



The Joint IPWG/GEWEX Precipitation Assessment

It rains cats and dogs or too little. Over the past few days we witnessed two types of opposite events: an extreme heat wave over NW US and western Canada and very intense precipitation associated with extended floods in Belgium, The Netherlands and Germany. In both cases, defining the event as “extreme” is a mere understatement because these are extraordinary occurrences with respect to what we are normally used to. Moreover, we have to consider hundreds of casualties.

In whatever way one considers the exceptional facts that still occupy the pages of the newspapers, we need to ask ourselves a question: what’s going on? Are the exceptional events and thus we need to pay just a temporary attention to them or are they here to stay? The answer is not easy at all since it implies a deep understanding of the mechanisms of meteorology on one side and of the climate on the other. Regardless our specific competence, we can state quite firmly that the climate is indeed changing and quite heavily so. The global warming is happening and it induces heat waves and extreme and very localized precipitation. This is the framework. The scenarios depicted by the climate models tell us quite clearly that these situations are starting to be “normal” and that we must expect that they will happen quite frequently from now on. In summary, let’s start worrying, meaning let’s work to adopt countermeasures, which are probably already late...

It is in this context that science works to measure global precipitation on the planet Earth. Yes, this is important because without accurately measuring rain and snow we cannot grasp the meaning of the mechanisms of the water cycle and try to predict scenarios at the climate scale on this fundamental process that supports life on Earth. Without water there is no life and here is the importance of the studies that see the collaboration of scientists from all over the world, including Italy and CNR.

More than twenty scientists from several countries have worked together to produce a fundamental document published by the World Climate Research Programme (WCRP, <https://www.wcrp-climate.org>) of the United Nations: *The Joint IPWG/GEWEX Precipitation Assessment* (Roca et al. 2021). The Report has seen a joint effort of the communities of the International Precipitation Working Group (IPWG, <http://ipwg.isac.cnr.it>) and of the Global Energy and Water Exchanges (GEWEX, <http://www.gewex.org>) Data and Analysis Panel (GDAP). These scientists are used to work together at the maximum international level and they understand how effective is the science without barriers or prejudices. Physicists, engineers, geographers, hydrologists, meteorologists, climatologists and many more have made available their knowledge to support the struggle against the devastating effects of climate change.

What does it mean “assessment”? It essentially means “evaluation”. In this specific case, the report is the result of an effort of the scientific community to evaluate the soundness of the measurement products available at the moment. Evaluating means understand if the measurements are reliable and what is the error associated with them. Without an assessment the products are meaningless and are equivalent to a mere opinion from this or that scientific group. In order to have the measurements used in the hydrological, meteorological and climate models, they must be “certified” and their merits identified in total honesty based on scientific competence. This is a very complex and difficult job, often tedious and scarcely rewarding, but it is of fundamental importance because it is at the ground of all climate sciences.

The report concentrates mostly on the measurements of precipitation from satellite and the reason is that such measurements are the only ones truly “global”, i.e. available at high temporal frequency (geostationary satellites provide images every 15 minutes) and covering the whole globe (all land

without geographic barriers and oceans). No other data source has these characteristics since the pluviometers and meteorological radars are installed only over land and mostly in the so called “developed” countries. Entire portions of the Earth are not covered by these observing networks and thus we need satellites.

The first chapter concentrates in some detail on the verification of the products at sub-daily time scales. This is crucial especially for the hydrological applications and for weather forecasting that need the amount of precipitation that falls within a certain time interval, i.e. the precipitation intensity. The algorithms generating precipitation intensity are based on three instrument types: radar, passive microwave and thermal infrared sensors. In this initial part the report describes the uncertainties of the precipitation products based on combinations of these three measurement methods at their native resolution and successively treats the errors for hydrological applications. The IPWG validation network is then introduced with its validation protocols that are one of the major information sources on uncertainties of satellite derived precipitation.

As previously commented, climate is the most important area in which the measurement of global precipitation finds its application and for various reasons. The first, which introduces the second chapter of the report, is the water and energy cycle closure of the planet Earth. “Closing” the cycle means deeply understand what are in details the cycle components and assign to them unambiguous numbers. For example, we still do not know what is the contribution of light rains and that of snowfall. The report continues in this second part with considering climate variability with respect to precipitation and its interannual and seasonal trends and much more. In summary, we need to know where we are heading and how much precipitation falls and its intensity and location. One more fundamental aspect is the verification of climate model outputs. Since we still have a considerable uncertainty in climate scenarios, satellite precipitation products are more and more used to validate climate predictions to spot their limits and indicate where they can be improved. Last but not least is the analysis of extremes. This is a very new and complicated investigation field and the report considers the applicability of satellite precipitation products based on their spatio/temporal resolution and their quality.

In the last section the authors list the future research lines on precipitation, in particular the concepts of next generation products that include new data sources and novel analysis methods. Error modeling is still a very young science field and we expect important developments in this direction shortly. Finally, if satellite precipitation data are so important, we need to maintain in orbit a satellite constellation of sensors for measuring precipitation. This is all but secure and the report provides guidelines that will help space agencies to plan future launches and understand what are the requirements of the scientific community and of the end users.

Obviously, the report does not represent the ultimate word on the topic because in science nothing is final, but it does represent a clear step forward with respect to the previous report published thirteen years ago (Gruber and Levizzani 2008).

CNR has actively contributed to the report and Vincenzo Levizzani of the Institute of Atmospheric Sciences and Climate (ISAC) in Bologna is one of the main authors. Research on precipitation is a main strength of CNR at national level, but also at the international level. This is the outcome of a school and of research centers at very high level and recognized worldwide.

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If you want to know more:

Gruber, A., and V. Levizzani (eds.), 2008: Assessment of global precipitation products. WCRP Series Report No. 128 and WMO TD-no. 1430, Geneva, available [here](#).

Roca, R., Z.S. Haddad, F.F. Akimoto, L. Alexander, A. Behrangi, G. Huffman, S. Kato, C. Kidd, P.E. Kirstetter, T. Kubota, C. Kummerow, T.S. L'Ecuyer, V. Levizzani, V. Maggioni, C. Massari, H. Masunaga, M. Schröder, F.J. Tapiador, F.J. Turk and N. Utsumi, 2021: The Joint IPWG/GEWEX Precipitation Assessment. WCRP Report 2/2021, World Climate Research Programme (WCRP): Geneva, Switzerland, 125 pp., doi:10.13021/gewex.precip, available [here](#).