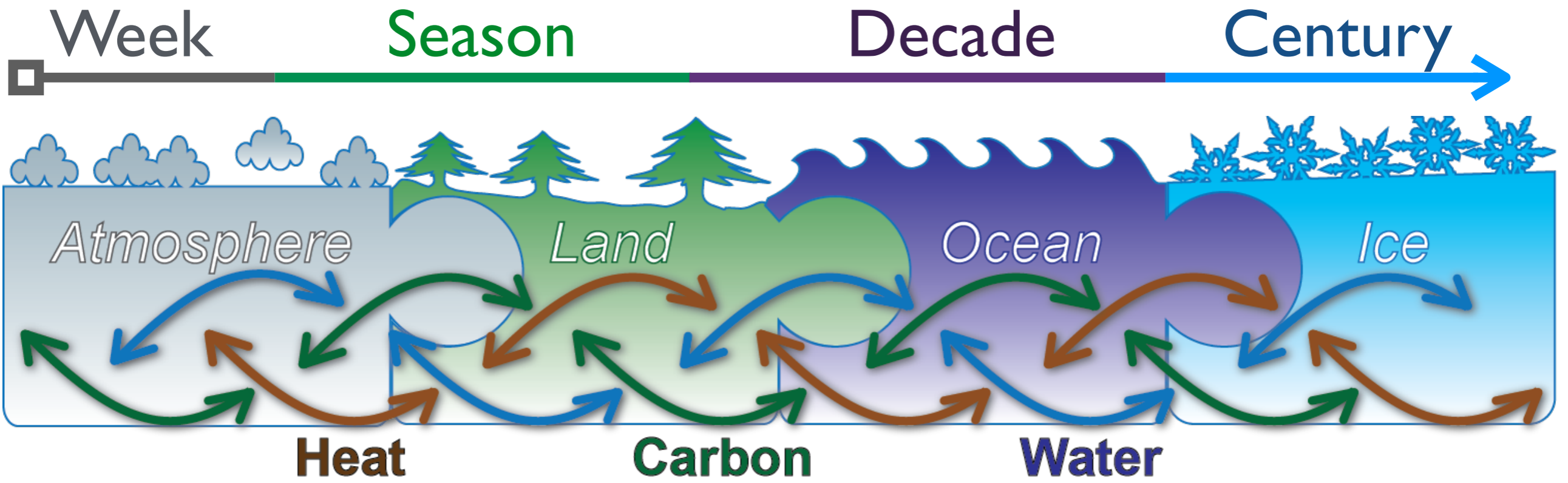


# Analysis & Prediction

## Indicators of the Climate System

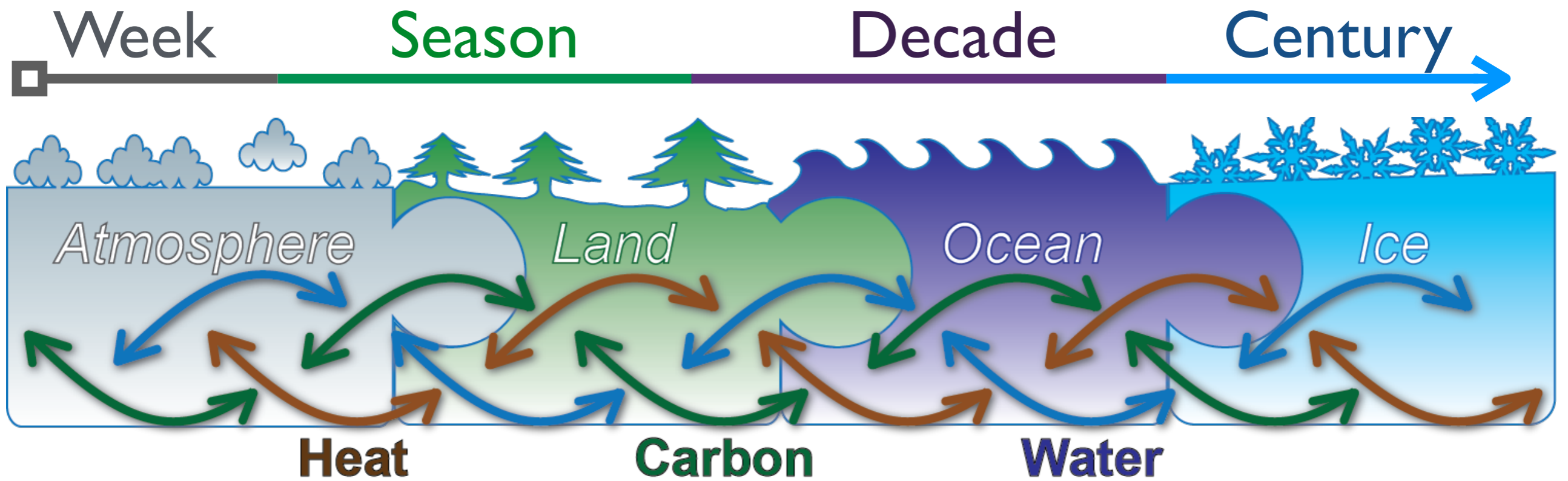
D Carlson  
Director, WCRP





WCRP UNFCCC 2016.11.08

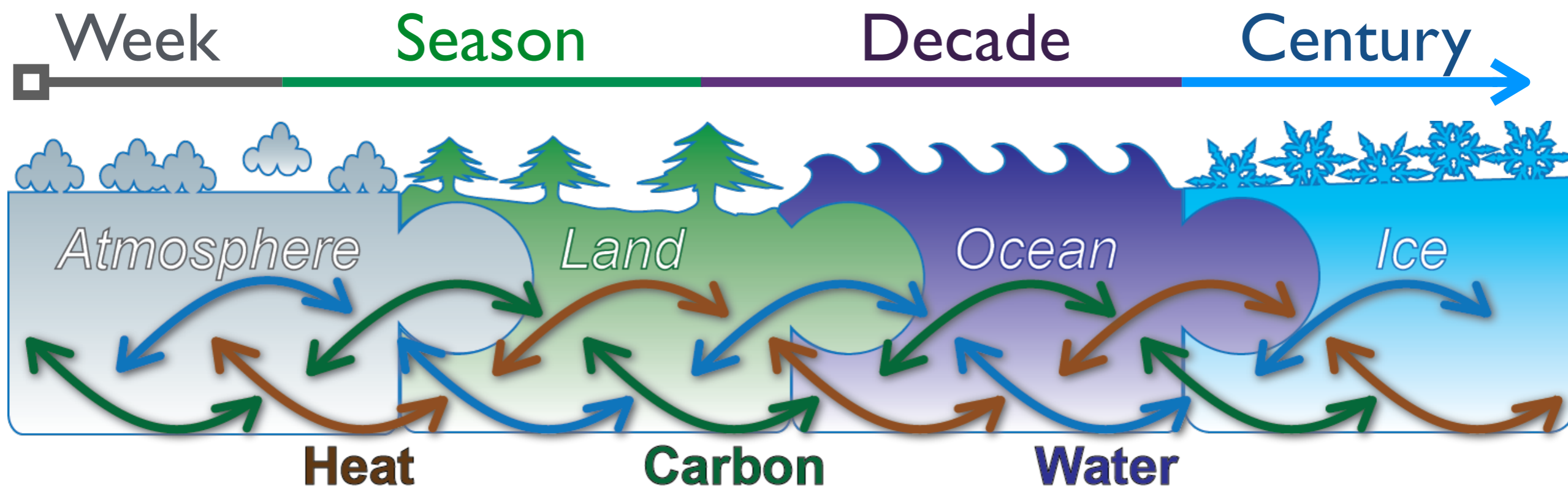
# Indicators of the entire system?



WCRP UNFCCC 2016.11.08

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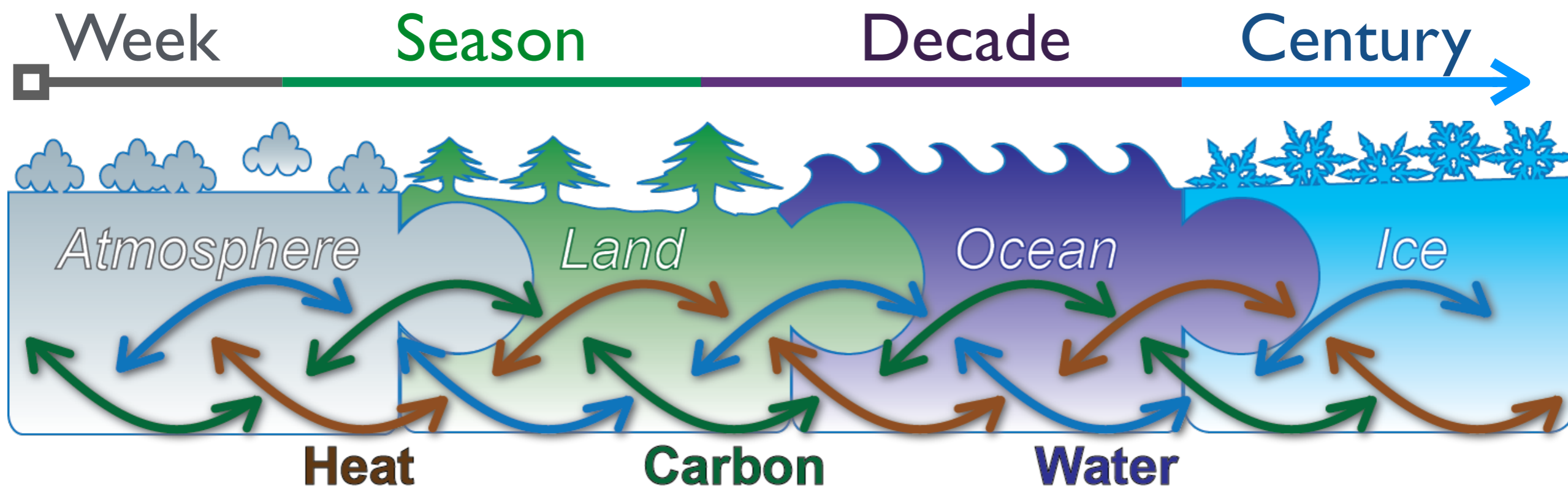
- Heat / energy
- Carbon - CO<sub>2</sub> and CH<sub>4</sub>
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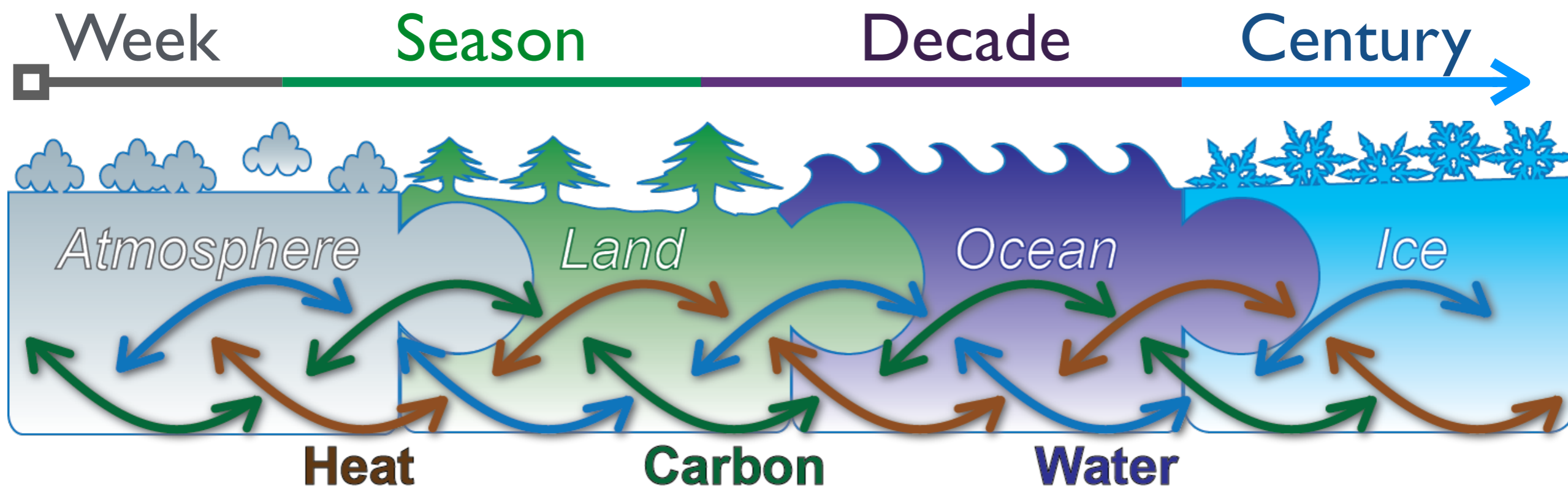
As budgets: inputs - outputs = net change



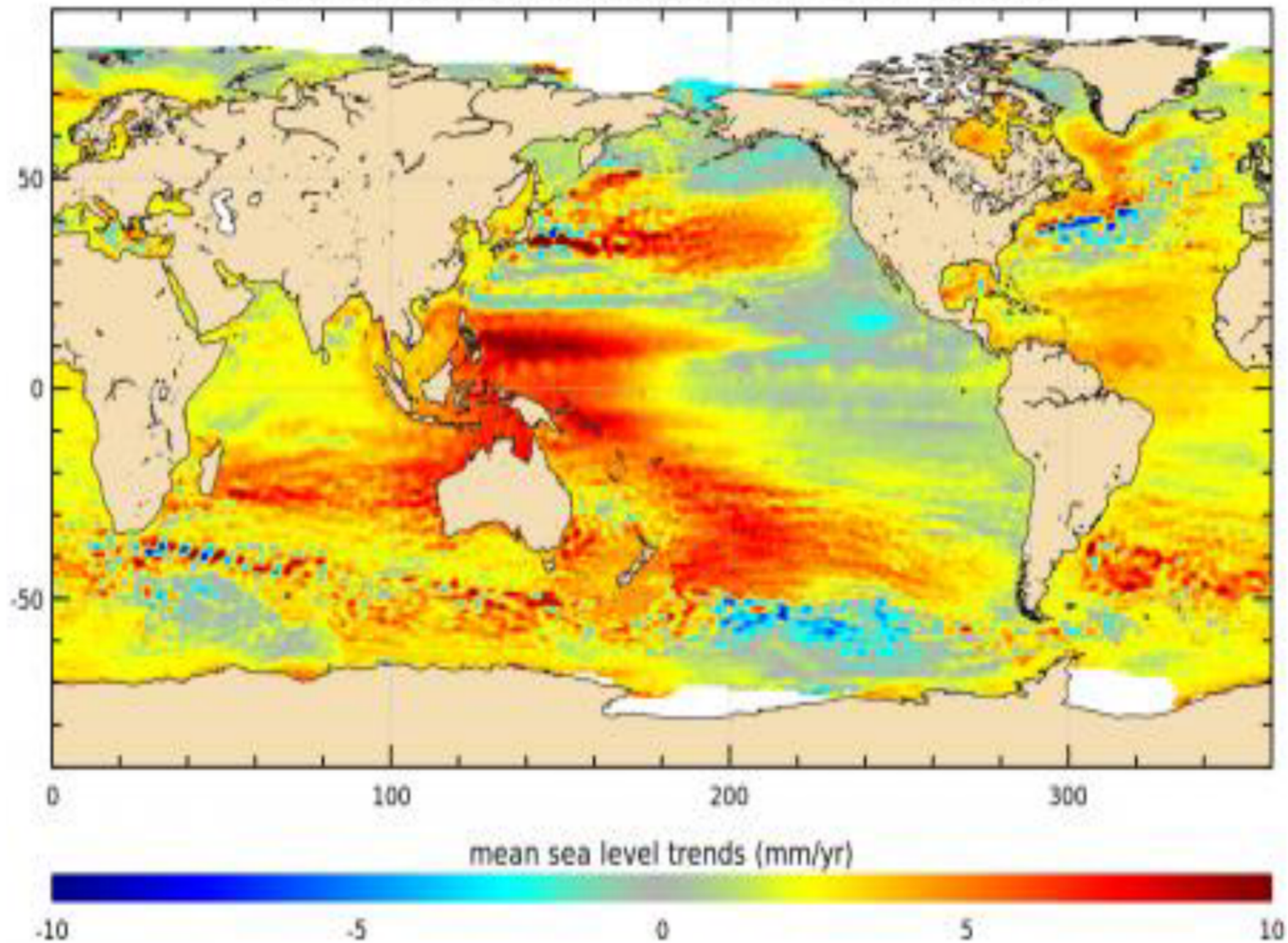
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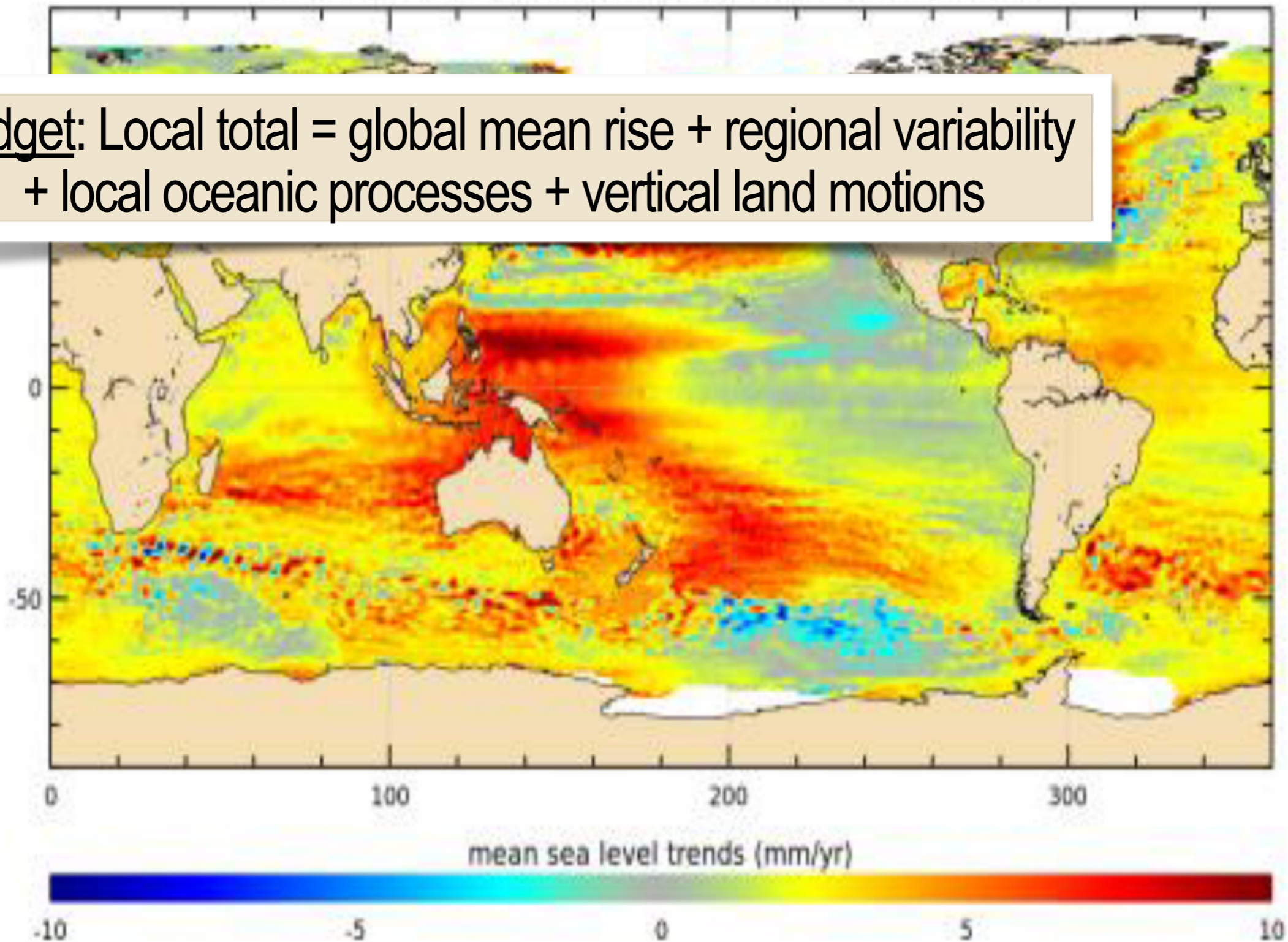


Sea Level CCI ECV v1.1 [1993-2014] ESA/CLS/LEGOS



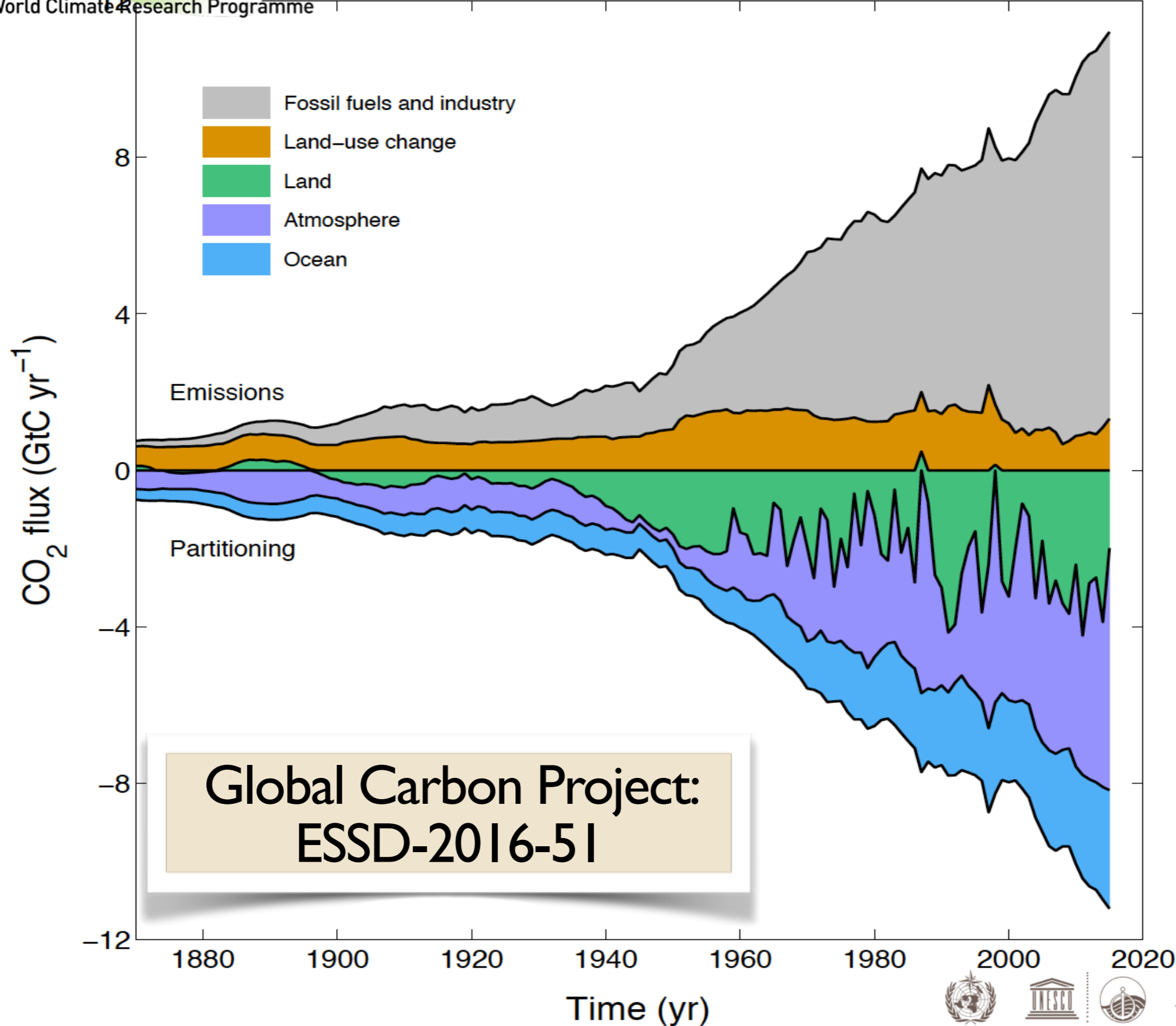
Sea Level CCI ECV v1.1 [1993-2014] ESA/CLS/LEGOS

Budget: Local total = global mean rise + regional variability  
+ local oceanic processes + vertical land motions



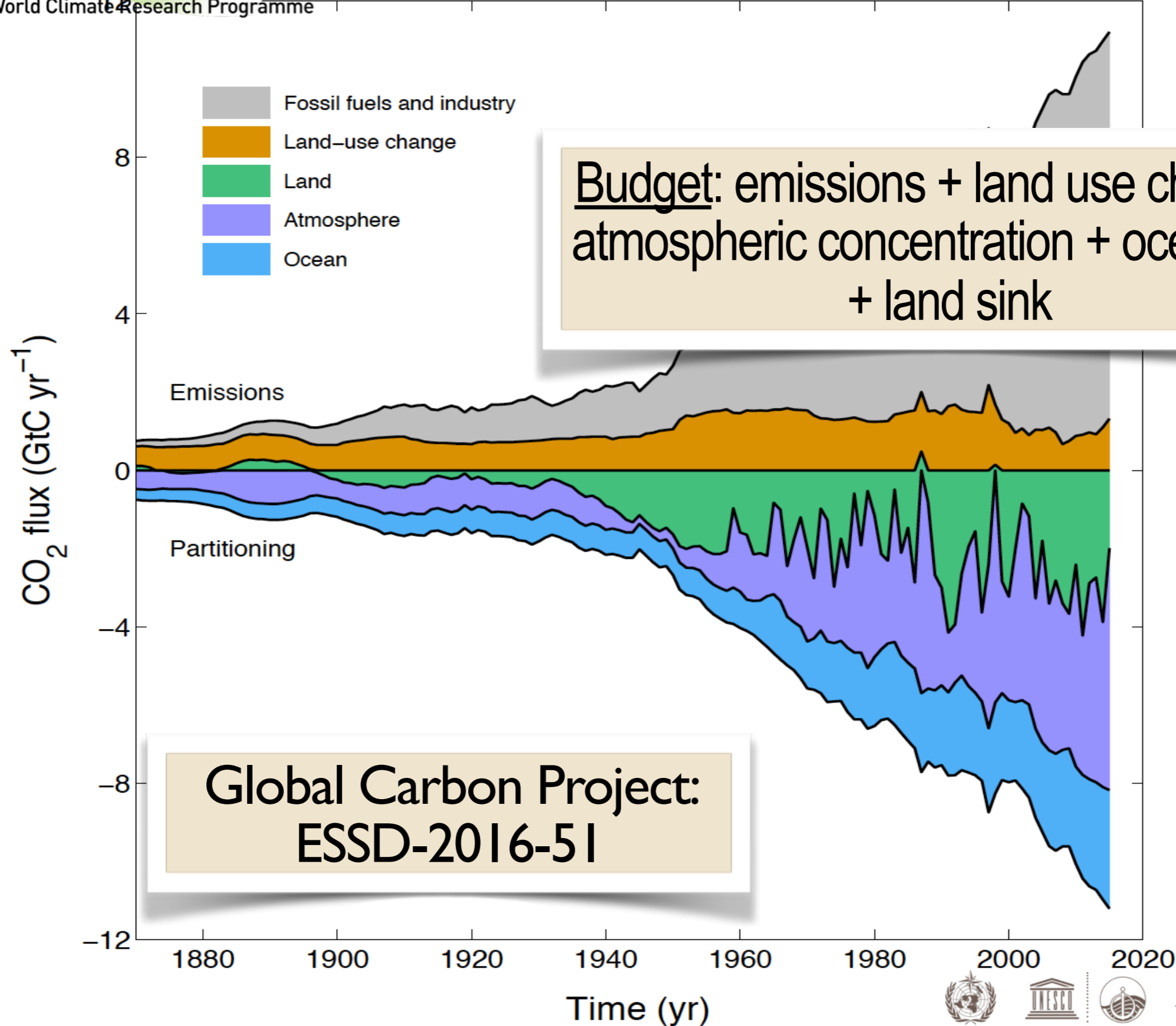


World Climate Research Programme



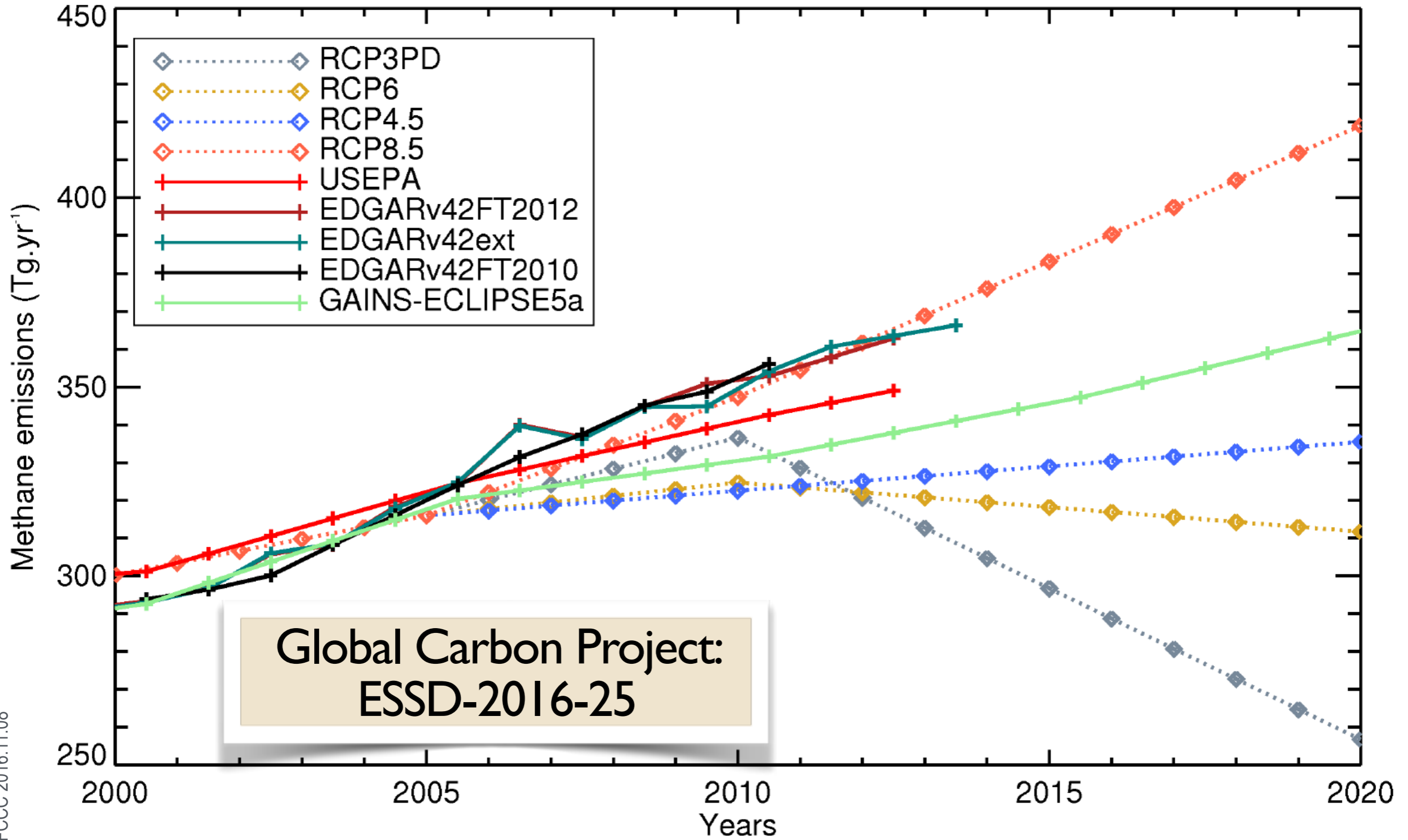
WCRP UNFCCC 2016.11.08

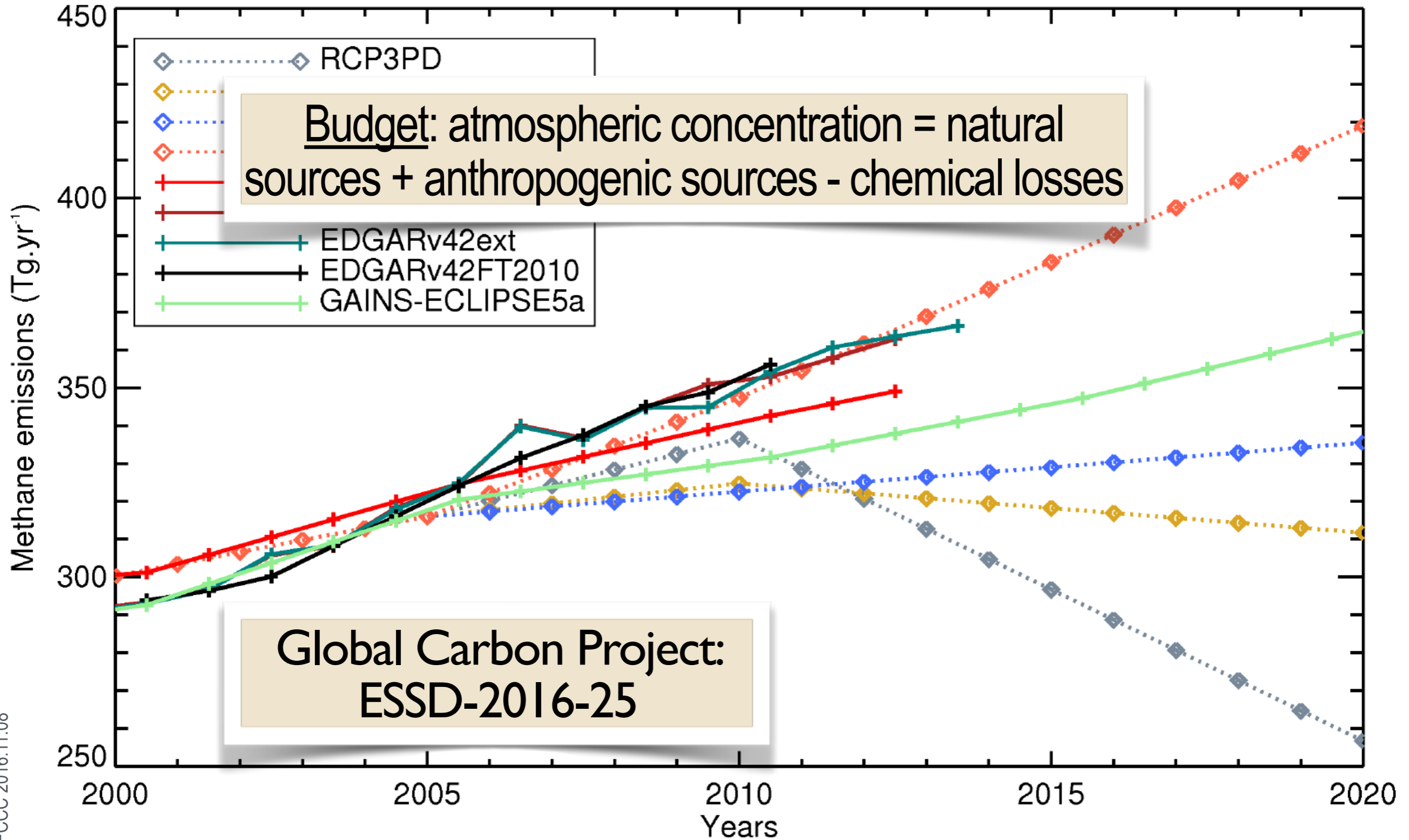
World Climate Research Programme



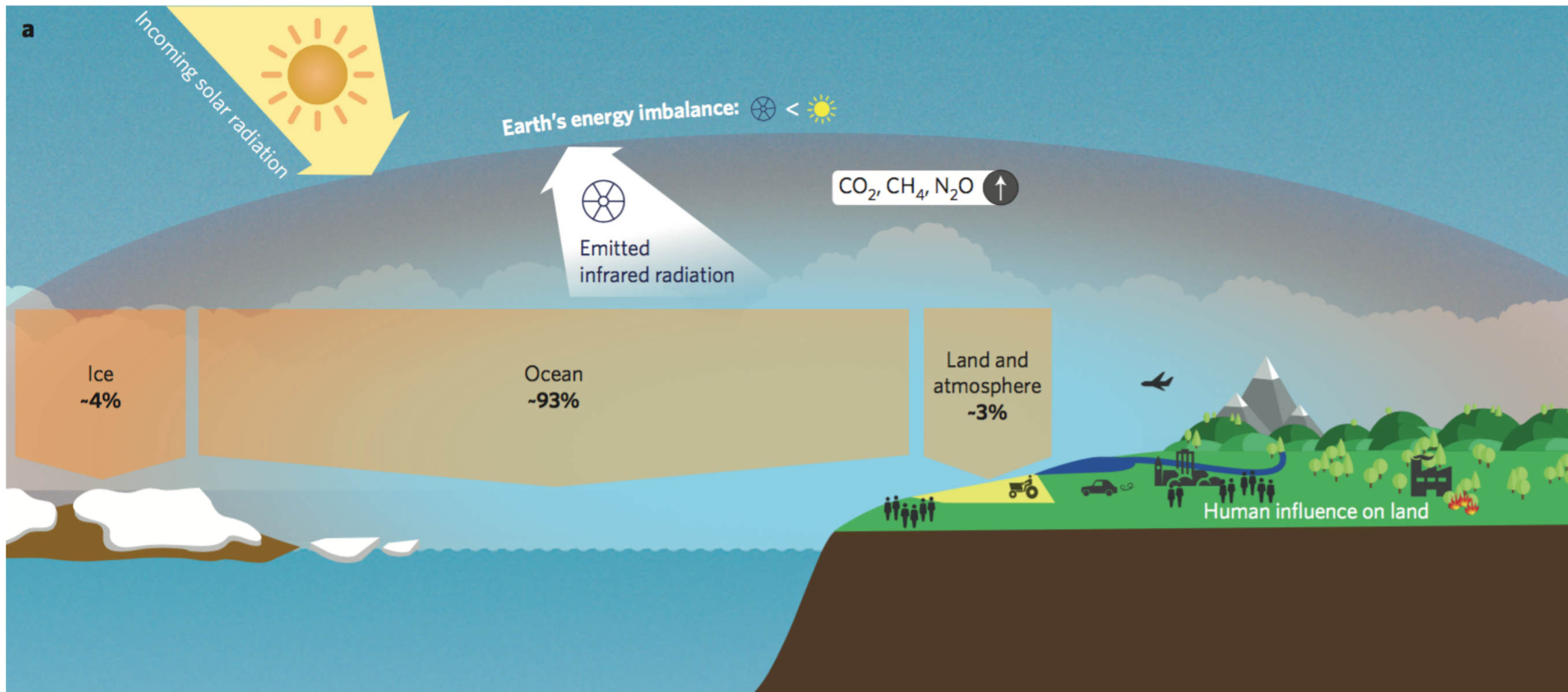
Budget: emissions + land use change = atmospheric concentration + ocean sink + land sink

Global Carbon Project:  
ESSD-2016-51

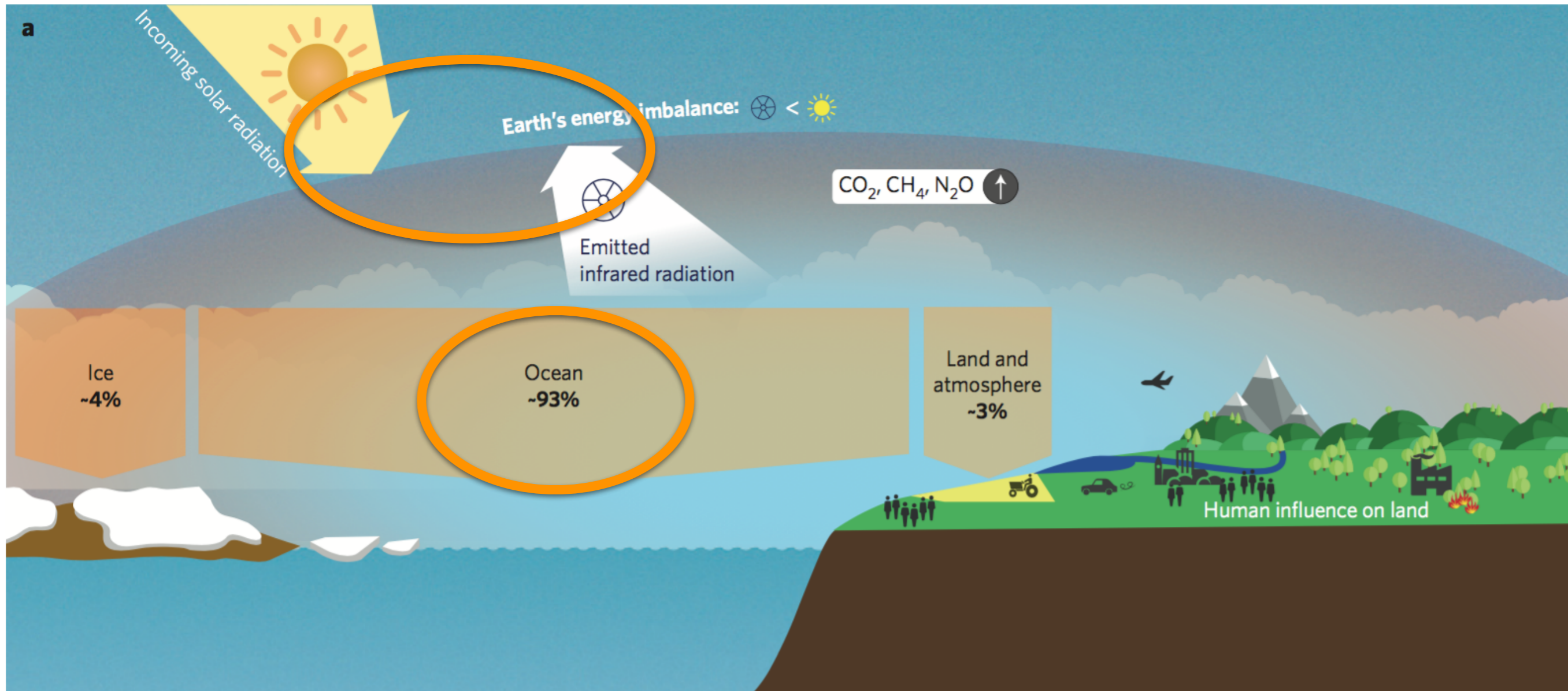




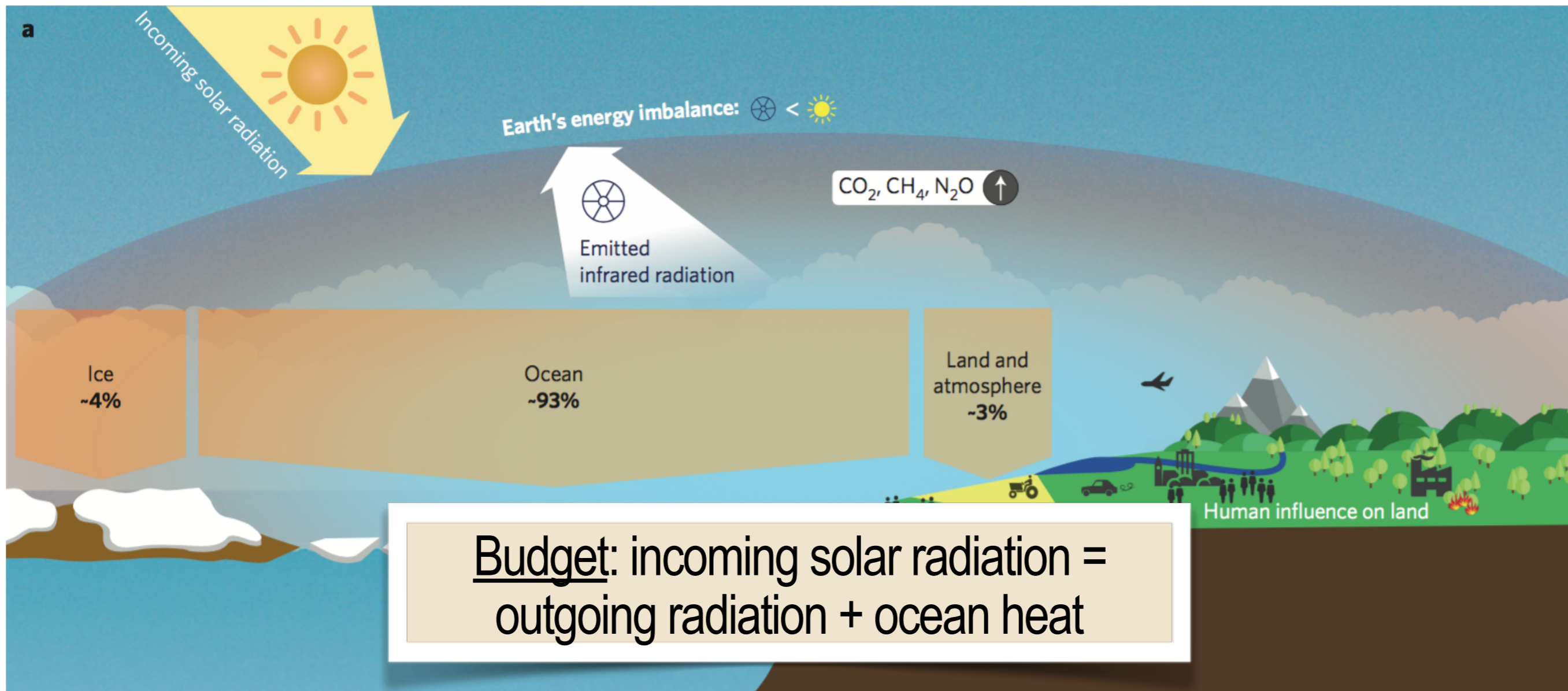
# Earth's energy imbalance



Schuckmann et al.  
2016, Nature Climate



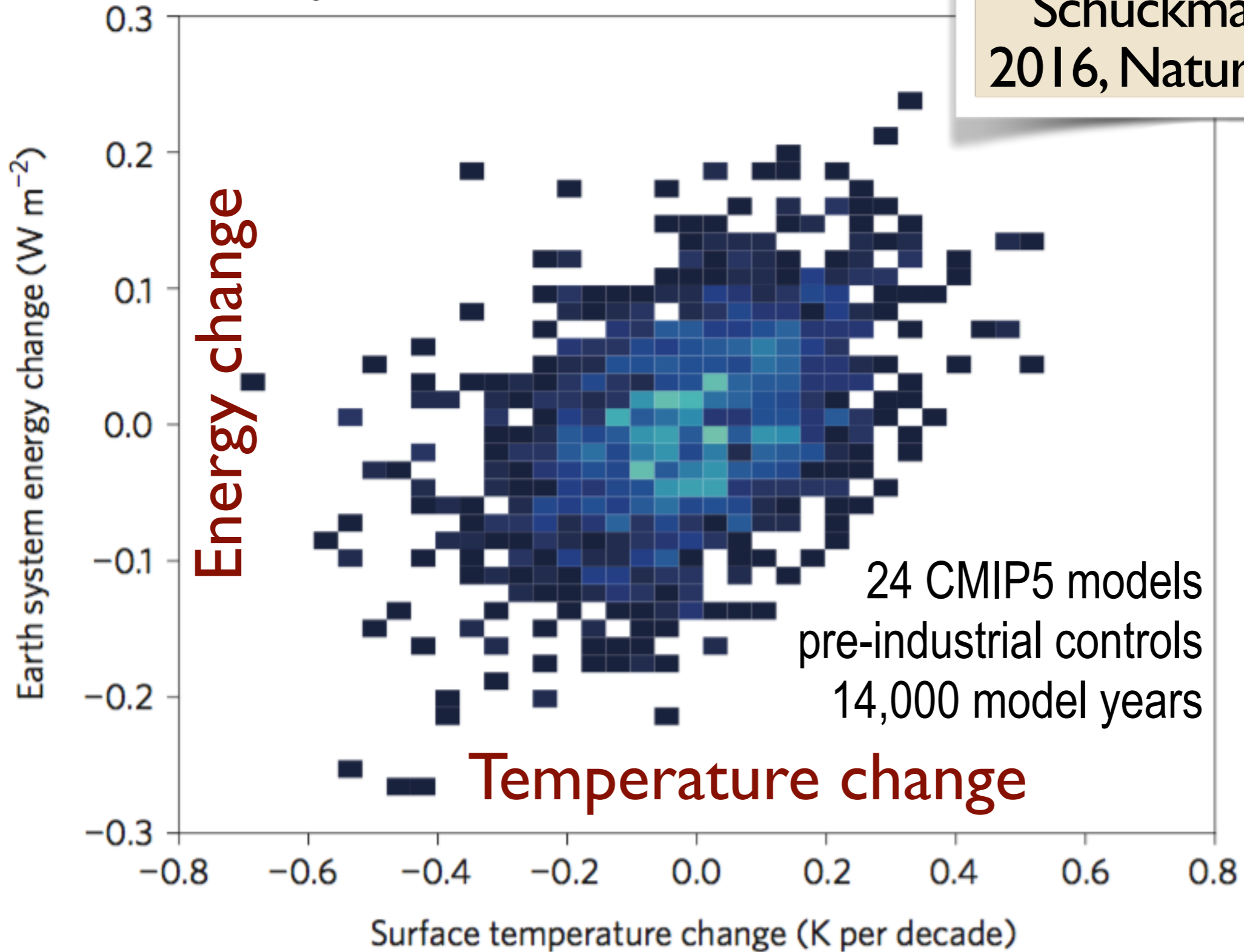
Schuckmann et al.  
2016, Nature Climate



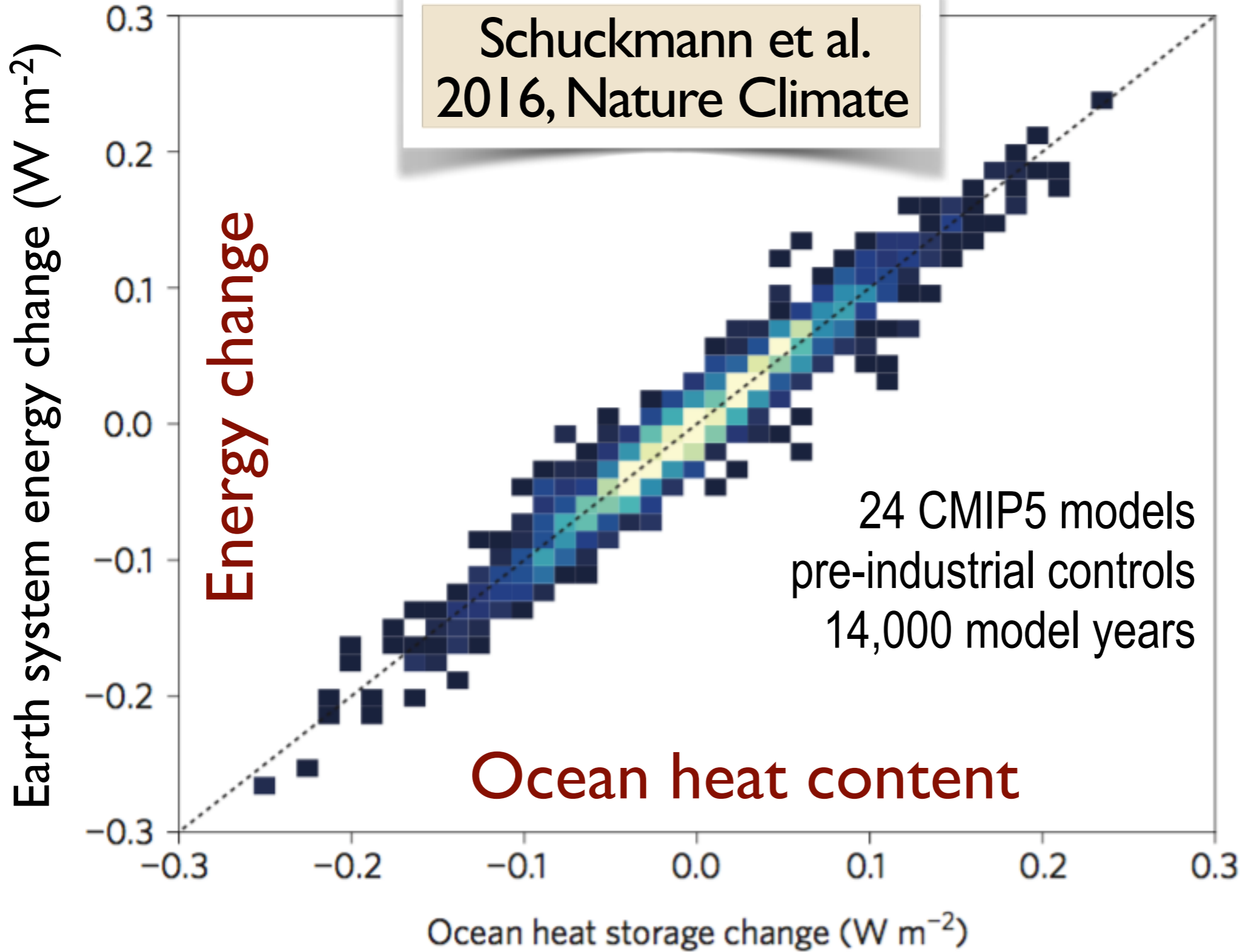
Schuckmann et al.  
2016, Nature Climate

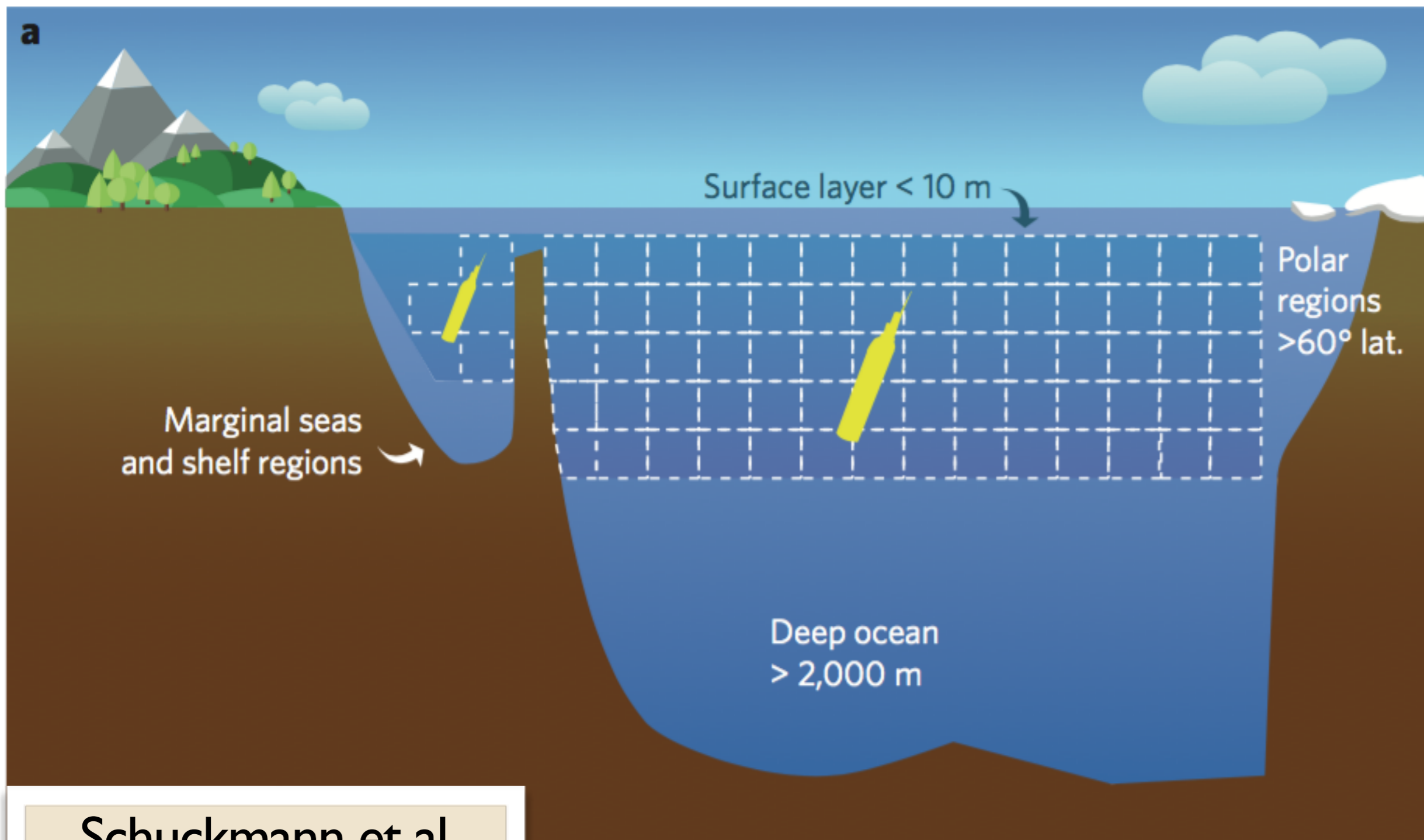
## Energy versus surface temperature

Schuckmann et al.  
2016, Nature Climate

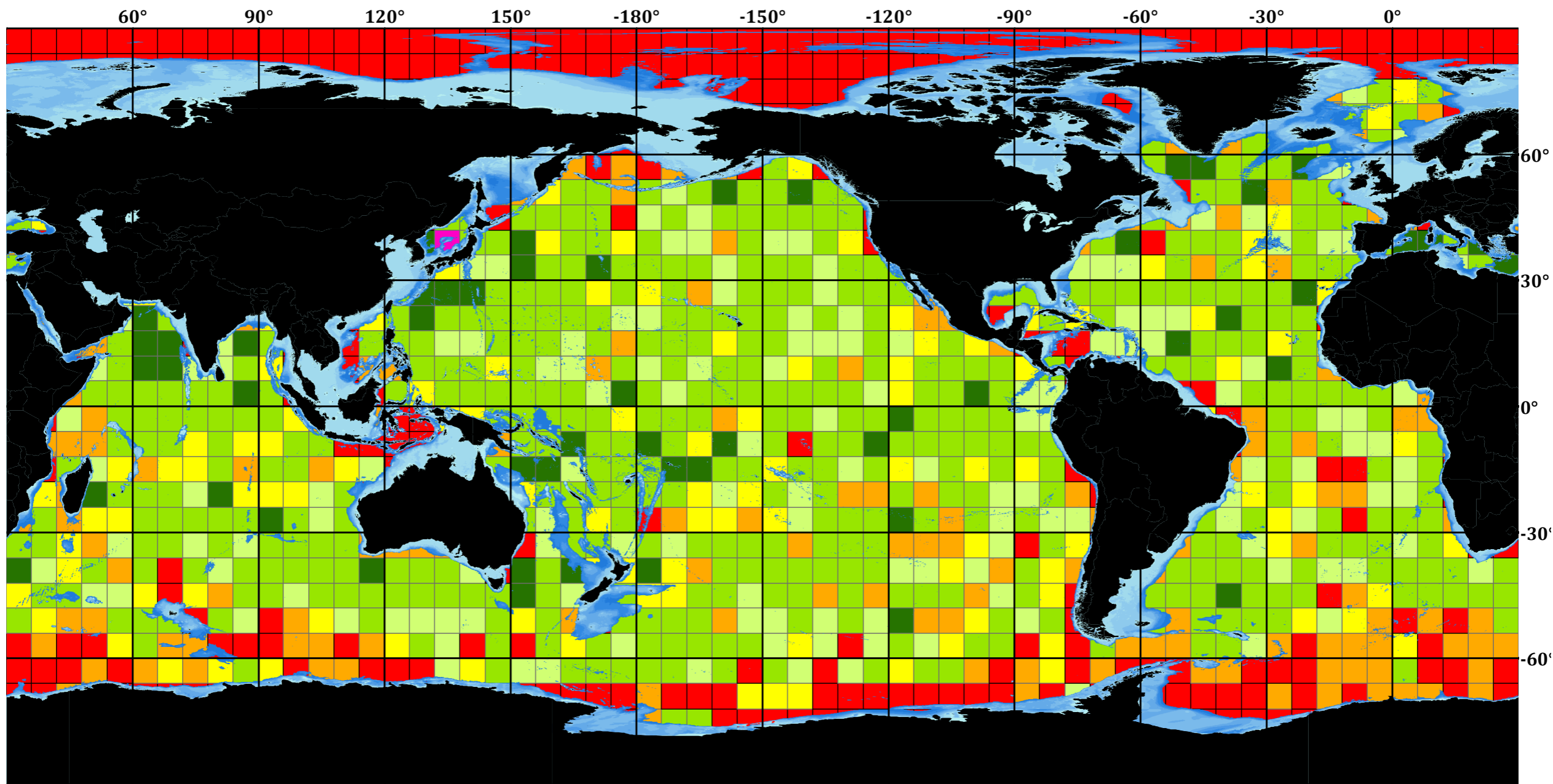




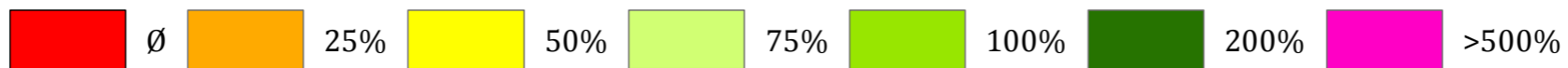




Schuckmann et al.  
2016, Nature Climate



**Argo Density**  
100% = 4 Floats

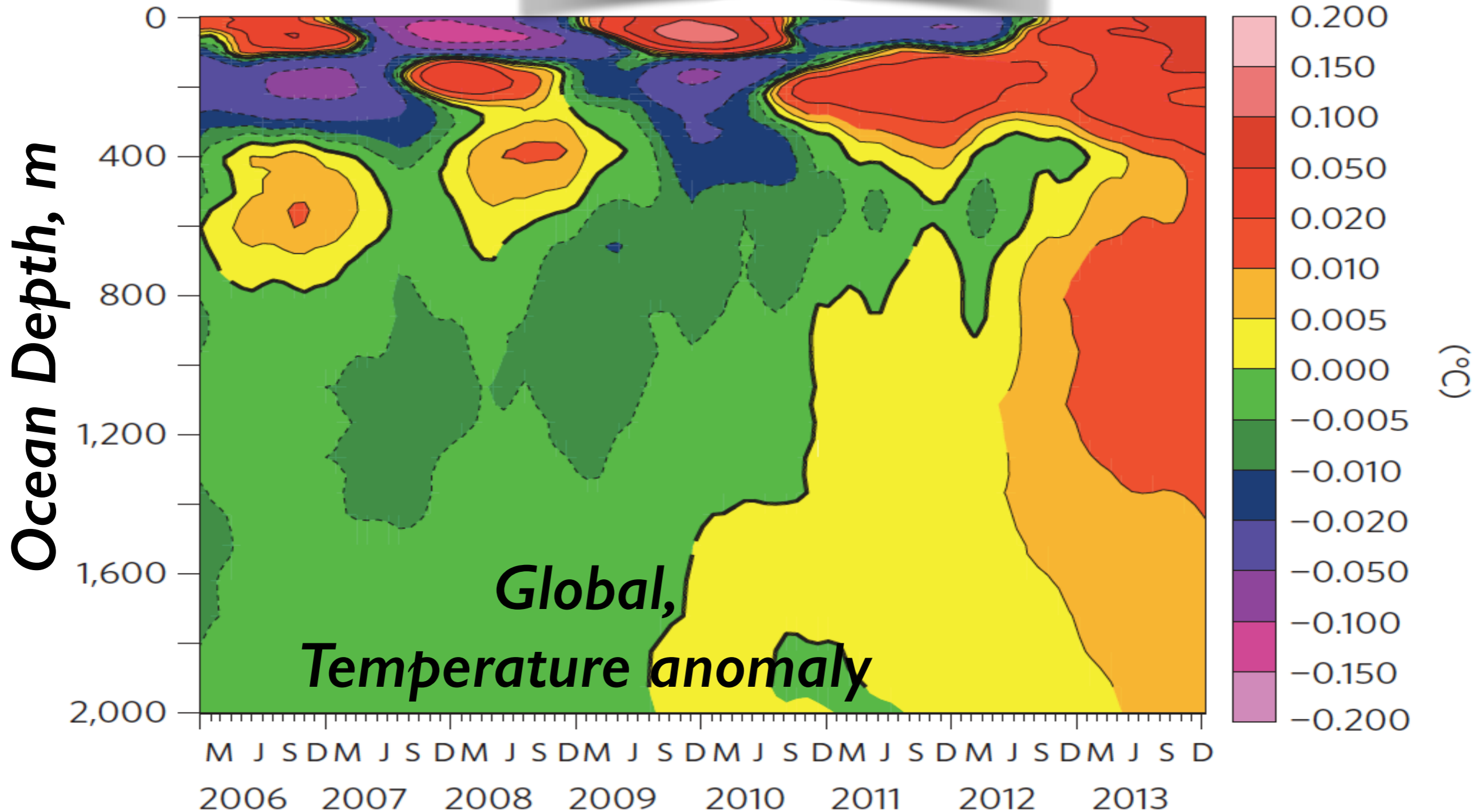


September 2015

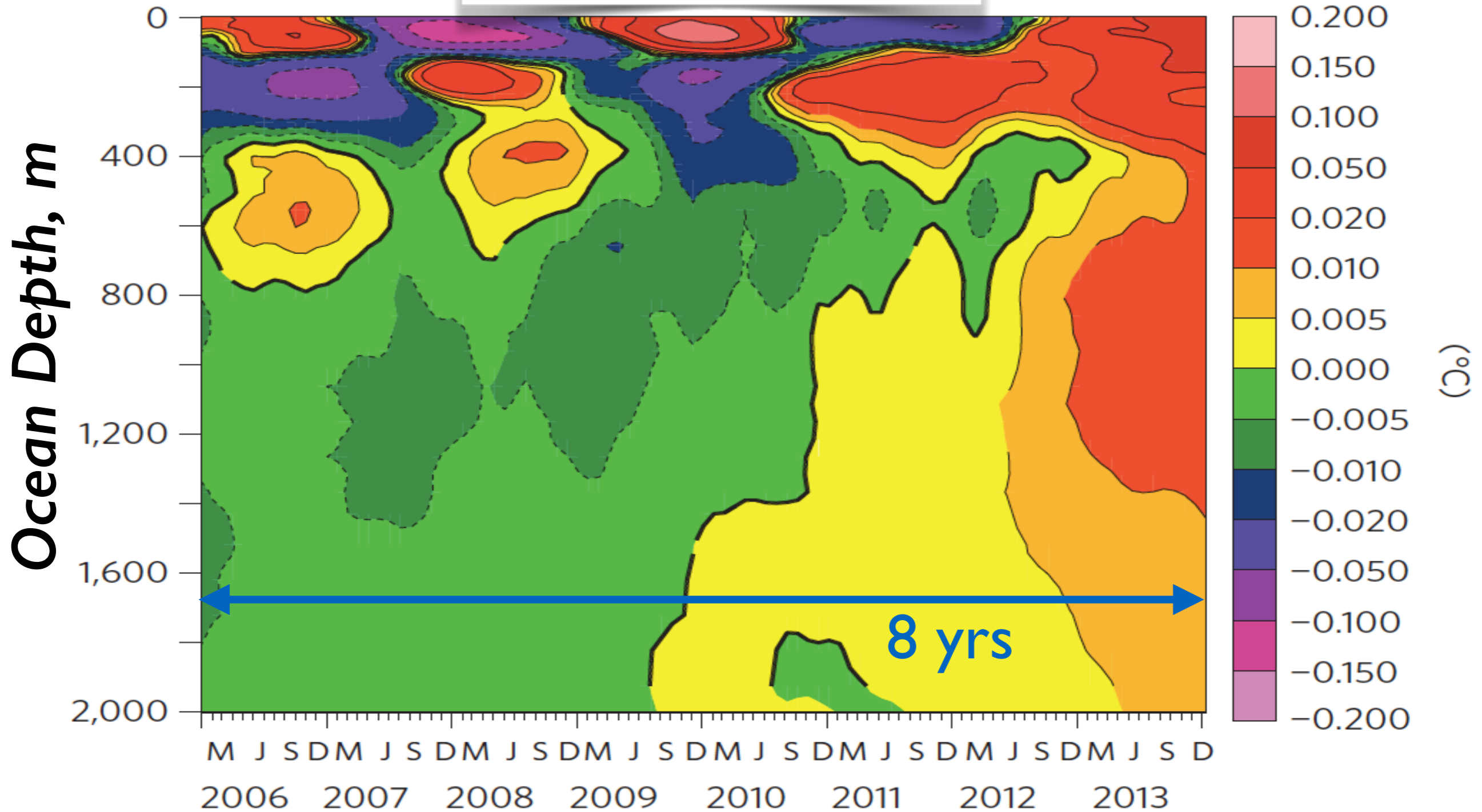


# Ocean heat content by ARGO

Roemmich et al. 2015  
Nature Climate



Roemmich et al. 2015  
Nature Climate



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  - Sea Level (heat & water)
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  - Annual (?) timescales

# Analysis & Prediction

**Climate  
challenges the  
human spirit**