Migrating insects observed by weather radar in traps

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1. Introduction

We have used dual-polarization weather radars in southern Finland to detect insect migrations, and we have had many insect traps at the surface to catch insects. We discuss the problems in correlating the high-flying insects observed by the radar to the insects in the traps near the ground. However, we had two of the traps and one of the radars near the coastline of the Gulf of Finland, which allows us to determine whether the insects causing radar echoes and appearing in the traps were long-range migrants or more local fliers.

We use the physical properties of insects in the catches to model radar scattering parameters, and compare the results to the actual radar observations. We discuss the background of the radar observed features in several different migration cases, and the capabilities of weather radars to monitor immigration of insect pests in real time.

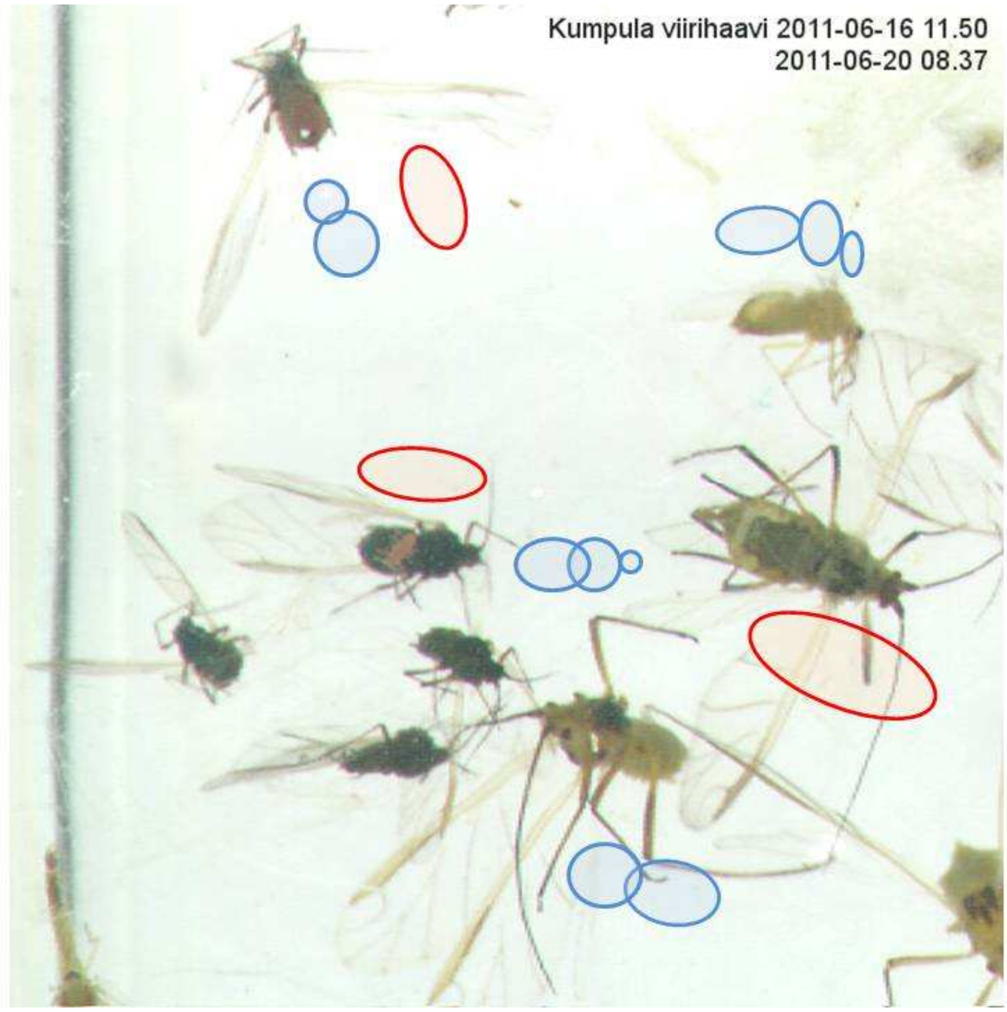

Fig. 1 Insects caught by the trap at the Kumpula radar site during a period of aphid migration and approximate oval shapes of the bodies.

2. Insect trap catches and scattering

Fig. 1 is a flat-bed scanner image of a catch in Kumpula tow-net trap (Leskinen et al. 2011). We are aiming to use the catches in estimating what kind of echoes we should get. Compared to the weather radar monitored flight levels of the migrants the traps are usually close to the ground. Typical level for insect migration monitoring traps is 12 m above the ground. Many traps are even much closer to the ground. Direct comparison of trap catches to the radar observations is therefore easily misleading. We select cases where we know that the insects were long-range migrants, and the surface observations can more reliably be related to the higher level migrants causing the radar echoes.

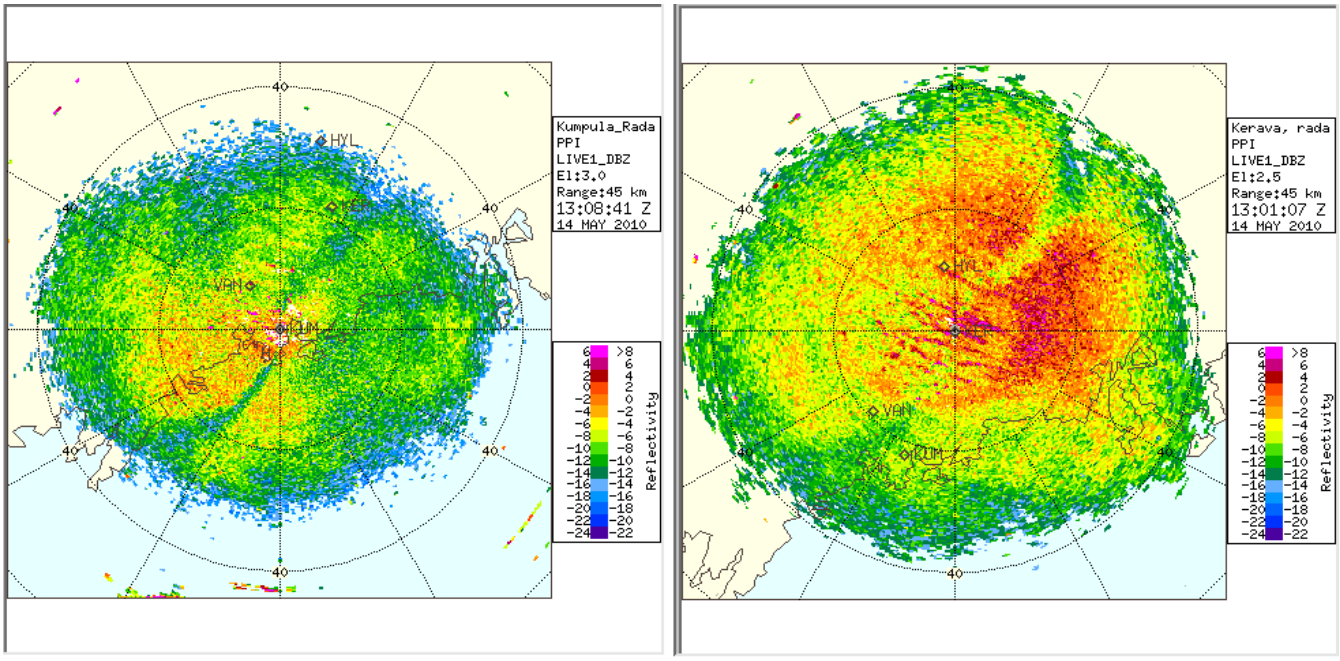

Fig. 2 Horizontal reflectivity. The slight difference in elevation angle (0.5 degrees), and the fact that more insects were in the air over the land may explain the intensity difference, notice that the step is only 2 dB.

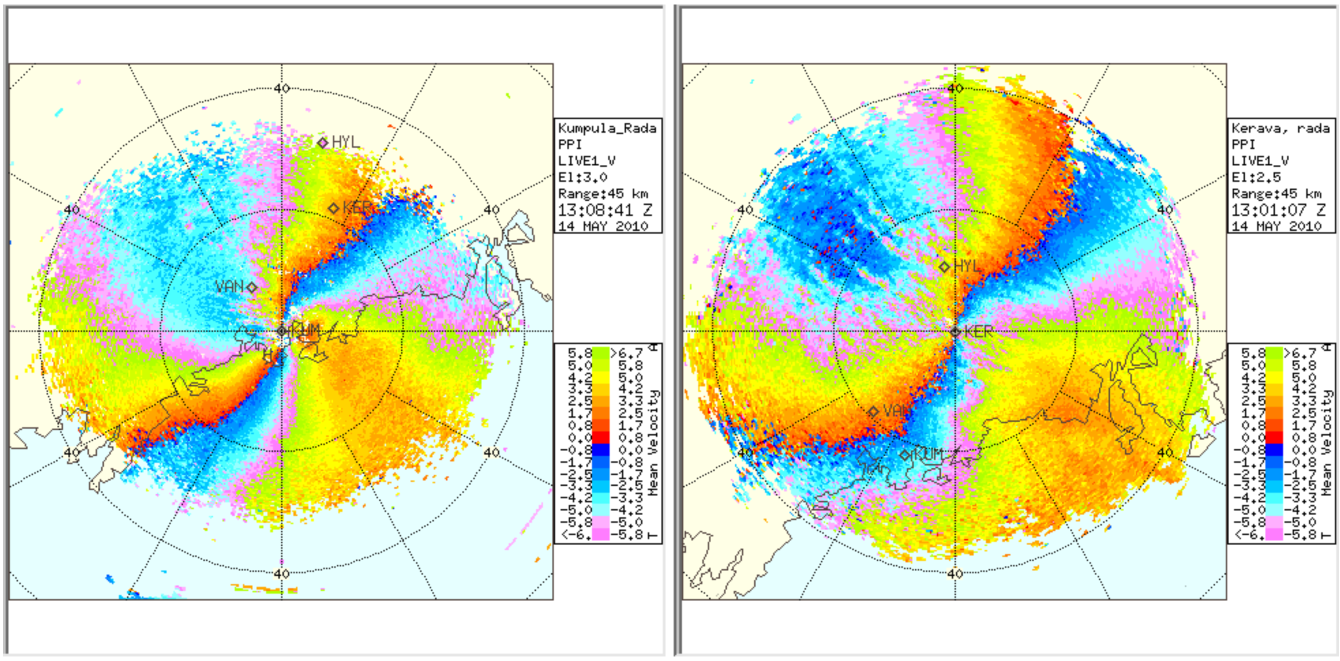

Fig. 3 Radial velocity. In Kerava the near surface speed maximum appears to be larger (2 times folding) in NW, and in Kumpula the maximum in E is due to the channeling effect of the Gulf of Finland.

3. Birch aphid migration in radar images

An example of how the migration is seen by dual-polarimetric weather radars is shown by the Kumpula and Kerava radar images. In these cases the differential reflectivity has usually been below 0 dB in the azimuths where the insects are oriented head or tail towards the radar, and the explanation for this could well be the significantly upward orientation of the aphids in their flight. Similar observations have been made during some small moth migration episodes as well. Mostly the higher air layers during daytime have insects that have much more reflectivity in horizontal than in vertical polarization.

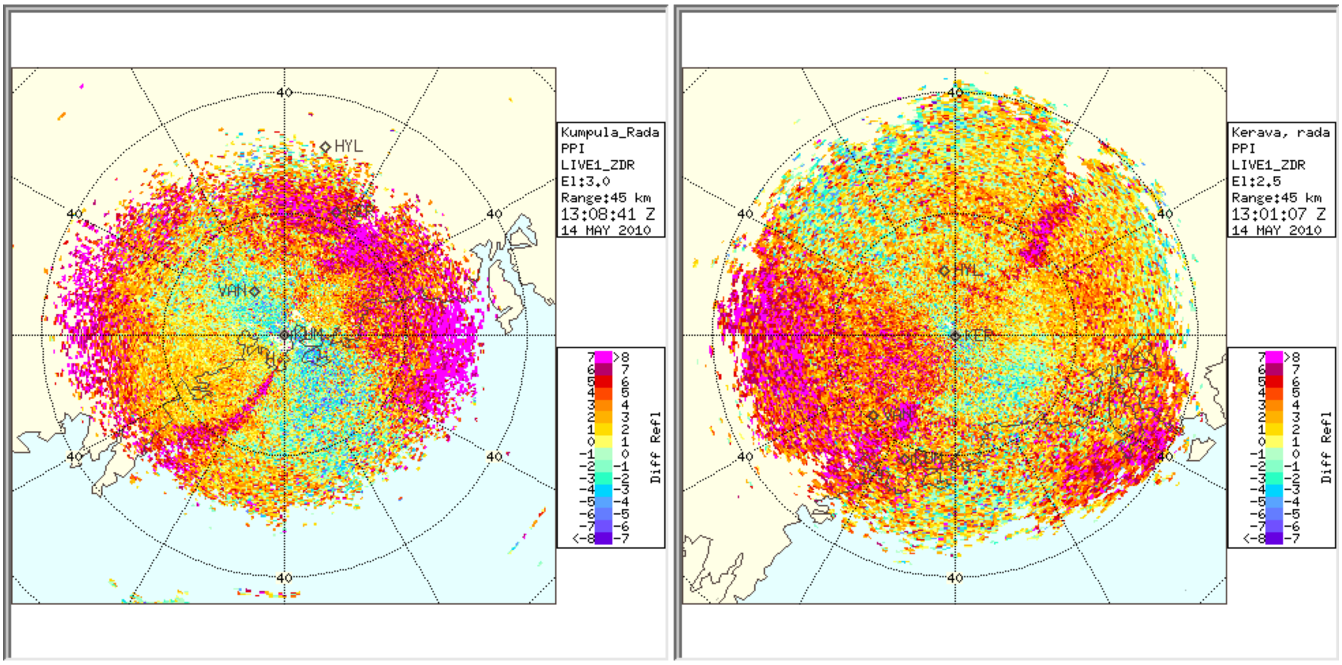

Fig. 4 Differential reflectivity. In Kumpula the below 0 dB values over the sea is typical in the lowest layers, the higher layer maxima seem to be quite symmetrical in E and W. Kerava has an upper maximum in SE, and in fact geographically the Kumpula maximum in E is close to that.

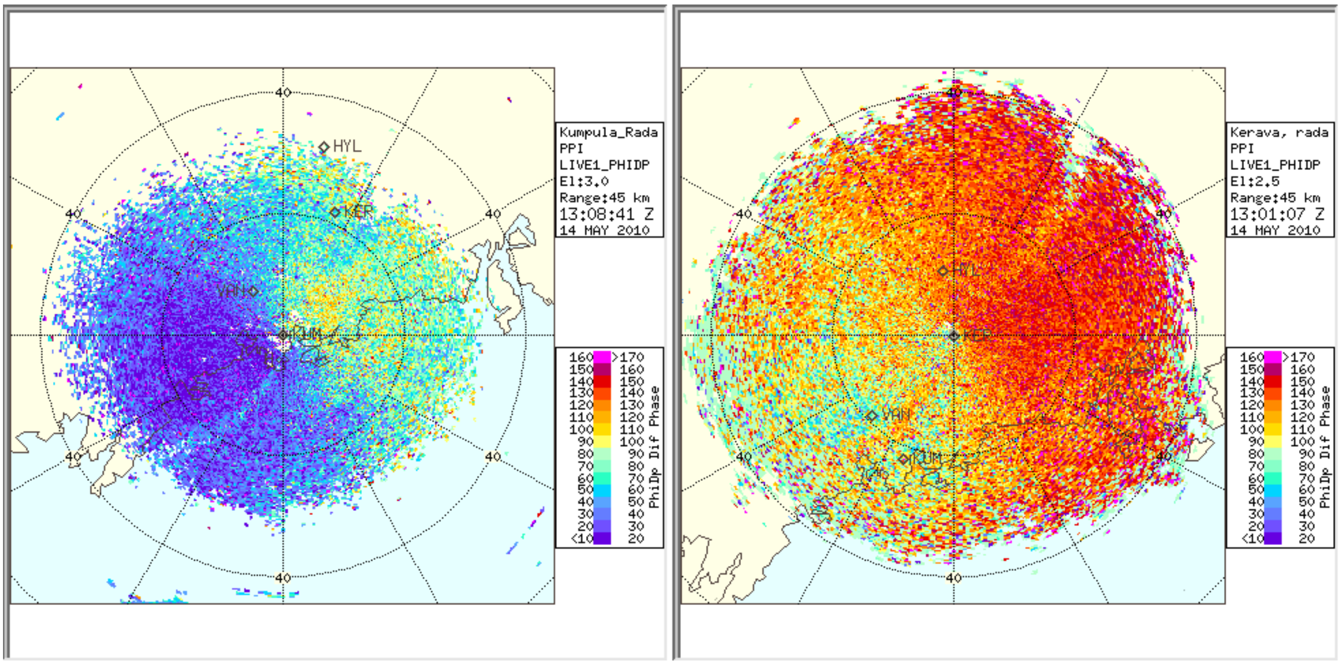

Fig. 5 Differential phase. There is an arbitrary phase difference in the start, and the radars have not equal offsets. Otherwise both radars show higher values in the NE sector compared to SW sector.

Assuming that the insects would fly their bodies horizontally oriented may not always be a bright idea. Fig. 5 shows an aphid photographed in its autumn migratory flight near the ground, and the well-known manner of upward aiming flight position is observed.

Fig. 6 An aphid (probably a bird-cherry aphid, Rhopalosiphum padi) migrating to winter host in its typical slant vertical orientation.

Acknowledgment

Analysis team in MTT has had a lot work to do in determining insect of the catches.

References

Leskinen M., Markkula I., Koistinen J., Pylkkö P., Ooperi S., Siljamo P., Ojanen H., Raiskio S., Tiilikkala K., 2011: Pest insect immigration warning system by an atmospheric dispersion model, weather radars and traps. *Journal of Applied Entomology*. **135**, 55-67.