UNDERSTANDING THE DIFFERENCES BETWEEN THE DOE ARGONNE GREET METHOD AND ICAO METHOD FOR ETHANOL-TO-JET SAF CARBON ACCOUNTING

Ethanol-to-jet lifecycle stage	Data/Information Source for DOE Argonne GREET Method (March 2023)	Data/Information Source for ICAO Method (June 2019)
1. "Core" Emissions According to ICAO, "core" emissions (sometimes referred to as "direct" or "attributional" emissions) include emissions linked to "the full supply chain of SAF production and use." ICAO says its core emission analysis includes all emissions related to: • Feedstock cultivation; • Feedstock harvest, collection, recovery; • Feedstock processing and extraction; • Feedstock transport to fuel production facilities; • Feedstock-to-fuel conversion processes; • Fuel transportation and distribution; and • Fuel combustion in aircraft engine.	The DOE Argonne GREET model is updated annually to reflect changes and improvements in activities linked to core emissions. The latest DOE Argonne GREET model was released in **March 2023** and uses a database with mostly **2022-era crop and fuel production data**.	The ICAO method relies on two sources for its corn ethanol-to-jet fuel "core emissions" estimate. ICAO simply averages the "core emissions" estimates from 1) a 2014 paper by *Staples et al*., and 2) the European Union's Joint Research Center (JRC). 1. The *Staples et al*. paper used the **2012 version** of the **DOE Argonne GREET** model, which relied on a database of **2008-2011** era feedstock and fuel processing data. 2. The JRC appears to have relied on a **2017 paper** by *Edwards et al*., which utilizes a variety of data sources from **2006-2012** for *European* (non-U.S.) corn ethanol production factors.
2. Land Use Changes Economic models are used to simulate potential future direct and indirect "land use changes" that could hypothetically result from expanded demand for crop-based biofuels. These models generate results (i.e., estimates of the amount of land converted) based on theoretical scenarios of biofuels expansion, along with assumptions about future crop prices, crop yields, biofuel conversion rates, demand responses, and other factors.	Via the **CCLUB** module, the DOE Argonne GREET model is integrated and linked with Purdue University's **GTAP-BIO** model (a computable general equilibrium, or CTE, model) for the purposes of estimating potential land use changes from various biofuel expansion scenarios ("shocks"). The current version of GREET is linked to the latest version of GTAP-BIO.	The ICAO method relies on two sources for its estimates of land use changes related to corn ethanol expansion: 1) **GTAP-BIO**, and 2) **GLOBIOM**, a European economic model. ICAO's method simply averages the results from the two different models. 1. ICAO relies on a version of GTAP-BIO that uses a **2011** global database for land cover and economic data. 2. GLOBIOM uses a global land cover data set from **2000**.
3. Emissions from Land Use Changes After economic models are used to estimate potential land use changes from various biofuel expansion scenarios, "emissions factors" are assigned to the different land types that are predicted to be converted.	The DOE Argonne GREET model primarily relies on the Carbon Calculator for Land Use Change from Biofuel Production (**CCLUB**) module to assign emissions factors to land use changes estimated by GTAP. The CCLUB module was developed by scientists at Northwestern University, Argonne National Lab, and the University of Illinois system. The CCLUB model was last updated in **October 2021.** CCLUB draws from Colorado State University's **CENTURY** model. The GREET model also allows users to instead use the emissions factors from the **AEZ-EF** developed by U.C. Berkeley and CARB in **2014** in lieu of CCLUB.	ICAO's method uses emissions factors from two different sources: 1) emissions factors from the **GLOBIOM** model are applied to land use change results from the **GLOBIOM** model, and 2) emissions factors from the "Agro-Ecological Zone Emissions Factor" model (**AEZ-EF)** are applied to land use change results from the **GTAP-BIO** model. The **AEZ-EF** model was developed by U.C. Berkeley and CARB in 2014 and relies on data on carbon emissions from various land types published in the **2006-2014** timeframe. The **AEZ-EF** model has not been updated since **2014**.
4. Time Horizon After total land use change emissions are estimated in steps 2 and 3, they are amortized across a "time horizon" to develop an annual average.	The GREET-GTAP-CCLUB framework uses a **30-year time horizon**, consistent with U.S. EPA, CARB, and other organizations. **IPCC** typically uses a **100-year** time horizon for GHG emissions accounting.	ICAO's method uses a **25-year time horizon**, which compresses emissions into a shorter timeframe, resulting in higher annual emissions estimates.

Table prepared by: **Renewable Fuels Association** (July 2023)