Meta-modeling for the Climate TRACE Emissions Inventory

Daniel Moore

WattTime

Nicole Brown, Gary Collins, Zoheyr Doctor, Marisa Hughes, Christy Lewis, Gavin McCormick, April Nellis, Michael Pekala, Krsna Raniga, Elizabeth Reilly, Michael Robinette, Justin Rokisky, Ishan Saraswat, Peter Thomas

IWGGMS-21

Takamatsu, Japan – 11 June 2025

Comprehensive Emissions Tracking

662,637,077 emitting assets
aggregated by city, state, country, etc.

10 sectors
67 sub-sectors

10+ years (2015-2025)
monthly data 2021 onwards

3 GHGs
8 non-GHG pollutants

Built by a global,
not-for-profit coalition
of over 100 universities, scientists,
and AI experts

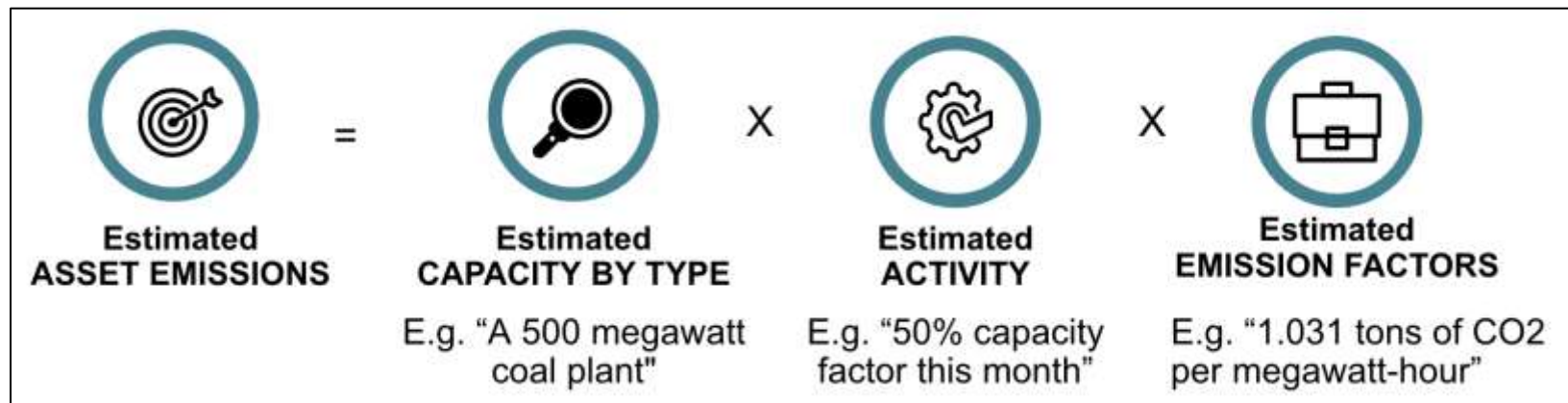→ Explore Map   → Access Open Data

Global inventory of individual emitting sources

- Allows for inventories for cities, states, countries, ownership, arbitrary **grids**

- Monthly release
  - 60-day latency

- Freely accessible

Examining the components of emissions

Estimated ASSET EMISSIONS = **Estimated CAPACITY BY TYPE** X **Estimated ACTIVITY** X **Estimated EMISSION FACTORS**

E.g. "A 500 megawatt coal plant"

E.g. "50% capacity factor this month"

E.g. "1.031 tons of CO_2 per megawatt-hour"

Each of these can individually measured/constrained (e.g. through satellites)…
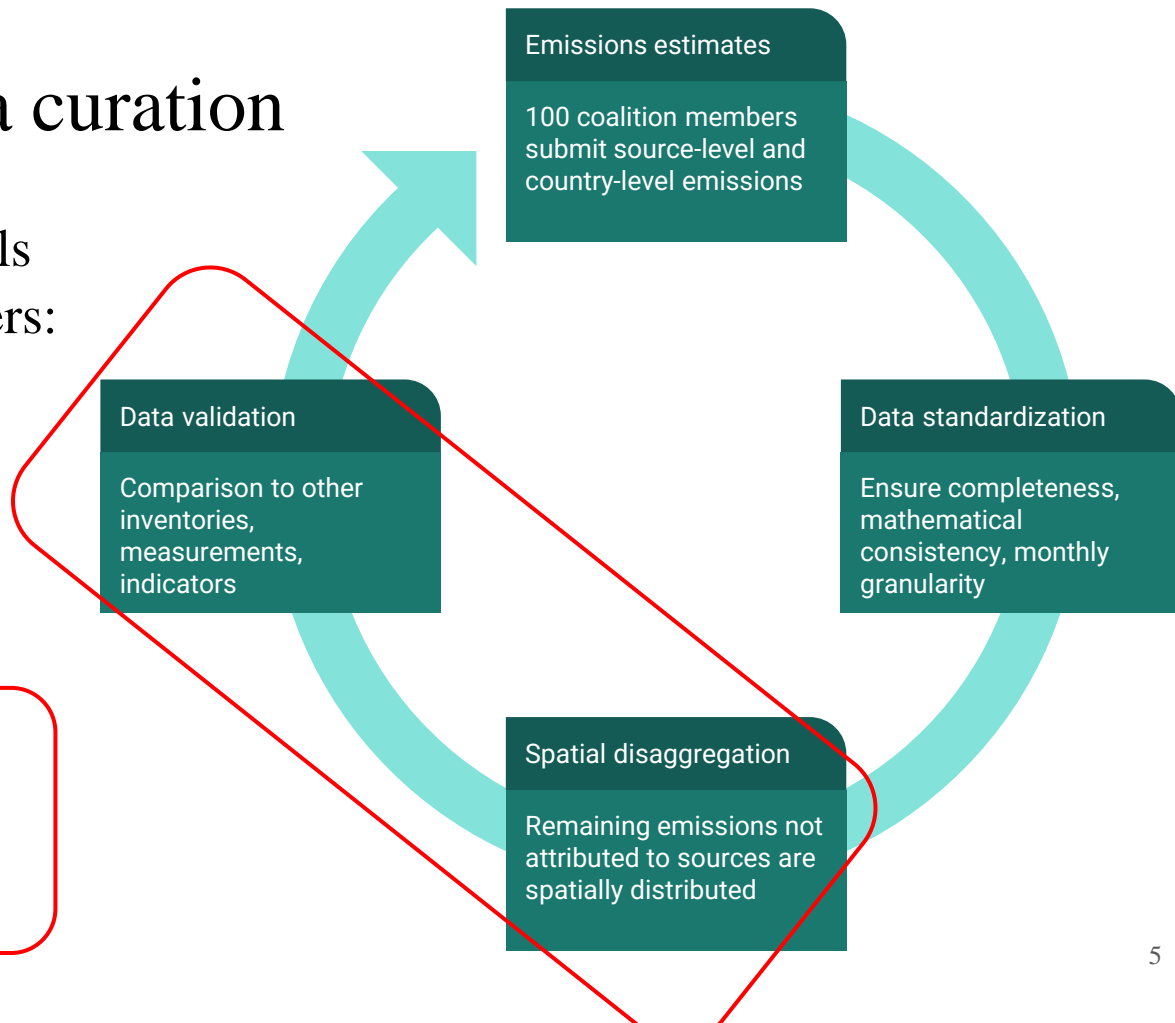
… allowing for cross-validation

Climate TRACE data curation

- Subsector-specific models used by coalition members:

Methodologies ➡

- Data specifications:
  - Monthly granularity
  - Source-level estimates
  - Complete timeseries'
  - Consistent metadata
  - Increasingly accurate estimates

Emissions estimates

100 coalition members submit source-level and country-level emissions

Data standardization

Ensure completeness, mathematical consistency, monthly granularity

Spatial disaggregation

Remaining emissions not attributed to sources are spatially distributed

Data validation

Comparison to other inventories, measurements, indicators

Climate TRACE data curation

- Subsector-specific models used by coalition members:

Me...

"Meta-modeling" (data-fusion): Incorporation of multiple data sources, including models, measurements, and related processes, to **validate** and/or **create best-possible estimates** of emissions and emissions-related activity.

- ...

  - Source-level estimates
  - Complete timeseries'
  - Consistent metadata
  - Increasingly accurate estimates

Emissions estimates

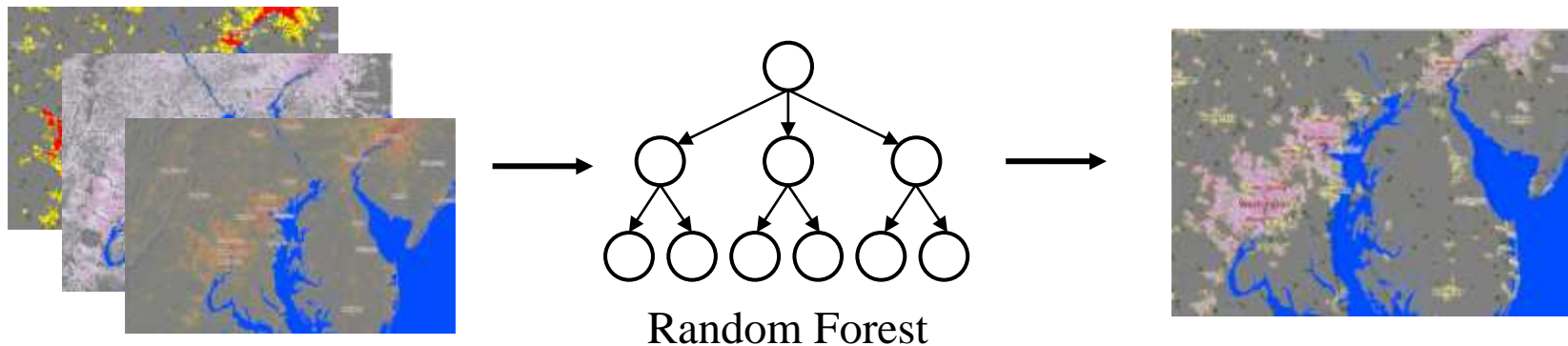100 coalition members submit source-level and country-level emissions

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Spatial disaggregation

Remaining emissions not attributed to sources are spatially distributed

6

Increased accuracy of spatial disaggregation of emissions

Random Forest

Collins, et al. AGU 2024
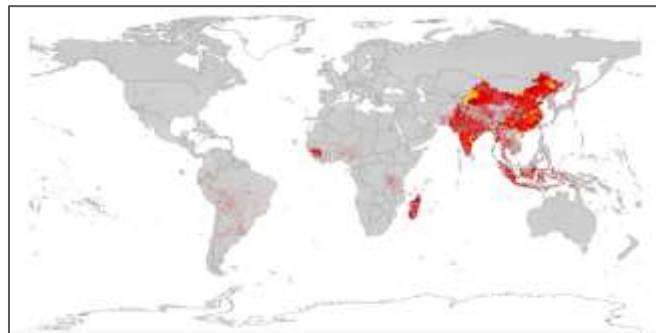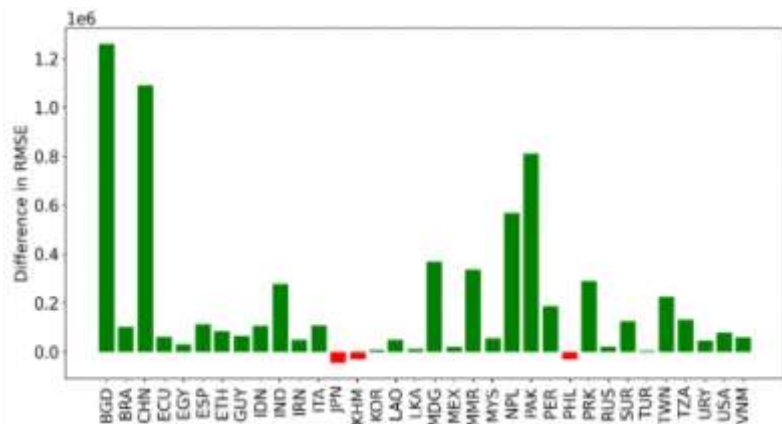
Incorporating satellite measurements to improve estimates

Bayesian framework to produce posterior distributions of emissions rates from individual sources or a collection of sources directly using measurements

Credit: Zoheyr Doctor
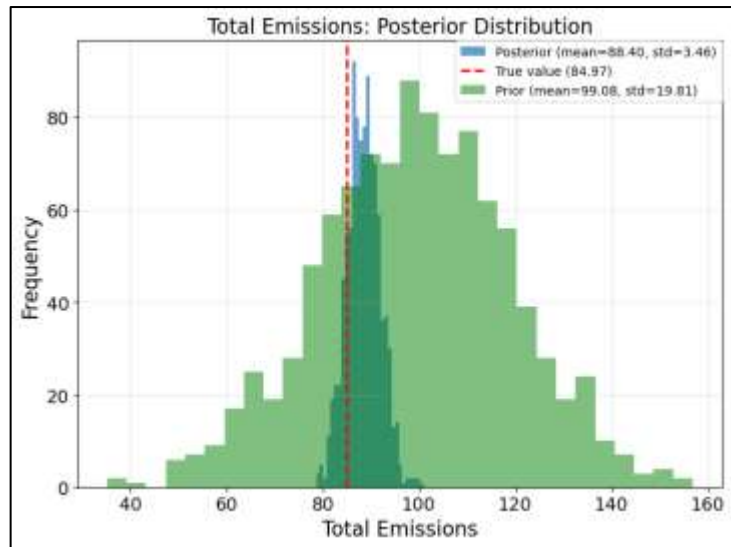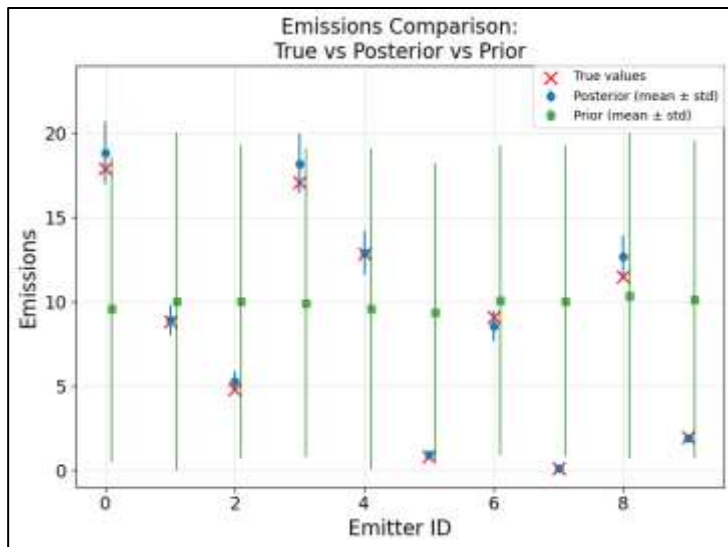
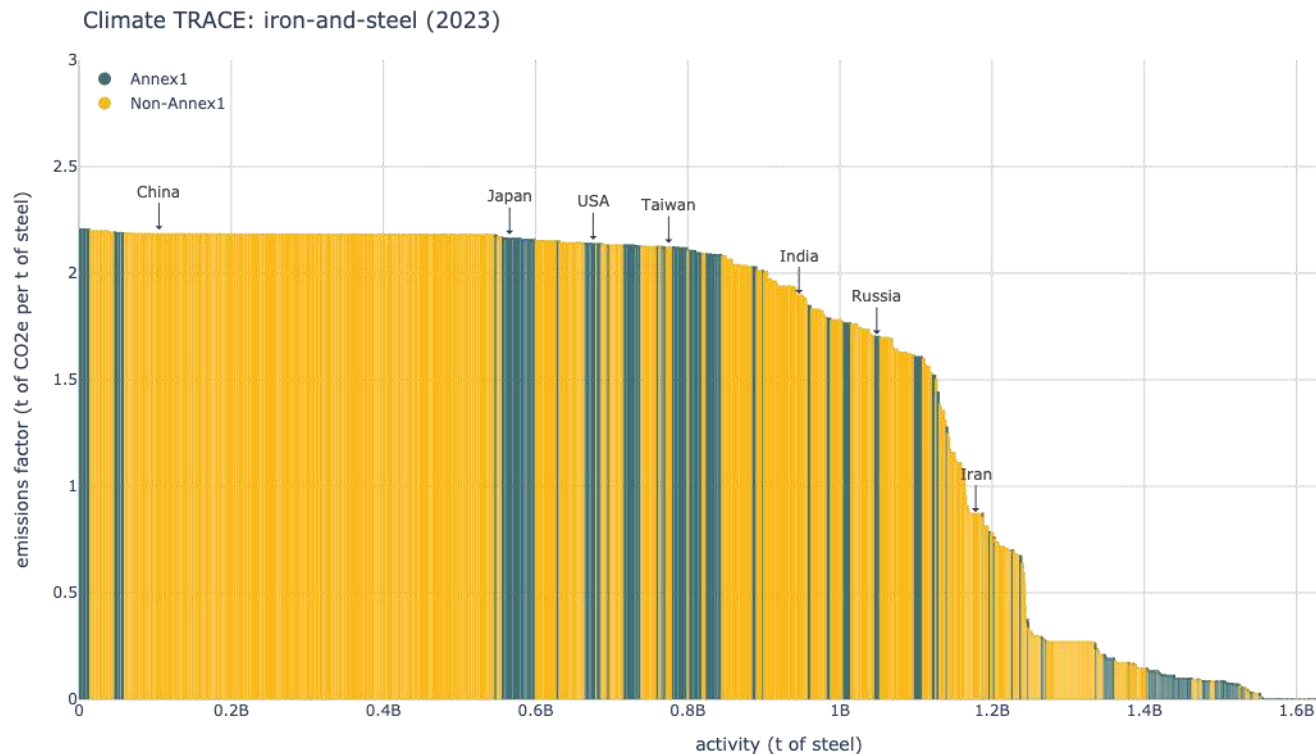# Emissions data to drive impactful decisions: case study of iron and steel production

different production technologies

↓

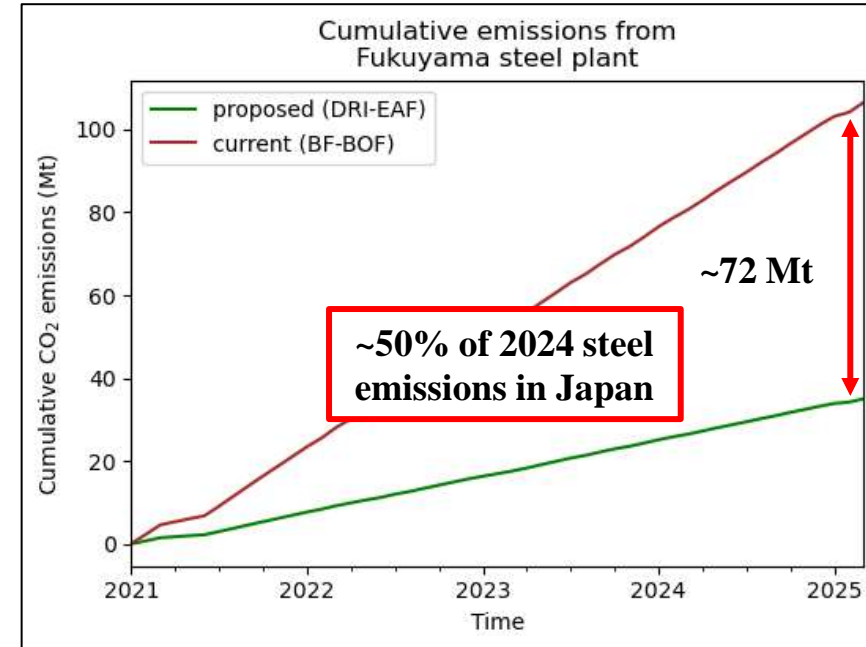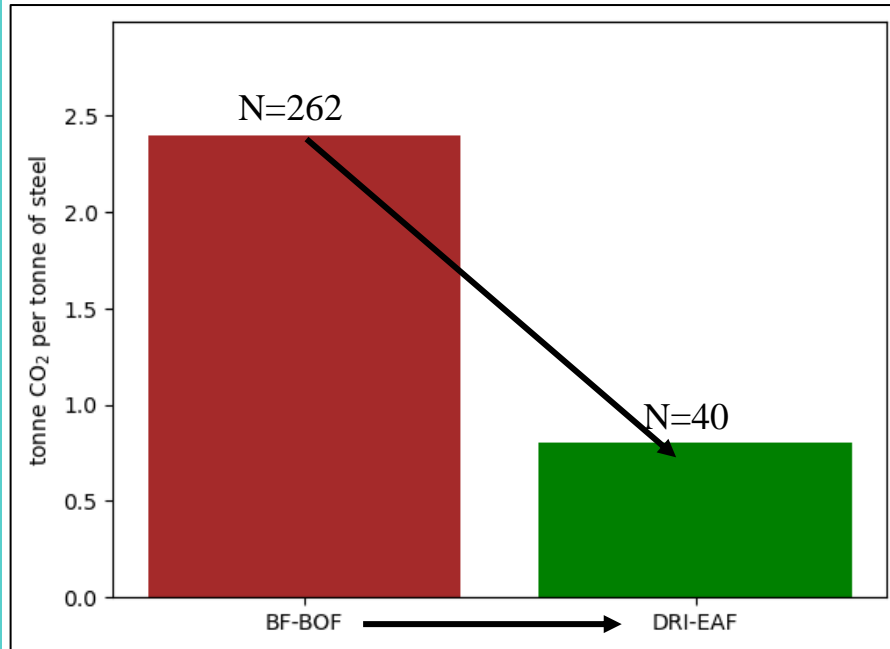wide variability in emissions per iron produced

↓

opportunity to decrease emissions

Climate TRACE: iron-and-steel (2023)

● Annex1
● Non-Annex1

Credit: Ting So

Emissions reducing solutions in steel production

BF-BOF: Blast furnace - basic oxygen furnace
DRI-EAF: Direct reduced iron – **electric** arc furnace

ClimateTRACE.org

Thank you!

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