The Cryosphere

Supplement of

Comparison of ice dynamics using full-Stokes and Blatter–Pattyn approximation: application to the Northeast Greenland Ice Stream

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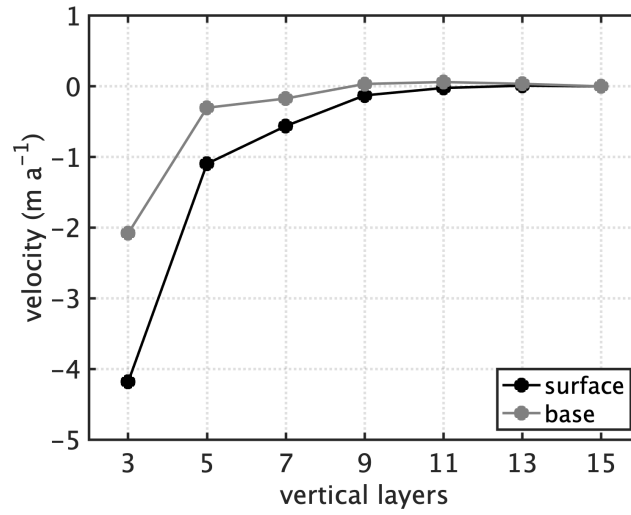
Figure S1. Surface and basal area-averaged velocity for different numbers of vertical layers. Velocity is presented relative to simulation results obtained with 15 vertical layers. Results are shown for FS, $E = 1$, $m = 1$, P1P1GLS-strong applied to the ice stream region with a horizontal resolution of $l = 400\,\text{m}$.
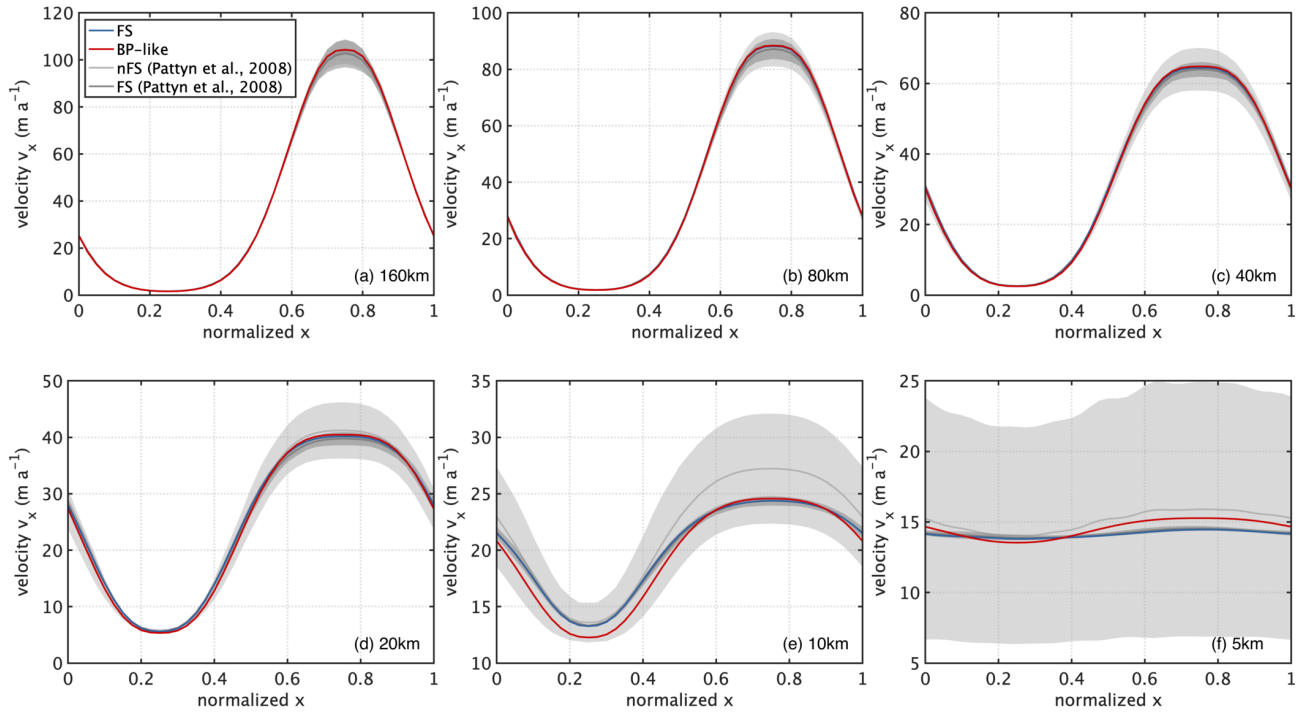
Figure S2. Results of ISMIP-HOM benchmark Exp. A. Surface velocity component v_x (m a^{-1}) across the bump at $y = L/4$ for different length scales, with L ranging from 160 to 5 km. Values computed in the study for FS and BP-like with P1P1GLS-strong are compared to results by simpler models (nFS) and FS from the ISMIP-HOM benchmark (Pattyn et al., 2008).

Figure S3. Results of ISMIP-HOM benchmark Exp. C. Surface velocity component v_x ($\mathrm{m\,a^{-1}}$) across the bump at $y = L/4$ for different length scales, with L ranging from 160 to 5 km. Values computed in the study for FS and BP-like with P1P1GLS-strong are compared to results by simpler models (nFS) and FS from the ISMIP-HOM benchmark (Pattyn et al., 2008).
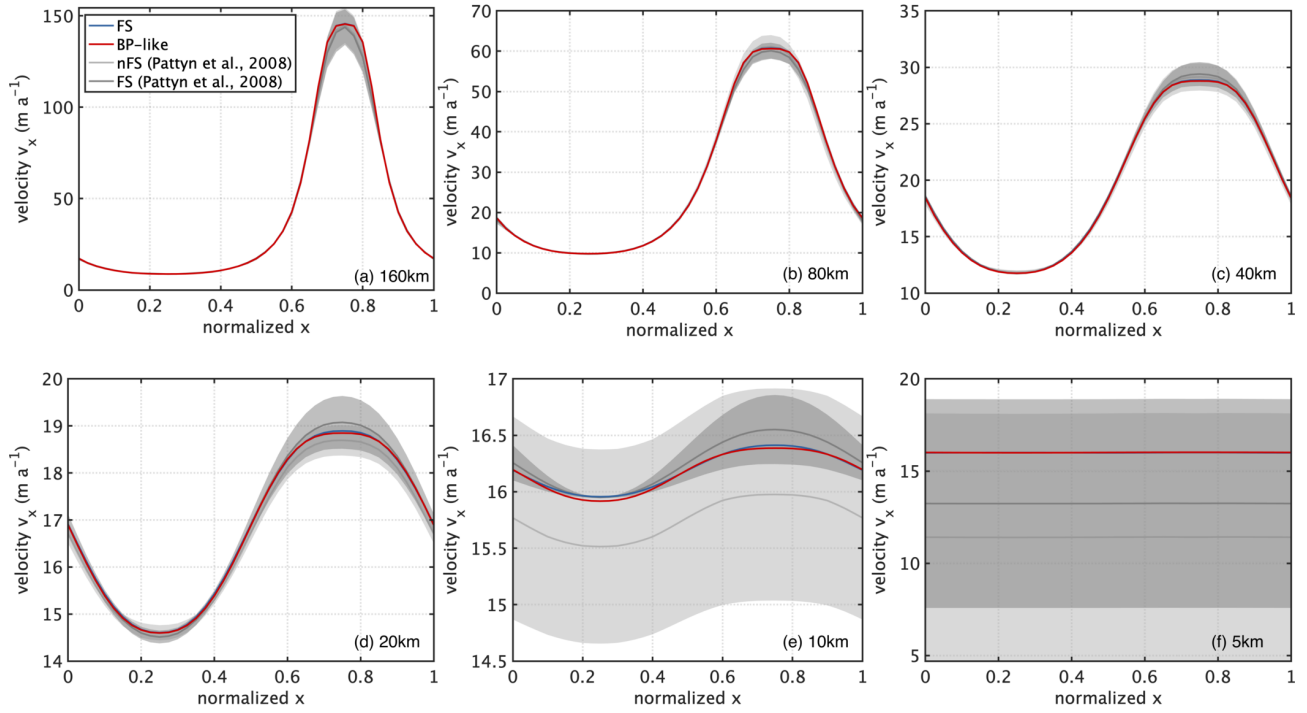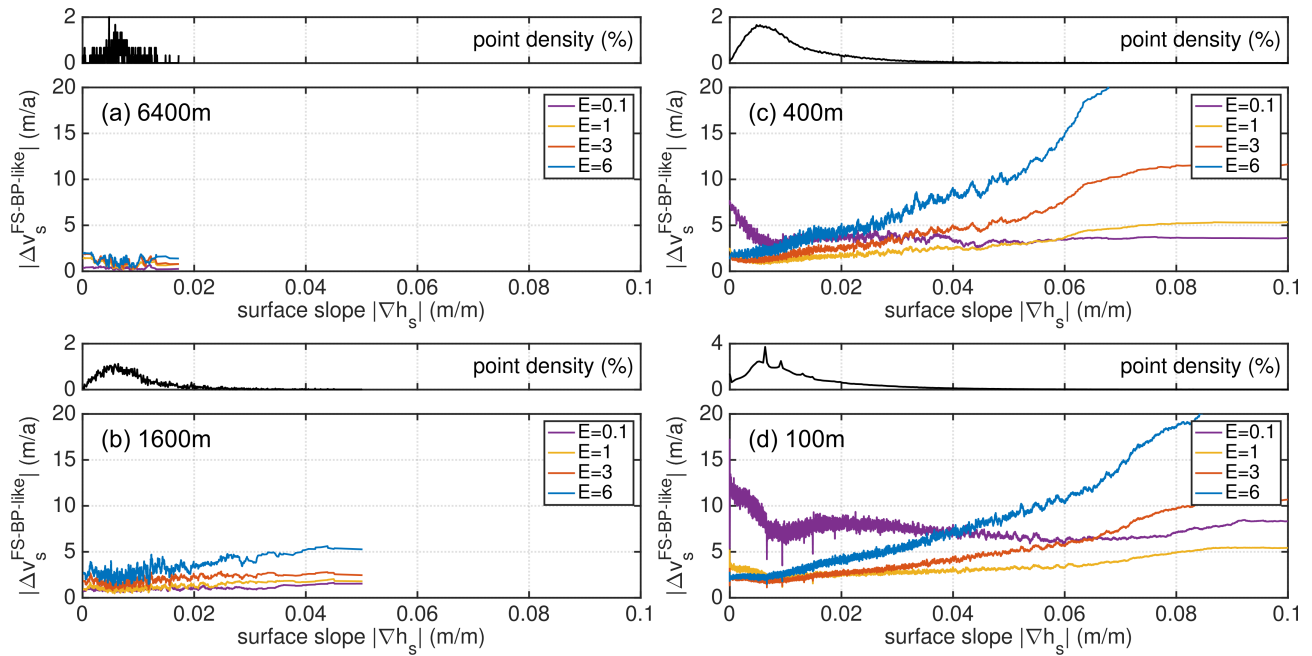
Figure S4. Line plots of the absolute surface velocity difference between FS and BP-like ($|\Delta v_s^{\text{FS-BP-like}}|$) with P1P1GLS-strong versus the surface slope for a resolution of $l = 6400\,\text{m}$ (a), a resolution of $l = 1600\,\text{m}$ (b), a resolution of $l = 400\,\text{m}$ (c), and a resolution of $l = 100\,\text{m}$ (d). A moving mean with a window of 2500 data points is applied.
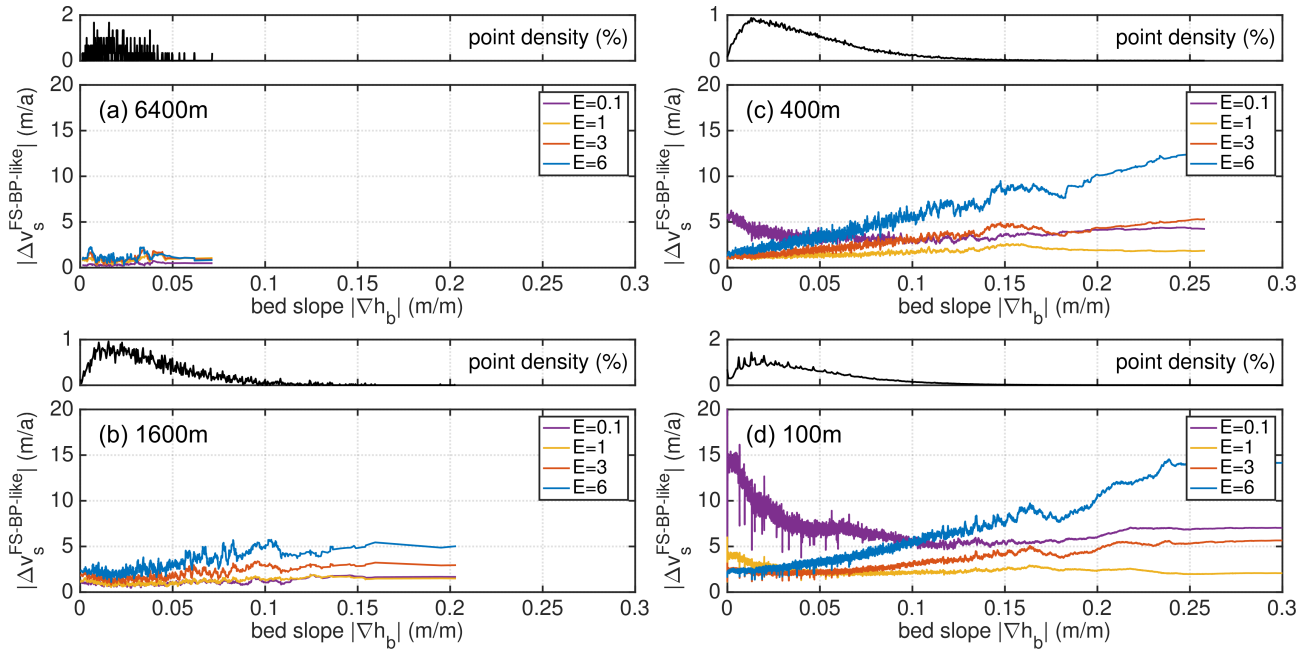
Figure S5. Line plots of the absolute surface velocity difference between FS and BP-like ($|\Delta v_s^{\text{FS-BP-like}}|$) with P1P1GLS-strong versus the bed slope for a resolution of $l = 6400\,\text{m}$ (a), a resolution of $l = 1600\,\text{m}$ (b), a resolution of $l = 400\,\text{m}$ (c), and a resolution of $l = 100\,\text{m}$ (d). A moving mean with a window of 2500 data points is applied.
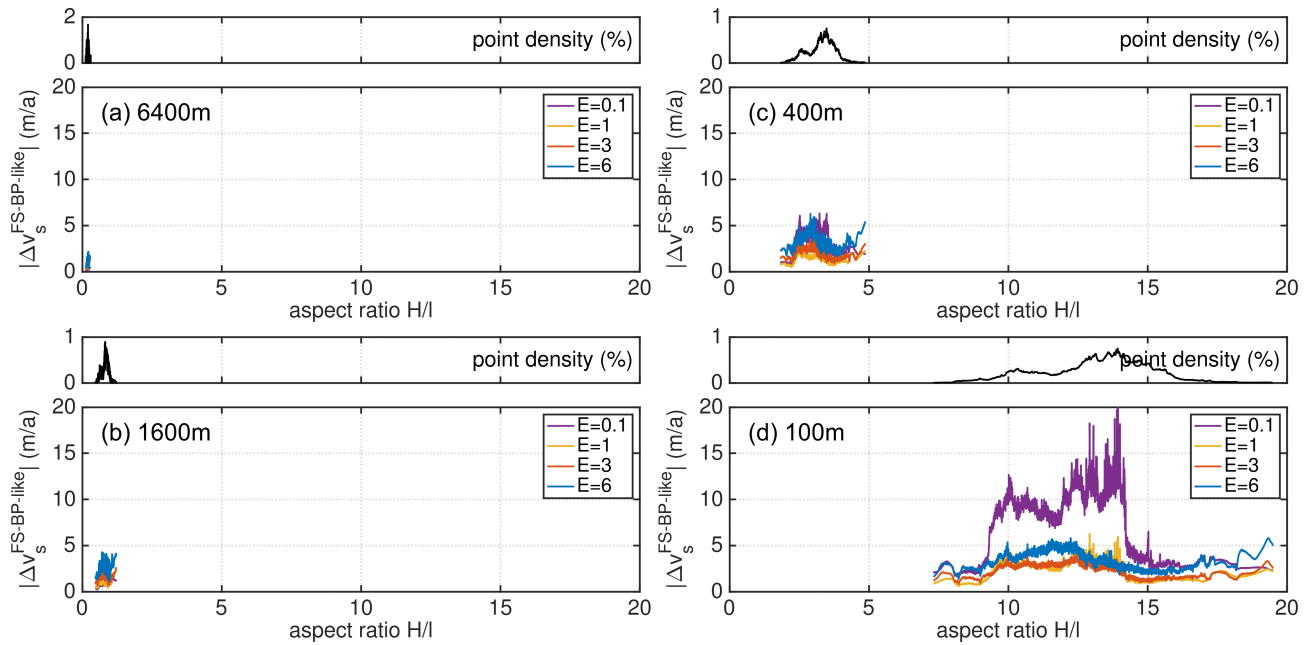
Figure S6. Line plots of the absolute surface velocity difference between FS and BP-like ($|\Delta v_s^{\text{FS-BP-like}}|$) with P1P1GLS-strong versus the local aspect ratio for a resolution of $l = 6400\,\text{m}$ (a), a resolution of $l = 1600\,\text{m}$ (b), a resolution of $l = 400\,\text{m}$ (c), and a resolution of $l = 100\,\text{m}$ (d). A moving mean with a window of 2500 data points is applied.
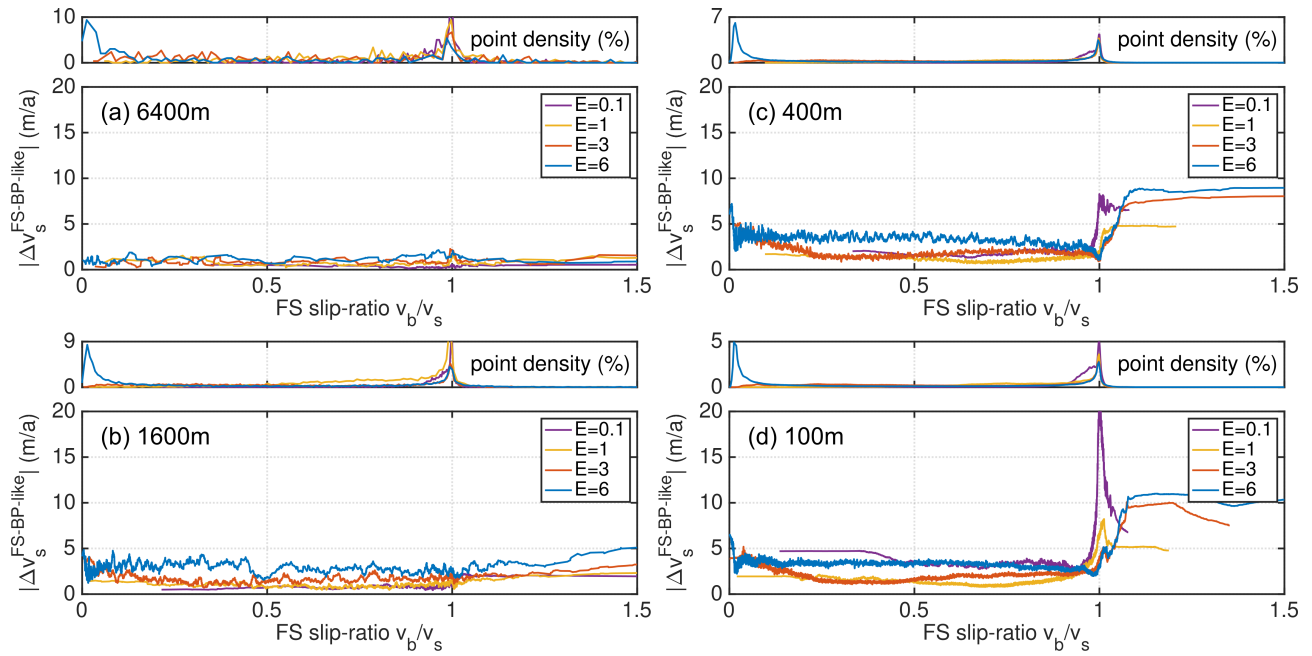
Figure S7. Line plots of the absolute surface velocity difference between FS and BP-like ($|\Delta v_s^{\text{FS-BP-like}}|$) with P1P1GLS-strong versus the FS slip ratio (v_b/v_s) for a resolution of $l = 6400\,\text{m}$ (a), a resolution of $l = 1600\,\text{m}$ (b), a resolution of $l = 400\,\text{m}$ (c), and a resolution of $l = 100\,\text{m}$ (d). A moving mean with a window of 2500 data points is applied.
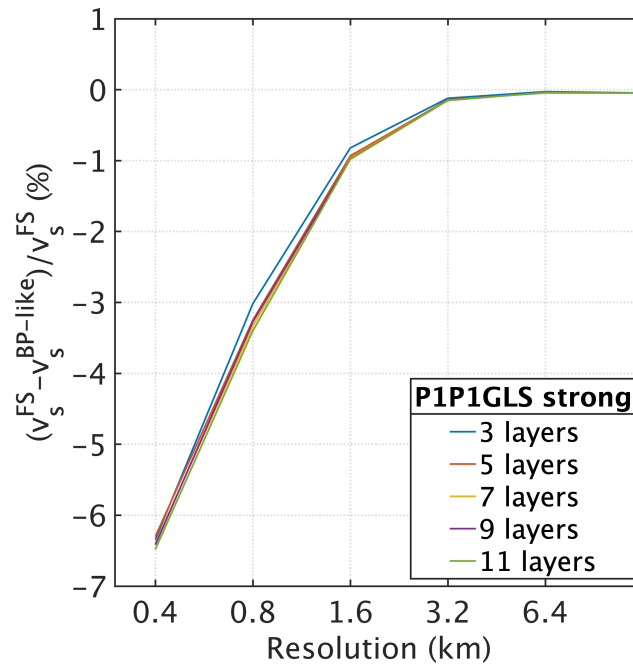
Figure S8. Relative surface velocity differences of spatially averaged surface velocities from FS and BP-like stress regimes for m=3 and P1P1GLS-strong. The coloured lines indicate the number of vertical layers.
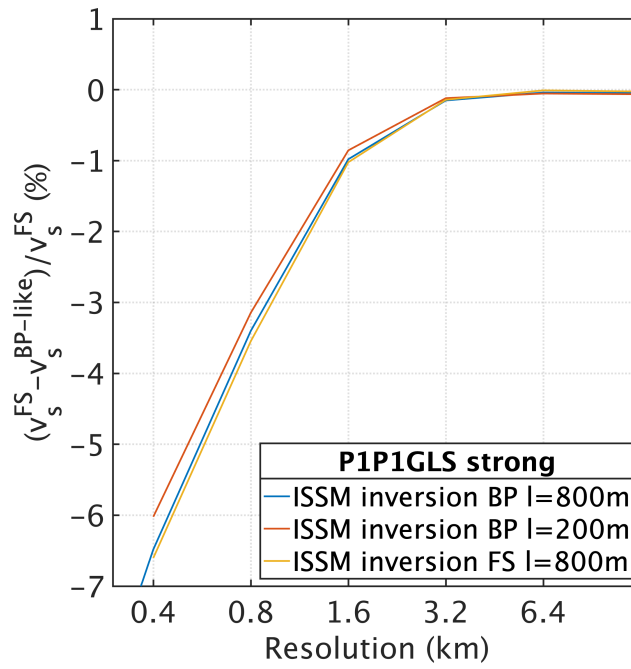
Figure S9. Relative surface velocity differences of spatially averaged surface velocities from FS and BP-like stress regimes for m=3 and P1P1GLS-strong. The coloured lines indicate the inferred friction coefficient with ISSM used as input for COMSOL.

References

Pattyn, F., Perichon, L., Aschwanden, A., Breuer, B., de Smedt, B., Gagliardini, O., Gudmundsson, G. H., Hindmarsh, R. C. A., Hubbard, A., Johnson, J. V., Kleiner, T., Konovalov, Y., Martin, C., Payne, A. J., Pollard, D., Price, S., Rückamp, M., Saito, F., Souček, O., Sugiyama, S., and Zwinger, T.: Benchmark experiments for higher-order and full-Stokes ice sheet models (ISMIP-HOM), The Cryosphere, 2, 95–108, https://doi.org/10.5194/tc-2-95-2008, 2008.

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