

R.LTWB – SECTION 03

Descarga, procesamiento y análisis de datos
hidroclimatológicos

Completado y extendido de series -
Imputación

<https://github.com/jlgingcivil/R.LTWB.CS2120>

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1. INTRODUCCIÓN

Se continua con curso Balance hidrológico de largo plazo para estimación de caudales medios usando SIG – LWTB con el desarrollo de la sección 3 Descarga, procesamiento y análisis de datos hidroclimatológicos. A continuación, se presenta en cada numeral las actividades realizadas de acuerdo con cada capítulo de la sección de estudio, incluyendo el resumen de actividades, logros alcanzados y capturas de pantalla de los ejercicios realizados. Se ha creado el repositorio <https://github.com/jlgingcivil/R.LTWB.CS2021> para la inclusión de los archivos y documentos de las actividades desarrolladas.

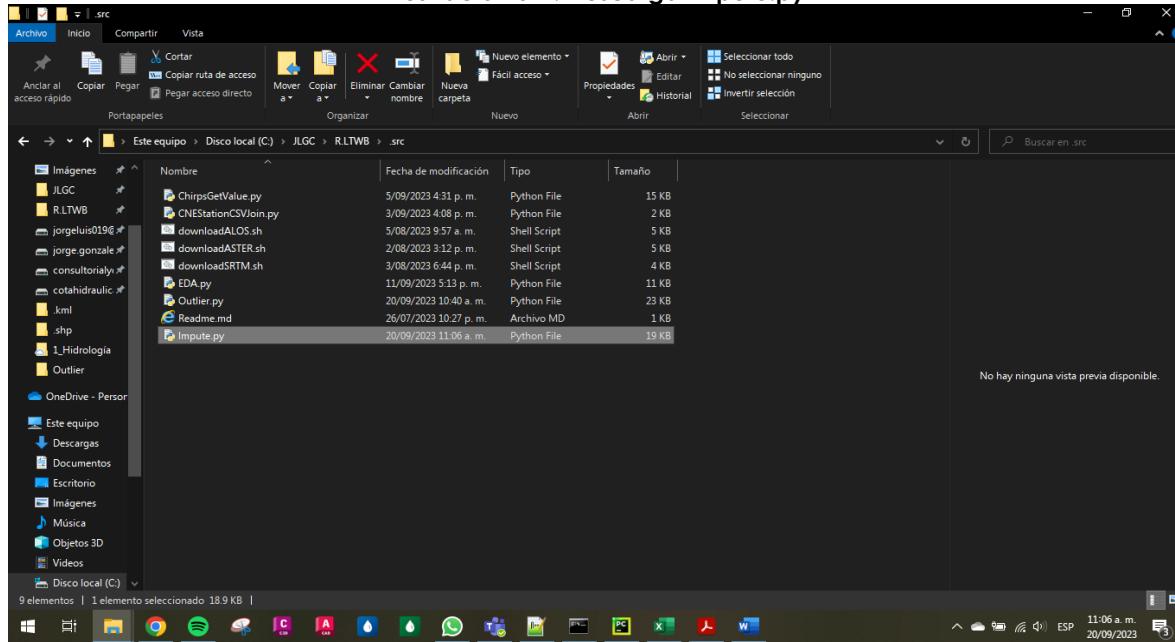
2. OBJETIVO GENERAL

El objetivo general en esta sección es realizar el complemento de datos a partir de 8 métodos estadísticos de las series no excluidas de datos descargadas desde el portal del IDEAM definidas a partir de la actividad de análisis de datos atípicos.

3. ACTIVIDAD 1: PROCESAMIENTO EN SOFTWARE

En primera medida se realiza la descarga del script `Impute.py` y la creación de la carpeta para almacenamiento de archivos.

Ilustración 3-1. Descarga `Impute.py`



Fuente: Elaboración Propia, 2023.

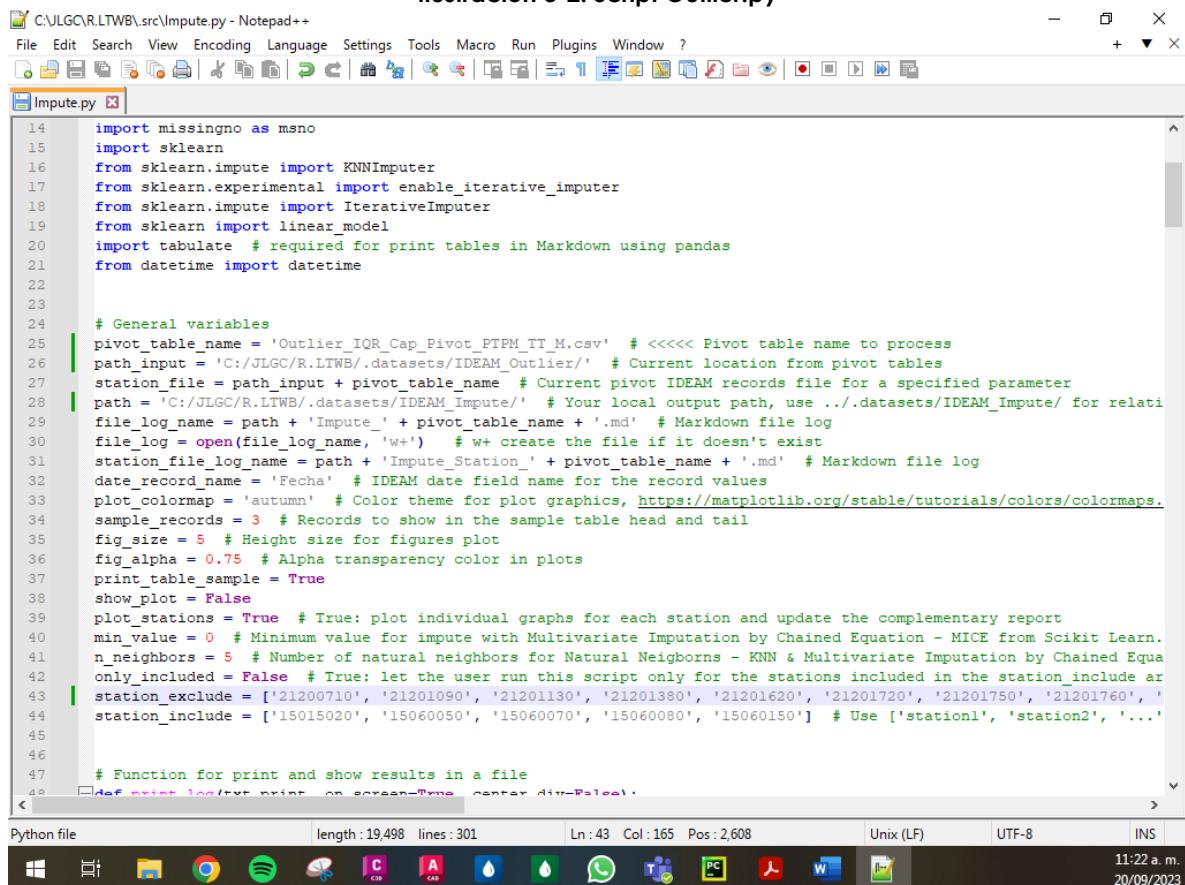
Luego se ajusta el script para que lea la ruta de almacenamiento de archivos, así como la definición de los parámetros tomando el ejemplo de clase para el archivo pivot de precipitación y se inicia con la ejecución de la herramienta; de igual manera se modifica en el script el código de las estaciones a ser excluidas del análisis.

SECTION 03
DESCARGA, PROCESAMIENTO
Y ANÁLISIS DE DATOS
HIDROCLIMATOLÓGICOS

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CS2021

- 21200710
- 21200800
- 21201090
- 21201130
- 21201380
- 21201620
- 21201720
- 21201750
- 21201760
- 21201790
- 21201840
- 21206070
- 21230080
- 23060040
- 24010380
- 21206100
- 35060280
- 35067050

Ilustración 3-2. Script Outlier.py



The screenshot shows a Notepad++ window titled "Impute.py". The code is a Python script for data imputation. It imports various libraries like missingno, sklearn, and tabulate. It defines several variables such as pivot_table_name, path_input, station_file, path, file_log_name, file_log, station_file_log_name, date_record_name, plot_colormap, sample_records, fig_size, fig_alpha, print_table_sample, show_plot, plot_stations, min_value, n_neighbors, only_included, station_exclude, and station_include. It also includes a function for printing results to a file. The script is designed to process a specific pivot table and generate plots and logs for IDEAM records.

```
14 import missingno as msno
15 import sklearn
16 from sklearn.impute import KNNImputer
17 from sklearn.experimental import enable_iterative_imputer
18 from sklearn.impute import IterativeImputer
19 from sklearn import linear_model
20 import tabulate # required for print tables in Markdown using pandas
21 from datetime import datetime
22
23
24 # General variables
25 pivot_table_name = 'Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv' # <<< Pivot table name to process
26 path_input = 'C:/JLGC/R.LTWB/.datasets/IDEAM_Outlier/' # Current location from pivot tables
27 station_file = path_input + pivot_table_name # Current pivot IDEAM records file for a specified parameter
28 path = 'C:/JLGC/R.LTWB/.datasets/IDEAM_Impute/' # Your local output path, use ../.datasets/IDEAM_Impute/ for relative
29 file_log_name = path + 'Impute.' + pivot_table_name + '.md' # Markdown file log
30 file_log = open(file_log_name, 'w+') # w+ create the file if it doesn't exist
31 station_file_log_name = path + 'Impute_Station.' + pivot_table_name + '.md' # Markdown file log
32 date_record_name = 'Fecha' # IDEAM date field name for the record values
33 plot_colormap = 'autumn' # Color theme for plot graphics, https://matplotlib.org/stable/tutorials/colors/colormaps.
34 sample_records = 3 # Records to show in the sample table head and tail
35 fig_size = 5 # Height size for figures plot
36 fig_alpha = 0.75 # Alpha transparency color in plots
37 print_table_sample = True
38 show_plot = False
39 plot_stations = True # True: plot individual graphs for each station and update the complementary report
40 min_value = 0 # Minimum value for impute with Multivariate Imputation by Chained Equation - MICE from Scikit Learn.
41 n_neighbors = 5 # Number of natural neighbors for Natural Neighbors - RNN & Multivariate Imputation by Chained Equations
42 only_included = False # True: let the user run this script only for the stations included in the station_include array
43 station_exclude = ['21200710', '21201090', '21201130', '21201380', '21201620', '21201720', '21201750', '21201760', '21201790']
44 station_include = ['15015020', '15060050', '15060070', '15060080', '15060150'] # Use ['station1', 'station2', ...]
45
46
47 # Function for print and show results in a file
48 def print_log(txt_print_on_screen=True, center_din=False):
<<
```

Fuente: Elaboración Propia, 2023.

SECTION 03 DESCARGA, PROCESAMIENTO Y ANÁLISIS DE DATOS HIDROCLIMATOLÓGICOS

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CS2021

Ilustración 3-3. Ejecución inicial Impute.py

```
Símbolo del sistema - C:\Python311\python.exe "C:\JLGC\R.LTWB\src\Impute.py"
Microsoft Windows [Versión 10.0.19045.3448]
(c) Microsoft Corporation. Todos los derechos reservados.

C:\Users\jorge>CD C:\JLGC\R.LTWB\datasets\IDEAM_Impute

C:\JLGC\R.LTWB\datasets\IDEAM_Impute>C:\Python311\python.exe "C:\JLGC\R.LTWB\src\Impute.py"
# Impute missing values in time series through statistical methods

* Processed file: [C:/JLGC/R.LTWB/.datasets/IDEAM_Outlier/Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](../IDEAM_Outlier/Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)
* Execution date: 2023-09-20 11:25:40.988728
* Python version: 3.11.5 (tags/v3.11.5:cc6ba9, Aug 24 2023, 14:38:34) [MSC v.1936 64 bit (AMD64)]
* Python path: ['C:\\JLGC\\R.LTWB\\.src', 'C:\\Python311\\python311.zip', 'C:\\Python311\\DLLs', 'C:\\Python311\\Lib', 'C:\\\\Python311\\']
* matplotlib version: 3.6.0
* pandas version: 2.1.0
* numpy version: 1.25.2
* missingno version: 0.5.2
* sklearn version: 1.3.0
* Stations exclude: ['21200710', '21201090', '21201130', '21201380', '21201620', '21201720', '21201750', '21201760', '21201790', '21202000', '21201840', '21206070', '21230080', '23060040', '24010380', '21206100', '35060280', '35067050']
* Stations include: ['15015020', '15060050', '15060070', '15060080', '15060150']
* Print table sample: True
* Instructions & script: https://github.com/r-cfdtools/R.LTWB/tree/main/Section03/Impute
* License: https://github.com/r-cfdtools/R.LTWB/blob/main/LICENSE.md
* Credits: r.cfdtools@gmail.com

## General dataframe information with 516 IDEAM records for 313 stations
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 516 entries, 1980-01-01 to 2022-12-01
Columns: 313 entries, 21170020 to 35070490
dtypes: float64(313)
memory usage: 1.2 MB
None

Dataframe records head sample

| Fecha | 21170020 | 21185040 | 21190030 | 21190060 | 21190110 | 21190170 | 21190210 | 21190300 |
| 21190310 | 21190360 | 21190430 | 21190440 | 21190450 | 21190460 | 21190470 | 21190500 | 21190580 |
| 21195140 | 21195190 | 21200040 | 21200080 | 21200110 | 21200130 | 21200160 | 21200170 | 21200190 |
| 21200200 | 21200230 | 21200240 | 21200260 | 21200270 | 21200310 | 21200320 | 21200340 | 21200380 |
| 21200400 | 21200430 | 21200440 | 21200500 | 21200510 | 21200520 | 21200550 | 21200580 | 21200590 |
| 21200600 | 21200610 | 21200620 | 21200650 | 21200660 | 21200690 | 21200700 | 21200720 | 21200740 |
| 21200750 | 21200760 | 21200770 | 21200780 | 21200790 | 21200800 | 21200810 | 21200820 | 21200830 |
| 21200840 | 21200850 | 21200860 | 21200870 | 21200880 | 21200890 | 21200900 | 21200910 | 21200920 |
| 21200930 | 21200940 | 21200950 | 21200960 | 21200970 | 21200980 | 21200990 | 21200990 | 21200990 |
| 21201000 | 21201010 | 21201020 | 21201030 | 21201040 | 21201050 | 21201060 | 21201070 | 21201080 |
| 21201090 | 21201100 | 21201110 | 21201120 | 21201130 | 21201140 | 21201150 | 21201160 | 21201170 |
| 21201180 | 21201190 | 21201200 | 21201210 | 21201220 | 21201230 | 21201240 | 21201250 | 21201260 |
| 21201270 | 21201280 | 21201290 | 21201300 | 21201310 | 21201320 | 21201330 | 21201340 | 21201350 |
| 21201360 | 21201370 | 21201380 | 21201390 | 21201400 | 21201410 | 21201420 | 21201430 | 21201440 |
| 21201450 | 21201460 | 21201470 | 21201480 | 21201490 | 21201500 | 21201510 | 21201520 | 21201530 |
| 21201540 | 21201550 | 21201560 | 21201570 | 21201580 | 21201590 | 21201600 | 21201610 | 21201620 |
| 21201630 | 21201640 | 21201650 | 21201660 | 21201670 | 21201680 | 21201690 | 21201700 | 21201710 |
| 21201720 | 21201730 | 21201740 | 21201750 | 21201760 | 21201770 | 21201780 | 21201790 | 21201800 |
| 21201810 | 21201820 | 21201830 | 21201840 | 21201850 | 21201860 | 21201870 | 21201880 | 21201890 |
| 21201900 | 21201910 | 21201920 | 21201930 | 21201940 | 21201950 | 21201960 | 21201970 | 21201980 |
| 21201990 | 21202000 | 21202010 | 21202020 | 21202030 | 21202040 | 21202050 | 21202060 | 21202070 |
| 21202080 | 21202090 | 21202100 | 21202110 | 21202120 | 21202130 | 21202140 | 21202150 | 21202160 |
| 21202170 | 21202180 | 21202190 | 21202200 | 21202210 | 21202220 | 21202230 | 21202240 | 21202250 |
| 21202260 | 21202270 | 21202280 | 21202290 | 21202300 | 21202310 | 21202320 | 21202330 | 21202340 |
| 21202350 | 21202360 | 21202370 | 21202380 | 21202390 | 21202400 | 21202410 | 21202420 | 21202430 |
| 21202440 | 21202450 | 21202460 | 21202470 | 21202480 | 21202490 | 21202500 | 21202510 | 21202520 |
| 21202530 | 21202540 | 21202550 | 21202560 | 21202570 | 21202580 | 21202590 | 21202600 | 21202610 |
| 21202620 | 21202630 | 21202640 | 21202650 | 21202660 | 21202670 | 21202680 | 21202690 | 21202700 |
| 21202710 | 21202720 | 21202730 | 21202740 | 21202750 | 21202760 | 21202770 | 21202780 | 21202790 |
| 21202800 | 21202810 | 21202820 | 21202830 | 21202840 | 21202850 | 21202860 | 21202870 | 21202880 |
| 21202890 | 21202900 | 21202910 | 21202920 | 21202930 | 21202940 | 21202950 | 21202960 | 21202970 |
| 21202980 | 21202990 | 21203000 | 21203010 | 21203020 | 21203030 | 21203040 | 21203050 | 21203060 |
| 21203070 | 21203080 | 21203090 | 21203100 | 21203110 | 21203120 | 21203130 | 21203140 | 21203150 |
| 21203160 | 21203170 | 21203180 | 21203190 | 21203200 | 21203210 | 21203220 | 21203230 | 21203240 |
| 21203250 | 21203260 | 21203270 | 21203280 | 21203290 | 21203300 | 21203310 | 21203320 | 21203330 |
| 21203340 | 21203350 | 21203360 | 21203370 | 21203380 | 21203390 | 21203400 | 21203410 | 21203420 |
| 21203430 | 21203440 | 21203450 | 21203460 | 21203470 | 21203480 | 21203490 | 21203500 | 21203510 |
| 21203520 | 21203530 | 21203540 | 21203550 | 21203560 | 21203570 | 21203580 | 21203590 | 21203600 |
| 21203610 | 21203620 | 21203630 | 21203640 | 21203650 | 21203660 | 21203670 | 21203680 | 21203690 |
| 21203700 | 21203710 | 21203720 | 21203730 | 21203740 | 21203750 | 21203760 | 21203770 | 21203780 |
| 21203790 | 21203800 | 21203810 | 21203820 | 21203830 | 21203840 | 21203850 | 21203860 | 21203870 |
| 21203880 | 21203890 | 21203900 | 21203910 | 21203920 | 21203930 | 21203940 | 21203950 | 21203960 |
| 21203970 | 21203980 | 21203990 | 21204000 | 21204010 | 21204020 | 21204030 | 21204040 | 21204050 |
| 21204060 | 21204070 | 21204080 | 21204090 | 21204100 | 21204110 | 21204120 | 21204130 | 21204140 |
| 21204150 | 21204160 | 21204170 | 21204180 | 21204190 | 21204200 | 21204210 | 21204220 | 21204230 |
| 21204240 | 21204250 | 21204260 | 21204270 | 21204280 | 21204290 | 21204300 | 21204310 | 21204320 |
| 21204330 | 21204340 | 21204350 | 21204360 | 21204370 | 21204380 | 21204390 | 21204400 | 21204410 |
| 21204420 | 21204430 | 21204440 | 21204450 | 21204460 | 21204470 | 21204480 | 21204490 | 21204500 |
| 21204510 | 21204520 | 21204530 | 21204540 | 21204550 | 21204560 | 21204570 | 21204580 | 21204590 |
| 21204590 | 21204600 | 21204610 | 21204620 | 21204630 | 21204640 | 21204650 | 21204660 | 21204670 |
| 21204680 | 21204690 | 21204700 | 21204710 | 21204720 | 21204730 | 21204740 | 21204750 | 21204760 |
| 21204770 | 21204780 | 21204790 | 21204800 | 21204810 | 21204820 | 21204830 | 21204840 | 21204850 |
| 21204860 | 21204870 | 21204880 | 21204890 | 21204900 | 21204910 | 21204920 | 21204930 | 21204940 |
| 21204950 | 21204960 | 21204970 | 21204980 | 21204990 | 21205000 | 21205010 | 21205020 | 21205030 |
| 21205040 | 21205050 | 21205060 | 21205070 | 21205080 | 21205090 | 21205100 | 21205110 | 21205120 |
| 21205130 | 21205140 | 21205150 | 21205160 | 21205170 | 21205180 | 21205190 | 21205200 | 21205210 |
| 21205220 | 21205230 | 21205240 | 21205250 | 21205260 | 21205270 | 21205280 | 21205290 | 21205300 |
| 21205310 | 21205320 | 21205330 | 21205340 | 21205350 | 21205360 | 21205370 | 21205380 | 21205390 |
| 21205390 | 21205400 | 21205410 | 21205420 | 21205430 | 21205440 | 21205450 | 21205460 | 21205470 |
| 21205470 | 21205480 | 21205490 | 21205500 | 21205510 | 21205520 | 21205530 | 21205540 | 21205550 |
| 21205550 | 21205560 | 21205570 | 21205580 | 21205590 | 21205600 | 21205610 | 21205620 | 21205630 |
| 21205630 | 21205640 | 21205650 | 21205660 | 21205670 | 21205680 | 21205690 | 21205700 | 21205710 |
| 21205710 | 21205720 | 21205730 | 21205740 | 21205750 | 21205760 | 21205770 | 21205780 | 21205790 |
| 21205790 | 21205800 | 21205810 | 21205820 | 21205830 | 21205840 | 21205850 | 21205860 | 21205870 |
| 21205870 | 21205880 | 21205890 | 21205900 | 21205910 | 21205920 | 21205930 | 21205940 | 21205950 |
| 21205950 | 21205960 | 21205970 | 21205980 | 21205990 | 21206000 | 21206010 | 21206020 | 21206030 |
| 21206030 | 21206040 | 21206050 | 21206060 | 21206070 | 21206080 | 21206090 | 21206100 | 21206110 |
| 21206110 | 21206120 | 21206130 | 21206140 | 21206150 | 21206160 | 21206170 | 21206180 | 21206190 |
| 21206190 | 21206200 | 21206210 | 21206220 | 21206230 | 21206240 | 21206250 | 21206260 | 21206270 |
| 21206270 | 21206280 | 21206290 | 21206300 | 21206310 | 21206320 | 21206330 | 21206340 | 21206350 |
| 21206350 | 21206360 | 21206370 | 21206380 | 21206390 | 21206400 | 21206410 | 21206420 | 21206430 |
| 21206430 | 21206440 | 21206450 | 21206460 | 21206470 | 21206480 | 21206490 | 21206500 | 21206510 |
| 21206510 | 21206520 | 21206530 | 21206540 | 21206550 | 21206560 | 21206570 | 21206580 | 21206590 |
| 21206590 | 21206600 | 21206610 | 21206620 | 21206630 | 21206640 | 21206650 | 21206660 | 21206670 |
| 21206670 | 21206680 | 21206690 | 21206700 | 21206710 | 21206720 | 21206730 | 21206740 | 21206750 |
| 21206750 | 21206760 | 21206770 | 21206780 | 21206790 | 21206800 | 21206810 | 21206820 | 21206830 |
| 21206830 | 21206840 | 21206850 | 21206860 | 21206870 | 21206880 | 21206890 | 21206900 | 21206910 |
| 21206910 | 21206920 | 21206930 | 21206940 | 21206950 | 21206960 | 21206970 | 21206980 | 21206990 |
| 21206990 | 21207000 | 21207010 | 21207020 | 21207030 | 21207040 | 21207050 | 21207060 | 21207070 |
| 21207070 | 21207080 | 21207090 | 21207100 | 21207110 | 21207120 | 21207130 | 21207140 | 21207150 |
| 21207150 | 21207160 | 21207170 | 21207180 | 21207190 | 21207200 | 21207210 | 21207220 | 21207230 |
| 21207230 | 21207240 | 21207250 | 21207260 | 21207270 | 21207280 | 21207290 | 21207300 | 21207310 |
| 21207310 | 21207320 | 21207330 | 21207340 | 21207350 | 21207360 | 21207370 | 21207380 | 21207390 |
| 21207390 | 21207400 | 21207410 | 21207420 | 21207430 | 21207440 | 21207450 | 21207460 | 21207470 |
| 21207470 | 21207480 | 21207490 | 21207500 | 21207510 | 21207520 | 21207530 | 21207540 | 21207550 |
| 21207550 | 21207560 | 21207570 | 21207580 | 21207590 | 21207600 | 21207610 | 21207620 | 21207630 |
| 21207630 | 21207640 | 21207650 | 21207660 | 21207670 | 21207680 | 21207690 | 21207700 | 21207710 |
| 21207710 | 21207720 | 21207730 | 21207740 | 21207750 | 21207760 | 21207770 | 21207780 | 21207790 |
| 21207790 | 21207800 | 21207810 | 21207820 | 21207830 | 21207840 | 21207850 | 21207860 | 21207870 |
| 21207870 | 21207880 | 21207890 | 21207900 | 21207910 | 21207920 | 21207930 | 21207940 | 21207950 |
| 21207950 | 21207960 | 21207970 | 21207980 | 21207990 | 21208000 | 21208010 | 21208020 | 21208030 |
| 21208030 | 21208040 | 21208050 | 21208060 | 21208070 | 21208080 | 21208090 | 21208100 | 21208110 |
| 21208110 | 21208120 | 21208130 | 21208140 | 21208150 | 21208160 | 21208170 | 21208180 | 21208190 |
| 21208190 | 21208200 | 21208210 | 21208220 | 21208230 | 21208240 | 21208250 | 21208260 | 21208270 |
| 21208270 | 21208280 | 21208290 | 21208300 | 21208310 | 21208320 | 21208330 | 21208340 | 21208350 |
| 21208350 | 21208360 | 21208370 | 21208380 | 21208390 | 21208400 | 21208410 | 21208420 | 21208430 |
| 21208430 | 21208440 | 21208450 | 21208460 | 21208470 | 21208480 | 21208490 | 21208500 | 21208510 |
| 21208510 | 21208520 | 21208530 | 21208540 | 21208550 | 21208560 | 21208570 | 21208580 | 21208590 |
| 21208590 | 21208600 | 21208610 | 21208620 | 21208630 | 21208640 | 21208650 | 21208660 | 21208670 |
| 21208670 | 21208680 | 21208690 | 21208700 | 21208710 | 21208720 | 21208730 | 21208740 | 21208750 |
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| 21208830 | 21208840 | 21208850 | 21208860 | 21208870 | 21208880 | 21208890 | 21208900 | 21208910 |
| 21208910 | 21208920 | 21208930 | 21208940 | 21208950 | 21208960 | 21208970 | 21208980 | 21208990 |
| 21208990 | 21209000 | 21209010 | 21209020 | 21209030 | 21209040 | 21209050 | 21209060 | 21209070 |
| 21209070 | 21209080 | 21209090 | 21209100 | 21209110 | 21209120 | 21209130 | 21209140 | 21209150 |
| 21209150 | 21209160 | 21209170 | 21209180 | 21209190 | 21209200 | 21209210 | 21209220 | 21209230 |
| 21209230 | 21209240 | 21209250 | 21209260 | 21209270 | 21209280 | 21209290 | 21209300 | 21209310 |
| 21209310 | 21209320 | 21209330 | 21209340 | 21209350 | 21209360 | 21209370 | 21209380 | 21209390 |
| 21209390 | 21209400 | 21209410 | 21209420 | 21209430 | 21209440 | 21209450 | 21209460 | 21209470 |
| 21209470 | 21209480 | 21209490 | 21209500 | 21209510 | 21209520 | 21209530 | 21209540 | 21209550 |
| 21209550 | 21209560 | 21209570 | 21209580 | 21209590 | 21209600 | 21209610 | 21209620 | 21209630 |
| 21209630 | 21209640 | 21209650 | 21209660 | 21209670 | 21209680 | 21209690 | 21209700 | 21209710 |
| 21209710 | 21209720 | 21209730 | 21209740 | 21209750 | 21209760 | 21209770 | 21209780 | 21209790 |
| 21209790 | 21209800 | 21209810 | 21209820 | 21209830 | 21209840 | 21209850 | 21209860 | 21209870 |
| 21209870 | 21209880 | 21209890 | 21209900 | 21209910 | 21209920 | 21209930 | 21209940 | 21209950 |
| 21209950 | 21209960 | 21209970 | 21209980 | 21209990 | 21210000 | 21210010 | 21210020 | 21210030 |
| 21210030 | 21210040 | 21210050 | 21210060 | 21210070 | 21210080 | 21210090 | 21210100 | 21210110 |
| 21210110 | 21210120 | 21210130 | 21210140 | 21210150 | 21210160 | 21210170 | 21210180 | 21210190 |
| 21210190 | 21210200 | 21210210 | 21210220 | 21210230 | 21210240 | 21210250 | 21210260 | 21210270 |
| 21210270 | 21210280 | 21210290 | 21210300 | 21210310 | 21210320 | 21210330 | 21210340 | 21210350 |
| 21210350 | 21210360 | 21210370 | 21210380 | 21210390 | 21210400 | 21210410 | 21210420 | 21210430 |
| 21210430 | 21210440 | 21210450 | 21210460 | 21210470 | 21210480 | 21210490 | 21210500 | 21210510 |
| 21210510 | 21210520 | 21210530 | 21210540 | 21210550 | 21210560 | 21210570 | 21210580 | 21210590 |
| 21210590 | 21210600 | 21210610 | 21210620 | 21210630 | 21210640 | 21210650 | 21210660 | 21210670 |
| 21210670 | 21210680 | 21210690 | 21210700 | 21210710 | 21210720 | 21210730 | 21210740 | 21210750 |
| 21210750 | 21210760 | 21210770 | 21210780 | 21210790 | 21210800 | 21210810 | 21210820 | 21210830 |
| 21210830 | 21210840 | 21210850 | 21210860 | 2121
```

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```
## Method 2 - Imputing with median values
According to this technique, the missing values are imputed using the median value in each feature and the serie has been completed filled.

Imputed file: [Impute_Median_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_Median_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)
![[R.LTWB]](Impute_Median_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
![[R.LTWB]](Missingno_Impute_Median_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

General statistics table - Imputed file
|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 516 | 98.825 | 73.1159 | 0 | 46.675 | 81.95 | 137.25 | 446 |
| 21185040 | 516 | 100.39 | 76.3722 | 0 | 40.45 | 87.6 | 141.875 | 438.462 |
| 21190030 | 516 | 95.1084 | 60.9247 | 0.4 | 52.05 | 87.2 | 118.225 | 390.356 |
| 21190060 | 516 | 132.145 | 49.4843 | 0 | 132.5 | 132.5 | 132.5 | 342 |
| 21190110 | 516 | 77.4176 | 4.94126 | 7 | 77.5 | 77.5 | 77.5 | 118.5 |
| 21190170 | 516 | 78.3703 | 9.07982 | 14.4 | 78.1 | 78.1 | 78.1 | 272.3 |
| 21190210 | 516 | 120.939 | 98.9186 | 0 | 44 | 101.9 | 175.025 | 593.066 |
| 21190300 | 516 | 163.839 | 131.813 | 0 | 89.25 | 135.4 | 200.475 | 764 |
| 21190310 | 516 | 142.188 | 87.9782 | 6.6 | 73.875 | 124 | 194.2 | 479 |
| 21190360 | 516 | 247.703 | 10.2528 | 101.9 | 248 | 248 | 248 | 348 |
| 21190430 | 516 | 45.1155 | 22.3608 | 0 | 43.45 | 43.45 | 43.45 | 351.4 |
| 21190440 | 516 | 25.0969 | 27.5419 | 0 | 22.05 | 22.05 | 22.05 | 413.9 |
| 21190450 | 516 | 31.111 | 18.8299 | 0 | 29.4 | 29.4 | 29.4 | 250.8 |
| 21190460 | 516 | 92.4956 | 43.9161 | 0 | 75.9 | 85.5 | 98 | 351.402 |
| 21190470 | 516 | 73.1138 | 26.4815 | 0 | 71.75 | 71.75 | 71.75 | 205.3 |
| 21195030 | 516 | 82.6031 | 34.6833 | 5 | 80 | 80 | 80 | 283.9 |
| 21195080 | 516 | 113.499 | 61.036 | 0 | 107.95 | 107.95 | 107.95 | 385.9 |
| 21195120 | 516 | 115.022 | 67.8597 | 1.9 | 64.875 | 105.65 | 153.25 | 352.2 |
| 21195140 | 516 | 44.8624 | 36.5643 | 0 | 38.95 | 38.95 | 38.95 | 277.2 |
| 21195190 | 516 | 74.4764 | 46.0321 | 0 | 39.275 | 64.25 | 104.025 | 262.6 |
| 21200040 | 516 | 33.3291 | 2.17737 | 0.7 | 33.4 | 33.4 | 33.4 | 55.8 |
| 21200080 | 516 | 103.876 | 50.5886 | 4.6 | 78.475 | 97.65 | 117.075 | 378.3 |
| 21200110 | 516 | 63.0475 | 33.779 | 1.7 | 45.475 | 57.7 | 68.4 | 261.7 |
| 21200130 | 516 | 103.683 | 50.7401 | 1 | 78.95 | 99.5 | 119.675 | 367.186 |
| 21200160 | 516 | 93.0062 | 58.5718 | 0 | 53.15 | 85.7 | 123.5 | 369.5 |
| 21200170 | 516 | 56.8996 | 5.57741 | 19.6 | 56.8 | 56.8 | 56.8 | 130.3 |
| 21200190 | 516 | 116.384 | 57.9018 | 0 | 91.2 | 111.75 | 127.625 | 345.2 |
| 21200200 | 516 | 67.0661 | 35.2478 | 0.1 | 48.775 | 62.8 | 78.25 | 230.1 |
| 21200230 | 516 | 83.1942 | 51.6653 | 1.4 | 61.875 | 73.5 | 87.35 | 345.2 |
| 21200240 | 516 | 108.624 | 51.0053 | 0 | 80.875 | 104.2 | 126.225 | 372.6 |
```

```
df_impute = df.fillna(method='ffill')

## Method 3 - Imputing with Last Observation Carried Forward (LOCF) values
According to this technique, the missing values are imputed using the immediate values before it in the time series and the missing values at the start are not filled but the series are completed fillet to the end.

Imputed file: [Impute_LOCF_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_LOCF_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)
![[R.LTWB]](Impute_LOCF_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
![[R.LTWB]](Missingno_Impute_LOCF_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

General statistics table - Imputed file
|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 462 | 101.331 | 77.157 | 0 | 40.6 | 82.55 | 148.825 | 446 |
| 21185040 | 516 | 100.399 | 76.4615 | 0 | 39.95 | 88.15 | 141.875 | 438.462 |
| 21190030 | 433 | 96.7692 | 66.4604 | 0.4 | 44.2 | 87.2 | 129.8 | 390.356 |
| 21190060 | 492 | 59.3961 | 70.5348 | 0 | 26 | 26 | 44.25 | 342 |
| 21190110 | 516 | 76.9293 | 4.93367 | 7 | 77 | 77 | 77 | 118.5 |
| 21190170 | 516 | 15.5345 | 13.0725 | 14.4 | 14.4 | 14.4 | 14.4 | 272.3 |
| 21190210 | 516 | 123.246 | 100.822 | 0 | 44 | 102.3 | 180 | 593.066 |
| 21190300 | 516 | 212.025 | 144.871 | 0 | 89.25 | 208.3 | 307 | 764 |
| 21190310 | 509 | 143.846 | 89.5832 | 6.6 | 71.7 | 125.7 | 196.5 | 479 |
| 21190360 | 516 | 143.559 | 92.103 | 101.9 | 101.9 | 101.9 | 101.9 | 348 |
| 21190430 | 372 | 65.7306 | 25.2527 | 0 | 65.3 | 65.3 | 65.3 | 351.4 |
| 21190440 | 372 | 38.3659 | 30.9576 | 0 | 35.2 | 35.2 | 35.2 | 413.9 |
| 21190450 | 372 | 30.311 | 22.3108 | 0 | 27.8 | 27.8 | 27.8 | 250.8 |
| 21190460 | 300 | 97.4052 | 57.1753 | 0 | 57.525 | 85.3 | 132.875 | 351.402 |
| 21190470 | 300 | 39.6557 | 51.5454 | 0 | 0 | 0 | 73.35 | 205.3 |
| 21195030 | 516 | 108.68 | 39.7813 | 5 | 91.85 | 122.2 | 122.2 | 283.9 |
| 21195080 | 454 | 123.701 | 68.9075 | 0 | 65.175 | 139.75 | 146.1 | 385.9 |
| 21195120 | 513 | 114.125 | 71.1152 | 1.9 | 60.1 | 103.3 | 158.6 | 352.2 |
| 21195140 | 318 | 38.906 | 53.415 | 0 | 0 | 0 | 46.3 | 277.2 |
| 21195190 | 516 | 74.8731 | 46.2783 | 0 | 39.275 | 64.65 | 104.125 | 262.6 |
| 21200040 | 492 | 19.6671 | 2.75854 | 0.7 | 19.4 | 19.4 | 19.4 | 55.8 |
| 21200080 | 516 | 161.335 | 108.561 | 4.6 | 72.275 | 123.35 | 317.1 | 378.3 |
| 21200110 | 516 | 84.4448 | 47.6087 | 1.7 | 42.65 | 72.15 | 138.1 | 261.7 |
| 21200130 | 516 | 137.616 | 75.4277 | 1 | 76.1 | 122.1 | 228.3 | 367.186 |
| 21200160 | 453 | 94.1051 | 62.7549 | 0 | 46.3 | 85.8 | 130.7 | 369.5 |
| 21200170 | 455 | 23.247 | 8.42912 | 19.6 | 22.3 | 22.3 | 22.3 | 130.3 |
| 21200190 | 516 | 108.717 | 64.3636 | 0 | 73 | 78.7 | 140.575 | 345.2 |
| 21200200 | 516 | 80.9029 | 40.4933 | 0.1 | 48.775 | 80.8 | 113.9 | 230.1 |
| 21200230 | 516 | 122.731 | 70.3191 | 1.4 | 59.4 | 126.65 | 195.7 | 345.2 |
```

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CS2021

```
## Method 4 - Imputing with Next Observation Carried Backward (NOCB) values
According to this technique, the missing values are imputed using the immediate values after it in the time series and the missing values at the end are not filled but the series are completed fillet to the start.

Imputed file: [Impute_NOCB_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_NOCB_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)

![[R.LTWB]](Impute_NOCB_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![[R.LTWB]](Missingno.Impute_NOCB_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
General statistics table - Imputed file
|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 516 | 91.6349 | 77.6988 | 0 | 25 | 72.75 | 138.25 | 446 |
| 21185040 | 513 | 101.708 | 77.3182 | 0 | 40 | 89.5 | 145 | 438.462 |
| 21190030 | 516 | 89.4854 | 62.9717 | 0.4 | 51.875 | 71.3 | 118.225 | 390.356 |
| 21190060 | 180 | 147.016 | 93.0233 | 0 | 69.375 | 152.5 | 232 | 342 |
| 21190110 | 12 | 73.9583 | 33.6117 | 7 | 53.75 | 77.5 | 97.25 | 118.5 |
| 21190170 | 7 | 98.0286 | 81.3592 | 14.4 | 69.95 | 78.1 | 90.75 | 272.3 |
| 21190210 | 516 | 120.595 | 100.476 | 0 | 42 | 101.1 | 176.25 | 593.066 |
| 21190300 | 388 | 173.639 | 151.2 | 0 | 66.2 | 130.5 | 236 | 764 |
| 21190310 | 516 | 142.883 | 93.1608 | 6.6 | 68.8 | 123.4 | 196.6 | 479 |
| 21190360 | 90 | 108.316 | 35.5484 | 101.9 | 101.9 | 101.9 | 101.9 | 348 |
| 21190430 | 176 | 95.092 | 38.5362 | 0 | 100.6 | 100.6 | 100.6 | 351.4 |
| 21190440 | 174 | 111.568 | 45.8055 | 0 | 119.3 | 119.3 | 119.3 | 413.9 |
| 21190450 | 176 | 121.389 | 42.8921 | 0 | 135.7 | 135.7 | 135.7 | 250.8 |
| 21190460 | 516 | 65.3344 | 58.4929 | 0 | 19.9 | 43.75 | 98.475 | 351.402 |
| 21190470 | 372 | 31.9804 | 48.8612 | 0 | 0 | 0 | 56.9 | 295.3 |
| 21195030 | 228 | 105.554 | 74.3875 | 5 | 49.625 | 90.15 | 142.325 | 283.9 |
| 21195080 | 383 | 99.6439 | 78.2768 | 0 | 52.2 | 69.1 | 133.2 | 385.9 |
| 21195120 | 516 | 116.466 | 70.1289 | 1.9 | 61.15 | 106.5 | 159.7 | 352.2 |
| 21195140 | 372 | 74.589 | 45.2677 | 0 | 46.075 | 90.5 | 90.5 | 277.2 |
| 21195190 | 516 | 74.9725 | 46.3653 | 0 | 38.85 | 64.55 | 105.975 | 262.6 |
| 21200040 | 36 | 10.5833 | 16.3581 | 0.7 | 0.7 | 0.7 | 19.875 | 55.8 |
| 21200080 | 376 | 105.009 | 60.4203 | 4.6 | 62.825 | 94.55 | 133.825 | 378.3 |
| 21200110 | 377 | 67.1279 | 42.6686 | 1.7 | 35.6 | 57.8 | 88.2 | 261.7 |
| 21200130 | 377 | 105.686 | 59.4306 | 1 | 62.9 | 100.7 | 135.2 | 367.186 |
| 21200160 | 516 | 89.4545 | 60.5758 | 0 | 51.3 | 69.4 | 124.475 | 369.5 |
| 21200170 | 72 | 28.8778 | 20.4111 | 19.6 | 23 | 23 | 23 | 130.3 |
| 21200190 | 374 | 116.827 | 72.7211 | 0 | 61.6 | 110.8 | 157.275 | 345.2 |
| 21200200 | 377 | 68.6468 | 41.1392 | 0.1 | 39.6 | 62.8 | 89.8 | 230.1 |
| 21200230 | 375 | 76.1739 | 67.2001 | 1.4 | 25.3 | 59.9 | 106.3 | 345.2 |
| 21200240 | 377 | 110.255 | 59.6102 | 0 | 69.7 | 104.2 | 145.4 | 372.6 |
| 21200260 | 384 | 79.5887 | 54.9381 | 0 | 38.5 | 69.7 | 110.675 | 327.571 |
```

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```
## Method 5 - Impute missing values with Linear Interpolation values
According to this technique, the missing values are imputed using the linear interpolation between knowing pair values in the time series and the missing values at the start are not filled but the series are completed fillet to the end.

Imputed file: [Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)

![[R.LTWB]](Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![[R.LTWB]](Missingno.Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
General statistics table - Imputed file
|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 35070480 | 516 | 97.0035 | 59.394 | 0.3 | 48.1 | 96.5 | 134.25 | 279.4 |
| 35070490 | 516 | 195.19 | 125.645 | 0 | 88.3 | 186.85 | 284.4 | 603.7 |
```

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```
## Method 5 - Impute missing values with Linear Interpolation values
According to this technique, the missing values are imputed using the linear interpolation between knowing pair values in the time series and the missing values at the start are not filled but the series are completed fillet to the end.

Imputed file: [Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)

![[R.LTWB]](Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![[R.LTWB]](Missingno.Impute_InterpolateLinear_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
General statistics table - Imputed file
|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|-----:|
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 462 | 100.962 | 77.0481 | 0 | 40.6 | 82.1 | 148 | 446 |
| 21185040 | 516 | 100.956 | 76.6597 | 0 | 40.45 | 88.15 | 144.025 | 438.462 |
| 21190030 | 433 | 96.6241 | 66.4127 | 0.4 | 44.2 | 87.2 | 128.4 | 390.356 |
| 21190060 | 492 | 59.3961 | 70.5348 | 0 | 26 | 26 | 44.25 | 342 |
| 21190110 | 516 | 76.9293 | 4.93367 | 7 | 77 | 77 | 77 | 118.5 |
| 21190170 | 516 | 15.5345 | 13.0725 | 14.4 | 14.4 | 14.4 | 14.4 | 272.3 |
| 21190210 | 516 | 121.92 | 99.4334 | 0 | 44 | 102.1 | 177.4 | 593.066 |
| 21190300 | 516 | 209.373 | 143.282 | 0 | 89.25 | 207 | 307 | 764 |
| 21190310 | 509 | 144.189 | 90.3353 | 6.6 | 71.7 | 124.9 | 196.9 | 479 |
| 21190360 | 516 | 123.289 | 55.4968 | 101.9 | 101.9 | 101.9 | 101.9 | 348 |
| 21190430 | 372 | 65.7306 | 25.2527 | 0 | 65.3 | 65.3 | 65.3 | 351.4 |
| 21190440 | 372 | 38.3659 | 30.9576 | 0 | 35.2 | 35.2 | 35.2 | 413.9 |
| 21190450 | 372 | 30.311 | 22.3108 | 0 | 27.8 | 27.8 | 27.8 | 250.8 |
| 21190460 | 300 | 97.7262 | 57.1634 | 0 | 57.975 | 85.6 | 133.5 | 351.402 |
| 21190470 | 300 | 39.6557 | 51.5454 | 0 | 0 | 0 | 73.35 | 205.3 |
| 21195030 | 516 | 111.762 | 41.7737 | 5 | 103.825 | 122.2 | 122.2 | 283.9 |
| 21195080 | 454 | 120.979 | 69.4909 | 0 | 62.385 | 133.2 | 146.1 | 385.9 |
| 21195120 | 513 | 115.619 | 69.6248 | 1.9 | 62.1 | 105.6 | 156.7 | 352.2 |
| 21195140 | 318 | 30.906 | 53.415 | 0 | 0 | 0 | 46.3 | 277.2 |
| 21195190 | 516 | 74.9228 | 46.1358 | 0 | 38.9 | 64.65 | 104.375 | 262.6 |
| 21200040 | 492 | 19.6671 | 2.75854 | 0.7 | 19.4 | 19.4 | 19.4 | 55.8 |
| 21200080 | 516 | 161.944 | 107.869 | 4.6 | 72.375 | 122.7 | 317.1 | 378.3 |
| 21200110 | 516 | 85.3455 | 46.984 | 1.7 | 43.975 | 74.45 | 138.1 | 261.7 |
| 21200130 | 516 | 138.166 | 74.7355 | 1 | 78.375 | 122.1 | 228.3 | 367.186 |
| 21200160 | 453 | 94.1408 | 62.6447 | 0 | 47.1 | 85.7 | 130.7 | 369.5 |
| 21200170 | 455 | 23.247 | 8.42912 | 19.6 | 22.3 | 22.3 | 22.3 | 130.3 |
| 21200190 | 516 | 106.742 | 63.4289 | 0 | 73 | 75.6 | 138.975 | 345.2 |
```

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 CC: 1032395475
 CS2021

```
## Method 6 - Impute missing values with Exponential (Weighted) Moving Average - EWM = 3
According to this technique, the missing values are imputed using the moving average values in the time series and the missing values at the start are not filled but the series are completed fillet to the end.

Imputed file: [Impute_MeanEWM_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_MeanEWM_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)

![[R.LTWB]](Impute_MeanEWM_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![[R.LTWB]](Missingno_Impute_MeanEWM_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

General statistics table - Imputed file
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 462 | 100.93 | 77.056 | 0 | 40.6 | 81.95 | 148 | 446 |
| 21185040 | 516 | 100.676 | 76.4115 | 0 | 40.45 | 88.15 | 141.875 | 438.462 |
| 21190030 | 433 | 96.6499 | 66.4112 | 0.4 | 44.2 | 87.2 | 128.4 | 390.356 |
| 21190060 | 492 | 133.142 | 50.6914 | 0 | 133.985 | 133.985 | 133.985 | 342 |
| 21190110 | 516 | 80.7272 | 5.0223 | 7 | 80.8883 | 80.8883 | 80.8883 | 118.5 |
| 21190170 | 516 | 79.2333 | 9.05461 | 14.4 | 78.9748 | 78.9748 | 78.9748 | 272.3 |
| 21190210 | 516 | 122.972 | 99.6736 | 0 | 44 | 102.75 | 180 | 593.066 |
| 21190300 | 516 | 196.337 | 136.515 | 0 | 89.25 | 208.3 | 245.577 | 764 |
| 21190310 | 509 | 143.042 | 88.6675 | 6.6 | 72.9 | 124.7 | 196.4 | 479 |
| 21190360 | 516 | 127.575 | 56.8581 | 101.9 | 101.9 | 101.9 | 101.9 | 348 |
| 21190430 | 372 | 90.2014 | 25.9438 | 0 | 92.0739 | 92.0739 | 92.0739 | 351.4 |
| 21190440 | 372 | 103.508 | 30.2992 | 0 | 106.057 | 106.057 | 106.057 | 413.9 |
| 21190450 | 372 | 67.6392 | 21.0071 | 0 | 68.6414 | 68.6414 | 68.6414 | 250.8 |
| 21190460 | 300 | 97.5323 | 57.1858 | 0 | 57.975 | 85.475 | 132.875 | 351.402 |
| 21190470 | 300 | 63.6309 | 37.0655 | 0 | 49.9484 | 49.9484 | 73.35 | 205.3 |
| 21195030 | 516 | 101.222 | 36.7228 | 5 | 88.343 | 112.161 | 112.161 | 283.9 |
| 21195080 | 454 | 121.15 | 66.0957 | 0 | 78.7867 | 129.258 | 135.533 | 385.9 |
| 21195120 | 513 | 115.443 | 68.3819 | 1.9 | 63.1 | 105.6 | 154.6 | 352.2 |
| 21195140 | 318 | 51.7049 | 45.693 | 0 | 33.4 | 45.9311 | 46.3 | 277.2 |
| 21195190 | 516 | 74.7529 | 46.0234 | 0 | 39.275 | 65 | 104.025 | 262.6 |
| 21200040 | 492 | 32.6129 | 2.20882 | 0.7 | 32.6695 | 32.6695 | 32.6695 | 55.8 |
| 21200080 | 516 | 131.092 | 66.4323 | 4.6 | 74.375 | 122.15 | 201.176 | 378.3 |
| 21200110 | 516 | 83.4978 | 45.1586 | 1.7 | 45.475 | 72.15 | 132.851 | 261.7 |
| 21200130 | 516 | 124.361 | 60.1721 | 1 | 76.1 | 122.1 | 177.366 | 367.186 |
| 21200160 | 453 | 94.1047 | 62.4623 | 0 | 48 | 85.9 | 130.1 | 369.5 |
| 21200170 | 455 | 62.8633 | 5.90062 | 19.6 | 62.8978 | 62.8978 | 62.8978 | 130.3 |
| 21200190 | 516 | 114.415 | 58.6081 | 0 | 87.2141 | 101.872 | 133.2 | 345.2 |
| 21200200 | 516 | 82.7152 | 42.0937 | 0.1 | 48.775 | 80.6 | 120.814 | 230.1 |
| 21200230 | 516 | 114.25 | 67.5482 | 1.4 | 60.05 | 93.4 | 185.442 | 345.2 |
| 21200240 | 516 | 135.814 | 66.1022 | 0 | 80.875 | 134.2 | 205.135 | 372.6 |
```

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```
## Method 7 - Impute missing values with Natural Neighbors - KNN = 5 Imputer from Scikit Learn
According to this technique, the missing values are imputed using the natural neighbors values and the serie has been completely filled. More information in https://scikit-learn.org/stable/modules/generated/sklearn.impute.KNNImputer.html

Imputer = KNNImputer(n_neighbors=n_neighbors, weights=uniform, metric=nan_euclidean)

Imputed file: [Impute_KNN_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_KNN_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)

![[R.LTWB]](Impute_KNN_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![[R.LTWB]](Missingno_Impute_KNN_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

General statistics table - Imputed file
| count | mean | std | min | 25% | 50% | 75% | max | |
|---|---|---|---|---|---|---|---|---|
| 21170020 | 516 | 100.027 | 75.3382 | 0 | 41 | 82.1 | 147.85 | 446 |
| 21185040 | 516 | 100.958 | 76.7127 | 0 | 39.95 | 88.95 | 144.025 | 438.462 |
| 21190030 | 516 | 95.5288 | 63.4581 | 0.4 | 45.35 | 87.2 | 127.625 | 390.356 |
| 21190060 | 516 | 128.458 | 68.7325 | 0 | 73.55 | 123.9 | 179.85 | 342 |
| 21190110 | 516 | 73.2616 | 13.4802 | 7 | 64.9 | 76.8 | 77.9 | 118.5 |
| 21190170 | 516 | 88.3152 | 22.4886 | 14.4 | 66.68 | 69.9 | 106.04 | 272.3 |
| 21190210 | 516 | 121.313 | 99.9135 | 0 | 43.825 | 101.1 | 177.4 | 593.066 |
| 21190300 | 516 | 173.423 | 143.274 | 0 | 68.75 | 140.5 | 240.175 | 764 |
| 21190310 | 516 | 142.614 | 88.9935 | 6.6 | 71.73 | 123.75 | 196.325 | 479 |
| 21190360 | 516 | 217.38 | 9.80334 | 101.9 | 217.38 | 217.38 | 217.38 | 348 |
| 21190430 | 516 | 68.2341 | 46.0522 | 0 | 35.36 | 55.4 | 97.7 | 351.4 |
| 21190440 | 516 | 69.3526 | 52.853 | 0 | 24.54 | 55.92 | 109 | 413.9 |
| 21190450 | 516 | 57.3858 | 39.8767 | 0 | 21.88 | 53 | 79.26 | 250.8 |
| 21190460 | 516 | 91.5414 | 50.8612 | 0 | 57.195 | 80.85 | 119.3 | 351.402 |
| 21190470 | 516 | 70.7419 | 38.0136 | 0 | 42.14 | 63.56 | 94.195 | 205.3 |
| 21195030 | 516 | 85.1278 | 51.1616 | 5 | 41.785 | 80.77 | 122.125 | 283.9 |
| 21195080 | 516 | 114.051 | 77.8887 | 0 | 51.3 | 102.37 | 163.225 | 385.9 |
| 21195120 | 516 | 114.018 | 69.317 | 1.9 | 60.55 | 104.3 | 155.235 | 352.2 |
| 21195140 | 516 | 56.5193 | 45.9252 | 0 | 22.29 | 44.73 | 84.86 | 277.2 |
| 21195190 | 516 | 74.2098 | 46.2405 | 0 | 38.4 | 63.6 | 104.025 | 262.6 |
| 21200040 | 516 | 31.8609 | 5.20392 | 0.7 | 28.92 | 30.64 | 35.82 | 55.8 |
| 21200080 | 516 | 107.303 | 56.2146 | 4.6 | 66.195 | 101.38 | 137.33 | 378.3 |
| 21200110 | 516 | 63.6965 | 37.3396 | 1.7 | 37.715 | 56.19 | 81.375 | 261.7 |
| 21200130 | 516 | 105.044 | 56.4225 | 1 | 64.45 | 100.43 | 133.27 | 367.186 |
| 21200160 | 516 | 91.7458 | 61.6439 | 0 | 46.035 | 82.5 | 126.825 | 369.5 |
| 21200170 | 516 | 59.792 | 17.6264 | 19.6 | 43.22 | 58.64 | 73.34 | 130.3 |
| 21200190 | 516 | 120.162 | 69.6953 | 0 | 69.675 | 111.25 | 158.3 | 345.2 |
| 21200200 | 516 | 68.6914 | 39.8659 | 0.1 | 40.45 | 62.8 | 92.115 | 230.1 |
```

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```
□ Símbolo del sistema
warnings.warn()

## Method 8 - Impute missing values with Multivariate Imputation by Chained Equation - MICE from Scikit Learn
According to this technique, the missing values are imputed using MICE values and the serie has been completed filled. More information in https://scikit-learn.org/stable/modules/generated/sklearn.impute.IterativeImputer.html

Imputer = IterativeImputer(estimator=BayesianRidge(), min_value=0, n_nearest_features=5)

Imputed file: [Impute_MICE_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv](Impute_MICE_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv)
![R.LTWB](Impute_MICE_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)

![R.LTWB](Missingno_Impute_MICE_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.png)
General statistics table - Imputed file
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| count | mean | std | min | 25% | 50% | 75% | max |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
21170020 | 516 | 100.78 | 75.0634 | 0 | 43.475 | 83.1883 | 144.193 | 446 |
21185040 | 516 | 101.052 | 76.6765 | 0 | 40.45 | 88.15 | 144.275 | 438.462 |
21190030 | 516 | 97.3545 | 64.7956 | 0.4 | 46.125 | 89.4 | 129.975 | 390.356 |
21190060 | 516 | 138.814 | 62.4035 | 0 | 100.76 | 134.333 | 175 | 342 |
21190110 | 516 | 107.816 | 31.9688 | 7 | 86.4975 | 102.889 | 124.348 | 262.166 |
21190170 | 516 | 91.0193 | 33.6877 | 0 | 67.6058 | 90.1443 | 115.43 | 272.3 |
21190210 | 516 | 122.052 | 99.3726 | 0 | 44 | 102.3 | 177.4 | 593.066 |
21190300 | 516 | 175.984 | 137.247 | 0 | 84.032 | 145.692 | 236 | 764 |
21190310 | 516 | 142.872 | 88.6367 | 6.6 | 72.6831 | 124.2 | 196.325 | 479 |
21190360 | 516 | 216.98 | 9.90767 | 101.9 | 215.964 | 217.299 | 218.095 | 348 |
21190430 | 516 | 81.9632 | 32.9344 | 0 | 62.6947 | 81.2989 | 99.132 | 351.4 |
21190440 | 516 | 83.3322 | 39.5804 | 0 | 58.4925 | 83.5054 | 104.994 | 413.9 |
21190450 | 516 | 86.4158 | 35.9957 | 0 | 69.0393 | 84.9618 | 105.009 | 275.584 |
21190460 | 516 | 93.3741 | 49.4303 | 0 | 59.175 | 82.3398 | 119.197 | 351.462 |
21190470 | 516 | 75.2196 | 35.6804 | 0 | 52.2803 | 69.4333 | 93.1892 | 212.94 |
21195030 | 516 | 90.0333 | 50.6374 | 5 | 50.85 | 81.95 | 119.86 | 283.9 |
21195080 | 516 | 120.972 | 72.9495 | 0 | 64.8939 | 112.041 | 159.613 | 385.9 |
21195120 | 516 | 114.378 | 68.882 | 1.9 | 61.15 | 105.05 | 153.5 | 352.2 |
21195140 | 516 | 56.5659 | 40.7035 | 0 | 31.5612 | 51.0931 | 73.5964 | 277.2 |
21195190 | 516 | 74.3134 | 46.1672 | 0 | 38.85 | 63.6 | 104.025 | 262.6 |
21200040 | 516 | 29.8518 | 2.7768 | 0.7 | 28.5126 | 29.5835 | 30.8646 | 55.8 |
21200080 | 516 | 108.963 | 54.99 | 4.6 | 69.925 | 102.915 | 137.787 | 378.3 |
21200110 | 516 | 64.9993 | 37.69 | 1.7 | 38.7764 | 57.2 | 83.7202 | 261.7 |
21200130 | 516 | 106.65 | 55.4444 | 1 | 67.15 | 101.2 | 136.875 | 367.186 |
21200160 | 516 | 92.8784 | 61.7843 | 0 | 46.175 | 84.05 | 128.825 | 369.5 |
21200170 | 516 | 62.8259 | 27.0425 | 16.7057 | 42.7154 | 58.3838 | 79.4851 | 197.996 |
21200190 | 516 | 123.564 | 71.3879 | 0 | 69.675 | 114.8 | 167.35 | 348.12 |

Windows Taskbar
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□ Símbolo del sistema
35030020 | 516 | 507.443 | 283.68 | 0 | 288.5 | 510.21 | 712.5 | 1301 |
35030080 | 516 | 75.7773 | 49.1733 | 0 | 34.125 | 73.4897 | 106.45 | 245.9 |
35030110 | 516 | 154.485 | 94.5342 | 0 | 88.2314 | 138.84 | 209.703 | 522.2 |
35030120 | 516 | 160.036 | 99.6521 | 0 | 84.7546 | 145.4 | 221.804 | 565.9 |
35030140 | 516 | 154.365 | 89.8528 | 1.4 | 86.4525 | 141.731 | 213.095 | 553.4 |
35030160 | 516 | 124.656 | 78.1756 | 0.8 | 60.6558 | 114.823 | 176.179 | 448.1 |
35030170 | 516 | 89.2831 | 56.9056 | 0 | 44.6132 | 79.7972 | 124.85 | 317.8 |
35030180 | 516 | 136.603 | 90.9104 | 0 | 65.4678 | 127.046 | 189.95 | 585.4 |
35030210 | 516 | 151.176 | 100.598 | 0 | 73.8096 | 133.582 | 214.021 | 514.941 |
35030230 | 516 | 173.661 | 98.3715 | 2.5 | 95.1725 | 165.634 | 235.154 | 522.2 |
35030250 | 516 | 178.242 | 111.898 | 0 | 91.7466 | 173.557 | 252.3 | 599.9 |
35030260 | 516 | 89.1258 | 56.6048 | 0 | 48.7155 | 77.2134 | 118.6 | 341.6 |
35035040 | 516 | 124.801 | 63.2449 | 7.3 | 77.0676 | 118.062 | 166.242 | 382.6 |
35035050 | 516 | 181.378 | 97.8902 | 5.2 | 110.506 | 168.768 | 244.536 | 593.4 |
35040010 | 516 | 553.524 | 326.334 | 0 | 306.75 | 560 | 764.5 | 1726 |
35060010 | 516 | 53.6361 | 18.902 | 0 | 42.9892 | 57.5654 | 68.1073 | 85.3032 |
35060020 | 516 | 114.783 | 82.0247 | 0 | 55.1 | 99.1 | 163.825 | 477.7 |
35060050 | 516 | 103.685 | 69.6694 | 0 | 49.725 | 93.65 | 144.7 | 378 |
35060090 | 516 | 184.777 | 115.486 | 0 | 92.269 | 171.7 | 261.8 | 698.557 |
35060100 | 516 | 177.747 | 108.316 | 0 | 92.225 | 170.15 | 249.9 | 514.3 |
35060120 | 516 | 246.369 | 145.474 | 0.7 | 135.75 | 233.35 | 342.95 | 919 |
35060130 | 516 | 268.47 | 167.238 | 0 | 137 | 255.6 | 380.95 | 974 |
35060150 | 516 | 278.244 | 178.005 | 0 | 142.4 | 261.25 | 382.8 | 1070.65 |
35060160 | 516 | 145.649 | 85.8609 | 2 | 78.75 | 136.05 | 195.95 | 421.8 |
35060170 | 516 | 144.322 | 97.3907 | 0 | 65.3 | 137.2 | 217.275 | 534 |
35060180 | 516 | 167.118 | 107.642 | 0 | 83.85 | 154.7 | 235.025 | 573 |
35060200 | 516 | 149.83 | 93.3291 | 0.8 | 83.2 | 133.55 | 203.7 | 493.6 |
35060210 | 516 | 161.076 | 98.3821 | 0.1 | 84.8 | 151.45 | 228.425 | 545 |
35060230 | 516 | 179.158 | 114.511 | 0 | 89.175 | 168.6 | 252 | 607 |
35060240 | 516 | 106.814 | 76.1416 | 0 | 45.225 | 95.7156 | 152 | 435 |
35065010 | 516 | 195.19 | 59.4146 | 0 | 61.925 | 99.4 | 145.225 | 320 |
35070110 | 516 | 100.118 | 65.6236 | 0 | 42.5 | 94.5 | 150.025 | 296.6 |
35070160 | 516 | 166.245 | 56.8279 | 55.8 | 121.895 | 158.447 | 199.13 | 403.481 |
35070230 | 516 | 94.6525 | 60.6044 | 0 | 46.15 | 88.2 | 134.15 | 310.4 |
35070480 | 516 | 94.5211 | 59.7889 | 0.3 | 46.8467 | 90.85 | 134.025 | 279.4 |
35070490 | 516 | 189.131 | 120.184 | 0 | 91.4902 | 175.348 | 266.375 | 603.7 |

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Complementary report with individual graphs for stations in [Impute_Station_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.md](Impute_Station_Outlier_IQR_Cap_Pivot_PTPM_TT_M.csv.md)

> As you notice, some of the techniques showed above can't fill complete the missing values at the start or at the end, however, you can first choice a method and then apply another complementary method for get full filled the missin values.

C:\JLGC\R.LTWB\.datasets\IDEAM_Impute>
```

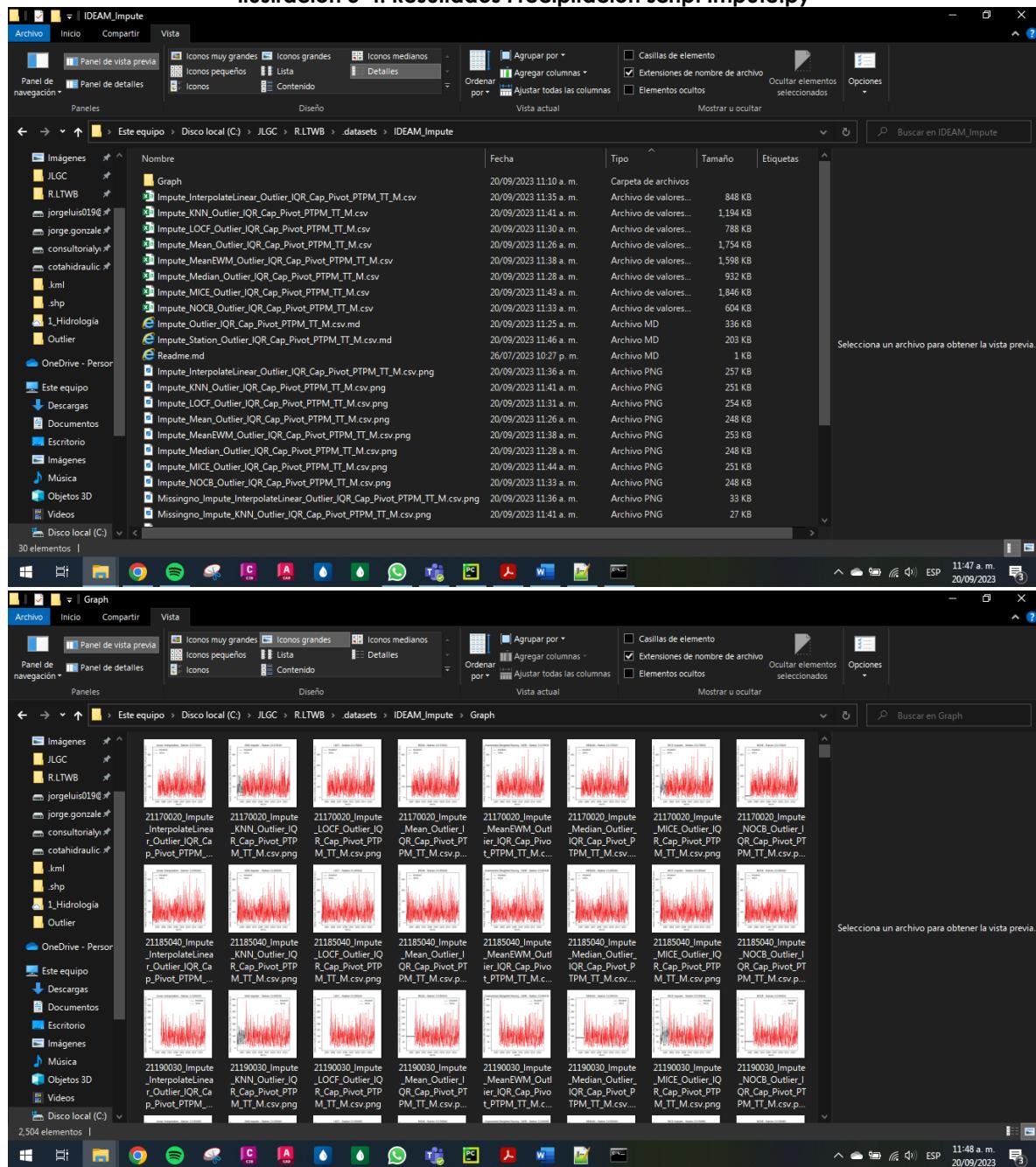
Fuente: Elaboración Propia, 2023.

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Se verificó que en la carpeta `./datasets/IDEAM_Impute` se almacenaron los resultados del script en cuanto a gráficas, tablas y archivo de visualización en formato Markdown.

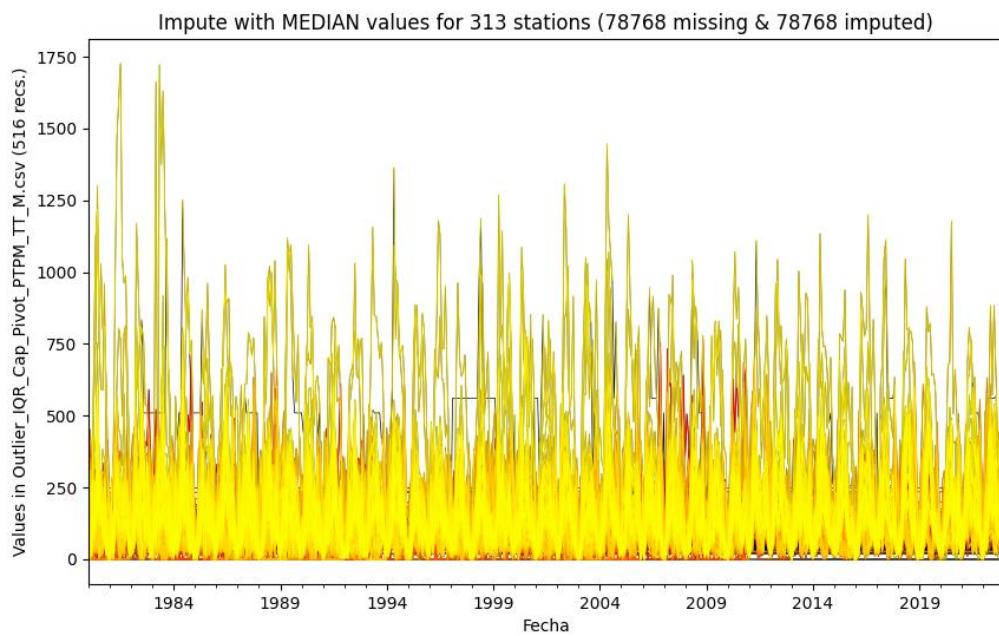
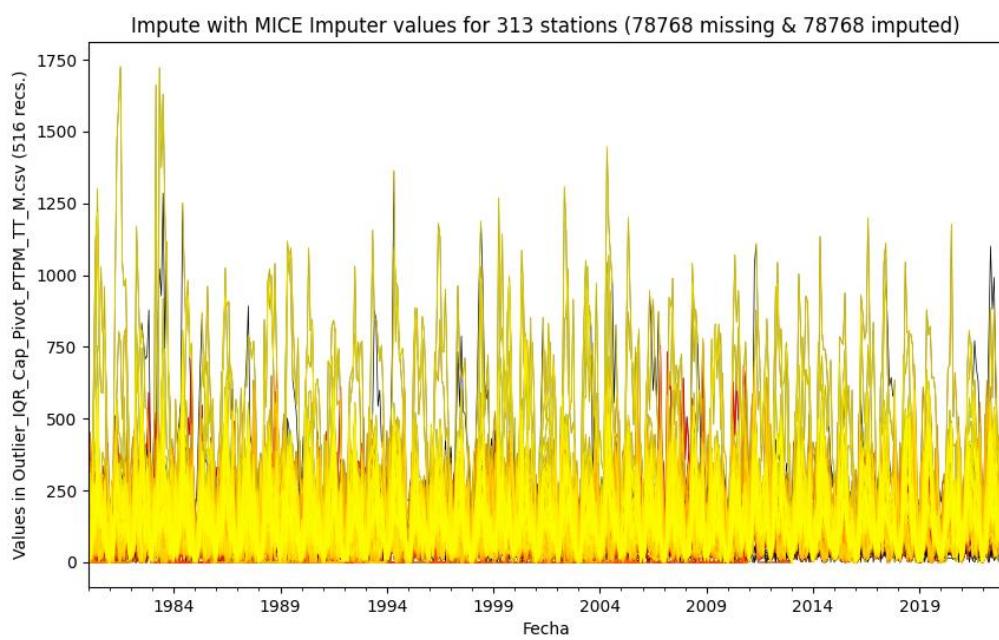
Ilustración 3-4. Resultados Precipitación script Impute.py



Fuente: Elaboración Propia, 2023.

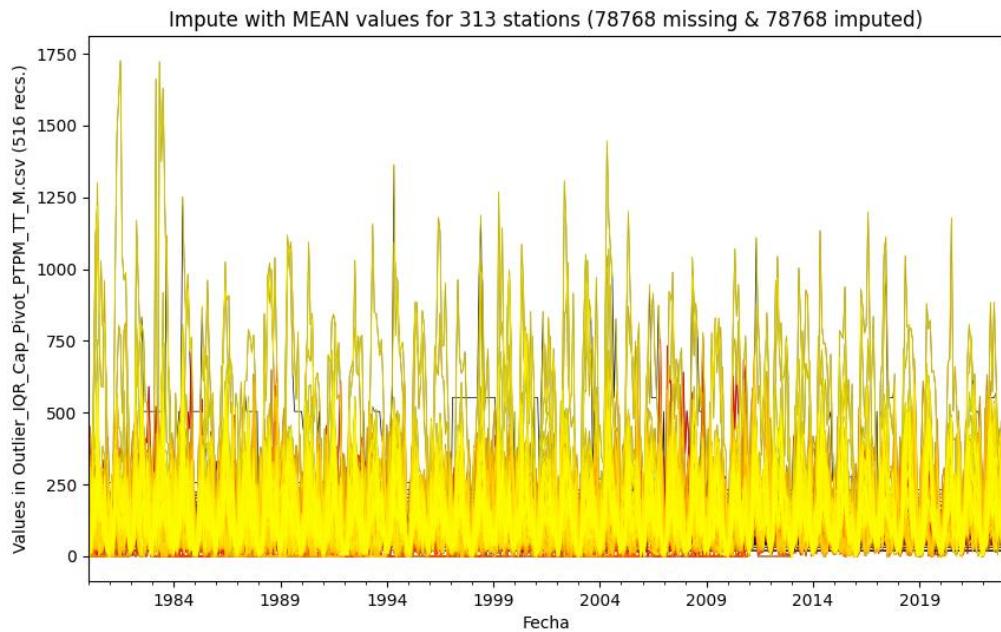
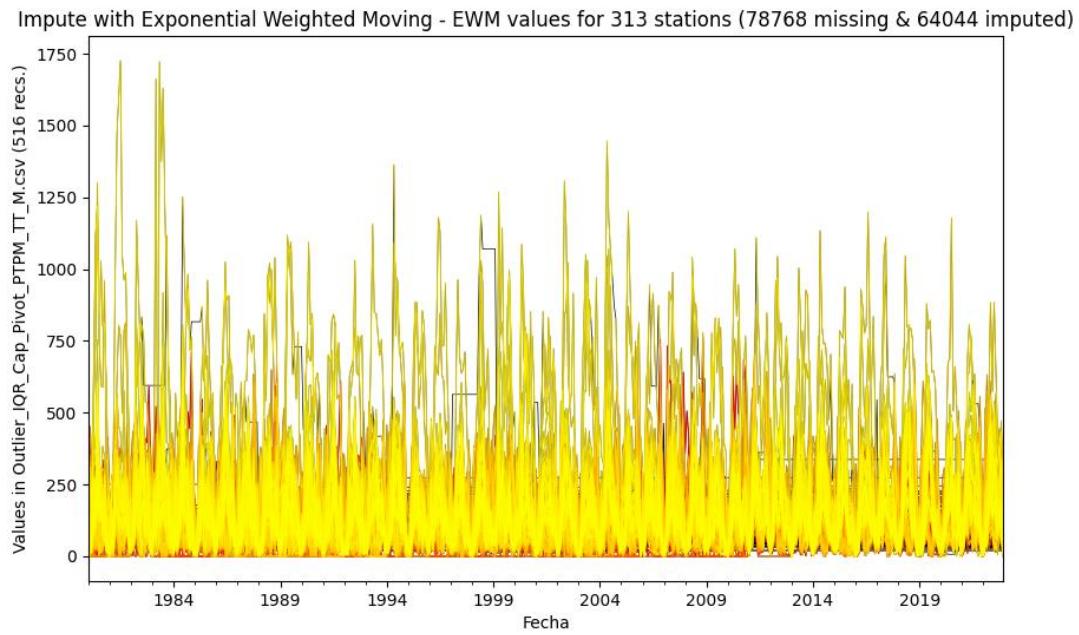
Las gráficas de resultados por cada método se presentan a continuación.

Ilustración 3-5. Resultados Impute 1 Precipitación



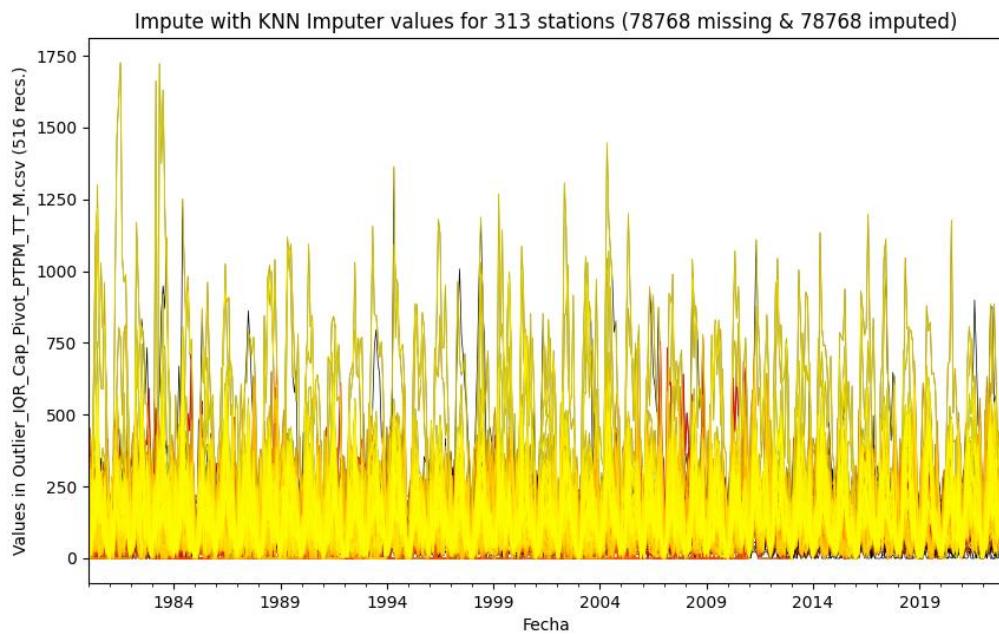
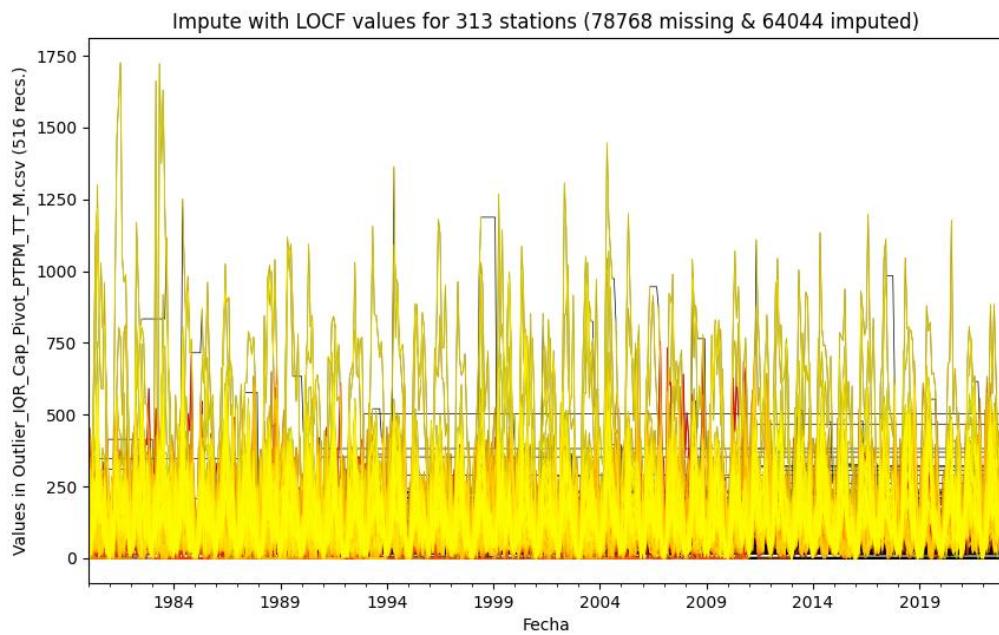
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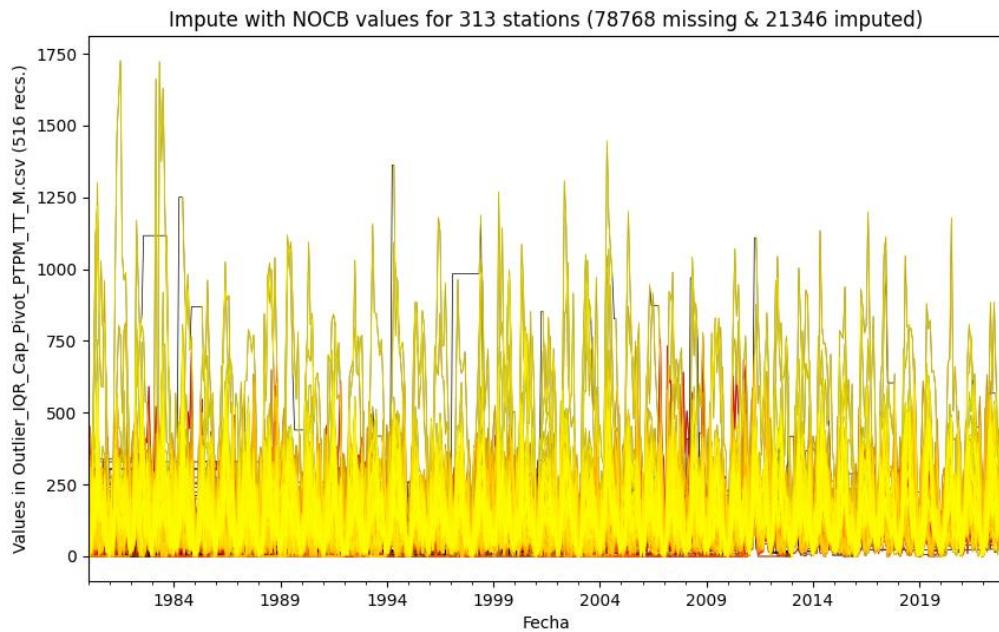
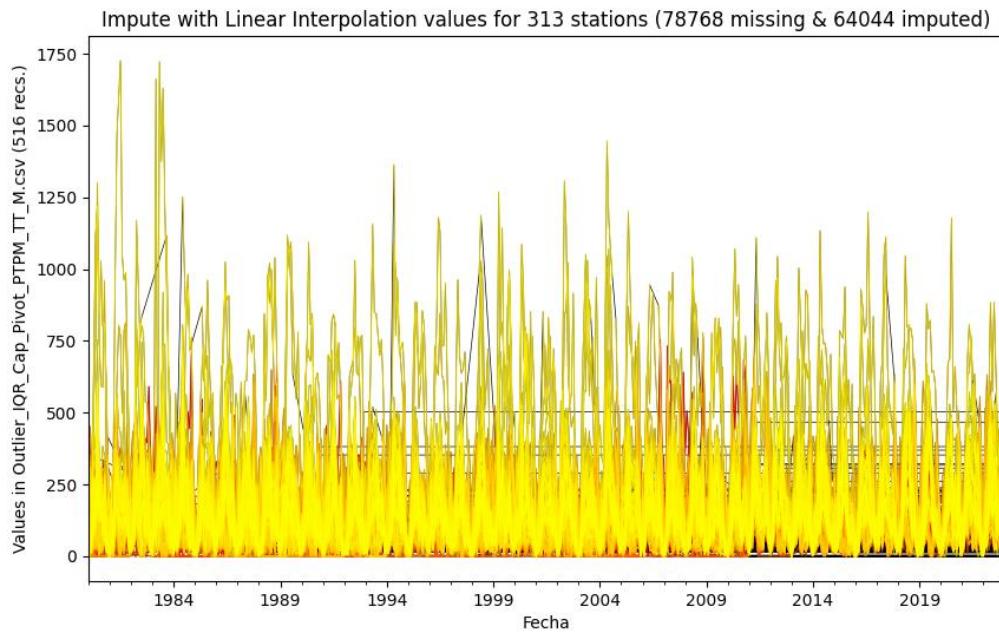
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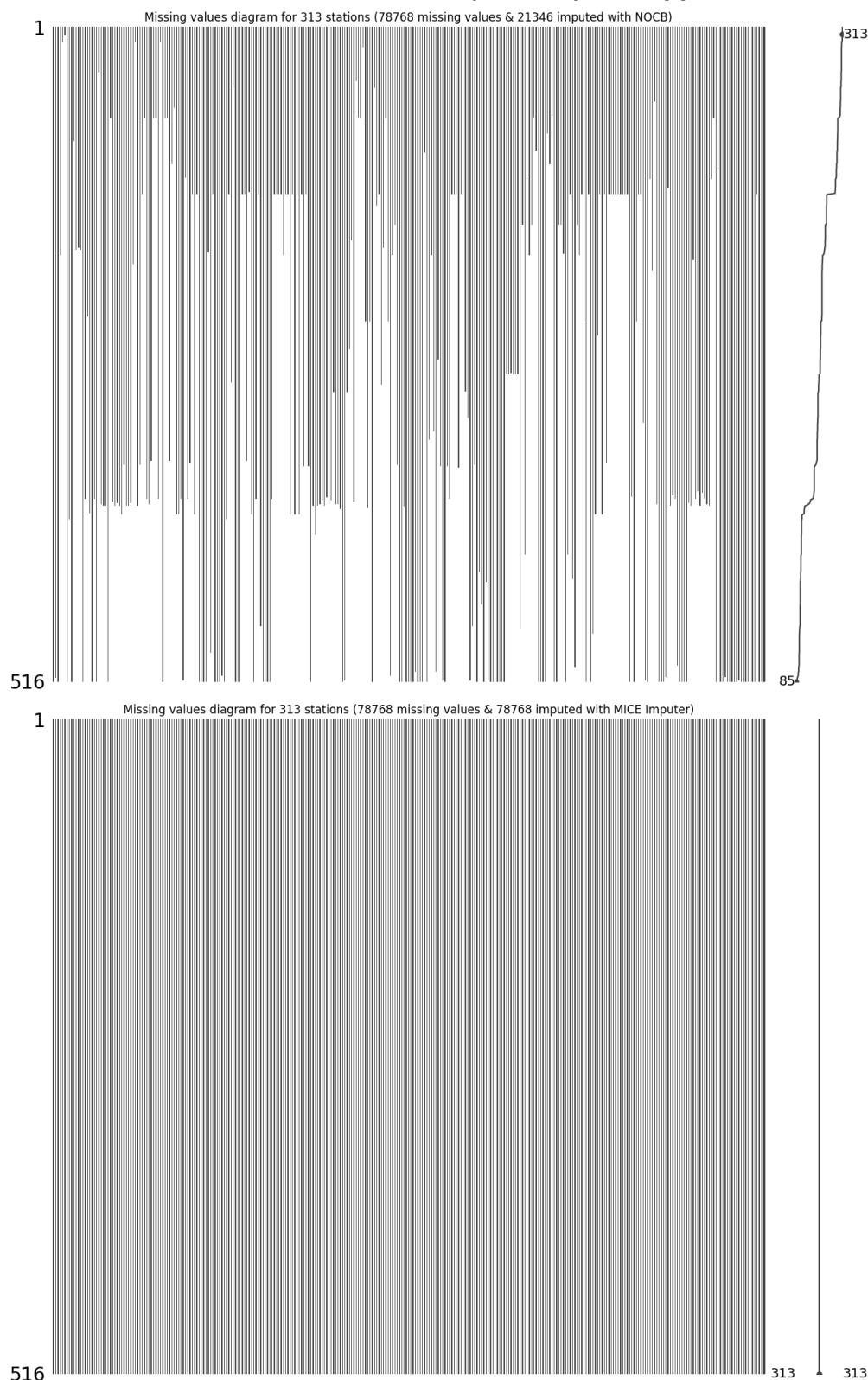
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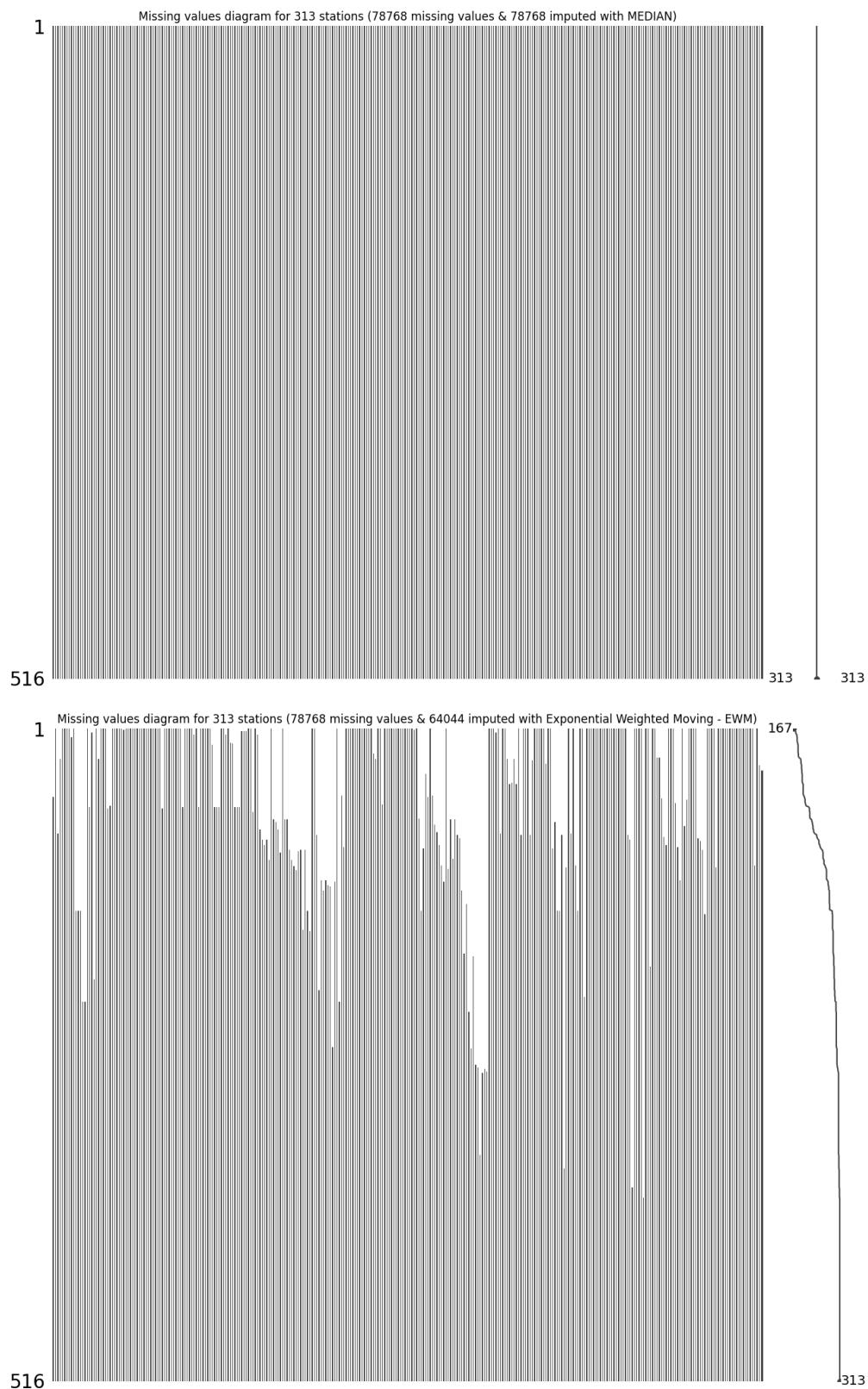
Fuente: Elaboración Propia, 2023.

Ilustración 3-6. Resultados Impute Precipitación (2)



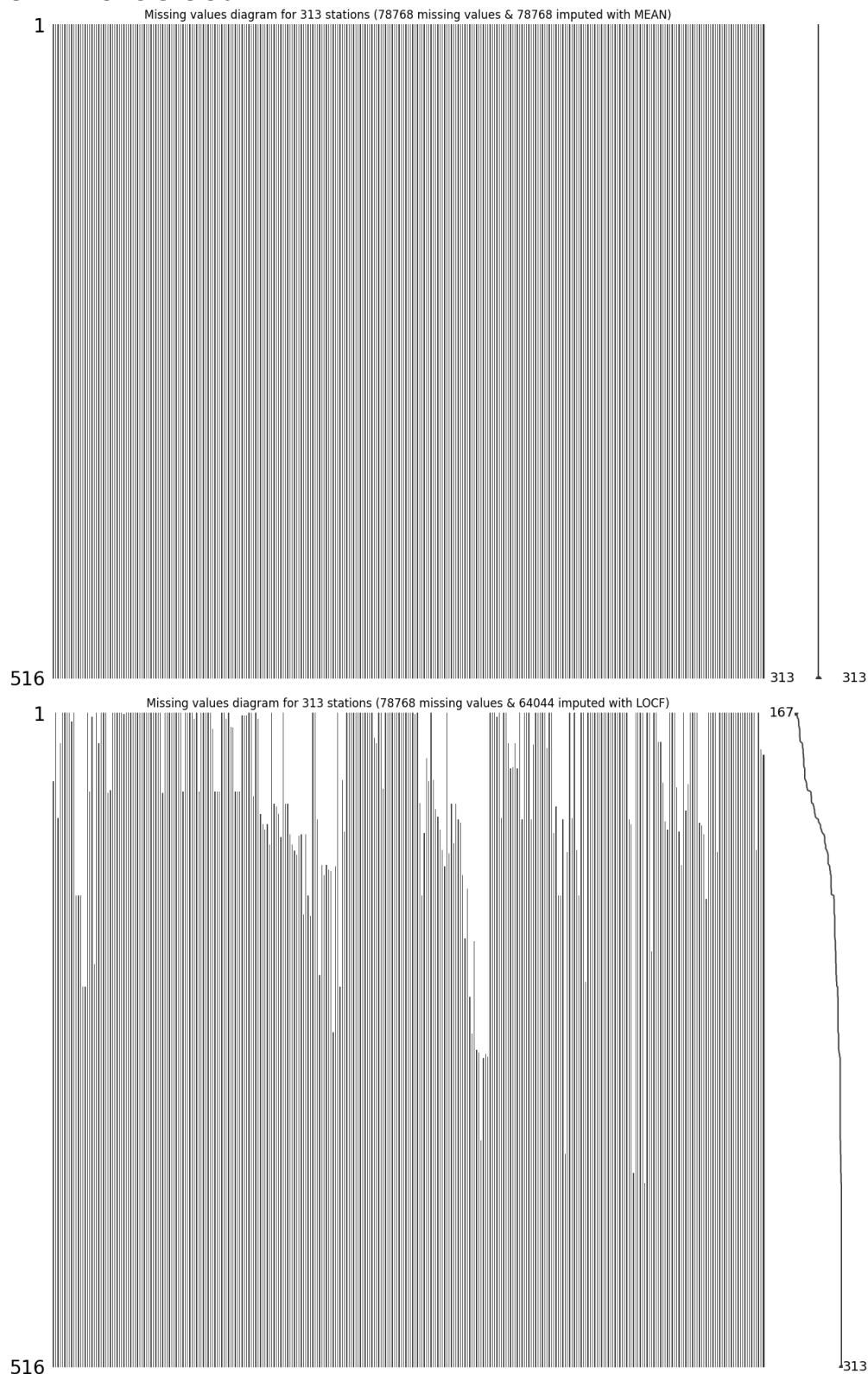
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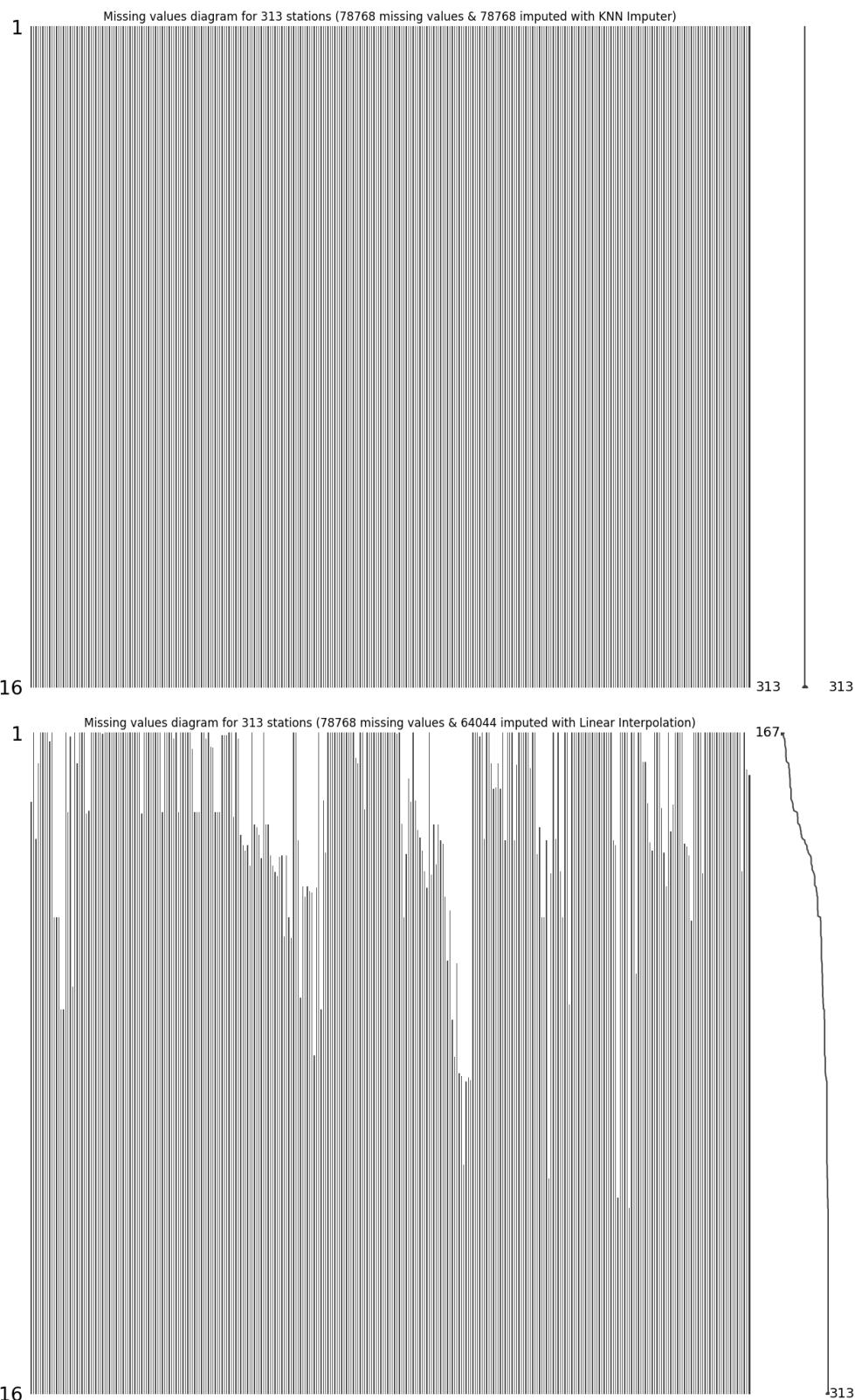
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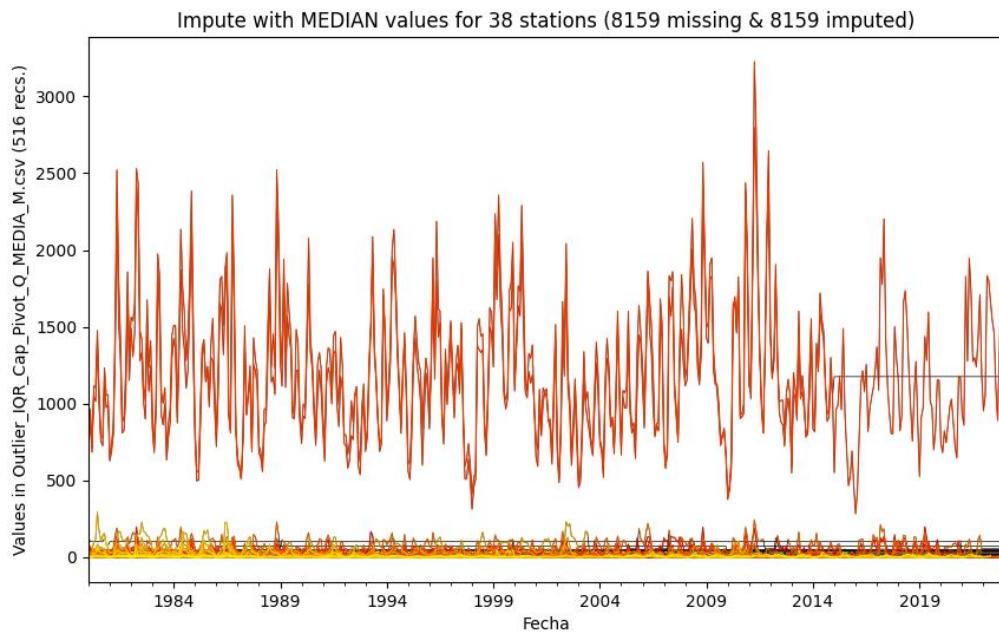
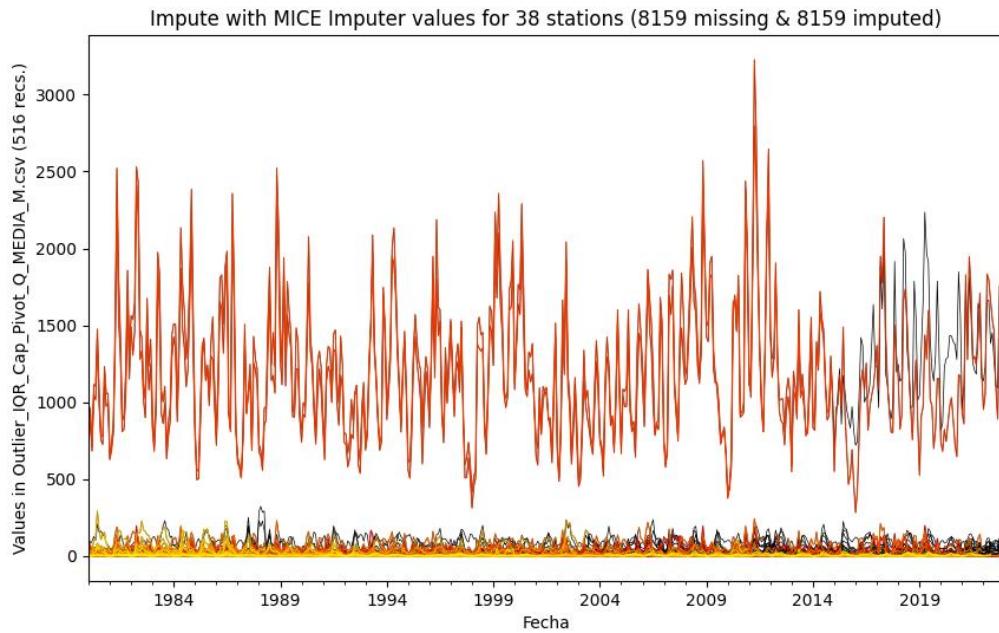
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Fuente: Elaboración Propia, 2023.

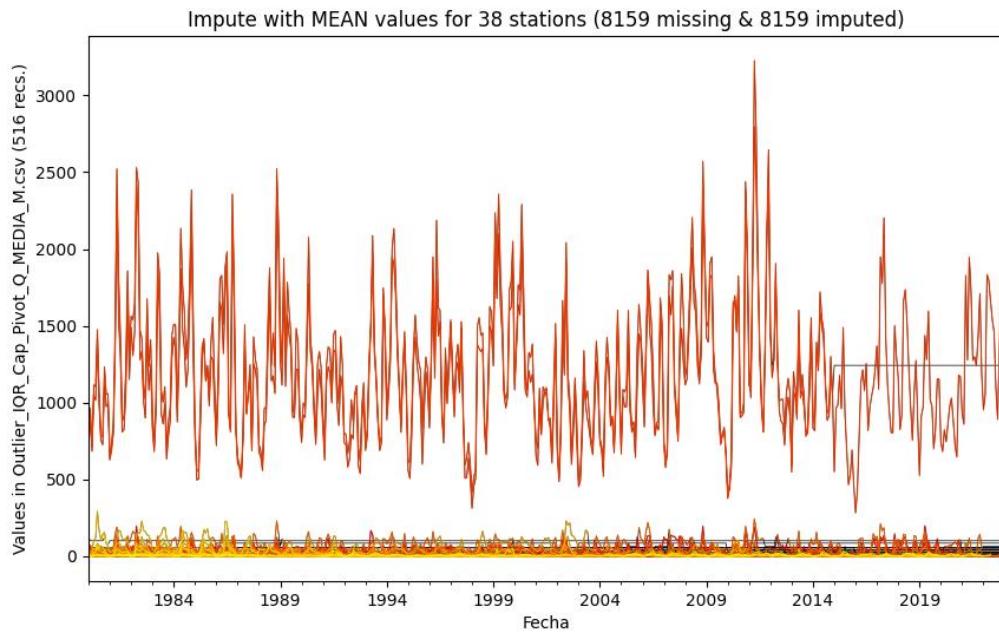
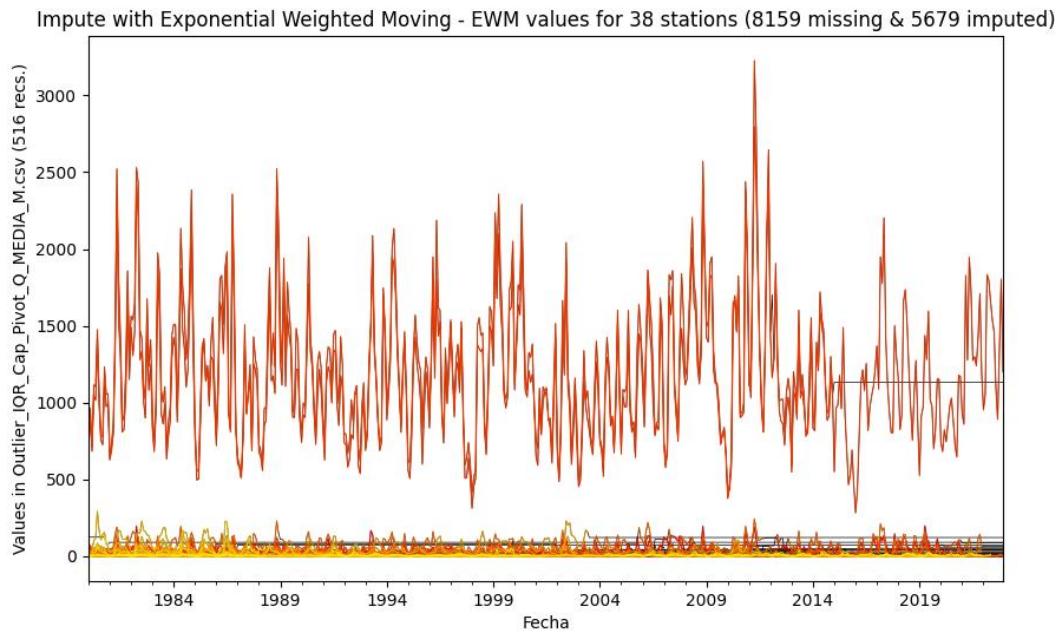
Se realizó el mismo ejercicio para los parámetros de caudal.

Ilustración 3-7. Resultados Impute Caudal



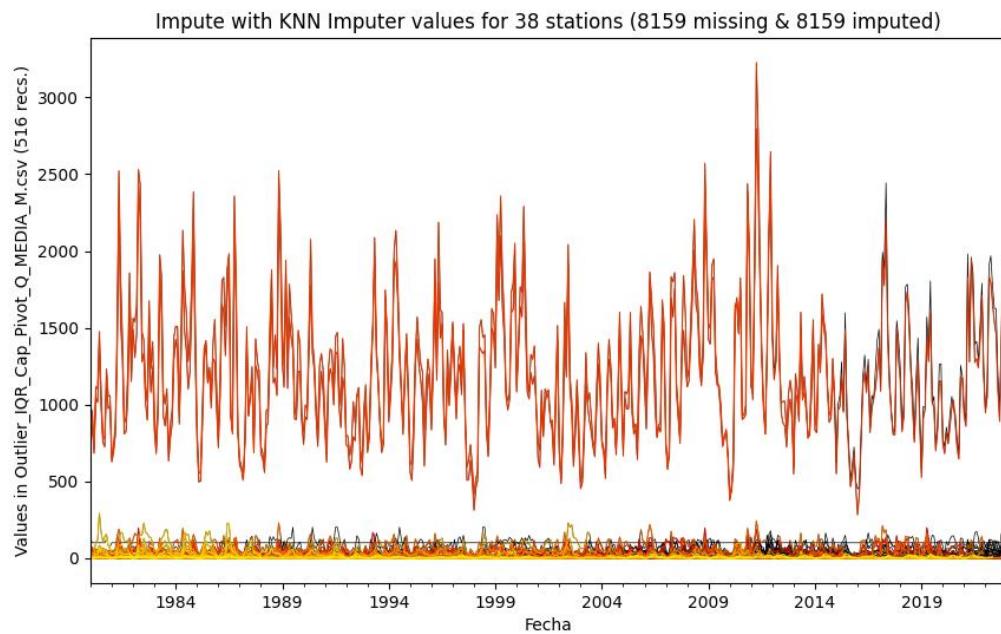
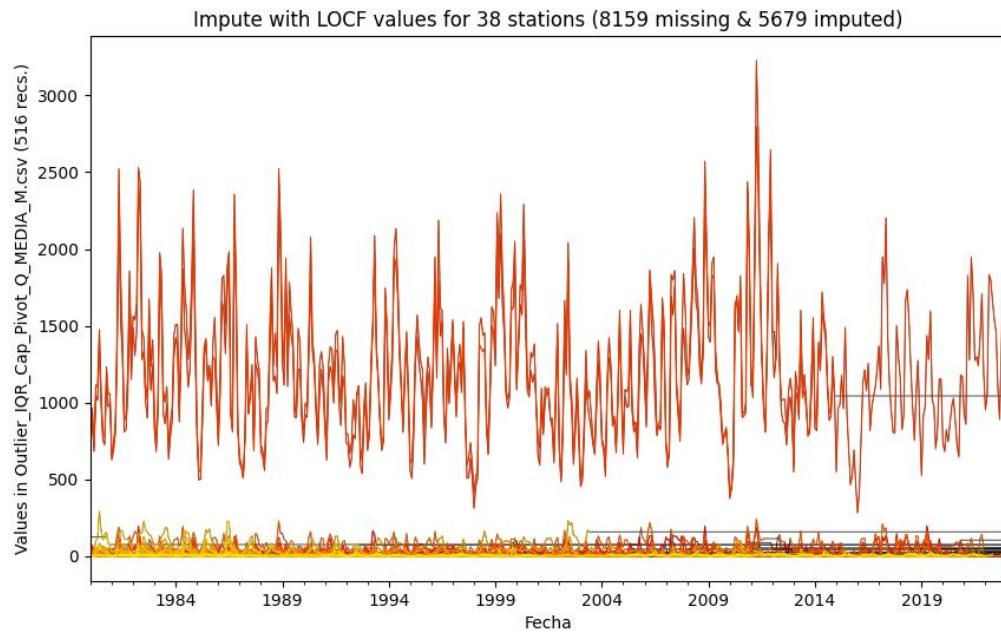
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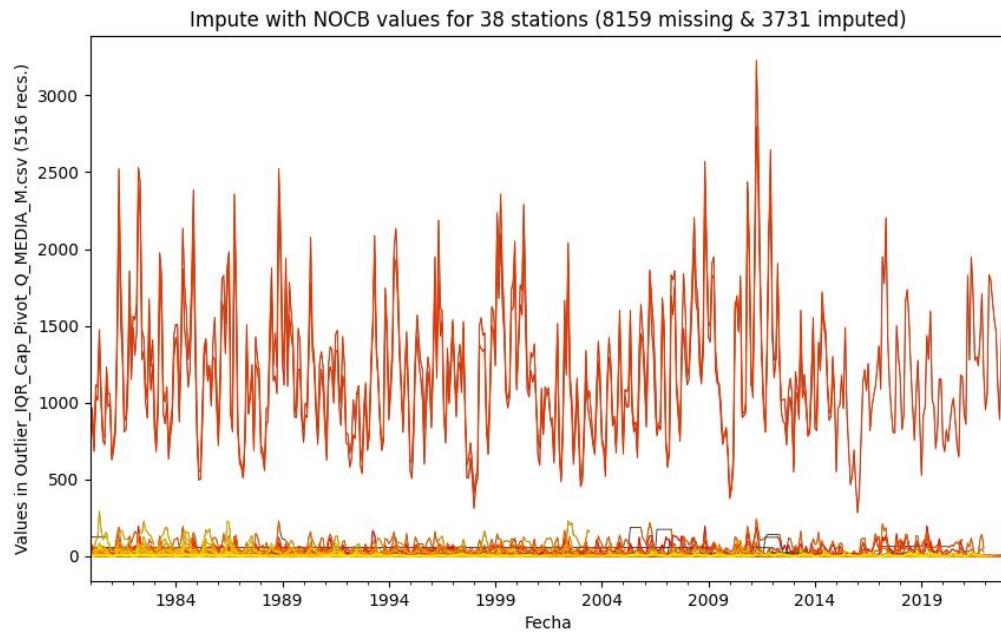
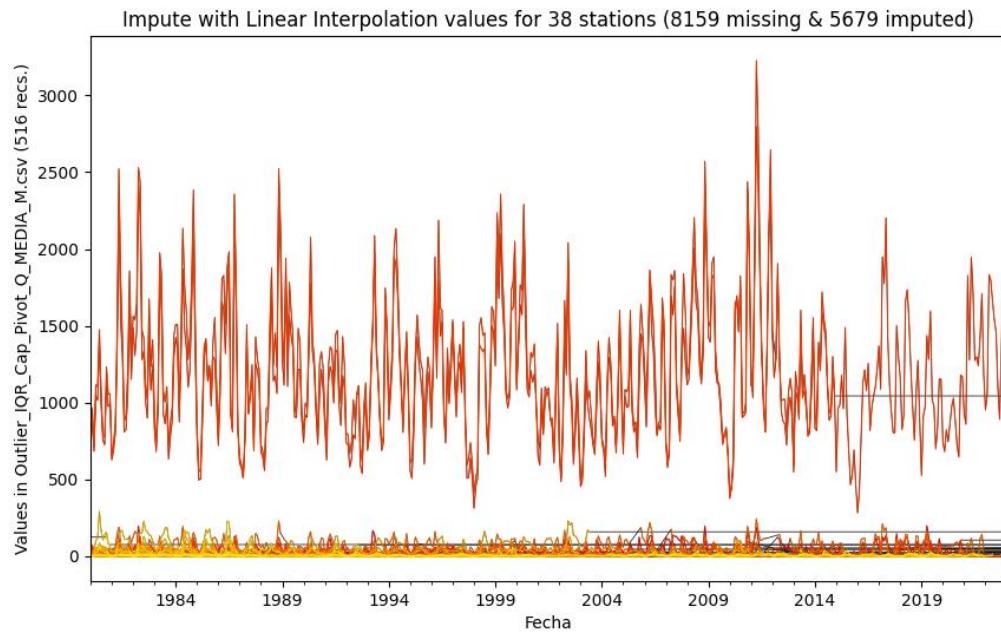
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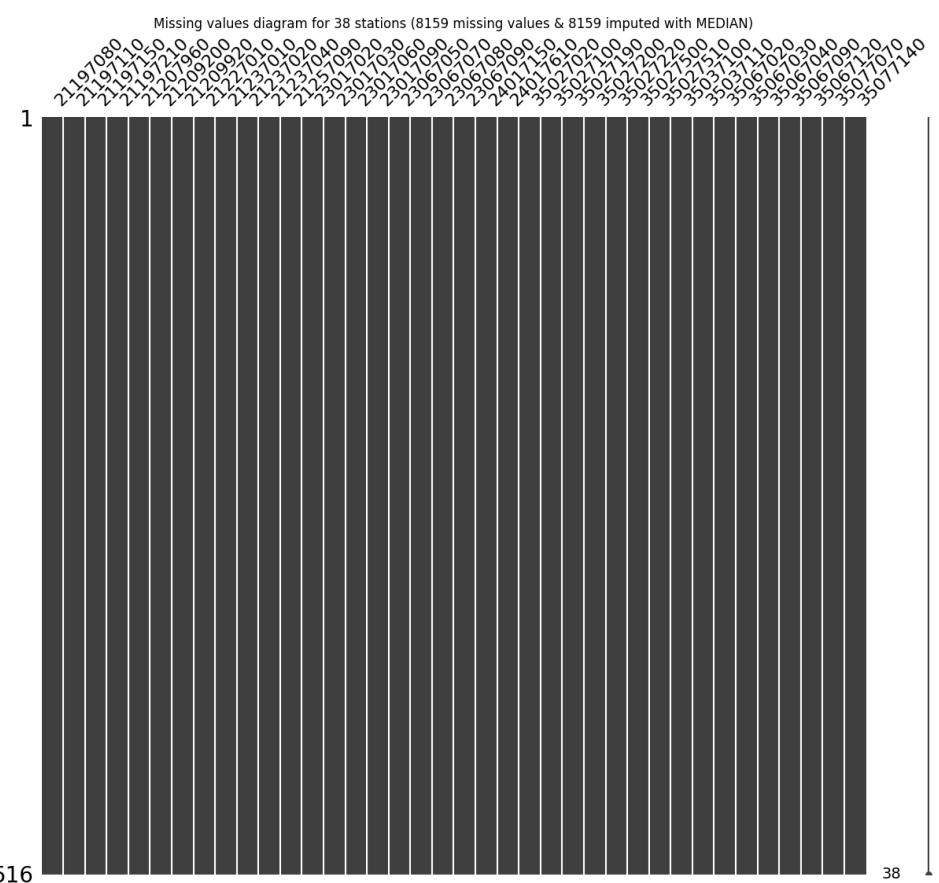
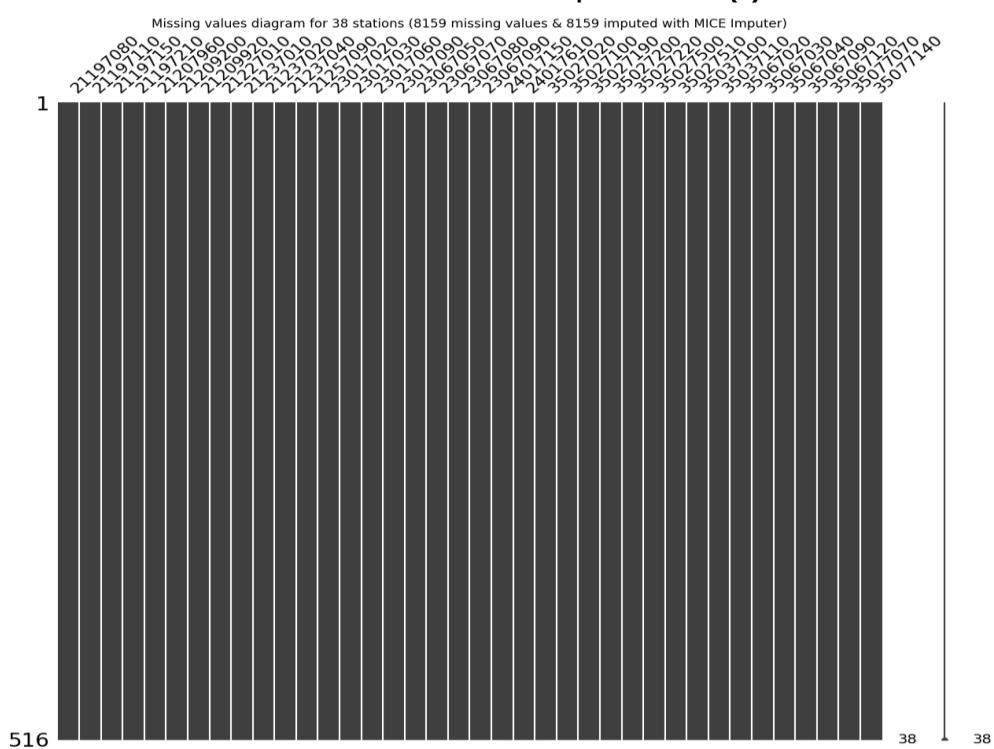


Fuente: Elaboración Propia, 2023.

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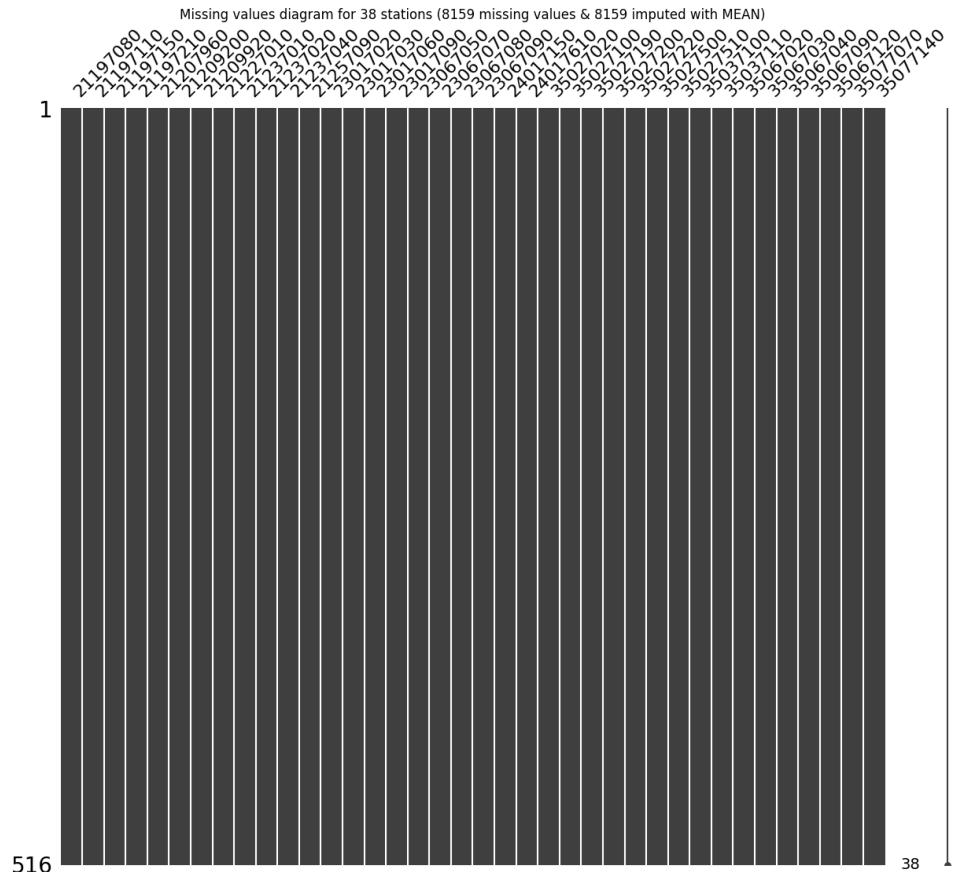
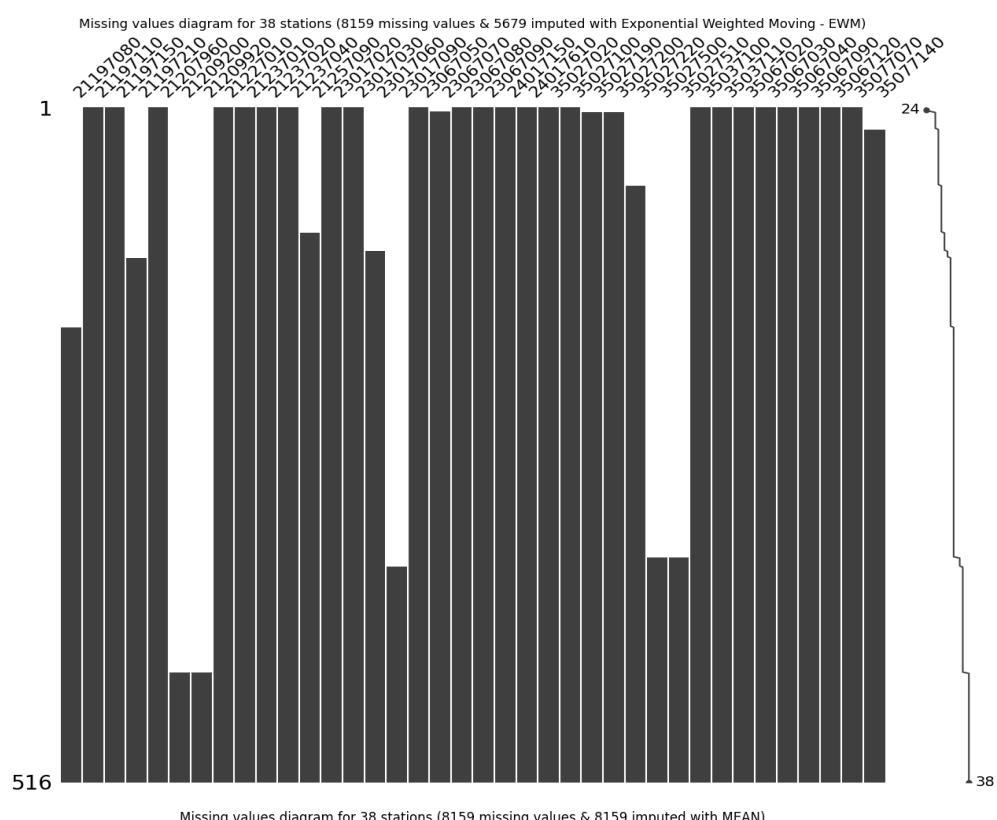
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Ilustración 3-8. Resultados Impute Caudal (2)



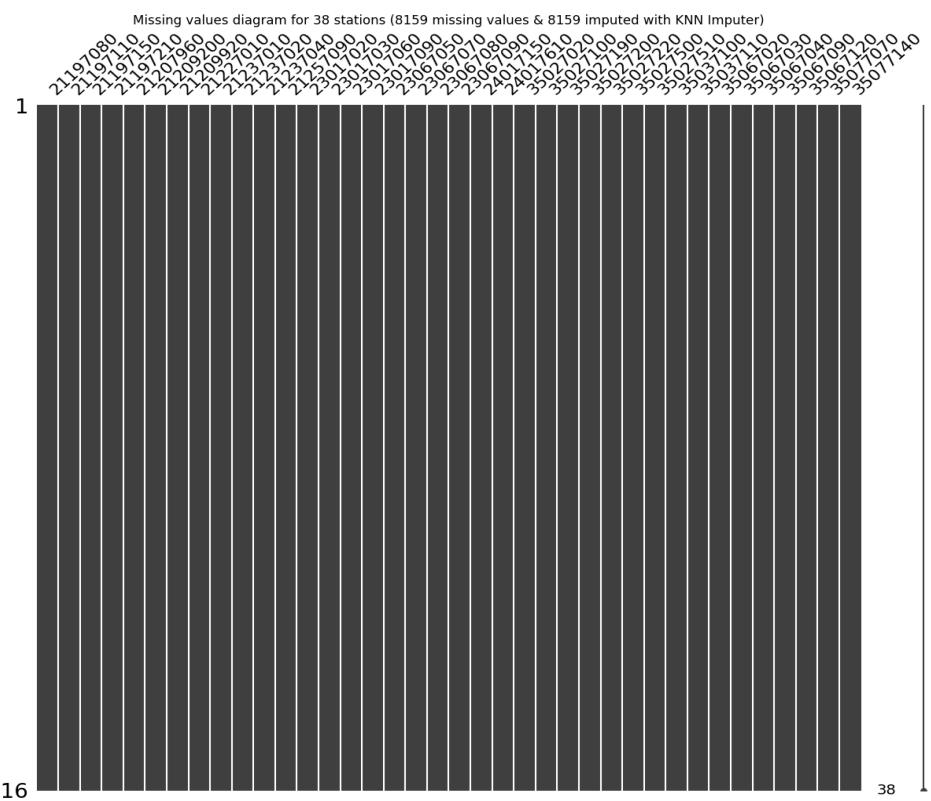
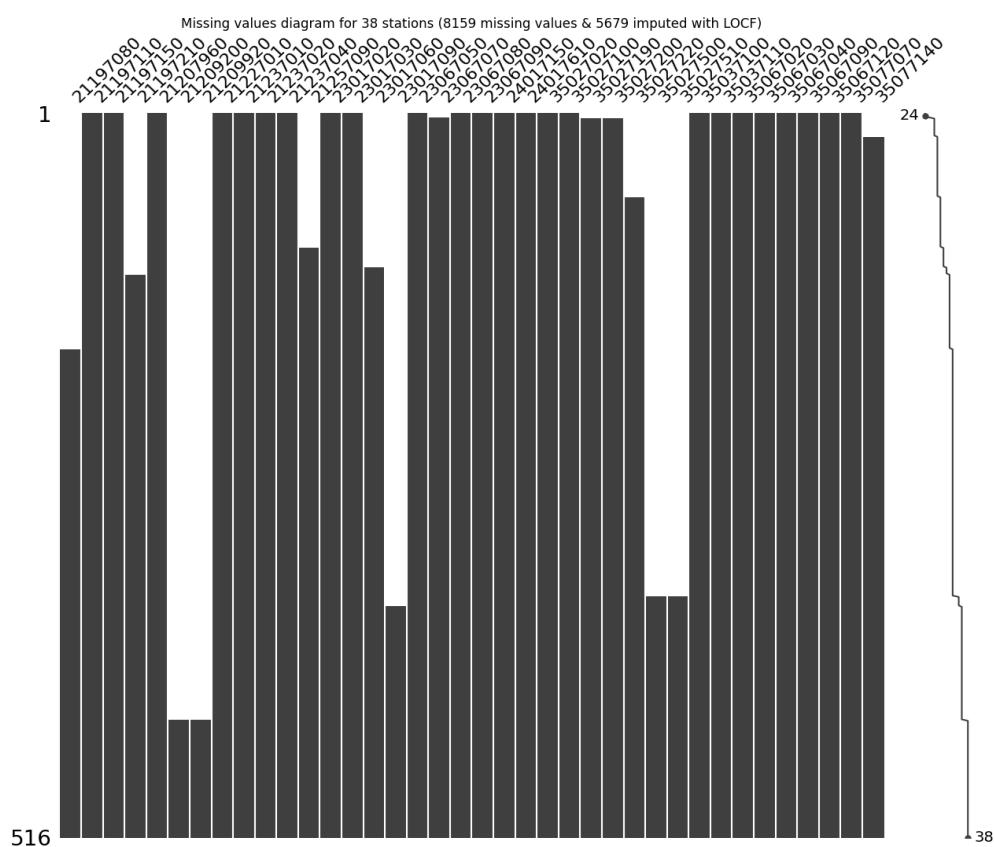
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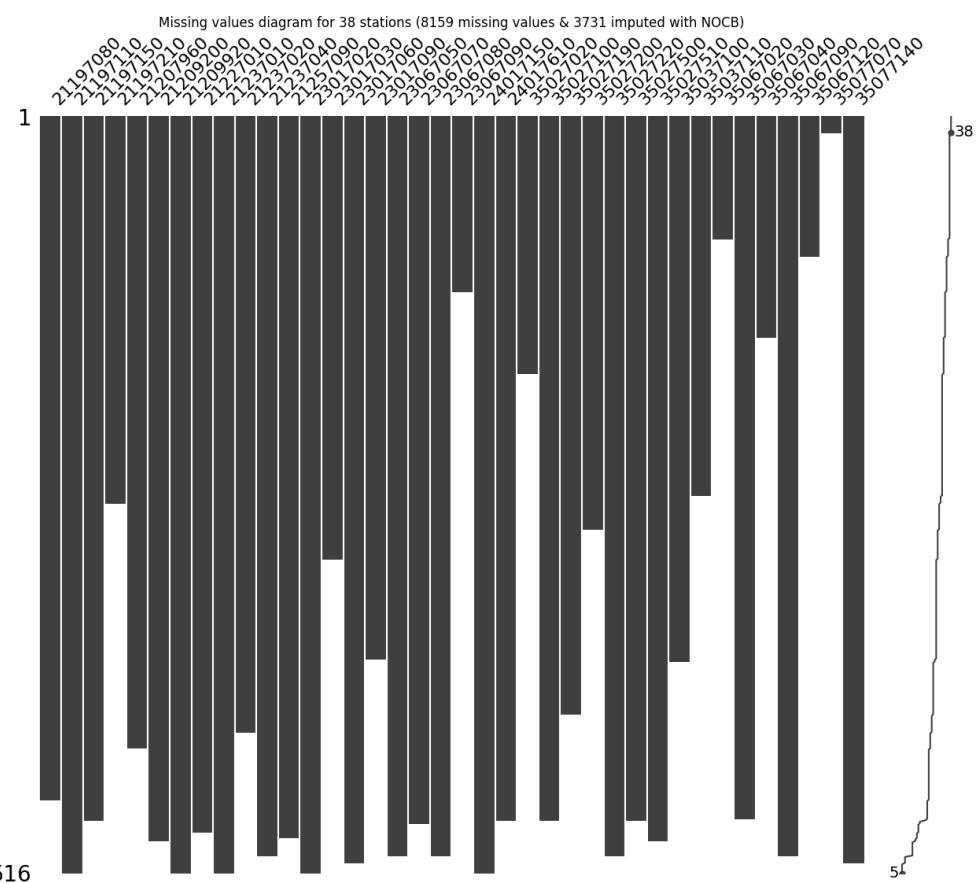
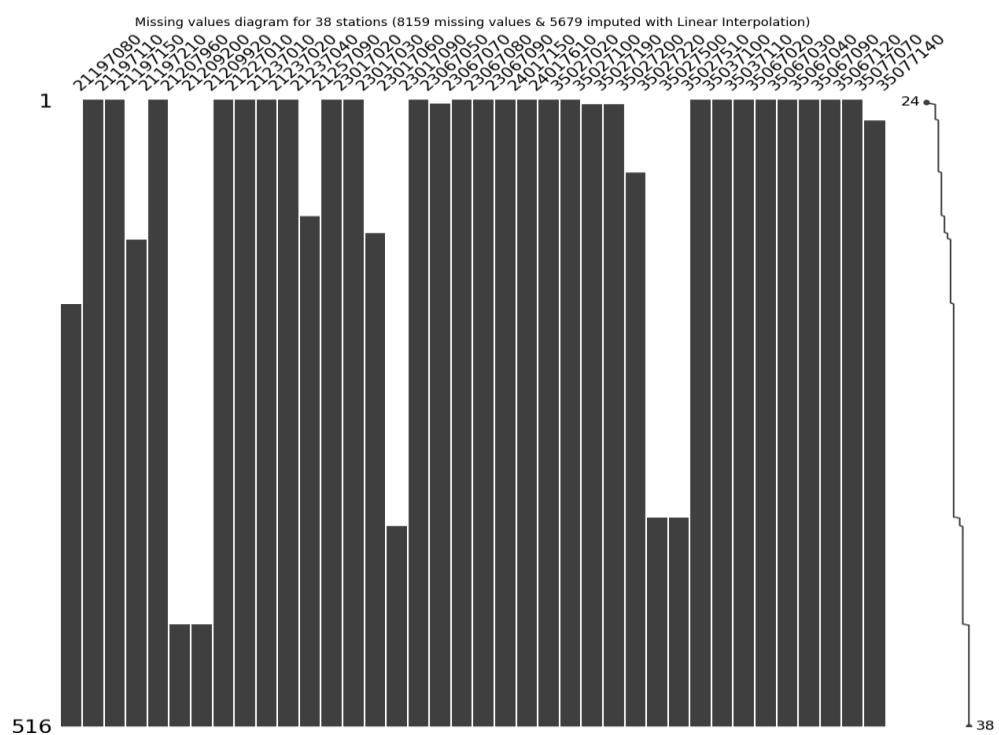
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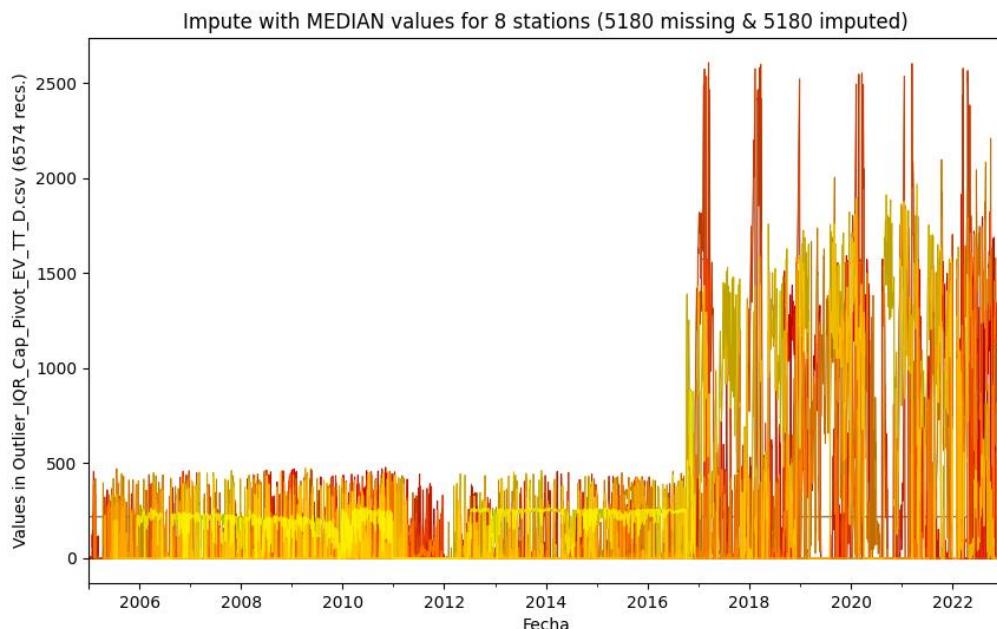
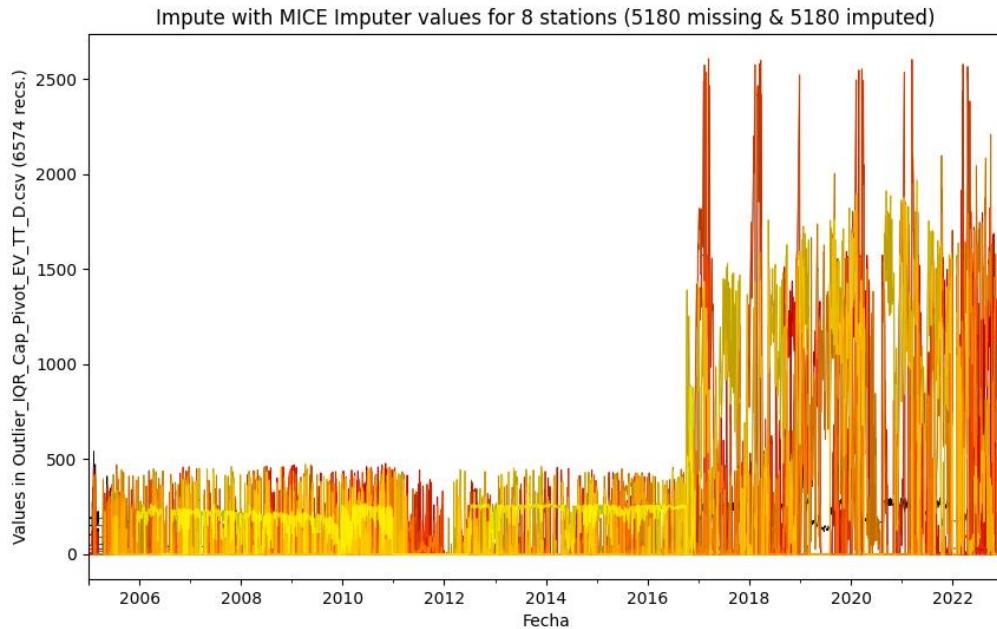
Fuente: Elaboración Propia, 2023.

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Se realizó el mismo ejercicio para los parámetros de evaporación.

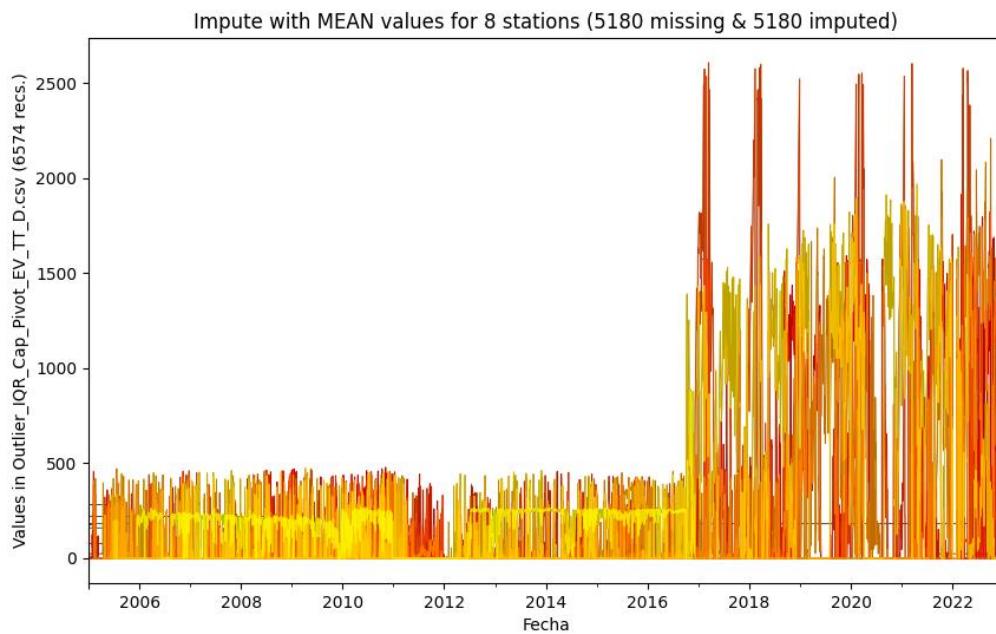
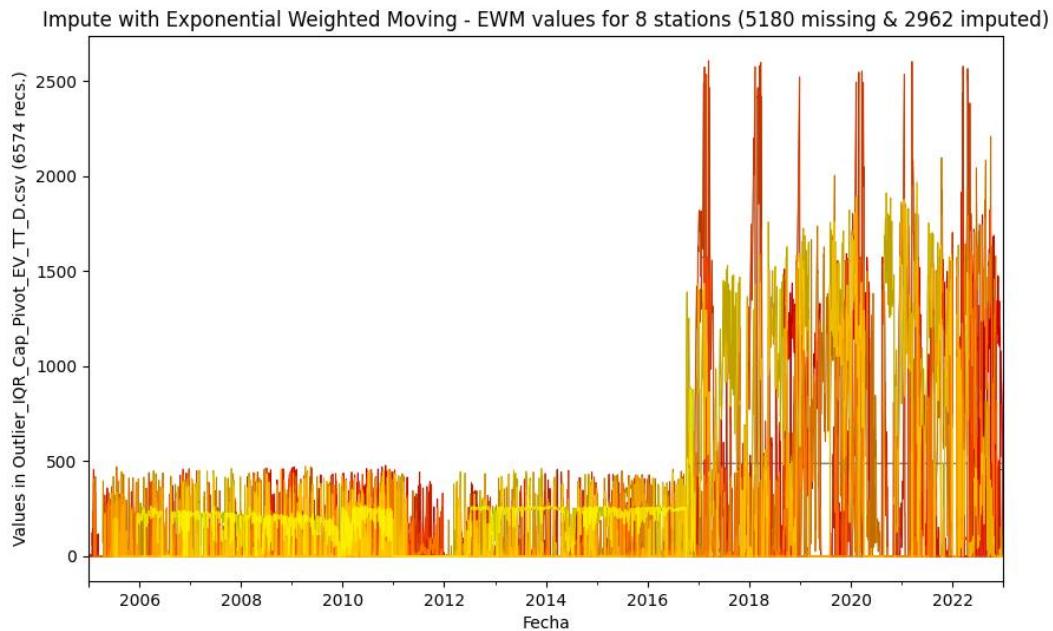
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Ilustración 3-9. Resultados Impute Evaporación



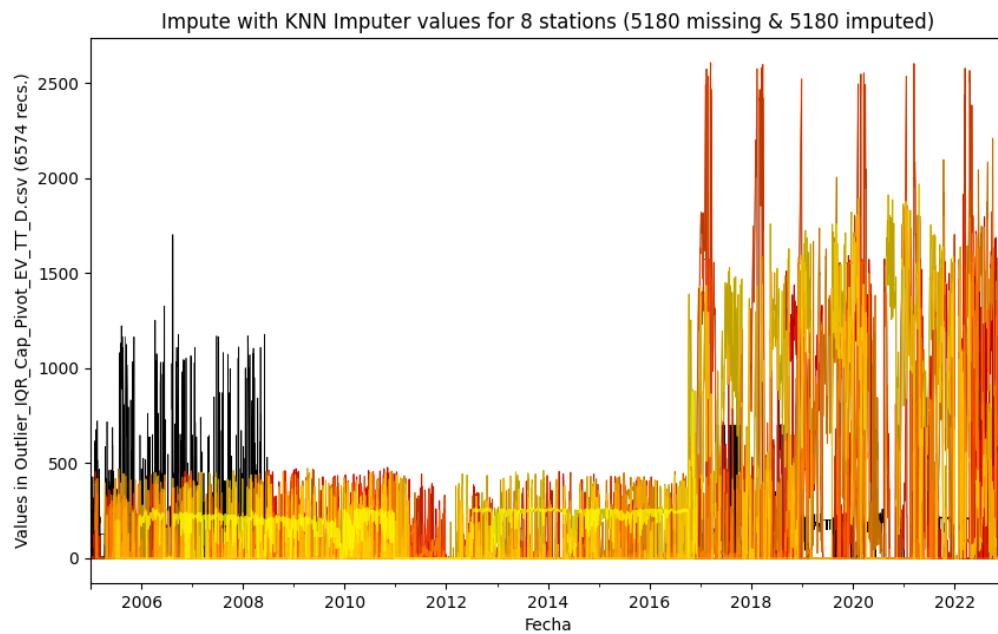
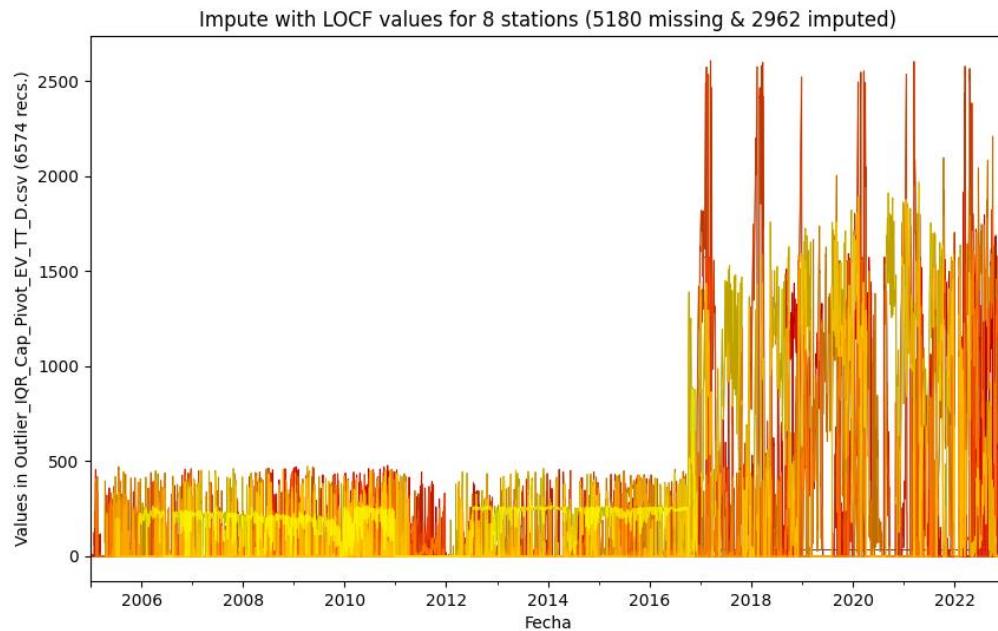
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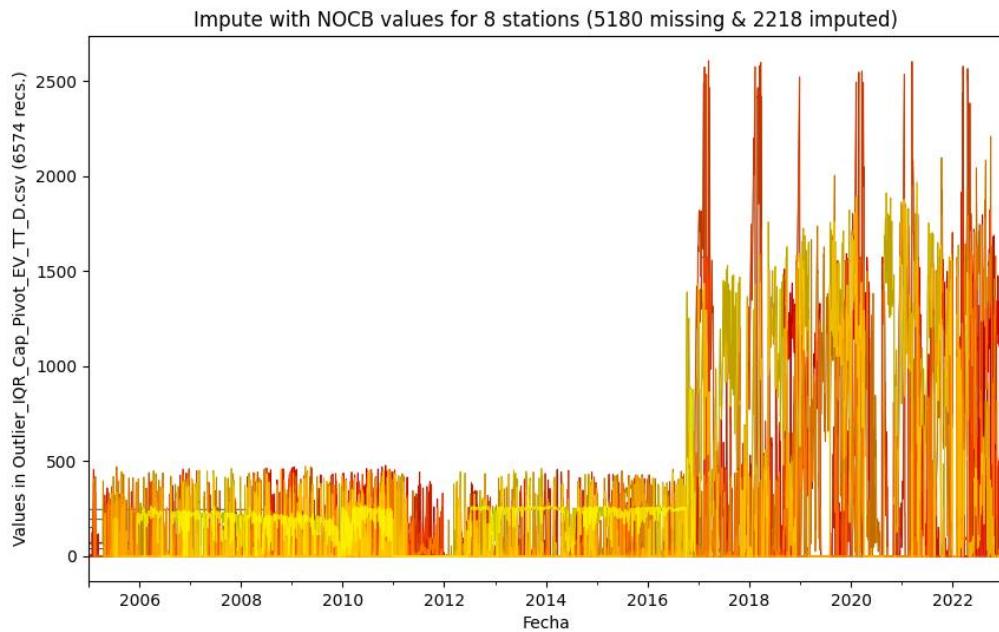
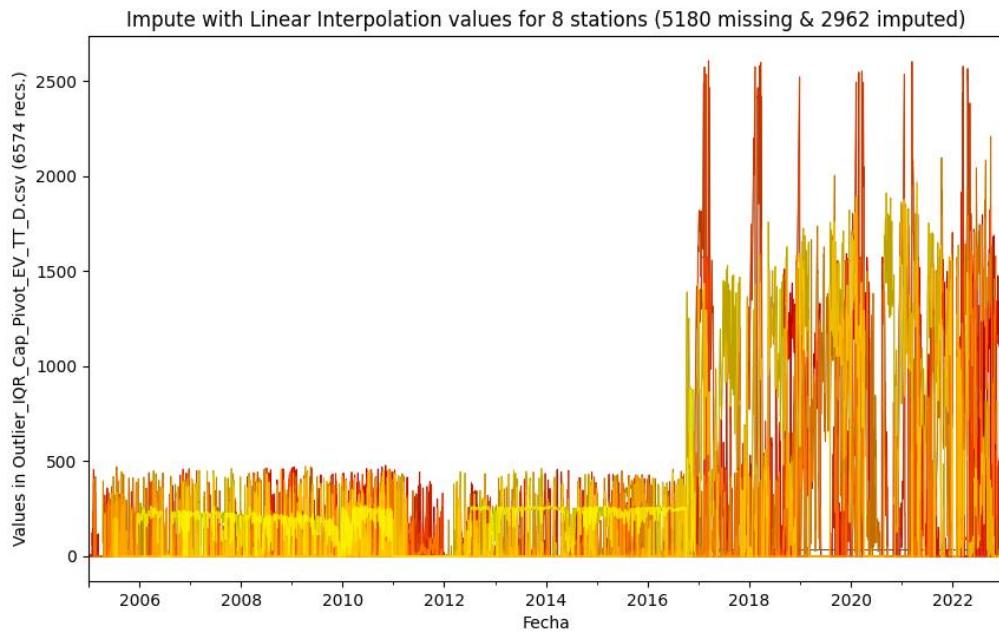
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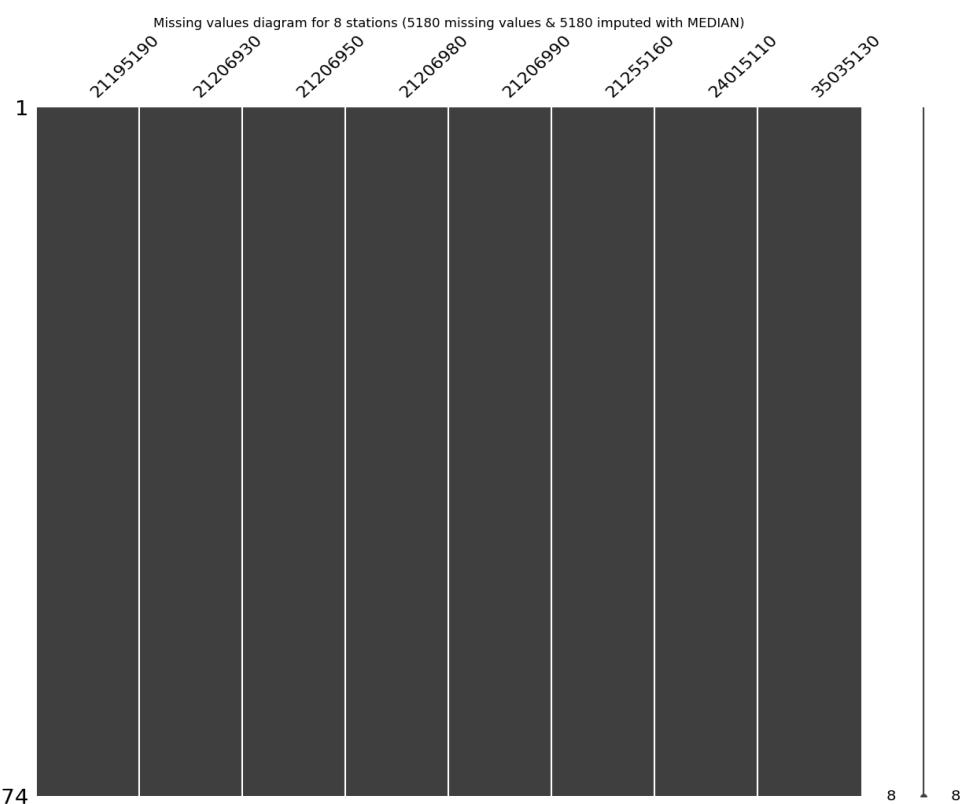
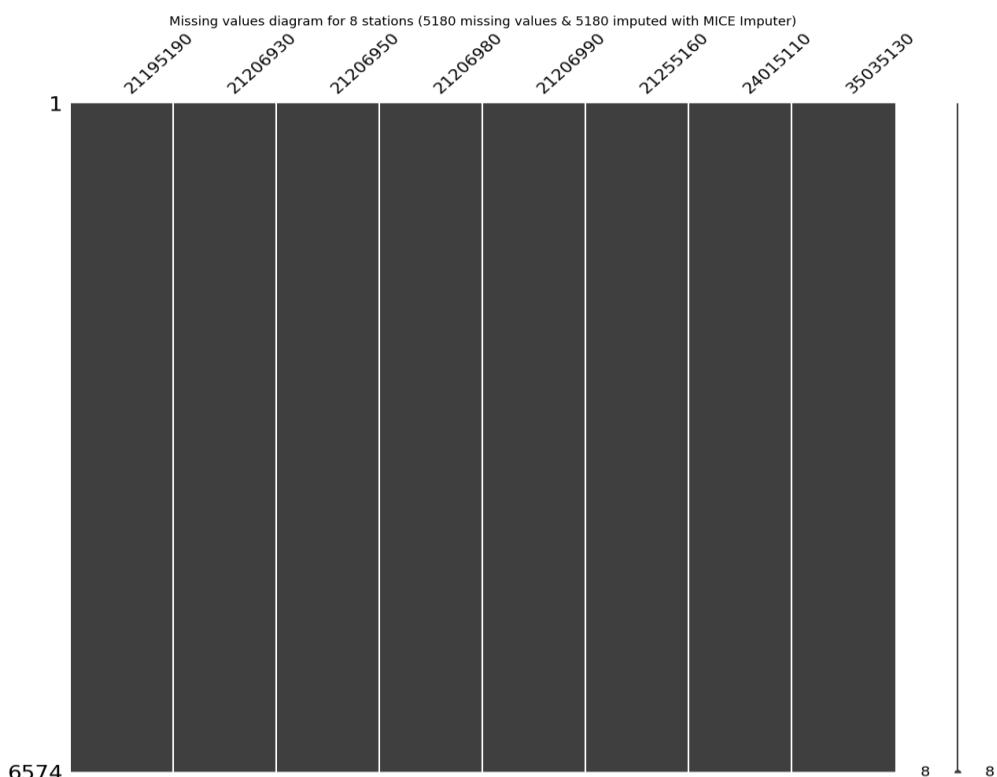


Fuente: Elaboración Propia, 2023.

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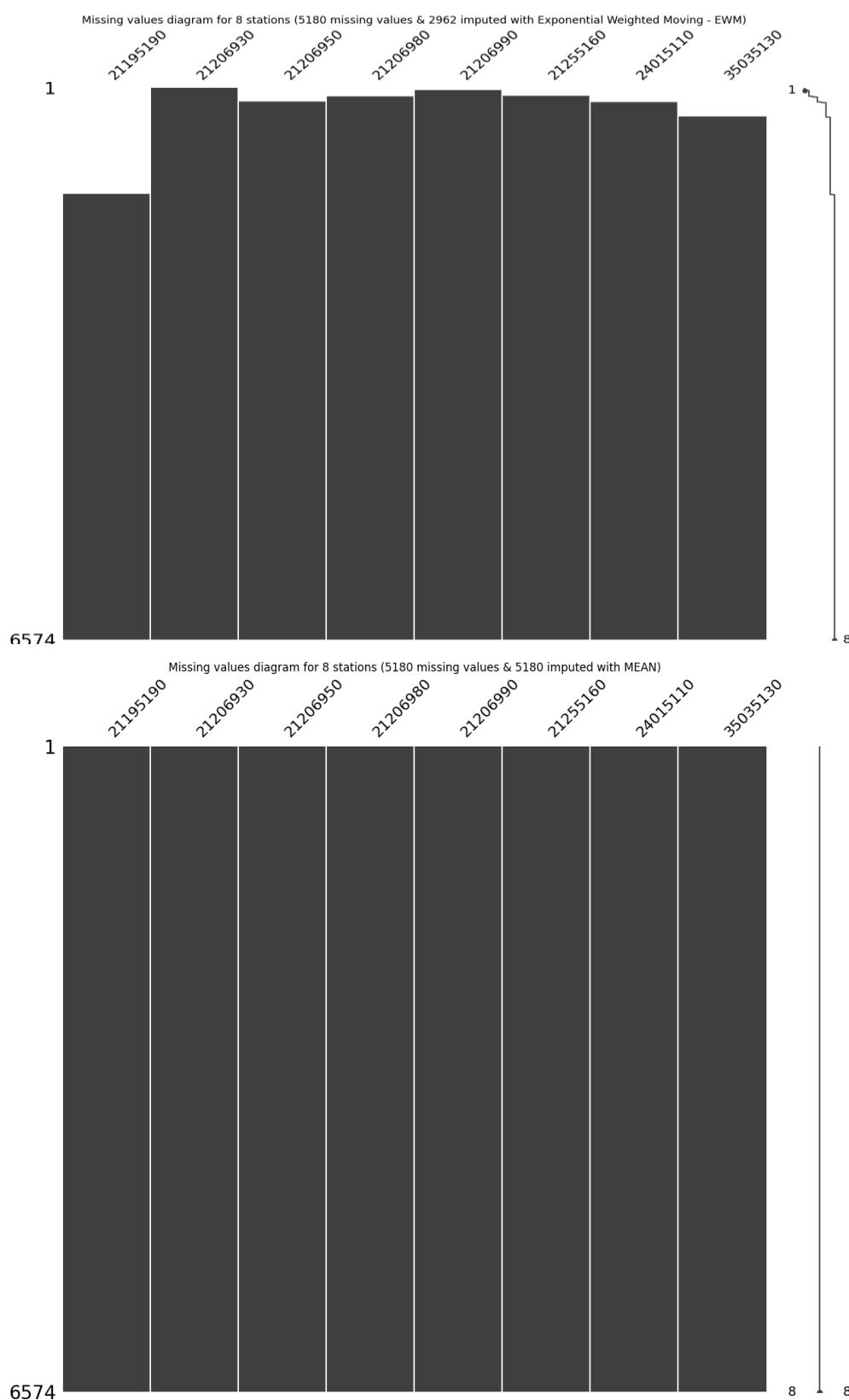
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Ilustración 3-10. Resultados Impute Evaporación (2)



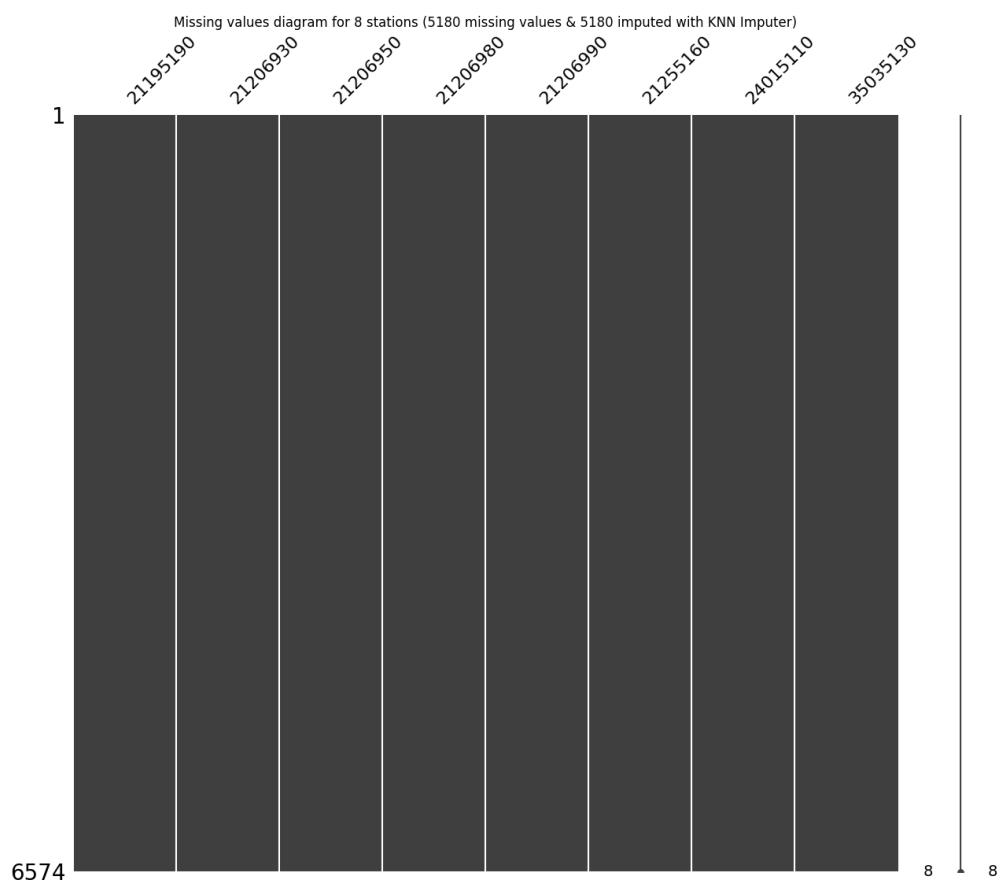
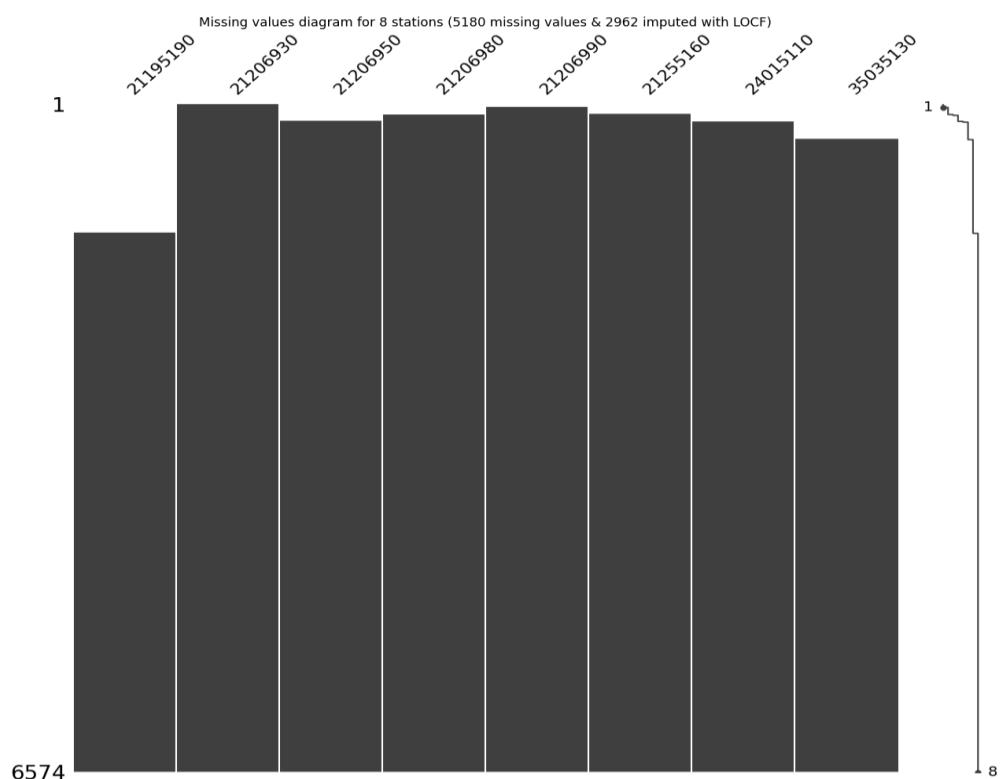
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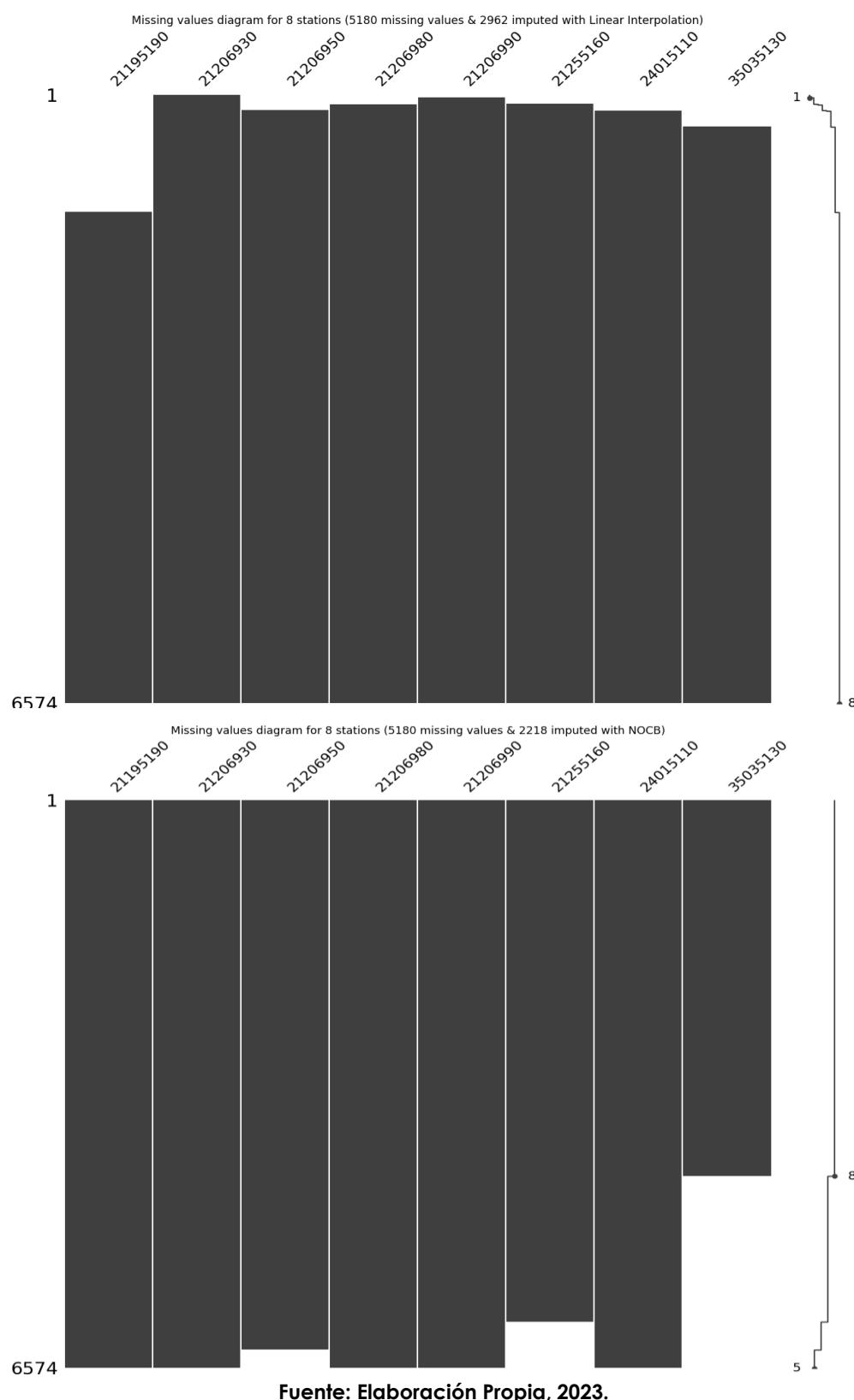
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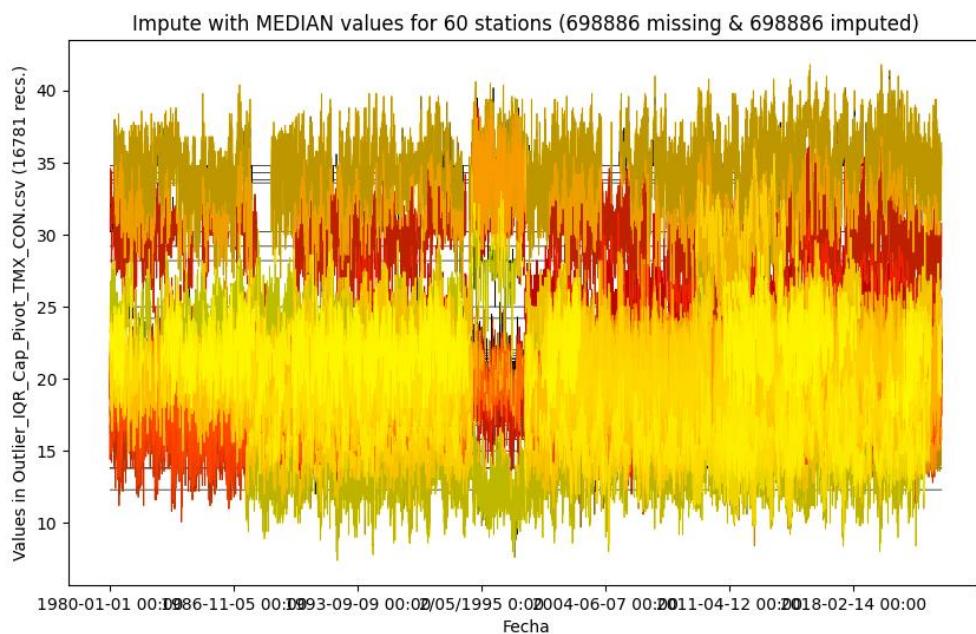
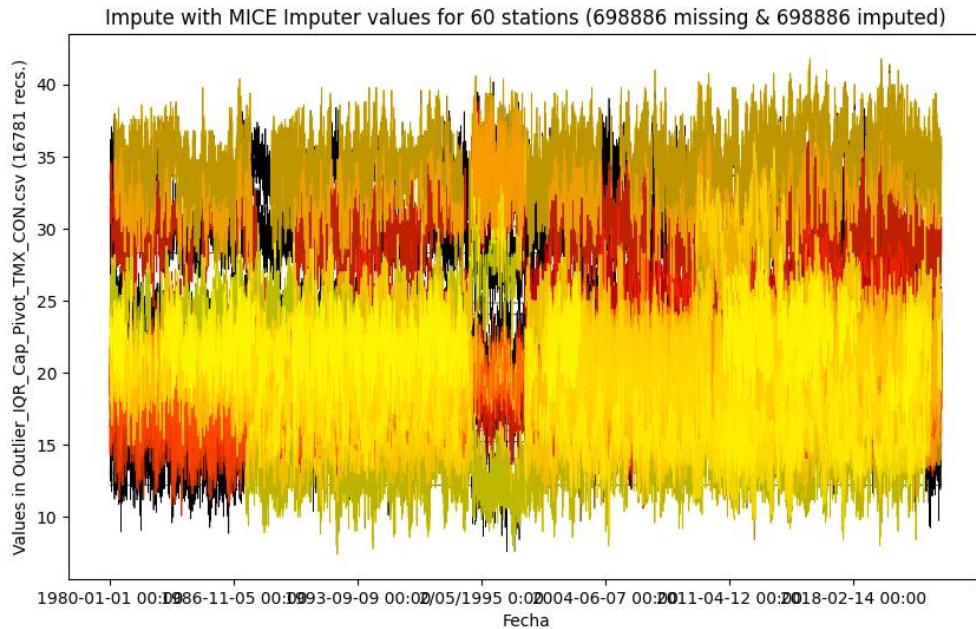
Fuente: Elaboración Propia, 2023.

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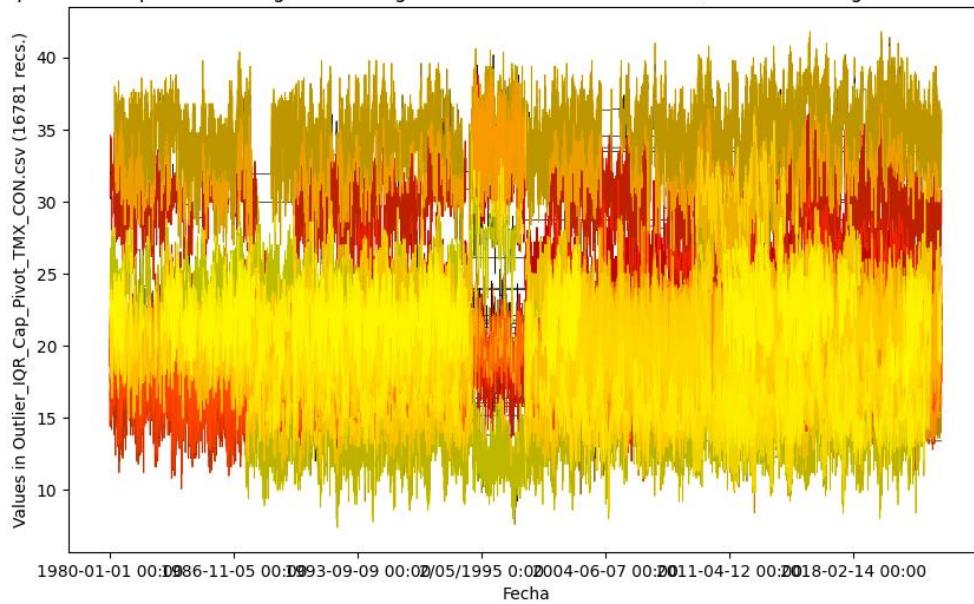
Ilustración 3-11. Resultados Impute Temperatura Máxima



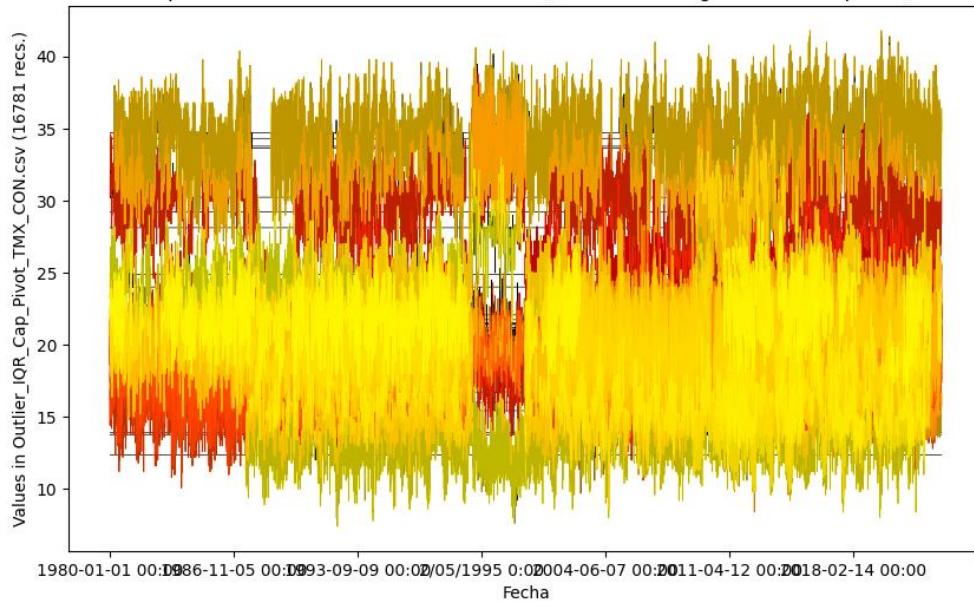
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Impute with Exponential Weighted Moving - EWM values for 60 stations (698886 missing & 389143 imputed)

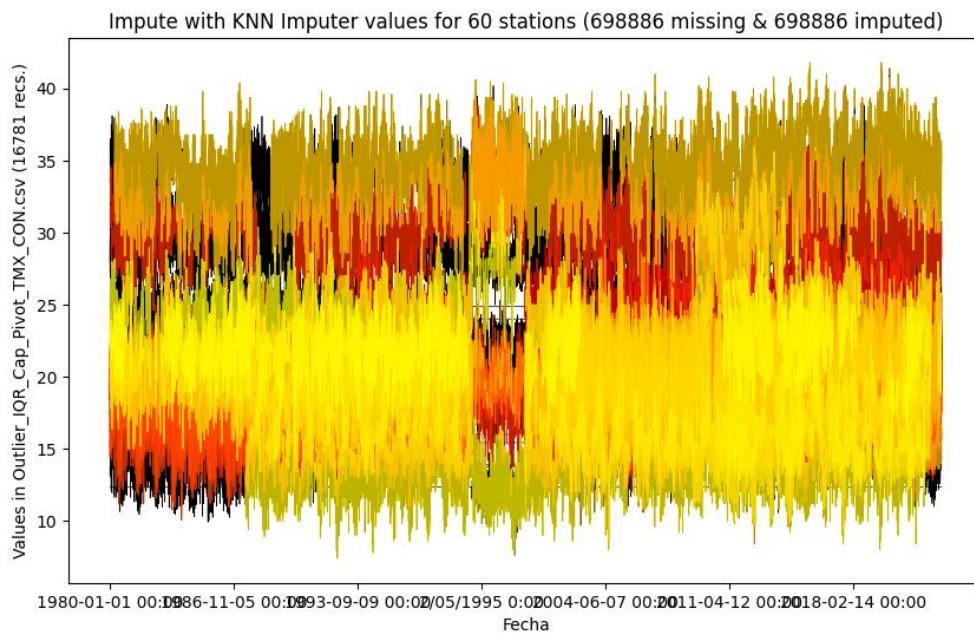
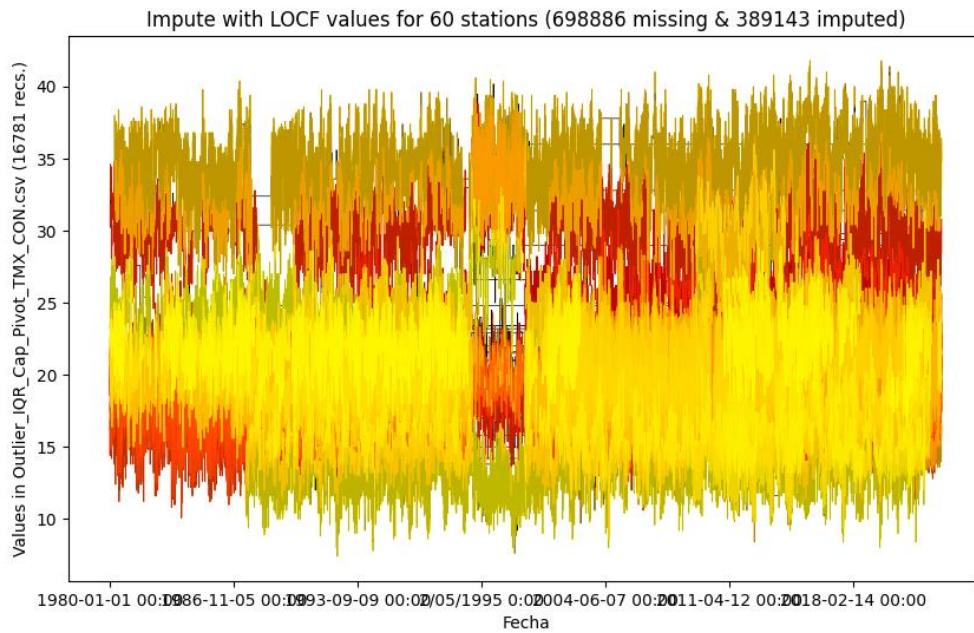


Impute with MEAN values for 60 stations (698886 missing & 698886 imputed)



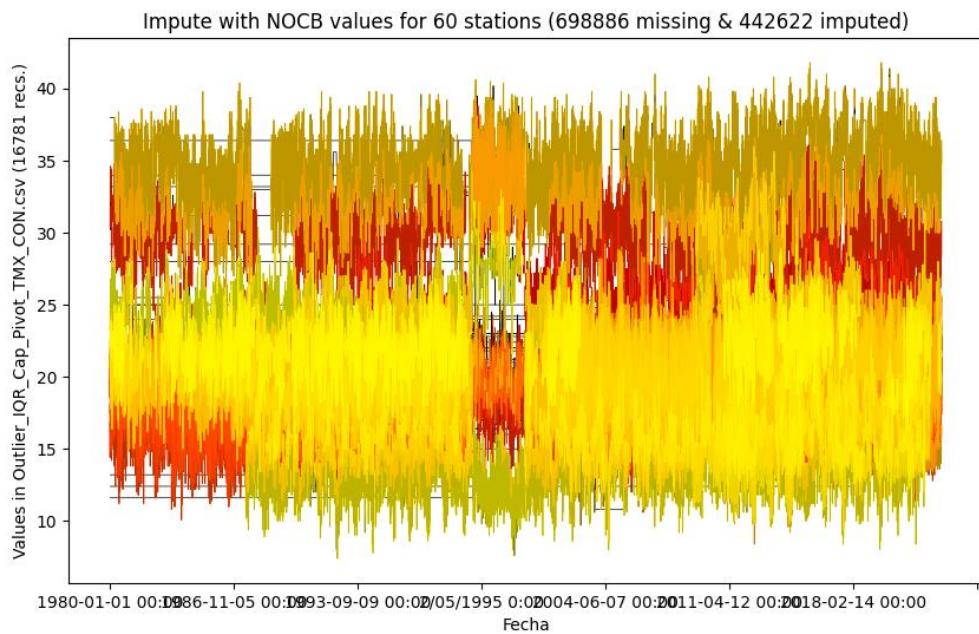
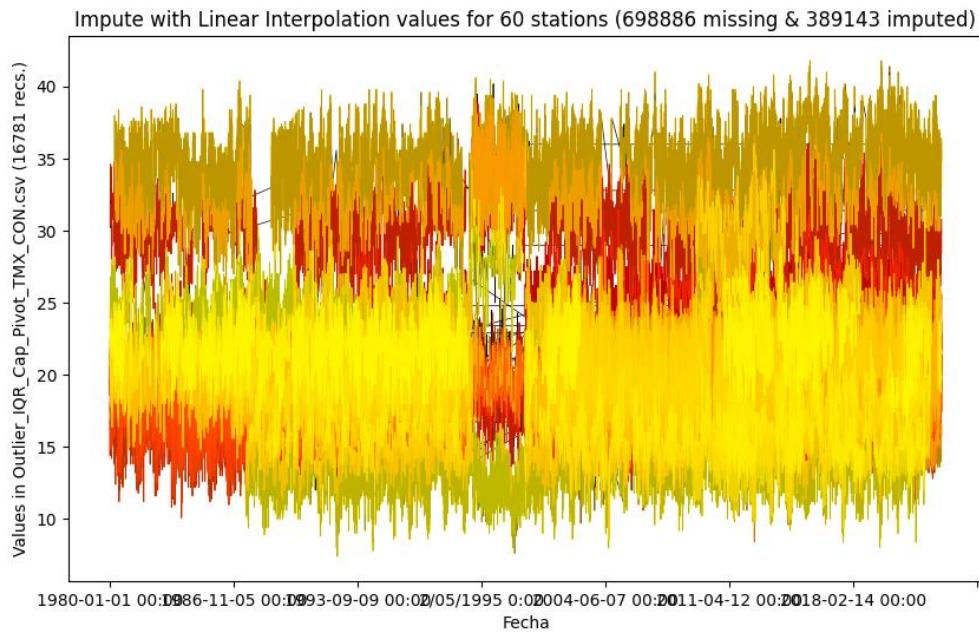
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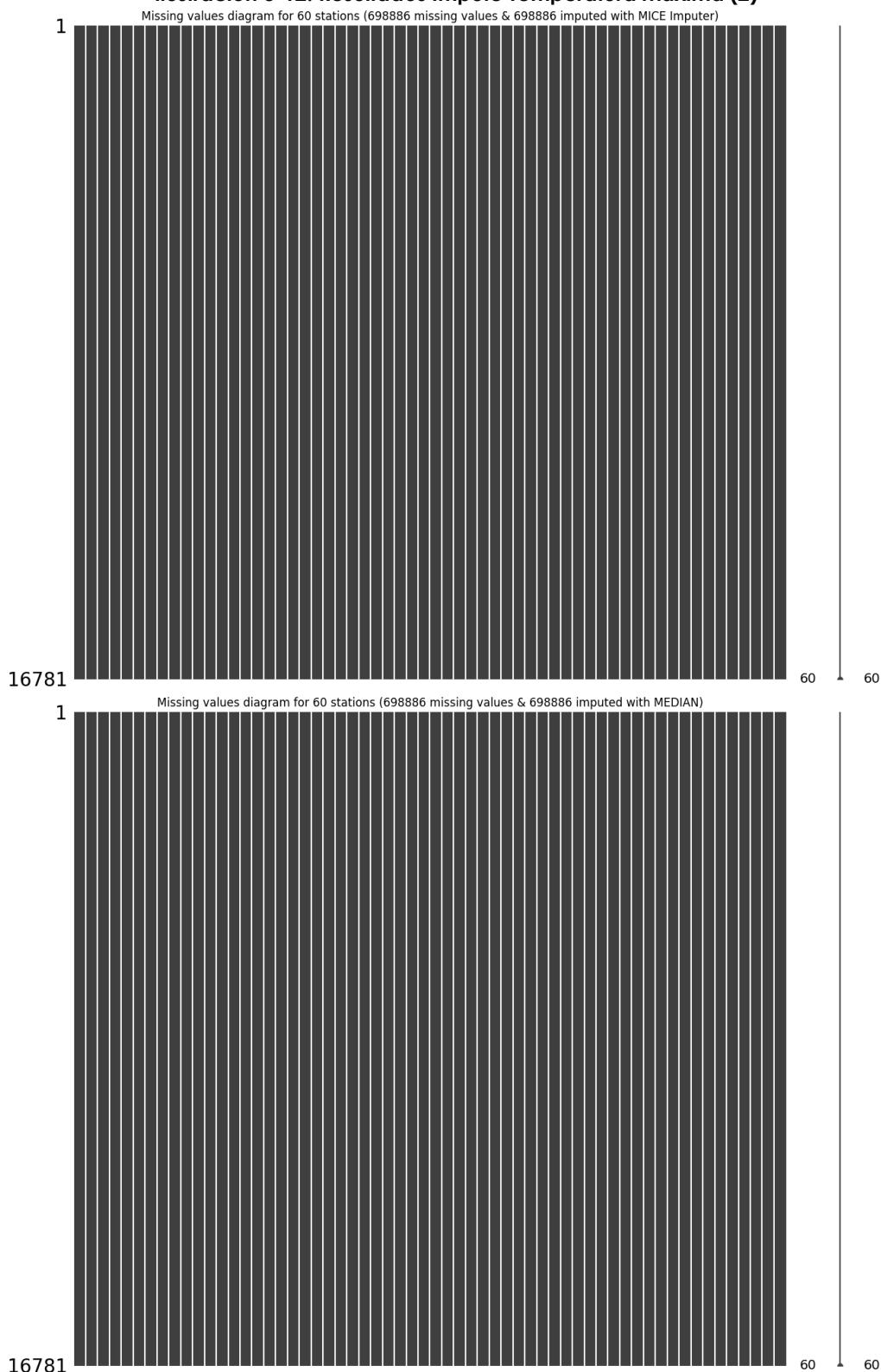
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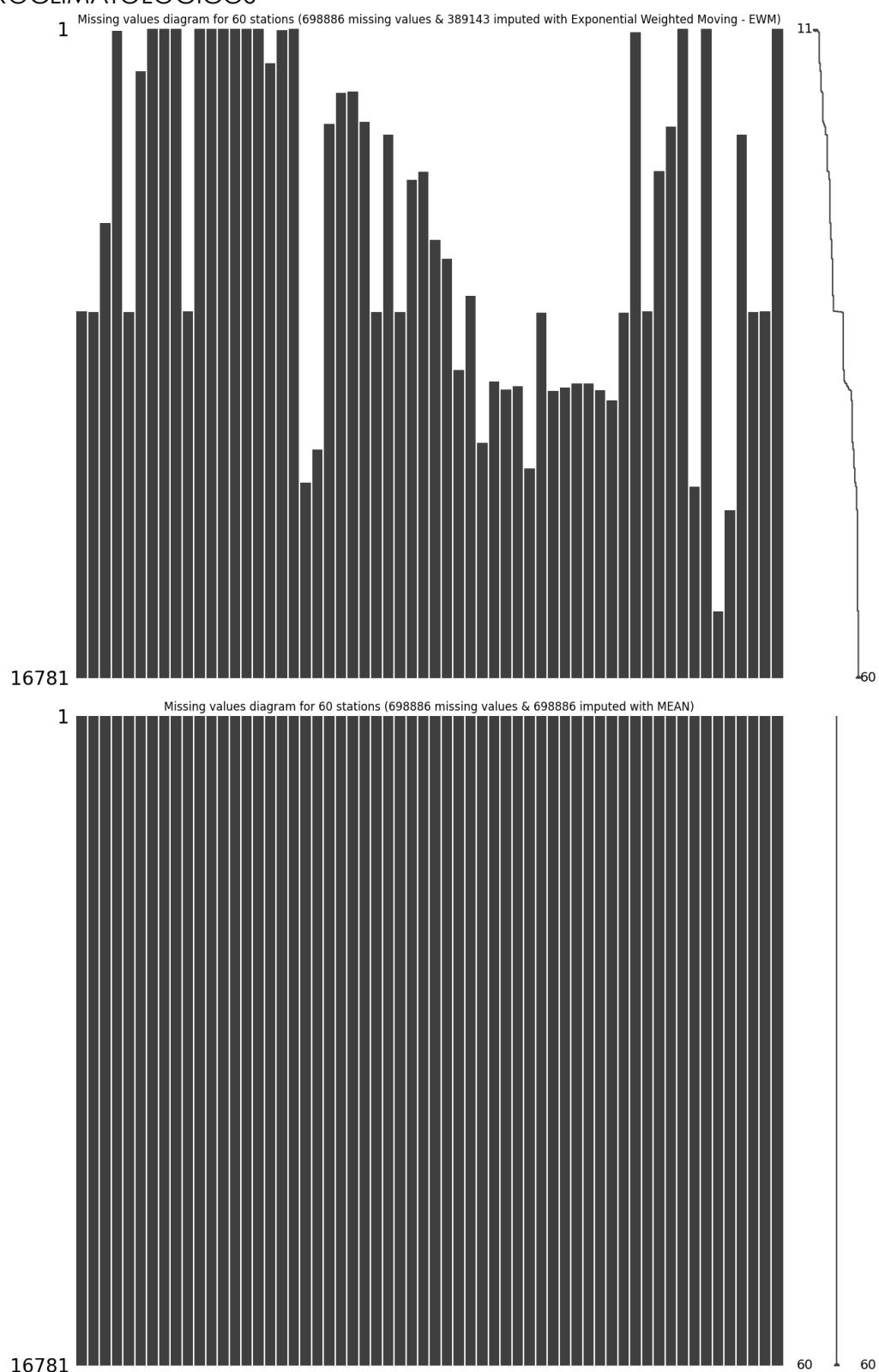
Fuente: Elaboración Propia, 2023.

Ilustración 3-12. Resultados Impute Temperatura Máxima (2)



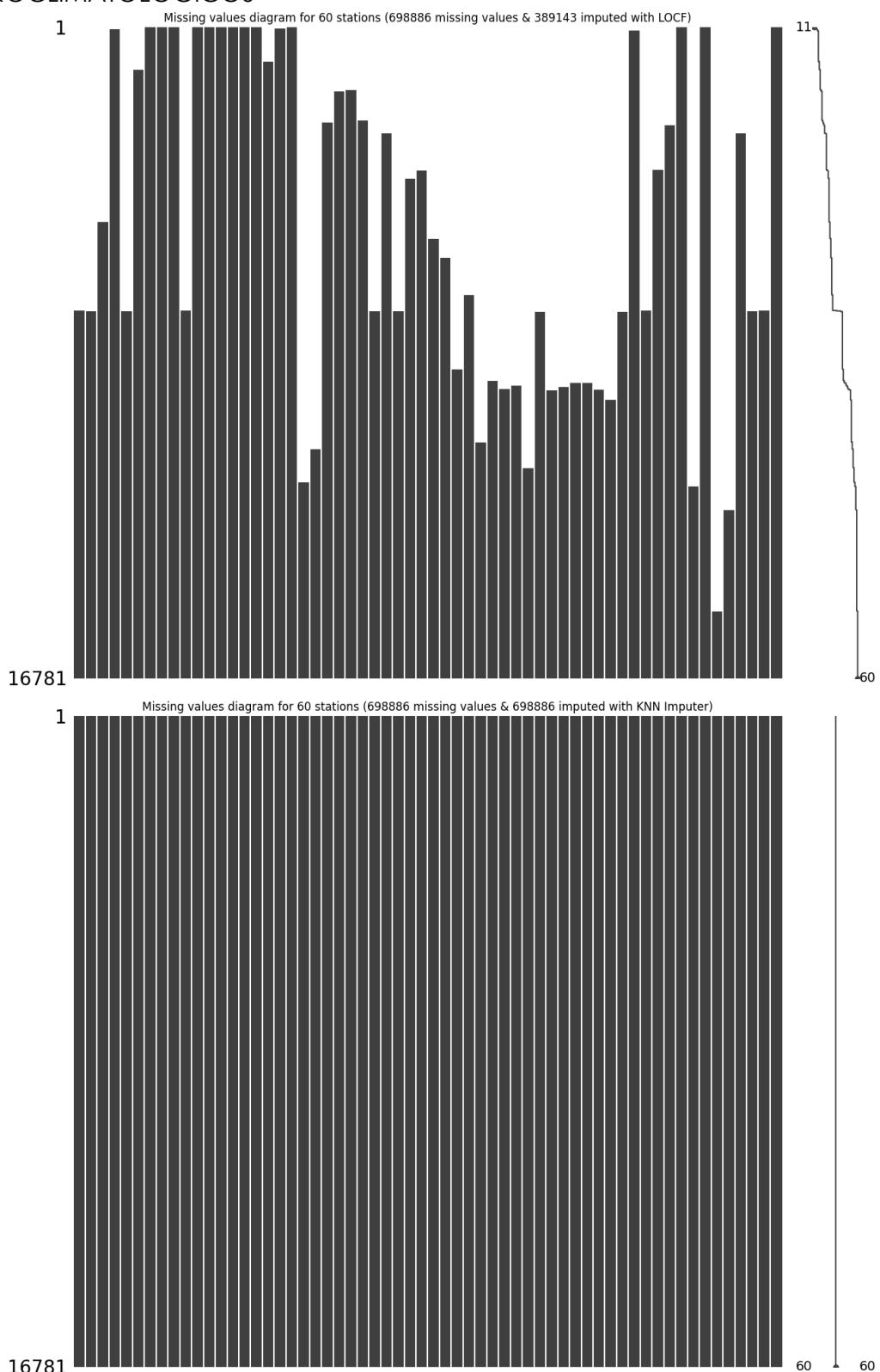
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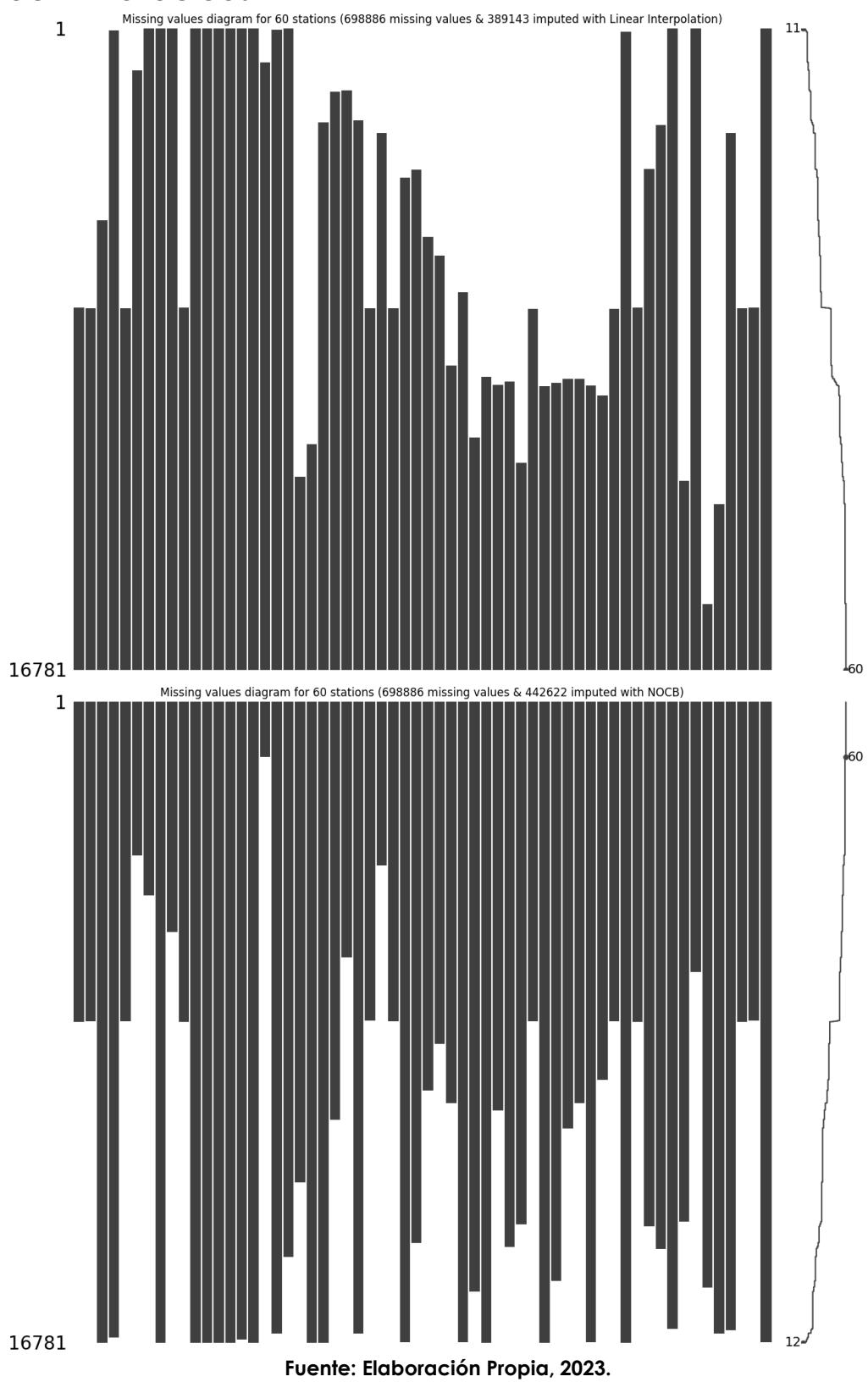
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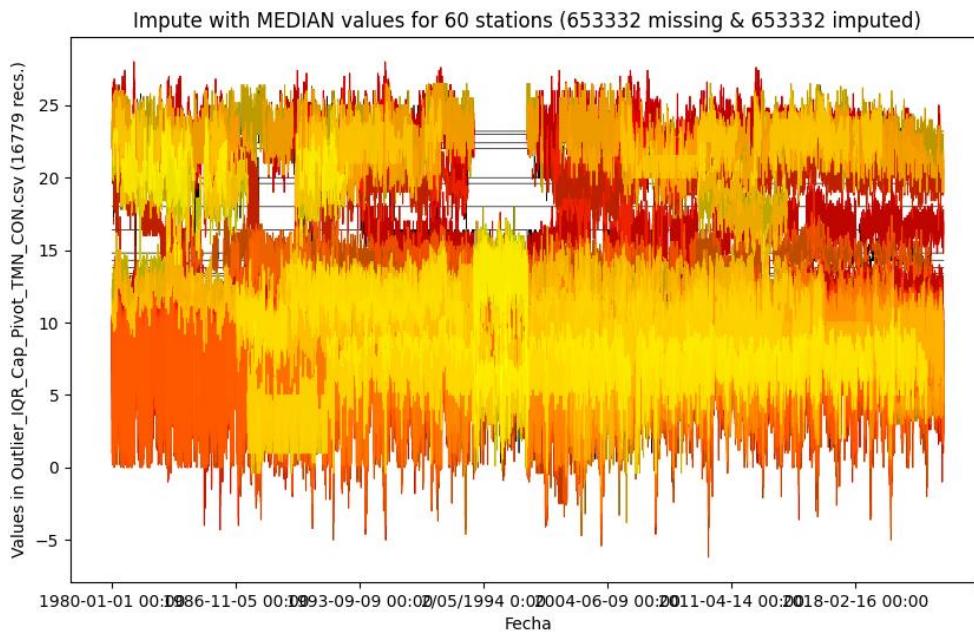
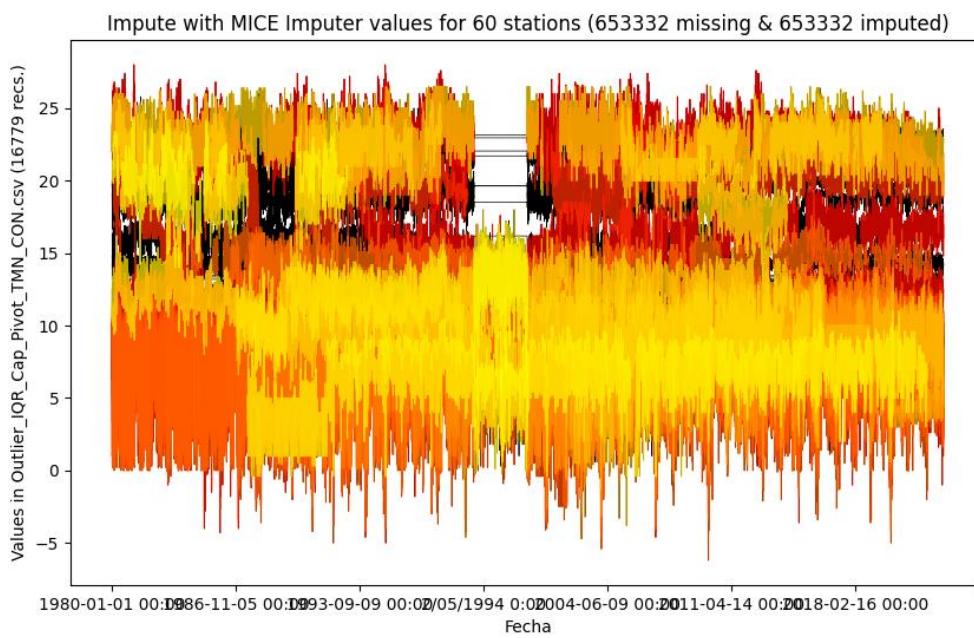
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CC: 1032395475
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Fuente: Elaboración Propia, 2023.

Se realizó el mismo ejercicio para los parámetros de temperatura máxima.

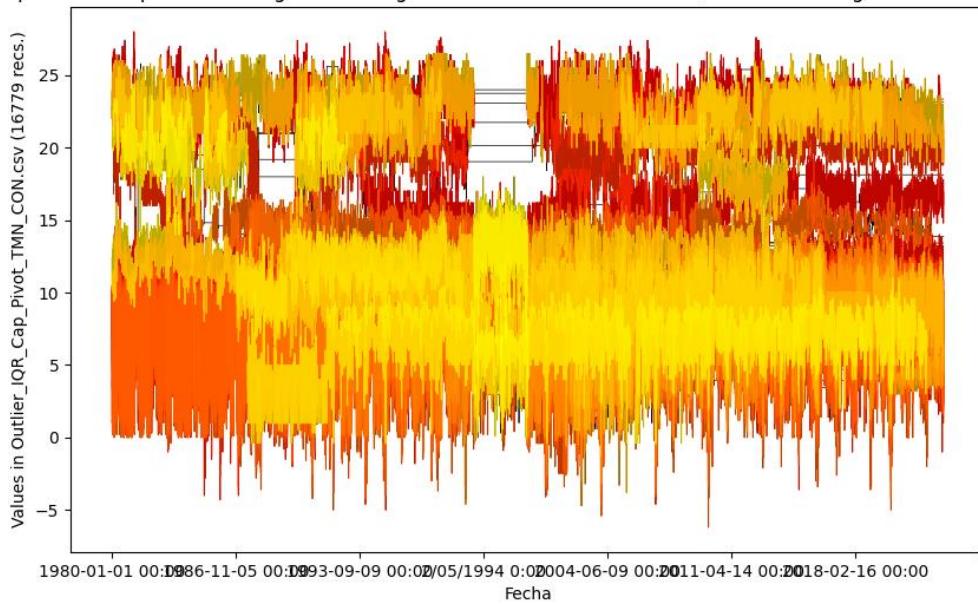
Ilustración 3-13. Resultados Impute Temperatura Mínima



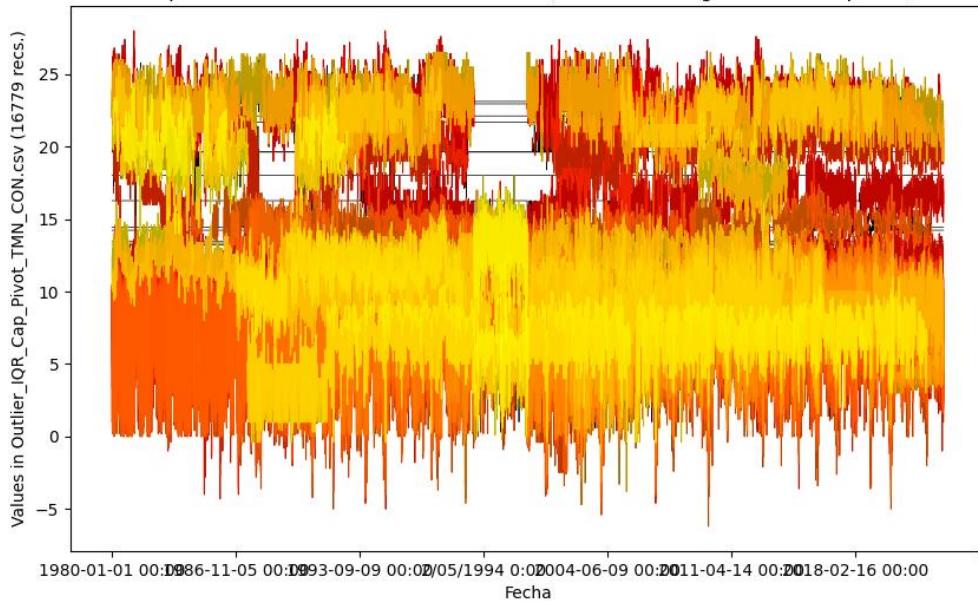
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Impute with Exponential Weighted Moving - EWM values for 60 stations (653332 missing & 379226 imputed)

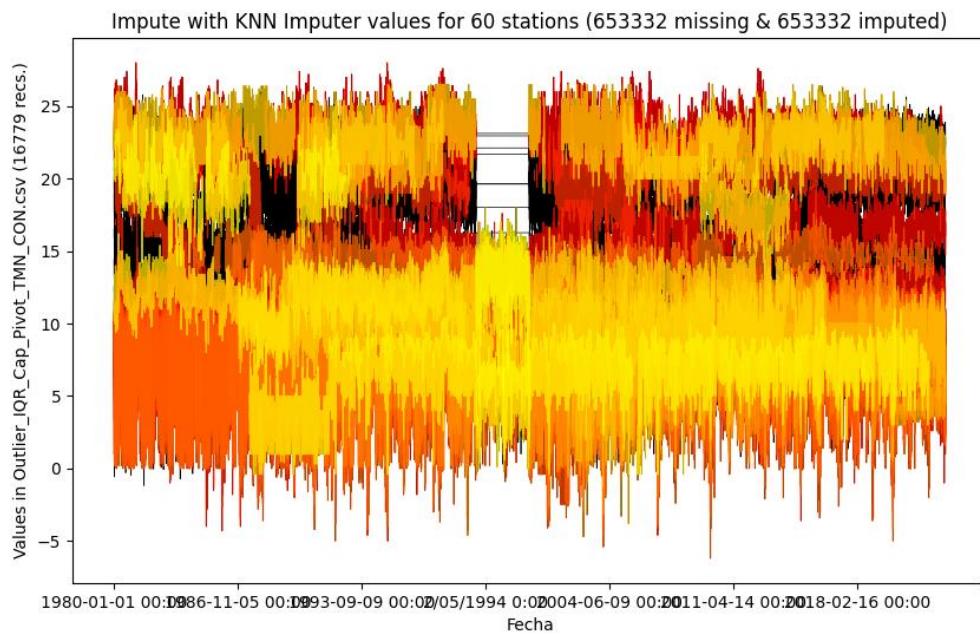
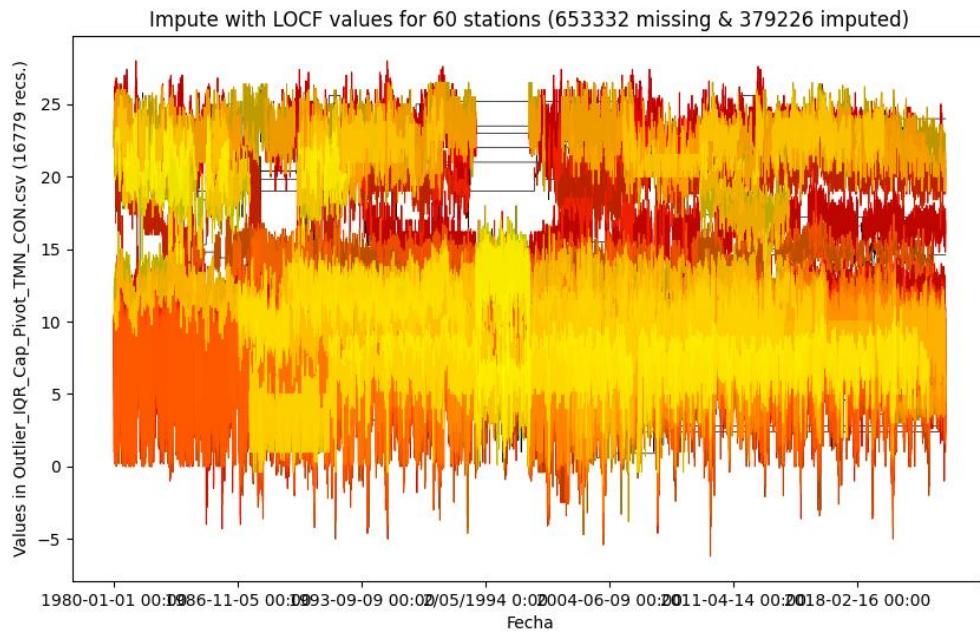


Impute with MEAN values for 60 stations (653332 missing & 653332 imputed)



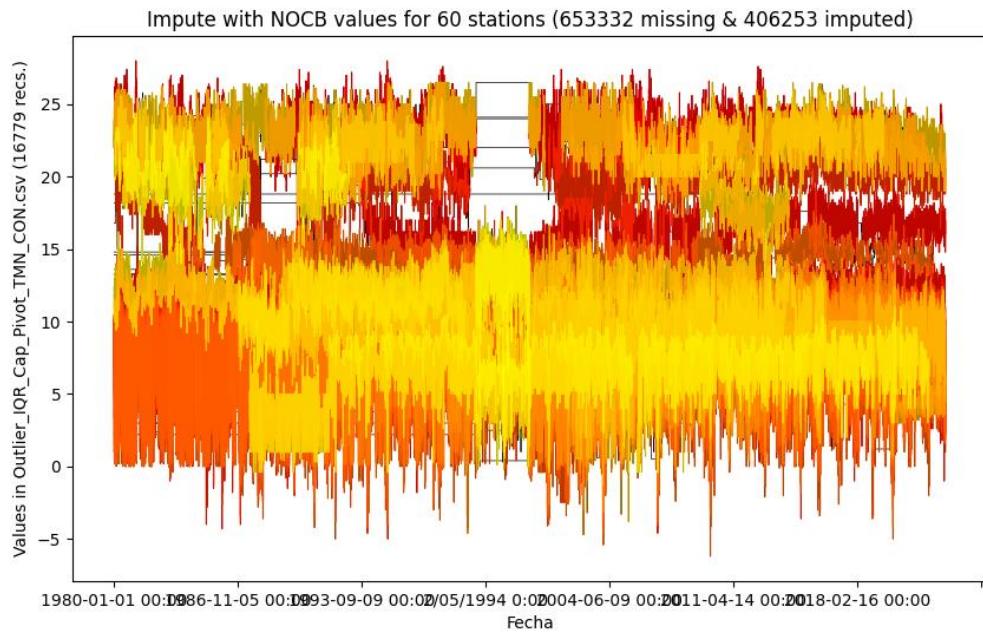
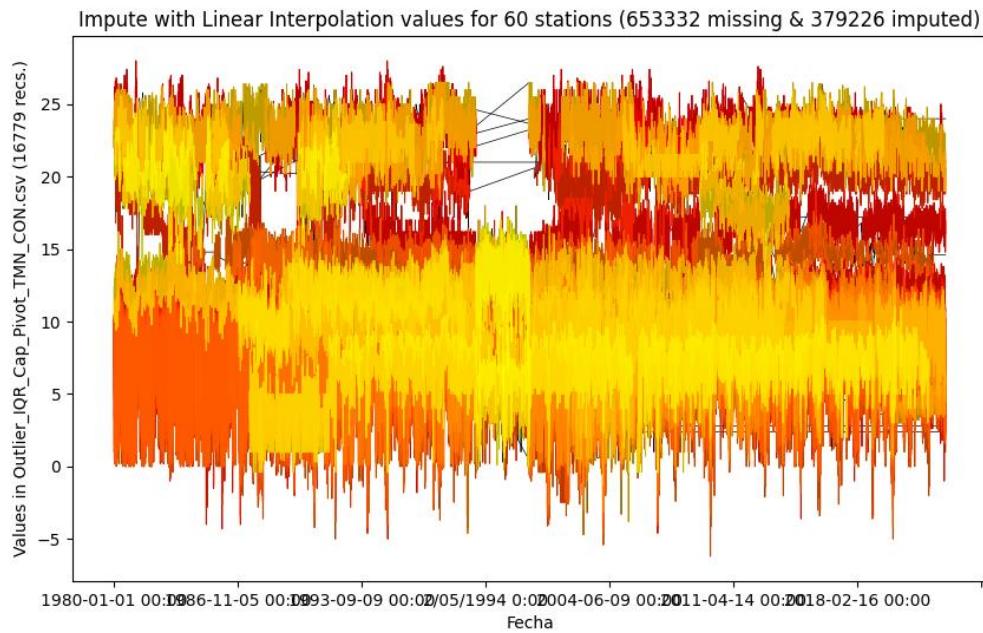
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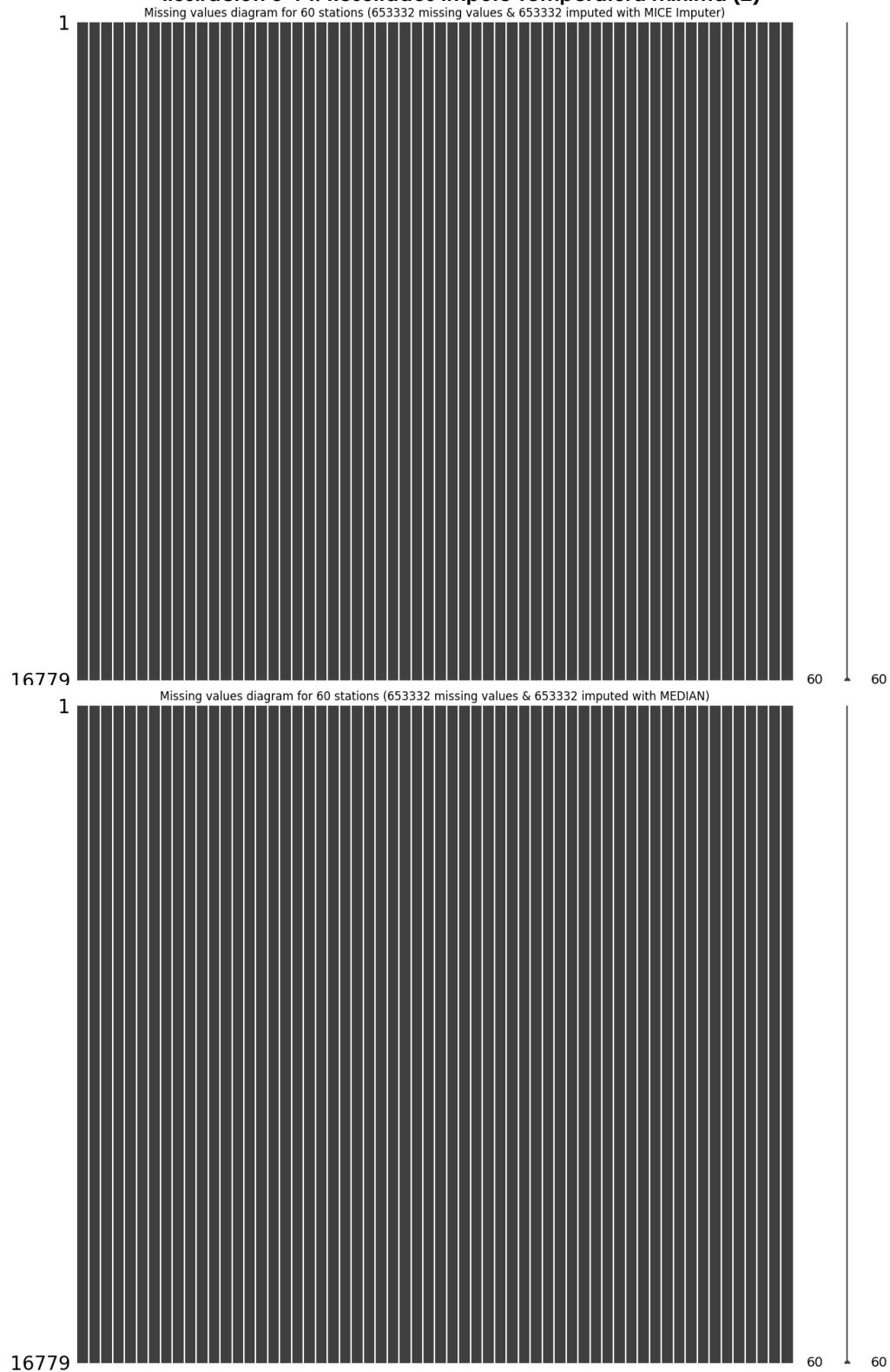


Fuente: Elaboración Propia, 2023.

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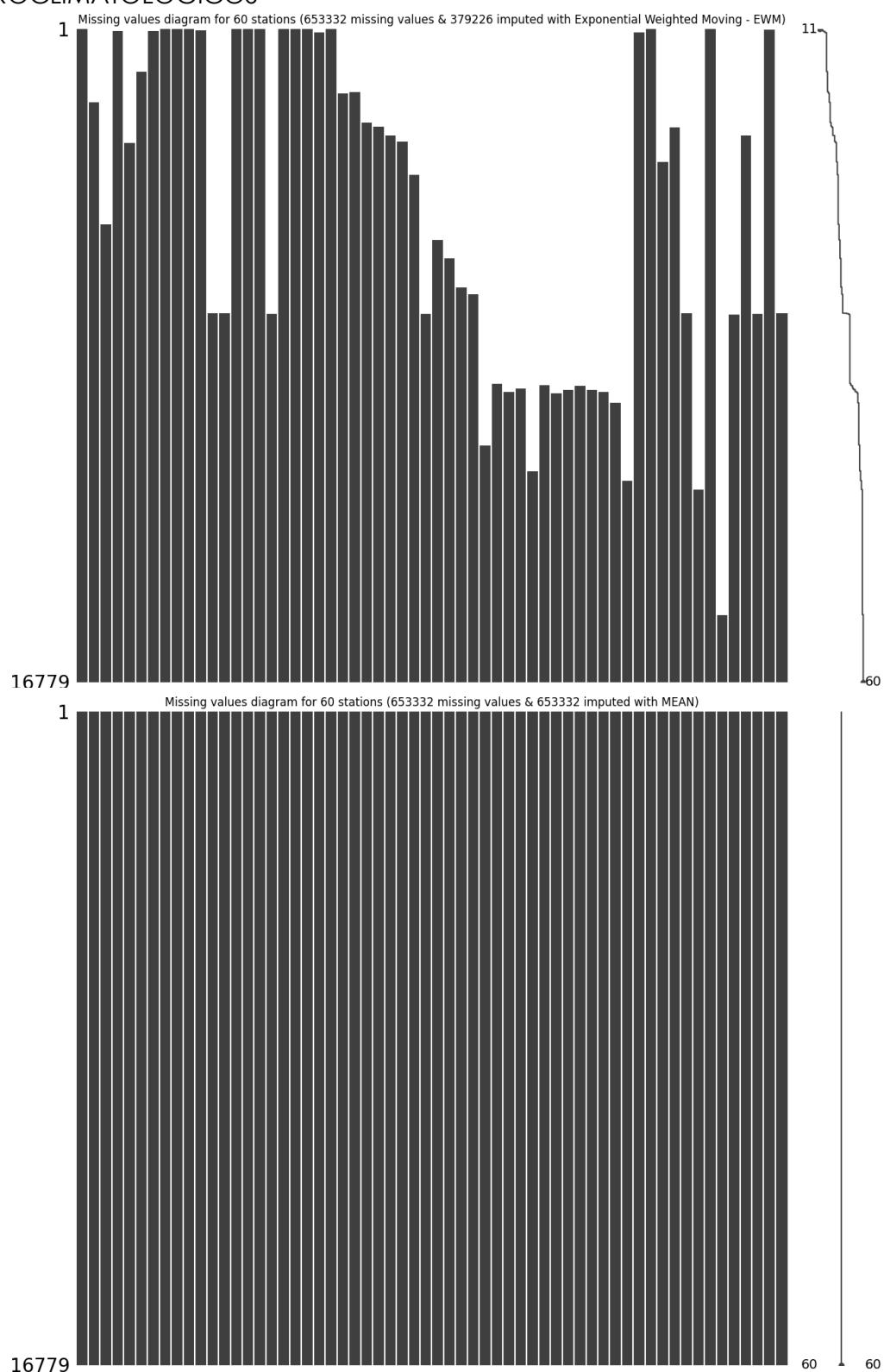
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Ilustración 3-14. Resultados Impute Temperatura Mínima (2)



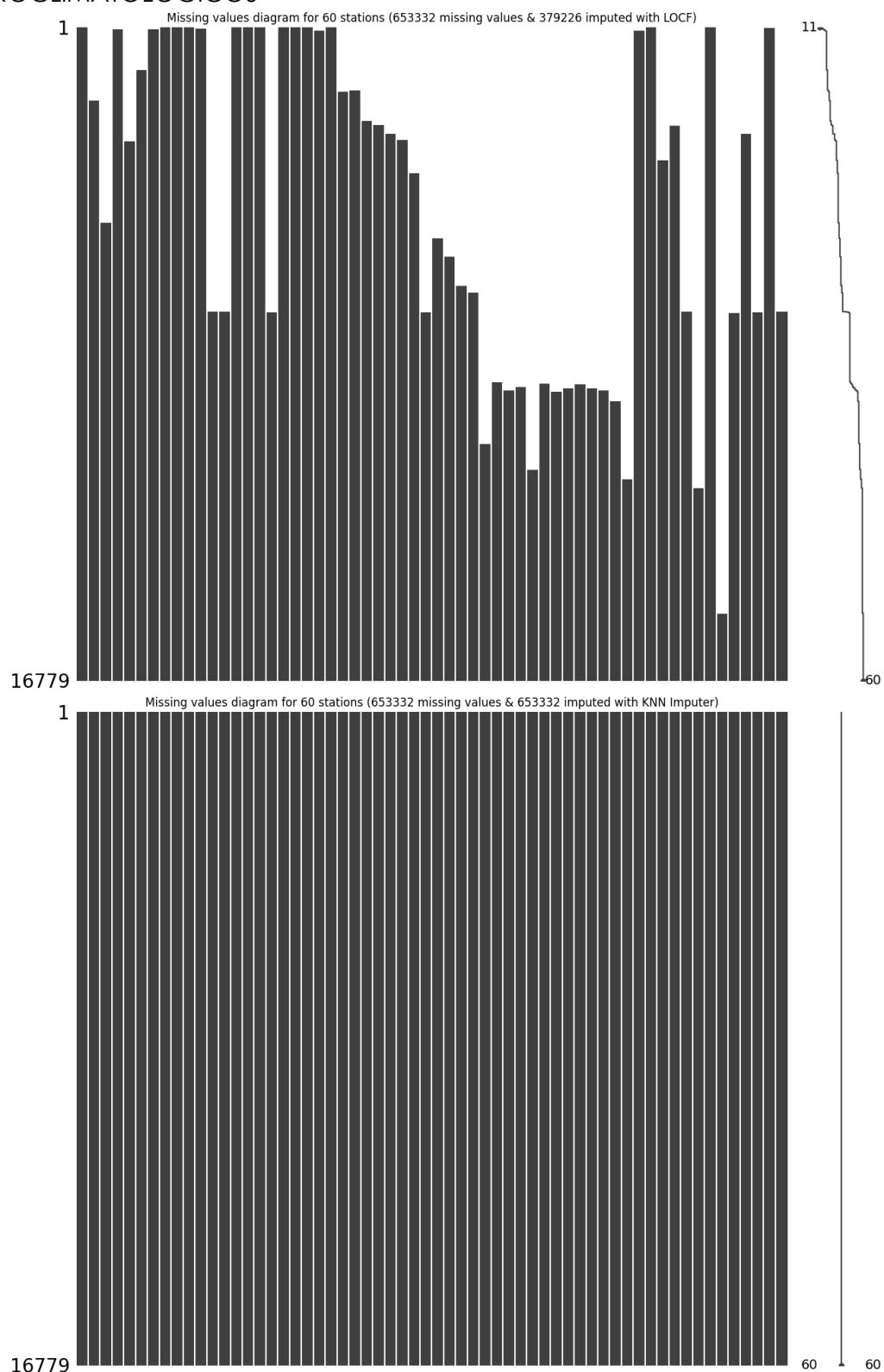
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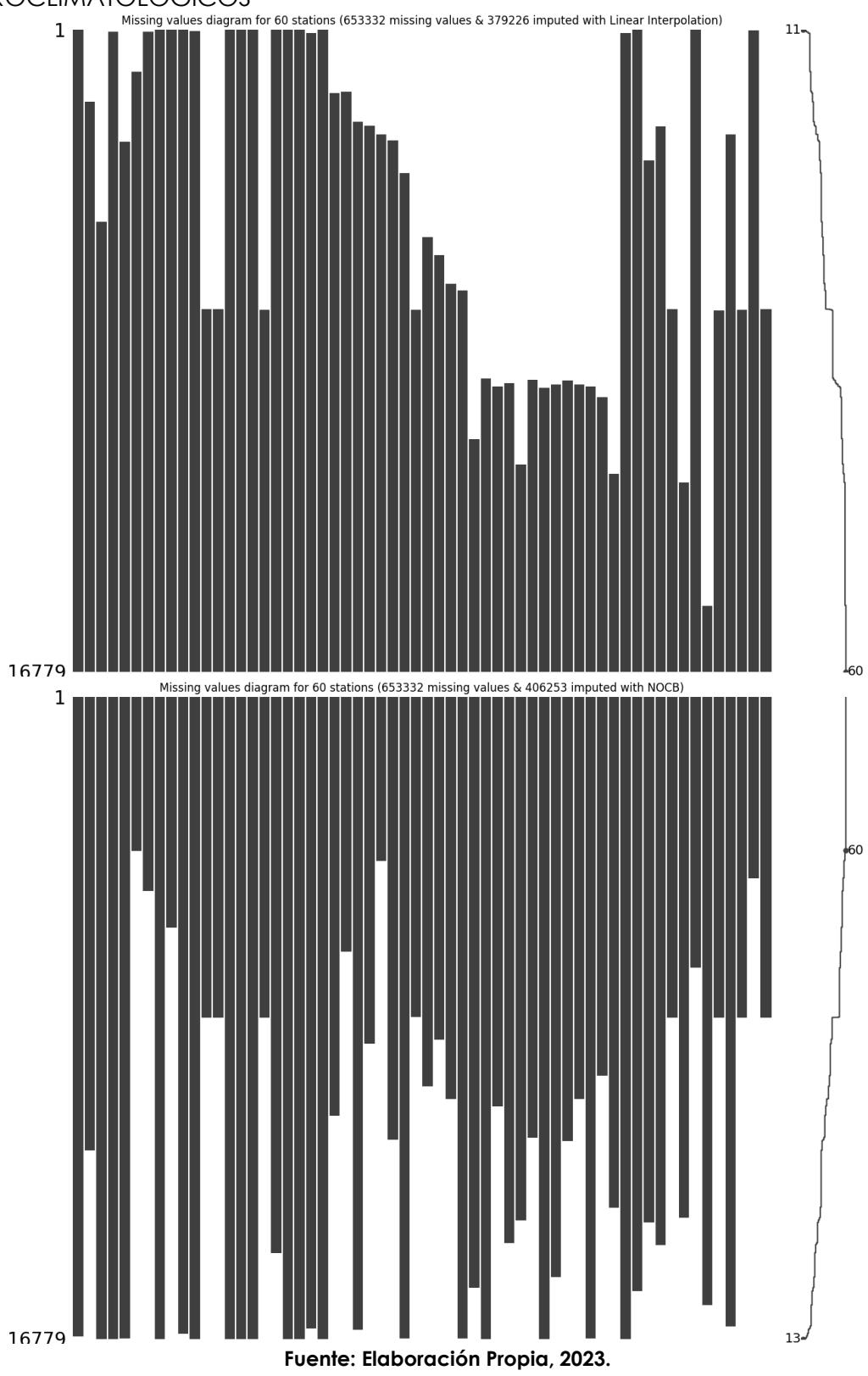
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En resumen, se tiene que:

Tabla 3-1. Resultados imputación de datos

Parámetro	Precipitación	Caudal	Evaporación	T. Mínima	T. Máxima
Estaciones	313	38	8	60	60
Registros	516	516	6574	16779	16781
Faltantes	78768	8159	5180	653332	698886
M1	78768	8159	5180	653332	698886
M2	78768	8159	5180	653332	698886
M3	64044	5679	2962	379226	389143
M4	21346	3731	2218	406253	442622
M5	64044	5679	2962	379226	389143
M6	64044	5679	2962	379226	389143
M7	78768	8159	5180	653332	698886
M8	78768	8159	5180	653332	698886

Fuente: Elaboración Propia, 2023.

4. ACTIVIDAD 2: SENSIBILIDAD PARÁMETROS ESTADÍSTICOS

En las siguientes ilustraciones se observa el resultado de las medias y desviaciones estándar de los resultados del ejercicio del numeral anterior, donde se compara en cada estación las series con datos imputados por cada uno de los métodos usados. A estos valores estadísticos se les calcula la desviación estándar para conocer la dispersión entre sí y valorar cuales estaciones no fueron consistentes en su llenado.

Se esperaría que la desviación estándar de los resultados entre los métodos sea similar o baja para determinar si se puede considerar consistente el llenado.

Ilustración 4-1. Resultados Precipitación

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar	
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
21170020	100.962	77.354	100.962	72.868	98.825	73.116	101.331	77.157	91.635	77.699	100.962	77.048	100.930	77.056	100.027	75.338	100.780	75.063	3.081163407	1.85489385
21185040	100.617	77.029	100.617	76.353	100.390	76.372	100.399	76.462	101.708	77.318	100.956	76.660	100.676	76.412	100.958	75.713	101.052	76.677	0.410060599	0.32602772
21190030	96.646	66.448	96.646	60.825	95.108	60.925	96.769	66.460	89.485	62.972	96.624	66.413	96.650	66.411	95.529	63.458	97.355	64.796	2.408360105	2.36022724
21190060	131.326	90.194	131.326	49.481	132.145	49.484	59.396	70.535	147.016	93.023	59.396	70.535	133.142	50.691	128.454	68.733	136.814	62.404	33.6113303	16.3688
21190110	73.958	33.612	73.958	4.912	77.418	4.941	76.929	4.934	73.958	33.612	76.929	4.934	80.727	5.022	73.262	13.480	107.816	31.969	10.90797483	13.6361158
21190170	98.029	81.359	98.029	8.782	78.370	9.080	15.535	13.073	98.029	81.359	15.535	13.073	79.233	9.055	88.315	22.489	91.019	33.688	33.74152218	30.0931681
21190210	121.431	100.143	121.431	98.871	120.939	98.919	123.246	100.822	120.595	100.476	121.924	99.433	122.972	99.674	121.313	99.914	122.052	99.373	0.882834513	0.66781978
21190300	174.428	153.124	174.428	130.664	163.839	131.813	212.024	144.871	173.639	151.200	209.373	143.202	196.337	136.515	173.423	143.274	175.984	137.247	17.5138348	7.90987592
21190310	142.807	89.402	142.807	87.914	142.188	87.978	143.846	89.583	142.883	93.161	144.189	90.335	143.042	88.668	142.614	88.994	142.872	88.637	0.616165382	1.60332637
21190360	217.380	111.237	217.380	9.809	247.703	10.253	143.559	92.103	108.316	35.548	123.289	55.497	127.575	56.858	217.380	9.809	216.980	9.908	53.12020446	38.4721764
21190430	70.303	87.225	70.306	21.400	45.116	22.361	65.731	25.253	95.092	38.536	65.731	25.253	90.201	25.944	68.234	46.052	81.963	32.934	14.92761685	20.8329475
21190440	74.457	103.899	74.457	24.655	25.097	27.542	38.366	30.958	111.568	45.806	38.366	30.958	103.508	30.299	69.353	52.853	83.332	39.580	29.73131691	24.6276083
21190450	56.991	71.786	56.991	17.612	31.111	18.830	30.311	22.311	121.389	42.892	30.311	22.311	67.639	21.007	57.386	39.877	86.416	35.996	29.88921298	17.5580806
21190460	97.573	57.197	97.573	43.509	92.496	43.916	97.405	57.175	65.334	58.493	97.726	57.163	97.532	57.106	91.541	50.861	93.374	49.430	10.41270297	6.00845866
21190470	76.261	48.122	76.261	26.400	73.114	26.482	39.656	51.545	31.980	48.861	39.656	51.545	36.631	37.066	70.742	38.014	75.220	35.680	18.26598459	10.0527894
21195030	87.462	58.519	87.462	34.500	82.603	34.683	108.680	39.781	105.554	74.388	111.762	41.774	101.222	36.723	85.128	51.162	90.033	50.637	11.20814828	13.2581496
21195080	120.083	89.911	120.083	60.735	113.499	61.036	123.701	68.908	99.644	78.277	120.979	69.491	121.150	66.096	114.051	77.889	120.972	72.950	7.372098683	9.30573344

Fuente: Elaboración Propia.

Se tienen 85 estaciones de precipitación donde la variación entre la estadística indica que no fueron consistentes entre los métodos el llenado de datos.

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Ilustración 4-2. Estaciones Parciales Precipitación No Consistentes

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar		
	meai	stdv	mean	stdv	meai	stdv	mean	stdv	meai	stdv	mean	stdv	meai	stdv	mean	stdv	meai	stdv	mean	stdv	
21190060	131.326	90.194	131.326	49.481	132.145	49.484	59.396	70.535	147.016	93.023	59.396	70.535	133.142	50.691	128.458	68.733	138.814	62.404	35.52607233	14.8818226	
21190110	73.958	33.612	73.958	4.912	77.418	4.941	76.929	4.934	73.958	33.612	76.929	4.934	80.727	5.022	73.262	13.480	107.816	31.969	11.45220986	12.58691444	
21190170	98.029	81.359	98.029	8.782	78.370	9.080	15.535	13.073	98.029	81.359	15.535	13.073	79.233	9.055	88.315	22.489	91.019	33.688	34.71241865	24.79159173	
21190360	217.370	111.237	217.370	9.803	247.703	10.253	143.559	92.103	108.316	35.548	123.289	55.497	127.557	56.585	217.378	9.803	216.980	9.908	54.7698579	30.87008339	
21190450	56.991	71.786	56.991	17.612	31.111	18.830	30.311	22.311	121.389	42.892	30.311	22.311	67.639	21.007	57.386	39.877	86.416	35.996	31.93251332	10.21999241	
21190470	76.261	48.122	76.261	26.400	73.114	26.482	39.656	51.545	31.980	48.861	39.656	51.545	63.631	37.066	70.742	38.014	75.226	35.680	18.50717976	19.2928958	
21195080	87.462	58.519	87.462	34.500	82.603	34.683	108.680	39.781	105.554	74.388	111.762	41.774	101.222	36.723	85.128	51.162	90.033	50.637	11.53553118	13.38733747	
21200080	106.725	60.891	106.725	50.413	103.876	50.589	161.335	108.561	105.009	60.420	161.944	107.869	131.092	66.432	107.303	56.215	108.963	54.990	25.2098874	24.49131844	
21200390	77.667	54.381	77.667	7.948	55.527	8.652	108.271	9.247	77.667	54.381	108.271	9.247	83.466	7.998	79.728	21.368	91.213	49.913	17.43407162	19.70679888	
21200440	83.456	77.235	83.456	34.204	61.829	35.852	46.795	53.983	81.777	73.287	44.685	48.035	71.923	39.550	74.658	56.188	79.047	47.847	15.31459033	12.80949553	
21200500	87.727	45.524	87.727	16.784	83.650	16.863	73.344	17.770	87.974	45.251	73.357	17.785	102.744	17.881	76.860	31.513	89.520	30.374	12.04688888	12.702880945	
21200580	72.847	50.341	72.847	18.692	68.418	18.777	60.846	19.308	72.847	50.341	60.846	19.308	81.567	16.978	69.938	35.236	73.089	36.136	6.903121905	12.03982673	
21200610	70.008	41.699	70.008	6.094	76.935	6.187	130.265	11.125	70.008	41.699	130.265	11.125	87.692	6.678	71.327	14.156	76.059	40.167	26.06041212	14.95754844	
21200650	76.786	57.228	76.786	20.948	65.778	21.398	38.204	26.022	75.725	56.769	38.153	25.983	41.216	21.144	74.845	39.673	17.73337247	16.72552444	17.73337247		
21200660	78.014	53.218	78.014	19.760	68.666	20.116	49.090	22.943	78.014	53.218	49.090	22.943	79.670	19.771	73.734	35.051	75.539	31.806	12.73029883	11.64196873	
21200700	138.021	99.144	138.021	0.0281	138.123	139.705	38.130	166.669	42.237	132.311	106.891	165.972	45.070	208.152	55.875	135.539	77.551	144.893	70.694	25.60702338	24.28933373
21200720	132.372	111.982	132.372	1.377	30.419	115.389	30.804	143.963	68.261	109.180	91.740	135.690	44.236	126.135	32.300	122.731	25.440	152.628	92.638	14.77337406	14.76976171

Fuente: Elaboración Propia.

Ilustración 4-3. Resultados Caudal

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar		
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	
	21197080	1.855	1.567	1.855	1.147	1.670	1.164	1.854	1.462	1.951	1.226	1.891	1.436	1.823	1.412	1.778	1.328	1.785	1.300	0.084439704	0.12228844
21197110	3.168	2.272	3.168	2.252	3.159	2.253	3.134	2.267	3.151	2.261	3.142	2.261	3.147	2.258	3.137	2.266	3.138	2.265	0.011590076	0.00564785	
21197150	46.772	33.494	46.772	31.483	45.632	31.626	46.712	32.054	47.514	34.407	47.154	32.100	48.094	31.846	46.940	32.742	47.738	32.376	0.759150025	0.98967264	
21197210	0.120	0.262	0.120	0.113	0.085	0.115	0.134	0.149	0.735	0.724	0.121	0.136	0.175	0.134	0.130	0.188	0.130	0.136	0.216058284	0.20832527	
21207960	41.549	22.437	41.549	19.525	40.476	19.617	36.845	24.304	40.650	22.322	36.244	23.669	36.727	23.118	41.462	21.470	42.214	21.266	2.479132963	1.77310054	
21209200	54.858	29.852	54.858	10.274	46.602	10.718	49.474	27.159	23.050	15.992	49.474	27.159	51.797	26.108	57.290	27.812	59.325	25.45	0.32053073	0.76118891	
21209920	5.186	1.815	5.186	0.711	4.928	0.719	5.221	1.778	3.904	0.898	5.167	1.776	5.220	1.777	5.161	1.119	5.071	1.451	0.0446246945	0.47513747	
21227010	5.047	4.132	5.047	3.789	4.832	3.821	5.090	4.410	4.776	4.034	4.883	4.062	4.897	3.894	5.002	3.941	5.082	3.889	0.12010164	0.19754725	
21237010	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	1148.510	410.094	0	0	
21237020	1242.840	525.952	1242.840	488.072	1230.270	408.908	1260.276	415.509	1242.930	452.415	1206.090	415.418	1223.330	410.844	1234.160	445.371	1253.440	443.090	17.22994232	17.3905905	
21237040	3.053	3.675	3.053	3.412	2.849	3.450	2.971	3.488	2.882	3.915	2.915	3.456	2.873	3.455	2.978	3.501	3.057	3.539	0.080273426	0.04052446	
21257090	23.666	21.506	23.666	17.110	21.239	17.406	29.036	27.762	23.452	20.534	29.779	27.508	26.912	24.938	25.688	19.223	23.285	19.668	0.008258132	0.43357125	
23017020	1.368	3.690	1.368	3.643	1.344	3.646	1.339	3.648	1.375	3.715	1.357	3.663	1.389	3.648	1.380	3.658	1.387	3.646	0.01841646	0.02368158	
23017030	43.449	19.990	43.449	44.349	44.975	41.739	15.100	44.736	15.524	43.478	20.333	44.651	15.500	41.827	15.155	43.649	18.511	44.122	18.675	1.14303342	2.10820645
23017060	5.290	2.754	5.290	2.300	5.151	2.309	5.245	2.645	5.678	2.580	5.209	2.638	5.288	2.624	5.266	2.545	5.227	2.550	0.161552696	0.14070591	
23017090	37.229	17.167	37.229	2.831	41.133	2.910	52.376	9.128	57.425	7.248	52.264	9.091	41.472	5.503	40.085	10.100	38.349	5.807	0.274489873	0.285698811	
23067050	65.627	46.177	65.627	44.393	64.879	44.472	65.647	45.377	69.814	49.745	67.553	46.265	76.582	45.537	65.367	61.001	45.758	66.234	45.758	1.57916363	0.20822555

Fuente: Elaboración Propia.

Se tienen 2 estaciones de caudal donde la variación entre la estadística indica que no fueron consistentes entre los métodos el llenado de datos.

Ilustración 4-4. Estaciones Caudal No Consistentes

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar	
	meas	std	meas	std	meas	std	meas	std	meas	std	meas	std	meas	std	meas	std	meas	std	mean	std
21209020	54.858	29.852	54.858	10.274	46.602	10.718	49.474	27.159	23.050	15.992	49.474	27.159	51.797	26.108	57.290	27.812	59.325	25.445	11.32053073	7.6817891
21237020	1242.840	452.952	1242.840	408.072	1230.270	408.908	1206.270	415.509	1242.930	452.415	1206.090	415.418	1223.330	410.844	1234.160	445.371	1253.440	434.090	17.22994232	17.5905905
35022700	55.253	37.045	55.253	27.284	50.740	27.707	102.794	59.167	54.865	37.103	102.814	59.137	85.957	43.389	55.181	31.236	57.158	30.571	22.69686492	13.2554428
35037100	85.589	58.565	85.589	25.154	74.915	25.667	41.080	34.433	29.471	44.535	37.566	34.447	67.065	30.845	86.601	42.019	73.126	53.216	22.5583586	9.68640249
50607020	56.361	42.223	56.361	16.951	51.843	17.067	20.034	56.361	42.223	32.165	20.034	69.351	17.894	53.934	27.015	68.165	41.974	14.08491143	10.7905019	
35067040	27.969	21.322	27.969	11.507	25.374	11.628	61.527	24.479	27.969	21.322	61.527	24.479	29.225	11.536	29.276	16.737	32.994	19.903	25.29100	6.5178706
35077070	101.498	70.046	101.497	2.064	102.125	2.065	77.667	6.636	117.166	18.259	77.666	6.647	81.860	4.711	101.497	2.064	79.877	47.528	14.40096322	15.60206

Fuente: Elaboración Propia

Ilustración 4-5. Resultados Evaporación

Estación	Ilustración 4-3. Resultados Evaporación																Análisis Desviación Estándar				
	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8				
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std			
21195190	221.429	446.829	221.429	401.271	178.585	410.696	221.429	446.829	226.377	401.399	221.429	446.829	221.429	446.829	221.982	424.025	195.779	405.761	16,99707787	21,0163958	
21206930	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	130.541	287.193	
21206950	130.443	406.471	130.363	427.743	151.094	429.377	157.055	433.792	157.103	435.153	157.055	433.792	170.042	436.609	158.821	432.944	157.195	428.184	5,33726583	3,33261766	
21206980	76.514	275.364	76.514	273.029	75.222	273.207	76.514	275.364	75.222	273.207	76.514	275.364	76.514	275.364	75.806	273.175	75.859	273.103	0,575880146	1,15033473	
21206980	178.095	368.500	178.095	367.573	177.203	367.789	178.095	368.500	177.959	367.578	178.095	368.500	177.294	367.762	177.983	367.577	178.095	368.500	0,377958969	0,445848516	
22155610	24.061	79.268	24.061	75.336	21.733	75.671	22.087	76.218	24.895	76.283	22.087	76.218	22.087	76.218	22.616	75.849	23.810	75.421	1,169419515	1,11784061	
24015110	281.441	478.338	281.441	471.816	278.232	474.023	281.441	478.338	279.073	472.030	281.441	478.338	276.899	473.158	278.956	472.210	2,784857905	3,02689624			
30535130	181.794	104.686	181.794	81.696	195.948	83.584	182.722	110.139	172.647	105.050	182.722	110.139	172.647	105.050	172.647	113.765	124.322	202.563	97.406	51,26974927	27,7969148

Fuente: Elaboración Propia.

SECTION 03
DESCARGA, PROCESAMIENTO
Y ANÁLISIS DE DATOS
HIDROCLIMATOLÓGICOS

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 CS2021

Se tienen 2 estaciones de evaporación donde la variación entre la estadística indica que no fueron consistentes entre los métodos el llenado de datos.

Ilustración 4-6. Estaciones Evaporación No Consistentes

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar	
	mea	std	mea	std	mea	std	mea	std	mea	std	mea	std	mea	std	mea	std	mea	std	mean	std
21195190	221.429	446.829	221.429	401.271	178.585	410.696	221.429	446.829	226.377	401.399	221.429	446.829	221.429	446.829	221.429	446.829	221.429	446.829	16.99707787	21.0163958
35053130	181.794	104.686	181.794	81.696	195.948	83.584	128.722	110.139	172.647	105.050	128.722	110.139	291.525	169.617	173.625	124.322	202.563	97.406	51.26974292	27.8796148

Fuente: Elaboración Propia.

Ilustración 4-7. Resultados Temperatura Mínima

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar	
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
21185040	23.122	1.345	23.122	1.156	23.142	1.156	23.102	1.293	23.159	1.258	23.129	1.244	23.054	1.224	23.126	1.194	23.147	1.165	0.032592919	0.05162711
21195080	21.696	1.521	21.696	0.638	21.947	0.648	21.676	1.235	22.139	1.576	21.747	1.177	21.647	0.979	21.775	0.901	21.708	0.716	0.167905258	0.33007053
21195120	16.277	1.239	16.277	0.901	16.333	0.903	16.172	1.188	16.771	1.513	16.166	1.269	16.090	1.265	16.160	1.028	16.183	1.019	0.216027141	0.21193675
21195190	11.394	1.487	11.394	1.347	11.431	1.350	11.456	1.854	11.508	1.680	11.483	1.742	11.257	1.574	11.406	1.399	1.371	0.076514545	0.20272303	
21205012	9.420	2.223	9.420	1.383	9.653	1.395	8.894	2.676	9.485	2.208	9.113	2.211	9.084	1.890	9.516	1.860	9.442	1.845	0.262178147	0.43296558
21205160	8.227	3.455	8.227	1.434	8.039	1.437	8.036	1.495	8.777	3.088	8.037	1.493	7.188	1.565	8.220	2.474	9.743	2.753	0.732939991	0.68719002
21205230	8.891	2.353	8.891	1.113	9.441	1.152	9.699	1.608	9.028	2.407	9.774	1.403	9.946	1.562	9.333	1.660	9.128	1.568	0.379304667	0.40015088
21205420	6.967	2.795	6.967	2.642	7.013	2.646	6.943	2.728	7.031	2.701	6.987	2.687	6.818	2.764	6.984	2.692	6.985	2.692	0.065540186	0.03990823
21205520	7.262	2.769	7.262	1.562	7.629	1.582	7.206	1.671	6.987	2.862	7.165	1.639	8.303	1.815	7.829	2.419	7.757	2.432	0.439591134	0.49916492
21205580	9.055	1.392	9.055	1.164	9.099	1.165	9.117	1.397	9.077	1.338	9.088	1.333	9.113	1.297	9.027	1.258	9.038	1.247	0.035202259	0.08295894
21205660	19.625	2.109	19.625	1.876	19.703	1.883	19.581	2.001	19.805	1.997	19.696	1.964	19.506	2.004	19.562	1.938	19.634	1.899	0.094172379	0.05412748
21205670	13.485	1.118	13.485	0.251	13.404	0.252	12.530	0.519	13.239	0.408	12.528	0.504	13.261	0.354	13.486	0.259	13.483	0.257	0.411821034	0.11467201
21205700	7.731	2.257	7.731	0.534	8.174	0.545	3.003	1.851	3.602	1.765	3.002	1.838	5.881	0.979	7.733	0.544	7.699	0.557	2.304503369	0.6316745
21205710	8.902	1.933	8.902	1.606	8.933	1.606	8.779	2.023	9.032	1.959	8.905	1.909	8.899	1.756	8.865	1.775	8.869	1.741	0.071114154	0.15516039
21205720	7.141	1.765	7.141	1.545	7.155	1.545	6.914	1.745	7.175	1.801	7.045	1.702	6.926	1.753	7.135	1.620	7.149	1.612	0.105906391	0.0984498
21205740	7.999	2.375	7.999	2.138	8.113	2.151	8.251	2.285	7.882	2.417	8.067	2.262	8.173	2.214	7.961	2.230	7.986	2.208	0.121014626	0.08779767
21205770	6.477	2.693	6.477	0.501	6.596	0.501	4.806	1.070	6.156	0.99	4.812	1.076	5.067	0.889	6.459	0.567	6.388	0.576	0.80085929	0.25135623

Fuente: Elaboración Propia.

La mayor diferencia entre las desviaciones de temperatura mínima es 2.3, lo que se considera mínimo y por ende una buena consistencia entre los métodos para todas las estaciones.

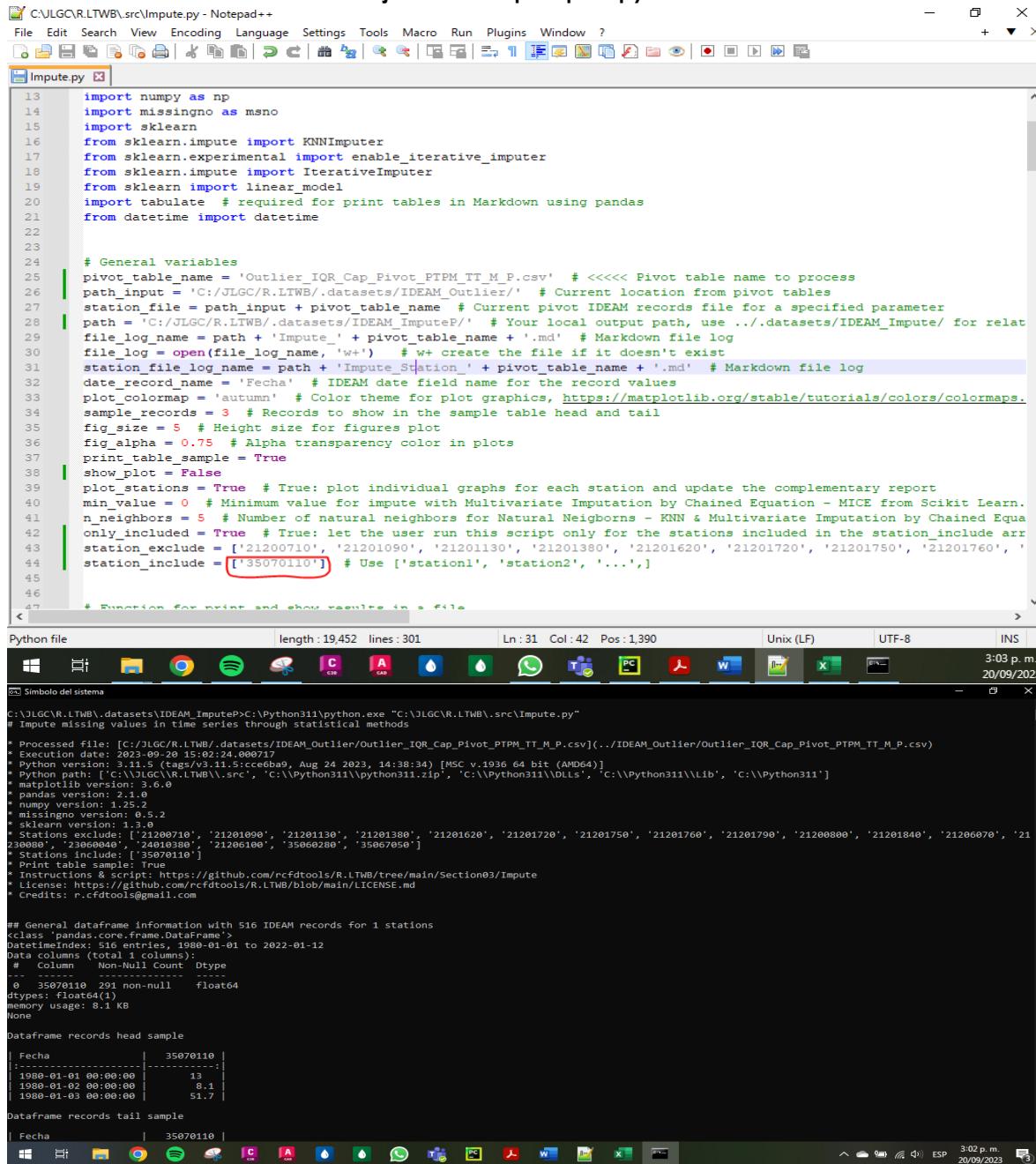
Ilustración 4-8. Resultados Temperatura Máxima

Estación	Serie Original		M1		M2		M3		M4		M5		M6		M7		M8		Análisis Desviación Estándar	
	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
21185040	33.782	2.177	33.782	0.500	33.799	0.500	32.905	0.784	36.068	1.159	32.910	0.764	33.508	0.685	33.780	0.519	33.744	0.537	0.987430421	0.242627472
21195080	33.645	1.999	33.645	0.266	33.601	0.267	31.626	0.929	33.185	0.709	31.607	0.825	33.742	0.516	33.642	0.372	33.649	0.453	0.922959694	0.25282316
21195120	24.884	1.708	24.884	1.208	24.942	1.210	24.693	1.708	24.631	1.542	24.797	1.657	24.789	1.539	24.882	1.421	24.848	1.402	0.104220199	0.18679316
21195190	19.626	1.564	19.626	1.314	19.618	1.314	19.459	1.697	19.461	1.473	19.467	1.539	19.549	1.668	19.566	1.390	19.610	1.382	0.072701463	0.15047649
21205012	19.596	1.560	19.596	0.233	19.600	0.233	19.251	0.551	20.496	0.604	19.258	0.487	19.807	0.408	19.596	0.276	19.590	0.329	0.390149428	0.1451785
21205160	19.878	2.320	19.878	0.963	19.813	0.963	22.336	1.546	21.407	3.191	22.336	1.545	21.684	1.322	20.472	1.785	20.184	1.554	1.056509867	0.70307189
21205230	19.973	1.591	19.973	0.758	19.994	0.759	20.692	0.996	19.946	1.737	20.687	0.979	20.119	0.814	20.277	1.306	19.972	1.199	0.316492051	0.33605555
21205420	19.625	1.470	19.625	1.377	19.622	1.377	19.682	1.426	19.631	1.433	19.656	1.411	19.635	1.394	19.627	1.403	19.637	1.411	0.020282787	0.02069106
21205520	19.517	1.418	19.517	0.764	19.505	0.764	18.942	1.179	19.736	1.412	19.039	0.978	19.156	0.973	19.787	1.243	19.701	1.278	0.332349085	0.24104657
21205580	18.629	1.801	18.629	0.349	18.601	0.349	18.965	0.627	19.138	0.637	18.967	0.566	18.689	0.516	18.620	0.382	18.647	0.433	0.203269784	0.12011643
21205660	30.241	2.016	30.241	1.758	30.231	1.758	30.430	2.093	30.557	1.995	30.493	1.999	30.370	1.886	30.179	1.841	30.180	1.853	0.147514909	0.1209144
21205674	21.012	1.508	21.012	1.260	20.948	1.264	21.241	1.600	20.667	1.672	20.954	1.456	21.081	1.363	20.975	1.340	21.000	1.335	0.160234216	0.15390442
21205700	18.362	1.884	18.362	1.635	18.372	1.635	18.344	1.826	18.010	2.141	18.177	1.871	18.309	1.722	18.368	1.729	18.417	1.718	0.135448782	0.16563039
21205710	20.347	1.510	20.347	1.261	20.302	1.262	20.606	1.624	20.436	1.545	20.521	1.479	20.494	1.398	20.332	1.345	20.368	1.335	0.106713364	0.13236273
21205720	16.733	1.728	16.733	1.469	16.752	1.470	16.809	1.622	16.691	1.570	16.757	1.577	16.710	1.573	16.689	1.567	16.746	1.551	0.039911044	0.05340868
21205740	17.140	1.951	17.140	1.755	17.152	1.755	16.951	1.973	2.065	17.179	1.914	17.147	1.815	17.159	1.828	17.167				

5. ACTIVIDAD 3: ANÁLISIS ESTACIÓN PRECIPITACIÓN 35070110

Para la estación de precipitación con código 35070110 que cuenta con 506 registros, se eliminaron desde el año 2002 los datos para ser generados sintéticamente y compararlos con los métodos de llenado, como se muestra a continuación.

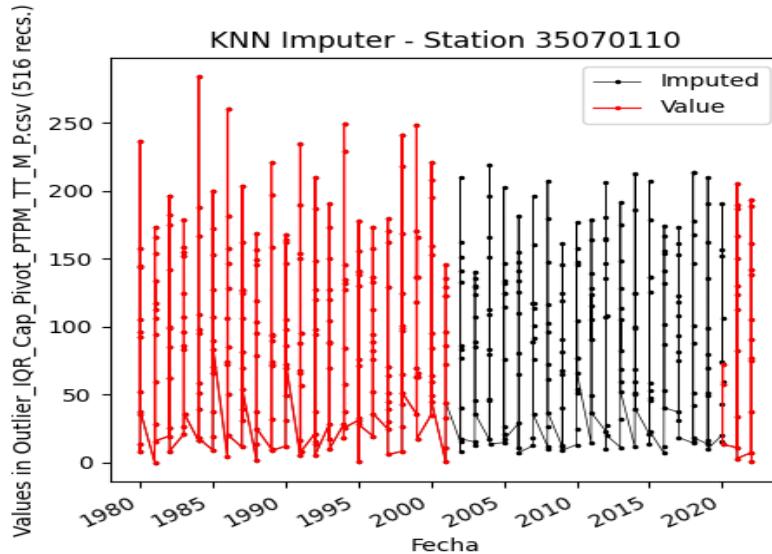
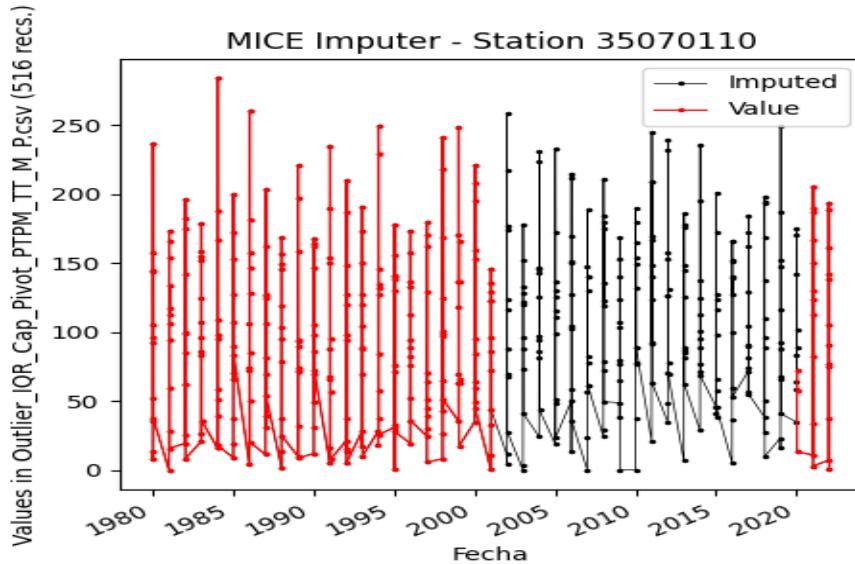
Ilustración 5-1. Ejecución script Impute.py Estación 35070110



```

13     import numpy as np
14     import missingno as msnos
15     import sklearn
16     from sklearn.impute import KNNImputer
17     from sklearn.experimental import enable_iterative_imputer
18     from sklearn.impute import IterativeImputer
19     from sklearn import linear_model
20     import tabulate # required for print tables in Markdown using pandas
21     from datetime import datetime
22
23
24     # General variables
25     pivot_table_name = 'Outlier_IQR_Cap_Pivot_PTPM_TT_M_P.csv' # <<<< Pivot table name to process
26     path_input = 'C:/JLGC/R.LTWB/.datasets/IDEAM_Outlier/' # Current location from pivot tables
27     station_file = path_input + pivot_table_name # Current pivot IDEAM records file for a specified parameter
28     path = "C:/JLGC/R.LTWB/.datasets/IDEAM_ImputeP/" # Your local output path, use ../../datasets/IDEAM_Impute/ for relative
29     file_log_name = path + 'Impute_' + pivot_table_name + '.md' # Markdown file log
30     file_log = open(file_log_name, 'w+') # w+ create the file if it doesn't exist
31     station_file_log_name = path + 'Impute_Station_' + pivot_table_name + '.md' # Markdown file log
32     date_record_name = 'Fecha' # IDEAM date field name for the record values
33     plot_colormap = 'autumn' # Color theme for plot graphics, https://matplotlib.org/stable/tutorials/colors/colormaps.
34     sample_records = 3 # Records to show in the sample table head and tail
35     fig_size = 5 # Height size for figures plot
36     fig_alpha = 0.75 # Alpha transparency color in plots
37     print_table_sample = True
38     show_plot = False
39     plot_stations = True # True: plot individual graphs for each station and update the complementary report
40     min_value = 0 # Minimum value for impute with Multivariate Imputation by Chained Equation - MICE from Scikit Learn.
41     n_neighbors = 5 # Number of natural neighbors for Natural Neighbors - RNN & Multivariate Imputation by Chained Equation
42     only_included = True # True: let the user run this script only for the stations included in the station_include arr
43     station_exclude = ['21200710', '21201090', '21201130', '21201380', '21201620', '21201720', '21201750', '21201760', '21201770', '21201780', '21201790', '21201800', '21201840', '21206070', '21206080', '21206090', '21206100', '21206110', '21206120', '21206130', '21206140', '21206150', '21206160', '21206170', '21206180', '21206190', '21206200', '21206210', '21206220', '21206230', '21206240', '21206250', '21206260', '21206270', '21206280', '21206290', '21206300', '21206310', '21206320', '21206330', '21206340', '21206350', '21206360', '21206370', '21206380', '21206390', '21206400', '21206410', '21206420', '21206430', '21206440', '21206450', '21206460', '21206470', '21206480', '21206490', '21206500', '21206510', '21206520', '21206530', '21206540', '21206550', '21206560', '21206570', '21206580', '21206590', '21206600', '21206610', '21206620', '21206630', '21206640', '21206650', '21206660', '21206670', '21206680', '21206690', '21206700', '21206710', '21206720', '21206730', '21206740', 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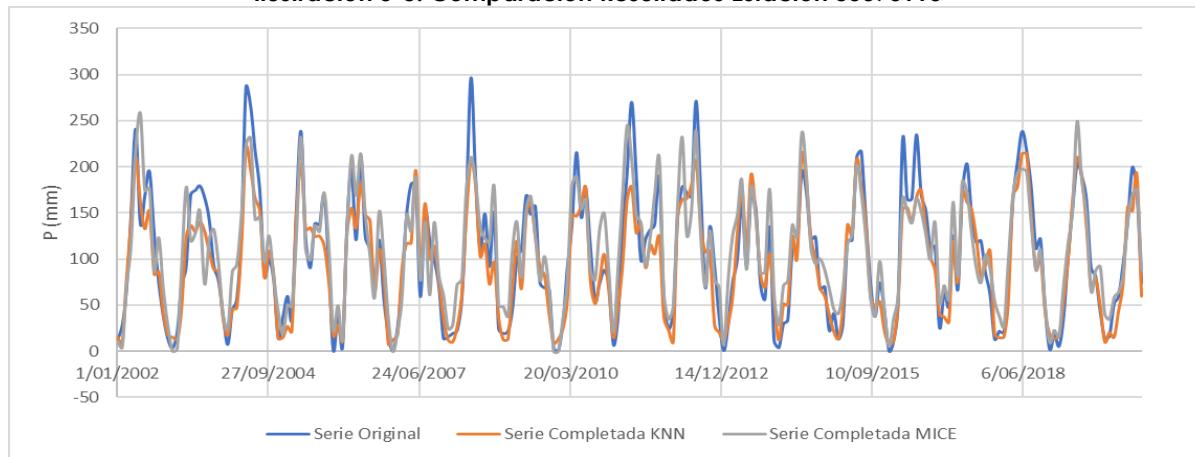
Ilustración 5-2. Resultados método KNNN y MICE Estación 35070110



Fuente: Elaboración Propia.

En la siguiente gráfica se observa que para los valores altos de la serie original no coinciden en de manera exacta con las series sintéticas, mientras que para valores medios y bajos si se tiene una tendencia similar.

Ilustración 5-3. Comparación Resultados Estación 35070110



Fuente: Elaboración Propia.

Comparándose la estadística se tiene que:

Tabla 5-1. Comparación estadística estación 35070110

	Serie Original	Serie Completada KNN	Serie Completada MICE
Media	103.90	94.82	108.93
Desviación Estándar	69.07	59.42	59.93

Fuente: Elaboración Propia.

Se observa que respecto a la serie original los valores de la media coinciden más con el método MICE, mientras que la desviación estándar es similar en los dos métodos usados, pero difiere bastante de la serie original.

Lo anterior indica que en casos extremos donde una estación no tenga datos registrados en períodos de tiempo seguidos y extensos puede usarse uno de estos métodos para completarla, pero con una alta incertidumbre especialmente en datos altos.

6. CONCLUSIONES

- Se realizó el complemento de datos con los 8 métodos del script Impute.py.
- Se realizó el análisis de los resultados de cada parámetro donde se observa que en no todos los casos los datos sintéticos entre métodos son consistentes entre sí.
- Se realizó el análisis de una estación de precipitación con datos completos suponiendo que la serie no lo estaba en un periodo seguido de 10 años para comprar los datos, donde se evidencio que los métodos MICE y KNN pueden ser utilizados en estos casos.

7. REFERENCIAS BIBLIOGRÁFICAS

- RCFDTOLS, 2023. Balance hidrológico de largo plazo para estimación de caudales medios usando SIG. Contenido del curso: <https://github.com/rcfdtools/R.LTWB/blob/main/Section03/Impute>.