LPHYS2267 - Paleoclimate Dynamics and Modelling

Homework V

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Contents

1 Simulations from the *berger91_ insol* program

A GitHub repository :
`https://github.com/AmauryLaridon/LPHYS2267---Paleoclimate-Dynamics-and-Modeling.git` has been created where the reader can found the *berger91_ insol* program, a Jupyter Notebook[1] used to analyse the data and some interesting figures.

Computation of the insolation of all months and all latitudes at 0 ka and 127 ka BP

True longitude

To not overload this document all the figures are placed in dedicated section at the end.
Fig.(1) shows the computation of the insolation of all months and all latitudes for year 0 ka with the true longitude and Fig.(2) for the year 127 ka BP.

Calendar date

Fig.(3) shows the computation of the insolation of all months and all latitudes for year 0 ka with the mean longitude and Fig.(4) for the year 127 ka BP.

Differences 127-0ka

First we plot the contour plot of the differences in insolation for year 127 ka BP - year 0 ka using the true longitude method on Fig.(5)
Then we do the same figure of the differences in insolation for year 127 ka BP - year 0 ka but using the mean longitude method on Fig.(6)

In order to compare those two different methods in the computation we finally plot the contour of the difference in insolation given by the true longitude method minus the mean longitude method. This is depicted on Fig.(7). In other words Fig.(7) is Fig.(5) - Fig.(6).
We observe that spatially the differences between the two methods is near $0W/m^2$ from January to June at almost all latitudes. Nevertheless from July to November there are huge difference between the two methods with a deviation from each other in the insolation computed ranging from $[+90W/m^2, -100W/m^2]$. We see that, with a maximum in August the method with true longitude gives $90W/m^2$ more than the mean longitude method at the highest northern latitudes. At the highest southern latitudes it is the opposite situation with a lack of $100W/m^2$ at the maxima from the true longitude method with regard to the mean longitude method. It is also interesting to notice that this second anomaly appears one month later than the first one.

Those two anomaly should be explain by the fact that by definition the true longitude method takes into account the varying orbital speed of the earth which is varying on the orbit while the mean longitude do not. Hence, in the true longitude method the Earth can arrive faster (sooner in the year) at the perihelion compare to the mean longitude and so receive more insolation. Nevertheless a bit, later the Earth will also move away from the perihelion more quickly which ten generates a negative anomaly with respect to the mean longitude method.1

2 Simulations from the *Berger10_ ellipticintegrals* program

Again all the usefull informations can be found on the Github. An other Jupyter Notebook[2] in Julia is used to analyse the data and some interesting figures.

[1]The Notebook can be found at the following adress : /Berger91_daily_insolation/DataSim/Data_analysis.ipynb
[2]The Notebook can be found at the following adress : /Berger10_ellipticintegrals/DataSim/Data_analysis.ipynb

Computation of the total irradiation between true longitude 0° and 90° at $65^\circ N$ for the last 600 ka

Fig.(8) shows the total irradiation for the true longitude method. We can observe the usual sinusoïdal behavior for the irradiance. Roughly we can observe a period of 30 years in the oscillations while the amplitude varies with a more complicated pattern.

Computation of the total irradiation between March 21 and June 22 at $65^\circ N$ for the last 600 ka

The solar irradiance between March 21 and June 22 display more complex variation Fig.(9). The variance of the time series is clearly greater and we observe period during which the irradiance takes more regular values for example the [-475 ka BP - -375 ka BP] period and on the other and period like from -250 ka BP to -100 ka BP where the variance takes larger values.

Comparison between the two methods

Finally we compute the difference between the true longitude method time series and the mean longitude time series Fig.(10). Without surprise the variations comes mostly from the mean longitude time series which depict more variate values. We can observe difference between those two methods up to $400MJ/m^2$. This difference is quite important since it can represent a 13.5 deviation from the mean of the two time series.

Figures

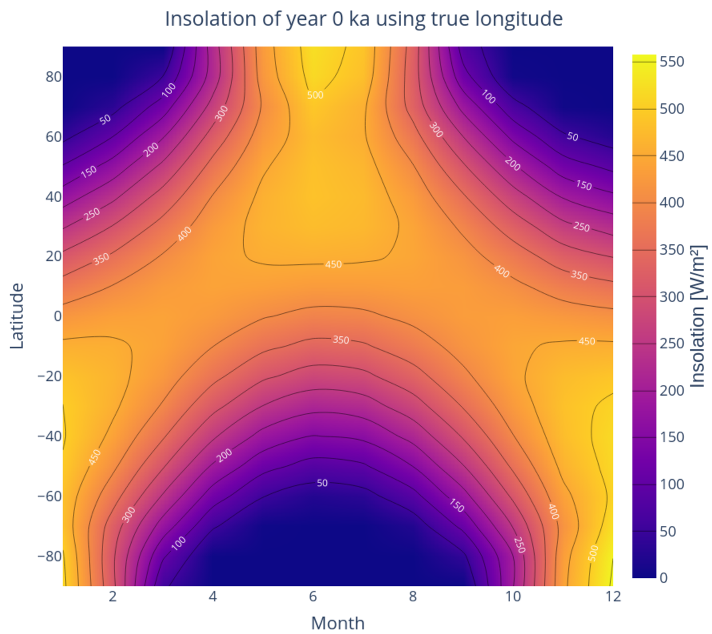

Figure 1: *Insolation of year 0 ka using true longitude. Figure available on the Github.*

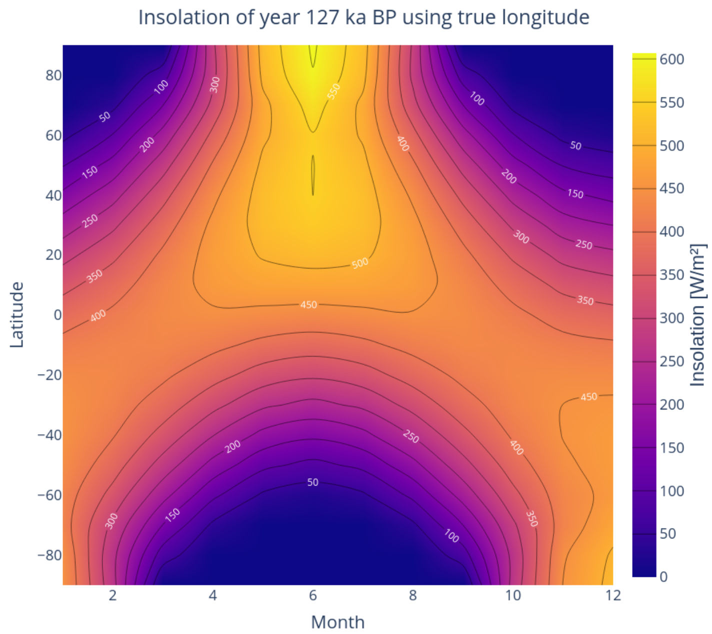

Figure 2: *Insolation of year 127 ka BP using true longitude. Figure available on the Github.*

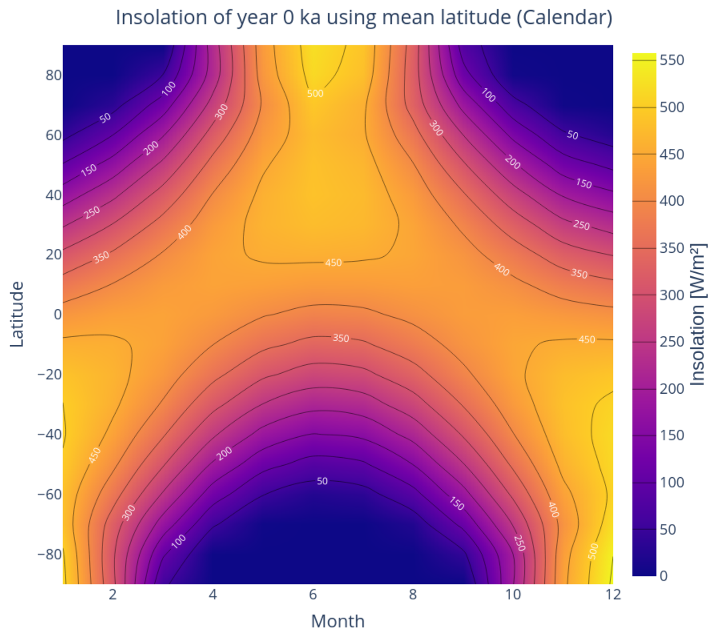

Figure 3: *Insolation of year 0 ka using mean longitude (calendar). Figure available on the Github.*

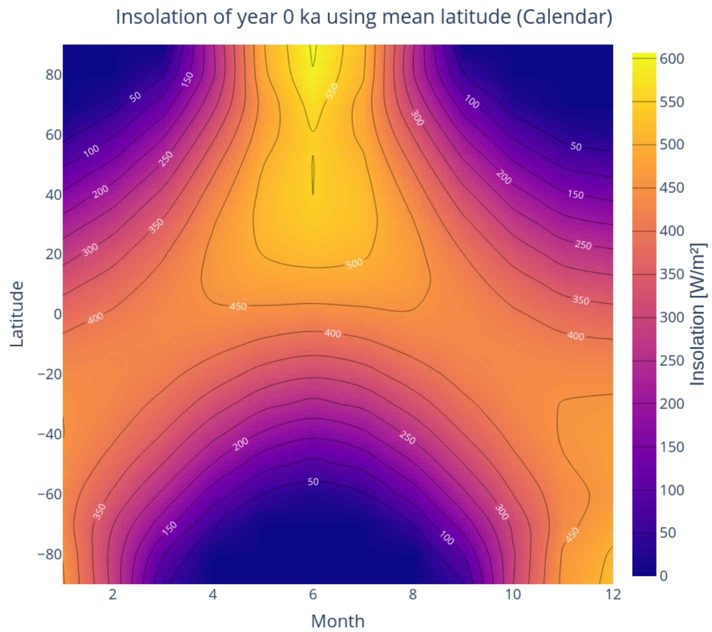

Figure 4: *Insolation of year 127 ka BP using mean longitude (calendar). Figure available on the Github.*

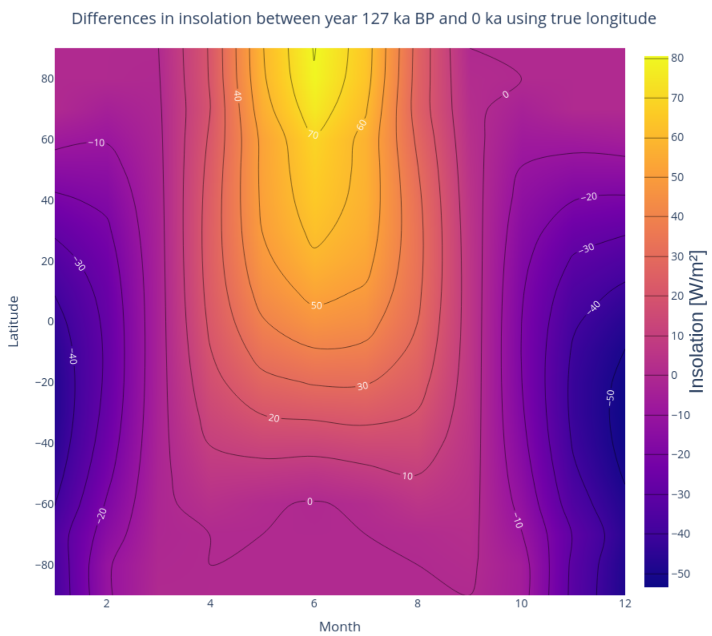

Figure 5: *Contour plot of the differences in insolation for year 127 ka BP - year 0 ka using the true longitude method. Figure available on the Github.*

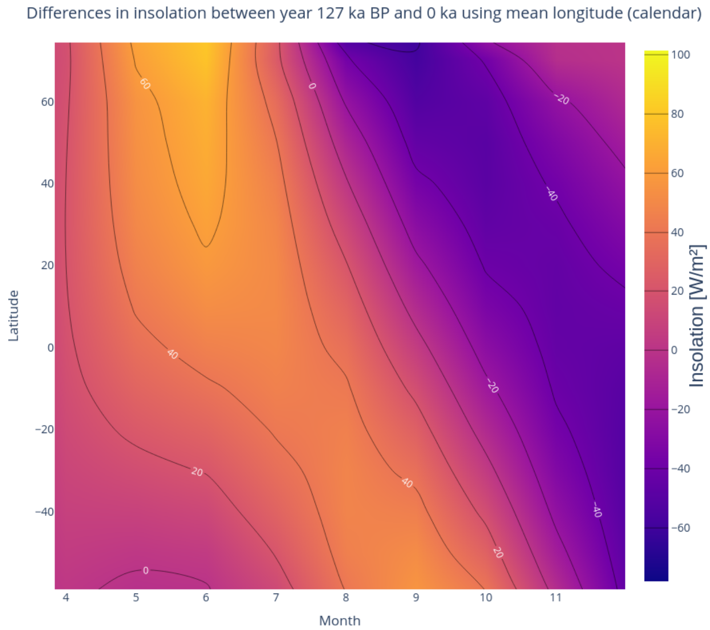

Figure 6: *Contour plot of the differences in insolation for year 127 ka BP - year 0 ka using the mean longitude method. Figure available on the Github.*

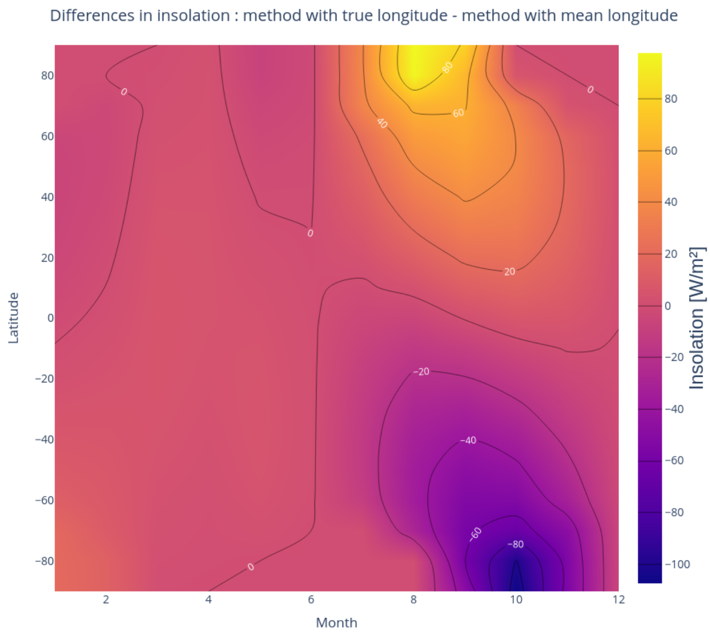

Figure 7: *Contour of the difference in insolation given by the true longitude method minus the mean longitude method. Figure available on the Github.*

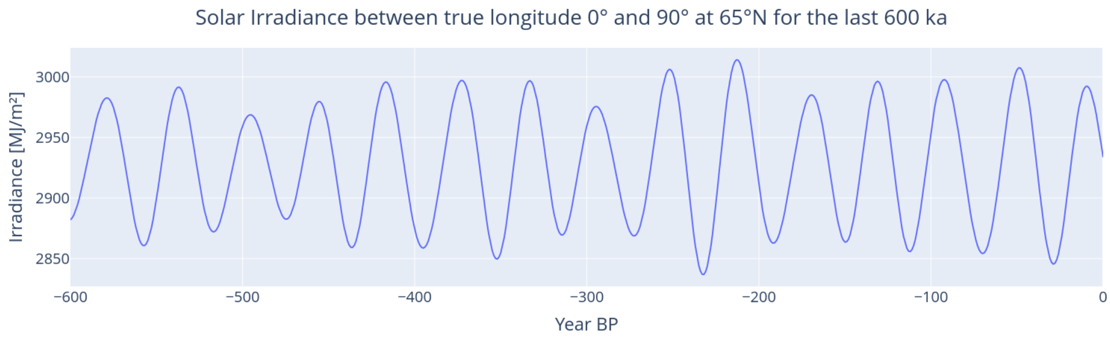

Figure 8: *Solar irradiance between true longitude* 0° *and* 90° *at* 65°*N for the last 600 ka. Figure available on the Github.*

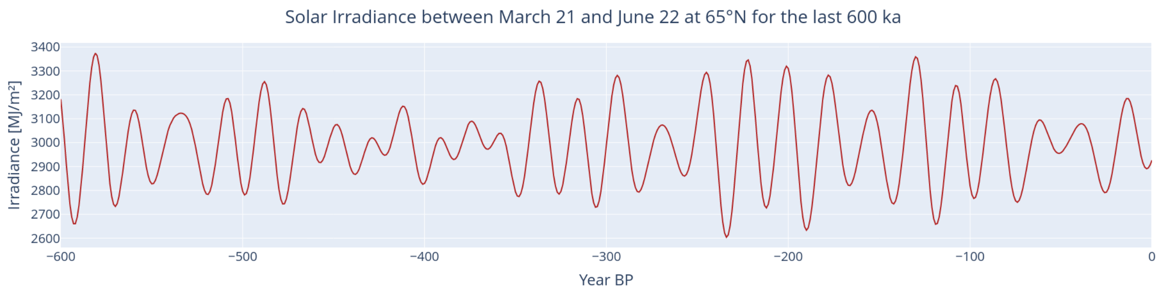

Figure 9: *Solar irradiance between March 21 and June 22 at* 65°*N for the last 600 ka. Figure available on the Github.*

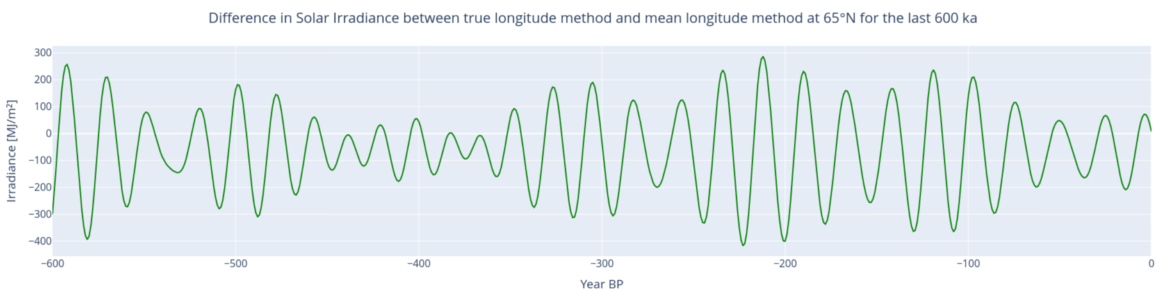

Figure 10: *Solar irradiance difference between the true longitude method and the mean longitude method at* 65°*N for the last 600 ka. Figure available on the Github.*