Update on MOD17, GPP and NPP, and MOD16 ET

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The Human Perturbation of the CO_2 Budget (2000-2009)

7.7±0.5 PgC y^{-1}

+

1.1±0.7 PgC y^{-1}

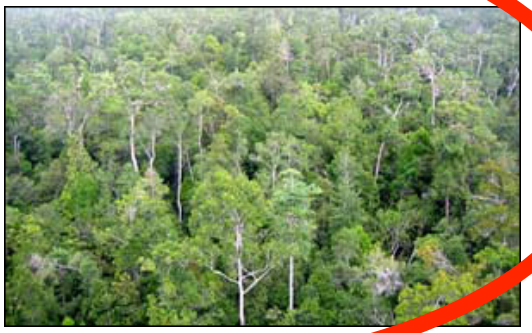
4.1±0.1 PgC y^{-1}

47%

2.4 PgC y^{-1}

27%

Calculated as the residual



26%

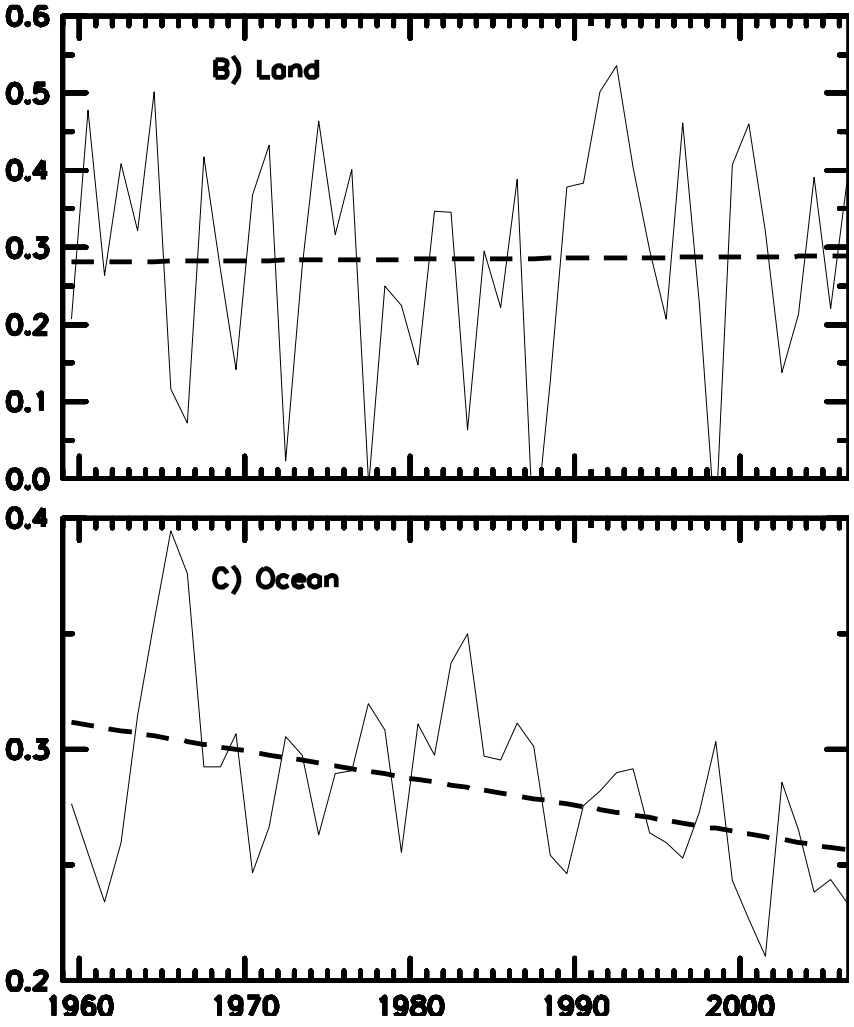
2.3±0.4 PgC y^{-1}

Global Carbon Project 2010; http://www.globalcarbonproject.org/carbonbudget/index.htm

Efficiency of Natural Sinks

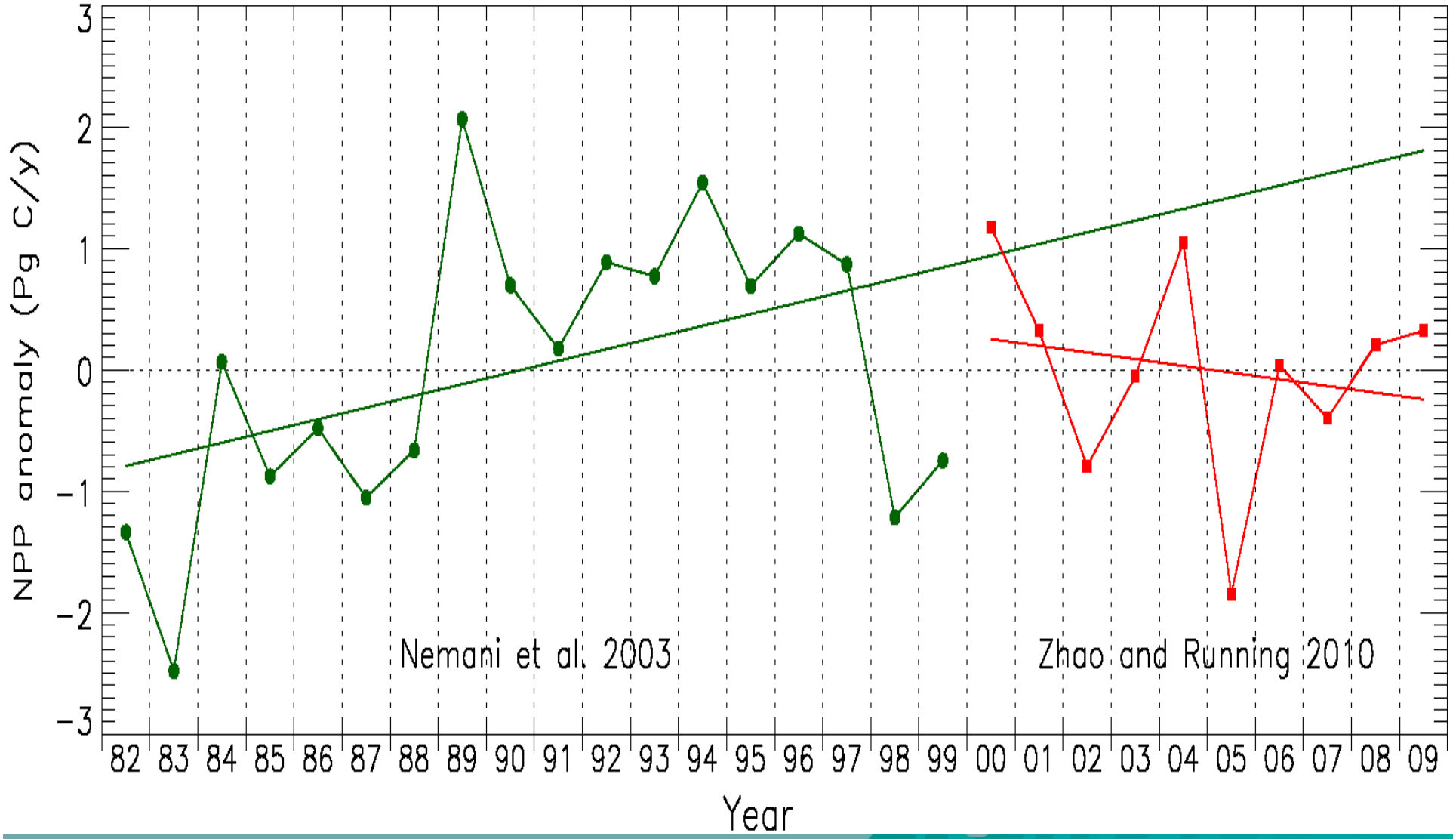
Land Fraction

Ocean Fraction

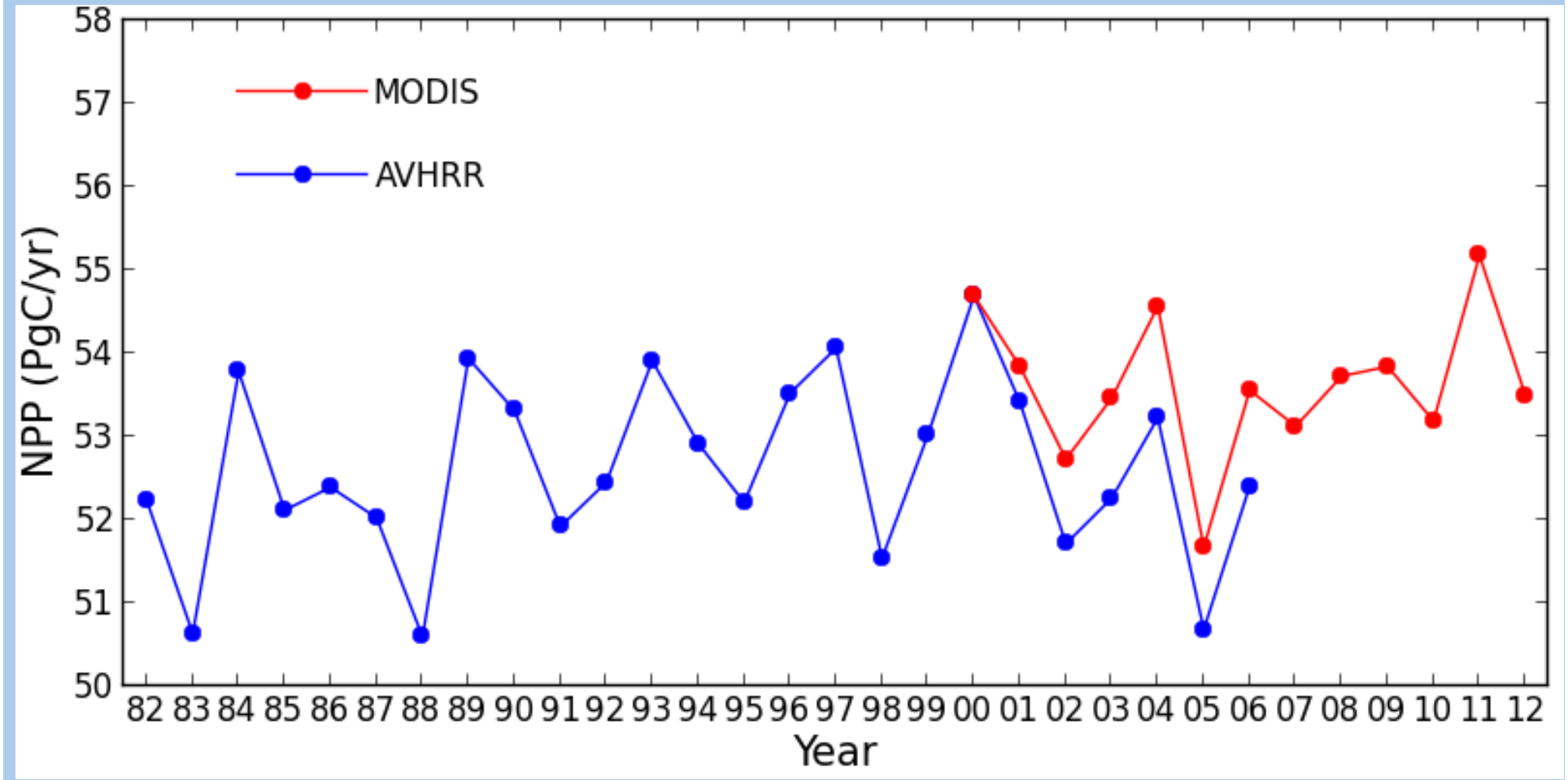


Canadell et al. 2007, PNAS

Global Trend in NPP (1982 – 2009)
AVHRR + MODIS with EOS algorithm



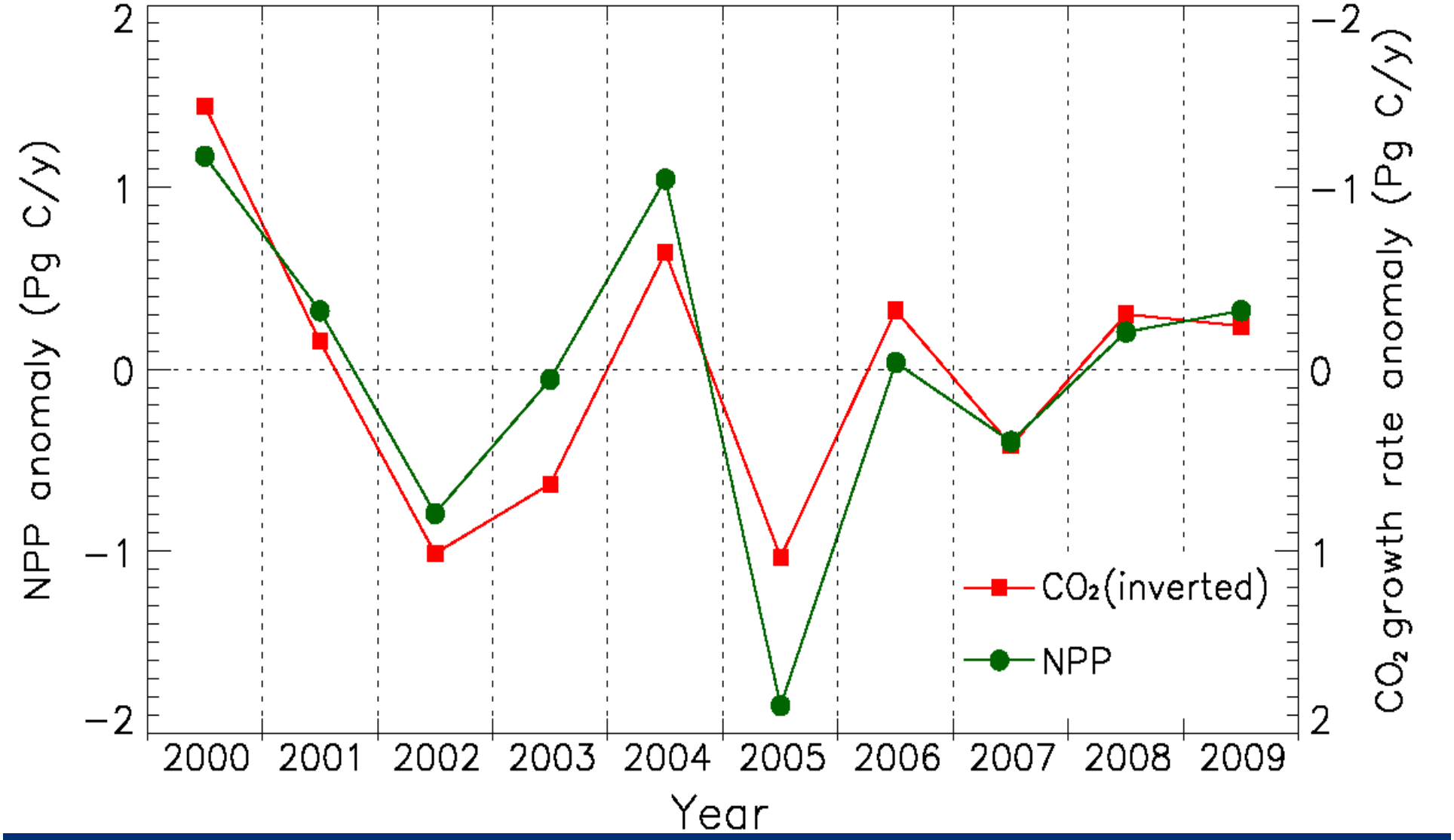
Global Terrestrial Net Primary Production (1982-2012)



+/- 1Pg or about 2%

Nemani et al 2003, Zhao and Running 2010

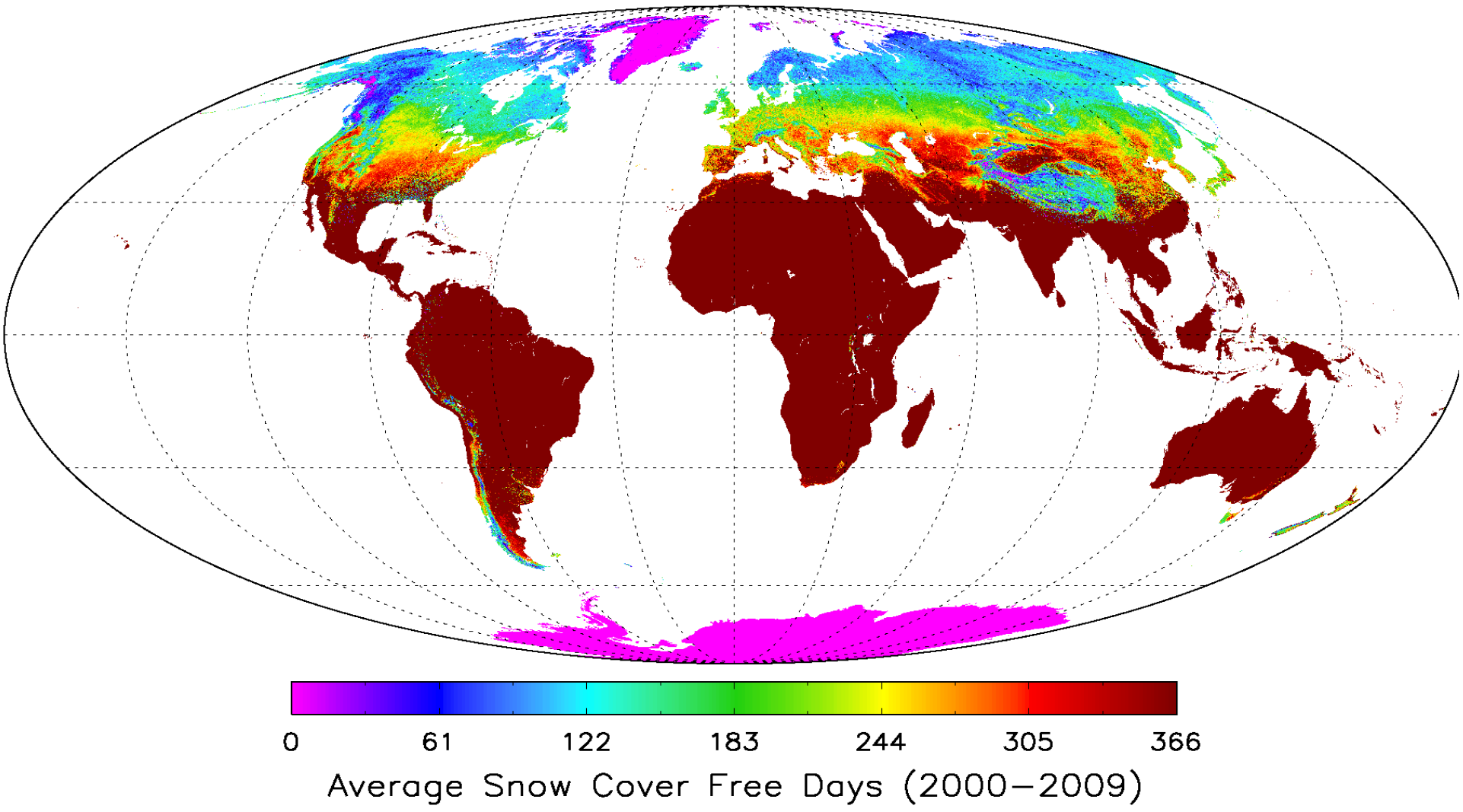
Global MODIS NPP Anomaly



R = -0.89, p < 0.0006

Zhao & Running 2010, *Science*

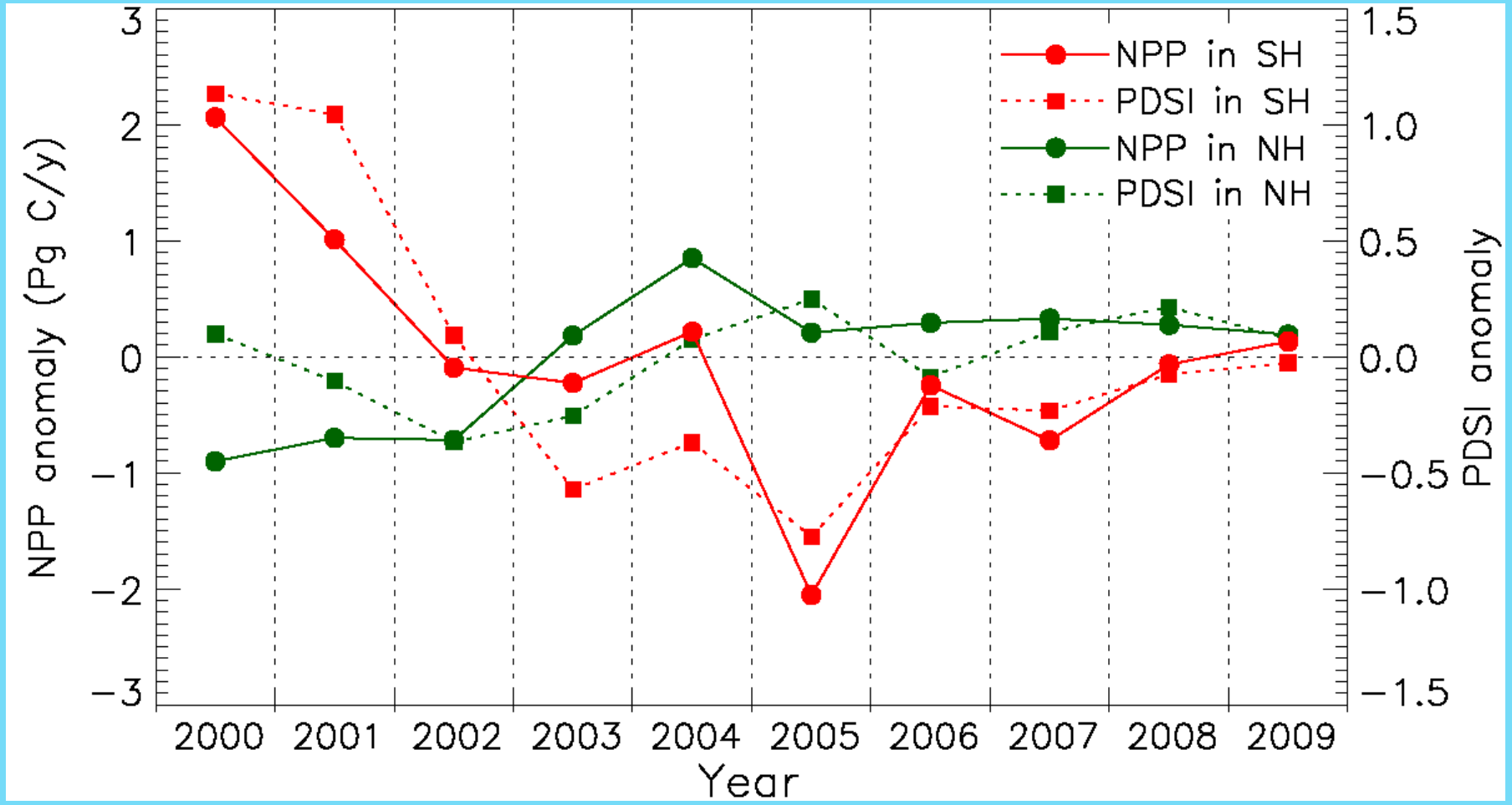
Temperature is a control factor of growing season for NH but not SH !



For NH, 125 days snow cover
For SH, 7.5 days snow cover

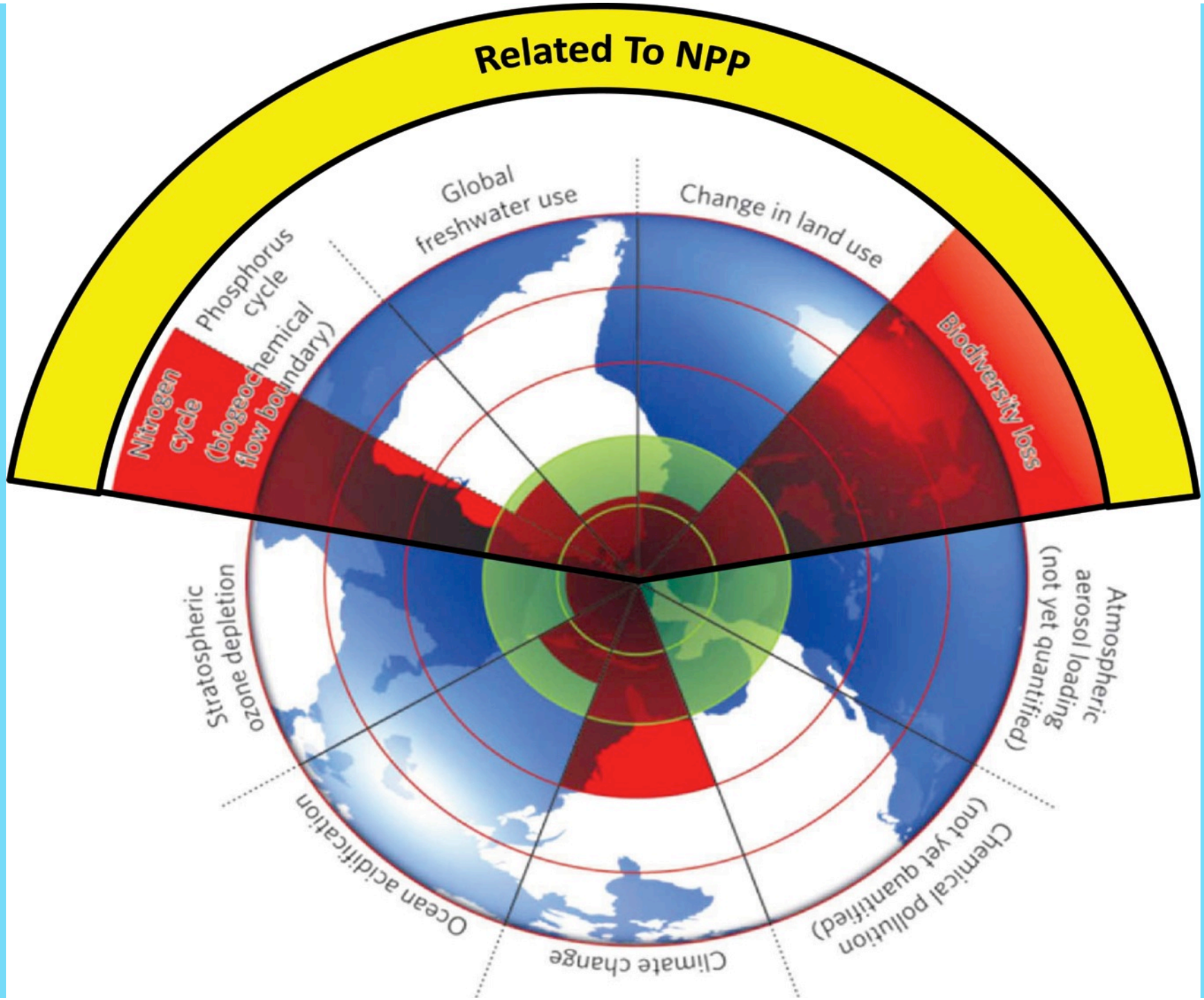
Zhao & Running 2010, *Science*

NPP over two hemisphere trend (2000-2009)



For NH, R = 0.39, p < 0.27
For SH, R = 0.87, p < 0.001

Zhao & Running 2010, *Science*


Related To NPP
Global freshwater use
Change in land use
Phosphorus cycle
Nitrogen cycle (biogeochemical flow boundary)
Biodiversity loss
Stratospheric ozone depletion
Atmospheric aerosol loading (not yet quantified)
Ocean acidification
Chemical pollution (not yet quantified)
Climate change

PERSPECTIVES

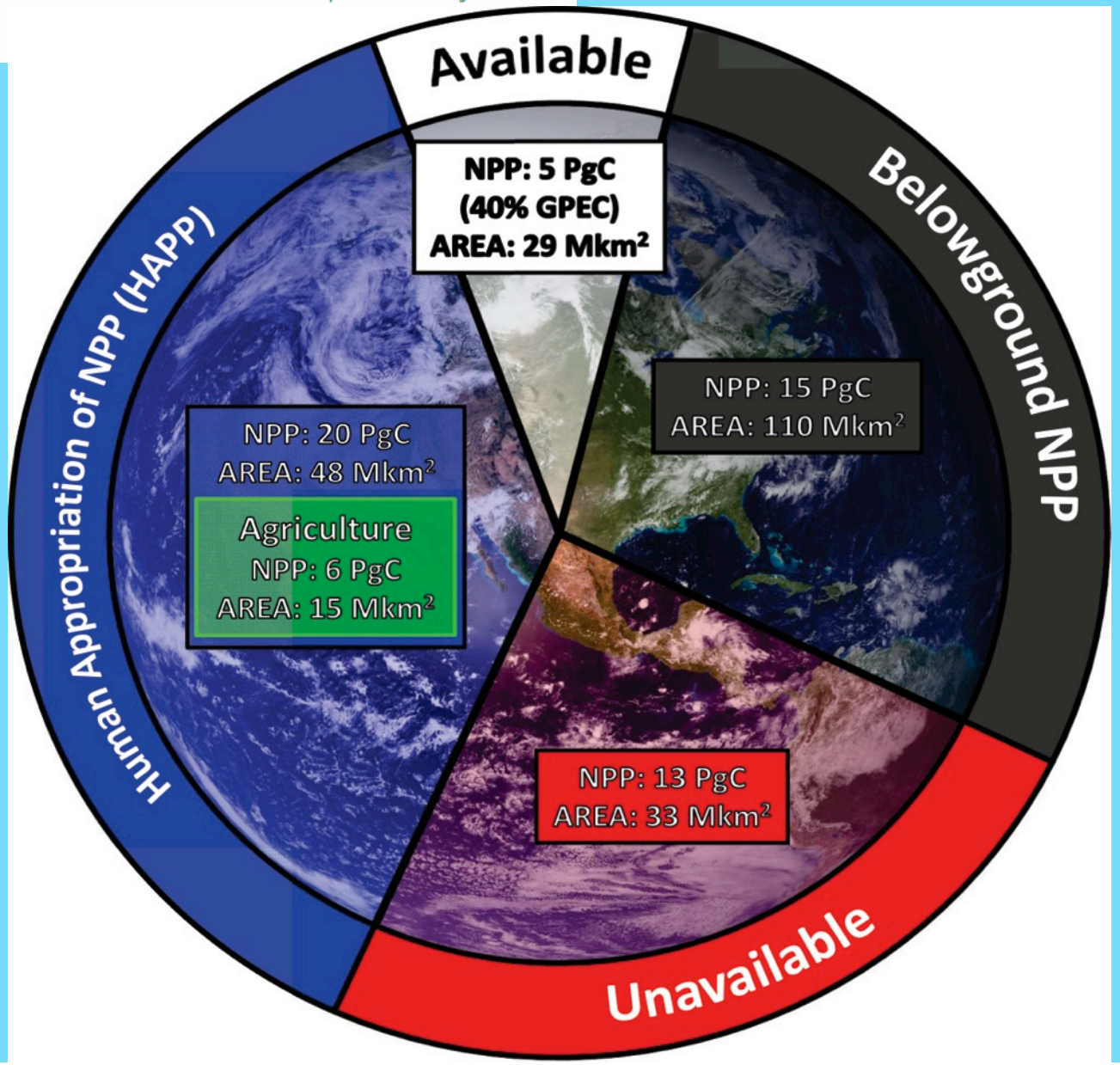
ECOLOGY

A Measurable Planetary Boundary for the Biosphere

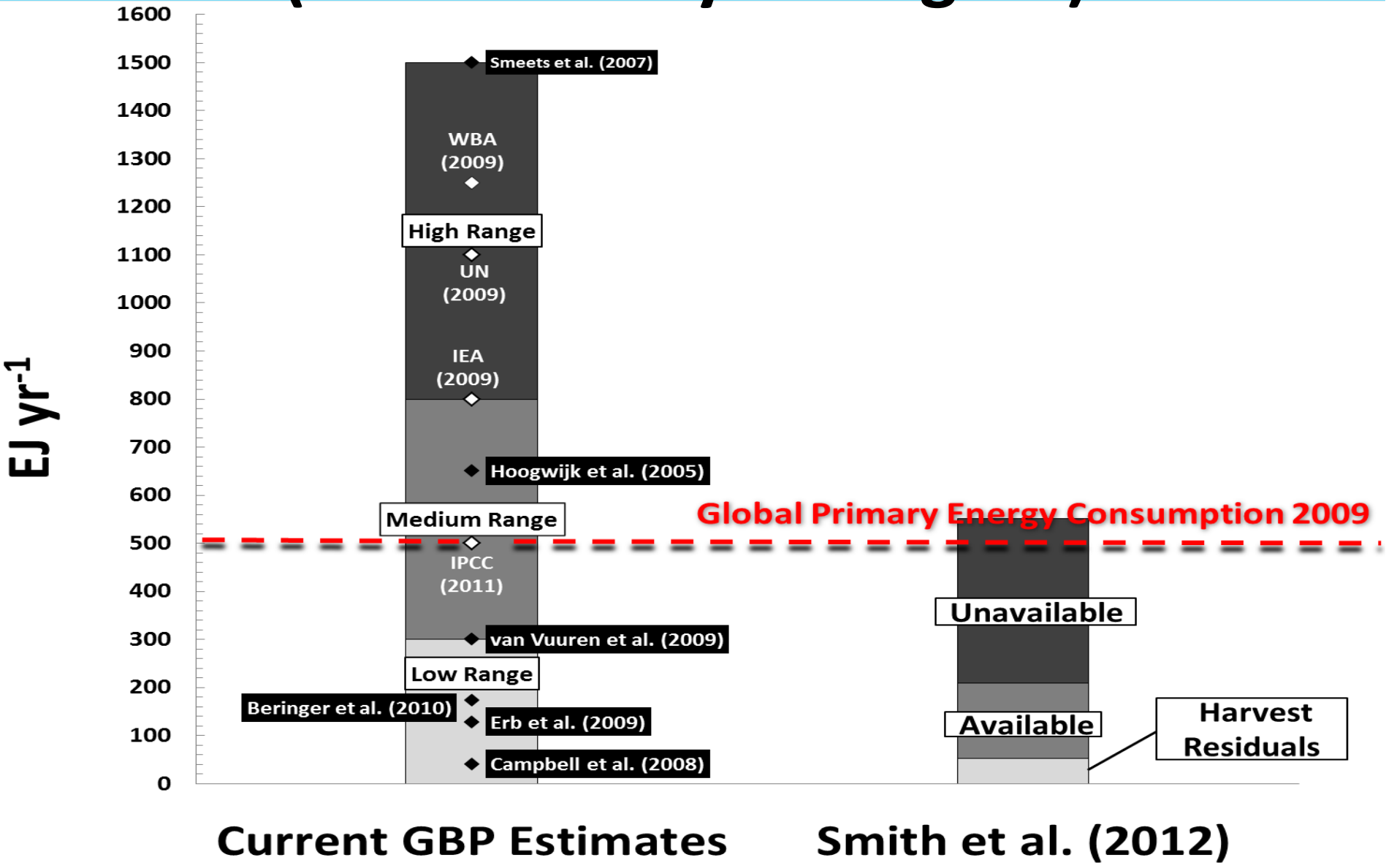
Steven W. Running

Terrestrial net primary (plant) production provides a measurable boundary for human consumption of Earth's biological resources.

From Running, SW. *Science* 337 p1458-1459, 2012



Capacity for Bioenergy Production (estimated by ecologists)



THE PROBLEM
Temperature + Precipitation does NOT show the landscape aridity

Land Water Balance = Precipitation – Evapotranspiration

PENMAN-MONTEITH equation for Evapotranspiration

Solar radiation

Air Temperature

Humidity

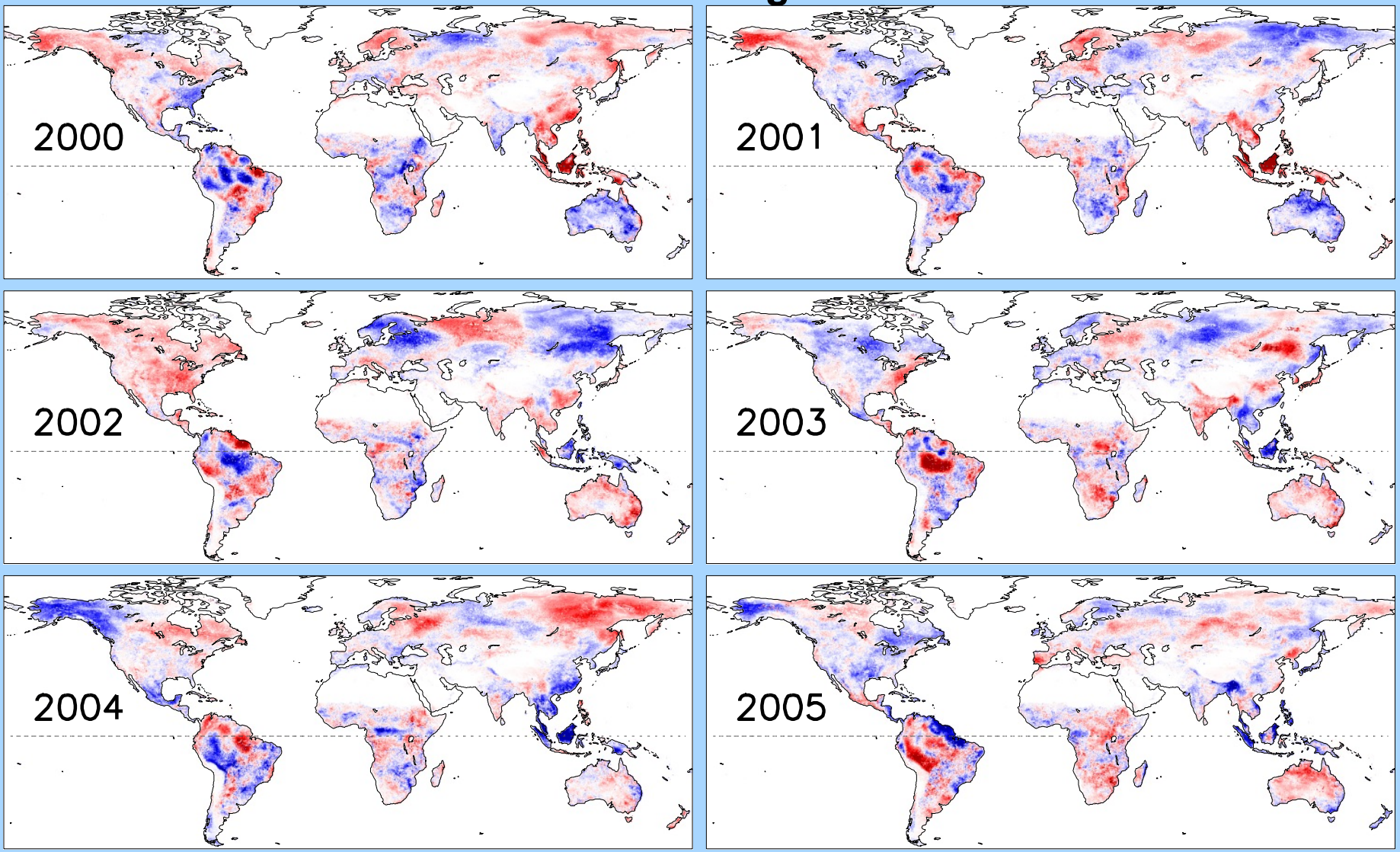
$$\lambda E = \frac{\Delta \cdot r_e \cdot (R_n - G_0) + \rho C_p \cdot (e_{sat} - e)}{r_e \cdot (\gamma + \Delta) + \gamma \cdot r_i}$$

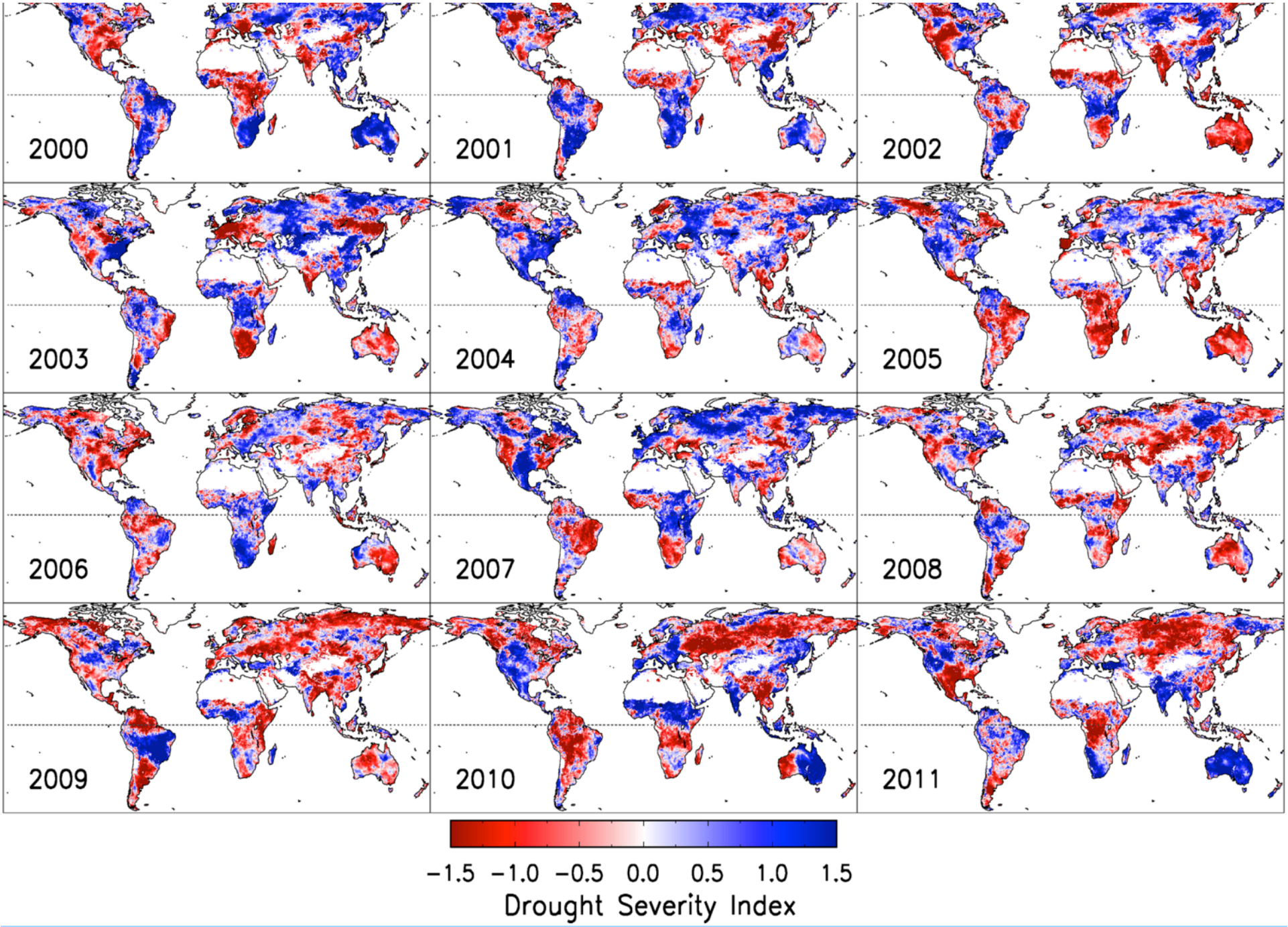
Windspeed

Veg Leaf Area

Fairbanks and Tucson have nearly identical annual precipitation, The difference is potential evaporation!

Spatial pattern of the 0.05°-resolution global MODIS ET anomalies during 2000-2005




2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
−1.5 −1.0 −0.5 0.0 0.5 1.0 1.5
Drought Severity Index

Volume 94 Number 1 January 2013

BAMS

Bulletin of the American Meteorological Society

SEAMLESS PREDICTION

GET READY FOR PYTHON

A DECADE OF OSIRIS

DROUGHT SEVERITY INDEX

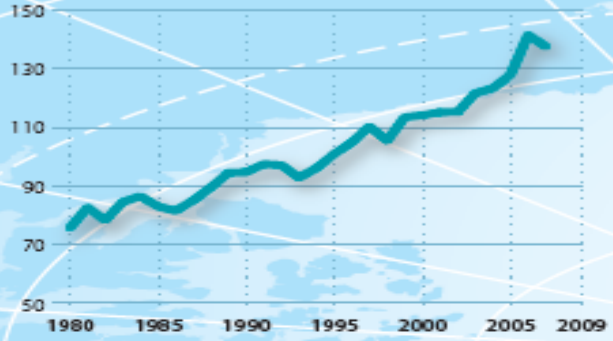
Measuring Conditions from Satellites

IGBP CLIMATE-CHANGE INDEX

Combining data to expose underlying global-change trends for the public and policymakers

SEA-LEVEL RISE

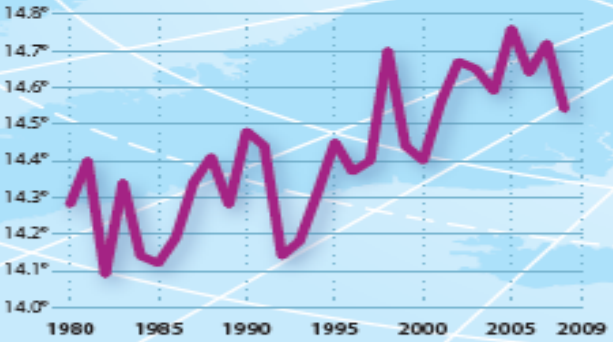
Sea-level rise (millimeters)



Source: Church and White global mean sea-level reconstruction. Permanent Service for Mean Sea Level, Proudman Oceanographic Laboratory, Natural Environment Research Council

GLOBAL AVERAGE TEMPERATURE

(absolute, degrees C)



Source: NASA

Rising index
A shift away from the current stable climate of the last 10,000 years

Falling index
A return to the planet's stable climate

The IGBP climate-change index combines the four key metrics that help unravel what is happening to the planet: temperature, carbon dioxide levels, sea level and Arctic sea ice. The index combines annual changes in each of these directly-measured parameters. Each year's change is added to the previous year. Natural variability sometimes obscures general trends in these metrics. By drawing together the four metrics as a single figure, the IGBP climate-change index exposes the underlying trend.

Developed by the International Geosphere Biosphere Programme

CURRENT TRAJECTORIES

Years to reach 450ppm CO_2 40 years
Years to reach 550ppm CO_2 100 years

ATMOSPHERIC CO_2

(parts per million by volume)

Source: Carbon Dioxide Information Analysis Center, Mauna Loa

ARCTIC SEA-ICE COVER

Northern hemisphere summer sea-ice minimum (millions of square kilometers)