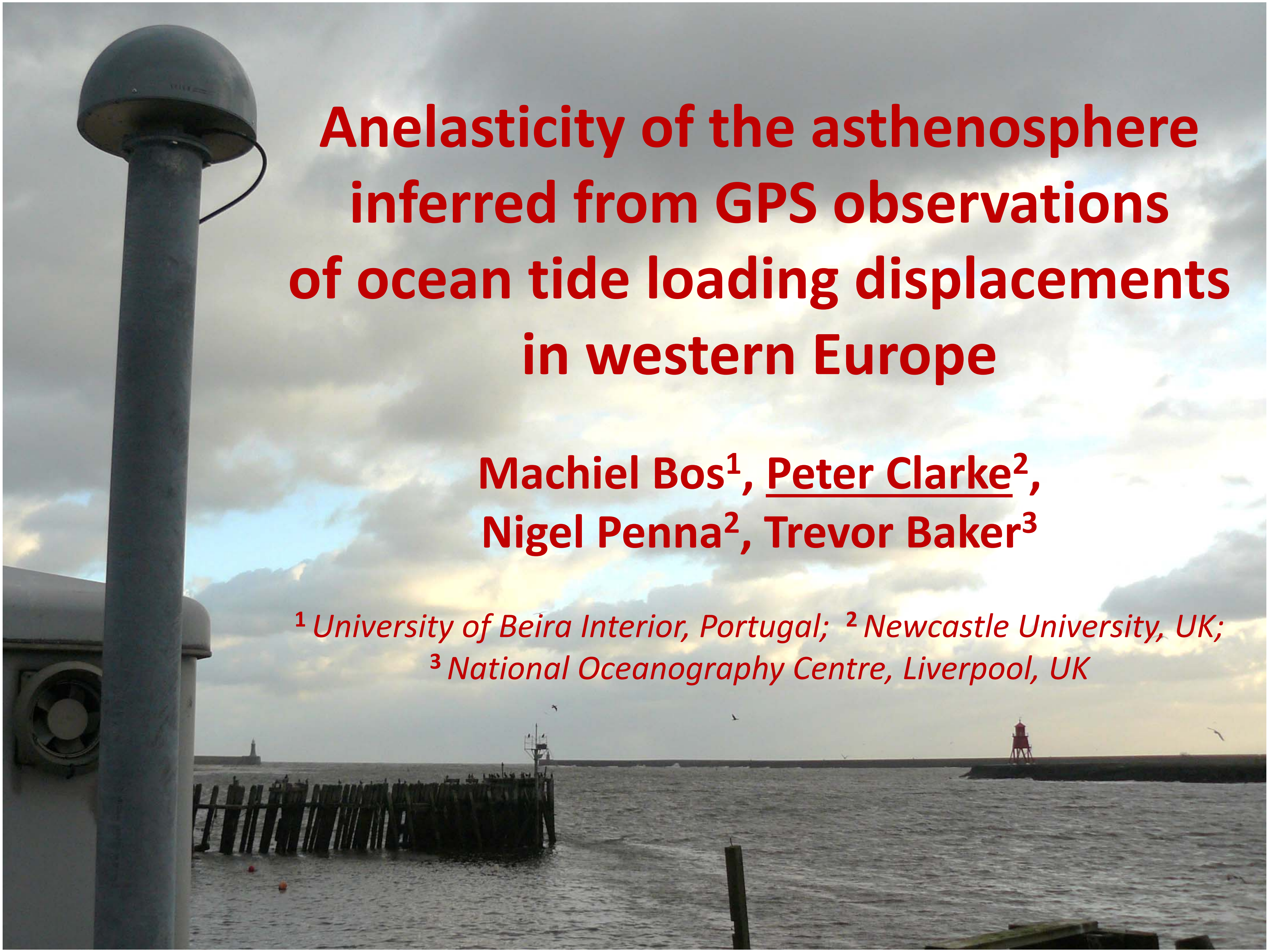


Anelasticity of the asthenosphere inferred from GPS observations of ocean tide loading displacements in western Europe

Machiel Bos[1], Peter Clarke[2], Nigel Penna[2], Trevor Baker[3]

[1] University of Beira Interior, Portugal; [2] Newcastle University, UK; [3] National Oceanography Centre, Liverpool, UK

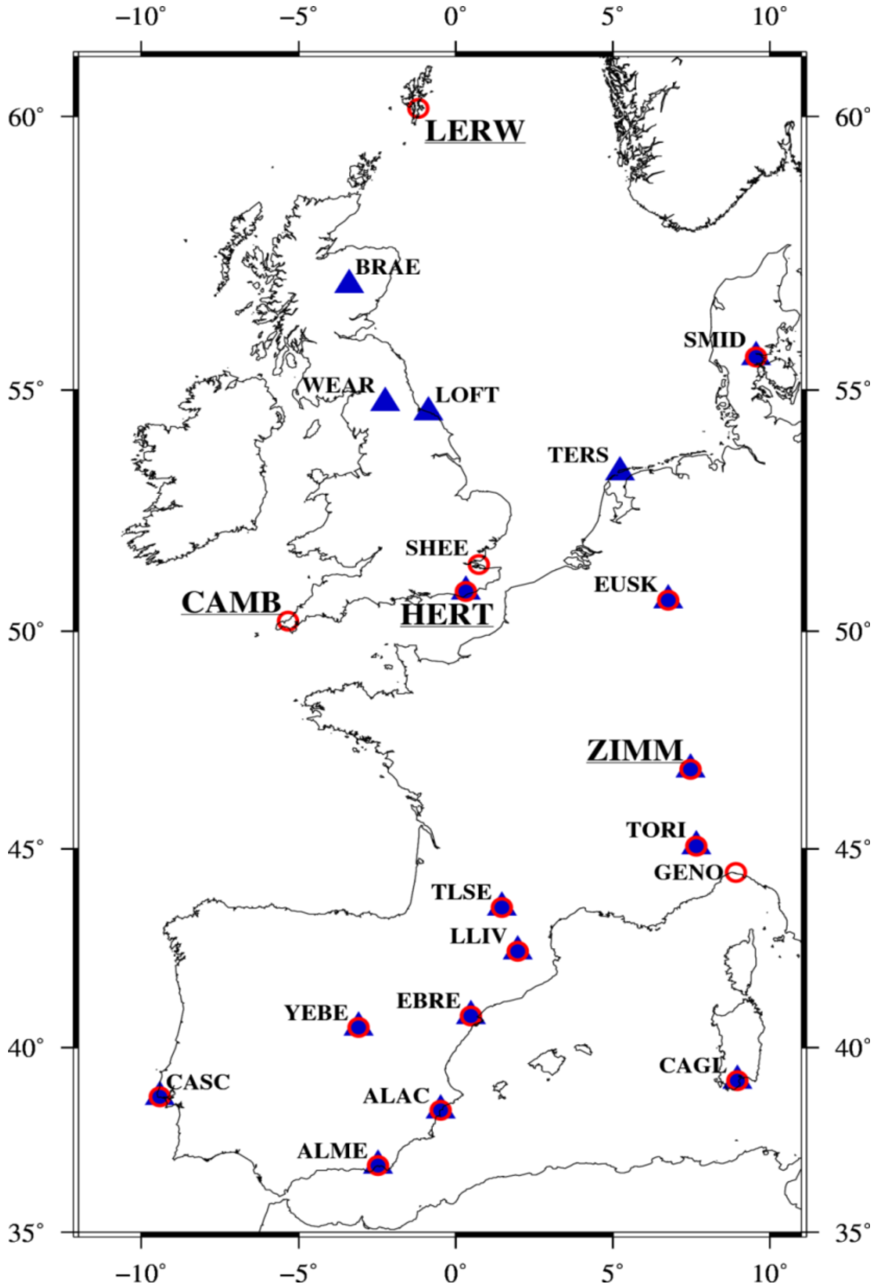
SUMMARY

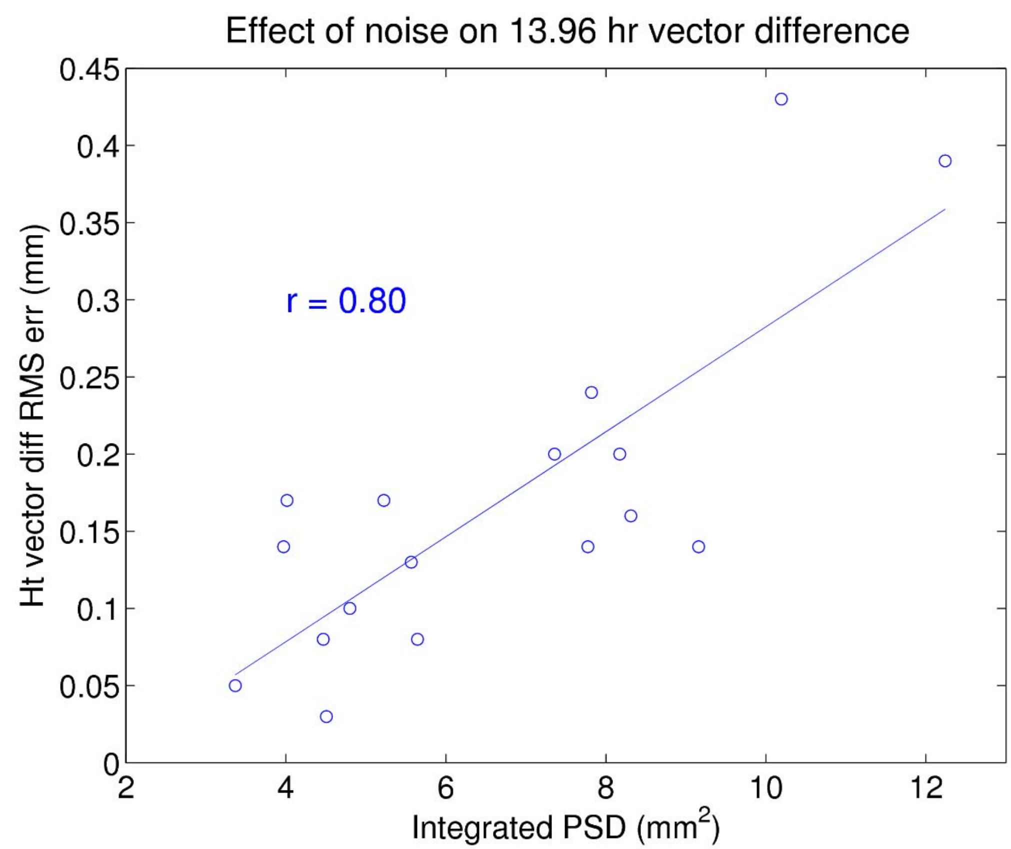
See also Penna *et al*, poster G04p-137 this afternoon

- Observed M2 ocean tide loading vertical displacements differ systematically from predictions by up to 2-3 mm in western Europe
- Discrepancies cannot be explained by credible model changes in ocean tides or <u>elastic</u> Earth parameters
- <u>Anelastic</u> dispersion with asthenospheric Q_μ constant from 1 Hz to ~2 cpd reduces discrepancies to ~noise
  - $Q \approx 70$-80, leading to 8-10% reduction in μ at M2 period

Acknowledgements
GPS data: NERC BIGF, IGN, EUREF, IGS. Tidal data: IHO, IAPSO, GLOUP data banks.
ETERNA, GMT, NASA/JPL GIPSY software.
Funding: UK Natural Environment Research Council (PJC, NTP, TFB);
Portuguese Foundation for Science & Technology (MSB)

Quality of GPS observations of OTL displacement





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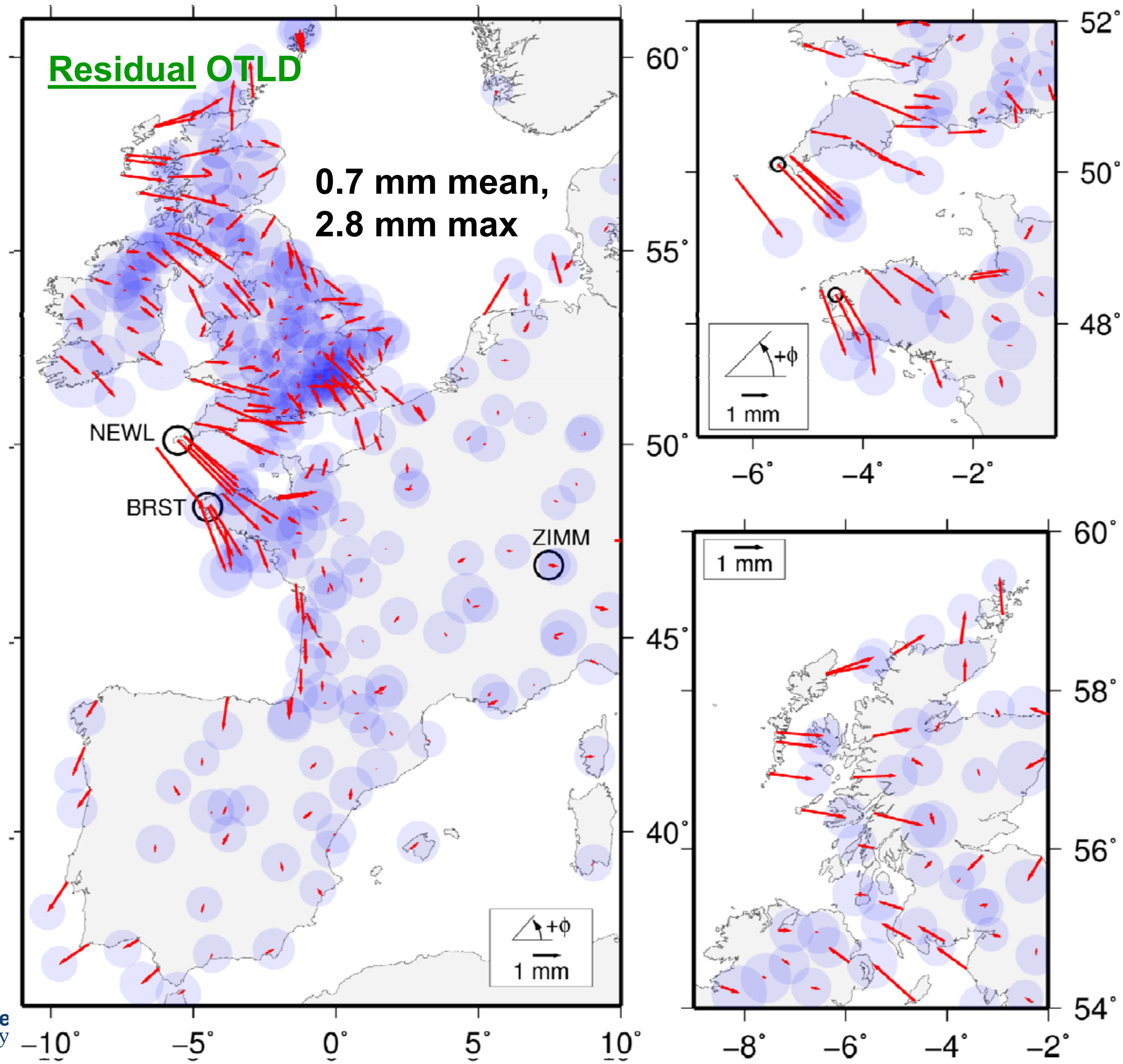

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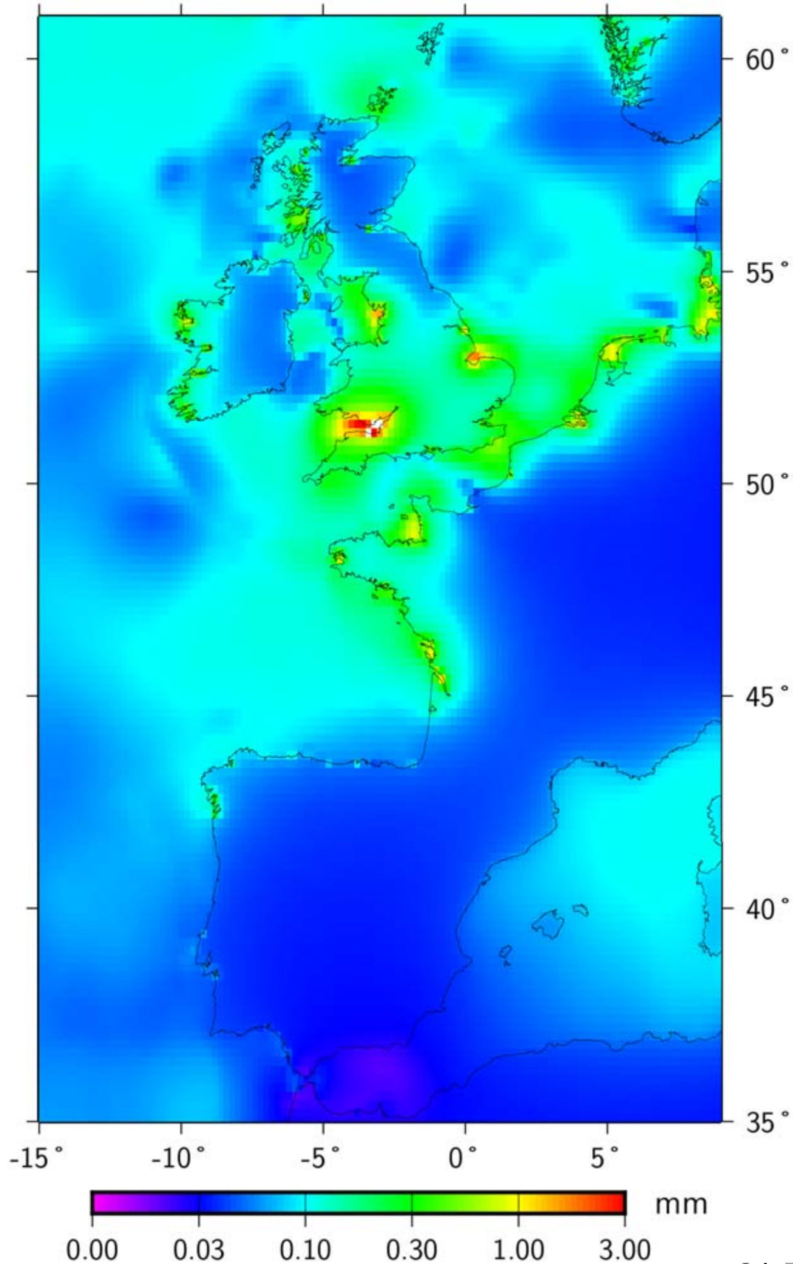
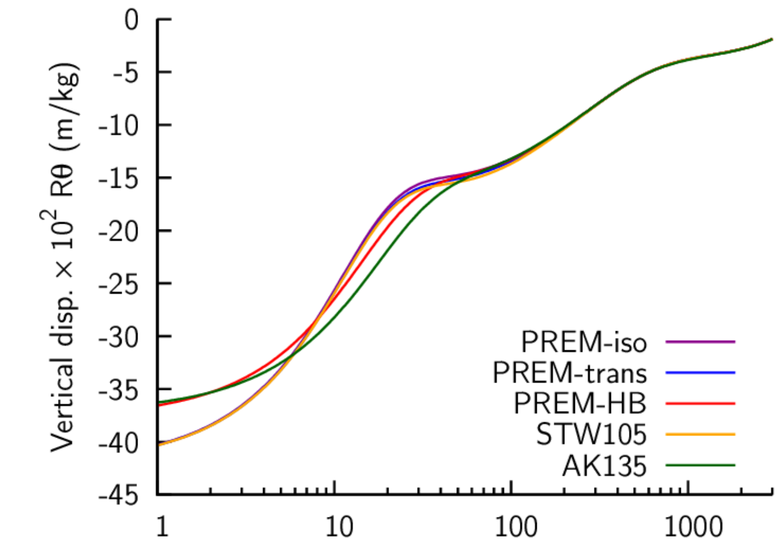
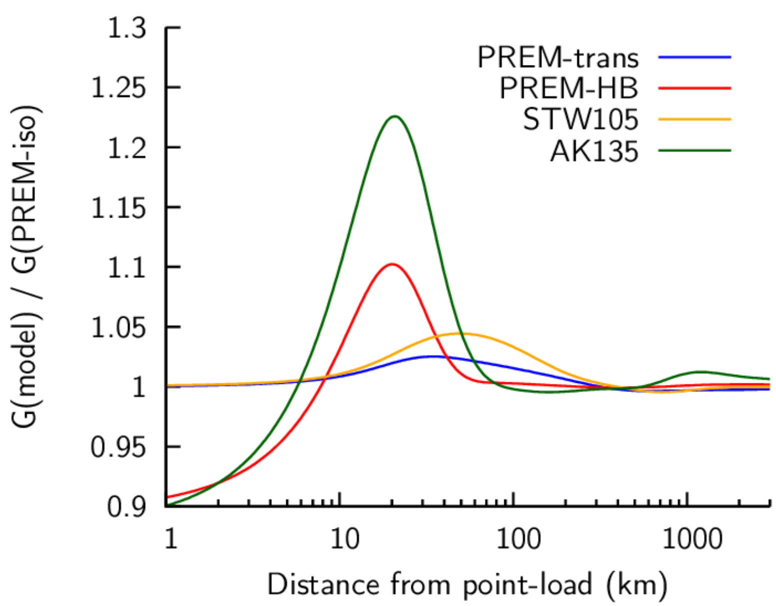
Ocean tide model errors

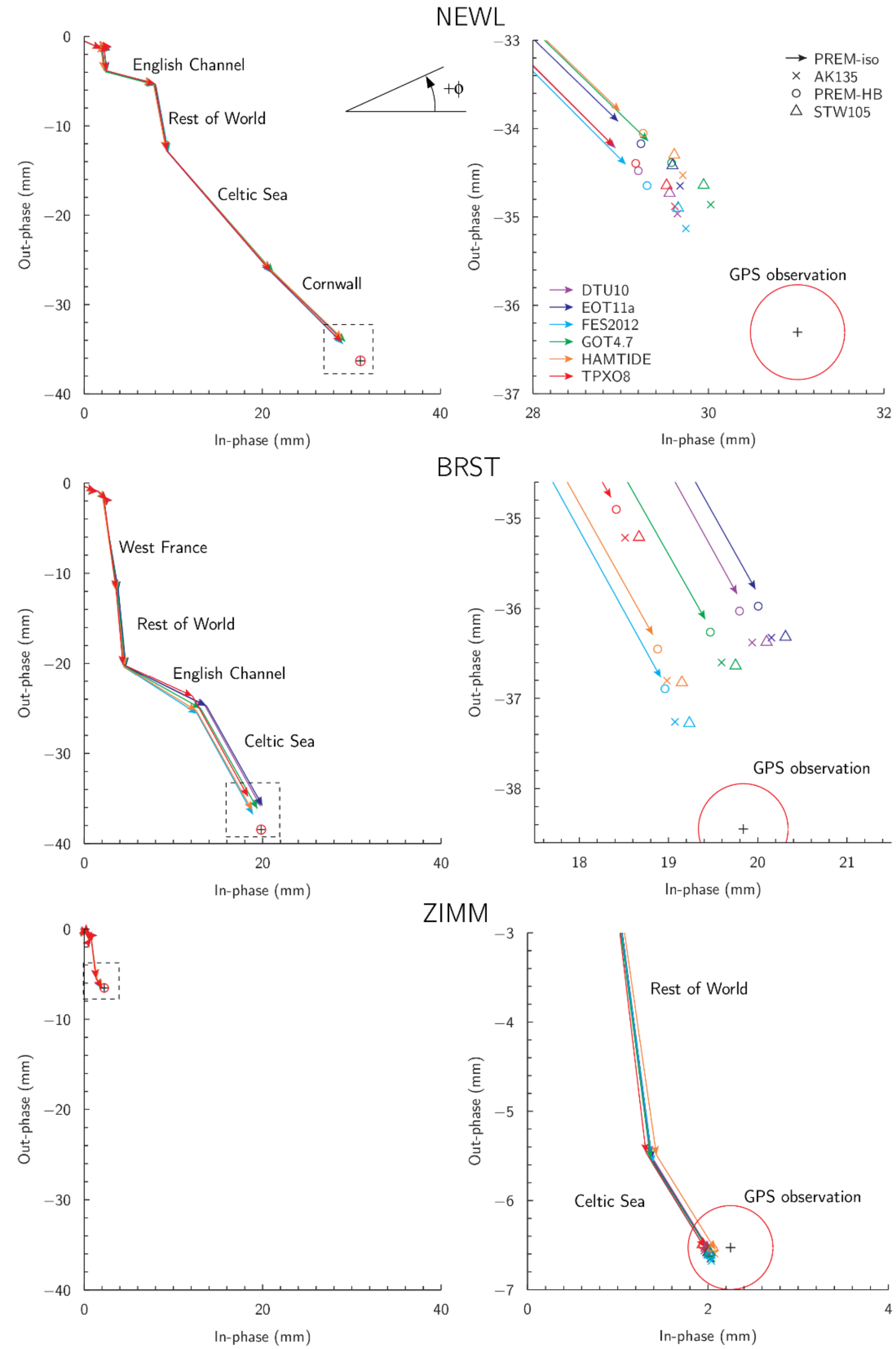
- DTU10, EOT11a, FES2012, GOT4.7, HAMTIDE, TPXO8 interpolated on to 1/16° grid and mean computed
- Standard deviation of M_2 vector differences from the mean shown here
- FES2012 agreements with coastal tide gauges and bottom pressure recorders:

Region	Mean (mm)	Stdev (mm)
Cornwall	16	17
Celtic Sea	33	33
English Channel	80	26
West France	181	39
North Sea	32	13
Bristol Channel	229	63
Irish Sea	39	33
West Scotland	6	6
Iberia	23	6



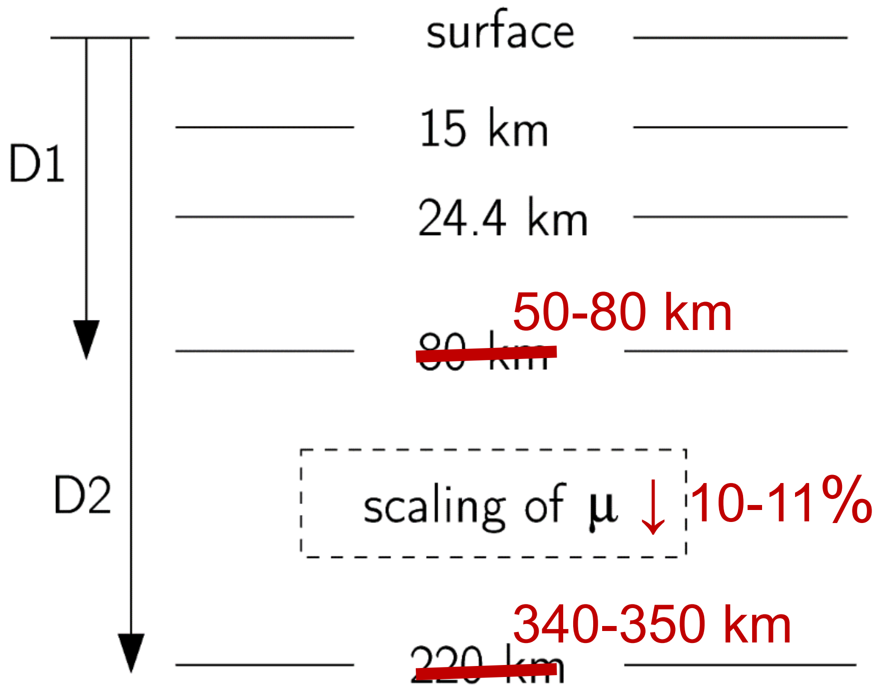


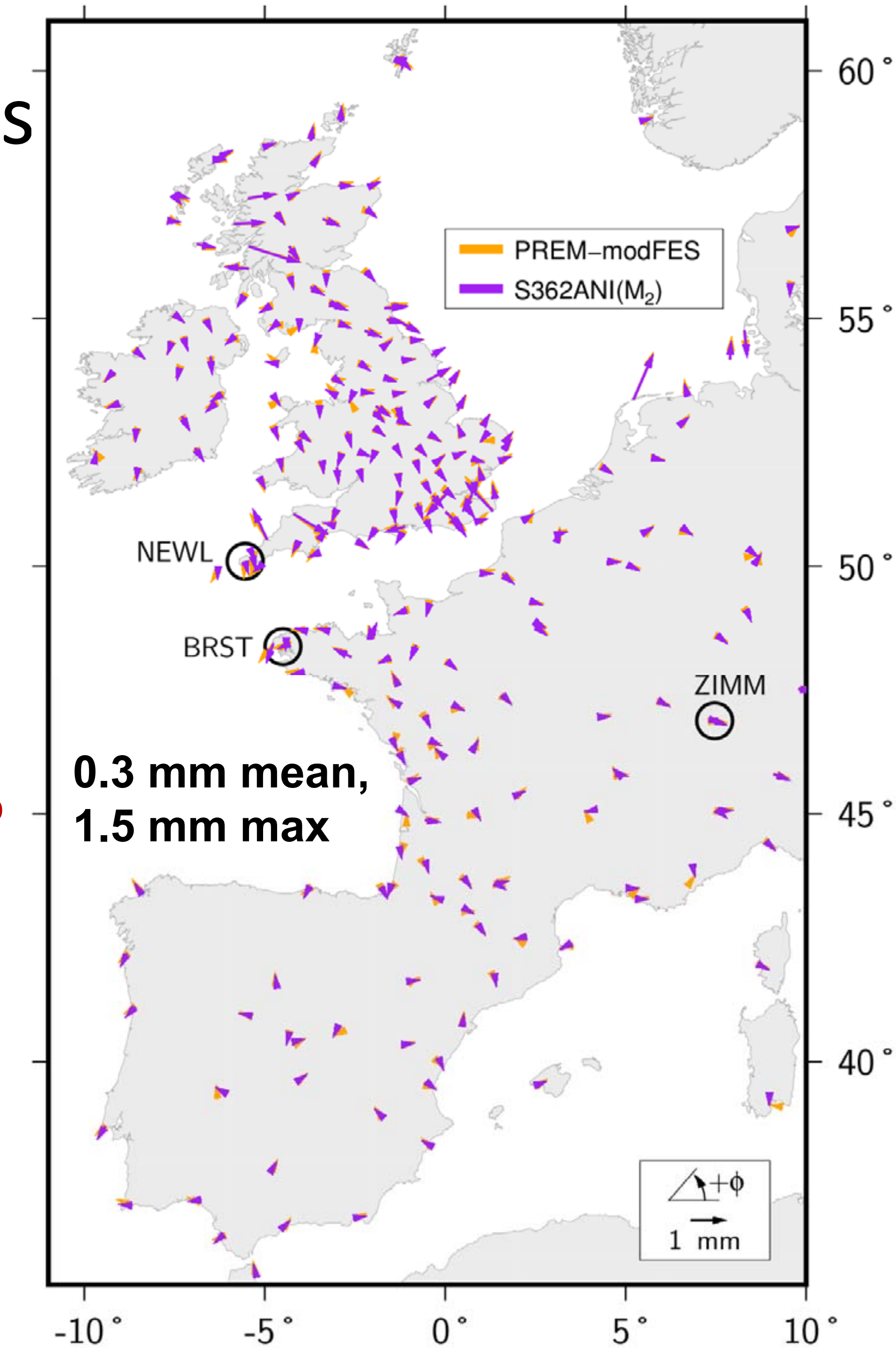




Dziewonski & Anderson (1981), *PEPI*
Holder & Bott (1971), *GJRAS*
Kustowksi *et al* (2008), *JGR*
Kennett *et al* (1995), *GJI*

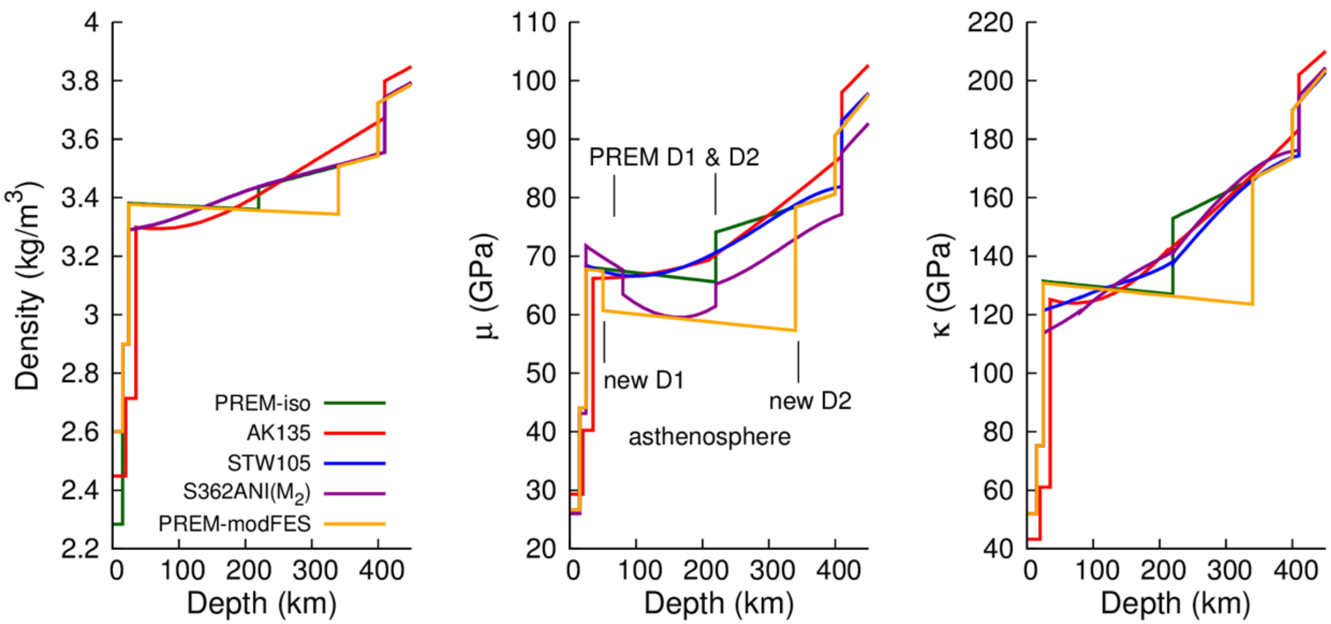
Empirical Green's function





Shear dissipation and *Q*

- PREM seismic velocities valid at 1 Hz
- *Q* is constant from seismic to tidal frequencies?



- Shear modulus change, $\delta\mu$ (for freq ω, with ω_0 = 1 Hz):

$$\delta\mu(\omega) = \frac{\mu}{Q_\mu}\left[\frac{2}{\pi}\ln(\omega/\omega_0) + i\right]$$

- Our empirical $\delta\mu/\mu$ of -10% for M2 implies $Q \approx 70$
- Q_{PREM} has a min of ~80 in asthenosphere, reduces μ by 8.5%
  - above this, $Q_{\mathrm{PREM}} \approx 600$, so effect of anelasticity is less
  - below, $Q_{\mathrm{PREM}} \approx 150$, but depth too great to affect OTL values

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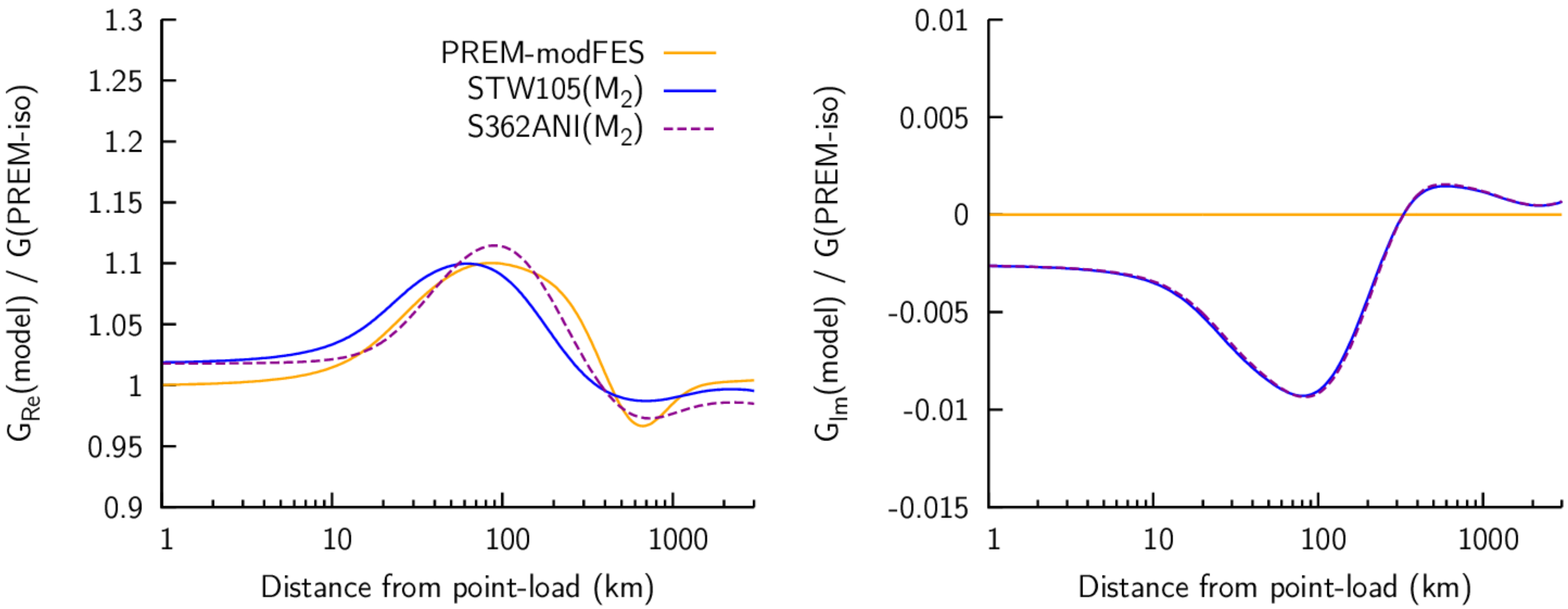
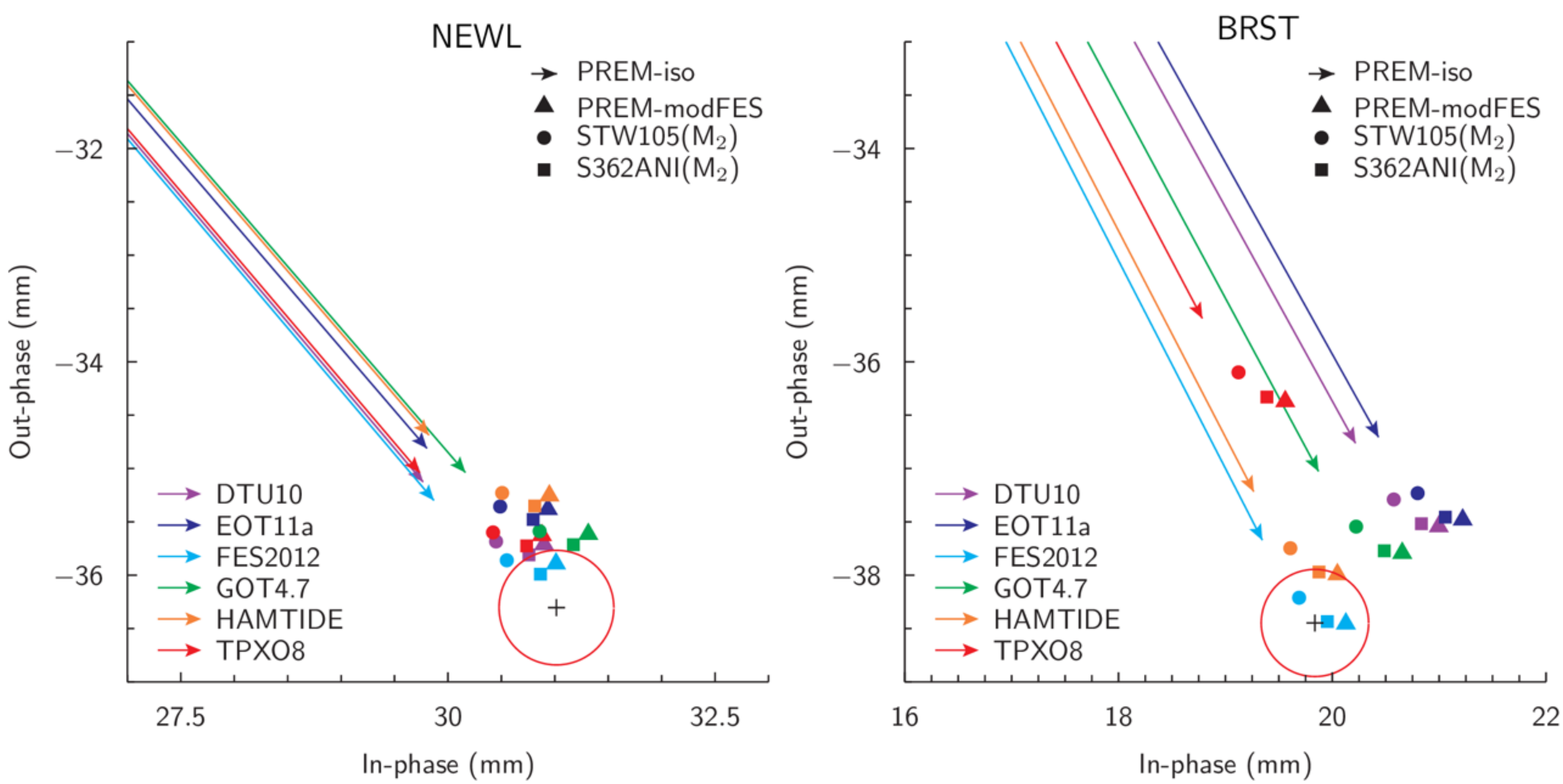


PREM-modFES
STW105(M2)
S362ANI(M2)
G_Re(model) / G(PREM-iso)
Distance from point-load (km)
G_Im(model) / G(PREM-iso)
Distance from point-load (km)



NEWL
PREM-iso
PREM-modFES
STW105(M2)
S362ANI(M2)
DTU10
EOT11a
FES2012
GOT4.7
HAMTIDE
TPXO8
Out-phase (mm)
In-phase (mm)
BRST
Out-phase (mm)
In-phase (mm)

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Penna *et al*. Ocean tide loading displacements in western Europe. Part 1: Validation of kinematic GPS estimates. *J. Geophys. Res.*, revised 20th June

Bos *et al*. Ocean tide loading displacements in western Europe. Part 2: GPS-observed anelastic dispersion in the asthenosphere. *J. Geophys. Res.*, in press.