# Operational and Evolving Hydrologic Applications of Satellite Observations

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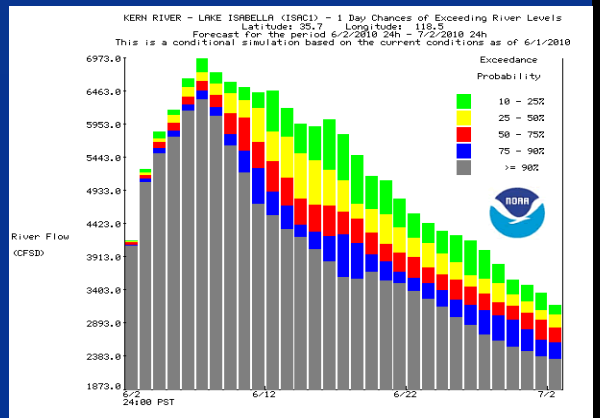


# Background

- NOAA Hydrology Program provides a variety of water and flood related forecast services
- Hydrology operations directly or indirectly rely on a suite of satellite products
- OHD been partnering with NESDIS and River Forecast Centers in assessing emerging satellite products
  - GPM/GOES-R/SMAP

# Today's Topics:

- NOAA Hydrology Program
  - Services
  - Data needs and satellite products in operation
- Experimental products, current R2O activities
- Products for future operation
- Challenges of R2O and anticipated path forward

# NOAA Integrated Water Forecasting Program

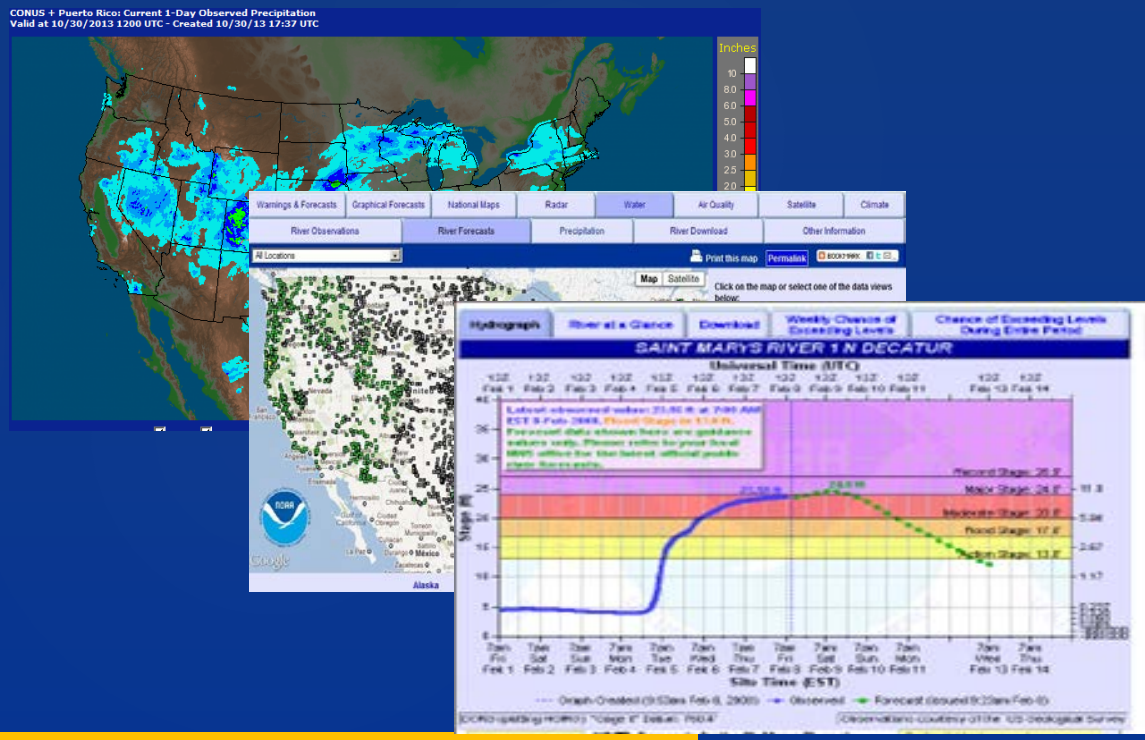
**Advanced Hydrologic Prediction Service (AHPS)**

**Water Resource Outlook**

**Flood Forecast and Outlook**

**Precipitation Product**

**Snow Observation**




**Integrated Water Resources Science and Services (IWRSS)**

- A “Summit to the Sea” framework
- Align multiple agencies with complementary water-related missions; NOAA, USACE, USGS

# Data Needs for Hydrology Program

- Issuing a forecast
  - Hydrologic Model
    - Parameters/Model States
  - Forcing data
    - Observations and forecast of P, T, radiation
- Forecast verification, adjustment and data delivery
  - Observations of:
    - streamflow
    - soil moisture
    - snowpack
    - inundation extent

# Satellite Products in Hydrologic Operation

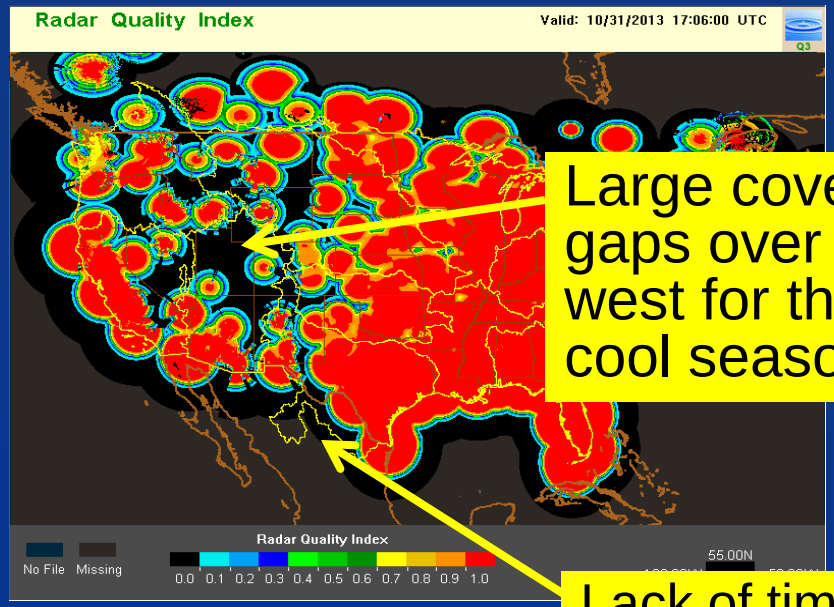
- Model setup/parameterization, e.g.,
  - Land cover from Landsat and forest cover from MODIS
- Forcing data
  - Precipitation Estimates
    - NESDIS Hydro-estimator (GOES)
  - QPF from NCEP models
    - Variety of satellite data being assimilated
- Land surface model state assimilation/validation
  - Satellite snow cover data
  - SMOS/SMAP soil moisture

# Satellite Precipitation Products

- Precipitation products needed for:
  - Real-time input to propagate model states
  - Historical records for model calibration
  - Water-related applications at partner agencies
    - e.g., USGS water survey
- GOES IR-based Hydro-estimator
  - Used at River Forecast Centers for QA and creating multisensor blended products
    - Part of Stage IV product suite

# Limitations of Radar/Gauge Networks

Radar Coverage and Quality Index




Large coverage gaps over the west for the cool season

Lack of timely data for Northern Mexico

Map of Hourly Gauges

coverage gaps in gauge data

From NOAA National Severe Storms Laboratory: http://nmq.ou.edu

# Experimental Products under Evaluation

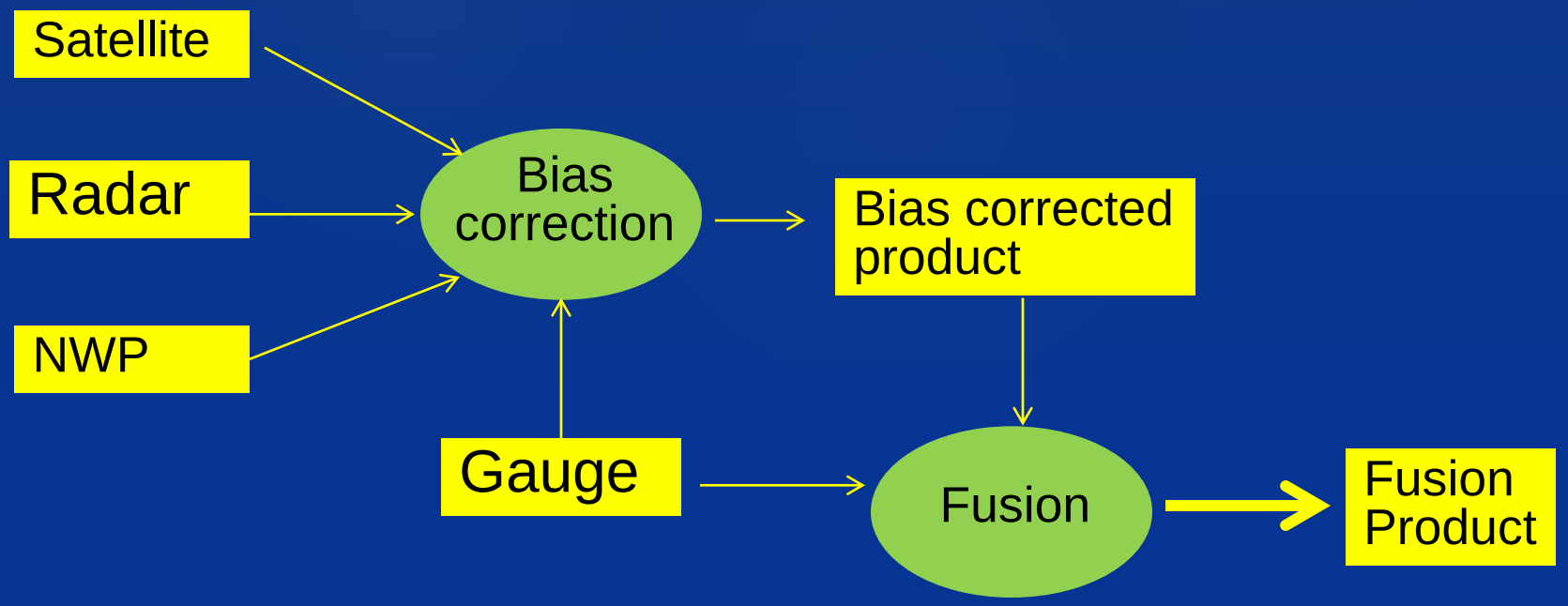
- Precipitation
  - Multi-satellite blended products
    - SCaMPR/CMORPH
  - Global Precipitation Mission (GPM - NASA)
- Fractional snow cover
  - GOES-R baseline
- Soil moisture
  - Soil Moisture Active Passive (SMAP – NASA)

# Ongoing R2O Activities

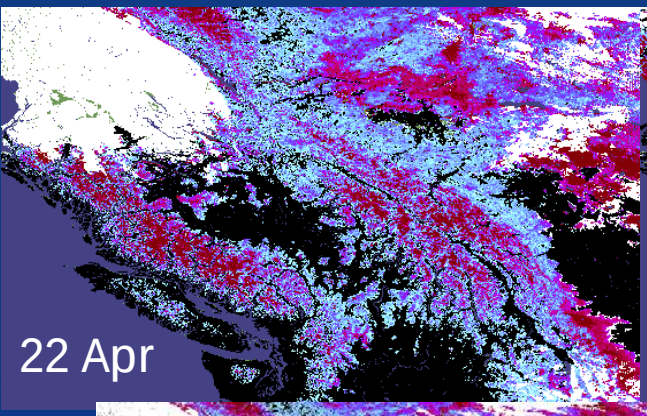
- Multisensor QPE fusion
  - OHD/NESDIS/OAR
  - Create blended multisensor product
  - Model state updates (real-time)/ calibration (off-line)
- Evaluation of snow products
  - GOES-R fractional snow coverage
  - NOHRSC(NWC)/JPL, CBRFC, AKRFC
- Assimilation of satellite-based soil moisture
  - CREST/OHD
  - Establish paradigm for utilizing incoming SMAP data

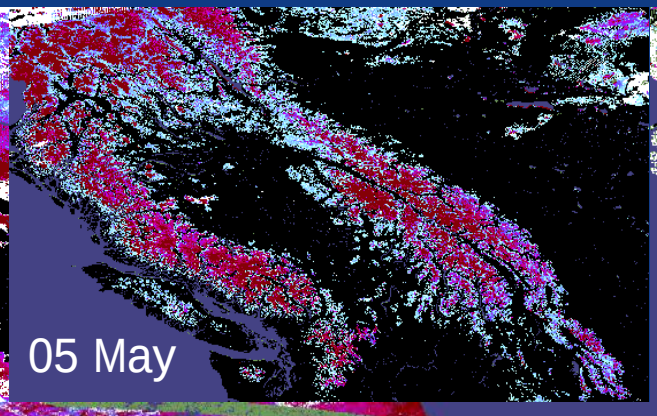
# Next Step: Multisensor Fusion

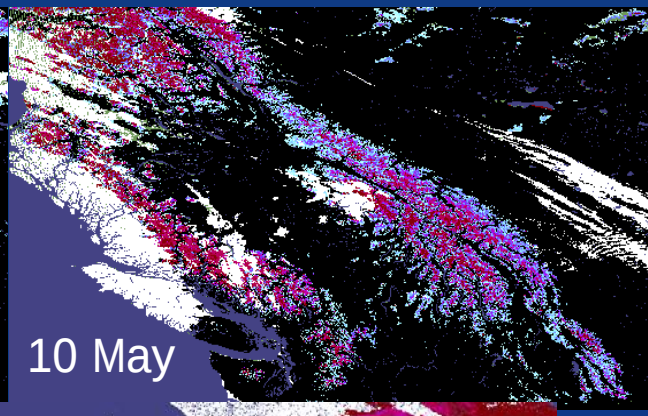
- Need objective multisensor fusion platform
  - Complementary info from satellite/radar/gauge/NWP
  - Automation and reducing forecast intervention
  - Seamless and spatially continuous

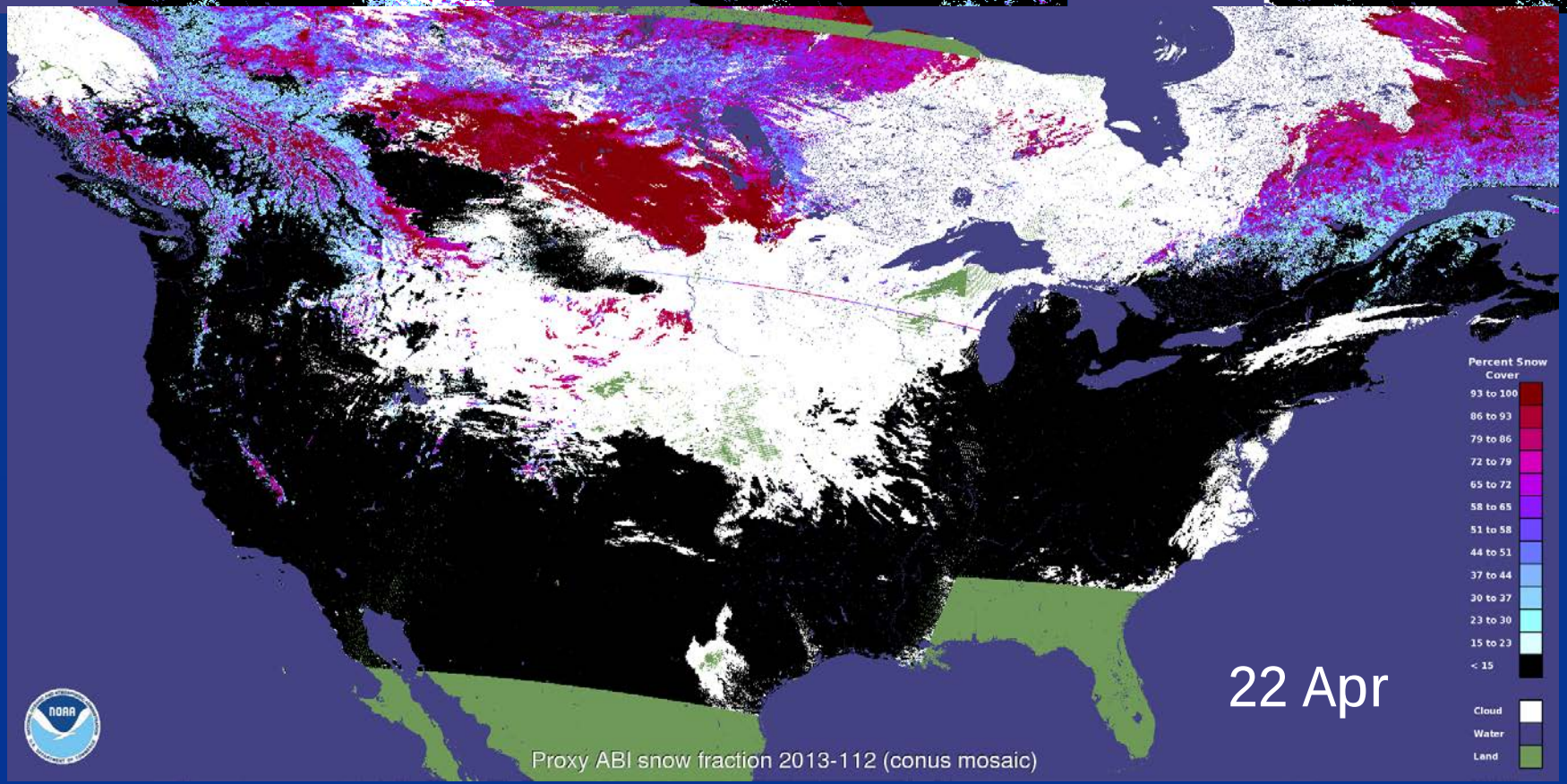


# Proxy ABI FSC, April/May 2013



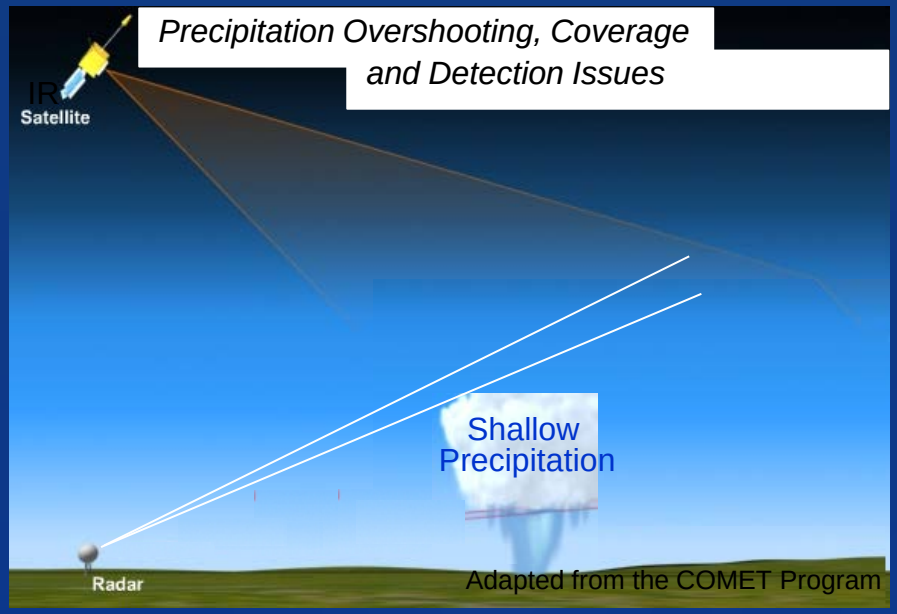



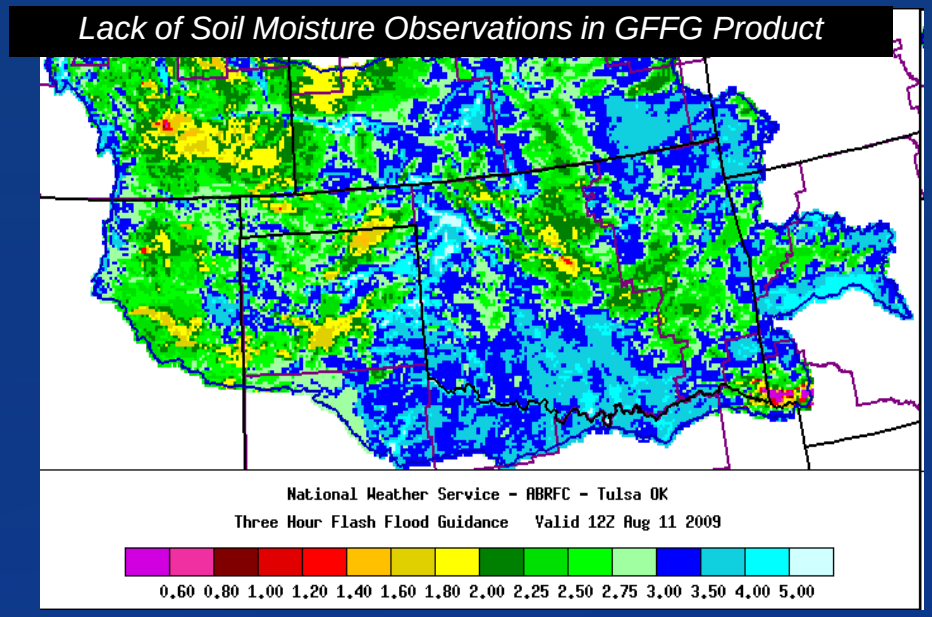
# Assimilation of Satellite Soil Moisture Estimates

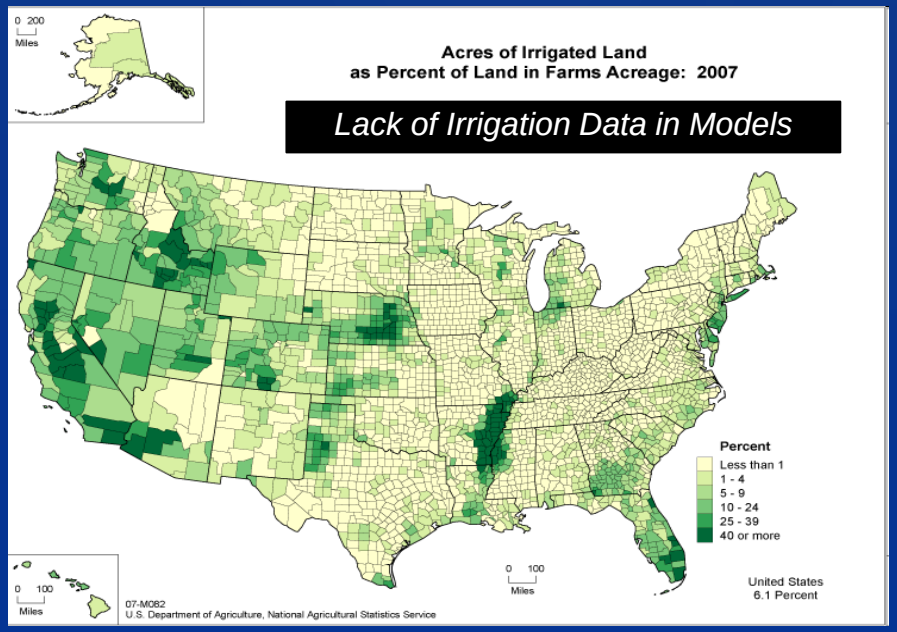
- Use of soil moisture in hydro operations
  - Update hydrologic model states via assimilation

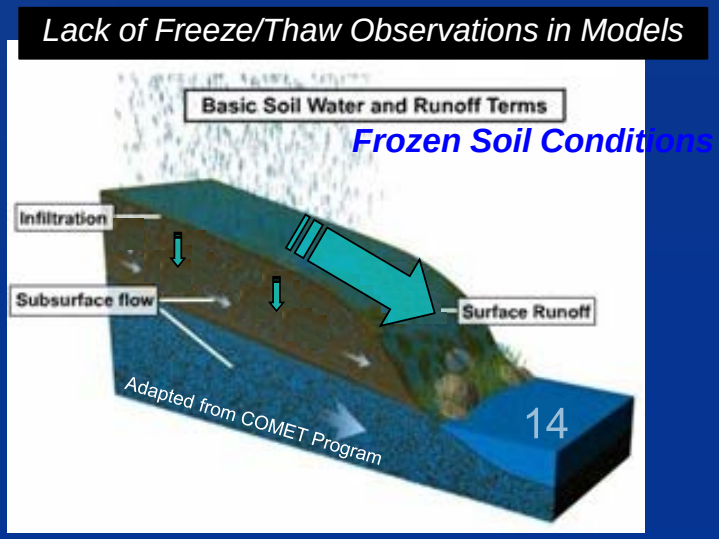
- CREST/OHD pathfinder effort, PhD research
  - Assimilation experiments using SMOS data
  - Use of SMAP possible after launch
  - SAC-HTET hydrologic model w/direct insertion
  - Entry point for further work in data assimilation
  - Potential improvements in products
    - Soil moisture and other water resource products
    - Gridded flash flood guidance
    - Routed stream flow

# SMOS/SMAP: Potential Areas of Benefit



# Satellite Products in Future Operation

- Surface Water Ocean Topography (SWOT)
  - Water coverage and water surface elevation
  - Potentially useful for:
    - Corroborating stage forecasts
    - Inundation mapping
- GOES-R radiation products
  - High resolution (2-km) PET estimates
- VIIRS river ice product (JPSS)
- NESDIS snowfall rate products (AMSU/MHS)

# Challenges of R2O

- Issues
  - Forecasters
    - Lacking expertise on product and associated quality
  - Developers
    - Unaware of actual operational gaps
- Questions need to be asked:
  - Are there ground obs available?
  - How does the data complement ground obs?
  - How does the data fit into operations
  - Continuity of satellite missions
  - Coverage/latency/accuracy/resolution?
  - How to judge value of a specific data ingest?

# Path Forward

- PG and Testbed with active participation from NWS Hydro Program and broader hydrologic community
  - Better communicate the operational context
  - Identify product relevance and maturity
    - Focus R2O effort on those with
      - high probability of yielding valuable outcome in operation
  - Objective, comprehensive assessments
    - Mimic operational forecast environment
    - Attain quantifiable outcomes
    - Avoid confirmation bias
    - Understand the applicability over a wide domain

# Path Forward

- The National Water Center
  - Evaluation / validation service
    - Evaluate operational value of new products
    - Identify new applications of new/existing products
    - Partnership with broad community

# Questions?