RCaN

Supplementary Material

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1 Introduction

1. Goals: an example of a RCaN study.
2. The case study: the Barents sea (main text).
3. The RCaN file has been previously built. It is joined.
4. All following commands in joined R script.
5. A first run with all main steps.
6. A second run after removing some constraints
7. Comparisons between both runs and interpretation

2 Preliminary: R Environment

A few libraries are to be loaded.

```
> library(RCaN) #the main package
> library(ggplot2) #to draw results
> library(coda) #to explore mcmc
> library(dplyr) #to manipulate data frame
> library(xtable) #to create latex tables
> library(xlsx) # to import excel files
```

3 The RCaN file

Parameters, observations and constraints have been gathered in an Excel file with a specific structure.

```
> NAMEFILE <- '/Users/christianmullon/Desktop/Ocean/BarentsSeaReconstructions_01_02_21.xlsx'
> # NAMEFILE <- '/Users/christianmullon/Desktop/Ocean/CaN_template_mini.xlsx'
```

3.1 Components

	Component	Inside	AssimilationE	Digestibility	OtherLosses
1	PP	0.00	0.00	0.65	0.00
2	Hzoo	1.00	1.00	0.90	8.40
3	Ozoo	1.00	1.00	0.90	5.50
4	Benthos	1.00	0.94	0.60	1.50
5	PelF	1.00	0.90	0.90	2.85
6	DemF	1.00	0.93	0.85	1.65
7	MM	1.00	1.00	0.00	5.50
8	Birds	1.00	0.84	0.00	60.00
9	Fisheries	0.00	0.00	0.00	0.00
10	NorSeaZoo	0.00	0.00	0.00	0.00

Table 1: Components

3.2 Fluxes

3.3 Observations

3.4 Constraints

	Flux	From	To	Trophic
1	PP_Hzoo	PP	Hzoo	1.00
2	PP_Ozoo	PP	Ozoo	1.00
3	PP_Benthos	PP	Benthos	1.00
4	Hzoo_Ozoo	Hzoo	Ozoo	1.00
5	Hzoo_PelF	Hzoo	PelF	1.00
6	Ozoo_Ozoo	Ozoo	Ozoo	1.00
7	Ozoo_PelF	Ozoo	PelF	1.00
8	Ozoo_DemF	Ozoo	DemF	1.00
9	Ozoo_MM	Ozoo	MM	1.00
10	Ozoo_Birds	Ozoo	Birds	1.00
11	Benthos_Benthos	Benthos	Benthos	1.00
12	Benthos_DemF	Benthos	DemF	1.00
13	PelF_PelF	PelF	PelF	1.00
14	PelF_DemF	PelF	DemF	1.00
15	PelF_MM	PelF	MM	1.00
16	PelF_Birds	PelF	Birds	1.00
17	DemF_DemF	DemF	DemF	1.00
18	DemF_MM	DemF	MM	1.00
19	NorSeaZoo_Hzoo	NorSeaZoo	Hzoo	0.00
20	NorSeaZoo_Ozoo	NorSeaZoo	Ozoo	0.00
21	PelF_Fisheries	PelF	Fisheries	0.00
22	DemF_Fisheries	DemF	Fisheries	0.00
23	MM_Fisheries	MM	Fisheries	0.00
24	Ozoo_Fisheries	Ozoo	Fisheries	0.00

Table 2: Fluxes

	Year	Prod_Sat	Hzoo_Biomass	Ozoo_Biomass	Pelagics
1	1988.00		25432.12	24275.61	428.28
2	1989.00		31987.20	16130.85	864.52
3	1990.00		23027.73	7481.54	5831.66
4	1991.00		21188.34	16833.36	7288.56
5	1992.00		27314.02	7940.31	5152.50
6	1993.00		37612.31	11880.41	799.64
7	1994.00		72438.19	22699.62	203.94
8	1995.00		57941.78	23526.60	195.66
9	1996.00		38465.04	24633.25	504.21
10	1997.00		43364.75	19153.71	912.15

Table 3: Observations

	Id	Constraint
1	C01	PP_Hzoo + PP_Ozoo + PP_Benthos <= Prod_Sat * 1.5
2	C02	PP_Hzoo + PP_Ozoo + PP_Benthos >= Prod_Sat / 1.5
3	C03	PP_Hzoo + PP_Ozoo + PP_Benthos <= 2000000
4	C04	PP_Hzoo + PP_Ozoo + PP_Benthos >= 500000
5	C05	NorSeaZoo_Hzoo = 8 * 1600
6	C06	NorSeaZoo_Ozoo = 2 * 1600
7	C07	PelF_Fisheries >= Pel_landings

Table 4: Constraints

4 Building polytope

```
> begin <- Sys.time()
> POLYTOPE <- buildCaN(NAMEFILE)
> end <- Sys.time()
> end-begin
```

```
Time difference of 3.074418 mins
```

```
> summary(POLYTOPE)
```

```
                 Length  Class      Mode
components_param      10 data.frame list
species                7 -none-     character
fluxes_def             4 data.frame list
flow                  24 -none-     character
series                22 data.frame list
ntstep                 1 -none-     numeric
data_series_name      21 -none-     character
constraints            5 data.frame list
H                     49 -none-     numeric
N                    168 -none-     numeric
A                2009575 dgCMatrix  S4
AAll             2009575 dgCMatrix  S4
C                  49600 dgCMatrix  S4
CAll               49600 dgCMatrix  S4
v                     64 -none-     numeric
vAll                  64 -none-     numeric
L                 173600 dgCMatrix  S4
b                   2593 -none-     numeric
bAll                2593 -none-     numeric
symbolic_enviro      903 -none-     environment
```

5 Structure of polytope

The polytope is defined by two pairs of a matrix and and a vector. F being the vector of all flows at all timesteps, first one (A, b) is an equality $A.F = b$, second one (C, v) is an eqality $C.F \leq v$. For the Barents sea, we have: :

```
> dim(POLYTOPE$A)
```

```
[1] 2593  775
```

```
> length(POLYTOPE$b)
```

```
[1] 2593
```

```
> dim(POLYTOPE$C)
```

```
[1]  64 775
> length(POLYTOPE$v)
[1] 64
```

6 Checking polytope

As it is defined in the RCaN file for the Barents' sea, the polytope is non-empty and bounded:

```
> checkPolytopeStatus(POLYTOPE)

[1] "polytope ok"
```

Limits of the Barents' sea polytope in all dimensions are obtained with getAllBoundsParam:

```
> BOUNDS <- getAllBoundsParam(POLYTOPE)

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```
> summary(BOUNDS)
```

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 Class :character   1st Qu.:     0.0   1st Qu.:   2667  
 Mode  :character   Median :     0.0   Median :   8629  
                    Mean   : 12566.2   Mean   : 311440  
                    3rd Qu.:   906.5   3rd Qu.:  86908  
                    Max.   :448256.5   Max.   :7983360  
```

Function plotPolytope2DCaNmod allows seeing the polytope in the plane defined by two parameters. In its first two dimensions, for the second 1990, the Barents sea polytope dimensions appears as.

```
> fluxX <- paste(FLUXES[1,1],'[1990]',sep="")
> fluxY <- paste(FLUXES[2,1],'[1990]',sep="")
> plotPolytope2D(POLYTOPE, c(fluxX, fluxY))
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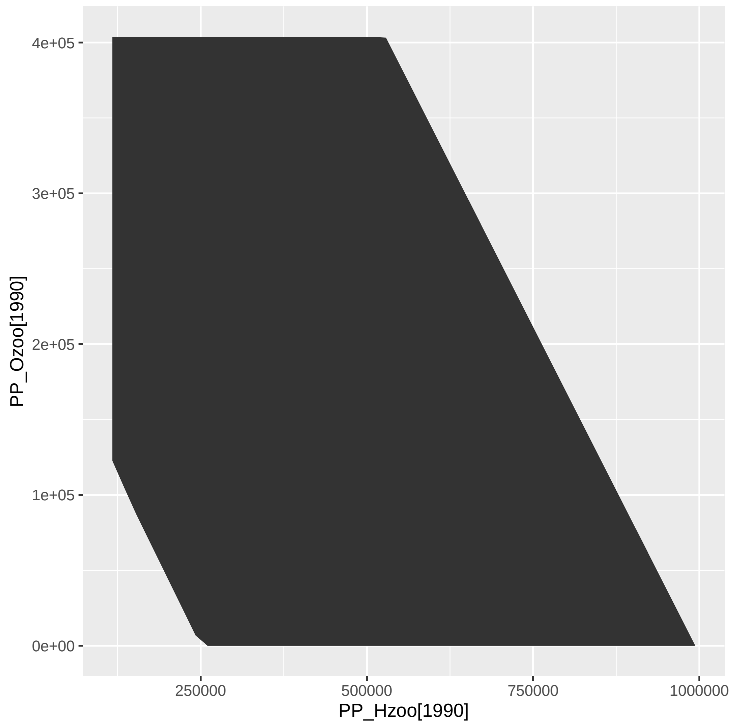
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3e+05
2e+05
1e+05
0e+00
PP_Ozoo[1990]
250000
500000
750000
1000000
PP_Hzoo[1990]

7 Sampling polytope

7.1 Sampling

```
> begin = Sys.time()
> SAMPLE <- sampleCaN(POLYTOPE,
+                      N=100,thin=100,
+                      nchain=2,
+                      ncore=2)
> end=Sys.time()
> end-begin
```

```
Time difference of 16.11554 mins
```

7.2 Convergence

```
> nchain(SAMPLE$mcmc)
```

```
[1] 2
```

```
> # summary(SAMPLE$mcmc)
```

Gelman diagnostics

```
> fluxY <- paste(FLUXES[2,1],'[1990]',sep="")
> gelman.diag(SAMPLE$mcmc[,fluxY])
```

```
Potential scale reduction factors:

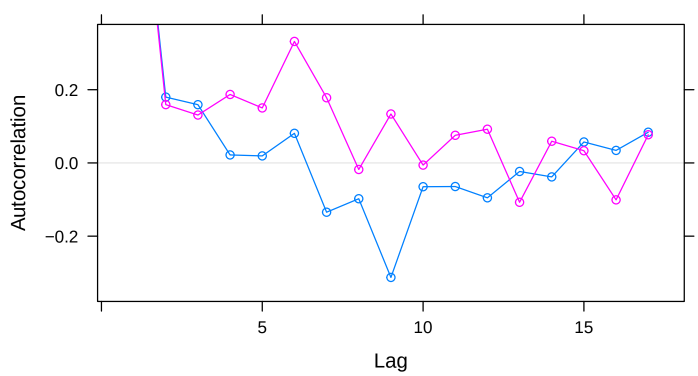
     Point est. Upper C.I.
[1,]       1.03       1.16
```

Autocorrelation function

```
> fluxZ <- paste(FLUXES[3,1],'[1990]',sep="")
> thinned_SAMPLE <- window(SAMPLE$mcmc,thin=2)
> thin(thinned_SAMPLE)
```

```
[1] 2
```

```
> acfplot(thinned_SAMPLE[,fluxZ])
```



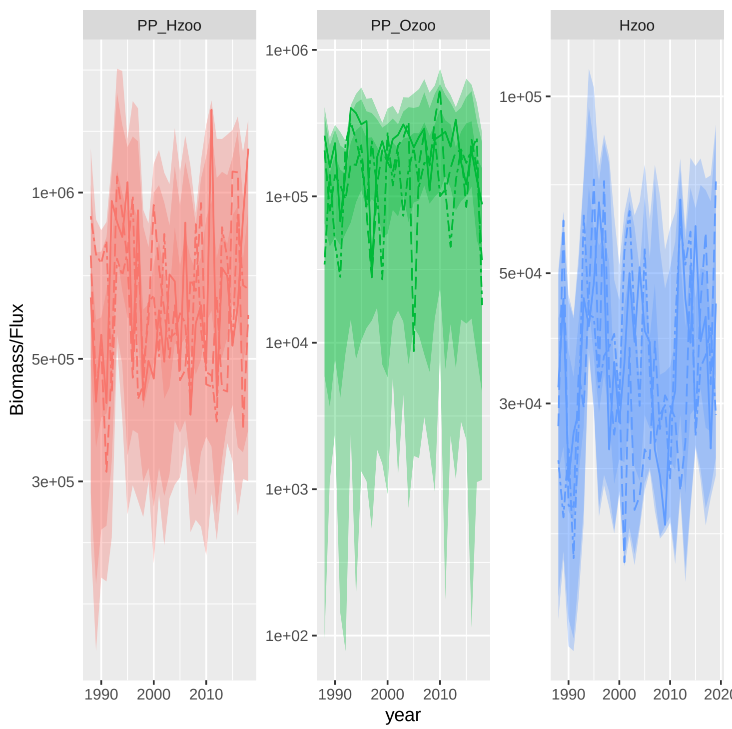
7.3 Dynamics

For several variables or flux, plots of sampled dynamics.

```
> fluxX <- FLUXES[1,1]
> fluxY <- FLUXES[2,1]
> compA <- COMPONENTS[2,1]
> c(fluxX,fluxY,compA)

[1] "PP_Hzoo" "PP_Ozoo" "Hzoo"

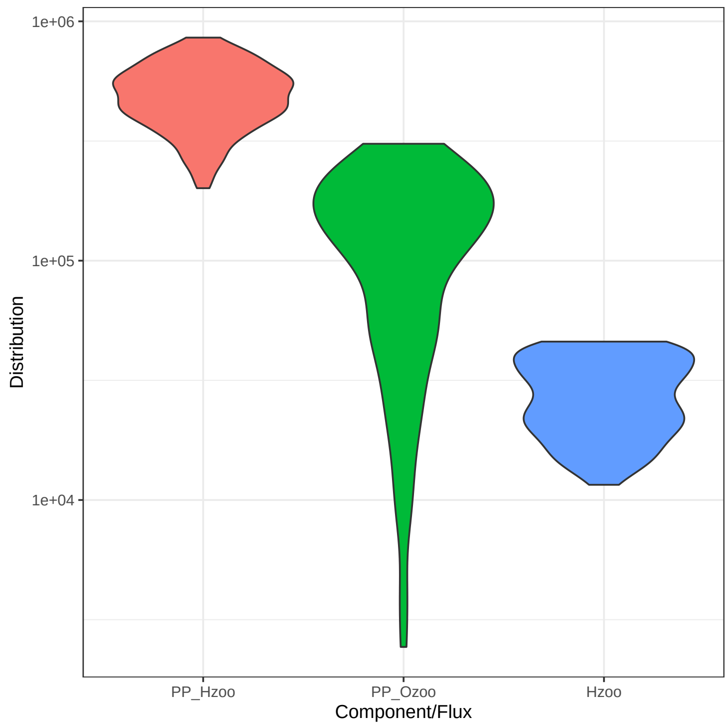
> g <- ggSeries(SAMPLE, c(fluxX,fluxY,compA), TRUE)
> g + scale_y_log10() + guides(color = FALSE, fill = FALSE)
```



7.4 Distribution

For a component or a flux, for a year, the distribution of sampled values.

```
> ggViolin(SAMPLE,c(fluxX,fluxY,compA),year=1990,TRUE)
```



7.5 Diet relationships

```
> ggDiet(SAMPLE, compA)
```