GCOS Joint Panels Meeting

GLOBAL CLIMATE OBSERVING SYSTEM

KEEPING WATCH OVER OUR CLIMATE

Observations for National Emission Inventories

Simon Eggleston

GLOBAL CLIMATE OBSERVING SYSTEM
KEEPING WATCH OVER OUR CLIMATE

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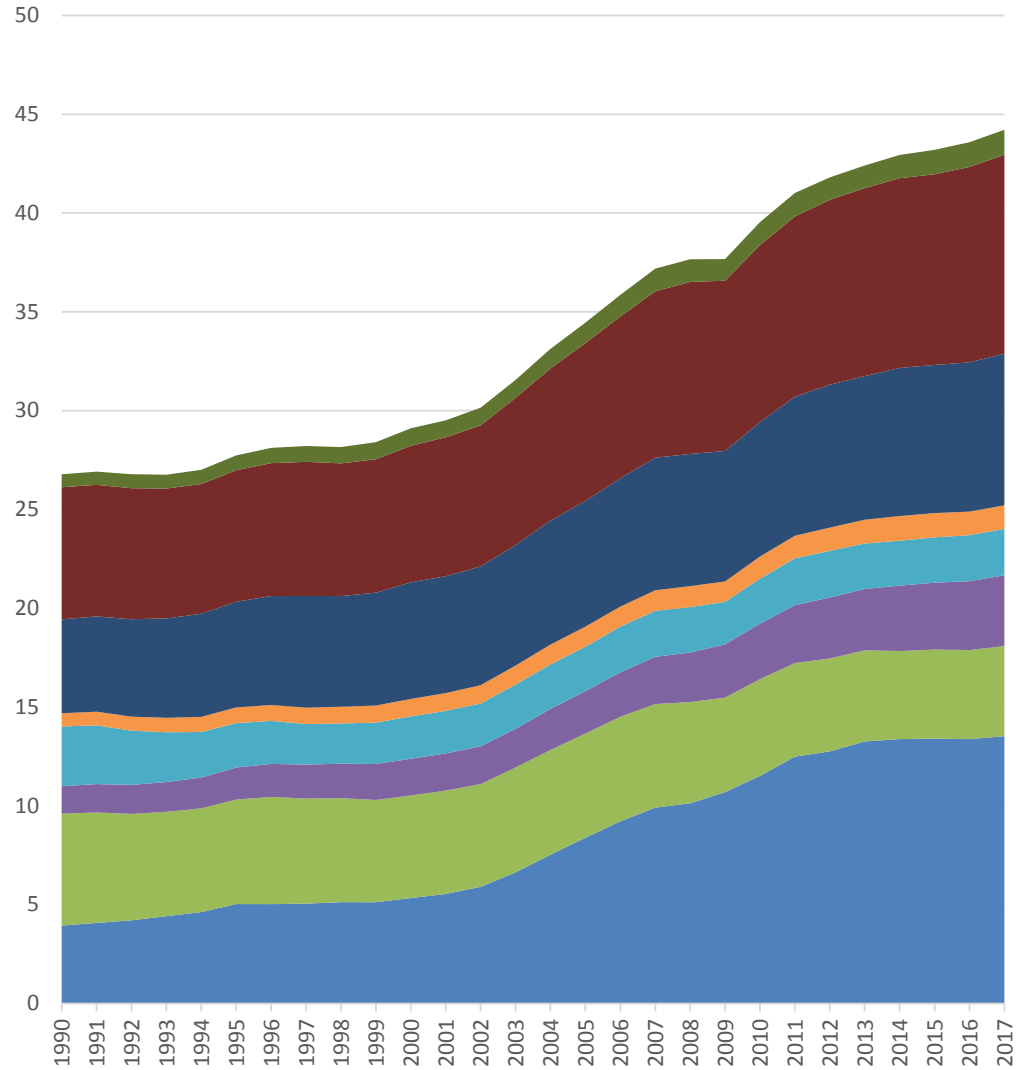
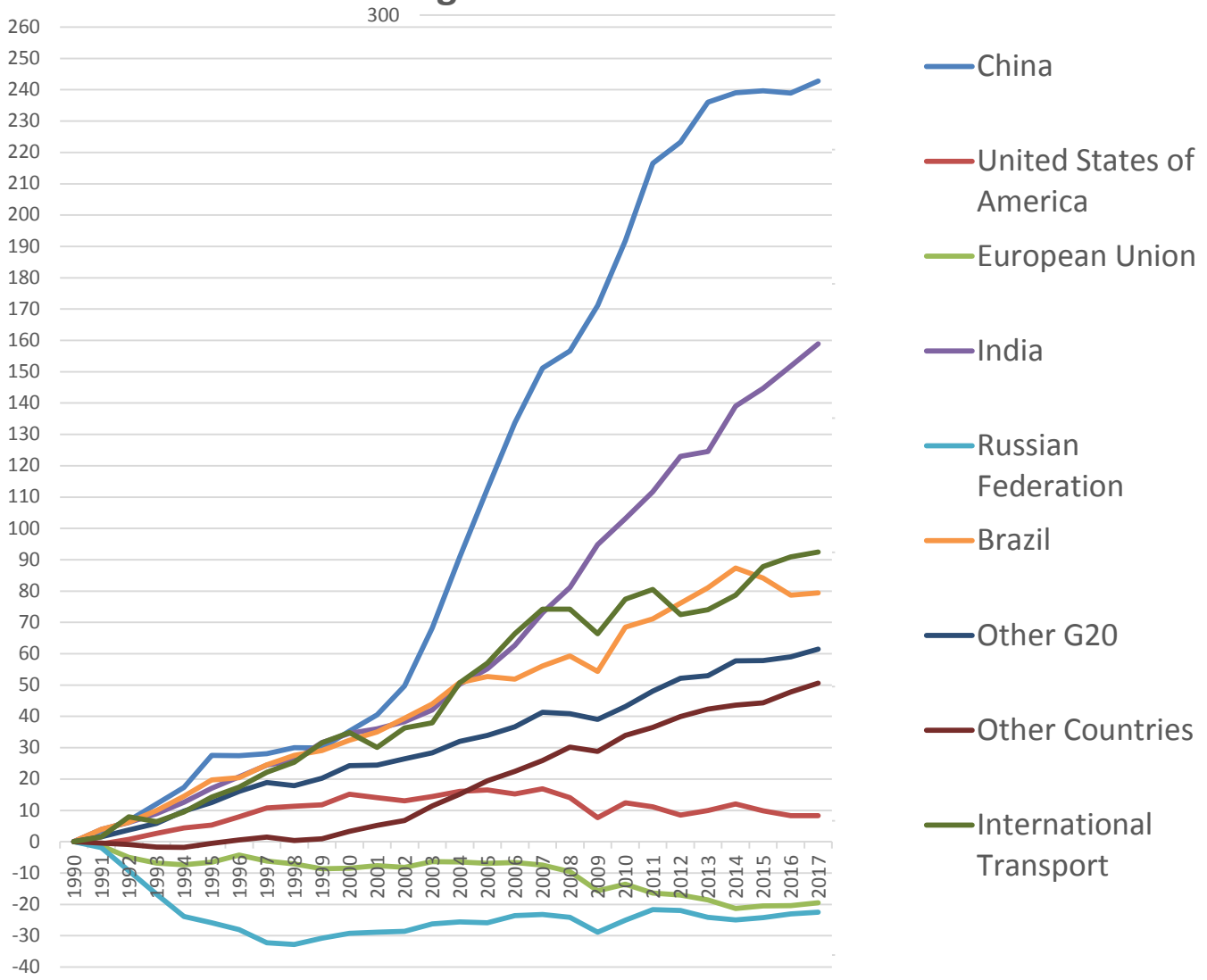
Global GHG Emissions (excluding LULUCF)

Global GHG Emissions



Emissions changes since 1990



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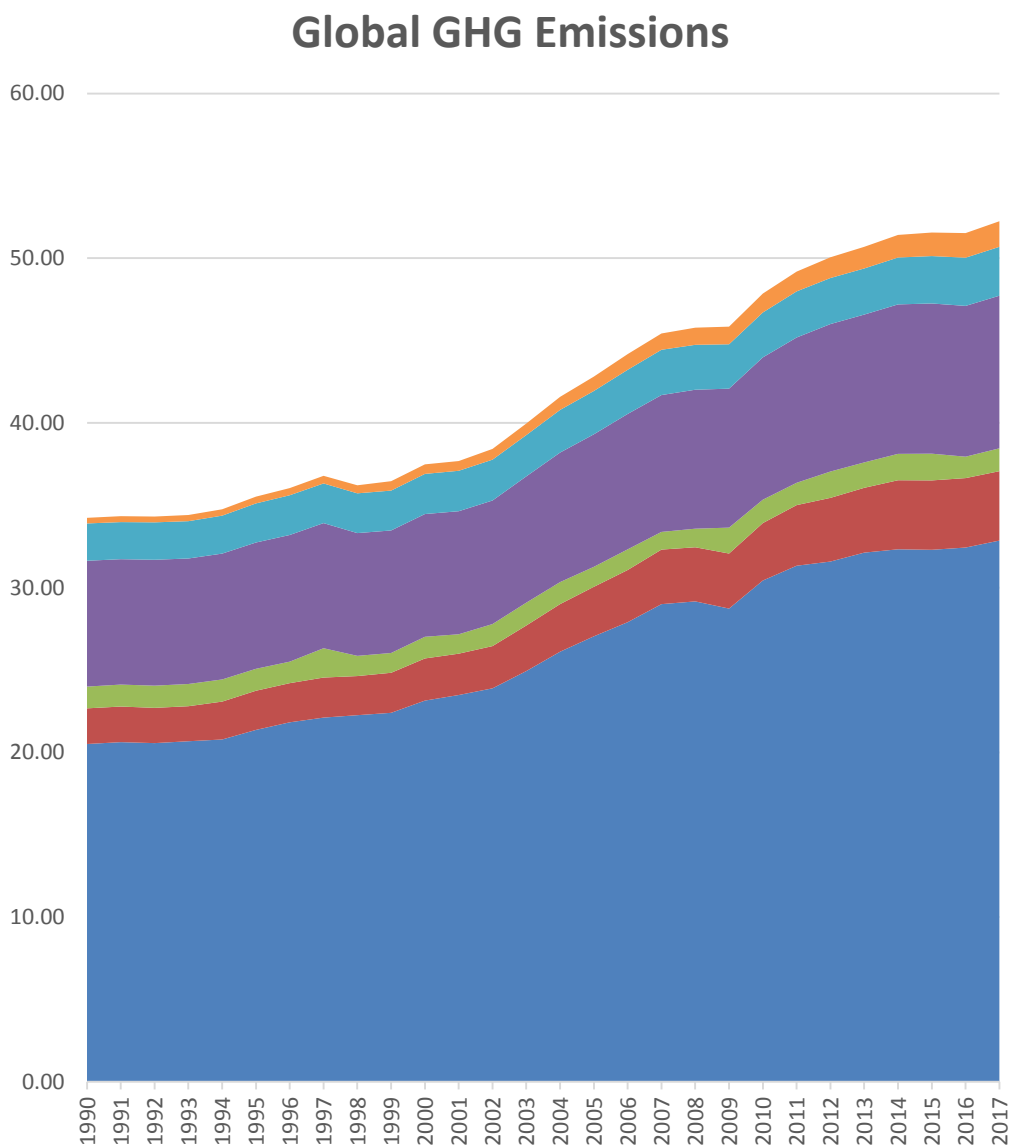
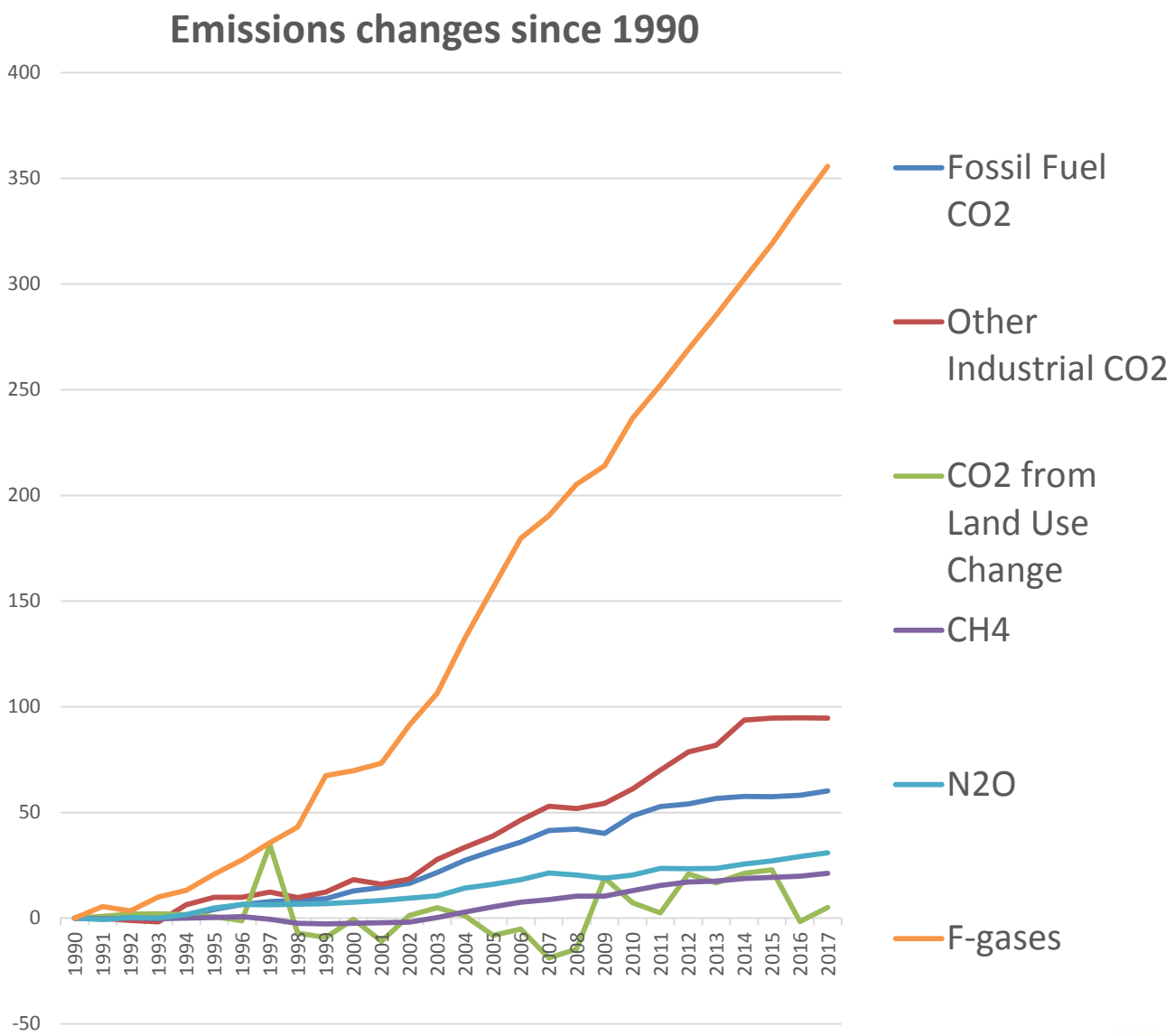
EDGAR EMISSION DATABASE FOR GLOBAL ATMOSPHERIC RESEARCH

Global GHG Emissions by Gas





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EDGAR EMISSION DATABASE FOR GLOBAL ATMOSPHERIC RESEARCH

GLOBAL CARBON PROJECT

National Inventory Guidelines

1995 Guidelines for National GHG Inventories

1995 Revised Guidelines for National GHG Inventories

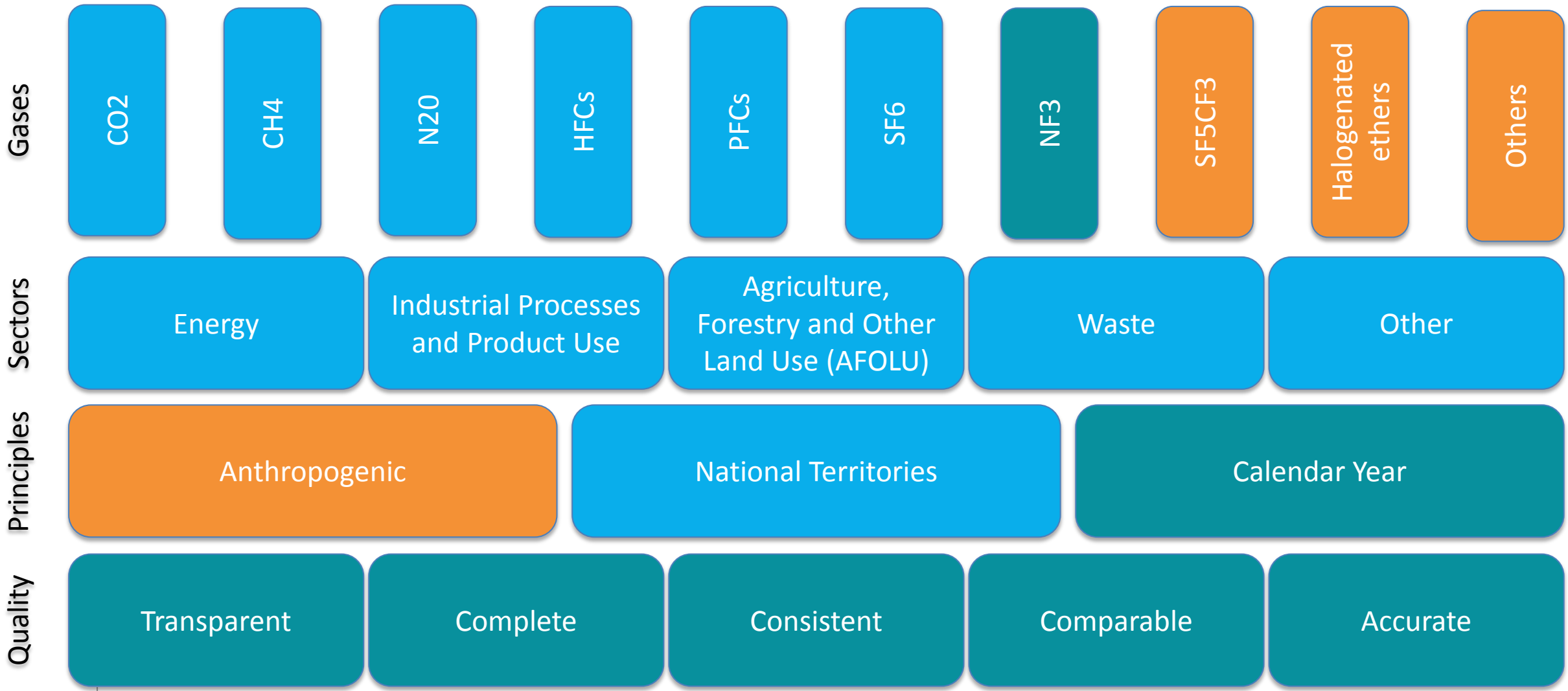
2000 Good Practice Guidance (GPG)

2003 GPG for Land-use, Land Use Change and Forestry (LULUCF)

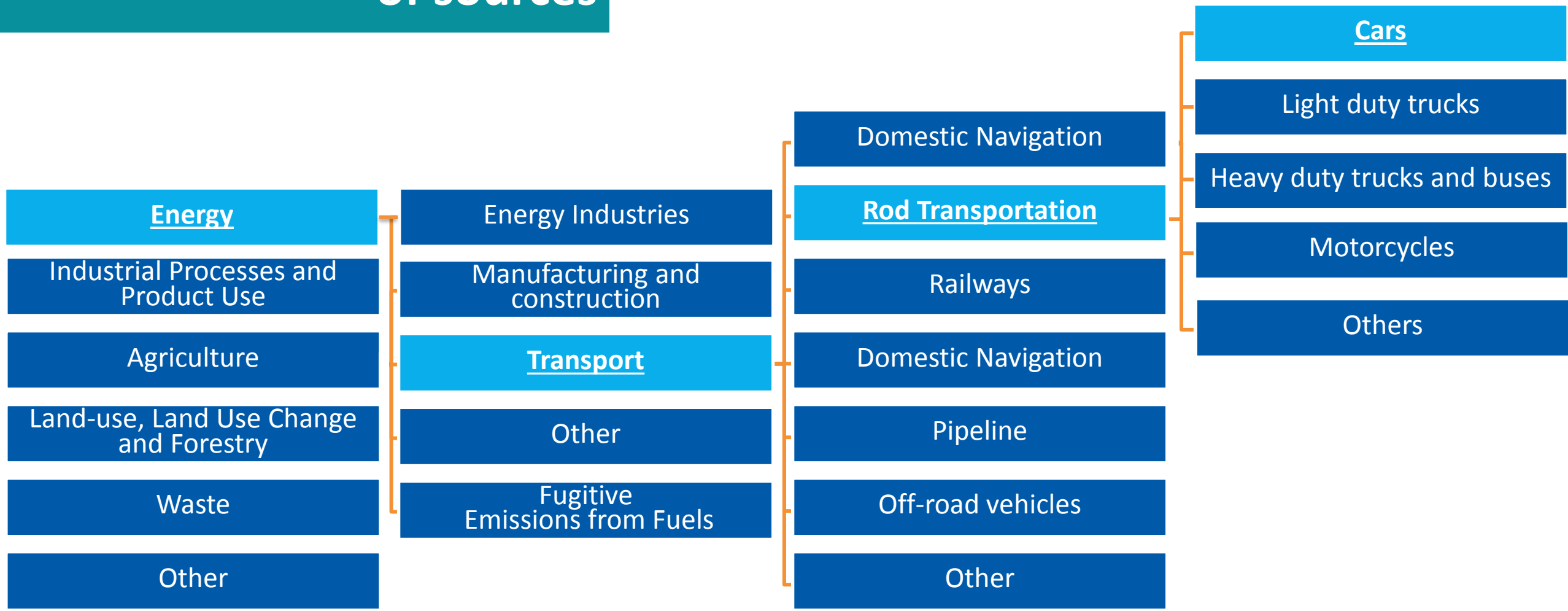
2006 Guidelines

- Developed since 1995
- 2006 Guidelines approved by UNFCCC and used in 2015
- 2015 Supplements on Wetlands and Kyoto Protocol
- 2019 Refinement to be approved by IPCC

National GHG Emission Inventories



Emissions are estimated from a detailed breakdown of sources



Emission Inventories

- Are national estimates
  - Do not provide more detailed geographical distribution of emissions
- Are calendar year estimates
  - No temporal variation within a year
  - Estimates for the year during which the emissions/removals occur.
  - For LULUCF average growth and decay rates are usually used
- Anthropogenic Emissions
  - The distinction between natural and anthropogenic emissions and removals follows straightforwardly from the data used to quantify human activity.
  - For AFOLU, emissions and removals on managed land are taken as a proxy for anthropogenic emissions and removals, and interannual variations in natural background emissions and removals, though these can be significant, are assumed to average out over time.
  - Note: this is anthropogenic NOT biogenic!
  - Countries report and account for emissions they can control

Ensuring Inventory Quality

- Follow IPCC (methods) and UNFCCC (reporting) guidelines
- UNFCCC Review Process
- National System
  - Responsibilities, MoU, agreements, plans, data checks, archiving, review…
- QA/QC Plan
- Identify main contributors to national total emissions
  - usually 10-15 sectors contribute 95% of the total
  - use county-specific factors (Tier 2 or 3)
  - Key category analysis
- Uncertainty Estimation – identify main sources of uncertainty
- Inventory Improvement Plan
- Emission Factor measurement programmes

Methods

$$Emission = (Emission\ Factor) * (Activity\ Data)$$

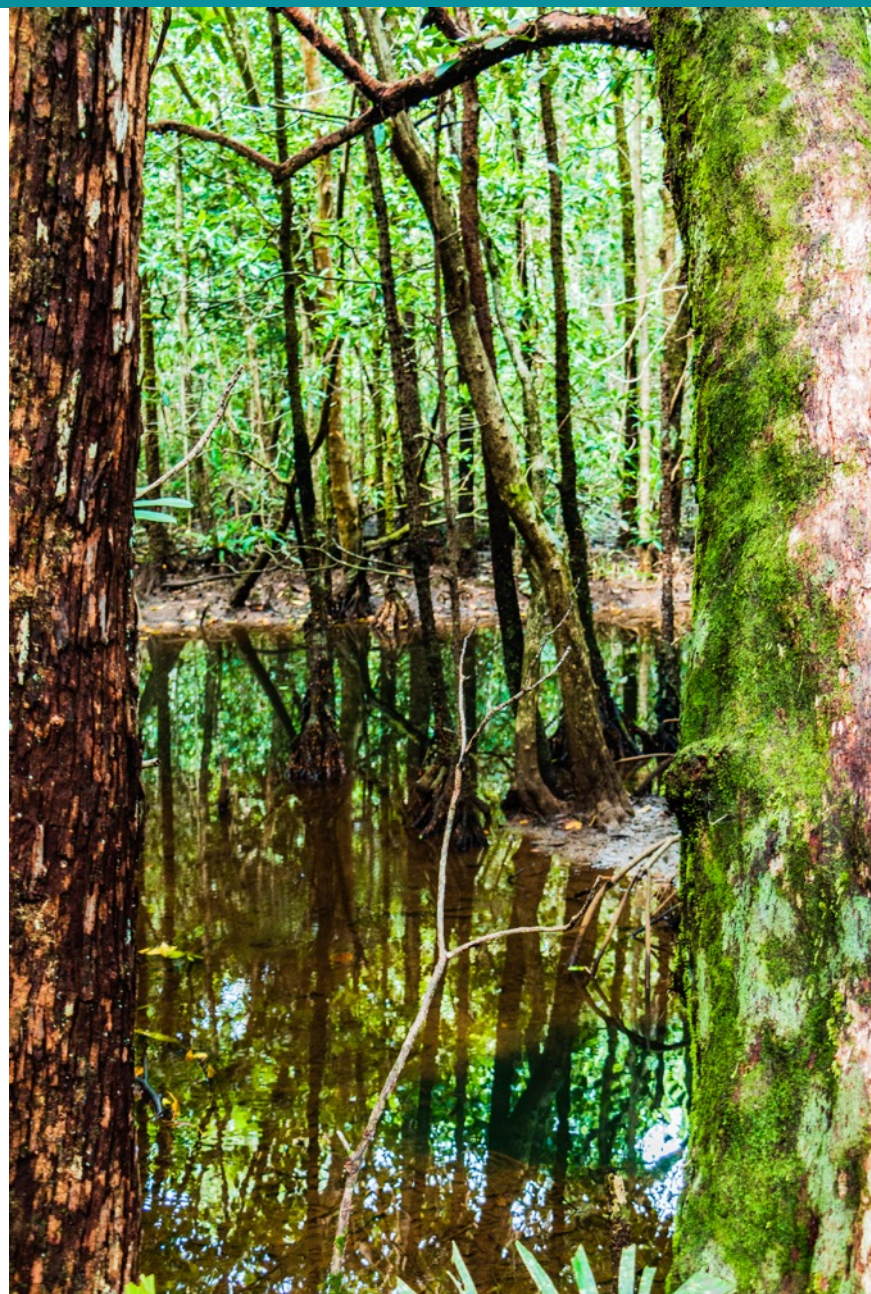
- Activity Data – information linked to emission/removal activity
  - E.g. Fuel consumption, Number of cows, Amount of waste
- Emission Factor – number relating activity data to emission
  - Carbon Content of fuel
    - Emission of CO2 = (mass of fuel) * carbon * 44/12
  - Measured methane per cow for each type of management/food
  - Methane per unit waste (varies according to putrescible content)
- Many methods more complex and involve more parameters
- IPCC provides methods of differing complexity:
  - Tier 1 – simplest methods suitable for smaller sources
  - Tier 2 – methods requiring country-specific factors, 95% of emissions
  - Tier 3 – more complex country-specific methods, usually models

Activity Data

- Much of the data comes from statistical agencies, e.g.:
  - Fuel is taxed and well measured
  - Improving statistics improve governance as well
  - Data on populations
- Survey and Census data important, e.g.:
  - Livestock census
  - Automatic and manual traffic counts
  - Fertiliser types and use
- May need to establish new data collection activities
  - These often have multiple uses in governments
- Must collect uncertainty information as well
- International databases either for checking or as a last resort

AFOLU/LULUCF Land Categorisation

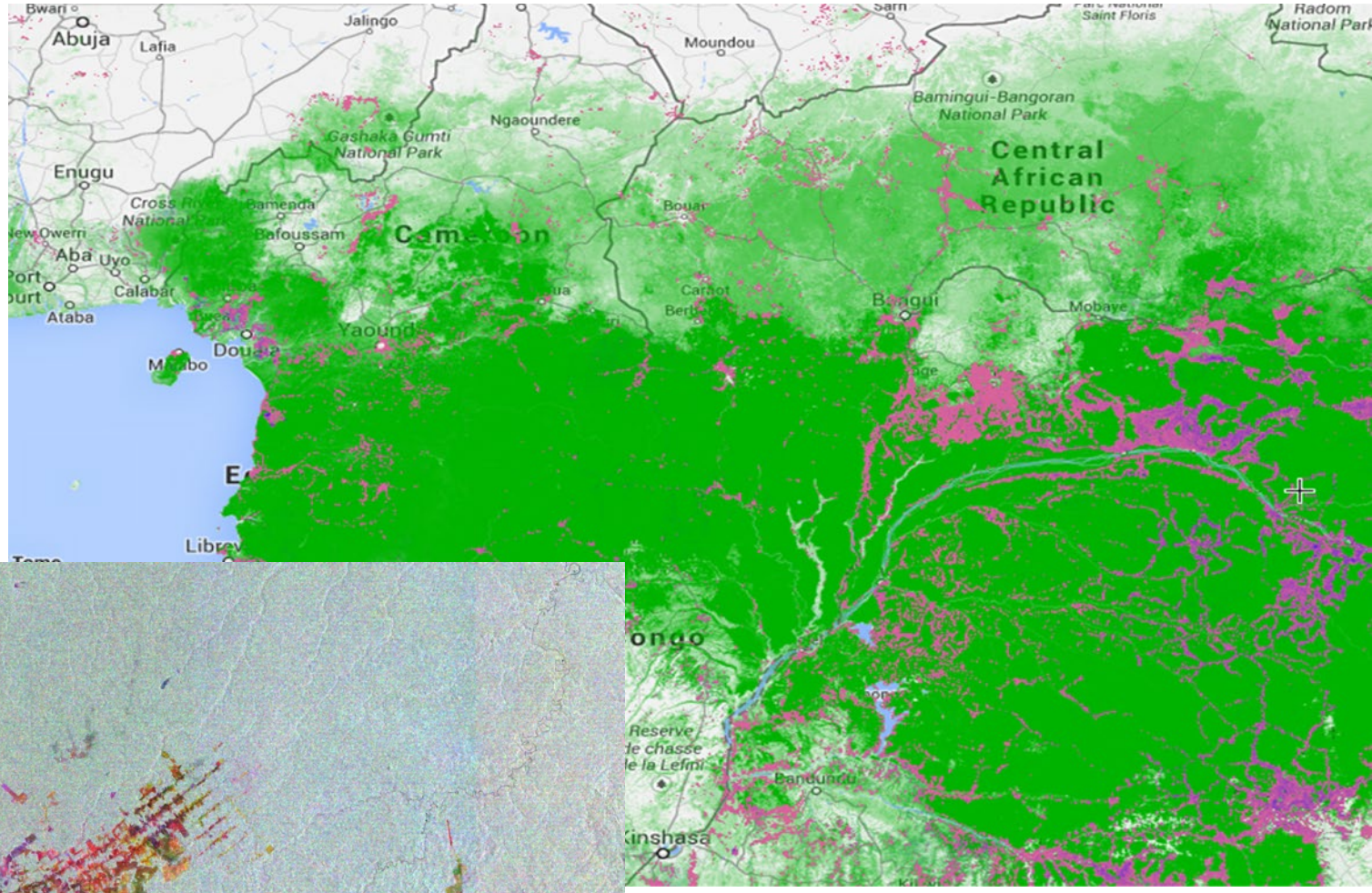
- A mix of land cover and land use
- IPCC Guidelines
  - all land is allocated to one of 6 categories:
    - Forest land
    - Cropland
    - Grassland
    - Wetlands
    - Settlements
    - Other Land
  - These should be subdivided as needed (e.g. broadleaf, conifers, and plantations)
  - Harvested Wood Products (HWP)

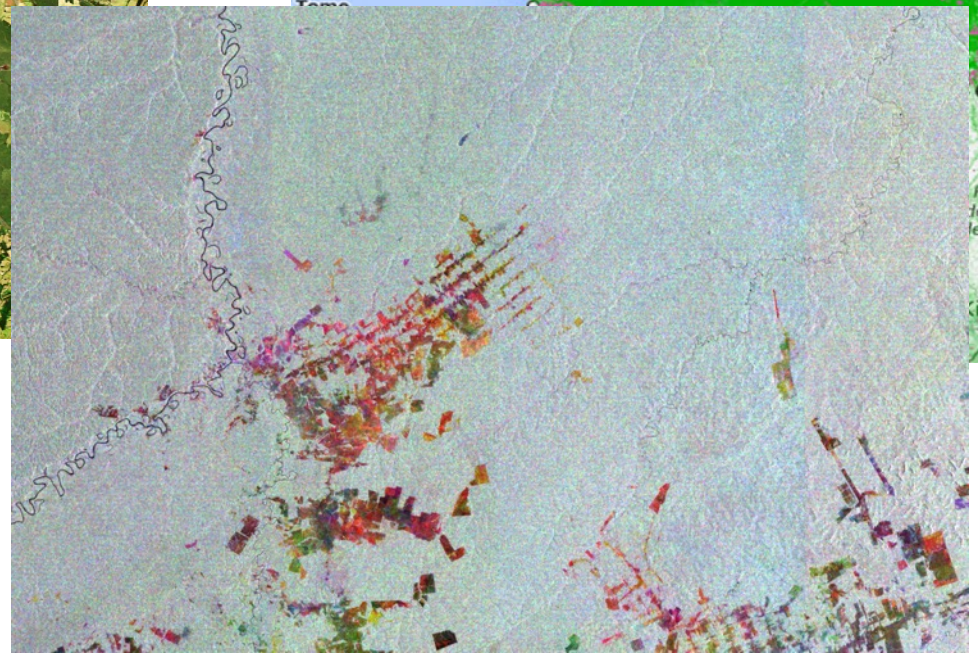


Land Use, Land-use change and Forestry

- Emissions/removals assumed to be caused by changes to land cover/use. Therefore need to track land changes
- Need to allocate land to categories at beginning and end of period (usually a year)
  - Best to keep track of which land undergoes which transition (approach 3 – spatially explicit)
  - Some carbon is lost immediately – e.g. wood removal and fires
  - Some stocks change over a number of years (e.g. 20 years) – e.g. regrowth, soil stock changes
  - Assumed carbon stocks for many different sub-types of land categories and carbon pools are given in the IPCC Guidelines
- Satellites can be used but some changes difficult to monitor
  - E.g. forest degradation

Satellite monitoring of forests





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Emission Factors

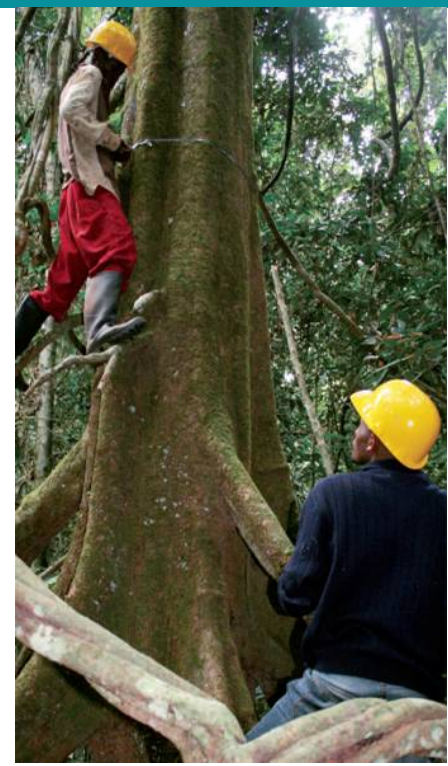
- IPCC provides default values for all Emission Factors for Tier 1
- For main sources of emissions, amounting to 95% of total (tier 2 or 3)
  - Need country specific factors
  - Best measured in country (e.g. fuel carbon, stack measurements)
  - Measurement programmes to estimate factors that can then be used more widely
  - Can be derived from literature
  - Look at similar countries/technologies/management methods etc.
  - As a last resort the IPCC maintains a database of emission factors that may be more appropriate than the Tier 1 defaults

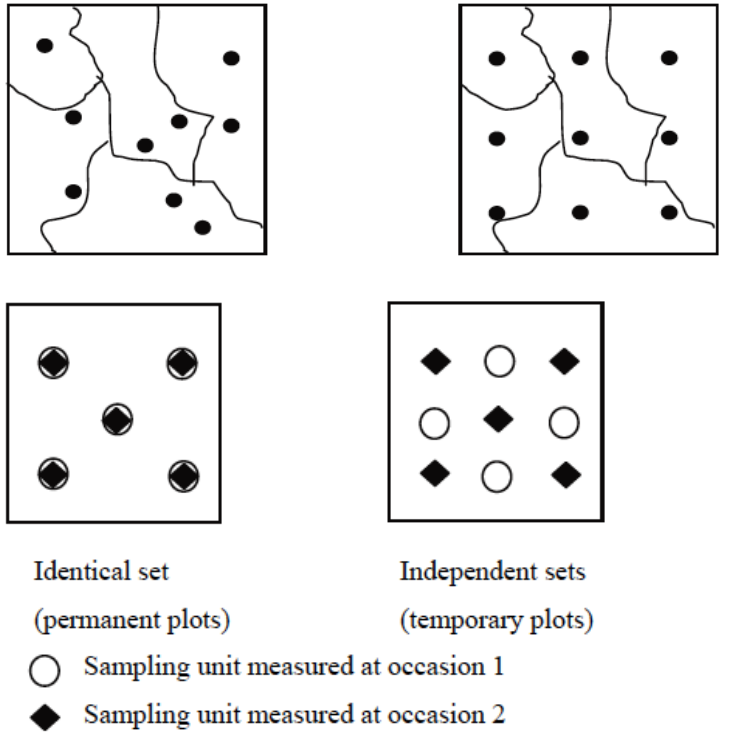
Measuring Emission Factors for Fossil Fuels

1. Based on carbon content of fuels: mass balance!
   - Easy/cheap to measure
   - Correlates closely with energy content
   - Large users monitor this closely – they pay for energy!
2. Stack Monitoring
   - Expensive and needs careful installation, operation & auditing
   - Mandatory for large plant in many countries
3. Use atmospheric composition/ plume measurements
   - Inverse modelling estimates source strength
   - Needs high quality composition measurements
   - Uncertainties

LULUCF: Ground-based measurements: Sample Plots

- Five Carbon Pools to be assessed
  - Aboveground biomass
    - Typically measure trunk diameter
    - Allometric equations relate this to biomass and carbon
  - Dead wood
  - Litter
  - Belowground biomass
    - Usually estimated form above-ground biomass as measurement is so destructive
  - Soil Carbon
    - Samples can be taken for laboratory analysis
- Major expense/time is simply accessing plots
  - Can be in inaccessible/remote areas





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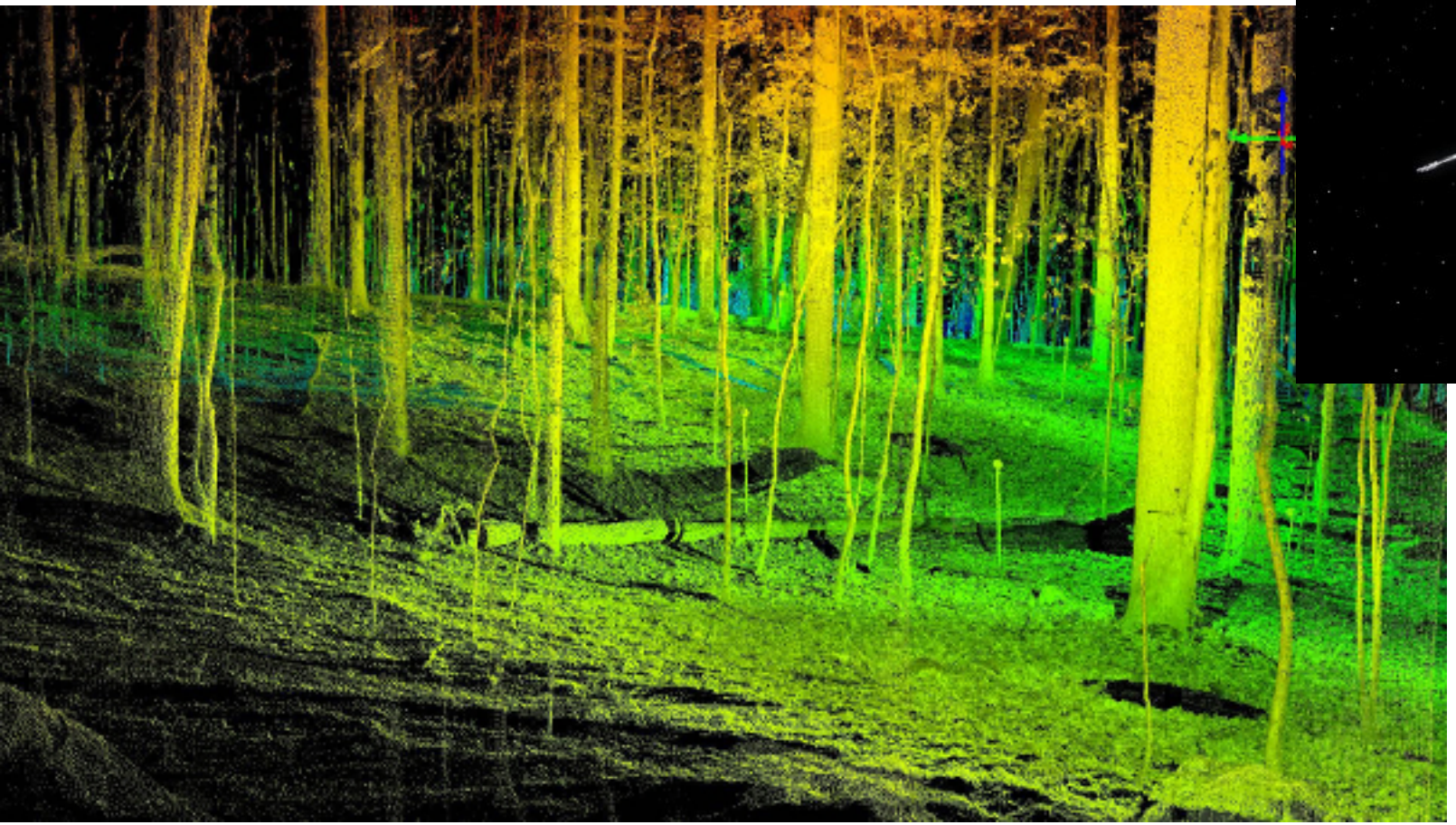

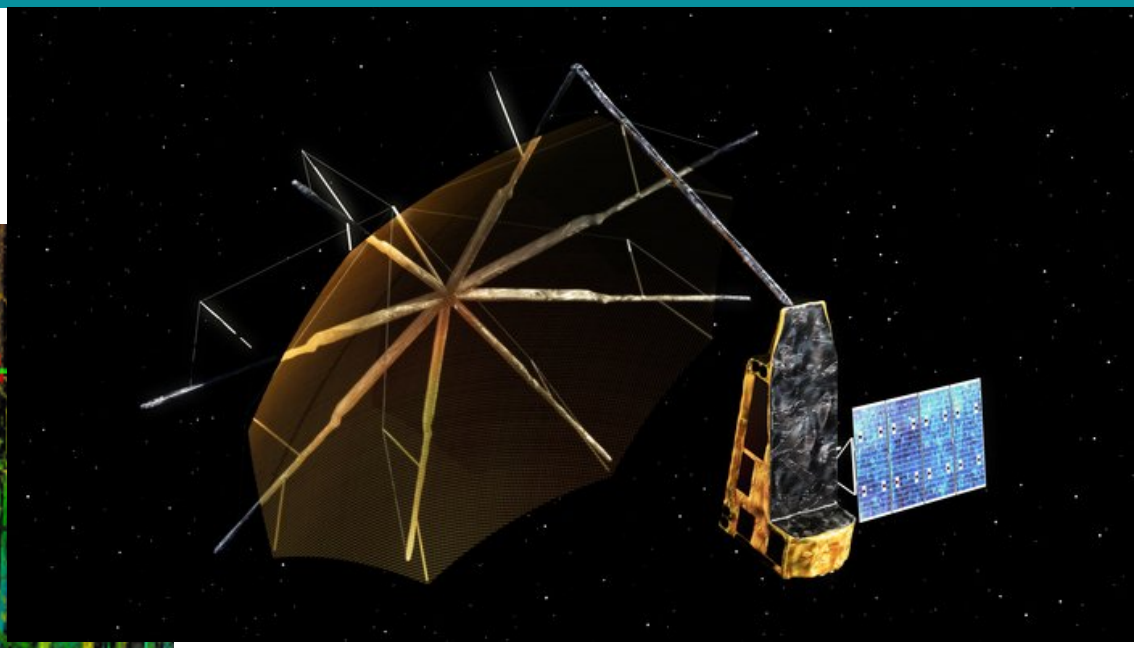

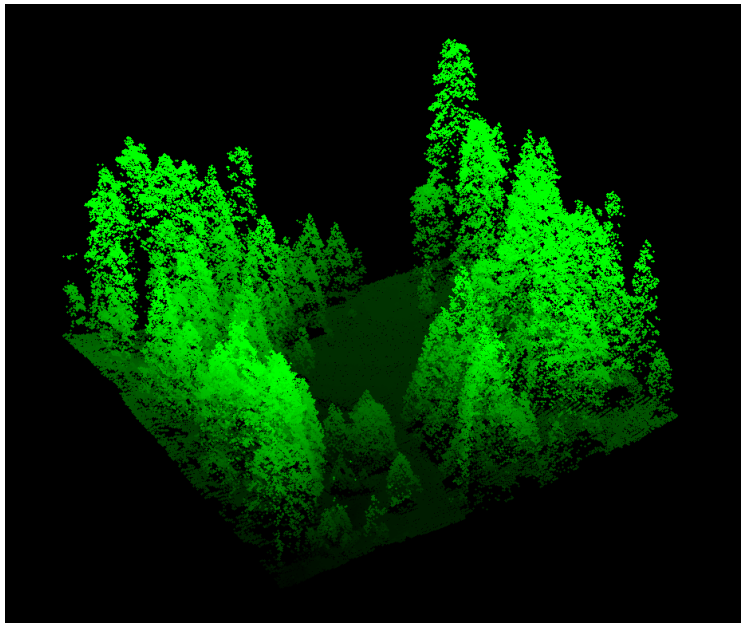

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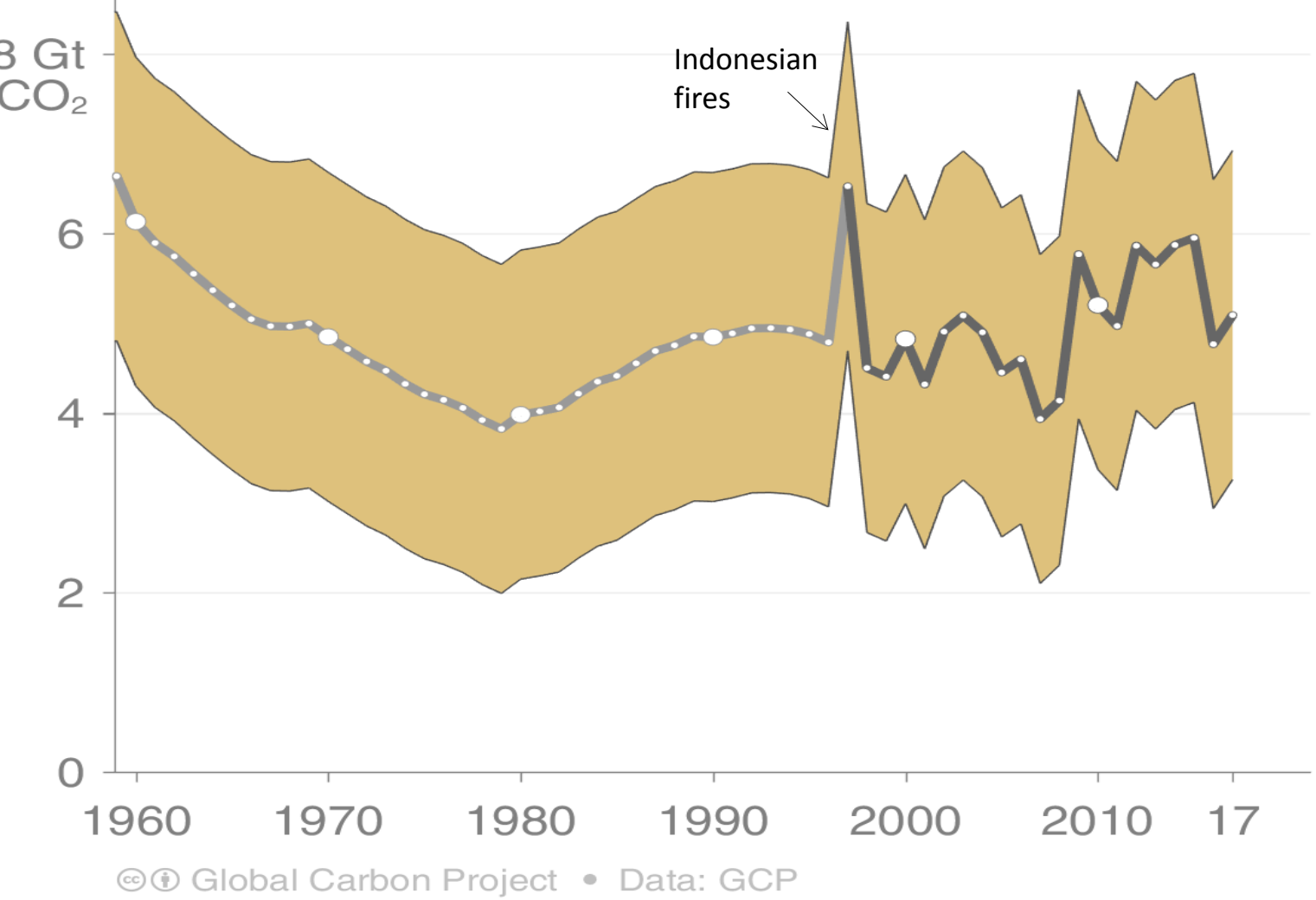
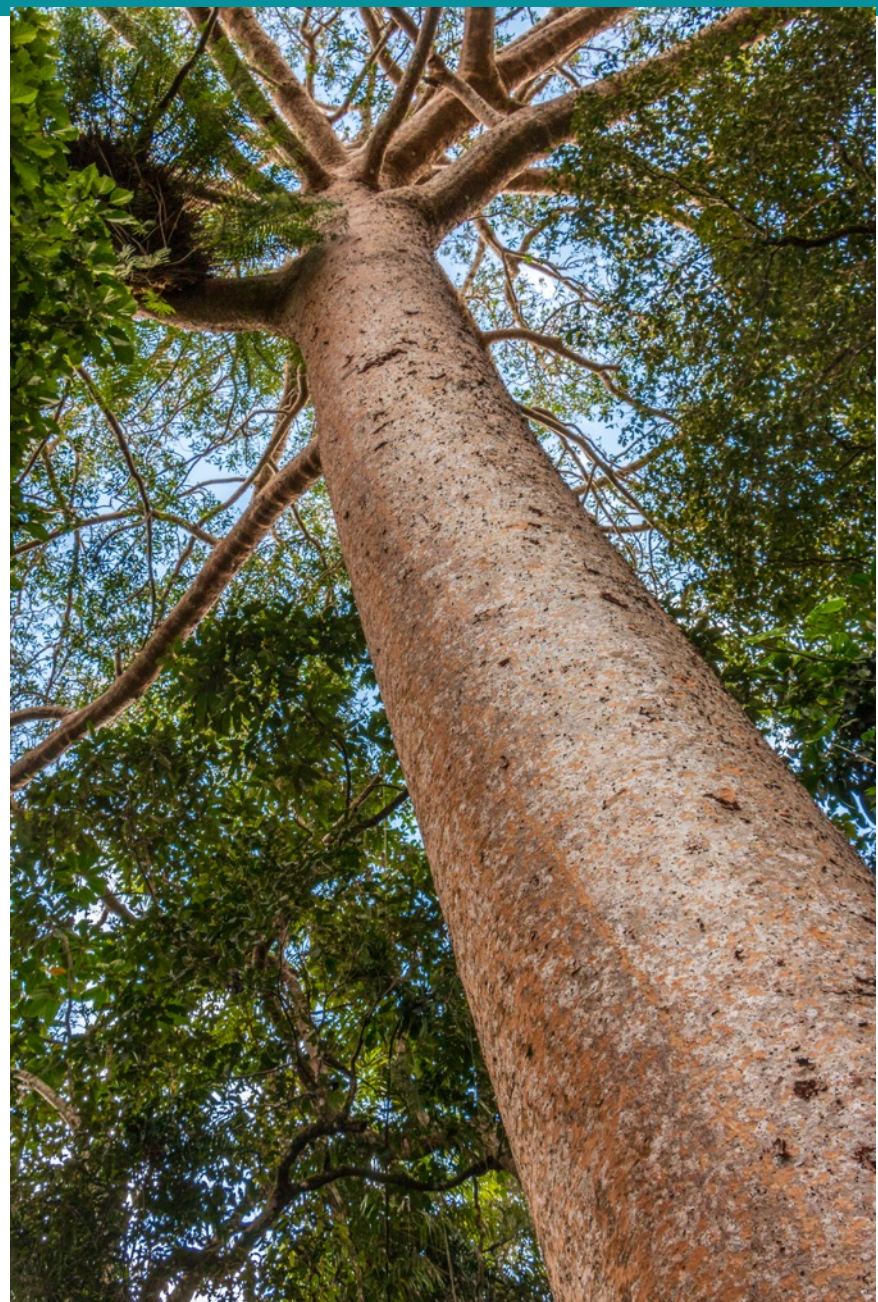
Annual CO2 from Land-use Change : impact of fire observations

- Land-use change emissions are highly uncertain, with no clear trend in the last decade.



Estimates from two bookkeeping models, using fire-based variability from 1997

Source: Houghton and Nassikas 2017; Hansis et al 2015; van der Werf et al. 2017; Le Quéré et al 2018; Global Carbon Budget 2018

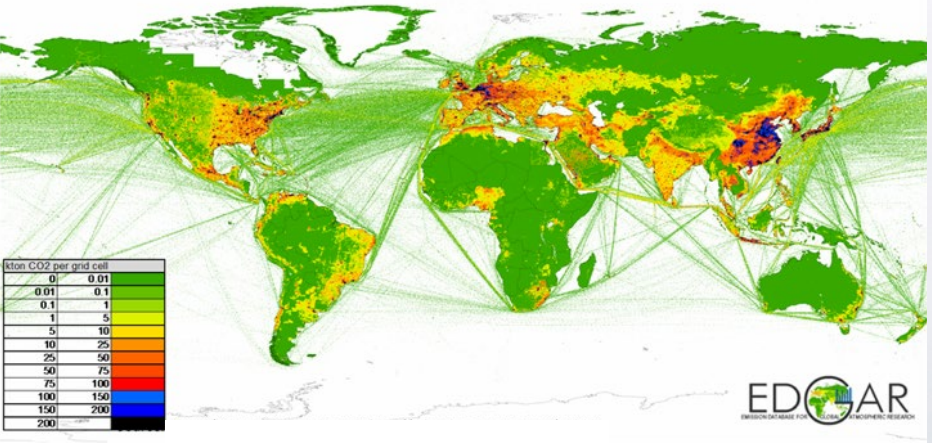


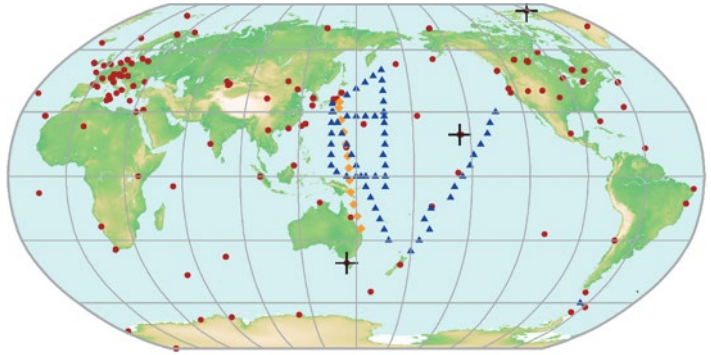
Mitigation – REDD+

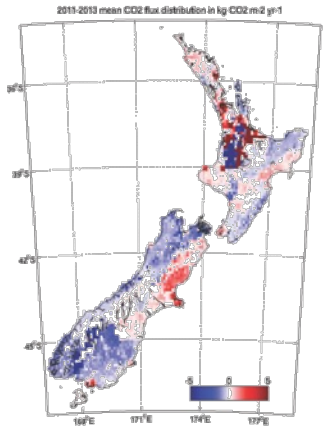
- Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries
- Typically payments for reduced emissions
- Needs detailed monitoring
- Satellite based using 10-30m resolution freely available
- Deforestation observable – forest degradation much harder
- Support and guidance available for countries to monitor forests

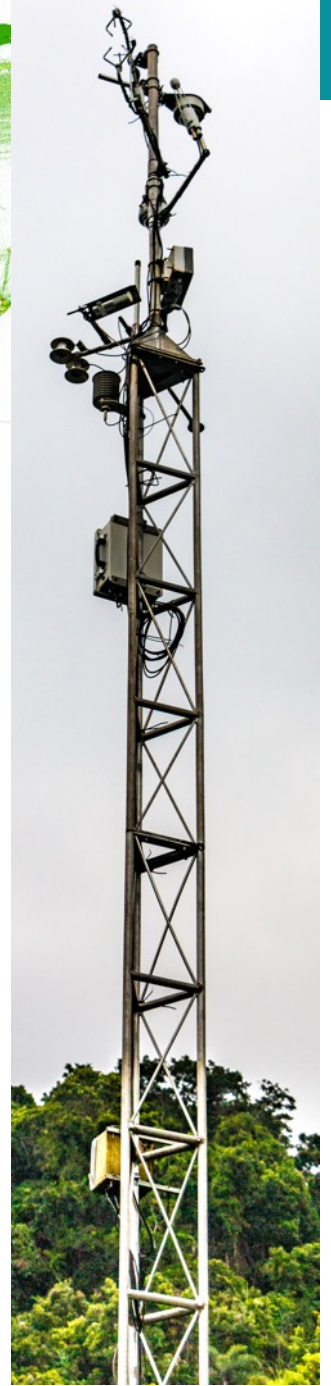

Tomas Munita/CIFOR

Atmospheric composition









- Ground-based and satellite measurements of atmospheric composition with estimates of emissions and removals are input into inverse models to support emission inventories e.g.:
  - To confirm estimates
  - To identify “missing” sources
  - To estimate/check emission factors from specific sites, e.g. oil and gas production

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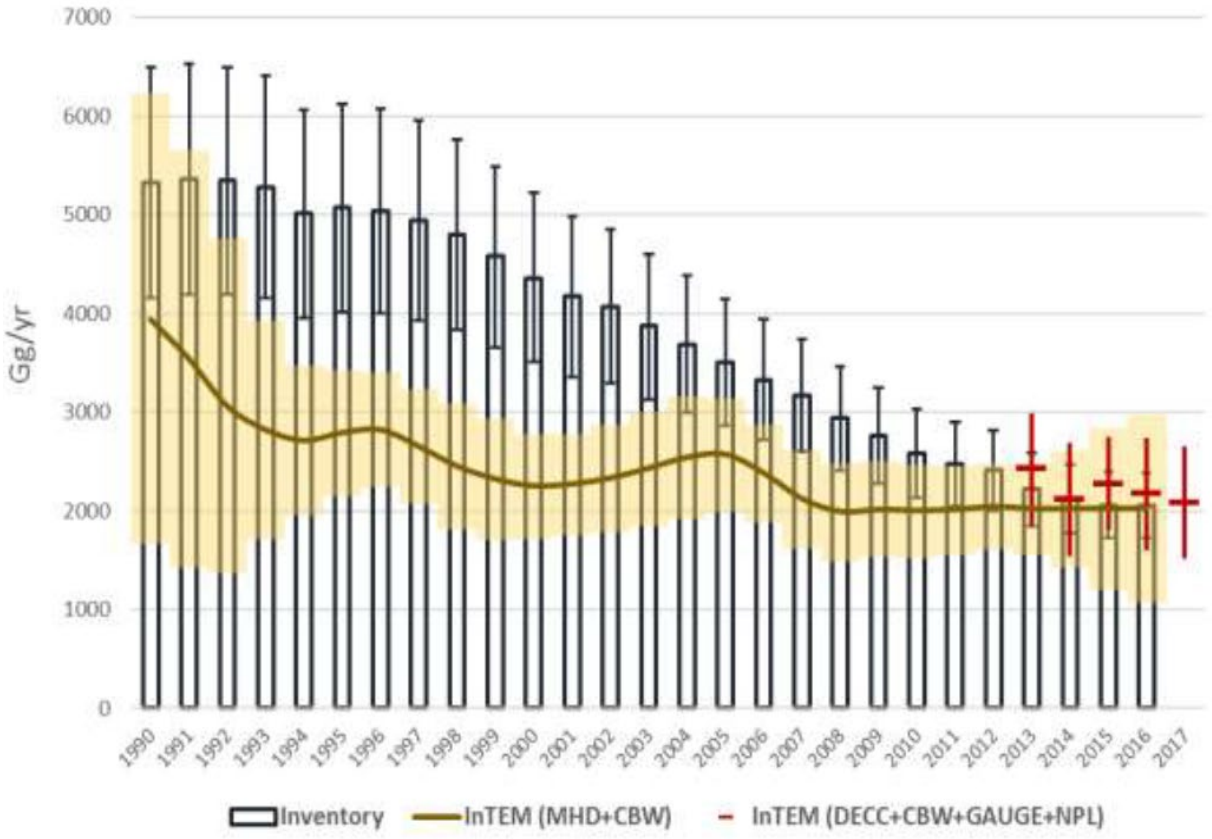
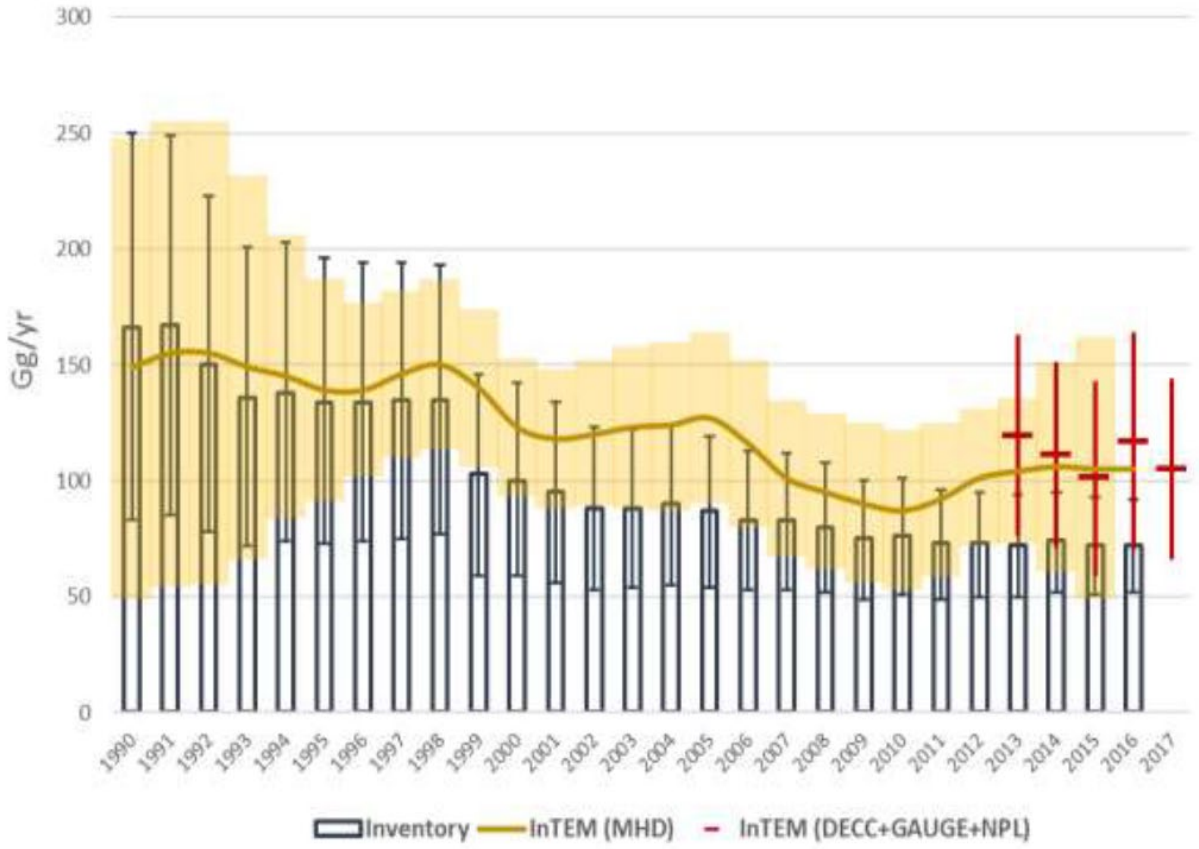
Inventory and Inverse model results for UK

Methane



Nitrous Oxide



Example from UK, see UK NIR 2018

Thank you

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