



Form for Regular Reporting of CIMO Testbeds and Lead Centres

(expand the cells as required to properly reflect your activities)

Terms of Reference for CIMO Testbeds and Lead Centres are available under:
<http://www.wmo.int/pages/prog/www/IMOP/Testbeds-and-LC.html>

Name of Testbed / Lead Centre	WMO – CIMO Lead Centre on Precipitation Intensity - “Benedetto Castelli”
Location of Testbed / Lead Centre	Italy (Genova, Vigna di Valle and Monte Cimone)

Contact Person for the Testbed/Lead Centre	
Courtesy Title	Dr. LtColonel
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Has contact person changed in last 2 years?	No
If yes, who was the previous contact person?	N/A

Report on Activities
<p>Main activities that TB/LC carried out in the last 2 years for which results are already available:</p> <ul style="list-style-type: none"> Final Report of the cooperation with WMO CAgM within the METAGRI Operational Project, testing of simple farmers' rain gauges in the laboratory and in the field, based on the intercomparison campaign held at the field test site of the Lead Centre in Vigna di Valle (Rome, I). The Report also

provides guidance material for improving the measurement accuracy and fostering standardization. November 2016.

- Use of the snow intensity variable for the assessment and application of the Transfer Function to correct snow measurements as a function of wind speed (see list of publications below).
- Collaboration with the National Centre for Atmospheric Research (NCAR/NOAA) in Boulder (CO, USA) for the development of collection efficiency curves for shielded and unshielded solid precipitation gauges.
- Collaboration with EURAMET (European Association of National Metrology Institutes) on the accuracy of liquid and solid atmospheric precipitation measurements and the calibration of instruments through active participation in the EMRP METEOMET-2 (2015-2017) project, REG3.
- Leading role (Principal Investigator) in the Italian research project PRIN2015-4WX5NA “Reconciling Precipitation with Runoff: The role of understated measurement biases in the modelling of hydrological processes” since February 2017.
- Visiting of the experimental site in Vigna di Valle by participants of the Italian research project PRIN2015-4WX5NA “Reconciling Precipitation with Runoff: The role of understated measurement biases in the modelling of hydrological processes” (30 November 2017) and presentation of the Lead Centre activities.
- Field experiments to study the effect of wind at the collector of precipitation gauges and correction methods for the associated undercatch;
- Wind tunnel experiments and fluid dynamic simulations to derive correction curves for wind induced errors of precipitation measurements;
- Collaboration with Environmental Measurements Limited, based in Newcastle (UK), in order to provide a calibration facility for catching-type gauges and calculation of the correction curve for systematic mechanical errors of tipping-bucket rain gauges.
- Collaboration within CEN TC318 to launch the public enquiry for publication of the European standard “Hydrometry – Measurement requirements and classification of rainfall intensity measuring instruments”, in collaboration with UK members of CEN TC318.
- Preparatory activities for the development of an ISO standard (“Hydrometry – Measurement requirements and classification of rainfall intensity measurement instruments”) in collaboration with the UK members of ISO TC 113.
- Collaboration with the LSI Lastem company, based in Milan (Italy), for the development of a Class A tipping-bucket rain gauge according to UNI 11452:2012 and the provision of a calibration facility for catching-type gauges with calculation of the correction curve for systematic mechanical errors of tipping-bucket rain gauges.
- Collaboration with the GEOVES company, based in Treviso (Italy), for the laboratory and field testing of their tipping-bucket rain gauge.
- Presentation at the 3rd STAIR-EMPIR Workshop “From metrology research to standardization”, CEN-CENELEC Meeting Centre, Bruxelles, 10 October 2017, entitled “Calibration and accuracy of non-catching type instruments to measure liquid/solid atmospheric precipitation”.
- Preparation of a PRT (Proposed Research Topic) proposal entitled “Calibration and accuracy of non-catching type instruments to measure liquid/solid atmospheric precipitation”, under the EMPIR Normative call 2018, Strand 1.
- Laboratory testing and calibration of tipping-bucket rain gauges and weighing rain gauges (2015-2016).
- Continued collaboration with the Hong-Kong Observatory (China) for the development of calibration facilities for catching-type rain gauges at the Hong-Kong Observatory.
- Continued collaboration with the Brazilian Environmental Metrology Institute (Prof. Márcio A. A. Santana, Metrologia Ambiental - INPE/ CPTEC / LIM - Brazil) in the field of environmental metrology for the development of a traceability chain towards the international standards of precipitation intensity measurements.
- Technical/scientific support to meteorological instrument manufacturers about calibration issues and improving the performance of their instruments in accurately measuring rainfall intensity, including

accounting for the wind-induced undercatch.

- Collaboration with the Artys company, based in Genoa (Italy), for the extensive testing in the field of a Smart Rainfall System (SRS) that estimates rainfall in real-time by means of the analysis of the attenuation of satellite signals (DVB-S in the microwave Ku band) and comparison with co-located traditional measurements.

Main activities that TB/LC carried out in the last 2 years for which results will soon be available:

- Preparation of the participation of Lead Centre staff to the JMA/WMO Workshop on Quality Management of Surface Observations - RA II WIGOS Project, to be held in Tokyo, Japan, 19-23 March 2018.
- Research activities within the Italian research project PRIN2015-4WX5NA "Reconciling Precipitation with Runoff: The role of understated measurement biases in the modelling of hydrological processes" (Feb 2017 – Feb 2020).
- Tests in the large size wind tunnel facility of the Polytechnic of Milan (Italy) to simulate the wind-induced undercatch of precipitation gauges.

Which guidance documents/standard procedures were developed during the last 2 years (please include full reference and web-link if available)?

- CEN TC318, proposed European standard on "Hydrometry – Measurement requirements and classification of rainfall intensity measuring instruments", in collaboration with UK members of CEN TC318

Which IOM reports / peer-reviewed publications were published in the last 2 years (please include full reference and web-link if available)?

Peer-reviewed journals

- Stagnaro, M., Colli, M., Lanza, L.G. and P.W. Chan (2016). Performance of post-processing algorithms for rainfall intensity measurements of tipping-bucket rain gauges. *J. Atmos. Meas. Techn.*, 9, 5699–5706.
- Merlone, A., Sanna, F., Beges, G., Bell, S., Beltramino, G., Bojkovski, J., Brunet, M., del Campo, D., Castrillo, A., Chiodo, N., Colli, M., Coppa, G., Cuccaro, R., Dobre, M., Drnovsek, J., Ebert, V., Fericola, V., Garcia-Benadí, A., García Izquierdo, C., Gardiner, T., Georgin, E., Gonzalez Calvo, A., Groselj, D., Heinonen, M., Hernandez de la Villa, S., Hogstrom, R., Hudoklin, D., Kalemci, M., Kowal, A., Lanza, L., Miao, P., Musacchio, C., Nielsen, J., Noguera Cervera, M., Pavlasek, P., de Podesta, M., Oguz Aytakin, S., Rasmussen, M., del Rio, J., Rosso, L., Sairanen, H., Salminen, J., Sestan, D., Šindelárová, L., Smorgon, D., Sparasci, F., Strnad, R., Voldán, M., Underwood, R., and A. Uytun (2018). The MeteoMet2 project – Highlights and results. *Measurement Science and Technology*, 29 (2), 2018.

Conference papers/abstracts (international)

- Colli, M., Thériault, J.M., Stagnaro, M., Lanza, L.G. and R.M. Rasmussen (2016). Study of the Solid Precipitation Wind Induced Under-Catch Using Snowfall Intensity (Abstract 9B.4). 96th Americal Meteorological Society (AMS) Annual Meeting, January 10-14, New Orleans, Louisiana (US).
- Thériault, J.M., Rasmussen, R.M., Colli, M. and L.G. Lanza (2016). Examination of the Catch Efficiency of Snow Gauges based on the Observed Characteristics of Snow (Abstract 9B.5). 96th Americal Meteorological Society (AMS) Annual Meeting, January 10-14, New Orleans, Louisiana (US).
- A. Merlone, G. Coppa, G. Lopardo, C. Musacchio, A. Piccato, F. Sanna, C.C. Garcia Izquierdo, Y.G. Kim, F. Sparasci, P. Thorne, J. Zhang, G. Strouse, E. Van der Ham, J. Tamba, T. Usuda, E. Ejigu, S. Bell, M. de Podesta, T. Gardiner, C. Monte, V. Ebert, P. Pavlacek, D. Groselj, M. Heinonen, M. Kalemci, G. Beges, J. Drnovsek, D. Hudoklin, J. Bojkovski, A. Castrillo, L. Lanza, A. Viola, V. Vitale, R. Emardson, and R. Feistel (2016). Metrology for climate observation. In: *Global Climate Observation: the Road to the Future*, 2-4 March 2016, Royal Academy of Arts and Sciences, Amsterdam (NL).
- Colli, M. and L.G. Lanza (2016). On the wind-induced undercatch in rainfall measurement using CFD-based simulations (Abstract). *EGU General Assembly, Geophys. Res. Abstr.*, 18, EGU2016-13349.
- Colli, M., Lanza, L.G., Rasmussen, R. and J. M. Thériault (2016). Advances in the evaluation of wind-induced undercatch using CFD-based simulations of snow gauge performance (Abstract). *EGU General Assembly, Geophys. Res. Abstr.*, 18, EGU2016-10822.
- Stagnaro, M., Colli, M., Lanza, L.G. and P.W. Chan (2016). Assessing rainfall intensity calculation

algorithms for tipping-bucket rain gauges at a field test site (Abstract). EGU General Assembly, Geophys. Res. Abstr., 18, EGU2016-15321.

- Colli, M., Pollock, M., Stagnaro, M., Lanza, L.G., Quinn, P., Dutton, M., O'Donnell, G., Wilkinson, M., Black, A. and P.E. O'Connell (2016). Evaluating the catching performance of aerodynamic rain gauges through field comparisons and CFD modelling (Abstract). EGU General Assembly, Geophys. Res. Abstr., 18, EGU2016-17048.
- Pollock, M., Colli, M., Stagnaro, M., Quinn, P., Dutton, M., O'Donnell, G., Wilkinson, M., Black, A., P.E. O'Connell and L.G. Lanza (2016). The extent of wind-induced undercatch in the UK winter storms of 2015 (Abstract). EGU General Assembly, Geophys. Res. Abstr., 18, EGU2016-16792.
- Cauteruccio A., Colli M., Lanza L.G. On the wind-induced undercatch in rainfall measurement using CFD-based simulations. 15th Plinius Conference on Mediterranean Risks, Giardini Naxos (ME, Italy), 8-11 June 2016. N° abstract: Plinius15-67.
- Cauteruccio A., Colli M., Lanza L.G. Wind induced effects on ground-based liquid precipitation observations. Technical Conference on Meteorological and Environmental Instruments and Methods of Observation (CIMO TECO 2016), Madrid (Spain), 27-30 September 2016.
- Stagnaro, M., Colli, M. and L.G. Lanza (2017). The impact of temporal aggregation of solid precipitation measurements on the correction for wind-induced undercatch (Abstract). EGU General Assembly, Geophys. Res. Abstr., 19, EGU2017-15555.
- Cauteruccio, A., Colli, M., Stagnaro, M., Freda, A. and L.G. Lanza (2017). Wind tunnel validation of the aerodynamic performance of rain gauges simulated using a CFD approach (Abstract). EGU General Assembly, Geophys. Res. Abstr., 19, EGU2017-16058.
- Caridi, A., Caviglia, D.D., Colli, M., Delucchi, A., Federici, B., Lanza, L.G., Pastorino, M., Randazzo, A. and D. Sguerso (2017). A field evaluation of a satellite microwave rainfall sensor network (Abstract). EGU General Assembly, Geophys. Res. Abstr., 19, EGU2017-15323.
- Pollock, M., Quinn, P., O'Donnell, G., Colli, M., Dutton, M., Black, A., Wilkinson, M., Kilsby, C., M., Stagnaro, Lanza, L.G., and P.E. O'Connell (2017). A UK portrait of wind-induced undercatch in rainfall measurements (Abstract). EGU General Assembly, Geophys. Res. Abstr., 19, EGU2017-17222.

Title(s) of IOM report(s) presently being developed by your Testbed/Lead Centre:
(please specify level of development: draft, ready for review, ...)

- None

Has your Testbed/Lead Centre collaborated with one or more CIMO Expert Teams in developing guidance material? Yes

If yes, with which CIMO Expert Team(s)?

- CIMO - ET on Instrument Intercomparisons (involvement in pre-SPICE and SPICE)
- CIMO Guide Editorial Board (to include the outcomes of the Field Intercomparison of RI gauge)
- CIMO - ET on Operational In Situ Technologies (WMO/ISO standard on the accuracy of rainfall intensity measurements)

Capacity Building and Training Activities

Which capacity building/training activities have been carried out by the LC in the last 2 years?

- Seminar on the CFD modelling of wind induced undercatch of precipitation measurements at Newcastle University, in March 2016, within the Knowledge Transfer Agreement between Environmental Measurements Ltd and the School of Civil Engineering & Geosciences, Newcastle University.
- Visit of Dr. Toshihiro Hayashi, from the Japan Meteorological Agency, and joint seminar on QC (Quality Control) on precipitation amount measured by rain gauge, University of Genoa, April 7-8, 2016.
- Visit of Dr. Robert Stefanski and Dr. Jose Camacho and seminar on the activities related with the testing of manual gauges for the METAGRI OPERATIONAL project, University of Genoa, June 27-28, 2016.

Has your testbed developed a twinning activity / special relationship with a companion station/site

from a developing country? No
If yes, with which station/site? N/A
Is your Testbed/Lead Centre making an oral/poster presentation at this year's TECO? Yes (If yes, please specify Title(s) and Author(s) of the presentation(s)) <ul style="list-style-type: none">• TBD

Recent Changes in Circumstance
Have there been any recent changes in your Test Bed/Lead Centre's capabilities? If so, please specify: <ul style="list-style-type: none">• No
Have there been any recent changes in your Test Bed/Lead Centre's infrastructure? If so, please specify: <ul style="list-style-type: none">• Laboratory calibration setup for non-catching rain gauges completed• Access to the wind tunnel facility of the University of Genoa for testing wind effects on rain gauges
Have there been any recent changes in your staffing? If so, please specify, and advise whether replacement staff have the required competencies: <ul style="list-style-type: none">• None

Future Plans	
What are your plans for the next two years? <ul style="list-style-type: none">• Develop correction methodologies for wind-induced errors on liquid and solid precipitation measurements to overcome the need of installing expensive wind-shields (experiments in the field and in the wind tunnel).• Continue the ongoing international collaboration with the experimental sites involved in WMO SPICE (Davos, Marshall, Heukeliseter, Formigal, ...).• Prepare an intercomparison of non-catching type instruments using new technologies for precipitation measurements, present weather and visibility.	
Is your Testbed/Lead Centre able to continue in the role of a Test Bed/Lead Centre during the coming two years?	Yes

Other relevant information (other activities of special interest to CIMO, etc.)
<ul style="list-style-type: none">• None

Date
15/02/2018

Name of Person Filling the Form
Prof. Luca G. Lanza