Benchmark Glaciers by Nagoya Univ

- Six glaciers have been measured by direct & geodetic methods
- Four of them were taken over by other institutions
- GJ is now in being surveyed
- AX waiting to be resurveyed
- One large glacier in plan
Climate Regime of Asian Glaciers Revealed by a New GAMDAM Glacier Inventory

Akiko Sakai, Koji Fujita & 12 collaborators
Nagoya University, Japan

www.cryoscience.net
Importance of Asian Glaciers

- Contribution to sea level rise
- Contribution to river runoff in arid terrain

**Volume Change**
Kääb+ 2012Nature
Gardner+ 2013Science

**Discharge**
Immerzeel+ 2010Science
Kaser+ 2010PNAS

www.cryoscience.net
Motivation 1: glacier inventory

- Area-altitude distribution is important

Mass balance profile

Area distribution hypsometry

- Positive
- Equilibrium
- Negative

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Motivation 2: mountain precipitation

- Higher altitude, more precipitation
- Gridded data ≠ observed data in mountain

more <- precipitation -> less

Precipitation in Krygyz Tien Shan

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Purpose

- Glacier Area Mapping for Discharge in Asian Mountains => GAMDAM Project
  - PI: Akiko Sakai
  - Period: 3 years (2011/4 – 2014/3)
Methods

- LANDSAT 1999-2003
  - Orthorectified by USGS
- Composite images
  - > 260 scenes
- Manual delineation
  - Contour line (SRTM)
  - Basin polygon
  - Google Earth
- Delineation test

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GAMDAM Glacier Inventory

Randolph vs. GAMDAM

<table>
<thead>
<tr>
<th></th>
<th>Area ($\times 10^3$ km$^2$)</th>
<th>Number ($\times 10^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GAMDAM</td>
<td>85</td>
<td>90</td>
</tr>
<tr>
<td>Randolph</td>
<td>120</td>
<td>85</td>
</tr>
</tbody>
</table>

- Date & ID of image
- Name of delineator
Median Altitude as ELA

- ELA: Equilibrium Line Altitude
Optimized Precipitation

Energy Mass Balance Model

with

PR × Fp
fr. Aphrodite
AT at ELA
RH, SR, WS
fr. NCEP/NCAR
Period: 1979-2007
in 0.5 x 0.5 degree

Change Fp

b = 0?

Yes

No

Optimized PR = PR × Fp
Median Altitude
Aphrodite Precipitation
Optimized Precipitation
Validation

Observed winter accumulation from 14 glaciers

Dyrugoev 2002, WGMS

www.cryoscience.net
Climate Regime on ELA

- Optimized precipitation partly consist with a global relation.
Precipitation Seasonality

- Summer accumulation type glaciers are more sensitive
Summary

- A GAMDAM glacier inventory
  - Now under final quality check
  - Technical paper will be submitted to TC
  - Inventory will be free to everyone
- Using the inventory, we reveal
  - Optimized precipitation
  - Climate regime
  - Sensitivity distribution