SKYDEW GDP

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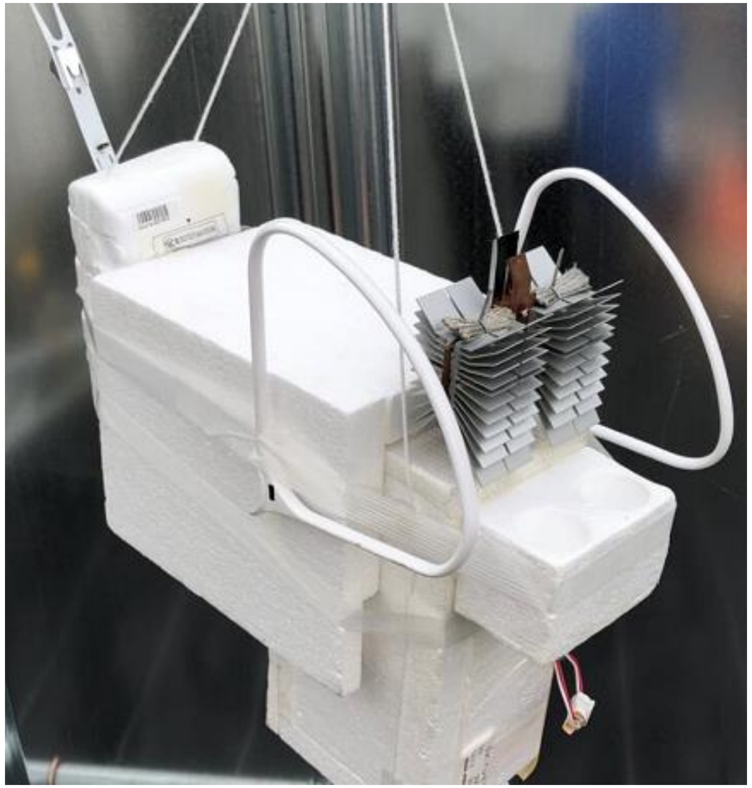
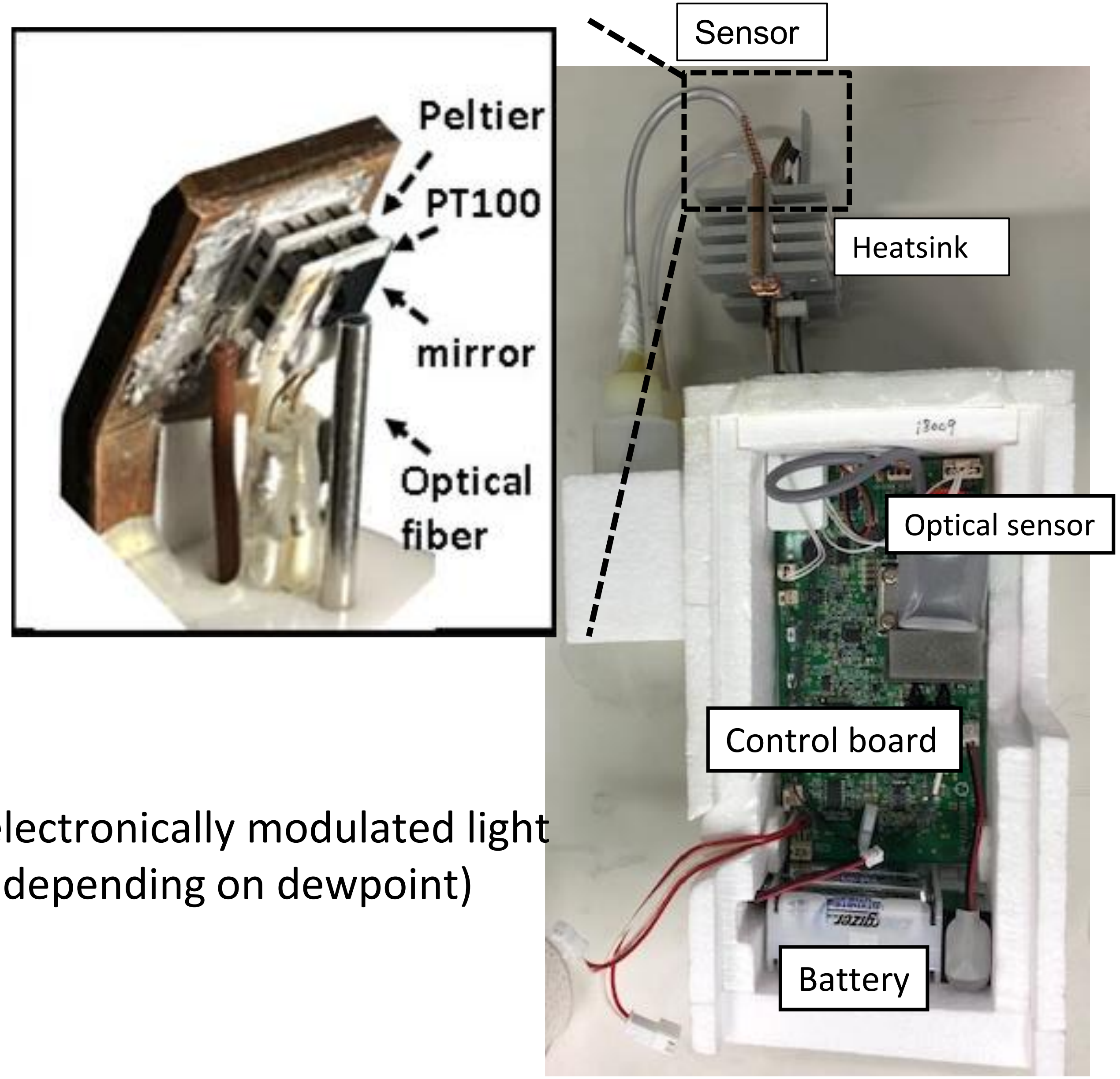
MEISEI

IHI GROUP
Realize your dreams

Peltier-based chilled-mirror hygrometer “SKYDEW”





Features of SKYDEW hygrometer

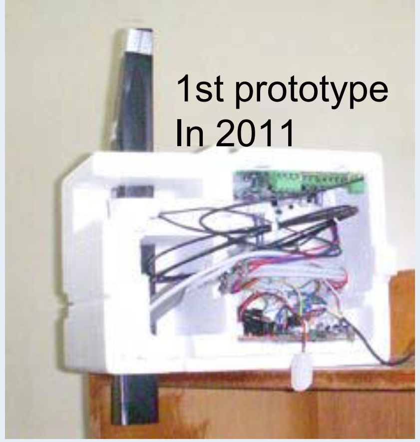
1. Two-stage Peltier device
2. Dew/frost detection by scattered light using an electronically modulated light
3. Digital controller (PID controller, gain scheduling depending on dewpoint)
4. Meisei original data format or XDATA format
5. Weight:~500 g (without a radiosonde)
   Size: 170(W) x 93 (D) x 318 (H) mm

History of SKYDEW development

2009 – 2014:

Several types of prototype

Lab tests and 9 test soundings



--> These results are described in Sugidachi, 2014, Ph. D paper at Hokkaido Univ. (https://eprints.lib.hokudai.ac.jp/dspace/bitstream/2115/55416/1/Takuji_Sugidachi.pdf)

ICM-9

2016 – 2019:

Design of product model

20 test soundings including the comparison sounding with CFH

The comparison results at Japan, Indonesia, and Lindenberg was reported at ICM-10, ICM-11.

2019 – 2022:

Test of 2nd product model

Product release for domestic users (in Japan, Tateno)

CE Certificate for EU users (Lindenberg, Potenza)

The sounding with the product model started. Refer to the ICM-12, 13 presentations

2021 – 2025:

Development of the SKYDEW GDP

1. A peer-reviewed paper (Sugidachi et al. 2025): completed
2. Data flow and processor for GDP: in progress

SKYDEW GDP development started. Refer to the ICM-14 presentation

A peer-reviewed paper about SKYDEW

Atmos. Meas. Tech., 18, 509–531, 2025
https://doi.org/10.5194/amt-18-509-2025

Atmospheric Measurement Techniques
Open Access
EGU

Development of a Peltier-based chilled-mirror hygrometer, SKYDEW, for tropospheric and lower-stratospheric water vapor measurements

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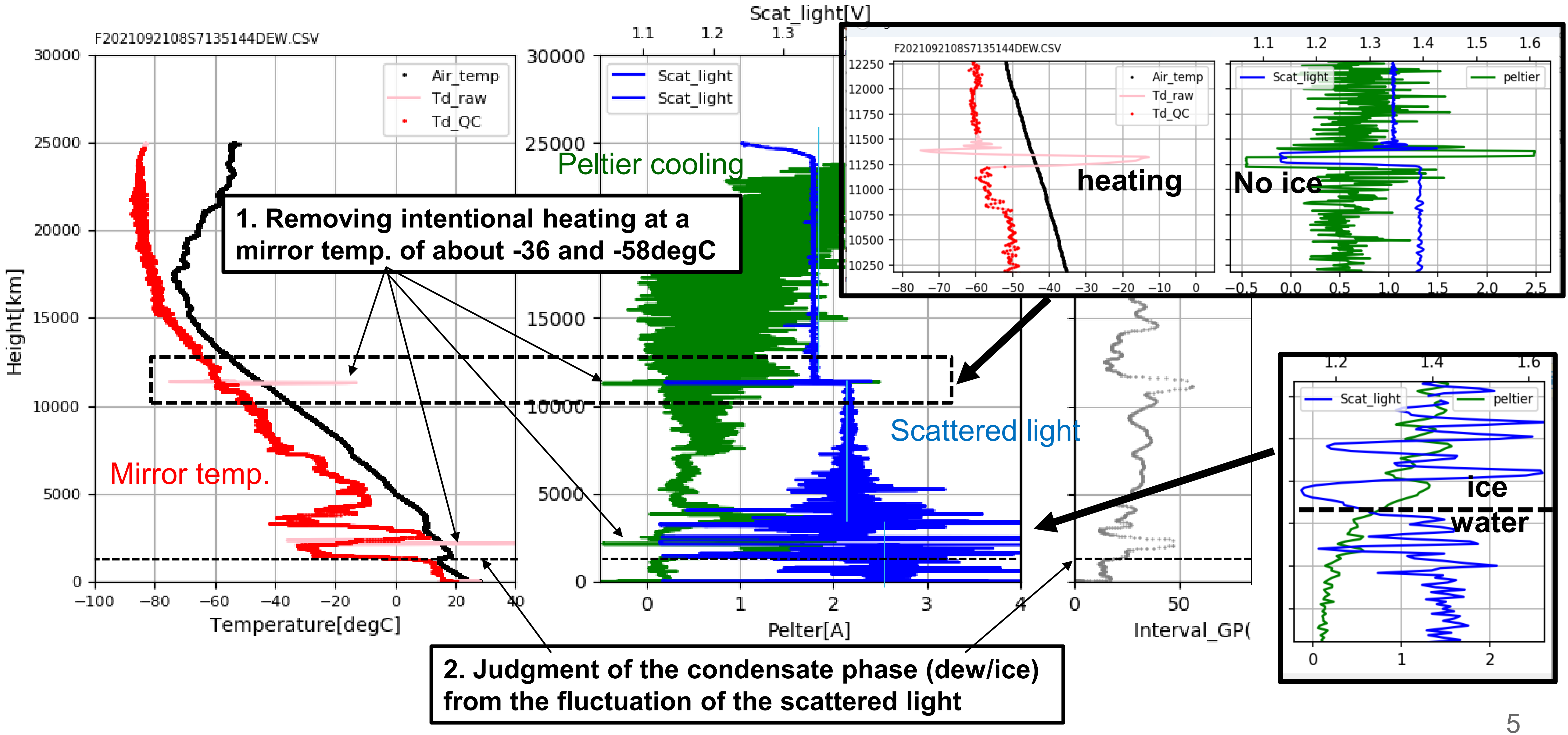
This paper describes the technical detail of SKYDEW measurement, including

1) data processing (QC, smoothing with the Golden point),
2) uncertainty estimation, and
3) validation with other instrument (CFH, satellite)

Data processing (Sugidachi et al. 2025)

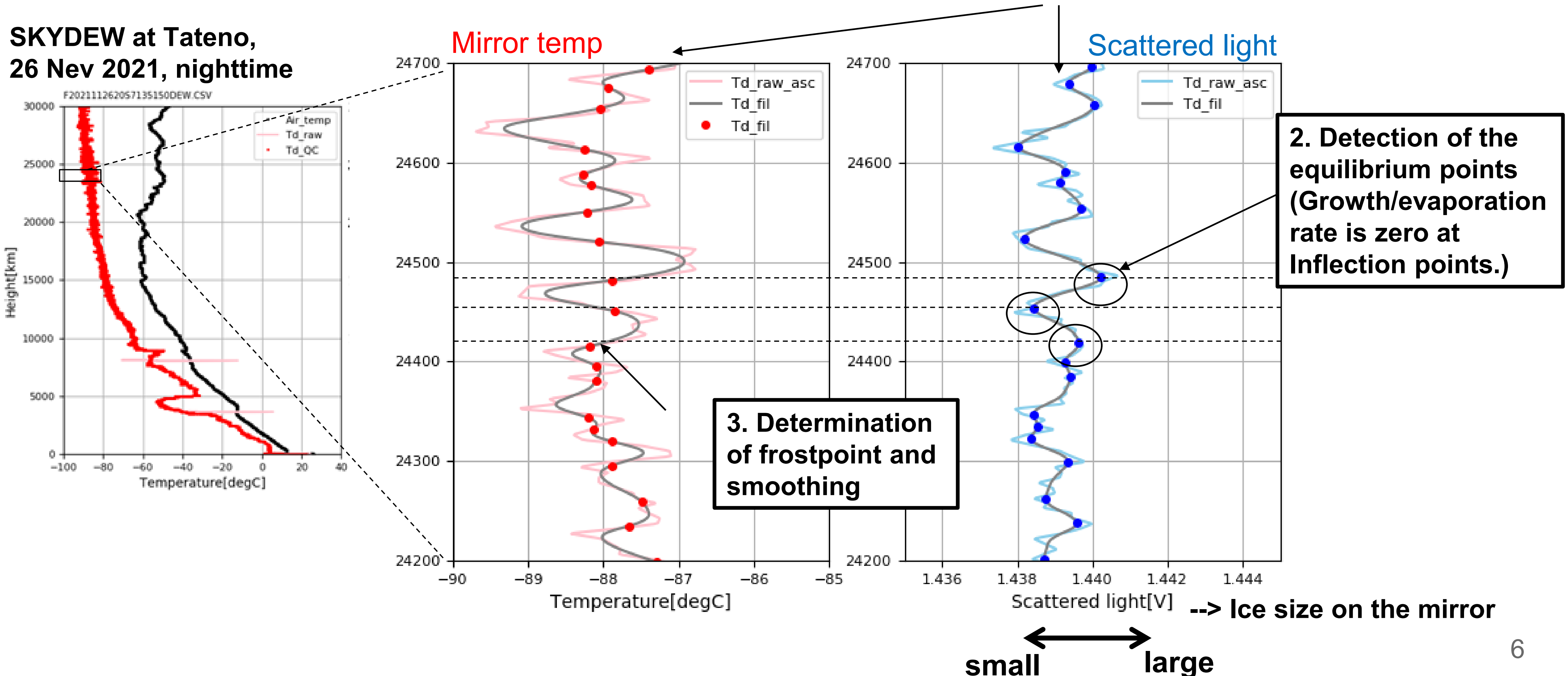
Quality control with the scattered light signal from the mirror.



Data processing (Sugidachi et al. 2025)

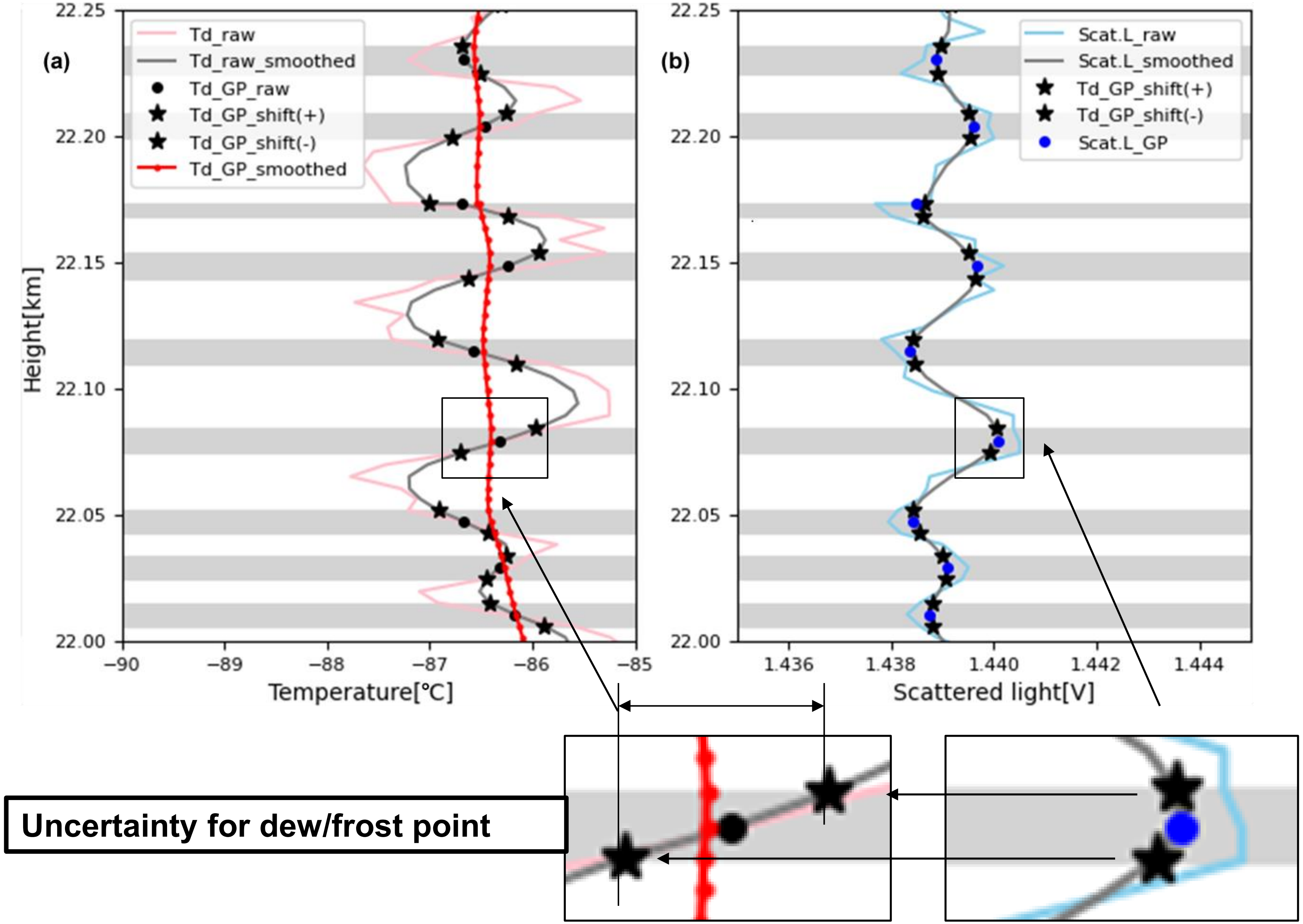
The profile of the mirror temperature is smoothed with the golden point method.
The golden point method is based on the measurement principle of a chilled-mirror hygrometer (Poltera et al. 2025 in review).

1. Smoothing for removing electric noise



Uncertainty estimation (Sugidachi et al. 2025)

The timing error in GP detection causes an error in the determination of the frost point.

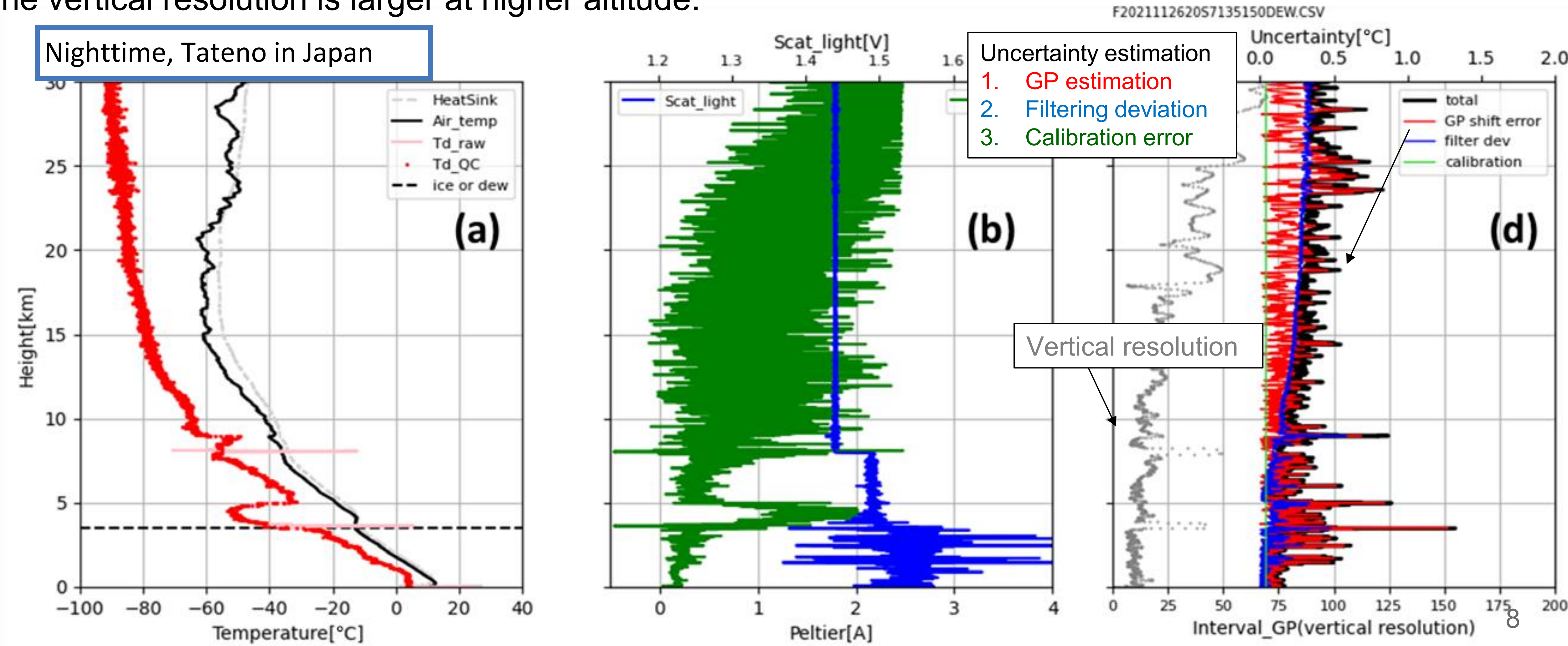


Assumption:
Max/Min of GP timing error is +/-1s

Blue dot: equilibrium point (GP)
Asterisk : +/-1 sec error of GP

Uncertainty estimation (Sugidachi et al. 2025)

The profile of the frost point and uncertainty on 26 November 2021 in Japan. Right panel shows the uncertainty(k=1) for this sounding. When the oscillation is enough small, the uncertainty is less than 0.2K. However, the uncertainty is larger for the stronger oscillation above 23km and sharp gradients of frost point for this sounding.
The vertical resolution is larger at higher altitude.



SKYDEW GDP development status

Tasks and Progress Overview for GRUAN certification

1. Peer-reviewed Paper — ✔ Completed (Sugidachi et al. 2025)

2. Technical Document — ✔ Draft Completed
   review process : not yet
   file formatting (word file --> LaTeX/Tex): not yet

3. Automated Data Processor — 🚩 In Trial Phase
   (collaboration with Lindenberg)

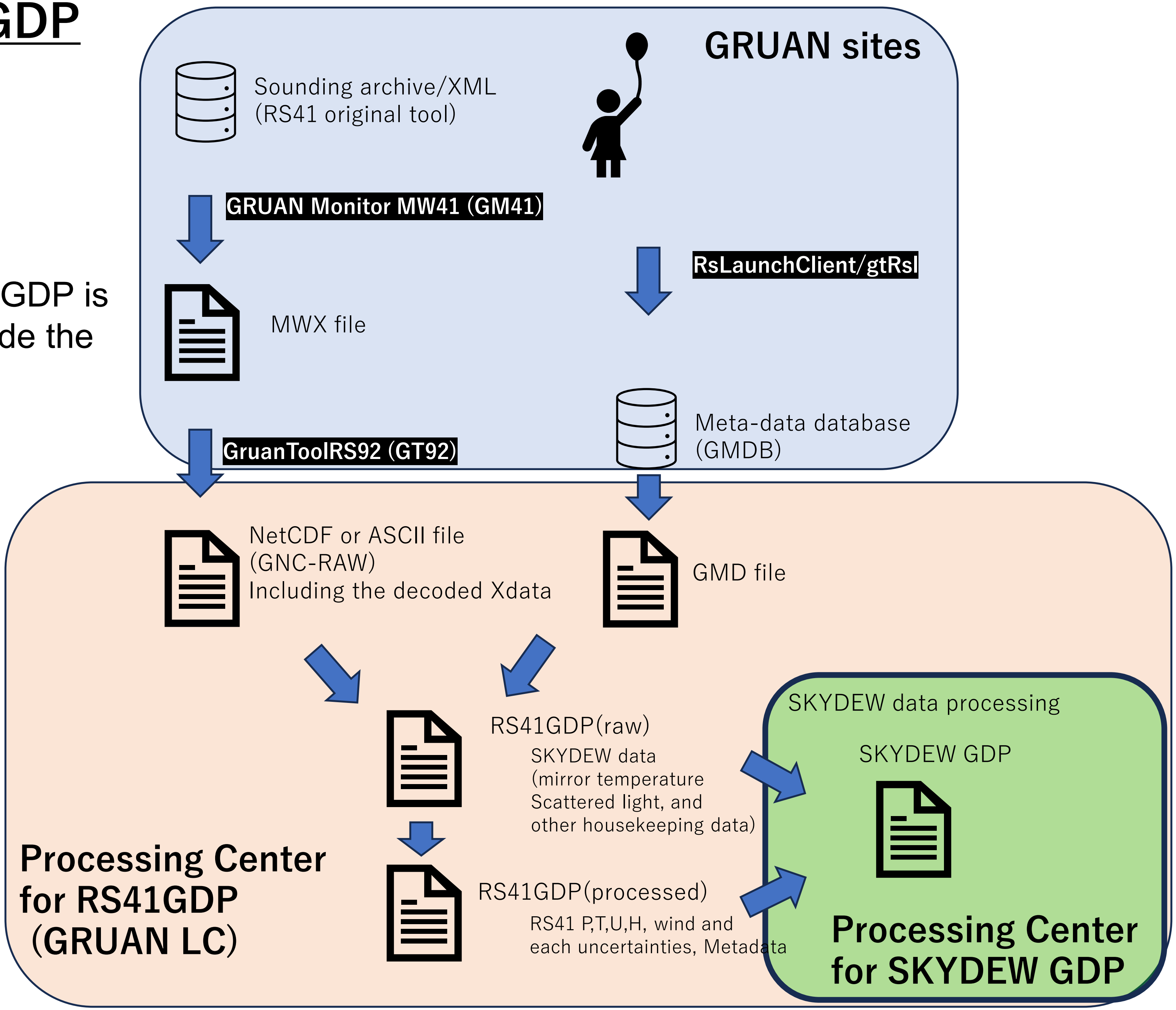
4. Establishment of Data Flow — 🚩 In Progress
   (collaboration with Lindenberg)

Next step is the setup of the processing SKYDEW GDP BETA1 hosted GRUAN LC

Practical work for SKYDEW GDP Data flow

The processing center is LC for Skydew.

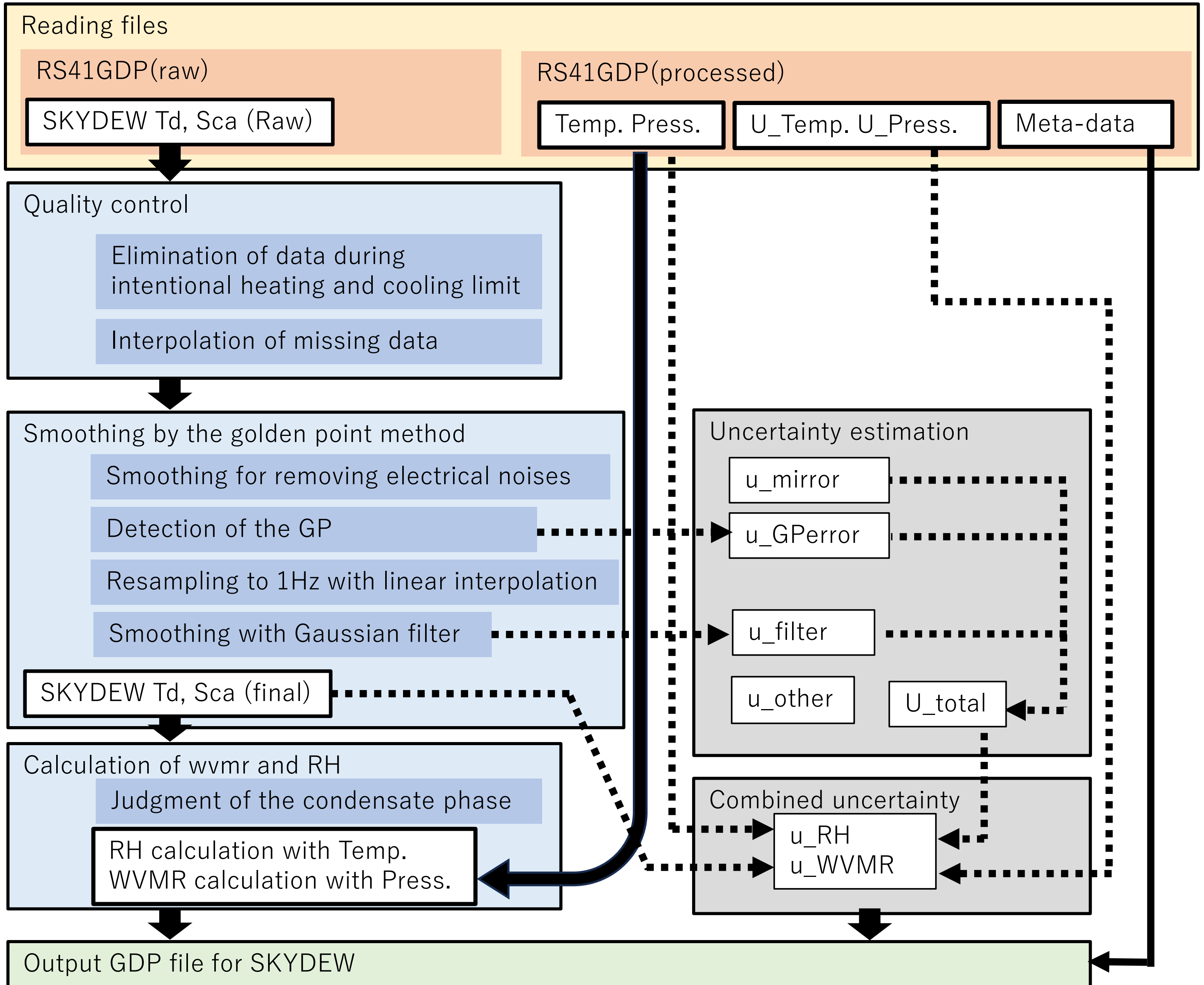
With the automatic processer, SKYDEW GDP is created from RS41GDP files, which include the external sensor data.



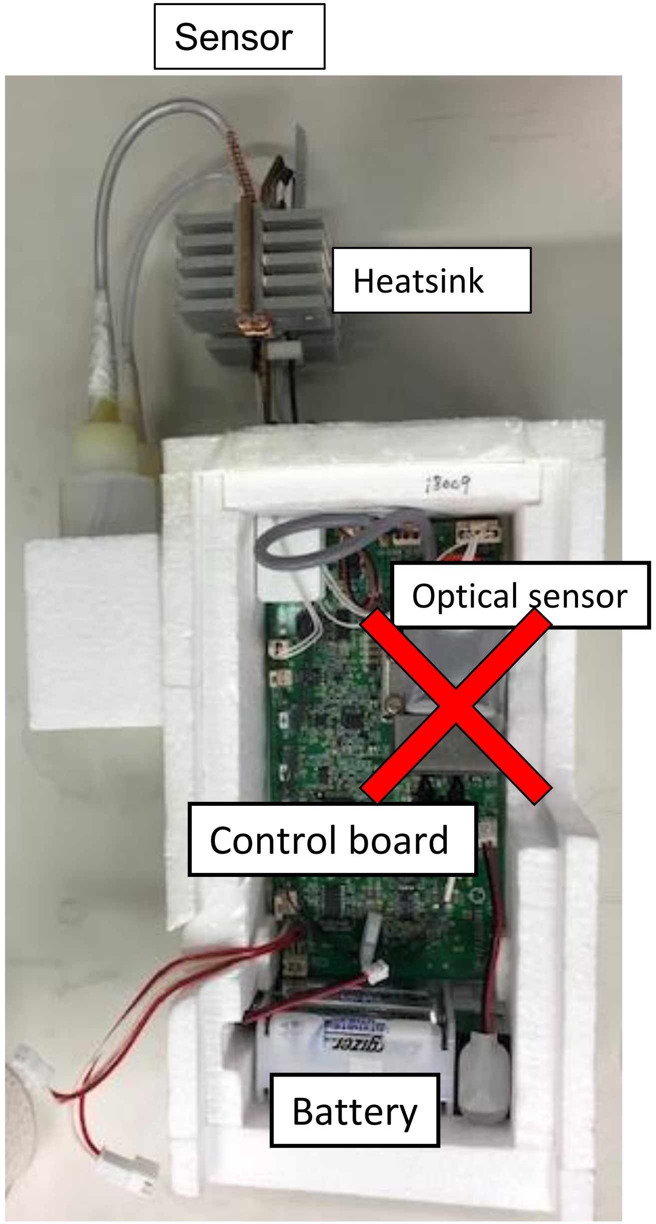
SKYDEW GDP data flow. In the case of the RS41 radiosonde as the transmitting radiosonde.

Automatic data processer for SKYDEW GDP

Flowchart showing an outline of the workflow of the processing step and uncertainty estimation.



The development for replacement for the discontinued electric part



The optical sensor has already been discontinued.

Meisei plans to develop the SKYDEW with an alternative optical sensor next year.

The dew/frost detection performance differs, and the PID controller may be retuned.(?)

The PT100 and Peltier device remain unchanged. the temperature measurement performance is expected to be equivalent to that of the current version.

Summary

SKYDEW GDP Certification: Tasks and Progress Overview

1. **Peer-reviewed Paper** ✔ **Completed (Sugidachi et al. 2025)**
2. **Technical Document** ✔ **Draft Completed**
3. **Automated Data Processor** 🚩 **In Trial Phase (collaboration with Lindenberg)**
4. **Establishment of Data Flow** 🚩 **In Progress (collaboration with Lindenberg)**

Acknowledgements:
We would like to thank everyone at the Lindenberg Observatory, especially Oelsner Peter, for their support in SKYDEW observations and data processing.

Thank you for your attention!