Comparison of everything with everything (CEWE) at the CESAR site:

An update of TARA CEWE for assessing the applicability of contemporary EDR retrievals for precipitation profiling Doppler radar

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Outline

- Ultra Fast wind SensOrs project
- Research question
- What is TARA CEWE?
- Contemporary turbulence retrieval methods
- Preliminary conclusion from TARA CEWE
- Back to the details
- Conclusions
- Outlook

Ultra Fast wind SensOrs project

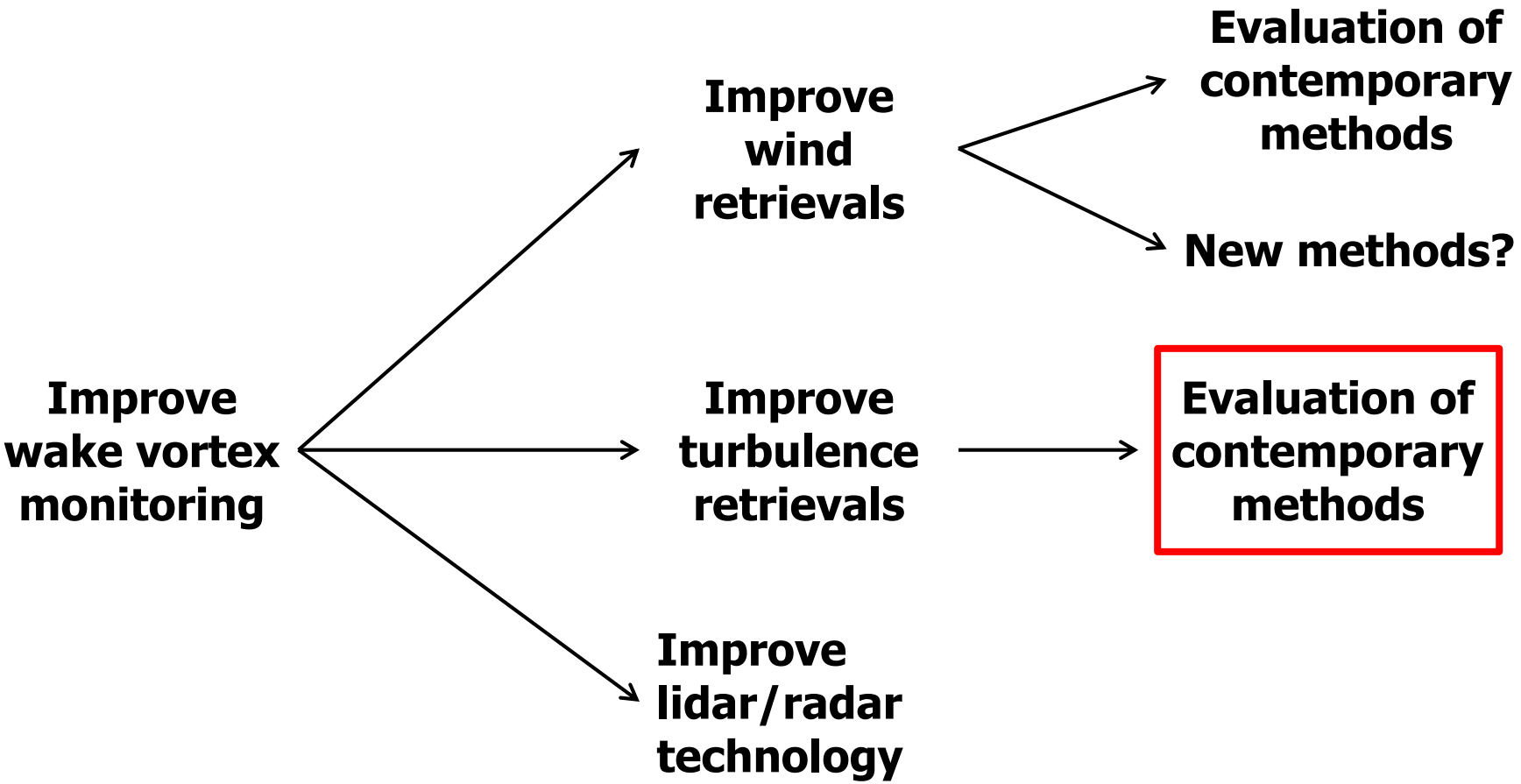
The UFO project. A solution to mitigate weather hazards and increase airport capacity.

UFO
ULTRA FAST WIND SENSORS

WVs and weather hazards can be monitored under all weather conditions by using UFO scanning radars and lidars ???????!!!!?????!!!

Ultra Fast wind SensOrs project

We would like to improve wind vector/turbulence intensity retrievals and improve wake vortex monitoring.



Research question

We would like to improve wind vector/turbulence intensity retrievals and improve wake vortex monitoring.

Evaluation of contemporary methods →

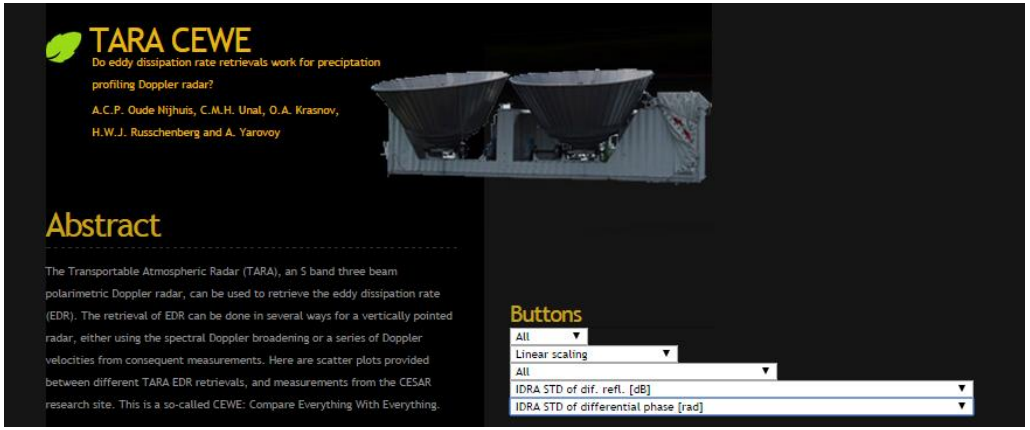
Research question:

Do the contemporary turbulence retrievals work for a precipitation profiling radar?

What is TARA CEWE?

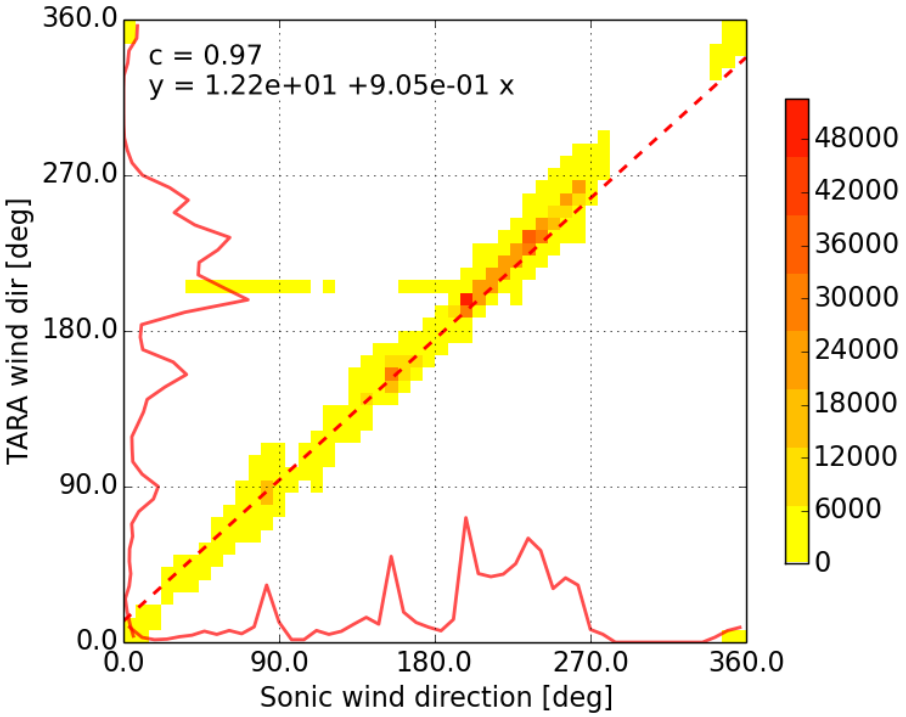
TARA: Transportable Atmospheric Radar
CEWE: Comparison of Everything with Everything

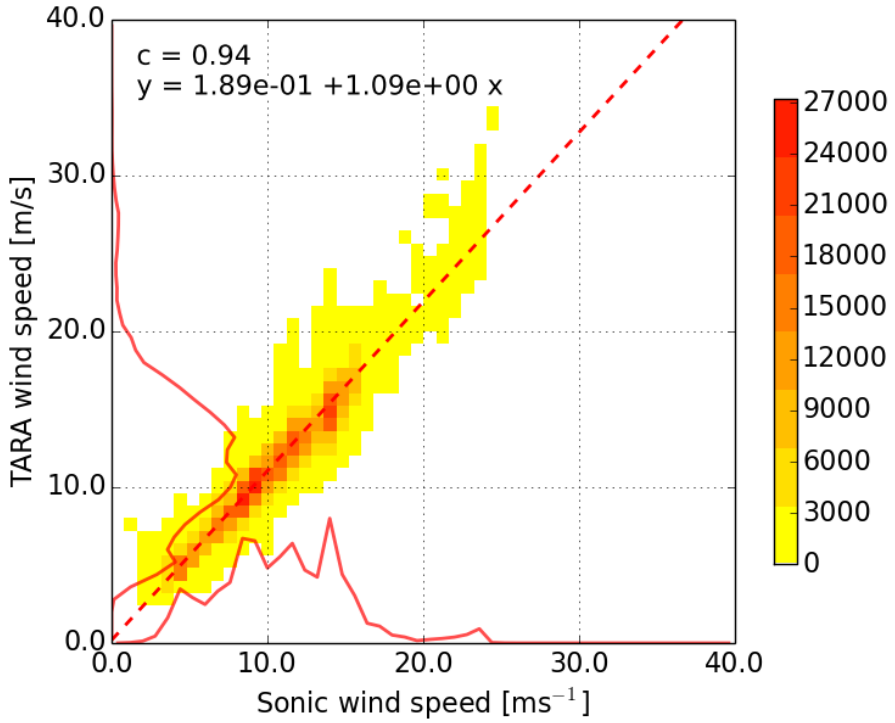
- CESAR instrument data interpolated to TARA grid.
- Website to investigate scatter density plots. http://taracewe.ewi.tudelft.nl/ (> 1 milion scatter density plots)
- BIG DATA!
- 140 days from TARA
- ~80 parameters from meteorological supersite instruments: BSRN, IDRA, Sonics, surface fluxes, TARA, tower instruments.



What is TARA CEWE?

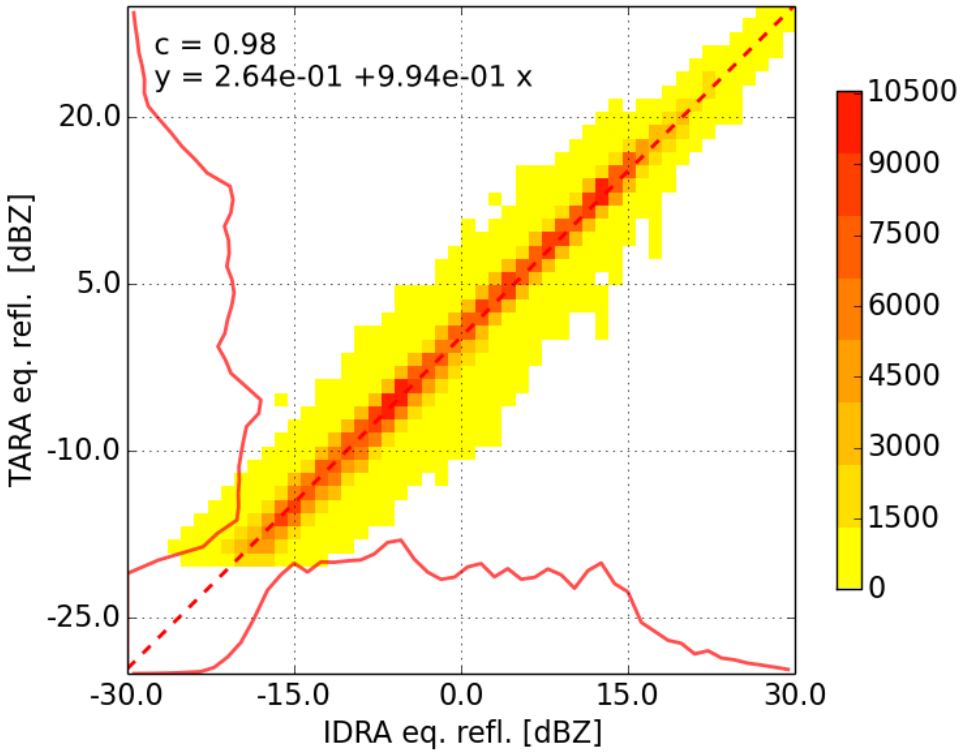
http://taracewe.ewi.tudelft.nl/
Example 1: validation of TARA wind retrieval algorithm





What is TARA CEWE?

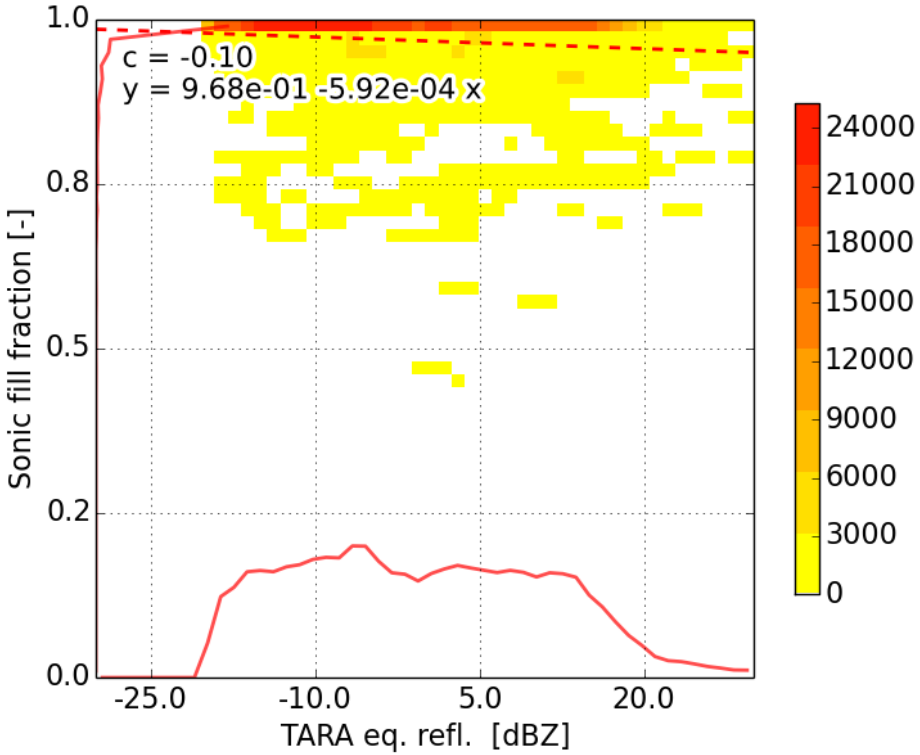
http://taracewe.ewi.tudelft.nl/
Example 2: validation of TARA and IDRA reflectivities



What is TARA CEWE?

http://taracewe.ewi.tudelft.nl/

Example 3: Does 180m sonic anemometer work when it rains?

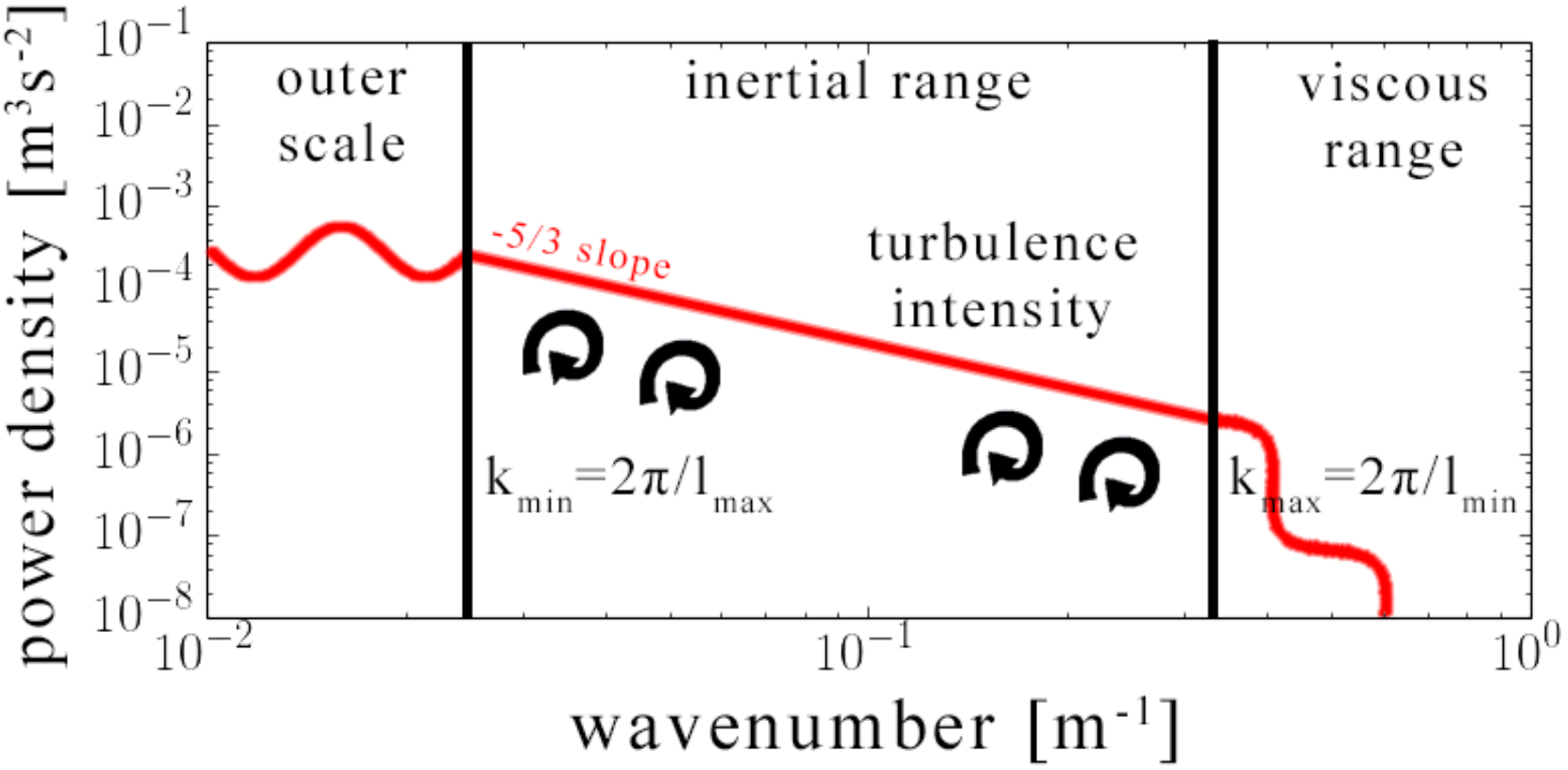


- Fill fraction is the fraction of data that passes a quality filter.
- Data is filtered when there are fill values or spikes occur.

Contemporary turbulence retrieval methods

Turbulence intensity retrieval

- Turbulence is quantified by the Eddy dissipation rate (EDR)
- Assumption on homogenous isotropic frozen turbulence



Contemporary turbulence retrieval methods

<u>Turbulence intensity retrieval</u>

- EDR can be derived from velocity measurements from radar, lidar or sonic anemometers.

EDR retrievals

→ **A sequence of velocities**

→ **Power spectrum**

$$E(\kappa) = C\,\varepsilon^{2/3}\kappa^{-5/3}$$

→ **Structure function**

$$D_{LL}(r) = <[v(x+r) - v(r)]^2> = C_2(\varepsilon r)^{2/3}$$

→ **Variance**

$$\sigma^2 = \frac{3}{2} C\,\varepsilon^{2/3}\left[\kappa_1^{-2/3} - \kappa_2^{-2/3}\right]$$

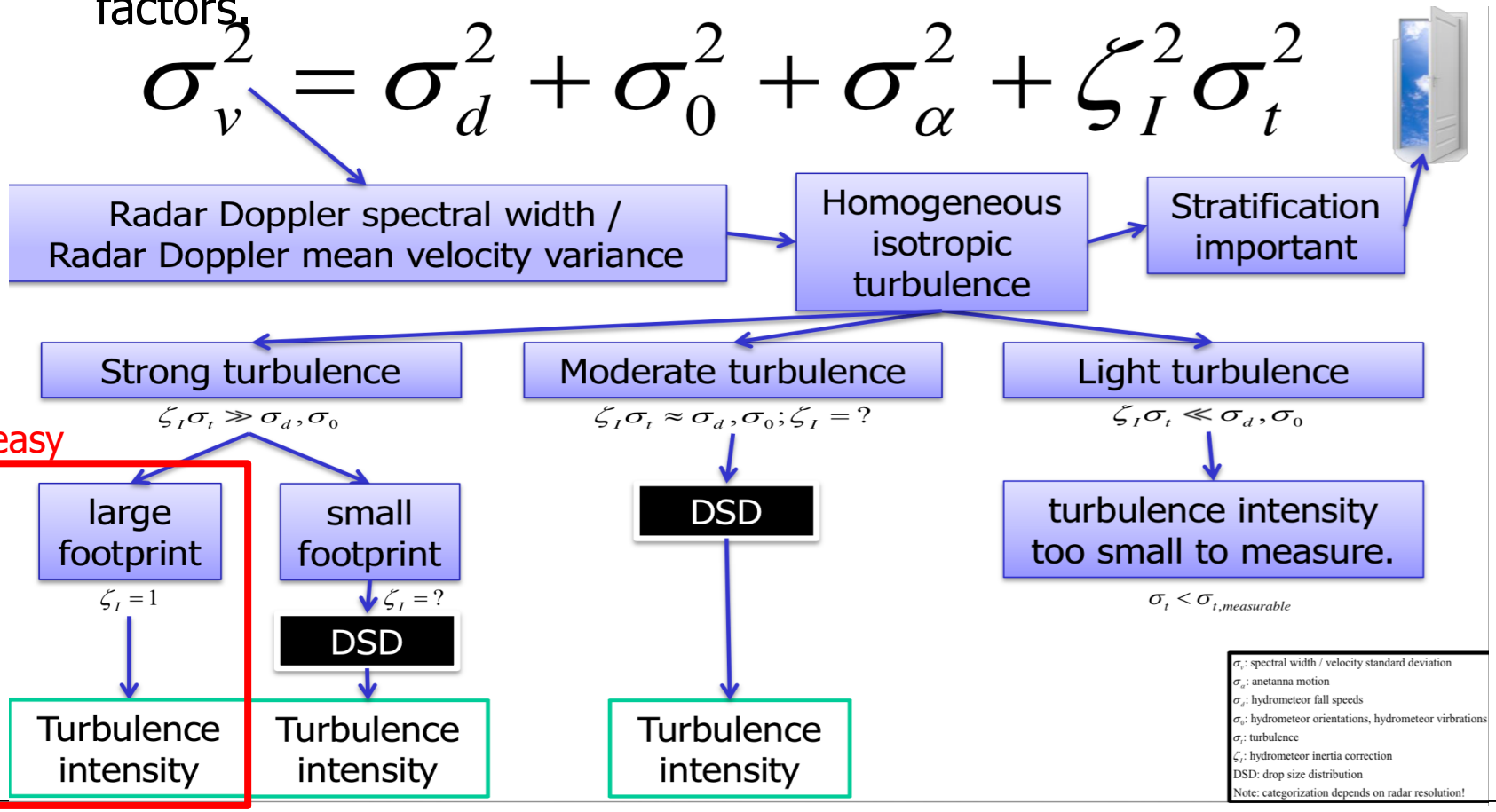
→ **Doppler Spectral width** → **More processing steps, e.g. Doviak (2006) / White (1999).**

Contemporary turbulence retrieval methods

Turbulence intensity retrieval from radar

- Radar Doppler velocity variance / spectral width is a combination of factors.

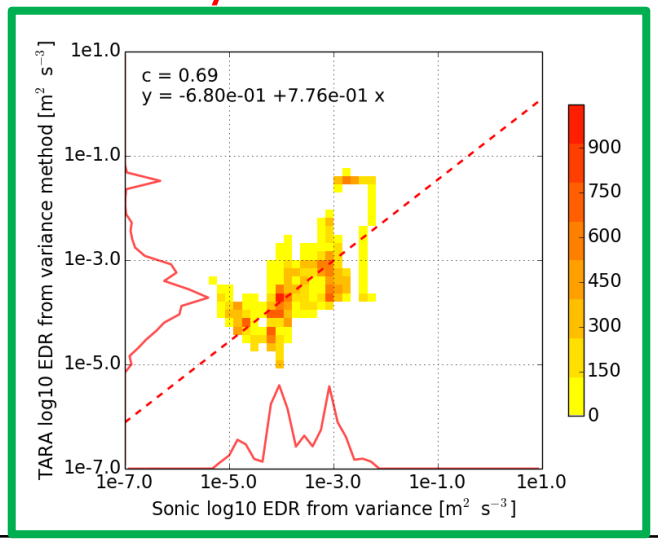
$$\sigma_v^2 = \sigma_d^2 + \sigma_0^2 + \sigma_\alpha^2 + \zeta_I^2 \sigma_t^2$$

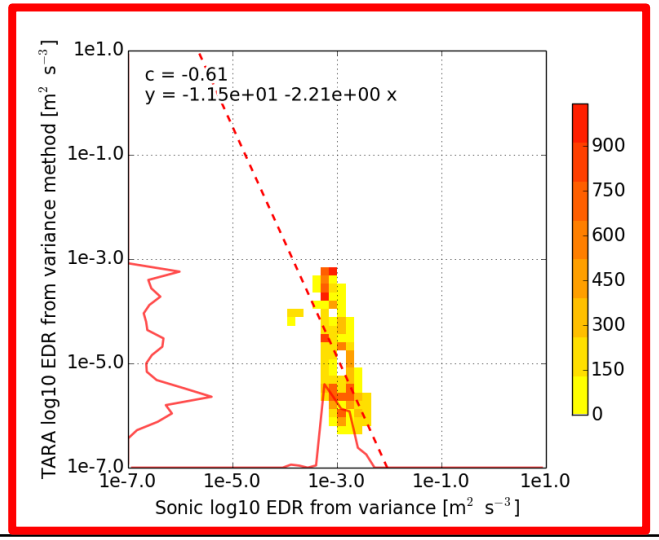


Preliminary results from TARA CEWE

Validation of TARA EDR vs Sonic EDR at 180 m lever with BIG DATA

- Small scale effects (DSD, drop inertia) on retrieved EDR mitigated by using a large footprint (10 min. scale).
- Comparison of EDR from vertically profiling radar (TARA) shows good agreement with sonic anemometer on June 21st 2012 in a convective mixed boundary layer.
- Comparison of EDR fails on January 19th 2012 in nocturnal boundary layer.



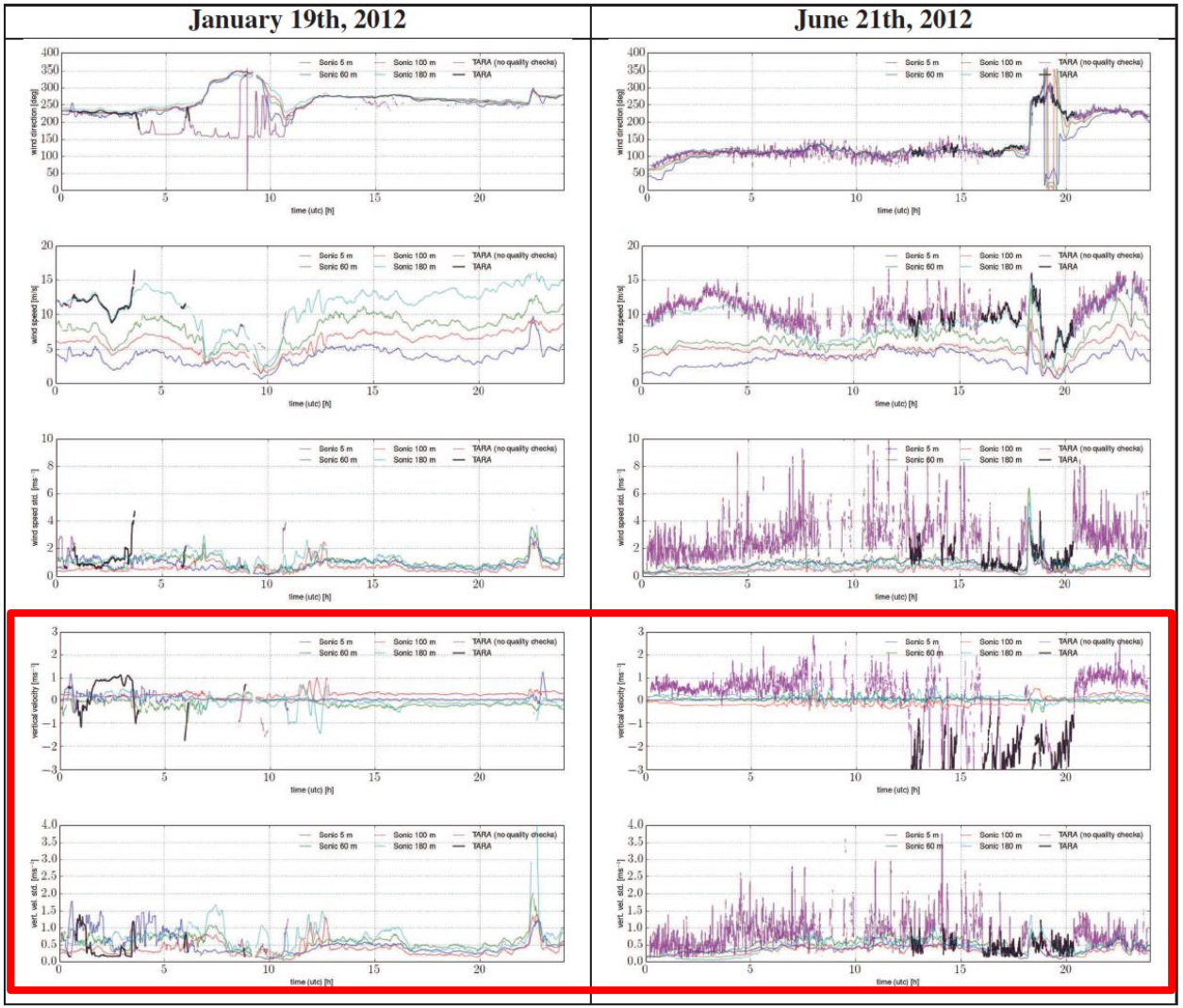


large footprint

$\zeta_I = 1$

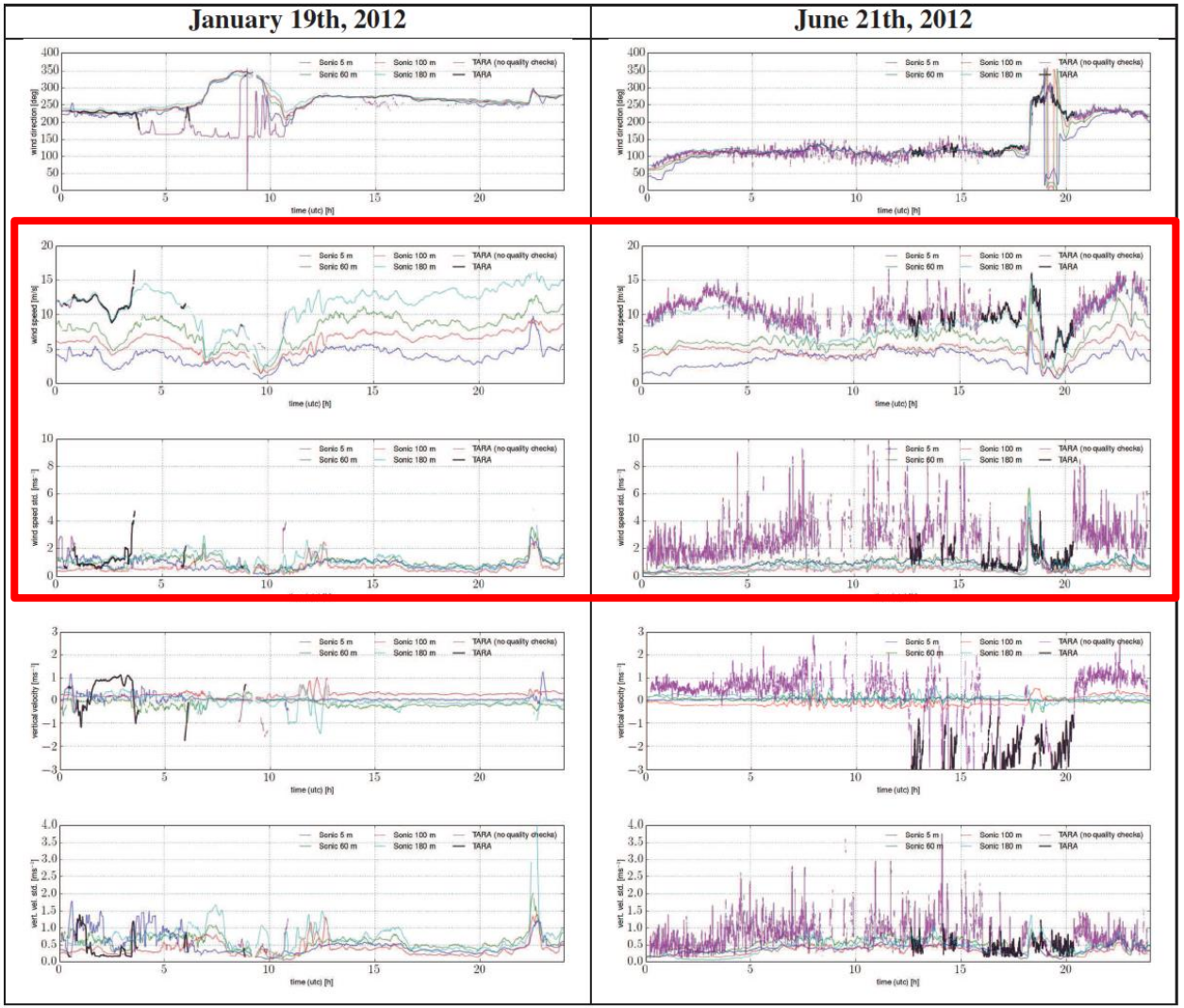
Turbulence intensity

Back to the details



- Correction for terminal fall is problematic

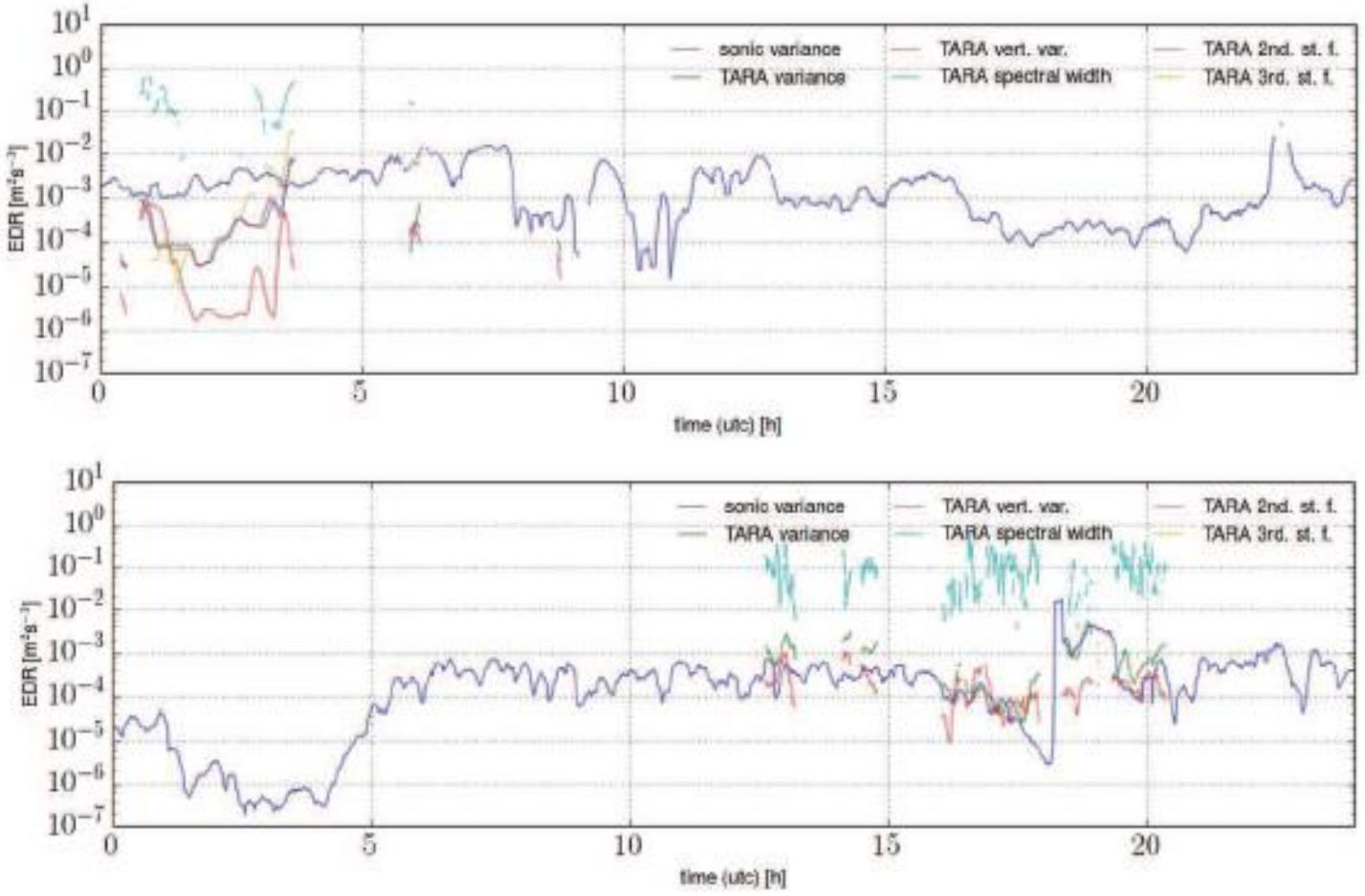
Back to the details



- Solution:
  use wind speed for analysis instead of vertical velocities.

Back to the details

EDR from wind speeds, instead of vertical velocities works better



Conclusion

- Terminal fall speed correction causes large errors in the standard deviation of vertical velocities. But not always.
- Typical processing (e.g. O'Connor (2010) using vertical velocities) is not suiteable for TARA.
- Alternative EDR processing using full wind speeds seems more reliable.

Outlook

- Updated version of TARA CEWE with new processing.
- Parametric turbulence model for simulation of radar observables. Optimal estimation based retrieval of DSD and turbulence intensity.

Questions?

Foto from Charlotte van den Arend

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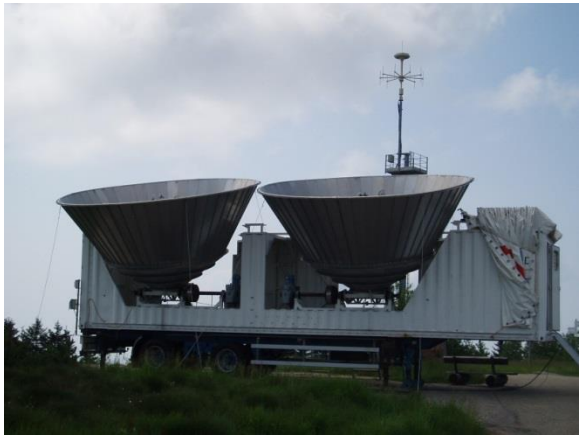
Backup-slide: Cabauw research site

Atmospheric Profiling between 180 m and ~ 15 km.

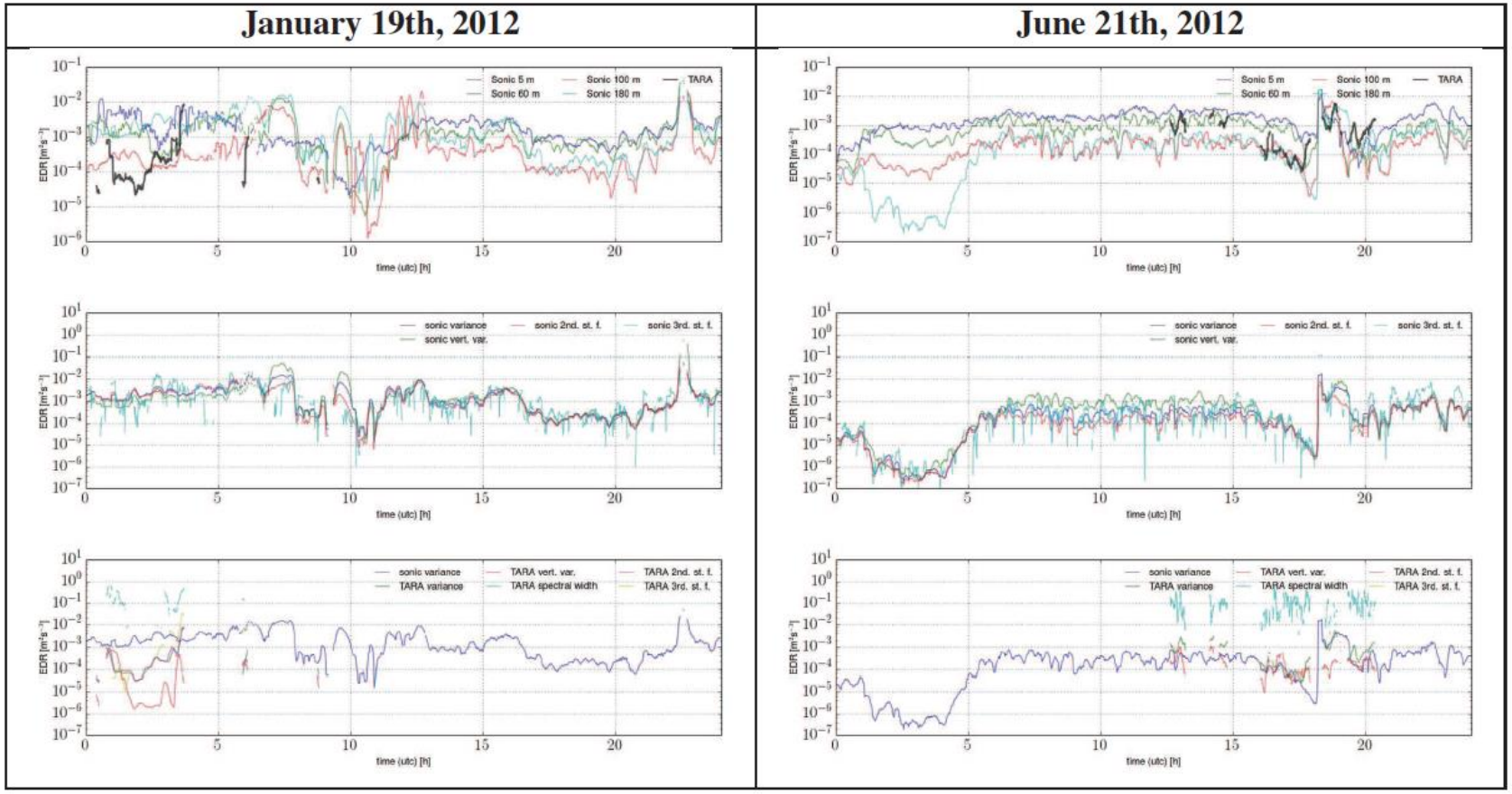
Tower with sonic anemometer at 180 m. (and other levels)



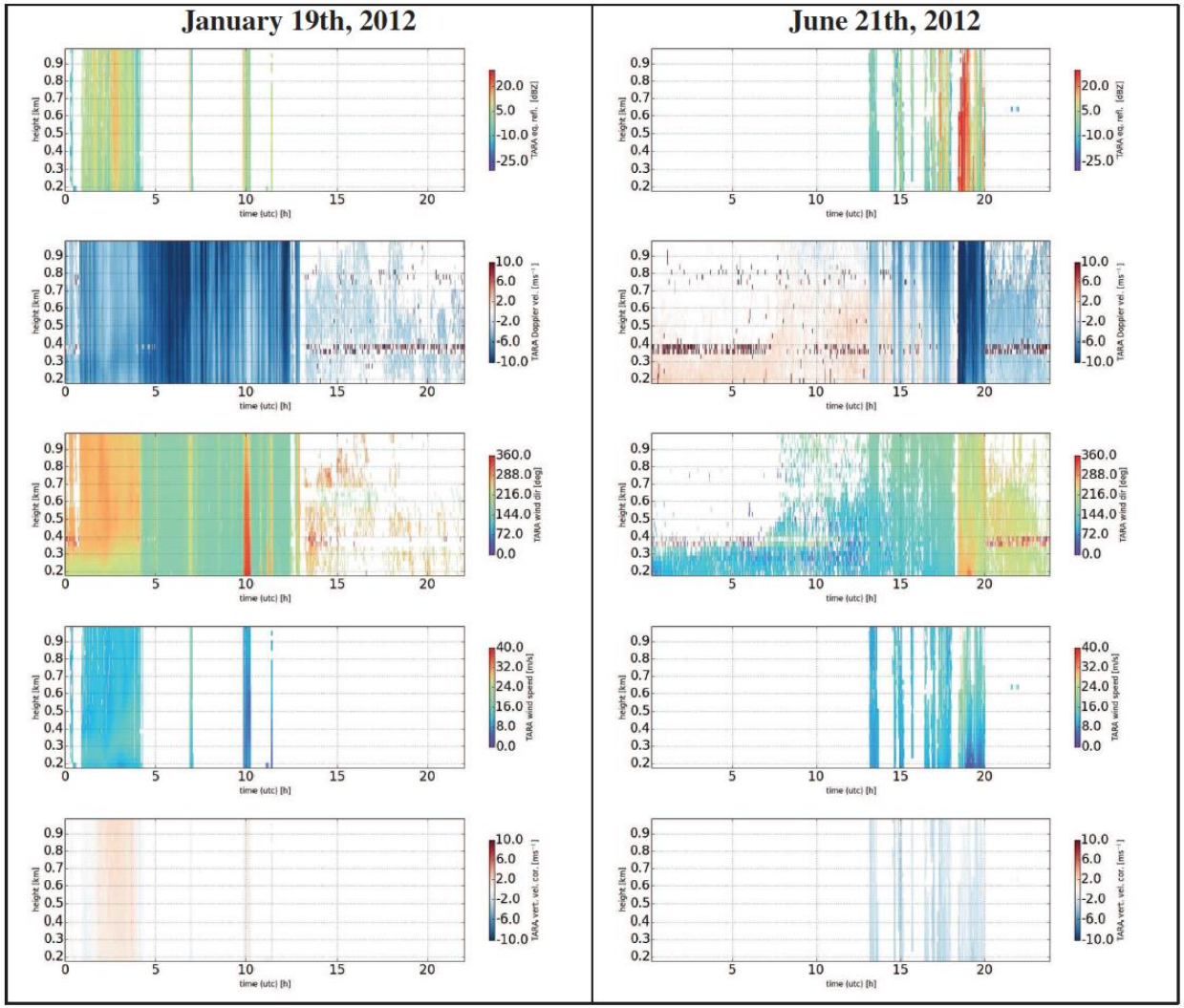
TARA (S-band RADAR) measures the vertical Doppler verlocities at Cabauw.

330 m

Backup-slide: different EDR methods



Backup-slide: TARA quicklooks



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CESAR Science Day, June 17th, 2015