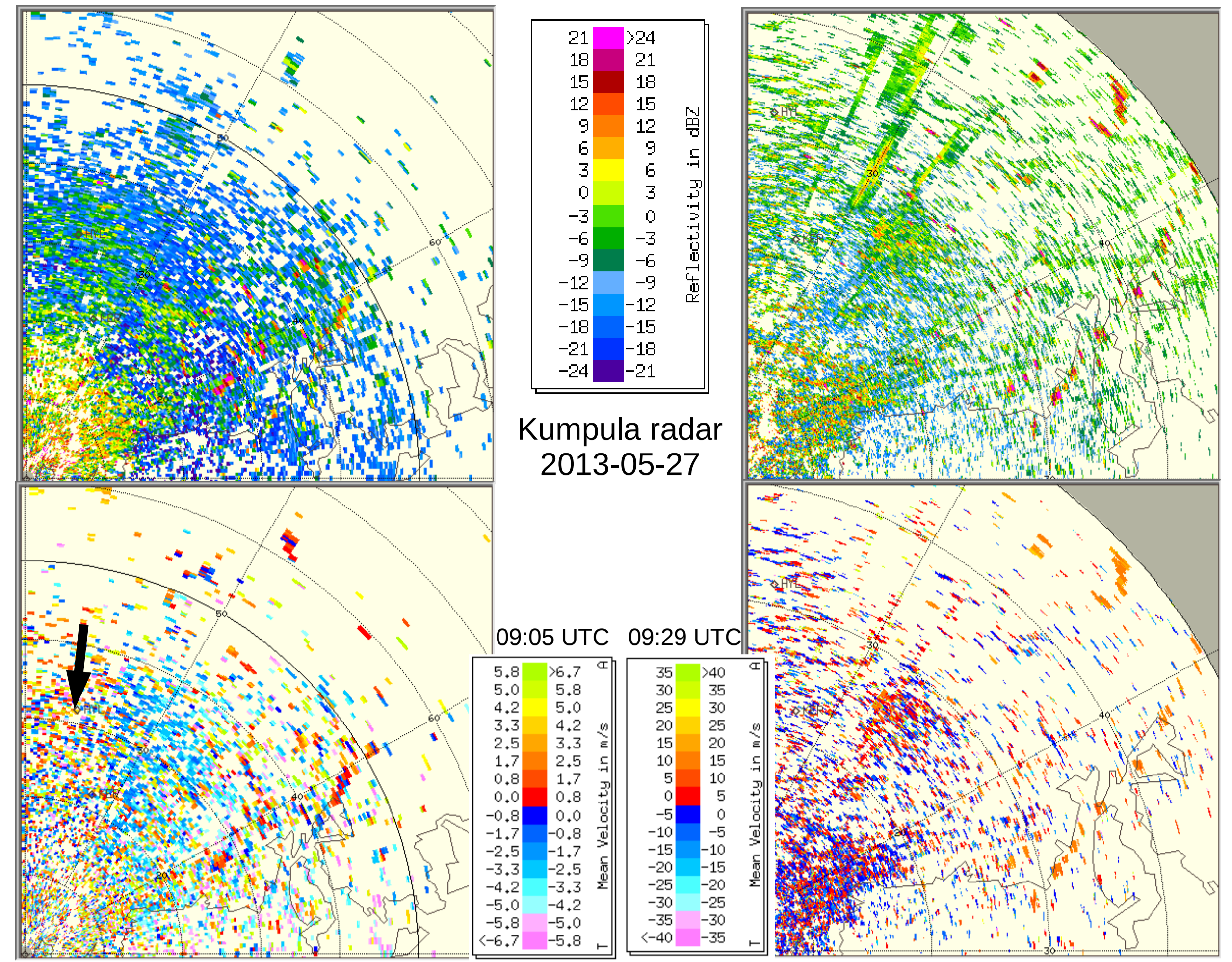


Bird flock tracking by weather radars

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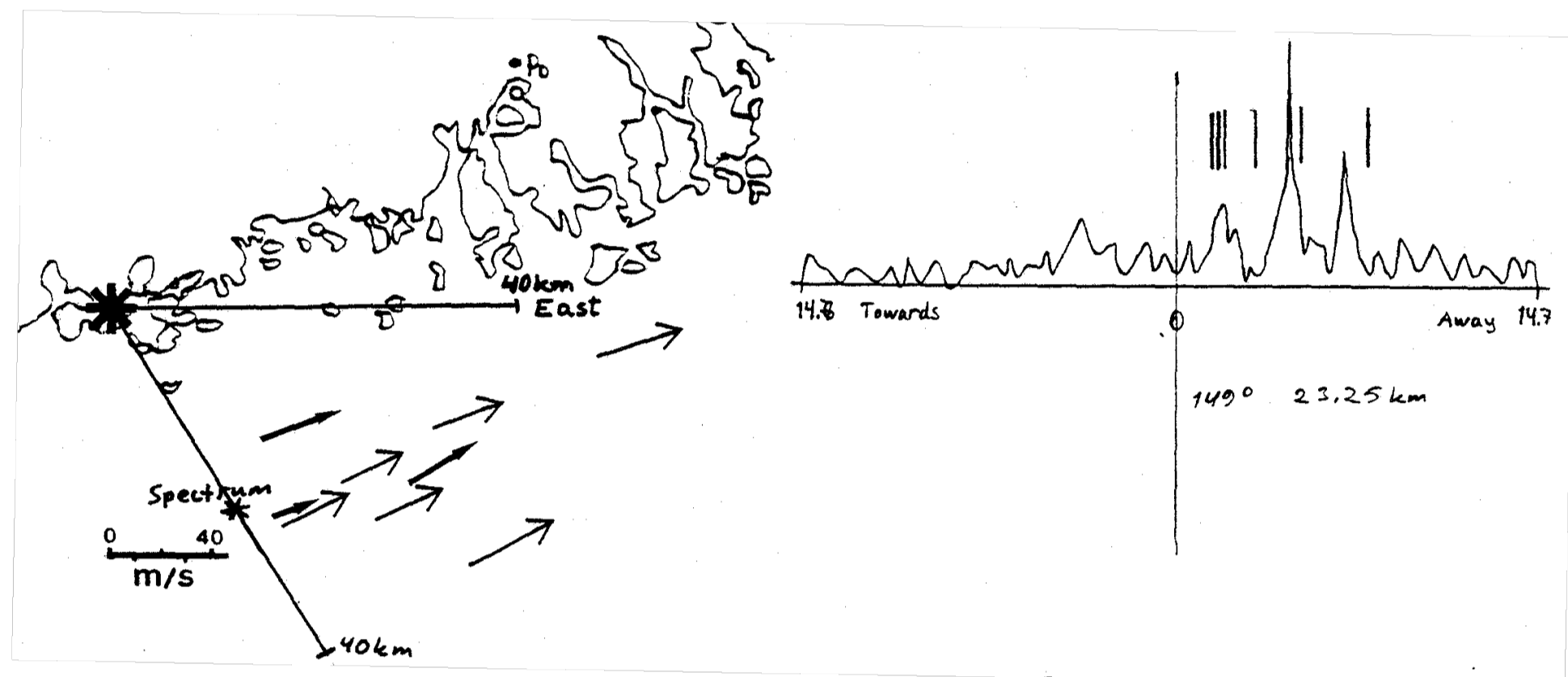
ENRAM, European Network for the Radar surveillance of Animal Movements, has discussed if flocks of big birds could be tracked using the available network of weather radars (OPERA in particular). We take a look on this issue utilizing the three dual-polarization C-band weather radar systems close to each other in southern Finland. Kumpula radar (KUM) is operated by the University of Helsinki, Vantaa radar (VAN) by the Finnish Meteorological Institute, and Kerava radar (KER) by Vaisala Ltd. KUM is a Vaisala WRK200, VAN and KER Vaisala WRM200 systems. The distances between the radars are 22, 19 and 9 km.



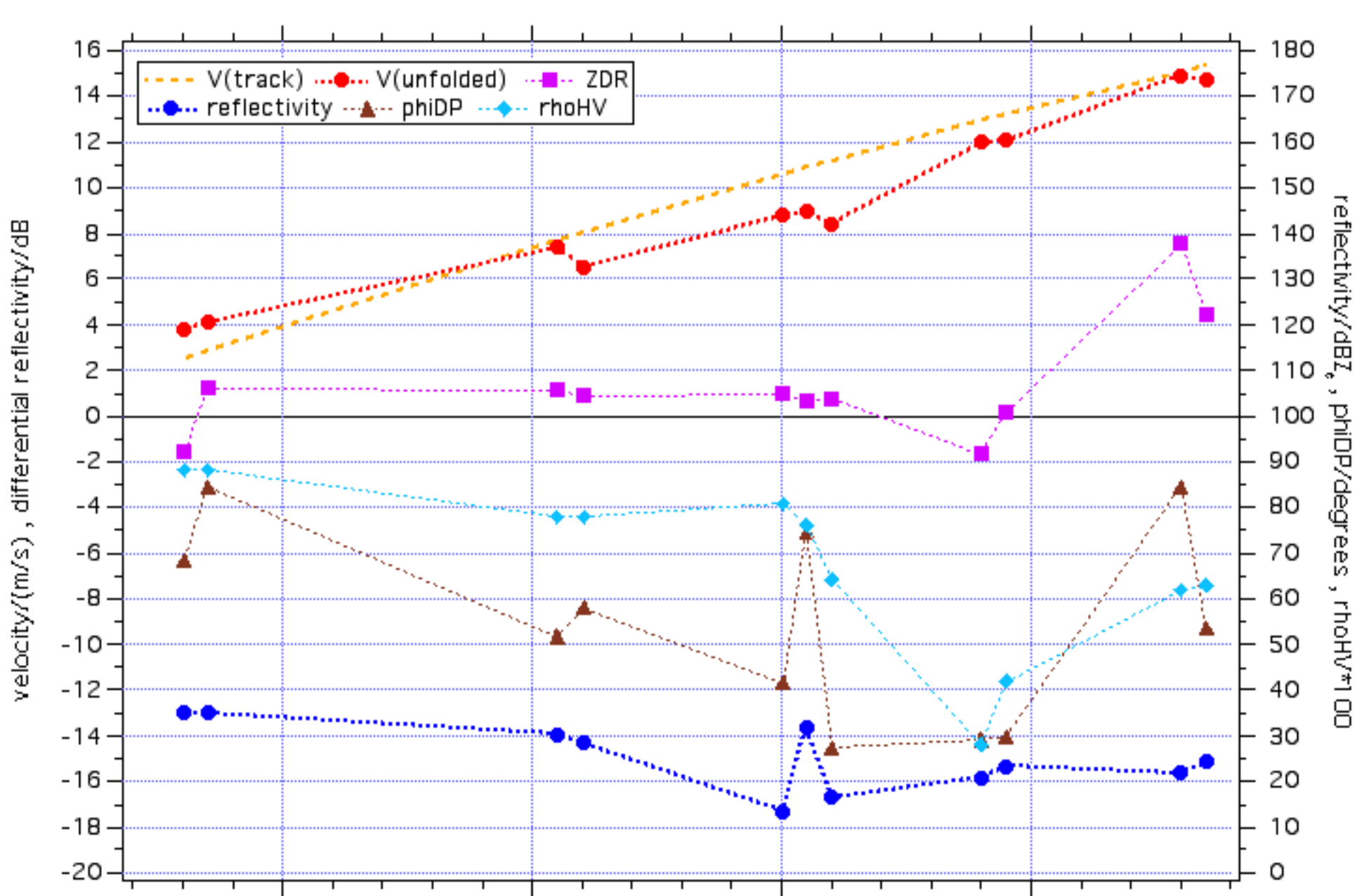
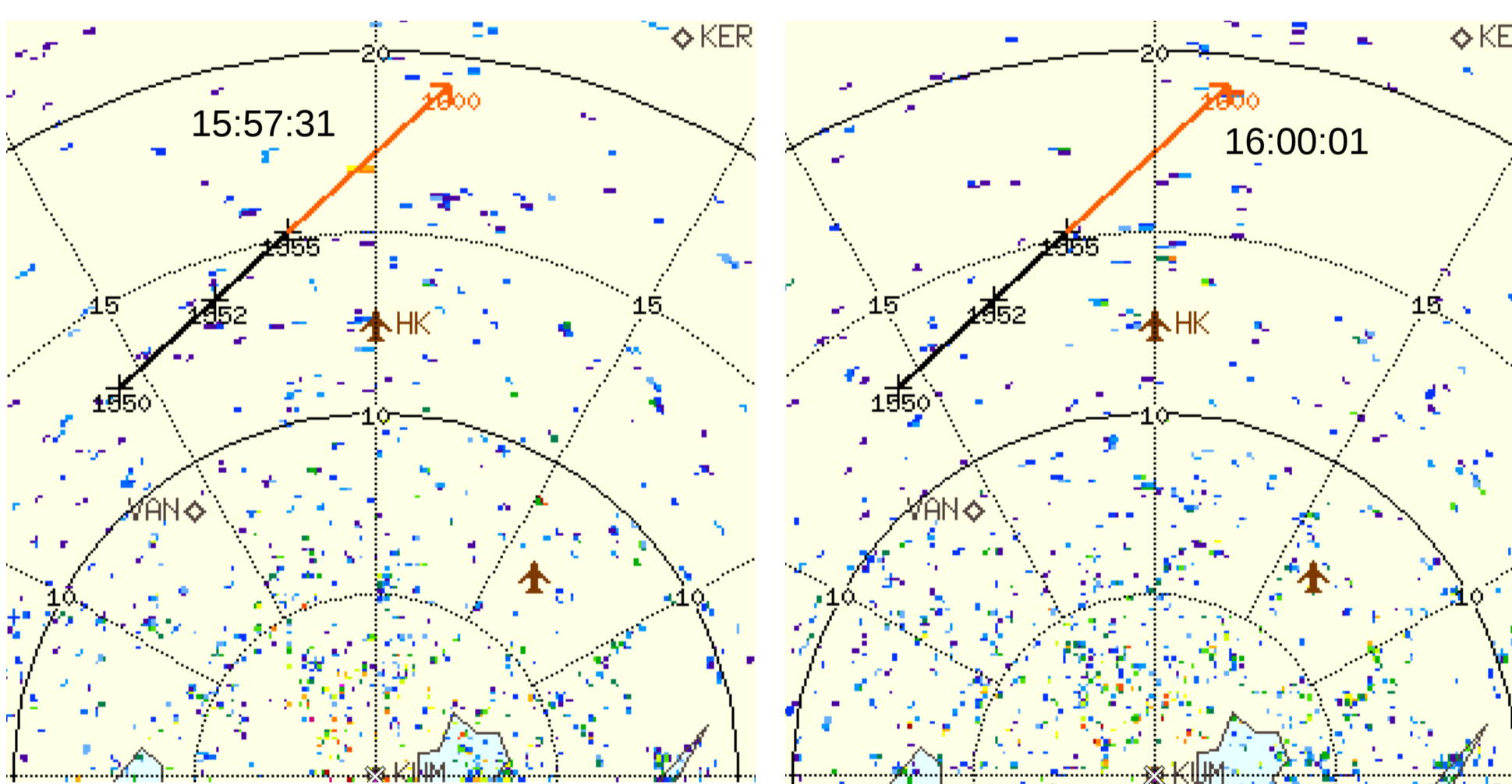
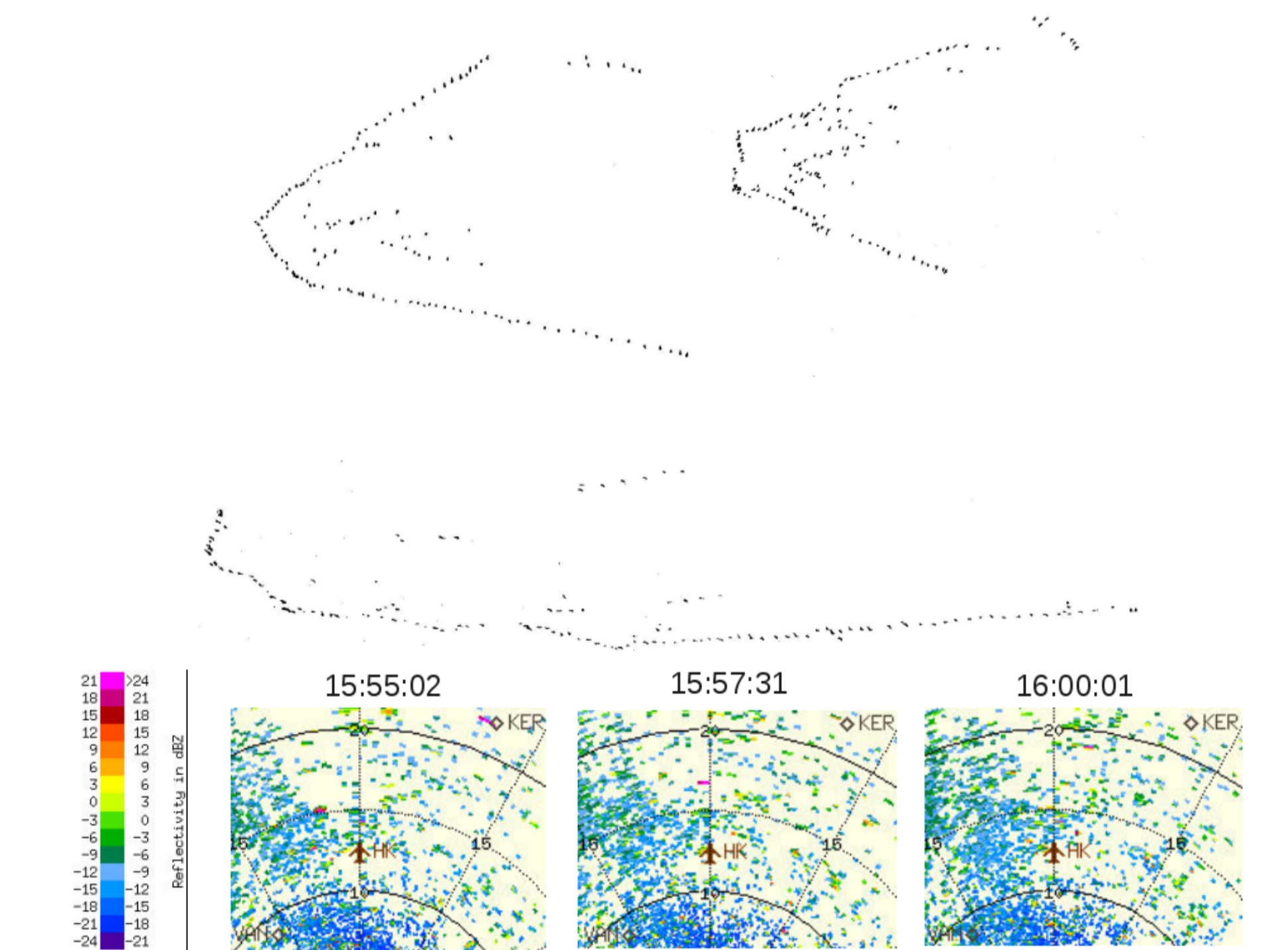
Photograph of a flock of geese passing the Järvenpää vertical looking Doppler weather radar site (HYL, arrow), and Kumpula dual-polarimetric radar images. The radar images on the left hand side are 5 minutes later than the photograph, and the other dual-PRF mode scan half an hour later. Near surface wind transports insects westwards 5 m/s, geese flocks travel towards NE 20 m/s.

Masses of birds migrating, "Arctica"

Birds in flapping flight in well formed flocks or more irregular shaped formations, but with constant heading.



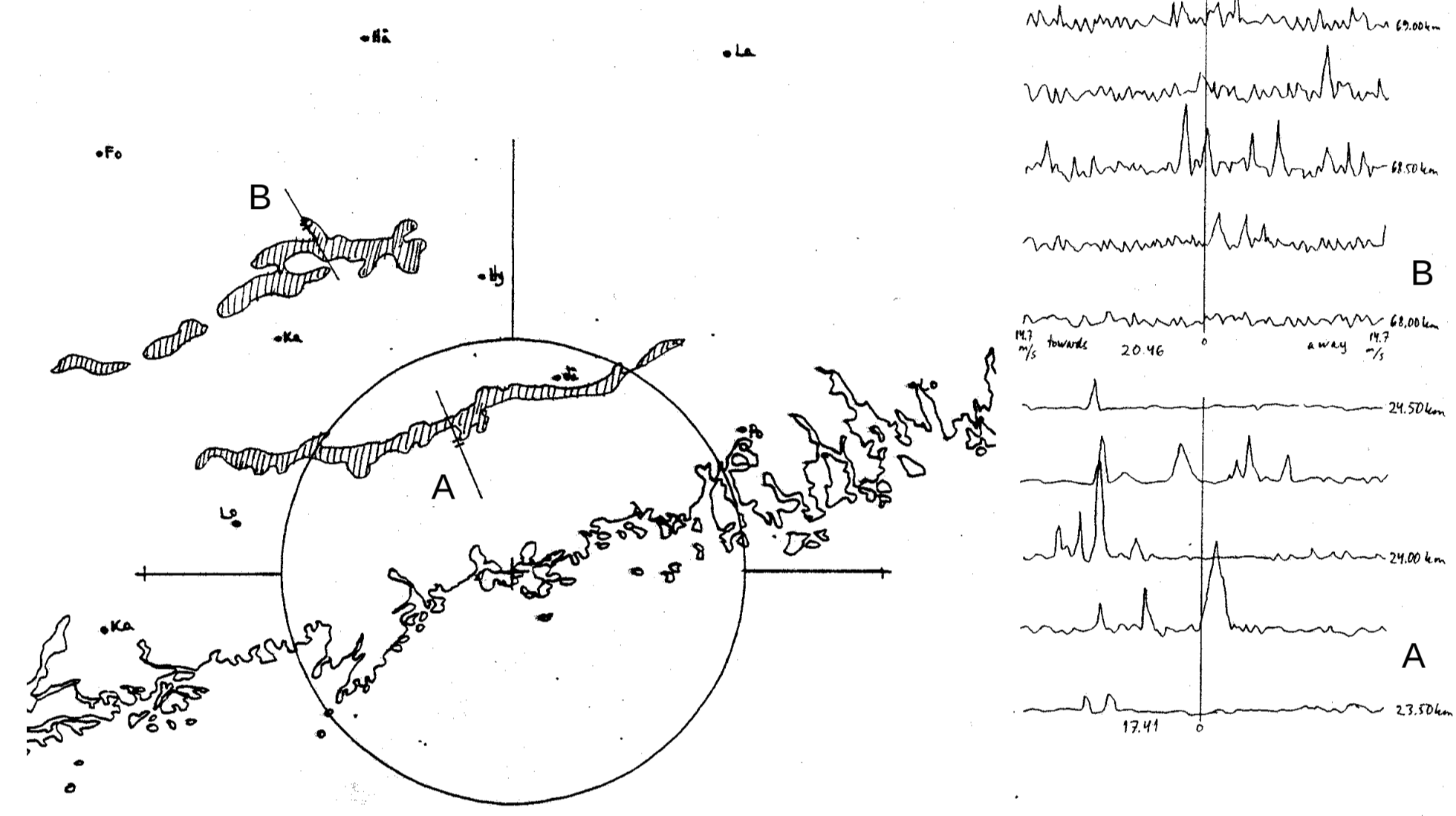
"Arctica" over the Gulf of Finland 1986-05-16. Large flocks of birds tracked using the University of Helsinki radar images by a human operator shown with arrows. Doppler spectrum of the echo at the spot indicated on the map. The mean radial velocity based on the tracks in the azimuth of the spectrum added as small vertical lines.



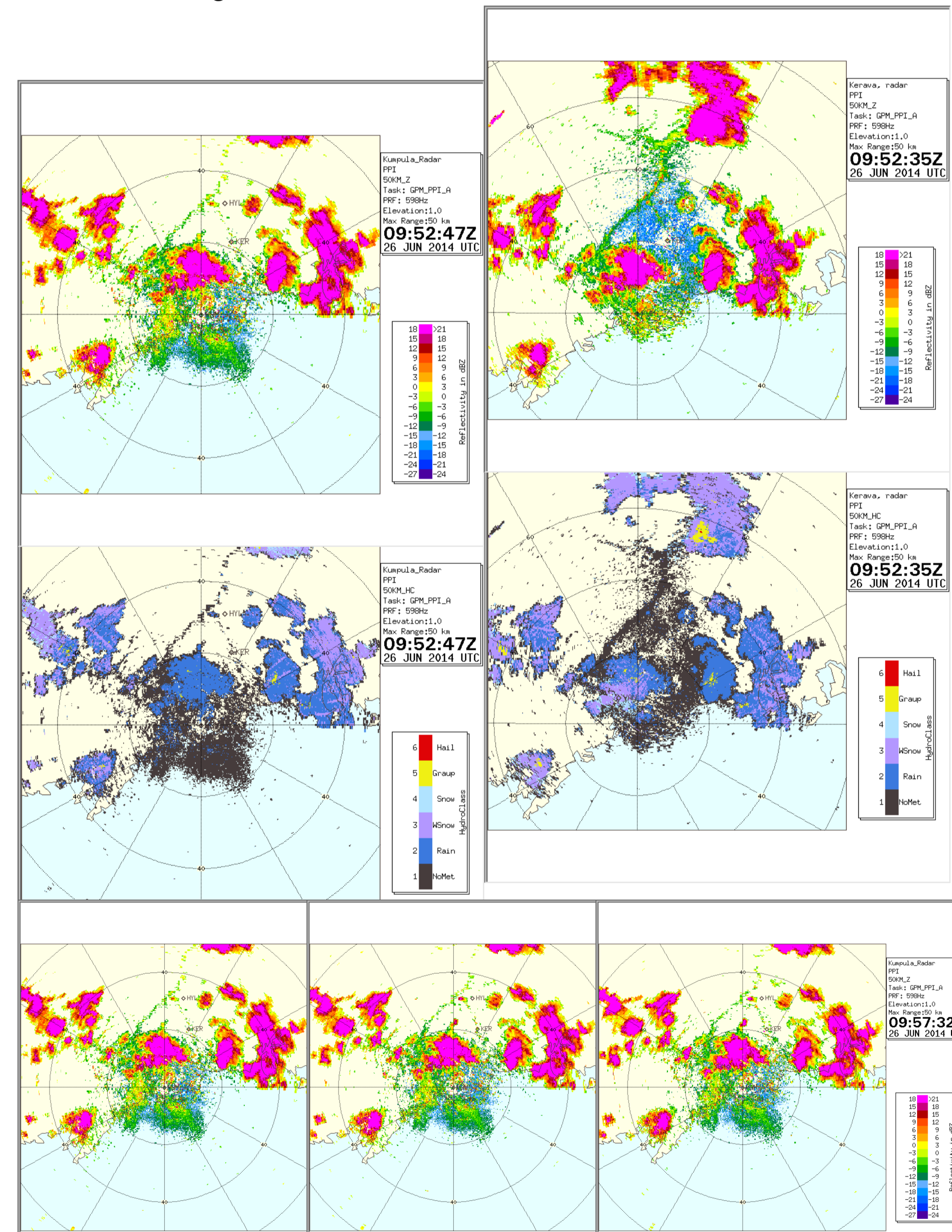
Flock of geese migrating towards NE in photographs and tracked by Kumpula dual-polarimetric radar 2014-05-21. Three photographs, thresholded, the small radar images have 2.5 minutes between the scans, and tracking tool output as forecast for 16:00 is shown in the lower radar image pair. The bottom plot shows various quantities of the bins at the flock's azimuth (2 to 3) and range. Radial velocity relation to the track may help in automatic tracking.

Birds in meteorological line phenomena

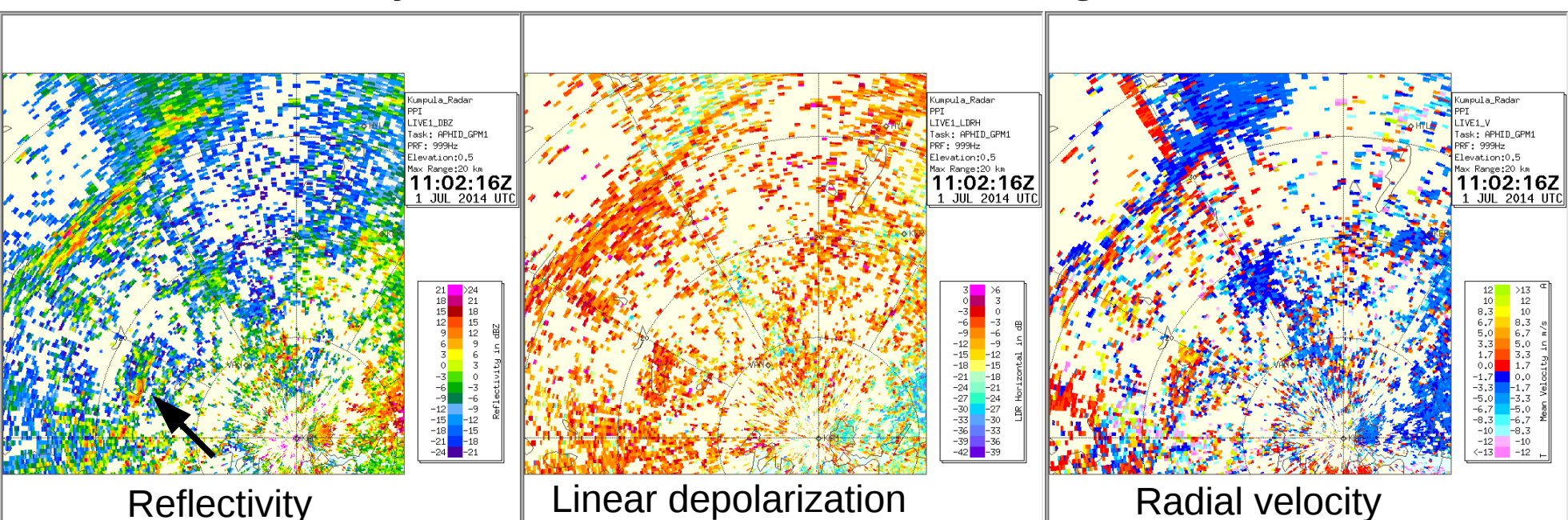
Sea-breeze fronts and gust fronts are convergence zones with upward air currents. Birds may gather there to catch insects or just to gain height. The movements of the birds vary a lot, but the line phenomenon is quite stable.



Echo bands of advancing sea-breeze front, the coastline and 40 km range ring of the University of Helsinki radar, 1986-07-03. Doppler spectra of the two front positions are plotted on the right hand side showing the many birds that cause most of the echo. Longer range in B means larger radar volume and more birds.



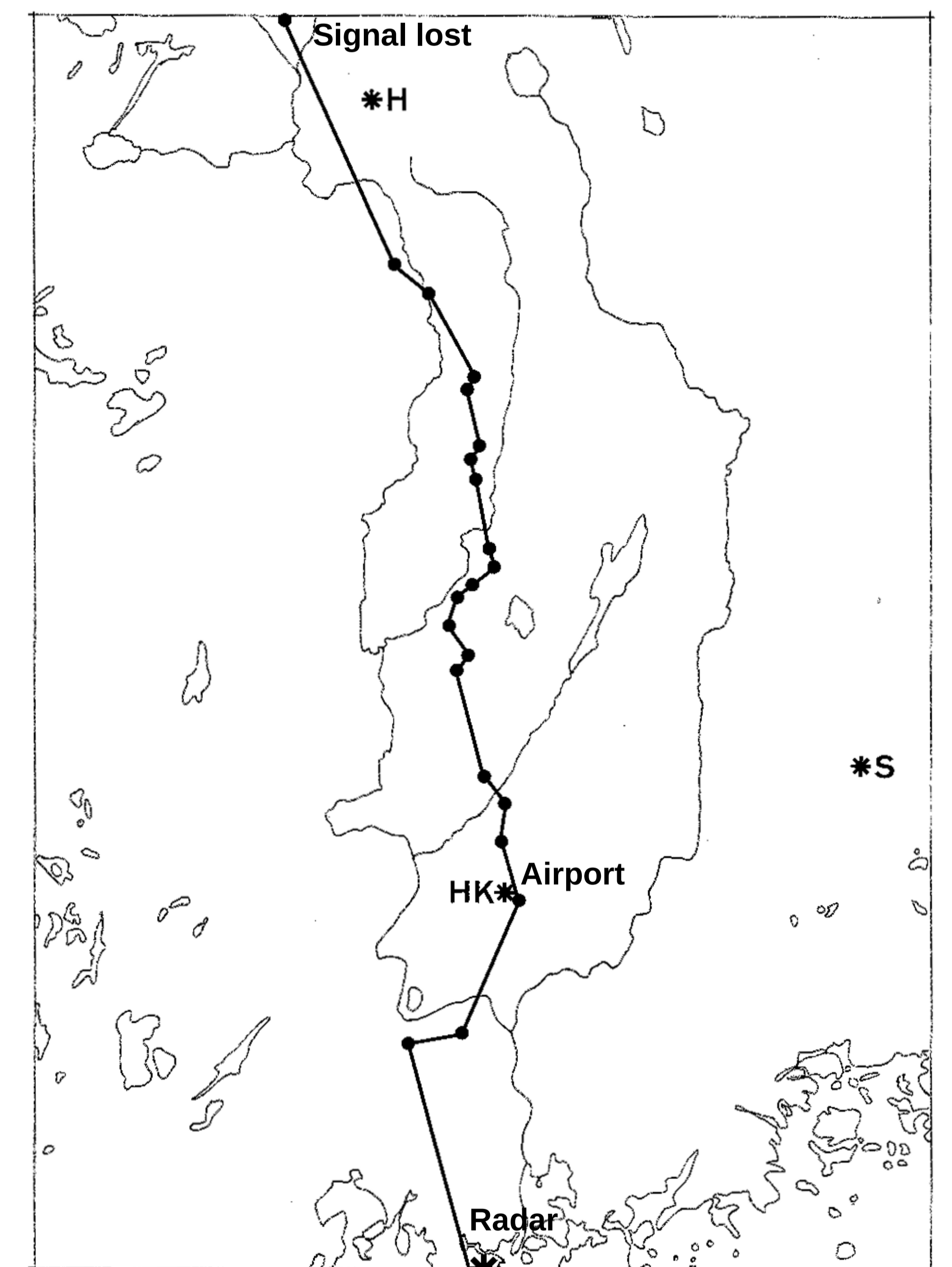
Kumpula and Kerava radar images showing gust fronts 2014-06-26, reflectivity and hydrometeors (Vaisala HydroClass), and Kumpula radar reflectivity in 2.5 minutes scan interval. Birds are important to make the gust fronts visible, new cells can be seen forming at the fronts as well. Close to the radars insects cause a lot of echoes, to some degree attenuated by the rain between the two radars. Target classification may be used in automatic tracking of bird flocks.



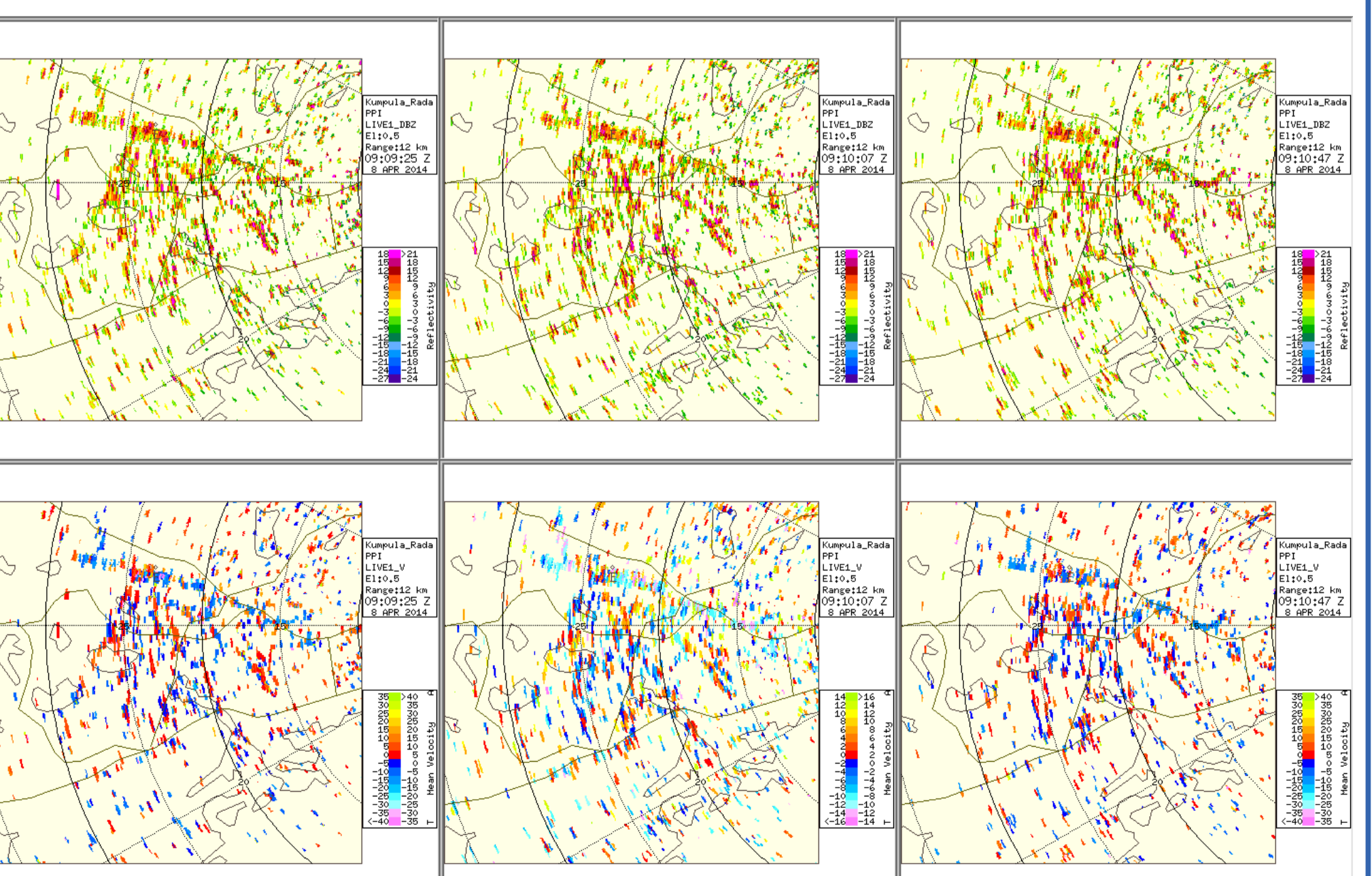
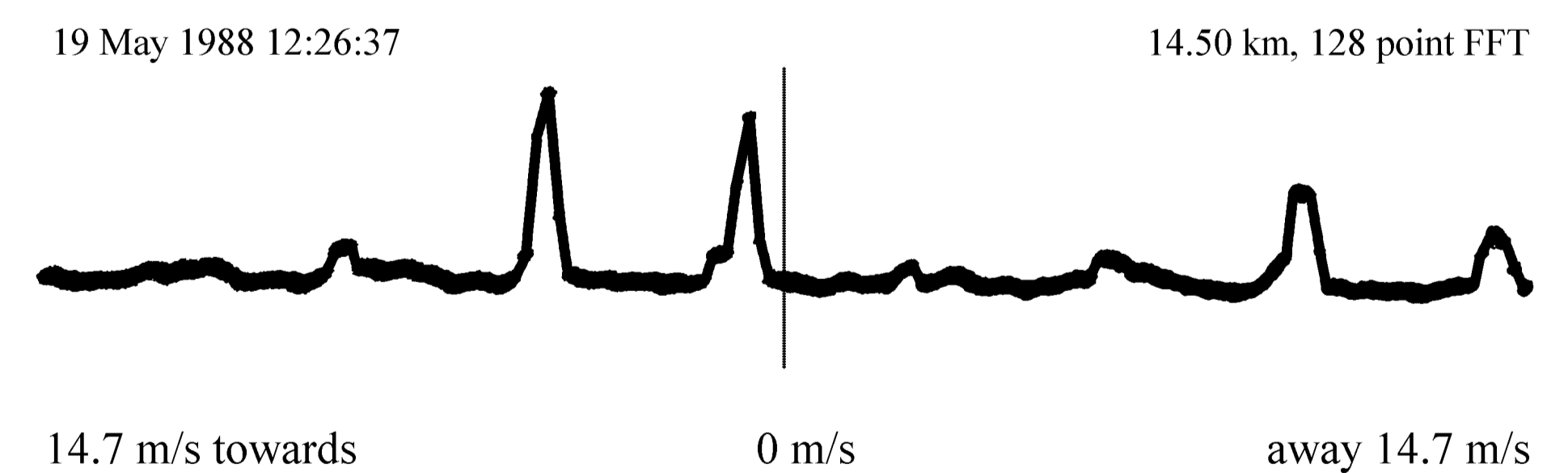
A not so simple meteorological event, 1900 swifts (*Apus apus*) were observed by Veikko Solantie close to a lake (arrow). Kumpula radar images show at that time many lines of birds, in addition to light rain and insects, this scan used horizontally polarized transmission only.

Big birds in variable flight

Small groups or large flocks related to seasonal migration (cranes etc.) or other goals. May use upward currents to gain height for gliding periods.



1988-05-19, the University of Helsinki Doppler weather radar was used to follow four White storks (*Ciconia ciconia*) that were seen from the University's window, at about simultaneously in the Department of Meteorology and on the other side of the birds in the Zoological museum. The Doppler spectrum showed four peaks, when the birds were circling. This kind of tracking is not possible in standard weather radar use.



Kumpula radar scans showing probably mostly gulls in their flights centered at the Helsinki Region waste management site (E). The scans had about 40 seconds time difference. The first and last scan were in dual-PRF mode, and there is not much difference in the output compared to the single PRT task in the middle. With this time resolution the flocks can be tracked, at least by a human operator.