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Chapter 1 : Pan Am Flight - Wikipedia

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Page 18 Share Cite Suggested Citation: The National Academies Press. Although wind shear can result from a number of basically different meteorological conditions, pilots have been trained to avoid thunderstorms in particular because of often associated severe wind variability and turbulence near the ground and aloft. It has recently been recognized that small, short-lived downdrafts, called microbursts, are serious hazards to aircraft during landings and takeoffs. In some microbursts the air carried downward strikes the ground and spreads out in a shal low layer--sometimes only a few hundred feet in thicknes s. The parent cloud from which the microburst descends is a convective one but one that has not necessarily grown to thunderstorm size and strength. Such outflows and downdrafts were newly emphasized as the cause of some serious accidents after a quantitative analysis of the winds encountered by Eastern Airlines Flight 66 while landing at John F. Kennedy International Airport on June 24, Analysis of the flight recorder data from another aircraft operating in the immediate vicinity provided a wind model considered to be very similar to that encountered by EAL Flight A detailed map of the wind-shear patterns at the time of the crash was constructed from an analysis of available data, including meteoro- logical satellite photographs and surface weather observations and measurements Fujita, ; Lewellen et al. The analysis provided valuable insight into the characteristics of violent downburst -Inless specified otherwise in this report, wind shear is the differ- ence of wind velocity at two points divided by the distance between the two points. More than 59, reports were reviewed, covering all classes of civil aircraft and flight operations. About one-third of the accidents or incidents, more than 19 ,, occurred during terminal area operations. Only 25 accidents or incidents involving large aircraft more than 12, pounds were identified in which low-altitude wind shear could have been a contributing factor. Of these 25 cases, 23 occurred during approach or landing and only 2 during takeof f. Table 1 lists 27 U. The list includes most of the 25 cases identified by the FAA. Some were omitted because, on further examination, they could not be attributed to wind shear. The table does include wind-shear-re lated accidents or incidents that have oc curred s ince , including 2 during In general aviation aircraft numbered more than , and flew more than 40 million hours compared with 3, aircraft and 8 million flight hours for air carriers. Of these, wind shear was reportedly the cause of one fatal accident and was a factor in two. It should be noted that the NTSB generally investigates only those general aviation accidents that result in a fatality, and not all of those attributed to weather were analyzed by trained meteorologists. Low-altitude wind variability may have been a factor in some of these. In , NASA, in cooperation with the FAA, instituted the Aviation Safety Reporting System ASRS , whereby safety-related incidents involving aircraft operations are submitted voluntarily and treated anonymously, with the expectation that potential flight safety problems may be identified and corrective action suggested. A total of 26 reports have been indexed as wind shear related out of nearly 21, reports received since May 1, Of these, 17 appear to involve wind shear as a primary factor. Furthermore, the term wind shear is subject to various - interpretations among pilots, and specific definitions are often misunderstood. Pilot judgments as to the aircraft types most suscep- tible to wind shear were not readily explicable in terms of aircraft size, landing speed, or wing loading. The use of standard terminology and improved training for pilots and air traffic controllers was recommended, along with research on optimal piloting techniques during wind-shear encounters. In the United Kingdom the Royal Aircraft Establishment has undertaken a program to extract wind-shear data from records obtained from 10 Boeing aircraft operated throughout the world by British Airways. This is a continuing effort to obtain wind information on strong wind-shear events during approach and landing. Time histories of wind velocities and aircraft reactions to interesting events are identified and analyzed. The results may lead to statistics on the probabilities of encountering wind shears and criteria for testing and evaluating autopilots and onboard wind-shear detection systems. The rarity and lack of a reliable statistical data base on wind- shear-related accidents, shear encounters, or even the frequency of occurrence of potentially hazardous wind shears does not diminish the importance or severity of the safety problem. The potentially catas- trophic consequences of an encounter during takeoff or approach and landing require that wind shear always be taken into account as a primary safety consideration when weather conditions are such that strong wind shears may be present. The widespread lack of appreciation among pilots, traffic controllers, and aircraft operations personnel of the seriousness of the possible safety hazards has exacerbated the problem. Several areas of investigation were addressed, including wind-shear forecasting techniques and means of detecting the presence of wind shear with both ground-based and airborne instrumentation. A multiphased research and development program was undertaken to investigate and develop cockpit displays, instrumentation, and operational procedures for assisting a pilot in the event of a wind-shear encounter. The project involved development of wind-shear models and evaluation of cockpit instrumentation, various cockpit instrument panel display configurations, and flight-path management systems in moving-base simulations of the flight of various large transport airplanes in wind shear. The results have been published in a series of reports e. Also, the FAA published an advisory circular AC , entitled Low Level Wind Shear, dated April 18, , intended to provide guidance for recognizing the possibilities of hazardous wind-shear situations and piloting techniques for recovery from wind-shear encounters. Project NIMROD conducted by the University of Chicago in the north-central midwestern United States during 19 79 and the JAWS Project in the Denver area during the surfer of have provided extensive new knowledge on the meteorological characteristics of wind shear required for more realistic computer modeling of wind-shear fields for flight simulation, instrument design and development, and system certification. No regulatory action has yet been taken directly in response to this proposal. In this connection, however, the FAA has prepared an advisory circular presenting criteria for operational approval of airborne wind-shear alerting and flight guidance systems and wind-shear detection and avoidance systems. These proposed criteria, including presently available mathematical models of a variety of wind-shear and turbulence fields, are intended to permit FAA acceptance of concepts designed to enable pilots to recognize the presence of wind shear, to optimize their reactions, and to fully utilize the performance capabilities of their aircraf t to cope with a wind-shear hazard that may be encountered. The circular provides that the wind-shear models will be updated as new data become available. This advisory circular is currently under review, preparatory to its adoption.

Chapter 2 : PDF Download LowAltitude Wind Shear and Its Hazard to Aviation PDF Full Ebook - Video Dai

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The thermal wind equation does not determine the wind in the tropics. Effects on tropical cyclones[edit] Strong wind shear in the high troposphere forms the anvil-shaped top of this mature cumulonimbus cloud, or thunderstorm. Tropical cyclone development requires relatively low values of vertical wind shear so that their warm core can remain above their surface circulation center, thereby promoting intensification. Vertical wind shear tears up the "machinery" of the heat engine causing it to break down. Strongly sheared tropical cyclones weaken as the upper circulation is blown away from the low level center. When the wind shear is weak, the storms that are part of the cyclone grow vertically, and the latent heat from condensation is released into the air directly above the storm, aiding in development. When there is stronger wind shear, this means that the storms become more slanted and the latent heat release is dispersed over a much larger area. Severe thunderstorm Severe thunderstorms, which can spawn tornadoes and hailstorms, require wind shear to organize the storm in such a way as to maintain the thunderstorm for a longer period of time. An increasing nocturnal, or overnight, low level jet can increase the severe weather potential by increasing the vertical wind shear through the troposphere. Thunderstorms in an atmosphere with virtually no vertical wind shear weaken as soon as they send out an outflow boundary in all directions, which then quickly cuts off its inflow of relatively warm, moist air and kills the thunderstorm. Daytime heating thickens the boundary layer as winds at the surface become increasingly mixed with winds aloft due to insolation , or solar heating. Radiative cooling overnight further enhances wind decoupling between the winds at the surface and the winds above the boundary layer by calming the surface wind which increases wind shear. These wind changes force wind shear between the boundary layer and the wind aloft, and is most emphasized at night. Effects on flight[edit] Gliding[edit] Glider ground launch affected by wind shear. In gliding, wind gradients just above the surface affect the takeoff and landing phases of flight of a glider. Wind gradient can have a noticeable effect on ground launches , also known as winch launches or wire launches. If the wind gradient is significant or sudden, or both, and the pilot maintains the same pitch attitude, the indicated airspeed will increase, possibly exceeding the maximum ground launch tow speed. The pilot must adjust the airspeed to deal with the effect of the gradient. As the glider descends through the wind gradient on final approach to landing, airspeed decreases while sink rate increases, and there is insufficient time to accelerate prior to ground contact. The pilot must anticipate the wind gradient and use a higher approach speed to compensate for it. It is a particular problem for gliders which have a relatively long wingspan , which exposes them to a greater wind speed difference for a given bank angle. The different airspeed experienced by each wing tip can result in an aerodynamic stall on one wing, causing a loss of control accident. Skydivers have been pushed off of their course by sudden shifts in wind direction and speed, and have collided with bridges, cliffsides, trees, other skydivers, the ground, and other obstacles. Soaring[edit] Soaring related to wind shear, also called dynamic soaring , is a technique used by soaring birds like albatrosses , who can maintain flight without wing flapping. If the wind shear is of sufficient magnitude, a bird can climb into the wind gradient, trading ground speed for height, while maintaining airspeed. Wind shear can also create wave. This occurs when an atmospheric inversion separates two layers with a marked difference in wind direction. If the wind encounters distortions in the inversion layer caused by thermals coming up from below, it will create significant shear waves that can be used for soaring. Note how merely correcting for the initial gust front can have dire consequences. Strong outflow from thunderstorms causes rapid changes in the three-dimensional wind velocity just above ground level. Initially, this outflow causes a headwind that increases airspeed, which normally causes a pilot to reduce engine power if they are unaware of the wind shear. Then, when the aircraft passes through the other side of the downdraft, the headwind becomes a tailwind, reducing lift generated by the wings, and leaving the aircraft in a low-power, low-speed descent. This can lead to an accident if the aircraft is too low to effect a recovery before ground contact. Wreckage of Delta Air Lines Flight tail section after a microburst slammed the aircraft into the ground. Another aircraft can be seen flying in the background past the crash scene. As the result of the accidents in the s and s, most notably following the crash of Delta Air Lines Flight , in the U. Federal Aviation Administration mandated that all commercial aircraft have on-board wind shear detection systems by Between and , wind shear directly caused or contributed to 26 major civil transport aircraft accidents in the U. The effect of low level wind shear can be factored into the selection of sail twist in the sail design, but this can be difficult to predict since wind shear may vary widely in different weather conditions. Sailors may also adjust the trim of the sail to account for low level wind shear, for example using a boom vang. Speed of sound Wind shear can have a pronounced effect upon sound propagation in the lower atmosphere, where waves can be "bent" by refraction phenomenon. The audibility of sounds from distant sources, such as thunder or gunshots , is very dependent on the amount of shear. The result of these differing sound levels is key in noise pollution considerations, for example from roadway noise and aircraft noise , and must be considered in the design of noise barriers. Meteorologists can use this plot to evaluate vertical wind shear in weather forecasting. NOAA The speed of sound varies with temperature. Since temperature and sound velocity normally decrease with increasing altitude, sound is refracted upward, away from listeners on the ground, creating an acoustic shadow at some distance from the source. It includes strong winds which may cause discomfort as well as extreme winds such as tornadoes , hurricanes and storms which may cause widespread destruction. Wind engineering draws upon meteorology , aerodynamics and a number of specialist engineering disciplines. The tools used include climate models, atmospheric boundary layer wind tunnels and numerical models. It involves, among other topics, how wind impacting buildings must be accounted for in engineering. Vertical wind-speed profiles result in different wind speeds at the blades nearest to the ground level compared to those at the top of blade travel, and this in turn affects the turbine operation.

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Chapter 6 : Terminal Doppler Weather Radar (TDWR) - SKYbrary Aviation Safety

low-altitude wind shear and its hazard to aviation On July 9, , Pan American World Airways Flight crashed shortly after taking off from New Orleans International Airport. One hundred forty five people on board the airplane and eight people on the ground died.

Chapter 7 : Wind shear - Wikipedia

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Definition. Wind shear refers to the variation of wind over either horizontal or vertical distances. Airplane pilots generally regard significant wind shear to be a horizontal change in airspeed of 30 knots (15 m/s) for light aircraft, and near 45 knots (23 m/s) for airliners at flight altitude.