There will be scientific and technological opportunities that will enable us to make significant improvements to the services we provide the aviation community. The NWS, the FAA and other Federal agencies as well as the academic community have joined in a comprehensive, cooperative effort to meet the challenge before us today.

NASA's Aviation Safety - Meteorology Research Programs

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One of the research areas included in NASA's subsonic aircraft programs is that of aviation safety. A major element in that aviation safety research program addresses meteorological hazards to flight. The various research programs in meteorological hazards have been underway for a number of years; some are phasing out; some are just starting. I'd like to go through what we now have currently underway, what we've done recently, and some of the ideas on where we think we're going.

In general, the areas that we have in the meteorological hazards program are: severe storms and the hazards to flight generated by severe storms; clear air turbulence, an area that's been with us a long time; icing; warm fog dissipation; and landing systems. Landing systems are included since once you make your way through what may be a hazardous atmosphere and end up on the ground, you are landing in what is a very large, heavy, fast tricycle; and the interface at that point becomes a rather critical area. We have also recently completed some experiments (one of the few areas in which satellites have been used as a source of data for us) relative to remote sensing of ozone. Also using satellites in a slightly different mode, as a data relay system, we have looked at the possible benefits to be derived from using essentially real-time wind data for flight planning.

In the severe storms research, started in 1977, we are attempting to identify what, in fact, is the makeup and the structure of severe storms, principally thunderstorms. Ideally, one would like to do this kind of work with remote sensing; but in many areas, it is impossible to remotely sense the kind of information that is needed. One such program that has become very successful, and is hardly a remote sensing program, is the F-106 that is used to fly into thunderstorms in an attempt to obtain direct lightning strikes. One hundred seventy-six (176) strikes have been obtained in three (3) years. It is a highly instrumented airplane. This instrumentation is now allowing us to identify or characterize lightning strikes in flight and identify and hopefully predict the effects of lightning on aircraft systems and structures.

A second area where remote sensing may be used in the future will be to sense gust environments. Currently, it is a matter of obtaining the data by experiencing the event. That is, we are attempting to find the microstructure of the gust environment.

Through the use of a specially instrumented B-57 aircraft, we are flying into turbulence and measuring the lateral gust gradients over the span of the airplane. This program is thus attempting to identify the effect on the airplane of gust gradients of the size of the aircraft. This program will be discussed later in detail by Warren Campbell of NASA/Marshall Space Flight Center.

NASA is also a participant in the Joint Airport Weather Studies (JAWS) program which is delving into the physical properties and generation of low-level wind shears. In addition to providing flight support via our B-57 aircraft, we are also involved in certain areas of data analysis. Dr. John McCarthy of NCAR will speak on this program in detail later in the Workshop.

Clear air turbulence (CAT) has been a hazard and an annoyance throughout the years as airplanes have changed in character from propellers to jets. The drag to mass ratio has changed. The upsets experienced by the large transports represent a severe hazard in air travel. Initially, as we learned to cope with the upsets, flying procedures were implemented to alleviate the effects during the turbulence encounters; the hazard was lessened significantly. Yet, we are continually reminded that the problem has not been solved. The last encounter I can recall directly was a DC-10 encountering severe CAT over Denver, and there were a number of people hurt in the airplane. No severe damage was sustained by the aircraft; but it was an unanticipated encounter with turbulence. NASA has undertaken a long-term study of devices that may have potential for remote detection and early warning of CAT. The Laser-Doppler Velocimeter (LDV), the infra-red radiometer and the microwave radiometer all have potential, but they all have shortcomings. We are, however, continuing to explore methods of overcoming these shortcomings.

Dr. Joe Shaw of Lewis Research Center will be giving a detailed discussion on our aircraft icing research program. This area has re-emerged as an area of concentration for NASA, centered directly about the icing research tunnel facilities at the Lewis Research Center. In addition, we have found that we need data on atmospheric icing to correlate with the icing tunnel predictions. Thus, we instituted the Twin Otter Icing Flight Program at the Lewis Research Center.

Atmospheric fog is a hazard regardless of aircraft avionics. Taking the pilot's vision away in that very final stage of touchdown and rollout creates hazardous situations. NASA is exploring a technique, which introduces electrically charged particles into warm fog which causes it to precipitate. At the present time, it appears to have potential but we must carry the research further for final proof.

As I alluded to earlier, the interface between the flight vehicle and the ground is one that periodically comes back and bites us in terms of accidents. As the airplanes get bigger, the approach and landing speeds become higher, the take-off gross weights go up (always with the potential for rejected take-off, and the runway-tire interface becomes very critical. Micro-scale description of this interface has been and will continue to be an area of significant research effort for us to insure safe runway operations in all types of meteorological conditions.

Figure 1 shows the effect on stopping distance of water, packed snow, or ice on the runway. The diagonal breaking vehicle (DBV) stopping distance ratio illustrates the magnitude of the runway surface condition on the amount of runway needed to stop the vehicle. As runways are used continuously, and become coated with rubber on the touchdown end, there is an additional increment of stopping distance that, in some cases, can be equal to the normal dry runway stopping distance. The significance of obtaining this kind of information is in pre-flight planning or for training simulation. An awareness of the true situation must be instilled in the flight crew as to what the runway-tire interface is when the weather and runway conditions change.

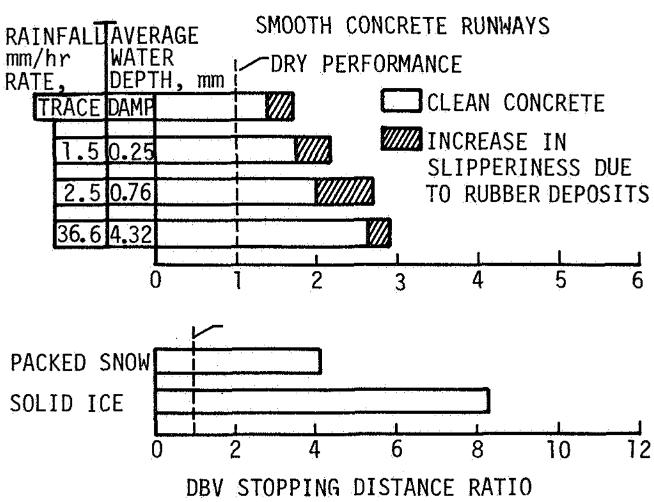

Figure 1. Surface Contaminants Evaluation

Relative to monitoring ozone concentrations which may be hazardous to crew and passengers, we were able to use, during March through May of 1981, existing sensors on the Nimbus 7 Satellite to detect ozone concentrations. These values could then be correlated with aircraft measured concentrations. The success of this program now provides, in our minds, a very real potential for forecasting ozone concentrations that are at or above the critical levels in sufficient time to avoid them through flight planning. The alternative, of course, is to carry additional equipment on the airplane for filtering.

One final program I want to mention is one in which aircraft equipped with inertial navigation systems as well as transponders transmitted wind data derived from the aircraft via a satellite link back to the Goddard Space Flight Center.

Using these data to re-plan the flight and estimate the effect on fuel performance of real-time wind information showed statistically significant savings in fuel, where potentially possible. In the North Atlantic runs, wind data that is normally used to establish the North Atlantic tracks can be up to 24 hours old. If that can be reduced to eight (8) hours, a saving, on a fleet-wide basis, of 2% to 3% of the fuel is possible. This translates to saving a few billion dollars every year in fuel costs.

The foregoing summarizes NASA's current aviation safety research programs that are related to meteorology. Each of these major programs will be discussed in detail by the various researchers that are here or will be here through the remainder of the conference.