Wind Profiler Applications

From aviation to air quality

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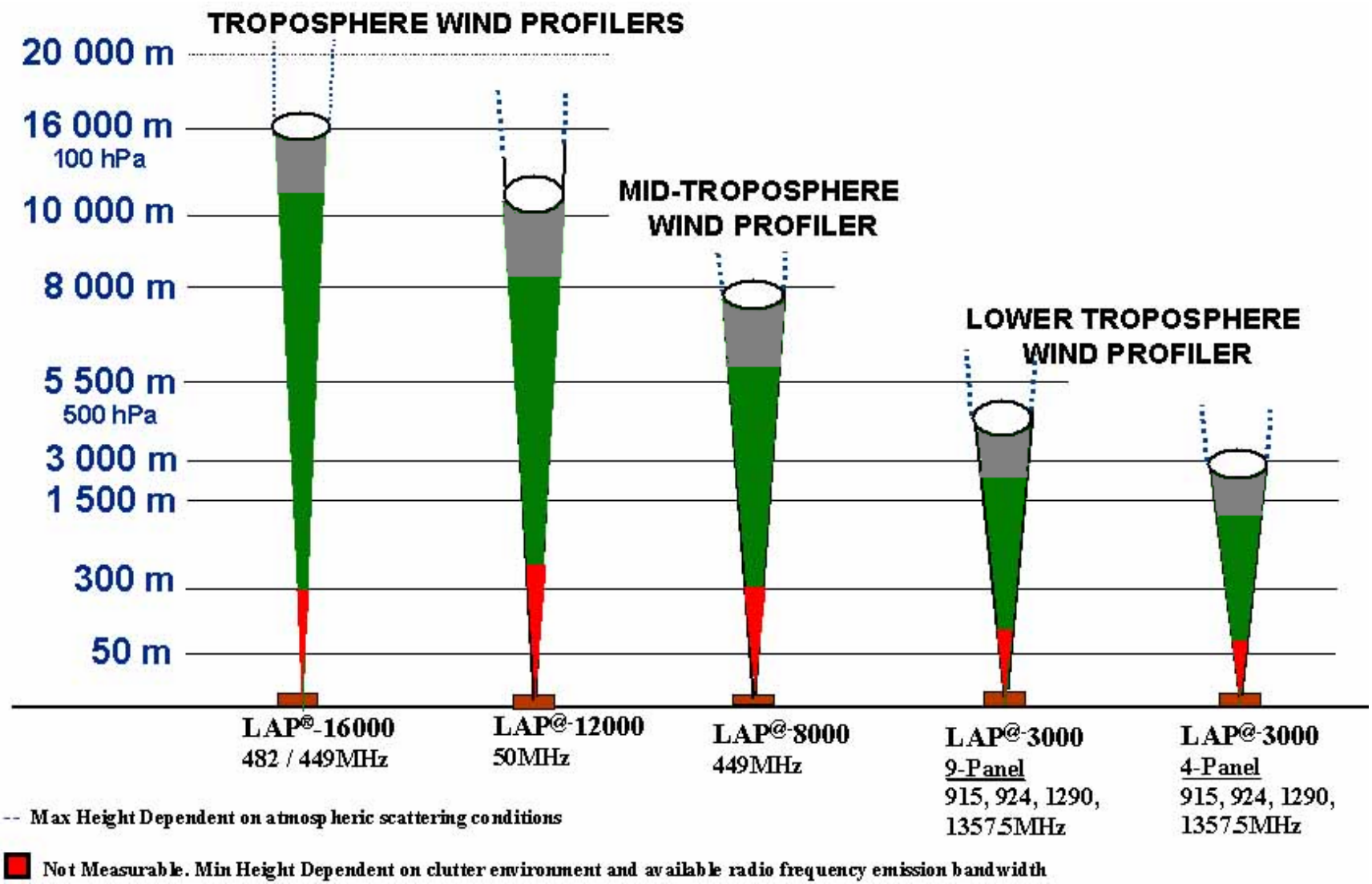
Vaisala LAP Wind Profilers

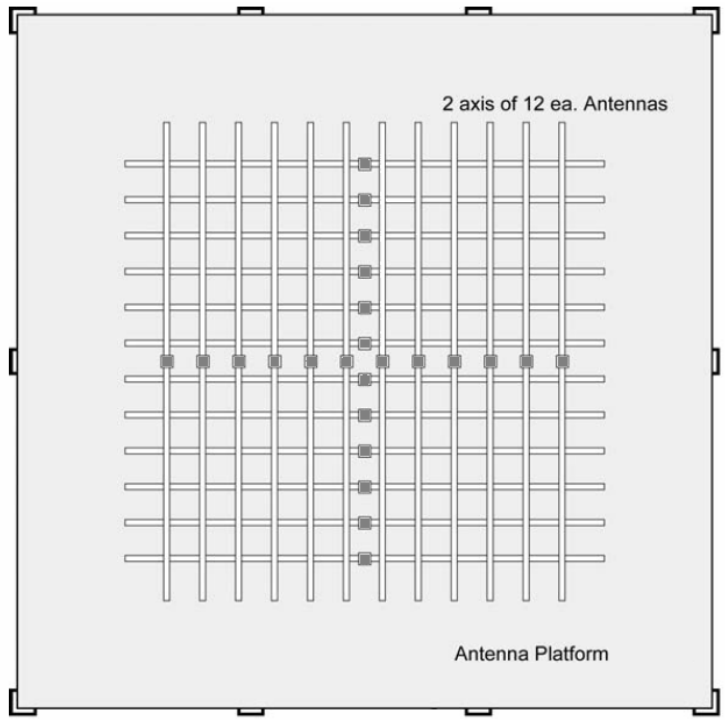


LAP®-3000 Applications

- Air Quality
- Homeland Defense
- Mesoscale Networks
- Atmospheric Research
- Tactical Artillery/Ballistics
- Test Range Support
- Space Vehicle Launch/Landing
- Aviation - Terminal Airport Weather

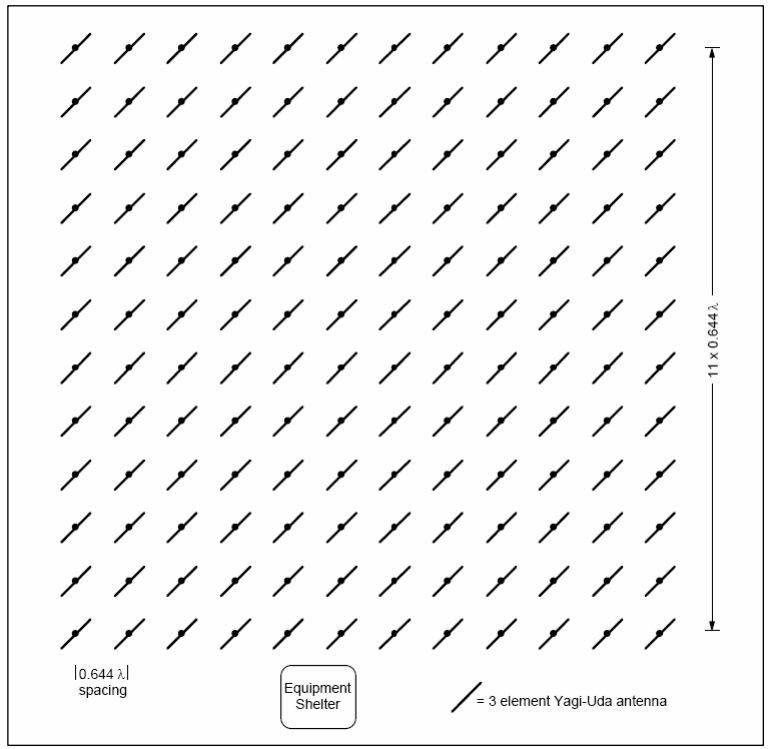
LAP®-8000 Applications

- Mesoscale networks
- Regional and synoptic modeling
- Supplemental/complementary upper-air observations
- National Security/Border surveillance
- Research



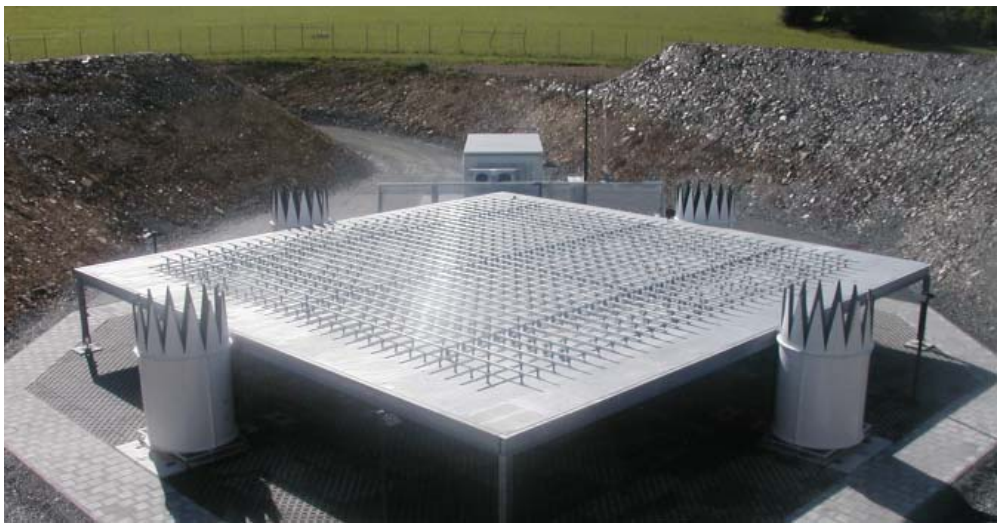
LAP®-12000 Applications

- Synoptic network systems
- Supplemental/complementary upper-air observations
- Space launch support



LAP®-16000 Target Applications

- Supplemental/complementary synoptic upper-air observations
- Special Research Programs
- Space launch support (when large antenna arrays are not practical due to land restrictions)



Applications and Examples of LAP® Users

- Terminal Area Weather Support - Wind Shear and Wake Vortex Apps.
  - Hong Kong Observatory, Hong Kong
  - Juneau, Alaska Airport
  - Austro-Control, Austria
  - CAAC, China
- Air Quality
  - Multiple users in the USA
  - Regione Piemonte
  - Israel Electric Company
  - Thailand
- Military Range Support
  - US Army White Sands Missile Range
  - China Lake Naval Test Range
- Space Launch Support
  - USAF Cape Canaveral
  - China Space Agency

Applications and Examples of LAP® Users

- Mesoscale Observational Networks
  - USAF Cape Canaveral and Vandenberg AFB
  - Helsinki Testbed
- National Observational Networks
  - NOAA Profiler Network
  - UK Met Office
  - DWD
- Research
  - KNMI
  - Multiple Universities
  - Institute of Atmospheric Physics (Beijing)
  - MeteoSwiss

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Air Quality Meteorology

- Air Quality Meteorology is an important application of atmospheric science
- The radar wind profiler is an important part of the suite of instruments for modeling air quality and tracking transport of pollutants
- Vaisala has a family of profilers and other instrumentation that supports air quality meteorology applications

Why is Air Quality Important?

Aerosols ($PM_{2.5}$)

- Induce respiratory diseases and cancer
- Reduce visibility
- Impacts climate

Ozone

- Induces respiratory diseases (e.g., asthma)
- Damages crops
- Greenhouse gas

Impacts of Poor Air Quality on Society

- 60,000 Death per annual (mean)*
- $143 Billion Cost per annual (mean)**

*Science 289, 2000; **American Lung Assoc. 2001

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Candidate Meteorological Measurement Systems for Air Quality

Dispersion Variables	Meteorological Variables	Candidate Measurement Systems
Transport	Three-dimensional fields of wind speed and wind direction	Profilers; Doppler weather radar; RAOBs; mesonets; aircraft; tethersonde; Doppler lidar
Diffusion	Turbulence; wind speed variance; wind direction variance; stability; lapse rate; mixing height; surface roughness	3D sonic anemometers; cup & vane anemometers; RAOBs; profilers; RASS; scanning microwave radiometer (maybe); tethersonde
Stability	Temperature gradient; heat flux; cloud cover; insolation or net radiation;	Towers; ceilometers; profiler/RASS; RAOBs; aircraft; tethersonde; net radiometers; pyranometers; pyrgeometers
Deposition, wet	Precipitation rate; phase; size distribution	Weather radar (polarimetric); cloud radar; profilers
Deposition, dry	Turbulence; surface roughness	See turbulence
Plume rise	Wind speed; temperature profile; mixing height; stability	Profilers/RASS; RAOBs; lidar; ceilometer; tethersonde; aircraft

Wind Profiler is a key instrument for most measurements

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Aviation and launch support

Wind shear

Jet stream identification

Wake Vortices

Clear Air Turbulence

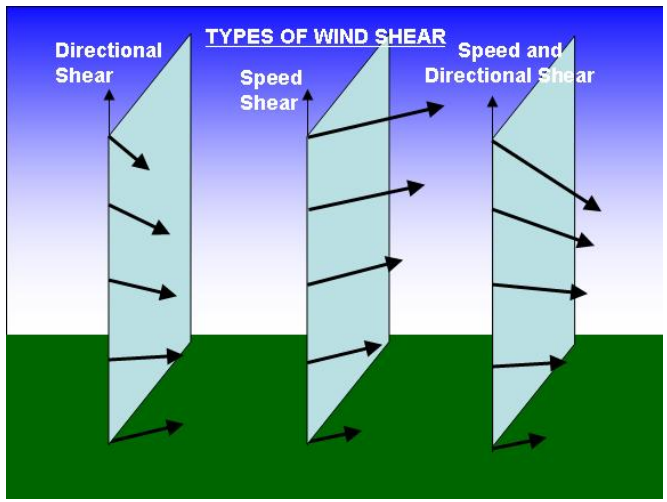
What Is Wind Shear?

A meteorological phenomenon associated with a sudden variation of wind speed and/or wind direction between two points

It can occur either horizontally or vertically

It is most often associated with strong temperature inversions or density gradients

It can occur at both high or low altitudes



FAA Wind Shear Terminology and Alert Criteria

- ”Wind Shear With Loss”
  - If the estimated IAS loss is between 15 and 30 knots, over 4 km of flight
- “Microburst”
  - If the estimated IAS loss is 30 knots or greater, over 4 km
- “Wind Shear With Gain”
  - If a convergence zone is detected with a wind shear of 15 knots (IAS gain) or greater

Why Is Wind Shear Detection Important?

If encountered close to the ground during aircraft take-off or landing procedures, low level wind shear can be particularly dangerous

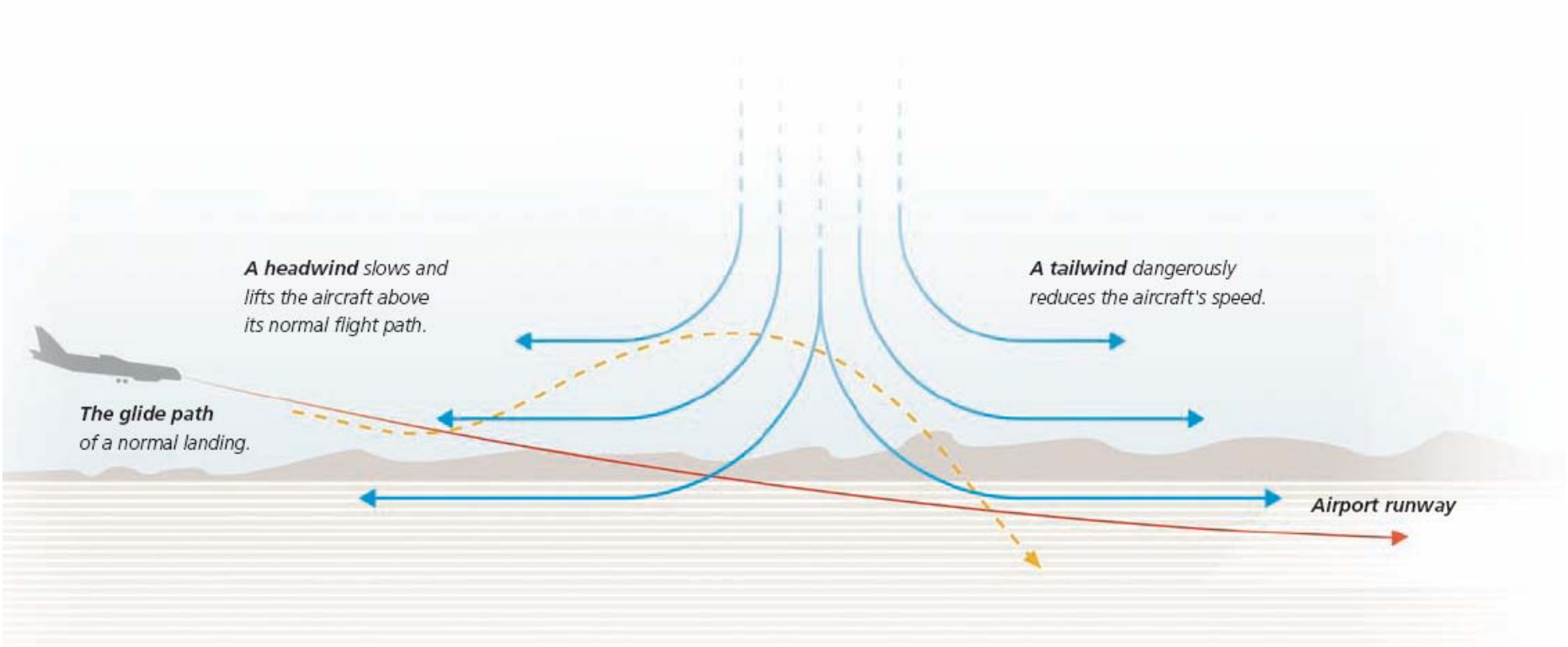
The change in velocity or direction can drastically alter lift, indicated airspeed (IAS), and thrust requirements

It may exceed aircraft climb capabilities (all classes of aircraft)

US wind shear related Incidents between 1964 and 1985

- Over 25 US airline accidents
- 625 fatalities
- 200 injuries

Loss of airspeed on final approach due to any type of wind shear can be catastrophic



Low Level Wind Shear

Four common sources of low level wind shear:

Thunderstorm

Frontal Activity

Temperature Inversions

Surface Obstructions

Vaisala LAP®-3000 deliveries to support Aviation

Location	Application	Systems
Air Force, Patrick AFB, Florida, USA	Aircraft and space shuttle support (launch/landing)	5
US Air Force, Vandenberg AFB,California, USA	Aircraft and space shuttle back-up landing support	6
Dallas/Ft Worth International airport, Texas, USA	Aviation safety research/wake vortex studies	1
Memphis International Airport, Tennessee, USA	Aviation safety research/wake vortex studies	1
Macau International Airport, Macau	General and commercial aviation	1
Juneau International Airport, USA	General and commercial aviation, turbulence detection	3
US Air Force, Travis AFB California, USA	Military aviation support and wind shear detection	1
Chek Lap Kok International Airport, Hong Kong	General and commercial aviation, turbulence detection	4
Kai Tek International Airport (former), Hong Kong	General and commercial aviation, turbulence detection	1
Sisimuit Regional Airport, Greenland	General and commercial aviation, turbulence detection	1
Vienna International Airport, Austria	General and commercial aviation	1
Salzburg International Airport, Austria	General and commercial aviation	1
Innsbruck International Airport, Austria	General and commercial aviation	1
Catania Airport, Italy	General and commercial aviation	1
CAAC, Jiu Zhai, China	Aviation	2
Xian Manned Space Center, China	Space Launch	1
CAAC, Shanghai Pudong Airport, China	Aviation	1
CAAC, Linzhi Airport , China	Aviation	3
Los Angeles International Airport California, USA	Air Quality & Airport winds	1
Ontario International Airport California, USA	Air Quality & Airport winds	1
Douglas International Airport Arizona, USA	Air Quality & Airport winds	1
	Total	**38**