An application of plume theory to assess impacts of subglacial discharge on glacier melting

Satoshi Kimura¹, Paul Holland¹, Adrian Jenkins¹ and Matthew Piggot²
¹British Antarctic Survey,
²Department of Earth Science and Engineering, Imperial College London

Key physics
1. meltwater feedback
2. buoyant jet

Tools
3D-unstructured, finite-element ocean model

Fjord
Salinity: $S_a = 33$ PSU
Temperature: $T_a = 2 \, ^\circ\text{C}$

Depth = 500 m
Width = 200 m
Length = 2000 m
$h = 10$ m
Fix the volume flux of subglacial discharge and change the channel size

Distribution of melt rate [m/day], viewing from the ice face

Volume flux = 20.0 m$^3$/s

Line source
width = 200 m
height = 10 m

Point source
width = 20 m
height = 10 m

Point source
width = 10 m
height = 10 m

Maximum melt rate
Side view

Profile of vertical velocity along ice face

Side view of temperature along the center of the channel
An application of plume theory to assess impacts of subglacial discharge on glacier melting

Satoshi Kimura¹, Paul Holland¹, Adrian Jenkins¹ and Matthew Piggot²
¹British Antarctic Survey,
²Department of Earth Science and Engineering, Imperial College London

Key physics
1. meltwater feedback
2. buoyant jet

Tools
3D-unstructured, finite-element ocean model

Depth = 500 m
Width = 200 m
Length = 2000 m
h = 10 m

Glacier
Velocity: $v_d$
Salinity: $S_d = 0$
Temperature: $T_d$

Plume
Fjord
$S_a = 33$ PSU
$T_a = 2$ °C
Fix the volume flux of subglacial discharge and change the channel size

Distribution of melt rate [m/day], viewing from the ice face

Volume flux = 20.0 m³/s

Line source
width = 200 m
height = 10 m

Point source
Width = 20 m
height = 10 m

Point source
width = 10 m
height = 10 m
Side view

Profile of vertical velocity along ice face

Side view of temperature along the center of the channel

-500 -400 -300 -200 -100 0 100 200 300 400 500
Z [m]

0 0.2 0.4 0.6 0.8 1.0 1.2 1.4
W [m/s]

0 50 100 150 200 250
Y [m]

1.90 1.91 1.92 1.93 1.94 1.95 1.96 1.97 1.98 1.99 2.00

1.2 m/s