Characterization of the time evolution of the PBL structure and dry-layers based on the use of Raman Lidar measurements collected during HYMEX-SOP1

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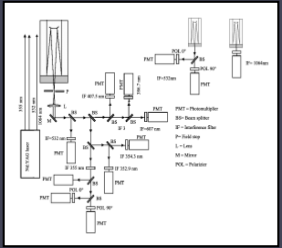
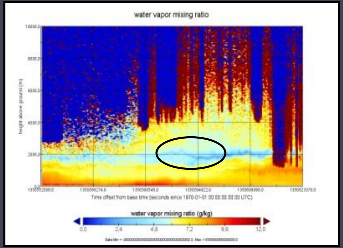
ABSTRACT

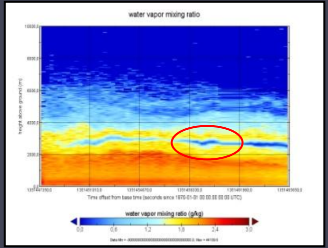
This paper reports results from an inter-comparison effort involving different sensors/techniques used to measure the Atmospheric Boundary Layer (ABL) height. The effort took place in the framework of the first Special Observing Period of the Hydrological cycle of the Mediterranean Experiment. Elastic backscatter and rotational Raman signals collected by lidar systems were used to determine the ABL height and its internal structure. In the present research effort, these techniques were compared with co-located wind profiler and a radiosounding measurements and with ECMWF modelling. In this effort we consider radiosondes released from a launching facility located close the lidar site belonging to IGRA (Integrated Global Radiosonde archive related in the Europe Region). The inter-comparison was carried out over the month of October 2012. Results reveal a very good agreement between the different approaches. The application of different techniques allows getting accurate and cross-validated estimates of the ABL height in different weather-climatic conditions Vertical profiles of atmospheric thermodynamic variables, i.e. temperature and humidity, or wind speed, clouds and aerosols can be used as proxy to retrieve PBL height from active and passive remote sensing instruments. In the presented research effort, water vapour concentration was computed and used to determine the PBL height. A dynamic index included in the European Centre for Medium-range Weather Forecasts (ECMWF) ERA5 atmospheric reanalysis (CAPE, Friction velocity, etc.) is also considered and compared with BASIL results. ERA5 provides hourly data on regular latitude-longitude grids at 0.25° x 0.25° resolution at 37 pressure levels .

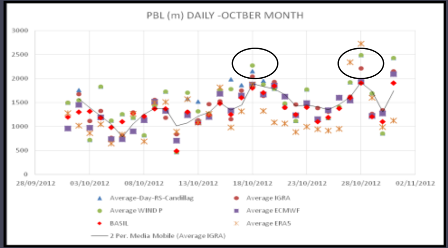
BASIL SYSTEM

The University of BASILicata ground-based Raman Lidar system (BASIL) was deployed in the Cévennes-Vivarais site (Candillargues, Southern France, Lat: 43°37' N, Long: 4° 4' E, Elev: 1 m) and operated between 5 September and 5 November 2012, collecting more than 600 hours of measurements, distributed over 51 measurement days and 19 intensive observation periods (IOPs). BASIL is capable to perform high-resolution and accurate measurements of atmospheric temperature and water vapour, both in daytime and night-time, based on the application of the rotational and vibrational Raman lidar techniques in the UV.



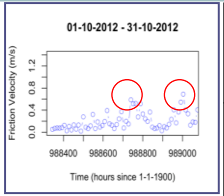


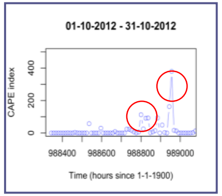


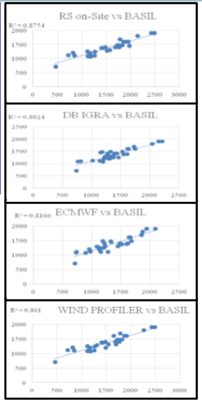


RESULTS

- In this effort we consider radiosondes released from a launching facility located close the lidar site belonging to IGRA (Integrated Global Radiosonde archive related in the Europe Region). The inter-comparison was carried out over the month of October 2012. Results reveal a very good agreement between the different approaches. Specifically, the scatter plot shows a good agreement from the different system with a coefficient R^2 including between 0.81 and 0.87. The application of different techniques allows getting accurate and cross-validated estimates of the ABL height in different weather-climatic conditions.
- During the second IOP at the end October there is better agreement between the observations and ERA5: the lidar show pretty similar behavior is growth of the mixing layer related to an approaching trough followed by a decrease towards the occurrence of clear sky conditions. The meteorological scenario is quite well capture in the additional ERA5 variable investigated in this study (e.g net total irradiance increase in the friction velocity). Nevertheless, clouds cover from ERA5 needs to be investigated as well).
- The integrated analysis with all the ERA5 parameters show that friction velocity is the main driver of the PBL variability in presence of an approaching lower pressure system while surface temperature determines the remaining variability.
- General statistics and a partial correlation analysis between measured PBL height and RH values provided by the lidar data analysis have been carried out. In particular, the latter reveals that RH can only partially explain the PBL height variability with a p-value for the partial correlation analysis of 0.37.







ACKNOWLEDGMENTS

Wind Profiler dataset were obtained from the HyMeX program, sponsored by Grants MISTRALS/HyMeX and ANR-11-BS56-0005 IODA-MED project.(Contact person: Said Frèdèrique Laboratoire d'Aérologie, Université de Toulouse, UMR CNRS 5560).

DATASET

Date	Ass err (RS-Basil)	Ass err (IGRA-BASIL)	Ass err (WINDP-BASIL)	Ass err (ECMWF -BASIL)	Date	Ass err (RS-Basil)	Ass err (IGRA-BASIL)	Ass err (WINDP-BASIL)	Ass err (ECMWF -BASIL)
01/10/2012	184,65	-16,51	184,65	-352,80	17/10/2012	132,62	20,12	-67,37	-85,37
02/10/2012	223,25	-156,75	13,25	-79,75	18/10/2012	-8,75	-18,75	211,25	-183,75
03/10/2012	-138,68	161,31	-138,68	116,06	19/10/2012	168,31	-146,68	95,81	-117,43
04/10/2012	285,68	-216,81	285,68	-354,56	20/10/2012	-3	-60,5	-3	66,5
05/10/2012	187,87	-172,12	187,87	-203,62	21/10/2012	-11,81	-101,81	-11,81	125,43
06/10/2012	243,31	-206,68	243,31	-279,93	22/10/2012	-89,93	252,56	-89,93	-72,6875
07/10/2012	68,93	81,43	68,93	-219,31	23/10/2012	155,31	-182,18	155,31	-128,4375
08/10/2012	-176,31	218,68	-176,31	133,93	24/10/2012	-11	26,5	-11	-4,5
09/10/2012	-48,12	64,37	-48,12	31,87	25/10/2012	-23,56	111,43	-23,56	-64,3125
10/10/2012	237,75	-307,2	237,7	-168,25	26/10/2012	-98,75	103,75	-98,75	93,75
11/10/2012	-129,5	145,5	-129,5	113,5	27/10/2012	145,31	-154,68	145,31	-135,9375
12/10/2012	121,06	-148,93	248,56	-220,68	28/10/2012	182,31	-95,18	182,31	-269,4375
13/10/2012	230	-57,5	30	-202,5	29/10/2012	223,12	-199,37	223,12	-246,875
14/10/2012	-8,87	93,62	-8,87	-75,875	30/10/2012	-176,87	110,62	-176,87	243,125
15/10/2012	75	-150	75	0	31/10/2012	11,5	31,5	-18,5	-24,5
16/10/2012	418,25	-406,75	218,25	-229,75					