



Operations (Deployment in Space and on the Ground)

Presented to: ***The National Academies of Sciences, Engineering, and Medicine
Board on Earth Science and Resources (BESR)***

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Day and date: ***Tuesday, 09 May 2017***

JPL Clearance No.: URS266016

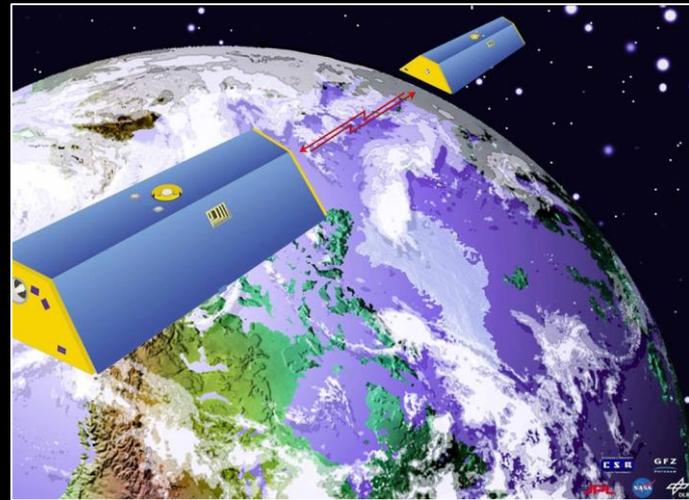


Jet Propulsion Laboratory
California Institute of Technology

Operations: An Engineer's Perspective



Credit: NASA



Credit: NASA Jet Propulsion Laboratory



Credit: NASA Jet Propulsion Laboratory



Credit: NASA

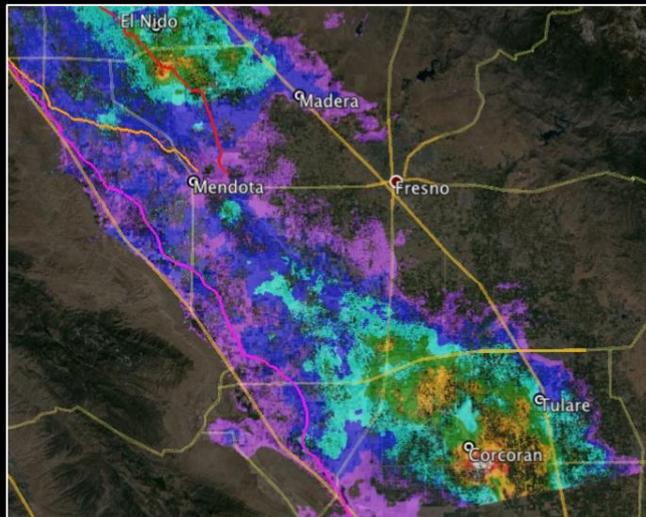
Operations: From the Eyes of a Scientist

Data from a Distributed Active Archive Center (DAAC)



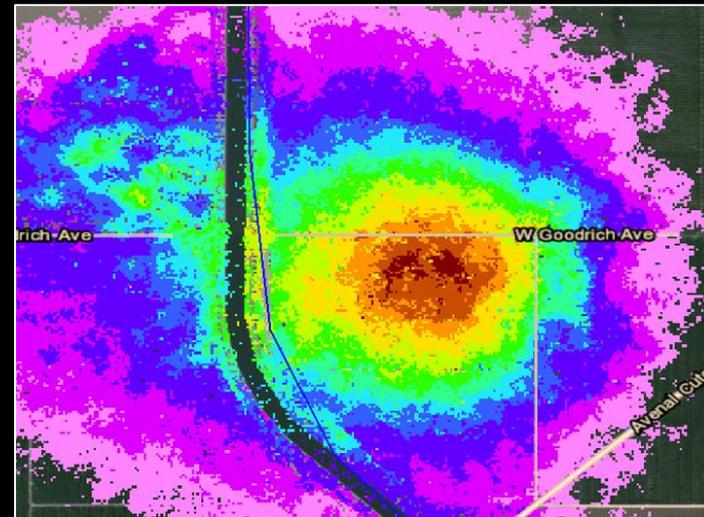
Research on Land Subsidence Due to Pumping of Ground Water

CA Central Valley



Credits: Canadian Space Agency/NASA/JPL-Caltech

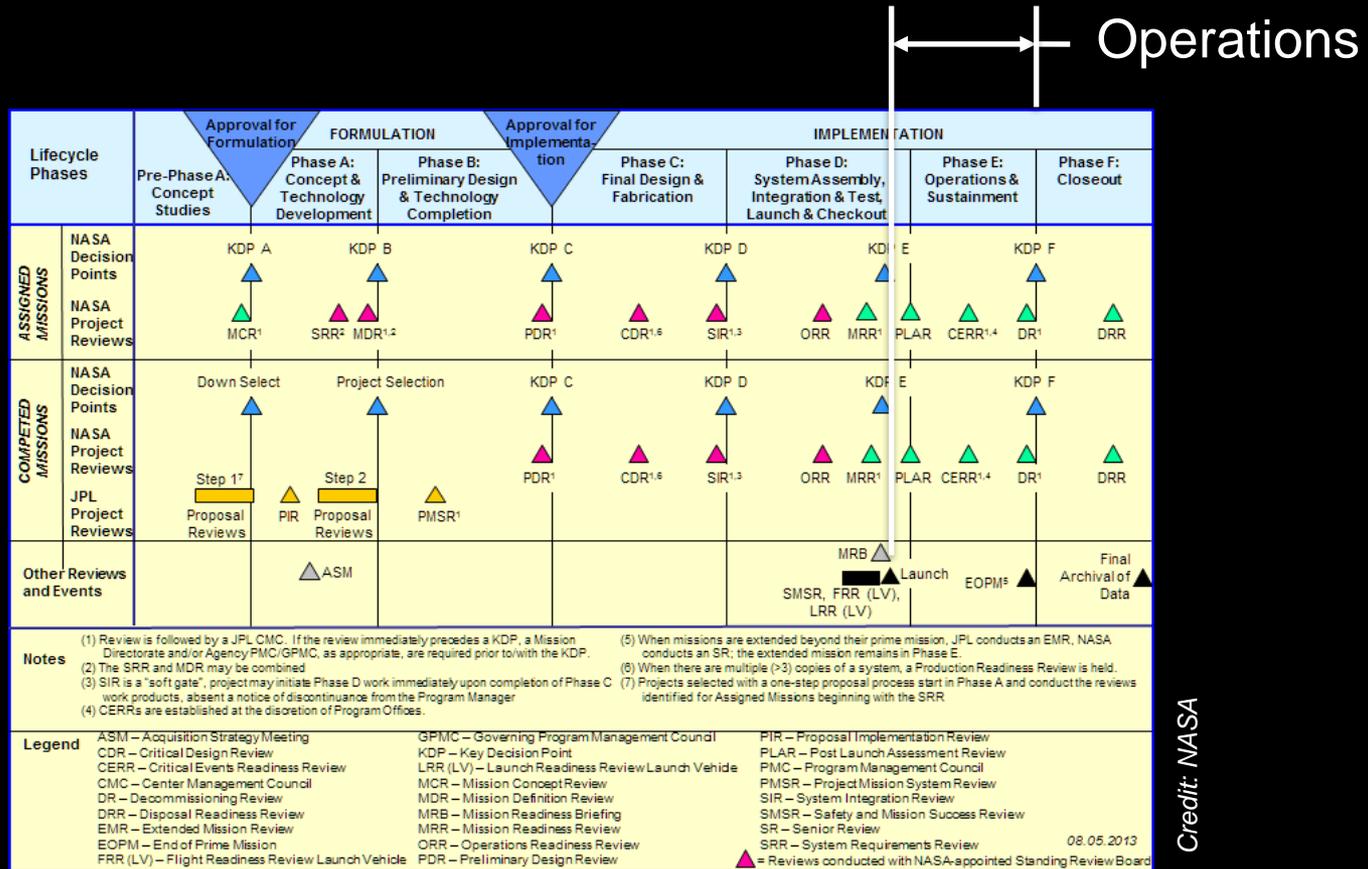
CA Aquaduct Near Huron



Credits: Canadian Space Agency/NASA/JPL-Caltech

- How does subsidence correlate with estimates of ground water availability and well depth measurements?
- What level of rebound was observed during the 2016-2017 water year?

Where Operations Fits Within the NASA Project Life Cycle



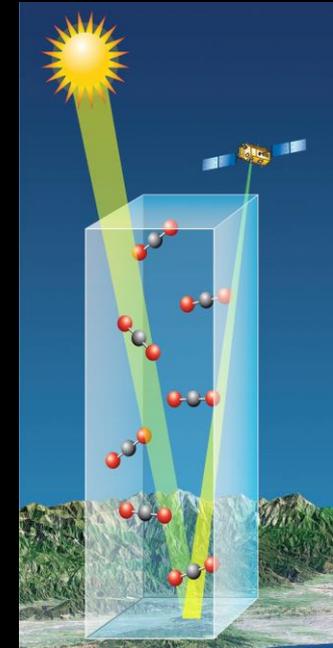
Credit: NASA

NASA Project Life Cycle for Space Flight Projects

- End of Phase D: Launch; installation, if applicable; IOC (In-Orbit Checkout); and PLAR (Post-Launch Assessment Review)
- Phase E: Full-up, routine operations (and possibly, an extended mission)

Accurately Predicting In-Flight Observatory Performance

- Space flight projects live under the “*test as you fly, fly as you test*” creed
- Every effort is made to identify exceptions, so that the risks are known, understood, and accepted before launch
- Every once in a while a known risk will become a reality
- Even more occasionally an unknown risk will manifest itself



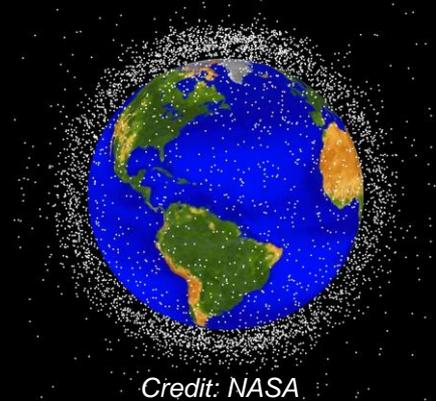
Credit: NASA Jet Propulsion Laboratory

Lesson

Projects are strongly encouraged to launch with as much technical margin as possible to address risks/problems and preserve the ability to meet the mission success criteria

Estimating the No. of Orbital Debris-Related Maneuvers

- A three-step process is utilized to protect an observatory from hazardous debris
 - Identification of a close approach (conjunction assessment)
 - Screening to determine the risk posed to a mission/observatory due to the conjunction event
 - Planning for and execution of Risk Mitigation Maneuvers (RMMs)
- Unfortunately, the amount of debris orbiting the Earth increases each year



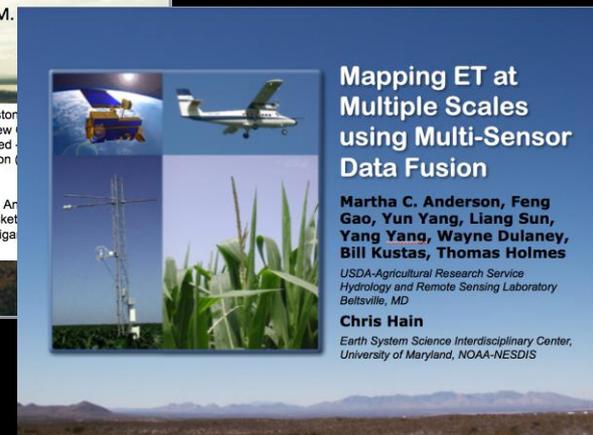
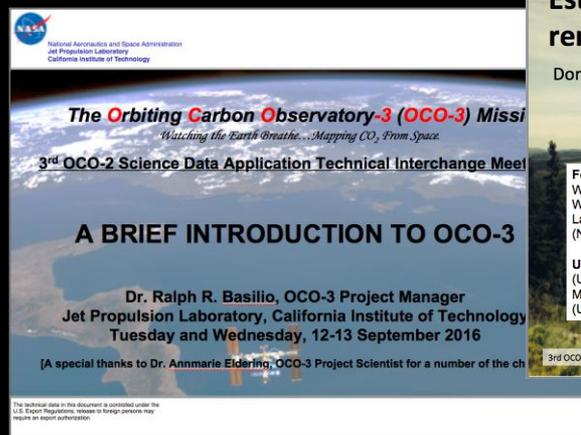
Credit: NASA

Lesson

Be conservative in estimating the number of RMMs that must be planned and executed as the number may be closer to reality

Providing Early Science Data Application Value

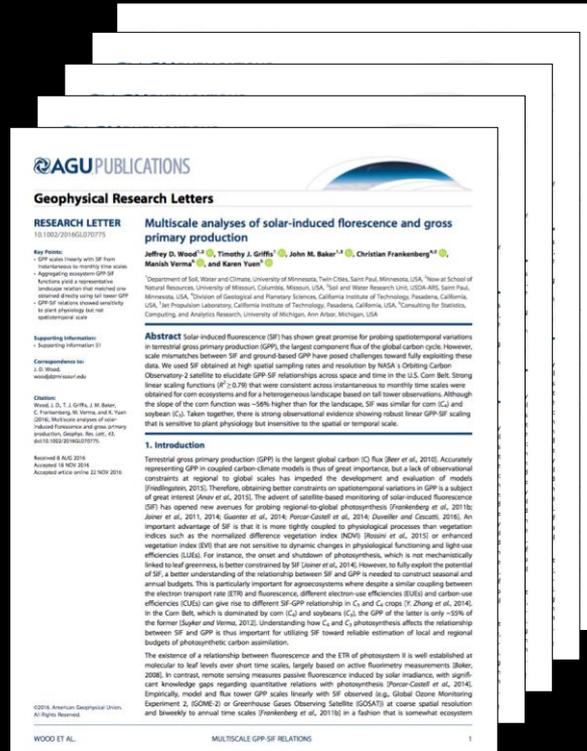
- Pre-Launch workshops are held to attract potential data users and to train early adopters



Challenge

What can be done to 'maximize' the number of potential users (i.e., increase interest in and confidence in use of the data to provide a benefit beyond the mission objectives)?

Publish, Publish, Publish!



[Wood et al., 2016]

Challenge

What can be done to increase the confidence in using the data as early as possible and instilling a sense of urgency in publishing findings, etc.?

Food for Thought...

- The engineer commits to advancing the state of the art and launching an observatory with high reliability
- The scientist commits to advancing science, expanding the body of knowledge, and improving our understanding
- What if we are equally committed to:
 - Developing and making technologies more accessible to other areas of NASA, other agencies, industry, and the private sector
 - Seeking to maximize the rate of return on investments to serve the needs of science/research, data applications, and informed decision-making
 - For a single mission
 - Combining multiple observations, computer models, uncertainty quantification, data analytics, and data visualization