

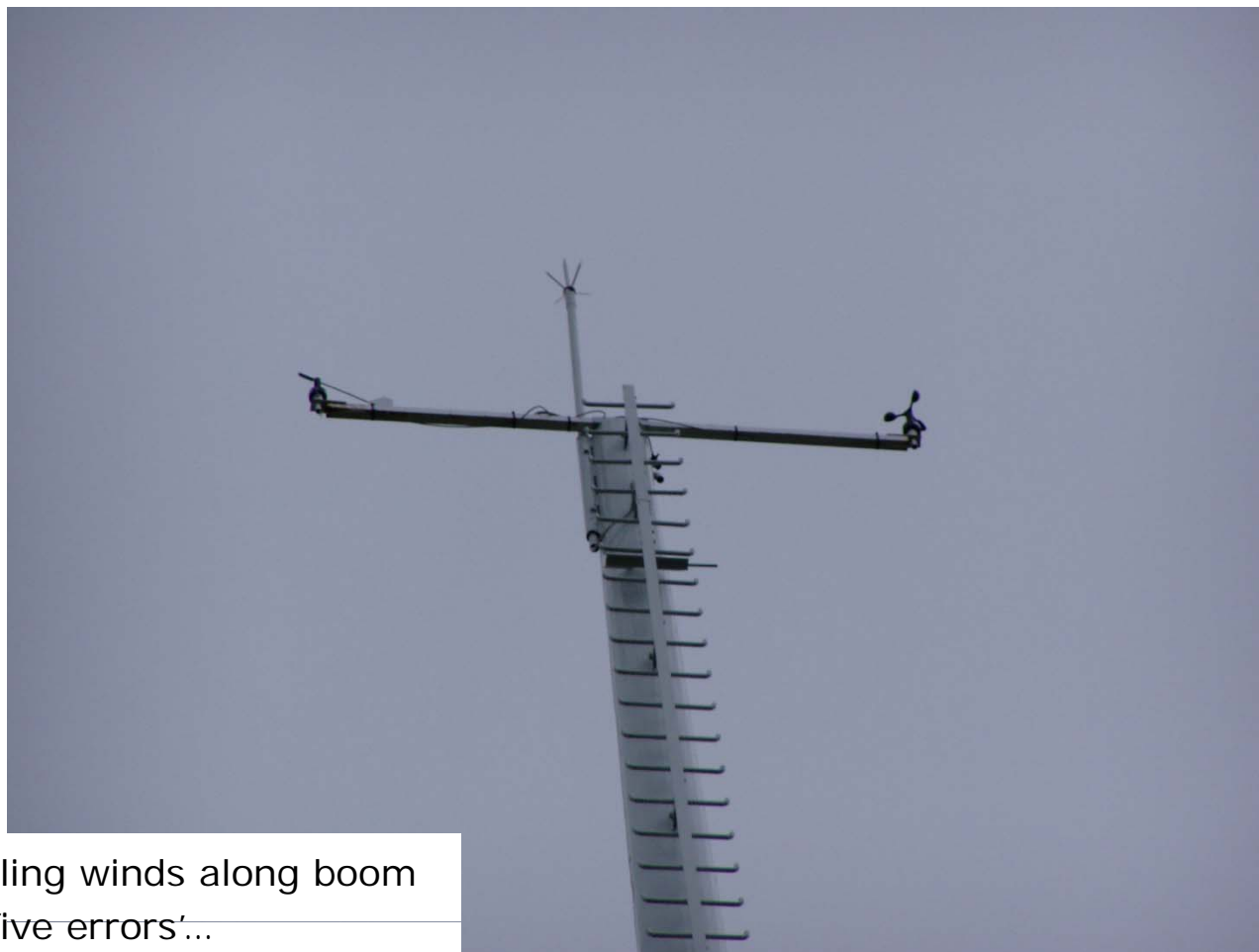
SAWEP Workshop Wind Atlas for South Africa (WASA)



Cape Town, 4th March 2010

Wind measurements and analysis of wind data

Sample met. mast



- Prevailing winds along boom
- Find 'five errors'...

Cup anemometry 1 (2)

- Tower effects (shadow)
 - lightning rod
- Boom and clamp effects
- Anemometer design
 - distance constant (l_0)
 - mech. and elec. construction
- Turbulent biases
 - u -bias $\propto (\sigma_u/U)^2$ (overspeeding)
 - v -bias $\propto (\sigma_v/U)^2$ (DP-'error')
 - w -bias $\propto (\sigma_w/U)^2$ (angular response)
 - stress-bias $\propto \langle uw \rangle / U^2$

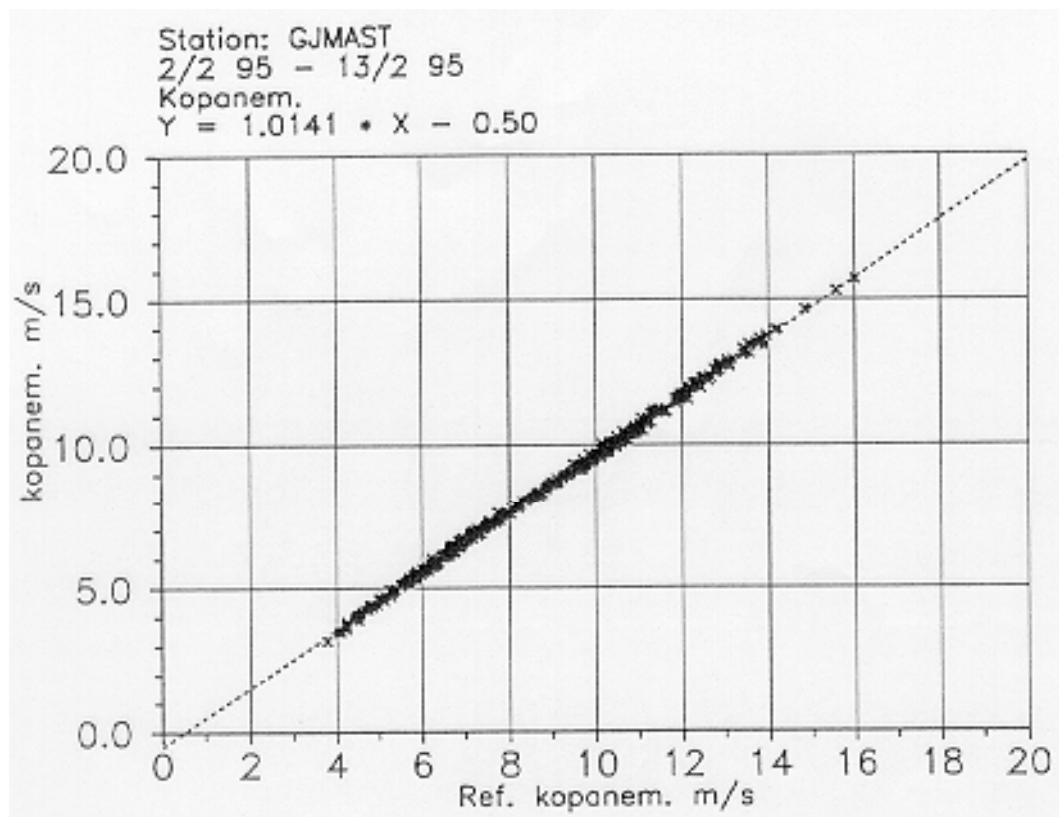


Cup anemometry 2(2)

- Anemometer condition
 - long-term stability of output
 - maintenance/rehabilitation schedule
- Environmental conditions
 - sea spray, salt, dust, insects...
 - icing of instrument
- Calibration procedure
 - wind tunnel calibration ('laminar')
 - atmospheric (in-situ, turbulent)
 - re-calibration at regular intervals
- Anemometer siting

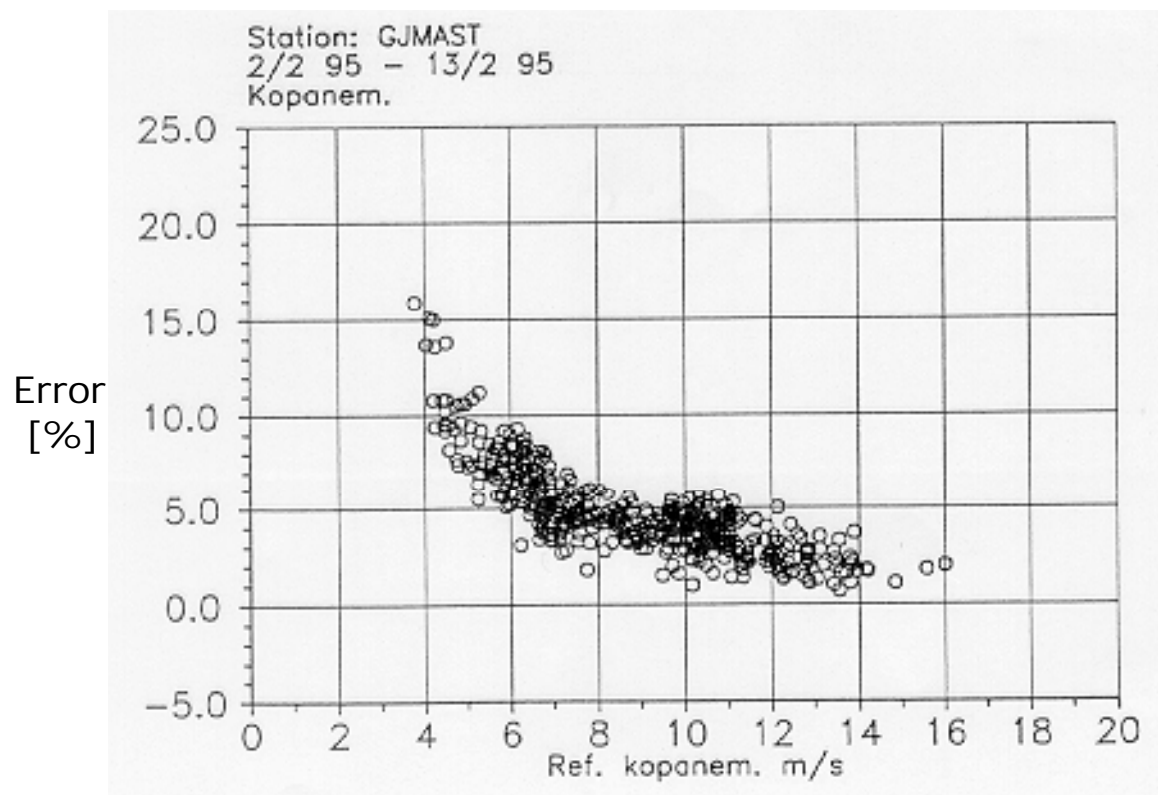


Anemometer calibration 1(2)



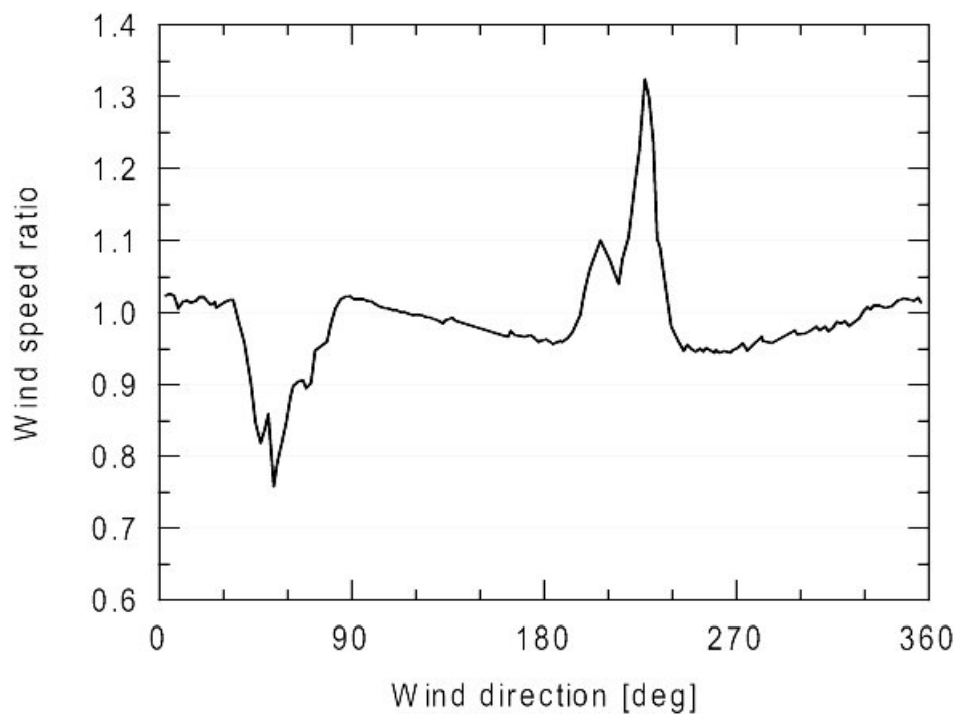
Generic calibration vs. reference anemometer: "looks good"?

Anemometer calibration 2(2)



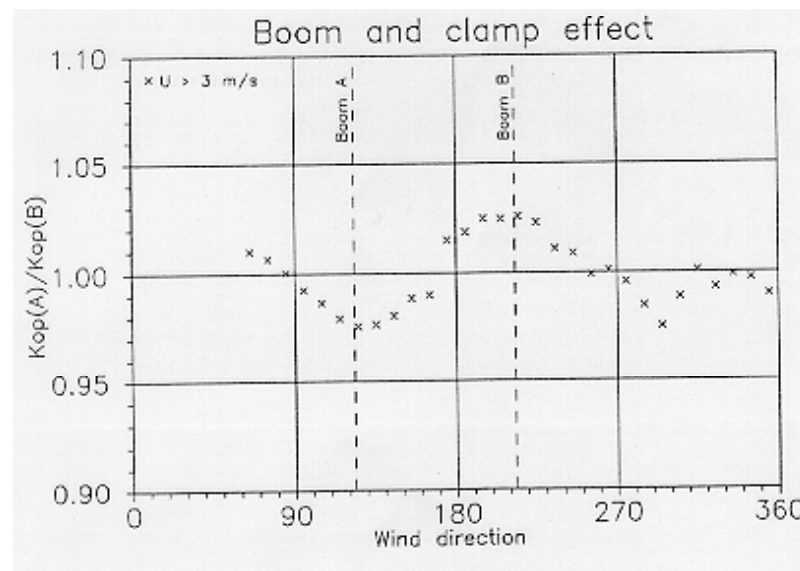
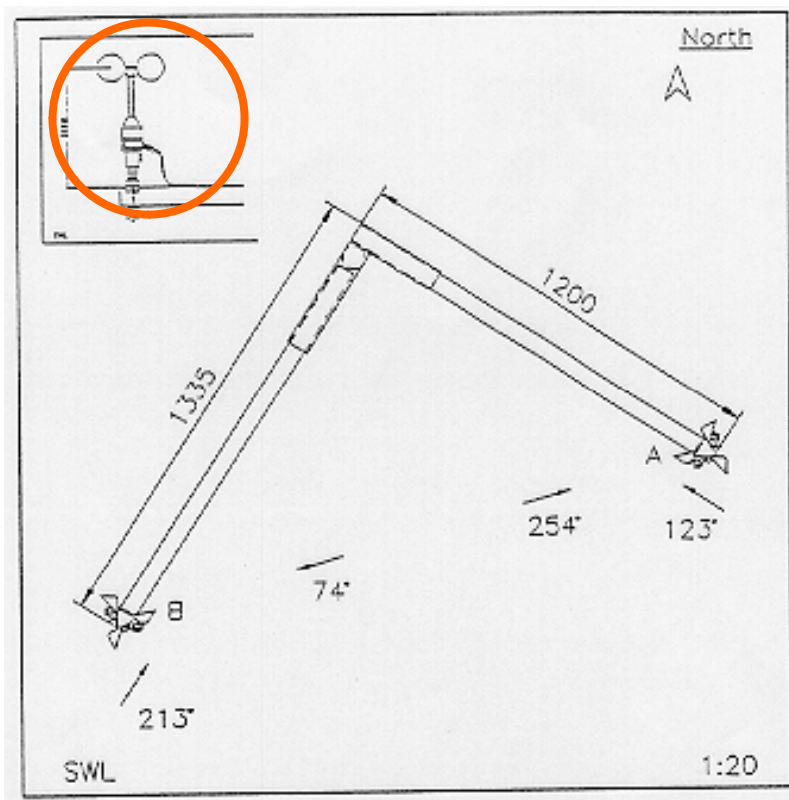
% difference can be significant! Solution: Individual Calibrations

Tower shadow

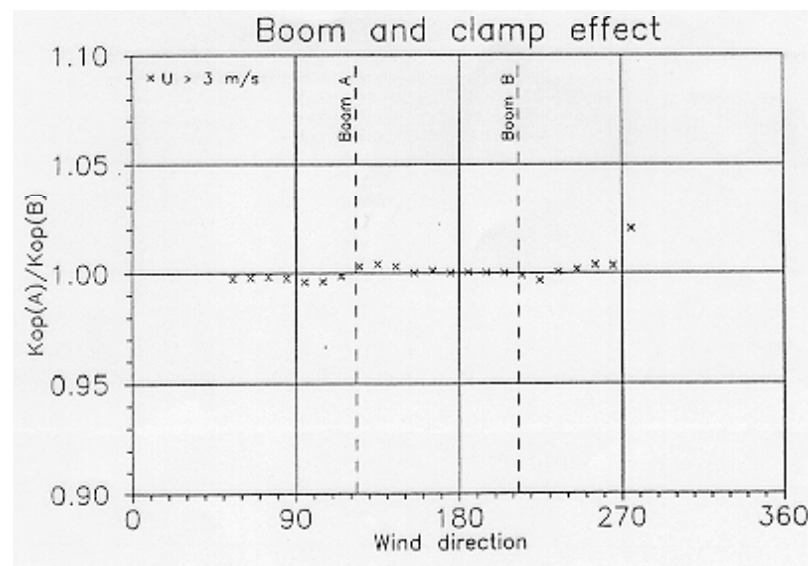
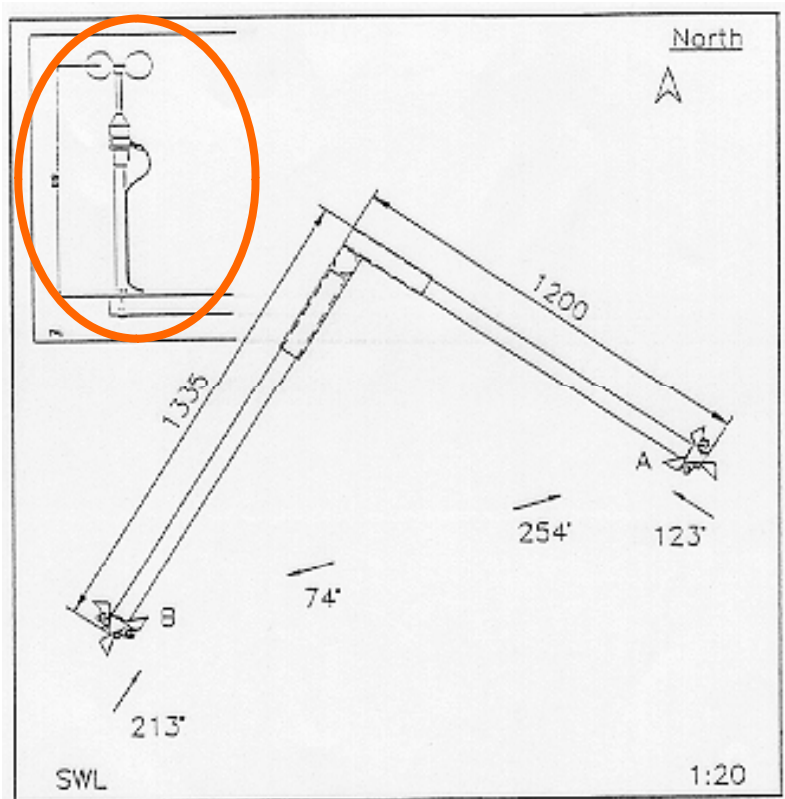


- Triangular lattice tower with side length 1.2 m
- two cups mounted on 2.5-m booms on opposite sides of the tower.

Boom and clamp effect 1 (2)



Boom and clamp effect 2(2)

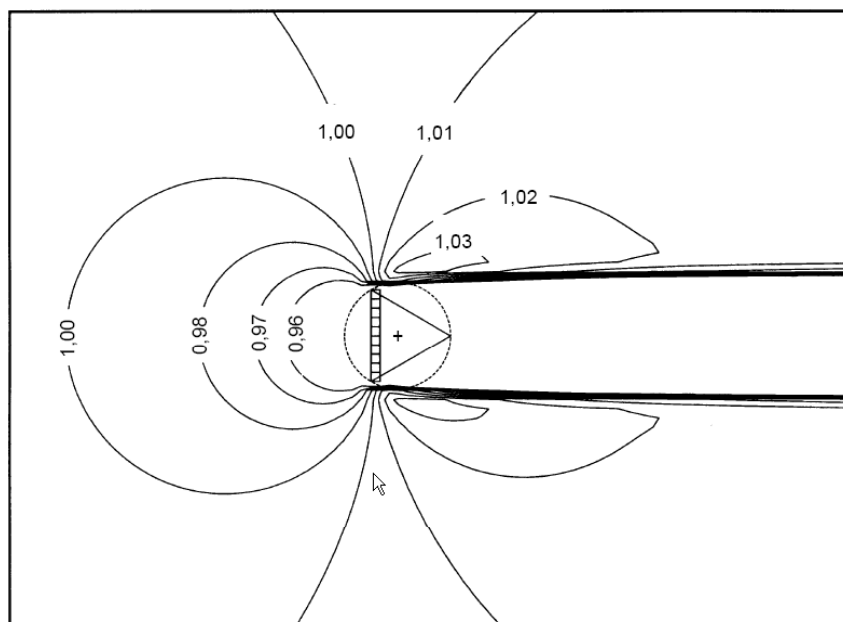


Cup rotor should be $> 12-15$ boom diameters above boom!

Flow distortion according to IEC 61400-12-1 standard

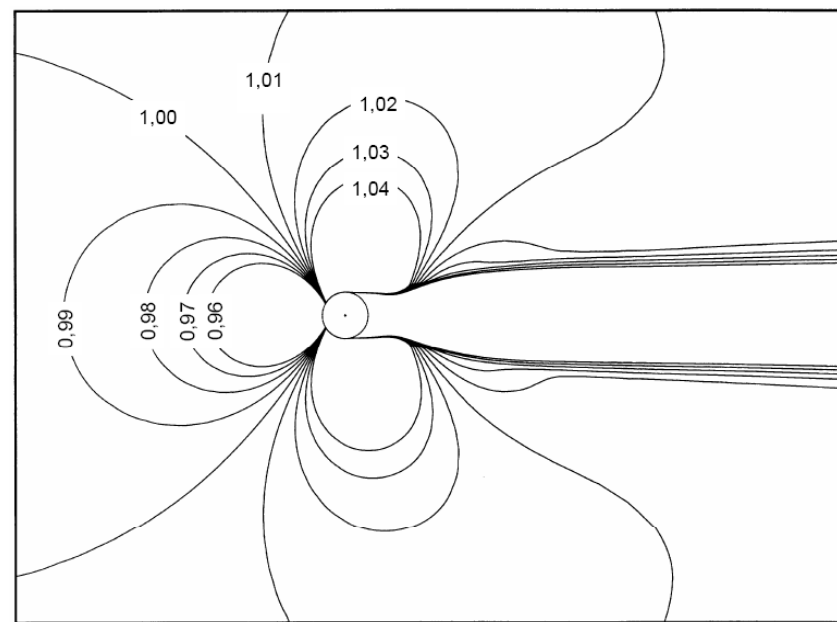
Triangular lattice mast

Optimum boom direction @ 90°

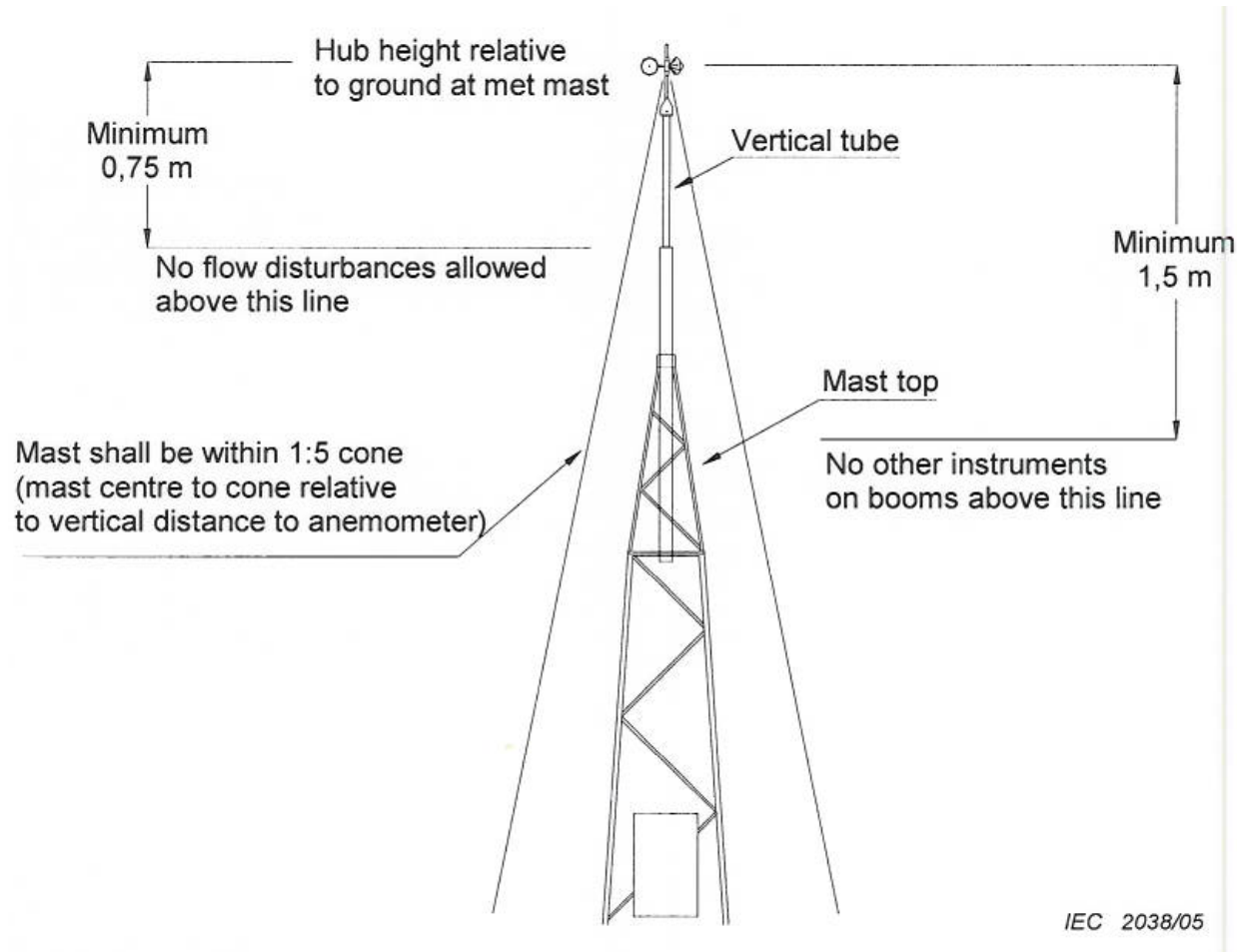


Cylindrical tubular mast

Optimum boom direction @ 45°



Met. mast top arrangement – IEC



Sample met. masts



25-m lattice mast

Risø DTU
National Laboratory for Sustainable Energy



Top-pole



70-m lattice mast

The GIGO principle

- This universal principle for computer models (and many other aspects of life ; -) states:

$$\text{Garbage In} = \text{Garbage Out}$$

or in math terms:

$$\text{Garbage Out} = (\text{Garbage In})^n$$

- Unfortunately, the exponent for wind energy models is:

$$n = 1.5-3$$

- 'Garbage' or not – it's difficult to make accurate, reliable, long-term wind measurements!

... and finally a few rules-of-thumb to remember

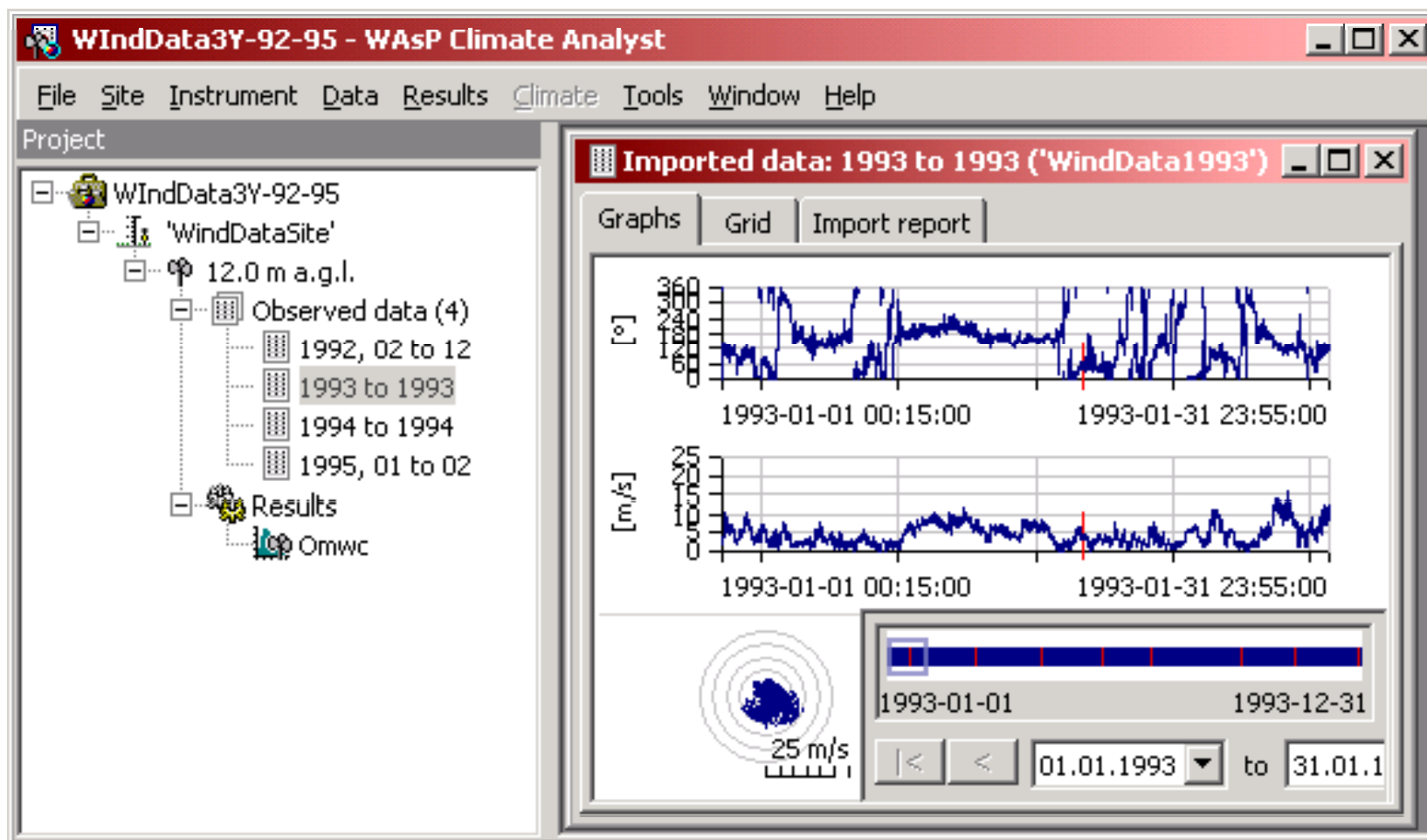
Wind measuring issues

- Cup anemometer rotors should be
> 12-15 boom diameters above boom
- Boom lengths
lattice mast: > 3-5 mast side widths
tubular mast: > 6 mast diameters
- Boom orientation
lattice mast: 45°-90° from prevailing
tubular mast: 45° from prevailing wind
- Uncertainty of wind measurements is
really still 1–3% (or worse)

Quality of wind data

- The wind data must be **accurate**
 - equipment design and specifications
 - calibration of sensors (anemometers)
 - careful mounting of sensors on mast
- The wind data must be **representative**
 - data collection for > 1 year
 - data statistics for a number of full years
(no seasonal bias – cut if necessary!)
 - data recovery > 90% (missing data distributed randomly)
 - careful siting of mast (similarity principle)
- The wind data must be **reliable**
 - verification of sensor outputs (QA)
 - O&M (rehabilitation and recalibration)
 - redundant sensors, long-term, wind index, ...

Climate Analyst details (1) – hierarchy



WAsP – the OWC view

The screenshot shows the WAsP software interface with the following components:

- Workspace hierarchy:** A tree view on the left showing the project structure, including 'Waspdale' Wind atlas, 'Waspdale' Observed wind climate (selected), and '1 MW' Wind turbine generator.
- Context menu:** A menu is open over the selected 'Waspdale' Observed wind climate, with options like 'Show Waspdale', 'Insert new', 'Rename', 'Remove', and 'Export to file...'. 'Show Waspdale' is highlighted.
- 'Waspdale' Observed wind climate window:**
 - Table:** A table with columns for Sector, Wind climate (angle, freq., W-A, Weibull-k, U), Power (power), and Quality (delta-U). The 'All (emergent)' row is highlighted in yellow.
 - Charts:** A wind rose chart on the left and a histogram on the right showing frequency distribution of wind speed (u [m/s]).
 - Summary:** A legend box on the right of the histogram provides summary statistics: Sector: All, A: 5.5 m/s, k: 1.97, U: 4.90 m/s, P: 135 W/m².
- Library:** A bottom-left panel showing 'Library folders' with 'Sample files (13 files)' and 'Wind turbine generators (41 files)'.

The OWC file (*.tab, now *.owc)

