



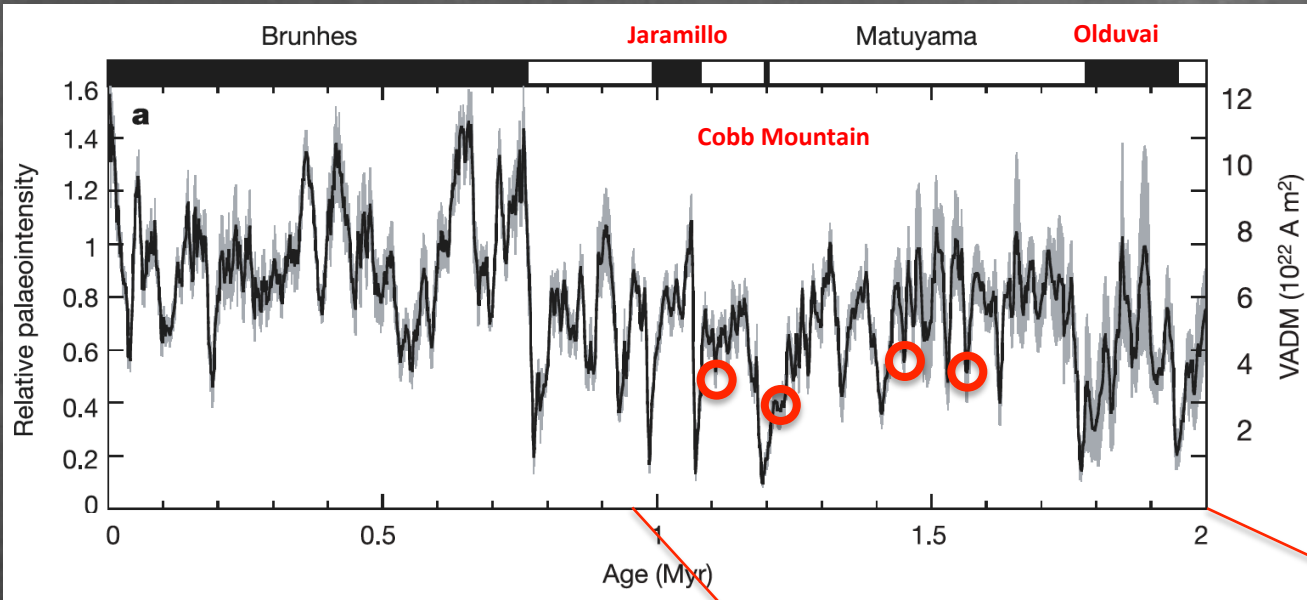
Long-term dipole field variations in geodynamo simulations: a statistical approach

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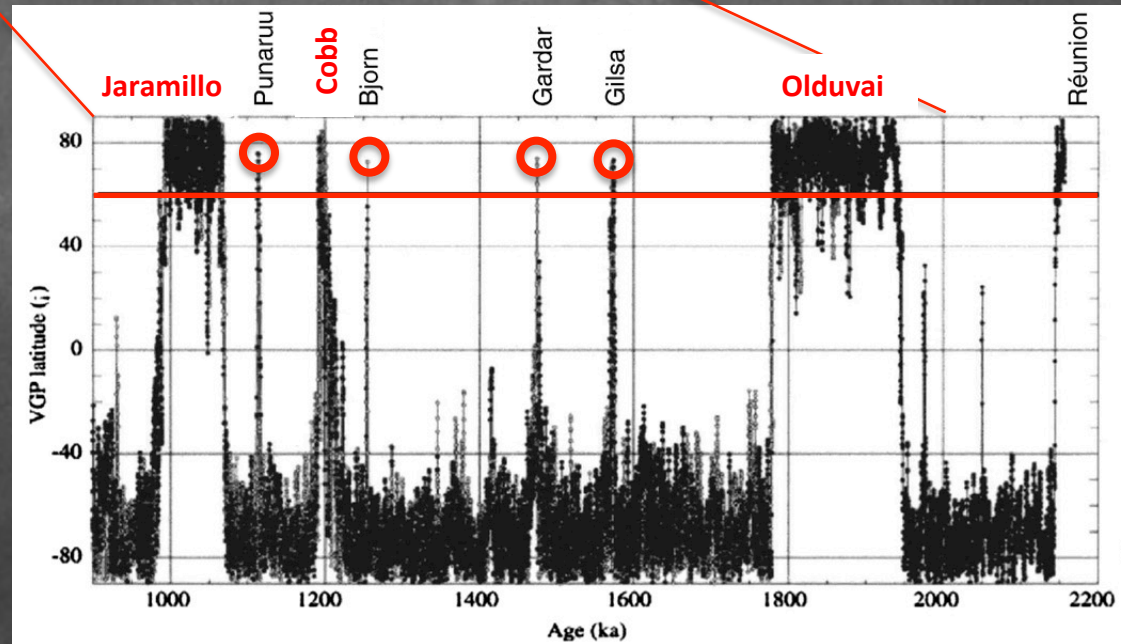


Geomagnetic dipole variations



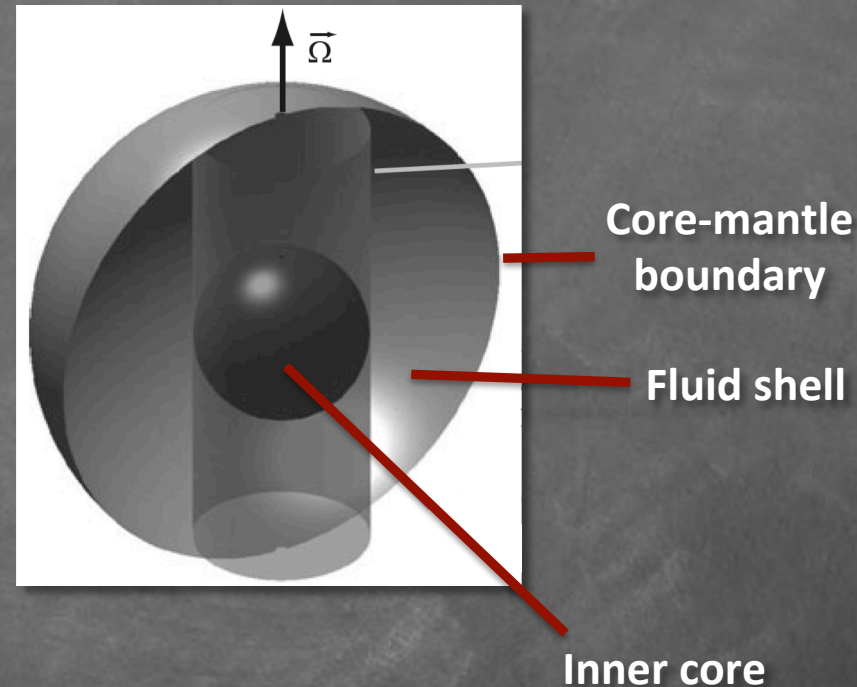
Adapted from Valet et al. (2005)

Channell et al. (2002)

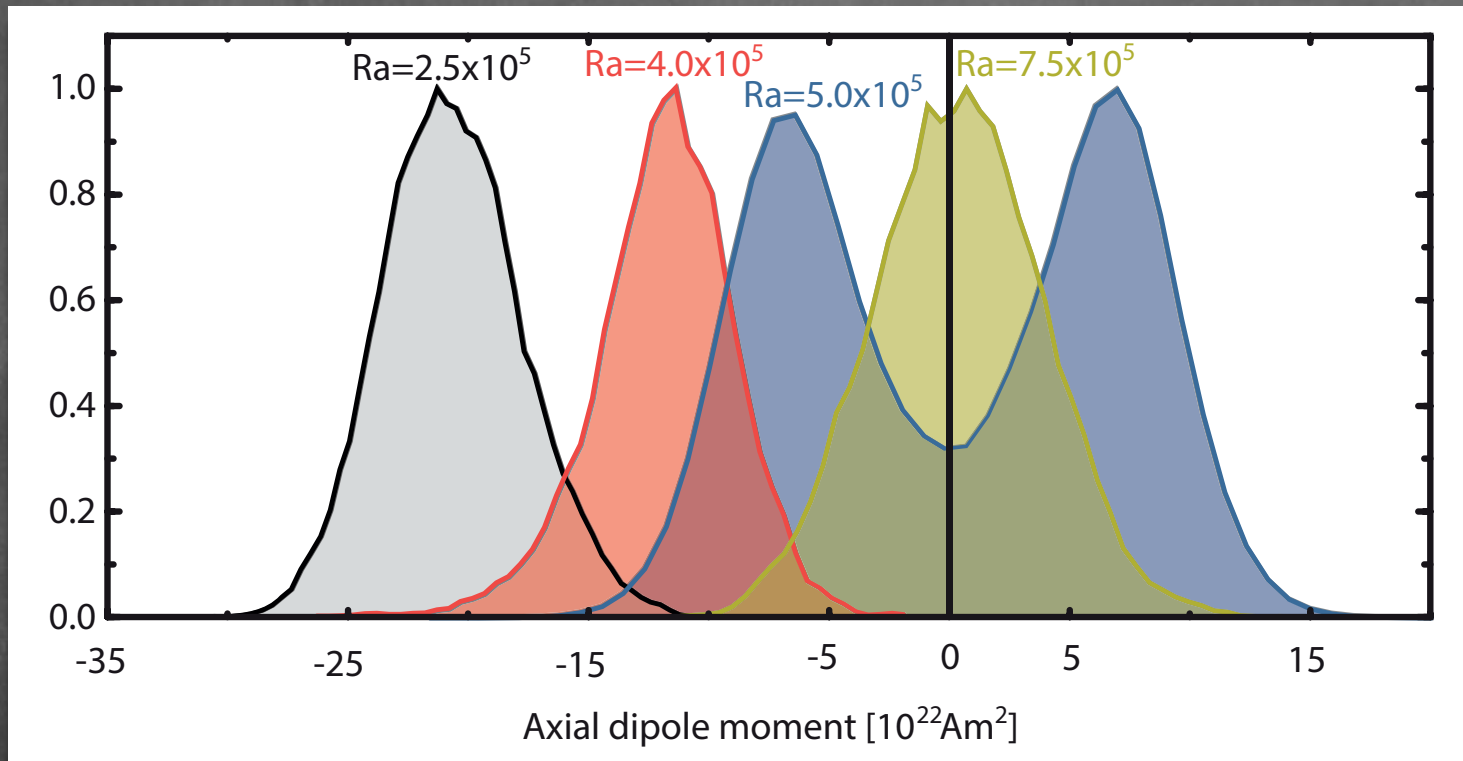


Explored dynamo models

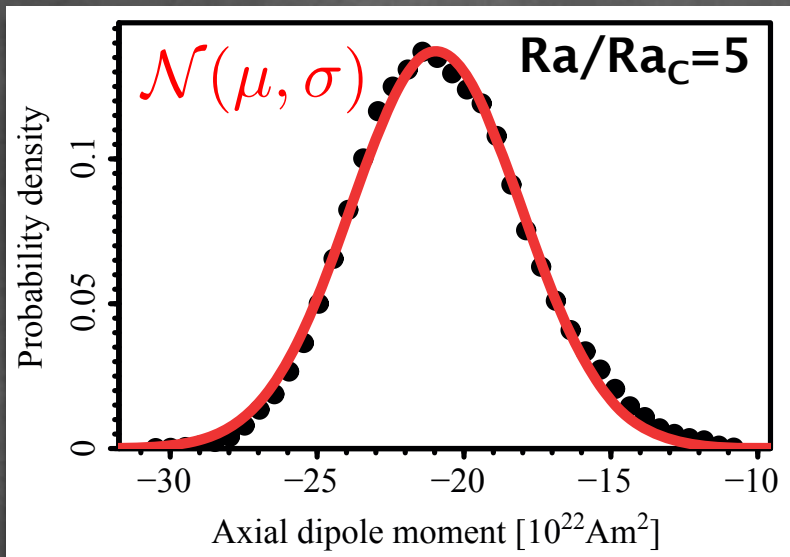
- Statistical properties of dipole moment variations
- Occurrence of reversals
- Are reversals and excursions equivalent events ?
- 3D self-consistent dynamo models
- Long runs to get a robust statistic
- Ekman numbers $E = 2 \times 10^{-2}, 10^{-3}, 3 \times 10^{-4}$
- $Pm = 3, 10 - Pr = 1$
- Various Rayleigh numbers Ra (dipolar \rightarrow reversing \rightarrow multipolar)
- Compositional or thermal driving
- Altogether about 3800 simulated reversals



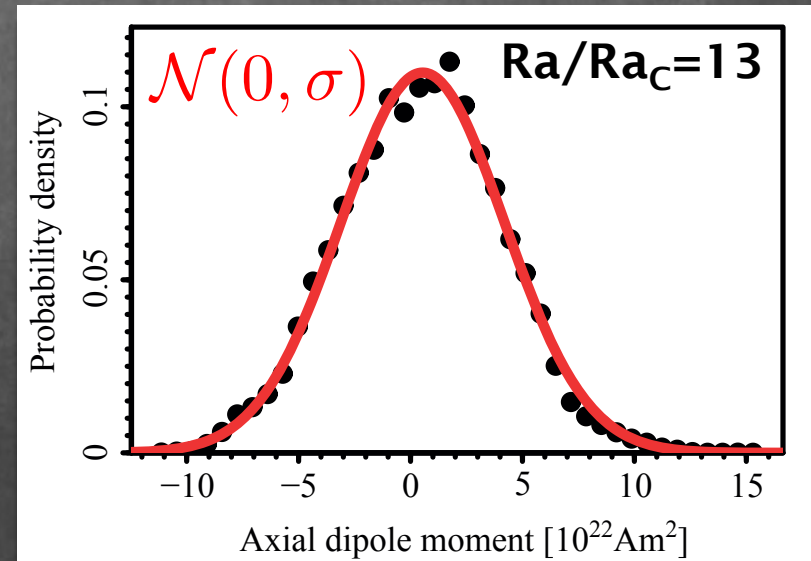
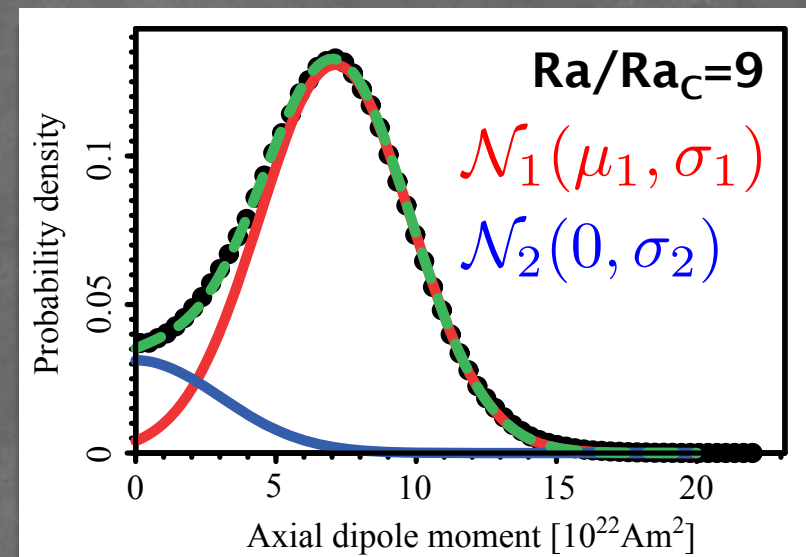
Dipole moment statistics



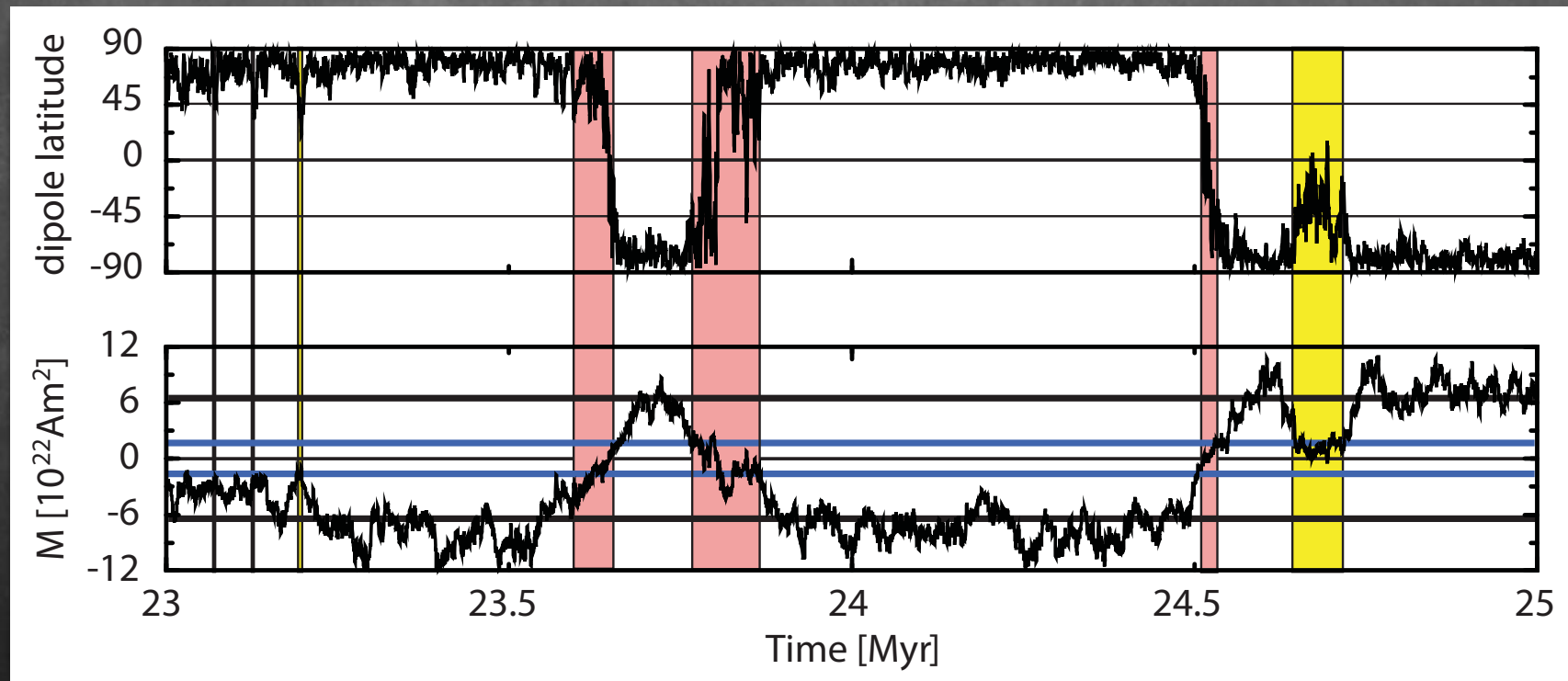
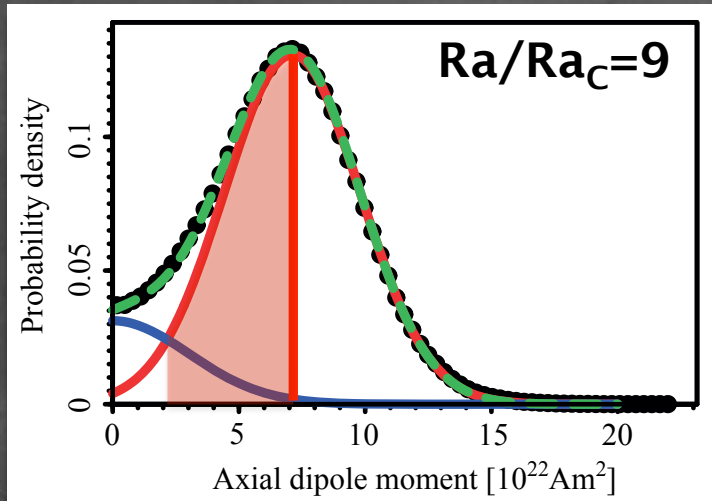
Gaussian axial dipole moment



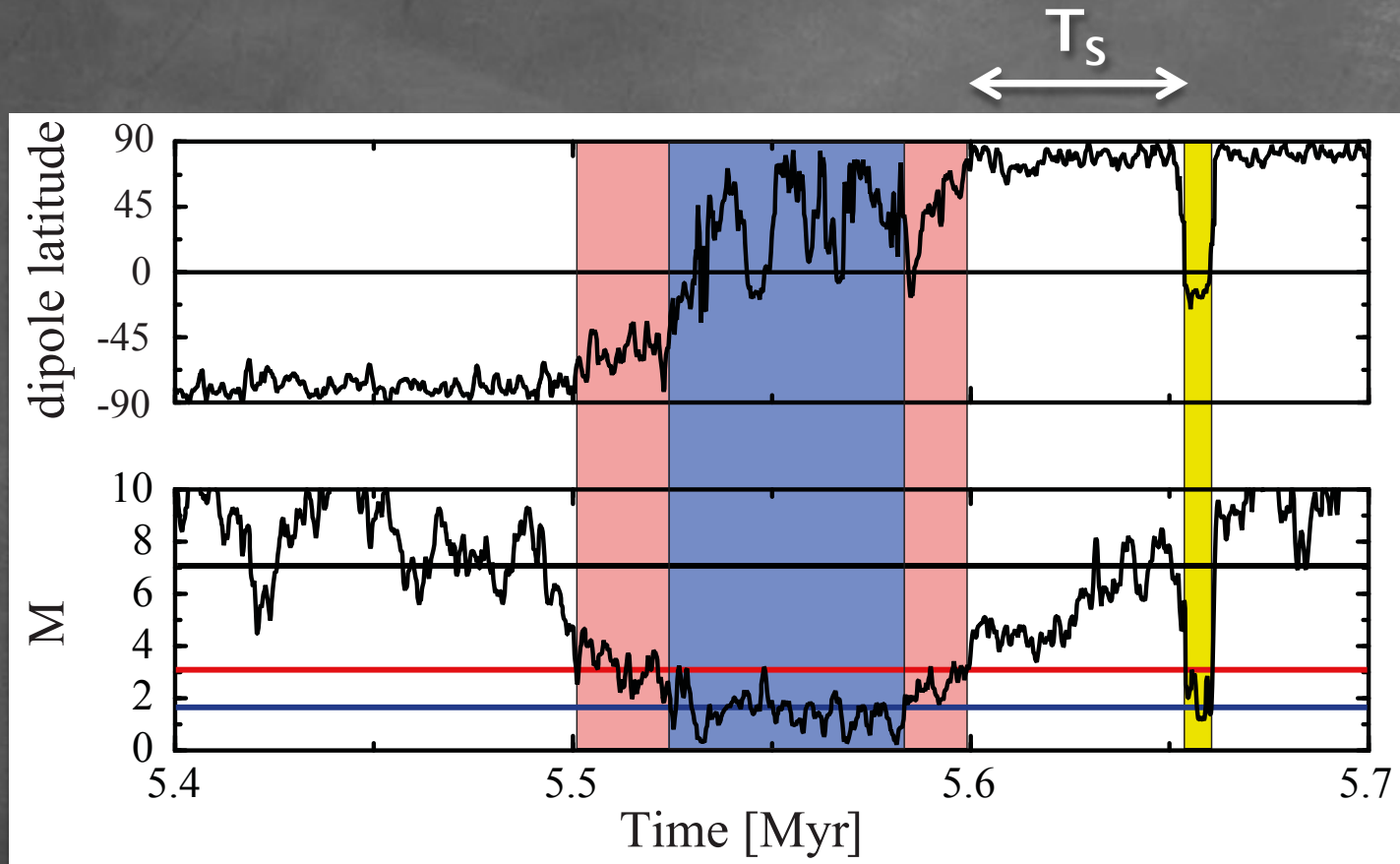
- Originally proposed by Constable & Parker (1988) (see also Hulot & Le Mouél, 1994).



Field behaviour during polarity transitions

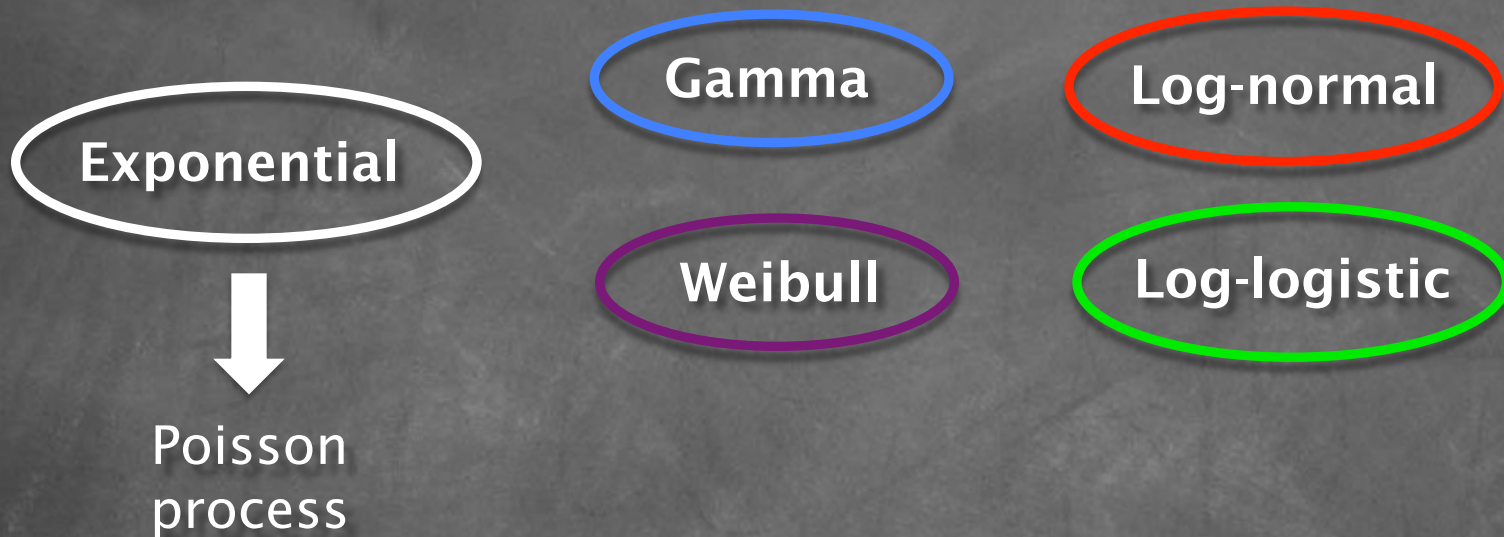


Timing events



Statistical methods

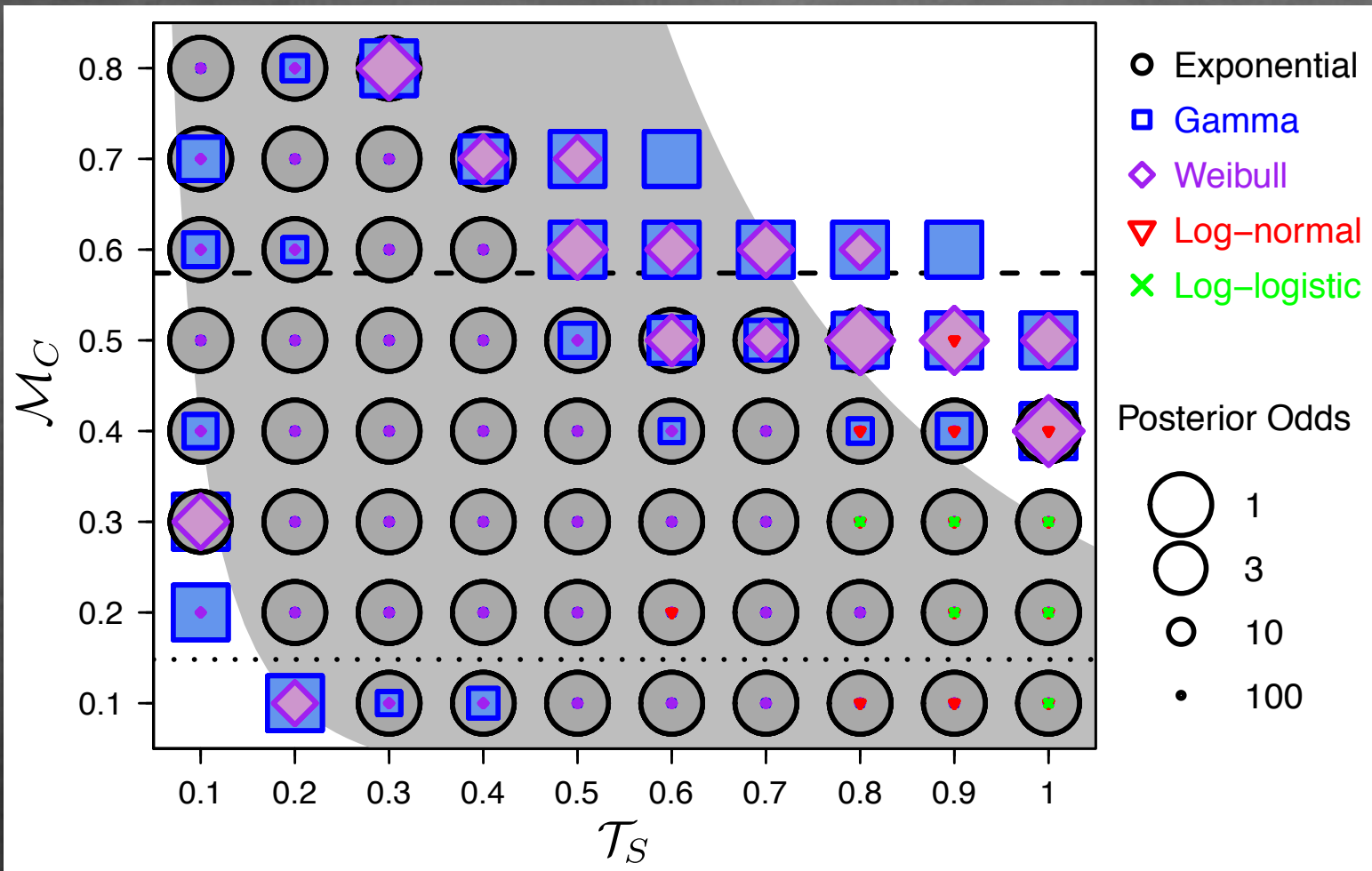
- Tested distribution functions:



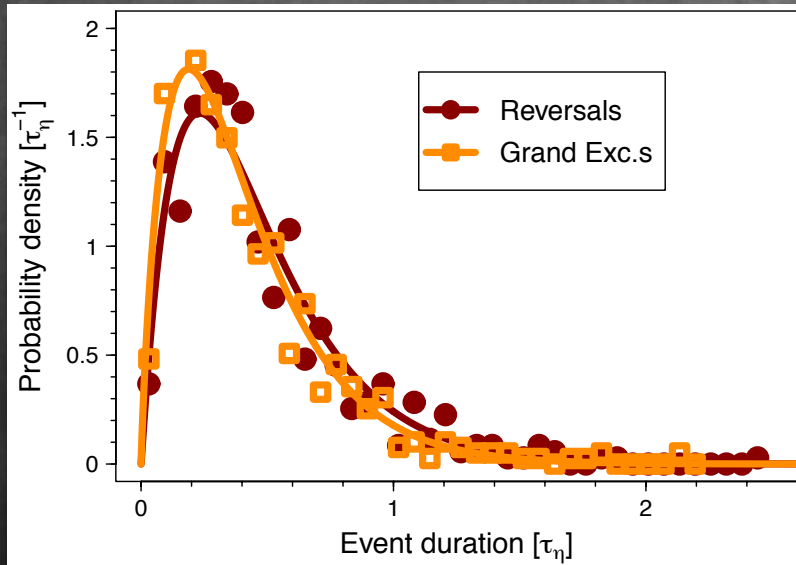
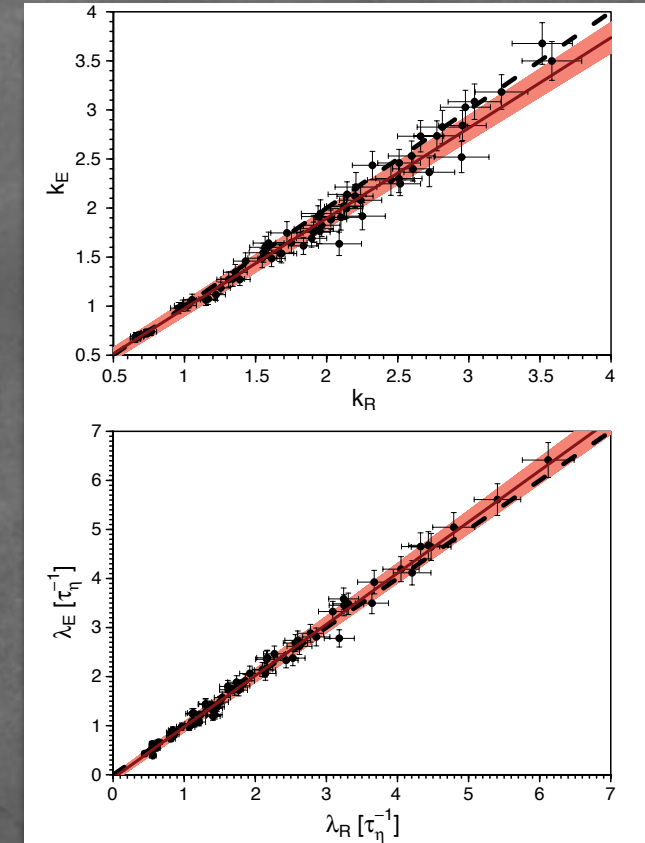
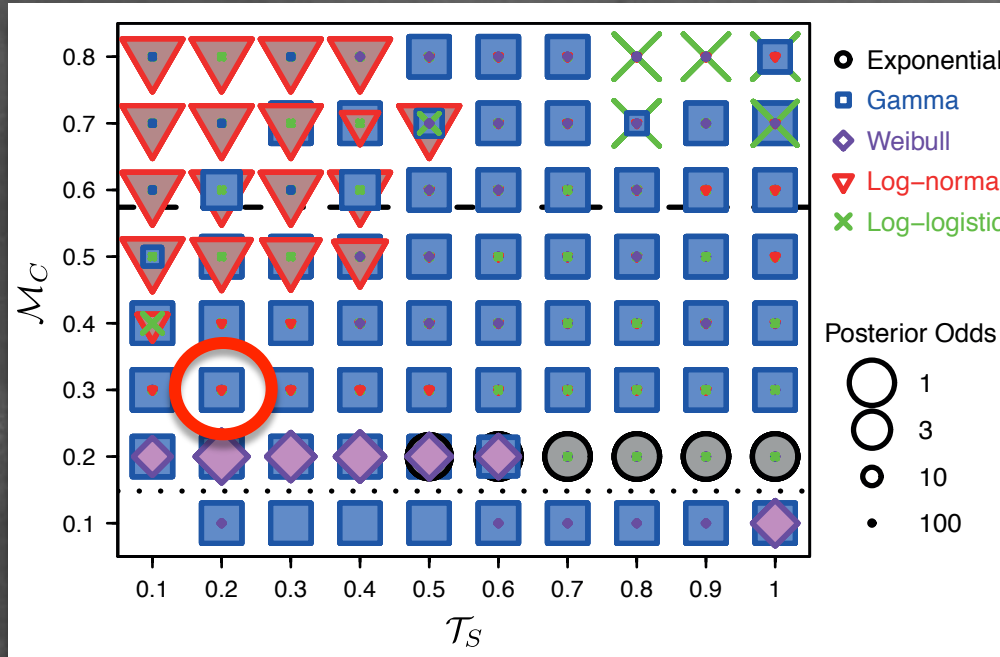
- Bayesian approach to assess models likelihood:

$$O_{ij} = \frac{P(M_i | D)}{P(M_j | D)}$$
$$= \frac{\int P(D | \theta_i, M_i) \pi(\theta_i | M_i) d\theta_i}{\int P(D | \theta_j, M_j) \pi(\theta_j | M_j) d\theta_j} \frac{P(M_i)}{P(M_j)}$$

Reversal waiting times



Reversals and grand excursions equivalence



Reversals and grand excursions

- no statistical differences in their temporal dynamics
- equally likely: $N_R/N_E < 10\%$

Conclusions

- We analysed the statistical properties of the long-term dipole moment variations in a suite of geodynamo simulations
- We propose a (Gaussian) two-states description of the reversal process for the axial dipole moment
- Simulated reversals occur according to a Poisson process, i.e. without “memory” of their previous history
- Simulated reversals and grand excursions have very similar characteristics (duration, number of events, decay and growth)
- They become possible once the dipole decreases to 30% of its mean strength

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**Thanks for
your attention!**

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