

INTEGRATION OF THE SCIENCE AND ECONOMICS OF CLIMATE CHANGE

Ronald G. Prinn, MIT

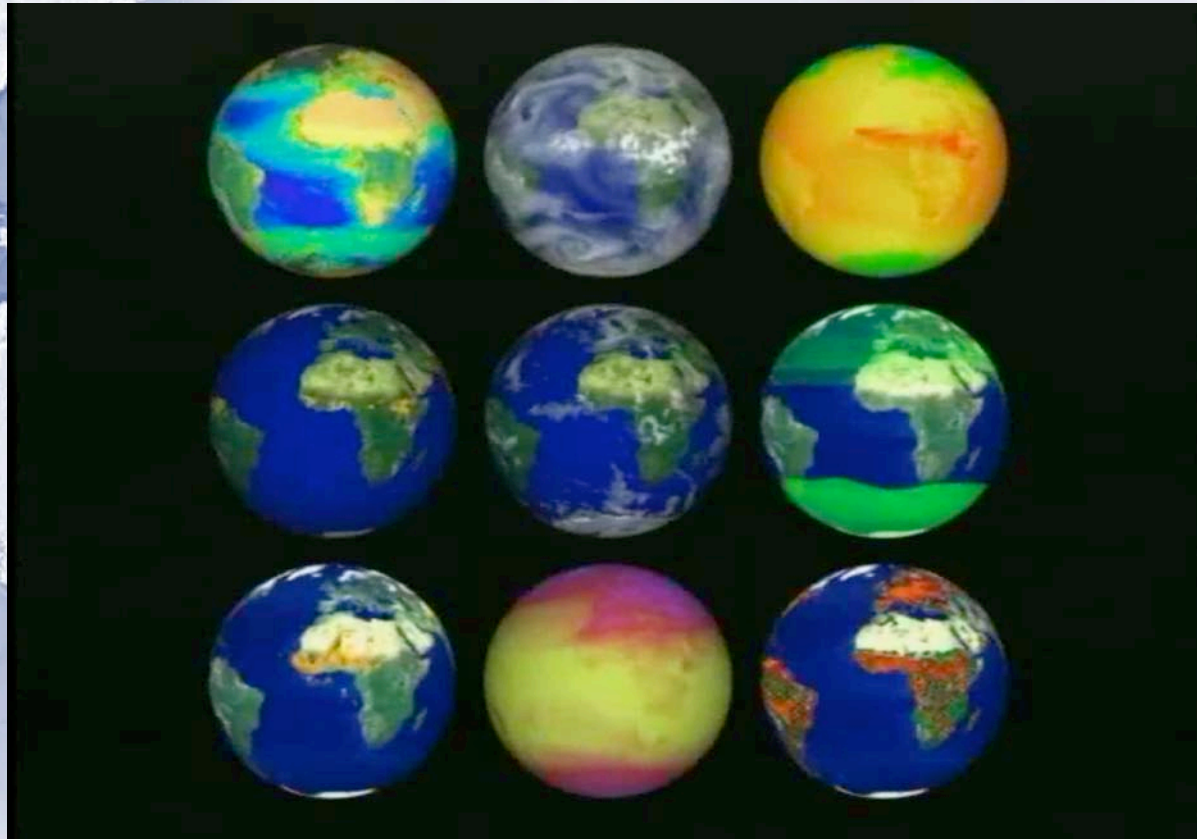


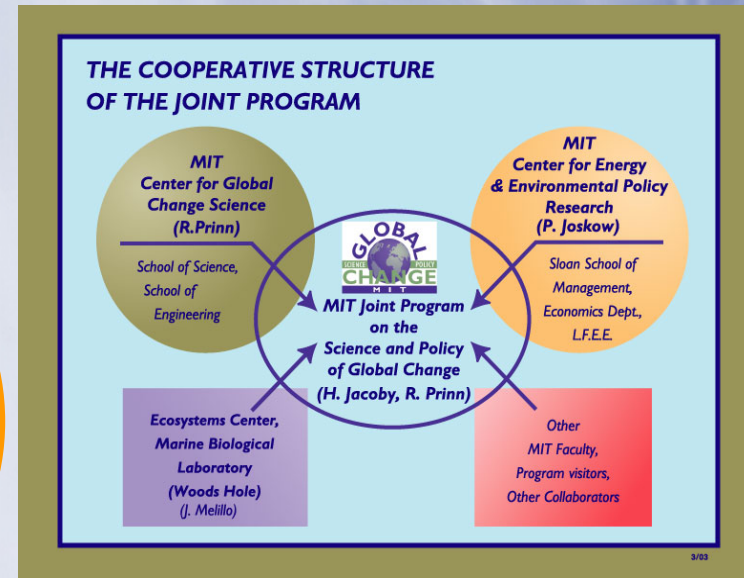
Image courtesy of NASA TERRA Satellite.

To see the animation, go to

http://esse21.usra.edu/june2003/presentations/from_cd/ESSE21_nasa_kaye/Terra9globes2.mov

MIT JOINT PROGRAM ON THE SCIENCE & POLICY OF GLOBAL CHANGE

Founded in 1991
Seed support from MIT
Now Supported by 5 federal Agencies, a consortium of 21 Industries, and a Foundation



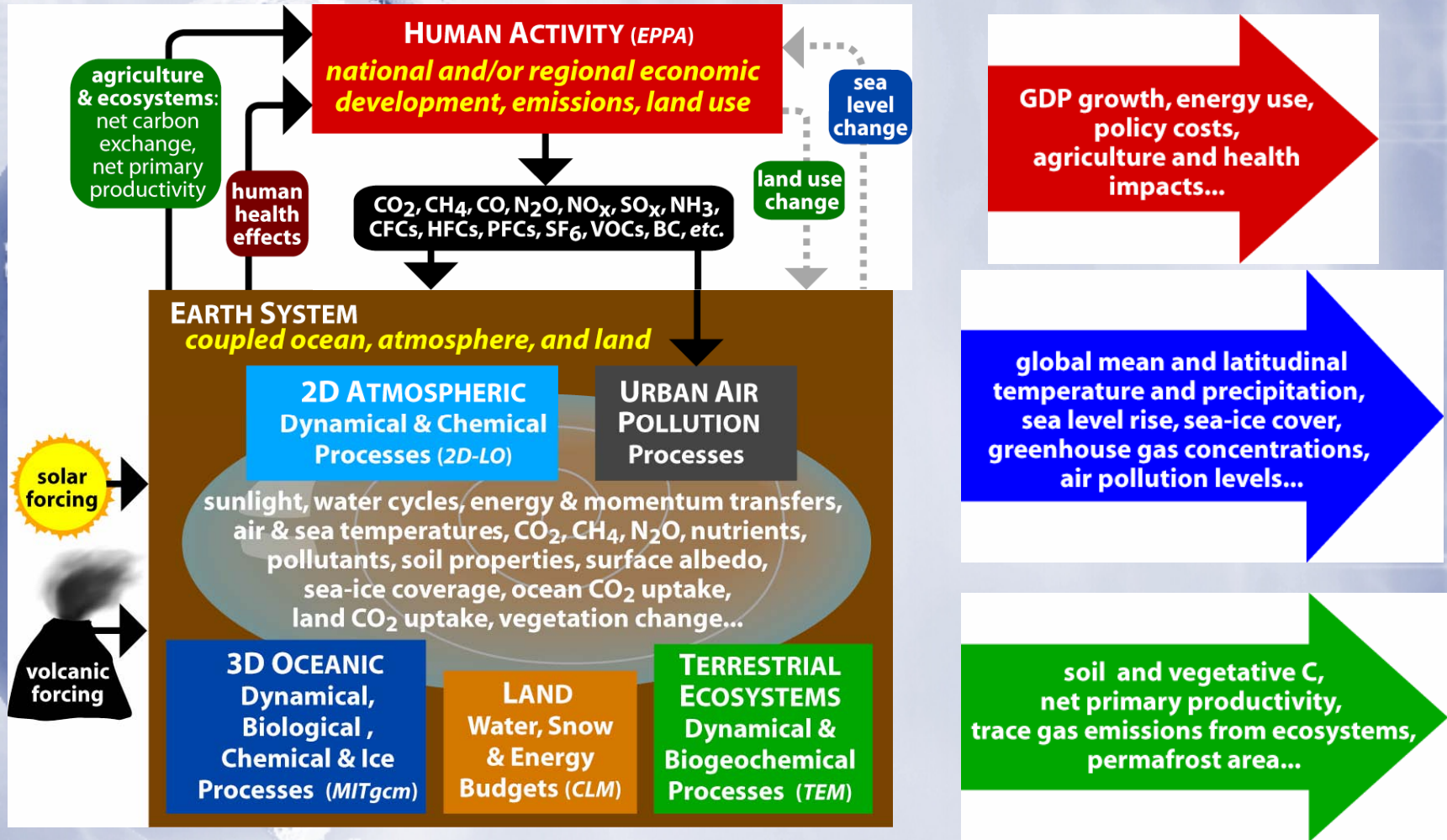
Discovery of new interactions among natural and human climate system components

Objective assessment of uncertainty in economic and climate projections

Critical and quantitative analysis of policy proposals

Understanding connections to other science and policy issues (e.g. air pollution)

The major analytical tool of the Global Change Joint Program is the Integrated Global System Model (IGSM)



Joint Program on the Science and Policy of Global Change

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HOW ACCURATE ARE CLIMATE FORECASTS?



**THE MAJOR CLIMATE
FORECAST MODEL
UNCERTAINTIES INVOLVE
CLOUDS, OCEAN MIXING
& AEROSOL FORCING.**

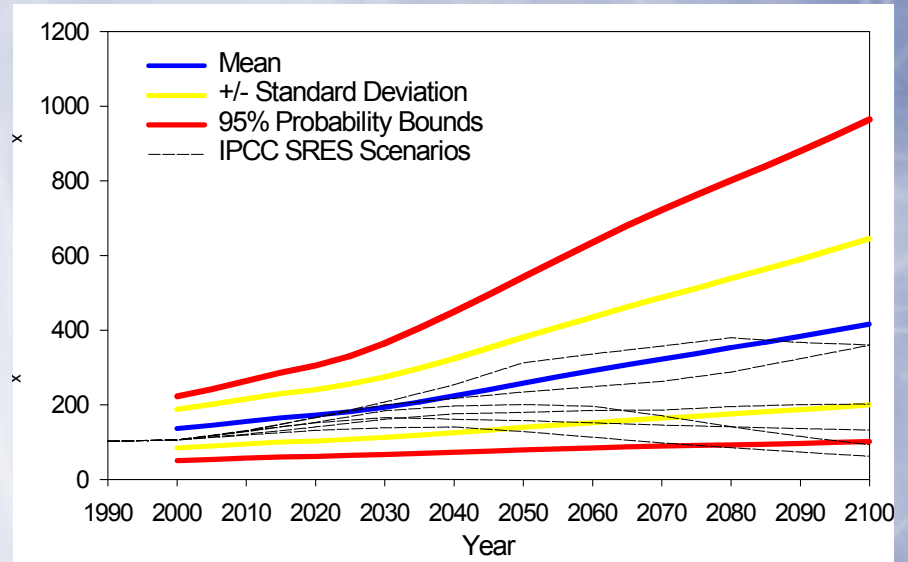
**THESE UNCERTAINTIES ARE
CONSTRAINED BY
OBSERVATIONS**

**ADDED TO THESE
ARE SUBSTANTIAL
UNCERTAINTIES
IN EMISSION
FORECASTING**

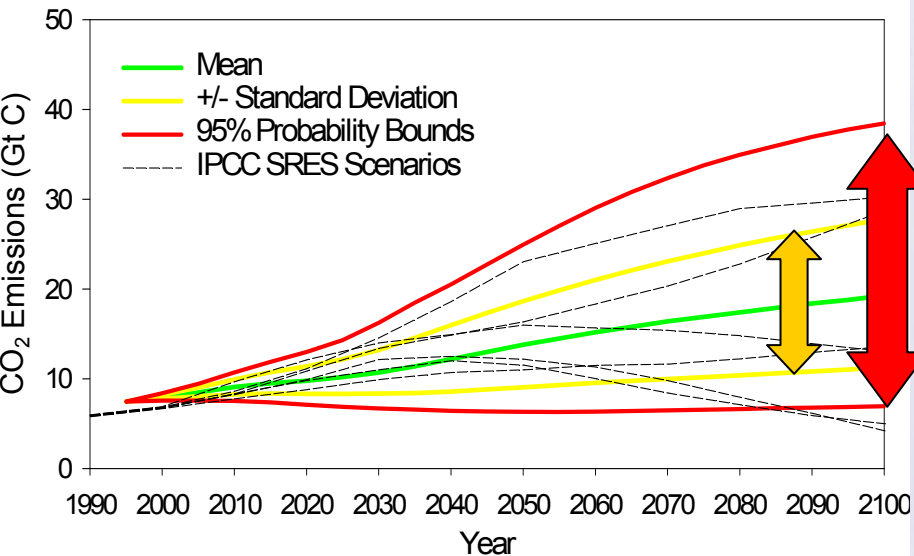
**THESE UNCERTAINTIES
SERIOUSLY LIMIT THE
ACCURACY OF
PREDICTIONS OF
FUTURE CLIMATE**

**WE USE VERY LARGE
ENSEMBLES OF IGSM
RUNS TO ESTIMATE THE
PROBABILITY OF
VARIOUS AMOUNTS OF
CLIMATE CHANGE**

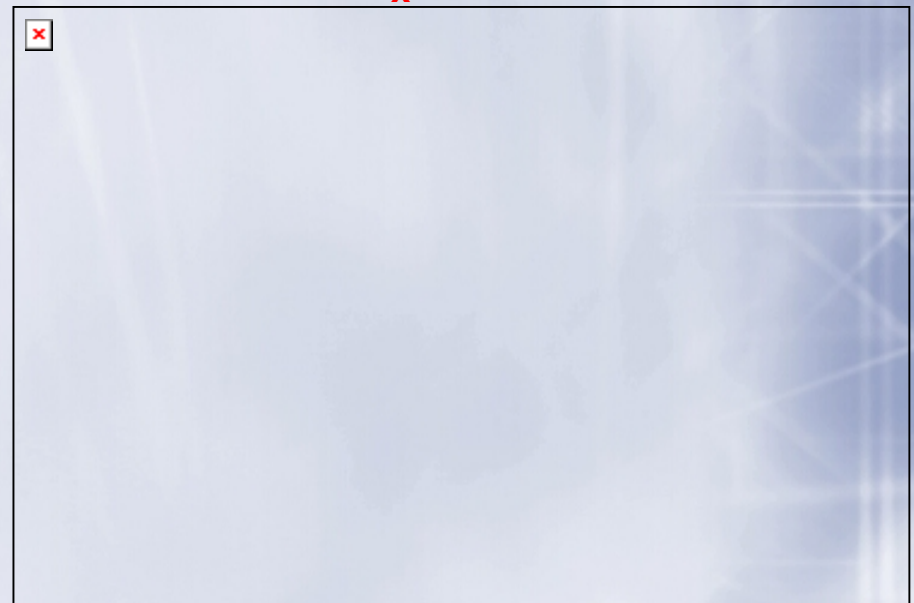
**WE USE ECONOMIC
MODEL TO PREDICT
EMISSIONS OF ALL
MAJOR CLIMATE-
FORCING &
POLLUTING GASES
AND AEROSOLS
(e.g. EPPA cf. SRES)**



Global NO_x Emissions (Tg/yr)



Global CO_2 Emissions (PgC/yr)



Global SO_2 Emissions (Tg/yr)

**MIT IGSM CALCULATES THE PROBABILITY OF
VARIOUS AMOUNTS OF CLIMATE CHANGE: 1990-2100**

Image removed due to copyright considerations.

See Figure 2. Webster et al., *Climatic Change*, 61, 295-320, 2003.

MIT IGSM CALCULATES THE PROBABILITY OF VARIOUS AMOUNTS OF CLIMATE CHANGE BY LATITUDE: 1990-2100

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See Figure 3. Webster et al., *Climatic Change*, 61, 295-320, 2003.

VULNERABLE HIGH LATITUDE SYSTEMS



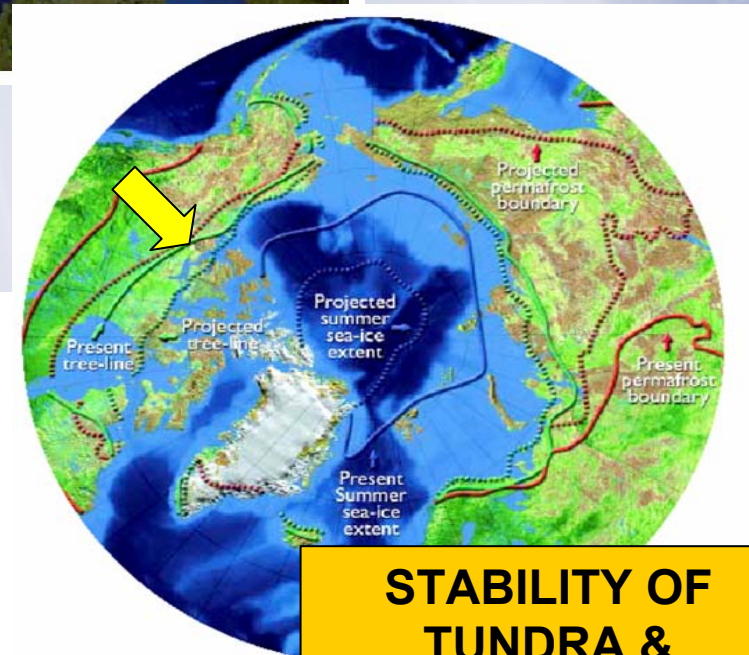
REF: ACIA, Impacts of a Warming Arctic, Climate Impact Assessment Report, 2004

Images courtesy of ACIA.

STABILITY OF ANTARCTIC ICE SHEET

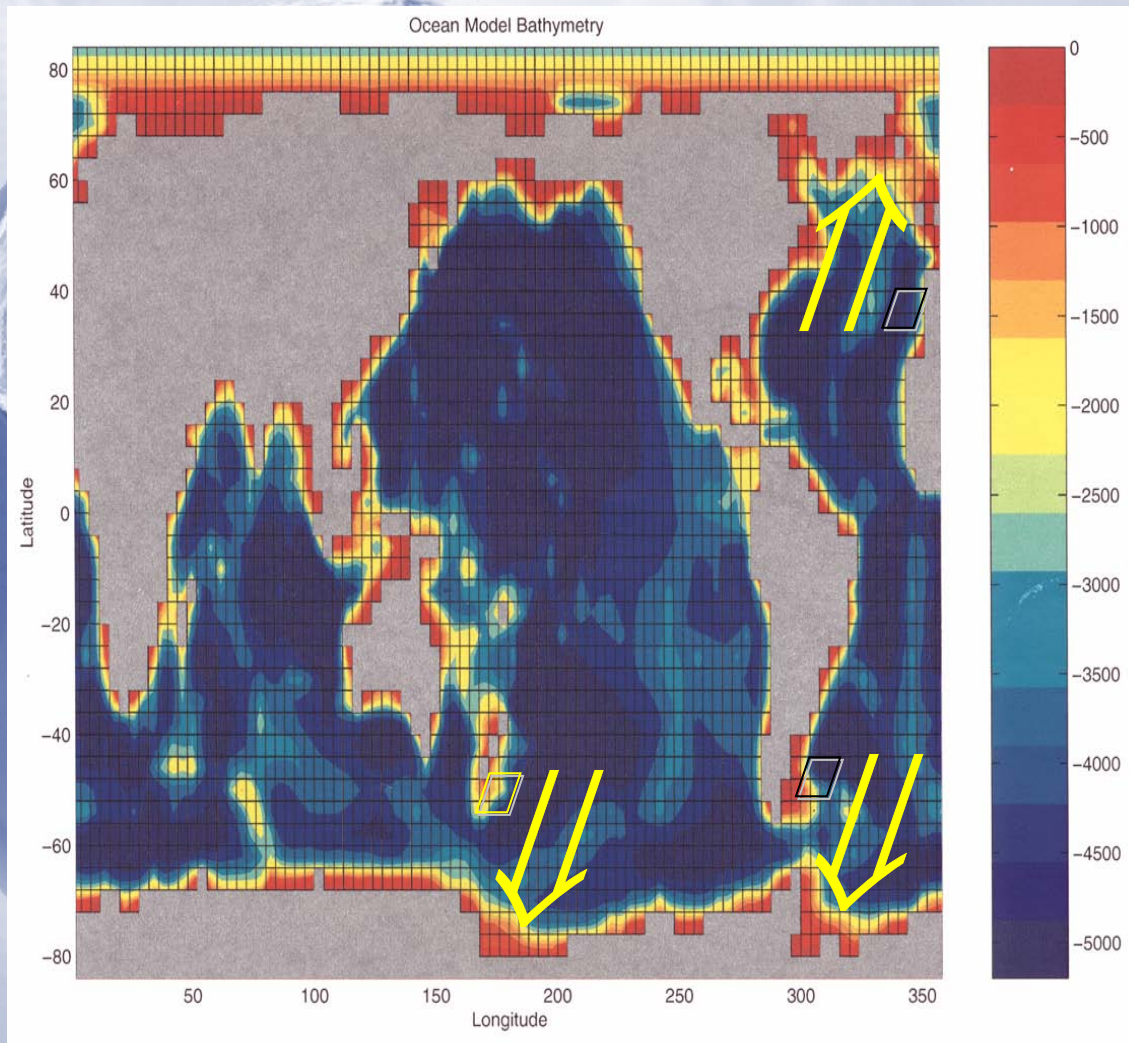
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See Figure 1. Bindshadler, R. A., R. B. Alley, J. Anderson, S. Shipp, H. Borns, J. Fastook, S. Jacobs, C. F. Raymond, What is happening to the west antarctic ice sheet?, Eos Trans. AGU, 79(22), 257-257, 10.1029/98EO00188, 1998.



STABILITY OF TUNDRA & PERMAFROST

3-DIMENSIONAL OCEAN IN IGSM ENABLES TREATMENT OF THE STABILITY OF THE OCEANIC CARBON & HEAT SINK



**OCEAN BOTTOM DEPTHS (meters)
(MIT 3D OCEAN MODEL)**



DRIVEN BY SINKING WATER IN THE POLAR SEAS (Norwegian, Greenland, Labrador, Weddell, Ross)

SLOWED BY DECREASED SEA ICE & INCREASED FRESH WATER INPUTS INTO THESE SEAS

INCREASED RAINFALL, SNOWFALL & RIVER FLOWS, & DECREASED SEA ICE, EXPECTED WITH GLOBAL WARMING

DANGEROUS SLOWDOWN OF OCEANIC OVERTURN?

MIT IGSM 3D OCEAN MODEL (100 years of CO₂ increase then steady)

Image removed due to copyright considerations.

THE IGSM INCLUDES A RECURSIVE DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM ECONOMICS MODEL (EPPA)

THE IGSM ECONOMICS MODEL HAS THE NEEDED SECTORAL DETAIL TO ANALYSE EXISTING OR PROPOSED POLICIES

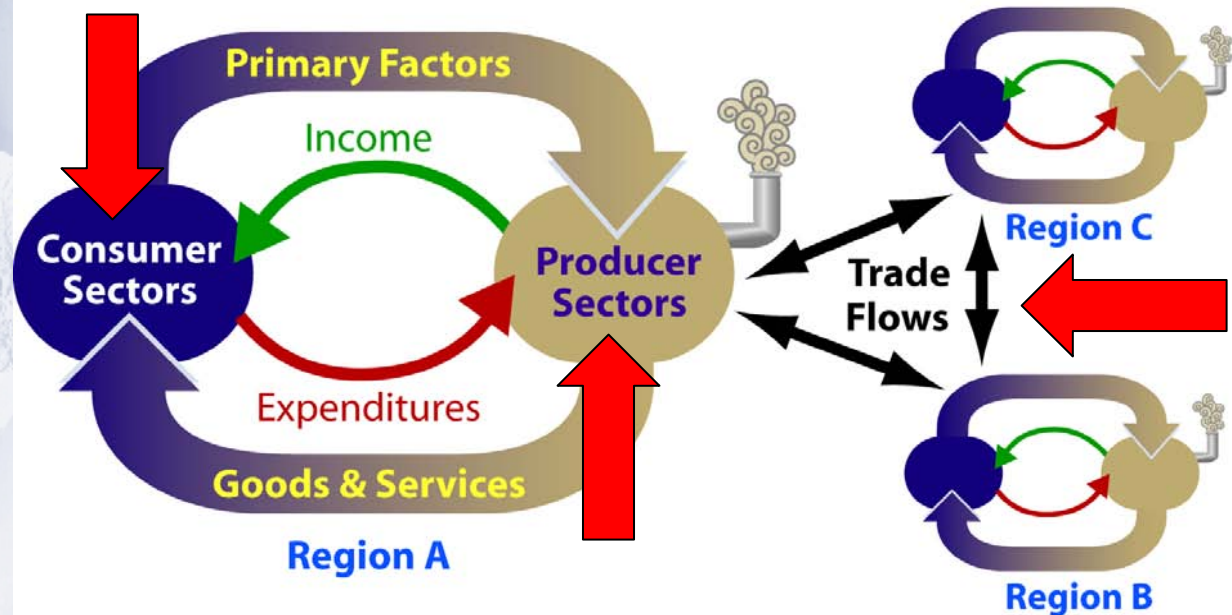
MIT Emissions Prediction and Policy Analysis (EPPA) Model

Model Features

- All greenhouse-relevant gases
- Flexible regions
- Flexible producer sectors
- Energy sector detail
- Welfare costs of policies

Mitigation Policies

- Emissions limits
- Carbon taxes
- Energy taxes
- Tradeable permits
- Technology regulation



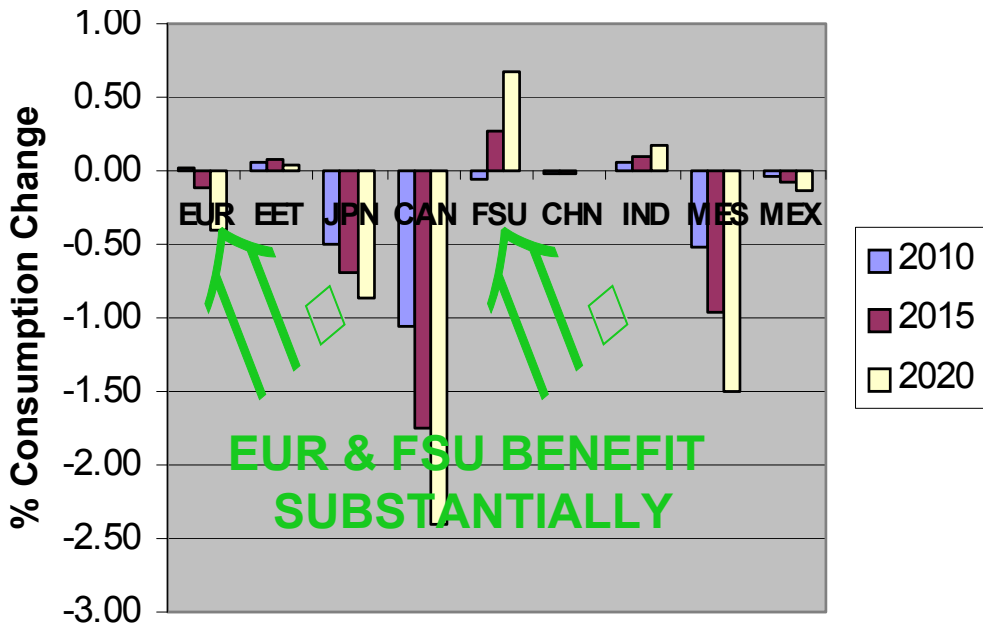
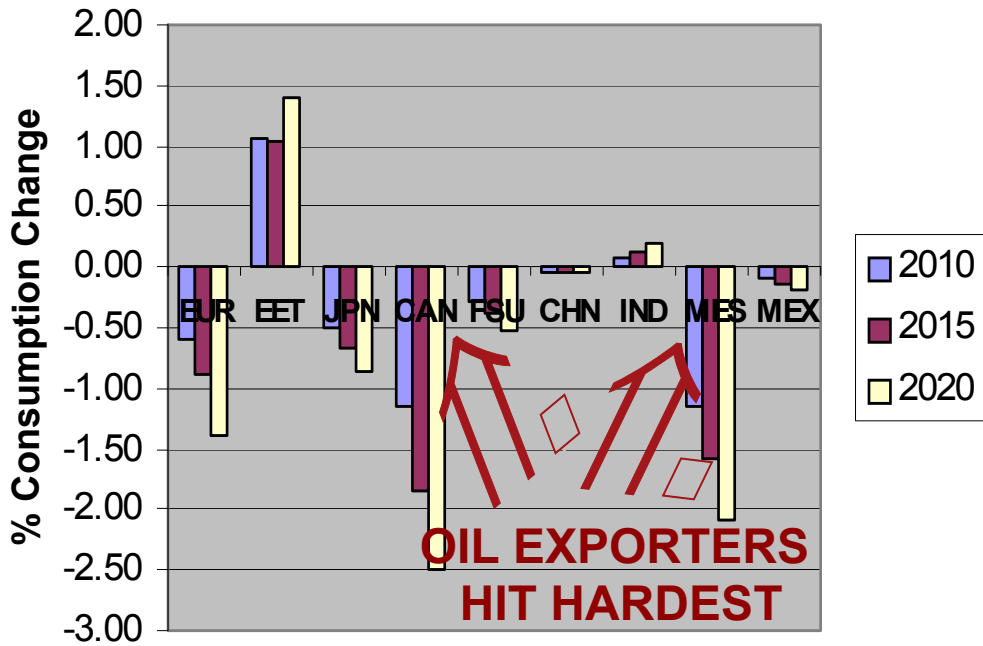
ECONOMICS MODEL (EPPA) ESTIMATES COUNTRY COSTS OF SPECIFIC POLICY PROPOSALS

e.g. Welfare (Consumption) Change Under Kyoto without USA & Australia



NO EMISSION TRADING

EMISSION TRADING (EU GETS ALL RUSSIAN PERMITS)



HOW CAN WE EXPRESS, IN EVERY-DAY LANGUAGE, THE VALUE OF A CLIMATE POLICY UNDER UNCERTAINTY?

Compared with NO POLICY

What would we buy with STABILIZATION of CO₂ at 550 ppm?

A NEW WHEEL with lower odds of EXTREMES

