HD(CP)^2
High definition clouds and precipitation for advancing climate prediction

Characterisation of convective organizations in Germany

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Motivation

- In idealized simulations convection spontaneously starts to organize:

  - drier atmosphere
  - more outgoing longwave radiation
  - negative feedback on the surface temperature

- Negative climate feedback ?

Research question

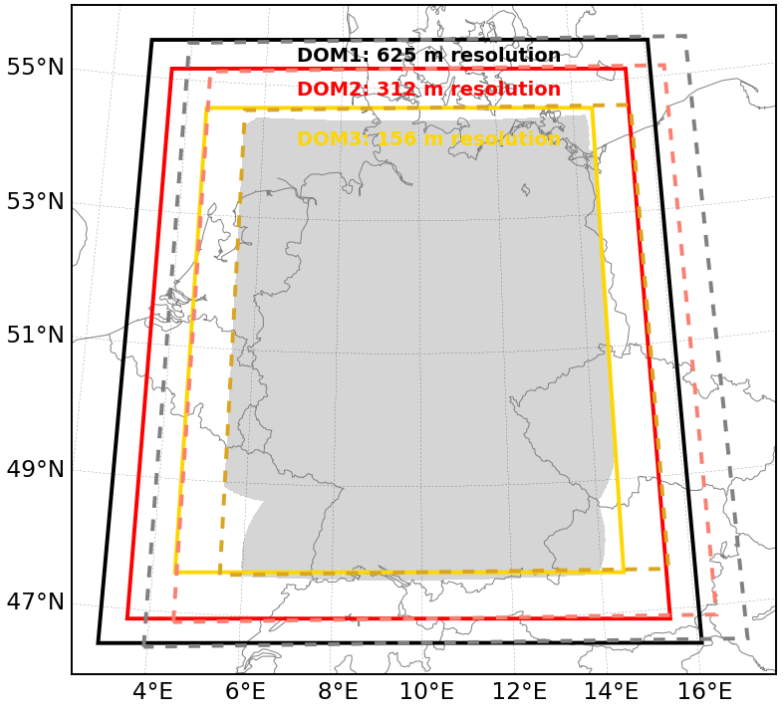
- How organized is convection over Germany ?

- How well are organizations simulated by a large eddy simulation model?

Framework

Observations:

- April to September of 2014 and 2015
- reflectivities & rain rates (Radolan)
- brightness temperature (MSG)
- 30 minutes and ~ 1.2 km resolution

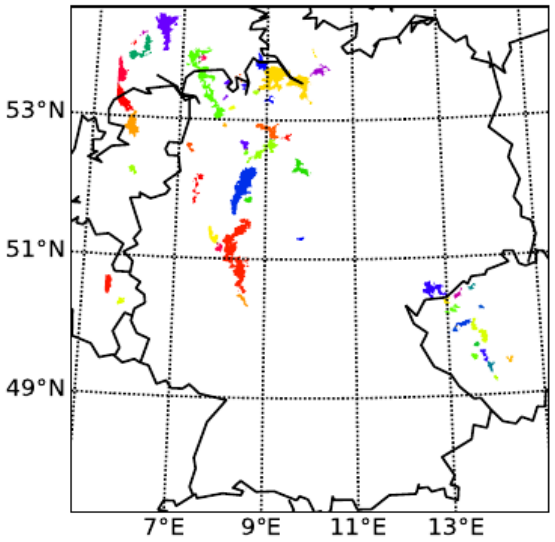


Simulations:

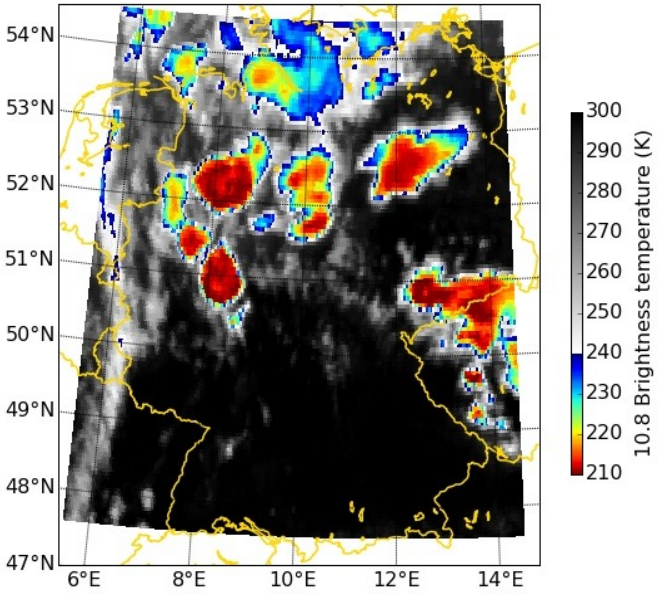
- ICON-LEM (LES ICOsahedral non-hydrostatic atmospheric model)
- multi nesting: 625 m (DOM01), 312 m (DOM02) and 156 m (DOM03)
- cases of convection: 29 July 2014, 15 August 2014, 4-5 July 2015

Method

Radar



Satellite

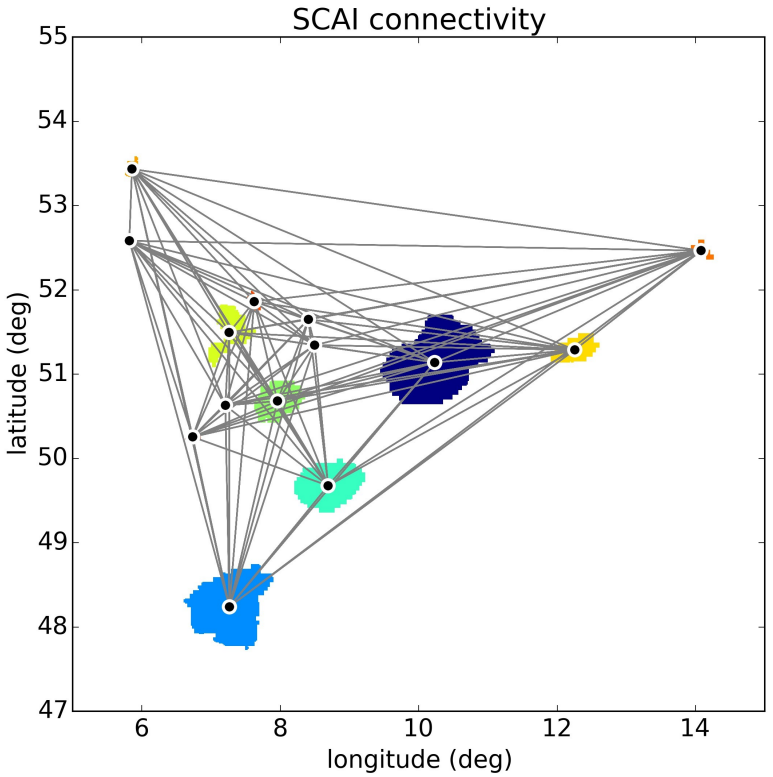


- Detection of convective cells/clouds:
  - watershed segmentation algorithm
  - radar/satellite
- Organization indices:
  - degree of organization:

    organized, random or regular
  - number of objects and shape
  - distance between objects
  - rainfall amount

Degree of organization

SCAI (simple convective organizaiton index)



$$scai = \frac{N D_o}{N_{max} L} 1000$$

N: number of objects

D_0 : geometrical mean distance between pairs of objects

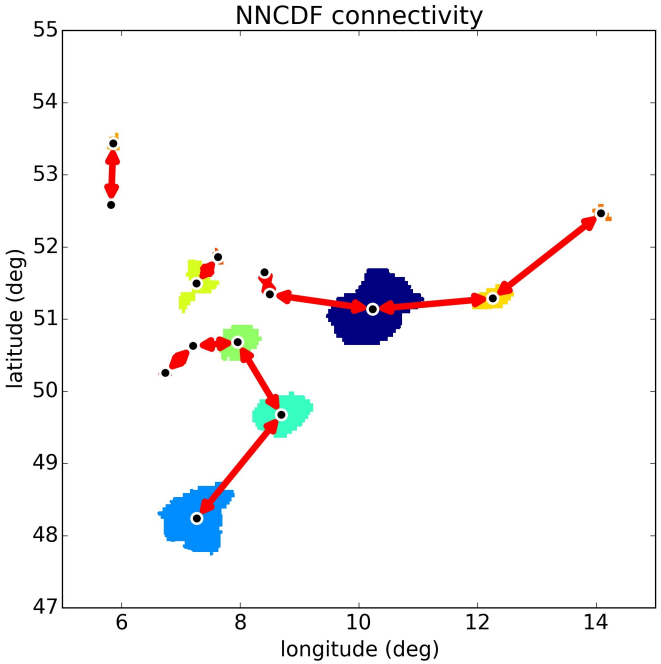
N_{max}: maximum number of grid points

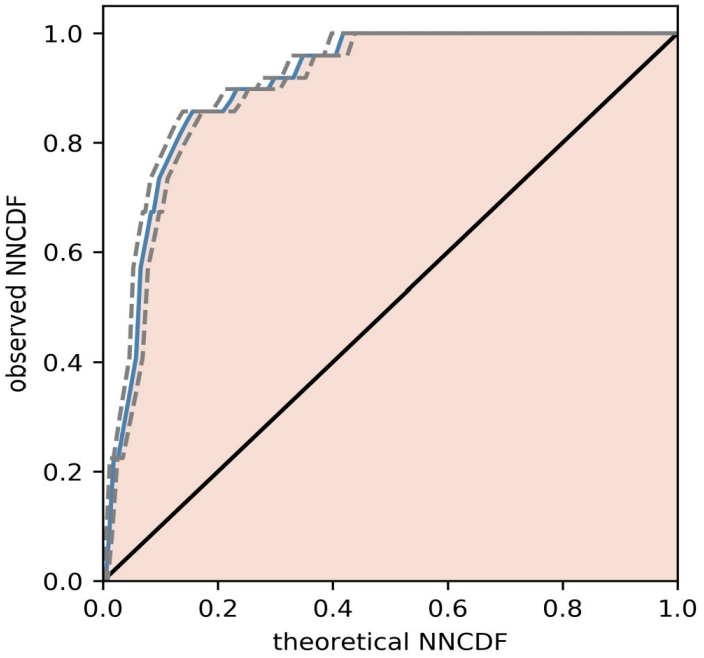
L : characteristic length

Organization increases as SCAI decreases

Degree of organization

I.org





- I.org ranges between 0 and 1
- scale invariant
- considers size of the objects

I.org	spatial arrangement
< 0.5	regular
= 0.5	random
> 0.5	organized

Shape

I.shape

$$I.shape = 1/N \sum_{I=1}^{N} I_i \qquad \text{where} \qquad I_i = \frac{\sqrt{(A_i)}}{0.282\, P_i}$$

Ai (area of the object i)

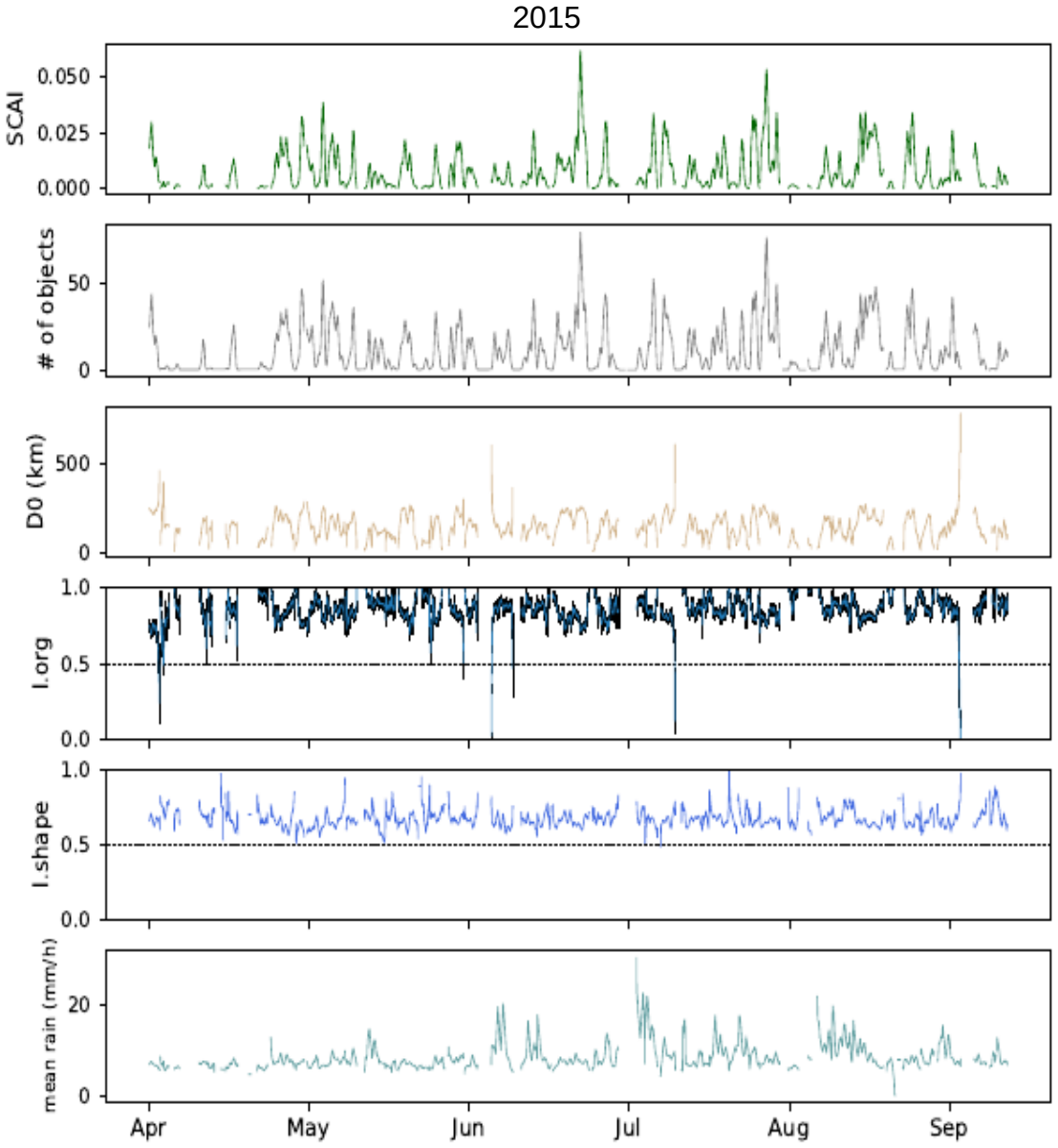
Pi (perimeter)

N (# of objects)

I.shape ranges between 0 and 1

I.shape	form of the object
0	line
0.5	ellipse
1	circle

How organized is convection over Germany ?



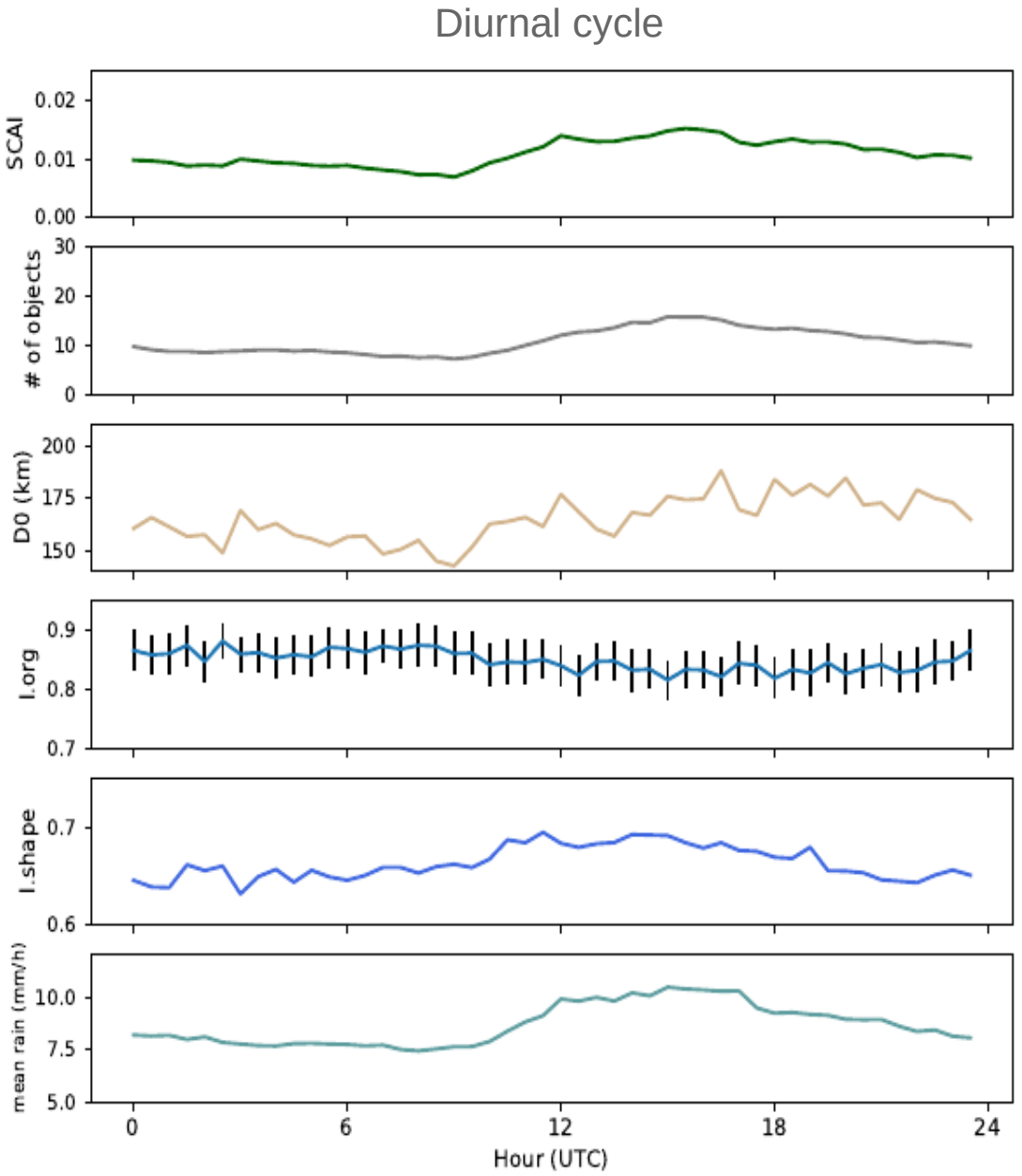
From radar observations

Organization	97.9 %
Regular	1.5 %
Random	0.6 %

Correlation coefficient

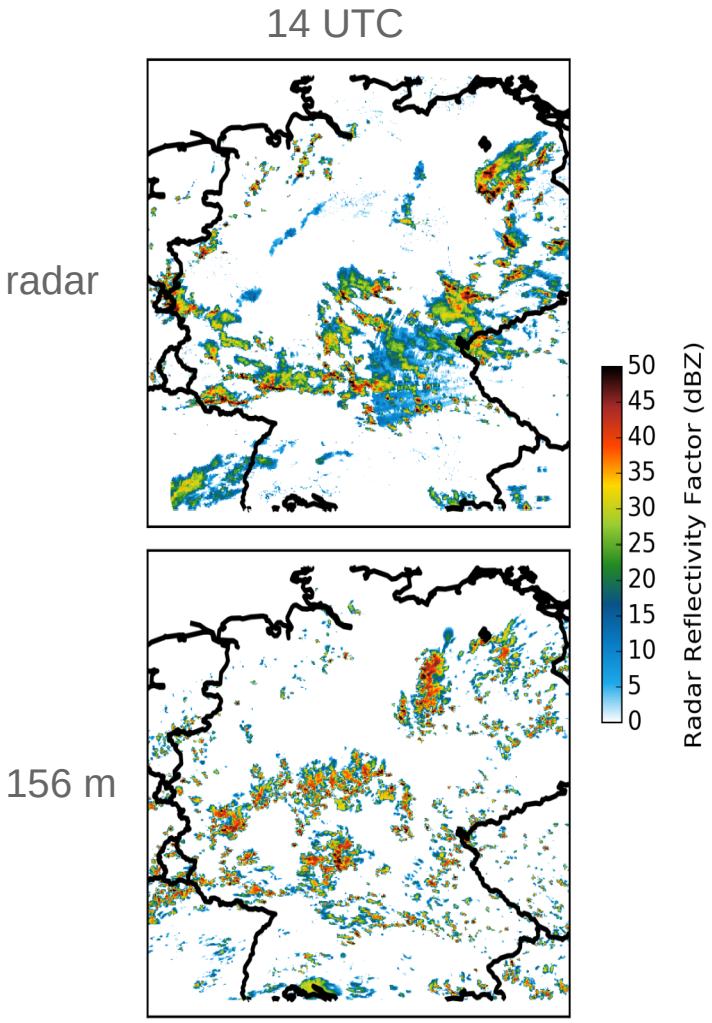
SCAI	# of objects	+0.96
D0	I.org	-0.72
mean rain	I.shape	+0.25

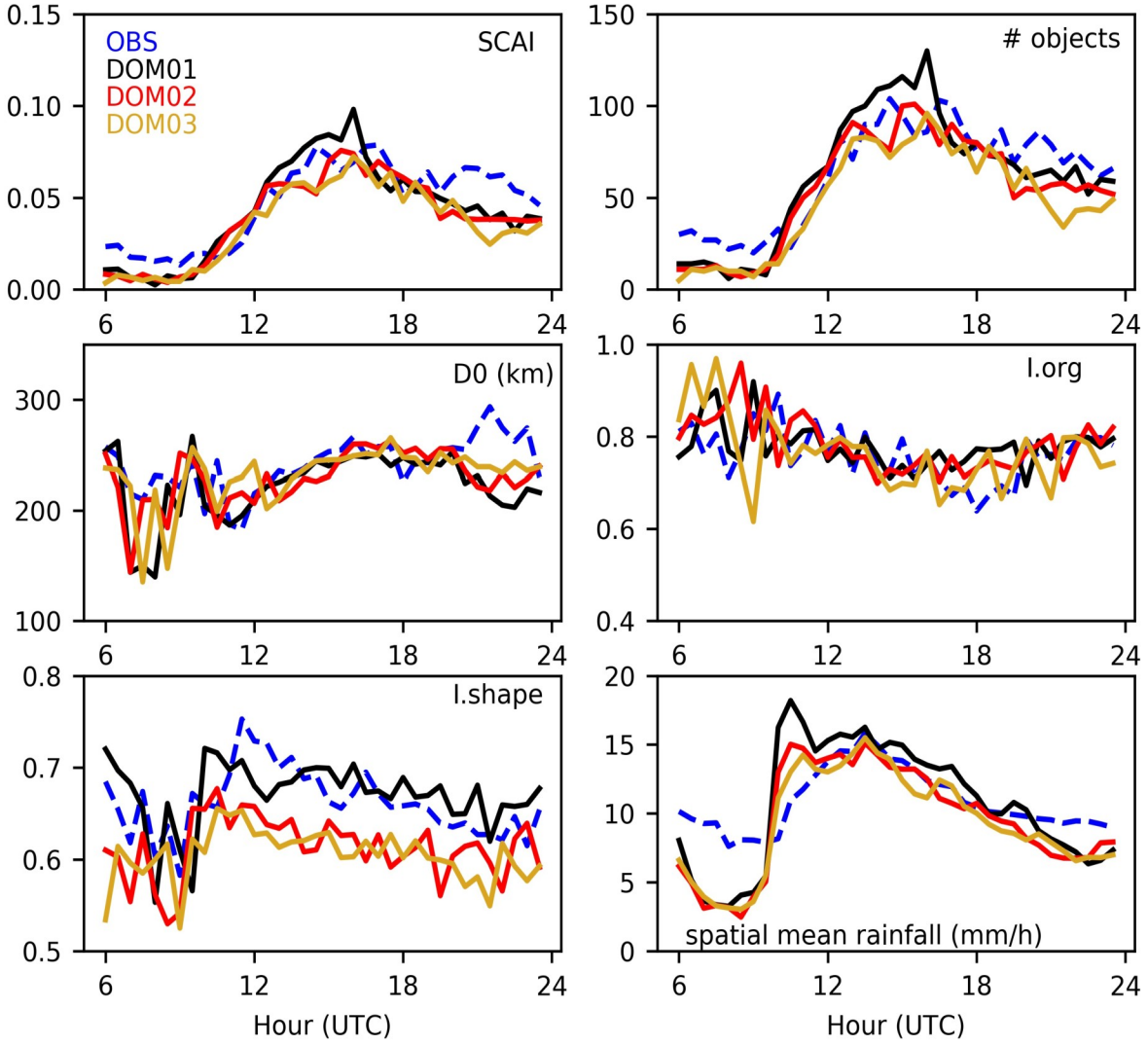
How organized is convection over Germany ?



Model Evaluation

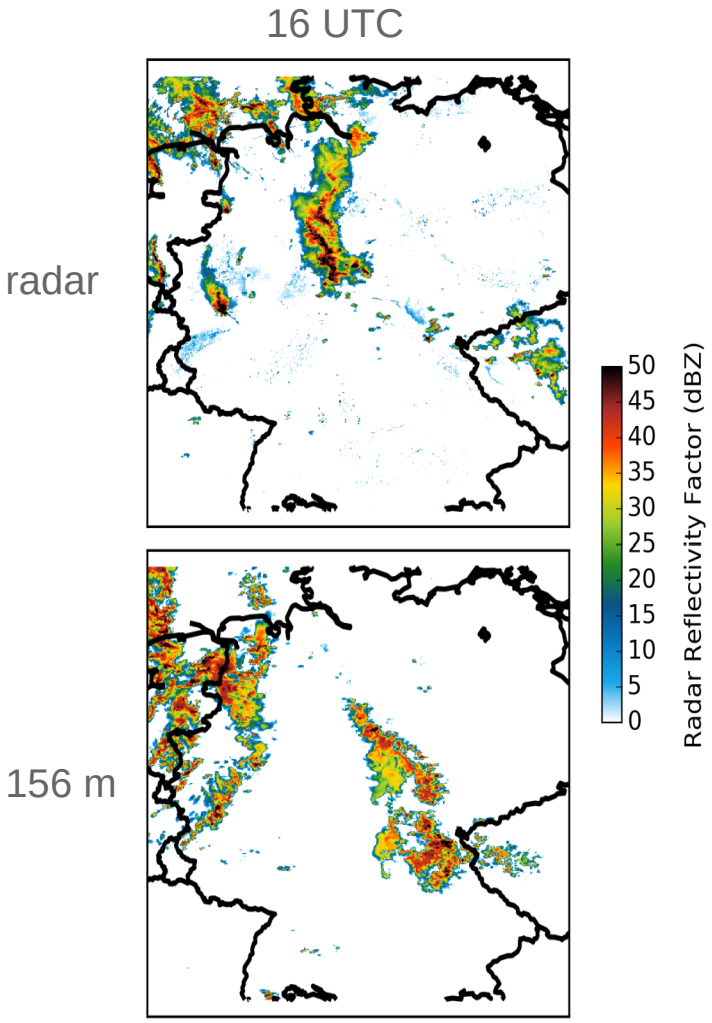
29 July 2014

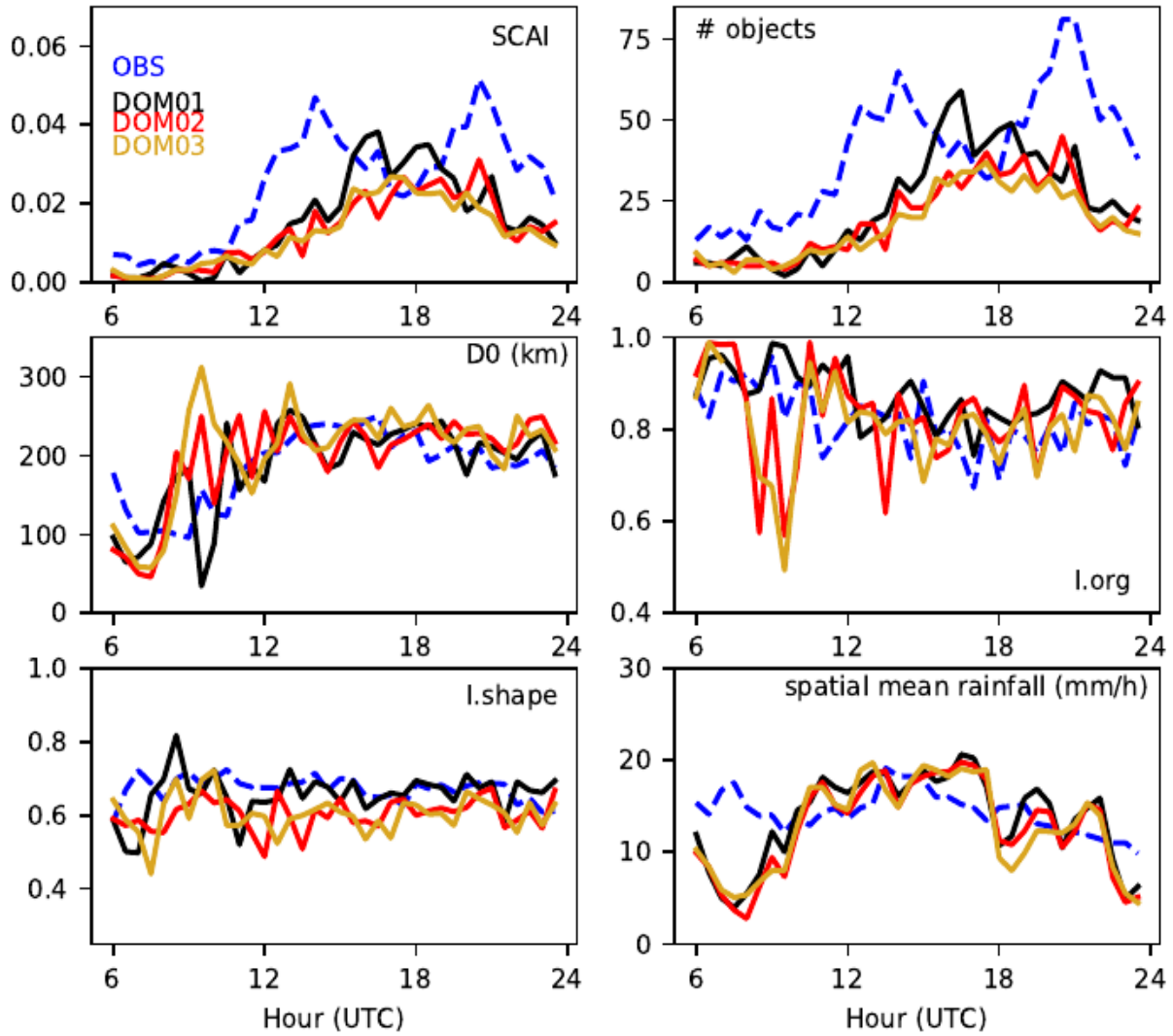




Model Evaluation

5 July 2015





Summary

Observations:

- convection is organized in ~ 98 % of the time during the German summer
- the amount of rainfall is independent of the degree of organization

Simulations:

- the number of objects and the amount of rainfall is underestimated
- DOM01 is more able to reproduce the degree of organization and the shape of the objects than DOM02 and DOM03