Socio-Economic Benefit Assessment of Global Earth Observations

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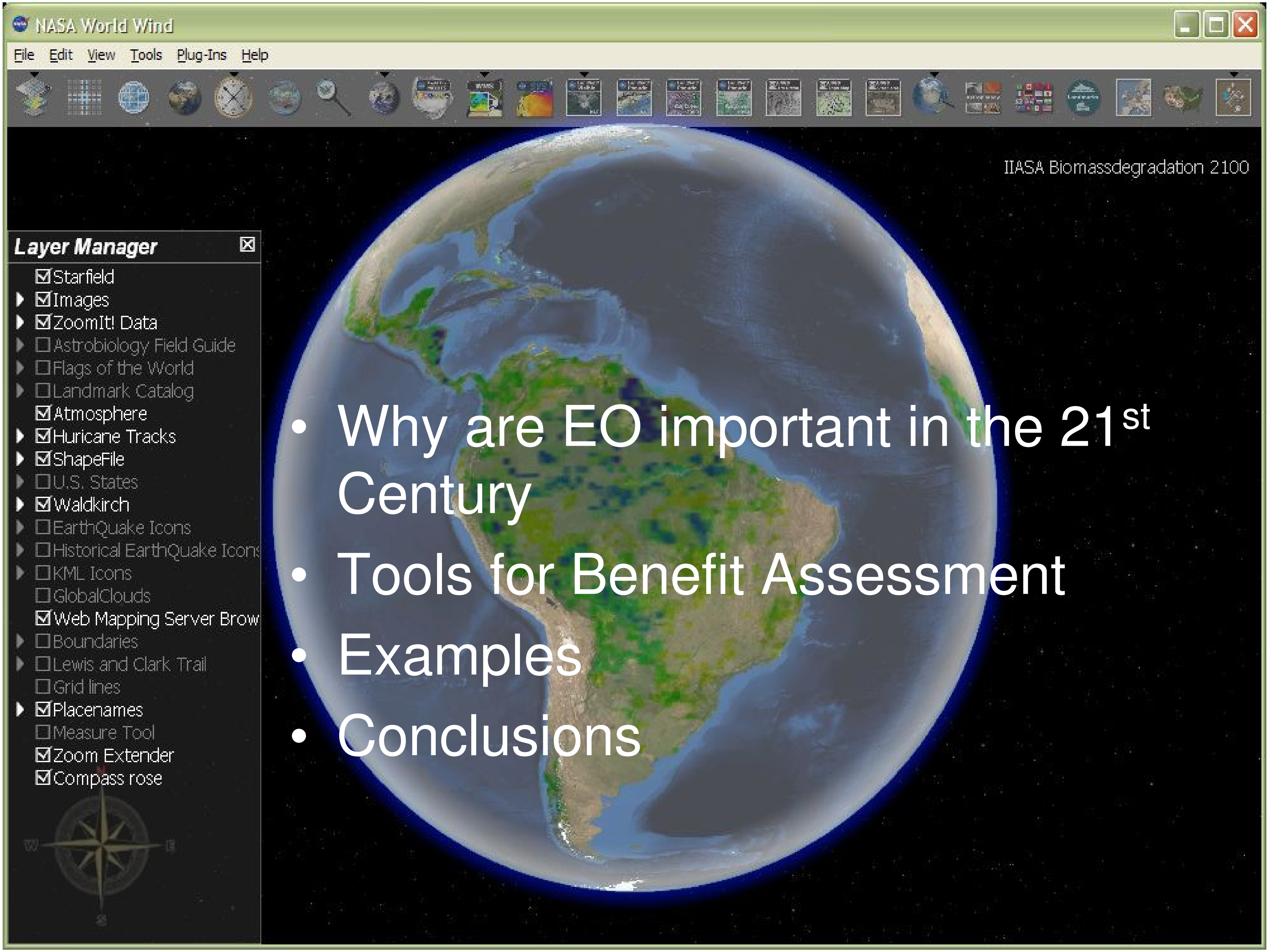
UN/Austria/ESA Symposium

GrazWorshop, 11th Sept07



- Why are EO important in the 21st Century
- Tools for Benefit Assessment
- Examples
- Conclusions

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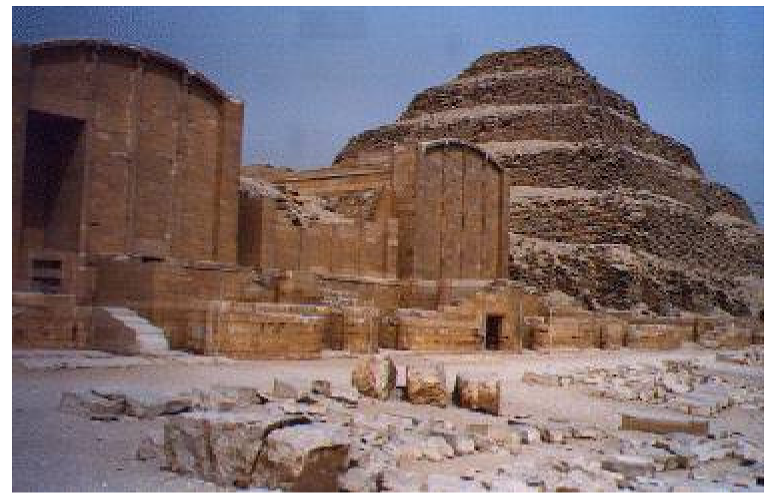
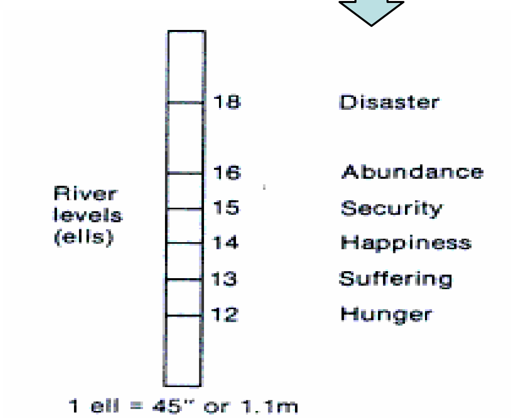
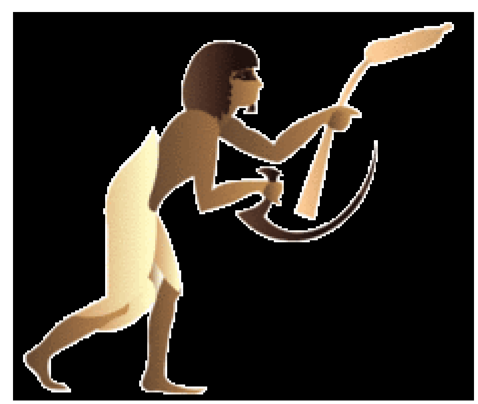
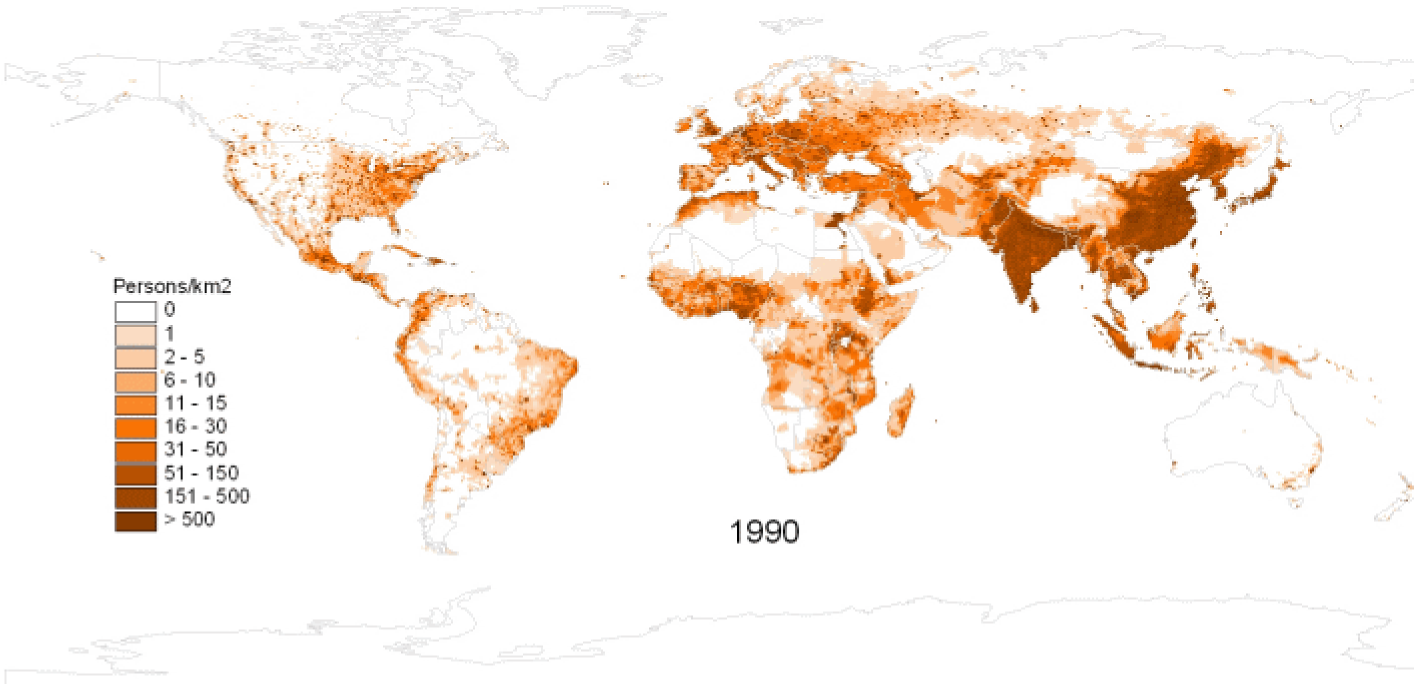
EO – We have benefited from it for a long time



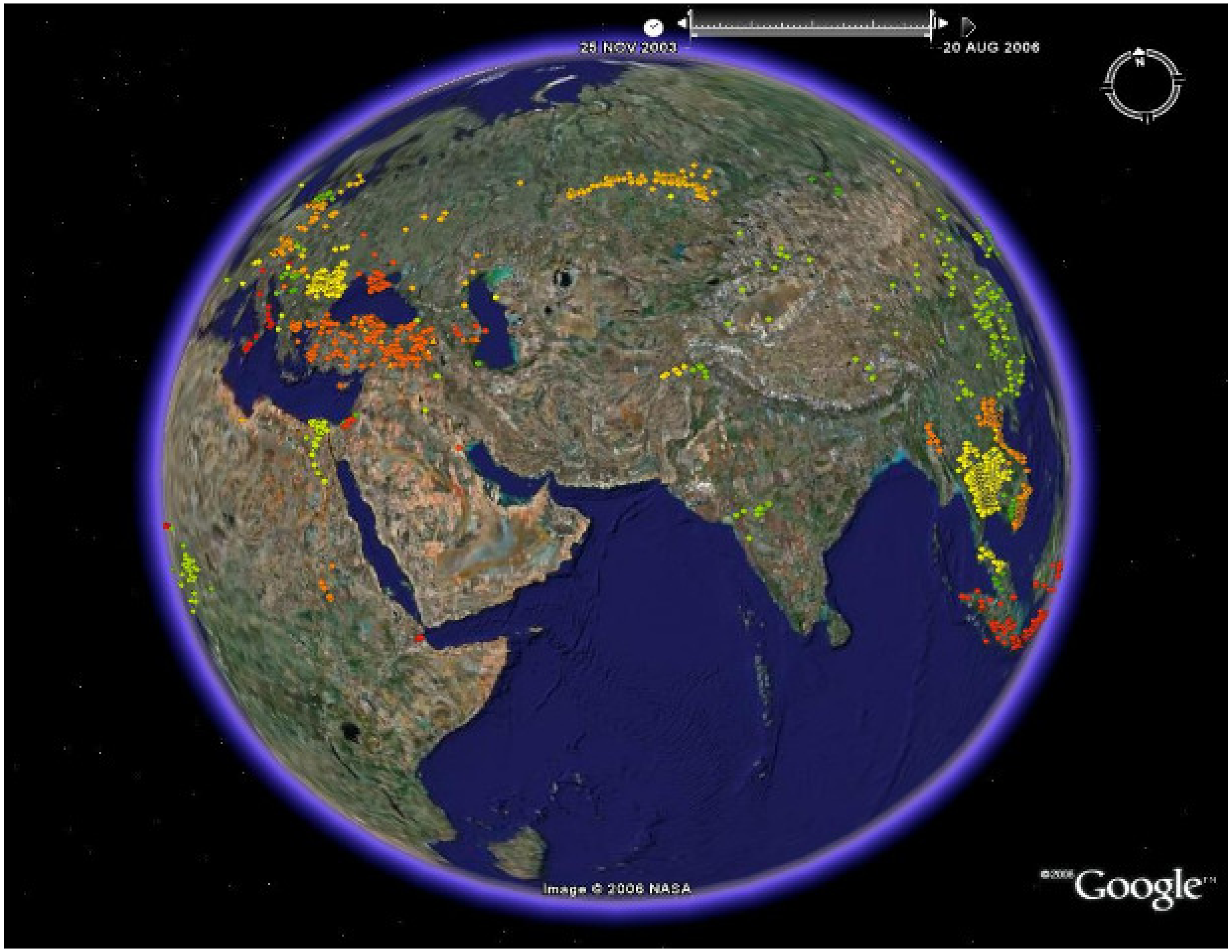






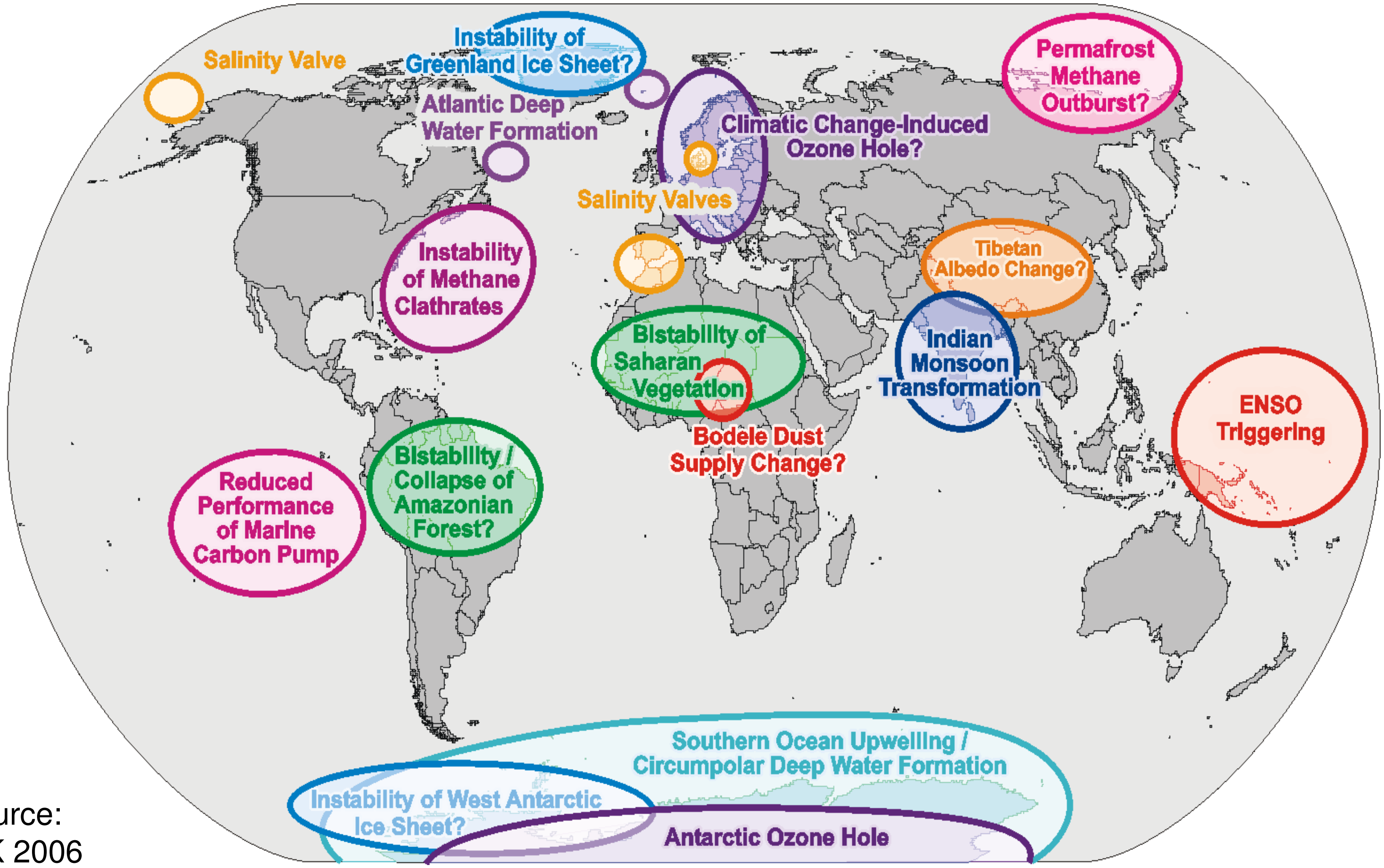
Population density dynamics 2010-2100, B1

Avian Flue Epidemic



Source: declanbutler.com

Tipping Points in the Earth System



Source:
PIK 2006

What would a Tipping Point Early Warning System look like?
What would a monitoring system for sustainability look like?

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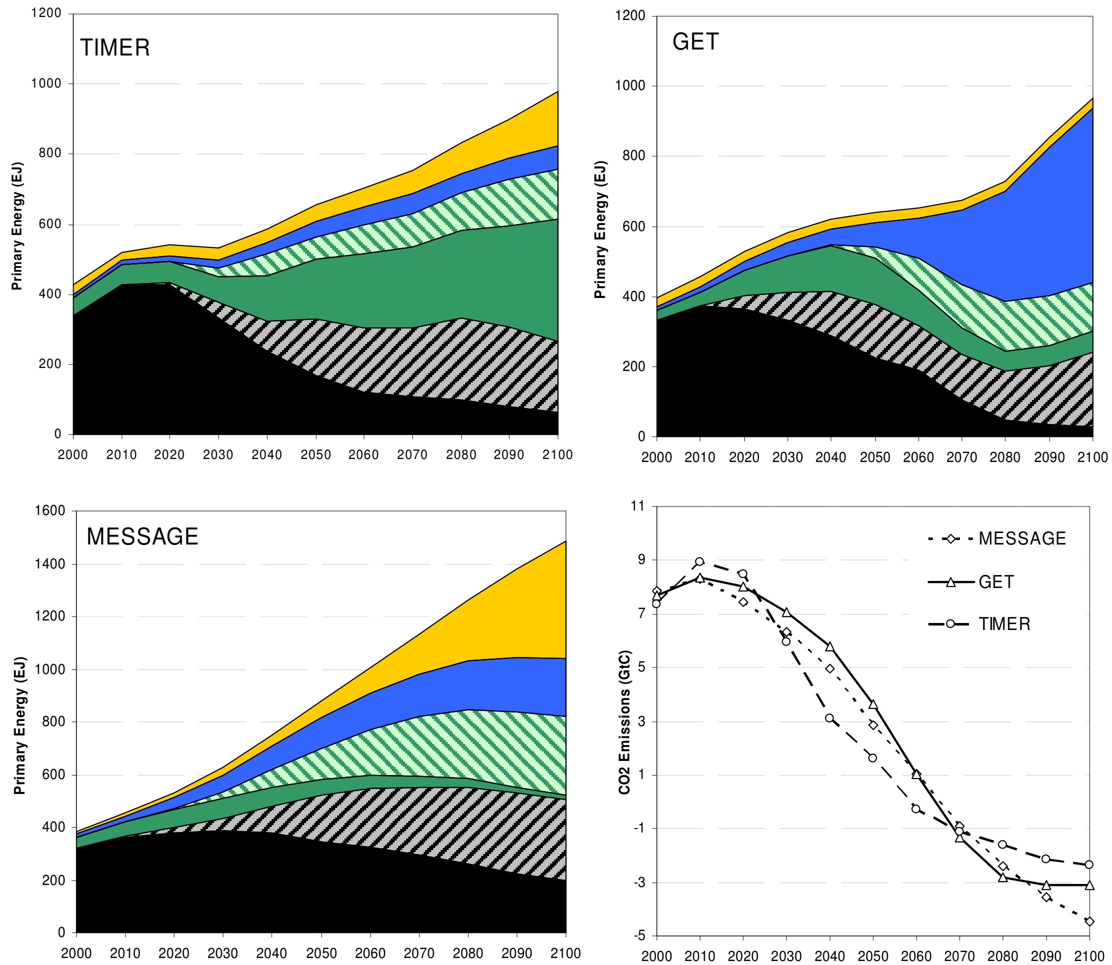
Global Energy Portfolio



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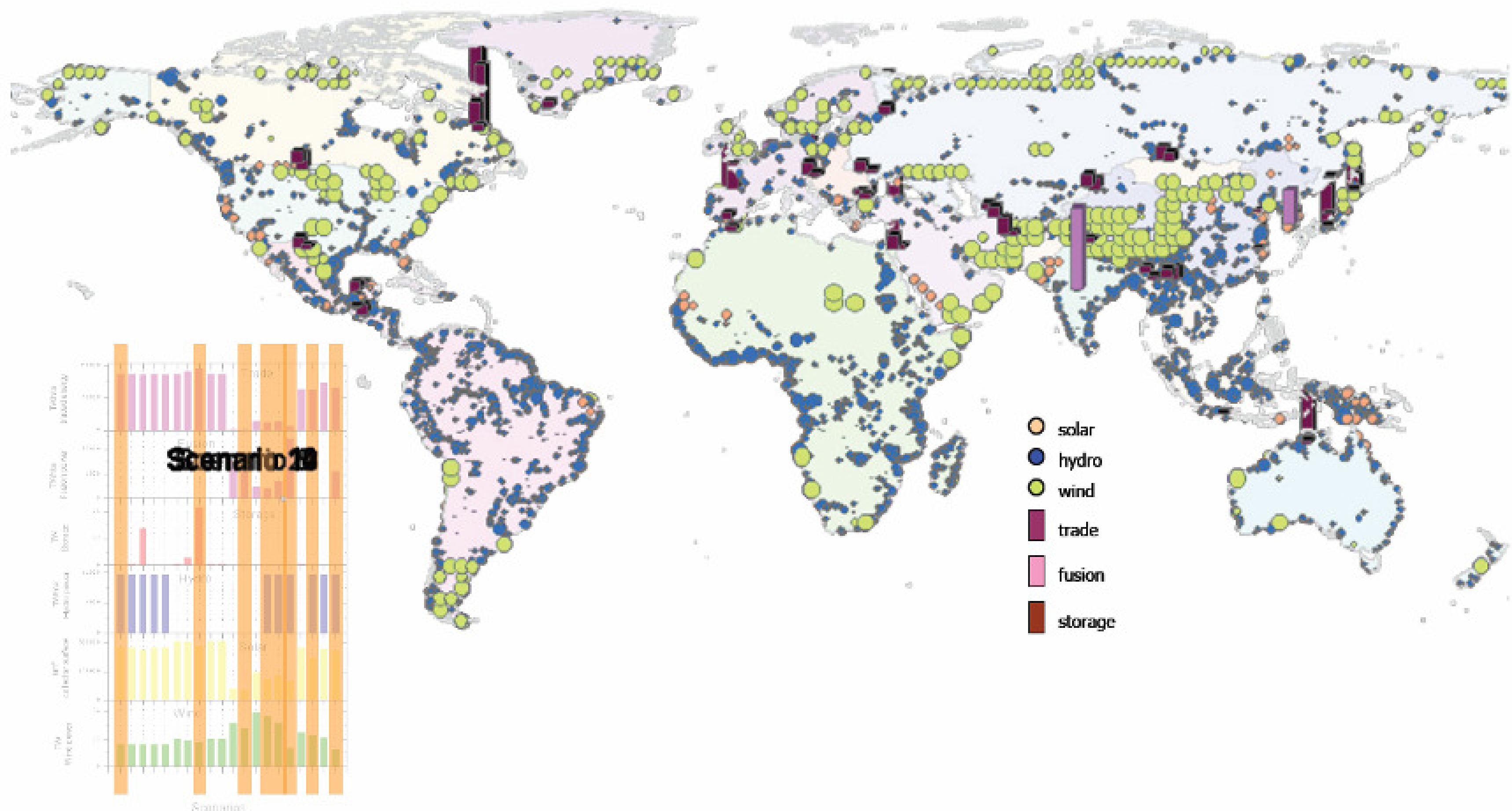

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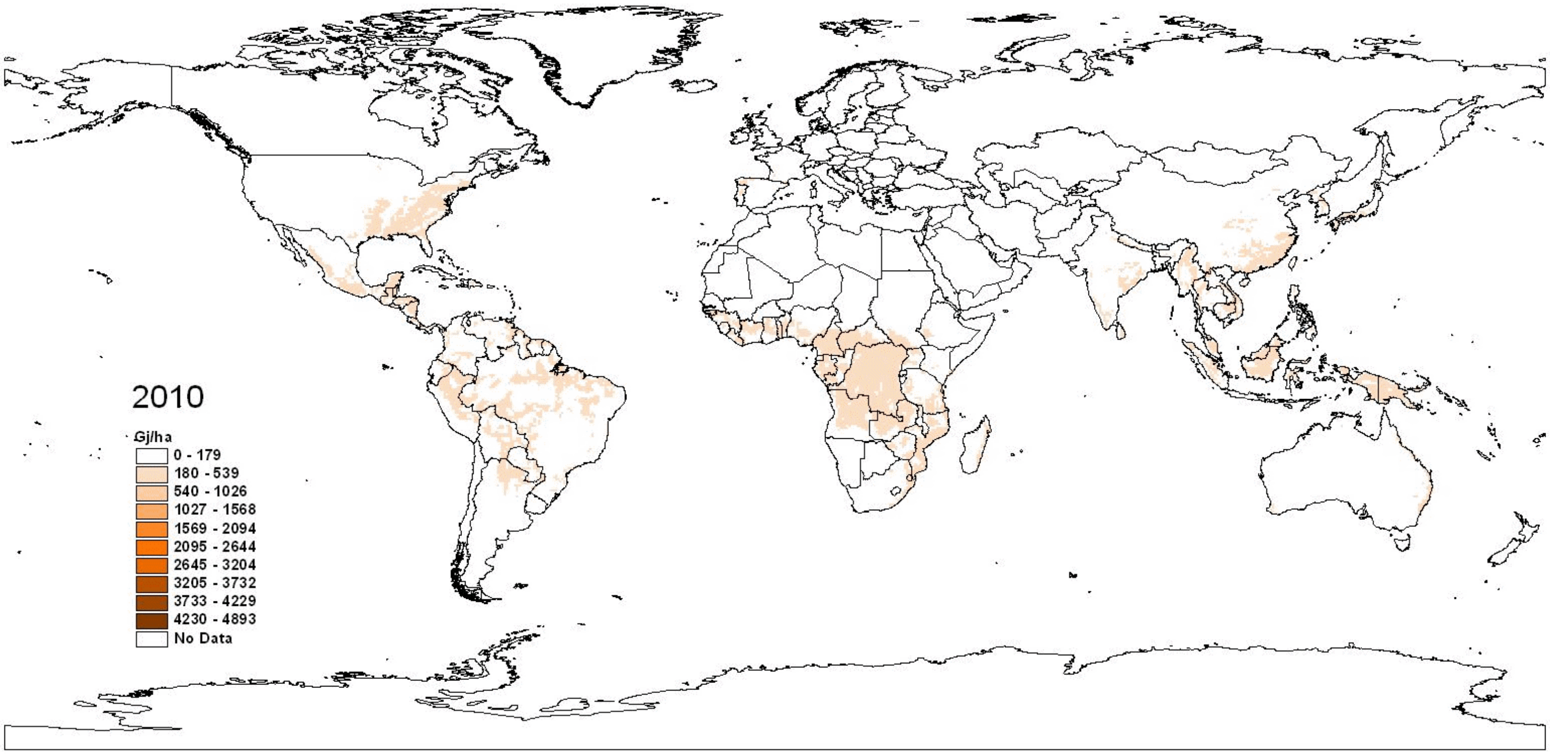
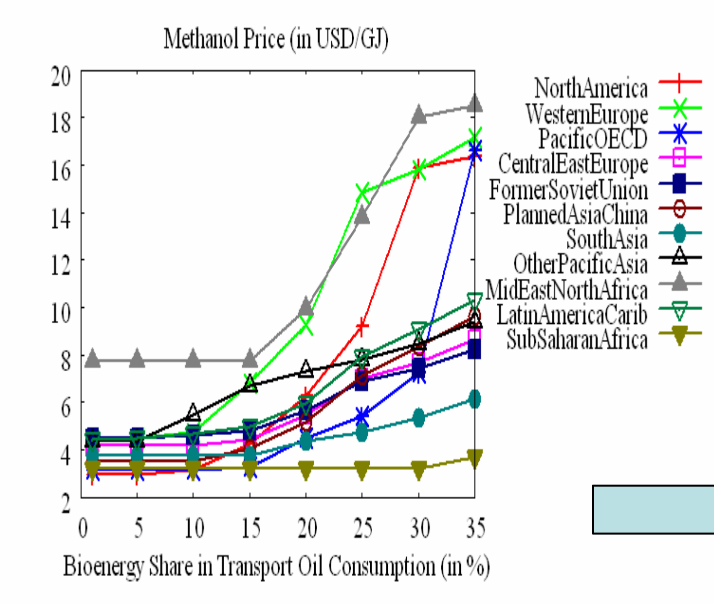
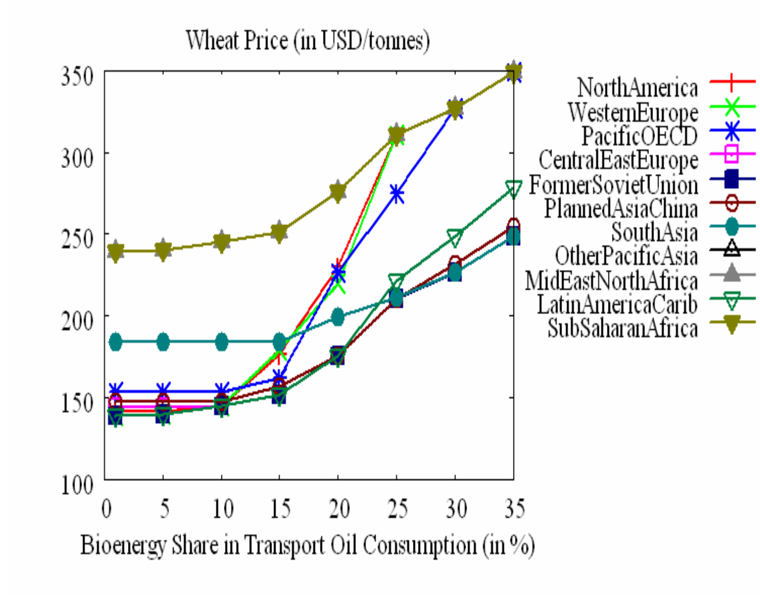


Bioenergy Supply for 2000-2100
B2 (Price < 6$/GJ)

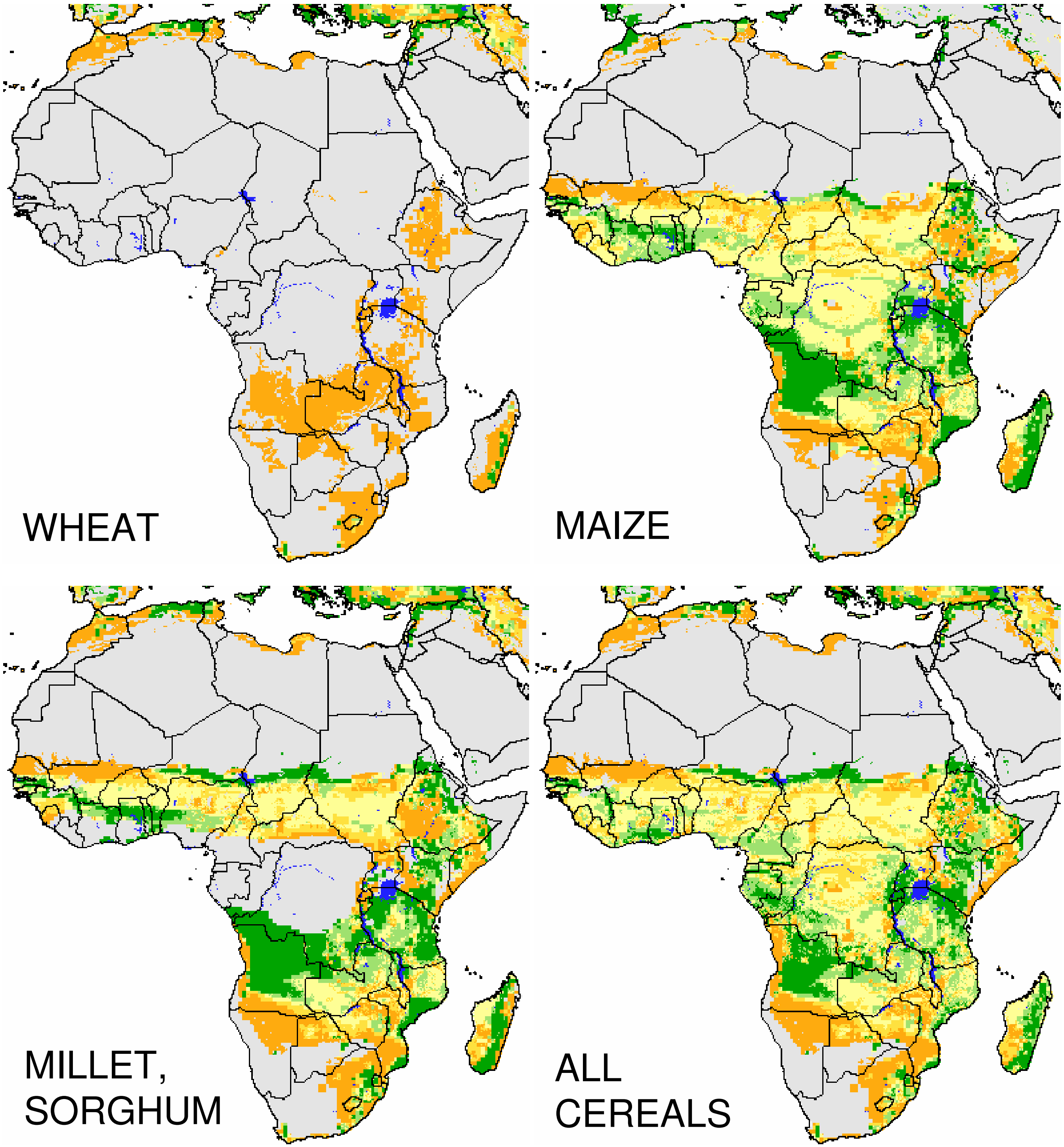
Competition over Land





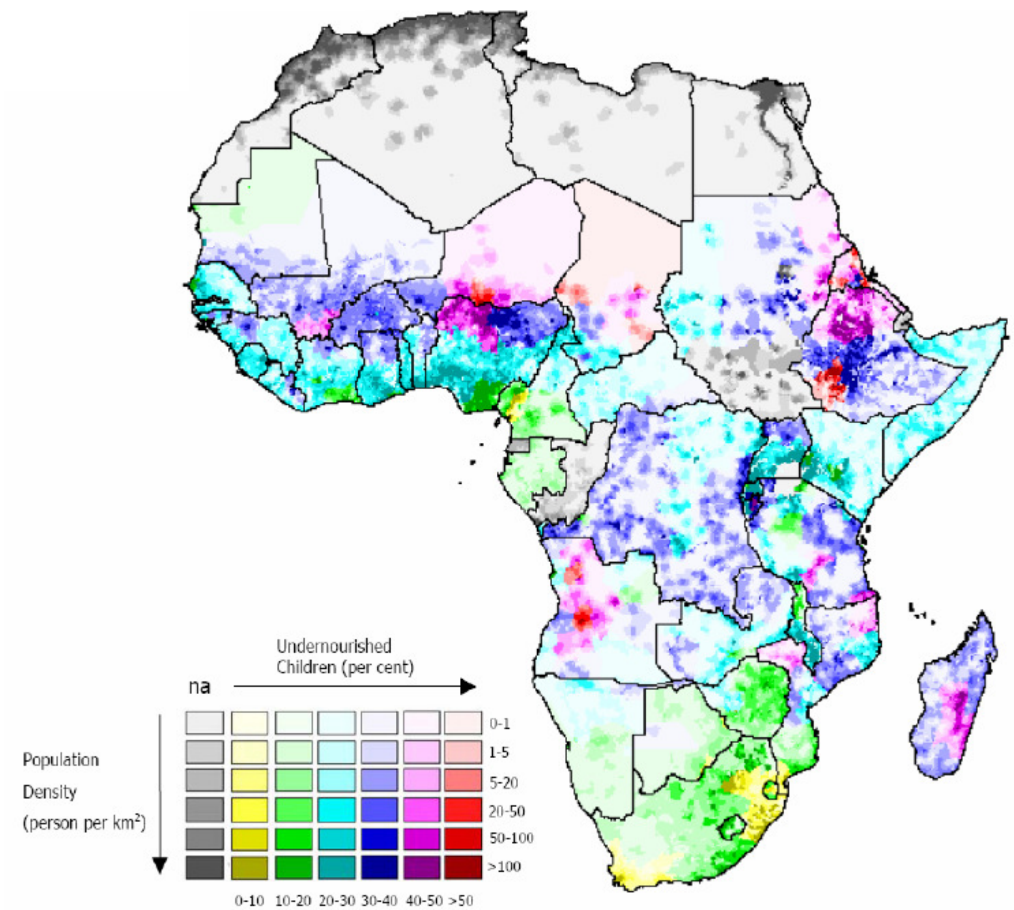
Changes in Rain-fed Cereal Potential

Reference climate vs climate of 2080s
HadCM3-A2 Scenario



Source: Tubiello and Fischer, 2006

Geography of Social Sphere: Undernourished children



Source: Keyzer 2006

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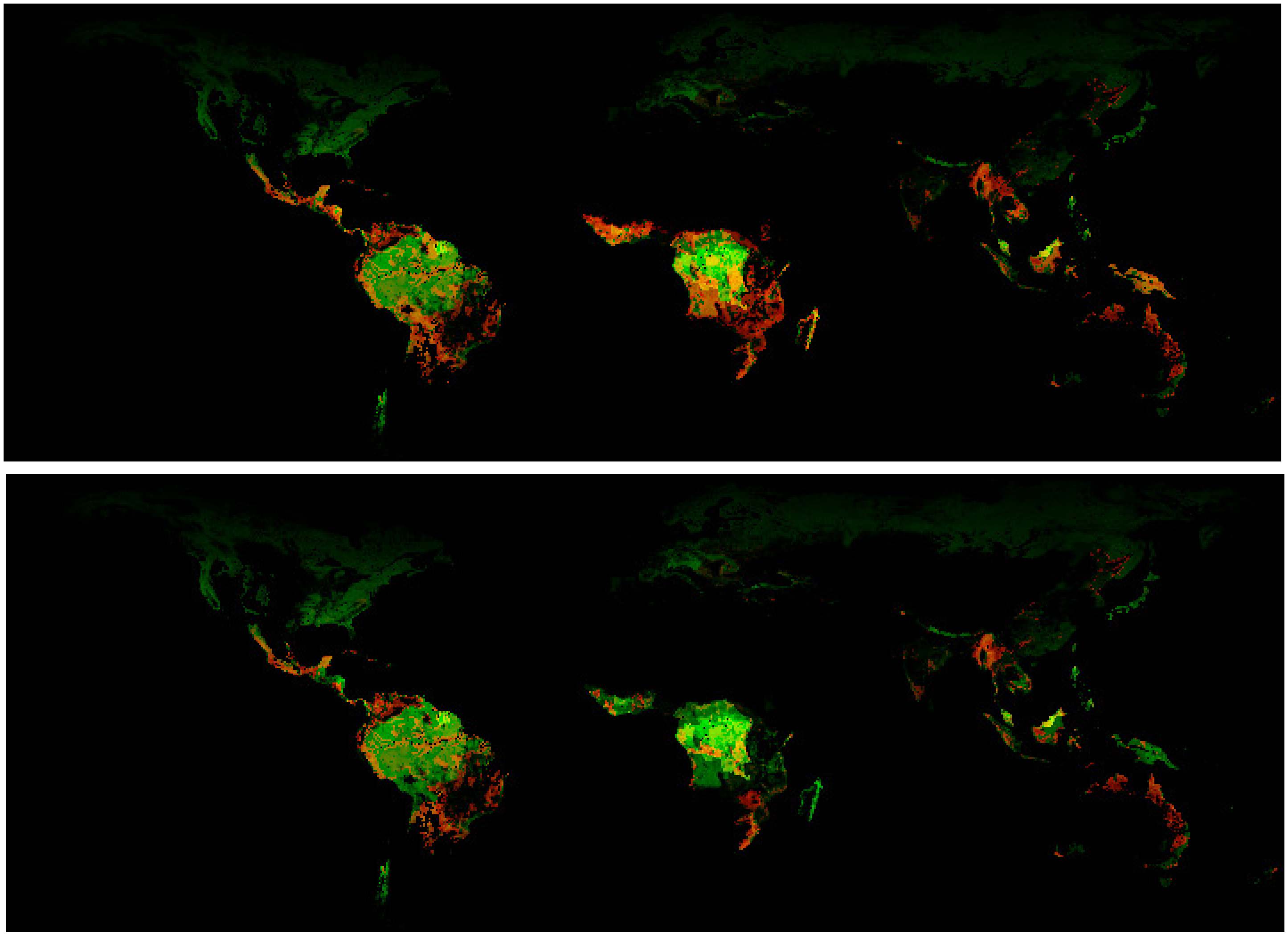
Cutting Deforestation in Half by 2025



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The world will be ONE world of change:

… governments will be asking for informatior

… observations systems need 20 years to be designed, tested, implemented

… the time to start their design is now

… and we need to document today‘s baselin of a world with only „small“ change

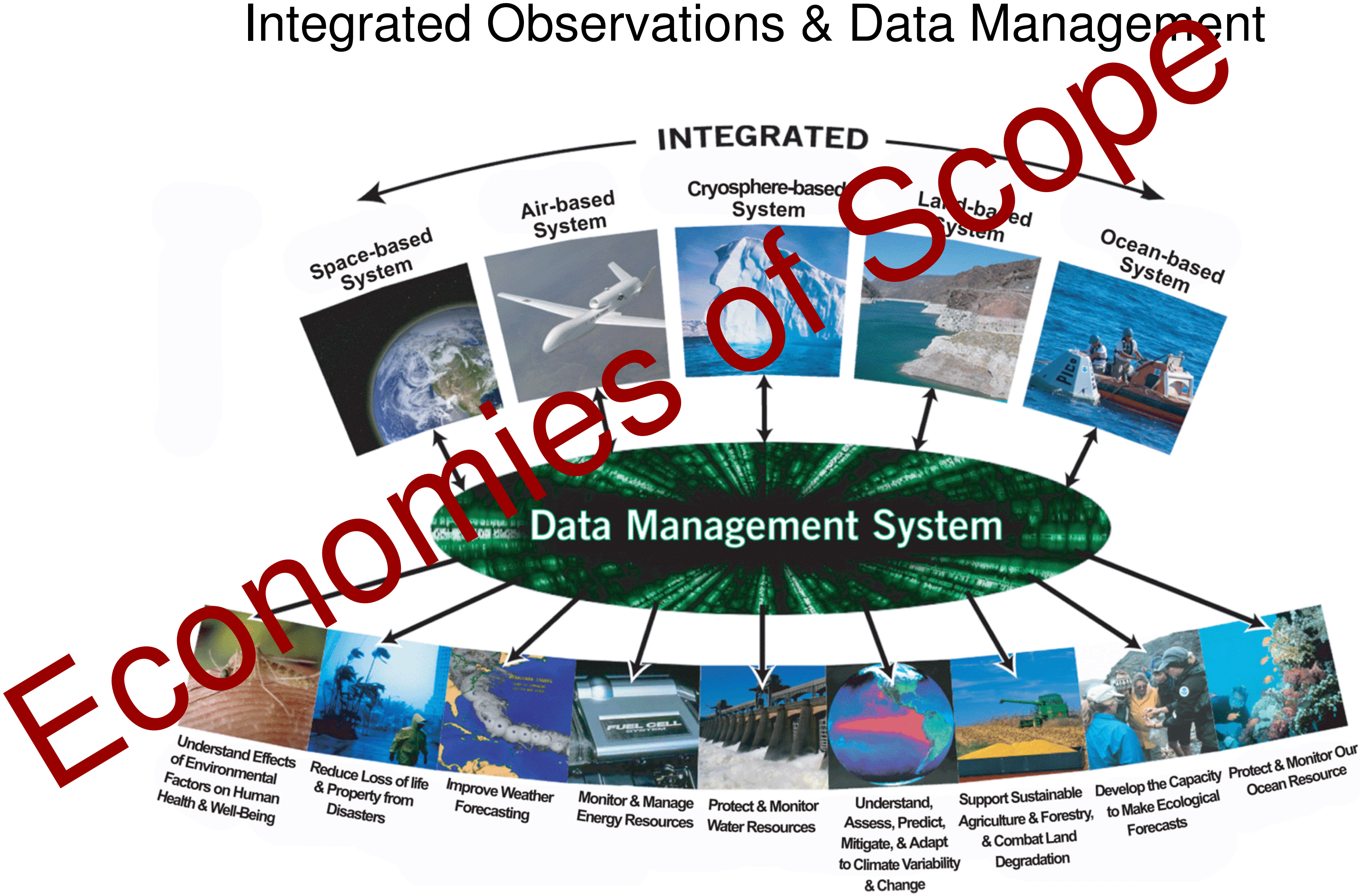
→ GEOSS idea

Blind Man Walking…..

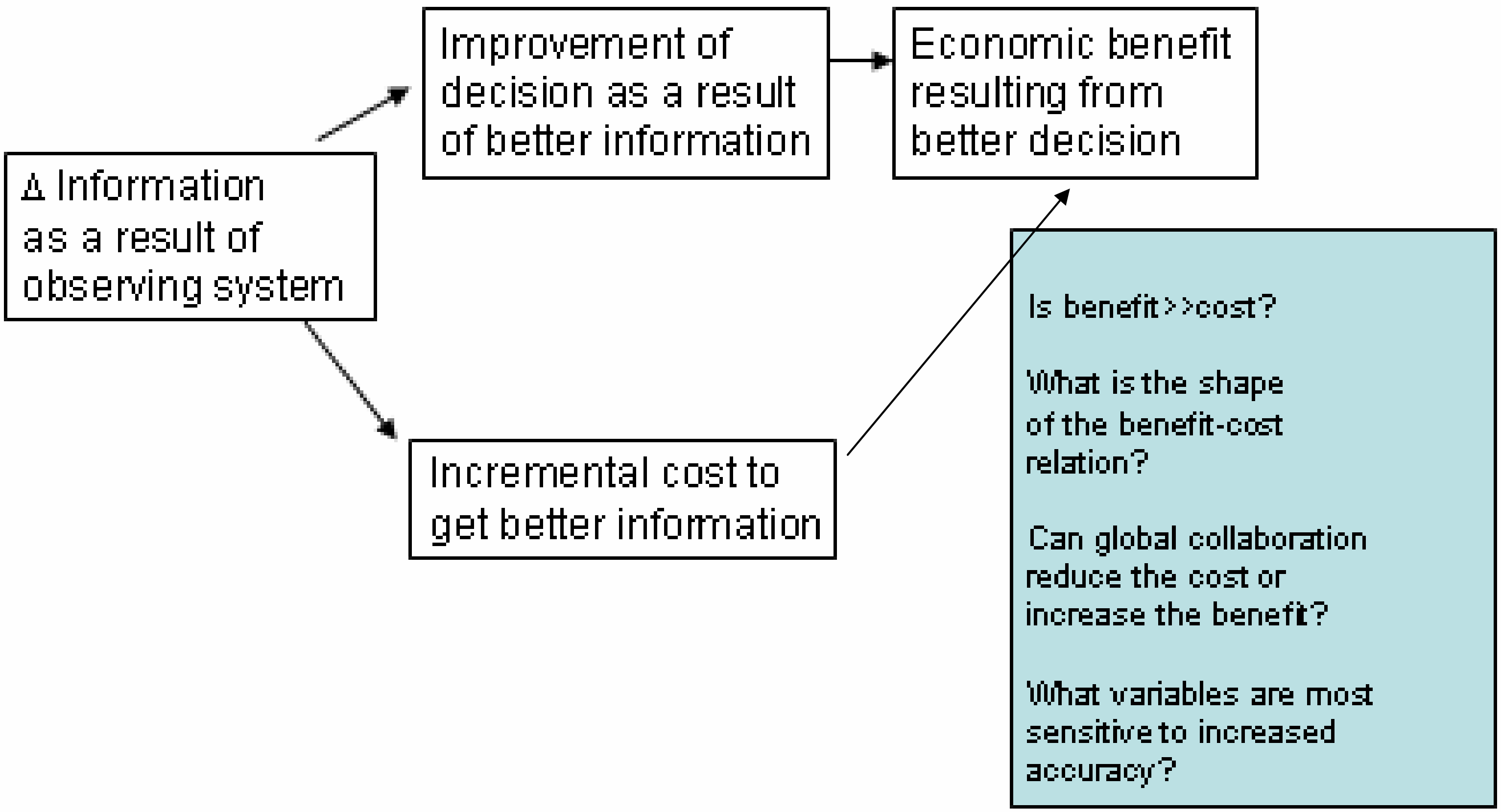
- GEOSS
  - SoS
  - Global Cooperation

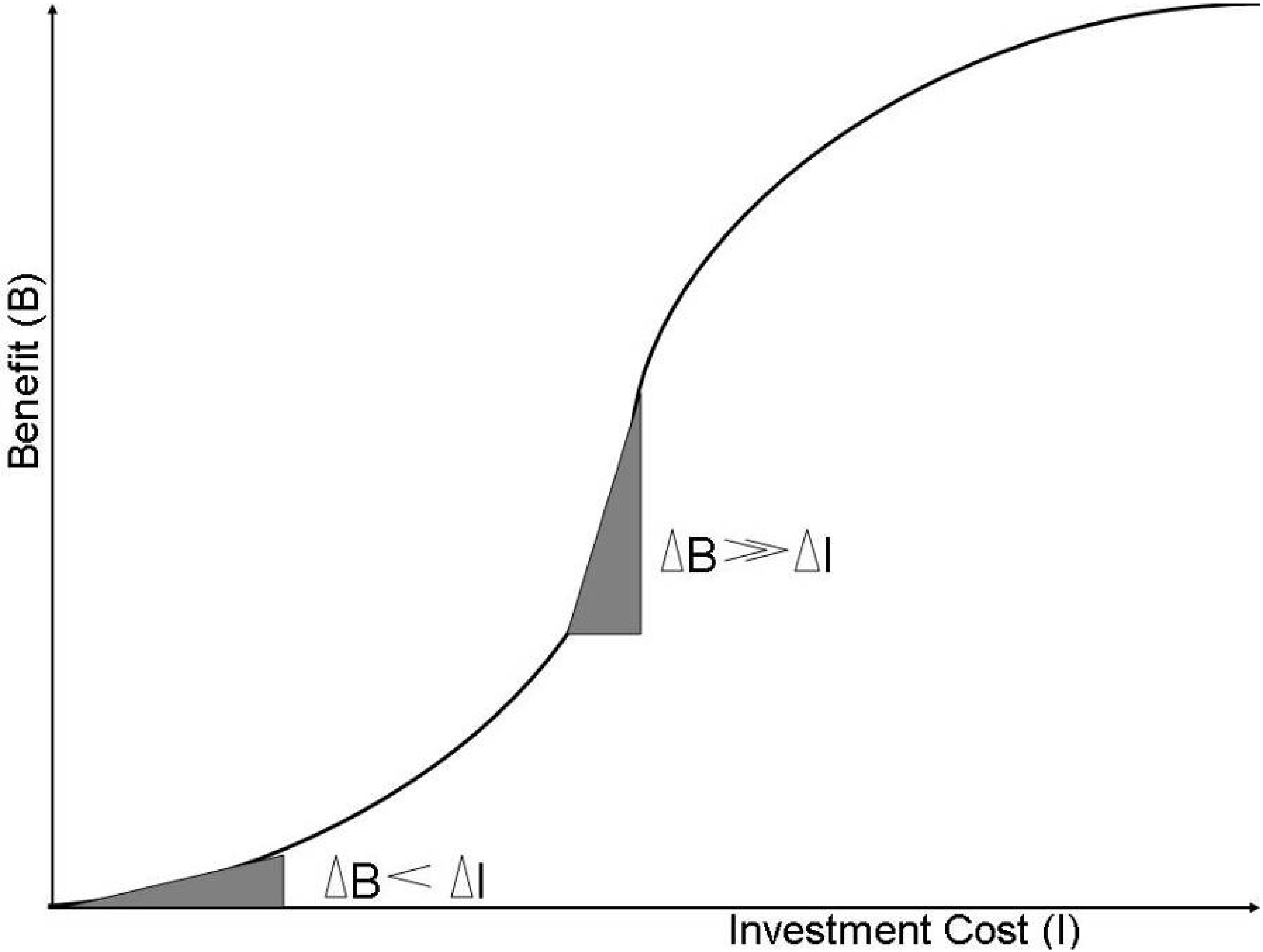
Global Earth Observation System of Systems

Integrated Observations & Data Management



Building a value chain for observation systems




Benefit (B)
ΔB ≫ ΔI
ΔB < ΔI
Investment Cost (I)

Improvement though higher spatial resolution

Increasing spatial resolution

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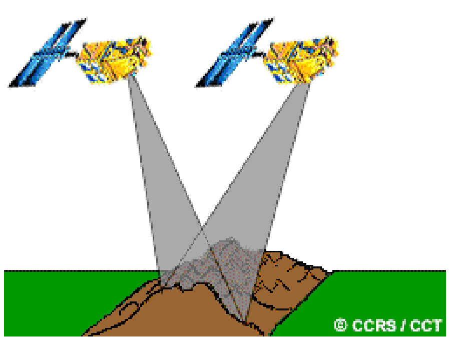
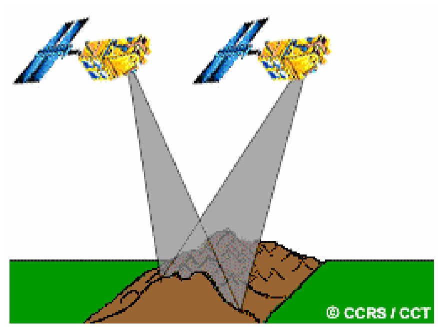
Improvement though higher temporal resolution

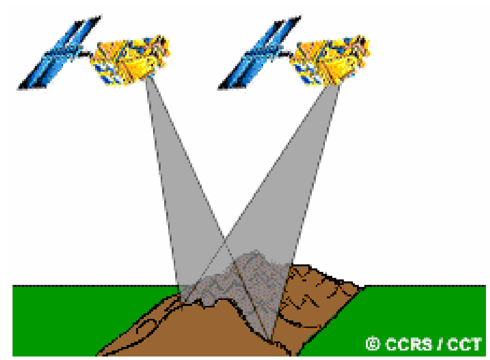
16 days



1 day



15 minutes



Increasing temporal resolution

http://www.earsc.org/web/pdf/workshop07/DCarrasco.pdf

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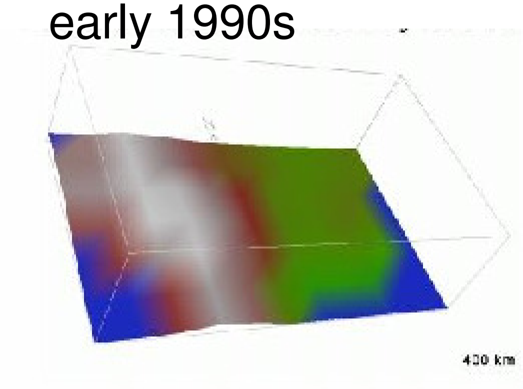
Improvement through better integration of Satellite EO and in-situ

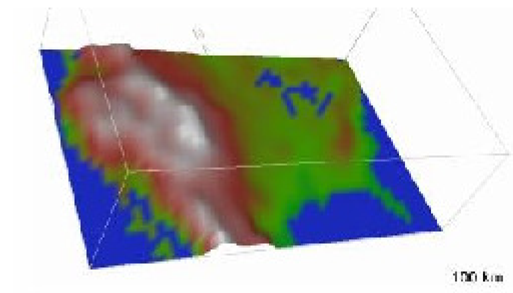
better integration

Improvement through better and improved models (models informed by observations)

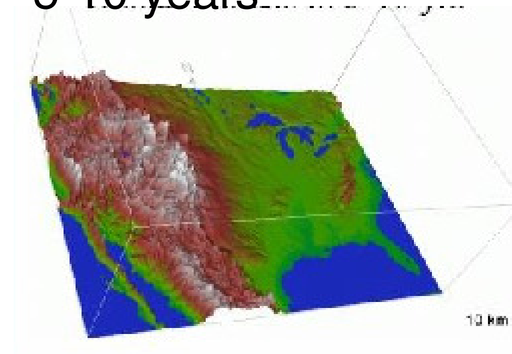
Climate Models early 1990s



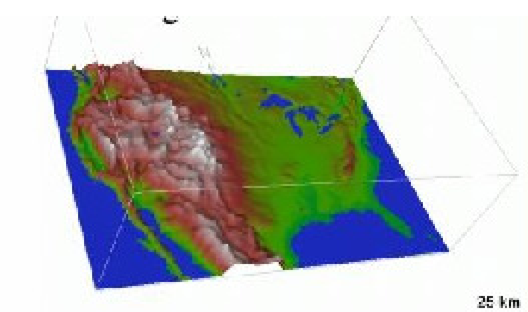
Global coupled climate models in 2006



Global Models in 5-10 years

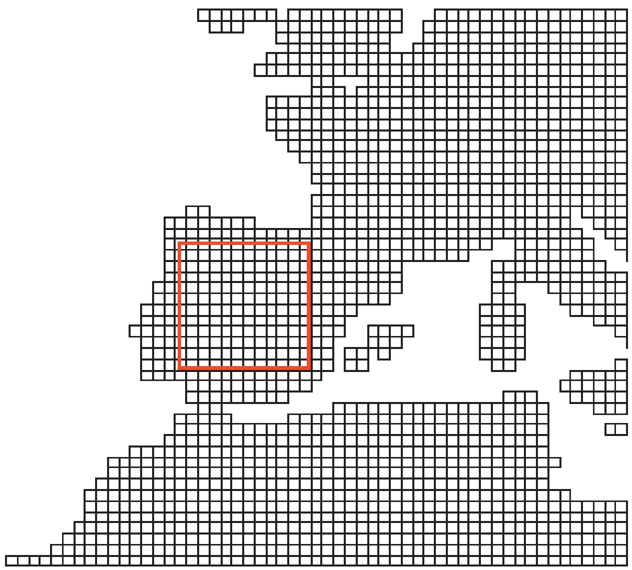


better models



Comparison with current regional model (resolution 25 km)

Source: NCAR



The area partly covering the territory of Spain and Portugal located approximately between -7.5W, 42.0N & -0.5W, 38.0N.

- "Fine" grid: 12 x 12 cells, 50 x 50 km each:
- "Rough" grid: 6 x 6 cells, 100 x 100 km each:

FDC ν	Frequency of air patrol	FDO[1] $\Delta t(\nu)$	BA[2] $d(\nu)$	APD[3] $c(\nu)$
I	no patrol	24	0.85	0
II	once in 2 days	15	0.36	1250
III	once daily	6	0.08	2500
IV	twice a day	3	0.03	5000
V	three times a day	2	0.02	7500

[1] Fire duration until observed (hours). We assume it to be constant depending on the fire danger class only.

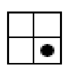
[2] Burned area (km^2). We allow 2 hours to extinguish the fire.

[3] Area patrolled per day (km^2).

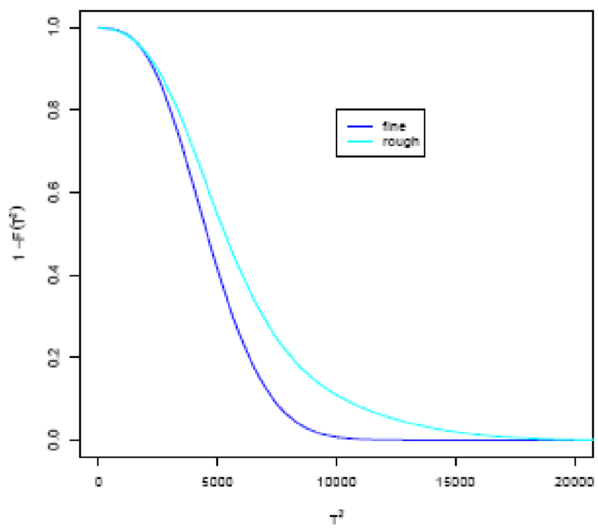
Results

	Rough* grid	Fine grid	Improvement
Burnt area, ha	74 899	55 887	25.38%
Patrolled area, km^2	112 305 000	108 237 500	3.62%

*Bottom right subcell represents the weather data for aggregated cell:

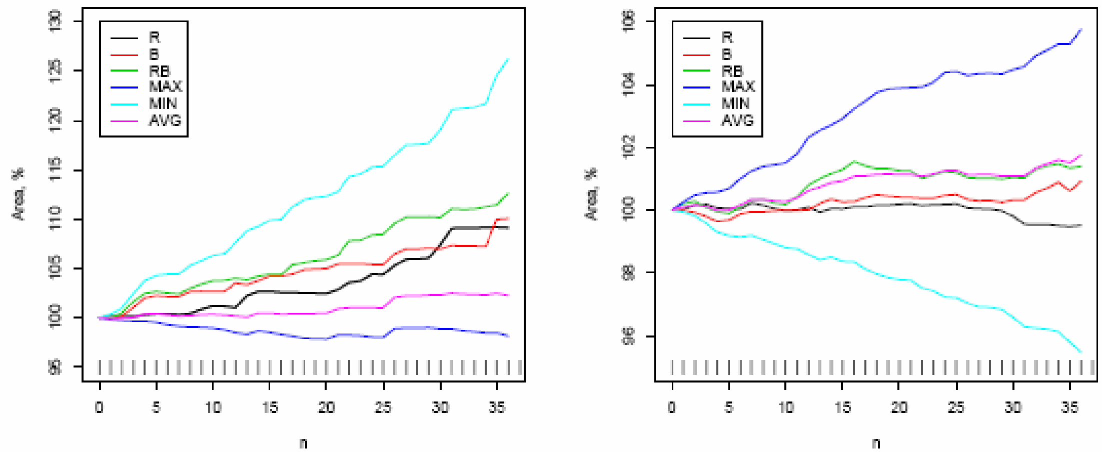


Extreme events probability



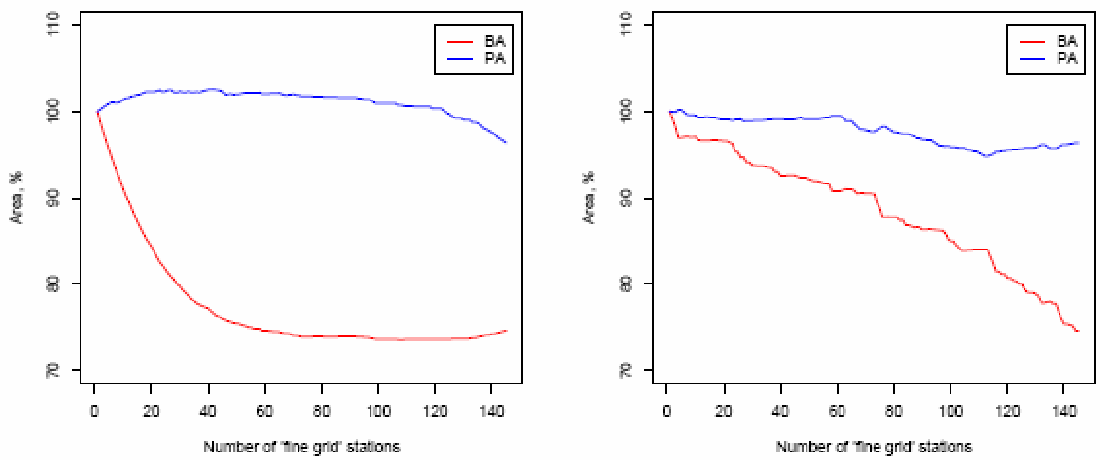
Probability of an event larger than T^2 ($\sim$ burned area).

Reduction of number of weather stations



Burned and patrolled areas. An inactive weather station is substituted by the neighboring station next to the Right, Bottom, Right-Bottom, and based on the Max, Min, and Average value of the Nesterov index.

Combining datasets

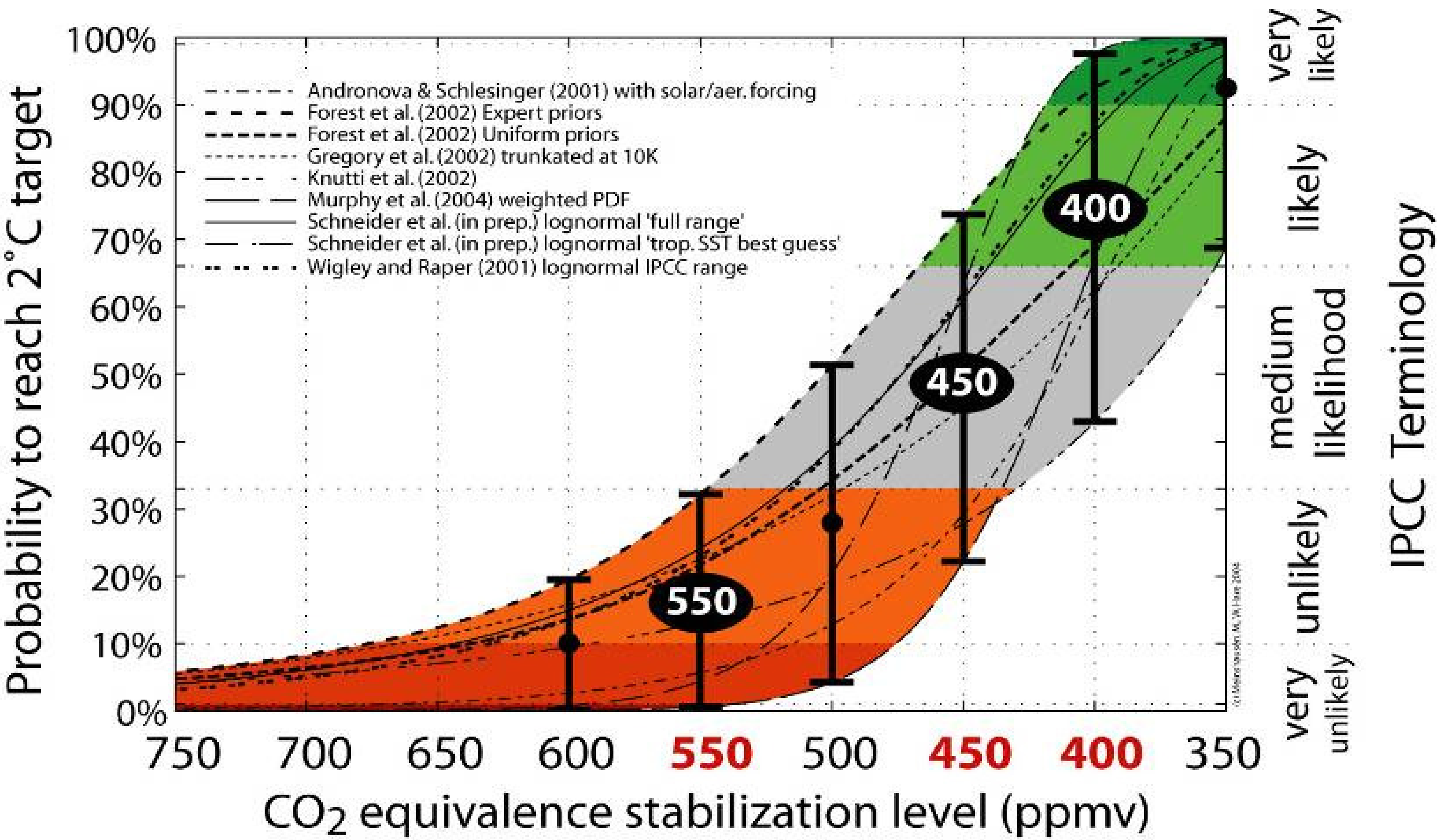


Rough dataset is refined by adding weather stations in most critical cells in terms of burned area (left) and patrolled area (right).

Conclusion from Forest Fire Experiment

- SoS delivers **economies of scope** rapidly
- Incremental increases in resolution deliver **incremental benefits**
- New observing system calls for new fire fighting rules - **innovation**

Meeting the 2℃ objective



Source: Mainshausen, Hare 2004

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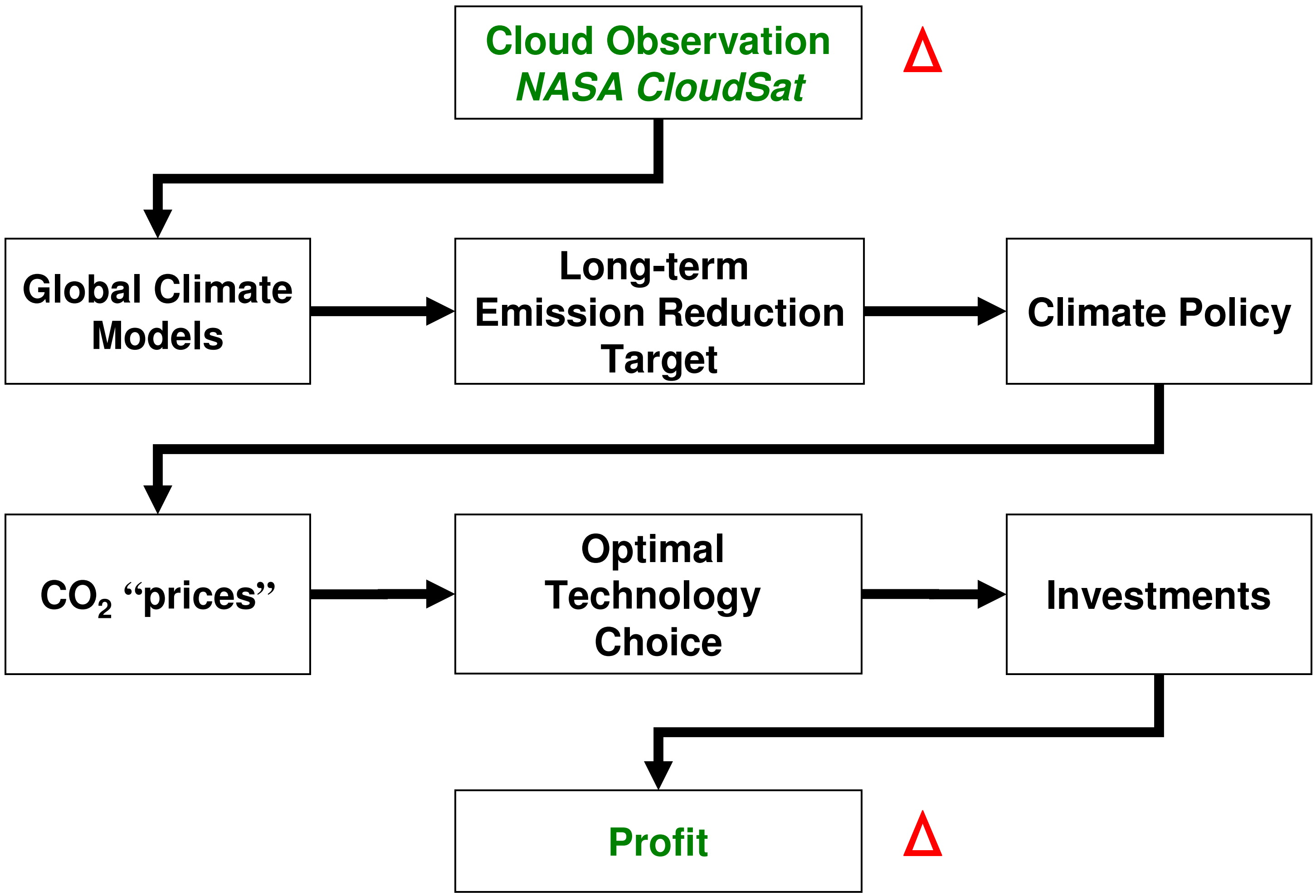
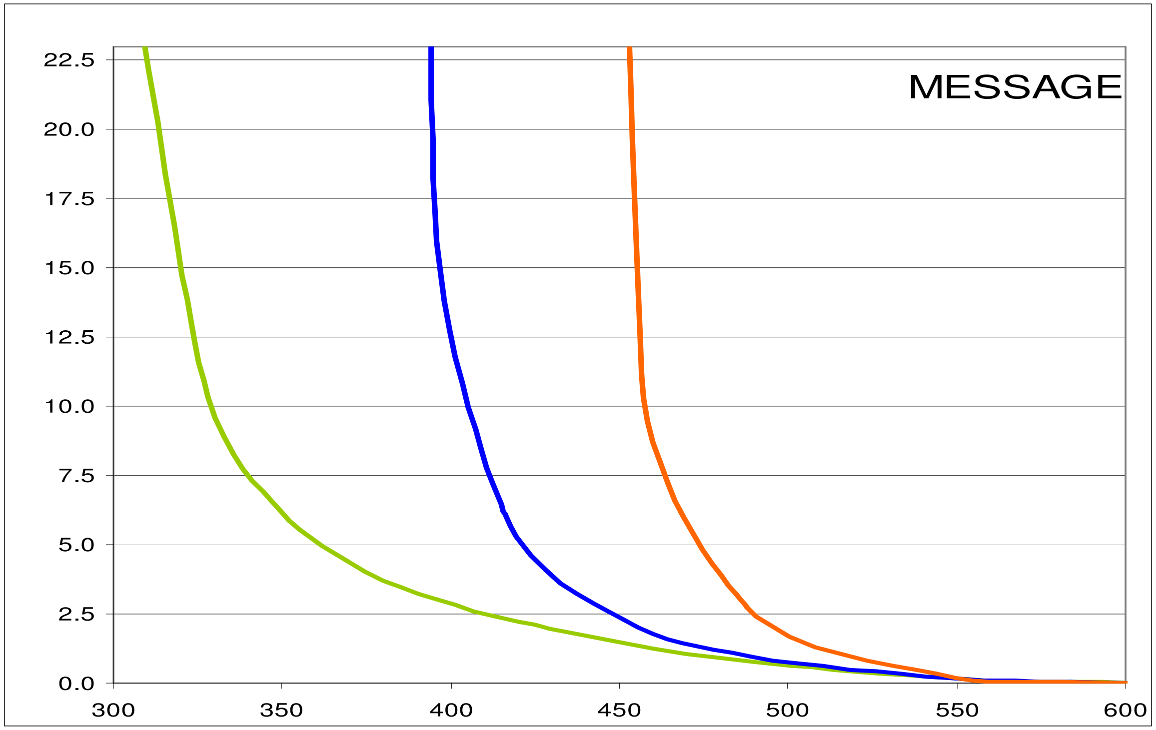
Observations ⇔ Benefits Chain



Net present value costs for atmospheric CO_2 stabilization by the year 2100



Green ~ BECCS is included
Blue ~ fossil CCS only
Red ~ no CCS

Trillions of 2000 US$

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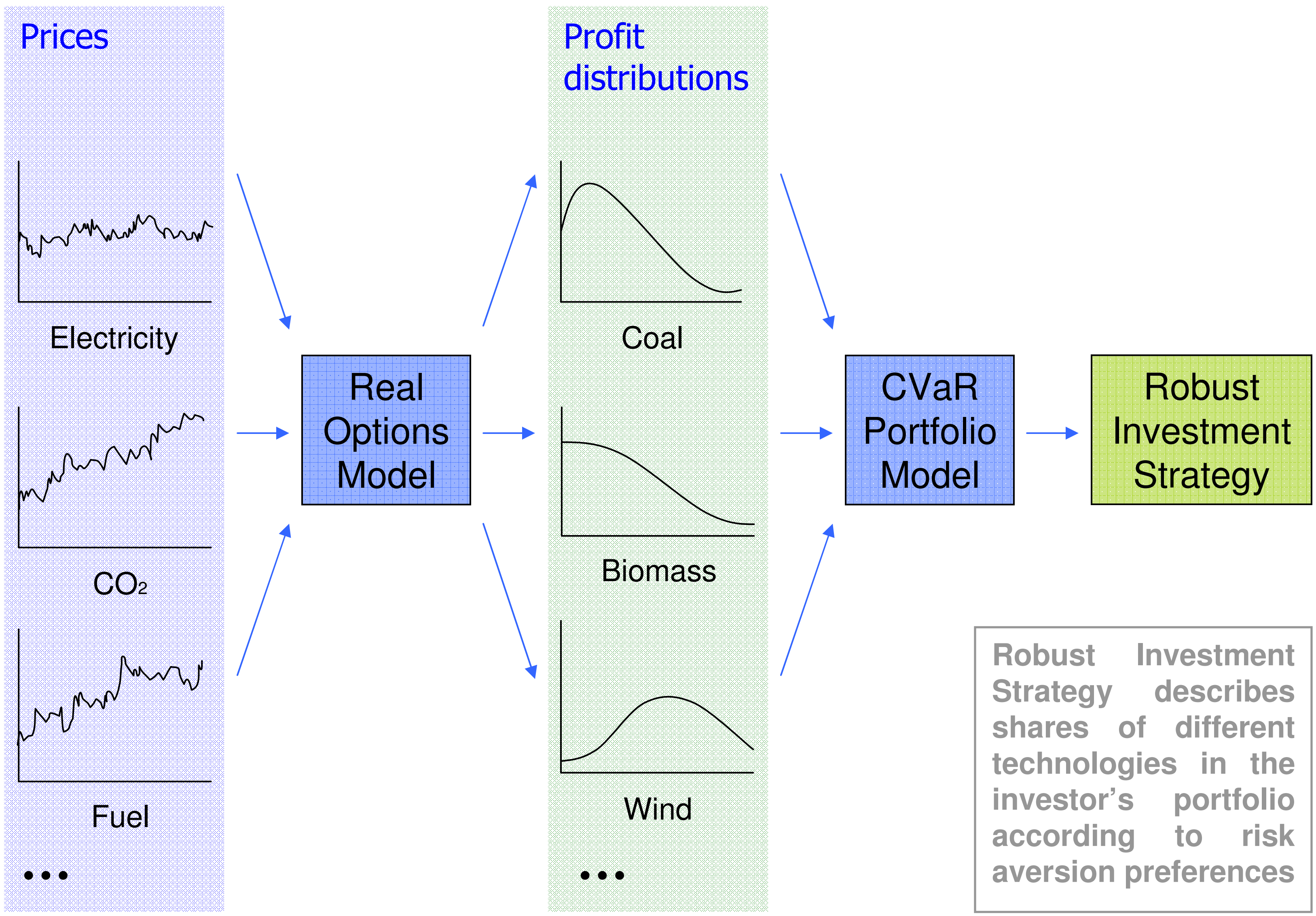
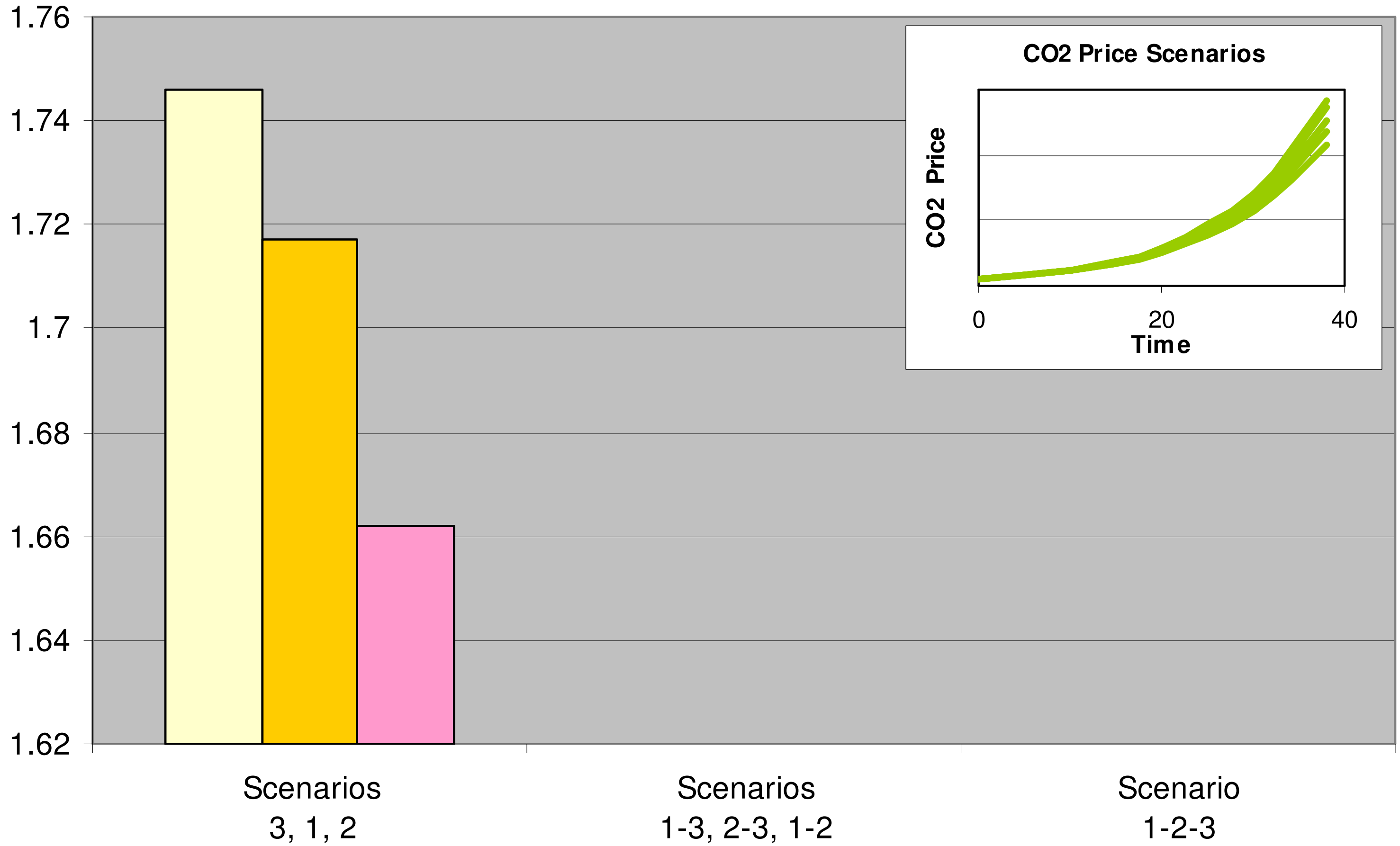
Combined Real Options & Risk Management Framework



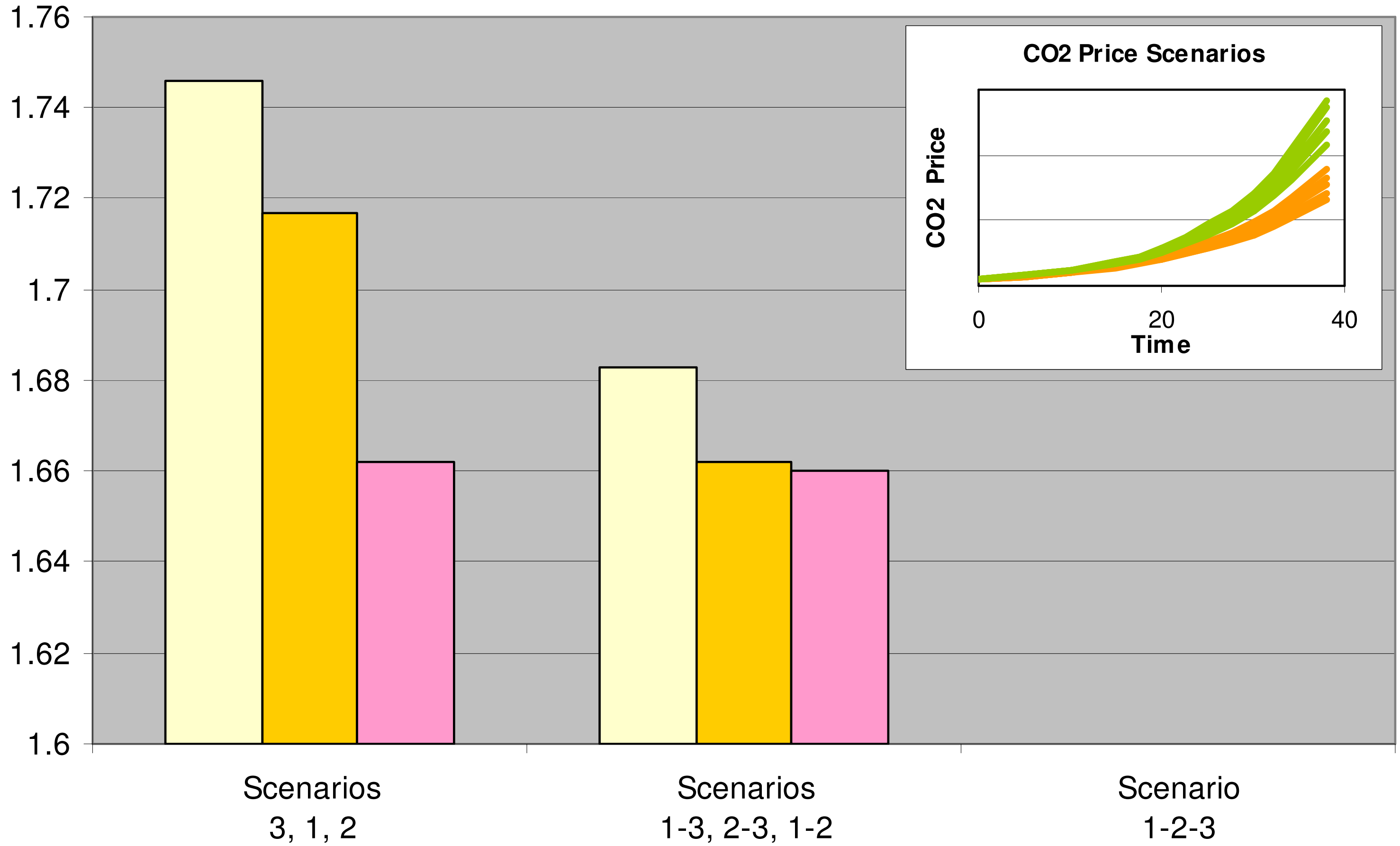
Impact of Uncertainty Reduction on Risks

Optimal Maximin Portfolios and 95%-CVaRs



Impact of Uncertainty Reduction on Risks

Optimal Maximin Portfolios and 95%-CVaRs



Impact of Uncertainty Reduction on Risks

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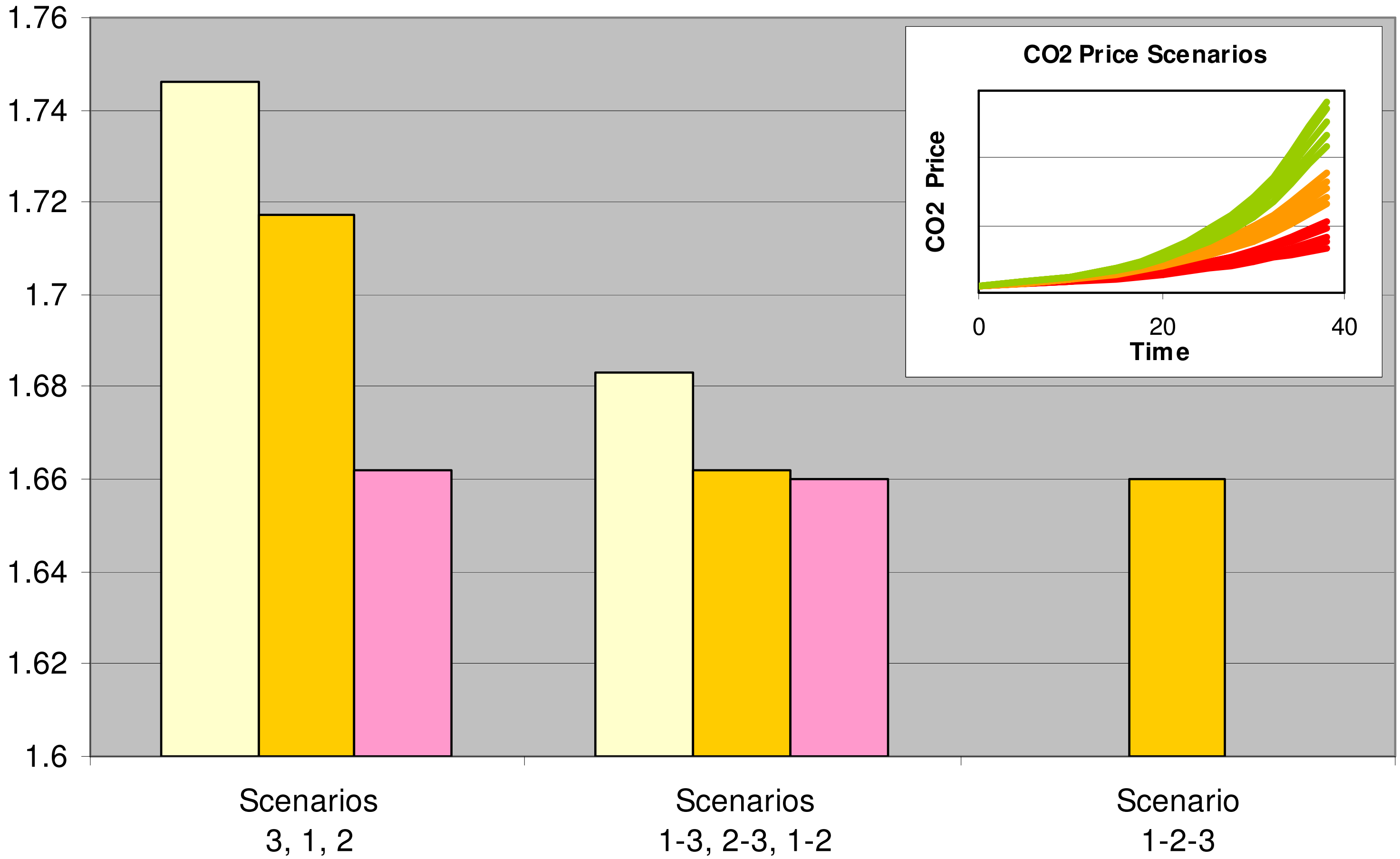
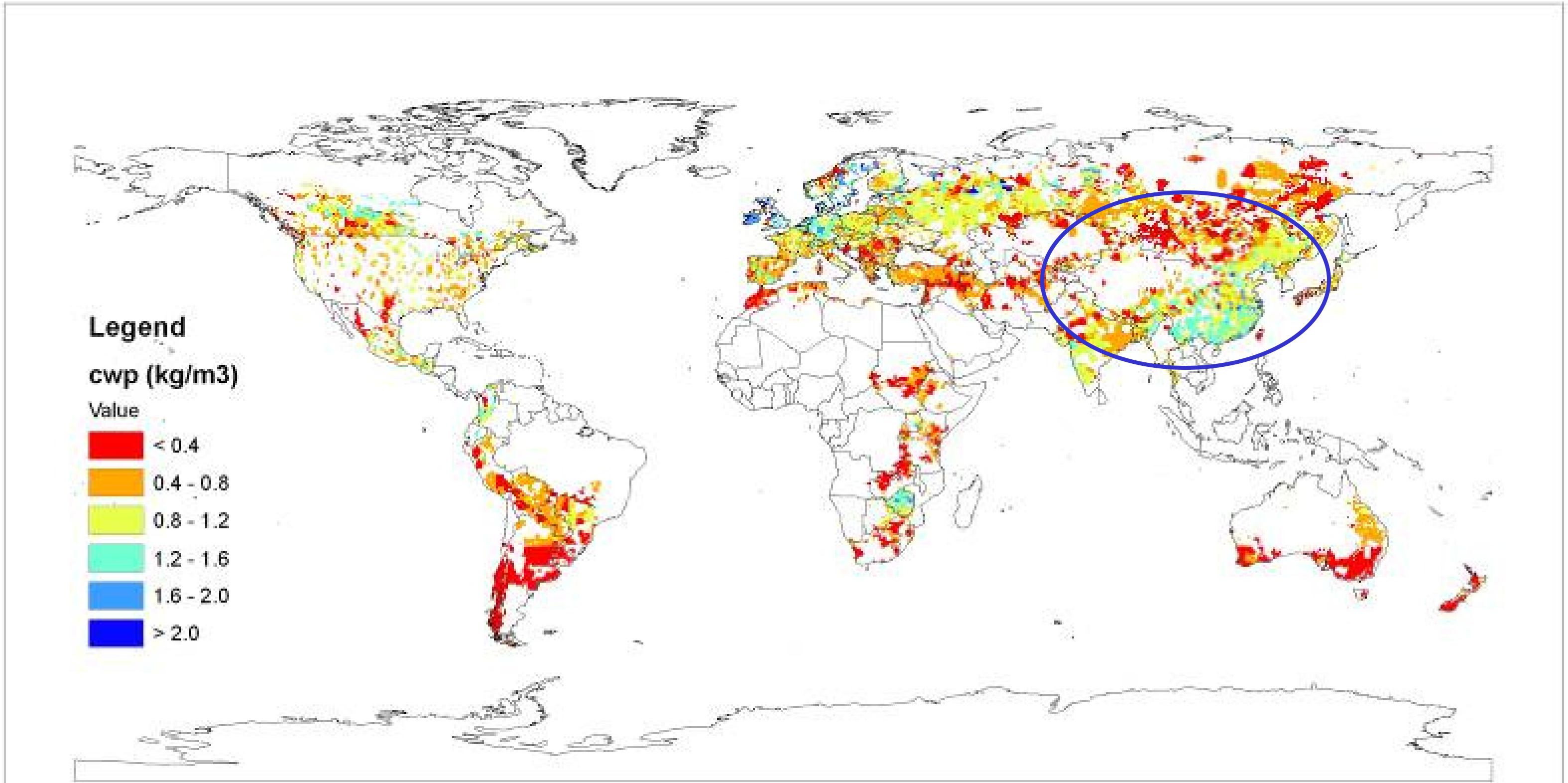


Conclusion

- The Question of knowing climate sensitivity is worth at least 2 digit Trillion US$ in net present value terms
- Much of it has to do with Cloud modelling (Grey-sky thinking, The Economist, 5 Jul 2007)
- The Energy portfolios look radically different in the long-run as a function of climate sensitivity (increasing share of renewables => increasing geobenefit)
- How do we hedge today

Benefit of GEO

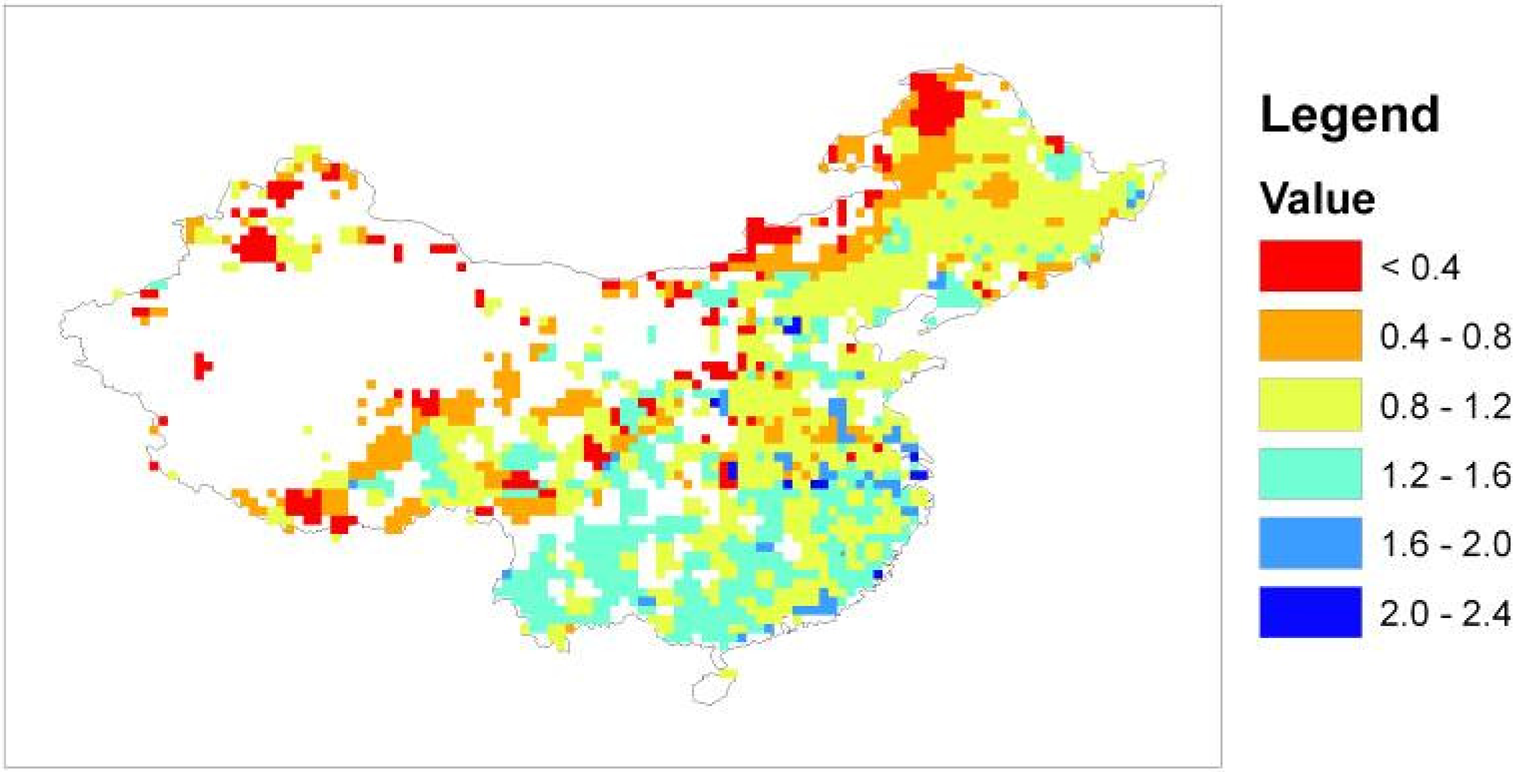
Crop Water Productivity of Wheat (2000)



Spatial resolution 30 arc-min

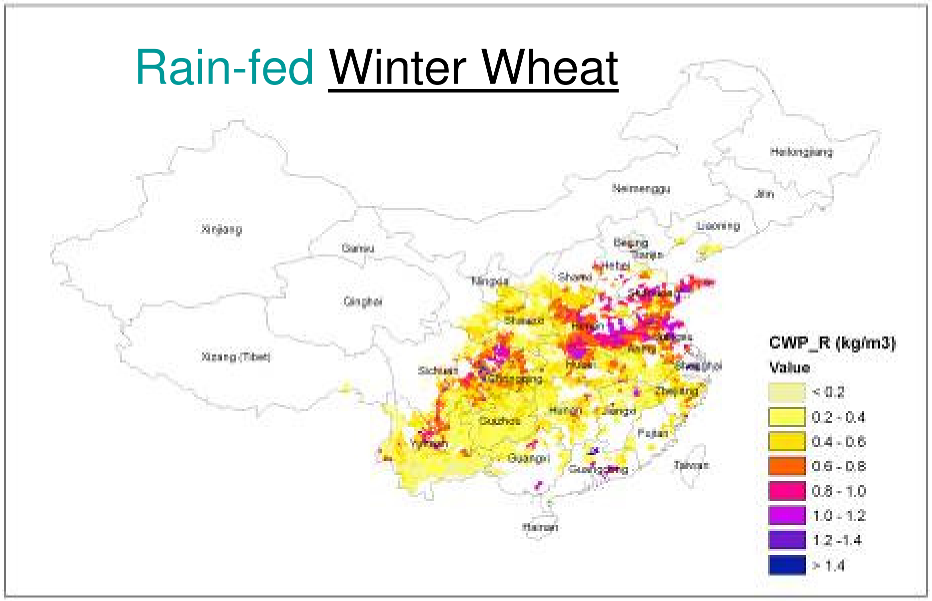
Benefit of GEO

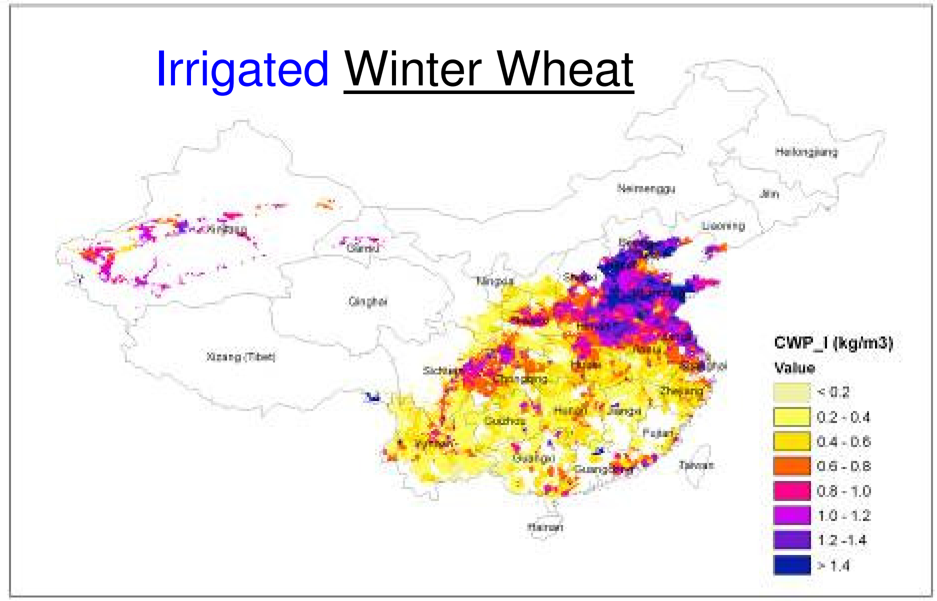
Global Maps of Crop Water Productivity (Wheat) (kg/m3)



Spatial resolution 30 arc-min

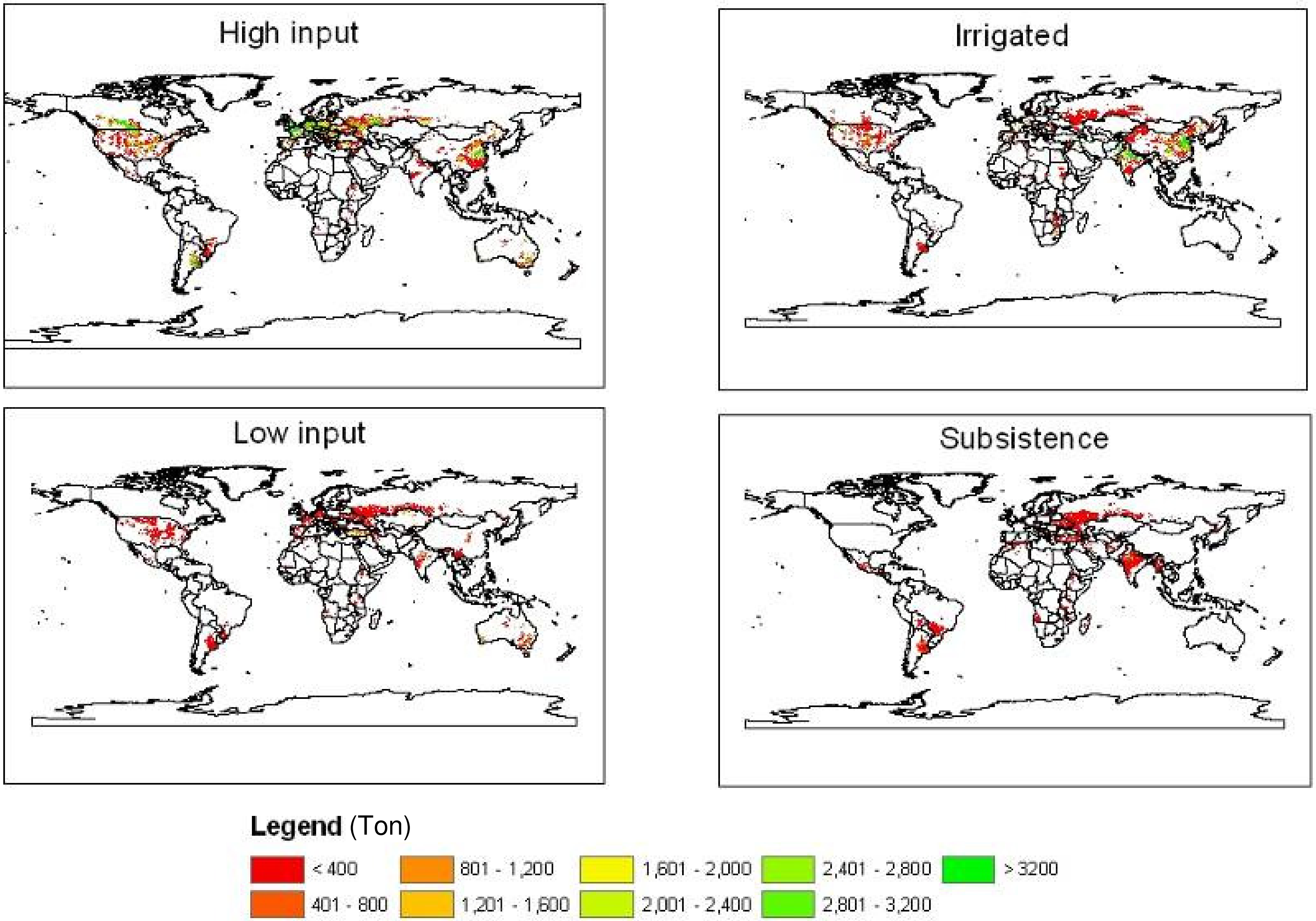
Benefit of GEO



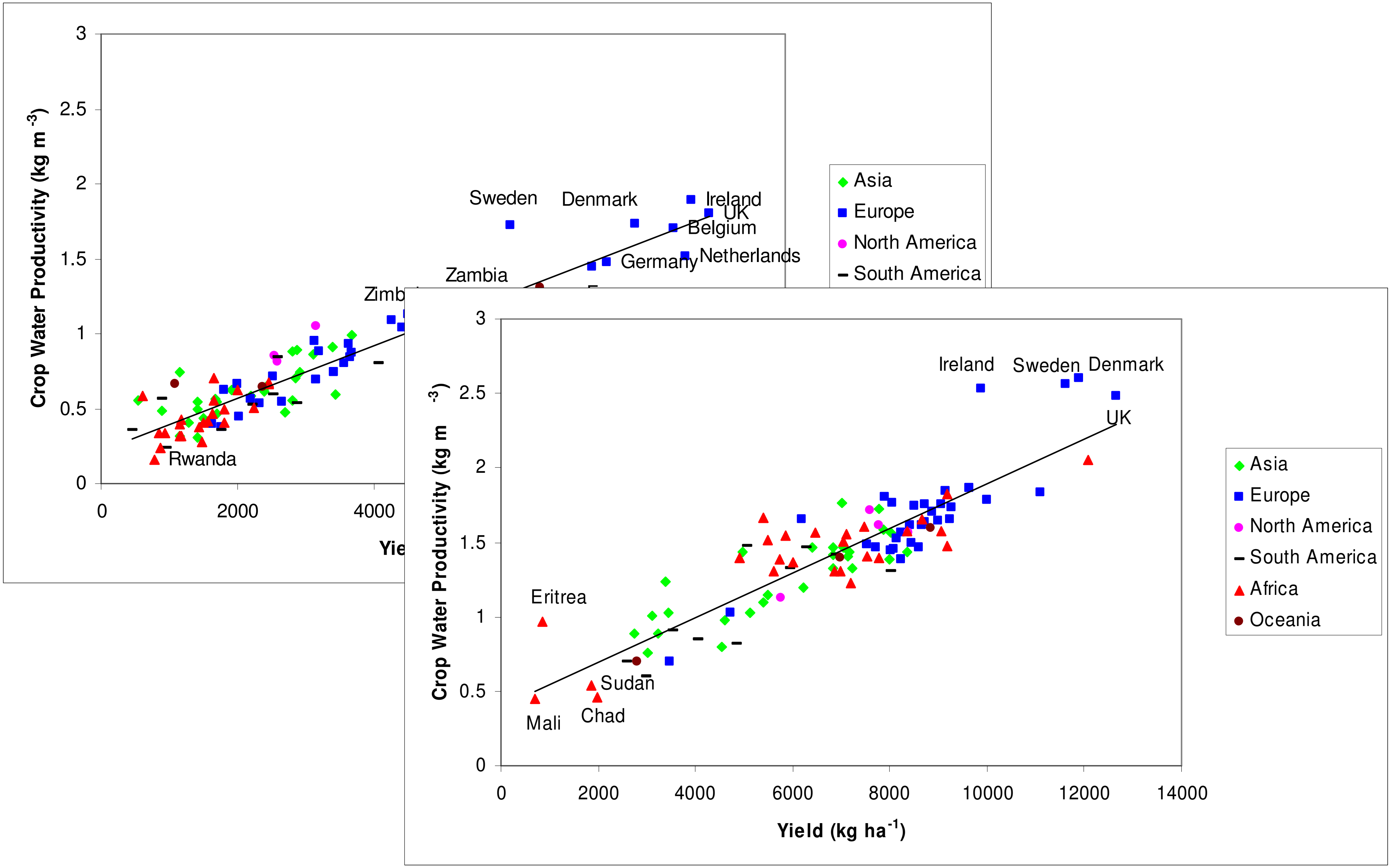


Spatial resolution 5 arc-min

Production of Wheat in Different Systems



Potential yield and yield gap at a global scale



Overall Conclusion

- Cooperation to build GEOSS necessity for mankind in the 21st century
  - Difficult to build Prisoner's Dilemma
    - Strong central coordination – GEO
    - Change perception of pay-offs or make them transparent (GEOBENE)
- Benefits are 2-10 times of the costs