Central Asia Snow Accumulation, Ablation & Cover

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## FFGS Snow Products

<table>
<thead>
<tr>
<th>DT</th>
<th>Gauge MAT</th>
<th>Latest IMS SCA</th>
<th>SWE</th>
<th>Melt</th>
</tr>
</thead>
<tbody>
<tr>
<td>06-hr</td>
<td><img src="image1.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
<td><img src="image2.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
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<td>24-hr</td>
<td><img src="image3.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
<td><img src="image4.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
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<tr>
<td>4-day</td>
<td><img src="image5.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
<td></td>
<td></td>
<td><img src="image6.png" alt="Image" /> 2017-10-29 06:00 UTC Text: view</td>
</tr>
</tbody>
</table>
Presentation Outline:

- FFGS Snow Components
- Snow Accumulation and Ablation Model
- Model Input (MAT and MAP)
- Snow Cover (IMS)
- Glaciers

- Model Evaluation
FFGS Snow Model Components

Satellite Rainfall
- GHE-CMORPH

Gauge Rainfall

Radar Rainfall
- (Real Time – 1-Hourly)

Rainfall Data
- Quality Control & Merging
  - (Real Time/ 6-Hourly)

MAP & MAT

Snow Model

Soil Model

Threshold Runoff

Climatological Reference ET

Spatial Data
- Terrain, LULC, Soils Streams

Temperature Estimate
- Gauge/GFS

Snow Cover Area

Flash Flood Guidance Model

Flash Flood Guidance

Forecaster Review and Warning Dissemination
Rain
MAP
Surface Temperature MAT
Rain MAP

Snow Model
Gauge
GFS
Climate

Surface Temperature MAT
Rain *(1-SCA)
For SCA < 0.6

FFT
FFG

Observed & Forecast MAP

Satellite Snow Cover

SWE
Melt
RAIN

Obs. Snow depth & SWE

IN= Rain *(1-SCA)
For SCA > 0.6


Snow Model

- Snow Accumulation and Ablation Model (SNOW-17) of the U.S. NWS (Anderson, 1973; Anderson, 2005)
- Operational model at the National Weather Service, U.S.A
- A conceptual areal lumped energy and mass balance model
- *Air Temperature* used as an index for pack energy and division of precipitation as rain or snow
- Considers: melt during no rain; melt during rain; no melt
- Model states track: snow water equivalent (SWE), heat deficit, liquid content, and snow cover area
SNOW-17 MODEL:

- Precipitation and Air Temperature
  - Rain or Snow
    - Accumulated Snow Cover
      - Energy Exchange at Snow-Air Interface
        - Snow Cover Heat Deficit
          - Ground Melt
            - Rain Plus Melt
              - Areal Extent of the Snow Cover
                - Deficit = 0
                  - Liquid Water Storage
                    - Transmission of Excess Water

Snow-17:
Conceptual energy and mass balance
Require MAP and MAT data
Single vertical layer
Three modules:
  - Melt during rain
  - Melt during no rain
  - Heat accounting during no melt
Describe the snow cover extent using the Snow Depletion Curve
Model Variables

**States**
- SWE - Snow water equivalent
- Liquid content – PLWHC parameter (vertical transmission through the pack)
- Heat Deficit - Energy required to bring the snowpack to isothermal 0°C
- ATI – Antecedent Temperature Index
- Snow Pack Depth – (Optional)
- SCA - Snow Cover Area

**Output**
- Rain plus Melt
Data Requirements

- **Surface Air Temperature**
  - Index for the pack energy balance and determine the form of precipitation (rain or snow)

- **Precipitation**
  - Determine amount of snowfall and amount of rain-on-snow (PXTEMP)
  - SCF - Multiplying factor that adjusts precipitation data for gage catch deficiencies during periods of snowfall

- **Other Data (when available)**
  - Snowfall
  - Snow course and/or snow sensors (water-equivalent)
  - Areal extent of snow cover (satellite)
Spatial Information for Parameter Estimation

AVHRR Global Land Cover Product
GLCF 1 km resolution

GTOPO –DEM (~km)
A weather forecast model:
National Centers for Environmental Prediction (NCEP), NOAA
- 0.5 degree globally 4-time per day [0 6 12 18 UTC]
- ~5-hr latency, forecast is used in realtime
- 16 days lead time 3-hour intervals
- a coupled model, composed of four separate models: atmosphere, ocean land/soil and a sea ice models
Interactive Multisensor Snow and Ice Mapping System (IMS), made available through National Snow and Ice Data Center, NOAA. [http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html](http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html)

Northern Hemisphere daily snow cover based on summary of multiple satellites at 4km x 4km resolution.

Product defines: Snow covered land, sea ice, sea land (no snow)

Since December 2014 a 1 km SCA and snow depth (4-km) products are available (to be evaluated for FFGS)

Generally available within 1 day (often within several hours) following date of observation

Archive is available for 2006-current

Helfrich et al., 2007 Hydrological Processes
Incorporating Glacier mapping information in the FFGS

GLIMS: Global Land Ice Measurements from Space (http://www.glims.org/)
- National Snow and Ice Data Center
- Contribution from more than 60 institutions
- Based on data from ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer) and the Landsat Enhanced Thematic Mapper Plus (ETM+) as well as historical information derived from maps and aerial photographs.

Map was updated in December 2014

CARFFFG Glacier percent cover
Scatterplots of snow depth (cm) from point sensors versus basin-average snow water equivalent (SWE) (mm) for the basin embedding the snow depth sensor.
INITIAL ASSESSMENT OF TAJIKISTAN SNOWMELT RUNOFF AND POTENTIAL FLOOD OCCURRENCE THROUGHOUT THE 2017 HIGH RISK PERIOD

KONSTANTINE P. GEORGAKAKOS, THERESA M. MODRICK, EYLON SHAMIR, RANDALL BANKS AND JASON A. SPERFSLAGE

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HYDROLOGIC RESEARCH CENTER, SAN DIEGO, CALIFORNIA, USA

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15 April 2017
Map Server Interface

Interactive Interface for Tajikistan Snow and Runoff Assessments

Loading speeds will improve as new tile views become cached on the server.

NOTE: Development in progress - contents and functionality might break frequently.

Select Product for Estimates, Differences and Forecasts
SWE

Select Date for Estimates and Forecasts
2017 April 01

Select Forecast Assessment

Zoom to Basin ID
Enter Basin ID

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Snow Cover Frequency from: NOAA-NESDIS
Interactive Multisensor Snow and Ice Mapping System [IMS]
Figure 17: Time series of ensemble-mean aggregated basin-average runoff (mm/6hrs) contributed at the Vakhsh River segment identified in Figure 14 (green dotted line), and 24-hour moving average runoff (also in mm/6hrs) as an approximate estimate of flow volumes at the segment (blue solid line).

Figure 18: As in Figure 17 but for the Yakhsu River segment identified in Figure 15.