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The Climate Archives of Indochina

Insights for Understanding Climate Change in Vietnam and Southeast Asia

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The Climate Archives of Indochina

Insights for Understanding Climate Change in Vietnam and Southeast Asia

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Résumé
Cet article présente une nouvelle base de données climatiques historiques intitulée *Climate data rescue of Vietnam, Cambodia and Laos*. Elle couvre la période allant de 1867 à 1973. Les données les plus anciennes proviennent des hôpitaux militaires selon les méthodes prescrites par le ministère de la Marine depuis 1851, puis à partir de 1898 du Service météorologique de l'Indochine, qui avait développé un vaste réseau de stations météorologiques et pluviométriques dans toute la péninsule indochinoise. Les données collectées sont très abondantes (température, pression atmosphérique, précipitations, insolation, etc.). L'article présente à la fois leur diversité et celle de leurs supports, ainsi que l'histoire de leur parcours entre le Vietnam et la France depuis les années 1950. Il décrit les différentes étapes de recherche qui ont conduit à leur récupération et à leur centralisation dans un dépôt de données unique afin de les mettre à la disposition de la communauté scientifique.

Mots-clés
Histoire du climat ; Archives climatiques ; Sauvetage de données climatiques ; bases de données ; Indochine.

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Abstract
This article presents a new historical climate database called *Climate data rescue of Vietnam, Cambodia, and Laos*. It covers the period from 1867 to 1973. The oldest data were produced by military hospitals according to methods prescribed by the Ministry of the Navy since 1851, then from 1898 onwards by the Indochina Meteorological Service, which developed a vast network of meteorological and rainfall stations throughout the Indochinese peninsula. The data are very abundant (temperature, atmospheric pressure, precipitation, insolation, etc.). The article presents both their diversity and the diversity of their media, as well as the history of their journey between Vietnam and France since the 1950s. It describes the various research steps that led to the recovery of the data and their centralization in a single data depository to make them available to the scientific community.

Keywords
Climate history, Climatic archives, Climate data rescue, database, Indochina.

Acknowledgements
This study was supported by the 2nd phase of the GEMMES Vietnam project, funded by the French Development Agency (AFD) through Facility 2050. We thank Béatrice Crépon, head of the Météo-France repositories at the National Archives, Xavier Popineau and Marie-Hélène Pépin from the Communications Department (DIRCOM) of Météo France, Sylvie Jourdain and Émeline Roucaute, in charge of the archives at the Climatology and Climate Services Directorate of Météo France (Météo France, Toulouse) for their invaluable support to this work. We also thank Mr Dubois, who was extremely helpful in guiding us through the complex history of the Society of Jesus. Finally, we thank Dr. Marie-Noëlle Woillez (AFD) for her careful review and valuable suggestions that helped improve this manuscript, and the AFD agency in Hanoi, the Ministry of Agriculture and Environment of Vietnam, and the VNMHA for their continuous support in collecting the data at VNMHA.

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Introduction

Long-term instrumental meteorological series are crucial for the understanding of the climate system and its variability at different time-scales (Page et al., 2004; Brunet & Jones, 2011). The analysis of historical climate data, combined with numerical climate model simulations or climate proxies, can provide new insights into climate mechanisms; historical data is widely used in climate change research, in particular for climate reconstructions and data assimilations. It also serves as a benchmark to assess current anthropogenic climate change compared to past variability (Lundstat et al., 2023). The World Meteorological Organization (WMO) has been supporting the preservation of meteorological data since the first World Climate Conference in Geneva in 1979 and many climate data rescue initiatives have already been conducted at the global or regional scale (e.g. Brunet & Jones, 2011; Coll et al., 2019; Allan, 2016; Noon et al., 2024; Jacobsen et al., 2018; Lundstat et al., 2023). The monthly global historical climate database HCLIM (Lundstat et al., 2023), for instance, provides series compiled from existing databases starting before 1890, gathering 12452 meteorological records from 118 countries. But the records from HCLIM are very sparse outside Europe, North America, Australia, and India. In particular, it does not include any data from the Indochina Peninsula.

The availability of high temporal and spatial resolution climate databases spanning several decades and at a daily resolution is also essential for the study of extreme events and their impacts. While gridded databases are generally available in regions with a good network of observation stations, they remain very limited in Vietnam. Nguyen-Xuan et al. (2016) developed the Vietnam Gridded Precipitation dataset (VnGP), which contains only daily precipitation data for the period 1980–2010, with spatial resolutions of 0.1° and 0.25°. Tran-Anh et al. (2023) produced the Vietnam Gridded Climate dataset (VnGC), which updated the VnGP dataset to cover the period 1980–2014 and included four variables: precipitation, daily mean temperature, daily maximum temperature, and daily minimum temperature. Recently, Tran et al. (2025) created an improved high-resolution (0.1°) VnGP daily precipitation product for the period 2001–2010 using a machine learning approach that combines eXtreme Gradient Boosting (XGB) with quantile regression. This new dataset, called VNpu (Vietnam Precipitation with Uncertainty), outperforms other satellite-based and station-based gridded products.

Global-scale climate reanalyses provide gridded data for all climate variables available from numerical climate models, but their spatial resolution remains relatively coarse (e.g., ~80 km for ERA Interim, 31 km for ERA-5), and they do not

cover the entire 20th century (e.g., 1950 to the present for ERA5-Land, at 10 km of spatial resolution).

If global climate change was still limited in the first half of the 20th century, it is nevertheless important to characterize the climate of Vietnam also for this period, in order to be able to better define the reference climate and to evaluate current climate trends. In order to verify whether some historical data collection work had already been undertaken for Vietnam, we reviewed the WMO's recommendations for implementing such a program, which were formalized in a 2004 guide (Tan et al., 2004), and we also consulted media outlets that raise awareness among scientific communities around the world in order to piece together the "climate history puzzle"[1]. Among existing initiatives, we identified the international initiative Atmospheric Circulation Reconstructions over the Earth (ACRE), launched in 2008 and dedicated to the recovery and digitization of historical meteorological observations on a global scale[2]. However, ACRE is not a data repository, and the data provided by the initiative's many partners actually remain hosted by those partners. The WMO has also developed a portal dedicated to climate data rescue programmes: the I-DARE platform, hosted by the Royal Netherlands Meteorological Institute (KNMI). This platform no longer exists, as it was recently integrated into the COPERNICUS programme set up by the EU in 2020[3]. COPERNICUS, as part of its C3S programme, is continuing the work of I-DARE[4]. The website dedicated to these programs provides a quick overview of the data rescue programmes in Southeast Asia that have been set up since the days of I-DARE. There are three such programs: in Myanmar, Indonesia and Thailand; but none in Vietnam, Cambodia or Laos. Page et al. (2004) reported that Vietnam was one of the first countries to benefit from I-DARE programmes. At the time, the Vietnam Meteorological and Hydrological Administration (VNMHA) reported having 30 rooms dedicated to the preservation of its meteorological data. It does not appear that this initial initiative was followed by an international programme to safeguard the data that was already kept in good condition.

The library of the National Oceanic and Atmospheric Administration in the United States (see NOAA Central Library) also stores some meteorological data concerning Indochina[5]. These appeared quite limited, consisting only of 22 months of the *Monthly Bulletin of Observations* (from the Central Observatory of Indochina) for the years 1927 and 1940, and 24 months of the Indochina *Rainfall*

[1] See in particular the following video: https://www.youtube.com/watch?v=c1PPrRBnuS8.

[2] https://www.met-acre.net/

[3] https://www.copernicus.eu/fr

[4] https://datarescue.climate.copernicus.eu/

[5] https://libguides.library.noaa.gov/weather-climate/foreign-climate

Bulletin for the years 1929 and 1930. We will see later that, as part of our own research, we managed to find 128 volumes of the first bulletin, covering the period from 1910 to 1942, and 288 months of the second, covering the period from 1906 to 1930. Similarly, it appeared that Météo-France had not posted any data relating to Indochina on its website dedicated to weather archives[6] so far. Finally, it should be noted that Nobuhiko Endo and Jun Matsumoto carried out several missions in France and Vietnam in the 2010s to supplement the Vietnamese meteorological data already held in the Japan Meteorological Agency (JMA) library. They collected various meteorological data, particularly rainfall data, from Météo-France and the VNMHA (Endo & Matsumoto, 2016). To our knowledge, none of this data has been made available online, but the authors have published an article laying the groundwork for the history of the French Indochina Meteorological Service (Endo & Matsumoto 2019). Although we do not have complete information about the datasets collected by our Japanese colleagues, we cautiously consider that the current dataset we compiled within the framework of the GEMMES project is more comprehensive, as we know to have had access to many more archives and data centres.

Hence, to the best of our knowledge, no programme to rescue historical meteorological data from Vietnam or more broadly from French Indochina and make it largely available to the scientific community had yet been undertaken. Within the framework of the GEMMES Vietnam project[7], Phase I (2019-2022), a first work on historical climate archives of Vietnam was carried out (Thomas et al., 2021), which showed the very promising potential of the colonial archives to gather historical meteorological data. Since then, new climate data from the pre-1954 period have been identified at different places, such as the National Archives in Hanoï or at the Météo France archives in France. However, this data was only available in old printed documents and therefore hardly accessible to the scientific community. In addition, it was at risk of being lost in the future due to a lack of funding and the retirement of many archivists.

To remedy this situation, we have undertaken an extensive work of "data rescue" in order to make the data available to the scientific communities and future generations. This work includes the investigation of different archive collections to make inventories and collect relevant data, the digitalization of paper documents, and the creation of an

[6] http://archivesmeteo.fr/

[7] https://www.afd.fr/en/gemmes-vietnam-analysis-socio-economic-impacts-climate-change-energy-transition-and-adaptation-strategies

online database named ***Climate data rescue of Vietnam, Cambodia, and Laos***.

This database contains all the meteorological observations from the colonial period in Indochina that we were able to gather as part of the GEMMES Vietnam project Phase I (2019-2022) and Phase II (2023-2026). These observations span from 1867 — the year of the first meteorological recordings at the Saigon military hospital — through to the end of the First Indochina War in 1954, and even beyond, up to 1973, for weather stations located in southern Vietnam. The construction of the database plays an important role in the GEMMES Vietnam project, as a critical source observation data to build a new high-resolution gridded historical climate dataset for Vietnam (Nguyen-Xuan et al., in revision). Both products will enable researchers to conduct studies over extended historical periods, providing valuable insights into past climate conditions and their potential links to natural and societal changes.

The aim of this article is to present the research that led to the creation of the database. Three major stages were necessary, described in the next sections. The first consisted of searching what we will refer to collectively as the French Indochina archives, scattered across various archive centres in Vietnam and France, in Hanoi, Ho Chi Minh City, Dalat and Aix-en-Provence (Section 1). As this first stage yielded meagre results in terms of data collection, we investigated the French National Archives in Pierrefitte, the Météo-France library in Saint-Mandé, and the Météo-France centres in Trappes and Toulouse, and ultimately the VNMHA in Hanoi, to which Météo-France returned a certain amount of meteorological data in the 1980s (Section 2). Finally, we looked at the data produced by the Jesuits at the Zi-Ka-Wei Observatory near Shanghai, as this observatory had close ties with the Indochinese stations (Section 3). In conclusion, we provide a brief overview of the organisation of the database and describe the access policy.

1. The French Indochina Archives

The French Indochina archives service was created in 1917, much earlier than for most other French colonies. It was created and organised by a professional, the chartist Paul Boudet, who was its first director. He established a unique classification system for all these collections, which still facilitates the work of historians today (Boudet, 1934; Ngo Thieu & al., 2001). In this classification system, the R series 'Sciences and Arts' contains a sub-series R8 entitled 'Meteorological Service'. At the time of decolonisation, the archives were divided between France and Vietnam under an agreement with the government of Emperor Bao Dai in 1950, which provided for the repatriation to France of the so-called 'sovereignty' archives and the transfer to the new independent state of the so-called 'management' archives[8]. Assuming that if meteorological data from the colonial period still existed, it would have remained in Vietnam, we first investigated the National Archives of Vietnam.

1.1. The National Archives of Vietnam

1.1.1. The centre n°1 of NAVN in Hanoi

By searching the digitised database of Vietnam's National Archives Centre No. 1 (which has retained the Boudet classification system), we identified 291 archive files originating not only from the Indochina Meteorological Service, but also containing all archives relating to climatology and meteorology. As an exhaustive reading of those files was not possible, we made a selection based on their titles. 46 files were studied, which provided information on the circumstances that led to the creation of the Indochina Meteorological Service and the development of its network of stations.

Several documents concerning the operation of the meteorological service described how meteorological observations were to be recorded on paper, archived, and sent to various recipients. Each station recorded its observations in a register that remained in the station's archives, and the station manager sent two copies of the daily observation sheet to the central observatory in Phu Liên within ten days of the following month, "one of these sheets remained at the observatory and the other was sent each month to the Central Meteorological Office in France"[9]. However, despite this intensity in the written recording of

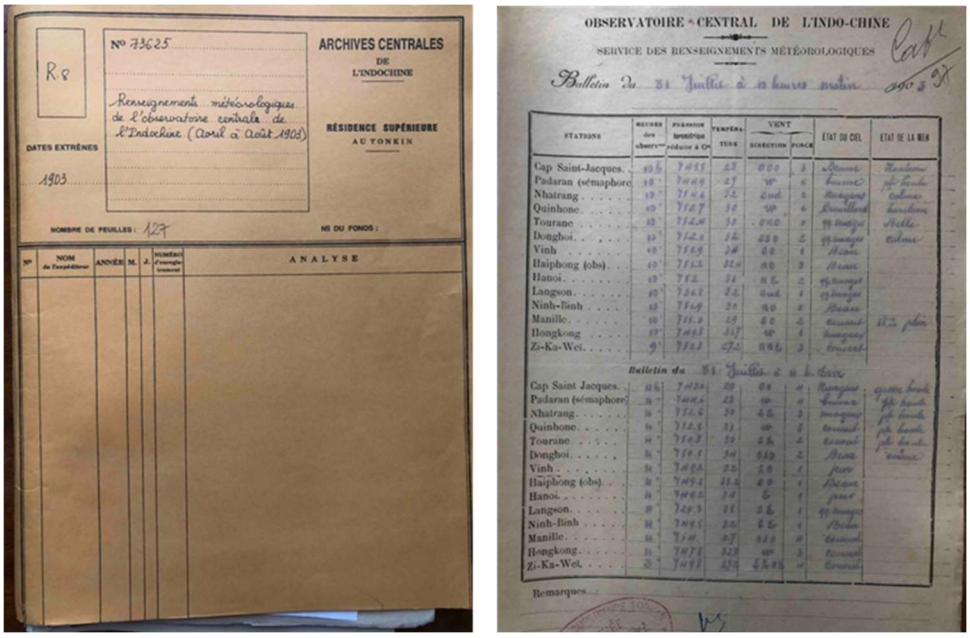
[8] For a better understanding of the context and content of this agreement, please visit the Archives de France website: https://francearchives.gouv.fr/fr/article/736004879

[9] NAVN n°1, file n° 2836 : Observation météorologiques des stations du service météorologique de l'Indochine 1903-1907. Courrier de Le Cadet, directeur du Service météorologique de l'Indochine, à G. Capus, directeur de l'Agriculture, des Forêts et du Commerce, Haïphong, le 25 octobre 1903.

meteorological observations, only a very small amount of observation data was actually found in the archives in Hanoi.

For the years 1903 and 1904, files n° 73625, 73625-01, 73625-02, and n° 73625-03 from the Tonkin Superior Residence in Hanoi contain Phu Liên's daily bulletins for the period from 23 April 1903 to 21 October 1904. These four files represent 544 bulletins, which were photographed in their entirety on site. File n° 2937 from the Indochina General Government collection contains bulletins from 19 stations from January 1st to July 1911, i.e., seven months, representing a total of 420 bulletins, which were also photographed in their entirety (photographs 1 and 2)[10]. The rainfall data is a little more extensive: 195 of the 215 files in the GGI collection are entitled 'Rainfall observation records', followed by the name of a province (photograph no. 3). These files contain a large number of bulletins from the rainfall stations in the Indochinese network. However, the lack of a classification of these files prevented their inclusion in the database, as putting them in order would have been too much time-consuming.

Photograph 1. Overview of Phu Liên weather reports from 1903/04.



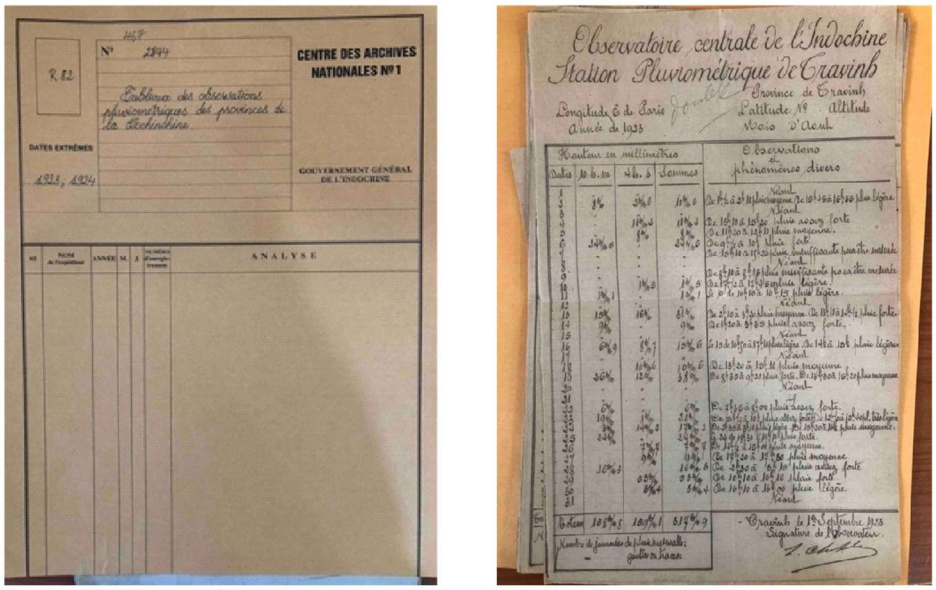
Source: Photograph by F. Thomas, NAVN, Centre n°1, Hanoi, October 2023 (files RST 73625, 73625-01, 73625-02 & 73625-03).

[10] NAVN n°1, Collection of GGI, file n° 2937, Bulletin météorologique de l'observatoire central de l'Indochine 1911.

Photograph 2. Overview of meteorological bulletins of Phu Liên, 1911.

Source: Photograph by F. Thomas, NAVN, Centre nº1, Hanoi, October 2023 (File GGI nº 2937).

Photograph 3. Rainfall bulletin of Travinh station, August 1923.



Source: Photograph by F. Thomas, NAVN, Centre nº1, Hanoi, October 2023 (File GGI nº 2844).

Overall, the meteorological observations in the Hanoi archives are very incomplete. Only the daily reports for a few years have been found (the year 1903, part of 1904 and a few months of 1911). Fortunately, the National Archives of Vietnam's Centre nº 1 also holds a bibliographic collection that includes numerous periodicals publishing meteorological data.

The *Indochina Economic Bulletin* (Bulletin économique de l'Indochine, hereafter *BEI*) is a monthly periodical reporting on the economic development of Indochina across all sectors.

It was published from 1898 to 1945, with a total of 283 issues. It contains data from daily meteorological observations at several Indochinese stations starting from September 1898 (photographs 4 and 5). From June 1904, likely due to the increasing volume of daily data, the *BEI* no longer published all daily observations, only selected data. A rough summary of the temporal coverage of meteorological data published in the *BEI* is as follows: 1898-1905; 1917-1922; September 1923; January 1930-June 1931; April 1932-August 1937.

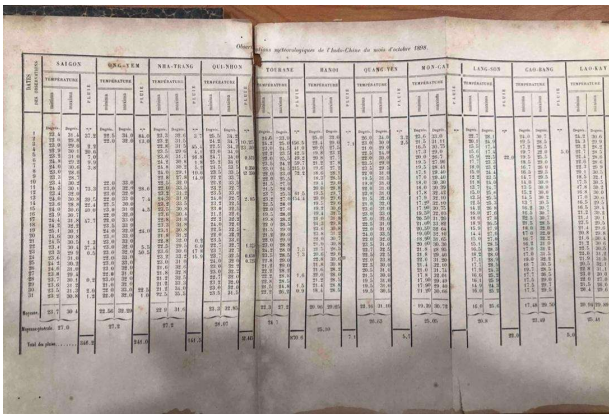
The *Indochina Statistical Yearbook*, (L'*Annuaire statistique de l'Indochine*, hereafter *ASI*) published between 1927 and 1948, contains monthly averages of temperature, precipitation, and humidity from 17 meteorological stations from 1922 to 1948. Additionally, the volume covering the years 1913 to 1922 includes the monthly averages of the same variables for the period 1906-1922 (photograph 6). The Statistical Yearbook of Vietnam, published from 1949 to 1954, is a continuation of the Indochina Statistical Yearbook; it follows the same structure and contains the same data for 15 stations.

The *Annals of the Indochina Meteorological Service* (Les *Annales du Service Météorologique de l'Indochine*, hereafter *ASMI)* (1928-1940) are the most valuable data found at Centre nº 1 of the National Archives of Vietnam. The collection is complete, comprising 13 volumes covering the period from 1928 to 1940 (photograph 7). These Annals contain:

- The list of meteorological, climatological, and rainfall stations within the network;
- The equipment of the stations categorized by type;
- A detailed description of the climatic conditions of the year by data category (temperature, rainfall, typhoons);
- The influence of annual climatic conditions on agricultural production in Cochinchina, Cambodia, Annam, Laos and Tonkin;
- Monthly maps of isohyet lines at the scale of French Indochina for the period 1907-1926 (photograph 6);
- An annual map of isohyet lines at the scale of French Indochina;
- Daily observations from the Phu Liên Central Observatory (reported as monthly averages) for atmospheric pressure, air temperature in the shade, relative humidity, evaporation, winds, sunshine, and precipitation;
- Atmospheric pressure data for 21 meteorological stations (minimum, maximum, mean, amplitude);
- Temperature data for 21 meteorological stations (mean of maximums, mean of minimums, amplitude, absolute maximum, absolute minimum...);
- Relative humidity, cloud cover, wind, and precipitation data for 21 meteorological stations;
- Monthly rainfall amounts collected at 282 rain gauge stations within the network.

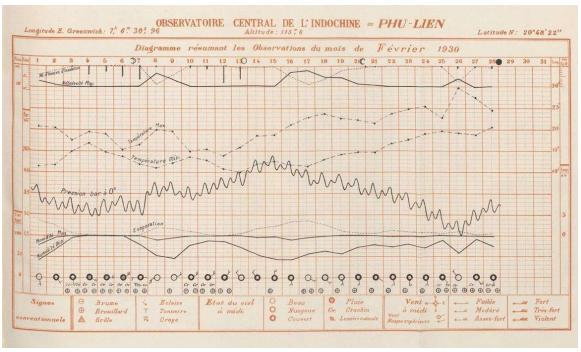
Finally, several issues of the *Monthly Weather Summary* (Le *Résumé mensuel du temps*, here after *RMT*), were found in the so-called « Bao Dai Government Collection », in file n° 455, which contains issues of this periodical for the years 1950, 1951, 1952 and 1953 and the months of January and February 1954 (Photograph 8).

Photograph 4. First meteorological data published in the *BEI* in August 1898.



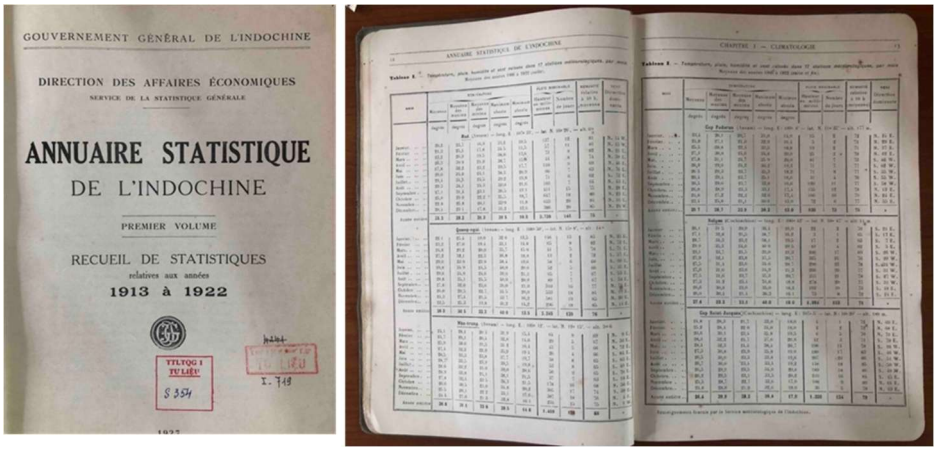
Source: Photograph by F. Thomas, National Library of Hanoi, Hanoi, July 2022.

Photograph 5. Diagram of the central Observatory of Phu Liên, published in the *BEI*



Source: National library of France BNF/Gallica.

Photograph 6. Temperature, rainfall, humidity (monthly average 1906-1922), *ASI*.

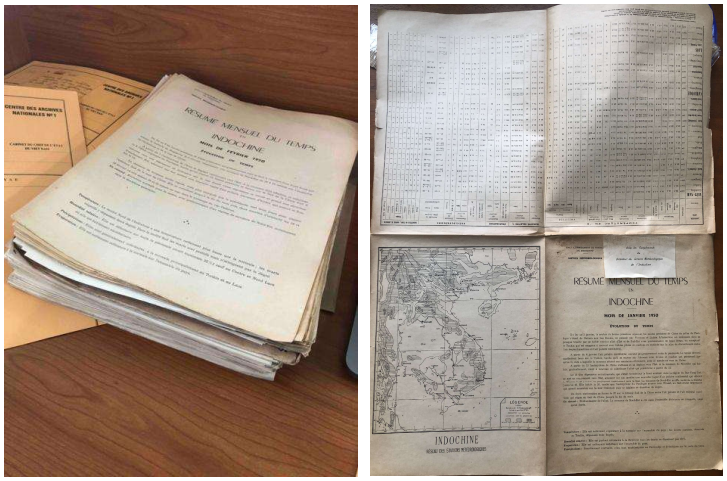


Source: Photograph by F. Thomas, NAVN, centre n°1, Hanoi, October 2023.

Photograph 7. Collection of the *ASMI* conserved by the centre n° 1 of National archives of Vietnam, (with monthly isohyetes maps for the period 1907-1926).

Source: Photograph by F. Thomas, NAVN, centre n°1, Hanoi, October 2023.

Photograph 8. Collection of the *RMT*.



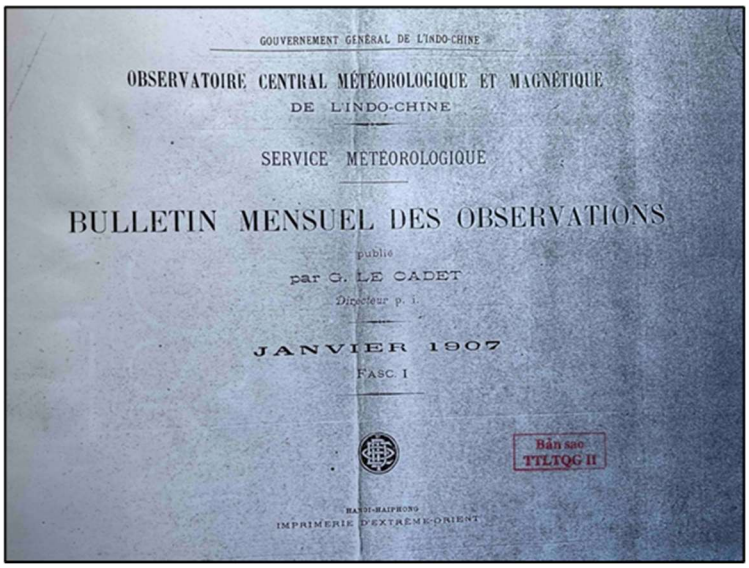
Source: Photograph by F. Thomas, NAVN, centre n°1, Hanoi, October 2023 (File n° 455 Collection Bao Đai Government).

1.1.2. The centres n°2 & 3 in Ho Chi Minh City and Dalat

The centres n° 2 and n° 3 of the NAVN in Ho Chi Minh City and Dalat inherited the archives of Cochinchina and Annam, respectively. These centres were visited to find documents dating back to before the establishment of the Indochina Union in 1887, during the era of the admiral-governors, and possibly to retrieve meteorological data dating back to the beginning of the French naval intervention in Cochinchina in 1858. We identified 121 files classified R8 in the two former collections of the admiral-governors and the Cochinchina Government. Due to time constraints, 38 documents were selected – based on the titles – among this large volume of archives for further study.

Similar to centre n° 1 in Hanoi, observation data is virtually absent from centre n° 2. The few data available are more illustrative than for preservation. Notably, we found only the first volume of the *Monthly Bulletin of Observations* (*Bulletin mensuel des observations,* hereinafter *BMO*) published by Georges Le Cadet, director of the Central Observatory of Phu Liên (January 1907 issue in file No. 52058, Photograph 9).

Photograph 9. First opus of the *BMO*.



Source: Photograph by F. Thomas, NAVN, centre n°2, Hô-Chi-Minh-City, October 2024 (File n° 52058).

It is important to emphasize that the collection of the *BMO* from Trappes contains 119 issues spanning from 1910 to 1942 (see Section 2). The purpose of the collection in Trappes is clearly the preservation of data; in contrast, the unique presence of the first issue from January 1907 in Ho Chi Minh City indicates quite clearly that the archival intent is not the same. It is not about preserving the data but rather illustrating the existence of this periodical. Keeping all the issues was not the function of colonial archives. This shows that the archivists of the colonial era, perhaps due to the volume of data or simply because they considered it outside their mission, did not take care to archive the meteorological data.

Also noteworthy is file n° 52053, which contains a copy of the *Manila Observatory's Monthly Bulletin* from 1902. This beautifully crafted bulletin contains tables of daily data for 1901 on atmospheric pressure, temperatures, relative humidity, winds, sunshine duration and much more (magnetic observations, earthquakes, agricultural meteorology). In fact, the presence of this copy in the archives of the Government of Cochinchina is evidence of the French

colonial administration in Indochina's awareness of its lag in the development of meteorology compared to neighbouring colonial powers[11].

As for the Annam Superior Residence's collection at NAVN Centre nº 3 in Dalat, the Boudet classification has completely disappeared. Therefore, we searched the digitised database using four keywords (and their register):

1. Meteorology and meteorological;
2. Climate, climatology and climatic;
3. Rainfall, rainfall measurement, flooding;
4. Typhoon(s).

Around twenty files were identified, which usefully supplemented the sources for writing the history of the Indochina Meteorological Service (Thomas, F., *in prep.*), but did not provide any new meteorological data.

1.1.3. Overview of the findings

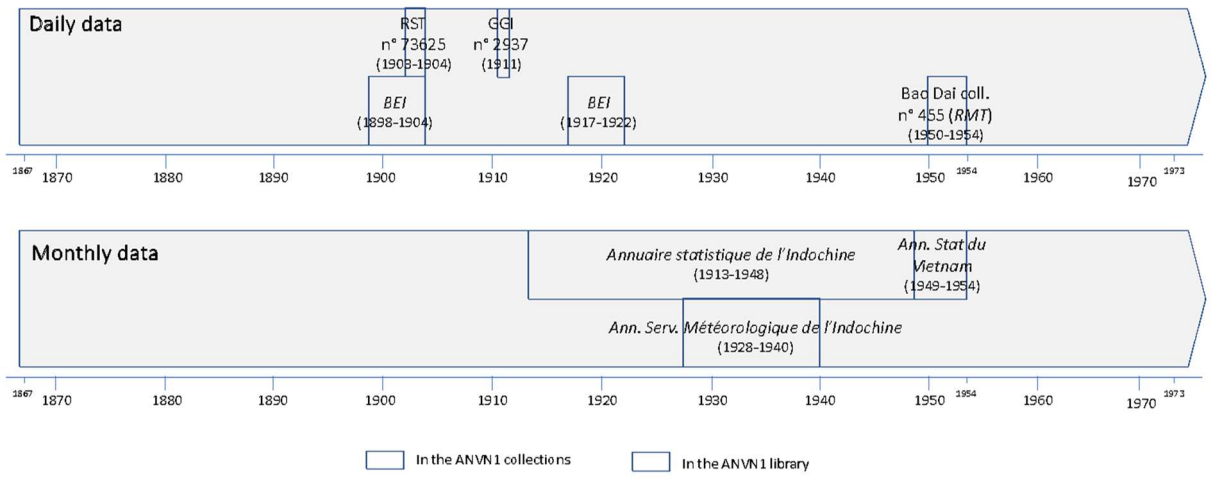
The results of the search for historical meteorological data in Hanoi, Ho Chi Minh City and Dalat are rather limited. The colonial archives themselves contain very little meteorological data. Only the results of the collection of meteorological data published in periodicals kept at the NAVN's Centre nº 1 library are relatively satisfactory (Figure 1). In addition, while the monthly data covers almost the entire colonial period, the collection of daily data is very limited. There are only a few weather reports from the Phu Liên central station for the years 1903-1904 and 1911, some meteorological data for the years 1898 to 1904 and 1917 to 1922 in the *Indochina Economic Bulletin*, then in the *Weather Summary of Indochine* for the years 1950, 51, 52, 53 and the first two months of 1954. The January 1907 issue of the *Monthly Bulletin of Observations* from the Phu Liên Observatory.

Finally, the exhaustive inventories of meteorological data clearly reveal a large number of discontinuities in the series of observations, first between periodicals, but also within the same periodical, as the network of meteorological stations varies and the types of data vary (there are, for example, a hundred ways to record temperature), not to mention the discontinuities linked to changes in measuring instruments and methods, despite multiple recommendations to standardise these practices (Javelle et al., 2000; Leroy, 2002).

[11] The history of colonial meteorology in French Indochina (Thomas, F., *in prep.*) demonstrates that Indochina was the weak link in meteorological observations in the Far East at the end of the 19th century.

Despite these strong limitations, the files found in the aforementioned archive centres provide useful information about the history of colonial meteorology in French Indochina, which is invaluable for assessing the quality of the data produced during the colonial period. These first investigations also revealed that the twice-daily weather reports centralised by the Phu Liên Central Observatory were sent in duplicate to the Central Meteorological Office in Paris, the predecessor of Météo France[12]. Hence, we continued our search in France.

Figure 1. Coverage of meteorological data held at Centre n° 1 of the National Archives of Vietnam.



Source: Author's elaboration.

1.2. The French National Overseas Archives (ANOM, Aix-en-Provence) and the Historical Service of Defence in Vincennes

We further searched for archives of French Indochina at the National Overseas Archives (ANOM), in Aix-en-Provence (France). The aim was to check whether the 'Indochina' Geographical Fund and the Colonial Ministry Fund contained any meteorological data[13]. The General Government of Indochina Fund proved to be richer than the equivalent fund in Hanoi in terms of the history of French meteorology in Indochina, but like the latter, virtually no meteorological data were found there. The other collections consulted (those of the Admiral-Governors, the Superior Residence of Tonkin and the Ministry of Colonies), although containing fewer files, also proved to be very rich in information for the history of colonial meteorology, but again, the data itself was absent.

[12] NAVN n°1, file n° 2836, *op. cit.*

[13] https://recherche-anom.culture.gouv.fr/

This confirms that over time meteorological data had been separated from the colonial archives. File INDO-AF 332 for instance contains extensive correspondence between the chief pharmacist of the military hospital in Saigon, a certain Garnault, who was in charge of meteorological observations from 1867 onwards, and his superior, the hospital's chief medical officer. This correspondence provides a very precise understanding of the type of observations he made, the type of instruments he used and, finally, the type of calculations and corrections he made to his observations over time[14]. In this correspondence, Garnault constantly mentions the data tables he sent to his superior, who forwarded them to the Colonial Meteorological Office of the Ministry of the Navy. One of the letters even carefully lists these tables, which we reproduce below (with the number of items in brackets):

1. Copy of a report on the meteorological service in 1867 (1)
2. Annual summary of meteorological observations made in Saigon in 1867 (1)
3. Monthly summary of observations made in Saigon in 1868 (12)
4. Annual summary of observations made in Saigon in 1868 (1)
5. Annual curves for the year 1868 (1)
6. Annual summary of observations made at Cape Saint-Jacques (1)
7. Summary of winds observed at the Cape Saint-Jacques lighthouse (1)

Unfortunately, none of these tables are present in Garnault's file.

Since this file comes from the Colonial Ministry Fund – which is supposed to have recovered the archives of the Ministry of the Navy concerning the colonies – we conducted further research for meteorological observations of the military hospital in Saigon, and perhaps also those of other military hospitals in Indochina, at the Historical Service of Defence in Vincennes, which holds the archives of the Ministry of the Navy. But this search was unsuccessful, refuting the claim of Endo & Matsumoto (2019) on the location of these archives. Another hypothesis was that the archives of colonial military hospitals might be kept in the archives of the Val de Grâce hospital in Paris. Unfortunately, these archives are closed to the public due to a lack of resources. However, the presence of the meteorological observations at the Val de Grâce seems highly unlikely. It would have meant that colonial hospitals kept duplicates of the meteorological data they transmitted to the Ministry of the Navy in metropolitan France throughout the colonial period (even though they lacked the space to do so), and that they then transmitted them to Val de Grâce during the decolonisation debacle.

[14] Letter from Mr Garnault to the Chief Medical Officer, Saigon, 26 February 1868. ANOM, Colonial Ministry Collection, INDO AF 332, sub-file 1867-1868, Cochinchina, Report by the Head of the Pharmaceutical Department of Saigon Hospital on meteorological observations made at Saigon Hospital.

Hence, according to the file INDO-AF 332 in Aix-en-Provence, the head of health at the military hospital in Saigon, in accordance with the instructions of his supervisory ministry published in 1852[15], must have forwarded Garnault's letters and the accompanying data tables to the Ministry of the Navy. Secondly, it must be noted that the letters were archived by the Ministry of the Navy, which explains why they are now found in the Overseas Archives in Aix-en-Provence. But the data itself followed a different path, its scientific value leading to its analysis, comparison, confrontation, compilation, and networking with other data of the same type for the development of colonial meteorology. So we turned to Météo-France and its policy on the conservation of meteorological data in the hope of better understanding what had become of this data.

[15] In 1851, a Colonial Meteorological Service was set up within the Ministry of the Navy, which was then in charge of the French colonies. In the *Revue Maritime et Coloniale*, it published instructions on meteorological observations for the colonial military hospitals, which thus became the main collection points for meteorological observations. Ministère de la Marine, « Instructions sur les observations météorologiques à faire dans les hôpitaux coloniaux. » *Revue Maritime et Coloniale*, 1874, 51-77. Source : Gallica.bnf.fr /BnF.

2. The Météo-France archives

Météo-France has always been attentive to the preservation of historical data. With global climate change and the development of big data, this concern has grown and was included in the organisation's 2009 objectives contract (Jourdain et al., 2015). The quantity of meteorological and climatic archives produced and preserved by Météo-France is therefore enormous. Most of the archives are still preserved in the collections of various departments of Météo-France (Jourdain et al., 2008; Brunet et al., 2013). Around ten linear kilometers of archives can be found in Météo-France's departmental and regional centres and in the intermediate archiving centre in Trappes. A very large number of archives were also deposited with the French National Archives between 1971 and 1990 at the Fontainebleau site, where they represented more than 2 linear kilometres stored in a former NATO building, known as "le Peigne", which was closed and then destroyed due to asbestos. This collection was subsequently transferred to the Pierrefitte site.

2.1. The archives of Météo-France deposited at the French National Archives in Pierrefitte

2.1.1. Météo-France archives returned to Vietnam in 1987

Deposit n° 19820606/28-33 is the first of these. The general inventory shows that this file contains meteorological data from Vietnam, Cambodia, and Laos, but the file was not physically present in the archives because it had been returned to the producing department - the DMN (the National Meteorological Directorate) - in 1987 (well before the transfer of the archives from Fontainebleau to Pierrefitte), to be returned to Vietnam to the Directorate of the Hydrometeorological Service of Vietnam, now VNMHA. Table 1 presents the inventory of the data on the basis of the packing slips for the 11 boxes sent back to Toulouse.

This table shows that these archives probably contain daily data from the various weather stations in the Indochinese network. We assumed it was all, or at least part, of the data regularly transmitted during the colonial era to the Central Meteorological Office of France (Bureau central météorologique de France - BCM), then from 1920 onwards to the National Meteorological Office (Office national météorologique - ONM). These are very old data dating from the end of the 19th century and the beginning of the 20th century, sometimes constituting very long time series. For example, the data from the Hanoi Hospital station covers the period 1898-1927. Many other examples of this type appear: Lao-Kay, 1898-1918; Lang-Son, 1898-1912; Ha-Giang, 1898-1914; Huê, 1881-1885, 1896-1919; Cap Saint-Jacques, 1868-1919, etc. The archives also contain the data from the Saigon military hospital for 1867-1869 and 1883 (item n°35), i.e., the data from the Garnault pharmacist.

Table 1. Inventory of the 11 boxes sent back to Vietnam in 1987, reference code 19820606/28-33.

Art n°	Box n° METC	Reference code	Description
27	3551	3357	TONKIN : Hanoi 1886-1915.
28	3552	3358	TONKIN : Hanoi Hôpital 1898-1927 ; Moncay 1898-1919.
29	3553	3359	TONKIN : Quang-Yen 1898-1913 ; Son-La 1905-1908 ; Tuyen-Quang 1898-1899 ; Haiphong 1881-1900 ; La-Pha 1910-1914 ; Nam-Dinh 1891-1895 ; Lao-Kay 1898-1918.
30	3554	3360	TONKIN : Lang-Son 1898-1912 ; Ha-Giang 1898-1914 ; Tchentou 1910 ; Cha Pa 1912 ; Hongay 1899-1905; Than-Ba 1912-1919 ; Bac-Kan 1899-1901 ; Tuyen-Quang 1897-1912 ; Ninh-Binh 1903-1904 ; Phu-Lang-Thuong 1896-1908 ; Phu-Thuy 1911-1918 ; Nam-Bu 1900-1904.
31	3555	3361	ANNAM : Thanh Hoa 1899-1919 ; Dong Hoi 1900-1919 ; Vinh 1910, 1915-1919 ; Dang Kia 1901-1908 ; Qui Nhon 1898-1919 ; Dalat 1902, 1910-1912, 1918, 1919 ; Hon Ba 1918, 1919.
32	3556	3362	ANNAM : Quang-Nhay 1905-1919 ; Quang-Tri 1905-1919 ; Djiring 1901-1912 ; Tai-Ninh 1899-1901 ; Huê 1881-1885, 1896-1919 ; Nam-Dinh 1895 ; Lang-Bian 1898-1900.
33	3557	3363	ANNAM : Nha-Trang 1898-1919 ; Padaran 1904-1919 ; Tien-Tcha 1906-1914 ; Tourane 1898-1908 ; Divers postes (doubles) 1901, 1909, 1910, 1915.
34	3558	3366	COCHINCHINE : Poulo-Condore 1880, 1881, 1900-1908 ; Soc-Trang 1899-1912 ; Ong-Yêm 1898-1909 ; Cap Saint-Jacques 1868-1919.
35	3559	3367	COCHINCHINE : Bara 1880 1881 ; My Tho 1880, 1881 ; Ngai Giao 1911-1913 ; Bien Hoa 1881-1904 ; Ha Tien 1880, 1881, 1904 ; Tay Ninh, 1880, 1881, 1901-1903 ; Saigon Hôpital militaire 1867-1869, 1883 ; Saigon 1879-1881, 1896-1919.
36	3560	3368	INDOCHINE : Divers postes 1880-1882, 1885, 1890-1906 ; Divers postes 1909-1916, 1919, 1934, 1936, 1937.
37	3561	3369	INDOCHINE : Phu Liên 1904-1905, 1909-1920 ; Phu Liên 1924, 1926, 1928-1930.

We later received confirmation that the 11 boxes of meteorological data returned in 1987 by Météo-France to the Vietnam Meteorological and Hydrological Administration (VNMHA) are now kept at the VNMHA centre in Hanoi. We were granted access to digitize them, and we added them to the database (Photograph 10).

Photograph 10. The VNMHA archives.

Source: Photograph by T. Nguyen-Ngoc-Minh, featuring T. Ngo-Duc next to the archive boxes returned by Météo-France to VNMHA in 1987, Hanoi, March 2025.

2.1.2. Daily reports from Indochinese stations in the 1950s

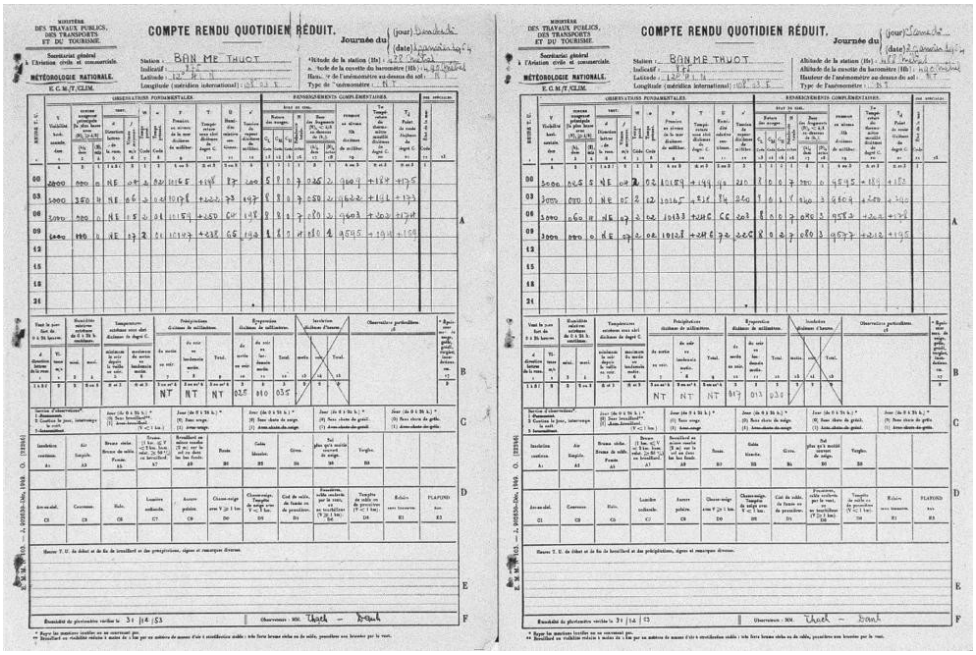
Deposit n° 19910603/1-164 is the second interesting item found in the Pierrefitte archives. The general inventory showed that it contained, among many other meteorological data, data concerning Indochinese stations[16]. We found that 4 boxes, numbered 130 to 133, contained the microfiche of the CRQs of 22 Vietnamese meteorological stations for the period 1950 to 1954, and that 2 boxes numbered 134 to 135 contained the CRQs of 13 Cambodian and Laotian stations.

CRQs (Compte-rendus quotidiens - daily reports) are documents that are well known to meteorologists, since they existed in more or less the same form from 1918 to 1995. They consist of a standardised four-page daily form summarising all the day's observations of temperature, pressure, humidity, winds, rainfall, sky conditions, cloud cover, visibility, aerological soundings and, finally, a summary of the day's weather. There are also reduced two-page CRQs for secondary weather stations (such as the one at Ban Mê Thuôt, Photograph 10). The presence of these CRQs at Pierrefitte showed two things: firstly, that the transmission of meteorological data from Indochinese stations resumed after the Second

[16] https://www.siv.archives-nationales.culture.gouv.fr/siv/IR/FRAN_IR_008485

World War with the National Meteorological Directorate (Direction de la météorologie nationale - DMN)[17], secondly, that the methods of observing and recording data in the colonies were brought up to the standards of the metropolis.

Photograph 11. Reduced CRQ from Ban Mê Thuôt, 1-2 January 1954.



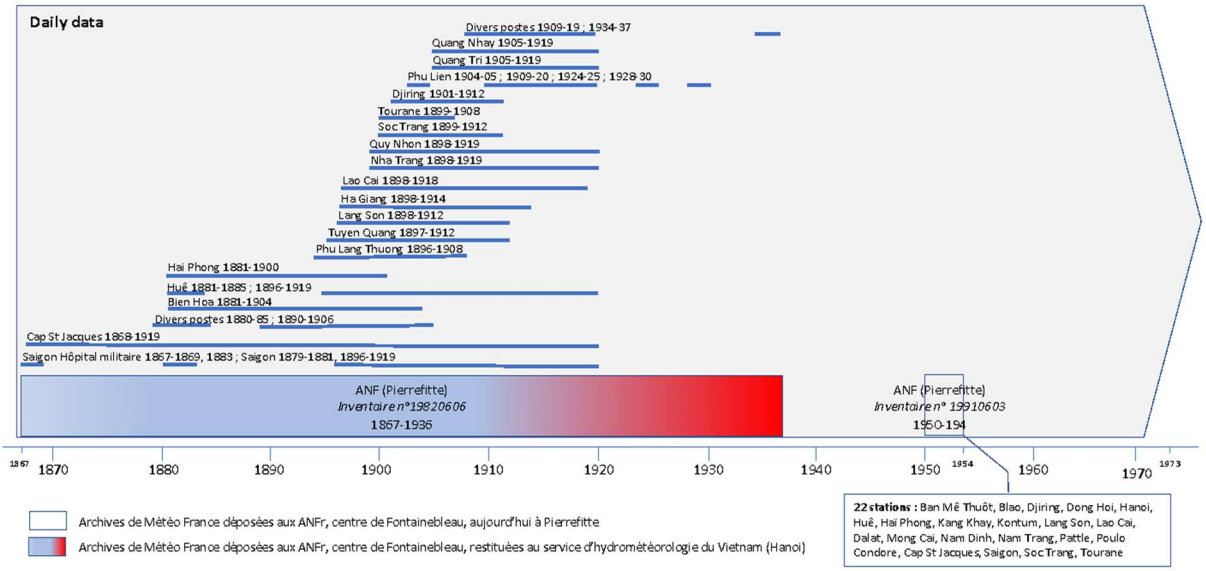
Source: Photograph by F. Thomas, Archives nationales de Pierrefitte, April 2023.

2.1.3. Overview

Figure 2 provides an overview of the temporal coverage of the historical data returned to Vietnam. While all the data does indeed cover the period from 1867 to 1937, the representation of the temporal coverage by station – the stations with the longest coverage are shown – corrects the illusion of having continuous data over the entire period. This timeline also reveals that from 1920 onwards, data is no longer transmitted, for currently unknown reasons.

Figure 2. Daily meteorological data returned by Météo-France to Vietnam in 1987 and CRQ from the 1950's conserved in Pierrefitte and Toulouse.

[17] The General Direction of Meteorology, created in 1945 and attached to the Ministry of Public Works, Transport and Reconstruction, became Météo France in 1993, a national public administrative establishment.



Source: Author's elaboration.

2.2. The archives of Météo France in Saint-Mandé, Trappes and Toulouse

2.2.1. The Central Library of Météo-France in Saint-Mandé

The Météo-France central library in Saint-Mandé stores a list of the issues of the *Annales du bureau central météorologique* (Photograph 12) in which data from Indochinese stations had once been published, which facilitated the inventory of the data in this periodical and its digitisation from the volumes in Saint-Mandé and from the online version on the BNF's Gallica site[18].

The entire collection comprises 124 volumes published between 1882 and 1926 by Gauthier-Villars in Paris, under the direction of Éleuthère Mascart. The first issue in 1882 in fact published data for 1878, then 1877, and the last volume published in 1926 published data for 1920, but it was not until 1890 and only until 1914 that data relating to stations in French Indochina were included in part C of the Annals devoted to the French colonies and abroad. The monthly data are as follows:

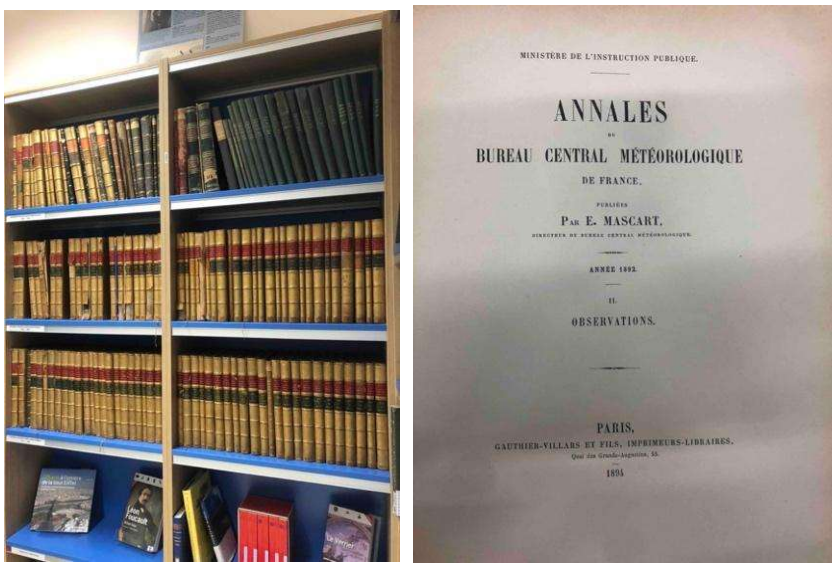
- Average monthly temperatures (diurnal minima and maxima);
- Temperature extremes (absolute minimum and absolute maximum);
- Rainfall (height in mm and number of days).

In 1890 they concerned the following stations: Hanoi, Haï-Phong, Quang-Yên, Thuan-An, and Ti-Cau, the number of stations increased over the years.

[18] https://gallica.bnf.fr/ark:/12148/cb32694356z/date&rk=21459;2

From 1894, the Annales also published daily data on pressure, temperature, humidity, and rainfall. Daily data from the Nam-Dinh station is available for 12 months of 1894 and 7 months of 1895. From May 1897 onwards, daily data from Hanoi, from 1900 onwards, daily data from Nha-Trang, and so on.

Photograph 12. Collection of the *ABCM* in the central library of Météo-France at Saint-Mandé.



Source: Photograph by F. Thomas, Central library of Météo-France, Saint-Mandé, May 2023.

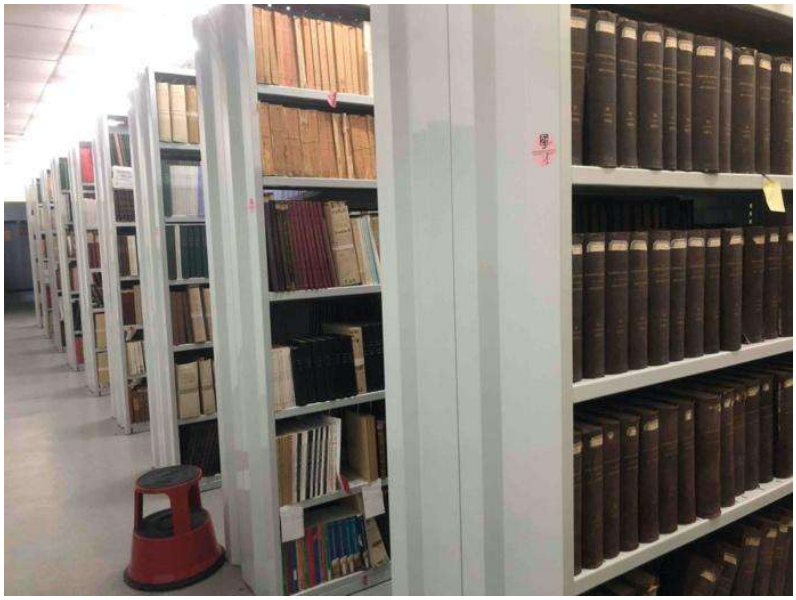
2.2.2. The Météo-France warehouse in Trappes

Trappes was an important site in the development of French meteorology at the end of the 19th century, particularly in the field of aerology[19]. It is also an absolutely essential place for any research into historical meteorological data, as buildings 55 and 65 house the paper collections of meteorological periodicals published since the 19th century throughout the world, particularly those from the former French colonies (photograph 13). We identified the following periodicals:

- The *Annales du Service météorologique de l'Indochine* (already consulted in Hanoi) ;
- The *Bulletin mensuel des observations* (only present in Trappes);
- The *Bulletin pluviométrique de l'Indochine* (only present in Trappes);
- The *Résumé mensuel du temps en Indochine* (already consulted in Hanoi, but the Trappe's collection is much more important)

Photograph 13. Warehouse 65, Météo-France, Trappes.

[19] See the historical documents compiled by Xavier Popineau at http://bibliotheque.meteo.fr/exl-php/ark/c7305/1010DOC00050437



Source: Photograph by F. Thomas, Centre Météo-France in Trappes, April 2023.

a) Inventory of the *BMO* collection in Trappes

The *BMO* is a very important periodical for the climatic history of the Indochina peninsula. Unfortunately, the collection held at Trappes (Photograph 14) does not appear to be complete. Only the following issues are present:

- 1910 (January, February, March)
- 1925 (full year)
- 1926 (January to October)
- 1927, 1928, 1929, 1930 (full years)
- 1937, 1938 (full years)
- 1939 (January to June)
- 1940, 1941 (full years)
- 1942 (July)

If we take into account the January 1907 issue found at the NAVN Centre n° 2 in Ho Chi Minh City, it seems that the *BMO* was alive from 1907 to 1942, which suggests that the data for 1907 to 1909, 1911 to 1924, and 1931 to 1936 might be found elsewhere. However, the collection in Trappes is the most complete of all those we have identified elsewhere[20]. We also know that the lack of resources and insufficient staff at the Meteorological Service made it difficult and uncertain to publish observations from the network's stations. George Le Cadet, director of the Phu Liên Central Observatory and the Indochina Meteorological Service, clearly mentioned this problem in a 1919 report available in the Hanoi archives: « *In addition to the*

[20] Department of periodicals of the National Library of France and the ANOM library also hold a few volumes of this periodical, but far fewer than those kept at Trappes.

regular daily service, the Observatory centralises the observations from the stations in its network. These observations are checked, discussed, corrected and edited to make up the Observatory's monthly Bulletin, the publication of which was inaugurated in 1907 but could not be continued due to a lack of credit and staff. »[21] It is therefore to be feared that the gaps in the Trappes collection are simply due to interruptions in the publication of this periodical.

It has to be noticed that the format of the *BMO* changes quite often, so the data it contains are not always the same, making it difficult to draw up a succinct inventory. It published daily data from the central observatory at Phu Liên (124 daily observations) (Table 2), and daily data from the Indochinese stations (Table 3), the number of which varied over time. From 1938 onwards, the *BMO* no longer published daily data, but only monthly data (Table 4).

Table 2. Daily data from the Phu Liên central meteorological observatory published in the *BMO* for 1910 and for the years 1925 to 1930.

Pressure	**Temperature** (in the shade)	**Temperature** (open air)	**Humidity**	**Rain**
12 obs./day (0 am-10 pm) Diurnal average	Min. (+ time) Max. (+ time) 12 obs./day (0 am-10 pm) Diurnal average	7 obs./day (6 am – 6 pm) Diurnal average Min. Max.	12 obs./day (0 am-10 pm) Diurnal average Min. Max. Difference	Qty. in mm (night) Qty. in mm (day) Qty. in mm (24 h)

Steam tension	**Evaporation**	**Cloudiness & transparency**	**Solar radiation**	**Cloud shape and direction**	**Wind**
12 obs./day Diurnal average	Night, day, total	7 obs./day Diurnal average	7 obs./day Diurnal total	7 obs./day Superior Inferior	24 obs./day Direction Strenght (kil.)

Table 3. Daily data from stations of the Indochinese meteorological network, published in the BMO for the years 1925 and 1926.

Pressure	**Temperature**	**Humidity**	**Wind**	**Cloud cover**	**Rain**	**State of the sea**	**Wind**
10 am 4 pm	10 am 4 pm Min. abs. (v & h) Max. abs. (v & h)	10 am 4 pm	Dir.&Strength 10 am 4 pm	10 am 4 pm	10 am 4 pm Total	10 am 4 pm	Main Dir. Strength

Table 4. Monthly data from meteorological network stations published in th *BMO* from 1938 onwards.

Pressure	**Temperature**	**Relative humidity**	**Rain**
Average min (Pn) (morning and evening)	Tn Tx	Average of min Average of Max	Monthly total in mm

[21] NAVN Centre n°1, Hanoi, Fonds GGI, n° 2863, Rapport sur l'organisation, le fonctionnement et le développement du service météorologique en Indochine.

The

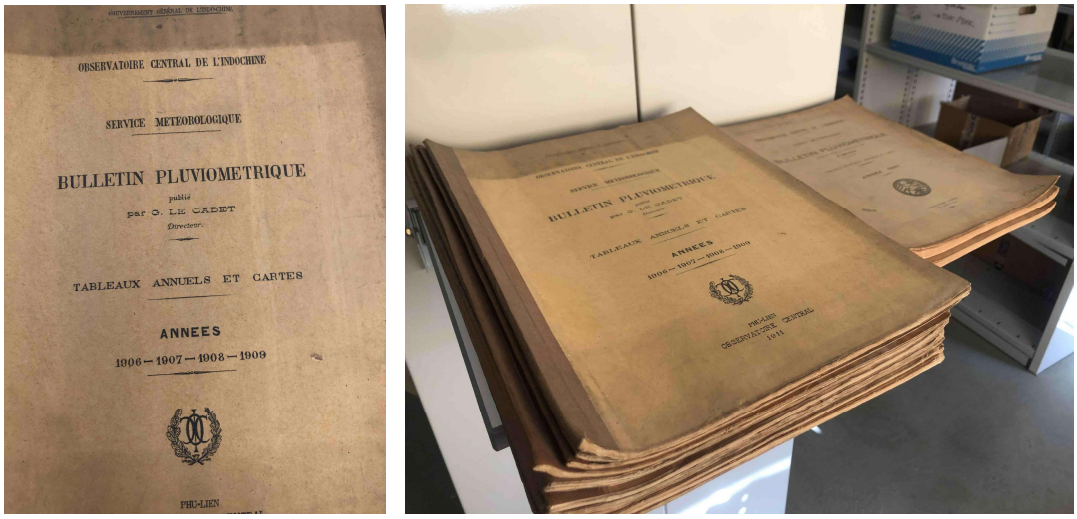
Average Max (Px) (morning and evening) Min abs Max abs Avrg (of 12 values h even) Moy (sea level) Moy (sea level) 7 am, 10 am, 1 pm, 4 pm	Monthly averge T min abs + date Max ab + date T : 7 am, 10 am, 1 pm, 4 pm	Average min abs Max abs U : 7 am, 10 am, 1 pm, 4 pm	Deviation from normal (/observation period) Max in 24 h Nbr day 0,1<R<1 Nbr day 1<R<10 Nbr day 10<R<50 Nbr day R>50 Nbr day R<0,1 (traces)

Bulletin mensuel des observations de l'Indochine, far from providing a continuous series of uniform data from 1910 to 1942, is a complex source to use because it records a very large quantity of diverse but non-continuous observations. We can hypothesise that the lack of continuity in the data published is, like the gaps in its publication, representative of all the operating difficulties of the Indochina Meteorological Service. Thus, if the collection of the *Bulletin mensuel des Observations* located in Trappes is complete in relation to the number of volumes that were actually published (a probable hypothesis), we believe that the data contained therein were published because they were deemed sufficiently solid by the successive directors of the Central Observatory to be so. Hence, the gaps in the publication of the *BMO* could be attributable not only to a lack of financial and human resources at the Phu Liên Observatory, but also to a lack of reliability in the data sent in by the stations. The *BMO* appears to be a huge jigsaw puzzle with many missing pieces, but the data it provides were checked and possibly corrected by the successive directors of the Central Observatory.

b) Inventory of the *BPI* collection at Trappes

The *Bulletin pluviométrique de d'Indochine* (*BPI*) was an annual periodical that appeared without interruption from 1911 to 1931, first under the editorship of Georges Le Cadet from 1911 to 1924, then under that of Étienne Bruzon from 1925 to 1931. The Trappes collection is complete (photograph 14). The first volume, published in 1911, includes data from 1906 to 1909, so the rainfall data published in the *BPI* stretches from 1906 to 1931.

Photograph 14. The state of the *BPI* collection at Trappes.



Source: Photograph by F. Thomas, Centre Météo-France, Trappes, warehouse 55, April 2023.

c) Inventory of the collection of the *RMT* présent in Trappes

The collection of the *Résumé mensuel du temps* found in Trappes shows that this periodical was in existence from 1949 to 1973, and the Trappes collection is virtually complete (Photographs 15 and 16). It therefore covers two very different political periods:

1. The period from 1949 to 1954, during which France refused to recognize the Democratic Republic of Vietnam proclaimed by Ho Chi Minh on September 2, 1945, and maintained the High Commissionery of France in Indochina. During this period, the *RMT* was published by the Indochina Meteorological Service under the direction of the High Commissionery;

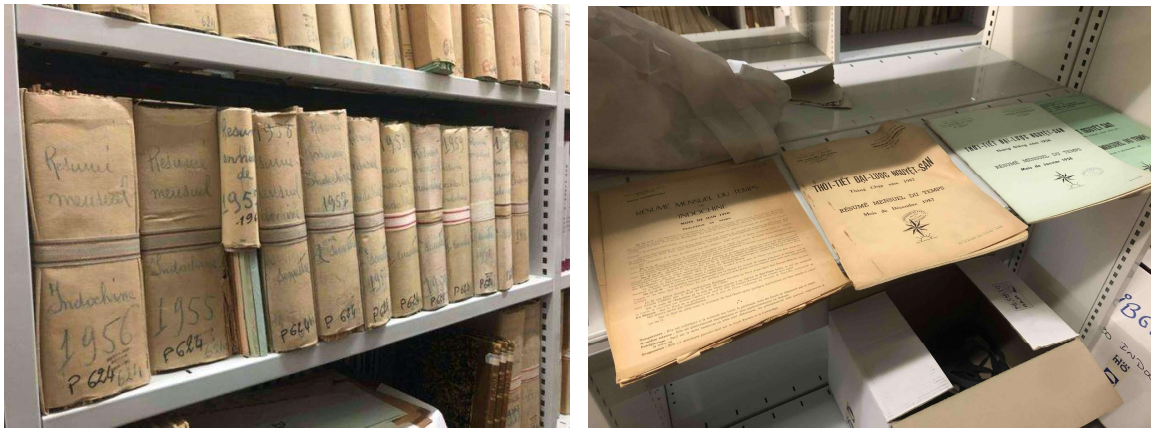
2. The period from 1955 to 1973 of the Republic of Vietnam (in fact, the Republic of South Vietnam) following the partition of the country at the 17th parallel at the time of the Geneva agreements in 1954). The *RMT* is published by the Meteorological Directorate of the Ministry of Public Works and Communications.

The state of the collection at Trappes is as follows:

1. 1949 to 1956 (full years)
2. 1957 to 1962 (complete years, 2 volumes per year)
3. 1963 to 1970 (full years)
4. 1971 January to June (volume II missing, 2nd half)
5. 1972 (full year, 2 volumes)
6. 1973 January to June (volume II, 2nd half missing)

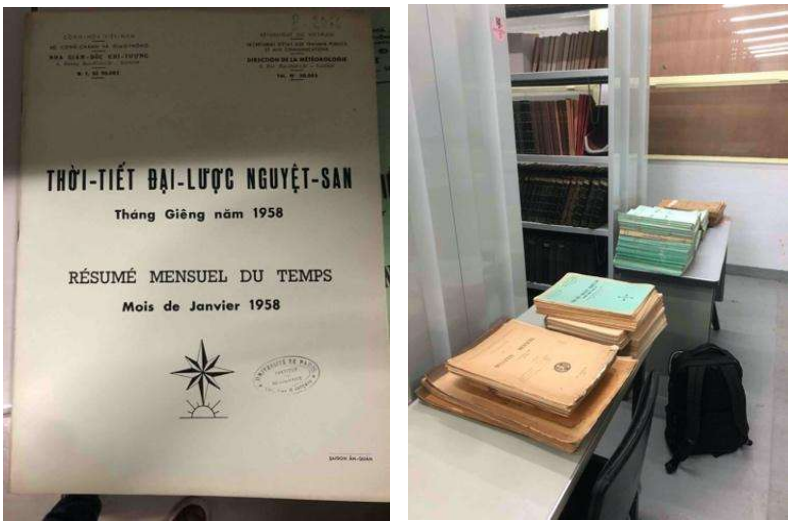
In 1962, the *RMT* changed its name to the *Bulletin mensuel des observations*, which should not be confused with the *BMO* mentioned in the previous paragraph. From this date onwards, the *RMT* only published data from stations in South Vietnam. In order not to confuse the BMO from 1962 to 1973 (continuation of the *RMT* from 1949 to 1961) with the BMO from 1907 to 1942, we have chosen to keep the name *RMT* in the database.

Photograph 15. *RMT* collection available in Trappes and different forms of publication depending on the year.



Source: Photograph by F. Thomas, Centre Météo-France, Trappes, warehouse 65, April 2023.

Photograph 16. Overview of the shape of *RMTI* in 1950s (cover of the January 1958 issue and physical importance of the collection).



Source: Photograph by F. Thomas, Centre Météo-France, Trappes, warehouse 65, April 2023.

As with the *BMO*, the climatic data published in the *RMT* is not easy to describe succinctly because it is abundant and changes over time. For the period 1949-1956, it provides daily temperature data (maximum and minimum) and rainfall for 23 Indochinese stations, as well as monthly data (Table 5) for 29 weather stations in Indochina, and aeronautical climatology

data for the following airports: Hai Phong, Tourane, Saigon, Vientiane, Phnom-Penh (Atmospheric pressure at 7am, 1pm, and 6pm; Visibility; Wind direction on the ground; Cloud base height; Cloud frequency).

Table 5. Monthly data from the *RMT*, 1949 to 1956.

Temperature	Humidity	Evaporation	Rainfall	Characteristic of the weather
Avrg of daily Max Avrg of daily Min Monthly average Absol. Max, date) Absol. Min, date Diurnal range, date	Avrg at 7 am Avrg at 1 pm Absol. Min, date	Monthly total (mm) Absol. Max, date	Height in mm Deviation from normal Abs. Max + date Nb of days	Rain, drizzle, fog, dew, thunderstorm, lightning, squalls, gales

Finally, it should be noted that the Trappes centre still holds a number of works on Indochina meteorology and climatology dating from the colonial period. These works are invaluable for the historian, as they constitute essential secondary sources for writing the history of colonial meteorology and climatology in Indochina. It is for this reason that they appear in addition to the meteorological data themselves in the database.

2.2.3. The Météo-France centre in Toulouse

Finally, we completed our research thanks to the Météo-France archives at the Toulouse Centre of Météo-France, with the following objectives:

1. To complete any missing issues of the Trappes periodicals, particularly those of the *BMO*;
2. To verify whether Météo-France keeps meteorological data from Indochinese weather stations in warehouses other than those already visited;
3. To better understand the circumstances (historical, political and diplomatic) of the transfer of the archives of Météo France in Vietnam in 1987 (reference 19820606/28 to 37) to the Vietnam Hydrometeorological Service in Hanoi.

The paper archives in the inventory reference 19820606/28 to 37 had indeed been returned in 1987 by the Meteorological Department to the Hydrometeorological Service in Hanoi, upon a decision of the Directorate of Climatology. However, the Climatology and Climate Services Division in Toulouse keeps daily reports (CRQ) in the form of microfiches, which turned out to be the same than those stored at the French National Archives in Pierrefitte. All the CRQs from 1950s, as well as the data from the Vietnamese stations in the previous entries have been digitized. They are known available online on the Archives-météo site of Météo

France[22], and were also added to the *Climate data rescue of Vietnam, Cambodia and Laos* database in order to facilitate access for users. Table 6 provides the inventory of these paper archives.

Table 6. inventory of paper archives concerning French Indochina remaining at the Climatology department in Toulouse.

Cote DCLIM	Title	Stations	Cover	Vol/p.
9931/1	Daily meteorological observations of temperature and pressure at 7.00 a.m. TMG	Hà Tiên	1937-1939	3 free sheets
9931/2	Daily meteorological observations of temperature and pressure at 7.00 a.m. TMG	Saigon	1931-1933 1936-1939	7 free sheets
9931/3	Daily meteorological observations of temperature and pressure at 7.00 a.m. TMG	Padaran	1930-1938	
9931/4	Daily meteorological observations of temperature and pressure at 7.00 a.m. TMG	Phnom-Penh	1930-1939	
9932/1	Meteorological bulletin from the Indochina Central Observatory	Manille, Hong-Kong, Zi-Ku-Wei, Kouang-Tchéou-Wan, Cap Saint-Jacques, Padaran, Nha-trang, Qui-Nhon, Quang-Ngai, Tourane, Quang-Tri, Dong-Hoi, Vinh, Than-Hoa, Phu-Liên, Haiphong, Hòn Dấu, Hanoï, Lao-Kay, Lang-Son, Moncay	1920	62 p.
9932/2	E. Bruzon, P. Carton, A Romer (dir.), *Le climat de l'Indochine. Aperçu général et régime des vents*, Saïgon, Imprimerie d'Extrême-Orient, 1950			
9932/3	Typhoon Vae: trajectory maps and station CRQs :	Battambang, Dalat, Kampong Cham, Krakor, Nha Trang, Saïgon	19-22 oct. 1952	
9933	Daily observation bulletins	Thaïlande (divers postes)	1991 (Oct, Nov)	
9934/1	Weather observations	Attopeu	1899-1910 1913	
9934/2	Weather observations	Khong	1900-1908	
9934/3	Weather observations	Haiphong	1910 (Feb,Aug)	
9934/4	Average monthly temperatures and relative humidity	Saïgon, Dalat, Huê, Hanoï	1907-1938	
9935/1	Weather observations	Luang Prabang	1900-1908 1910-1917	

[22] http://archives-climat.fr/

9935/2	Notebook of one year's meteorological observations in Upper Laos made during Auguste Pavie's mission to Laos		1886-1887	
9935/3	Observations météorologiques	Savannakhet	1900-1908	
9935/4	Weather observations	Vientiane	1900-1910	
9935/5	Climatology of Vientiane in 1900 according to the observations of Mr Pallier, head warden, summarised by Mr Le Lay.		1900-1901	Free sheets
9935/6	Weather observations	Xieng-Khouang	1901-1910	

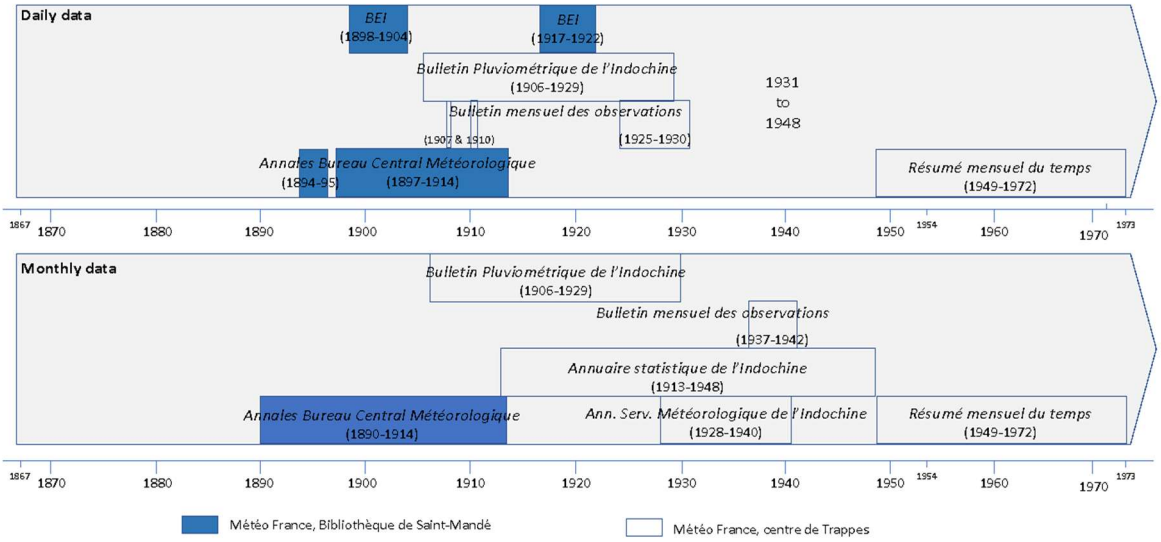
2.2.4. Overview

Our research at Saint-Mandé and Trappes brings to seven the number of periodicals containing large sets of meteorological data from Indochinese stations:

1. The *Annales du bureau météorologique central de Paris*
2. The *Bulletin économique de l'Indochine*
3. The *Bulletin pluviométrique de l'Indochine*
4. The *Bulletin mensuel des observations*
5. The *Annuaire statistique de l'Indochine*
6. The *Annales du Service météorologique de l'Indochine*
7. The *Résumé mensuel du temps en Indochine*

All the data gathered in this way significantly fills the temporal gaps left by the data summarized in Figure 1 and 2, particularly for daily meteorological data (Figure 3).

Figure 3. Coverage of daily and monthly meteorological data for the seven periodicals collected at Météo-France Centres.



Source: Author's elaboration.

The most important points concerning these daily data should be highlighted:

1. Thanks to the *ABCM*, we have an initial fine series of virtually continuous daily data from 1894 to 1914. This series covers a relatively small but significant number of stations. The fact that they are published in the *ABCM* also gives them a certain robustness, as we know that before publication, the meteorologists at the Bureau Central de Paris checked the quality of the raw observations.

2. We have a second very long continuous series of daily rainfall data thanks to the *BPI* from 1906 to 1929. The duration and continuity of this periodical is the result of the great investment made by Georges Cadet, the second director of the Indochina Meteorological Service, in developing the network of rain gauge stations from the start of the Service. This bulletin should be complemented by the many publications on rainfall patterns that these data have made possible (Le Cadet, 2017).

3. The *BMO* undoubtedly bears witness to the ambition of the Director of the Indochina Meteorological Service to publish, as early as 1907, to archive all the daily observations in the network's meteorological stations (in the same way as he succeeded in doing for the rainfall data published in the *BPI*). But the task could not be completed, since we have found only three issues for the year 1910, nothing between 1911 and 1924, between 1931 and 1936, and from 1937 until 1942, the data published in the *BMO* are no longer daily data but monthly data (see Figure 3). To this collection of the Trappes *BMO* should be added the January 1907 found in the Ho Chi Minh City archives. As our research progresses the chances of finding other issues become slimmer, and we assume that the gaps in the

Trappes collection are simply due to the *BMO* not being published for all these long periods because of a lack of resources.

4. As for the *RMT*, it contains the following daily data for the period 1949 to 1955: minimum and maximum temperatures and rainfall in mm for more than twenty stations. From 1956 onwards, daily rainfall data continued to be published (until the end of the periodical's publication in 1973), but daily data on temperature, pressure, etc., were only published in the form of graphs for a limited number of stations.

5. It should be noted that there remains a long period from 1931 to 1948, for which we still have no daily meteorological data. This grey area can be explained for the period 1940 to 1948: the Second World War and the political turbulence after the war disrupted the Meteorological Service and its network of stations, and there is little hope of finding data for this period. On the other hand, the absence of daily data for the period 1931-1939 is more surprising, as this was the heyday of the Indochina Meteorological Service, as demonstrated by the number of communications from the Service on the occasion of the Colonial Exhibition in Paris in 1931[23]. These data have maybe been published in France by the Office national de la météorologie (ONM), which succeeded the Bureau météorologie central de France from 1920 to 1945, or by the Service météorologique des colonies (Colonial Meteorological Service) created in 1929 within the Ministry of the Colonies, which will require further research.

Finally, at the Toulouse centre, we found the duplicate microfiches of the CRQs from 1950 to 1954 that we had been unable to reproduce at the French national archives in Pierrefitte, and which were included in the database.

[23] See in particular: *Le Service Météorologique et L'Observation Central de l'Indochine*, Exposition Coloniale Internationale, Paris 1931, Hanoi, Imprimerie d'Extrême Orient, 1931, 25 p.

3. The meteorological data of Zi-Ka-Wei Observatory

3.1. The Jesuit archives in Vanves

The Jesuits have played a leading role in meteorological observations in the Far East, and particularly in China (see Box 1). In particular, Father Froc, director of the Zi-Ka-Wei observatory near Shanghai at the end of the 19th century, was the main adviser to the Indochina General Government in setting up the Indochina Meteorological Service and in choosing the site for the central observatory at Phu Liên[24].

However, when we searched for meteorological data at the Jesuit archives in Vanves[25] (France), and in particular in the 27 linear metres of archives of the Chinese mission in the FCh series[26] classified by Father Déhergne, it appeared that the immense archives of the Zi-Ka-Wei Observatory had been destroyed by the Jesuits themselves in 1953[27]. The documents in the current collection do not therefore come from China, but from correspondence between the mission and the Procure des Missions in Paris. Nevertheless, from the Déhergne directory we have drawn up an inventory of the files relating to Jesuit meteorology in China and the Zi-Ka-Wei Observatory. We were thus able to consult around twenty files relating to the Zi-Ka-Wei Observatory.

The aim here is not to summarise these archives, but to highlight some essential points concerning the production and publication of meteorological data from the Zi-Ka-Wei Observatory. Father Henri Le Lec evidently began observations in 1865, although the Observatory was not inaugurated until 1872, when continuous observations began, while constant observation of typhoons in the China Sea was ensured from 1873 onwards[28]. The first data were published in *the Annuaire de la Société Météorologique de France*[29], but as early as 1872 the *Bulletin des Observations de l'Observatoire de Zi-Ka-Wei* published meteorological data compiled by the Jesuit fathers. It was published without interruption until 1937, unfortunately only the 1877 volume publishing the 1876 data was present in the

[24] NAVN n°1, Fonds Gougal, série R8, n° 2865, Création et organisation du Service météorologique de l'Indochine, 1898-1902.
[25] https://archives.jesuites.com/
[26] French Archives of the Society of Jesus (AFCJ), Fonds de la Province de Paris, *Répertoire numérique détaillé de la série FCh, archives de la mission de Chine*, Travaux de recherche du P. Joseph Dehargen s. j., 97 p.
[27] AFCJ, Fch 298, Lettre du P. Raguin au P. Dehergne, octobre 1953 « Vous devez savoir quel sort ont subi les grandes archives de Zikawei. Le père Burgaud et le père Merlet les ont mises en petits morceaux. »
[28] Henri Gauthier S. J., « L'observatoire de Zi-Ka-Wei », Tiré à part extrait de *Relations de Chine*, Janvier-Avril 1919, Archives jésuites, dossier FCh 341.
[29] Ibid.

archives[30] (Photograph 17). Examination of this volume shows that the Observatory published daily data on atmospheric pressure and temperature under shelter (8 times a day), as well as daily data on precipitation, temperature extremes, solar radiation intensity, vapour pressure, relative humidity, wind direction, evaporation under shelter, cloud cover and ozone.

Box 1. The Jesuits in China (Old and New Mission)

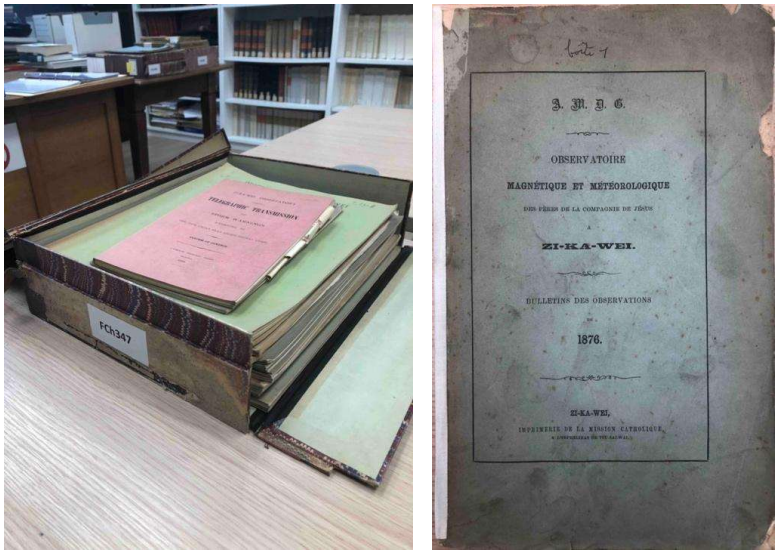
The first Jesuits arrived in China in 1582. Applying the method of inculturation, which consisted of acquiring the culture of Chinese scholars in order to be closer to them, Fathers Michele Ruggieri and Matteo Ricci became the first Western sinologists and gradually acquired great influence with the Emperor and the great mandarins. Their scientific culture, particularly in mathematics and astronomy, was an important aid to their influence. The prestige of Fathers Schall and Verbiest at the Court of Astronomy of the Imperial Court was immense. According to Father de Déhergne, what made the Jesuits successful in China for two centuries in the 17th and 18th centuries "was their ability to work on correcting the (imperial) calendar and to introduce China to the great European discoveries: Copernicus, Tycho-Brahé, Newton...". (Dehergne, 1976).

In 1773, however, Pope Clement XIV suppressed the Society of Jesus, in particular because of the "quarrel over rites", of which the Jesuit missionaries in China were the main culprits. This marked the end of the mission in China, as well as the end of all Jesuit missions throughout the world. However, the Society of Jesus was re-founded in 1816 by Pope Pius VII, and a new mission in China was launched in 1841. The new mission tried to rebuild the golden age of the first one with the same methods, which explains why in 1845, Father Gotteland, Superior of the new mission in Kiang-an, took the first steps towards building a new meteorological, astronomical and seismic observatory, which was to become the famous Zi-Ka-Wei Observatory.

Catherine Jami has placed this Jesuit influence in the general history of the sciences in China, showing that the appointment of Father Verbiest to head the Court of Astronomy by the Emperor Kangxi in 1669 was part of an ancient tradition, with successive dynasties having recourse to scientists from all over the world, including Muslims, to establish the imperial calendar (Jami, 2023).

[30] Files FCh 347, *Bulletin des observations de 1876*, Observatoire magnétique et météorologique des pères de la compagnie de Jésus à Zi-Ka-Wei, published by P. Marc Dechevrens, Imprimerie de la commission Catholique, à l'orphelinat de Sou-Sai-Wai, 1877, 256 p.

Photograph 17. Cover of the *Bulletin des observations* of the Zi-Ka-Wei Observatory, 1876.



Source: Photograph by F. Thomas, Archives jésuites, dossier FCh 347, Vanves, January 2025.

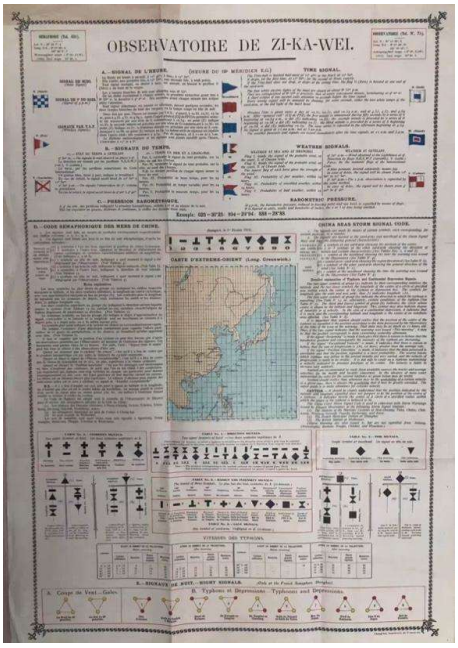
Photograph 18. The Father Froc at the Zi-Ka-Wei observatory.

Source: Photograph by F. Thomas, Archives jésuites, Vanves, January 2025.

The Jesuit archives revealed the importance of the work of the Jesuit fathers in building meteorology throughout the Far East. Father Froc was known as the "Father of Typhoons" and very famous in his day (Photograph 18). He was renowned for his expert study of the formation of typhoons in the China Sea. Thanks to a very extensive network of stations, including a number in Indochina, he methodically tracked the trajectory of all the typhoons. He thus acquired the ability to anticipate their arrival and became famous for developing an international typhoon warning system that all the national navies adopted in the China Sea (Photograph 19). Father Froc's work should be seen in the context of the general history

of meteorological forecasting, bearing in mind that the first forecasts from the Paris Observatory date back only to 1863 (Locher, 2008).

Photograph 19. Zi-Ka-Wei typhoon and storm warning system.



Source: Photograph by F. Thomas, Archives jésuites, dossier FCh 341, Vanves, January 2025.

3.2. The Zi-Ka-Wei Observatory collection in the Météo-France warehouse in Trappes

Unfortunately, we could not find any copy of the *Bulletin des observations* at the Jesuit archives, nor at the Loyola Paris faculties[31]. Actually, the remaining data from the Zi-Ka-Wei observatory are currently stored in the Météo-France archives at Trappes (Photograph 20). This centre has not only a large collection of the *Bulletins des Observations de l'Observatoire de Zi-Ka-Wei*, but also other periodicals relevant for our purpose.

The *Bulletins des observations* collection at Trappes, under the reference P 0601, comprises 43 bound volumes from 1874 to 1937, in fact 63 volumes (one per year), with some volumes comprising several volumes.

The first volume contains meteorological data from September 1874 to December 1875, which means that the first two bulletins from December 1872 to November 1873 and December 1873 to August 1874, whose existence is attested in the Jesuit archives, are not present in the Trappes collection. Apart from these two bulletins, the Trappes collection is complete. In the introduction to the first volume in Trappes, Father Le Lec states that he

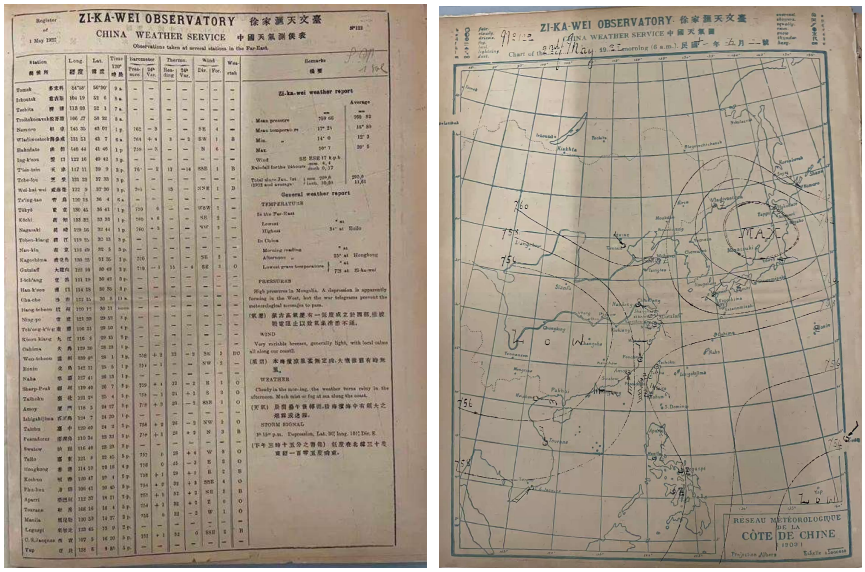
[31] https://bibliotheque.loyolaparis.fr/

began making observations continuously from August 1873. The sources are therefore somewhat contradictory when it comes to dating the start of continuous observations at Zi-Ka-Wei: December 1872, according to Father Gauthier, August 1873 according to Father Le Lec, and September 1874 if we refer to the Trappes collection. Finally, it should be noted that from 1874 to 1900 the bulletin was bound under the name *Bulletin mensuel*, then from 1901 *Bulletin des observations*. The 43 volumes represent a total of 13 757 pages.

Photograph 20. Inventory of the Zi-Ka-Wei Observatory collection in Trappes.

Source: Photograph by F. Thomas, featuring Mr. Xavier Popineau and the Zi-Ka-Wei archives at the Météo-France warehouse in Trappe, February 2025.

Photograph 21. Zi-Ka-Wei Observatory stations list – China Weather Service and spatial coverage of the Zi-Ka-Wei Observatory station network.



Source: Photograph by F. Thomas, Trappe, February 2025.

Hence, our research exhumed part of the immense work of the Jesuits in China, despite the destruction of 1953, and are now available for the analysis of climate change in the region.

Other Zi-Ka-Wei periodicals can be found in Trappes: *the Bulletins des observations. Distribution de la pluie en Chine à 198 stations* whose collection at Trappes runs from 1910 to 1936, is a subdivision of the first *Bulletin*; the *Revue mensuelle* from 1913 to 1936; le *Calendrier Annuaire* from 1903 to 1922 which deals with astronomy; and finally, a publication in English, *Zi-Ka-Wei Observatory - China Weather Service* (daily bulletins with maps) from 1922 to 1936. This last periodical contained data on pressure, temperature and wind for 47 stations ranging from Tomsk, Irkutsk and Wladiwostock in Russia to Phu Liên, Tourane and Cap Saint-Jacques in Vietnam, via Tokyo and Nagazaki in Japan and Aparri and Legaspi in the Philippines (Photograph 21).

4. Conclusions

The database *Climate data rescue of Vietnam, Cambodia and Laos* now brings together all the meteorological data collected over the course of 3 years of research and discussed in this article in a single, comprehensive online data warehouse, available at:

https://dataverse.ird.fr/dataverse/climate_vietnam_cambodia_laos

The data come from the following centres and warehouses:

1. Centre nº 1 of the National Archives of Vietnam in Hanoi (NAVN1);
2. Centre nº 2 of the National Archives of Vietnam in Ho Chi Minh City (NAVN2);
3. Centre nº 3 of the Vietnam National Archives in Dalat (NAVN3);
4. The Vietnam Meteorological and Hydrological Administration (VNMHA);
5. The Météo-France library in Saint-Mandé (Météo France, Saint-Mandé);
6. The Météo-France warehouses in Trappes (Météo France, Trappes);
7. The Météo-France warehouses in Toulouse (Météo France, Toulouse);
8. The Archives nationales d'Outre-mer centre in Aix-en-Provence (ANOM) ;
9. The Jesuit archive centre in Vanves.

This set covers data produced by the French Navy and military hospitals from 1867 onwards, by the Indochina Meteorological Service from 1897 to 1942 and by the Zi-Ka-Wei Observatory run by the Jesuit fathers from 1874 to 1937. It also includes meteorological data from the Meteorological Service of the French High Commissionery in Indochina from 1949 to 1955. After 1955, and from the same service (under the Republic of South Vietnam), the database also includes meteorological data for stations in southern Vietnam, as well as those in Cambodia and Laos. In total, these data cover a period from 1867 to 1973, in other words, 108 years of climatic history, now available for researchers working on climate change in Vietnam and Southeast Asia.

We organized the database by major types of data without breaking the unity of the original publication medium, which led to 5 distinct collections:

- Collection A: all meteorological data from Indochinese stations published in periodicals;
- Collection B: all the meteorological data from the Zi-Ka-Wei Observatory;
- Collection C: all unpublished meteorological data found in various forms in the various archives we consulted;
- Collection D: all the archives (correspondence, minutes, reports, memoirs) relating to the history of meteorology and climatology in Indochina;

- Collection E: all the bibliography from the colonial period relating to meteorology and climatology in Indochina.

In a forthcoming publication, we will provide a detailed description of each of these collections. Texts describing their contents are already available online in the database.

Access to the database is currently open for all the metadata that we have written to present its contents, but access to the data itself is limited to researchers in the GEMMES Vietnam programme for the duration of the programme and for a period of 3 years after its end. After this period, i.e. from January 2029, the database will be openly accessible under a Common Creative licence (CC-BY-NC-ND). These conditions of access are the result of discussions taking into account the missions of the initial data providers (Météo-France, ANOM and the Jesuit archives in France and the NAVN in Vietnam), the interests of the researchers in the GEMMES programme, and the copyright of the database creator. They comply with European and French commitments and the charters of our various institutions in favour of open science, which requires that all research results obtained with public funding should be openly accessible[32]. Note that open access for the data of Météo-France provided to VNMHA are currently in discussion with the Vietnamese authorities. Finally, we have endeavoured to implement as far as possible the FAIR principles, which are also widely accepted, aimed at making data easy to find, accessible, interoperable and reusable. May this work contribute to a better understanding of past climate evolution in Vietnam and Southeast Asia, as well as to better modelling of ongoing anthropogenic climate change.

[32] EU Framework programme for Research & Innovation Horizon 2020 https://openscience.eu/Open-Science-in-Horizon-Europe ; Loi sur la République numérique en France (Octobre 2016), voir notamment le site https://www.data.gouv.fr/fr/ ; Charte de partage, de diffusion et de valorisation des résultats de la recherche de l'IRD https://www.ird.fr/charte-de-partage-de-diffusion-et-de-valorisation-des-resultats-de-la-recherche-de-lird

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List of acronyms and abbrevations

ABCM	Annales du Bureau central météorologique de Paris
ACRE	Atmospheric Circulation Reconstructions over the Earth
AFD	Agence française de développement
ANOM	Archives nationales d'Outre-mer, Aix-en-Provence
ASI	*Annuaire statistique de l'Indochine*
ASMI	*Annales du Service météorologique de l'Indochine*
BEI	*Bulletin économique de l'Indochine*
BMO	*Bulletin mensuel des Observations*
BPI	*Bulletin pluviométrique de l'Indochine*
CRQ	Compt-rendu quotidien
GGI	Fonds du Gouverneur Général de l'Indochine
NAVN	National Archives of Vietnam
NOAA	National Oceanic and Atmospheric Administration in the United States
ONM	Office national de la météorologie
RMT	*Résumé mensuel du temps*
RST	Fonds de la Résidence Supérieur du Tonkin
VNMHA	Vietnam Meteorological and Hydrological Administration
VnGC	Vietnam Gridded Climate dataset
VnPG	Vietnam Gridded Precipitation dataset
VNpu	Vietnam Precipitation with Uncertainty
WMO	World Meteorological Organization

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