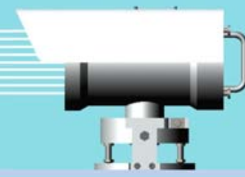
LAS

LARGE APERTURE SCINTILLOMETER



The Large Aperture Scintillometer (LAS) and eXtra Large Aperture Scintillometer (X-LAS) are instruments designed for measuring the path-averaged structure parameter of the refractive index of air (C_n^2) over horizontal paths of several kilometers. Structure parameter measurements obtained with both scintillometers and additional standard meteorological observations (air temperature, wind speed and air pressure) can be used to derive the surface sensible heat flux (H).

The LAS optically measures the structure parameter (C_n^2) between transmitter and receiver separated by several kilometres. Compared to traditional 'point' measurements the LAS and X-LAS operate at spatial scales comparable to the grid box size of numerical models and the pixel resolution of satellite images used in meteorology, hydrology and water-management studies. The LAS has important applications in energy balance and water balance studies, because the surface flux of sensible heat is linked to evaporation.

The scintillometers require little power and are suitable for use in remote areas. Their robust housing and mounting make the instruments ideal for long-term operation and require little maintenance. Both the LAS and the X-LAS have a heated window to eliminate condensation problems and embodies onboard calibration and reference signals allowing rapid confirmation of the instrument performance. Both instruments have analogue output signals which can be directly connected to any data logger with at least 2 analogue input channels.

FEATURES

Provide path-averaged turbulent statistics (C_n^2) of the atmosphere over long distances

Fast response time, the averaging in both time and space provides reliable statistics in a few minutes

Suited for measuring over distances in excess of 8 kilometers

No flow distortion by the instrument itself

Window/lens heater to eliminate condensation problems

Easy transportation and installation

Suitable for use in remote areas (low power consumption, e.g. solar - battery power)

No moving parts, low operational costs, easy data processing

Onboard reference signal allow on scene performance checks of the electronics

APPLICATIONS

Agriculture and Forestry:
optimal timing for spraying

Climatology:
support of energy balance studies

Environmental services:
air pollution forecast and warning in urban areas

Hydrology:
regional and basin-scale evaporation

Irrigation, water & management:
optimal timing for irrigating

Meteorology:
regional weather forecasting

Radio physics:
electromagnetic wave propagation

Remote sensing:
ideal instrument (ground truth) for validation studies of satellite/aircraft remote sensing methods

Turbulence:
inertial sub-range scale turbulence measurements

MEASUREMENT PRINCIPLE

A scintillometer is an instrument that measures the 'amount' of scintillations by emitting a beam of light over a horizontal path. The scintillations 'seen' by the instrument can be expressed as the structure parameter of the refractive index of air (C_n^2), which is a representation of the 'turbulent strength' of the atmosphere. The turbulent strength describes the ability of the atmosphere to transport heat and water vapour.

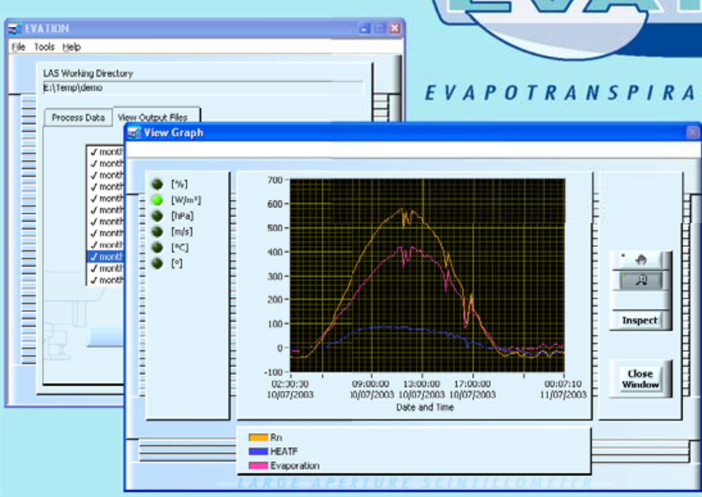
The LAS and X-LAS measure the structure parameter of air using a near-infrared light source of 880 nm. At this wavelength temperature fluctuations are dominant. Therefore, C_n^2 measurements and standard meteorological observations (wind speed, air temperature and air pressure) can be used to derive the surface sensible heat flux (H), representative of areas of several square kilometres.

SOFTWARE

The recorded C_n^2 data from the LAS or X-LAS can be processed using the included WINLAS software. This is a Windows™ program that calculates the sensible heat flux, using additional wind speed, air temperature and pressure data, for both unstable (day-time) and stable (night-time) conditions. WINLAS displays the input data file and the results using a simple viewer. The results are written in an output file that can be imported into spreadsheet programs. At extra cost the user can upgrade to the specially developed Kipp & Zonen 'EVATION' software package. This software provides installation, set-up, configuration and help files for a complete Kipp & Zonen Evapo-Transpiration (E-T) system comprised of the LAS or X-LAS, comprehensive meteorological sensors and data loggers. EVATION calculates and displays sensible heat flux, evapo-transpiration and other parameters in a graphical environment.

EVATION

EVAPOTRANSPIRATION SOFTWARE



SCINTILLATION

The scintillation technique to determine the path-averaged structure parameter of the refractive index of air is based on the propagation statistics of electromagnetic radiation through the atmosphere. When an electromagnetic beam of radiation propagates through a turbulent atmosphere it is distorted by a number of processes, which remove energy from the beam leading to signal attenuation. The most dominant of these are small fluctuations in the refractive index of air (n) caused by temperature and humidity variations. These refractive index fluctuations lead to intensity changes, which are known as scintillations.

LAS

EXAMPLE

Figure 1 shows the typical diurnal course of C_n^2 measured with the LAS for a sunny day with some scattered clouds. The two transition periods at sunrise and sunset are clearly noticeable by the distinct drops of C_n^2. During these transition periods the atmospheric stability changes from unstable (day-time period) to stable (night-time period) or vice versa.

ALIGNMENT

It is important that the transmitter and receiver have stable, secure mountings and that the transmitted infrared beam is optimally aligned with the receiver. To simplify the procedure the LAS and X-LAS are supplied with integrated pan and tilt mechanisms and pre-aligned sighting telescopes which can be removed after installation. The transmitter power is adjustable for different path lengths and the receiver incorporates a signal strength meter for fine tuning. The controls are visible through windows in the rear covers.

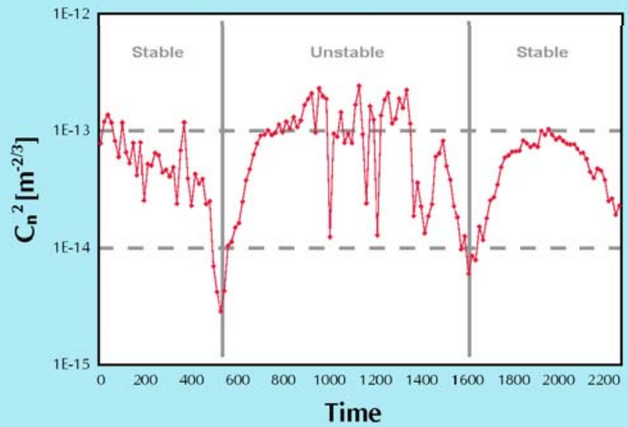


Figure 1

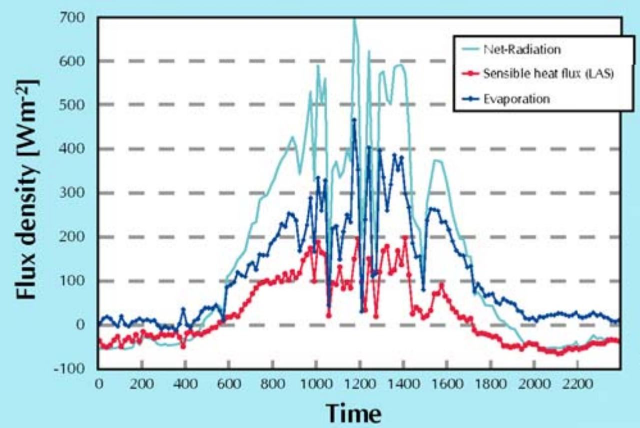
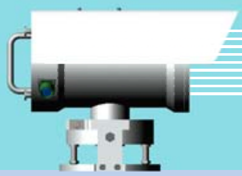


Figure 2

The C_n^2 data obtained with the LAS can be used to derive the surface flux of sensible heat. The fluxes derived from the C_n^2 data shown in Figure 1 are plotted in Figure 2 together with net radiation measurements. The sensible heat fluxes were calculated by the WINLAS software using additional air temperature and wind speed data. Again it can be clearly seen that during the day clouds pass the measurement site (net radiation drops). Once the net radiation and soil heat flux densities are known the evaporation rate can be derived indirectly from the LAS data. Finally, the daily average evaporation can be estimated.



SPECIFICATIONS	LAS	X-LAS
Path length range	0.25 to >4.5 km[1]	1 to >8 km[1]
Aperture diameter	0.152 m	0.328 m
Lens type	Fresnel	Fresnel
Optical wave length LED	880 nm	880 nm
Power output LED	80 mW (max.)[1]	80 mW (max.)[1]
Carrier frequency	7 kHz (0.5 duty cycle)	7 kHz (0.5 duty cycle)
Power requirements	12 VDC nominal (10.5 - 15)	12 VDC nominal (10.5 - 15)
Power consumption	0.5 A max. (path length dependant) 3 A max. (window heater included)	0.5 A max. (path length dependant) 1.7 A max. (window heater included)
Window heater	self regulating at 55 °C	14 W (non-regulating)
Onboard calibration test	Yes	Yes
Operating temperature range	-20 °C to +50 °C	-20 °C to +50 °C
Alignment	Integrated pan and tilt adjustment. Removable pre-aligned sighting telescopes. Signal strength meter.	
Physical dimensions (including pan and tilt adjuster)	0.35 m length[2] 0.23 m width[2] 0.32 m height[2]	1.04 m length[2] 0.43 m width[2] 0.57 m height[2]
Weight	13.5 kg	30 kg

[1] Dependant of surface conditions and measurement height of LAS / X-LAS.

[2] Excluding sun cover for LAS and removable sighting telescopes.

SOLAR & ATMOSPHERIC SCIENCE

CAMPBELL SCIENTIFIC
CANADA CORP.
11564 - 149 street - edmonton - alberta - T5M 1W7
tel 780.454.2505 fax 780.454.2655
www.campbellsci.ca