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Climate Change Impacts on Pavement Engineering

International Sustainable Pavements Workshop

Airlie Center
Warrenton, Virginia

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NATIONAL CENTER of EXCELLENCE for SMART INNOVATIONS

Topic

- Is it “climate change impact on pavement engineering” or “pavement engineering impact on climate change”?
- Fit within sustainability?

Criteria for Sustainable Pavements?

- Performance / Durability
  - Material / Design
- Safety
- Ride Quality or Comfort
- Life Cycle Cost
- Energy Consideration
- Quality of Life Issues
  - Highway Noise
  - Air Quality
  - Urban Heat Island
- Recyclability

TRB on Transportation and Climate Change

"Reducing transportation-related emissions of carbon dioxide--the primary greenhouse gas--that contribute to climate change and adapting to the consequences of climate change will be among the biggest public policy challenges facing the transportation profession over the coming decades. "

US GHG Estimates

- Fact: coal is the primary generator of electricity (~50%) in the US
- Electric power generation: ~80% of total GHG emissions , *EPA 2006*
- Transportation Sector: 15-30%
- Pavements???
  - Raw materials production, manufacturing, placement,…

Needed Tools

- A methodology for road designers and transportation officials to model the impact of different pavement types on climate change potentials.
- Input variables that can be modified by the designer to customize for their specific road configuration and materials type.
- Examine the direct CO_2 emissions related to pavement designs.
- Incorporate as part of the life cycle cost analysis.

Model

$$Total \cdot annual \cdot kgCO_2.Eq/km = \frac{\sum \left[T * W * 1000 * Dn * (Pn + Mn) + (Di * Tp) \right]}{Y}$$

Where,

T = thickness of pavement layer, meters

W = width of road, meters

Dn = density of pavement material, kg/m^3

Pn = material production value, kg CO2 Eq. /kg

Mn = material mixing value, kg CO2 Eq. /kg

Di = distance from material production site to application site, km

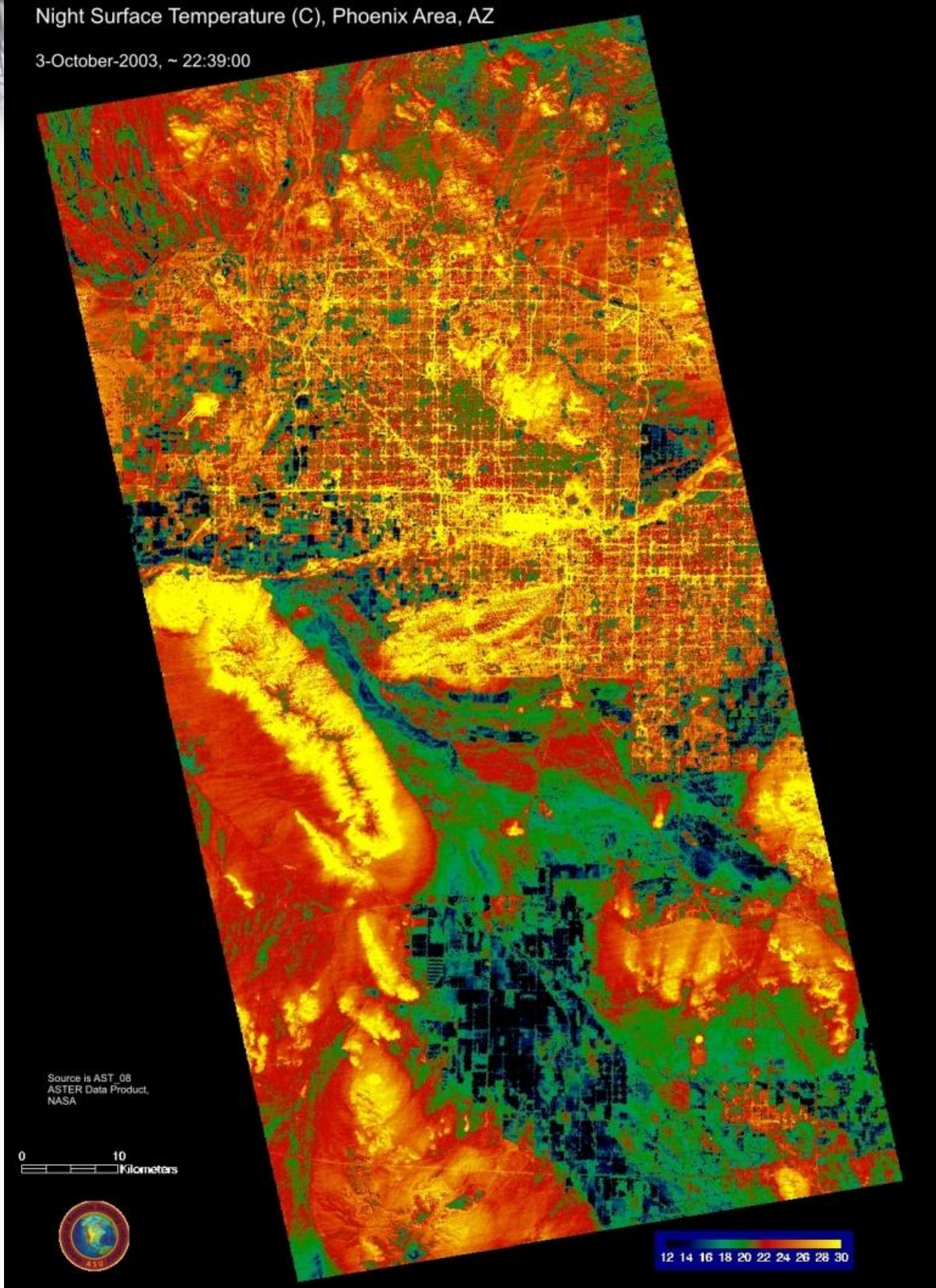
Tp = transport from production site to application site value, kg CO2 Eq. /kg material-km

Y = road life, years

Sequestering CO_2 *Brent Constanz, 2009*

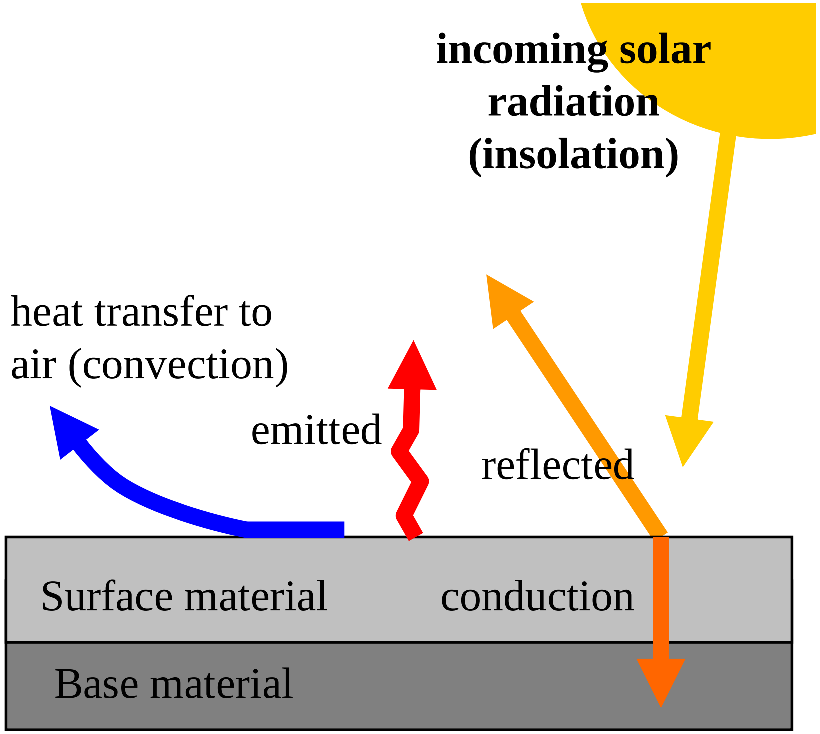
- Transform CO_2, primarily from coal, into carbonate minerals
- Worldwide: reduce CO_2 emissions by 50 billion tons /yr

Urban Heat Island

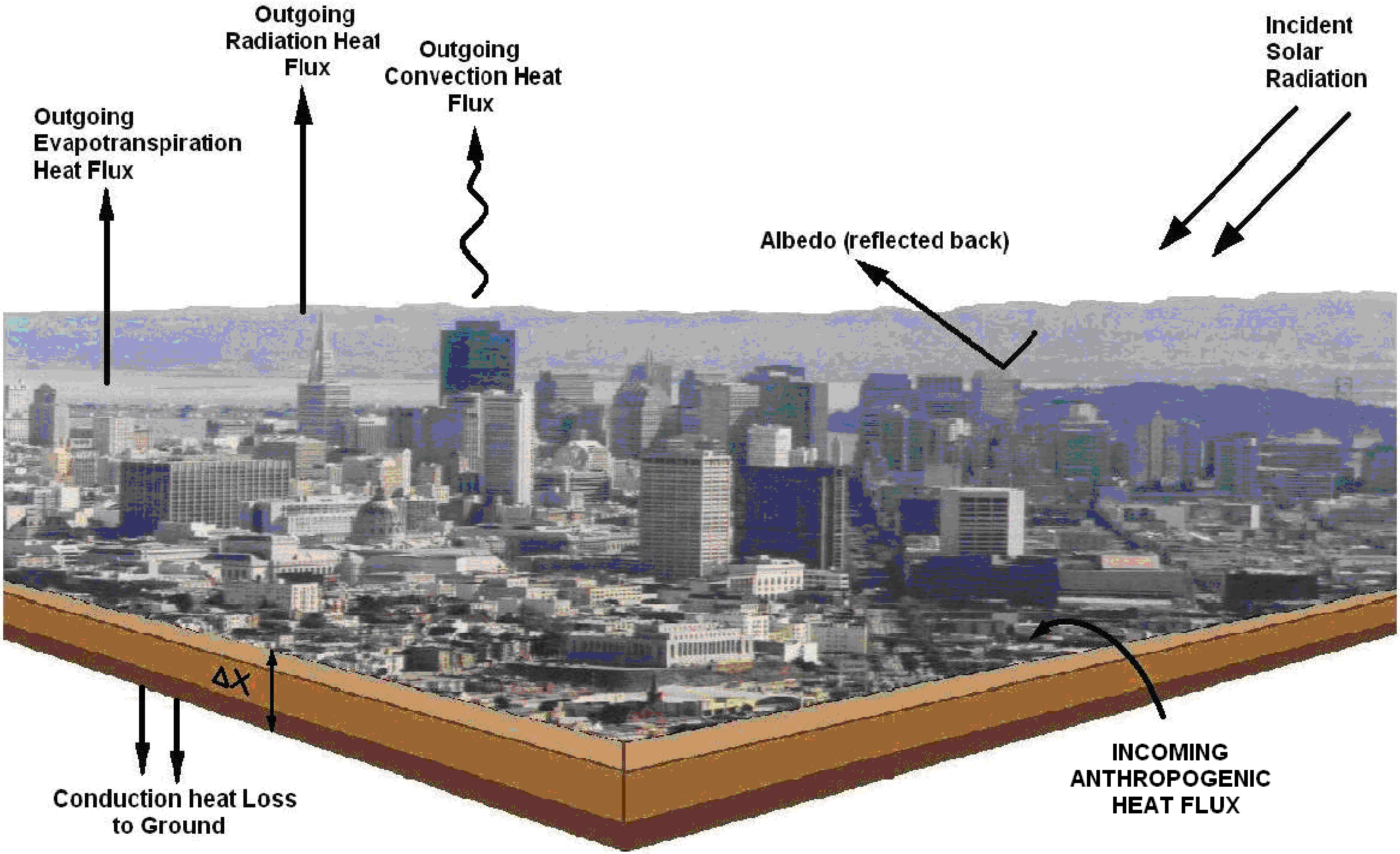


Need Better Understanding of Influencing Factors

- Albedo, α
- Emissivity, ε
  - controls the far-infrared re-radiation from the surface back to the sky.
- Convection Coefficient, h
- Thermal Conductivity, *k*
- Specific Heat, C
- Density, *ρ*
- Volumetric Heat Capacity
- Thermal Diffusivity, α,κ
- Porosity, φ



Models for City – Wide Analysis



Meeting			AF000	Pavement Materials and the Urban Climate Subcommittee, AF000(2)	Marriott, Balcony D	Jan 12 2010 10:15AM-12:00PM
Meeting			AF000	Climate Change, Energy and Sustainability Impacts on the Transportation Infrastructure Subcommittee, AF000(3)	Marriott, Embassy	Jan 10 2010 4:00PM-5:30PM
S	373		ADC20	Climate Change Roundtable	Marriott, Delaware A	Jan 11 2010 7:30PM-9:30PM
M			ADC70	Climate Change Joint Subcommittee of ADC70, ADC80	Marriott, Washington B6	Jan 13 2010 12:15PM-2:15PM
S	260		A0020T	Federal Climate Change Legislation and Policies: Update and Outlook	Marriott, Maryland B	Jan 11 2010 10:15AM-12:00PM
	P	441	ADC70	Transportation, Climate Change, and Sustainability	Hilton, International Center	Jan 12 2010 9:30AM-12:00PM


Thank You!