## Interpreting DayCent model results from the COMET-Farm system

## Either API results or downloaded XML results

## M. Easter, 30 October 2018

# Introduction

The COMET-Farm system is designed to offer users opportunities to conduct scenario analyses, to support decision making in adopting different land management scenarios. The following steps are completed to accomplish this task:

1. The parcel or point definition is intersected with NRCS SSURGO soils maps, and PRISM weather maps, to determine how many unique land management – soil – weather combinations must be run.
2. The current management crop rotation is projected forward ten years as the “Baseline” Scenario.
3. All of the greenhouse gas models in the COMET-Farm platform (e.g. DayCent, rice methane, residue burning, liming, urea fertilizer, etc.) are run against the baseline scenario and then against each conservation scenario, on each unique combination of soil map units found within each parcel or point for each model run.
4. DayCent model results are returned in the output.xml file first as “File Results” under the heading “Current” (for the current period 2000 to present year), “Baseline” for the Baseline projection, and “Scenario” for the scenario projection.
5. Aggregated Baseline and Scenario results totals for all models are also returned, named “Baseline” and “Scenario”.

Model runs completed for each map unit are indicated by the map unit key (mukey) associated with the SSURGO map unit database. For example, consider a parcel of 1 hectare in size that has two map units. Map unit #31997 covers 75% of the parcel, and map unit #31998 covers 25% of the parcel. The COMET-Farm system completes separate DayCent model runs for both map units, return DayCent results by map unit id (indicated as “id) for both the baseline and conservation scenarios. The results are then area-weighted based on the area each map unit represents in the parcel, and combined with the results of other models to predict the area-weighted greenhouse gas emissions for the parcel.

Following are definitions of the baseline and conservation scenarios:

**Baseline Scenario:** The baseline scenario is projected forward from the “current management” data entered in the tool for the time period of year 2000 to present.

**Conservation Scenario:** This is taken from the future period (current year to 10 years into the future) entered into the tool.

In order to calculate the greenhouse gas benefit of a conservation scenario, one calculates the area-weighted greenhouse gas balance (soil C stock change + N2O emissions + CH4 emissions) for the conservation scenario, and subtracts from that area-weighted greenhouse gas balance of the baseline scenario in order to determine net greenhouse gas benefit of the conservation scenario.

Following is a summary of how to interpret the DayCent output data embedded in the XML output files.

# Soil Carbon Stock Change

The equation to evaluate changes in soil carbon (C change expressed in CO2e) over a single model run is as follows, using data derived from the <somsc> tag in the output file. The units of the somsc field are grams of soil carbon per meter squared:

( ( somsc at beginning of model run – somsc at end of model run ) / time period in years of model run ) \* ( size of parcel in ha ) \* ( 10,000 m2/hectare ) \* ( 1 Mg / 1,000,000 grams) \* (44/12 C to CO2e conversion factor) = change in soil C (Mg CO2e/yr)

For example, consider the following output string for a Baseline or Scenario model run (2018-2027) on a 1 hectare parcel:

<somsc>2018,2123.619,2018,2123.619,2019,2088.882,2019.08,2089.717,2019.17,2089.622,2019.25,2088.398,2019.33,2087.020,2019.42,2126.069,2019.5,2125.795,2019.58,2125.745,2019.67,2125.703,2019.75,2125.663,2019.83,2123.432,2019.92,2126.339,2020,2128.082,2020.08,2128.814,2020.17,2128.392,2020.25,2127.149,2020.33,2125.131,2020.42,2161.546,2020.5,2160.695,2020.58,2160.638,2020.67,2160.590,2020.75,2160.327,2020.83,2158.577,2020.92,2161.639,2021,2162.496,2021.08,2193.740,2021.17,2189.395,2021.25,2188.424,2021.33,2187.072,2021.42,2186.517,2021.5,2186.506,2021.58,2186.505,2021.67,2186.505,2021.75,2185.258,2021.83,2183.854,2021.92,2181.359,2022,2179.427,2022.08,2177.698,2022.17,2175.273,2022.25,2171.838,2022.33,2168.388,2022.42,2136.654,2022.5,2136.536,2022.58,2136.496,2022.67,2136.497,2022.75,2136.508,2022.83,2137.563,2022.92,2140.801,2023,2141.968,2023.08,2141.821,2023.17,2141.005,2023.25,2139.048,2023.33,2137.359,2023.42,2164.672,2023.5,2164.312,2023.58,2164.241,2023.67,2164.179,2023.75,2164.120,2023.83,2158.864,2023.92,2159.686,2024,2160.665,2024.08,2160.916,2024.17,2160.653,2024.25,2159.234,2024.33,2156.932,2024.42,2192.706,2024.5,2191.195,2024.58,2191.138,2024.67,2191.091,2024.75,2190.903,2024.83,2190.592,2024.92,2190.637,2025,2192.005,2025.08,2193.154,2025.17,2193.226,2025.25,2191.870,2025.33,2189.529,2025.42,2223.305,2025.5,2222.761,2025.58,2222.694,2025.67,2222.637,2025.75,2222.013,2025.83,2221.815,2025.92,2221.791,2026,2220.562,2026.08,2219.991,2026.17,2221.222,2026.25,2221.933,2026.33,2221.290,2026.42,2254.737,2026.5,2253.623,2026.58,2253.567,2026.67,2253.522,2026.75,2253.481,2026.83,2253.399,2026.92,2253.436,2027,2255.490,</somsc>

One uses the somsc in 2018 (beginning of model run) and the somsc in 2027 (end of model run) and divides by 10 years. Here is the equation for the period of 2018 to 2027:

( ( 2123.619 - 2255.490 ) / 10 ) \* ( 1 hectare ) \* ( 1 / 100 ) \* ( 44/12 ) = -0.483527 Mg CO2e/yr

Note that the negative value indicates net soil carbon sequestration for this parcel.

# Direct Soil Nitrous Oxide

Direct soil nitrous oxide (N2O expressed in CO2e) over a single model run is derived from data in the <n2oflux> tag in the output file. The units of the n2oflux field are grams of N2O-N per meter squared per year. The equation to calculate the soil direct N2O emissions is as follows:

( average DayCent yearly N2O emissions over the model run ) \* ( 44 / 28 N2O-N to N2O conversion ) \* ( 298 N2O to CO2e conversion) \* ( size of parcel in ha ) \* ( 10,000 m2/hectare ) \* ( 1 Mg / 1,000,000 grams)

For example, consider the following output string for a 1 hectare parcel:

<n2oflux>2018.92,0.226457,2019.92,0.168679,2020.92,0.194825,2021.92,0.105641,2022.92,0.152511,2023.92,0.159609,2024.92,0.166308,2025.92,0.175853,2026.92,0.210536,</n2oflux>

The yearly direct soil N2O emissions predicted by DayCent would be as follows for the period of 2008 to 2017:

(0.226457+0.168679+0.194825+0.105641+0.152511+0.159609+0.166308+0.175853+0.210536 ) \* ( 1 / 10 years ) \* ( 44/28 ) \* ( 298 ) \* ( 1 ha ) \* ( 10000 / 1000000 ) = 0.7307 Mg N2O / yr ( in CO2e )

# Indirect Soil Nitrous Oxide

Indirect soil nitrous oxide (N2O expressed in CO2e) over a single model run are a product of both volatilized nitrogen and leached nitrogen, and are derived from data in the <volpac> tag for volatilized N, and <strmac\_2> for leached N. The units for the two variables are g N m2/yr.

For example, consider the following output strings for a Current Management model period (identified as “Current”, or 2000-2017) on a 1 hectare parcel:

<strmac\_2\_>2009,0.0,2009.08,0.245,2009.17,0.265,2009.25,0.266,2009.33,0.269,2009.42,0.271,2009.5,0.272,2009.58,0.272,2009.67,0.272,2009.75,0.272,2009.83,0.272,2009.92,0.272,2010,0.272,2010.08,0.0,2010.17,0.0,2010.25,0.0,2010.33,0.0,2010.42,0.0,2010.5,0.0,2010.58,0.0,2010.67,0.0,2010.75,0.0,2010.83,0.0,2010.92,0.0,2011,0.0,2011.08,0.0,2011.17,0.0,2011.25,0.0,2011.33,0.0,2011.42,0.0,2011.5,0.0,2011.58,0.0,2011.67,0.0,2011.75,0.0,2011.83,0.0,2011.92,0.0,2012,0.0,2012.08,0.0,2012.17,0.0,2012.25,0.284,2012.33,0.346,2012.42,0.351,2012.5,0.356,2012.58,0.359,2012.67,0.359,2012.75,0.359,2012.83,0.359,2012.92,0.359,2013,0.359,2013.08,0.0,2013.17,1.785,2013.25,2.878,2013.33,2.881,2013.42,2.881,2013.5,2.886,2013.58,2.887,2013.67,2.887,2013.75,2.887,2013.83,2.887,2013.92,2.887,2014,2.887,2014.08,3.031,2014.17,4.010,2014.25,4.083,2014.33,4.093,2014.42,4.094,2014.5,4.094,2014.58,4.094,2014.67,4.094,2014.75,4.094,2014.83,4.094,2014.92,4.094,2015,4.094,2015.08,0.0,2015.17,0.0,2015.25,0.0,2015.33,0.0,2015.42,0.0,2015.5,0.0,2015.58,0.0,2015.67,0.0,2015.75,0.0,2015.83,0.0,2015.92,0.0,2016,0.0,2016.08,3.230,2016.17,3.466,2016.25,4.978,2016.33,4.993,2016.42,4.993,2016.5,4.995,2016.58,4.995,2016.67,4.995,2016.75,4.995,2016.83,4.995,2016.92,4.995,2017,4.995,2017.08,0.184,2017.17,2.175,2017.25,2.880,2017.33,2.882,2017.42,2.884,2017.5,2.884,2017.58,2.884,2017.67,2.884,2017.75,2.884,2017.83,2.889,2017.92,2.891,2018,3.122,2018,0.0,</strmac\_2\_>

<volpac>2009,0.313,2009.08,0.0,2009.17,0.0,2009.25,0.0,2009.33,0.0,2009.42,0.0,2009.5,0.0,2009.58,0.0,2009.67,0.0,2009.75,0.0,2009.83,0.318,2009.92,0.318,2010,0.318,2010.08,-8.506E-09,2010.17,6.5631E-06,2010.25,1.4848E-05,2010.33,5.6368E-03,2010.42,1.7234E-02,2010.5,2.6689E-02,2010.58,3.3214E-02,2010.67,3.9155E-02,2010.75,4.2075E-02,2010.83,4.4129E-02,2010.92,4.5445E-02,2011,4.5872E-02,2011.08,7.5126E-05,2011.17,-1.394E-05,2011.25,1.9422E-04,2011.33,5.0168E-04,2011.42,5.0168E-04,2011.5,5.0168E-04,2011.58,0.216,2011.67,0.216,2011.75,0.216,2011.83,0.216,2011.92,0.216,2012,0.216,2012.08,0.0,2012.17,0.0,2012.25,0.0,2012.33,0.0,2012.42,0.0,2012.5,0.0,2012.58,0.0,2012.67,0.0,2012.75,0.0,2012.83,0.335,2012.92,0.335,2013,0.335,2013.08,0.0,2013.17,0.0,2013.25,0.0,2013.33,0.0,2013.42,0.0,2013.5,0.0,2013.58,0.0,2013.67,0.0,2013.75,0.0,2013.83,0.335,2013.92,0.335,2014,0.335,2014.08,0.0,2014.17,0.0,2014.25,0.0,2014.33,0.0,2014.42,0.0,2014.5,0.0,2014.58,0.0,2014.67,0.0,2014.75,0.0,2014.83,0.357,2014.92,0.357,2015,0.357,2015.08,0.0,2015.17,0.0,2015.25,0.0,2015.33,0.0,2015.42,0.0,2015.5,0.0,2015.58,0.0,2015.67,0.0,2015.75,0.0,2015.83,0.320,2015.92,0.320,2016,0.320,2016.08,0.0,2016.17,0.0,2016.25,0.0,2016.33,0.0,2016.42,0.0,2016.5,0.0,2016.58,0.0,2016.67,0.0,2016.75,0.0,2016.83,0.335,2016.92,0.335,2017,0.335,2017.08,-2.711E-08,2017.17,8.9977E-06,2017.25,6.2888E-04,2017.33,3.3137E-03,2017.42,1.0772E-02,2017.5,2.3423E-02,2017.58,3.1529E-02,2017.67,3.8201E-02,2017.75,4.3781E-02,2017.83,4.6393E-02,2017.92,4.6729E-02,2018,4.6745E-02,2018,0.0,</volpac>

The volpac field is an annual indicator, showing amount of N volatilized from the soil in g N m2/yr. The value corresponding to the <year>.00 record corresponds to accumulated volatilized N from the previous year. For example, a value of 2013,0.335 corresponds to a total volatilized N of 0.335 g N m2 in 2012.

The strmac\_2 field is an annual indicator, showing amount of N leached from the soil profile, in g N m2/yr. The value corresponding to the <year>.00 record corresponds to accumulated leached N from the previous year. For example, a value of 2013,0.359 corresponds to a total leached N of 0.359 g N m2 in 2012.

The equation to calculate the soil indirect N2O emissions from volatilization is as follows for the period 2008 to 2017:

( 0.0 + 0.272 + 0.0 + 0.0 + 0.359 + 2.887 + 4.094 + 0.0 + 4.995 + 3.122 ) ( 1/10 yrs) \* ( 0.01 EFleach) \* ( 44/28 N2O-N to N2O conversion ) \* ( 298 N2O to CO2e conversion) \* ( size of parcel in ha ) \* ( 10,000 m2/hectare ) \* ( 1 Mg / 1,000,000 grams) = 0.074 Mg/ha CO2e

The equation to calculate the soil indirect N2O emissions from leaching is as follows for the period of 2008 to 2017:

( average DayCent volpac emissions over the model run ) \* ( 0.0075 EFvol) \* ( 44/28 N2O-N to N2O conversion ) \* ( 298 N2O to CO2e conversion) \* ( size of parcel in ha ) \* ( 10,000 m2/hectare ) \* ( 1 Mg / 1,000,000 grams)

The yearly indirect soil N2O emissions predicted by DayCent from leaching would be as follows:

( 0.313 + 0.318 + 0.045872 + 0.216 + 0.335 + 0.335 + 0.357 + 0.320 + 0.335 + .046745 ) \* ( 1 / 10 years ) \* ( 0.01 ) \* ( 44/28 ) \* ( 298 ) \* ( 1 ha ) \* ( 10000 / 1000000 ) = Mg N2O / yr ( in CO2e ) = 0.0092 Mg/ha CO2e