Supplementary information for 'Hydrothermal activity, functional diversity and chemoautotrophy are major drivers of seafloor carbon cycling.'

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Data : LIM model for Bransfield Strait Sedimented Vents, sampled Jan 2011
Site : Bransfield Control
Units :
Fluxes : mmol C m-2 d-1
Stocks : mmol C m-2

Depth : upper 10 cm

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!----------!
! !
! PARAMETER & VARIABLES !
! !
!----------!

PARAMETERS
!Site-specific data
! Flows
minPOCdeposition = 0.70 {mmol C m-2 d-1}
maxPOCdeposition = 27.17 {mmol C m-2 d-1}
minTotResp = 0.81 {mmol C m-2 d-1}
maxTotResp = 2.86 {mmol C m-2 d-1}
Tlim = 0.20 {-}

! Stocks
Detritus = 114.47 {mmol C m-2}
HeterotrophicBac = 11.21 {mmol C m-2}
FreeChemoautotrophicBac = 0.00 {mmol C m-2}
MacroEndosymbiotic = 0.56 {mmol C m-2}
MacroDepositFeeder = 73.08 {mmol C m-2}
MacroSuspensionFeeder = 2.04 {mmol C m-2}
MacroPredatorScavenger = 14.48 {mmol C m-2}
MegaDepositFeeder = 21.04 {mmol C m-2}
MegaSuspensionFeeder = 0.00 {mmol C m-2}

! Bacterial Respiration
ChBacResp = 0.00 {mmol C m-2 d-1}

! Macro Respiration
TotRespMacDF = 0.765*Tlim {mmol C m-2 d-1} !total respiration
TotRespMacSF = 0.019*Tlim {mmol C m-2 d-1}
TotRespMacPS = 0.128*Tlim {mmol C m-2 d-1}
TotRespMacES = 0.009*Tlim {mmol C m-2 d-1}

! Mega Respiration
TotRespMegDF = 0.044*Tlim {mmol C m-2 d-1}
TotRespMegSF = 0.000*Tlim {mmol C m-2 d-1}

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! Methane Flux
minSulphideFlux   = 0.00    {mmol C m-2 d-1}
maxSulphideFlux   = 1.00    {mmol C m-2 d-1}

! Stable Isotope Data
13C_Det_w       =  -27.0  {delta 13C}
13C_Det         =  -25.9  {delta 13C}
13C_Bac         =  -26.8  {delta 13C}
13C_ChBac       =    0.0  {delta 13C}
13C_MacES       =  -45.3  {delta 13C}
13C_MacDF       =  -25.9  {delta 13C}
13C_MacSF       =    0.0  {delta 13C}
13C_MacPS       =  -26.9  {delta 13C}
13C_MegDF       =  -26.1  {delta 13C}
13C_MegSF       =  -27.0  {delta 13C}

! Generic Data
! Detritus
minBur          = 0.01    {-}
maxBur                = 0.03    {-}
maxRelDOCefflux       =       0.10    {-}

! Bacteria
minBGE                = 0.05      {-}
maxBGE            =    0.45      {-}
minLysBP          =    0.30      {-}
maxLysBP           =   0.80      {-}
minChemoEff      = 0.10    {-}
maxChemoEff      = 0.50    {-}

! Macrofauna
minGrowthMac          =       Tlim*0.01       {d-1}
maxGrowthMac        =         Tlim*0.05       {d-1}
minMacAss       = 0.20     {-} !assimilation efficiency
maxMacAss       = 0.75     {-}
minMacNGE       = 0.30     {-} !net growth efficiency
maxMacNGE       = 0.70     {-}
minMacExcrete   = 0.25     {-}
maxMacExcrete   = 0.80     {-}
MacRespUpper    = 1.50     {-}
MacRespLower    = 0.50     {-}
MaintRespMacDF  = Tlim*0.001*MacroDepositFeeder     {mmol C m-2 d-1}
MaintRespMacSF  =   Tlim*0.001*MacroSuspensionFeeder  {mmol C m-2 d-1}
MaintRespMacPS      =         Tlim*0.001*MacroPredatorScavenger {mmol C m-2
d-1}
MaintRespMacES  =   Tlim*0.001*MacroEndosymbiotic     {mmol C m-2 d-1}

! Megafauna
minGrowthMeg        =         Tlim*0.0027   {d-1}
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```
maxGrowthMeg        =        Tlim*0.014    {d-1}
minMegAss      = 0.20      {-} !assimilation efficiency
maxMegAss      = 0.75      {-}
minMegExcrete   = 0.25      {-}
maxMegExcrete   = 0.80      {-}
minMegNGE      = 0.50      {-} !net growth efficiency
maxMegNGE      = 0.70      {-}
MegRespUpper    = 1.50      {-}
MegRespLower    = 0.50      {-}
MaintRespMegDF  = Tlim*0.00001*MegaDepositFeeder    {mmol C m-2 d-1}
MaintRespMegSF  = Tlim*0.00001*MegaSuspensionFeeder {mmol C m-2 d-1}

## END PARAMETERS

### VARIABLES

!-- Detritus
OMInput       =   Det_w -> Det + Det_w -> MacSF + Det_w -> MegSF + ChBacProd +
MacESProd
POCdeposition   =   Det_w -> Det
DetDis        =   Det   -> DOC
BurialOC      =   Det   -> Det_s

! DOC
DOCefflux     =   DOC -> DOC_w

! Bacteria
BacResp       =  Bac -> Respiration
BacUpt        =  DOC -> Bac
BacDocProd     =  Bac -> DOC
BacProd       =  BacUpt - BacResp
ChBacResp      =  ChBac -> Respiration
ChBacUpt       =  flowto(ChBac)
ChBacDocProd    =  ChBac -> DOC
ChBacProd      =  ChBacUpt - ChBacResp

! Macrofauna
MacESUpt       =  flowto(MacES)
MacESProd      =  MacESUpt - MacESResp
MacESResp      =  MacES -> Respiration
MacEsDetProd    =  MacES  -> Det
MacESAss       =  MacESupt - MacESDetProd
MacESPro       =  MacESAss - MacESResp

MacDFResp      =  MacDF  -> Respiration
MacDFDetProd    =  MacDF  -> Det
MacDFupt       =  flowto(MacDF)
MacDFAss       =  MacDFupt - MacDFDetProd
MacDFPro       =  MacDFAss - MacDFResp
```

```
MacDFGrowth    =  MacDFAss - MacDFresp + MaintRespMacDF

MacSFResp      =  MacSF  -> Respiration
MacSFDetProd   =  MacSF  -> Det
MacSFupt       =  flowto(MacSF)
MacSFAss       =  MacSFupt - MacSFDetProd
MacSFPro       =  MacSFAss - MacSFResp
MacSFGrowth    =  MacSFAss - MacSFresp + MaintRespMacSF

MacPSResp      =  MacPS  -> Respiration
MacPSDetProd   =  MacPS  -> Det
MacPSupt       =  flowto(MacPS)
MacPSAss       =  MacPSupt - MacPSDetProd
MacPSPro       =  MacPSAss - MacPSResp

! Megafauna
MegDFResp      =  MegDF  -> Respiration
MegDFDetProd   =  MegDF  -> Det
MegDFupt       =  flowto(MegDF)
MegDFAss       =  MegDFupt - MegDFDetProd
MegDFPro       =  MegDFAss - MegDFResp
MegDFGrowth    =  MegDFAss - MegDFresp + MaintRespMegDF

MegSFResp      =  MegSF  -> Respiration
MegSFDetProd   =  MegSF  -> Det
MegSFupt       =  flowto(MegSF)
MegSFAss       =  MegSFupt - MegSFDetProd
MegSFPro       =  MegSFAss - MegSFResp
MegSFGrowth    =  MegSFAss - MegSFresp + MaintRespMegSF

! Totals
BacterialResp      =  BacResp + ChBacResp
MacResp            =  MacDFResp + MacSFResp + MacPSResp + MacESResp
MegResp            =  MegDFResp + MegSFResp
Suspensionfeeding  =  Det_w -> MacSF + Det_w -> MegSF
NetSuspensionfeeding =  Suspensionfeeding - MacSFResp - MegSFResp
TotInSituProd      =  DIC -> ChBac + DIC -> MacES
NetInSituInput     =  ChBacProd + MacESPro
MacPredation       =  MacES -> Predation + MacDF -> Predation + MacSF ->
Predation + MacPS -> Predation
MegPredation       =  MegDF -> Predation + MegSF -> Predation
TotPredation       =  MacPredation + MegPredation
ExtPredation       =  flowto(Predation)
TotResp            =  BacterialResp + MacResp + MegResp
TotSinkingOM       =  POCdeposition + Suspensionfeeding
NetSinkingOMInput  =  POCdeposition + NetSuspensionfeeding
TotOMinput         =  POCdeposition + Suspensionfeeding + TotInSituProd
NetTotOMInput      =  NetInSituInput + NetSinkingOMInput
TotDetProd         =  flowto(Det)
```

END VARIABLES

!--!
!   !
!   SYSTEM DECLARATION   !
!   (STOCKS, EXTERNALS, FLOWS)   !
!   !
!--!

STOCK

Det = Detritus
DOC
Bac = HeterotrophicBac
ChBac = FreeChemoautotrophicBac
MacES = MacroEndosymbiotic
MacDF = MacroDepositFeeder
MegDF = MegaDepositFeeder
MacPS = MacroPredatorScavenger
MacSF = MacroSuspensionFeeder
MegSF = MegaSuspensionFeeder

END STOCK

EXTERNALS

Det_s !Burial
Predation !e.g. Fish/ Megafaunal Predators
Respiration
DIC
DOC_w
Det_w

END EXTERNALS

FLOW

! Detritus production/ Mortality
Det_w -> Det
DOC -> DOC_w
Det -> DOC
Bac -> DOC
ChBac -> DOC

MacDF -> Det
MacES -> Det
MacSF -> Det
MacPS -> Det

```
MegDF    ->  Det
MegSF    ->  Det

! Bacteria
DIC      ->  ChBac
DOC      ->  Bac

! Macrofauna
DIC    ->  MacES
Det    ->  MacDF
ChBac  ->  MacDF
Bac    ->  MacDF
Det_w  ->  MacSF
Bac    ->  MacPS
ChBac  ->  MacPS
MacES  ->  MacPS
MacDF  ->  MacPS
MacSF  ->  MacPS

! Megafauna
Det    ->  MegDF
ChBac  ->  MegDF
Bac    ->  MegDF
Det_w  ->  MegSF

! Respiration
Bac      ->  Respiration
ChBac    ->  Respiration
MacES    ->  Respiration
MacDF    ->  Respiration
MacSF    ->  Respiration
MacPS    ->  Respiration
MegDF    ->  Respiration
MegSF    ->  Respiration

! Predation
MacES    ->  Predation
MacDF    ->  Predation
MacSF    ->  Predation
MacPS    ->  Predation
MegDF    ->  Predation
MegSF    ->  Predation

! Burial
Det      ->  Det_s

###### END FLOW

!----------------------------------------------------------------!
```

```
!                                        !
!              DATA DECLARATION                        !
!          (RATES, EQUATIONS, CONSTRAINTS)                 !
!                                        !
!----------------------------------------------------------------!

######## RATE

! all rates zero

###### END RATE

###### EQUATION

Flow(Det,MacDF)*13C_Det   + Flow(ChBac,MacDF)*13C_ChBac +
Flow(Bac,MacDF)*13C_Bac   - &
Flow(Det,MacDF)*13C_MacDF - Flow(ChBac,MacDF)*13C_MacDF -
Flow(Bac,MacDF)*13C_MacDF = 0

Flow(Det,MegDF)*13C_Det   + Flow(ChBac,MegDF)*13C_ChBac +
Flow(Bac,MegDF)*13C_Bac   - &
Flow(Det,MegDF)*13C_MegDF - Flow(ChBac,MegDF)*13C_MegDF -
Flow(Bac,MegDF)*13C_MegDF = 0

Flow(Bac,MacPS)*13C_Bac     + Flow(MacSF,MacPS)*13C_MacSF +
Flow(ChBac,MacPS)*13C_ChBac + &
Flow(MacES,MacPS)*13C_MacES  + Flow(MacDF,MacPS)*13C_MacDF - &
Flow(Bac,MacPS)*13C_MacPS    - Flow(MacSF,MacPS)*13C_MacPS -
Flow(ChBac,MacPS)*13C_MacPS - &
Flow(MacES,MacPS)*13C_MacPS  - Flow(MacDF,MacPS)*13C_MacPS = 0

###### END EQUATION

##### CONSTRAINT

! POC
POCdeposition   =   [minPOCdeposition,maxPOCdeposition]

! Totals
TotResp       =   [minTotResp,maxTotResp]

! Bacteria
ChBacUpt      =   [minChemoEff, maxChemoEff]*[minSulphideFlux,
maxSulphideFlux]
ChBacProd     =   [minBGE,MaxBGE]*ChBacUpt
ChBacDocProd  =   [minLysBP,maxLysBP]*ChBacProd
BacProd       =   [minBGE,MaxBGE]*BacUpt
BacDocProd    =   [minLysBP,maxLysBP]*BacProd
```

! Macrofauna ES
MacESUpt = [minChemoEff, maxChemoEff]*[minSulphideFlux, maxSulphideFlux]
MacESAss - MacESresp + MaintRespMacES = [minMacNGE, maxMacNGE]*MacESAss
MacESAss - MacESResp + MaintRespMacES = [minGrowthMac, maxGrowthMac]*MacES

! Macrofauna DF
MacDFresp = [MacRespLower, MacRespUpper]*TotRespMacDF
MacDFAss = [minMacAss, maxMacAss]*MacDFUpt
MacDFDetProd = [minMacExcrete, maxMacExcrete]*MacDFUpt
MacDFAss - MacDFresp + MaintRespMacDF = [minMacNGE, maxMacNGE]*MacDFAss
MacDFAss - MacDFResp + MaintRespMacDF = [minGrowthMac, maxGrowthMac]*MacDF

! Macrofauna SF
MacSFresp = [MacRespLower, MacRespUpper]*TotRespMacSF
MacSFAss = [minMacAss, maxMacAss]*MacSFUpt
MacSFDetProd = [minMacExcrete, maxMacExcrete]*MacSFUpt
MacSFAss - MacSFresp + MaintRespMacSF = [minMacNGE, maxMacNGE]*MacSFAss
MacSFAss - MacSFResp + MaintRespMacSF = [minGrowthMac, maxGrowthMac]*MacSF

! Macrofauna PS
MacPSresp = [MacRespLower, MacRespUpper]*TotRespMacPS
MacPSAss = [minMacAss, maxMacAss]*MacPSUpt
MacPSDetProd = [minMacExcrete, maxMacExcrete]*MacPSUpt
MacPSAss - MacPSresp + MaintRespMacPS = [minMacNGE, maxMacNGE]*MacPSAss
MacPSAss - MacPSResp + MaintRespMacPS = [minGrowthMac, maxGrowthMac]*MacPS

! Megafauna DF
MegDFresp = [MegRespLower, MegRespUpper]*TotRespMegDF
MegDFAss = [minMegAss, maxMegAss]*MegDFUpt
MegDFDetProd = [minMegExcrete, maxMegExcrete]*MegDFUpt
MegDFAss - MegDFresp + MaintRespMegDF = [minMegNGE, maxMegNGE]*MegDFAss
MegDFAss - MegDFResp + MaintRespMegDF = [minGrowthMeg, maxGrowthMeg]*MegDF

! Megafauna SF
MegSFresp = [MegRespLower, MegRespUpper]*TotRespMegSF
MegSFAss = [minMegAss, maxMegAss]*MegSFUpt
MegSFDetProd = [minMegExcrete, maxMegExcrete]*MegSFUpt

MegSFAss - MegSFresp + MaintRespMegSF = [minMegNGE, maxMegNGE]*MegSFAss
MegSFAss - MegSFResp + MaintRespMegSF = [minGrowthMeg, maxGrowthMeg]*MegSF

!-- Efflux of DOC from the sediment
DOCefflux < maxRelDOCefflux*TotResp !Burdige GCA 63:1507-1515

! Burial
BurialOC = [minBur, maxBur]*TotOMinput

END CONSTRAINT

Data : LIM model for Bransfield Strait Sedimented Vents, sampled Jan 2011
Site : Hook Ridge 1
Units :
Fluxes : mmol C m-2 d-1
Stocks : mmol C m-2

Depth : upper 10 cm

########

!----------!
! !
! PARAMETER & VARIABLES !
! !
!----------!

PARAMETERS

!Site specific Data
! Flows
minPOCdeposition = 0.70 {mmol C m-2 d-1}
maxPOCdeposition = 27.17 {mmol C m-2 d-1}
minTotResp = 1.62 {mmol C m-2 d-1}
maxTotResp = 2.86 {mmol C m-2 d-1}
minChemoFix = 2.80 {mmol C m-2 d-1}
maxChemoFix = 16.80 {mmol C m-2 d-1}

Tlim = 1.30 {-}

! Stocks
Detritus = 114.47 {mmol C m-2}
HeterotrophicBac = 13.82 {mmol C m-2}
FreeChemoautotrophicBac = 30.73 {mmol C m-2}
MacroEndosymbiotic = 4.46 {mmol C m-2}
MacroDepositFeeder = 25.51 {mmol C m-2}
MacroSuspensionFeeder = 5.98 {mmol C m-2}
MacroPredatorScavenger = 4.18 {mmol C m-2}
MegaDepositFeeder = 27.45 {mmol C m-2}
MegaSuspensionFeeder = 0.00 {mmol C m-2}

! Macro Respiration

TotRespMacDF = 0.33*Tlim {mmol C m-2 d-1} !total respiration
TotRespMacSF = 0.06*Tlim {mmol C m-2 d-1}
TotRespMacPS = 0.05*Tlim {mmol C m-2 d-1}
TotRespMacES = 0.11*Tlim {mmol C m-2 d-1}

! Mega Respiration

```
TotRespMegDF    = 0.064*Tlim    {mmol C m-2 d-1}
TotRespMegSF    = 0.000*Tlim    {mmol C m-2 d-1}

! Stable Isotope Data
13C_Det_w       =  -27.0   {delta 13C}
13C_Det         =  -25.6   {delta 13C}
13C_Bac         =  -26.6   {delta 13C} !weighted average less PLFA offset
13C_ChBac       =  -20.4   {delta 13C}
13C_MacES       =  -20.7   {delta 13C}
13C_MacDF       =  -25.2   {delta 13C}
13C_MacSF       =  -26.8   {delta 13C}
13C_MacPS       =  -23.9   {delta 13C}
13C_MegDF       =  -26.1   {delta 13C}
13C_MegSF       =    0.0   {delta 13C}

! Sulphide Flux
minSulphideFlux   = 0.08 {mmol C m-2 d-1}
maxSulphideFlux   = 7.45 {mmol C m-2 d-1}

! Generic Data
! Detritus
minBur          =         0.01  {-}
maxBur                  = 0.03  {-}
maxRelDOCefflux         =       0.10  {-}

! Bacteria
minBGE            =       0.05    {-}
maxBGE          =         0.45    {-}
minLysBP        =         0.30    {-}
maxLysBP        =         0.80    {-}
minChemoEff = 0.10  {-}
maxChemoEff = 0.50  {-}

! Macrofauna
minGrowthMac            =       Tlim*0.01       {d-1}
maxGrowthMac          =         Tlim*0.05       {d-1}
minMacAss       = 0.20      {-} !assimilation efficiency
maxMacAss       = 0.75      {-}
minMacNGE       = 0.3       {-} !net growth efficiency
maxMacNGE       = 0.7       {-}
minMacExcrete   = 0.25      {-}
maxMacExcrete   = 0.80      {-}
MacRespUpper    = 1.5       {-}
MacRespLower    = 0.5       {-}
MaintRespMacDF  = Tlim*0.001*MacroDepositFeeder     {mmol C m-2 d-1}
MaintRespMacSF  =   Tlim*0.001*MacroSuspensionFeeder  {mmol C m-2 d-1}
MaintRespMacPS      =         Tlim*0.001*MacroPredatorScavenger {mmol C m-2
d-1}
MaintRespMacES  =   Tlim*0.001*MacroEndosymbiotic     {mmol C m-2 d-1}
```

```
! Megafauna
minGrowthMeg        =        Tlim*0.0027   {d-1}
maxGrowthMeg        =        Tlim*0.014    {d-1}
minMegAss      = 0.20       {-} !assimilation efficiency
maxMegAss      = 0.75       {-}
minMegExcrete   = 0.25      {-}
maxMegExcrete   = 0.80      {-}
minMegNGE      = 0.5        {-} !net growth efficiency
maxMegNGE      = 0.7        {-}
MegRespUpper    = 1.5       {-}
MegRespLower    = 0.5       {-}
MaintRespMegDF  = Tlim*0.00001*MegaDepositFeeder    {mmol C m-2 d-1}
MaintRespMegSF  =  Tlim*0.00001*MegaSuspensionFeeder {mmol C m-2 d-1}

## END PARAMETERS

### VARIABLES

!-- Detritus
OMInput       =   Det_w -> Det + Det_w -> MacSF + Det_w -> MegSF + ChBacProd +
MacESProd
POCdeposition   =   Det_w -> Det
DetDis        =   Det   -> DOC
BurialOC      =   Det   -> Det_s

! DOC
DOCefflux     =   DOC -> DOC_w

! Bacteria
BacResp       =   Bac -> Respiration
BacUpt        =   DOC -> Bac
BacDocProd    =   Bac -> DOC
BacProd       =   BacUpt - BacResp
ChBacResp     =   ChBac -> Respiration
ChBacUpt      =   flowto(ChBac)
ChBacDocProd   =   ChBac -> DOC
ChBacProd     =   ChBacUpt - ChBacResp

! Macrofauna
MacESUpt      =  flowto(MacES)
MacESProd     =  MacESUpt - MacESResp
MacESResp     =  MacES -> Respiration
MacEsDetProd   =  MacES  -> Det
MacESAss      =  MacESupt - MacESDetProd
MacESPro      =  MacESAss - MacESResp

MacDFResp     =  MacDF  -> Respiration
MacDFDetProd   =  MacDF  -> Det
```

```
MacDFupt      =  flowto(MacDF)
MacDFAss      =  MacDFupt - MacDFDetProd
MacDFPro      =  MacDFAss - MacDFResp
MacDFGrowth    =  MacDFAss - MacDFresp + MaintRespMacDF

MacSFResp     =  MacSF  -> Respiration
MacSFDetProd   =  MacSF  -> Det
MacSFupt      =  flowto(MacSF)
MacSFAss      =  MacSFupt - MacSFDetProd
MacSFPro      =  MacSFAss - MacSFResp
MacSFGrowth    =  MacSFAss - MacSFresp + MaintRespMacSF

MacPSResp     =  MacPS  -> Respiration
MacPSDetProd   =  MacPS  -> Det
MacPSupt      =  flowto(MacPS)
MacPSAss      =  MacPSupt - MacPSDetProd
MacPSPro      =  MacPSAss - MacPSResp

! Megafauna
MegDFResp     =  MegDF  -> Respiration
MegDFDetProd   =  MegDF  -> Det
MegDFupt      =  flowto(MegDF)
MegDFAss      =  MegDFupt - MegDFDetProd
MegDFPro      =  MegDFAss - MegDFResp
MegDFGrowth    =  MegDFAss - MegDFresp + MaintRespMegDF

MegSFResp     =  MegSF  -> Respiration
MegSFDetProd   =  MegSF  -> Det
MegSFupt      =  flowto(MegSF)
MegSFAss      =  MegSFupt - MegSFDetProd
MegSFPro      =  MegSFAss - MegSFResp
MegSFGrowth    =  MegSFAss - MegSFresp + MaintRespMegSF

! Totals
BacterialResp      =  BacResp + ChBacResp
MacResp          =  MacDFResp + MacSFResp + MacPSResp + MacESResp
MegResp          =  MegDFResp + MegSFResp
Suspensionfeeding   =  Det_w -> MacSF + Det_w -> MegSF
NetSuspensionfeeding = Suspensionfeeding - MacSFResp - MegSFResp
TotInSituProd      =  DIC -> ChBac + DIC -> MacES
NetInSituInput     =  ChBacProd + MacESPro
MacPredation       =  MacES -> Predation + MacDF -> Predation + MacSF ->
Predation + MacPS -> Predation
MegPredation       =  MegDF -> Predation + MegSF -> Predation
TotPredation       =  MacPredation + MegPredation
ExtPredation       =  flowto(Predation)
TotResp          =  BacterialResp + MacResp + MegResp
TotSinkingOM       =  POCdeposition + Suspensionfeeding
NetSinkingOMInput   =  POCdeposition + NetSuspensionfeeding
```

```
TotOMinput         =  POCdeposition + Suspensionfeeding + TotInSituProd
NetTotOMInput      =  NetInSituInput + NetSinkingOMInput
TotDetProd         =  flowto(Det)

#### END VARIABLES

!--------------------------------------------------------------------!
!                                                                    !
!                  SYSTEM DECLARATION                                !
!               (STOCKS, EXTERNALS, FLOWS)                           !
!                                                                    !
!--------------------------------------------------------------------!

#### STOCK

Det   =   Detritus
DOC
Bac   =   HeterotrophicBac
ChBac =   FreeChemoautotrophicBac
MacES =   MacroEndosymbiotic
MacDF =   MacroDepositFeeder
MegDF =   MegaDepositFeeder
MacPS =   MacroPredatorScavenger
MacSF =   MacroSuspensionFeeder
MegSF =   MegaSuspensionFeeder

##### END STOCK

##### EXTERNALS

Det_s !Burial
Predation !e.g. Fish/ Megafaunal Predators
Respiration
DIC
DOC_w
Det_w

##### END EXTERNALS

##### FLOW

! Detritus production/ Mortality
Det_w  ->  Det
DOC    ->  DOC_w
Det    ->  DOC
Bac    ->  DOC
ChBac  ->  DOC

MacDF  ->  Det
```

MacES -> Det
MacSF -> Det
MacPS -> Det
MegDF -> Det
MegSF -> Det

! Bacteria
DIC -> ChBac
DOC -> Bac

! Macrofauna
DIC -> MacES
Det -> MacDF
ChBac -> MacDF
Bac -> MacDF
Det_w -> MacSF
Bac -> MacPS
ChBac -> MacPS
MacES -> MacPS
MacDF -> MacPS
MacSF -> MacPS

! Megafauna
Det -> MegDF
ChBac -> MegDF
Bac -> MegDF
Det_w -> MegSF

! Respiration
Bac -> Respiration
ChBac -> Respiration
MacES -> Respiration
MacDF -> Respiration
MacSF -> Respiration
MacPS -> Respiration
MegDF -> Respiration
MegSF -> Respiration

! Predation
MacES -> Predation
MacDF -> Predation
MacSF -> Predation
MacPS -> Predation
MegDF -> Predation
MegSF -> Predation

! Burial
Det -> Det_s

```
###### END FLOW
!-----------------------------------------------------------------!
!                                                 !
!              DATA DECLARATION                        !
!          (RATES, EQUATIONS, CONSTRAINTS)                 !
!                                                 !
!-----------------------------------------------------------------!

####### RATE

! all rates zero

##### END RATE

##### EQUATION

Flow(Det,MacDF)*13C_Det   + Flow(ChBac,MacDF)*13C_ChBac +
Flow(Bac,MacDF)*13C_Bac - &
Flow(Det,MacDF)*13C_MacDF - Flow(ChBac,MacDF)*13C_MacDF -
Flow(Bac,MacDF)*13C_MacDF = 0

Flow(Det,MegDF)*13C_Det   + Flow(ChBac,MegDF)*13C_ChBac +
Flow(Bac,MegDF)*13C_Bac - &
Flow(Det,MegDF)*13C_MegDF - Flow(ChBac,MegDF)*13C_MegDF -
Flow(Bac,MegDF)*13C_MegDF = 0

Flow(Bac,MacPS)*13C_Bac     + Flow(MacSF,MacPS)*13C_MacSF +
Flow(ChBac,MacPS)*13C_ChBac + &
Flow(MacES,MacPS)*13C_MacES  + Flow(MacDF,MacPS)*13C_MacDF - &
Flow(Bac,MacPS)*13C_MacPS    - Flow(MacSF,MacPS)*13C_MacPS -
Flow(ChBac,MacPS)*13C_MacPS - &
Flow(MacES,MacPS)*13C_MacPS  - Flow(MacDF,MacPS)*13C_MacPS = 0

###### END EQUATION

##### CONSTRAINT

! POC
POCdeposition   =   [minPOCdeposition,maxPOCdeposition]

! Totals
TotResp       =   [minTotResp,maxTotResp]

! Bacteria
ChBacUpt      =   [minChemoEff, maxChemoEff]*[minSulphideFlux,
maxSulphideFlux]
ChBacProd     =   [minBGE,MaxBGE]*ChBacUpt
ChBacDocProd  =   [minLysBP,maxLysBP]*ChBacProd
BacProd       =   [minBGE,MaxBGE]*BacUpt
```

BacDocProd = [minLysBP,maxLysBP]*BacProd

! Macrofauna ES

MacESUpt = [minChemoEff, maxChemoEff]*[minSulphideFlux, maxSulphideFlux]
MacESAss - MacESresp + MaintRespMacES = [minMacNGE, maxMacNGE]*MacESAss
MacESAss - MacESResp + MaintRespMacES = [minGrowthMac, maxGrowthMac]*MacES

! Macrofauna DF
MacDFresp = [MacRespLower, MacRespUpper]*TotRespMacDF
MacDFAss = [minMacAss, maxMacAss]*MacDFUpt
MacDFDetProd = [minMacExcrete, maxMacExcrete]*MacDFUpt
MacDFAss - MacDFresp + MaintRespMacDF = [minMacNGE, maxMacNGE]*MacDFAss
MacDFAss - MacDFResp + MaintRespMacDF = [minGrowthMac, maxGrowthMac]*MacDF

! Macrofauna SF
MacSFresp = [MacRespLower, MacRespUpper]*TotRespMacSF
MacSFAss = [minMacAss, maxMacAss]*MacSFUpt
MacSFDetProd = [minMacExcrete, maxMacExcrete]*MacSFUpt
MacSFAss - MacSFresp + MaintRespMacSF = [minMacNGE, maxMacNGE]*MacSFAss
MacSFAss - MacSFResp + MaintRespMacSF = [minGrowthMac, maxGrowthMac]*MacSF

! Macrofauna PS
MacPSresp = [MacRespLower, MacRespUpper]*TotRespMacPS
MacPSAss = [minMacAss, maxMacAss]*MacPSUpt
MacPSDetProd = [minMacExcrete, maxMacExcrete]*MacPSUpt
MacPSAss - MacPSresp + MaintRespMacPS = [minMacNGE, maxMacNGE]*MacPSAss
MacPSAss - MacPSResp + MaintRespMacPS = [minGrowthMac, maxGrowthMac]*MacPS

! Megafauna DF
MegDFresp = [MegRespLower, MegRespUpper]*TotRespMegDF
MegDFAss = [minMegAss, maxMegAss]*MegDFUpt
MegDFDetProd = [minMegExcrete, maxMegExcrete]*MegDFUpt
MegDFAss - MegDFresp + MaintRespMegDF = [minMegNGE, maxMegNGE]*MegDFAss
MegDFAss - MegDFResp + MaintRespMegDF = [minGrowthMeg, maxGrowthMeg]*MegDF

! Megafauna SF

```
MegSFresp                    =  [MegRespLower, MegRespUpper]*TotRespMegSF
MegSFAss                     =  [minMegAss, maxMegAss]*MegSFUpt
MegSFDetProd                 =  [minMegExcrete, maxMegExcrete]*MegSFUpt
MegSFAss - MegSFresp + MaintRespMegSF    =  [minMegNGE,
maxMegNGE]*MegSFAss
MegSFAss - MegSFResp + MaintRespMegSF    =  [minGrowthMeg,
maxGrowthMeg]*MegSF

!-- Efflux of DOC from the sediment
DOCefflux     <  maxRelDOCefflux*TotResp !Burdige GCA 63:1507-1515

! Burial
BurialOC      =  [minBur, maxBur]*TotOMinput

##### END CONSTRAINT
```

Data : LIM model for Bransfield Strait Sedimented Vents, sampled Jan 2011
Site : Hook Ridge 2
Units :
Fluxes : mmol C m-2 d-1
Stocks : mmol C m-2

Depth : upper 10 cm

########

!----------!
! !
! PARAMETER & VARIABLES !
! !
!----------!

PARAMETERS
! Site-specific data
! Flows
minPOCdeposition = 0.70 {mmol C m-2 d-1}
maxPOCdeposition = 27.17 {mmol C m-2 d-1}
minTotResp = 1.62 {mmol C m-2 d-1}
maxTotResp = 2.86 {mmol C m-2 d-1}
minChemoFix = 2.80 {mmol C m-2 d-1}
maxChemoFix = 16.80 {mmol C m-2 d-1}
Tlim = 7.00 {-}

! Stocks
Detritus = 82.25 {mmol C m-2}
HeterotrophicBac = 13.82 {mmol C m-2} !estimate of ~52% of labelled biomass
FreeChemoautotrophicBac = 6.26 {mmol C m-2}
MacroDepositFeeder = 8.88 {mmol C m-2}
MacroEndosymbiotic = 0.00 {mmol C m-2}
MacroSuspensionFeeder = 13.96 {mmol C m-2}
MacroPredatorScavenger = 0.62 {mmol C m-2}
MegaDepositFeeder = 24.30 {mmol C m-2}
MegaSuspensionFeeder = 0.04 {mmol C m-2}

! Macro Respiration
TotRespMacDF = 0.10*Tlim {mmol C m-2 d-1} !total respiration
TotRespMacSF = 0.12*Tlim {mmol C m-2 d-1}
TotRespMacPS = 0.04*Tlim {mmol C m-2 d-1}
TotRespMacES = 0*Tlim {mmol C m-2 d-1}

! Mega Respiration
TotRespMegDF = 0.042*Tlim {mmol C m-2 d-1}
TotRespMegSF = 0.000059*Tlim {mmol C m-2 d-1}

```
! Stable Isotope Data
13C_Det_w       =  -27.0   {delta 13C}
13C_Det         =  -25.9   {delta 13C}
13C_Bac         =  -26.6   {delta 13C}
13C_ChBac       =  -20.4   {delta 13C}
13C_MacDF       =  -24.8   {delta 13C}
13C_MacSF       =  -27.0   {delta 13C}
13C_MacES       =   0.0    {delta 13C}
13C_MacPS       =  -25.3   {delta 13C}
13C_MegDF       =  -26.1   {delta 13C}
13C_MegSF       =  -27.0   {delta 13C}

! Sulphide Flux
minSulphideFlux   = 0.08 {mmol C m-2 d-1}
maxSulphideFlux   = 7.45 {mmol C m-2 d-1}

! Generic Data
! Detritus
minBur          = 0.01  {-}
maxBur                  = 0.03  {-}
maxRelDOCefflux         =       0.10  {-}

! Bacteria
minBGE            =     0.05    {-}
maxBGE          =       0.45    {-}
minLysBP        =       0.30    {-}
maxLysBP        =       0.80    {-}
minChemoEff = 0.10  {-}
maxChemoEff = 0.50  {-}

! Macrofauna
minGrowthMac            =       Tlim*0.01       {d-1}
maxGrowthMac            =       Tlim*0.05       {d-1}
minMacAss       = 0.20     {-} !assimilation efficiency
maxMacAss       = 0.75     {-}
minMacNGE       = 0.30     {-} !net growth efficiency
maxMacNGE       = 0.70     {-}
minMacExcrete   = 0.25     {-}
maxMacExcrete   = 0.80     {-}
MacRespUpper    = 1.50     {-}
MacRespLower    = 0.50     {-}
MaintRespMacDF  = Tlim*0.001*MacroDepositFeeder     {mmol C m-2 d-1}
MaintRespMacSF  =   Tlim*0.001*MacroSuspensionFeeder  {mmol C m-2 d-1}
MaintRespMacPS      =           Tlim*0.001*MacroPredatorScavenger {mmol C m-2
d-1}
MaintRespMacES  =   Tlim*0.001*MacroEndosymbiotic     {mmol C m-2 d-1}

! Megafauna
```

```
minGrowthMeg        =        Tlim*0.0027   {d-1}
maxGrowthMeg        =        Tlim*0.014    {d-1}
minMegAss      = 0.20       {-} !assimilation efficiency
maxMegAss      = 0.75       {-}
minMegExcrete   = 0.25      {-}
maxMegExcrete   = 0.80      {-}
minMegNGE      = 0.50       {-} !net growth efficiency
maxMegNGE      = 0.70       {-}
MegRespUpper    = 1.50      {-}
MegRespLower    = 0.50      {-}
MaintRespMegDF  = Tlim*0.00001*MegaDepositFeeder    {mmol C m-2 d-1}
MaintRespMegSF  = Tlim*0.00001*MegaSuspensionFeeder  {mmol C m-2 d-1}

## END PARAMETERS

### VARIABLES

!-- Detritus
OMInput       =   Det_w -> Det + Det_w -> MacSF + Det_w -> MegSF + ChBacProd +
MacESProd
POCdeposition   =   Det_w -> Det
DetDis        =   Det   -> DOC
BurialOC      =   Det   -> Det_s

! DOC
DOCefflux     =   DOC -> DOC_w

! Bacteria
BacResp       =   Bac -> Respiration
BacUpt        =   DOC -> Bac
BacDocProd    =   Bac -> DOC
BacProd       =   BacUpt - BacResp
ChBacResp     =   ChBac -> Respiration
ChBacUpt      =   flowto(ChBac)
ChBacDocProd   =   ChBac -> DOC
ChBacProd     =   ChBacUpt - ChBacResp

! Macrofauna
MacESUpt      =  flowto(MacES)
MacESProd     =  MacESUpt - MacESResp
MacESResp     =  MacES -> Respiration
MacEsDetProd   =  MacES -> Det
MacESAss      =  MacESupt - MacESDetProd
MacESPro      =  MacESAss - MacESResp

MacDFResp     =  MacDF  -> Respiration
MacDFDetProd   =  MacDF  -> Det
MacDFupt      =  flowto(MacDF)
MacDFAss      =  MacDFupt - MacDFDetProd
```

```
MacDFPro      =  MacDFAss - MacDFResp
MacDFGrowth   =  MacDFAss - MacDFresp + MaintRespMacDF

MacSFResp     =  MacSF  -> Respiration
MacSFDetProd  =  MacSF  -> Det
MacSFupt      =  flowto(MacSF)
MacSFAss      =  MacSFupt - MacSFDetProd
MacSFPro      =  MacSFAss - MacSFResp
MacSFGrowth   =  MacSFAss - MacSFresp + MaintRespMacSF

MacPSResp     =  MacPS  -> Respiration
MacPSDetProd  =  MacPS  -> Det
MacPSupt      =  flowto(MacPS)
MacPSAss      =  MacPSupt - MacPSDetProd
MacPSPro      =  MacPSAss - MacPSResp

! Megafauna
MegDFResp     =  MegDF  -> Respiration
MegDFDetProd  =  MegDF  -> Det
MegDFupt      =  flowto(MegDF)
MegDFAss      =  MegDFupt - MegDFDetProd
MegDFPro      =  MegDFAss - MegDFResp
MegDFGrowth   =  MegDFAss - MegDFresp + MaintRespMegDF

MegSFResp     =  MegSF  -> Respiration
MegSFDetProd  =  MegSF  -> Det
MegSFupt      =  flowto(MegSF)
MegSFAss      =  MegSFupt - MegSFDetProd
MegSFPro      =  MegSFAss - MegSFResp
MegSFGrowth   =  MegSFAss - MegSFresp + MaintRespMegSF

! Totals
BacterialResp      =  BacResp + ChBacResp
MacResp            =  MacDFResp + MacSFResp + MacPSResp + MacESResp
MegResp            =  MegDFResp + MegSFResp
Suspensionfeeding  =  Det_w -> MacSF + Det_w -> MegSF
NetSuspensionfeeding =  Suspensionfeeding - MacSFResp - MegSFResp
TotInSituProd      =  DIC -> ChBac + DIC -> MacES
NetInSituInput     =  ChBacProd + MacESPro
MacPredation       =  MacES -> Predation + MacDF -> Predation + MacSF ->
Predation + MacPS -> Predation
MegPredation       =  MegDF -> Predation + MegSF -> Predation
TotPredation       =  MacPredation + MegPredation
ExtPredation       =  flowto(Predation)
TotResp            =  BacterialResp + MacResp + MegResp
TotSinkingOM       =  POCdeposition + Suspensionfeeding
NetSinkingOMInput  =  POCdeposition + NetSuspensionfeeding
TotOMinput         =  POCdeposition + Suspensionfeeding + TotInSituProd
NetTotOMInput      =  NetInSituInput + NetSinkingOMInput
```

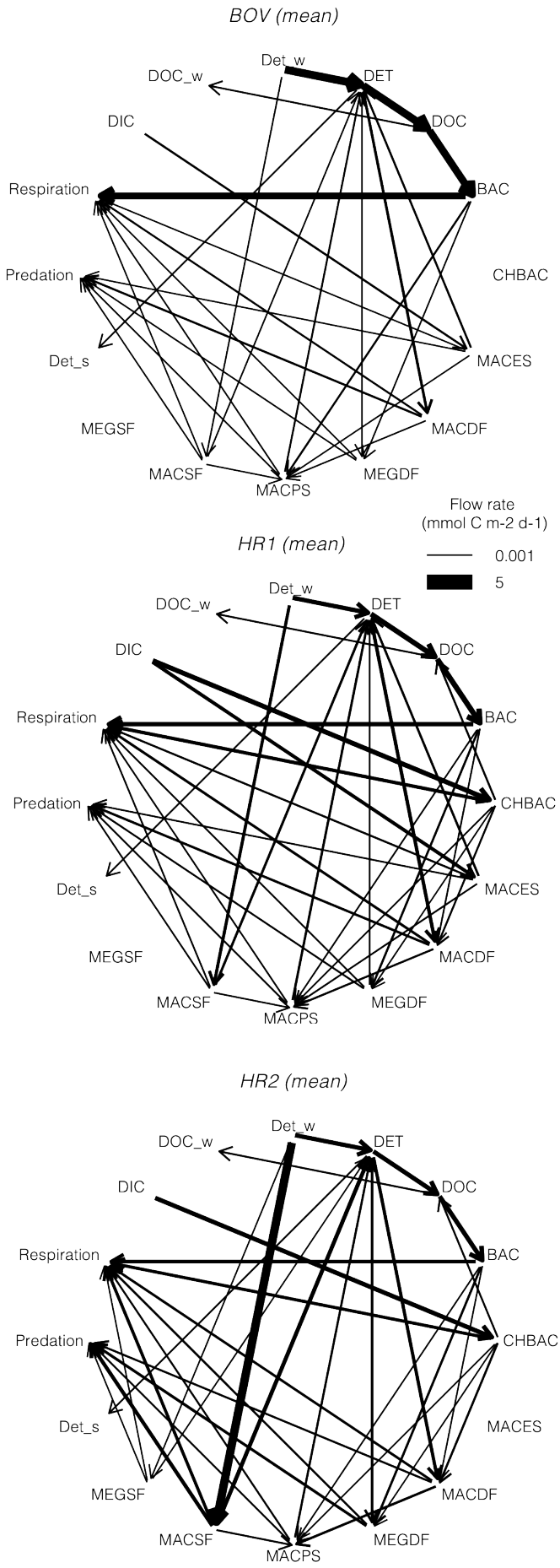
```
TotDetProd        =  flowto(Det)

#### END VARIABLES

!-------------------------------------------------------------------!
!                                                   !
!                SYSTEM DECLARATION                 !
!              (STOCKS, EXTERNALS, FLOWS)               !
!                                                   !
!-------------------------------------------------------------------!

#### STOCK

Det   =  Detritus
DOC
Bac   =  HeterotrophicBac
ChBac =  FreeChemoautotrophicBac
MacES =  MacroEndosymbiotic
MacDF =  MacroDepositFeeder
MegDF =  MegaDepositFeeder
MacPS =  MacroPredatorScavenger
MacSF =  MacroSuspensionFeeder
MegSF =  MegaSuspensionFeeder

##### END STOCK

##### EXTERNALS

Det_s !Burial
Predation !e.g. Fish/ Megafaunal Predators
Respiration
DIC
DOC_w
Det_w

##### END EXTERNALS

##### FLOW

! Detritus production/ Mortality
Det_w  -> Det
DOC    -> DOC_w
Det    -> DOC
Bac    -> DOC
ChBac  -> DOC

MacDF  -> Det
MacES  -> Det
MacSF  -> Det
```

```
MacPS  -> Det
MegDF  -> Det
MegSF  -> Det

! Bacteria
DIC    -> ChBac
DOC    -> Bac

! Macrofauna
DIC    -> MacES
Det    -> MacDF
ChBac  -> MacDF
Bac    -> MacDF
Det_w  -> MacSF
Bac    -> MacPS
ChBac  -> MacPS
MacES  -> MacPS
MacDF  -> MacPS
MacSF  -> MacPS

! Megafauna
Det    -> MegDF
ChBac  -> MegDF
Bac    -> MegDF
Det_w  -> MegSF

! Respiration
Bac      -> Respiration
ChBac    -> Respiration
MacES    -> Respiration
MacDF    -> Respiration
MacSF    -> Respiration
MacPS    -> Respiration
MegDF    -> Respiration
MegSF    -> Respiration

! Predation
MacES    -> Predation
MacDF    -> Predation
MacSF    -> Predation
MacPS    -> Predation
MegDF    -> Predation
MegSF    -> Predation

! Burial
Det      -> Det_s

###### END FLOW
```

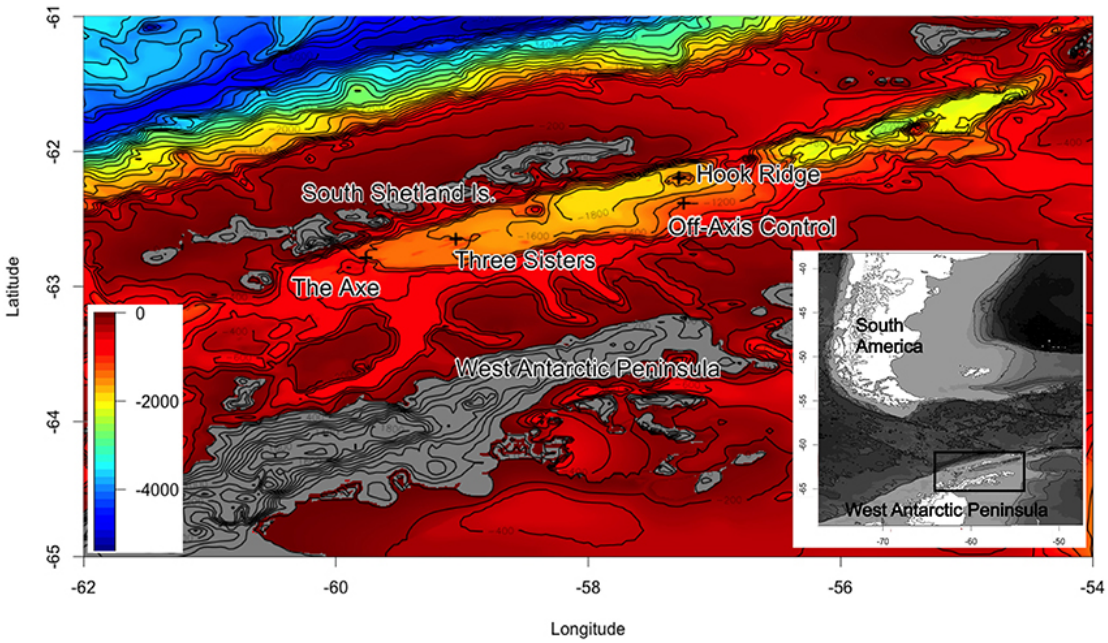
```
!-------------------------------------------------------------------!
!                                                                   !
!              DATA DECLARATION                                     !
!         (RATES, EQUATIONS, CONSTRAINTS)                           !
!                                                                   !
!-------------------------------------------------------------------!

######## RATE

! all rates zero

##### END RATE

##### EQUATION

Flow(Det,MacDF)*13C_Det   + Flow(ChBac,MacDF)*13C_ChBac +
Flow(Bac,MacDF)*13C_Bac - &
Flow(Det,MacDF)*13C_MacDF - Flow(ChBac,MacDF)*13C_MacDF -
Flow(Bac,MacDF)*13C_MacDF = 0

Flow(Det,MegDF)*13C_Det   + Flow(ChBac,MegDF)*13C_ChBac +
Flow(Bac,MegDF)*13C_Bac - &
Flow(Det,MegDF)*13C_MegDF - Flow(ChBac,MegDF)*13C_MegDF -
Flow(Bac,MegDF)*13C_MegDF = 0

Flow(Bac,MacPS)*13C_Bac     + Flow(MacSF,MacPS)*13C_MacSF +
Flow(ChBac,MacPS)*13C_ChBac + &
Flow(MacES,MacPS)*13C_MacES  + Flow(MacDF,MacPS)*13C_MacDF - &
Flow(Bac,MacPS)*13C_MacPS    - Flow(MacSF,MacPS)*13C_MacPS -
Flow(ChBac,MacPS)*13C_MacPS - &
Flow(MacES,MacPS)*13C_MacPS  - Flow(MacDF,MacPS)*13C_MacPS = 0

flowto(MacES) = 0

###### END EQUATION

##### CONSTRAINT

! POC
POCdeposition   =   [minPOCdeposition,maxPOCdeposition]

! Totals
TotResp       =   [minTotResp,maxTotResp]

! Bacteria
ChBacUpt      =   [minChemoEff, maxChemoEff]*[minSulphideFlux,
maxSulphideFlux]
ChBacProd     =   [minBGE,MaxBGE]*ChBacUpt
ChBacDocProd   =   [minLysBP,maxLysBP]*ChBacProd
```

```
BacProd       =   [minBGE,MaxBGE]*BacUpt
BacDocProd    =   [minLysBP,maxLysBP]*BacProd

! Macrofauna ES
MacESAss - MacESresp + MaintRespMacES    =   [minMacNGE,
maxMacNGE]*MacESAss
MacESAss - MacESResp + MaintRespMacES    =   [minGrowthMac,
maxGrowthMac]*MacES

! Macrofauna DF
MacDFresp                    =   [MacRespLower, MacRespUpper]*TotRespMacDF
MacDFAss                     =   [minMacAss, maxMacAss]*MacDFUpt
MacDFDetProd                 =   [minMacExcrete, maxMacExcrete]*MacDFUpt
MacDFAss - MacDFresp + MaintRespMacDF    =   [minMacNGE,
maxMacNGE]*MacDFAss
MacDFAss - MacDFResp + MaintRespMacDF    =   [minGrowthMac,
maxGrowthMac]*MacDF

! Macrofauna SF
MacSFresp                    =   [MacRespLower, MacRespUpper]*TotRespMacSF
MacSFAss                     =   [minMacAss, maxMacAss]*MacSFUpt
MacSFDetProd                 =   [minMacExcrete, maxMacExcrete]*MacSFUpt
MacSFAss - MacSFresp + MaintRespMacSF    =   [minMacNGE,
maxMacNGE]*MacSFAss
MacSFAss - MacSFResp + MaintRespMacSF    =   [minGrowthMac,
maxGrowthMac]*MacSF

! Macrofauna PS
MacPSresp                    =   [MacRespLower, MacRespUpper]*TotRespMacPS
MacPSAss                     =   [minMacAss, maxMacAss]*MacPSUpt
MacPSDetProd                 =   [minMacExcrete, maxMacExcrete]*MacPSUpt
MacPSAss - MacPSresp + MaintRespMacPS    =   [minMacNGE,
maxMacNGE]*MacPSAss
MacPSAss - MacPSResp + MaintRespMacPS    =   [minGrowthMac,
maxGrowthMac]*MacPS

! Megafauna DF
MegDFresp                    =   [MegRespLower,
MegRespUpper]*TotRespMegDF
MegDFAss                     =   [minMegAss, maxMegAss]*MegDFUpt
MegDFDetProd                 =   [minMegExcrete, maxMegExcrete]*MegDFUpt
MegDFAss - MegDFresp + MaintRespMegDF    =   [minMegNGE,
maxMegNGE]*MegDFAss
MegDFAss - MegDFResp + MaintRespMegDF    =   [minGrowthMeg,
maxGrowthMeg]*MegDF

! Megafauna SF
MegSFresp                    =   [MegRespLower, MegRespUpper]*TotRespMegSF
MegSFAss                     =   [minMegAss, maxMegAss]*MegSFUpt
```

```
MegSFDetProd                    =   [minMegExcrete, maxMegExcrete]*MegSFUpt
MegSFAss - MegSFresp + MaintRespMegSF    =   [minMegNGE,
maxMegNGE]*MegSFAss
MegSFAss - MegSFResp + MaintRespMegSF    =   [minGrowthMeg,
maxGrowthMeg]*MegSF

!-- Efflux of DOC from the sediment
DOCefflux      <   maxRelDOCefflux*TotResp !Burdige GCA 63:1507-1515

! Burial
BurialOC       =   [minBur, maxBur]*TotOMinput

##### END CONSTRAINT
```



Supplementary Figure 1 – Mean flow rates between compartments at each site.



Supplementary Figure 2 – Map of sampling locations in the Bransfield Strait (after Bell et al., 2016 *F.Mar.Sci* http://journal.frontiersin.org/article/10.3389/fmars.2016.00032/full)