

1.0 PLUVIO DATA ANALYSIS

The Pluvio records precipitation using several measurement outputs, including accumulated rainfall (RT), total accumulated precipitation (NRT), and bucket-based measurements. These represent different ways of calculating precipitation from the instrument, and were compared to ECCC data to assess whether the data is reasonable and representative of actual precipitation.

Data Quality and Completeness

Data completeness is a major limitation, with a large gap from late November to mid-February and many partially recorded days (with fewer than 96 recordings per day - every 15 min), reducing the confidence in daily totals. As a result, the most reliable analysis is limited to days with complete data (data_status = OK).

Comparison with ECCC (Timing, Magnitude, Intensity)

The Pluvio appears to be functioning, as the timing of precipitation events generally aligns with ECCC observations on days with complete data. At the hourly scale, it captures the onset and overall pattern of precipitation well, although it often records precipitation slightly longer after events, likely due to residual water entering the gauge.

The magnitude of precipitation is less consistent. While some events closely match ECCC values, others show over- or underestimation, particularly during low-precipitation periods. This variability is more pronounced in daily totals, which are more affected by delayed melting and incomplete data.

Winter conditions further contribute to discrepancies. When snow is present and temperatures are below freezing, the Pluvio may record delayed or exaggerated precipitation due to accumulation and later melting within the gauge.

At a higher time resolution (15-min data), the Pluvio provides relative changes in precipitation intensity during events; however, direct comparison of intensity is limited because ECCC records it differently.

Figure 1 shows daily precipitation recorded by the Pluvio (best-performing method) and ECCC over the study period. Pluvio data are categorized by completeness, where OK represents full data coverage (96 records/day) and PARTIAL represents incomplete daily records.

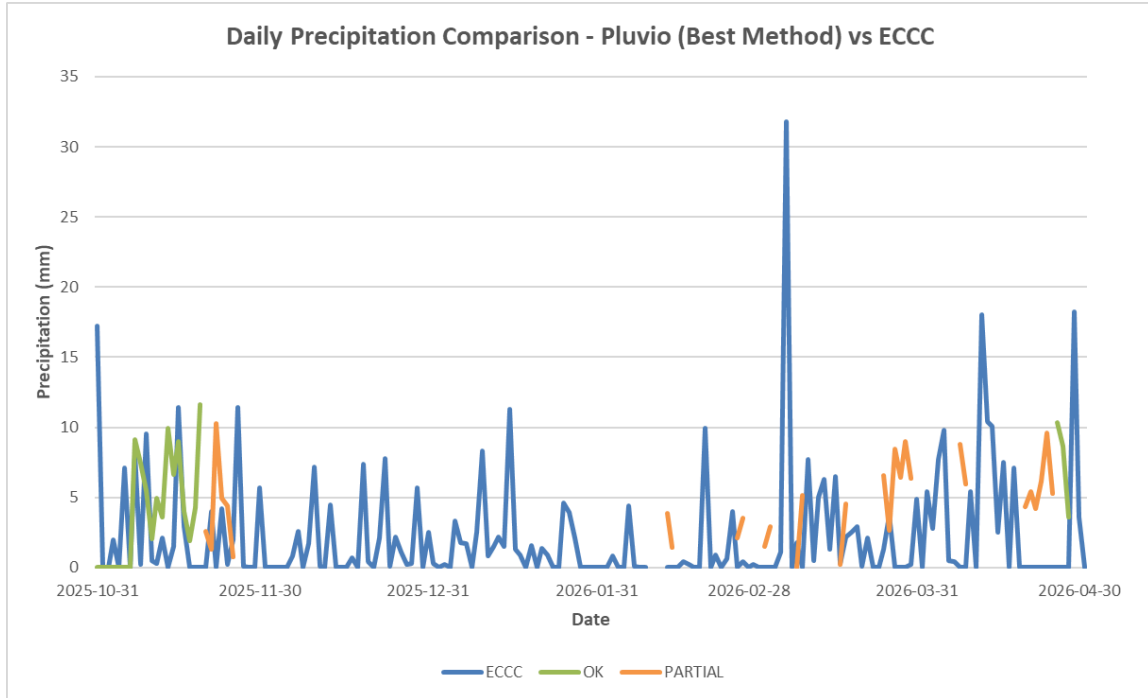


Figure 1. Daily precipitation from the Pluvio (best method) and ECCC over the study period

Summary

Overall, the Pluvio is operational and captures the timing of precipitation events well, but the accuracy of daily precipitation totals is affected by incomplete data and winter-related measurement challenges. Daily values are most reliable during periods of complete data and should be interpreted cautiously when snow or freezing conditions are present.

A structured data processing system (Python + Excel) was developed to organize the raw Pluvio output into cleaned 15-minute, hourly, daily, and comparison datasets, allowing future users to easily access and analyze precipitation trends as explained in Section 2.0.

2.0 PYTHON DATA CLEANING AND COMPARISON SCRIPT

This section will explain the organization system for data analysis.

2.1 User Instructions

A Python script was created to organize the raw Pluvio output into cleaner and more usable Excel sheets. The only section that needs to be edited by future users is the SETTINGS section at the top of the file.

Users should update:

```
INPUT_FILE = r“...”  
OUTPUT_FILE = r“...”  
ECCC_FILES = [...]  
START_DATE = “YYYY-MM-DD”  
END_DATE = “YYYY-MM-DD”
```

**Please note that the files (input, output etc) should use the file path on your computer where the files are stored.*

The script can produce hourly, daily, weekly, and ECCC comparison outputs depending on these settings:

```
MAKE_HOURLY = True  
MAKE_DAILY = True  
MAKE_WEEKLY = False  
MAKE_ECCC_COMPARISON = True
```

2.2 Output Excel Sheets

The script outputs an Excel file with the following sheets:

Cleaned_15min

Cleaned Pluvio data in 15-minute intervals with date, time, datetime, precipitation variables, intensity, temperature, flags, and calculated precipitation deltas.

Hourly_Summary

Hourly precipitation totals, maximum intensity, average load cell temperature, percent bad flags, total records, and data status.

Daily_Summary

Daily precipitation totals from the three Pluvio methods, maximum intensity, average load cell temperature, percent bad flags, total records, and data status.

Weekly_Summary

Weekly summary, created only if MAKE_WEEKLY = True.

Pluvio_vs_ECCC

Daily comparison between Pluvio precipitation and ECCC precipitation. This sheet includes:

- data_status: OK, PARTIAL, or MISSING
- total_records: number of Pluvio records available that day
- precipitation from the three Pluvio methods
- ECCC daily precipitation
- closest Pluvio method
- closest Pluvio value
- absolute error
- percent error
- ECCC mean temperature

Data Status Meaning

- **OK** means the day has enough Pluvio records for a more reliable daily comparison.
- **PARTIAL** means some Pluvio data exists, but the day is incomplete. These values are included for context but should be interpreted carefully.
- **MISSING** means there was no Pluvio data for that day.

Colour Coding in the Comparison Sheet

The comparison sheet is highlighted to make the data easier to interpret:

- **Yellow ECCC column** = Environment Canada precipitation value
- **Grey rows** = missing Pluvio data
- **Green OK cell** = complete/usable Pluvio day
- **Orange PARTIAL cell** = incomplete Pluvio day
- **Green Pluvio method cell** = closest Pluvio method to actual ECCC value for an OK day
- **Orange Pluvio method cell** = closest Pluvio method to actual ECCC value for a PARTIAL day

This makes it easier to see which precipitation method is closest to ECCC and whether the comparison is based on complete or incomplete Pluvio data.

Additional Winter Condition Indicators

To account for winter conditions, additional columns from the ECCC dataset are included where available, such as:

- snow on ground (cm)
- mean temperature (°C)

Using these variables, a winter_condition_flag column is created in the comparison sheet to help interpret discrepancies between Pluvio and ECCC data.

This column may contain:

- SNOW_ON_GROUND → snow was present on the ground
- BELOW_FREEZING → mean temperature was $\leq 0^{\circ}\text{C}$

These indicators are not used to modify or correct the Pluvio data. Instead, they provide context for potential sources of error, as snowfall can accumulate in the Pluvio gauge and be recorded later during melting, leading to delayed or exaggerated precipitation values.