Paillard-Parrenin threshold models of glaciation - quick results of models

1. Paillard's original 3-state threshold model for glaciation (1998)

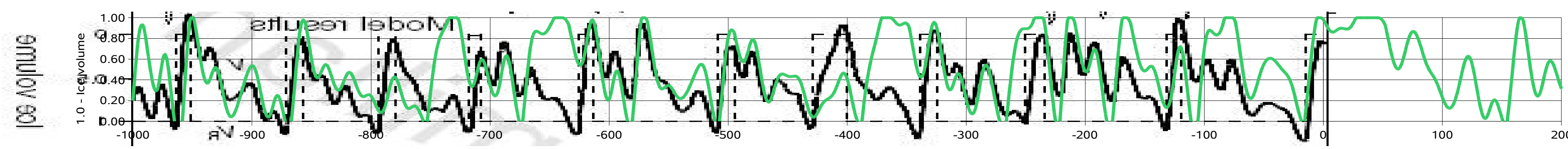
...Incomplete modelling - much improvement still needed to reproduce Paillard's 1998 results.

This model is from Paillar 2003. Briefly, the model uses solar insolation thresholds for switching between three states: interglacial, mild glacial, and full glacial. The glacial ice volume changes according to a simply single ODE that depends on a "target ice volume" for each state, and the solar insolation driving force at latitude 65 North:

dVdt := ((v_rel - v) / tau_V) - (i65N / tau_Insoln)

The black curve is Paillard's model result, while the green curve is the results of a "standard set" of parameters as used. Notice that my results do not match Paillard's, so I have not fully reproduced their results. Besides errors in coding, my numerical integration method is lacking. Here I've shown the simple but low-accuracy Euler method results, and not the Cash-Karp-Runge-Kutta (CKRK) ?5th? order method, which tended to "jump"around too much, even though results were somewhat comparable.

However, I chose not to pursue this variant any further, as the resemblance was adequate for my primary work.

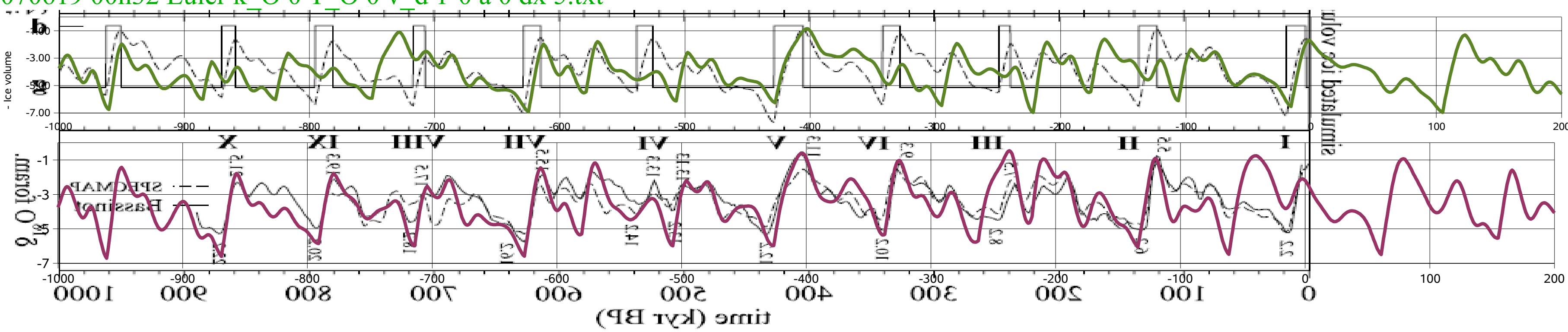


2. Parrenin-Paillard 2-state threshold model for glaciation (2003)

The Parrenin-Paillard 2 state threshold model for glaciation improves on Paillard's 1998 model

My objective here (as in the other examples) was to reproduce the Paillard-Parrenin model results, and not to fit the geological data for glaciation ice volumes. While there are still issues with integration method accuracy, and the adjustment of unspecified parameters, there is clearly good agreement (upper chart). Agreement with the basic data (lower chart) with a slightly different model is also good enough for the present needs.

070619 00h32 Euler k_O 0 T_O 0 v_d 1-0 a 0 dx 5.txt



070618 23h16 Euler v_d 1-0.txt

3. Paillard-Parrenin 2-state threshold model for glaciation

4. Howell adaptation of Paillard-Parrenin models -

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1. Paillard's original 3-state threshold model for glaciation

070617 14h55 Euler dxmin 1.txt

Didier Paillard (1998), The timing of Pleistocene glaciations from a simple multiplestate climate model, Nature, 391, 378–381

```
derivs  IS OP  ky  Conditions  state
{  NONLOCAL  nrhs   ;
   nrhs               := nrhs + 1  ;
   v junk := Conditions ;
                                                              %  ;
   i65N  i60S  :=  interpolate_Insolation  ky ;                              % could simplify! dont need i60S ;
                                                              %  ;
   IF state = "i  THEN       IF i65N < i_0   THEN state := "g                                  ENDIF ;   ENDIF ;     % check for state
changes and set up factors ;
   IF state = "g  THENIF v    > v_max THEN state := "Gg ELSE tau_V := tau_g  ; v_rel := v_g  ;  ENDIF ;   ENDIF ;
   IF state = "Gg THENIF i65N > i_1  THEN state := "i  ELSE tau_V := tau_Gg ; v_rel := v_Gg ; ENDIF ;   ENDIF ;
   IF state = "i  THEN                                        tau_V := tau_i  ; v_rel := v_i  ;           ENDIF ;
   dVdt :=  ((v_rel - v) / tau_V)  - (i65N / tau_Insoln) ;
                                                              %  ;
   (dVdt 0.0)  state
}
```

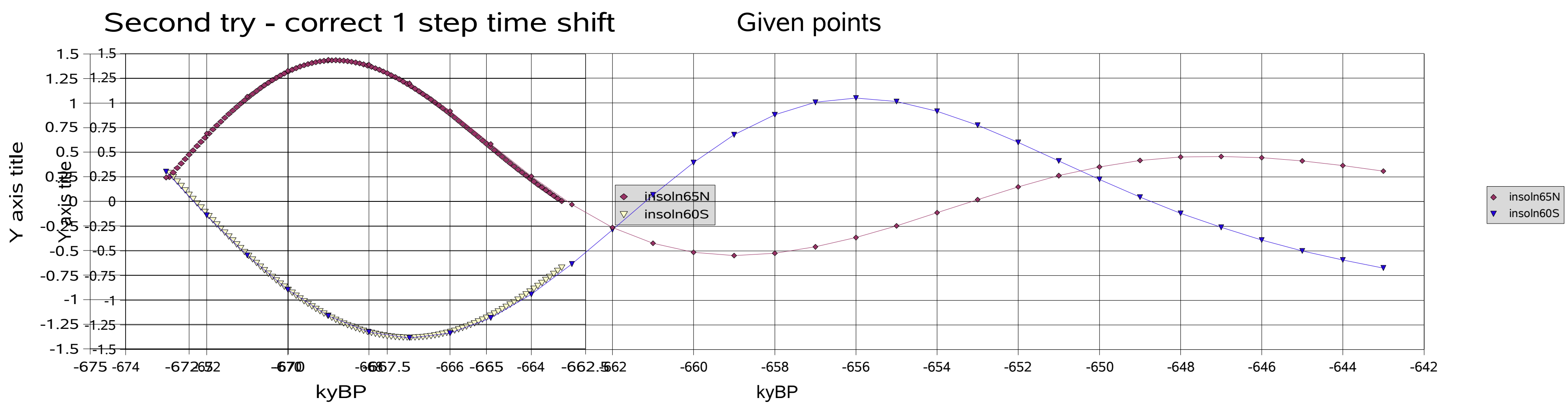
****

```
Paillard threshold model of glaciation.ndf  -  uses Cash-Karp-Runge-Kutta integrate ODEs with accuracy monitoring.ndf

Description of run        : Results.txt
stop message              : ?Stepsize too small, dx   < dx_min, in routine odeint
successful steps          : 773
bad        steps          : 26
function evaluations      : 8904
stored intermediate values: 795
state (F) changes         : 0

Paillard inputs:
```

kyBP_initial	kyBP_final	dkyBP_initial	Ice_initial	
(ky)	(ky)	(ky)	(rel volume)	
-1000	200	1.	0.8	
Insolation	a	i->g insoln	Gg->i insoln	eps
(stddev)	1	-0.75	0.	0.0001
(standard)	1.0s	-0.75s	0.0s	<1e6s

Volume	Interglacial	Mild glac	Full glac	
(0 to 1)	0	1	1	v_max
(standard)	0.0s	1.0s	1.0s	1.0s
Periods	tau_i	tau_A	tau_C	
(ky)	10	50	50	50
(standard)	10s	50s	50s	25s

Check on interpolations of insolation data



This is part of an important confirmation of the accuracy of the interpolation routine used - an ?8-point 5th order polynomial?.

IMPORTANT - Notice that occassionally i65N and i60S move in the **SAME** dirction! (precession-only changes would suggest counter-moves).

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