Hydrologic research in interior Alaska and beyond

Anna Liljedahl with collaborators

akliljedahl@alaska.edu
• Glacier-permafrost-hydrology interactions
• Ice wedge polygon & watershed hydrology
• Hydrology model developments
Permafrost & glaciers—what are their role in controlling Interior Alaska watershed hydrology?
Runoff in the Upper Susitna basin: Planning for the Susitna Hydropower Dam

Regine Hock
Juliana Braun
Ronald Daanen
Alessio Gusmeroli
University of Alaska Fairbanks
* Gabriel Wolken
Division of Geophysical & Geological Surveys
Combining field measurements & hydrologic modeling

- Watana Dam
- Temp, RH, Repeater
- Temp, RH, Precip
- Temp, RH, Precip, Wind
- Ablation stakes
- Ablation stakes, Temp, RH
- USGS/NWS river discharge
**WaSiM**

**Water balance Simulation Model**

1) **3D groundwater** confined & unconfined, overland flow (kinematic wave approach with stepwise constant parameters).

2) **1D soil heat transfer module** with conduction, advection and phase change (Daanen and Nieber, 2009).

3) **Penman-Monteith multi-layered vegetation parameterization scheme** coupled to **Richard’s equation**. Moss evaporation from the top soil layer.

4) **Dynamic glacier module**, glacier can shrink/grow, incl. debris cover.

5) **Parallel programmed** (OpenMP, experimental MPI version).
Preliminary results (calibration phase): Glacier melt 10-30% of runoff
Soil heat transfer modeling: Preliminary results

10 yr WaSiM spin-up

Soil Temperature Profiles

Air Temperature °C

Surface Temperature °C

1982-1983

Min Temp = -10.3 °C
Max Temp = -2.21 °C

Min Temp = -10.37 °C
Max Temp = 1.37 °C

50 m
Future work in Susitna

- Finish calibration of glacier melt and 50 m soil temperature profile
- Continue and expand monitoring network
- Validate simulations on 2012 and future data
- Future projections
Modeling the effects of climate change on US Army training lands: CPCRW as the test basin

Charles Downer and Nawa Pradhan, Engineering Research and Development Center

Sergei Marchenko, UAF

*Thomas Douglas (PI), CRREL
Watershed Modeling and Management

Surface Water Hydrology

Surface Water/Groundwater Interaction

Surface Water Quality and TMDL’s

Sediment Management

Contaminant fate/transport in surface water and groundwater and related health risk assessment

Watershed Modeling and Management

Linking GSSHA with GIPL

Charles Downer
Nawa Pradhan
Sergei Marchenko

Future work:
- Testing GSSHA-GIPL on CPCRW
- Applying it on US Army land
Water balance of Arctic wetlands with differing ice wedge polygon type

Ronald Daanen and Alessio Gusmeroli, UAF

Cathy Wilson and Brent Newman, Los Alamos National Lab.
Variations in surface and frost tables

Low centered polygon with trough

Low centered polygon limited trough
WaSiM model experiment

Polygon type control watershed hydrology

Liljedahl et al. 2012
Similar total SWE but differing spatial variability
Model experiment: The large snow accumulation in troughs favors runoff

- Snow accumulation

- Distributed

- Scalar

- High-centered polygon

- +18% runoff with the same SWE

- Cumulative runoff (mm)

- Jun  Jul  Aug  Sep  Oct
Future efforts in Barrow

Continue water level, frost table and snow surveys
Measure surface runoff and subsurface flows

WaSiM developments

1D soil heat transfer
Dynamic glacier and debris cover
2D soil heat transfer...
Thank You
Developing solutions – Snow accumulation measurements
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