Operational Processing of GRAS Radio Occultation Data at EUMETSAT
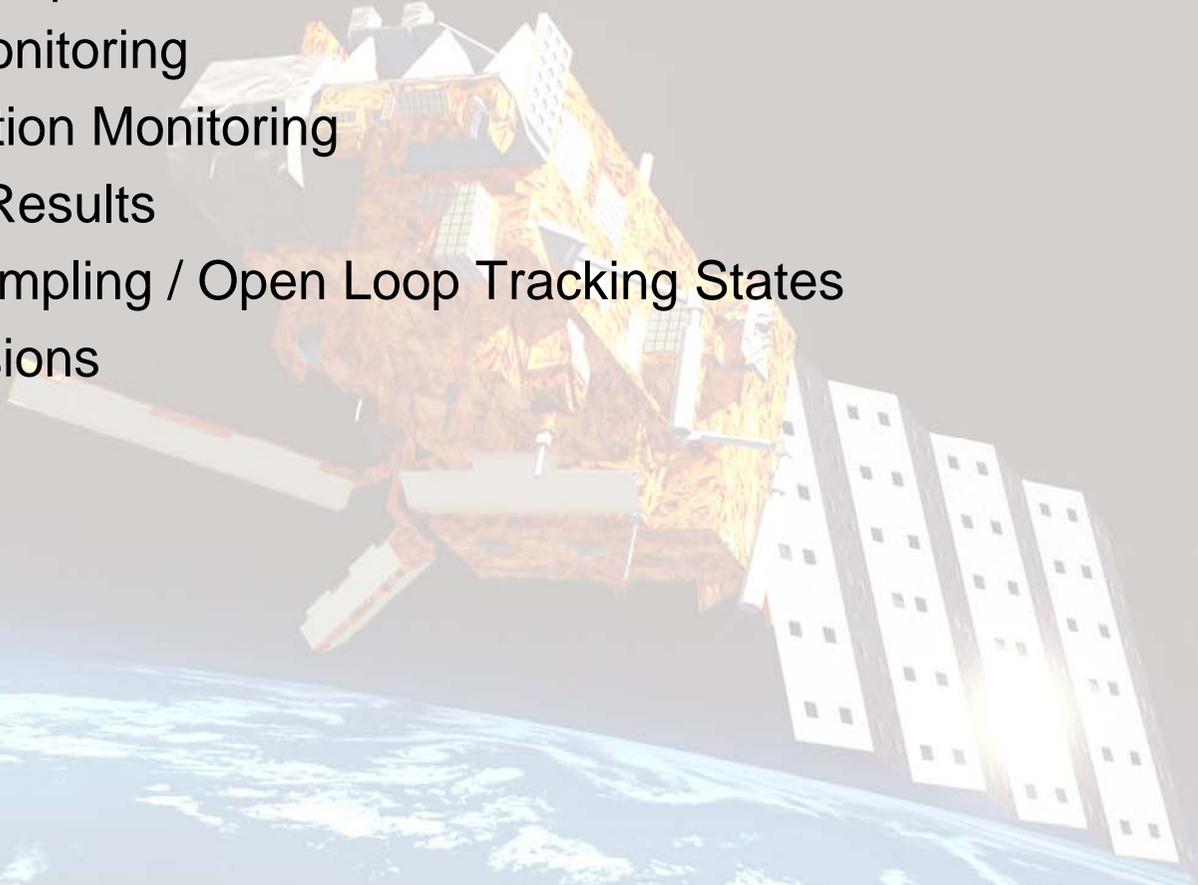
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Overview

- POD Setup

- POD Monitoring

- Occultation Monitoring

- Offline Results

- Raw Sampling / Open Loop Tracking States
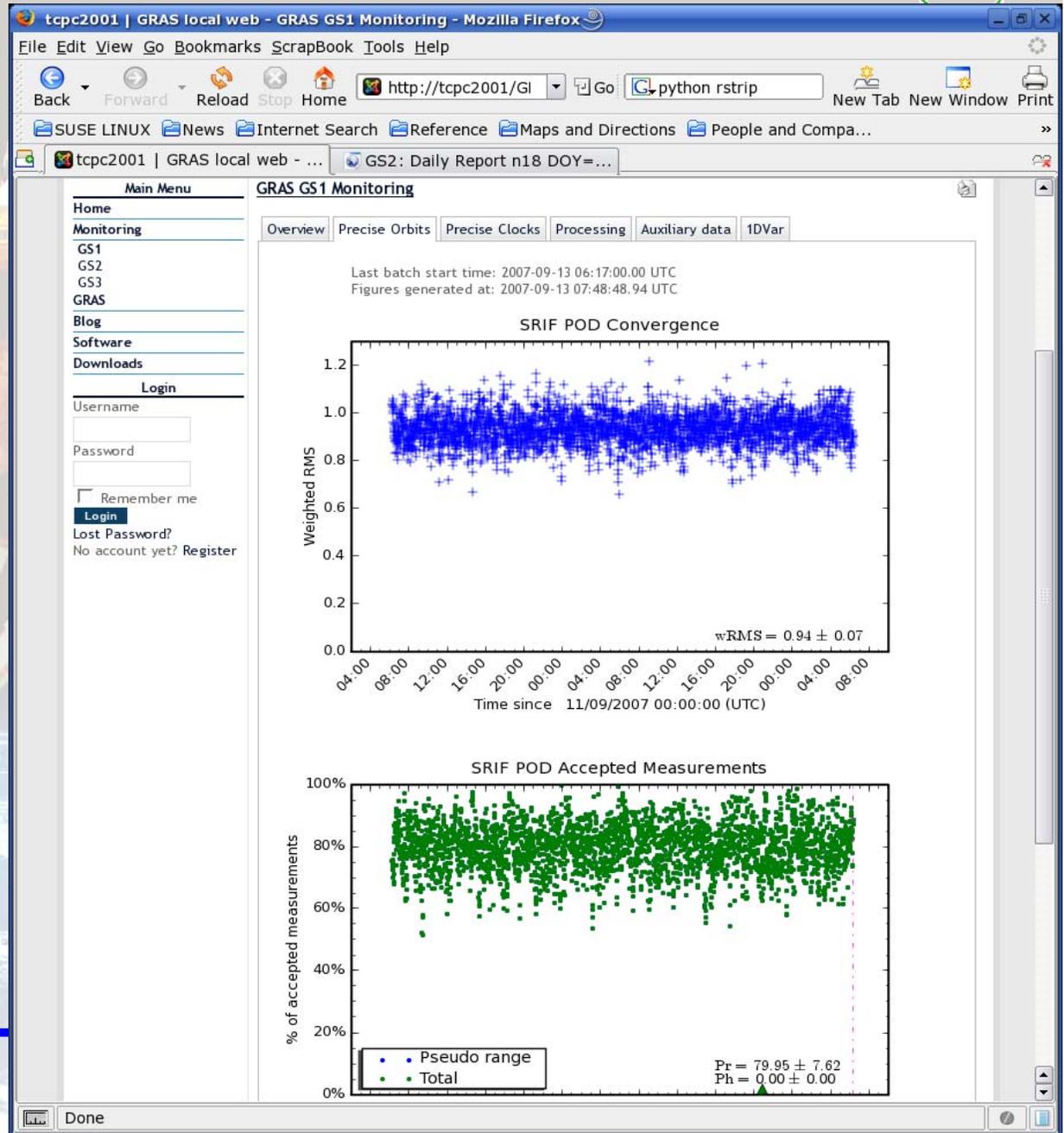
- Conclusions

POD Setup

- ***First pass:***

  – PR only, determine precise orbit

- ***Second pass:***

  – PR & CP, estimate clocks using fixed orbit from previous pass

- **Undergoing testing:**

  – One run solving orbit and clocks with PR & CP
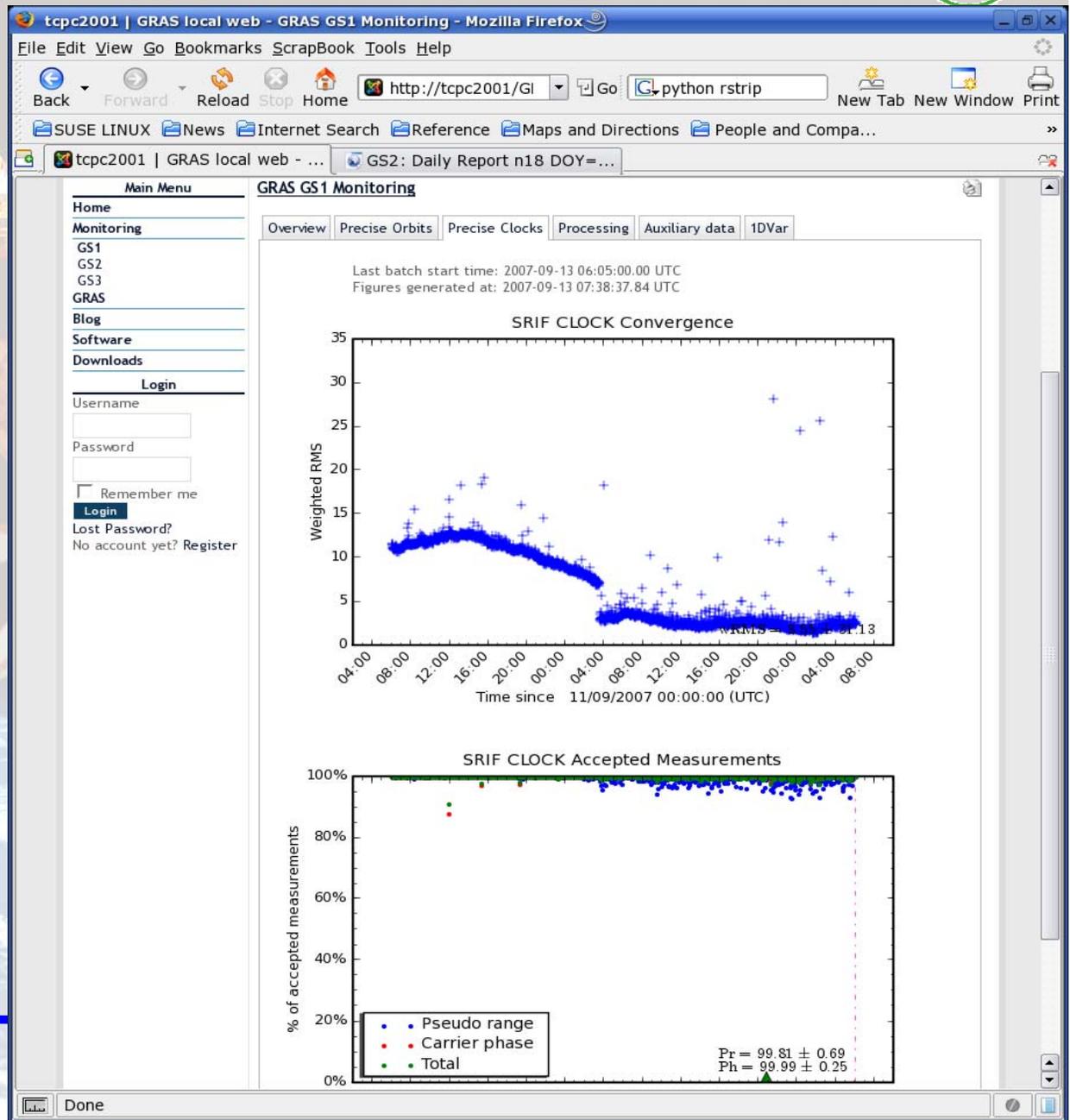
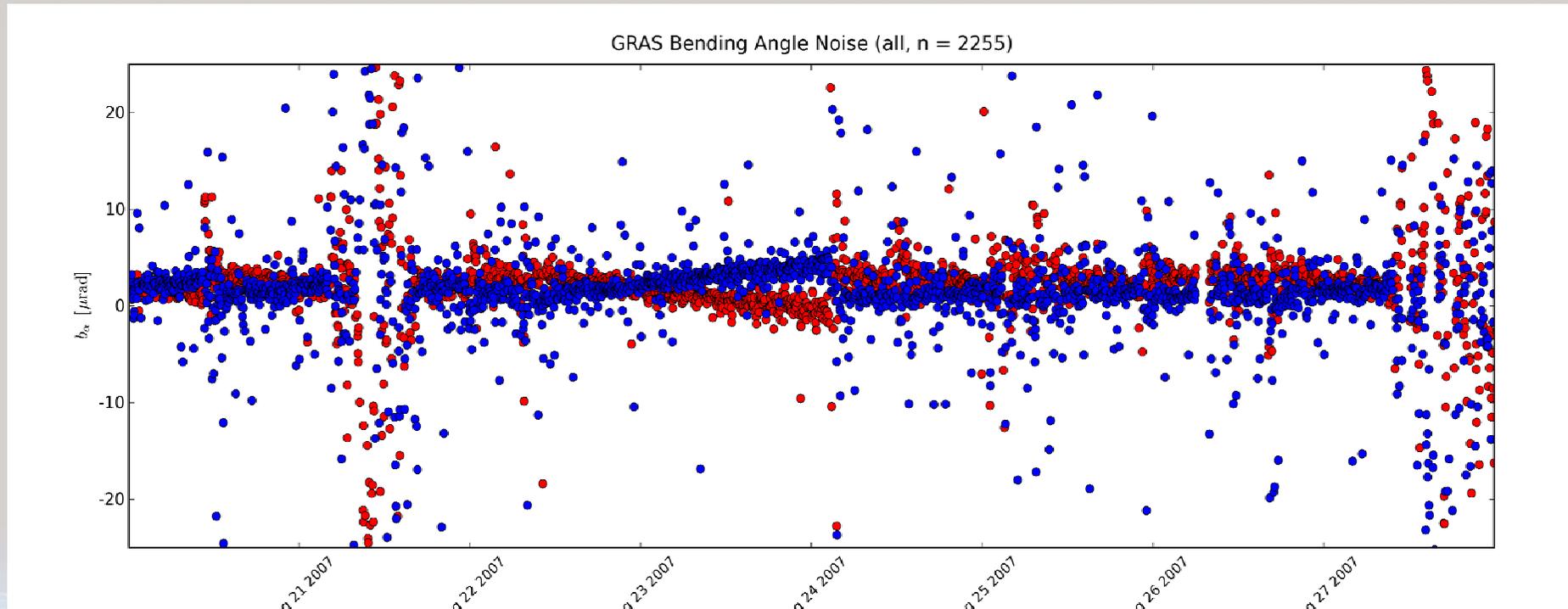# POD Monitoring: Orbits

Screenshot of POD
Monitoring Website

POD Monitoring: Clocks

Screenshot of

Clocks Monitoring

Website

Occultation Monitoring: Upper atm Bias

GRAS Bending Angle Noise (all, n = 2255)

Episodes of slow convergence mixed with frequent POD
resets caused by external sources…

"Offline" processing

- **PyGras**: measurement reconstruction / level 1a
  - Started as reader for (small parts) of level 0
  - Mostly developed after MetOp launch to aid PPF debugging
  - Now does code and carrier phase reconstruction for all PLL tracking, parts of telemetry, most of instrument corrections, Rinex output,…
  - Will be used to feed CalVal / Offline POD
  - contributed a lot to discovering and solving several PPF bugs

- **Napeos**: Offline batch POD (provided by ESOC), validated with several LEO missions (CHAMP, ERS, Envisat,…)

- **Yaros**: Old level 1b / level 2 processing for CHAMP
  - Geometrical optics retrieval, wave optics (FSI) prototype
  - validated with ~100,000 CHAMP occultations
  - Dry temperature and 1DVar's (ROPP is a partial rewrite)
  - Some diagnostics (noise levels, information content…)
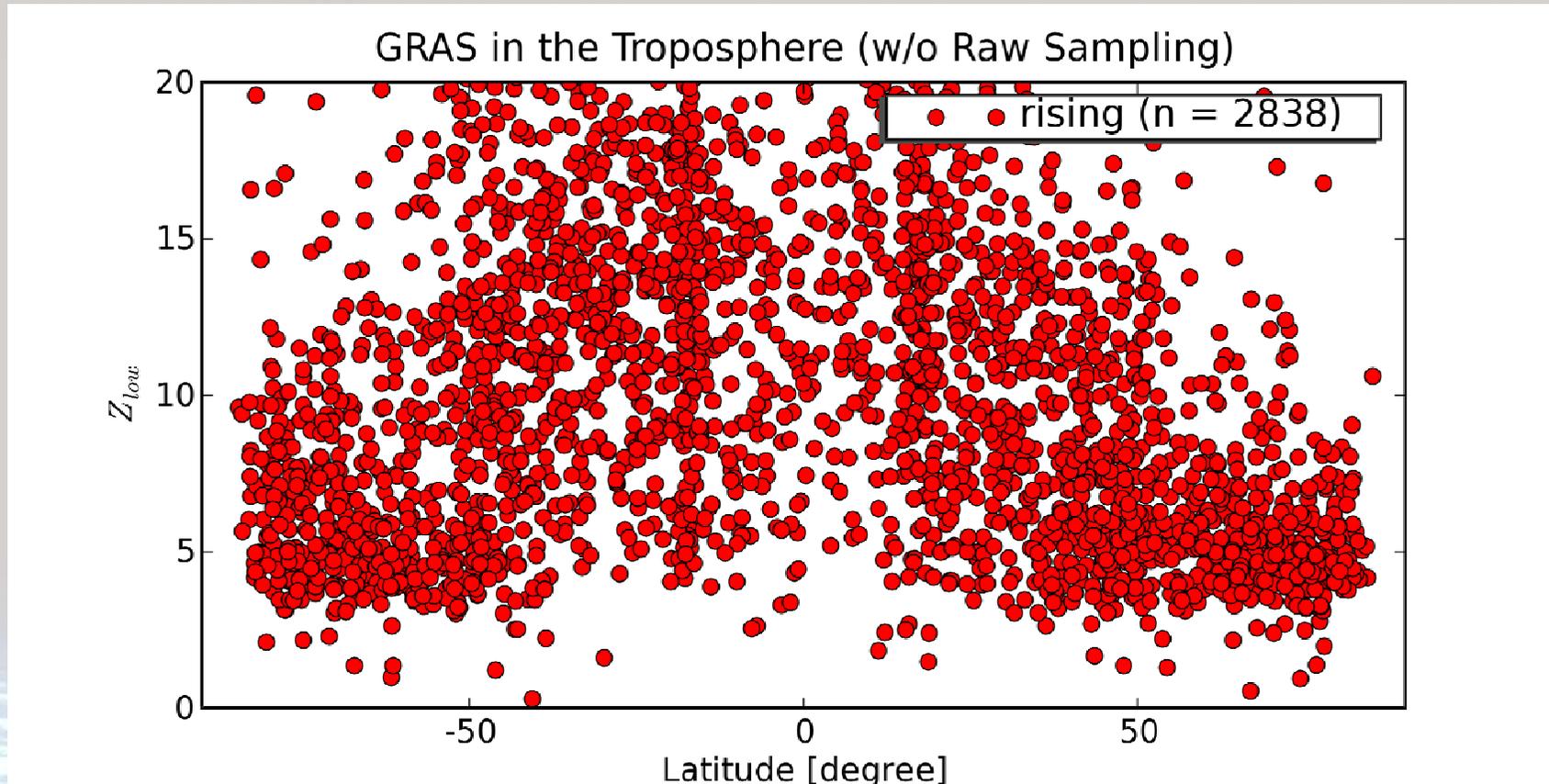
Upper level noise and bias (cont'd)
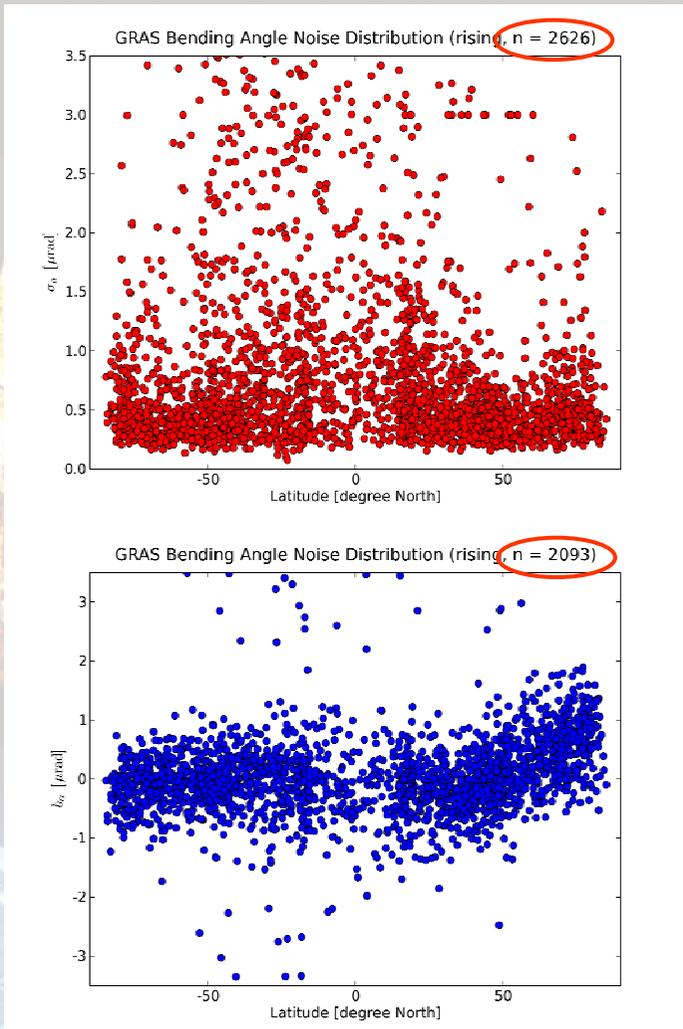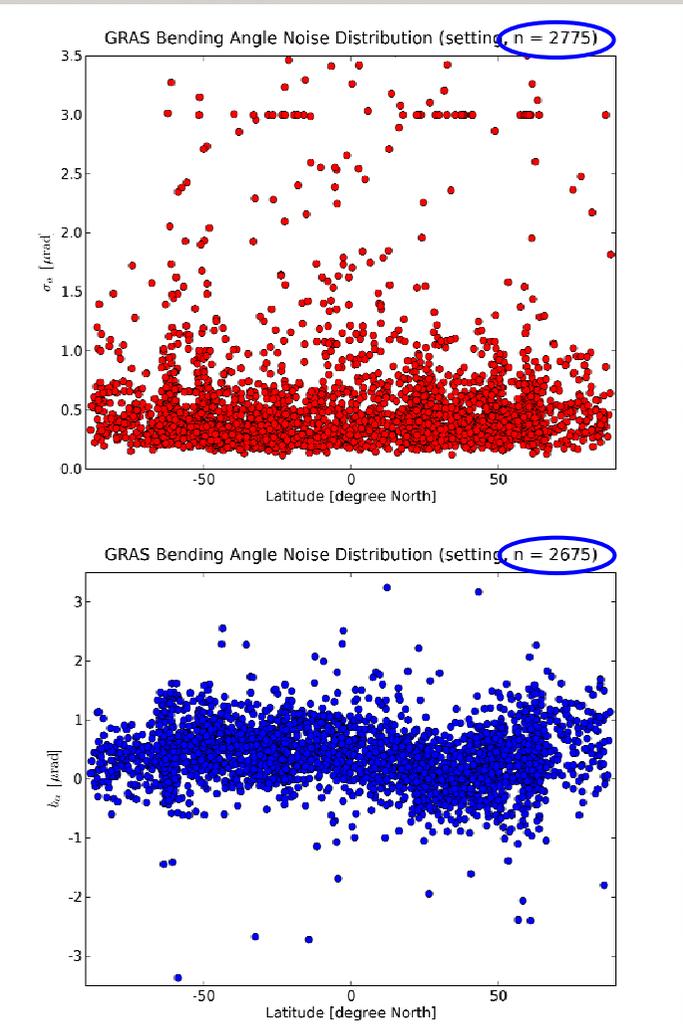
Penetration into troposphere

GRAS in the Troposphere (w/o Raw Sampling)

setting (n = 2882)

Z_{low}

Latitude [degree]
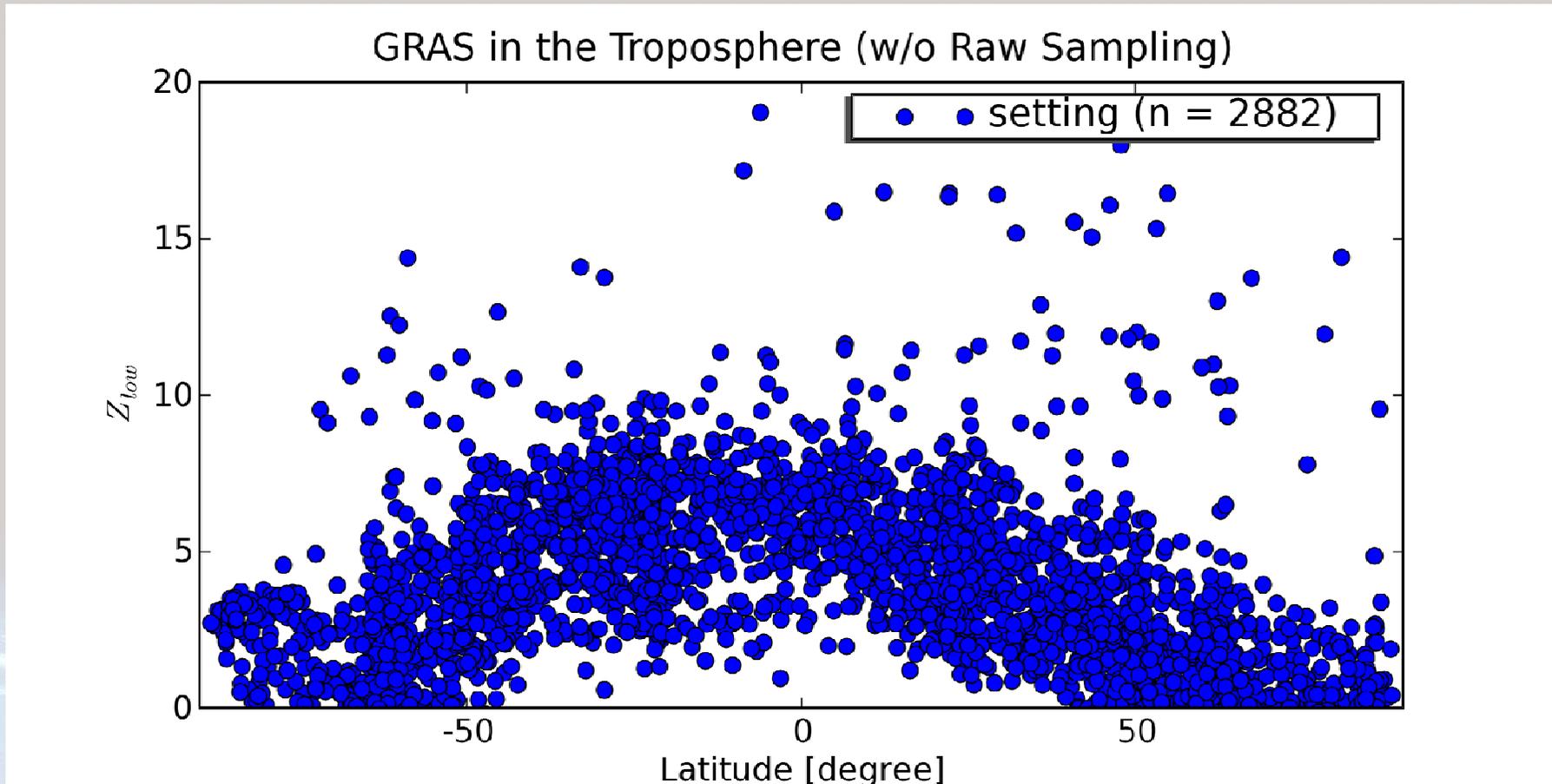
Note: NO raw sampling data, just dual/single frequency tracking!

Penetration into the troposphere (cont'd)

GRAS in the Troposphere (w/o Raw Sampling)

rising (n = 2838)

Z_{low} vs Latitude [degree]
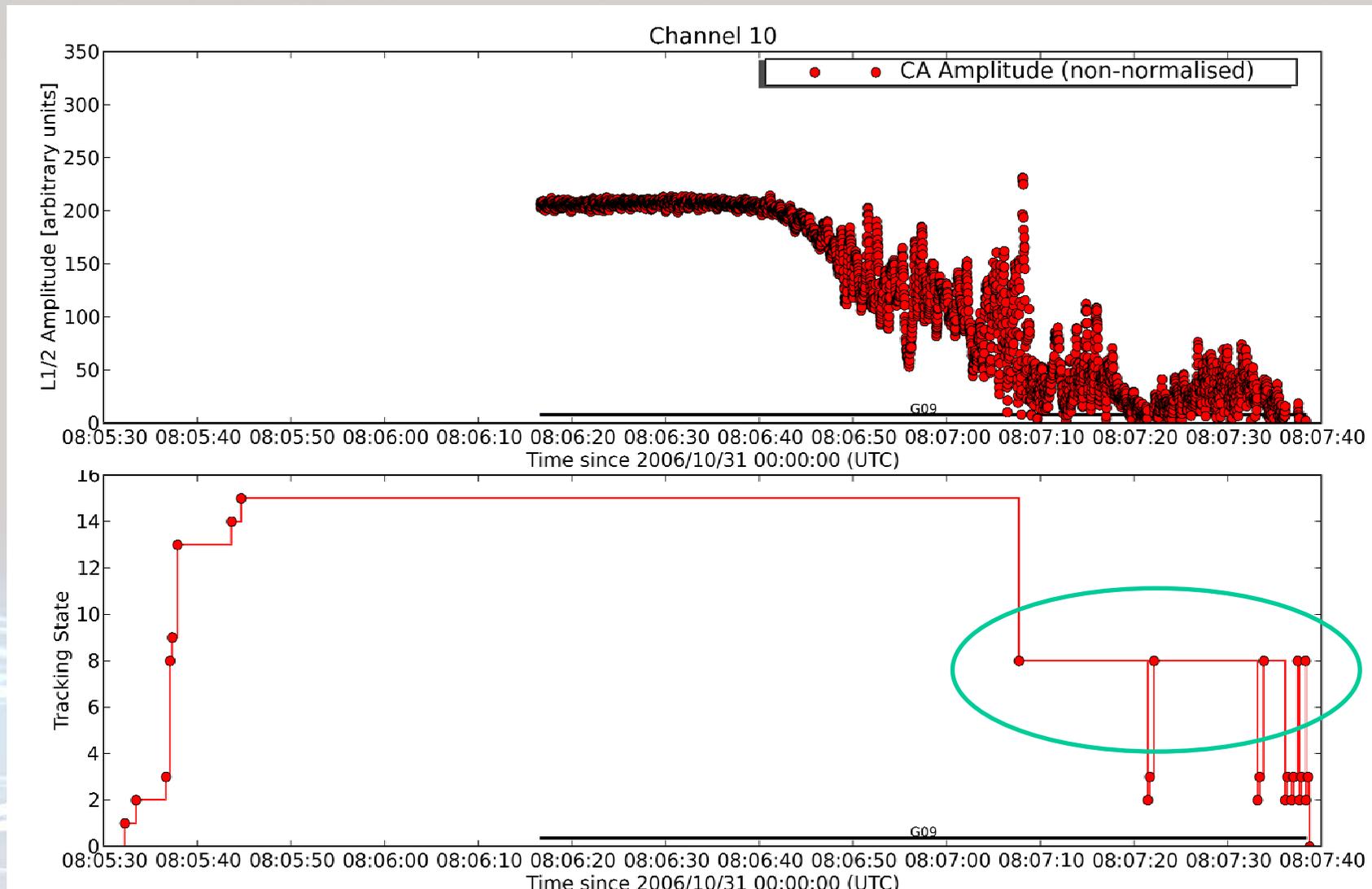
Note: There are issues in Yaros with rising ocultations and the ionospheric correction in the troposphere!
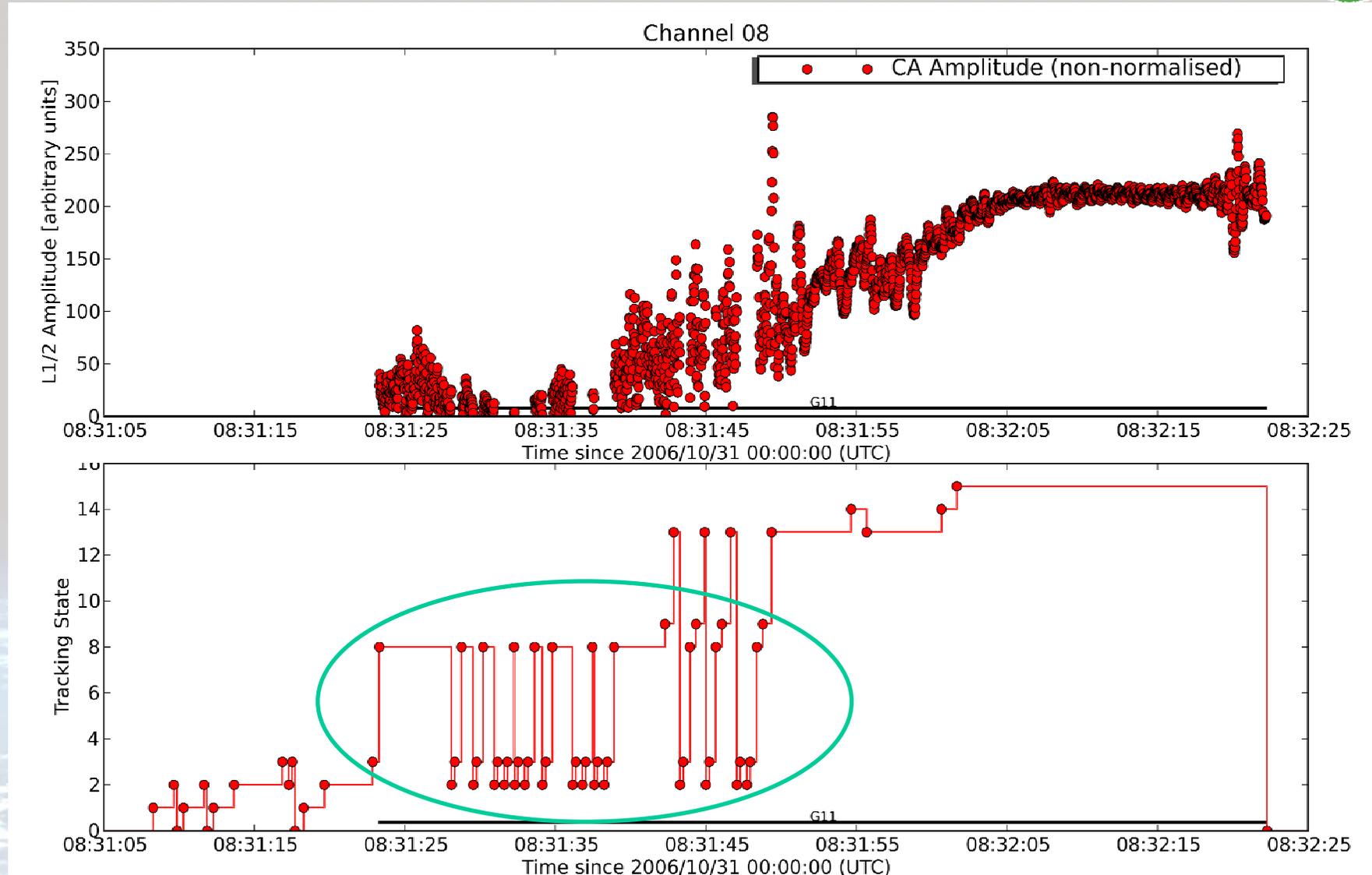
Nevertheless, RS processing will be a requirement to get lower down (I think)

Raw sampling / open loop Tracking States

Raw sampling / open loop Tracking States

Conclusion

- 5600+ occultations in 9 days, or ~ 600 / per day

  – More occultations than actually expected (500/day) - there is one more GPS satellite than nominal

- Rising occultations and raw sampling worked out of the box
  – Buffer overflow in January because GRAS occasionally tracks 4 satellites in RS at the same time

- GRAS clock is as stable as hoped / specified
  – All results in this presentation based on zero differencing (as initial PPF products), with POD clock estimates used for clock corrections in the excess phase calculations

- So far, there have been no (bad) surprises on the instrument side.