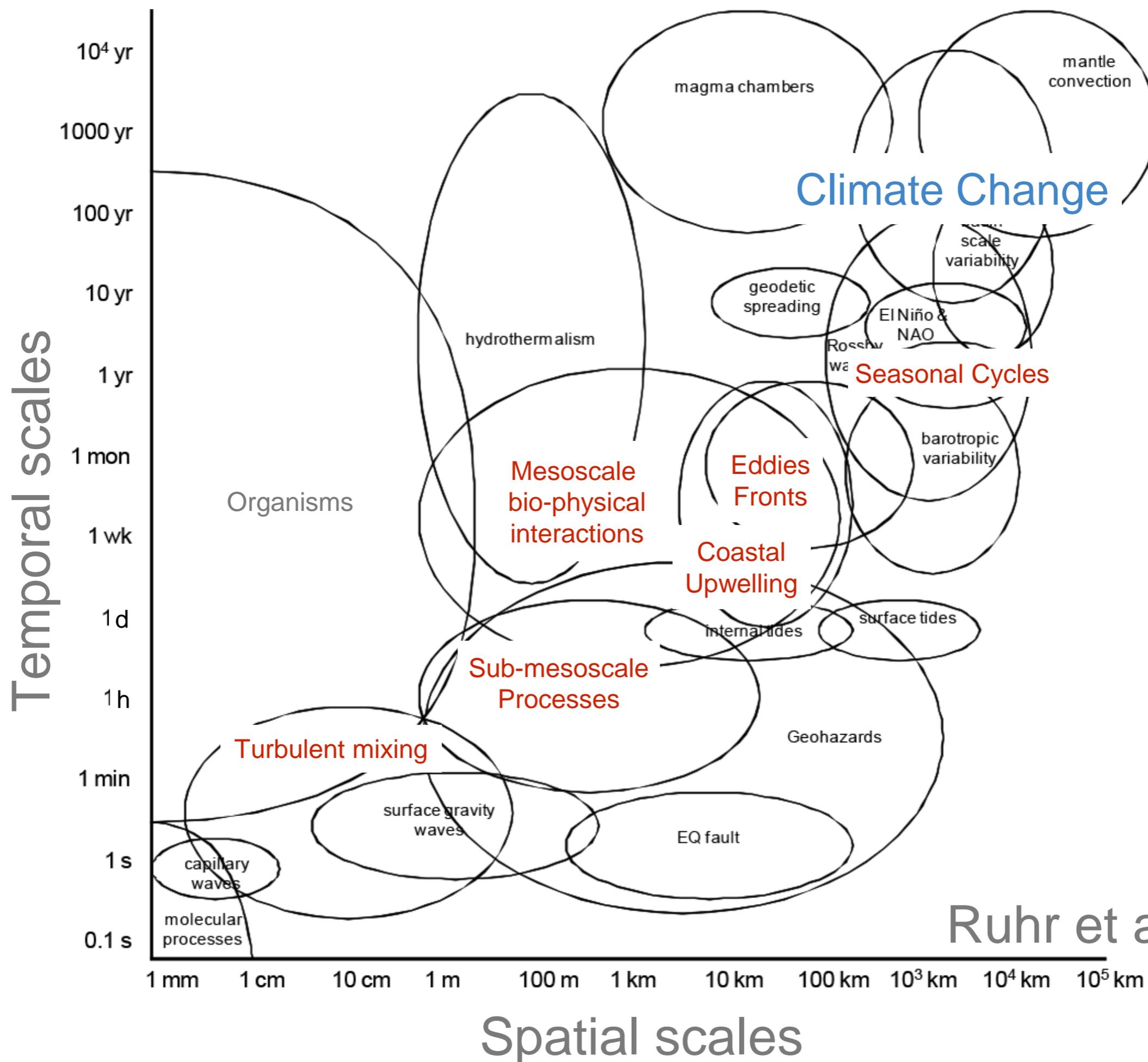


New Statistics to
Bridge Temporal and Spatial Scales
of Biological Production
in the Ocean

Bror Jönsson
Plymouth Marine Laboratory



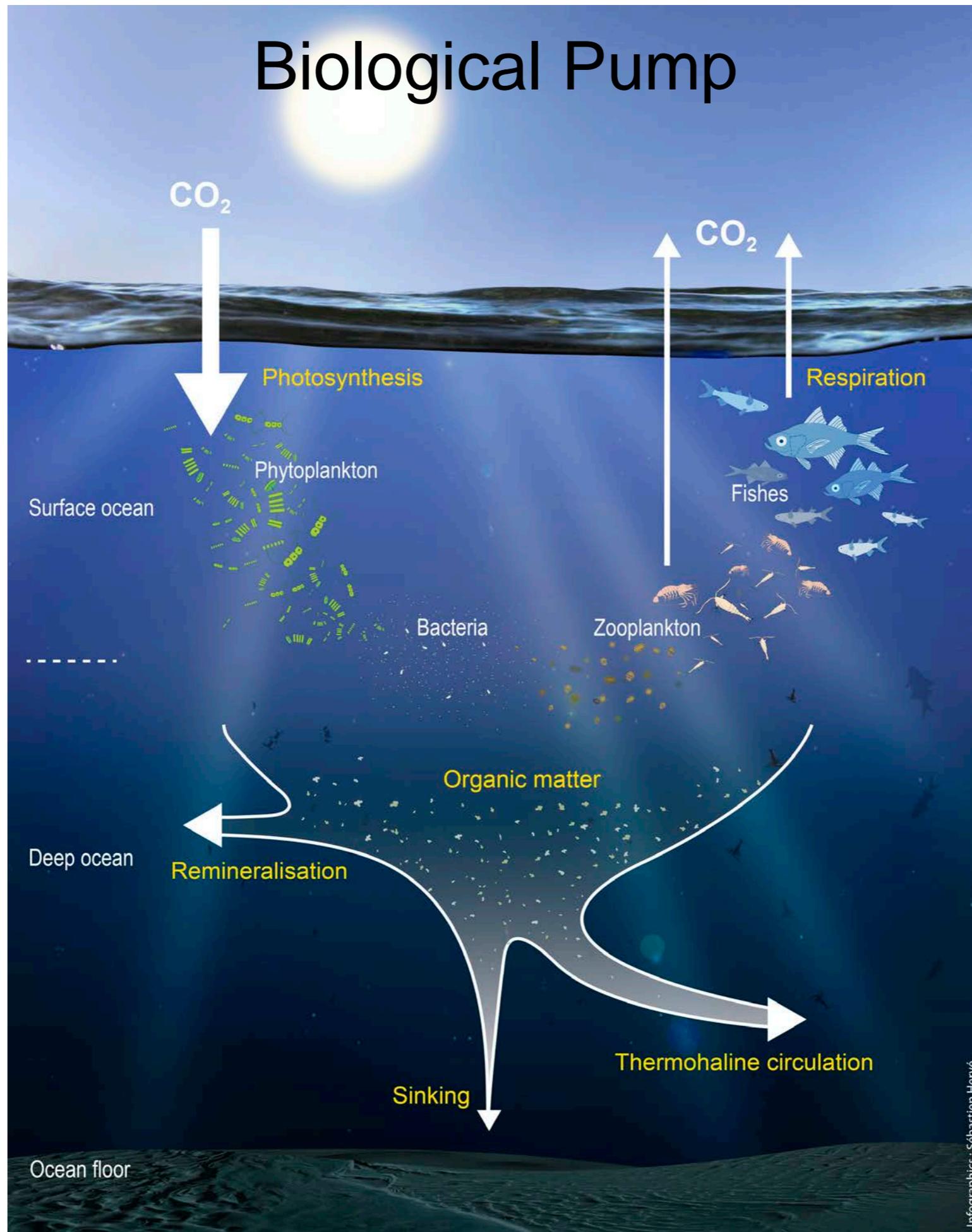
Ruhr et al 2011

Biological Pump

Hour-week

Day-Season

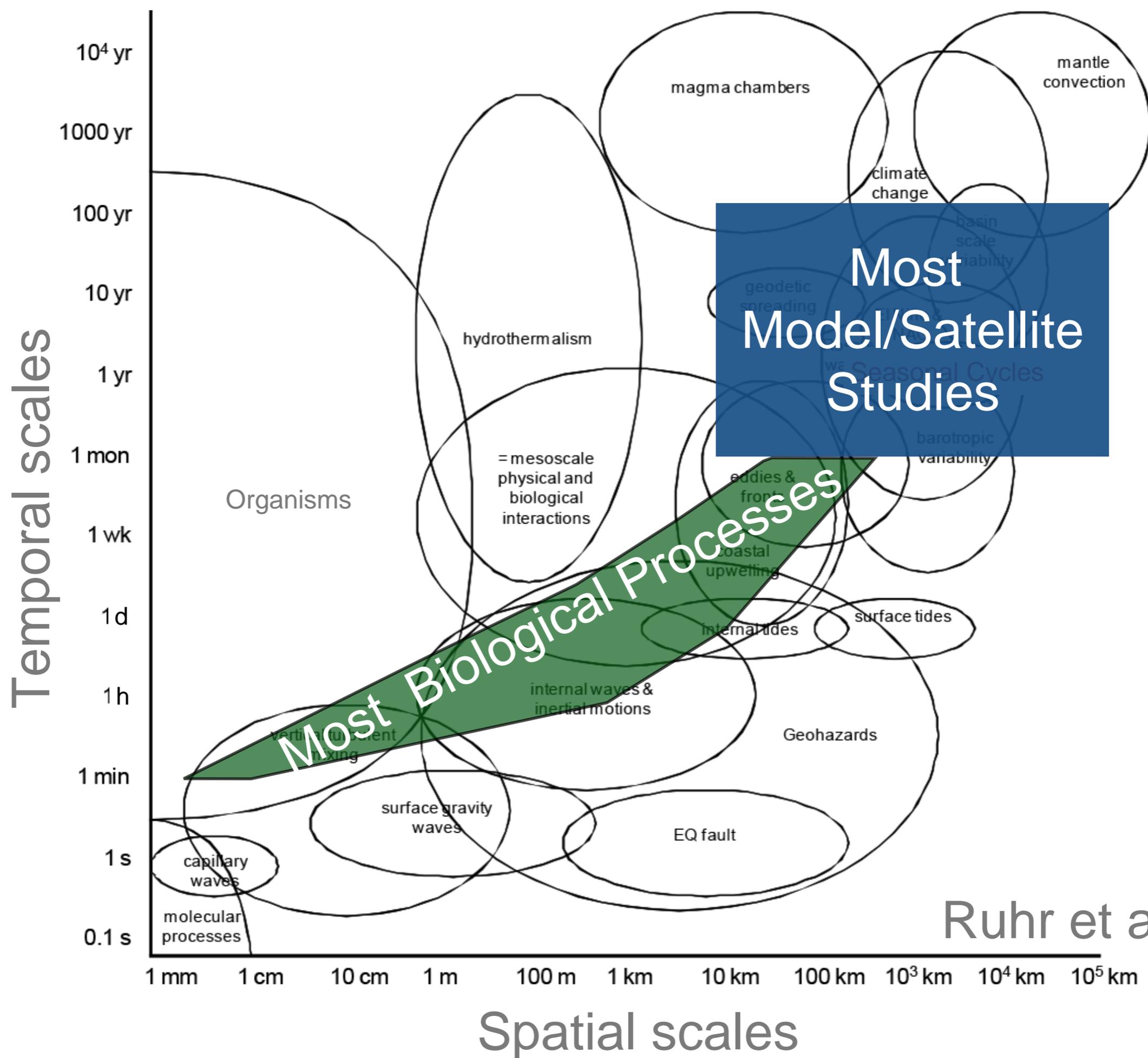
Season-Century



Mixed Layer

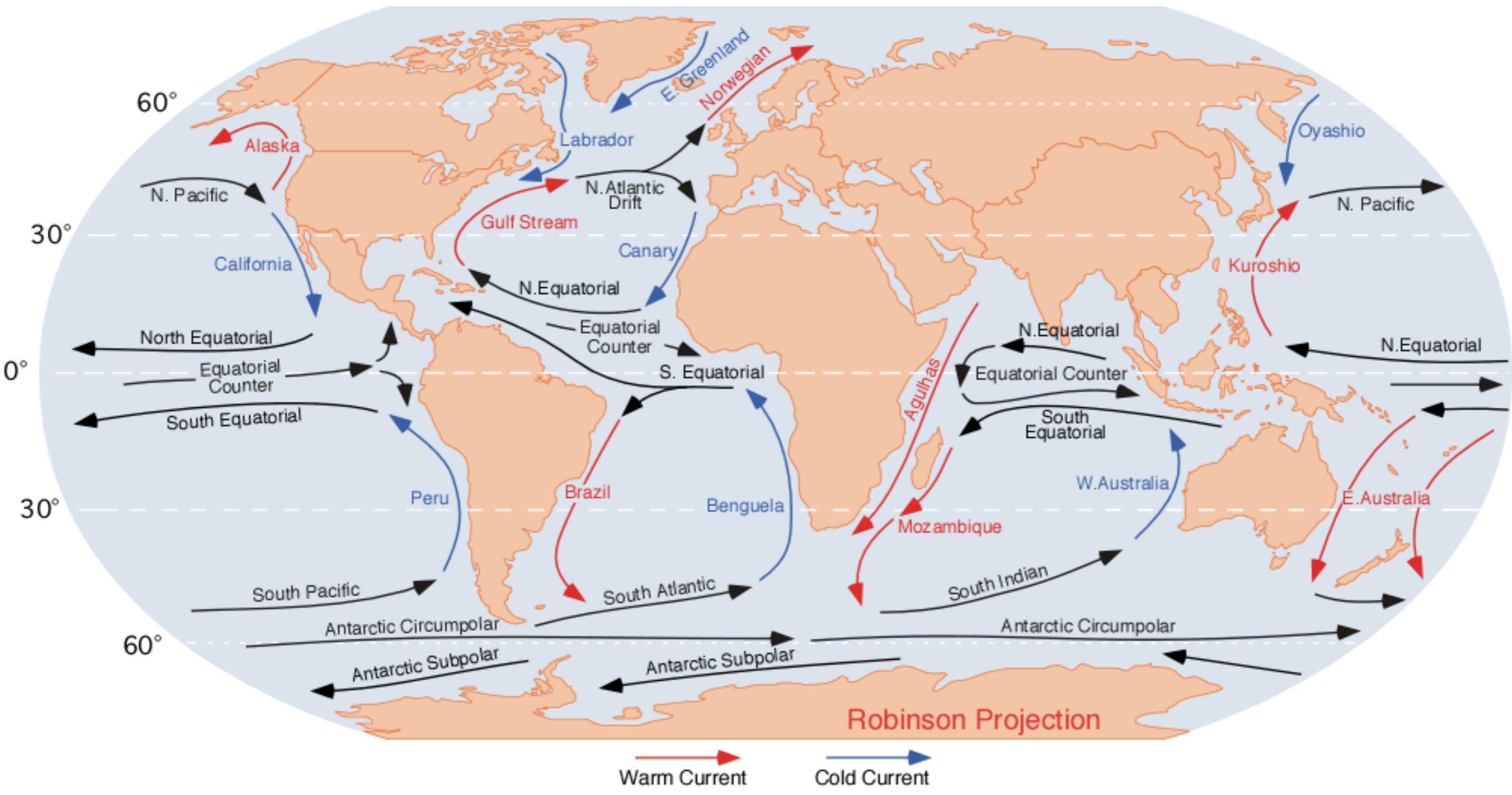
Shadow Zone

Deep Sea

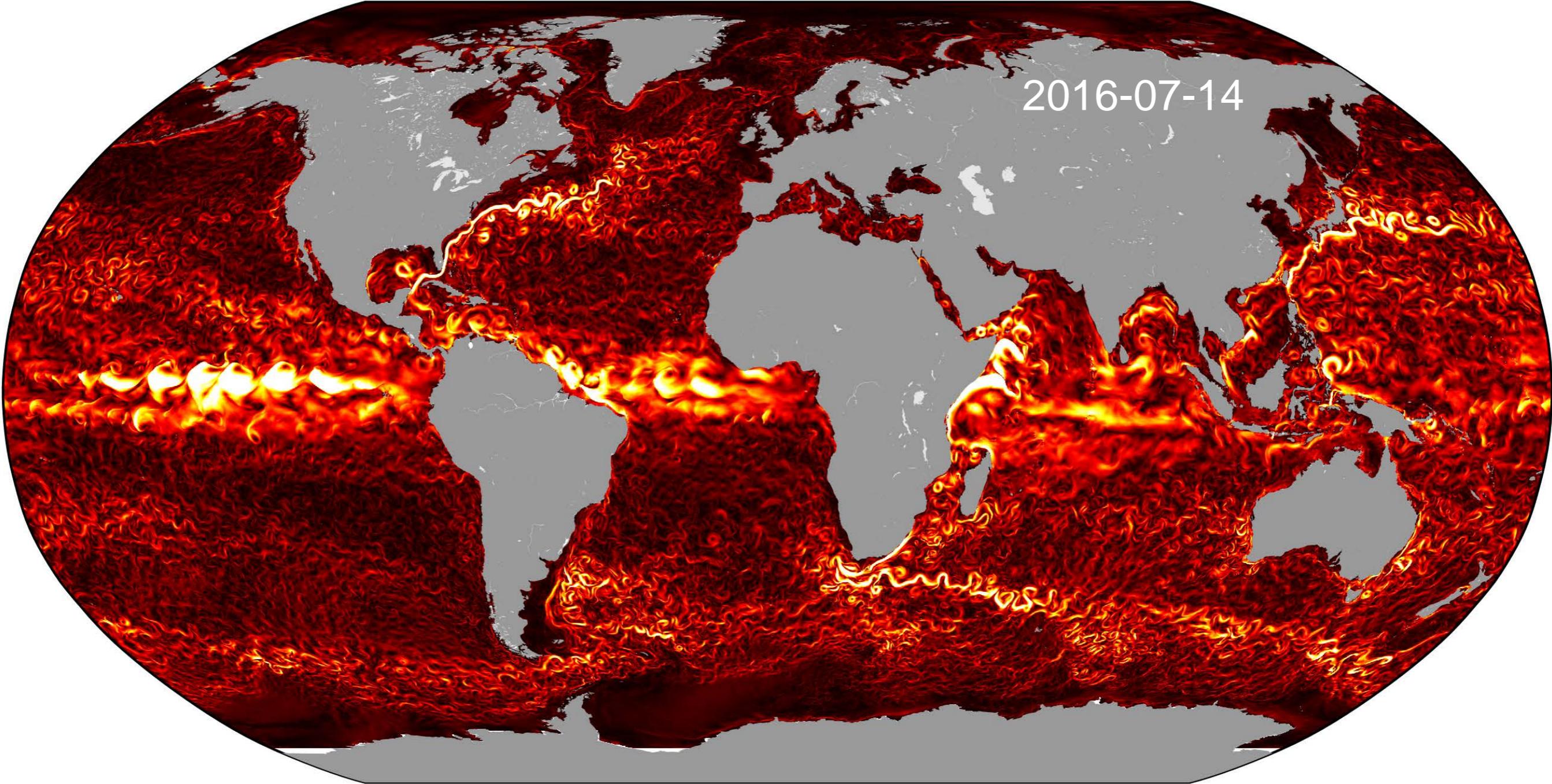


Ruhr et al 2011

Cartoon Oceanography



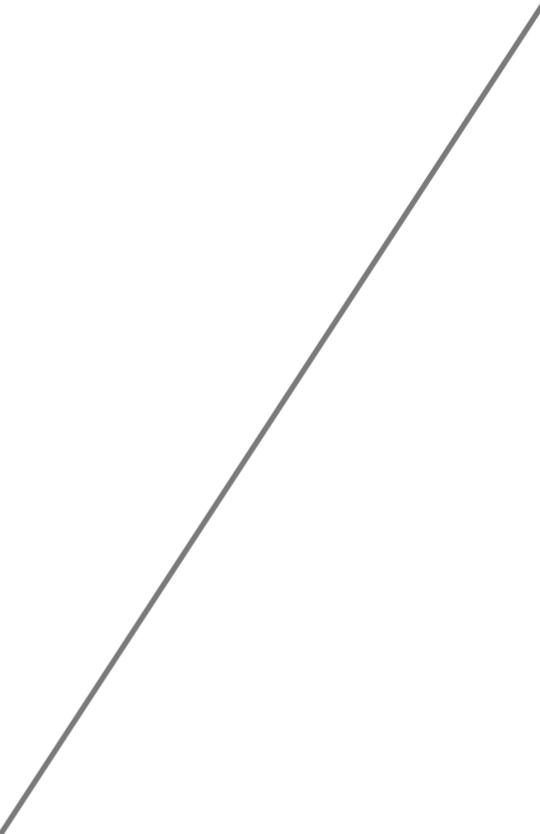
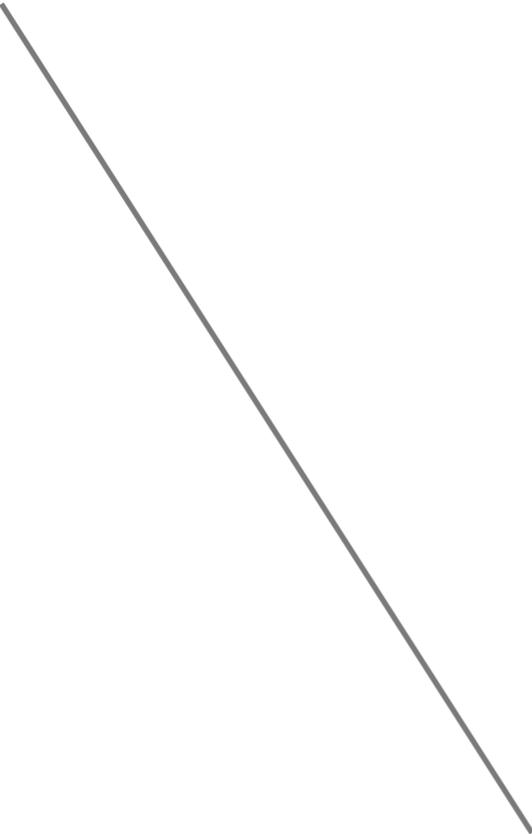
2016-07-14



Copernicus/Mercator 1/12° simulation

Modeling

Observations



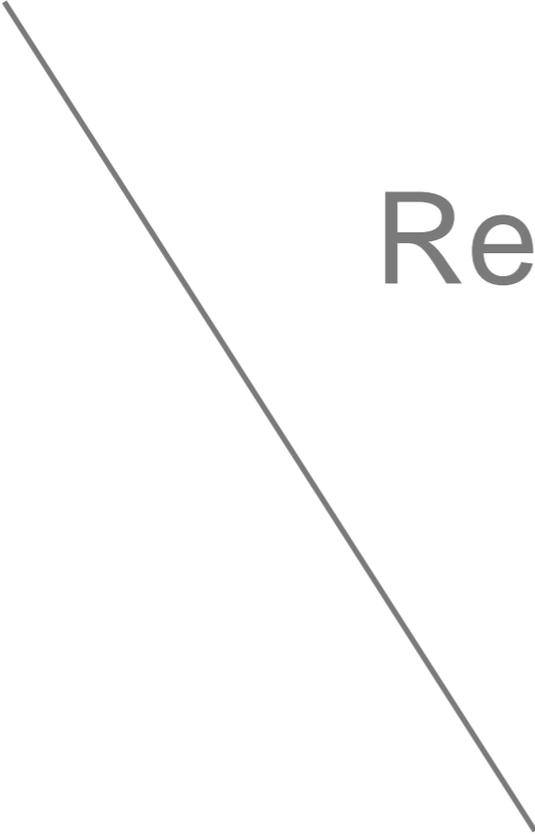
Processes

Modeling

Observations



Representability

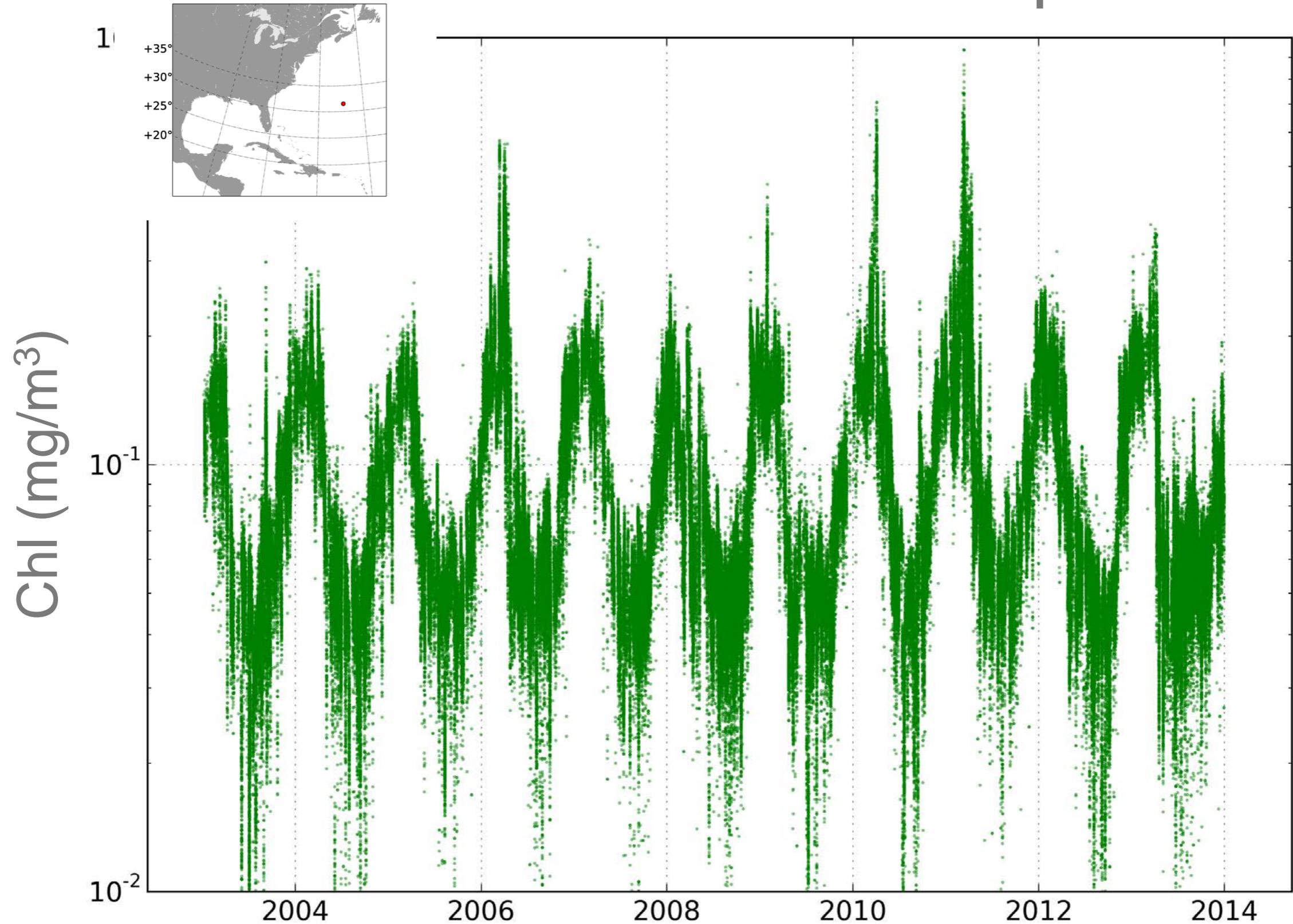


Processes

Dominant timescales

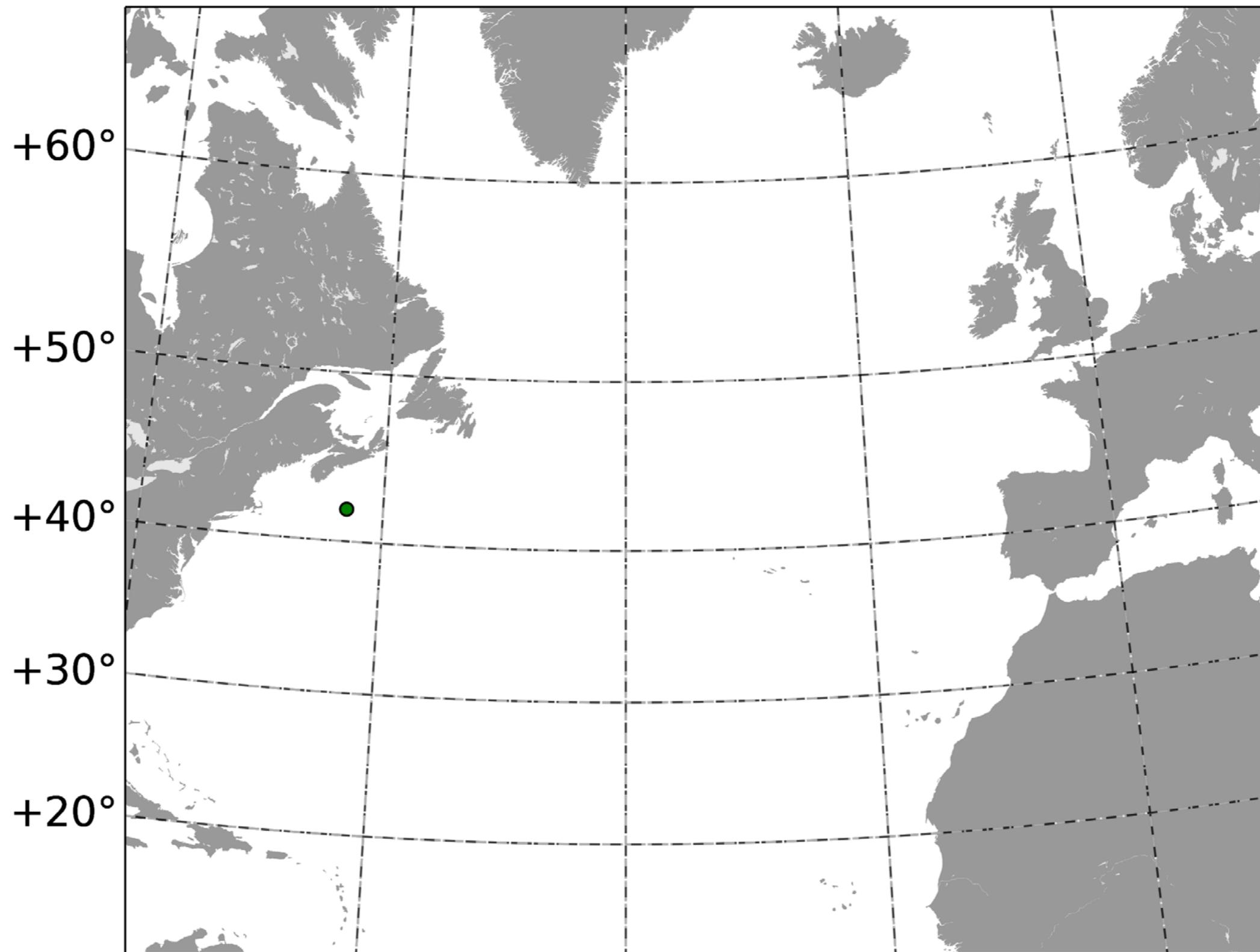
Rare events

Temporal Scales

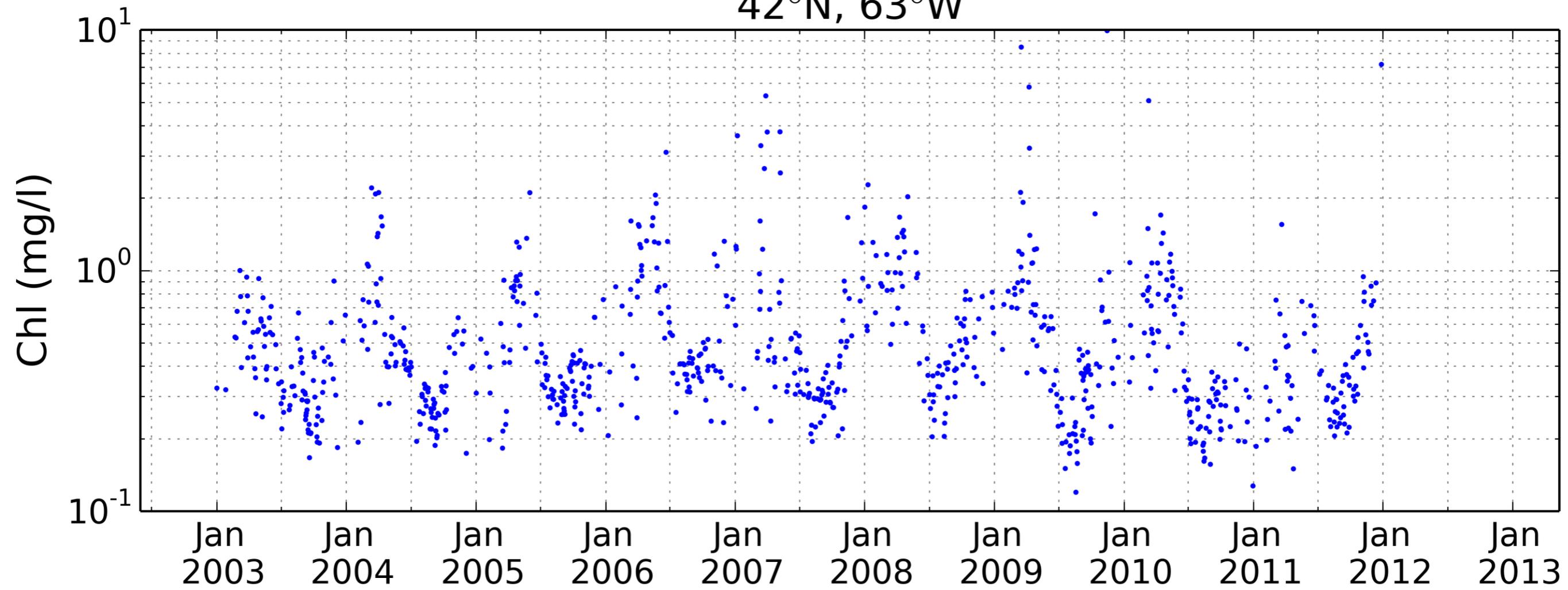


MODIS L3 4km 31°N – 32°N , 64°W – 65°W

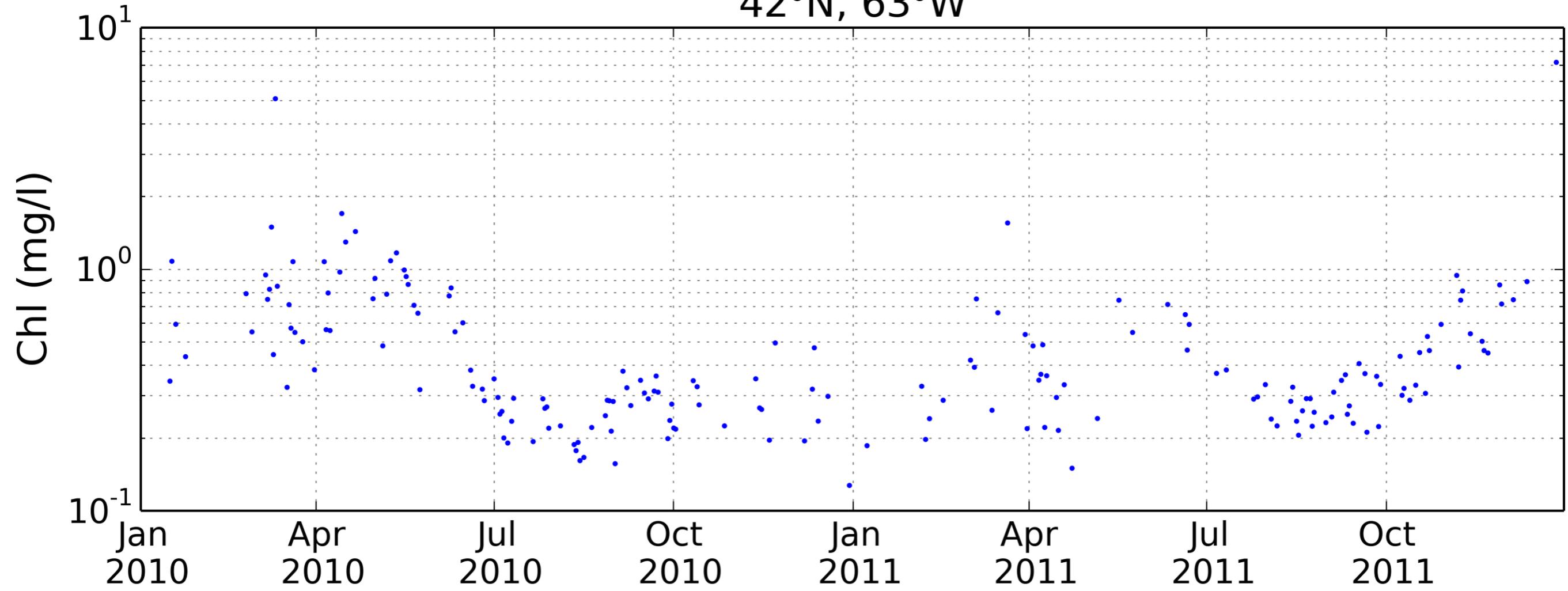
Satellite ocean color:
Great coverage but sparse



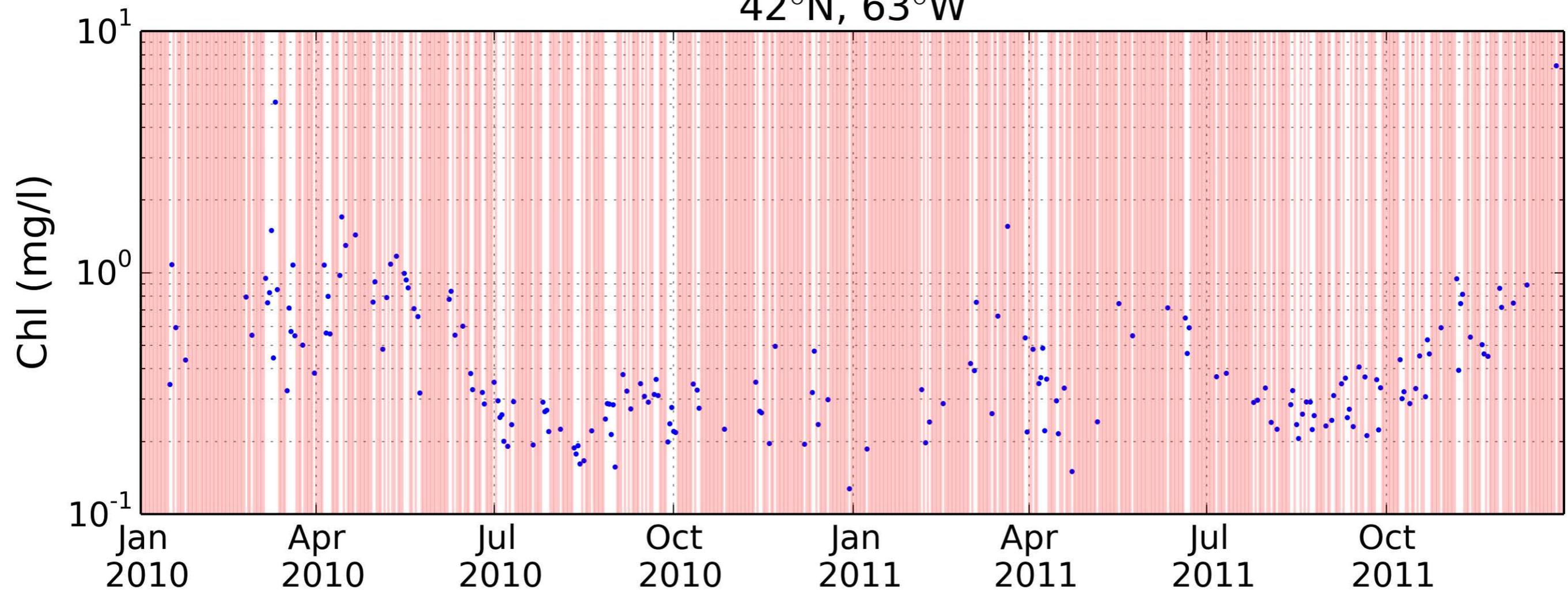
42°N, 63°W



42°N, 63°W

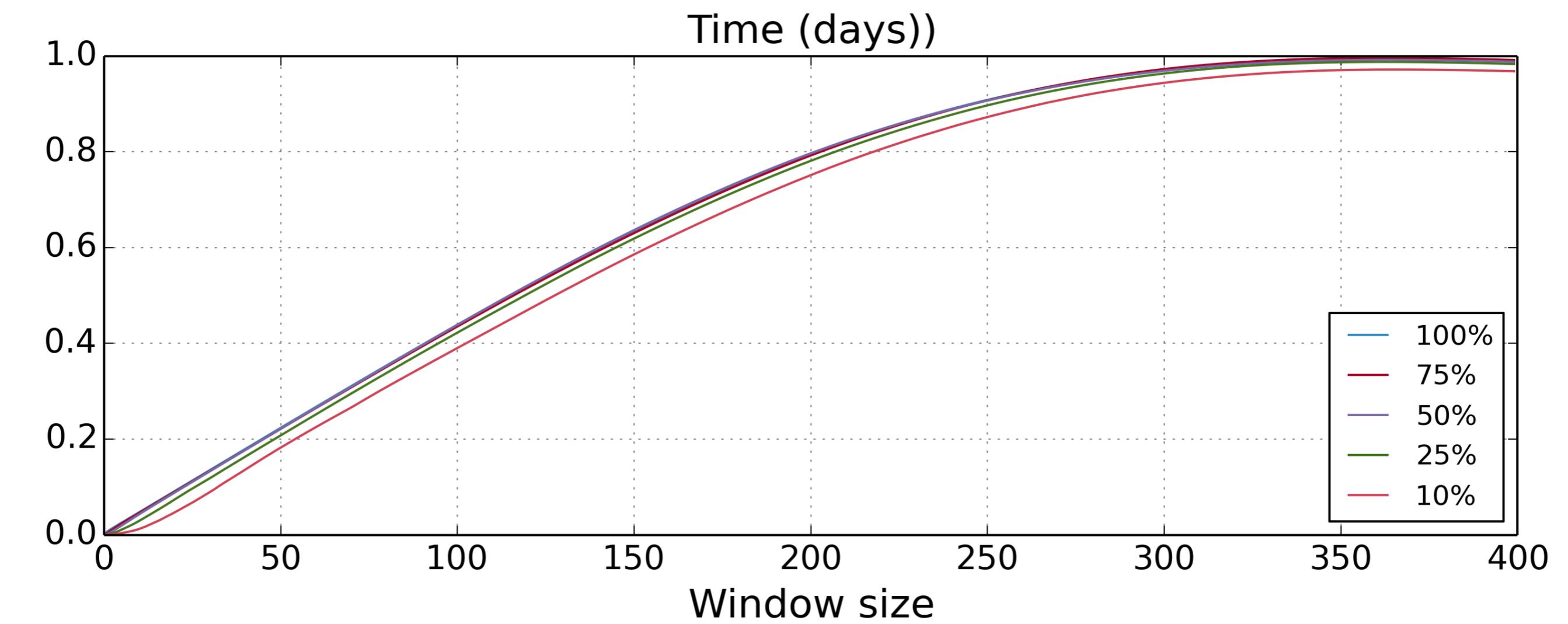
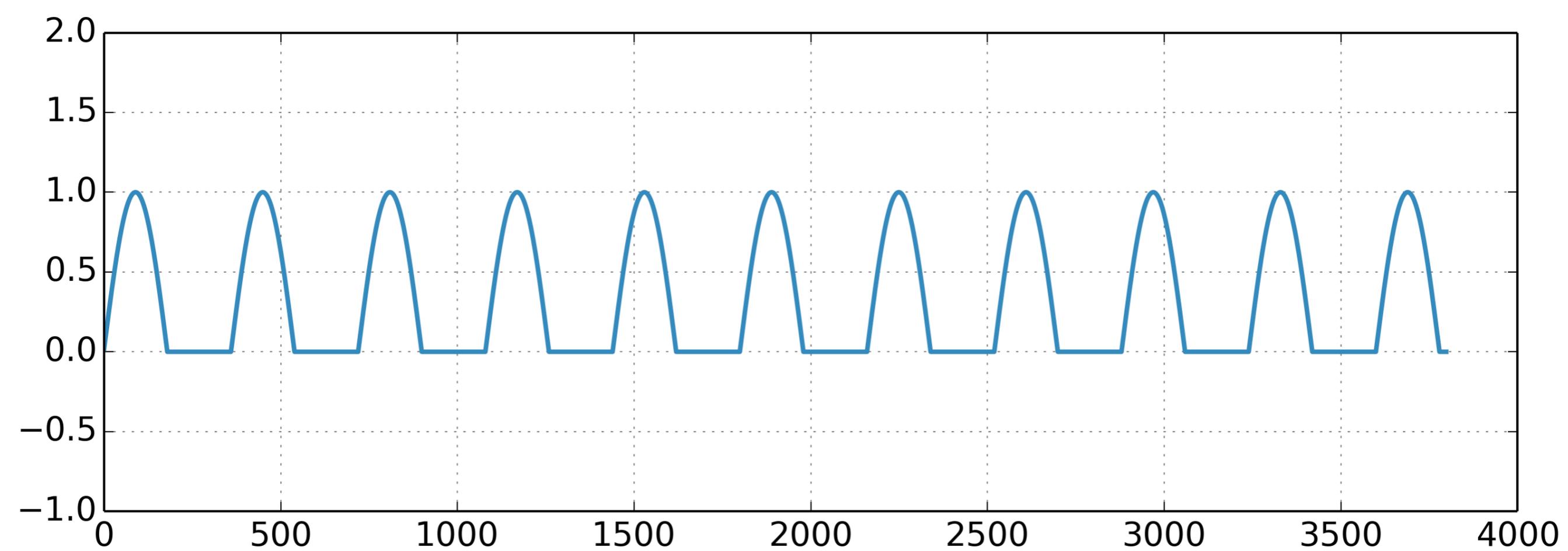


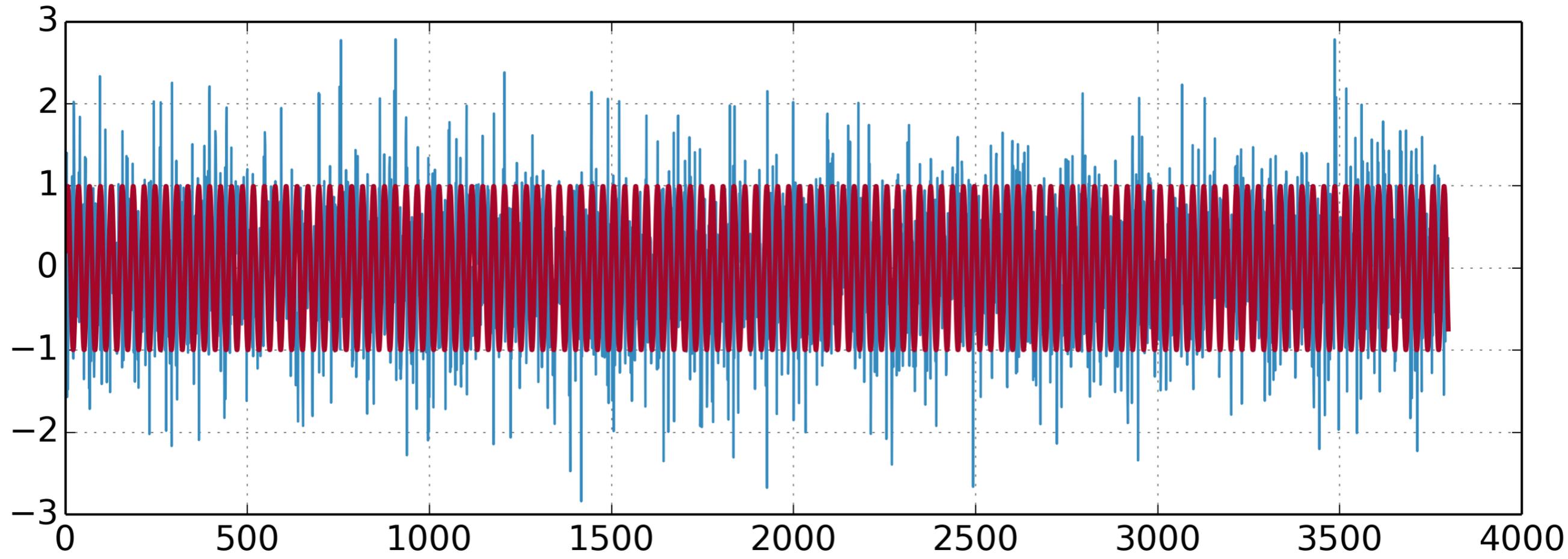
42°N, 63°W



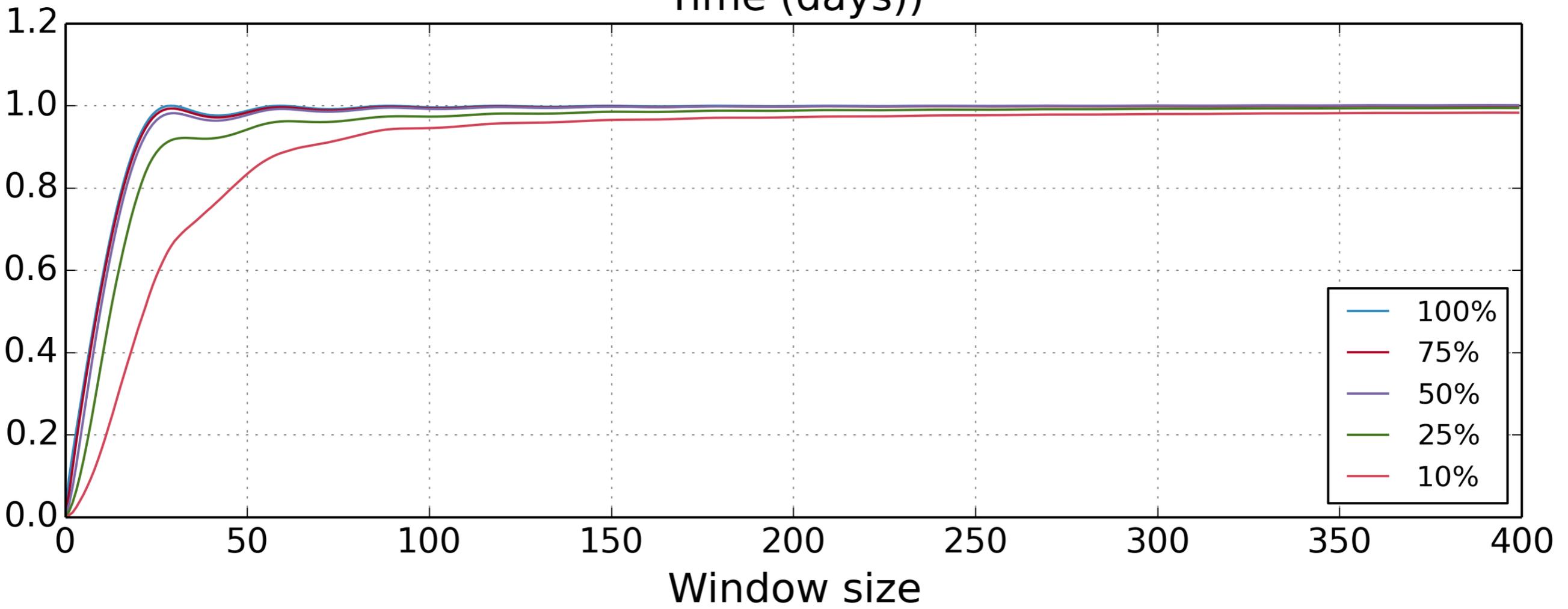
Running Standard Deviation

Mean of running STD
Start with window size=1
Increase step-wise
Zero when WS=1
Saturates for large WS





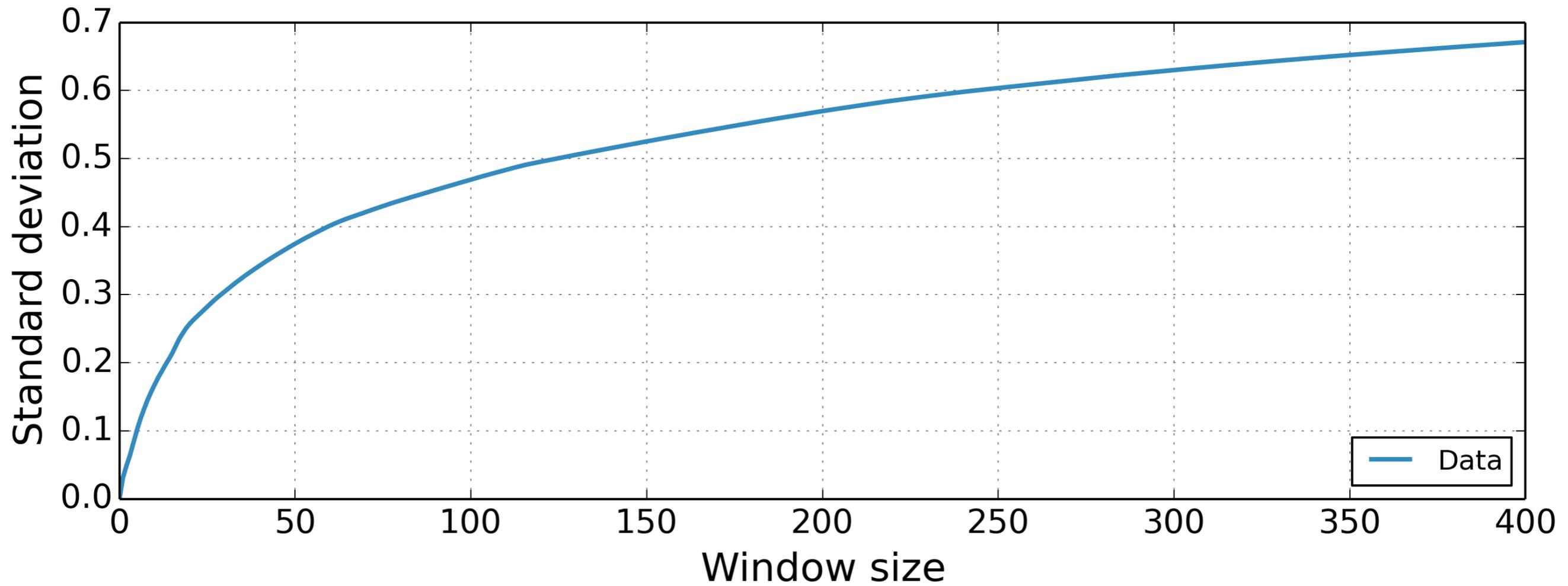
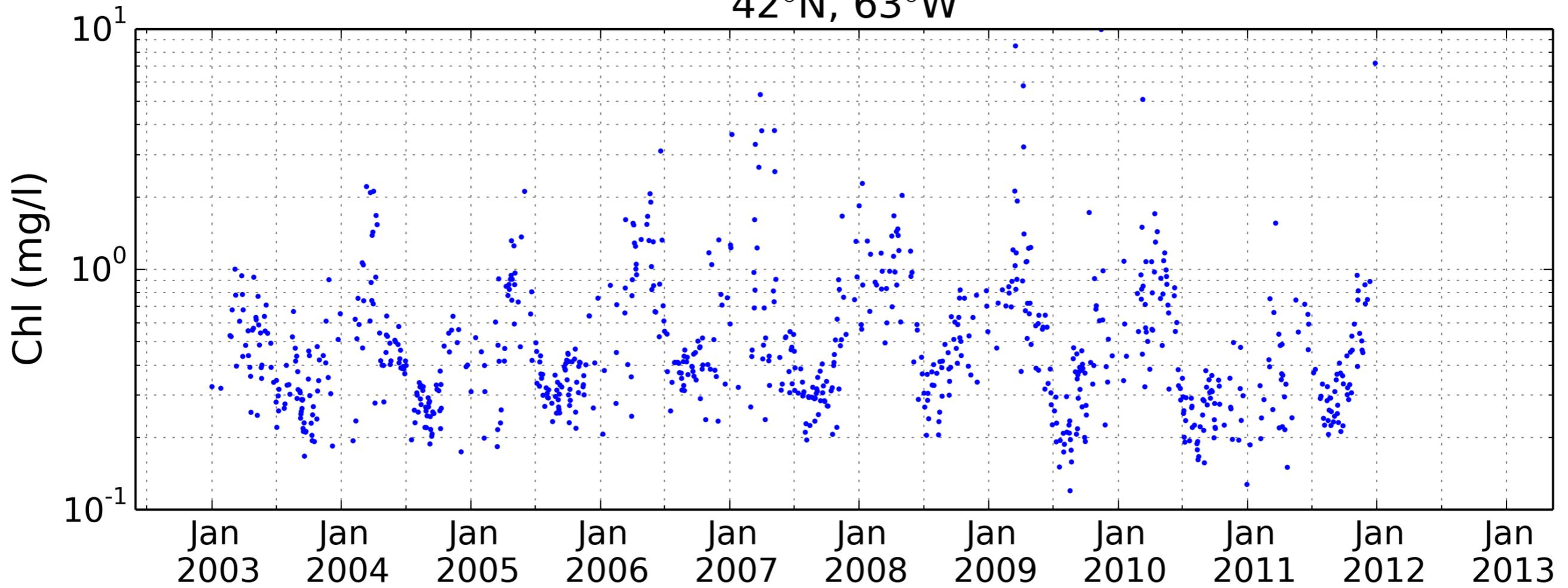
Time (days))



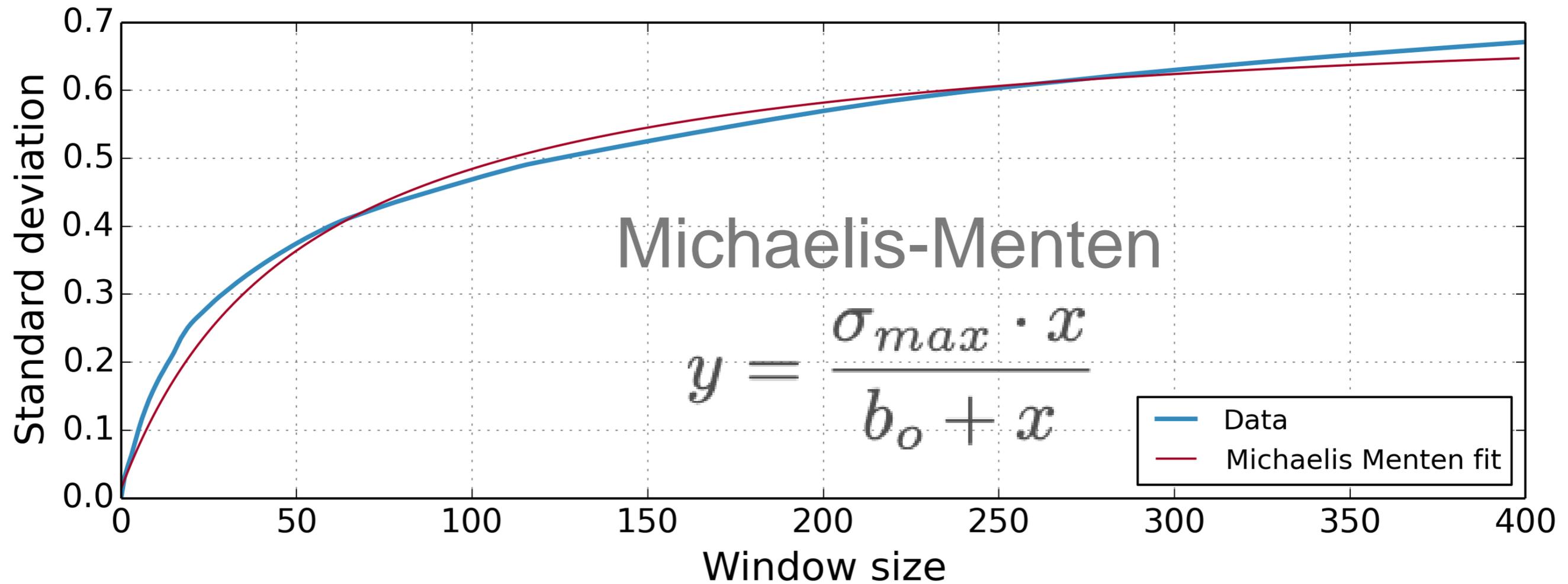
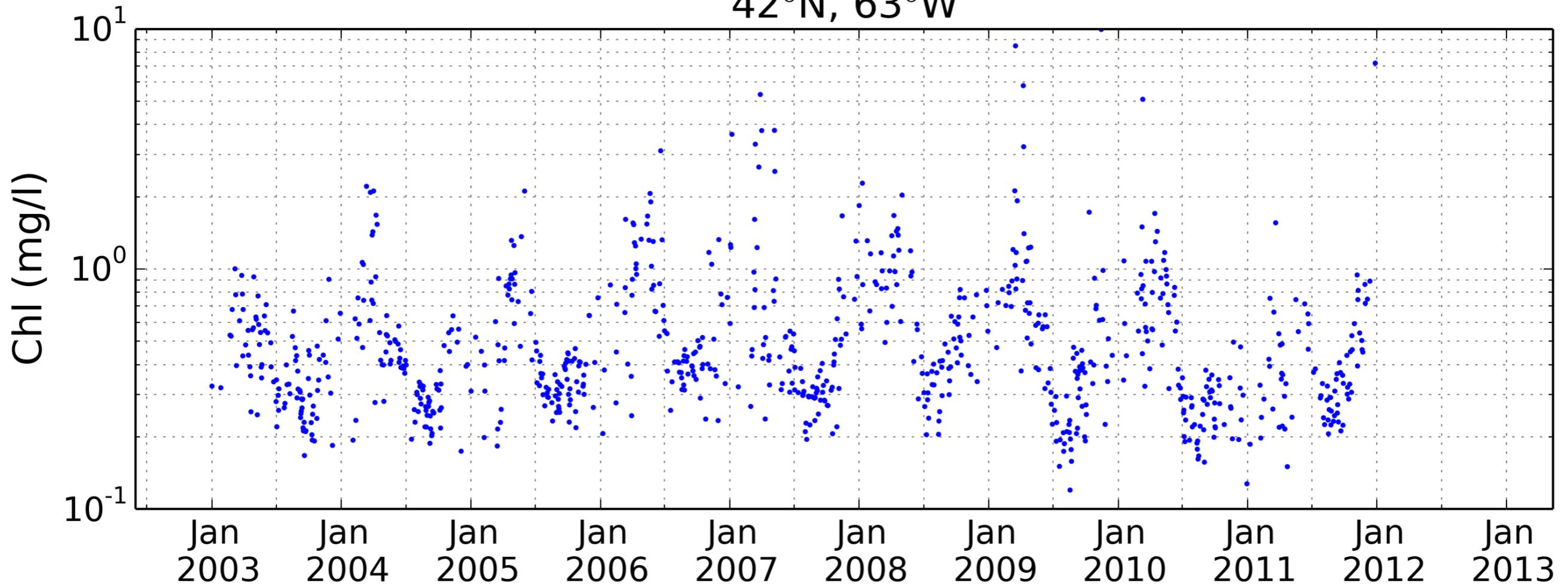
Window size

Steepness of curve
corresponds to
dominating timescale

42°N, 63°W



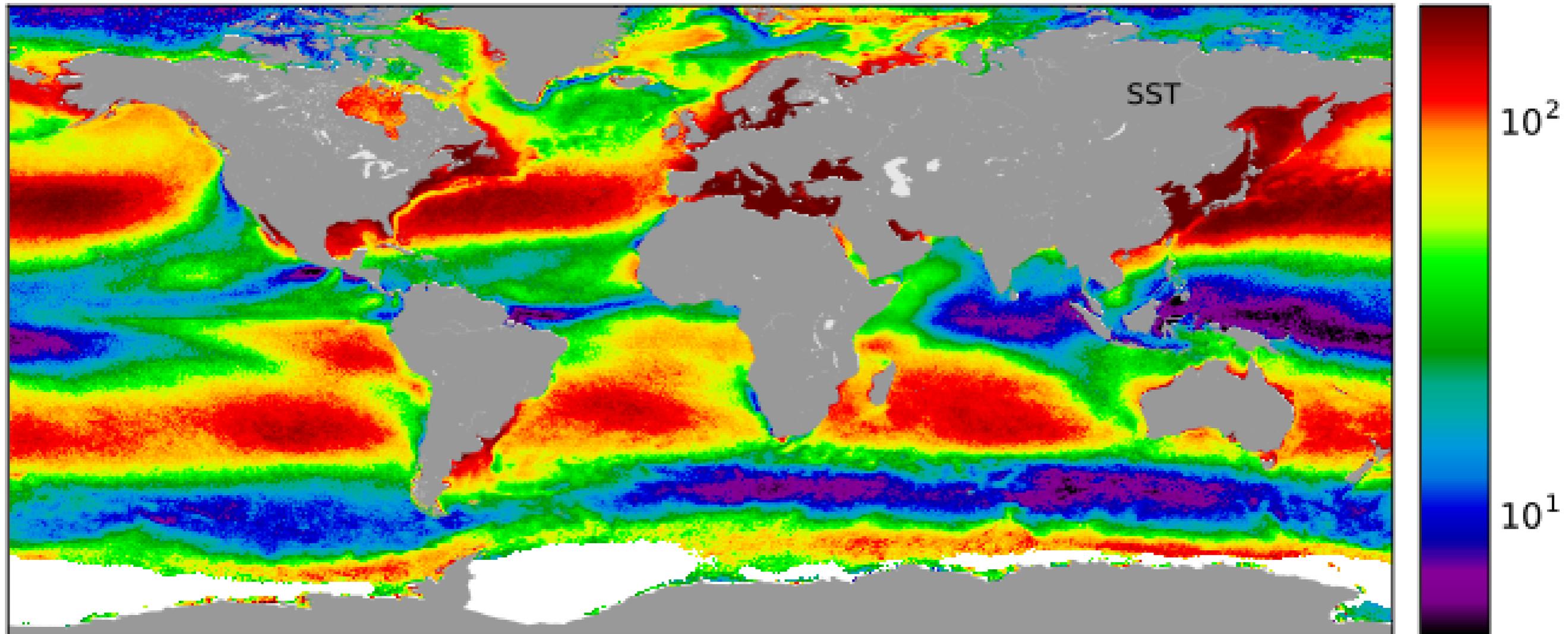
42°N, 63°W



Michaelis-Menten

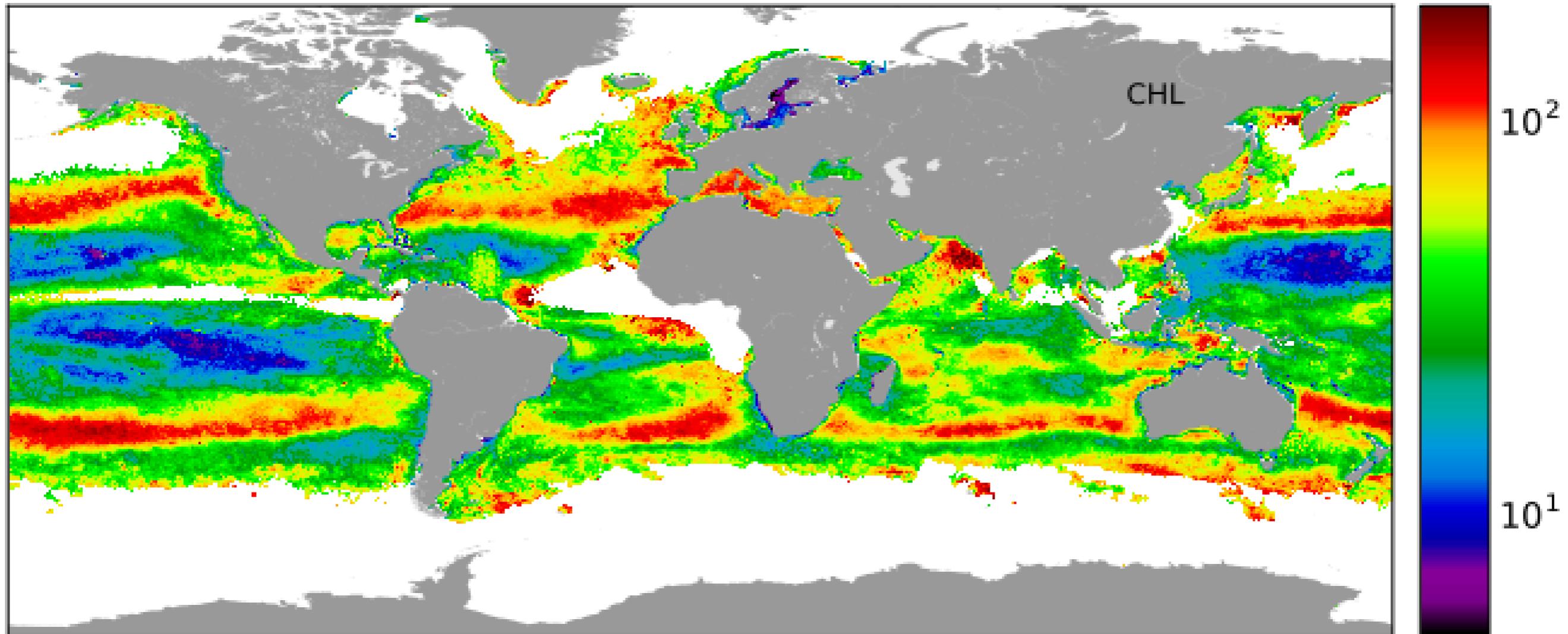
$$y = \frac{\sigma_{max} \cdot x}{b_o + x}$$

NASA/MODIS 16km resolution



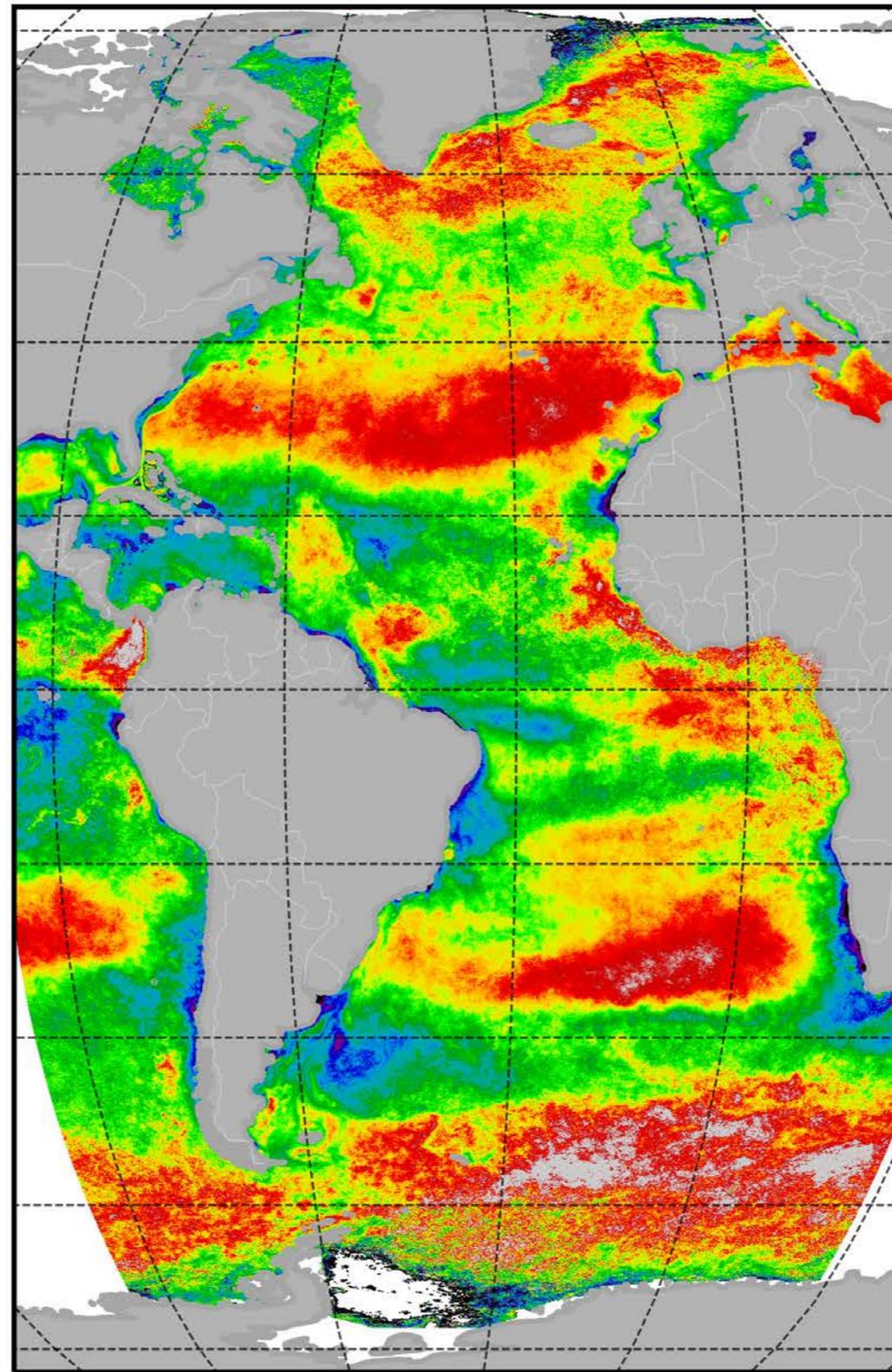
b_0 , Chl (days)

NASA/MODIS 16km resolution



b_0 , Chl (days)

CCI 4km resolution



b_0 , Chl (days)

World ocean circulation user
consultation meeting
21 - 22 Feb 2019, Frascati, Italy

<http://woc2019.esa.int/>

Heat strokes

Ecosystem inefficiency
Export efficiency

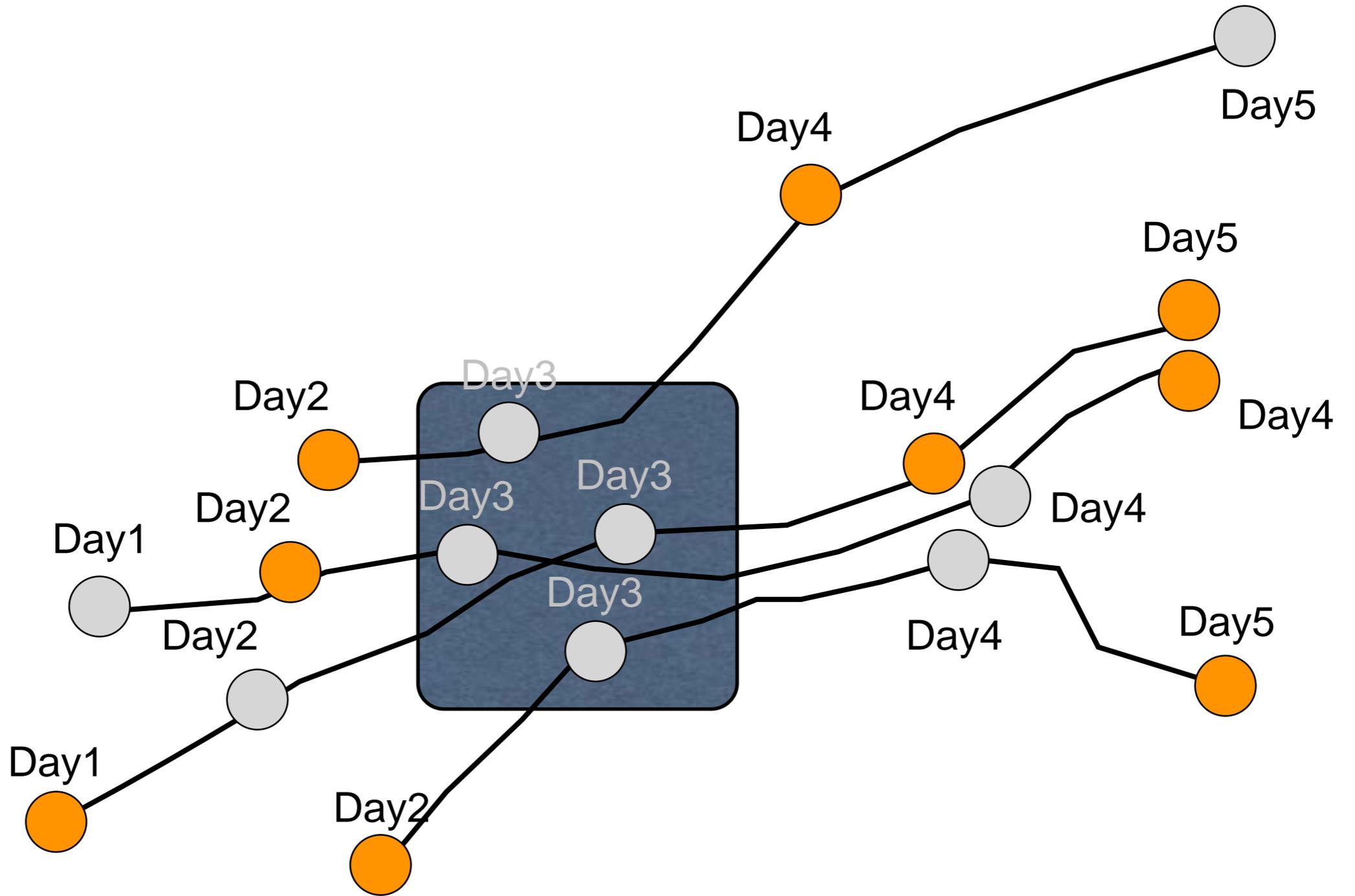
Dominant timescales

Rare events

A new framework to estimate
NCP.

Combine satellite data
and numerical models

Follow Many Particles

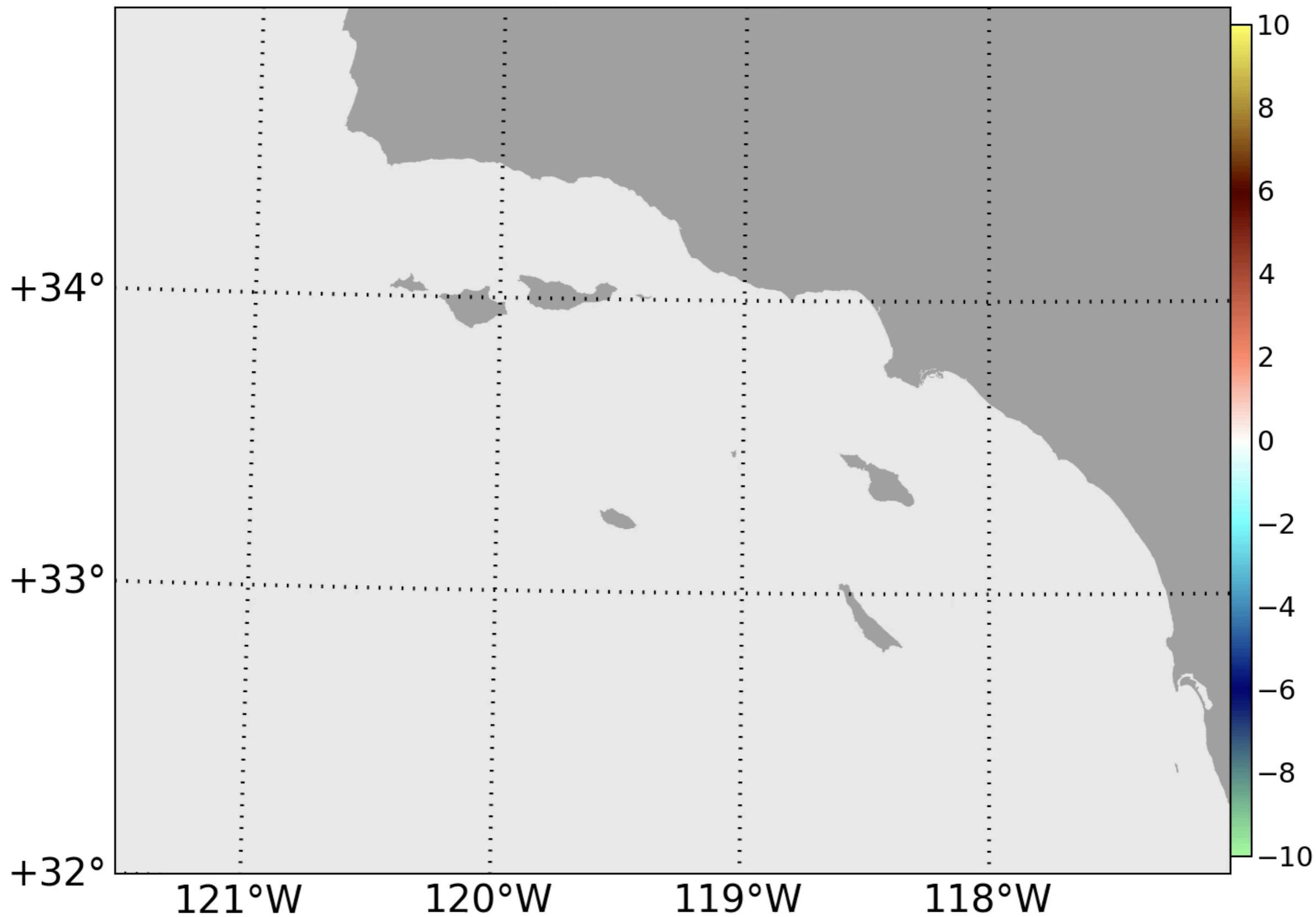


A grayscale map of the South California Bight region, showing the coastline from the Gulf of California in the north to the Baja Peninsula in the south. A small rectangular area in the southern part of the bight is highlighted in blue. The text "South California Bight" and "CalCOFI" is overlaid on the map.

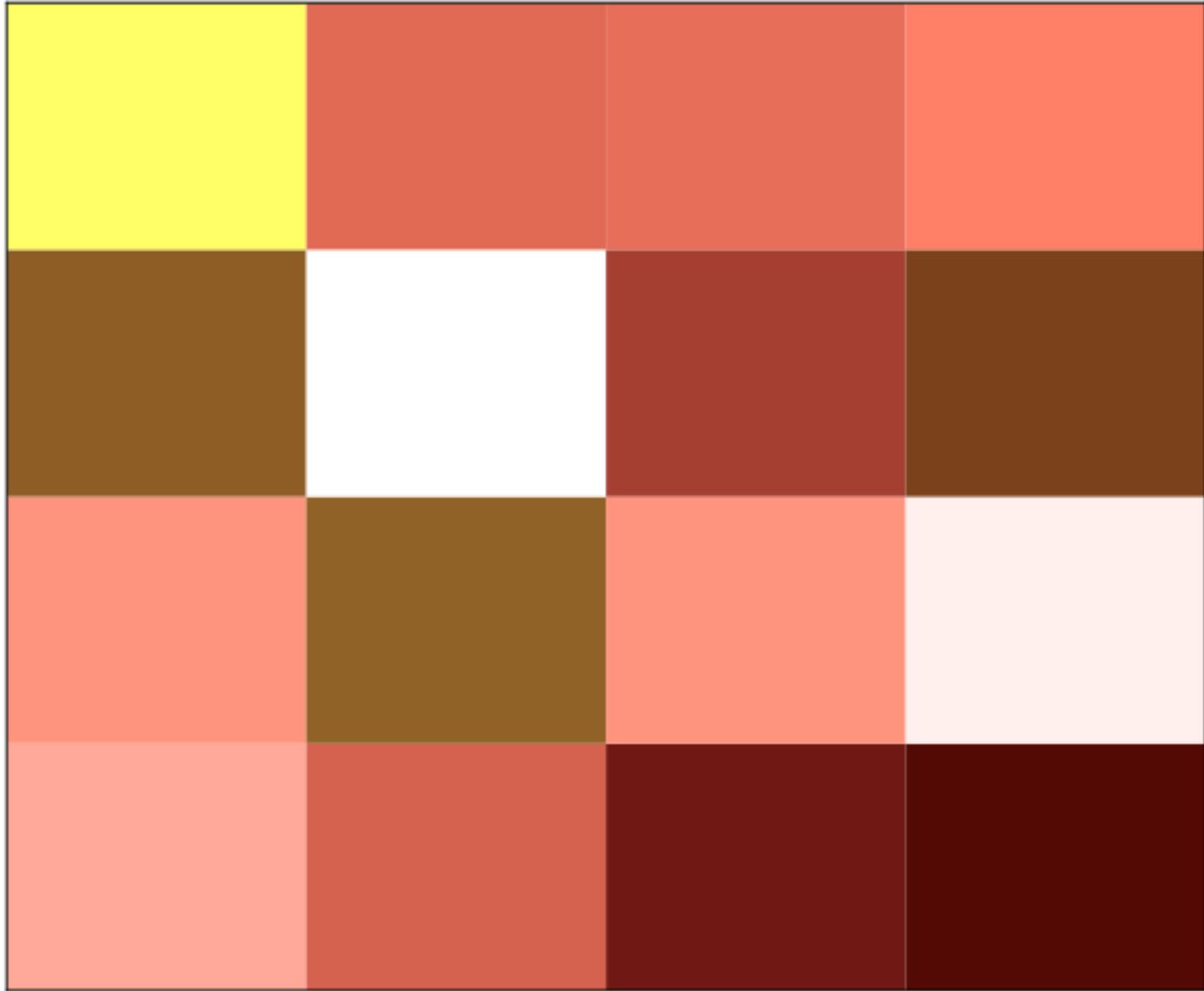
South California Bight CalCOFI

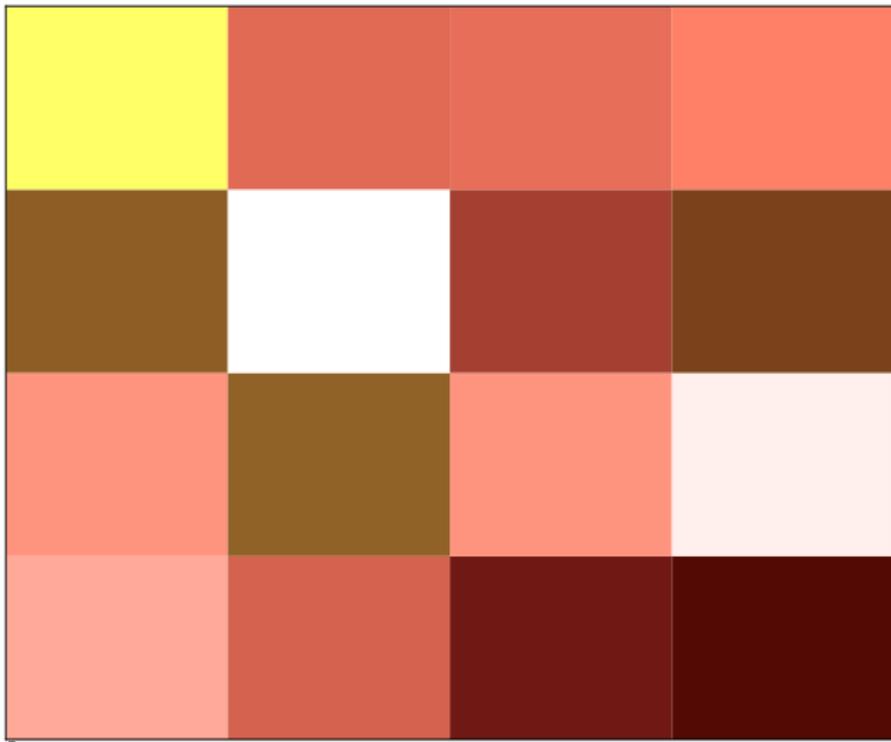
Change, Chl ($\text{mg m}^3 \text{d}^{-1}$)

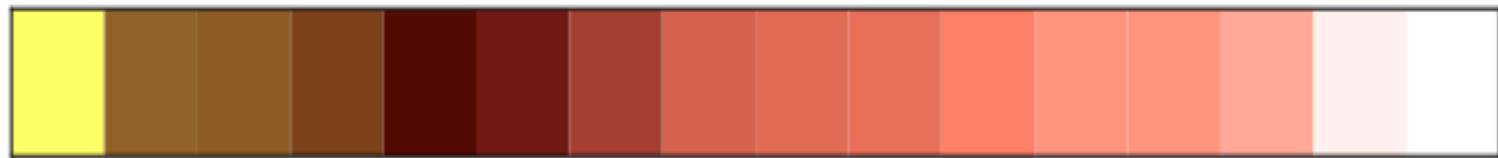
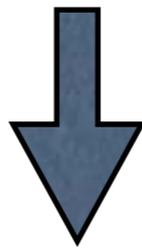
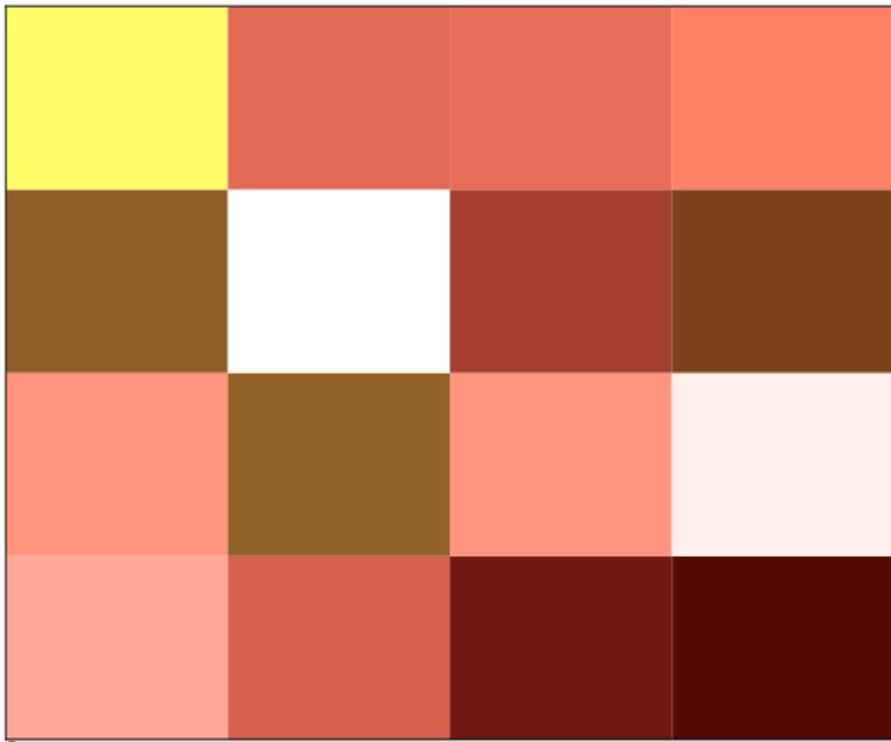
2010-01-01

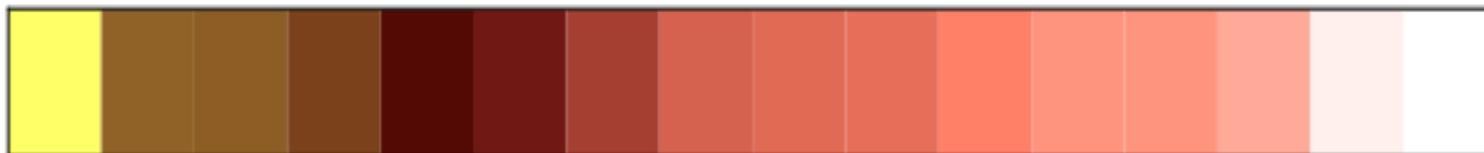
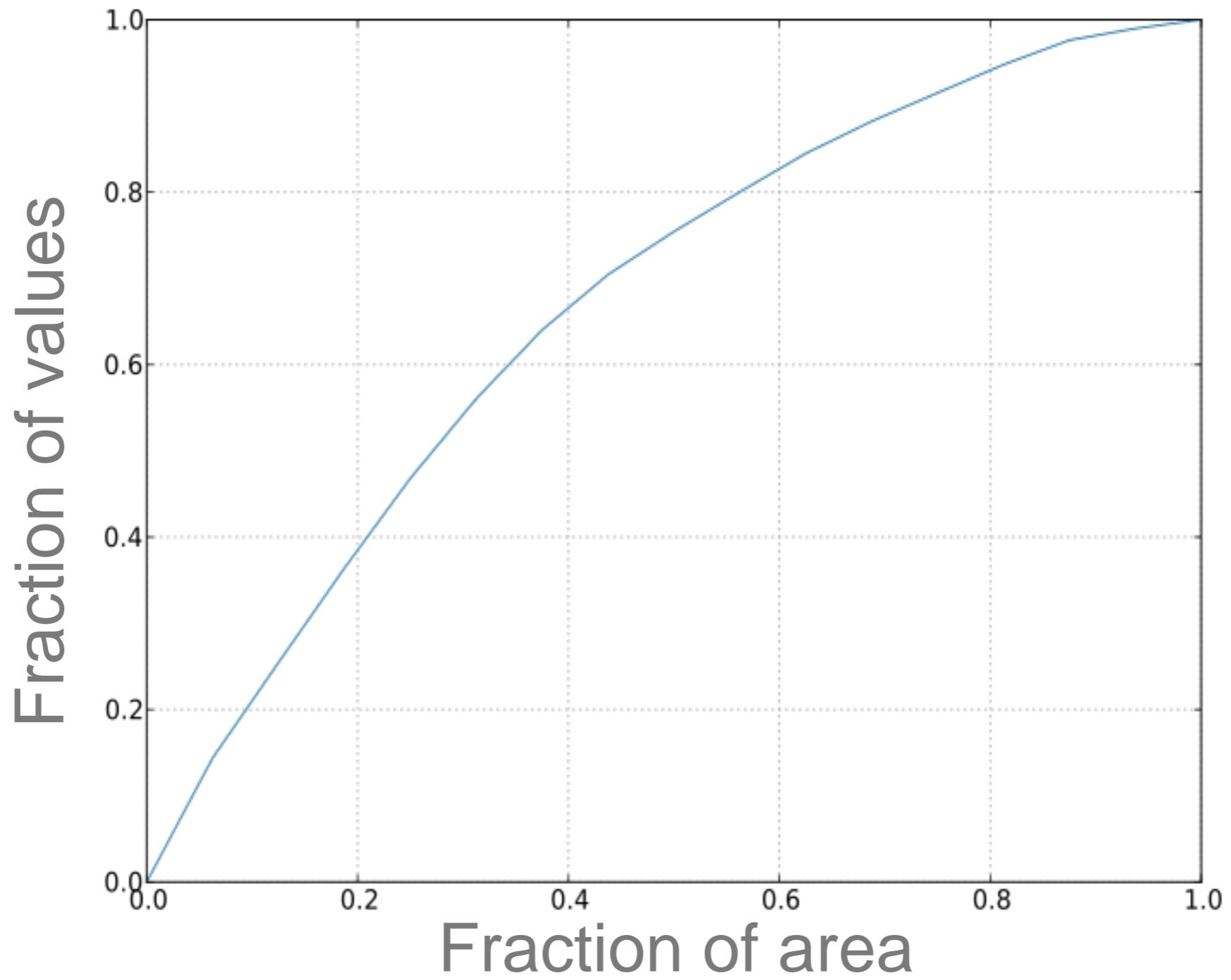


Quantify
the importance of
episodic events

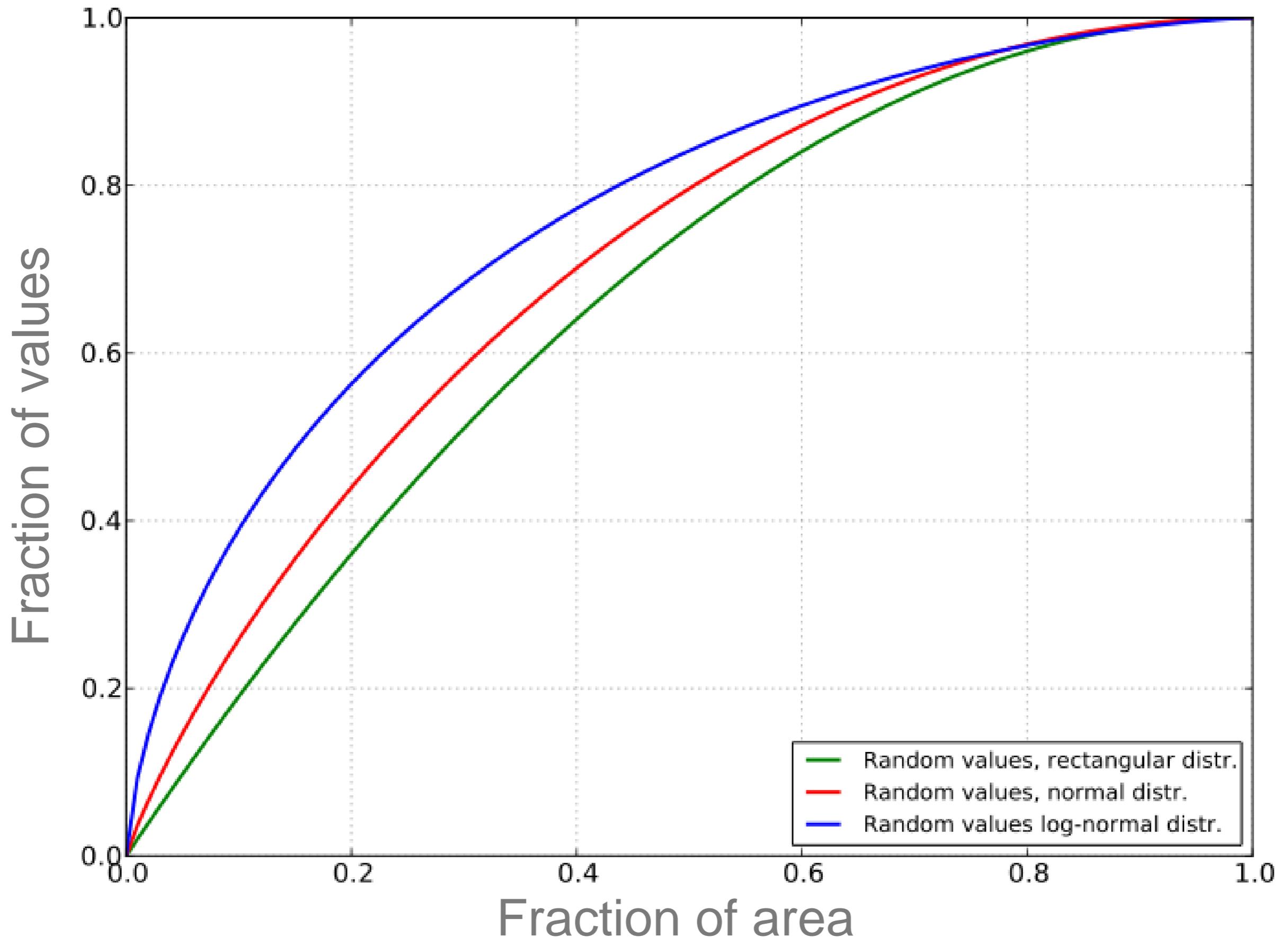




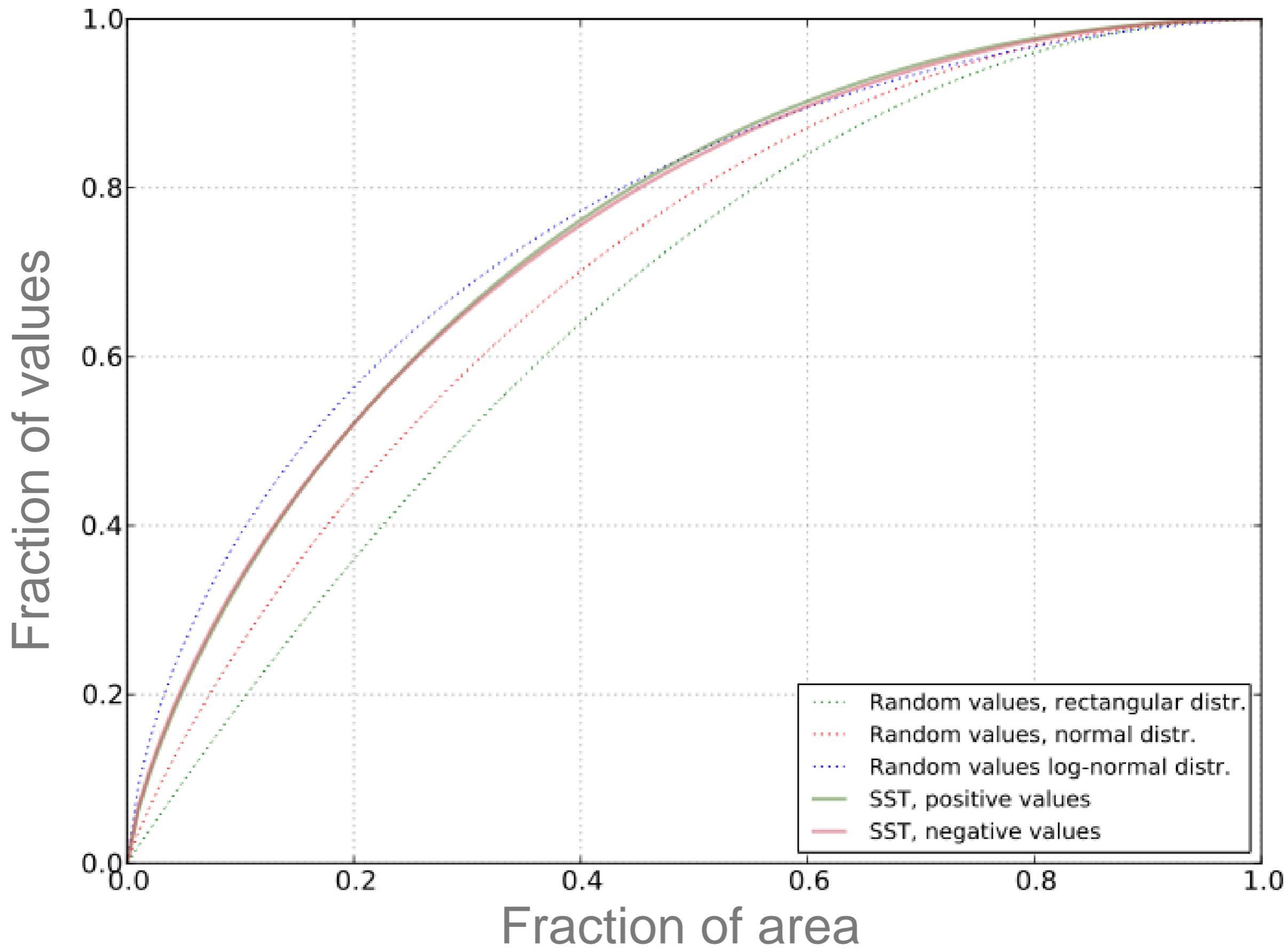




50 000 random values, log-normal distribution



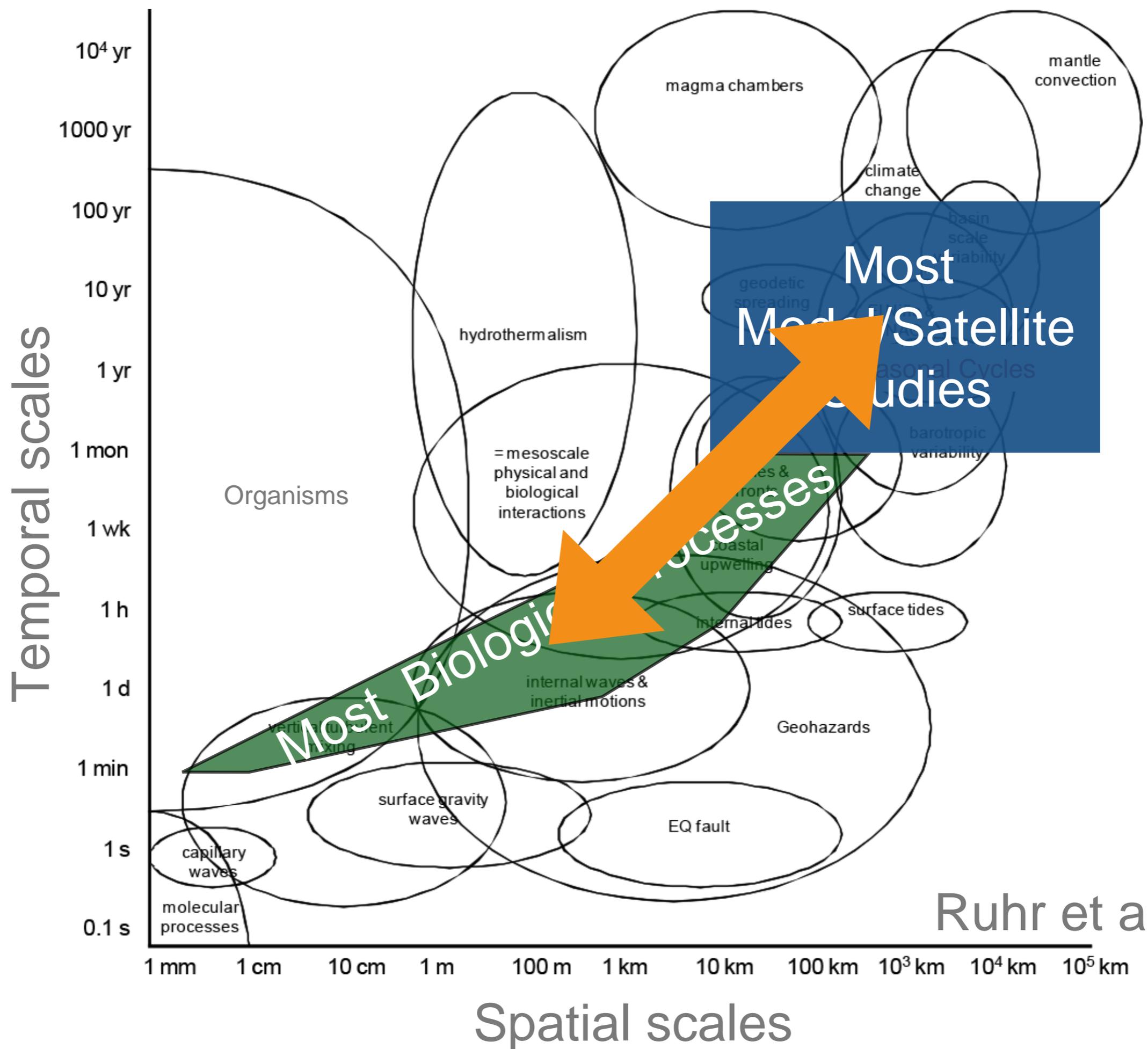
All changes in SST



Episodic events dominates

Frequencies might be
as important as means

Heat strokes



Ruhr et al 2011

Recommendations
Geostationary satellites
Ocean Circulation
Focus on Ecoregions

Joe Salisbury, UNH
Amala Mahadevan, WHOI
Michael Bender, Princeton University
Kristofer Döös, Stockholm University
Warren Joubert, CSIR
Scott Doney, WHOI
John Dunne, GFDL

NASA

brj@pml.ac.uk