The author considers that individual production rates are proportional to the square of electron density. It should be reconsidered.

According to Zhang et al. (2010), the electron density N_e is determined by chemical equilibrium between production and loss of ion. P_{euv} and P_e are the electron production rates due to solar EUV flux and electron precipitation, respectively. Due to the dissociative recombination, molecular ion, such as O_2+ and NO+ are recombined. This recombination process can be written as

$$XY^+ + e^- = \mathrm{X} + \mathrm{Y} \qquad (1)$$

Loss rate of ion is $\alpha[XY^+][e^-] = \alpha N_e^2$, where [ ] denotes density, and α is the recombination rate coefficient. If the production rate of ion is equal to the loss rate of ion, we obtain

$$\alpha N_e^2 = P_{euv} + P_e \qquad (2)$$

This is Eq. (2) of Zhang et al. (2010). In Zhang et al. (2010), they describe

$$\alpha (N_e^{euv})^2 = P_{euv} \qquad (3)$$

$$\alpha (N_e^{e})^2 = P_e \qquad (4)$$

where N_e^{euv} represents the electron density due to solar EUV only and N_e^e due to electron precipitation only. Then, they obtain

$$N_e = \sqrt{(N_e^{euv})^2 + (N_e^e)^2} \qquad (5)$$

Although the authors have followed Zhang et al. (2010), this reviewer considers that Eqs. (3)-(4) are incorrect, and that thus, Eq. (5) is also incorrect. The reason is described below.

1).

To obtain Eq. (3), this reviewer considers that Zhang et al. (2010) assume the following reaction for loss of the ion produced by solar EUV only

$$XY^{+\,euv} + e^{-\,euv} = X + Y \qquad (6)$$

where $XY^{+\,euv}$ and $e^{-\,euv}$ are the ion produced by solar EUV only, and electron precipitation only, respectively. They consider that loss rate of $XY^{+\,euv}$ is

$$\alpha[XY^{+\,euv}][e^{-\,euv}] = \alpha(N_e^{euv})^2 \qquad (7)$$

However, this reviewer doubts the reaction (6). Why does $XY^{+\,euv}$ react with only $e^{-\,euv}$? Why doesn't $XY^{+\,euv}$ react with e^-? How does $XY^{+\,euv}$ distinguish $e^{-\,euv}$ from e^-? Correct chemical reaction (6) should be

$$XY^{+\,euv} + e^- = X + Y \qquad (8)$$

because $XY^{+\,euv}$ reacts not only with $e^{-\,euv}$ but also $e^{-\,e}$. So, the loss rate of $XY^{+\,euv}$ is written as

$$\alpha[XY^{+\,euv}]\{[\,e^{-\,euv}] + [\,e^{-\,e}]\} = \alpha[XY^{+\,euv}][\,e^{-}\,] = \alpha N_e^{euv}\, N_e \qquad (9)$$

In the same way, the loss rate of $XY^{+\,e}$, which is the ion produced by electron precipitation only is written as

$$\alpha[XY^{+\,e}]\{[\,e^{-\,euv}] + [\,e^{-\,e}]\} = \alpha[XY^{+\,e}][\,e^{-}\,] = \alpha N_e^{e}\, N_e \qquad (10)$$

From Eq. (9)-(10), total loss of the ion is obtained as

$$\alpha(N_e^{euv}\, N_e \; + \; N_e^{e}\, N_e) = \alpha(N_e^{euv} + \; N_e^{e})N_e = \; \alpha N_e^{2} \qquad (11)$$

where

$$N_e^{euv} + \; N_e^{e} = \; N_e \qquad (12)$$

is used. Eq. (12) is consistent with loss rate shown in Eq. (2). Consequently, Eqs. (3)-(5) are incorrect.

2). By defining a percentage of N_e^{e} in N_e as γ,

$$N_e^{e} = \gamma N_e \qquad (13)$$

$$N_e^{euv} = (1-\gamma)N_e \qquad (14)$$

are obtained. Substituting Eq. (13) and (14) to Eq. (5),

$$\begin{aligned} N_e &= \sqrt{(N_e^{euv})^2 + (N_e^{e})^2} \\ &= \sqrt{(1-\gamma)^2 + \gamma^2} N_e \\ &= \sqrt{2\gamma^2 - 2\gamma + 1}\, N_e \end{aligned}$$

Thus, $1 = 2\gamma^2 - 2\gamma + 1, \quad \gamma(\gamma - 1) = 0$

$$\gamma = 0, 1$$

For the case of $\gamma = 0$, $N_e^{e} = 0$ and $N_e^{euv} = N_e$.

For the case of $\gamma = 1$, $N_e^{e} = N_e$ and $N_e^{euv} = 0$.

Eq. (5) is valid only when $N_e = \; N_e^{euv}$ or N_e^{e}. This result indicates that Eq. (5) is incorrect. This is because Eqs. (3)-(4) are incorrect.

In this manuscript, the authors follow Eqs. (3)-(4). This reviewer recommends the authors not to follow Eq. (3)-(5) of Zhang et al. (2010).