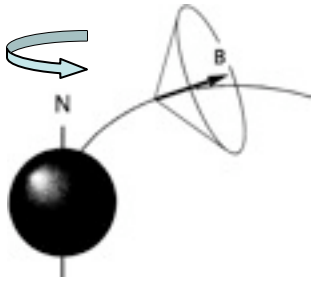
Saturn's Variable Radio Period: Modulation by the Solar Wind

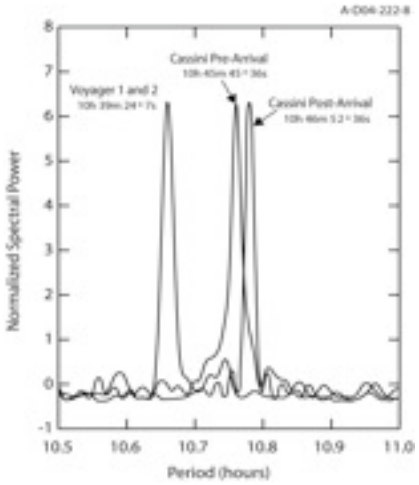
P. Zarka, L. Lamy, B. Cecconi, R. Prangé
LESIA, Observatoire de Paris – CNRS – UPMC – Univ. Paris Diderot, 92190 Meudon, France

H. O. Rucker
Space Research Institute, Austrian Academy of Sciences, A-8042 Graz, Austria



- Rotation of giant planets « usually » measured via Radio Period

- « Voyager » SKR period = 10h 39m 24s ±7s (if constant)

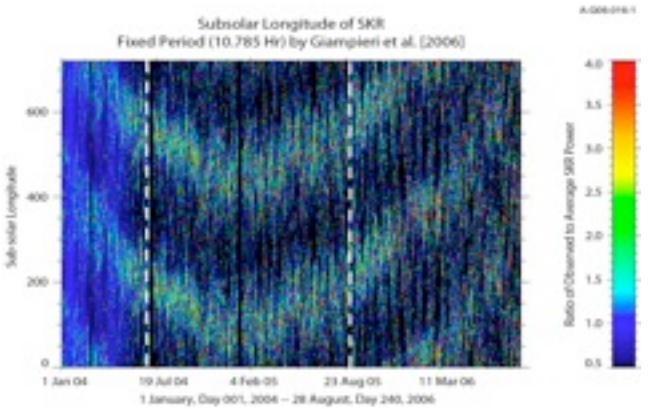


- Radio Period found variable for Saturn (SKR)

[Galopeau and Lecacheux, 2000; Gurnett et al., 2005]

- Long-term variations (several months-years) ephemeris

[Kurth et al., 2007]



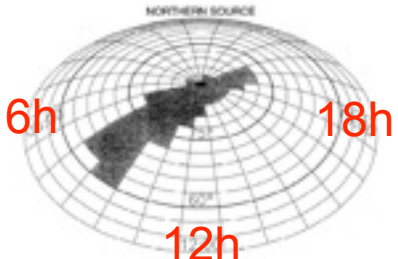
- Compared with magnetic field data

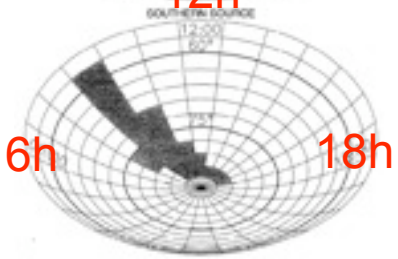
[Southwood et al., 2006; Gurnett et al., 2007]

- Origin ?

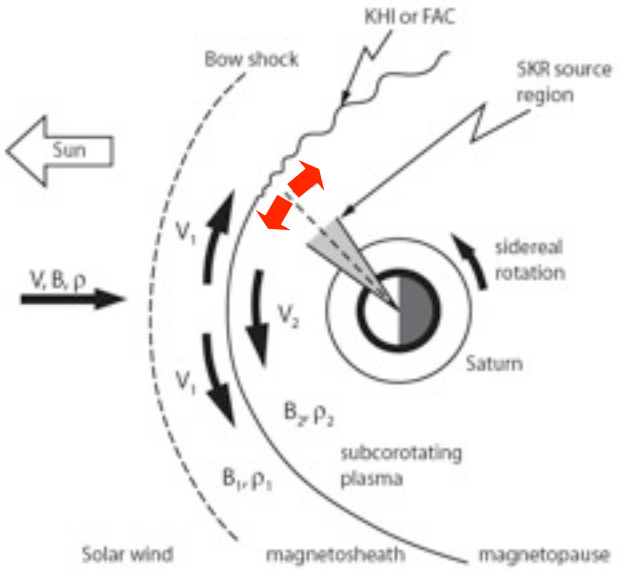
- Non random V_{SW} fluctuations ⇒ SKR source displacement in LT (external cause)

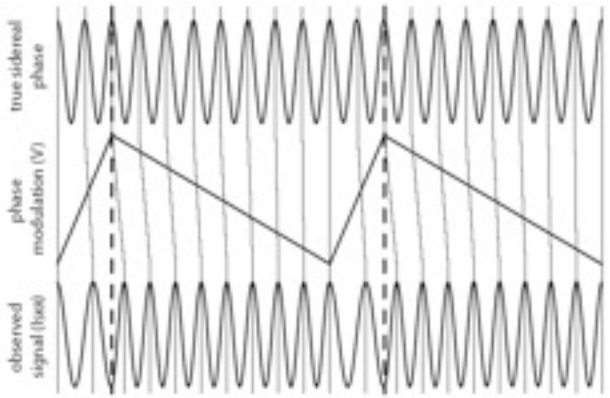
[Cecconi and Zarka, 2005]

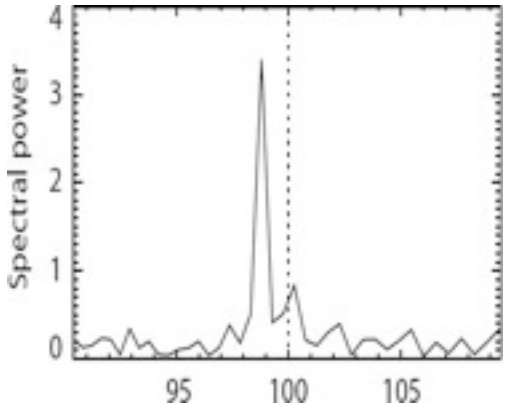




[Galopeau et al., 1995]







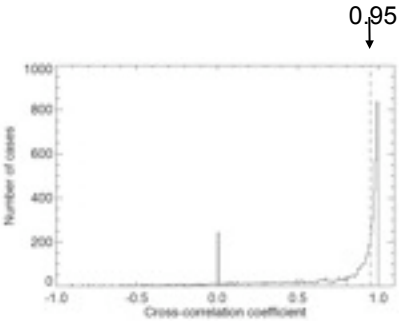
% of injected period

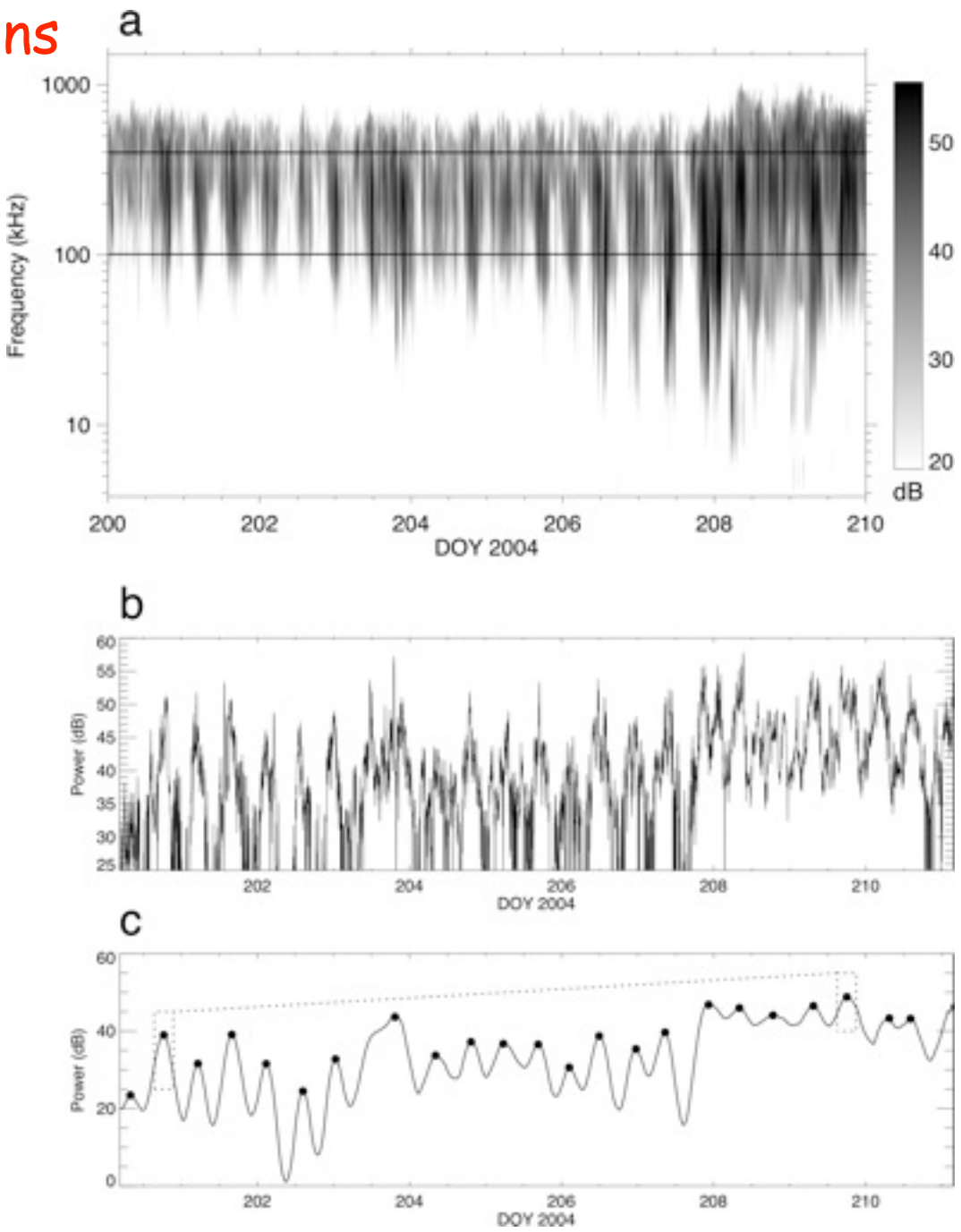
- Mass injection from Enceladus + variable electrodynamic plasma disk / ionosphere coupling (internal cause)

[Gurnett et al., 2007]

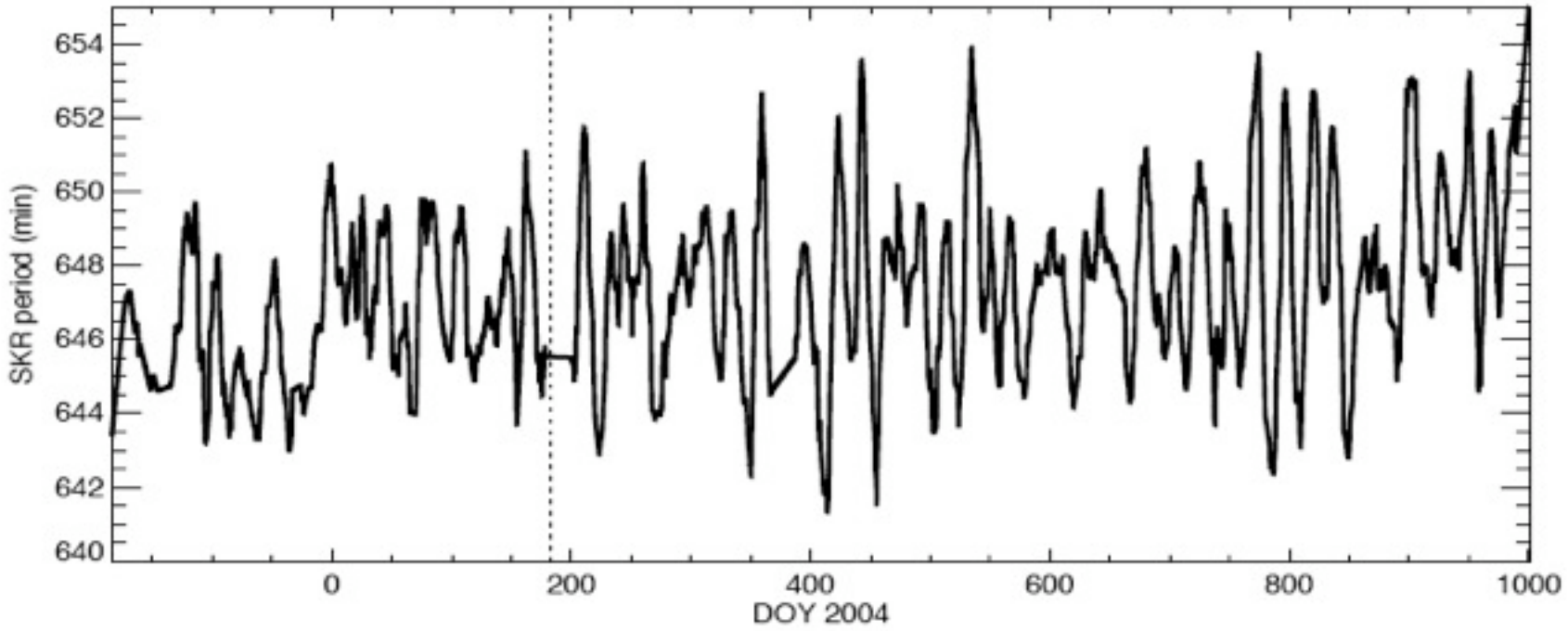
• Short-term P_{SKR} variations

- « super-clean » SKR data 2003/181 → 2006/270 (cf. talk & poster by Lamy et al.)
- $\int$ 100-400 kHz
- smoothing over 5h sliding window
- detection of local maxima
- cross-correlation of 6h intervals around local maxima at ±20 rot. distance

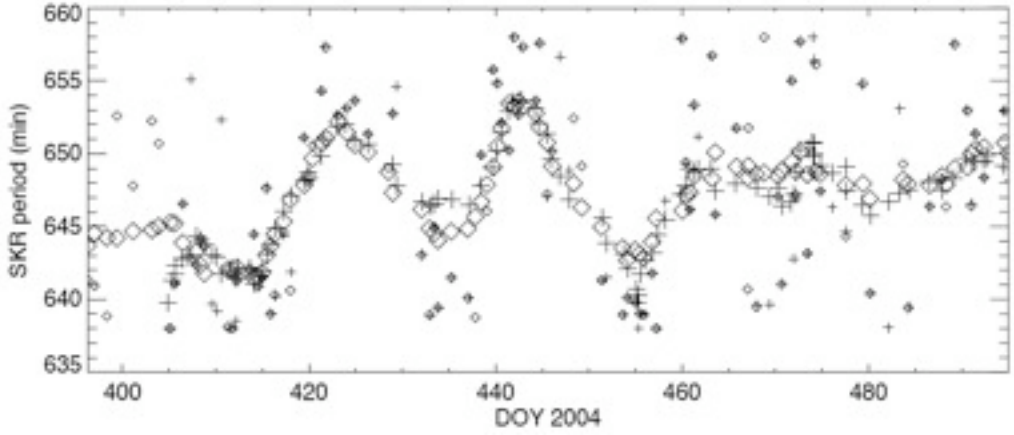




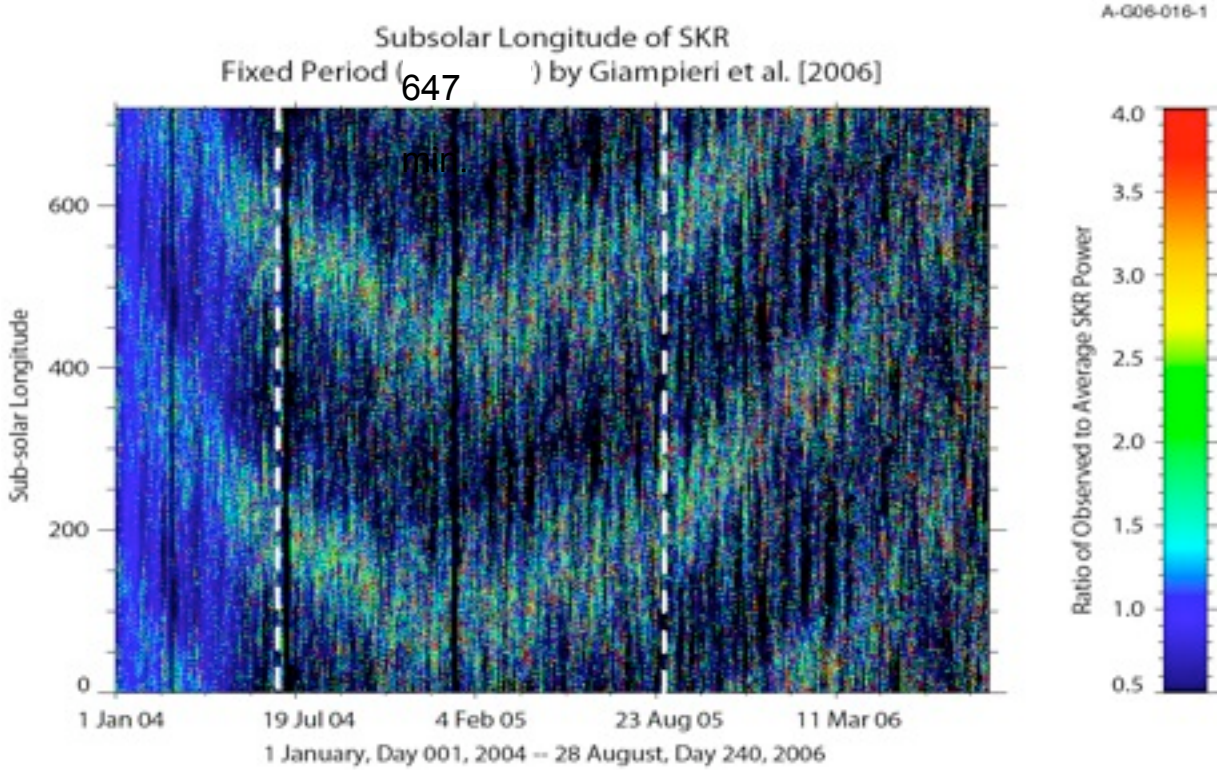
- Ubiquitous P_{SKR} fluctuations at 20-30 days, ±1% amplitude



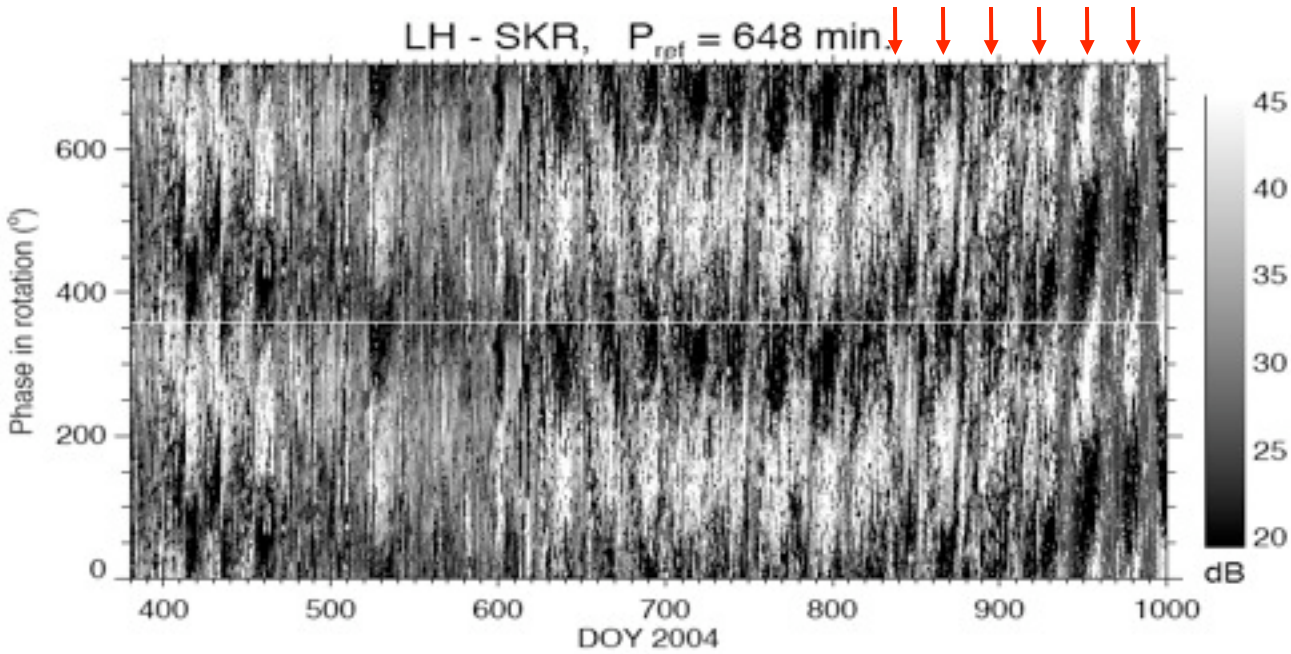
- ~5 σ significance



- Comparison with [Kurth et al., 2007]

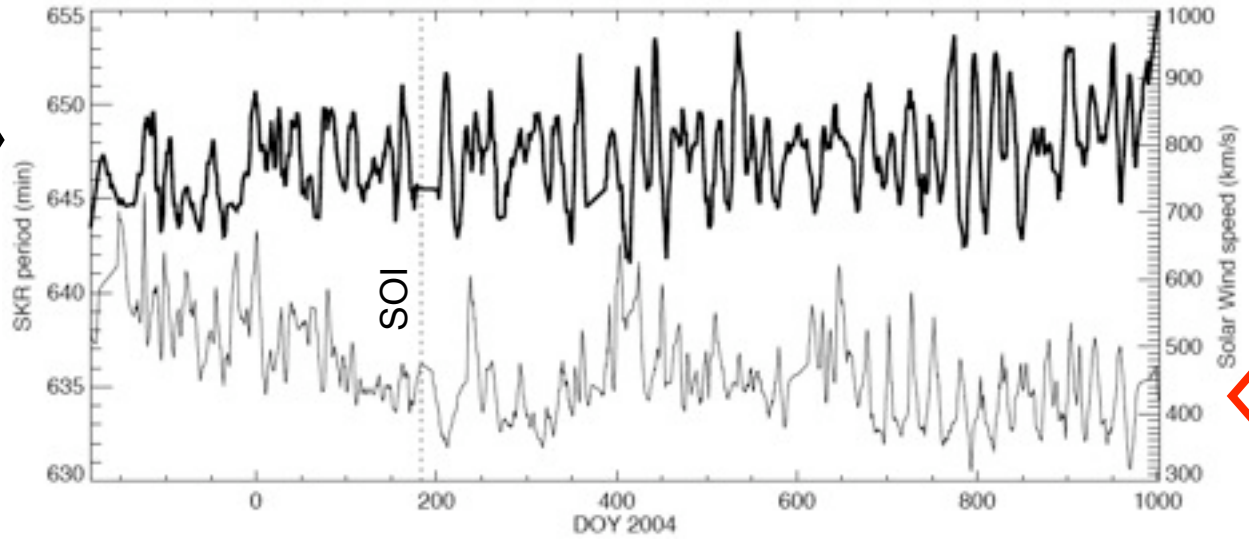


This work

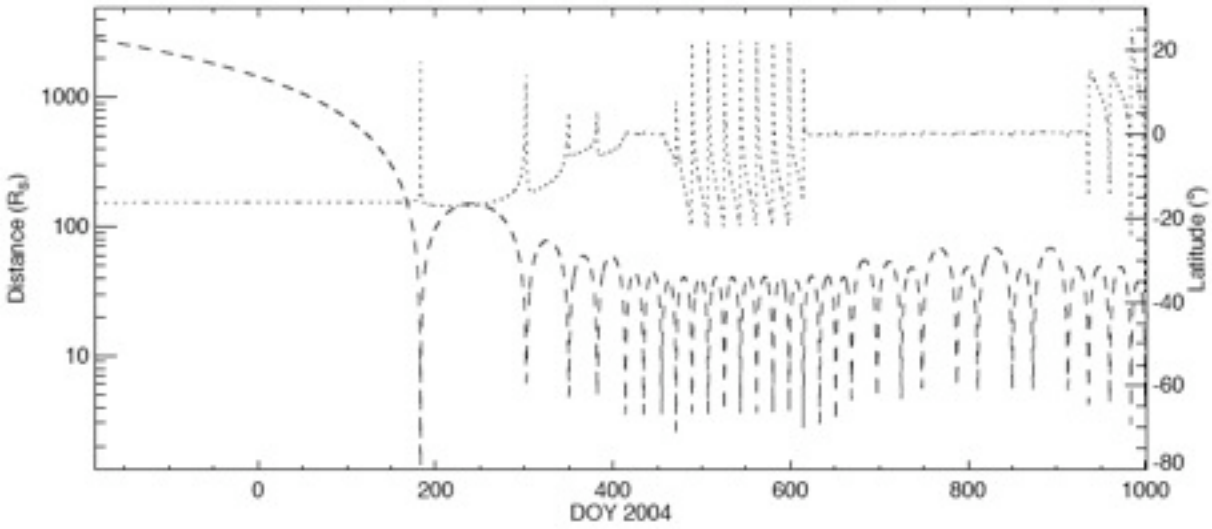


• Fluctuations have same timescale as V_{SW} at Saturn & Cassini orbital variations (→SKR visibility)

P_{SKR} ⇨



⇦ V_{SW}



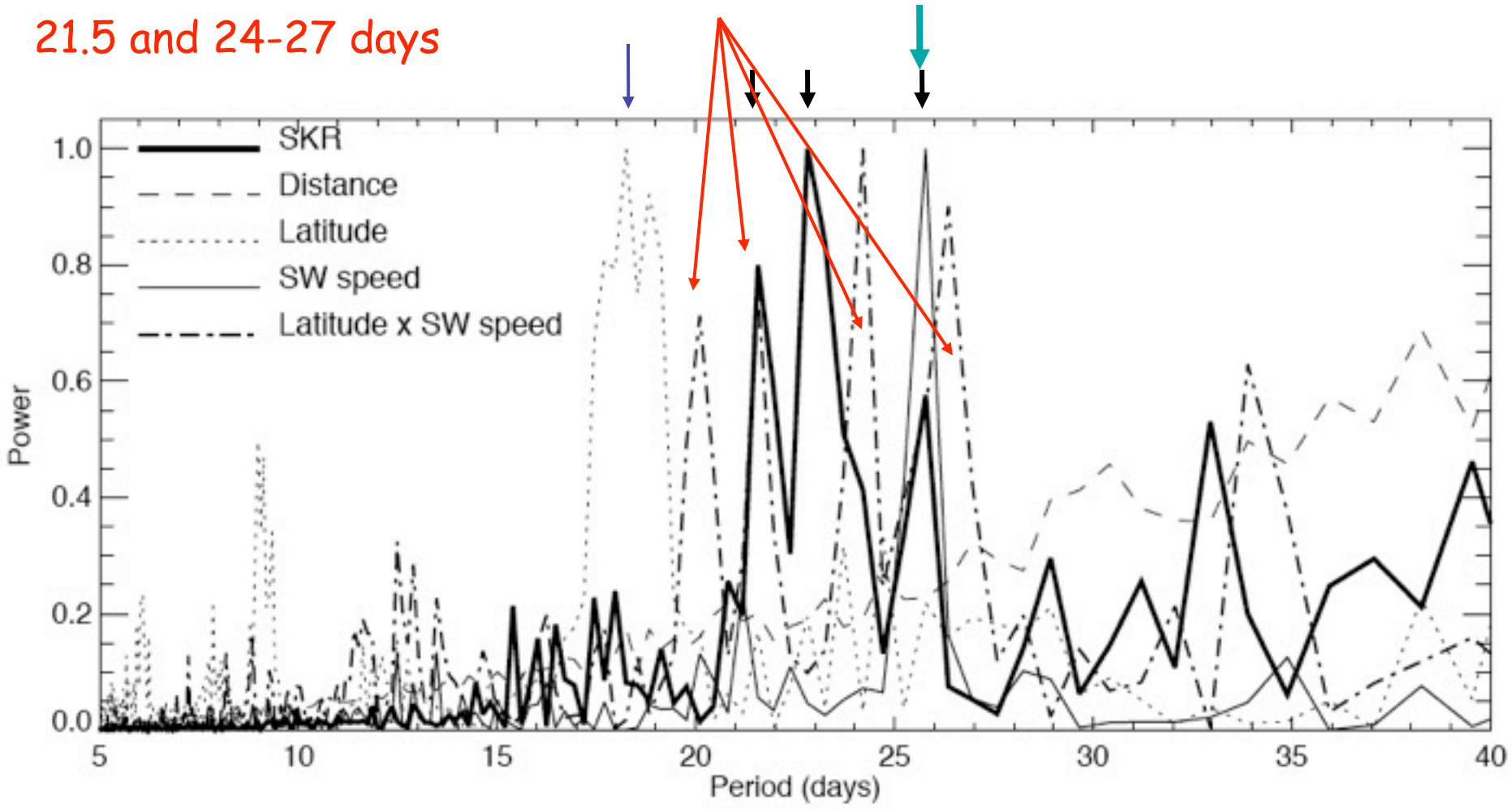
Cassini

⇦ Latitude

&

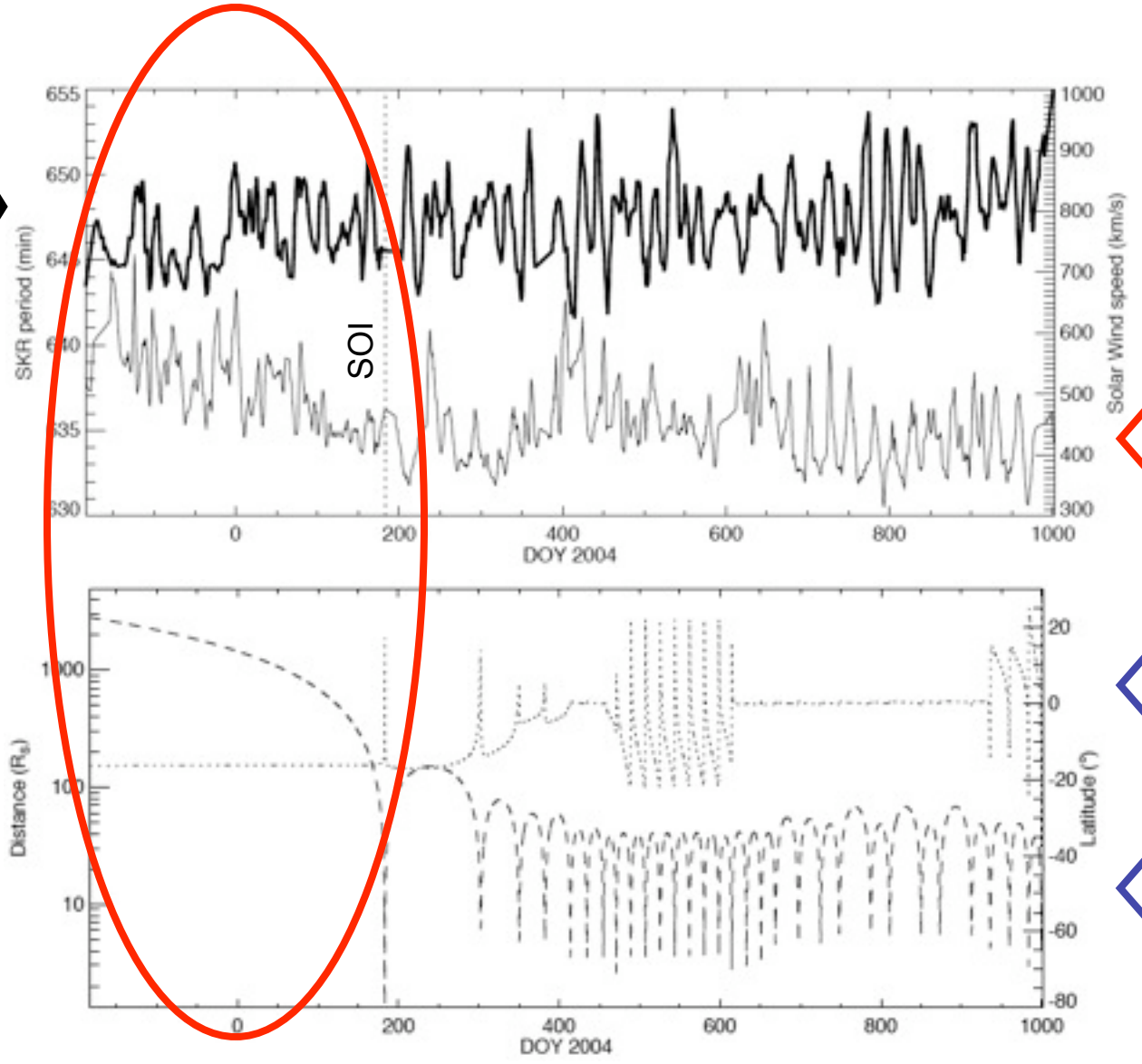
⇦ Distance

- Peaks in fluctuations of P_{SKR} at ~21.5, 23, and 25.5 days
- Main peak in fluctuations of V_{SW} at ~25.5 days
- Main peak in fluctuations of orbital parameters at ~18-19 days
- Peaks in coupled fluctuations of V_{SW} x Orb.Param. (latitude) at ~20, 21.5 and 24-27 days



- Correlation of P_{SKR} with V_{SW} pre-SOI

P_{SKR} ⇨



⇦ V_{SW}

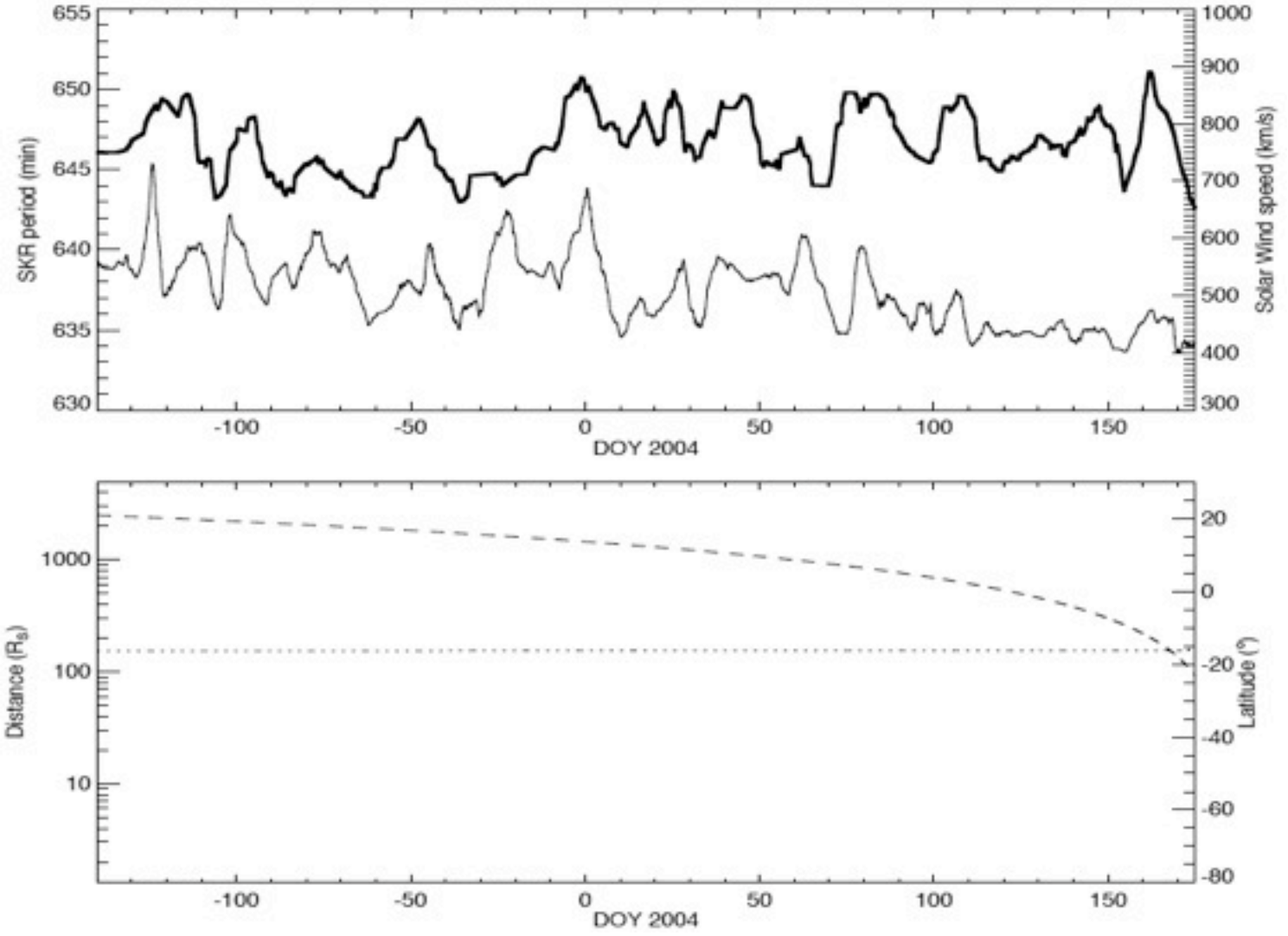
Cassini

⇦ Latitude

&

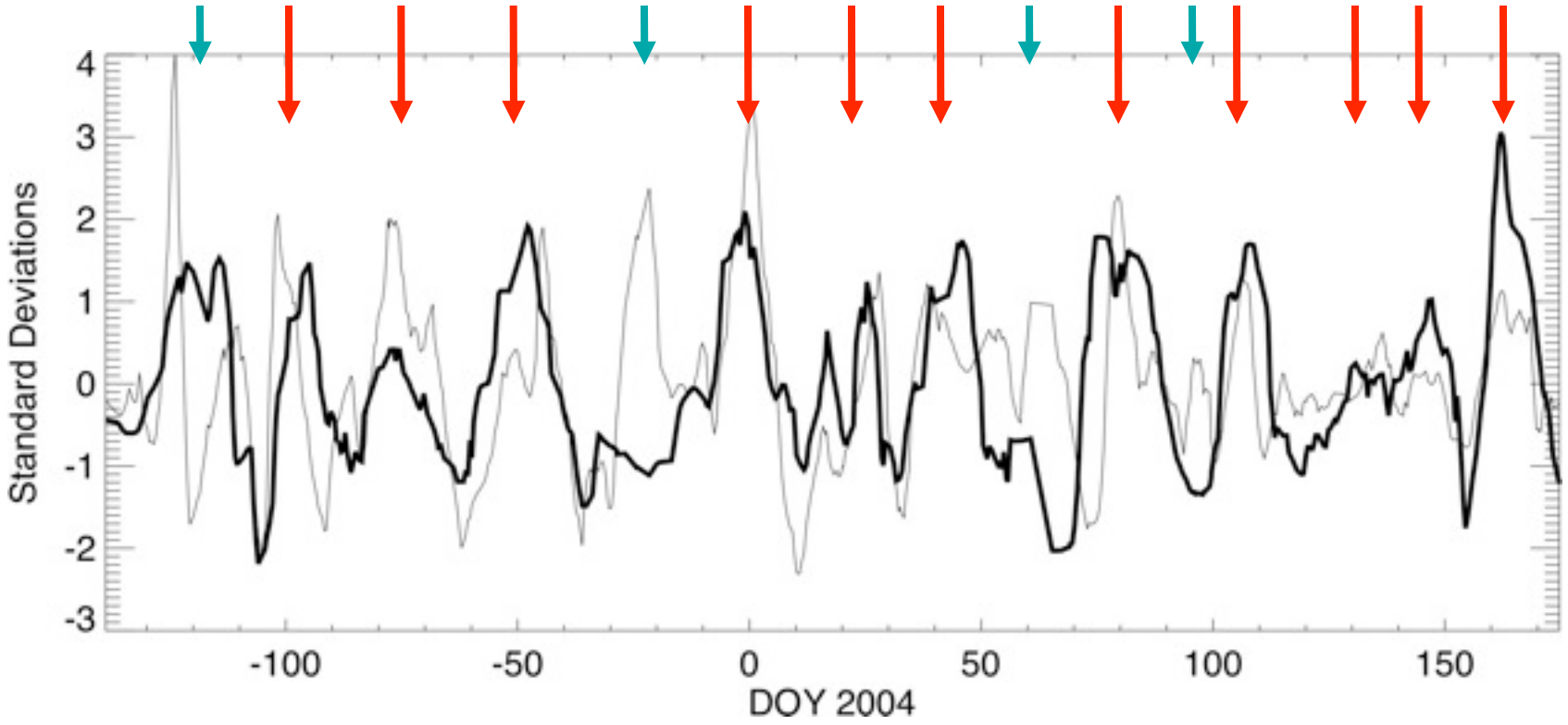
⇦ Distance

- Correlation of P_{SKR} with V_{SW} pre-SOI



- Correlation of P_{SKR} with V_{SW} pre-SOI

(C>40%, zero lag, 100% confidence)



CONCLUSIONS

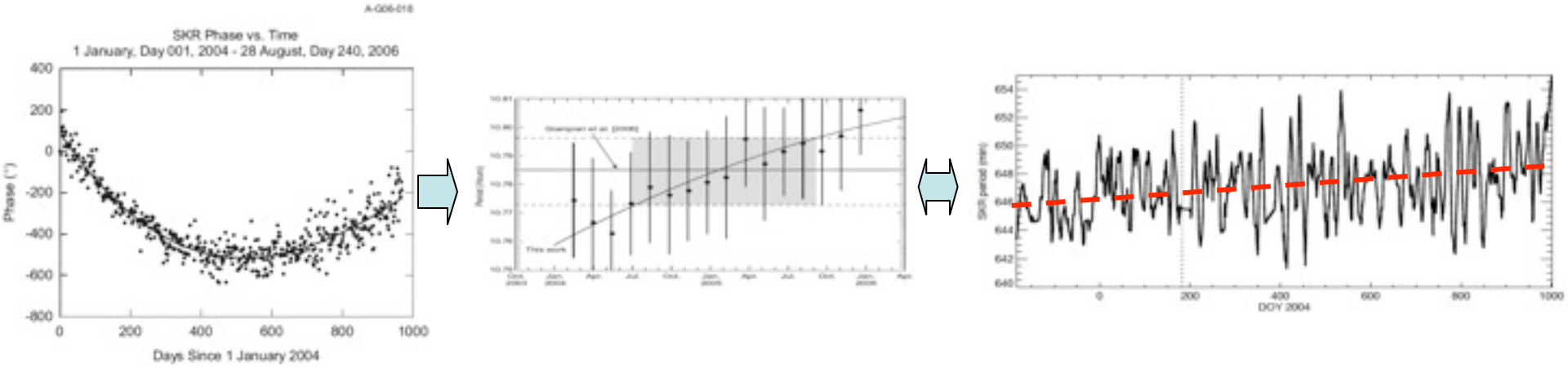
- Short-term variations of P_{SKR} discovered at ±1% level
- Driven by V_{SW} (+ SKR visibility related to Cassini's orbit)

⇒ Supports [Cecconi and Zarka, 2005] model

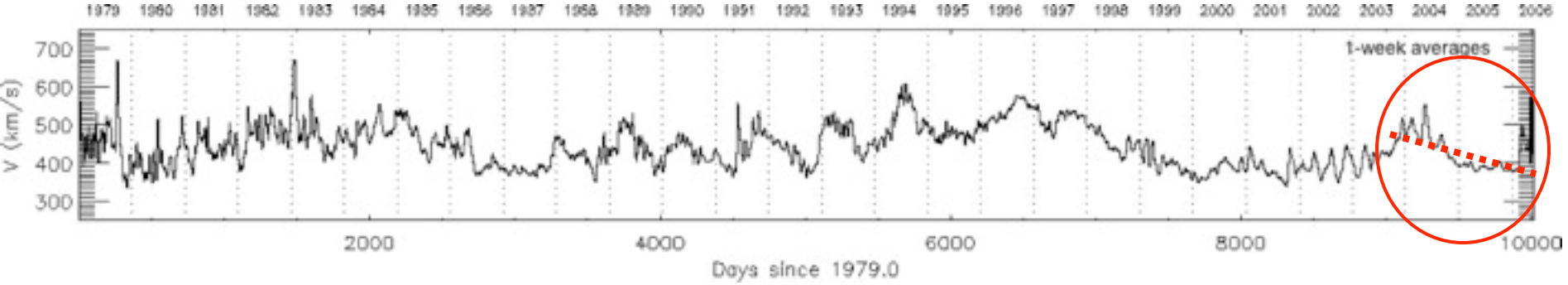
[paper submitted, under refereeing …]

- Long-term variations of P_{SKR} ?

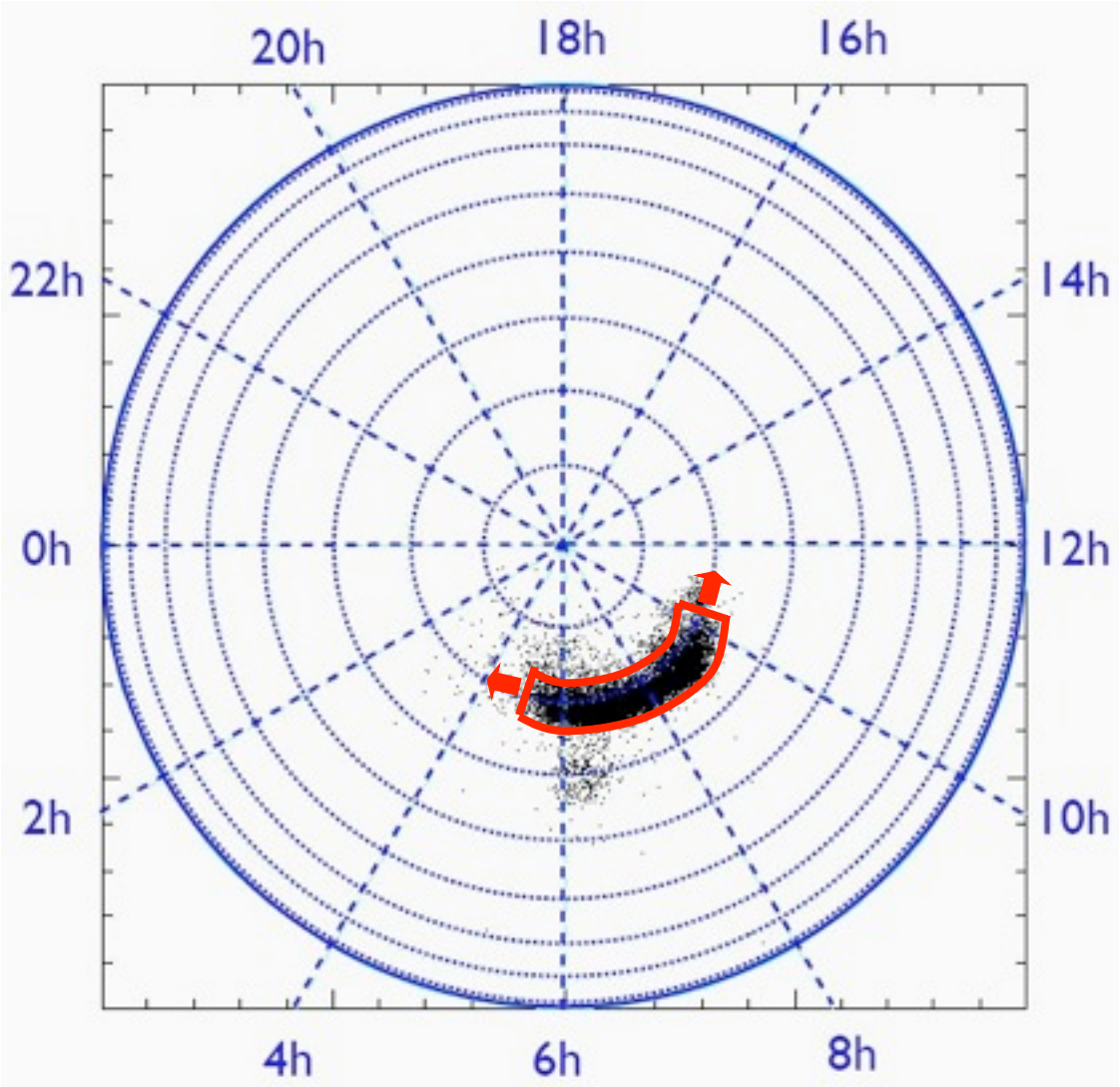
- Long-term average of short-term variations = previously noted long-term variations (of 3-4x lower amplitude) ⇒ residual ?



- Opposite long-term trend in V_{SW} ⇒ indirect control ?



- Determination of Saturn's true internal period ?



- Possible « deconvolution » of V_{SW} from P_{SKR} (cf. talk by Cecconi et al.)