ACC28-01 Room:201B Time:May 25 09:00-09:15

Problem on non-dependent of curl distance to initial angular velocity of stone

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There are two different theory based on anisotropy of friction between left and right or between front and back for curl mechanism. However, more difficult problem is non-dependency of curl distance to angular velocity of stone.

From analysis of stone motion, we thought that transversal movement of stone gives curl distance. Self-rotation gives anisotropy of friction between left and right, and decline the stone goes to transversal movement. Namely, stone goes to the declined direction, gives curl distance. Therefore curl distance is not depend on angular velocity.

ACC28-02 Room:201B Time:May 25 09:15-09:30

Atmospheric electric field variation during drifting snow

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Two concentric spherical conducting shells in the earth, i. e., ionosphere and lithosphere, form a global-scale capacitor. The ionosphere has a large electric potential, roughly 250 kV, to the ground surface. The capacitor is charged by global cloud-to-ground lightning and precipitation, while it constantly discharges in the fair weather region through air-earth current. This constructs a global electrical circuit (GEC). The atmospheric electric field (AEF) is affected by slight air pollution. Therefore it is ideal to observe AEF in pole area. However, the electrostatic charge of the ground snowstorm becomes the noise source of the observation in the pole area. The snow in the South Pole Showa station and the study of the AEF are often conducted for a long time and AEF is known to grow big until order of kV/m when the wind velocity becomes big. Because there is not a thundercloud in the Showa station, only ground snowstorm becomes the noise source of the AEF. In this study, we investigate the relationship between the snowstorm and AEF variation.

Keywords: Drifting snow, Atmospheric electric field, Triboelectrification

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ACC28-03 Room:201B Time:May 25 09:30-09:45

Cooling by the melting of snowfall on the Toyama Plain during the winter monsoon

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The peaks of the appearance frequency of the surface air temperature during precipitation are clearly observed near the melting point of water on the Toyama Plain during the winter monsoon. The peaks could be explained by the hypothesis that the melting of snowfall is the primary cause of the cooling on the Toyama Plain. To verify this hypothesis, we investigated the relation of temperature between the inland and the coast using observed data in January from 1990 to 2009 and applied a simple estimation method of the cooling due to the melting of snowfall. The temperature on the Toyama Plain tends to remain around the melting point when the surface air temperature on the coast is higher than 273.15 K and lower than 277.15 K, which almost corresponds to the changeover from snowfall to rainfall. The relation is unclear when hardly any precipitation is observed. The simply estimated cooling by the melting of snowfall using the observed precipitation can also represents the cooling on the Toyama Plain. Accordingly, the local climatic temperature could be greatly influenced by advection of the air mass cooled by the melting of snowfall until the air mass reaches the Toyama Plain during the winter monsoon.

Keywords: snowfall, cooling of melting, surface air temperature, winter monsoon

ACC28-04 Room:201B Time:May 25 09:45-10:00

Geo-environmental Monitoring on Post-fire alpine slopes of Mount Shirouma-dake, northern Japanese Alps

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This is the continuous study to clarify the geo-environmental changes on the post-fire alpine slopes of Mount Shirouma-dake in the Northern Japanese Alps. The fire occurred at May 9, 2009 on the alpine slopes of Mount Shirouma-dake, and the fire spread to the *Pinus pumila* communities and grasslands. Although the grass had a little damage by the fire, the *P. pumila* received nearly impact of the fire. In the *P. pumila* communities where the leaf burnt, forest floor is exposed and become easy to be affected by atmospheric condition such as rain, wind, snow, and etc.

First, we illustrated a map of micro-landforms, based on geomorphological fieldworks. We observed these micro-landforms repeatedly for fifth years after the fire. As the results of the observation, it is clear that remarkable changes of these micro-landforms have not occurred but some litters on the forest-floor in the *P. pumila* communities are flushed out to surroundings. The litter layer on the forest-floor in the *P. pumila* communities were 3-4 cm thick in August of 2011, but it became 0.5 cm thick in September of 2014. The *P. pumila* communities established on the slopes consists of angular and sub-angular gravel with openwork texture, which are covered by thin soil layer. Therefore, it is necessary to pay attention to soil erosion following the outflow of the litter.

In addition, we observe the ground temperature and soil moisture, under the fired *P. pumila* communities and the no fired *P. pumila* communities after the fire, to find influence of the fire. The ground temperature sensors were installed into at 1 cm, 10 cm, and 40 cm depth. The soil moisture sensors were installed into at 1 cm and 10 cm depth. The 1 cm depth of the soil on the post-fire slopes, diurnal freeze-thaw cycles occurred in October and November of 2011, 2012 and 2013, but it had not occurred in 2009 and 2010. In addition, the period of seasonal frost at 10 cm and 40 cm depth on the post-fire slopes are extended for two weeks. These thermal condition changes are triggered by decrease in the thickness of the litter layer on the fired *P. pumila* communities.

Keywords: Fire, Alpine zone, Pinus pumila, Slope erosion, Ground temperature variation, Shirouma-dake

ACC28-05 Room:201B Time:May 25 10:00-10:15

Temporal and spatial variations in pigment compositions of snow algae in Mt. Tateyama in Toyama prefecture, Japan

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Snow algae are photosynthetic microorganisms inhabiting on alpine and polar snow fields. When they bloom, they can change color of snow to red or green since they have various pigments in their cells. Variation in snow color may be associated with environmental conditions and/or taxa of the algae. However, detailed information is not known. In this study, we analyzed pigment compositions, microscopic cell morphology and abundance, and 18S rRNA gene of algal snow collected in the melting season of 2014 on Mt. Tateyama in Toyama prefecture, Japan. We aim to understand the relationship among taxa, life cycles, and pigments of algae.

Absorption spectrums of extracts from the colored snow showed that there were four absorption maximums in absorption spectrums. Each absorption maximums may correspond to pigments contained in the algae, including Chlorophyll *a*, Astaxanthin and unknown Carotenoid. Absorption spectrums varied among the samples, and that could be classified into 4 types: Type A (with maximums of Chlorophyll *a* and Astaxanthin), B (with maximums of Chlorophyll *a* and unknown Carotenoid), C (with maximums of Chlorophyll *a* only), and D (without any maximum). Microscopy of the samples revealed that the samples of A and B types contained snow algae of different color and structure: red sphere cells in Type A, and orange sphere, yellow sphere, green oblong cells in Type B. Analyses of the 18S rRNA gene identified 15 OTUs of algal gene in the samples. The samples of Type A and B contained distinctive OTUs of the algae, respectively, suggesting that the difference of algal pigments between Type A and B is not due to pigment compositions in same algal taxon, but to those of different algal taxa. Analysis of seasonal changes revealed that pigment compositions changed from Type A to Type B at the same location during the study period, suggesting that algal species composition on the snow surface change with time. The results also showed that the colored snow of Type A, B, and C appeared on several locations in Tateyama mountains from June to August. Variations in algal species and pigment compositions among time and locations may be attributed to life cycles and the dispersal of algae.

Keywords: Tateyama, Snow algae, Chlorophyll a, Astaxanthin, Carotenoid

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ACC28-06 Room:201B Time:May 25 10:15-10:30

Snowmelt monitoring of alpine zone in Japan by using time-lapse cameras

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The vulnerability of alpine ecosystems to climate change and the necessity to conduct monitoring in the alpine zone have been recognized worldwide. The Japanese Alps is characterized by extremely heavy snowfall, and snowmelt is a key factor for the growth of alpine vegetation. The Center for Global Environmental Research (CGER) at the National Institute for Environmental Studies has, therefore, launched long-term monitoring of snowmelt and ecosystems in the Japanese alpine zone since 2011 by using automated digital time-lapse cameras and aerial photographs.

In this study, a new method for monitoring alpine zones by digital cameras was developed in order to detect yearly change of snow-cover areas at high temporal and spatial resolutions. We used images from cameras that have been installed at mountain lodges in the northern Japanese Alps (at elevations around 2350-3100 m) and at around Mt. Rishiri in Hokkaido. RGB digital numbers were derived from each pixel within the images. The snow-cover and snow-free pixels were statistically classified by analysis of variance of gray-level histograms. In this discriminate analysis method, a flexible threshold was determined for each image to maximize the between-class variance.

The detected distributions of the snowmelt dates showed site-specific characteristics and yearly variations. Finally, we produced ortho-rectified maps of snowmelt dates over North Alps areas and Mt. Rishiri.

Keywords: RGB digital number, ortho-rectify, discriminate analysis method

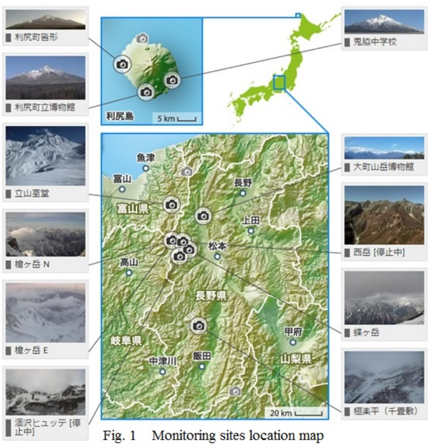

Fig. 1 Monitoring sites location map

ACC28-07 Room:201B Time:May 25 10:30-10:45

Numerical simulation of snow avalanches on the west-facing slope of Mt. Iwate, Japan

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Large-scale avalanches occurred on the west-facing slope of Mt. Iwate during the winter of 2010-11, which damaged 7 ha of subalpine forest in the two paths. Both were likely to be dry-slab avalanches, with starting zones higher than the tree line at around 1730 m a.s.l., because they seem to have penetrated the forest at high speed according to the investigation (Takeuchi et al., 2014). In this study, avalanche flow was simulated over the terrain of Mt. Iwate using the numerical model TITAN2D, in order to verify the position of the starting zone of the avalanches and the effect of forests on reducing velocity and stopping the avalanches of Mt. Iwate. Firstly, we simulated where the avalanches have started by changing the position of starting zone in the model and compared the results with actual positions of the paths and the farthest end of the avalanche. As a result, when the starting zone was regarded as an ellipse with the major axis of 300 m at around 1950 m a.s.l., the avalanche separated in the middle of the runout zone and flowed in the two paths as same as the actual avalanche. Although Takeuchi et al. (2014) supposed that the two avalanche paths are due to two avalanches of which starting zones are different, the model simulations suggested that the two avalanche paths can be due to the one avalanche which started from the one wide starting zone. Secondly, the best fit bed friction angle was examined. In the simulations, forest was distinguished from open area without forest by giving the larger bed friction angle. The bed friction angle were regarded as 25 - 26 degrees in the forest and 12 - 14 degrees without forest through trial and error according to the actual position of the farthest end of avalanche. As a result of the simulation, if the forest had not existed, the avalanche would have traveled quite farther than the actual end in the forest. The distinct stopping effect of forest was shown.

Keywords: Mt. Iwate, snow avalanche, subalpine forest, numerical simulation

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ACC28-08 Room:201B Time:May 25 11:00-11:15

Characteristics of the Yukishiro events and ground factor of slush avalanche on the eastern slope of Mount Fuji

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The ground condition as the mechanical factor and meteorological condition as the trigger of "Yukishiro (slush avalanche and slushflow in Mt. Fuji)" were well studied by Mr. Hirose in 1940s and subsequent works by researcher of snow/ice and mountain climber. However, according to case study based on long-term data, boundary of occurrence or non-occurrence of Yukishiro event, under the right conditions is not clear.

The author carried out field survey in the before and after of the day which were meteorological right condition in the eastern slope of Mt. Fuji. Following results were obtained,

- even if, there is enough snow accumulation, warm temperature and heavy rain with frozen ground (ice filled scoria and ash), non-occurence of Yukishiro is common.
- the occurrence tendency of slushflow from the bottom of small canyon and opened shallow valley is more frequent event rather than slush avalanche from the slope face.
- ice layer(s) have been widely existed in snow. However it was not observed in February 2014 after heavy snow accumulation.

According above mentioned feature, snow depth and existing the ice layer should be key condition of "Yukishiro".

Keywords: slush avalanche, slushflow, snow profile observation, ice layer, case study, disaster prediction

Japan Geoscience Union Meeting 2015
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ACC28-09 Room:201B Time:May 25 11:15-11:30

Winter speed-up of polythermal surging glacier in West Kunun Shan

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Glacier surging is a short-lived rapid flow punctuated with a years-decades long quiescent phase in which a glacier stream become stagnant or relatively slower than those of non-surge type glaciers. It is consider that the surging flow is triggered by high basal water pressure. It reduces overburden ice pressure and the yield stress of basal till, which can be attributed to enhance the basal slip. Two possible mechanisms are proposed according to velocity development during the surging. The detailed surging mechanisms, however, remain uncertain because temporal observations of surging flow are still limited.

We examined the spatial-temporal evolution of the surface velocities at the two surging glaciers in West Kunlun Shan, northwestern Tibet, applying the offset-tracking method to both ALOS/PALSAR and TerraSAR-X SAR imageries. West Kunlun Shan is one of the driest and the coldest region around Tibetan Plateau. Accumulation and ablation mainly concentrates during May-September (Zhang et al. 1989). An ice cap is frozen to the bed (Thompson et al., 1995), whereas many glaciers are found to be polythermal type glaciers (Aniya 2008).

Two surging had already activated by 2007 and still continued by 2014, gradually changing their flow speed. Furthermore, we detected the surging flow modulated seasonally that the flow speeds increased up to $\sim$180-200% in late fall to winter against in spring to early summer. Pressure melting and frictional heating have been proposed to explain the years-long surging flow at poly-thermal glaciers. But the observed seasonal modulation strongly suggests that the influx of surface meltwater influenced the surging flow, indicating that the hydrological processes play an important role under the sub-polar environment.

Keywords: glacier surging, SAR, West Kunlun Shan, winter speed-up

Japan Geoscience Union Meeting 2015
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ACC28-10 Room:201B Time:May 25 11:30-11:45

Seasonal changes of basal water pressure computed from numerical glacier hydrology model

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Seasonal velocity changes at mountain glaciers have been known since 1980s (e.g., Iken and Bindschadler, 1986), and those at Greenland Ice sheet were detected in early 2000 (Zwally et al., 2002). While such short-term glacier dynamics have not been taken into account in the standard "long-term" glacier modeling, this is not only due to the limitations of computational resources but also due to the implicit assumption that the winter velocity is the slowest. Spring/early summer speed-up has been well-documented and studied from both observational and theoretical sides. Meanwhile, although the wintertime initiation of glacier surge in Alaska has been empirically known, no extensive wintertime velocity measurements have been performed because of logistics problems. However, Abe and Furuya (2014) detected those signals at the quiescent surge-type glaciers in Yukon/Canada. Moreover, at the two surging glaciers in the West Kunlun Shan, NW Tibet, Yasuda and Furuya (2015, submitted) detected seasonal modulation signals in their surface velocity data, indicating ~200 % increase of surface velocities from fall to winter. These new glacier velocity observations indicate that the effects of meltwater on glacier dynamics are still poorly understood. We review the present status of numerical modeling of subglacial hydrology, and argue the future prospects.

Keywords: glacier surface velocity, seasonal change, glacier hydrology, basal water pressure

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ACC28-11 Room:201B Time:May 25 11:45-12:00

Seasonal and interannual variations of mountain glaciers in Wrangell Mountains, Alaska

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Recent satellite data have revealed significant ice mass loss on ice-sheets and mountain glaciers (e.g., Garder et al., 2013). GRACE data from 2003 to 2010 show the rate of ice loss in Alaskan glaciers is 65 Gt/yr (Arendt et al., 2013). DEM differencing is also used to estimate the ice thickness change, and Berthier et al. (2010) revealed the changes at the regional scales. Das et al. (2014) estimates the ice thickness changes by DEM differencing and airborne laser altimetry in Wrangell Mountains. While the ice thickness change is -0.07±0.19 m w.e.yr-1 from 1957 to 2000, it increases by up to -0.24±0.16 m w.e.yr-1 from 2000 to 2007. This indicates accelerated mass loss over the Wrangell Mountains during 21st century. However, the glaciers variation following the interannual ice loss remains unclear. Thus, we have examined the spatial and temporal variations of ice speed and terminus position in mountain glaciers in Wrangell Mountains by satellite imageries.

Synthetic Aperture Radar (SAR) data have revealed ice velocity fields of ice sheets and mountain glaciers with high resolution (e.g., Rignot et al., 2011; Yasuda and Furuya, 2013). Near the border of Alaska and Yukon (surrounding the St. Elias Mountains), the ice speed distributions have been clarified (Burgess et al., 2013) and their spatial and temporal changes (Abe and Furuya, 2014). We found significant upstream accelerations at many surge-type glaciers from fall to winter, regardless of surging episodes. Given the absence of upstream surface meltwater input in winter combined with an earlier observation of vertical surface motions (Lingle and Fatland, 2003), we support the hypothesis of englacial water storages that promote basal sliding through increased water pressure as winter approaches.

We expanded the analysis area to Wrangell Mountain in order to examine (1) seasonal speed change, (2) interannual variation (3) whether the winter speed-up is universal or not. The temporal coverage of ALOS/PALSAR is only for 5 years (from 2006 to 2011). This is too short to examine the interannual changes. Thus, we use Landsat optical imageries (1999-2014) to examine the terminus position in addition to SAR intensity images. In terms of interannual change in ice speed, we compare the result shown in Lie et al. (2008). They showed the ice speed of Nabesna Glacier, which is the largest land-terminating glacier in Alaska, by applying InSAR analysis to 5-tandem pairs of ERS 1-2 SAR data acquired from 1994 to 1996.

Our results show the clearly seasonal speed-up is shown at Nabesna glacier, but there seems to be no interannual change between 1995 and 2010. Besides, the proglacial lakes have been extending between 1999 and 2014. At Copper Glacier, we found upstream accelerations from fall to winter at every year. The winter speed-up can be found in the confluences of the tributaries and valley constrictions, where it is likely to form overdeepened bed topography (MacGregor et al., 2000; Hooke, 2005). As comparing with Turrin and Foster (2014), we discuss the relation between overdeepenings and englacial water storage, and its link to surface speeds.

Keywords: Alaskan Glaciers, SAR, Winter speed-up, Overdeepenings, Englacial water storage

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ACC28-12 Room:201B Time:May 25 12:00-12:15

Calibration and evaluation of glacier surface elevation change in accumulation area using ICESat laser altimeter

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In general, remote sensing derived digital elevation model (DEM) accompany bias and/or error, specific measurement method (photogrammetry, radar and laser). For example, photogrammetry derived DEM could contain large error in low contrasted accumulation area. Therefore, cross validation using other measurement method is necessary to evaluate photogrammetry derived DEM in accumulation area. We evaluated bias and error of grid DEM (2000–2012) using ICESat laser derived point DEM (2003–2008).

At first, glacier surface elevation change between 2000 and 2012 has been calculated by grid DEM using linear regression (Nuimura et al. 2011). Meanwhile, ICESat laser measurement has been carried out 30 times between 2003 and 2008 in this region (Z_{ICESat}). Hence, we extracted surface elevation of each date from linear regression from grid DEM (Z_{eval}). And those difference has been evaluated altitudinally for on/off-glacier.

Altitudinal distribution of the difference is near from zero line off glacier. On the other hand, Z_{eval} shows over estimation of altitude upper than 5300 m a.s.l. on glacier.

Keywords: glacier, DEM, ICESat, Himalaya

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ACC28-13 Room:201B Time:May 25 14:15-14:30

Densification of layered firn of the ice sheet at Dome Fuji, Antarctica

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In order to better understand the densification of polar firn, firn cores from three sites within approximately 10 km of Dome Fuji, Antarctica, were investigated, using surrogates of density: dielectric permittivities ε_v and ε_h at microwave frequencies with electrical fields in the vertical and the horizontal planes, respectively. Dielectric anisotropy $\Delta\varepsilon$ (= ε_v - ε_h) was then examined as a surrogate of the anisotropic geometry of firn. Firn was found to become denser as a result of complex effects of two phenomena that commonly occur at the three sites. Basically, firn with initially smaller density and smaller geometrical anisotropy deforms preferentially throughout the densification process due to textural effects. Second, layers having a higher concentration of Cl^- ions deform preferentially at depths from the surface to ~30 m. We argue that Cl^- ions dissociated from sea salts softened firn due to modulation of dislocation movement, but that the layered deformation ceases when Cl^- is smoothed out by diffusion. Moreover, firn differs markedly between the three sites in terms of strength of geometrical anisotropy, mean rate of densification, and density fluctuation. We suggest that these differences are caused by textural effects resulting from differences in depositional conditions within various spatial scales.

Keywords: Firn, Antarctica, ice sheet, Antarctic glaciology, glacial rheology

ACC28-14 Room:201B Time:May 25 14:30-14:45

Spatial and temporal variability of surface snow chemistry and snow deposited condition at East Antarctic ice sheet

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[1]National Institute of Polar Research, [2]Institute of Statistical Mathematics

Snow stakes along the traverse routes have been observed for long term monitoring program 'the variation of ice sheet surface mass balance' from the 1960's by the Japanese Antarctic Research Expedition in Shirase glacier drainage basin, East Antarctica. During the traverse route between coastal S16 point (69 02'S, 40 03'E, 580m a.s.l.) to inland Dome Fuji (77 22'S, 39 42'E, 3,810m a.s.l.), the snow stake observations every 2 km have been carried out from 1993. Yearly net snow accumulations from S16 to Dome Fuji were calculated.

Surface snow samplings were conducted every 10km along the traverse route. Generally, the snow surface features are classified into three regions.

(1) coastal region: smooth surface, high snow accumulation

(2) katabatic slope region: rough sastrugi surface and smooth glazed surface

(3) high plateau region: smooth surface, little snow accumulation

We will show the spatial and temporal variability of surface snow accumulation and snow chemistry at East Antarctic ice sheet.

The chemistry of surface snow changes from the coast to inland. Furthermore, the chemical properties of snow are different for each surface at the same area. We can classify the surface snow with fresh drifting snow, deposited drift snow, soft and hard surface snow, sastrugi, surface hoar and so on. The value of each isotope ration and ion concentration greatly varied. Sometimes, snow might deposit thick equally. But the deposited snow was redistributed by the wind. When the snowstorm occurred, the blowing snow started to deposit in a certain opportunity. As for it, the area was not the uniform. It is necessary to discuss inhomogeneity of the depositional condition quantitatively.

Keywords: Antarctic ice sheet, depositional condition, surface snow, snow chemistry

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ACC28-15 Room:201B Time:May 25 14:45-15:00

A simple anisotropic flow law for polar ice based on anisotropic, scalar flow enhancement

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The flow of polycrystalline polar ice is often described by Glen's flow law, in which ice is assumed to be an isotropic, non-linearly viscous fluid. This goes along with the assumption that the ice crystallites (grains) in the polycrystalline aggregate are essentially randomly oriented. However, observations show that, especially in the deeper parts of an ice sheet or glacier, different patterns of preferred c-axis orientations and anisotropic flow properties develop, which vary according to the flow regime. Adopting some concepts proposed by Budd et al. (J. Glaciol. 59, 374-392, 2013), we will describe a newly developed, simple anisotropic flow law based on an anisotropic, scalar flow enhancement factor. The scalar character is similar to the flow law of the CAFFE model by Placidi et al. (Cont. Mech. Thermodyn. 22, 221-237, 2010). However, while the CAFFE model contains an evolution equation for the anisotropic fabric, here we assume that on a large scale the fabric (microstructure) evolves at a rate to remain compatible with the deformation regime. This makes ice deformability a function of the current deformation regime, eliminating the requirement for a fabric evolution scheme. The parameters of the anisotropic flow law are based on laboratory ice deformation experiments conducted in a range of combined stress configurations incorporating compression and simple shear (Treverrow et al., J. Glaciol. 58, 301-314, 2012). These results show that ice is softer under simple shear than under compression. We have implemented the new flow law in the three-dimensional ice sheet model SICOPOLIS (www.sicopolis.net), and we will discuss some simulation results for a simple geometry (EISMINT; Payne et al., J. Glaciol. 46, 227-238, 2000) and for the Antarctic ice sheet.

Keywords: Anisotropy, Flow law, Polar ice, Antarctic ice sheet, Modelling