

# Reply to Referees

## Referee #1: Vermeer

### General assessment:

A basically good paper describing a new and valuable geodetic infrastructure and its establishment. The paper doesn't offer much in the way of scientific novelty, though some test computations using the new facility are described. I believe that presenting an important new research infrastructure is the kind of novelty worth publishing, and that the paper is publishable with minor corrections.

### Detailed comments:

#### Abstract

1) I dislike the way how, in the last paragraph, several specific undertakings are mentioned by name. I think an abstract should remain more 'abstract', describing rather the scientific problems in geodesy or geophysics that the new system may help address. Of course in the body text these undertakings may be mentioned and described, as they are.

#### Answer:

Slightly changed. Naming the projects gives background information, which we think is useful.

2) "...exceed the scope of an observing system" -> "...exceed the scope of the EXISTING observing system GGOS" (?)

#### Answer:

*changed*

#### Introduction

3) "There are several ongoing projects..." I wouldn't characterise DynaQLim or EPOS as "projects", rather as much broader undertakings. "Initiatives"?

#### Answer:

*changed*

4) THE International Lithosphere Program (add article)

#### Answer:

*done*

5) "...and this raises an issue to discuss and develop the products of an observing system" Clumsy language. Perhaps "Specific data needs in such research may exceed the scope of an existing observing system, and this raises the issue of observing system product development."

#### Answer:

*changed*

6) The ECGN network (add article)

#### Answer:

*done*

7) "supervised at" I propose "commissioned by"

#### Answer:

*sentence removed*

#### Section 2

8) "the usefulness of THE database in research" (add article)

#### Answer:

*done*

9) "error estimate", "error", "error", ... Rather "uncertainty" or "standard deviation".

#### Answer:

*done; uncertainty is according to the terminology used in metrology*

10) "the end of THE 19th century"

#### Answer:

*done*

## Referee # 2 Anonymous

I would like to congratulate the authors on their manuscript "Using the Nordic Geodetic Observing System for land uplift studies". Although it does not present new research results it introduces the Nordic Geodetic Observing System (NGOS) to interested readers and shows the application of it to study vertical land motions in Fennoscandia. The manuscript refers to a number of data sets (GNSS, absolute gravity and tide gauge) for which either direct or indirect estimates of vertical land movements are compared to the widely used land uplift model NKG2005LU. Hence it is certainly worthwhile to be published in Solid Earth.

I have no major concerns. The manuscript is well written and reads well. There are a few grammatical issues that need to be addressed before final publication. Most comments are on the PDF, but here are a few:

P383: Eq 1: how valid is this conversion for Fennoscandia. Please give a range of conversions previously published for this region with references.

**Answer:**

*References and some values added.*

P384: How consistent are the AG results from Gitlein and Breili (different instrument, time spans, modeling)? In your later analysis you use both but you do not comment on potential effects from this.

**Answer:**

*Hard to say, some text added to reflect the uncertainty.*

P384: The PSMSL long-term trends were updated last in January 2013. Why do you use a dataset from 2004? Better would be to consider Woodworth and Player (2004) as a reference to PSMSL and use the updated trends. It should also be mentioned that these trends stem from the revised local reference (RLR) database.

**Answer:**

*Updated. Added.*

P385: How does Ekman's value of 0.2mm/yr for the uncertainty in the sea level trends compare to the uncertainties given by PSMSL? Why do you use Ekman's and not the PSMSL uncertainties?

**Answer:**

*PSMSL uncertainties added.*

P385: indicate Karelian area on Fig 1.

**Answer:**

*A clarification about the geographical extent of the area added in the text.*

P387: Different reference levels is a little vague here. I do understand that the details of these cannot be discussed here but a little more effort could be made. For GNSS, critical is the ability of the reference frame to determine and track the center of mass of the Earth consistently over long periods. The big advantage of absolute gravity measurements is that they do not need a reference frame. Gravimeters measure gravity with respect to the centre of mass. Sea level fundamentally follows gravity changes as well (apart from other effects). So these have no reference frame dependency. Furthermore, with the higher latitude of Fennoscandia, a large uncertainty in the z-translation rate of the reference frame has a larger impact on the vertical than for mid-latitudes.

**Answer:**

*Some text added to lessen vagueness.*

P387, I25: This seems a bit low. If you would use a more recent reference for their sea level rise estimate you would see that best estimates for the globally –averaged 20<sup>th</sup> century sea level rise agree to be around 1.8 mm/yr.

**Answer:**

*It depends on the time period chosen, see IPCC AR5 (Church et al. 2013). Text modified to make this clear.*

P388, I15: it might be worthwhile to actually say something about the length of the AG time series when these are introduced. Then it could be referred here when discussing this issue.

**Answer:**

*True, done.*

P388, I 25: the authors must be careful discussing the "usefulness" of the AG measurements. They are highly useful and give information GNSS cannot. What may be the issue here is that the Fennoscandian AG measurements and the time series derived from them to date may need more observations and better modeling of local effects.

**Answer:**

*True, some text added to make it clear that the length of time series and local effects cause problems with short time series.*

P389, l5: By introducing published values for the conversion of gravity to height changes earlier, a more detailed discussion could be given here.

**Answer:**

*Some text added.*

P389, l15-20: probably one of the most important points made in the paper. To highlight this further, this issue could be raised much earlier and then returned to during the paper. This was the dominant feeling when reading through the manuscript the first time.

**Answer:**

*Some sentences added to the abstract and intro.*

### **referee # 3 Anonymous**

review solid earth, "Using the Nordic Geodetic Observing System for land uplift studies" pg 380, line 20; In the explanation on GIA it is stated that this is due to variation of glaciers in the Northern Hemisphere. But all glaciers contribute to GIA, also variation on Antarctica!

**Answer:**

*True, Northern Hemisphere removed.*

pg 385, ch 2.4; For the NKG2005LU model, repeated levellings was a very important source of observations for the empirical land uplift modelling.

**Answer:**

*A sentence added.*

pg 386, line 17 ff; pg 386, last sentence; pg 387, line 21 ff, pg 388 line 11 ff; The relation between global mean sea level rise, sea level rise in northern Europe and the Baltic, and effect from GIA is included in the paper, but could be improved. In the results from the used data it is found that the obtained value of the sea level rise (regional data from the Nordic/Baltic area) fit almost perfect to the global sea level rise. The it is concluded that an other value is found from other work (e.g. Vestol, and Ekman) and some reasons for the difference is given. But the possibility that difference may be due to regional differences caused by the effect of GIA is not so clearly pointed out in the discussion (but it is mentioned in pg 387 line 23).

**Answer:**

*The point is important, but hard to add to the text.*