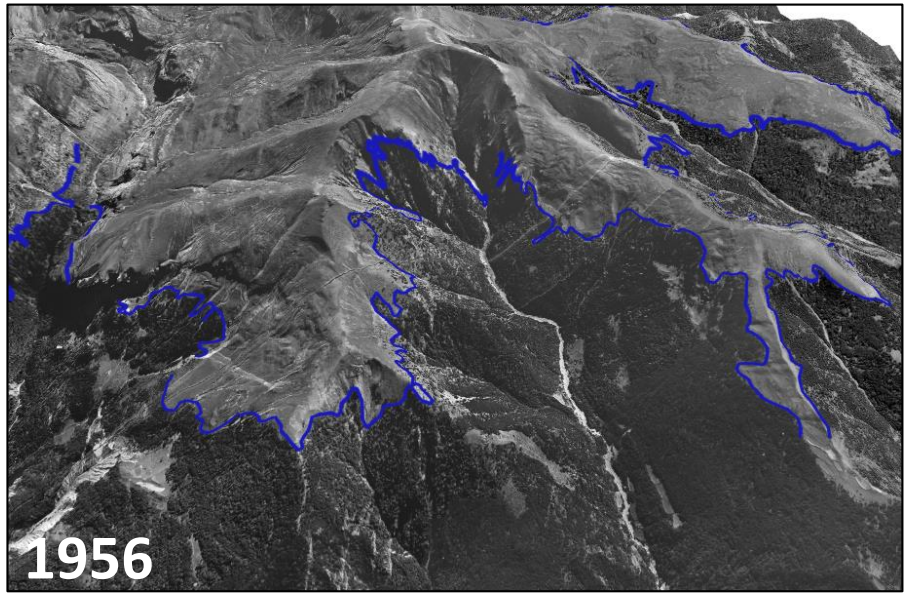
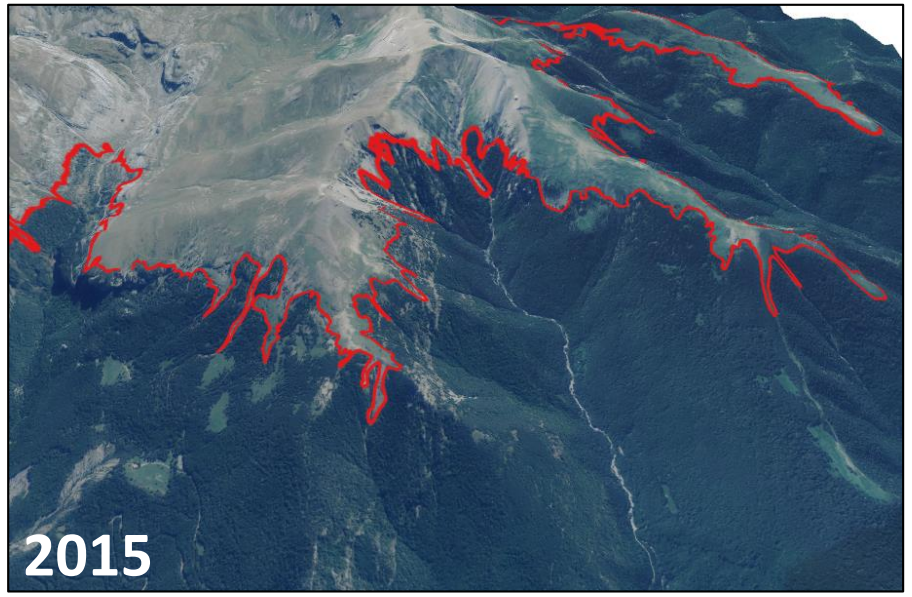
What explains the elevational shifts at the upper treeline ecotone?

Àngela Manrique-Alba & Santiago Beguería





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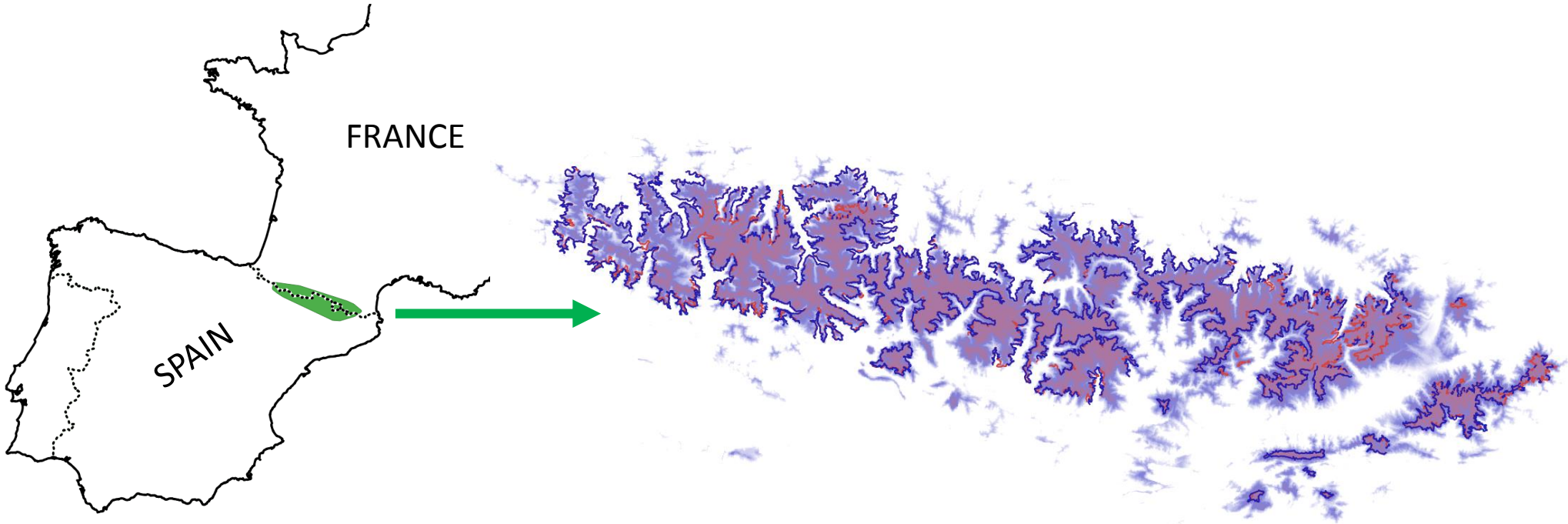
STUDY AREA

The **Pyrenees mountain range** between Spain, Andorra and France, with an area of 5,800 km^2 of territory higher than 1500 m. above the mean sea level.



OBJECTIVES

1. Study the **altitudinal change of the upper treeline** between 1956 and 2015.
2. Assess the effects of climate variables (**irradiance, diurnal heat** and the Normalized-Difference Snow Index, **NDSI**) and physiography: **elevation**, **slope, convexity** and **contributing area** on the treeline dynamics.

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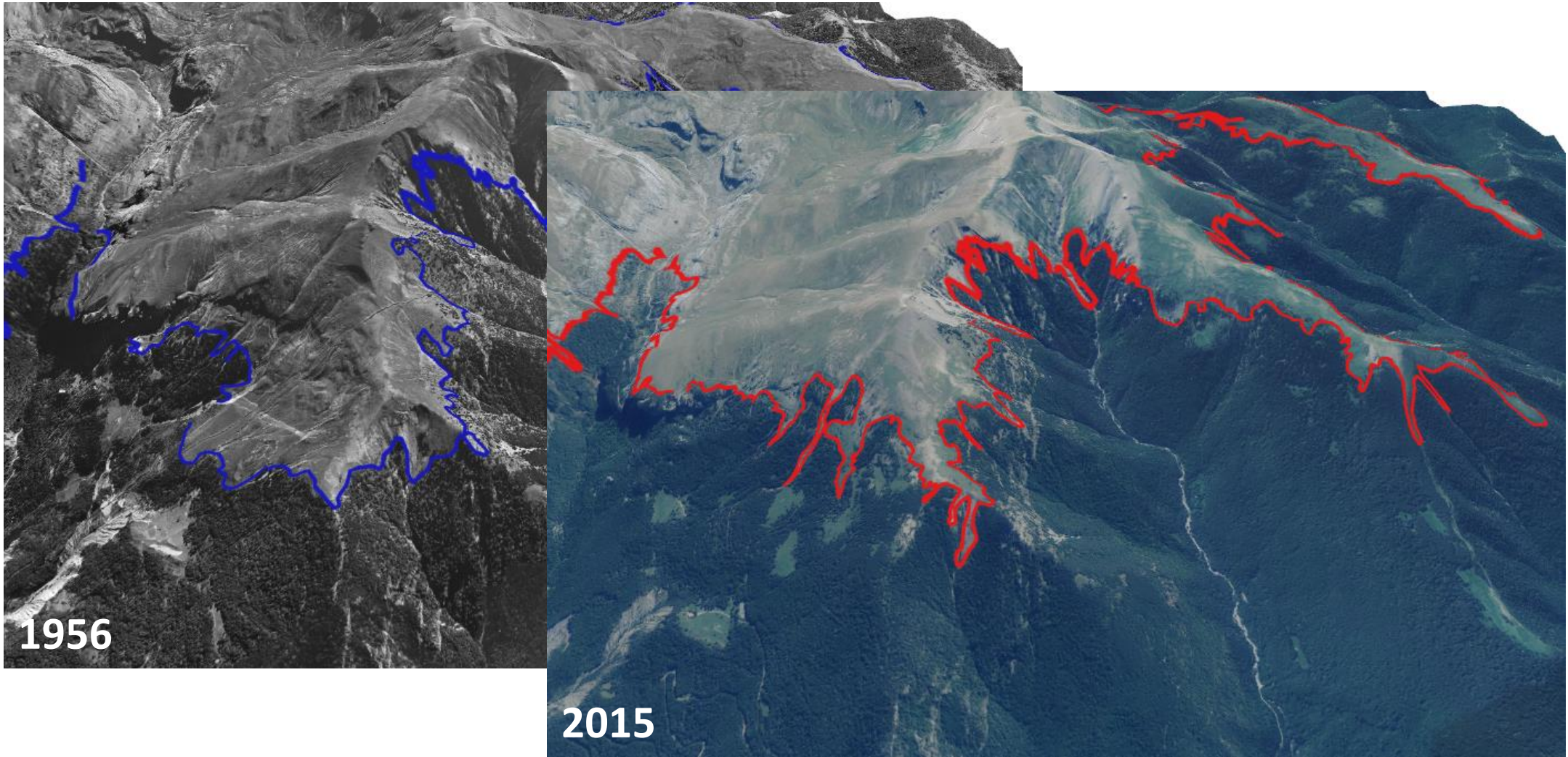
METHODOLOGY (I)

To explore the elevation shift of the tree line we used **pairs of aerial photographs** taken in 1956 and 2015. We identified the position of the tree line using a criterion based on **canopy cover** thresholds **(equal or greater than 10%)**. A total of **12,844 km** of tree line were identified and mapped.



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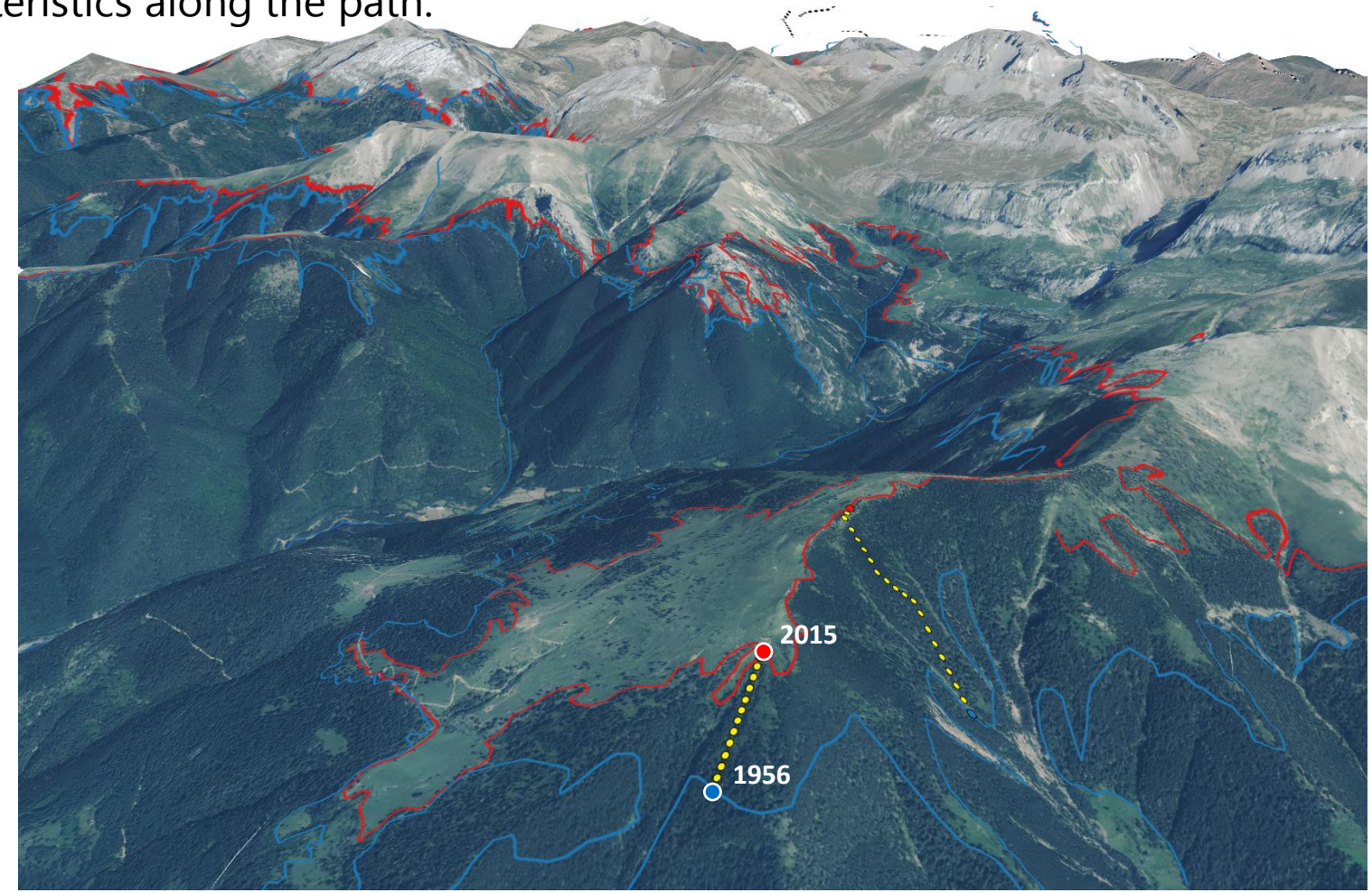
METHODOLOGY (II)

A path analysis was then performed on more than **3000 points** along the 2015 treeline, following the **trajectory of maximum gradient** using a digital elevation model with 20x20 m spatial resolution. The altitudinal difference between the 1956 and 2015 points was recorded, as well as several climatic and morphologic characteristics along the path.



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RESULTS (I)

The mean elevation shift was of **69.16 m**, and ranged between 14.81 (Q1) and 92.17 (Q3) m. Differences between 1956 and 2015 existed in slope gradient, convexity, catchment area, topographic position index (tpi), topographic wetness index (twi), potential irradiance and innivation (NDSI Landsat).

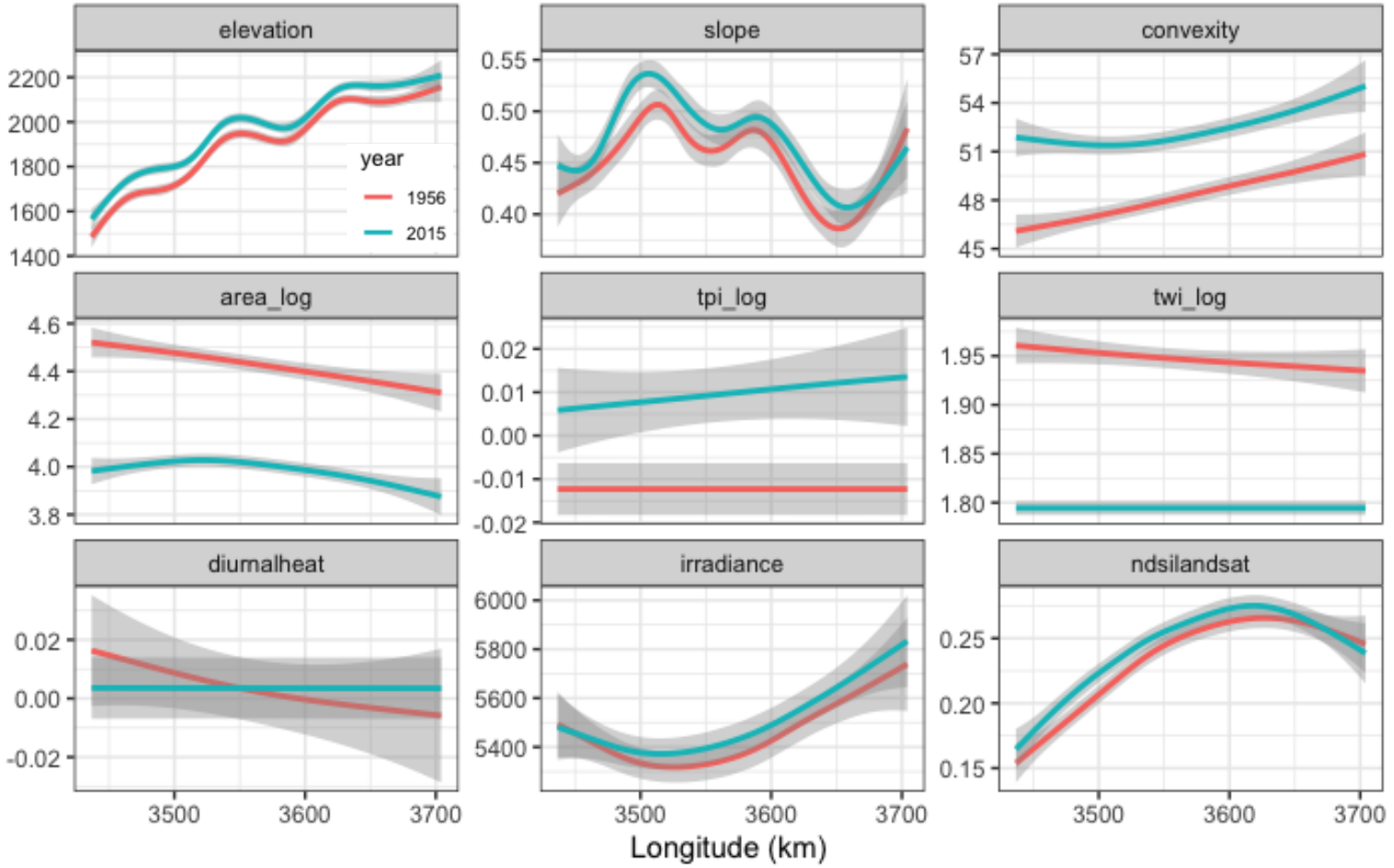

Figure: Main characteristics of 1956 and 2015 points from path analysis.

RESULTS (II)

The starting elevation in 1956 was the main variable explaining the magnitude of the treeline ascent, with other physiographic variables showing also significant (non-linear) relationships: slope, convexity, catchment area and TWI. Climate variables (diurnal heat, potential irradiance, innivation) did not show a relationship.

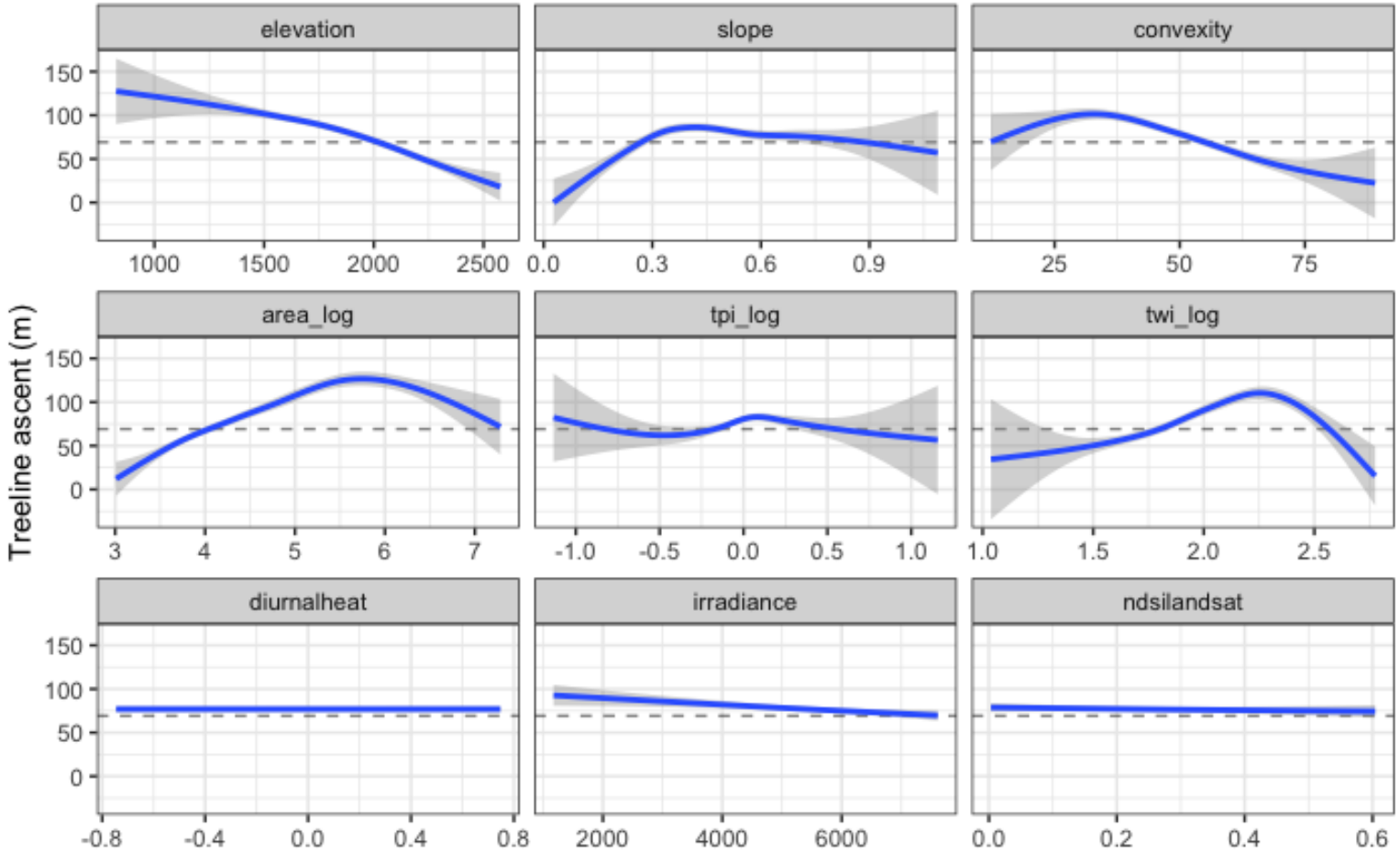

Figure: Bi-variate relationships between treeline ascent and climatic and physiographical variables.

The authors would like to thank the EU, the *Ministerio de Economía, Industria y Competitividad* of Spain, the *Research Promotion Foundation* of Cyprus, the *Agence Nationale de la Recherche* and the *Office National de l'Eau et des Milieux Aquatiques* of France, the *Ministry for Education, University and Research* of Italy, the *Center of International Projects* of Moldova, and the *Foundation for Science and Technology* of Portugal for funding, in the frame of the collaborative international consortium INNOMED financed under the ERA-NET WaterWorks2015 Cofunded Call. This ERA-NET is an integral part of the 2016 Joint Activities developed by the Water Challenges for a Changing World Joint Programme Initiative (Water JPI) as a result of a joint collaborative effort with the Joint Programming Initiative on Agriculture, Food Security and Climate Change (FACCE JPI).

✉a.manrique@eead.csic.es

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