

AVIATION WEATHER SERVICE REQUIREMENTS
1980 - 1990

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There is a whole spectrum of meteorological problems associated with aircraft operations including air traffic control in the years ahead. These must be solved in order to continue the excellent safety record of aeronautics. With the advent of higher-speed aircraft, expanded use of aircraft in pleasure and business flying, the jumbo jets with up to 1,000 passengers aboard, and the V/STOL aircraft, everything we do today must be done better tomorrow. The lead time is short.

Aircraft operations in the decade of the 1980's will be global in nature rather than regional or local as in the past. The National Meteorological System is important to the safe and efficient operation of all classes of aircraft. It is through this system that the dynamic state of the atmosphere (temperature, wind and pressure) is determined, and this basic information is vital in the prediction of specific weather elements (cloud height, visibility, precipitation, turbulence, winds, and temperature) important to aviation.

The National Meteorological System produces vital information concerning the atmosphere. This must be considered an important adjunct to the air transportation system, including air traffic control. Since the National Meteorological System and the Air Traffic Control System are autonomous and since both have a mutual weather responsibility, there must be an effective means of communication between them to apply, distribute, display and present the operationally significant weather information on a timely basis for the controllers, pilots, and operational planners. Such communication does not presently exist. If this system gap is eliminated, noticeable and immediate improvements in the orderly and safe flow of traffic can be realized.

In the post-1980 period, the National Meteorological System should have greatly improved capability with weather radar, weather satellites, and the analysis and prediction of the state of the atmosphere up to 30 km, utilizing high-speed computers. Weather radar will detect severe weather and produce conflict displays for air traffic control. Poor visibility as a result of fog will be improved by weather modification techniques so that adequate visibility for visual landings and take-off can be maintained under most conditions.

However, technical gaps must be eliminated for future improvements, especially in the light of increased traffic. For the purpose of the following discussion, the terminal area is defined as the air volume within a cylinder of about 160 km diameter extending up to about 10 km. This area is the most critical from the viewpoint of planning, dispatch, operations and air traffic control, and the elements of most serious concern are visibility, turbulence, and icing. Accurate observations and forecasts of these elements are imperative in the years ahead. The inability of the weather system to provide this service by producing observations and forecasts with the accuracy and detail required in the future is a serious technical gap demanding prompt attention by the research community.

The following represent the highest priority weather requirements in the terminal area:

1. Terminal area visibility for approach, landing, and take-off for slant ranges of 5000 meters or less, with special emphasis on the very low horizontal visibility of less than 1500 meters.
2. Turbulence in the free atmosphere in the terminal area and over the runway, regardless of the cause, with special consideration given to thunderstorms and squall lines, including areas of hail.
3. Freezing rain and areas of moderate and heavy icing in clouds for the terminal area.

Deficiencies exist in the following terminal area weather observations and forecast services:

1. Wind shear and temperature profile with special emphasis on the wind shear in the lowest 60 meters on the final approach path.
2. Slant range visibility in the final approach with specific emphasis on the runway horizontal

visibility. This involved new methods of measuring and techniques for predicting the very low ranges, i.e., 800 meters and below.

3. Airport and, more specifically, runway wind measurements which would provide a more precise index of gustiness.
4. Precisely locating, identifying intensity, and tracking of areas of turbulence, icing and hail.

Much more effort needs to be en route operations up to 30 Km in the following areas:

1. Turbulence of all classes perhaps is the most elusive parameter for the meteorologists to observe, analyze and predict. This is particularly true of clear air turbulence as a result of wind shear in the free atmosphere. Very little is known about the magnitude of this turbulence above 12 km, but there is sufficient evidence to know that Clear Air Turbulence (CAT) does occur in the region between 12 km and 30 km. Thunderstorms have been observed to extend above 20 km, particularly in tropical latitudes. The extent to which turbulence exists in these convective storms above 13 km is relatively unknown. Here, again, there is sufficient evidence by isolated experiences to indicate severe turbulence can occur at these altitudes in and above thunderstorm clouds. Mountain waves above and down wind of the major mountain ranges of the world can produce severe turbulence in the stratosphere. This is evidenced by actual flight experience at altitudes of 20 km over the Rocky Mountain range. More explanatory effort, research and development work is needed in this area to provide sufficient

techniques to predict and identify areas of severe turbulence, particularly as it is related to the super sonic transport (SST) operation.

2. The presence of suspended ice and water particles at the very high altitudes is somewhat an unknown quantity, although it is known that they can and do exist. The presence of hail in the tops of thunderstorms at very high altitudes is also unknown, but again some evidence exists that it can occur at these altitudes. More effort is needed in this area through actual flight and meteorological research.
3. The transition of the SST to supersonic speeds (between 10 and 15 km) is in the area of the tropopause where maximum changes in temperature and winds occur vertically as well as horizontally. This will be very critical to the SST operations during the transition from subsonic to supersonic. It is at these altitudes and during this phase of flight that the maximum effort is demanded of the power plant which is very sensitive to high temperatures or variable temperatures.
4. Solar radiation and ozone are perhaps design problems. However, the magnitude of these phenomena is not too well known over the globe at all latitudes. If these are limiting factors, then more should be learned about their nature, extent and predictability. Of particular concern will be the intensity of the cosmic rays as a result of solar storms for flight planning purposes.
5. Sonic boom is alleged to be one of the most critical problems facing the SST program, It is not unreasonable to expect that the meteorological

services may be required to provide a prediction of a "least-noise" track for both the en route operations over populated areas and for the climb-out corridors. This is a serious problem and research work is needed to specifically identify the meteorology of the sonic boom.

Much more scientific knowledge of the atmosphere is required before any revolutionary breakthroughs can be expected in forecasting. This is the scientific limitation. Its removal will be achieved only through fundamental research at a gradual pace over a long period of time. This is a problem common to all meteorological services. Adequate effort must be expended by the meteorological service to eliminate these technical gaps.

In many areas improvements can be brought about if more funds could be made available. This is particularly true in the areas of observations at airports, briefing facilities, communications in the broad sense, and items of this nature. The problem here is one of justification based on a reasonable return for the investment in terms of better operations and/or improved safety. This poses a difficult problem since the operational weather requirements for expanded services are not very well defined and there is not unanimity within government or the industry as to the relative importance of the various services, i.e., more weather radar vs. more communications, etc. There are also different priorities for service to the air carriers as opposed to general aviation. Here, again, the requirements for general aviation are ill-defined. The operational requirements for all spectrums of aviation operations should be quantitized and placed in a priority list for the guidance of the meteorological services.

Conclusions

1. Weather information is one of the essential tools for management of the air space and conducting aircraft operations in a safe and efficient manner. Aviation weather services must be considered an integral part of the air traffic system providing detailed and up-to-the-minute information in a form that will precisely define the environment as it is and as it will be.
2. Meteorological elements having the greatest direct impact on the safety of aircraft operations for the foreseeable future are as follows:
 - (a) restricted visibilities at terminals, particularly as a result of fog, heavy rain and snow;
 - (b) turbulence in the free atmosphere as a result of thunderstorms, mountain waves, and wind shear; and
 - (c) heavy rains, snow and freezing rain affecting runway surfaces.
3. The meteorological elements indirectly affecting safety of flight are:
 - (a) low-level wind shears in the approach zone;
 - (b) unusually high surface and en route temperatures;
 - (c) strong winds en route;
 - (d) restricted visibilities in the air hampering VFR flight; and
 - (e) strong and gusty surface winds.
4. The special meteorological elements affecting the operations of supersonic aircraft operations are:
 - (a) cosmic radiation levels at cruise altitude;
 - (b) precise temperature information for transition and cruise altitude;

- (c) precise information on the existence of rain, hail, and turbulence for transition and cruise altitudes; and
 - (d) absolute tops of clouds along the route.
5. If airport noise and sonic boom problems cannot be solved by design, the operators, the air traffic control system, and the pilot will have to consider these problems on a day-to-day basis, using meteorological information in the decision process.

For V/STOL operations (short-haul urban transportation) there appear to be no unique weather problems that are identified. However, the same information will be needed for more airports (heliports) and quicker. These factors will be important because of the handling of these aircraft by air traffic control in a mixed environment and the need to maintain a dependable and continuous scheduled operation. An automatic terminal weather observational package with weather radar to detect and track severe storms over the major metropolitan areas is a "must" in the years ahead.

Recommendations

- (1) Support the funding requirements to improve the overall National Meteorological System on a continuing basis.
- (2) Eliminate the systems gap by establishing an effective and dedicated communications link between the weather system, the pilot, the operator, and air traffic control.
- (3) Bridge the technical gap by stimulating scientific interest in and encouraging support of mission oriented research concerned with airport observations and forecasting of visibility, turbulence and icing in the en route and terminal areas.

- (4) Precisely determine aviation's impact on the environment due to pollutants of gases and noise, aloft and around the terminal.