



- WSP; Weather Signal Processor (ENIGMA III)
- AU: Adaptation unit to the ATC sensor
- WDP; Weather data processor with Software FrogRT on LINUX PC
- ASTERIX CAT 8 data Interface to the ATC controller consoles

#### 4 Weather data and bird migration data results

##### 4.1 Typical weather data display examples

Reflectivity Z and V measurement (with clutter correction)  
R=100 = 60 nm km range

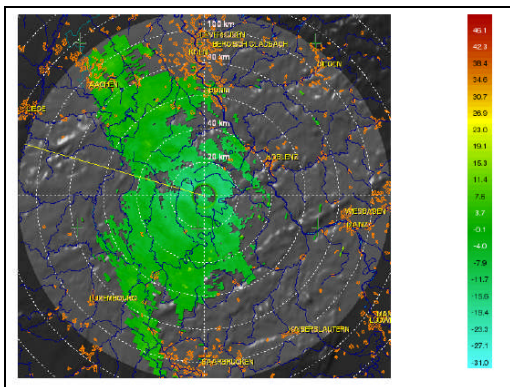


Fig. 2. Corrected Reflectivity Z, example

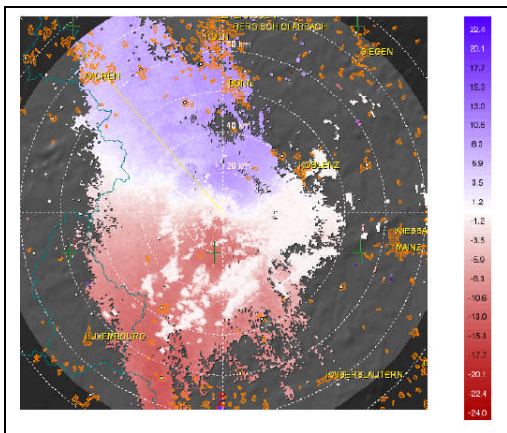


Fig. 3. Radial Velocity V, example

##### 4.2 ASTERIX data for the ATC controller consoles

The Category 8 window is used for monitoring contoured two dimensional weather images. It is primarily used by the Air Traffic Controllers to have a visualization of the clouds as underlay in the control area. Additionally the algorithm for bird detection will generate a special layer contour for warning in case birds or flocks of birds are detected.

The following screenshot shows a CAT 8 ATC weather contour display which may be easily exported to ATC controller positions

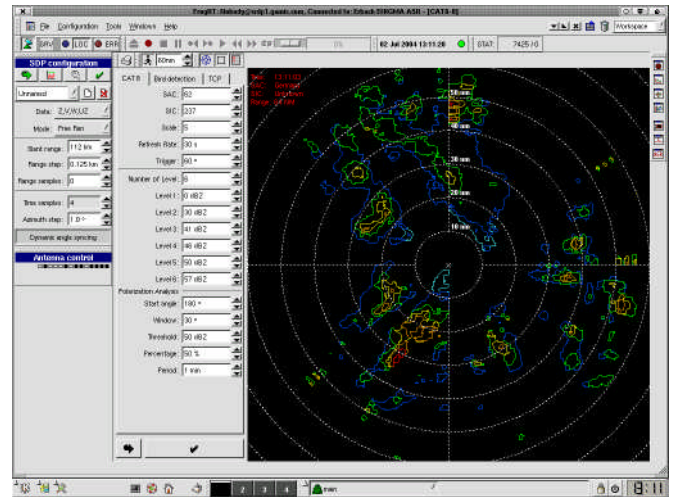


Fig. 4. ASTERIX CAT 8 weather contour image.

##### 4.3 Comparison with DWD weather radar data

The comparison with data recorded at approximately the same time using German Weather Service DWD radar data shows the following results:

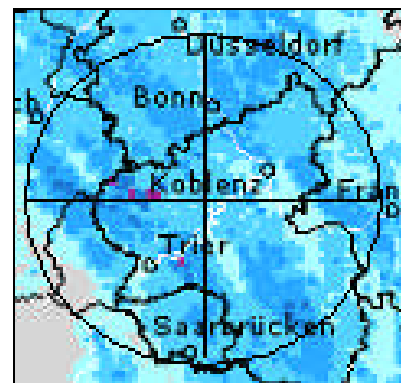


Fig. 5. DWD - PPI data (Z)

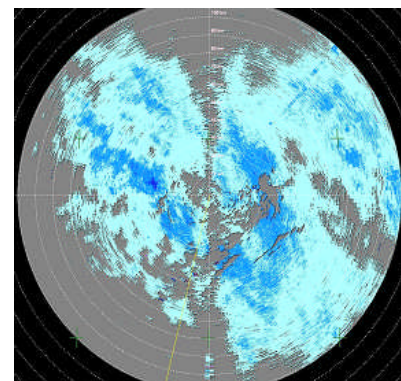


Fig. 6. ASR-S radar weather channel data (Z)

It is observed that the phenomena are slightly underestimated at longer range, which can be corrected. Generally it shows that a good qualitative presentation of the weather situation is achieved, particularly in the vicinity of the radar site – which is most important for the flight operations.

#### 4.4 Bird migration detection algorithms and implementation

The EADS European Aeronautic Defence and Space Company in cooperation with GAMIC has developed a new approach for the detection of bird migration. Some constraints:

- An ATC Primary Surveillance Radar does not have enough Azimuth/Range/Doppler resolution which allows a satisfying classification rate between a slow aircraft and a group of birds in real time because of a limited amount of dwell hits.
- Bird migration is an activity spread over half a day without major changes.
- Bird flock is similar to widespread discrete moving clutter contrary to an aircraft or a weather front.

A lot of Radar data were recorded and evaluated during the year 2005 and 2006. The campaigns of measurements were done in collaboration with the Geo Info. Off. Biology Sect. of the German Army in order to confirm the presence of Birds.

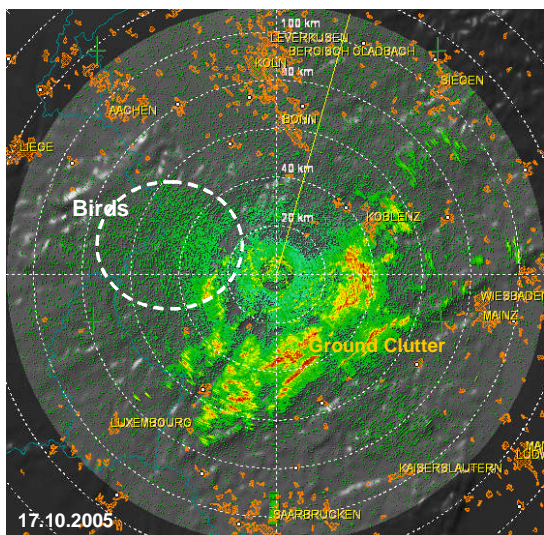


Fig. 7. ASR-S radar weather channel data with bird data

A new algorithm was developed using image processing together with the pattern recognition. The pattern recognition is a modern and necessary approach for decision making; Aircraft, weather front, or Bird migration. The relevant features from the texture analysis are statically assessed in order to distinguish information from clear weather, from weathers front, from ground clutter and from birds.

The radar data flux is processed simultaneously with antenna azimuth rotation as received from WSP. A PPI-detection matrix (PDM) comprising 600 x 75 cells is generated. The PDM first is stored on WDP for post processing.

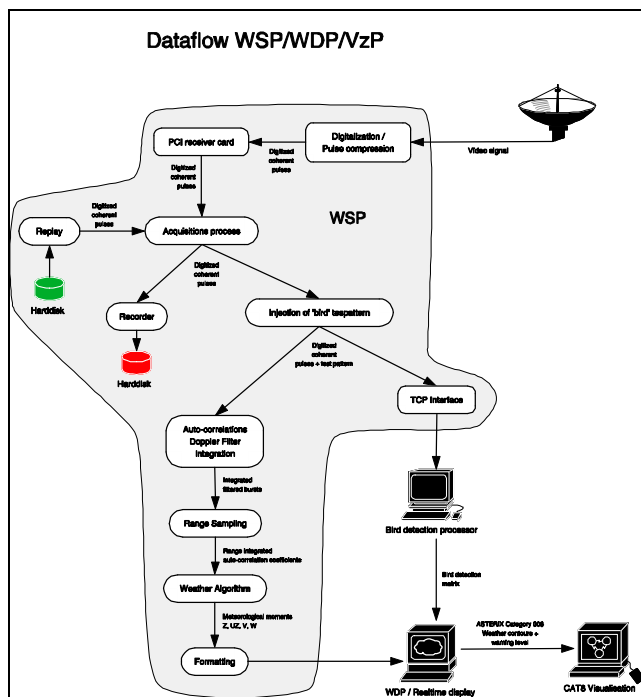


Fig. 8. ASR-S radar weather channel data flow

Subsequently the bird detection based on the PDM uses pattern recognition methods. Image processing algorithms like texture analysis together with a Doppler analysis are applied. The relevant features for rain, clutter and bird migration are separated in the radar data and finally are used as input data for a statistical classification system.

After optimisation the successive stages of the processing chain (Pattern optimisation, classification tree optimisation and threshold optimisation), a classification better than 80% (Fig.8) could be achieved.

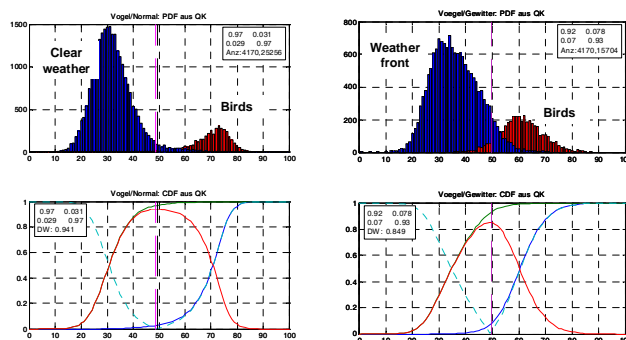


Fig. 9. Classification plots – probability of detection of clutter, rain, birds

The first results from the Years 2005 and 2006 are promising. It has been demonstrated that a better classification of target reports can assist the controller to make better decisions without decreasing the sensitivity of the primary radar.

## 5 Conclusion

The ASR-S weather channel with GAMIC WSP-WDP is tested to improve safety by warning controllers and pilots of hazardous weather like strong rain, wind and bird migration events near runways. The FROG-MURAN can be used to predict the arrival and track weather event motion giving a complete picture of current and future terminal area hazardous weather conditions which may impact runway usage for take-off and landing. The weather channel will detect hazardous weather and bird migration on the ASR-S improving the capabilities security in air traffic control as needed by mission sensitive flight operations.

The GAMIC WSP-WDP weather channel can easily be used with a variety of operational ATC radars (Magnetron, Klystron, TWT, Solid-State) to upgrade the weather detection capabilities to modern technology.

The possibility of using such ASR weather information as a supplement or merged with data from "civilian" weather radars operated by DWD is currently under consideration.

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## **References**

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