Data-sharing rationale for climate services

Preamble

The overarching goal of the EU-funded Intra-ACP Climate Services and Related Applications Programme (ClimSA) is to improve wide access and use of climate information by the ACP (African, Caribbean, and Pacific) group of countries, and to enable and encourage the generation and use of climate services and applications for decision making.

Figure 1 shows the elements of the climate services value-chain and the fundamental role of observations for the provision of climate services. Climate services may be tailored for a specific location and a specific sector, and they need to be based on observations on national, regional and global scales, due to the connections between all scales within the weather/climate system. A key element for the success of the ClimSA project therefore is the exchange of data between regional and national partners.

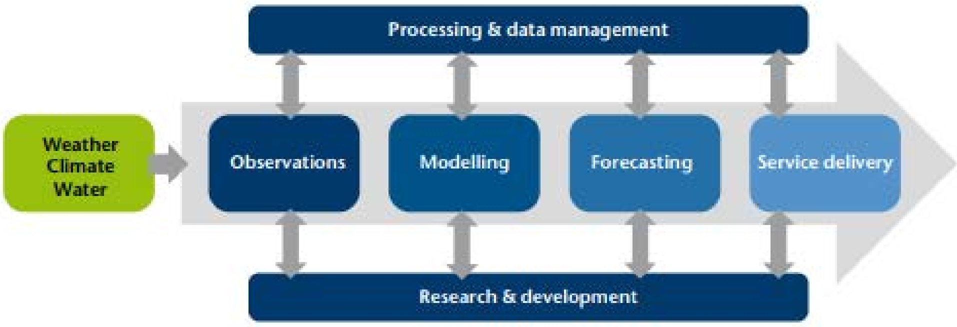

Figure 1: Components of the service production and delivery system of NMHSs (Source, Figure: Valuing Weather and Climate: Economic Assessment of Meteorological and Hydrological Services, WMO- No.1153)

The Data-sharing rationale presented in this document provides the motivation for the exchange of basic observational data in relation to improvements in climate services. It briefly explains current international arrangements and provides some examples from the International Climate Assessment and Dataset (ICA&D), illustrating the benefits of sharing data.

This Data-sharing rationale for climate services is prepared under WMO grant under ClimSA, and in particular, Activity 3.4 (‘*Ensure RCCs have operational access to existing climate information produced at national level through NMHSs, including data rescue*’), with the aim to contribute to the signing of a joint declaration by NMHSs directors in each sub-region to make meteorological data available for RCC operations.

Background

Climate change will affect weather patterns and frequencies of weather extremes, with increasing probability of severe impacts. The importance of meteorological services, from early warnings to seasonal forecasts and climate projections, are higher today than several decades ago.

It should be pointed out that the creation of an efficient early warning system for climate anomalies and related extremes has been a focus of the World Meteorological Organization (WMO) and the National Meteorological and Hydrological Services (NMHSs) for more than a decade in order to improve climate risk management capabilities among nations (Zhai and others, 2005). To this effect, NMHSs should be adequately equipped and prepared to continuously monitor, assess and provide information on the state of the climate and its departure from the historical climate averages with reference to the observed extreme values of weather and climate variables.

Increased computing power, a deeper understanding of atmospheric processes and availability of observational data have led to a significant improvement of forecast skills. A key factor for this success is the long-standing tradition of international exchange of observational data. History proves that sharing data and collaboration beyond the national borders strongly benefit forecasts and projections.

For climate services the benefits are also clear. Adaptation measures to climate change often take place on regional, national and local scales, where droughts, floods and other extremes – more often than not expanding beyond national borders - have direct impact on society. Collaboration and sharing of historical observational data within regions, like through the WMO Regional Climate Centers (RCCs), enable basic climate assessments and analyses, as well as the regional perspective of climate change and variability, that are needed by countries for their National Adaptation Plans.

NMHS services on weather and climate extremes depend critically on the availability of high-quality climate observations with sufficient spatial coverage over a long period of time. For many countries, new actions for Data Rescue (DARE) and digitization are necessary.
Continued monitoring of climate is absolutely necessary for adaptation to climate change for all countries. Obtaining a thorough understanding and appreciation of the uncertainties and constraints associated with the use of both observational data and climate change projections based on global and regional models is more easily accomplished on a regional than national basis (WMO-No.1500, 2009)

This document provides information on arrangements that are made for the international exchange of observational data. It also provides some examples using the ICA&D-system illustrating the benefits of data sharing in the climate context.

WMO resolutions related to data exchange

25 Years ago, the 12th World Meteorological Congress adopted Resolution 40, WMO policy and Practice for the Exchange of Meteorological and Related Data and Products including Guidelines on relationships in Commercial Meteorological Activities. The process that led to this resolution, and the impact of its acceptance is described in a paper by John Zillman [WMO Bulletin Vol 68(2)-2019]. The resolution was a response to the increased competition between the national weather services and between the public and private players in this field which had led to more and more restrictions on the free exchange of observational data that had been the practice in meteorology for over a century.

Similar resolutions were adopted for the exchange of hydrological observations and products (Res. 25, 1999) and for the exchange of climate data and products (Res. 60, 2015).

These resolutions, plus the proposed new WMO Unified Data Policy (that will be discussed at Cg-Ext 2021) do not settle all data-related issues as they all leave room for specifics of national data-policies. However, they represent a commitment to broadening and enhancing the free and unrestricted international exchange of data which is imperative for providing effective weather and climate services to society.

Data exchange within the WMO Regional Centers

From the analyses provided by the State of the Climate Services Report (2020) it was concluded that: “Sustainable observations are key, but inadequate”, which is illustrated by the map showing the reporting surface observation stations (figure 2). It shows that upgrades and extensions of observation networks are needed, but also that increasing the reporting and exchange of data from existing stations in data-sparse regions would already be very effective and solving a part of the problem of a lack of data.

Apart from the direct benefits of data-assimilation for operational services like early warnings and weather forecast, access to a high-quality observational dataset covering the whole region will serve for instance the assessment of model skill and bias and calibration of retrieval algorithms and avoid repetition of these activities by every country using its own national dataset.

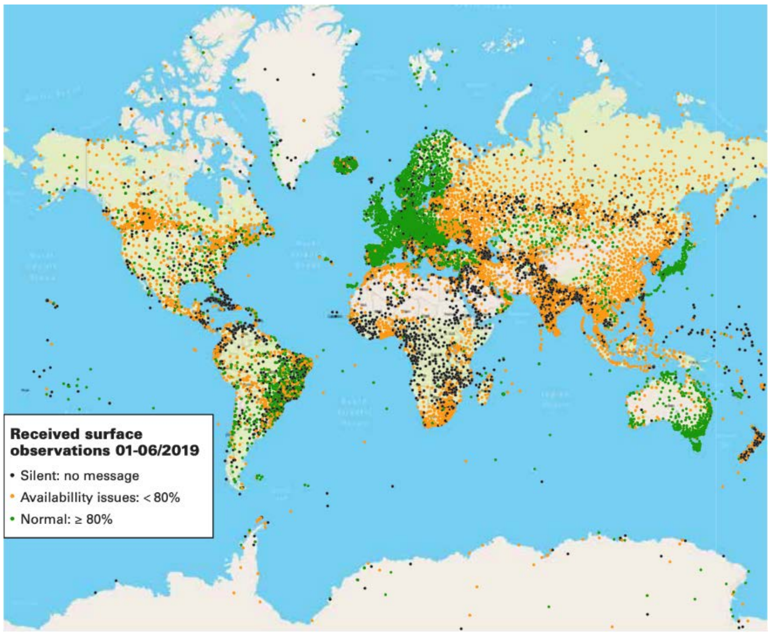

Figure 2: Reporting surface stations against the WIGOS baseline for January to June 2019. Black dots show stations that do not report at all, orange dots indicate stations with reporting < 80%, green dots indicate compliance with the baseline (≥ 80%.). (from: State of the Climate Services 2020, WMO, 2020)

Climate services on a regional scale require the availability of observational data with a sufficient space and time resolution (see the WMO Rolling Requirements Review http://www.wmo-sat.info/oscar/requirements for different variables and application areas). In many parts of the world, especially in developing regions in the South, these requirements are not met. Moreover, despite the gradual move towards open data policies, the current reality is that in most regions a variety of national data policies co-exist, which further limits the development and availability of climate information products.

As a consequence, regional climate centers serving NMHSs that have the responsibility to inform sectors like agriculture, water management, disaster prevention, etc., need to make formal agreements with each data provider in the region, such as NMHSs, but also other institutions dealing with applications such as national hydrological services, Agriculture, DRR, heath, etc. regarding the use of the data on which the services are based. Only strictly following the different data-policies of the data providers will provide the mandate to the RCC to compile and analyze a sufficient number of observations needed for its monitoring products. Data entrusted to the RCC should be safe, not being shared with other parties without explicit consent and providers should remain owner of the data, meaning that they have the authority to add, update, or remove their data when needed.

As an example, Annex 1 provides the data policy of the European RCC-node on climate data, which was set-up and maintained by KNMI. One of the restrictions is that the data may only be used for non-commercial research and education. Separate conditions and restrictions are set for basic station data and for derived data such as gridded fields and climate indices. The data policy explicitly distinguishes the possibilities that the actual observations, which are at the basis of the derived data products, can be made available to web uses (under the given restrictions) or can be withheld from web users.

The rules for data exchange may be different for each RCC, tailored to what is feasible within the region while maximizing the benefits for the countries. For practical reasons the number of different data-policies that can be accommodated will be limited.

Figures 3a and 3b exemplify the situation in Europe and Southeast Asia. The map shows stations providing precipitation observations to the European and Southeast Asia Regional Climate Centres. The colors reflect the national data policies that apply and that are facilitated by the RCC. Some countries have a fully open data policy (green), others only allow data downloads for a selection of stations (e.g., Poland and France). Nevertheless, data from all stations shown can be used to derive climate indices or for gridding, thus providing an important regional perspective for all participating countries.

Data Rescue and link to other DBMSs

To further increase the number of observations available for its monitoring products the RCC should facilitate the ingestion of historical observations from data rescue projects. These activities may provide time series covering several decades, which is very valuable for providing the historical perspective in the occurrence of climatic extremes and the detection of trends in extremes. Another way to increase the data availability is to provide tools to easily exchange of data from existing national observational databases and the regional center.

Implementation of data policies for RCCs in ACP-regions

The functioning of the Regional Climate Centers in ACP-regions depends crucially on the agreements that can be reached concerning the use of observational data from the countries. This is the case for real time data needed for initialization of the model forecasts, as well as for the climatological series needed for verification, calibration and climate monitoring. The technical implementation should adhere to the data policies and should at the same time provide an effective platform for dissemination of the monitoring products.

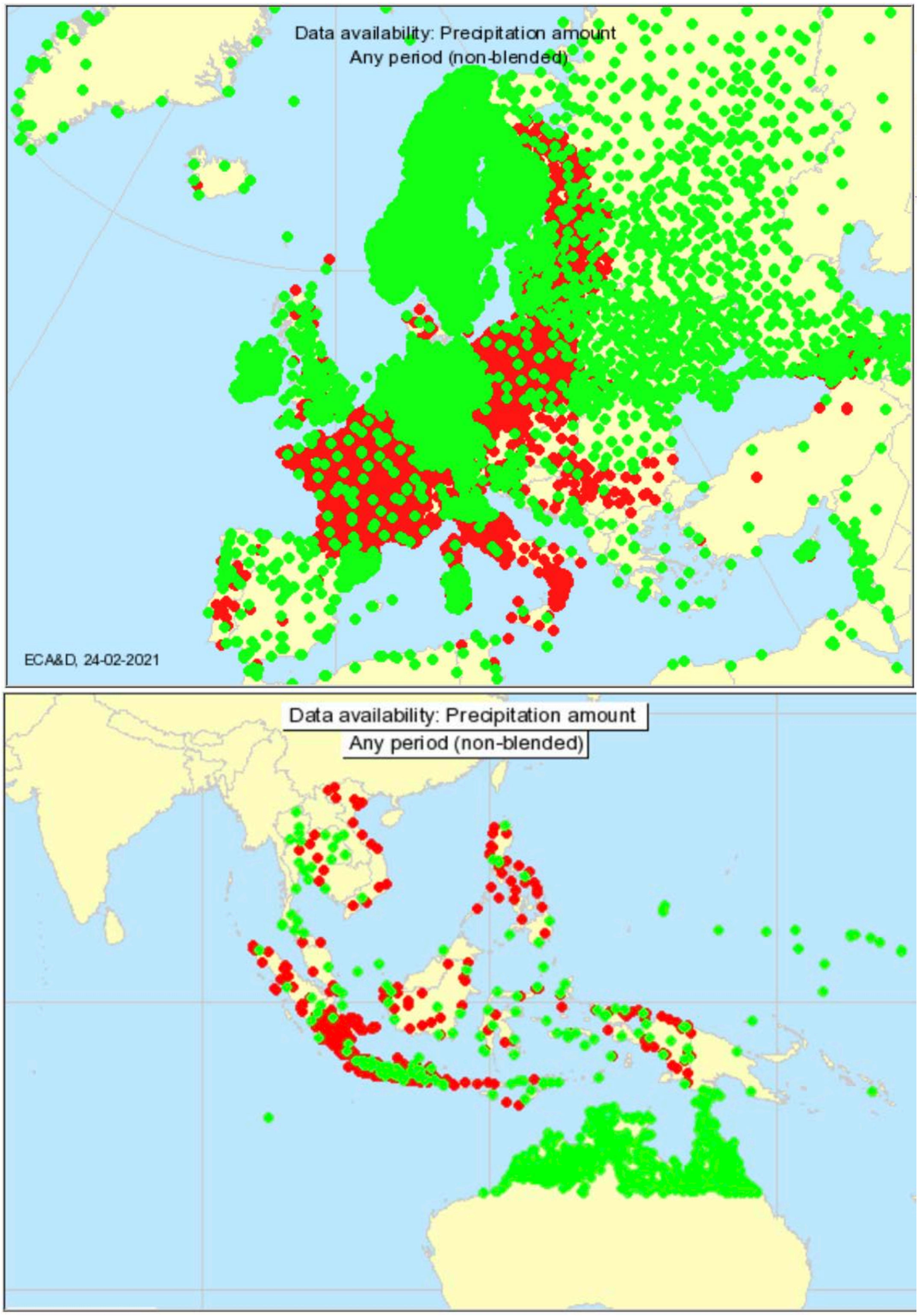

Figure 3a: Precipitation data availability map of the European Assessment and Dataset (ECA&D, Upper panel), and 3b, the Southeast Asian Assessment and Dataset (SACA&D, Lower panel). Green dots indicate stations where precipitation data is available for download; red dots indicate stations from which only derived data (such as climate indices) can be downloaded. In both cases the information is only available for non-commercial research and education.

The benefits of sharing data in 3 examples

The benefits of sharing data on a regional scale are highlighted by examples from 3 different regional climate centres.

Example 1 - Validation of regional climate model output with observed data.

Hariadi et al. (2021) studied the performance of climate models for Southeast Asia by comparing different regional and global climate model data with observations. The focus was on the onset and the total precipitation of the rainy season, which are essential parameters for the agricultural sector in SE Asia. For the comparison the observations in the region have been interpolated to the same grid as the model. To derive a representative grid the network of precipitation observations needs to be sufficiently dense, a condition that is met in most parts of the region due to the exchange of observational data within the Regional Climate Centre for SE Asia hosted by the Indonesian Weather Service (BMKG). Figure 4 shows maps of the average onset date of the rainy season in the period 1981-2005 based on observations and as represented by a high-resolution climate model (Roberts et al. 2020).

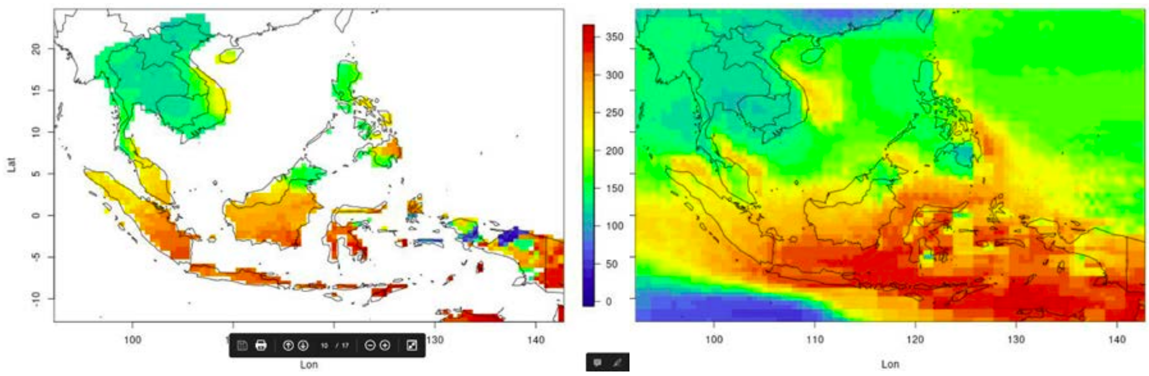

Figure 4: Map of the mean onset of the rainy season in Southeast Asia. The mean onset is calculated from gridded surface observations (LEFT) and a high-resolution climate model (RIGHT) for the period 1981-2005.

Example 2 - Central-European flooding event in 2013

At the end of May and the beginning of June 2013 a large area in central Europe saw high precipitation amounts. Several places received as much as the normal monthly precipitation within just one or two days. The excess of precipitation resulted in high water levels in European rivers such as the Danube, Elbe, and Rhine. Water levels of the Danube in Passau and Budapest exceeded their highest point in at least 100 years. The large-scale flooding along the riverbanks caused extensive damage. Thousands of people had to be evacuated from places in Germany, Czech Republic and Austria. At least 14 casualties have been recorded.

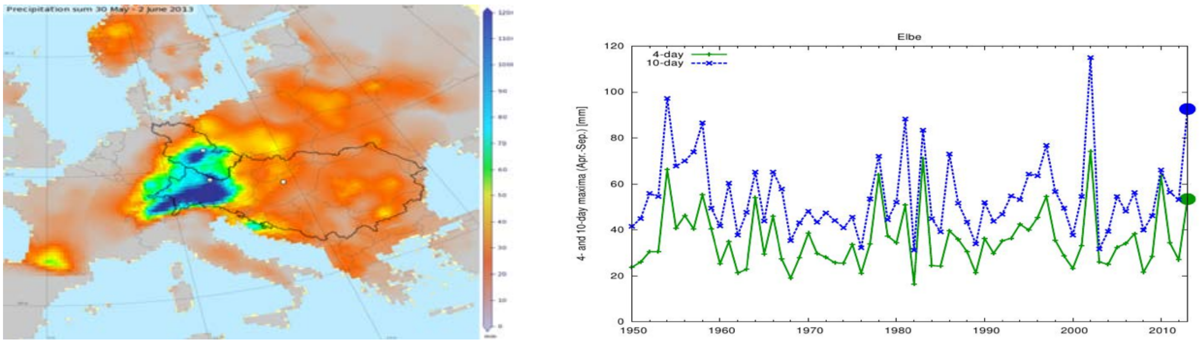

Figure 5: Accumulated precipitation amount over Europe between 30 May and 2 June 2013. Black lines indicate the catchment area of the Elbe and the Danube rivers (LEFT); Yearly maximum of the 4 and 10-days precipitation sum from 1950 onward. Big blue and green dots indicate the sum during the 2013 flooding event (RIGHT)

Figure 5 LEFT above is derived from E-OBS, a daily gridded dataset for Europe based on many daily station observations. The river basins of the Elbe and Danube are outlined by the black lines, and each cover multiple European countries. Sharing station observation within the European RCC allowed for the generation of the gridded regional precipitation maps and the integration over the catchment areas. The extreme precipitation event and its impact crosses multiple borders and nicely illustrates the value of regionally sharing observational data (see also: https://knmi-ecad-assets-prd.s3.amazonaws.com/download/FloodingEvent.mp4).
The historical perspective was obtained by gridding observations from the past and compare those with data from the event (Figure 5 RIGHT). From this it could be concluded that for both rivers the event was extreme but not unique in the past 60 years. This is important information to unravel what caused the severe impact during these days.

Example 3 - Calibration and verification of precipitation observed by satellite

Daily precipitation in the tropics typically has a patchy spatial structure. The benefits of using satellite observations, whose primary strength is its high spatial resolution, is potentially very high and its spatial coverage can never be met by a conventional rain gauge network. Satellite precipitation products are therefore widely used in the tropics, e.g., to issue early warnings and for water management and agriculture applications.
To calibrate the retrieval algorithms used for the precipitation amount estimation rain gauge data are used, whose primary strength is their accuracy. In figure 6 and 7 TAMSAT data is shown, taken from a study by Maidment et al. (2017). The authors conclude from their evaluation study that satellite observations generally detect rainy days reliably, but that different satellite products give a range of the precipitation amounts suggesting that the skill for this parameter is much more limited. To evaluate and calibrate satellite systems the ground truth data is essential. Skill assessments for a region can only be done when sufficient and representative data is available. Sharing data will help the development of these satellite products that are the basis of several key services provided by NMHSs in the region.

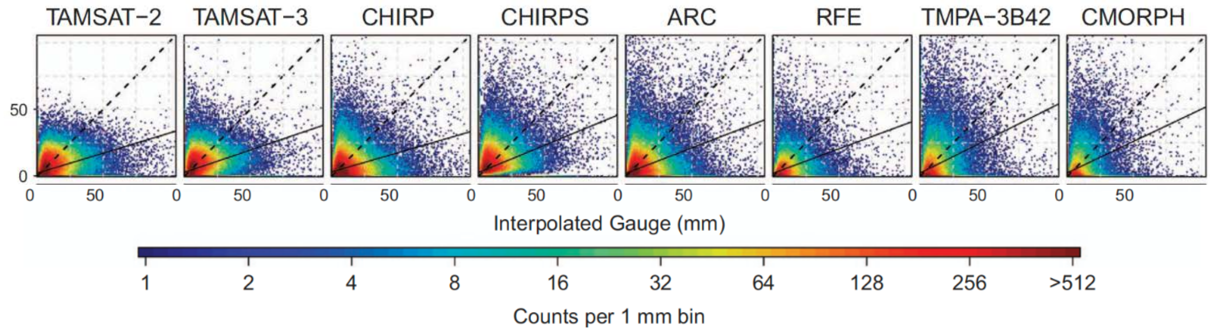

Figure 6 Scatterplot of daily satellite rainfall estimates against kriged gauge estimates for 0.25° grid cells that contain at least one rain gauge. Scale gives the counts per 1mm bin. Dashed line indicates the one-to-one correspondence; solid line gives the linear regression best fit. (taken from Maidment et al, 2017)

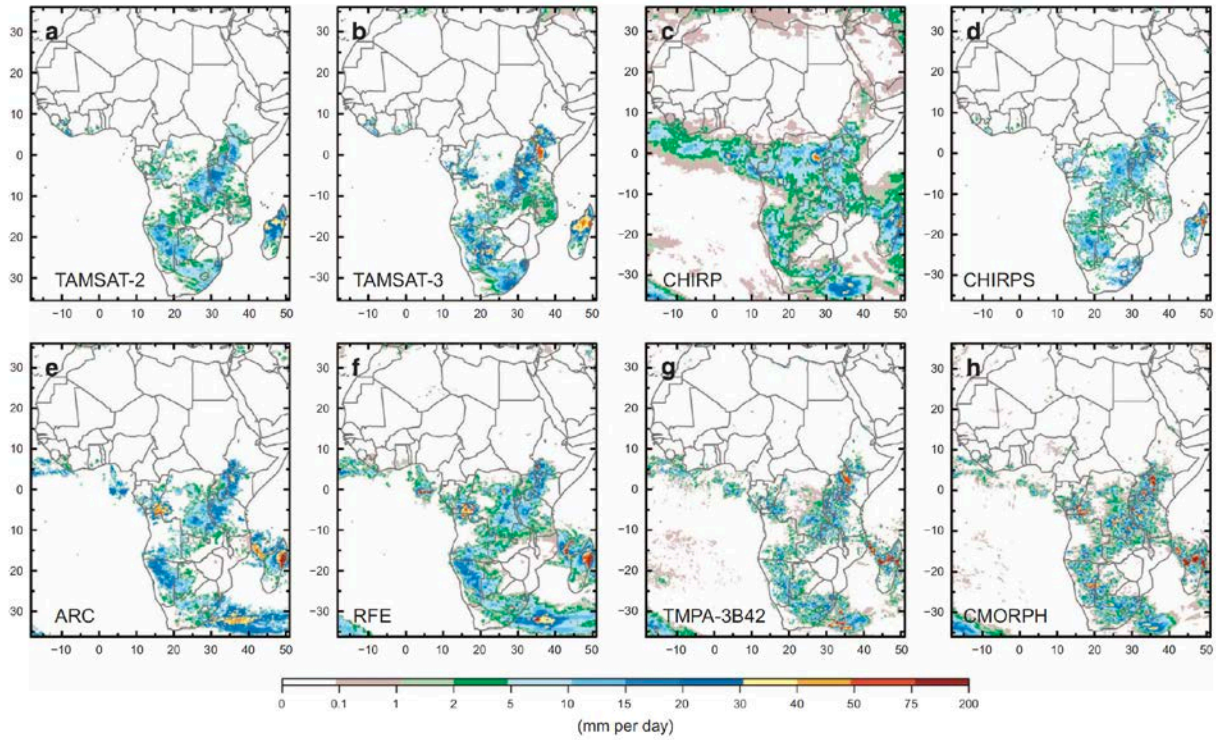

Figure 7 Africa-wide rainfall fields (at 0.25° by 0.25° resolution) for January 1st , 2010 from each daily satellite-based dataset. (a) TAMSAT-2, (b) TAMSAT-3, (c) CHIRP, (d) CHIRPS, (e) ARC, (f) RFE, (g) TMPA-3B42 and (h) CMORPH. (taken from Maidment et al, 2017)

REFERENCES

Maidment et al., A new, long-term daily satellite-based rainfall dataset for operational monitoring in Africa Scientific Data 4:170063 doi:10.1038/sdata.2017.63 (2017); Published 23 May 2017; Updated 11 July 2017

Hariadi et al., 2021, Evaluation of the Southeast Asia rainy season in CMIP5 regional climate model results and HighResMIP Global climate models (submitted)

Bautista Pérez, M., 1996: Resolution 40 (Cg-XII)—WMO policy and practice for the exchange of meteorological and related data and products, including guidelines on relationships in commercial meteorological activities. WMO Bulletin, 45(1):24–29.

John W. Zillman,2019, Origin, Impact and Aftermath of WMO Resolution 40, WMO Bulletin 68 (2) – 2019

Roberts, M. J., Camp, J., Seddon, J., Vidale, P. L., Hodges, K., Vanniere, B., ... & Ullrich, P. (2020). Impact of model resolution on tropical cyclone simulation using the HighResMIP–PRIMAVERA multimodel ensemble. Journal of Climate, 33(7), 2557-2583.

ANNEX 1: Data Policy for ECA&D and E-OBS

1. Terms and conditions of use

a) Observational station data of the European Climate Assessment & Dataset (ECA&D) and the gridded observational dataset (E-OBS) are made available free of charge from https://www.ecad.eu.

b) These data, which include many GCOS-defined Essential Climate Variables (ECVs) for the atmosphere near the surface, are strictly for use in non-commercial research and education projects only. Scientific results based on these data must be submitted for publication in the open literature without delay. If you are unsure about the terms "non-commercial", "research", and "education", please contact the ECA&D Project Team at eca@knmi.nl for clarification.

c) Part of the data in ECA&D is for stations which are labelled "non-downloadable". This indicates that the daily data for these stations are not publicly available from https://www.ecad.eu. "Non-downloadable" daily data are used together with "downloadable"
daily data to calculate derived value-added products, such as indices of extremes or daily maps of gridded data (E-OBS). The derived products are made publicly available irrespective of the "non-downloadable"/"downloadable" status of the daily data these products are based on.

d) "Non-downloadable" daily data are also used for research projects conducted by ECA&D staff or jointly by ECA&D staff and other research groups. You can contact us for suggestions for joint research. The "non-downloadable" data may be available from the data provider directly, as well as additional data. Please direct your inquiries to obtain these data to the ECA&D Project Team (eca@knmi.nl).

e) Although care has been taken in preparing and testing the data products, we cannot guarantee that the data are correct in all circumstances; neither do we accept any liability whatsoever for any error or omission in the data products, their availability, or for any loss or damage arising from their use.

f) Users should help improve the quality of the data and its delivery by giving feedback where appropriate. Frequent updates are published, and a version control system is in place for EOBS.

g) Participation in ECA&D is open to anyone maintaining daily data for stations in the region. Please contact us if you want to take part. ECA&D forms the backbone of the climate data node in the Regional Climate Centre (RCC-CD) in WMO Region VI (Europe and the Middle East).

2. Citation and acknowledgement

a) For the success of ECA&D and E-OBS we rely on the cooperation and responsiveness of the participating data holding institutions: National Meteorological and Hydrological Services (NMHSs), observatories and universities. We would like to thank them for kindly agreeing to the release of some or all of their climate data.

b) Whenever you publish research or applications based in whole or in part on these data, you should include the following citation and acknowledgement:
-For ECA&D:
"We acknowledge the data providers in the ECA&D project.
Klein Tank, A.M.G. and Coauthors, 2002. Daily dataset of 20th-century surface air temperature and precipitation series for the European Climate Assessment. Int. J. of Climatol., 22, 1441-1453.
Data and metadata available at https://www.ecad.eu"
-For E-OBS:
"We acknowledge the E-OBS dataset and the data providers in the ECA&D project (https://www.ecad.eu).
Cornes, R., G. van der Schrier, E.J.M. van den Besselaar, and P.D. Jones. 2018: An Ensemble Version of the E-OBS Temperature and Precipitation Datasets, J. Geophys. Res. Atmos., 123. doi:10.1029/2017JD028200"

3. User registration

a) At present, users of ECA station data are not registered whereas user registration is requested for access to E-OBS grids. The registration procedure adds your name and email address to a mailing list which is used to keep users updated of the status of E-OBS and new versions only. You can have your name removed from this list at any time.

b) A more sophisticated user authentication system will be put in place for both ECA&D and E-OBS when European policies relating to data access have taken a more definite shape.

4. Rationale

a) In theory, WMO Resolution 40 on the free exchange of data produced by the NMHSs states that: "As a fundamental principle …, WMO commits itself to broadening and enhancing the free and unrestricted international exchange of meteorological and related data and products".

b) In practice, there are still large obstacles to data being accessible at the European scale. Even with the formal arrangements for international data exchange in place, there is still a lack of data in international repositories.

c) The station network for near-surface climate observations in Europe is managed by a large number of (predominantly) NMHSs, each of which has its own data archive and distribution policy. Data policy issues are pertinent for both the historical data and the modern data. Many NMHSs impose conditions and charge a fee for access. This arises from the need to sell the data in order to recoup the costs of making observations and preparing the data. In many countries, the NMHSs are made to cover part of their costs by their respective national governments.

d) A clear disconnect exists between NMHSs and international institutions such as the IPCC, SUBSTA, UNFCCC and related bodies such as GCOS and the GEO. UNFCCC advocates open access to data and the GEO has set principles for promoting the full and open access to existing databanks in accordance with set principles at no more than the cost of reproduction and distribution. However, these institutions do not enforce anything and leave open the possibility to charge for data by stating that national politics and legislation should be recognized.

e) The disconnect between NMHSs and international climate change research/policy is illustrated by the so-called Oslo Declaration which has been issued by the directors of the NMHSs in Europe in 2009. The declaration states that: "Recognizing the different funding policies associated with different economic models for NMHSs and associated different official mandates, the directors of the NMHSs in Europe have reached consensus … on progressive expansions of their set of essential data made available on a free and unrestricted basis". However, there is no mention of the international requirements for climate data and the declaration does not specify whether historical daily data (as in ECA&D) are part of the free set.

f) As a result, our data policy outlined above is a pragmatic compromise between providing full and open access on the one hand, and collecting the largest possible amount of data (and use these data in derived value-added products) on the other hand. We will build upon existing practice, but pursue our efforts for enlarging the quantity of data available within the "downloadable" category in order to guarantee traceability to the source (i.e. the daily observations that were made).

g) We accept the trade off between transparency and data quantity used for derived products. The reason is that the quality of derived products (such as the E-OBS grids) depends critically on the amount of input data. Restricting these products to only including "downloadable" station data that can be freely exchanged (less than 50% of the total) would be detrimental to the products.

h) Although not all source data of derived products can be passed onto the users, we do recognize the importance of retaining strong provenance tracking. The details of the "nondownloadable" data used in the derived products are reported and so are the contact points for obtaining these data.

24 August 2011, ECA&D Project Team [Updated: 12 Dec. 2012 and 16 Sept. 2019]