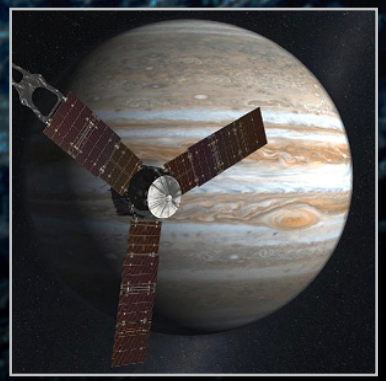
Space Age Tools for Effective Water Management: NASA's Contribution Today and Tomorrow

National Water Issues Panel
American Water Resources Association, Florida Section Meeting
Key West, Florida
July 15-16, 2010

Charles Laymon, Ph.D.



Earth Science Mission

. . . to understand and protect our home planet by using our view from space to study the Earth system and improve prediction of Earth system change.

NASA Responds to Future Hydrological Needs

Earth Science Vision 2030
March 2004

NASA Science Plan
2007

National Research Council
Earth Science and Applications from Space
January 2007

Predictive Goals — Water

Today	2015	2030
Prediction of land surface state-snow, soil moisture, surface water, evapo-transpiration-at a micr	Land surface state can be reliably predicted independently of the	Land surface state predictions include linkages to weather, climate and
Components of the wa cycle understood, but budget not accurately		

Measurement Needs — Water

Measurements	Frequency	Horizontal Resolution	Precision
Soil Moisture	Daily	< 1 km	10 %
Soil properties (carbon stocks, nutrient availability, hydrologic properties)	Monthly to Weekly	< 1 km	NA
Reservoir and Aquifer Impoundment			
Ice sheet elevation			
Snow Pack			

Measurement Needs — Weather

Measurements	Frequency	Horizontal Resolution	Precision/Accuracy
Tropospheric wind profiles (20 levels in troposphere)	3 Hours	5 km	1 m/s per horizontal component
Wind vectors within storm systems (20 levels in troposphere)	1-3 Hours	5-25 km	3 m/s per horizontal component
Temperature and water vapor profiles in clear air (20 levels in troposphere)	1-3 hours	5 km	<1° C, T & Td (dew point T)
Temperature and water vapor profiles within storm systems (20 levels in troposphere)	1-3 Hours	5-25 km	<1° C, T & Td
Surface precipitation 3-D precipitation structure	Hourly	5-25 km	5-10 mm/h

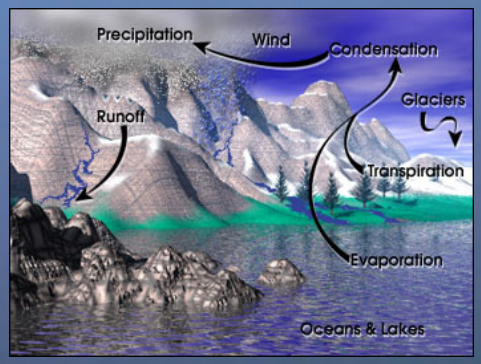
NASA should continue sustained measurements of precipitation and landcover.

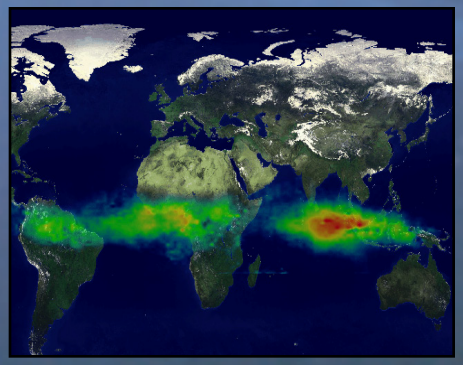
Recommended with high priority that NASA launch a soil moisture mission in the 2010-2013 timeframe.

NASA Earth Science Focus Areas

Earth Science Research Foci

- Atmospheric Chemistry and Composition
- Carbon Cycle and Ecosystems
- Climate Variability and Change
- Earth Surface and Interior
- Water and Energy Cycle
- Weather





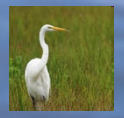
Earth Science Applications

- Agriculture

- Air Quality

- Climate

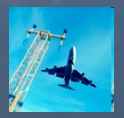
- Natural Disasters



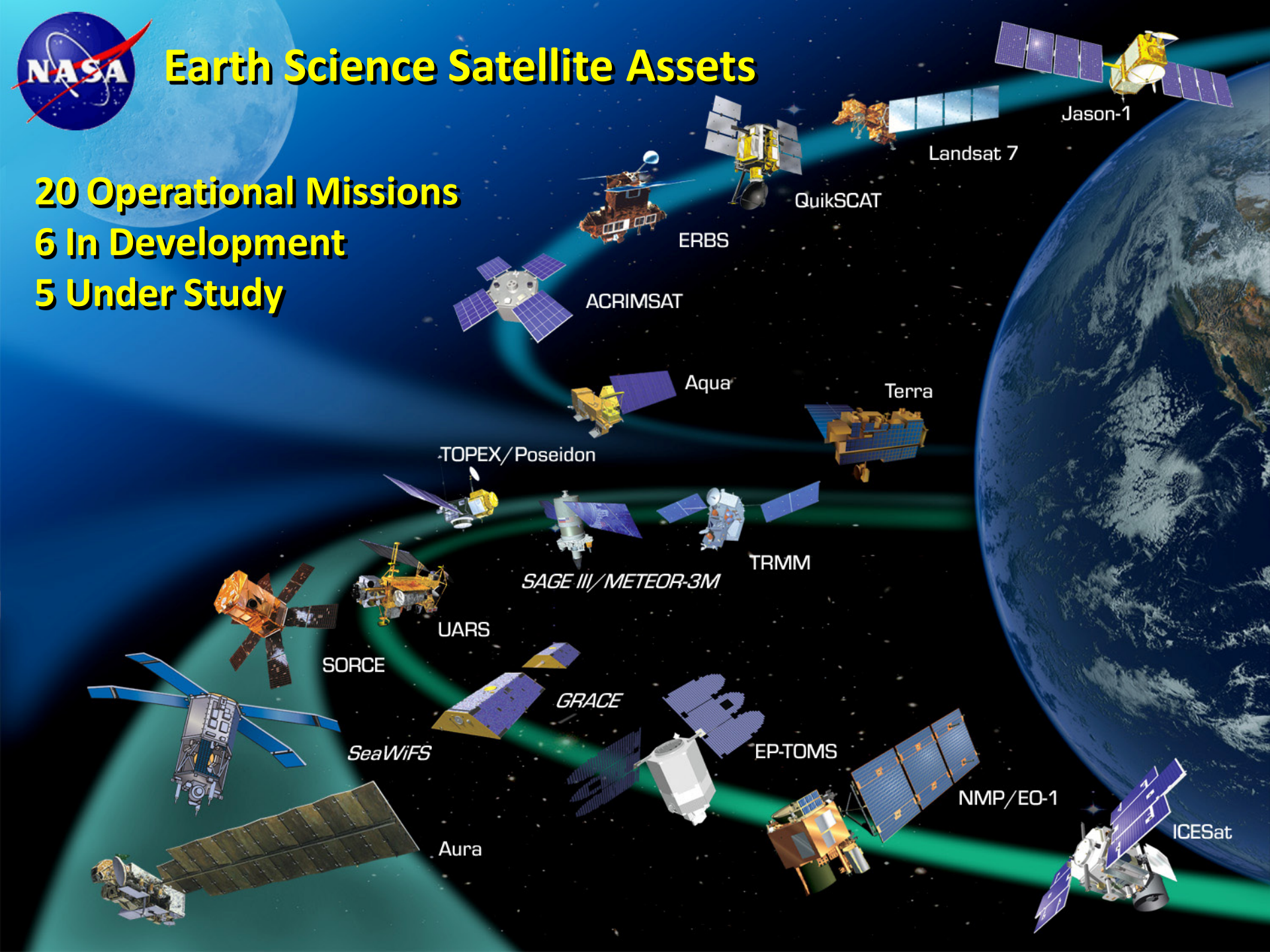
- Ecological Forecasting

- Public Health

- Water Resources



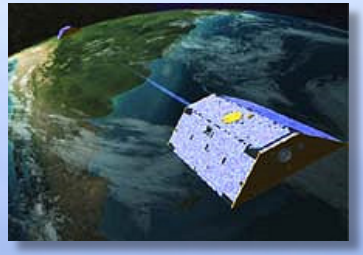
- Weather


Earth Science Satellite Assets
20 Operational Missions
6 In Development
5 Under Study
Jason-1
Landsat 7
QuikSCAT
ERBS
ACRIMSAT
Aqua
Terra
TOPEX/Poseidon
TRMM
SAGE III/METEOR-3M
UARS
SORCE
GRACE
SeaWiFS
EP-TOMS
NMP/EO-1
ICESat
Aura

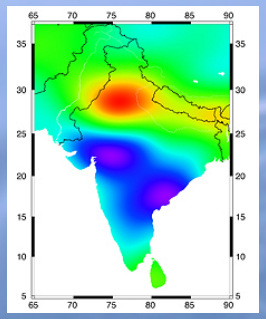
Hydrometeorological Missions

GRACE

2002-2015



Provide detailed measurements of Earth's gravity field



Retrieve changes in ground water storage

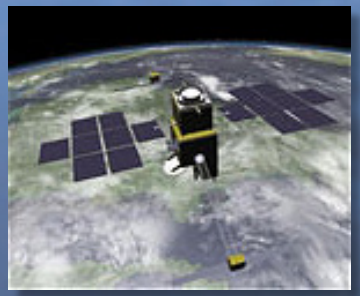
SMAP

2014-

Global measurement of surface soil moisture and freeze/thaw state.

SWOT

2020-

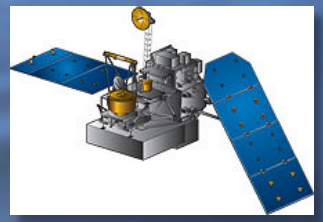


First global survey of Earth's surface water.

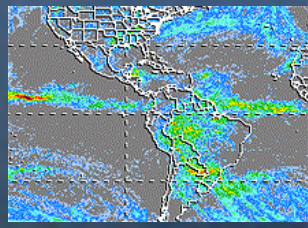
Will measure water storage changes in all wetlands, lakes, and reservoirs
Repeated measurements of water height during floods

GPM

2013-



Global measurement of precipitation, its distribution, and physical processes; to improve the accuracy of weather forecasts; better understanding of climate and hydrometeorological processes



Marshall's Airborne Science Instruments

MAPIR

Soil Moisture Remote Sensing

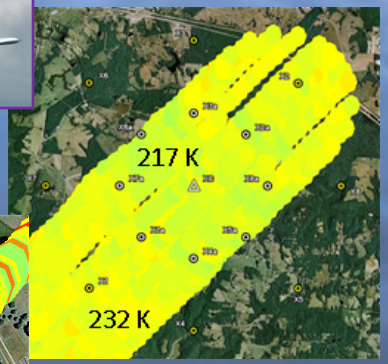
PI: C. Laymon, NASA/MSFC

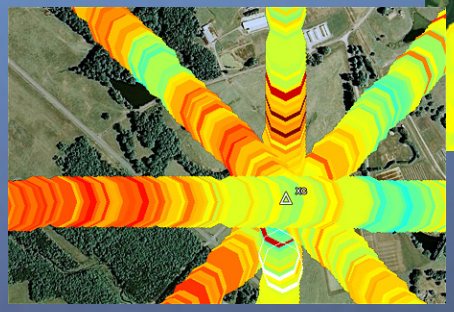
Objective:

Measure soil moisture to improve streamflow and weather forecasts, and estimation of evaporation.

Antenna

MAPIR enclosed in fairings





Partnership between Government, Universities and Industry

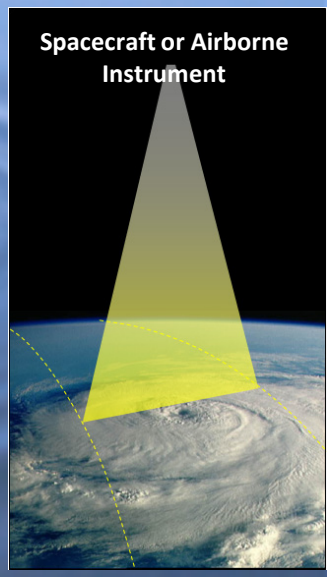
HIRAD

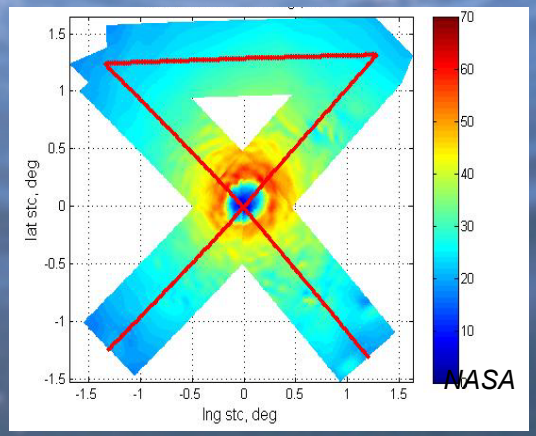
Remote Sensing of Sea Surface Wind Speed and Rain Rate in Hurricanes

PI: T. Miller, NASA/MSFC

Objective:

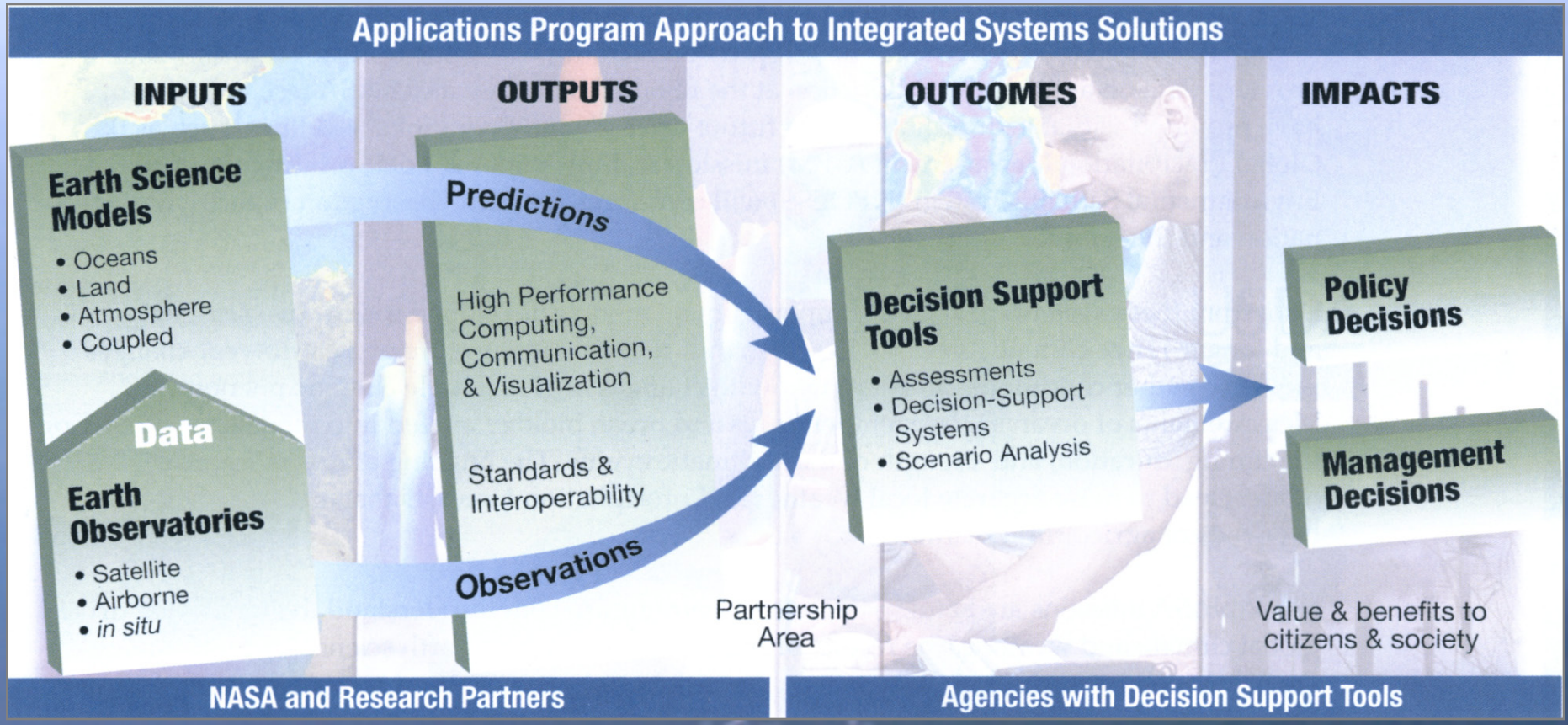
- To improve prediction of storm intensity, structure, and path.
- To better determine storm location, intensity, and flooding prediction will save lives and property.





Partnership between Government, Universities and Industry

Research to Operations Transition



...To enable timely and affordable delivery of Earth Science data and information to users

Applied Science Projects in Hydrology

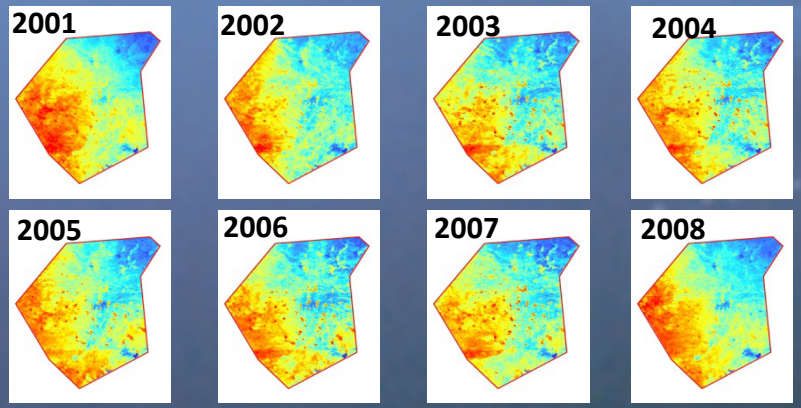
Improved Streamflow Forecasts

Infusing NASA Science & Technology to Improve Streamflow Forecasts

Objective: Use remotely sensed cloud cover, and surface temperature data to estimate evapotranspiration, which was ingested into NOAA hydrologic models to improve streamflow prediction. **–recover lost functionality**

Partner: NOAA Office of Hydrologic Development

Annual Average Potential Evapotranspiration



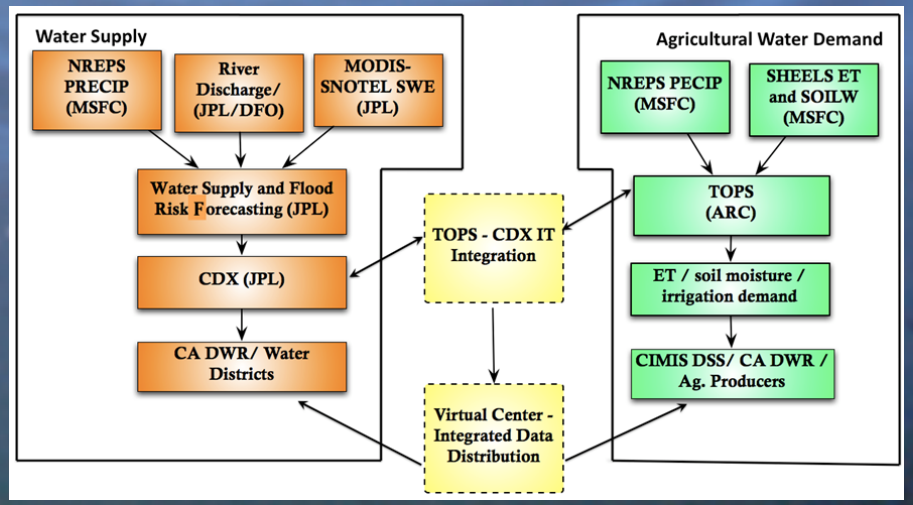
Improved Water Management

Infusing NASA Science & Technology to Improve Water Management

Objective: Use precipitation estimates from NEXRAD radars, and estimates of soil moisture and ET from a distributed hydrologic model to improve efficiency of agricultural irrigation and municipal water use.

Study Area: San Joaquin Valley, CA

Partners: Federal, State, Local NGOs

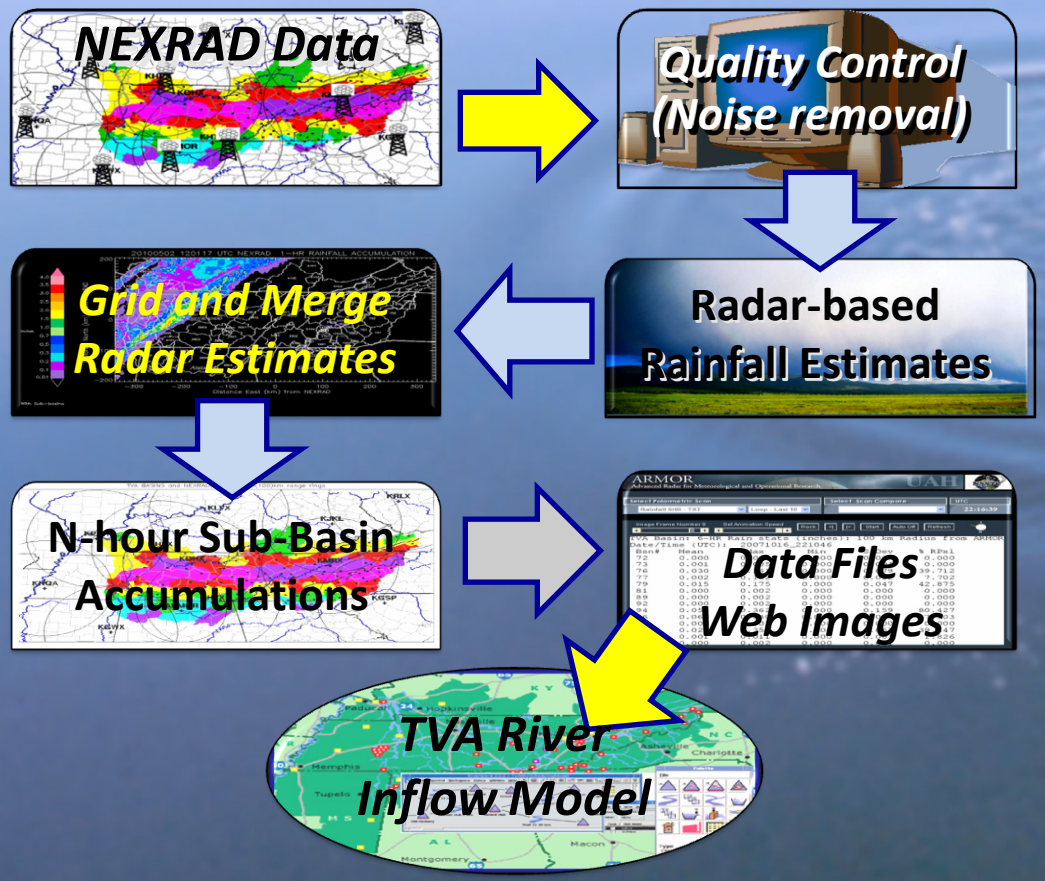


Improved Streamflow with Better Precipitation

Infusing NASA Science & Technology to Improve Operational Hydrologic Forecasts

Customer: Tennessee Valley Authority

NEXRAD Rainfall Estimation Processing System (NREPS)



CURRENT TVA

Lumped inflow-model relies on coarse gauge net

NSSTC Transition of Radar and QPE Research to operations

FUTURE TVA

Quality radar-based QPE that reduces gauge costs; basis for distributed model

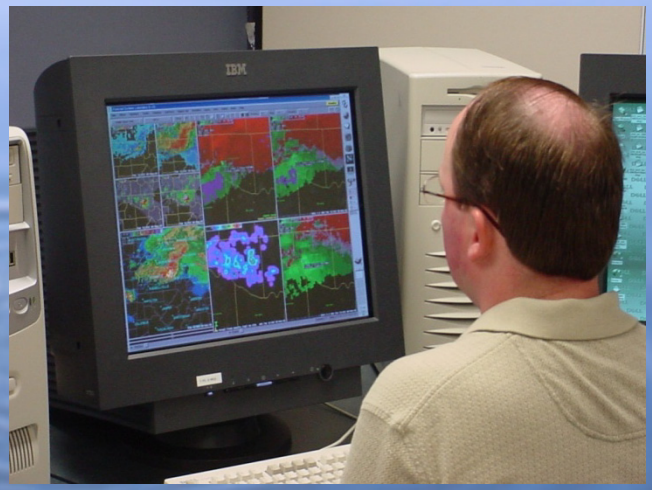
Improved Operational Weather Forecasts

Infusing NASA Science & Technology to Improve Operational Weather Forecast

Mission:

Apply ***NASA measurement systems and unique Earth science research*** to improve the accuracy of short-term (0-24 hr) weather prediction at the regional and local scale

- conduct focused research
- evaluate in "testbed" mode
- transition priority products to WFOs



End users:
National Weather Service Forecast Offices across the country, other government organizations, and numerous private sector weather partners

Partners: *Other NASA Centers, NOAA, private sector weather entities*

- *Apply real-time data from NASA climate satellites such as Terra, Aqua, and CloudSat to weather forecast problems*
- *NASA satellites are prototypes for future NOAA satellites*

Short-term Prediction Research and Transition (SPoRT)

Summary

Mission:

To improve scientific understanding of the Earth's global water cycle and other major weather and climate processes, **to assess the interaction between Earth's weather and climate systems and human activity** as it relates to regional and global weather and climate variability, and **to apply this scientific knowledge to specific issues of concern to decision-makers and the general scientific community**.

NSSTC National Space Science and Technology Center

Who We Serve:

Governmental and non-governmental partners with global to local scale needs

What We Provide:

- Innovative solutions that maximize utility of existing assets
- Solutions that are smarter, not harder
- Focus in areas in which we excel
- Engage in partnerships where relationships matter

Core Competencies

Research
- *Surface hydrology*
- *Meteorological processes*
- *Atmospheric electricity*
- *Climate dynamics & variability*

Applications
- *Water management*
- *Public health*
- *Research to operations*
- *Application specific solutions*