Revealing the role of “hidden heavy ions” component in the terrestrial polar wind outflow

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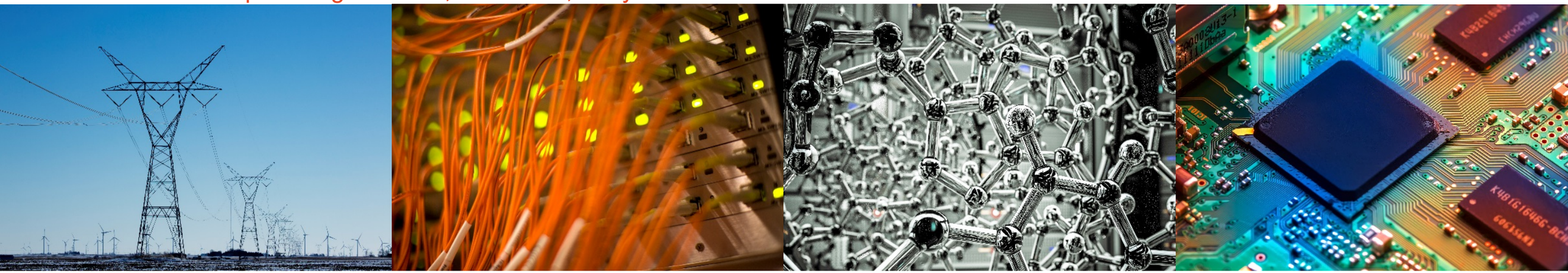

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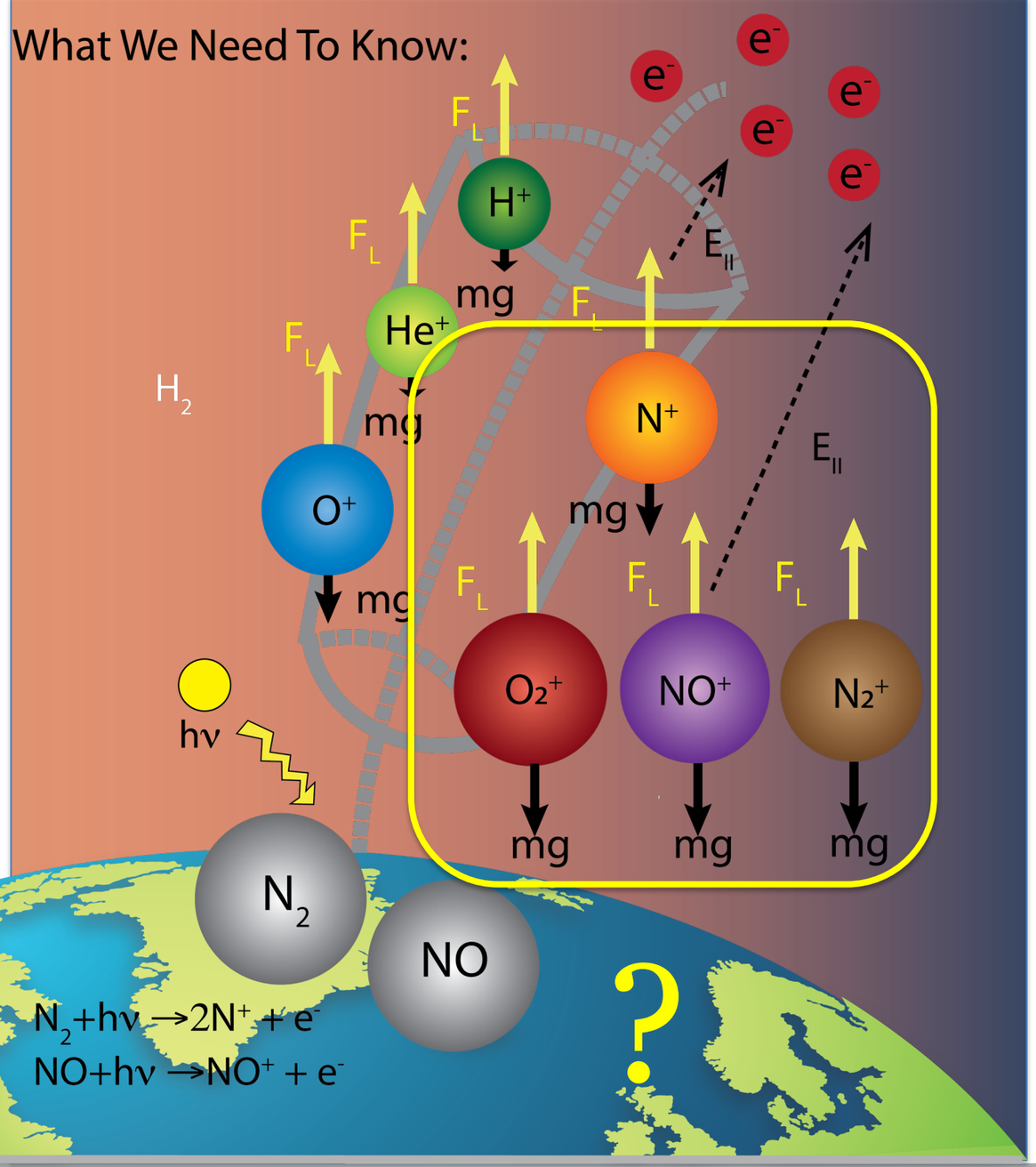
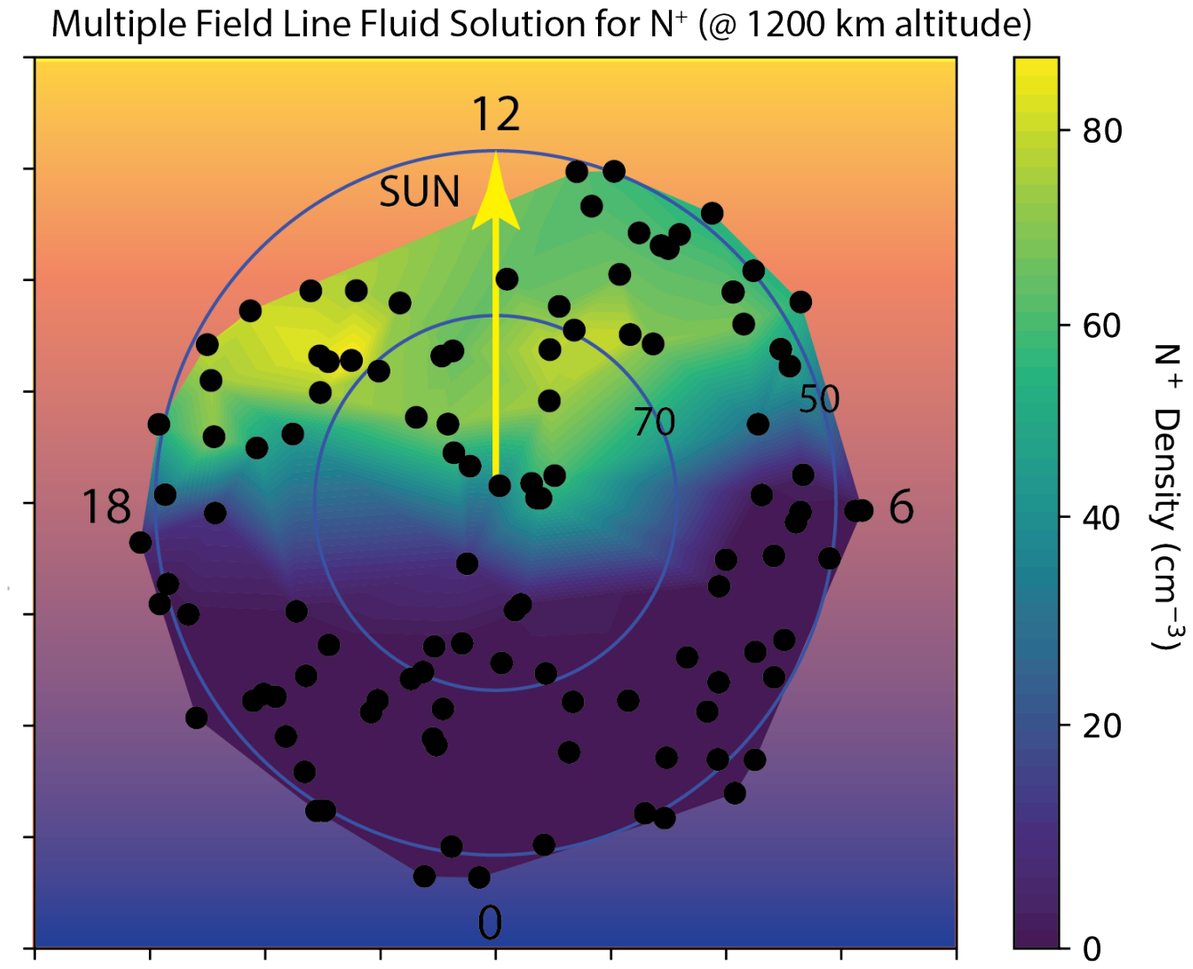
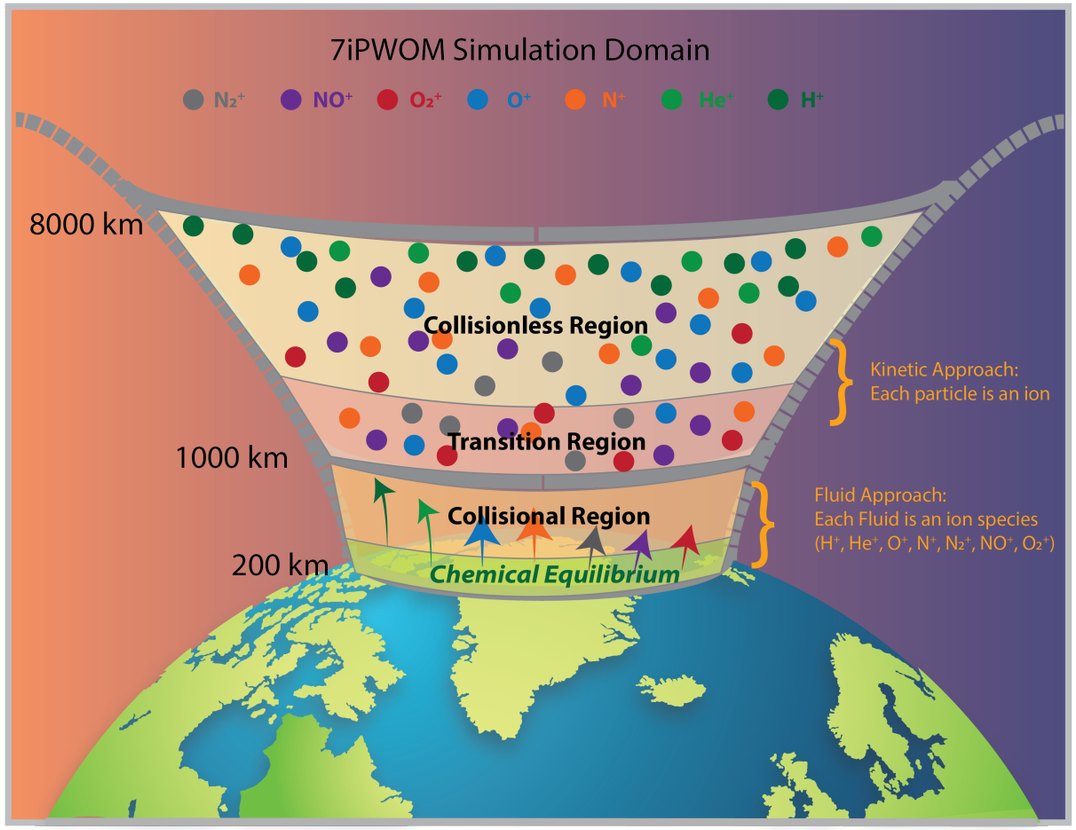
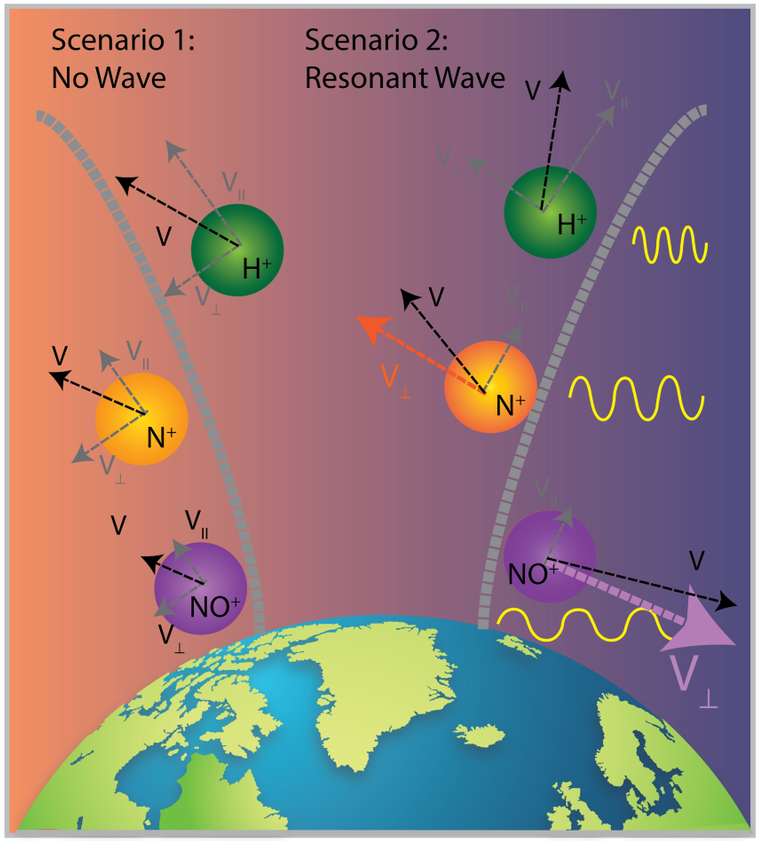


~ 2500 lbs of N^+ lost a day



Seven Ion Polar Wind Outflow Model (7iPWOM)





WPI increase $V_\perp$

↓

Ions move up ($V_\parallel$) along B

↓

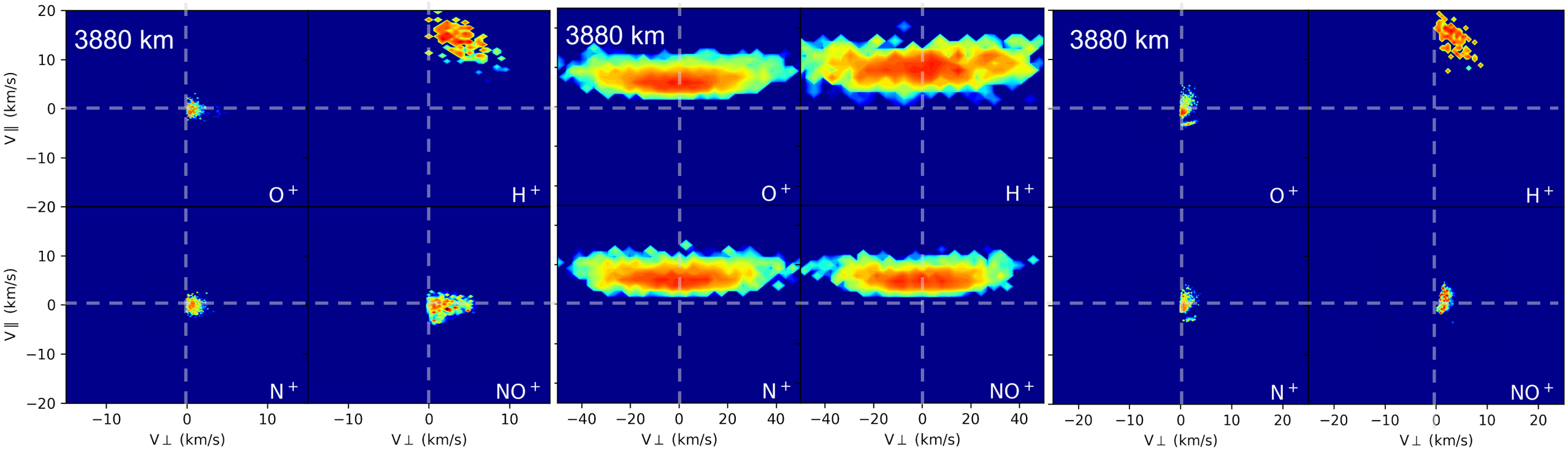
Form ion conic in velocity space

- Developed from PWOM (Glocer et al., 2018), 7iPWOM solves H^+, He^+, N^+, O^+, N_2^+, NO^+, O_2^+ with fluid approach below 1000 km altitude and kinetic approach beyond.
- Heavy ions, especially molecular ions, are expected to be preferentially heated.

(Glocer et al., [2018], *JGR)*

Effect of Wave Heating

- **N^+ ions are a key species** in the ionospheric outflow.
- Preliminary simulations show that **molecular ions can acquire sufficient energy via WPI** to escape from the high latitude ionosphere.



Steady State (T = 0) | Turn on wave heating (T =15 min) | Turn off wave heating (T = 100 min)

- Few NO^+ ($n < 10^{-5}$ cm^{-3}) existed during the steady state. However, after turning on wave, $n(NO^+)$ increase to 10^{-1} cm^{-3} and the average $V_{\parallel}$ is ~ 10 km/s (> escape velocity).
- The presence of molecular ions upflows provides an important framework to understand wave heating mechanisms in the polar wind.