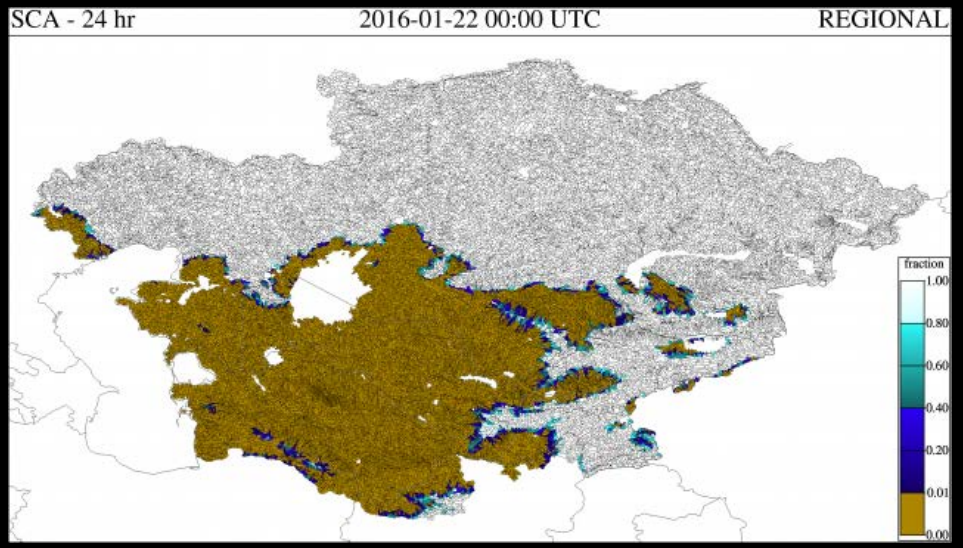
Central Asia Regional Flash Flood Guidance System
SCM-4 Astana Kazakhstan October 2017



Central Asia Snow Accumulation, Ablation & Cover

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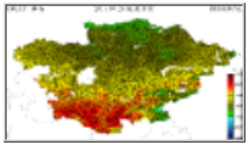
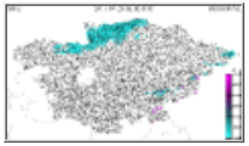
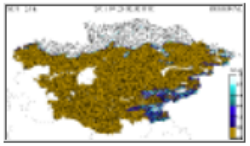
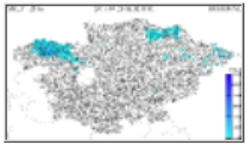
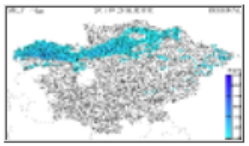
A Non-profit, Public Benefit Corporation
http://www.hrcwater.org

FFGS Snow Products

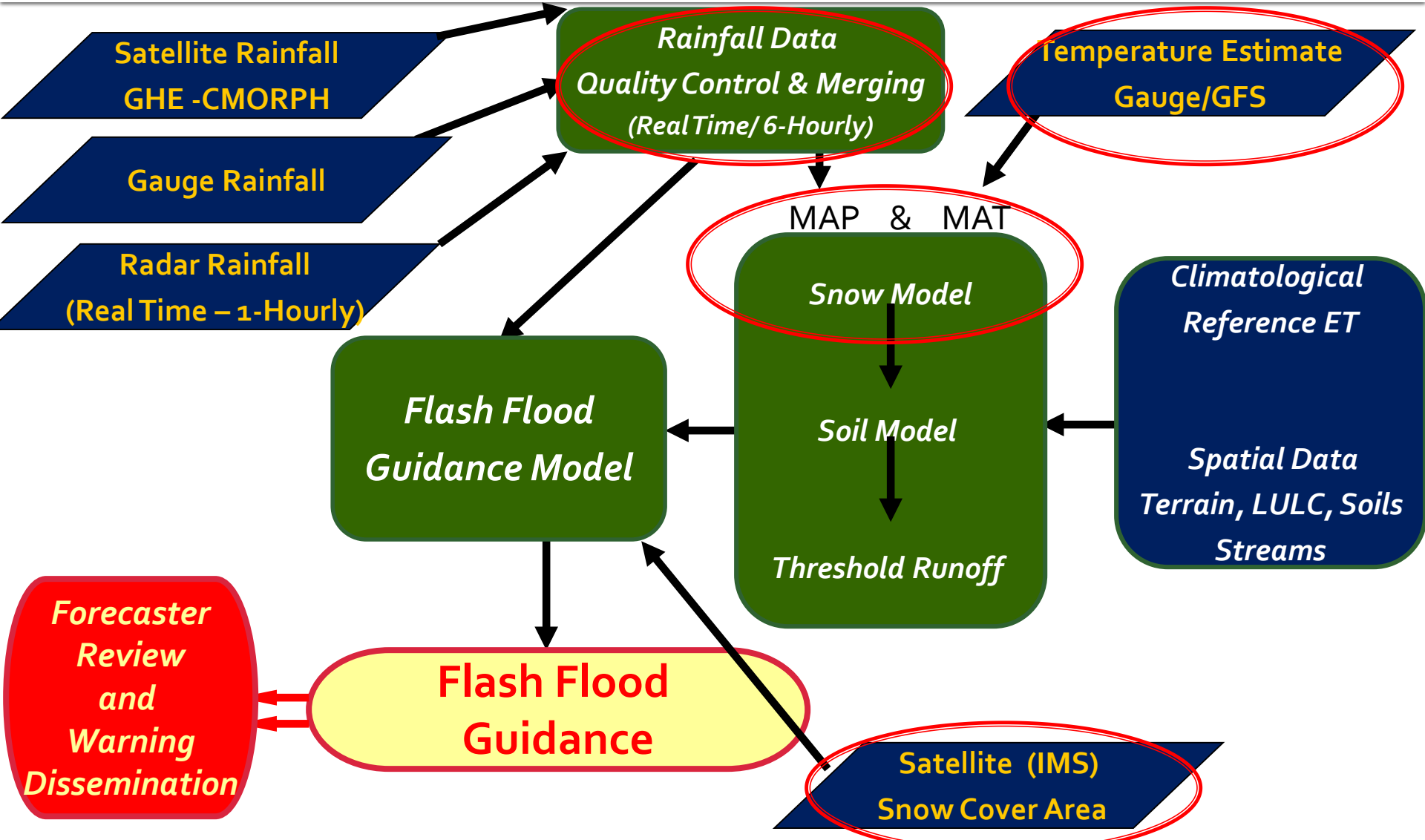
Snowpack Products				
DT	Gauge MAT	Latest IMS SCA	SWE	Melt
06-hr	 2017-10-29 06:00 UTC Text: view		 2017-10-29 06:00 UTC Text: view	
24-hr		 2017-10-29 00:00 UTC Text: view		 2017-10-29 06:00 UTC Text: view
4-day				 2017-10-29 06:00 UTC Text: view

Presentation Outline:

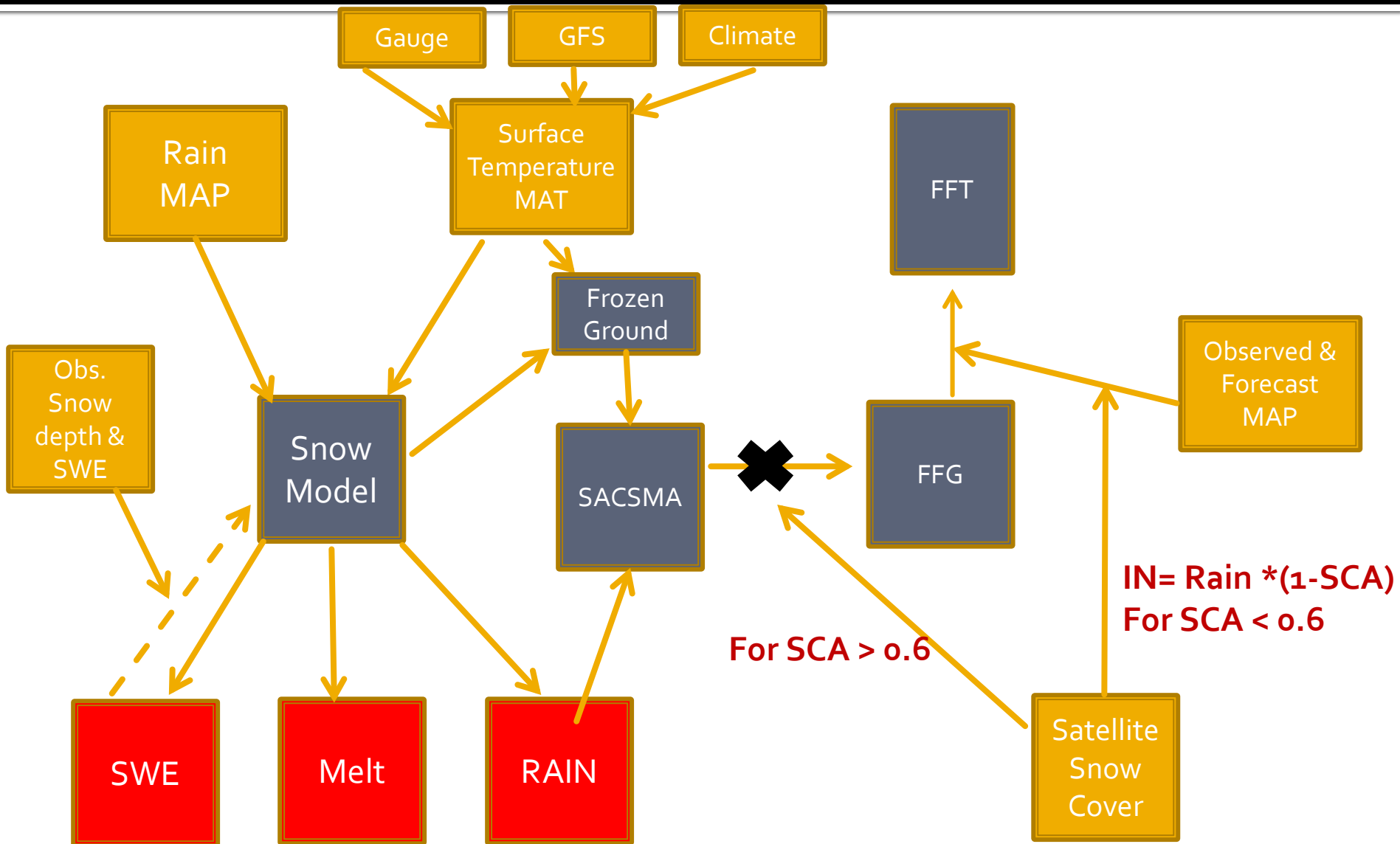
- FFGS Snow Components
- Snow Accumulation and Ablation Model
- Model Input (MAT and MAP)
- Snow Cover (IMS)
- Glaciers

- Model Evaluation

FFGS Snow Model Components



Modeling Schematic



Snow -17

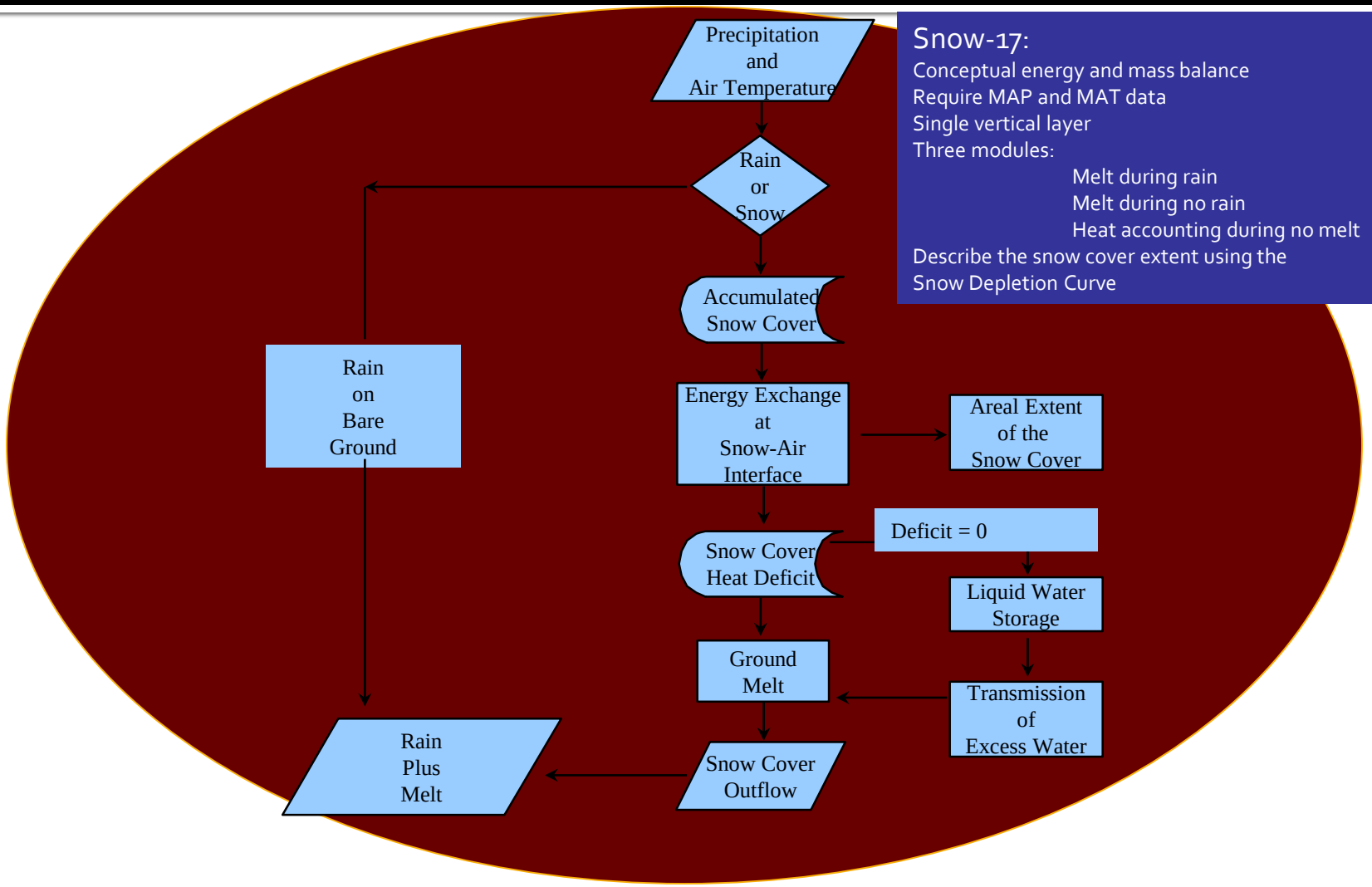
- Anderson, Eric A., 1973: "National Weather Service River Forecast System -- Snow Accumulation and Ablation Model", *NOAA Technical Memorandum NWS HYDRO-17*, US Dept. of Commerce, Silver Spring, MD, 217p.

- Anderson, Eric, A., 1976: "A Point Energy and Mass Balance Model of a Snow Cover", *NOAA Technical Report 19*, U.S. Dept. of Commerce, Silver Spring, MD, 150p.
- http://www.nws.noaa.gov/oh/hrl/nwsrfs/users_manual/part2/_pdf/22snow17.pdf

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:



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

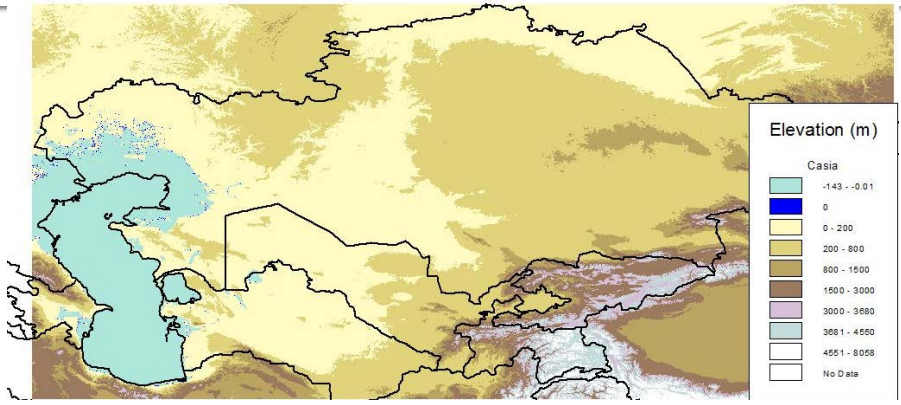
- Rain plus Melt

Data Requirements

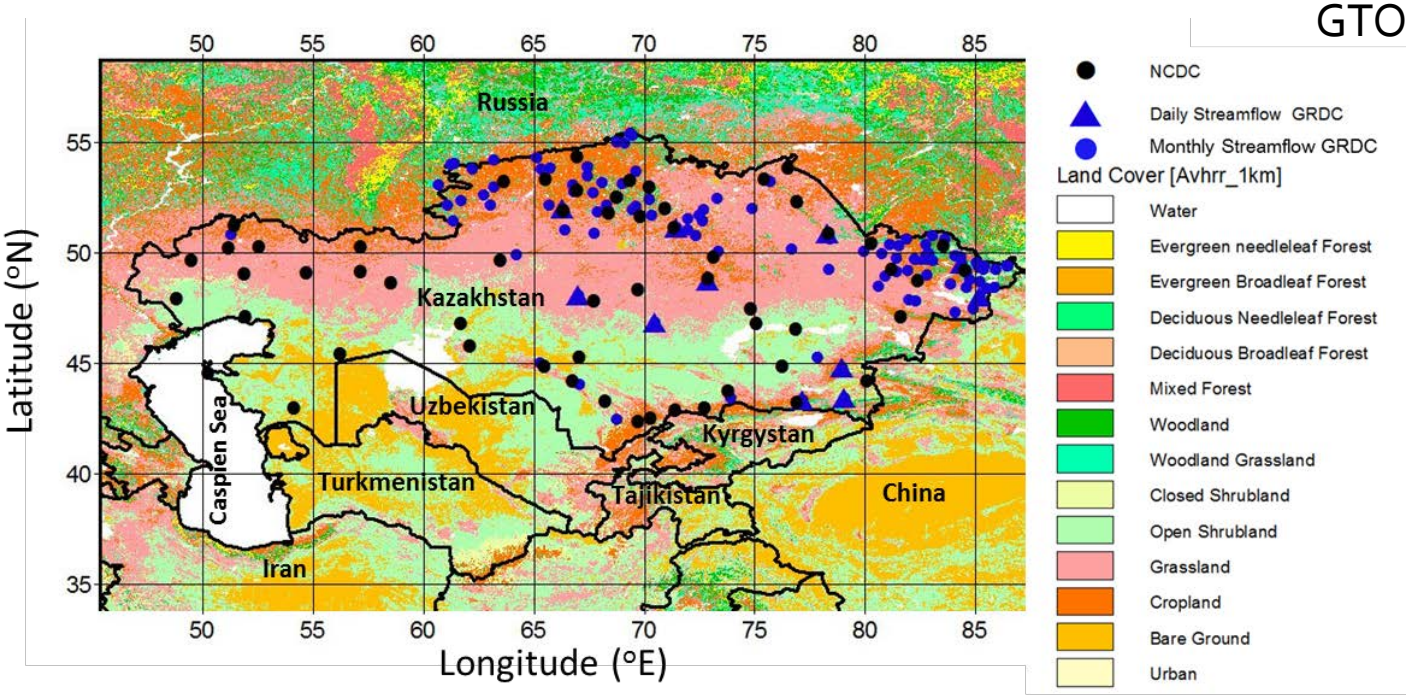
- Surface Air Temperature
  - Index for the pack energy balance and determine the form of precipitation (rain or snow)
- Precipitation
  - determine amount of snowfall and amount of rain-on-snow (PXTEMP)
  - SCF - Multiplying factor that adjusts precipitation data for gage catch deficiencies during periods 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

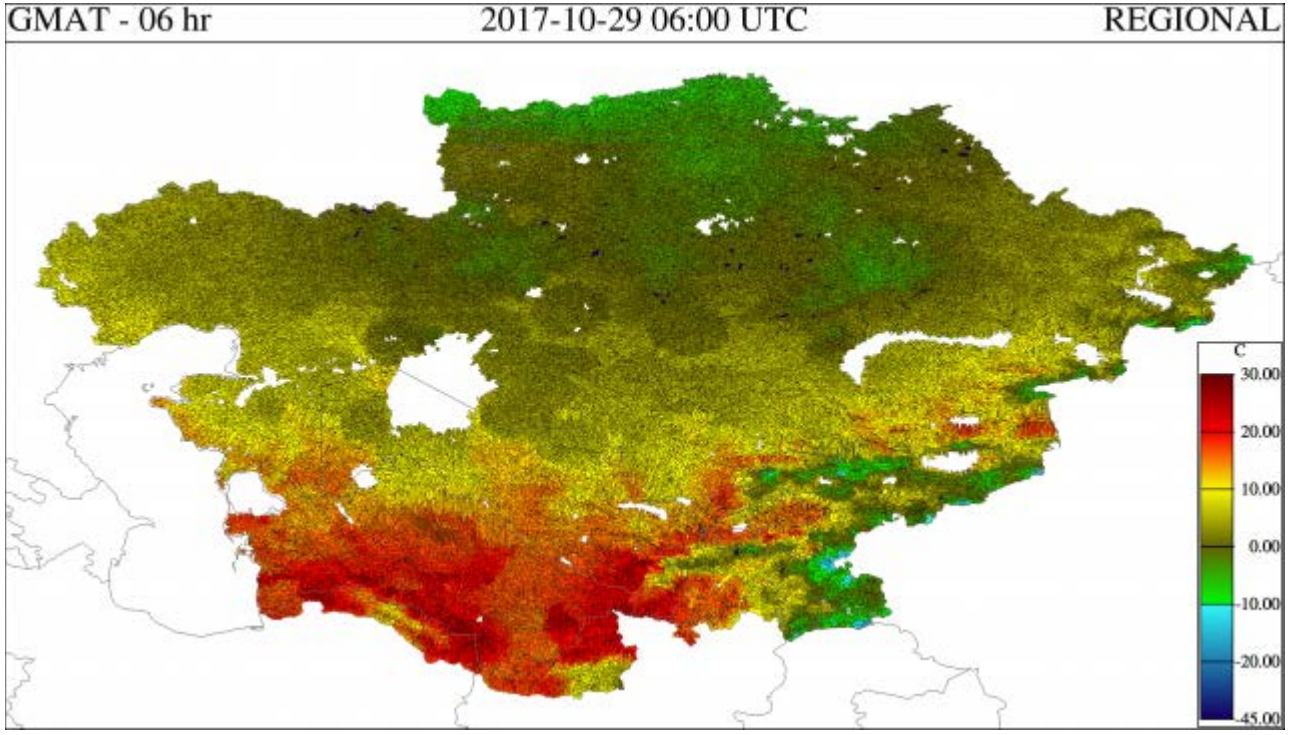


GTOPO –DEM (~km)

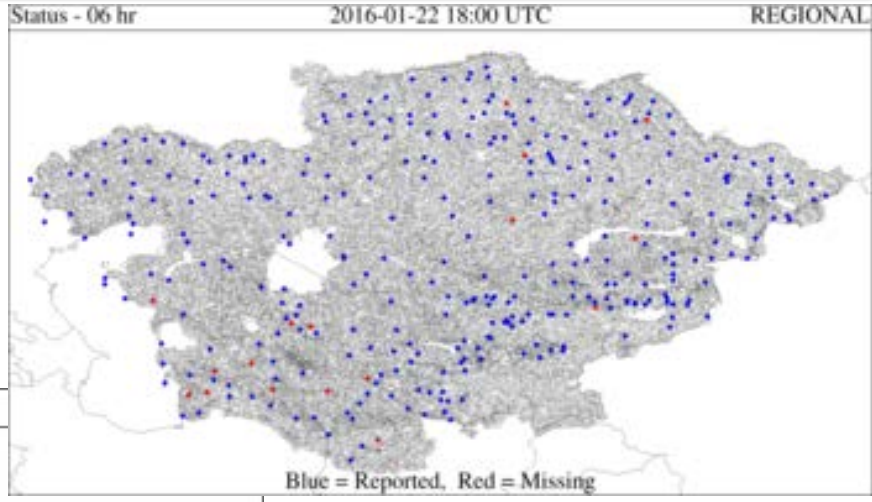


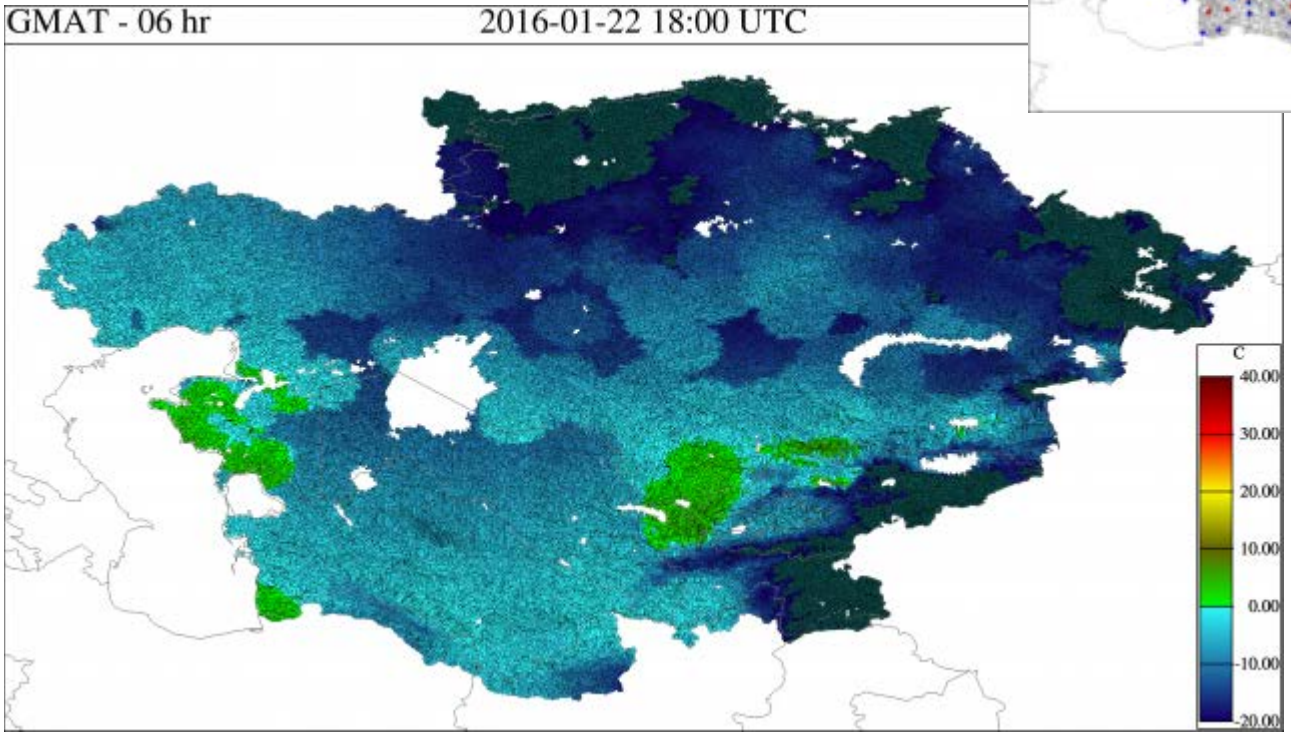
MAT from the Global Forecast System [GFS]

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



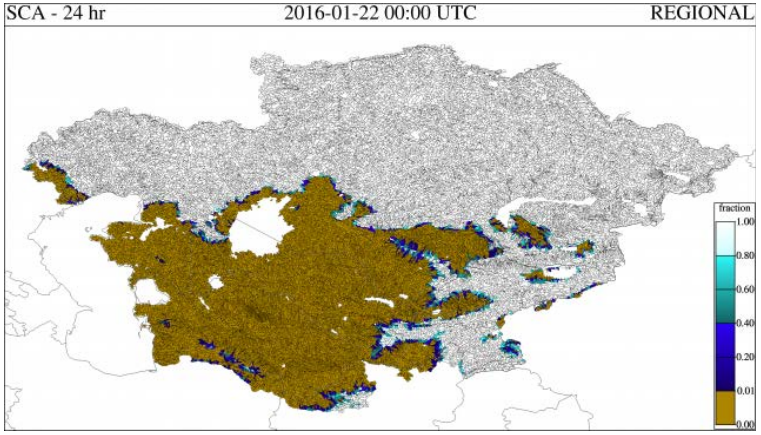
Monthly Climatological temperature
Climate Research Unit –East Anglia [1960-1990]





Satellite Snow Covered Area

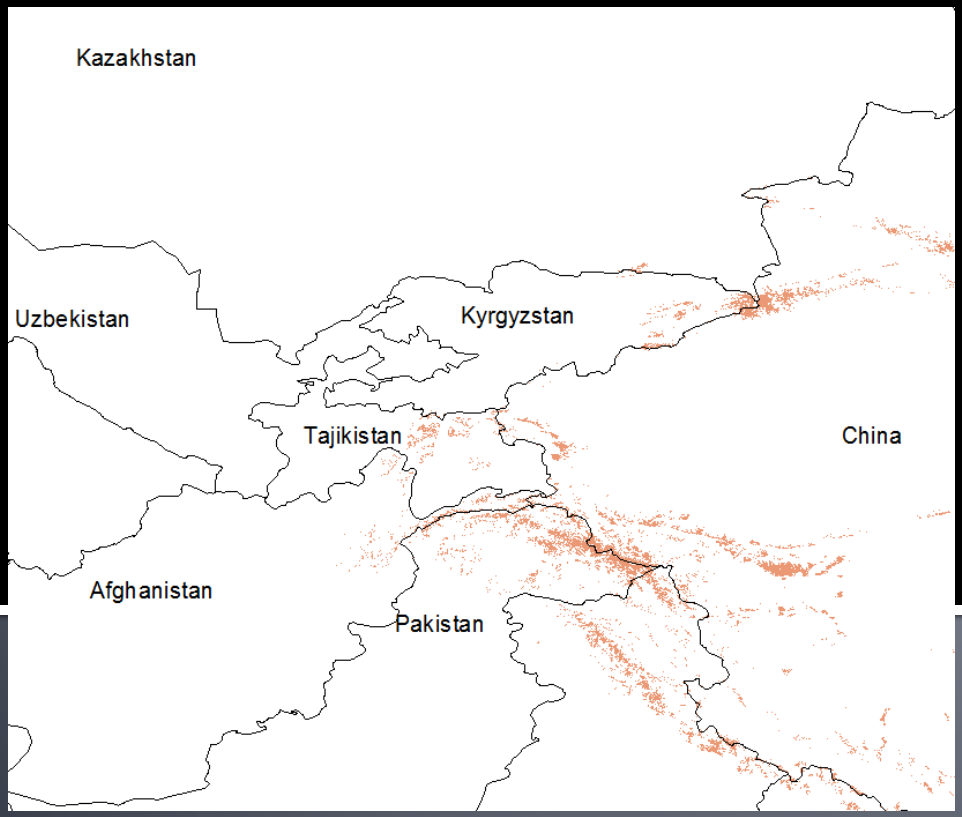
- Interactive Multisensor Snow and Ice Mapping System (IMS), made available through National Snow and Ice Data Center, NOAA.
  http://nsidc.org/data/docs/noaa/g02156_ims_snow_ice_analysis/index.html
- Northern Hemisphere daily snow cover based on summary of multiple satellites at 4km x 4km resolution.
- 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/)

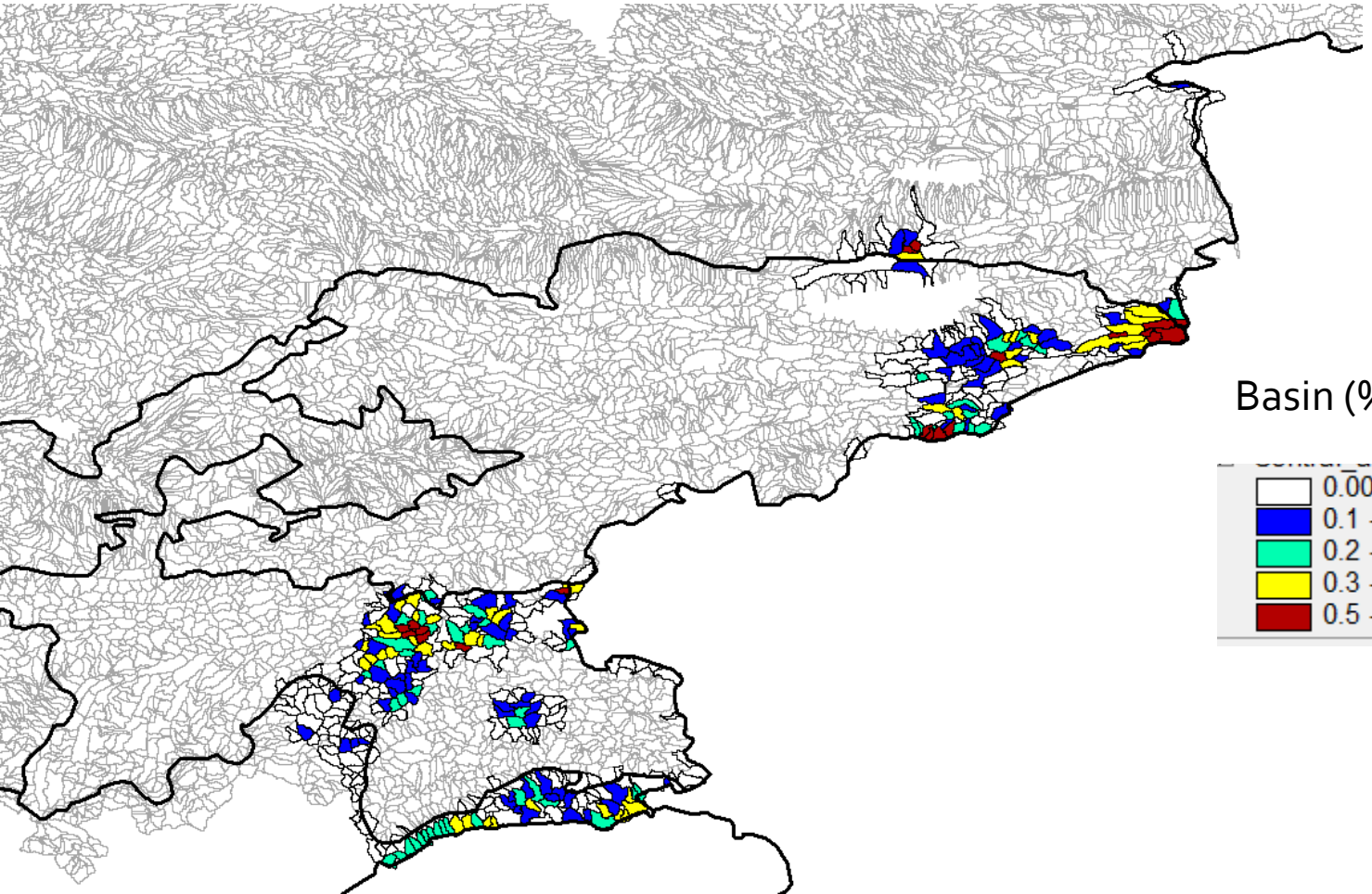
- National Snow and Ice Data Center
- Contribution from more than 60 institutions
- Based on data from ASTER (Advanced Spaceborne Thermal Emission and reflection Radiometer) and the Landsat Enhanced Thematic Mapper Plus (ETM+) as well as historical information derived from maps and aerial photographs.



Map was updated in December 2014

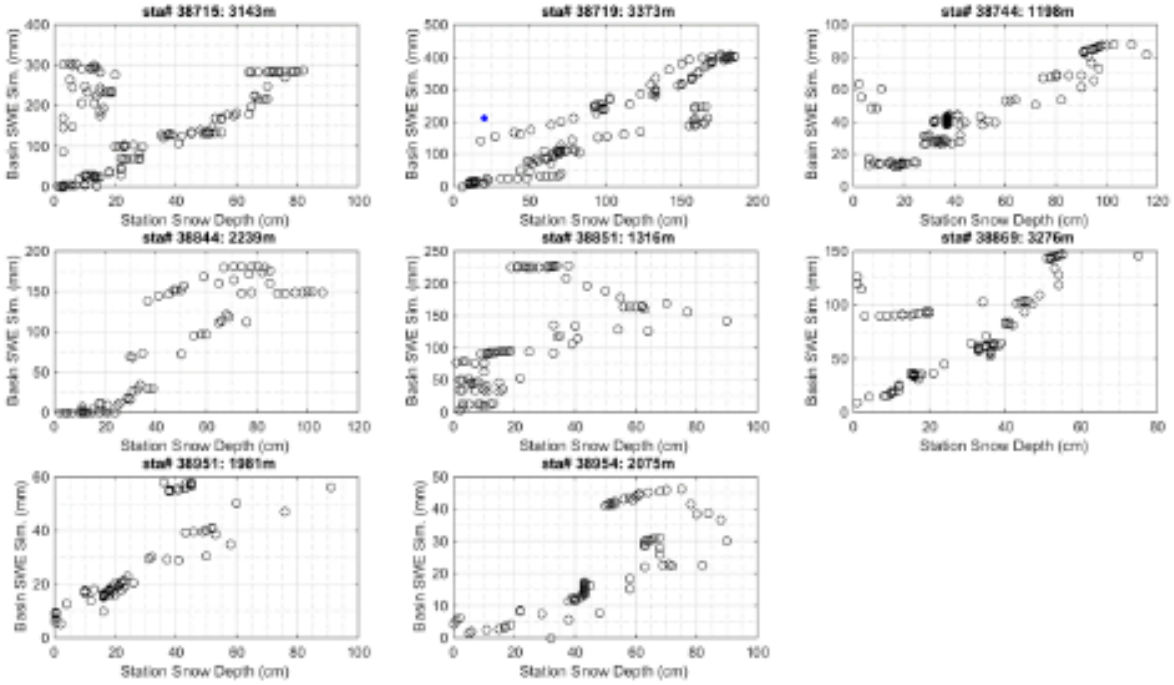
Raup, B.H.; A. Racoviteanu; S.J.S. Khalsa; C. Helm; R. Armstrong; Y. Arnaud (2007). "The GLIMS Geospatial Glacier Database: a New Tool for Studying Glacier Change". Global and Planetary Change 56:101--110. (doi:10.1016/j.gloplacha.2006.07.018)

CARFFG Glacier percent cover

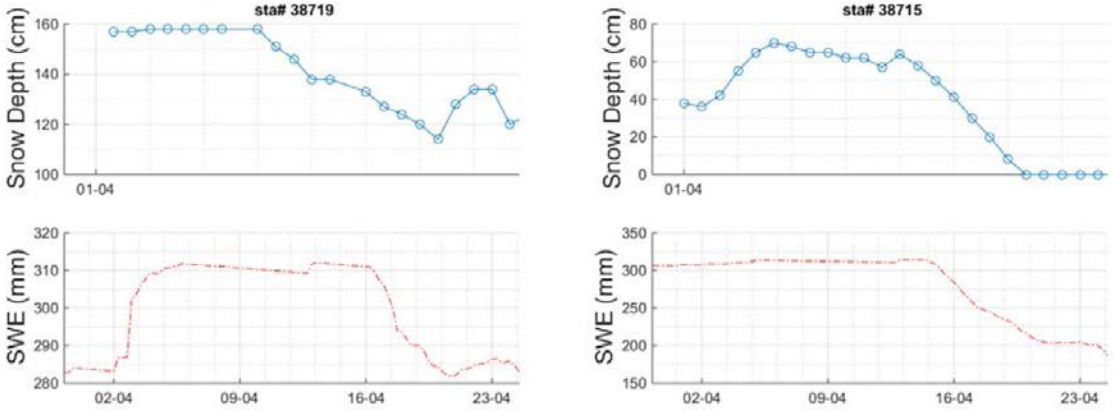


Basin (%) cover

Snow Evaluation



7: 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

HRC Technical Note No. 89

HYDROLOGIC RESEARCH CENTER, SAN DIEGO, CALIFORNIA, USA

Supported by

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GFDRR
Global Facility for Disaster Reduction and Recovery

Utilizing the CARFFG supported by

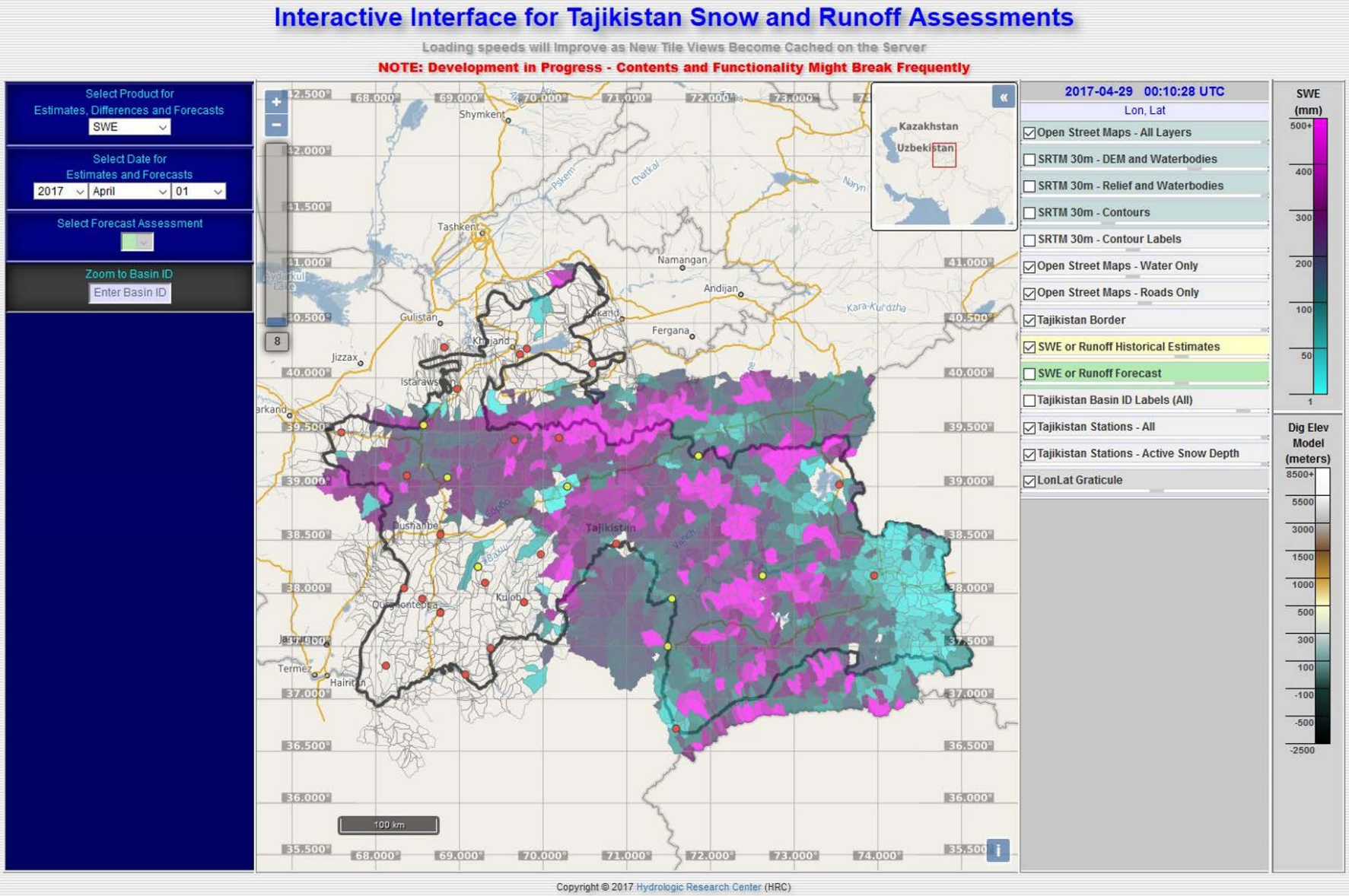
USAID
OFDA
Office of U.S. Foreign Disaster Assistance

World Meteorological Organization

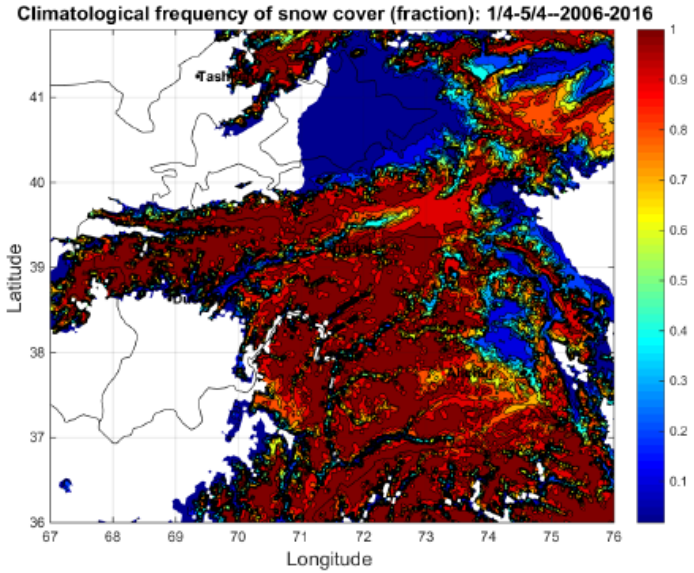
NOAA

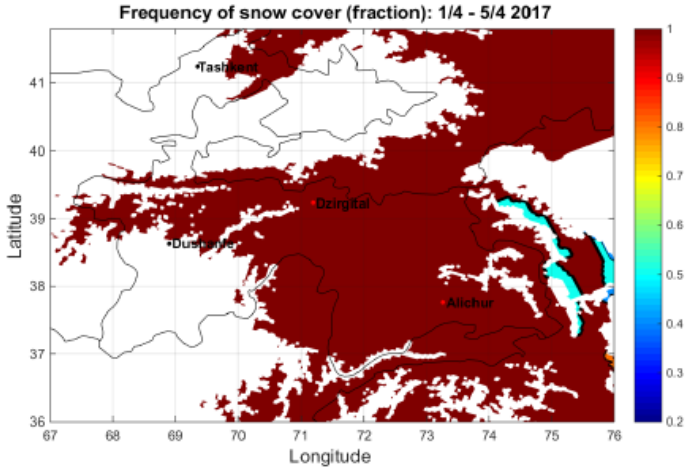
15 April 2017

Map Server Interface



Snow Cover Frequency from: NOAA-NESDIS Interactive Multisensor Snow and Ice Mapping System [IMS]





Streamflow Projections

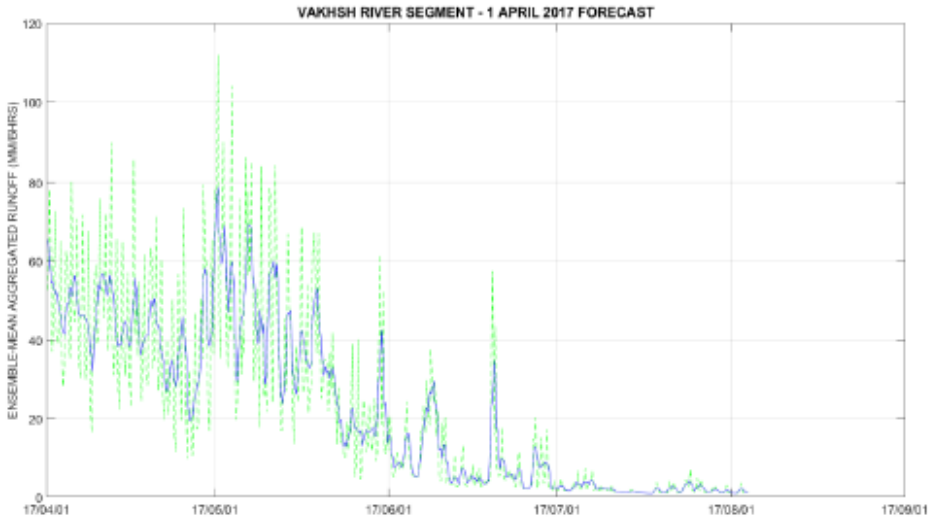


Figure 17: Time series of ensemble-mean aggregated basin-average runoff (mm/6hrs) contributed at the Vakhsh River segment identified in Figure 14 (green dotted line), and 24-hour moving average runoff (also in mm/6hrs) as an approximate estimate of flow volumes at the segment (blue solid line).

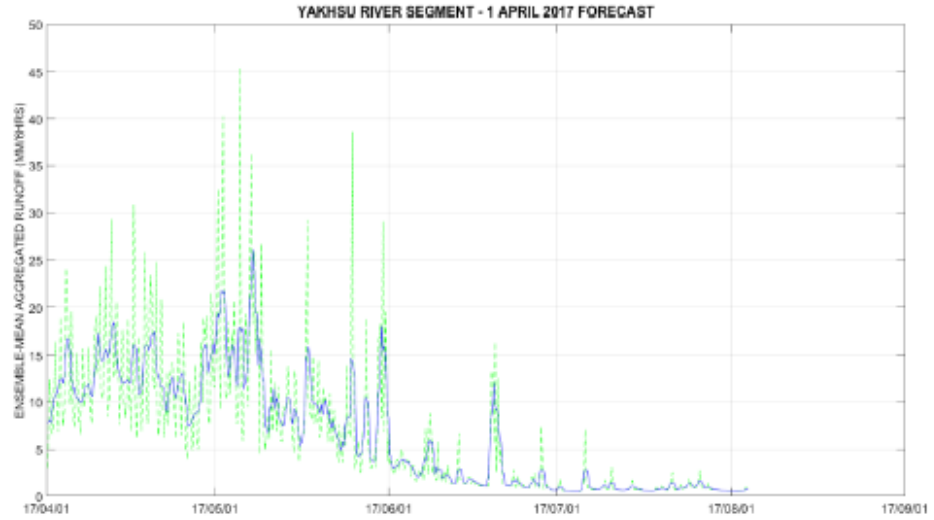


Figure 18: As in Figure 17 but for the Yakhsu River segment identified in Figure 15.