54

N91-24167

Wind Shear Program in France

LIDAR Studies on Microbursts

Y. Aurenche and J.L. Boulay, ONERA

ONERA's Program about Windshear Studies

Preliminary Analysis of Requirements for Future Airborne Windshear Detection Systems

Y. Aurenche, Binh Dang Vu, D. Guffond
Office National d'Etudes et de Recherches Aérospatiales (ONERA)
Châtillon, FRANCE

1. INTRODUCTION

With DGAC and DRET support, ONERA works since 89 on Windshear problems. The main studies are:
- Flight Mechanics
- Microbursts modeling
- Microburst detection with airborne systems
  (LIDAR, radar, passive infrared sensors)
- Microbursts prediction with ground systems
  (VHF interferometry)

The purpose of this presentation is to give a short overview of theses studies and some results.

2. FLIGHT MECHANICS

The studies concern the behavior of two airplanes (B727 and A310) equipped with an ILS and crossing a microburst.

A simulation program has been developed, using for each airplane a classical and simplified guidance and flying loop; the loop takes into account the flight maneuvering capabilities in order to realize an automatic approach and to land with a conventional speed.

The principal criteria for a good landing are:
- an angular error with respect to the glide path inferior to 1°
- a vertical impact speed inferior to 7 ft/s

Six windfield models have been considered:
- 3 historical cases; the New York, Dallas, and Atlanta accidents.
- 2 standard FAA cases (AD 120-41); n°6, being the most severe.
- 1 symmetrical RAE model, with the conditions Kr=1, Kx=3, Kz=1, giving a high Severity Factor equal to 0.8 during about 25 seconds.

For each simulation, the parameters are presented versus time and can be analyzed (Fig. 1): horizontal and vertical wind speed, thrust, conventional speed, incidence, trim, etc ...

For the New York case, the Fig. 2 shows:
- the fatal flight path
- the glide path
- the simulated flight path

The simulation conclusion is that, with an ILS and a conventional landing speed, the two airplanes have sufficient performances for following the glide path and landing with acceptable conditions. In certain cases, the impact vertical speed is slightly over the criterion (8 ft/s for Dallas case). But, for all historical and FAA models, the simulation shows that the landing is possible. On the other hand, for the RAE model, the ILS is insufficient.

The next study consisted in equipping the airplane with a forward looking system giving a microburst detection at a certain range R (Fig. 3) and setting off a new flying strategy:

that is to command at this time a speed increment dV in function of the Severity Factor measured.

A parametric study has been developed versus R, dV and D, the distance between the microburst core and the runway. The global result for RAE model is presented on the Fig. 4. The speed increment is 20 knots. The two airplanes equipped with an ILS and using this strategy can land with acceptable conditions only if the prediction range is 1.5 Km.

At the present time, the pursuit of this study consists in simulating more severe cases.

3. MICROBURSTS MODELING

In order to study radar and LIDAR beam propagation across microbursts, a modeling program has been developed.

It simulates a vertical dry airflow directed to the ground with three dimensional Navier Stokes equations, in incompressible and instationary form. The domain sizes are 10 by 10 by 5 Km (Fig. 5). The spatial resolution is 200 m but must be reduced. The vertical airflow is initialized by a certain law. The Fig. 6 presents a vertical section and give the speeds and the vortex locations. The Fig. 7 presents the iso-speed profiles.

At present, the task concerns hydrometers introduction in the model by using a regular raindrops injection in airflow. The problem is to know if the instationary wind action on the droplets trajectory does not bring them together and does not give over or under concentration zones.

The calculation hypothesis are:

- the rain drops don't modify the flowfield velocity
- the forces taken into account are gravity and the drag forces produced by drops and air velocity differences.

The Fig. 8 shows the concentration factor Cf at t=1000s and for a 30 m/s injected airflow speed. The over-concentration locations do not correspond with maximal speed location presented on the Fig. 7.

At present, these studies are going on with a smaller spatial resolution.

4. AIRBORNE DETECTION SYSTEMS

Up to now, the activities on this subject have been mainly feasibility studies; no hardware has been developed yet.

5. GROUND PREDICTION SYSTEMS

An experiment campaign using a VHF interferometer has been realized in August 90 at Orlando in cooperation with the Lincoln Laboratory using several radars; the first results are presented in the next paper.

Fig.1

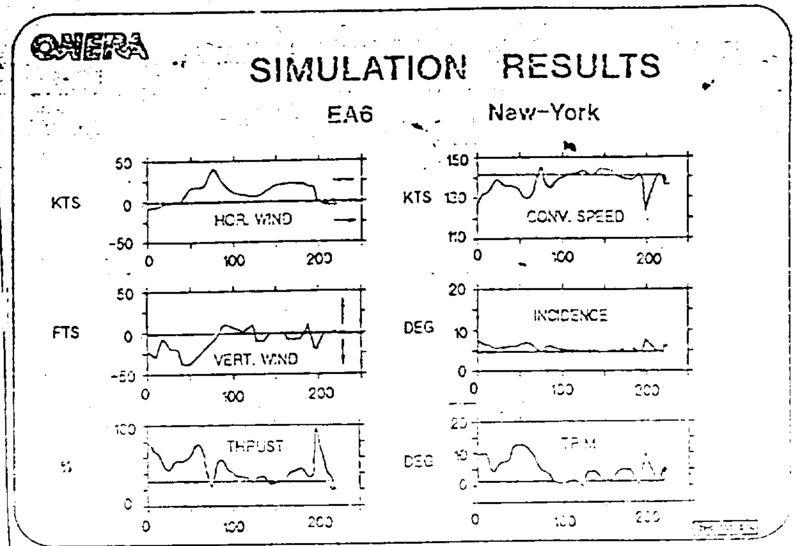


Fig.2

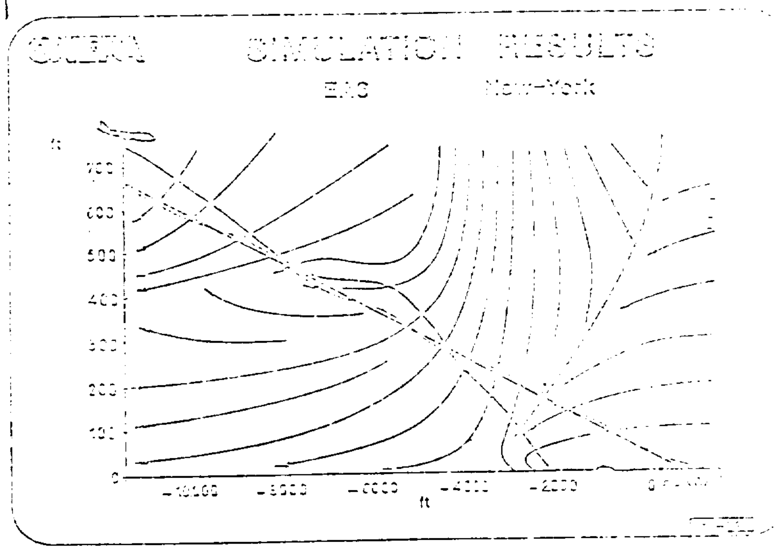
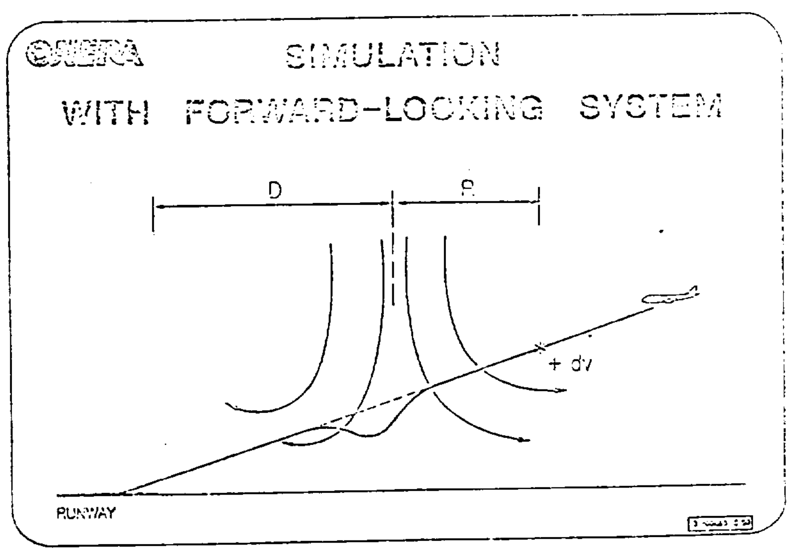


Fig.3



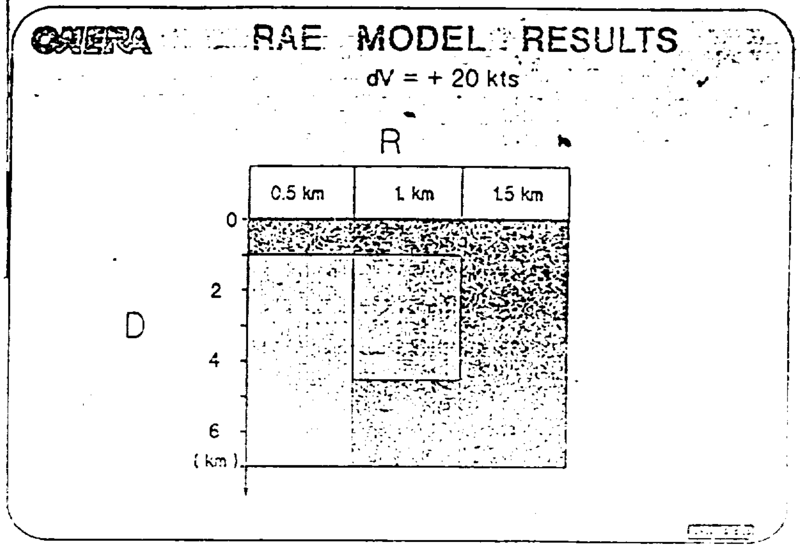


Fig.4

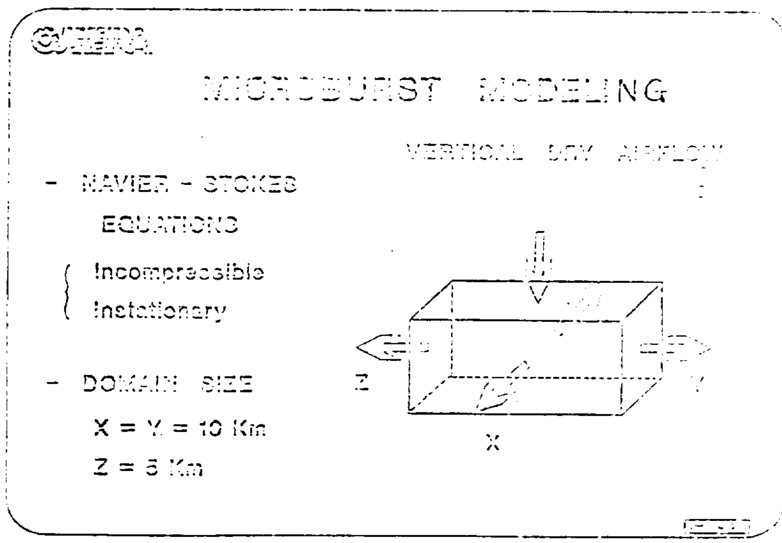


Fig.5

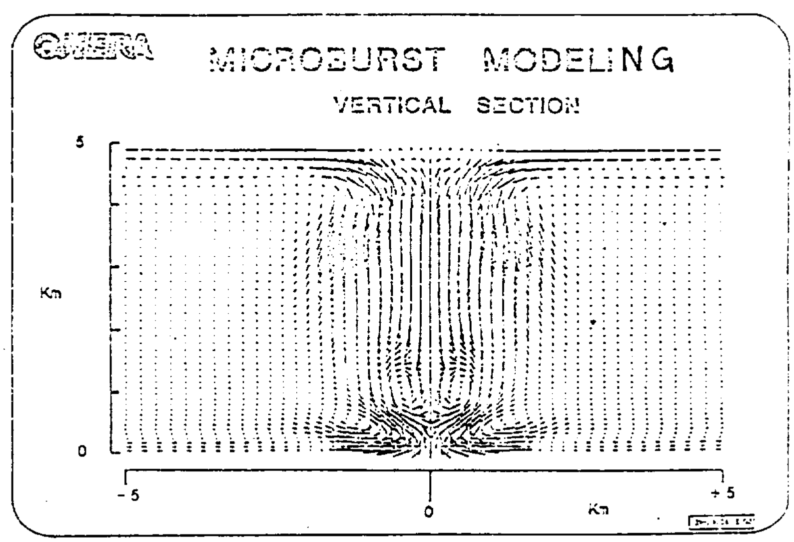
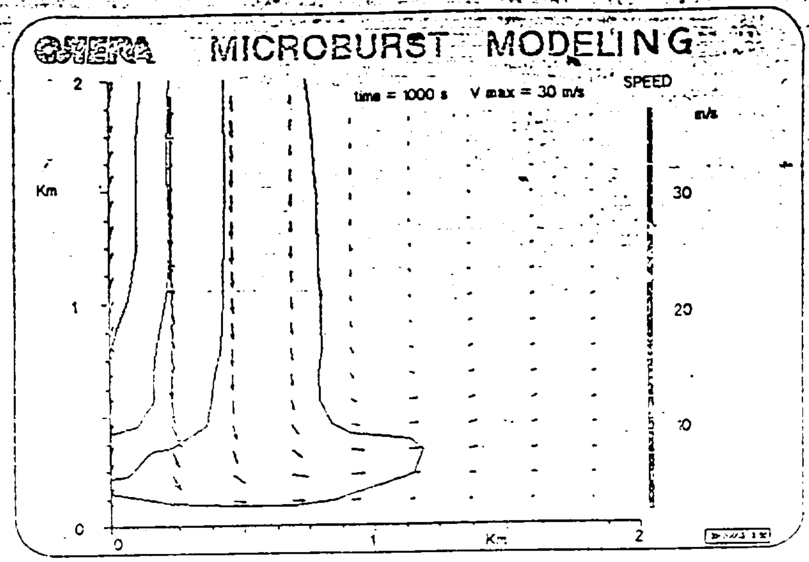
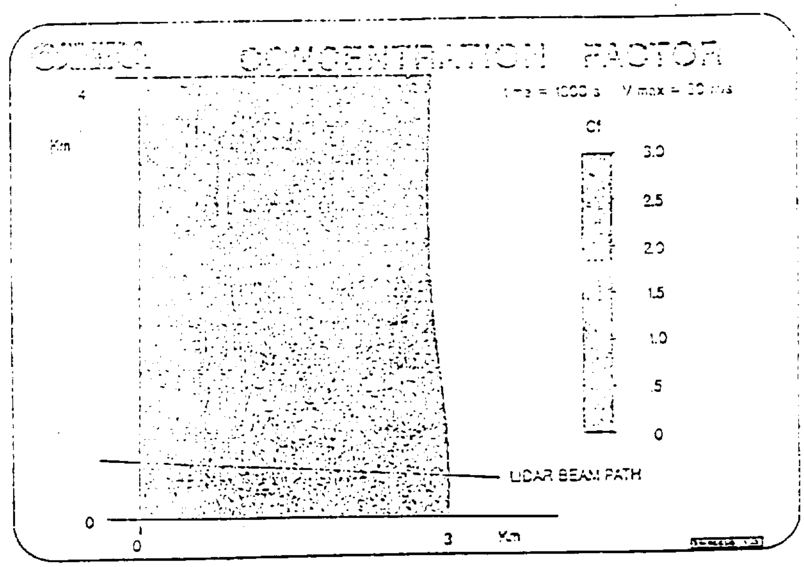


Fig.6



MICROBURST MODELING
time = 1000 s V max = 30 m/s
SPEED
m/s
Km
Km

Fig.7



Cf
LIDAR BEAM PATH
Km

Fig.8