

Is climate change affecting the biotic pump of the Pacific Ocean?

Sander van der Laan¹

Andrew C. Manning¹, Laure Resplandy², Laurent Bopp³, Penelope A. Pickers¹, Ingrid T. van der Laan-Luijkx⁴ and Ralph F. Keeling²

1: University of East Anglia, Norwich, United Kingdom.

2: Scripps Institution of Oceanography, La Jolla, USA.

3: Laboratoire des Sciences du Climat et de l'Environnement, Gif sur Yvette, France.

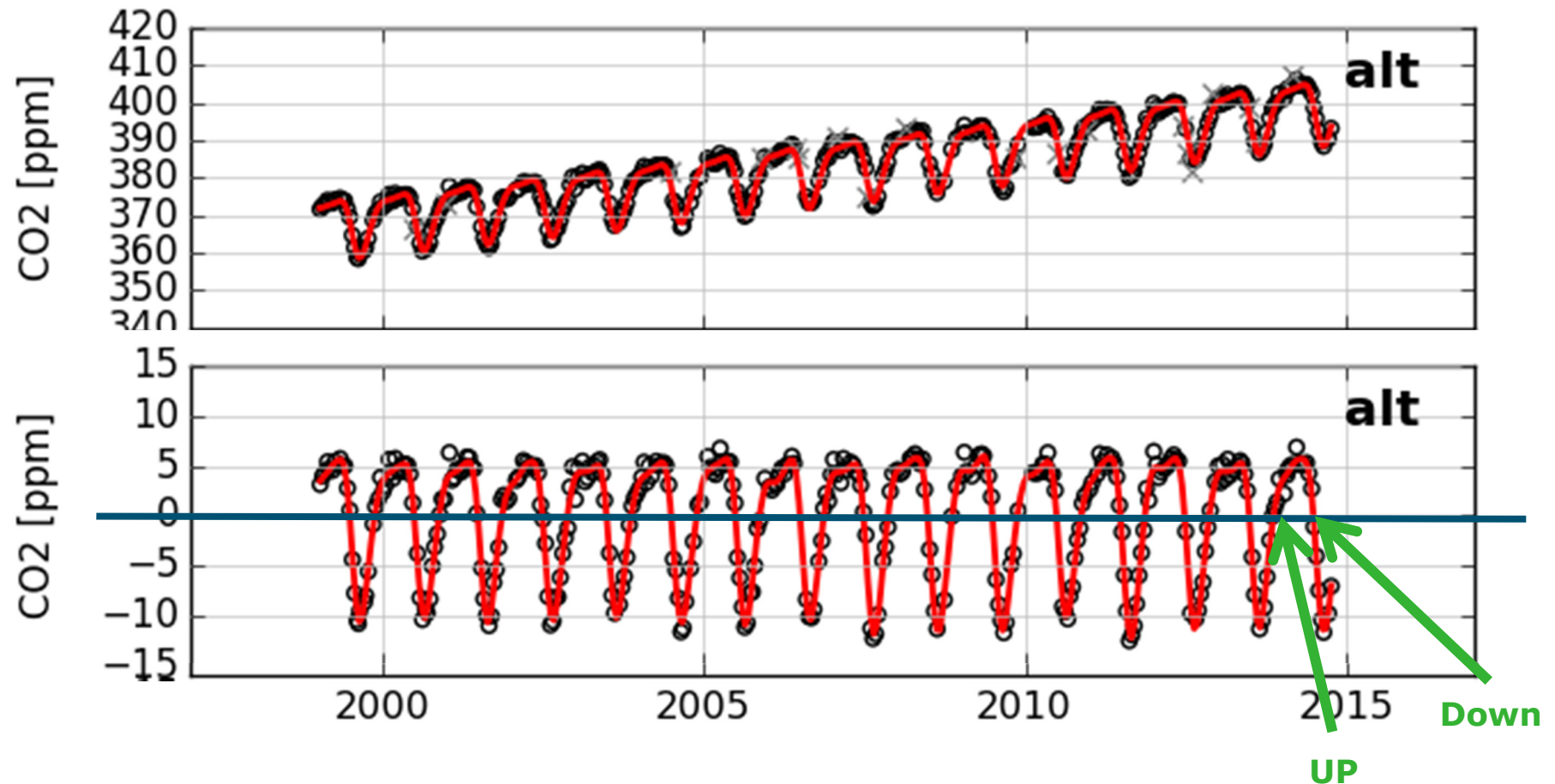
4: Meteorology and Air Quality Group, Wageningen, the Netherlands.

Outline

- 1. Introduction/Research question**
- 2. Methods**
- 3. Results**
- 4. Preliminary conclusions/discussion**
- 5. Future strategy**

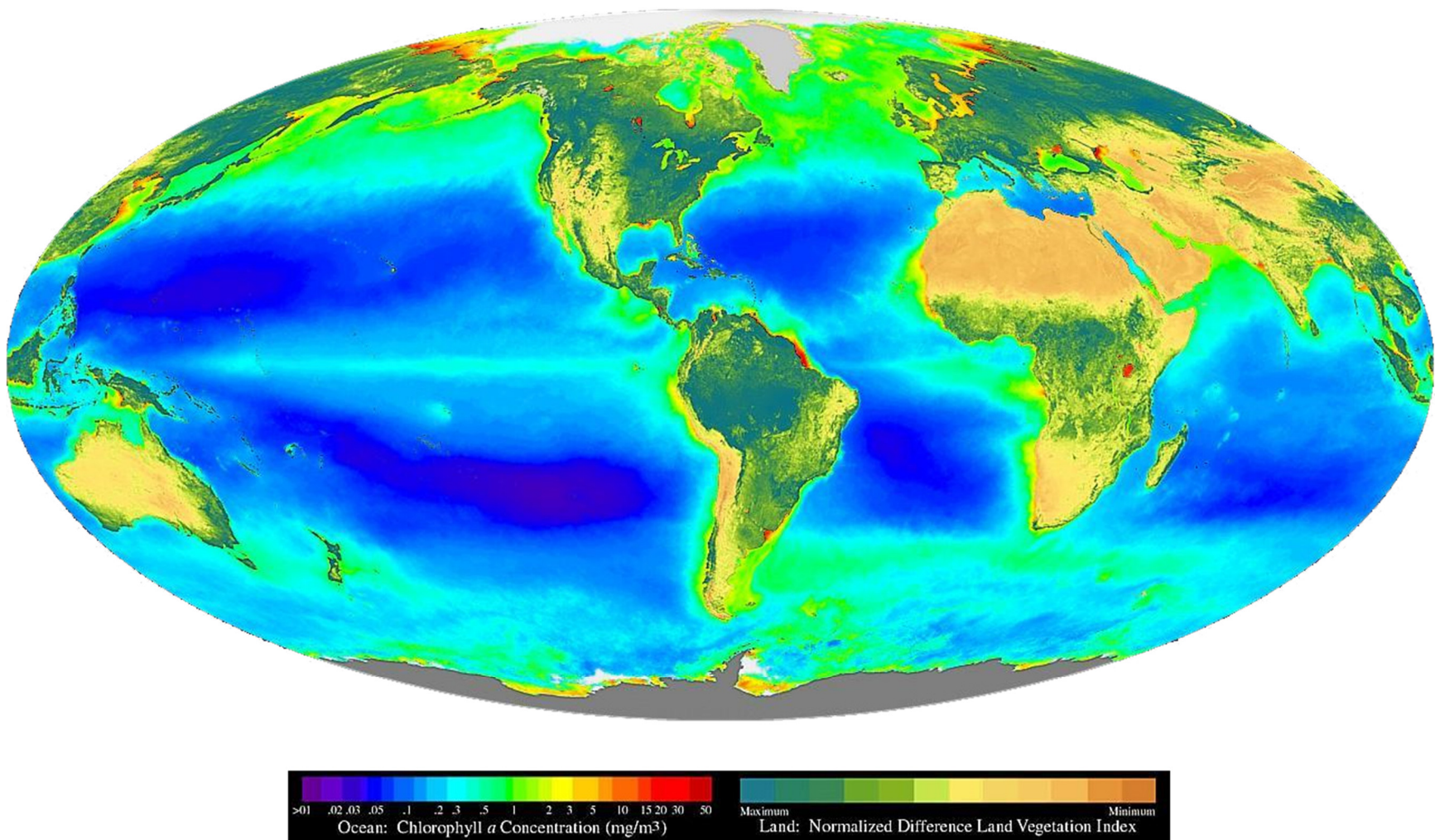
Introduction

- Atmospheric CO₂ mole fractions suggest trends towards earlier autumn/winter shrinking (respiring) of terrestrial biosphere.
- Suggests a shorter net carbon uptake period, correlated with increasingly warmer autumn temperatures. [Piao et al, Nature, 2008]



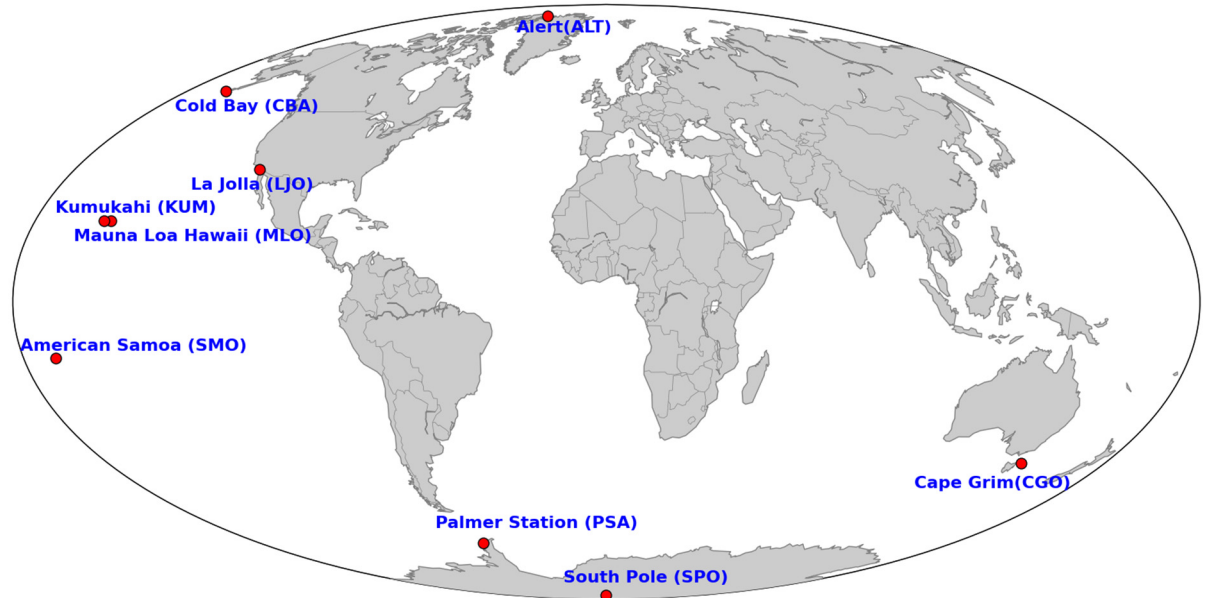
Introduction

How about the marine biosphere?
What can we tell from our APO records?



Methods

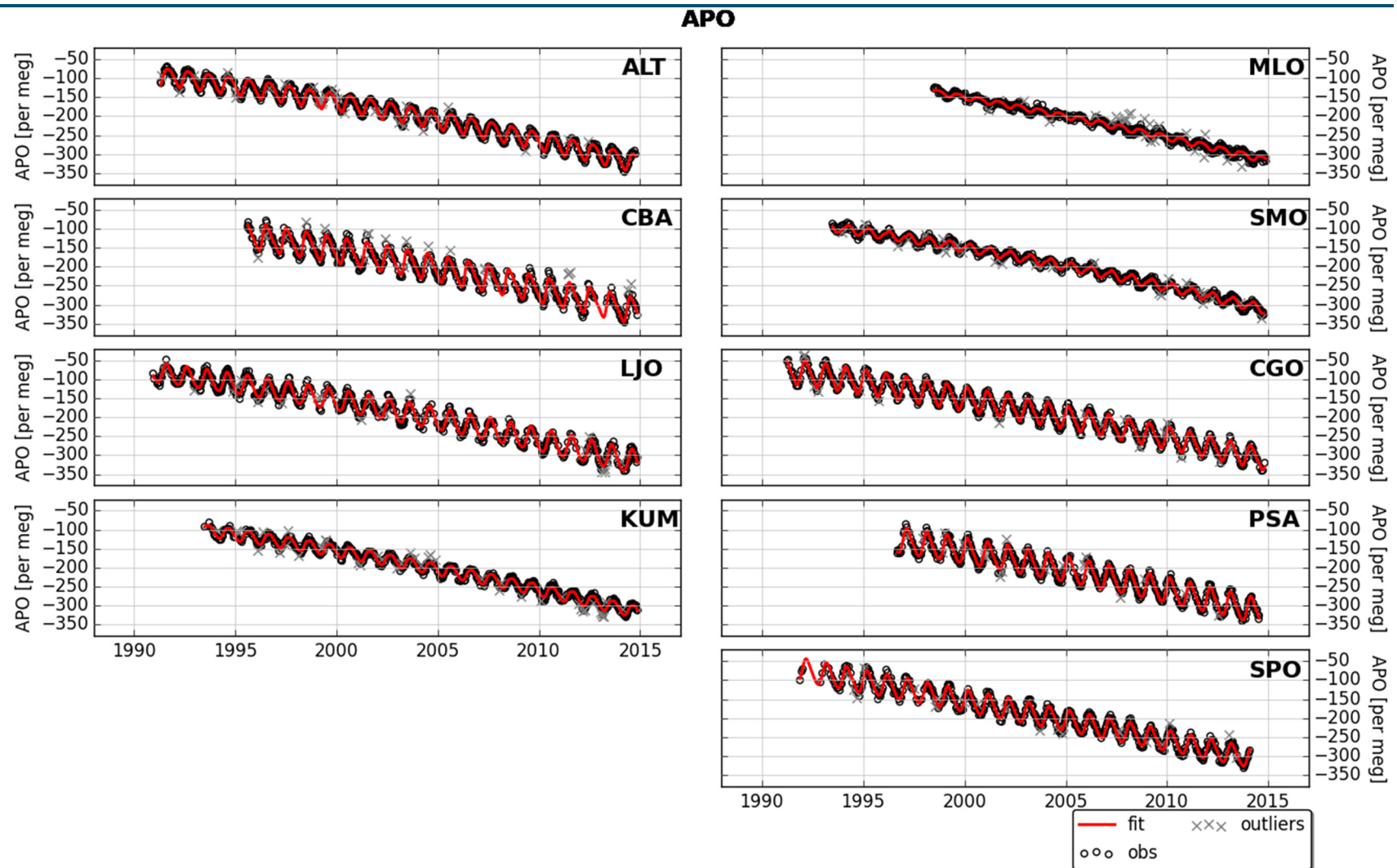
- APO flask data from Scripps network (Pacific focus)
- De-trend with CCGCRV curve fitting routines (Python version)
- "zero-crossing" analysis:
Up, Down, Difference (i.e. season length)
- Also for model output: **NEMO-PISCES* + TM3**



*Nucleus for European Modelling of the Ocean Pelagic Interactions Scheme for Carbon and Ecosystem Studies

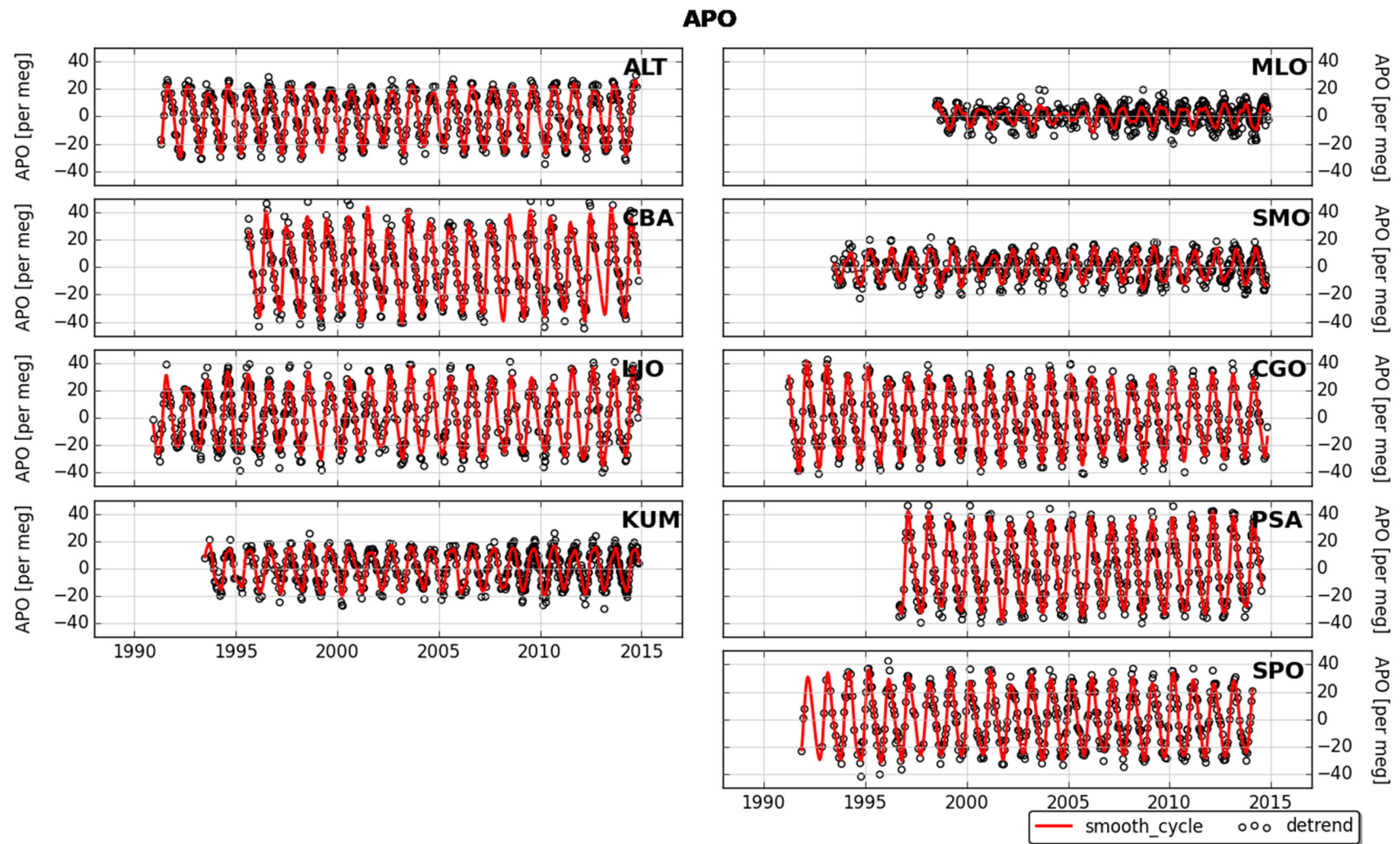
Methods

Curve fitting



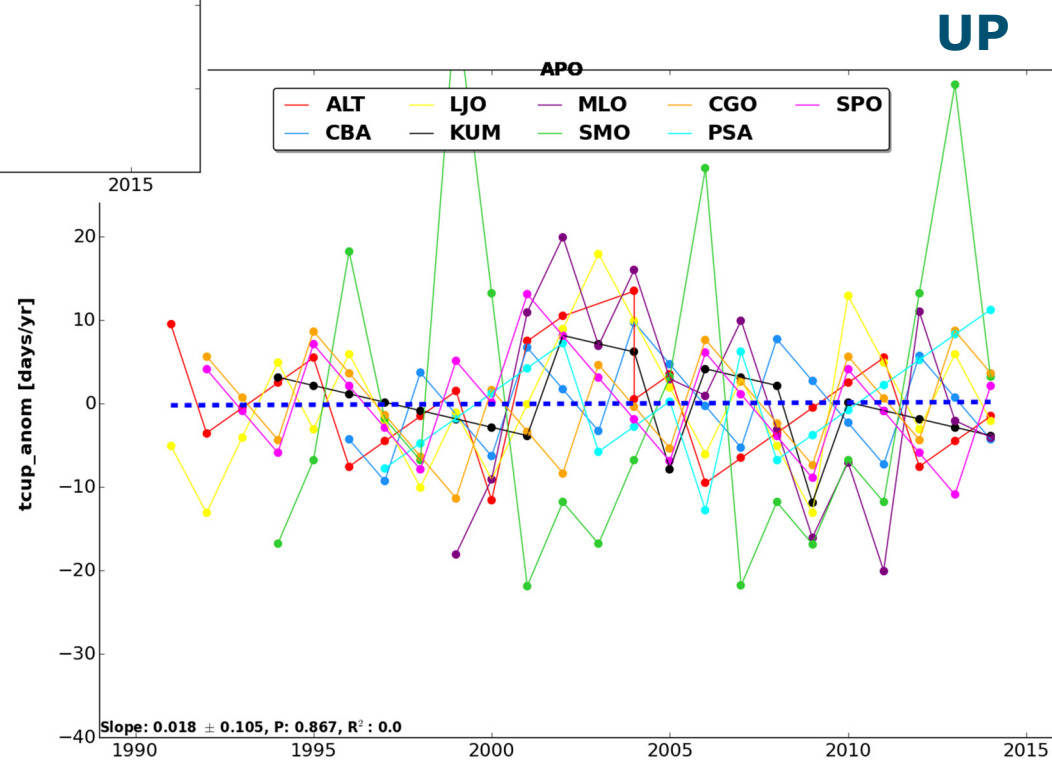
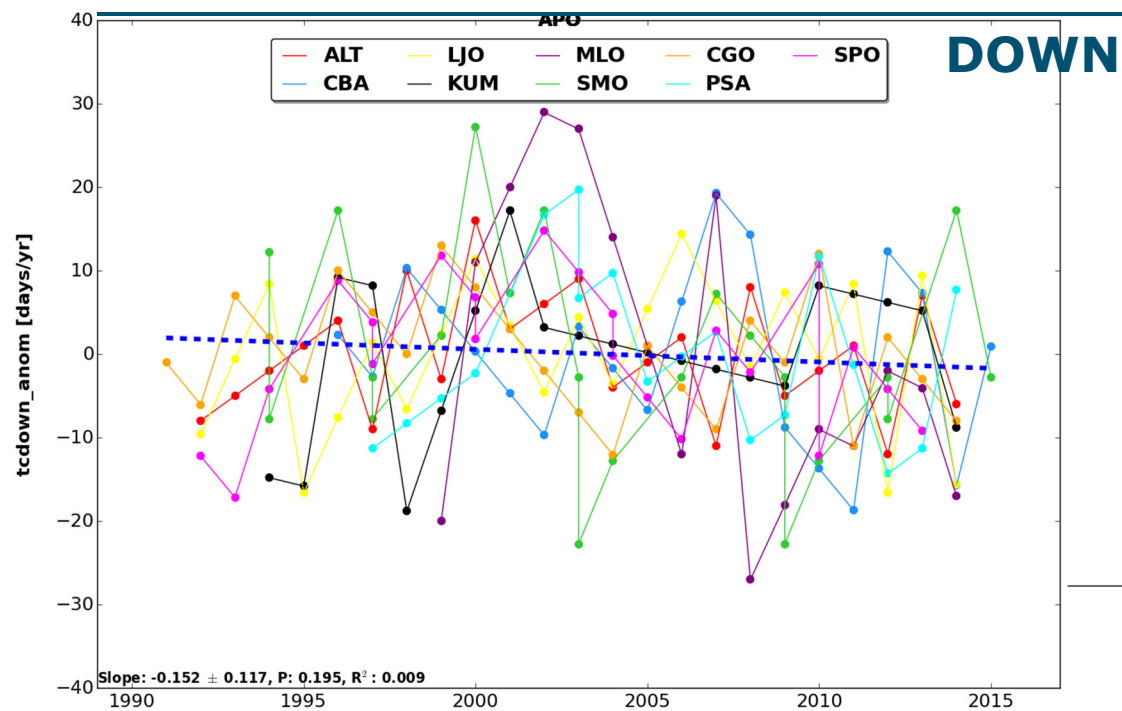
Methods

Curve fitting



Method/Results

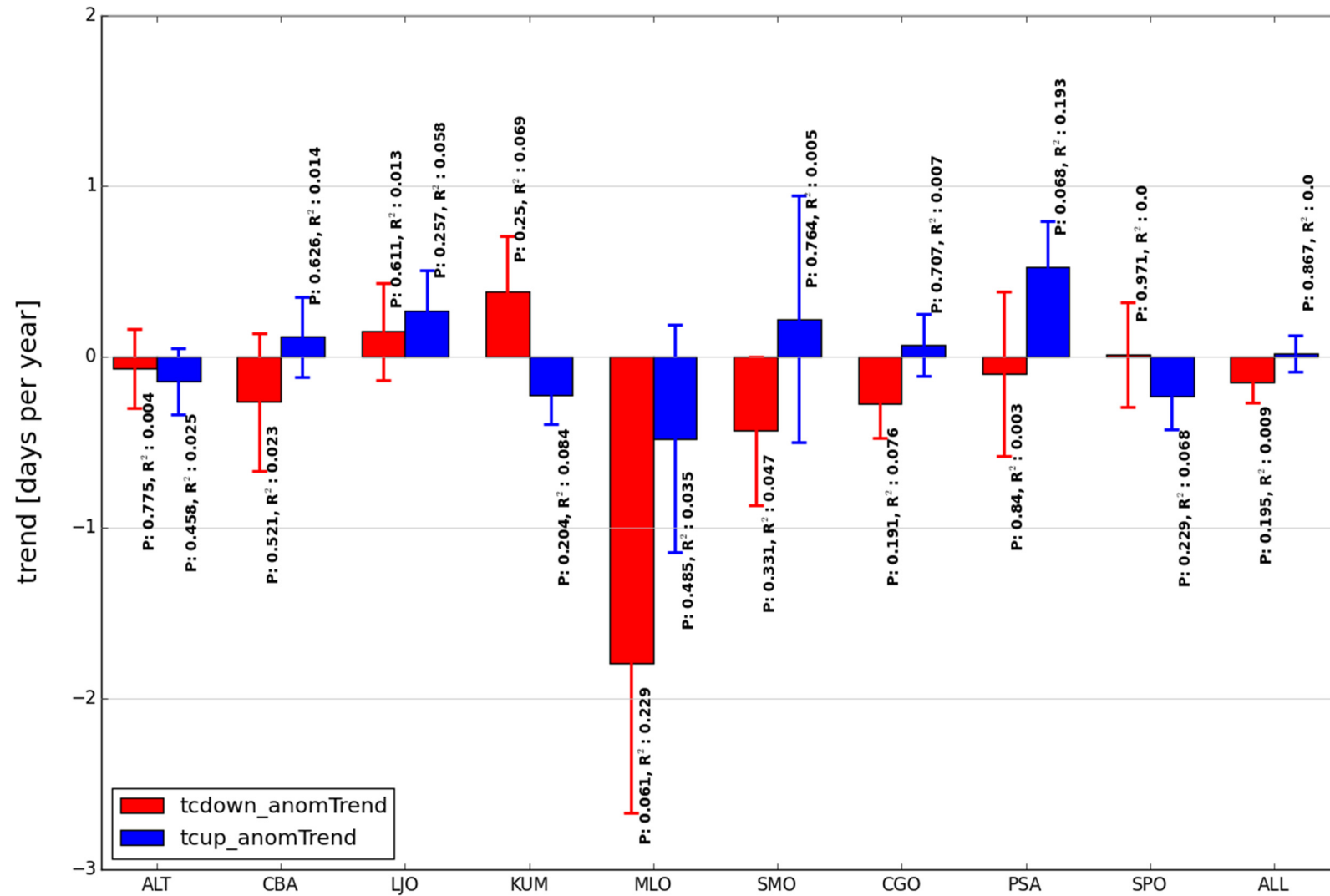
long term trend anomaly **up** & **down**



Observations 1990-2015

long term trend anomaly **up** (O_2 release) & **down** (O_2 uptake)

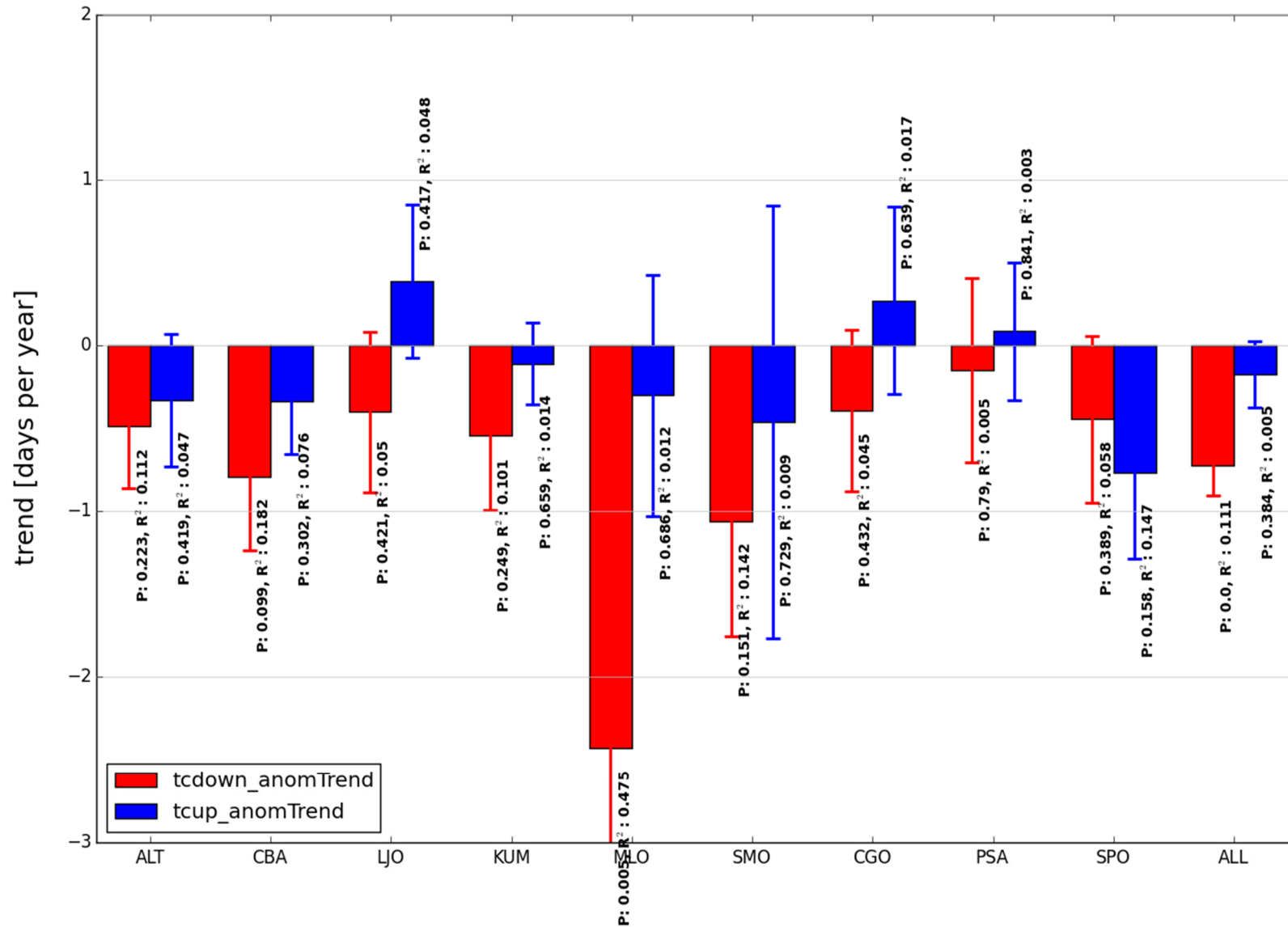
APO



Observations **2000-2015**

long term trend anomaly **up** (O₂ release) & **down** (O₂ uptake)

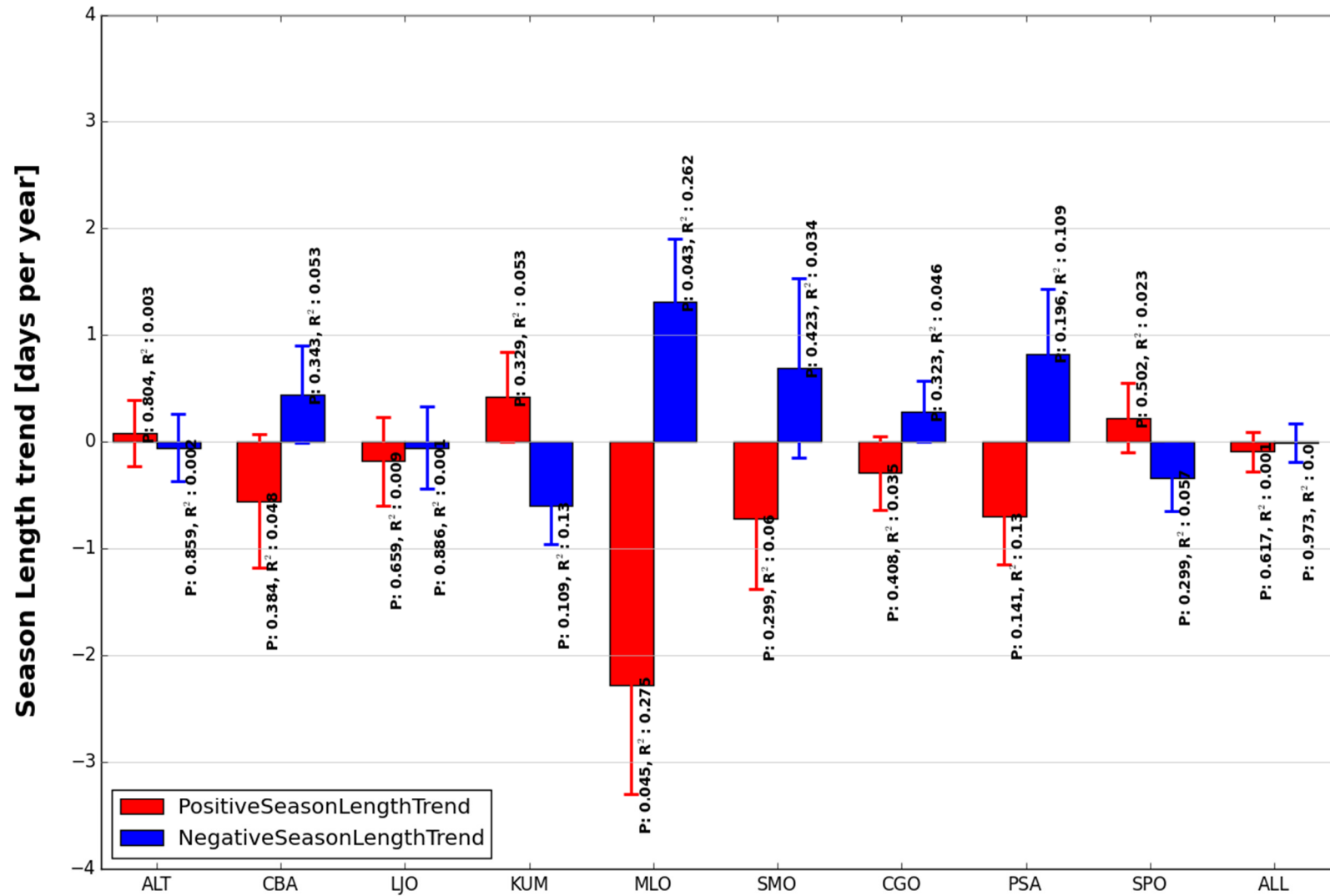
APO



Observations **1990-2015**

long term trend season length **POS** (O₂ release) & **NEG** (O₂ uptake)

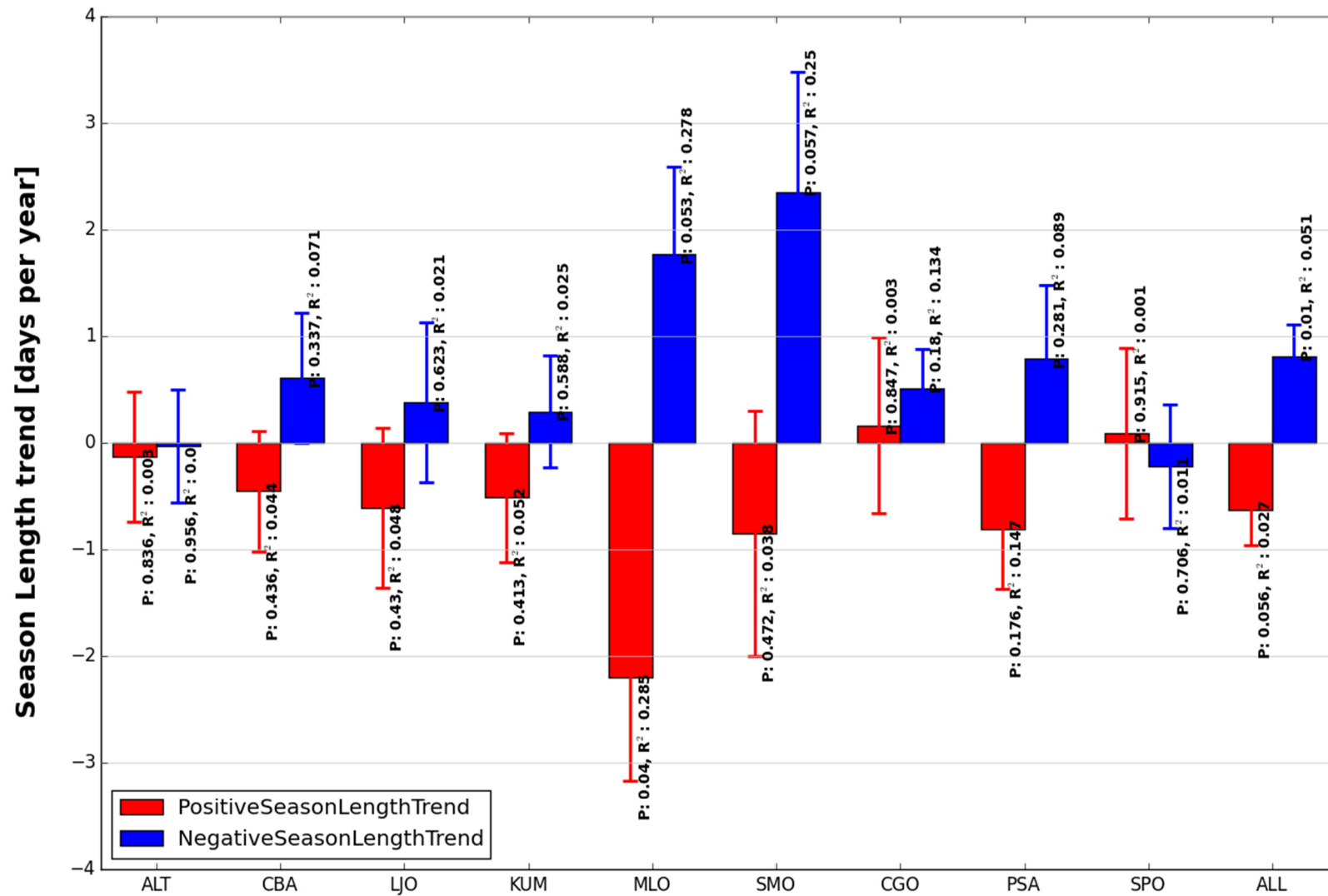
APO



Observations **2000-2015**

long term trend season length **POS** (O₂ release) & **NEG** (O₂ uptake)

APO

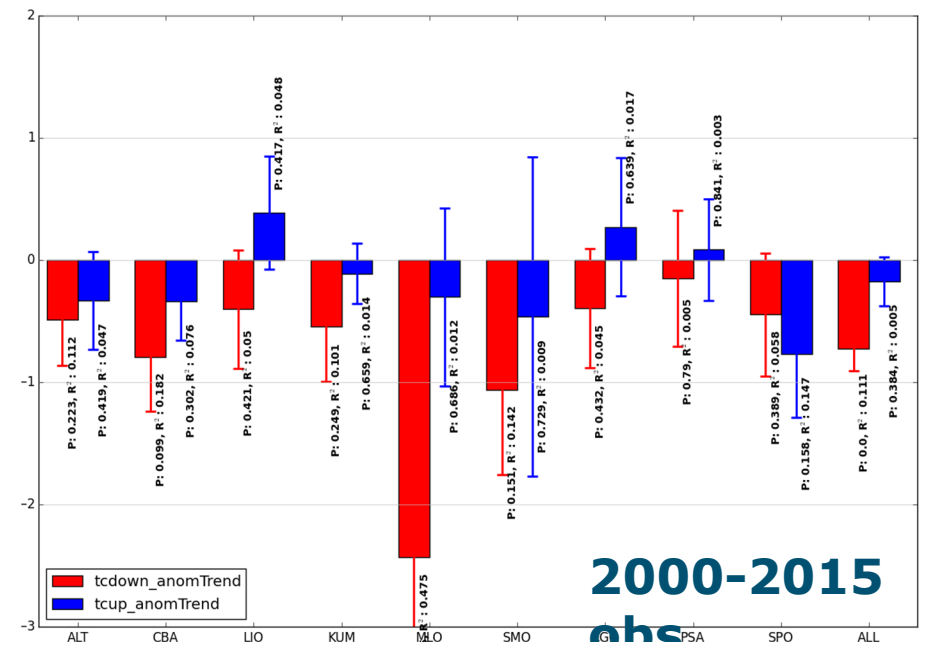
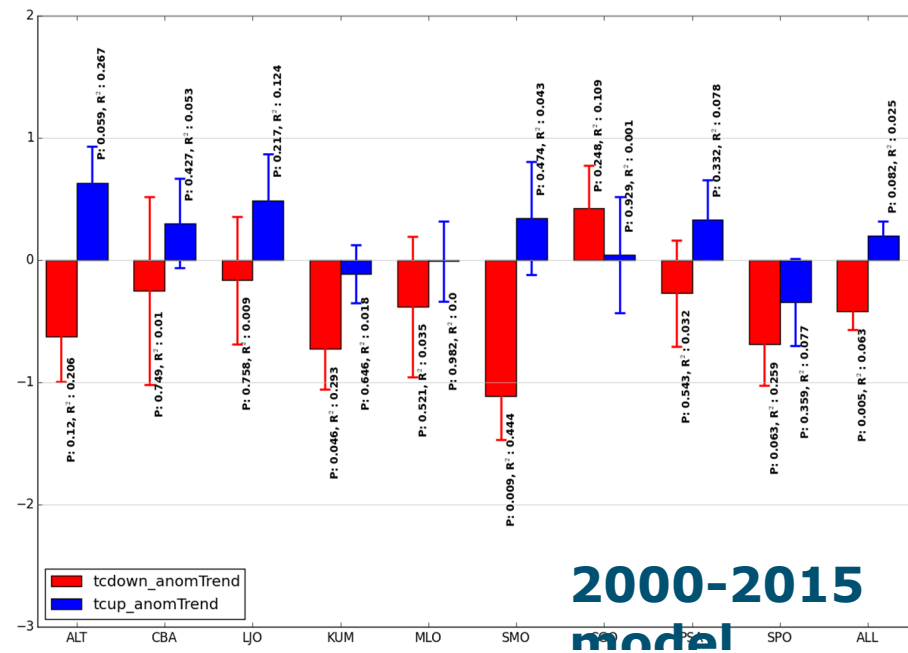
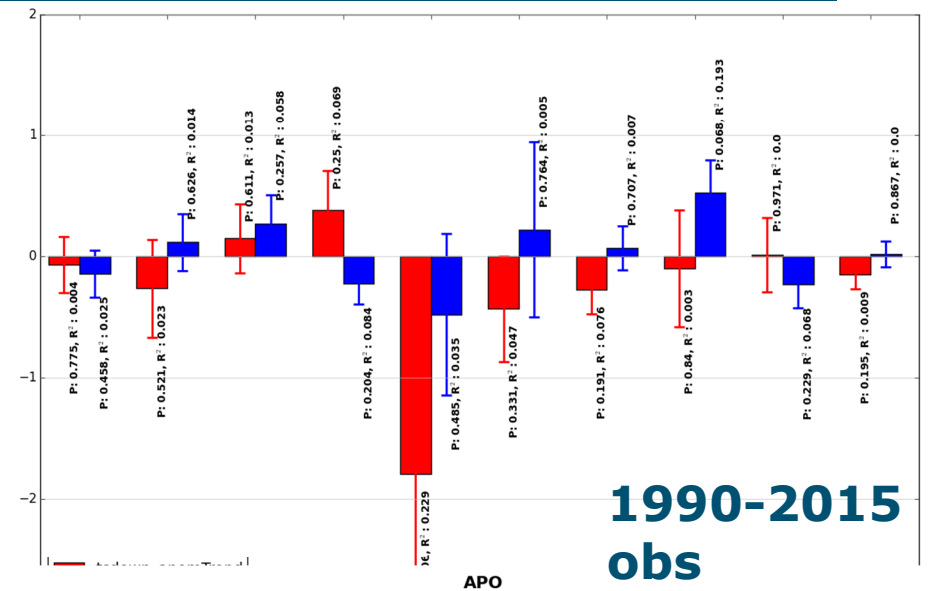
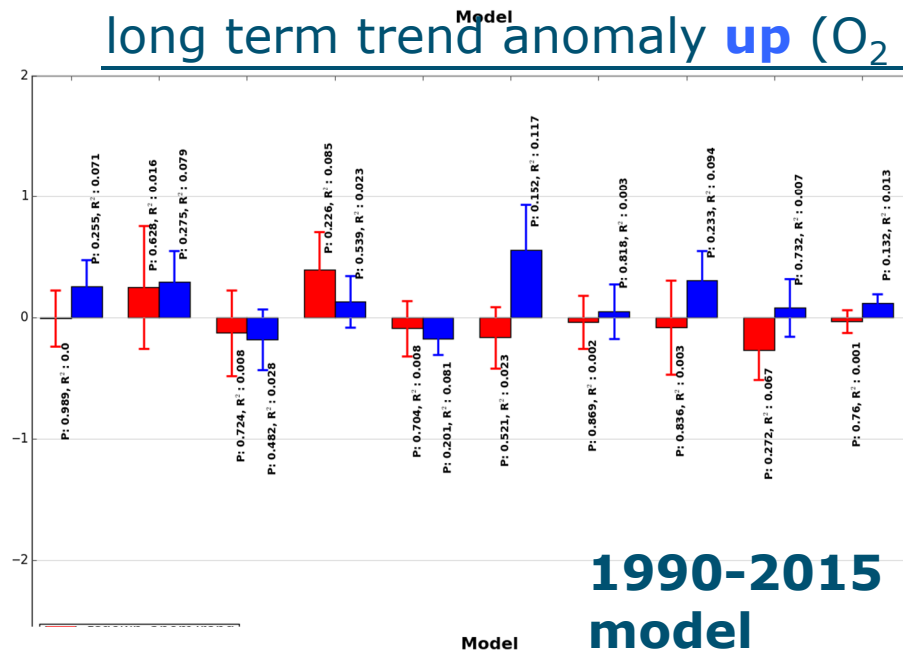


Preliminary conclusions/discussion

- O₂ uptake season (winter) is coming (increasingly) earlier
 - O₂ release period is getting smaller and O₂ uptake period is getting longer
 - Is oceanic O₂ uptake increasing? (need to check amplitude)
 - Something seems to be going on in the pacific and perhaps even globally (MLO)
- > Can we model this and investigate the driving processes?

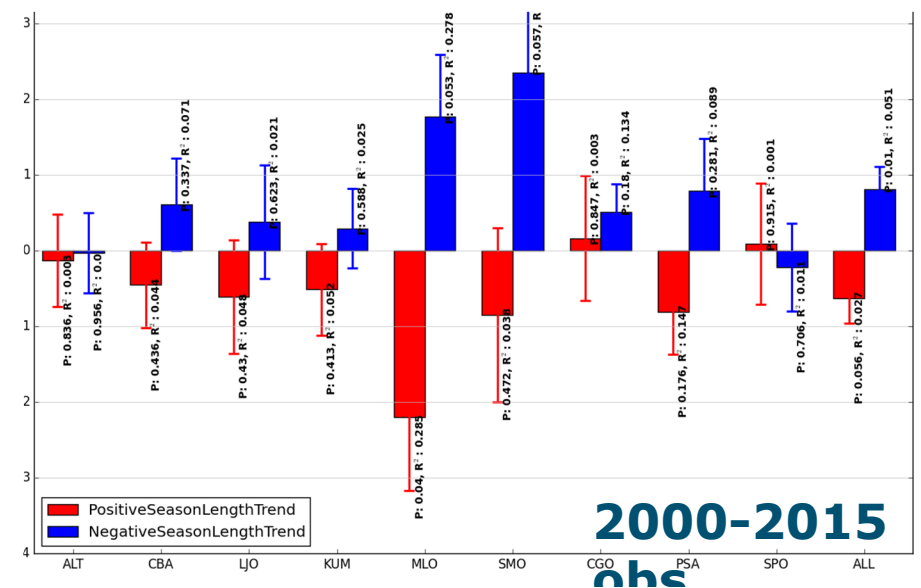
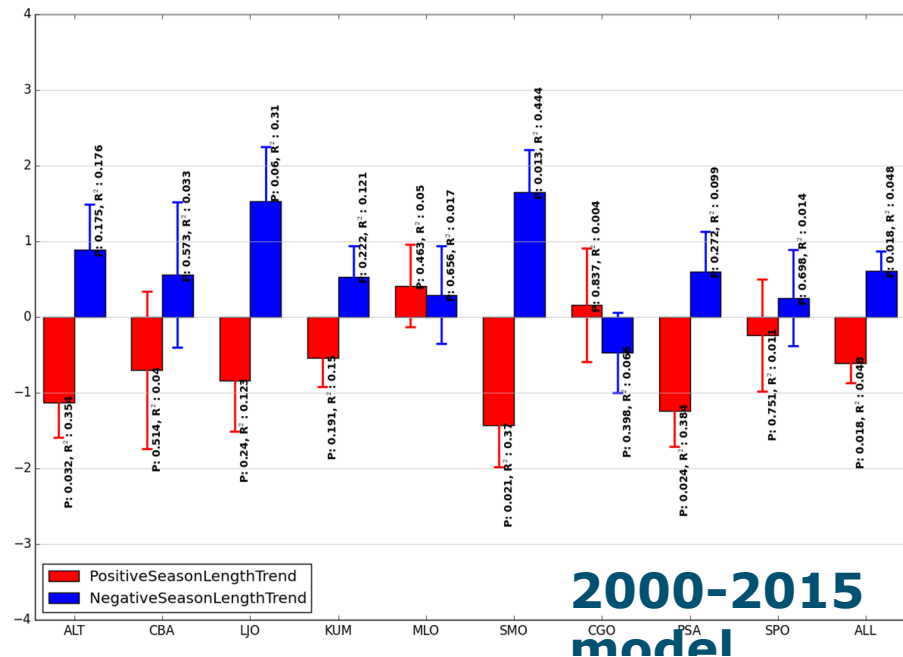
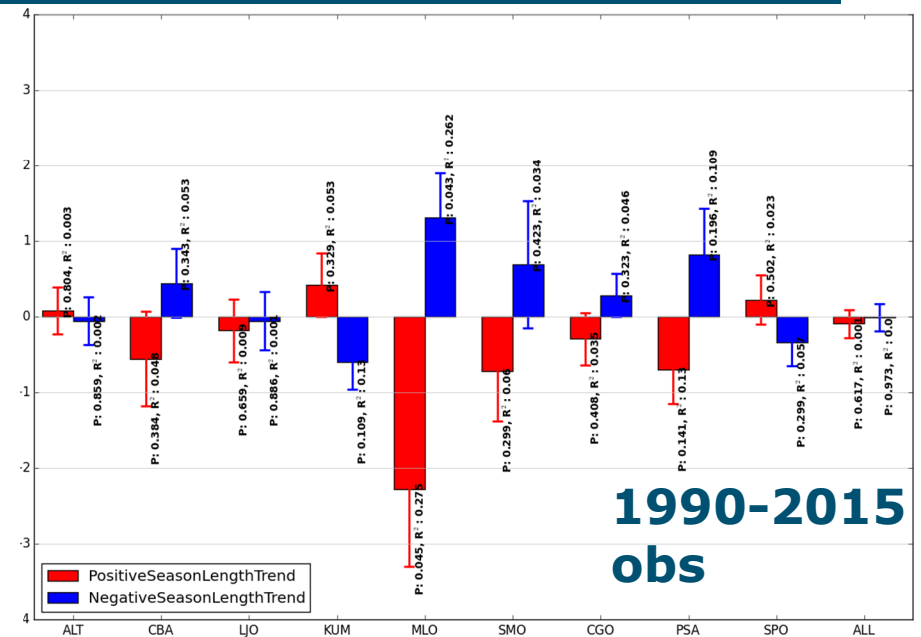
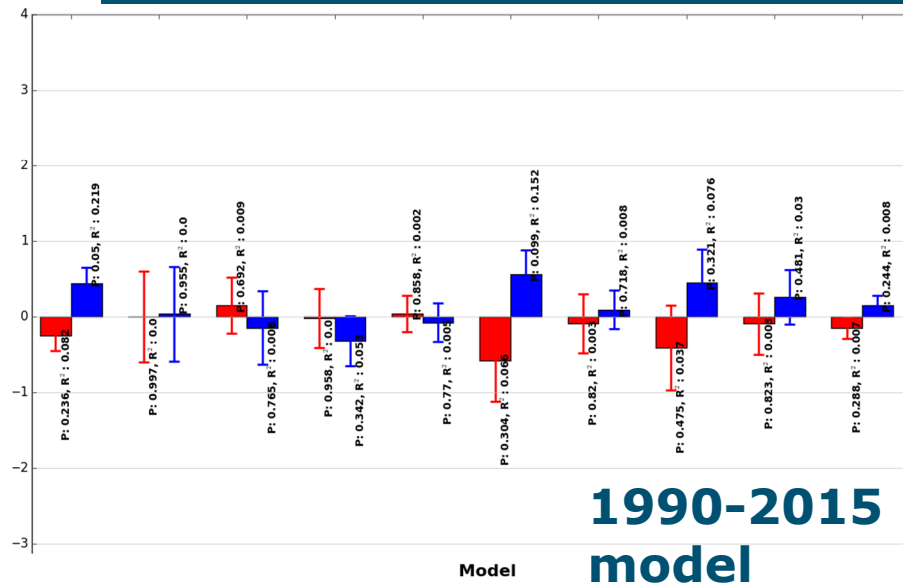
Model vs Observations

long term trend anomaly **up** (O₂ release) & **down** (O₂ uptake)



Model vs Observations

long term trend season length **POS** (O_2 release) & **NEG** (O_2 uptake)

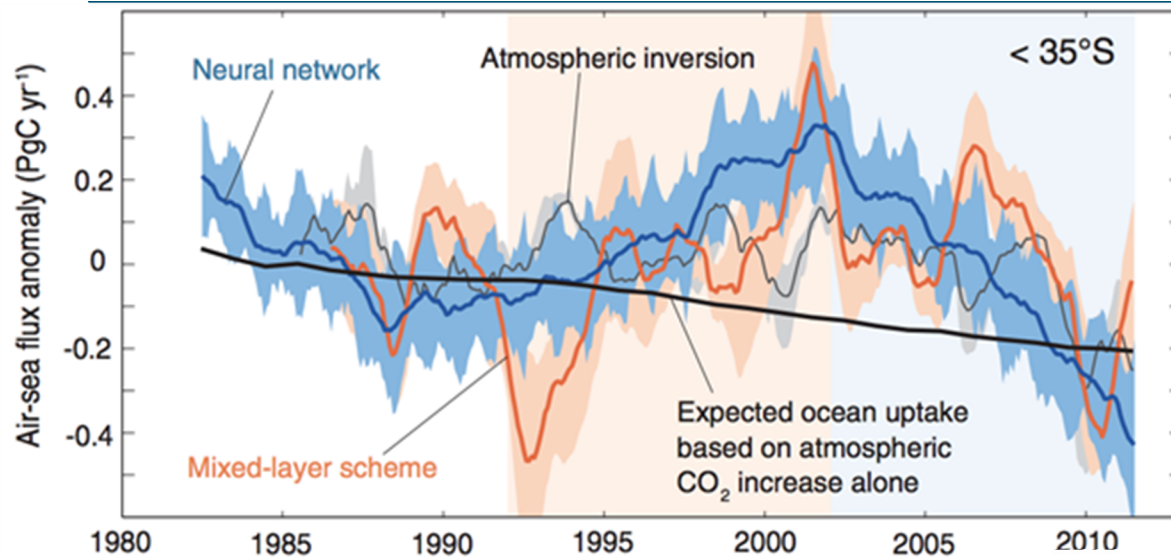




Where to go from here..(?)

- (Footprint based?) correlations SST, PDO, SSTNINO3.4 chlorophyll
- Model-sensitivity tests (winds etc.)
- N₂O, ventilation correction
- Other?

Is it related ?



Lanschutzer et al 2015, Science

Ocean carbon sink in the 2014 Global Carbon Budget

