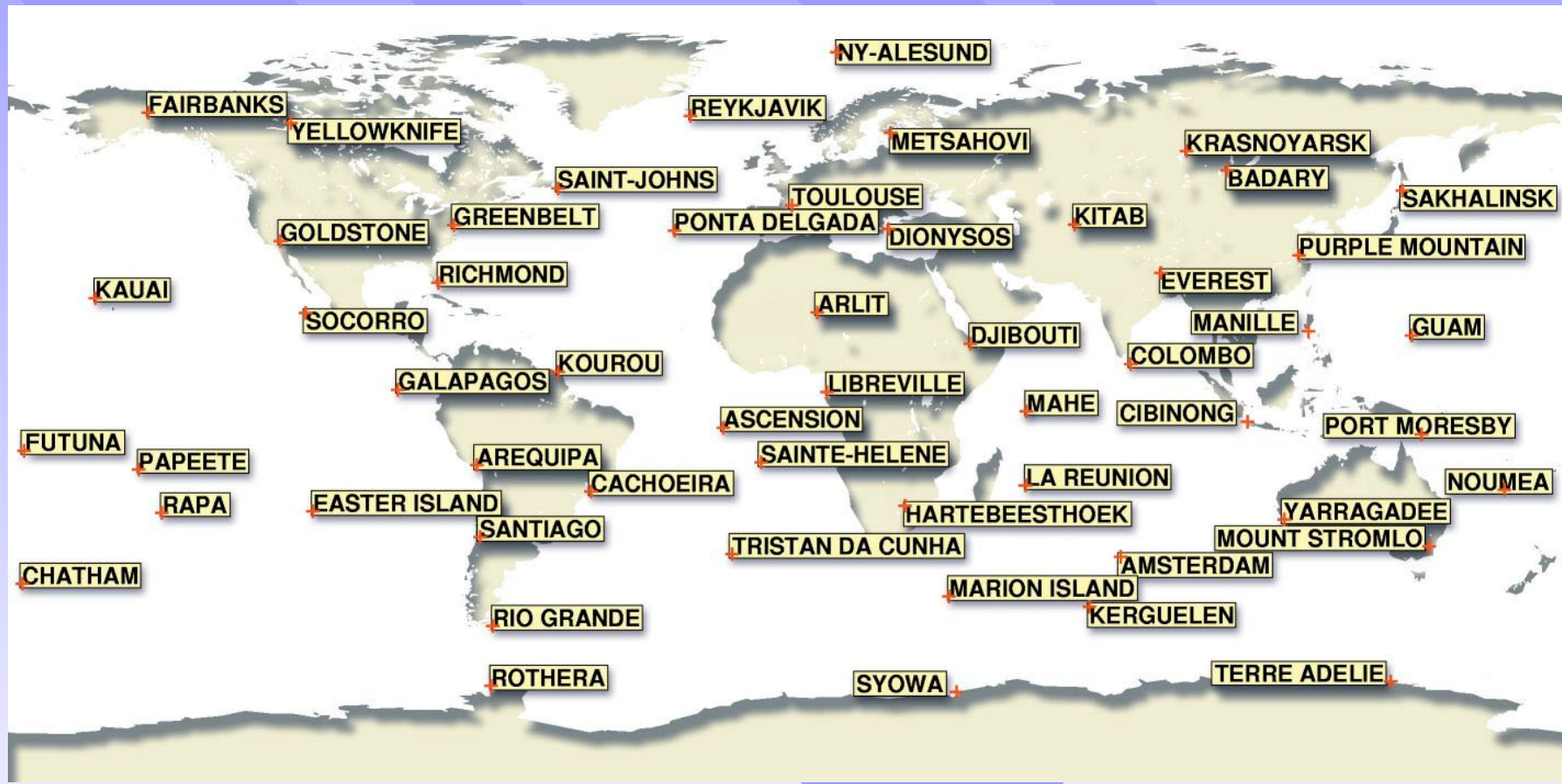
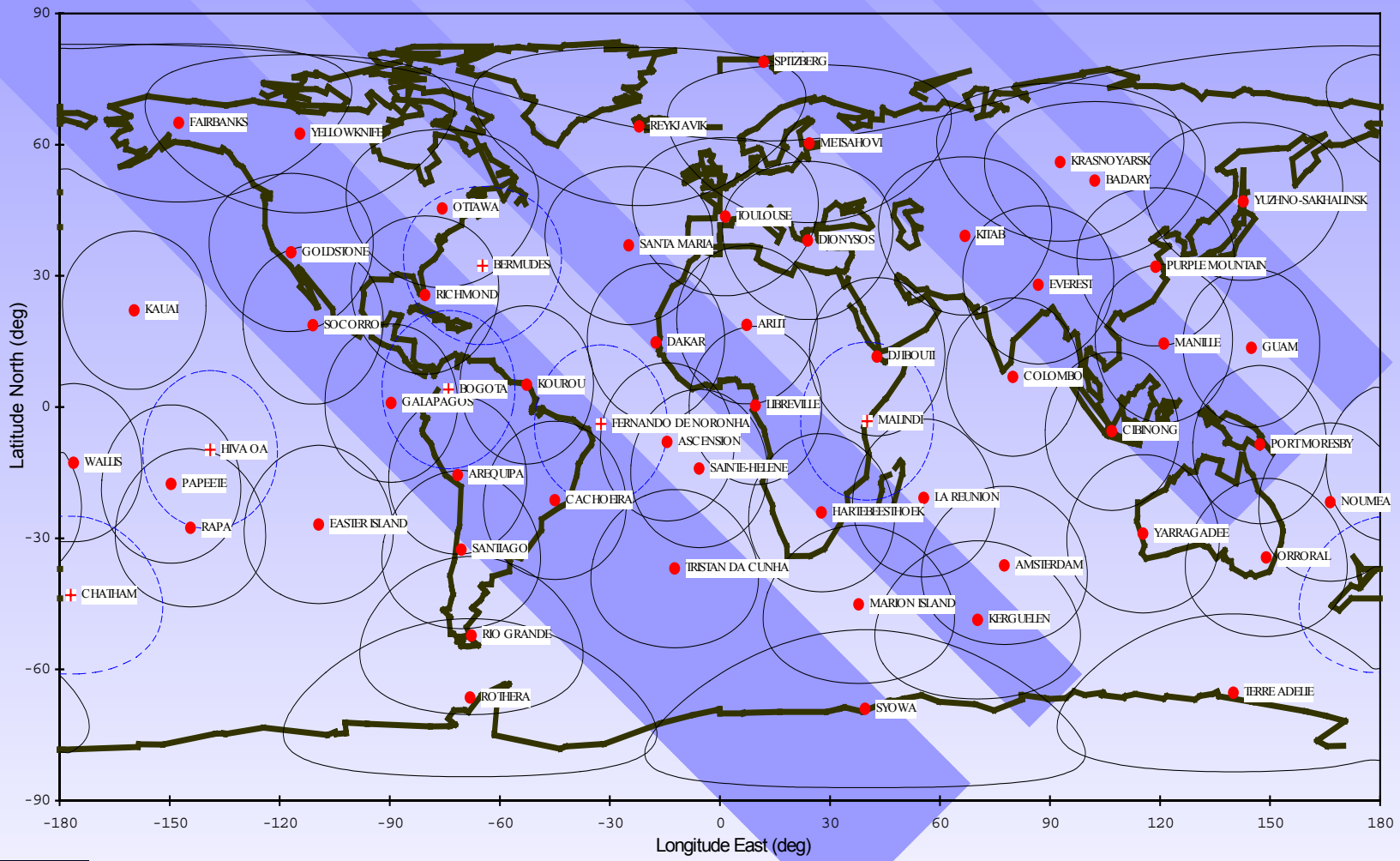
Real-time on-board orbits: 10 centimeters DORIS-DIODE current status

- DORIS & DIODE main features
- DIODE / SPOT4 in-flight results
- DIODE / Jason-1 in-flight results
- News about DIODE / ENVISAT
- current status

The DORIS network



DORIS coverage



SPOT4 (12° elevation)

DIODE

- On-Board Orbit Determination function, providing:
  - satellite position/velocity (plus a quality assessment),
  - TAI time-tagging (plus a quality assessment),
  - ancillary products (next beacon, expected Doppler, …),
  - elaborated on-board and in real-time every ten seconds.
- Products are useful for:
  - platform and payload,
  - ground processing of the data (images, altimetry, …),
  - DORIS receiver (self-programming and reduction of Doppler tolerances).

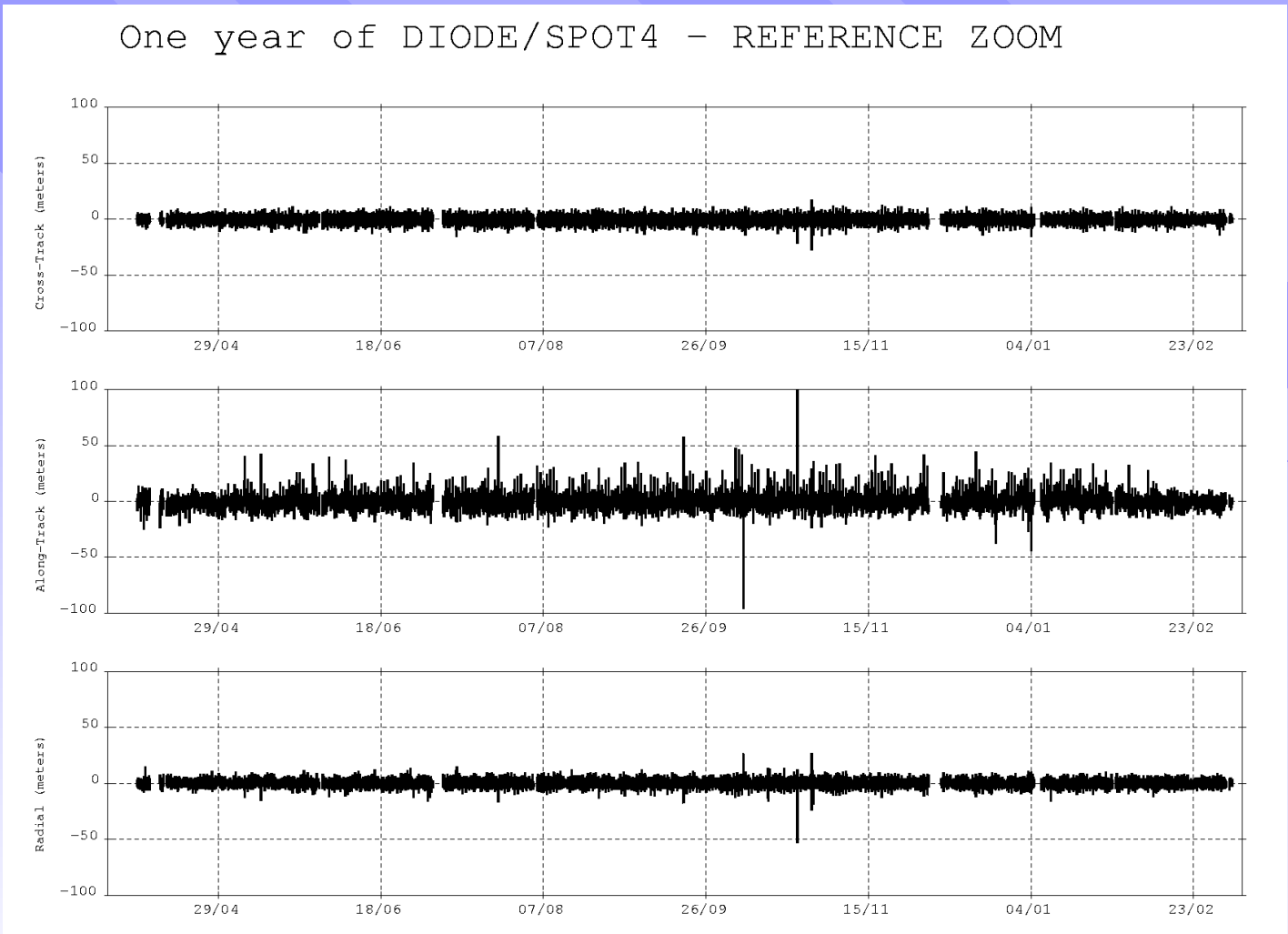
DIODE / SPOT4

- A probatory experiment ...
  - validation of the concept (routine filter only),
  - limited amount of memory on a dedicated card,
  - software completed in June 1995.
- … but already users of the products:
  - POAM (NRL, for optical terminal pointing),
  - SPOT IMAGE (ground immediate and precise rectification),
  - VEGETATION (idem),
  - DIODE monitoring and R&T evolutions.

DIODE / SPOT4: main features

- Only the routine Kalman filter:
  - prediction/correction every ten seconds,
  - state vector : position, velocity, frequency & tropospheric biases.
- Extrapolation model:
  - Runge-Kutta numerical integration (Gill),
  - force model = 15x15 E.G.F., nominal thrust accel.
- Measurement model:
  - ionospheric error (two-frequency measurement),
  - on-board clock estimated with Master Beacons.

DIODE/SPOT4 on-orbit results



DIODE / SPOT4 conclusions

- After more than four years:
  - accuracy = a few meters RMS,
  - availability ≅ 99.5% (MTBF ≅ one year),
  - meet specifications (200 m MAX) > 99.9%),
  - good behaviour during manœuvers.
- users of the products:
  - POAM several times a day (near poles),
  - SPOT IMAGE: DIODE is the nominal source for image positionning,
  - VEGETATION (permanent since July 1999).

DIODE / Jason-1

- Complete mission, including:
  - improved dynamical model,
  - improved autonomy:
    - » self-initialisation (« lost in space »),
    - » self-programming of the DORIS receiver,
  - TAI (or UTC) time-tagging of external events.
- Users of the products:
  - quick-look processing of altimetric data,
  - possible use by the platform,
  - and by the ground Control Center.

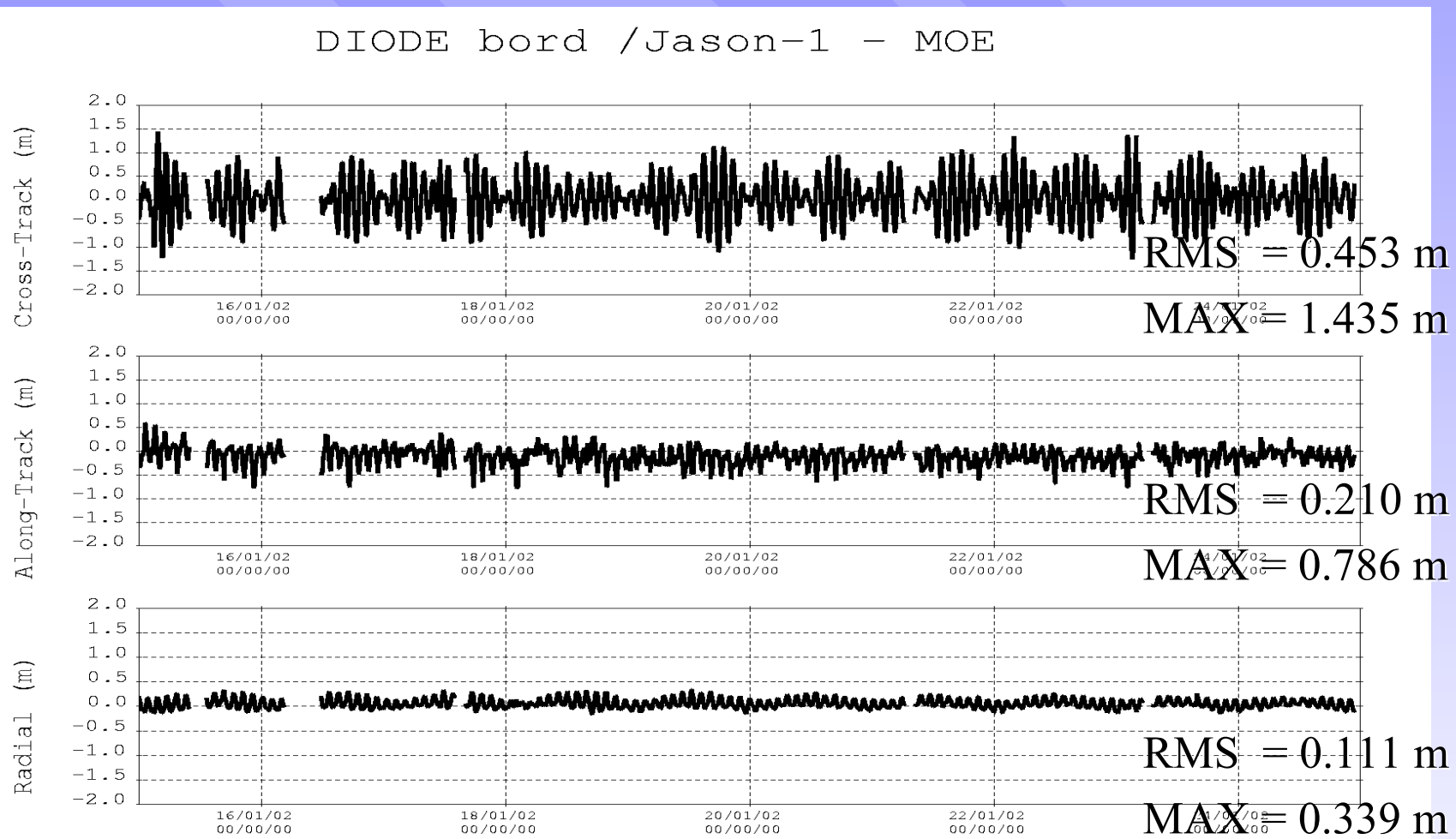
DIODE / Jason-1: main evolutions

- New functionnalities:
  - self-initialisation algorithm (4 passes, two filters),
  - receiver programming (prediction of the next-to-come beacon, optimal choice, Doppler shift).
- Improved models:
  - adjusted: Earth pole coordinates, Hill accelerations, thrust accelerations,
  - force model = 40x40 optimised E.G.F., moon&sun attractions, solar pressure (box&wings), air drag.
- improved quality assessments.

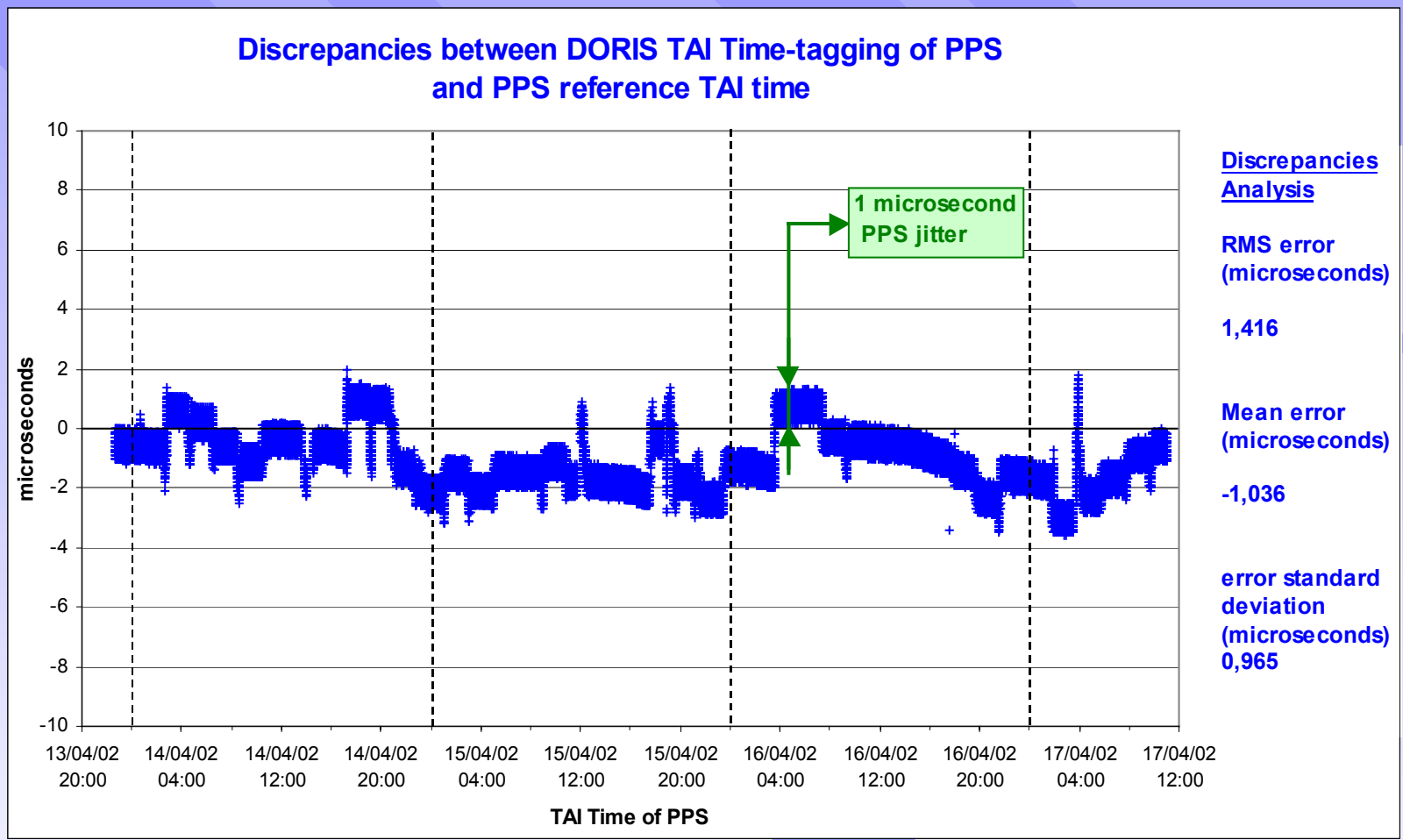
DIODE / Jason-1 performances

- Performances:
  - routine accuracy: 1m RMS 3D, a few centimeters radial RMS (between 8 and 14),
  - self-initialisation:
    - » ten hours after launch (without any TC in barbecue mode),
    - » in January, first position 35 mn after restart.
  - time determination (between 1 and 3 microseconds),
  - operationnal use of the self-programming mode.
- Availability: 100 % until now.

DIODE/Jason-1on-orbit results



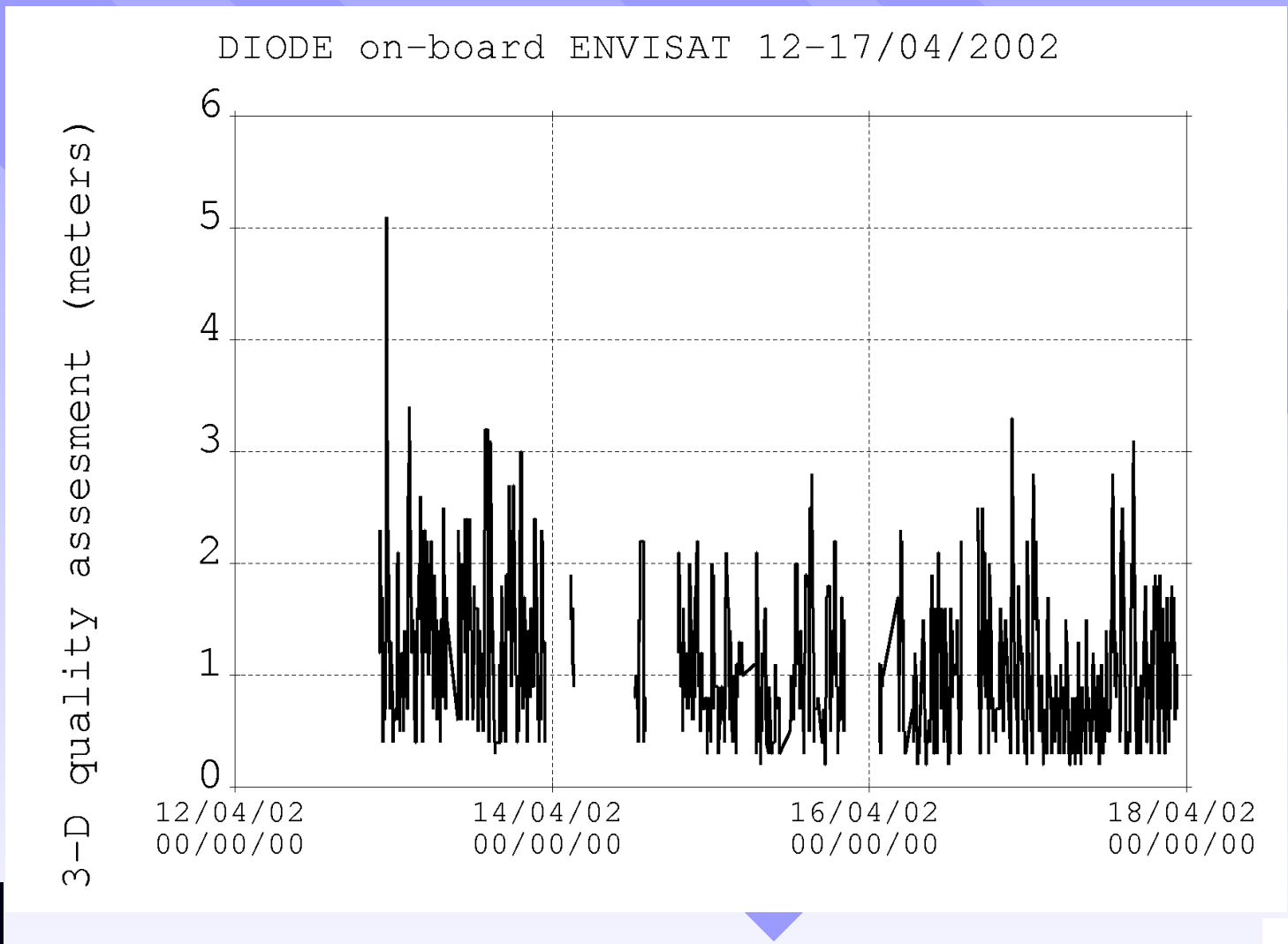
Time determination results



DIODE/ENVISAT

- Operating since April 12, 2002.
- Undergoing on-orbit acceptance test
  - comparisons with ground orbits,
  - time determination results.
- Operationnal use of the self-programming mode.

DIODE/ENVISAT

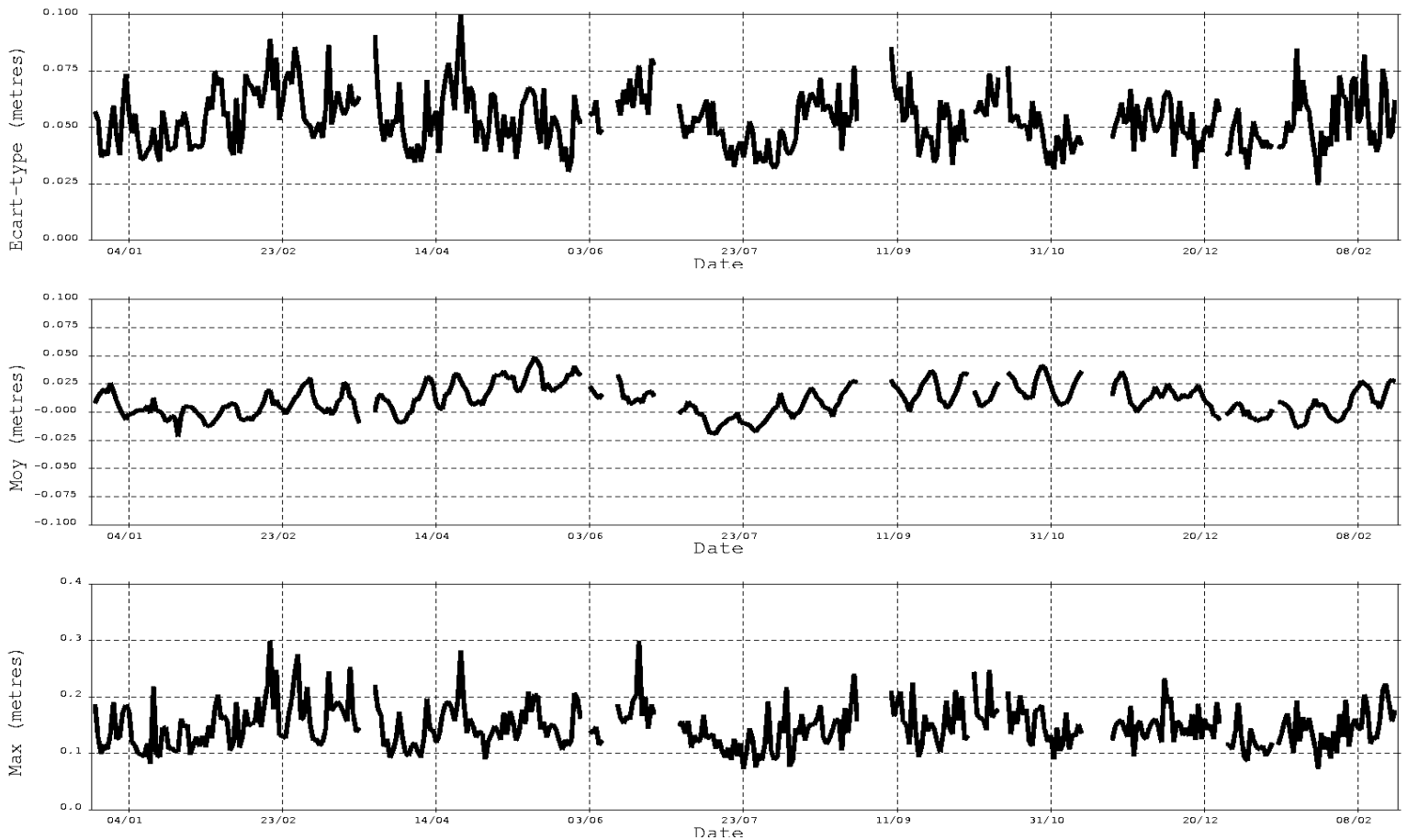


DIODE current status

- On-orbit: SPOT4, Jason-1, ENVISAT.
- Waiting for flight: SPOT5 and a retrofit on SPOT4,
- On Skybridge, DORIS/DIODE has been evaluated as technically acceptable,
- First CRYOSAT/Pléiades version under validation (ERC32 64 bits processor),
- Currently under study:
  - AltiKa, Jason-2, NPOESS, ...

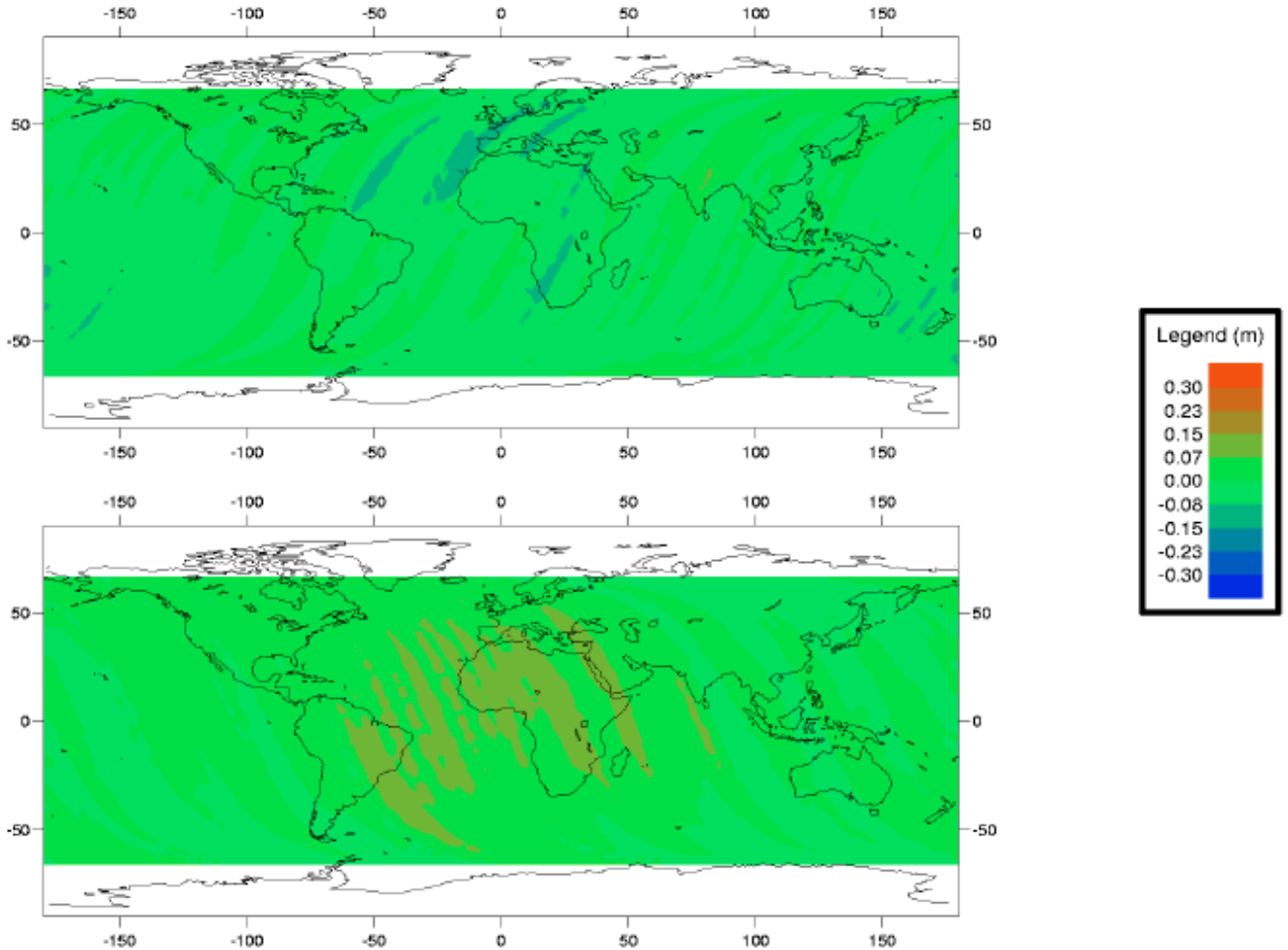
DIODE/TOPEX radial errors

– (64 bits SPARC processor)



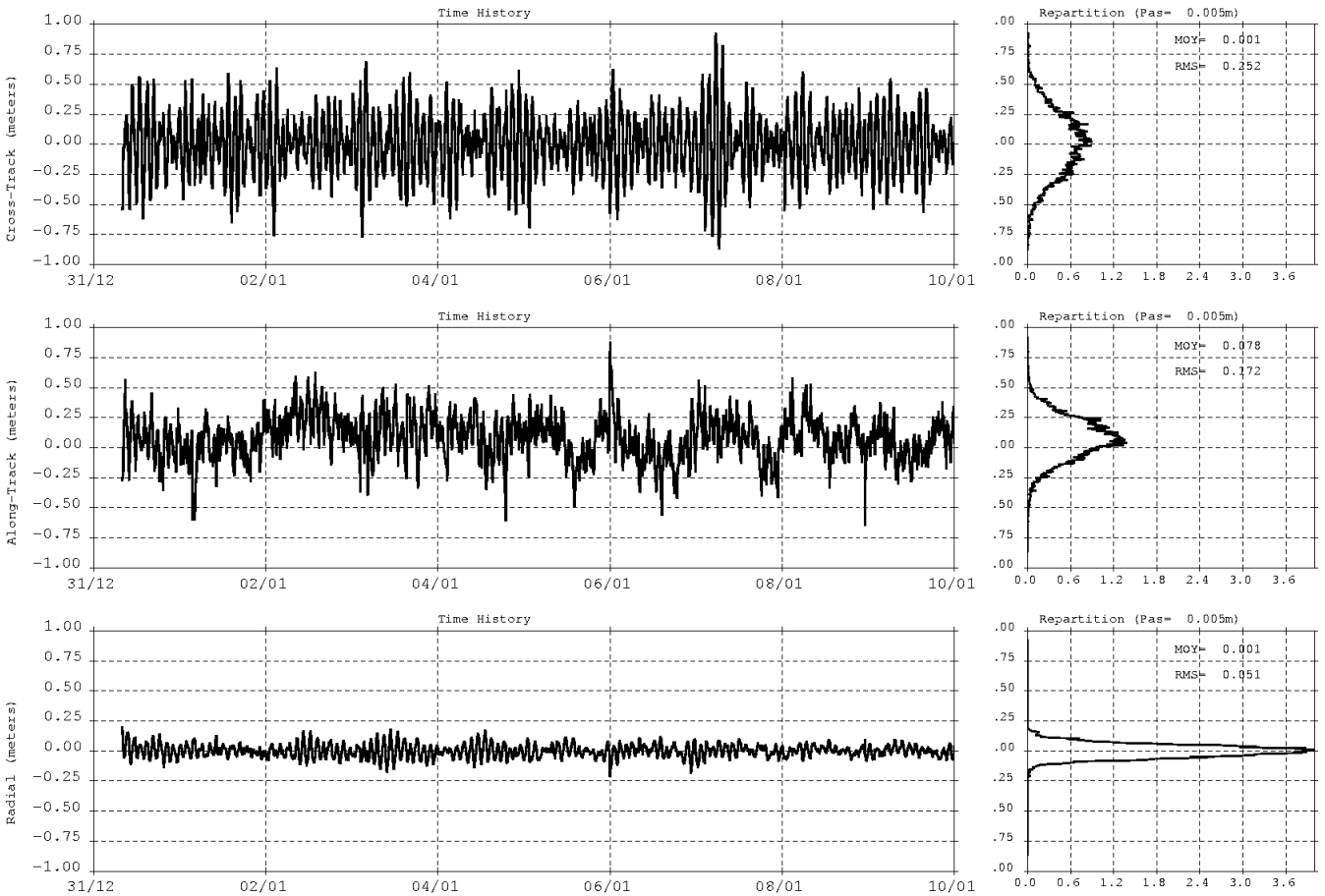
DIODE/TOPEX cy 232 radial errors

– (64 bits SPARC processor)



DIODE/TOPEX ground results

– (64 bits SPARC processor)



Contact

- For further details, please contact :

Christian Jayles, CNES

email : Christian.Jayles@cnes.fr