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BIRD MIGRATION OBSERVATION IN THE BERLIN AREA USING ATC-RADAR AND WIND-PROFILER

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Summary

Air traffic around Berlin is continously growing, whereas Berlin is located in an environment with a high bird population. An additional bird strike risk arises in periods of bird migration. Observations have been made recently by video-digitizing of an air traffic control (ATC) radar located at Berlin-Tegel Airport and simultaneously by a wind profiler located at the Meteorological Observatory in Lindenberg, 65 km southeast of Tegel. Both methods are described. An analysis of a selected dataset is presented in respect of heavy bird migration and heights. A coincidence of several bird strike events with observed high bird migration densities could be detected.

Key Words: Migration, Bird Populations, Radar, forecasting, Electronic

1. Introduction

Although during the last decades a good knowledge of the bird migration pattern has been achieved by radar observations in the horizontal plane, there is a substantial lack of information on the vertical distribution of bird migration. New technological developments in radar techniques will make it possible to fill in the informational gap. In Germany three dimensional air defence pencil beam radars will be implemented in near future, which will then allow a three dimensional bird tracking. Some experiments with tracking radars have already revealed usefull height information, but the birds are randomly tracked and may not always be representative. A new approach is outlined in this article, showing first results of measurements with a continously operating vertical wind sounder [3]. However, like with ATC-Radars, the ornithological targets detected by the equipment are considered as disturbances of the main task and are usually tried to be suppressed. A synopsis of first continous horizontal and vertical soundings provides new results on the matter.

2. Siting and general bird migration situation

Berlin is geographically located in the glacially formed plane of the ice age. Besides the City itself the typical landscape includes pine forests, lakes and agricultural land on sandy soils. The area is crossed by many migratory birds on their way from southwestern Europe and the western Mediterranean towards the eastern Baltic and northern Russia. Many species rest in the area for some weeks, because of the relatively undisturbed environment and good feeding conditions.

The siting and observational range of the ATC-Radar at Berlin Tegel Airport, the other airports as well as the location and the distance to the wind profiler at the Meteorological Observatory Lindenberg are illustrated by Figure 1. The range of the radar in which birds can be detected does not cover the site of the wind profiler, but in general, the information from the ATC-Radar can be extrapolated in times of significant widespread bird migration towards the site of the wind profiler.

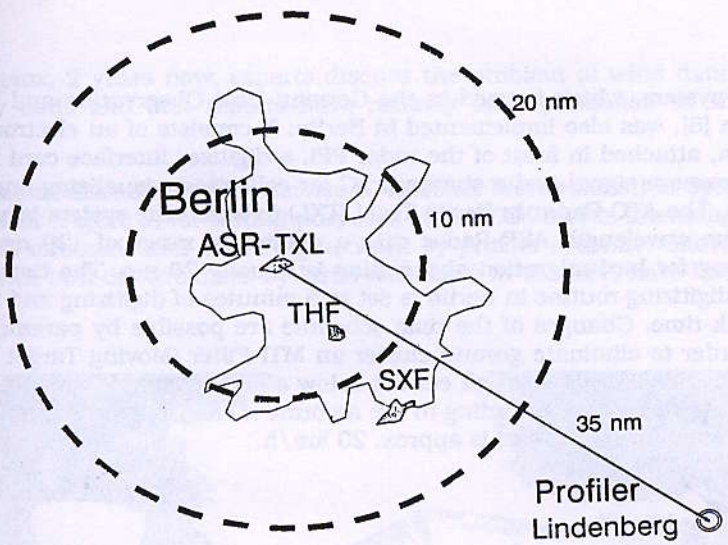


Figure 1 : Siting and range of observation equipments.

3. Observation Methods

3.1 Radar-Video-Digitizing of the ATC-Radar

The basic principle of bird migration observation by ATC-Surveillance-Radar has been widely described in literature [1][2]. Instead of looking at the actual video of the radar, the targets are integrated over a specific period of time. Bird targets form short irregular tracks, with a certain length according to their speed. A bird-target usually exists of at least a flock of birds, in order to form a relevant echo-crossection. The time integration of echo plots can technically be carried out either by the old fashioned method of long exposure-photography or by computerized video-digitizing from the radar PPI (Plan Position Indicator). More sophisticated systems take the plot data directly from the radar antenna.

The system, which is used in the German Bird Observation and Warning System [6], was also implemented in Berlin. It consists of an electronic video camera, attached in front of the radar PPI, a digitizer interface card for digitizing the camera signal and a standard PC for collecting, visualizing and storing the data. The ATC-Radar in Berlin Tegel (TXL) to which the system is attached, is a 23 cm wavelength ASR-Radar with a maximum range of 120 nm. The range setting for bird migration observation is usually 20 nm. The time schedule of the digitizing routine in Berlin is set to 5 minutes of digitizing and 5 minutes of break-time. Changes of the time schedule are possible by parameter settings. In order to eliminate ground clutter an MTI-Filter (Moving Target Indicator) is used, which suppresses all echoes below a certain speed, which move tangentially to the radar, according to the amount of the Doppler frequency shift. The threshold speed in Tegel is approx. 20 km/h.

3.2 Wind Profiler

As the name already indicates, wind profilers are devices for measuring primarily wind speed and wind direction but combined with the RASS (Radio Acoustic Sounding System) they are able to profile also virtual temperature in the vertical direction. Technically, wind profilers are radars as well. They are able to detect scattering of their electromagnetic energy by the atmosphere. Akcording to the typical wavelength of ≥ 23 cm these radars are usually not effekted by cloud or rain particles so that they are often referred to as clear air radars. The targets that cause the scattering are inhomogenities of refractivity along the path of the transmitted radar beams. These inhomogenities are parcels of air with different temperature, humidity or pressure whose dimensions are nearly half of the radar wavelength. These inhomogenities are common at all elevations. In order to obtain the wind direction and speed, three radar beams with fixed directions point into the atmosphere under fixed angles, one of them being vertical. The range of wind profiler measurements depends mainly on the wavelength of the profiler, its power and its antenna area. In the actual case it is approx. 5000 m height with an average accuracy of 0.3 m/s for wind speed and 3 deg for wind direction against measurements of the traditional rawinsonde. Virtual temperature measurements with a profiler/RASS in Lindenbergare possible up to 1500 m height with an accuracy of around 0.2 K.

Wind profiler have the big advantage of measuring the wind and temperature of the lower atmosphere continuously with a high resolution in the vertical, whereas rawinsondes are usually only launched once in 12 hours. In the USA a profiler network is partly realised. The Next Generation Doppler Weather Radar (NEXRAD), which will be implemented countrywide in a few years, is also able to measure vertical wind profiles, but only during rainy or cloudy situations.

Since approx. 2 years now, experts discuss the problem of wind data disturbance by birds and first reports have recently been published on this item [4][5][7].

The German National Weather Service (Deutscher Wetterdienst) is operating a wind profiler (Figure 2) for testing purposes since 1994 and is intending to modernize its national wind sounding network by profiler systems. Similar experiences with bird disturbances by birds like those in the USA have been made as well.

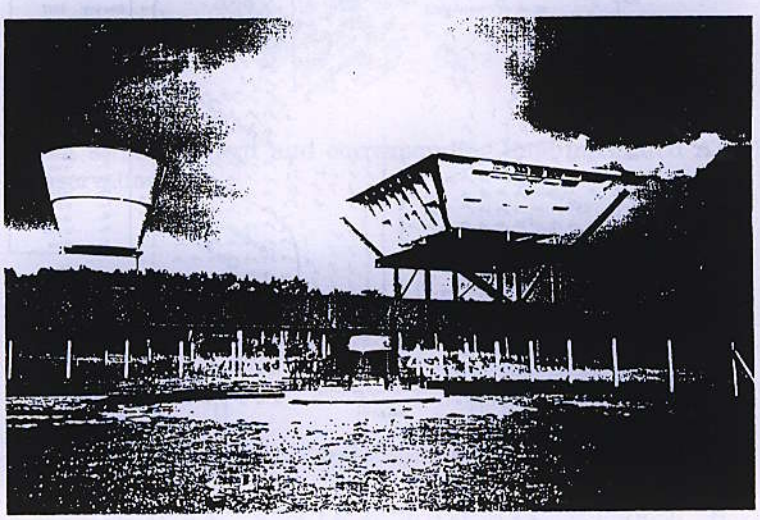


Figure 2 : Wind profiler at the Meteorological Observatory Lindenberg.

The typical features that appear in wind measurements when they are disturbed by bird movements are illustrated in Figure 3. It shows a time-height-cross-section of hourly mean wind speed and wind direction at fixed elevations over a one day period in autumn. The comparison with measurements of a rawinsonde proved that all the wind arrows with directions from NE towards SW and speed of 10 to 15 m/s are not true winds. Around 00 Z the hourly mean wind values are disturbed from 500 m up to approx. 3500 m. Towards morning hours the band of disturbed values narrowed towards an elevation intervall of

2000 to 2500 m. During the day the winds were realistic, but after sunset again an ENE direction and speed of 10 to 15 m/s occurred in a height range from 1000 to 3000 m.

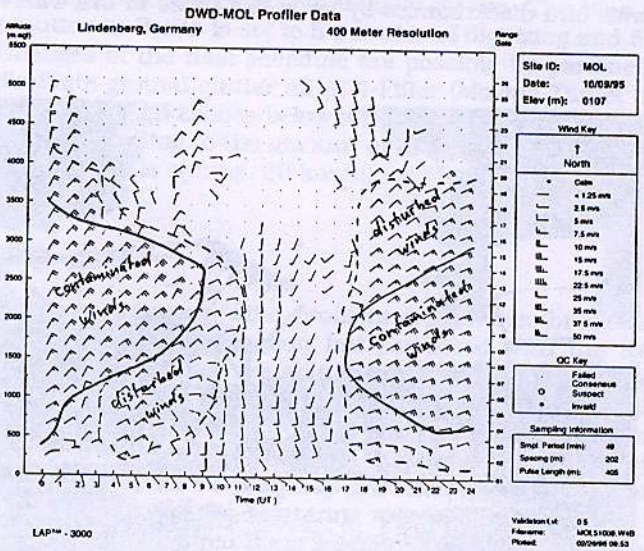


Figure 3 : Wind measurements (Time-Cross-Section) disturbed by birds from 09.10.1995

4. Observational Results

From August 1995 onwards the continuous recording of the ATC-Radar-Scope has been carried out. The images form a time lapse sequence of the two dimensional air traffic flight paths, also including those of bird flocks (Example: Figure 4). From the sequence of the recordings periods of bird migration were analyzed. Bird migration intensities were classified in three classes (light, moderate, severe). The time pattern of the intensities for the first half of October 1995 are plotted in Figure 5.

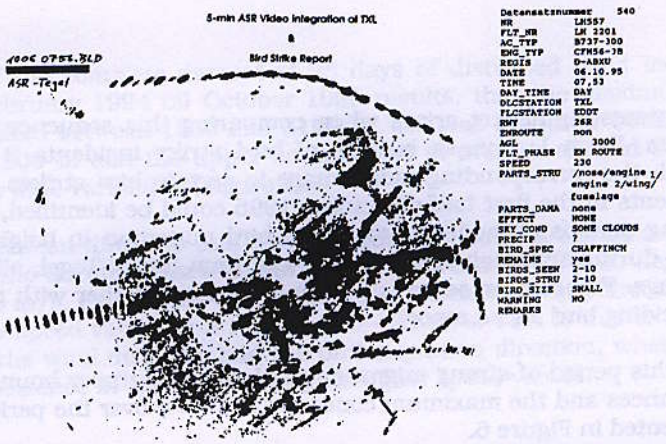
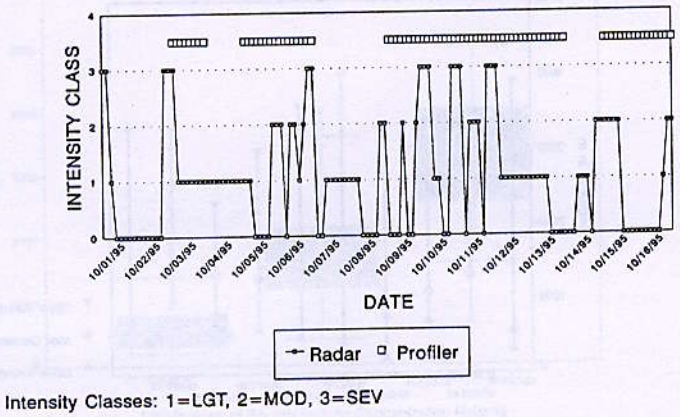


Figure 4 : Bird strike incident and corresponding time integrated ATC-Radar observation.



Intensity Classes: 1=LGT, 2=MOD, 3=SEV

Figure 5 : Analyzed bird migration intensity classes from ATC-Radar observations and the occurrence of wind profiler contaminations.

An interesting aspect arises when comparing this sequence with actual bird strikes. From Lufthansa records of bird strike incidents it was possible to match the corresponding radar image to certain bird strikes. Four bird strike incidents in the first half of October 1995 could be identified, which happened during periods of moderate to severe bird migration in heights up to 3000 ft GND during approach or take off to and from Berlin-Tegel, all of them without damage. Figure 4 presents one such situation together with the data from the coinciding bird strike report.

For this period of strong migration the lower and upper boundaries of the disturbances and the maximum concentration level over the period of one day are presented in Figure 6.

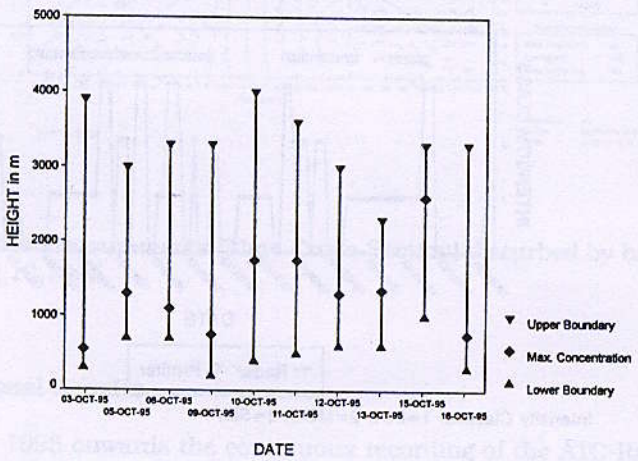


Figure 6 : Height distribution of averaged wind data disturbed by birds during the period 1.-16. October 1995, derived from the Lindenberg wind profiler.

An analysis of the complete dataset of 95 days of disturbed wind measurements from February 1994 till October 1995 results, that the maximum disturbance appeared between 1500 and 2100 m, whereas the lower boundary is usually below 500 m and the upper boundary is in average around 3500 m, however with a wide variability (Figure 7).

The relation between direction and speed (Figure 8) shows a significant lower speed level in the autumn cases (disturbed wind direction: 30 - 90 deg), ranging around 10 m/s, than in the spring situation (disturbed wind direction 180 - 330 deg) with speed values in a range of 10 - 30 m/s. This is due to the superposition of the wind direction and the bird migration direction, where there is a better coincidence in spring, resulting in higher speed values.

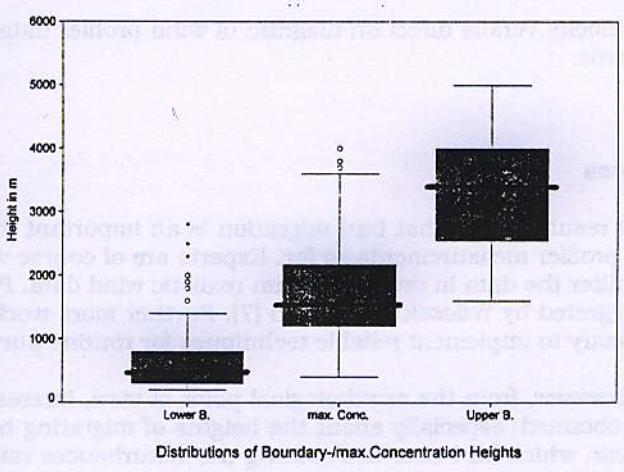


Figure 7 : Height distribution of wind data disturbed by birds.

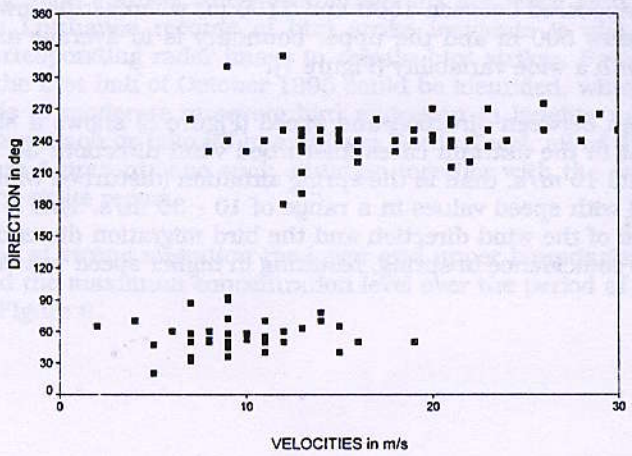


Figure 8 : Velocity versus direction diagram of wind profiler data disturbed by birds.

5. Conclusions

The outlined results show, that bird migration is an important disturbing faktor for wind profiler measurements so far. Experts are of course working on algorithms to filter the data in order to obtain realistic wind data. Potential Solutions are suggested by Wilczak et.al. 1995 [7]. Further more work on this item will be necessary to implement reliable techniques for routine purposes.

Meanwhile however, from the ornithological point of view, interesting information can be obtained, especially about the heights of migrating birds. So far it is not yet clear, which bird sizes are causing the disturbances rather than species. There are indications, that the disturbance is mainly caused by the size scale of passerines. In Lindenberg the disturbances extremely occur during the migration periods in spring and autumn and almost always during twilight and darkness hours. The observed heights usually astonish even ornithologists, but they are more and more confirmed also by other three dimensional radar observations. This will probably have an input to the height information of birdtam messages.

The continuous recording by an ASR-Radar in the same area makes it possible to investigate wind data more carefully, so that situations can also be detected when wind data are less obviously disturbed. On the other hand, the profiler extends the PPI-Information of the ATC-Radar towards a three dimensional picture. A further analysis will reveal more basic knowledge on bird migration patterns in the area.

Even though wind profiler data of the wind vector in future will be separated from bird data, it will remain possible to get information about migrating birds. So one can think about a cooperation between those institutions who provide bird migration warnings and forecasts to air traffic units and those who run wind profiler networks, both contributing to air safety. Bird migration forecasts and warnings can thus be an important input for profiler measurements as well.

The study also emphasizes the possibility and necessity to monitor bird migration around airports by the ATC-Unit in order to minimize the risk of severe bird strike accidents. In periods of continous heavy bird migration it will not be possible to change flight plans and routes, but, the information from the ATC-Unit will make the pilot aware of the danger.

6. References

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