Brother TGF

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Brother TGF

486 TGFs were found by ASIM

(Neubert, T., Østgaard, N., Reglero, V. et al. 2019)

during their firsts **589 days**

Mean rate = 486/589

0.82 TGF/day

2018-Jun-02	07:27:46.212351	
2018-Jun-05	**04:55:55.390864**	Δt
2018-Jun-05	**04:57:26.643230**	Δt
2018-Jun-16	13:23:44.926642	Δt
2018-Jun-20	09:02:04.972262	Δt
.		
.		
.		

Brother TGF

Exponential distribution

$[f(x)=\lambda e^{-\lambda x}]$,

should describe well the “time between TGF” distribution found by ASIM

Being λ the mean rate of TGF in a given time

The distribution of Δt “time between TGF” could be generated by

$$\Delta t=-\log(U)/\lambda$$

Being U the random uniform 0-1 distribution

2018-Jun-02	07:27:46.212351	
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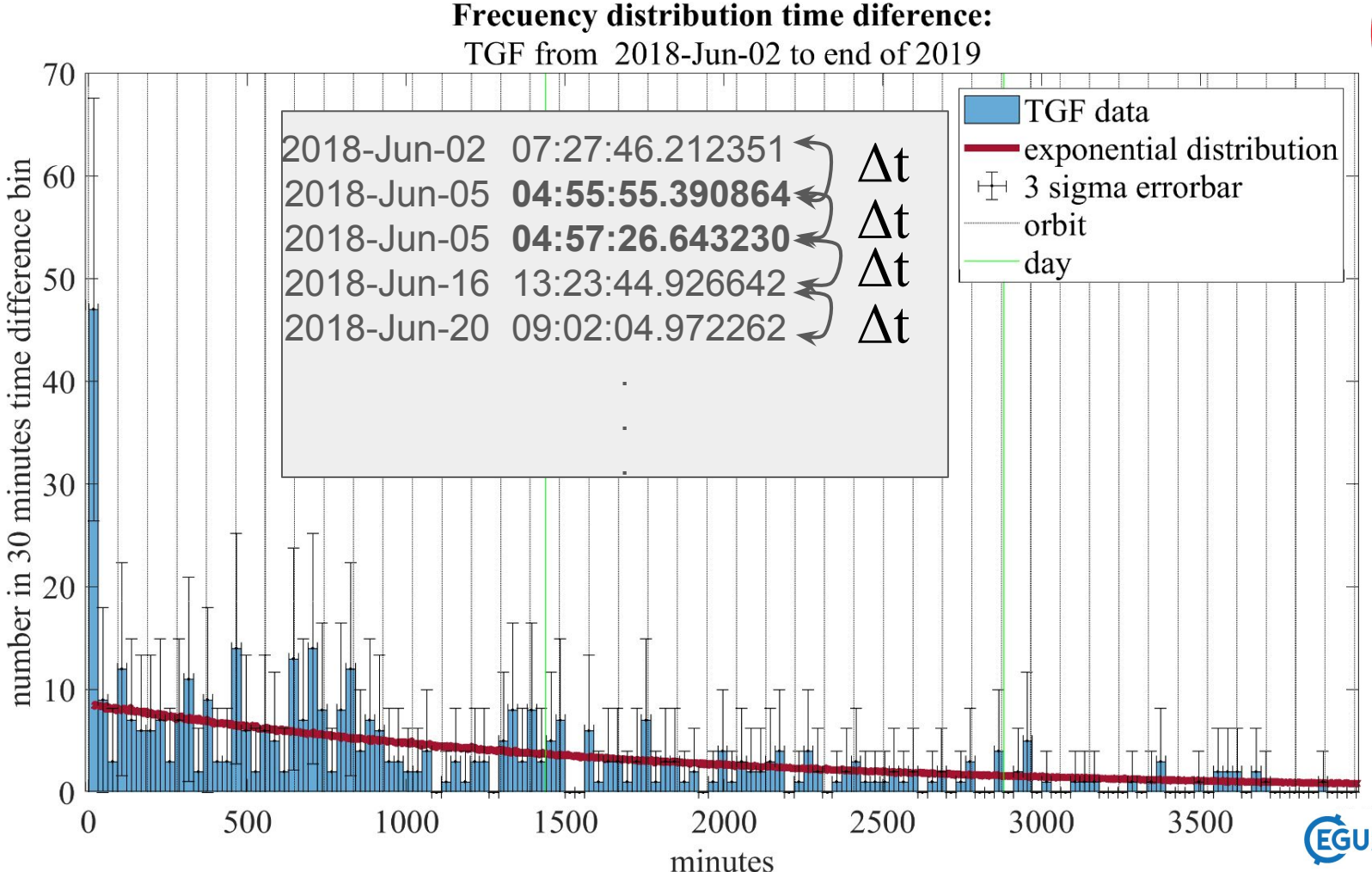
Brother TGF



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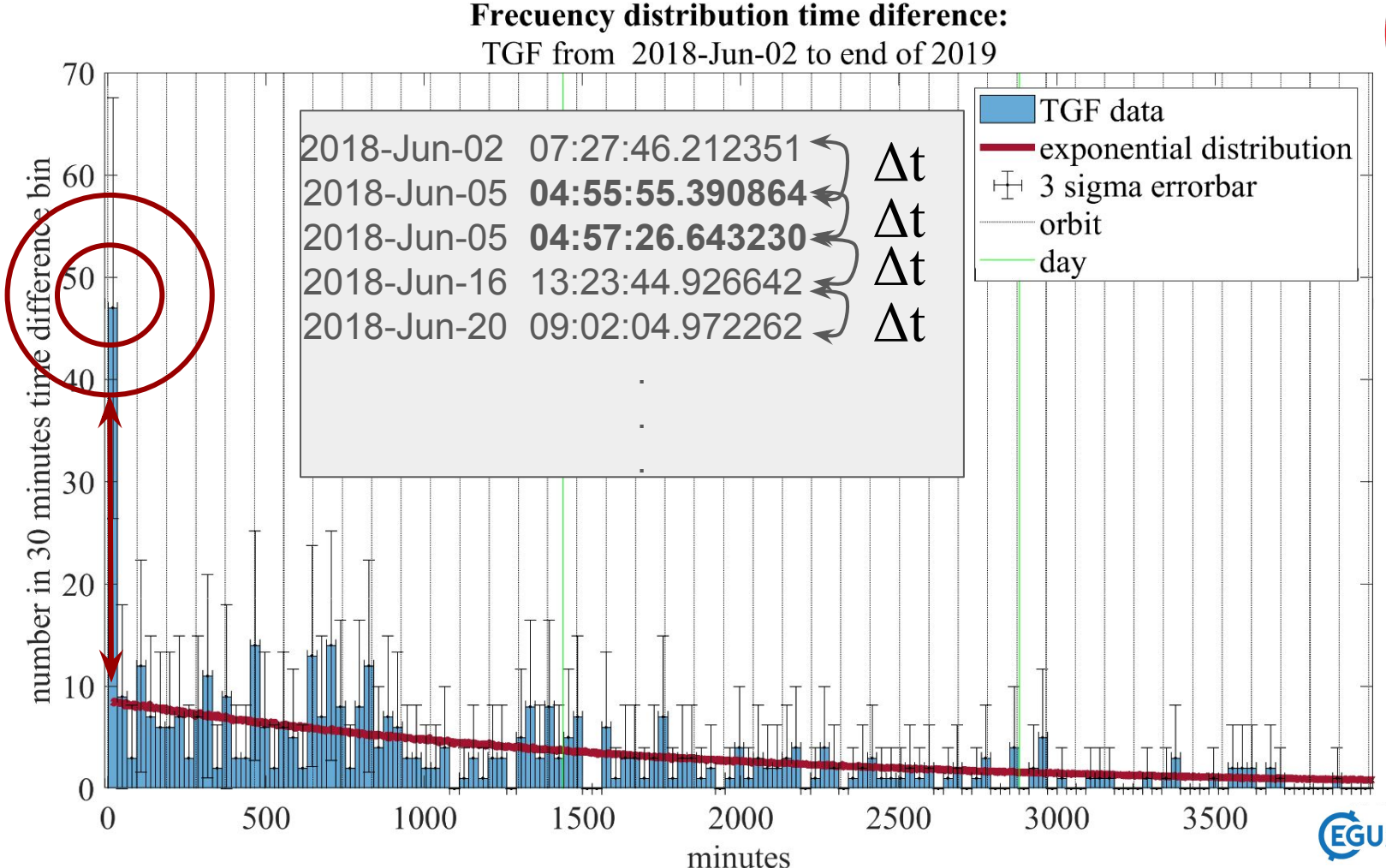
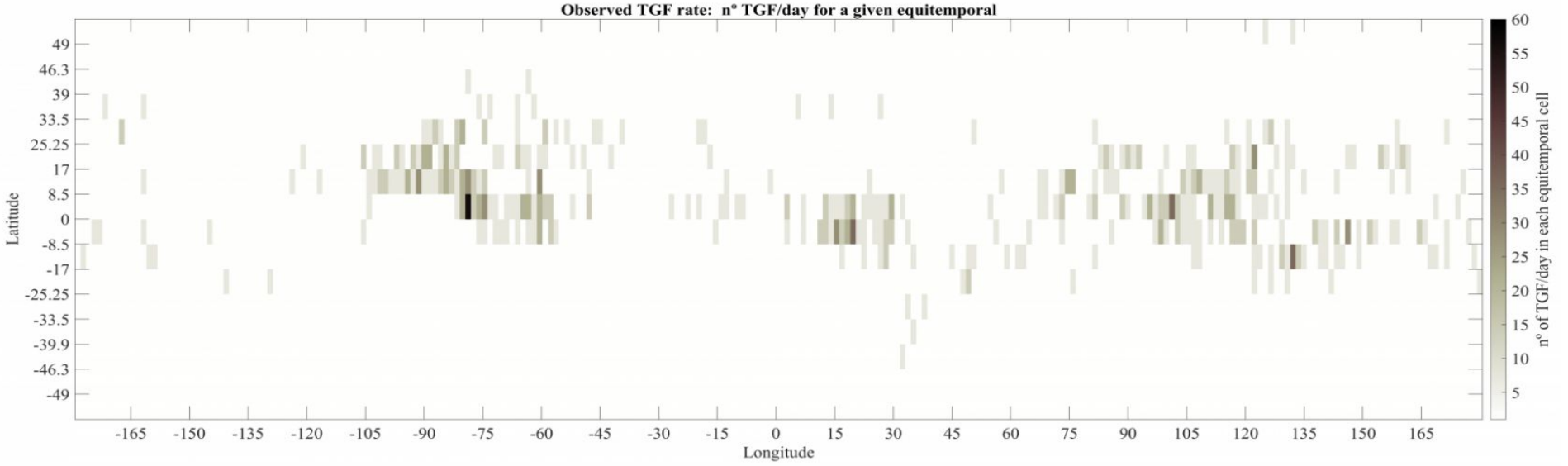

Frecuency distribution time diference:
TGF from 2018-Jun-02 to end of 2019
2018-Jun-02 07:27:46.212351
2018-Jun-05 04:55:55.390864
2018-Jun-05 04:57:26.643230
2018-Jun-16 13:23:44.926642
2018-Jun-20 09:02:04.972262
Δt
Δt
Δt
TGF data
exponential distribution
3 sigma errorbar
orbit
day
number in 30 minutes time difference bin
minutes
0
10
20
30
40
50
60
70
0
500
1000
1500
2000
2500
3000
3500

Brother TGF

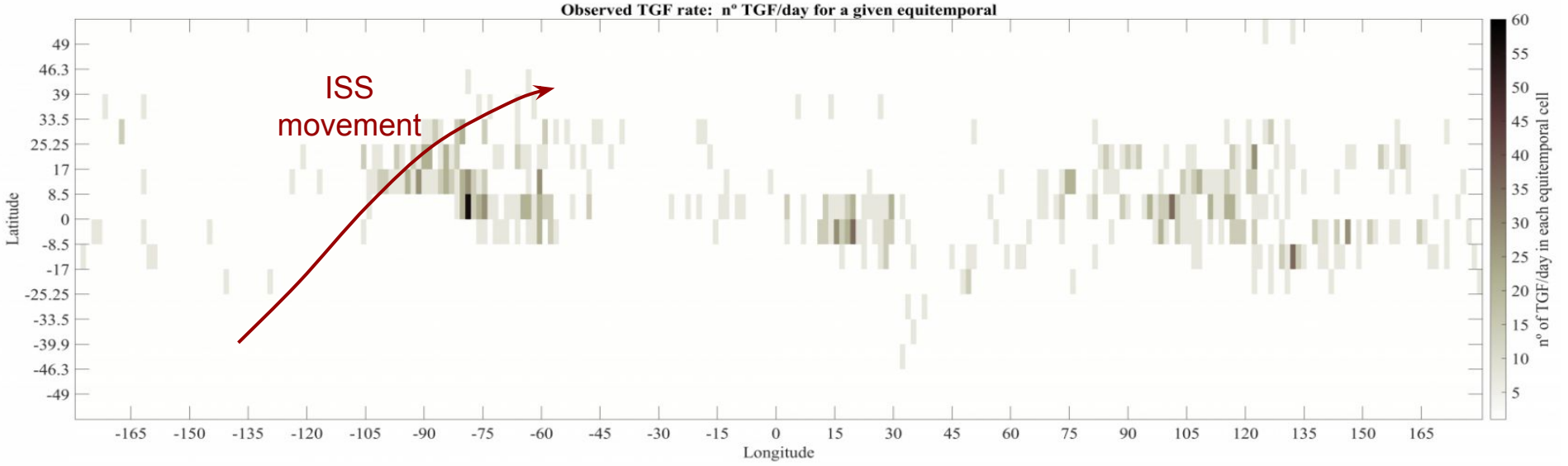
This **excess of pairs observed** compare with the rude approximation of 0.82 TGF/day uniform distributed, is the motivation to a **detailed Monte Carlo** model that have into account the **non uniform distribution of TGF** over the planet.

Brother TGF



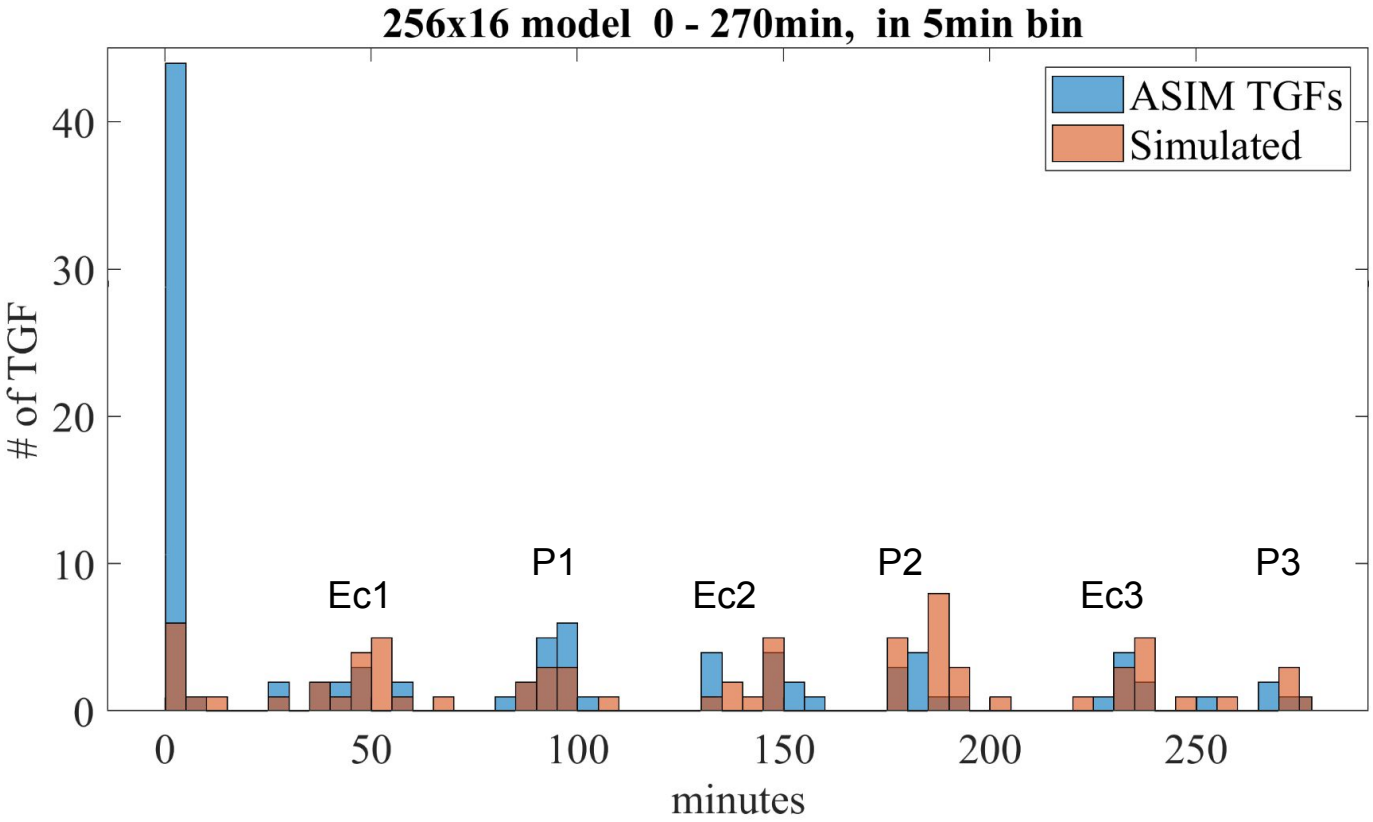
To model the TGF pair generation, a **grid of 256x16** is generated, with the criteria of **equi-temporal ISS** time passes over each cell. A total of **203.2 minutes** observation time for each cell in the 578 days considered.

Brother TGF



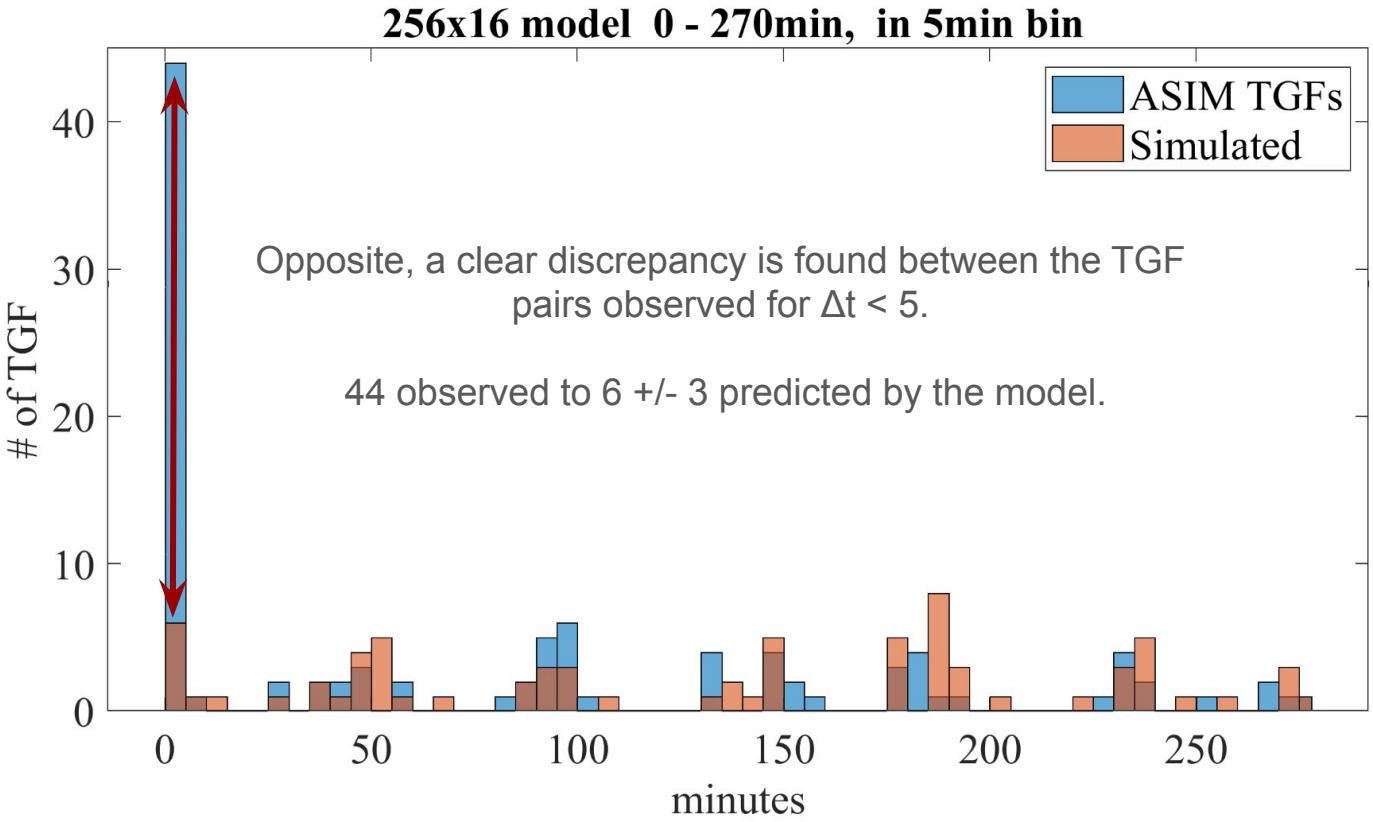
- **Every time step**, the ISS is moved according with their true orbit.
- After the algorithm ask which cell the ISS is.
- Depending on the frequency of the cell, the **occurrence of a TGF** is computed.
- **If there is any,** the algorithm **keep the time and position** and
- go to the next time step.

Brother TGF

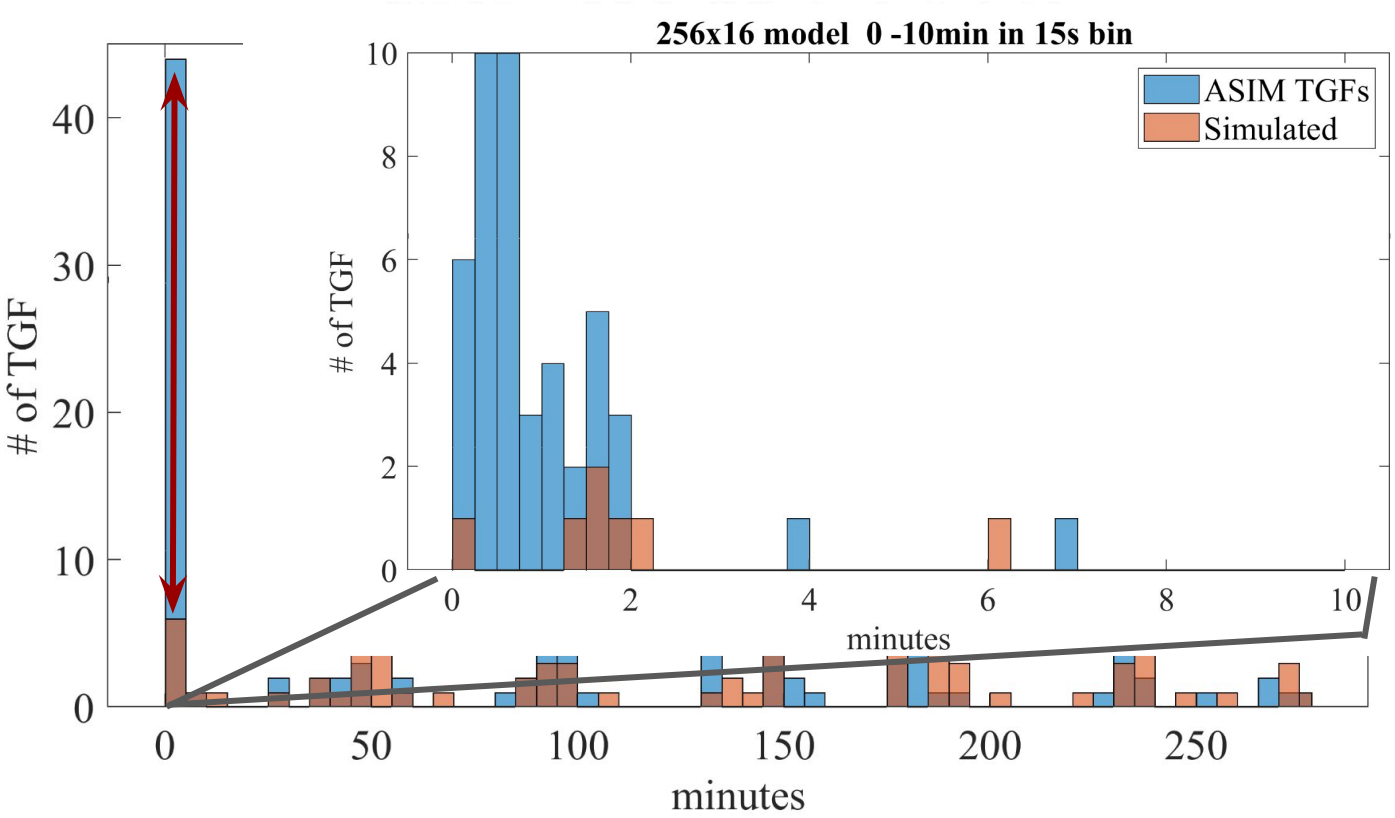


The model predict 490 +/- 20 TGFs in 578 days. “Resonances” (Ursi et al. 2016 , Stambro et al. 2018) in each ISS orbit (P1,P2,P3) and ecuatorial pases (Ec1,Ec2,Ec3)

Brother TGF


256x16 model 0 - 270min, in 5min bin
ASIM TGFs
Simulated
Opposite, a clear discrepancy is found between the TGF pairs observed for Δt < 5.
44 observed to 6 +/- 3 predicted by the model.
# of TGF
0
10
20
30
40
0
50
100
150
200
250
minutes

Brother TGF



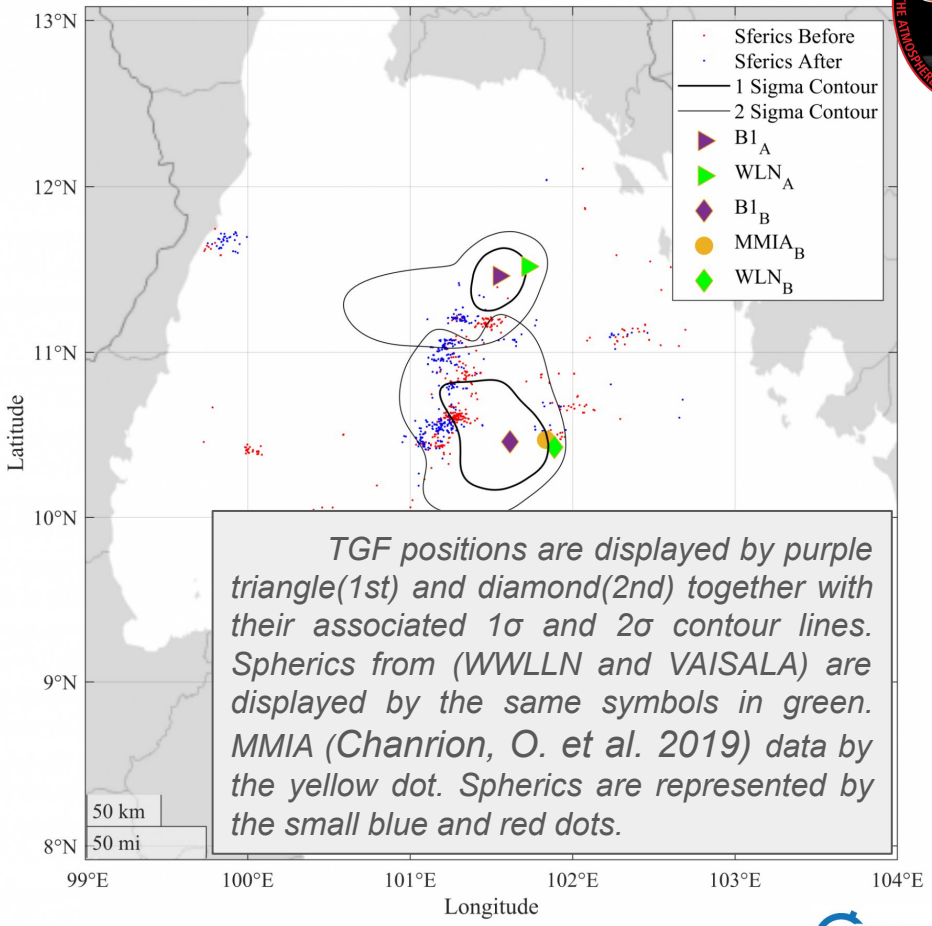
This observed anomalous pair frequencies indicates that pair TGF production may require some additional relationship, not only in time but also in space.

Brother TGF

In order to investigate this scenario of additional relationship between TGF pairs and its geographical distribution we use the ASIM Imaging capabilities (Østgaard et al. 2019) .

In this period of 578 days we found 117 TGF with imaging solution. We identify 12 TGF pairs that fulfills the requirement of Δt < 2min.

A detailed map of our first couple (one of this 12) is presented as an example of the analysis. **In this case it is clear that both TGF are born at the same thunderstorm complex defined by the spherics. Δs = 112km, Δt = 40s.**



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The main conclusions of the detailed study of the 12 TGF pairs, within Δt < 2min are:

- 3 pairs are not born at the same thunderstorm in good agreement with the model prediction.
- 9 pairs with a mean of Δs = 80km and a Δt = 56s, were found coming from the same thunderstorm. We name them Brother TGF, because their close connection in space and time within the same thundercloud progenitor.

A paper is in preparation with the detailed analysis of this 12 TGF pairs, including light curves, spherics ground data (WWLLN and VAISALA) abd GLM data. GOES maps for those events are also included.

The question if the second TGF in a pair is “generated” by the first brother is outside the scope of this presentation, but is an open question to be considered in future studies.

Brother TGF

References:

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