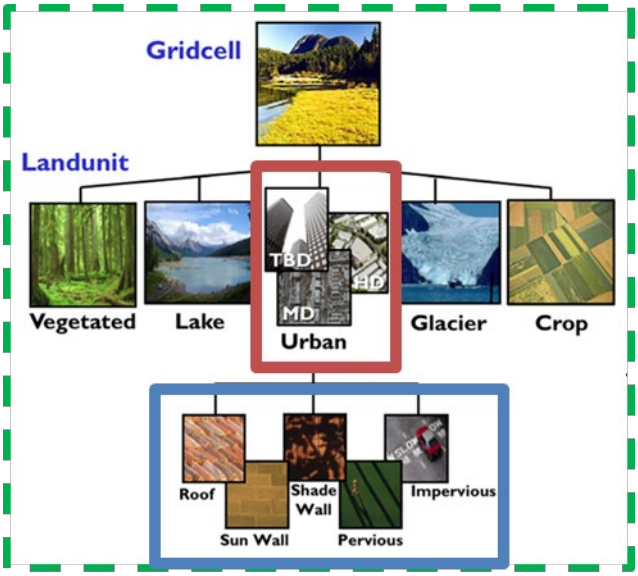
Environmental Engineering & Sciences

Department of Civil and Environmental Engineering
CEE 595AG Seminar

Friday, February 3, 2023 | 10:00 – 10:50 a.m. CST | 3310 Newmark Lab

Implementing a Dynamic Urban Scheme in the Community Earth System Model (CESM)



Schematic diagram of urban parameterization in CESM's land model component (Lawrence et al., 2019). Orange box: urban land-unit in three density classes. Blue box: representation of various urban surfaces. This work bases on such urban parameterization and further enables the representation of urbanization (change in urban extents) to better depict urban dynamics.

Urbanization represents one of the most significant anthropogenic land use / land cover changes where buildings and impervious surfaces replace the natural landscapes, leading to modification of local thermal conditions and potentially regional climate. Numerical simulation with earth system models (ESMs) is a powerful tool to study such climate impact of urbanization. Among the models, the Community Earth System Model (CESM) has a physically-based urban scheme that is sufficiently detailed to represent the properties and processes in the urban environment; however, such representation is static, limiting its capability to represent realistic urbanization coupled with climate change. This is one missing piece in CESM's transient land capability.

Here we implement a dynamic-urban feature in the Community Terrestrial System Model (CTSM) that enables CESM to update urban land areas dynamically under various scenarios. We also compile an urbanization dataset based on one socio-economic projection and make it possible for model users to supply their own projection. Results show that urbanization has considerable climate impact within the terrestrial model as well as greater indirect climate effect when interacting with the atmosphere. This new dynamic-urban feature makes CESM the first ESM that allows explicit transient urban land and facilitates research of urban climate under impacts of both climate change and urbanization.

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Bowen Fang received his B.S. degree from Peking University, Beijing, China, and the M.S. degree in Environmental Science from the Yale School of the Environment, New Haven, CT, USA. He is currently a 4th-year Ph.D. student at the Department of Civil and Environmental Engineering, working with Dr. Lei Zhao. His research uses Earth system model and remote sensing to study the interactive impact of urbanization and climate change. He is also interested in urban heat island mitigation and other engineering solutions to sustainable urban development.