SCIENTIFIC REPORT

ACTION: ES1303 TOPROF
MEETING: SWG ABL
TITLE: Atmospheric boundary layer depth retrievals from automatic lidar and ceilometers, Doppler lidar and microwave radiometers
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Workshop objective:

To prepare a review paper on the topic of atmospheric boundary layer (ABL) aiming for submission date in early 2018).

1. What are the research questions?

- ABL is a central parameter for many research questions related to boundary layer meteorology, air pollution, gas concentrations, wind energy, …
- Several end-user communities will be asked to state why ABL parameters / phenomena are important for them.
- Several end-user communities will be asked to state what they mean by terms like 'Atmospheric Boundary Layer', 'Mixing Layer Depth', and others.
- 'How are ABL parameters observed?' is also an important research question.

2. Objective of the review paper.

- Review the literature starting since Seibert et al. (2000) concerning ABL parameter observations and retrievals, focusing on remote sensing networks.
- Condense available literature, from the perspective of remote sensing networks.
- Provide a single point reference for all reference, clarifying the existing glossaries.
- Help end-users digest existing information from the literature.
- Provide recommendations on ABL detection.
- Identify end-user community needs.
- Identify knowledge gaps
- Make recommendations for future research

3. Why is it an important objective which requires literature review?

Since 2000:

- Several new instruments and networks and algorithms are available
- More sensitivity, more resolution, more parameters, more spatial coverage are available
- More operational, need for harmonization
- More end-user demand: air quality and boundary layer weather (CTMs and NWP)
- More confusion
- Convergence of concepts

4. Main results of the paper.

Definitions

Presenting methods/instruments

Intercomparisons

Synergies

Climatology

5. What can the results contribute relative to the existing literature?

A single point of reference

Condense, analyze, and digest the published results

Guidelines for future research

6. What are the implications of these results?

Better exploitation of instrument networks

Better informed end-users

More focused future research

Facilitate exchange between different communities (end-users and data providers)

Paper structure

Author list: 1st author (J-A. Bravo-Aranda) + N major contributors (coordinators, contributors) + alphabetical order for more minor contributions

1. Definitions

1.1. Definitions from point of view of different user groups

Coordinator: Juan-Antonio

Contributors: Simone,

How to implement the retrievals for different user groups.

User communities:

- NWP people: for model validation of many model variables.
- CTM and air quality: (Henri Gaimoz; London air quality network; Paris groups)
- ICOS: Leo Rivier
- Local forecasters in applied fields (airports, wind resource): Sven-Erik Grynning
- In-situ aerosol characterization research community (new particle formation, NPF)

Formulate a common question to ask each user community.

Are there end-user-community specific papers?

What climatology are you interested in?

Why are these parameters / phenomena important for end-user communities?

→ highlight research questions and user needs

If you answer to these questions, your contribution will be acknowledged.

If you provide more support in writing the manuscript, you will be proposed co-authorship.

1.2. Defining important terms (phenomena, variables)

Coordinator: Juan-Luis

Contributors: Juan-Antonio, Maria Joao

The planetary boundary layer is the part of the troposphere that is directly or indirectly influenced by the presence of the Earth's surface (ground or sea), and responds to surface forcings with a time scale of about an hour or less. These forcings include heat transfer, frictional drag, atmospheric aerosol particles emission, gases emission and terrain induced flow modification".

Includes the terms:

- entrainment zone, residual layer, capping inversion
- sea and ground
- aerosols and gases

Time-scale of residual layer is different (longer)

How different tracers fit the definition

Processes: stabilization, mixing,

How do different tracers react to the processes.

Glossaries standard terminology:

- CF convention (nomenclature). Atmosphere boundary layer thickness.
- AMS glossary
- WMO
- Encyclopedia of atmospheric sciences

Provide definitions for several internal layers (RL, SBL, CBL); link this with different tracers.

List of terms (it should be ordered from general terms to more precise ones):

1) Mixing layer:
2) Convective boundary layer:
3) Stable layer:
4) Residual layer:
5) Entrainment zone:
6) Planetary boundary layer:
7) Surface layer:
8) Shear layer:
9) Aerosol boundary layer:
10) Atmospheric boundary layer:
11) Atmospheric boundary layer thickness -> ABL (CF v42)

12) Capping inversion:
13) Surface-based temperature inversion:
14) Cloud-driven mixing layer:
15) Coupled Vs decoupled layer:
16) Nocturnal boundary layer:
17) Neutral boundary layer:
18) Mixed layer:

Classification using the list of terms.

Illustrations of ABL diurnal cycle for different types of locations (urban, coastal, high-altitude site, …)

1.3. Defining instruments and observed quantities

Coordinator: Juan-Antonio

Contributions: all

For each phenomena, explain how each observed quantity is used for retrievals.

Observed quantities are:

- Temperature ; brightness temperature
- Specific Humidity
- Particles (Aerosol, cloud) backscattering
- High frequency Wind:

Instruments with potential for networks:

- Automatic backscatter lidar and ceilometer
- Microwave radiometers
- Doppler Lidars
- In-situ profiles from towers and radiosonde
-

(mention Sodar, Raman Lidar, Radar wind profiler)

Comprehensive Classification of MLD based on instrument synergies should come out as a recommendation.

Include what classification should be.

What can be done for

User requirements from user community: Different community points of view. How to implement the retrieval. ICOS' definition. Modelers (chemical transport models, air quality, NWP for model validation, wind energy companies). 'New particle formation' community.

Rely on published work

2. Retrievals from different instruments

For each instrument: common structure.

General introduction:

2.1. Section for each instrument

Coordinator ALC: Martial

Contributors: Juan-Antonio, Maxime, Simone, Marc-Antoine

Coordinator DL: Ewan

Contributors: Jan,

Coordinator MWR: Nico

Contributors: Maria Joao

Coordinator RS: Nico

Contributors: Martine, Jan,

Coordinator other: Ewan

Contributors: Maxime (RWP), Lucia, Juan Luis

- Goal: I have this instrument, what are the capabilities and limitations
- ALC, DL, MWR, RS, (Others: RWP, Sodar, RL)
- Measurement principle (measured quantities)
- Existing network
- Range of use
- Retrieval methods for each phenomena, measurement requirements (SNR, post-processing, …)
- ABL classification method
- Method intercomparisons
- Instrument type intercomparison
- Uncertainties, range of use, limitations
- Verification, evaluation: what's been done in the lit.

ILLUSTRATIONS:

- Multi-instrument map (Alc, mwr, dl, rwp, supersite)

3. Section about intercomparisons

Coordinator: Simone

Contributors: Martial, Ewan,

- Introduction: there is not a truth dataset so the intercomparison is always difficult.
- Goal: what instrument + method is best suited for each phenomena?
- recommendation to reach highest confidence level for each phenomena
- Present by phenomena : convective layer, sbl, decoupled layers
- Public datasets
- Confidence level,
- Verification, evaluation: what's been done in the literature?

ILLUSTRATIONS:

4. Section about instrument synergy (IS)

Coordinator: Juan-Antonio

Contributors: Nico, Ewan, Umar, Jan, Simone, Martial, Juan Luis

- Goal: what can we learn from instrument synergy, incl. use of ancillary data?
- Results from the Lit. combining 2+ instruments
- Better description of phenomena
- How IS helps to improve single instrument retrievals
- Datasets: Sites that provide multi-instrument datasets
- Incl. unpublished figures and illustrations.

5. Section on model evaluation

Coordinator: Maxime

Contributors: Maxime, Martine, Ewan, Jan

- Goal: what important questions are raised by papers dealing with model evaluation?
- What is the confidence in MLD retrievals from models?
- See ECMWF technical note

Include satellite remote sensing somewhere!

To include published and un-published material

MLD retrievals

BL structure and typing analysis, mixing origin.

6. Section on ABL climatology

Coordinator: Martine

Contributors: Simone, Juan-Luis, Maria Joao

- Goal: provide an overview of current understanding of ABL variability at different time scales. What do modelers need?
- Day Vs night ABL: main characteristics?
- Annual variability
- Coastal Vs inland ABL
- Marine Vs continental ABL
- Urban rural

Summary and future work

The SWG gathered experts on ABL detection to set the basis of a review paper on the topic of atmospheric boundary layer. During the first part of the SWG, participants showed the advances on ABL detection achieved during the last years, emphasizing developments performed in the TOPROF framework. During the second part, participants successfully identified the structure and the content of the ABL review paper. Due to the scope of the review, participants split the work by sections and a coordinator was identified for each section to organize the tasks.

The future work includes decisions like the tool to write the manuscript (google doc, overleaf …), the journal to publish the review (open-access, open-review process …) and the list of relevant references for each section. The next deadlines are listed below:

- 2nd week: share the first draft with the sections established during the SWG (before 4 May).
- 1st month: list of references for each section (17 May)
- 2nd month: detailed layout of each section (16 June)