モンゴル西部の気候と Potanin氷河の質量収支

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もくじ

1. 研究の背景
2. 氷河について
3. 観測の方法
4. 研究内容
5. 観測地域の文化の紹介

1．研究の背景

氷河の質量収支変動による海水準変動への影響

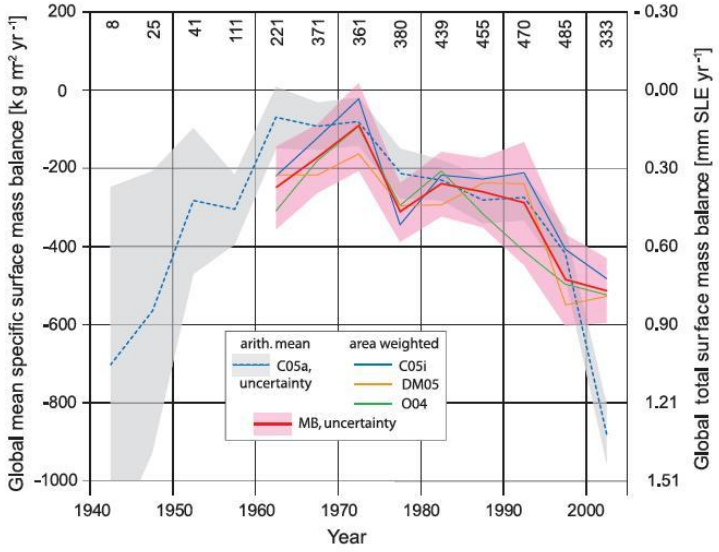
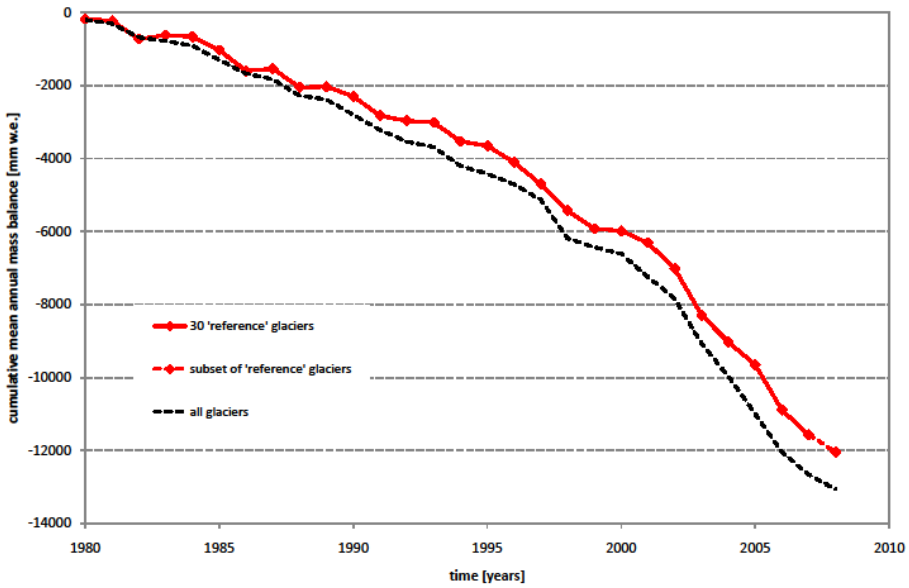


Figure 4.14. *Pentadal (five-year) average mass balance of the world's glaciers and ice caps excluding those around the ice sheets of Greenland and Antarctica. Mean specific mass balance (left axis) is converted to total mass balance and to SLE (right axis) using the total ice surface area of 546 × 10³ km² (Table 4.3) and the ocean surface area of 362 × 10⁶ km². C05a is an arithmetic mean over all annual measurements within each pentade (Cogley, 2005); the grey envelope is the 90% confidence level of the C05a data and represents the spatial variability of the measured mass balances. The number of measurements in each time period is given at the top of the graph. C05i is obtained by spatial interpolation (Cogley, 2005), while DM05 (Dyurgerov and Meier, 2005) and O04 (Ohmura, 2004) are area-weighted global numbers. MB is the arithmetic mean of C05i, DM05 and O04, and its uncertainty (red shading) combines the spatial variability and the structural uncertainty calculated for the 90% confidence level. This does not include uncertainties that derive from uncertainties in the glacier area inventories. The authors performed area weighting and spatial interpolation only after 1960, when up to 100 measured mass balances were available. The most recent period consists of four years only (2000/2001 to 2003/2004).*

IPCC2007

質量収支変化の積算値



(World Glacier Monitoring Service, web site)

Records of directly measure glacier mass balances are few and stretch back only to the mid-century. Because of the very intensive fieldwork required, these records are biases forwards logistically and morphologically “easy” glaciers.

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モンゴル西部　水源としての雪氷

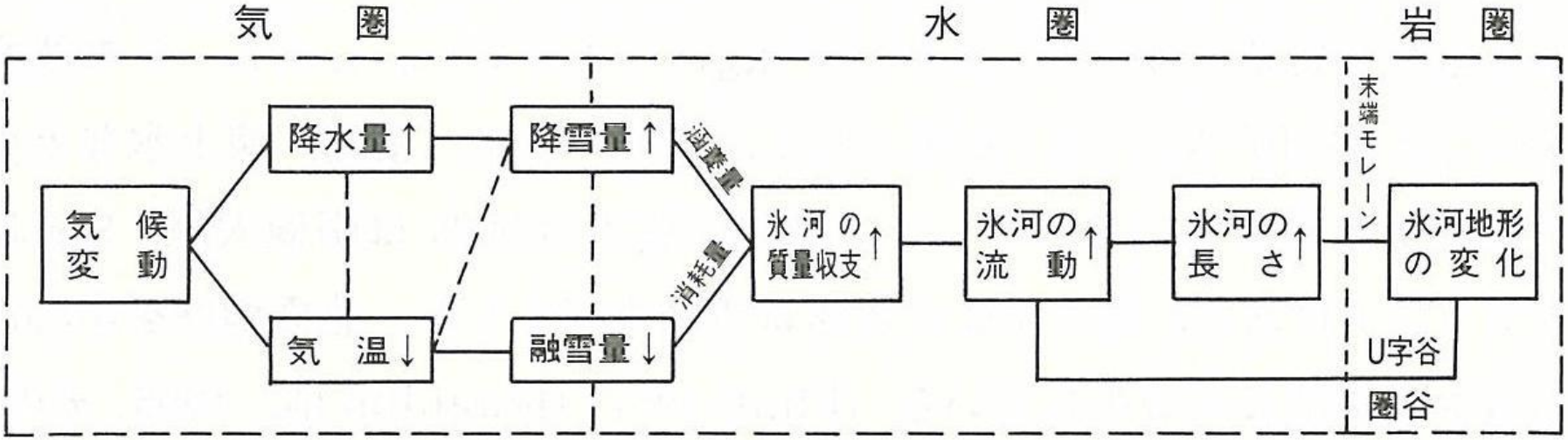
No	River and Gauge site	Percent in annual flow		
		Ground water	**Snow and ice**	**Rainfall**
Altay Mts.				
1	Sagsay at Buyant soum	**32**	**51**	**17**
2	Hovd river at Ulgii	**32**	**63**	**5**
3	Hovd river at Myangad soum	**40**	**57**	**3**
4	Buyant river at Hovd	**33**	**63**	**4**
5	Kharkhiraa river at Tarialan soum	**31**	**57**	**12**

Reference: Edited by Myagmarjav B. and Davaa, G. (1999): Surface Water of Mongolia, Interpress, Ulaanbaatar, 345p.

氷河は含まれていません。

2. 氷河について

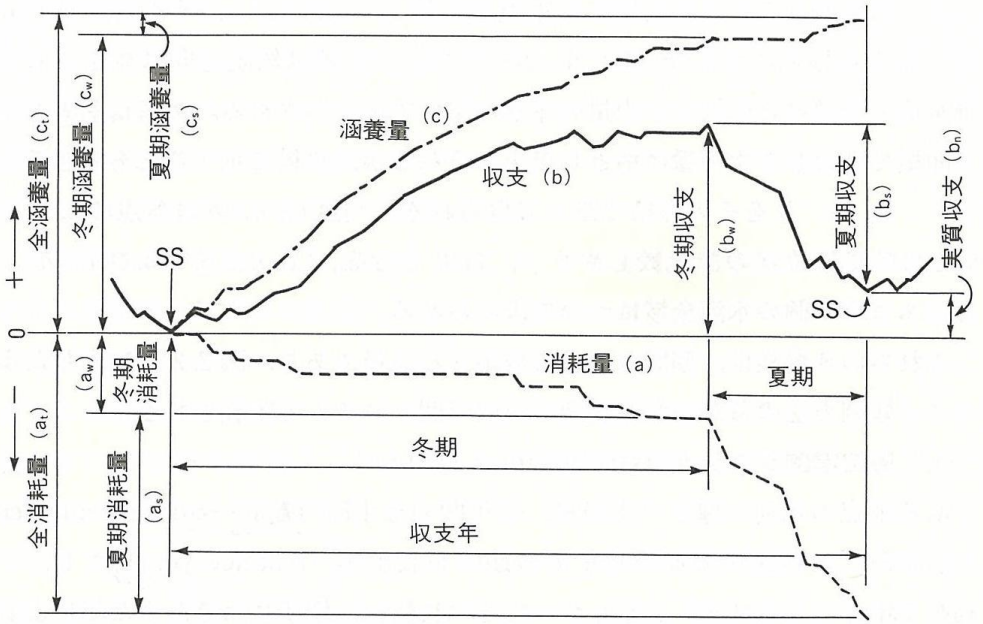
氷河は
重力によって流動する氷体



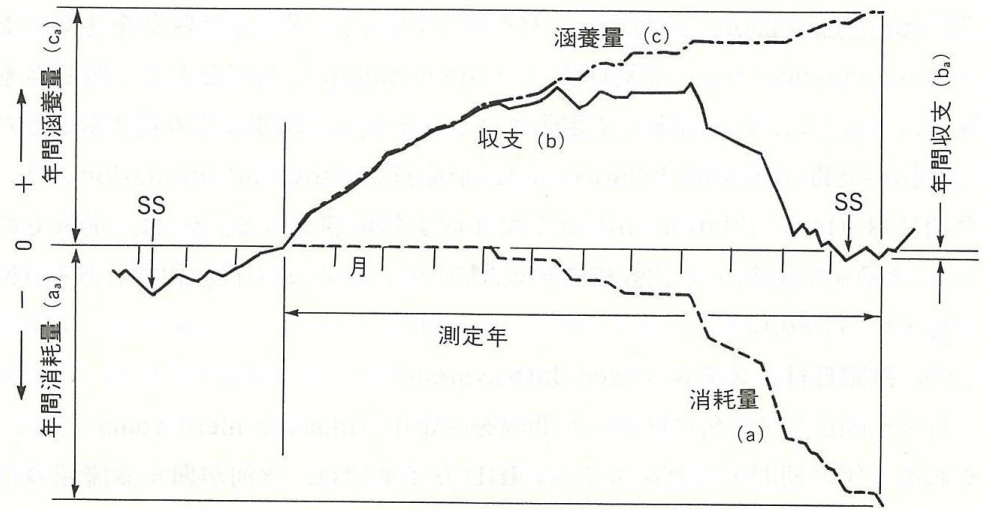
矢印は，氷河の末端が前進するためにはそれぞれの量が増加(↑)するのか減少(↓)するのかを示す．

図 2.1.1　気候変動から氷河の拡大・縮小をへて地形変化にいたる過程
上田（1977）による．

藤井ほか編「氷河」



a）層位学的システム



b）確定日付システム

図 2.2.1　質量収支の術語（氷河上の 1 点での例）
SS：夏面の形成時
UNESCO/IASH（1970）による．

藤井ほか編「氷河」

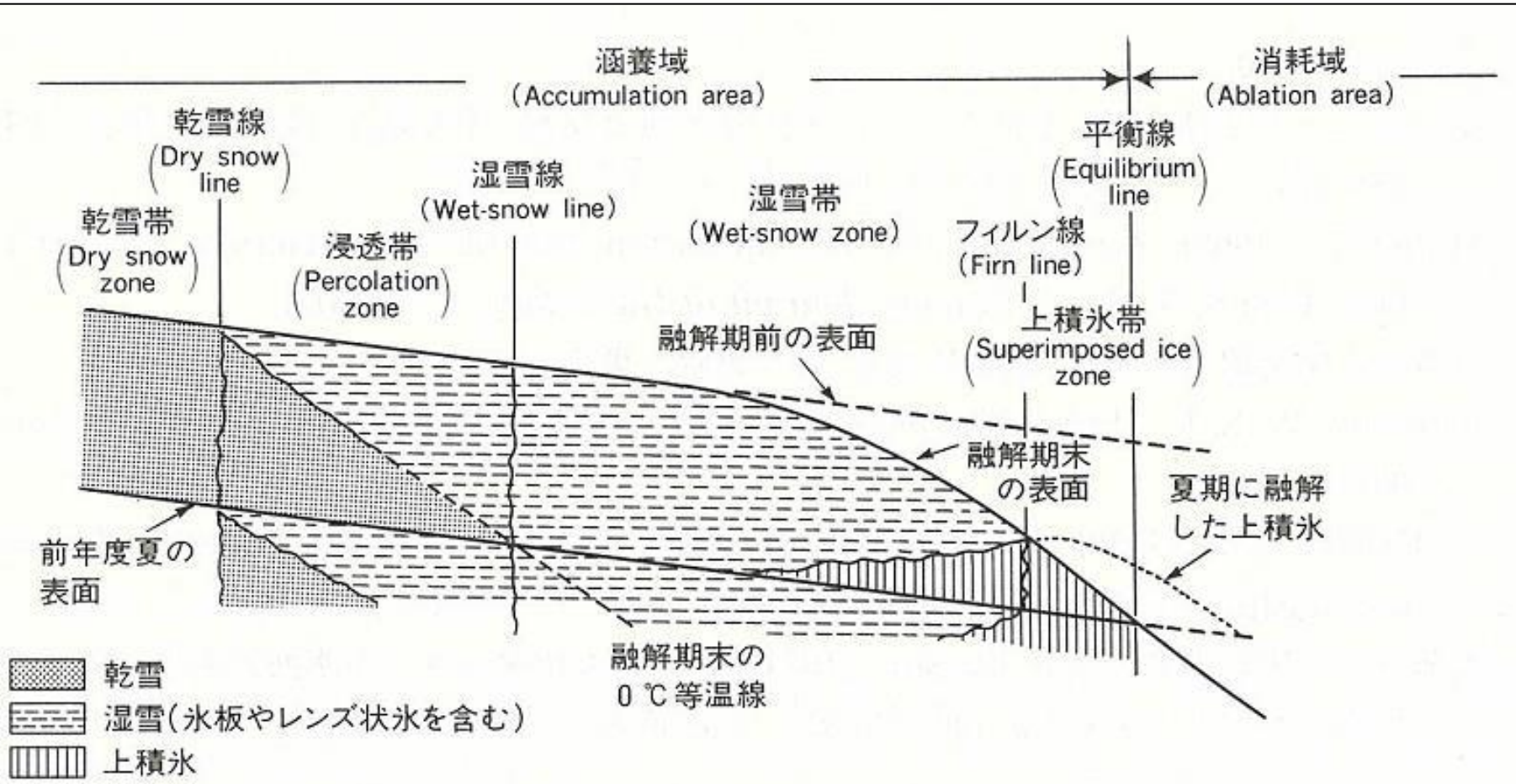


図 1.3.1　氷河の分帯区分の概念

藤井ほか編「氷河」

3．観測の方法

STUDY SITE


Russia
Kosch-Agach
Aktru
gate
Potanin
Ulaangom
Ulgii
~150km
Kazakhstan
Mongolia
Hovd
Potanin Glacier
Google

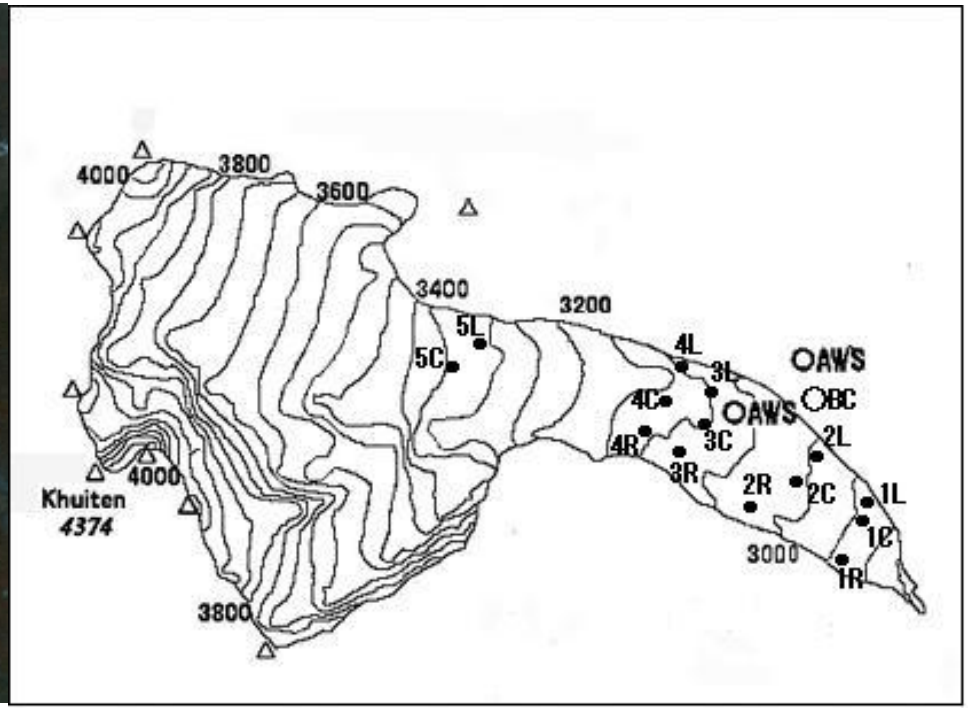

Ulgii


On the way


TavanBogd


Glacier

Map of **Potanin glacier**



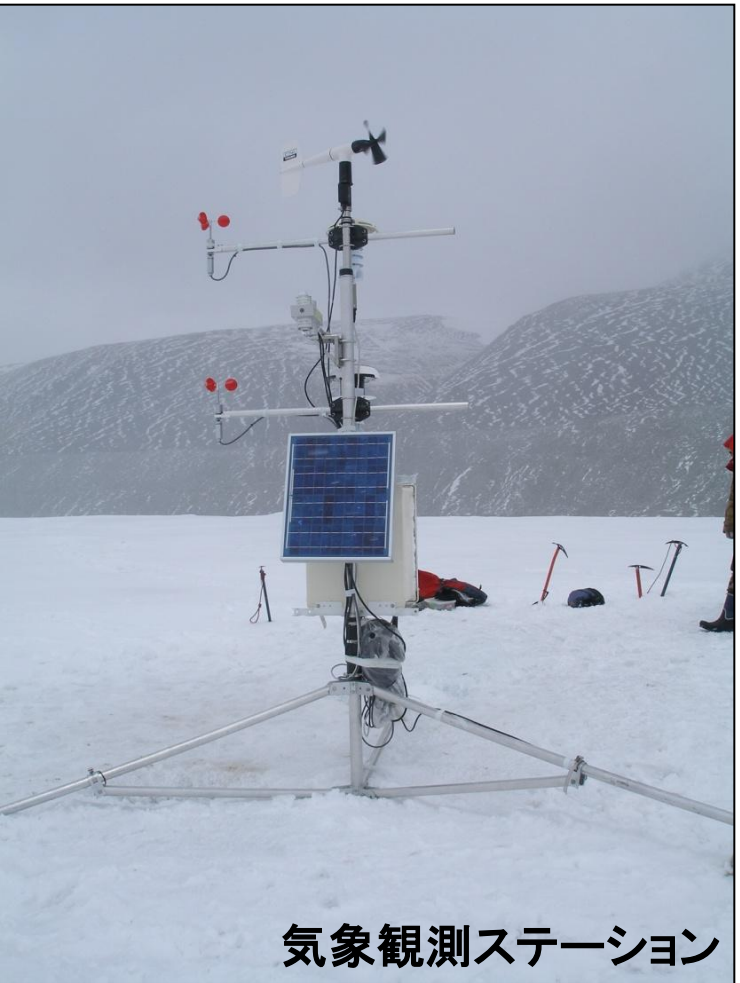

ベースキャンプ


降雪後の様子（9月）

下流域での観測


気象観測ステーションに向かう

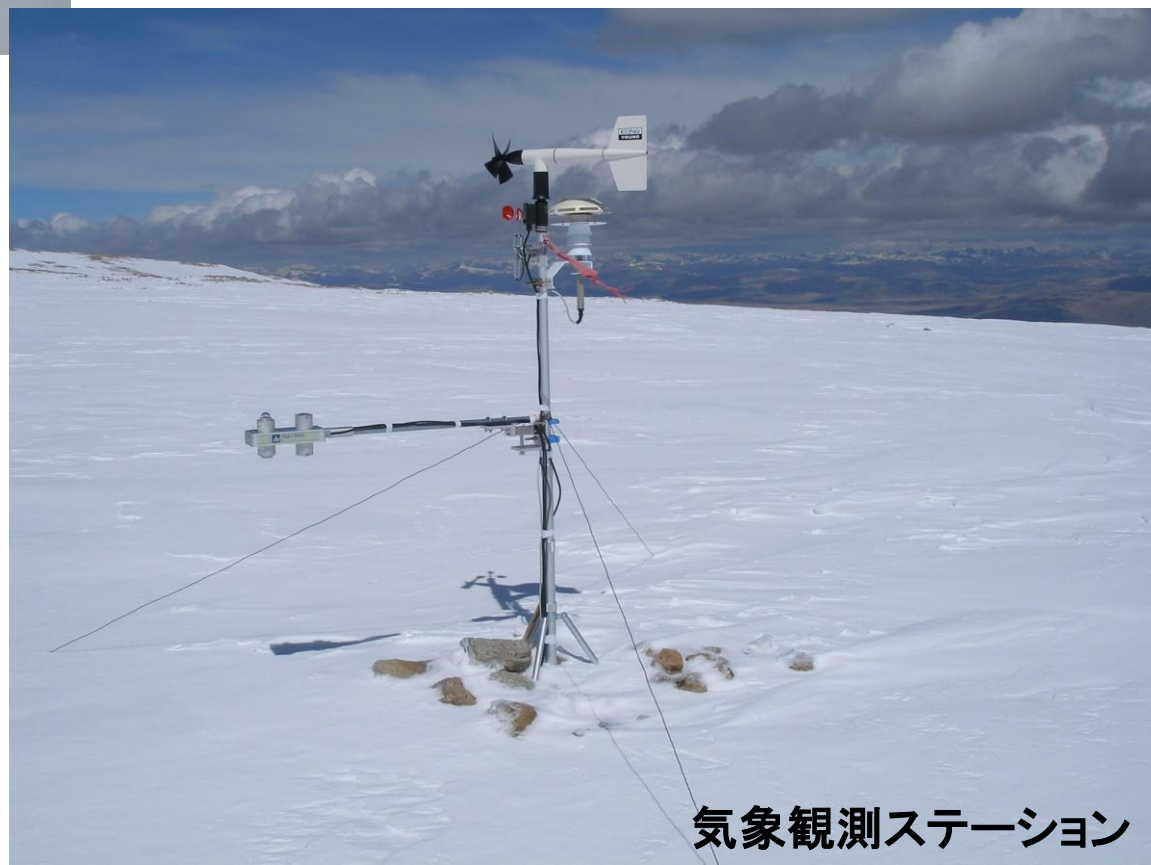

氷河末端、氷河の下


気象観測ステーション


表面融解量・流動速度の測定

稜線上での観測

気温・湿度
風向・風速
放射



気象観測ステーション

上流域での観測

流出河川での観測

観測中の食事

メニュー例
・リゾット（のようなもの）
・うどん（のようなもの）
・焼きうどん
・茹で肉
・カレー
・ホーショール

氷河の末端位置の変化比較

1905年　撮影
Sapozhnikov, V.V. (1911)に掲載

2010年7月　撮影
末端が後退して、湖が形成された。
氷河氷が薄くなった。

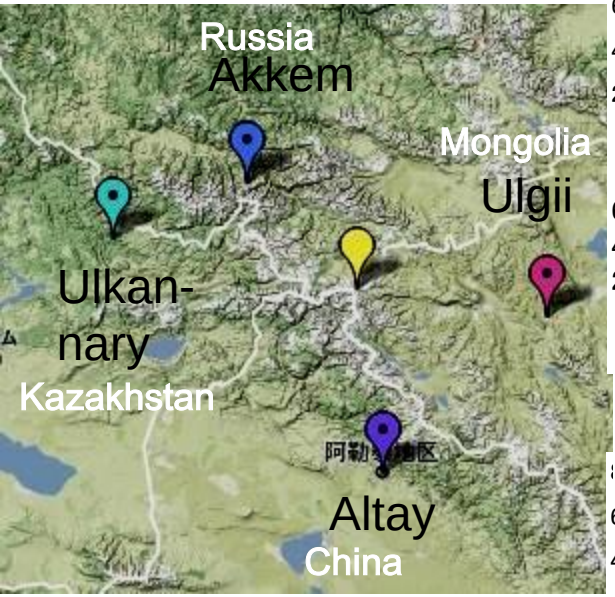
衛星画像（ASTER）から

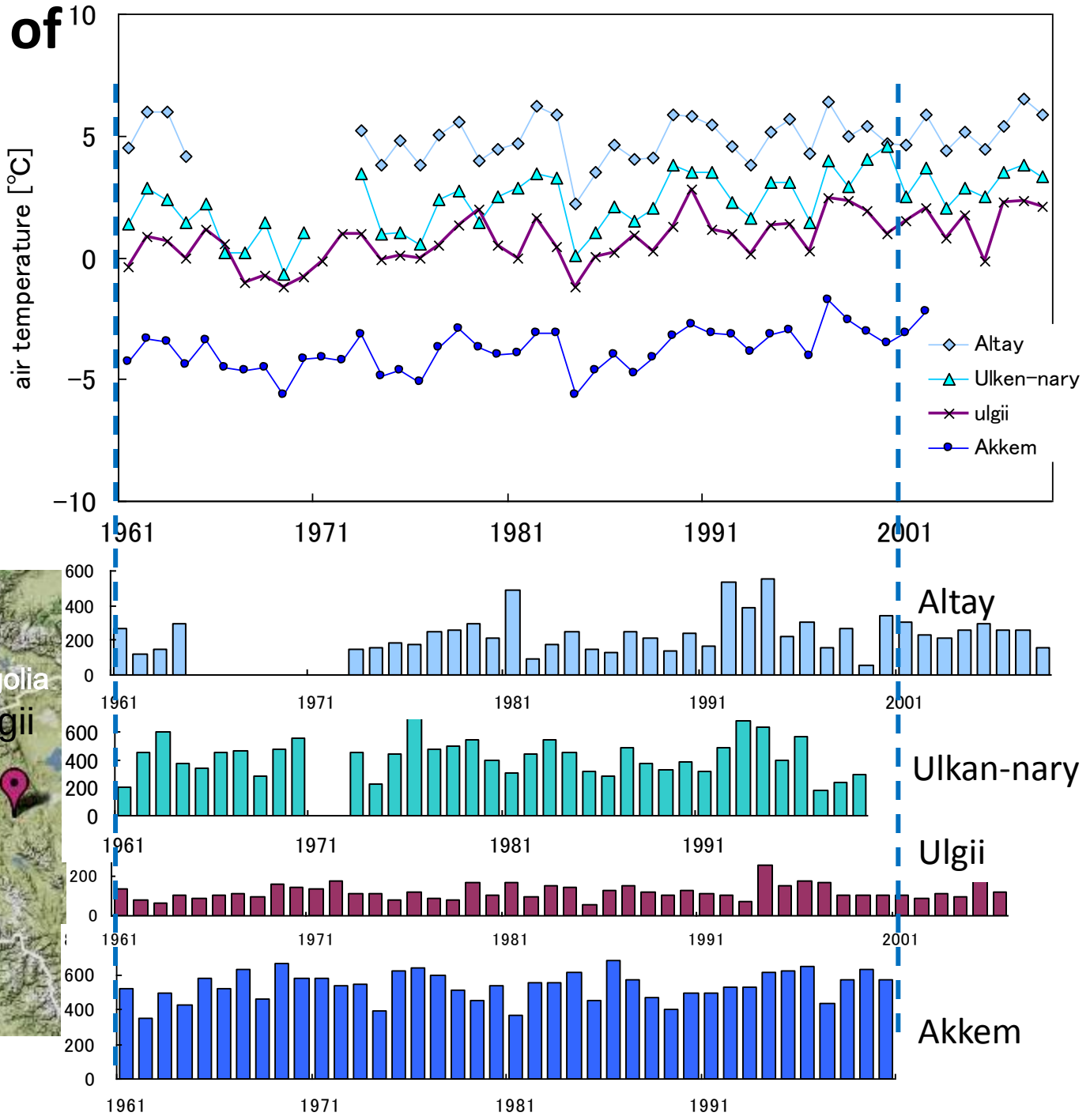
「1950～2000年（50年間）で、末端位置が866m後退した」

ことが分かった。　（Yabuki, personal communication)

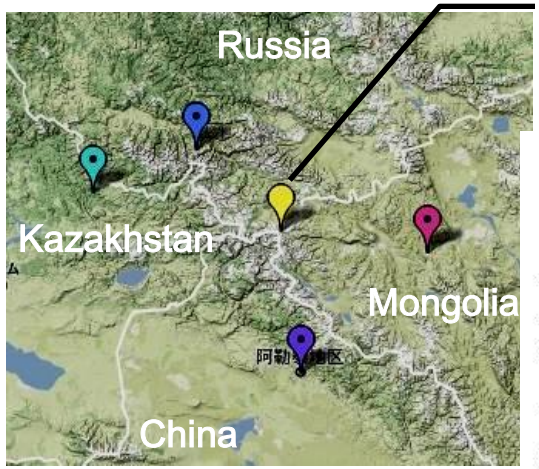
General climate of the region

0.03~4/℃
（3~4℃/100yr）
の上昇率

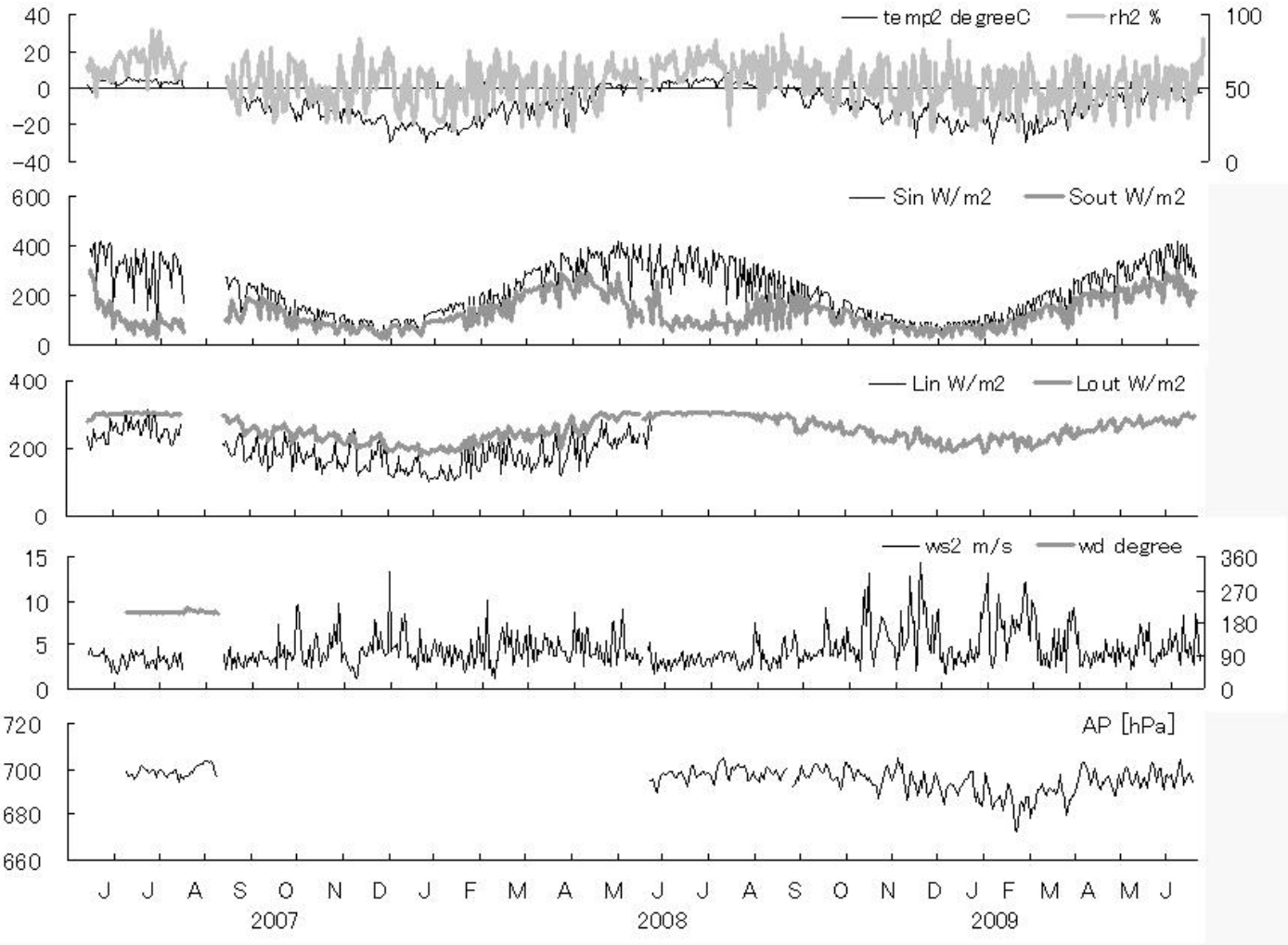




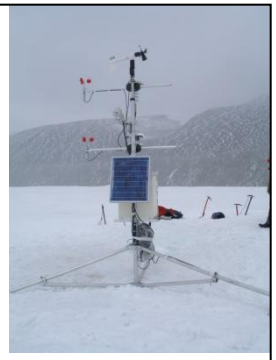
Climate of Altai

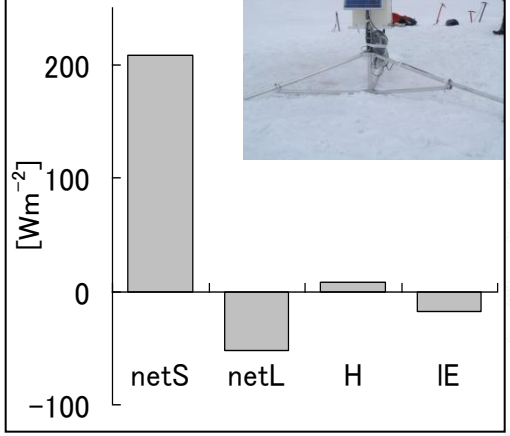


Meteorological data at Potanin Glacier

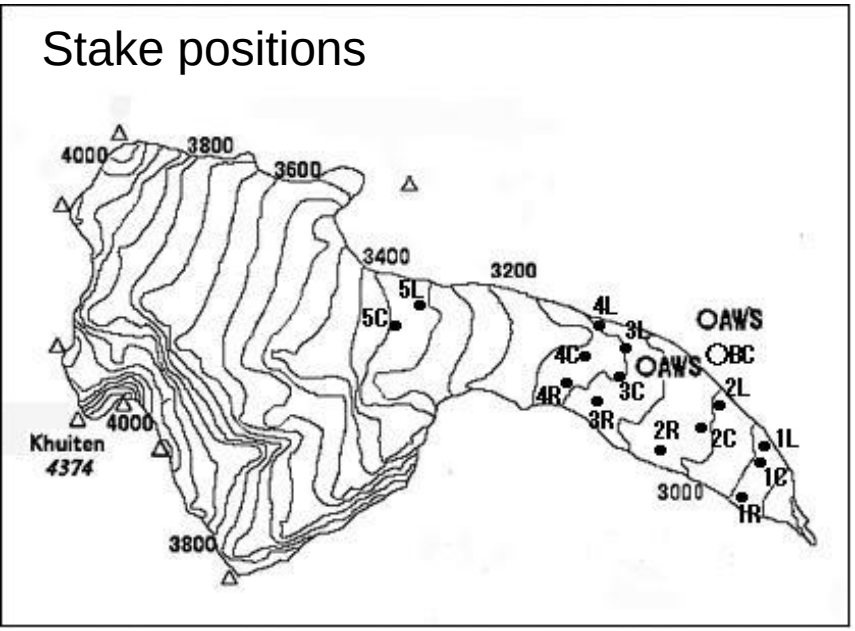


Energy contributing rate for surface melt

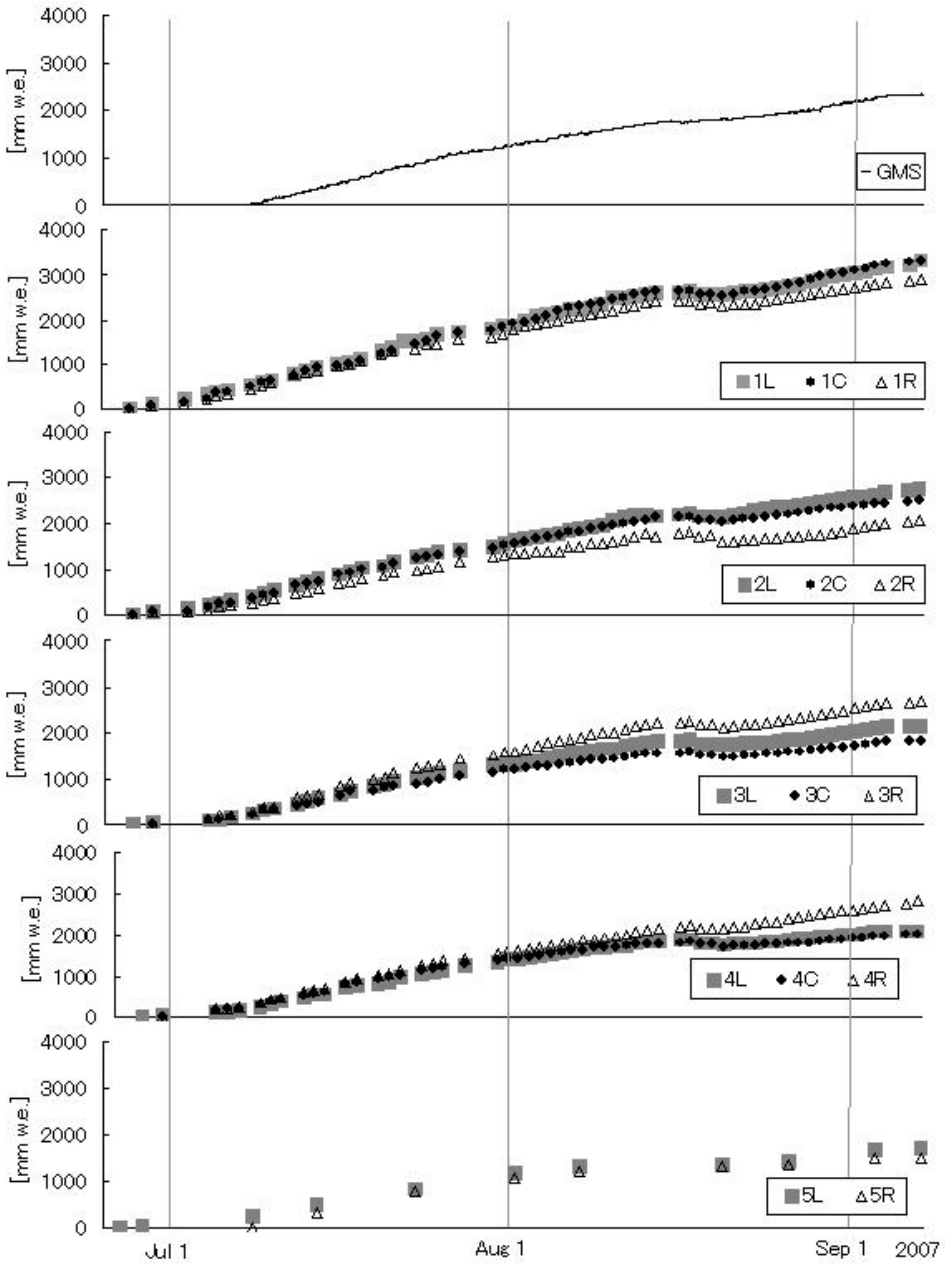




消耗域　年間収支の推定

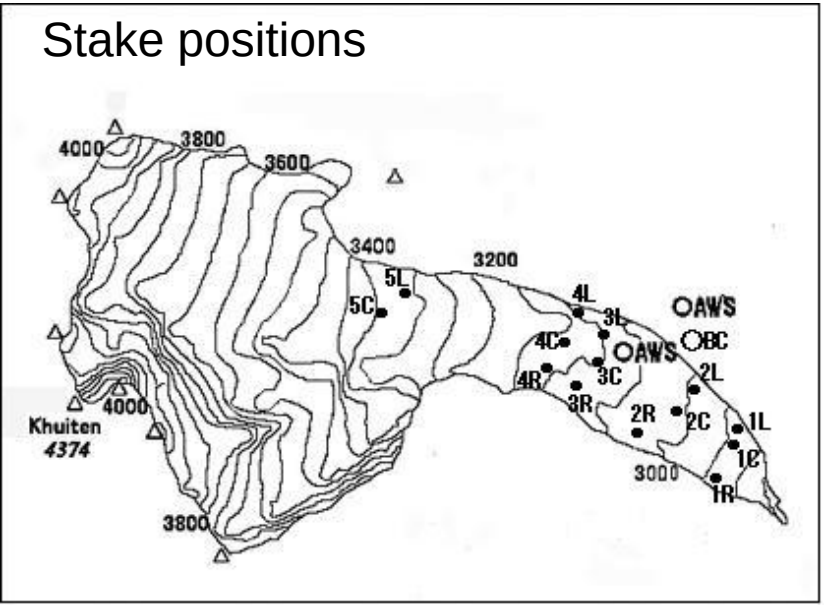

Stake positions
4000
3800
3600
3400
3200
5L
5C
4L
3L
4C
3C
4R
3R
2R
2C
2L
1L
1C
1R
AWS
BC
AWS
4000
Khuiten
4374
3000
3800


stake
measurement


[mm w.e.]
4000
3000
2000
1000
0
GMS
1L
1C
1R
2L
2C
2R
3L
3C
3R
4L
4C
4R
5L
5R
Jul 1
Aug 1
Sep 1
2007

消耗域　年間収支の推定

Stake positions



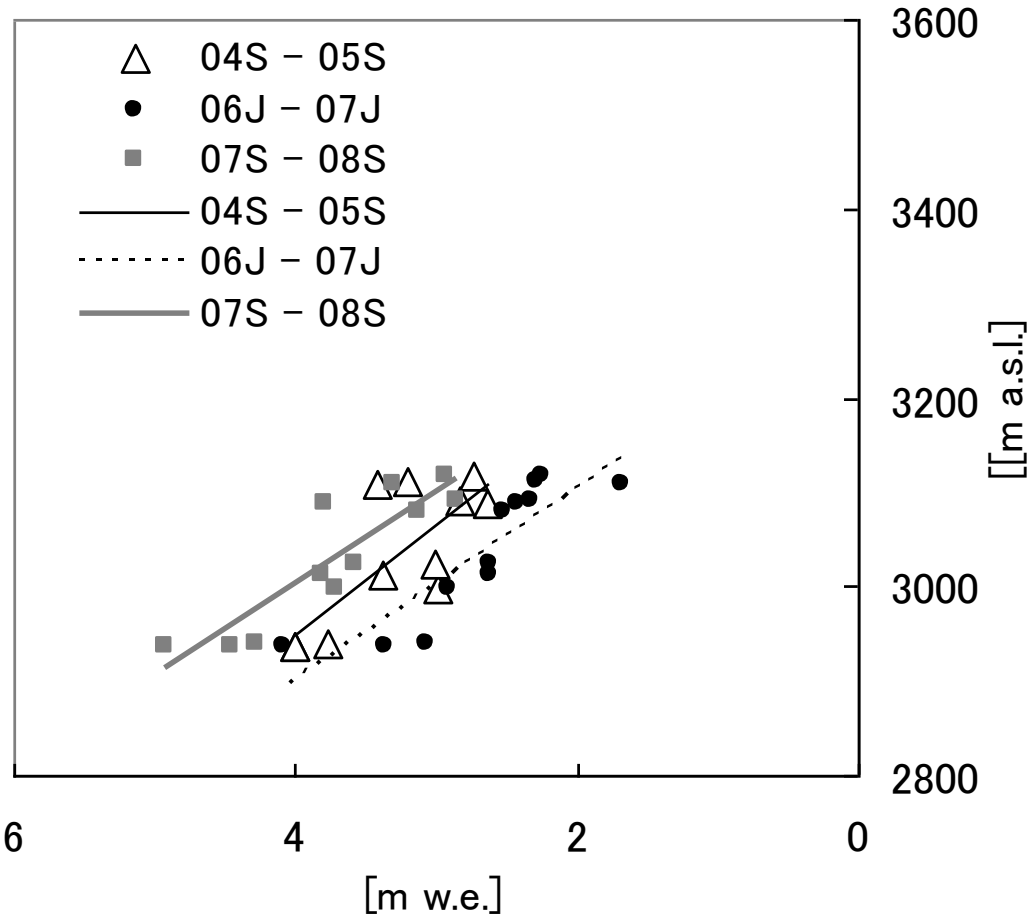
stake measurement

2004 – 2008

summer and winter balance

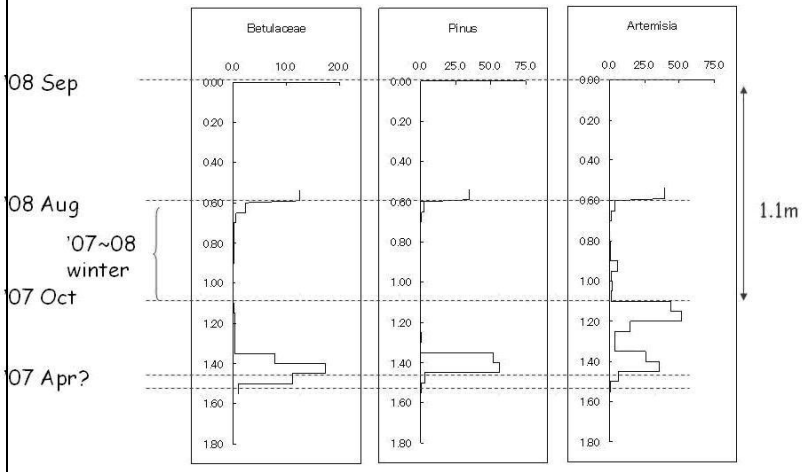
(J:June, S:September)

Gradient was similar for every year

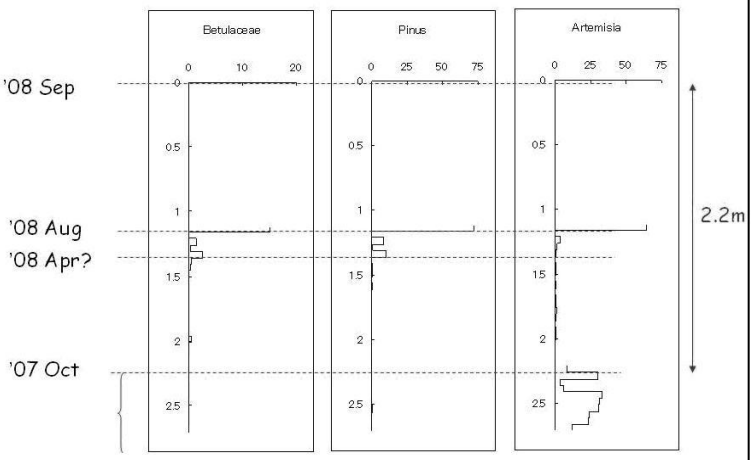


花粉分析による涵養域年間収支の推定
Nakazawa et al. 2004 による方法

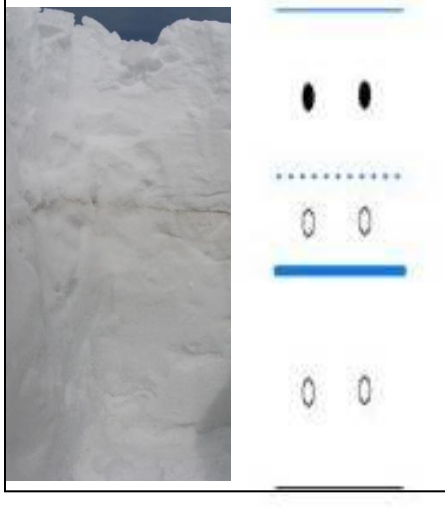
Pit #0 (3752m)

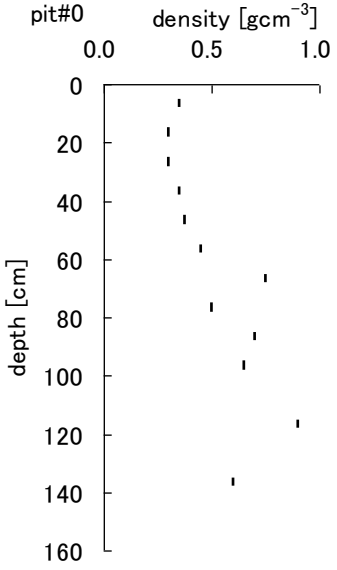


Pit #4 (3890m)



Density (#0)



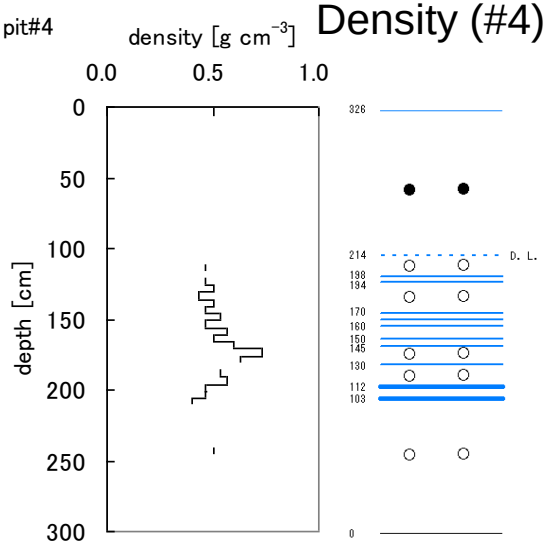


Mean density:
0.52

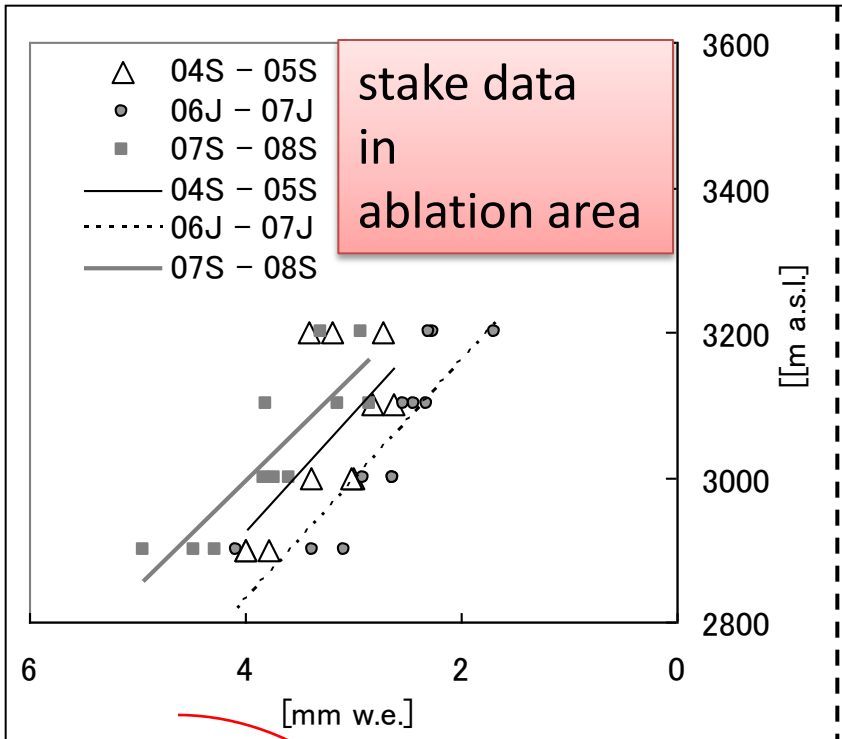
↓
Pit#0
0.57 m w.e.

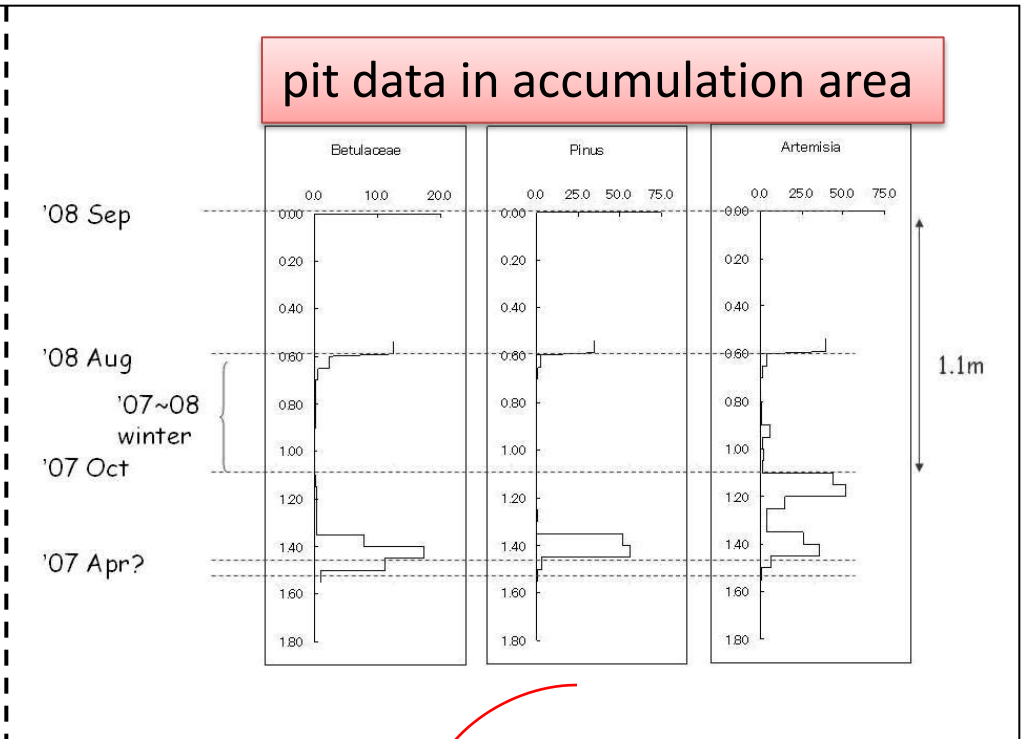
Pit#4
1.14 m w.e.

Density (#4)

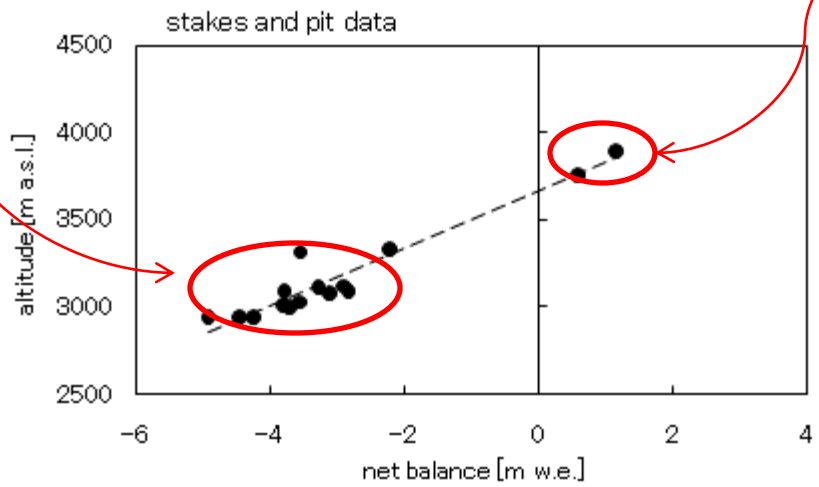


Net balance of ablation/accumulation area





2007/08
net balance
ablation area

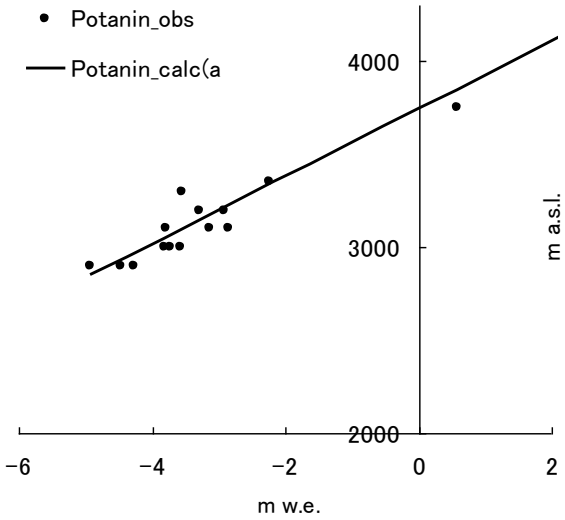


2007/08
net balance
accumulation
area

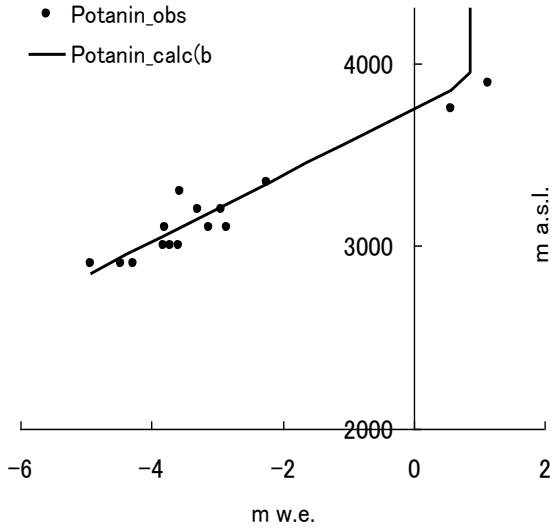
Net balance gradient

Assuming 3 patterns of net balance gradient of Potanin glacier

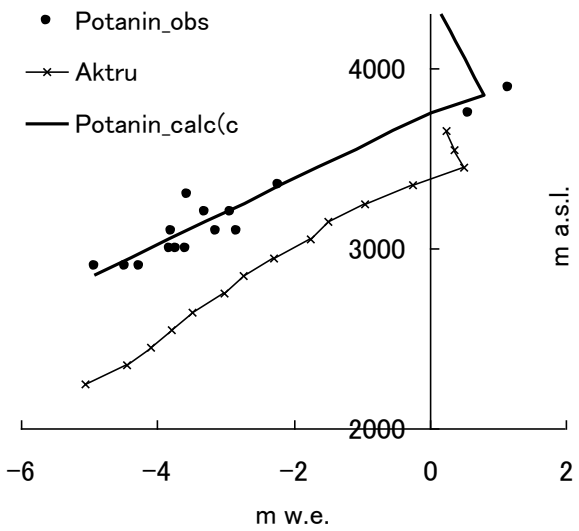
1) Linear

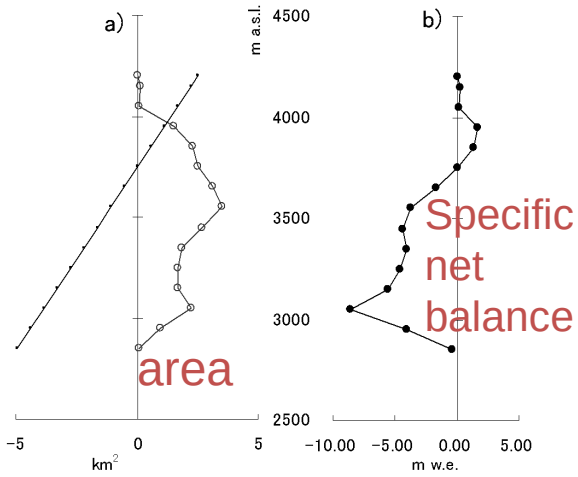


2) Linear + constant



3) Maliy Aktru





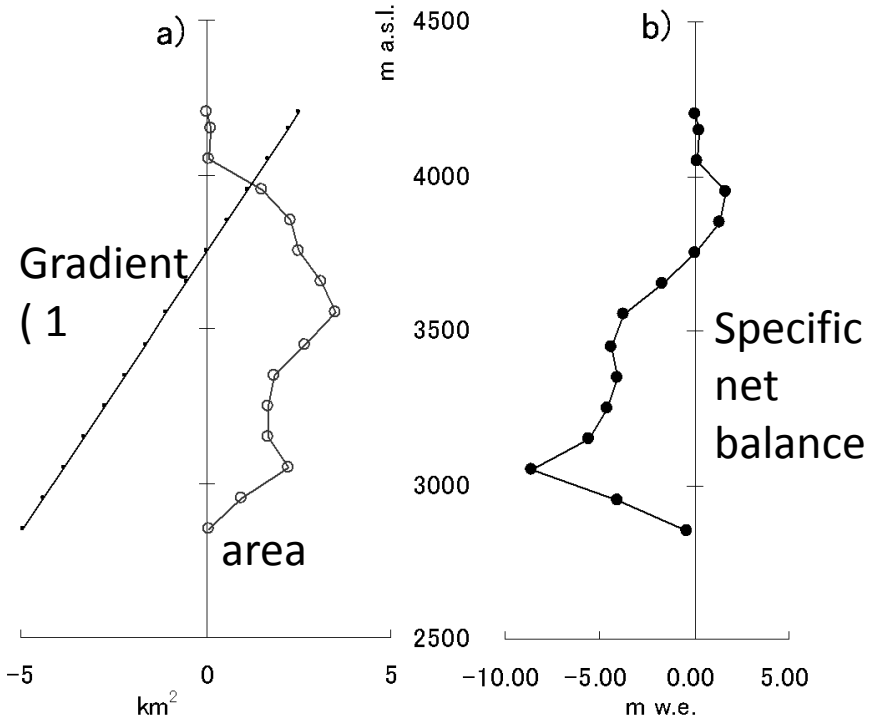
2007/08 [m w.e.]

	1)	2)	3)
b_n	-1.03	-1.10	-1.12

Specific mass balance

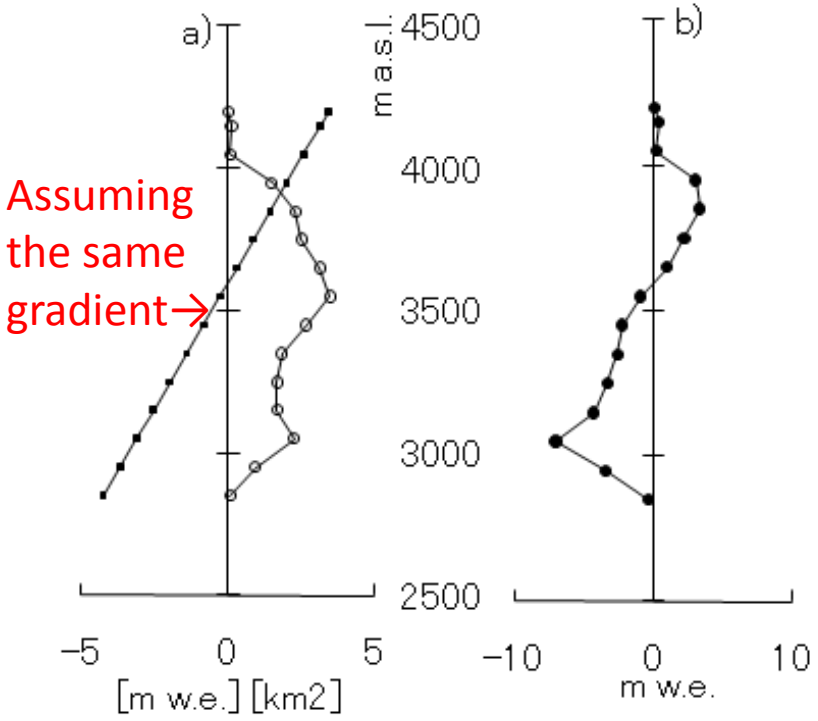
Assuming the Gradient of (1: linear

2007 / 2008



-1.03 m w.e.

2004 / 2005

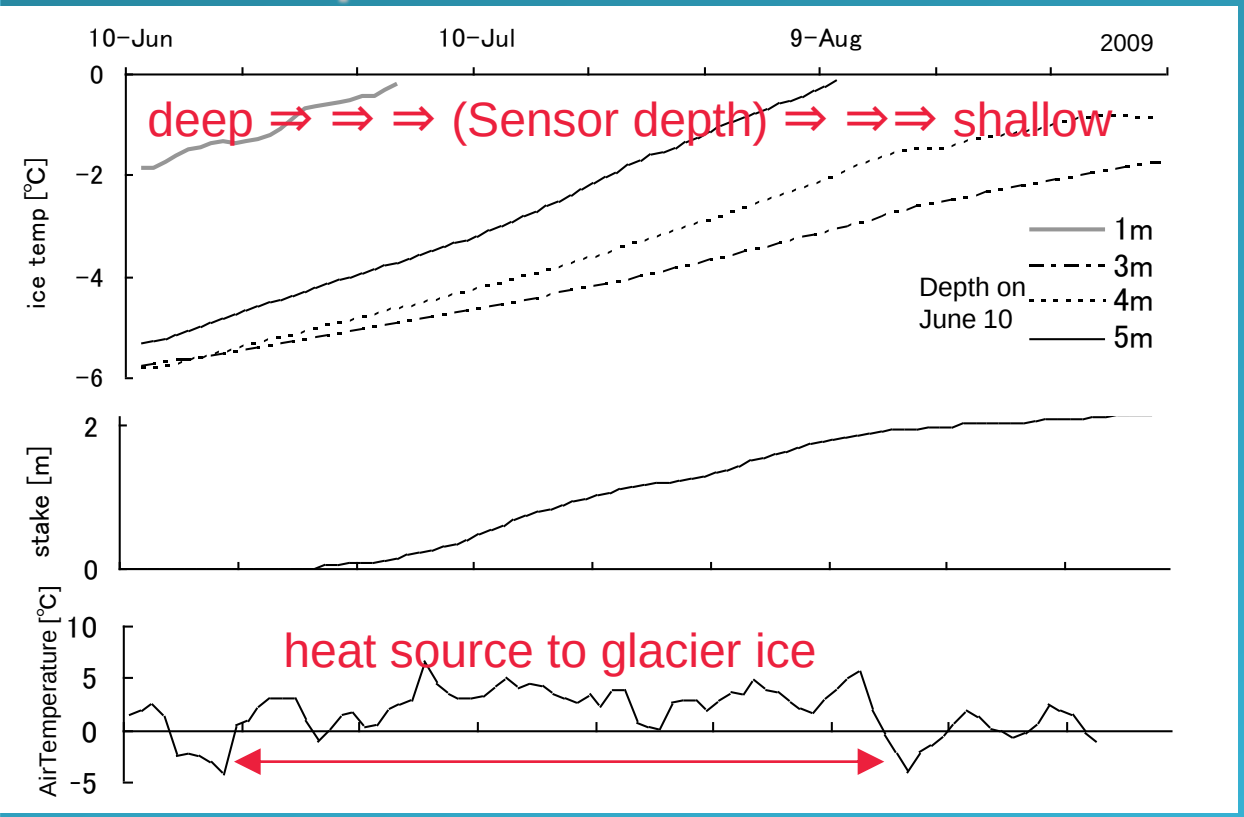


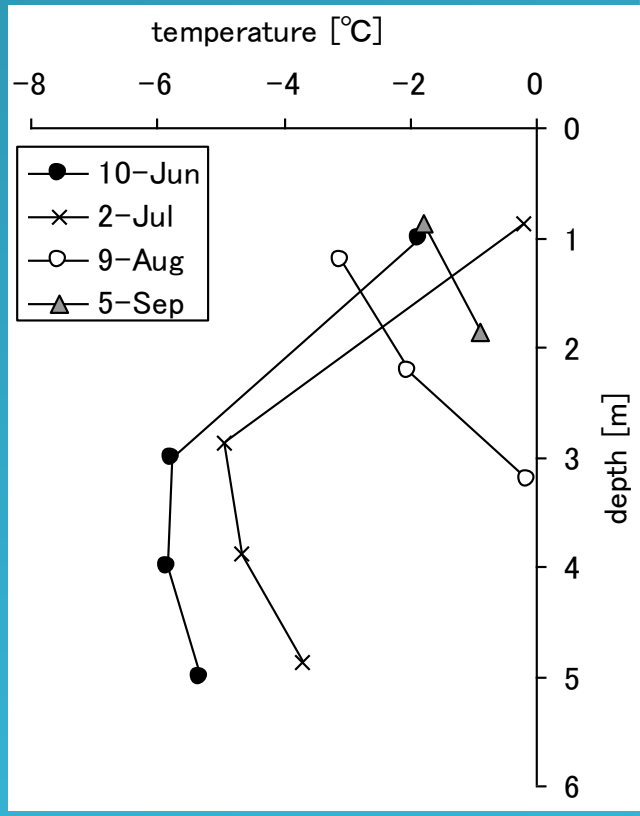
-0.58 m w.e.

Refreezing?

Is it a cold glacier? Is there internal accumulation? How does it affect on Mass balance?

Ice temperature at AWS





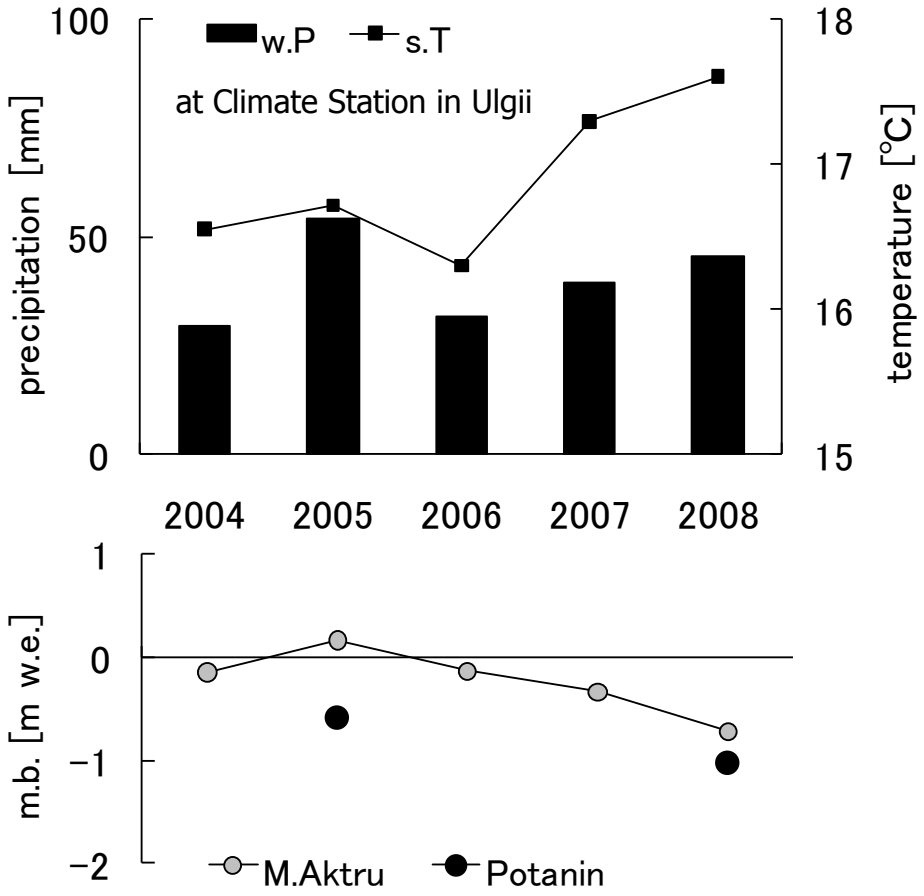
Ice temperature in summer 2009 in ablation area was <u>below freezing</u>

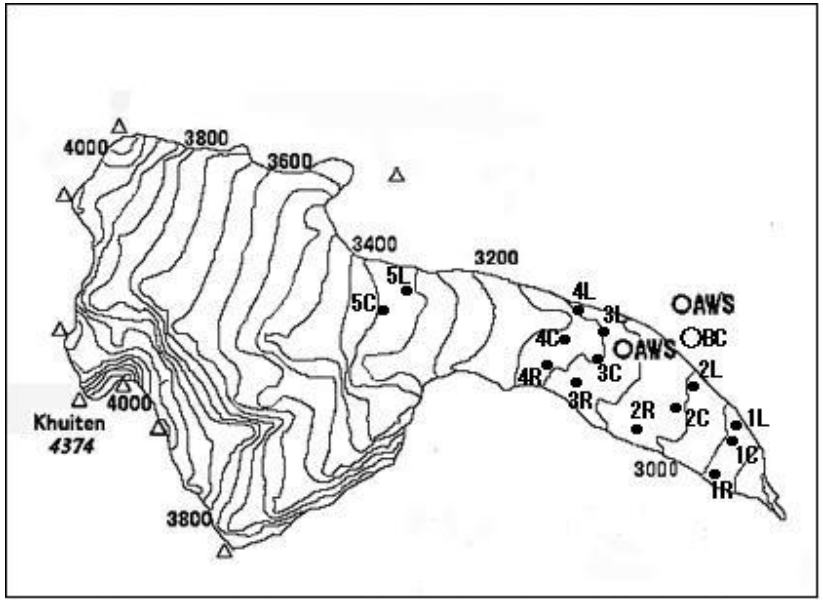
⇒ firn in accumulation area was also below freezing?

Refreezing was seen in annual layer by pit observation ⇒ no internal accumulation?

**ice temperature may increase to 0℃ in hot summer year

Mass balance of glaciers in Altai

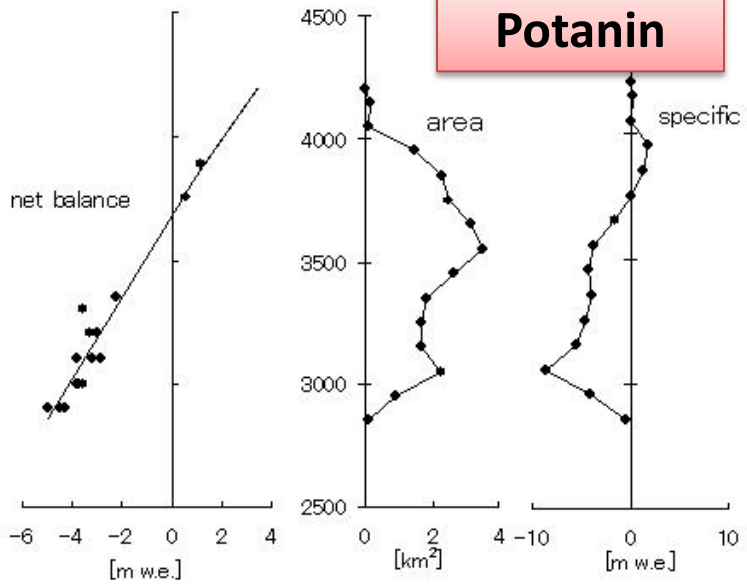


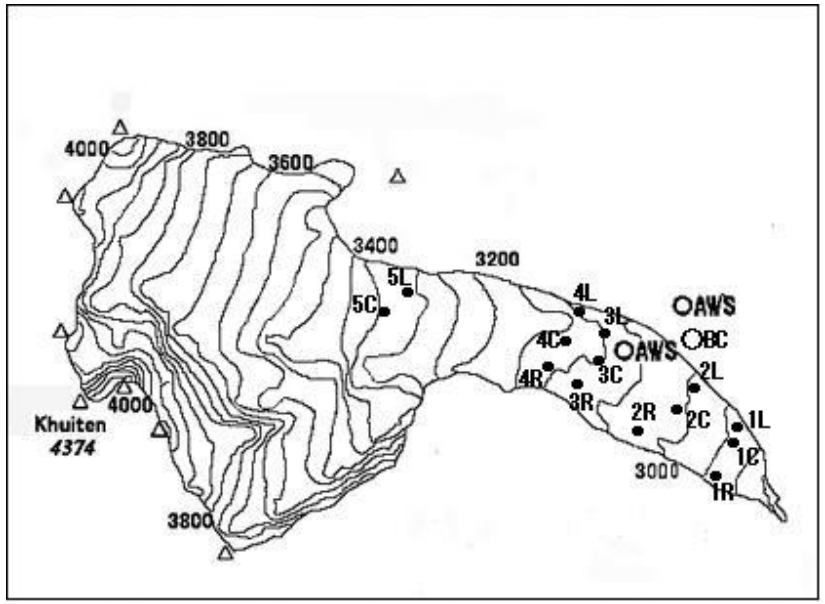


	bn		AAR				ELA			
	2008	2005	2008	2005	bn0	sensitivity	2008	2005	bn0	sensitivity
MaliyAktru	0.16	-0.87	35	72	70	40	3175	3200	3152	240
Potanin	-0.58	-1.03	27	40	54	25	3675	3596	3495	174

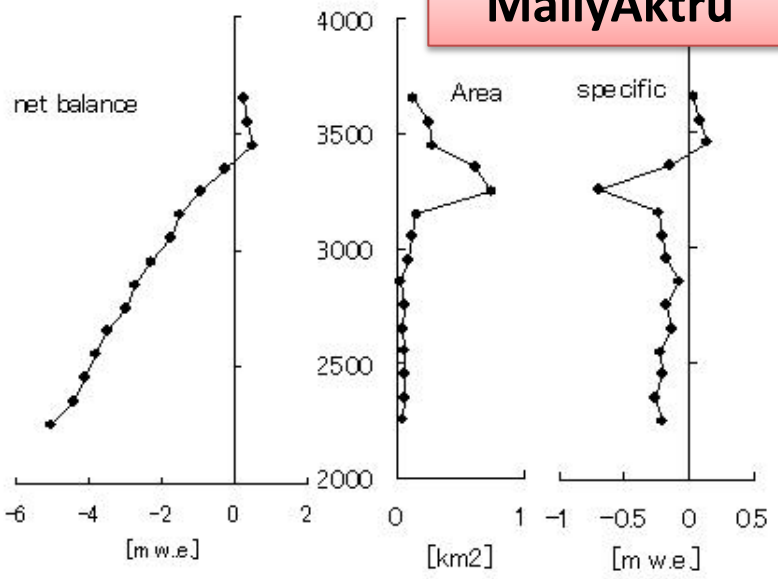
Mass balance of glaciers in Altai

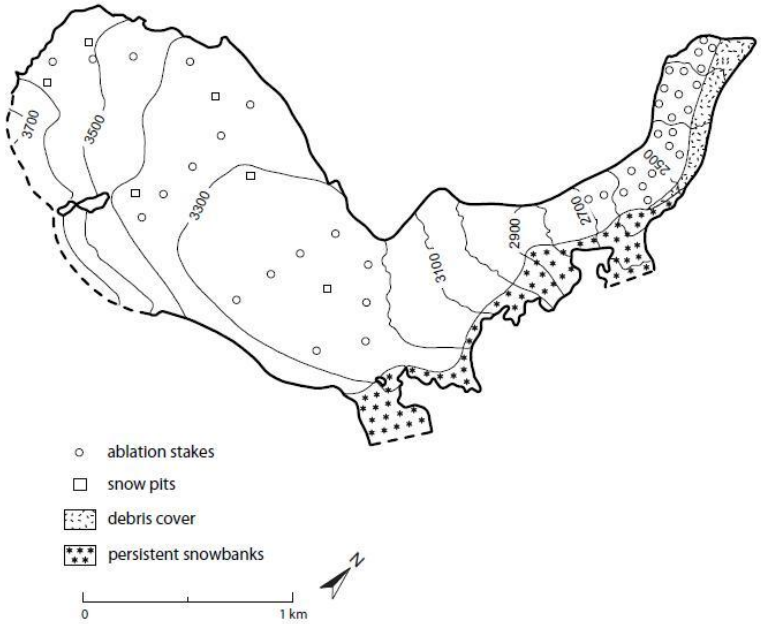
Potanin





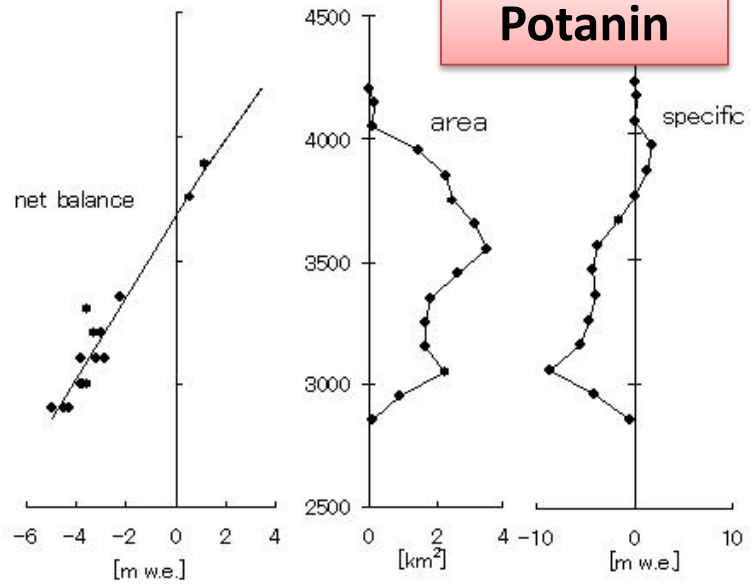
MaliyAktru



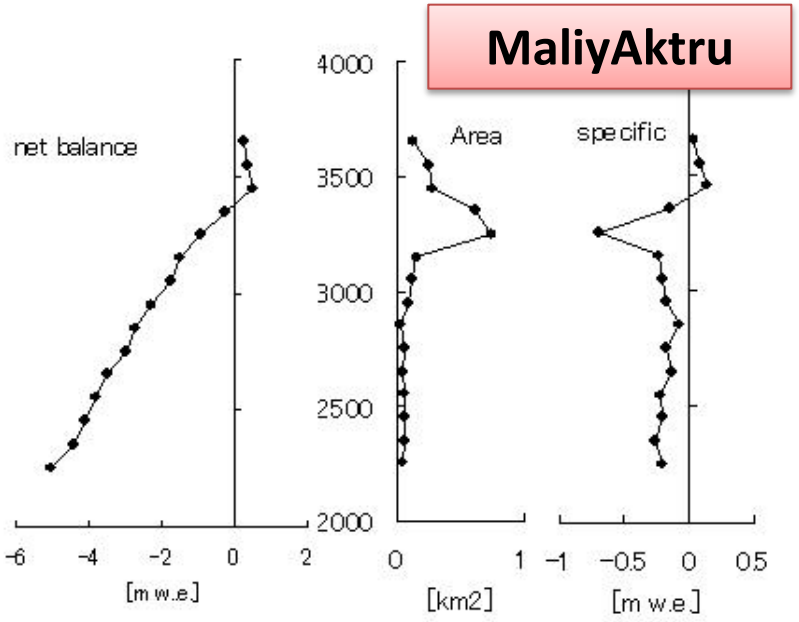


Mass balance of glaciers in Altai

Potanin

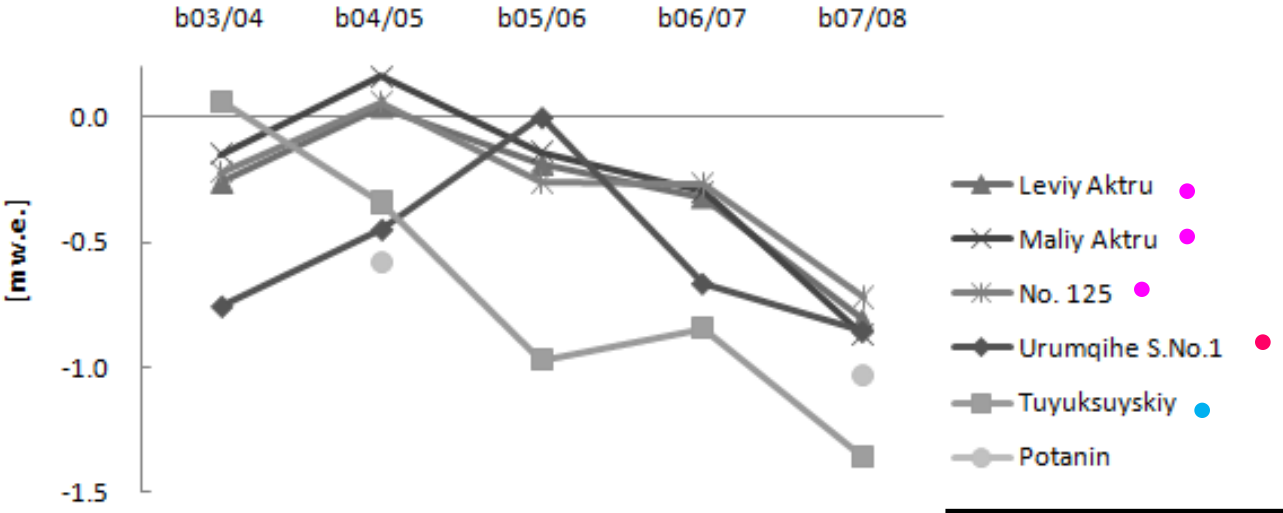


MaliyAktru

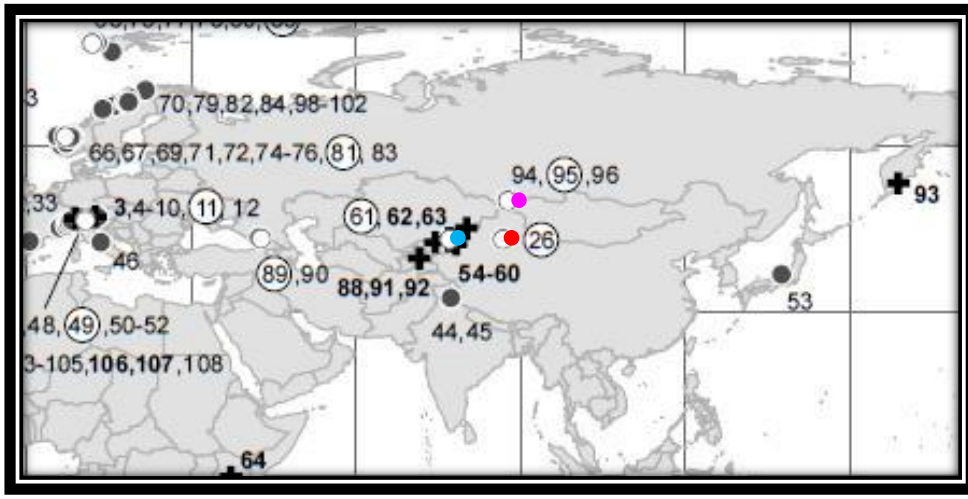


Mass balance of glaciers in Altai

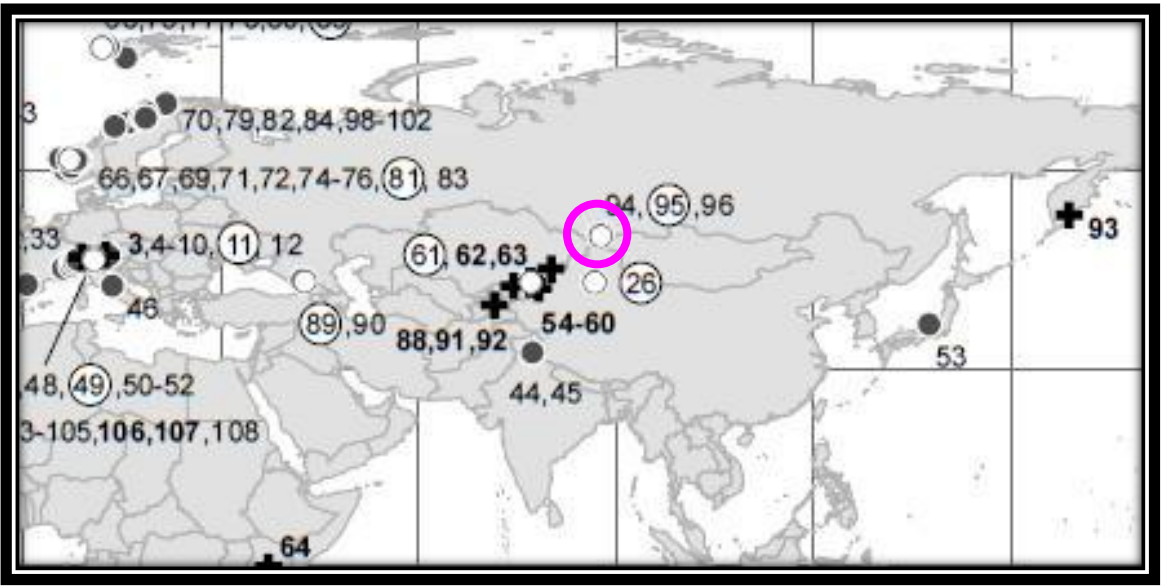
Compare the mass balance to other glaciers in and around Altai

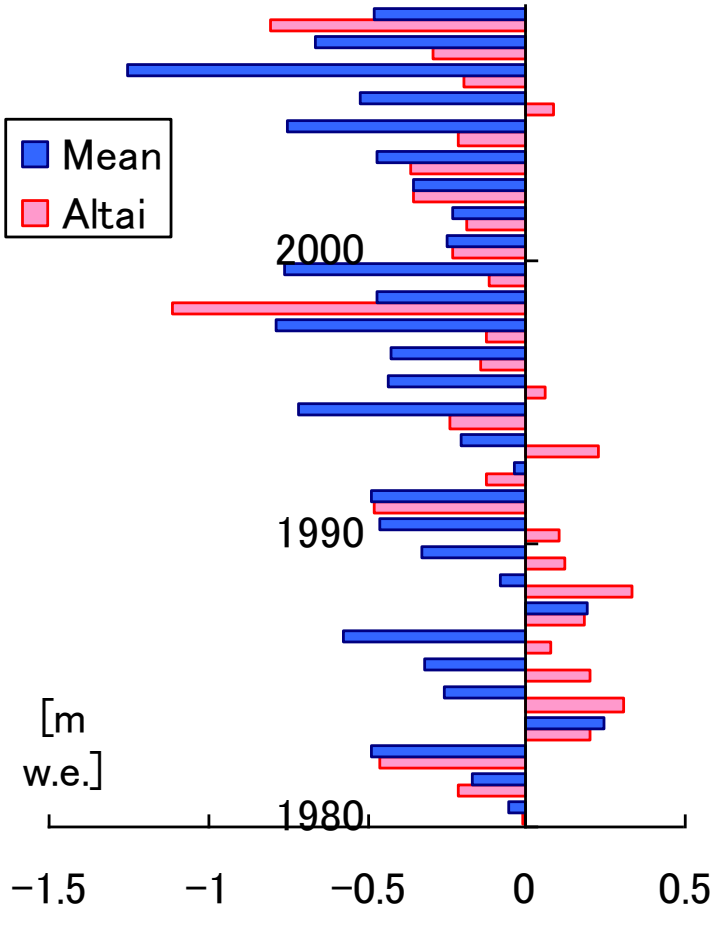


	AAR0	ELA0
Urumqihe No.1	56	4025
Tuyuksuyskiy	52	3746
Maliy Aktru	70	3152
LeviyAltru	61	3160
No.125	68	3203
Potanin	54 ?	3495 ?



Mass balance of glaciers in Altai





過去の質量収支

- 消耗量

  融解のほとんどは放射によるもの

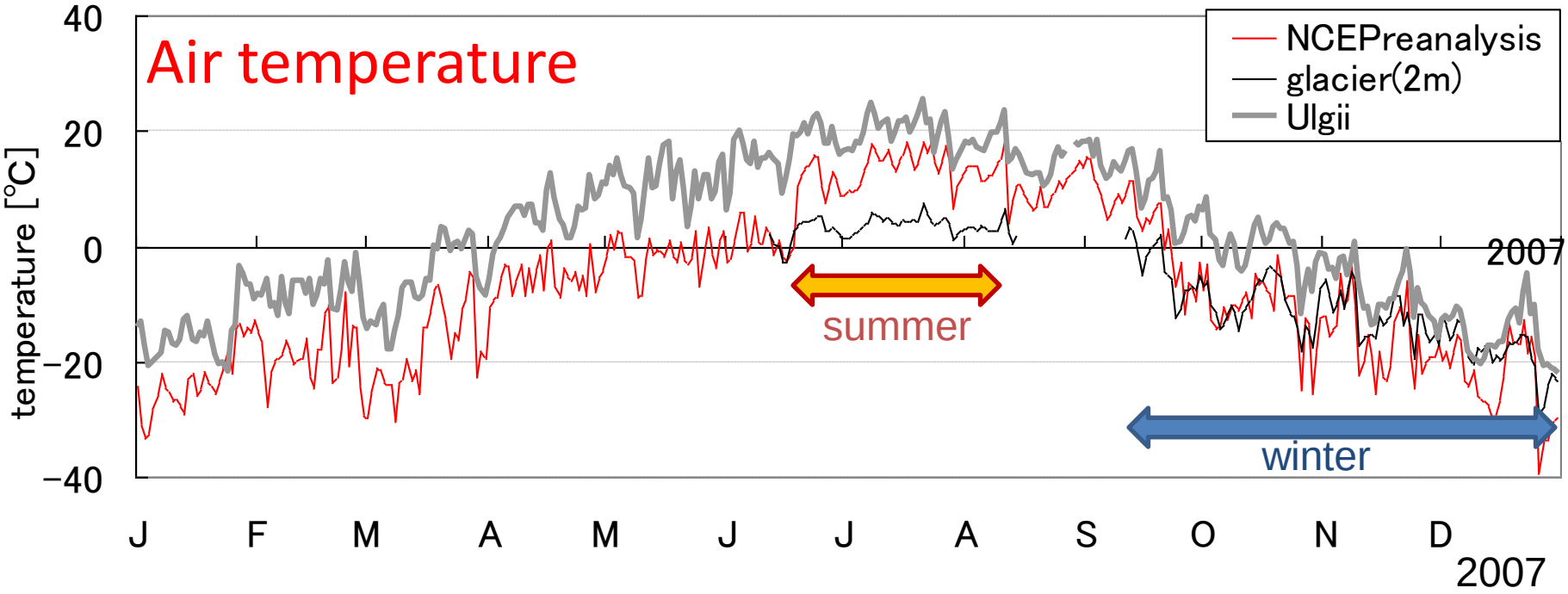
  ⇒消耗量は、過去もあまり変わらない？

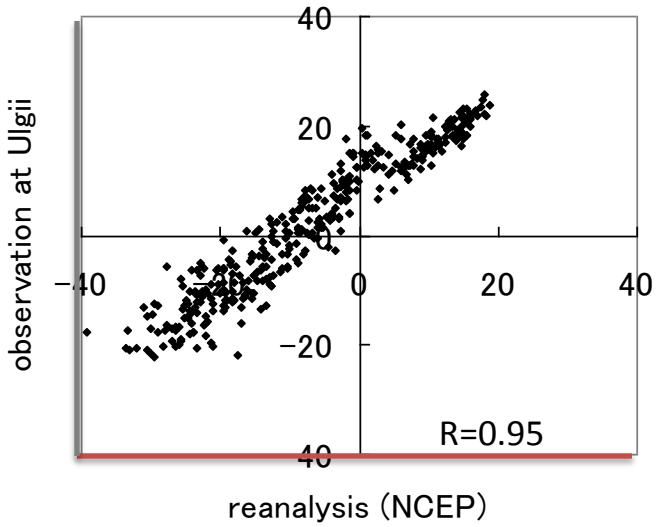
- 涵養量

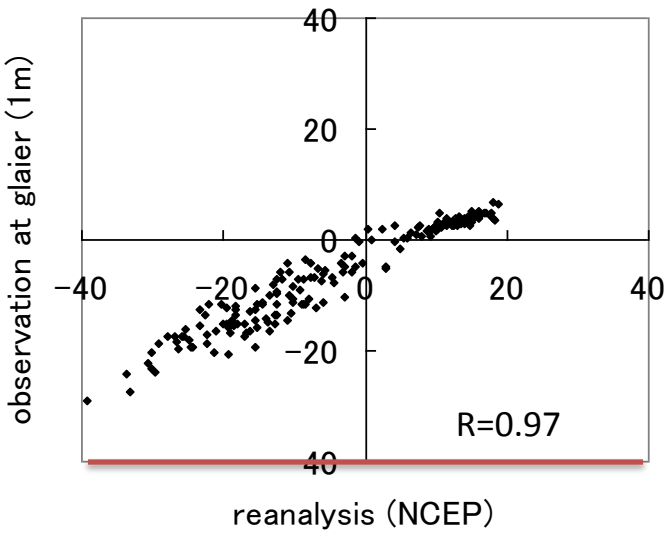
  夏の降雪、地上は0℃付近

  ⇒寒かった過去は雪が多かった？

過去の気温、降水量
→ モデルで表せるか？







まとめ

- アルタイ山脈Potanin氷河にて質量収支の観測研究を実施している。
- 2007/08年および2004/05年の質量収支はそれぞれ -1.03, -0.58であった。
- 質量収支の変動傾向はロシア・アルタイのMaliyAktru氷河と似ていると考えられる。質量収支の値の違いは、気候と地形の違いを反映していると考えられる。

5．観測地域の文化の紹介

遊牧民の生活


ロシア
Kosch-Agach
gate
Potanin
Ulgii
カザフスタン
モンゴル
中国

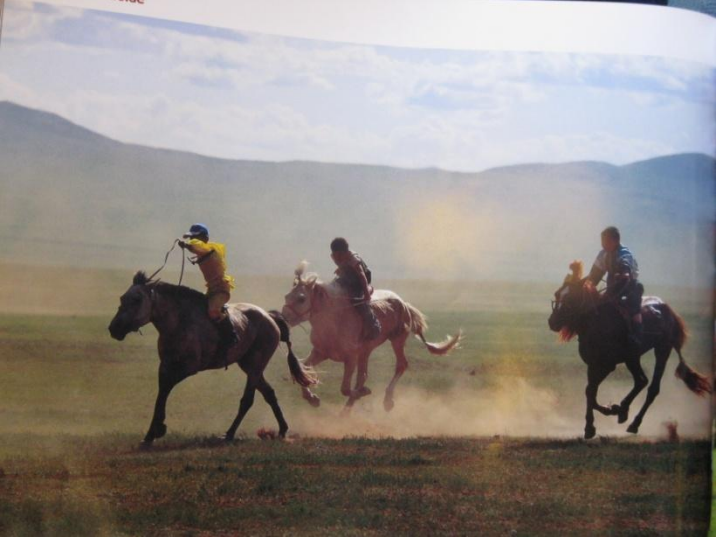

elcome to Mongolia
鷹狩り


定住住居

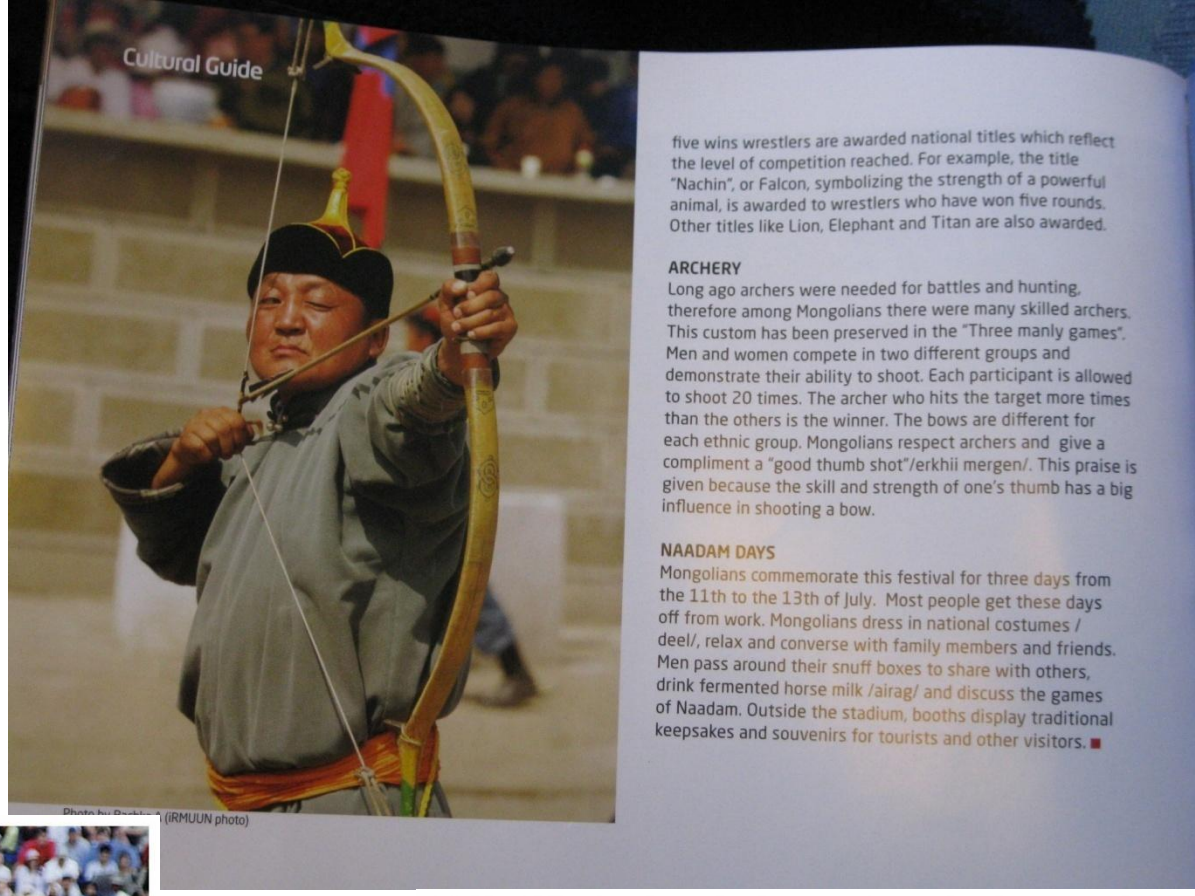
カザフ族の生活


カザフゲル


モンゴルゲル



ナーダム(祭り)


Cultural Guide
five wins wrestlers are awarded national titles which reflect the level of competition reached. For example, the title "Nachin", or Falcon, symbolizing the strength of a powerful animal, is awarded to wrestlers who have won five rounds. Other titles like Lion, Elephant and Titan are also awarded.
ARCHERY
Long ago archers were needed for battles and hunting, therefore among Mongolians there were many skilled archers. This custom has been preserved in the "Three manly games". Men and women compete in two different groups and demonstrate their ability to shoot. Each participant is allowed to shoot 20 times. The archer who hits the target more times than the others is the winner. The bows are different for each ethnic group. Mongolians respect archers and give a compliment a "good thumb shot"/erkhii mergen/. This praise is given because the skill and strength of one's thumb has a big influence in shooting a bow.
NAADAM DAYS
Mongolians commemorate this festival for three days from the 11th to the 13th of July. Most people get these days off from work. Mongolians dress in national costumes / deel/, relax and converse with family members and friends. Men pass around their snuff boxes to share with others, drink fermented horse milk /airag/ and discuss the games of Naadam. Outside the stadium, booths display traditional keepsakes and souvenirs for tourists and other visitors.
(iRMUUN photo)


elcome to Mongolia
oriflame


MONGOLIA

海洋研究開発機構　北半球寒冷圏研究プログラム

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おわり