

# Magnetospheric compressions, magnetopause shadowing and the last-closed-drift-shell

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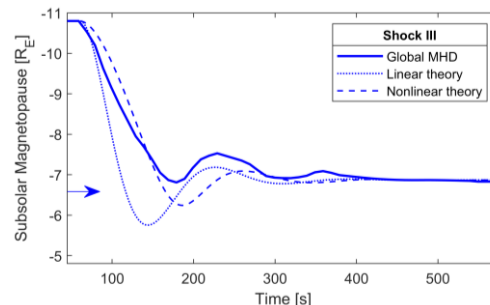
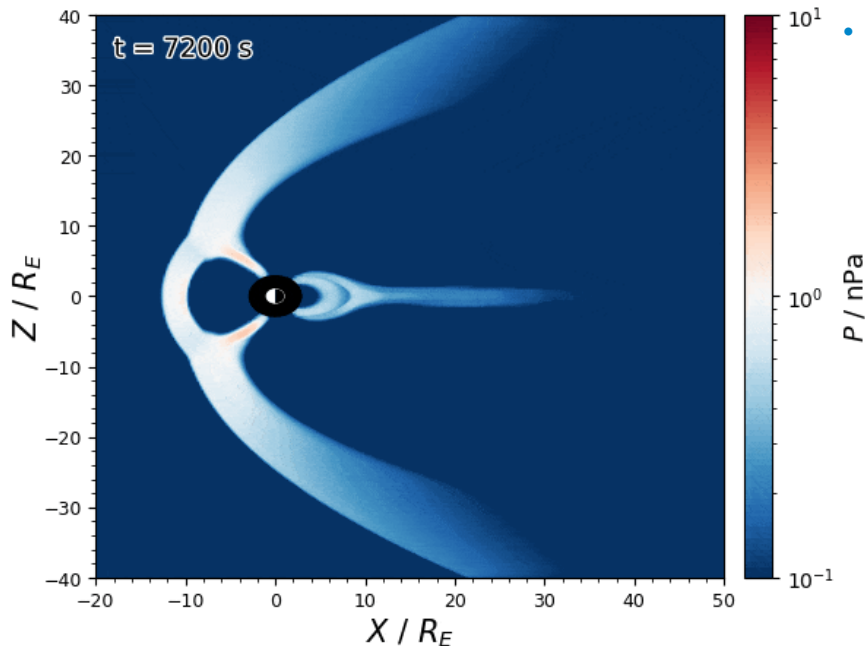
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# Shock-induced magnetopause motion

- We model large-scale compressions and oscillations using Gorgon global MHD model
- Results agree with theoretical predictions & observations following large IP shocks of 1972 and 1991 (Cahill+ 1997)



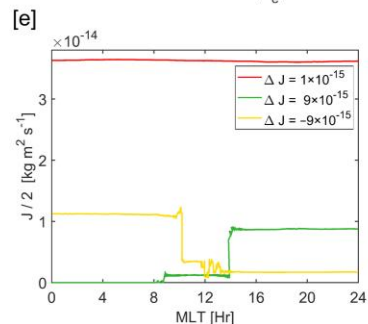
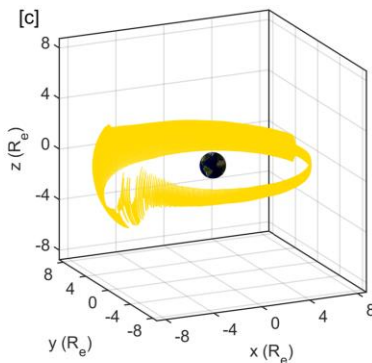
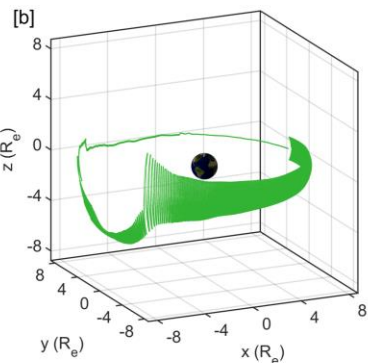
$$\frac{d^2 R}{dt^2} + \frac{s}{cR_\infty} \left[ \left( u_\infty + \frac{dR}{dt} \right)^2 - u_\infty^2 \left( \frac{R_\infty}{R} \right)^2 \right] = 0.$$

Linearising Equation 3 by substituting  $R(t) = R_\infty + r(t)$ , assuming  $r \ll R_\infty$ ,

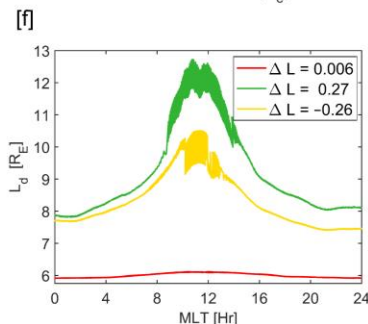
$$\frac{d^2 r}{dt^2} + \left( \frac{2}{K\tau} \right) \frac{dr}{dt} + \left( \frac{6}{K\tau^2} \right) r = 0$$

# Integrated Van Allen Radiation Belt model

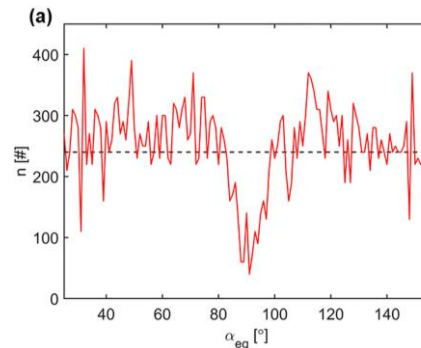
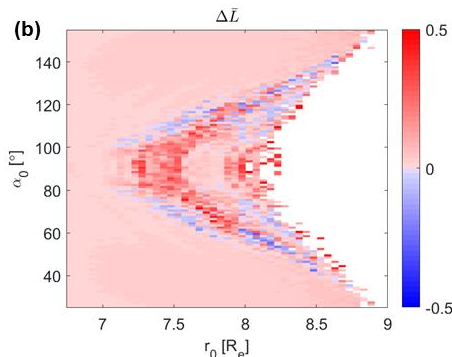
Solar  
Wind



Bifurcating orbit #1



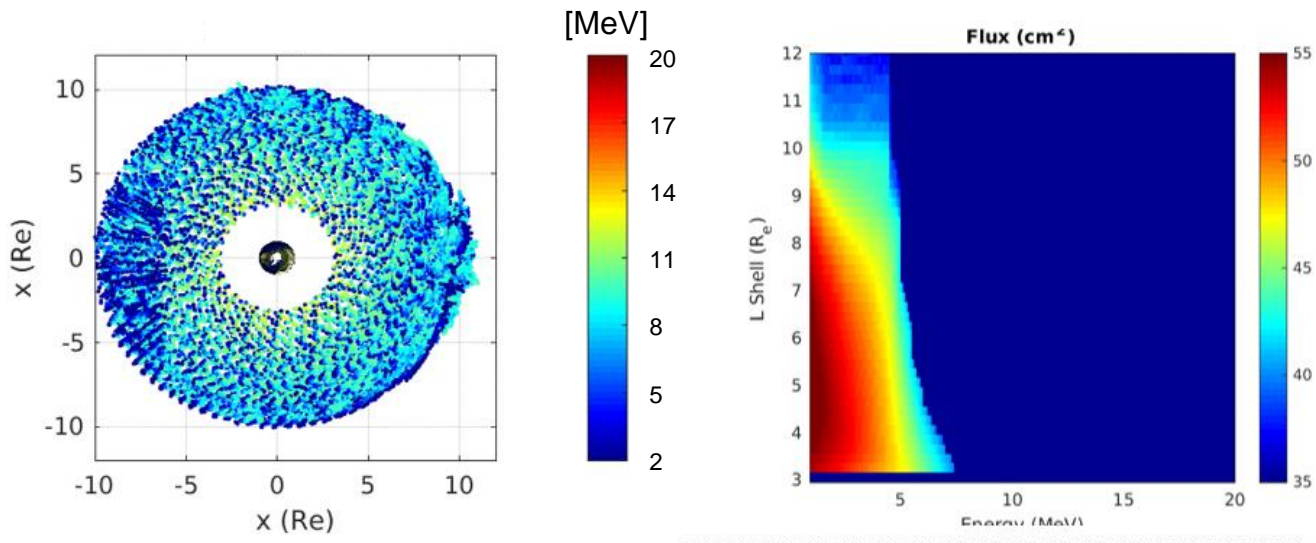
Bifurcating orbit #2



- Convective electric field has significant impact on long-term transport and magnetopause losses
- DOBs / Shabansky orbits produce butterfly pitch angle distributions in the night sector

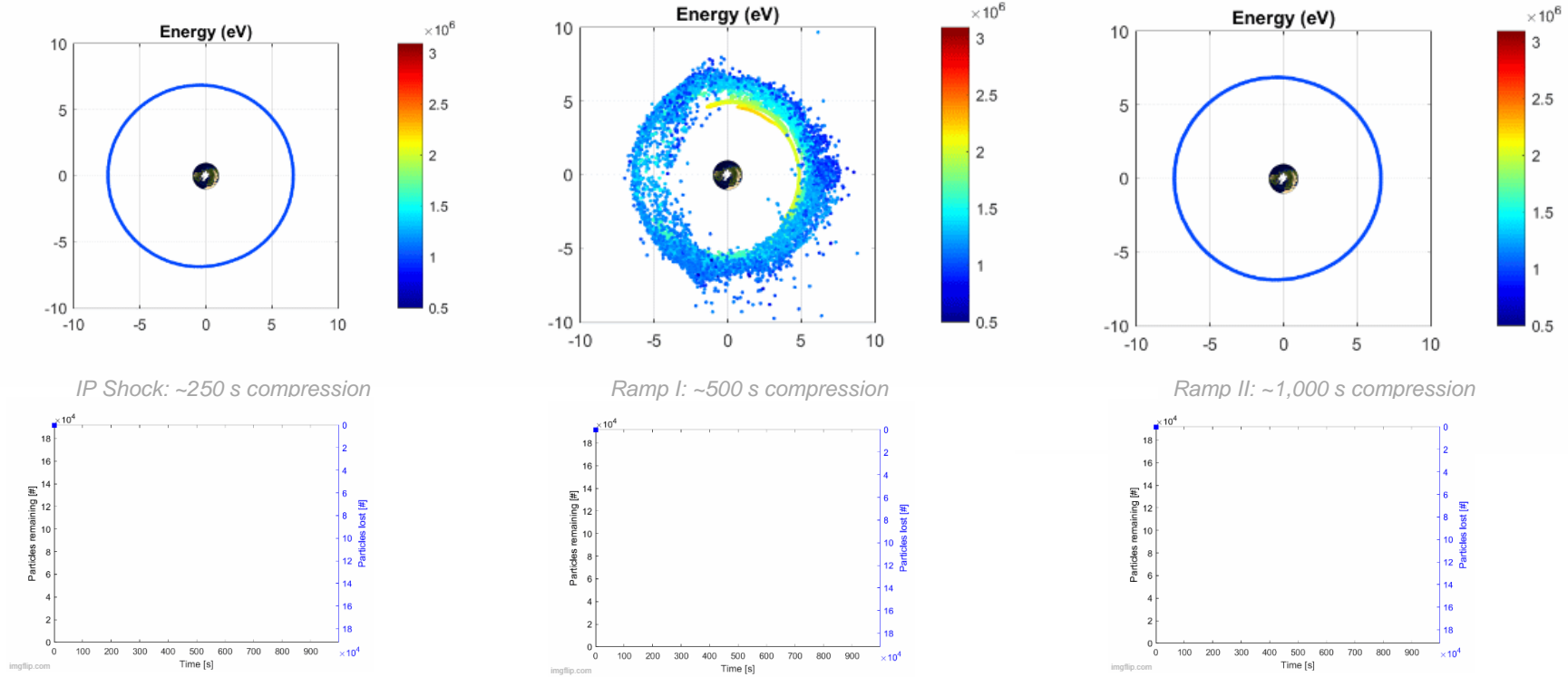
# Shock-Induced Acceleration

- NASA AE8 electron radiation belt distribution initialised in evolving MHD fields



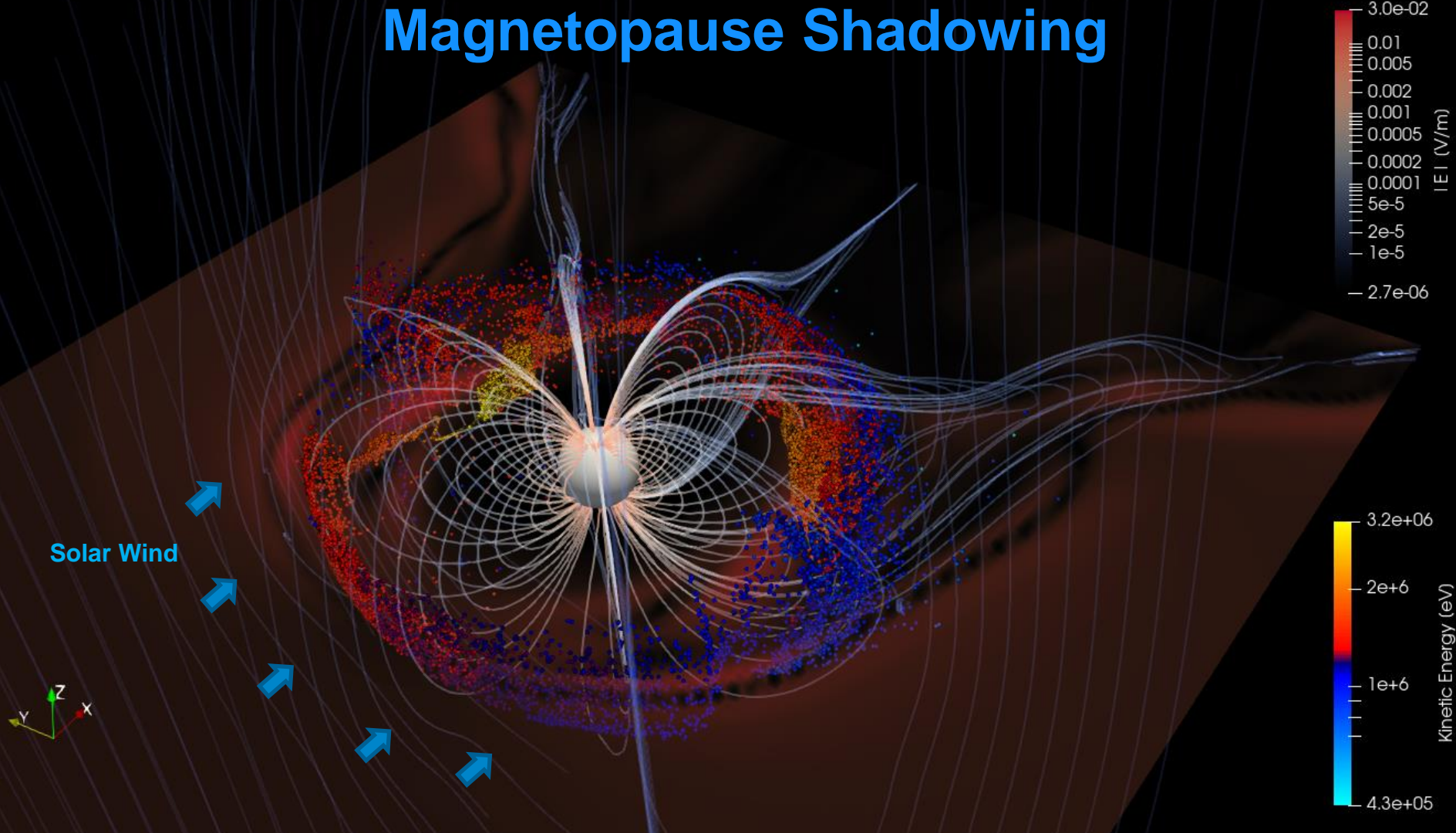
*Full coverage over MLT, Pitch  
angle and Energy*

# Magnetopause shadowing



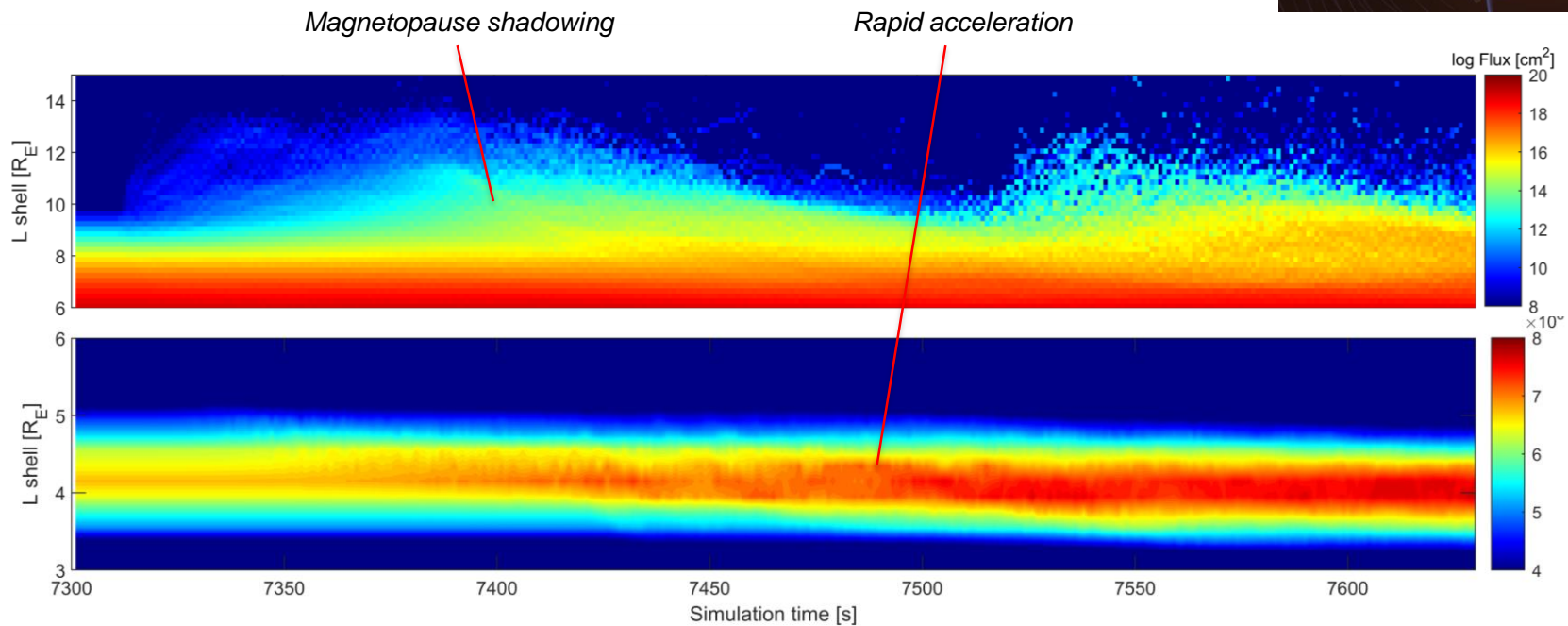
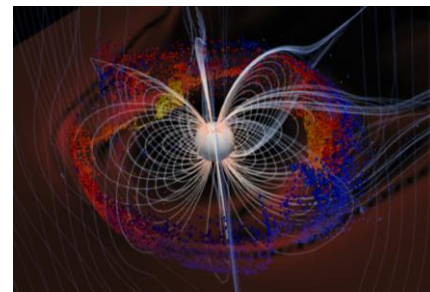
- How fast does the magnetopause have to move for particles to be lost? What is the influence of the electric field?
- We implement an  $L^*=6.9$  delta function at  $90^\circ$  pitch angle, reaches  $L=7.405$  on the dayside

# Magnetopause Shadowing





# Shadowing vs Acceleration



# Conclusions

- **Global-MHD simulations** can capture the dynamic evolution of the global magnetosphere such as large-scale oscillations and magnetopause compressions [Desai et al., 2021a]
  - ...but assumes thermal equilibrium
- **Integrated Particle simulations** are able to capture radiation belt dynamics [Desai et al., 2021b]
  - We used this capability to model acceleration and loss during rapid compressions
  - Immediate losses appear to be dependent on magnetopause speed
  - Analysis of longer term losses ongoing and comparisons to *Olifer et al. (2021)*

*Thank you for listening/viewing*