Simulating EB-like events

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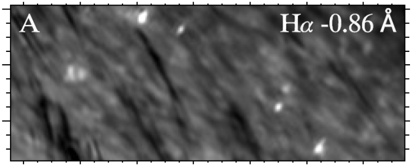
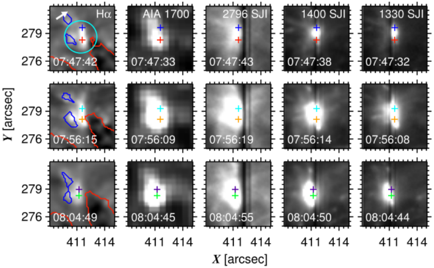
IRIS-6 meeting
June 21th, 2016

EBs - why do we care?

- peculiar signatures in different observables
  - visible in H_α and Ca II 8542 line (Watanabe et al. 2011)
  - not visible in Mg I b2 and Na I D1 lines (Rutten et al. 2015)
  - sometimes visible IRIS observables (Vissers et al. 2015)
  - CRISP does not show mixed polarity for every case (Vissers et al. 2013)
- part of a whole spectrum of phenomena that might have the same physical mechanism behind - QSEBs (Rouppe van der Voort et al. 2016) at the low and IRIS bombs at the high-energy end of this spectrum (Peter et al. 2013, Tian et al. 2016)





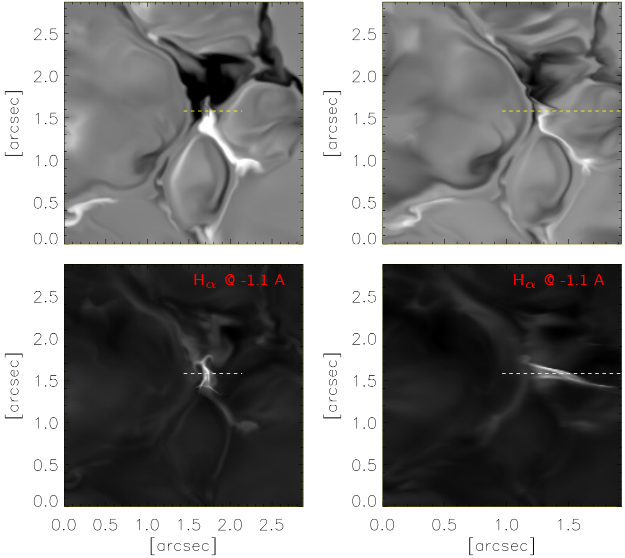
What makes an EB to become an EB?

Finding clues in MHD simulations about their:

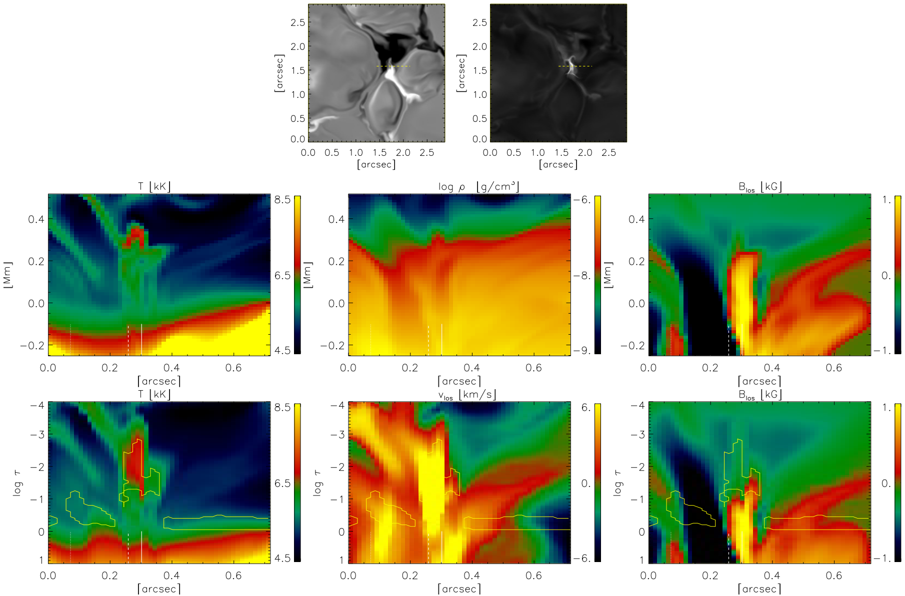
- morphology
- field topology
- evolution

An example of EB-like feature in MURaM

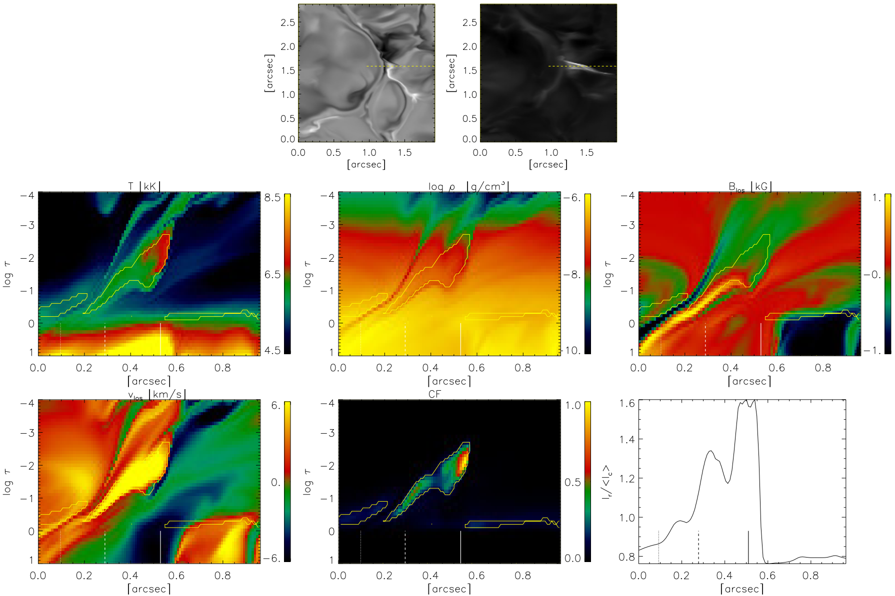
@ $\mu = 1$ and $\mu = 0.67$



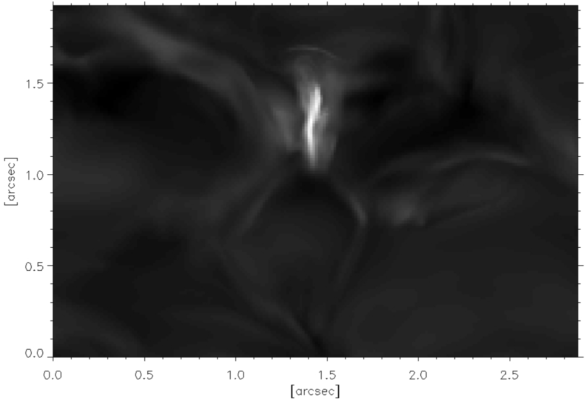
The 'event' - cut through



The 'event' - cut through



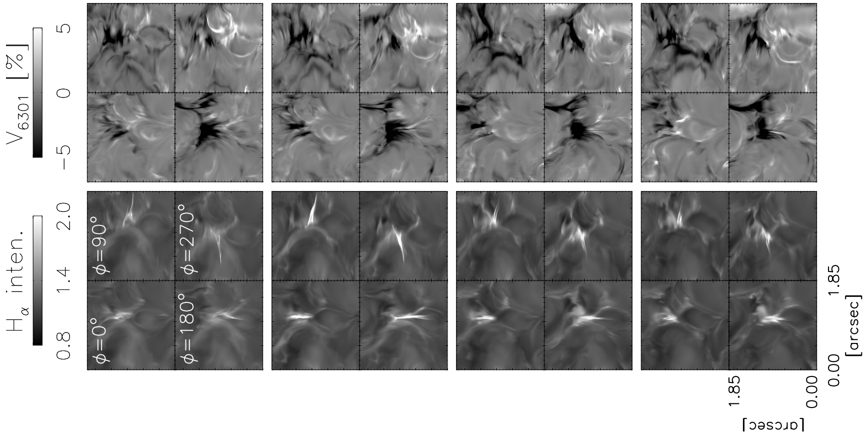
Looking at it from different angles..



The 'event' - simulated SST observations

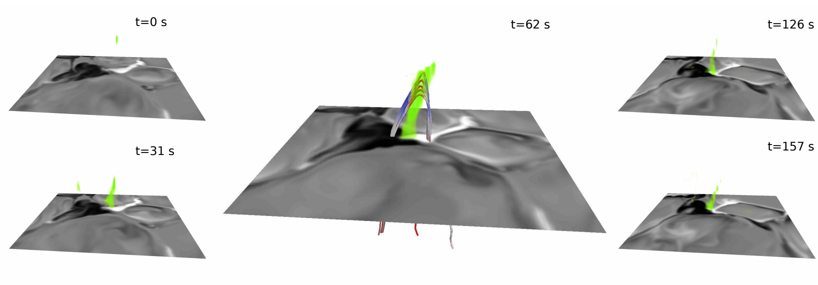
time

$\mu = 0.67$



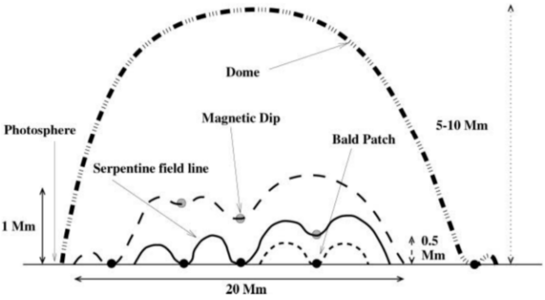
The 'event' - field configuration

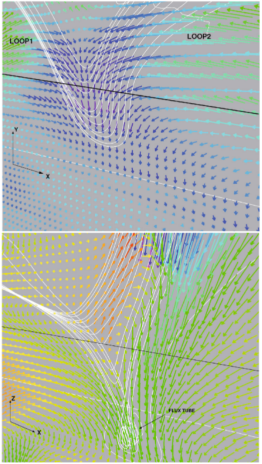
- 2 features of opposite polarities pushed in by the flow
- horizontal plane show B_z @ $\tau = 1$
- green shows temperature in the range 5700-6500 K



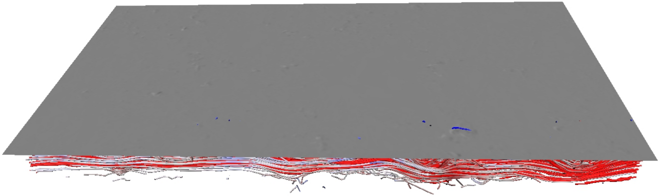
Active region field topology - a bald patch?

- Pariat et al. 2004,2012
- Archontis & Hood (2009) - horizontal flux sheet; emergence with successive reconnection locations of EB events



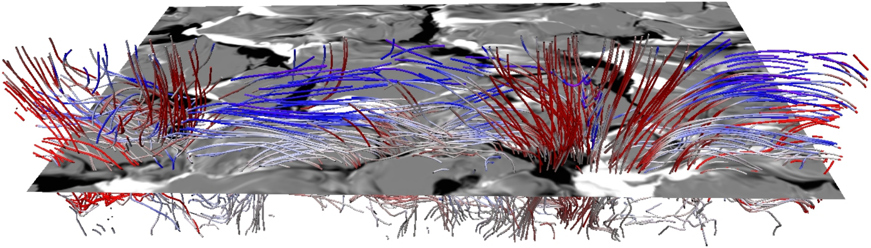


Field topology

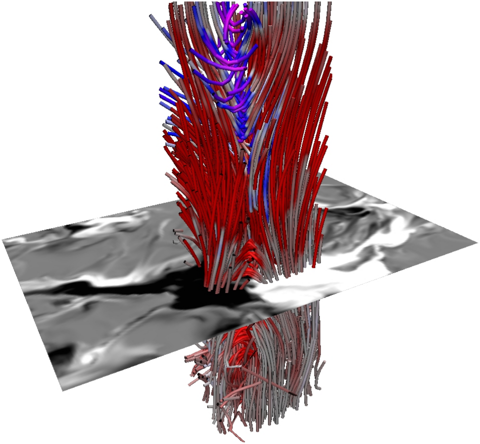


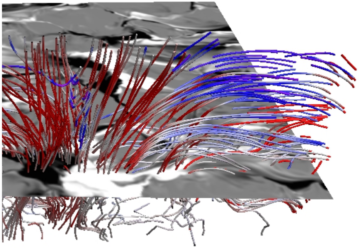
magnetic field lines; colorcoding corresponds to vertical velocity - blue: upflow
2D horizontal plane: vertical component of magnetic field at $\tau = 1$ [-1,1] kG
a sheet placed some 300 km below optical depth unity
maximum field strength 5000G

Field topology



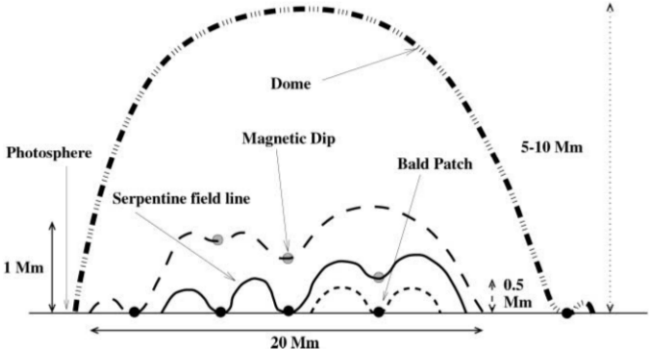
Field topology





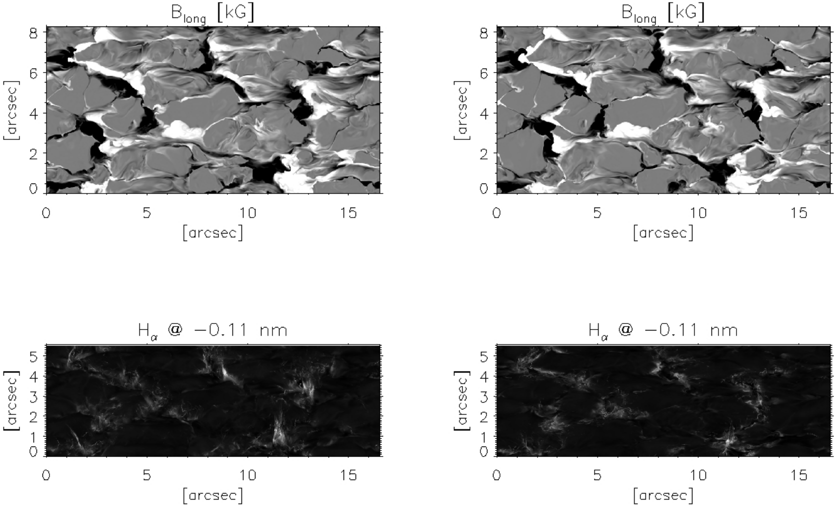
And if we close the upper boundary?

Is the arch filament essential for the EB evolution? - Mark Cheung asked

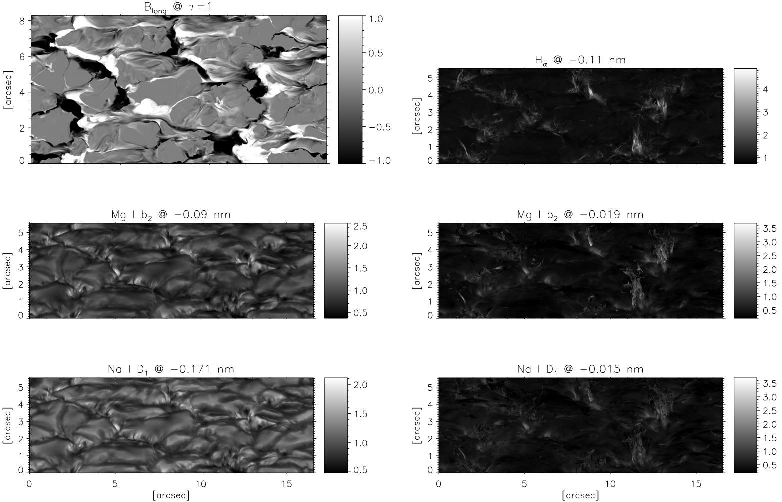


And if we close the upper boundary?

a test - **one run** - closed vs open upper boundary - significant result?

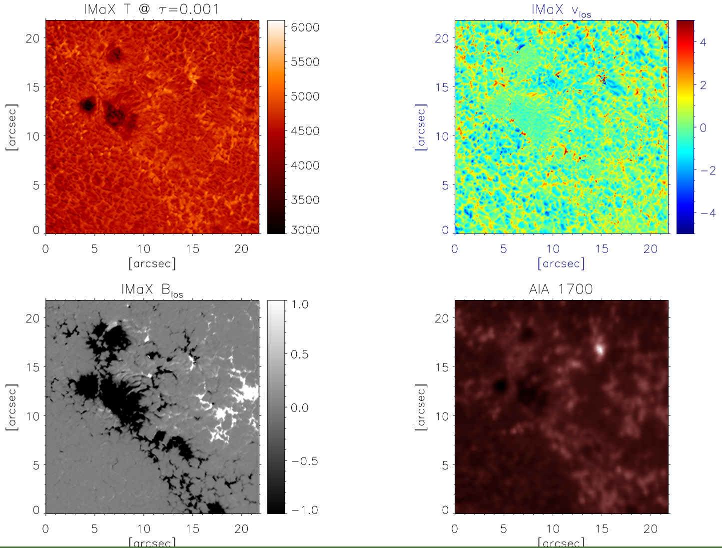


But still visible in Mg I b2 and Na I D1



EB observed by Sunrise II - inverted IMaX vs. AIA 1700

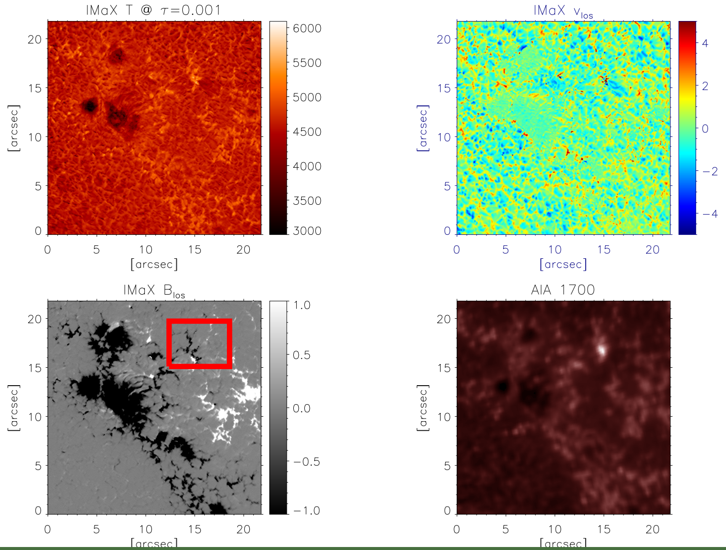
thanks to Tino and the Sunrise team



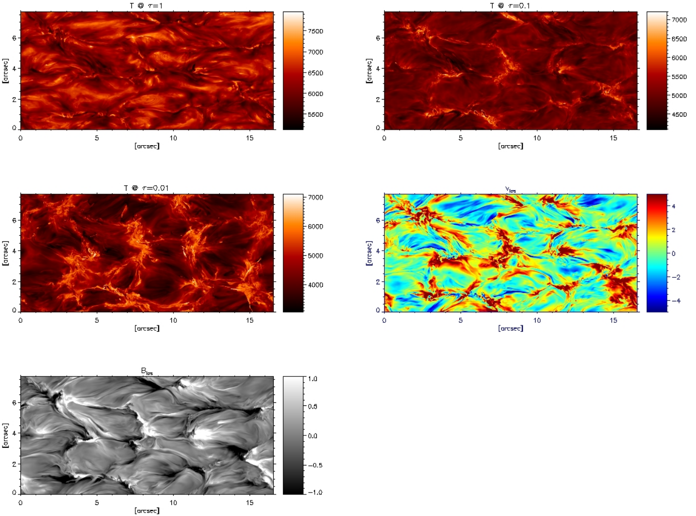
And the real Sun - Sunrise/IMaX

EB observed by Sunrise II - inverted IMaX vs. AIA 1700

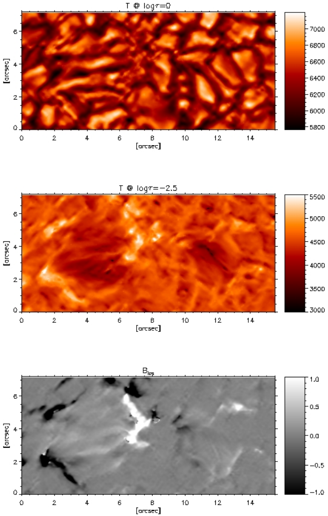
thanks to Tino and the Sunrise team



Simulations - top view



Inverted Sunrise/IMaX



So..

What did we learn?

- morphology
  - MURaM simulations show EB-like features (Nelson et al. 2013)
  - flames produced during cancellation of magnetic elements
  - increase in T and rho (Kitai 1983, Bello Gonzalez et al. 2013, Berlicki & Heinzel 2014,..)
  - length and intensity agree with QSEB characteristics
  - QSEB visible in Mg I b2 and Na I D1 lines?
- field topology
  - EB-like features appear naturally in serpentine field scenario (Georgoulis et al. 2002, Pariat et al 2004, Archontis Hood 2009, ..)
  - actual omega loops at formation height of these features
  - omega loops essential?
- evolution
  - presence of arch filament helps the formation
  - a thin magnetic sheet won't do it; more flux needed
  - large horizontal velocities essential? (Reid et al. 2015, Nelson et al?)