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THE AVIAN HAZARD ADVISORY SYSTEM

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Abstract

The Air Combat Command (ACC) Bird Hazard Working Group (BHWG), in conjunction with Geo-Marine Inc., has developed a system to use NEXRAD weather radar data, weather forecasts, and known bird distributions, to identify bird hazards to military aircraft conducting low altitude, high speed training, and provide aircrews with hazard advisories. The paper presented here describes Phase I of AHAS implementation, the demonstration and validation phase, conducted during the fall 1998 migratory season in the Northeast U.S. Forecasts of bird activity for the next 24 hours, observations of current migratory conditions and historic data from the US Bird Avoidance Model (BAM) were provided to aircrews via the Internet. Phase II will expand coverage to the entire East Coast of the U.S. in 1999. The Avian Hazard Advisory System (AHAS) was designed to pinpoint actual bird movement to allow for more effective risk management than is possible from historic data alone.

Background

Geo-Marine Inc and HQ Air Combat Command (ACC) conducted a risk assessment of bird strikes during low altitude training in 1997. Risk was defined as number of strikes multiplied by body mass.

1	Turkey Vulture
2	Red-Tailed Hawk
3	***Snow and Canada Geese***
4	***Ducks (Mallard and Pintails)***
5	Golden and Bald Eagles
6	Black Vulture
7	***Herring Gull***
8	***Sandhill Crane***
9	***White Pelican***
10	***Tundra Swan***
11	***Double Crested Cormorants***

Table 1

The results (table1) showed that 94% of the risk came from just ten groups of birds. An eleventh species was added in 11th position in the table due to rapid population growth and flight behavior that makes a strike on low altitude missions highly likely in the future. These became the priority species for risk management by the Air Combat Command (ACC) Bird Hazard Working Group (BHWG). 7 groups in table one (in italics) can be detected on the NEXRAD (WSR-88D) weather radar. The remainder are not reliably detected at the normal densities found in N. America due to processing techniques employed by the radar. The activity of these species can only be predicted from weather conditions and cannot be monitored in near real time.

The AHAS concept was developed by HQ ACC/SEF and funded by HQ ACC/DOR to manage the risk to ACC aircraft conducting low altitude training. ACC has the greatest exposure to bird strikes of all

branches of the United States Air Force (USAF) due to the nature of their mission. Over the past twenty years, the Air Force has reported more than 30 aircrew fatalities, 20 lost aircraft, and hundreds of millions of dollars in damage.

In the fall of 1998 the Avian Hazard Advisory System (AHAS) was tested by HQ ACC and Geo-Marine, Inc. In the test phase AHAS provided USAF with a means to monitor and predict potentially hazardous bird activity along selected regions of the Atlantic Coast of the United States.

The aim of AHAS is to
a) Prevent loss of life
b) Prevent the loss of aircraft and
c) Reduce the cost of bird strike damage.

Project Description

AHAS consists of the following elements:

A forecast of bird migratory activity for the next twenty-four hours.
A forecast of soaring bird activity for the next twenty-four hours.
Near real time monitoring of bird activity with NEXRAD radar.
Radar Data archiving for system development.
A link to the US Bird Avoidance Model (US BAM).

Forecasting

AHAS is a dynamic version of the US BAM. The US BAM is based on historical data on where large concentrations of birds are located and when they are active. The US BAM integrates this data in a Geographic Information System.

AHAS takes current weather data from the National Weather Service and calculates the risk large bird species present, based upon the relationships found between behavior, weather and strike rate with each species. Standard meteorological calculations are used to determine thermal depth and strength that gives Red-tailed Hawks the energy to soar over their territories and Turkey Vultures the altitude to cover long distances when searching for food. Weather data is also used to determine when birds will initiate migration. A new rule based forecast technique was developed to predict when weather conditions favor migration. This technique was considered more stable and predictable than results from conventional statistical techniques.

Test results show that AHAS can predict bird conditions 24 hours in advance. These 24-hour predictions are often less restrictive than the US BAM because AHAS forecasts recognize that birds don't migrate with strong headwinds or soar without thermals. In some cases, the AHAS forecast may identify higher risks than predicted from the historical US BAM data.

Near real time monitoring

AHAS uses the Next Generation Weather Radar, WSR 88-D (NEXRAD) weather radar system to monitor bird activity in near real time. Birds are, in simple terms, bags of water, so sensitive radars such as NEXRAD cannot differentiate between bags of water wrapped in feathers or the same volume of water distributed as precipitation. Birds do differ from rain in one important aspect. Rain tends to have both vertical and horizontal distribution. A storm can be 20 to 30 thousand feet up and cover many square miles on the ground. Large movements of birds tend to lack any significant vertical distribution. Most birds on the East Coast fly below 4000 ft and elsewhere below 12,000ft.

By some clever data processing it is possible to remove much of the weather from the radar data due to the vertical distribution of the precipitation and leave the bird returns. This technique was developed for

the AHAS project and provides a means to turn off and on the risk levels presented in the US BAM in near real time. This eliminates the need to identify the type of bird target on the radar. The logic used is that if bird activity is detected by NEXRAD in an area where hazardous bird activity is expected by the BAM then the area is designated as hazardous by AHAS.

This system provides for regular updates (approximately 20-35 minutes old) of current bird conditions. These are posted at hourly intervals via the internet and provides information that can give a Supervisor of Flying (SOF) or a pilot the real picture on current flying conditions.

Link to the US Bird Avoidance Model

The AHAS system has ported NEXRAD NIDS data to a GIS platform. This provides a means to relate bird activity detected by radar to known hazardous concentrations described in the BAM. With weather targets largely removed from the radar images this allows for an automatic interpretation of the worst case risk situation for the detected targets. This removes the need for human radar image interpretation, a time consuming process, which would add excessively to the timeliness of the risk analysis. The GIS is used to extract risk information that is made available to aircrews via the Internet in near real time.

When radar or weather data is not available to AHAS then the system automatically defaults to the risk described in the US BAM. This ensures that the best available data is always available to pilots, aircrew and commanders via the Internet.

Radar Data archiving for system development

The AHAS system has capability to archive all GIS images of radar data, weather observations and forecast model data. This provides a means to test weather suppression techniques and new data products on actual data for rapid system development. New methods and data products can be tested on weather conditions that may take 12 months or more to experience in operational testing. It also permits forecasting techniques to be further refined based on a larger set of observations. This archive is also considered an important feedback loop to the US BAM as one of the highest fidelity sources of data on the historical spatial distribution of birds.

Results

Observations and predictions made from the Panama City, FL, base were validated in the field by biologists equipped with a mobile radar system and thermal imaging camera, a system capable of very accurately monitoring and describing bird activity day and night.

During the fall of 1998, many migrant waterfowl stayed in Canada, due to exceptionally mild weather conditions, until well after they would be expected in the northern states. When the weather changed in November it occurred right before the Veteran's Day holiday. A warning was posted on the AHAS site 36 hours ahead of the worst of the migration hitting the East Coast. Twenty-four hours after the warning was posted, most of the migration corridors in the lower 48 states were saturated with migrating waterfowl. The northern states, where the birds would normally stop over, were covered in six inches of fresh snow so the birds pressed on. Based on these observations, HQ ACC/SEF issued a bird warning to all flying units as they returned from the holiday via e-mail. The forecast system showed probabilities of one, the highest possible, for this significant event.

The initial test was considered an overwhelming success. Bird hazard forecast models and radar data processing protocols evolved quickly to provide rapid data analysis and risk assessment. The PC based platforms were down less than 12 hours (0.8% of the time) during the 1,464 hour test period. Daily bird hazard forecasts were posted each morning at 1000 hours on a dedicated website. The forecast covered the entire airspace designated for the test and provided risk assessment for each segment of the designated low-level routes. These forecasts were based upon bird distributions from the BAM and

corrected risk based upon weather forecasts and previous days bird movements from radar data. Hourly advisories were provided based upon filtered radar data. During this test period, the US BAM reflected the expected large concentrations of waterfowl. While most biologists agree that the real risk exists only during portions of this time, few were willing to estimate when those periods were without the benefit of weather data and actual field observations. AHAS, using hourly weather information, weather radar data, and field observations resulted in less restrictive advisories 49.2% of the test period. AHAS yielded the same level of restrictions 40.2% of the time and was more restrictive 10.6% of the test period.

Future Development

The system is currently being expanded to cover 1/3rd of the lower forty-eight states in phase two and within two years should cover the entire lower 48 states. Real time updates and forecasts will again be posted on the internet and coverage will expand to cover all VR and IR routes, MOA's, Ranges, LATIN Areas and military airports in the eastern 1/3rd of the US by the end of the year. Refinements to the weather suppression technology used on the NEXRAD radar images are planned. Additional bird data products are also planned based on advanced processing techniques of NEXRAD radar images.