

## Migrating bats cross top of Europe

Bats have evolved migration to escape unfavourable climatic conditions. However, their migratory flyways and the way how they surmount geographical barriers are still unknown. The Jungfrauoch in the Swiss Alps is a mountain covered in permafrost (3460m ASL), known colloquially as the “Top of Europe”. Using broadband ultrasound recorders, we tested the occurrence of bats at the high altitude research station. In 36 nights, we recorded 268 bat call sequences of 8 species, including all European long-distance migrant bats. Since no feeding buzzes were recorded, we assume the bats were on transit. This is the first evidence to show that migrating bats can fly at unprecedented altitudes to cross the Alps. This feat outperforms the spectacular behaviour of the high altitude foraging bat *Tadarida brasiliensis*. Our findings shed light on the bats’ migratory flyways and demonstrate that the field of aeroecology can still uncover unexpected perspectives on the behaviour of bats.

# 1 Migrating bats cross Top of Europe

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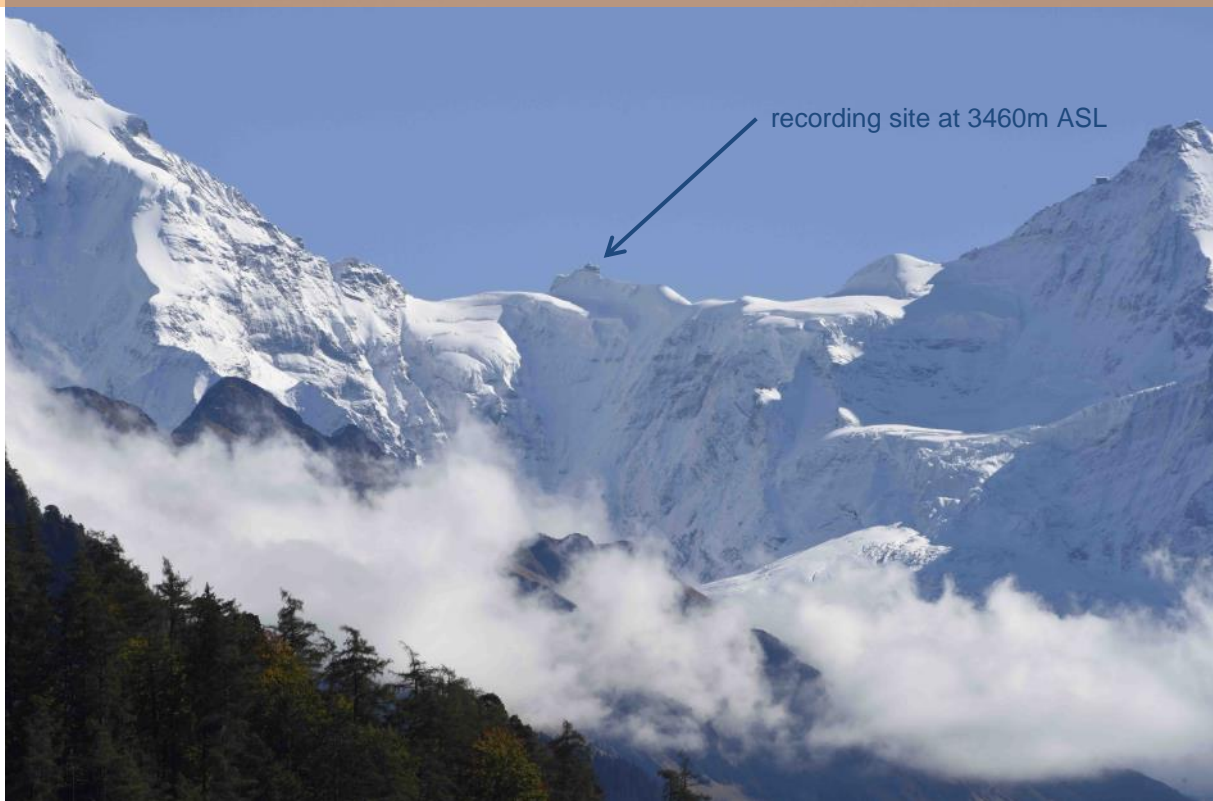
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17 Seasonal migration is essential to escape unfavourable climatic conditions and to access better food  
18 resources (Popa-Lisseanu & Voigt, 2009). Bats normally survive cold climatic conditions by hibernation,  
19 however from northern latitudes they have evolved migration over thousands of kilometres to escape  
20 winter mortality (Humphries et al., 2002, Giavi et al., 2014). Although long-distance migration is known in  
21 multiple bat species across the continents, their migratory flyways are still unknown. Large numbers of bats  
22 cross the Baltic Sea or aggregate at mountain edges (Ahlén et al., 2009, Bontadina et al., 2014), however, it  
23 remains unknown if bats can surmount high mountain peaks.

24 The Jungfrauoch in the Swiss Alps is a mountain covered in permafrost (3460m ASL, polar tundra climate,  
25 Fig. 1), known colloquially as the "Top of Europe". Using broadband ultrasound recorders (Batlogger, Elekon),  
26 we tested the occurrence of migrating bats at the high altitude research station. Over a period of 36 nights  
27 in Spring and Autumn 2011, we recorded 268 bat call sequences of 8 species, including the long-distance  
28 migrant bats *Nyctalus noctula*, *N. leisleri*, *Vespertilio murinus*, *Pipistrellus nathusii* and the tiniest European bat *P.*  
29 *pygmaeus*, weighing only 5g. During a single night in October, 147 bats were recorded. Bats were flying at  
30 temperatures down to -4.3 °C and in wind speeds of up to 11m/s to maximize the benefit of tailwinds.  
31 Since feeding buzzes were never recorded, we assume the bats were on transit.

32 This is the first evidence to show that migrating bats can fly at unprecedented altitudes to cross  
33 geographical barriers such as the Alps. This feat outperforms the spectacular behaviour of *Tadarida*  
34 *brasiliensis*, a bat detected at altitudes of 3000m AGL when foraging (Williams et al., 1973). Our findings  
35 shed light on the bats' migratory flyways and demonstrate that the field of aeroecology can still uncover  
36 unexpected perspectives on the behaviour of bats. Furthermore, impacts on migrating bats must be  
37 considered when developing wind energy sites at high altitudes.



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39 Fig. 1. Location of the High Altitude Research Station Jungfraujoch in the Swiss Alps where bat migration

40 was recorded (photo Peter E Zingg)

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