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Proposal to Develop a Global Network to Predict Bird Movements on a Real-Time and Daily Scale by Using Radars

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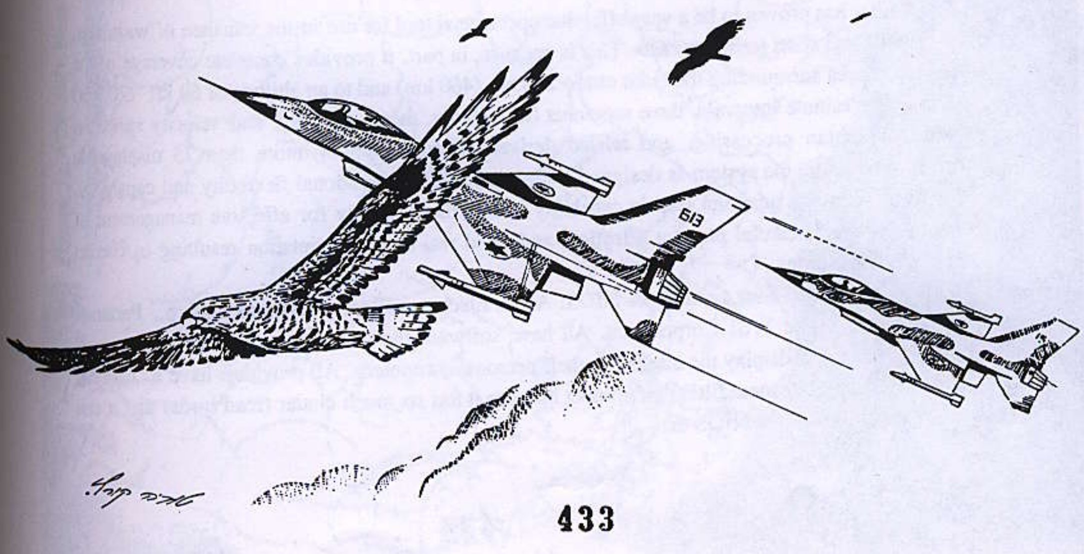
Summary

Civilian air traffic as well as military flights have increased significantly during the last decades. Military aircraft now fly at low altitudes and high velocities during day and night, using fire zones in several countries. The cost of commercial and military aircraft has increased two fold during the last decades. For these reasons, the potential for damage caused by birds has increased dramatically. We propose to develop a global network of radar to predict bird movement on a real-time and daily scale through the use of a network of regional radar systems.

A network of regional radar systems should be developed in the Middle East, around the Mediterranean Sea, in Western, Northern, and Eastern Europe, in Asia, and in Africa which will provide together a global network as currently in place in the USA for weather prediction by NEXRAD WSR-88D radar. It should be proposed by BSCE to the European Market, leading insurance companies, and others to develop the system which can significantly reduce the number of air collisions in order to save lives and billions of dollars.

Keywords

Weather, Warning System, Migration, Radar, Visual, Aircraft, Airline, Civil Aviation, Military Aviation, Low level, Risk Assessment, Avoidance



Introduction

Radars were developed for military purposes, in order to control air traffic and locate aircraft. The greatest advantage of the radar is its ability to identify diurnal as well as nocturnal migration, and to follow migration at high altitudes beyond the scope of observers on the ground. Researchers previously used existing radar systems, developed for 5 main goals: 1) Military use and air traffic control 2) Anti aircraft fire system radars 3) Airports surveillance radars 4) Weather surveillance radars 5) Marine radars.

Civilian air traffic as well as military flights have increased significantly during the last decades. Military air forces now fly at low altitudes during day and night, using fire zones in several countries. The cost of commercial and military aircraft has increased two fold during the last decades.For these reasons, the potential for damage caused by birds has increased dramatically.

Over the past three decades a number of articles on migration research by radar have been published (Eastwood, 1967; Gauthreaux, 1970; Richardson,1979 ;Kerlinger, 1989; Bruderer&Liechti,1995; Buurma 1995, and others). During several meetings of the BSCE, it was felt necessary to produce a publication on the application of radar for bird strike reduction. Buurma and Bruderer (1990) produced a comprehensive booklet on this subject which summed up very well the problem, general aspects of bird detection by radar, different types of radars, and their suitability for bird observation and operational use. In this paper we will propose the development of a global network to predict bird movement at the same level as has been achieved in weather prediction.

Networks predicting changes in weather have improved significantly in the last 20 years. The networks are based on weather radars, satellites and worldwide databases. The U.S government has invested $2.1 billion in a joint project of the Federal Aviation Administration (FAA), National Weather Services (NWS) and the Department of Defense in creating a network of 150 NEXRAD radars (NEXt generation doppler RADar) model WSR-88D replacing the older model WSR-57 radars. The NEXRAD radars are located at airports and weather stations, covering the whole country. 137 radars are already operational, and by the end of 1996, all 150 radars will be in place (see figure 1).

The radar has proven to be a very effective operational tool for use in the issuance of warnings, statements, and short term forecasts. This is because, in part, it provides complete coverage of the volumetric area surrounding the radar out to 248 nm (460 km) and to an altitude of 60 kft (20 km) AGL at five minute intervals, three moments (reflectivity, mean velocity, and velocity spectrum width), algorithm processing, and related derived products totaling more than 75 displayable forms. In addition, the system is designed with considerable operational flexibility and capability. However, with this quantum leap in capability comes the necessity for effective management of system resources, careful product selection, and rapid real-time interpretation resulting in correct decisions and actions.

The NWS approved four vendors of NIDS: Alden Electronics Inc. ,Kavouras Incorp., Paramax Systems Corp., and WSI Corporation. All have software that enables a user to access current WSR-88D data and display the images on their personal computers . All providers have a "national mosaic" product, but some filter that product because it has so much clutter (read birds) that it can be confusing to users of NIDS data.

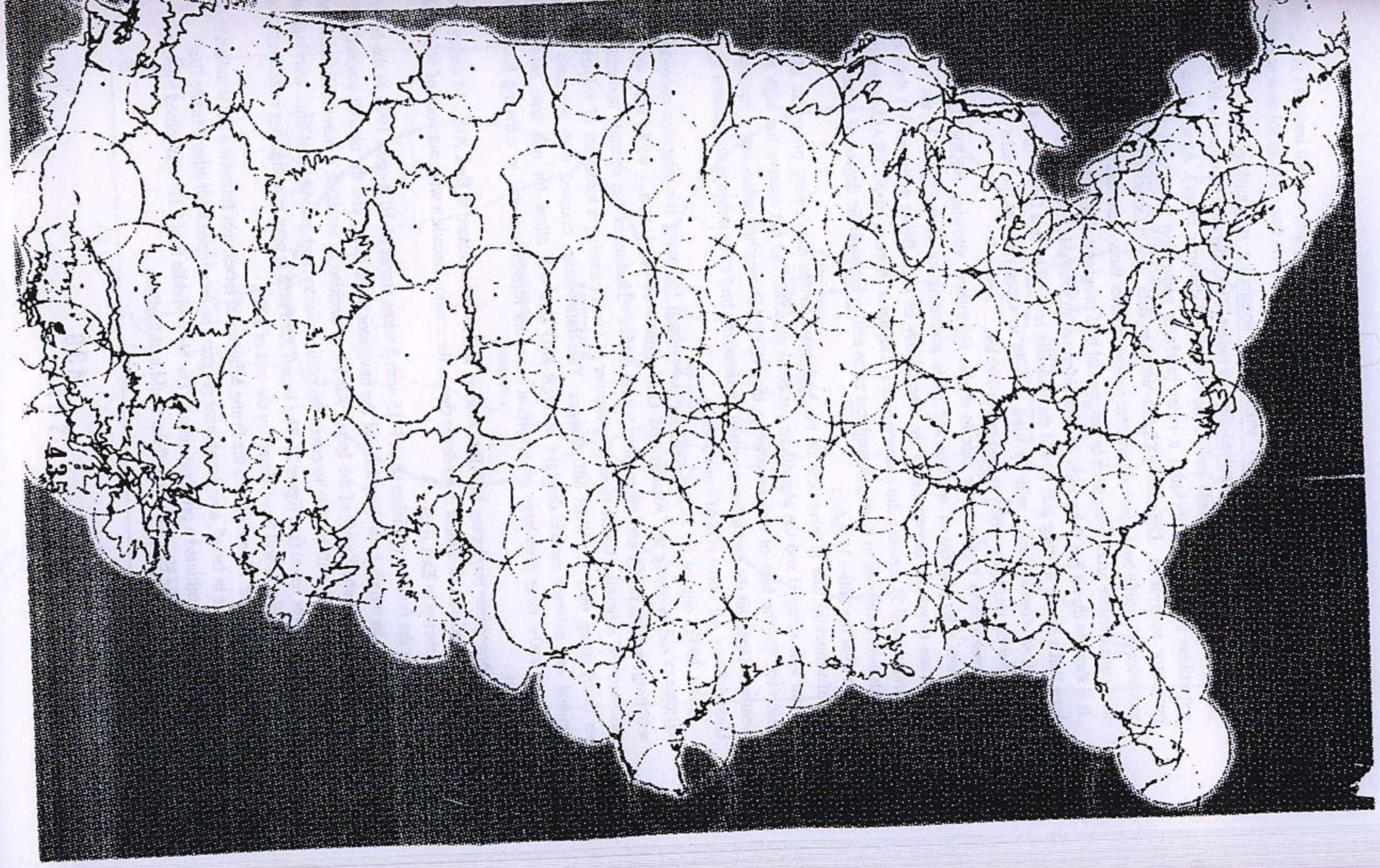


Figure 1: WSR-88D, Next Generation Weather Radars (NEXRAD), network over the USA.

Larkin & Quine (1988,1989) studied the possibility of implementing bird recognition algorithms in the large S-band pulsed doppler radars. The radars are equipped with a narrow beam and great power (1 megawatt) and sensitivity (90 dB dynamic range). Apart from the radar data acquisition subsystem it includes a radar products generation subsystem and a principle user processor subsystem. Digital NEXRAD weather data are automatically processed by large computer programs but in periods without severe weather the system has the optional capacity to offer considerable processing time to run special bird programs (De-Fusco, Larkin & Quine, 1986) . It is thought that it has the option of bird information available every 5-15 minutes. Calculations show that a single herring gull would theoretically be visible as a faint target at a distance of 450 km (but, of course, never will fly high enough to ascend above the radar horizon). Songbird echoes during migration often extend out to 200 km.

The researchers expect to be able to devise algorithms allowing NEXRAD to automatically distinguish echo patterns of weather and birds according to: 1) the speed of the birds, 2) their appropriate migratory directions, 3) the time of day of their flying activities, 4) their relation to topography, and 5) certain echo characteristics. The plans were to let NEXRAD radars report bird hazards with reference to large geographical areas and to estimate the degree of hazard in different altitude over the entire U.S.A.

Unfortunately, the involvement of the bird issue in the developing programs of NEXRAD system was stopped and the algorithms for birds detection did not receive the high priority they deserved. To the best of our knowledge the NEXRAD weather radars are a success story for weather usage, but the enormous potential for detecting bird movements is not utilized by either the United States Air Force (USAF) or the FAA.

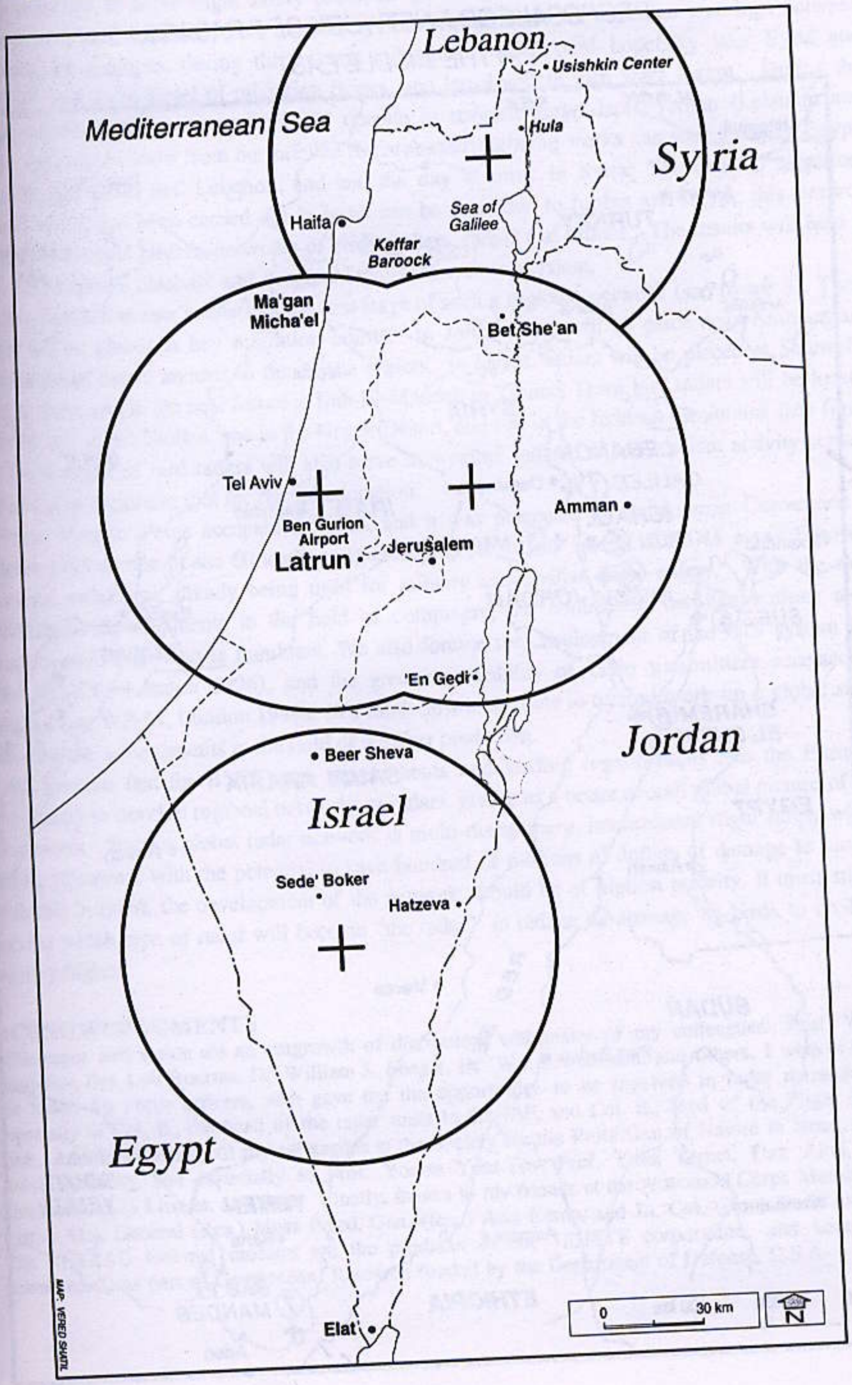
Since 1992, one of us (S.A Gauthreaux) has been following the migration recorded by 14 NEXRAD radars along the Atlantic and Gulf Coasts of the U.S.A., while also using moon watching, marine radar, and other direct visual means. Gauthreaux has recently completed a bird calibration of migration traffic rates (the number of birds crossing a kilometer of migratory front per hour) using only the WSR-88D images. This information coupled with regularly updated regional and national mosaic displays of WSR-88D data will allow for real time measures of migration traffic rates over large geographical expanses informaion vital to reducing bird/aircraft collisions.

A daughter group producing NEXRAD radars will soon be created in East Asia. 14 radars have already been ordered and there is no doubt that in the coming decade a wide network of NEXRAD radars will develop in East Asia.

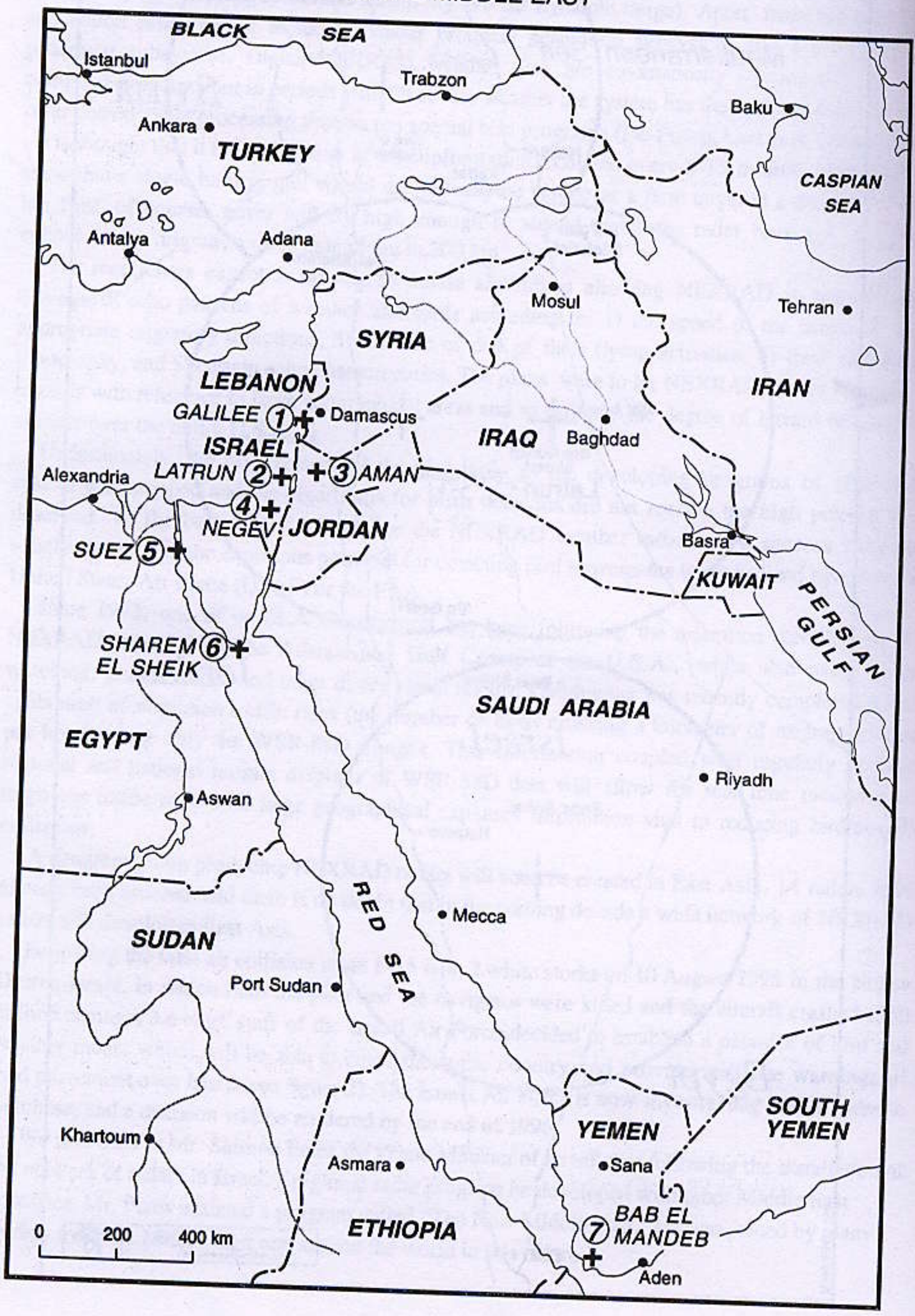
Following the fatal air collision of an F-15 with 3 white storks on 10 August 1995 in the Negev Desert, Israel, in which both the pilot and the navigator were killed and the aircraft crashed ($50 million damage) the chief staff of the Israeli Air Force decided to establish a network of bird and weather radars which will be able to cover the entire country and provide real-time warnings of bird movement over Israel (see figure 2). The Israeli Air Force is now investigating which radar to purchase, and a decision will be rendered by the end of 1996.

We proposed to Mr. Shimon Peres the Prime Minister of Israel, that following the installation of the network of radars in Israel, a regional radar program be developed with other Middle East countries. Mr. Peres initiated a program called "The New Middle East." He was joined by many leaders from the Middle East and around the world in this effort.

Figure 2: Proposal for covering all of Israel with radars to establish a real-time bird movement warning system for military and civilian flights.



PROPOSAL FOR A NETWORK OF 7 RADARS
IN THE MIDDLE EAST



We proposed to solve flight safety problems on a regional level, which will be much more effective than local systems. This regional system would allow for real-time warnings between countries; for example, during the autumn migration Jordan (and hopefully later Syria and Lebanon) will warn Israel of migrating flocks, and Israel will in turn warn Egypt. During the spring migration, the same system will operate in reverse: Egypt-Israel-Jordan (Lebanon and Syria). We already know from our satellite research that migrating storks can start a day in Egypt, cross through Israel and Lebanon, and end the day at roost in Syria. The detailed migratory research which has been carried out in Israel can be expanded to Jordan and Egypt; this research involves motorized gliders, networks of birdwatchers, radars and drones. The results will help to establish a regional database and a regional real-time warning system.

We proposed to use 7 radars as the first stage of such a regional network (see figure 3). These radars will be placed at key migration points. In Jordan, one will be place near Amman, and perhaps in the future another in the Aqaba region. In Egypt, radars will be placed at Sharm-El-Sheikh, Suez, and in the near future at Bab-El-Mandeb in Yemen. Three bird radars will be located in Israel: one in the Galilee, one in the Negev Desert, and one in the Judaean Mountains (see figure 2). The network of bird radars will also serve as weather radars, as eco-tourism activity-centers, and as a very important tool for formal education.

Prime Minister Peres accepted the idea, and it was presented at the Amman Convention in October 1995 as one of the 60 leading regional projects for the Middle East. In many European countries, radars are already being used for military and civilian flight safety. With the rapid technological developments in the field of computers, the connection between nations along computer superhighways is imminent. We also foresee the development of the GIS system (see WP-52 BSCE, London 1996), and the greater availability of radio transmitters accepted by satellites (see WP-51, London 1996). We think now is the time to try and work on a global scale, following the achievements in the field of weather prediction.

We propose that the BSCE urge governments and leading organizations like the European Community to develop regional networks of radars, giving us a better overall global picture of bird movements. Since a global radar network is multi-disciplinary, international flight safety will be greatly advanced, with the potential to save hundred of millions of dollars of damage to aircraft. With this in mind, the development of the network should be of highest priority. It must still be decided which type of radar will become "the radar" to reduce the damage of birds to civil and military flights.

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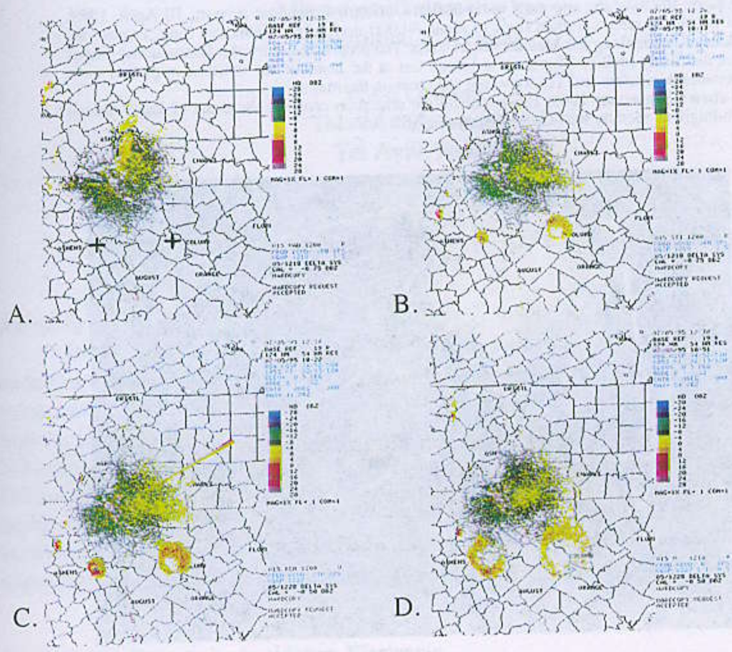
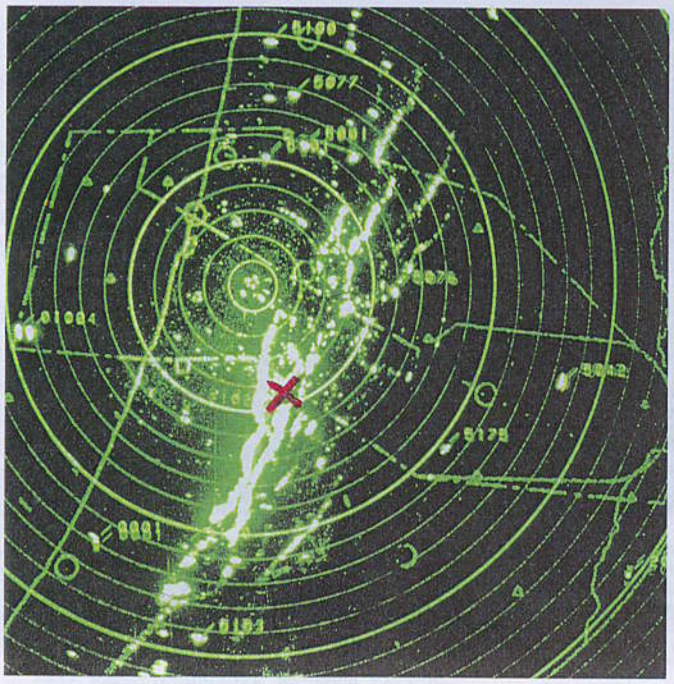
Above: National network of 137 Nexrad Radars in the U.S.A. The compressed reflection of heavy migration follows a front on 4.10.95 at 04:26 (Photo: S.A. Gauthreaux JR).
Below: 4 sequences of a roost of purple martins. (a) 7.5.95 at 04:03 -- the two crosses mark the location of the roosts (left: about 50,000 birds, right: about 150,000 birds). The birds are not seen while roosting on the trees. (b) 7.5.95 at 05:13 -- birds start to move. (c) 7.5.95 at 05:22 (d) 7.5.95 at 05: 51.





Above: Photo of the approach radar at Ben-Gurion International Airport, 10 April, 1989, at 14:18. On screen, a giant flock of about 30,000 storks, 165 kilometers long, crosses the skies of Israel along the Mediterranean coast. The proposed site for the International Center for the Study of Bird Migration at Latrun lies at the heart of the western migration axis, between Jerusalem and Tel Aviv (see red cross on the map).
Below: September 1989: Heavy nocturnal migration crossing the coast of Israel around midnight as seen by Ben-Gurion Airport's ASR-8 Radar.