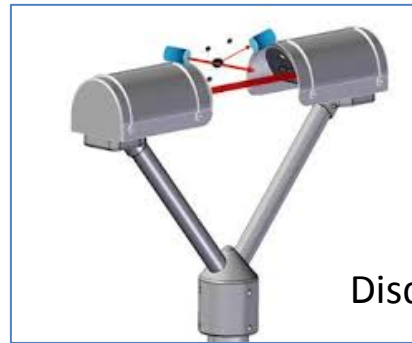# Offshore precipitation climate
How can we monitor?

Raingauges

Disdrometers

Weather radars

Workshop on Main Factors for Leading Edge Erosion
DTU Wind Energy (Risø Campus), 22 February 2018
Flemming Vejen, DMI

Offshore precipitation climate, definition of erosion classes
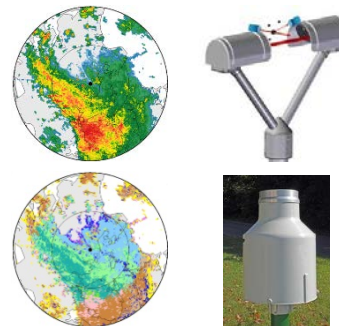
Overall objectives of activities at DMI:

- To increase knowledge about offshore prepitation climate (especially interested in frequency of hail and heavy rain), i.e. erosion climate
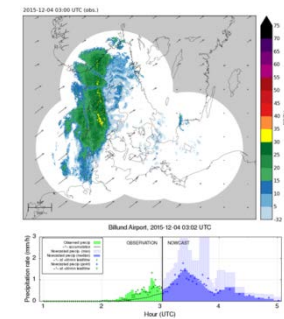- To develop methods for short term prediction of eroding conditions

Statistics
Rain classes

Erosion
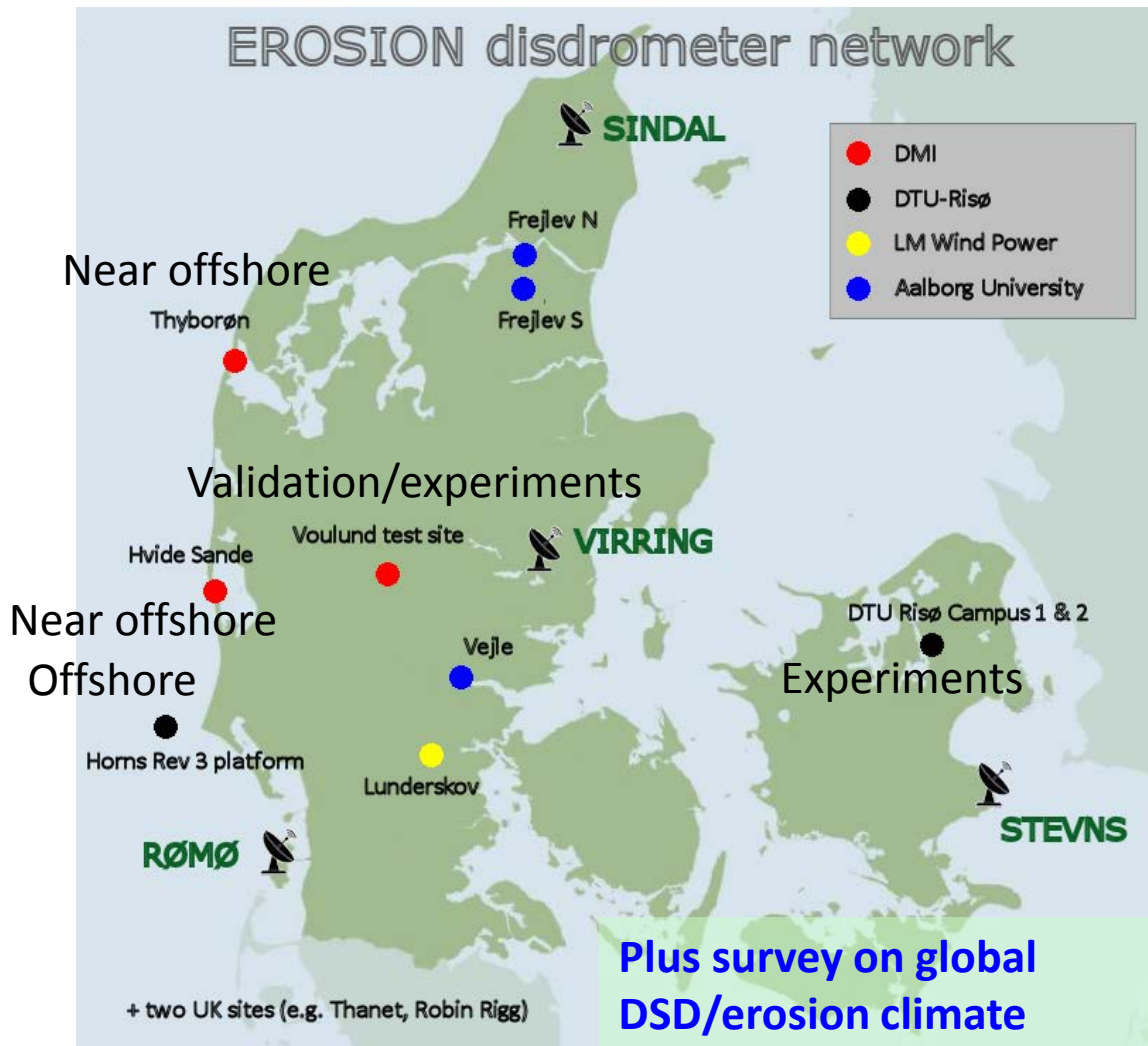classes

Data analyses
Develop model

Nowcasting
model

This presentation will focus on *MEASUREMENT TECNIQUES*

How can we establish the required data series for the analyses to be carried out?

One approach is to establish point measurements of drop size distribution

EROSION disdrometer network

Near offshore

Validation/experiments

Near offshore

Offshore

Experiments

Plus survey on global DSD/erosion climate

+ two UK sites (e.g. Thanet, Robin Rigg)

parameter	Parcivel²
Precip type	X
Reflectivity	X
Rain rate	X
Rain amount	
Energy of precipitation	X
DSD	X
Fall speed spectrum	X

Thiess   Parcivel²

A drawback might be, that disdrometers are point data

Representativeness??
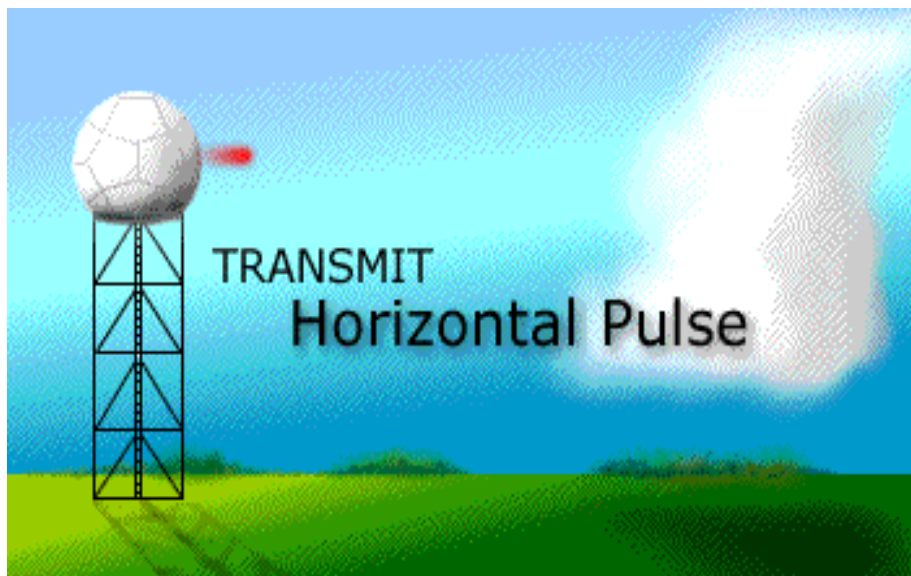
Alternative approach: Spatial info from weather radar data

Parameters we can calculate from radar data

→

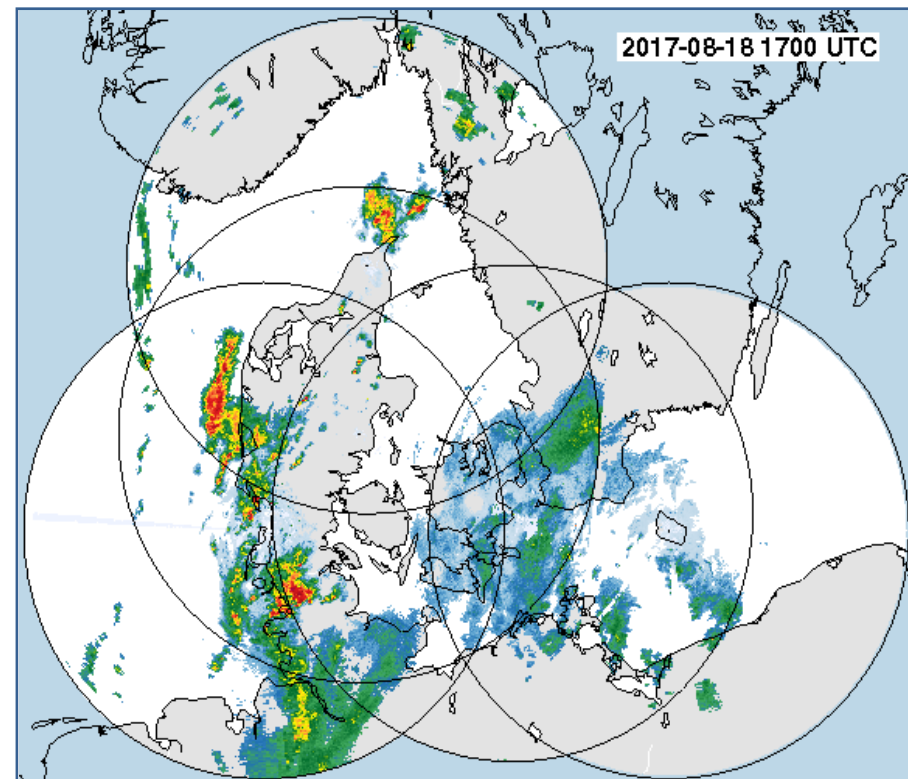- Rain rate
- Duration of "impact"
- Hydrometeor type

→

Can we estimate kinetic energy and potential erosion from radar data?

TRANSMIT
Horizontal Pulse
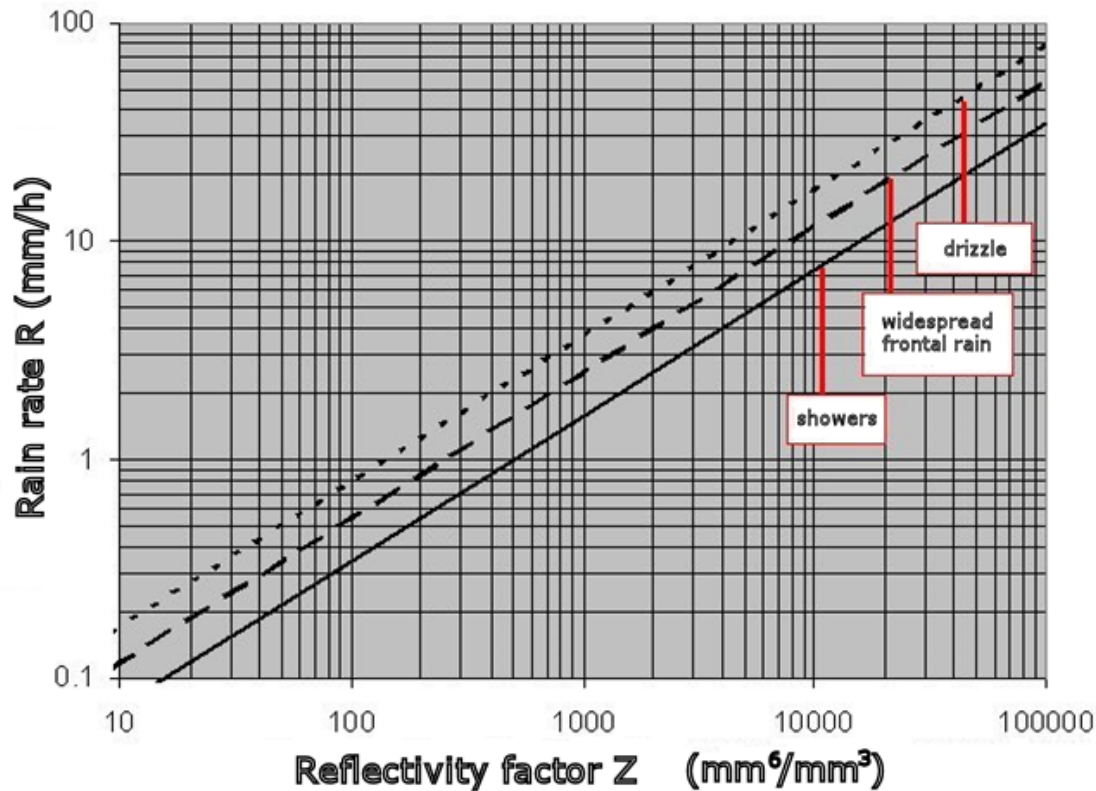
2017-08-18 1700 UTC

DMI's radar network:

- 5 dual-polarization radars
- Resolution: 5-10 min, 500 m pixels
- (1 minute, interpolation between radar frames)

About the conversion between radar Z and rain rate R

Radar reflectivity is related to number of drops n and diameter D in 6'th power:

$$Z = \sum_i n_i D_i^6$$

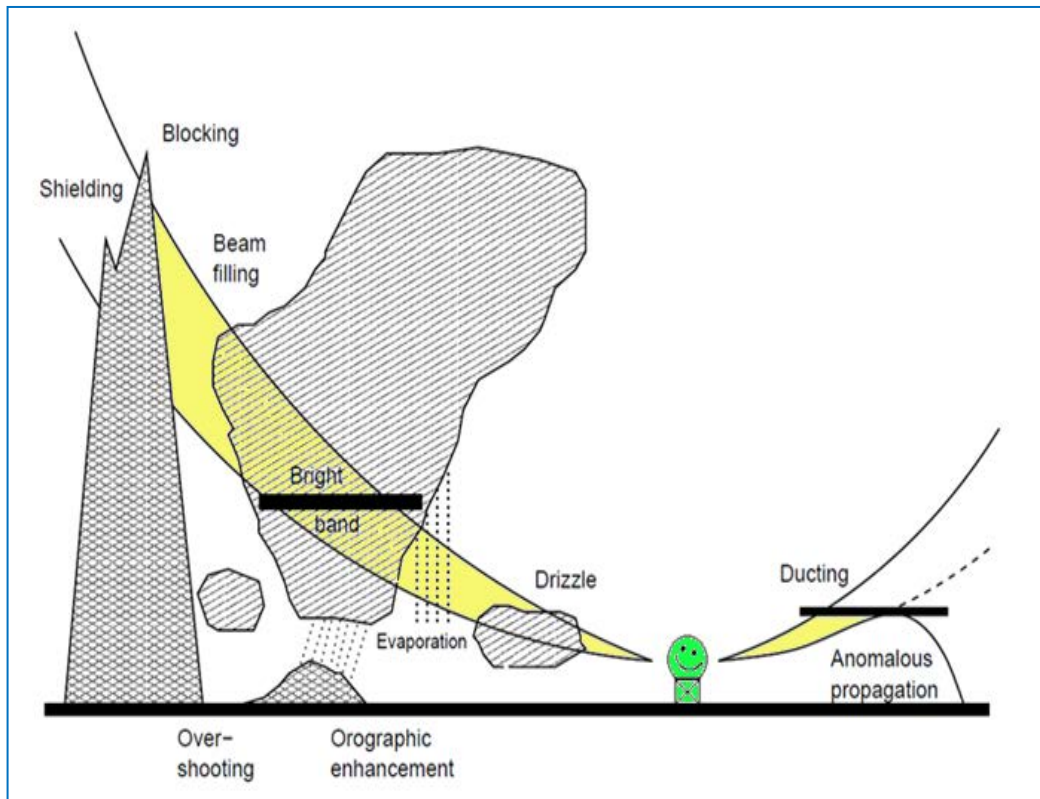Using a standard Z-R relation results in biased conversion between Z and R

Widely used method: Adjustment of radar data using raingauges

Many emphirical Z-R relations:

$$Z = AR^b$$

E.g. Marshall-Palmer:

$$Z = 200R^{1.60}$$

Sources of error on radar data and radar QPE

QPE = Quantitative Precipitation Estimate

Uncertainty of radar QPE comes from two aspects: bias and noise

Errors of radar data:

- False echoes
- Radar beam propagation issues
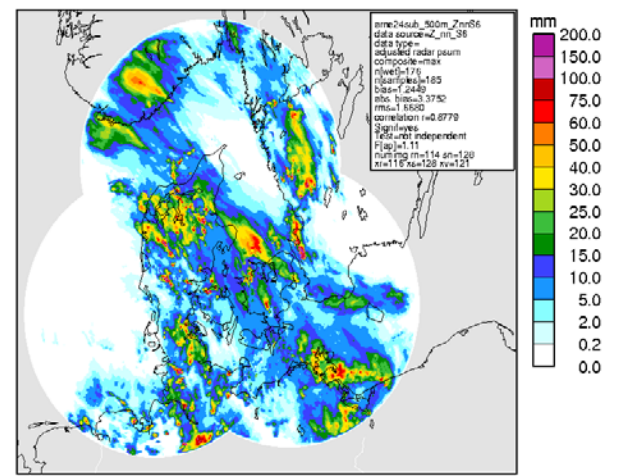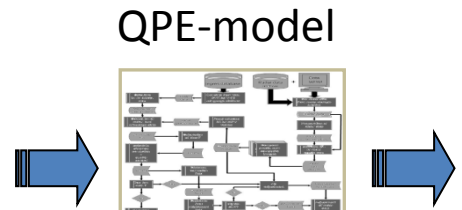- Melting layer (bright band)
- Blocking/shielding
- Beam broadening

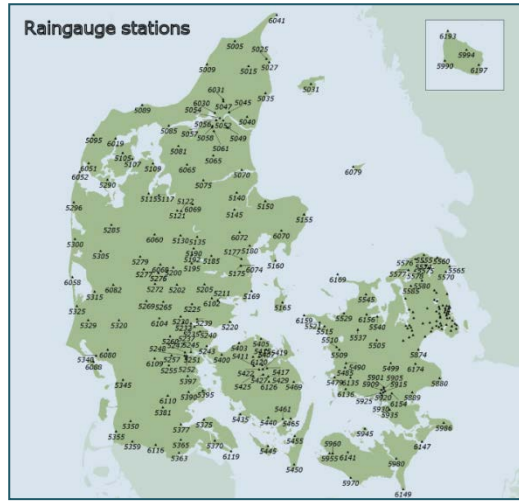Errors of raingauge data:
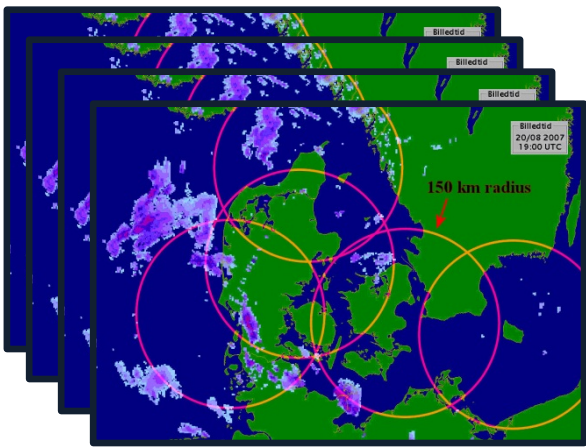
- wind induced bias

- Uncertainty related to radar-raingauge adjustment

Estimation of radar rain parameters

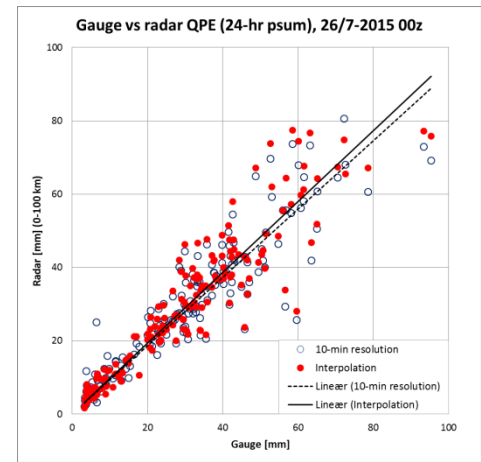Relative rain-rate from radar images –adjustment against raingauges

Raingauge stations

QPE-model

Spatial distribution of rain

2016–06–16 0900 UTC, 24 h acc.

+

Evaluation statistics

Gauge vs radar QPE (24-hr psum), 26/7-2015 00z

150 km radius

○ 10-min resolution
● Interpolation
- - - - Lineær (10-min resolution)
——— Lineær (Interpolation)

Adjusted time series

Radar vs gauge 05237 den 5/5-2015

gauge 5237
radar ekxv
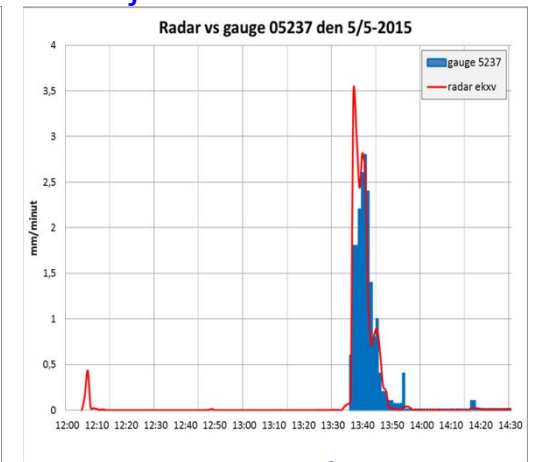
1-minute resolution

Calculation of offshore statistics based on radar data

Calculation of radar rain-rates:

- Along coast line of Jutland
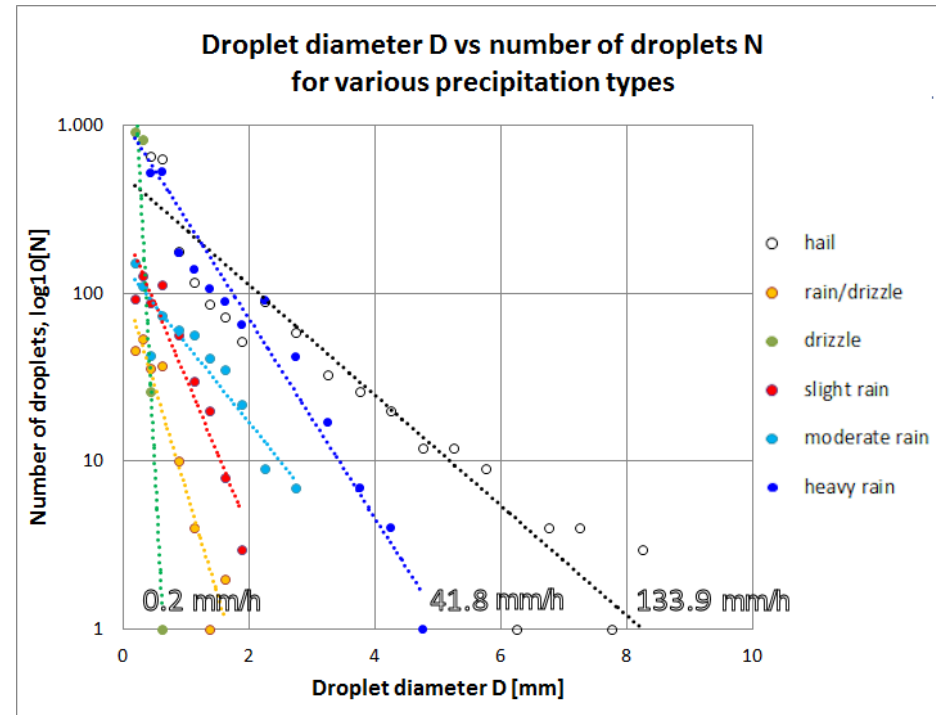- Study rain rate frequency/PDF's
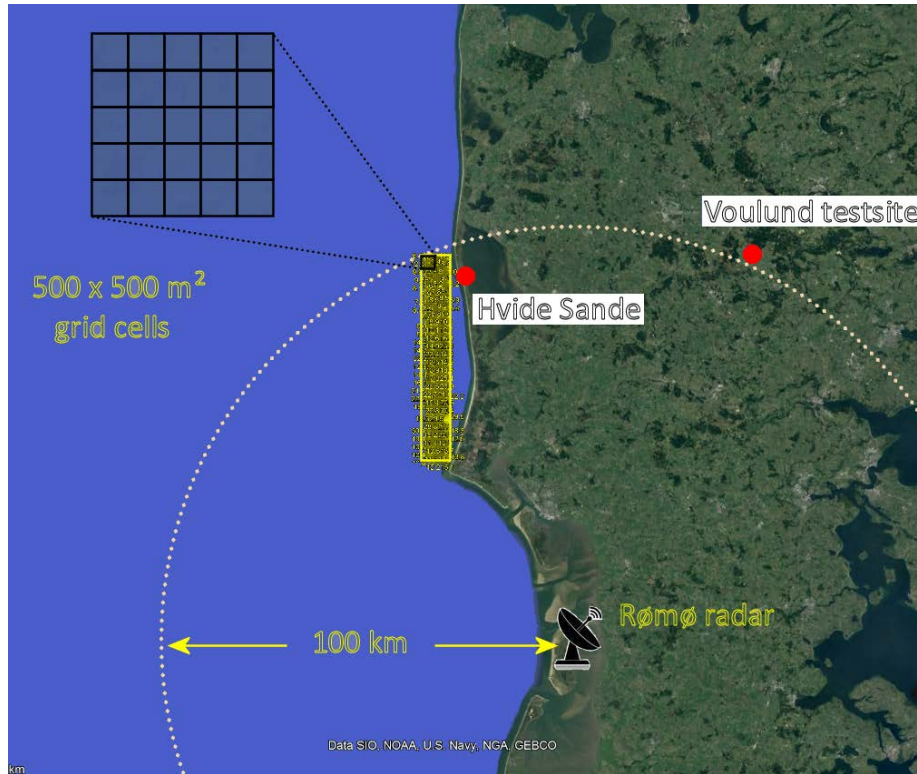
Relationship between drop size disdribution and rain rate:

In practice more convinient to use radar rain rates for calculation of kinetic energy and erosion class
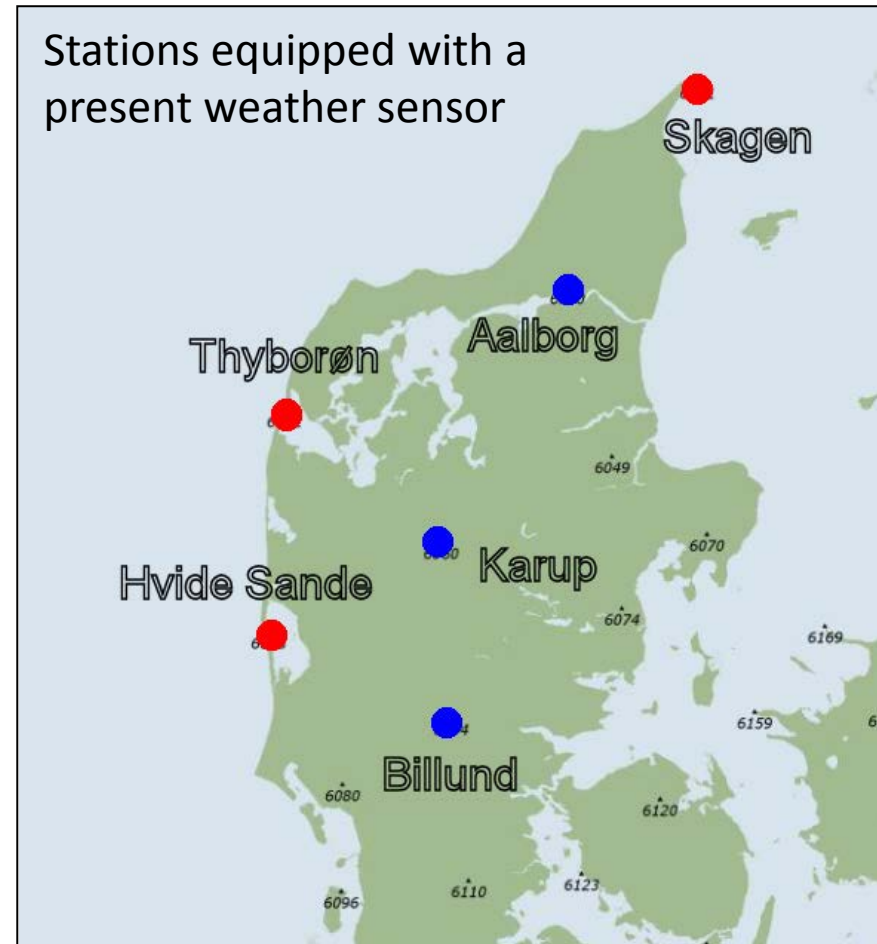
Preliminar near offshore rain rate frequency, June-August 2017
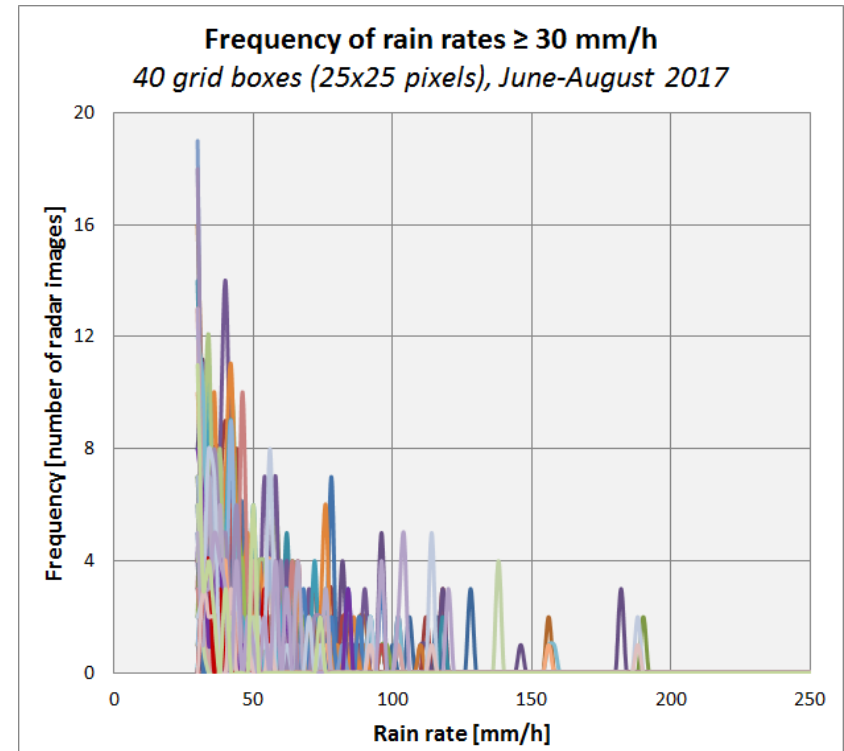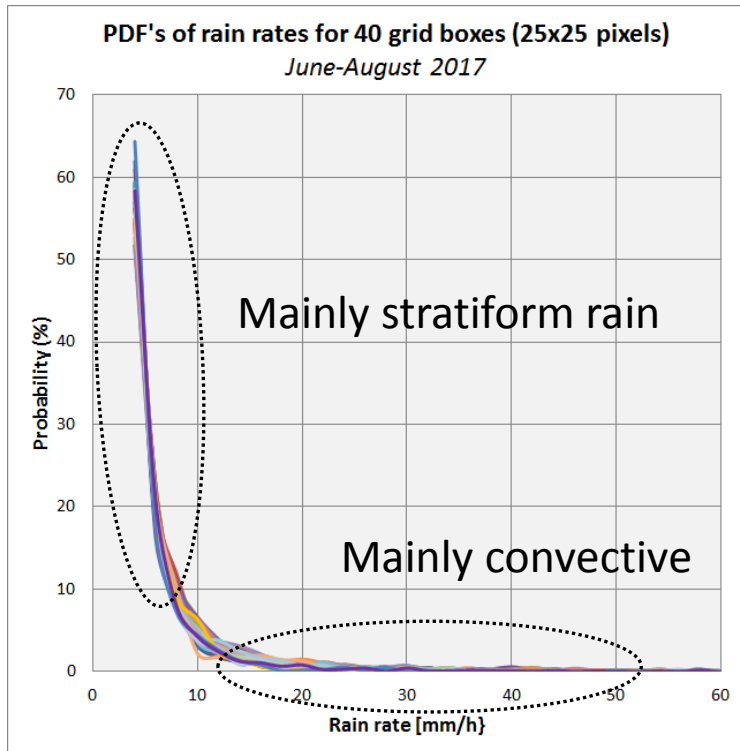
- Relatively small spatial differences in rain rate for stratiform rain
- Low frequency of high rain rates (convective rain)
- But even a few hours of very high rain rates in combination with strong wind may cause blade erosion
- Largest rain rates may be related to false echoes in radar data

Precipitation type (10-min resolution) at DMI weather stations, 2017

type	intensity	offshore	inland
drizzle	slight	3197	1162
	moderate	3327	374
	heavy	82	38
rain	slight	7987	11433
	moderate	1325	1715
	heavy	147	226
rain	violent	0	8
rain/snow	slight	83	248
	moderate	5	7
snow	slight	575	1889
	moderate	0	935
frezzing rain	all	35	135
ice pellets	all	24	26
snow grains	all	14	0
hail	all	3	1

Stations equipped with a present weather sensor

Skagen

Aalborg

Thyborøn

Hvide Sande

Karup

Billund

- Very few hail observations!
- Heavy/violent rain accounts for 0.9-1.4 % of all observations (≈ 25-39 hours)
- Freezing rain/ice pellets/snow grains: 0.4-1.0 % of all observations (≈ 13-27 hours)

Closing remarks

Further work and improvement:

- Improve model for calculation of radar rain rates + establish long data series
- Evaluate radar rain-rates against independent data

- Include radar hydrometeor classification in analyses
- Evaluate hydrometeor classification against disdrometers/weather stations

- Study historical (violent) events to further develop ideas/models

- Establish offshore rain climate statistics
- Develop model for calculation of potential risk of erosion

Acknowledgements to Innovation Fund Denmark for support to the EROSION project Sagsnummer: 6154-00018B

Thank you for your attention!