

Historic Data For Anthropogenic Emissions

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Historical Emissions for CMIP6

The quality of emissions data needed for model simulations depends on the goal

- Are MIPs idealized exercises to compare models?
 - If so, then any “reasonable” emissions can be used for the models since the key goal is to have the same inputs for all models
- However, if the model results are meant to be compared to observations, then emissions should:
 - Be a “best estimate” of actual emissions, 2) have consistent trends over time
 - Contain uncertainty estimates
- If meant to be have policy relevance for atmospheric chemistry & air quality
 - Then emissions should be based on country inventory data where those are judged by the scientific community to be adequate

This can be done, but it requires a dedicated effort.

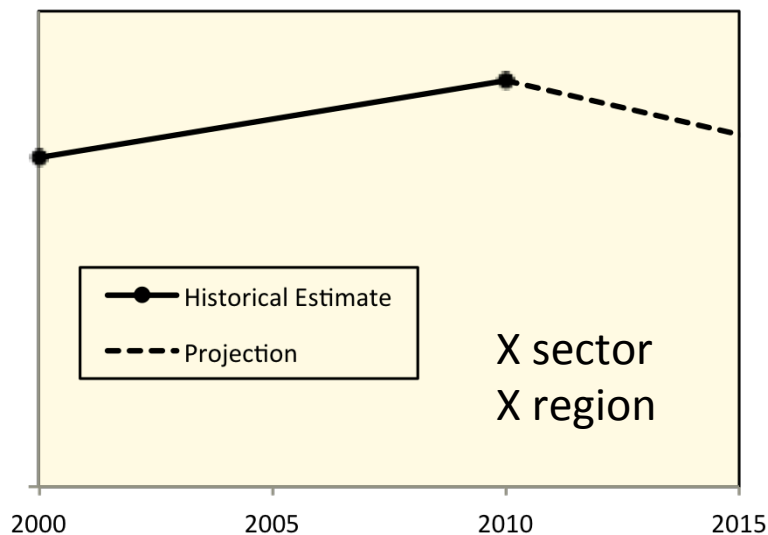
- For CMIP5, we got lucky.
- By coincidence, several individuals were able to devote quite a lot of time, building off of current projects, to put together a historical dataset.

A Solution: Proposed Community Emissions Data System

Timely estimates for emissions of aerosol (BC, OC) and aerosol precursor compounds (SO_2 , NO_x , NH_3 , CH_4 , CO , NMVOC) are key inputs for aerosol research and Earth System Models

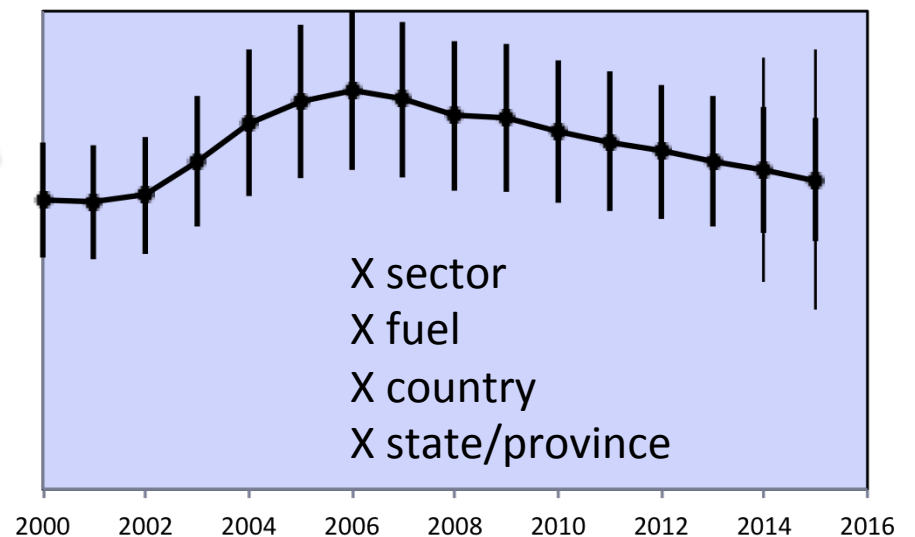
Needed for historical and future simulations, validation/comparisons with observations, historical attribution, uncertainty quantification, IAM calibration and validation, and economic/policy analysis.

Instead of this



Produced using an open-source data system to increase data transparency and facilitate research advancements.

Produce



Uncertainty essential if extended to more recent years.

CEDS Introduction

Have proposed the development of an open-source Community Emissions Data System

- Annual estimates of all chemically reactive species and CO₂ over the entire industrial era (as reference). Updated every year.
- Emissions estimated at level of country, sector/sub-sector, and fuel.
 - Have proposed greater spatial detail (state/province) for large countries
- **Uncertainty estimated** at the same level (Country, fuel, sector)
- Seasonal cycle (monthly)
- Aggregate NMVOCs by sector/sub-sector
- Annual updates up to latest full calendar year.
- Gridded emissions (0.1°) w/ sub-national resolution for large countries

Goals

- Consistent extrapolation over time (prevent spurious discontinuities)
- Community data review: aggregate (country, sector, ...) & gridded
- Facilitate cross-country comparison (EF consistency, trends)
- Transparent emission results (assumptions -> emissions)

Interim CEDS Emissions Dataset for CMIP6

Because of CMIP6 timeline, the new CEDS historical dataset that contains the improvements requested by the community cannot be produced in time for CMIP5 model runs starting in 2015

The proposed solution is to produce an interim emissions data product that updates the current historical dataset in time for CMIP6. This approach:

- Provides recent emissions that are consistent with most recent data
- Can be done relatively quickly (by fall 2015), and vetted by community
- However, does not contain all the improvements needed by the community (see later)

The full historical CEDS data product would then be produced

- For use in analysis that requires more detailed data
 - If produced ~2016, could be used for AerChemMIP, decadal prediction
 - Future research

Overview: Interim CEDS CMIP6 Dataset

- Use RCP historical anthropogenic and land-use (fire) emissions (Lamarque et al. 2010) from 1850-1990
 - Would still be using 0.5°C grids
 - Downscale to 0.1° using HTAP V2 sub-grid distribution
- Extend to more recent years using:
 - Country + regional inventory data w/ EDGAR 4.3 for other countries (as in Lamarque et al. 2010 and HTAP)
 - Aggregate to RCP 40-region breakout (e.g., static spatial grids f/ region)
 - Adjust trends to match RCP history in 1990 where needed
 - *The need for this will, hopefully, be small*
 - Could consider providing grids at 5-year intervals starting in 1995

Most of the work required for the interim product, is also needed for the full CEDS dataset

Details - Interim CMIP6 Emissions Dataset

- Provide emissions at the sector level as in RCP
 - Needed for IAM calibration and harmonization
- Collect emissions by sector (as also needed by full CEDS)
 - Allows more robust data checking and trend extrapolation
- Extended to 2014 using reported fossil fuel drivers
 - Detailed IEA data to about 2012; less detailed BP data to 2014
 - Non-fossil emissions would likely be held constant after last inventory year

Provides a robust dataset (trends will be similar to full CEDS version)

Features, not in the interim product, that will be available in the full CEDS data product

- **Uncertainty** by emission and sector -> historical emissions ensembles
- Consistent historical trends
- Seasonality in anthropogenic emissions
- Consistent CO₂ emissions
- Annual emissions by country (& state)
- Additional sectoral detail

Interim CMIP6 Data: Timeline

Can use current pre-industrial emissions: same 1850 starting point

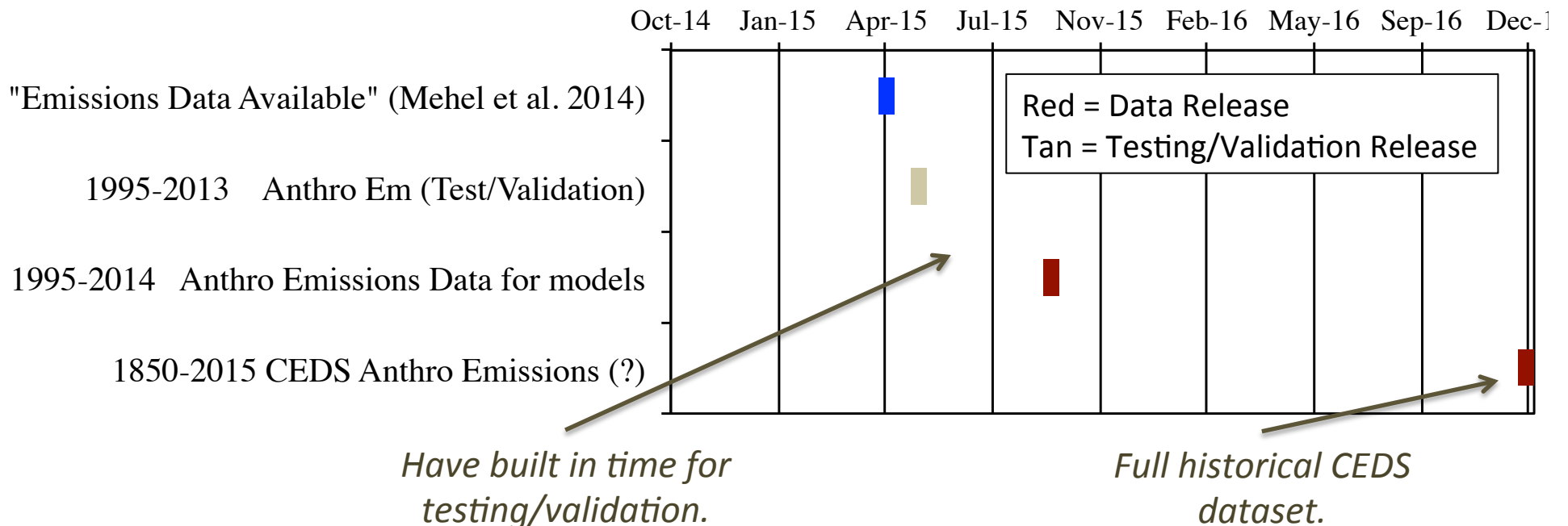
- Would need to downscale current 1850-1990 emissions data to 0.1°

Test dataset (gridded and region/sector) available for review, Spring 2015.

- Estimates out to 2013 in review release
- Updated to 2014 by early fall 2015 for final release

Final dataset, published and available to models Fall 2015

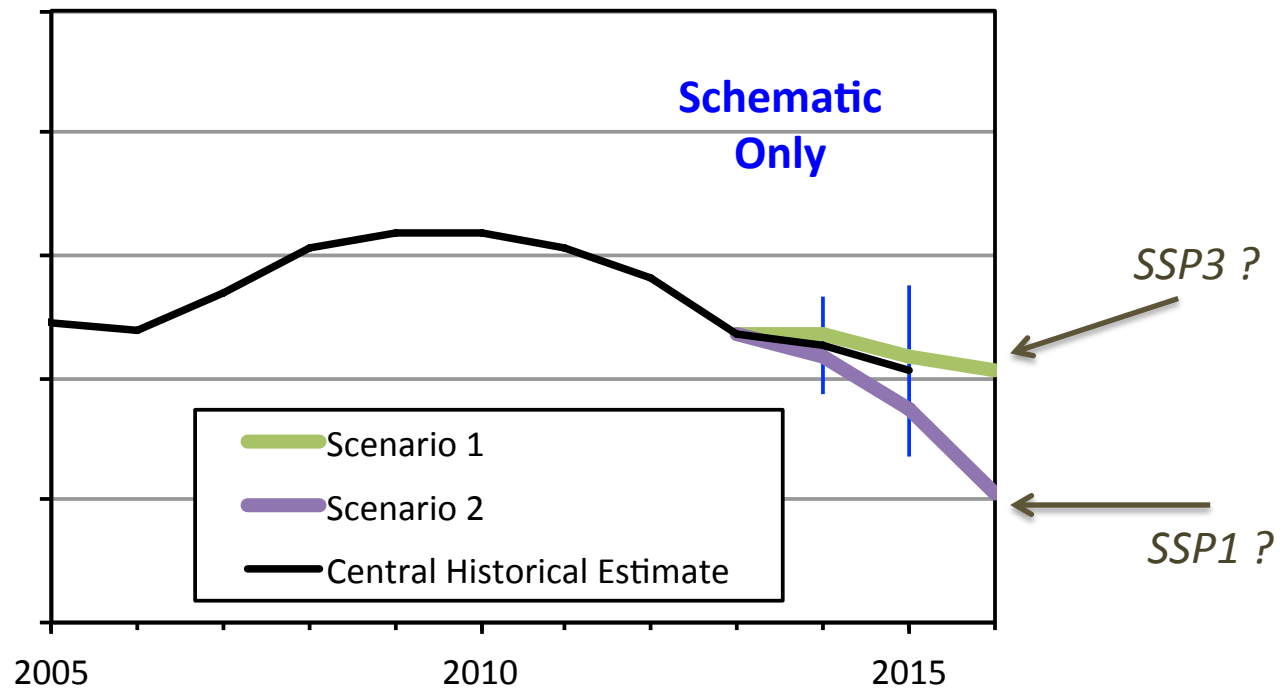
CMIP6 Plan "C" Deliverable Timeline



CMIP6 Harmonization Questions

While there is a desire to have historical emissions up to the most recent year possible, pollutant emissions are not necessarily known. Providing one estimate over-states emissions certainty. One possibility:

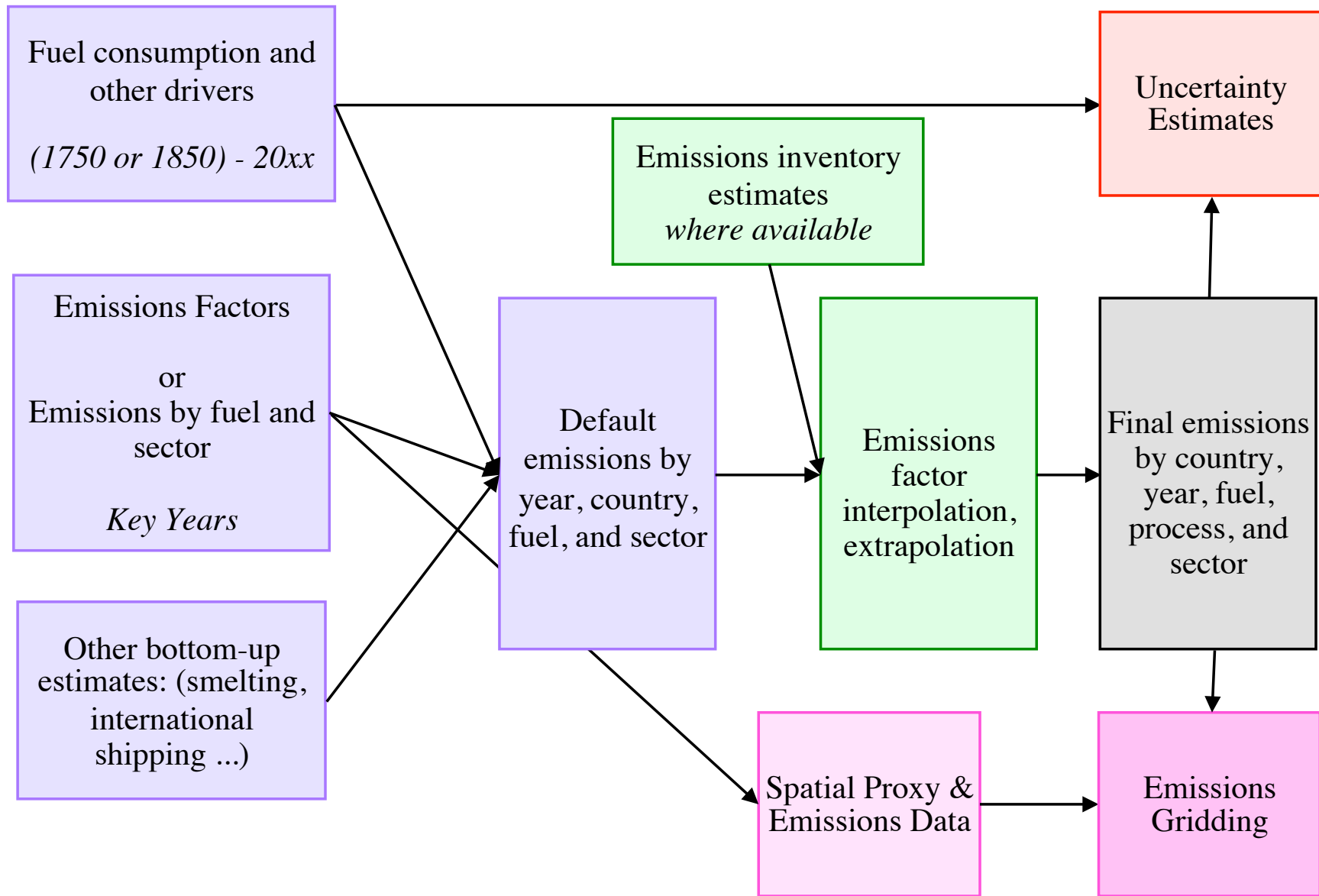
Emissions



- Central estimate provided up to where emissions are relatively certain.
- Allow divergence, in future IAM projections
- Common GHG concentrations consistent with observations to the latest year possible (2013/2014?)

ADDITIONAL SLIDES

System Diagram



Uncertainty Estimates

Overall Approach

All bottom-up emission uncertainty estimates contain a substantial element of expert judgment

- Guide assumptions with literature & comparisons between inventories
- Reduce dimensionality by a “tiered” approach to group assumptions
Otherwise: ~10 sectors X 200+ countries X 5 fuels X ~10 emissions
- Consider correlations across sectors and countries
- Result: consistent uncertainty across emissions and regions

Uncertainty For Most Recent Years

It is critical that emissions for recent years are coupled with uncertainty estimates

- The additional uncertainty in the most recent years can be rigorously assessed by applying the extension methodologies to past data
Although “past uncertainty does not guarantee future uncertainty”

Issues: Producing a community inventory

- Discrepancies w/ different versions of country inventories (e.g. Janssens-Maenhout, EDGAR-HTAP 2013)
 - Can document these issues as part of data system
 - How can we use this open data system to either resolve these discrepancies or at least highlight areas that need further investigation?
 - Need to engage country-level agencies and experts
- Reconciling different research estimates (& with country estimates)
 - Process for deciding on default values when estimates disagree?
 - Will help that uncertainty is also estimated (> disagreement = > uncertainty)
- Make sure contributions are recognized!
 - This will build on, and use data from, existing more detailed efforts (GAINS, EDGAR, CDIAC, REAS, country-level inventories, Bond et al.).
 - Paper co-authorship, publishing strategy (separate papers), branding, require uses to separately obtain specific data.
- Develop process for community review
 - Both for initial data products and on-going improvements.

Issues II

- Emissions gridding
 - Many gridding processes rely on proprietary data that cannot be released and that would be difficult for users to obtain.
 - Goal is for the community data system would produce gridded data
 - Produce only on basis of broad sectoral grids? (e.g. RCP sectors)
 - Globally consistent proxies (e.g., EDGAR) or use regionally detailed data (e.g. most recent HTAP)
- NMVOC speciation
 - Are there specific sectors that should be explicitly detailed in order to facilitate NMVOC speciation?
 - Perhaps the greater sectoral detail of EDGAR can be used where needed for sub-sector speciation detail?
- Special sectors/sub-sectors
 - Updates to shipping and aircraft emissions? Bricks? Others?
- Coordination with Open burning emissions
 - Temporal resolution (annual?). Speciation? Other?