Supplementary Material to *Brief Communication: The Khurdopin surge revisited – extreme surge velocities and formation of a dammed lake in 2017*

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# 1 Data

Table S1: LANDSAT/Planet Data for Velocity Datasets and Animation. All scenes within the years given in the last column were acquired and visually pre-selected for cloud cover, snow cover and image quality over the glacier outline

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Satellite / Scene** | **Band** | **Resolution** | **Acquisition Dates** |
| 1 | Landsat MSS 1-5 (351/97) | 7/4 (NIR) | 60 m | 1972 - 1981 |
| 2 | Landsat 5 | 7 (SWIR) | 30 m | 1989 - 2011 |
| 3 | Landsat 7 | 8 (Panchromatic) | 15 m | 1999 - 2003 |
| 4 | Landsat 8 | 8 (Panchromatic) | 15 m | 2013 – 2017 |
| 5 | Planet | Optical Bands | 3 m | 2016 - 2017 |

Table S1: DEM Data

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Satellite / Product ID | Resolution | Acquisition Date | Reference |
| 1 | ASTER / AST\_L1A.003:2253120815 | 30 m | 2017/05/21 | (NASA LP DAAC, 2017) |
| 2 | TanDEM-X / TDM1\_DEM\_\_04\_N36E075\_DEM | 12 m | Multiple during 2011 | DLR |

# 2 Model Settings and Uncertainties

COSI-Corr is sensitive to chosen initial window sizes as well as window steps (Leprince et al., 2007). In this study we work with different satellite products in respect to resolution and band quality – from the 30 m bands of the initial LANDSAT MSS Satellite to the 3 m optical product of Planet – which made different setups necessary. For the 30 m bands of Landsat MSS and Landsat-5 we used an initial window (W) of 128 pixels, a final window (F) of 16 pixels and a step size of 2 pixels (d) (W128-F16-d2). For Landsat-7 and Landsat-8 as well as Planet imagery we used a W128-F16-d4 setting while for surge events when displacement is substantial or imagery is far apart in time, a W256-F16-d8 is used. We used the Non-Local Means Filter of COSI-Corr (Ayoub et al., 2009) to smooth the gridded data. Velocities measured on stable off-glacier terrain were used to assess the validity of the on-glacier data. The Landsat-MSS off-glacier velocities are in the same range as on-glacier velocities, which makes the COSI-Corr approach not suitable for this data. Off-glacier displacement based on Landsat-5 data was between 2 – 5 m a-1, and this is sufficiently accurate to investigate the build-up and surge phase where velocities are generally one order of magnitude higher. Landsat-7 and 8 as well as Planet data used in the analysis from 2013 onwards generally show off-glacier displacements of 2 - 3 m a-1 for imagery multiple days to weeks apart, which corresponds to the likely error identified by (Luckman et al., 2007). To make sure that noise, resulting from errors in the co-registration process, is not included in the data analysis, we discard all pixel values with a signal-to-noise ratio smaller than 0.75, following (Kraaijenbrink et al., 2016). As large displacements during a surge are picked up as noise by the algorithm in many cases, this constraint had to be loosened for surge peaks. In these cases patches on the surface that showed erratic behaviour (no uniform direction, large variability in velocities on a small area) were discarded visually.

**3 Supplementary Animation of all Landsat Scenes**

Making use of all available Landsat imagery we compiled an animation over all scenes with suitable image quality (SupplementaryMaterial.zip). The images were not enhanced but rather the raw GEOtiffs used for the analysis of velocity data were used.

# References

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