BIRD AVOIDANCE MODELS VS. REALTIME BIRDSTRIKE WARNING SYSTEMS – A COMPARISON

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Abstract

Bird Avoidance Models provide either short range bird strike risk forecasts or historically based average bird strike risk levels. Bird strike warning systems are based on real time monitoring and bird strike risk assessment of imminent bird hazard. In military aviation both concepts have proven to be effective tools to decrease the number of bird aircraft collisions. Based on personal knowledge about current models and systems as well as the experience with the Bundeswehr Geoinformation Office Real Time Observation and Warning System and working with the US and Alaska BAM the basic design concepts, advantages and limitations are discussed.

An attempt is being made to define and classify different types of existing models/systems and a proposal is made on a standardisation of naming conventions, which appears to be necessary, in order to use the same wording for similar products and not confuse the aviation community.

Keywords: Bird Migration, Bird Strike Warning, BIRDTAM, Bird Strike Risk Forecast, Avoidance, Radar

1. Introduction

Birdstrike prevention apart the airfield is most effectively conducted by warning procedures. As there is no direct interference possible to influence bird activity aloft, the only chance to minimize the risk of bird strikes is to avoid flying through high bird concentrations in the air. The presence of hazardous bird concentrations are well known during migration periods in the large temporal and spatial scale. But they also occur occationally throughout the year on a local or regional scale, mainly governed by the diurnal cycle. Monitoring, modelling, warning, predicting, forecasting are the major aspects of handling the problem and result in a certain advise, that is passed to the aviation community.

In military aviation there is often a good chance to change flight schedules according to bird strike warnings. This however is rarely possible in civil aviation. But, the awareness of an increased risk prepares for decisions that need to be made in case of a serious impact.

The following gives a brief overlook and discussion on some currently existing models, systems, methodologies and concepts. These models are all developed for the large spatial scale, bigger than the airport scale. It immediately becomes obvious that wording and naming should be carefully chosen in order not to confuse the aviation community, e. g. what is considered to be a model and what characterizes a system. This surely needs some discussion, but, a first attempt and proposal is made for a standardization, especially under the perspective of future international cooperation and globalization.

2. Bird Avoidance Models

a. United States Bird Avoidance Model

The USBAM is based on approx. 30 years of historic bird observation data for winter and summer distributions. These point data are transformed into average bird mass values and are interpolated spatially in a GIS environment for each of the birdstrike relevant species with a resolution of 1 km^2. The latest extension for Alaska also takes land cover characteristics into account for more realistic bird distributions in areas where data are sparse. Between the winter and the summer distribution a temporal interpolation is conducted, based on diurnal and annual activity pattern, breeding success and mortality rate. The overall average mass of birds per km^2 is transformed into 9 bird strike risk levels according to a logarithmic scale. Model output is displayed in an internet map application that combines the birdstrike risk level information with additional important map information for aviators.

Modelling in this case stands for an widely automized process to transform the historic bird count information into average time and space dependent birdstrike risk levels. Updates according to new data are provided approx. every 2-5 years.

b. German Birdstrike Risk Forecast Model

A different modelling approach is used in the operational German Birdstrike Risk Forecast Model. Statistical correlation analysis on the weather dependency of bird migration results in a decision tree algorithm for each season. The parameter s used are wind speed, wind direction, temperature, temperature change, precipitation intensity and soil conditions. Based on ornithological expert knowledge and up-to-date weather forecasts a 24 hour forecast and a 3-day outlook for 13 geographical regions in Germany are derived and transmitted to the German Forces where they become part of the daily flight weather briefing.

The currently still manually conducted modelling process is the transformation of weather forecasts and ornithological knowledge into a bird strike risk forecast. Updates are provided daily, during main migration periods twice daily.

c. Swiss/Dutch Dynamic Bird Migration Model

The most recent and not yet operational approach to model bird migration as the basis for bird strike risk assessments and forecasts is a fluid dynamic algorithm developed by Swiss and Dutch researchers. The grid based model currently uses a species dependent energy balance model and the wind component from operational numerical weather forecasts to simulate the flight path of birds starting in a certain area. The model area extends all over Europe and Northern Africa. The conceptual algorithm is flexible to account for new and additional sub-models.

Modelling is based on physical and biological rules and is a fully automized numerical process. Updates can be run any time and are able to account for any changes in input or parameter values.

3. Real Time Birdstrike Warning Systems

a. United States Avian Hazard Advisory System

The United States AHAS System provides bird strike advisory information to clients via web application on request. It uses the USBAM bird strike risk levels as the base line that provides the average risk level for any time and location in the US. For a current short range forecast up to 24 hours numerical weather forecasts and specific modules that account for thermal activity are processed by neural network technology to get an up-to-date birdstrike risk information and nowcast. A nowcast up to 1 hour is additionally processed and updated by NEXRAD-Weatherradar data. A trend is assessed and displayed for another hour if applicable. Information is presented in tabular format, presenting the details for military flight routes, training areas, airfields and military operations areas. Advisories contain a risk level of either low, moderate or severe. No altitudinal information is

given, however it is implied, that the risk level is valid for the lowest 3000 ft AGL. Current information is updated hourly by NEXRAD-Data. Meteorological forecasts are incorporated every 12 hours.

The system consists of a central server architecture, including a web and internet map server. Data are taken stationary from the GIS based USBAM risk surfaces and dynamically via broad band communication links to the US National Weather Service for downloading NEXRAD-Data and numerical weather forecasts. The information is displayed by user request from on the internet.

a. Dutch ROBIN System

A major component of the Dutch Radar Observation of Bird Intensities System is the scientifically sophisticated bird radar data processing unit which is especially designed and optimized for bird detection. Besides some two-dimensional air traffic control radars the two main radar systems are long range air defense radars. The raw data extracted from these radars are taken from the lowest two beams, which allows for a rough estimate on the altitudinal distribution of echoes. Tracking radar systems and small mobile radars are partly and temporary used to directly measure the altitude of flocks. The computer supported analysis is conducted by experts at a central location where all the data are available. Birdstrike warnings are submitted to national military users and internationally via flight safety network.

b. German BIRDTAM System

Based on existing military infrastructure and a central agency within a geophysical service the German BIRDTAM System is an efficiency optimized operational system. It uses reliable visual bird observation taken from trained weather observers and pilots, radar reports from air traffic control units and bird radar data from air defense radar systems. The latter is the backbone of the system. Although the currently used data are operationally filtered, so that some areas are masked and some echoes are suppressed according to the needs of the controller personal, high intensities of bird migration are still visible. The system covers the area and detects in three dimensions. Data gathering and processing is widely computerized and automized, but interpretation and analysis is needed. An expert system is used to support the experts. Warnings are created and submitted in real time by the computerized system. The communication systems used are the meteorological and the military and civil aviation flight safety networks as well as direct communication links between radars and the analysis center. Warning situations are also displayed on the internet.

c. Comparing Model and System Characteristics

Models and systems described above have in common that there overall goal is to assist in reducing bird strikes. The methodologies however are partly very different, resulting from the availability of data and communication networks and their historical development.

Confusing, even within the IBSC community, is the not existing clear definition of the wording used. Other than, e.g. in meteorology, the word model associates with different meanings. In order to better describe the type of model it should be named a conceptual, a statistical or a simulation model, as it is the case in the atmospheric sciences.

- The statistical model is based on historic data records and provides a statistic or stochastic information.
- The conceptual model is based on current data and a mathematically-physically representation of a relationship to forecast a situation into the near future.
- The simulation model describes a relationship between certain input values and output values that provides no information on a future situation.

The USBAM is a typical statistical model. The information that it provides is a prediction of an average situation. It does not tell the user about the probability of its occurrence. However, the information is valuable for planning in long temporal scales and has a positive effect in short term mission scheduling and planning. In the long run there is a positive effect on bird strike reduction, in short term it can well be negative.

The German Birdstrike Risk Forecast Model can be classified as a conceptual model. It uses relationships between weather parameters and bird activity. Forecasting bird strike risk is based on numerical and heuristic weather forecasts as the forcing elements. Although the term “Risk” might be misleading, it provides short range forecasts of birdstrike risk levels close to reality. Accuracy depends on the meteorological forecast skill and the accuracy of the correlation. The methodology allows for further improvement.

The Swiss/Dutch Dynamic Bird Migration Model in its current state performs as a simulation model, although its basis is a conceptual approach. Linking bird behaviour and weather forecasts accounts for high accuracy. Difficulties are the lack of knowledge on parameter values for individual bird species and the approach to model each species, even individuals, separately. The most sophisticated theoretical background needs to be parameter optimized, calibrated and build into an overall forecasting model.

All the “Systems” have in common that they are providing bird intensity information mainly focussing on the very near future, a “Nowcast” in meteorological terms. They all rely on real time observations and use communication networks. Output goal is to generally provide warnings for above average bird concentrations. Whereas the data analysis, whether automized, partially automized or manually, is relatively complex, the warning generation algorithm is rather simple. The assumption is, that in a short-term nowcast there is no big change in the influencing factors like weather conditions.

Based on what has been described and discussed above, important differences between “Models” and “Systems” are that Models are more independent on real time data than Warning Systems. Models focus on forecasts or predictions and use complex algorithms to extend the forecast period into the future or display statistical information. Systems generally consist of complex hard and software infrastructure. Classical components are observation, analysis, communication, display. Systems are open for new components. Usually they are in an operational environment and have to be adapted to the user’s demands.

d. Naming convention proposal

In order to overcome confusion in naming different methodologies and definitions, the following definitions are proposed and should be subject of further discussion within the IBSC:

- **Birdstrike Risk**
  - Probability of birdstrikes at a certain density of birds. It also depends of the aircraft type, aircraft speed and other factors
- **Bird Hazard**
  - Increased birdstrike risk that is well above average at a specific time and location.
- **Bird Avoidance**
  - No aviation in areas with known hazardous bird strike risk.
- **Bird Awareness**
  - Aviation under known hazardous conditions and being specifically prepared to take actions.
- **Technique, Algorithm**
  - Theoretical physically, mathematically based structure to describe a specific process.

- **Model**
  - Framework of techniques and algorithms to theoretically describe a real world system in order to either predict or forecast a situation.
- **System**
  - Interacting Components, such as models, sensors, communication networks to utilize model outputs.
- **Simulation**
  - Modelling of a real world system to redo and understand a known situation.
- **Advisory**
  - Information based on best available knowledge for decision making.
- **Warning**
  - Information about a critical situation.
- **Prediction**
  - Information about an expected situation that is based on statistical significance and probabillity.
- **Forecast**
  - Information about an expected situation in the near future based on observation and modelling.
- **Nowcast**
  - Information about a current observed situation that is extrapolated into the very close future
- **Real Time**
  - Very close to present.
- **Historically**
  - Based on long records of data.

e. Conclusions

Under the perspective of globalization and that new models and systems are about to be developed in North America and elsewhere, these and existing national methodologies should be standardized so that at least the output and user interface should follow similar conventions.

Comprehensive “Advisory Systems” could combine models and systems under one umbrella so that information can be provided in different spatial and temporal scales and serve different needs. A distinction has to be made on the spatial scale whether it is small (airport) scale or large (mission) scale. The temporal scale has to be divided into long term prediction, short or medium term forecasting and real time nowcasting. The scale clearly defines the methodology being used.

Wording should be carefully chosen in order to avoid misunderstanding in international communication.