Global Biomass Burning Emissions Product (GBBEPx)

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Fires release large amounts of aerosols into the atmosphere that have adverse affects on human health and economy.

- Long range transport of smoke from fires impacts air quality in downwind regions. Worldwide 250,000 premature deaths per year (Jacobson, JGR, 2014).
- Impacts national parks, monuments, and transportation due to reduced visibility.

Ft. McMurray Fire, Canada, May 2016
Types of Fires

- Peate Fire
- Trash Fire
- Agricultural Fire
- Savanna Fire
- Forest Fire

Image descriptions:
- Peate Fire
- Trash Fire
- Savanna Fire
- Forest Fire
- Agricultural Fire
Numerical models that predict air quality (ozone and PM2.5) need to know where the fires are located, how high is the aerosol loading being emitted, at what height is the plume injection, and the duration of the fire.

Near real time information from satellites that models need

- Fire location - yes
- Fire Radiative Power (a proxy to calculate emissions) - yes
- Fire duration (if satellite is in geostationary orbit) - yes
- Plume injection – no
- Aerosol composition - no
Emissions Calculation

\[ E_x = FRP \times \beta \times F \]

\[ E_{fx} = \beta \cdot \frac{FRP}{A} \cdot F \]

- \( E_x \): biomass burning emissions (kg) of species x
- \( S \): burned area (km\(^2\))
- \( F \): emission factors (g/kg)
- \( \beta \): a combustion rate per unit energy (KgC/Joules)
- \( A \): area of the pixel

Emission Factors (g/kg) in computing GBBEP-Geo. LC1-forests, LC2-savanna, LC3-shrublands, LC4-grasslands, LC5-croplands.

<table>
<thead>
<tr>
<th></th>
<th>LC1</th>
<th>LC2</th>
<th>LC3</th>
<th>LC4</th>
<th>LC5</th>
<th>Average</th>
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<tr>
<td>PM2.5</td>
<td>12.3</td>
<td>7.35</td>
<td>9.3</td>
<td>5.4</td>
<td>5.8</td>
<td>8.04</td>
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<tr>
<td>CO</td>
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<td>63.5</td>
<td>68</td>
<td>59</td>
<td>111</td>
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<tr>
<td>OC</td>
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<td>4.6</td>
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<td>0.5</td>
<td>0.37</td>
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<td>0.481</td>
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<td>SO2</td>
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<td>0.58</td>
<td>0.68</td>
<td>0.48</td>
<td>0.4</td>
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<tr>
<td>CH4</td>
<td>5.42</td>
<td>2.05</td>
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<td>6</td>
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<td>7</td>
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</table>
MODIS (Aqua and Terra) Fire Hot Spots and FRPs

Compute FRPs for each model grid

Daily Emissions for CO, OC, BC, SO$_2$, CO$_2$, CH$_4$, NO$_x$, NMHC, NH$_3$

Satellite specific scaling factors based on MODIS AOD tuning

QFED Emissions
Generate Diurnal FRP profile for missing hotspots due to clouds certain times of the day

Tune GBBEP-Geo Emissions with QFED

Satellite specific scaling factors

Daily Emissions for CO, OC, BC, SO\textsubscript{2}, CO\textsubscript{2}, CH\textsubscript{4}, NO\textsubscript{x}, NMHC, NH\textsubscript{3}

GBBEP-Geo Emissions
Generate Diurnal FRP profile for missing hotspots due to clouds certain times of the day.

115.4°W, 44.49°N
Tune GBBEP-Geo Emissions with QFED

Satellite specific scaling factors
Regress VIIRS FRPs with QFED Emissions

VIIRS Hot Spots and FRPs

Daily Emissions for CO, OC, BC, SO$_2$, CO$_2$, CH$_4$, NO$_x$, NMHC, NH$_3$
MODIS (Aqua and Terra) Fire Hot Spots and FRPs

Compute FRPs for each model grid

VIIRS Hot Spots and FRPs

Daily Emissions for CO, OC, BC, SO\textsubscript{2}, CO\textsubscript{2}, CH\textsubscript{4}, NO\textsubscript{x}, NMHC, NH\textsubscript{3}

Satellite specific scaling factors

GOES-E Fire Hot Spots and FRPs

GOES-W Fire Hot Spots and FRPs

MSG Fire Hot Spots and FRPs

MTS Fire Hot Spots and FRPs

Generate Diurnal FRP profile for missing hotspots due to clouds certain times of the day

Daily Emissions for CO, OC, BC, SO\textsubscript{2}, CO\textsubscript{2}, CH\textsubscript{4}, NO\textsubscript{x}, NMHC, NH\textsubscript{3}

Global Blended Emissions Product that is operational and used by NWS in operational aerosol forecasts using NGACV2
GBBEPx is an output of daily emissions, an average of QFED, GBBEP-Geo, VIIRS.

* Not in operations yet
Two examples of fire emissions:
• geostationary satellites only
• MODIS only
• VIIRS only
Total PM2.5 (June 15 – August 15 2017)
Daily PM2.5 (June 15 – August 15 2017)
NWS/NCEP operational model run with GBBEPx V2
FV3GFS-Chem is the Next Generation Global Prediction System (NGGPS) for aerosols. We are currently adapting GBBEPx file format to FV3 grid so it can be tested.

- FV3GFS_Chem is the Next Generation Global Prediction System (NGGPS) for aerosols.
- We are currently adapting GBBEPx file format to FV3 grid so it can be tested.
• GBBEPx is an operational product currently being used by operational NGAC v2 aerosol model at NCEP
• Plans underway to add NOAA-20 fire emissions to GBBEPx
• Despite repeated proposal submissions to PSDI to replace legacy GOES and MTSAT with GOES-16/17 and Himawari-8/9 fire emissions, no funding
• GBBEPx sample data were provided to HRRR-smoke model for testing
• GBBEPx output is being adapted for FV3 grid for testing purposes
• Algorithm/product has been published in multiple journal articles


