"Unique Approach to Measuring Mixing Layer Structures Using a Common Lidar Ceilometer"

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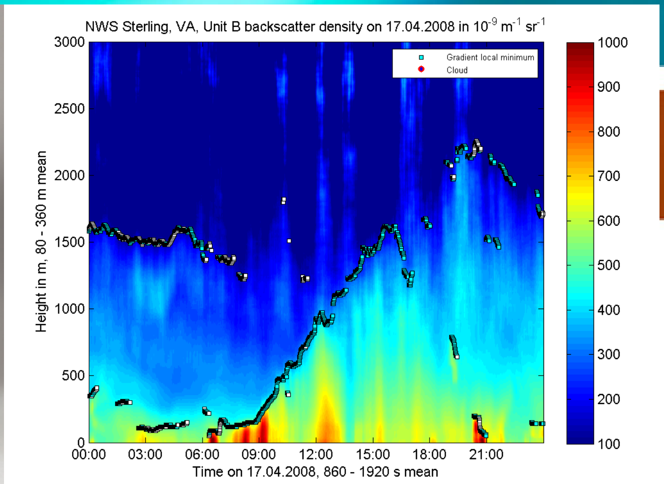

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Vaisala Ceilometers

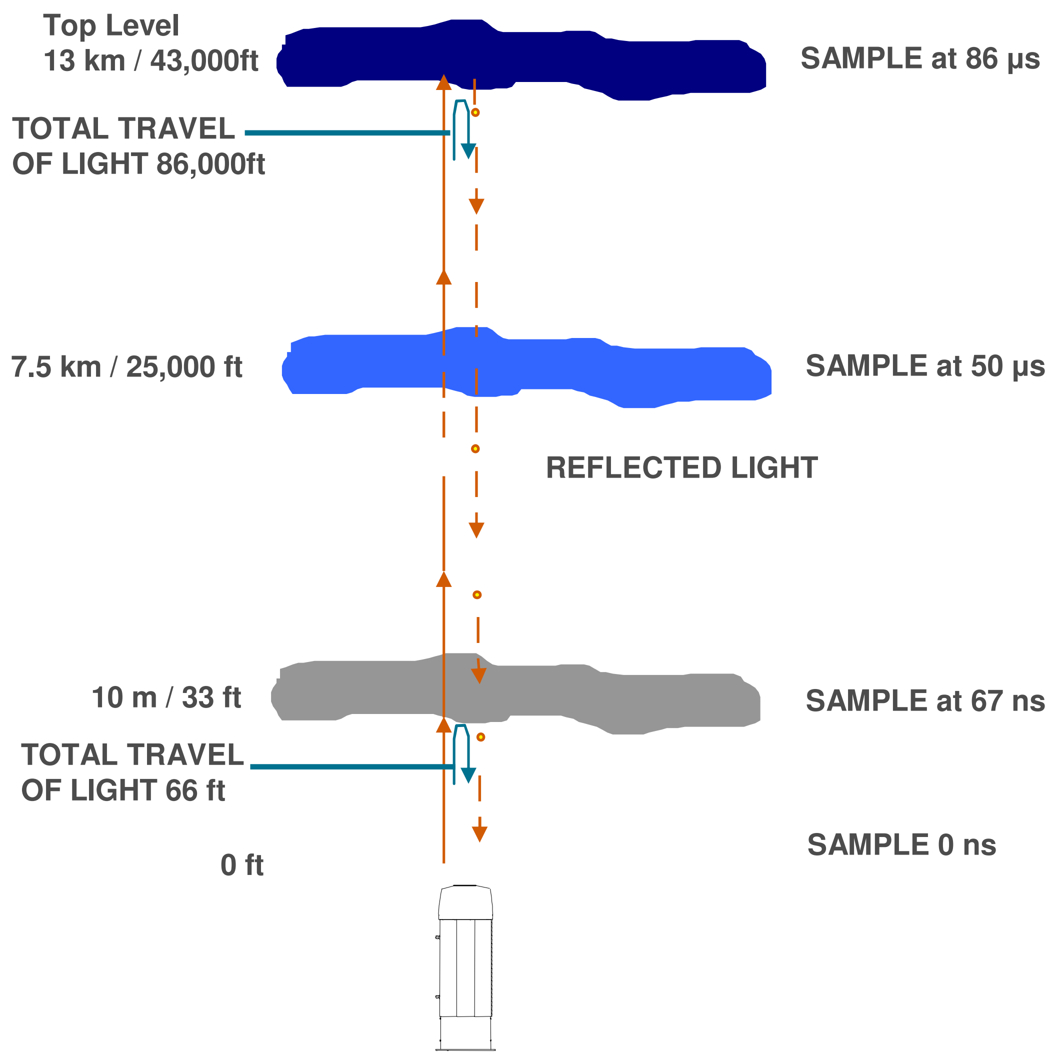
Name	CT12K	CT25K	CL31	CL51
Cloud reporting range	12600 ft	25000 ft	25000 ft	43000 ft
Manufactured	1987 - 1996	1995 - 2006	2005 -	2010 -
Installed base	2000	2600	2000	
NWS installations	1000	< 10	500 now >500 to be delivered	
				

LIDAR ceilometer operating principle

LIDAR = Light Detection

And Ranging

- Short pulse of light is transmitted into air
- Receiver monitors the light backscattered by aerosols
- Altitude of backscatterer is given by time (speed of light is 30 cm/ns ~ 1 ft/ns)
- Several profiles are summed to increase signal to noise ratio



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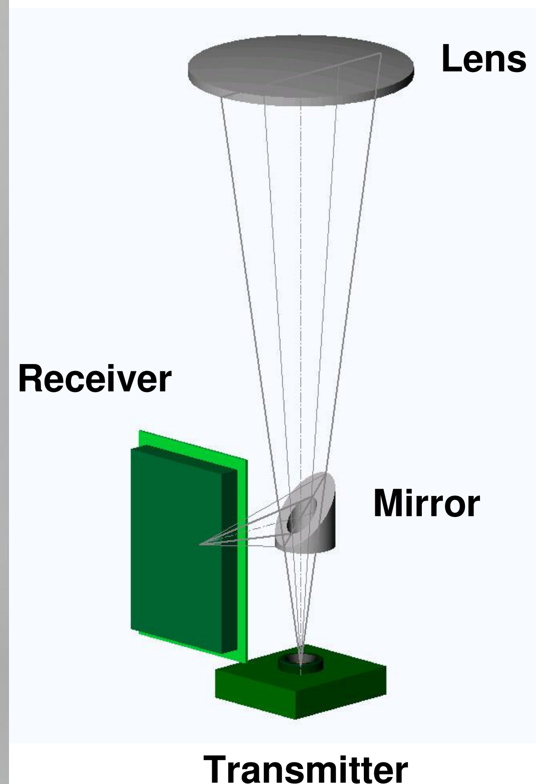
Enhanced single lens system – Vaisala Ceilometers CL31 and CL51



- Mirror with a hole in the center divides lens into transmitting and receiving area.
- The single lens technology provides excellent data at low altitudes (below 200m).
- Simple and reliable instrument design fit for 24/7 operation in harsh environments.

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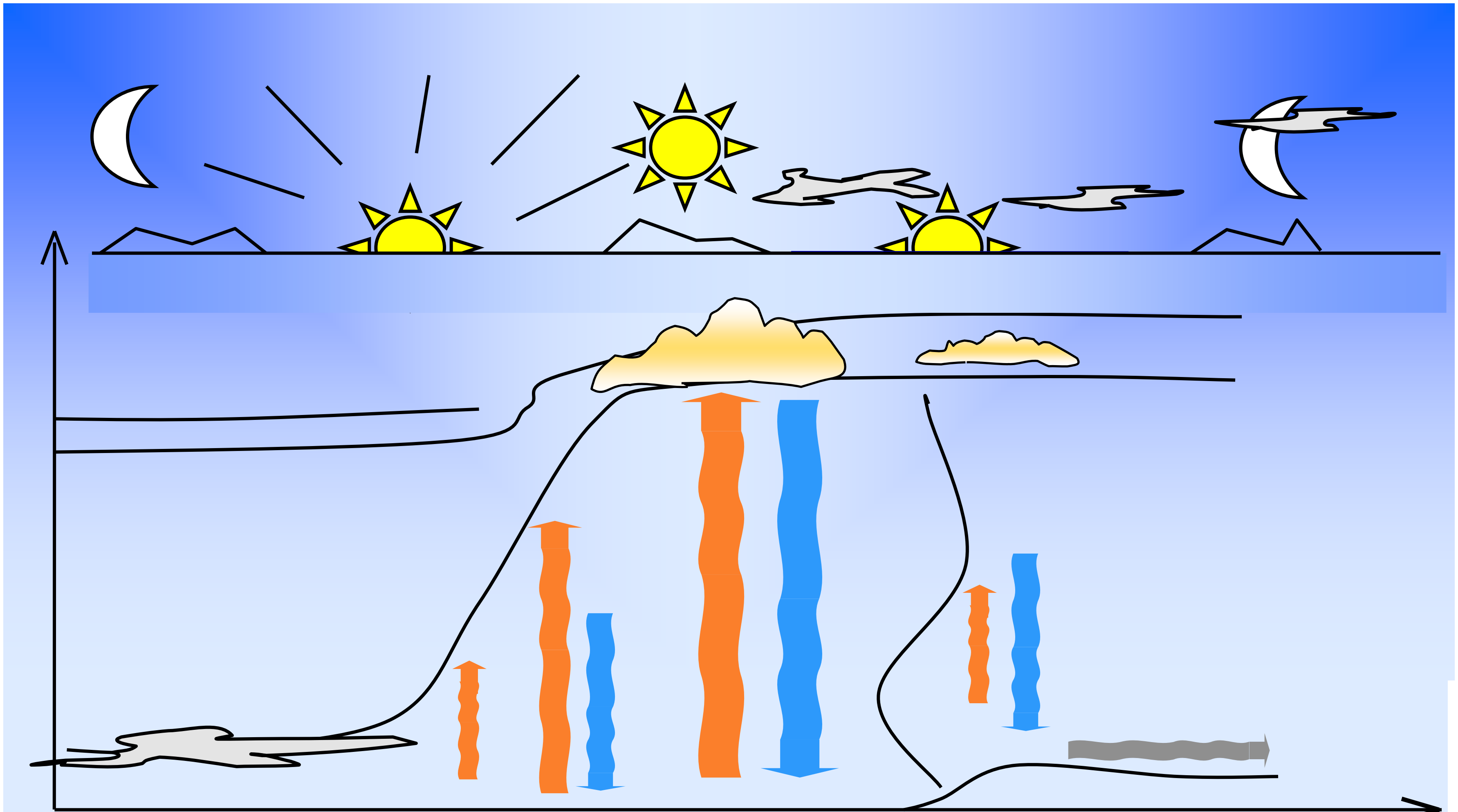
Clear day mixing layer evolution



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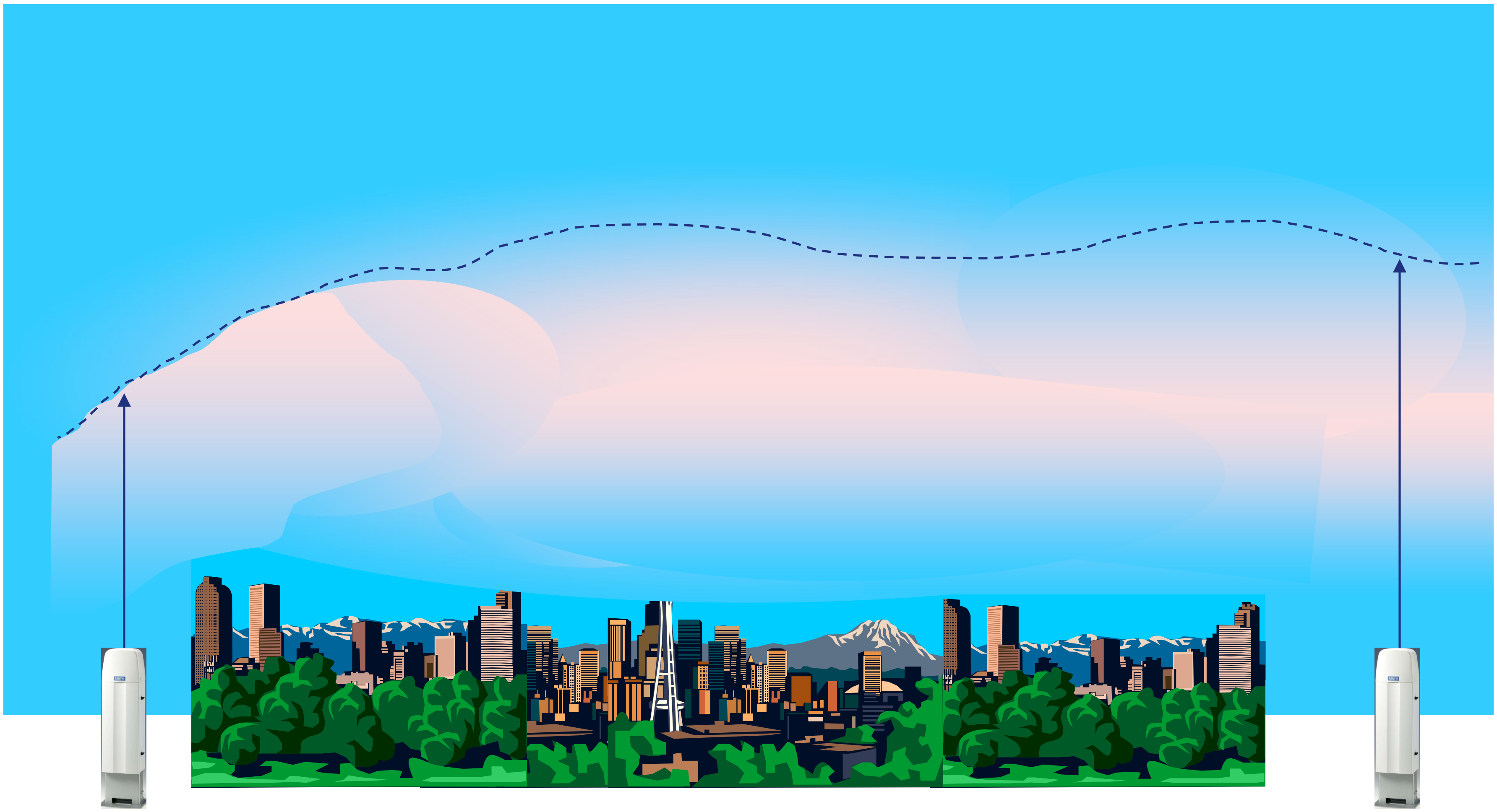
Mixing layer height retrieval – motivation

- The mixing layer height is a
  - key parameter for the characterization of air pollution impacts e.g. wind, long-range transport and deposition.
  - necessary parameter for the verification of numerical simulations of air pollution.
  - necessary parameter for the calculation of near-surface pollutant concentrations from optical thickness data derived from satellite images.

Mixing layer height retrieval with ceilometer



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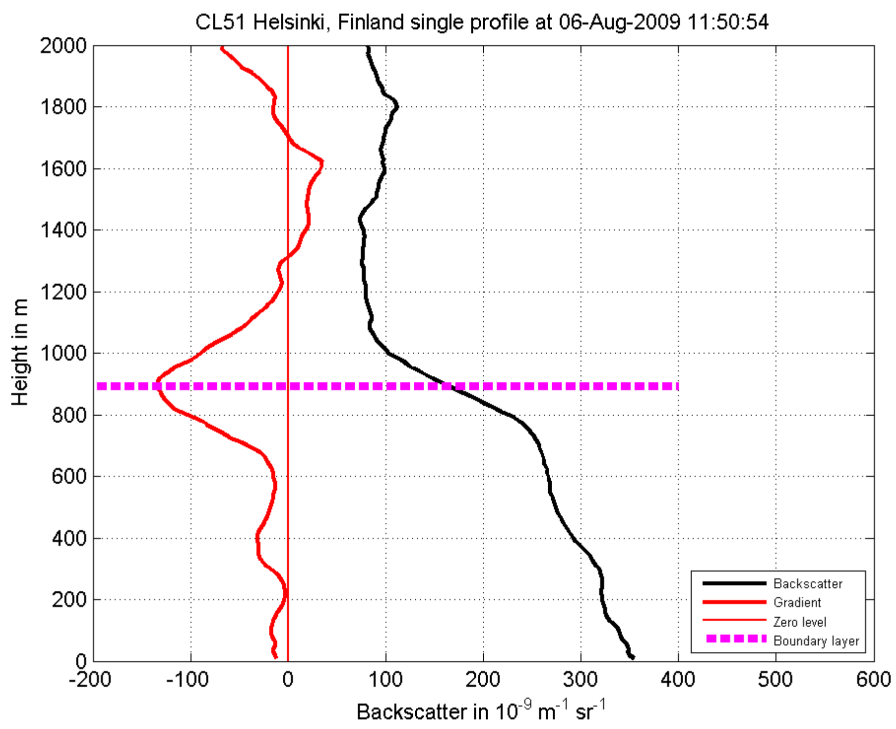
Mixing layer height retrieval with ceilometer – gradient method



- The mixing layer is expected to have a somewhat constant aerosol concentration that is higher than in the layers above.
- Consequently, the difference between the mixing layer and the air above is assumed to be seen as a shift from a relatively strong backscatter inside the boundary layer to a lower backscatter level above it.
- The gradient method takes focuses on the gradient minimum usually seen at the top of the boundary layer.

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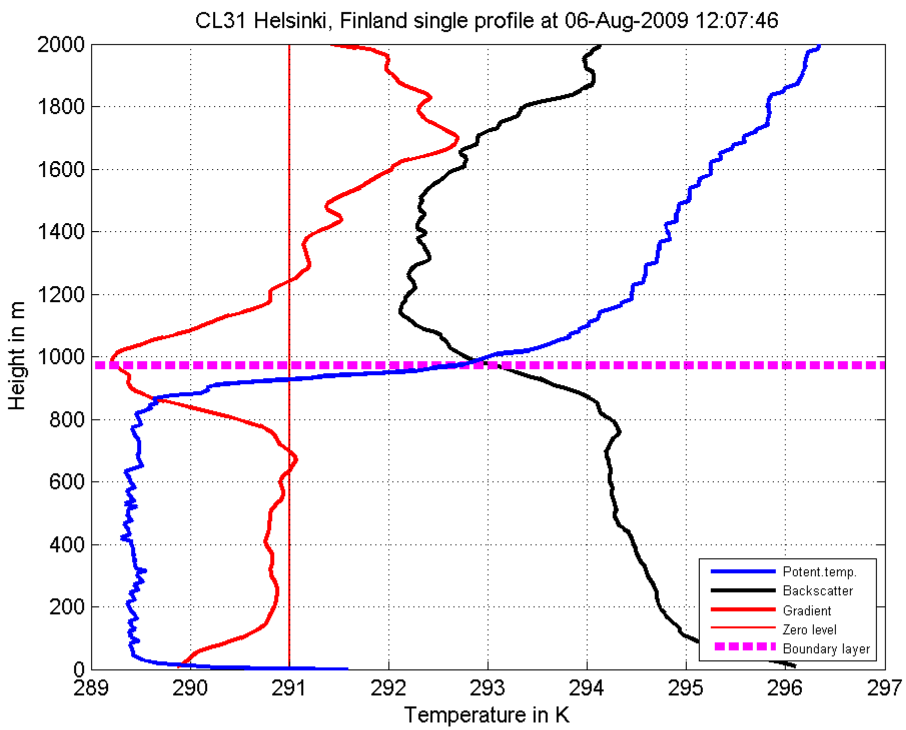
Mixing layer height retrieval with ceilometer – radiosonde verification



- High resolution sounding data are available at the Vaisala test field in Helsinki, Finland.
- Sharp increases within the potential temperature profile mark inversion layers and are a reliable tool for ceilometer mixing layer height verification.

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Some CL31 installation sites for mixing layer investigation

- Puget Sound Clean Air Agency, Seattle, WA
  - Comparison campaign involving wind profiler and RASS, summer 2007
- National Weather Service test site Sterling, VA
  - Testing of up to six CL31 units, comparison to regular Sterling soundings, 01-2008 till 11-2009
- Karlsruhe Institute of Technology (KIT) air quality measuring campaign in Augsburg, Germany
  - Two CL31 units, one co-located to a RASS, ongoing since 2007
- Department of Environment, Perth, Western Australia
  - Comparison to AMDAR temperature profiles, ongoing since 2007
- Installations in harsh environments
  - Neumayer Station III, Antarctica, since 2009
  - Princess Elisabeth Station, Antarctica, since 2009
  - Research vessel Planet (German Navy), Mediterranean Sea and North Atlantic, 06-2007

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Some CL31 installation sites for mixing layer investigation

Augsburg

Princess Elisabeth Station, Antarctica

René Robert - © International Polar Foundation

Mediterranean Sea

Source: Dr. Lothar Ginzkey

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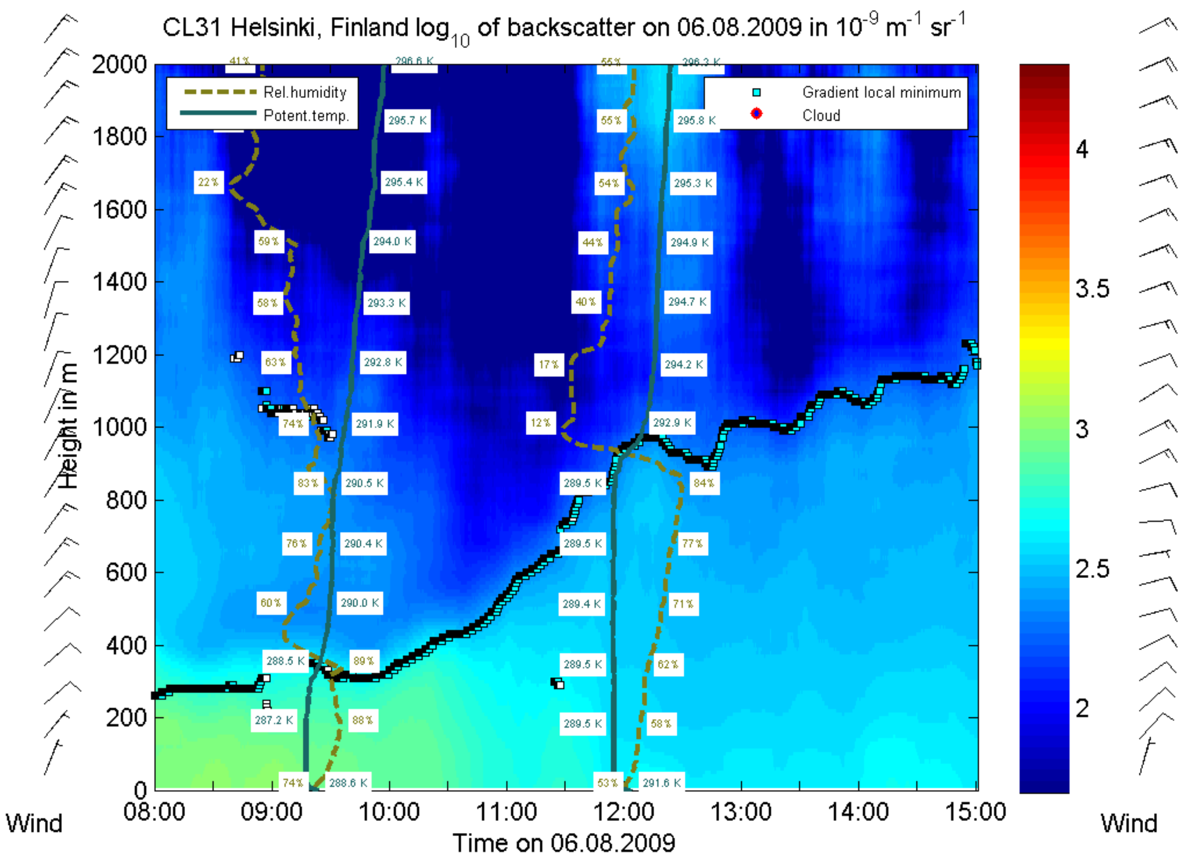
Convective boundary layer evolution in Helsinki, Finland – CL31



- Gradient local minima mark
  - 300 m layer till 10:00
  - Convective layer rising up to 1200 m in the afternoon.
- Potential temperature profiles from soundings launched at 09:23 and 12:03 local time confirm these results.

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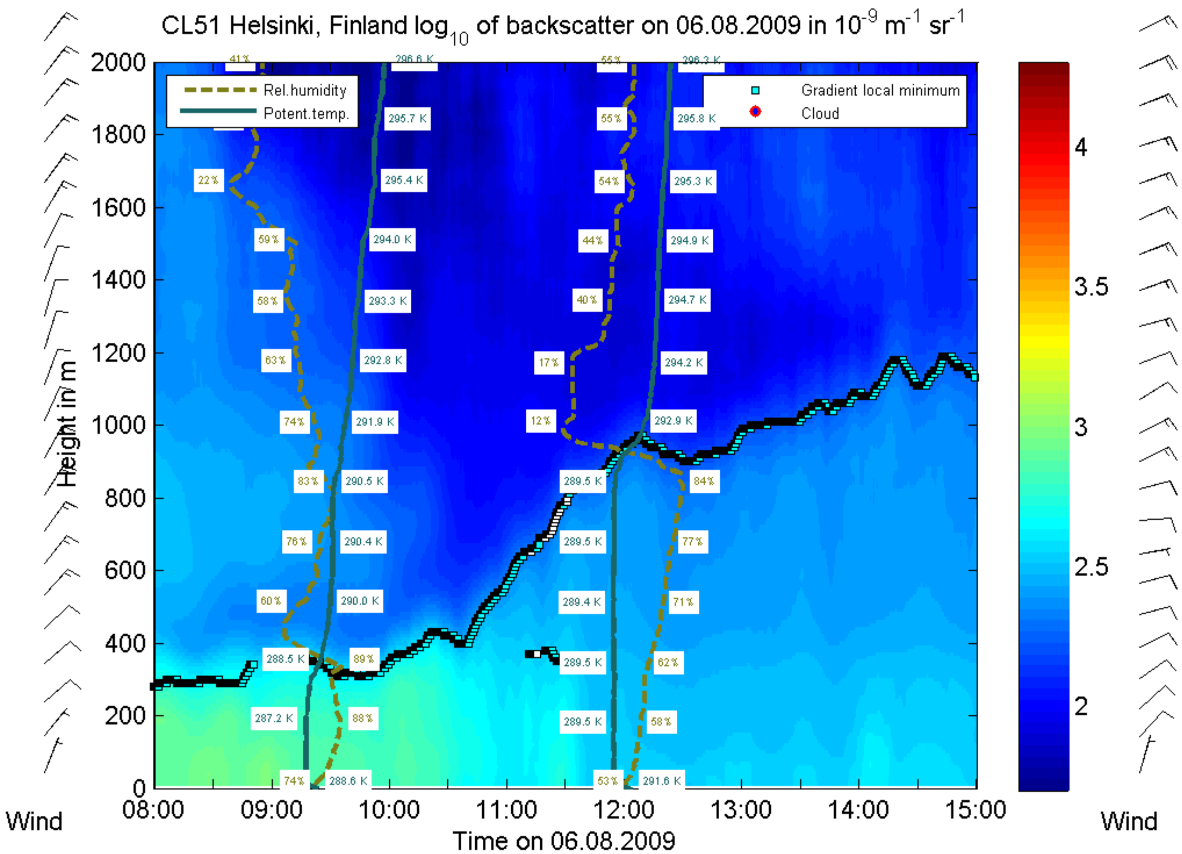
Convective boundary layer evolution in Helsinki, Finland – CL51



- Result is very similar to that of CL31.
- Better signal-to-noise ratio reveals more structures above the boundary layer.
- Backscatter amplitudes are correlated to relative humidity values.

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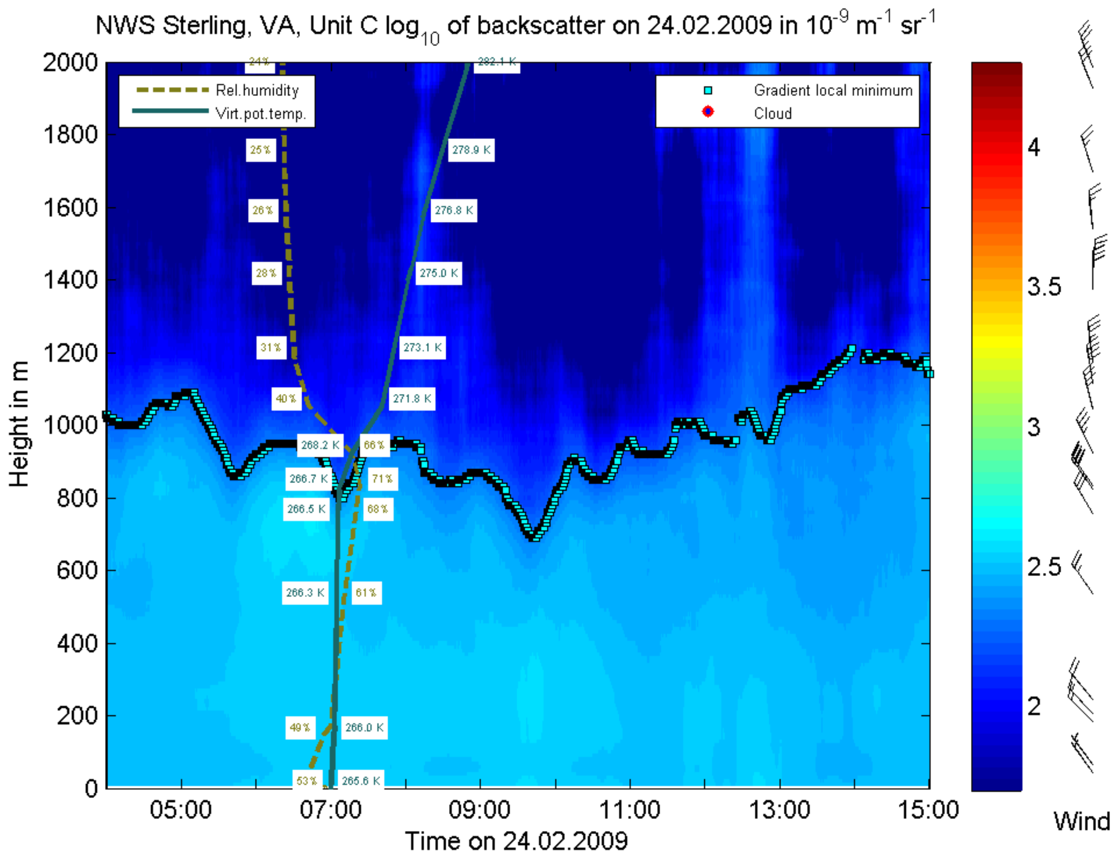
Stable winter boundary layer in Sterling, VA



- Gradient local minima mark a layer reaching up to about 1000 m.
- Potential temperature profile from the 07:00 sounding confirms this layer.
- Wind direction changes from NW to N at mixing layer height.

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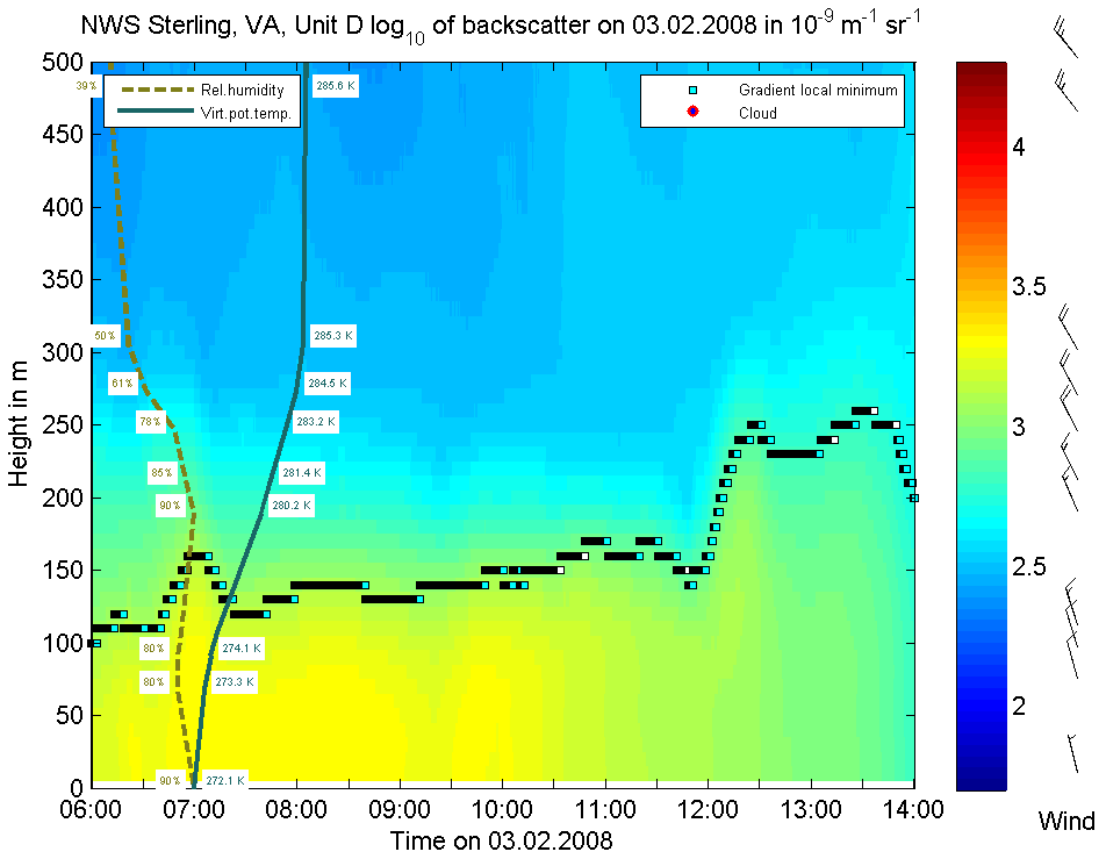
Low winter inversion layer in Sterling, VA – unit D



- Nearly full overlap in the first range gates enables reliable detection of very low winter inversion layers.

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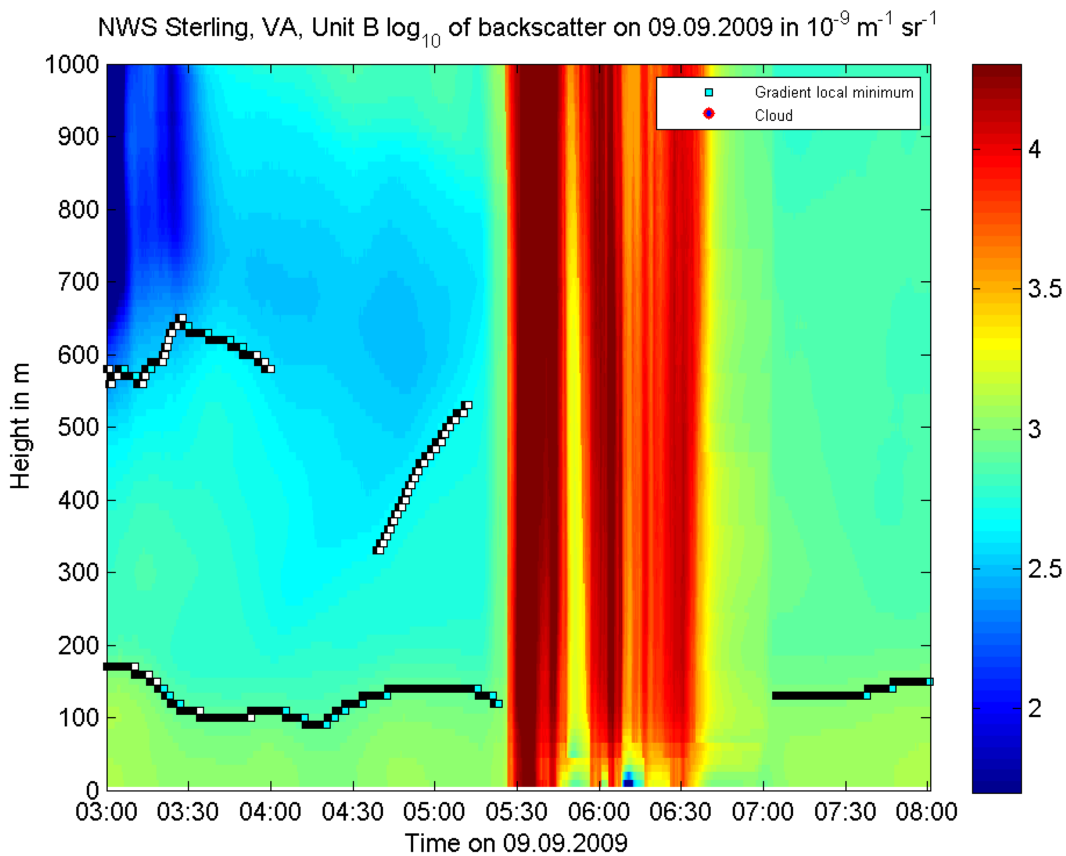
Precipitation filter – no profile averaging and mixing layer reports during rain showers



- Stable nocturnal layer is detected before and after the rain showers.
- Enhanced gradient method detects precipitation and suppresses profile averaging to avoid false hits after the rain shower.

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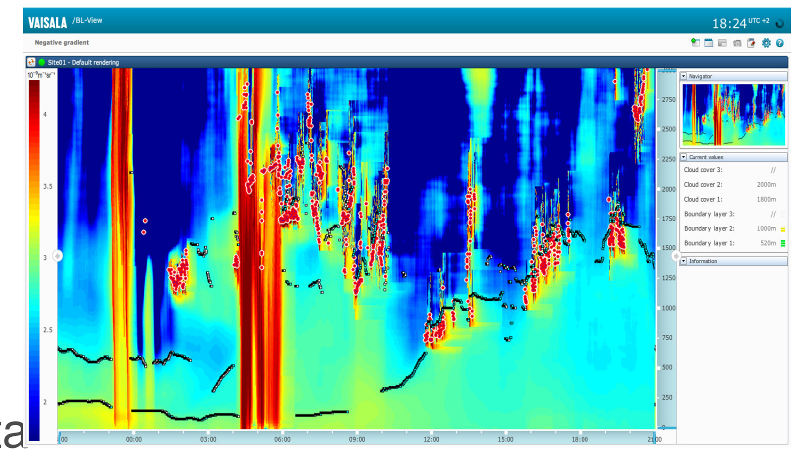
Vaisala BL-VIEW
Mixing layer Reporting and Analysis Tool

- BL-VIEW - Supportive PC-software package for Vaisala Ceilometers
  - Ceilometer CL31 or CL51 reports profile data
  - BL-View calculates PBL/Mixing layer structure parameters and generates graphics and text output



- Main features
  - Automatic reporting of Mixing Layer structure with cost effective Vaisala Ceilometers CL31 and CL51
  - Reporting of evolution of Mixing Layer
  - Quality index of reported Mixing Layer data
- Available spring 2010
- For more information: www.vaisala.com/airquality
- **frank.defina@vaisala.com**

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