

Typical and Design Weather Year Based on Quantile Mapping

Research background: Typical weather year and design weather data

Meteorological data for building thermal load calculation are classified into two types: standard weather data for estimating average thermal load and design weather data for estimating maximum thermal load. Whether standard weather data that accurately represents multi-year weather data can be obtained or not depends on weather data in the past method, and maximum heat which is strongly influenced by simultaneous occurrence of meteorological elements and continuous occurrence. A method of creating design weather data for estimating the load has not yet been established.

Research objective: Propose new year weather data (Typical and Design Weather Year: TDWY)

We propose annual weather year data named typical and design weather year (TDWY) that can also be used as highly accurate and highly versatile design weather data as both typical weather year and design weather data.

Research method: Utilize Quantum Mapping (QM)

Typical and Design Weather Year (TDWY) is created by implementing quantile mapping (QM) using weather data (MY) of multiple years for a certain year's weather data (Y). First, we create cumulative density function (CDF) for annual weather data and multi-year annual weather data, and replace the annual weather data values with multi-year annual weather data values (QM) showing equal percentiles. Weather data for standard design is created. The TDWY can be expected to have high performance as standard weather data because the CDF of each meteorological element perfectly matches MY. The use as weather data for design with high versatility is also expected.

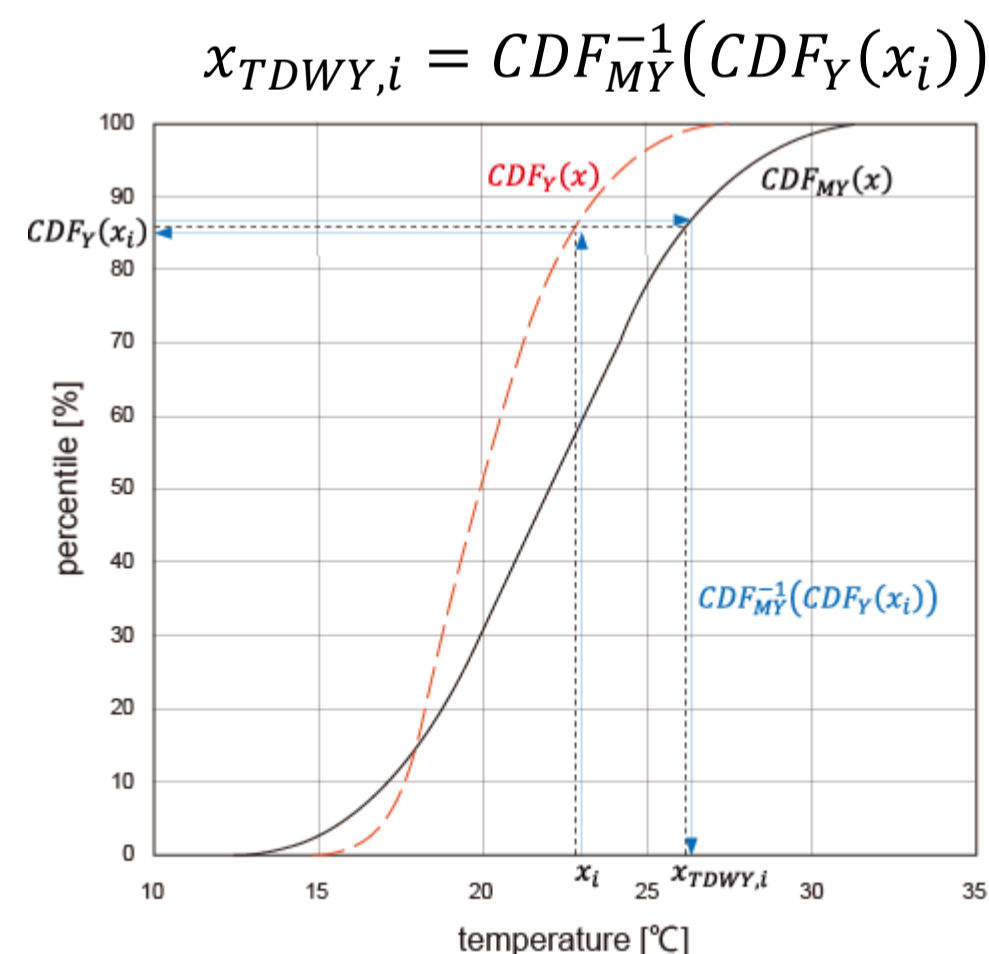
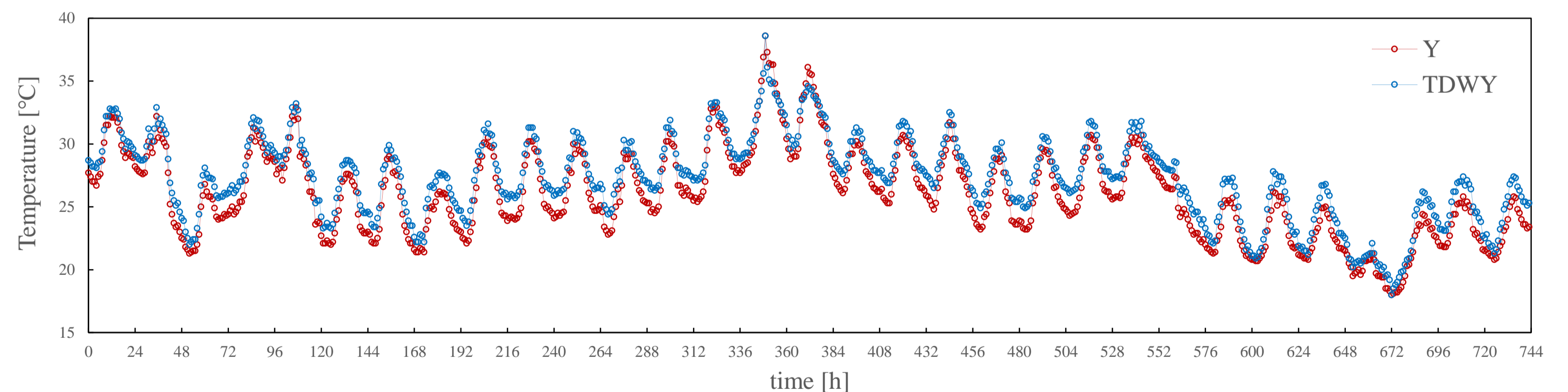


Diagram of creating TDWY

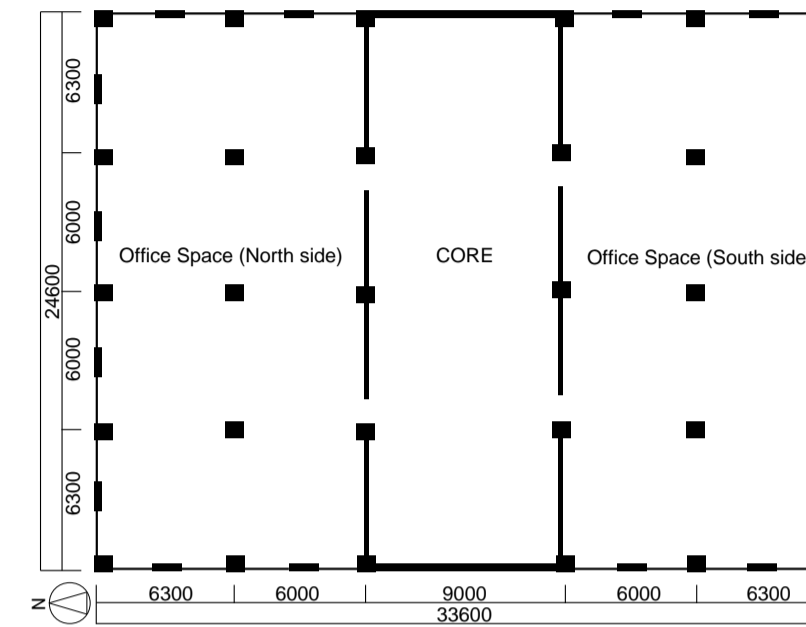


Chronological change of temperature of TDWY and Y (1996) (August, Tokyo)

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Performance evaluation of TDWY by building thermal load calculation

Building heat load calculation was performed to evaluate the performance as typical and design weather year (TDWY). We use four types of weather data, the observed weather data (MY) of multiple years (1991-2000), annual weather data (AY), past standard weather data (Std EA), typical and design weather year created by QM method (TDWY), assumed to be office buildings.



- Air conditioning setting
- Cooling: 26 °C / 60%
 - Heating: 22 °C / 50%
 - Time: 8: 00-18: 00
 - Introduction of outside air: 25 m³ / h / person
 - Counterstorm: 0.5 / h
- Internal heat generation
- 41 people (≈ 0.2 / m²)
 - Lighting: 19 W / m²
 - Machine: 5.81 W / m²

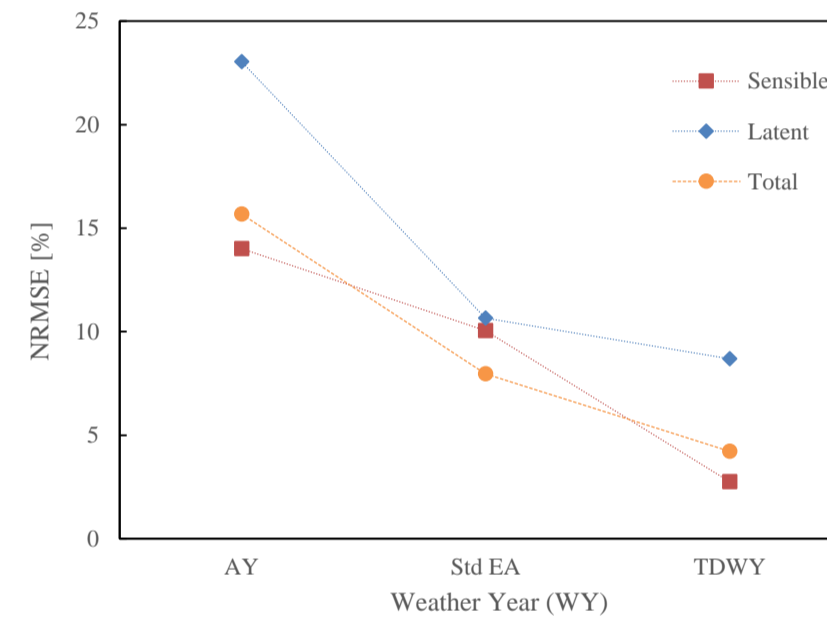
Target office building (floor area: 826.56 m², floor height 3.6 m)

Performance indicator as typical weather data

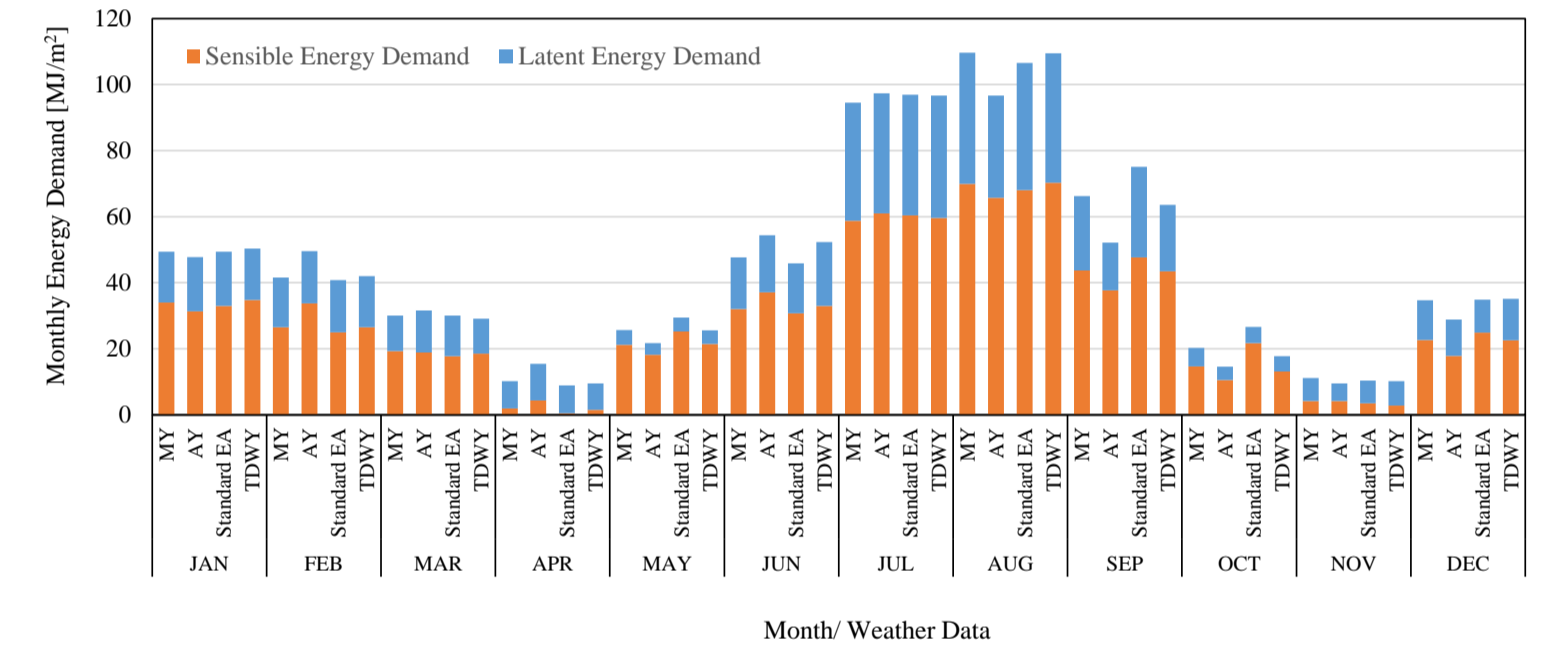
The Normalized Root Mean Square Error (NRMSE)

evaluated the degree of agreement between the cooling / heating load HL_{WY} predicted from each annual weather data and the cooling / heating load HL_{MY} estimated from the multi year annual weather data. TDWY It has about twice the performance of existing Std EA.

$$NRMSE_{WY} = \sqrt{\frac{1}{M} \sum_m (HL_{WY,m} - HL_{MY,m})^2} / \frac{1}{M} \sum_m HL_{MY,m} \times 100$$



NRMSE of each weather data (Tokyo)

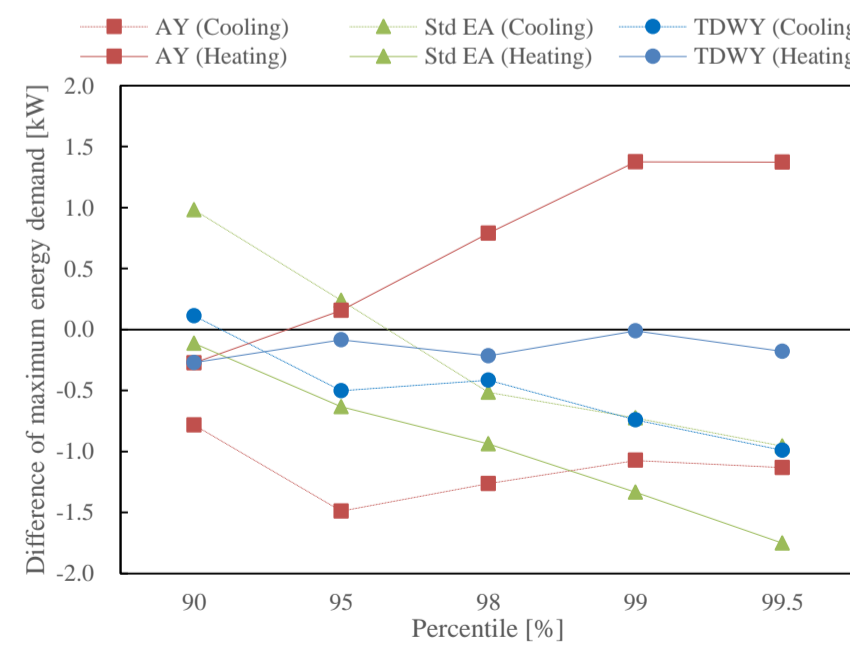


Air conditioning load predicted by each weather data (Tokyo)

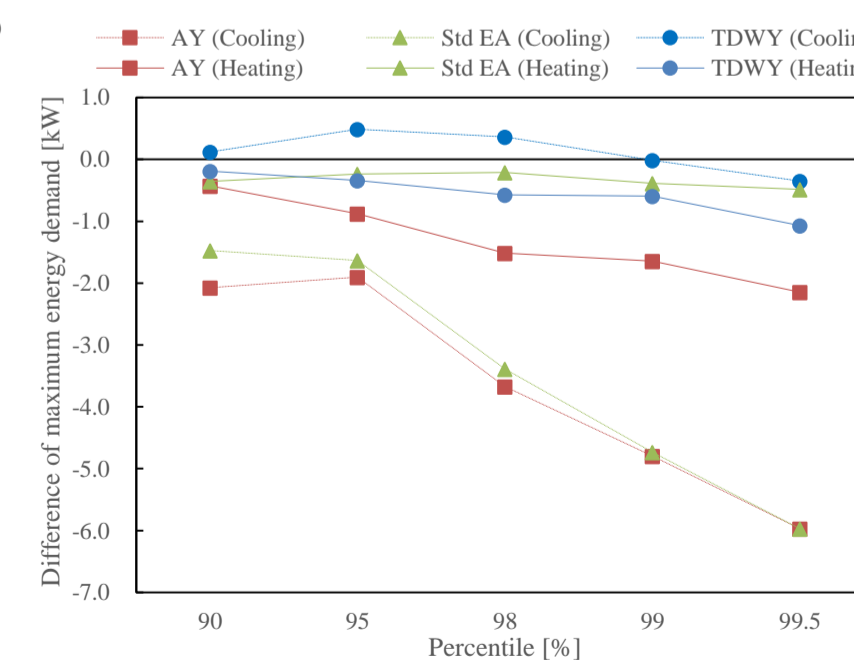
Performance evaluation as design weather data

Normalized Bias Error (NBE) was used to evaluate the degree of coincidence between the maximum cooling and heating load $MHL_{WY,p}$ corresponding to the high percentile p predicted from each annual weather data and the maximum cooling/heating load $MHL_{MY,p}$ corresponding to the same percentile predicted by the multi year annual weather data. TDWY can predict maximum thermal load with high accuracy.

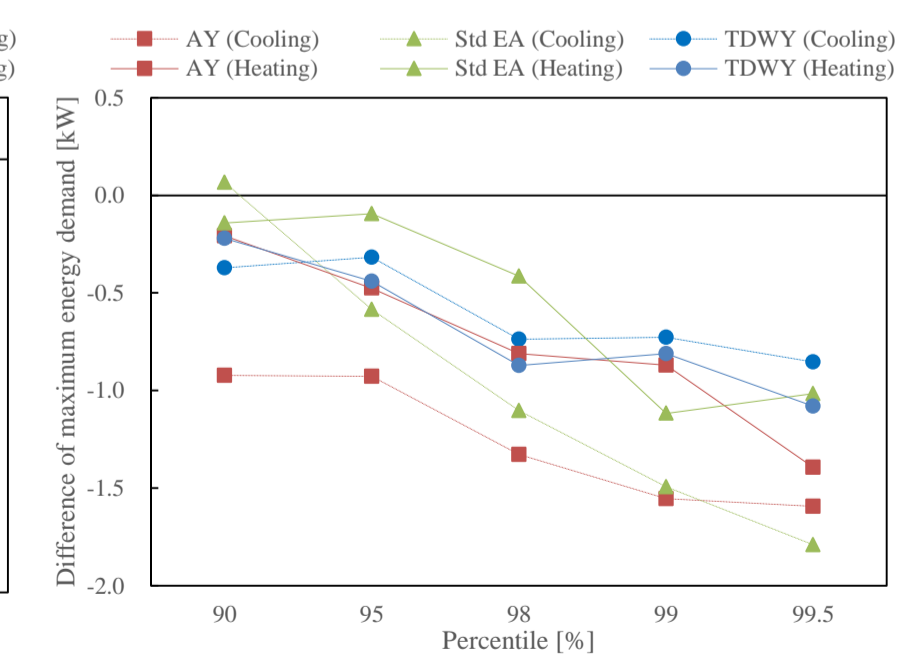
$$NBE_{WY,p} = |MHL_{WY,p} - MHL_{MY,p}| / MHL_{MY,p} \times 100$$



(a) Tokyo



(b) Sapporo



(c) Kagoshima

The maximum thermal load of each city NBE (south side office)