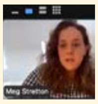
Urban Climate News

Quarterly Newsletter of the IAUC

ISSUE NO. 83 MARCH 2022 • www.urban-climate.org • INTERNATIONAL ASSOCIATION FOR URBAN CLIMATE

Inside the March issue...



From the IAUC President

I wish to begin this column by briefly reflecting on the tragic situation that continues to unfold in Ukraine as a result of the totally unjust war inflicted on that country. Our IAUC membership includes a number of colleagues from Ukraine and there have been several memorable IAUC activities in that country. I wish to express my concern for them and their relatives in these very difficult times; please feel free to reach out if there is anything that we can do to help you in these difficult circumstances.

In a recent column I mentioned the increased focus on urban areas in the current deliberations of the IPCC. This is confirmed with the recent release (February 28 and April 4) of the reports from IPCC Working Groups (WGs) II and III. This is especially the case for the WG II report *"Impacts, Adaptation and Vulnerability"* where a substantial number of the headline statements in the Summary for Policymakers (SPM) explicitly mention the key vulnerabilities of cities and their important role in addressing issues of climate change. This is impressive justification for our work in the area. For example, some key statements drawn from the WGII SPM include that… *"4.3 billion urban people, property and critical infrastructure are increasingly adversely affected by climate change (high confidence). Key impacts include heat stress and flooding, and cascading impacts through supply chains and resource flows, which damage the lives, health and livelihoods of urban residents and connected rural places (high confidence)."* And in relation to adaptation…*"Urban systems are critical adaptation spaces for advancing the health and well-being of the majority of the world's population (high confidence). Adaptation of natural, physical and social infrastructure play a critical role in building climate resilient urban systems."* The statement …*"Increasing evidence shows that nature-based solutions in urban areas (e.g., shade trees, natural ecosystems, green roofs) can provide important livelihood options and health benefits and reduce poverty while also supporting mitigation and adaptation (high confidence)"*… and the underlying material in the background report draws heavily on the work of our community. I am sure that our membership will find many ways of using material from the current assessment for promoting their work.

The August **2022 IAUC Virtual Poster Conference** Organising Committee has met several times since the beginning of the year and has developed an very exciting program. I am delighted to announce the opening of the **website** (iaucposter2022.com) and the **call for abstracts** https://iaucposter2022.com/submission-and-registration. The deadline for submission of abstracts is 01 June 2022. Remember that this low-fee conference is focused on our graduate and early career researchers and will feature daily keynotes, a multiple time-zone friendly format, and will provide significant points of difference from other virtual conferences. Remember also that this is a stepping-stone to our flagship ICUC-11 conference to be held face-to-face in 2023.

Please enjoy this current *Urban Climate News* – David Pearlmutter and his dedicated team have once again provided a newsletter packed with useful and informative material on various urban projects, features of special interest and newsworthy reports. With my very best wishes to you in these turbulent times.

– Nigel Tapper,
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New Research Shows How Health Risks to Children Mount as Temperatures Rise

The first nationwide study on rising temperatures and younger Americans found that hotter days were associated with more visits to emergency rooms.

January 2022 — Higher temperatures in late spring and summer were associated with higher rates of emergency-room visits for children across the United States, researchers said Wednesday. The research adds to a growing body of evidence of the dangers that heat poses to vulnerable populations, including children and adolescents. Although children dissipate heat in the same way as adults, they suffer the effects differently, in part because of differing body surface areas, body fat composition and hydration.

"We've run into trouble previously assuming that children are little adults," said Dr. Aaron Bernstein, a pediatrician at the Boston Children's Hospital who was one of the paper's authors. But the findings show that their bodies suffer from some unique effects of heat.

The research, published Wednesday in *Environmental Health Perspectives*, is the first to offer a comprehensive study on the effects of rising temperatures on people 18 and under across the country. The authors analyzed data from nearly four million emergency department visits at 47 children's hospitals nationwide in late spring and summer between 2016 and 2018. They found that nearly 12 percent of those emergency department visits could be attributed to elevated temperatures. But those rates were much higher for certain conditions. Nearly a third of emergency department visits for heat-related illness, like heat stroke and heat exhaustion, and a quarter of the visits for bacterial intestinal infections, were attributed to heat.

Dr. Bernstein said that some of the infections that peaked in the summer could be associated with changes in behavior caused by the warm weather. For instance, higher rates of ear infections could be a result of more time spent in swimming pools, and bacterial intestinal infections could be a result of picnicking or eating foods that had been removed from refrigeration. But a number of the findings surprised researchers. For instance, the increased risk for children suffering from blood, immune and nervous-system diseases during periods of higher heat are not easily explained by changes in behavior and have not been seen in studies of adults.

With climate change, heat waves and rising temperatures are becoming more frequent. And that has repercussions for human health. It is well established that days of extreme heat are dangerous for adults and can lead to excess deaths, particularly in vulnerable populations like older people. When temperatures rise, people can become severely ill or die if they are unable to effectively sweat and cool off. This can lead to an increase in internal body temperature.

In addition to temperature-related illnesses like heat strokes or heat exhaustion, adults can also suffer cardiovascular and respiratory disorders. Last summer, a New York Times analysis found that the deadly heat wave in the Pacific Northwest resulted in 600 more deaths than would have been typical. "We know that, due to climate change, days with extreme heat are going to be more frequent and more intense," said Francesca Dominici, a biostatistician at Harvard's T.H. Chan School of Public Health who has studied the effects of extreme heat on human health and was not involved in the new research. "The degree to which children are susceptible to climate change risk, it should be a high priority for scientists to study."

A misting station in Queens in August. National research shows that children face particular dangers during heat waves. *Source:* https://www.nytimes.com

One reason it is important to study children is because of the possibility of lifelong effects. "The question of which of these diseases that manifest on a hot day are completely curable with proper intervention and which may create chronic disease later in life, is a very open research question," Dr. Dominici said.

Dr. Dominici added that this research could make clinicians and parents more aware of the range of disorders that affect children during higher temperatures. "If we know what types of diseases m ight be exacerbated on these days in kids, we can either prevent these diseases or when kids come into the E.D. clinicians are knowledgeable about what's happening."

Dr. Bernstein said the research underscored the inequities in pediatric health care. For instance, though a quarter of all bacterial intestinal infections were attributed to heat, those rates were substantially higher for nonwhite children and those who rely upon public health insurance like Medicaid. The data, which did not include pediatric visits to community hospitals or primary care appointments, reiterated that "children without good access to care are more likely to use an emergency department," he said.

"It's one thing when we see these inequities laid bare in people at the end of life," Dr. Bernstein said. But for a child, "we essentially put them on a different course for the rest of their life." *Source:* https://www.nytimes.com/2022/01/19/climate/children-climate-change.html?smid=em-share

Urbanization is driving evolution of plants globally, study finds

March 2022 — Humans re-shape the environments where they live, with cities being among the most profoundly transformed environments on Earth. New research now shows that these urban environments are altering the way life evolves.

A study led by evolutionary biologists at the University of Toronto Mississauga and including the University of Washington Urban Ecology Research Lab examines whether parallel evolution is occurring in cities all over the world. In findings published March 18 in the journal *Science*, the Global Urban Evolution Project (GLUE) analyzed data collected by 287 scientists in 160 cities in 26 countries, who sampled the white clover plant in their cities and nearby rural areas.

What they found is the clearest evidence yet that humans in general, and cities specifically, are a dominant force driving the evolution of life globally.

"We've long known that we've changed cities in pretty profound ways and we've dramatically altered the environment and ecosystems," said co-lead author James Santangelo, a doctoral student at the University of Toronto Mississauga. "But we just showed this happens, often in similar ways, on a global scale."

The researchers examined white clover because it is one of the few organisms present in almost every city on Earth, providing a tool to understand how urban environments influence evolution. The study illustrates that the environmental conditions in cities tend to be more similar to each other than to nearby rural habitats. In that sense, downtown Toronto is more comparable to downtown Tokyo in many ways than it is to surrounding farmland and forests outside of the city.

What they found is the clearest evidence yet that humans in general, and cities specifically, are a dominant force driving the evolution of life globally.

In addition to observing global adaptation to cities, researchers identified the genetic basis of that adaptation and the environmental drivers of evolution. White clover produces hydrogen cyanide as both a defense mechanism against herbivores and to increase its tolerance to water stress, and the study found that clover growing in cities typically produce less of it than clover in neighboring rural areas due to repeated adaptation to urban environments.

It is the changes in the presence of herbivores and water stress in cities that is pushing white clover to adapt differently than their rural counterparts.That finding holds true for cities across various climates, and the implications reach far beyond the humble clover plant.


Researchers from all over the world, including the University of Washington, studied white clover to gauge impacts of urbanization. *Source:* https://www.washington.edu

"Increasing evidence shows that urbanization is causing rapid evolution in heritable traits of many plants and animal populations which provide important ecosystem functions that support human well-being, such as nutrient cycling, seed dispersal and biodiversity," said co-author Marina Alberti, UW professor of urban design and planning. "Finding a clear signal that cities are altering trait changes across the globe has important implications for ecosystems' adaptive capacity that enables their stability and resilience in the face of rapid global environmental change."

The information from this study can be used to start developing strategies to better conserve rare species and allow them to adapt to urban environments, researchers said. It can also help experts better understand how to prevent unwanted pests and diseases from adapting to human environments. In collecting more than 110,000 clover samples and sequencing more than 2,500 clover genomes, the team also created a massive dataset for further research.

"This study is a model to understand how humans change the evolution of life around us. Cities are where people live, and this is the most compelling evidence we have that we are altering the evolution of life in them. Beyond ecologists and evolutionary biologists, this is going to be important for society," said co-author Rob Ness, an assistant professor of biology at the University of Toronto Mississauga.

Other UW co-authors on the study, all doctoral students in the Urban Ecology Research Lab, are Karen Dyson, Tracy Fuentes and Meen Chel Jung. For more information, contact Alberti at malberti@uw.edu. *Source:* https://www.washington.edu/news/2022/03/18/urbanization-is-driving-evolution-of-plants-globally-study-finds/

Seven takeaways from the latest IPCC report

March 2022 — On 28 February, the IPCC Sixth Assessment Report (AR6) launched. The report focuses on impacts, adaptation and vulnerability, while recognising the interdependence of climate, ecosystems and biodiversity, and human societies.

The irreversible damage already caused; a call for urgent political action, and an emphasis on systems change and climate justice; the role of cities, conservation and Indigenous knowledge: Here are our seven takeaways from the report.

Climate change has already caused irreversible damage

"Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability. Some development and adaptation efforts have reduced vulnerability. Across sectors and regions the most vulnerable people and systems are observed to be disproportionately affected. The rise in weather and climate extremes has led to some irreversible impacts as natural and human systems are pushed beyond their ability to adapt…

Climate change impacts and risks are becoming increasingly complex and more difficult to manage. Multiple climate hazards will occur simultaneously, and multiple climatic and non-climatic risks will interact, resulting in compounding overall risk and risks cascading across sectors and regions…

Soft limits to some human adaptation have been reached, but can be overcome by addressing a range of constraints, primarily financial, governance, institutional and policy constraints. Hard limits to adaptation have been reached in some ecosystems…

Any further delay in concerted anticipatory global action on adaptation and mitigation will miss a brief and rapidly closing window of opportunity to secure a livable and sustainable future for all."

Adaptation must be long-termist

"Progress in adaptation planning and implementation has been observed across all sectors and regions, generating multiple benefits. However, adaptation progress is unevenly distributed with observed adaptation gaps. Many initiatives prioritise immediate and near-term climate risk reduction which reduces the opportunity for transformational adaptation…

Integrated, multi-sectoral solutions that address social inequities, differentiate responses based on climate risk and cut across systems, increase the feasibility and effectiveness of adaptation in multiple sectors."

Source: https://www.climate-kic.org

Focus on systems change

"This report has a particular focus on transformation and system transitions in energy; land, ocean, coastal and freshwater ecosystems; urban, rural and infrastructure; and industry and society. These transitions make possible the adaptation required for high levels of human health and well-being, economic and social resilience, ecosystem health, and planetary health."

Climate justice is social justice

"The report recognises the value of diverse forms of knowledge such as scientific, as well as Indigenous knowledge and local knowledge in understanding and evaluating climate adaptation processes and actions to reduce risks from human-induced climate change. AR6 highlights adaptation solutions which are effective, feasible, and conform to principles of justice. The term climate justice, while used in different ways in different contexts by different communities, generally includes three principles: Distributive justice which refers to the allocation of burdens and benefits among individuals, nations and generations; procedural justice which refers to who decides and participates in decision-making; and recognition which entails basic respect and robust engagement with and fair consideration of diverse cultures and perspectives…

Vulnerability of ecosystems and people to climate change differs substantially among and within regions, driven by patterns of intersecting socio-economic development, unsustainable ocean and land use, inequity, marginalisation, historical and ongoing patterns of inequity such as colonialism, and governance. Approximately 3.3 to 3.6 billion people live in contexts that are highly vulnerable to climate change…

Climate resilient development is facilitated by international cooperation and by governments at all levels working with communities, civil society, educational bodies, scientific and other institutions, media, investors and businesses; and by developing partnerships with traditionally marginalised groups, including women, youth, Indigenous Peoples, local communities and ethnic minorities. These partnerships are most effective when supported by enabling political leadership, institutions, resources, including finance, as well as climate services, information and decision support tools."

Political commitment and follow-through required

"Enabling conditions are key for implementing, accelerating and sustaining adaptation in human systems and ecosystems. These include political commitment and follow-through, institutional frameworks, policies and instruments with clear goals and priorities, enhanced knowledge on impacts and solutions, mobilisation of and access to adequate financial resources, monitoring and evaluation, and inclusive governance processes."

Cities can be centers of mitigation and adaptation

"Interactions between changing urban form, exposure and vulnerability can create climate change-induced risks and losses for cities and settlements. However, the global trend of urbanisation also offers a critical opportunity in the near-term, to advance climate resilient development. Integrated, inclusive planning and investment in everyday decision-making about urban infrastructure, including social, ecological and grey/physical infrastructures, can significantly increase the adaptive capacity of urban and rural settlements. Equitable outcomes contribute to multiple benefits for health and well-being and ecosystem functions, including for Indigenous Peoples, marginalised and vulnerable communities. Climate resilient development in urban areas also supports adaptive capacity in more rural places through maintaining peri-urban supply chains of goods and services and financial flows. Coastal cities and settlements play an especially important role in advancing climate resilient development."

Source: https://www.climate-kic.org

Conservation is key

"Safeguarding biodiversity and ecosystems is fundamental to climate resilient development, in light of the threats climate change poses to them and their roles in adaptation and mitigation. Recent analyses, drawing on a range of lines of evidence, suggest that maintaining the resilience of biodiversity and ecosystem functions at a global scale depends on effective and equitable conservation of approximately 30 per cent to 50 per cent of Earth's land, freshwater and ocean areas, including currently near-natural ecosystems." *Source:* https://www.climate-kic.org/news/seven-takeaways-from-the-latest-ipcc-report/

Pataxó women created the Jaqueira Reserve, comprising 827 hectares in the Environmental Protection Area of the Coroa Vermelha Indigenous Territory in South Bahia. *Source:* https://www.climate-kic.org

The World's Fastest-Growing Cities Are Facing the Most Climate Risk

A new UN report warns that rapid urbanization in Asia and Africa could expose billions of people to the impacts of global warming. But urban growth presents opportunities as well as threats.

February 2022 — In the struggle to manage climate change, cities in the Global South will be the front line. So suggests a report Monday from the world's top climate scientists, which strikes a note of warning that time is running out for decisive global action on the climate.

In an alarming call to action, the United Nations-backed Intergovernmental Panel on Climate Change (IPCC) notes that the effects of melting glaciers and thawing permafrost are now approaching irreversibility, that half the world is now living with annual periods of severe water scarcity, and that we can expect global increases in heat-related deaths without more efforts toward adaptation. In a world that continues to urbanize, cities in developing countries will feel the brunt of these drastic shifts most strongly.

At the same time, their future development along more sustainable paths could make a major contribution to mitigating climate change's worst effects. Cities across the world are already showing vulnerabilities to climate change, the report notes, whether directly through heat waves or flooding, or indirectly through the exacerbating impact that extreme weather can have on other issues such as pollution. The pandemic has further exposed vulnerabilities even in the world's wealthiest cities, highlighting systemic underinvestment in necessary infrastructure. But it is in socially and economically marginalized urban communities that the effects of climate change will be felt most keenly. It is also these communities that are poised to grow dramatically in the coming decades.

As the report points out, the world's urban population is expected to increase by 2.5 billion people between now and 2050, with 90% of that growth taking place in Asia and Africa. As a result of this huge shift, the proportion of people living in urban areas highly exposed to climate change impacts will also increase greatly. Thanks in part to urbanization, an estimated 1 billion people living in low-lying cities and settlements will be at risk from coastal flooding events by 2050. Cities in the Global South may also prove especially vulnerable to such risks because their urban development is frequently informal, creating sprawling, unplanned urban areas that that suffer from a relative lack of adaptive capacity.These cities nonetheless offer great opportunities for meaningful action. The process of urbanization provides the chance for a significant reset of planning, construction and the economy towards greater resilience and sustainability.

Floods along the Ciliwung River in Jakarta, Indonesia, in 2020 underscore that city's vulnerability to climate change. The risks of global warming-related disasters are increasingly focused on cities in the Global South, says a new IPCC report. *Source:* https://www.bloomberg.com/

"Integrated development planning that connects innovation and investment in social, ecological and grey/physical infrastructures can significantly increase the adaptive capacity of urban settlements and cities," says the report, which was assembled by teams of 270 researchers in 67 countries. "Transitioning cities to low carbon development and equitable resilience may lead to trade-offs with dominant models of economic growth based on housing and infrastructure investment."

This is, however, a "time-limited opportunity," the report states — and the clock is running. While scores of cities have announced emissions goals and climate adaptation plans, only a few have actually been implemented, and they tend to focus too narrowly on risk reduction, such as improving disaster warning systems and erecting stronger flood control measures, rather than the broader goals of mitigation and sustainable development. Urban climate action has too often been slow and uneven, while a lack of agreement on metrics to measure impact and investment has reduced "the scope for sharing lessons and joined-up action." Effective action will mean not just overcoming these hurdles, but also adopting an intersectional approach to climate action that engages with and protects those most vulnerable.

"Climate impacts are felt disproportionately in urban communities with the most economically and socially marginalized," says the report. It recommends that cities and states give priority to investment in reducing climate risk for low-income and marginalized residents, making informal settlements a particular priority. *Source:* https://www.bloomberg.com/news/articles/2022-02-28/global-south-cities-face-dire-climate-impacts-un-report

Urban water storage capacity inferred from observed evapotranspiration recession

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This report is based on: Jongen HJ, Steeneveld GJ, Beringer J, Christen A, Chrysoulakis N, Fortuniak K, ... and Teuling AJ (2021) Urban water storage capacity inferred from observed evapotranspiration recession. *Geophysical Research Letters,* e2021GL096069.

Introduction

Urbanization magnifies the risk of heat stress and flooding. Both risks are linked to the water storage in the city. Cities also increase the annual flood volumes by a factor of 2-9 compared to the countryside. Less vegetation results in a hotter city since vegetation can cool by evaporating water. The cooling effectivity is strongly dependent on water availability, and thus the water storage. Cities also increase the annual flood volumes up to volumes 2-9 times larger than in rural areas. Solutions for flooding focus on increasing infiltration and effective storage capacity. To minimize both risks, insight on the effective water storage capacity is needed.

However, it is a challenge to estimate the water storage capacity in an area as heterogenous as an urban landscape. This variation is reflected by the water leaving the storage as evapotranspiration (ET) (Sailor, 2011). Fortunately, the ET can be measured on a neighborhood level with the eddy-covariance method and scintillometry. Depending on the height at which the instrument is located, these methods measure fluxes from a footprint that includes fluxes from a multitude of sources such as impervious surfaces, vegetation, and open water. Thus, if the urban water storage capacity is estimated from these observations, the estimation refers to the complete urban landscape rather than only impervious surfaces. Since we analyze these footprint-scale observations, we define the water storage capacity as the dynamic water storage capacity available for ET.

This study extends a method to estimate the water storage capacity from ET for rural areas. The method derives the water storage from the ET decline under water-limited circumstances. We applied the method to an *urban* ET dataset covering various climate conditions, and city morphology. The analysis yields a first estimation of urban water storage capacities, which allows for a comparison amongst cities and for a comparison with natural ecosystems.

Methods

The method builds on the idea that the storage capacity can be estimated from the sum of water leaving the system. ET is the only water leaving the urban system during periods without precipitation, before irrigation, and after runoff. Runoff is considered zero on a daily timescale since runoff stops within hours of the last precipitation. This leaves ET and a storage change as the only terms of the water balance. These terms are thus directly linked and we assume ET depends linearly on the water left in the storage. Consequently, daily ET declines exponentially over time (Figure 1). The urban water storage capacity can be calculated by summing all *ET* during a complete drydown ($S_0 = \int_{t_0}^{\infty} ET(t)dt = \lambda ET_{initial}$). This sum is equal to the water storage capacity, since we found no relation between the amount of precipitation before the drydown and the estimated water storage capacity. What we have now is the most direct estimation of water storage, as measuring all water storage in a complete urban footprint is not feasible.

This estimation was made for the first ten days of all drydowns in the dataset that lasted for more than three days, since three days is the minimum to fit an exponential decay. The fit gave two parameters: the timescale λ and the initial ET. A separate fit was performed for each drydown to allow for different timescales, as the timescale depends on changing energy availability. Additionally, this approach yields multiple estimation, from which we could derive the uncertainty. The uncertainty was quantified by taking 5000 random samples from the estimates. Each sample contained 90% of the estimates. The median of all samples was added to a distribution, from which the 5th and 95th percentile are considered the lower and upper bound of the uncertainty.

Results

The individual drydowns follow the expected behavior of an exponential decay (in grey, Figure 2). The quick decay of ET indicates water availability is strongly limiting ET within the first days in all cities. The large uncertainty for some cities is caused by shorter time series. Shorter time series generally contains less drydowns than a longer time series. The results indicate at least two years are needed to minimize uncertainty, which is not available for Amsterdam, Melbourne, Mexico City, Seoul, and Singapore.

The estimated timescales ranged between 1.8-20.1 days, and the estimated water storage capacities between 1.3-28.4 mm. These numbers are based on 583 drydowns from the total 1606 drydowns in the dataset. The other drydowns were excluded for three different reasons. Firstly, we did not include all drydowns with a negative or extremely high time- scale or initial ET, respectively 80 days, and 10 mm per day. Secondly, drydowns were excluded if the R^2 of the fit was below 0.3, which catches drydowns with a rising ET over time. This rise can be explained by increasing availability of energy or irrigation. Thirdly, snow cover conditions were removed by requiring a positive average temperature over the whole drydown.

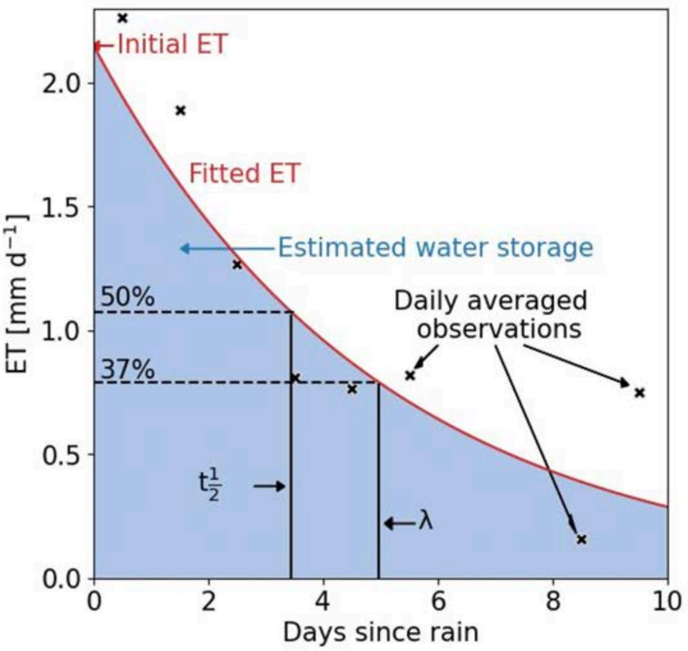

Figure 1. Illustration of the recession analysis. 24-hour aggregated ET versus the number of days following the last hour of precipitation for an example drydown from the Seoul data set with the fitted recession curve. Note that the fit was obtained by a linear fit on log-transformed data. In the figure the parameters are indicated.

Discussion

Our results are in contrast with the results for natural ecosystems in Teuling et al. (2006), who found timescales (λ) between 15 and 35 days, and storage capacities (S_0) between 30 and 150 mm. Both timescales and water storage capacities are at least five times higher than our values for cities (1.8-20.1 days and 1.3-28.4 mm).

Since our methodology directly estimates the water storage capacity from ET observations, the observation representativeness and quality is key to our conclusions. Both representativeness and quality have been important factors in the careful selection of observational sites (Feigenwinter et al., 2012). Sites are selected to be as homogenous as possible to prevent changing footprints to change the characteristics of the sampled area. On top of that, all sites observe higher than the mean building height to prevent surface roughness from distorting the observations. Additionally, all timeseries were quality controlled according to the current standards.

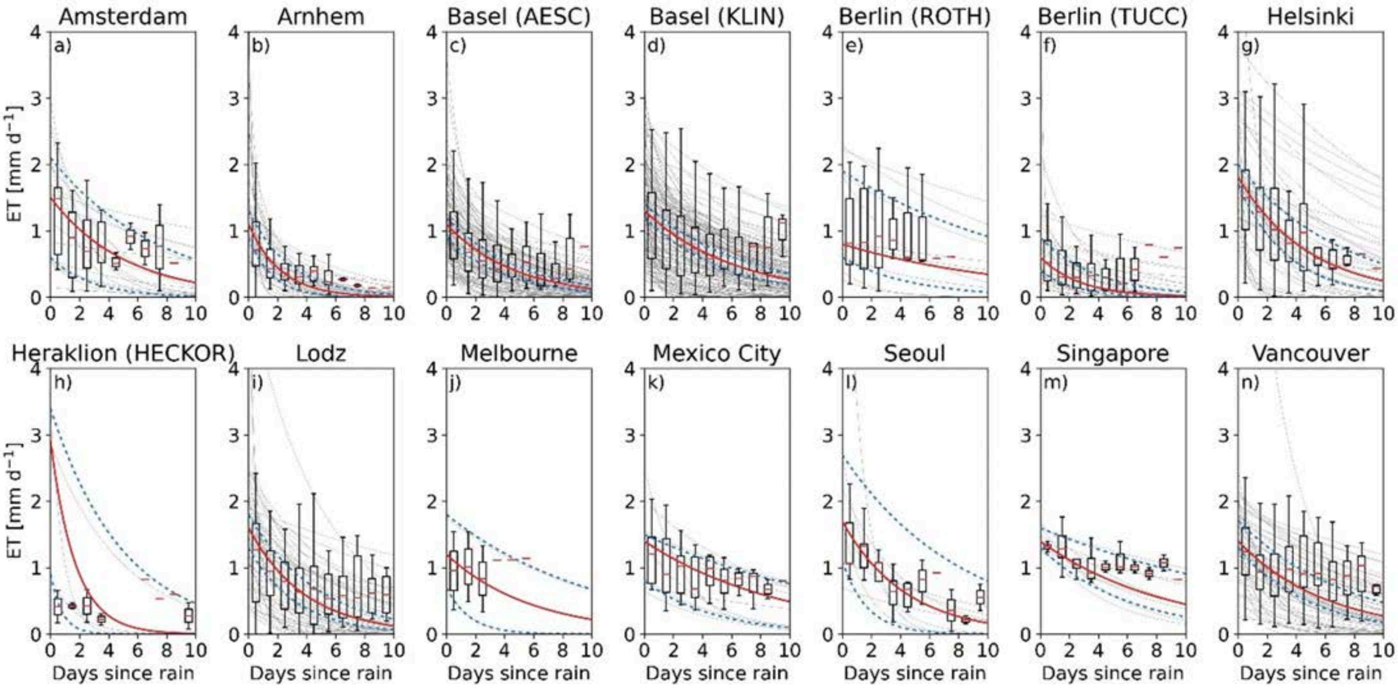

Figure 2. Daily average ET versus the day since the last precipitation with in red (continuous) the recession curve using the median parameter values, in blue (dotted) the 5th and 95th percentile of the median distribution from the bootstrapping re-samples, and in grey all individual drydowns. The boxplots show the spread of the observations. Since the parameters are based on individual drydowns, they do not necessarily follow the trend of the distributions.

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Would you like your work featured in *Urban Climate News*?

If you would like to write an article for the IAUC newsletter, please contact the Projects Editor **Helen Ward** (helen.ward@uibk.ac.at). Our "Urban Project" articles usually provide a short summary of recent work and can be a good way to advertise a recent journal publication to a wide audience, perhaps including additional information, figures or photographs.

Our "Feature" articles offer the opportunity to highlight results from a particular project or collection of projects, often bringing together findings from a series of complementary publications in a concise overview.

We are always happy to receive suggestions for future issues of the newsletter – please get in touch!

FAIR network of micrometeorological measurements

Invitation for IAUC members to join and contribute to the FAIRNESS project

In October 2021, a new international project entitled "FAIR network of micrometeorological measurements" (acronym FAIRNESS) was lunched, funded by the European Cooperation in Science & Technology – COST Action (https://www.cost.eu/cost-action/fair-network-of-micrometeorological-measurements/). In the next four years (until the end of 2025) through the FAIRNESS project, the main activity will be providing better access to open micrometeorological databases from urban and rural areas around the world, as well as creating an international network of researchers and experts focused on micrometeorological monitoring and the results of micrometeorological assessments.

Reliable and sufficient knowledge of environmental conditions or processes obtained from micrometeorological and microclimatological data plays a central role in assessing and modelling trends and effects of climate change and adverse weather events on the environment and ecosystems over all spatial and temporal scales. Enormous efforts have already been made at the European level to centralize data from ground-based (synoptic scale) and satellite measurements, weather and climate simulations and to make them available for public use (e.g., COPERNICUS, ECMWF database, e-OBS). These well-established data sources are widely and successfully used in research, education, and economics. However, beyond specific initiatives, they lack another very important component – micrometeorological data, i.e., data addressing meteorological conditions of the microenvironment (few kilometers scale) that are open and available for different applications and user groups.

FAIRNESS's innovation is the establishment of the first **micrometeorological knowledge share platform** (**Micromet_KSP**) which will serve as the basis for a future European micrometeorological database (EU-Micro_Met) that will complement other databases. Micromet_KSP will be established: **a)** by compiling an inventory of available in situ micrometeorological data (including metadata) and calculated indices at European level and beyond; **b)** recommendations for measurements and data management designed to meet FAIR principles and avoid temporal and spatial gaps; **c)** designing complete pilot data sets representing rural and urban micrometeorological conditions and **d)** evaluating Q&A communication in order to assess hot topics for all actors, particularly stakeholders and end-users at different societal levels (i.e., institutional/governmental, industrial/commercial and private/farmers). To demonstrate its functionality and application potential, we will implement Micromet_KSP as an element of the Action web page. The structure of Micromet_KSP will enable a wide range of applications from practice to research levels, which will be tested in sector-specific case studies (e.g., agriculture, forestry, urban thermal assessments, urbanization, health).

The main goal of the FAIRNESS Cost Action is the establishment, implementation and dissemination of Micromet_KSP throughout Europe and beyond. The strategy is to build Micromet_KSP on existing micrometeorological sources of data and methodologies and permanently integrate new members from Europe and beyond, thus widening the spatial, multi-, inter- and transdisciplinary scale of the Action.

The FAIRNESS project intends to improve standardization and integration between databases/sets of micrometeorological measurements that are part of research projects or local/regional observational networks established for special purposes (agrometeorology, urban microclimate monitoring). The challenges identified through project activities require an efficient transboundary network of researchers, stakeholders (extension services and environmental agencies, local authorities and ministries, SME) and civil society (specialized and general public) from Europe and beyond to identify and fill knowledge gaps, standardize, optimize and promote new environmental-tailored measurements and control procedures, enhance research effectiveness and improve dissemination.

All project activities are defined and organized through four working groups: WG1 – Networking and communication; WG2 – Development and implementation; WG3 – Dissemination and application; and WG4 – Beyond FAIRNESS strategies. More information on the project and WG activities can be found in the project activities diagram (Figure 1) and the project link.

Finally, the successful implementation and dissemination of the Micromet_KSP, as a data framework, will create a strong basis for future research and modelling studies, as well as a European Micrometeorological database.

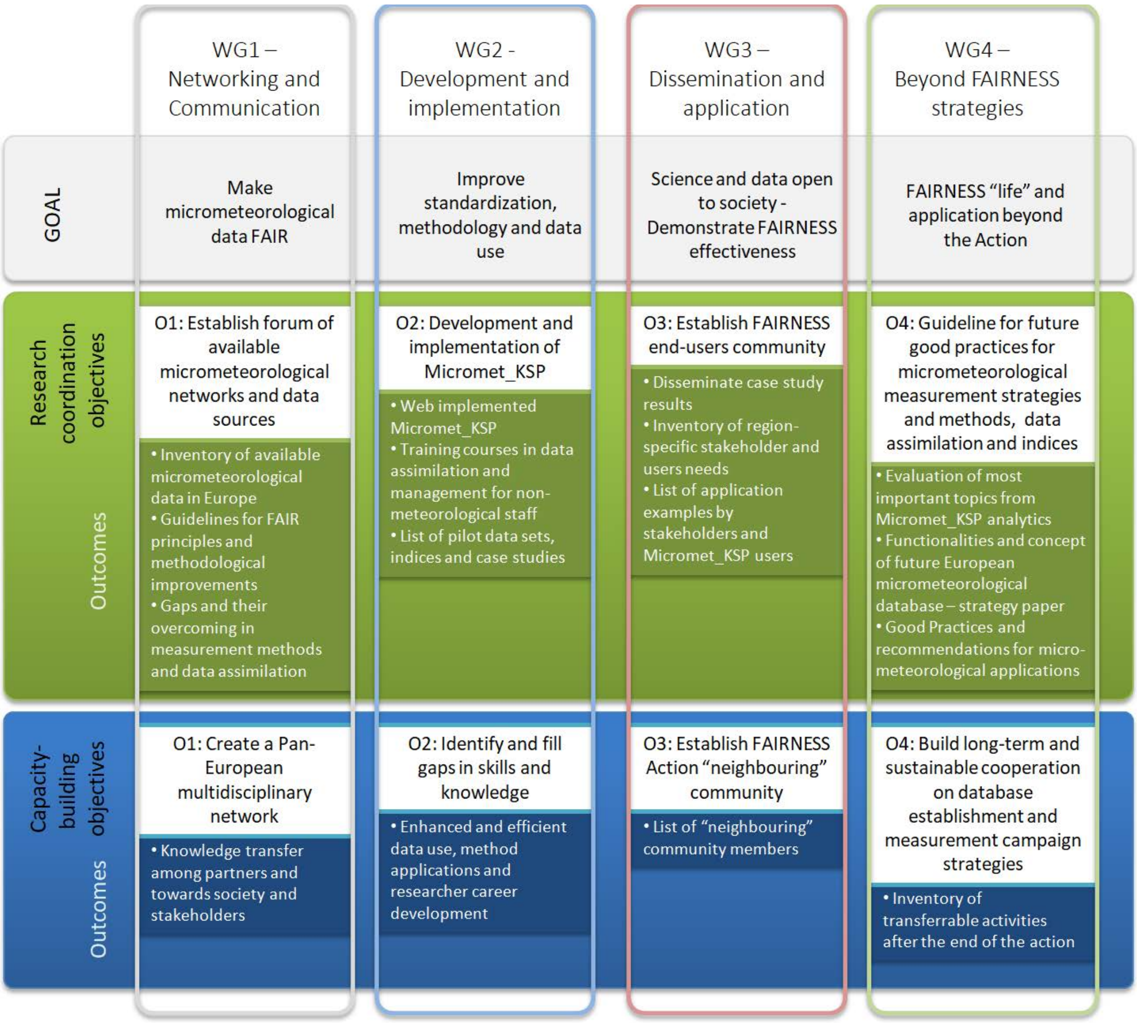
How to join and contribute to the project

Are you interested in our project? If so, then you are probably wondering how to join the project and contribute to its results. Go to the project link, and you will find the following information: *project description, how to inform the Main Proposer/Chair of your interest in joining the project, how to apply to join your Working Group of interest* and *how to reach the COST National contact points*.

The project is currently in the implementation phase, and the first defined activities are in progress. Therefore, **we would like to take this opportunity to invite you to join the FAIRNES project and contribute to its successful implementation. Firstly, you are invited to participate in filling out two questionnaires**:

Questionnaire 1 - refers to "Inventory of available micrometeorological data and their structure". We are looking to collect data information on urban/rural micrometeorological networks (which are not part of national official networks) through the questionnaire

Questionnaire 2 – aims to create a multidisciplinary network of experts for micrometeorological data measurement



	WG1 – Networking and Communication	WG2 - Development and implementation	WG3 – Dissemination and application	WG4 – Beyond FAIRNESS strategies
GOAL	Make micrometeorological data FAIR	Improve standardization, methodology and data use	Science and data open to society - Demonstrate FAIRNESS effectiveness	FAIRNESS "life" and application beyond the Action
Research coordination objectives	O1: Establish forum of available micrometeorological networks and data sources	O2: Development and implementation of Micromet_KSP	O3: Establish FAIRNESS end-users community	O4: Guideline for future good practices for micrometeorological measurement strategies and methods, data assimilation and indices
Outcomes	• Inventory of available micrometeorological data in Europe • Guidelines for FAIR principles and methodological improvements • Gaps and their overcoming in measurement methods and data assimilation	• Web implemented Micromet_KSP • Training courses in data assimilation and management for non-meteorological staff • List of pilot data sets, indices and case studies	• Disseminate case study results • Inventory of region-specific stakeholder and users needs • List of application examples by stakeholders and Micromet_KSP users	• Evaluation of most important topics from Micromet_KSP analytics • Functionalities and concept of future European micrometeorological database – strategy paper • Good Practices and recommendations for micro-meteorological applications
Capacity-building objectives	O1: Create a Pan-European multidisciplinary network	O2: Identify and fill gaps in skills and knowledge	O3: Establish FAIRNESS Action "neighbouring" community	O4: Build long-term and sustainable cooperation on database establishment and measurement campaign strategies
Outcomes	• Knowledge transfer among partners and towards society and stakeholders	• Enhanced and efficient data use, method applications and researcher career development	• List of "neighbouring" community members	• Inventory of transferrable activities after the end of the action

Figure 1. The main goals and Working groups as well as the outcomes from the Research coordination and Capacity-building objectives of the FAIRNESS Project.

and assimilation, i.e., experts who monitor and use urban/rural micrometeorological measurements, work on assessments, assimilations, modeling, work on climate/environmental strategies, projects etc. Furthermore, we would like to see not only experts from universities or research institutions, but also from NGOs, administrative institutions, companies, etc. The final version of this list of experts will be visible on the project website and freely open to everyone to search for potential future partners. Finally, the goal of this list is to expand and contribute to better connectivity of experts and institutions working on and using urban/rural micrometeorological datasets.

Stevan Savić, University of Novi Sad, Faculty of Sciences, Serbia
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Steven Caluwaerts, Ghent University & Royal Met Institute, Belgium
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Branislava Lalić, University of Novi Sad, Faculty of Agriculture, Serbia
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Link to both Questionnaires: https://drive.google.com/drive/folders/1DS-oWEthRC7ANjccrsK-bVs-o9LopJEpX?usp=sharing.

Please, either download the questionnaires (excel files), fill them out and email them to stevan.savic@dgt.uns.ac.rs or fill them out online.

Also, for everyone who cannot access the files through the link, please do not hesitate to send your request to stevan.savic@dgt.uns.ac.rs and both questionnaires will be sent to you through your email.

On the combined case of an extreme heat and an air quality episode in the coastal-urban city of New York

Introduction

More than half the global population lives in urban areas, most megacities (70%) are in less-developed global regions, and 78% are coastal. Urbanization leads to altered microclimates, including urban heat islands (UHIs), defined as the excess warmth of a city over its surrounding rural areas (Stewart and Oke, 2012). Strong UHIs produce convergent winds into their centers, while with weak UHIs, regional speeds are reduced over these centers (Bornstein and Johnson, 1977). Coastal cities experience sea breezes, which provide cooling (Yamamoto and Ishikawa, 2020) and may impact air quality due to transport to inland regions. Urban areas retard sea breeze front (SBF) inland movement due to surface-roughness/building-barrier effects (Boucouvala and Bornstein, 2003), while UHI convergence enhances SBF convergence zones (Ferdiansyah et al., 2020). The diurnal cycles of surface pollutant concentration are complicated by SBFs, as their convergent surface winds and capping inversions (Darby et al., 2007) produce accumulation. Other impacts include early morning offshore precursor transport (Ding et al., 2004) and reduced dry deposition in their stable marine air. Recirculated polluted air onshore by a next-day SBF (Wentworth et al., 2015) and downward fumigation of elevated-layers (Lyons et al., 1981) can, however, produce local late morning pollutant maxima.

In this note we summarize a study whose main objective was to investigate the complex interactions between the synoptic heat wave conditions, coastal shape, UHI and building-barrier impacts on the coastal megapolis of New York City (NYC). More specifically, the study focuses on a five-day summer period with a synoptic-scale heat wave and associated regional ozone (O_3) episode during a data-rich 2018 LISTOS (Long Island Sound Tropospheric Ozone Study, http://www.nescaum.org/documents/listos) Intensive Observational Period (IOP) campaign. Few studies have addressed the complex interactions of coastal flows, UHI, and air quality, and the study's aims are to contribute to close this gap.

Methodology

The regional O_3 episode that impacted the NYC area on 2 July 2018 occurred during a four-day regional heat wave that started on 30 June and was associated with a complex local sea-land breeze system. Hourly surface O_3 concentrations of >140 ppb were twice the US Environmental Protection Agency (EPA) National Ambient Air Quality Standard (NAAQS) of 70 ppb, herein "the standard," but ignoring the 8-h running-average aspect. Scientific questions addressed herein include how the extensive surface and PBL observations from a LISTOS IOP can provide a better understanding of how: (a) NYC UHIs and building barriers impact the movement of the: photochemical precursor emissions, multiple SBFs that form along the complex coastlines, and O_3 peaks at the surface and within the PBL; (b) regional heat waves exacerbate area O_3 peaks, and (c) all the above interact to produce concurrent surface O_3 maxima within and downwind of NYC.

Data

Two observational domains were used, i.e., an outer one (Fig. 1a) that encompasses NYC and its surrounding areas and a zoomed-in sub-domain over the City (Fig. 1b). Hourly 2-m temperature and 10-m wind velocities were obtained from 364 stations (Fig. 1a) within 11 networks; these levels are hereafter referred to as the "surface". Hourly surface O_3 and Nitrogen dioxide (NO_2) concentrations were provided by the US EPA Air Quality System at 25 and 13 sites in the outer domain, respectively (Fig. 1c), with 11 and nine of these, respectively, in the inner domain (Fig. 1d). The Natural Neighbor Interpolation (NNI) scheme of Sibson (1981) was used on the surface T, O_3, and NO_2 data. It uses 2-D triangulation to connect all pairs of neighboring data points. Areas with the fewest sites in the O_3 network are on the plain southeast of the NJ hills and in the NO_2 network are north of NYC (Fig. 1c). So isolines are more approximate in those areas.

Analysis

Nocturnal 2-m level UHI values were calculated from 19 NYC sites and from 15 fewer urban (hereafter "rural") sites west of the City (Fig. 1b). The area containing the urban sites best illustrated the horizontal extent of the high NYC temperatures, while the area of the rural sites forms a ring around the City at locations not influenced by either the hills to their west or the water bodies to their east. UHI magnitude was defined as the difference between the warmest of the 19 urban and coolest of the 15 rural sites at each hour.

As the SBF over NYC on 2 July generally involved only a pulse of marine air with an increased speed on top of a regional onshore flow, its inland movement required careful analysis. The following seven factors were thus used to determine its positions: (i) directional convergence, as wind directions shift across an SBF, (ii) post-frontal speed increases in the pulse of the SB air, (iii) pre- frontal calm speeds, as speeds are low within an SB convergence

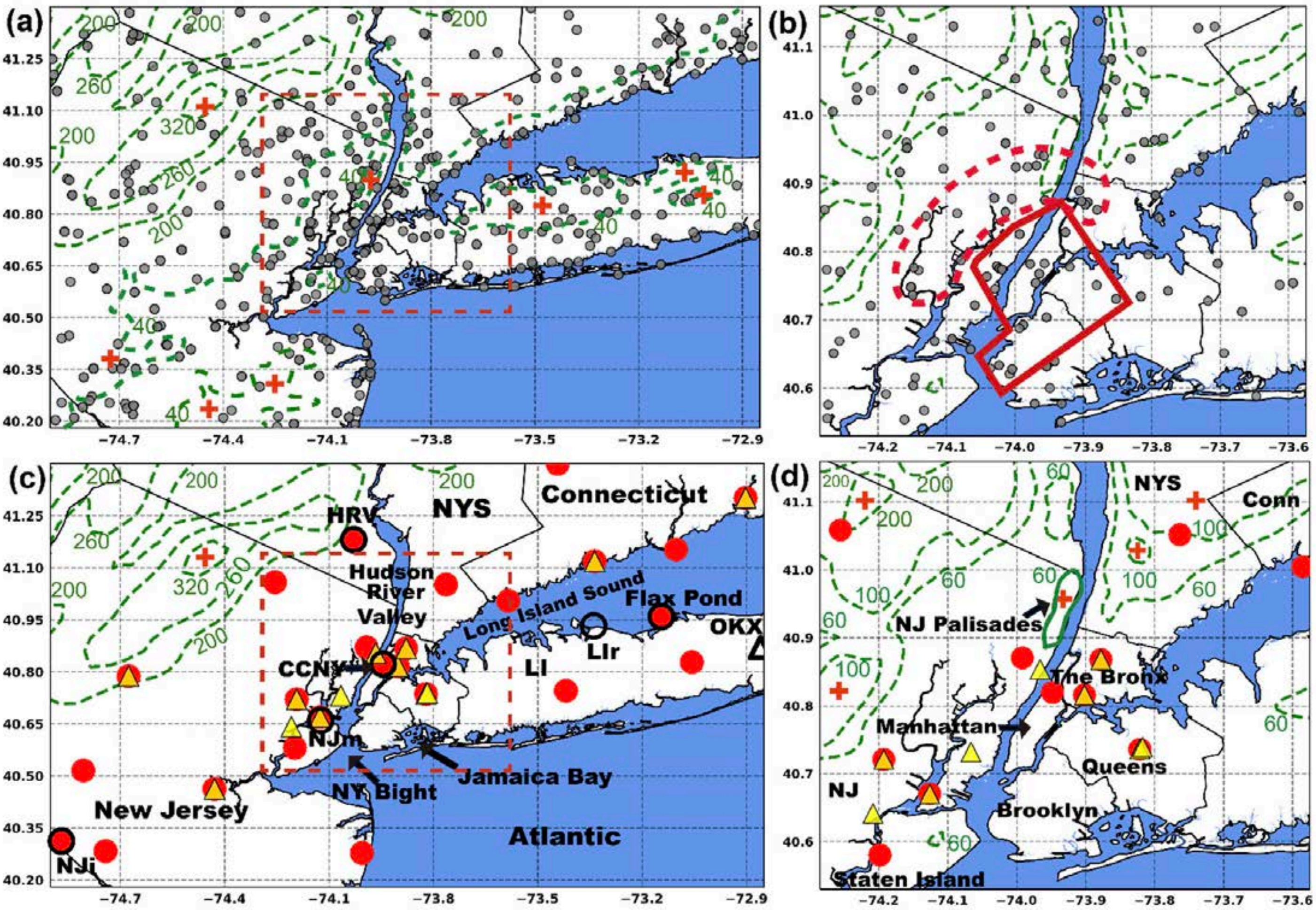

Figure 1. Meteorological observational sites in (a) outer and (b) inner [also red box in (a)] domains, as well as O_3 (●) and NO_2 (△) sites in (c) and (d). In (b) The outlines of urban (red solid) and rural (red dashed) areas for UHI calculations are shown in (b), while (c) shows Fig. 5 sites (black circles) and OKX radiosonde site (Δ). Throughout: county boundaries (thin black lines) and key topographic heights (m, green lines), with peak terrain points (+). US States include NYS, Conn., and NJ, while NYC boroughs are Manhattan, Brooklyn, Queens, Staten Island, and The Bronx.

zone, (iv) temperature differences at inland sites, as the current "pulse" type SBF produces only minimal coastal cooling as it passes, (v) coastal shape, including Jamaica Bay and the various inlets of the New York Bight, (vi) spatial and/or hourly consistency, and (vii) details gleaned from zoom-ins over NYC. NYC provided additional challenges, due to the relative scarcity of sites within a few areas of the City (Fig. 1b) and the somewhat chaotic nature of urban winds. Investigation of the NYC wind network metadata, however, has shown that the instruments are generally well-sited and are capable of yielding coherent wind flow patterns (Bornstein and Johnson, 1977, as well as other such NYC studies).

Results

Synoptic conditions on 1–2 July were dominated by a high-pressure ridge centered northeast of NYC. Concurrent surface flows over the City changed from along shore on 1 July to onshore on the episode day, while surface T-values on both days showed a regional heat wave event. Such conditions in coastal areas are conducive to SBF formation and to strong regional photochemical activity.

Inner domain nocturnal UHI and NO_2 values

Nocturnal surface T-values over NYC on the episode day of 2 July at 0300 EST (not shown) and 0400 EST (Fig. 2a) show the warmest areas (for display convenience, arbitrarily defined as ≥26°C) centered over its four northern boroughs (all except Staten Island). By 0600 EST (Fig. 2c), however, the warm area has extended westward into NJ and eastward into LI, while maximum NYC values have increased by 1°C, and thus the UHI increased to its maximum of 8.3°C (Fig. 2c). An hour later, the more rapid solar warming of the less urbanized areas surrounding the City almost masked its UHI (Fig. 2d). Such differential morning warming is characteristic of adjacent urban and suburban areas (Oke et al., 2017). The average UHI value over the period was 7.3°C. The UHI peaks at 0600 and 0700 EST

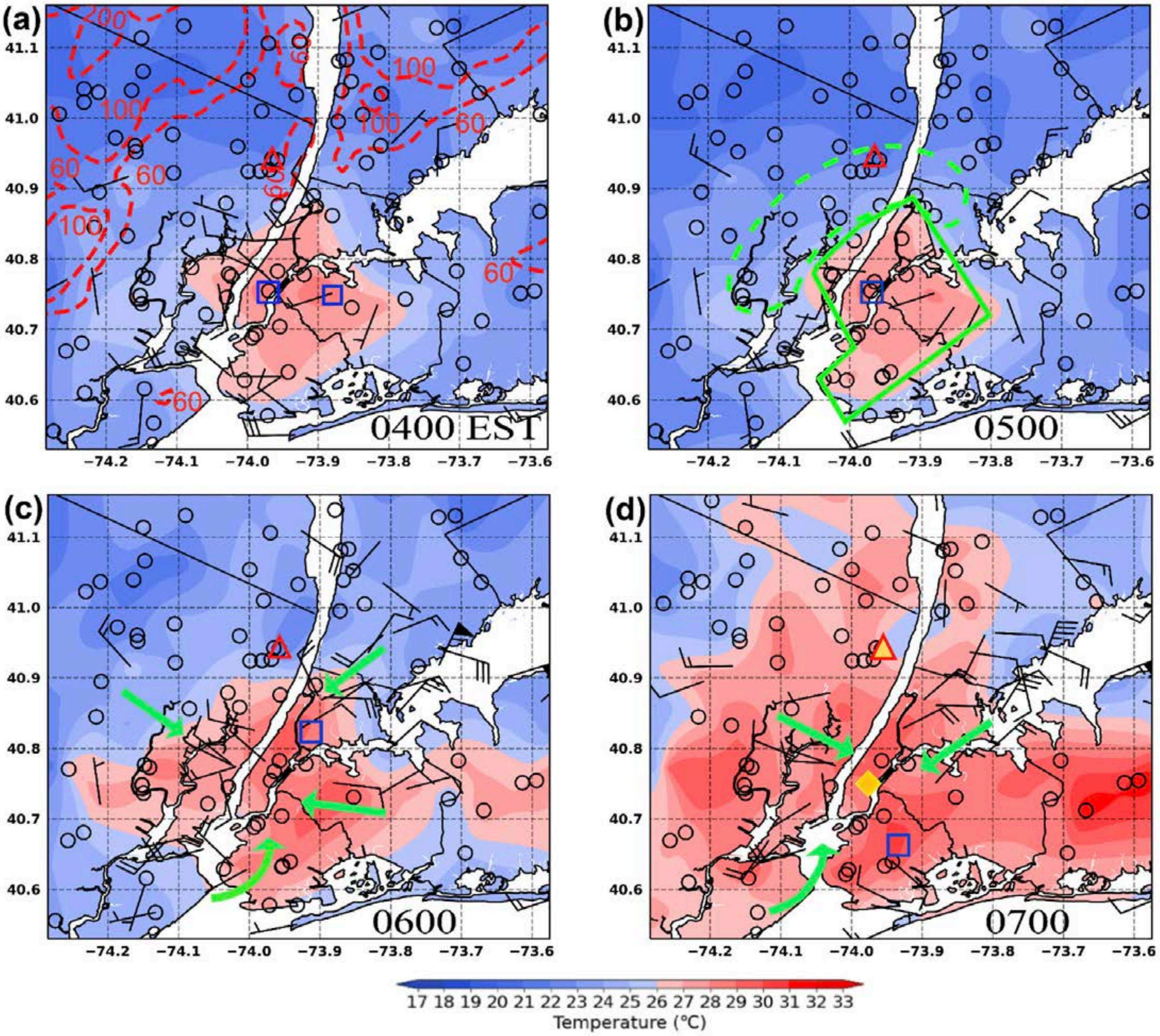

Figure 2. Hourly surface temperatures (°C, colors) and wind vectors (1 full barb is 1 m/s, circles indicate calm) in and around NYC on 2 July at (a) 0400, (b) 0500, (c) 0600, and (d) 0700 EST, while green arrows represent subjectively located area-average flows. Panel (b) shows the urban and rural areas of Fig. 1b for UHI calculations (solid and dashed green outlines, respectively). Also shown are key topographic heights (m, red lines) and sites with *hourly* maximum (☐) and minimum (△) temperatures, as well as those with maximum (◆) and minimum (▲) *averages* over a 5-h period.

induced a clearly discernible convergence over NYC into its associated thermal Low (L) (Figs. 2c and d).

Surface winds in and around NYC at 0100 EST on 2 July (Fig. 3a) show mostly calm conditions north and west of the City. Photochemical precursor NO$_2$ concentrations are maximum (30 ppb) just west of NYC, extending eastward into Brooklyn. The concurrent weak local northward flow in NJ (and the next four hours) could impact the future O$_3$ peak north of NYC. By 0600 EST (Fig. 3b) the UHI convergence (of Fig. 2c) has increased the NO$_2$ to its maximum value (about 50 ppb) due to containment of its rush hour emissions. In summary, given the limited NO$_2$ observations network, the fate of its pre-SBF emissions is unknowable from just this data. It seems, however, that early morning precursor pollutants were drifted into a calm area in NJ by a weak westerly regional flow, before the latter emission became trapped in the UHI-induced convergent flow into NYC. Late morning emissions were once again pushed, this time by the SBF, into NJ and northward around the Palisades into the HRV.

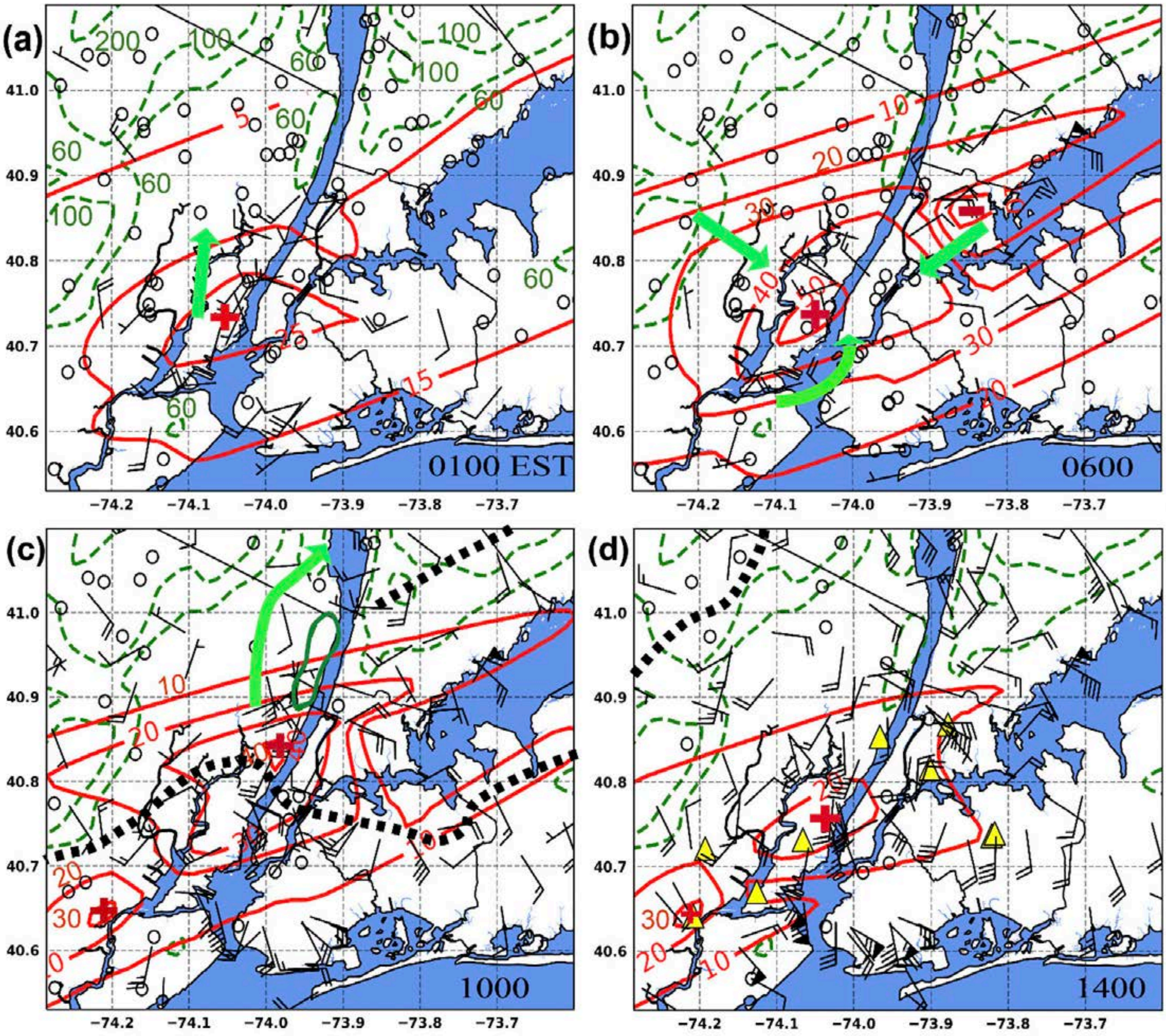

Figure 3. Surface NO_2 concentration (ppb, red lines) and wind vectors (1 full barb is 1 m/s, circles indicate calm) in and around NYC on 2 July at (a) 0100, (b) 0600, (c) 1000, and (d) 1400 EST. Also indicated are local NO_2 maxima (+), NO_2 sites (△), subjectively placed area-averaged flow directions (green arrows), and sea breeze frontal positions (black dashed lines).

Outer domain heat wave, SBFs, NO_2, and O_3

Two SBFs that formed from flows from the LI Sound were first seen at 0700 EST, i.e., the Connecticut front (seen 3-h later in Fig. 3c) along its southern coast and a short-lived “Northern LI” front. The separate Ocean front (also seen 3-h later in Fig. 3c) along the southern LI and NYC coasts here is seen to follow the shape of Jamaica Bay. All three fronts brought speed increases of up to 4–6 m/ s when they came onshore.

The concurrent photochemical O_3 maximum of 90 ppb (first one >70 ppb) exists just west of NYC (site NJm in Fig. 1c), co-located with the NO_2 maximum of Fig. 3c. By 1000 EST (Fig. 4a, b), a local warm spot (>35°C) appears just northeast of the New Jersey maximum (NJm) O_3 maximum, which has increased to 110 ppb. Local communities were now thus in areas above the NYC heat wave warning of 32.2°C and within the EPA AQI range of unhealthy for sensitive groups. A small new peak of 85 ppb has also formed at the HRV site, perhaps due to photochemical conversion of the early morning northward advected NO_2 emissions of Fig. 3a.

Inland SBF penetration has again concurrently continued an hour later (not shown), with the Ocean and coastal NJ fronts now having joined into a single “Combined” front, whose shape follows the outline of the NY Bight. While its segment over LI continues to now move only

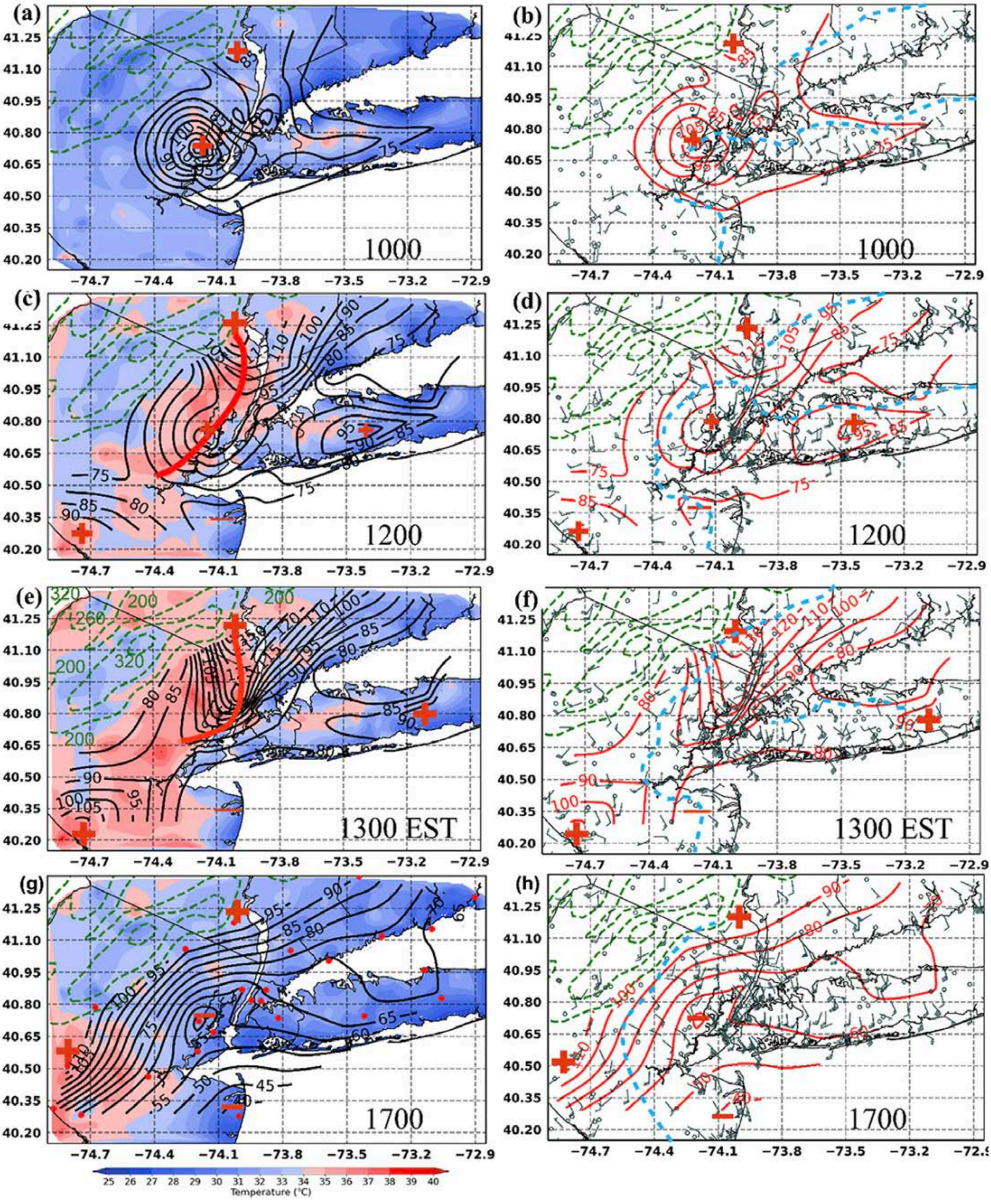

Figure 4. Contours of high (≥ 70 ppb) surface O_3 concentration (ppb, black lines), their local maxima (+) and minima (-), and temperatures (°C, colors) on 2 July at (a) 1000, (c) 1200, (e) 1300, and (g) 1700 EST. Concurrent wind vectors (1 full barb is 1 m/s) and O_3 concentrations (ppb, red lines) are shown in (b), (d), (f), and (h), respectively, along with subjectively placed: sea breeze frontal positions (blue) and maxima O_3 ridge lines (red).

slowly northward, as it approaches the hills in that area (in Fig. 1), that over central Manhattan is even more distorted by its buildings, consistent with Novak and Colle (2006).

By 1200 EST (Fig. 4c, d), while the Connecticut front is now somewhat closer to the HRV peak, the O_3 ridge line is further behind the Combined front. Such a high O_3 concentration band behind a moving SBF was observed by Gaza (1998) for the Connecticut SBF. The current effort seems to be the first to show it downwind of a major urban area and impact its movement. It also seems first to identify an O_3 maximum in the HRV.

Outer domain maximum T-values an hour later (1300 EST, Fig. 4e, f) are 1°C higher than in the preceding hour over most of NJ, except for its western hilltops. In the post-frontal flow over NYC and LI, values are still <36°C. The local NJi O_3 peak has increased to 105 ppb, while the local LIr peak has moved eastward towards Flax Pond and started to decrease. The NJm and HRV O_3 peaks have combined, producing an absolute peak near the northern site, while the O_3 ridge line has kept moving slowly westward. The combined 143-ppb value is the highest of the episode and is just above the lower limit for the direst EPA warning: very unhealthy for all populations with a measured AQI value of 204. This health impact is compounded in much of the area by the simultaneous heat wave.

By 1700 EST (Fig. 4g, h) uniformly cool T-values exist throughout the domain, except its southwest corner. The O_3 band has grown to encompass the NJi peak, and values there have finally decreased. Two maxima still exist, i.e., >110 and 95 ppb at the southern and northern locations, respectively, and the coastal minimum has decreased by another 10 ppb. While the concurrent regional front is still moving westward, it has yet to reach the NJi site. A frontal position could not be determined after 1800 EST (not shown).

Episode summary

A summary time-series plot of episode values on 2 July around NYC (Fig. 5a) shows peak hourly surface NO_2 values with a nocturnal background residual of about 35 ppb until 0300 EST. The slow increase to about 55 ppb over the next 3-h was due to home energy use and automotive rush hour emissions trapped by the UHI-induced convergence of Fig. 3b. The resulting near-constant peak lasted until 0900 EST and was followed by a rapid 2-h decrease to the background value due to O_3 photochemical conversion processes. Values remained low until 1800 EST, when reduced insolation and late afternoon rush hour traffic produced a peak of 45 ppb at 2200 EST, a value below the early morning peak. A similar plot of high O_3 values at four key areas shows the earliest local maximum (120 ppb, unhealthy for all populations) at 1000 EST near NJm, west of NYC. This peak arose from photochemical conversion of the nearby 0900 EST NO_2 peak, and then decreased by advection as the Ocean front passed. The LI peak occurred 2-h after the first maximum, with a lower value (100 ppb) from a recirculated air mass (discussed below) and then decreased as the Ocean front passed. The (episode) peak at HRV (145 ppb that occurred yet another hour later at 1300 EST arose from northward transport of pre-frontal NO_2 emissions. The latest O_3 peaks near NJi at 1400 and 1600 EST (127 and 135 ppb, respectively) were due to local industrial emissions.

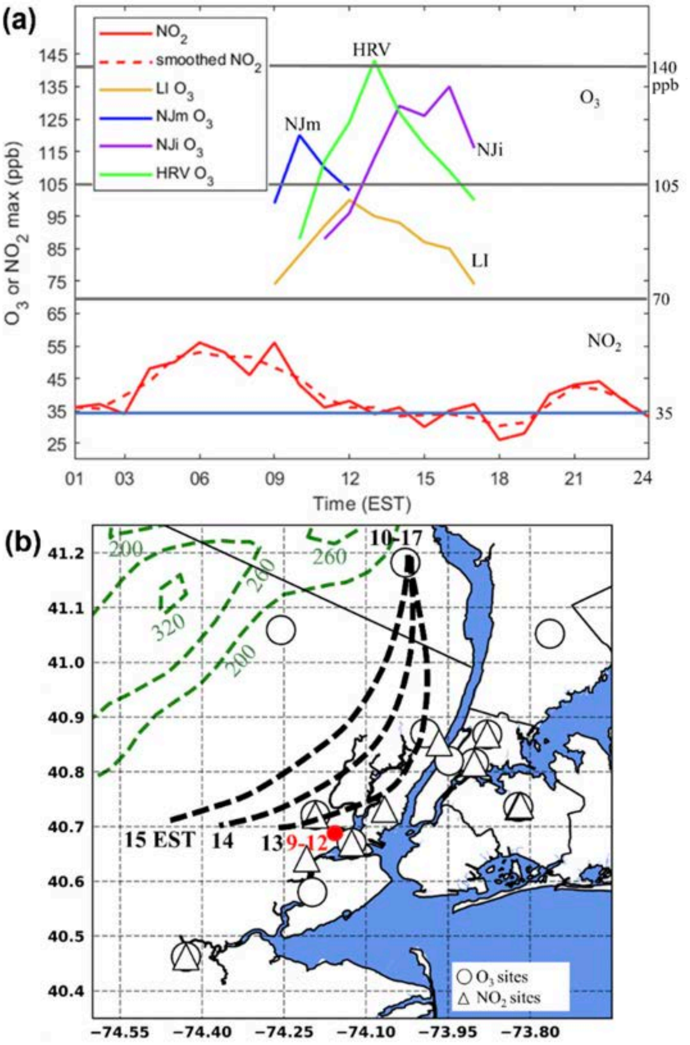

Figure 5. Observed (a) surface peak NO_2 (red) and O_3 at the LI (orange), NJm (blue), NJi (purple), and HRV (green) sites in Fig. 1c for 2 July. Horizontal lines are the EPA eight-hour O_3 criteria (and 1.5 and twice that value) and NO_2 background concentration. Panel (b) shows the O_3 maximum site at 0900-1200 EST (●), subsequent peak value ridge lines (black dashed), as well as NO_2 (Δ) and O_3 (○) sites.

A spatial summary of the above O_3 results (Fig. 5b) focuses on NYC impacts and thus omits the discussion of the LI and NJi peaks. The NJm peak first appeared southwest of NYC at 0900 EST and remained localized until

1200 EST. The HRV peak was first seen at 1000 EST and remained at this site (only one in area) until 1700 EST. These independent peaks lay along a single ridge of high values at 1100 EST, and combined as the ridge moved further into NJ during the next 2-h. After 1500 EST, the O_3 from NYC area NO_2 emissions could no longer be differentiated from that in the regional O_3 episode to the west. This study is the first to identify an O_3 maximum in the HRV, which seems to have arisen first from northward-transported early morning precursor emissions, before they were cut off by a UHI-induced convergence into NYC, and then from post-SBF precursors emissions transported northward around the NJ Palisades into the HRV. Tri-state area (NY, NJ, and Connecticut) air quality networks focus on coastal pollutants and have fewer inland sites. The current effort has identified areas with too few sites, i.e., north of NYC for NO_2, north of the HRV site, and near the NJ hills for O_3.

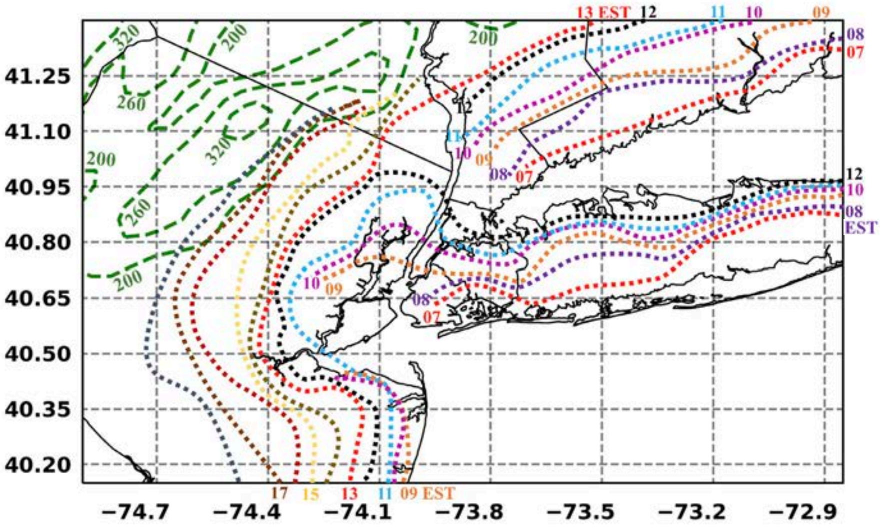

Figure 6. Hourly 2 July sea breeze front locations during 0700-1800 EST; short-lived Northern LI front not shown.

A summary of all hourly SBF positions (except for the short-lived North LI front) shows that they came ashore at 0700 EST (Fig. 6), were distorted by Jamaica Bay and the NY Bight, retarded over Manhattan, and combined into a single Regional front, which could be tracked inland until 1800 EST. This pattern is more realistic than the idealized one shown by Bornstein and Thompson (1981), which had the fronts crossing the Bight and Jamaica Bay. The early appearance of the Ocean SBF over the NYC boroughs of Brooklyn and Queens was probably aided by the still extant UHI, which strengthened the existing land-sea T-gradient.

Conclusions

This study analyzed the combined air quality and meteorological conditions of a heat wave a O_3 episode in the NYC metropolitan area during a five-day period during the July 2018 LISTOS IOP field campaign. The period was characterized by a regional heat wave and an O_3 episode, both of which peaked on 2 July. The data were used to determine NYC impacts at the surface and within the PBL on regional temperature, wind, NO_2, and O_3 patterns, initially including multiple sea breeze fronts (SBFs) that ultimately combined into a single regional front.

In summary, the study showed that its O_3 maxima were generally collocated with maximum temperature areas, and the high O_3 band was generally just behind the SBF. Early morning UHI-induced convergence into NYC, as well as later building-drag retardation of the SBF over the City, both slowed O_3 precursor transport from NYC. This delayed transport impacted the location, time evolution, and magnitude of the resulting downwind O_3 concentrations over NJ and at the newly identified Hudson River Valley peak. The study also showed that the western limit of NYC emissions and flow impacts extended to the NJ hills, at which point the O_3 and flow patterns probably blended into the regional episode and heat wave values.

The results of the current study are thus important as they attempt to answer the science questions posed above. The results have shown how the surface and PBL observations from the July 2018 LISTOS IOP can provide an improved understanding of how NYC impacts the movement of NO_2 precursor emissions, as it first traps them in an early morning UHI-induced convergence. They also have shown how these impacted transport patterns interact with the several SBFs that formed in the area along its complex coast to produce the several O_3 peaks at the surface and aloft. As the fronts moved inland, the regional heat wave was seen to exacerbate the surface O_3 peak that formed behind it, as well worsening as its health impacts. As summer O_3 prediction is a significant challenge in and around large coastal cities, the current results should be useful in planning how to improve urban coastal environments and how to mitigate such environments in changing climates. Knowledge of the reduction of winds over cities and their retardation of SBFs, which both delay the inland cooling from such fronts, as well as impact their altered pollutant transport patterns, should significantly enhance urban planning processes in and around NYC, at other US urban areas, and for cities globally.

Future efforts should continue the analysis of the rich LISTOS observations. Numerical simulations of the event should involve the use of the urbanized WRF-Chem model, with a focus on NYC impacts on regional flow patterns and 3-D sea breeze frontal structures, as well as interactions with inert and photochemical pollutants. Such studies should also consider urban impacts on PBL convective processes along such SBFs (Pielke, 1974). Additional long-term climatological and short-term intensive field studies of NYC impacts on SBFs and O_3 are also needed, especially for fronts formed in otherwise calm circumstances and during opposing offshore flows. They should include surface sites in areas that require additional meteorological measurements. i.e., north of Jamaica Bay, as well as new NO_2 sites north of NYC and new O_3 sites both in the NJ hills and within the Hudson River Valley. Their PBL observations should include additional lidars, radars, ceilometers, flux towers, aircraft, and helicopter platforms.

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[3] Department of Meteorology and Climate Science, San Jose State University, San Jose, CA, USA

Multi-faceted UMEP seminar attracts 150 online particpants

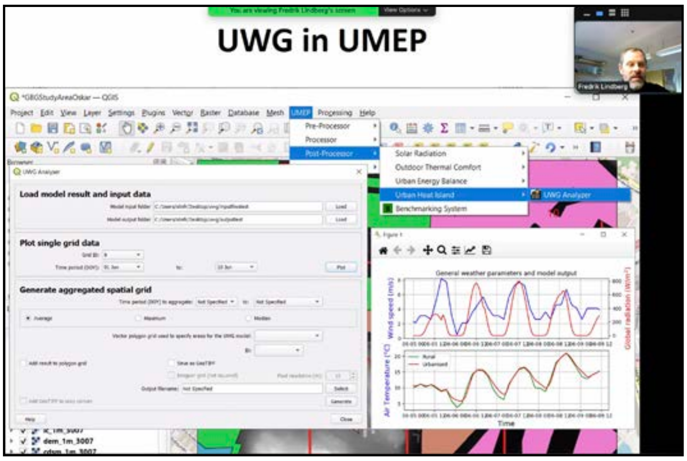
The **Urban Multi-scale Environmental Predictor (UMEP)** is a city-based climate service tool designed for researchers and practitioners. The tool is shipped as a plugin for the open source geographical information system (GIS) software QGIS (www.qgis.org) to facilitate interaction with spatial data and to provide viewing, editing and analysis capabilities directly in a GIS software environment.

The half-day **open online seminar on the 27th of January** this year, organised by the UMEP developers, attracted 150 signed-up participants. The seminar included an overview of the plugin and the community, recent developments as well as a discussion on future workshops, new features, spatial data etc.

In the "Microscale" session on thermal comfort and radiation, two new tools were presented. **The TreePlanter** (main developer. Nils Wallenberg, Univ. of Gothenburg) is a tool that applies a meta-heuristic hill climbing algorithm for optimal location of street trees for urban radiation heat load mitigation. The tool is based on output from SOLWEIG, a radiation model to estimate 3D radiation fluxes in complex urban environments.

Jeremy Bernard (Univ. of Gothenburg) presented **URock**, a semi-empirical pedestrian wind model that is able to solve 3D wind fields within an urban setting at a low computational cost. This tool is planned to be released in UMEP within the upcoming months. Recent upgrade of the SOLWEIG model was also presented in this session.

The "Local-scale" session included a number of presentations on developments within **SUEWS**, the Surface Urban Energy and Water Balance Scheme, which originally simulated the urban radiation, energy and water balances and now also CO_2-fluxes as presented by Leena Järvi, Univ. of Helsinki. Meg Stretton and Lewis Blunn (Univ. of Reading) presented a coupling scheme between SUEWS and a vertical radiation model and Xiaoxiong Xie and Ting Sun talked about coupling SUEWS with a building energy model.

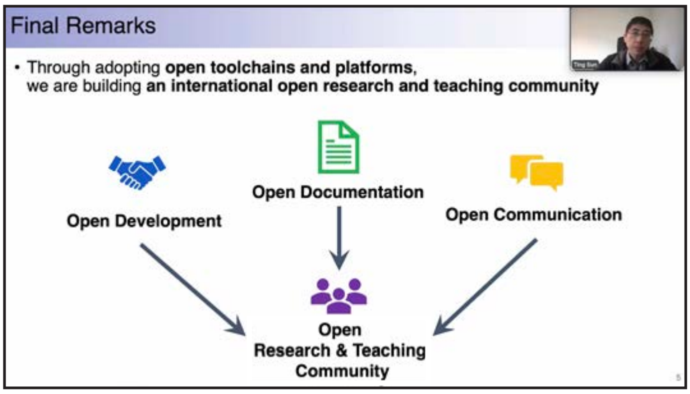


UWG in UMEP

Fredrik Lindberg presented the inclusion of the **Urban Weather Generator (UWG)** in UMEP. UWG is a tool that can be used to estimate temperature and humitidy variations within a city using spatial information, foremost on building morphology and land cover. A number of tools related to UWG have been added in UMEP to facilitate preparation and analysis of the urban heat island using the UWG. Finally, Oskar Bäcklin presented his work on an urban characteristics database to better describe the urban environment of more accurate modelling via the SUEWS model.The last session included breakout sessions on specific topics for closer interactions between users and developers.

Worth mentioning is the recent development that has also moved the majority of UMEP functionalities over to the Processing toolbox within QGIS. This facilitates that the algorithms in UMEP can be accessed via stand-alone python scripting as well as be included in the Model Designer in QGIS, where workflow of multiple processes can automatically be executed in sequence after each other. More information can be found on our website (https://umep-docs.readthedocs.io)

Documentation and presentation pdfs can be accessed via the UMEP Discussion forum on our Github-page (https://github.com/UMEP-dev/UMEP/discussions).



Final Remarks

- Through adopting **open toolchains and platforms**, we are building **an international open research and teaching community**

Open Development

Open Documentation

Open Communication

Open Research & Teaching Community

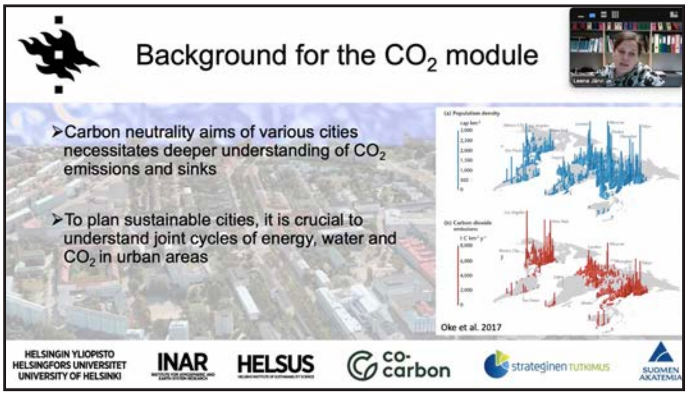
Thanks to everyone who joined!

*– The UMEP Development Team
via Fredrik Lindberg
fredrikl@gvc.gu.se*


INAR
INSTITUTE FOR ATMOSPHERIC AND EARTH SYSTEM RESEARCH
UNIVERSITY OF HELSINKI

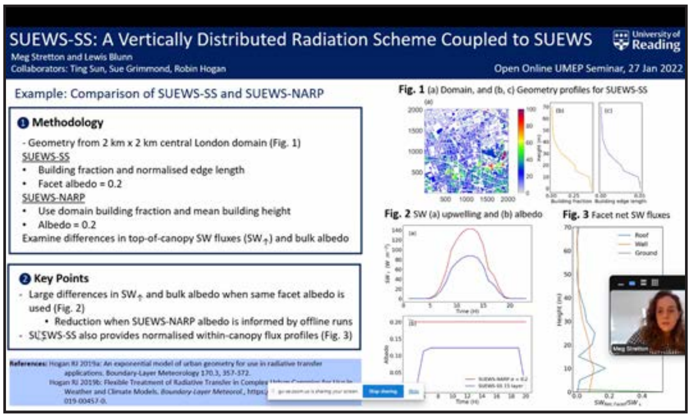
Simulating CO_2 emissions and sinks in SUEWS

Leena Järvi
27 January 2022


Background for the CO_2 module

➤Carbon neutrality aims of various cities necessitates deeper understanding of CO_2 emissions and sinks

➤To plan sustainable cities, it is crucial to understand joint cycles of energy, water and CO_2 in urban areas


SUEWS-SS: A Vertically Distributed Radiation Scheme Coupled to SUEWS

Meg Stretton and Lewis Blunn
Collaborators: Ting Sun, Sue Grimmond, Robin Hogan
Open Online UMEP Seminar, 27 Jan 2022

Example: Comparison of SUEWS-SS and SUEWS-NARP

❶ Methodology

- Geometry from 2 km x 2 km central London domain (Fig. 1)

SUEWS-SS
- Building fraction and normalised edge length
- Facet albedo = 0.2

SUEWS-NARP
- Use domain building fraction and mean building height
- Albedo = 0.2

Examine differences in top-of-canopy SW fluxes (SW↑) and bulk albedo

❷ Key Points

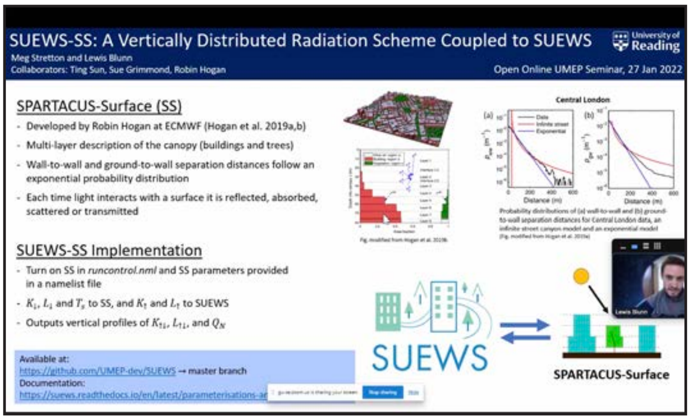
- Large differences in SW↑ and bulk albedo when same facet albedo is used (Fig. 2)
  - Reduction when SUEWS-NARP albedo is informed by offline runs
- SUEWS-SS also provides normalised within-canopy flux profiles (Fig. 3)

References: Hogan RJ 2019a: An exponential model of urban geometry for use in radiative transfer applications. Boundary-Layer Meteorology 170.3, 357-372.
Hogan RJ 2019b: Flexible Treatment of Radiative Transfer in Complex Urban Canopies for Use in Weather and Climate Models. *Boundary-Layer Meteorol.*, https://... 019-00457-0.

Fig. 1 (a) Domain, and (b, c) Geometry profiles for SUEWS-SS

Fig. 2 SW (a) upwelling and (b) albedo

Fig. 3 Facet net SW fluxes


SUEWS-SS: A Vertically Distributed Radiation Scheme Coupled to SUEWS

Meg Stretton and Lewis Blunn
Collaborators: Ting Sun, Sue Grimmond, Robin Hogan
Open Online UMEP Seminar, 27 Jan 2022

SPARTACUS-Surface (SS)

- Developed by Robin Hogan at ECMWF (Hogan et al. 2019a,b)
- Multi-layer description of the canopy (buildings and trees)
- Wall-to-wall and ground-to-wall separation distances follow an exponential probability distribution
- Each time light interacts with a surface it is reflected, absorbed, scattered or transmitted

SUEWS-SS Implementation

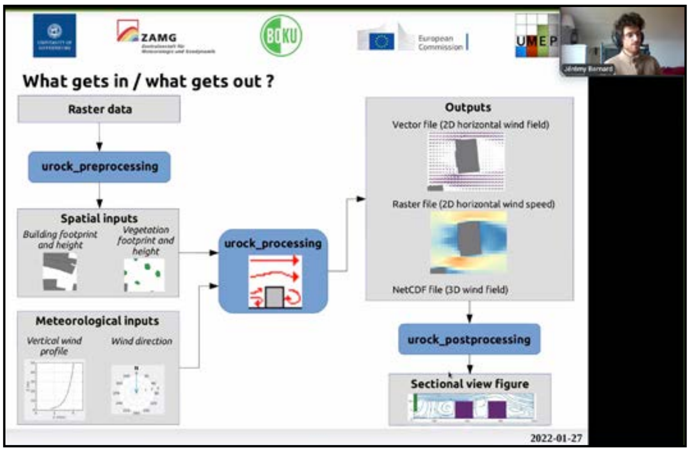
- Turn on SS in *runcontrol.nml* and SS parameters provided in a namelist file
- $K_\downarrow$, $L_\downarrow$ and T_s to SS, and $K_\uparrow$ and $L_\uparrow$ to SUEWS
- Outputs vertical profiles of $K_{\uparrow\downarrow}$, $L_{\uparrow\downarrow}$, and Q_N

Available at:
https://github.com/UMEP-dev/SUEWS → master branch
Documentation:
https://suews.readthedocs.io/en/latest/parameterisations-ar

Central London

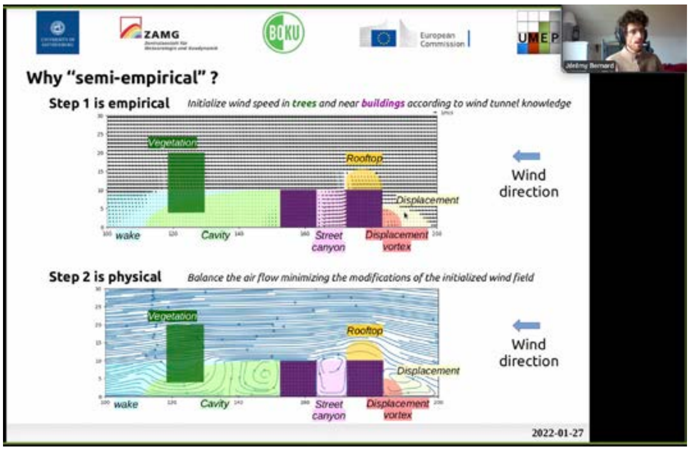
Probability distributions of (a) wall-to-wall and (b) ground-to-wall separation distances for Central London data, an infinite street canyon model and an exponential model (Fig. modified from Hogan et al. 2019a)

Fig. modified from Hogan et al. 2019b


What gets in / what gets out ?

Raster data
urock_preprocessing
Spatial inputs
Building footprint and height
Vegetation footprint and height
Meteorological inputs
Vertical wind profile
Wind direction
urock_processing
Outputs
Vector file (2D horizontal wind field)
Raster file (2D horizontal wind speed)
NetCDF file (3D wind field)
urock_postprocessing
Sectional view figure

2022-01-27


Why "semi-empirical" ?

Step 1 is empirical *Initialize wind speed in trees and near buildings according to wind tunnel knowledge*

Step 2 is physical *Balance the air flow minimizing the modifications of the initialized wind field*

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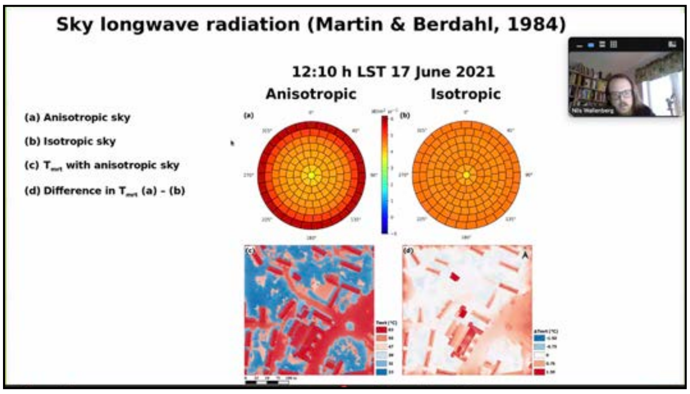

Sky longwave radiation (Martin & Berdahl, 1984)

12:10 h LST 17 June 2021

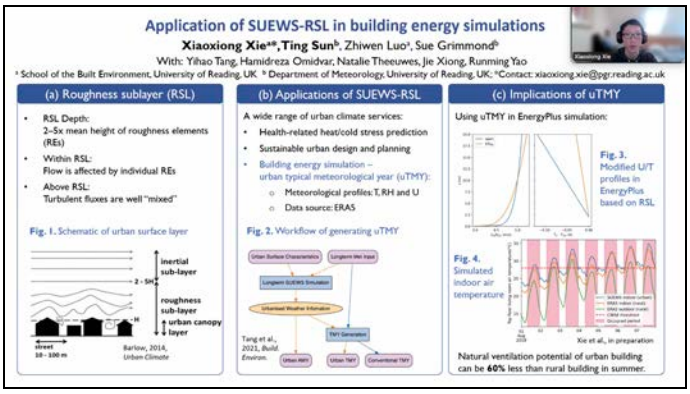
Anisotropic Isotropic

(a) Anisotropic sky

(b) Isotropic sky

(c) T_{mrt} with anisotropic sky

(d) Difference in T_{mrt} (a) - (b)


Application of SUEWS-RSL in building energy simulations

Xiaoxiong Xie[a*], **Ting Sun**[b], Zhiwen Luo[a], Sue Grimmond[b]
With: Yihao Tang, Hamidreza Omidvar, Natalie Theeuwes, Jie Xiong, Runming Yao
[a] School of the Built Environment, University of Reading, UK [b] Department of Meteorology, University of Reading, UK; *Contact: xiaoxiong.xie@pgr.reading.ac.uk

(a) Roughness sublayer (RSL)

- RSL Depth:
  2–5x mean height of roughness elements (REs)
- Within RSL:
  Flow is affected by individual REs
- Above RSL:
  Turbulent fluxes are well "mixed"

Fig. 1. Schematic of urban surface layer

Barlow, 2014, Urban Climate

(b) Applications of SUEWS-RSL

A wide range of urban climate services:
- Health-related heat/cold stress prediction
- Sustainable urban design and planning
- Building energy simulation – urban typical meteorological year (uTMY):
  - Meteorological profiles: T, RH and U
  - Data source: ERA5

Fig. 2. Workflow of generating uTMY

Tang et al., 2021, *Build. Environ.*

(c) Implications of uTMY

Using uTMY in EnergyPlus simulation:

Fig. 3. Modified U/T profiles in EnergyPlus based on RSL

Fig. 4. Simulated indoor air temperature

Xie et al., in preparation

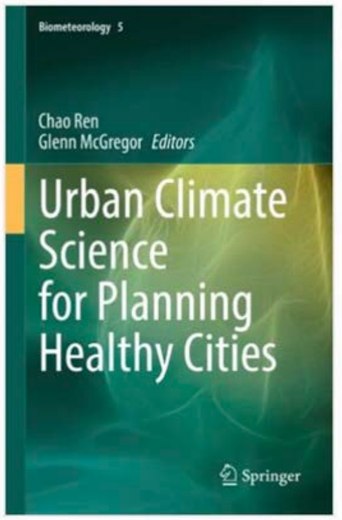
Natural ventilation potential of urban building can be **60%** less than rural building in summer.

Urban Climate Science for Planning Healthy Cities

Edited by Chao Ren and Glenn McGregor

While Mega cities and high-density urban living may make lives more convenient and society more economically efficient (Ng, 2012; 2009) they pose a range of environmental challenges, especially as increasingly dense, complex and interdependent urban systems leave cities vulnerable (WMO, 2012; 2016) and sensitive to climate variability and change (Grimmond, 2010). Climate threats come mainly in the form of poor air quality (WMO, 2012), wind storms, heat waves, drought and floods. Flowing from these are a range of possible health impacts including death, physical injury, heat related illness, vector and water borne disease and mental illness (Grimmond, 2010; WHO, WMO & UNEP, 2003; WMO, 2016). The visibility of how climate affects cities and their infrastructure and inhabitants has generated wide-ranging concern from both the general public, local and national governments and international agencies. This 'climate of concern' has led to the emergence of the call for climate resilient cities, especially as minds become focused on how climate change may have fundamental influences on how cities might have to plan for the future. Given this, a pressing imperative is to generate information about the causes of urban based climate hazards and disasters and to acquire spatial and quantitative understanding of exposure and vulnerability of people and infrastructure in cities.

To achieve this, a cross-disciplinary collaboration among scientists, planners, government, non-governmental organizations, the private sector and also the general public is required (Cleugh et al., 2009; Parker & Penning-Rowsell, 2005; WHO, 2016). However, the application of urban climate science in the realm of planning for healthy living in cities has had low uptake in the policy arena (Eliasson, 2000; Schiller & Evans, 1990/91). This apparent intransigence in the city planning and policy community is most likely related more to the lack of data and hence information related to a number of unanswered urban climate questions, as opposed to the resistance to mainstreaming climate information into devising policy. Some of these questions include how to assess current and future climatic extremes and relevant health risks, how to make decisions to enhance climate resilience to climate extremes and disasters, the modes by which information should be conveyed to city leaders and stakeholders and how and what mitigation and adaptation actions are needed to cope with climate change in cities. These questions provide the context for the newly published book entitled '*Urban Climate Science for Planning Healthy Cities*' (see https://link.springer.com/book/10.1007/978-3-030-87598-5).



Biometeorology 5

Chao Ren
Glenn McGregor *Editors*

Urban Climate Science for Planning Healthy Cities

Springer

Book summary

Comprised of three major sections entitled "The Rise of Mega-cities and the Concept of Climate Resilience and Healthy Living," "Urban Climate Science in Action," and "Future Challenges and the Way Forward," the book *Urban Climate Science for Planning Healthy Cities* argues for the recognition of climate as a key element of healthy cities.

The book demonstrates how urban climate science can provide valuable information for planning healthy cities and illustrates the idea of "Science in Time, Science in Place" by providing worldwide case-based urban climatic planning applications for a variety of regions and countries and utilizing relevant climate-spatial planning experiences to address local climate and environmental health issues. Topics covered include: urban resilience in a climate context, climate responsive planning and urban climate interventions to achieve healthy cities, climate extremes, public health impact, urban climate-related health risk information, urban design and planning, and governance and management of sustainable urban development. The book will appeal to an international audience of practicing planners and designers, public health and built environment professionals, social scientists, researchers in epidemiology, climatology and biometeorology, and international to city scale policy makers.

For more details, please visit: https://link.springer.com/book/10.1007/978-3-030-87598-5#about

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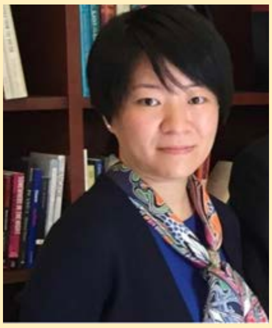

Dr. Chao Ren is an Associate Professor in the Faculty of Architecture at the University of Hong Kong. Her research interests include sustainable environmental design, climate sensitive design, and planning.

Dr. Glenn McGregor is a Professor of Climatology in the Dept. of Geography, Durham University. His research interests include climate & health, synoptic climatology, climate & society, and hydroclimatology.

Recent Urban Climate Publications

Abdullah A (2022) Experimental study of natural materials for an evaporative cooling design in hot-arid climate. *Building and Environment* 207 108564.

Abunnasr Y, Mhawej M (2021) Downscaled night air temperatures between 2030 and 2070: The case of cities with a complex- and heterogeneous-topography. *Urban Climate* 40 100998.

Adam MG, Tran PTM, Balasubramanian R (2021) Air quality changes in cities during the COVID-19 lockdown: A critical review. *Atmospheric Research* 264 105823.

Aggarwal A, Toshniwal D (2021) A hybrid deep learning framework for urban air quality forecasting. *Journal of Cleaner Production* 329 129660.

Akemi Yamasoe M, Manuel Évora Rosário N, Novaes Santos Martins Almeida S, Wild M (2021) Fifty-six years of surface solar radiation and sunshine duration over São Paulo, Brazil: 1961-2016. *Atmospheric Chemistry and Physics* 21 6593-6603.

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Avichal M, Maxim S, Jérôme F, Van-Freeck C (2022) Urban energy simulations using open CityGML models: a

In this edition is a list of publications that have generally come out between **November 2021 and February 2022**. Publications in **boldface** are highlighted papers recommended by the members of the Bibliography Committee. If you believe your articles are missing, please send your references to the email address below with a header "IAUC publications" and the following format: Author, Title, Journal, Year, Volume, Issue, Pages, Dates, Keywords, URL, and Abstract. Important: do so in a .bib format.

We would like to warmly welcome Debanjali Banerjee (Univ. of Cincinnati, USA), who joined the committee in February 2022. Note that we are always looking for (young) researchers to join and contribute to the Committee. If you are interested to join or would like to receive more information, please let me know via the email address below.

Happy reading,

Chenghao Wang

Chair, IAUC Bibliography Committee
Stanford University (USA)
chenghao.wang@stanford.edu

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Iara Santos

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Backlin O, Lindberg F, Thorsson S, Rayner D, Wallenberg N (2021) Outdoor heat stress at preschools during an extreme summer in Gothenburg, Sweden- Preschool teachers' experiences contextualized by radiation modelling. *Sustainable Cities and Society* 75 103324.

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Upcoming Conferences...

The information in this list is current as of the publication date of the newsletter, but readers should check for updated information online in the event of schedule changes due to the COVID-19 pandemic.

ASIA OCEANIA GEOSCIENCES SOCIETY (AOGS), Session on "Future of Cities within the Context of Climate Change"
Online • June 5-10, 2022
https://www.asiaoceania.org/aogs2022/

36TH PLEA CONFERENCE ON SUSTAINABLE ARCHITECTURE AND URBAN DESIGN
Santiago, Chile • November 23-25, 2022
https://plea2022.org/

INTERNATIONAL CONFERENCE ON URBAN CLIMATE (ICUC-11)
Sydney, Australia • August 2023
https://conference.unsw.edu.au/en/icuc11

Special issue on "Effects of the COVID-19 Pandemic on the Use and Perception of Urban Green Space "in *Land.*
Abstract deadline: April 30, 2022
https://www.mdpi.com/journal/land/special_issues/pandemic_ugs

Call for nominations – 2022 Luke Howard Award

The IAUC is pleased to announce the call for nominations for the 2022 'Luke Howard Award for Outstanding Contributions to the Field of Urban Climatology.'

The Luke Howard Award may be given annually to an individual who has made **outstanding contributions to the field of urban climatology** in a combination of **research, teaching, and/or service** to the international community of urban climatologists.

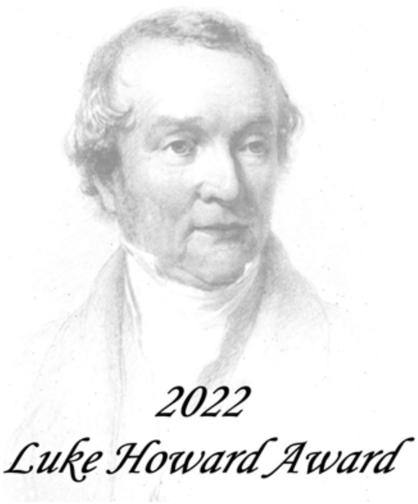
The IAUC is committed to promoting equality and diversity. Therefore, we particularly encourage nominations for suitable candidates from under-represented groups.

The person making the nomination will act as the co-ordinator to put together a nomination package (details given below). Self-nominations are not permitted, and current Awards Committee members can only be nominated if they step back from their role on the Committee for the period that the nomination is active. Complete nomination packages should be submitted (as a single electronic submission) to the IAUC Awards Committee Chair, **Dr Helen Ward**: helen.ward@uibk.ac.at

Luke Howard Award Nomination Process:

- Inform the Awards Committee Chair of the intent to nominate an individual. The intent to nominate should be communicated via email to the Awards Committee Chair by **Friday 27 May 2022**.
- Nomination materials should be collected by the co-ordinator (i.e. the person notifying the Awards Committee Chair that a particular individual will be nominated).
- The coordinator should collect and submit the following documentation in a single pdf file:
  (a) a one-page cover letter from the nomination coordinator (optional)
  (b) a three-page candidate-CV
  (c) three letters of recommendation (of no more than two pages in length) from IAUC members from at least two different countries. The nomination coordinator can, but does not have to, provide one of the letters of recommendation. Any individual providing a letter of support should do so for a maximum of one candidate for the Luke Howard Award in each year.
- Complete packages should reach the Awards Committee Chair by **Friday 24 June 2022**.

The IAUC Awards committee will then recommend the name of a recipient for consideration and approval by the IAUC Board. Nominations will be active for three years, and updated information may be submitted for consideration in the second and third years.



Previous winners of the Luke Howard Award:

- 2021 Dr Gerald Mills
  University College Dublin, Ireland
- 2020 Dr Alberto Martilli
  CIEMAT, Spain
- 2019 Professor Janet Barlow
  University of Reading, UK
- 2018 Professor Wilhelm Kuttler
  University of Duisburg-Essen, Germany
- 2016 Dr Walter Dabberdt
  Vaisala Group, USA
- 2015 Professor Emeritus Anthony Brazel
  Arizona State University, USA
- 2014 Professor Manabu Kanda
  Tokyo Institute of Technology, Japan
- 2013 Professor Emeritus Yair Goldreich
  Bar-Ilan University, Israel
- 2010 Professor John Arnfield
  Ohio State University, USA
- 2009 Professor Sue Grimmond
  King's College, UK
- 2008 Professor Bob Bornstein
  San José State University, USA
- 2007 Professor (Emeritus) Masatoshi Yoshino
  University of Tsukuba, Japan
- 2006 Professor Arieh Bitan
  Tel Aviv University, Israel
- 2005 Professor Ernesto Jauregui
  UNAM, Mexico
- 2004 Professor Tim Oke
  UBC, Canada

Call for nominations – 2022 Timothy Oke Award

The IAUC is pleased to announce the call for nominations for the 2022 'Timothy Oke Award for Original Research in the Field of Urban Climatology'.

The Timothy Oke Award was established in 2020 and is given annually to early- and mid-career researchers who have conducted original research with high impact in the field of urban climate science. Nominations should thus focus on a particularly relevant study or collection of papers and their impact. Eligible candidates should be approximately 3-12 years after PhD and will be assessed in accordance with their career stage. Nominations for candidates which fall outside these guidelines should be justified. The IAUC is committed to promoting equality and diversity. Therefore we particularly encourage nominations for suitable candidates from under-represented groups.

The Timothy Oke Award rules and nomination process are identical to those described for the Luke Howard Award, on the previous page. This includes the submission deadlines of **27 May 2022** (intent to nominate) and **24 June 2022** (complete nomination package), both by email to the IAUC Awards Committee Chair, **Dr Helen Ward**: helen.ward@uibk.ac.at

The IAUC Awards committee will recommend the names of **up to three recipients** for consideration and approval by the IAUC Board. Nominations made this year will only be considered for the 2022 award but can be updated and resubmitted in subsequent years.

Previous winners of the Timothy Oke Award:

- 2021 Prof. Benjamin Bechtel, Ruhr-University Bochum, Germany; Associate Prof. Leena Järvi, University of Helsinki, Finland; Dr Iain Stewart, Global Cities Institute, University of Toronto, Canada
- 2020 Assistant Prof. Scott Krayenhoff, University of Guelph, Canada; Associate Prof. Chao Ren, University of Hong Kong, Hong Kong

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- Matthias Demuzere (Ruhr-University Bochum, Germany and CEO and Founder Kode), 2018-2022
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- Simone Kotthaus (Institut Pierre Simon Laplace, France), 2020-24
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- Dev Niyogi (Purdue University, USA): *ICUC10 Local Organizer*, 2016-2021
- Negin Nazarian (University of New South Wales, Australia): *ICUC-11 Local Organizer, 2020-24*
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- Natalie Theeuwes (Royal Netherlands Meteorological Institute, the Netherlands), 2021-25
- James Voogt (University of Western Ontario, Canada), *Past President*: 2014-2018*
- Helen Ward (University of Innsbruck, Austria), 2019-2022

* non-voting, ** non-voting appointed member

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  - News Editor: Dragan Milosevic
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The next edition of *Urban Climate News* will appear in late June. Contributions for the upcoming issue are welcome, and should be submitted by May 31, 2022 to the relevant editor.

Submissions should be concise and accessible to a wide audience. The articles in this Newsletter are unrefereed, and their appearance does not constitute formal publication; they should not be used or cited otherwise.

Bibliography: Chenghao Wang and BibCom members
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