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Estimation of conflict resolution ways between aircrafts and convectively unstable atmosphere

The analysis of mid-air conflicts ways of resolution is provided. The complexities of aircraft handling during convectively unstable atmosphere are defined. Discrepancies of flight crew operations are defined and corresponding recommendations to them are proposed.

The Free-Flight Air Traffic Management concept has been proposed as a mean of increasing airspace safety, efficiency and capacity by permitting user defined trajectories [1].

The problem of conflict detection and resolution is very resource demanding. First of all, it is needed to define the methods of conflict detection and then the ways of their resolution. Unfortunately, midair collisions in airspace have repeatedly occurred for different reasons:

- due to controller's inability to predict the loss of separation between aircraft;
- it occurred at night, with the affecting on both pilots' ability to see and avoid;
- utilizing visual flight rules (VFR) flight following;
- the area where the airplanes were operating is congested, mountains, class B airspace, and class D airspace surround the corridor in which the pilots were flying.

All pilots need to learn how and what to look for to avoid a midair collision. Proper 'See and Avoid' techniques as well as proper scanning will help to reduce future midair collisions.

"See and Avoid" is recognized as a method for avoiding collision when weather conditions permit and requires that pilots should actively search for potentially conflicting traffic, especially when operating in airspace where all traffic is not operating under the instructions of Air traffic control (ATC).

"See and Avoid" requires the application of:

- effective visual scanning;
- the ability to gather information from radio transmissions from ground stations and other aircraft;
- situational Awareness; and
- the development of good airmanship.

According to Federal Aviation Administration statistics, weather is the cause of approximately 70 percent of the delays in the National Airspace System. In addition, weather continues to play a significant role in a number of aviation accidents and incidents. While National Transportation Safety Board reports most commonly find human error to be the direct accident cause, weather is a primary contributing factor in 23 percent of all aviation accidents [2].

Hazards associated with convective weather include thunderstorms with severe turbulence, intense up- and downdrafts, lightning, hail, heavy precipitation, icing, wind shear, microbursts, strong low-level winds, and tornadoes.

Convectively instability (Fig. 1) or stability of an air mass refers to its ability to resist vertical motion. A stable atmosphere makes vertical movement difficult, and small vertical disturbances dampen out and disappear. In an unstable atmosphere, vertical air movements (such as in orographic lifting, where an air mass is displaced upwards as it is blown by wind up the rising slope of a mountain range) tend to become larger, resulting in turbulent airflow and convective activity. Instability can lead to significant turbulence, extensive vertical clouds, and severe weather such as thunderstorms [3].

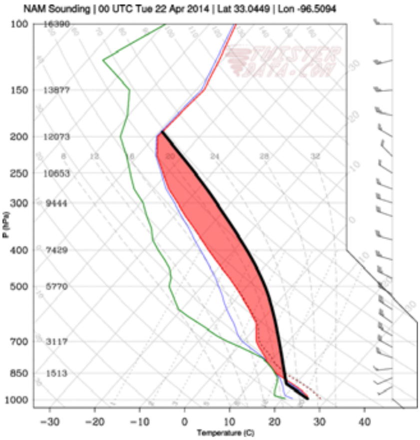

Fig. 1. Convective instability, denoted in the red highlighted region ("positive area")

Aviation weather radar is used for detection and avoiding hazards associated with Cumulonimbus clouds (Fig.2).

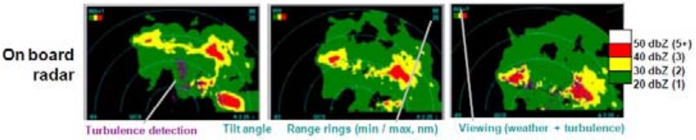

Fig.2. On board radar display with arrows pointing towards descriptions of data and mode. Purple regions on weather radar view depict turbulence identified by the on board radar turbulence detection algorithm [4]

Although the tilt of the radar antenna can be adjusted upward and downward, the weather phenomena that the weather radar can detect are limited in both direction and range. The radar system in Fig. 3 fails to detect the two cells that lie below and beyond the radar beam. As illustrated in Fig. 3, you must be careful not to assume that the only cells in the area are the ones shown on the radar display. The two additional cells in Fig. 3 are present, but not detected by the onboard weather radar system. Only optimum use of the weather radar makes possible the flight safety.

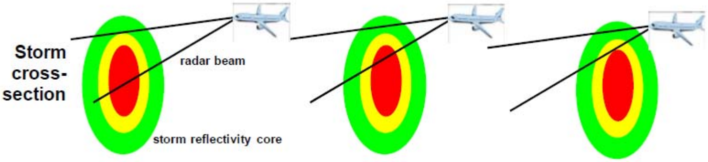

Fig. 3.The the issue of reduced filling of on board weather radar beam as aircraft approached convective core.

Reductions in collision risk can be achieved by reducing the most important reasons why the individual barriers are unsuccessful, especially common-causes; improving beneficial influences that may make existing barriers more successful; and introducing new barriers, if this can be done without degrading the ones that are already there. As well as reducing collision risk, it is also desirable to maintain awareness of reasons why collision risks have been made as low as they are, so as to prevent deterioration in the future.

Key areas with potential for improvement include [5]:

1. Improved positive safety culture. This includes improving crew/team resource management, air ground communications, compliance with airborne collision avoidance system (ACAS) warnings etc.

2. More extensive fitment of safety nets (shot term conflict alert (STCA) and ACAS). This includes developing STCA suitable for terminal areas.

3. Improved reliability and consistency of safety nets. These need to provide early and dependable warning, and to reduce nuisance alerts. This includes using information downlinked from the aircraft, providing this is sufficiently reliable to offset the extra hazard potential of common-cause failures.

4. Improved aircraft systems to alert pilots to any non-availability of transponders and ACAS.

5. Improved ATC systems and procedures to enhance conflict management during any degradation of surveillance or STCA.

6. Improved communications systems and procedures, such as controller-pilot datalink. This has the potential to reduce very high frequency VHF congestion and communication errors, providing it is sufficiently reliable to offset the lost benefits of broadcast voice communication.

7. Improved predictability of aircraft trajectories, so that conflicts can be predicted and resolved at an earlier stage, using similar systems, and air traffic controllers need to make fewer interventions to maintain separation.

Rules for Pilots of thunderstorm avoidance:

- Avoid all thunderstorms.
- Never go closer than 5 miles to any visible storm cloud with overhanging areas, and strongly consider increasing that distance to 20 miles or more. You can encounter hail and violent turbulence anywhere within 20 miles of very strong thunderstorms.
- Do not attempt flight beneath thunderstorms, even when visibility is good, because of the destructive potential of shear turbulence in these areas.
- At the first sign of turbulence, reduce airspeed immediately to the manufacturer's recommended airspeed for turbulent air penetration for a specific gross weight (that is, maneuvering speed).
- If the aircraft inadvertently penetrates the thunderstorm, maintain a straight and level altitude on a heading that will take you through the storm area in the minimum time.

Current warnings are largely based on observations, but this new effort will develop the ability to issue a warning based on a computer forecast. These new guidance tools will offer detailed information on the type, severity, and probability of the weather threat before it is detected.

References

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