Economic Value of Improved Climate Observations

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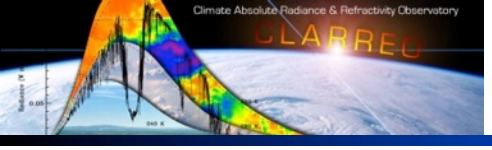
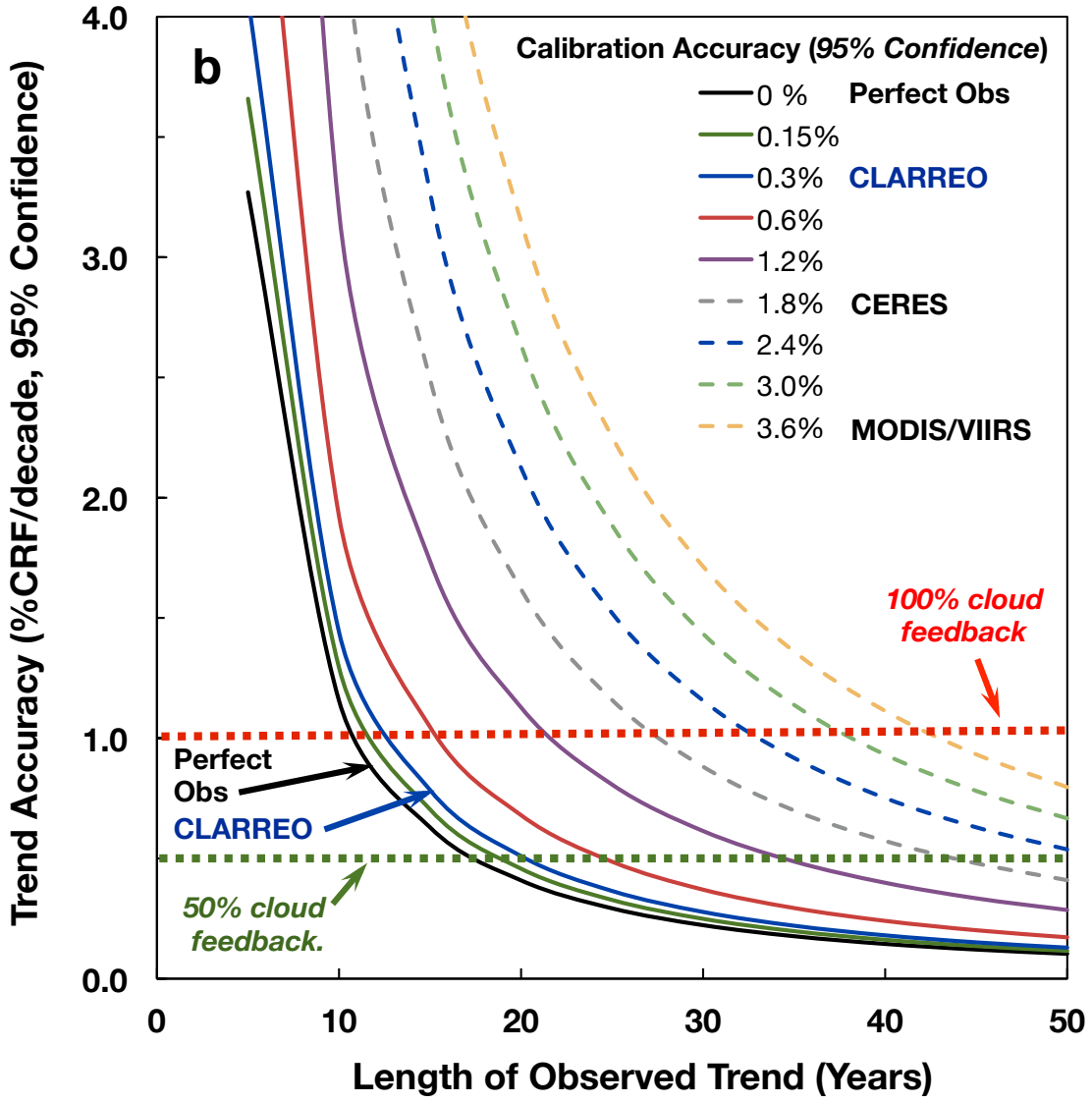


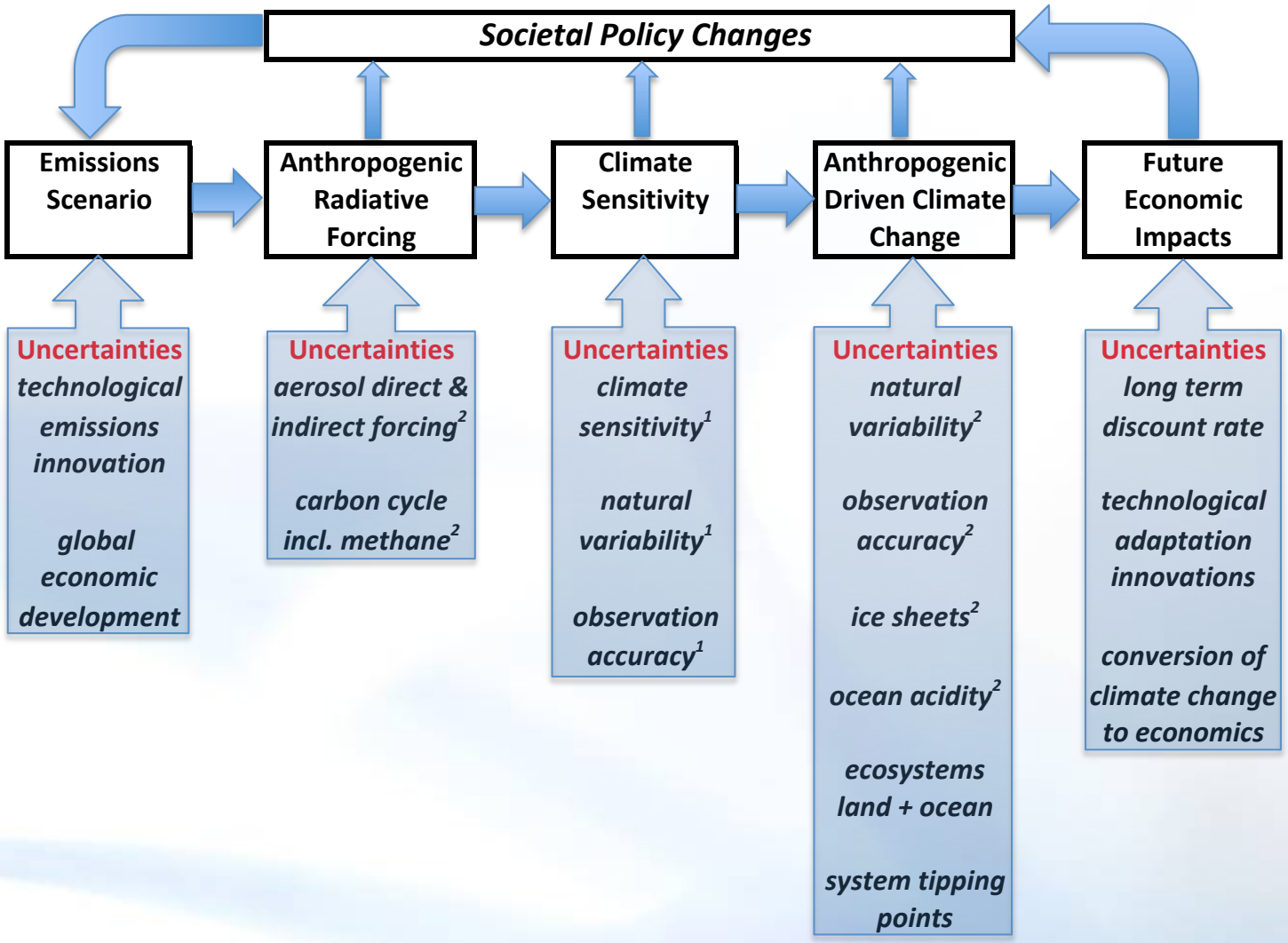
Accuracy and Narrowing Climate Sensitivity Uncertainty with Improved Observations



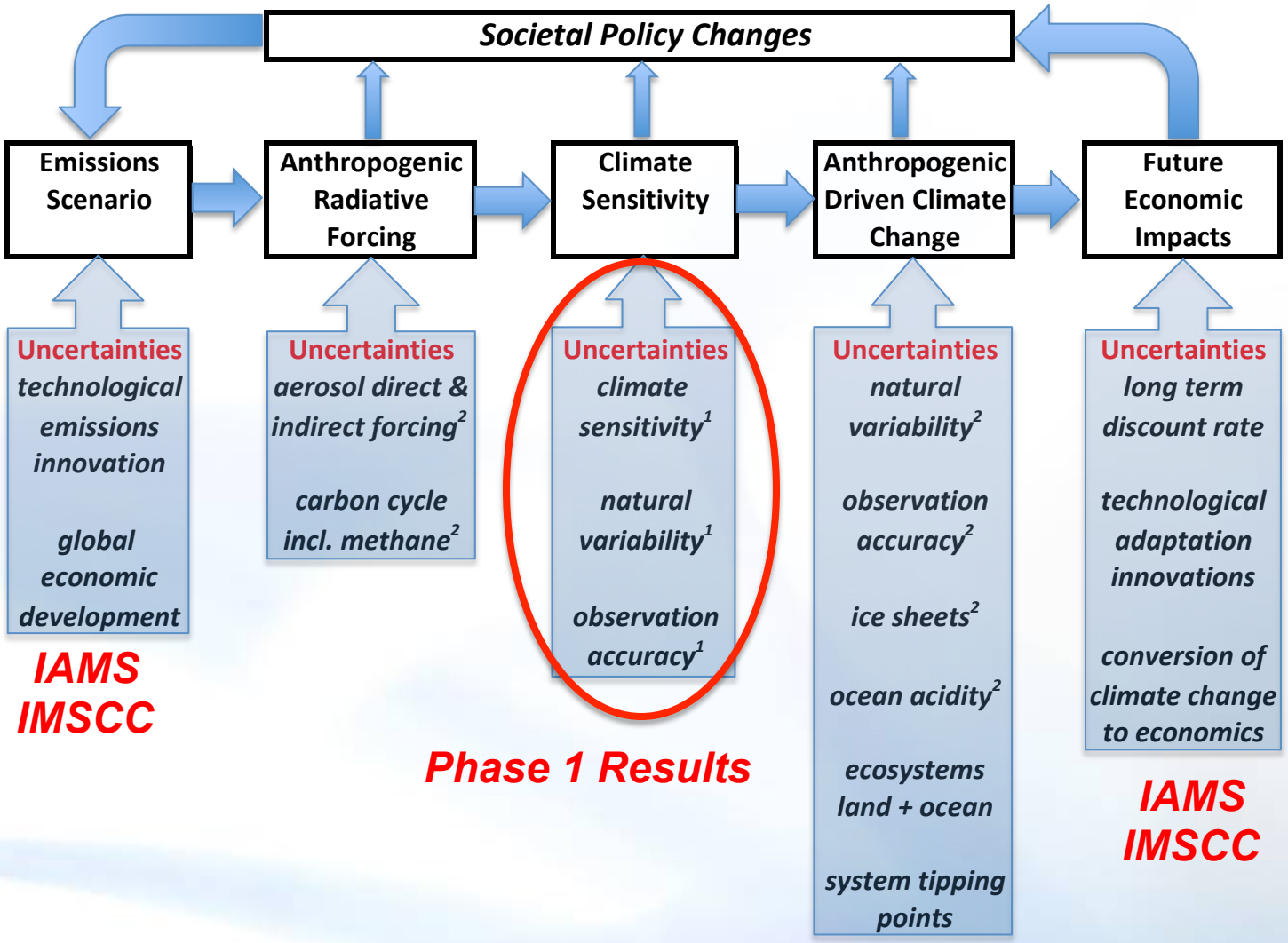
- ***CLARREO accuracy narrows uncertainty in cloud feedback (low clouds, SW cloud radiative forcing)***

Advance knowledge of climate sensitivity by 10 to 20 years

Value of Climate Science Observations

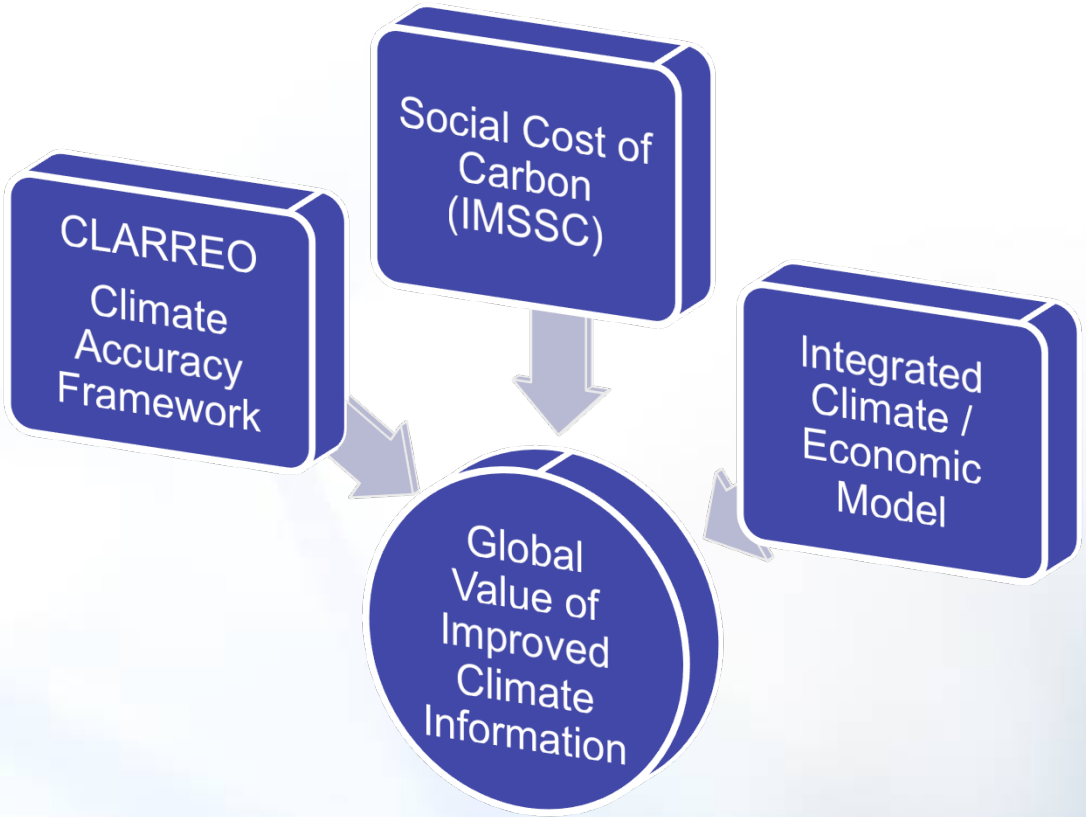


Value of Climate Science Observations



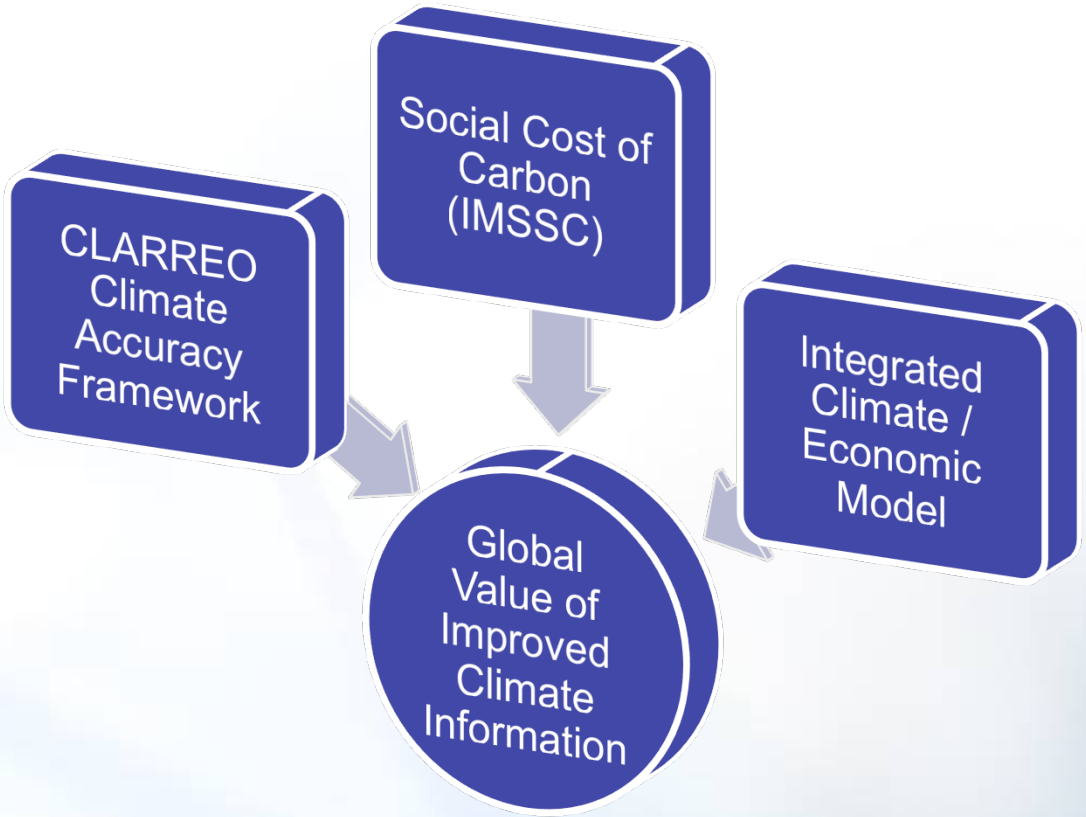
Value of Information (VOI) Calculation

- Climate Accuracy Framework determines trigger points for societal action
  - Developed to set accuracy requirements for CLARREO
  - Based on accuracy needed to determine climate sensitivity
- Economic impacts determined using the Interagency Memo on the Social Cost of Carbon (IMSCC, 2010)
- Dynamic Integrated model of Climate and the Economy (DICE 2007, Nordhaus, 2008).
  - Includes uncertainties in climate sensitivity, economics
  - Can vary discount rates*: 1.5% (Stern) - 5.5% (Nordhaus)
  - Policy options: Business as Usual (BAU), DICE Optimal, Aggressive Emission Reductions (AER), Stern, 2007.



*Discount rate accounts for the idea that money available now is worth more than the same amount of money available in the future, and is a concept beyond simple inflation adjustment

Value of Information (VOI) Calculation

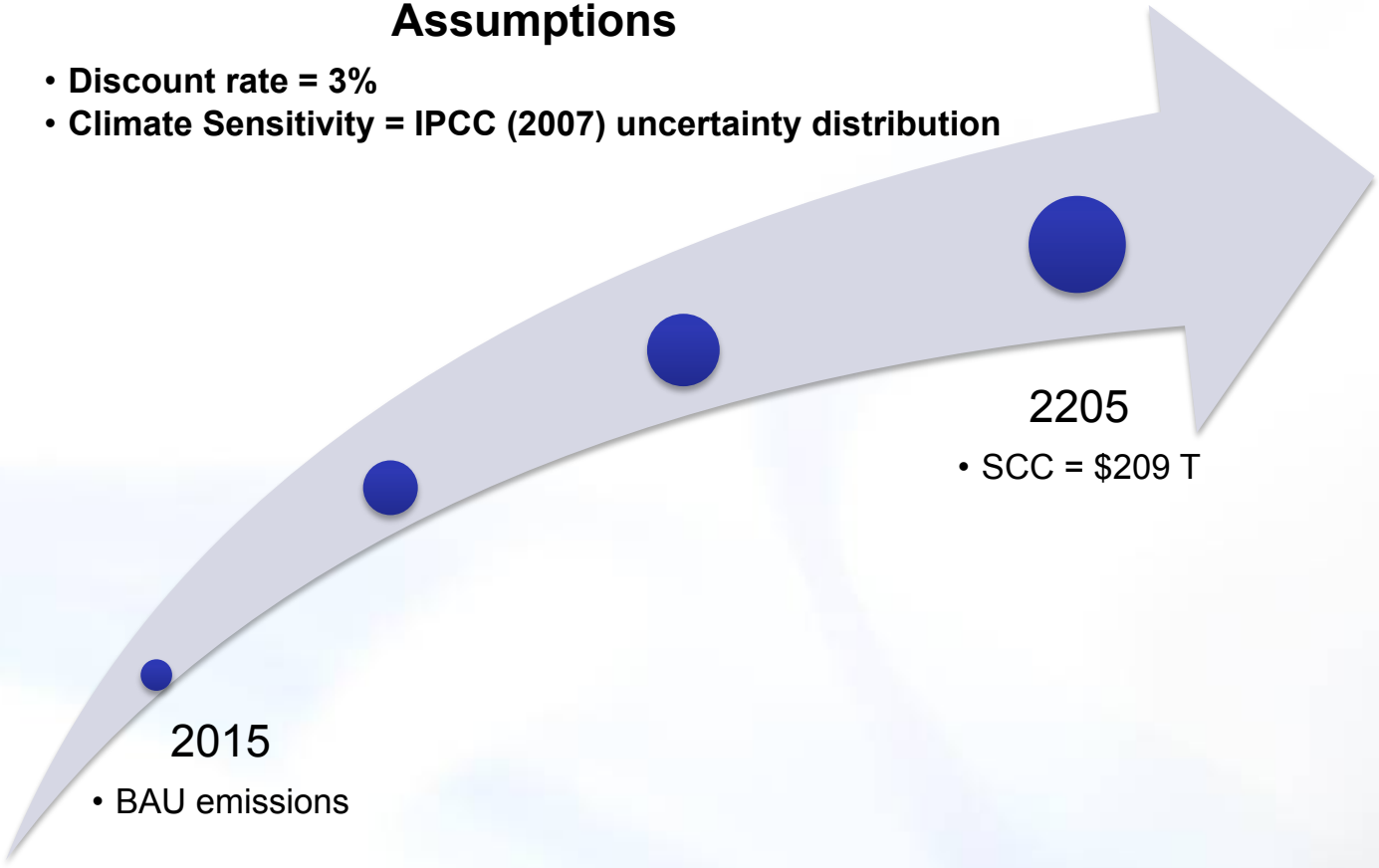


- ***Current IPCC factor of 3 uncertainty in climate sensitivity = factor of 3^2 = factor of 9 uncertainty in economic impacts***

VOI Calculation

Assumptions

- **Discount rate = 3%**
- **Climate Sensitivity = IPCC (2007) uncertainty distribution**

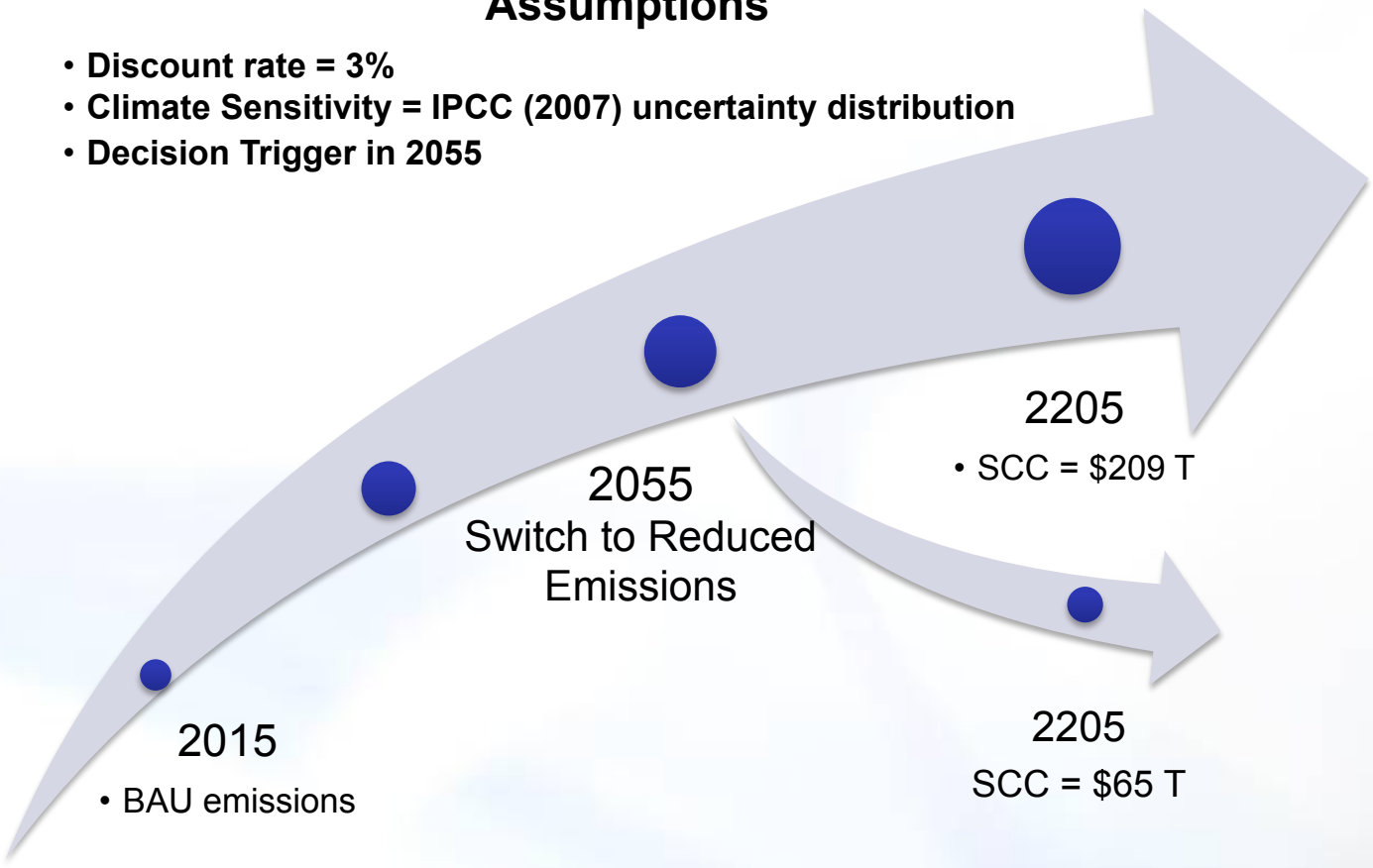


Baseline

VOI Calculation

Assumptions

- **Discount rate = 3%**
- **Climate Sensitivity = IPCC (2007) uncertainty distribution**
- **Decision Trigger in 2055**

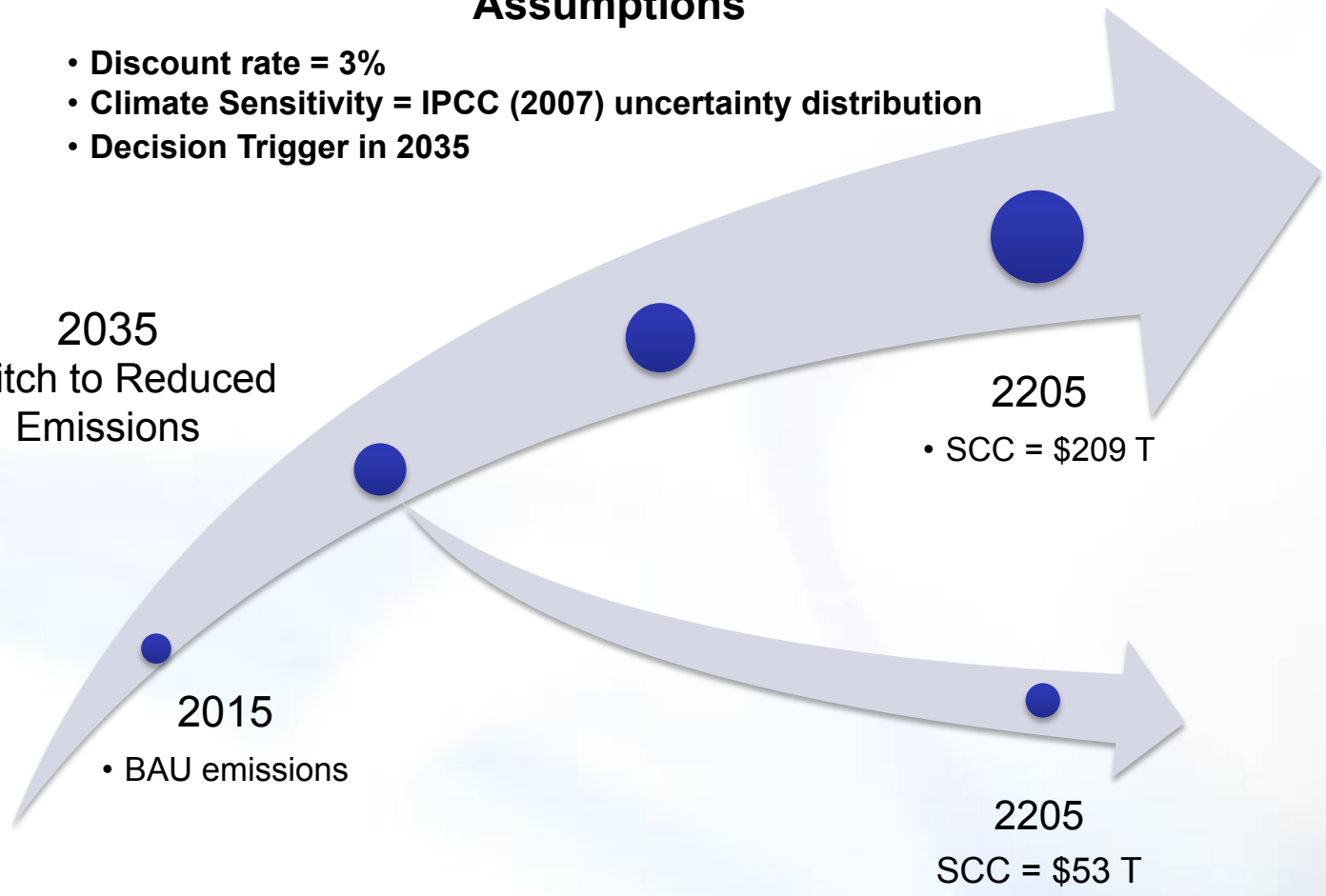


Current Observing System

VOI Calculation

Assumptions

- **Discount rate = 3%**
- **Climate Sensitivity = IPCC (2007) uncertainty distribution**
- **Decision Trigger in 2035**



Improved Accuracy Observing System (2020 launch)

Improved accuracy yields savings of $11.7 T in net present value

Value of Information Parameters

	Decision Context	
Trigger Variable	**ΔT/decade**	**ΔCRF/decade**
Trigger Value	**0.2C or 0.3C/decade**	**3C for 2X CO2**
Confidence Level	**80%, 95%**	**80%, 95%**
Launch Date	**2020, 2025, 2030**	**2020, 2025, 2030**
Trigger Policy Change	**DICE Optimal, Aggressive**	**DICE Optimal, Aggressive**
Discount Rate	**2.5%, 3%, 5%**	**2.5%, 3%, 5%**
Aerosol Forcing Obs	**Start Date = CLARREO**	**Start Date = CLARREO**

Run 1000s of Monte Carlo cases with:

- Full pdf of climate sensitivity uncertainty in IPCC fit to Roe and Baker (2007)
- Gaussian climate natural variability as specified in the CLARREO BAMS article for global mean temperature and SW cloud radiative forcing.

Results are the ensemble mean of the 1000s of Monte Carlo Simulations

How Sensitive are Results to Assumptions?

Parameter Change	CLARREO/Improved Climate Observations VOI (Trillion US 2015 dollars, NPV) 3% discount rate
Baseline (blue values)	$11.7 T
BAU => AER	$9.8 T
0.3C/decade trigger	$14.4 T
2030 launch	$9.1 T

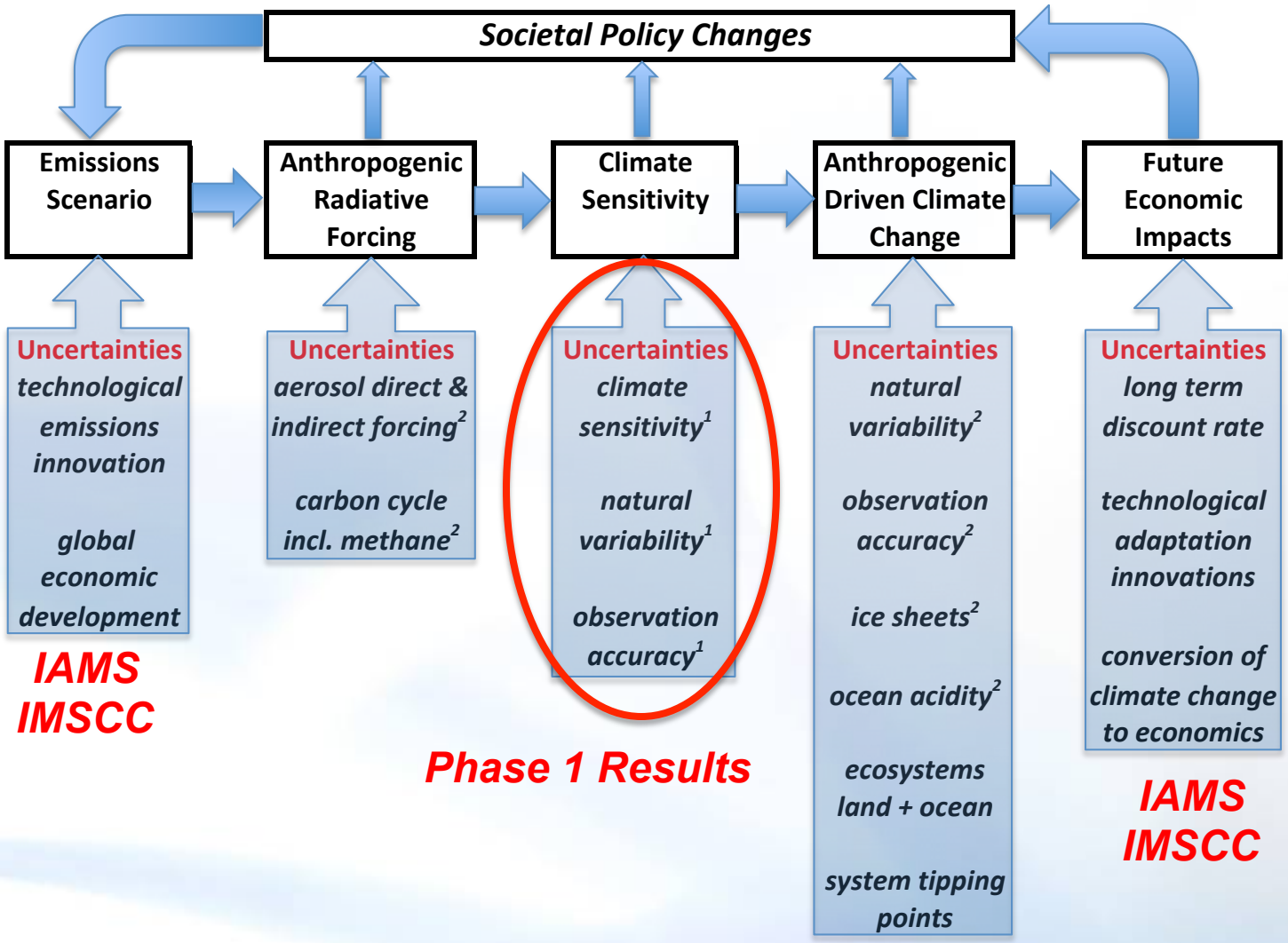
- Delaying launch by 10 years reduces benefit by $2.6 T
- Each year of delay we lose $260B of benefits

Value of Information Summary

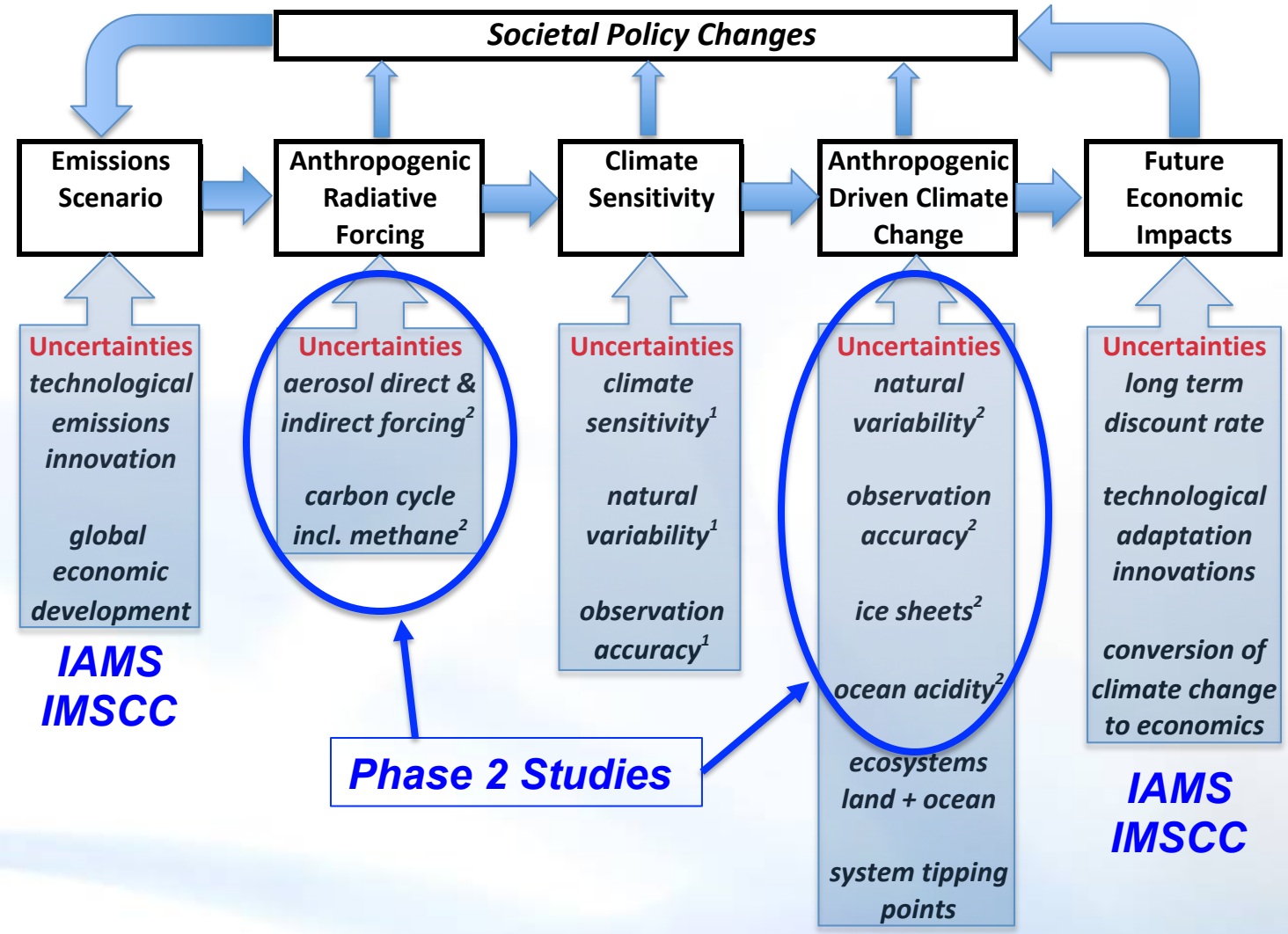
Discount Rate	VOI for CLARREO/ Improved Climate Observations	Cost of 30 yrs of improved full climate observing system (4X current effort)	Payback Ratio VOI / Obs Improvement Cost
2.5%	$17.6 T	$260B	65
3%	$11.7 T	$245B	45
5%	$3.1 T	$200B	15

- *All economic values in Net Present Value (NPV) in 2015 U.S. dollars*
- *Even with the most pessimistic discount rate, the return on investment is large: factors of 15 to 65.*

Value of Climate Science Observations



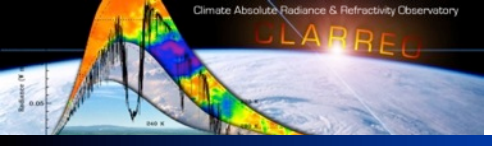
VOI for Climate Science – Next Steps



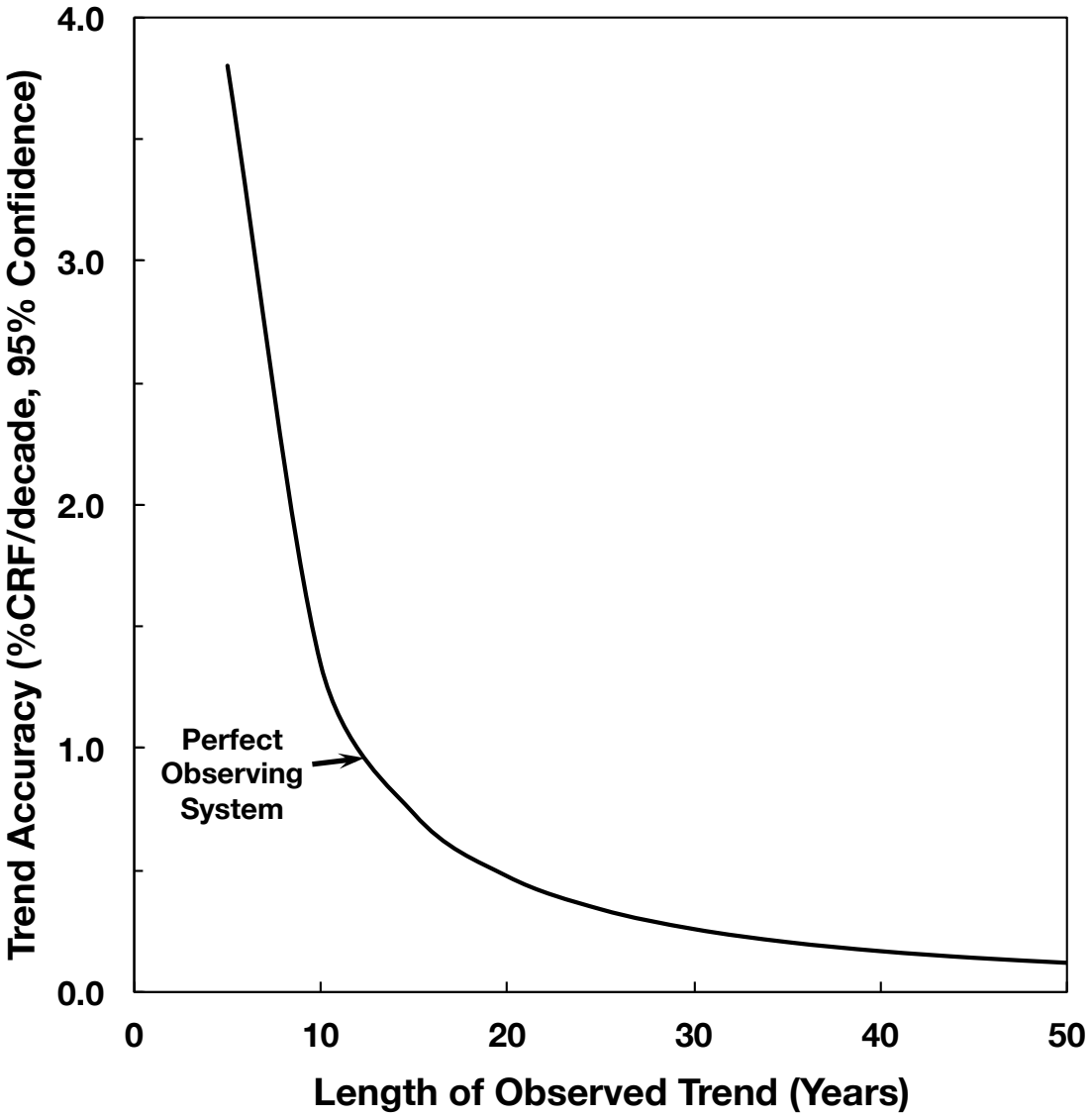
Status

- Journal papers in preparation on Phase 1 results (science and economics journals)
- Proposal submitted end of September for Phase 2 research to NASA Applications program
- Phase 2 Studies:
  - Enable more realistic multiple societal decision triggers
  - Change from step function to time phased transitions from one emissions path to another
  - Examine additional key climate variables:
    - aerosol anthropogenic radiative forcing (e.g. ACE mission)
    - carbon cycle (carbon absorption fraction, sources/sinks) (e.g. OCO/ASCENDS missions), expert panels
    - ice sheet mass loss (sea level rate of change, e.g. ICESAT2/GRACE/DESDYNI missions), expert panels

BACKUPS



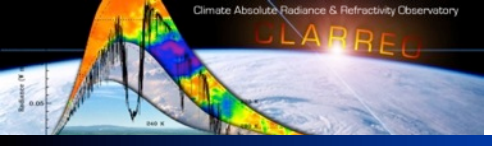
Accuracy and Anthropogenic Climate Change Detection



The length of time required to detect a trend is determined by:

- ***Natural variability***
- ***The strength of the signal***
- ***The accuracy of the observing system***

Even a perfect observing system is limited by natural variability



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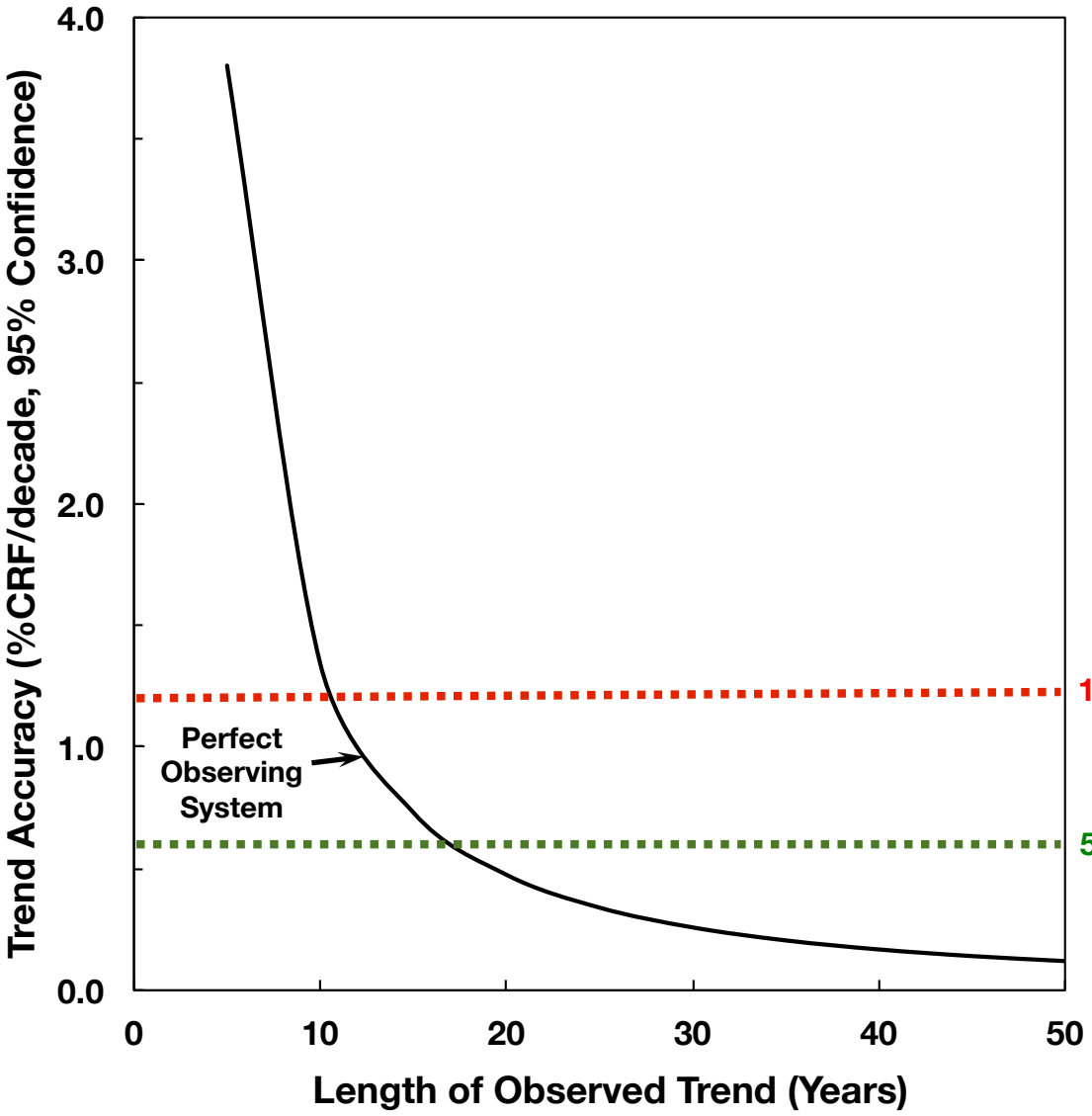
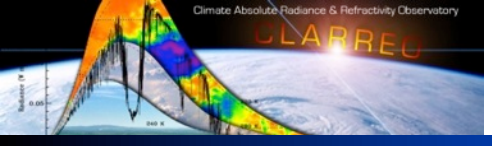


Stronger cloud feedback signals can be detected sooner.

Weaker cloud feedback signals may require substantially longer observation records

Confidently detecting small climate signals requires decadal observations



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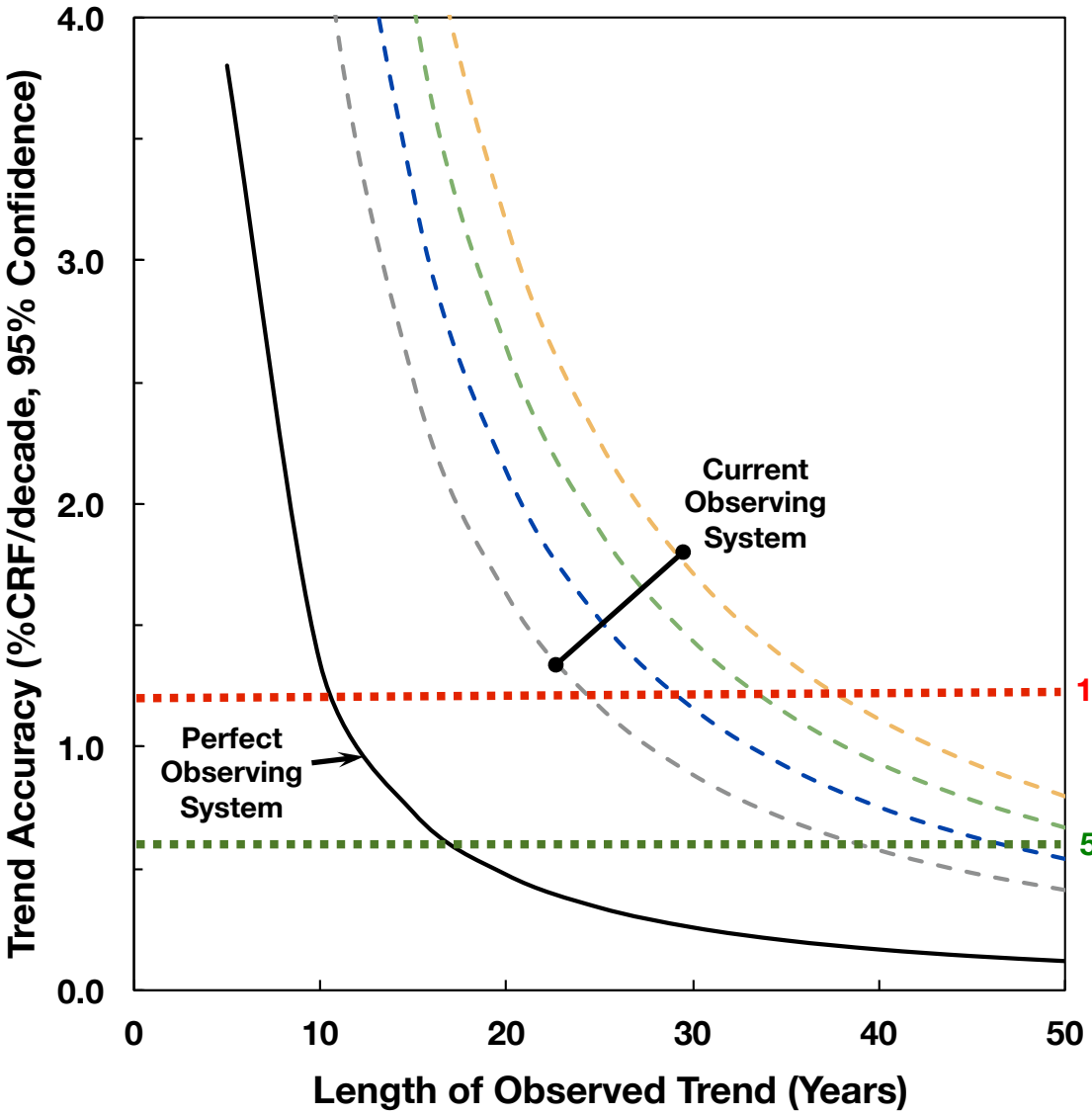
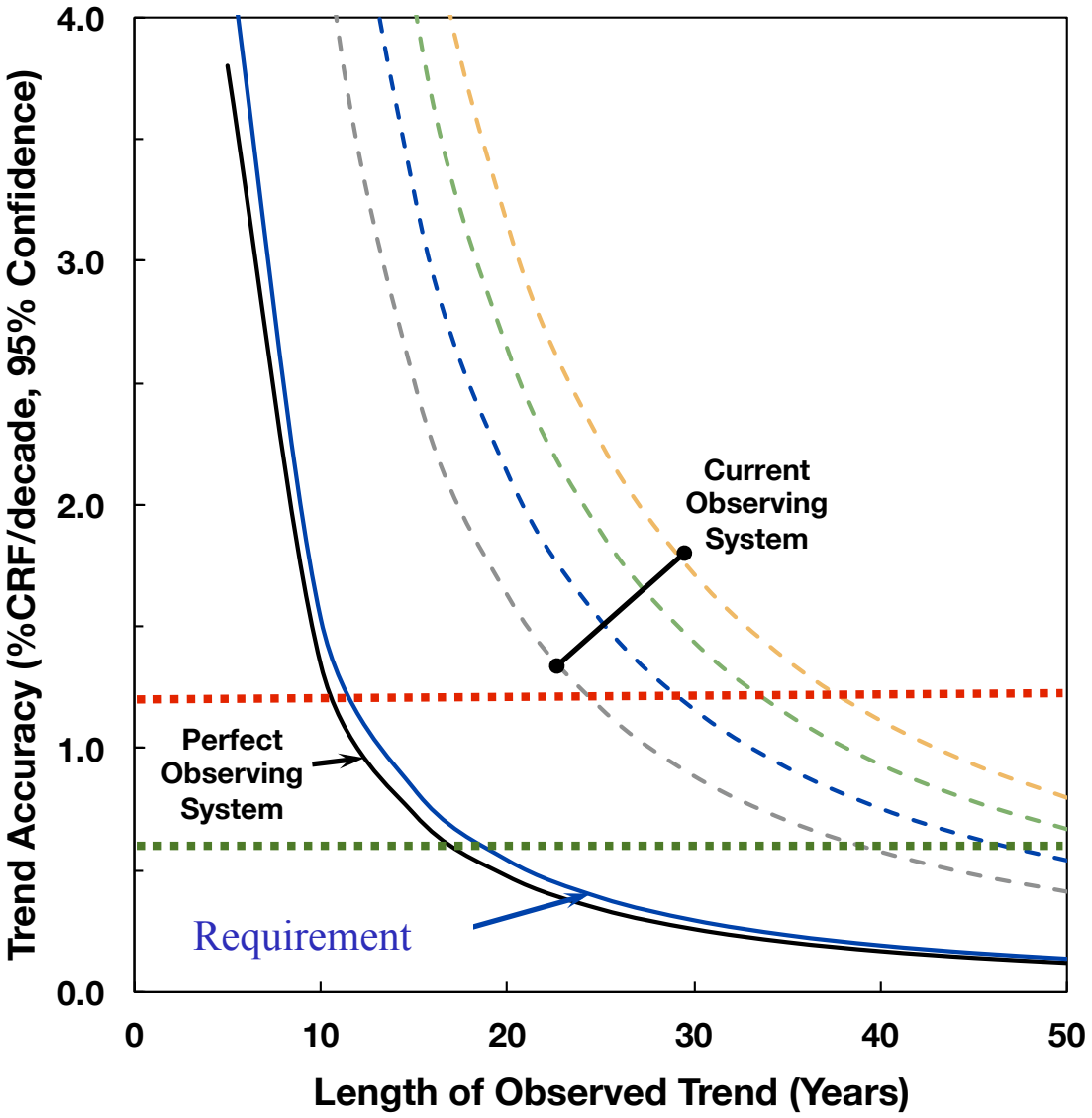


The limited accuracy of the current observing system significantly increases the observation time required to confidently define climate sensitivity

Defining climate sensitivity will take 40-50 years with our current sensors

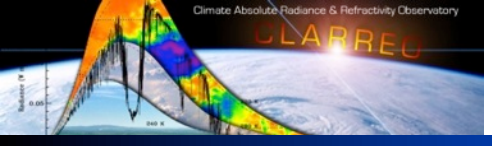
Accuracy and Anthropogenic Climate Change Detection



Improving the accuracy leads to dramatic reductions in the time to define climate sensitivity

This will lead to more accurate climate projections for decision makers

Accuracy improvements would allow timely societal decisions



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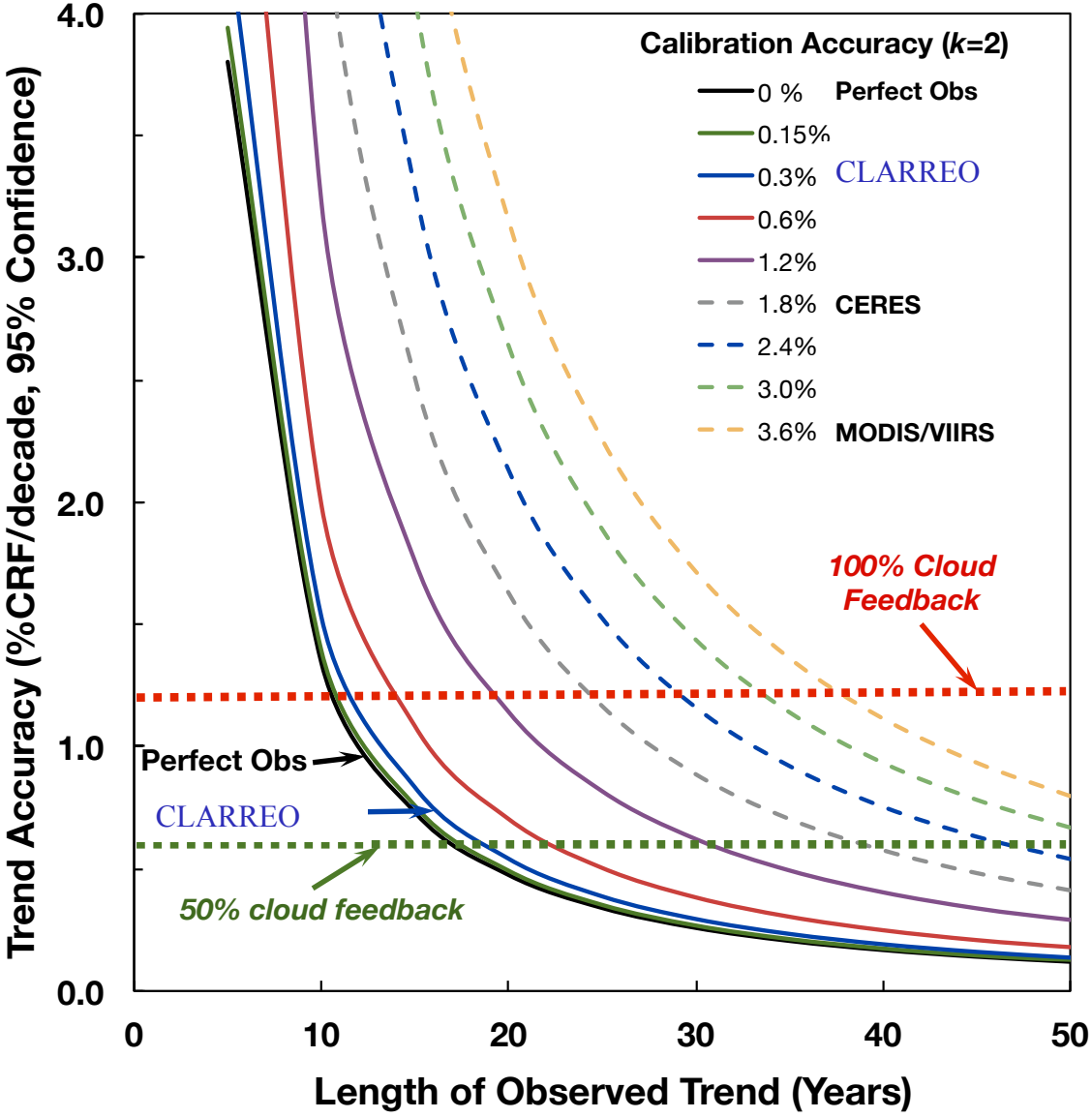

Current instruments forced to rely on weaker stability assumptions and data gaps kill climate records.

Current system is high risk and fails to achieve high confidence levels.

Future missions like the CLARREO Decadal Survey mission act as "NIST in Orbit" to bring this accuracy to both reflected solar instruments like CERES/VIIRS/Landsat as well as infrared instruments such as CrIS/IASI/VIIRS

Climate change requirement is 0.3% absolute accuracy (95% confidence)