

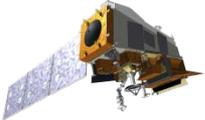
# Joint Polar Satellite System

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Economic Benefit Analysis  
2015 AMS Annual Meeting



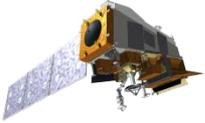
Ajay Mehta, Deputy Director  
Joint Polar Satellite System



# Outline



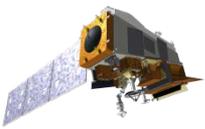
- **Purpose**
- **Summary**
- **Background**
- **Methodology**
- **Results Discussion**
- **Other Benefits**
- **Comparison to Other Analysis**
- **Conclusions**



# Purpose



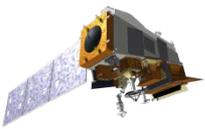
- **Provide an overview of NOAA's efforts to analyze the Economic Benefits of the Joint Polar Satellite System (JPSS)**
  - Analysis conducted by Tecolote Research, Inc. to maintain impartiality
  - The scope covers the operation of the Suomi-National Polar-orbiting Partnership (SNPP) mission and the operation of JPSS-1 and JPSS-2 missions (2012 through 2025)
  - The JPSS program supports many benefit areas for which the socio-economic benefits are not easily quantifiable – this analysis focuses primarily on JPSS' contribution to NOAA's weather forecasting mission
  - The final results are still under review – this brief focuses on the methodology



# Summary



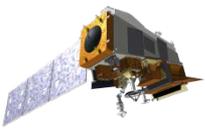
- **NOAA/JPSS conducted an Economic Benefit Analysis to quantify the impact of JPSS in monetary terms**
  - The analysis used existing studies and data, supported by simulations, to arrive at a range of economic benefits
    - » Contribution of JPSS data obtained from World Meteorological Organization (WMO) to minimize national viewpoints
  - Tecolote Research, Inc. provided freedom to conduct the analysis and develop methodology
  - Reviewed by NOAA’s Chief Economist
- **The analysis resulted in an economic benefits range. These figures are being vetted through the Agency.**
- **Additional work is required to conduct a “bottom-up” estimate which would analyze the impact of JPSS on various segments of the economy and validate the results presented here**



# Background (1 of 4)



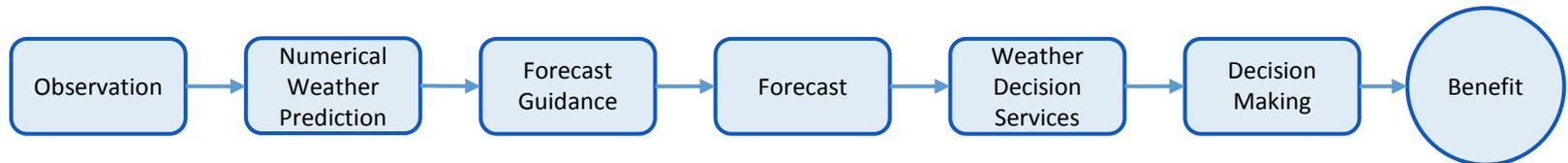
- **JPSS microwave and infrared instruments in the afternoon orbit are critical to accurate 3-7 day weather forecasts, especially for extreme events**
- **NOAA/JPSS set out to develop an authoritative and defensible economic benefit analysis to quantify in monetary terms the benefits of JPSS**
- **Analysis will help to:**
  - Articulate the value of JPSS in economic terms
  - Respond to stakeholder inquiries on value of polar-orbiting satellites, especially JPSS
  - Consolidate and use past studies and existing data
- **The costs of JPSS are well understood and validated against independent estimates – so this analysis focuses on benefits**



# Background (2 of 4)



- **The are many challenges to conducting an economic benefit analysis for environmental satellites**
  - They support all of NOAA’s mission goals and benefits many different societal areas – makes any analysis daunting due to scope of program
  - Past analysis focused on how large the benefit areas were; but did not quantify the impact of satellite data to that economy
  - Link to ultimate benefits to the public and the economy require understanding the full value chain – increasingly difficult to estimate benefits as you move down the value chain



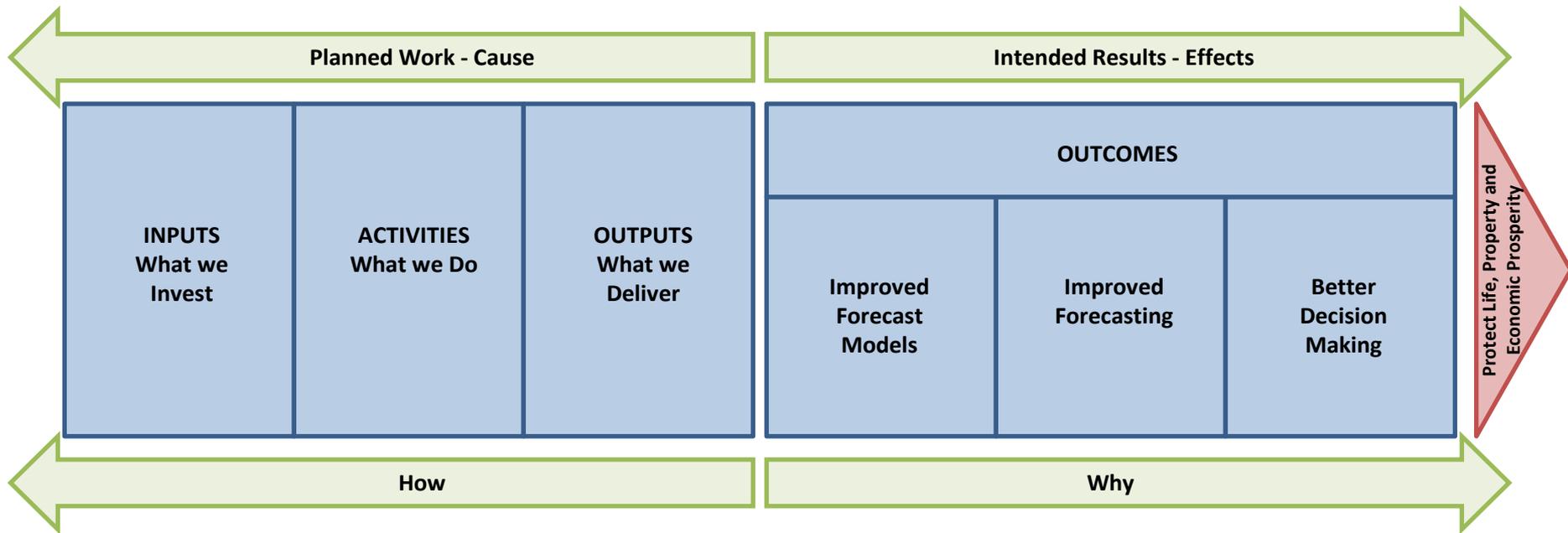
- Difficult to estimate the value of weather information to the general public
- Proper cost-benefit analysis are time-consuming, costly and require access to data at all levels of the value chain

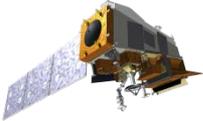


# Background (3 of 4)



## Logic Model

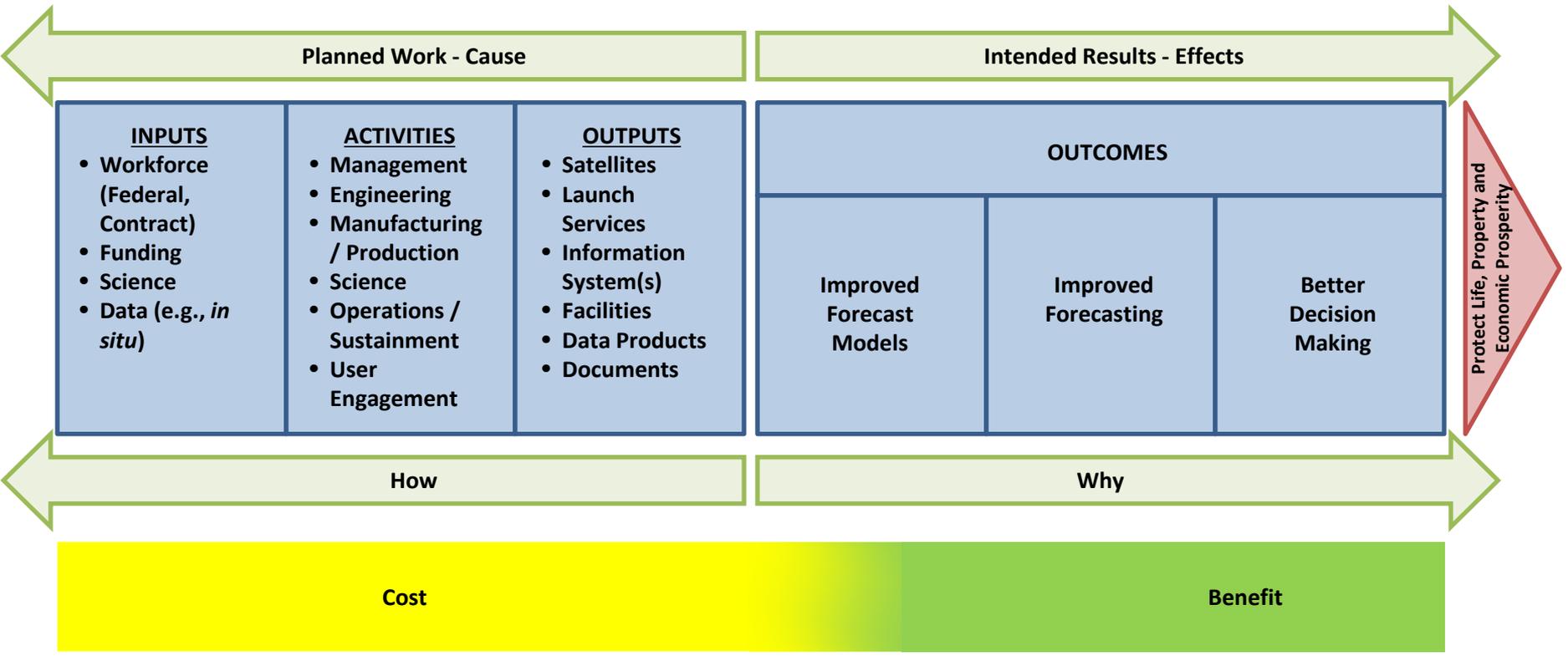


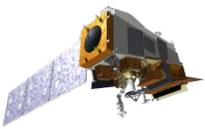


# Background (4 of 4)



## JPSS Logic Model

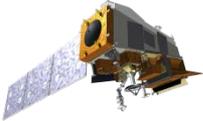




# Methodology (1 of 4)

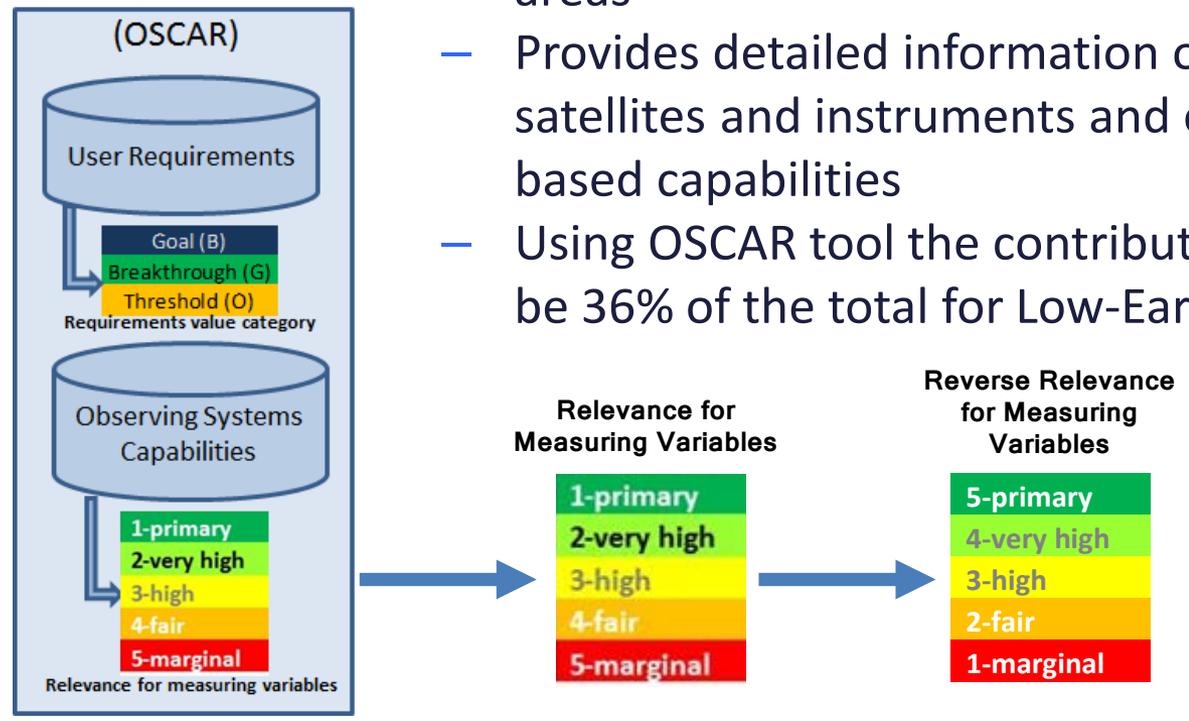


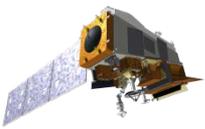
- **Conduct a “top-down” analysis – focuses on positive impact of JPSS observations on weather forecasting as it relates to the Gross Domestic Product (GDP)**
  - Use past studies and existing data
  - Assess impacts that cannot be quantified in monetary terms
- **Benefits assessed by**
  - Collecting and normalizing data on GDP
  - Assessing the percentage of GDP that is sensitive to weather
  - Determining a factor that identifies the benefits from weather forecasts to the portion of GDP that is sensitive to weather
  - Adjusting the benefit calculation by the contribution to meteorological forecasts from the JPSS program
- **JPSS contribution to weather forecasts determined by using WMO’s Observing System’s Capability Analysis and Review (OSCAR) Tool**



# Methodology (2 of 4)

- **OSCAR**
  - Resource developed by WMO in support of Earth Observation applications, studies and global coordination
  - Contains quantitative user-defined requirements for observation of physical variables in WMO application areas
  - Provides detailed information on all Earth observation satellites and instruments and expert analysis of space-based capabilities
  - Using OSCAR tool the contribution of JPSS was found to be 36% of the total for Low-Earth Orbiting satellites

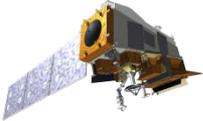




# Methodology (3 of 4)



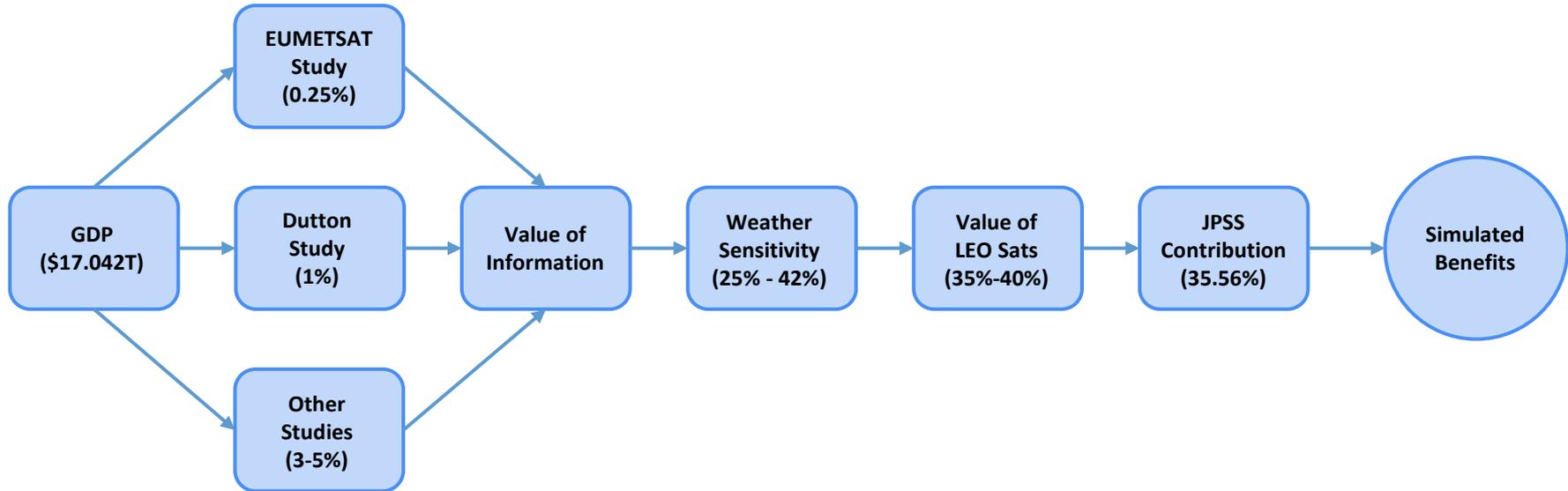
- **Assumptions used to approximate the low-end to high-end benefits (key sources identified in the backup)**
  - A factor between 0.25% and 5% of GDP is used to estimate the portion of weather sensitive GDP that represents the benefits (i.e., the Value of Information)
  - A factor between 35% and 42% is used for the sensitivity of GDP to weather
  - The contribution to meteorological forecasts by low-Earth orbiting satellites is between 35% and 40%
  - The contribution to meteorological forecasts by JPSS is 35.56% of all low-Earth orbiting satellites
  - A discount rate of 7% is used
  - GDP assumed to be \$17.042 trillion
- **Monte Carlo Simulations were as run to cross-check the results**



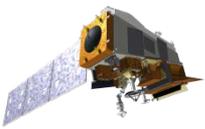
# Methodology (4 of 4)



- Flowchart for “conservative” Value of Information Monte Carlo simulation provided below



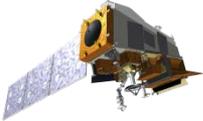
- Boolean Logic Monte Carlo simulation assumed more optimistic Value of Information and different weather sensitivity



# Results Discussion



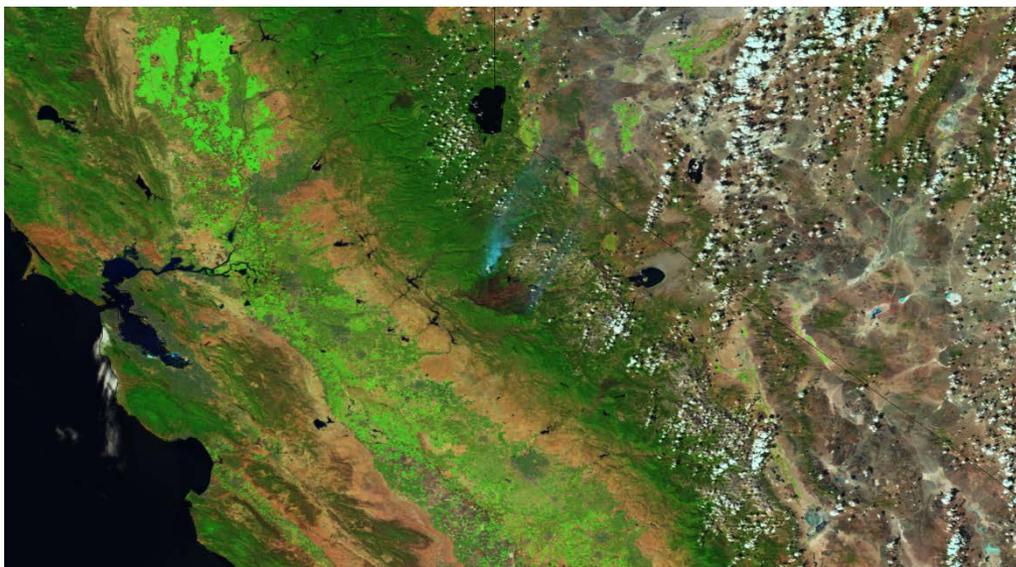
- **Discounted benefits were calculated for the time period 2012 (launch of SNPP) through 2025 (end of program). This produced monetary benefits range**
- **A Monte Carlo simulation cross-check was developed using different value of information (e.g., conservative value of information, more optimistic Boolean Logic Monte Carol simulation)**
- **Measured the minimum benefit value, the 5<sup>th</sup> percentile, the median and mean, the 95<sup>th</sup> percentile and the maximum benefit value**



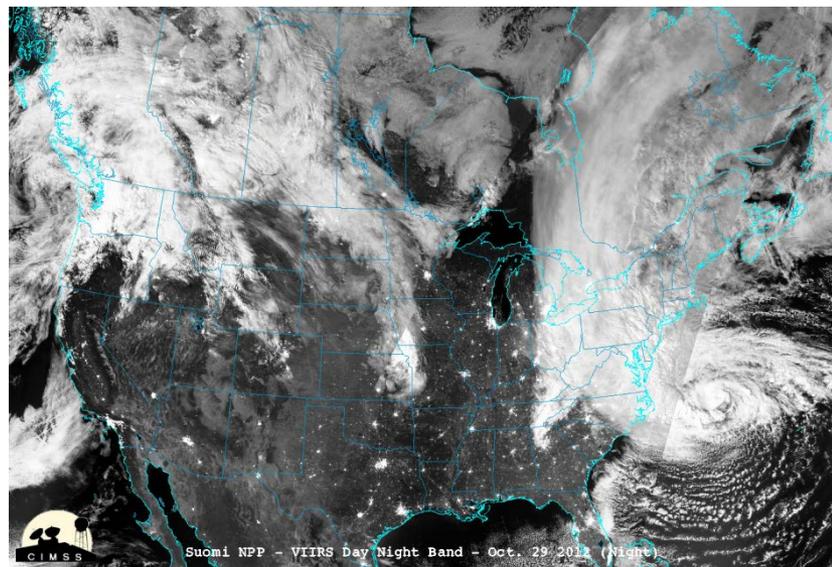
# Other Benefits (1 of 2)



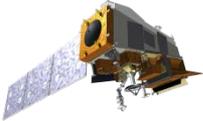
- **JPSS provides non-market benefits that could be significant**
  - Microwave data provides rainfall rates, sea ice, snow and surface temperatures
  - Infrared data provides atmospheric chemistry and cloud properties
  - The visible/infrared imagery provides information on chlorophyll, cloud imagery, cloud products, sea surface temperatures, fires, smoke, ice and oil spills
  - Ozone data can provide information on aerosols



Fires detected by Visible Infrared Imaging Radiometer Suite (VIIRS) on JPSS



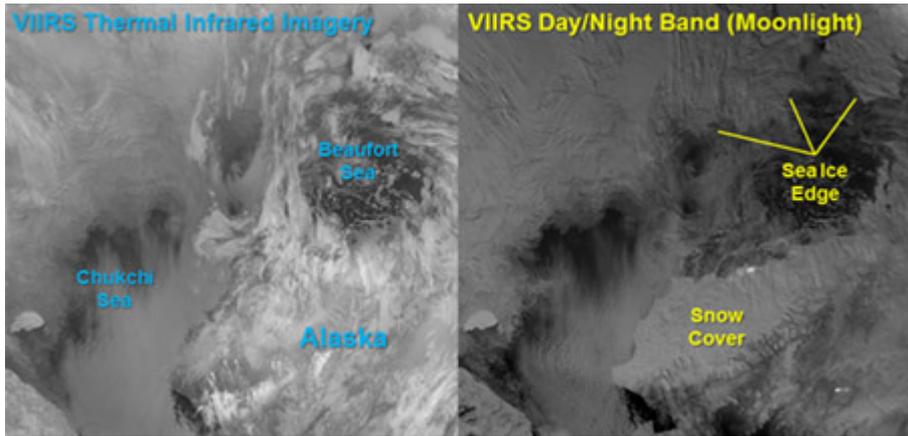
VIIRS Day/Night Band Image of Sandy



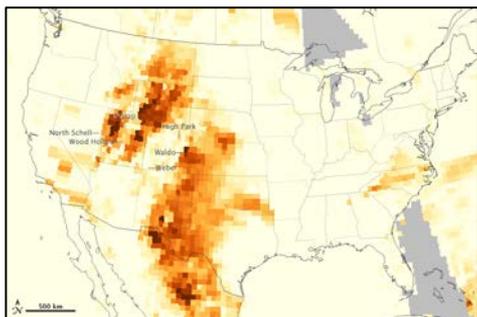
# Other Benefits (2 of 2)



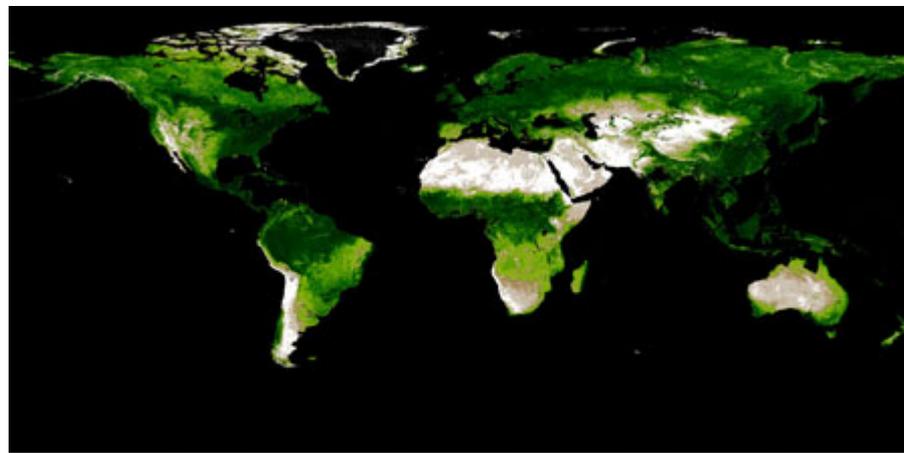
Harmful Algal Blooms caused by agricultural runoff



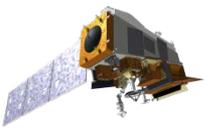
Snow/Ice Products to aid navigation



Aerosols from fires



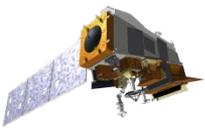
Vegetation products to aid in drought monitoring



# Comparison to Other Studies



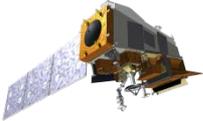
- **EUMETSAT concluded that the total socio-economic benefit of forecast information ranged from a minimum of €15.7B for EPS-Metop/SG to a likely benefit of €62.6B**
  - Based on *The case for EPS/Metop Second Generation: Cost Benefit Analysis*
  - Evaluated Protection of Property and Infrastructure; Added Value to the European Economy; and Private Use by European Citizens
  - Evaluated for 20 years of operations
  - Benefits most likely conservative (e.g., safety of life not included)
- **Benefits based on a European Union GDP of €12.28T (in 2010)**
- **Results are comparable**



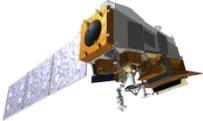
# Conclusions



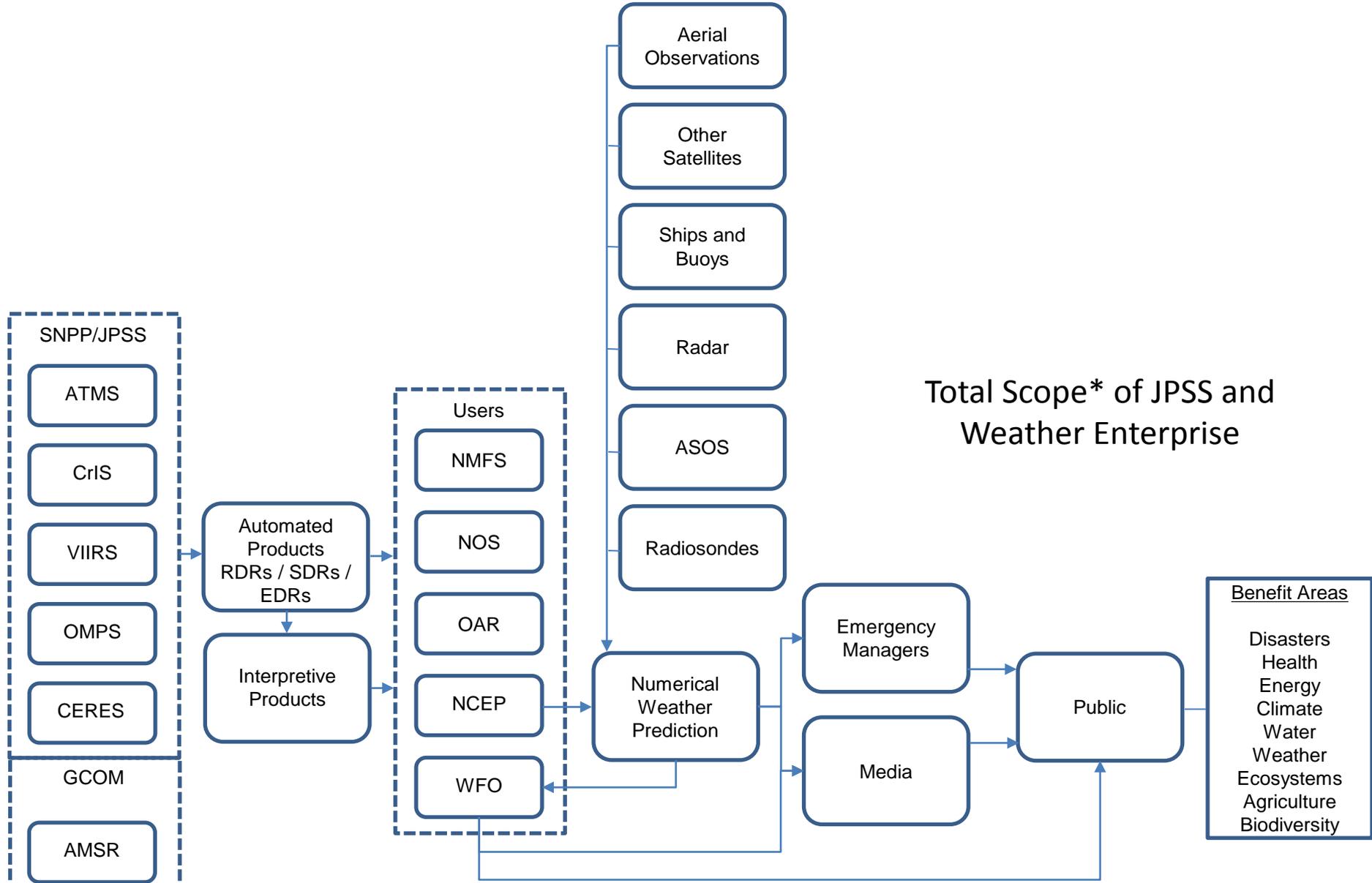
- **Analysis confirmed that JPSS provides significant economic benefits**
  - Additional benefits in the areas of safety of life; protection of property; emergency management; transportation; power; insurance; now-casting; season forecasting; and agriculture need further work
- **Benefits likely to grow in the future**
  - Percentage of population vulnerable to extreme weather and high-dollar severe weather events increasing
  - Modeling and decision making improving
- **Analysis helped to refine questions that must be answered going forward**
- **Further work is required to develop “bottom-up” benefits to validate “top-down” estimate of benefits**



# Backup

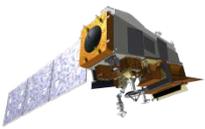


# JPSS and Weather Enterprise



Total Scope\* of JPSS and Weather Enterprise

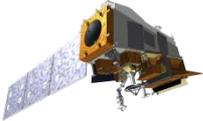
\* Note, scope focuses only on support to weather mission



# Key Data Sources



- **GDP Source Information**
  - Bureau of Economic Analysis – captures economic activity for 2012 and 2013
  - Congressional Budget Office – provides projections of economic activity over a 10 year time period
- **“Opportunities and Priorities in a New Era for Weather and Climate Services” by John A. Dutton**
- **“U.S. Economic Sensitivity to Weather Variability” by Jeffrey K. Lazo, Megan Lawson, Peter H. Larsen, and Donald M. Waldman**
- **"JPSS Preliminary Benefit Study (Draft)" by Eric Wolfe**
- **The case for EPS/Metop Second Generation: Cost Benefit Analysis, Full Report” by EUMETSAT**
- **Partnerships in Weather and Climate Services, Committee on Geophysical and Environmental Data, National Research Council**



# Template for Future Work



Benefit Area	Socio-Economic Value of 01:30 Polar Orbit – Continuity of Observations (Retrospective View)	Additional Value of JPSS – Future Benefits (Prospective View)	Total Value of JPSS
<b>Tangible Benefits</b>			
Lives Saved/Protected <sup>(1)</sup>			
Property Protected <sup>(1)</sup>			
Economic Activity <ul style="list-style-type: none"> <li>a. Agriculture</li> <li>b. Fisheries</li> <li>c. Forestry/Land Management</li> <li>d. Energy</li> <li>e. River Management</li> <li>f. Manufacturing and Retail</li> <li>g. Construction</li> <li>h. Transportation               <ul style="list-style-type: none"> <li>1. Air</li> <li>2. Ocean/Sea/Lake</li> <li>3. Land</li> <li>4. Space</li> </ul> </li> <li>i. Utilities               <ul style="list-style-type: none"> <li>1. Water</li> <li>2. Electric</li> <li>3. Communications</li> </ul> </li> <li>j. Recreation</li> <li>k. Emergency Management</li> <li>l. Environmental Information               <ul style="list-style-type: none"> <li>1. Finance</li> <li>2. Insurance</li> <li>3. Commodities</li> <li>4. Weather Industry</li> </ul> </li> </ul>			
Government/Military Operations			
Total			
<b>Intangible Benefits</b>			
Public Policy/Decision Making			
Quality of Life (Public)			

(1) From severe storms, floods (coastal/river), droughts, heat/cold, pollution, etc)