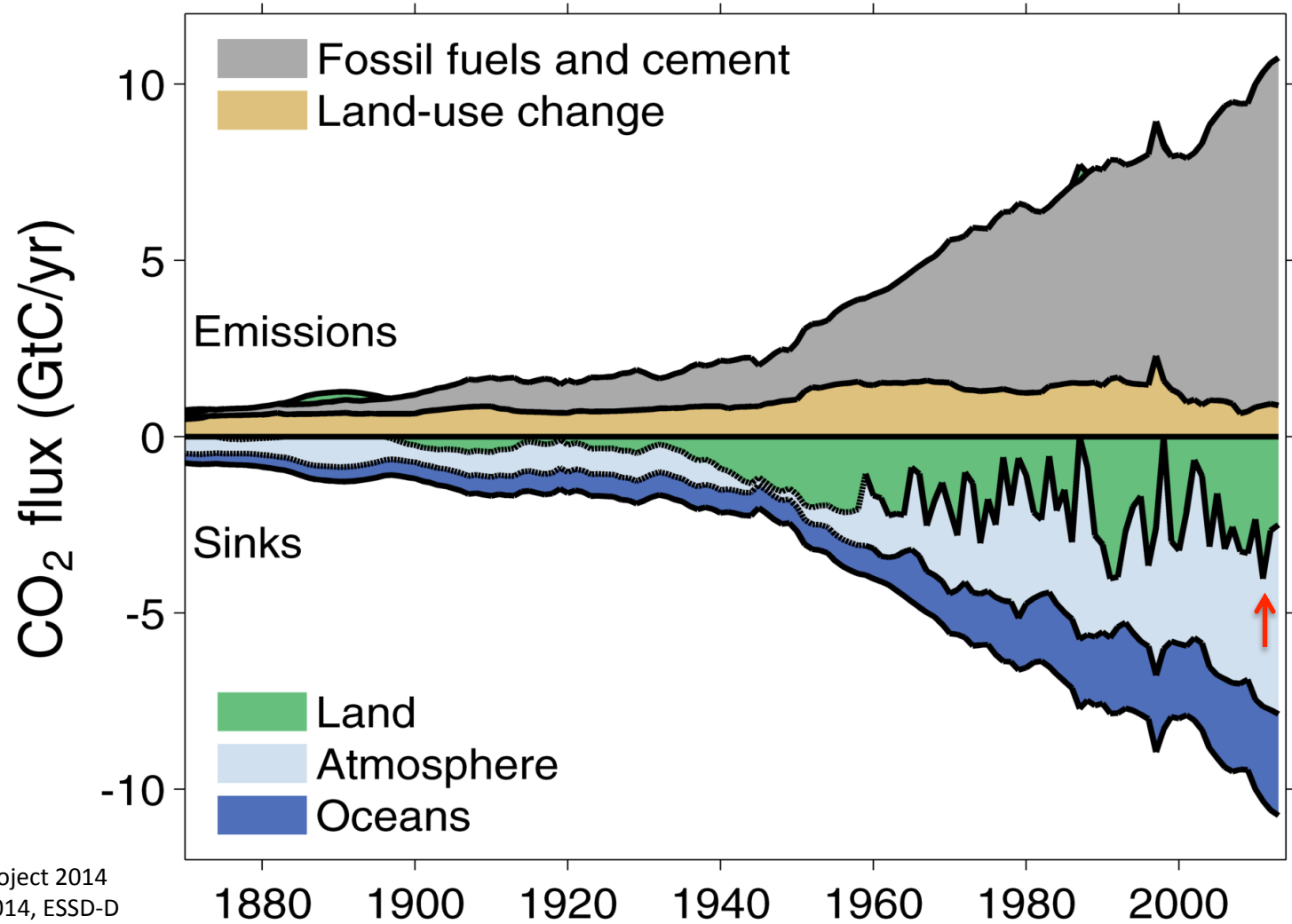


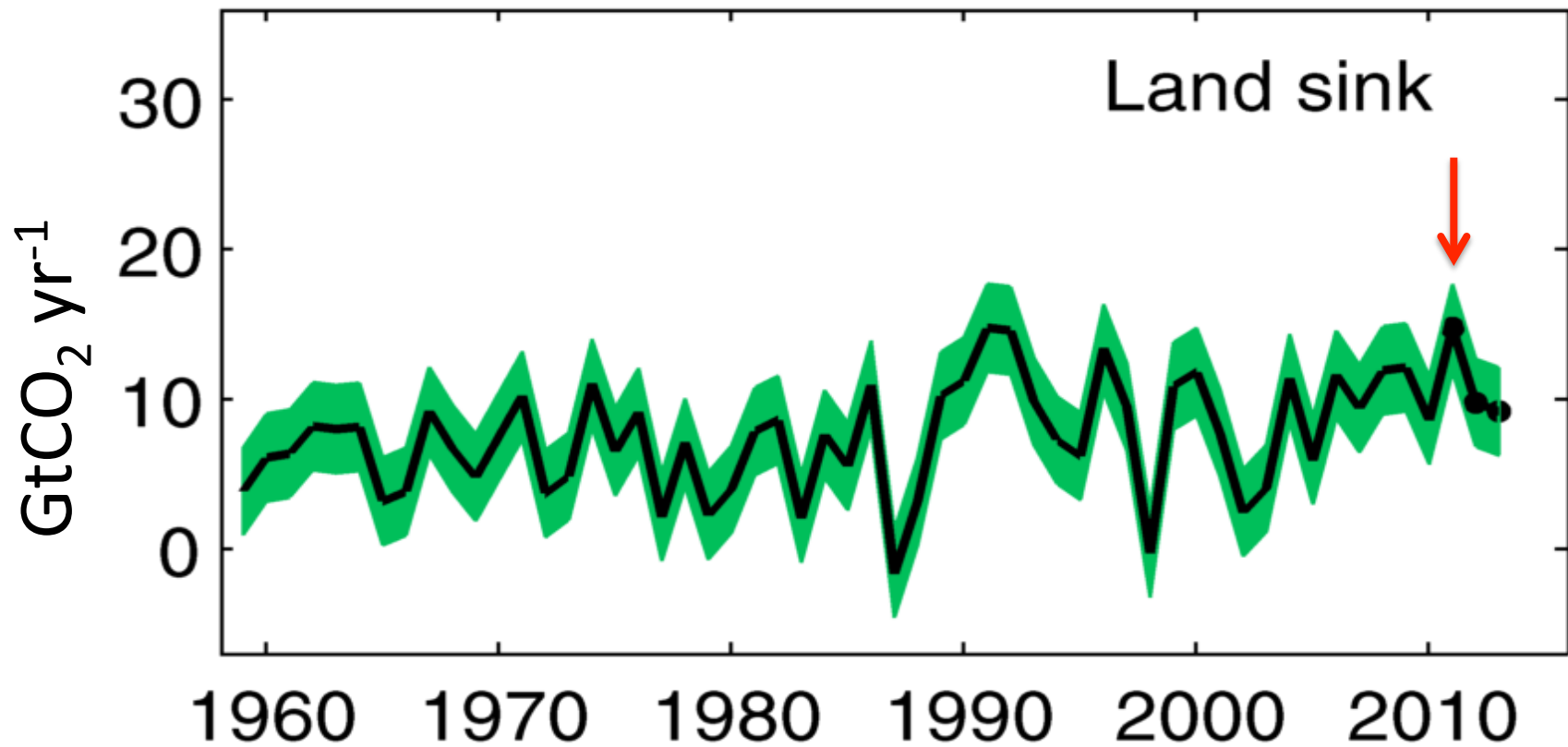
When the Ocean Fell and the Land Turned Green

Pep Canadell*,
B.Poulter, D Frank, P Ciais, R Myneni,
N Andela, J Bi, G Broquet, F Chevallier,
YY Liu, SW Running, S Sitch and GR van
der Werf

*Global Carbon Project
CSIRO Oceans & Atmosphere Flagship
Canberra

Photo: Garry Cook





Global Land Sink 2011

4.1 PgC yr⁻¹

Mean Sink 2002-2011

2.6±0.8 PgC yr⁻¹

Higher sink

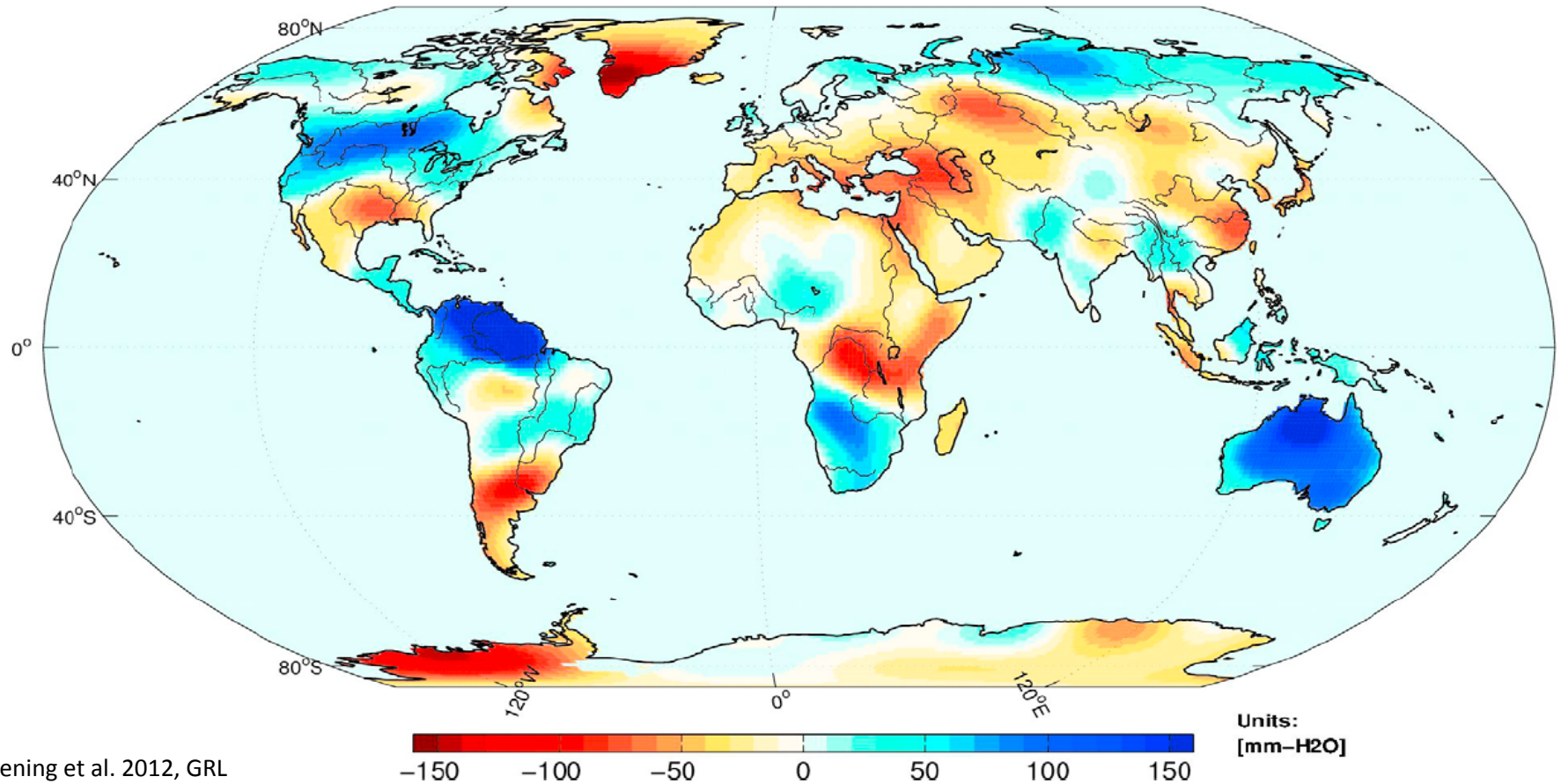
63%

Equivalent

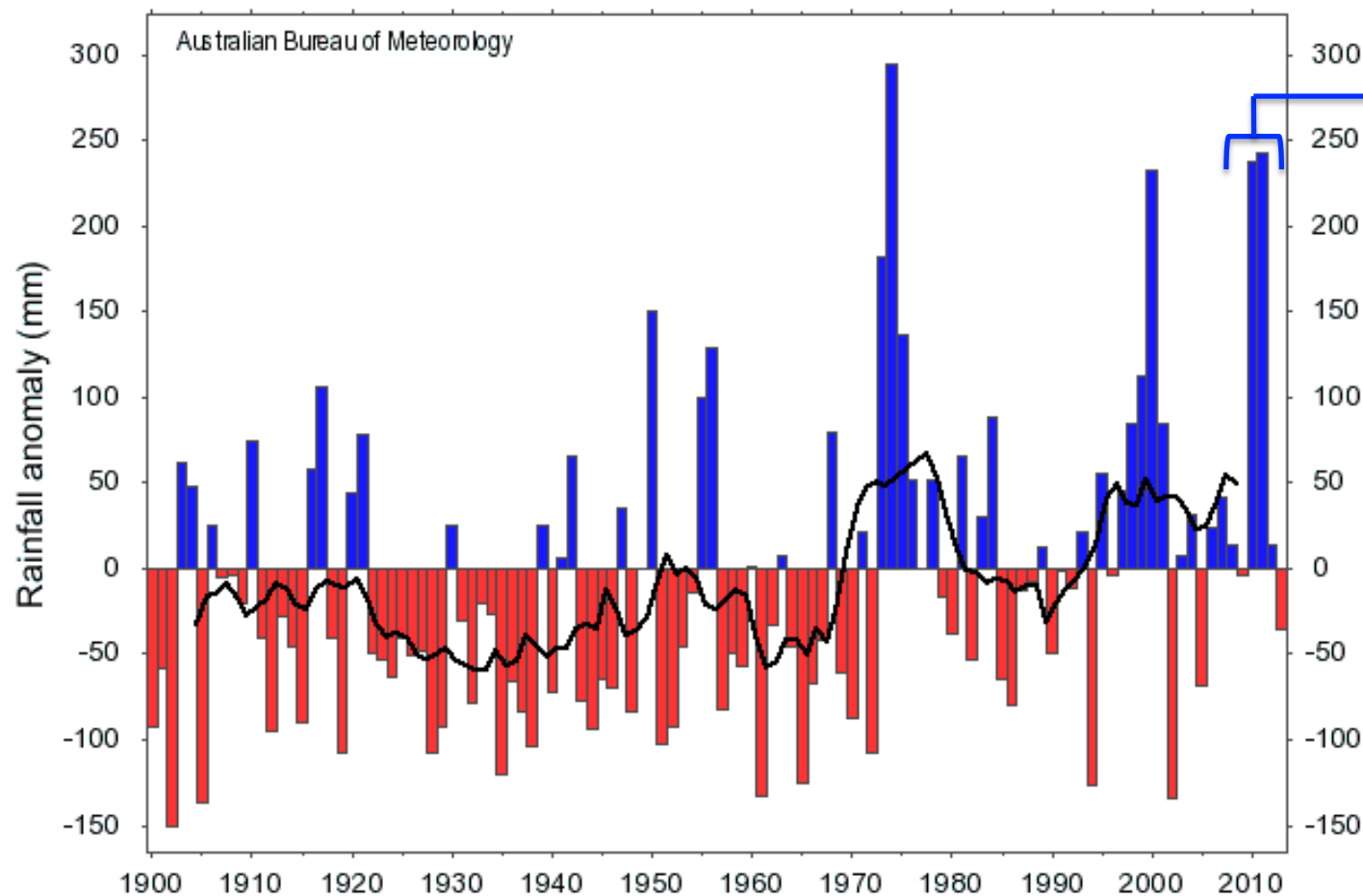
40% FF emissions

Changes in Water Mass (GRACE)

2010 (JFM) - 2011 (MAM)



Annual rainfall anomaly - Australia (1900-2013)

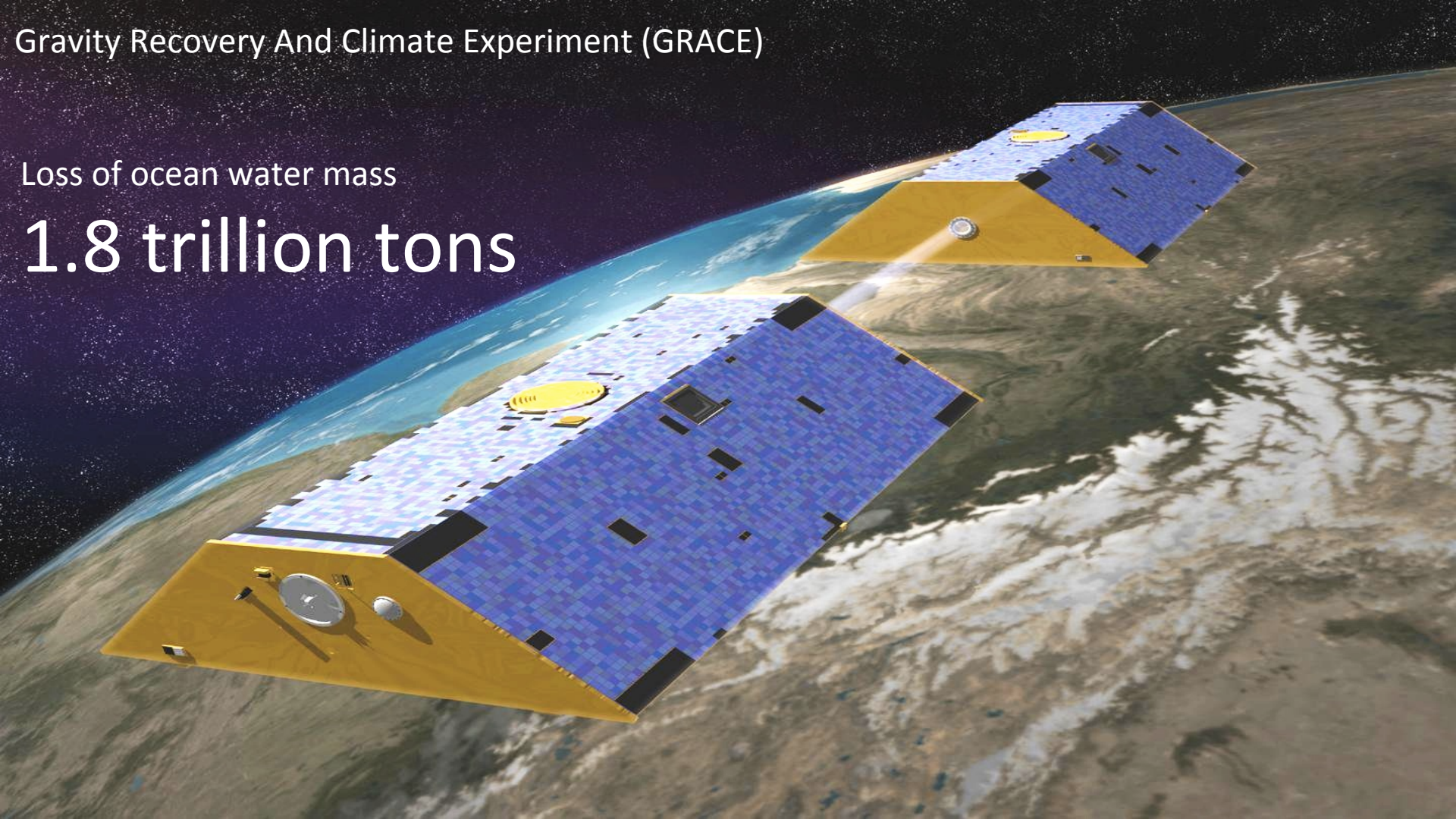


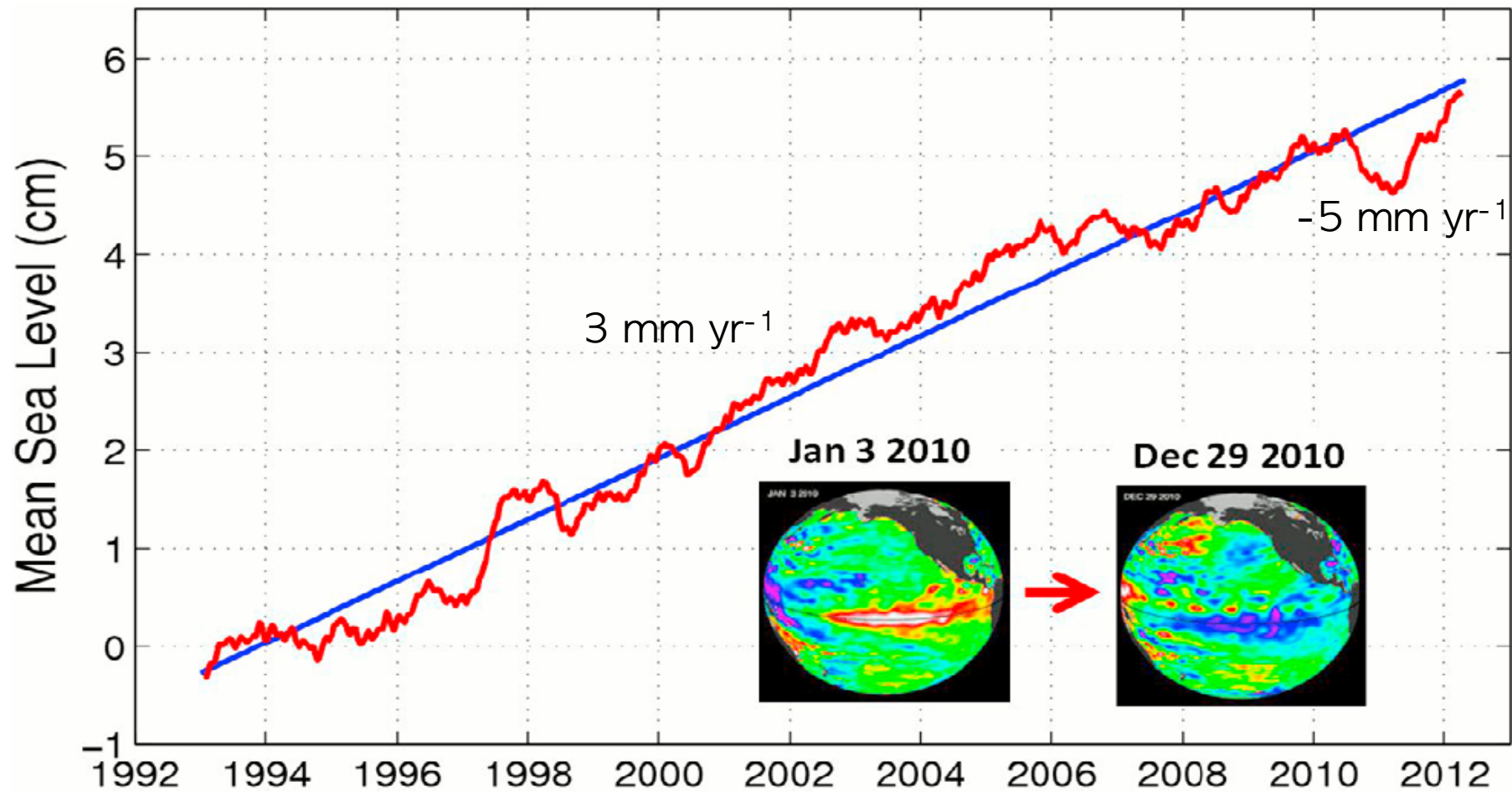
6 consecutive seasons with La Niña conditions

Gravity Recovery And Climate Experiment (GRACE)

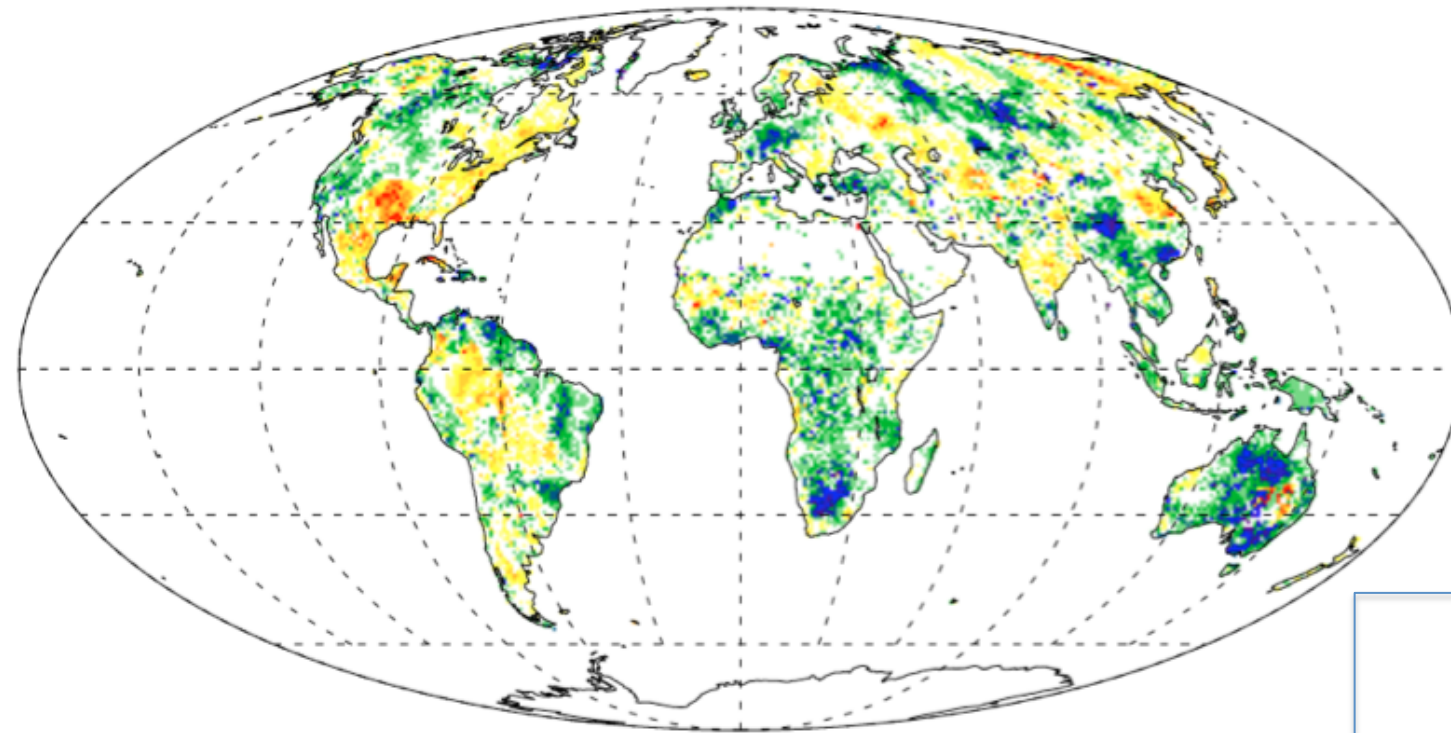
Loss of ocean water mass

1.8 trillion tons

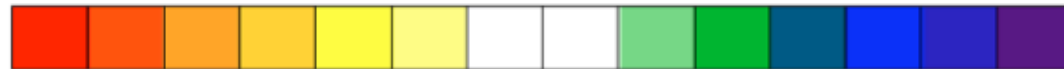




LPJ-Net Ecosystem Exchange Anomaly



2011 LPJ NEE anomaly



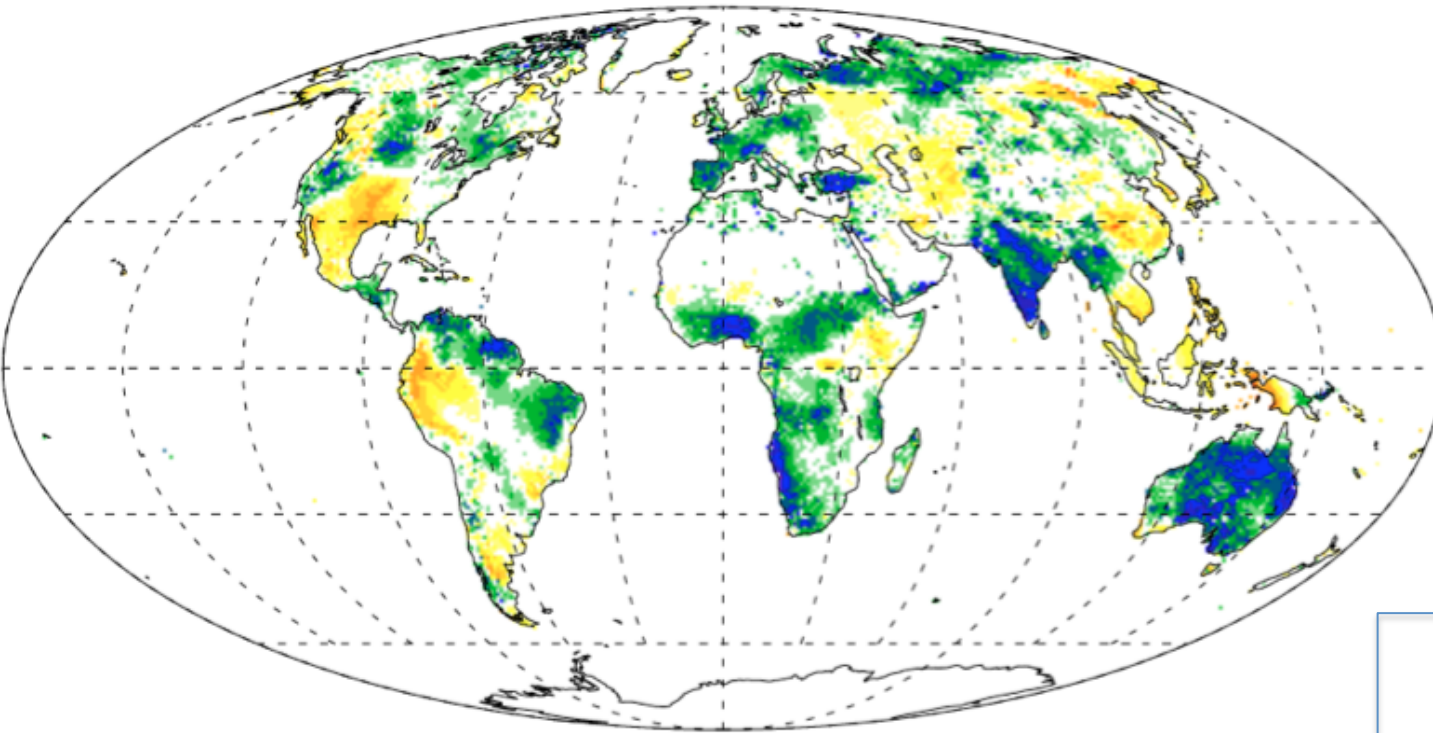
-3 -2 -1 0 1 2 3

NEE

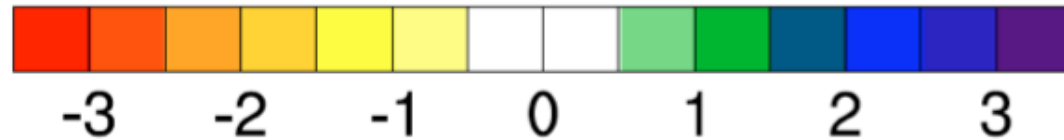
Australia = 57% of
S. Hemisphere
anomaly

(Absolute NEE= 0.8 PgCy^{-1})

MODIS NPP Anomaly



2011 MODIS NPP anomaly



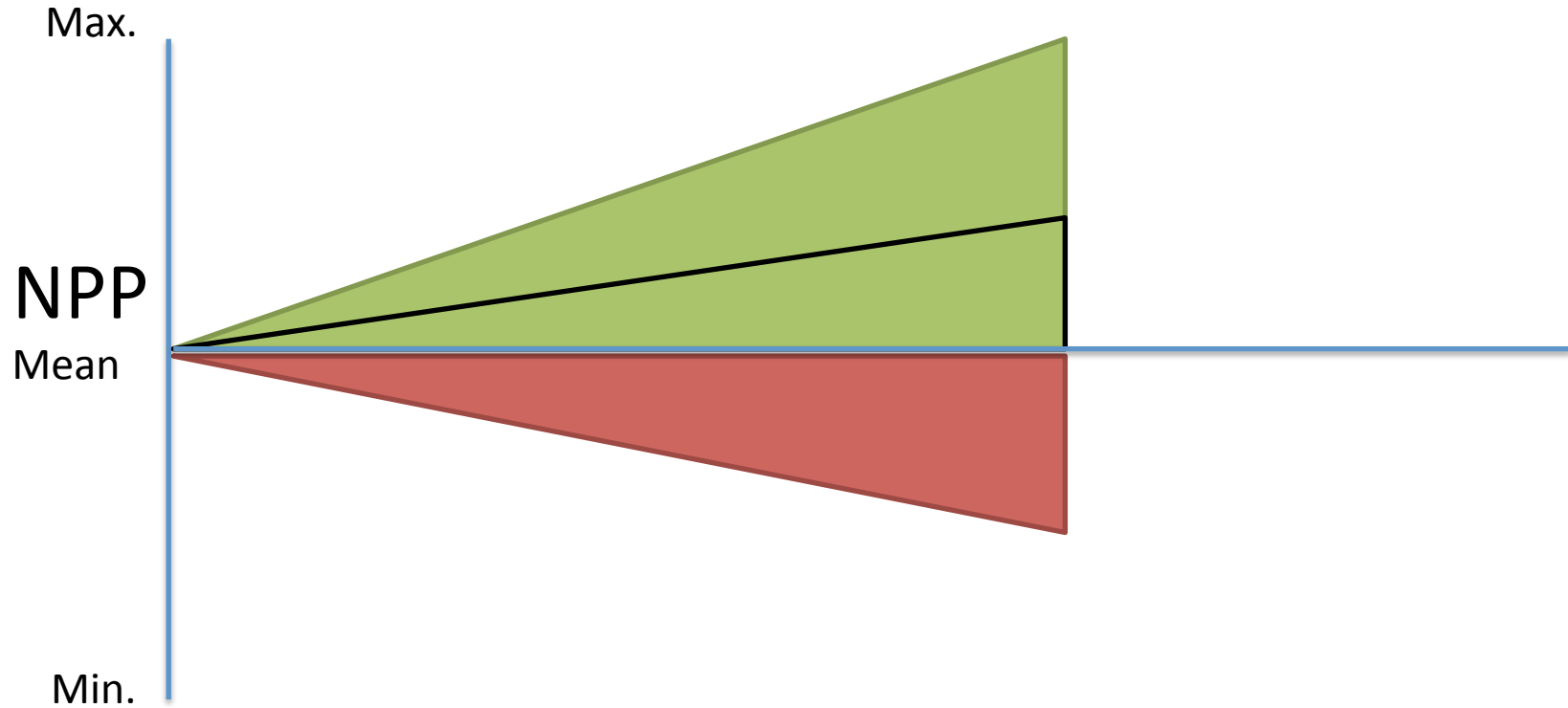
NPP
87% anomaly
of the S. Hemisphere

Flux Attribution - Australia 2011

(compared to 2003–2012, LPJ)

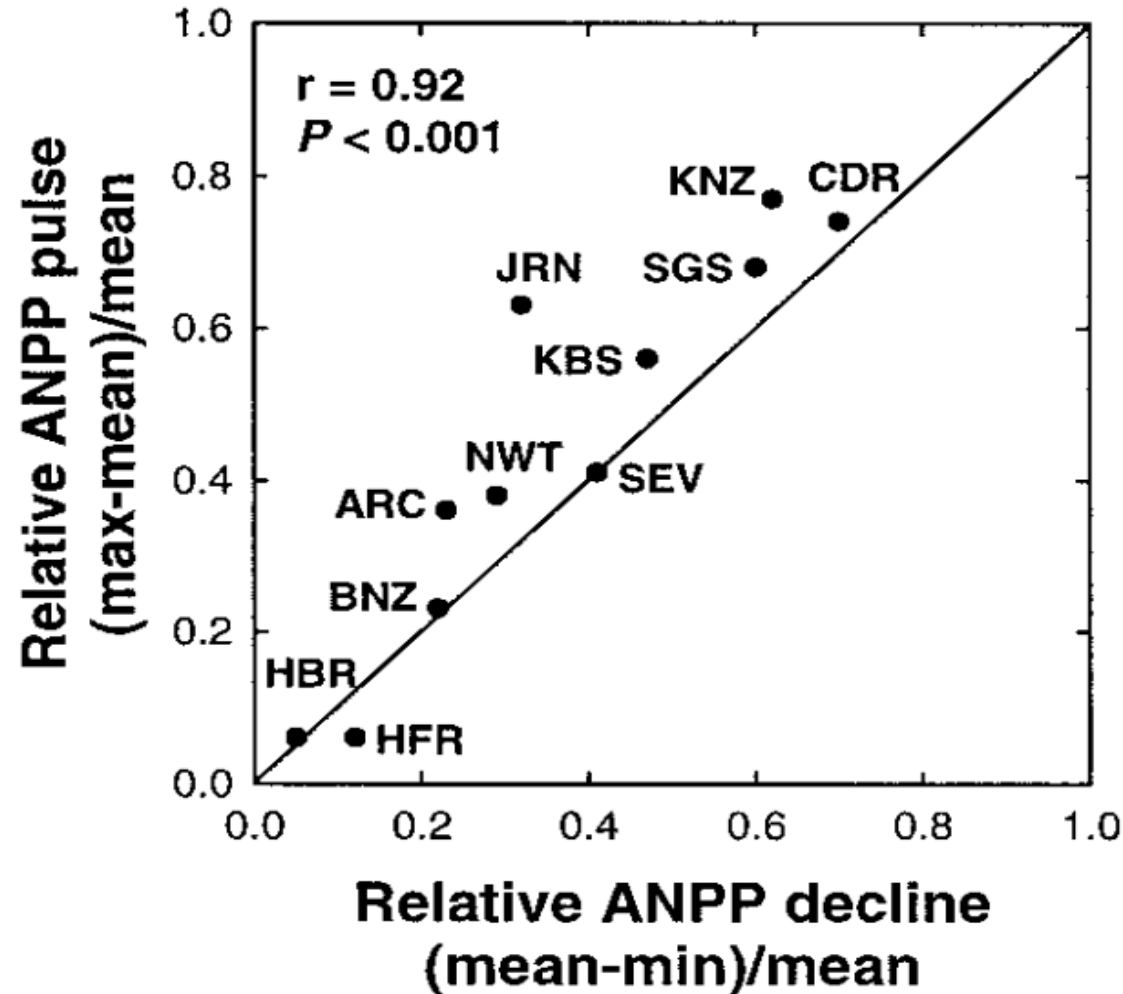
- **NPP:** 45% increase (from 1.75 to 2.54 PgC yr⁻¹)
- **R_h:** 9% increase (from 1.48 to 1.61 PgC yr⁻¹)
- **Fire:** 29% decrease in fire emissions (from 0.13 to 0.09 PgC yr⁻¹) yielding a net 0.84 PgC

Extremes
Frequency/Intensity

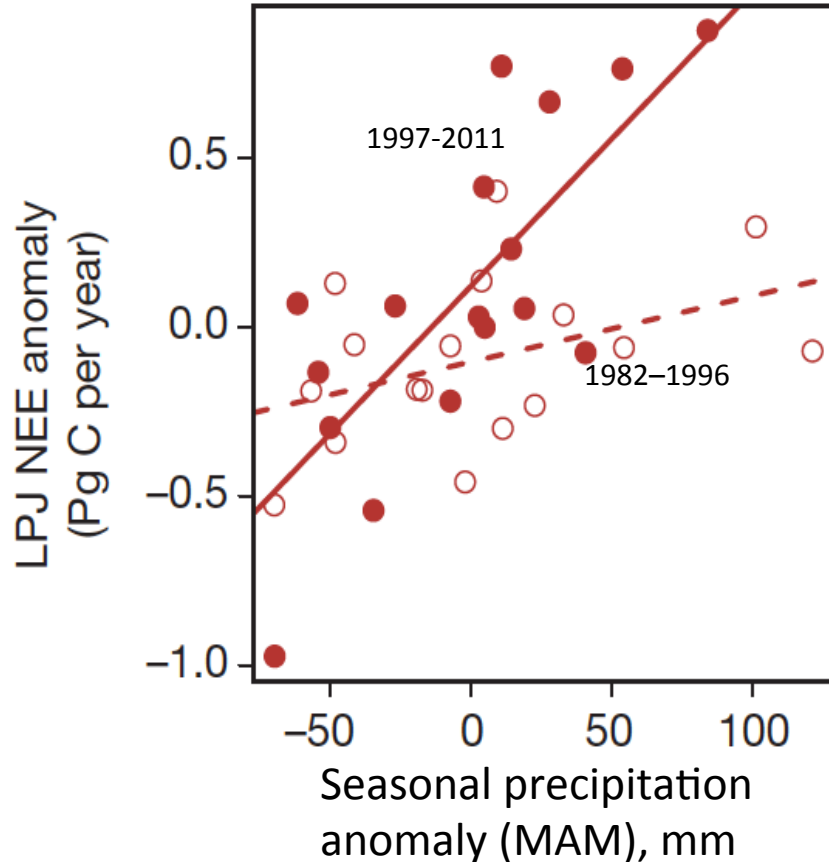


Asymmetric Responses to Wet/Dry

Asymmetric NPP Responses to Wet/Dry



Changes in Precipitation Sensitivity – Australia



x4 increase
sensitivity of continental net C
uptake to precipitation

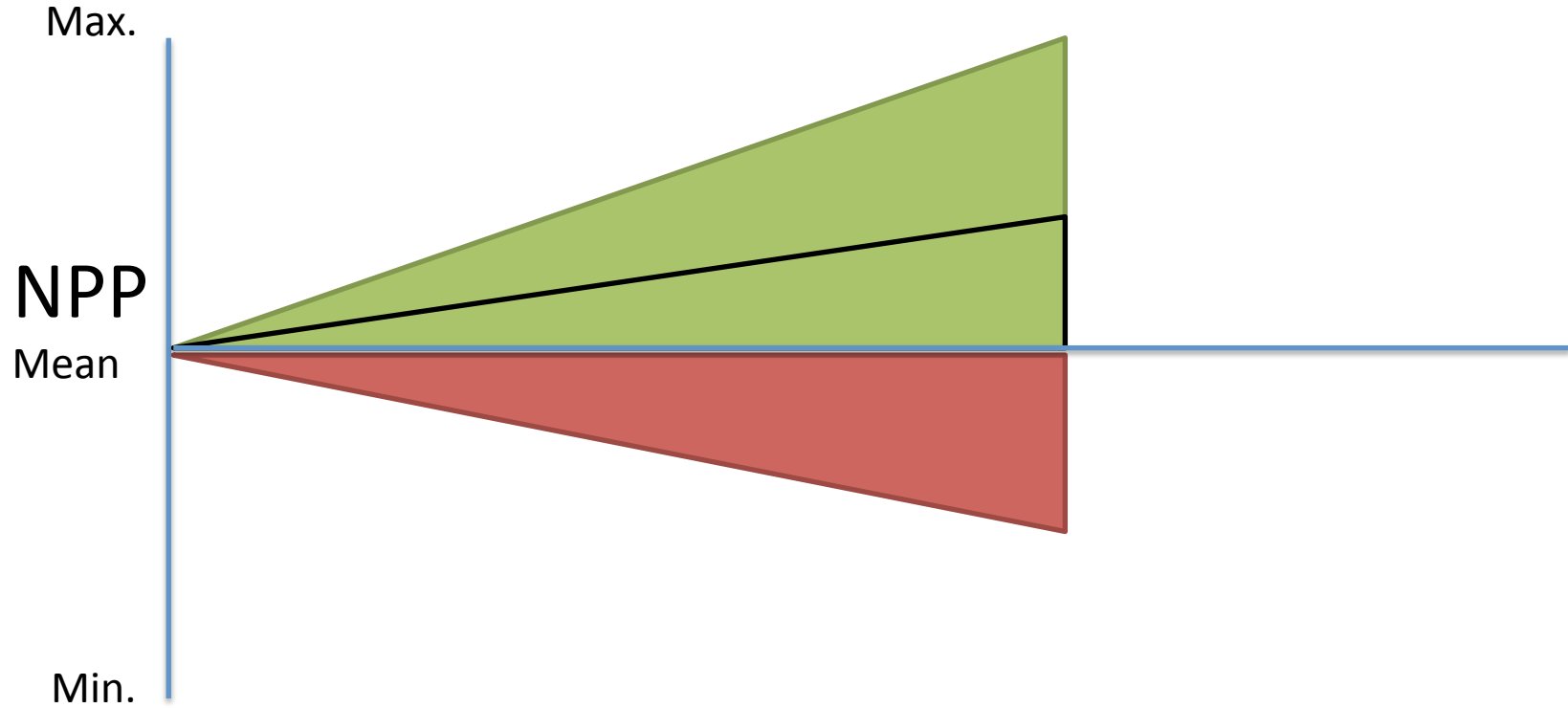
before 1997:

100 mm → 0.2 PgCy⁻¹

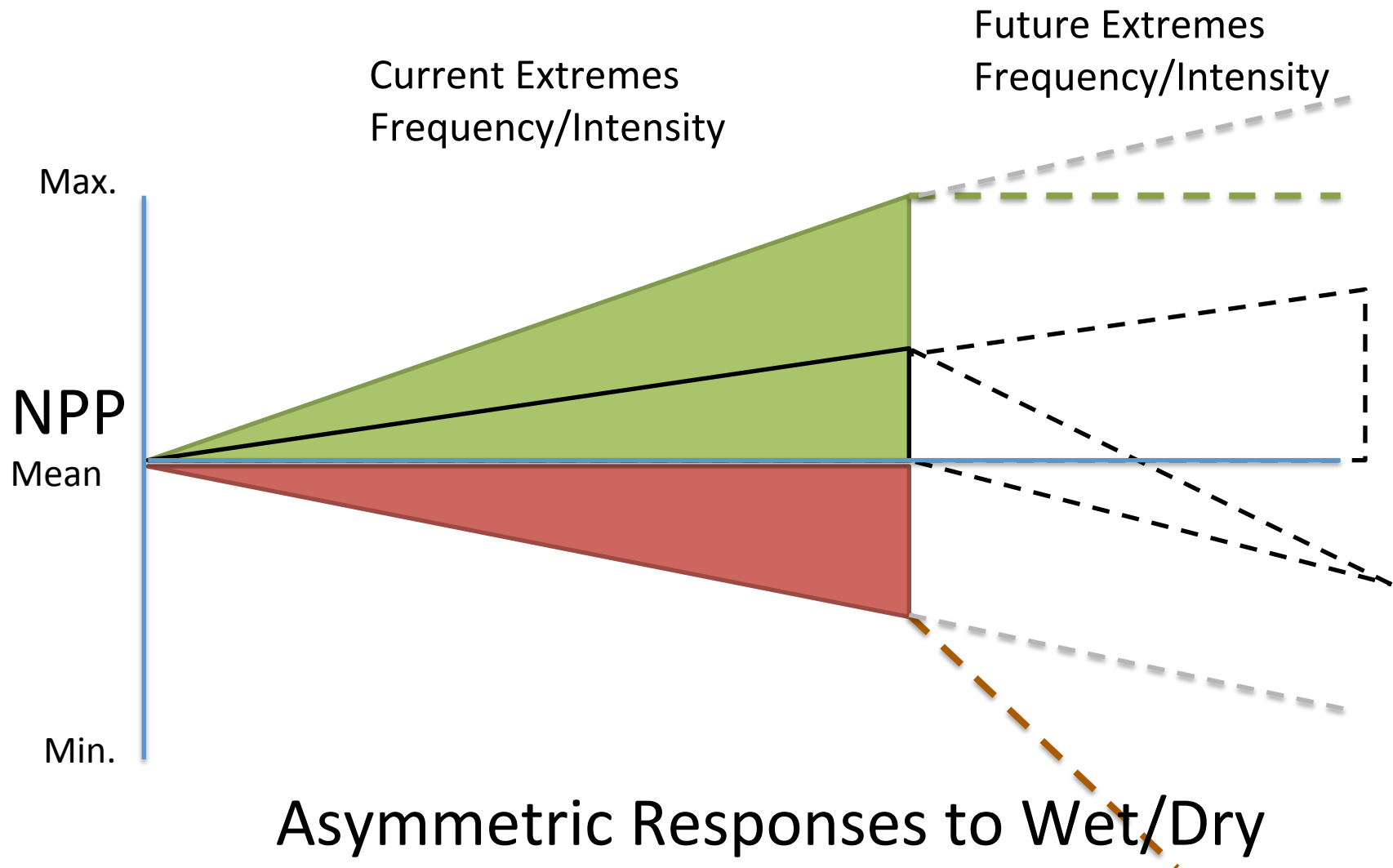
after 1997:

100 mm → 0.8 PgCyr⁻¹

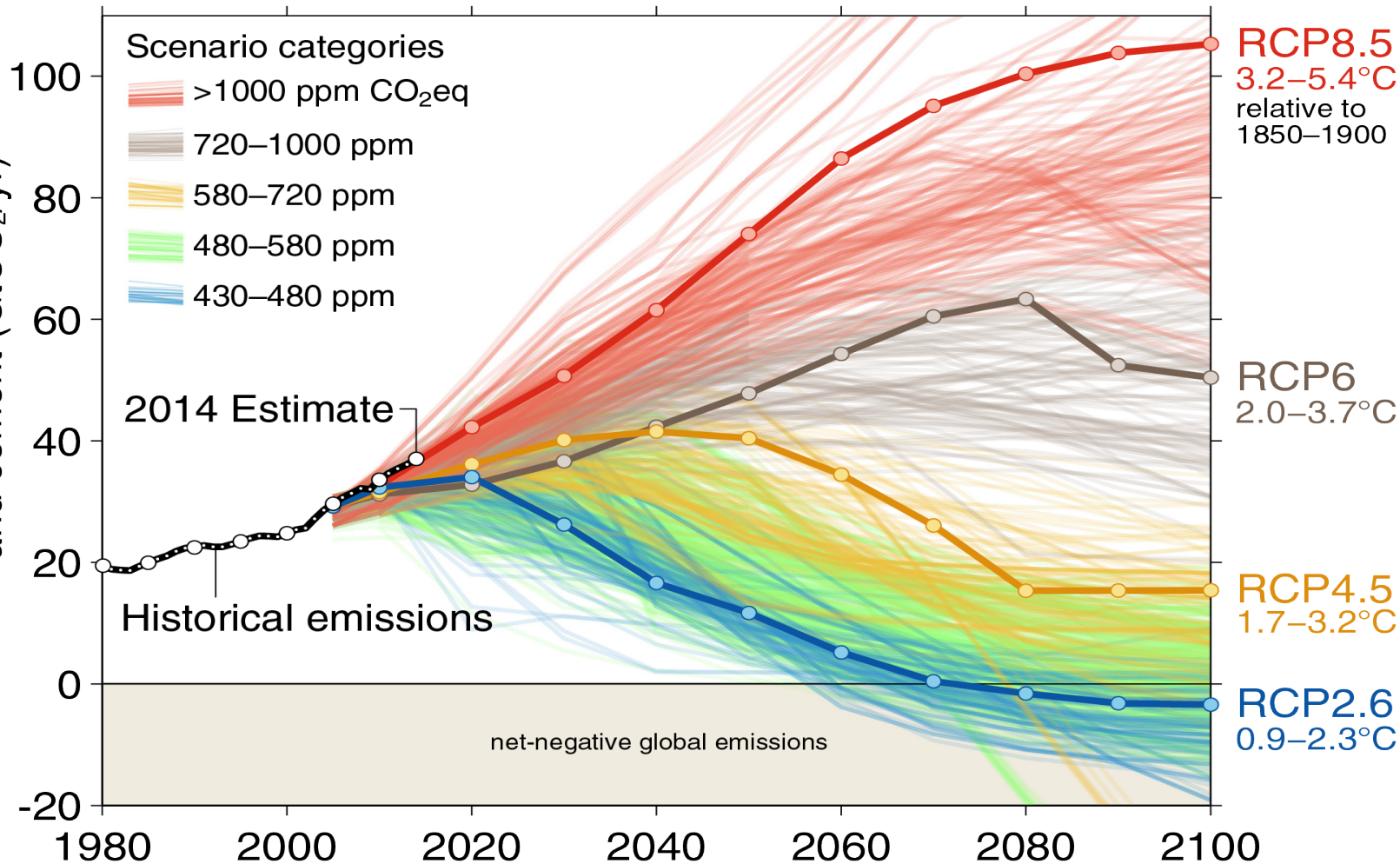
Extremes
Frequency/Intensity



Asymmetric Responses to Wet/Dry

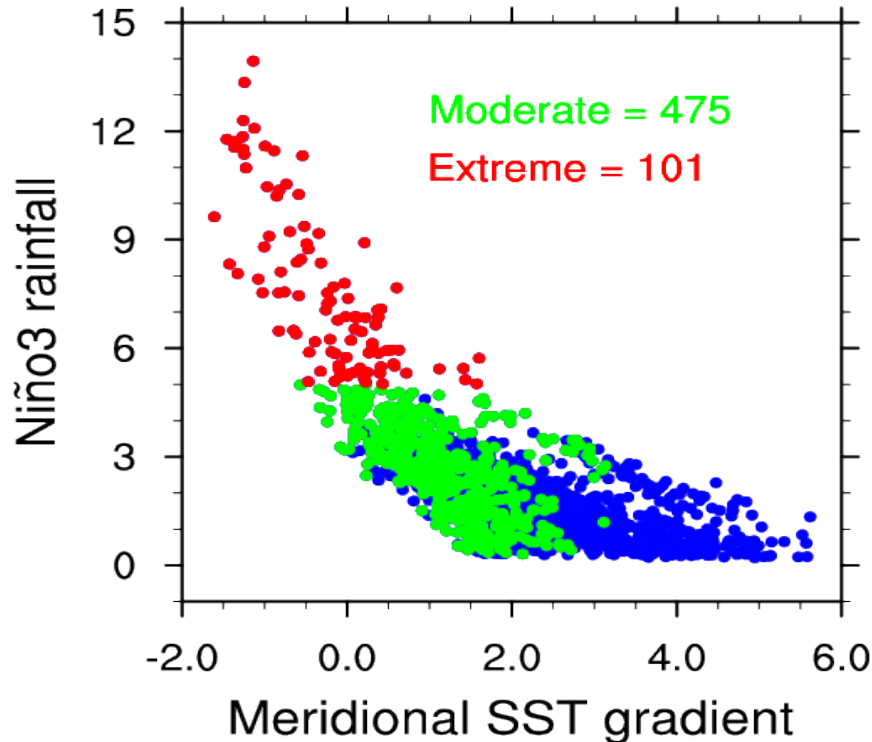


Emissions from fossil fuels
and cement (GtCO₂/yr)

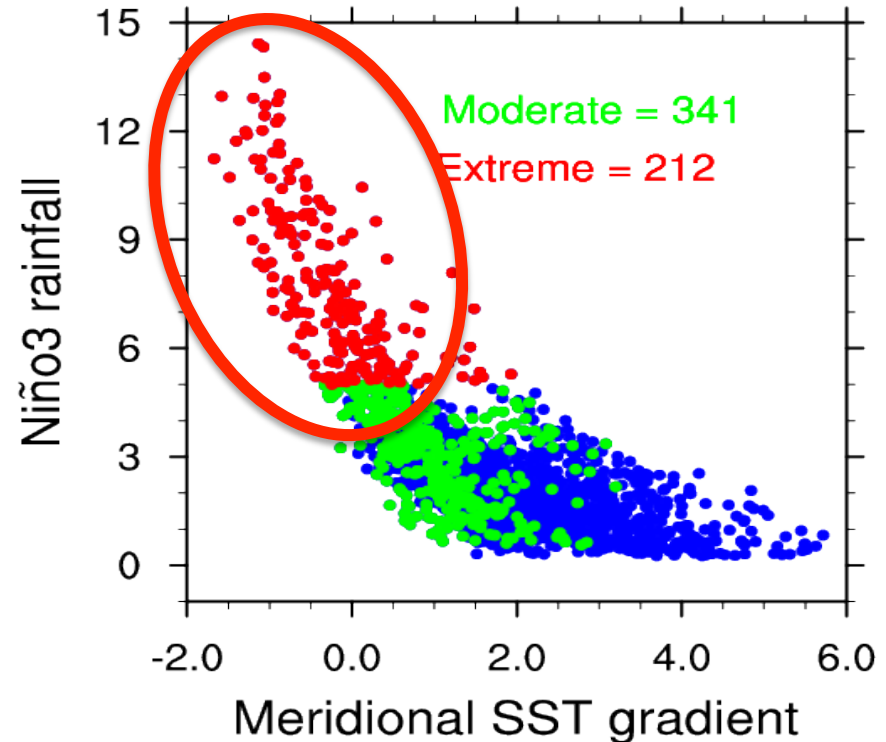


Doubling (x2) of extreme El Niño events

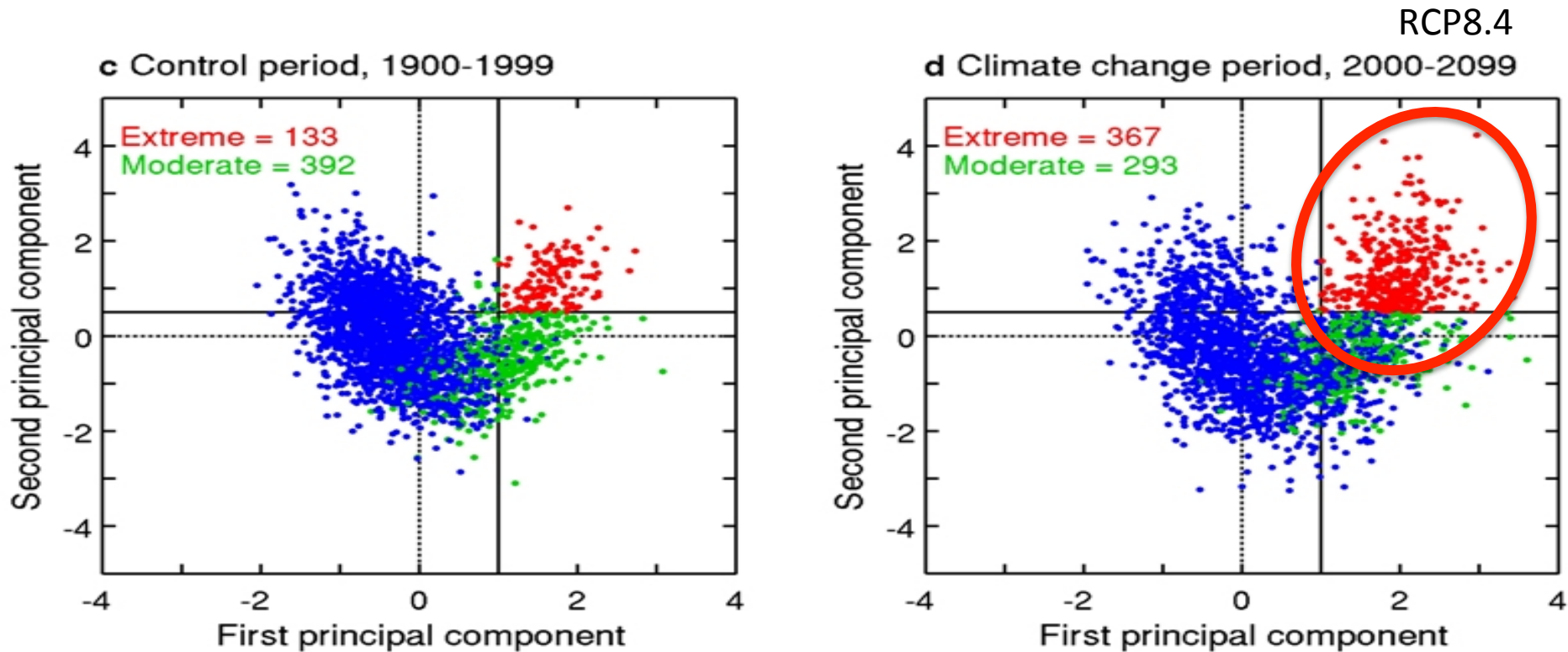
c Modelled relationship, 1891-1990



d Modelled relationship, 1991-2090



Tripling (x3) of Indian Ocean Dipole



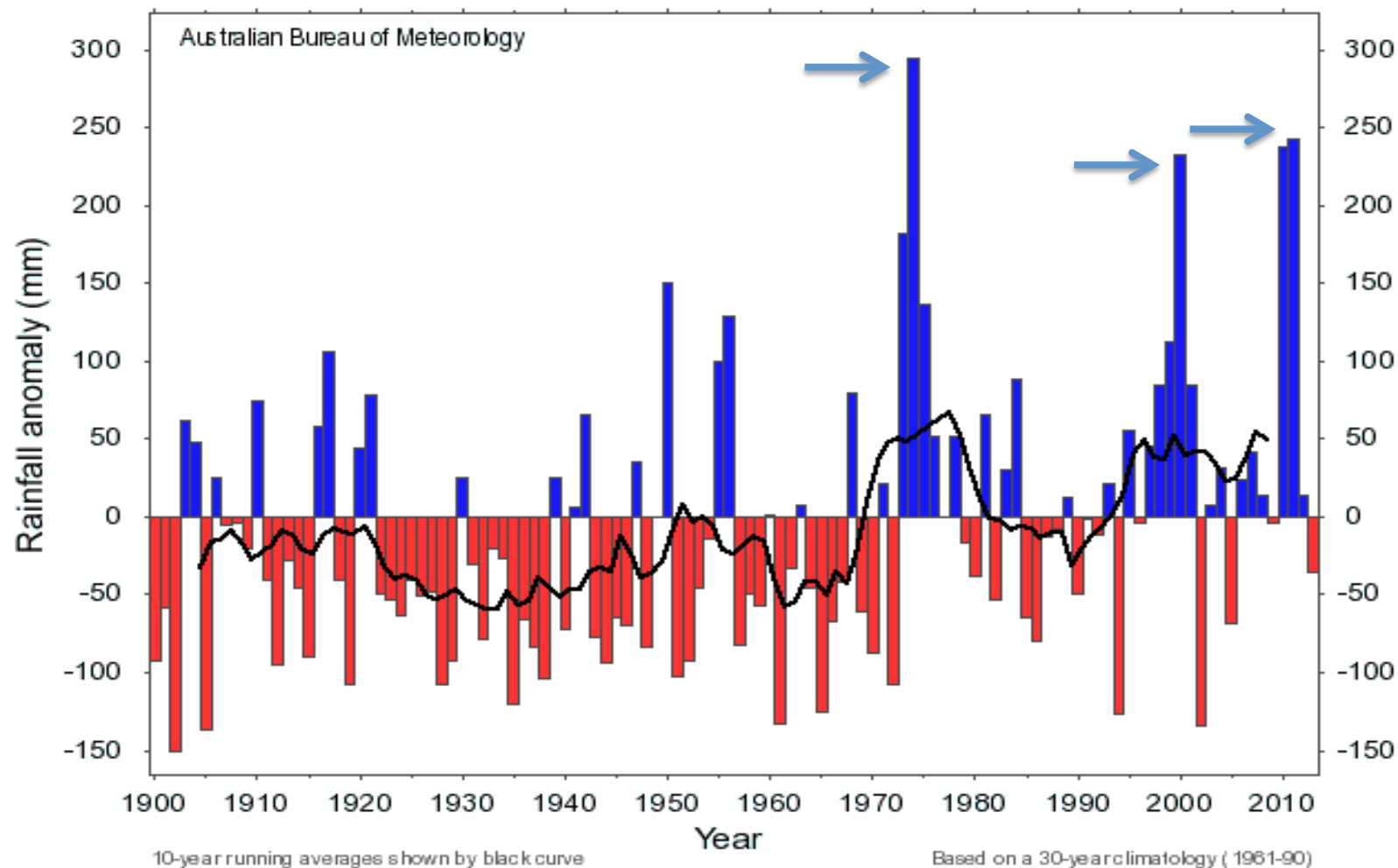
Near Doubling of Extreme La Niña events

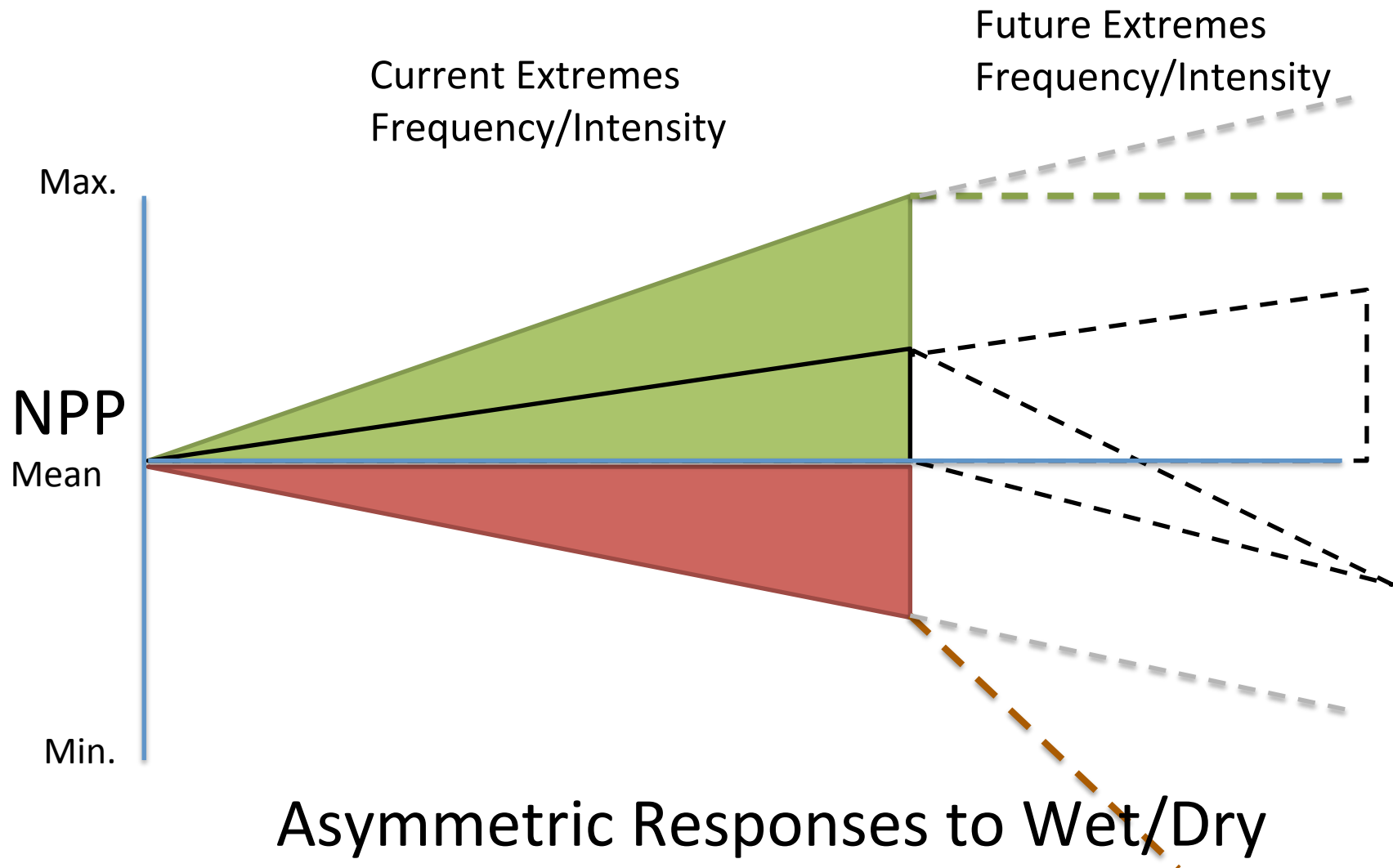
RCP8.4

One in 23 years  One in 13 years

About 75% of the increase occurs in years
following extreme El Niño events

Annual rainfall anomaly - Australia (1900-2013)





end

Global AVHRR FPAR Anomalies

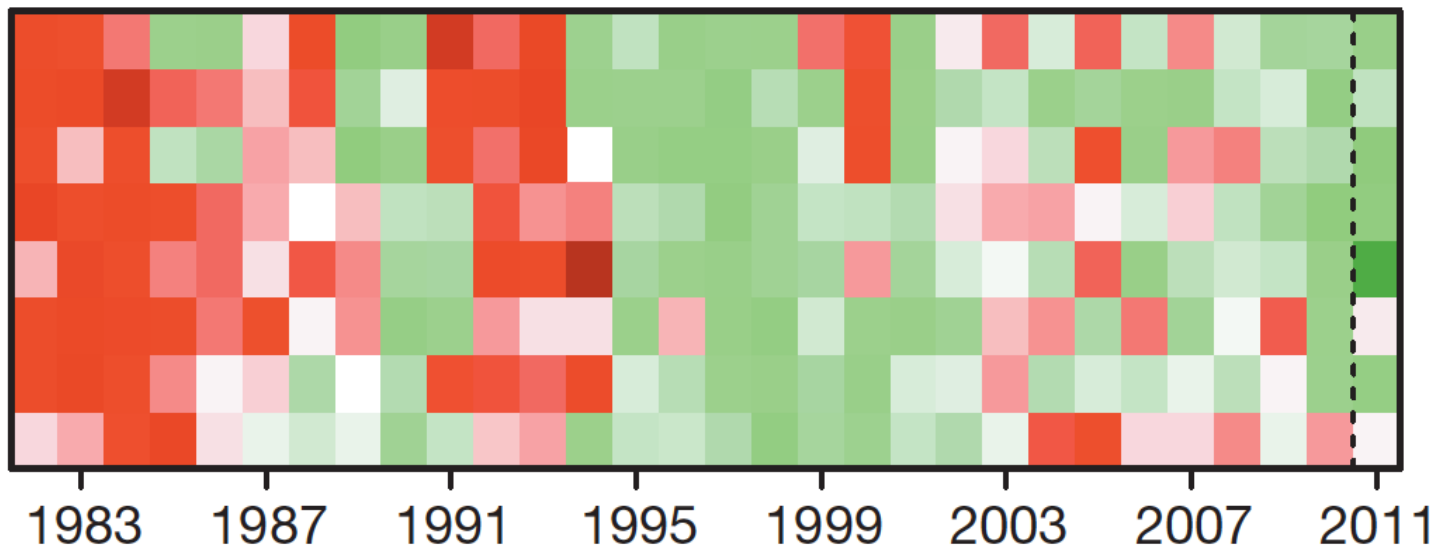
S – Southern Hemisphere

N – Northern Hemisphere

c

Seasonal FPAR

SON S
SON N
JJA S
JJA N
MAM S
MAM N
DJF S
DJF N



Anomalies against 1982-2011 average
Australia FPAR June-July-August 2011 highest of period