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Soil Research

Supplementary Material

Modelling nitrous oxide emissions: comparing algorithms in six widely used agro-ecological models.

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Table S1. Source and equations to represent nitrification APSIM, DNDC, DayCent, FASSAT, NOE and WNMM. Abbreviations are given in Table S4.

	Model	Equations	Source
Nitrification rate	APSIM	$R_n = R_{P\_n} \times f_{n(NH4)} \times \min(f_{n(SW)}, f_{n(ST)}, f_{n(pH)})$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$R_n = R_{p\_n} \times f_{n(NH4)} \times B_n \times f_{n(pH)}$	Li et al. 2000
	DayCent	$R_{n\_Max} = K_{max} \times f_{n(NH4)} \times f_{n(SW)} \times f_{n(ST)} \times f_{n(pH)} + K_1 \times N_{min}$ $R_n = \min\,(R_{p\_n}, C_{NH4} \times R_{n\_Max})$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$R_n = R_{P\_n} \times f_{n(NH4)} \times f_{n(SW)} \times f_{n(ST)} \times f_{n(pH)}$	Chatskikh et al. 2005
	NOE	$R_n = \begin{cases} f_{n(NH4)} \times f_{n(SW)} \times f_{n(ST)} & WFPS < 0.8 \\ 0 & WFPS > 0.8 \end{cases}$	Henault et al. 2005
	WNMM	$R_n = R_{P\_n} \times f_{n(NH4)} \times (1.0 - \exp(-f_{n(SW)} \times f_{n(ST)} \times f_{n(pH)}))$	Li et al. 2007
Soil moisture	APSIM	$f_{n(SW)} = \begin{cases} WFD/0.5; & 0.0 < WFD \le 0.25 \\ 1.0\;; & 0.5 < WFD \le 1.0 \\ 1.0 - (WFD - 1.0) * 0.5; & 1.0 < WFD \le 2.0 \\ 0; & WFD > 2.0 \end{cases}$ $WFD = \begin{cases} 1.0 + (SW - DUL)/(SAT - DUL) & SW > DUL \\ (SW - LL)/(DUL - LL) & SW \le DUL \end{cases}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$f_{n(SW)} = \begin{cases} 0.8 + 0.21 \times (1.0 - WFPS) & WFPS > 0.05 \\ 0 & WFPS \le 0.05 \end{cases}$	Li et al. 2000
	DayCent	$f_{n(SW)} = (\frac{WFPS-b}{a-b})^{d \times \frac{(b-a)}{(a-c)}} \times \left(\frac{WFPS-c}{a-c}\right)$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001

	FASSAT	$f_{n(SW)} = \begin{cases} 0.6 & \varphi \geq -9.81 \times 10^{-5} \\ 0.6 + 0.4 \times \log_{10}(-\frac{\varphi}{-9.81} \times 10^{-5})/1.5 & -9.81 \times 10^{-5} > \varphi \geq -3.1 \times 10^{-3} \\ 1.0 & -3.1 \times 10^{-3} > \varphi \geq -3.1 \times 10^{-2} \\ 1.0 - (\log_{10}\left(-\frac{\varphi}{-9.81} \times 10^{-5}\right) - 2.5)/3.0 & -3.1 \times 10^{-2} > \varphi \geq -3.1 \times 10^{2} \\ 0.0 & -31 > \varphi \end{cases}$	Chatskikh et al. 2005
	NOE	$f_{n(SW)} = a \times SW_g + \mathrm{b}$	Henault et al. 2005
	WNMM	$f_{n(SW)} = \begin{cases} \frac{SW-WP}{SW25-WP} & SW < SW25 \\ 1.0 & SW25 \leq SW < FC \\ 1.0 - \frac{SW-FC}{PO-FC} & SW > FC \end{cases}$	Li et al. 2007
Soil temperature	APSIM	$f_{n(ST)} = \begin{cases} (ST/32)^2 & 0 \leq ST \leq 32 \\ 1 & ST > 32 \end{cases}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$f_{n(ST)} = ((60 - ST)/25.78)^{3.503} \times \exp\,(3.503 \times (ST - 34.22)/25.78)$	Li et al. 2000
	DayCent	$f_{n(ST)} = A_{nitr} + B_{nitr} \times \exp\,(C_{nitr} \times ST)$	Parton et al. 1996; Parton et al. 2001
	FASSAT	$f_{n(ST)} = a_u \times \exp\,(b_u + c_u \times ST \times \left(1 - 0.5 \times \frac{ST}{d_u}\right))$	Chatskikh et al. 2005
	NOE	$f_{n(ST)} = \begin{cases} \exp\left((ST - 11) \times ln(89) - 9 \times \frac{ln(2.1)}{10}\right) & ST < 11\,°\mathrm{C} \\ \exp\left((ST - 20) \times \frac{ln(2.1)}{10}\right) & ST \geq 11°\mathrm{C} \end{cases}$	Henault et al. 2005
	WNMM	$f_{n(ST)} = 0.41 \times \frac{ST-5}{10} \quad ST > 5°\mathrm{C}$	Li et al. 2007

soil pH	APSIM	$f_{n(sw)} = \begin{cases} 0 & pH < 4.5 \\ \frac{pH-4.5}{1.5} & 4.5 \le pH < 6.0 \\ 1.0 & 6.0 \le pH < 8 \\ 9.0 - pH & 8.0 < pH \le 9.0 \\ 0 & pH > 9.0 \end{cases}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$f_{n(pH)} = pH$	Li et al. 2000
	DayCent	$f_{n(pH)} = 0.56 + \frac{atan(\pi \times 0.45 \times (-5+pH))}{\pi}$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	NA	Chatskikh et al. 2005
	NOE	NA	Henault et al. 2005
	WNMM	$f_{n(pH)} = \begin{cases} 0.307 \times pH - 1.269, & pH < 7.0 \\ 1.0, & 7.4 \ge pH \ge 7.0 \\ 5.367 - 0.599 \times pH, & pH > 7.4 \end{cases}$	Li et al. 2007
NH_4^+	APSIM	$f_{n(NH4)} = \frac{C_{NH4}}{K_m + C_{NH4}}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$f_{n(NH4)} = C_{NH4}$	Li et al. 2000
	DayCent	$f_{n(NH4)} = 1 - e^{-0.0105 \times C_{NH4}}$	Parton et al. 1996; Parton et al. 2001; DayCent source code
	FASSAT	$f_{n(NH4)} = C_{NH4}$	Chatskikh et al. 2005
	NOE	$f_{n(NH4)} = \frac{C_{NH4}}{K_m + C_{NH4}}$	Henault et al. 2005
	WNMM	$f_{n(NH4)} = C_{NH4}$	Li et al. 2007

Soil organic carbon	APSIM	NA	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$U_g = U_{max} \times (C_{DOC}/(1 + C_{DOC}) + f_{n(SW)}/(1 + f_{n(SW)}))$ $U_d = A_{max} \times B_n/(5 + C_{DOC})/(1 + f_{n(SW)})$ $U_b = (U_g - U_d)B_n \times f_{n(SW)} \times f_{n(ST)}$	Li et al. 2000
	DayCent	$f_{OC} = K_1 \times N_{min}$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	NA	Chatskikh et al. 2005
	NOE	NA	Henault et al. 2005
	WNMM	NA	Li et al. 2007
N_2O from nitrification	APSIM	$N2O_n = K_{N2O\_n} \times Rn$ $K_{N2O\_n} = K_1$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	$N2O_n = K_{N2O\_n} \times Rn \times f_{(ST\_N2O\_n)} \times WFPS$ $K_{N2O\_n} = K_1$ $N2O_n = K_{N2O\_n} \times Rn$	Li et al. 2000 Li (2000)
	DayCent	$N2O_n = K_{N2O\_n} \times Rn$ $K_{N2O\_n} = K_1$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$N2O_n = K_{N2O\_n} \times R_n$ $K_{N2O\_n} = K_1 \times f_{(SW\_N2O\_n)} \times f_{(ST\_N2O\_n)}$ $f_{(ST\_N2O\_n)} = min\,[1.0, \exp\left(-0.5\left(\frac{ST-2a_n}{a_n}\right)^2\right)]$	Chatskikh et al. 2005
	NOE	$N2O_n = \begin{cases} K_{N2O\_d} \times K_{N2O\_n} \times R_n & WFPS < 0.62 \\ K_{N2O\_n} \times R_n & WFPS \geq 0.62 \end{cases}$	Henault et al. 2005

		$K_{N2O\_n} = K_1$	
	WNMM	$N2O_n = K_{N2O\_n} \times R_n$ $K_{N2O\_n} = K_1 \times f_{(SW\_N2O\_n)} \times f_{(ST\_N2O\_n)}$ $f_{(SW\_N2O\_n)} = f_{n(SW)}$ $f_{(ST\_N2O\_n)} = 0.9 \times \left(\frac{ST}{ST+\exp(9.93-0.312\times ST)}\right) + 0.1$	Li et al. 2007

Table S2. Source and equations to represent denitrification APSIM, DNDC, DayCent, FASSAT, NOE and WNMM. Abbreviations are given in Table S4.

	Model	Equations	Source
Denitrification rate	APSIM	$R_d = R_{P\_d} \times f_{(NO3)} \times f_{(C_{OC\_A})} \times f_{(SW\_d)} \times f_{(ST\_d)}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	$R_d = \min\left(f_{(NO3)}, f_{(CO2)}\right) \times f_{(SW\_d)}$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$R_d = R_{P\_d} \times f_{(NO3)} \times f_{(SW\_d)} \times f_{(ST\_d)}$	Chatskikh et al. 2005
	NOE	$R_d = R_{P\_d} \times f_{(NO3)} \times f_{(SW\_d)} \times f_{(ST\_d)}$	Henault et al. 2005
	WNMM	$R_d = \begin{cases} 0, & WFPS < 0.8 \\ f_{(NO3)} \times \left(1.0 - \exp\left(-1.4 \times f_{(SW_d)} \times f_{(ST_d)} \times f_{(SOC)}\right)\right), & WFPS \geq 0.8 \end{cases}$	Li et al. 2007
Soil moisture	APSIM	$f_{(SW\_d)} = \frac{SW-DUL}{SAT-DUL}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	$f_{(SW\_d)} = 0.5 + a\,tan(\,0.6 \times \pi \times (0.1 \times WFPS - a_d))/\pi$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$f_{(SW\_d)} = \max\left(0, \min\left(1, a_Q + \frac{b_Q}{1+\exp\left(-\frac{WFPS-c_Q}{d_Q}\right)}\right)\right)$	Chatskikh et al. 2005
	NOE	$f_{(SW\_d)} = \begin{cases} 0 & WFPS < 0.62 \\ ((WFPS - 0.62)/0.38)^{1.74} & WFPS \geq\ 0.62 \end{cases}$	Henault et al. 2005

	WNMM	$f_{(SW\_d)} = \exp(-23.77 + 23.77 \times WFPS)$	Li et al. 2007
Soil temperature	APSIM	$f_{(ST\_d)} = 0.1 \times \exp(0.046 \times ST)$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	NA	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$f_{(ST\_d)} = a_u \times \exp\left(b_u + c_u \times ST \times \left(1 - 0.5 \times \frac{ST}{d_u}\right)\right)$	Chatskikh et al. 2005
	NOE	$f_{(ST\_d)} = \begin{cases} \exp\left((ST - 11) \times ln(89) - 9 \times \frac{ln(2.1)}{10}\right) & ST < 11\ ^{\circ}\mathrm{C} \\ \exp\left((ST - 20) \times \frac{ln(2.1)}{10}\right) & ST \geq 11^{\circ}\mathrm{C} \end{cases}$	Henault et al. 2005
	WNMM	$f_{(ST\_d)} = 0.9 \times \left(\frac{ST}{ST + \exp(9.93 - 0.312 \times ST)}\right) + 0.1$	Li et al. 2007
soil pH	APSIM	NA	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	NA	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	NA	Chatskikh et al. 2005
	NOE	NA	Henault et al. 2005

	WNMM	NA	Li et al. 2007
Soil organic carbon	APSIM	$f_{(C_{OC\_A})} = 0.0031 \times C_{OC\_A} + 24.5$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	$f_{(CO2)} = 0.1 \times CO2^{1.3}$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$R_{P\_d} = (a_d + b_d \times CLAY) \times N_{min}$ $f_{(OC)} = R_{P\_d}$	Chatskikh et al. 2005
	NOE	NA	Henault et al. 2005
	WNMM	$f_{(OC)} = 1.0 - e^{(-1.4 \times C_{OC})}$	Li et al. 2007
NO_3	APSIM	$f_{(NO3)} = C_{NO3}$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	$f_{(NO3)} = 1.15 \times C_{NO3}{}^{0.57}$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$f_{(NO3)} = \max\left(0, \min\left(1, a_N \times \frac{C_{NO3}}{b_N + C_{NO3}}\right)\right)$	Chatskikh et al. 2005
	NOE	$f_{(NO3)} = \frac{C_{NO3}}{K_{m\_d} + C_{NO3}}$	Henault et al. 2005
	WNMM	$f_{(NO3)} = C_{NO3}$	Li et al. 2007

N_2O	APSIM	$N2O_d = K_{N2O\_d} \times R_d$ $K_{N2O\_d} = \frac{1}{K_{r\_d}+1}$ $K_{r\_d} = f_{(NO3/SOC\_N2O\_d)} \times f_{(SW\_N2O\_d)}$ $f_{(NO3/SOC\_N2O\_d)} = \max(0.16 \times k_{d1},\ k_{d1} \times \exp(\frac{-0.8 \times C_{NO3}}{CO2})$ $f_{(SW\_N2O\_d)} = \max(0.1, 1.5 \times WFPS - 0.32)$	Thorburn et al. 2010; Xing et al. 2011
	DNDC	See Table S3	
	DayCent	$N2O_d = K_{N2O\_d} \times R_d$ $K_{N2O\_d} = \frac{1}{K_{r\_d}+1}$ $K_{r\_d} = f_{(NO3/SOC\_N2O\_d)} \times f_{(SW\_N2O\_d)}$ $f_{(NO3/SOC\_N2O\_d)} = \max(0.16 \times k_{d1},\ k_{d1} \times \exp(\frac{-0.8 \times C_{NO3}}{CO2})$ $f_{(SW\_N2O\_d)} = \max(0.1, 1.5 \times WFPS - 0.32)$	Parton et al. 1996; del Grosso et al. 2000; Parton et al. 2001
	FASSAT	$N2O_d = K_{N2O\_d} \times R_d$ $K_{N2O\_d} = f_{(SW\_N2O\_d)} \times f_{(ST\_N2O\_d)} \times f_{(NO3\_N2O\_depth)} \times f_{(clay)}$ $f_{(ST\_N2O\_d)} = 1/(1 + \exp(a_T + b_T \times ST))$ $f_{(SW\_N2O\_d)} = (1.0 - f_{(SW\_d)})$ $f_{(NO3\_N2O\_depth)} = \max(0, \min(1, a_D - b_D \times Depth - c_D \times Depth^2))$ $f_{(clay)} = \max(0, \min(1, a_C \times \exp(b_C \times CLAY) - c_C)))$	Chatskikh et al. 2005
	NOE	$N2O_d = K_{N2O\_d} \times R_d$	Henault et al. 2005
	WNMM	$N2O_d = \begin{cases} 0.05 \times R_d, & WFPS \geq 1.0 \\ a_{den} \times R_d \times (1.0 - f_{(SW\_N2O\_d)}), & WFPS < 1.0 \end{cases}$ $f_{(SW\_N2O\_d)} = \exp(-23.77 + 23.77 \times WFPS)$	Li et al. 2007

Table S3. Source and equations used to represent denitrification in DNDC. Abbreviations are given in Table S4.

Model		Equations	Source
DNDC	The dynamics of dinitrifiers	$U_{NOx} = U_{NOx(max)} \times C_{DOC}/(Kc + C_{DOC}) \times C_{NOx}/(Kn + C_{NOx})$ $U_{dg} = f_{ST\_d} \times (U_{NO3} \times f_{pH1} + U_{NO2} \times f_{pH2} + U_{NO} \times f_{pH2} + U_{N2O} \times f_{pH3})$ $R_{dg} = U_{dg} B_{dg}$ $R_d = M_c \times Y_c \times B_{dg}$ $R_C = (U_{dg}/Y_c + M_c) \times B_{dg}$	Li et al. 2000
	The consumption rates of NO_x	$R_{NOx} = (\frac{U_{NOx}}{Y_{NOx}} + M_{NOx} \times \frac{C_{NOx}}{C_N})/B_{dg}$	Li et al. 2000
	Soil temperature impact on denitrifiers	$f_{ST\_d} = 2^{((ST-22.5)-10)}$	Li et al. 2000
	pH impact on denitrifiers in each stage	$f_{pH1} = 1.0 - 1.0/(1.0 + \exp(pH - 4.25/0.5))$ $f_{pH2} = 1.0 - 1.0/(1.0 + \exp(pH - 5.25)$ $f_{pH3} = 1.0 - 1.0/(1.0 + \exp(pH - 6.25/1.5))$	Li et al. 2000
	Diffusion rate of N_2O and NO in the balloon	$D\_NO = (0.0006 + 0.0013 \times f_{clay}) + (0.013 - 0.005 \times f_{clay}) \times PO \times (1.0 - ANVF)$ $D\_N2 = 0.017 + ((0.025 - 0.0013 \times f_{clay}) \times PO \times (1.0 - ANVF)$ $f_{clay} = 2.0 \times CLAY/0.63$	Li et al. 2000

Table S4. Nomenclature used in APSIM, DNDC, DayCent, FASSAT, NOE and WNMM.

Terminology	Definitions
R_n	Actual nitrification rates. The unit varies with models
R_{n_Max}	Maximum daily nitrification rate (g N ha^{-1} day^{-1}), used in DayCent
R_{P_n}	Potential nitrification rates. The unit varies with models
$f_{n(NH4)}$	Effects of NH_4^+ concentration on nitrification
$f_{n(SW)}$	Rate modifiers for the effect of soil moisture on nitrification
$f_{n(ST)}$	Rate modifiers for the effect of soil temperature on nitrification
$f_{n(pH)}$	Rate modifiers for the effect of soil pH conditions on nitrification
$N2O_n$	N_2O flux produced from nitrification
K_{N2O_n}	Actual fraction of nitrified N lost as N_2O flux
K_1	Potential fraction of nitrified N lost as N_2O flux
K_{max}	Maximum fraction of NH_4^+ nitrified (0.10 d^{-1})
K_m	NH_4^+ concentration that produces a rate of 1/2 V_{max}, which is the maximum nitrification rate at the optimum NH_4^+ concentration
$f_{(SW\_N2O\_n)}$	Modifiers for the effects of soil moisture on K_1
$f_{(ST\_N2O\_n)}$	Modifiers for the effects of soil temperature on K_1
B_n	Biomass of nitrifiers (kg C ha^{-1})
C_{NH4}	NH_4^+ concentration
pH	Soil pH
ST	Soil temperature
SW	soil volumetric water content
SWg	soil gravimetric water content
FC	Soil water content at field capacity
PO	Soil porosity
WP	Soil water content at plant wilting point

SW25	Soil water content at WP + 0.25× (FC−WP)
φ	Soil water potential (m H_2O)
N_{min}	Daily net N mineralization rate
WFPS	Water Filled Pore Space
DUL	Soil water content at drained upper limit
SAT	Soil water content at saturation
LL	Soil water content at lower limit, assumed to be equivalent to water content at 15 bars in APSIM
WFD	Internal parameter used in APSIM
R_d	Actual rates of denitrification. The unit varies with models
R_{P_d}	Potential rates of denitrification. The unit varies with models
$f_{(NO3)}$	Dimensionless modifiers for the effect of NO_3^- on denitrification
$f_{(OC)}$	Dimensionless modifiers for the effect of soil organic carbon on denitrification
$f_{(C_{OC\_A})}$	Dimensionless modifiers for the effect of soil active soil organic carbon on denitrification, used in APSIM
$f_{(CO2)}$	Dimensionless modifiers for the effect of soil heterotrophic CO_2 respiration on denitrification, used in DayCent
$f_{(SW\_d)}$	Dimensionless modifiers for the effect of soil moisture on denitrification
$f_{(ST\_d)}$	Dimensionless modifiers for the effect of soil temperature on denitrification
$f_{(pH\_d)}$	Dimensionless modifiers for the effect of soil pH on denitrification
C_{oc}	Percent content of the soil organic carbon (%)
C_{SOC}	Concentration of soil organic carbon (kg C ha^{-1})
C_{OC_A}	Active soil organic carbon, estimated by Humus and fresh organic carbon pools. This is used in APSIM
C_{DOC}	Concentration of dissolved organic carbon (kg C/ha)
C_{NO3}	NO_3^- concentration
K_{m_d}	NO_3^- concentration that produces a rate of 1/2 V_{max}, which is the maximum nitrification rate at the optimum NO_3^- concentration
K_{N2O_d}	Potential fraction of N_2O emitted from denitrification to daily denitrification rate
$N2O_d$	N_2O flux produced from denitrification (kg N ha^{-1} day^{-1})

K_{r_d}	Ratio of N_2/N_20 emitted during denitrification
CO_2	Heterotrophic CO_2 respiration
$f_{(NO3\_N2O\_d)}$	Modifiers for the effect of NO_3^- concentration on K_2
$f_{(SOC\_N2O\_d)}$	Modifiers for the effect of soil organic carbon on K_2
$f_{(SW\_N2O\_d)}$	Modifiers for the effect of soil moisture on K_2
$f_{(ST\_N2O\_d)}$	Modifiers for the effect of soil temperature on K_2
$f_{(ST\_N2O\_dwpth)}$	Modifiers for the effect of soil depth on K_2
$f_{(clay)}$	Modifiers for the effect of soil clay content on K_2
$f_{(NO3/SOC\_N2O\_d)}$	Modifiers for the interaction effect of NO_3^- concentration and heterotrophic CO_2 respiration on K_2
CLAY	Soil clay content (%)
Depth	Soil depth (cm)
k_{d1}	Parameter is related to gas diffusivity in soil at field capacity
$U_{NO3(max)}$	Maximum growth rate of nitrogen oxides denitrifier
Kc	Half-saturation value of soluble carbon
Kn	Half-saturation value of N-oxide
Mc	Maintenance coefficient on C
Yc	Maximum growth rate of soluble C
C_N	Concentration of NO_3^-, NO_2^-, NO and N_2O (kg N/m^3)
C_{NOx}	Concentration of all NO_x (kg N/m^3)
f_{pH1}	pH factors for NO_3^- denitrifiers
f_{pH2}	pH factors for NO_2^- and NO denitrifiers
f_{pH3}	pH factors for N_2O denitrifiers
B_{dg}	Denitrifiers biomass (kg C/ha)
U_{NOx}	Relative growth rate of NO_x denitrifiers
U_{dg}	Relative growth rate of total denitrifiers
R_{dg}	Growth rate of total denitrifiers
R_d	Death rate of total denitrifiers

R_c	Carbon consumption rate
R_{NOx}	Consumption rates of NO_x
M_{NOx}	Maintenance coefficient on N oxides
Y_{NOx}	Maximum growth rate on N oxides (NO_3^-, NO_2^-, NO and N_2O)
D_NO	Gas diffusion to NO and N_2O
D_N2	Gas diffusion rate of N_2O and NO
ANVF	Volumetric fraction of anaerobic microsites
a, b, c, d and a_d	Inner parameters used in DayCent
A_{nitr}, B_{nitr}, C_{nitr}	Inner parameters used in DayCent for estimating soil temperature impact on daily nitrification rate, which vary with the optimal soil temperature for nitrification (site specific parameter)
a_n, a_Q, b_Q, c_Q, d_Q, a_u, b_u,c_u,d_u, a_d,b_d, a_N, b_N, a_C, b_C, and c_C	Inner parameters used in FASSAT
Amax	Maximum death rate of nitrifiers
Umax	Maximum growth rate of nitrifiers
a_{den}	Maximum fraction of N_2O emission in total denitrification that is at 0.8 of WFPS (0–1)