Inter-hemispheric comparison of the ionosphere-plasmasphere system.

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BEZA-COM: Interhemispheric Comparison of the Ionosphere-Plasmasphere System. 2019-2021

"What are the differences in the inter-hemispheric conjugacy between the ionosphere and that in the lower, middle and upper atmospheres, and what causes those differences?"

From : Kennicutt, et al., 2015 - A roadmap for Antarctic and Southern Ocean science for the next two decades and beyond*, International Steering Committee of the Scientific Committee on Antarctic Research (ISC-SCAR) *, Antarctica Science.

BEZA-COM: Interhemispheric Comparison of the Ionosphere-Plasmasphere System. 2019-2021

One of the goal of BEZA-COM is to provide inter-hemispheric comparison of the I/Ps implying:

A characterisation of the climatological behaviour of the Total Electron Content (TEC) in the I/Ps, over European, South African regions.

GNSS data processing

SWSC Journal of Space Weather and Space Climate

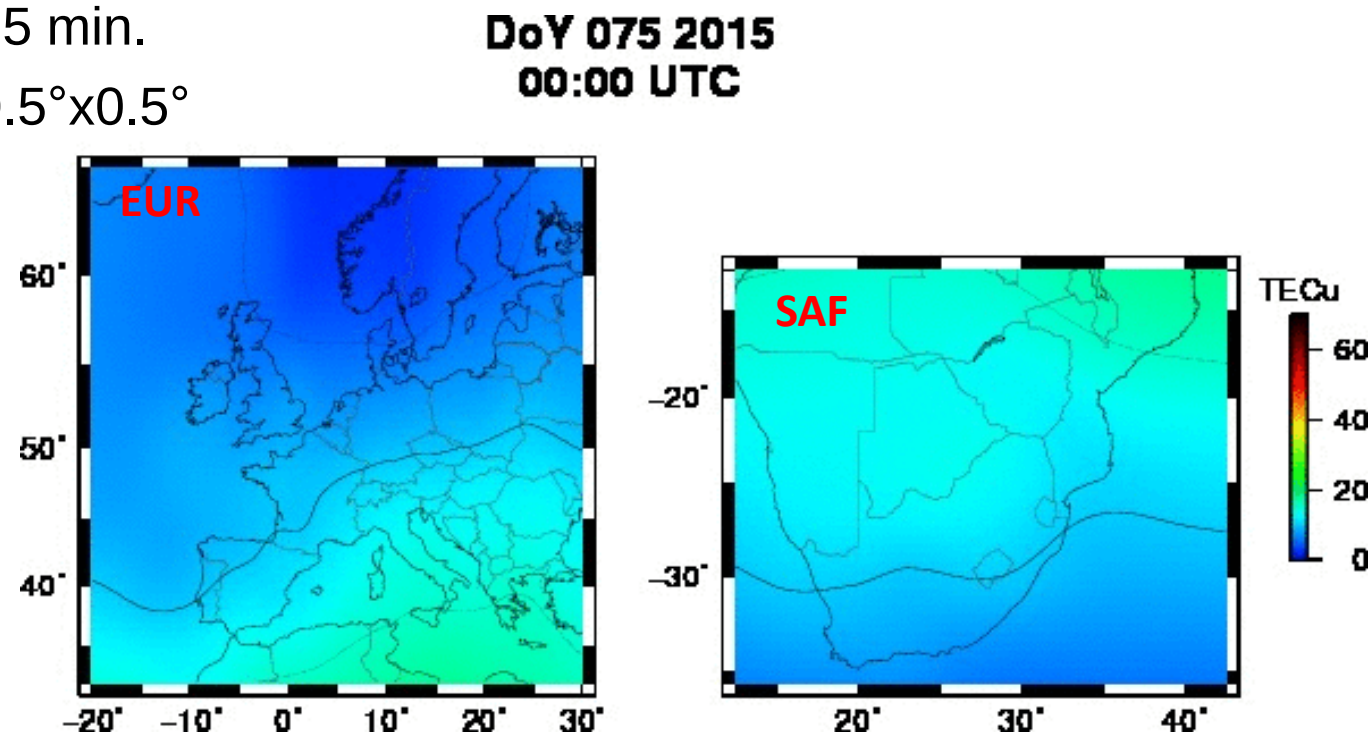
Bergeot N., et al. (2014) J. Space Weather Space Clim.

- Input data: ROB-IONO software. GPS + GLONASS data from the EUREF (~320 stations, Bruyninx et al. 2012) or TRIGNET and IGS (~80 stations, www.trignet.co.za and Dow et al. 2009) permanent networks since 1998.

- Outputs: TEC maps in IONEX format in TECu (1 TECu = $10^{16} e^{-}.m^{-2}$)

  Sampling rate : 15 min.

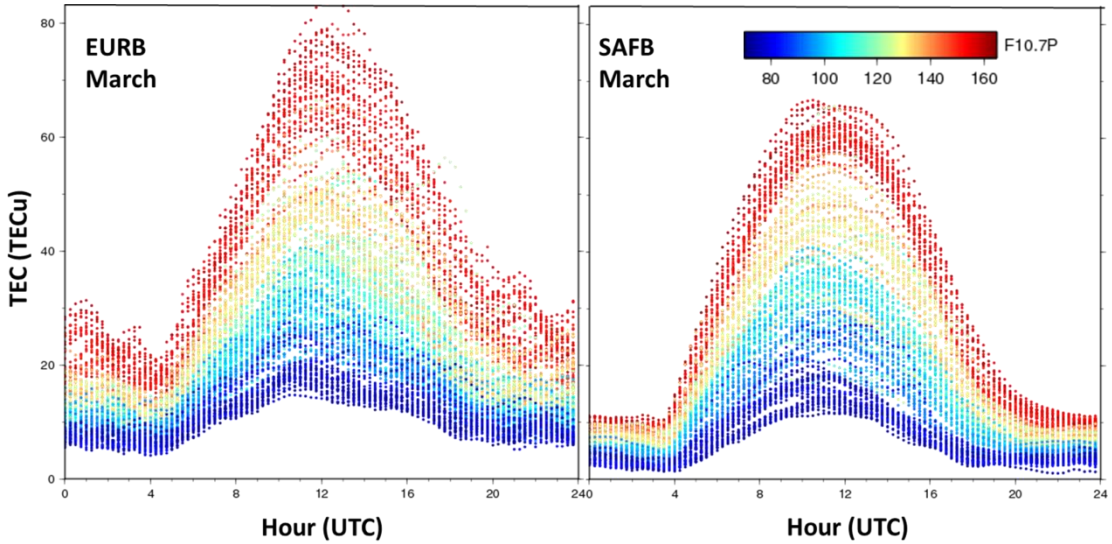
  Grid resolution : 0.5°x0.5°

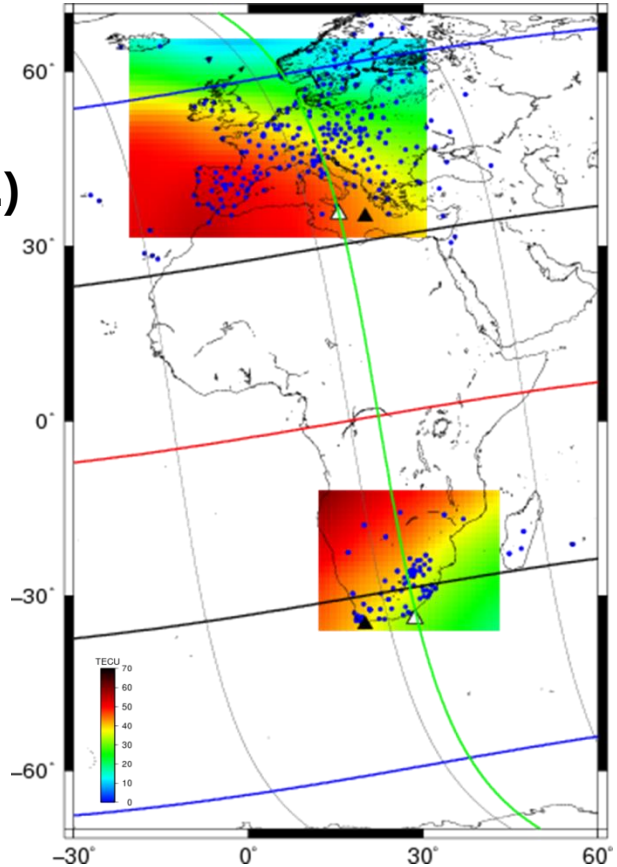


TEC time-series at conjugate locations.

Region	Data processing		#Stations	Extracted coordinates	
	TEC at IPP	TEC maps		Geographic	Geomagnetic
EU (EPN)	1998-2017	1998-2017	57-320	E20 / N35 **EURG**	E95 / N35 **EURB**
SA (TRIGNET) + IGS	2000-2017	2003-2017	3-83	E20 / S35 **SAFG**	E95 / S35 **SAFB**

14 years of TEC maps for South Africa
19 years of TEC maps for Europe
Conjugate locations : E95° N-S 35° (Geomag. Coord.)

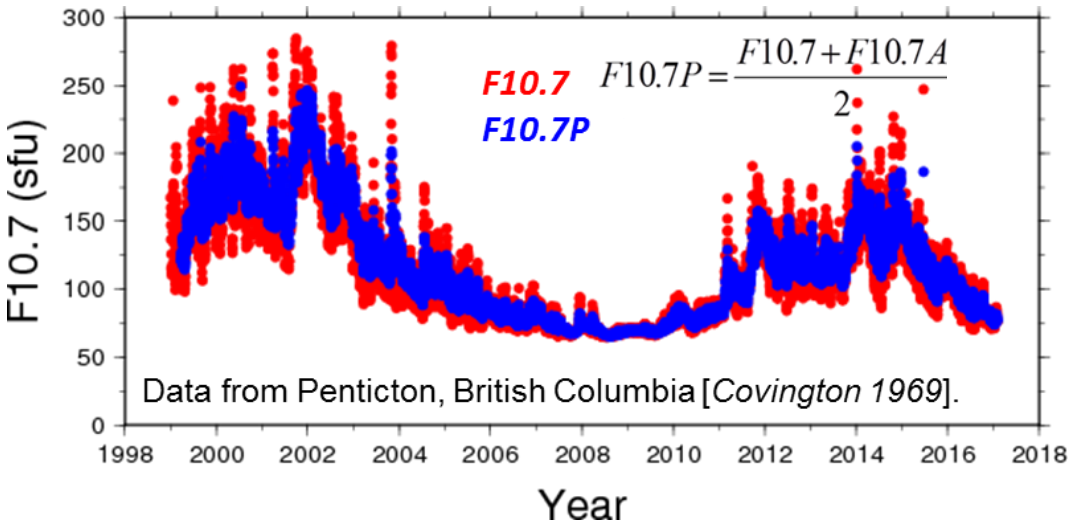




Empirical TEC-model

Empirical model based on F10.7P index (~ EUV emission from the Sun)

The data set is then employed to constrain an empirical model to predict the vTEC at a given time and location from F10.7P solar index in entrance using a least-square adjustment.



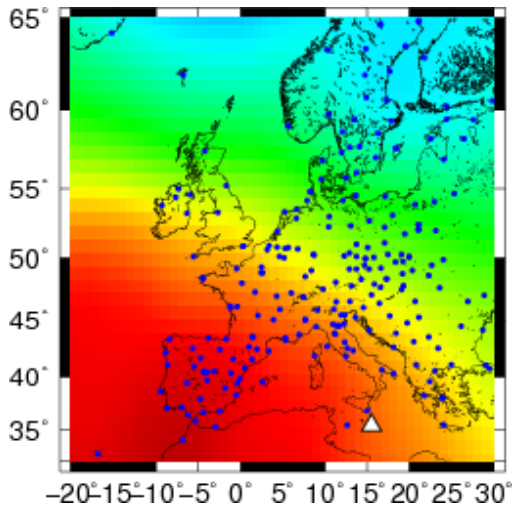
To minimize the differences between the modelled and observed TEC we considered:

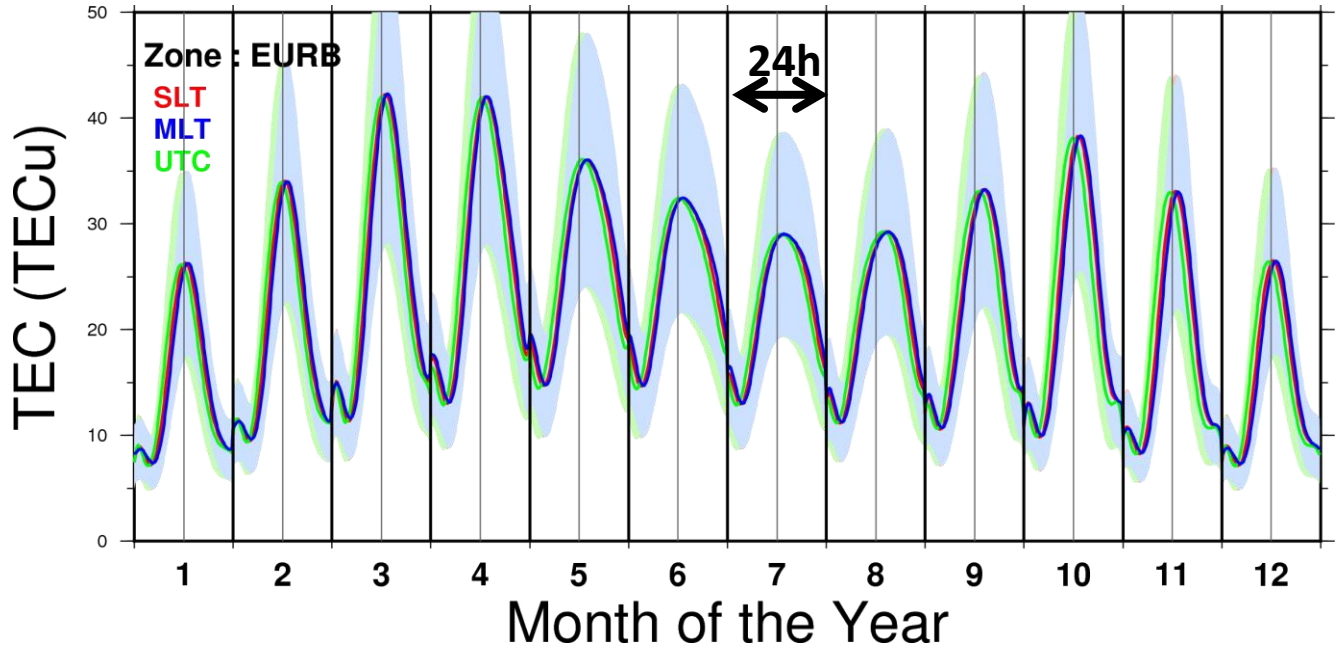
- An eight-order polynomial function between the TEC and F10.7P

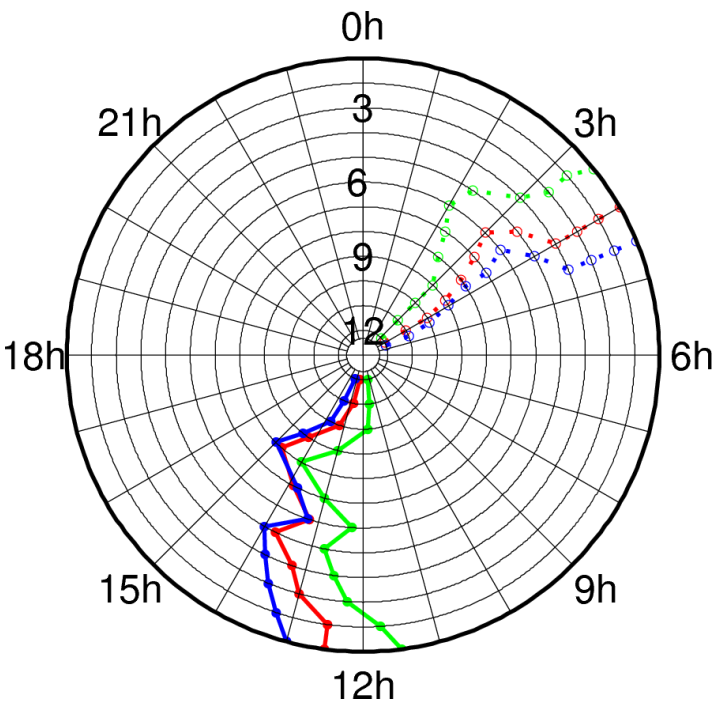
$$TEC = F10.7P \sum_{i=0}^{i=8} \left(\alpha_i t^i + \beta\right)$$

- A discretization with respect to the month of the year.

Daily-TEC climatological patterns - Europe







TEC presents mean differences with observed values of 0.5 ± 1.2 TECu for European region (~57000 data/month).

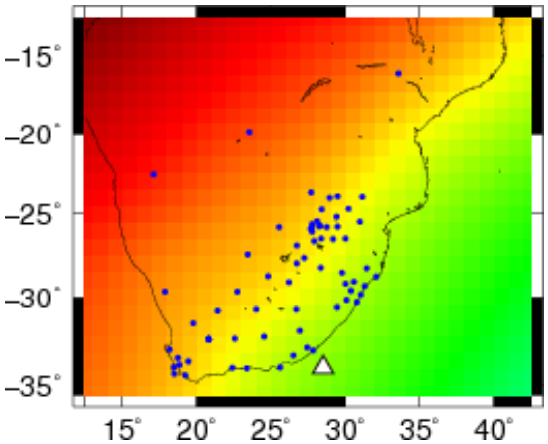
The maximum TEC occurs mainly around 13:00 for any of the time definitions (UTC, SLT and MLT) and are quite constant over the year.

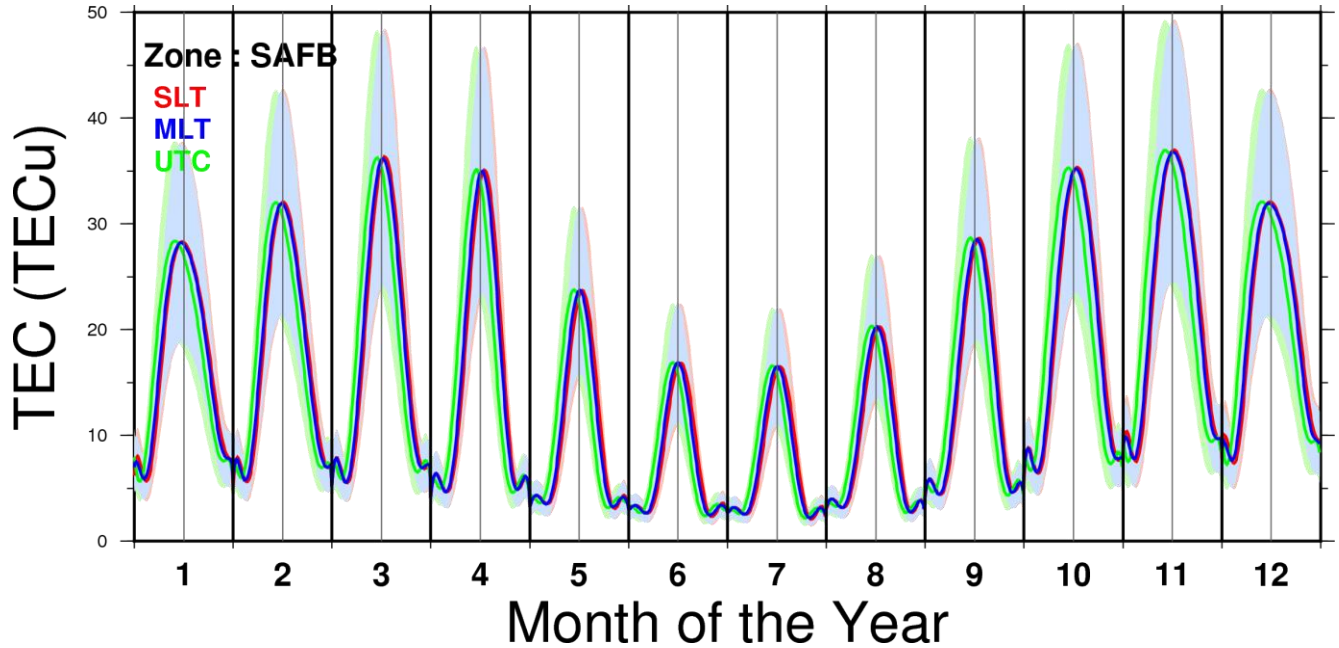
F10.7P=120 sfu

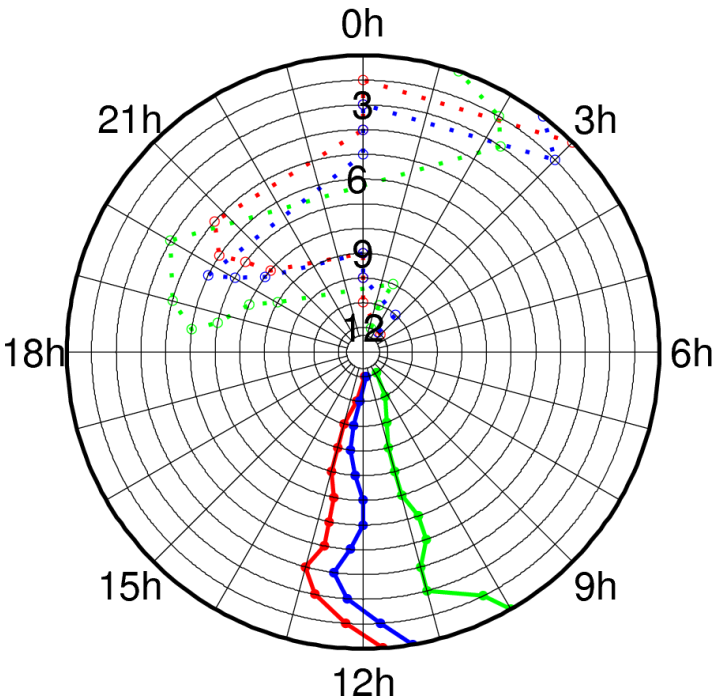
Max. TEC = 42 TECu in March

Min. TEC = 7 TECu (F10.7P=120 sfu) in December

Daily-TEC climatological patterns - South Africa







TEC presents mean differences with observed values of 0.4 ± 0.6 TECu for South African region (~41 000 data/month).

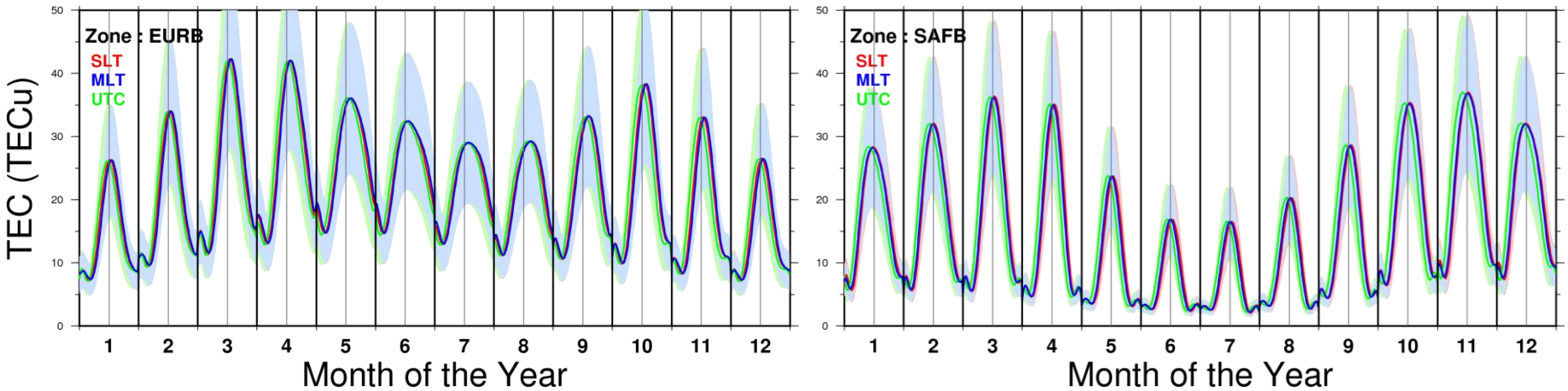
The maximum TEC occurs mainly around noon for any of the time definitions (UTC, SLT and MLT) and are quite constant over the year.

F10.7P=120 sfu

Max. TEC = 36 TECu in March

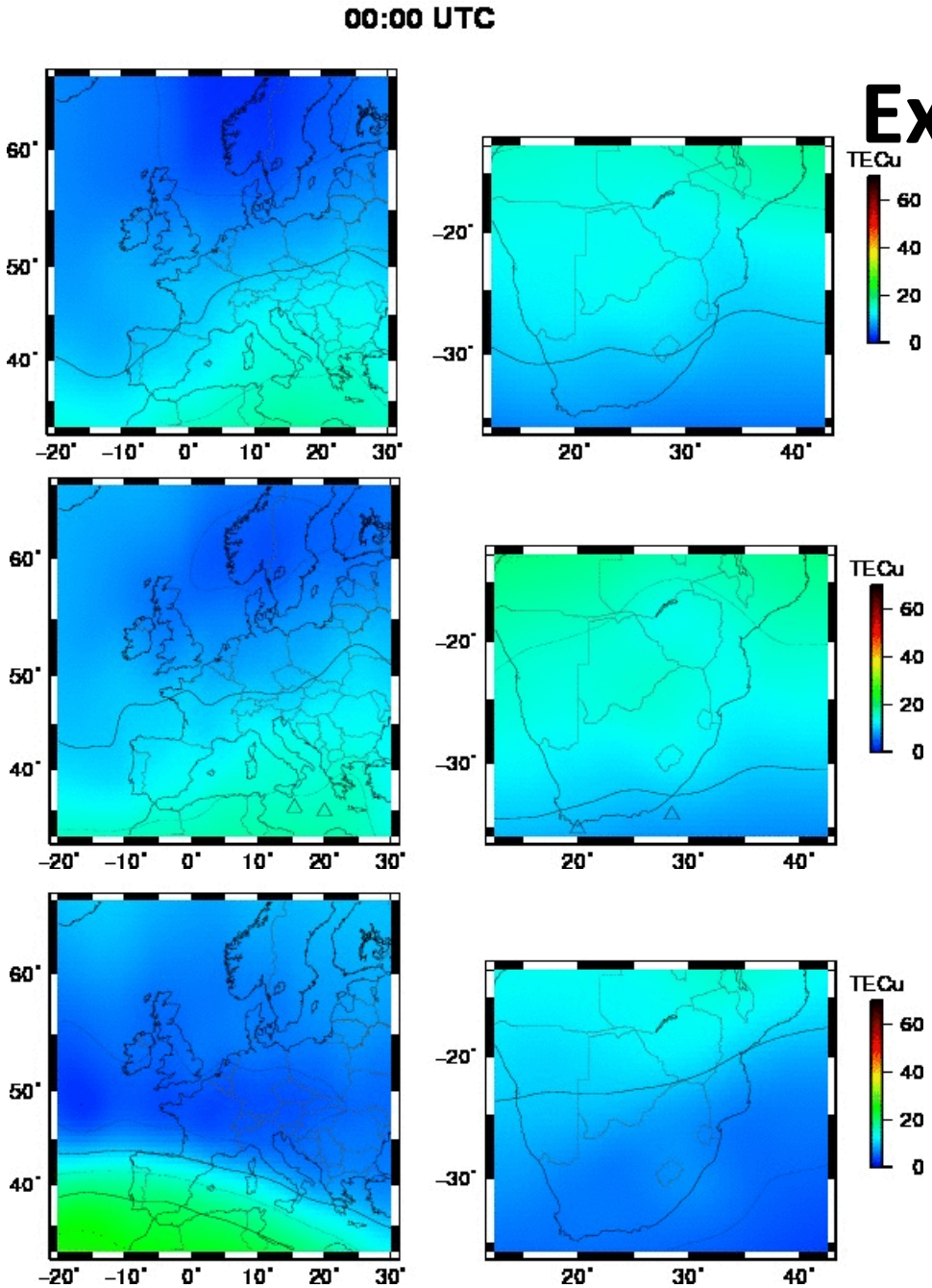
Min. TEC = 2 TECu in November

Inter-hemispheric comparison



- ✓ The maximum of the TEC is higher during the daylight (10 to 55% for hours between 10:00 and 15:00) in the Northern hemisphere compare to the Southern for February to September.
- ✓ The maximum of the TEC is higher (5 to 20% for hours between 10:00 and 15:00) in the Southern hemisphere from November to January.
- ✓ The minimum TEC (i.e. during low solar zenith angle between 22:00 and 6:00) is also higher in the Northern hemisphere for the period February-September (16 to 80%).
- ✓ The minimum TEC is higher in the Southern hemisphere (16 to 45%) during from November to January.
- ✓ The time of occurrence of the minimum TEC is generally constant over the year for the European region.

Intense I/P activity
Ex. St Patrick Storm 2015



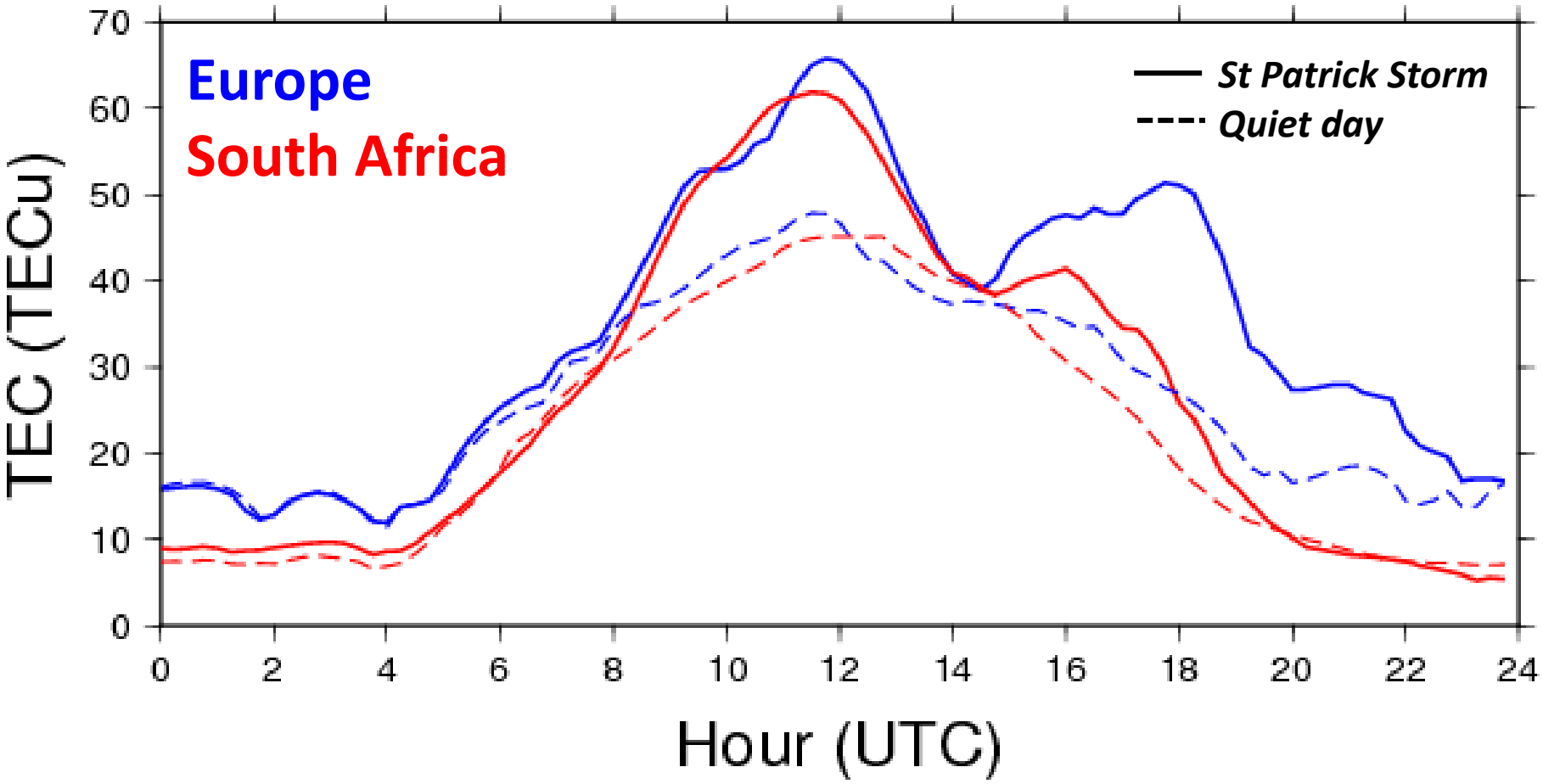
16th March 2015

17th March 2015

18th March 2015

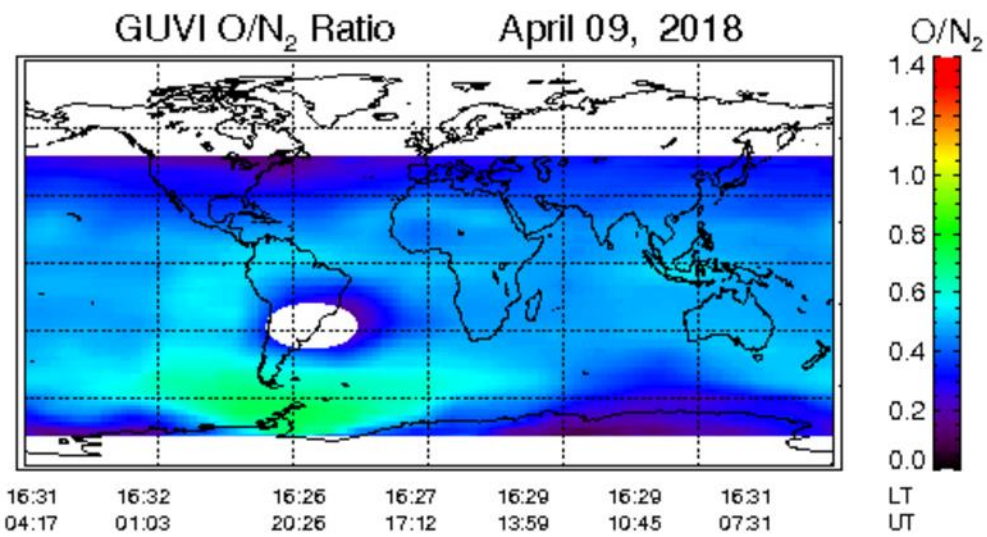
March 17, 2015 - Onset 03:30 UTC
Dst = -223 nT – Geom. Storm (Kp=7)

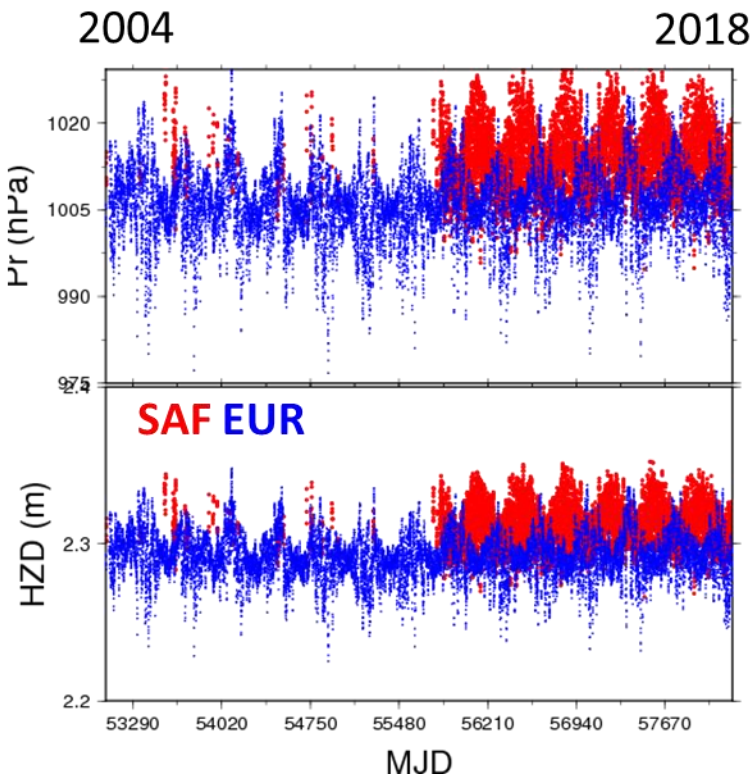
Intense I/P activity
Ex. St Patrick Storm 2015



Next Steps

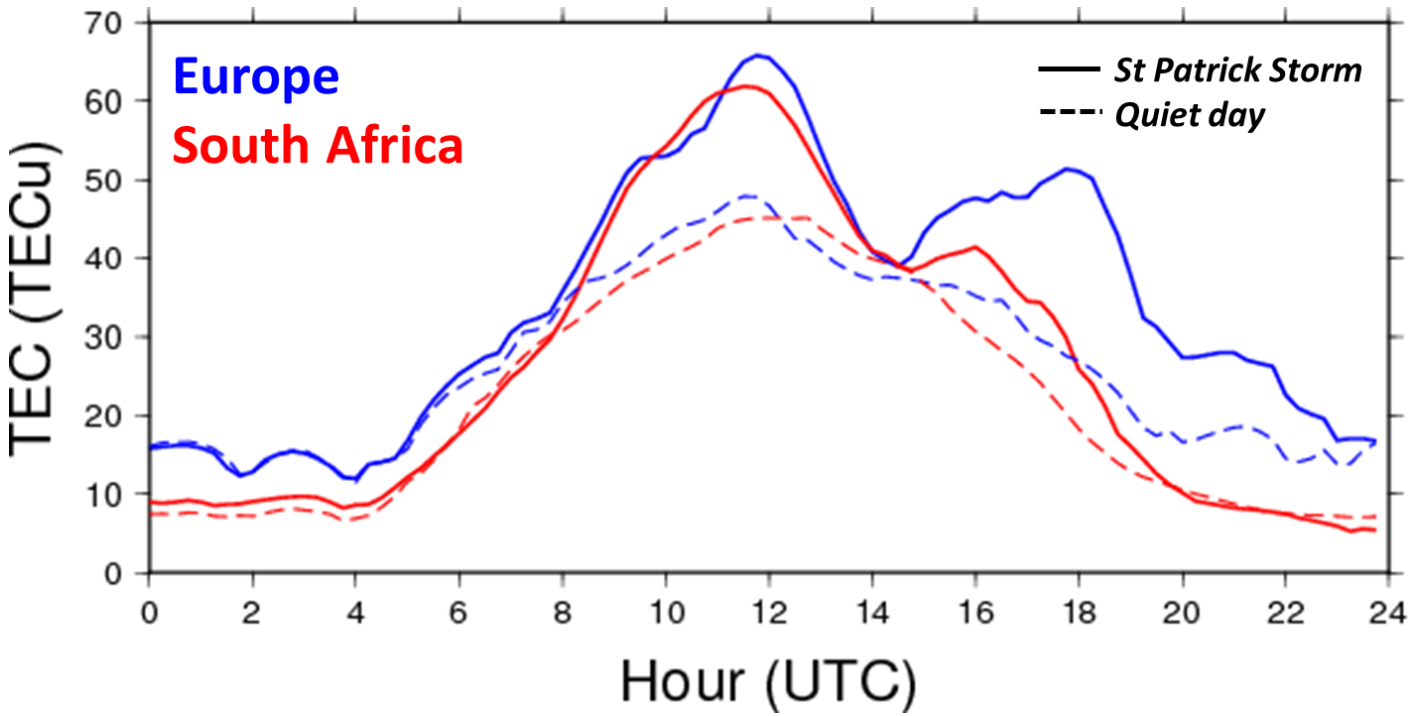
- An identification of the mechanisms that regulate inter-hemispheric differences, asymmetries and commonalities in the I/Ps from low to high-latitudes.





Next Steps

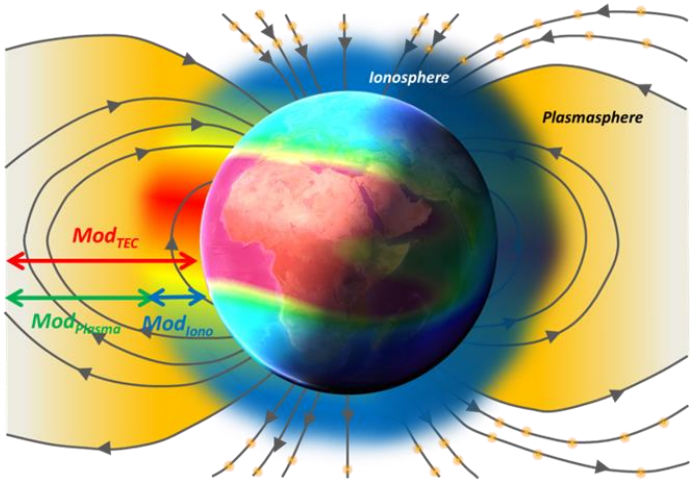
- A study of the different responses of the I/Ps during extreme solar events and induced geomagnetic storms in the two hemispheres.



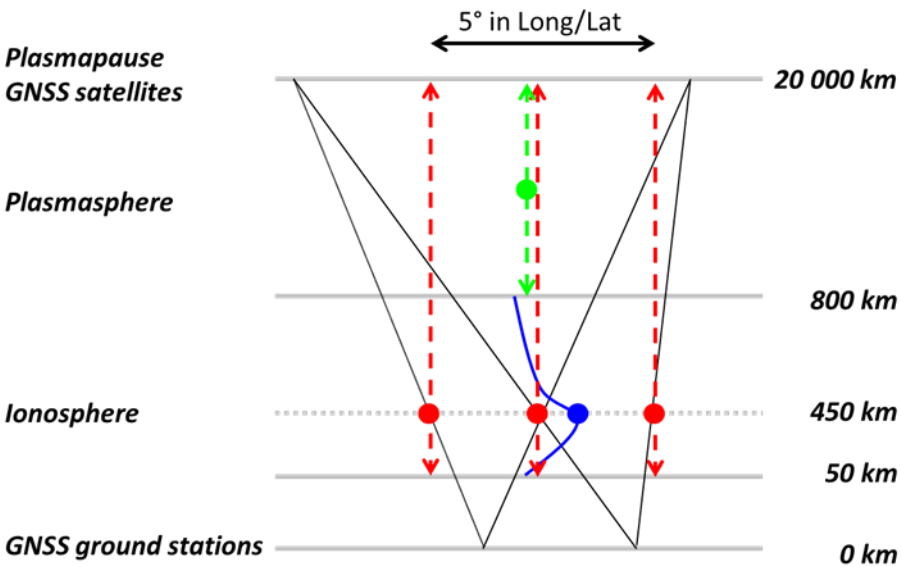
Next Steps

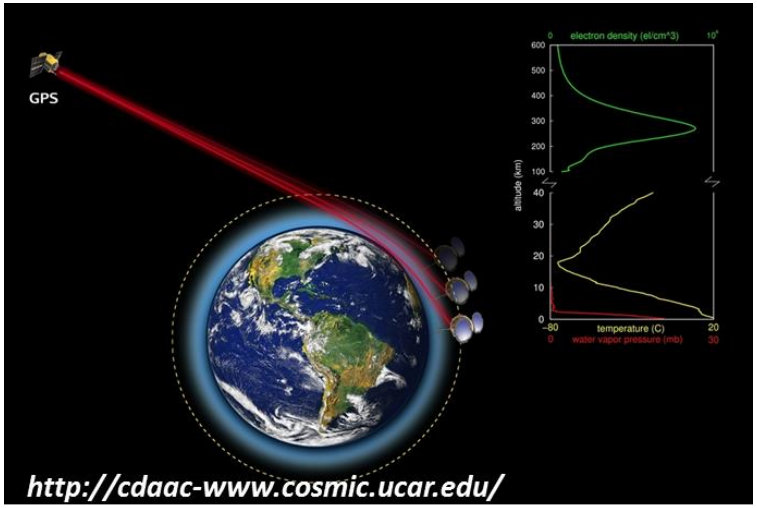
- A separation of the ionospheric and plasmaspheric contribution to the TEC.

POSTER N°40 : Ionosphere-Plasmasphere empirical model over Antarctica region.



$$PTEC = TEC - ITEC$$





Comparison with IRI 2018

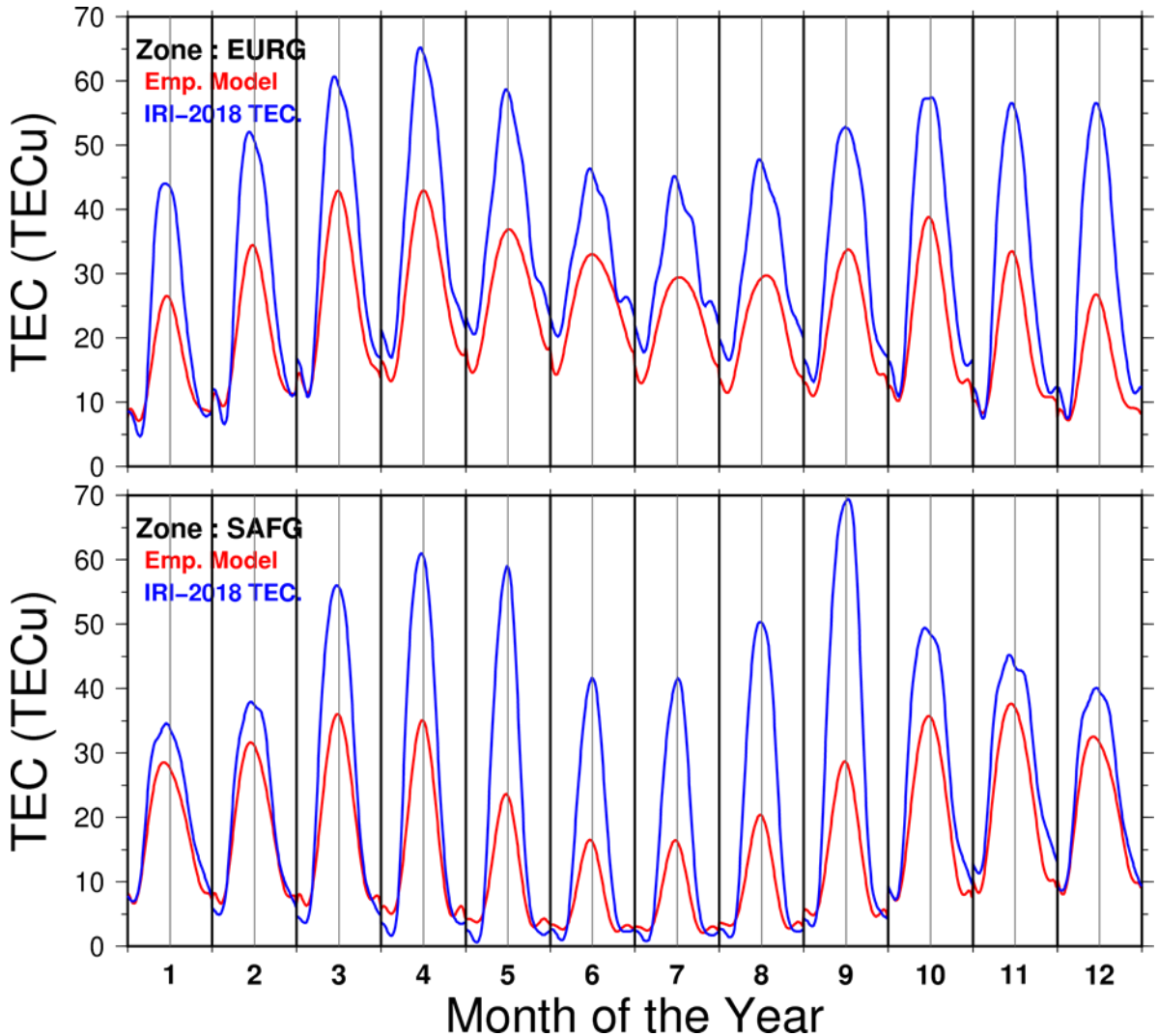
Comparison with IRI-2018 for moderate solar activity level

F10.7P = 120 sfu

Max Differences:

> 30 TECu in December over Europe.

> 45 TECu in September over South Africa.



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Radio Sciences Research on AntarctiC AtmospherE

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Resource is a new scientific research programme: RESOURCE (Radio Sciences Research on AntarctiC AtmospherE).

RESOURCE wish to represent:

- the need of the scientists that **investigate the atmosphere** by means of radio observation,
- the requirement of the scientists that want **to remove or to mitigate the atmospheric noise** from their radio measurements.

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