

THE ROLE OF DIURNAL MOUNTAIN WINDS DURING SEVERE DRYING OUT CONDITIONS: IMPACTS AT MADRID~BARAJAS AIRPORT



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MOTIVATION

DURING SUMMER 2016:

(1) THE SOIL UNDERWENT A PROGRESSIVE AND EXTREME DRYING OUT

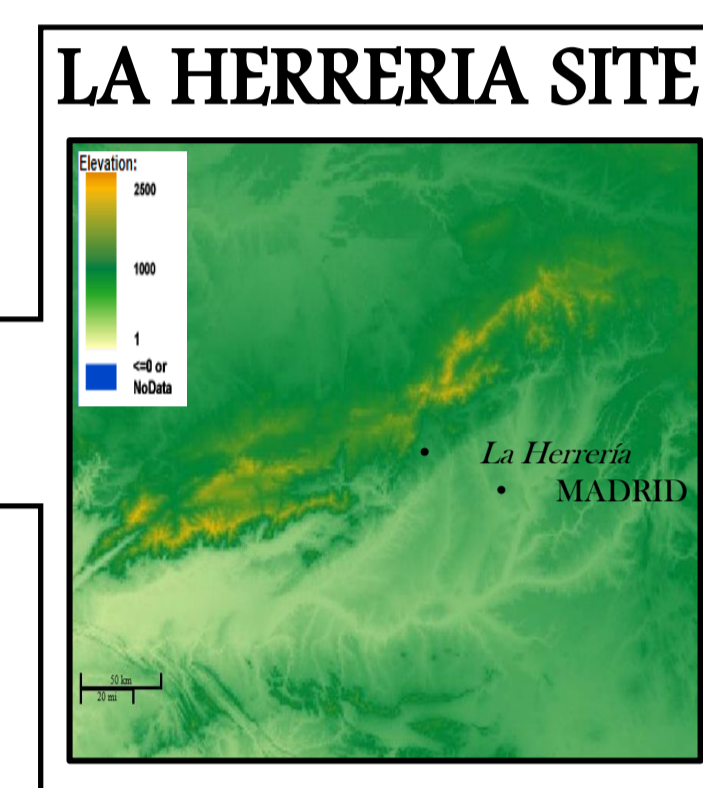
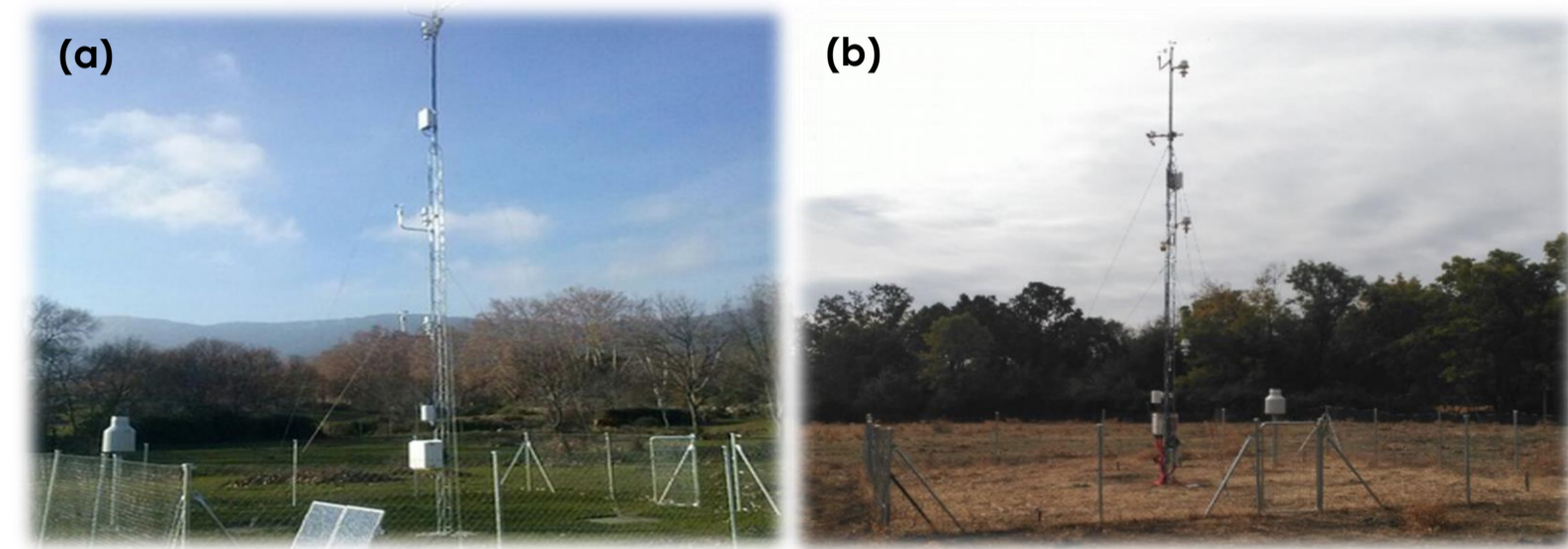
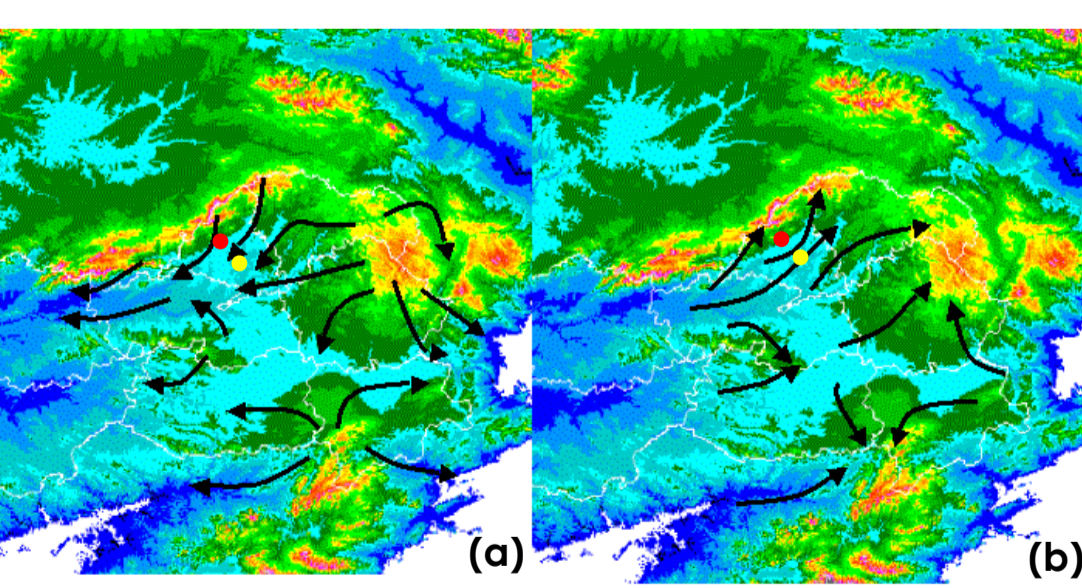
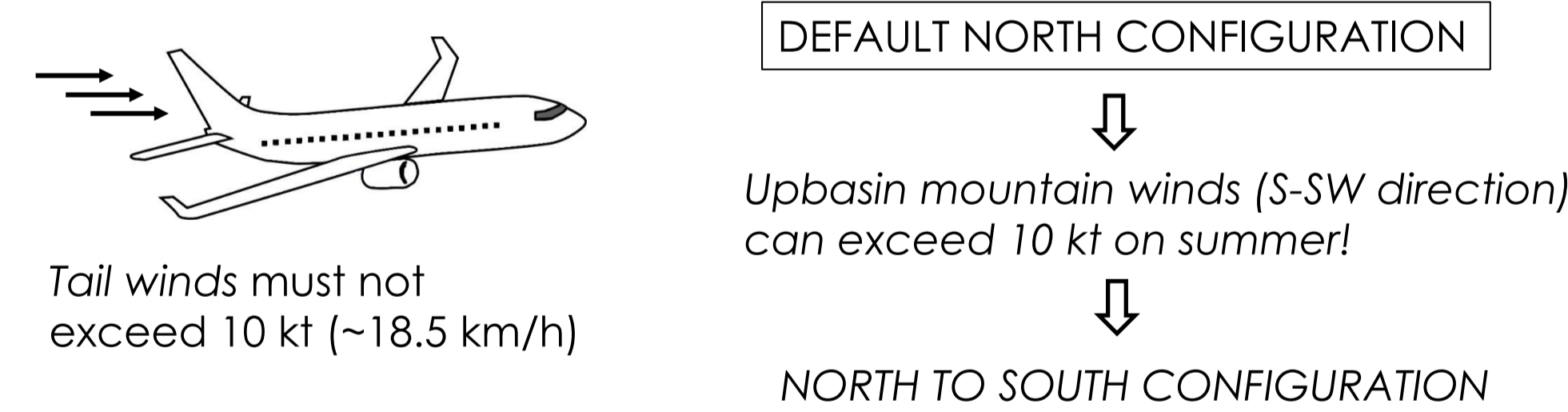
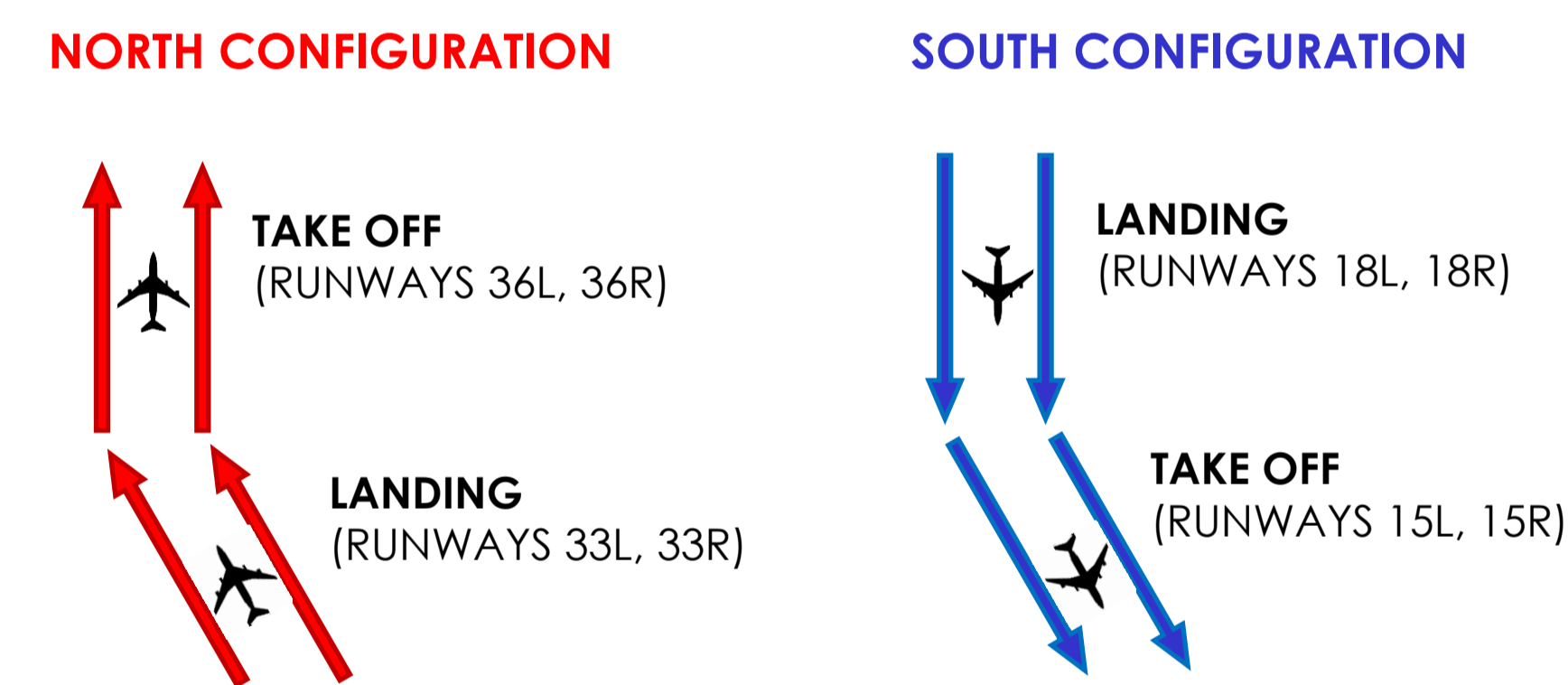


Figure 1. Photography of La Herrería site (a) at the beginning of the summer and (b) at the end of the summer.

(2) THERE WAS AN INCREASE OF FINE-WEATHER DAYS WITH RUNWAY-CONFIGURATION CHANGE (NORTH TO SOUTH) AT THE AIRPORT OF MADRID



DIURNAL MOUNTAIN WINDS DEVELOP UNDER FINE-WEATHER CONDITIONS:
 - LIGHT LARGE-SCALE WINDS (V_{850})
 - NO SYNOPTIC FRONTS (θ_{850} , q_{850})
 - NO PRECIPITATION

Figure 2. Diurnal mountain winds (a) during night-time and (b) daytime. The location of La Herrería and the airport of Madrid are pointed with a red and yellow dot respectively.

MONTH	FINE-WEATHER DAYS	DAYS with CONFIGURATION change / (%)
JUNE	4	3 / 75 %
JULY	18	9 / 50 %
AUGUST	28	17 / 61 %
SEPTEMBER	10	9 / 90 %

Table 1. Number of fine-weather days (absolute and percentage) with a North to South runway configuration change for each month during the analysed summer period [21/06/16 – 13/09/16].

METEOROLOGICAL MEASUREMENTS

(1) HOW DRY WAS THE SOIL?

We calculated the Bowen ratio (β):

$$\beta_{DAY} = \frac{SH_{daily\ mean}}{LH_{daily\ mean}}$$

It represents the ratio between the energy available for heating the air (SH) and evaporating the liquid water (LH).

Drier soil $\rightarrow \beta \uparrow$

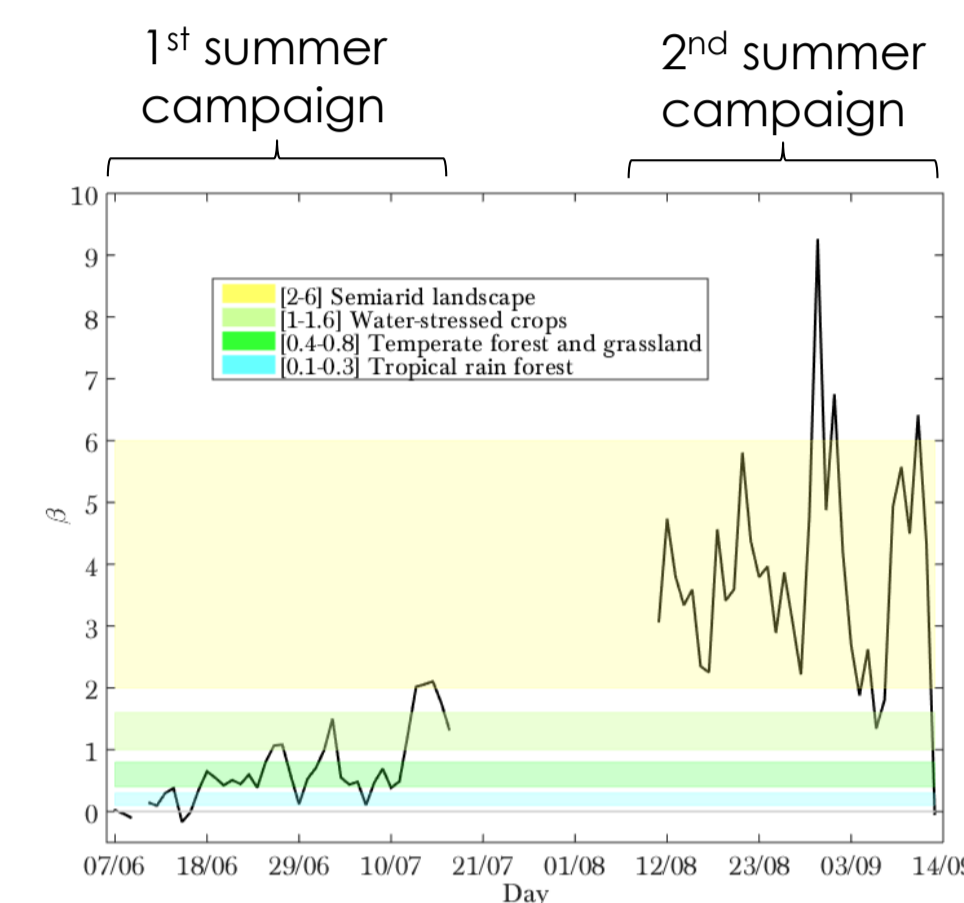


Figure 3. Evolution of the mean daily Bowen ratio over the summer at La Herrería site. We include shaded areas of typical values for different types of soils.

(2) DIURNAL MOUNTAIN WINDS

70% of fine-weather days during the period: (21/06/16 – 13/09/16)

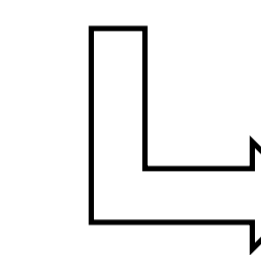
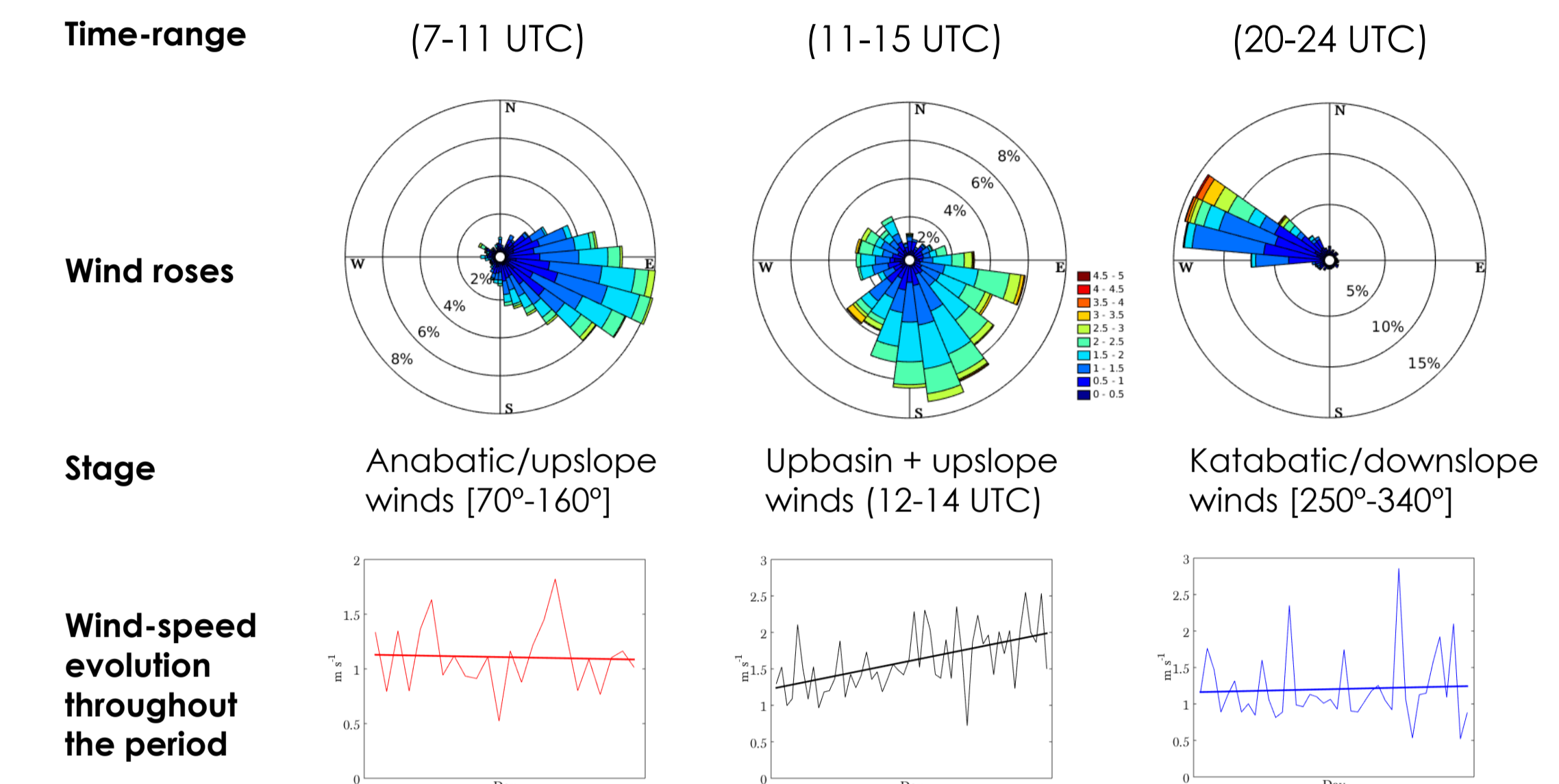
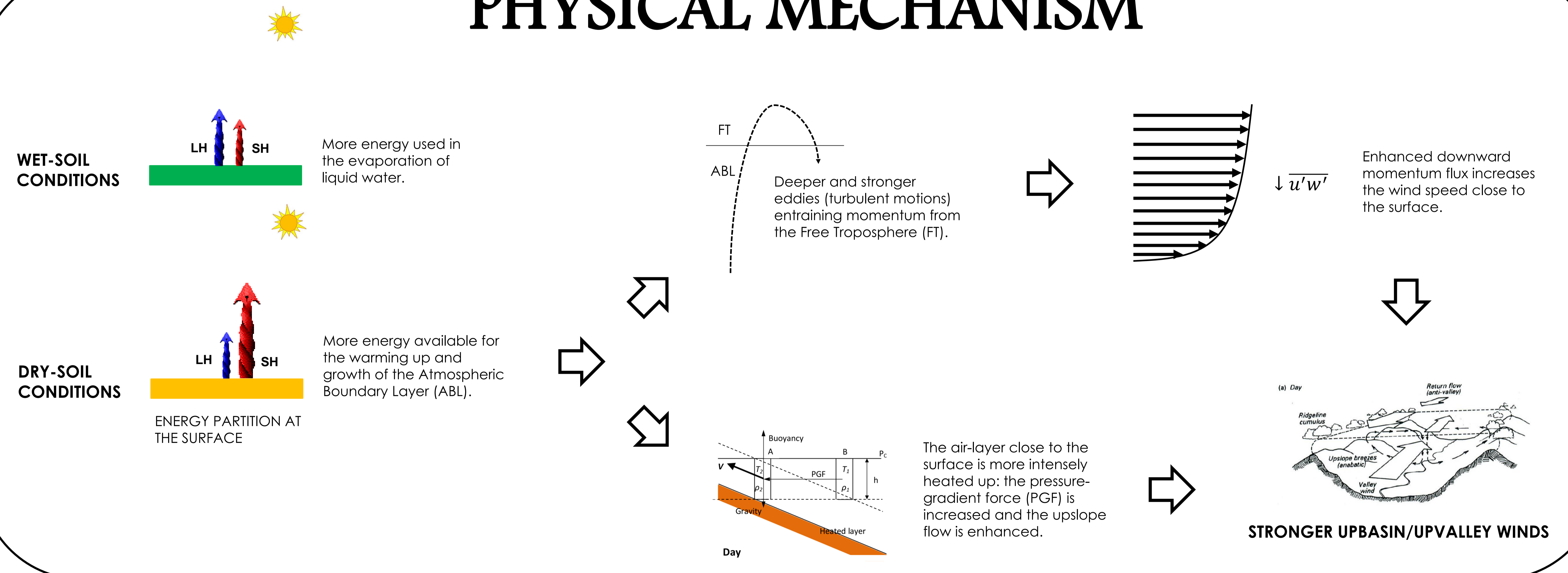


Figure 4. Analysis of the different stages of the diurnal mountain winds.



PHYSICAL MECHANISM



TAKE-HOME IDEAS

- Summer 2016 was characterised by a progressive and severe **drying out** of the soil.
- The intensity of the katabatic and anabatic winds did not vary over the summer, while **upbasin winds** intensified significantly. We suggest that under drier conditions, more energy is available to heat up the lower atmosphere and enhance the downward transport of momentum during daytime.
- The strengthening of the upbasin winds (from the S-SW) resulted in problematic tail winds at the Madrid-Barajas airport, and the **runway configuration** was switched (North to South) more frequently at the end of the summer (i.e. under drier conditions).

CHALLENGING FUTURE PERSPECTIVES



Under the future perspective of the climate change, we may move towards warmer and drier conditions in our region. The 10-kt threshold for the wind could be exceeded more frequently under those conditions, and as a consequence, economic losses and more frequent delays could be expected at the Madrid-Barajas airport.