engineering airscience PTY LTD

BOUNDARY LAYER METEOROLOGY

Boundary layer meteorology is the area of meteorology concerned with the atmospheric boundary layer; the layer of the atmosphere directly influenced by the surface of the Earth.

Moisture and, generally more significantly, diurnal thermodynamic effects strongly influence atmospheric flow and turbulence in the region immediately above the Earth's surface. Obstacles on the surface retard the flow, reducing the wind speed and introducing random motions or fluctuations within the flow known as turbulence. Turbulence acts to mix the atmospheric flow vertically as well as aid in the dilution of pollutants.

The roughness of the underlying surface influences the velocity reduction. Regions of more rough terrain or obstacles such as cities create greater drag on the flow and reduced lower level wind speeds, with less reduction and higher wind speeds observed over smoother surfaces such as open plains or water. Daytime solar radiation heats the ground, generating a positive heat flux as the warm surface heats the air immediately above.

A thermal instability is developed with less dense warm air forming below the more dense cooler air, generating large buoyancy forced turbulent motions as the warm air rises in a thermal. Cooler air from above subsides to replace the warmer air. Primary interest in this phenomenon, known as the convective boundary layer (CBL), relates to air pollution, particularly emissions from tall stacks. The size and strength of the convective circulations, typically 1 to 2km, can bodily transport a plume to ground, potentially creating high ground level concentrations for a period of a up to 20 minutes. The CBL is the common day time condition over much of the earth's land mass.

The other principal form of the atmospheric boundary layer is the stable boundary layer. This occurs when the Earth's surface is at a lower temperature than the air flow immediately above and thus acts to cool the air from below. It is also known as the nocturnal boundary layer, typically occurring on clear nights when the ground cools through the radiation of energy to the atmosphere. Layers of cooler, denser air develop below warmer less dense air, with a stabilising temperature gradient established. Elevated source emissions (tall stacks) remain aloft, however dispersion of low level emissions is reduced leading to higher pollutant concentrations from ground level sources. Many odour emissions occur at or close to ground, and thus are potentially more likely to cause nuisance under clear, calm nights with significantly reduced dispersion.

Engineering Air Science provides be-spoke solutions on issues relating to air quality and the environment, atmospheric flow and meteorology, industrial fluid mechanics and thermodynamics.

As wind speed increases, surface drag derived turbulent energy becomes more significant, overwhelming any thermal gradients and controlling the atmospheric boundary layer turbulent structure. High wind conditions are generally more critical from a wind engineering perspective; the design of buildings and structures and the dangers associated with the 'wind tunnel' effect in streets and open spaces. Higher winds also bend plumes emitted from tall stacks over more rapidly, potentially causing interaction with structures, entrainment and downwash. Higher wind speeds also act to dilute a plume more rapidly as the total air volume increases.

Engineering Air Science brings local and international experience in monitoring, analysis and simulation of complex meteorological conditions for research and application to design and assessment.

-EXPERIENCE-

Experience in measurement and analysis of environmental conditions and the advanced application and development of modelling technologies.

-KNOWLEDGE-

Knowledge of extreme critical conditions from both wind engineering and an environmental and air quality perspective.

-EXPERTISE-

Expertise and insight gained through the application of physical and numerical simulation tools to complex physical states of the atmospheric boundary layer, improving understanding of boundary layer meteorology and complex dispersive behaviour.

SERVICES

» Meteorological Modelling & Monitoring
» Complex Flow Modelling, CFD & Physical
» Air Quality Modelling & Monitoring
» Data Analysis & Statistics
» Peer Review

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