**The Cryosphere Discussions**

# *Interactive comment on* "Mass balance, runoff and surges of the Bering Glacier, Alaska" *by* W. Tangborn

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Response of Mauri Pelto

1.Model needs to be compared with another model that produces annual balances from weather observations (a minimal model)

Is there another model that produces annual balances for multiple years directly from weather observations, independently, without reference to measured balances? Most degree-day models use measured balances and weather data to force simulated balances (It used to be called curve-fitting in the USGS). I hope I have made it clear enough that the PTAA model does not produce balances this way.

The PTAA model is based on an idea that is entirely foreign to a degree-day type

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model although the weather observations it uses may be identical (daily observations of precipitation and temperature collected at a standard weather station). The main difference is derived from the imprint left on the bedrock underlying a glacier that is formed by sliding and erosion of the bed throughout geologic time. This indelible imprint has the history of the climate that formed and nourished the glacier embedded in it. The distribution of a glacier's surface area (its area-altitude or AA profile) is thus a manifestation of the underlying topography and is the key to the PTAA model's function. It is similar to a neural network (or artificial intelligence), which processes information using a connectionist approach to computation. Neural networks are often used to analyze complex relationships between the input and output of data and to find patterns, which is the primary intent of the PTAA model. The AA profile of a glacier could then be thought of as a primitive "brain" that converts weather observations to glacier balances. It also detects rapid changes in atmospheric carbon dioxide by relating glacier ablation to global temperatures. See the Wrangell Glacier report on the Mountain Views Newsletter

http://www.fs.fed.us/psw/cirmount/publications/pdf/Mtn_Views_nov_12.pdf

Comparing the model ELA and actual (observed) ELA for a number of years to verify model accuracy is suggested. The main problem with this approach is that visual observation of the actual ELA is often obscured by recent snowfall, especially later in the season and at higher elevations. There is a tendency to report an ELA at a lower elevation than the actual when this occurs.

2. Model must be better validated for individual years (1972-2002 volume change comparison is not enough.

For the Bering Glacier, the only possible comparison is the 1972-2002 measured volume change as balances for individual years do not exist for the Bering Glacier.

3. Paper needs reorganization

Agreed

5097-8 Support weather station choice. There are not many stations to choose from in this region of Alaska that have sufficiently long, unbroken records and are reasonably close to the glacier. It more a matter of using what is available close to the glacier rather than a selective process.

Section 2 Change Mass Balance Results to Mass Balance Model Approach Agreed

5097-10-13 Sentence is a result that should come later Agreed

5097-20 I do not see where IACS report depicts this. See Figure 8 under Mass Balance profile in IACS report which shows South Cascade balance versus elevation with elevation on the Y axis. It is confusing to have elevation dependent on balance for anyone who attempts to simulate glacier balances using weather observations.

5098-9 What are the seven different mass balance variables? See Tangborn (1999) for detailed description of these variables. A PDF of this article that was published in Geografisca Annaler can be found at www.ptaagmb.com under How It Works. Naming them here is unnecessary unless further explanations are included - a line must be drawn somewhere about how much of this article is reproduced.

Section 3 – The PTAA mass balance model – should come before section 2 Agreed

5098-17 Can more detail be provided here for previous model verification. Year by year comparisons of measured versus the PTAA annual balances have been made for the Gulkana and Wolverine Glaciers in Alaska and the Vernatferner in Austria for the past 60 years and can be found at www.ptaagmb.com

5098-19 The comparison should be made to other models not to field methods What other models? All other models that I know about use measured annual balances for calibration. The PTAA model does not.

5099-10 Muskett et al (2003) These are important papers that document changes in

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the Bering and other SE Alaska glaciers, but are they directly pertinent to PTAA model balances? They should be included in the references but only as indirect citations.

5099-20 How does this model generated ELA compare with the ELA from Landsat imagery 9/11/2004? Where would I find this Landsat image? I would like to add another section to this paper that demonstrates a relationship between observed and model-generated ELAs . To do so I would need Landsat images of the Bering glacier for many years and for different times of the year. Is there a source for such images?

Section 4 Comparison with geodetic balances- this section should follow model calibration The revised paper that will be written later this month when all review comments have been posted will take this into account.

Section 5 Should be incorporated as part of the validation The revised paper that will be written later when all review comments have been posted will take this comment into account

5101 Section 7 This is a worthy and valuable goal to generate real-time mass balance. However, should this plan be mentioned in this paper without a more comprehensive validation process? Figure 8 is the potential, but is it a robust result?

What is meant by a "more comprehensive validation process?" How is a "robust result" determined?

5102-7 Muskett (2009) report on the surge cycle elevation changes The connection between the elevation changes shown in this report and the surge-runoff analysis in Figure 9a is needed and will be included in the revised TC article.

5102-9 The potential causal relationship makes sense; however , this data set is not a robust examination of the relationship

The suggestion of a causal relationship will be removed in the revision.

5102-21 Figure 9a and 9b should be a single graph Agree that showing both runoff

and accumulation plots on one figure will be an improvement and will be done for the revision

5102-25 This does not confirm the process , it supports the concept. Reference Burgess et al (2012) paper on Bering Glacier surges Agree and will cite Burgess et al (2012) in the revised article

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