A GHG Information System

(emphasizing near-term operational decision-support)

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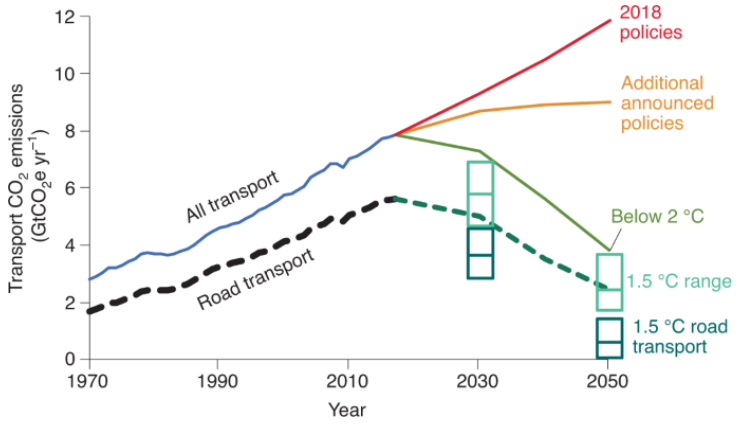
GHG Information: for what?



Mitigation planning

How large are emissions in my ____?
What sectors, what fuels? What gases?
What is big/small?
What can I control/influence?
Who are the emitters?

Mitigation Tracking

(information feedback loop)

Am I on track?
Do I need to course-correct?
Intensify effort?
Will I generate credits?

Mitigation assessment

("enforcement", "verification")

How did I do?
Did I meet target?
Can I demonstrate that?
What would I do differently next time?

GHG Information: For Whom?

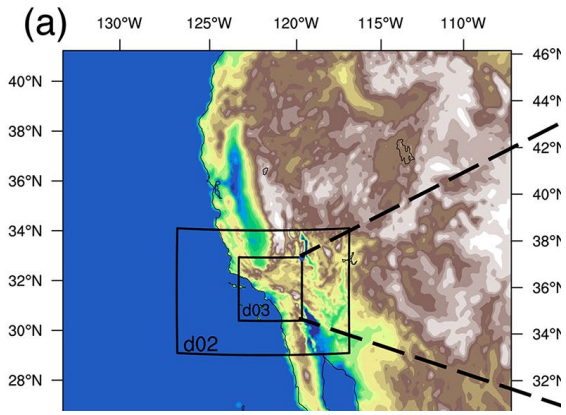
GHG Information: Specifications

1) Fluxes
2) Functional attributes (sector, fuel, technology, address…)
3) Granular – scales relevant to humans making decisions, taking actions
4) Multiscale (that conserves mass!) – ”it adds up”
5) Accurate, rigorous, data-driven
6) Transparent
7) Ongoing, timely
8) Scope 1, 2, and 3 (direct and supply-chain)
9) Accessible/Usable
10) Apolitical/trusted with Standards

Actionable

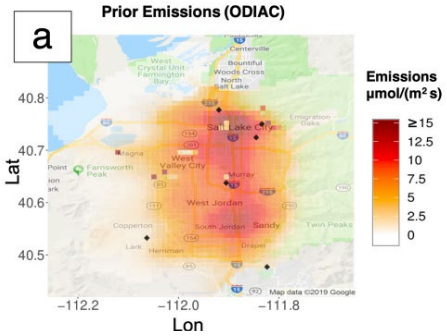
GHG Information: The Traditional View

"Prior"
(~fluxes)



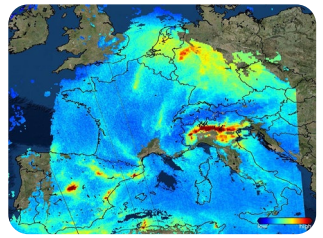
Rough estimates to provide some needed constraint

Atmospheric Inversion

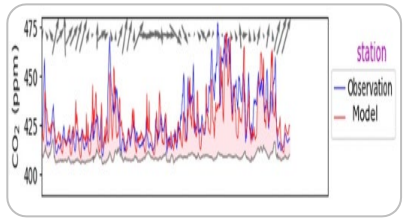


"Posterior"

"Observations"
(concentrations, column amounts, sometimes fluxes)



Spaceborne observations

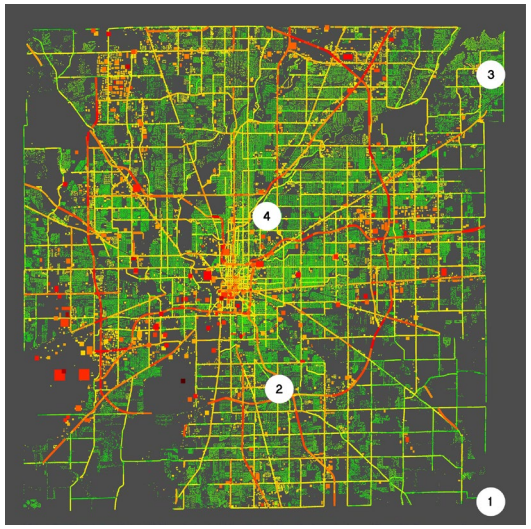


Surface measurements

Aircraft measurements

More integration is needed

GHG Information: An Operational System(s)



BOTTOM-UP Data Integration

data

data

Assimilation system

Nudge, locate problems

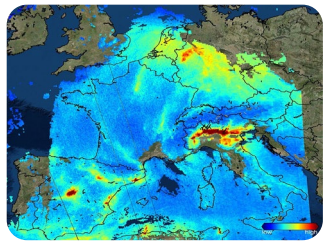
data

data

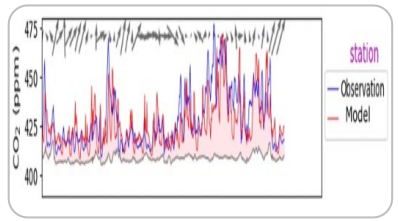
integrated

”Observations”

(concentrations, column amounts, sometimes fluxes)



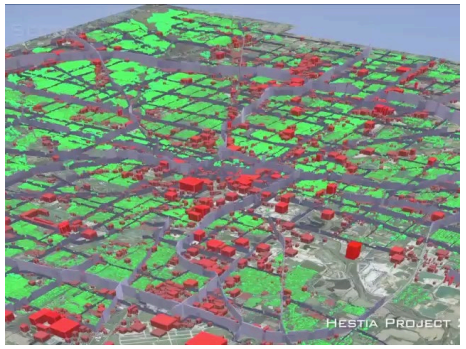
Spaceborne observations



Surface observations

Aircraft measurements

BOTTOM-UP Data Collection

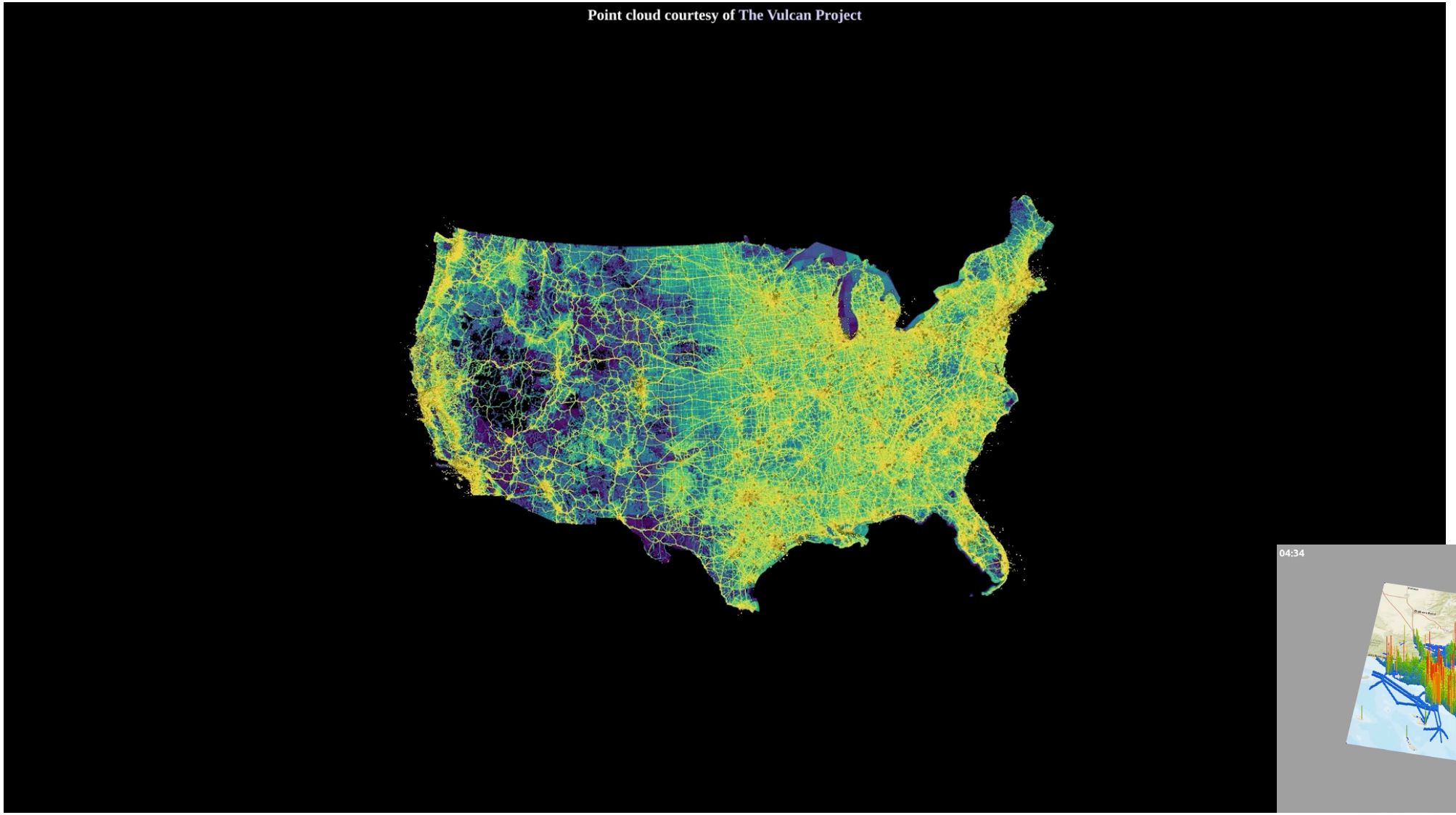


Granular, accurate, functional, dynamic. actionable

Rich in granularity, functional detail…..limited absolute accuracy (face norms globally)

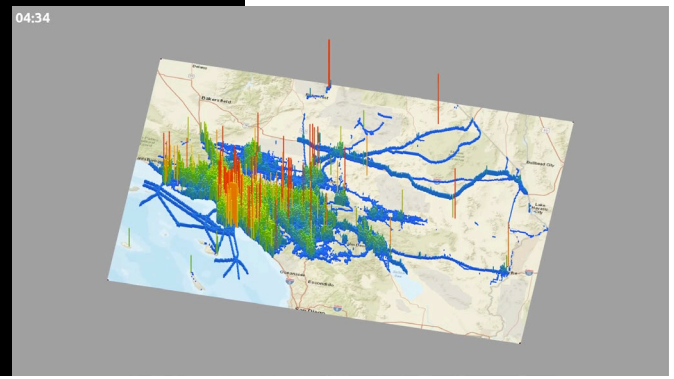
Accurate and potentially global, but limited in granularity and functional information

GHG Information: Bottom-up state-of-the-art



Fully bottom-up, engineering approach:

~0.5km^2
hourly
timeseries up to NRT
all fuels
all sectors, sub-sector, tech



GHG Information: Atmospheric integration

Estimating US fossil fuel CO_2 emissions from measurements of ^{14}C in atmospheric CO_2

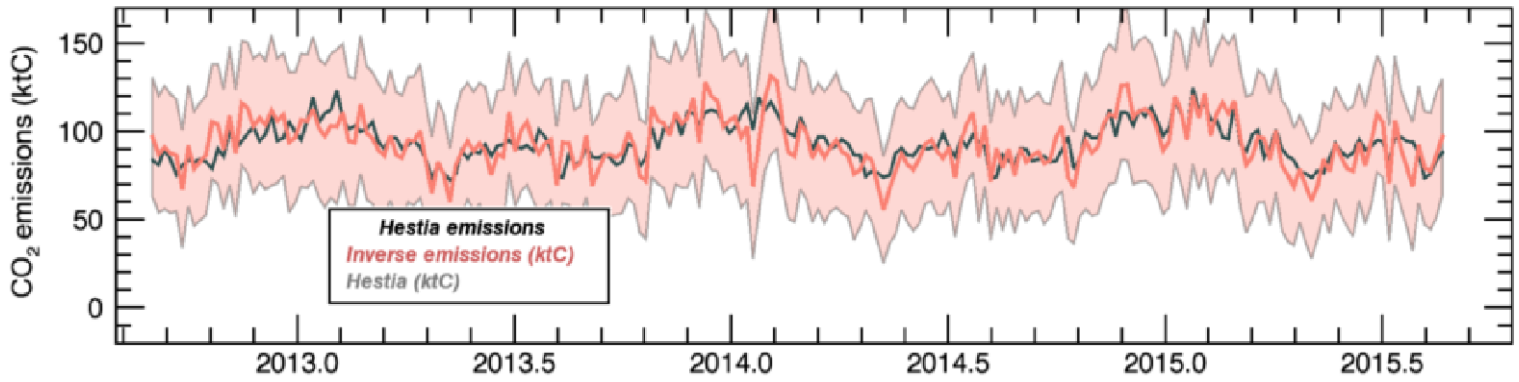
Sourish Basu[a,b,1,2,3], Scott J. Lehman[c], John B. Miller[a], Arlyn E. Andrews[a], Colm Sweeney[a], Kevin R. Gurney[d], Xiaomei Xu[e], John Southon[e], and Pieter P. Tans[a]

Proceedings of the National Academy of Sciences, 2019

agreed to within 1.4%

US landscape

Indianapolis Testbed



Lauvaux et al., *ES&T*, 2020

agreed to within 3%

GHG Information: A Shift in Perspective

To deliver actionable information now to enable, inform, support, track, and verify real emissions mitigation

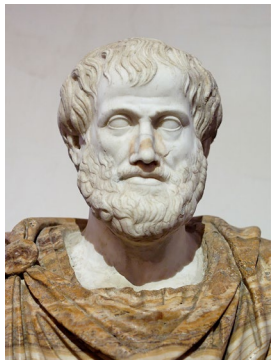
- More remotely-sensed column concentration measurements are necessary but not sufficient
- More ground-based and aircraft concentration measurements are necessary but not sufficient
- More R&D on the carbon cycle or biosphere exchange is necessary but not sufficient

This requires integration of these with new capabilities that single-mindedly focus on what decisionmakers need and for what purpose

……good news:

we have many of these elements and have tested them successfully in prototypes

GHG Information: Opportunity Cost

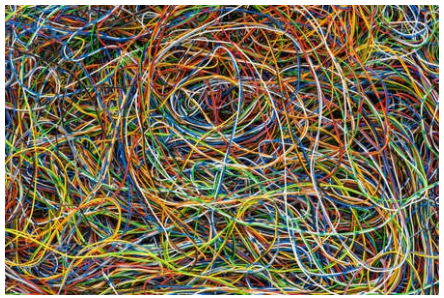


"horror vacui"

If we decide not to take up this wider perspective…….

beyond a missed opportunity, there is an opportunity cost!

NGOs academics private companies city govt activist groups	Measuring planning estimating tracking



no standards, biases, imperfect/incomplete information, misunderstandings, lacking transparency, resource deficits, issues of environmental justice

across scales and decisionmaker groups

Mitigation is not achieved (pledges no action), conflicts, cheating, mitigation investment remains sidelined

Inevitably bad actors enter with financial loss, mistrust, disengagement

GHG Information: recommendations

- Convene key players/institutions:
  - generate situational awareness
  - reduce duplicated effort
  - build a roadmap and strategy towards near-term operationalization
- An operational home – this needs focused leadership
- Serve ALL decisionmakers – we have a stick, but we also have carrots
  (the carrots are what will drive emission reductions)
- Organize (and free up) data within the Federal family (purchase, clearinghouse, across-agency harmonization)
- Promote international cooperation towards Federation (~weather system)
- A few more “full system testbeds” - harden our prototypes

Thank you