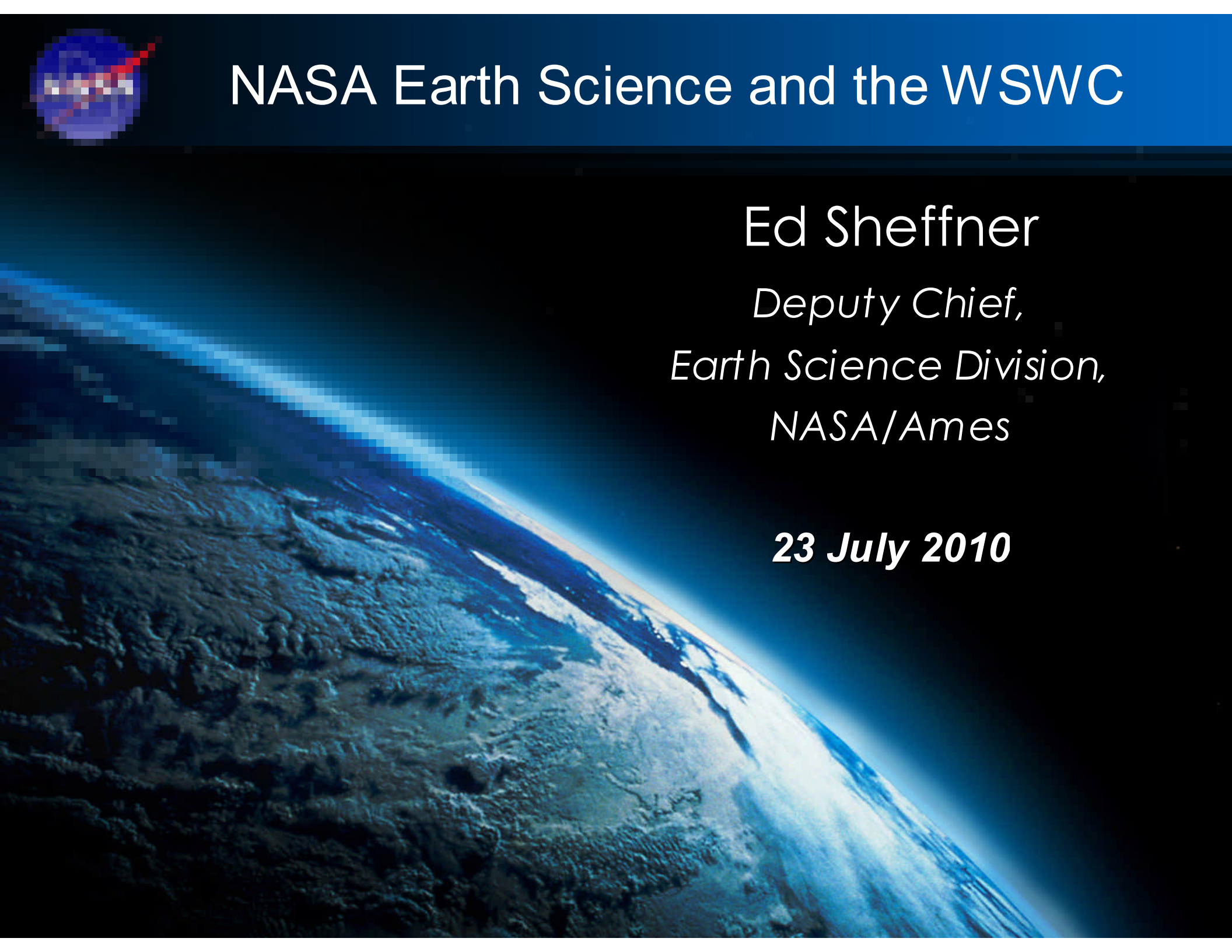
NASA Earth Science and the WSWC



Ed Sheffner

Deputy Chief,

Earth Science Division,

NASA/Ames

23 July 2010

National Aeronautics & Space Administration

Presentation Theme

- NASA is an R and D agency with the mandate to lead the US civil space program and maximize the economic and social value of space exploration.
- NASA supports an Earth science program that studies fundamental processes of the land, oceans and atmosphere globally from space (augmented with airborne and in situ observations.)

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Presentation Themes (continued)

- The Earth Science Program wants its capabilities to be utilized by the community beyond NASA Earth science research.
- NASA Earth science is seeking new approaches for long term interaction with the broader user community to help shape future Earth observing missions and maximize the benefits from missions already planned.

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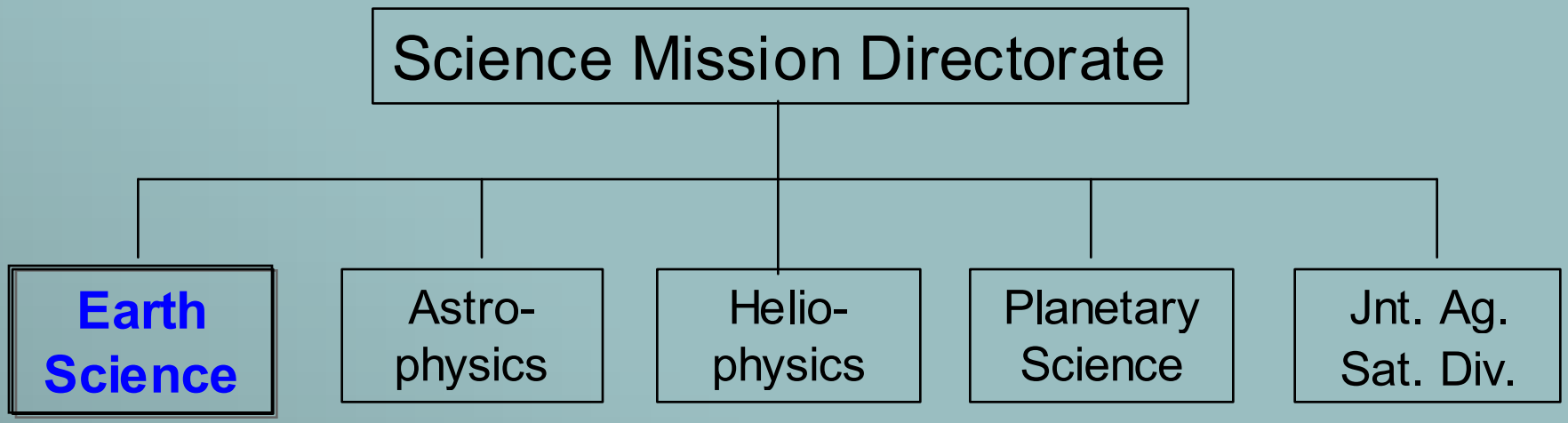
NASA Science Mission



The purpose of NASA's Earth science program is to develop a scientific understanding of Earth's system and its response to natural and human-induced changes, and to improve prediction of climate, weather, and natural hazards.

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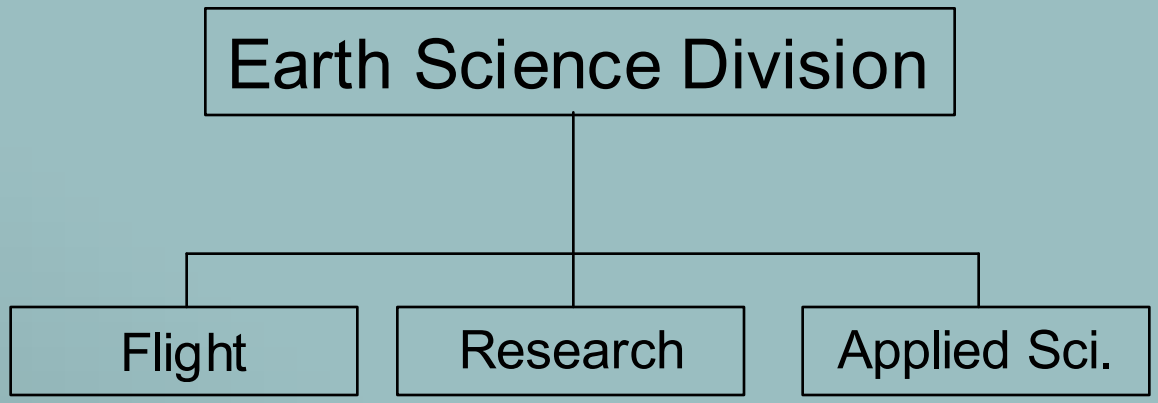
NASA Earth Science



Research focus areas:

- Atmospheric composition
- *Weather*
- *Climate Variability and Change*
- *Water and Energy Cycles*
- *Carbon Cycle and Ecosystems*
- Earth Surface and Interior

Relevant to WSWC

Applied Sciences Program elements:

- *Agriculture*
- Air Quality
- *Climate*
- *Natural Disasters*
- *Ecological Forecasting*
- Public Health
- *Water Resources*
- *Weather*

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NASA Earth Science Capabilities

- *Earth observations*
  - Largest suite of Earth observing satellites of any nation.
  - Airborne instruments and platforms with a Distinguished history of missions around the world.
  - Ground observations for calibration and Validation
- *Earth system modeling*
  - Process and predictive models
- *Systems engineering*
  - Development and testing of integrated systems
- *Earth science research results*

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NASA's Earth Observing Missions

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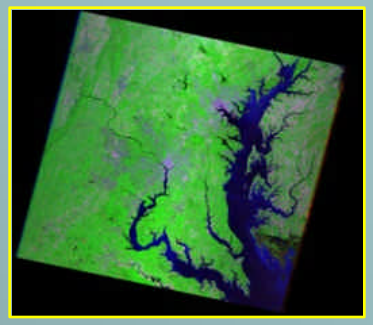
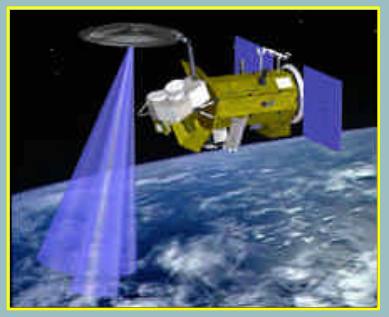
NASA Missions in Development



Landsat Data Continuity Mission (LDCM)

GPM

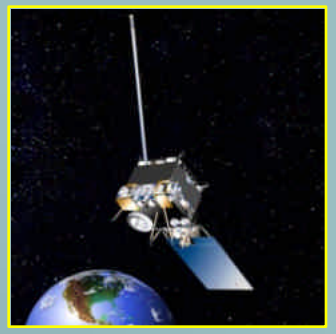


Aquarius

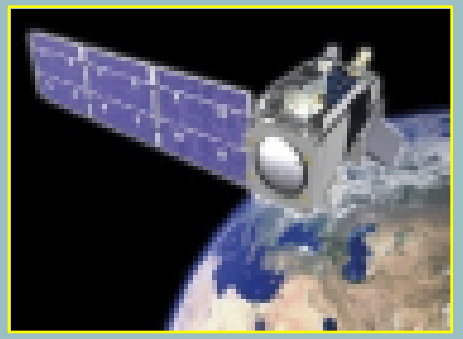
SMAP

OCO-2

ICESAT-2

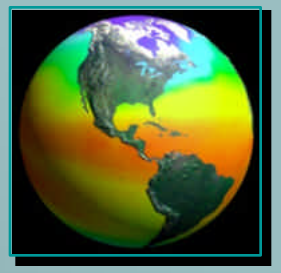


Geostationary Operational Environmental Satellite (GOES)



National Polar-Orbiting System (NPOESS) Preparatory Project (NPP)

NOAA Polar Operational Environmental Satellite (POES)



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NASA Decadal Survey Tier 1 Missions

Mission	Description	Instrument(s)
• CLARREO	Solar and Earth radiation spectrally resolved forcing and response of the climate system	Absolute, spectrally resolved interferometer
• SMAP	Soil moisture and freeze thaw for weather and water cycle processes	L- band radar L- band radiometer
• ICESAT-II	ice sheet height changes for climate change diagnosis	Laser altimeter
• DESDynI	Surface and ice sheet deformation; natural hazards and climate; vegetation structure and ecosystem health	L- band InSAR Laser altimeter

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NASA Airborne Platforms

Role: Remote sensing, Upper Tropospheric and Stratospheric *In situ* sampling

Altitude: 70K ft
Payload: 1200 kg
Range: 4,000+ nmi
Based: NASA DFRC

Role: Tropospheric *In situ* sampling, vertical profiles, Synthetic Aperture Radar, remote sensing

Altitude: 41K ft
Payload: 18,100 kg
Range: 5,400 nmi
Based: Univ. of North Dakota

Role: Remote sensing, Laser profiling, Tropospheric *In situ* sampling

Altitude: 30K ft
Payload: 6,800 kg
Range: 3,800 nmi
Based: NASA Wallops

Role: Remote sensing, Upper Tropospheric and Stratospheric *In situ* sampling, vertical profiling

Altitude: 60K ft
Payload: 2,700 kg
Range: 2,500 nmi
Based: NASA JSC

Role: Synthetic Aperture Radar, Remote sensing, Tropospheric *In situ* sampling

Altitude: 52K ft*
Payload: 340 kg
Range: 4,500 nmi
Based: El Mirage, CA

* Altair parameters; Predator-B TBD

Role: Remote sensing, Upper Tropospheric and Stratospheric *In situ* sampling

Altitude: 65K ft
Payload: 900 kg
Range: 11,000 nmi
Based: NASA DFRC
(Availability TBD)

Role: Atmospheric *In situ* sampling, state parameters.

Altitude: 23K ft
Payload: 1-2 kg
Range: 1,630 nmi
Based: NASA Wallops

Role: Remote sensing, Upper Tropospheric and Stratospheric *In situ* sampling, vertical profiling

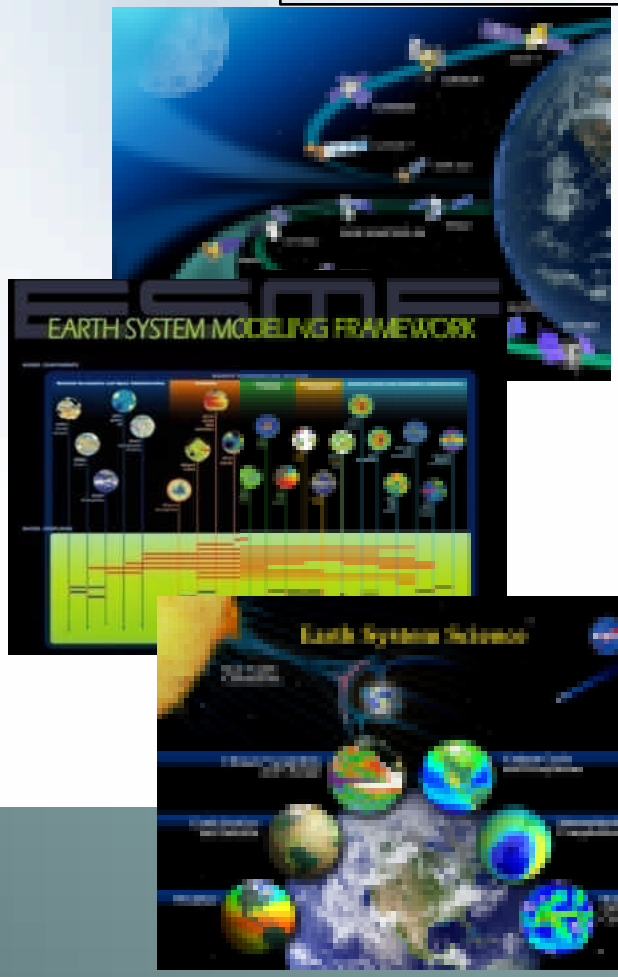
Altitude: 60K ft
Payload: 1,500 kg
Range: 5,000 nmi
Based: Mojave, CA

NASA Applied Sciences Program

A Pathway Between Earth Science & Society

Results of NASA Earth Science Research

Uses by Partners and Stakeholder Communities



NASA Applied Sciences Program

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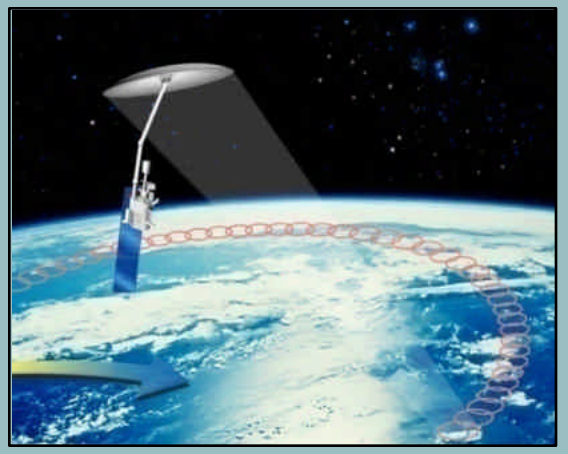
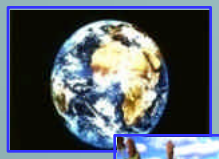
Soil Moisture Active/Passive (SMAP) Mission

Soil Moisture Mapping

A *dedicated* soil moisture mission; extends soil moisture observations to deeper depths with improved spatial resolution



Societal Benefits:



- Water, Energy & Carbon Cycles

- Water and Food

- Water Quality and Human Health

- Water and the Environment

http://smap.jpl.nasa.gov/benefit/

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NASA Water Resources

Goal: Facilitate application of NASA Earth science products as a routine use in integrated water resources management for the sustainable use of water. Also includes extreme events of drought and floods and the adaptation to the impacts from climate change.

Water Resources Functional Themes:

1) Streamflow & Floods (Includes Snowpack) {4-Projects}
2) Drought Monitoring & Prediction {5-Projects}
3) Irrigation and Water Delivery {3-Projects}
4) Water Quality {3-Projects}
5) Climate Change and Water Resources {1} 'NEW'

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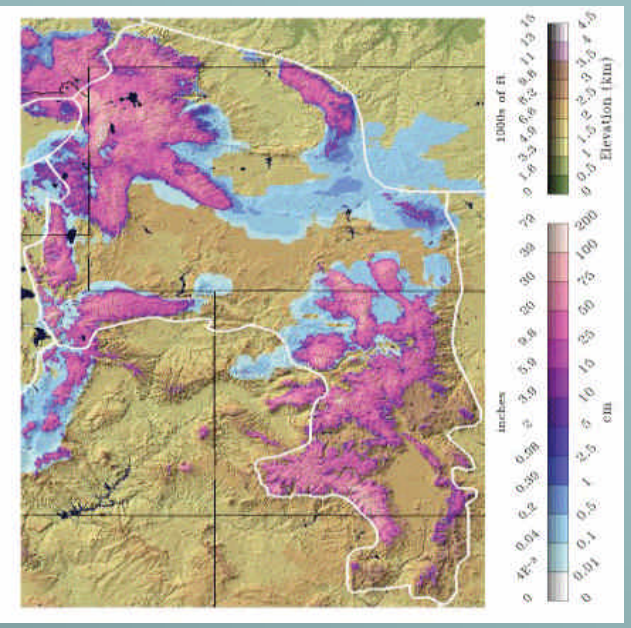
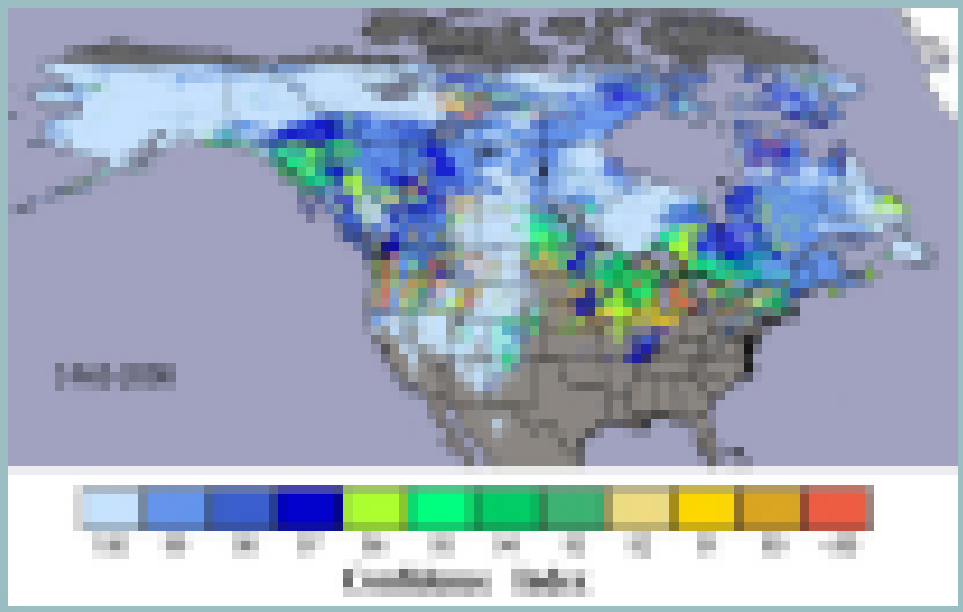
NASA Snow Activities

NOAA SNODAS SWE
Central Great Rockies

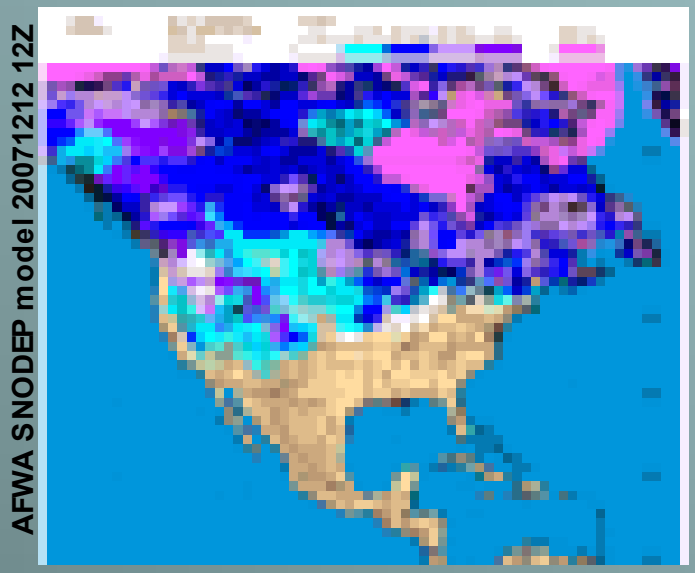


NASA-NOAA NOHRSC Project to Evaluate Use of NASA Products for Snow Water Equivalent & US Water Availability

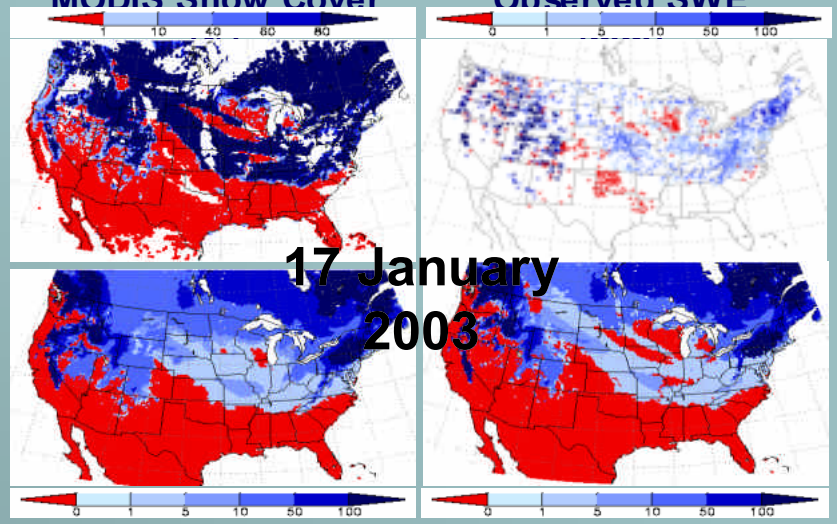
MODIS cloud-gap-filled snow map



NASA-AFWA Blended AMSR-E & MODIS SWE



'GLDAS' Assimilated Snow Water Equivalent



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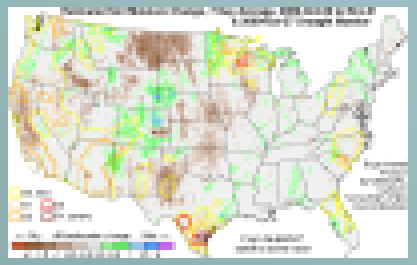
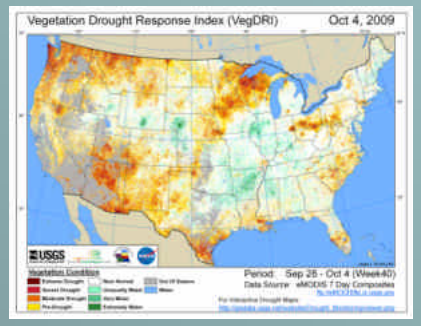
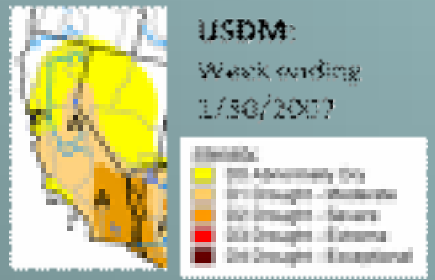
JPL-USGS USDM DROUGHT – Accomplishments







User community interactions:
Drought Forum 2009

- **Prototype of Soil Moisture Change (SMC) with Drought D-Level Overlay:** JPL automated system produces data; weekly automatic uploaded to NOAA PSD, who creates multiple SMC products and derivatives with D-level overlay.
- **Expedited MODIS Vegetation Drought Response Index (VegDRI) :** USGS/EROS and NDMC have integrated MODIS NDVI 7-day composites into the national VegDRI model on a rapid, weekly schedule to meet requirements of US Drought Monitor authors.
- **Resolution Benchmark:** NASA results have excellent resolutions to resolve the county-level goal of NIDIS. This is evident in the comparison of SMC and VegDRI products versus USDM drought maps at the lower resolution.
- **Improvements of USDM are important for users:** NOAA NWS uses D2 to trigger drought information statements, IRS for tax deferrals, USDA programmatic usage, and Livestock Forage Disaster Program disbursement ($147,109,381 in 2008, and $77,608,125 in 2009).

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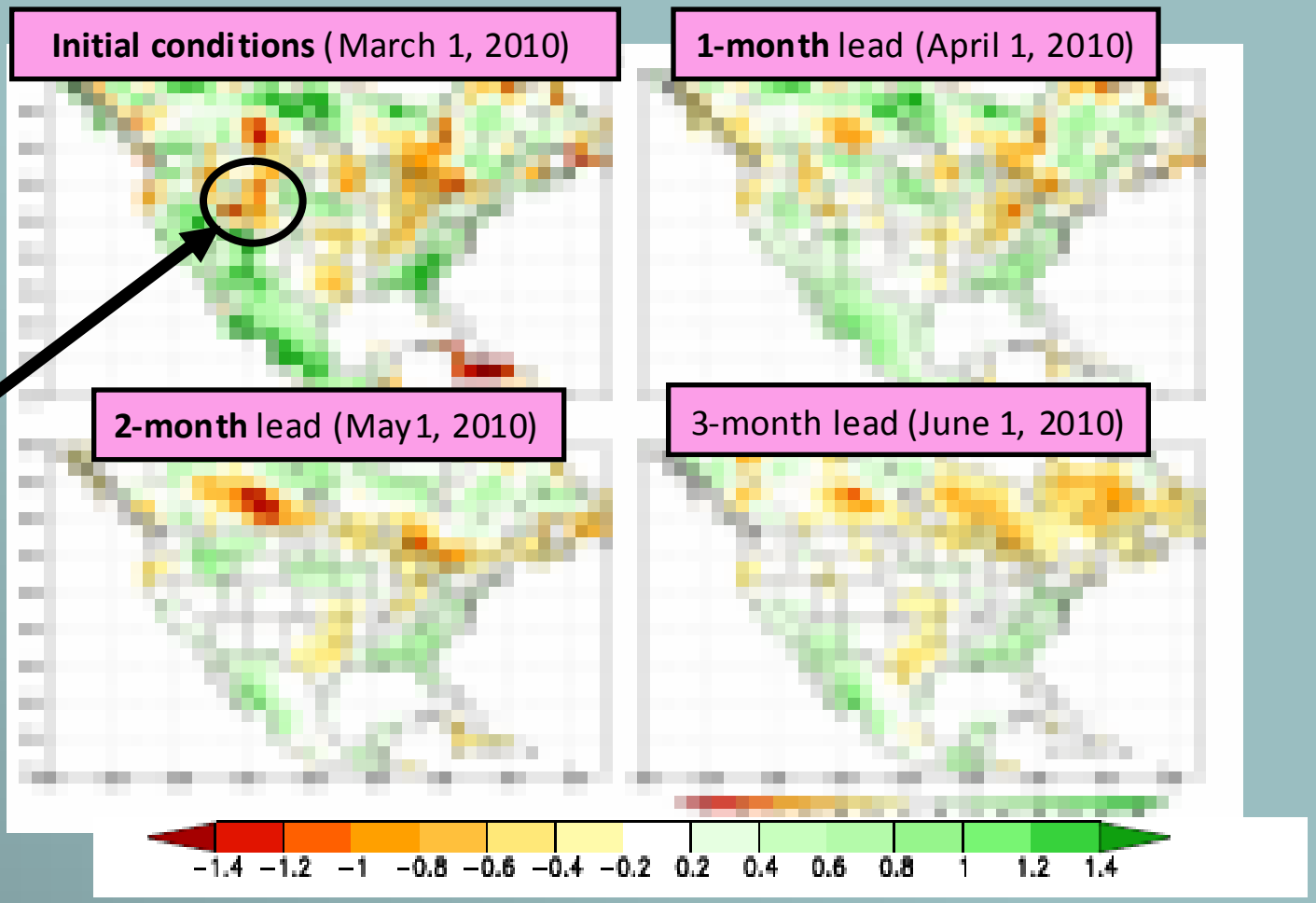
Seasonal Predictions – Drought Outlook

Root zone soil moisture anomaly (expressed as percentile)

Known drought conditions are predicted by GMAO seasonal prediction system to persist into April but be gone by May.



Project: Development of a Robust Drought Index for Agricultural Applications.

PI: R. Koster, NASA/GSFC

http://gmao.gsfc.nasa.gov/forecasts/# http://www.cpc.ncep.noaa.gov/products/fews/

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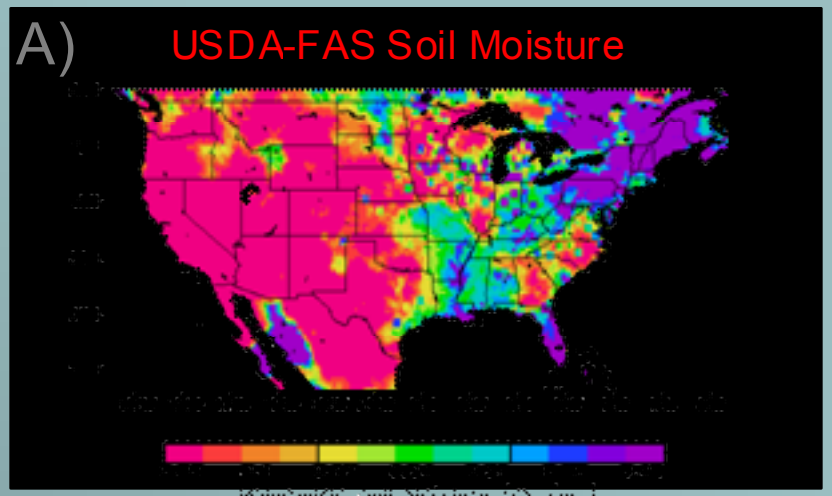
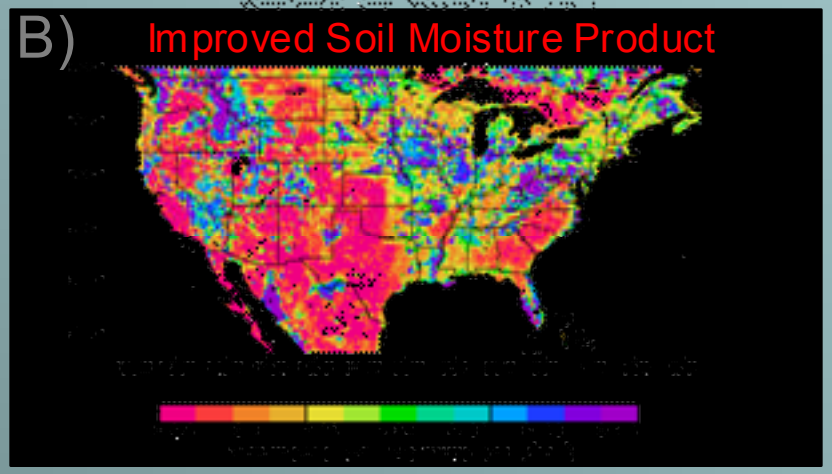
Assimilation of AMSR-E Soil Moisture into the USDA-FAS Global Crop Production Decision Support System

P.I. – Wade Crow USDA-ARS-HRSL
Co. I. – John D. Bolten NASA GSFC 614.3

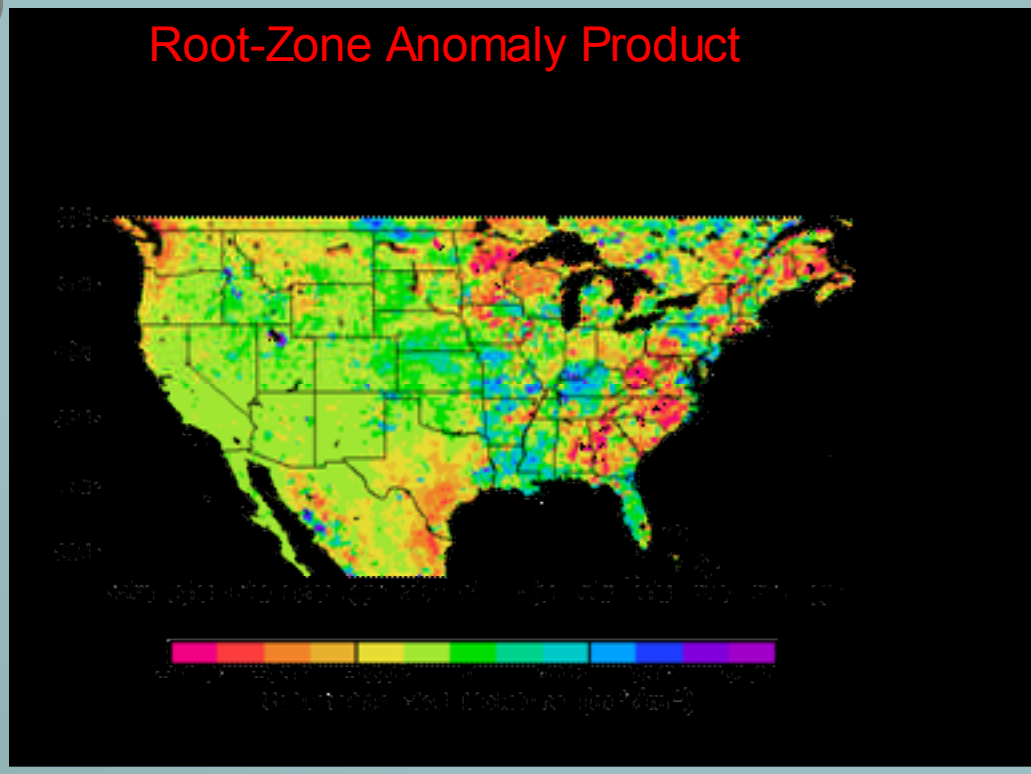
A) USDA-FAS Soil Moisture



B) Improved Soil Moisture Product



C) Root-Zone Anomaly Product



- Contribution: provide global soil moisture observations at higher accuracy, finer spatial resolution, and over broader geographic domains than existing USDA-FAS product, improved ROOT ZONE ANOMALY observations

- Benefits: more accurate crop monitoring and drought prediction, greater agricultural economic security, improved food shortage warnings, increased agricultural efficiency, policy and resource management decision support

- Status: Operationally delivered to the USDA-FAS in near real-time

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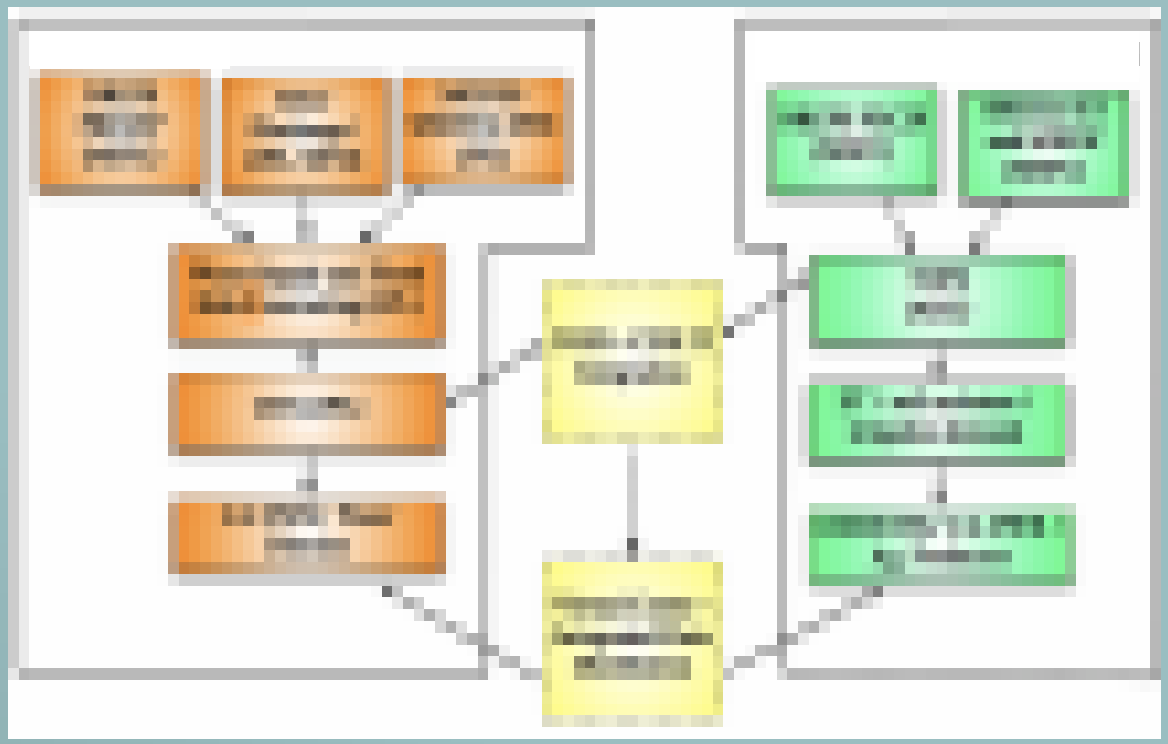
Water Supply and Demand in California

Goals:

1) Enhance snow pack and precipitation monitoring and snow water equivalent (SWE) forecasting to improve the ability of state and local agencies to estimate water availability and annual water budgets, and forecast flood risk.

Water Supply: JPL

Ag Water Demand: ARC



2) Create a cyber-infrastructure for use of NASA data and models to support irrigation monitoring / optimization; and,

3) Add value to current investments in ground-based monitoring networks such as the California Irrigation Management and Information System (CIMIS)

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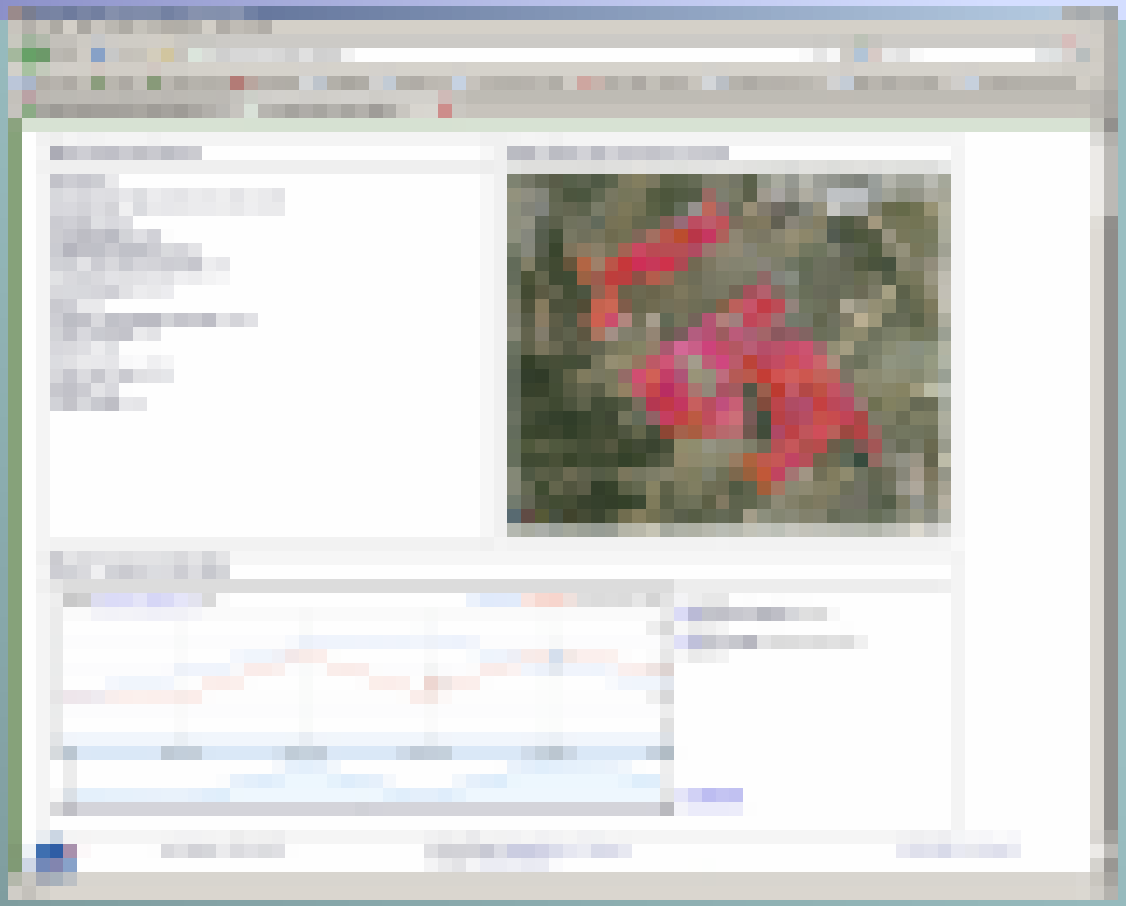
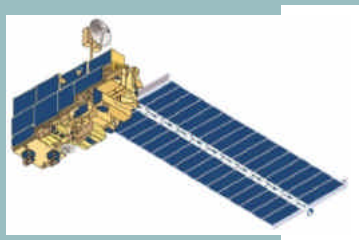
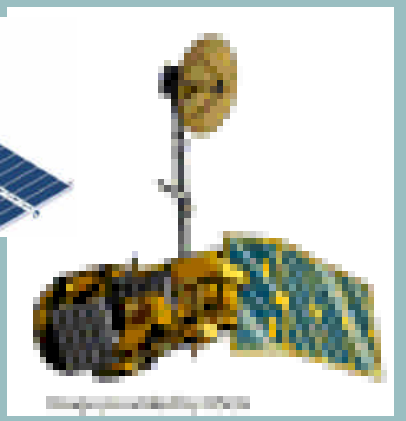
Irrigation Monitoring & Optimization - NASA TOPS







- Application of the NASA Terrestrial Observation and Prediction System (TOPS)
- Builds on CIMIS, as well as previous success in vineyards
- Data exchange via applications for web and mobile devices
- Use of wireless soil moisture sensor networks for calibration
- Partnerships with CA Dept. Water Resources, USDA-ARS, Agricultural producers, Universities, and Irrigation consultants

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NASA Earth Exchange

Common Platform for Model Evaluation

1. Facilitate access to NASA computational systems
2. Provide platform for inter-comparison of model results within and among projects
3. Suitable for research and operations

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Summary & Future Directions

- NASA Water Resources wants to leverage our large Earth Science activities ($1.5B) to help benefit society
- NASA works with other US federal agencies to optimize usage of data and products
- NASA wishes to work with WSWC and WestFAST to address critical western US water issues.
- NASA seeks to leverage existing and new projects and activities with WSWC and WestFAST to further maximize activities

  - NASA strongly supports NIDIS, US Drought Monitor and Outlook

  - NASA has several western US projects addressing snowpack, water loss (evapotranspiration), irrigated agriculture, groundwater monitoring, etc.

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Summary & Future Directions (cont.)

- NASA seeks to work with WestFAST and other groups to plan and coordinate future solicitations for coordinated activities.
- Support of possible US agency led programs affecting western water including Water Smart, NIDIS, Land Conservation Corps, RISAs, Climate Centers (USGS and NOAA), etc.

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How do we work together?

Recommendations from: “Climate Adaptation Priorities for the Western States: Scoping Report”, June 2010, Western Governors’ Association

- Begin with user needs
- Give priority to processes over products
- Link information producers and users
- Build connections across disciplines and organizations
- Seek institutional stability
- Design for learning

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