Annual Variation of the Plasmasphere Mass Density at L = 1.6 - 1.8 as deduced from Geomagnetic Field Line Resonance Measurements

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Whistler results (Park et al., 1978)

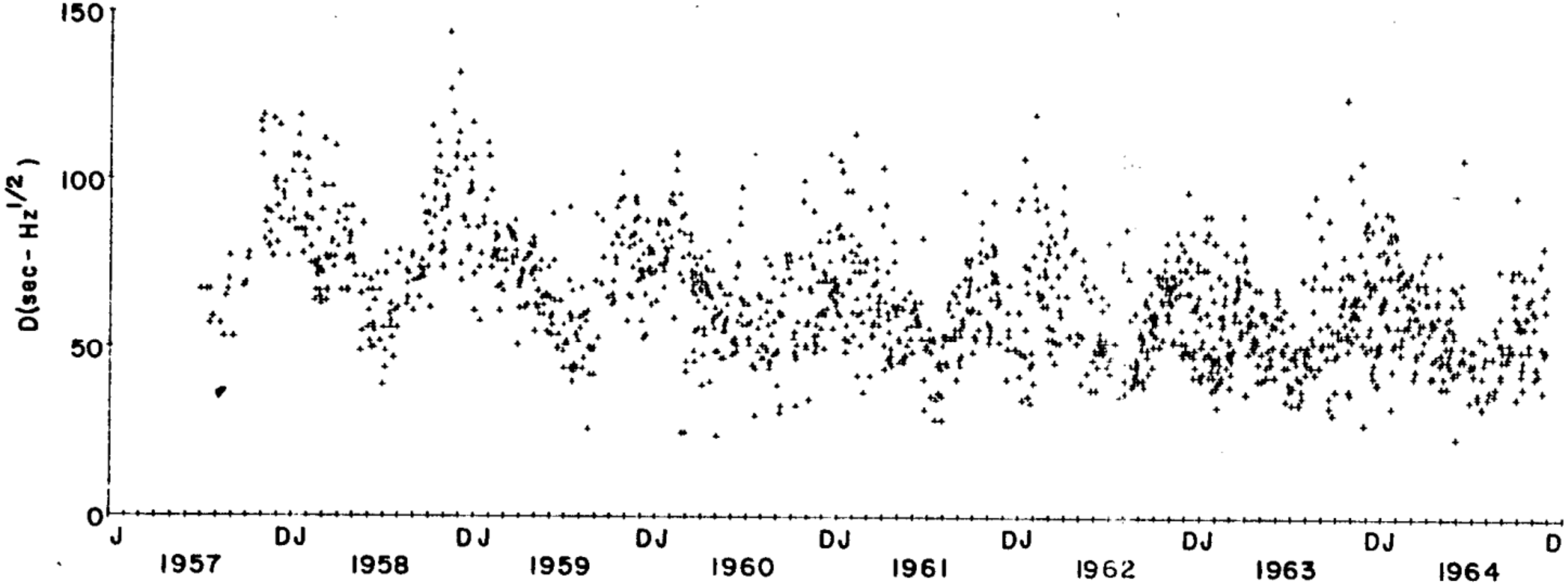
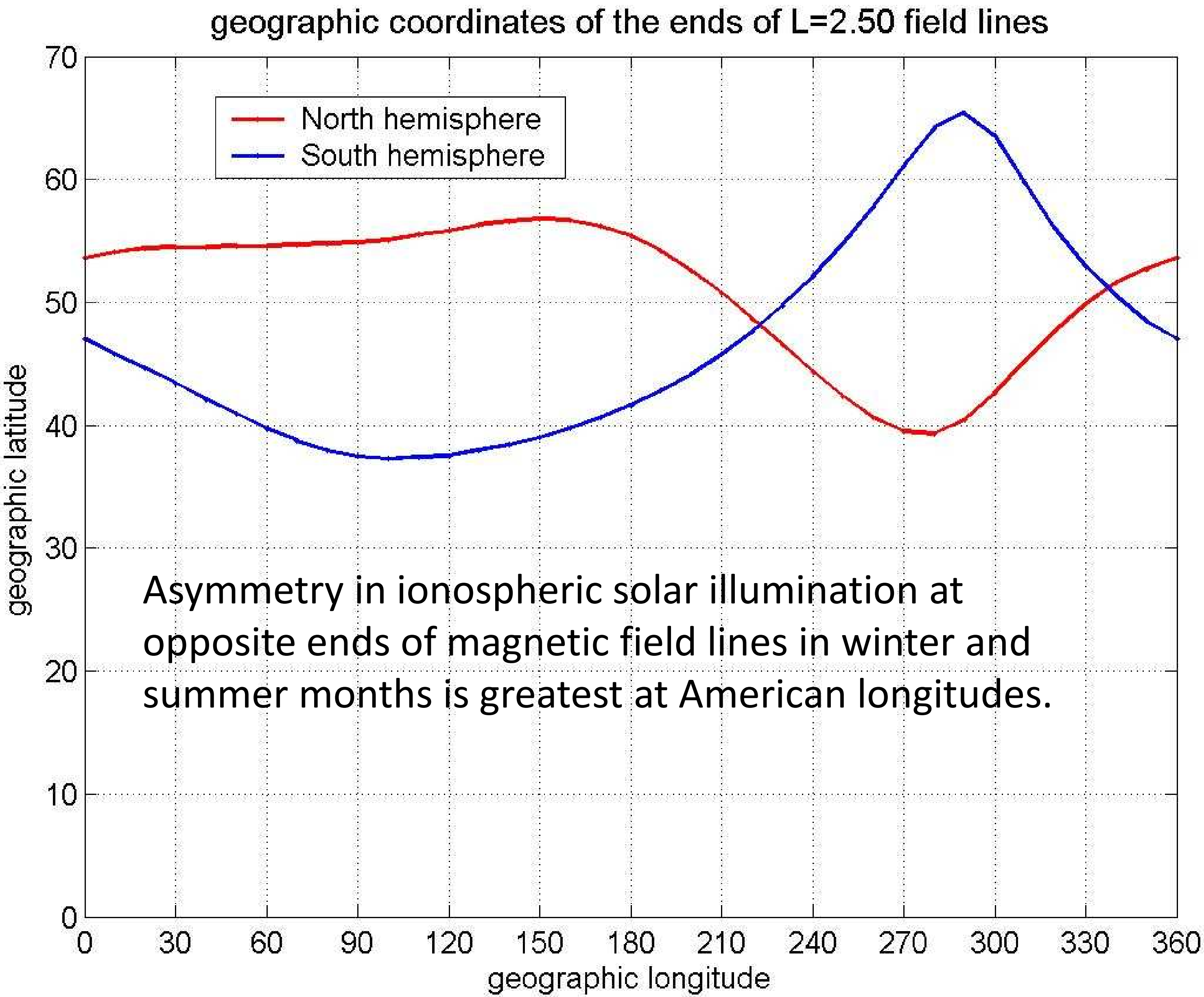
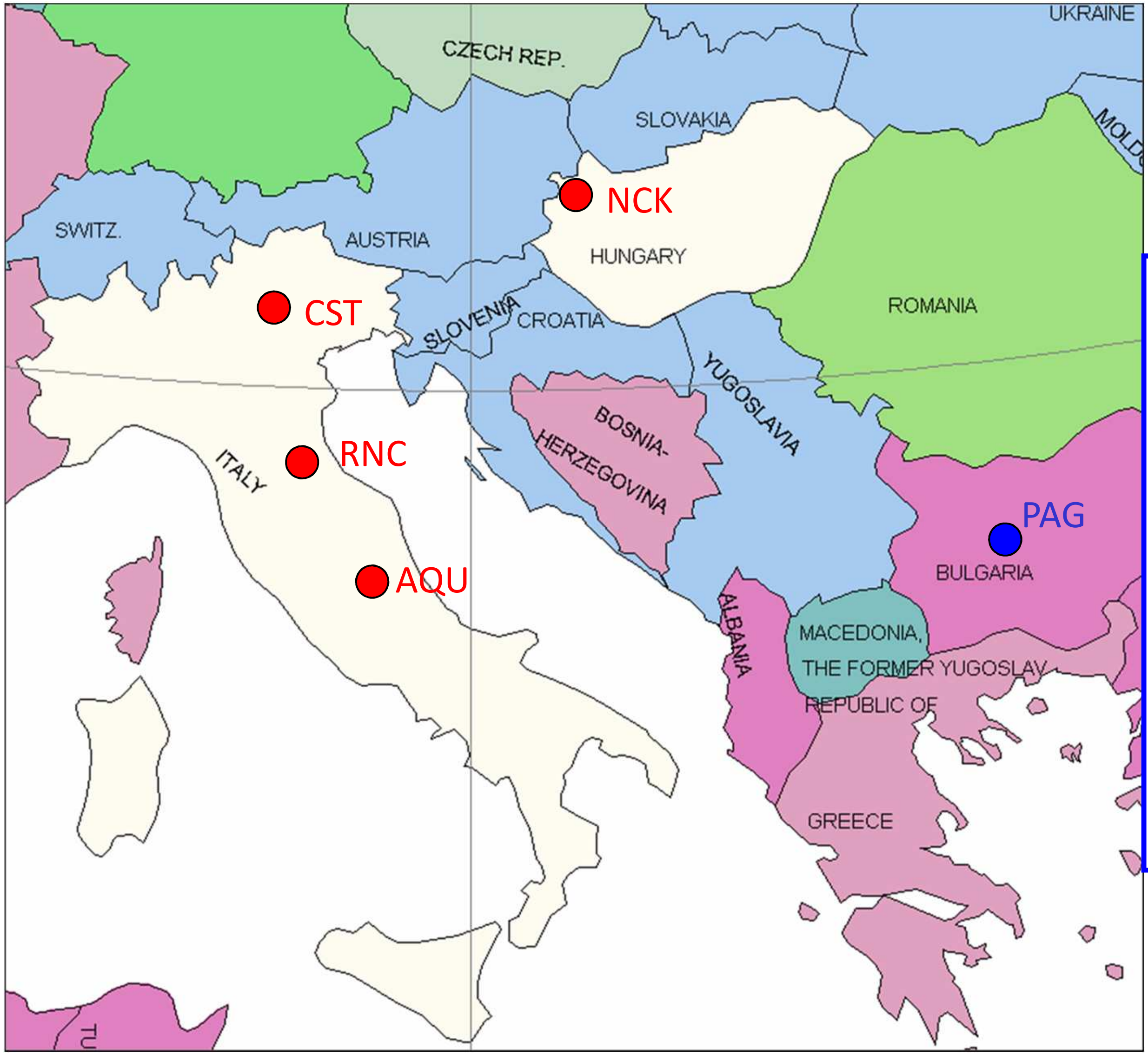


Fig. 2. Whistler data illustrating secular changes in magnetospheric electron density near L=2.5. Annual and solar cycle variations are particularly clear. The quantity plotted, D_5=70.7t_5, is a measure of whistler travel time at 5 kHz. As such it is approximately proportional to the equatorial plasma frequency at L=2.5 and hence to $n_e^{1/2}$. The recordings were made at Stanford University (~110° W). Adapted from *Park et al.* [1978].



Asymmetry in ionospheric solar illumination at opposite ends of magnetic field lines in winter and summer months is greatest at American longitudes.

SEGMA (South European GeoMagnetic Array) (1.56 < L < 1.88)



3 gradient installations

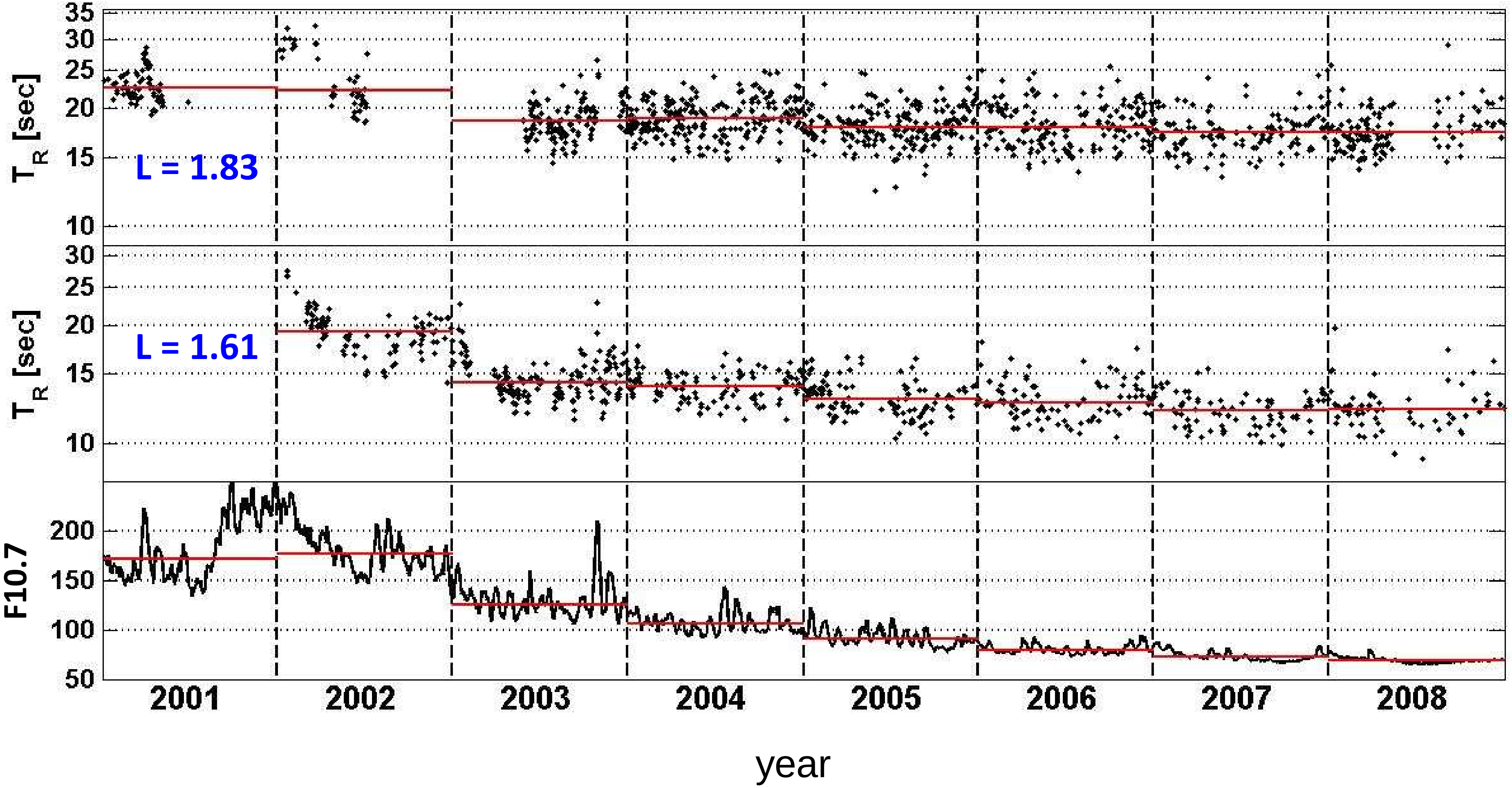
Stations	Latitud. separ.	L
NCK - CST	1.9°	1.83
CST - RNC	2.5°	1.71
RNC - AQU	1.9°	1.61

Cooperation between:

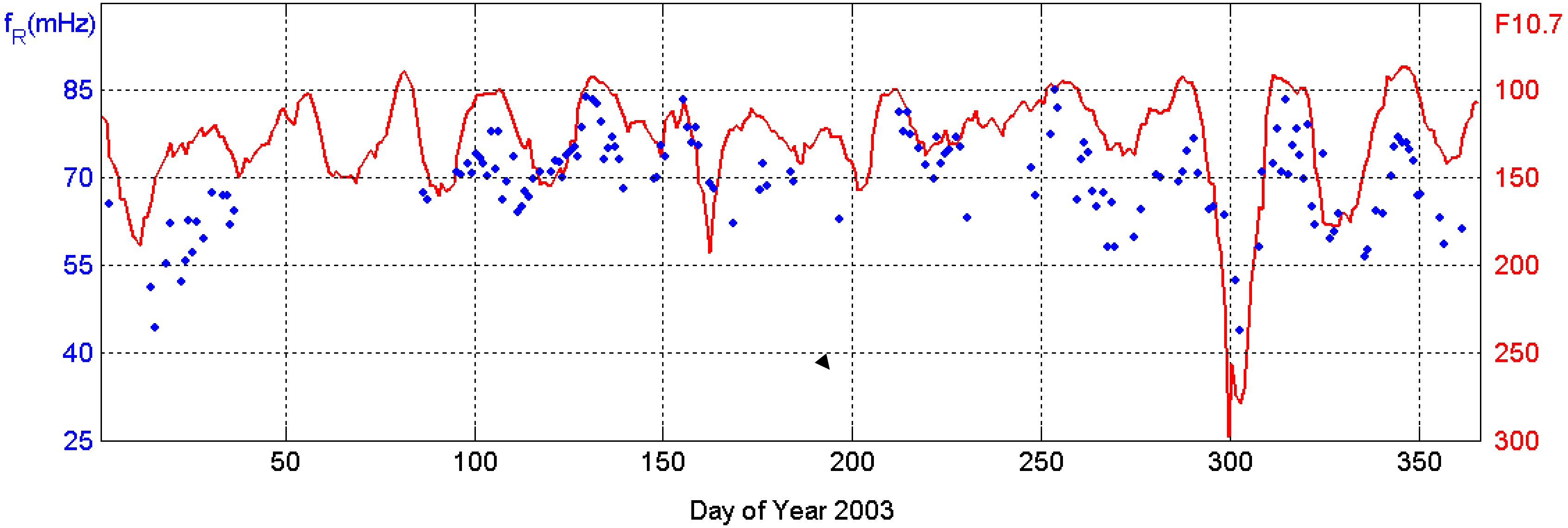
- **Space Research Institute of Graz (Austria)**
- **Physics Department, University of L'Aquila (Italy)**

FLR period, daily means (0900 – 1600 LT)

$$\rho_{eq} \propto T_R^{\ 2}$$



SOLAR IRRADIANCE DEPENDENCE OF THE FLR FREQUENCY (*L* = 1.61)



Day-to-day variations of the solar EUV/X-ray radiation affect not only the ionization content in the ionosphere but, through a rapid diffusion, also the whole flux tube plasma content at low latitudes.

Monthly medians

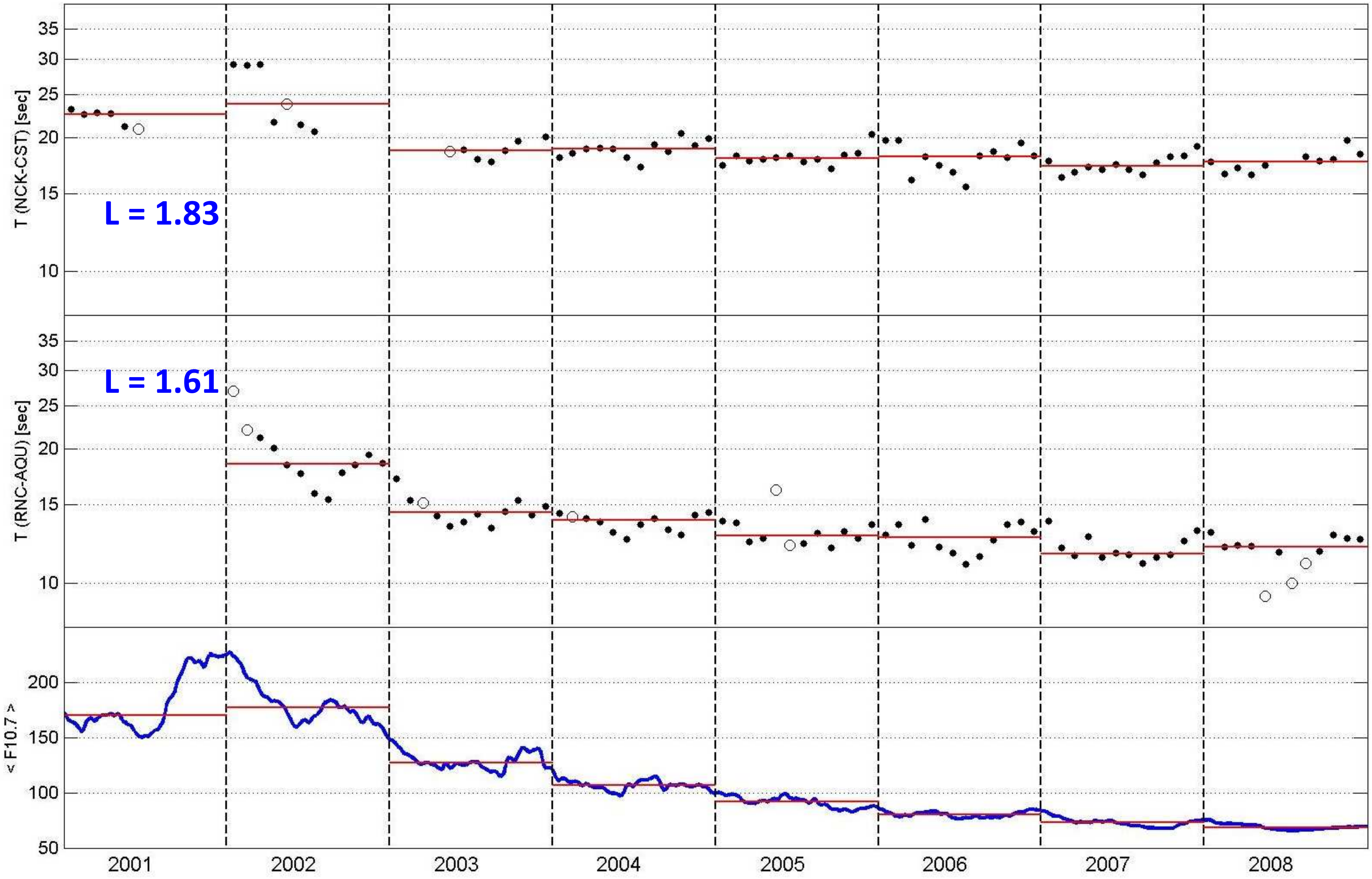


Figure 2

Statistical analysis

To separate solar activity and seasonal dependence observations were fitted by:

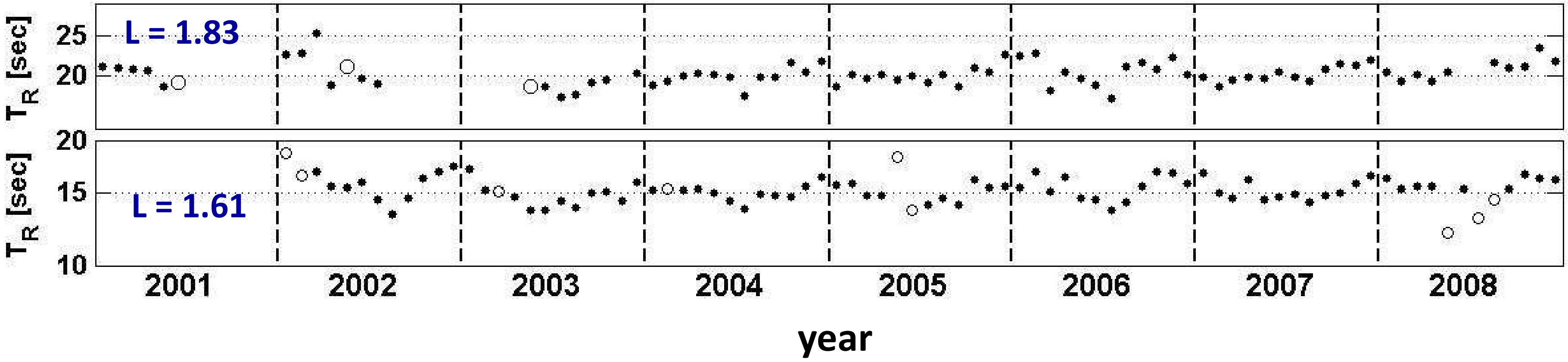
$$\log T = \log T_o + b\,(F_{10.7} - 130) + A_1 \cos[\omega_1(d - d_1)] + A_2 \cos[\omega_2(d - d_2)]$$

d : DoY ; $\omega_1 = 2\pi / 365$ day^{-1} ; $\omega_2 = 2\omega_1$; d_1 , d_2 : days when annual and semiannual modulation reach the maximum. Analytical modelling similar to that of *Carpenter and Anderson* [1992] .

Table 1. Results of the best fit

L	# points	corr.coeff.	$T_o(s)$	b	10^A$_1$	d_1	10^A$_2$	d_2
1.83	1098	0.62	20.3	0.0012	1.042	Dec. 23	1.024	Apr. 27
1.61	716	0.85	15.2	0.0018	1.059	Jan. 6	1.002	Mar. 6

Monthly medians (reduced to $F_{10.7}$ = 130)



***L*=1.83:** the annual modulation: ± 4%, extreme values at solstices; semi-annual component smaller (±2%), max values in late April and late Oct. ; resulting variation (annual + semiann.) maximum in November (12% higher than in July.

***L*=1.61**: only the annual component is significant, maximum in early January with values 12% higher than in June/July.

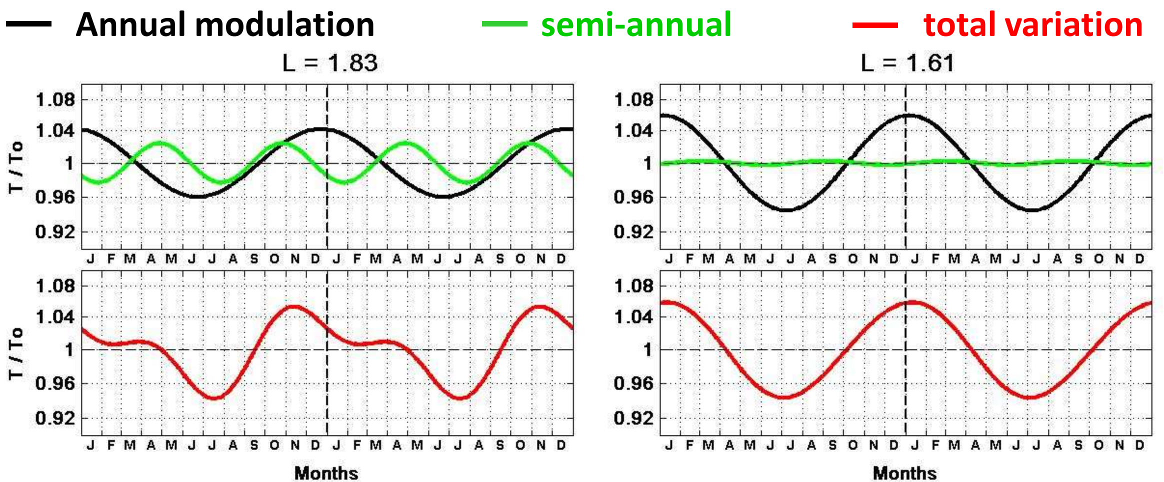


Figure 3

Theoretical modelling

Physical numerical model of the plasmasphere -ionosphere [*Förster & Jakowski*, 1988].

Two different simulated conditions :

high solar activity (*F*10.7 = 180),

low solar activity (*F*10.7 = 80).

Monthly values of the predicted FLR periods (noon time) at both L-shells are computed and a decomposition in terms of annual and semiannual modulations is carried out.

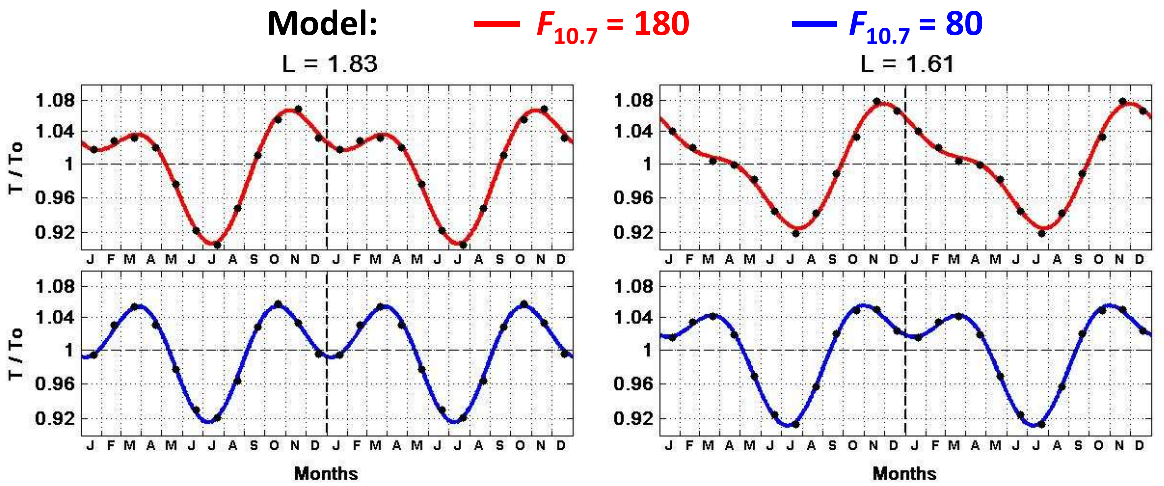


Figure 4

A good agreement (both in amplitude and phase) is observed between the simulated high solar activity conditions (red line) and the experimental observations. In particular, the model predictions confirm a minor contribution of the semiannual variation at *L*=1.61, and the presence of a secondary maximum in March/April at *L*=1.83.

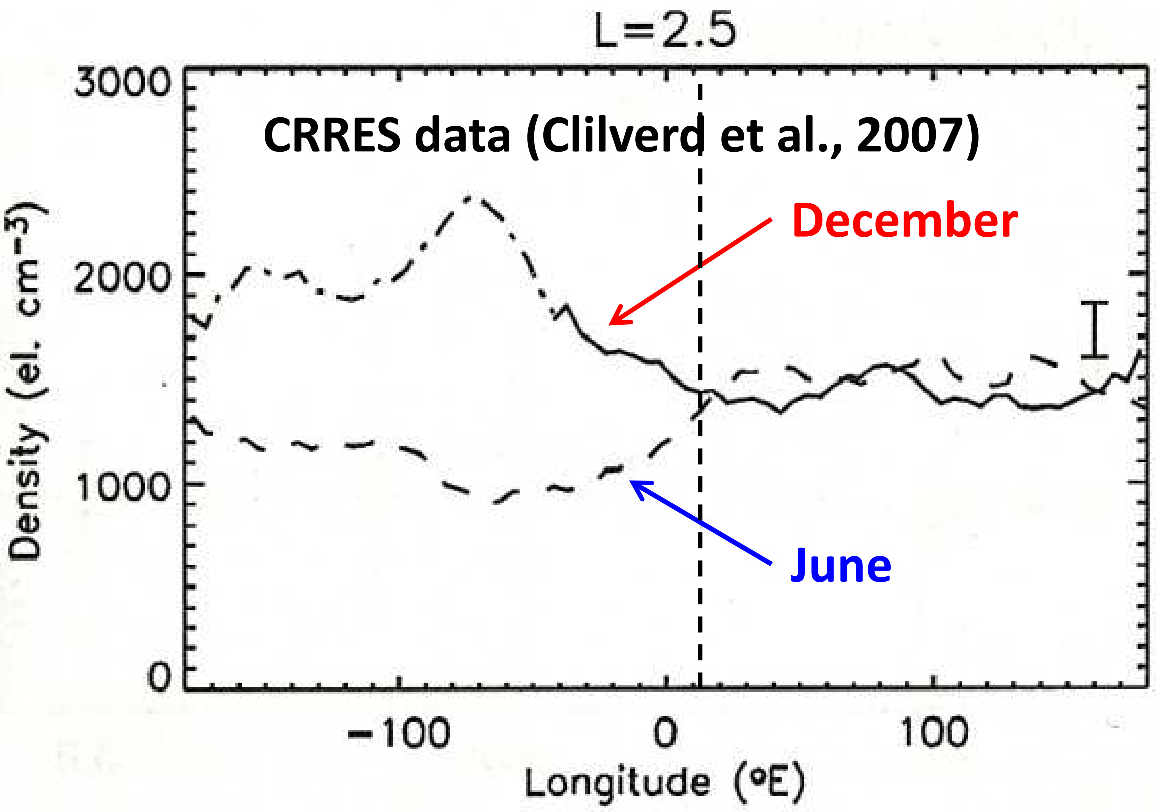
Conclusions

We deduce density values at L = 1.61 to be ~ 25% larger in December/January with respect to June/July.

A similar excursion is inferred at L=1.83 although (because of a significant contribution of the semiannual variation) the maximum value occurs in November.

Good agreement is observed with predictions given by a physical-numerical model of the plasmasphere.

We then confirm previous results obtained from whistler [*Lemaire and Gringauz*, 1998] and satellite [*Clilverd et al*., 2007] measurements showing that the annual variation in the European longitudinal sector is of much lower amplitude than that in the American sector essentially because of a smaller asymmetry in the ionospheric solar illumination at opposite ends of the magnetic field lines.



CRRES data (Clilverd et al., 2007)

December

June