The elimination
of spurious trends
in marine wind data
by calibration
with individual pressure differences

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Relative portion of Beaufort estimates
12 Hurricane
11 Storm
10 Whole Gale
 9 Strong Gale
 8 Fresh Gale
 7 Moderate Gale
 6 Strong Breeze
 5 Fresh Breeze
 4 Moderate Breeze
 3 Gently Breeze
 2 Light Breeze
 1 Light Air
0 Calm.

Of just sufficient to give steerage way.
Of that in which a man could stand on his head without capsizing.
Of that in which one could just carry a light oar without capsizing.
Of that in which a well-protected vessel could lie, with all sail set.
Of that in which a vessel could lie with all sail set and steer full, or 4 hours.
Of that in which a vessel would go in smooth water for 6 hours.

Wardigeck
Of that which she could securely bear close-recessed main-topgallant
Triple-recessed topgallant, etc.
Double-recessed toposhalls, etc.

Chose-recessed toposhalls and course.

Of that which would reduce her to storm straits.
Of that which no canvas could withstand.
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<th>Windstärke 0—12</th>
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### Beaufort 4:
The wavelets are becoming more pronounced and longer; all over whitecaps are developing; the breaking of the sea becomes louder and is sounding like enduring murmur.
Spatial gradient of the temporally averaged pressure field

$$\sqrt{\langle \frac{\partial p}{\partial x} \rangle^2 + \langle \frac{\partial p}{\partial y} \rangle^2} \propto \sqrt{\langle u \rangle^2 + \langle v \rangle^2} \neq \langle \sqrt{u^2 + v^2} \rangle$$

Mean pressure differences could be used only if the wind steadiness $\frac{\sqrt{\langle u \rangle^2 + \langle v \rangle^2}}{\sqrt{\langle u^2 + v^2 \rangle}}$ is constant in time.
• In principle triples of simultaneous pressure observations are necessary.

• However, random observation errors would dominate the results by increasing systematically the derived gradients.

• Using more than three simultaneous observations could help, but this would drastically reduce the data base.
relative wind direction = 290
Vg raw = 13.3 m/s
ageos = 17.6 degr
pairs = 1021039
Effect of errors in the wind direction
$\cos(D_1 - D_2)$ vs distance / km

1960 – 1971
40N – 50N
January

$a_0 = 0.804$
$a_1 = -0.40$ per Mm
error = $\arccos(\sqrt{a_0}) = 26.3$ degr
40N – 50N
January 1960 – 1971

$V_g = 14.8 \text{ m/s}$
$V_h = 10.2 \text{ m/s}$

$V_g \text{ raw} = 13.3 \text{ m/s}$
$\text{ageos} = 17.6 \text{ degr}$
$pairs = 1021039$
$A1 = 1.81 \quad A0 = -3.7 \text{ m/s}$
\[ G \text{ m/s} \]

\[ U \text{ m/s} \]

\[ a_1 = 1.55 \quad a_0 = -0.3 \text{ m/s} \]
\[ A_1 = 1.81 \quad A_0 = -3.7 \text{ m/s} \]

\[ \text{Faktor} = 0.856 \]
\[ \text{Const.} = 1.86 \text{ m/s} \]
$a_1 = 0.704 \text{ kn}$
$a_2 = 1.737 \times 10^{-2} \text{ kn}^2$
$a_3 = -3.205 \times 10^{-4} \text{ kn}^3$
$a_4 = 1.789 \times 10^{-6} \text{ kn}^4$
CONCLUSIONS

- A method to detect and eliminate spurious wind trends in COADS is presented.

- The negative trend recorded in the North Atlantic before 1950 is reversed, the positive trend between 1950 and 1979 vanishes after the correction.

- In order incorporate also the growing number of anemometer measurements into the data a function to homogenize these observations with Beaufort estimates is presented.

- After 1980 regional varying trends are found in the homogenized data set which are confirmed by concurrent trends in the geotrophic wind.