TENDENCIAS DE LA VELOCIDAD DEL VIENTO EN CANARIAS, 1948-2014

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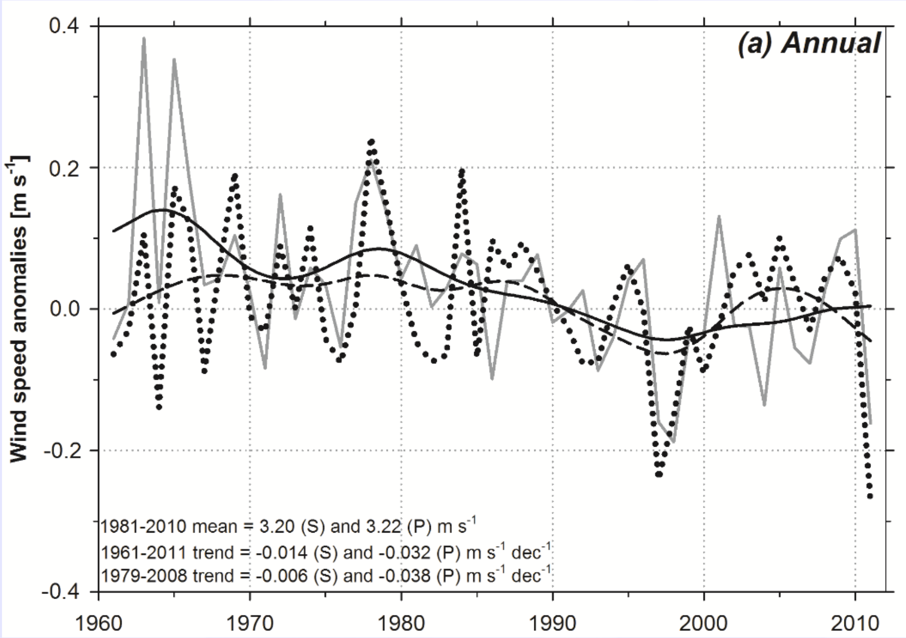
Climate change ≠ global warming

- **La investigación climática sólo ha prestado atención al estudio de la variabilidad decadal del viento en los últimos 20 años, con la mayoría de trabajos centrados en el análisis de tendencias de la temperatura del aire y la precipitación.**

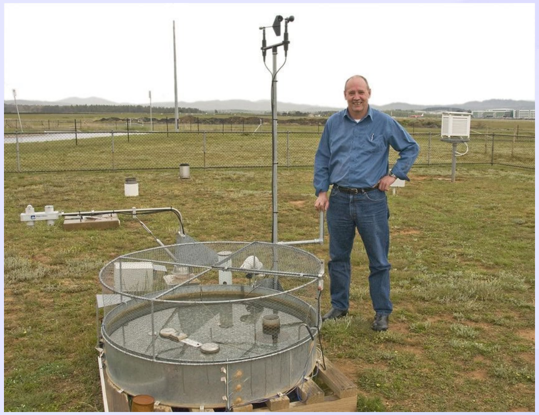


Azorin-Molina et al. 2014
"Homogenization and Assessment of Observed Near-Surface Wind Speed Trends over Spain and Portugal, 1961–2011"
Journal of Climate, 27 (10), 3692-3712.

- **El principal descubrimiento de esta línea de investigación ha sido el descenso observado en la velocidad del viento en las últimas décadas, que recibe el término de "STILLING".**

Definición de "Stilling"

Roderick et al. (2007) propuso el término "STILLING" para referirse a este descenso observado en la velocidad del viento en superficie.



Roderick et al. 2007

"On the attribution of changing pan evaporation"

Geophysical Research Letters, 34, L17403

Australian National University

NATURAM PRIMUM COGNOSCERE RERUM

McVicar et al. (2012) cuantificó este descenso de la velocidad del viento en -0.140 metros por segundo por década (m s^{-1} dec^{-1}) en promedio sobre superficies continentales de latitudes medias en los últimos 30-50 años.

CSIRO

McVicar et al. 2012

"Global review and synthesis of trends in observed terrestrial near-surface wind speeds: Implications for evaporation""

Journal of Hydrology, 416-417, 182-205

Menendez *et al.* 2014. *Clim. Dyn.* 42, 1857-1872.

Clim Dyn (2014) 42:1857–1872
DOI 10.1007/s00382-013-1912-8

High-resolution sea wind hindcasts over the Mediterranean area

M. Menendez · M. García-Díez · L. Fita ·
J. Fernández · F. J. Méndez · J. M. Gutiérrez

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Abstract The goal of this study is to develop a high-resolution atmospheric hindcast over the Mediterranean area using the WRF-ARW model, focusing on offshore surface wind fields. In order to choose the most adequate model configuration, the study provides details on the calibration of the experimental saet-up through a sensitivity test considering the October–December 2001 period (the 2001 super-storm event in the West Mediterranean). A daily forecast outperforms the spectral technique of previous products and the boundary data from ERA-Interim reanalysis produces the most accurate estimates in terms of wind variability and hour-to-hour correspondence. According to the sensitivity test, two data sets of wind hindcast are produced: the SeaWind I (30-km horizontal resolution for a period of 60 years) and the SeaWind II (15-km horizontal resolution for 20 years). The validation of the resulting surface winds is undertaken considering two offshore observational datasets. On the one hand, hourly surface buoy stations are used to validate wind time series at specific locations; on the other hand, wind altimeter satellite observations are considered for spatial validation in the whole Mediterranean Sea. The results obtained from this validation process show a very good agreement with observations for the southern Europe region. Finally, SeaWind I and II are used to characterize offshore wind fields in the Mediterranean Sea. The statistical structure of sea surface wind is analyzed and the agreement with Weibull probability distribution is discussed. In addition, wind persistence and extreme wind speed (50 year return period) are characterized and relevant areas of wind power generation are described by estimating wind energy quantities.

Keywords Dynamical downscaling · Multiphysics · Hindcast · Offshore surface wind · WRF

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1 Introduction

Ocean surface wind plays a key role in a wide variety of phenomena that have an important effect on the climate all over the world. Changes in air masses, humidity fluxes from sea surface evaporation, storm surges, or the waves, are examples of phenomena in which wind is the main driver. Offshore wind is also a key factor for many socio-economic sectors, including renewable energy and, in particular, offshore wind farms, a sector of growing technical and commercial relevance in the last decade. Wind-induced storm surge and waves are key elements in the determination of coastal risks in the Mediterranean Sea (Marcos et al. 2009). The hydrodynamic modeling of waves and sea level extreme events is highly dependent on the quality of the forcings (Weisse et al. 2012; Sanchez-Vidal et al. 2012). Therefore, a high resolution dynamic downscaling of offshore wind fields is essential for the estimation of storm oceanic events.

Consequently, in recent years there has been an increasing interest in gathering homogeneous offshore wind datasets with high spatial and temporal resolution.

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Azorin-Molina *et al.* 2018. *Clim. Dyn.* 50, 4061-408.

Clim Dyn
DOI 10.1007/s00382-017-3861-0

CrossMark

Wind speed variability over the Canary Islands, 1948–2014: focusing on trend differences at the land–ocean interface and below–above the trade-wind inversion layer

Cesar Azorin-Molina[1] · Melisa Menendez[2] · Tim R. McVicar[3,4] · Adrian Acevedo[2] · Sergio M. Vicente-Serrano[5] · Emilio Cuevas[6] · Lorenzo Minola[1] · Deliang Chen[1]

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Abstract This study simultaneously examines wind speed trends at the land–ocean interface, and below–above the trade-wind inversion layer in the Canary Islands and the surrounding Eastern North Atlantic Ocean: a key region for quantifying the variability of trade-winds and its response to large-scale atmospheric circulation changes. Two homogenized data sources are used: (1) observed wind speed from nine land-based stations (1981–2014), including one mountain weather station (Izaña) located above the trade-wind inversion layer; and (2) simulated wind speed from two atmospheric hindcasts over ocean (i.e., SeaWind I at 30 km for 1948–2014; and SeaWind II at 15 km for 1989–2014). The results revealed a widespread significant negative trend of trade-winds over ocean for 1948–2014, whereas no significant trends were detected for 1989–2014. For this recent period wind speed over land and ocean displayed the same multi-decadal variability and a distinct seasonal trend pattern with a strengthening (late spring and summer; significant in May and August) and weakening (winter–spring–autumn; significant in April and September) of trade-winds. Above the inversion layer at Izaña, we found a predominance of significant positive trends, indicating a decoupled variability and opposite wind speed trends when compared to those reported in boundary layer. The analysis of the Trade Wind Index (TWI), the North Atlantic Oscillation Index (NAOI) and the Eastern Atlantic Index (EAI) demonstrated significant correlations with the wind speed variability, revealing that the correlation patterns of the three indices showed a spatio-temporal complementarity in shaping wind speed trends across the Eastern North Atlantic.

Keywords Wind speed · Trade-winds · Trends · Land–ocean · Inversion-layer · Atmospheric circulation · Canary Islands

Electronic supplementary material The online version of this article (doi:10.1007/s00382-017-3861-0) contains supplementary material, which is available to authorized users.

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1 Introduction

Global terrestrial near-surface (~10-m height) wind speed exhibited an average decline of −0.140 meters per second per decade ($m\ s^{-1}\ dec^{-1}$) over the past 50-years (McVicar et al. 2012). This "stilling" (Roderick et al. 2007) has been attributed to various causes; see Azorin-Molina et al. (2014, 2016) and McVicar et al. (2012), and the relevant references therein. The identification of the exact cause(s) is still unresolved. Global terrestrial stilling is not ubiquitous (McVicar et al. 2012), as positive trends are reported for coastal (Pinard 2007), high-latitudes (i.e., >70°; McVicar et al. 2012; Minola et al. 2016), or the last

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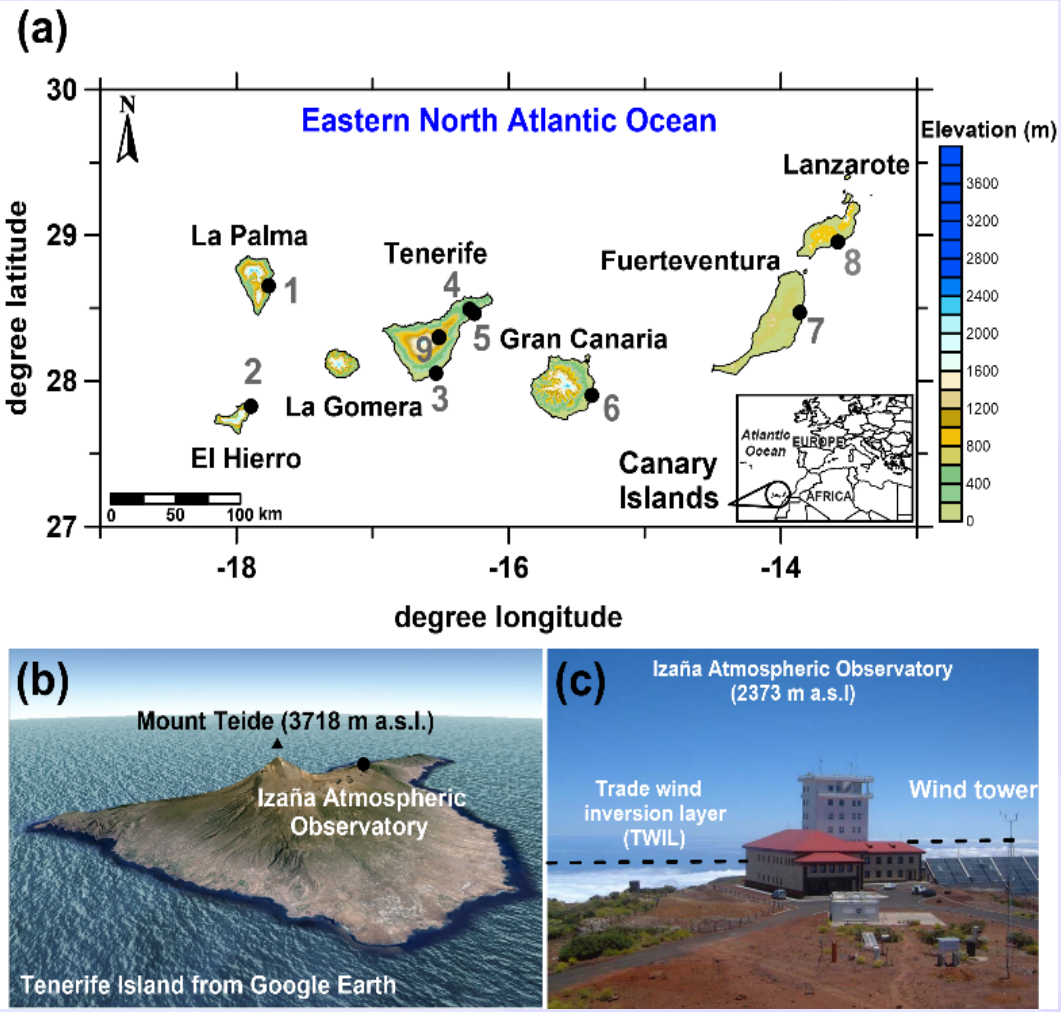
¿Por qué el archipiélago canario?



Emplazamiento singular en el Atlántico para el estudio:

(i) Dominio de la circulación del **ALISIO – ALTA AZORES.**

(ii) Observaciones y simulaciones climáticas del viento en la capa límite: **INTERFASE TIERRA-OCÉANO.**

(iii) Observaciones por encima de la inversión del alisio (troposfera libre; viento del NO): **IZAÑA.**

Datos homogeneizados / validados

Observaciones en tierra

(i) 8 estaciones de baja altitud.

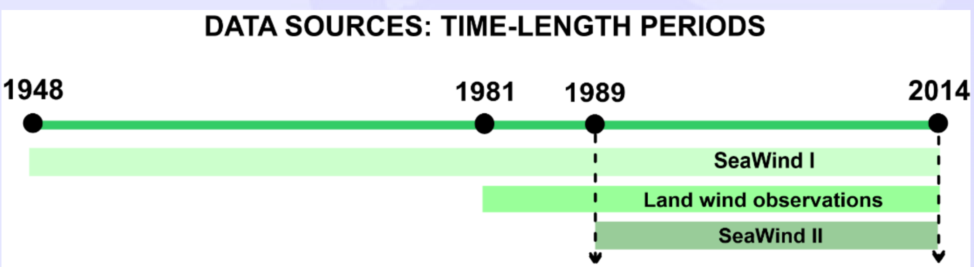
(ii) 1 estación de montaña: Izaña.

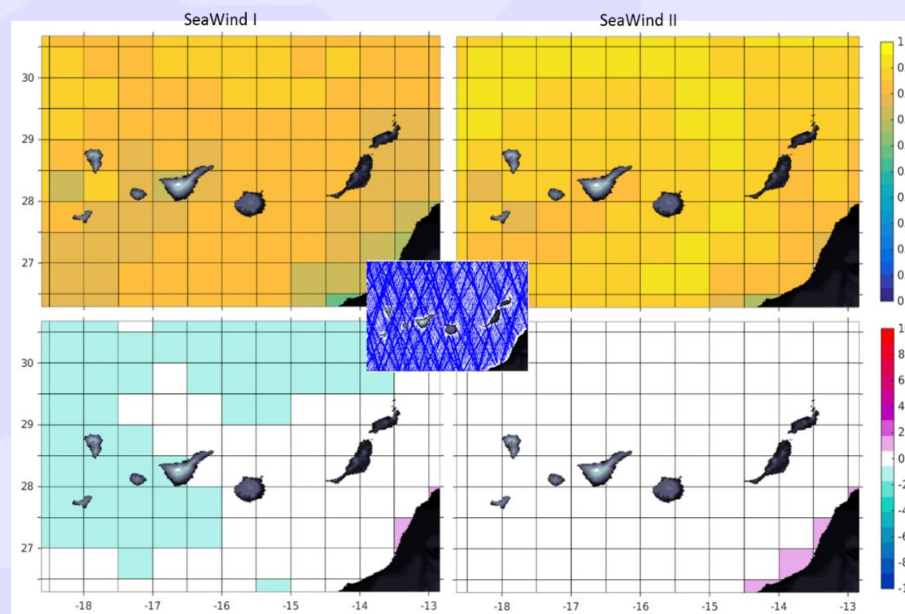
(iii) 1981-2014

Simulaciones sobre océano -WRF

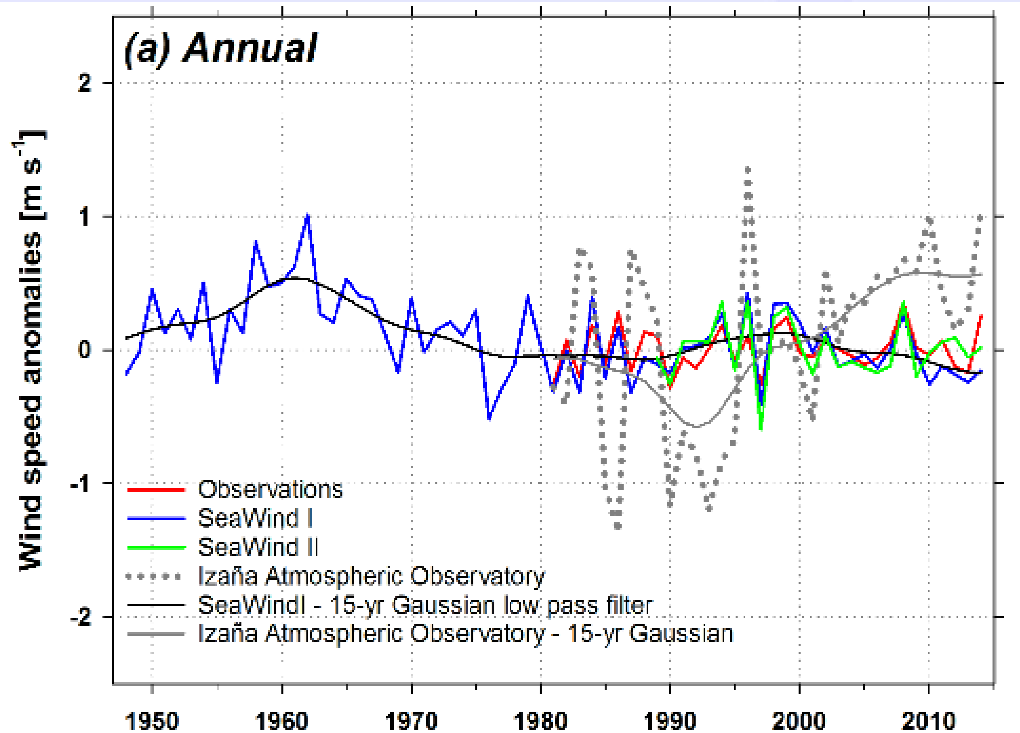
(i) SeaWind I, 30-km, NCEP/NCAR, 1948-2014.

(ii) SeaWind II, 15-km, ERA-Interim, 1989-2014.





Tendencia anual



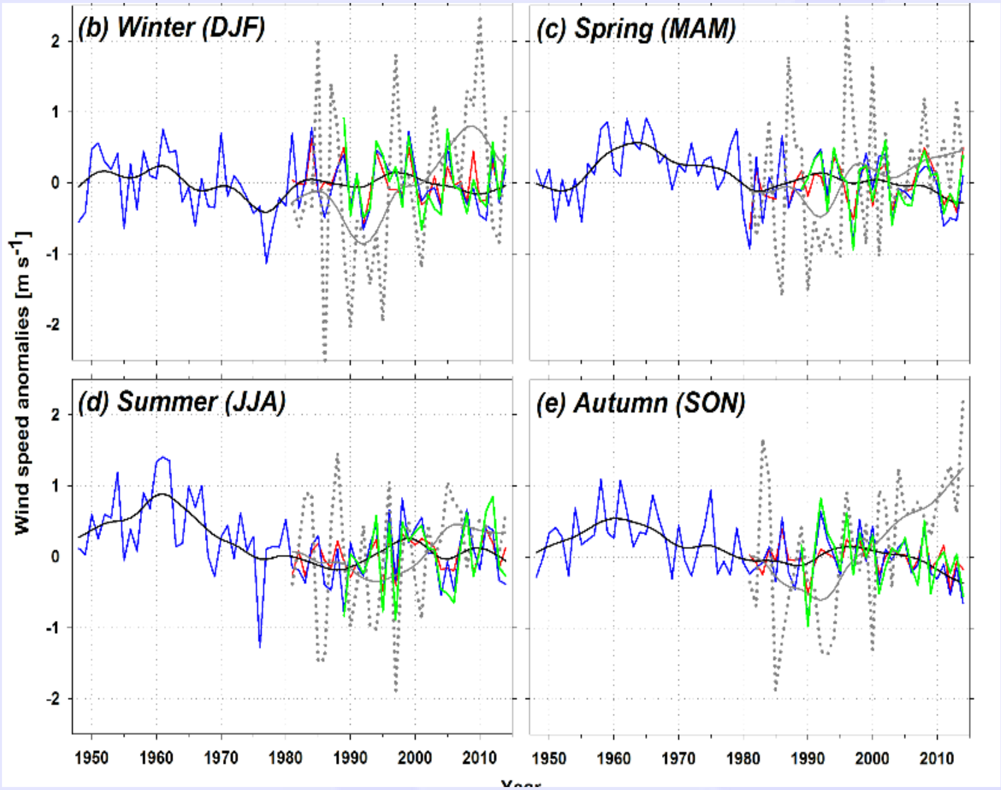
(i) **Descenso significativo sobre el océano en SWI, en ambos periodos. *Sesgado(¿?).**

(ii) **Tendencias no significativas y misma variabilidad decadal en la interfase océano-tierra (*r* 0.7-0.9; *p*<0.05). *Calidad de los datos.**

(iii) **Ascenso significativo en Izaña, con tendencias opuestas comparadas con la capa límite.**

Periodo	SW I 1948-2014	Obs. 1981-2014	Izaña 1981-2014	SW I 1989-2014	SW II 1989-2014	Obs. 1989-2014	Izaña 1989-2014
Anual	(-0.064)	+0.023	(+0.316)	-0.077	-0.008	+0.032	(+0.587)

Tendencia estacional



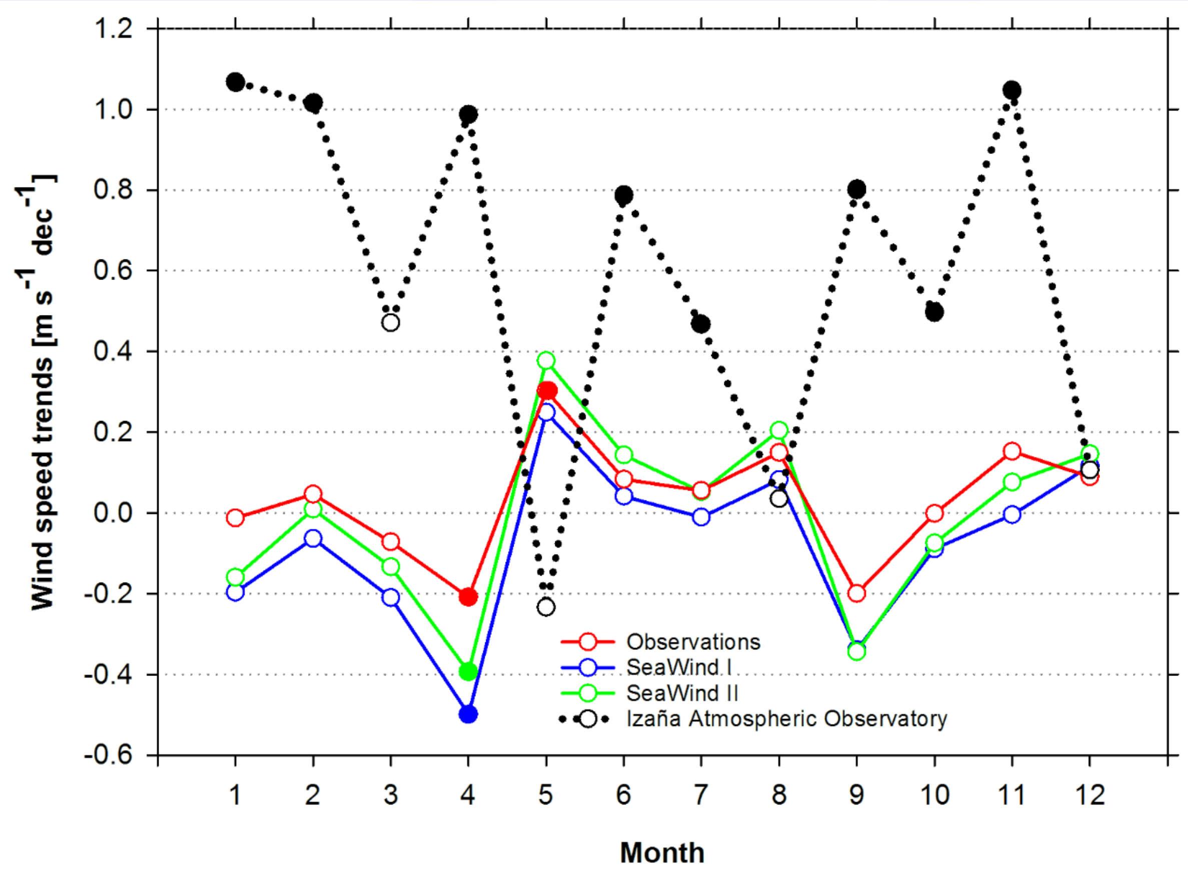
(i) **Descenso significativo en otoño y primavera, y en menor grado en invierno** en SWI y SWII, no significativo en las observaciones.

(ii) **Reforzamiento no significativo en verano** (y final de primavera: Mayo y Agosto).

(iii) **Ascensos significativos en Izaña;** tendencias opuestas respecto a la capa límite.

Periodo	SW I 1948-2014	Obs. 1981-2014	Izaña 1981-2014	SW I 1989-2014	SW II 1989-2014	Obs. 1989-2014	Izaña 1989-2014
Invierno	-0.016	-0.020	**+0.366**	-0.086	-0.047	+0.019	**(+0.784)**
Primavera	**(-0.058)**	+0.042	+0.215	**-0.153**	-0.050	+0.007	**(+0.408)**
Verano	**(-0.100)**	+0.067	+0.188	+0.038	+0.133	+0.096	**(+0.430)**
Otoño	**(-0.082)**	-0.014	**(+0.505)**	**(-0.144)**	**-0.114**	-0.016	**(+0.782)**

Tendencia mensual



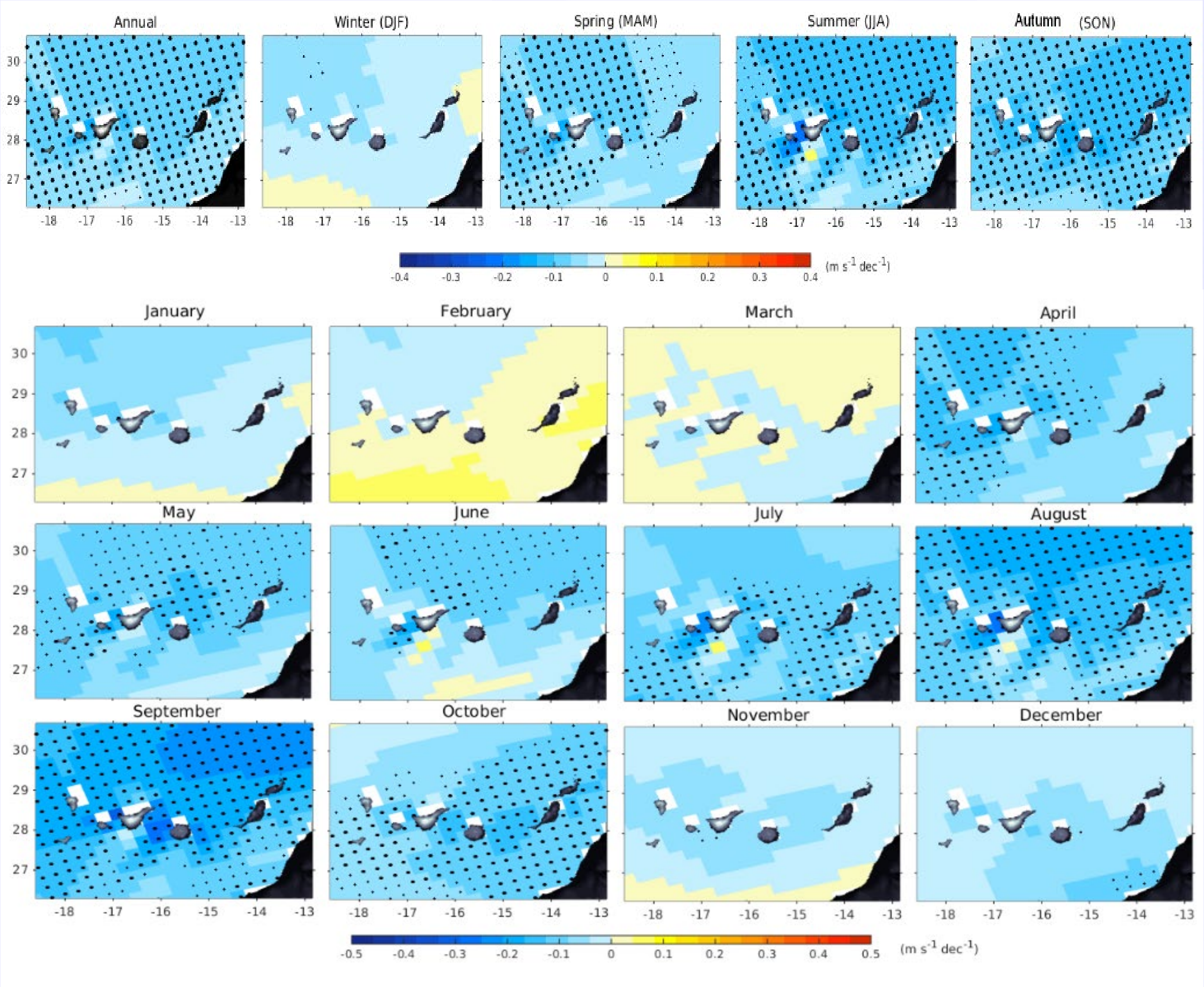
Tendencias opuestas entre Izaña y la capa límite (p.ej. Mayo)

SWI y SWII *r* -0.66 *p*<0.05

Observaciones *r* -0.57 *p*<0.05

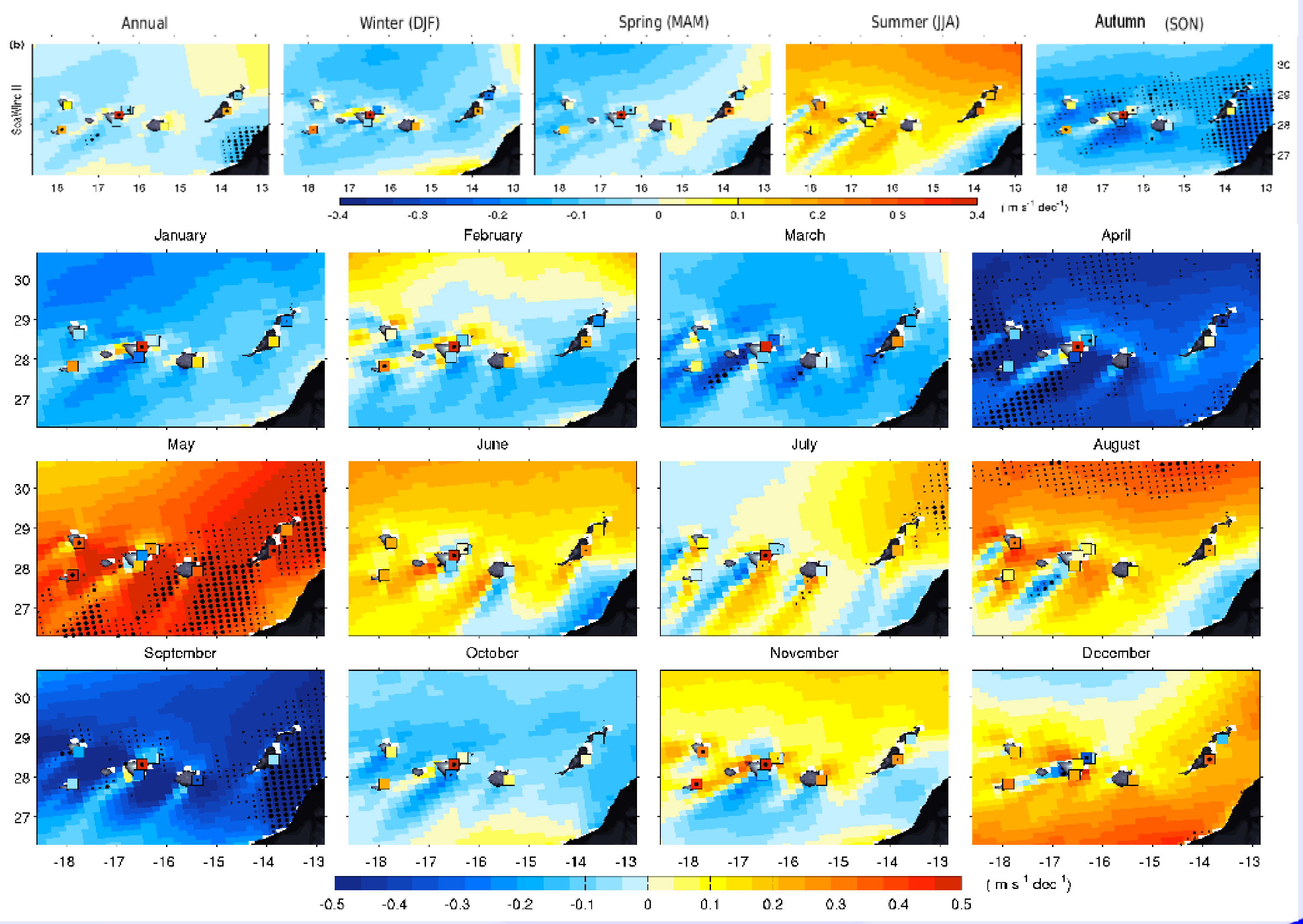
Distribución espacial de las tendencias

SeaWind I, 1948-2014



Distribución espacial de las tendencias

SeaWind II y observaciones, 1989-2014



CONCLUSIONES

(i) **Descenso significativo de la velocidad del viento sobre el océano 1948-2014**.

(ii) No se observan cambios significativos sobre océano-tierra para **1989-2014**, con un patrón estacional: **ascensos a finales de primavera y verano**, **y descensos en invierno-primavera-otoño**.

(iii) **Ascenso significativo de los vientos de la troposfera libre en Izaña**.

TRABAJO FUTURO: Atribuir las causas de este desacoplamiento y tendencias opuestas entre la capa límite y por encima de la inversión del alisio.

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