Exosphere

State of development

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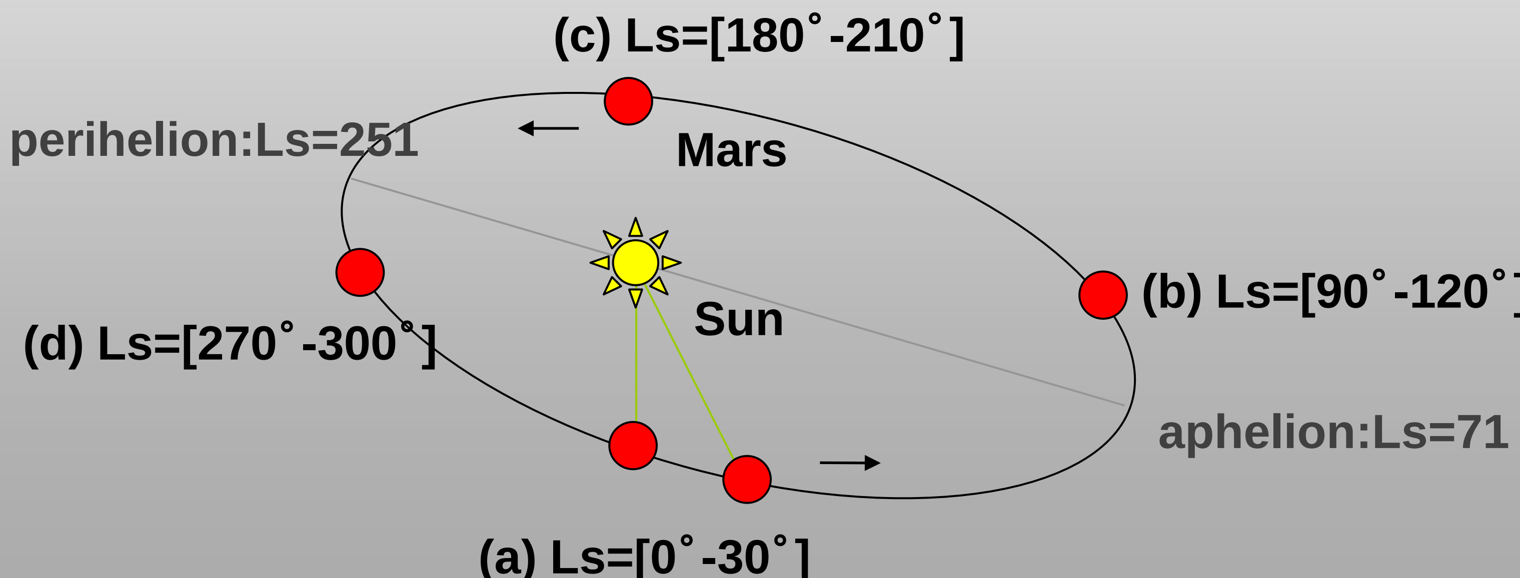
Exospheric description

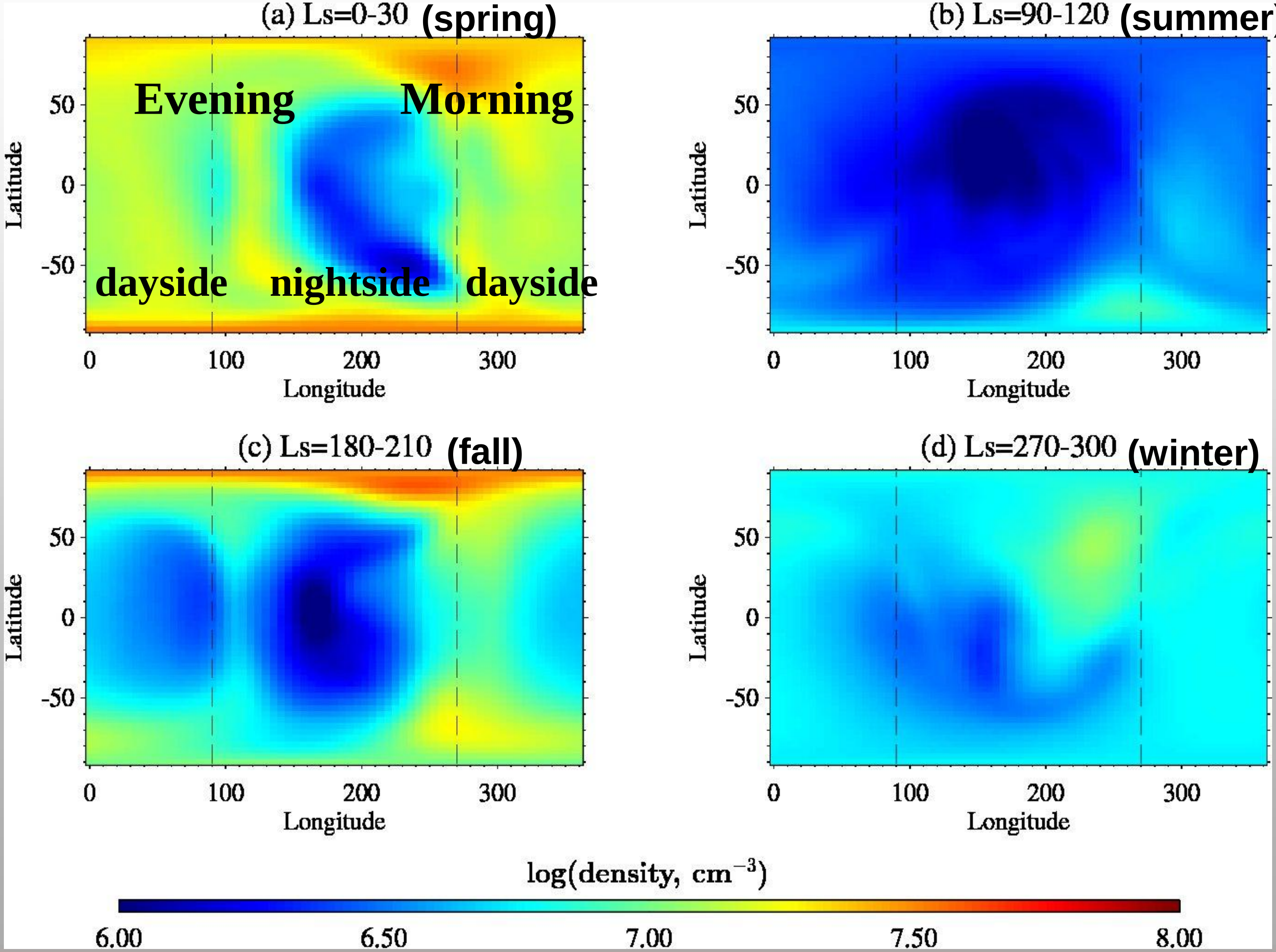
I Thermal component

・Thermal exospheric density from velocity distribution at the collisional - collisionless boundary (from a critical altitude = ~200 km in altitude).

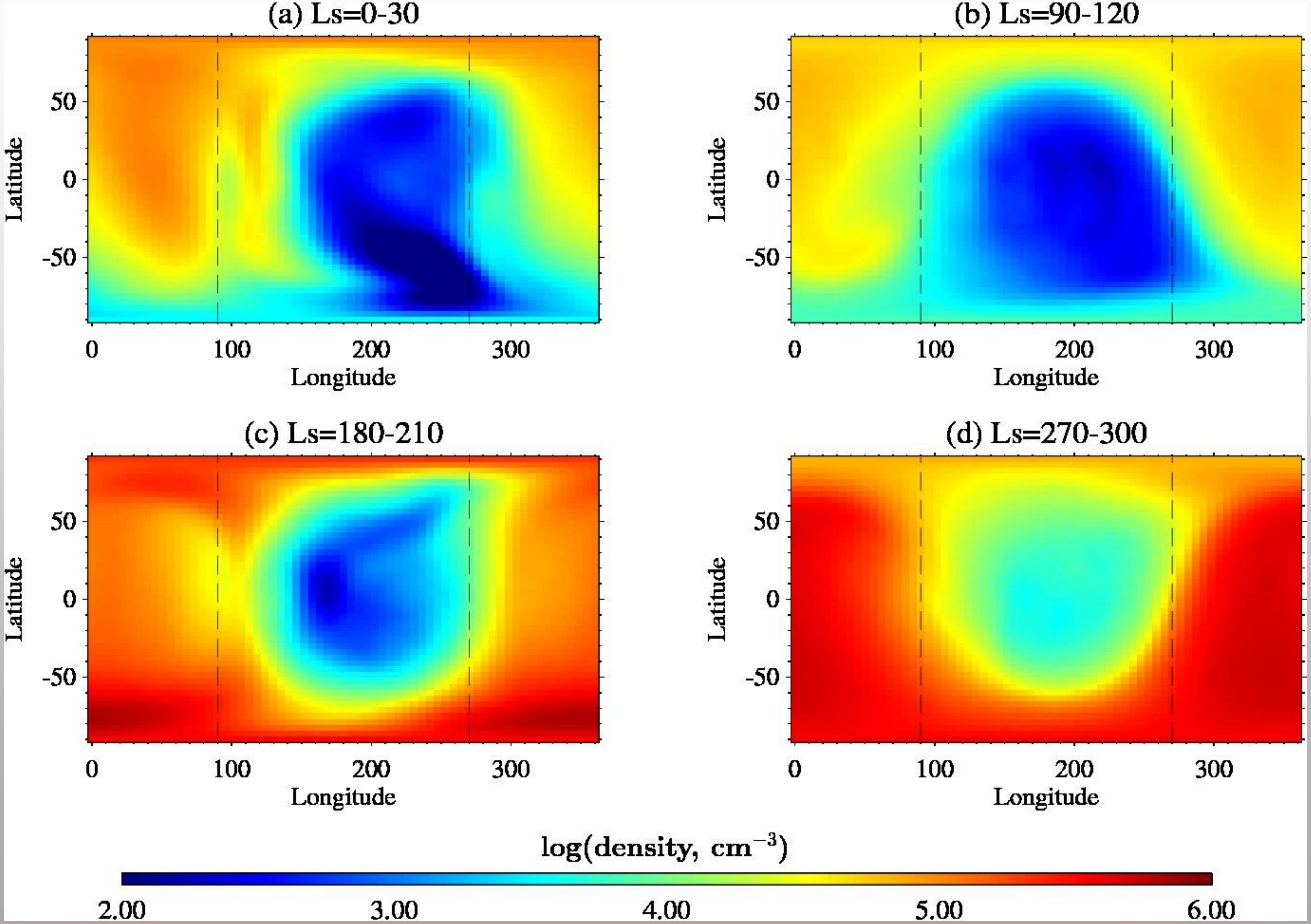
・Density and Temperature of O, CO and CO_2 at 200km from Martian GCM [Chaufray et al. 2014].



Seasonal variation of O density at 300 km



Seasonal variation of CO_2 density at 300 km



Exospheric description
II Non-thermal component: DR

- Main source of hot oxygen is O_2^+ dissociative recombination

$O_2^+ + e- \rightarrow O^* + O^*$ [Chaufray et al., 2007].

- O_2^+ profile from Martian GCM [Chaufray et al. 2014]

$CO_2^+ + O \rightarrow CO + O_2^+$,

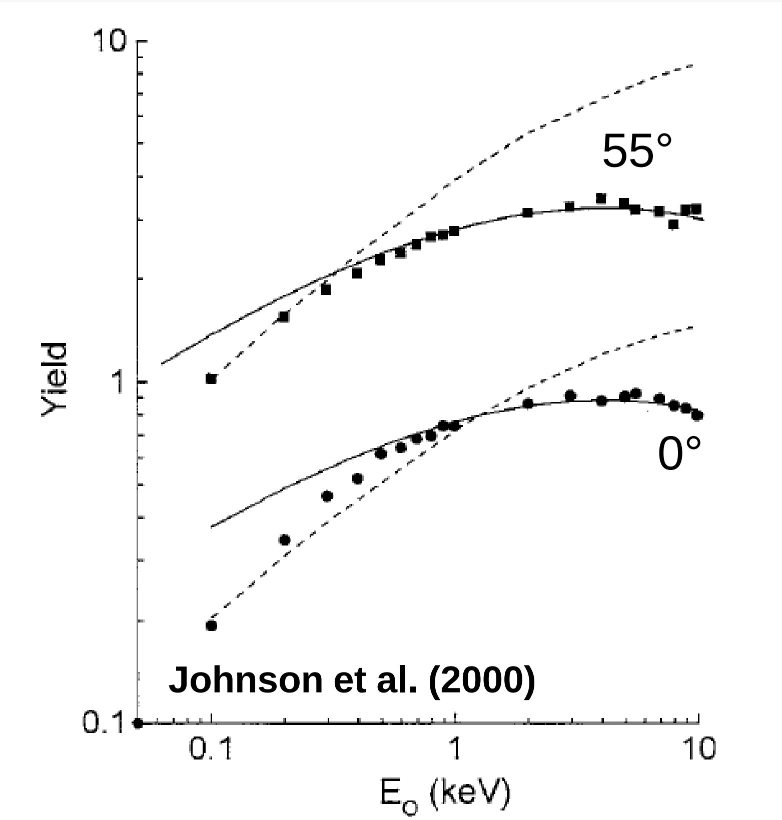
$CO_2^+ O+ \rightarrow CO + O_2^+$

- Collisions between hot O and O background atmosphere (from O and CO_2 derived by GCM) simulated from 120km to ~300km.

$\Rightarrow$Products could be all atmospheric species

Exospheric description

II Non-thermal component: Sputtering



Efficiency of the O sputtering vs E at 2 different incident angle: 55° is the most probable incident angle

O^+ pickup ions reimpact Mars

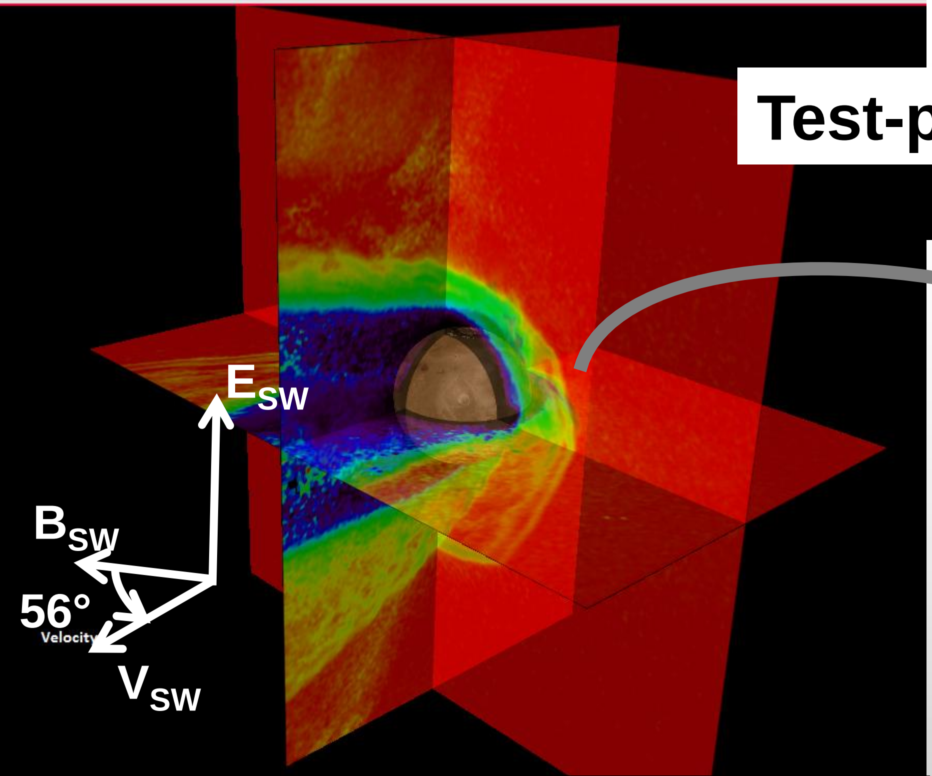
⇒ Y from 0 to 10

⇒ At low energy Y< 1

⇒ Loss rate << Absorption rate

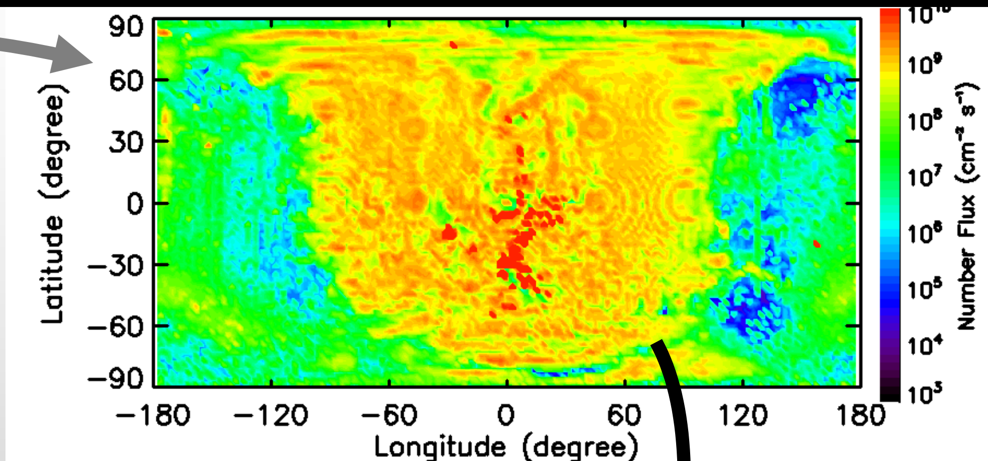
⇒ **The energy flux distribution is a key information**

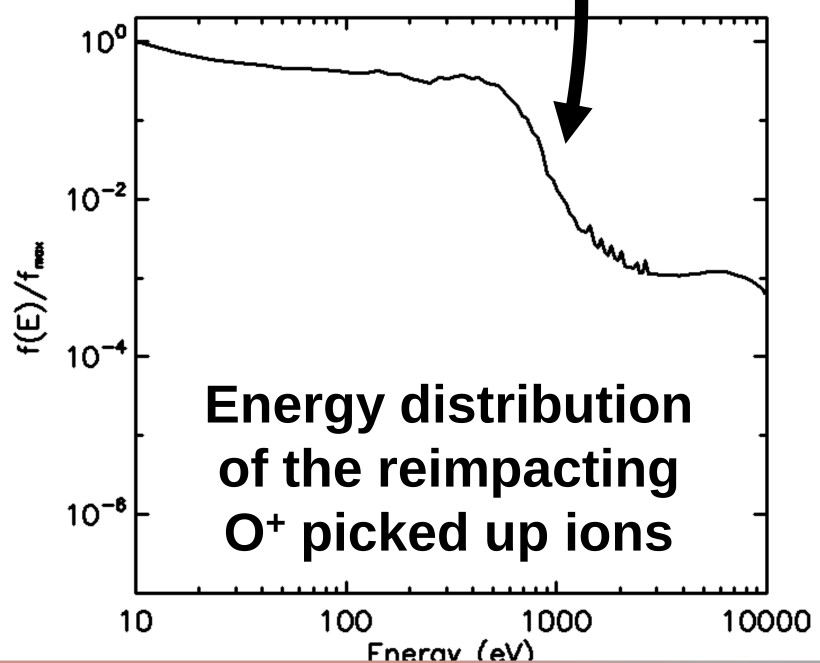
Test-particles simulation



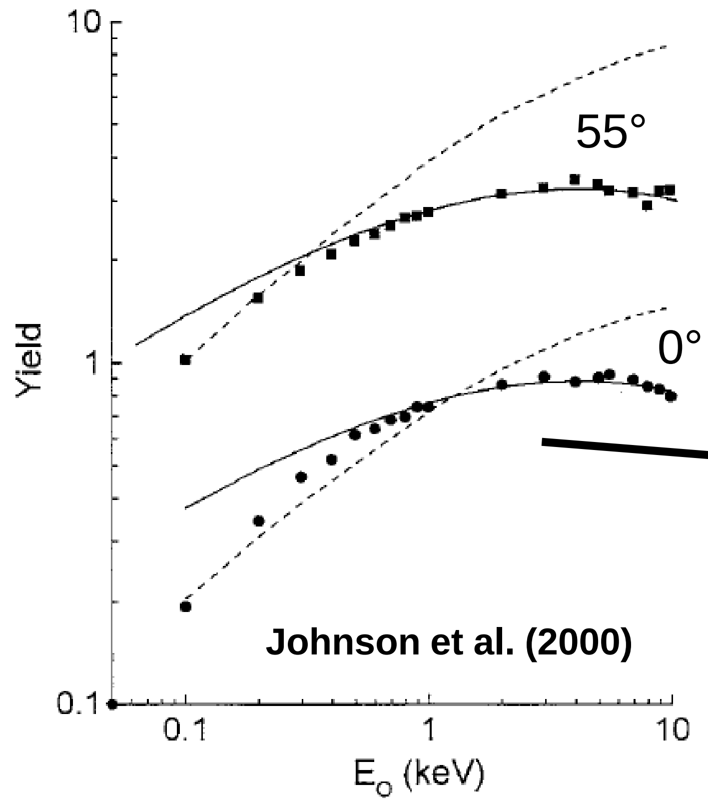
Simulated velocity field by the hybrid code (Modolo et al. 2014)

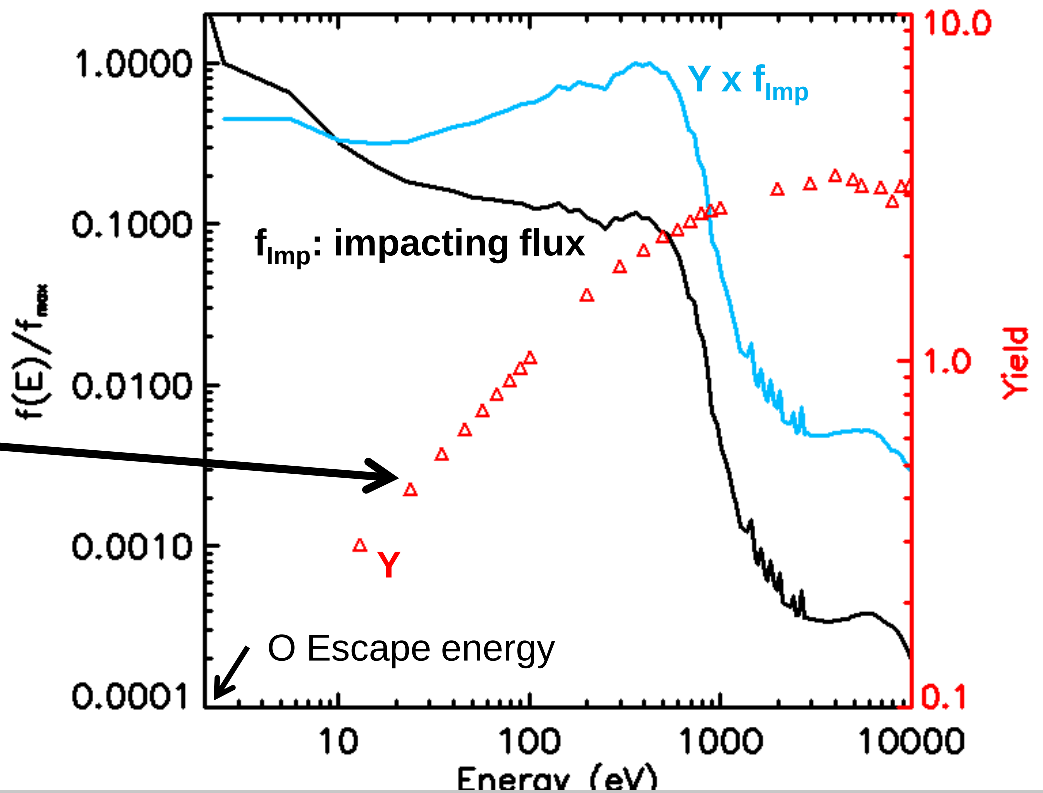
Flux at the exobase of reimpacting O^+





SW (4 cm^{-3}, 400 km/s), 3 nT Parker, Ls=90°-Northern summer, Solar Mean Crustal field at noon





The 100-1keV range most important for escape <u>(not for exospheric production)</u>

SW (4 cm^{-3}, 400 km/s), 3 nT Parker, Ls=90°-Northern summer, Solar Mean Crustal field at noon

Exospheric description

II Some illustrations

Dissociative recombination vs Sputtering vs Thermal components

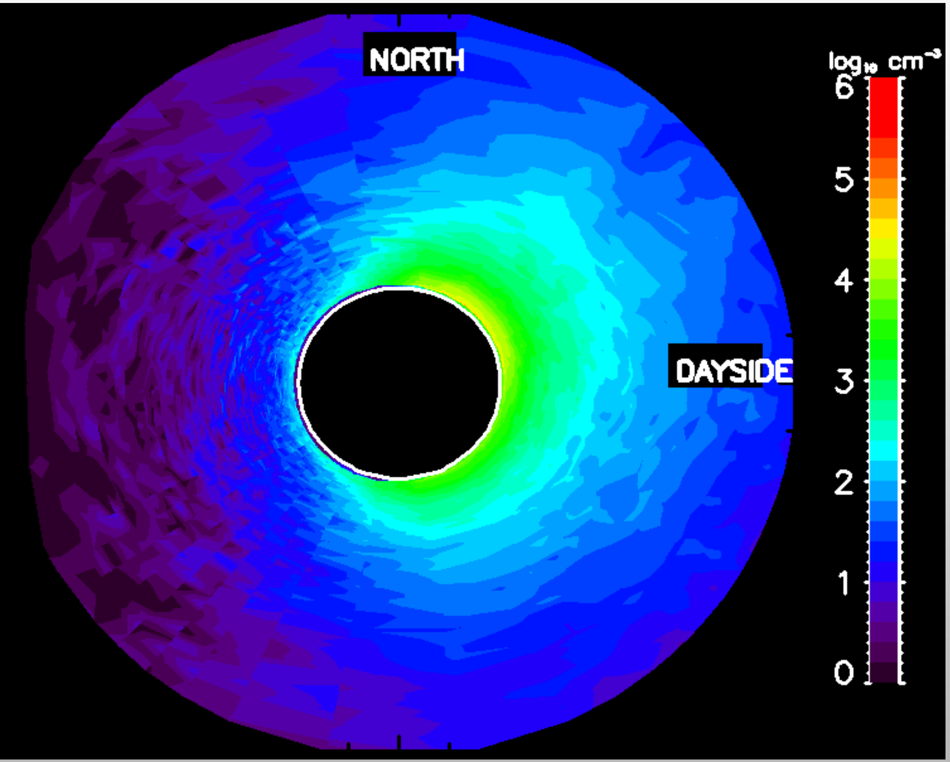
Could we distinguish something?

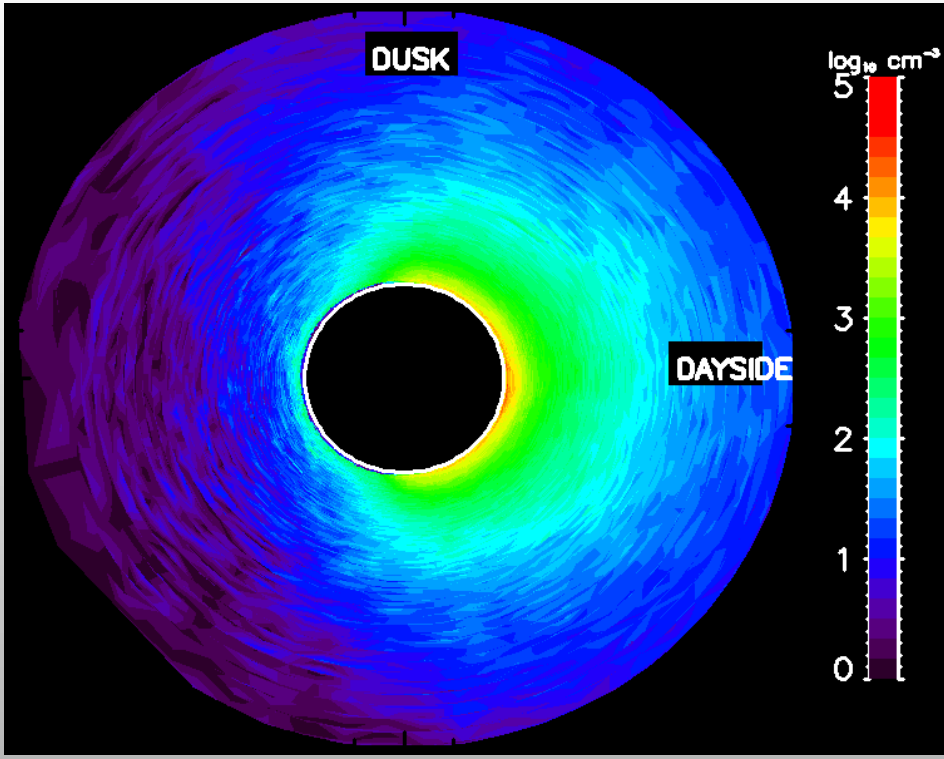
Ls=90°- Northern summer, Solar Mean

SW (4 cm^{-3}, 400 km/s), 3 nT Parker

Crustal field at noon

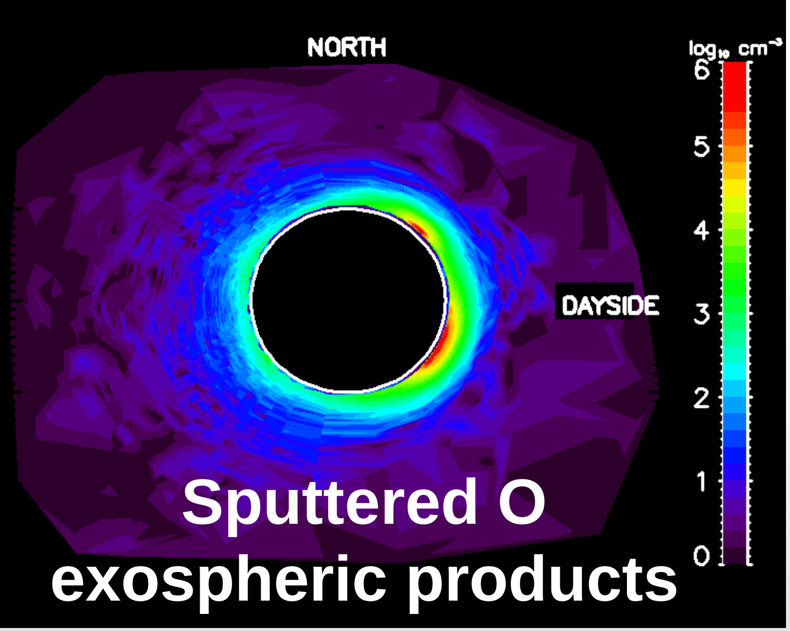
Dissociative recombination O exospheric products

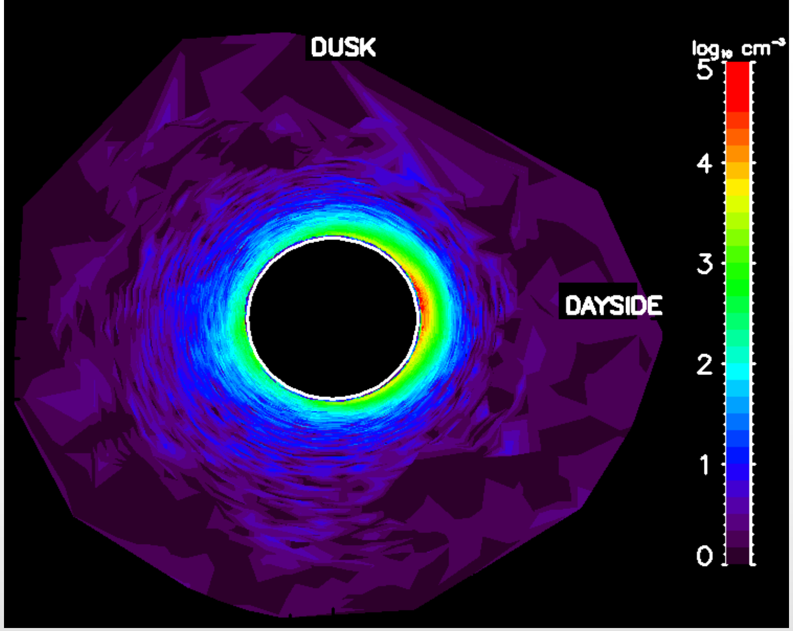


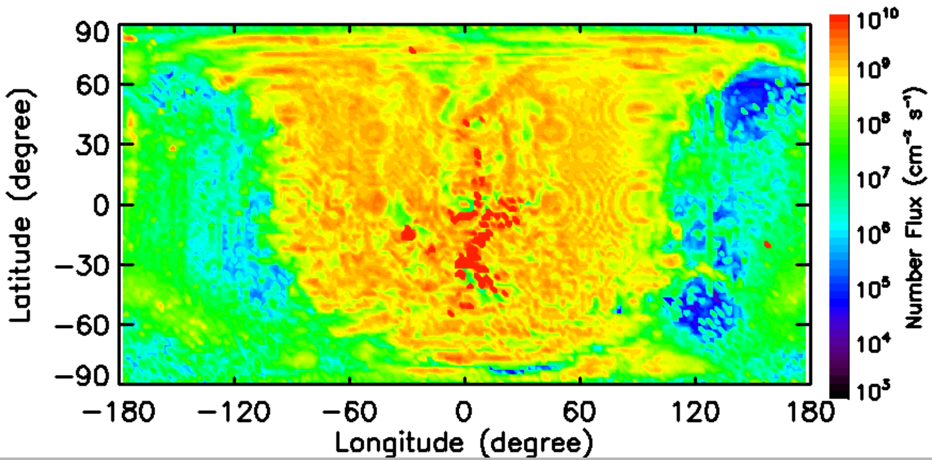


Ls = 90°- Northern summer, Solar Mean

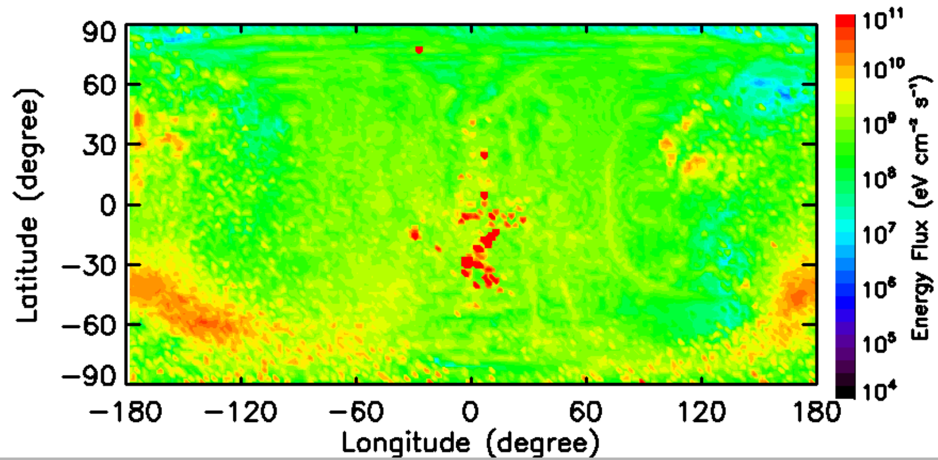
Sputtered O exospheric products







TOTAL: 8.8E+27 s^{-1}

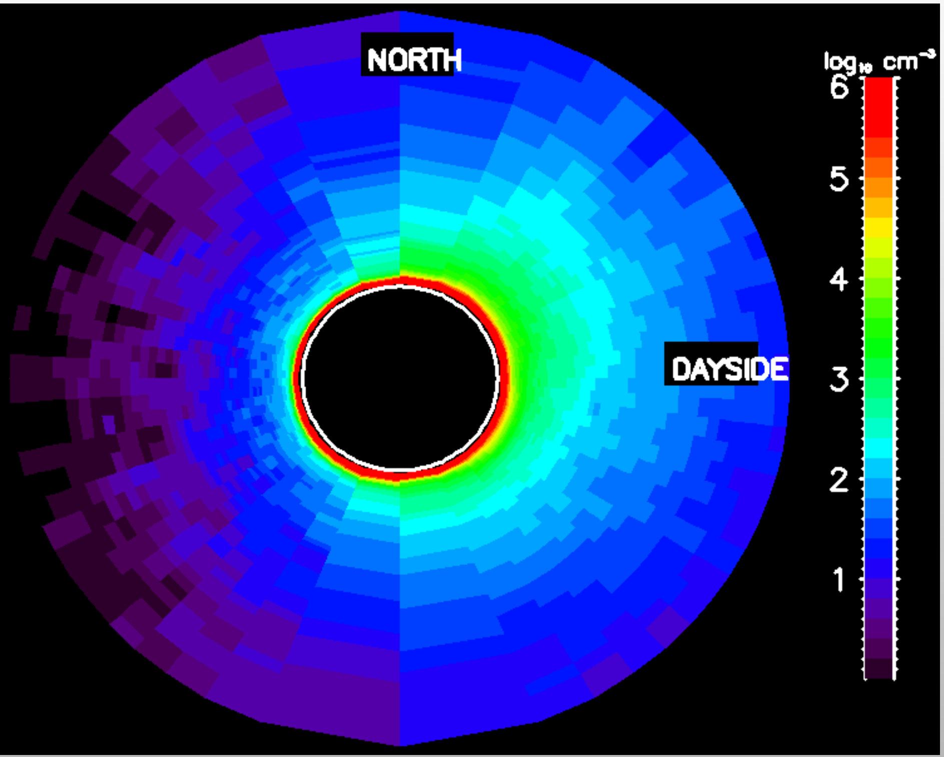


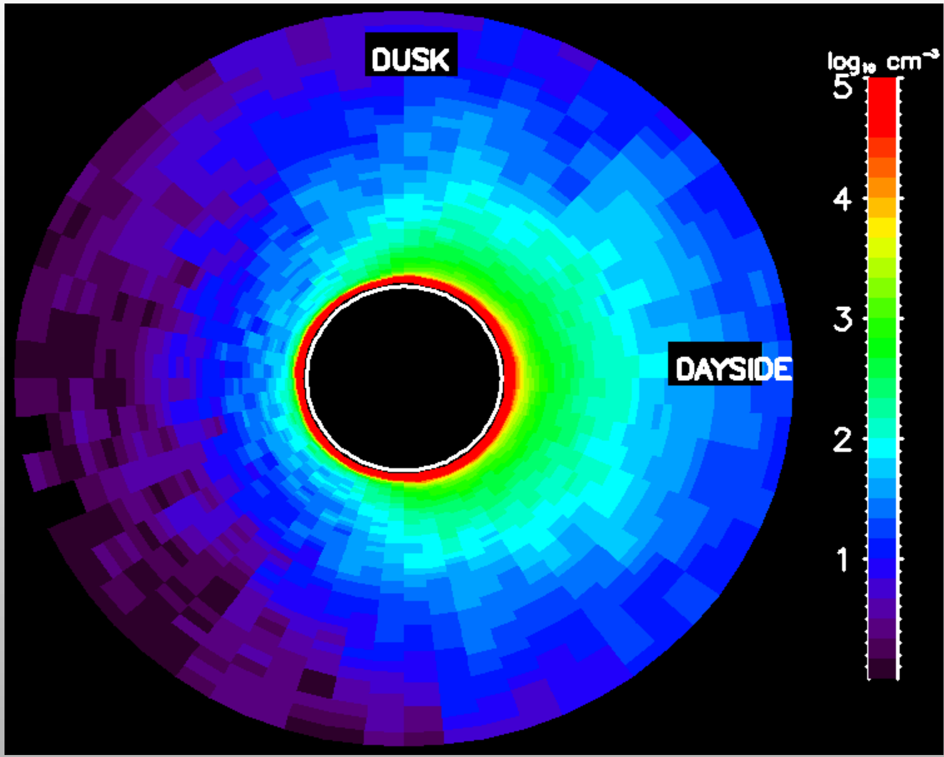
TOTAL: 7.4E+27 eV s^{-1}

Ls=90°-Northern summer, Solar Mean

SW (4 cm^{-3}, 400 km/s), 3 nT Parker, Crustal field at noon

O DR + SP + Thermal components





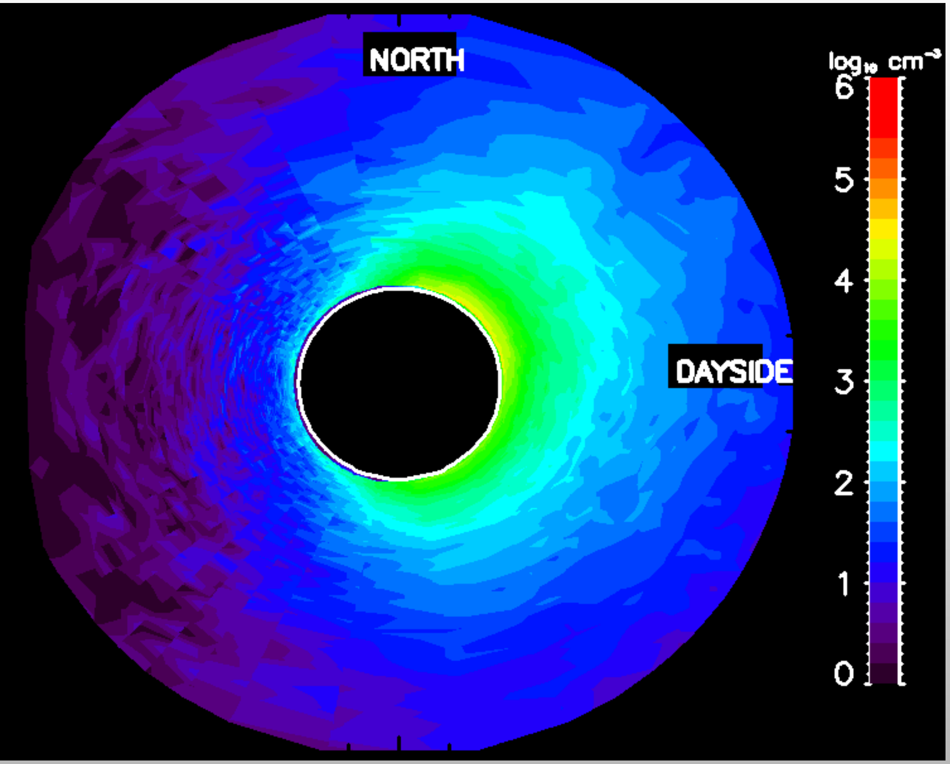
Ls=90°-Northern summer, Solar Mean
SW (4 cm^{-3}, 400 km/s), 3 nT Parker, Crustal field at noon

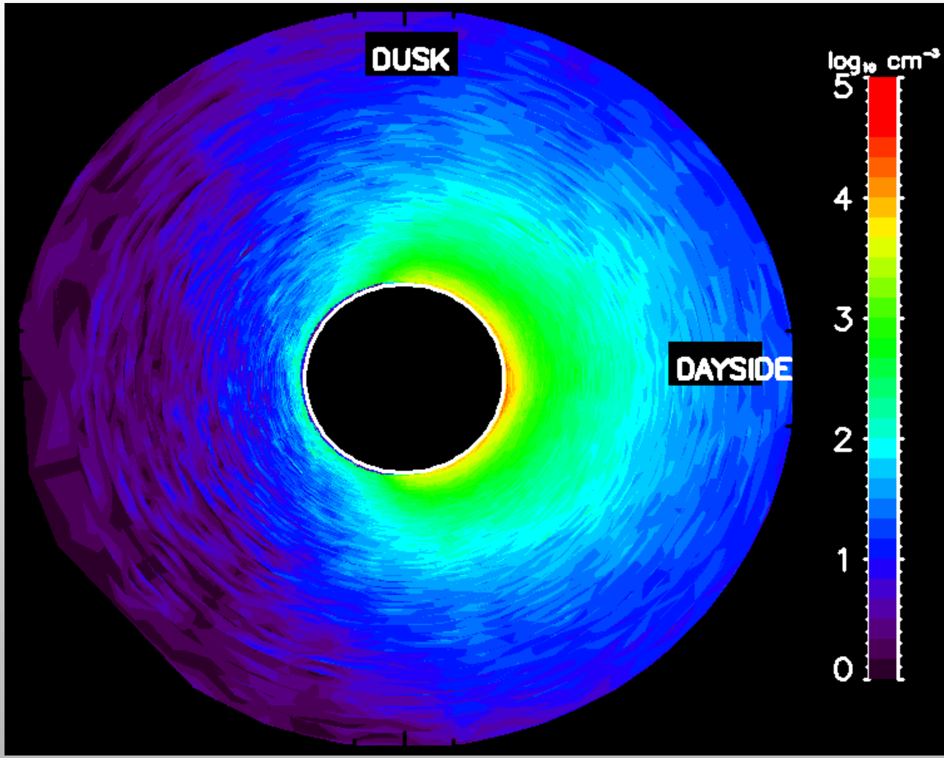
Ls=90°- Northern summer, Solar Mean

SW (2.7 cm^{-3}, 485 km/s), 3 nT Parker

Crustal field at midnight

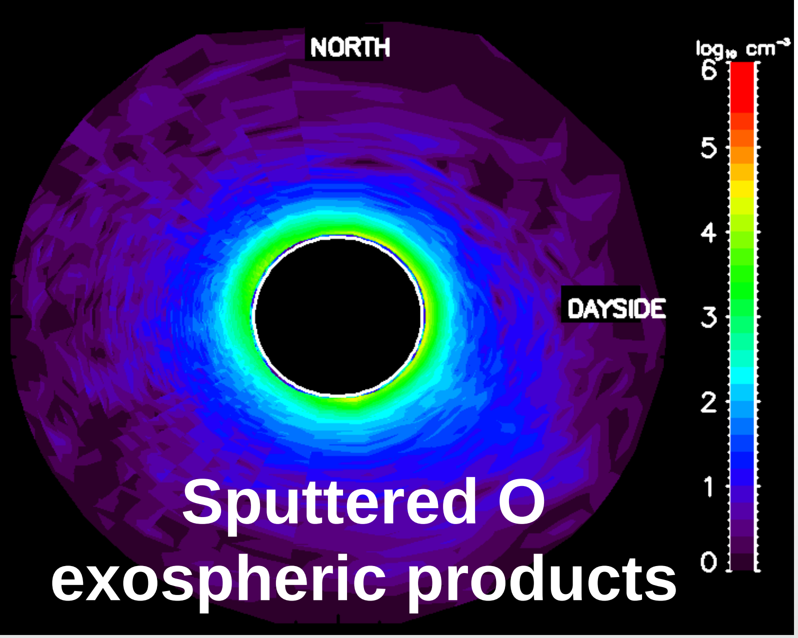
Dissociative recombination O exospheric products

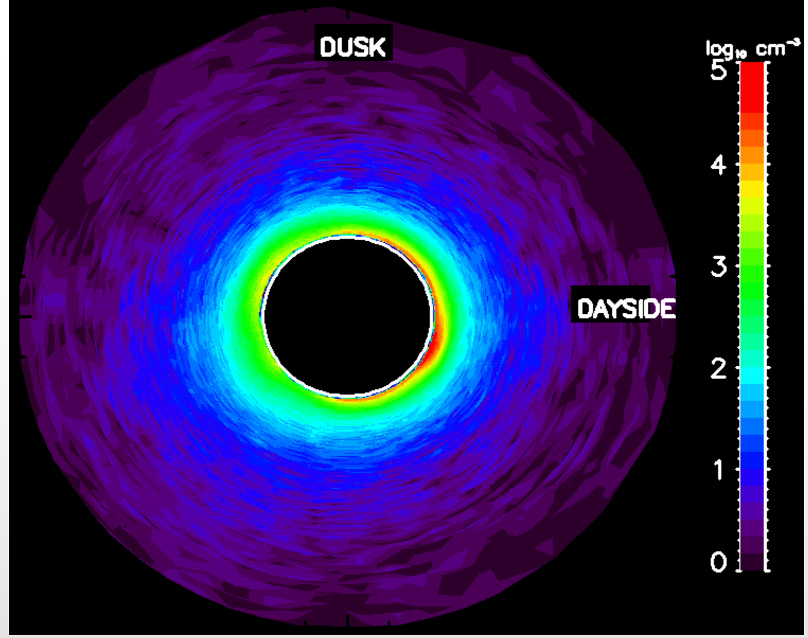


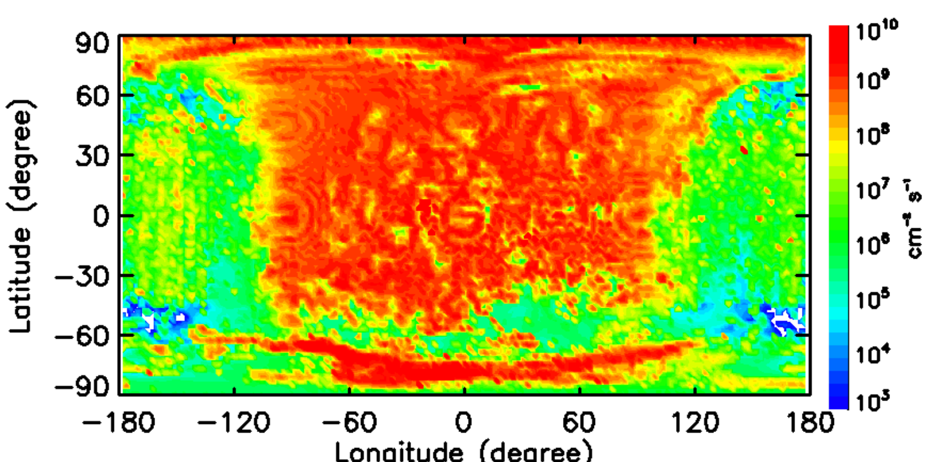


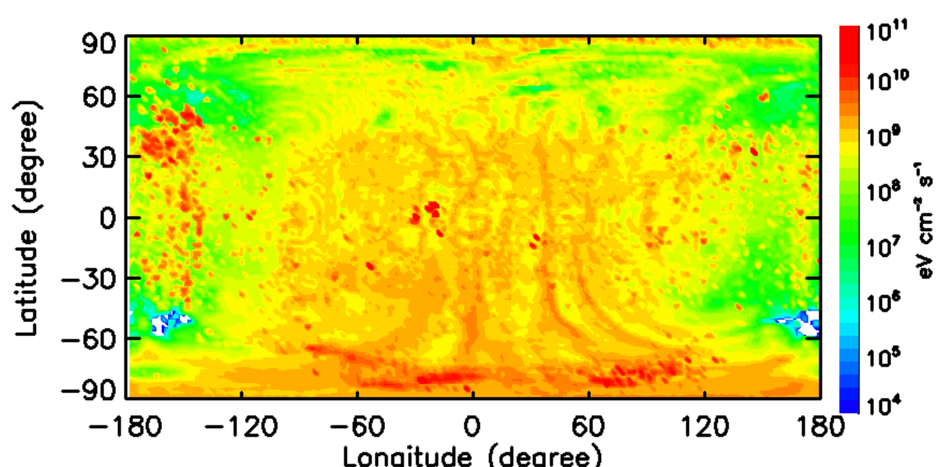
Ls = 90°- Northern summer, Solar Mean

Sputtered O exospheric products









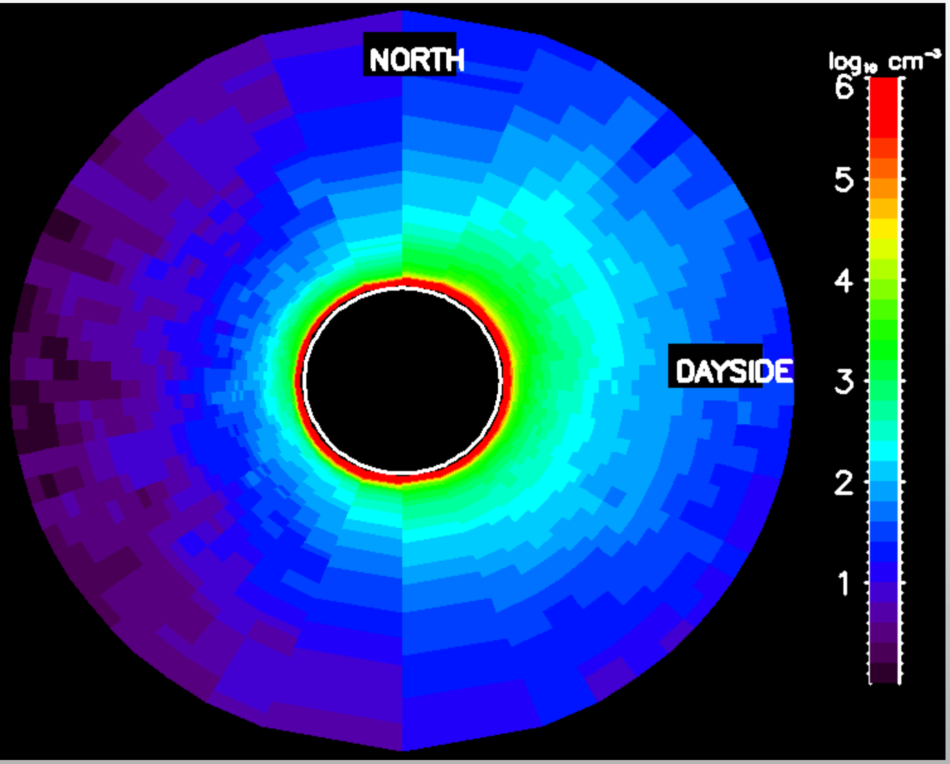
TOTAL: 1.5E+27 s^{-1}

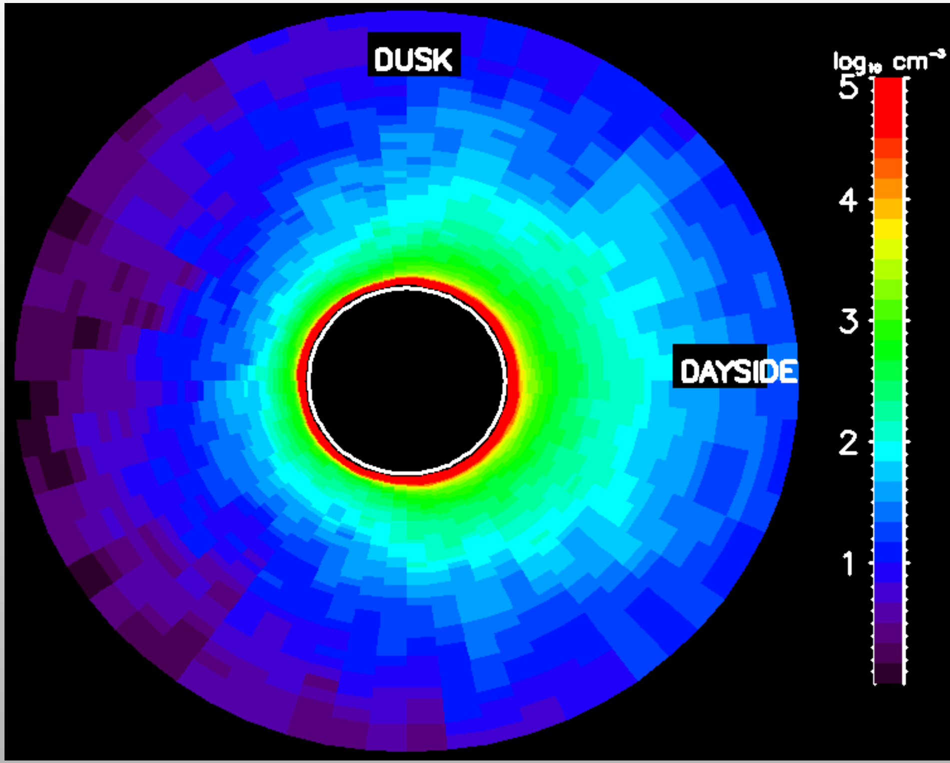
TOTAL: 2.3E+27 eV s^{-1}

Ls=90°-Northern summer, Solar Mean

SW (2.7 cm^{-3}, 485 km/s), 3 nT Parker, Crustal field at midnight

O DR + SP + Thermal components





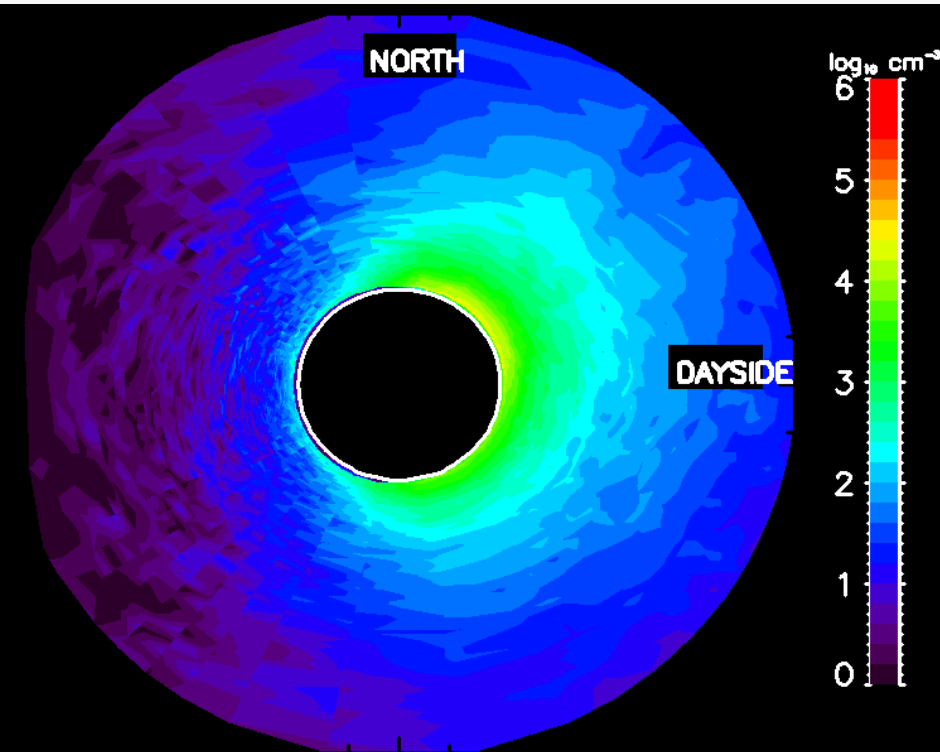
Ls=90°-Northern summer, Solar Mean
SW (2.7 cm^{-3}, 485 km/s), 3 nT Parker, Crustal field at midnight

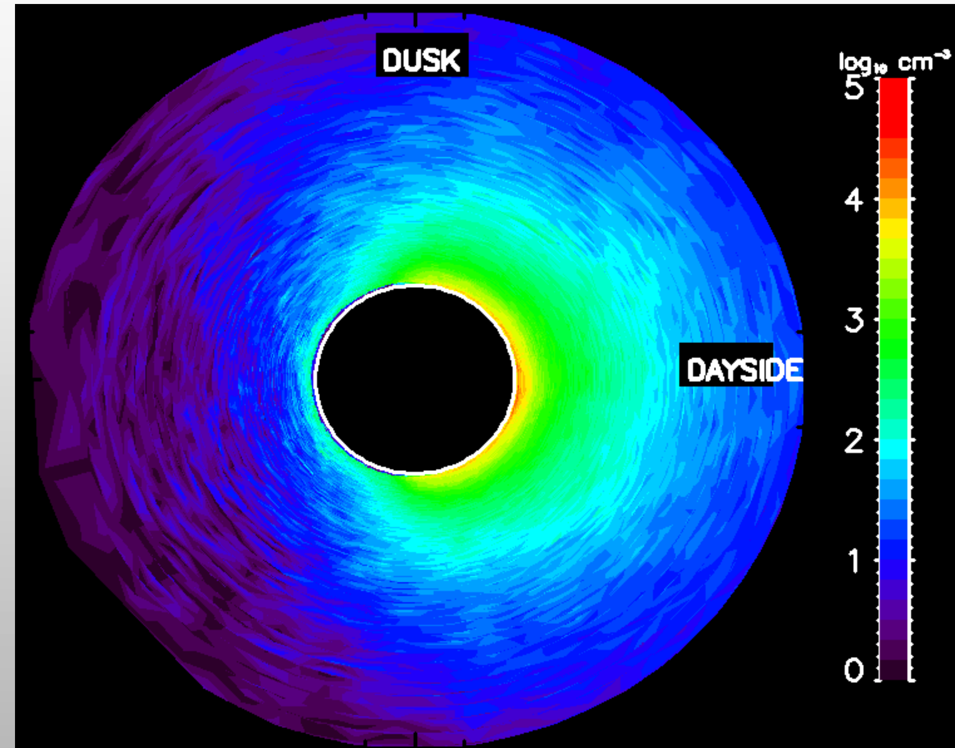
Ls=90° - Northern summer, Solar Mean

SW (20 cm^{-3}, 1000 km/s), 20 nT (By only)

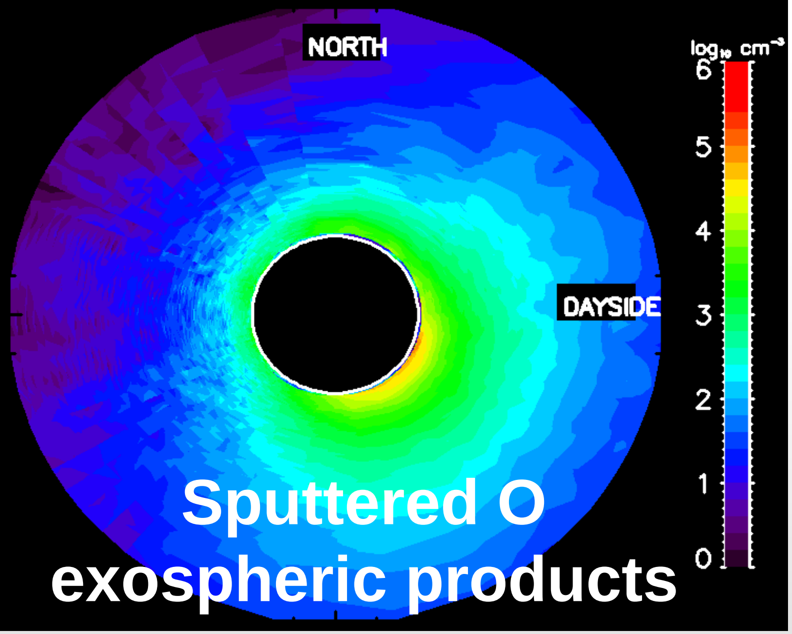
Crustal field at noon

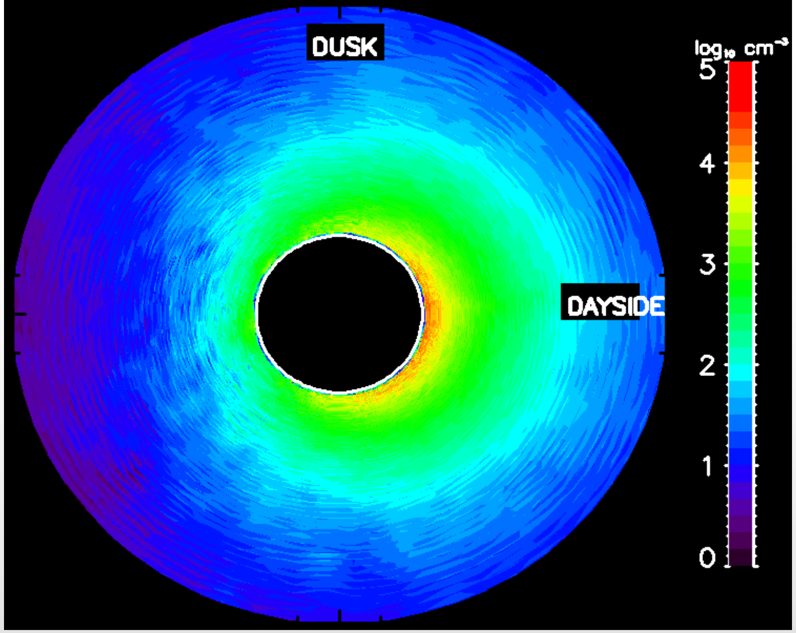
Dissociative recombination O exospheric products



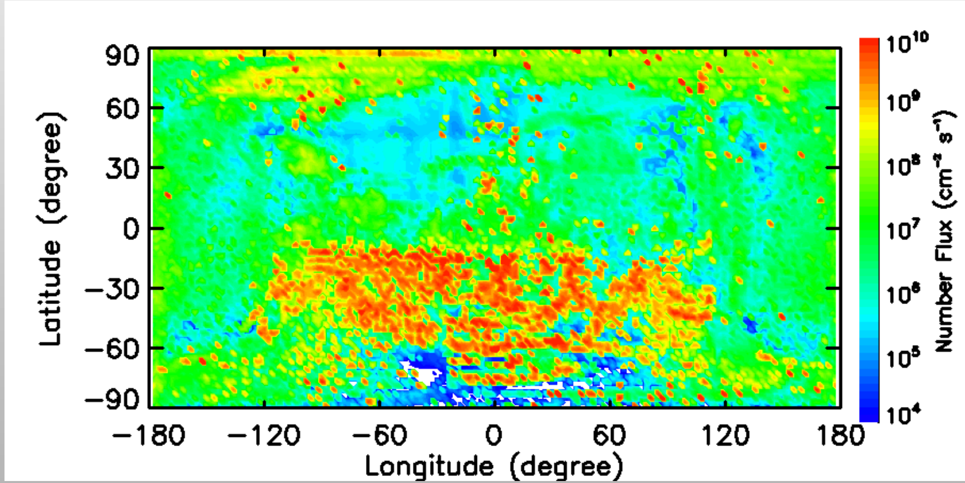


Ls = 90°- Northern summer, Solar Mean

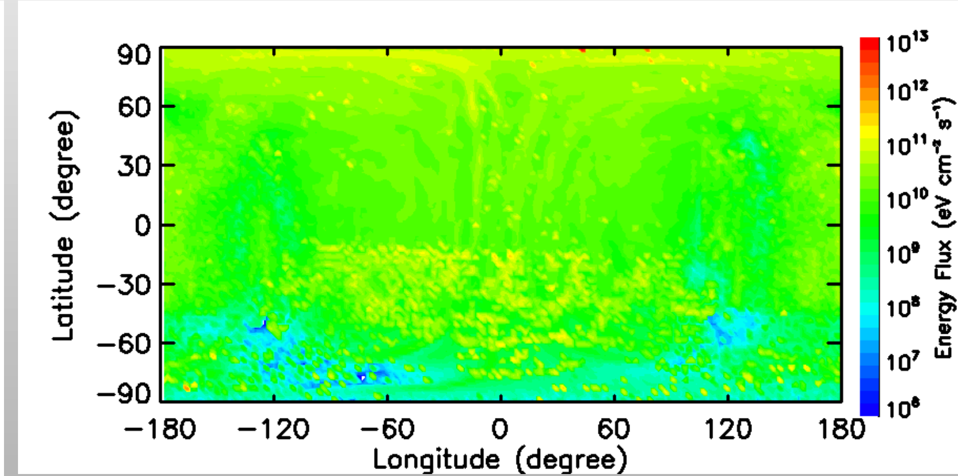




Sputtered O exospheric products



TOTAL: 8.4E+26 s^{-1}

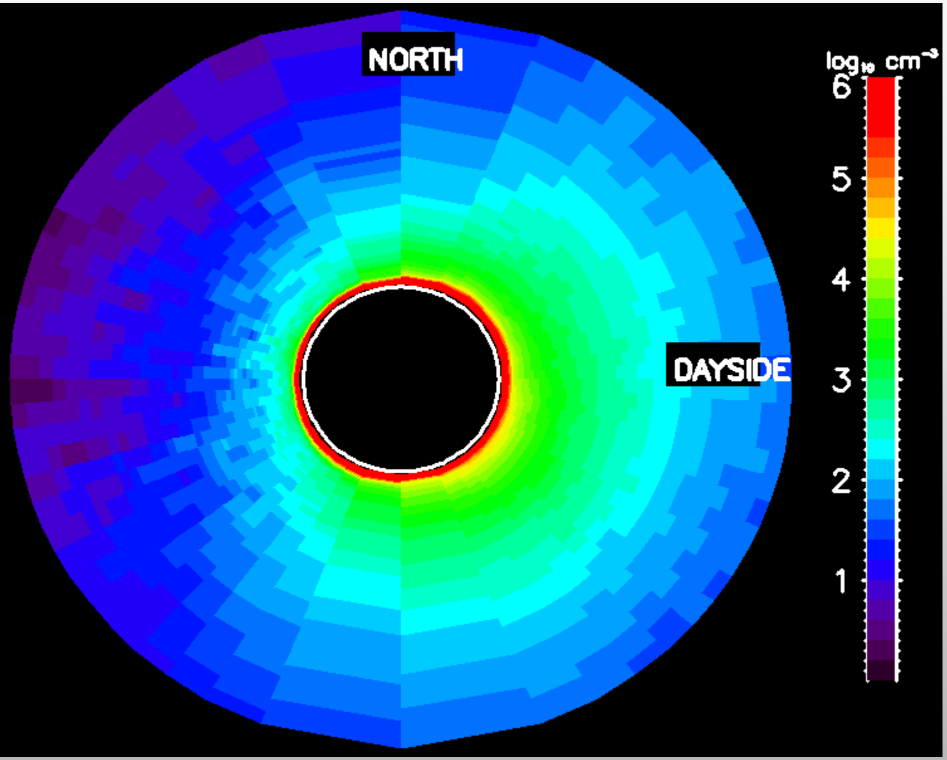


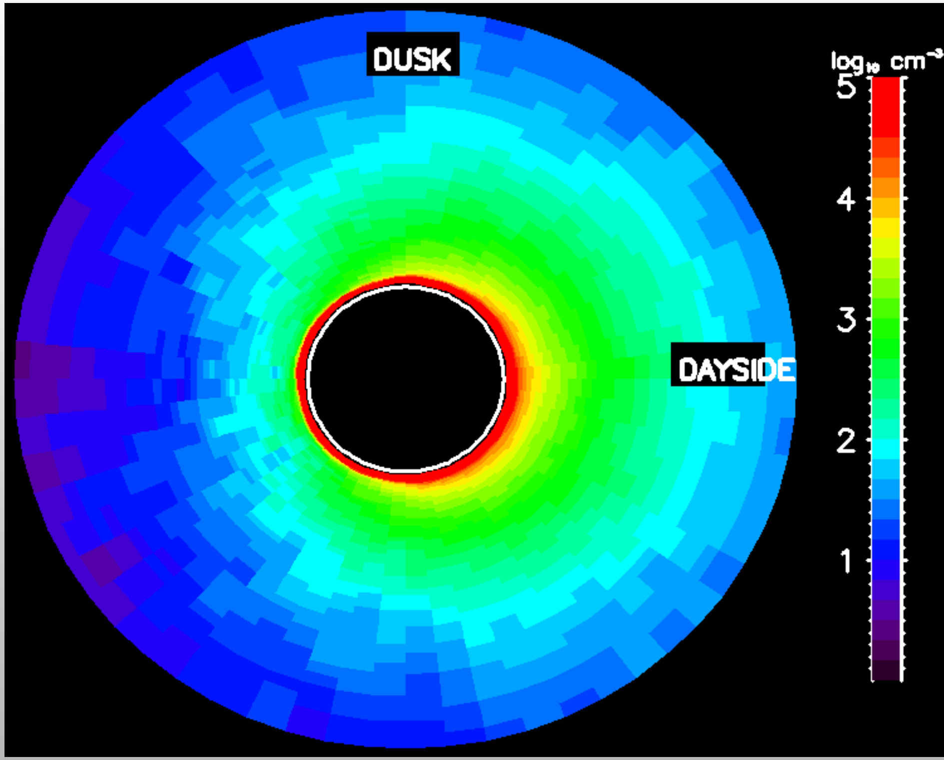
TOTAL: 3.2E+28 eV s^{-1}

Ls=90° , Northern summer, Solar Mean

SW (20 cm^{-3}, 1000 km/s), 20 nT (By only) Crustal field at noon

O DR + SP + Thermal components





Ls=90°, Northern summer, Solar Mean

SW (20 cm^{-3}, 1000 km/s), 20 nT (By only) Crustal field at noon

Exospheric description
IV Conclusion

Towards a 3D Multi-species model

- 3D model of RD and sputtering coupled with GCM and hybrid models DONE
- Model of molecular dynamic model simulating collisions between CO_2/CO_2, CO_2/O-C, CO_2/CO, CO/O-C, CO/CO and O/O-C DONE
- Parallellisation DONE
- Validation ON-GOING
- Library of exospheric simulations IN PROGRESS