Comparison of Wind Measured at Faro Airport and at Peninsula do Ancao

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3 COMPARISON OF WIND MEASURED AT FARO AIRPORT AND AT PENINSULA DO ANCÃO

Introduction

To be able to make calculations of long-term sediment transport for the Faro Barrier islands, it is necessary to have access to long-term wind data. Wind data are available for Faro Airport. To use these data for prediction of transport at Ancão, they need to be correlated to the wind data measured at Ancão.

Methods

Wind measurements at Faro Airport are provided by the Portuguese Meteorological Service. The measurements are recorded at 10 m above the surface and are stored as hourly averages. Wind measurements at Ancão are recorded at several positions and levels, but for this study only the recordings at the dune crest at 4.2 m above the surface are used. Measurements are performed every 5 seconds and data are stored as 10 minute, 30 minute and hourly averages, together with minimum and maximum wind speed over those intervals, and standard deviation. The wind measurements were carried out from 12-01-1999 19:00 until 28-03-1999 11:00. For derivation of friction velocities half-hourly wind profiles are measured on the beach on the 2^{nd}, 4^{th}, 6^{th}, 15^{th} and 17^{th} of February 1999, at a height of 0.25, 0.5, 1.0, 2.0 and 4.0 m.

Results

The wind measurements at Ancão correlated well with those at Faro Airport, and varied for different wind directions, due to the influence of topography and wind speed.

Wind direction

Wind directions recorded at Ancão and at Faro Airport appeared to be very well correlated (Figure 1). For low wind speeds the correlation is worse because of local disturbances of the airflow. Regression equations were derived for the equation

WindDirectionFaroAirport = a * WindDirectionAncão (+b) (1)

Table 1 shows the regression parameters for data, for different sets of wind speeds. For higher wind speeds the correlation is better than for lower wind speeds, which is expected. At lower wind speeds, the airflow is influenced by stability, or by local circumstances. For example, land-sea breezes may be observed at the beach during low wind speeds, but not at Faro Airport.

Table 1. Regression parameters for the correlation between wind directions measured at Ancão and at Faro Airport.

$WSP_{Ancão4.2}$	a_1	b_1	R^2	a_2	R^2
> 2 m/s	1.0217	-4.8089	0.709	1.0038	0.7088
> 3m/s	1.005	-6.439	0.907	0.9803	0.9063
> 4 m/s	1.0197	-8.435	0.878	0.9869	0.8769
> 5 m/s	0.9942	-5.5848	0.9824	0.9714	0.9818
> 6 m/s	1.012	-10.245	0.9797	0.9683	0.9776

According to Table 1 the deviation in wind direction between Faro Airport and Ancão is small. Because of a higher roughness inland, the wind direction at Faro Airport is 5-10 degrees less than the wind direction at Ancão. However, part of the observed difference could also be related to measurement errors, for example in aiming the wind mast at Ancão to the North. The estimated measurement error for the wind direction at Ancão is in the order of 5º. Therefore, it is legitimate to suggest that the wind directions are equal. The resulting error is small, and in the order of measurement errors.

Wind speed

The correlation between wind speeds measured at Faro Airport and Ancão depends on the wind direction. Figure 2 shows the correlation for all data. For onshore winds, airflow is accelerated on the dune, whereas for parallel winds the airflow is decelerated because of a higher roughness. Regression equations were derived for the equation

$$\text{WindSpeedFaroAirport} = a * \text{WindSpeedAncão} + b \qquad (2)$$

Table 2 shows the different regression parameters for a range of wind directions. All data are used. For most circumstances the wind velocity at Faro Airport is smaller than at the beach. This is expected because of the presence of a rougher surface near the airport.

Table 2. Regression parameters for the correlation between wind speed measured at Ancão and at Faro Airport.

wind direction	a	b	R^2
150-180	0.7297	0.8566	0.8627
180-210	0.6479	0.9692	0.8677
210-240	0.7307	0.7142	0.8318
240-270	0.8712	0.2946	0.8499
270-300	0.7252	0.2257	0.6731

Equations (1) and (2) can be used to calculate the wind speed at Ancão from Faro Airport data. In order to convert these wind speeds to friction velocities, a number of wind profiles measured on the beach were compared to wind speeds measured at the dune crest. A simple linear regression equation was derived to compute friction velocities from wind speeds. The computed (hourly) friction velocities can then be used as input for the model SAFE.

Friction velocity

For modelling purposes, or for application of transport equations, the friction velocity at the beach is needed as input. The wind speed at Ancão dune crest can be converted to a friction velocity by means of several methods. We have chosen here for a direct correlation between the wind speed at the dune crest, and the friction velocity measured on the beach during a number of events.

Figure 3 shows a typical wind profile (half hour average) measured on the beach. Most profiles show a kink between 1 and 2 m, which is probably related to the steep beach topography. In all profiles, the part from 0.25 to 1 m is a straight line, implying that over this range of heights the profile is more or less logarithmic. When the wind profile is logarithmic, the relation between wind speed, height and friction velocity is given by:

$$U_z = \frac{U_X}{\kappa} \ln \frac{z}{z_0} \qquad (3)$$

The friction velocity can now be derived by means of regression analysis, with wind speed as the dependent variable and log(height) as the independent variable. The friction velocity is derived with

$$U_* = a\kappa \qquad (4)$$

where a is the slope of the regression line and κ is the von Karman constant (0.41).

The friction velocities that are derived in this way can be correlated to the wind speed at the dune crest at 4.2 m.

$$U_{*beach} = a * U_{4.2} \qquad (5)$$

We assume a fit through the origin because when the wind speed is 0, we expect also a friction velocity of 0. Table 3 gives the regression parameters for onshore and oblique onshore winds. The correlation is reasonable well. Stability effects, especially at low wind speeds, will produce some scatter. Figure 4 illustrates the relationship for all data and Figure 5 for onshore winds. For wind directions 135-180 (oblique onshore) the data are badly correlated and it is not possible to derive sensible regression parameters.

Table 3. Regression parameters for the correlation between wind speeds measured at Ancão dune crest and friction velocities measured on the beach.

wind direction	a	R^2	n (number of half hourly wind profiles)
135-180	X	X	5
180-270	0.0518	0.9208	35
270-315	0.0631	0.8276	11
offshore	0.0513	0.6297	12
oblique onshore 135-180 and 270-315	0.065	0.5896	16
all data	0.0531	0.8122	63

Conclusions

The correlation between wind speeds and wind direction measured at Faro Airport and Ancão is very well. Several regression equations are derived to calculate wind direction, speed and friction velocity for Ancão, from Faro Airport data. By means of these relationships long-term wind data can be used for predictions of sediment transport at Ancão.

Figures

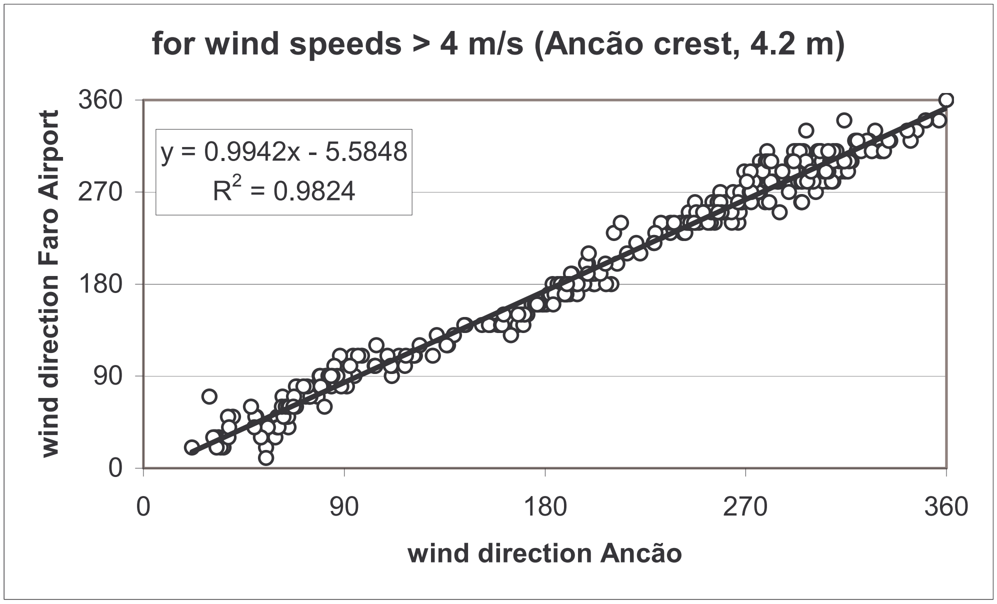

Figure 1. Relation between wind direction measured at Ancão and at Faro Airport.

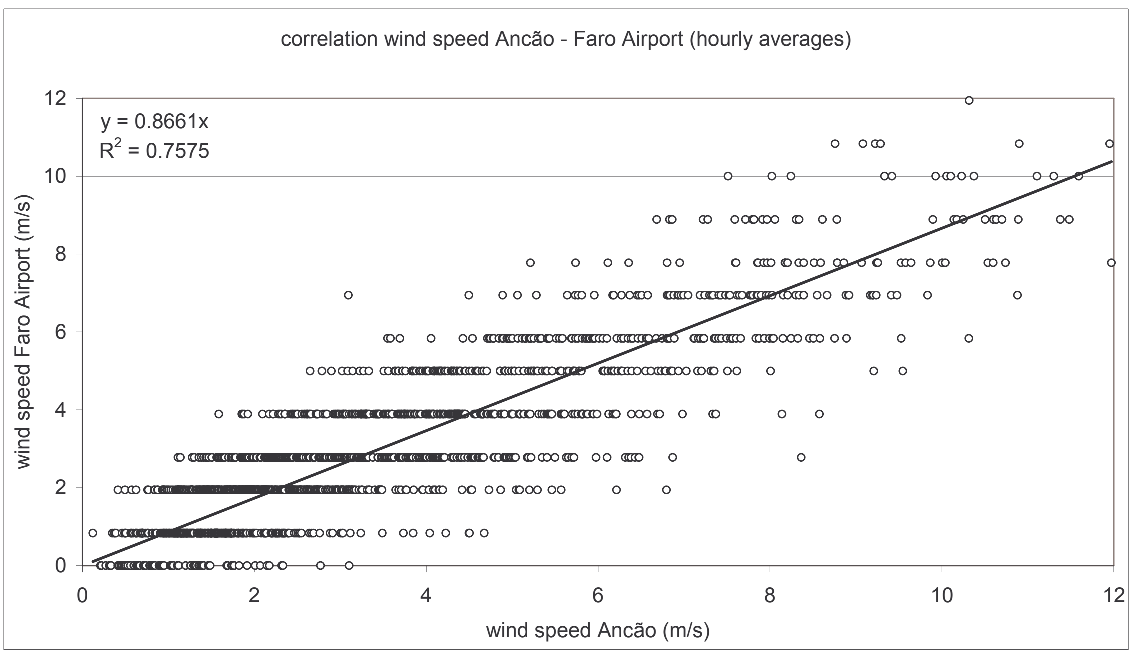

Figure 2. Wind speed measured on the dune crest at Ancão versus wind speed measured at Faro Airport.

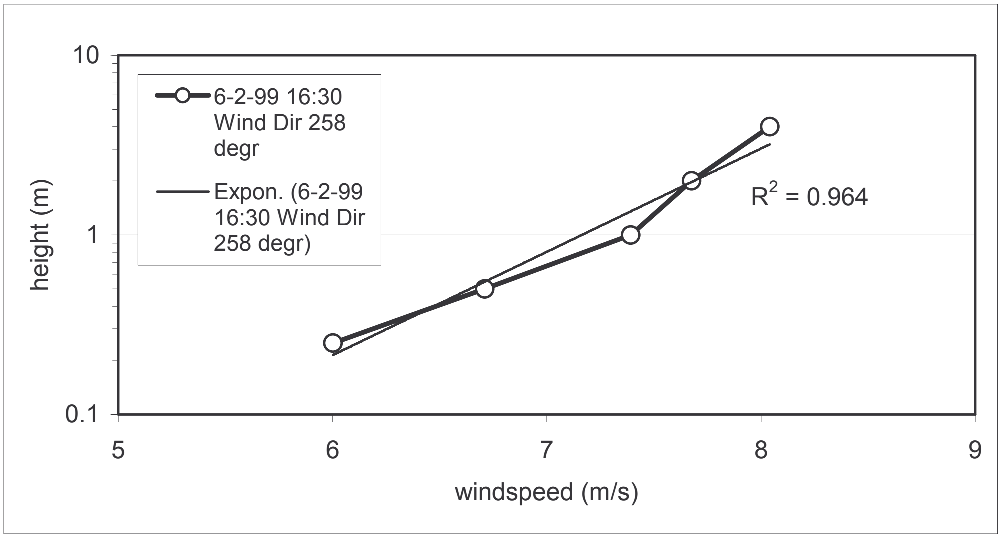

Figure 3. A typical wind profile measured on the beach.

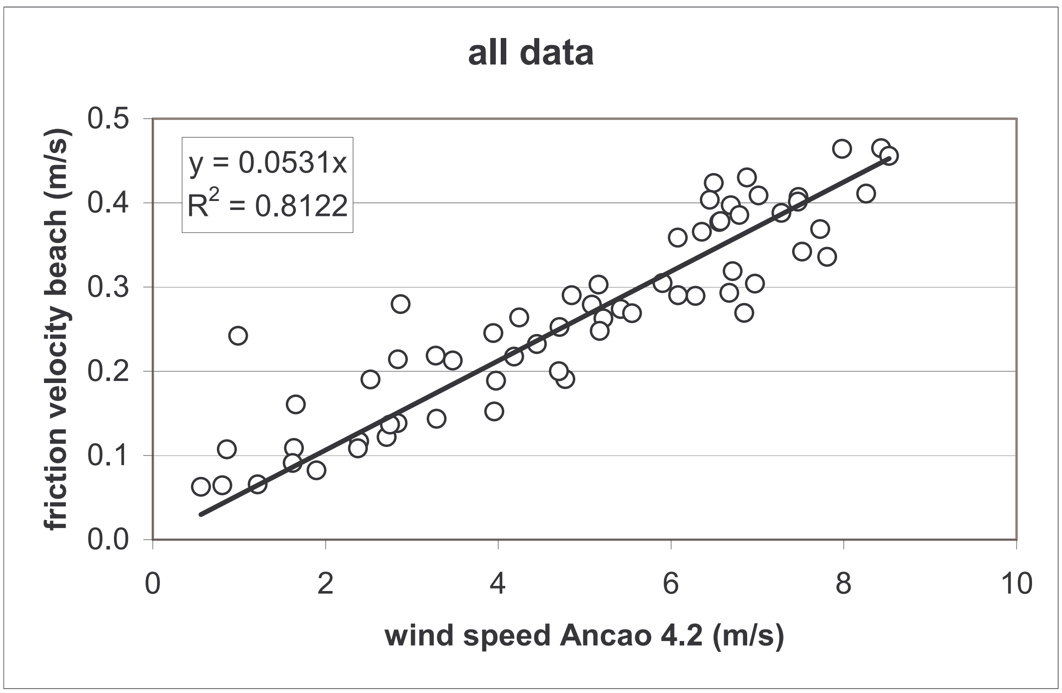

Figure 4. Relationship between wind speed measured at the dune crest at 4.2 m and friction velocity measured on the beach (all data, half hour averages).

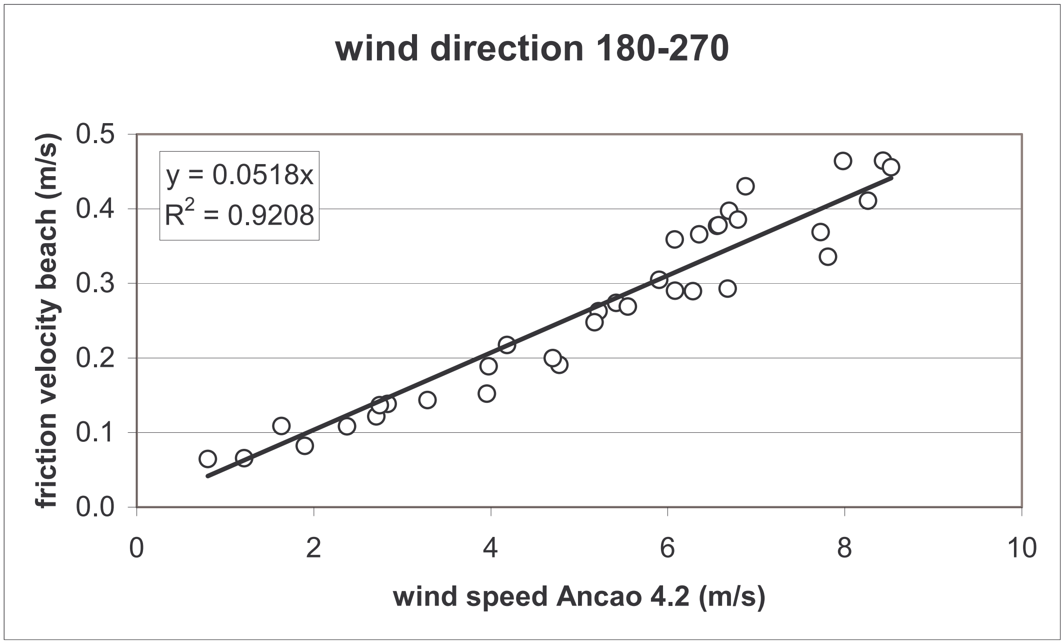

Figure 5. Relationship between wind speed measured at the dune crest at 4.2 m and friction velocity measured on the beach (onshore winds).