ABSTRACT
We estimate the electron density \( N_e \) distribution in the solar corona for the last two recent minima of solar activity, with LASCO using a new time-dependent tomography method.

(1) Do we have realistic \( N_e \) distributions at the equator and in the coronal holes?
(2) How is the temporal evolution of the \( N_e \) distributions during the last two solar minima?
(3) Does the position of the maximum \( N_e \) follow the streamer belt?

Electron density of the corona: \( N_e(r, \theta, \varphi, t) = \arg\min_x \left( \frac{1}{2} \| y - Ax \|^2 \right) \)

\( y \) contains pixels of the PB images;
\( x \) contains the bins of the \( N_e \); with the constraint of positivity \( x \geq 0 \);
\( A \) is the projection matrix determined by the physics and the geometry of the problem.
\( R \) is the regularization matrix. Usually, only a spatial regularization is used \( R = \lambda R_x \).

2. TOMOGRAPHY RECONSTRUCTION METHOD

Electron density of the corona: \( N_e(r, \theta, \varphi, t) = \arg\min_x \left( \frac{1}{2} \| y - Ax \|^2 \right) \)

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3. DENSITY RECONSTRUCTION vs. PFSS vs. PredSci MHD Model

Tomography reconstruction \( N_e \)
PredSci MHD Model \( N_e \)

Fig.2: Spherical plane at 3.5R\( \odot \), 180 long corresponds to Dec 28, 2008 (Carrington Rotation 2077).

Tomography reconstruction \( N_e \)
PredSci MHD Model \( N_e \)

Fig.3: Spherical plane at 3.5R\( \odot \), 180 long corresponds to Jun 17, 2010 (Carrington Rotation 2098).

Black line: Heliospheric Magnetic Equator (HME) from PFSS model (coronal fields extrapolated from SOHO/MDI magnetograms) [2]. Dashed line: Maximum \( N_e \) from tomography shows a mismatch with PFSS/HEM.

\( N_e \) from tomography is more detailed at the poles and at the equator compared to PredSci.
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4. LATITUDE OF THE CURRENT SHEET AND THE DENSITY MAXIMUM

How does the position in latitude of the PFSS/HEM, \( N_e \) maximum in the MHD model and \( N_e \) maximum in the tomography reconstruction, vary with time?

PFSS and PredSci show similar result since they both use Magnetogram Synoptic Maps.

Location of the maximum \( N_e \) does not always follow the HME.

\( \rightarrow \) Pseudo-staminer could be denser than the streamer belt?

\( N_e \) maximum at 3.5R\( \odot \), during the solar minimum, 2008–2010.

5. DENSITY RADIAL PROFILE

Red \( N_e \) maximum at the equator.
Blue \( N_e \) average over the poles above \( \pm 65^\circ \).
Dashed line: First solar minimum.
Continuous line: Second solar minimum.
Skewness: Saito model [4].
Dots: PredSci MHD Model during the second minimum.

Fig.6: Electron density, \( N_e \), at the current sheet (red) and the poles (blue).

6. TEMPORAL EVOLUTION OF THE ELECTRON DENSITY AT 3.5R\( \odot \)

Black Sunspots Number (SIDC).
Red \( N_e \) maximum at the equator.
Blue \( N_e \) average over the poles above \( \pm 65^\circ \).

\( \rightarrow \) Good agreement with the Sunspots number (SSN).
At the poles \( N_e \) is similar for two minima.
At the equator \( N_e \) is lower for the second minimum.

Fig.5: \( N_e \) estimation at 3.5R\( \odot \), Time – year [UT]

SUMMARY & CONCLUSION
Realistic values? Time evolution? The value range of PredSci/\( N_e \) is shorter and over-estimates the tomography results by an order of magnitude. Temporal variations in the 3D \( N_e \) distribution from tomography are non negligible.

Realistic radial profiles? Deviation in \( N_e \) between Saito model and tomography at the poles for distance < 5R\( \odot \); radial profile changes between solar minima: at the poles they cross at 3.5R\( \odot \); at the equator they differ by \( \sim 10^7 \) cm\(^{-3} \); \( \rightarrow \) Saito model cannot be used realistically for solar activity evolution.

Realistic positions? Positions of PFSS/HEM and PredSci/\( N_e \) max are usually similar and follow the streamer belt. However, positions of \( N_e \) max from tomography do not always follow the predicted streamer belt.

The results provide important constraints and initial conditions for a realistic and running time models of the solar corona and solar wind. So far, time-dependent MHD models suffer from realistic initial conditions (density, temperature, velocity) close to the surface and are not well constrained outward (radial profile).

[3] Predictive Science: www.predsci.com (Riley et al., JGR 2001)

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Judith de Patoul (j.depatoul@exeter.ac.uk)
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