Committing to the environment and climate at MIT
ENVIRONMENTAL SOLUTIONS INITIATIVE
PEOPLE
PLANET
PROFIT

PEOPLE

PROFIT
AI & Next Gen Climate Models

Using machine learning to take advantage of vast new observational datasets in global climate models

- **Persistent Problems**
  Climate models have done a good job of capturing global trends, but regional biases make it hard to predict local impacts of climate change

- **New Opportunities**
  Machine learning can improve climate models by incorporating huge observational datasets and new high-resolution simulations too complex to run in live modeling
Non-CO$_2$ Greenhouse Gases

Providing tools to better compare greenhouse gases like CH$_4$ and HFCs directly to CO$_2$

- **Regulatory Blind Spot**
  Non-CO$_2$ greenhouse gases account for one third of global warming effects, and may rise under regulations that target CO$_2$ alone

- **Energy Implications**
  More natural gas means more CH$_4$ emissions; more refrigeration means more HFCs

- **Policy Evaluation**
  New metrics are needed to compare energy mixes
Air Pollution in China
Quantifying the environmental impacts of China’s coal reductions under the 2013 Air Pollution Action Plan

- **Environmental Impact**
  Measured carbon, ozone and mercury emissions against baseline and captured regional variation

- **Econometrics**
  Concluded that health benefits from coal reductions outweighed the cost of the APAP

- **Policy**
  Presented results to senior policy officials in China and at the 2015 Paris Climate Conference
Autonomy-Enabled Transport

Modeling new transport systems with self-driving vehicles to minimize environmental impacts

- **Multiple Scales**
  Analyze the most efficient systems for autonomous trucks, aircraft, and door-to-door transport

- **Deep Learning**
  Take advantage of large satellite datasets to model truck convoys on highways and contrails in air travel

- **Environmental Efficiency**
  Study whether designing the most efficient transport systems conflicts with minimizing carbon emissions
Repurposing Industrial Waste

Turning coal ash and other industrial byproducts into cement-like building materials

**Sustainable Production**

Design chemical processes to form building materials with safe chemical activators at low temperatures

**Multiple Benefits**

Repurpose environmentally harmful waste products into a substitute for energy-intensive cement

**Past Success**

Build on a regional project in India creating safe, high-quality bricks from boiler ash
Deep Sea Mining

Mineral mining of the sea floor is a new phenomenon with unknown impacts on the environment

- **Modeling**
  Developed a new model of sediment plumes and tailings created in deep sea mining

- **Field Work**
  Released tracer dye in a planned mining location to collect real-world data on dispersion of byproducts

- **Policy**
  Produced a new protocol to evaluate future deep sea mining projects for risks to the environment
Plastics and the Environment Prog
Plastics: annual and cumulative production

Data sources:
PlasticsEurope’s Market Research and Statistics Group (PEMRG); Conversio Market & Strategy GmbH;
Compiled by Boya Xiong, PhD (Plata Lab)
What we currently know about the plastic lifecycle

Units:
- Million metric tons/yr
- % of total plastic products

Xiong, Johnson, Olsen, Plata; unpublished

A= Direct measurement  B= Calculated from mass balance
C= Assumed release rates  D= Poor estimate
Plastics and the Environment (PEP)

MIT faculty and students are working with the public sector, foundations, industry, and other researchers to reduce the impact of plastic waste in the environment.
Plastics and the Environment: current research

**Prof. Desirée Plata**¹ Engineered environmental degradation pathways for broad families of polymer types and multiple environmental variables

**Prof. Admir Masic**¹ Sensors for characterization of microplastics in the oceans

**Prof. Pierre Lermusiaux**² & **Tom Peacock**² 3D modelling of dispersion and degradation transport and biological interactions in aquatic environments

**Prof. Jeremiah Johnson**³ Chemical modification of existing polyolefins to enhance recyclability through depolymerization & compatibilization strategies

**Prof. Julia Ortony**⁴ Recyclable, self-assembled nano-scale fibers

**Profs. Anthony Sinskey**⁵ & **Gregory Stephanopoulos**⁶ Bioprocess for closed-loop PET (polyethylene) recycling*

**Prof. Brad Olsen**⁶ Packaging simplification for hybrid degradation-recycling

**Prof. Jeff Grossman**⁴ Microfiber filtering technology

¹Civil and Environmental Engineering ²Mechanical Engineering ³Chemistry ⁴Material Science and Engineering ⁵Biology ⁶Chemical Engineering

*MIT Energy Initiative Seed Grant
Plastics and the Environment Program (PEP)
Public Policy and Economic Incentives Workshop
MIT, Spring 2020: Chris Noble at crn@mit.edu
Adapted from: Graedel and Allenby; Gordon, Koopmans, Nordhaus and Skinner
Here and Real
Cities adapting to climate change
Los Angeles 1948 (early pm)
Urban Metabolism of Bangkok
Old projection for 2050

20 MILES

THAILAND

Bangkok

New projection for 2050

In 2100, 80-85% of global population will be living in cities, the largest in Africa and Asia.
A 21st c. World of Cities
HOW TO ADAPT & THRIVE IN A CHANGING CLIMATE?

Climate Action through
TECHNOLOGY
DEVELOPMENT &
DEPLOYMENT

DRIVE
Climate Science
+ BIG & PERVERSIVE DATA

COMMERCIALIZATION
Industry + MIT Partnerships

WHAT ARE THE CATALYSTS FOR FUTURE GROWTH?
the ESI announces…

Cities and Climate Change – C3

BD/Al UAVs  ES + Inf  Resilience  UrbMet/Risk