

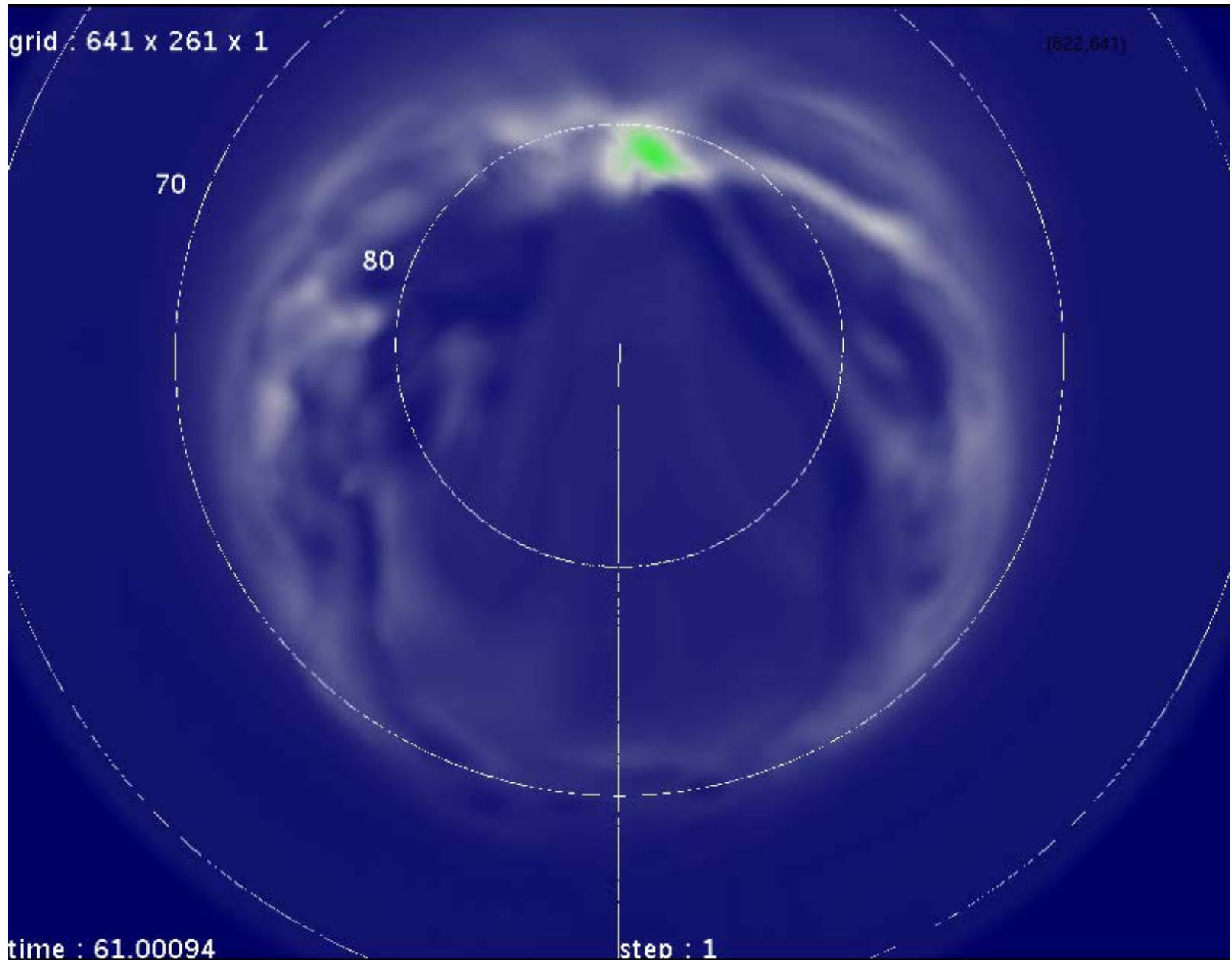
Super DARN 研究集会
2015.9.14、名古屋大学

最近のシミュレーション研究によって得られた
サブストームの描像

九州大学名誉教授
Emeritus Professor, Kyushu University

田中高史
T. Tanaka

Development of auroral substorm

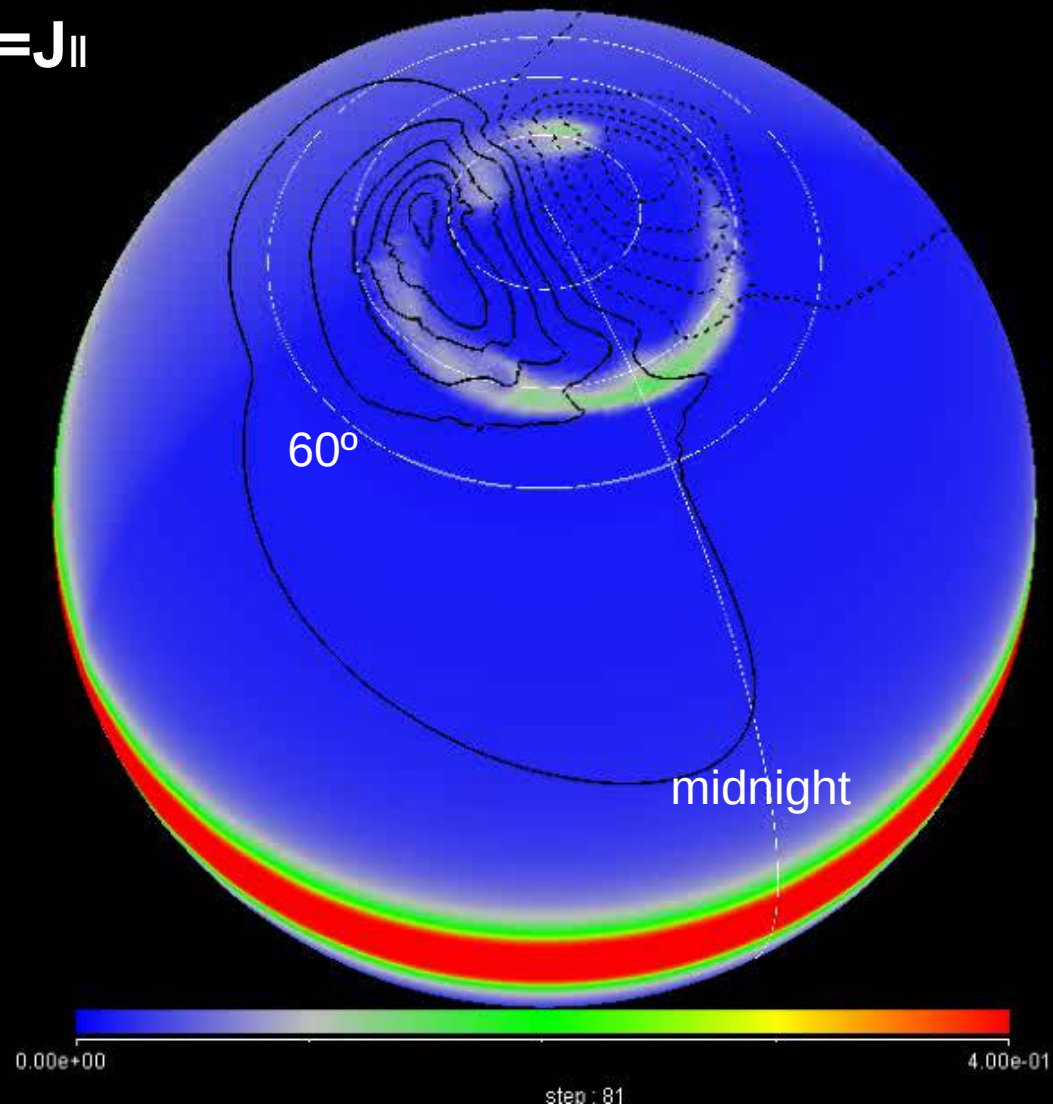


development of ionospheric convection

(shading: Σ_{xx} , solid contour: negative, dotted contour: positive potential)

(1362, 672)

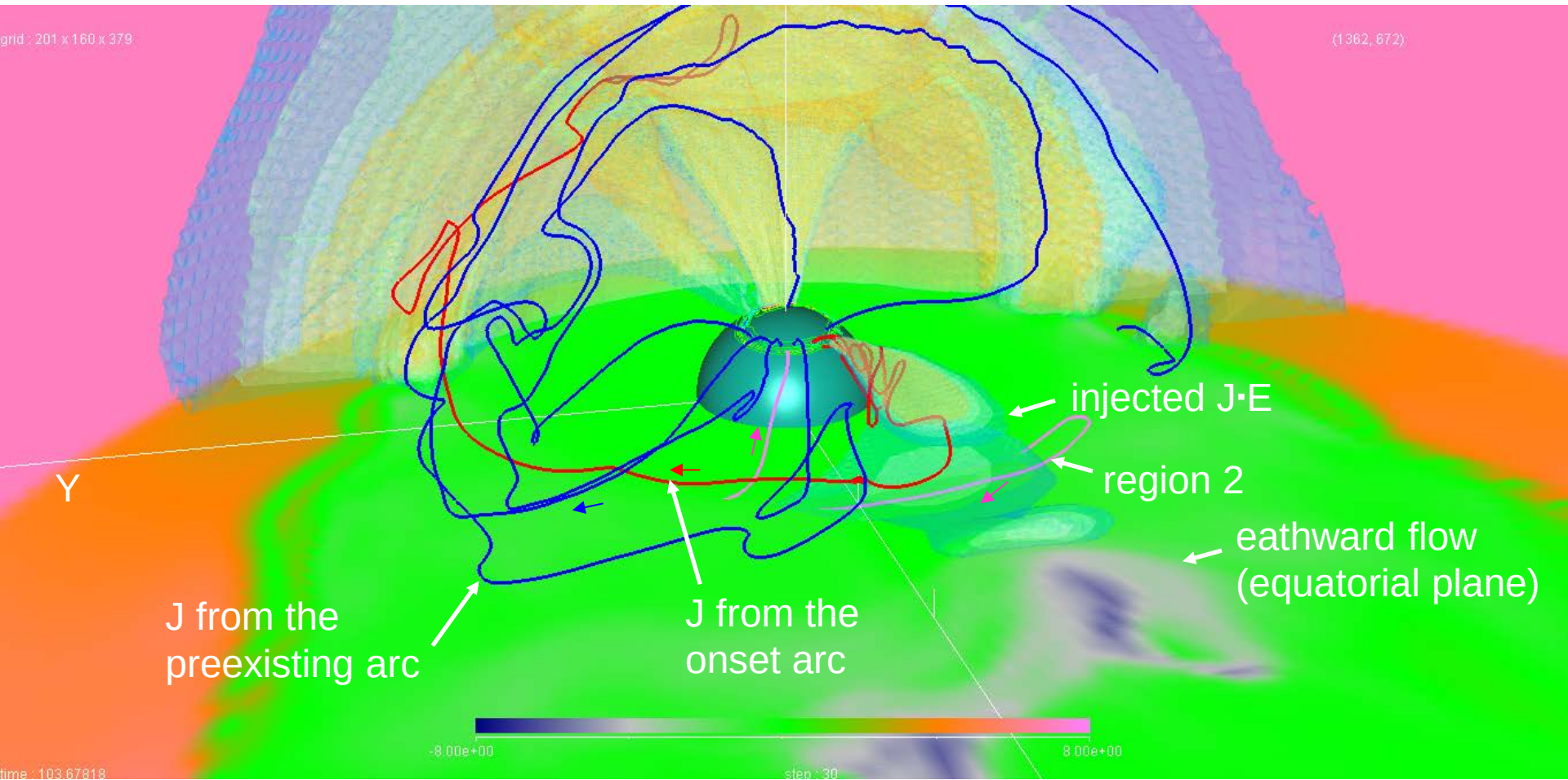
$$\text{div} \Sigma \text{grad} \phi = J_{\parallel}$$



login/nagoya/data6i.nict4

Formation of the near-earth dynamo at the onset

(shading: V_x , red lines: from onset arc, blue lines: from preexisting arc)

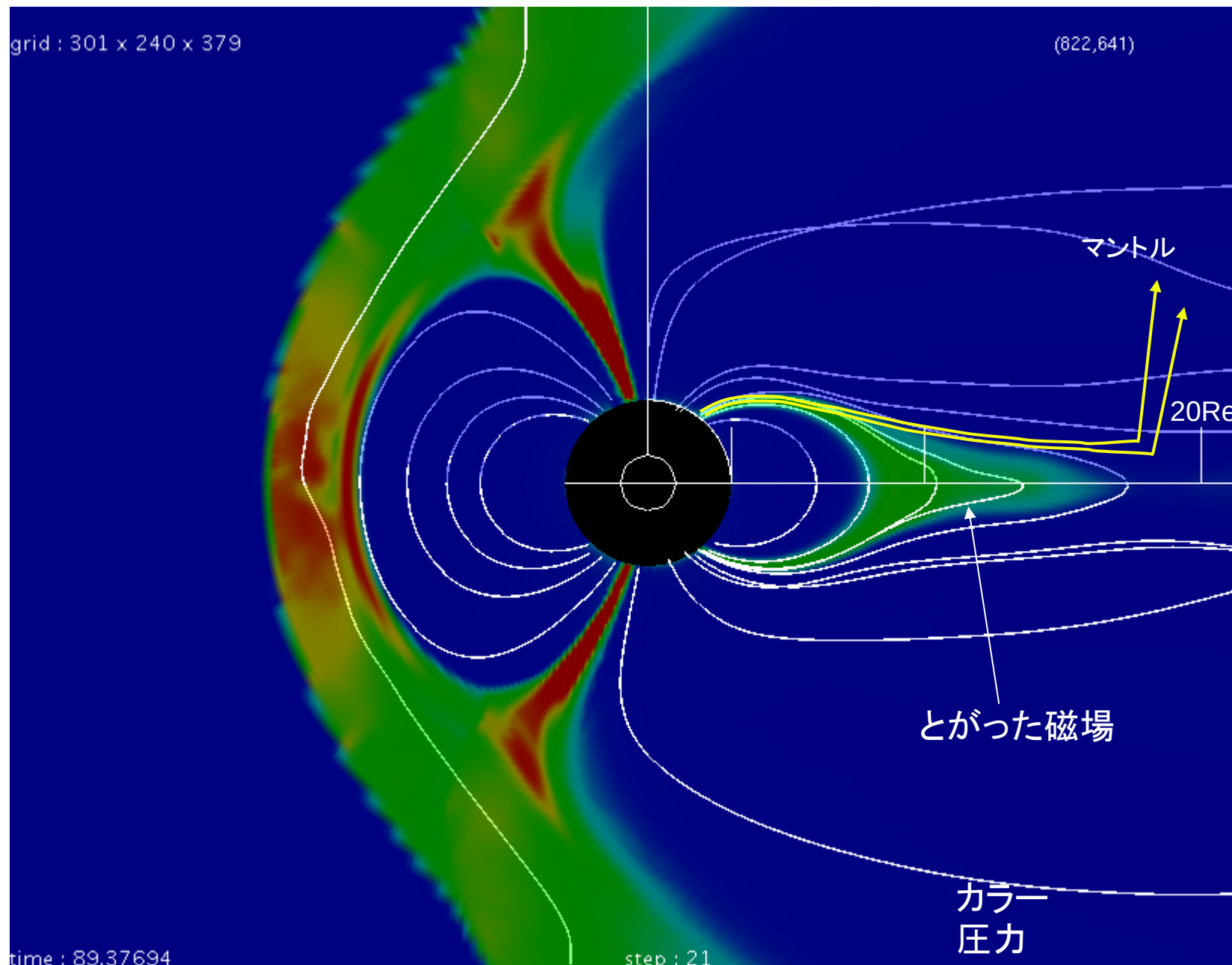


t=0min

HD/nicts/data5js.s30, hist.10.m5j30d

grid : 301 x 240 x 379

(822,641)

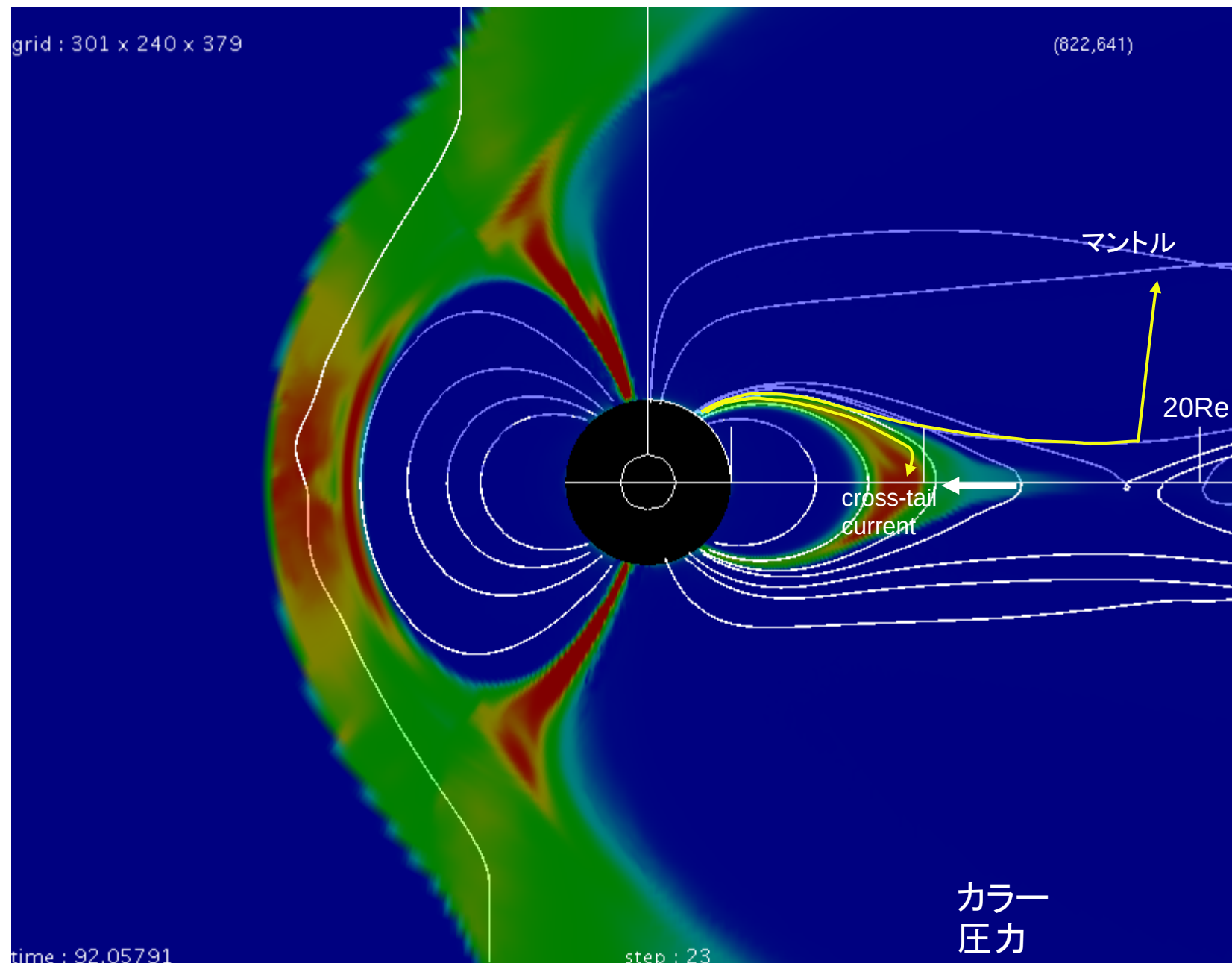


time : 89.37694

step : 21

grid : 301 x 240 x 379

(822,641)



grid : 301 x 240 x 379

(822,641)

膨らんだ磁場

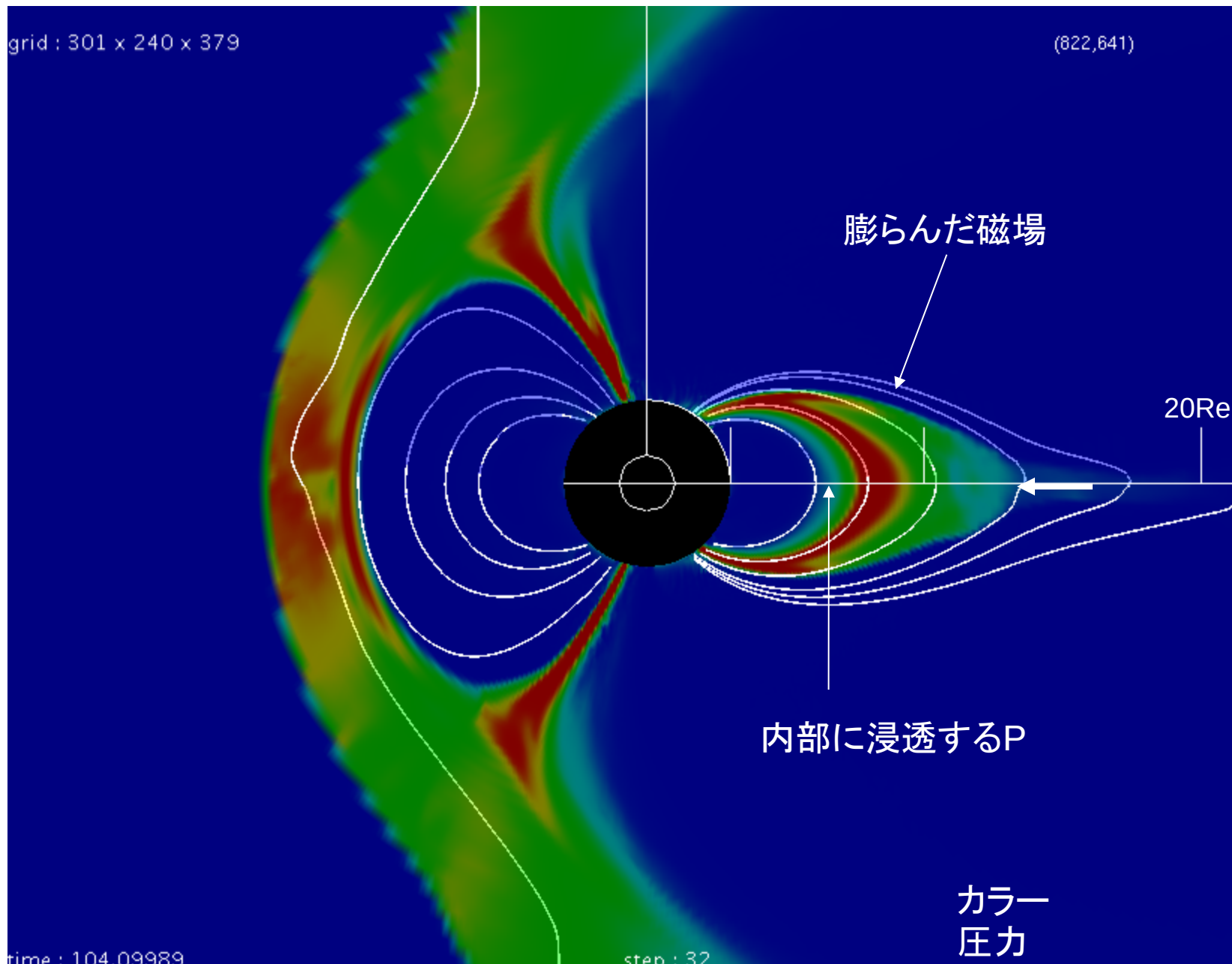
20Re

内部に浸透するP

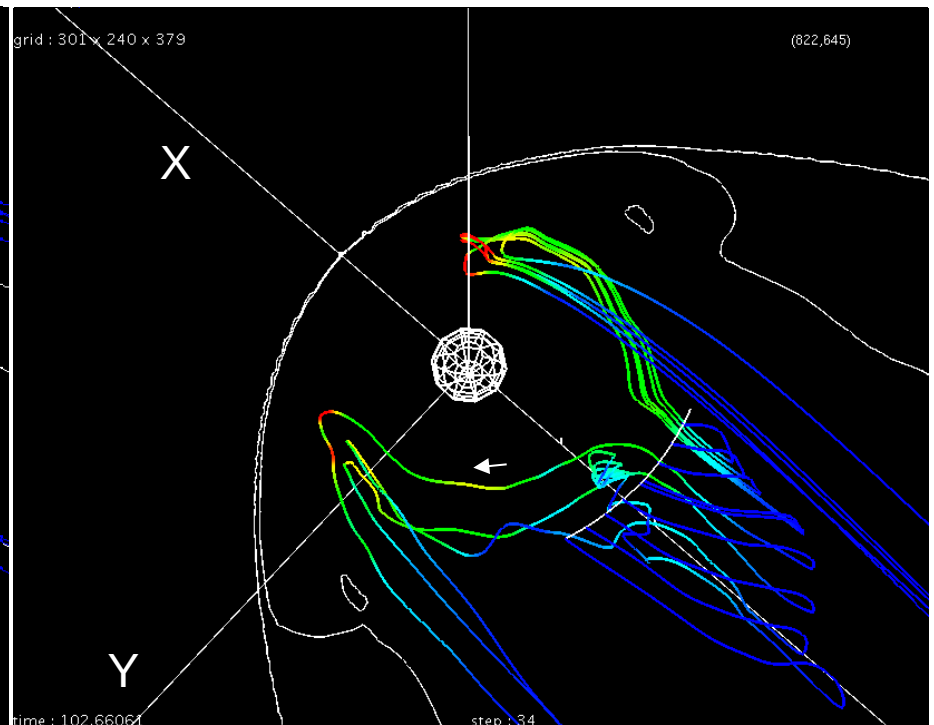
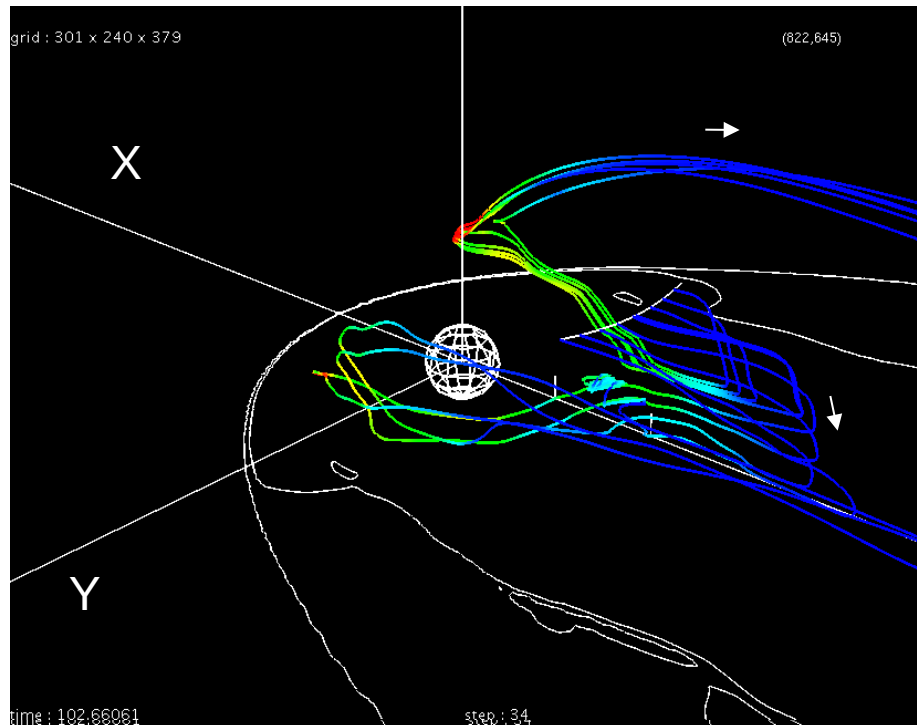
カラー
圧力

time : 104.09989

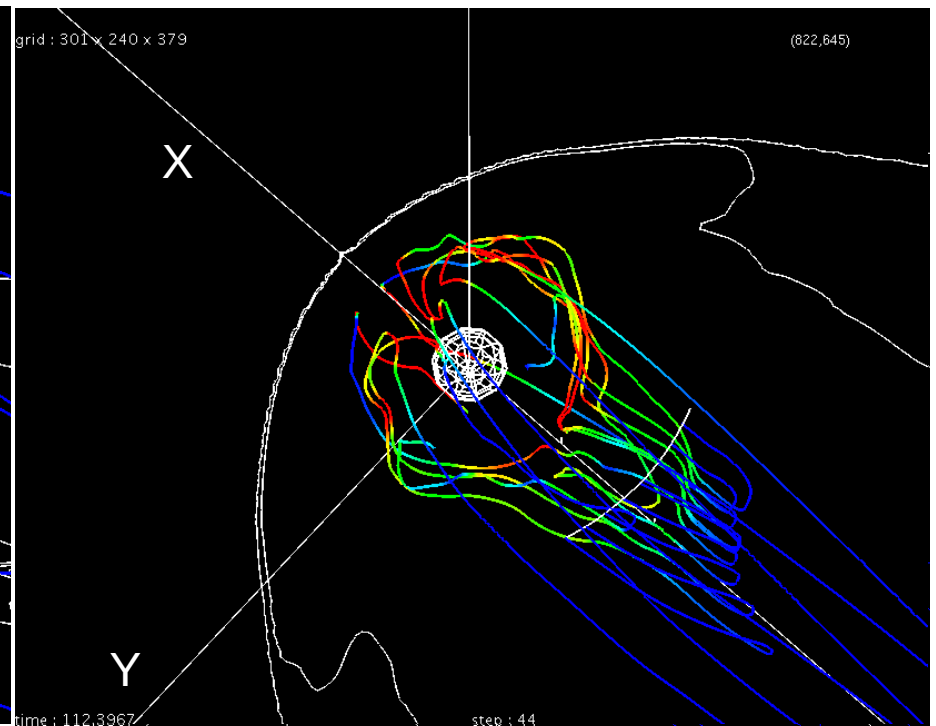
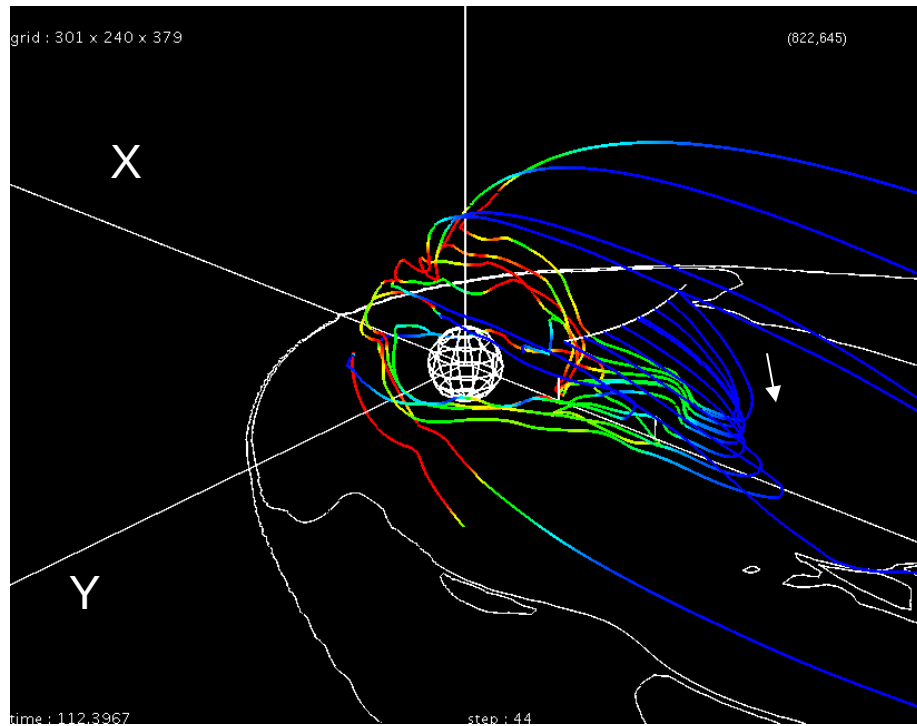
step : 32



Growth phase convection



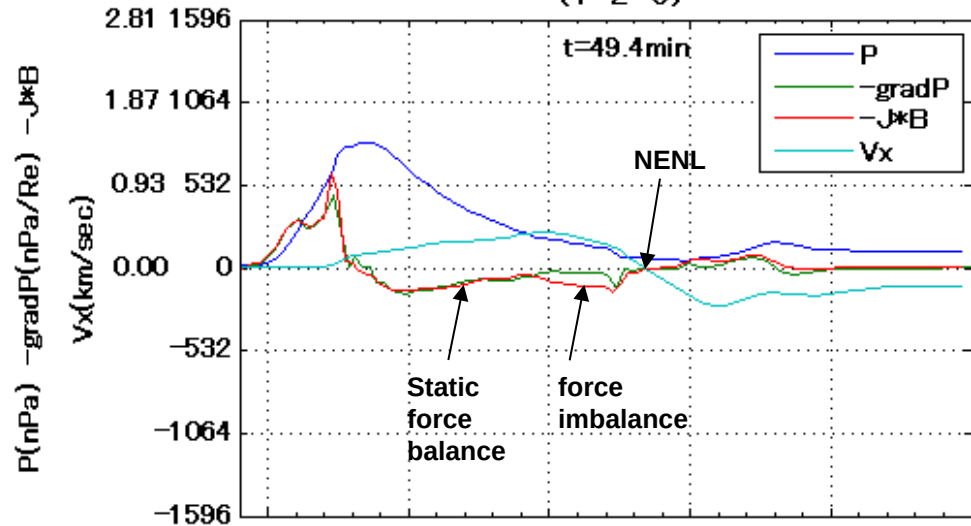
Expansion phase convection



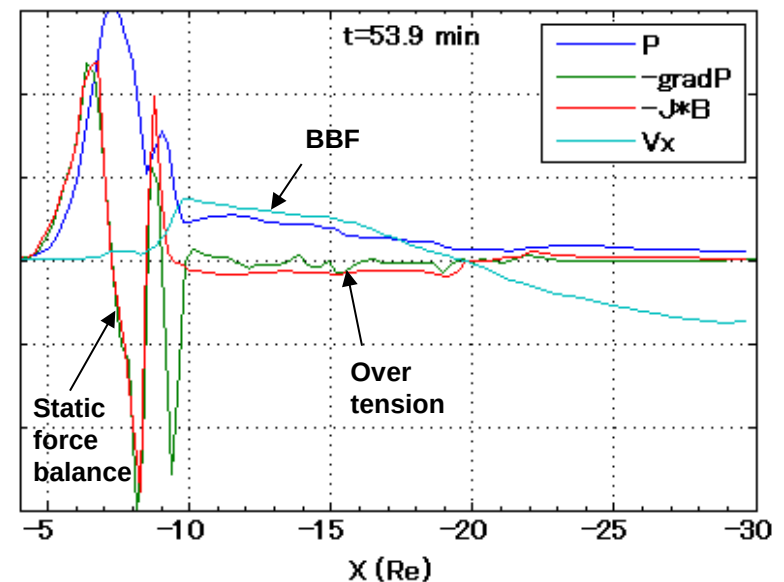
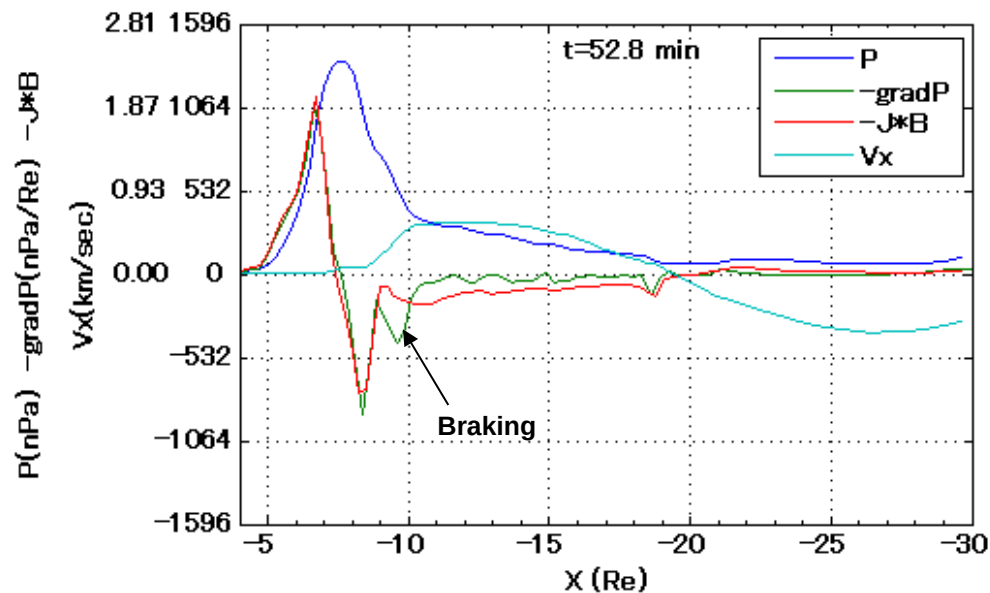
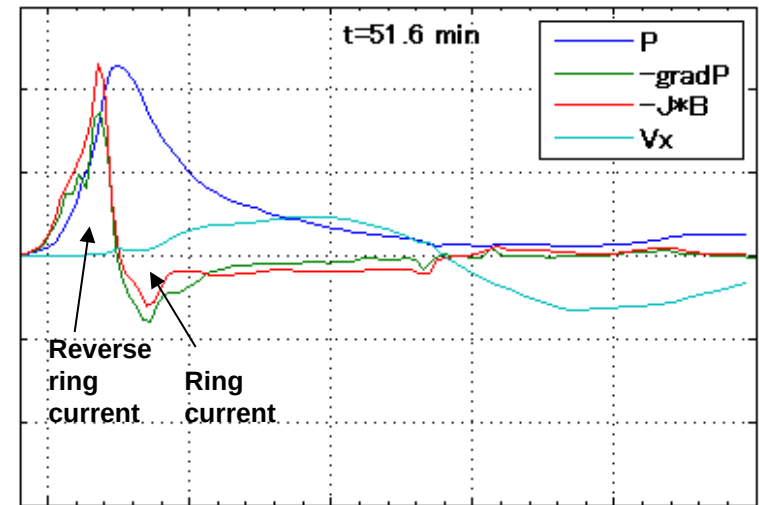
Self-organization of the plasma sheet at the onset

(force balance)

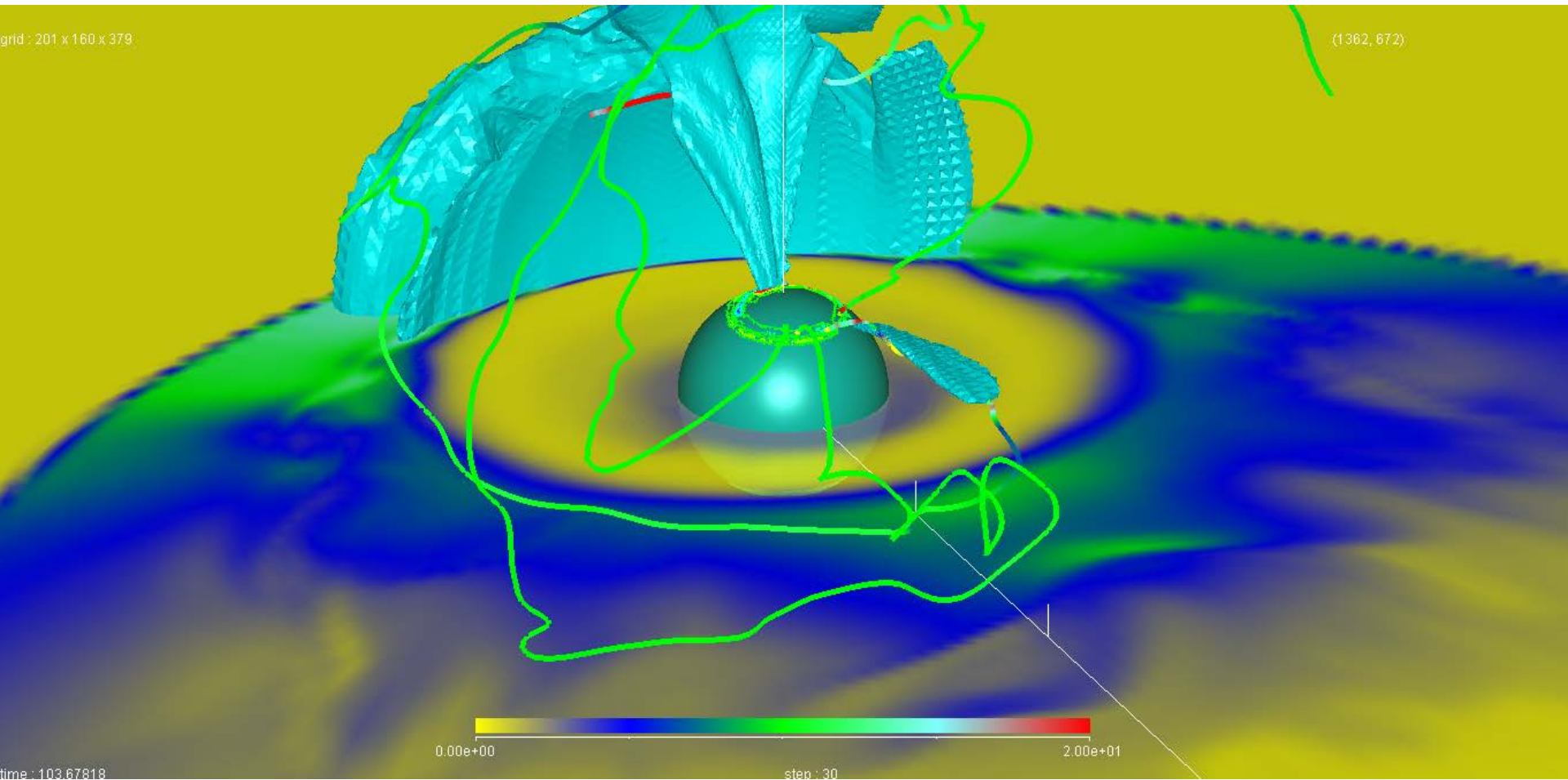
Change of force balance at the onset
($Y=Z=0$)



Change of force balance at the onset
($Y=Z=0$)



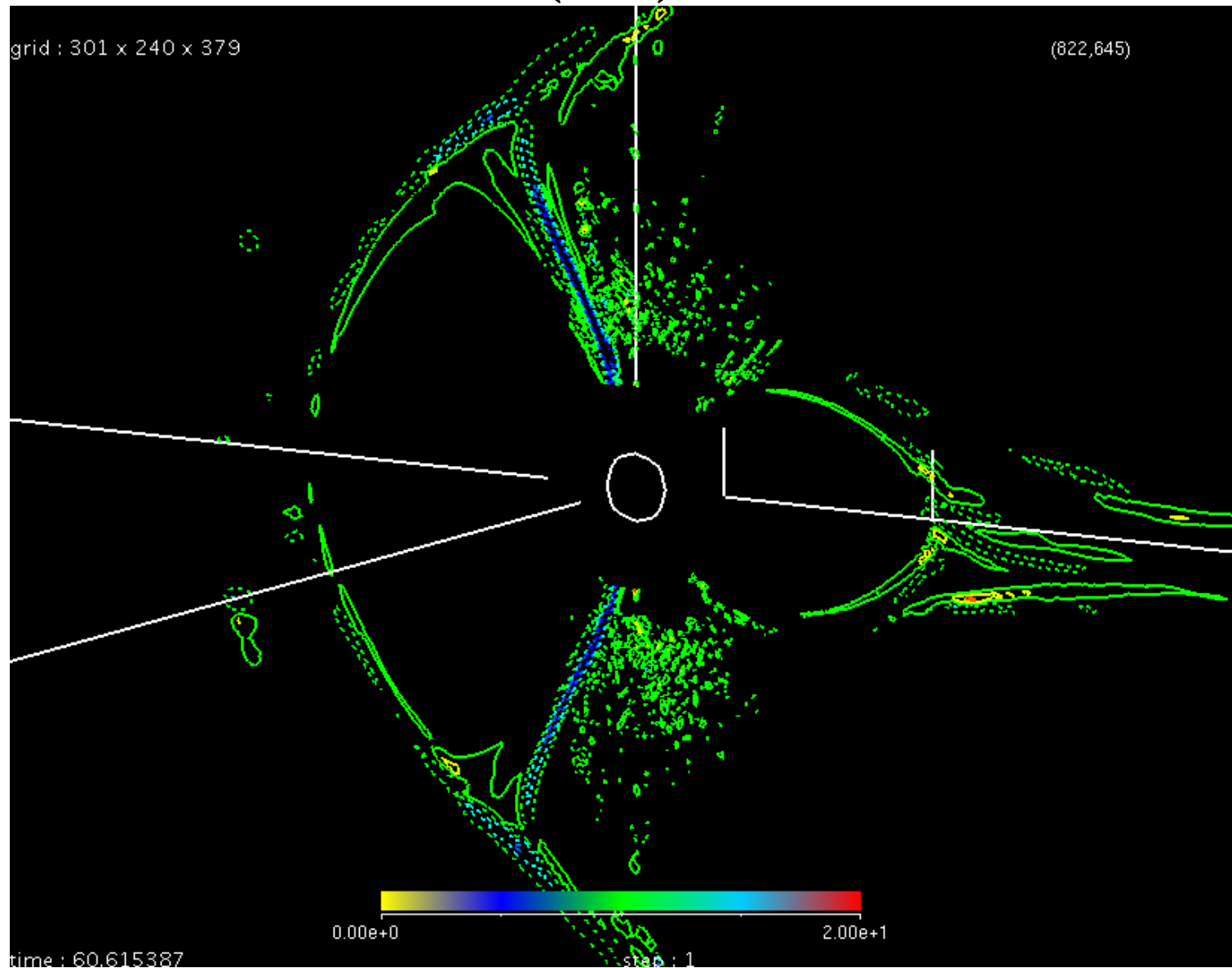
Current lines extending from the onset arc
(shading: P in the equatorial plane, contour surface: P, lines: B)



login/nicts/data5js.s30, hist.10.v5s6s30

Flow vortex x-component

$(\text{rot}V)_x$

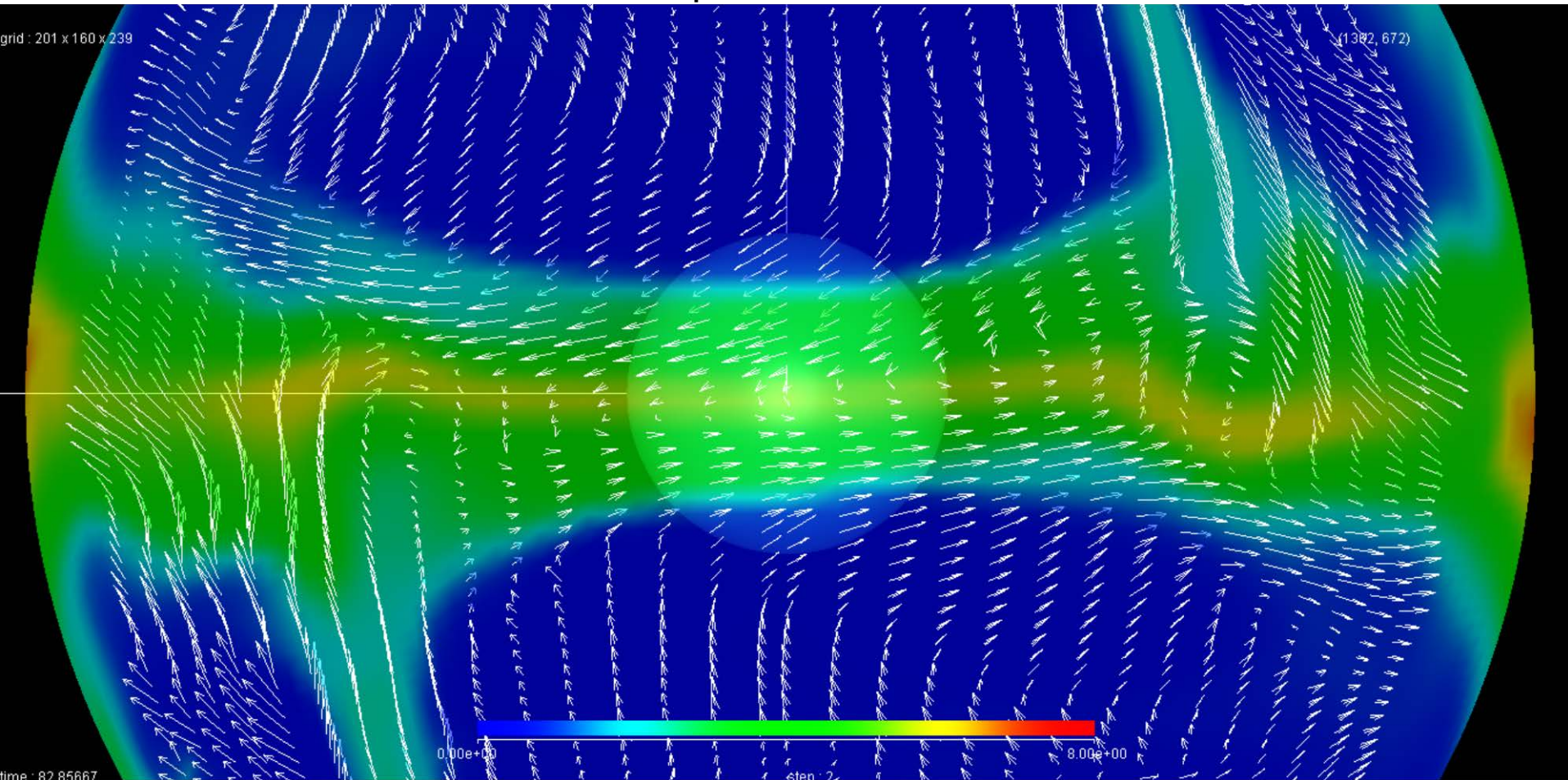


login/nicts4

Flow shear at the lobe-plasma sheet boundary

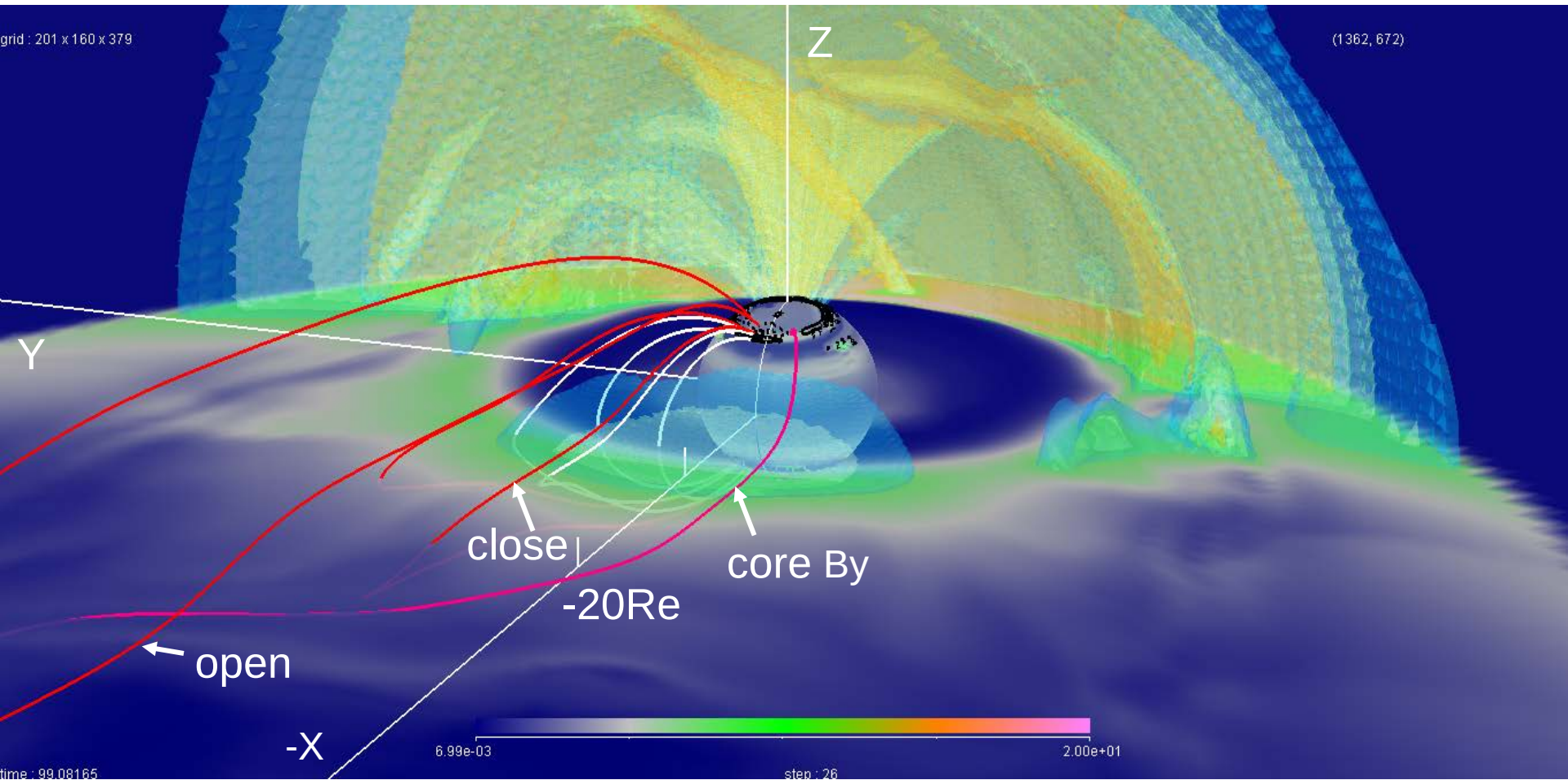
(shading; P, arrows; V_y - V_z at $X = -18 \text{ Re}$)

YZ plane, $X = -18 \text{ Re}$



dynamo and shear
 $X = -18 \text{ Re}$, nict2/data5i, hist. $10.10 v^{13}$

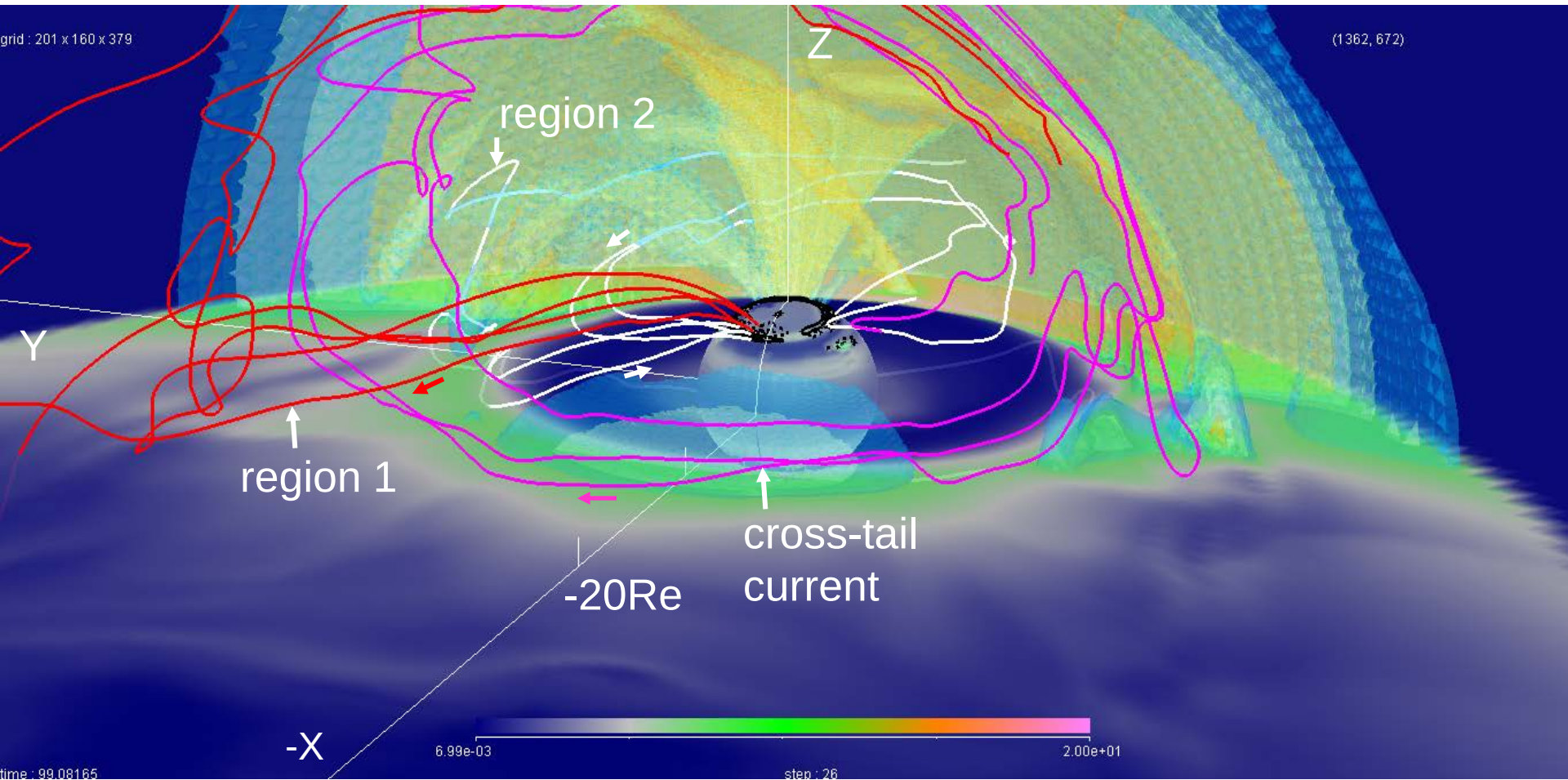
Magnetic field lines extending from the growth phase arc (shading: P, red lines: from region 1, white lines: from region 2)



t=-8min

HD/nicts/data5is.s26, hist.10.m5i26db

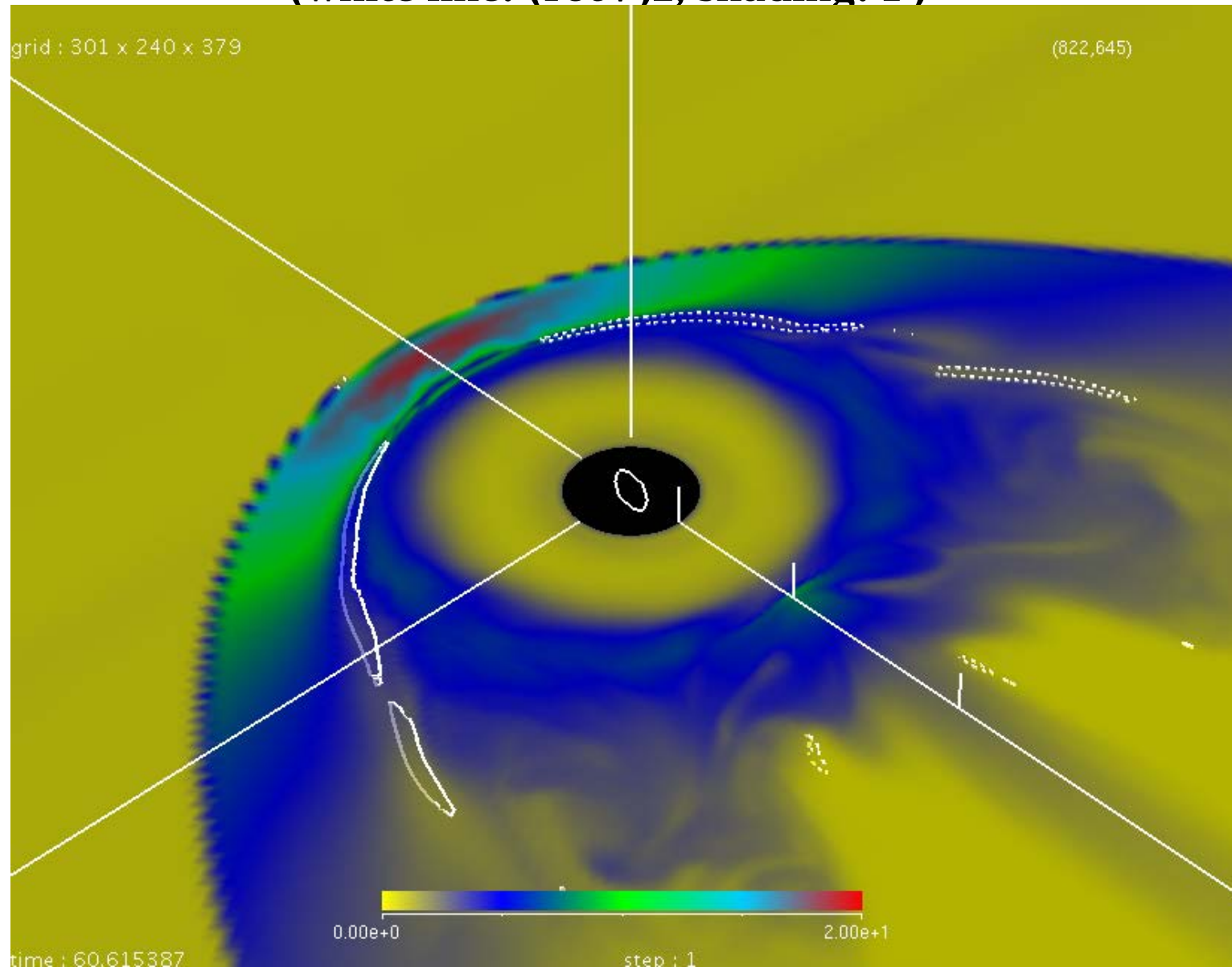
Current lines extending from the growth phase arc (shading: P, red lines: from region 1, white lines: from region 2)



$t = -8\text{min}$

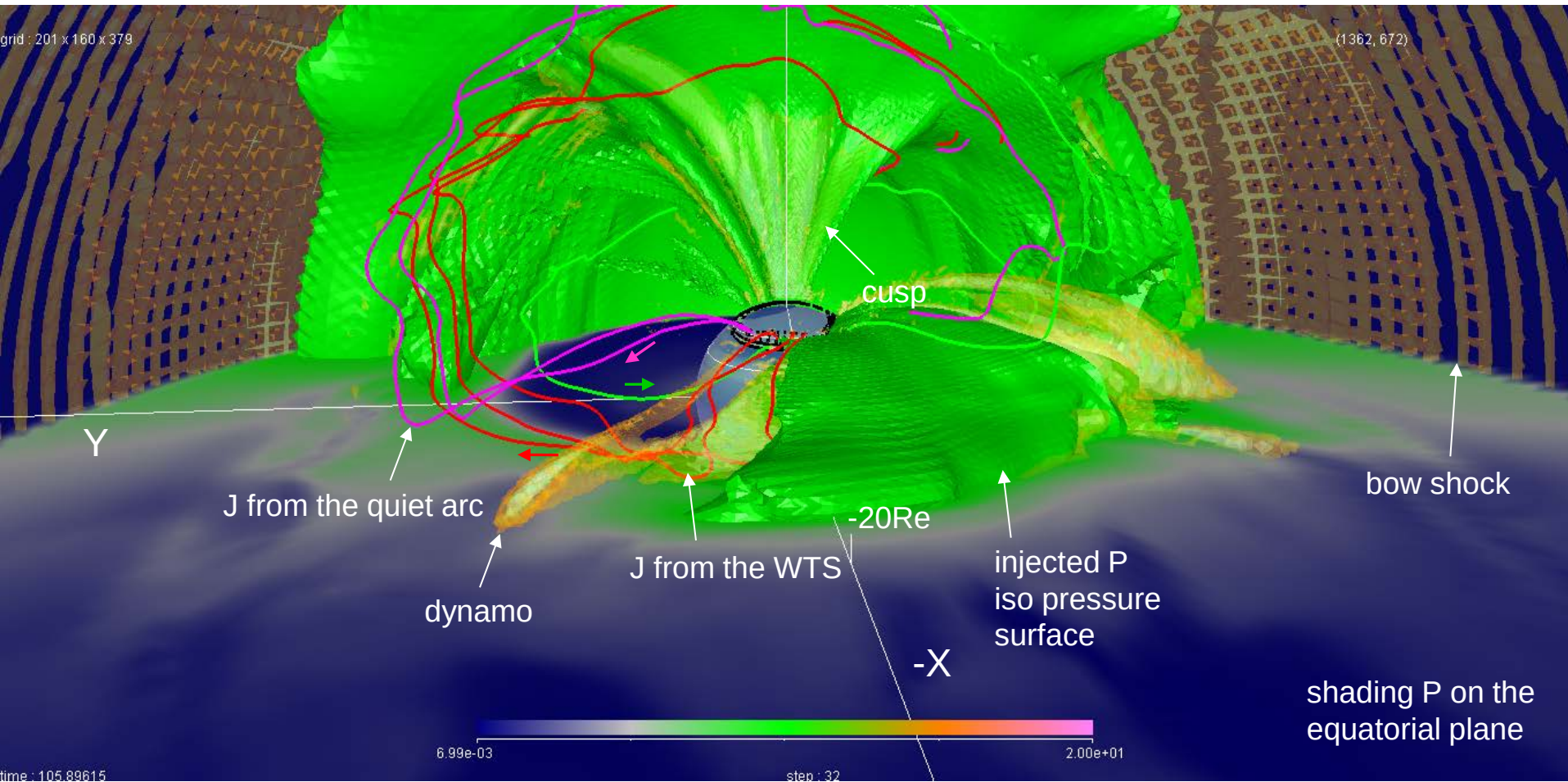
HD/nicts/data5js.s26, hist.10.m5i26dj

Flow vortex z-component (white line: $(\text{rot}V)_z$, shading: P)



Expansion phase magnetosphere

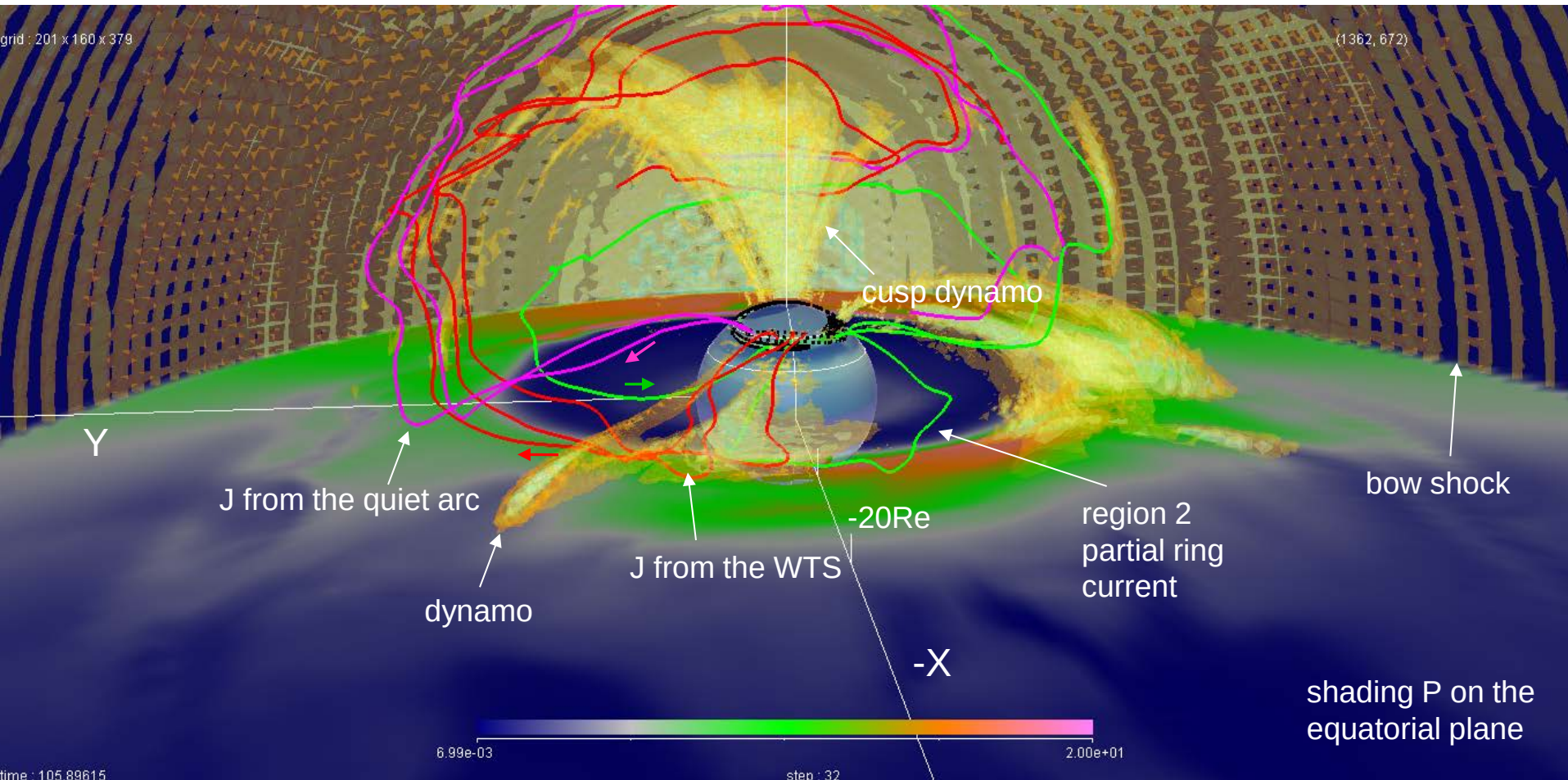
Current lines and 3D contour surface of P



t=4.8 min

Expansion phase magnetosphere

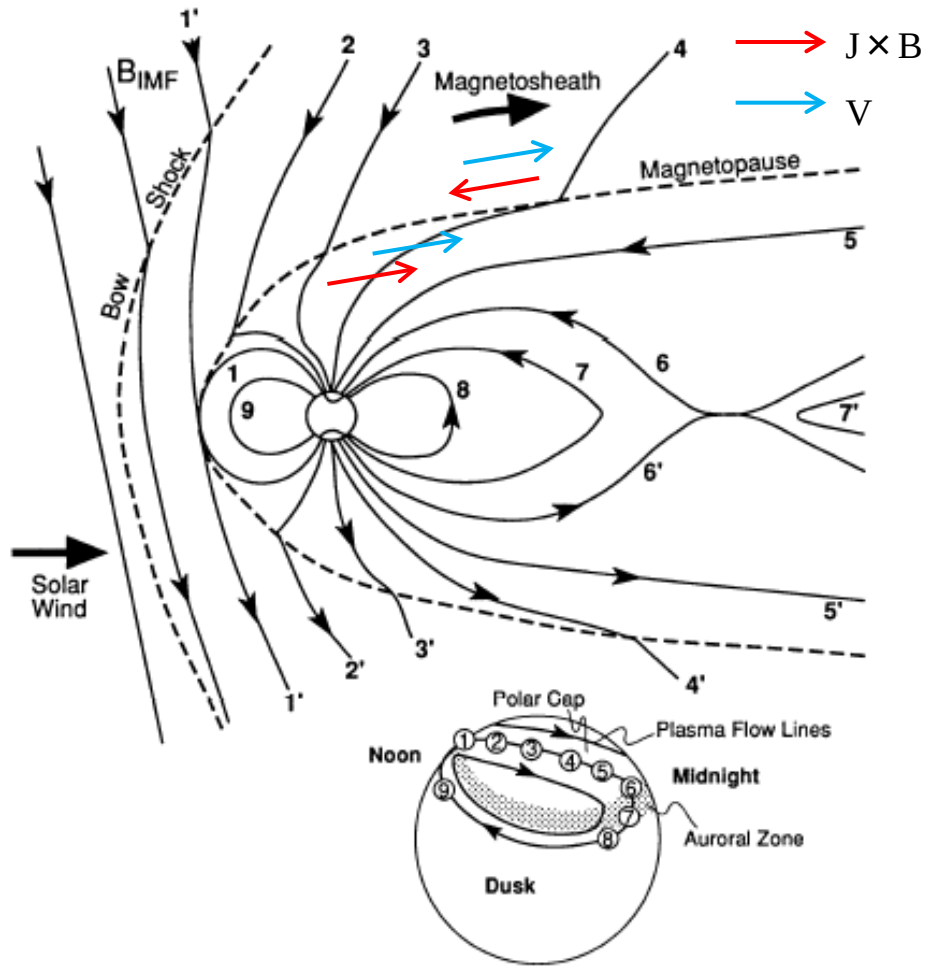
Current lines and 3D volume rendering of dynamo



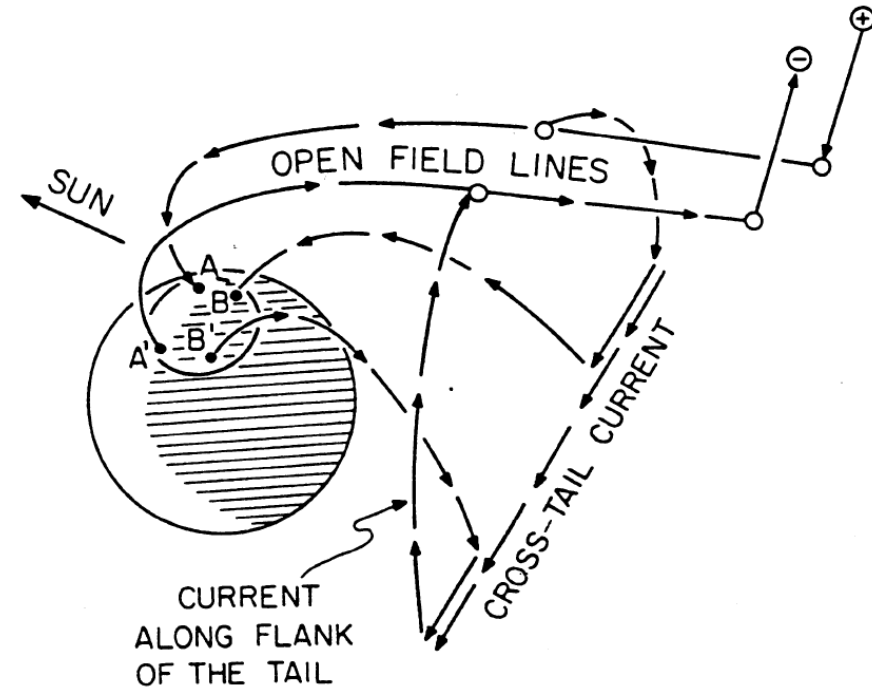
t=4.8 min

Traditional excitation of convection by the magnetic tension

(Pressure regime $\times$, force balance $\times$, dynamo $\times$)



Dungey(1961)



Stern (1983)

結論

磁気圏物理学→複合系(トポロジー科学)の全体構造

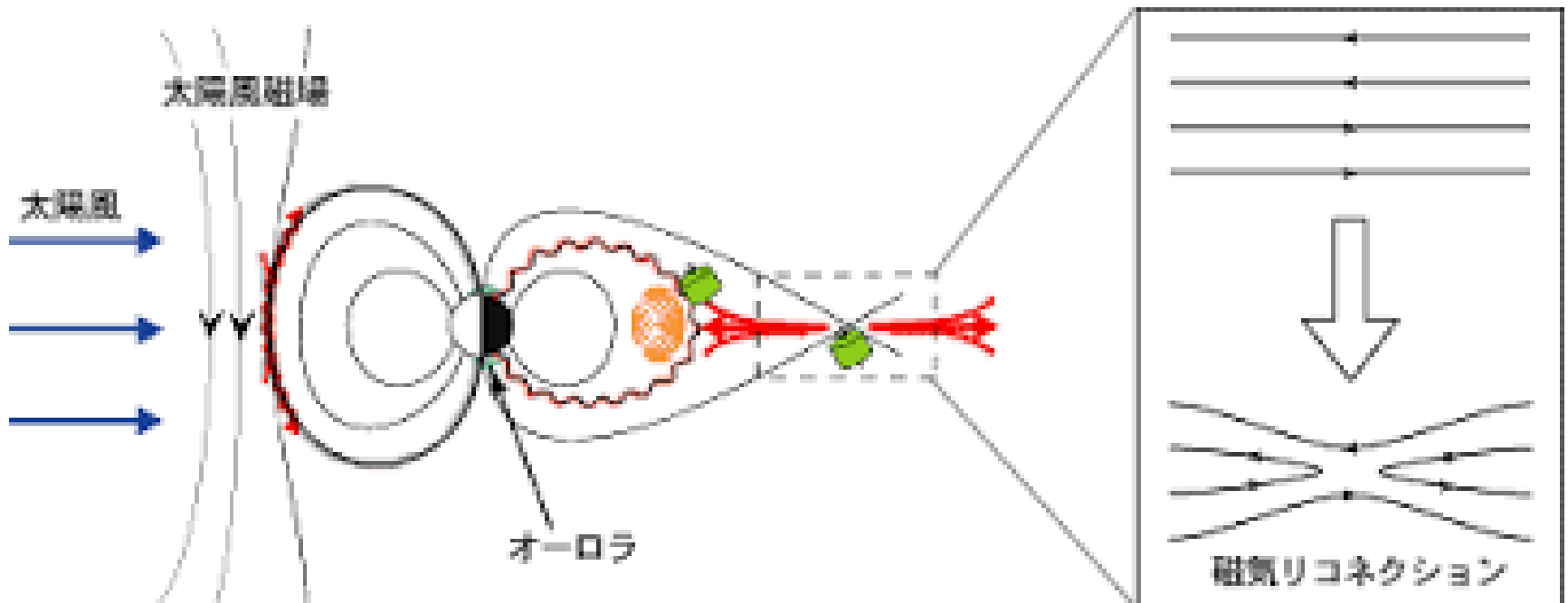
サブストーム→対流の遷移・ダイナモ・シアアの形成・FAC・多圏間結合

サブストームは異常プラズマ過程の現れ→ (=CW 誤り)

サブストームはMHDの破れ ×

サブストームは不安定現象 ×

サブストームは爆発現象 ×



simbolized structureによる説明 ×

end