Analysis of weather radar data in the context of bird migration

STSM-2016 Cost Action ES1305-European Network for the Radar surveillance of Animal Movement (ENRAM)

Nadja Weisshaupt
Aranzadi - Society of Sciences, San Sebastian, Spain
University of the Basque Country, Spain

Hosted by

Dr. Adriaan Dokter, Dr. Judy Shamoun-Baranes
Institute of Biodiversity and Ecosystem Dynamics
University of Amsterdam, Netherlands

STSM

This STSM was proposed to complement the analysis of wind profiler and thermal imaging data, which is part of the PhD project of Nadja Weisshaupt at Aranzadi - Society of Sciences, Spain. The PhD was initiated in September 2013 and will last three years. It is a joint project of biologists from Aranzadi - Society of Sciences and engineers from Euskalmet – Basque agency for meteorology/University of the Basque Country. It aims at characterizing the migration phenology of birds passing the Bay of Biscay on their journey between Central/Northern Europe and the Iberian Peninsula. The assessment of the significance of the Bay of Biscay as a geographical barrier for migrating landbirds is important from an ecological and evolutionary point of view and regarding the conservation of Basque coastal ecosystems as stopover sites.

The STSM analysis was conducted at the Institute of Biodiversity and Ecosystem Dynamics at the University of Amsterdam from 15-19 February 2016.

The aim of this STSM was further explore by means of weather radar data whether or not migratory birds cross the Bay of Biscay in spring and, if they do so, to investigate potential geographical patterns (e.g. West-East or North-South gradients). This STSM should complement previously obtained vertical data (wind profiler radar and thermal-imaging) on bird migration from the Basque coast (Spain) with horizontal information from C-band weather radars along the Spanish and French coasts of the Bay of Biscay.

Methodology

Input data & study period

Overall data of seven weather radars were included: four French C-band weather radars (Plabennec, Treillères, Bordeaux, Momuy) and three Spanish C-band weather radars (Oviedo and Jata from the Spanish state meteorological agency, AEMET; and Kapildui from the Basque meteorological agency, Euskalmet), all situated at or in proximity of the coast of the Bay of Biscay (Fig. 1). The Kapildui radar was added to complement the Jata radar, which was undergoing maintenance during two weeks in March 2015, just in the decisive period. An overview over the available data set is provided in Table 1.

The time period selected for all radars was 1 March to 6 April 2015 to coincide with previous field campaigns based on thermal imaging which identified March and first half of April as the months of strongest migration activity in the region. Furthermore, a previous calibration campaign based on vertical radar data and

and thermal imaging had been performed in the same period. Analysing the same period would potentially give us the opportunity to compare and complement the information obtained by different measurement systems.

Data analysis

It was the first time that the bird algorithm developed by Dr. Adriaan Dokter was run on Windows systems and it was first necessary to adapt the settings on the Windows computers to be able to start running the program. Monday and half of Tuesday was needed to fix these incompatibility issues. Eventually, the algorithm was run in Oracle VM VirtualBox to extract the data tables from the ODIM-H5 files and the plots were then created in R. Only radar data in a range of 5-25 km was included in the analysis to avoid issues arising from larger sampling volumes if distances are longer.

Results

Spanish radar data

The AEMET radar data (Oviedo and Jata) has been previously filtered by some special non-precipitative echo removal algorithm and therefore practically no bird migration was visible. In very few plots, there seem to be remaining traces of bird migration at night, but the quality is too low for any analysis derived from the data (Fig. 2). Unfortunately this fact was not known prior to the STSM. A posterior inquiry directed at AEMET to potentially obtain unfiltered data was so far not successful, because it would interfere with the routine operation of the radars and because of lack of personnel.

In data from the Kapildui radar the radial velocity and the dBZ information are stored in separate files by default, so the bird algorithm could not process it either as it is based on files including both radial velocity and dBZ. To solve this problem, a specific preliminary script had to be written for the R package rhdf5 to merge the two data sets. Unfortunately there was no time to run the script and to complete data processing during the STSM week. Analysis will continue after the STSM.

French Radar data

French weather radar data matched the format required for the bird algorithm and provided generally good bird migration plots. No filter had been applied as in the AEMET radars. Some qualitative issues were observed as follows.

A key issue during processing was the relatively low quality of radial velocity data (Fig. 3). There were many dealiasing errors, and certain regions showed folded velocities (perceived as sharp transitions in the velocity field). Owing to the French triple-PRT scanning scheme, the unambiguous Nyquist velocity was very high but nonetheless we encountered folding problems. Especially the high number of dealiasing errors is problematic. It affects the extraction of bird echoes because the algorithm uses the amount of variability in radial velocity data as an indicator of bird migration.

A second issue we encountered were some few highly convective weather situations to which no good linear radial velocity model could be fitted.

Another qualitative aspect linked to radial velocity was due to high bird densities in Bordeaux, Momuy and Treillères. The radars perceive high bird densities as one large object with low radial velocity SD <2. As the selection of targets in the algorithm is based on SD values of ≥2, these high densities are removed by the algorithm. As a consequence the algorithm creates gaps in the altitudinal profiles (Fig. 4 and 5). In order to prevent this, the threshold for radial velocity SD was lowered from 2 to 1.7 for the affected sites. This measure helped fill some, but not all of the gaps and also more precipitation was visualized. So the benefit of lowering the SD to 1.7 remains ambiguous and is probably not recommendable to improve data quality.

And finally, the low elevations with which French radars measure, led to low maximum sampling altitudes of only about 1-1.5 km at 25 km distance. To improve the altitudinal profile, the affected radars (Momuy and Treillères) were set to a distance threshold of 40 km, which allowed completing the profiles upwards (Fig. 6).

Conclusions & outlooks

The STSM enabled the researcher to perform a part of the analysis of weather radar data. The results shown are preliminary and data analysis is still on-going. As the algorithm could only be successfully applied to the French dataset, it remains unsure if the proposed goal to describe bird migration patterns across the Bay of Biscay can be reached, as information from both coasts would be needed. According to the information obtained in the meantime from AEMET, it is not possible to reverse their filtering method to obtain “true” raw data from past periods or make any changes for the future seasons. Any further progress will therefore depend on the results obtained from the Kapildui radar. Furthermore, it remains open if the radius of 25km around each radar will suffice to provide conclusive answers regarding sea crossing because this radius just permits looking over the sea adjacent to the coast or only the coastal terrestrial areas (e.g. in the Momuy and Kapildui radar which are situated more than 25 km from the coast (Kapildui ca. 70 km).

Lastly, even though French data generally yielded better results than the AEMET data, radial velocity data was of low quality which proved to have a negative impact on the extraction of bird migration patterns without any interfering precipitation.

Basically, there is the intention to publish the results in collaboration with the host of this STSM, but it strongly depends on the options available for processing the Spanish data.

Acknowledgements

We extend our gratitude to the hosts of this STSM, Dr. Adriaan Dokter and Dr. Judy Shamoun-Baranes for dedicating their time and sharing their skills during the STSM. Furthermore we thank all the engineers of Euskalment, AEMET, Meteo France and Dr. Günther Haase from SMHI for providing us with the weather radar data.

Tab. 1 Overview over the availability of weather radar data per site (blue: available; white: unavailable).

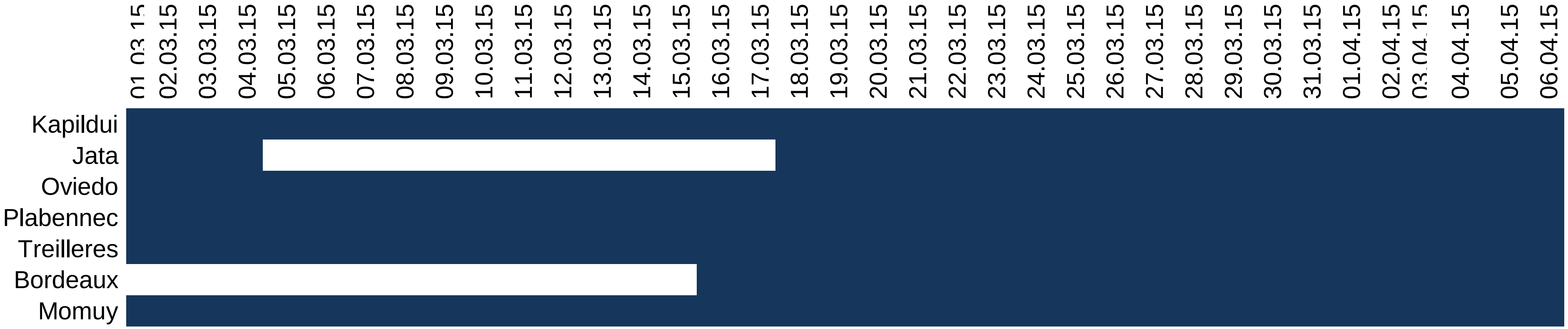


Fig. 1 Weather radar sites included in this STSM (Ov: Oviedo; Ja: Jata; Ka: Kapildui; Mo: Momuy; Bo: Bordeaux; Tr: Treillères; Pl: Plabennec).

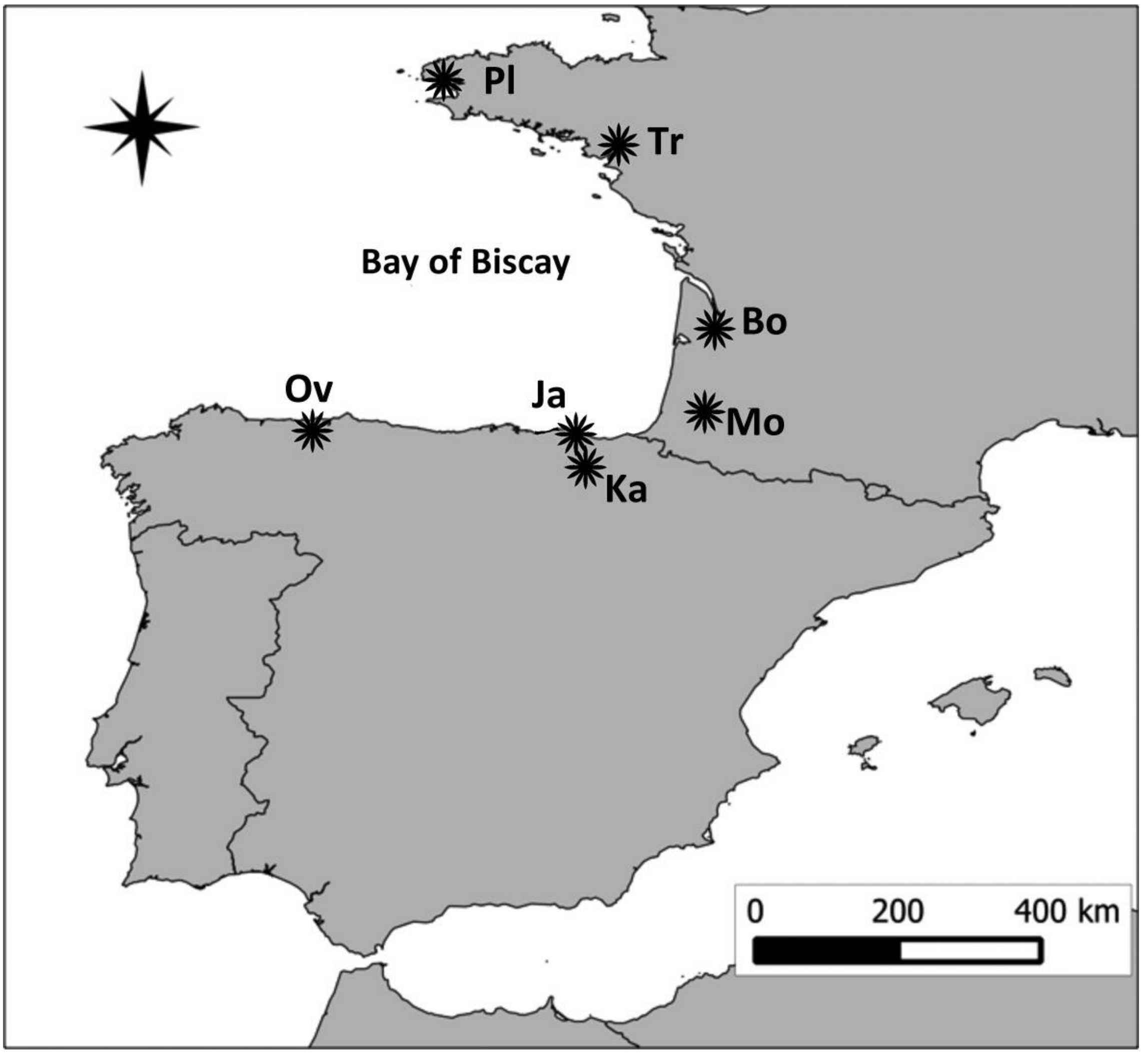


Fig. 2 Time-height plot from the Jata radar (Spain) with applied non-precipitative echo removal algorithm during the period of 23-31 March 2015.

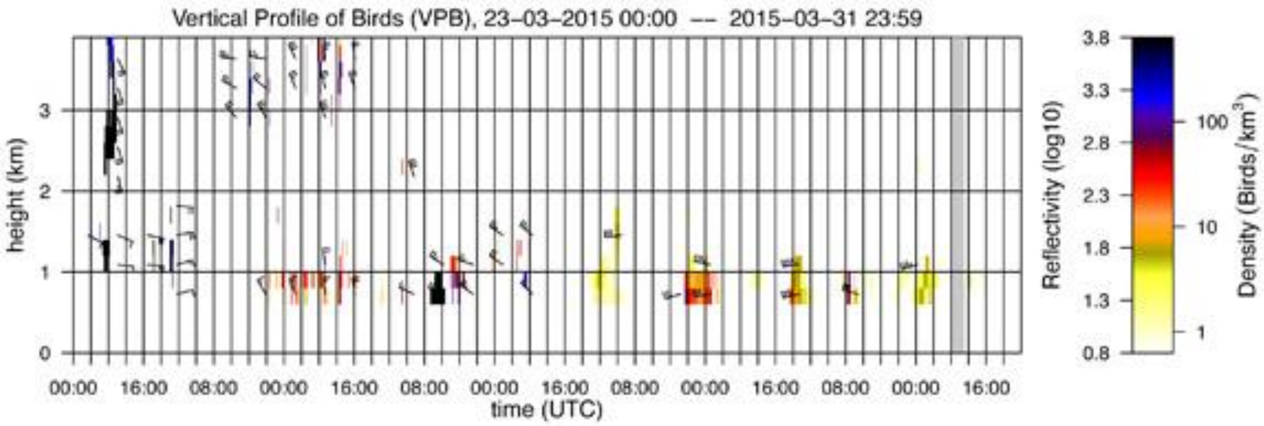
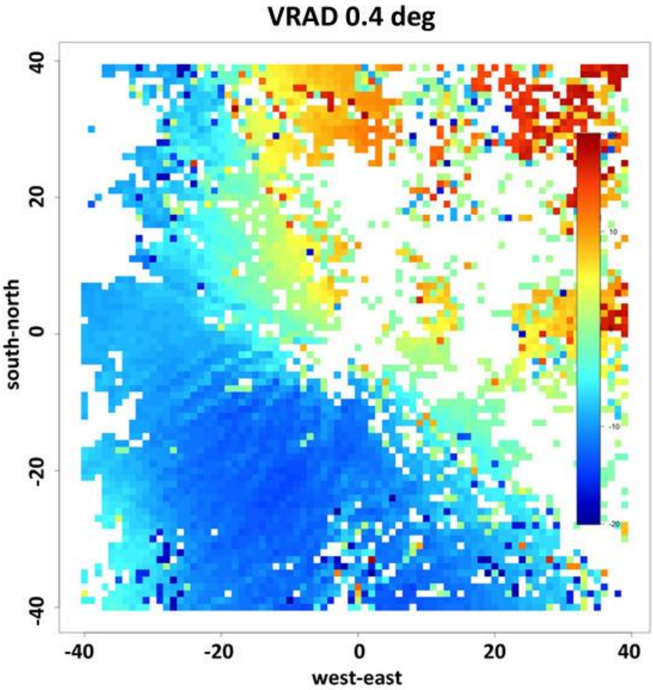


Fig 3. Two examples of precipitation in the Treillères radar which were not filtered out correctly, depicted as radial velocity. (a) from Mar 26, 2015, 10:00 h UTC; and (b) from Mar 29, 2015, 20:00 h UTC.

(a)



(b)

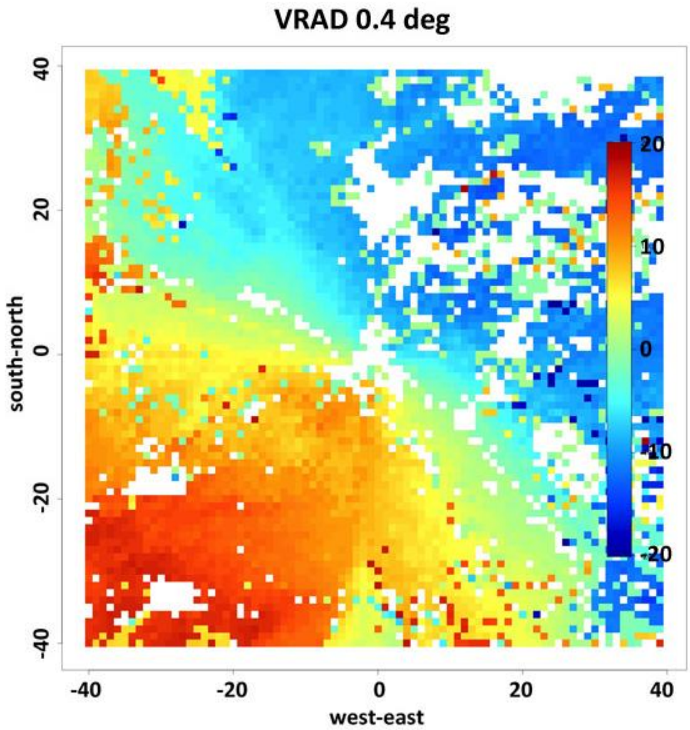


Fig 4. An example of high bird densities in the Bordeaux radar from Mar 16, 2015, 23:45 h UTC, depicted as radial velocity, of which the highest densities were cut out in the time-height profiles by the algorithm.

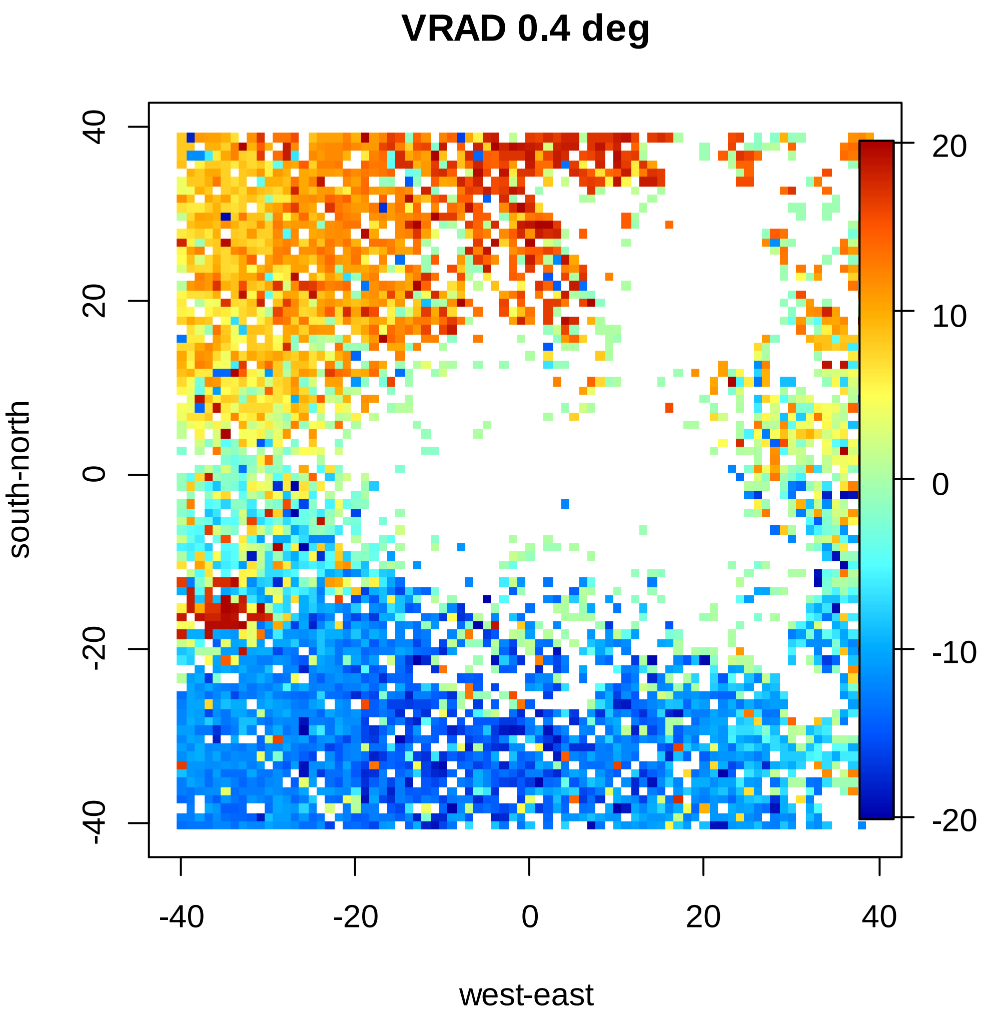
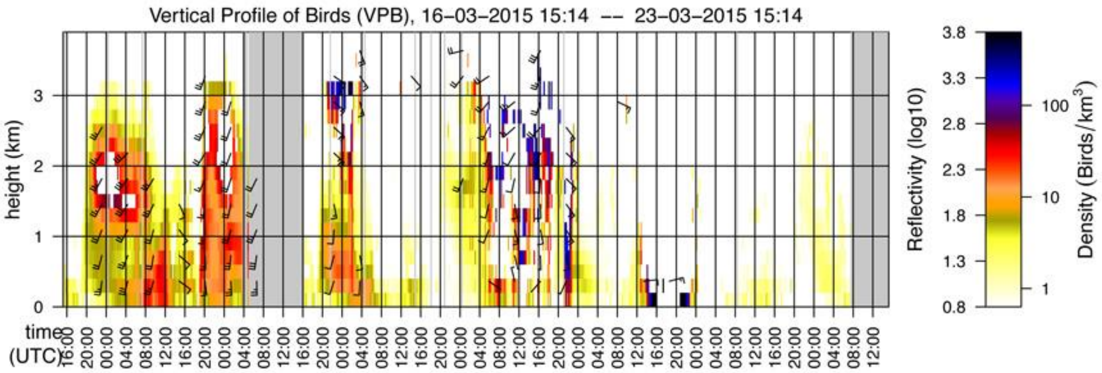


Fig 5. Time-height plots with radial velocity SD = 2 (a) and SD = 1.7 (b) of the radar in Bordeaux (France) after processing by the bird algorithm.

a)



b)

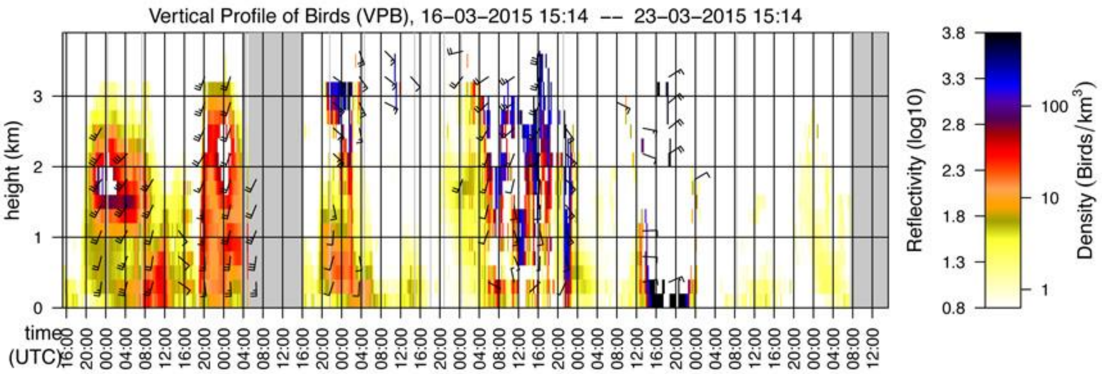
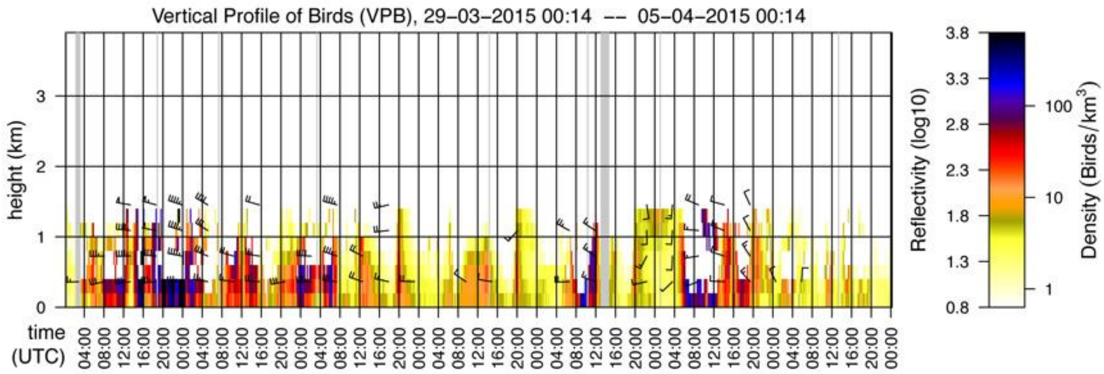


Fig 6. Time-height plots for 25 km (a) and 40 km (b) of the radar in Treillères (France) after processing by the bird algorithm.

a)



b)