Modelling and Correction of Carrier Phase Multipath Effects

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Outline

Introduction

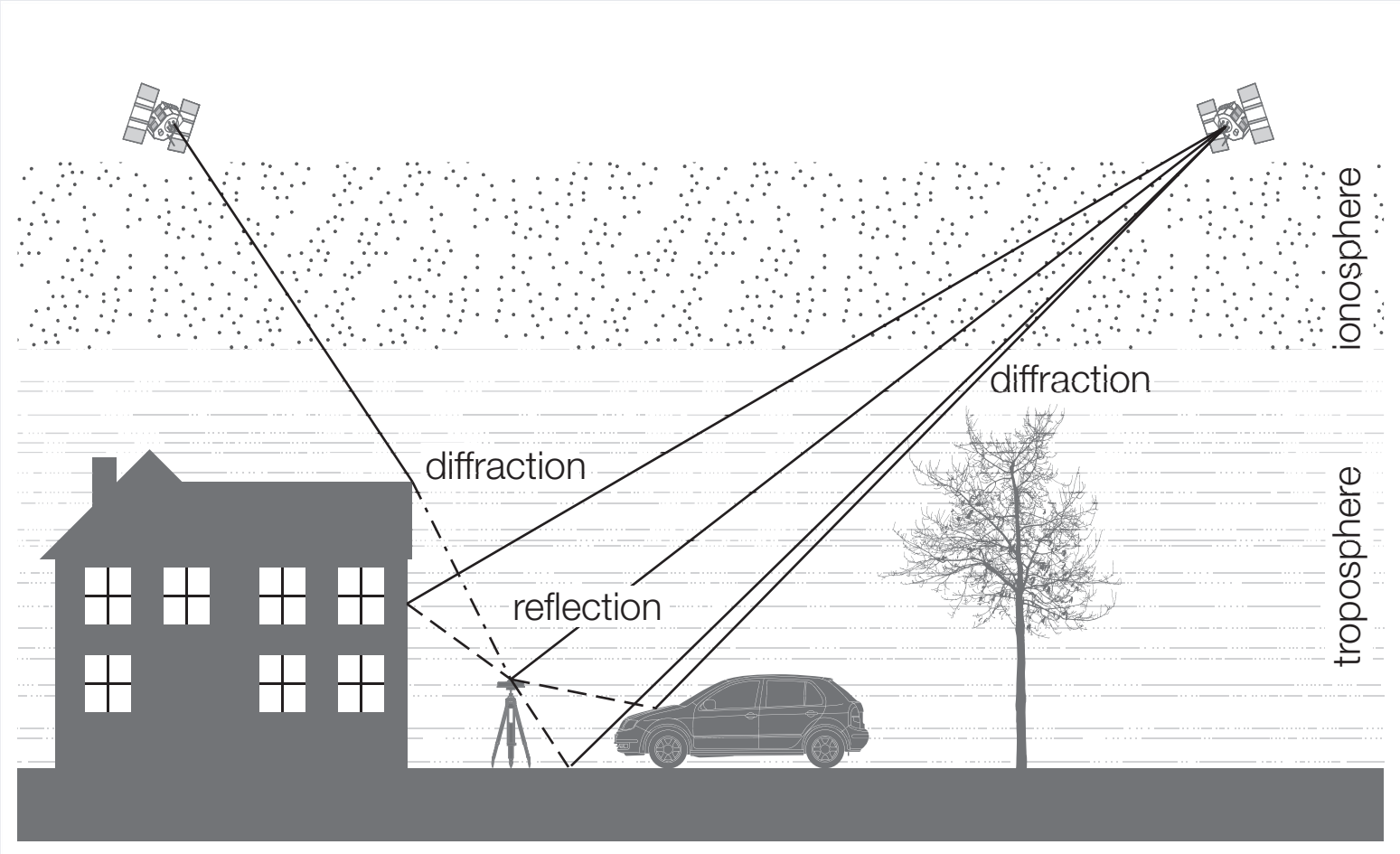
Multipath influence

Modelling and Correction

Conclusions

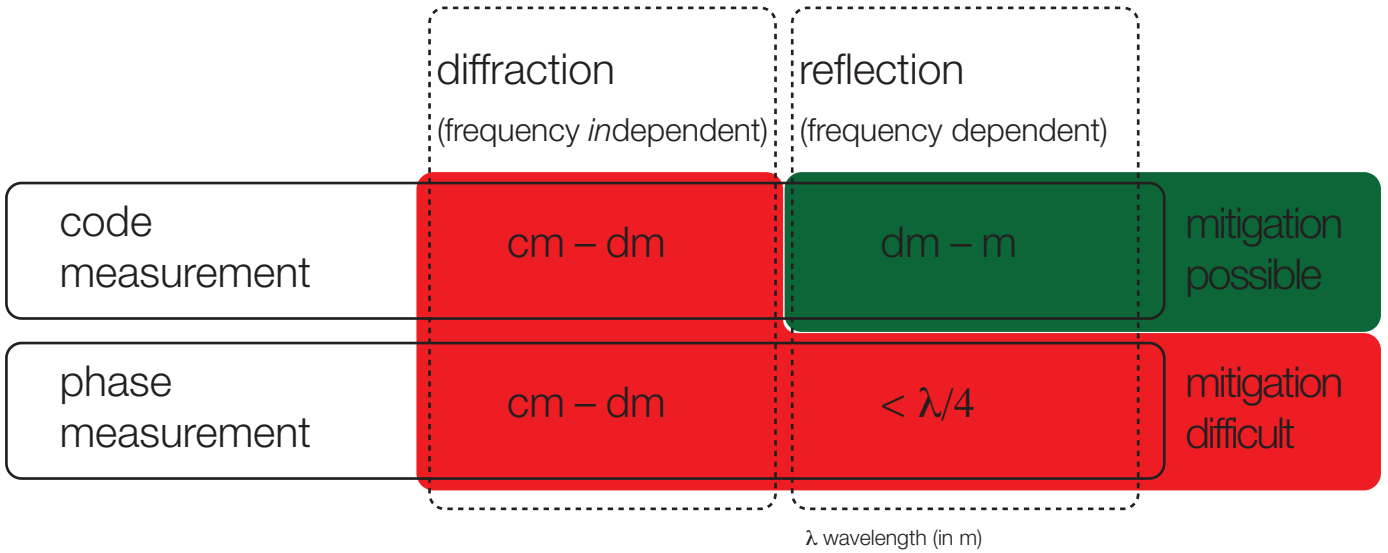
Motivation

STATION DEPENDENT MULTIPATH EFFECT



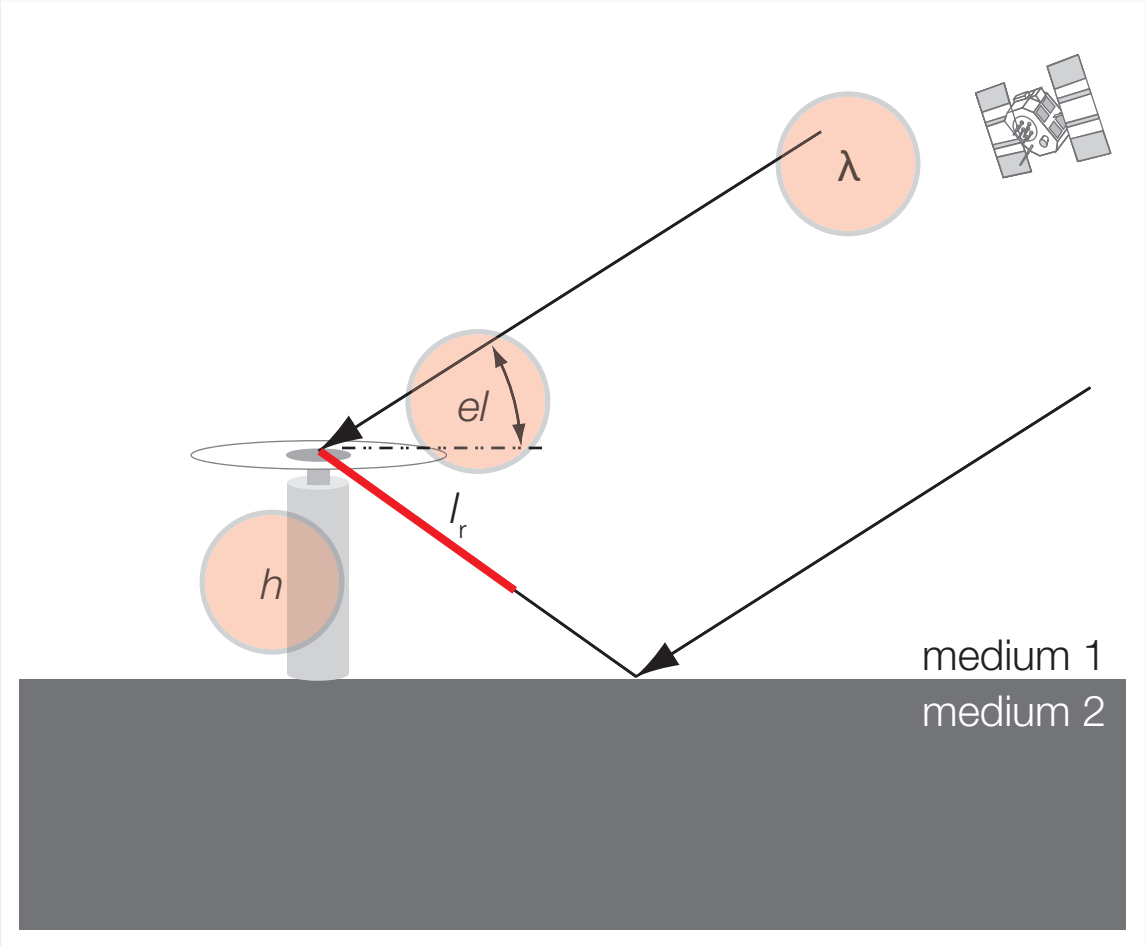
Motivation

MULTIPATH



Multipath geometry – additional path length

”SIMPLIFIED REALITY” – SIMPLE RAY GEOMETRY

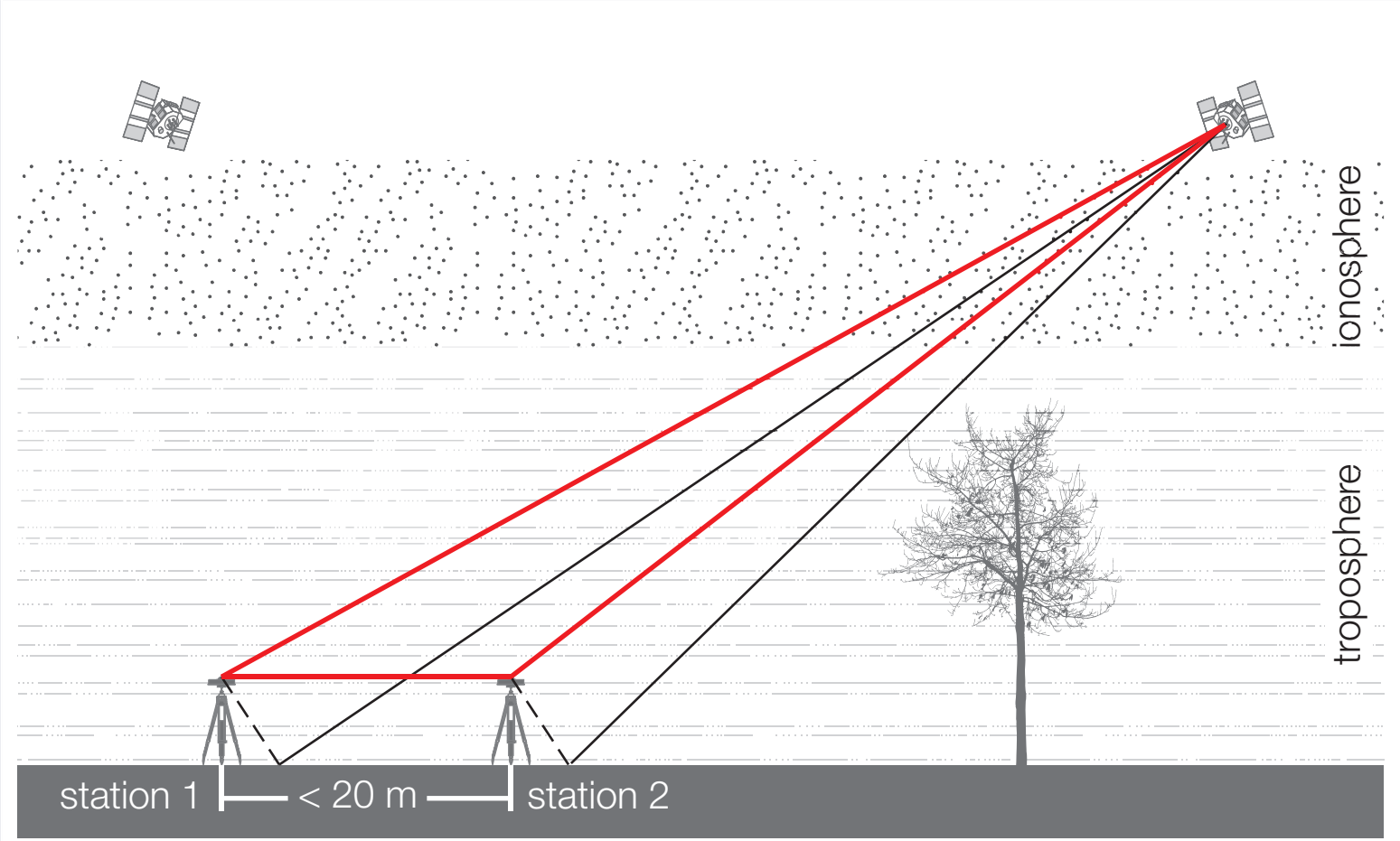


$$\Delta\varphi_r = \frac{2\pi}{\lambda} l_r = \frac{2\pi}{\lambda} 2\, h \sin el$$

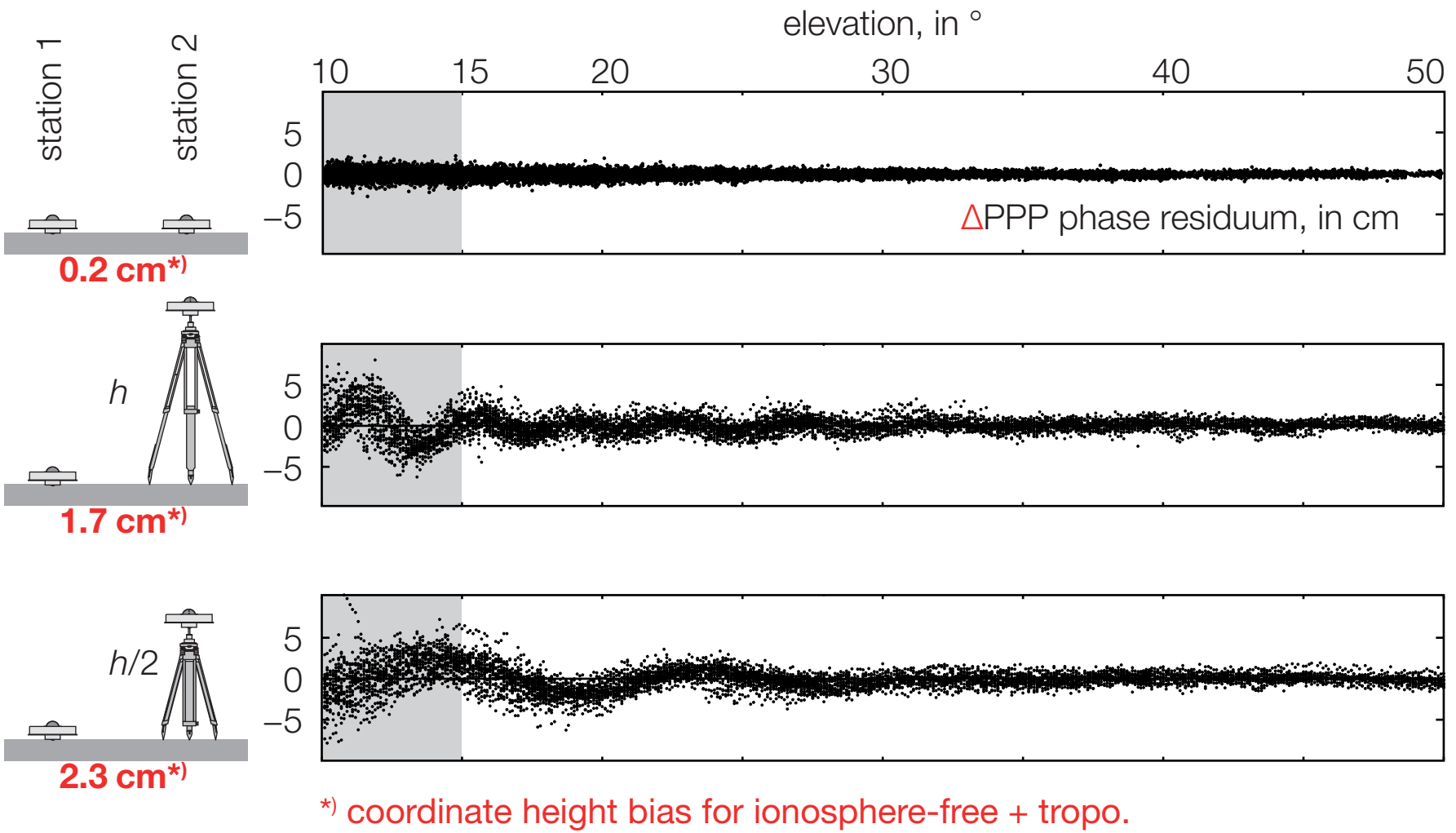
Influence antenna height and elevation – simulation

Play/Pause

Influence antenna height and elevation – practice



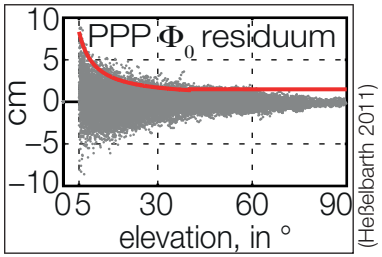
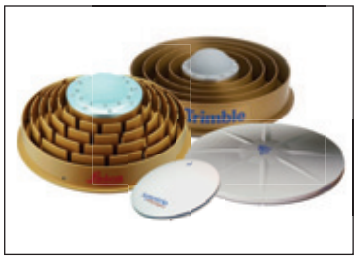
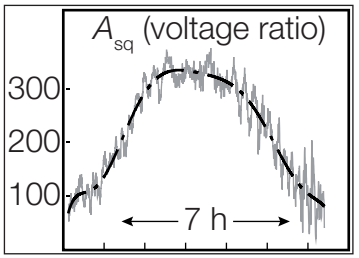
Influence antenna height and elevation – practice



*) coordinate height bias for ionosphere-free + tropo.

Overview mitigation techniques – general

multipath mitigation

site selection/ monumentation	equipment-dependent	observation weighting	station calibration
MORP  (www.epncb.oma.be)	 (Leica, Trimble, Septentrio 2012)	 (Heßelbarth 2011)	Modelling of station environment
ASPA  (http://igscb.jpl.nasa.gov)			Analysis of signal quality (e.g. C/N_0)
BRFT  (Ray 2007)	 (Brown & Mathews 2005)		Analysis of carrier phase residuals

Station calibration of reference stations – detail (1)

ASSUMPTION: **STABLE ENVIRONMENT**

TRUE? ⇒ How about changing vegetation, rain, snow etc.?

(1) model of reflecting surfaces in close vicinity geometry + reflection properties, ray tracing (Lau & Cross 2007; Liso Nicolás et al. 2011)

+ model of physical cause

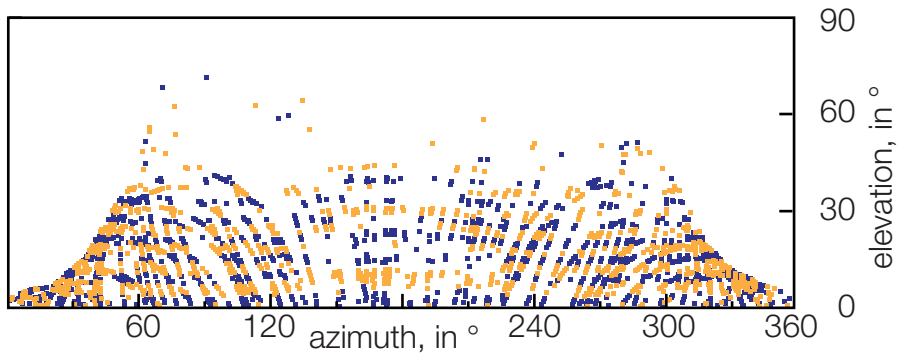
– model deficiencies

(2) analysis of signal quality (C/N_0), estimate carrier phase corrections (Comp & Axelrad 1996; Bilich & Larson 2007; Rost & Wanninger 2009)

+ adapts to changing environment

– geometrical assumptions on reflectors, single main reflector

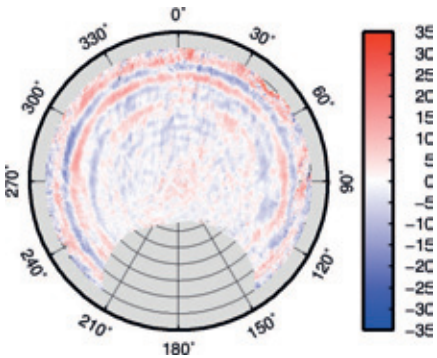
(Liso Nicolás 2011)



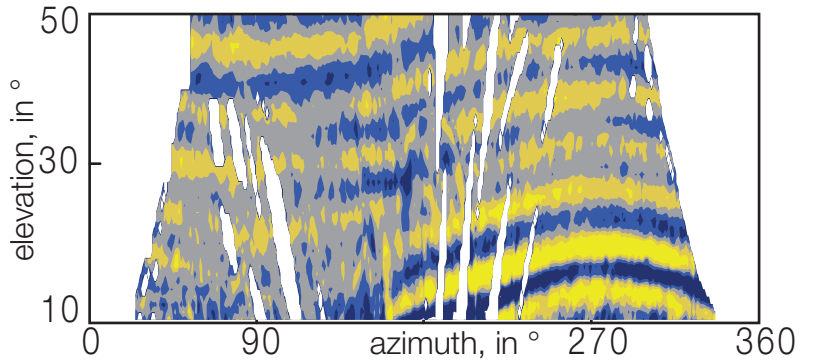
Station calibration of reference stations – detail (2)

(3) analysis of carrier phase residuals of past observations, time stacking
⇒ correction of present observation

- Precise Point Positioning (PPP) (Lidberg et al. 2007; Moore et al. 2012)
  - \+ applicable to all stations without additional effort
  - – ionosphere-free only, far-field multipath only
- regional network of stations (Wanninger & May 2000)
  - \+ applicable to all stations of a regional network without additional effort
  - – mainly for ionosphere-free, far-field multipath only



(Moore 2012)



(Wanninger 2000)

Station calibration of reference stations – detail (3)

(3) analysis of carrier phase residuals of past observations, time stacking
$\Rightarrow$ correction of present observation

- additional temporary local site with low multipath

+ L1/L2/L5

– large efforts and costs
  - directional antenna (Park et al. 2004)
  - robot (kinematic site, multipath $\rightarrow$ noise) (Böder et al. 2001)
  - high poles (Wübbena et al. 2010)


(Park 2004)


(Böder 2001)


(Wübbena 2010)

Summary

CARRIER PHASE MULTIPATH:

- far-field effects $\rightarrow$ residuals $\rightarrow$ corrections,
- near-field effects $\rightarrow$ parameters $\rightarrow$ ground-truth?

DETECTION:

- far-field effects in ionosphere-free carrier phase observation residuals

CORRECTION of L1/L2/L5 carrier phase observations:

- most promising $\rightarrow$ additional local observations
- **but** $\rightarrow$ large effort and costs
- **but** $\rightarrow$ environmental changes (vegetation, rain, snow etc.)

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