CA18235 PROBE

Deliverable 1.4

Recommendations for addressing studies that have not been covered by T1.2

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1 CONTEXT

As we approach the end of the COST Action PROBE, it becomes imperative to consolidate our efforts and maximise the impact of our research outcomes. Several studies conducted in the course of the Action have already aimed at quantifying the value of Atmospheric Boundary Layer (ABL) profiling for various stakeholders, providing a robust understanding of the significance of ABL profiling across diverse domains. This deliverable serves as a strategic roadmap for guiding the last months of activity within the COST Action PROBE. We have identified four key domains that demand focus and completion in this remaining period:

- **Knowledge Transfer**. Stakeholders have expressed a pressing need for standardised procedures, software development initiatives, and showcases to effectively disseminate our research findings.
- **Instrument Operations**. This encompasses all instruments considered throughout the action. Further operational guidelines and best practices are required.
- **Advanced Products**. Further investigation is needed to enhance the quality and typology of advanced products related to aerosols, wind, temperature, and humidity profiles. These can also be employed to retrieve derived products such as ABL layering and fog alerts. Benefits from the synergy of different instruments should be further considered.
- **Modelling, Data Assimilation, and Reanalysis** studies. These complement and motivate the experimental activities conducted and the data collected so far.

To advance on these crucial topics, the efforts will primarily be channelled through the implementation of Virtual Mobility Grants (VMGs). The following sections of this deliverable will delve deeper into the specific initiatives and activities facilitated by the VMGs.

2 RECOMMENDATIONS

2.1 KNOWLEDGE TRANSFER

The following activities are scheduled to support the development of operating procedures, software development and description of showcases for different stakeholders.

- How to create a PROBE Zenodo document repository (Jana Preißler), centralise the documents of the action on Zenodo (Melania Van Hove) and promote the PROBE Cost Action impact in the European network (Claudia Acquistapace)
- How to extend an existing monitoring network to improve air-quality forecast - The experience in the Slovenian Environmental Agency (RAVNIK-VM-W1)
- Applications of ABL profiling in the urban context - How to use available remote sensing measurement to improve urban planning (SZKORD-VM-W1) and Impacts of atmospheric boundary layer profiling on urban environments (KORMON-VM-W1)
- Knowledge transfer to the ITC countries and to Young researchers. Remote sensing (RS) instruments are very expensive to purchase and require sophisticated maintenance and highly qualified operators. The ITC countries fall short in the usage of RS due to the shortage

in resources. PROBE helps to establish a knowledge pipeline between leading institutions and institutions from ITC (AMEZCU-VM-W1, BARANT-VM-W1, STEFAN-VM-W1, PFITZE-ST-W2-RAD, STACHL-ST-W2-ABL, TOANCA-VM-W4-MWR). Mainly young researchers in the ITC countries took responsibility for the operation of new instruments.

- Coordinate discussion on summary for Wind Energy stakeholders (GANDOI-VM-W1) and Air quality/Environmental Protection agencies (RAVNIK-VM-W1-AQ)
- Describe the impact of atmospheric boundary layer profiling for Solar energy applications (TOANCA-VM-W1)
- Capacity building of young researchers on DWL tool (DIFELI-VM-W1-WIND)
- Exchange knowledge on forecast indices impact (TOPORO-VM-W2)
- Information exchange on UAS regulations & measurement principles (BANGE-VM-W3-UAS)
- Satellite applications related to impact of ABL profiling (NEMUC-VM-W1-SAT)

Finally, all VMGs and STSMs will be beneficial for knowledge transfer between all participating researchers. An example is provided by the windsonde training and PANAME collaboration (RICKET-ST-W1).

2.2 Instrument operations

- ALC: The following efforts are carried out to developed new methodologies and assess the uncertainty of ALC backscatter profiles:
  - Description of current methodologies for the retrieval of aerosol extinction and mass concentration profiles from Automated Lidar-Ceilometers (BELLIN-VM-W2-AER)
  - Investigating the seasonal fluctuations of the CHM15K Ceilometer calibration constant in relation to the presence of undetected aerosol layers (BUXMAN-VM-W3-ALC)
  - Liquid-Cloud Calibration Algorithm for ALC - new algorithm implementation and testing (CESPED-ST-W4-ALC)
  - Comparison of ALC retrieval algorithms on common data sets (OSBORN-VM-W2-ALC)
  - Seasonal variation in the Rayleigh calibration factor of Automatic Lidar-Ceilometers: amplitude across Europe and possible explanations (HOVE-VM-W2-ALC)
  - ALC processing routines (WAGNER-VM-W2-ALC) and Support standardisation/harmonisation of ALC data (GEISS-VM-W4-ALC)

- AHL (Aerosol High Power Lidar) - Development of an ultra near range telescope. The aim of such a telescope is to retrieve optical products from 150 m up to at least 2 km in order to cover the entire PBL (BELEGA-VM-W2-ABL).

- DWL: Approaches to DWL scanning strategy
  - Doppler wind lidar toolbox - adjustment for WindCube (KAYSER-VM-W3-DWL)
  - Integrating Vaisala WindCube long-range scanning DWL into the ACTRIS processing framework (OCONNO-VM-W2-DWL)
  - Test of Doppler lidar configurations (scan strategies) for wind retrieval (BERTON-VM-W2-DWL)

- DCR:
  - Survey for Cloud Radar Community (ACQUIS-VM-W1-RAD) - scanning strategies, attenuation correction in precipitation, calibration procedure and

maintenance, need of proper documentation of full data processing chain from raw to level2 variables.
    - 94 GHz Radar from RPG short radar manual and maintenance report (PFITZE-ST-W2-RAD)
    - Coordinate on available radar processing routines (DUPONT-VM-W4-DCR)

- MWR:
    - MWR observation minus background brightness temperature monitoring (MARKE-VM-W2-MWR)
    - HATPRO MWR Uncertainty Assessment (BOCKTO-VM-W3-MWR)
    - HATPRO MWR: rain flagging and radome status monitoring (LOFFLE-VM-W3-MWR)
    - Microwave radiometer data quality assurance (TOANCA-VM-W4-MWR)
    - Inter-comparison of thermodynamic profile inversion methods based on ground-based microwave radiometers (FATHAL-VM-W2-MWR)

- UAS:
    - Knowledge exchange on Uncrewed Aerial Systems UAS in view of the 2 preparation of the Joint Network Document (BRAMAT-VM-W2-UAS)

2.3 Advanced products

- Wind
    - Test of Doppler lidar configurations (scan strategies) for wind retrieval (BERTON-VM-W2-DWL)
    - Doppler Wind Lidar products in urban settings to inform wind tunnel studies (CESPED-VM-W1-WIND)
- Aerosol:
    - current methodologies for the retrieval of aerosol extinction and mass concentration profiles from Automated Lidar-Ceilometers (BELLIN-VM-W2-AER)
    - Advanced aerosol vertical profiling in drylands: case study of an olive grove (RASCAD-VM-W2-AER2)
    - Advanced aerosol products (BELLIN-VM-W2-AER2 and LOOSCH-VM-W2-AER)
    - Depolarization products and calibration for ALC-Automatic Lidars and Ceilometers (BELEGA-VM-W4-ALC)
- Humidity and temperature
    - Requirements for temperature and humidity products for data assimilation (MARTIN-VM-W2-TEMP)
- ABL
    - ABL over complex terrain (GOLZIO-VM-W2-ABL)
    - Implementation of ABL height detection algorithm within E-PROFILE (OSBORN-VM-W2-ABL)
    - ABL structure in Cape Verde (TSIKOU-ST-W2-ABL)
    - Synergy products for quantification of ABL stratification based on Bulk Richardson number (BURGOS-VM-W2-ABL)
    - LIDAR data analysis to assess real profiles of boundary layer in urban area (KELLNE-VM-W1-WIND)
- Fog alerts
    - PARAFOG application and strategy (RIBAUD-VM-W2-FOG)
    - Infrared-Microwave synergy to improve low liquid water path retrievals in fog (GALLUC-VM-W2-FOG)
- Instrument synergy

- The synergic use of the ground-based passive and active remote sensing: cloud radar, microwave radiometer, and aerosol-polarisation lidar (STACHL-ST-W2-ABL)
- synergy of DWL and MWR to estimate the Bulk Richardson number (BURGOS-VM-W2-ABL)
- Synergy of ceilometer and Doppler wind lidar observations in Arctic climate (BATCHV-VM-W2-SYN)
- Synergy for volcano eruption detection and characterisation, pollen events, and dry land characteristic - sun-photometer and one-wavelength lidar (MPL and ceilometers) data (SALGUI-VM-W2-AER, GRANAD-VM-W2-AER, RASCAD-VM-W2-AER2)
- Infrared-Microwave synergy to improve low liquid water path retrievals in fog (GALLUC-VM-W2-FOG)
- Survey showcases for synergy of wind lidar, cloud radar, and ceilometer (PIRLOA-VM-W2-ABL)

2.4 Modelling, data assimilation and reanalysis

- MWR observation minus background brightness temperature monitoring (MARKE-VM-W2-MWR)
- HATPRO MWR: Uncertainty Assessment (BOCKTO-VM-W3-MWR), rain flagging and radome status monitoring (LOFFLE-VM-W3-MWR)
- Roadmap on reanalysis of long-term, multivariate time series based on ReOBS, CARBO-ACT, AMBRE (RIBAUD-VM-W2-ABL)
- Requirement for temperature and humidity products for data assimilation (MARTIN-VM-W2-TEMP)
- Assessing the role of atmospheric stability on surface pollen concentrations - ABL height showed high correlation with pollen concentrations (RASCAD-VM-W2-AER)
- Network operation and requirements - analysis of different requirements of different networks (E-profile, ACTRIS), scanning strategies, etc. (POSPIC-VM-W3)