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Supplementary Information for
A Gap in Nitrous Oxide Emissions Reporting Complicates Long Term Climate.

Stephen J. Del Grosso, Stephen M. Ogle, Cynthia Nevison, Ram Gurung, William J. Parton, Claudia Wagner-Riddle, Ward Smith, Wilfried Winiwarter, Brian Grant, Mario Tenuta, Ernie Marx, Shannon Spencer, Stephen Williams

Stephen J. Del Grosso
steve.delgrosso@ars.usda.gov

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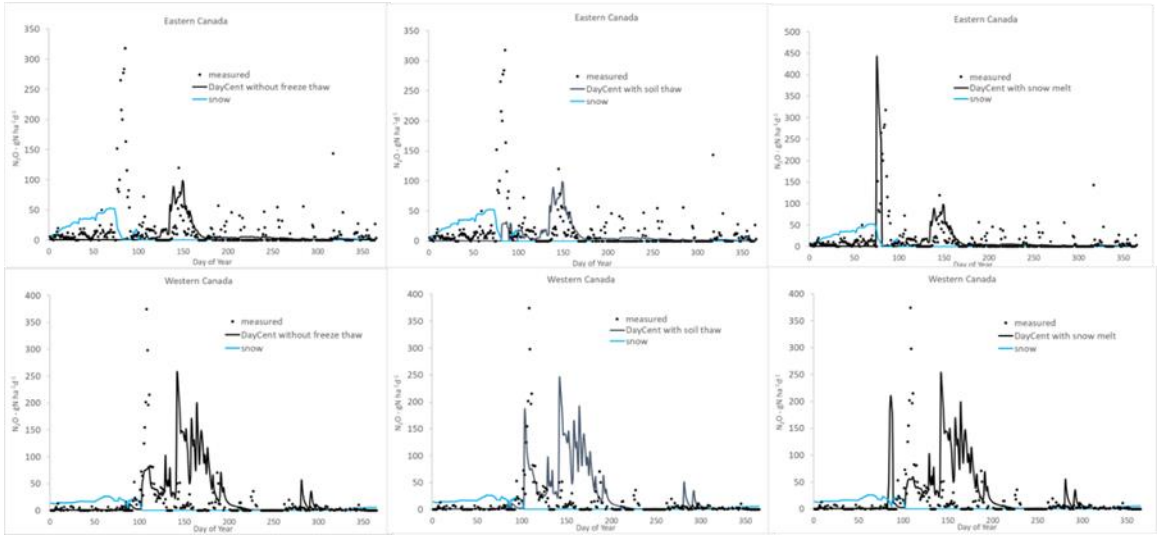

Fig. S1. Simulated and observed N2O emissions from cropped soils in Eastern and Western Canada comparing DayCent without freeze-thaw and enhancements based on thawing of soil and melting of snow, and simulated snowpack..

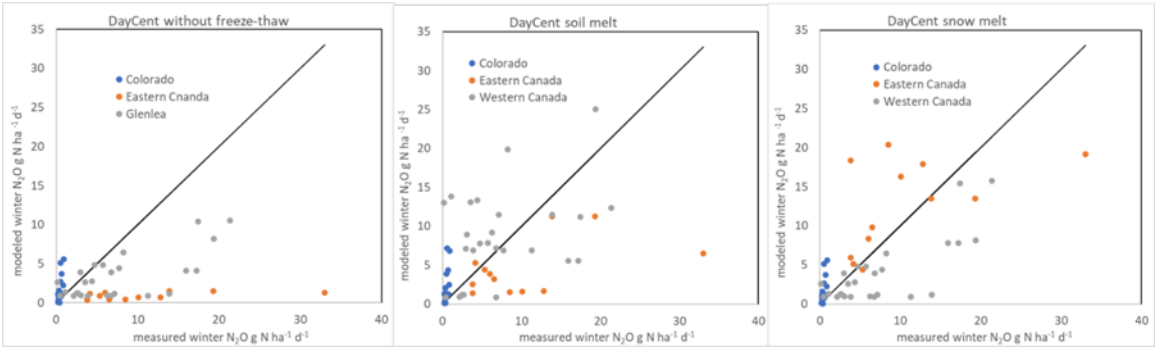

Fig. S2. N_2O emissions from cropped soils used for model parameterization in Colorado, Eastern and Western Canada comparing DayCent without freeze-thaw and enhancements based on thawing of soil and melting of snow.

Table S1. Research sites used for freeze-thaw related N_2O emission calibration of the DayCent model. Fluxes were measured at the Colorado site using ground level chamber-based measurements and the Canadian sites used micro metrological flux data.

Site	crop	tillage	N fertilizer kg N ha^{-1}	years
ARDEC, Colorado (1)	maize	conventional	0	2002-2004
ARDEC Colorado	maize	no till	0	2002-2004
ARDEC Colorado	maize	conventional	130	2002-2004
ARDEC Colorado	maize	no till	130	2002-2004
ARDEC Colorado	maize	conventional	170	2002-2004
ARDEC Colorado	maize	no till	170	2002-2004
ARDEC Colorado	maize	conventional	70	2003-2004
ARDEC Colorado	maize	no till	70	2003-2004
Elora, Ontario (2)	maize, soybean, wheat, clover	no till	160, 0, 90	2000-2005
Elora Ontario	maize, soybean, wheat	conventional	60[1], 0, 60	2000-2005
Glenlea, Manitoba (3)	maize, faba bean, alfalfa	conventional on maize	90, 0, 0	2006-2012
Glenlea Manitoba	maize, faba bean, spring wheat, rapeseed, barley	conventional	130, 0, 110, 150, 110	2006-2012
Glenlea Manitoba	maize, faba bean, spring wheat, rapeseed, barley	conventional	130, 0, 110, 150, 110	2006-2012
Glenlea Manitoba	Maize, faba bean, alfalfa	conventional	90, 0, 0	2006-2012

[1]Organic N

Table S2. Comparisons of the the DayCent model without freeze-thaw) and different optimized freeze-thaw models with N_2O flux data from research sites in Sup. Table 1 for January-April mean fluxes. CFDmin is the minimum cumulative freezing degree days required to trigger a pulse of minimum magnitude and pulse magnitude increases linearly up to CFDmax.

$CFD = \sum_{i=1}^{n}(-T_s)$ For Ts < 0°C, where Ts is soil temperature at 5 cm depth and n = number of days over the non-growing season

				Site level Comparisons			Inversion Comparison
Event Conditions	Event Activation	CFDmin	CFDmax	RMSE	Bias	r	r
No freeze thaw				7.57	-3.99	0.45	0.74
Snow Accumulation	Snow Melt			6.21	-0.27	0.49	
CFD without reset after F-T events	Thawing in 0-2 cm	90	180	7.34	0.10	0.52	
CFD with reset after F-T events	Thawing in 0-2 cm	5	25	6.49	-0.33	0.57	
CFD without reset after F-T events	Thawing in 2-5 cm	100	180	6.74	-0.22	0.56	0.81
CFD with reset after F-T events	Thawing in 2-5 cm	5	10	6.28	-0.33	0.56	
Snow Accumulation, CFD without reset after F-T events	Snow Melt	190	280	5.31	-0.93	0.56	0.68
Snow Accumulation, CFD with reset after F-T events	Snow Melt	110	160	4.52	-0.36	0.56	0.71

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SI References

1. A.R. Mosier, A.D. Halvorson, C.A. Reule, X.J Liu, Net global warming potential and greenhouse gas intensity in irrigated cropping systems in northeastern Colorado. *Journal of environmental quality*, 35(4),1584-1598 (2006).
2. C. Wagner-Riddle, et al., Intensive measurement of nitrous oxide emissions from a corn–soybean–wheat rotation under two contrasting management systems over 5 years. *Global Change Biology* 13: 1722–1736 (2007).
3. S.E. Maas, A.J. Glenn, M. Tenuta, D.B. Amiro, Net CO_2 and N_2O exchange during perennial forage establishment in an annual crop rotation in the Red River Valley, Manitoba. *Can. J. Soil Sci*. 93: 639-652 (2013).