

A Continuous Infrastructure Index for Mapping Human Settlements

Christopher Small₁ Son Nghiem₂

1 - Lamont Doherty Earth Observatory, Columbia University, Palisades, NY 10964 USA

2 - NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109

The Challenge of Mapping Infrastructure - *Form vs Function*

A Strategy for Mapping Infrastructure - *Multi-Sensor, Multi-Scale Multi-Temporal*

Spectral Stability and Impervious Surface

Corner Reflectors & Radar Backscatter

A Continuous Infrastructure Index

Challenges to Mapping Human Settlements

Diversity of applications, definitions, form & function

results in

Diversity of composition, structure, scale and response

Modification of land cover takes many forms - at all scales

Modification of land cover does not necessarily change the physical properties. Natural materials are often used.

Modification of land cover is rarely spatially contiguous.

Generally fractal and not simply connected.

Physical Properties of Built Environments

Impervious Surfaces - Roofs, but not necessarily streets

Characteristics - Differing, but stable, reflectance. Don't absorb water

Persistent Shadow - Narrow canyons between buildings

Characteristics - Stable dark fractions over under varying illuminations

Buildings - High density of vertical walls create corner reflectors

Characteristics - High radar backscatter under varying illuminations

Strategy

Multi-Sensor - Intersection of multiple non-unique physical responses is more diagnostic than any single response alone.

Landsat/Sentinel 2 optical + SRTM/Sentinel 1 radar

Multi-Scale - Characterize physical properties of human modified landscapes at meter to kilometer scales in diverse environments.

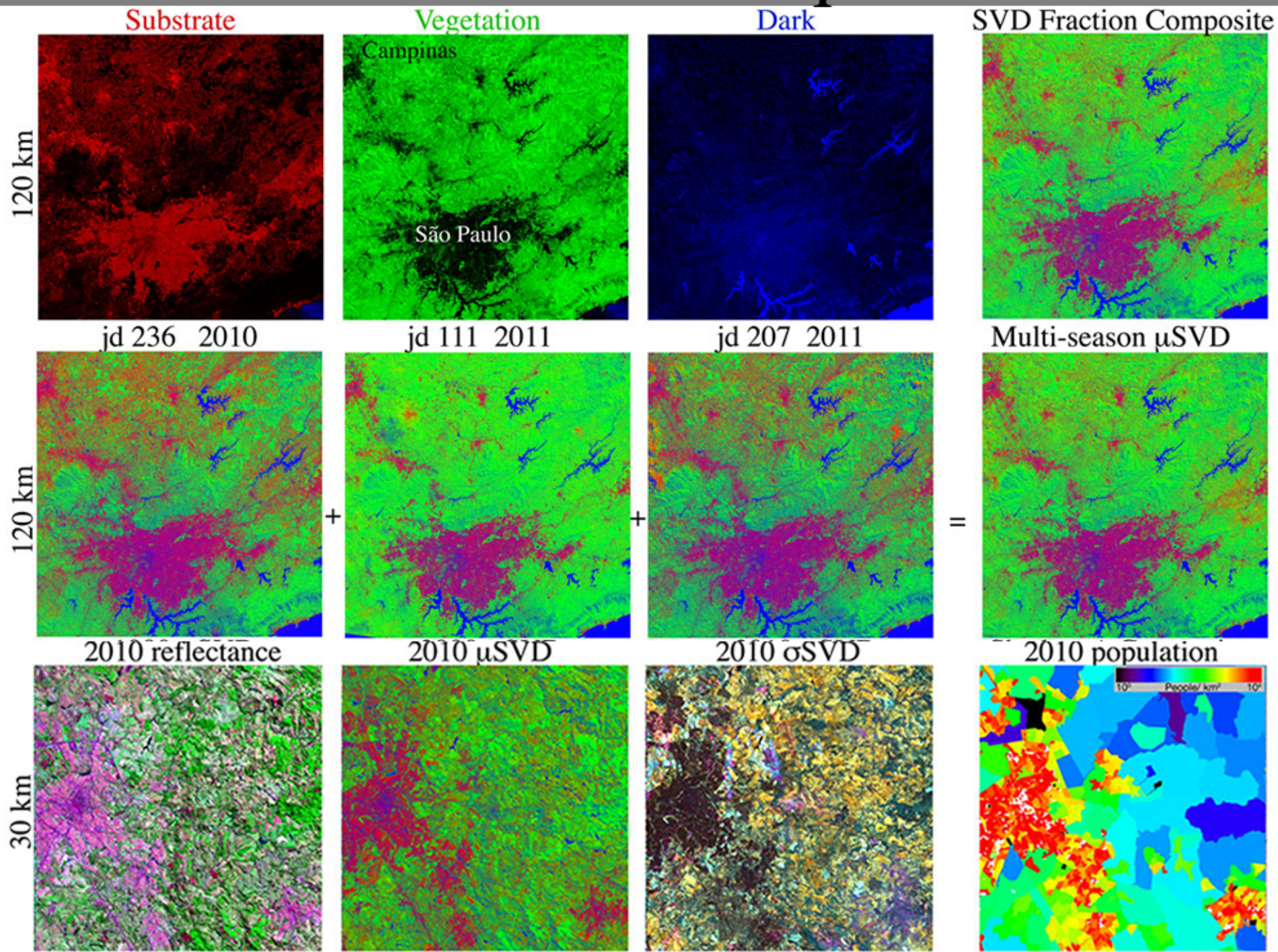
Response of land surface at meter scale as imaged at decameter scale

Multi-Temporal - Characterize seasonal changes of landscapes using multi-season mean and variability of subpixel land cover

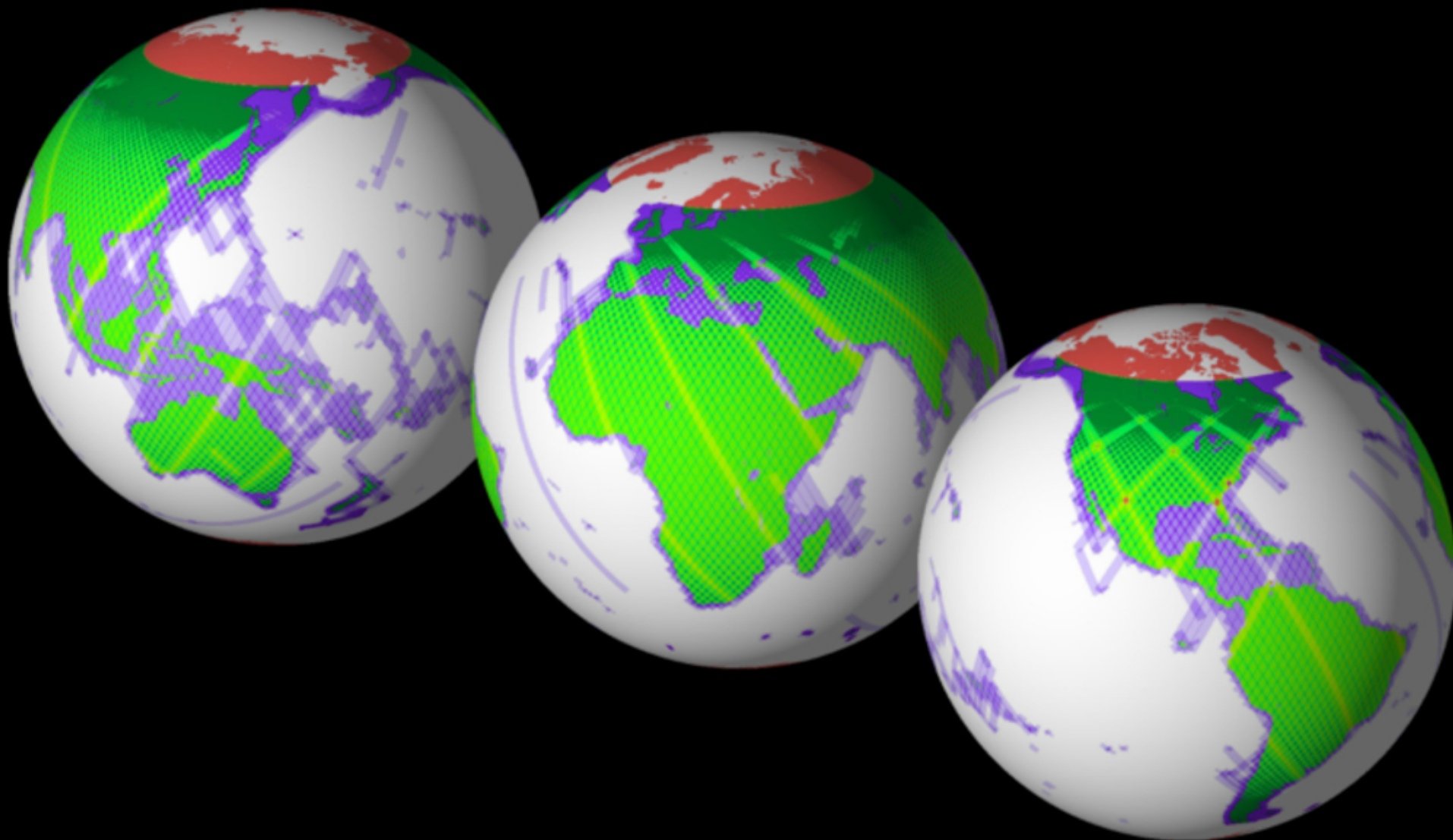
Seasonal changes characterize pervious & impervious surfaces

Interannual changes in land cover characterize infrastructure growth

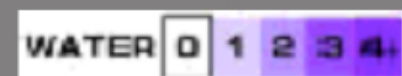
Multi-Scale Multi-Spectral



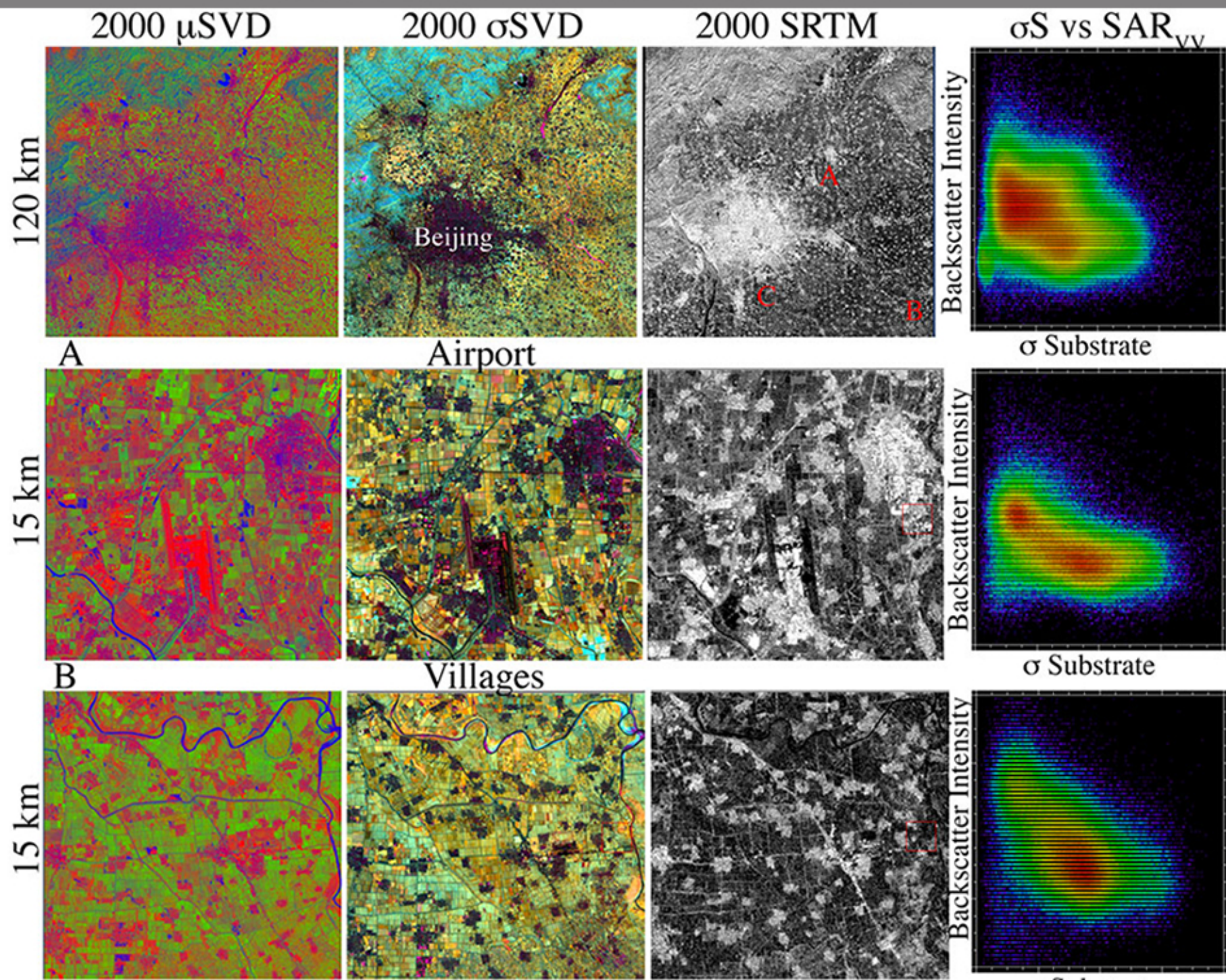
2000 SRTM Coverage



Number of times imaged



Multi-Sensor Multi-Scale



Generic Infrastructure Index

$$II = \frac{aS_{\mu} * bR_{vv} * dD_{\sigma}}{cS_{\sigma}}$$

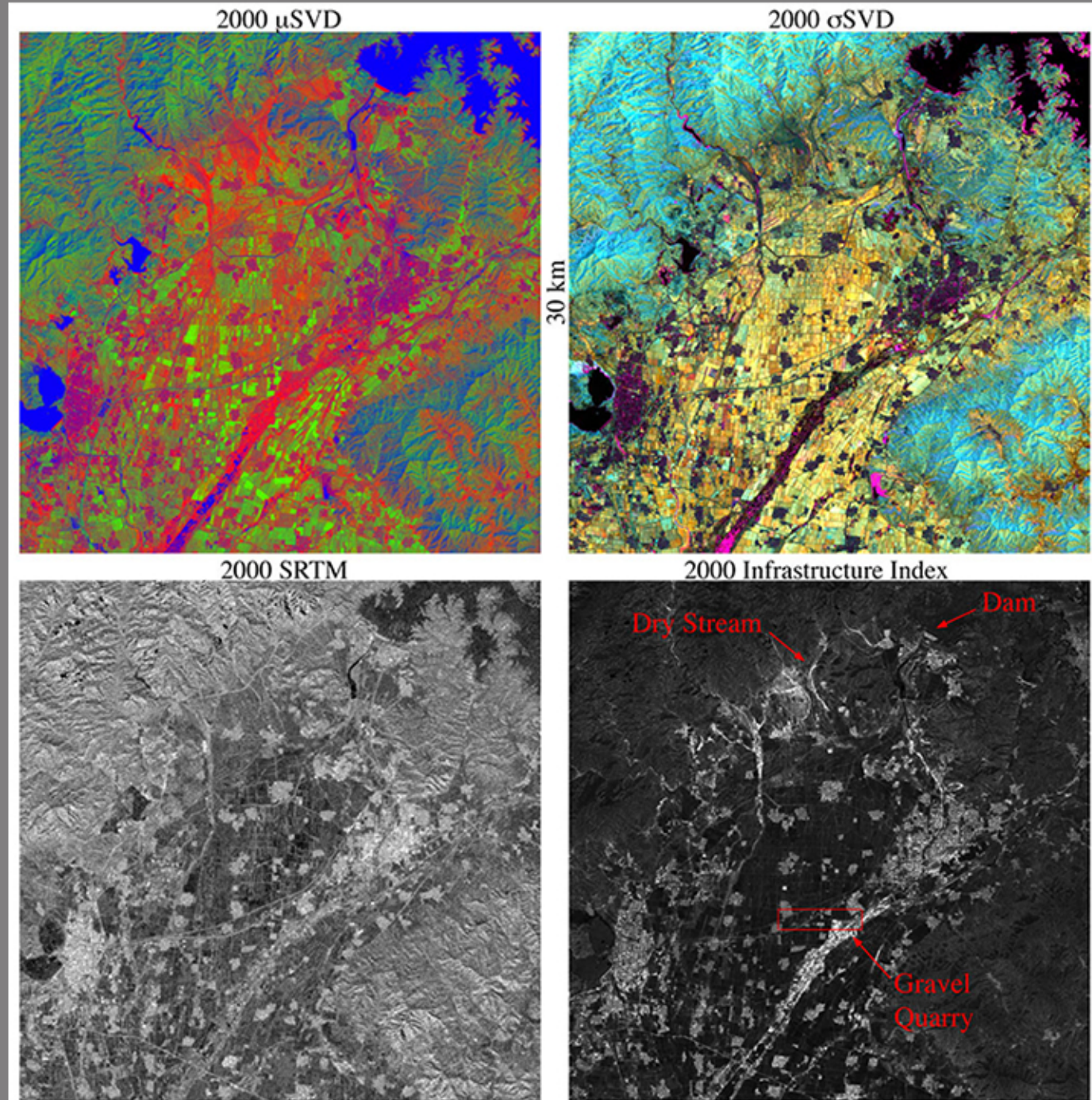
S_{μ} = Substrate μ

R_{VV} = Radar VV

D_{σ} = Dark σ

S_{σ} = Substrate σ

Optimize a, b, c, d



Conclusions

- > The form, function and physical characteristics of the built environment are diverse.*
- > The potential applications of a human settlement product are diverse.*
- > A diversity of products will be required to represent the diversity of built environments for a diversity of applications.*
- > Continuous fields of physical properties accommodate multi-scale spectral mixing and exploit spatiotemporal variability while allowing for application-specific thresholds, estimation of uncertainty and a wide diversity of applications.*
- > Different representations of the built environment can be combined to yield a more versatile, and potentially more accurate, product than any single representation.*

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