Tables

Table 1: State variables, model forcings, and derived output variables for which calibration data were available. The * indicates availability of a data counterpart for calibration. The subscript i refers to the two phytoplankton groups ($i \in \{I, II\}$)

Acronym	Description	Units	
	State variables		
DIN	dissolved inorganic nitrogen	$\mathrm{mmol m^{-3}}$	*
DON	dissolved organic nitrogen	$\mathrm{mmol m^{-3}}$	*
$^{13}C_{Phyto_i}$	^{13}C in phytoplankton group i	$\mathrm{mmol m^{-3}}$	
$^{12}C_{Phyto_i}$	^{12}C in phytoplankton group i	$\mathrm{mmol m^{-3}}$	
$^{13}C_{Zoo}$	^{13}C in zooplankton	$\mathrm{mmol m^{-3}}$	
$^{13}C_{Det}$	^{13}C in detritus	$\mathrm{mmol m^{-3}}$	
$^{12}C_{Det}$	^{12}C in detritus	$\mathrm{mmol m^{-3}}$	
$^{13}C_{Bac}$	^{13}C in bacteria	$\mathrm{mmol m^{-3}}$	
$^{13}C_{LDOC}$	^{13}C in labile dissolved organic carbon	$\mathrm{mmol m^{-3}}$	
$^{12}C_{LDOC}$	^{12}C in labile dissolved organic carbon	$\mathrm{mmol m^{-3}}$	
$^{13}C_{Sed}$	^{13}C in sedimented detritus	$\mathrm{mmol m^{-3}}$	
$^{12}C_{Sed}$	^{12}C in sedimented detritus	$\mathrm{mmol m^{-3}}$	
	Forcing functions		
$^{13}C_{DIC}$	^{13}C in dissolved inorganic carbon	$\mathrm{mmol m^{-3}}$	
$^{12}C_{DIC}$	^{12}C in dissolved inorganic carbon	$\mathrm{mmol m^{-3}}$	
I	irradiance	$\mathrm{W m^{-2}}$	
	Derived output variables relevant for calibration		
DOC_{tot}	total DOC (labile + refractory background)	$\mathrm{mmol m^{-3}}$	*
POC	particulate organic carbon	$\mathrm{mmol m^{-3}}$	*
PON	particulate organic nitrogen	$\mathrm{mmol m^{-3}}$	*
C_{Phyto_i}	carbon in phytoplankton group i	$\mathrm{mmol m^{-3}}$	*
C_{Sed}	carbon in sedimented detritus	$\mathrm{mmol m^{-3}}$	*
N_{Sed}	nitrogen in sedimented detritus	$\mathrm{mmol m^{-3}}$	*
$\delta^{13}C_{Phyto_i}$	$\delta^{13}C$ of phytoplankton group i	‰	*
$\delta^{13}C_{Zoo}$	$\delta^{13}C$ in zooplankton	‰	*
$\delta^{13}C_{Bact}$	$\delta^{13}C$ in bacteria	‰	*
$\delta^{13}C_{Sed}$	$\delta^{13}C$ in sedimented detritus	‰	*
$\delta^{13}C_{POC}$	$\delta^{13}C$ in POC	‰	*

Table 2: Rate equations, mass balance equations for the state variables, and equations for the calculation of derived output variables. The subscript i refers to the phytoplankton groups ($i \in \{I, II\}$). The superscript x refers to the carbon isotope ($x \in \{12, 13\}$).

Rate equations

$$F_{DIC}^{^{13}C} = pref \times \frac{^{13}C_{DIC}}{^{13}C_{DIC} + ^{12}C_{DIC}} \quad (4)$$

$$growth_{Phyto_i} = \mu_i \times \frac{DIN}{DIN + ks_N} \times \frac{I}{I + ks_I} \times C_{Phyto_i} \quad (5)$$

$$mort_{Phyto_i} = \xi_i \times C_{Phyto_i} \quad (6)$$

$$Loss_{Phyto_i}^{DOM} = f_{DOM} \times mort_{Phyto_i} \quad (7)$$

$$Loss_{Phyto_i}^{Det} = f_{Det} \times mort_{Phyto_i} \quad (8)$$

$$resp_{Phyto_i} = (1 - f_{Det} - f_{DOM}) \times \sum_i mort_{Phyto_i} \quad (9)$$

$$exud_{Phyto_i} = \gamma_i \times growth_{Phyto_i} \quad (10)$$

$$graz_{Phyto_i} = \mu_g \times \frac{C_{Phyto_i}}{C_{Phyto_i} + ks_g} \times C_{Zoo} \quad (11)$$

$$resp_{Zoo} = (1 - f_{faeces} - f_{sink}) \times \sum_i graz_{Phyto_i} \quad (12)$$

$$Loss_{Zoo}^{Det} = f_{faeces} \times \sum_i graz_{Phyto_i} \quad (13)$$

$$Loss_{Zoo}^{Sed} = f_{sink} \times \sum_i graz_{Phyto_i} \quad (14)$$

$$growth_{Bac} = \mu_{Bac} \times \frac{LDOC}{LDOC + ks_{DOC}} \times C_{Bac} \quad (15)$$

$$resp_{Bac} = growth_{Bac} \quad (16)$$

$$min_{DON} = \rho \times DON \quad (17)$$

$$min_{Det} = \rho \times C_{Det} \quad (18)$$

$$sinking = r_{sink} \times C_{Det} \quad (19)$$

$$resp = \sum_i resp_{Phyto_i} + resp_{Zoo} + resp_{Bac} \quad (20)$$

Mass balance equations

$$\frac{d\,DIN}{dt} = (-\sum_i growth_{Phyto_i} + min_{Det} + resp) \times NC + min_{DON} \quad (21)$$

$$\frac{d\,DON}{dt} = (\sum_i exu_{Phyto_i} - growth_{Bac}) \times NC + \sum_i Loss_{Phyto_i}^{DOM} \times NC - min_{DON} \quad (22)$$

$$\frac{d\,^x C_{Phyto_i}}{dt} = growth_{Phyto_i} \times F_{DIC}^{^jC} - (mort_{Phyto_i} + graz_{Phyto_i} + exu_{Phyto_i}) \times F_{Phyto_i}^{^xC} \quad (23)$$

$$\frac{d\,^x C_{Det}}{dt} = \sum_i [F_{Phyto_i}^{^xC} \times Loss_{Phyto_i}^{Det} + F_{Zoo}^{^xC} \times Loss_{Zoo}^{Det}] - F_{Det}^{^xC} \times (min_{Det} + sinking) \quad (24)$$

$$\frac{d\,^x C_{LDOC}}{dt} = \sum_i [F_{Phyto_i}^{^xC} \times (exud_{Phyto_i} + Loss_{Phyto_i}^{DOM})] - F_{LDOC}^{^xC} \times growth_{Bac} \quad (25)$$

$$\frac{d\,^x C_{Sed}}{dt} = F_{Det}^{^xC} \times sinking + F_{Zoo}^{^xC} \times Loss_{Zoo}^{Sed} \quad (26)$$

$$\frac{d\,^{13} C_{Bac}}{dt} = growth_{Bac} \times (F_{LDOC}^{^{13}C} - F_{Bac}^{^{13}C}) \quad (27)$$

$$\frac{d\,^{13} C_{Zoo}}{dt} = \sum_i [(1 - f_{faeces}) \times graz_{Phyto_i} \times (F_{Phyto_i}^{^{13}C} - F_{Zoo}^{^{13}C})] \quad (28)$$

Additional output variables

$$C_{Phyto_i} = ^{13}C_{Phyto_i} + ^{12}C_{Phyto_i} \quad (29)$$

$$C_{Det} = ^{13}C_{Det} + ^{12}C_{Det} \quad (30)$$

$$C_{Sed} = ^{13}C_{Sed} + ^{12}C_{Sed} \quad (31)$$

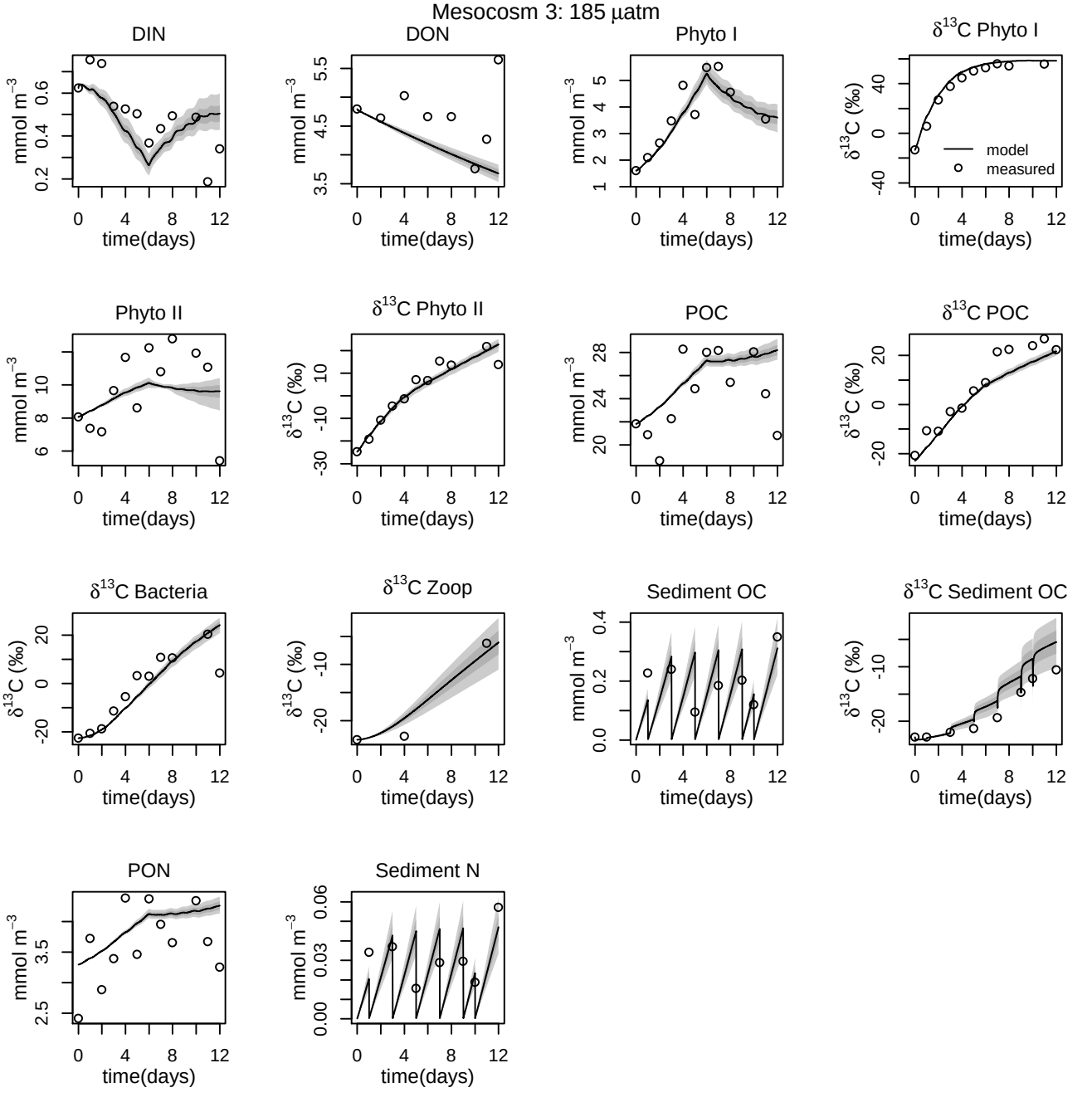
$$N_{Sed} = C_{Sed} \times NC \quad (32)$$

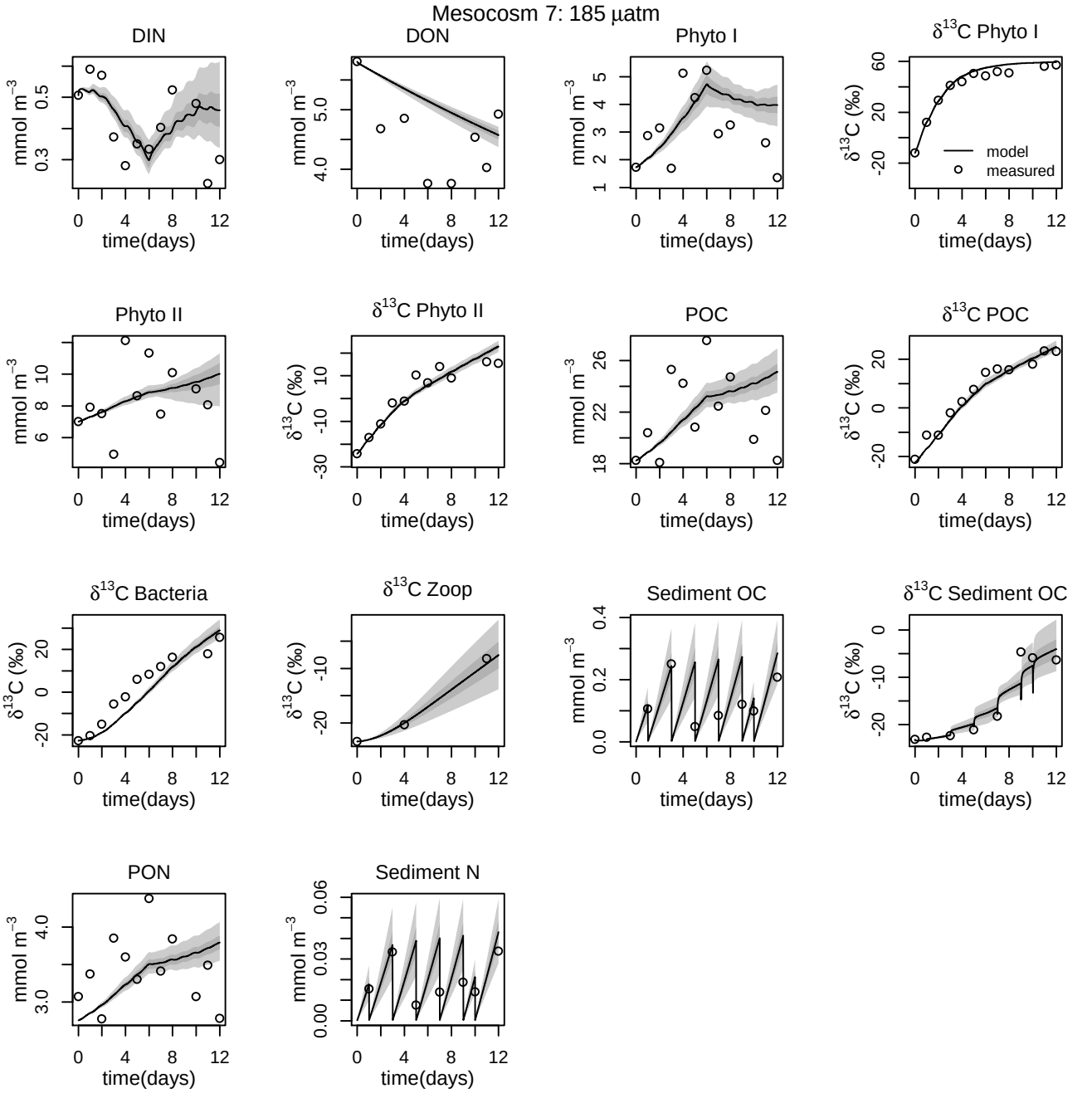
$$LDOC = ^{13}C_{LDOC} + ^{12}C_{LDOC} \quad (33)$$

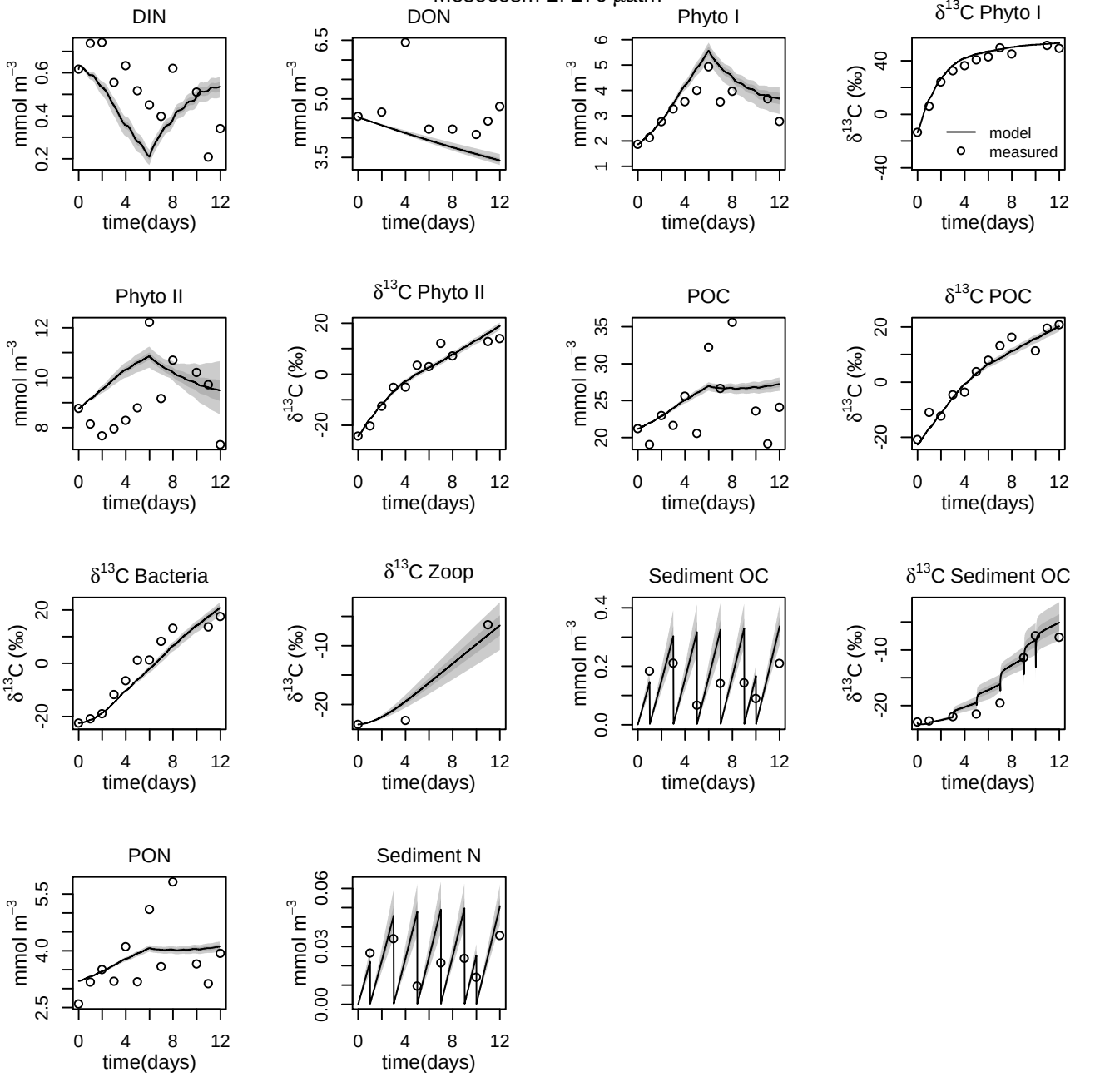
$$POC = \sum_i C_{Phyto_i} + C_{Zoo} + C_{Det} + C_{Bac} \quad (34)$$

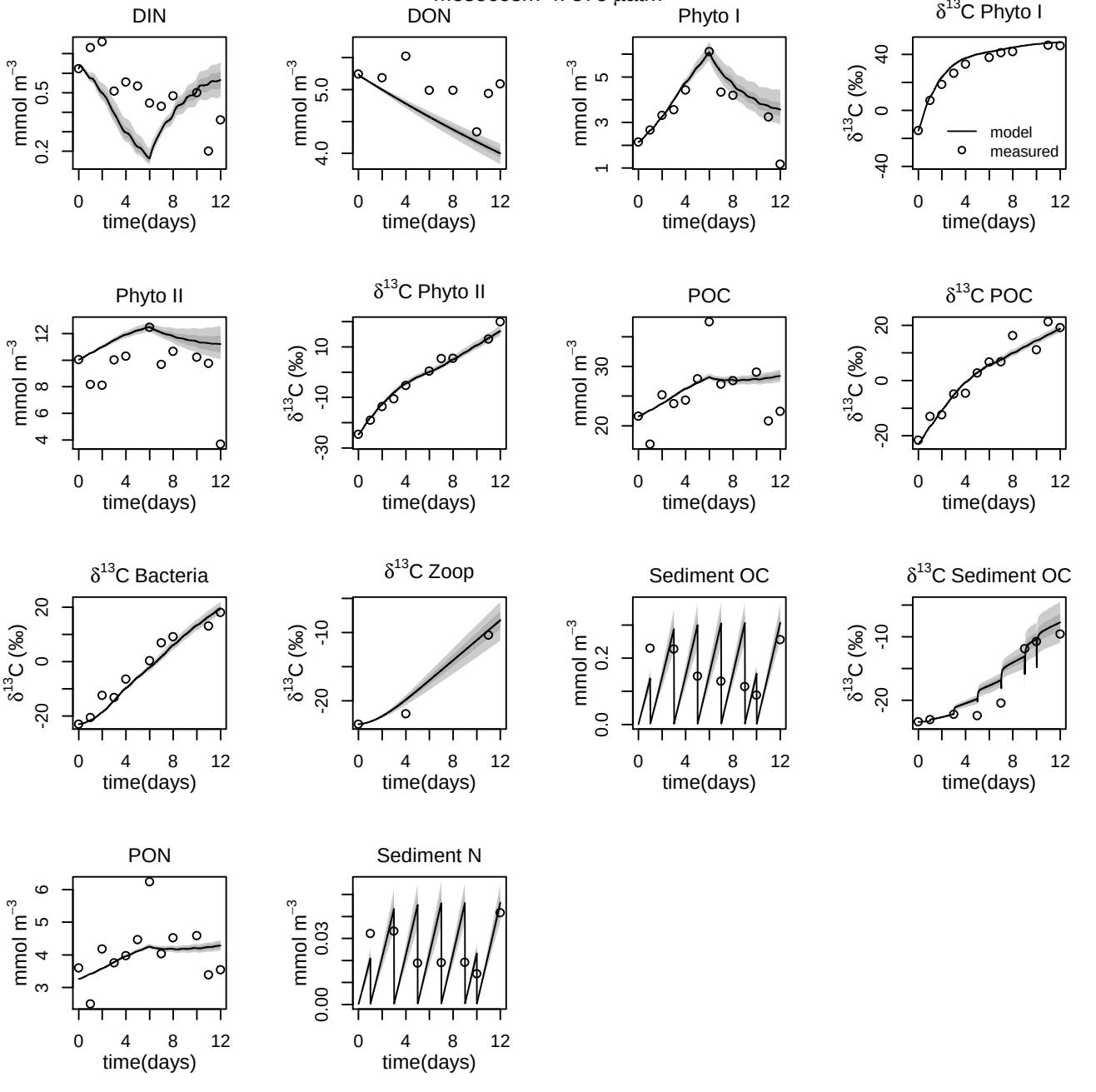
$$PON = POC \times NC \quad (35)$$

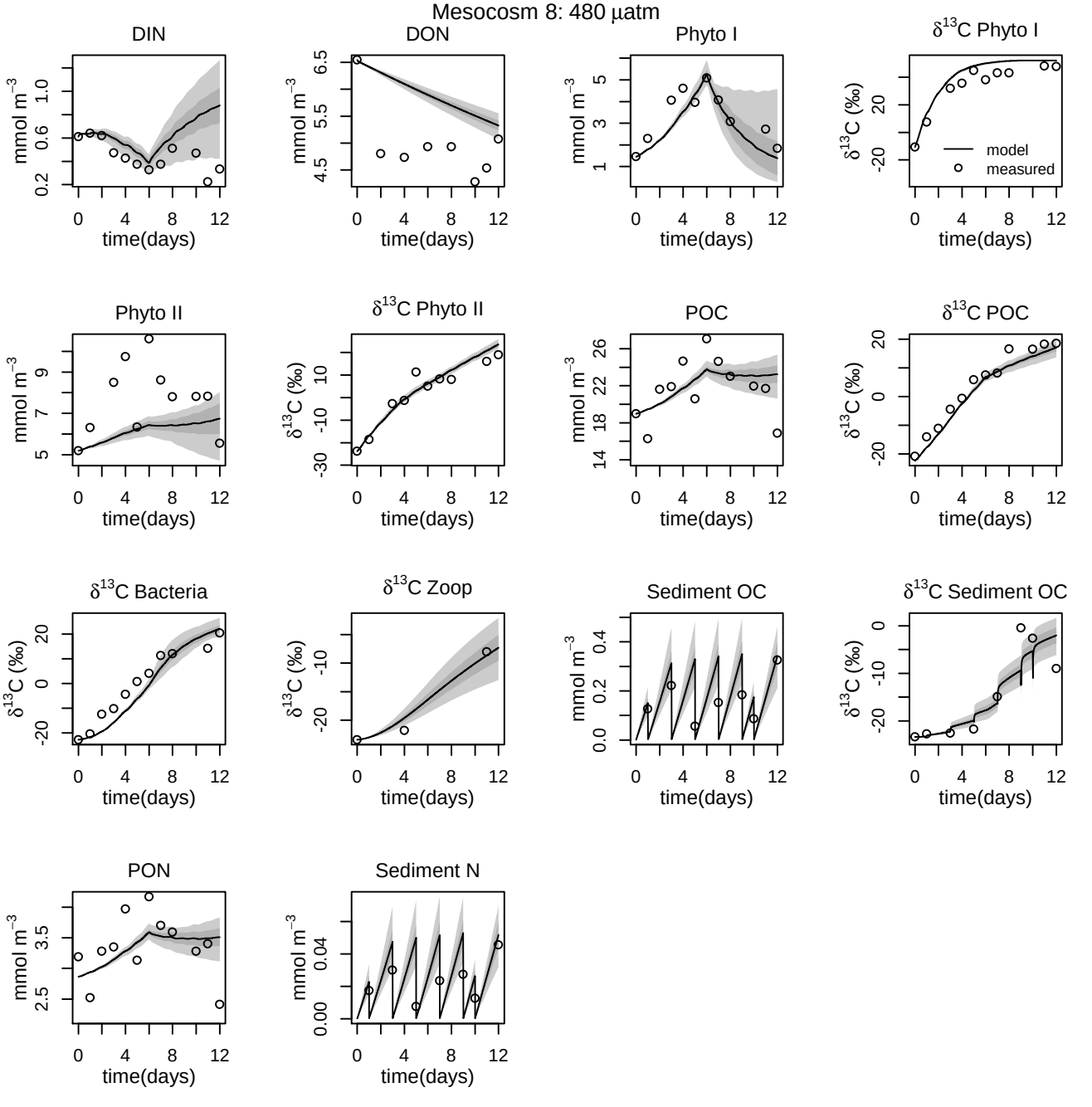
$$DOC_{tot} = DOC + LDOC \quad (36)$$

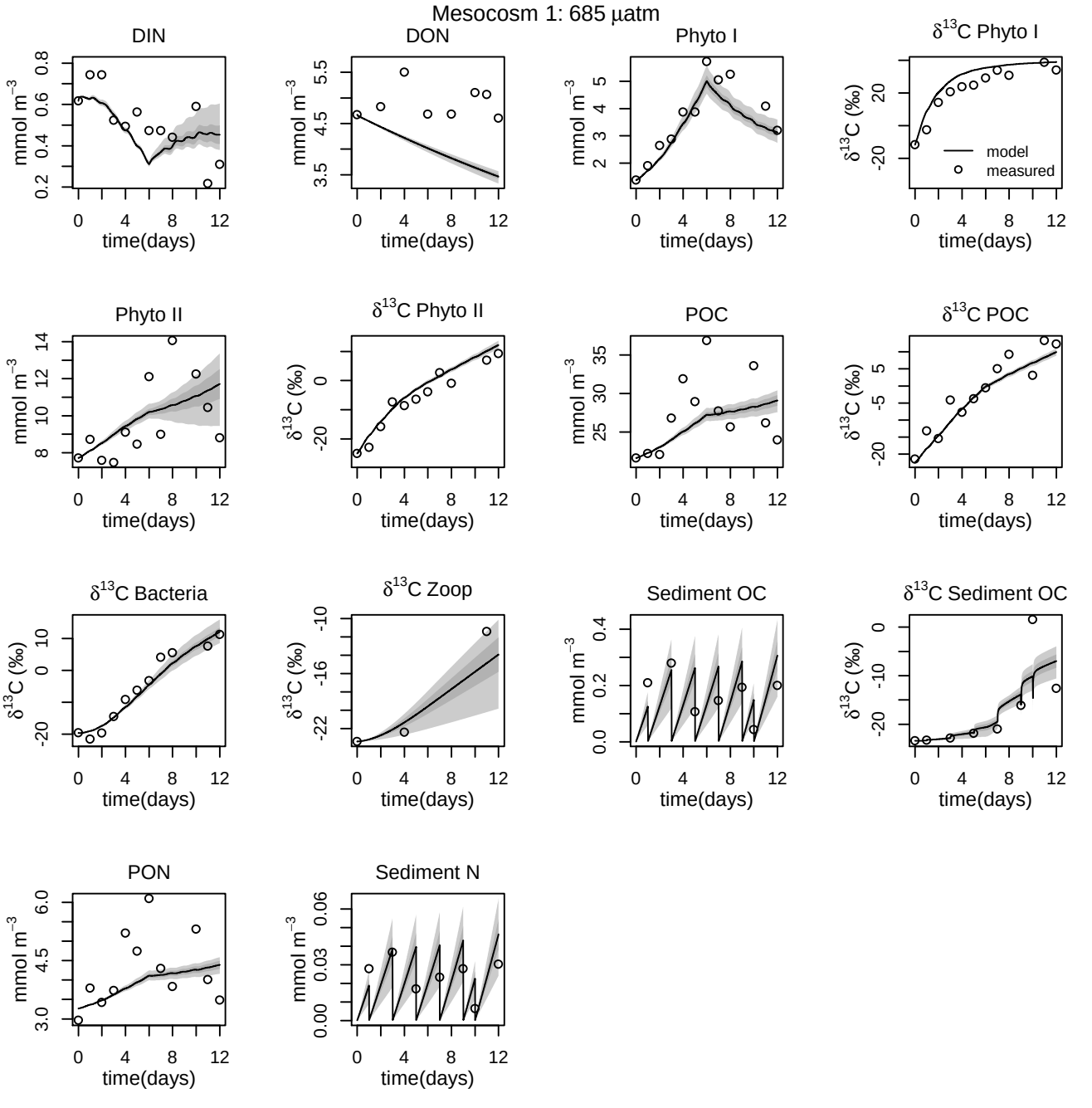

Mesocosm 3: 185 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured

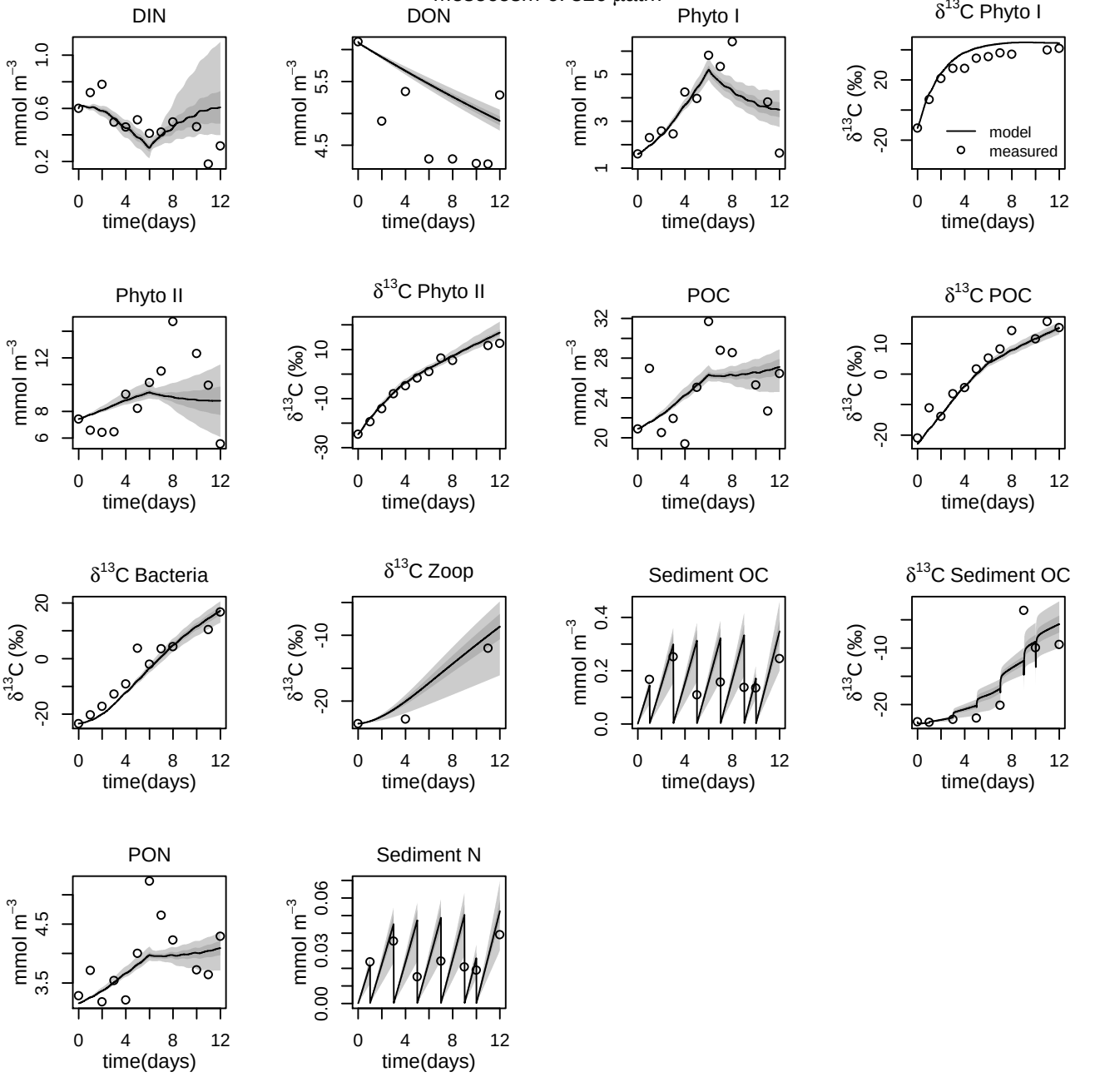

Mesocosm 7: 185 µatm
DIN
mmol m^{-3}
0.3
0.5
DON
mmol m^{-3}
4.0
5.0
Phyto I
mmol m^{-3}
1
2
3
4
5
δ^{13}C Phyto I
δ^{13}C (‰)
-20
20
60
model
measured
Phyto II
mmol m^{-3}
6
8
10
δ^{13}C Phyto II
δ^{13}C (‰)
-30
-10
10
POC
mmol m^{-3}
18
22
26
δ^{13}C POC
δ^{13}C (‰)
-20
0
20
δ^{13}C Bacteria
δ^{13}C (‰)
-20
0
20
δ^{13}C Zoop
δ^{13}C (‰)
-20
-10
Sediment OC
mmol m^{-3}
0.0
0.2
0.4
δ^{13}C Sediment OC
δ^{13}C (‰)
-20
-10
0
PON
mmol m^{-3}
3.0
4.0
Sediment N
mmol m^{-3}
0.00
0.03
0.06
0
4
8
12
time(days)

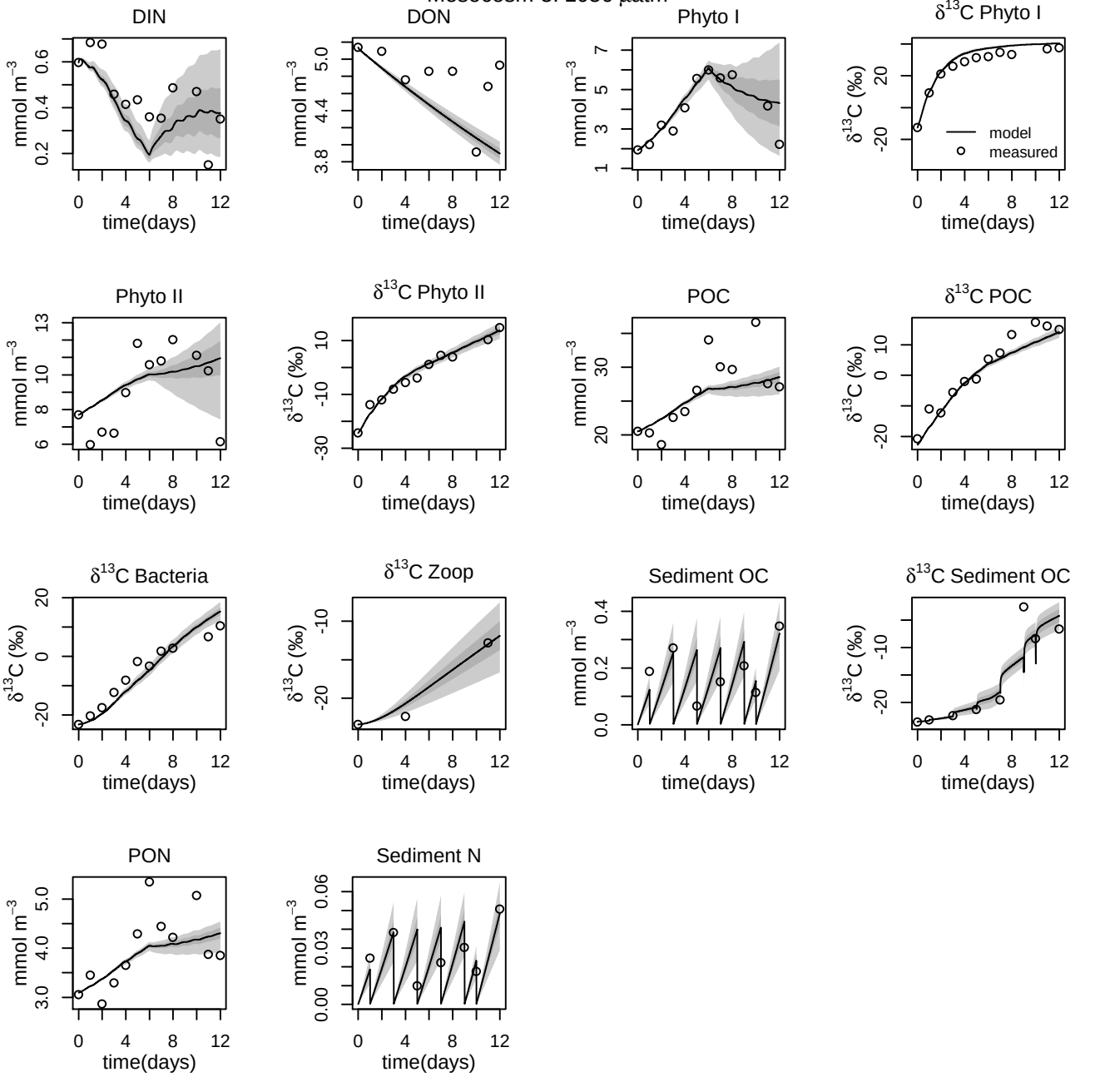

Mesocosm 2: 270 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured

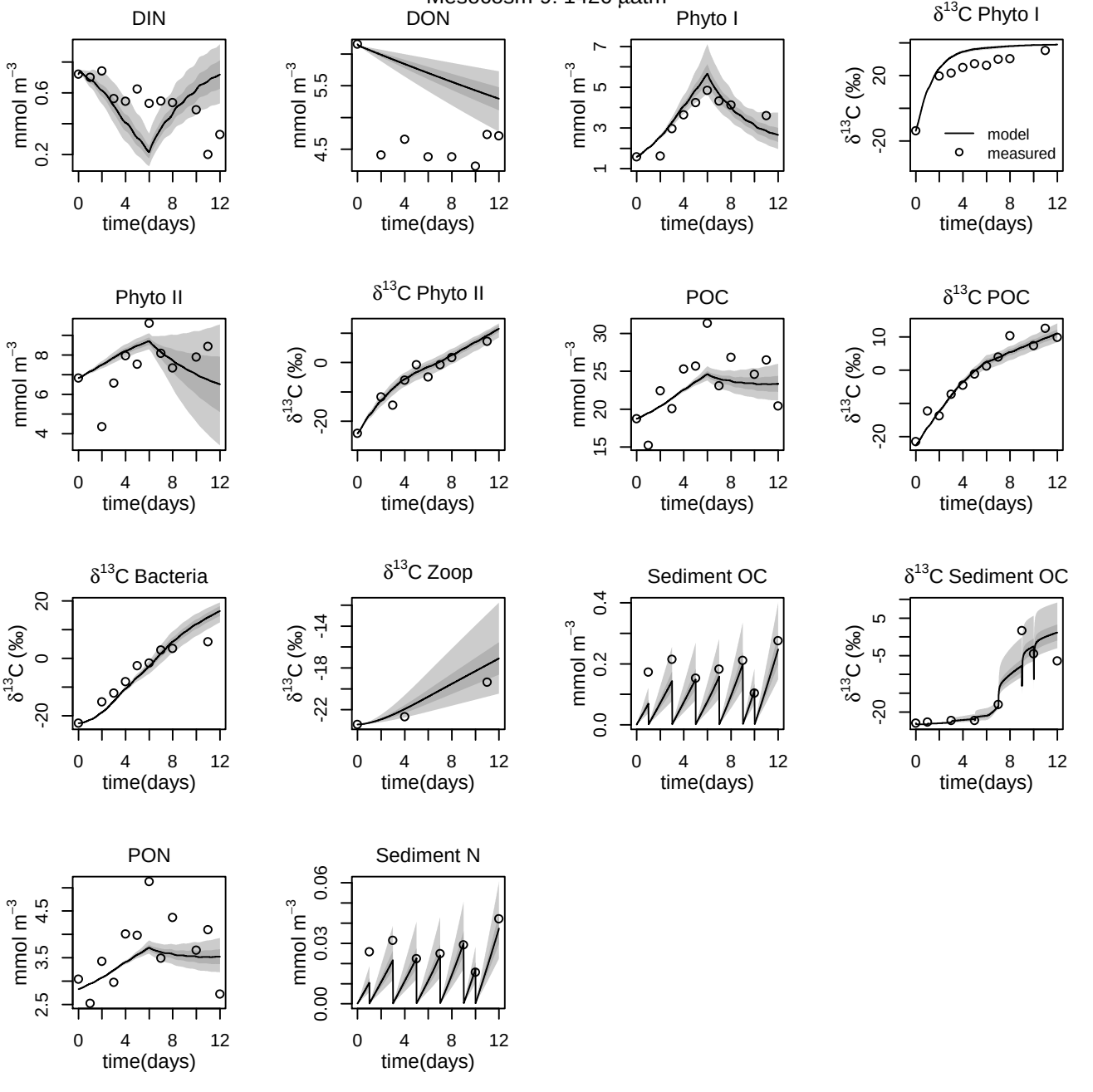

Mesocosm 4: 375 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured


Mesocosm 8: 480 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured


Mesocosm 1: 685 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured


Mesocosm 6: 820 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured


Mesocosm 5: 1050 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured


Mesocosm 9: 1420 µatm
DIN
DON
Phyto I
δ13C Phyto I
Phyto II
δ13C Phyto II
POC
δ13C POC
δ13C Bacteria
δ13C Zoop
Sediment OC
δ13C Sediment OC
PON
Sediment N
mmol m−3
δ13C (‰)
time(days)
model
measured