

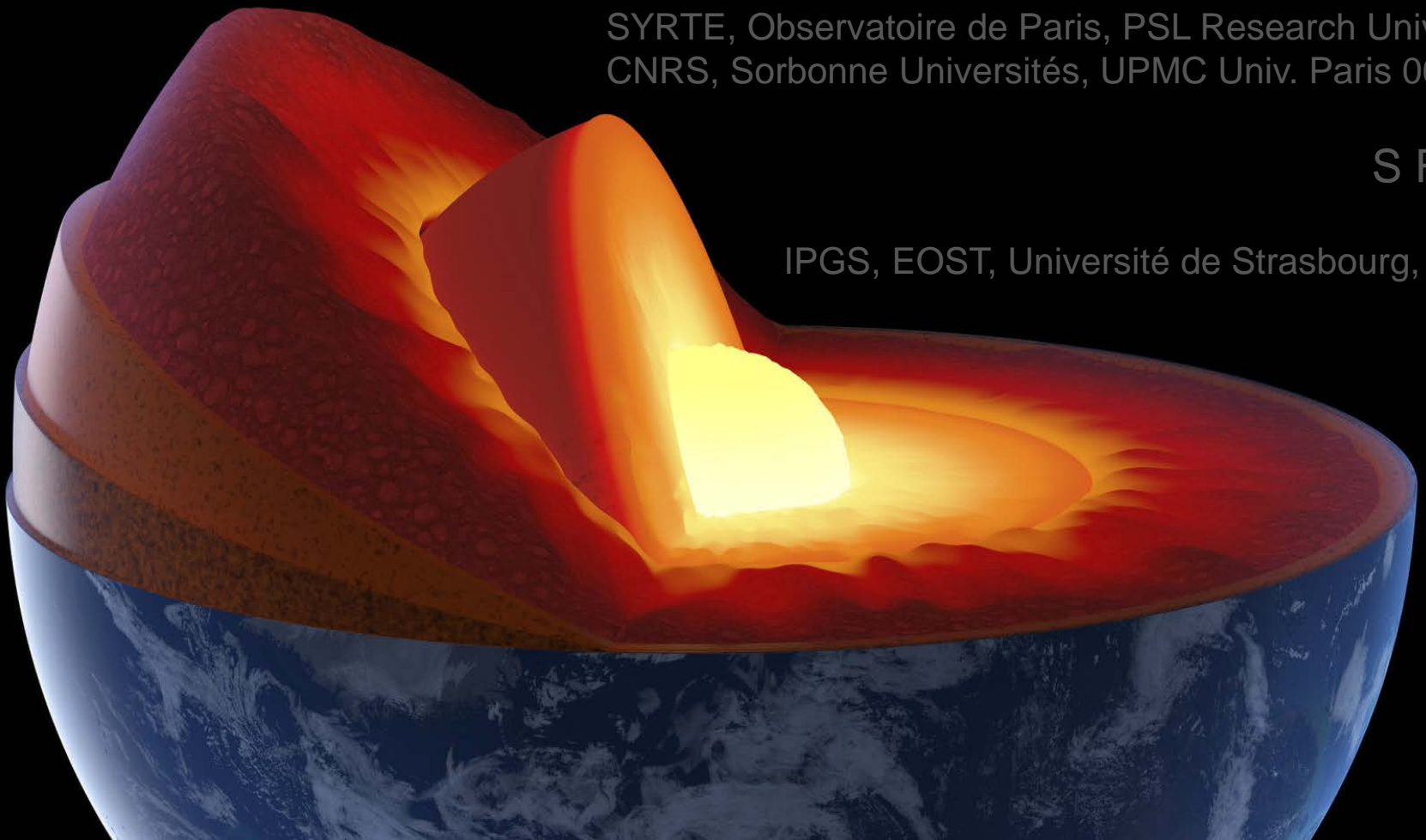
Drilling down to the Earth's core with VLBI

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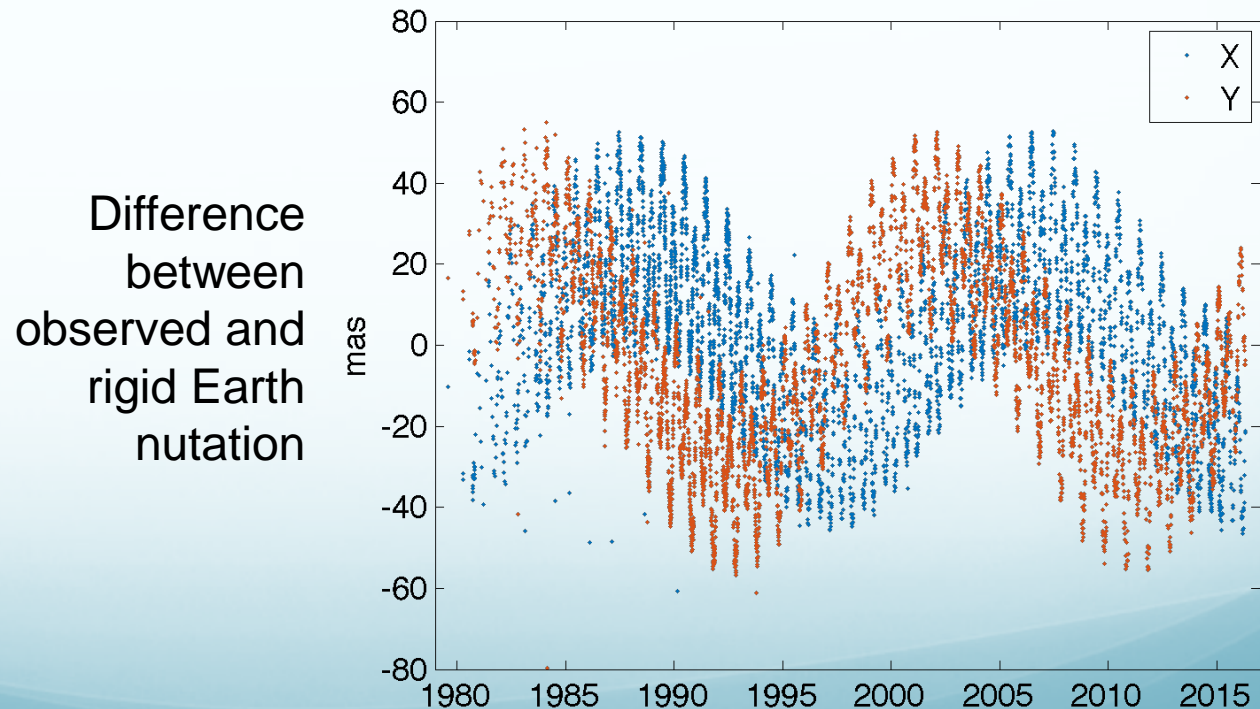


VLBI

- VLBI is the only technique giving access to
 - Radio source coordinates
 - Earth rotation angle (UT1)
 - Pole coordinates wrt space (nutation)
- Accuracy < 0.1 mas
- Next years developments
 - VGOS deployment
 - New ICRF
- 30+ years of data

VLBI and Earth's Interior

- Nutations are the response of the Earth's axis to external gravitational forcing
- The amplitude depends on the internal structure



VLBI and Earth's Interior

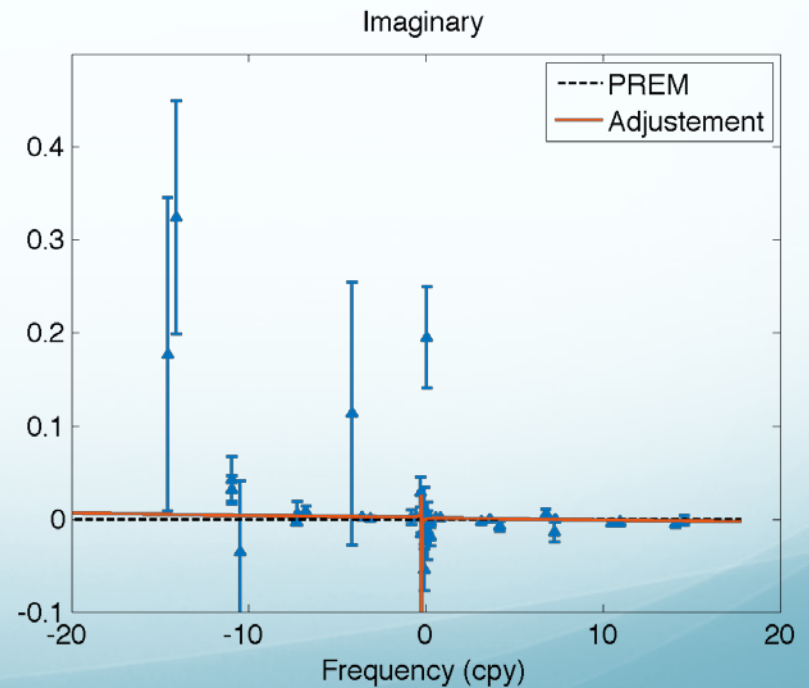
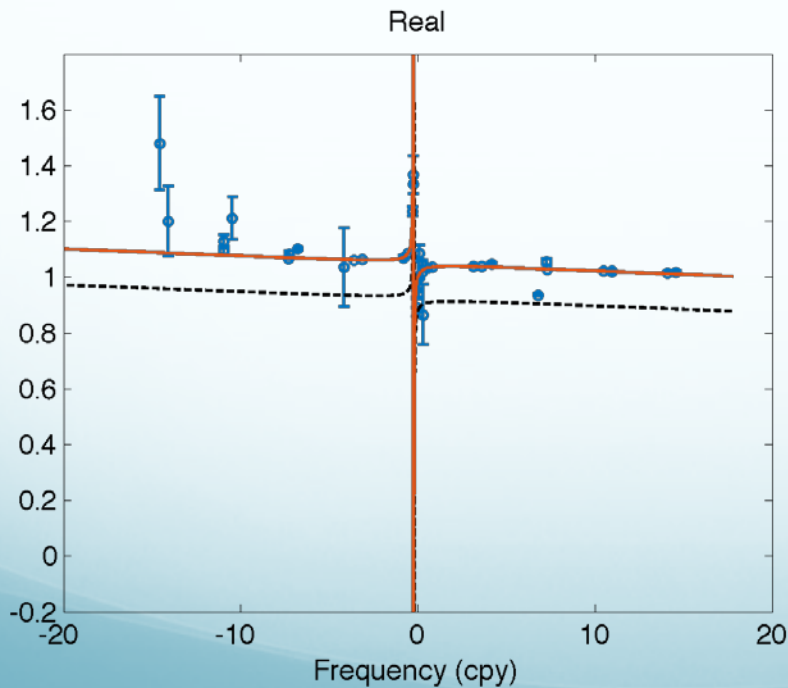
- “Non-rigid” Earth nutation N_{NR} modeled in the frequency domain as a function of the “rigid” Earth nutation N_R and a *geophysical transfer function* T (e.g., Sasao et al. 1980)

$$N_{NR}(\sigma) = T(\sigma) N_R(\sigma)$$

- T depends on Earth's internal structure
 - Resonant frequencies of the whole Earth and internal layers
 - Layers' flattening
 - Admittances at interfaces
 - Coupling constants between layers

VLBI and Earth's Interior

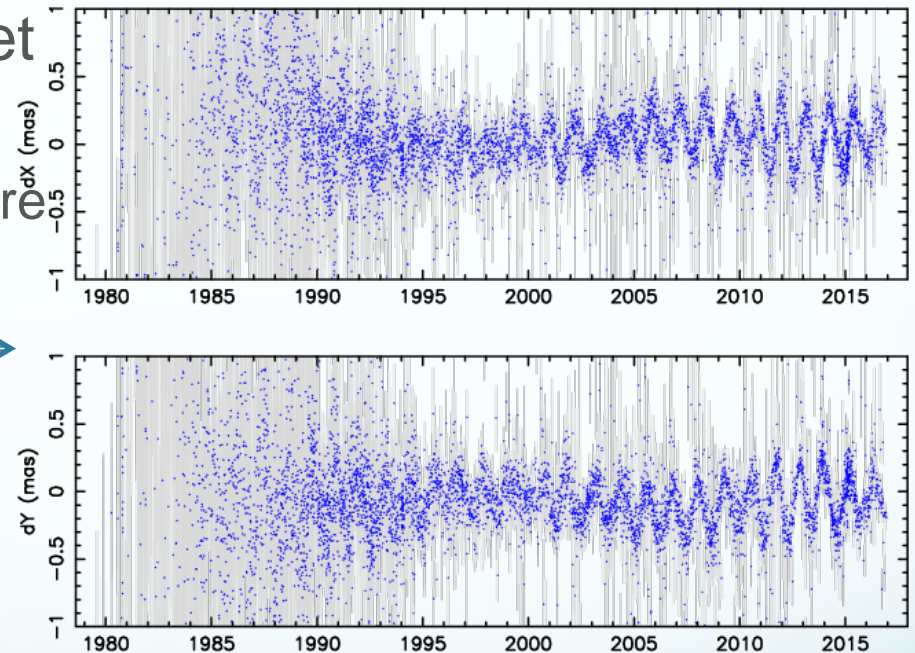
- $T = N_{NR}/N_R$ with parameters of T fitted to observations
- Example: adjustment starting from a rigid Earth and PREM a priori values



VLBI and Earth's Interior

- Powerful study by Mathews et al. (2002)
 - Extended Sasao to the inner core + oceans
 - Residuals →

opa2015a: nutation offsets to IAU 2006

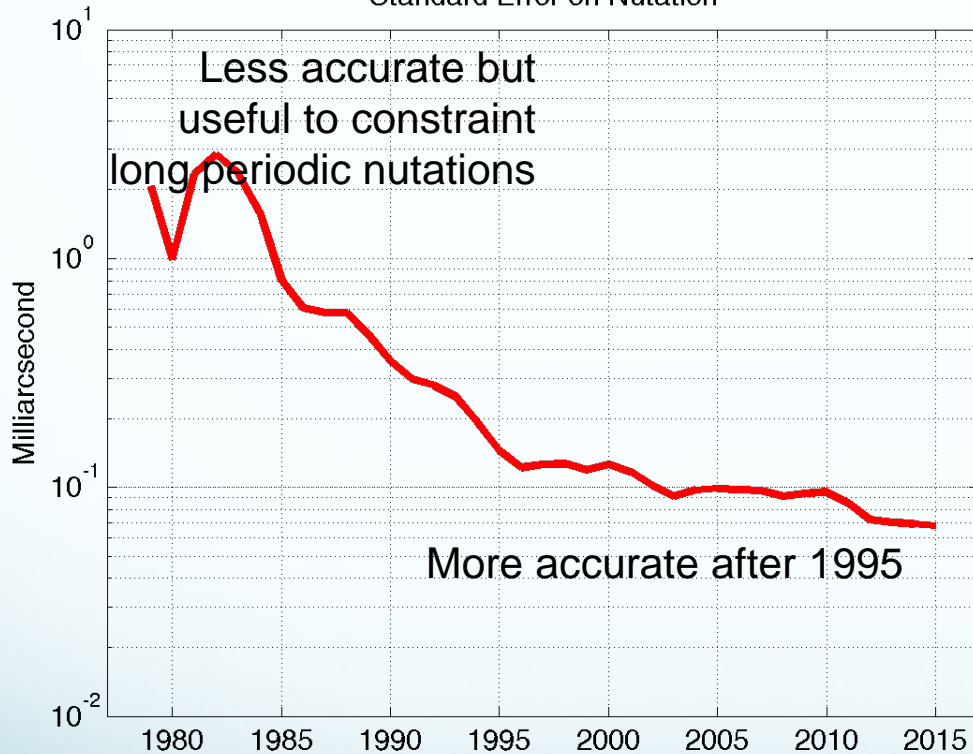


Some pending questions

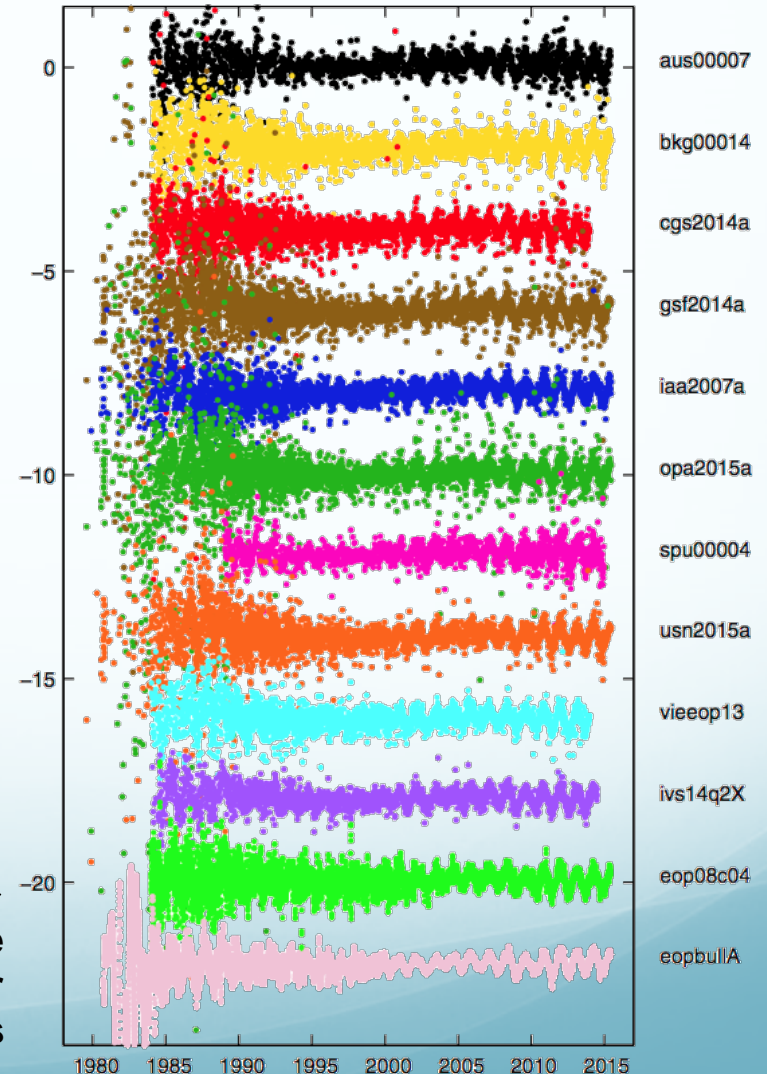
- **Excitation mechanism of the FCN?**
- **Reliability of the FICN period?**
- **Separation topographic/electromagnetic couplings at CMB?**
- **Value of the the radial magnetic field at CMB?**

VLBI and Earth's Interior

Standard Error on Nutation



Available series (Gattano, Lambert, Bizouard 2017) →
Issues about observation/analysis strategies to optimize the geophysical signal including combination w/ other techniques



VLBI and Earth's Interior

- The quest of the FICN
 - Mathews et al. 2002, Koot et al. 2008 ~ 1000 ± 100 days with strong a priori constraints
 - Rosat, Lambert, Gattano, Calvo 2017 based on VLBI and surface gravimetry, Bayesian inversion ~ confidence interval as large as the period itself... but period in closer agreement with theoretical predictions (~400 days)
 - Gattano, Lambert, Bizouard 2017 ~ confidence interval based on a comparison between analysis centers, as large as the period itself...
 - Sensitivity to the annual (atmosphere-driven) nutation...
- The FICN quest must be solved for addressing the topographic/electromagnetic couplings and value of the internal magnetic field

What VLBI Can Do?

- Some analysis issues must be explored
 - Reliability of nutation series (why they are different from one analysis center to another? who is doing right, who is doing wrong?)
 - Contribution of the atmosphere to nutations?
 - Help from other techniques (surface gravimetry)?
 - Inversion method (e.g., LSQ vs. Bayesian)
- Ongoing projects
 - Royal Observatory of Belgium: ERC “Rotanut”
 - SYRTE: combination VLBI/superconducting gravimeter data (Yann Ziegler, postdoc, next EGU poster)
 - SYRTE: direct estimates of the geophysical parameters from VLBI delays (Ibnu Nurul Huda, PhD)