Choice of the mean pole model

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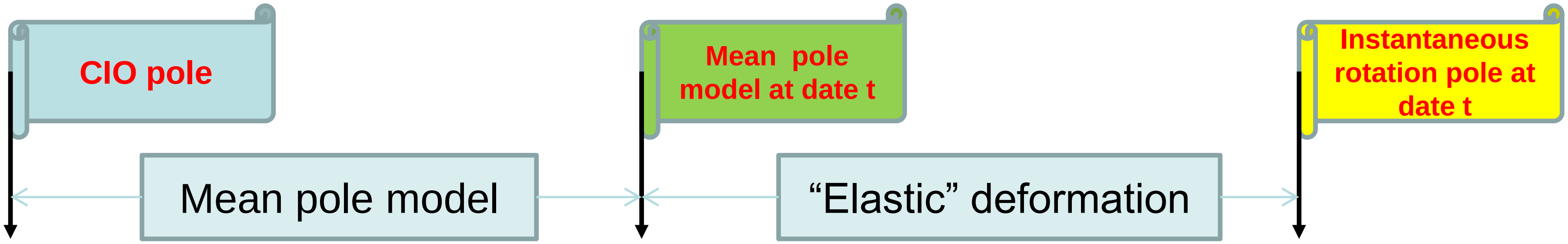
CONTEXT

Z-axis for:
*** TRF**
*** Gravity field model**

The C21/S21 (t) values of the TVG model will depend on the choice of the mean pole model

The fast-changing perturbations of the potential induced by the difference between instantaneous and mean pole is taken care of by the pole tide models (solid and liquid).



Pole tide model with
k2 = 0.3077+0.0036i

CONTEXT

Questions:

1- Is the choice of the mean pole model **VERY** important, or is it somewhat arbitrary?

2- **IF** it is important, is it possible to choose the best model between different candidates?

Method:

We solved for the C21/S21 gravity coefficients data (in fact, all degree 2) on a 10-day basis over 14.5 years using Lageos + Lageos-2 SLR data.

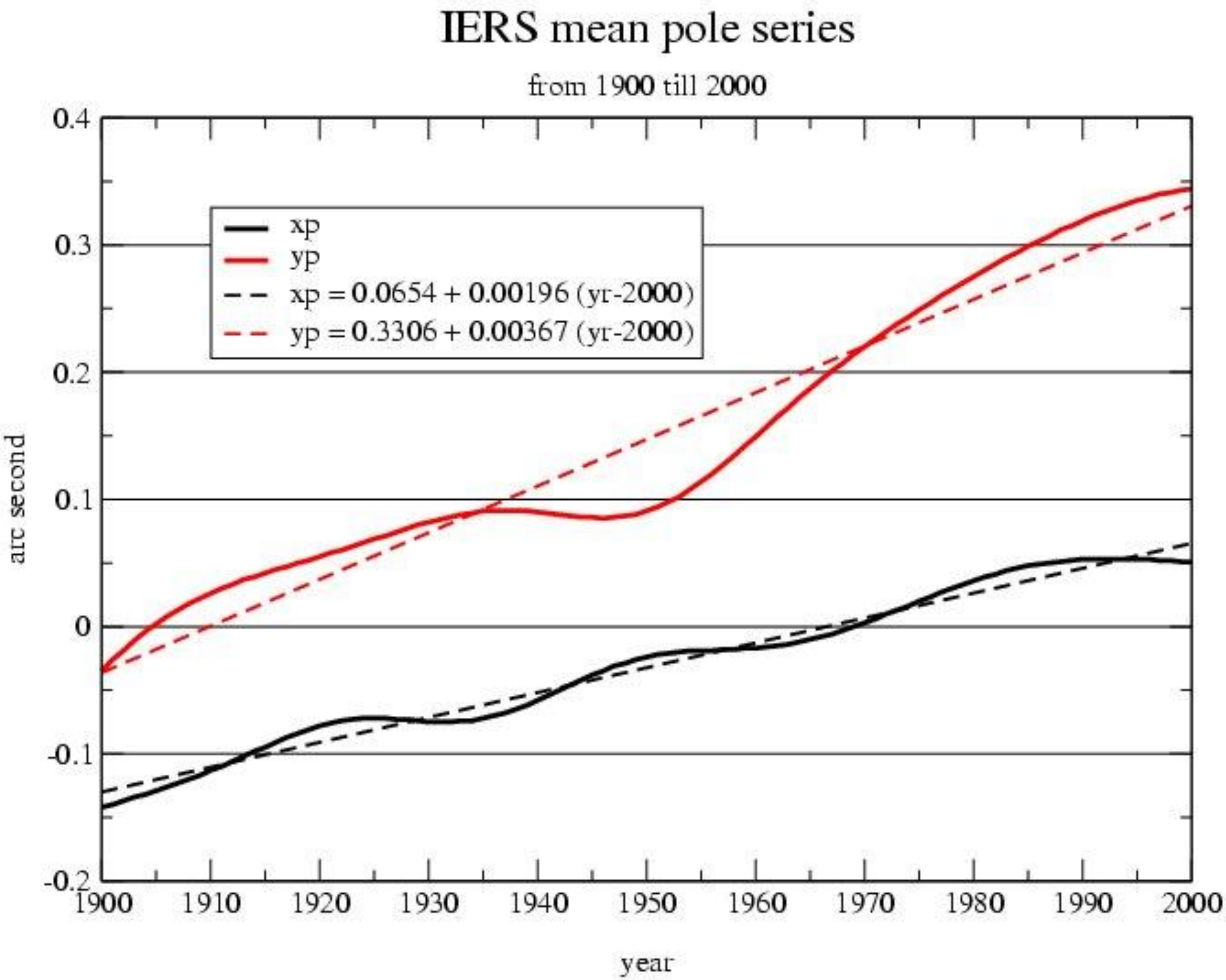
We did the same computation using 3 different mean pole conventions:

1- “**CIO mean pole**”: the mean pole coordinates are constant and equal to 0

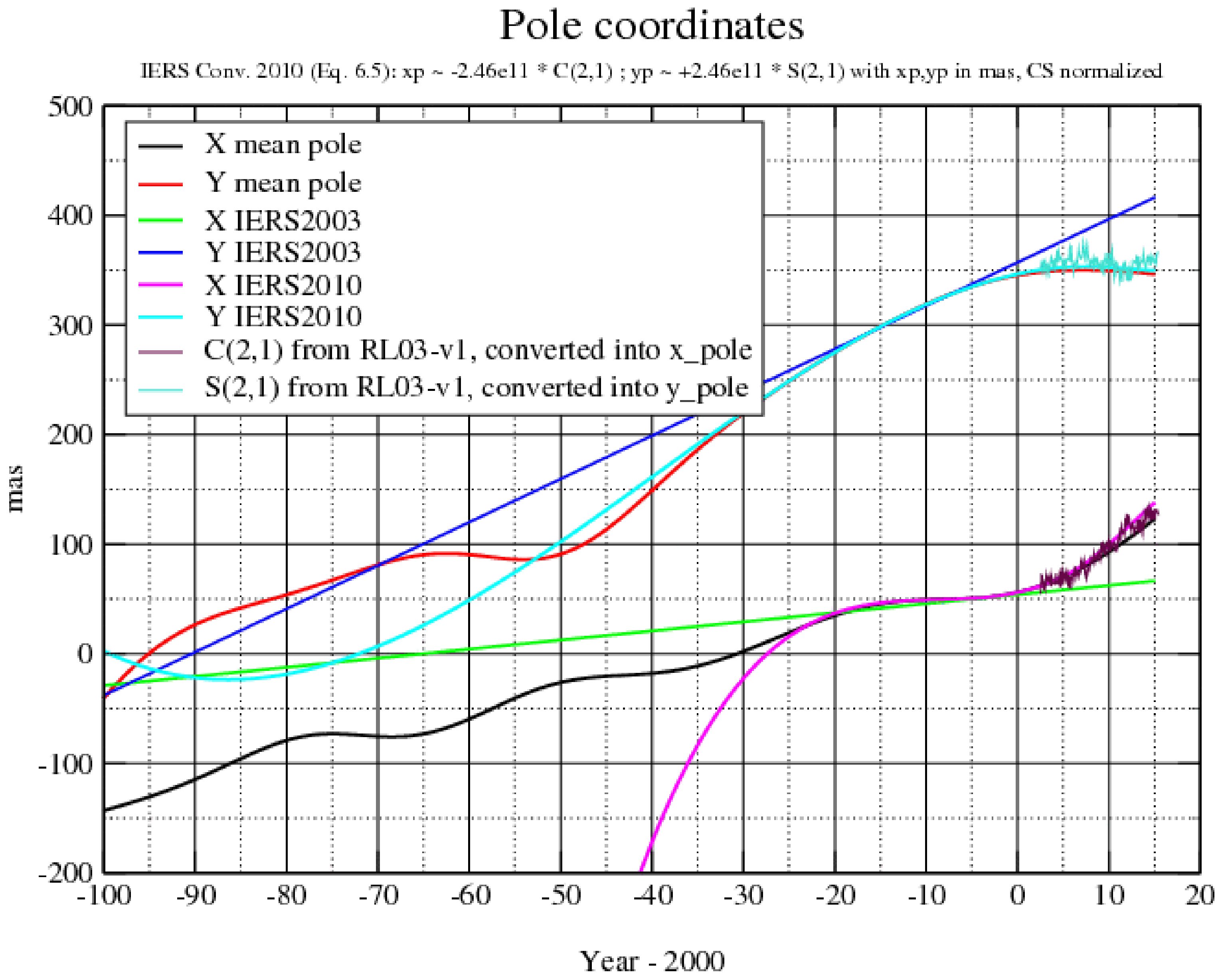
2- “**M100Y mean pole**”: linear regression over the last 100 years of the instantaneous pole position

3- “**IERS2010 mean pole**”: according to the IERS conventions 2010

“M100Y mean pole”



“IERS2010 mean pole”

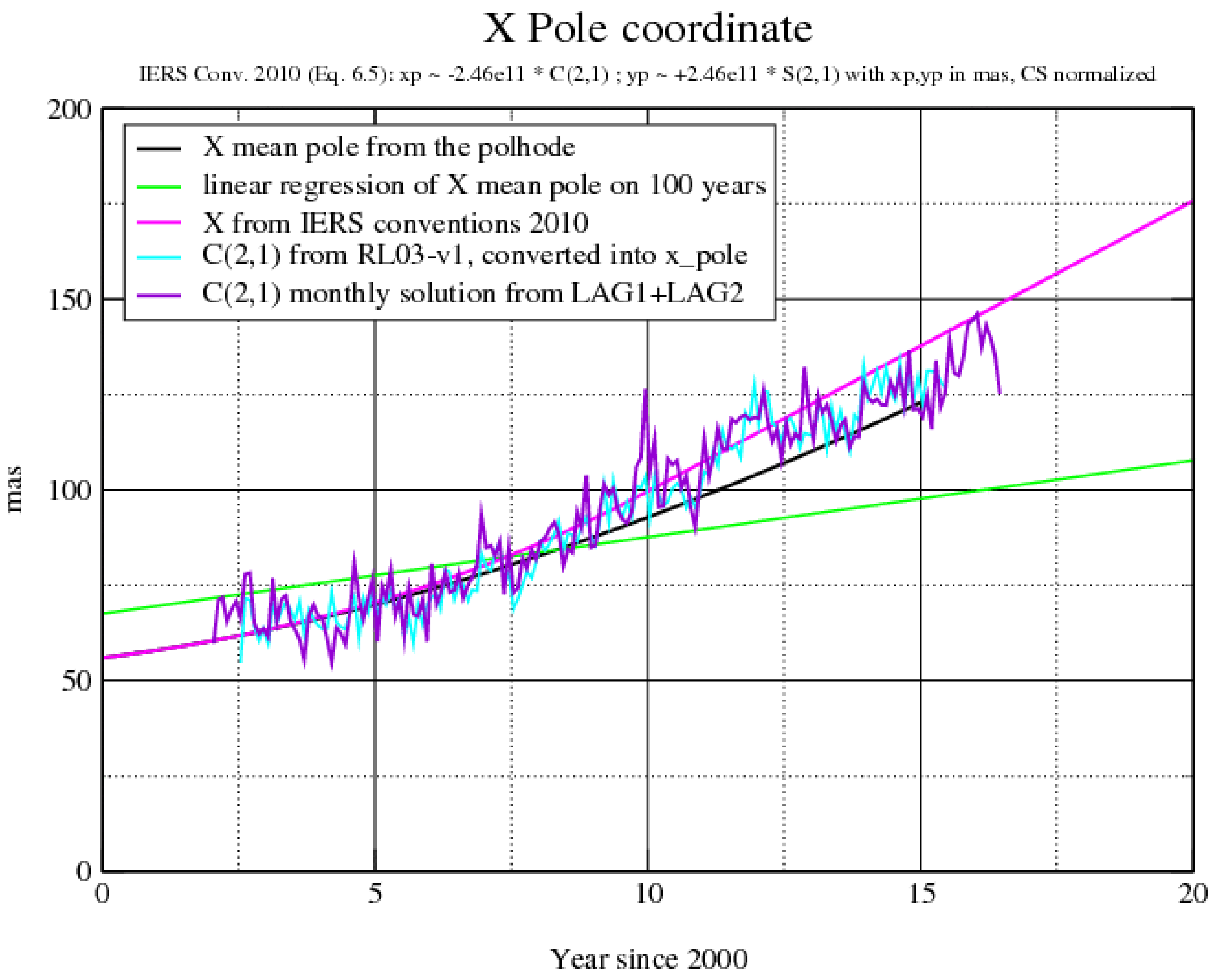


C21/S21 in the standard case ("IERS2010 mean pole")

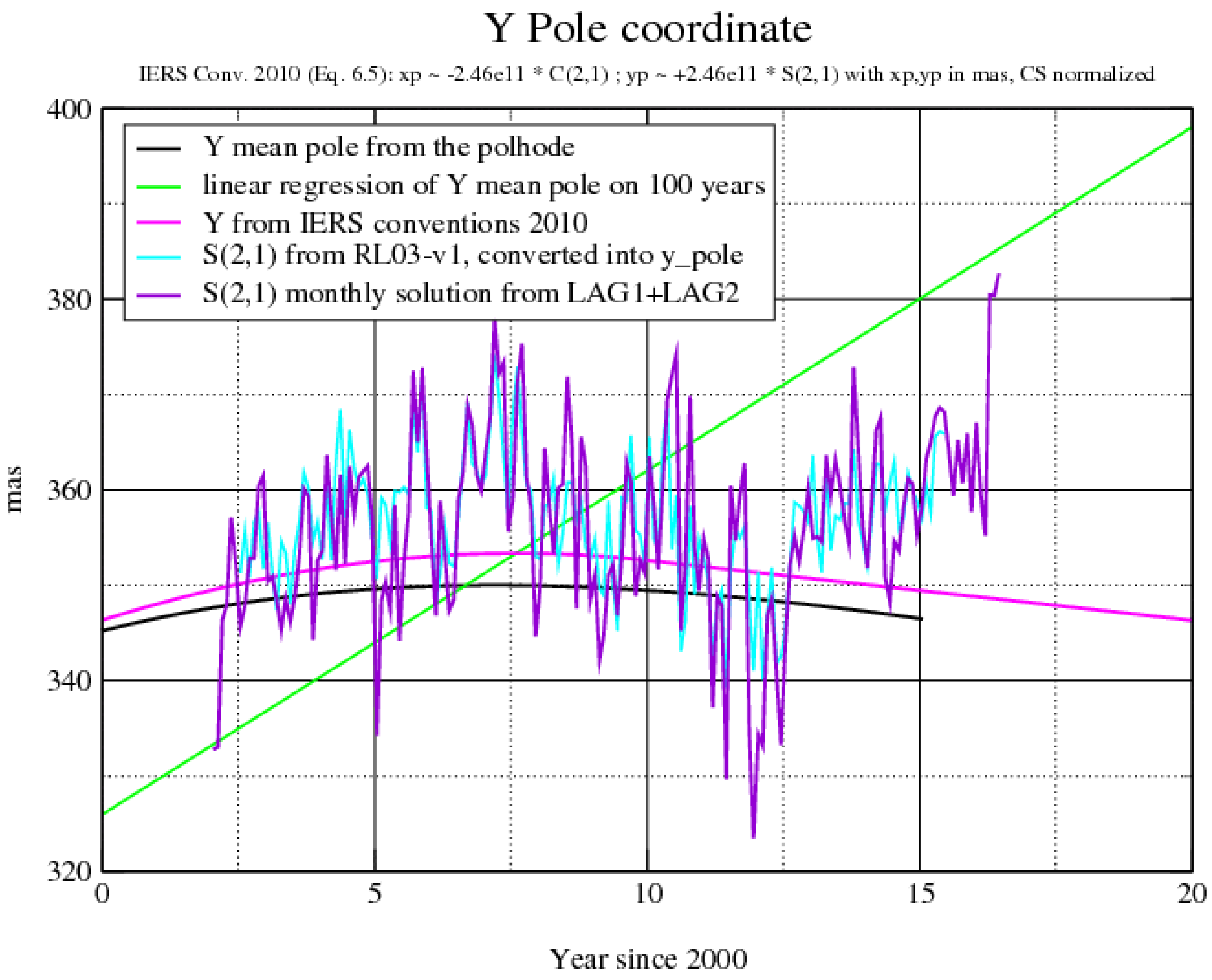
The coefficients solved are C21/S21 (and C20, C22/S22).
In order to plot them on the same graph as the pole coordinates, we convert them into pole units using the equation 6.5 of TN n°36 (simple rotation of the spherical harmonics, no hypothesis has to be made on the value of the k2 Love number):

$$\begin{cases} \bar{C}_{21}(t) = +\sqrt{3}\bar{x}_p(t)\bar{C}_{20} - \bar{x}_p(t)\bar{C}_{22} + \bar{y}_p(t)\bar{S}_{22} \\ \bar{S}_{21}(t) = -\sqrt{3}\bar{y}_p(t)\bar{C}_{20} - \bar{y}_p(t)\bar{C}_{22} - \bar{x}_p(t)\bar{S}_{22} \end{cases}$$

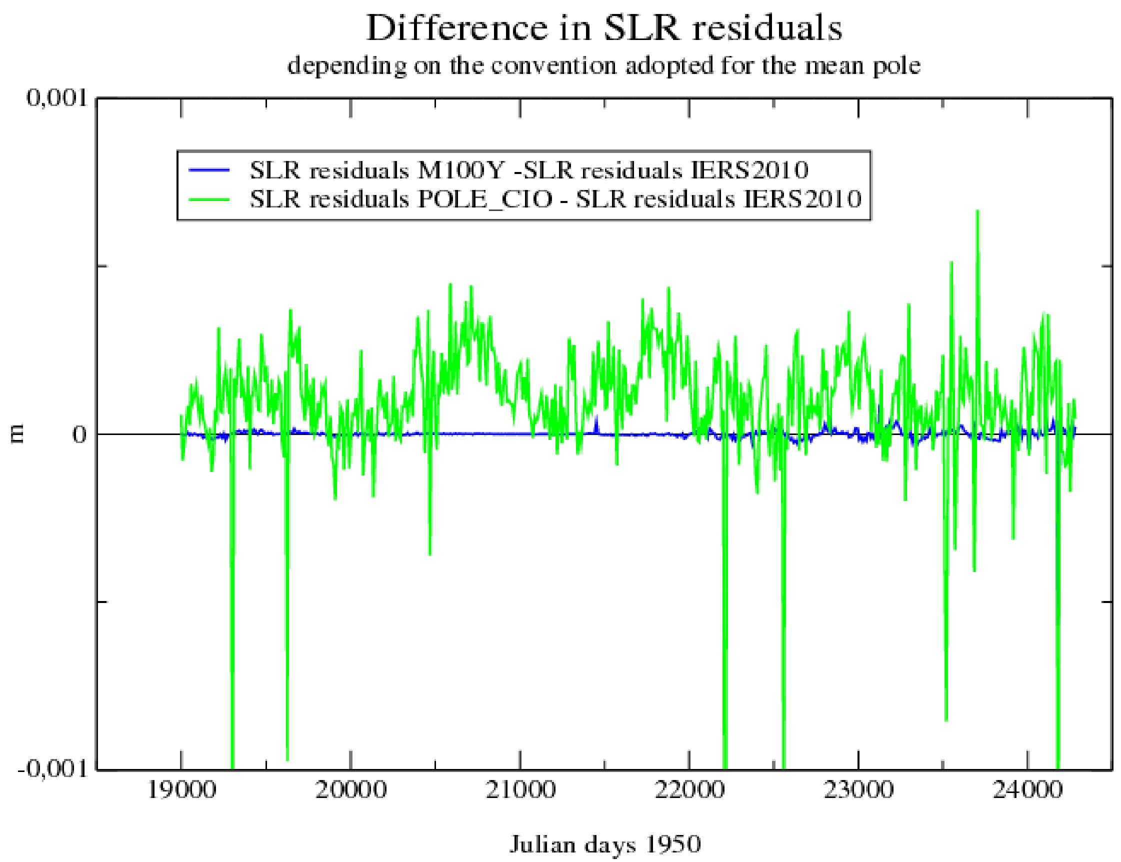
C21/S21 in the standard case ("IERS2010 mean pole")



C21/S21 in the standard case ("IERS2010 mean pole")



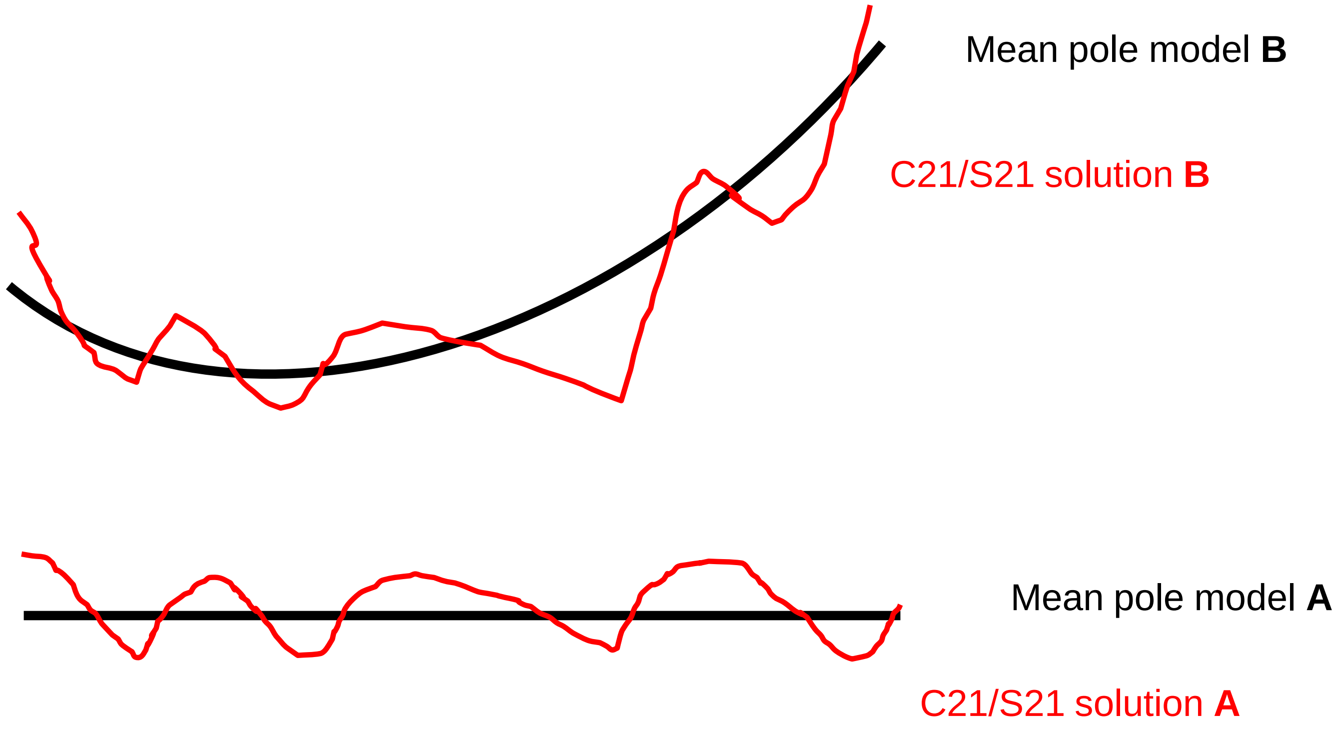
Experimenting 3 conventional mean poles: 1/ SLR residuals



- The average positive value of the green line indicates a poorer performance of the “CIO pole” convention compared to IERS2010.
- No conclusion can be drawn between M100Y and IERS2010 conventions.

Experimenting 3 conventional mean poles: 2/ C21/S21 solutions

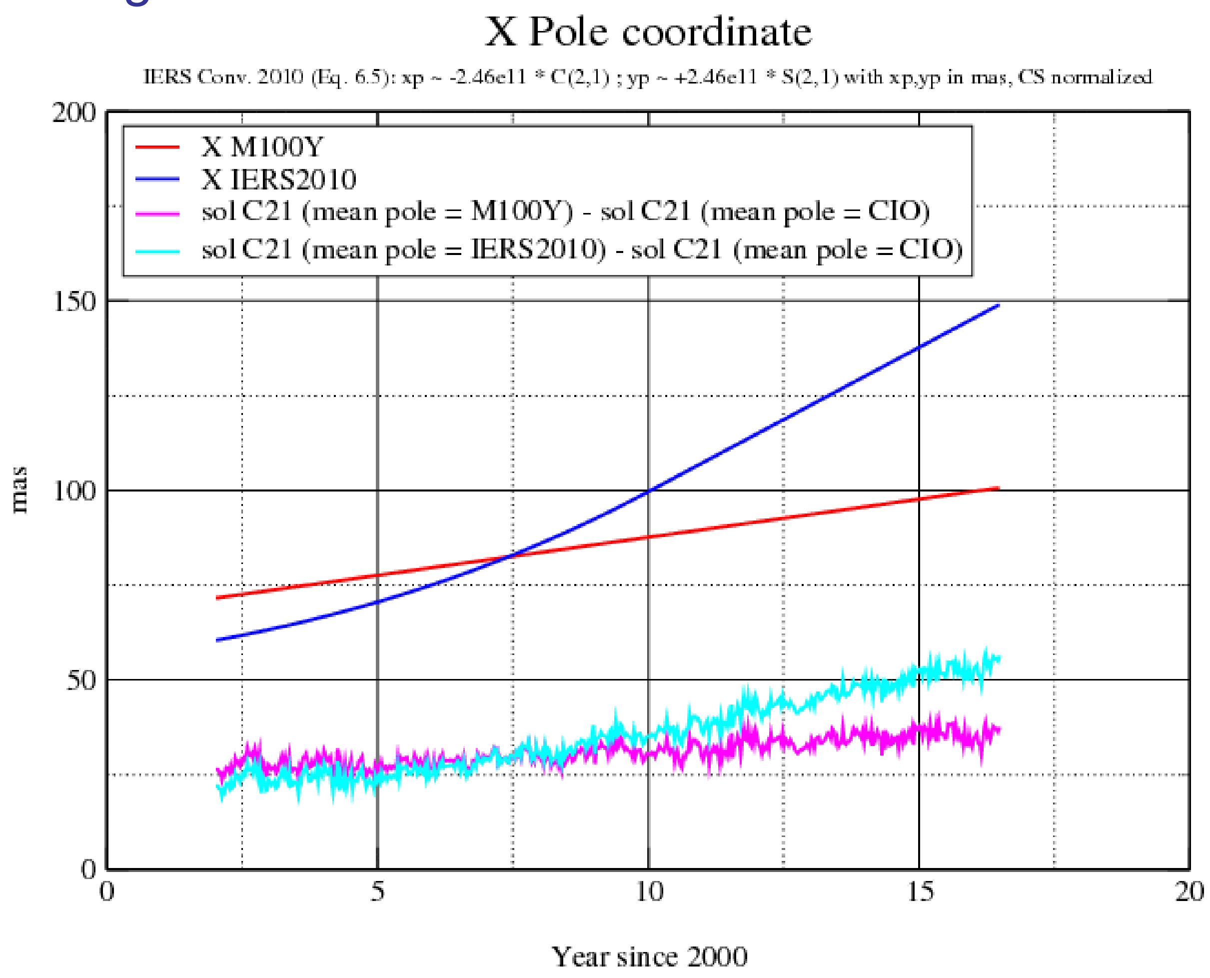
- **IF** the elastic k2 Love number used in the pole tide models was valid for all frequencies, then the C21/S21 solutions would closely follow the mean pole model:



- In fact, this is far from being the case…

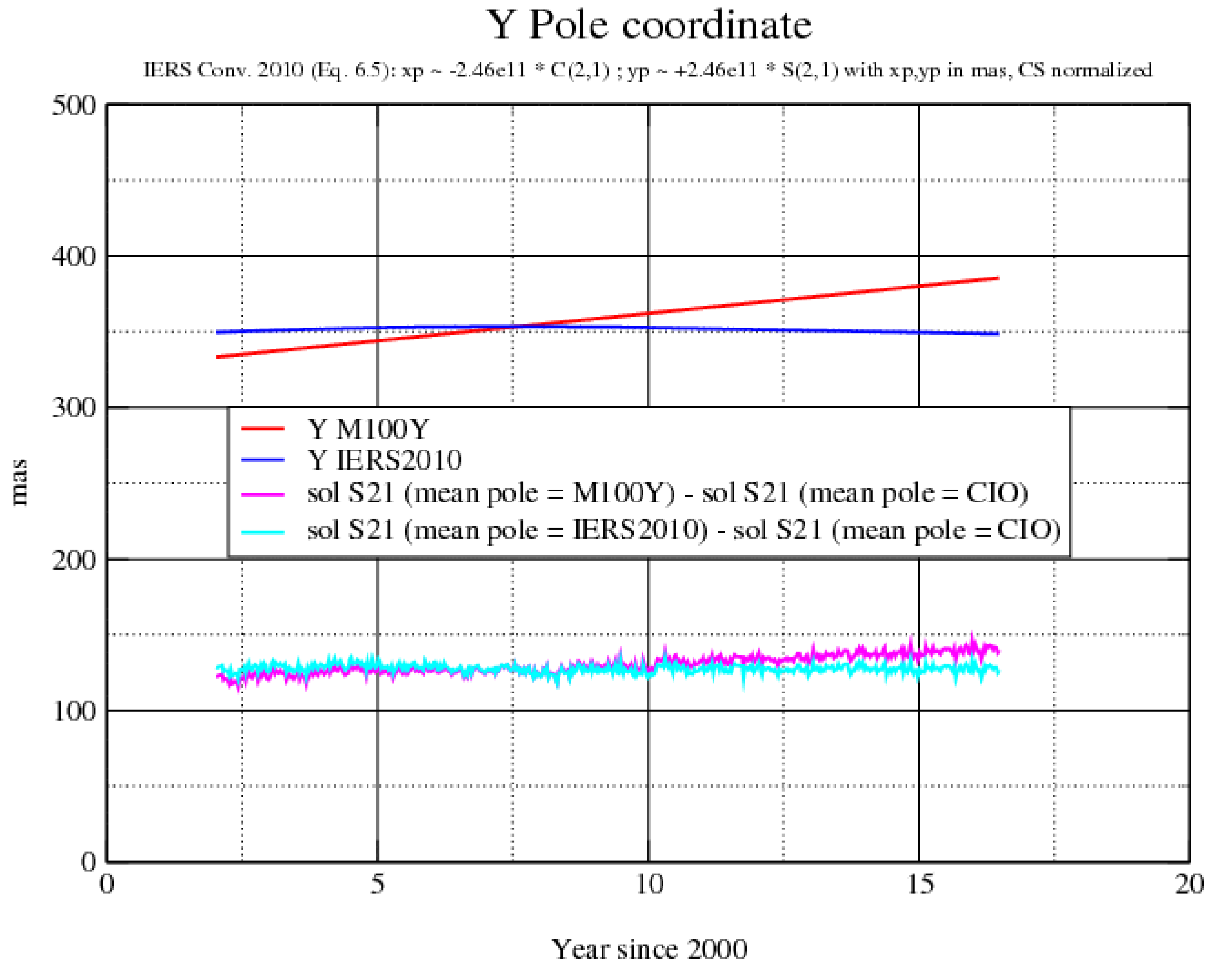
Experimenting 3 conventional mean poles: 2/ C21/S21 solutions

… by a factor greater than 2.



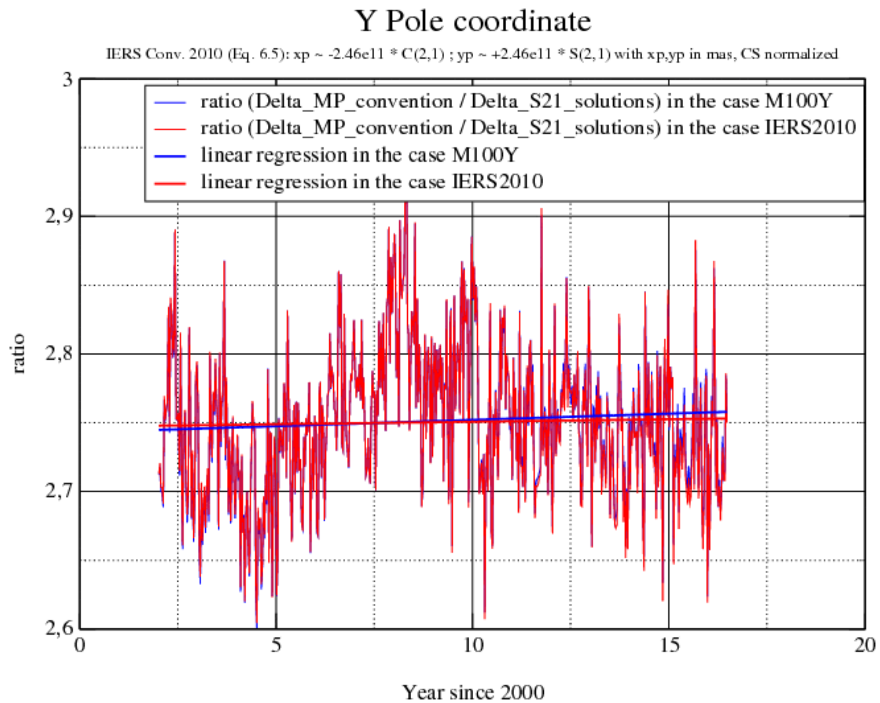
Experimenting 3 conventional mean poles: 2/ C21/S21 solutions

… by a factor greater than 2.



Experimenting 3 conventional mean poles: 2/ C21/S21 solutions

This factor is very stable, equal on average to 2.751 ± 0.005



It indicates that for the secular part of the pole motion we should have taken a k2 value greater than 0.3077, i.e. 0.3077* 2.751 = 0.8465. This figure is intermediate between the short-period Love number k2 = 0.3077 and the secular Love number ks = 0.9383.

Conclusions

A. **Very important:**

When using the C(2,1)/S(2,1) values of a gravity field model, one must adopt **the same mean pole convention** as the one used for the computation of the model. Therefore this information ought to be delivered together with the gravity field model by the makers of the model.

B. The choice of the mean pole convention is not indifferent because the pole tide corrections cannot recover gross errors in the mean pole models, since the k2 Love number that is used for the computation of the pole tides (k2=0.3077) at the annual and Chandler periods is not valid for the correction of the quasi-secular pole tide produced by the PGR. The relevant Love number for the PGR part seems to be k_pgr=0.8465.

C. The evolution of the mean pole (and of the principal axis of inertia of the Earth system) is a combination of two contributions: the purely secular PGR part and the random long-term changes associated with climatology (i.e. polar ice mass loss at the present time). Should the mean pole model reflect only the secular part (PGR) or secular + climatology, and which Love numbers have to be associated with each?