IGS LEO session

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LEO activities at ESOC

Henno Boomkamp

Presentation outline

- Overview of CHAMP analysis at ESOC
- Current POD results for CHAMP
- Expected development of LEO+GPS processing capability
- Conclusions

CHAMP analysis at ESOC (1)

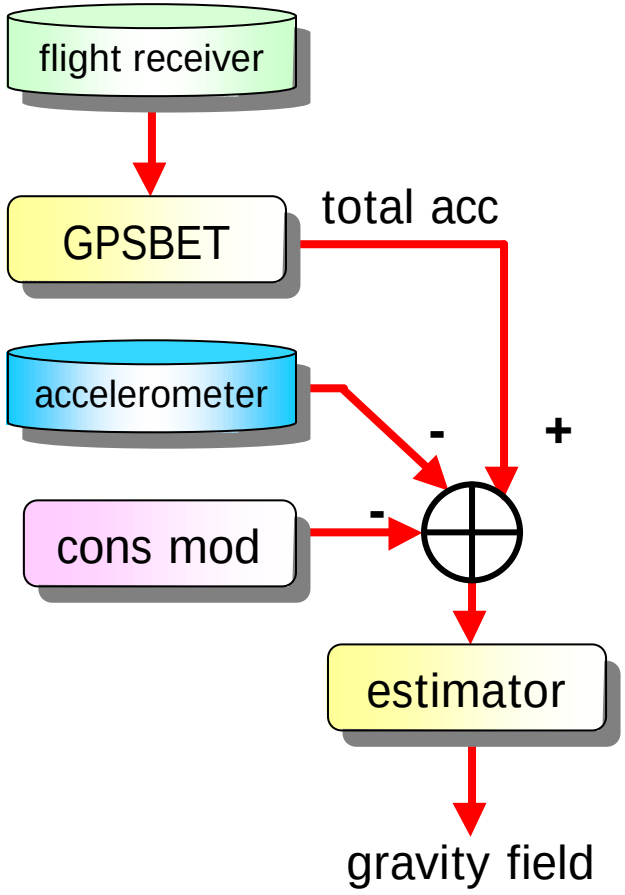
Objectives, status before CHAMP

- Objectives
  - Development of *low* LEO analysis capability based on GPS
  - Participation in IGS LEO pilot project analysis
  - Development of combination solution capability LEO+GPS
- Dynamic POD before CHAMP
  - ESOC POD software never used below orbits like ERS, Envisat
  - Implemented gravity field models only partially normalised, numerically unstable for degrees higher than 80 - 85
  - Limited capability for estimating empirical accelerations
- Reduced dynamic and kinematic POD before CHAMP
  - Some experience with flight receiver data, sequential filter GPSBET
  - Precision levels strongly dependent on data quality and LEO clock estimation

CHAMP analysis as initially planned

- Kinematic solutions from sequential filter provide position, velocity and total acceleration
- Accelerometer signal used to remove non-conservative component from the total acceleration
- Several components of conservative acceleration can be accurately modelled (luni- solar gravity, planets, solid Earth tides)
- Remaining signal used to estimate gravity field in new software

New gravity field allows dynamic POD



CHAMP analysis in practice

- Experience with kinematic POD
  - Sequential filter precision levels limited to ~20 cm in position and ~10^{-3} m/s^2 in acceleration
  - Data gaps cause orbit gaps or temporary divergence at meter level
- Experience with accelerometer data in dynamic models
  - The normal points do not always provide the added precision that is expected from the signal, especially around attitude events
  - Problems with numerical integration of the signal due to gaps, noise, spikes in the early data
- New approach- dynamic solutions
  - Implementation of fully normalised, high resolution gravity field
  - Accelerometer signal still used to assist non-conservative modelling, but not to replace it fully
  - Abundance of empirical parameters to provide adequate freedom to the solution, but not as much as a kinematic solution

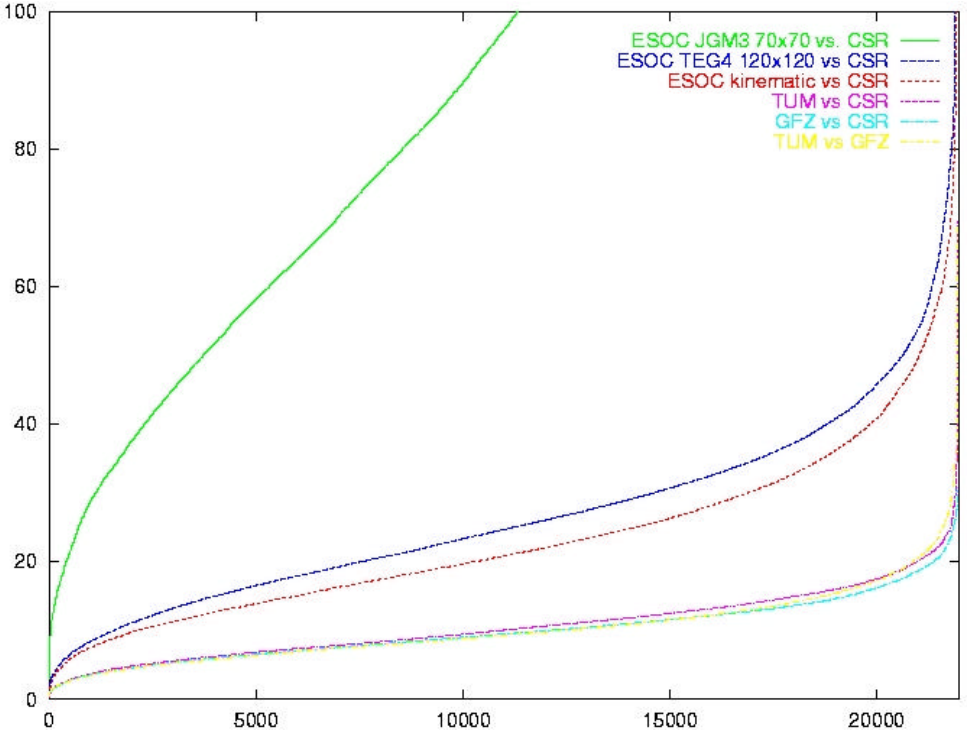
Current POD results for CHAMP (1)

Comparison kinematic - dynamic

- Both solutions use
  - Zero differenced pseudo range and phase data
  - GPS orbits and clocks fixed to ESOC contribution to IGS
- Kinematic solution (from campaign)
  - Two prediction / smoothing cycles, data editing process after first run
  - Solution is very homogenous but limited to ~25 cm RMS
- Dynamic solution
  - At present limited to 120 x 120 gravity (TEG4 used)
  - Arc lengths still limited (~ 4 hours)
  - 1 drag parameter per orbit
  - Empirical 1-CPR every hour
  - Pass-dependent biases for CHAMP (LEO clock)

Current POD results for CHAMP (2)

Estimated POD precision



Orbit error distributions ESOC (cm)

Using precision estimates (cm) from the orbit campaign:

• CSR	6.75
• GFZ	7.31
• TUM	8.31
• ESOC Kinematic	26.0
• old ESOC dynamic	29.3
• new ESOC dynamic	84.6

Precision dynamic solutions limited by known software problems.

These problems are being solved together with implementation of combined LEO + GPS capability.

Development of combined LEO + GPS capability

Required modifications to POD

- Software changes
  - Satellite dependend memory allocations
  - LEO and GPS pre-processing merged into one system
  - Some remaining modifications to gravity field and tides
  - Changes to handling of LEO clock in combination solution
  - Perhaps some further changes for JASON
- Analysis and verification
  - Experiments for reaching adequate set of estimated parameters
  - Experiments for relative weighting LEO and GPS
- Schedule
  - Capability for combined analysis LEO + GPS expected at ESOC around September - October 2002

Conclusions

- Current ESOC POD for LEO still based on kinematic solutions
- Precision of kinematic solutions limited to around ~ 25 cm
- Kinematic solutions will not allow for combined analysis with GPS
- Dynamic solutions are rapidly improving. LEO only solutions are expected to reach adequate precision in immediate future.
- Combination analysis with GPS developed simultaneously in parallel with LEO improvements.
- First combination solutions LEO+GPS expected around September