Inventory of U.S. Greenhouse Gas Emissions and Sinks: Emissions from Fires

Mark Flugge, ICF International
Tom Wirth, EPA/OAR/OAP/CCD

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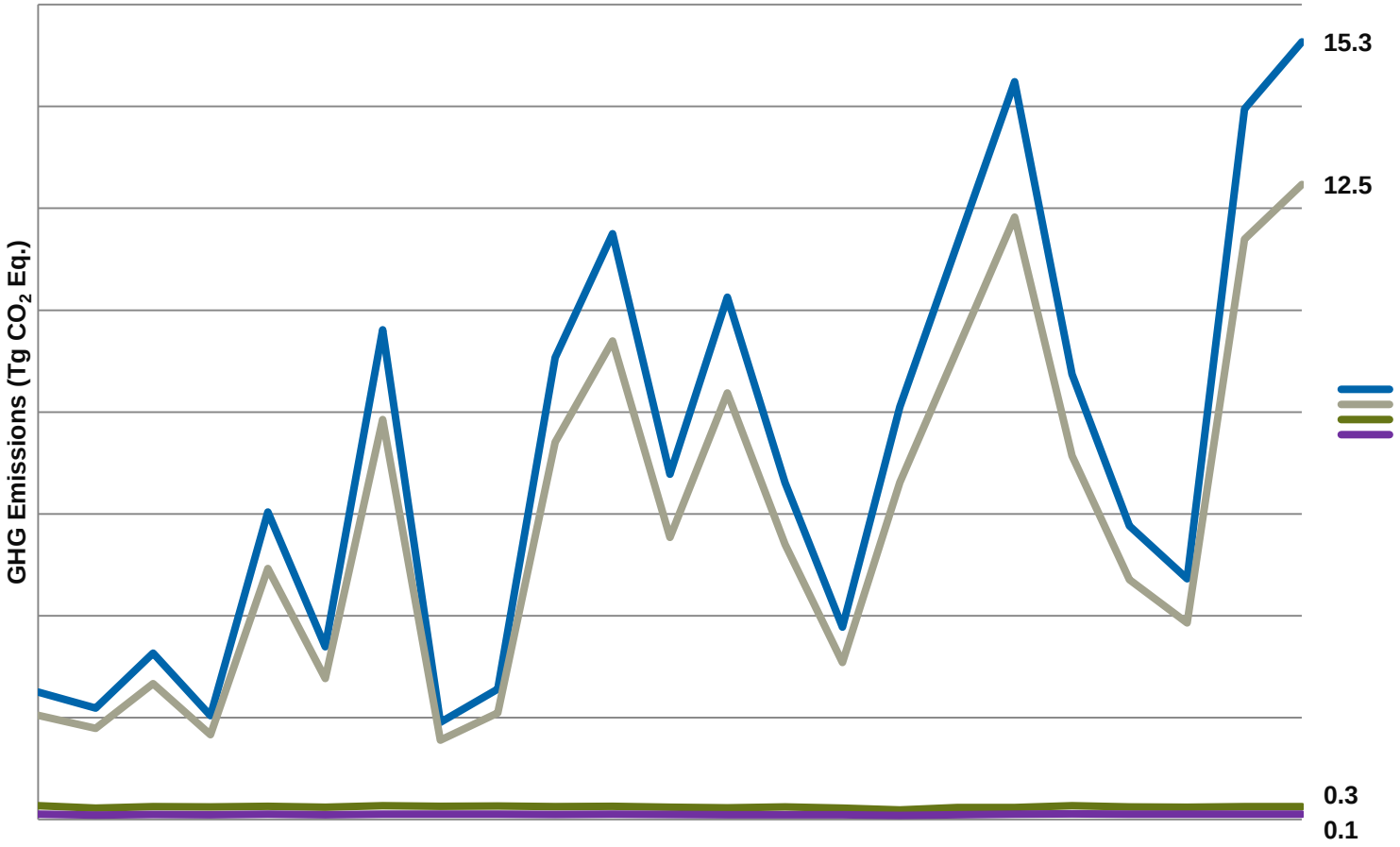
U.S. Greenhouse Gas Inventory

- U.S. EPA prepares the official *Inventory of U.S. Greenhouse Gas Emissions and Sinks* to comply with existing commitments under the United Nations Framework Convention on Climate Change (UNFCCC)
- Work is done by EPA's Climate Change Division in OAR:
  - Tom Wirth is the EPA lead for the Agriculture and Land Use, Land-use Change, and Forestry (LULUCF) sectors
  - ICF International prepares the Emissions from Forest Fires (and other Agriculture and LULUCF source categories—e.g., *Field Burning of Agricultural Residues*) under contract to EPA CCD
- Basis of the methods are from the Intergovernmental Panel on Climate Change (IPCC), which includes methods for:
  - CO_2 and *Non-CO_2 Emissions from Forest Fires*
  - *Field Burning of Agricultural Residues*
  - Grassland Burning
  - Burning of Drained Inland Organic Soils

- **Figure 1: Non-CO_2 Emissions from Forest Fires and Field Burning of Agricultural Residues: NIR data for 1990–2012**
  (blue line = CH_4 from Forest Fires, grey line = N_2O from Forest Fires, green line = CH_4 from Field Burning, purple line = N_2O from Field Burning)



Description

- Emissions from Forest Fires are reported under *Forest Land Remaining Forest Land* under LULUCF
- Changes in Forest Carbon Stocks estimates already include carbon loss from forest fires and are the sum of five carbon storage pools (IPCC 2003):
  - (1) Aboveground biomass, (2) Belowground biomass, (3) Deadwood, (4) Litter, and (5) Soil Organic Carbon (SOC)
- Forest carbon stock estimates are based on measured FIA plot data, so if carbon from a particular pool is burned, it is not available to be re-measured during the next FIA forest inventory cycle
- Both CO_2 and *Non-CO_2 Emissions from Forest Fires* are estimated in the national inventory report (NIR):
  - CO_2 estimates are included only for informational purposes and serve as basis for *Non-CO_2 Emissions from Forest Fires*
  - Included in response to interest in forest fires as a source of emissions

Methodology

Activity data
Tier 2/3 factor
IPCC default factor

- IPCC (2003) methodology, IPCC (2006) default combustion factors, and IPCC (2006) default emission ratios
- *Forest area burned* × *Carbon density* × *Combustion factor (0.45)* × *Conversion factor for CO_2 units (44/12)* × *Emission factor ratio for CH_4 or N_2O*
- Ratio developed to approximate forest area burned:
  - (*Reported area burned*) × (*Forest land under protection from fire/Total land under protection from fire*) = *Forest area burned*
- Default emission factors from IPCC (2006) were converted into gas-specific emission ratios and incorporated into the methodology:
  - *CH_4 emissions* = (*Carbon released*) × 92.8% × (44/12) × (*CH_4 to CO_2 emission ratio*)
  - *N_2O emissions* = (*Carbon Released*) × 92.8% × (44/12) × (*N_2O to CO_2 emission ratio*)
- Prescribed and wildfire emissions were estimated for lower 48 states and only wildfire emissions were estimated for Alaska

Activity Data Collection

- Wildfire statistics available for "reported area burned:"
  - National Interagency Fire Center (lower 48 states)
  - Alaska Department of Natural Resources
  - Alaska Interagency Coordination Center
  - Data includes non-forest land
- USDA Forest Service forest area data
- Total land under wildland fire protection (USDA FS data, reported by State foresters)
- Carbon densities differ between the lower 48 states and Alaska:
  - Wildfire carbon densities include weighted averages of the aboveground, deadwood, and litter carbon pools for each state in each year:
  - Prescribed fire carbon densities only include weighted averages for the litter and deadwood carbon pools for each lower 48 state in each year
  - *Dynamic carbon densities based on annual carbon pool data from USDA FS research were applied from 1990–2012*

Uncertainty

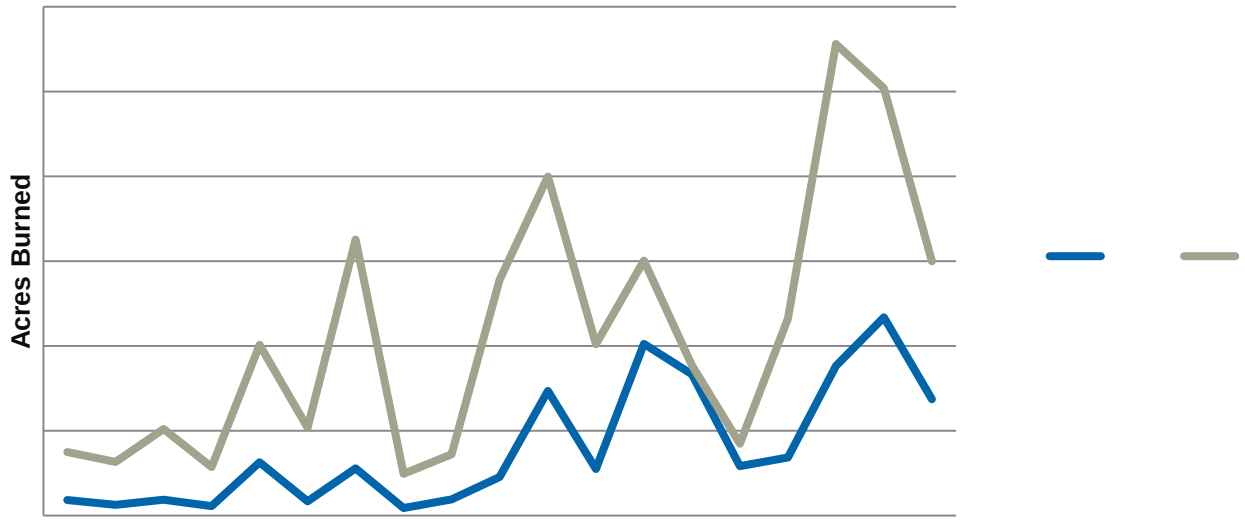
- 2012 uncertainty range for CH_4 emissions: –82% to +176% from actual emission estimate of 15.3 Tg CO_2 Eq.
- 2012 uncertainty range for N_2O emissions: –74% to +144% from actual emission estimate of 12.3 Tg CO_2 Eq.
- Uncertainty inputs (and source of uncertainty bounds and distribution):
  - Forest area for Alaska and lower 48 states (expert judgment)
  - Average carbon density for wildfires and prescribed fires in the lower 48 states (expert judgment)
  - Average carbon density for wildfires in Alaska (expert judgment)
  - Emission ratios (IPCC 2006)
  - Combustion factor values (IPCC 2003)
- Monte Carlo (Tier 2 quantitative analysis)

Planned Improvements

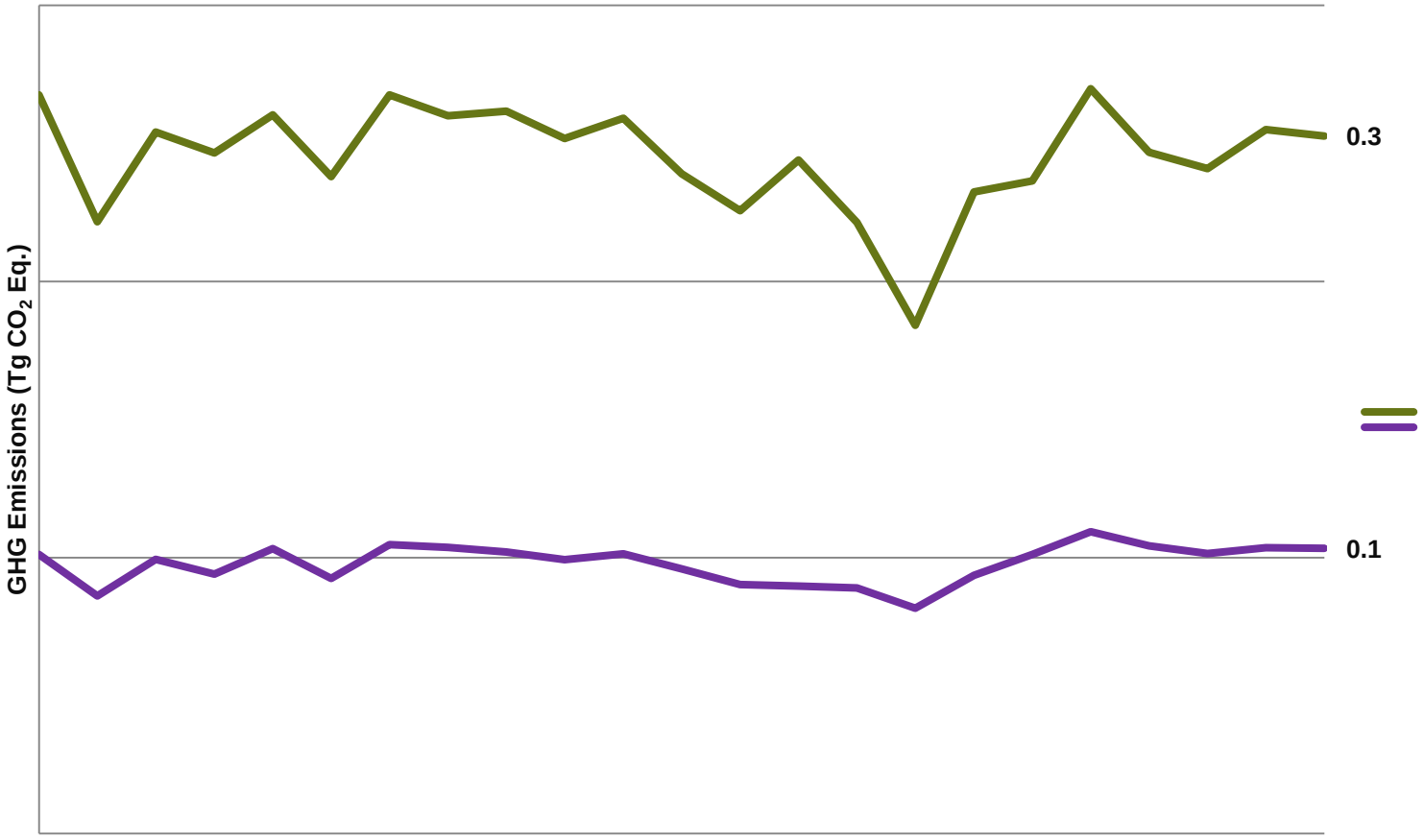
- Conducting additional research into the availability of a combustion factor specific to prescribed fires
- Considering incorporation of improved combustion efficiency factors based on burn severity
- Evaluating other methods of obtaining data on forest area burned:
  - Replace method using ratios of protected forest area/total area under protection:
    - *Monitoring Trends in Burn Severity (MTBS)*
    - *On April 16, 2014, MTBS released the 2012 fire season data which is now part of a data record that covers 1984–2012*

Comparison of MTBS and NIR Area Burned

- **Figure 2: A comparison of forest area burned due to wildfire: MTBS and NIR data for 1990–2008**
  (grey line = NIR, blue line = MTBS)



- **Figure 3: Non-CO_2 Emissions from Field Burning of Agricultural Residues: NIR data for 1990–2012**
  (green line = CH_4 from Field Burning, purple line = N_2O from Field Burning)



Methodology

Activity data
Tier 2 factor
IPCC default factor

- Field Burning of Agricultural Residues is reported under Agriculture
- IPCC (1997) Tier 2 methodology
- For each crop, *Area burned* ÷ *Crop area harvested* × *Crop production* × *Residue/Crop ratio* × *Dry matter fraction* × *Burning efficiency* × *Combustion efficiency* × *Fraction of C or N*
- Crops: corn, cotton, lentils, rice, soybeans, sugarcane, and wheat
- Area burned is a national average of area burned by crop:
  - Underlying data from McCarty (2010)—Remote sensing data from Moderate Resolution Imaging Spectroradiometer (MODIS)
  - MODIS data available for 2003–2007, all other years use the average percent area burned from these five years
- Crop-specific factors from a number of published literature sources

Activity Data Collection

- Crop production and area harvested data from USDA's QuickStats (except rice in Florida and Oklahoma)
- Rice production in Florida and Oklahoma derived from rice area harvested (collected from rice experts during Rice Cultivation estimation process) and multiplied by yield:
  - For Florida, use average Florida rice yield from Schueneman and Deren (2002)
  - For Oklahoma, use Arkansas rice yield, estimated from the USDA data (rice production/rice area harvested)
- Area burned from remote sensing data for 2003–2007 from McCarty (2010)

Uncertainty

- 2012 uncertainty range for CH_4 emissions: –41% to +42% from actual emission estimate of 0.25 Tg CO_2 Eq.
- 2012 uncertainty range for N_2O emissions: – 30% to +32% from actual emission estimate of 0.10 TgCO_2 Eq.
- Monte Carlo (Tier 2 quantitative analysis)
- For some years in Florida and Oklahoma, the total area burned measured was greater than the area harvested information provided by the in-state experts. In these cases, the percent area burned is set equal to 100%

Planned Improvements

- Incorporating state-level estimates of percentage crop area burned
- Investigating inconsistent area harvested data from Florida and Oklahoma
- Investigating the availability of data to incorporate emissions estimates for burning of Kentucky bluegrass and “other crops” indicated as burned in the McCarty dataset
- Investigating newly available crop area burned data and new data to estimate crop-specific burning efficiency and consumption efficiency

- Contact:

  - Tom Wirth, EPA
  - 202-343-9313

  - Mark Flugge, ICF International
  - 202-862-1231


Inventory of U.S. Greenhouse Gas
Emissions and Sinks: 1990-2009