Thunderstorm Characteristics in Austria
A Study based on Radar and Lightning data

Vera Meyer, Lukas Tüchler

vera.meyer@zamg.ac.at

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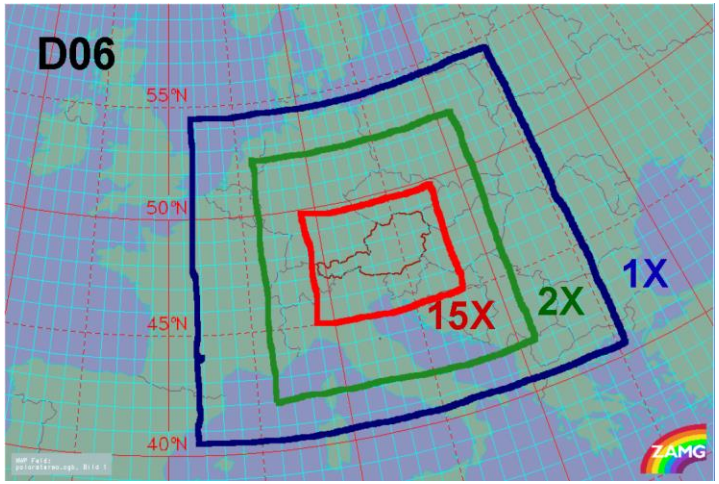
DATA SOURCES

WEATHER CONDITION CLASSIFICATION (WLK)

Automated **daily** pattern classification **WLKC733** at ZAMG since 2004
on the basis of **ECMWF 12h UTC run**

domestic development following Bissolli und Dittmann (2001) described in COST733 Action

Domain: „D06“ - Nesting



Input Parameters:

- u(700hPa), v(700hPa)
- z(925 hPa), z(500hPa)
- TWC

Output Parameters

- dominant wind direction
- „C“yclonic / „A“nti- cyclonic
  at 925 hPa und 500 hPa
- humidity indicator: „W“et oder „Dry“

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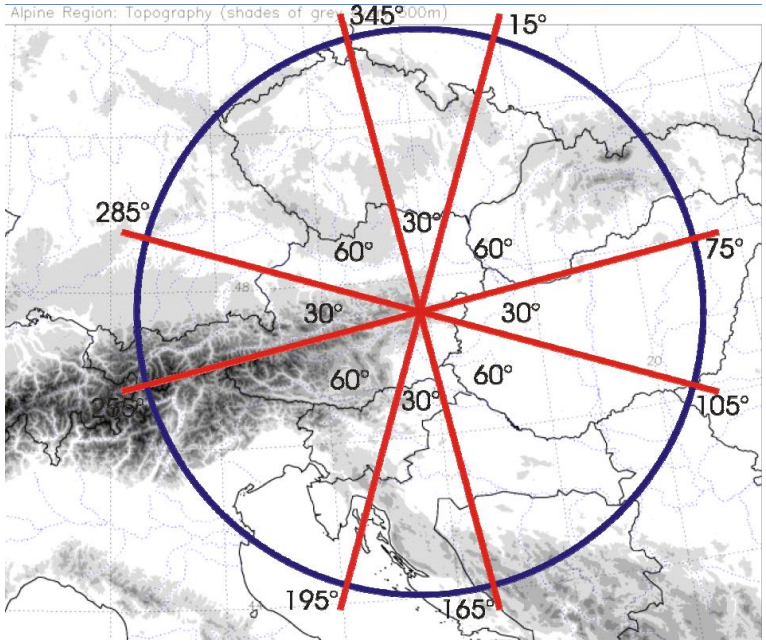
DATA SOURCES

WEATHER CONDITION CLASSIFICATION

8 wind direction sectors & weak gradient



0	weak gradient	--	--
1	N	345° - 15°	30 ° Sektor
2	NE	15° - 75°	60° Sektor
3	E	75° - 105°	30 ° Sektor
4	SE	105° - 165°	60° Sektor
5	S	165° - 195°	30 ° Sektor
6	SW	195° - 255°	60° Sektor
7	W	255° - 285°	30 ° Sektor
8	NW	285° - 345°	60° Sektor

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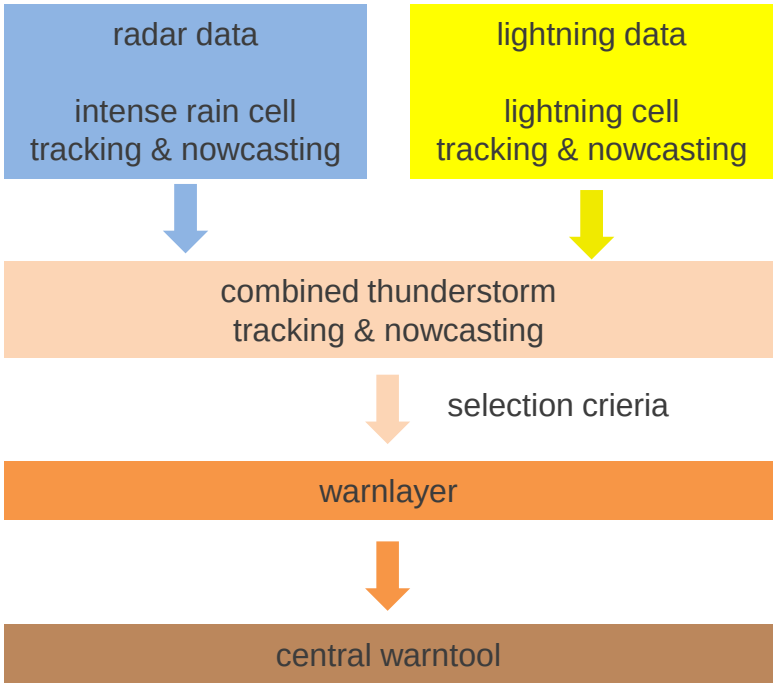
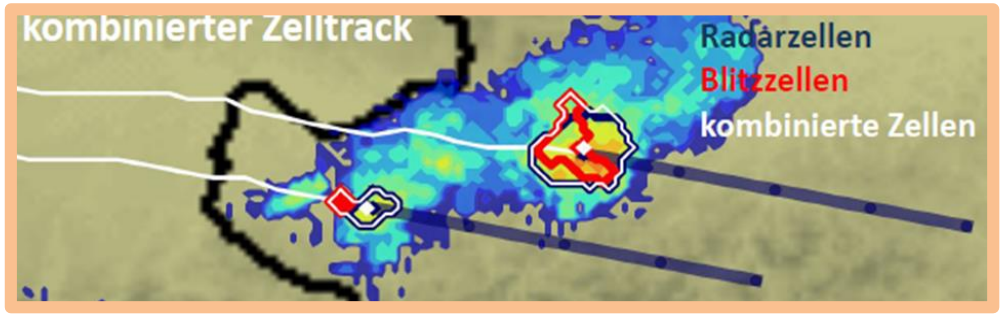
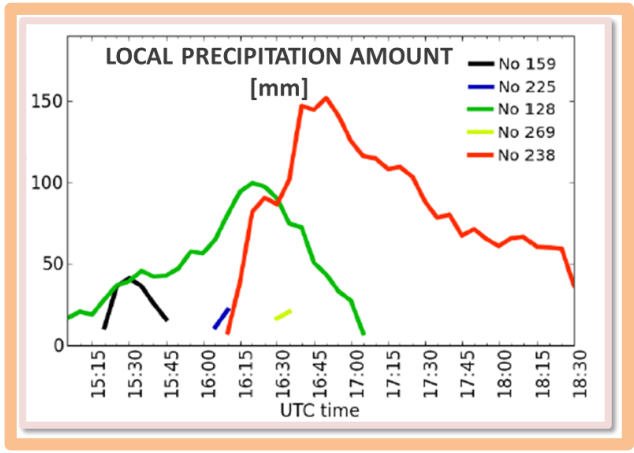
DATA SOURCES

AUSTRIAN THUNDERSTORM NOWCSATING TOOL (A-TNT)







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DATA SOURCES

AUSTRIAN THUNDERSTORM NOWCASTING TOOL (A-TNT)

For each selected thunderstorm cell the maximum or sum of the following paramters were investigated as CHARACTERISTICAL PARAMETERS

2D ANALYSES MAXCAPPI since 26.03.2014

3D ANALYSES MAXCAPPI/CAPPI since 04.08.2015

CELL AREA (area)	km²
LIFETIME (lt)	min
TRAVEL DISTANCE (dist)	km
TRAVEL VELOCITY (vel)	Km/h
MAXIMUM LIGHTNING RATE (ligmax)	1/(9 min)
SUM LIGHTNING STROKES (ligsum)	-
LIGHTNING STROKES per LIFETIME (ligdens)	1/min
MAX. REFLECTIVITY DBZ_MAX (dbzmax)	dBZ
MEAN REFLECTIVITY DBZ_MEAN (dbzmean)	dBZ
12 dBZ reflectivity core top height (hmax)	km
38 dBZ reflectivity core top height (hdbz38)	km
45 dBZ reflectivity core top height (hdbz45)	km
Maximum reflectivity core top height (hdbzmax)	km

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DATA SOURCES

AUSTRIAN THUNDERSTORM NOWCSATING TOOL (A-TNT)

DATA SELECTION

1. THUNDERSTORM
   at least 2 lightning strokes once during life-cycle
   lifetime > 10 min (traveldirection compass also > 40 min)

2. COMPLETE ASSESSMENT

   CHARACTERISTICAL PARAMETERS
   - entire cell development within radar domain
   - no cell initiation from cell splitting & no cell dissipation to cell merging

   CELL INITIATION MAP
   - cell initiation within radar domain
   - no cell initiation from cell splitting

   CELL DISSIPATION MAP
   - cell dissipationwithin radar domain
   - no cell dissipation to cell merging

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DATA SOURCES

WLK Statistics	01.01.2014 - 31.12.2016 January – December
assumption:	*neglectible number of thunderstorms between 01.01. – 26.03.2014.*
Thunderstormparameters	26.03.2014 - 31.12.2016 April – September

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INTERPRETATION

To be considered for the interpretation:

- 3D radar parameter not available before August 2015
- local radar beam shading
- periphery
- underlying statistic
- daily resolution of the weather condition classification

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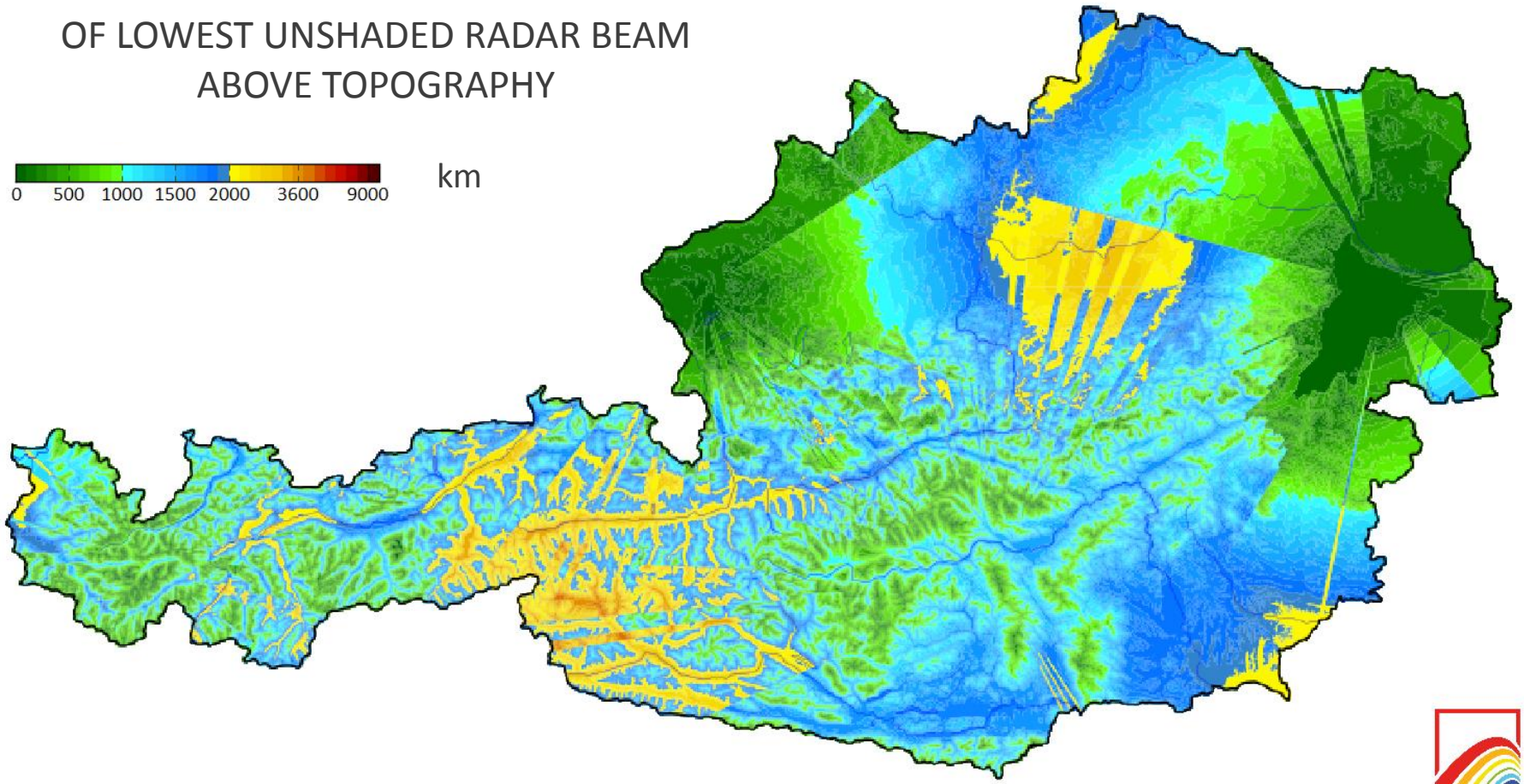
RADAR BEAM SHADING MAP

RELATIVE HEIGHT
OF LOWEST UNSHADED RADAR BEAM
ABOVE TOPOGRAPHY

km



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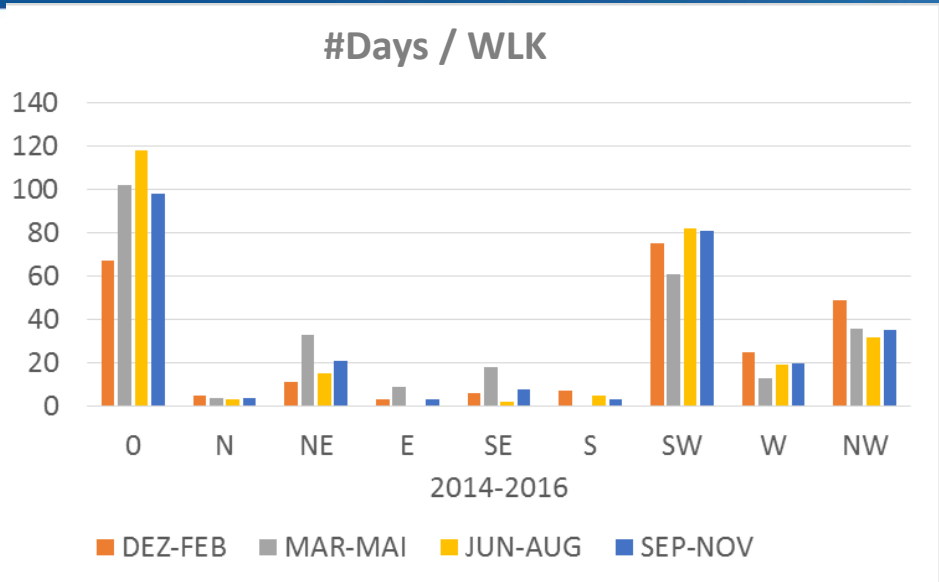
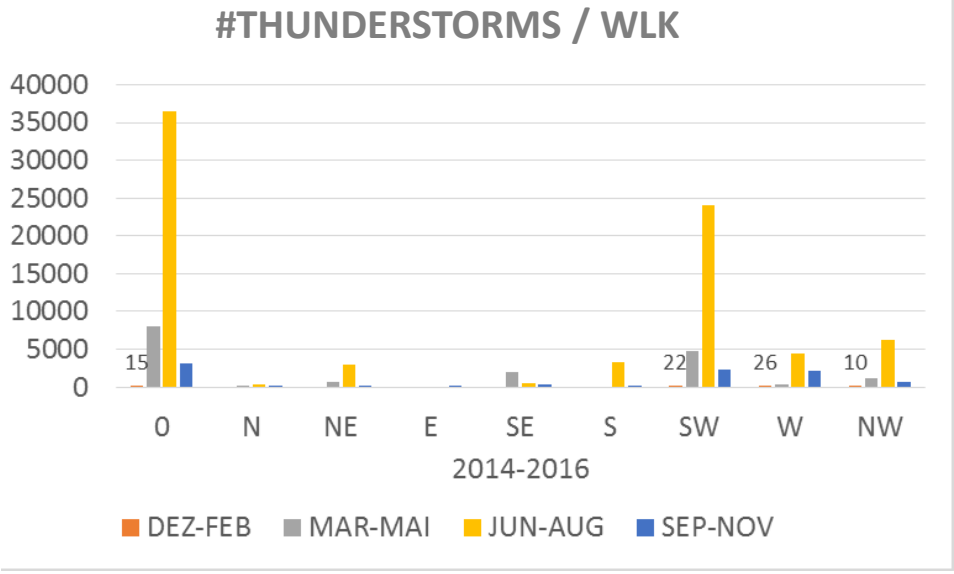
WEATHER PATTERN STATISTIC





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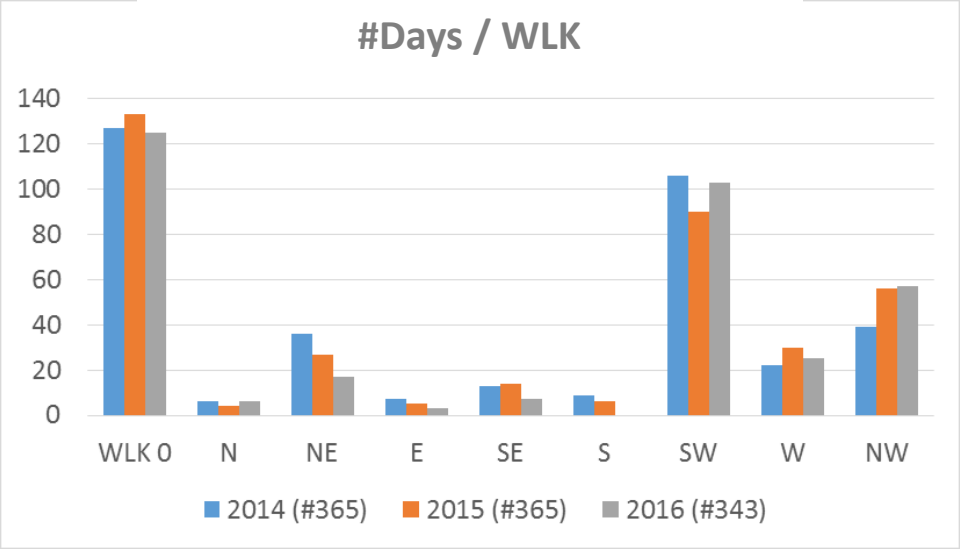
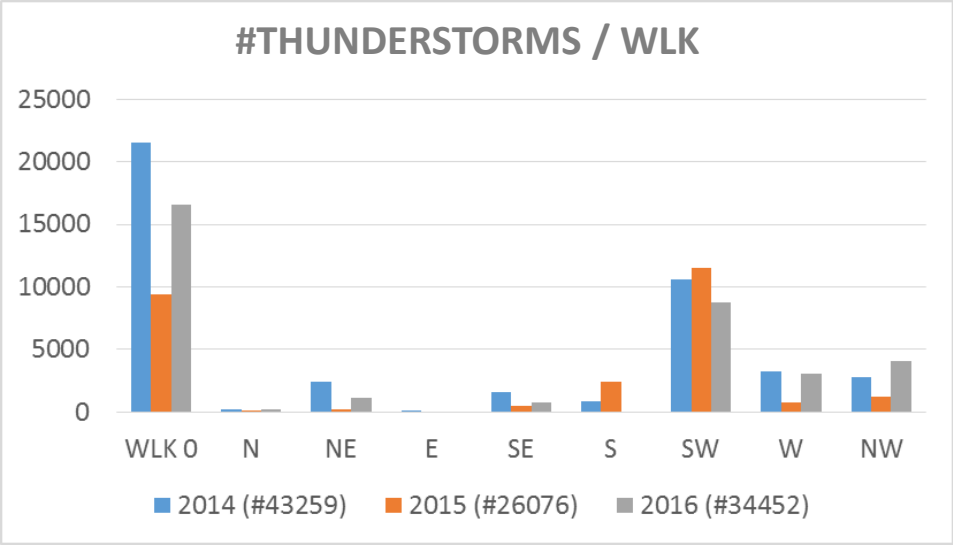
WEATHER PATTERN STATISTIC





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ANALYSES METHODS

FREQUENCY MAPS

Absolute Frequence of

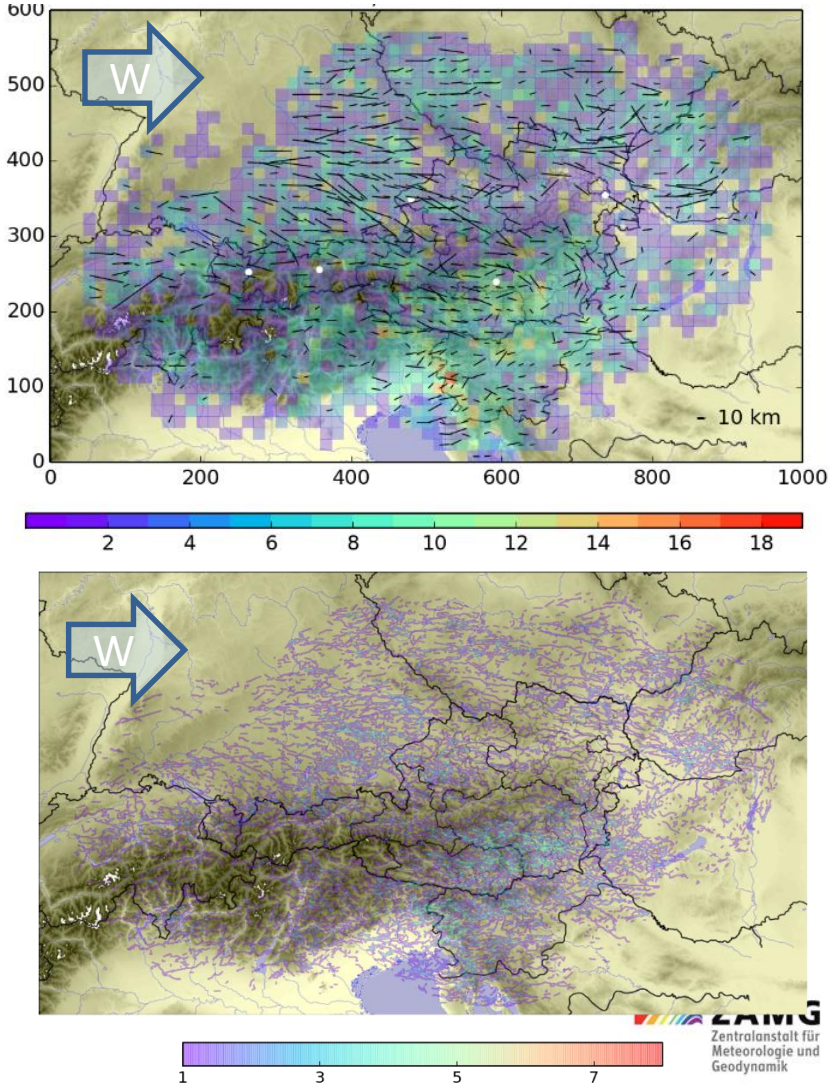
- cell initiation
  with mean travel direction and distance*
  mean travel distance if #cells/square > 3

  resolution: 5 km x 5 km, 15 km x 15 km
  (depending on the underlying statistic)

- cell track density

  resolution: 1 km x 1 km

*travel direction and distance are achieved by comparing the cell centers of initiation and dissipation points

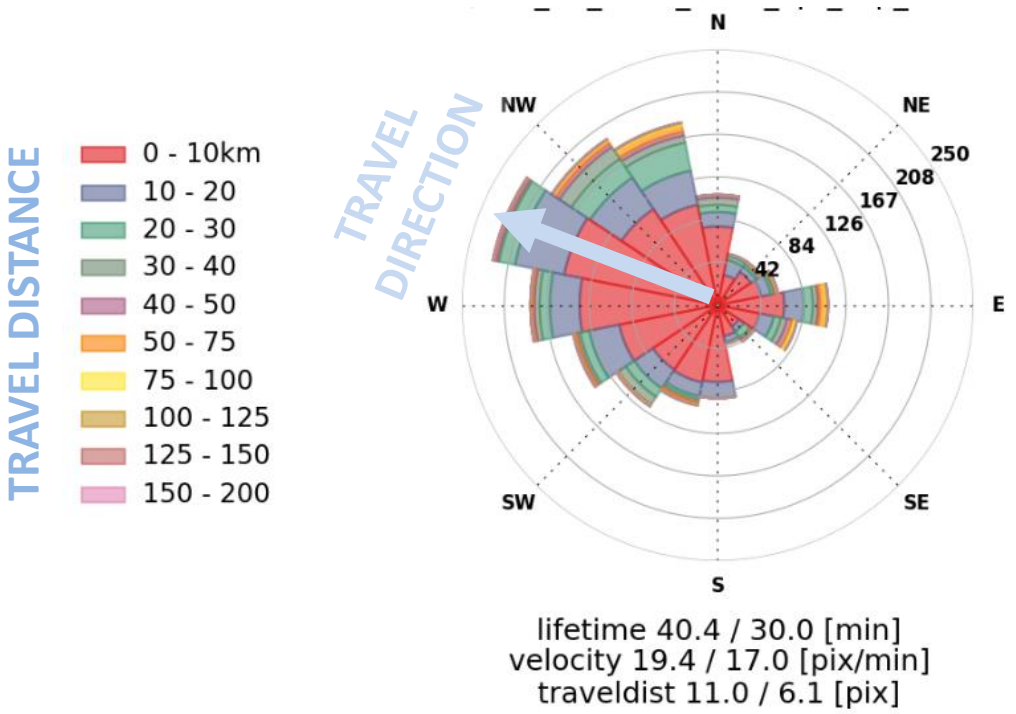


ANALYSES METHODS

STORM PATH COMPASS

Absolute frequencies of
- travel direction*
- travel distance*

Statistic



*travel direction and distance are achieved by comparing the cell centers of initiation and dissipation points

STATISTIC
Mean/Median

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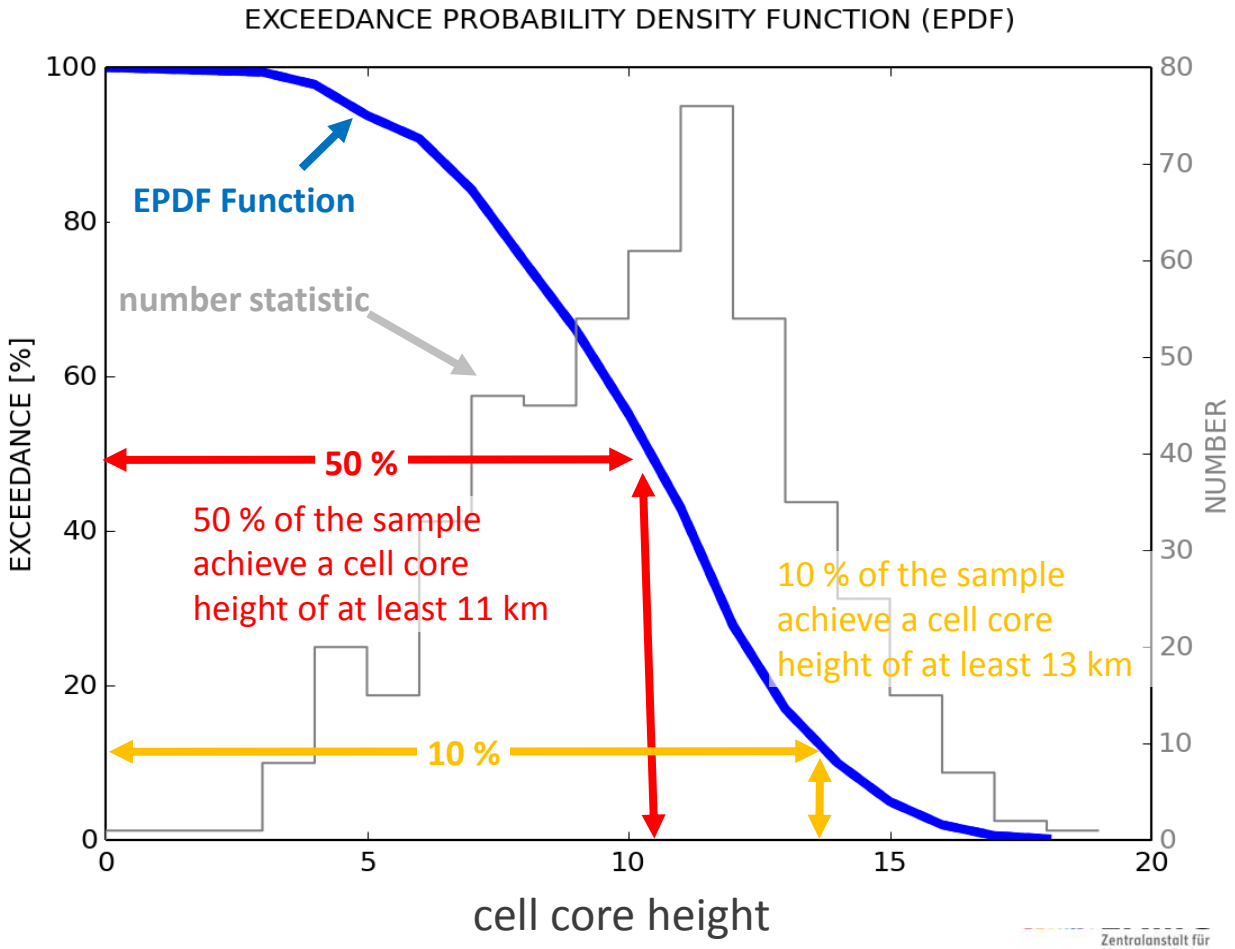
ANALYSES METHODS

EXCEEDANCE PROBABILITY/ EXCEEDANCE PROBABILITY DENSITY FUNCTIONS (EPDF)

Percentage of storm cells in the data sample which achieve a

value
≥
value at the x-axis

Exceedance Probability
⇩
Exceedance Frequency

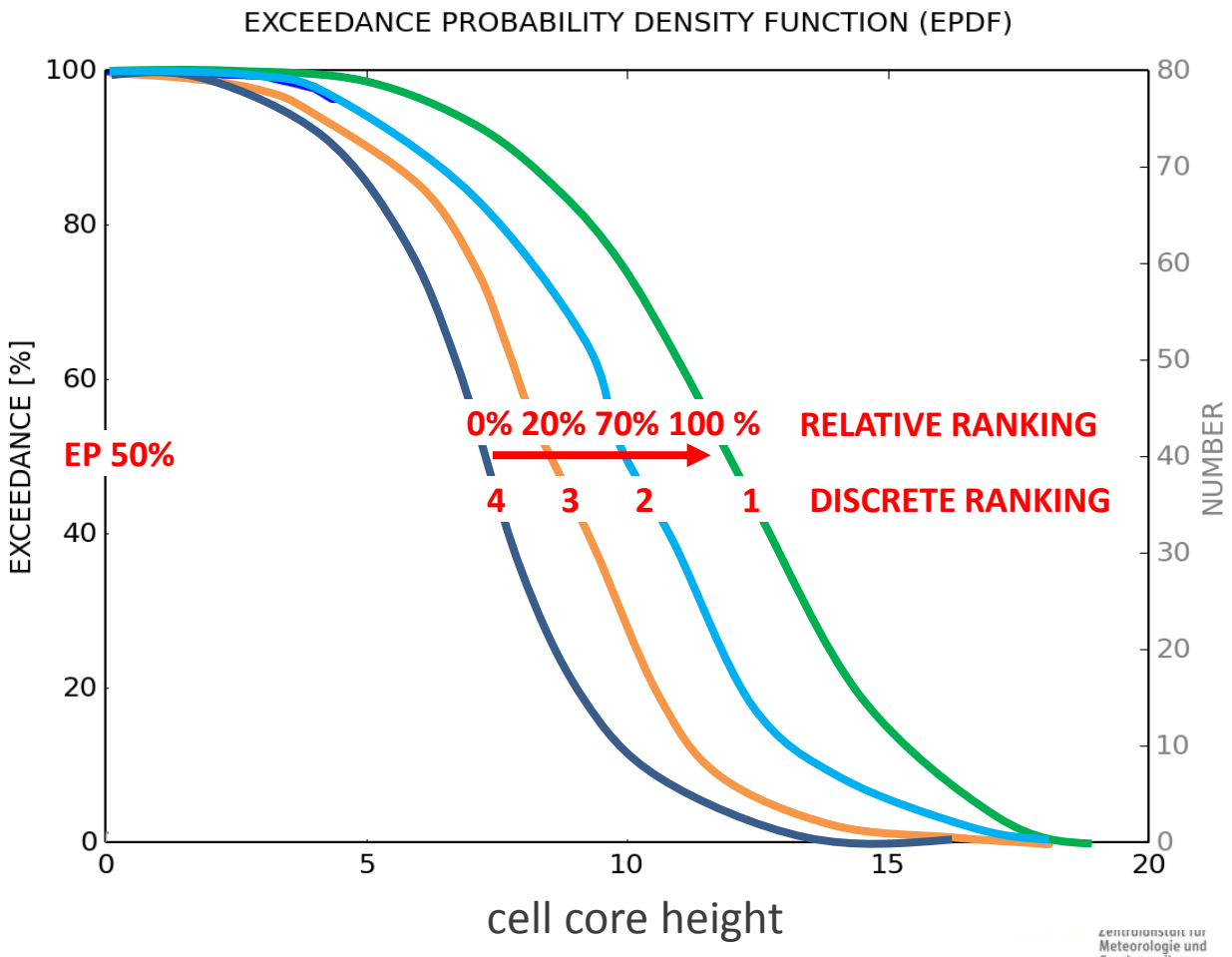


ANALYSES METHODS

EPDF RANKING

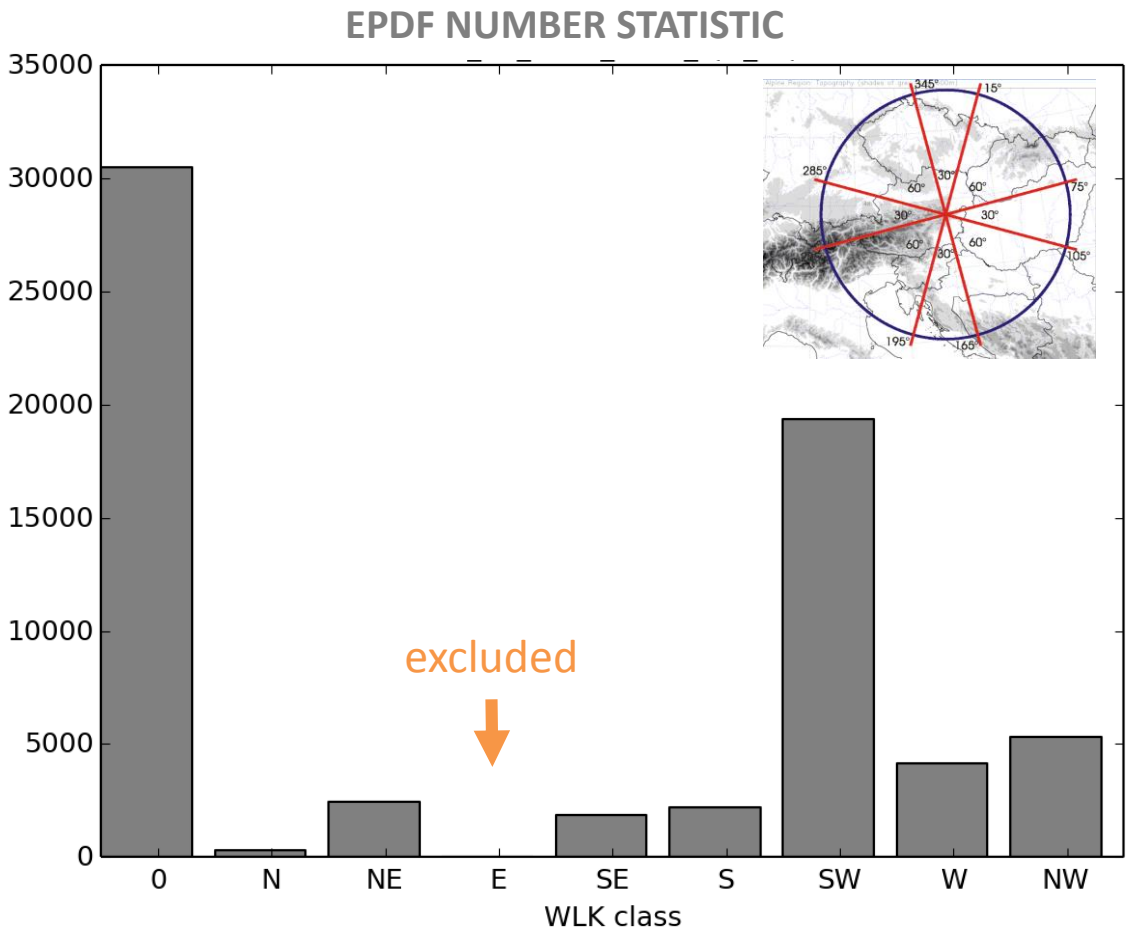
A ranking can be done by comparing the EPDF functions for different weather patterns

For a specific exceedance probability data samples with tendential higher values will be found at higher parameter values.



ANALYSES METHODS

EPDF RANKING



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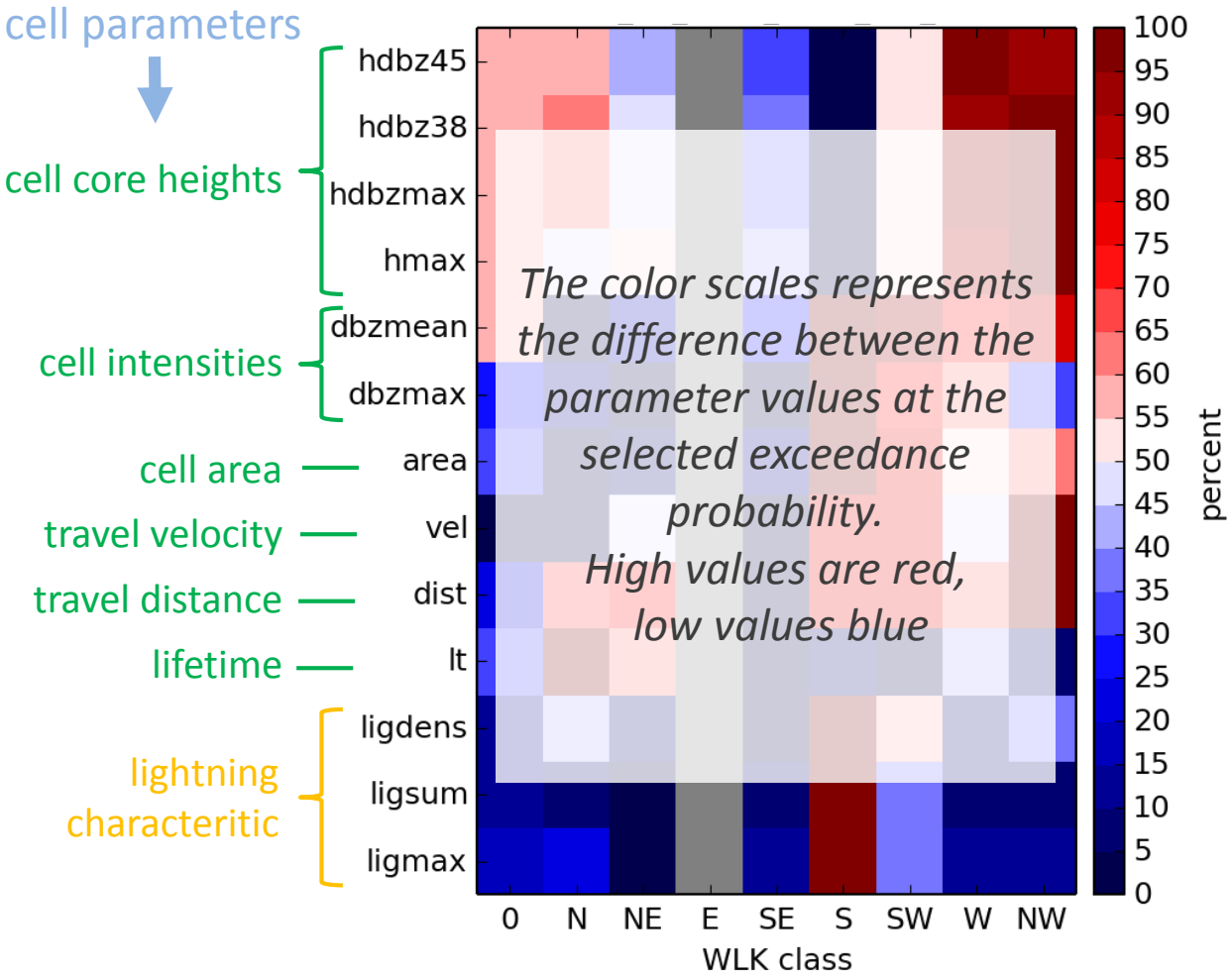
ANALYSES METHODS

EPDF RELATIVE RANKING
at Exceedance Probability 50%



STATISTIC
Interval: [Min – Max]

value range

- 0.40 : [0.50-0.90] km
- 0.50 : [0.50-1.00] km
- 0.49 : [0.50-0.99] km
- 0.40 : [0.50-0.90] km
- 2.0 : [36.5-38.6] dBZ/km2
- 2.9 : [45.0-47.9] dBZ
- 25 : [13-38] km2
- 12 : [17-29] km/h
- 4.4 : [6.4-10.9] km
- 8.3 : [31.2-39.5] min
- 0.09 : [0.55-0.64] 1/min
- 29 : [22-52] -
- 0.63 : [1.53-2.17] -

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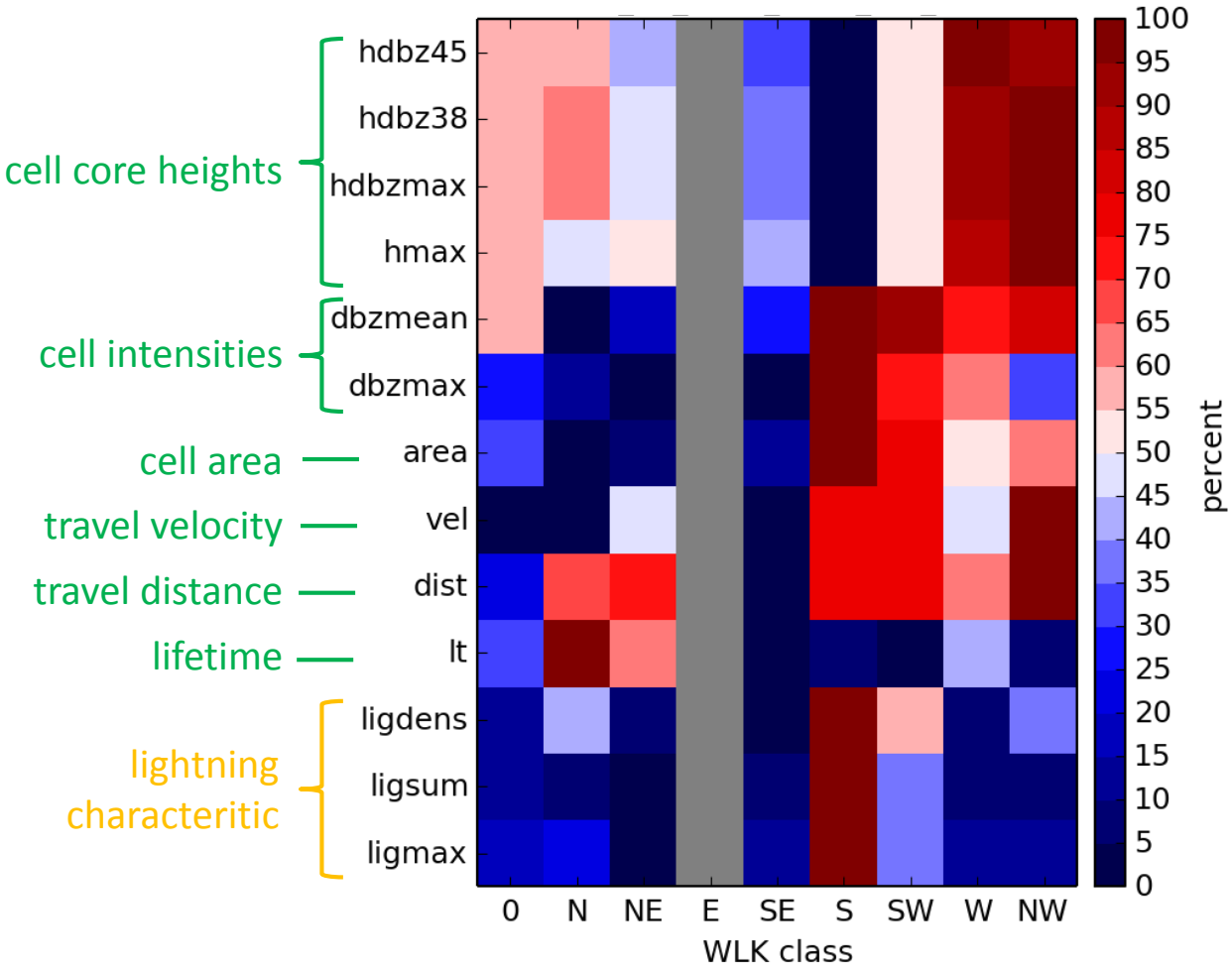
ANALYSES METHODS

EPDF RELATIVE RANKING
at Exceedance Probability 50%



value range

- 0.40 : [0.50-0.90] km
- 0.50 : [0.50-1.00] km
- 0.49 : [0.50-0.99] km
- 0.40 : [0.50-0.90] km
- 2.0 : [36.5-38.6] dBZ/km2
- 2.9 : [45.0-47.9] dBZ
- 25 : [13-38] km2
- 12 : [17-29] km/h
- 4.4 : [6.4-10.9] km
- 8.3 : [31.2-39.5] min
- 0.09 : [0.55-0.64] 1/min
- 29 : [22-52] -
- 0.63 : [1.53-2.17] -

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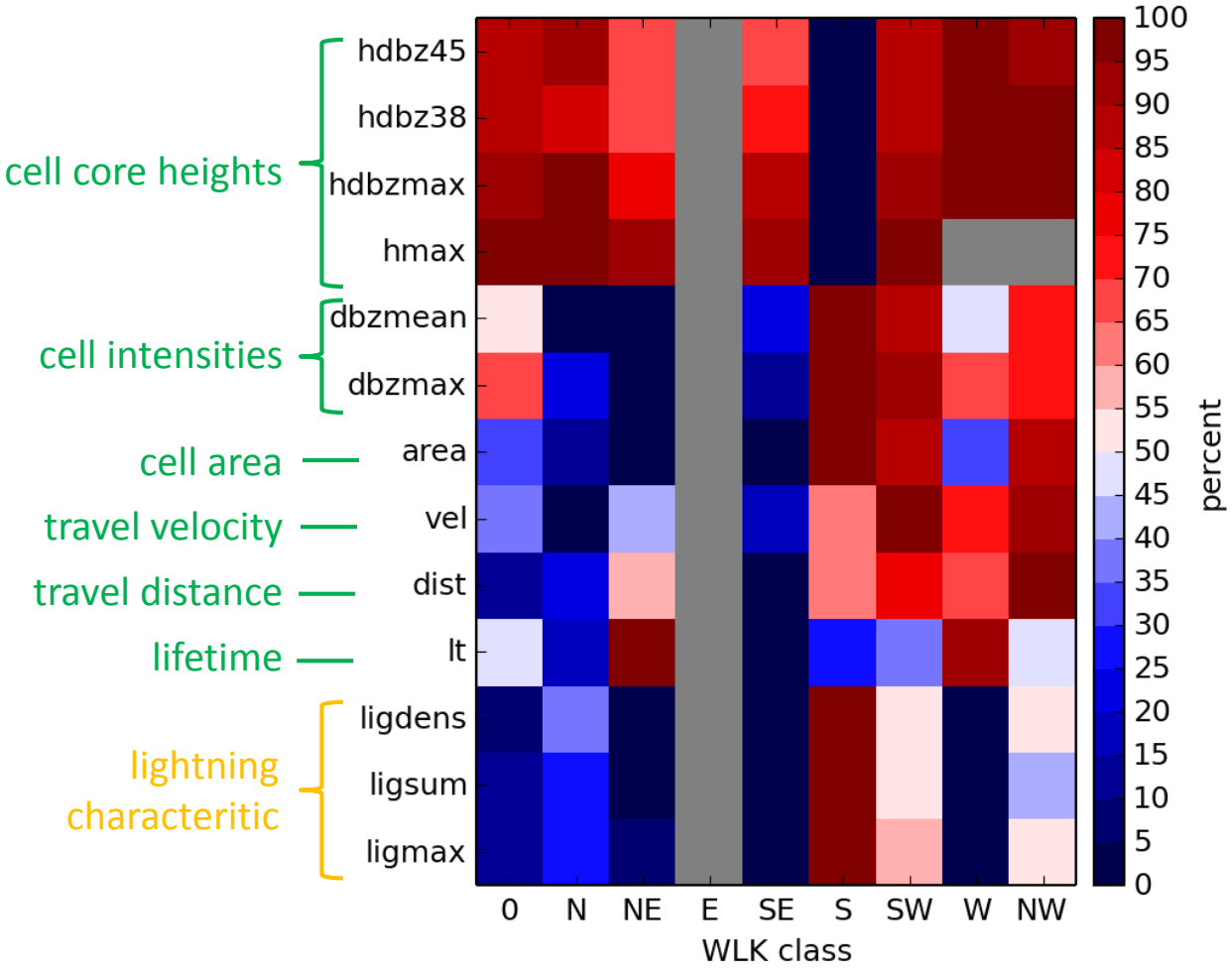
ANALYSES METHODS

EPDF RELATIVE RANKING
at Exceedance Probability 10%



value range

- 7.6 : [0.9-8.5] km
- 7.6 : [0.9-8.5] km
- 6.7 : [0.9-7.6] km
- inf : [1-inf] km
- 2.2 : [39.7-41.9] dBZ/km2
- 6.2 : [52.6-58.8] dBZ
- 103 : [90-193] km2
- 22 : [33-54] km/h
- 16 : [27-43] km
- 11 : [85-97] min
- 2.1 : [1.0-3.1] 1/min
- 712 : [320-1032] -
- 20 : [9-29] -

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OUTLOOK

Work in Progress

- Extend Period 2011 –2020
- Include other Parameters
  i.e. Probability of Hail, estimated local precipitation amount, 3D radar parameters
- Closer look at outstanding features
- Refined cell selections (WLK wet/dry, high lightning activities, high probabilities of hail, etc.)

- Feasibility study to integrate local prediction qualities in adaptive nowcasting cones.

More Ideas

- Investigate the role of the topography on thunderstorm paths and development
- right shift in the direction compasses

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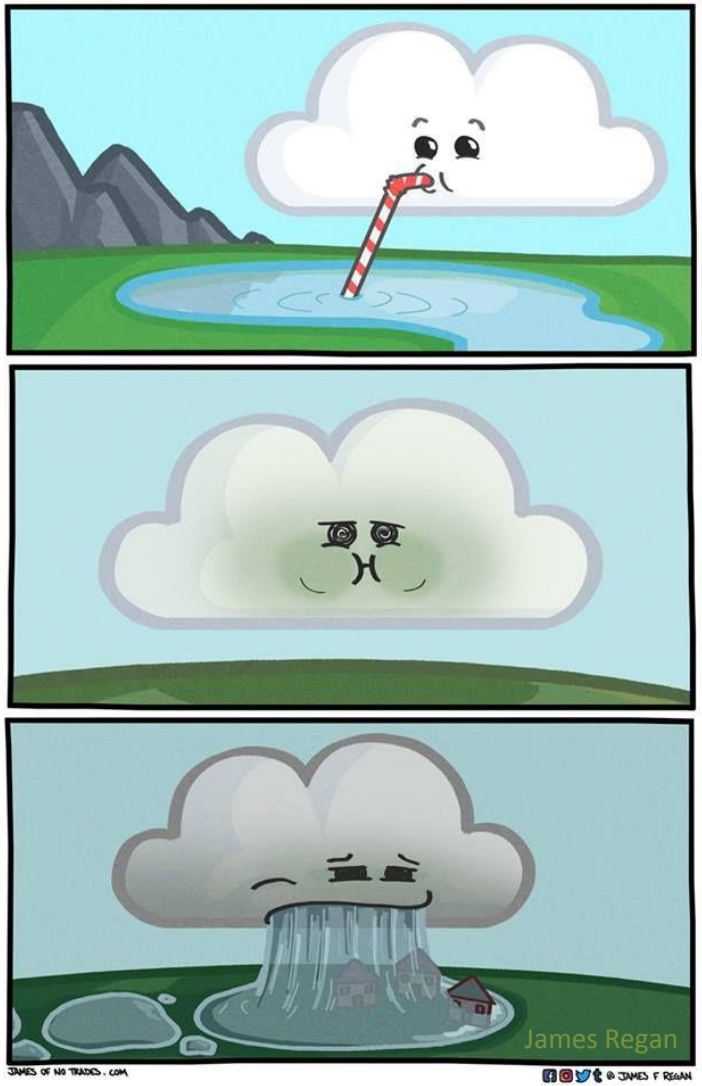

THANK YOU

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