

A Python-enhanced urban land surface model SuPy (SUEWS in Python, v2019.2): development, deployment and demonstration

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Abstract. Accurate and agile modelling of the climate of cities is essential for urban climate services. The Surface Urban Energy and Water balance Scheme (SUEWS) is a state-of-the-art, widely used, urban land surface model (ULSM) which simulates urban-atmospheric interactions by quantifying the energy, water and mass fluxes. Using SUEWS as the computation kernel, SuPy (SUEWS in Python), stands on the Python-based data stack to streamline the pre-processing, computation and post-processing that are involved in the common modelling-centred urban climate studies. This paper documents the development of SuPy, which includes the SUEWS interface modification, F2PY (Fortran to Python) configuration and Python frontend implementation. In addition, the deployment of SuPy via PyPI (Python Package Index) is introduced along with the automated workflow for cross-platform compilation. This makes SuPy available for all mainstream operating systems (Windows, Linux, and macOS). Furthermore, three online tutorials in Jupyter notebooks are provided to users of different levels to become familiar with SuPy urban climate modelling. The SuPy package represents a significant enhancement that supports existing and new model applications, reproducibility, and enhanced functionality.

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0.1 test section

To address these considerations, SuPy's architecture uses Python's data processing and Fortran's computational efficiency.

SuPy consist of three parts (fig. 1):

- 1) *SUEWS*: a Fortran-coded local scale urban land surface model of moderate complexity that can simulate the urban surface energy balance in combination with the complete urban hydrological cycle, considering irrigation and runoff processes (Grimmond and Oke, 1986, Grimmond and Oke 1991, Grimmond et al. 1991, Offerle et al. 2003, Järvi et al. 2011, Jarvi et al. 2014, Ward et al. 2016).
- 2) *SuPy_driver*: calculation kernel compiled by F2PY (Fortran to Python, part of the NumPy package) (Peterson, 2009) to facilitate the transfer of SUEWS Fortran modelling ability to Python and guarantee the computational performance.
- 3) *SuPy*: a Python-based frontend processor using pandas `DataFrame` and derived functionality for data analysis and simulation management.

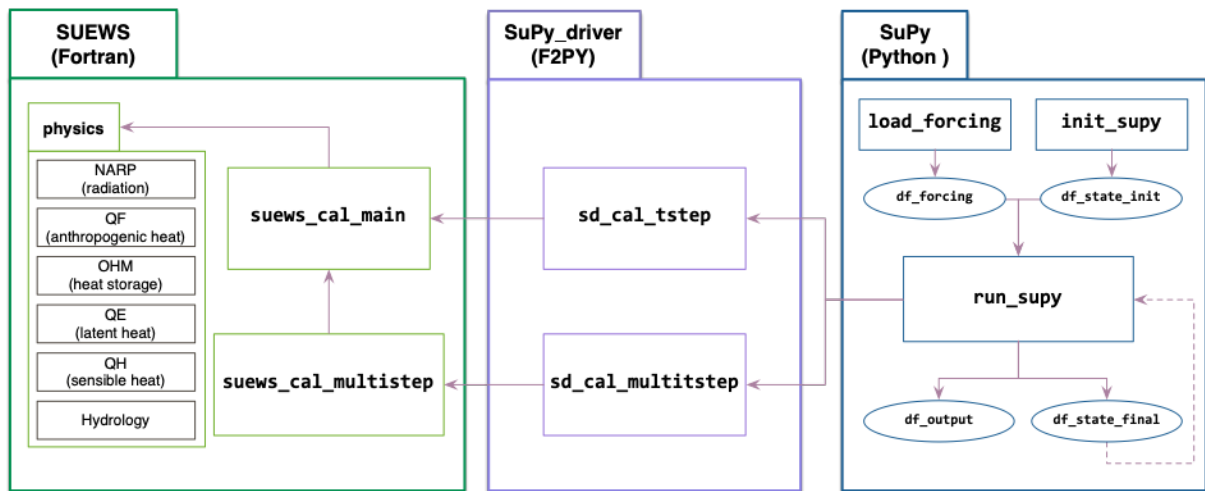


Figure 1. SuPy’s three major components (left to right): a) SUEWS, a Fortran-coded local scale urban land surface model; b) SuPy_driver, the calculation kernel compiled by F2PY; c) SuPy, a Python-based frontend processor

Code and data availability. use this to add a statement when having data sets and software code available

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Appendix A: Figures and tables in appendices

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Author contributions. Daniel wrote the package. Josiah thought about pottery. Markus filled in for a second author.

Competing interests. The authors declare no competing interests.

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