GPS L2C Tracking of Radio Occultation Signals with the COSMIC Receiver

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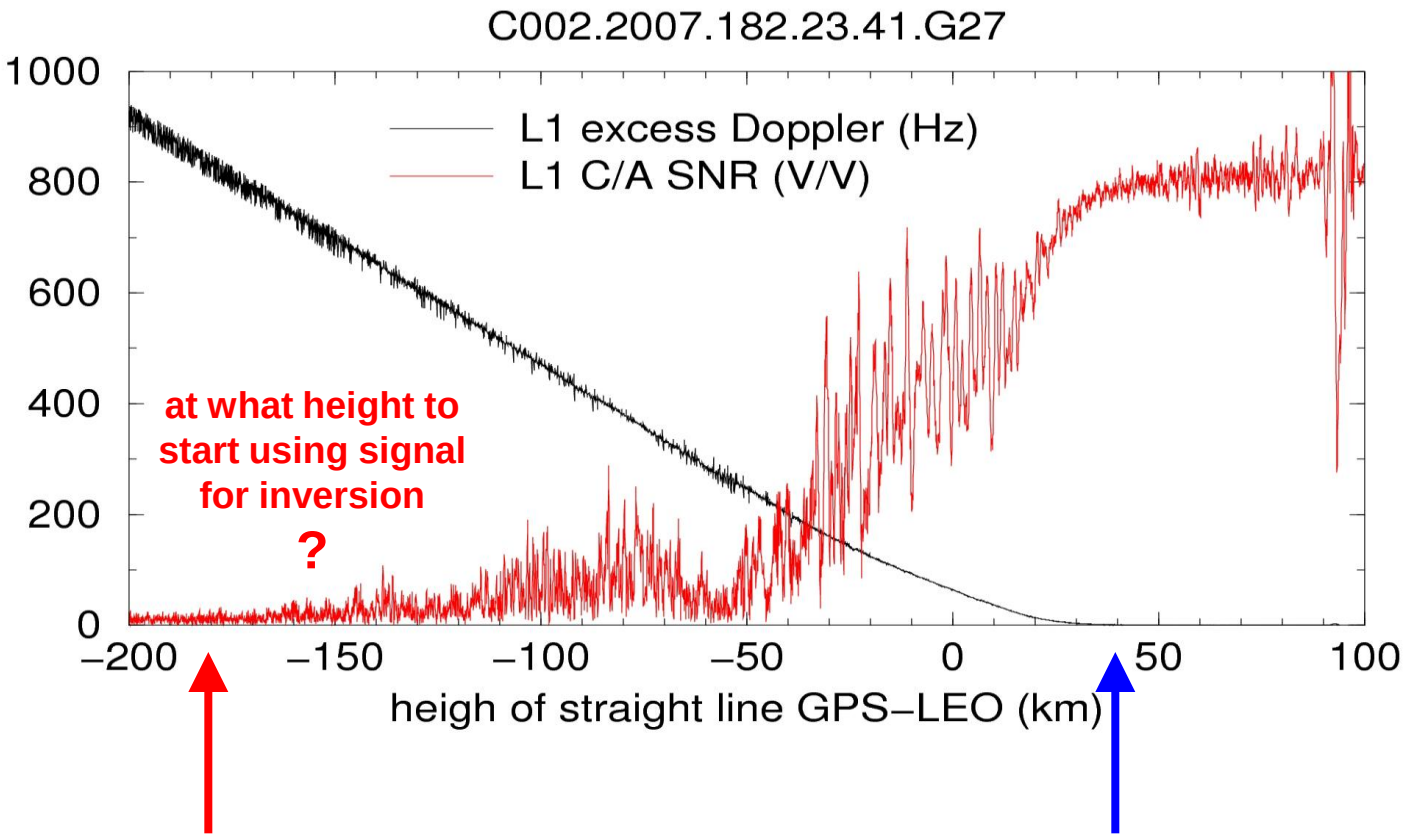
Upper stratosphere and lower troposphere are regions of maximum uncertainty for GPS RO inversions



In the lower troposphere:
the signal reduces below noise level in terms of the amplitude

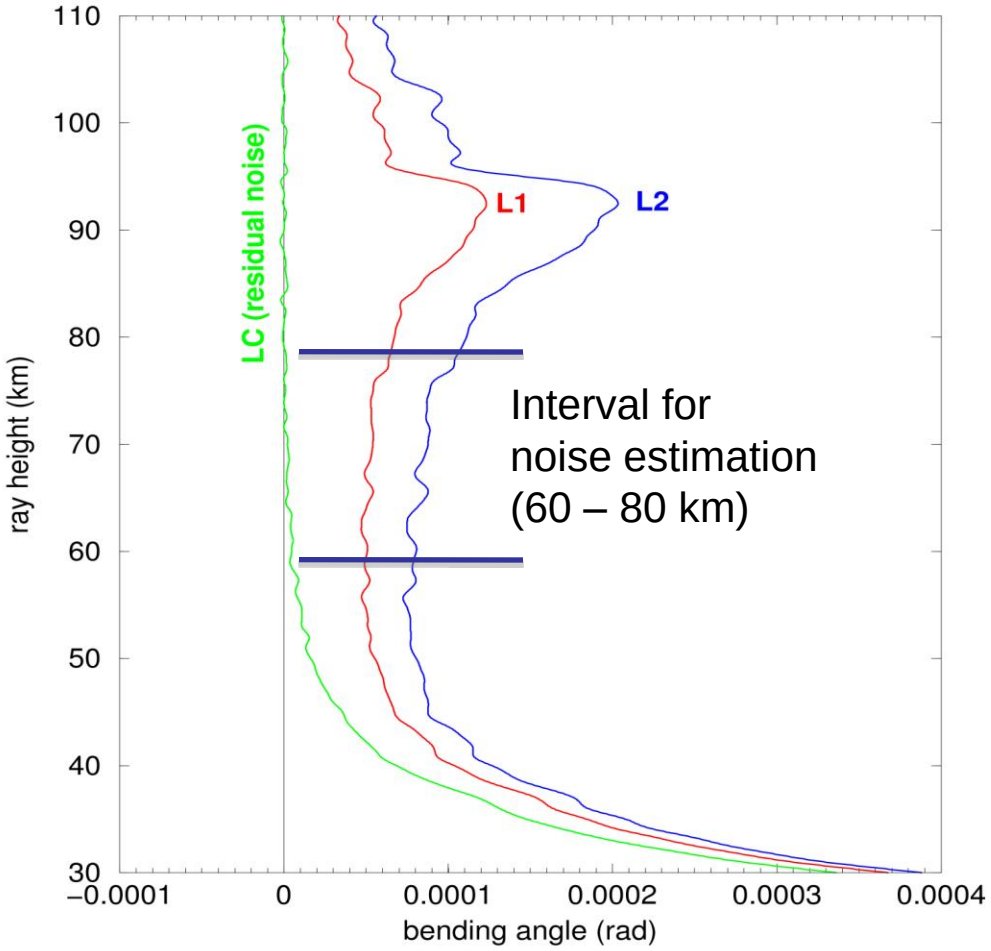
In the upper stratosphere:
the signal reduces below noise level in terms of the phase (Doppler)

Benefits of L2C Tracking

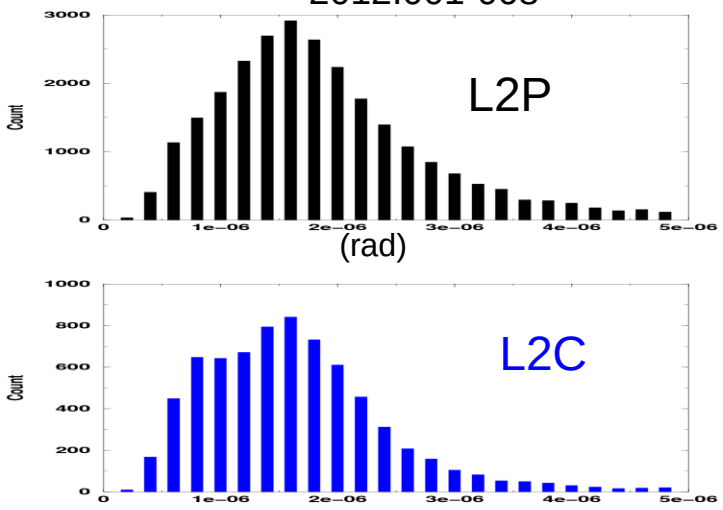
- Improves L2 SNR
- Reduces BA noise in the stratosphere
- Use of L2 down to lower heights for ionospheric correction
- L2C Phase-Lock Loop tracking may allow significant reduction of errors due to diffractional effects for occultations affected by the ionospheric scintillation
- Combined use of L1CA and L2C Open-Loop signals may reduce impact of noise in lower troposphere inversions

Estimation of Bending Angle Noise

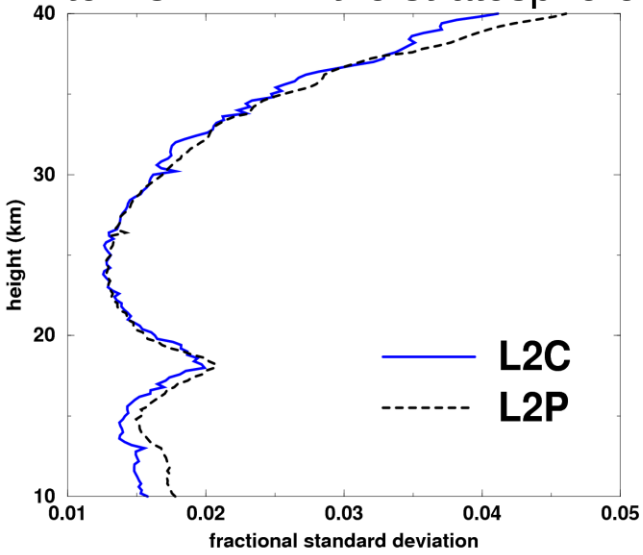
L2C results in lower noise of the bending angles (important for inversions in the stratosphere)



Histograms of STDV between 60 - 80 km
2012.001-068



Statistical comparison of COSMIC to ECMWF in the stratosphere



Truncation of L2 Signal

Determination of L2 cut-off altitude

1) Mean deviation

$$\left(\left\langle f_{L1}^{Dop}\right\rangle - c\cdot\left\langle f_{L2}^{Dop}\right\rangle\right) > 1\,Hz$$

2) Fluctuations

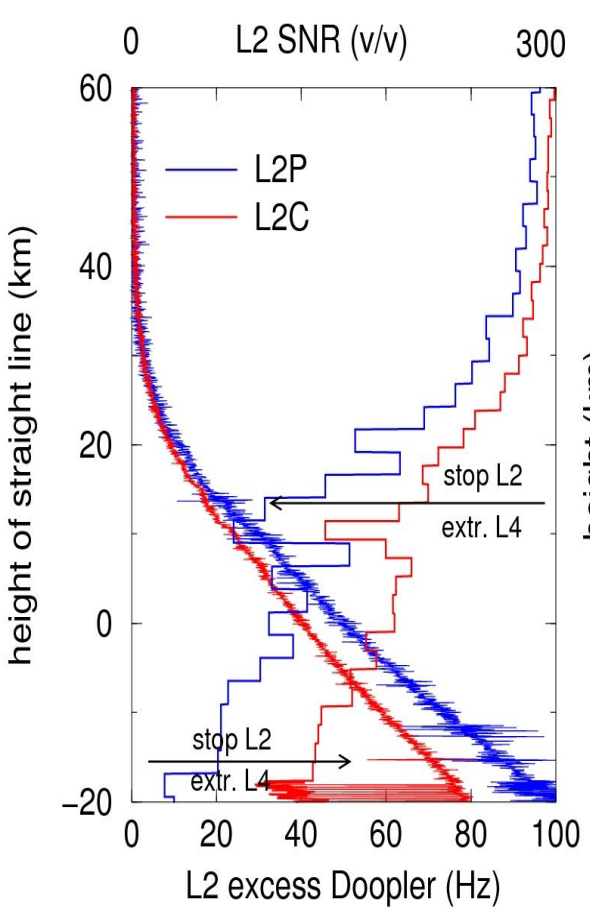
$$\left(f_{L2}^{Dop} - \left\langle f_{L2}^{Dop}\right\rangle\right) > 6\,Hz$$

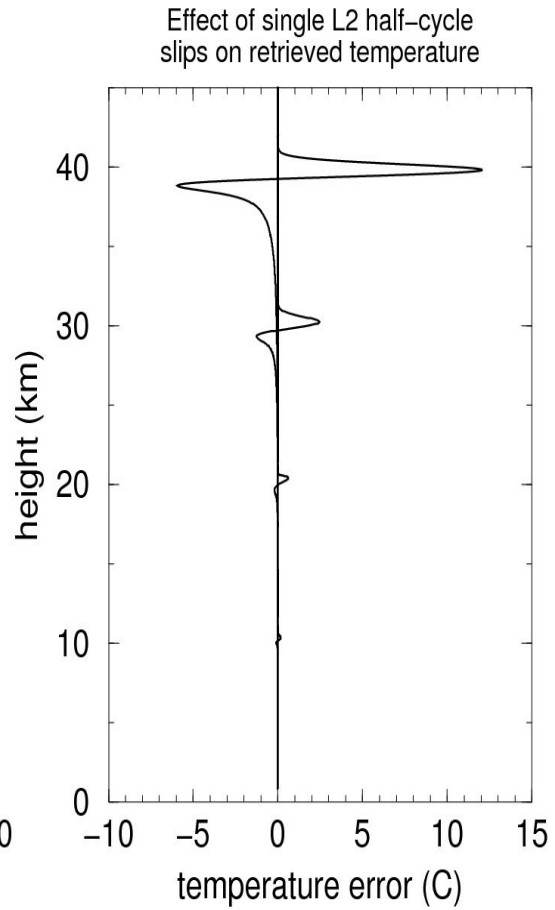
Ionospheric calibration below cut-off

Extrapolation of difference $\alpha_{L1} - \alpha_{L2}$

$$\alpha_{iono-free} = \alpha_{L1} + C\left\langle \alpha_{L1} - \alpha_{L2}\right\rangle$$

$\langle\ \rangle$ denotes mean





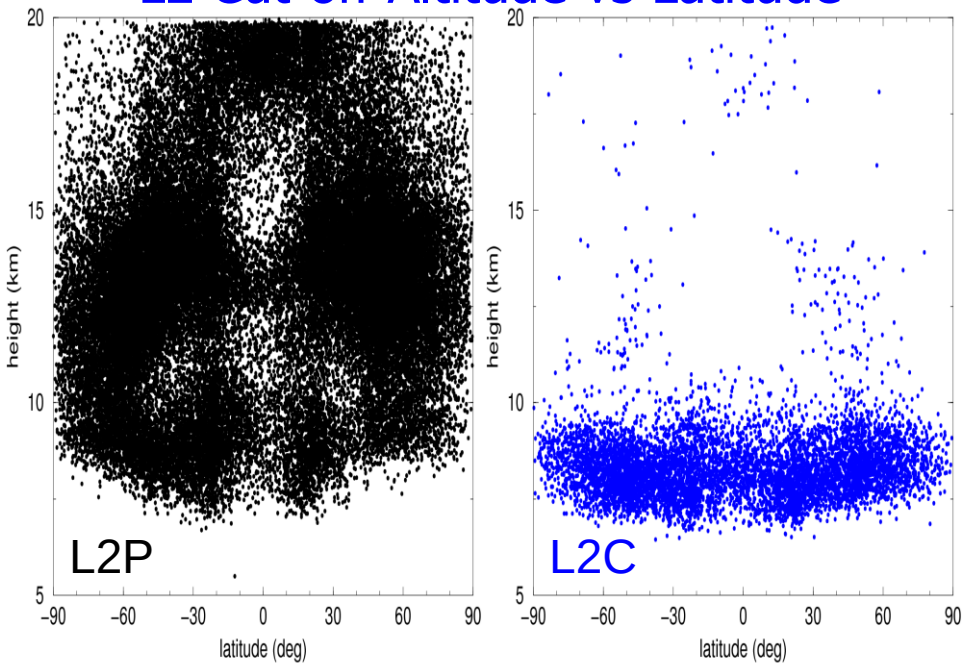
L2 Truncation with COSMIC

Since Jan 2012, COSMIC receivers are configured to track L2C (setting occultations)

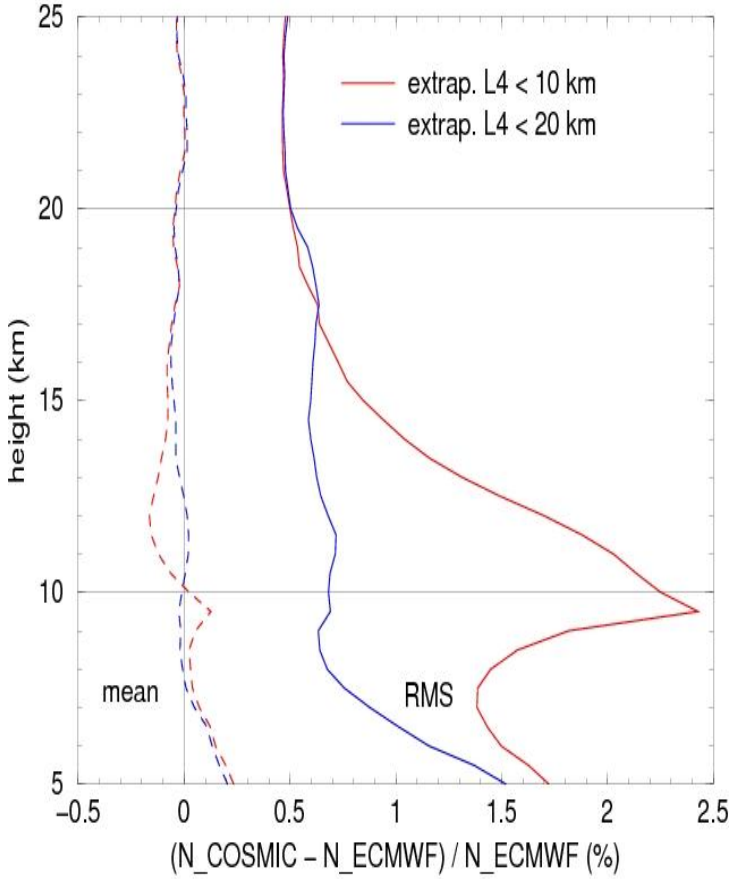
Higher stability to fluctuations

L2C can be used down to lower heights than L2P (L2P often fails at sharp tropopause)

L2 Cut-off Altitude vs Latitude



Statistical Comparison with ECMWF



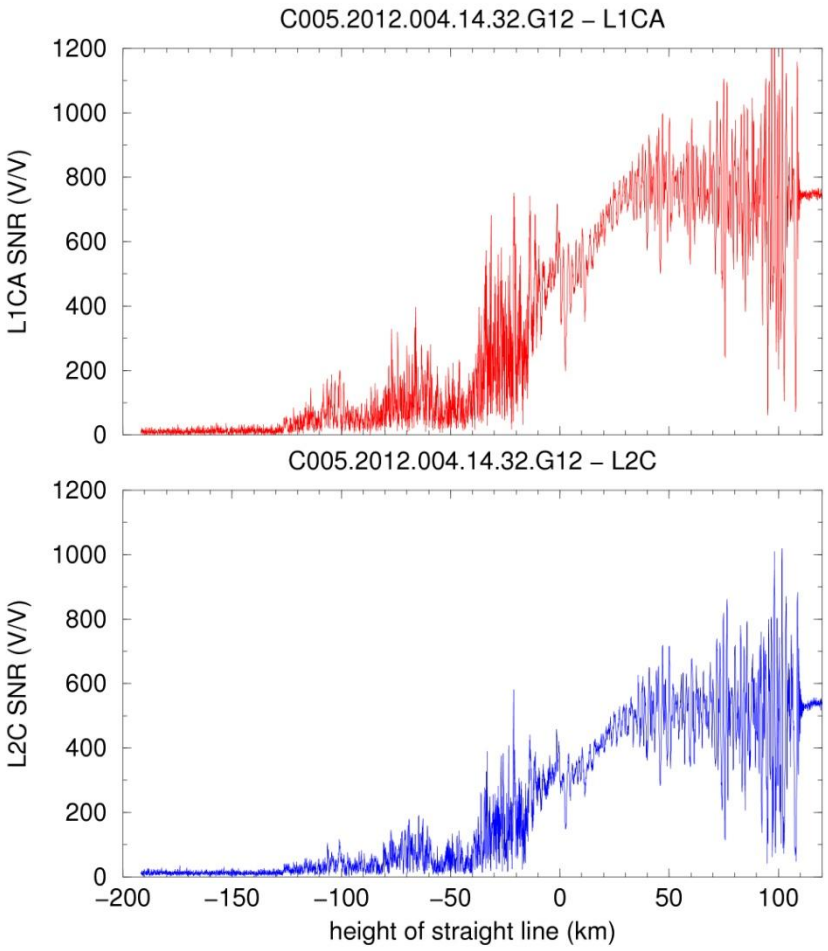
L2C less noisy than L2P

L2P ~ 18% fail QC

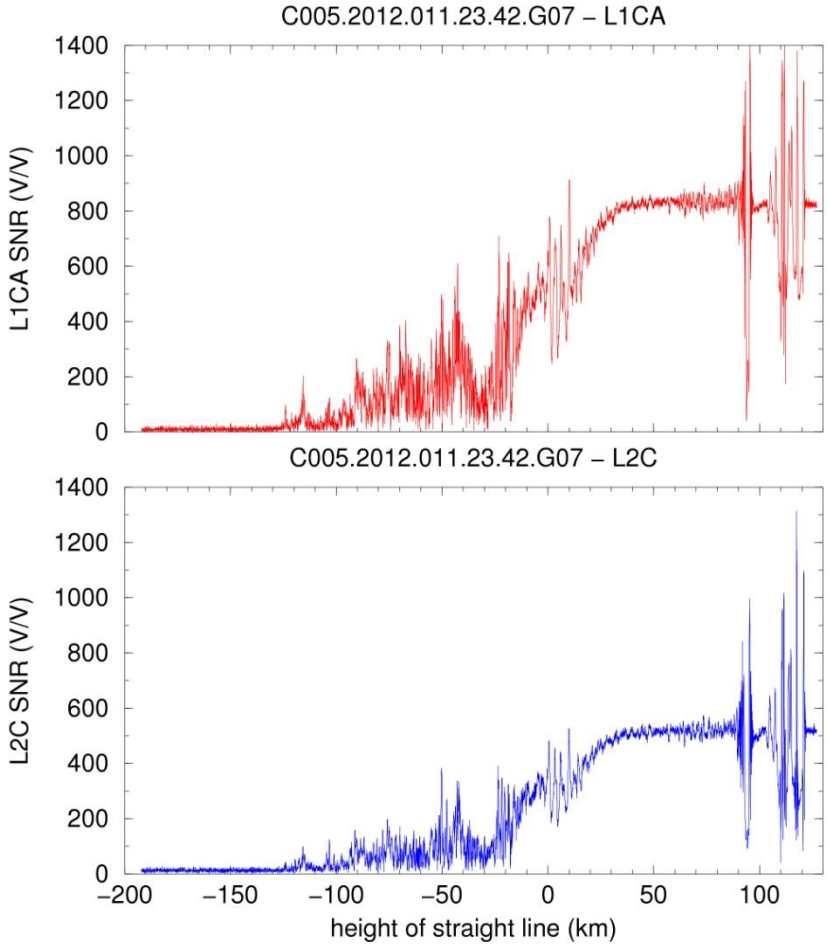
L2C ~ 3% fail QC

Examples of ionospheric scintillation on L1CA and L2C signals

scintillation

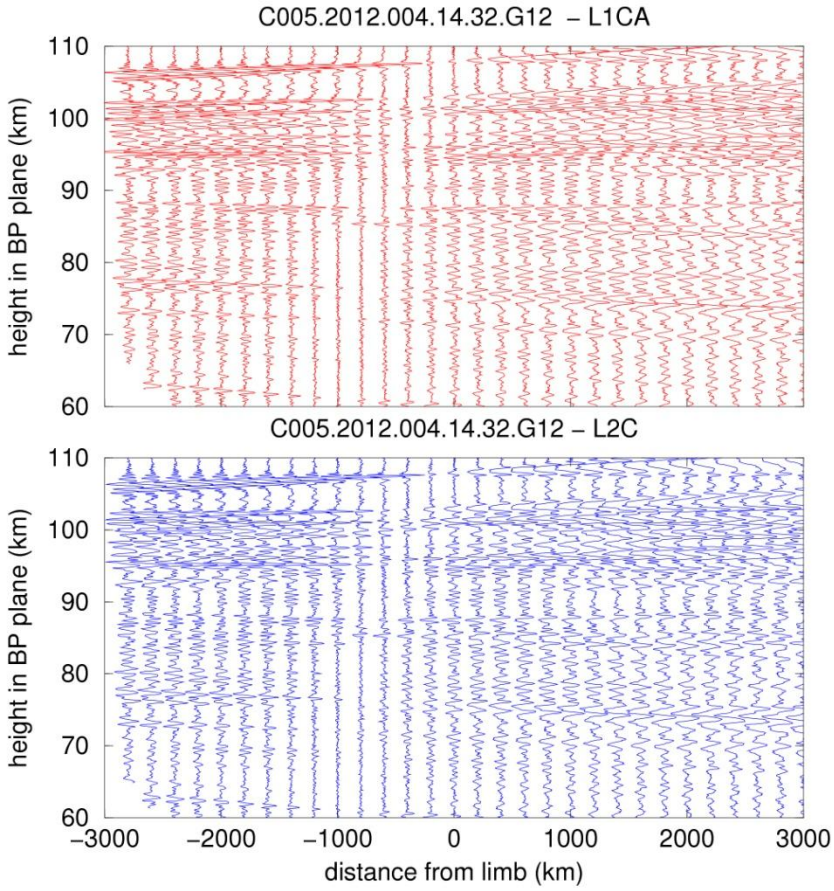


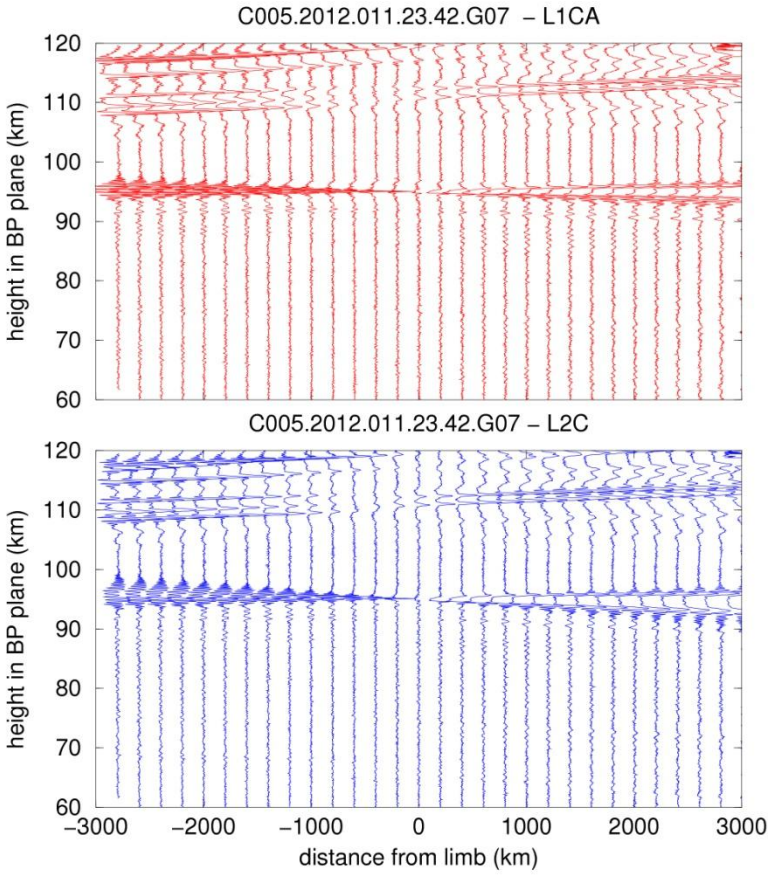
sporadic E-clouds



Back propagation of RO signals

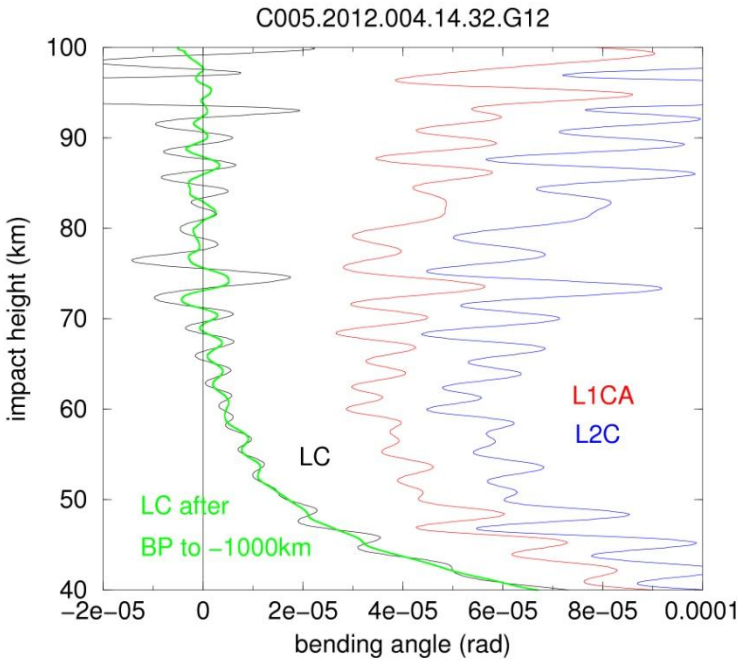
In case of localized ionospheric irregularities, the regions with minimum fluctuation of BP amplitude correspond to the regions with minimum diffractional effects on complex signals. BA should be calculated in these regions.

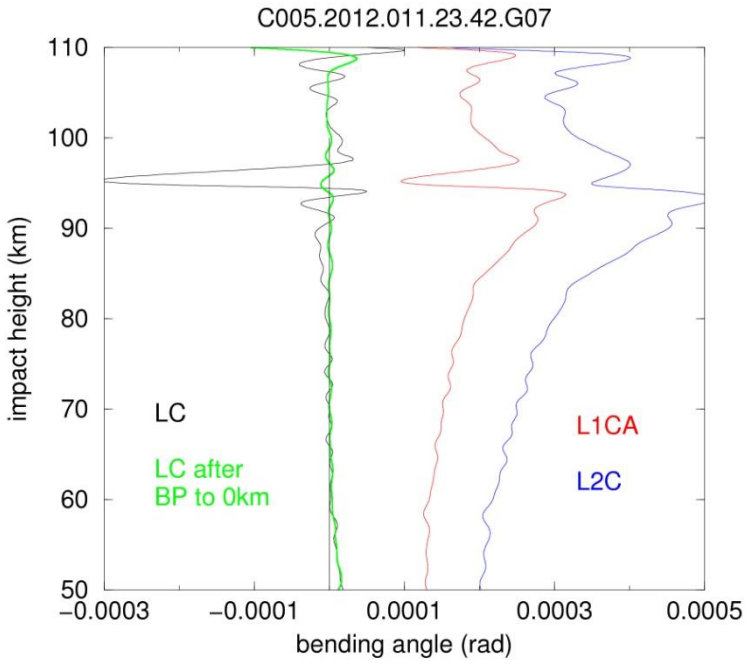




BA from RO signals calculated

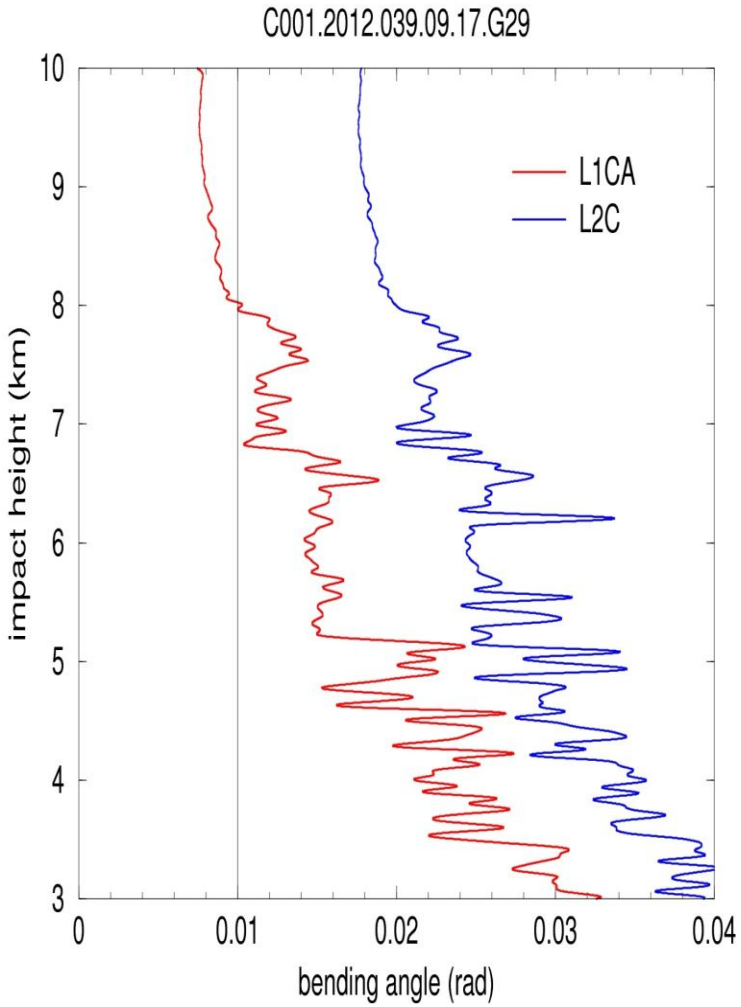
- Directly and
- After back propagation of complex signals
  to the regions of minimum fluctuation of amplitude

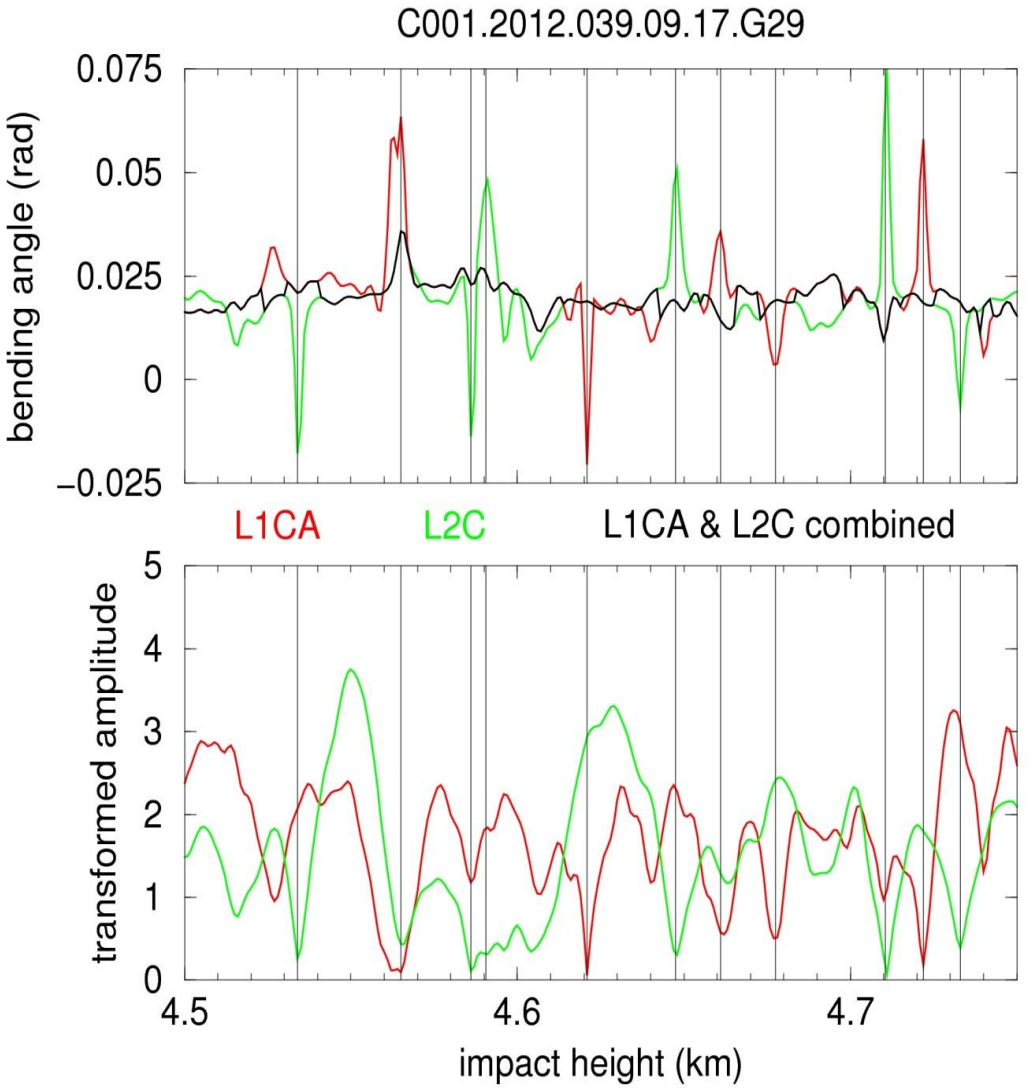




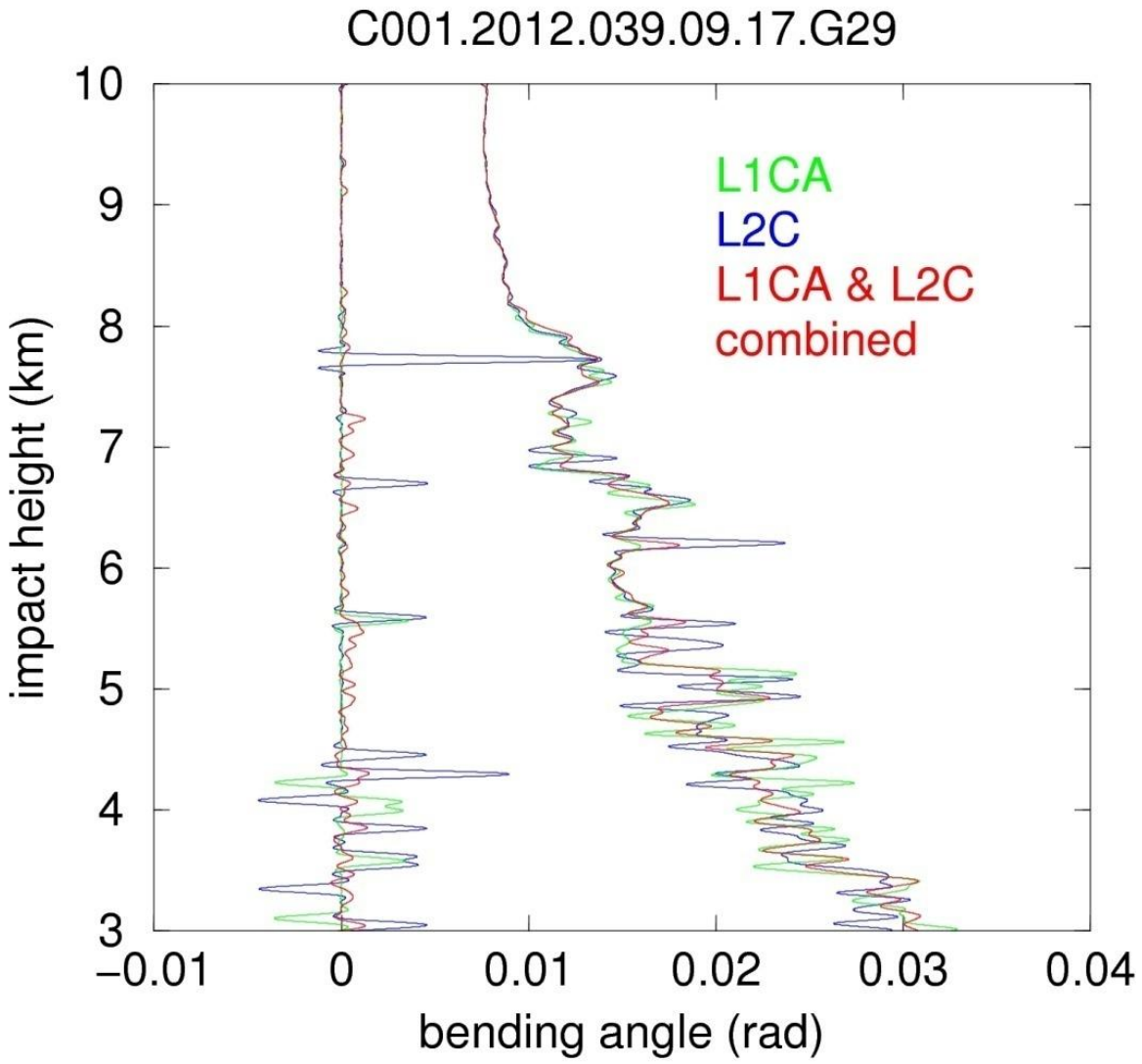
Combining L1CA and L2C BA in the lower troposphere by use of the amplitude of WO transform

- largest BA spikes correspond to regions of small amplitude





Combined BA is less responsive to noise on RO signal



Summary

- JPL implemented L2C tracking on COSMIC – Operational ~ Jan 2012
- L2C data reduces BA noise in the stratosphere
- L2C allows use of L2 signal down to lower heights for ionospheric correction
- L2C Phase-Lock Loop tracking allows significant reduction of errors due to diffractional effects for some example occultations affected by the ionospheric scintillation. Statistical comparisons next.
- Combined use of L1CA and L2C Open-Loop signals reduces impact of noise in some example lower troposphere inversions. Statistical comparisons next.

Acknowledgments

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UCAR

NSF

NASA


USAF

NOAA

NSPO

ONR