Field observations[1] and modelling[2] of tall building wakes

[1]Janet Barlow

[2]Omduth Coceal

Sue Grimmond, Will Morrison, Matthew Paskin, Matt Clements

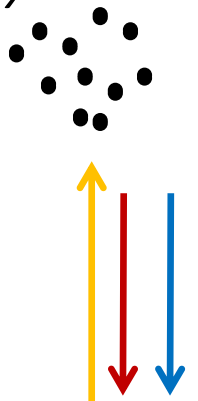
(University of Reading)

Matthias Zeeman, Fred Meier, Daniel Fenner, Andreas Christen

(urbisphere project)

Doppler lidars – ideal for measuring urban winds

Doppler effect: frequency shift proportional to velocity



HALO Photonics Streamline

- Wind, turbulence, particulate pollution at ranges typically out to a few km's
- Eye-safe (1.5 µm, pulsed)
- Gate length 18 m
- Integration time: 2 s (20k pulses)

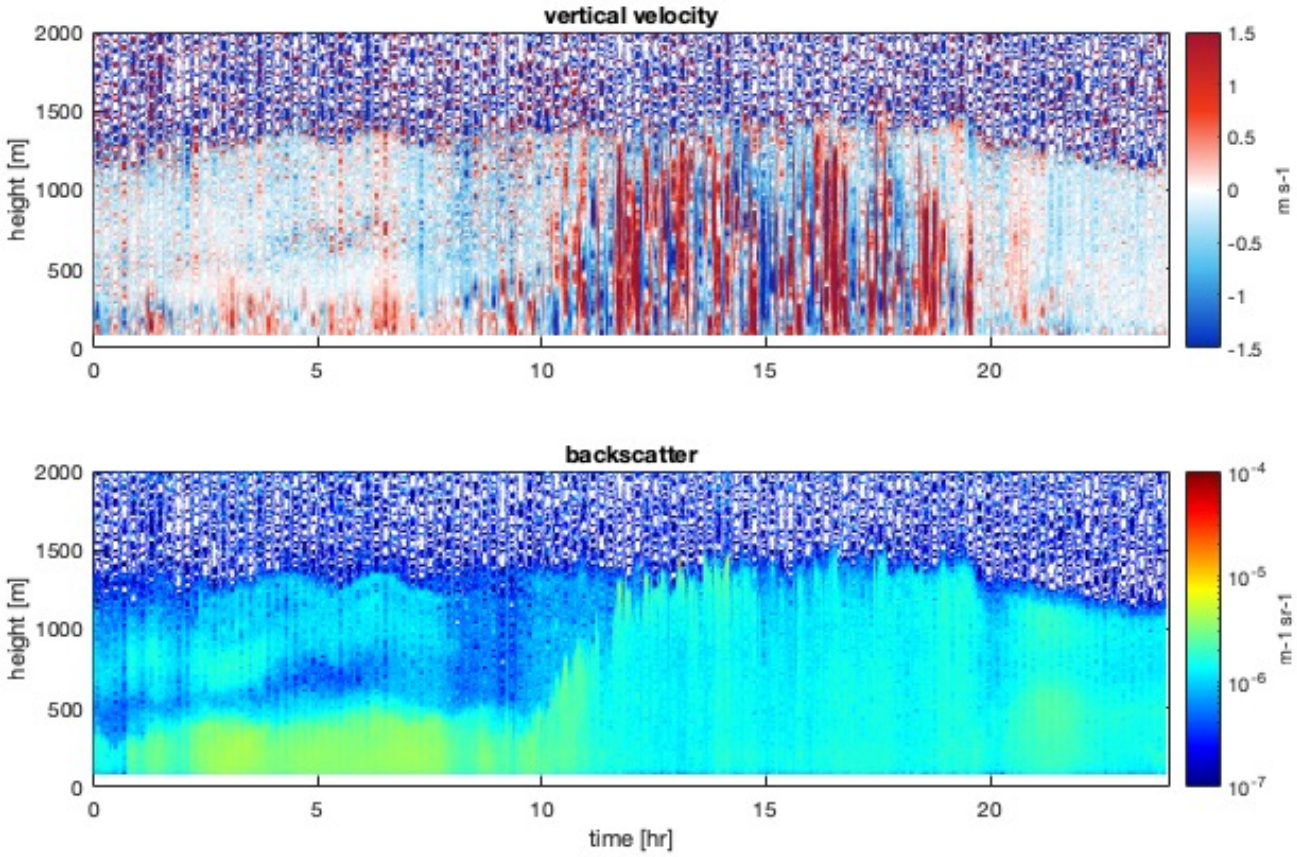
e.g.

Barlow et al. 2011 ACP turbulence profiles

Drew et al. 2013 JWEIA

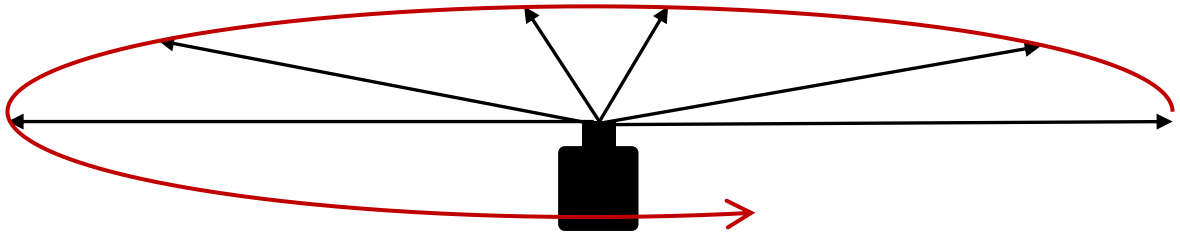
wind profiles over London

London, September 18 2019

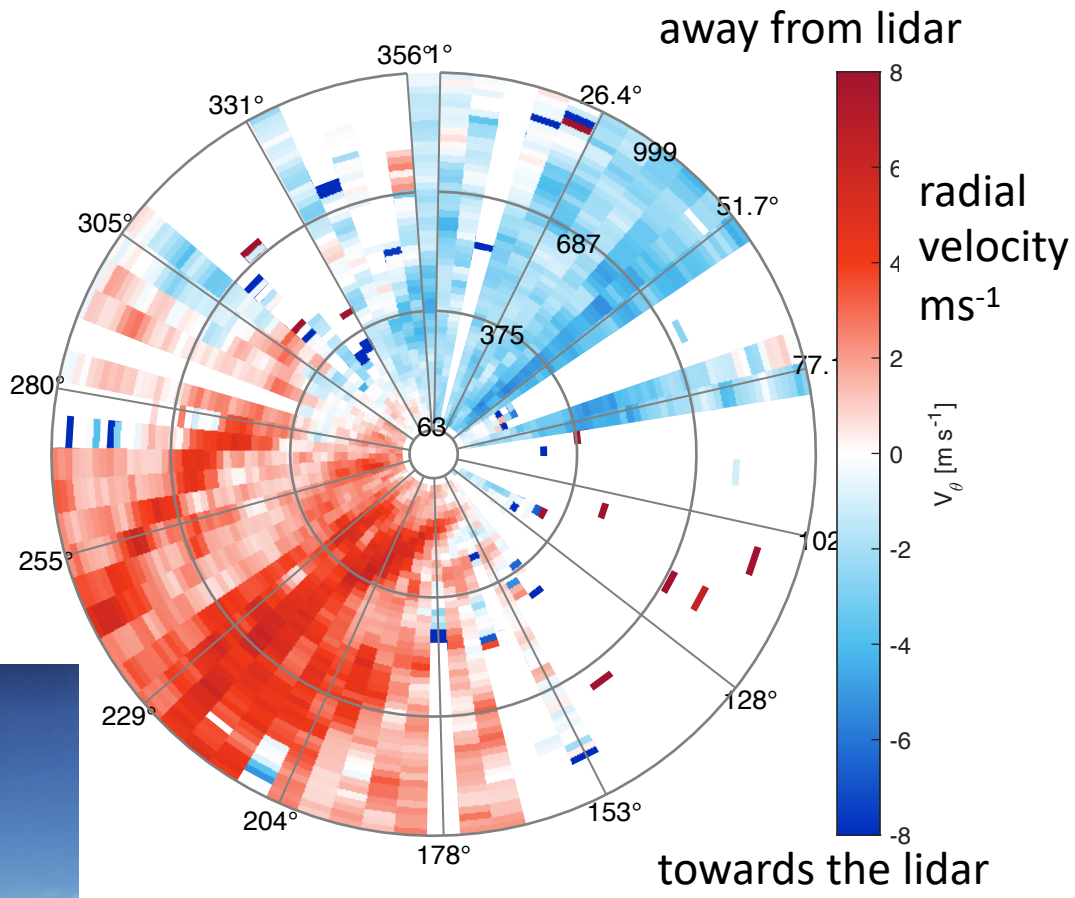


Horizontal scanning

- Plan Position Indicator (**PPI**) horizontal scan
- “slice” through building wakes



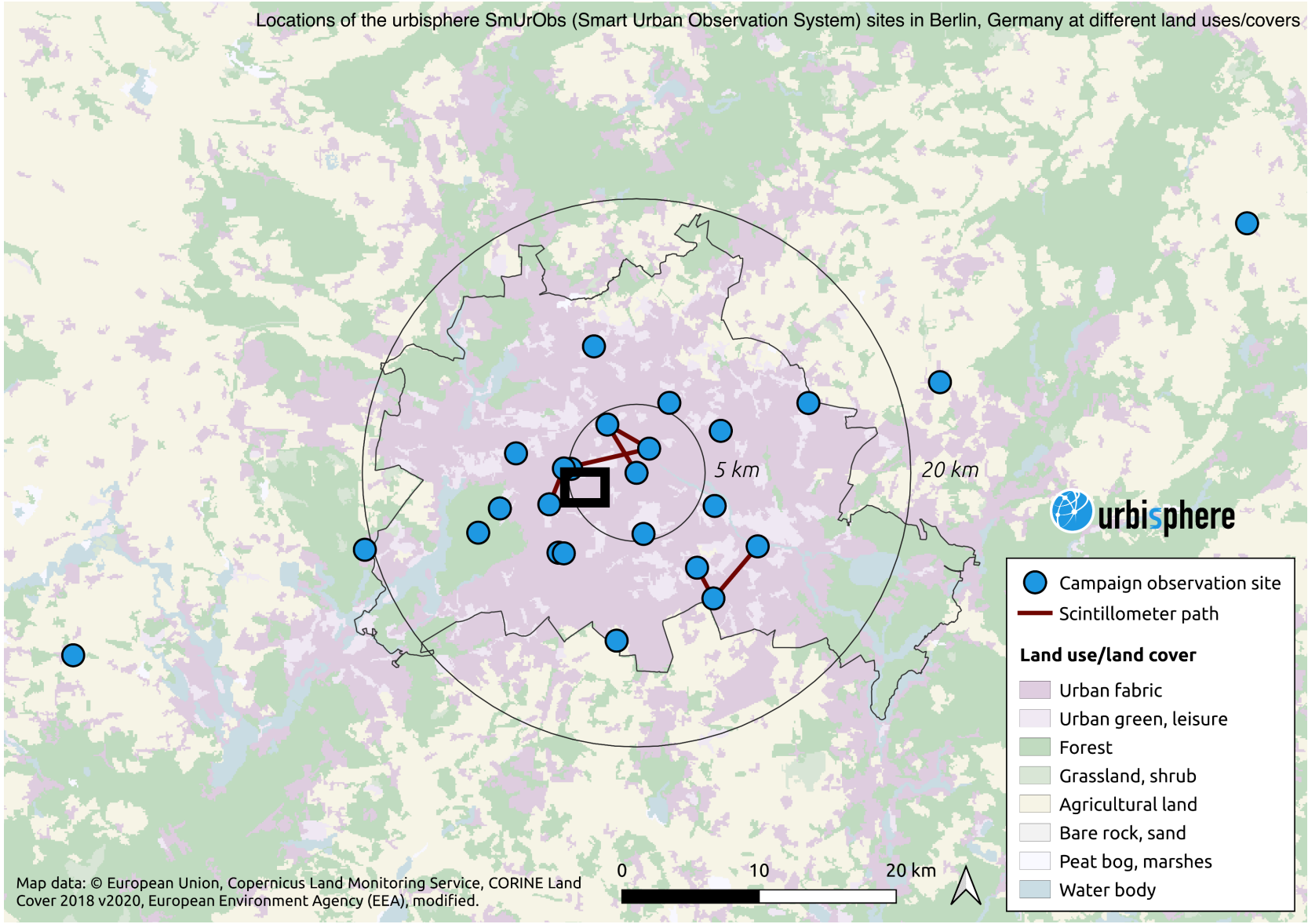
Scan around tall buildings in central London,
Sensor at: London Southbank University site (MAGIC project)



Building wakes analysis paper
Natalie Theeuwes et al., *in prep*.

FUTURE Project: Collaboration with urbisphere - Berlin field campaign

urbisphere
coupling dynamic cities and climate



Berlin field campaign 2021-22

- Aim: **Impact of city on urban- and regional-scale boundary layer**

- Observations:

boundary layer depth/winds
surface heat flux
microclimate, radiation aerosol, clouds
digital surface model
satellite data

- micro/mesoscale modelling
- socio-economic analysis

http://urbisphere.eu/index.html

FUTURE Project: Berlin **dual** lidar wake observations

Deployed: (28/06/22 – 19/09/22)

- PPI horizontal scan – every 5 mins

Other scans:

boundary layer depth:

- *time variation*
- *spatial variation*

aerosol layering

wind profile

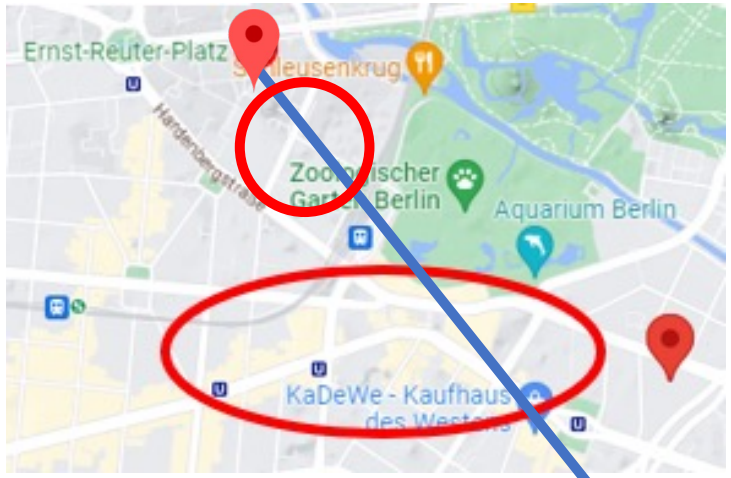
turbulence profile

View from SCHO site, looking WNW

SCHO site:

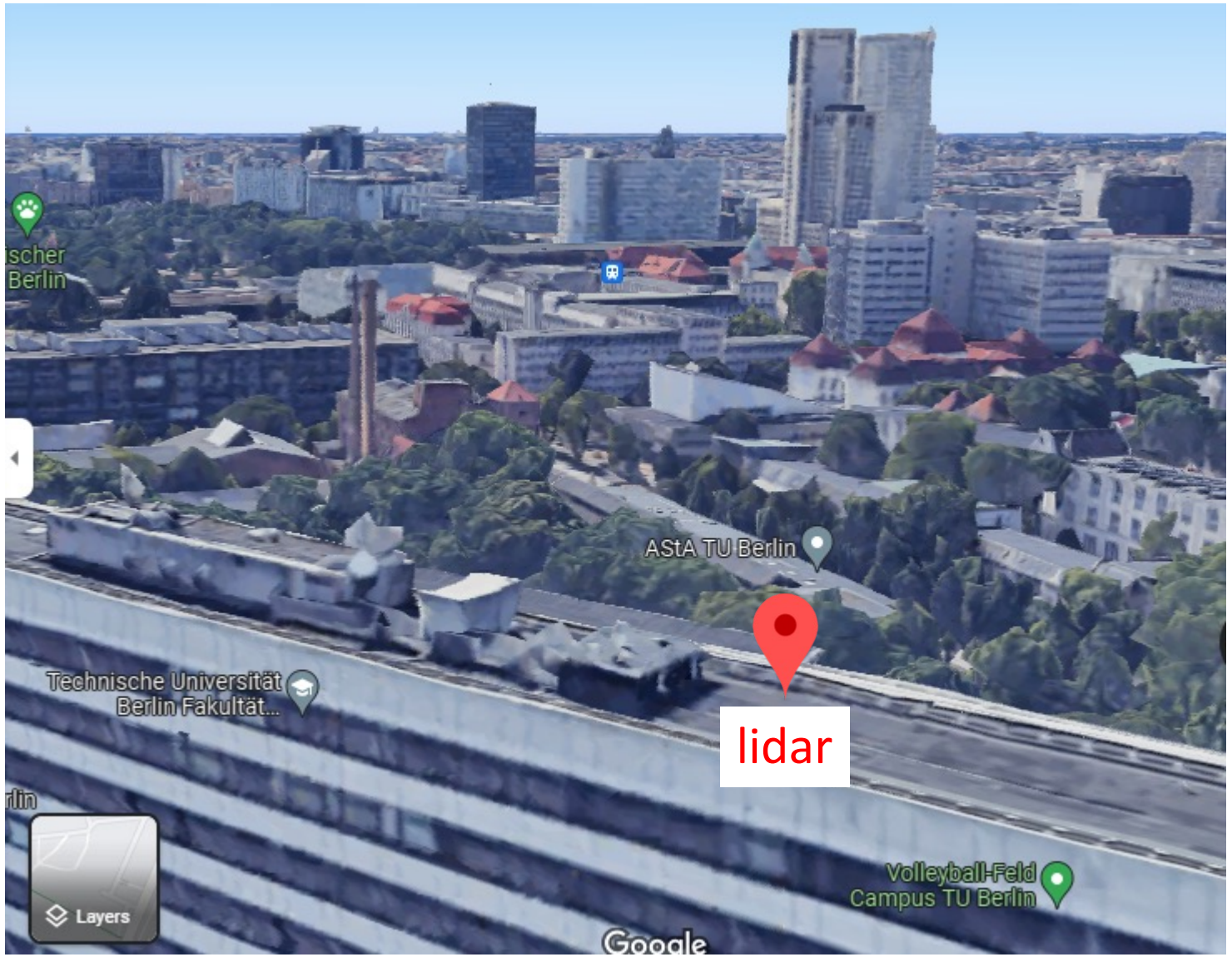
- Sensor height: 87 - 92 m above sea level
- Building cluster extent approx. 280° → 295°

View from TUCC site, looking SE



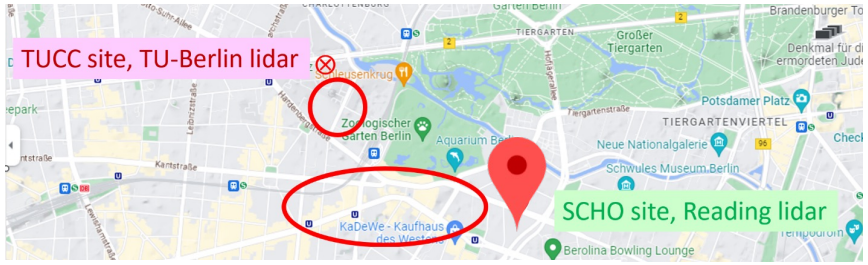
TUCC site:

- Sensor height: 80 - 82 m above sea level
- Building cluster extent approx. 140° → 160°

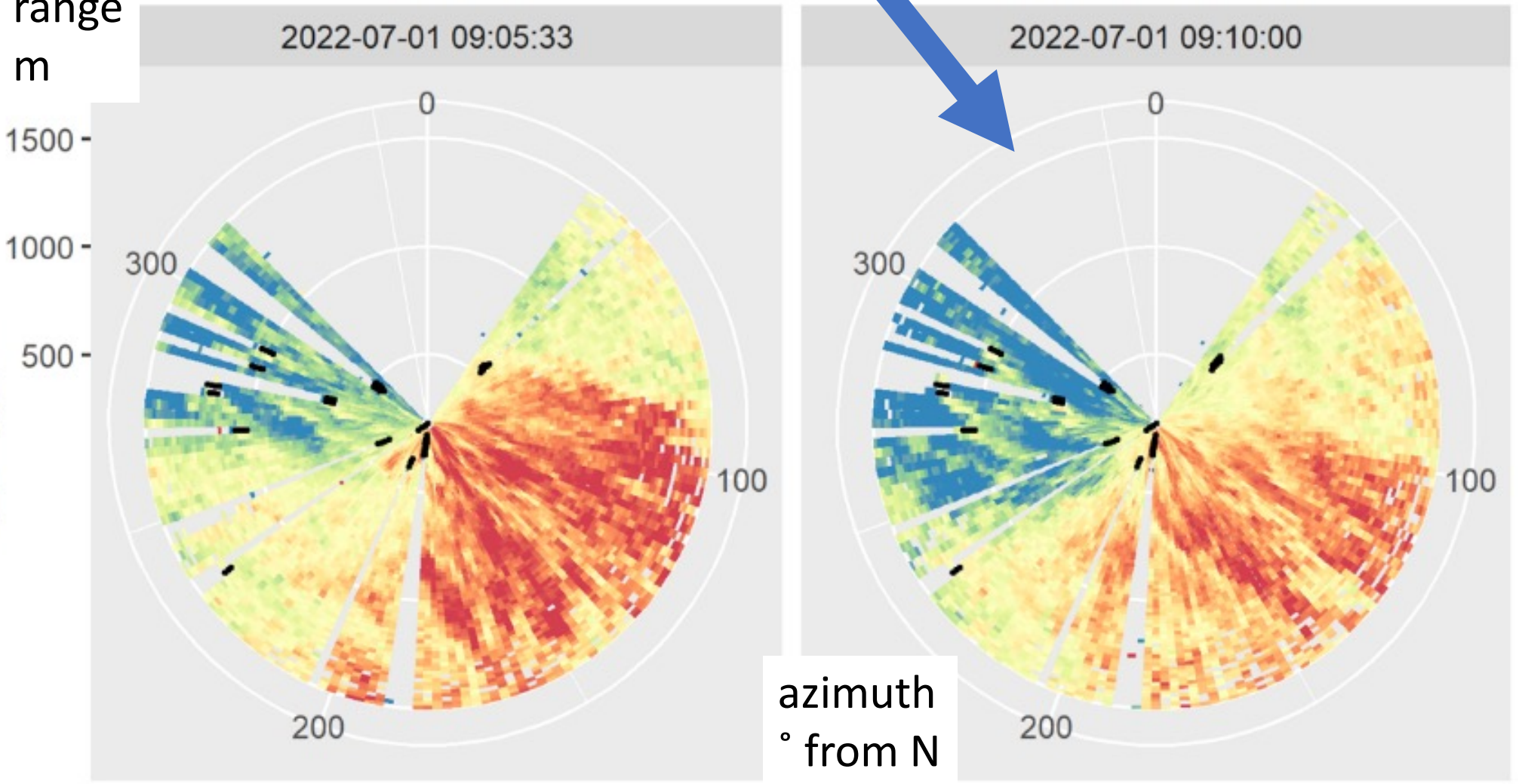


Horizontal PPI scans from SCHO

NW wind direction

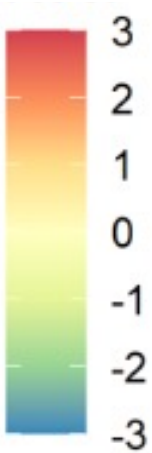


range
m



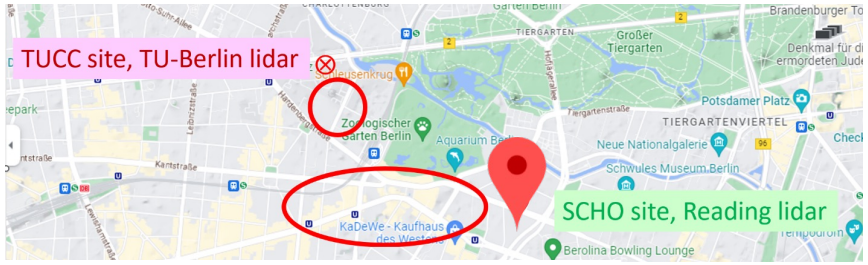
azimuth
° from N

radial velocity
ms^{-1}



Horizontal PPI scans from SCHO

NW wind direction



range
m

2022-07-01 09:05:33

2022-07-01 09:10:00

1500
1000
500
0
300
200
100

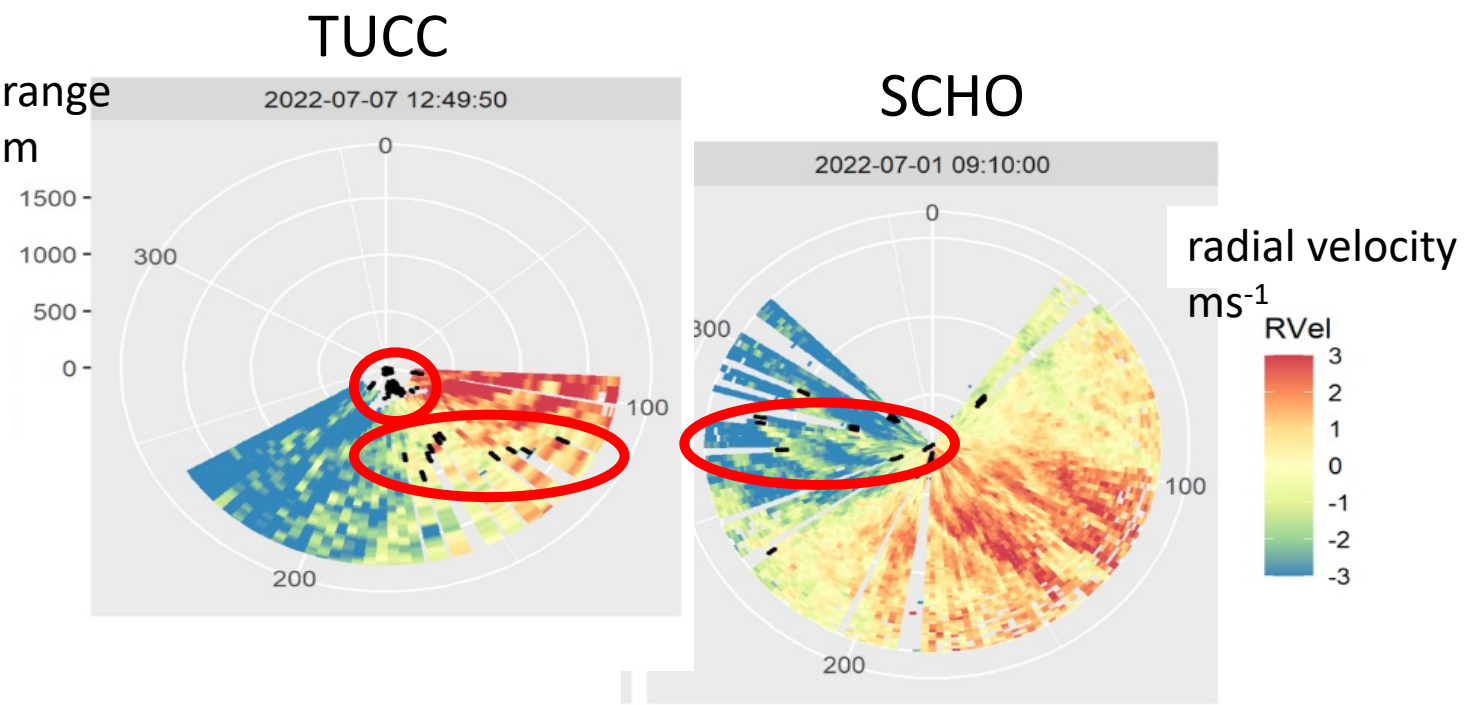
velocity deficit in wakes

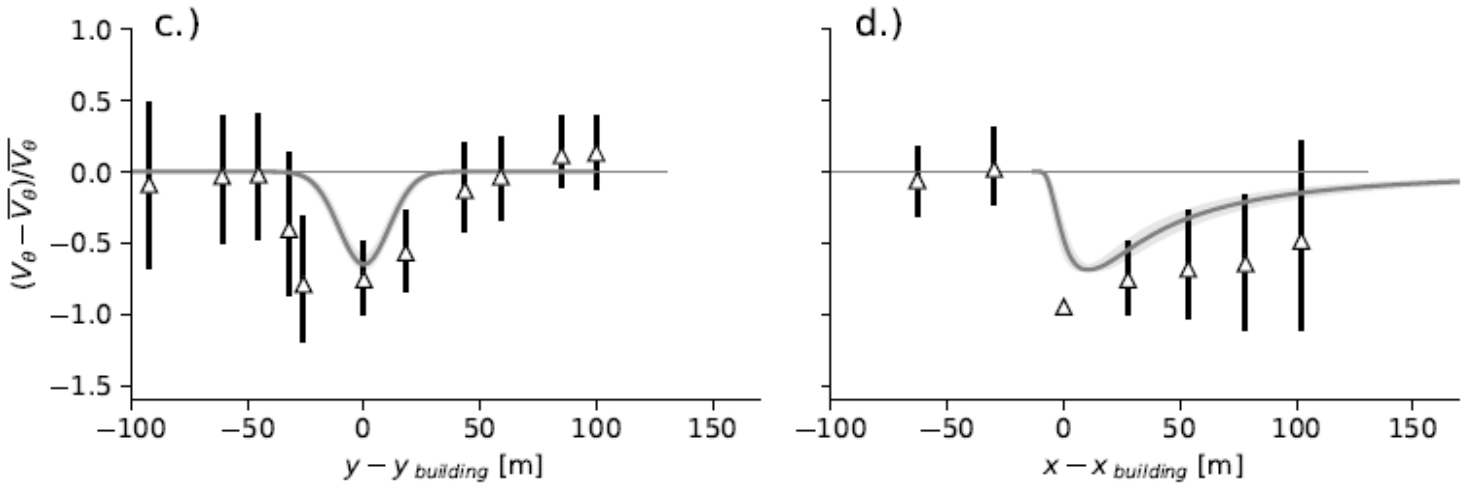
azimuth
° from N

radial velocity
ms^{-1}

3
2
1
0
-1
-2
-3

Next steps





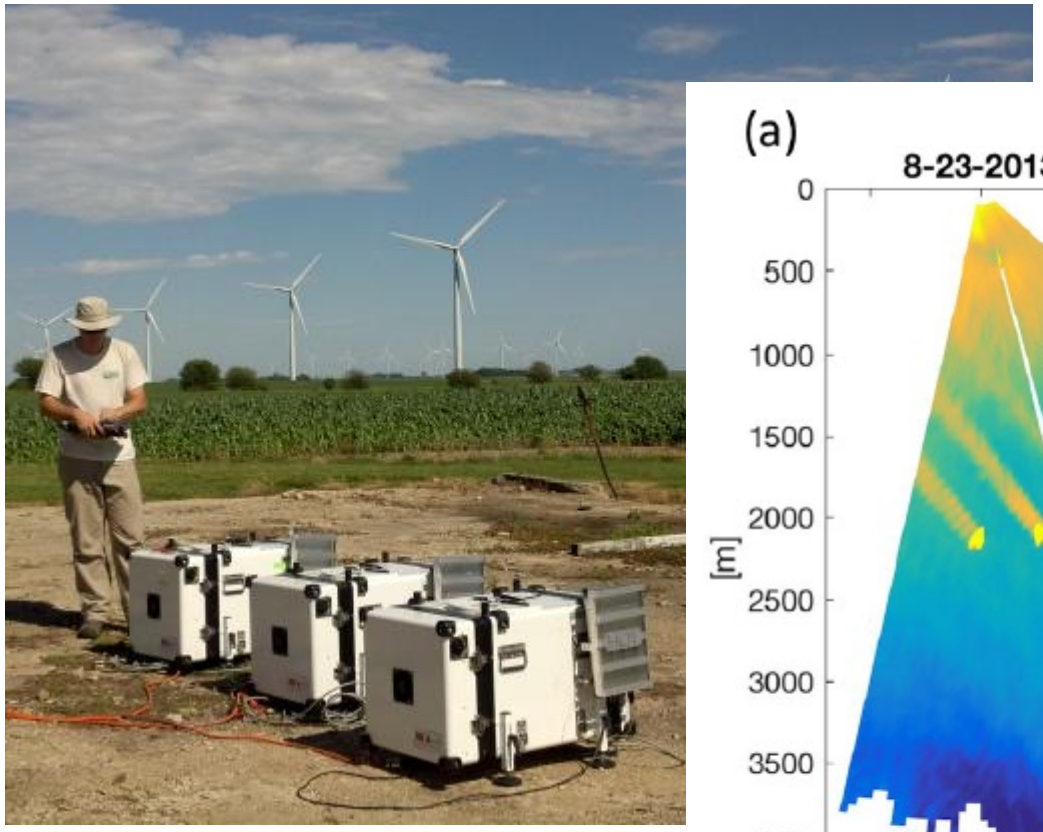
- Welcome Matt Clements!
  PDRA@ Reading!

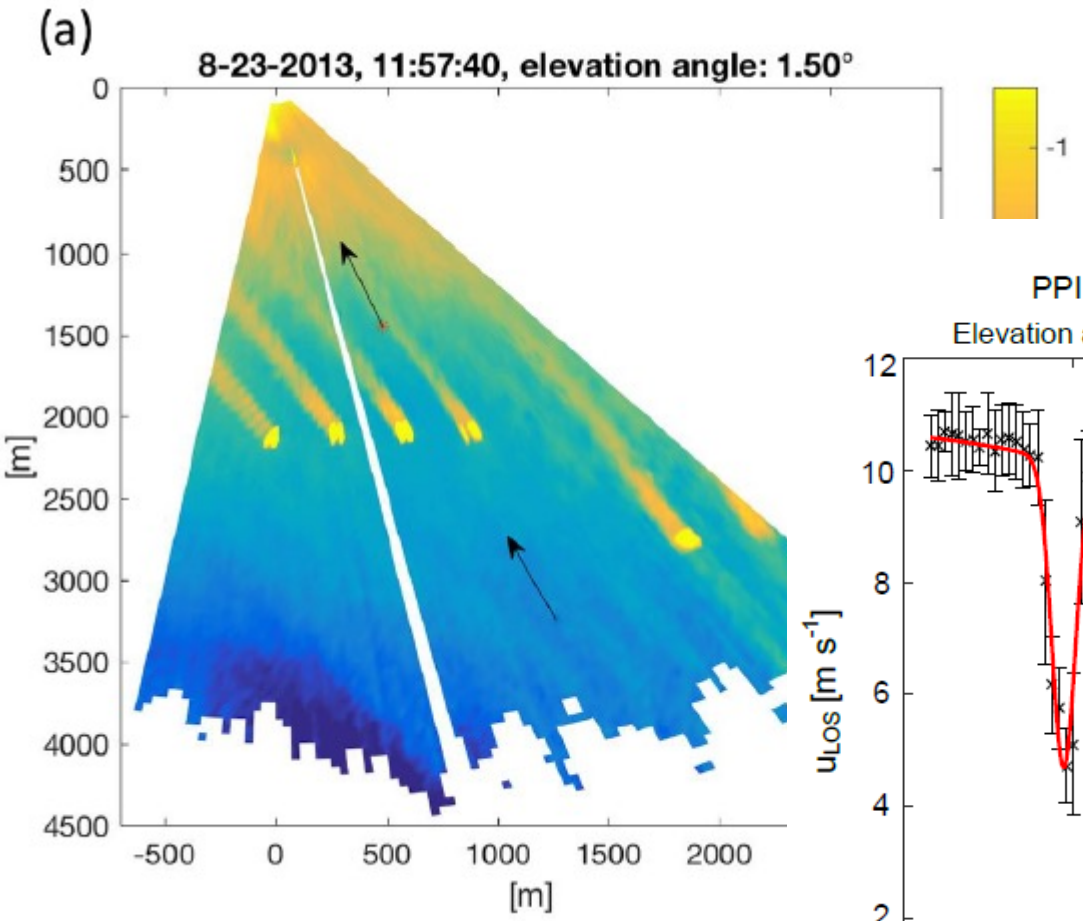
- Data analysis:
  QAQC: 68 days data from both lidars (19.5k PPI scans!)
  Analysis of wind direction, weather conditions
  Co-locating buildings and velocities

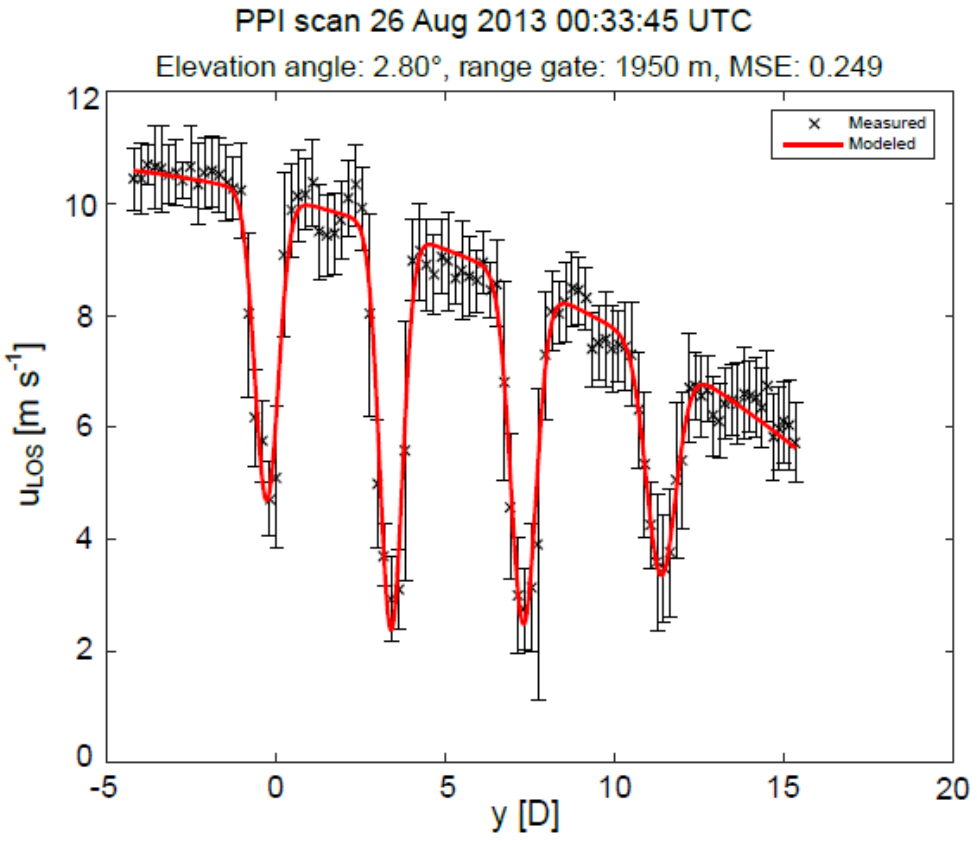
  - Ensemble wake analysis:

  Ex: comparing velocity deficit in neutral conditions with ADMS model wake
  (Theeuwes et al., in prep)

Using Doppler lidars to measure turbine wakes







DWLs in use since 2010

Example: CWEX-13 campaign, Bodini et al. (2017) AMT