SBML Model Report

Model name: “Phillips2007_AscendingArousalSystem_SleepWakeDynamics”

May 5, 2016

1 General Overview

This is a document in SBML Level 2 Version 4 format. This model was created by the following three authors: Catherine Lloyd[1], Catherine Lloyd[2] and Catherine Lloyd[3] at June 25th 2010 at 12:34 a. m. and last time modified at June 25th 2010 at 12:34 a. m. Table 1 provides an overview of the quantities of all components of this model.

Table 1: Number of components in this model, which are described in the following sections.

Element	Quantity	Element	Quantity
compartment types	0	compartments	1
species types	0	species	0
events	0	constraints	0
reactions	0	function definitions	0
global parameters	24	unit definitions	9
rules	10	initial assignments	0

Model Notes

This a model from the article:
A quantitative model of sleep-wake dynamics based on the physiology of thebrainstem as-

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cending arousal system.
Phillips AJ, Robinson PA. J Biol Rhythms 2007 Apr;22(2):167-79 17440218 ,

Abstract:
A quantitative, physiology-based model of the ascending arousal system isdeveloped, using continuum neuronal population modeling, which involvesaveraging properties such as firing rates across neurons in each population. Themodel includes the ventrolateral preoptic area (VLPO), where circadian andhomeostatic drives enter the system, the monoaminergic and cholinergic nuclei ofthe ascending arousal system, and their interconnections. The human sleep-wakecycle is governed by the activities of these nuclei, which modulate thebehavioral state of the brain via diffuse neuromodulatory projections. The modelparameters are not free since they correspond to physiological observables.Approximate parameter bounds are obtained by requiring consistency withphysiological and behavioral measures, and the model replicates the humansleep-wake cycle, with physiologically reasonable voltages and firing rates.Mutual inhibition between the wake-promoting monoaminergic group andsleep-promoting VLPO causes ;;flip-flop" behavior, with most time spent in 2stable steady states corresponding to wake and sleep, with transitions betweenthem on a timescale of a few minutes. The model predicts hysteresis in thesleep-wake cycle, with a region of bistability of the wake and sleep states.Reducing the monoaminergic-VLPO mutual inhibition results in a smallerhysteresis loop. This makes the model more prone to wake-sleep transitions inboth directions and makes the states less distinguishable, as in narcolepsy. Themodel behavior is robust across the constrained parameter ranges, but withsufficient flexibility to describe a wide range of observed phenomena.

This model was taken from the CellML repository and automatically converted to SBML.
The original model was: **Phillips AJ, Robinson PA. (2007) - version=1.0**
The original CellML model was created by:
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2 Unit Definitions

This is an overview of 13 unit definitions of which four are predefined by SBML and not mentioned in the model.

2.1 Unit mV

Name mV

Definition mV

2.2 Unit mV_second

Name mV_second

Definition $\mathrm{mV} \cdot \mathrm{s}$

2.3 Unit hour

Name hour

Definition $3600\,\mathrm{s}$

2.4 Unit per_hour

Name per_hour

Definition $(3600\,\mathrm{s})^{-1}$

2.5 Unit nM

Name nM

Definition $\mathrm{nmol} \cdot \mathrm{l}^{-1}$

2.6 Unit nM_second

Name nM_second

Definition $\mathrm{nmol} \cdot \mathrm{l}^{-1} \cdot \mathrm{s}$

2.7 Unit mV_per_nM

Name mV_per_nM

Definition $\mathrm{mV} \cdot \mathrm{nmol}^{-1} \cdot \mathrm{l}$

2.8 Unit `per_second`

Name per_second

Definition s^{-1}

2.9 Unit `time`

Name time

Definition 3600 s

2.10 Unit `substance`

Notes Mole is the predefined SBML unit for `substance`.

Definition mol

2.11 Unit `volume`

Notes Litre is the predefined SBML unit for `volume`.

Definition l

2.12 Unit `area`

Notes Square metre is the predefined SBML unit for `area` since SBML Level 2 Version 1.

Definition m^2

2.13 Unit `length`

Notes Metre is the predefined SBML unit for `length` since SBML Level 2 Version 1.

Definition m

3 Compartment

This model contains one compartment.

Table 2: Properties of all compartments.

Id	Name	SBO	Spatial Dimensions	Size	Unit	Constant	Outside
`COMpartment`			3	1		☑	

3.1 Compartment COMpartment

This is a three dimensional compartment with a constant size of one litre.

4 Parameters

This model contains 24 global parameters.

Table 3: Properties of each parameter.

Id	Name	SBO	Value	Unit	Constant
Qv	Qv		0.00		☐
Vv	Vv		0.00		☐
tau_v	tau_v		10.00		☑
v_vm	v_vm		-1.90		☑
Qa	Qa		0.00		☐
Va	Va		0.00		☐
Vao	Vao		1.00		☑
Qm	Qm		0.00		☐
Vm	Vm		0.00		☐
tau_m	tau_m		10.00		☑
v_mv	v_mv		-1.90		☑
v_maQao	v_maQao		1.00		☑
H	H		15.00		☐
chi	chi		10.80		☑
mu	mu		3.60		☑
D	D		0.00		☐
C	C		0.00		☐
c0	c0		1.00		☑
omega	omega		0.00		☐
v_vc	v_vc		-6.30		☑
v_vh	v_vh		0.19		☑
Qmax	Qmax		100.00		☑
theta	theta		10.00		☑
sigma	sigma		3.00		☑

5 Rules

This is an overview of ten rules.

5.1 Rule Vv

Rule Vv is a rate rule for parameter Vv:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Vv} = \frac{\mathrm{v\_vm} \cdot \mathrm{Qm} + \mathrm{D} - \mathrm{Vv}}{\frac{\mathrm{tau\_v}}{3600}} \tag{1}$$

5.2 Rule Vm

Rule Vm is a rate rule for parameter Vm:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{Vm} = \frac{\mathrm{v\_maQao} + \mathrm{v\_mv} \cdot \mathrm{Qv} - \mathrm{Vm}}{\frac{\mathrm{tau\_m}}{3600}} \tag{2}$$

5.3 Rule H

Rule H is a rate rule for parameter H:

$$\frac{\mathrm{d}}{\mathrm{d}t}\mathrm{H} = \frac{\mathrm{mu} \cdot \mathrm{Qm} - \mathrm{H}}{\mathrm{chi}} \tag{3}$$

5.4 Rule Qv

Rule Qv is an assignment rule for parameter Qv:

$$\mathrm{Qv} = \frac{\mathrm{Qmax}}{1 + \exp\left(\frac{(\mathrm{Vv} - \mathrm{theta})}{\mathrm{sigma}}\right)} \tag{4}$$

5.5 Rule Qa

Rule Qa is an assignment rule for parameter Qa:

$$\mathrm{Qa} = \frac{\mathrm{Qmax}}{1 + \exp\left(\frac{(\mathrm{Va} - \mathrm{theta})}{\mathrm{sigma}}\right)} \tag{5}$$

5.6 Rule Va

Rule Va is an assignment rule for parameter Va:

$$\mathrm{Va} = \mathrm{Vao} \tag{6}$$

5.7 Rule Qm

Rule Qm is an assignment rule for parameter Qm:

$$\mathrm{Qm} = \frac{\mathrm{Qmax}}{1 + \exp\left(\frac{(\mathrm{Vm} - \mathrm{theta})}{\mathrm{sigma}}\right)} \tag{7}$$

5.8 Rule D

Rule D is an assignment rule for parameter D:

$$D = \mathrm{v\_vc} \cdot C + \mathrm{v\_vh} \cdot H \tag{8}$$

5.9 Rule C

Rule C is an assignment rule for parameter C:

$$C = \mathrm{c0} + \cos(\mathrm{omega} \cdot \mathrm{time}) \tag{9}$$

5.10 Rule omega

Rule omega is an assignment rule for parameter omega:

$$\mathrm{omega} = \frac{2 \cdot \pi}{24} \tag{10}$$

SBML2LaTeX was developed by Andreas Dräger[a], Hannes Planatscher[a], Dieudonné M Wouamba[a], Adrian Schröder[a], Michael Hucka[b], Lukas Endler[c], Martin Golebiewski[d] and Andreas Zell[a]. Please see http://www.ra.cs.uni-tuebingen.de/software/SBML2LaTeX for more information.

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