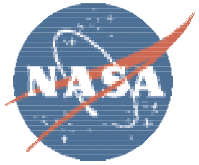
Atmospheric Corrections Study

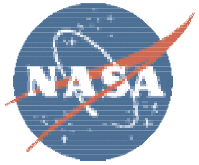
Virgilio B. Mendes, FC/UL

Erricos C. Pavlis, JCET/UMBC



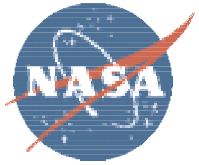
Atmospheric Corrections Study

- During the October 2002 ILRS Workshop we presented results from the NMFs for various wavelengths.
- It was discussed and agreed at that time to look into improved zenith delay computations and to undertake a comparison study using the 1999 - 2002 period of LAGEOS 1 & 2 ILRS NPs.



Atmospheric Corrections Study

- Four years of LAGEOS 1 & 2 ILRS NPs
- Reduced with ***identical*** modeling in weekly arcs, using NASA Goddard's GEODYN II (3 iterations)
- One set of reductions used the 1973 Marini-Murray atmospheric delay model (**MM**)
- A second set used a modified Saastamoinen zenith delay model with the *Mendes et al.* mapping function FCULb (**NMF**)
- Compared the Dry, Wet and Total delay differences



Atmospheric Corrections Study

- Used the refractive index computation of P. Ciddor (1996):

$$(n-1)=\left(\frac{\rho_a}{\rho_{axs}}\right)\left(n_{gaxs}-1\right)+\left(\frac{\rho_w}{\rho_{ws}}\right)\left(n_{gws}-1\right)$$

- With group refractive index for dry air:

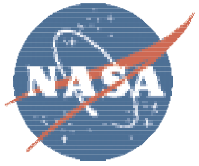
n_{gaxs} – group refractive index for dry air component (unitless)

$$\left(n_{gaxs}-1\right)\times 10^6=10^{-2}\times\left[k_1\frac{\left(k_0+\sigma^2\right)}{\left(k_0-\sigma^2\right)^2}+k_3\frac{\left(k_2+\sigma^2\right)}{\left(k_2-\sigma^2\right)^2}\right]\left[1+0.534\times 10^{-6}\left(x_c-450\right)\right]$$

- And group refractive index for water vapor:

n_{gws} – group refractive index for water vapor component (unitless)

$$\left(n_{gws}-1\right)\times 10^6=10^{-2}\times cf\cdot\left(\omega_0+3\omega_1\sigma^2+5\omega_2\sigma^4+7\omega_3\sigma^6\right)$$



Atmospheric Corrections Study

- Define zenith delay as:

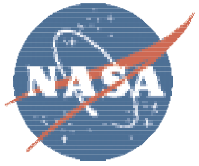
$$d^z_{atm} = 10^{-6}\int_{r_s}^{r_a} N_h + 10^{-6}\int_{r_s}^{r_a} N_{nh}$$

- After some derivations we get the hydrostatic term:

$$d^z_h = 0.002417565\frac{f(\lambda)}{f(\varphi, H)}P_s$$

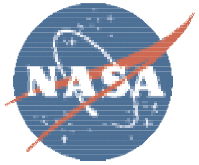
- And the non-hydrostatic term:

$$d^z_{nh} = \left(0.000532 f_{nh}(\lambda) - 0.000376 f_h(\lambda)\right)\frac{e_s}{f(\varphi, H)}$$

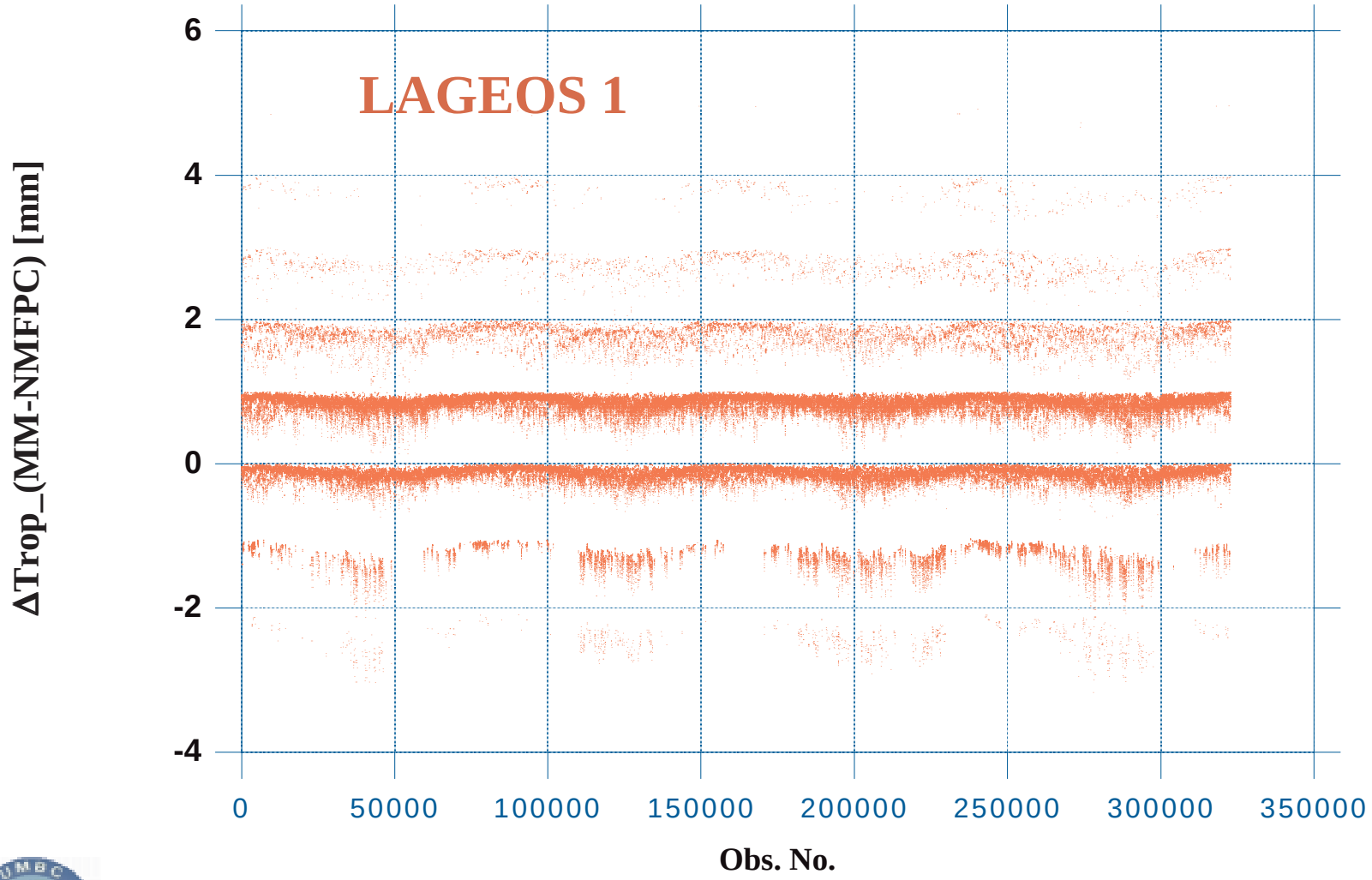


Atmospheric Corrections Study

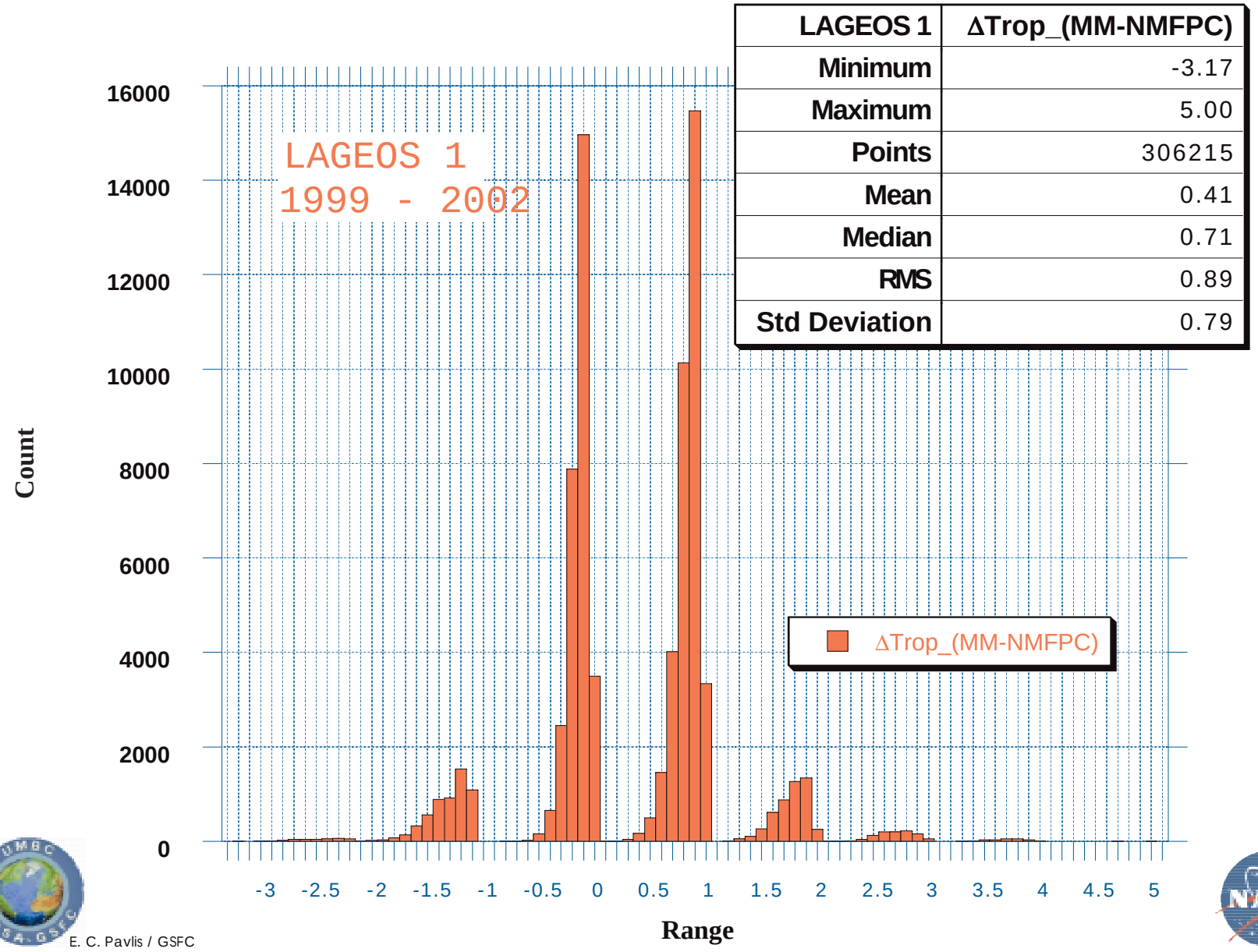
- A modified version of the subroutines we distributed last year, FCULa and FCULb, was developed based on the new derivation.
- In addition to the improved zenith delay model, the new subroutines were implemented in a test version of GEODYN II in a way that the dry and wet components are computed and reported separately in the corrections file.
- The results reported here were obtained using the new version of the model and s/w.



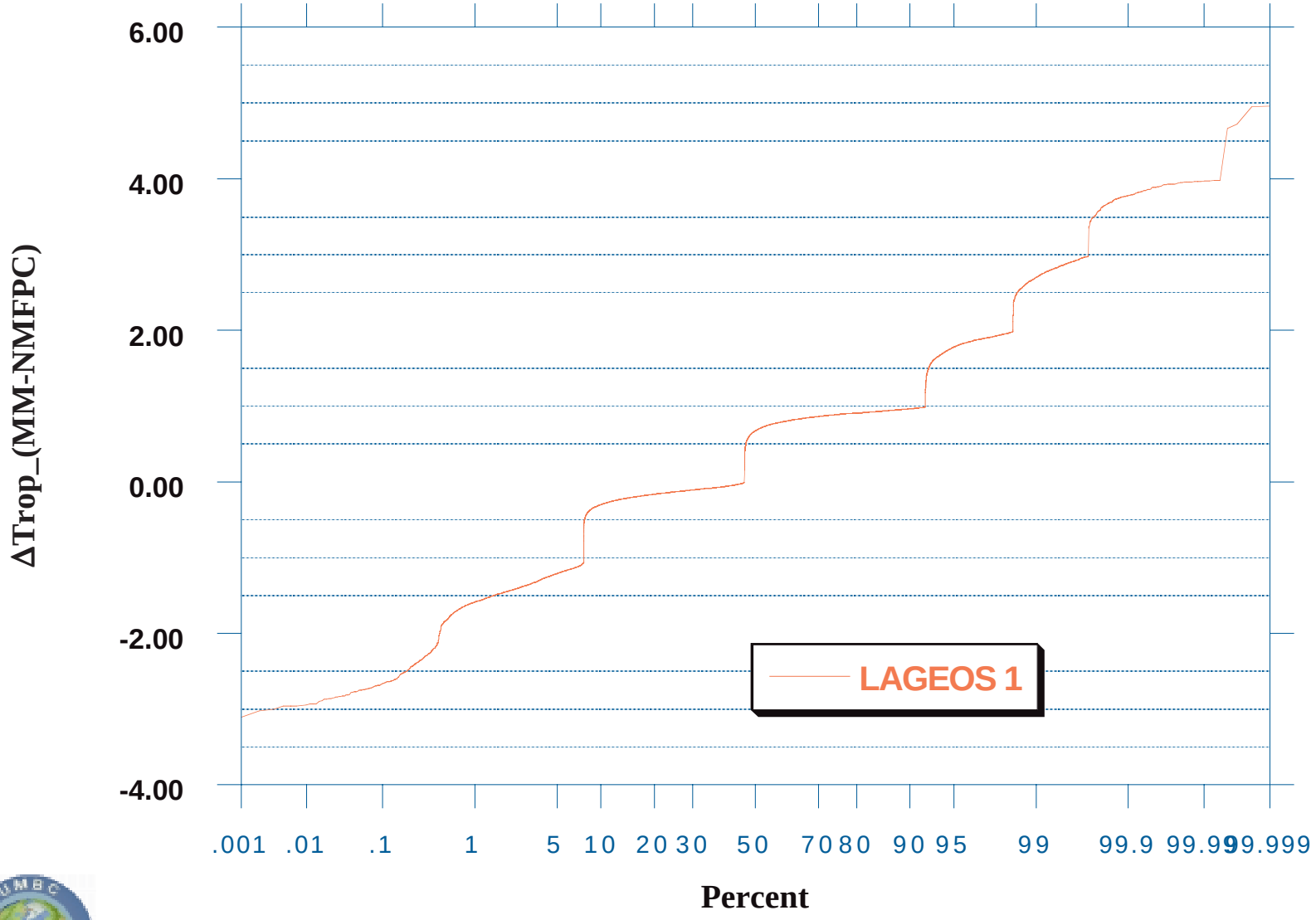
Atmospheric Corrections Study



E. C. Pavlis / GSFC

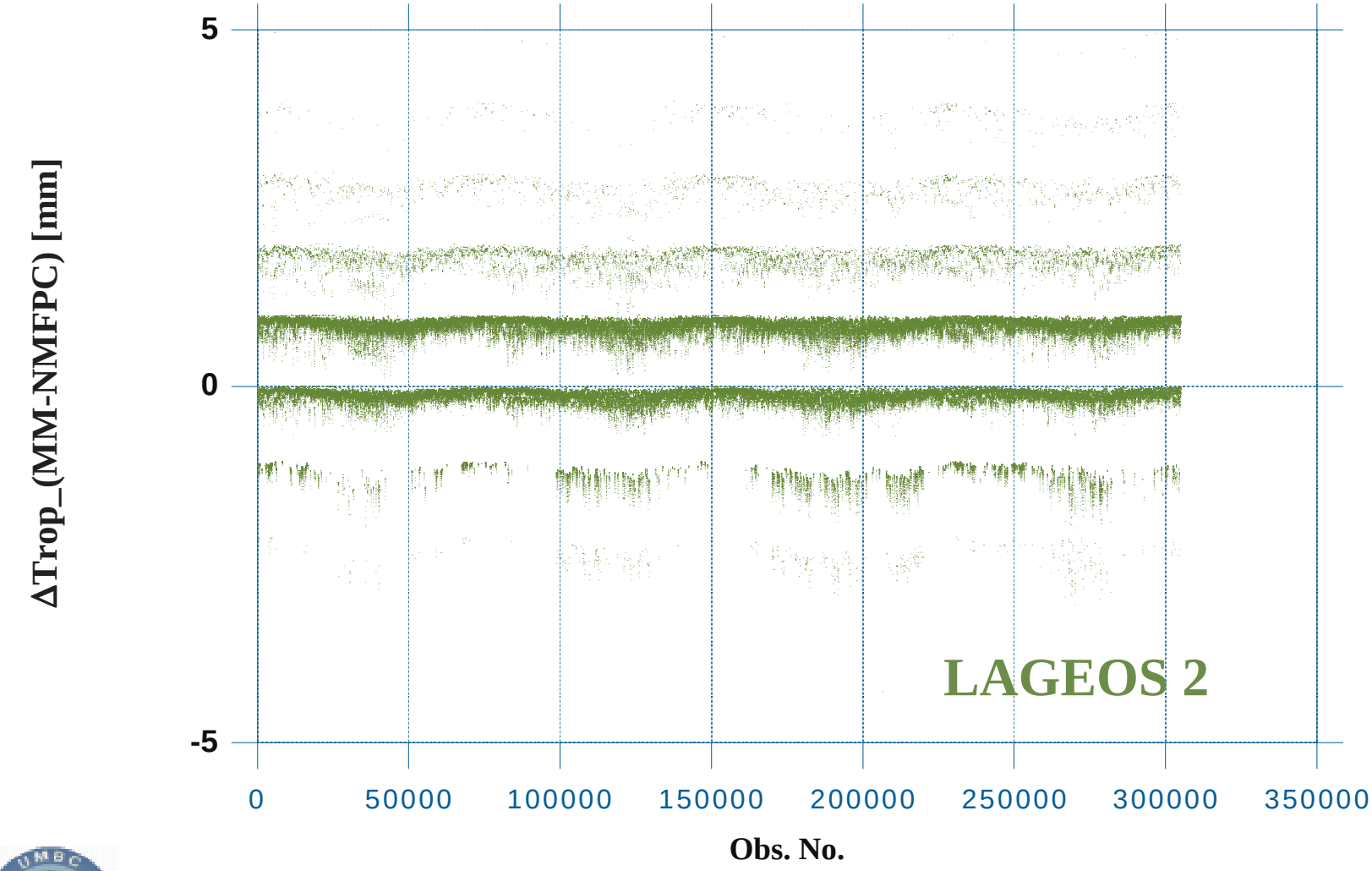

LAGEOS 1
1999 - 2002
LAGEOS 1 | ΔTrop_(MM-NMFPC)
Minimum | -3.17
Maximum | 5.00
Points | 306215
Mean | 0.41
Median | 0.71
RMS | 0.89
Std Deviation | 0.79
ΔTrop_(MM-NMFPC)
Count
Range
16000
14000
12000
10000
8000
6000
4000
2000
0
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5

Atmospheric Corrections Study

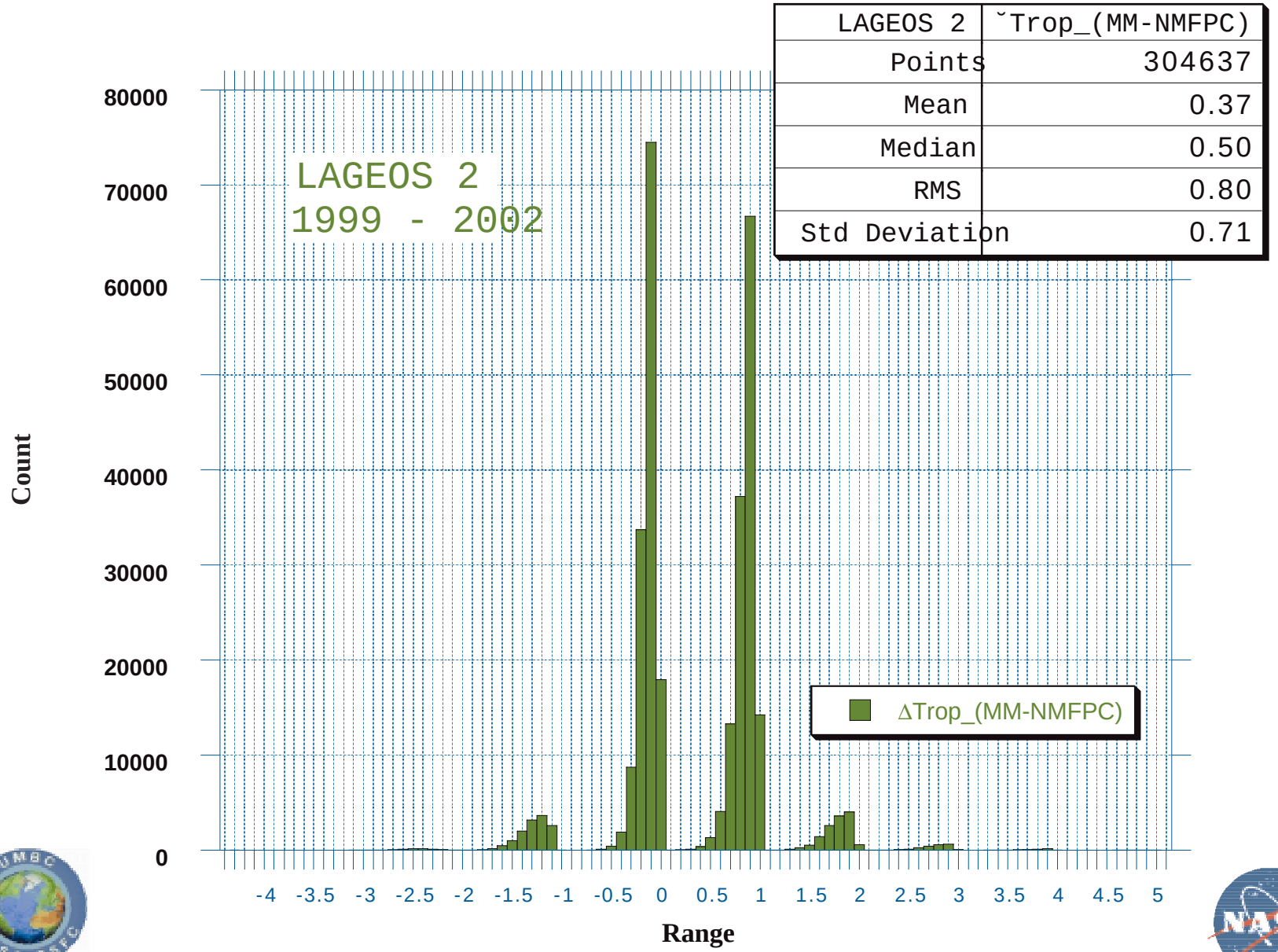


E. C. Pavlis / GSFC

Atmospheric Corrections Study

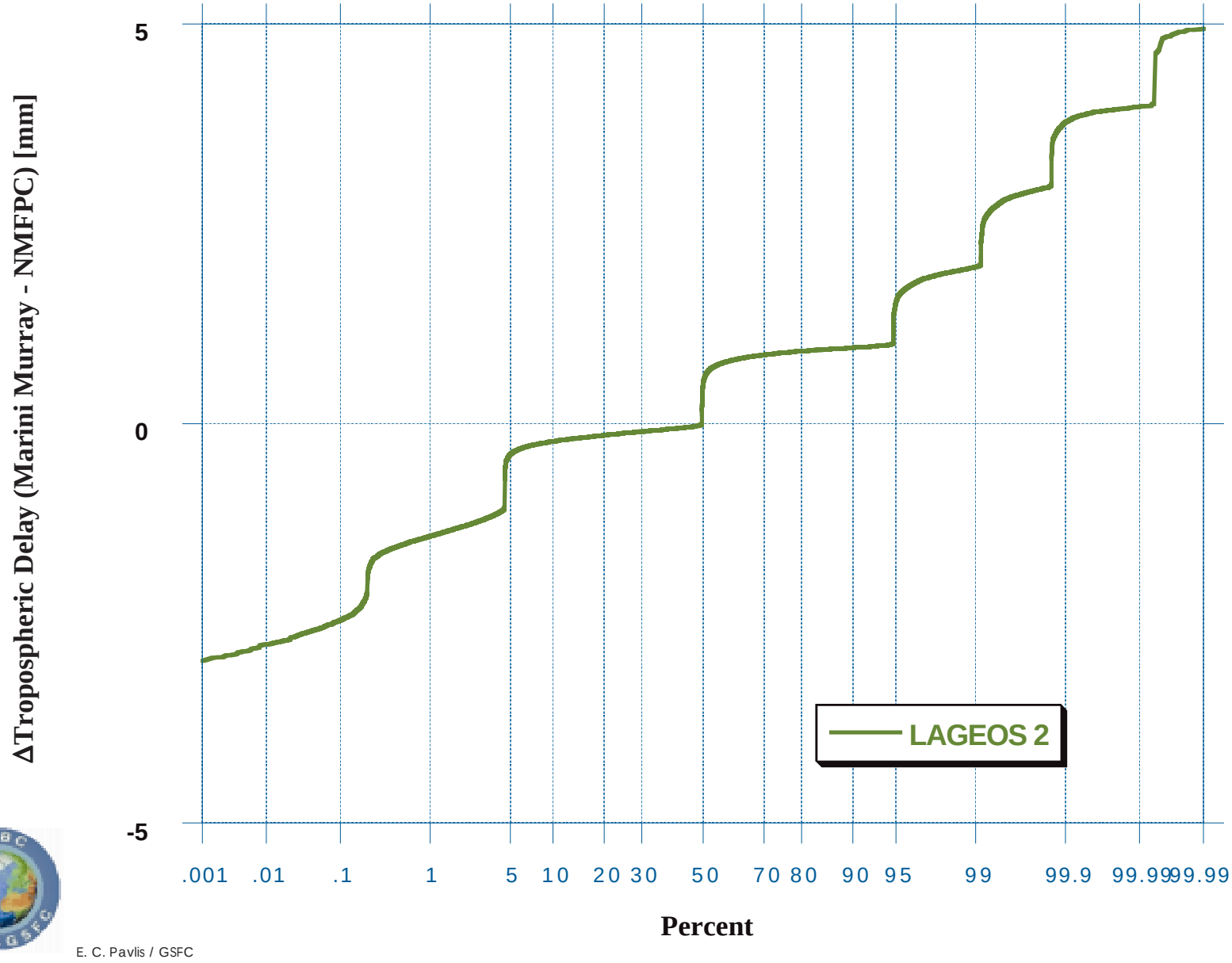


Atmospheric Corrections Study



L2_MM+NMFPC_1999-02.cor.dat

Atmospheric Corrections Study

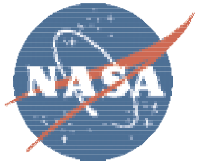


E. C. Pavlis / GSFC

Atmospheric Corrections Study

Summary

- We used four years of high quality SLR ILRS NP observations on LAGEOS 1 & 2: 1999 - 2002
- Reduced then in identical fashion except for the atmospheric delay models, M-M and NMF+PC and modified Saastamoinen ZD
- Dry component exhibits ~1 mm bias
- Wet component shows an order of magnitude smaller bias
- Overall, the residual differences are smaller by ~0.8 mm with NMF yielding the smaller residuals



Atmospheric Corrections Study
Future Work

- The current study used the standard release ILRS NPs
- To validate the new model and discriminate between that and the M-M, we need data with higher sensitivity
- There are several months of low elevation FR data taken at Grasse, and NP data from Graz.
- A new analysis (underway) incorporates these data sets
- We are still testing the new models for wavelength sensitivity and developing the mechanism to adapt them for multi-wavelength SLR (although it seems that the wavelength dependence is rather small)