Investigating Impacts of the Wind Field and Unknown Flying Objects on High-Res Ceilometer Profiles during ScaleX 2016

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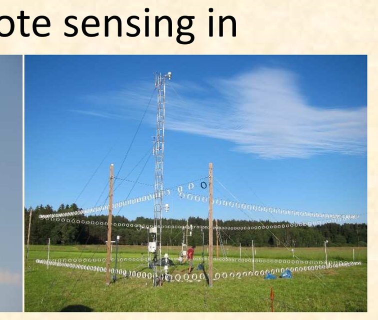
ScaleX

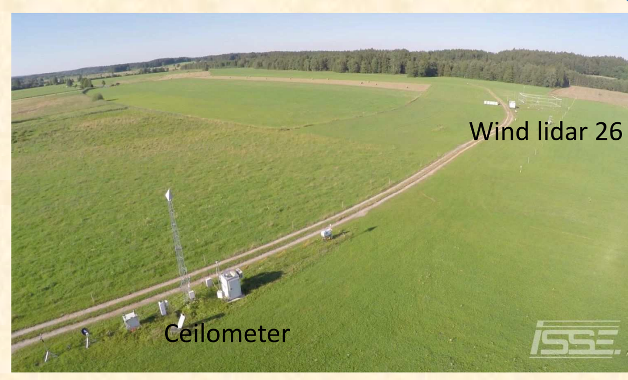
- Is a collaborative measurement campaign, co-located with a long-term environmental observatory of the German TERENO (TERrestrial ENvironmental Observatories) network in mountainous terrain of the Bavarian Prealps, Germany.
- Combines the benefits of a long-term environmental monitoring approach (TERENO) with a series of intensive campaigns, to bridge across a wide span of spatial and temporal scales.
- Explores the question how well measured and modeled components of biogeochemical and biophysical cycles match at the interfaces of soils, vegetation and the atmosphere, and across various spatial and temporal scales.
- Hosted a variety of ground-based and airborne instruments for in-situ and remote sensing in June and July 2016.

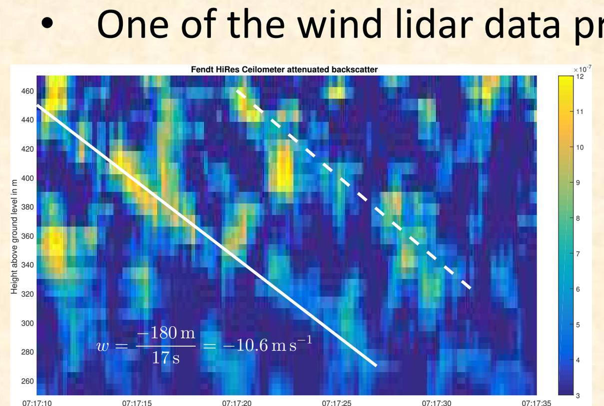
For more details, see
http://journals.ametsoc.org/doi/10.1175/BAMS-D-15-00277.1,
http://scalex.imk-ifu.kit.edu

Wind field investigation

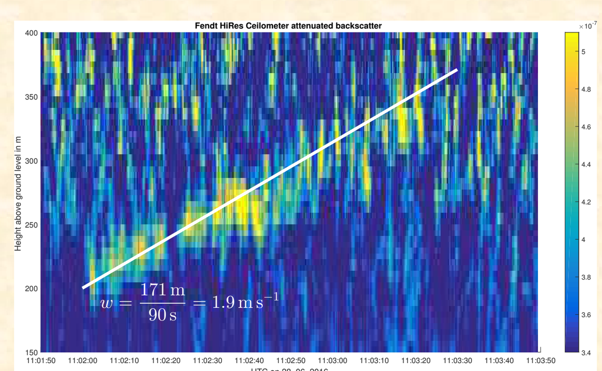
- ScaleX hosted three Halo Photonics Streamline wind lidars
- Two of these systems operated close to the Hi-Res ceilometer
  - Wind lidar 26: 160 m East of ceilometer
  - Wind lidar 74: 640 m South-East of ceilometer
- One of the wind lidar data products was vertical wind speed

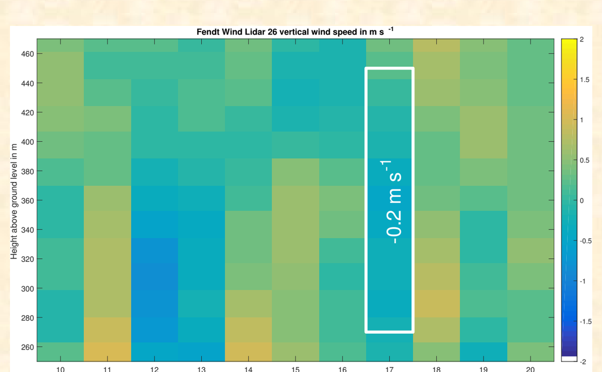


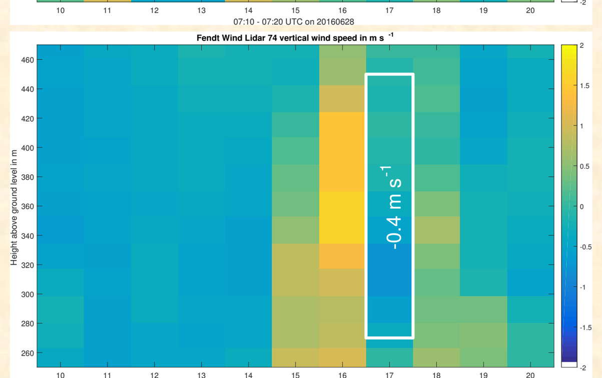


Halo Photonics Streamline Doppler wind lidar at IMK-IFU

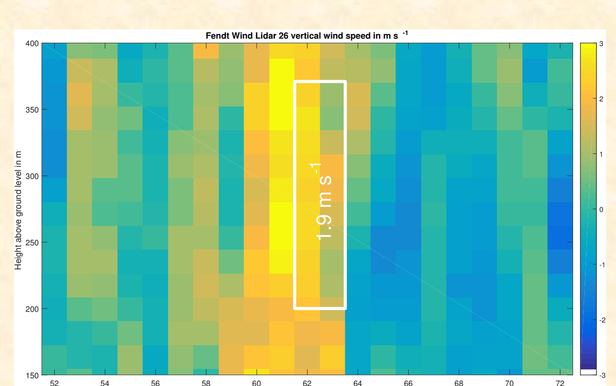
An aerosol bubble starts its rise at 11:02:00 and the Hi-Res ceilometer sees it during 90 s. Both wind lidars report similar mean vertical wind speeds.

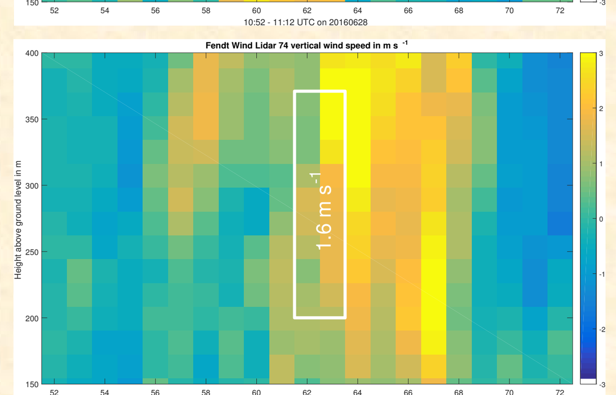






Halo Photonics Streamline Doppler wind lidar at ScaleX





Increased Hi-Res ceilometer backscatter suggests downward moving aerosol bubbles at 07:17. At that minute, both wind lidars report low mean vertical wind speed .

UFO experiment

Motivation

- Ceilometers use averaging periods of 2 s to 2 min to probe the atmosphere for
  - Cloud base and vertical visibility
  - Aerosol layers
- Insects, birds, bats, leafs, etc. reflect laser pulses back to the ceilometer and cause sudden signal increase, possibly resulting in
  - False cloud base reports (very unlikely)
  - False aerosol layer reports (more likely)
- This study concentrates on all 2 min intervals without precipitation or low clouds recorded by the Hi-Res ceilometer described below between 2016-06-01 and 2016-11-18 to examine the impact of UFO reflections on aerosol layer analysis .
- Excluding all profiles with UFO reflections from averaging improves layer detection performance.

Instrument

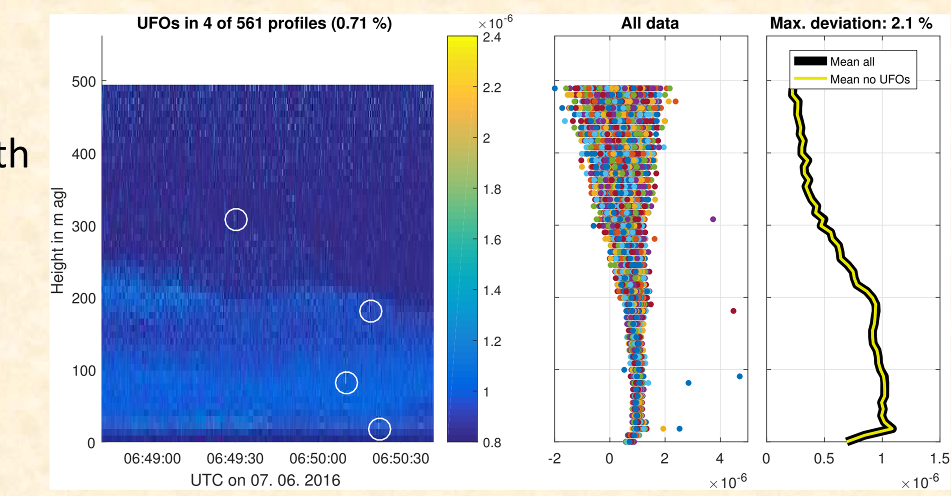
- Vaisala Ceilometer CL51
- Tilted from the vertical by 25°
- Operated in Hi-Res mode
  - Range 550 m
  - Range resolution 10 m
  - Laser pulse length 70 ns
  - Profile report interval 0.2 s

Hi-Res CL51
Standard CL51

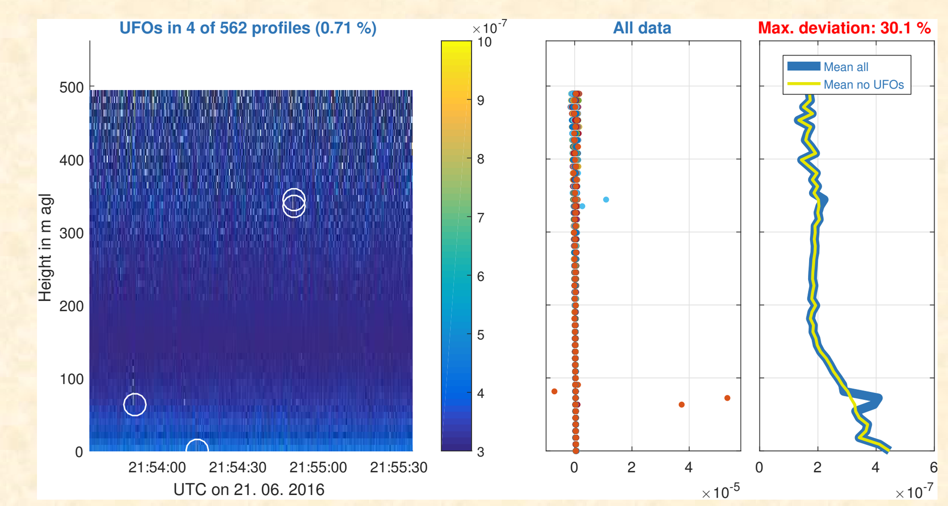
Finding UFOs, UFO statistics

1. Examine all Hi-Res 2 min data intervals with
   a) No cloud base base below 500 m
   b) No fog or precipitation
2. For these 2 min intervals, calculate signal mean *M(i)* and standard deviation *σ(i)* for all range gates *i*
3. All signals *S(i,j)* from profile *j* with
   $S(i,j) > M(i) + 8*\sigma(i)$
   indicate an UFO
4. An UFO is called *significant* if it increases the 2 min average signal by at least 5 %

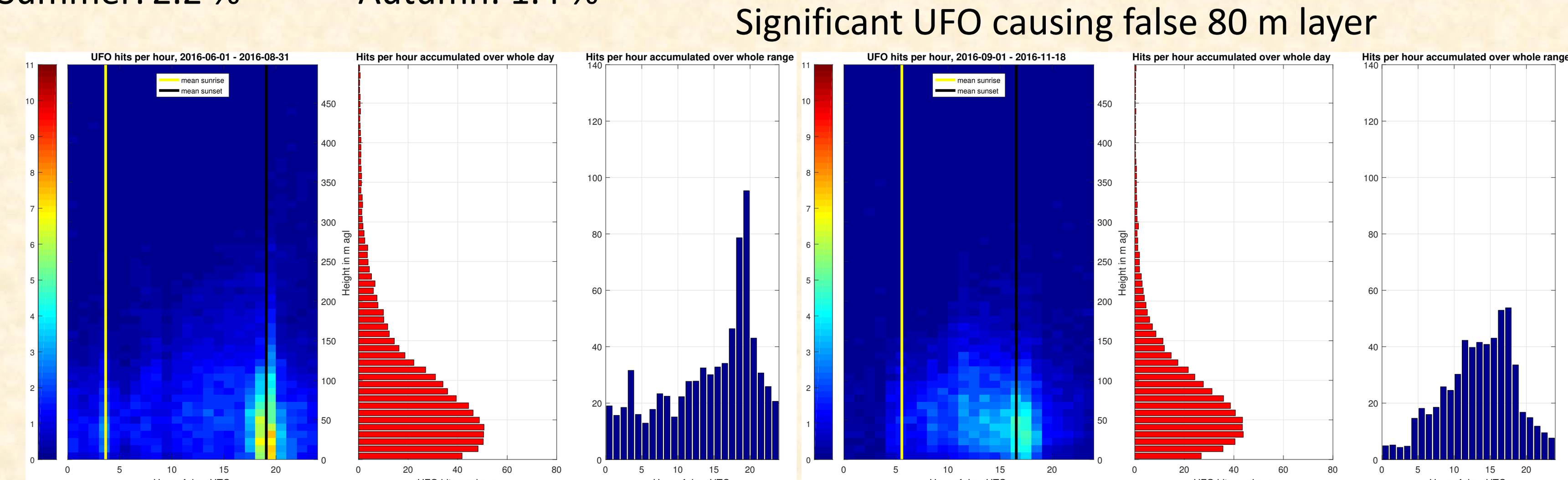
- Measurements during 3956 hours
- Periods qualifying for UFO examination
  Summer: 62.6 % Autumn: 53.4 %
- 2 min intervals with UFOs
  Summer: 43.7 % Autumn: 33.9 %
- 2 min intervals with significant UFOs
  Summer: 2.2 % Autumn: 1.4 %



4 UFOs in 2 min, none of them significant



Significant UFO causing false 80 m layer



Conclusions, Outlook, Acknowledgements

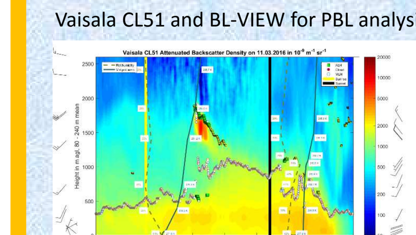
- Hi-Res ceilometer profiling
  - has been performed at one location for more than 5 months
  - is capable of reducing false aerosol layer hits
  - confirms that insects and birds are most busy around sunset
  - enables monitoring of moving aerosol bubbles
- Future ScaleX evaluation of ceilometer and wind lidar data will
  - investigate the applicability of Hi-Res ceilometer profiles for estimating turbulence parameters
  - result in detailed information about 3D wind fields based on measurements from 3 wind lidars
  - lead to more conference presentations and publications

The TERENO pre-Alpine infrastructure is funded by the Helmholtz Association and the Federal Ministry of Education and Research. Aerial view of the ScaleX site was provided by the Institute for Software & Systems Engineering (ISSE) of the University of Augsburg; ScaleX ground based pictures are from Martin Kunz, Max Planck Institute for Biogeochemistry, and from Matthias Zeeman, IMK-IFU at KIT.

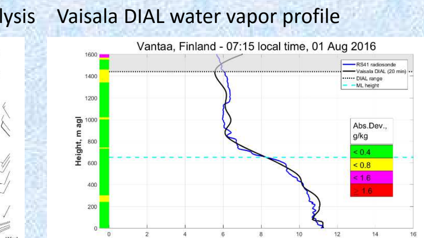
„Observations Lead the Way“

1. First-priority needs for mesoscale measuring include
   I. Height (and structure) of the PBL
   II. Hi-res vertical profiles of atmospheric humidity
   III. Air quality concentrations above the atmospheric surface layer
   Uncertainty requirements for these depend on the application and should be defined by the user community.
2. Instruments required for this
   I. Ceilometers or lidars with dedicated PBL algorithms (for example BL-VIEW)
   II. Profiler for atmospheric humidity like Water Vapor DIAL, drones
   III. In-situ air quality sensors, ceilometers and lidars, drones
3. Examples

Vaisala CL51 and BL-VIEW for PBL analysis



Vaisala DIAL water vapor profile



Vaisala AQT transmitters

Measure NO_2, SO_2, CO, O_3, PM2.5 and PM10

Presentations: Thursday, 11:30, Yakima 1 Thursday, 11:00, Skagit 4 Booth Number 313