

A satellite image of Earth from space, showing the Americas, the Atlantic Ocean, and parts of Europe and Africa. The text is overlaid on the image.

# Engaging the User Community in Developing Earth Observing Remote Sensing Data Products

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# Outline

- NASA and the Applied Sciences Program
- Defining Applications
- “ARLs”
- 2 Example Stories





## NASA's Earth-Observing Future Launches

2014/2015 launch



# National Research Council Decadal Survey



- Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond
- *However, the compelling need for measurements in support of human health and safety and for documenting, forecasting, and mitigating changes on Earth creates a continuum between science and applications—illustrating again the need for multiple agencies to be intimately involved in the development of Earth science and applications from space.*
- *The declarations call for a renewal of the national commitment to a program of Earth observations in which attention to securing practical benefits for humankind plays an equal role with the quest to acquire new knowledge about the Earth system.*

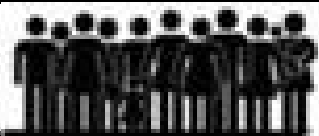
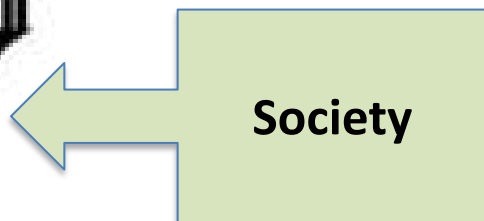
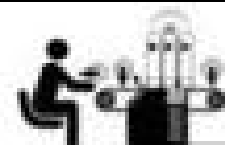


# NASA Applied Sciences Program

## 9 Areas of Societal Benefit



- Weather forecasting
- Reduce loss of life and property damage from disasters
- Understand assess, predict mitigate and adapt to climate variability
- Support sustainable agriculture and forestry and combat land degradation,
- Understand the effect of environmental factors on human health and well being
- Develop the capacity to make ecological forecasts
- Protect and monitor water resources
- Monitor and manage energy resource



- Extended time in implementing products
- Challenges with data (access latency, use, size, format, structure)
- Disconnect with organization's present day goals



# What are *applications*?

Applications help hazard mitigation and decision-making in government, private, and civic institutions working to reduce its impact on human wellbeing.

Producing science *is not enough*, products must have a link to societal benefits and demonstrate value to users.

*“The high-resolution data gleaned from VIIRS are available in a short time period and significantly enhance the Forest Service's current strategic fire detection and monitoring capabilities.” Brad Quayle, U.S. Forest Service*



# What is an Early Adopter?

- A subset of volunteers from the mission's Community of Practice
- Given access to pre- and post-launch data streams and conduct applications demonstrations in collaboration with the science team member.
- The selection process may be through a competitive, peer-reviewed NASA announcement of opportunity as was done for the science definition team, or a more informal process.

*Early Adopters' feedback and engagement provides a link to science development, that helps a product move from a research effort...*

*...to a user friendly decision support system*

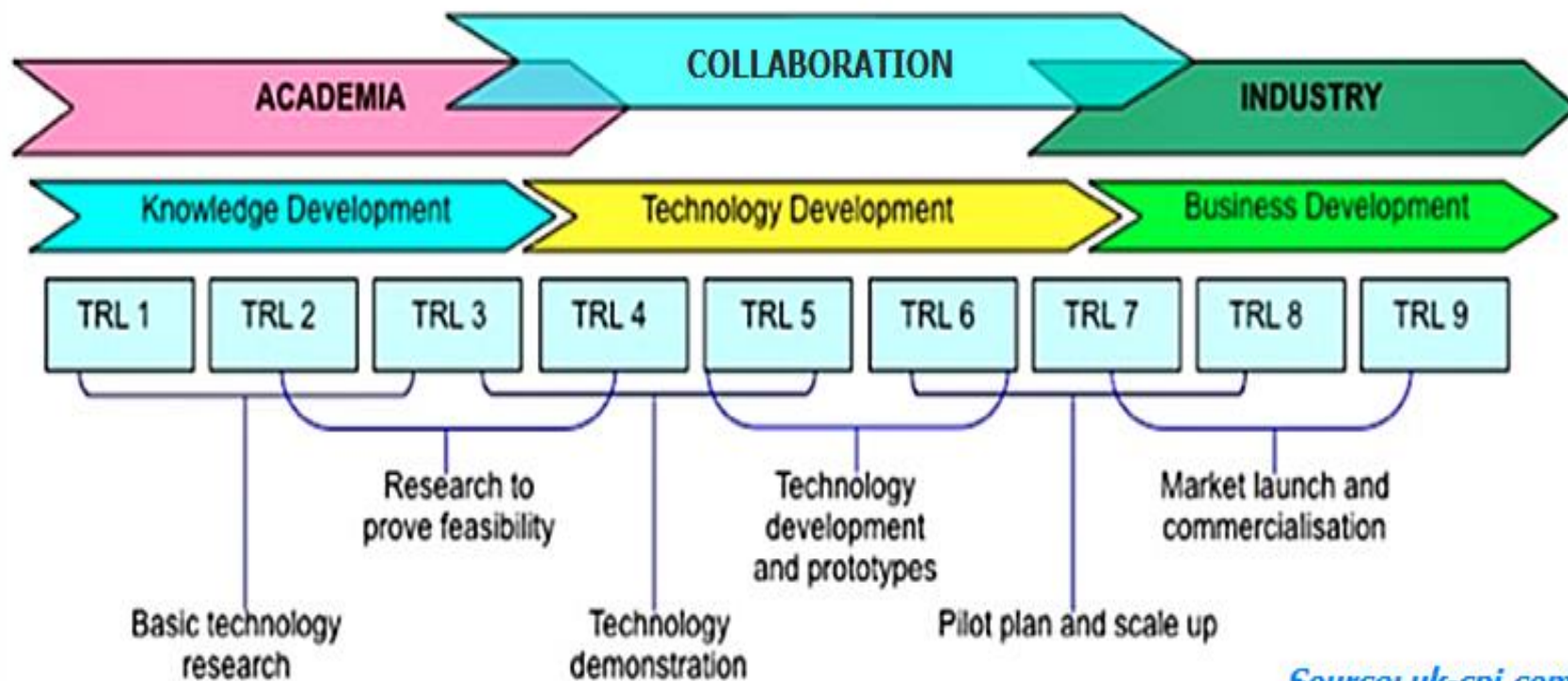




# Data Products

# Technology Readiness Levels

## The Innovation Chain: Converting Science into Wealth



Source: [uk-cpi.com](http://uk-cpi.com)



# Application Readiness Levels





# ARLS

## ➤ Informative

- Sets expectation for what the intent of the product use(s) is (are).
- Communicated how this product can be best applied.

## ➤ Thematically Flexible

- ARLs may need a temporary “reset” when passed from a developer to a user based on the user organization needs and processes.
  - Modeling challenges, internal validation, organization policies, funding, etc.

## ➤ Product ARL and the Use Case ARL



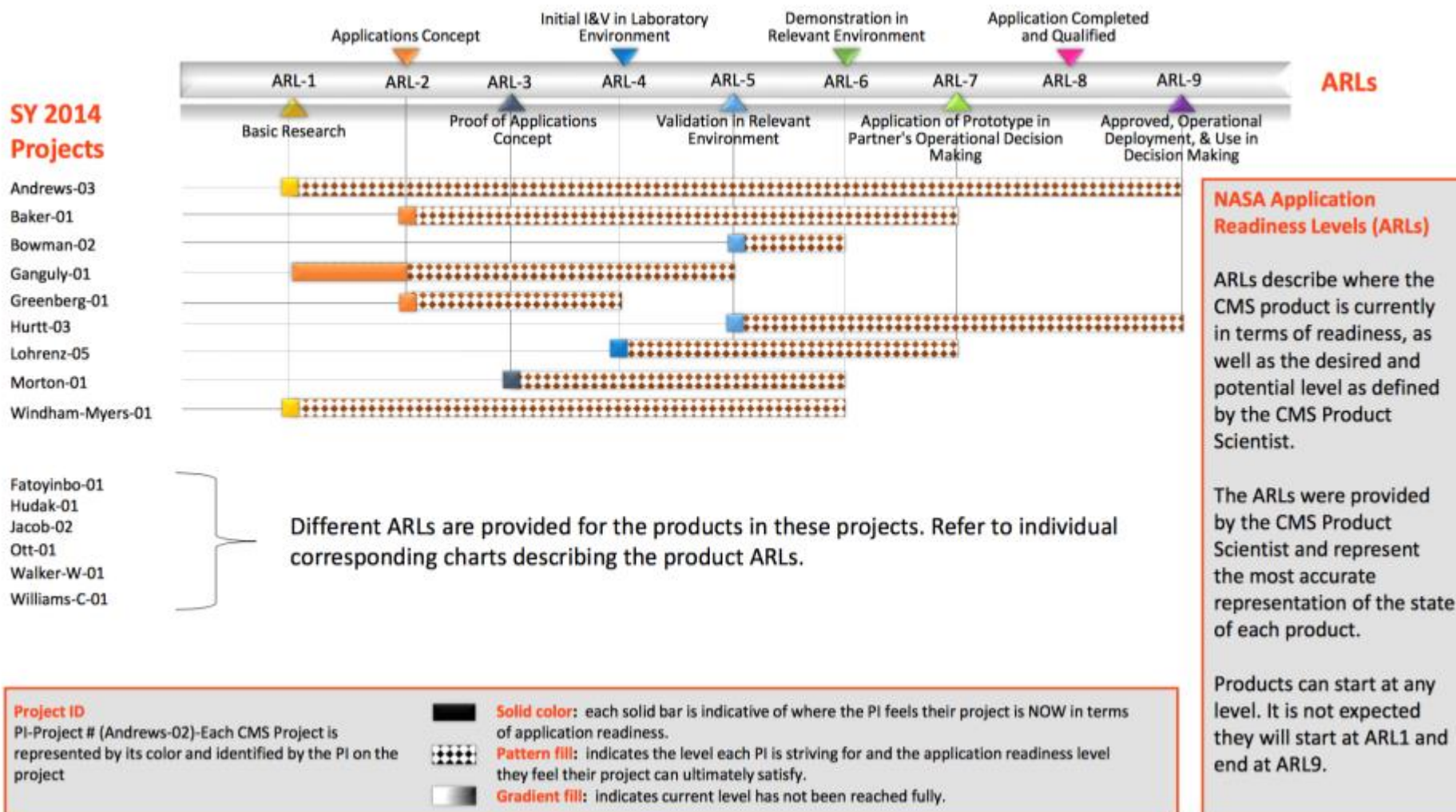
# Opportunities at each ARL when collaborating with Early Adopters

- Early ARLs, Level 1-3:
  - Insight into research and perspective
  - Opportunity to provide details and guidance
  - Early feedback for development and baseline ideas
- Mid ARLs Level 4-6:
  - Opportunity to help validate
  - Feedback into development/inform prototypes
- Higher ARLs Level 7-9:
  - Impact analyses on the functionality of the product
  - Feedback to uses and lessons learned



# ARLs for NASA's Carbon Monitoring System

## SY 2014 Projects



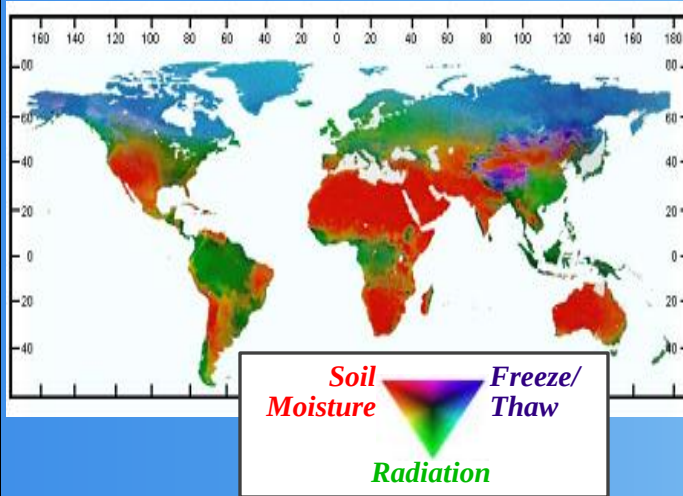


# Example Stories

# Story #1: Soil Moisture Active Passive (SMAP) Mission



## Science Returns

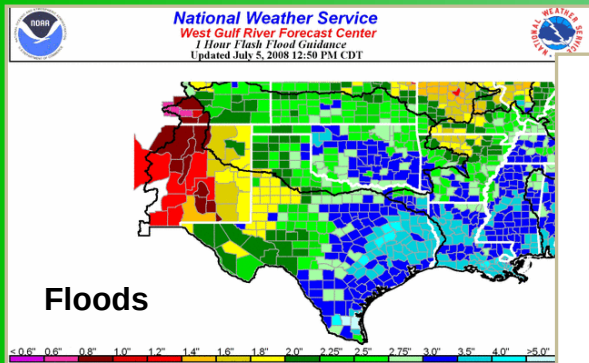
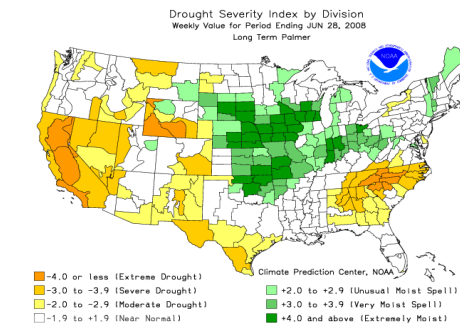


1. Estimating global surface water and energy fluxes
2. Quantifying net carbon flux in boreal landscapes
3. Reduce uncertainty of climate model projections



L-band (~21 cm; All-Weather; Canopy Penetration; Sensing Depth)

## Applications Returns



4. Enhancing weather forecasts
5. Improving flood prediction and drought monitoring

6m conically scanning (14 rpm) antenna for 1000 km swath

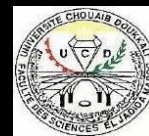
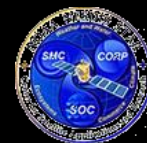
Global coverage every 2-3 days

All products ARL-9



EXELIS

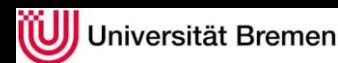
Visual Information Solutions



Agriculture and Agri-Food Canada



**52 SMAP Early Adopters are Spanning Agriculture, Weather, Emergency Response, Human Health, and Military Readiness**



Environment Canada

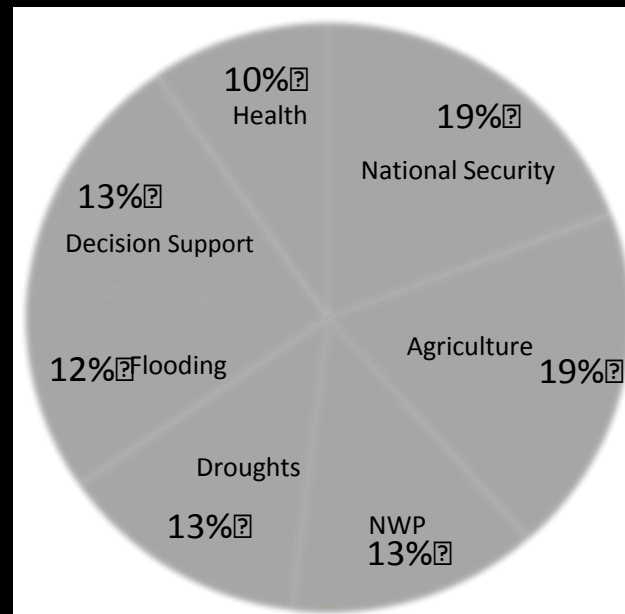




# SMAP Science and Application Returns

## What was Designed

- SMAP Product suite developed to an **ARL-9**
- Intended to satisfy 5 areas of applications (agriculture, weather, drought, flood, health)
- HDF-5 Format

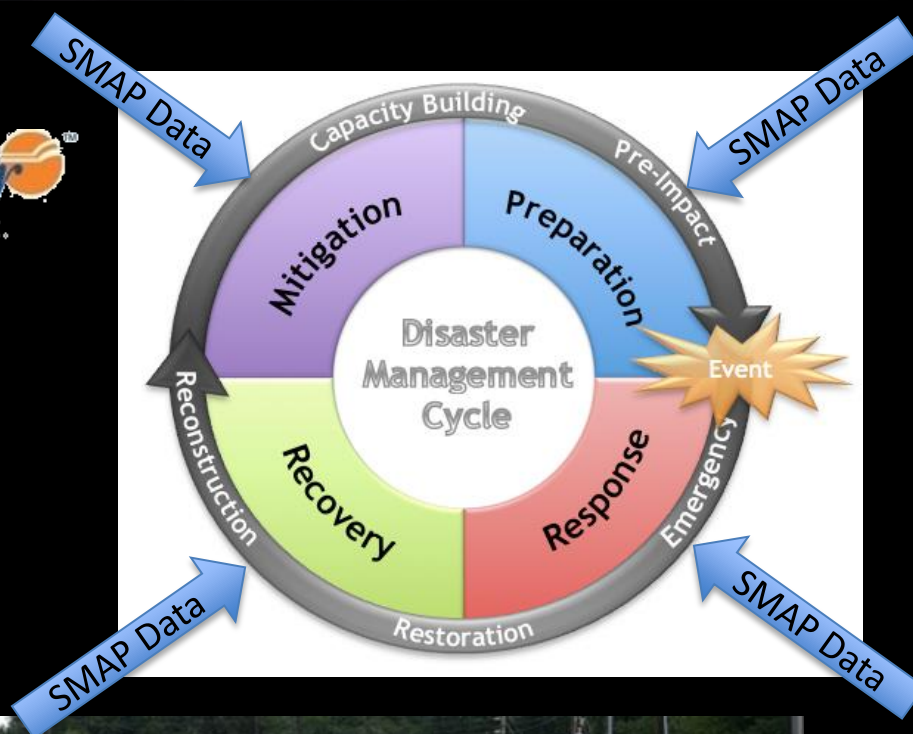


## What's actually happening post launch

- Users of SMAP data **average ARL5-6** due to testing SMAP products in through their organizational processes and needs.
- Most demanded Format KMZ and GEOTiffs
- Satisfy over 10 areas of applications



# Format really does matter!



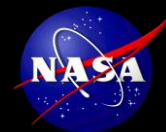
## 2012 SMAP Survey

- 55% of the SMAP community involved hazards, risk response and post event mitigation.
- 73% of the hazard community was challenged by HDF5 Format and not interested in using the data.

## SEVERE WEATHER & FLOODING

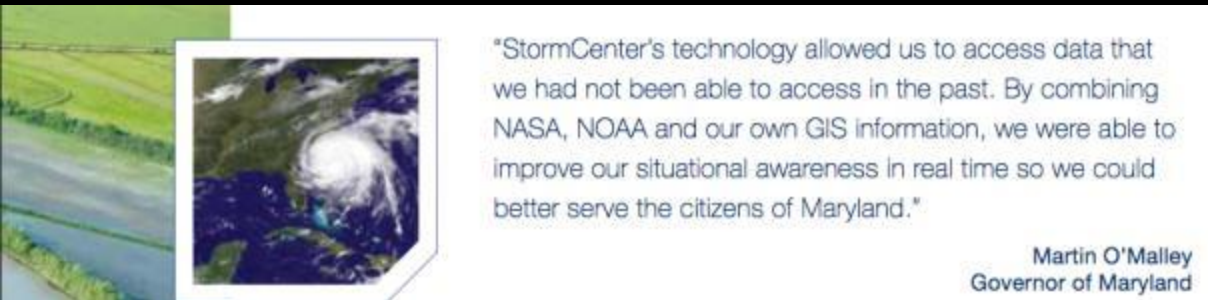
Despite all the sunshine, don't get rid of that raincoat or umbrella just yet! Los Angeles is a semi-desert area of mountains, canyons, ravines and vast basins, the perfect setting for disaster when major thunderstorms, high winds and other inclement weather strikes. Flooding can quickly occur in the mountain passes and valleys, while hillsides with sparse vegetation become prime starting points for treacherous mudslides. For the most part, the area's weather is mild and sunny, so it is easy to forget how quickly a storm system can change the landscape... and send you running for cover!





# Outcome

- SMAP Product ARL 9 (L3 SMP), used as ARL 5 for Emergency planning and operations.
- After Format change-used as ARL 8 (prototype) for flood planning in Emergency Operations. (Efforts are ongoing).
- KMZ are now a NASA standard format at all Data Centers.
- Personal engagement with Emergency Management centers to understand and evaluate data needs for events.
- Work with Early Adopters towards developing more efficient systems and technologies.



"StormCenter's technology allowed us to access data that we had not been able to access in the past. By combining NASA, NOAA and our own GIS information, we were able to improve our situational awareness in real time so we could better serve the citizens of Maryland."

Martin O'Malley  
Governor of Maryland

# Story #2: NASA's Carbon Monitoring System (CMS)

Initiated following a 2010 Congressional Direction.  
NASA CMS has 73 projects and 181 data products.

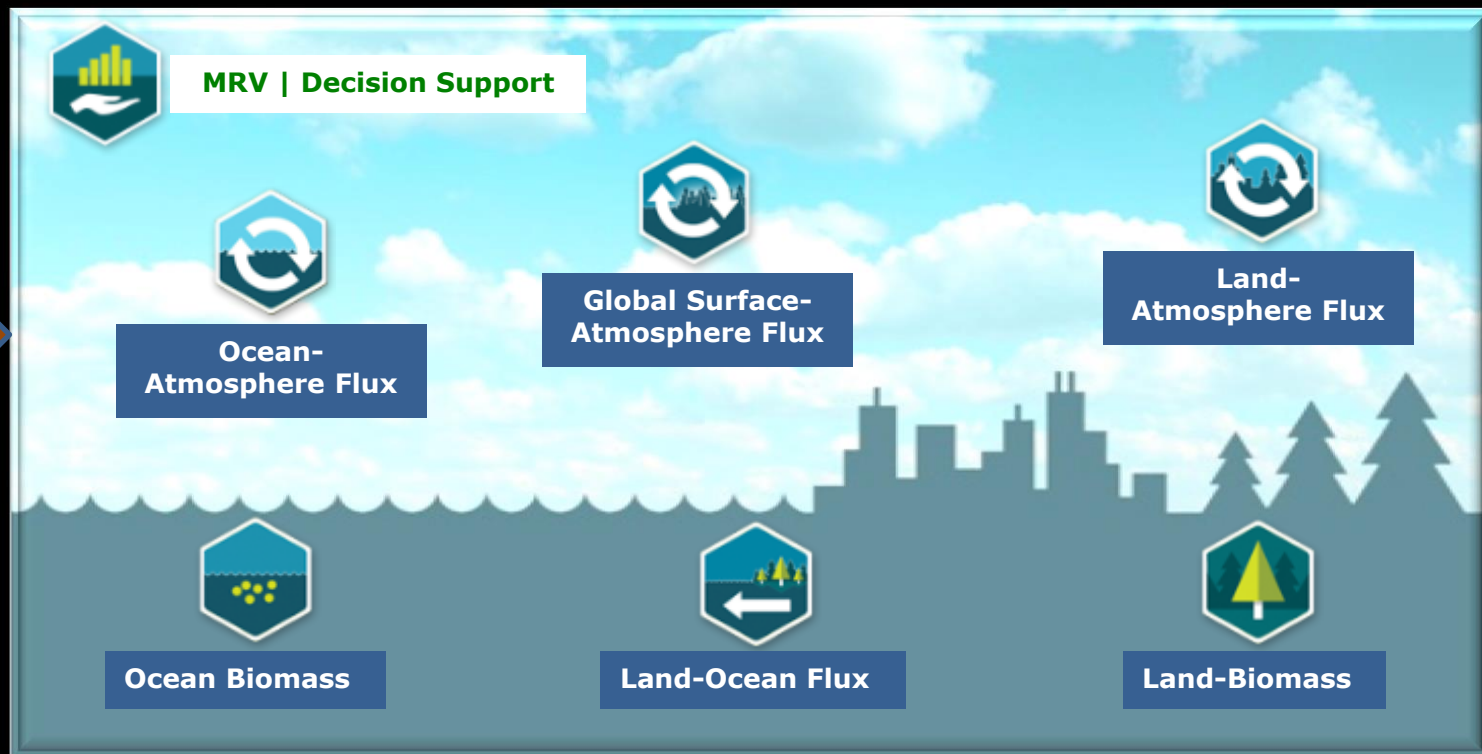


Characterizing

Quantifying

Understanding

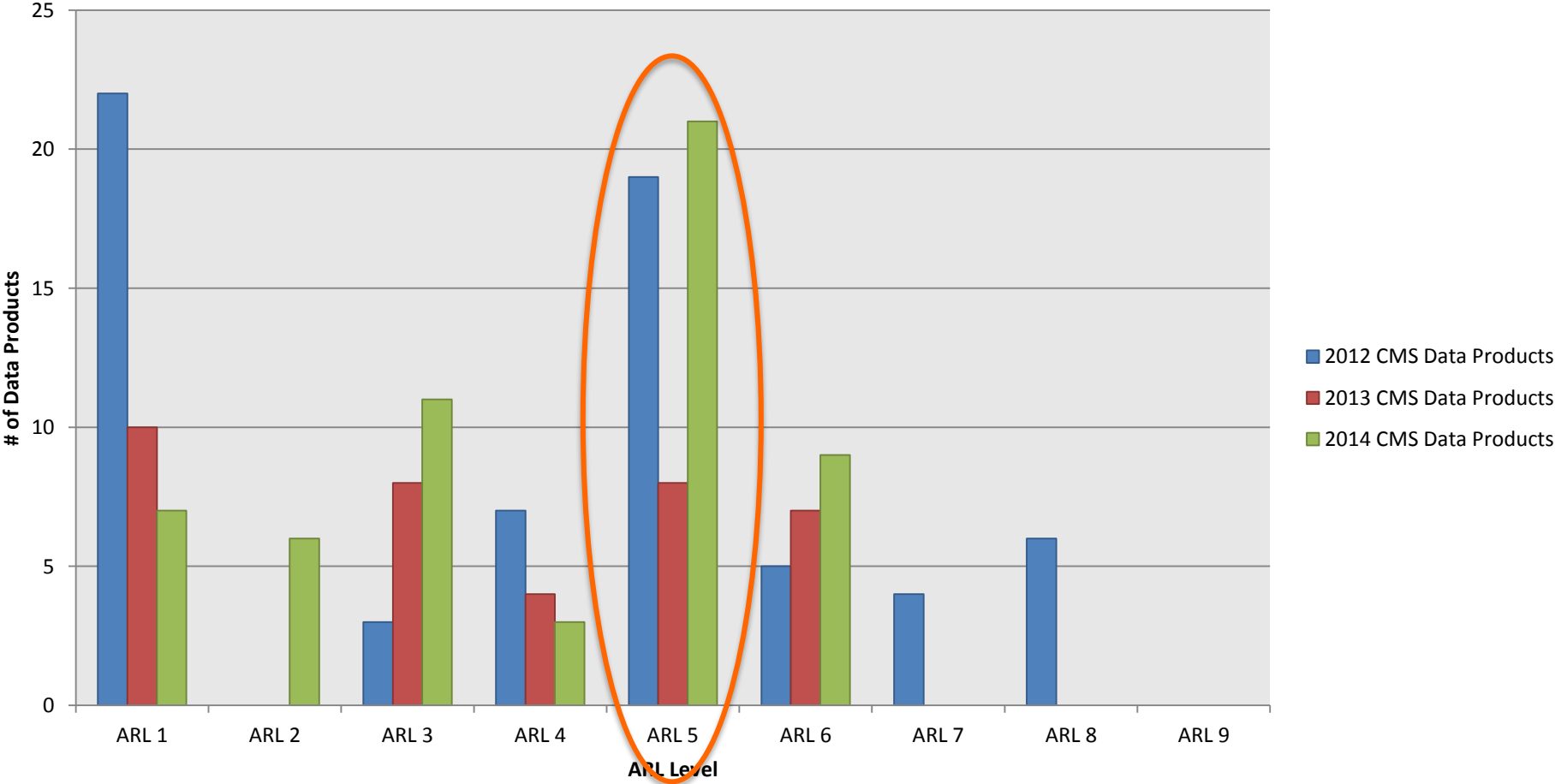
Predicting





# CMS Application Readiness Levels (ARLs)

2012-2014 CMS Data Products By ARL

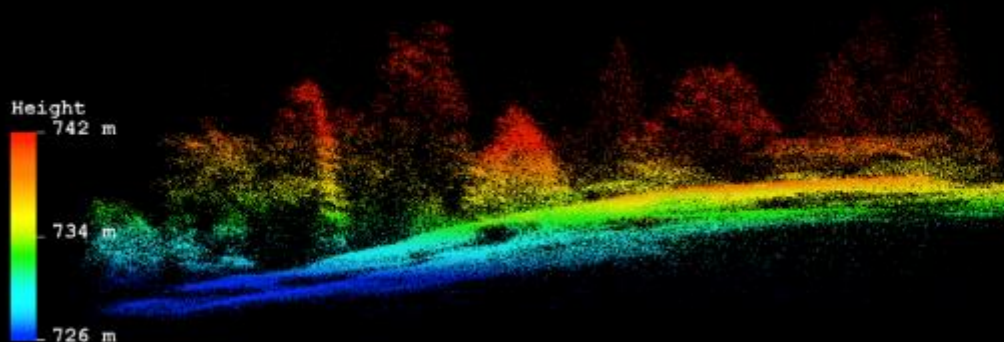




***43 CMS Stakeholders are spanning Forestry, Land Use, Air Quality, GHG Inventories, Conservation, and Ecosystem Services***

**P**





### Policies of Interest within Maryland Department of Natural Resources (DNR) Forestry Programs

- Woodland Incentive Program
- Conservation Reserve Enhancement Program
- Lawn to Woodland
- Environmental Quality Incentive Program
- Urban Tree Canopy
- No Net Loss of Forests Policy



## CMS Product: ARL 9



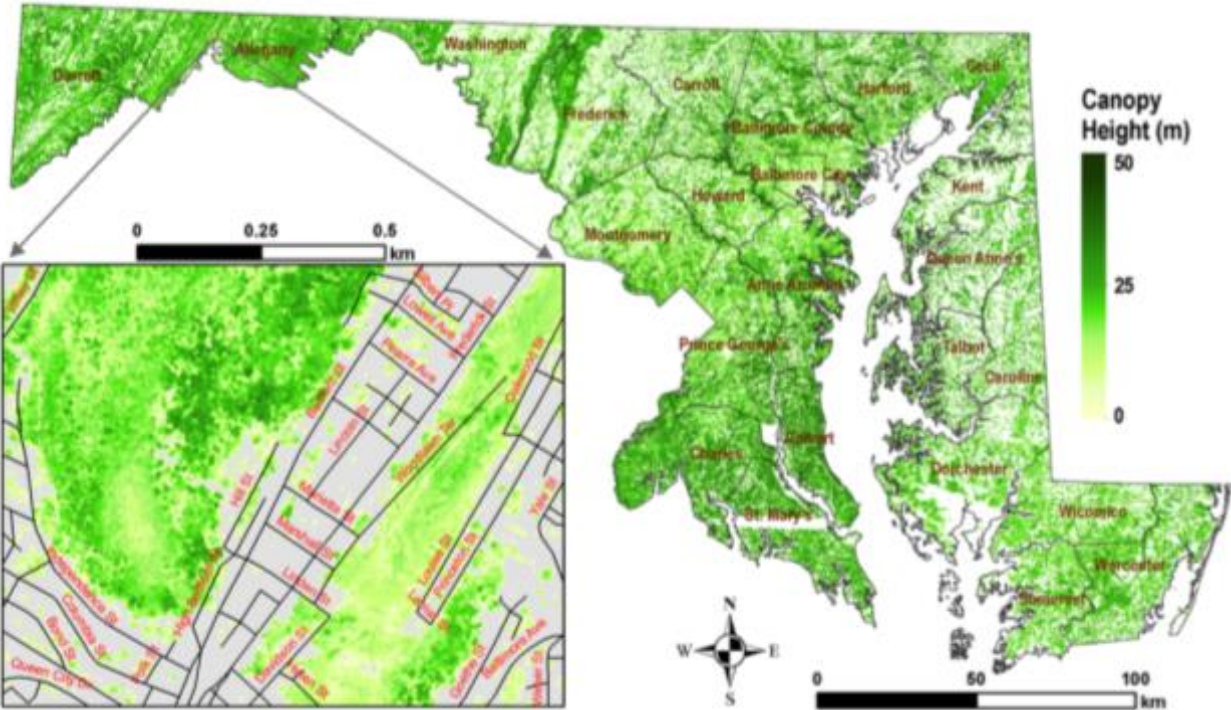
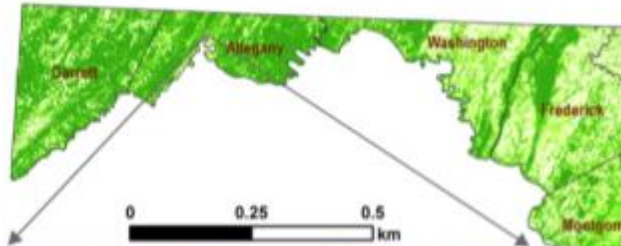
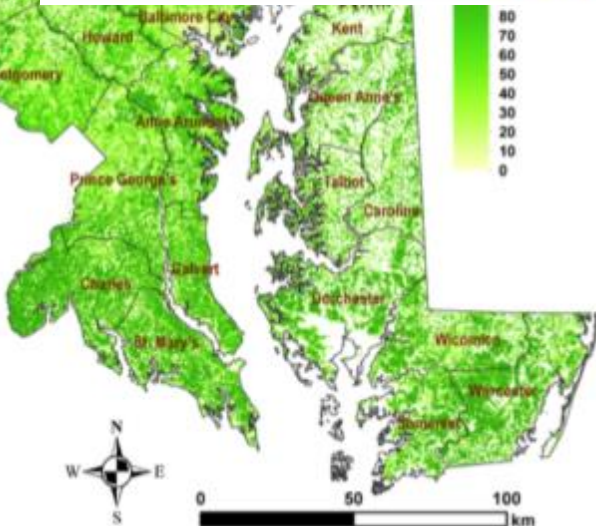
DNR use of Product: ARL 5

# Story #2: NASA's Carbon Monitoring System (CMS) Initiative



## Wicomico Landcover

- Highway
- tree canopy
- grass/shrub
- bare earth
- water
- impervious



- 3 impervious classes are mapped: Building, roads and "other paved"

CMS allows us leverage to



# Outcome

- CMS Product ARL 9 (Canopy cover, extent and biomass estimates for MD), used as ARL 5 (a product where the *potential* has been determined) due to internal policy and organization's funding focus.
- After translating benefits of data in the context of impervious surface, the CMS data was used as ARL 9 (Operational use in decision making, sustained use).
- An organizations policy and time line is as important as the data requirements.
- Policy evaluation is now "step one" for CMS applications in assessing data needs for users involved with state and federal decision support.



# Take Home Message

- ARLs serve as a road map to the uses and applications of Satellite data-intended to help both the scientists and the users know about where they are in the science/application journey.
- ARLs are flexible and can be accelerated by collaborating with users throughout mission design.
- All ARLs can serve as an operational product-dependent on user needs.
- Improving the methods and approaches of applying data, provides a clearer picture for policy-value of satellite data.
- Applications are central to ensuring science is used in society for improved decision making.



**Society and Science Developers integrating feedback  
to improve applications of data**

Applications through Early Adopters bridge science development and the user community



# Actions

- Collaboration, collaboration, collaboration!
- Cross mission and cross agency synergies to leverage data uses in thematic applications.





# Thank you for your attention!

