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Opportunity Title: Characterization of Physics and Approximations in Urban Weather and Atmospheric Dispersion Models
Opportunity Reference Code: ICPD-2019-05

Organization Office of the Director of National Intelligence (ODNI)

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Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: https://orise.orau.gov/icpostdoc/index.html.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 3/1/2019 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

- Urban and microscale weather models have been developed and deployed by many sectors within the U.S. Government for purposes of energy production, consequence management, pollution monitoring, force protection, and first responder coordination. New advancements in computing architectures, such as highly parallel processing (Graphical Processing Units, GPUs), and novel algorithms provided by the Artificial Intelligence and Machine Learning (AI and ML) communities provides new approaches to explore the non-linear processes of *Urban Weather* and *Material Dispersion Modeling*.

- The dispersion of materials throughout the environment is driven by highly complex nonlinear atmospheric processes, which have proven incredibly difficult to accurately model, especially in urban/microscale environments. *Current urban dissemination models* are driven by high order approximations, which lowers computational demand at the cost of prediction accuracy and robustness. However, research has also shown that modeling attempts based solely on physics and first order calculations have also surprisingly fallen short of performance expectations. These two points suggest there is an optimal point of balance between approximations and physics as it pertains to urban dissemination modeling. The “point of balance” between approximations and physics will likely be completely unique to a particular scenario, and thus balance will need to be dynamically derived to be useful across the many potential use cases.

- The interest of the current solicitation is not to generate a dispersion prediction model, but is rather focused on the academic pursuit and characterization of the optimal balance of ***Physics and Approximations*** in the context of the highly complex urban weather and dispersion scenarios.

- Urban environments provide an almost infinite dimensionality to dispersion modeling, through complex turbulence features and shifting boundary layers, which arise from tightly packed architectural volumes and pattern of life activities. Factors defining the “urban setting” further compound the already highly variable fluid dynamics of atmospheric systems that are the driving force behind dispersion processes.

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- Dispersion modeling, especially in urban environments, requires the careful balance of first order calculations with environmental approximations. Each modeling scenario is uniquely dynamic, and the approximation/calculation balance would seem to require varying degrees of optimization between scenarios.

- The current research solicitation involves the characterization of the optimization between first order physics and dispersion approximations across modeling scenarios in urban settings.

- The key question this announcement is trying to answer is; how should one balance physics and approximations in ATD modeling in urban environments? Generating and running urban dispersion is not within scope of this announcement and those responses detailing such efforts will not be accepted. Scientific understanding yielded under this announcement will provide a foundational understanding of dynamic interplay in modelling between physics and approximations which currently does not exist. *Therefore, results of this work would likely be broadly impactful and applicable across the modelling communities using various Urban Weather and Dispersion Models.*

Example Approaches:

- Research could focus on deconstructing dispersion events to approximate the highest contributing physical factors driving the process of urban dispersion. This approach would enable the ranking of the feature space to determine which model features should be approximated. Open datasets, such as Joint Urban 2003 Tracer Field Tests, could be leveraged as ground truth experimental data.
- Machine learning (ML) alone is not expected to yield significant increases in dispersion prediction accuracy, but ML could be leveraged to sort out which contributing factors should be prioritized through physics and which features should be handled through approximations only. How should models handle features within a scenario to yield the highest performance?
- Approaches should be compared against the available experimental data to demonstrate a performance improvement. The key research question under the current announcement is solely focused on characterizing the optimization of approximation versus physics to enable higher accuracy predictions. Other considerations, such as speed and processing efficiency, are not the focus of the current solicitation. The solicitation is not seeking new dispersion models.

Key Words: Weather Research and Forecasting Model; Urban Weather; Atmospheric Transport and Dispersion (ATD); Plume Modeling; Machine Learning; Parallel Processing; Atmospheric Physics; Large Eddy Simulations; Computational Fluid Dynamics; Climatology; Metrology; Chemical, Biological, Nuclear, Radiological, & Explosives (CBRNE); Computer Science

Qualifications

Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the application deadline
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship

Program.

Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Eligibility Requirements

- **Citizenship:** U.S. Citizen Only
- **Degree:** Doctoral Degree.
- **Discipline(s):**
  - **Chemistry and Materials Sciences** (12)
  - **Communications and Graphics Design** (6)
  - **Computer, Information, and Data Sciences** (16)
  - **Earth and Geosciences** (21)
  - **Engineering** (27)
  - **Environmental and Marine Sciences** (14)
  - **Life Health and Medical Sciences** (45)
  - **Mathematics and Statistics** (10)
  - **Other Non-Science & Engineering** (5)
  - **Physics** (16)
  - **Science & Engineering-related** (1)
  - **Social and Behavioral Sciences** (28)