

SLS 20

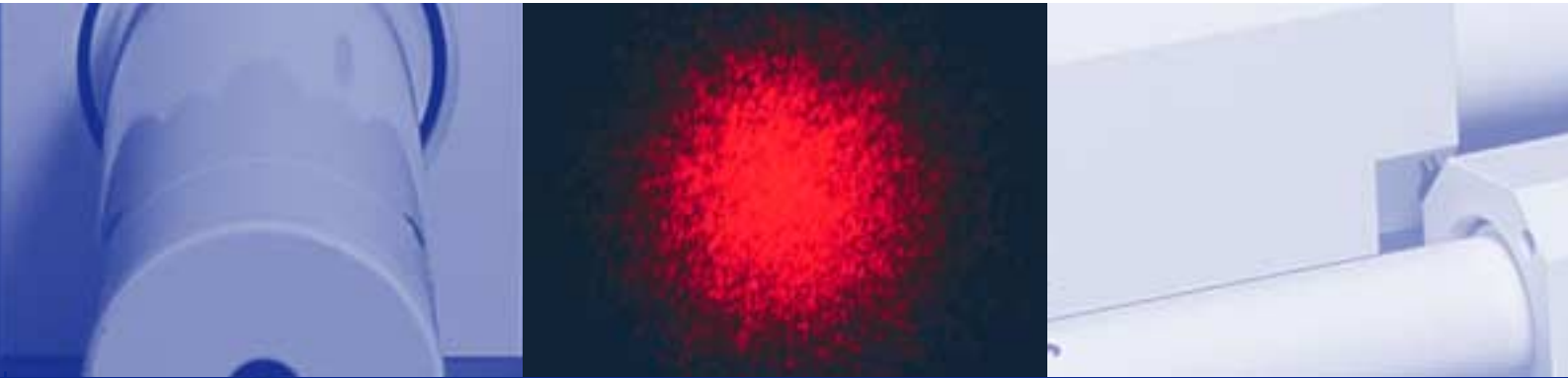
SLS 20-A

SLS 40

SLS 40-A

OEBMS1

Surface Layer Scintillometers



The Ultimate Sensors for Turbulence,
Heat Flux, Momentum Flux, Crosswind

Including:
Optical Energy Balance Measurement System

PREFACE

The measurement of atmospheric turbulence has traditionally been a difficult task. In particular it has been realized, that conventional instruments suffer significantly from flow distortions caused by the aerodynamic properties of the sensors and mountings. It has also been limiting that statistics demand quite long averaging times.

Recent micrometeorological research has demonstrated the superior capabilities of scintillometers for turbulence measurements. The spatial averaging over a line of sight replaces the temporal averaging of conventional point sensors. This results

in an outstanding temporal resolution. Besides, scintillometers provide high sensitivity and accuracy and the reliability of an instrument without any moving parts.

With a proprietary displaced-beam laser technique, Scintec's Surface Layer Scintillometers deliver extensive turbulence information, including the fluxes of heat and momentum.

Scintec offers four instrument versions for different applications:

SLS20, SLS40, SLS20-A, SLS40-A. A crosswind extension is available for each of these models.

THE ULTIMATE TURBULENCE SENSOR



Model SLS20

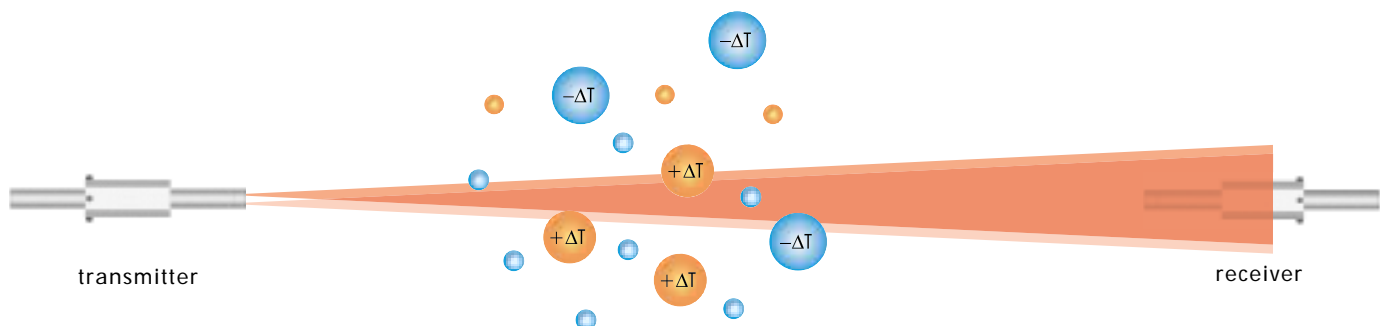
OPERATION PRINCIPLE

The term "scintillation" describes turbulence-induced fluctuations of the observed intensity of a remote light source. A well-known example is the twinkling of a star. A scintillometer uses this effect to measure atmospheric turbulence.

With Scintec's Surface Layer Scintillometers, a transmitter emits two parallel laser beams. The receiver is located 50 to 250 m apart from the transmitter. From the

measured variances and covariances at two detectors, the structure constant C_n^2 and the inner scale l_0 of refractive index fluctuations are derived. The instrument's operating software converts this into the structure constant of temperature C_T^2 and the dissipation rate ϵ of turbulent kinetic energy. By application of the dissipation technique, the software calculates accurate values of the turbulent fluxes of heat and momentum.

A REVOLUTIONARY TECHNIQUE



Optical measurement of turbulence with Surface Layer Scintillometer

ADVANTAGES

The line averaging optical method has substantial advantages over traditional point measurement techniques:

Spatial coverage

Due to the extended spatial averaging, large experimental areas can be representatively characterized with a single instrument.

No flow distortion

The optical, contact-free access to the medium avoids mechanical interactions as observed with conventional instruments and mountings.

Very low statistical noise at high temporal resolution

The temporal resolution achievable with Scintec's Surface Layer Scintillometers is one order of magnitude higher than that of a point measurement. Typical averaging times are 1 - 5 min for the fluxes and 10 - 60 s for the other turbulence statistics, with virtually no statistical noise.

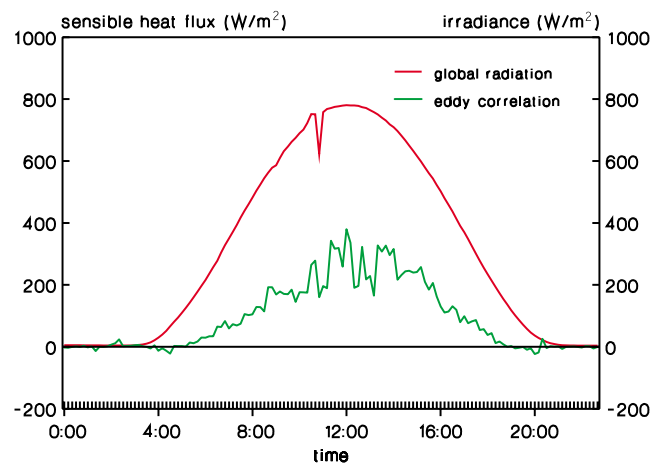
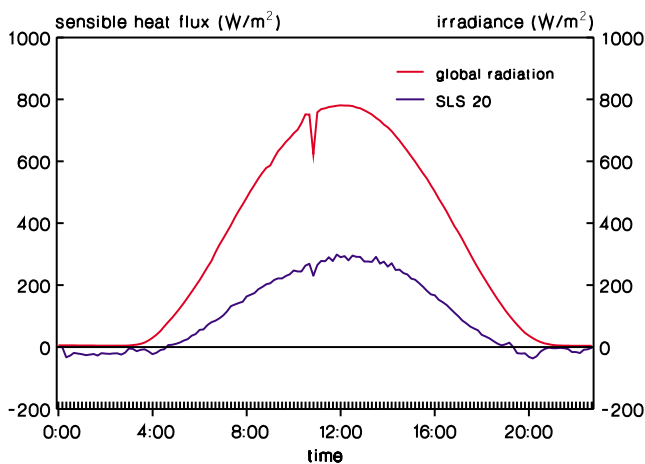
Sensitivity and reliability

Scintec's Surface Layer Scintillometers accurately respond even to small temperature and wind fluctuations. The measurement principle is based on the evaluations of relative intensity statistics, hence the system is free of longterm drift and does not require calibration.



Line average over a road

ADVANTAGES



Turbulent heat flux measured by the SLS20 scintillometer (left graph) compared with eddy correlation measurements (right graph). Due to a much lower statistical noise, the cloud event before noon can be identified only in the scintillation heat flux data. Measurements were taken in the Scottish tundra (May 23, 1993; data courtesy of UMIST, University of Manchester).

SOFTWARE

The SLSRUN software makes the operation of Scintec's Surface Layer Scintillometers comfortable and easy. Averaging time, path length and height can be set individually. The following measurement outputs are displayed graphically on the screen:

- turbulent flux of heat (absolute value)
- turbulent flux of momentum
- Obukhov length
- structure constant C_n^2 of refractive index and inner scale l_0
- structure constant C_T^2 of temperature and dissipation rate ϵ of kinetic energy
- path averaged wind speed perpendicular to the beam axis (with crosswind extension)

COMFORT AND CONTROL

MODELS

MODELS

The SLS20 is the standard model, appropriate for most measurement environments.

The model SLS20-A adds an automatic beam steering which permits operation when manual beam alignment is undesirable or difficult (e. g. on towers). It may also be useful when the pointing stability of the mounting is poor.

The SLS40 is specifically designed for operation on towers or other platforms prone to vibrations. Using

a receiver with four detectors, vibration effects are eliminated.

The model SLS40-A includes both the features of the SLS20-A and the SLS40.

With the extension SLSCW-20, Scintec's Surface Layer Scintillometers additionally sense the line-averaged wind speed component perpendicular to the optical propagation path. The measurement range extends down to a few centimetres per second.



SLS40-A

APPLICATIONS

Scintec's Surface Layer Scintillometers are perfectly suited for a variety of applications, including:

- turbulence studies
- measurements of surface energy budgets
- diffusion experiments
- micrometeorological stability monitoring
- pollution flow analysis
- wind divergence measurements
- satellite data "ground truth" measurements
- airport runway cross wind measurements
- airplane wake vortex and downdraft detection
- performance studies of electro-optic systems (range finders, imagers, surveying instruments, etc.)



Measurement over water at low height



Measurement over forest (Karuizawa, Nagano, July 2001, courtesy Central Research Institute of Electric Power Industry).



Measurement over urban area (Tokyo, August 1996, courtesy of Tokyo Institute of Technology).

APPLICATIONS

OPTICAL ENERGY BALANCE MEASUREMENT SYSTEM

The OEBMS1 represents a revolutionary technique to obtain the components of the Surface Energy Balance, based on the use of optical scintillation. Unlike conventional systems, a high accuracy is achieved even with short averaging periods. While traditional stations need averaging times of 30 – 60 min, the OEBMS1 resolves all flux components in 5 min

steps – virtually without statistical noise and representatively characterizing large experimental areas. For comparison: about 100 eddy correlation sensors mounted on masts along the optical propagation path would be required to achieve a similar performance.

The OEBMS1 consists of one SLS20⁽¹⁾ scintillometer system with tripods to

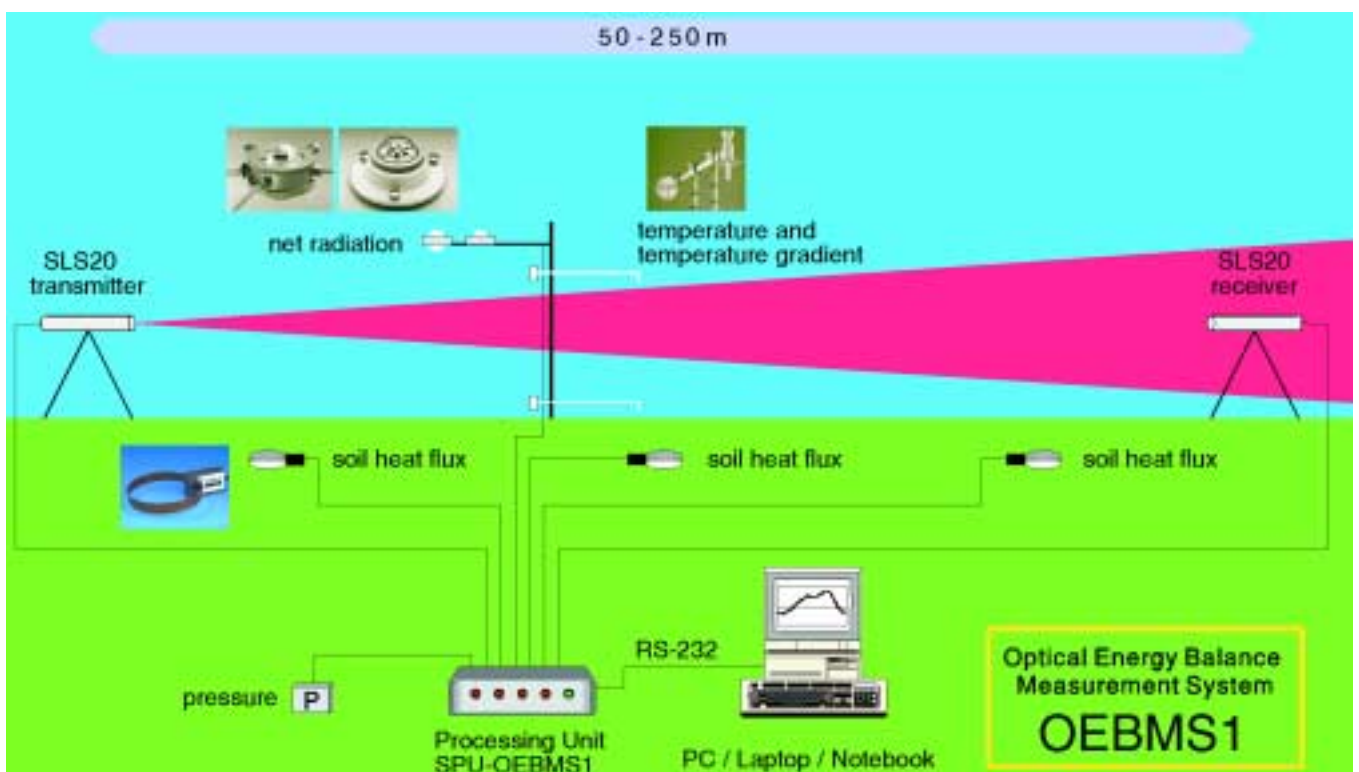
measure the sensible heat flux, one pyrradiometer (0.3 – 30 μm) and one pyranometer (0.3 – 3 μm) to measure the radiation flux balance and three soil heat flux sensors. The latent heat flux is calculated as residuum of the other components. Two ventilated thermometers Pt1000 and one pressure sensor provide the auxiliary data for an automatic

derivation of the turbulent heat flux from the scintillation measurements.

The Signal Processing Unit interfaces with all sensors and communicates with a PC via a RS232 link. The software outputs the turbulent fluxes of sensible and latent heat, the incoming solar and net radiation and the ground heat flux.

⁽¹⁾ SLS20-A, SLS40, SLS40-A optional

TURN-KEY ENERGY BALANCE



SPECIFICATIONS

specifications	SLS20 / SLS20-A SLS40 / SLS40-A	remarks
optical wavelength	670 nm	visible (red)
mean output power	1 mW	laser safety class IIIa ⁽³⁾
beam divergence	5 mrad	approximately
scan cone diameter	1 degree	SLS20-A and SLS40-A only
path length	50 - 250 m	others optional
analog input channels	input range 0 – 10 V	11 optional channels, 12 bit resolution
supply voltage and current	12 V, 0.6 - 0.9 A, depending on options	for SLS20 transmitter, receiver, SPU20 Signal Processing Unit
	12 V, 0.2 A	for window heating
operation temperature range	-20 to +50 °C	
dimensions (length x width x height)	0.65 m x 0.11 m x 0.11 m	SLS20 / SLS40 transmitter
	0.61 m x 0.11 m x 0.11 m	SLS20 / SLS20-A receiver
	0.69 m x 0.11 m x 0.11 m	SLS20-A / SLS40-A transmitter
	0.62 m x 0.11 m x 0.17 m	SLS40 / SLS40-A receiver
weights	2.9 kg	SLS20 / SLS40 transmitter
	2.7 kg	SLS20 / SLS20-A receiver
	3.3 kg	SLS20-A / SLS40-A transmitter
	5.2 kg	SLS40 / SLS40-A receiver
mount of transmitter and receiver	5/8 inch thread	for surveying tripods, others on request

measurement ranges ⁽¹⁾	from	to	unit	depends on
structure constant C_n^2	1×10^{-16}	3×10^{-12}	$m^{-2/3}$	path length
inner scale l_0	2	16	mm	path length
structure constant C_T^2	1×10^{-4}	3	$K^2 m^{-2/3}$	path length ⁽²⁾
kinetic energy dissipation rate ϵ	2×10^{-4}	1	$m^2 s^{-3}$	path length ⁽²⁾
sensible heat flux	2	600	$W m^{-2}$	path length and height, Obukhov length ⁽²⁾
	-2	-120	$W m^{-2}$	
momentum flux	-4×10^{-3}	-1.2	$N m^{-2}$	path length and height, Obukhov length ⁽²⁾
wind speed	0.01	10	$m s^{-1}$	with SLSCW-20 extension

Specifications are subject to change without notice.

⁽¹⁾Typical values SLS20(-A), SLS40(-A) for path 100 m long and 2 m high;

⁽²⁾Values for normal temperature and pressure

⁽³⁾: CDRH
Warning Label



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