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The Weather Information Value Chain

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Outline

- “Shout out” on WMO/USAID/World Bank book
- Are there any fundamental economic (theoretical / methodological / application) questions in HIWeather?
- Why a “Weather Information Value Chain”
- What is the “Weather Information Value Chain”
- Example of value study
- Recommendations

What is the value of weather information?



WMO, WBG, GFDRR & USAID. 2015.
*Valuing Weather and Climate:
Economic Assessment of
Meteorological and Hydrological
Services.* World Meteorological
Organization, World Bank Group,
Global Facility for Disaster Reduction
and Recovery, and United States
Agency for International Development,
WMO No. 1153, Geneva, Switzerland.

Valuing Weather and Climate:
Economic Assessment of
Meteorological and
Hydrological Services



World
Meteorological
Organization
Weather - Climate - Water

WMO-No. 1153



WORLD BANK GROUP



GFDRR

Global Facility for Disaster Reduction and Recovery



USAID
FROM THE AMERICAN PEOPLE

Economics?

Are there any fundamental economic (theories/ methods/ applications) questions in HIWeather?

- **integration of economics with user-relevant decision making**
- **insights from behavioral economics**
- **optimization of research based on quantified economic benefits (broadly defined)**
- **issues of measurement of vulnerability, impacts, and benefits in context of fundamental income inequality, socio-economic barriers to response, institutional failures (corruption?)**

Weather Information Value Chain

Far too many research and operational programs justify themselves as “providing benefits to society” without actually measuring or even characterizing that value or how the new products and services will be created, communicated, understood, or used

What is the weather information value chain?

- A model of the value creation process that can be used to understand and explicate societal benefits of hydromet information products and services**
- If this process is not adequately assessed then benefits to society have not been adequately and may not be validly and reliably assessed**

Why the Weather Information Value Chain?

- **Use economic concepts to explicate mapping of the value of information from creation to valuation**
 - Stakeholders (Agents)
 - Objectives
 - Resources
 - Constraints
- **Tie information to value so value estimates are valid and reliable**
- **Detail potential contributions of other social sciences – to evaluating the chain and to enhancing value**
- **Explicate how user-relevant information can drive product and service development**

Weather Information Value Chain



Weather Information Value Chain



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Observations

- Satellites
- Radar
- Ground stations
- ...
- Your car ...

Weather Information Value Chain



Modeling

Numerical Weather Prediction
Nowcasting
Climate models

Weather Information Value Chain



Forecasting

Weather forecast
Seasonal forecasts
Climate forecasts
Watches and warnings

Weather Information Value Chain



Dissemination

Internet
Television
Radio
Telephone
Newspapers
Sirens
Word of mouth

Weather Information Value Chain



Communication

Format
Content
Detail
Uncertainty

Weather Information Value Chain



Perception / Interpretation

Threat
Impacts
Probability
Reliability / trust

...

Weather Information Value Chain



Decisions

Run / hide

Buy / sell

Sunglasses / coat

...

Weather Information Value Chain



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Value of Information

Decisions

- Run / hide
- Buy / sell
- Sunglasses / coat
- ...

Subject to objectives, resources, constraints

Ex ante

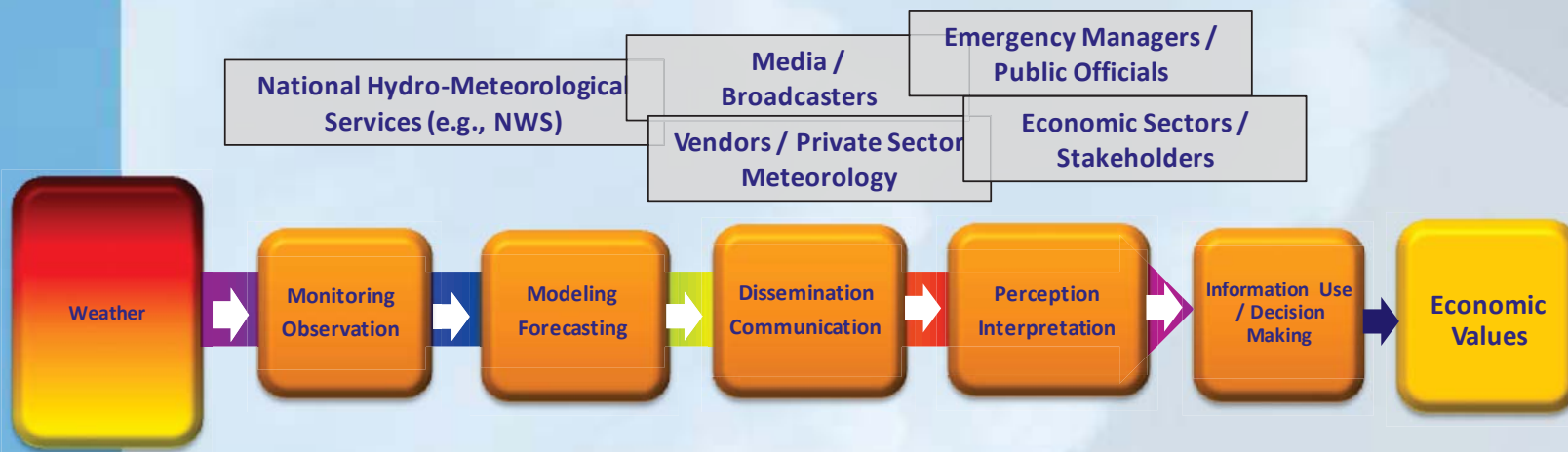
Weather Information Value Chain



**Economic
impact of
weather**

- Outcomes**
- Live / die
 - Happy / sad
 - Cold / wet
 - Profit / loss
 - ...
- Ex post

Weather Information Value Chain

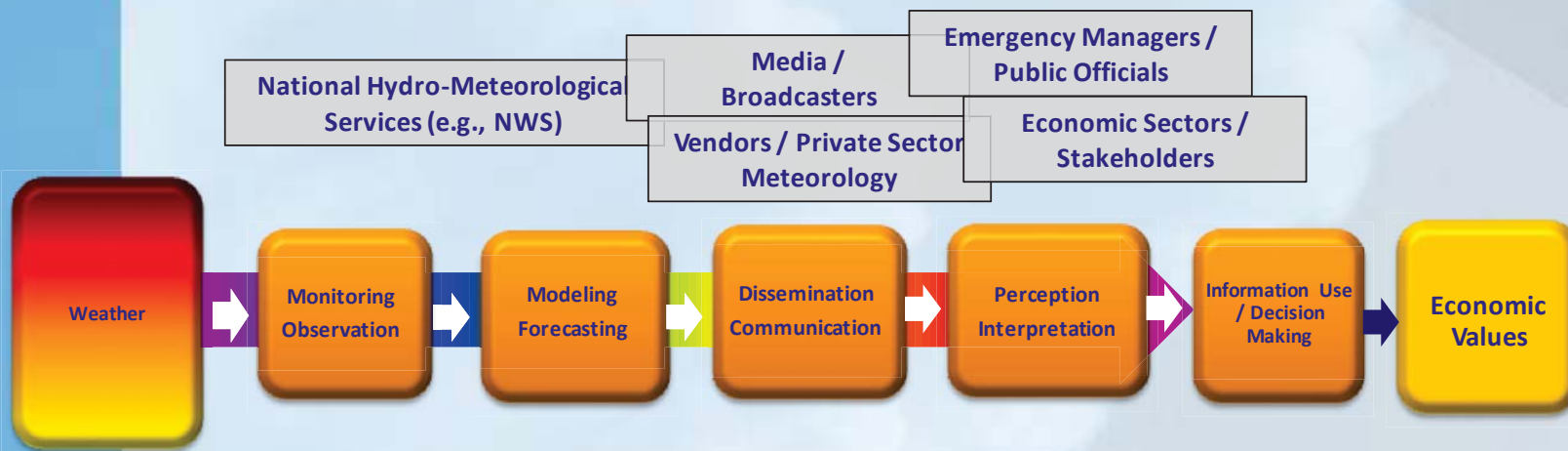


Each stakeholder, agent, and decision maker has his or her own set of:

- objectives
- resources and
- constraints

that frame their transformation or use of information

Weather Information Value Chain



Economic values are the result of a complex process

- **Ultimately value of information is a function of the ability of decision makers to receive, understand, and act on information on uncertain future events.**
- **Have to be able to tell the story end-to-end to derive valid benefit estimates.**

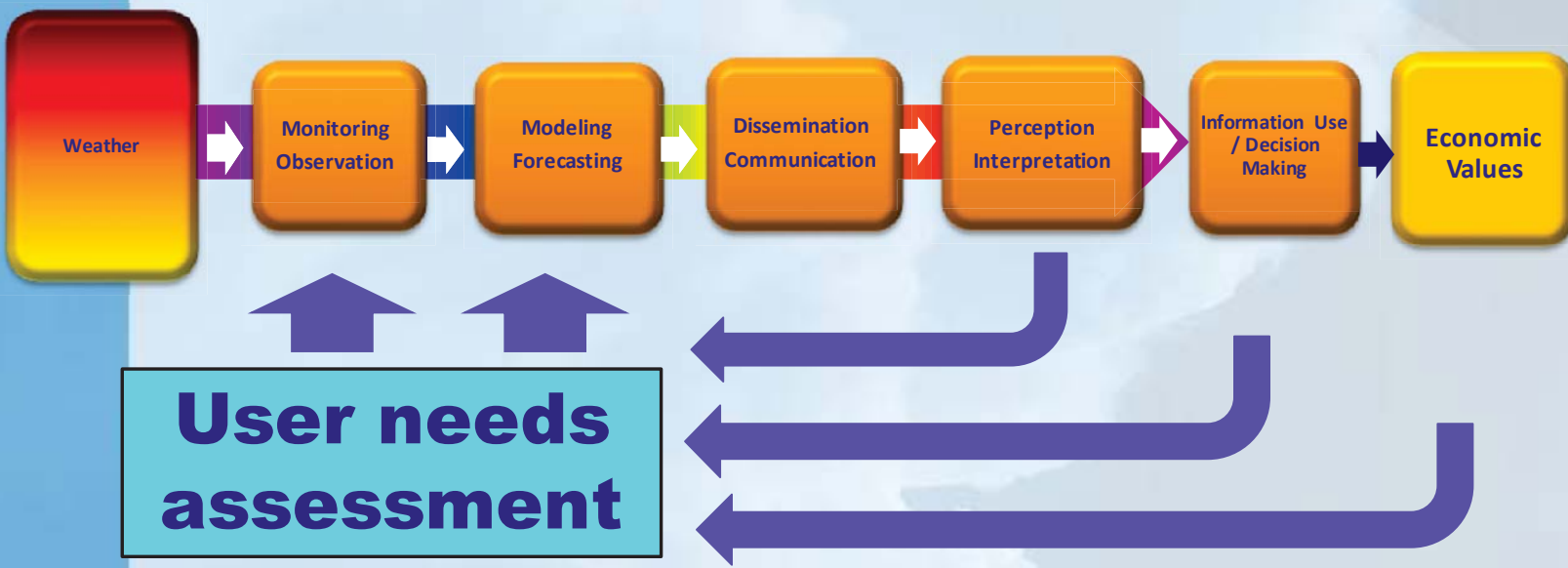
Valuation Methods



Valuation is at the end of the chain so valuation methods ultimately depend on the decisions and potential outcomes being evaluated

- Morbidity / mortality (VSL)
 - Reduced costs
 - Reduced damages
 - Increased profits
- Improved welfare (WTP)

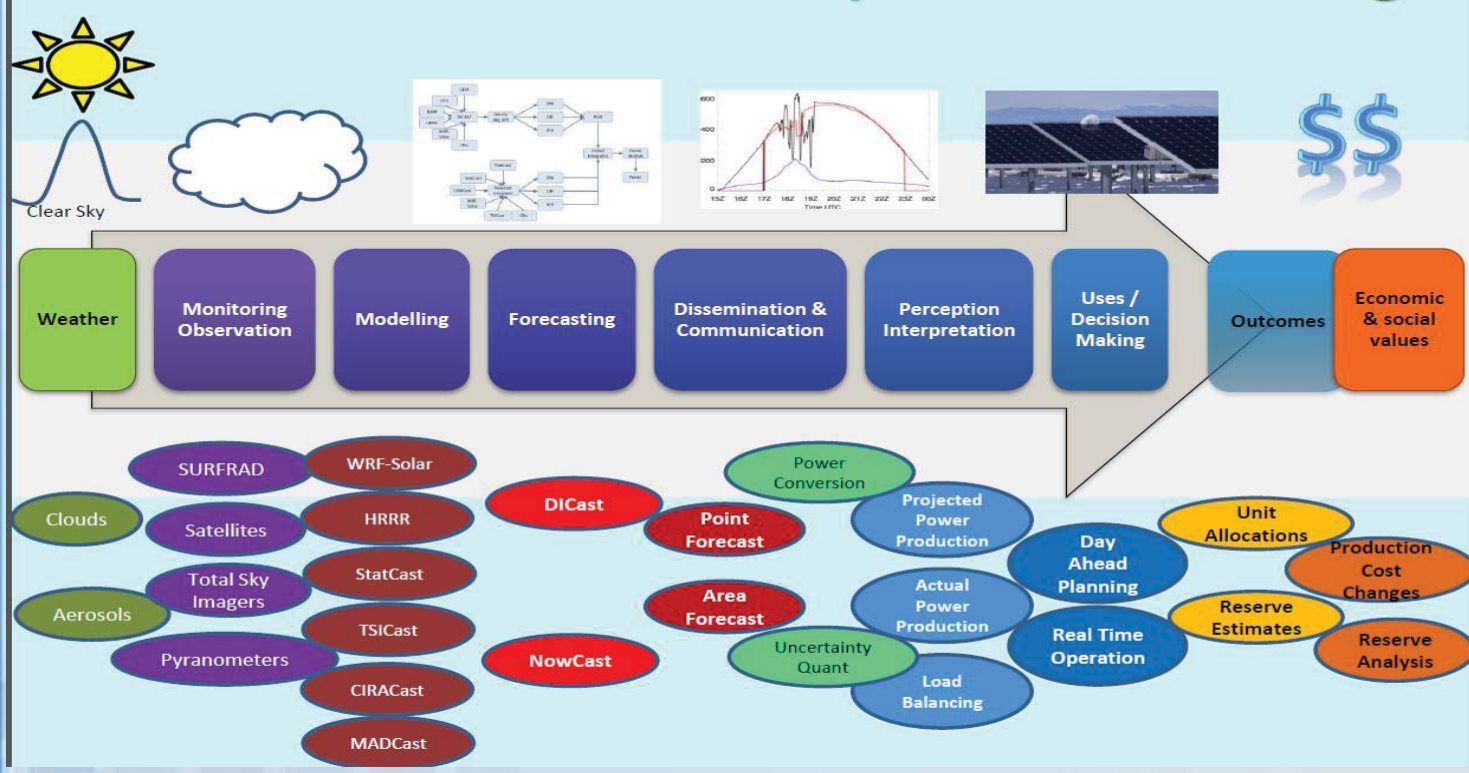
Stakeholder preferences and information needs



Example of a Wx Info Value Chain – DOE Solar



Value Chain: What is the value of solar power forecasting?



Value of research to improve solar power forecasts



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- Based on measures of improved power forecasts – reduced error in power by up to 50% (Mean Absolute Error - MAE)
- Utilities - historical data on forecast and actual power to evaluate historical errors
- Utility provided year of (historical) hourly solar power generation
- Generated “synthetic” forecasts with reductions in MAE
- Utility used “synthetic” forecasts to run production cost model (PCM) under different error reduction scenarios and percent of solar in overall generation profile – including perfect information

Value of improved solar power forecasts

PCM – used in day ahead decision making to decide what “assets” to use to meet demand based on demand (and solar power) forecasts – PCM runs cost minimization

PCM Costs with *current* forecast error
- PCM Costs with *reduced* forecast errors
Value of improved forecasts

- For different levels of error reduction
- For different levels of solar generation

Value of improved solar power forecasts



Analysis Scenario:

- Public Service Company of Colorado
- 2024 Solar Integration Study
- 1,800 MW solar generation capacity (~15% of total)
- 20% Mean Absolute Error (MAE) reduced to 10%

PCM Costs with *current* forecast error

- PCM Costs with *reduced* forecast errors

Value of improved forecasts

Value of improved solar power forecasts – PSCo Results

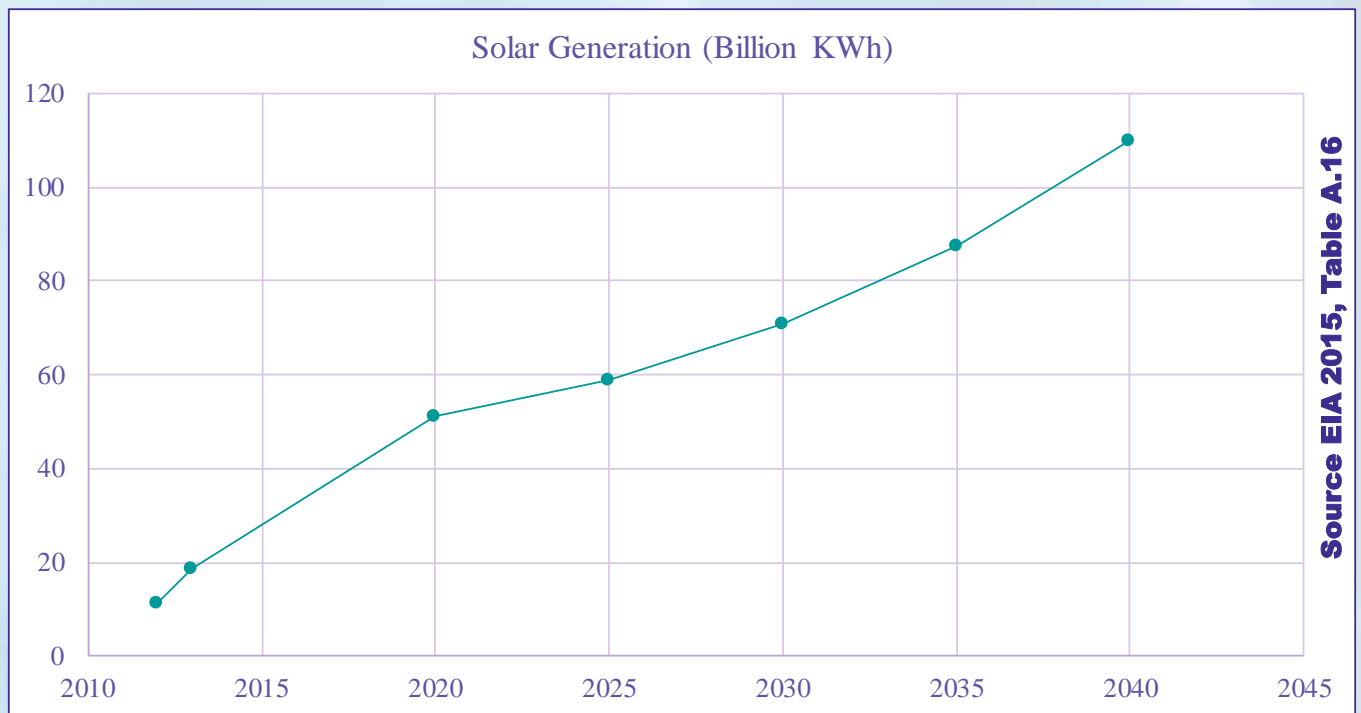


PCM Modeling - Cost Savings from 50% Reduction in MAE

Cost Category	Forecast (1800MW of solar state-wide) \$(000)	50% Improvement to Forecast (1800MW of solar state-wide) \$(000)
Generation Cost	1,173,816.71	1,173,056.56
Start & Shutdown Cost	22,009.18	21,985.44
Wind Curtailment Cost	13,603.99	13,568.06
Total Production Cost	1,209,429.88	1,208,610.06
Value of forecast improvement)		819.82

- \$819,820 annual savings just for PSCo
- total reduction in forecast errors over the year to 290,755 MWh
- averages into a savings of \$2.82 per MW reduction in error

National Aggregation - Projected US Total Solar PV Generation



- Assume similar baseline MAE – 20%
- Assume similar 50% reduction in MAE – to 10%
- Assess benefits (no cost estimates) from 2015-2040

National Aggregation



Present Value of National Benefits (26 years – 3% Discount Rate)

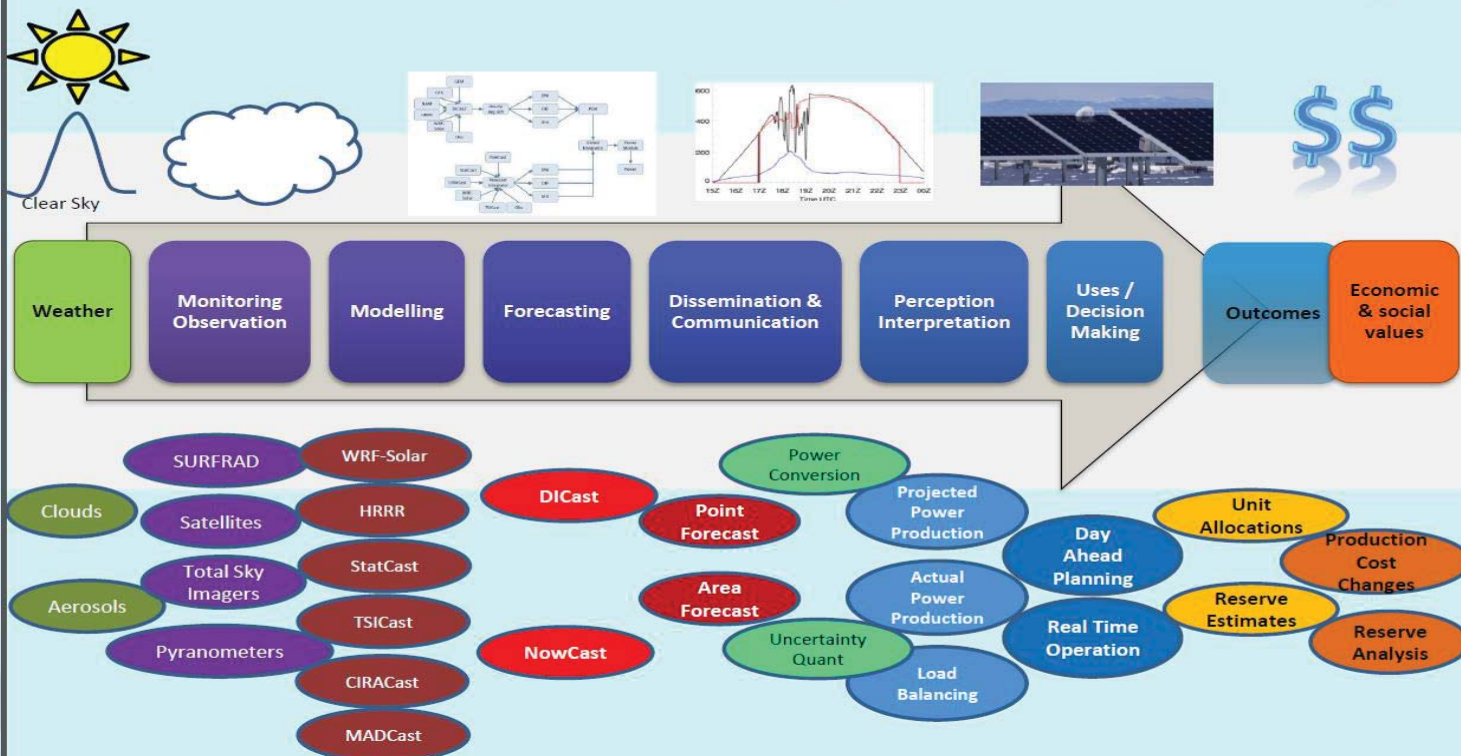
Year	Current Value Benefit	Discount Factor	Present Value Benefit
2015	10,969,888	1.000	10,969,888
2016	12,814,133	0.971	12,440,906
2017	14,658,379	0.943	13,816,928
•	•	•	•
•	•	•	•
2038	39,776,104	0.507	20,154,224
2039	41,555,127	0.492	20,442,369
2040	43,334,149	0.478	20,696,631
	Present Value Total Benefits		454,854,415

- **Present Value Benefit**
- **2015-2040 with 3% Discount rate**
- **\$455 Million – value of research improving solar power forecast**

Value of improved solar power forecasts



Value Chain: What is the value of solar power forecasting?



Final thoughts and recommendations

- Ethical, metaphysical, epistemological questions that haven't been mentioned ... (e.g., what is the “right” response to a flash flood warning? Can we model human behavior?)
- Are there any fundamental economic (theories/ methods/ applications) questions in HIWeather?
- in a “perfect” world ... development and prioritization of research approaches starts with identification of needs, preferences, and economic values of end-users
- economic valuation must be based on adequate and meaningful characterization of the information value chain
- **HIWeather needs to fully integrate economics**

Thank You!

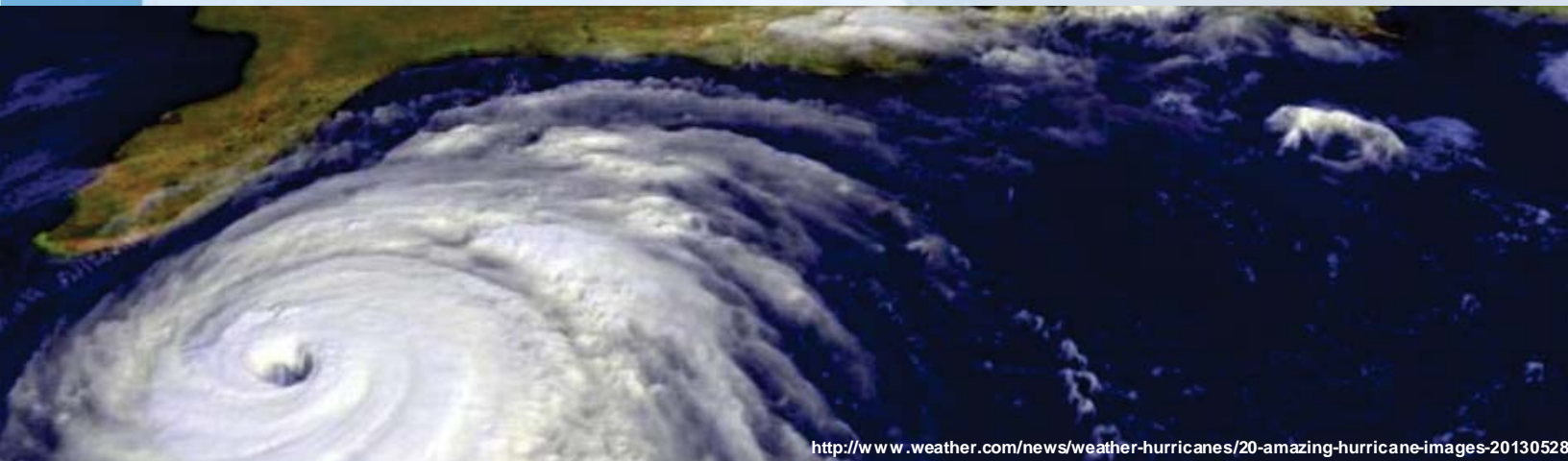


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<http://www.weather.com/news/weather-hurricanes/20-amazing-hurricane-images-20130528>