Lidars

Description

Lidars, or LIght Detection And Ranging instruments, measure the radiation that is returned either from particles in the atmosphere or from the Earth's surface when illuminated by a laser source. Compared with radar, the shorter wavelengths used in a lidar allow greater detail to be observed, but cannot penetrate optically thick layers such as clouds.

There are a number of different types of lidar instrument:

– the backscatter lidar, in which the laser beam backscattered, reflected or re-radiated by the target gives information on the scattering and extinction coefficients of the various atmospheric layers being probed;

– the differential absorption lidar which analyses the returns from a tuneable laser at different wavelengths to determine densities of specific atmospheric constituents as well as water vapour and temperature profiles;

– Doppler lidar which measures the Doppler shift of the light backscattered from aerosol particles transported by the wind, thereby allowing the determination of wind velocity;

– the ranging and altimeter lidar which provides accurate measurements of the distance from a reference height to precise locations on the Earth's surface.

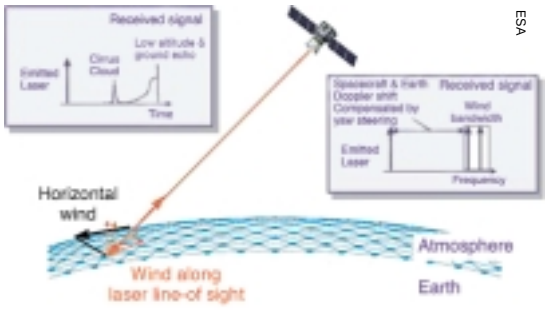
The first satellite-borne lidars are expected to fly on the NASA VCL and ICESat missions within the next few years.

Applications

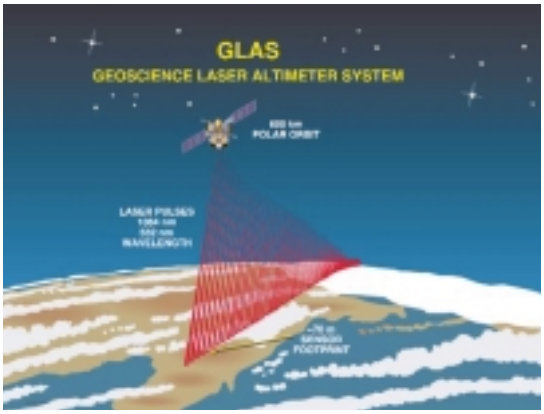
The different types of lidar may be used to measure a diverse range of parameters. Ranging and altimeter lidars may be used to provide surface topography information, for example on ice sheet height and land altitude. Missions planned within the next few years will undertake to determine the mass balance of the polar ice sheets and their contributions to global sea level change; others will focus on study of the vegetation canopy structure and provide unique data sets including estimations of global biomass and carbon stocks, and fractional forest cover.

Multifrequency ranging lidars with probe wavelengths in the visible and near IR will be used to measure aerosol height distributions and cloud height. Differential absorption and backscatter lidar may be used to measure cloud properties over an extended swath width, and Doppler lidars may be used to measure 3-D winds. This capability for measuring clear air winds (ie in the absence of clouds or winds above clouds) is of particular importance since it will correct a major deficiency in wind-profiling of the current global meteorological observing systems. Instruments such as ESA's ALADIN will provide wind profile measurements to establish significant advances in atmospheric modelling and analysis.

Instrument catalogue



Doppler Wind Lidar principle: The lidar emits a laser pulse towards the atmosphere, then collects, samples, and retrieves the frequency of the backscattered signal. The received signal frequency is Doppler-shifted from the emitted laser due to the spacecraft, Earth, and wind velocity. The lidar measures the wind projection along the laser line-of-sight, using a slant angle versus nadir.



GLAS on ICESat will provide data on ice-sheet topography from late 2002.

ALADIN: www.esa.int/export/esaLP/aeolus.html

VCL: www.geog.umd.edu/vcl/

GLAS: www.csr.utexas.edu/glas/

CALIPSO: essp.gsfc.nasa.gov/calipso/