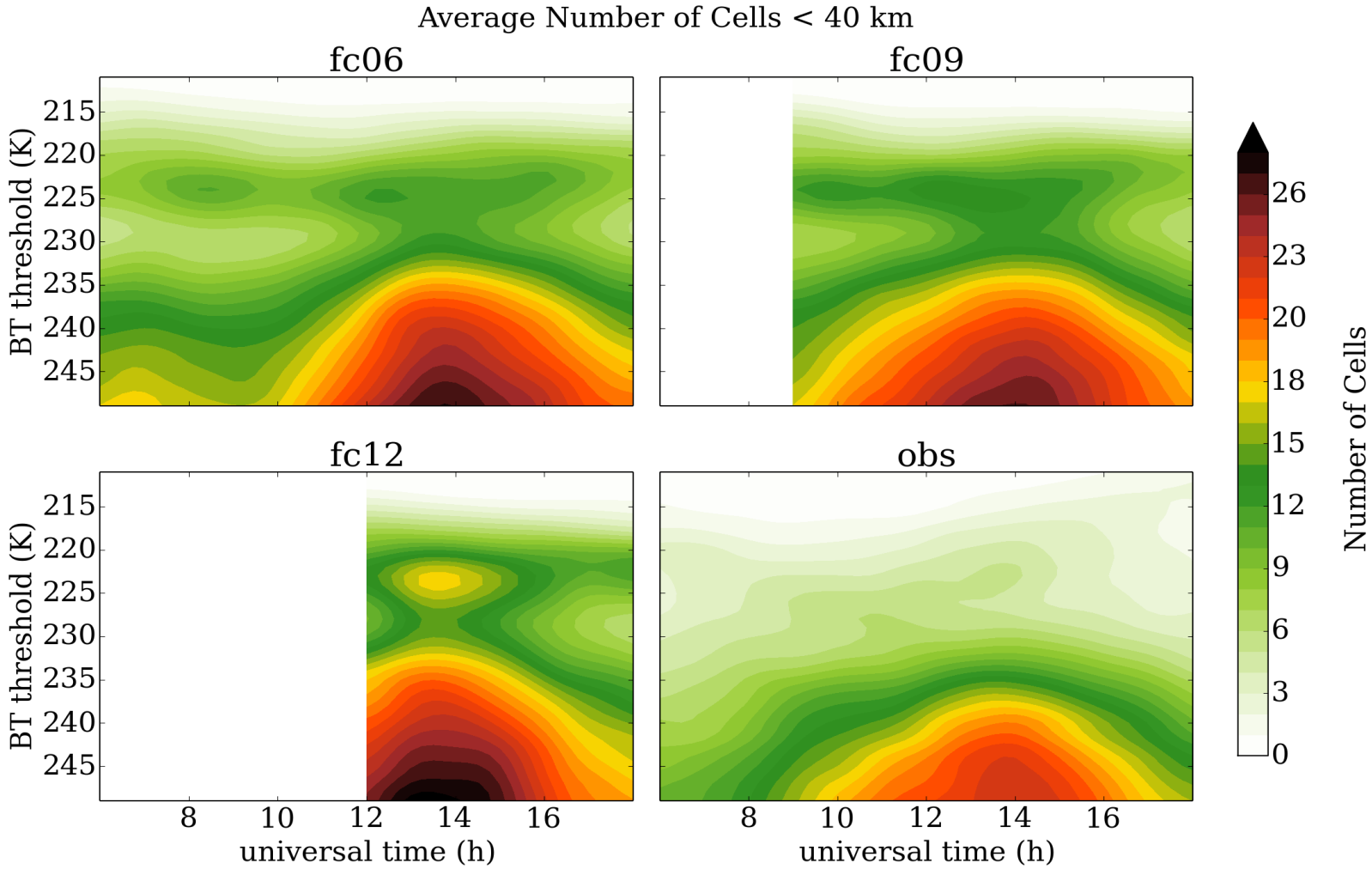


Results

21 cases

Diurnal Cycle



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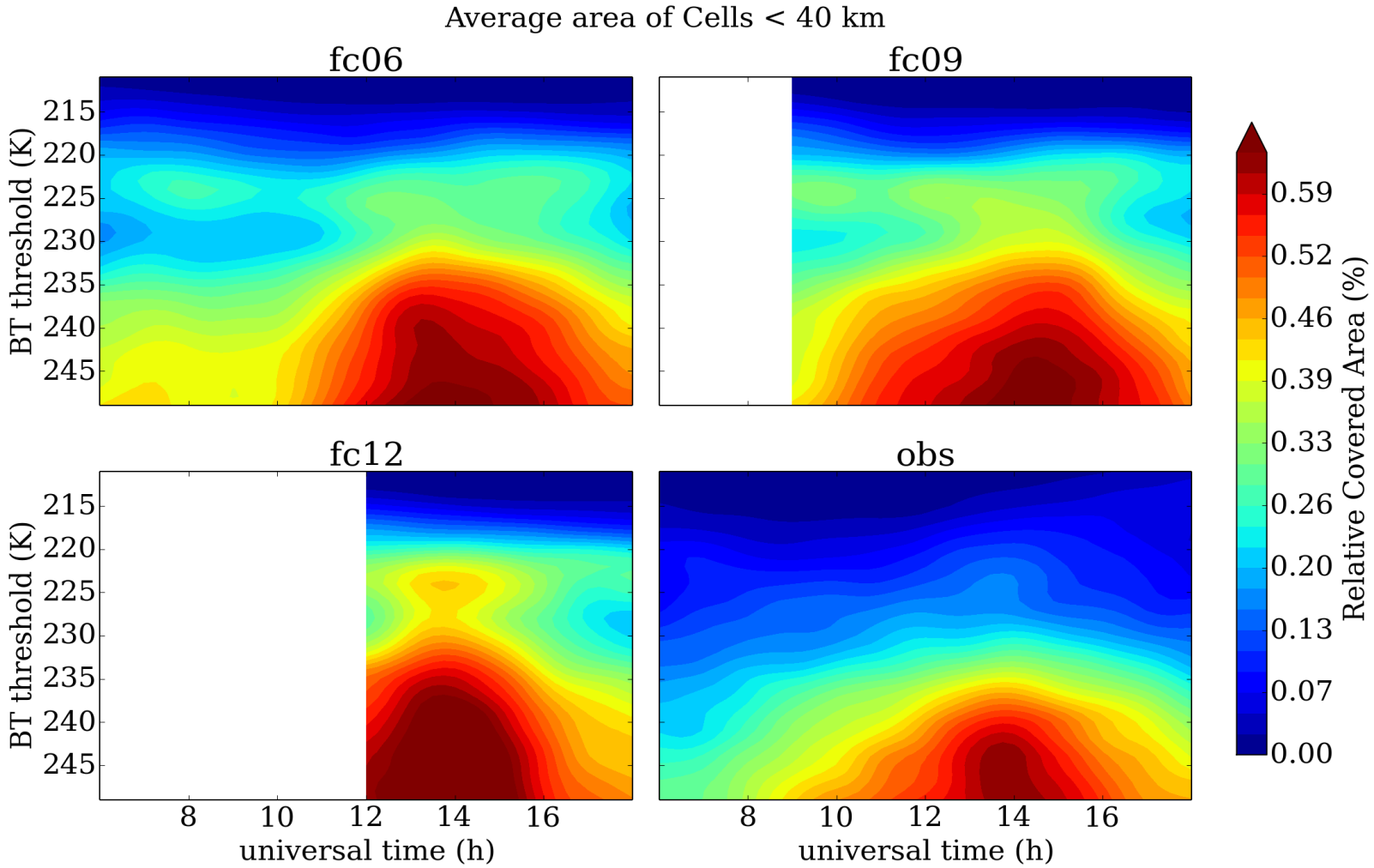

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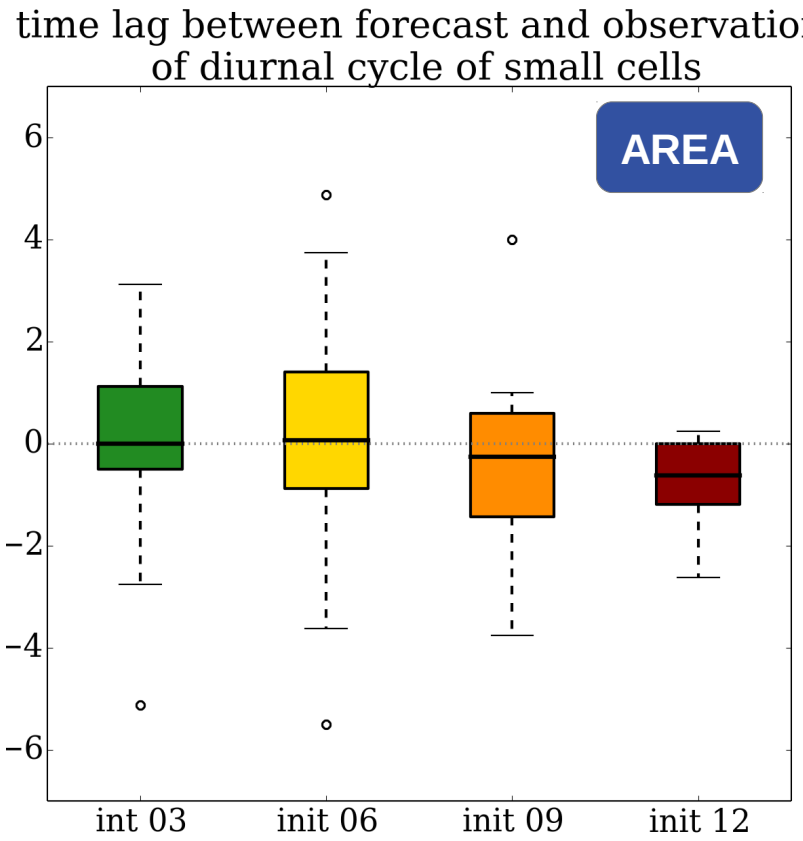
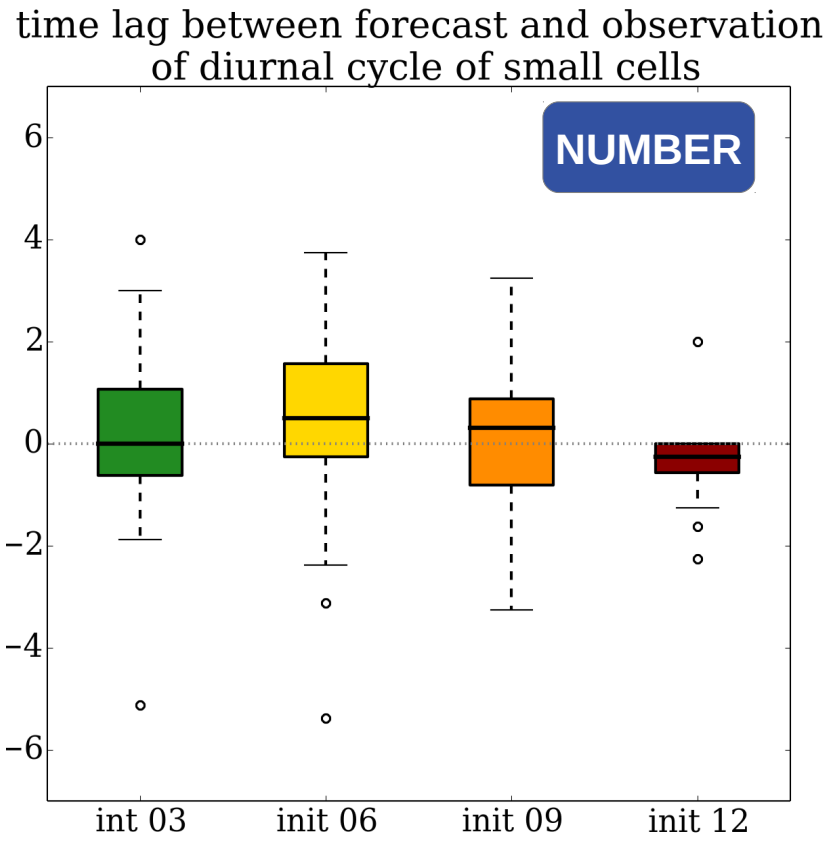
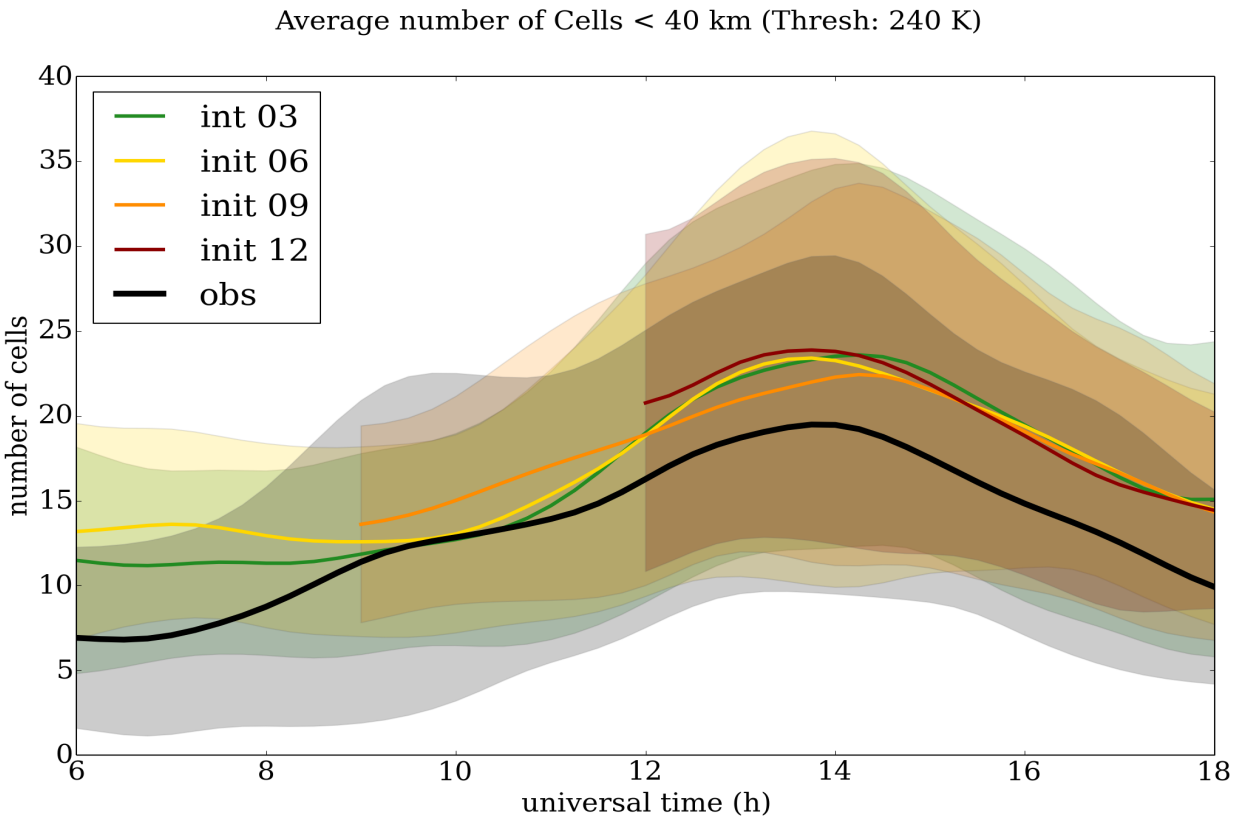




- later inits of COSMO forecast: to early maximum in small cell number and area

Results

Diurnal Cycle



- COSMO forecasts overestimated average amplitude of the diurnal cycle of the small cell area / number of 20 - 30 %
- but, large variability in the observed and modelled diurnal cycle

Results

Meteosat-based SAL

Results

SAL – Structure, Amplitude, Location

- developed for verification of precipitation forecasts (Wernli et al., 2008)
- threshold-based object identification
- no explicit match between objects needed – **statistical verification method**

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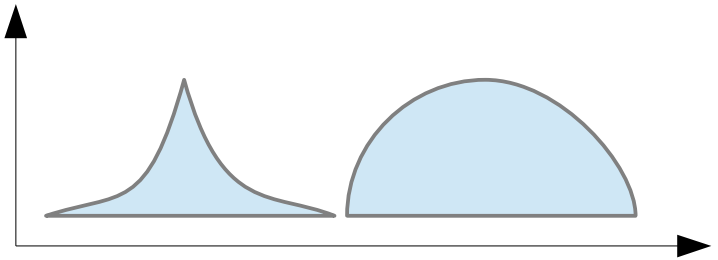
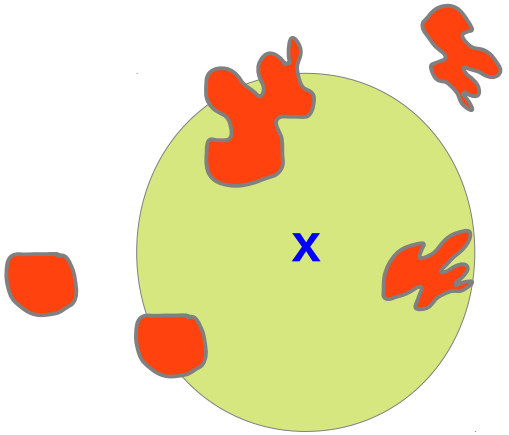
- **Structure:**
  - average cell shape,
    e.g. peaked or flat, small or large



- **Amplitude:**
  - field bias

- **Location:**
  - center of mass
  - compactness



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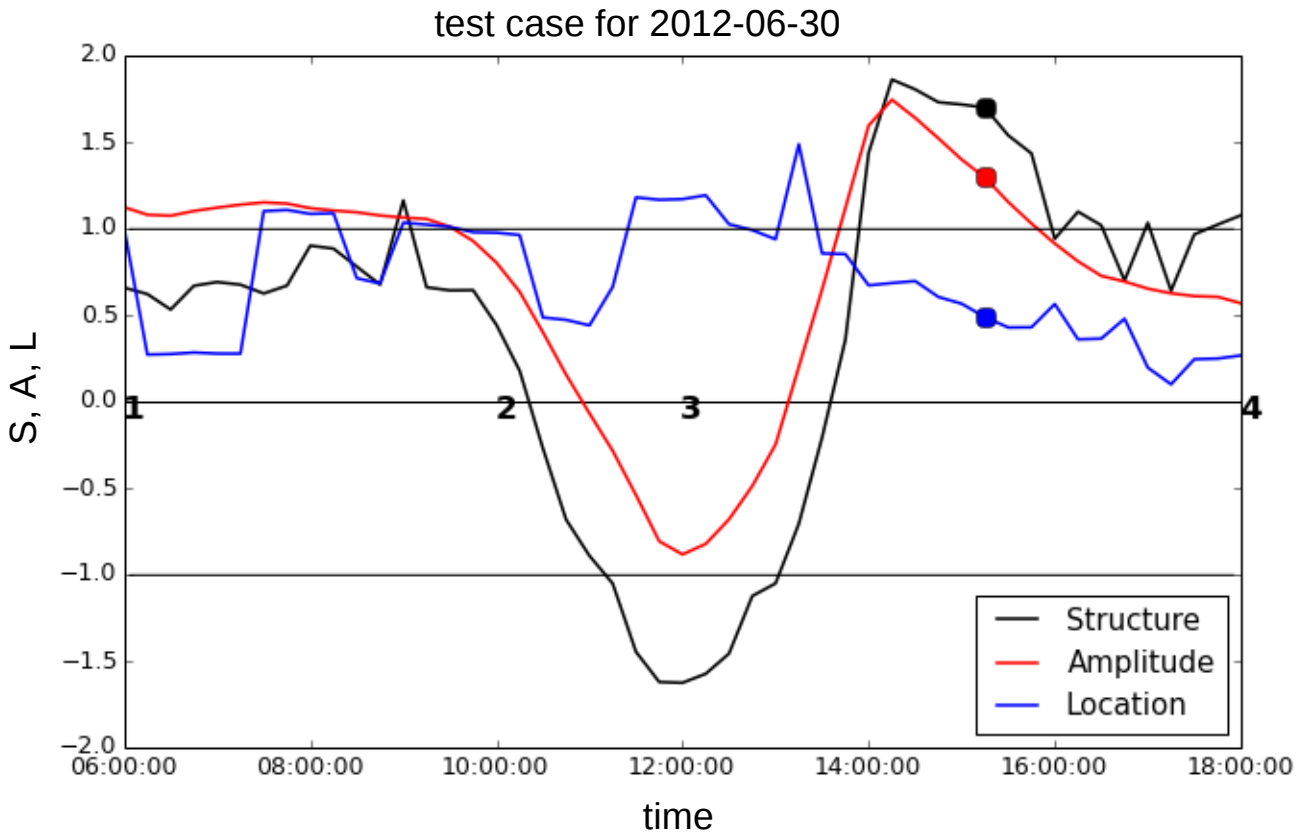

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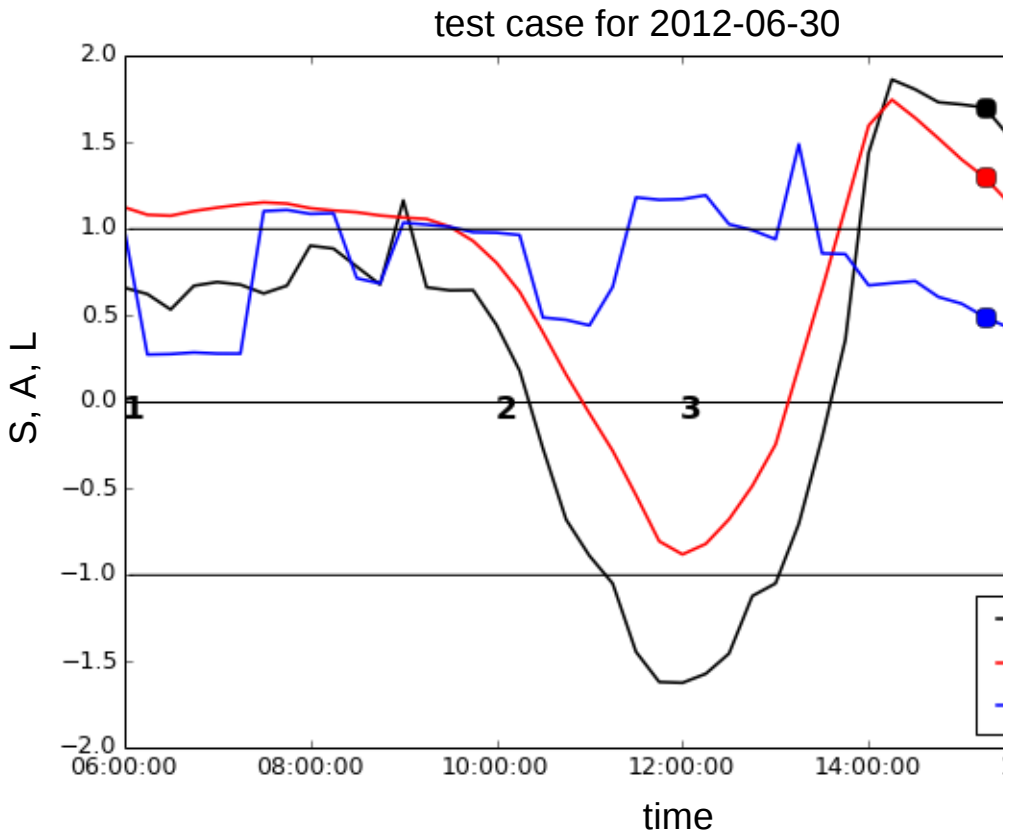

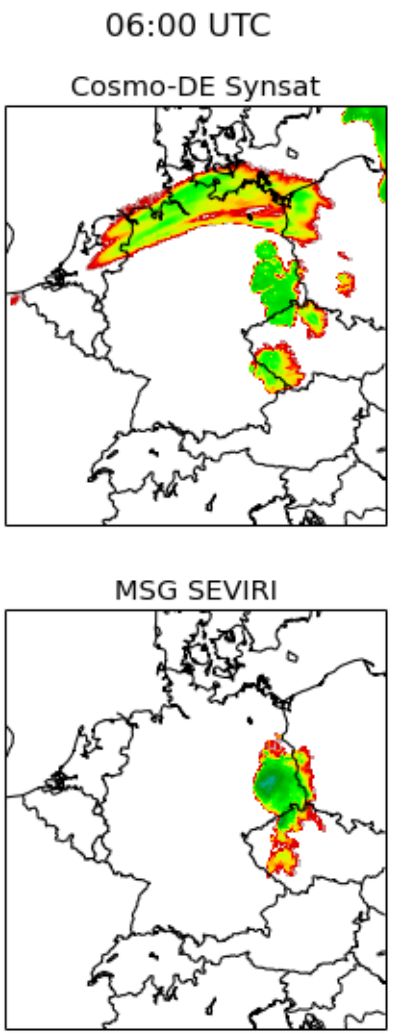

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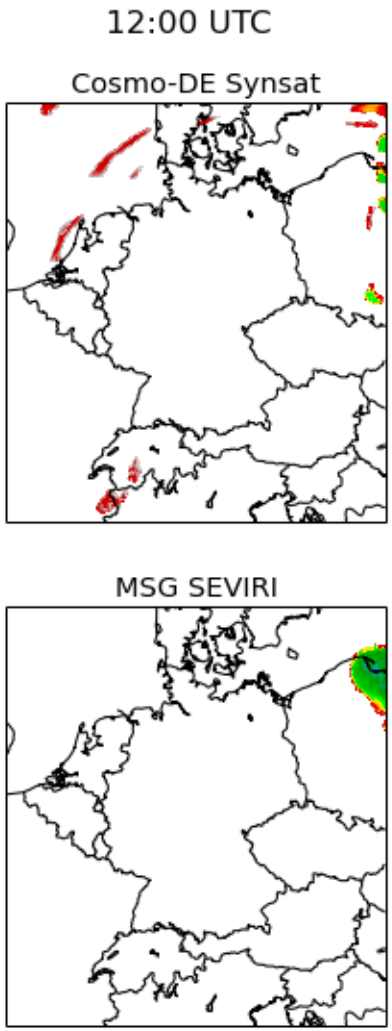
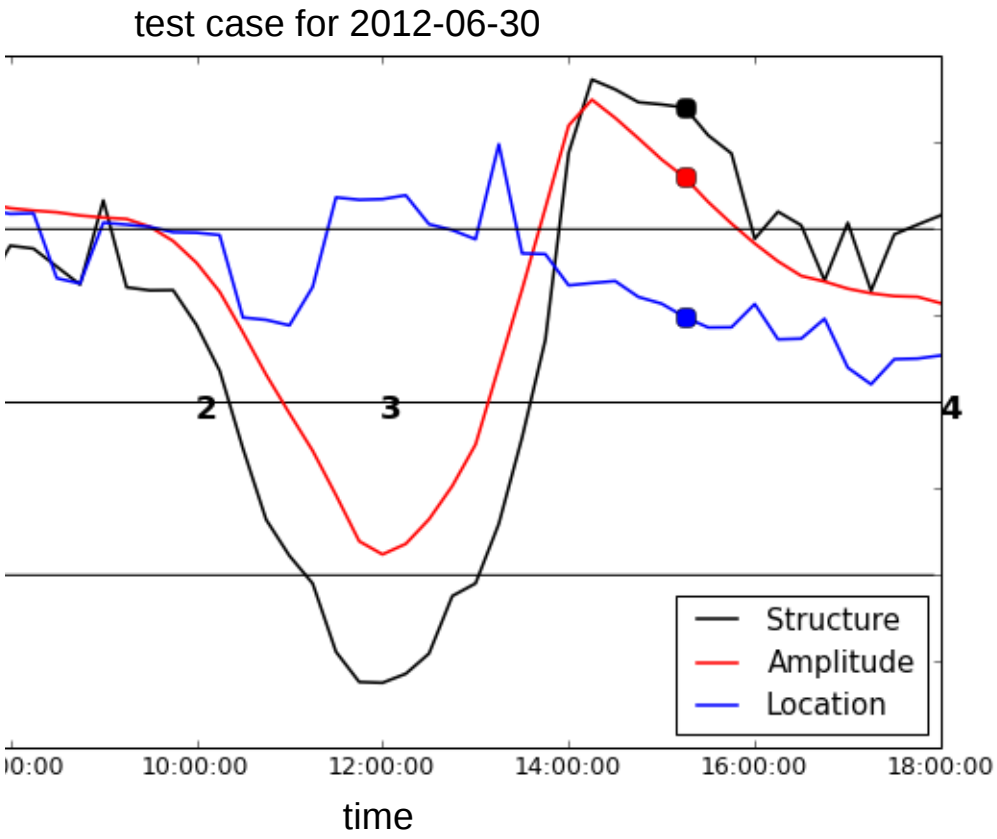




Results

SAL – Structure, Amplitude, Location

Challenges for Adaptation

- interpretation:
  - ➔ What is good, what bad?
  - ➔ How does it compare to precip. forecasts?
- sensitivity:
  - ➔ object identification, splits, merges, temporal causality
- uncertainties:
  - ➔ statistical properties of method
  - ➔ uncertainties in the real and synthetic observations

Conclusions

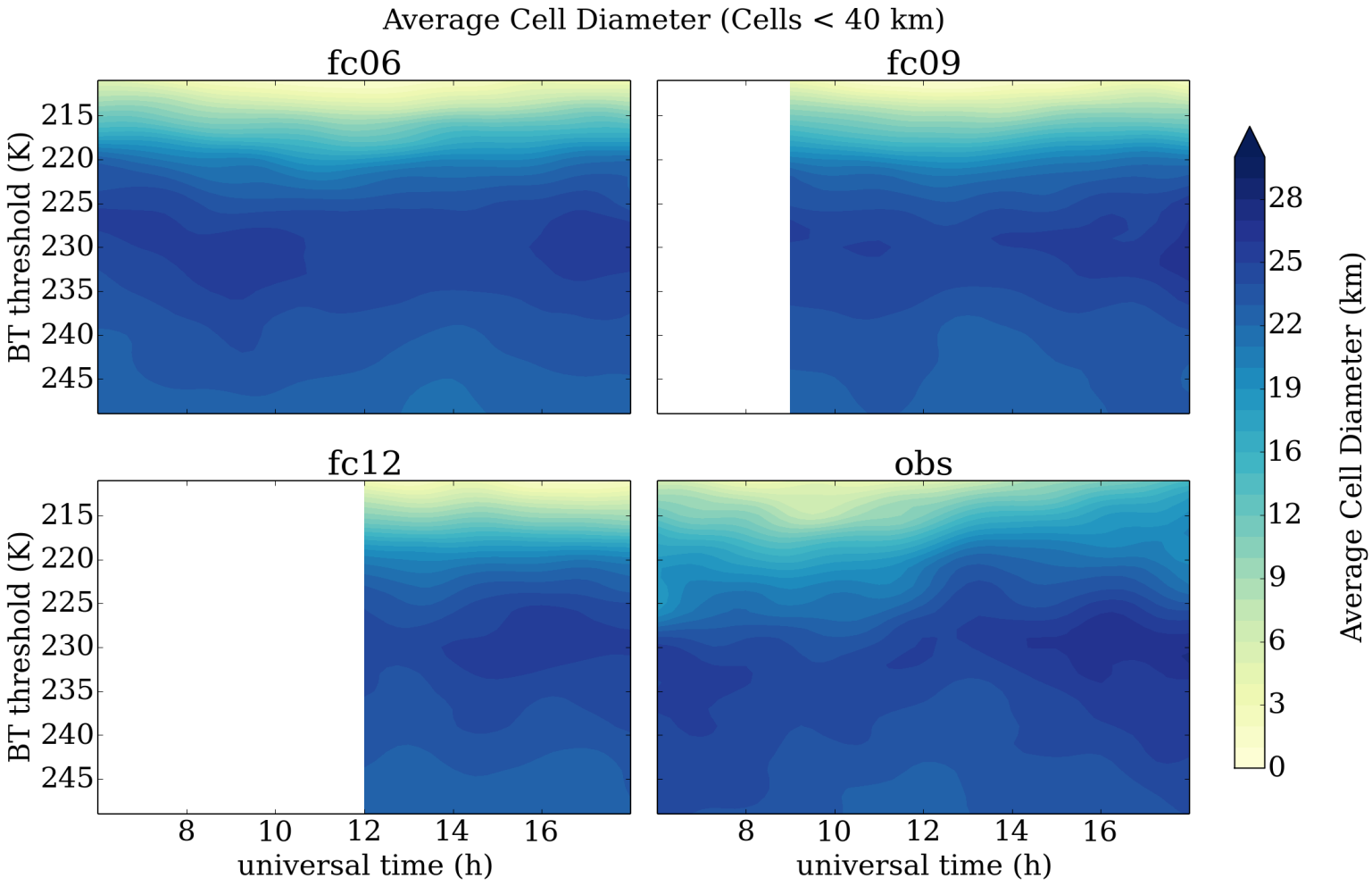
Summary

- number of small cells is over-estimated in convection-permitting forecast model COSMO-DE
- diurnal cycle of convective cells is qualitatively captured

Outlook

- extend analysis of cell size statistics and SAL to 2013 and 2014
- incorporate information about uncertainties
- diurnal cycle in combination with the preconvective environment
- closer look on temporal changes in cloud properties
  (e.g. cloud-top cooling rate, anvil expansion)

Supplement



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