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THE USE OF RADAR DATA FOR BIRD STRIKE PREVENTION IN GERMANY

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In the Federal Republic of Germany military and civil radar stations are performing observations of bird movements by polaroid pictures or movie pictures of the radar scope. The polaroid pictures give information of actual migratory movements of birds, and are used for bird strike warnings (birdtam). The observations by movie film are used for the investigation of seasonal and spatial variations of bird movements as well as for the correlation between weather and bird migration. The knowledge of factors influencing the timing and amount of bird migration is fundamental to the bird strike risk forecast issued by the German Military Geophysical Office.

1. INTRODUCTION

The control of birds over large expanses of airspace in which aircraft movements and bird activities overlap needs a dense observation network. Information about migrating birds at lower altitudes can be obtained by visual observations. For larger areas and heights above 1000 ft GND radar observations are necessary. A problem of radar observation is the varying quality in different areas based on the radar coverage, the used type of indicator and video processing. In the Federal Republic of Germany military and civil radar stations are performing observations of bird movements by polaroid pictures or 16 mm-film pictures of the radar scope. The results are used in different ways for the warning and forecast system of the Federal Armed Forces.

2. BIRD MOVEMENT DATA OBTAINED BY MILITARY RADAR STATIONS

The high-powered air defense radar stations of the German Air Force observe continuously migratory movements of birds. For the identification and determination of bird echoes polaroid pictures are taken from the radar scope with an exposure time of 12+3 minutes, with an interruption of 2 minutes, every three hours between dawn and dusk. In the morning and during periods with bird migration the time between two pictures is shortened to one hour. The observations are not carried out on weekends.

Disadvantages of the photographic system are a loss of information in the video processing as well as the identification and determination of bird echoes by different persons. Nevertheless a well-trained radar staff is able to discriminate echoes caused by bird movements from other targets and clutter echoes. The bird intensity according to the international 0 to 8 scale can be determined with an accuracy of $\pm$ 1 scale unit. This is sufficient for bird strike warnings (birdtam), because the bird strike hazard indicated by the bird intensity is always an average number, and the density of bird movements is varying within the relatively large area covered by birdtam. The electronic counting system for radar echoes can avoid many disadvantages of the photographic system, but it is difficult to estimate how significant the bird intensity counted in a reference area is for the entire area covered by the birdtam.

After the evaluation of the radar photo the following data are transmitted to the Geophysical Information Offices of the radar stations or of nearby air bases: radar site, time of observation, bird intensity, GEOREF-areas covered by bird echoes, and the direction of bird migration. There is generally a lack of detailed information concerning the altitude of bird migration. Therefore standard heights must be used in the birdtam. The observation message is transmitted via teleprinter to the Forecast Centre of the German Military Geophysical Office, where the message is immediately transformed into a birdwarning message (birdtam) according to formalized procedures. The birdtam are distributed to all military aerodromes as well as to foreign air traffic control centres via EDCCIV (see figure 1).

Additional sources of information concerning bird migration are some GCA- and Wx-radar equipment of aerodromes, pilot reports and visual observations. Foreign birdtam and bird warning messages are transformed into the format of NOTAM class 1 used in the German birdtam. A standardization of bird warning messages and birdtam/bird strike warnings will occur in 1986. Nevertheless differences of bird intensities and warning heights will still occur because of the different radar equipment, and the different procedures of evaluation. The main purpose of all observations by military radar stations is the immediate warning of bird strike hazards to the flying units.

3. BIRD MOVEMENT DATA OBTAINED BY CIVIL RADAR STATIONS

During the last years only a small part of the entire passage of migratory birds could be observed by the German military radar stations due to the priority of other tasks or technical problems. Therefore the data obtained are insufficient for a detailed analysis of bird migration. The continuous observations necessary for this purpose are performed by 3 civil L-Band radar stations. In contrast to the military observations the radar scope (PPI) is recorded by 16 mm-cine-film. In 1972 and 1973 the radar scope was filmed by the timelapse technique only during spring and fall. In 1975 the switching mechanism was modified to work at two photographs/hour, each with an exposure time of 15 minutes. During 3 months only 30 m film material are necessary for that purpose. Therefore the radar scope can be filmed continuously throughout the year. Nevertheless some interruptions occur by the change of the film or by the maintenance of the equipment. The owner of the movies is the German Bird Strike Committee (DAVVL). The evaluation of the total sequences enables the discrimination of bird echoes from other clutter. The observation of single pictures enables the determination of bird intensities and of flight directions.

The recordings by movie film cannot be used for actual bird strike warnings, but they are the most complete existing data of large-scale bird movements at altitudes above 600 ft GND. Therefore the films are important for the investigation of seasonal and spatial variations of bird movements as well as for the correlation between weather and bird migration. The figures 2 - 4 show the seasonal variation of maximum bird intensities detected by the radar station at Munich during the years 1981 - 1983, using mean intervals of 2 weeks to avoid variations of bird intensities due to days with insufficient observation. The intensity of bird migration was estimated according to the internationsl 0 - 8 scale.

During Spring higher bird intensities were registered than during fall,depending on generally greater flight altitudes,due to favourable air currents in spring. At night the migratory movements reached generally higher intensities than in the daytime. From the end of March to mid of May as well as from September to mid October night migration dominates in relation to daytime migration. The maximum intensities of bird migration at high altitudes and the busiest times of general bird migration correspond to each other. High and moderate intensities of bird migration do not continue longer than 3 days/nights in succession. The example of fall migration in 1983 (figure 5) shows the relatively quick change between days with high, medium or light bird intensities. The intensities and directions of the bird movements are influenced by the weather conditions of the departure areas as well as the weather enroute. Moderate bird movement intensities were reached for the first time on the 13th of October after the passage of a cold front, and under high pressure influence over Central Europe. Two days with moderate to high bird movement intensities occurred on the 22nd and 23rd of October after the presence of good flight weather over southern Scandinavia, Poland and East Germany on October 21st. Similar weather conditions with dropping temperatures caused moderate to high bird movement intensities on October 29th. The highest bird movement intensities of fall migration occurred on November 2nd and 12th, at high pressure influence and weak northeasterly winds over the departure areas CSSR/Poland as well as over Bavaria.

The correlations between bird movement intensities and weather factors are fundamental to the birdstrike risk forecast. This forecast issued daily by the German Military Geophysical Office considers the phenology of bird migration and vegetation as well as the weather conditions of the departure and passage areas of bird migration. The weather influence has been related to four parameters: flight weather (especially precipitation and visibility). Change of the temperature during 24 hours, wind direction, and wind speed. These conditions are determined from weather analysis and forecast data, and combined to a weather factor

modifying the mean bird strike intensity expected in accordance to the season and the actual bird migration 'till that date. The connections between the birdtam and the bird strike risk forecast system are shown in figure 6. As birdtam are based on actual observations of large-scale bird migration, and the bird strike risk forecast provides information on the average bird strike risk over a relatively large area, mostly the geographical forecast areas A1 to A4 (see figure 7), the two factors concerning bird strike hazards do not correspond in detail. The purpose of future work must be a denser network of data concerning migratory movements of birds as well as sophisticated computer models for the relation between bird movement intensities and predictable biological and meteorological factors. Also in the future radar observations of bird movements will be the main source to get fundamental data for the procedures necessary for the prevention of bird strikes.

FIGURE 1 Survey of the German bird strike warning system

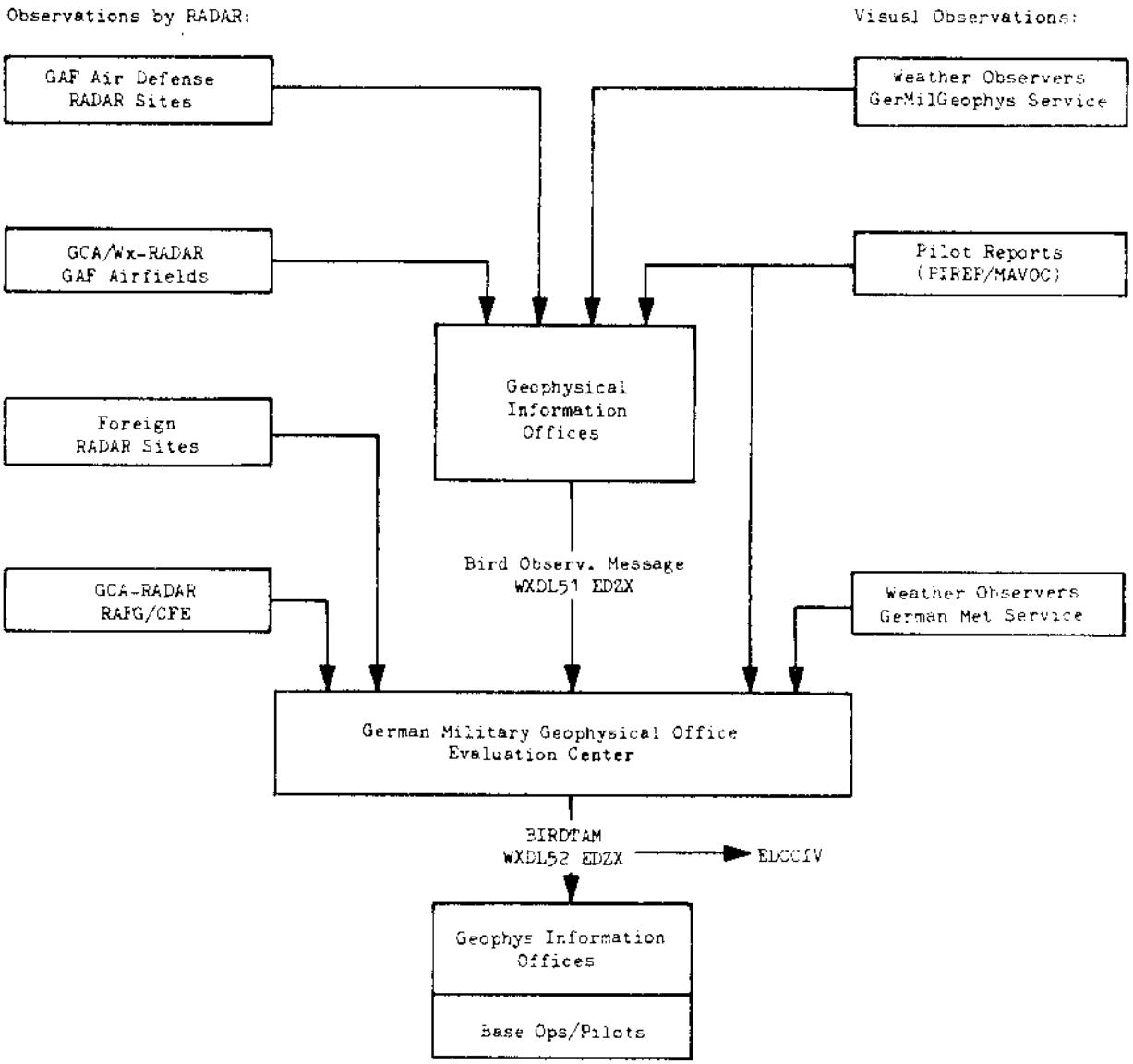

FIGURE 2 Seasonal variation of the average maxima of daytime bird movement intensities over Bavaria from 1981 to 1983

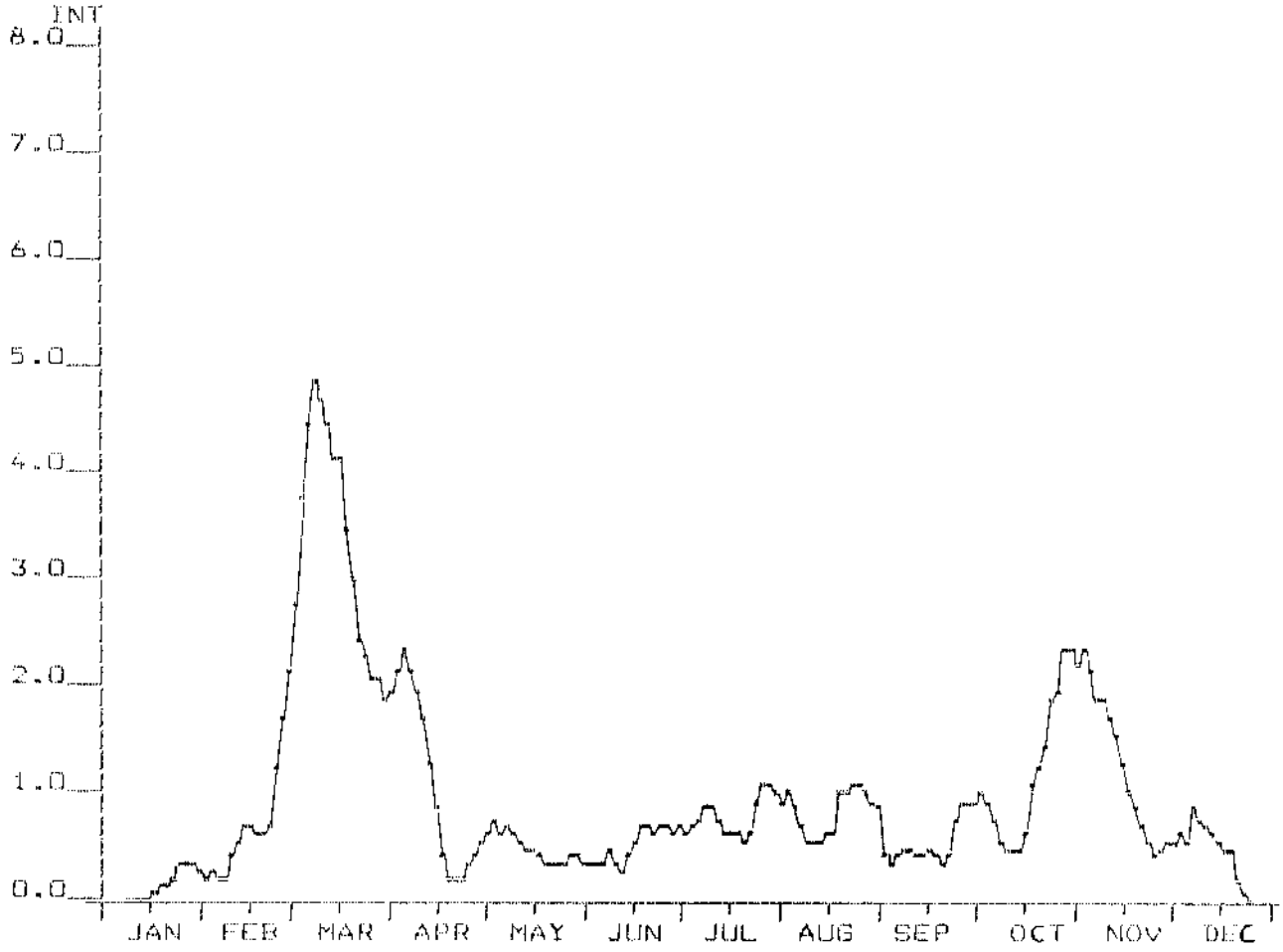

FIGURE 3 Seasonal variation of the average maxima of birdmovement intensities at night over Bavaria from 1981 to 1983

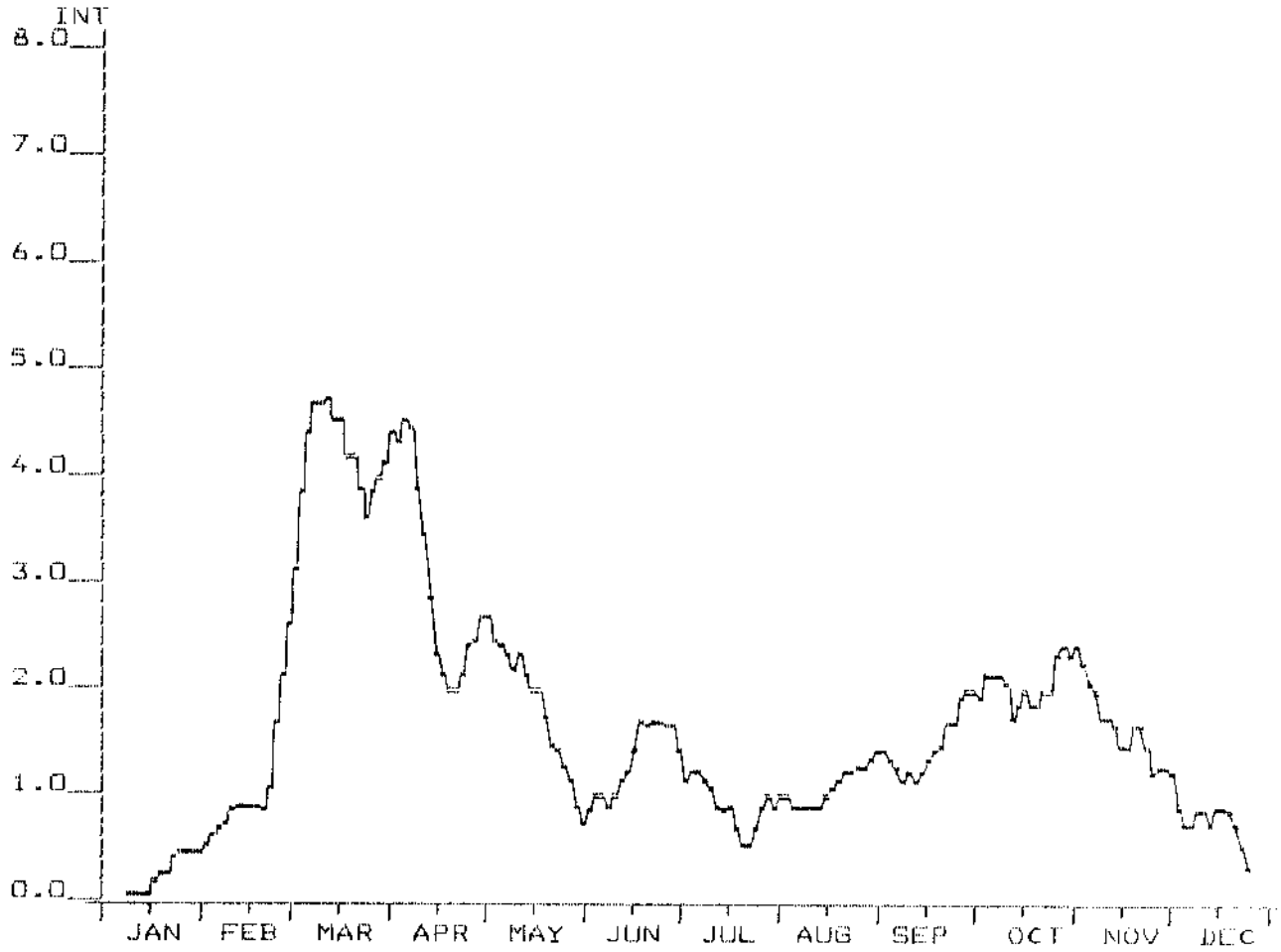

FIGURE 4 Seasonal variation of the average maxima of bird movement intensities at high altitudes over Bavaria from 1981 to 1985

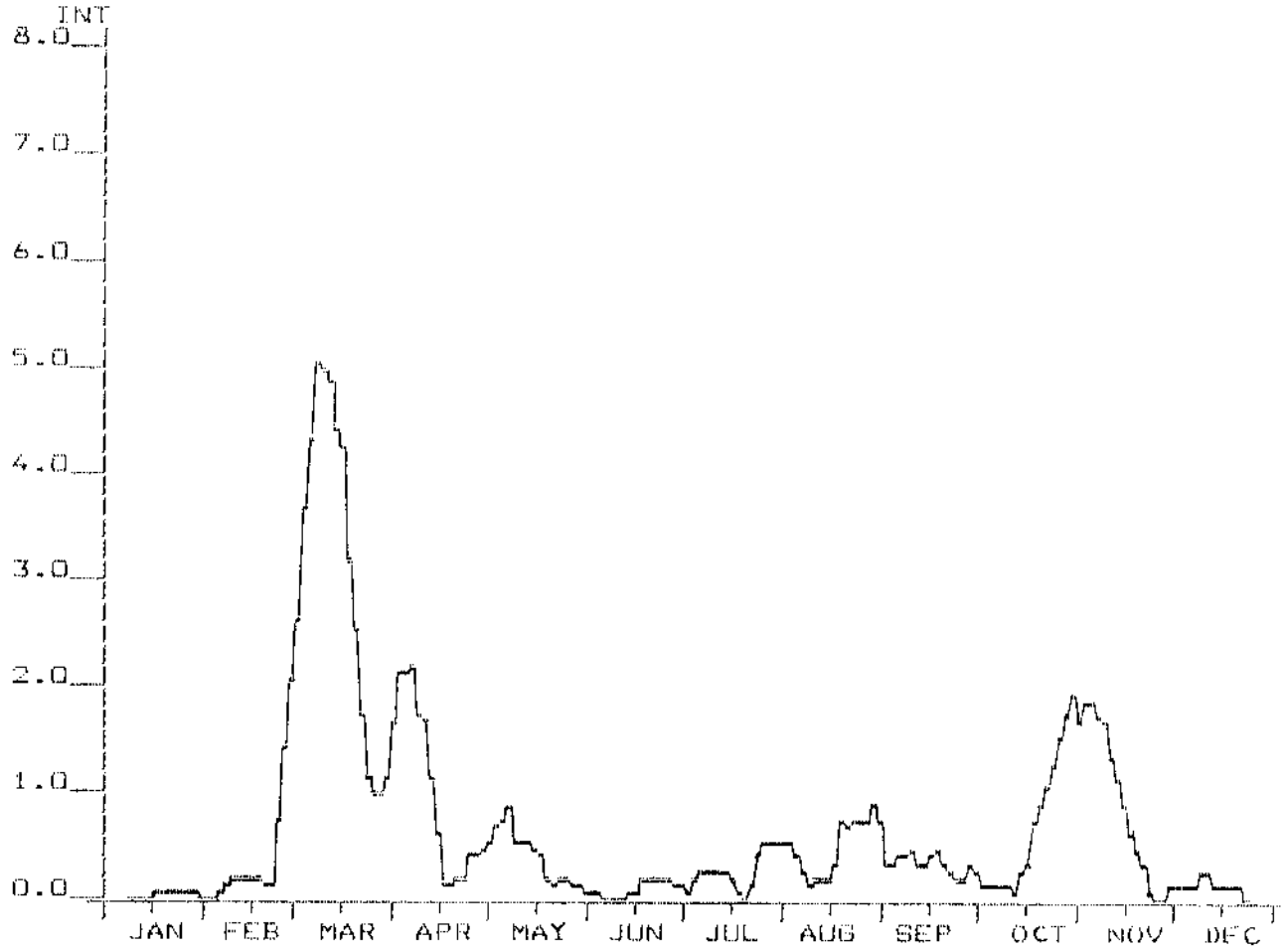

FIGURE 5 Daily maximum bird movement intensities over Bavaria from 15 September to 15 November 1983

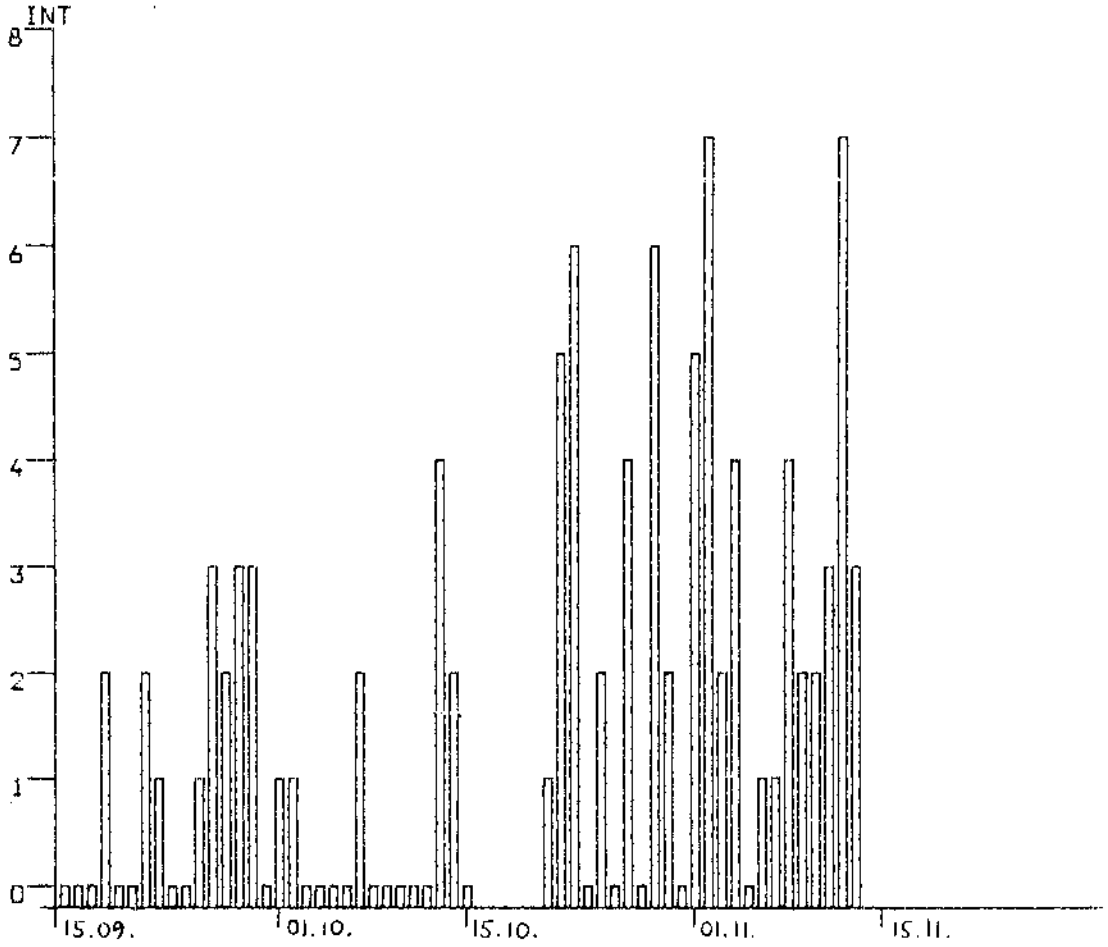

FIGURE 6 Survey of the German bird migration forecast and warning system

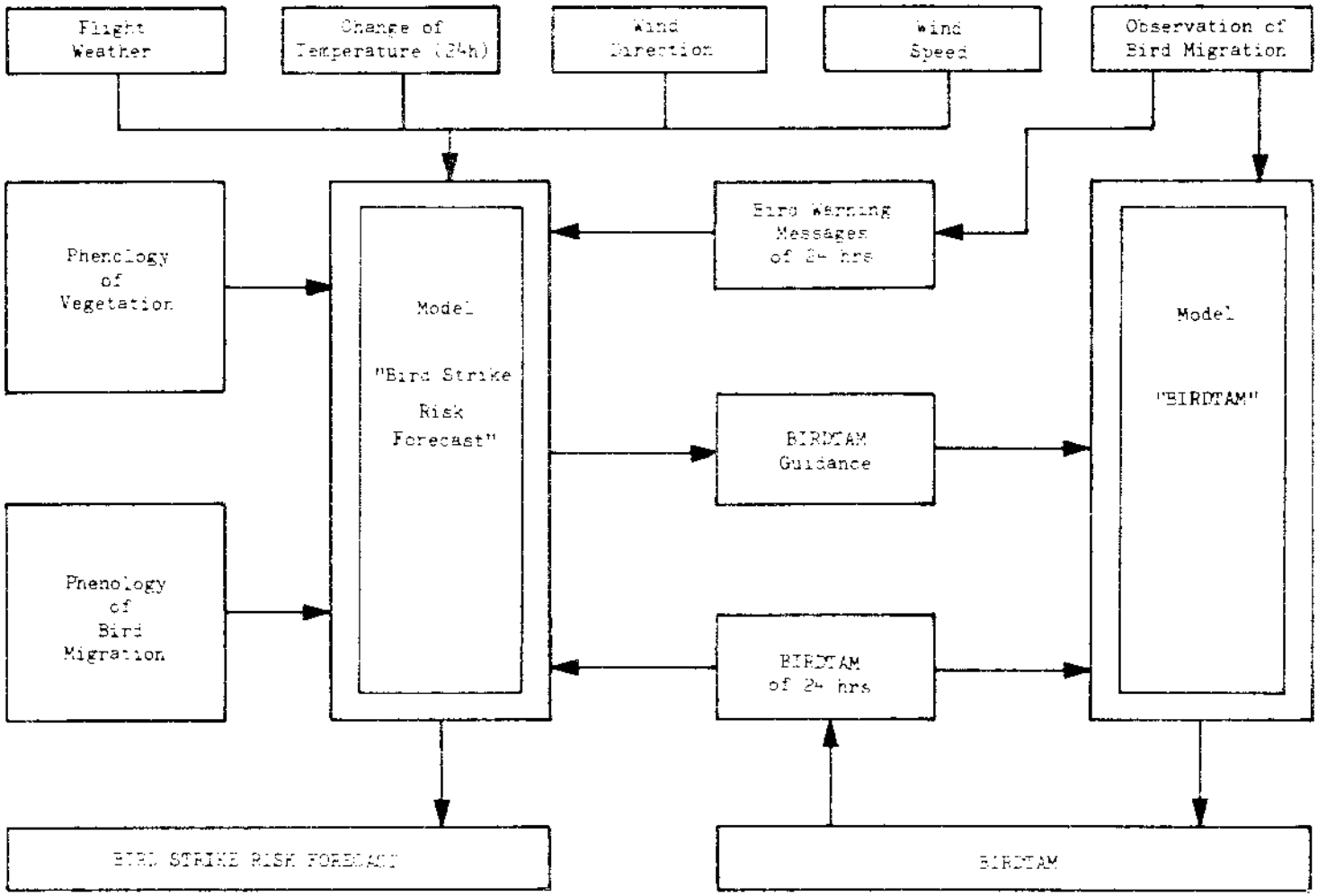

FIGURE 7 Reference areas of birdtam (GEOREF) and bird strike risk forecast (areas A1 - A4)