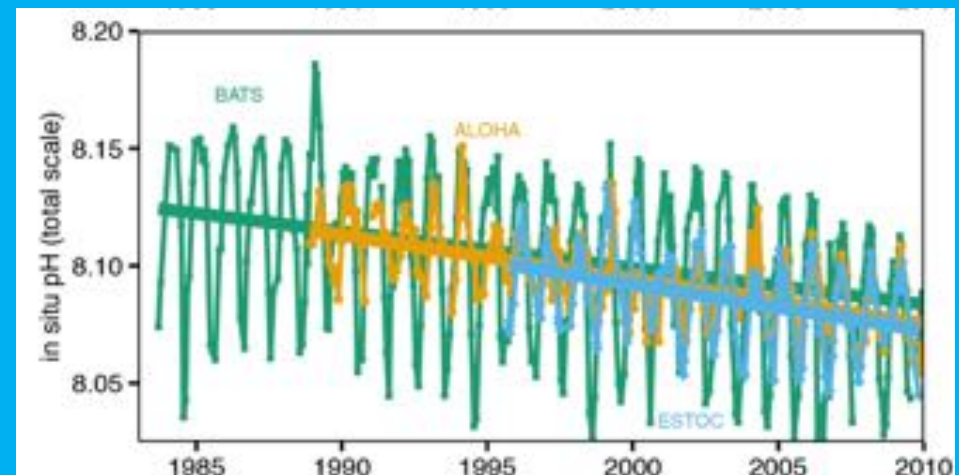
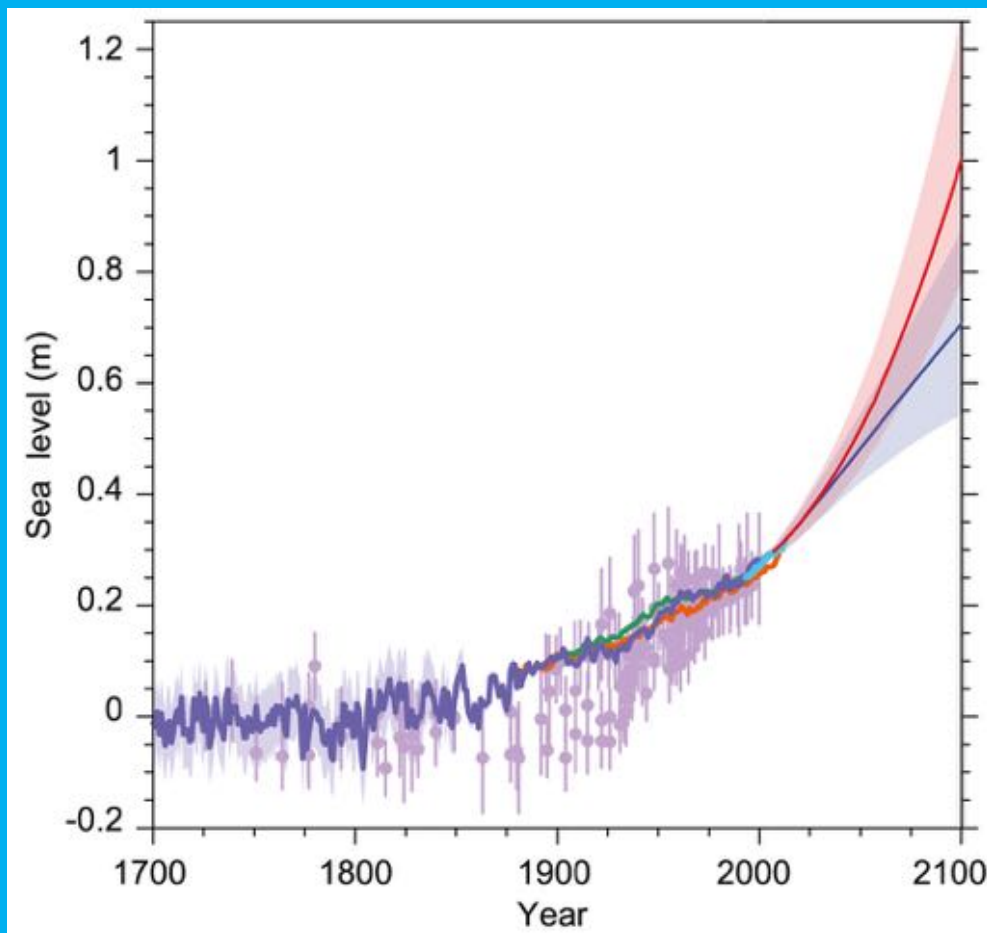


Climate Change and Society

GEOL-G490

Lecture 4: Observations: Ocean

WG1AR5_Chapter03_FINAL



1. Ocean temperature and heat content

2. Ocean salinity

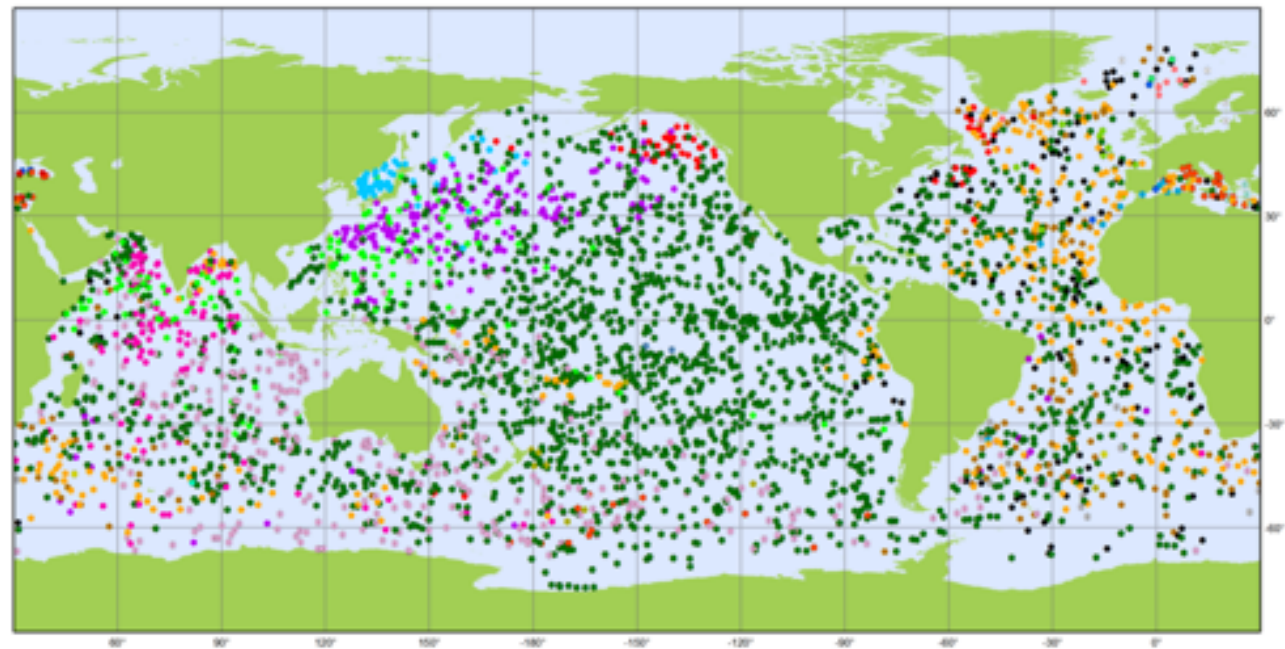
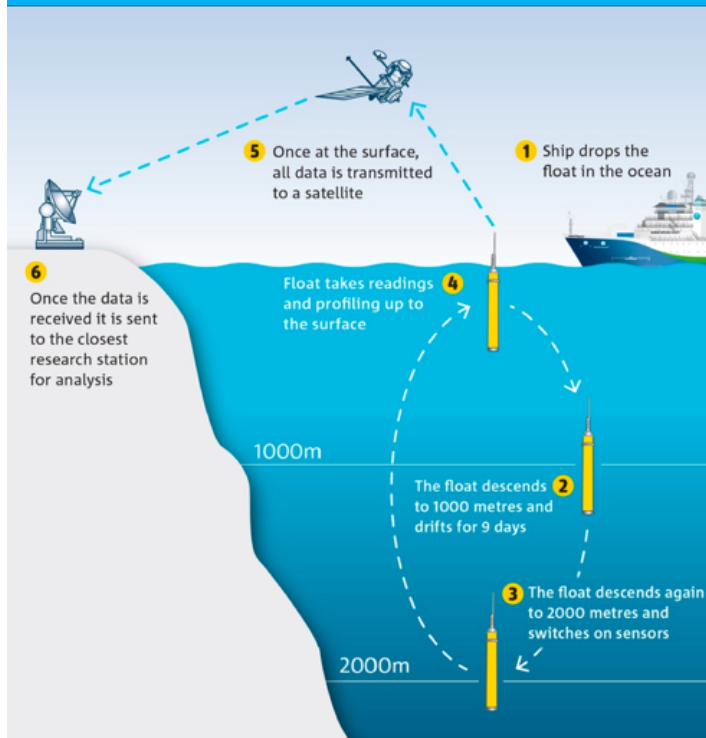
3. Sea level

4. Ocean Biogeochemical Changes

1. Ocean temperature and heat content

Upper ocean temperature

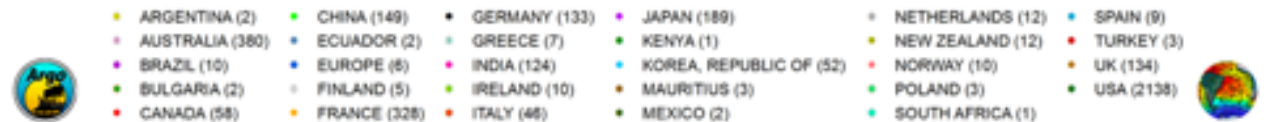
Argo



Argo

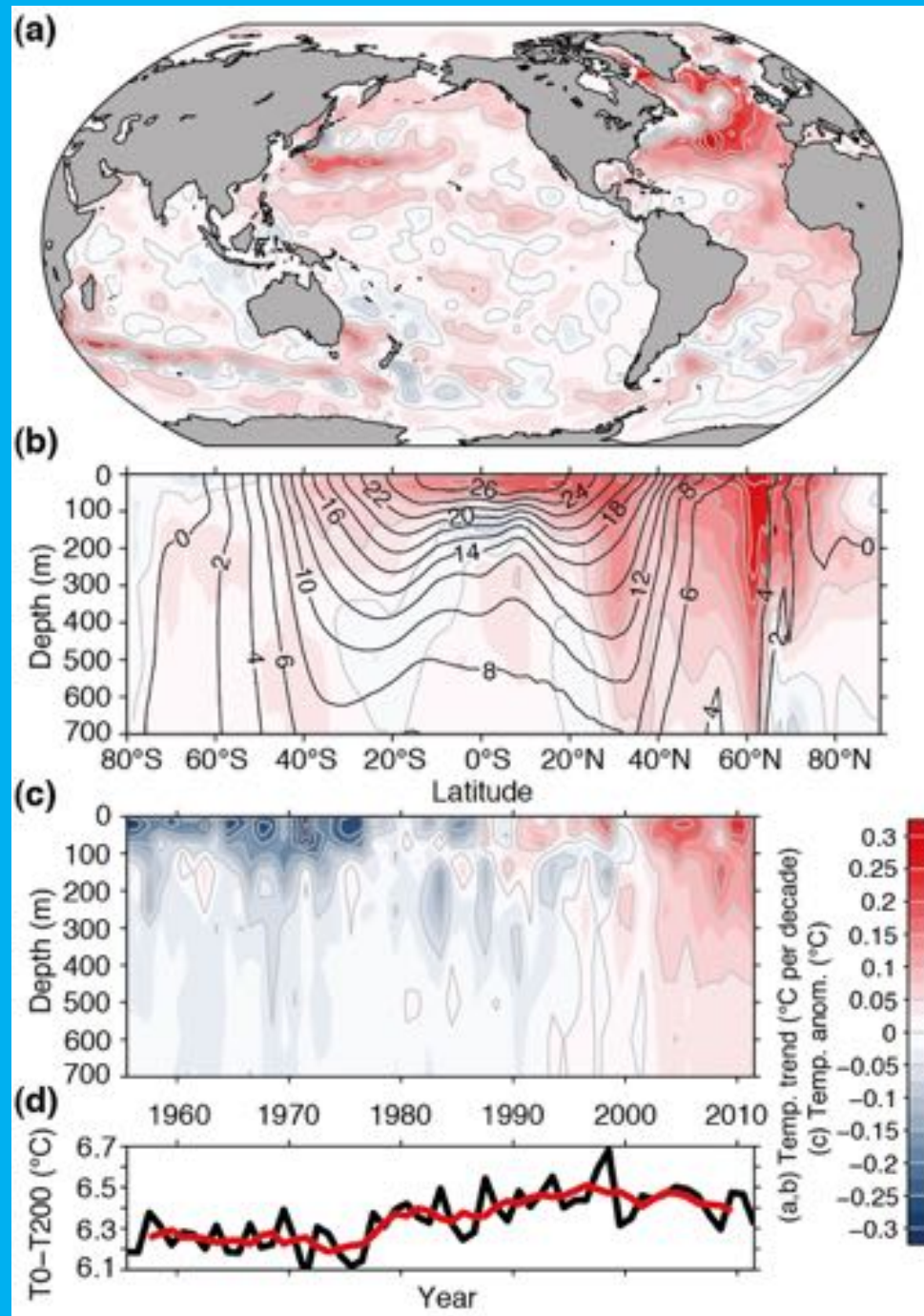
National contributions - 3829 Operational Floats
Latest location of operational floats (data distributed within the last 30 days)

April 2016



Generated by www.jcommaps.org, 08/05/2016

1. Ocean temperature and heat content Upper ocean temperature



1971-2010

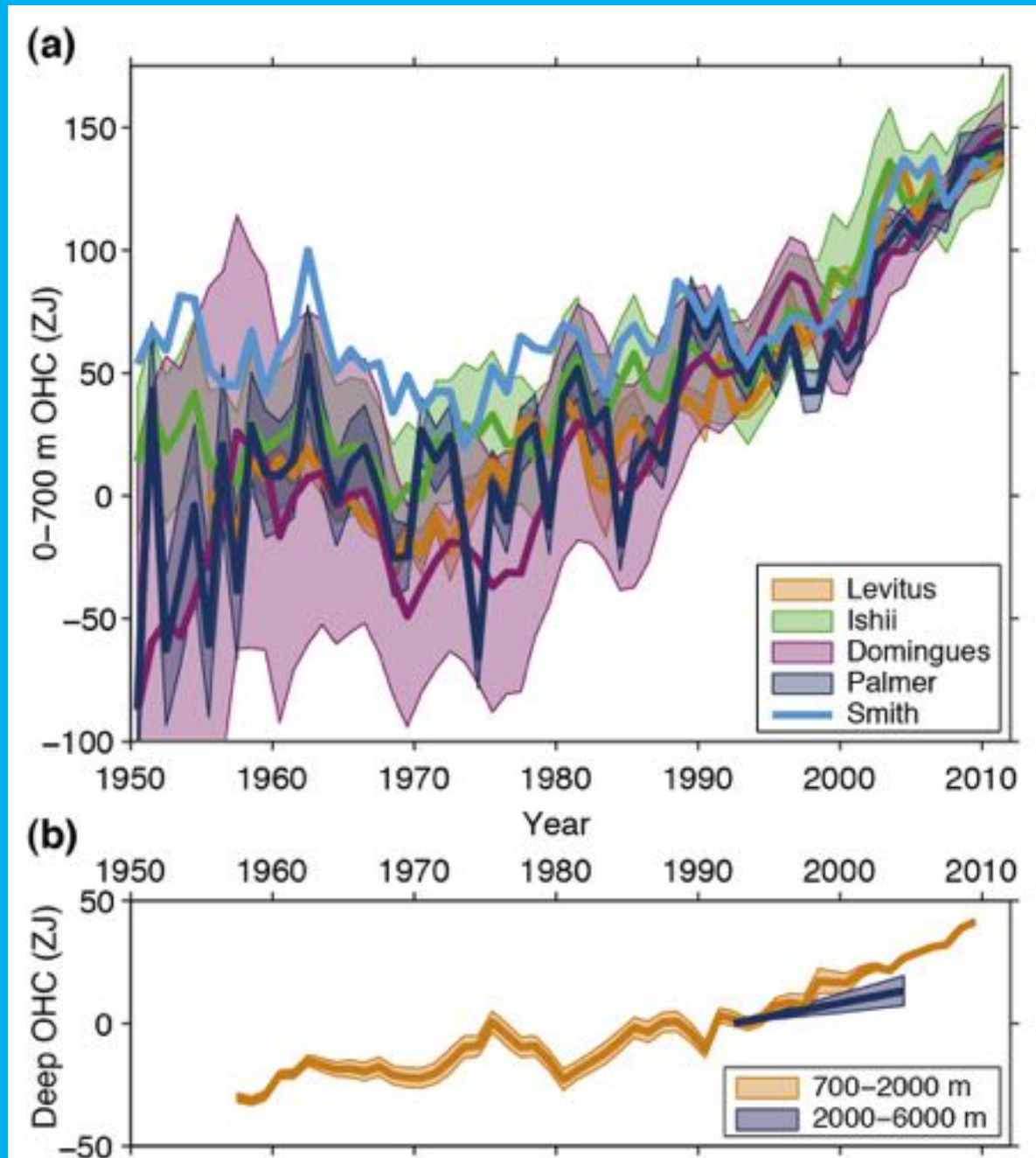
1971-2010

1971-2010
(reference
period)

Fig. 3. 1

1. Ocean temperature and heat content

Upper ocean heat content

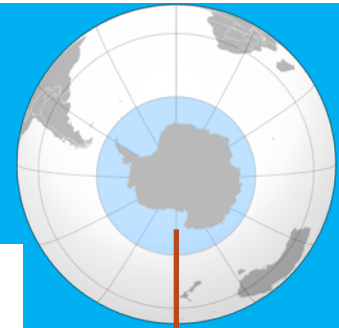
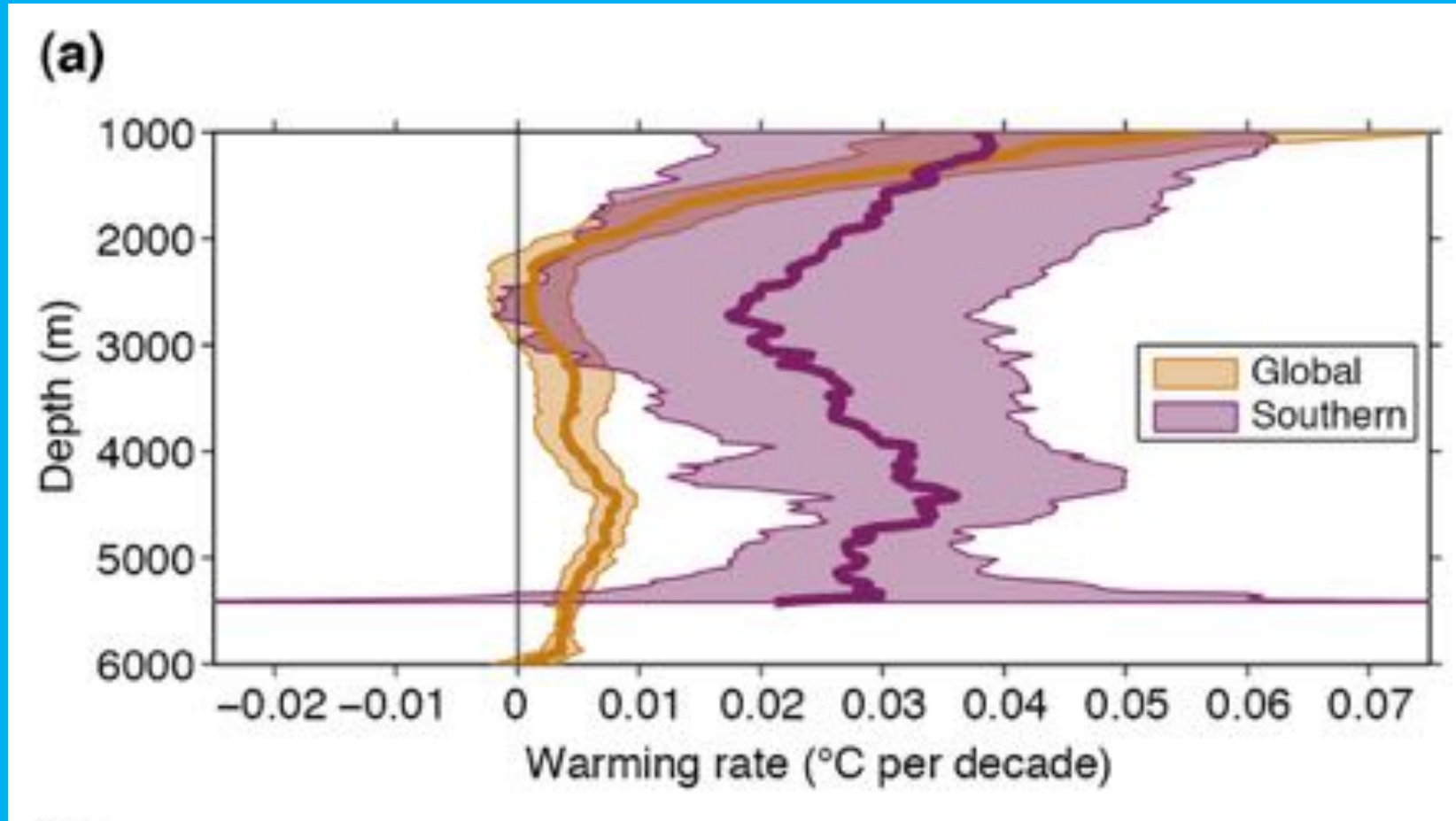


1971

Fig. 3. 2

1. Ocean temperature and heat content

Deep ocean temperature



Southern
Ocean

1992-2005

Fig. 3. 3

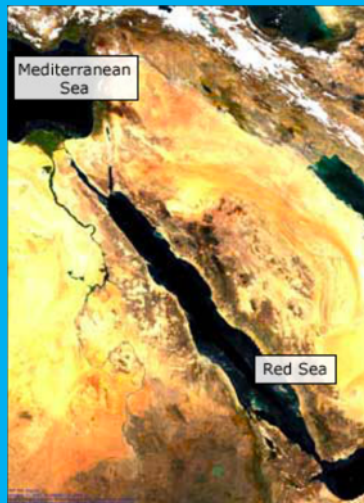
2. Ocean salinity

Salinity

the concentration of dissolved salts in water etc., usually expressed in parts per thousand by weight (ppt) **35 ppt**

Practical Salinity Scale 1978 (PSS78)

PSS-78 is based on an equation relating salinity to the ratio of the electrical conductivity of seawater at 15°C to that of a standard potassium chloride solution (KCl).



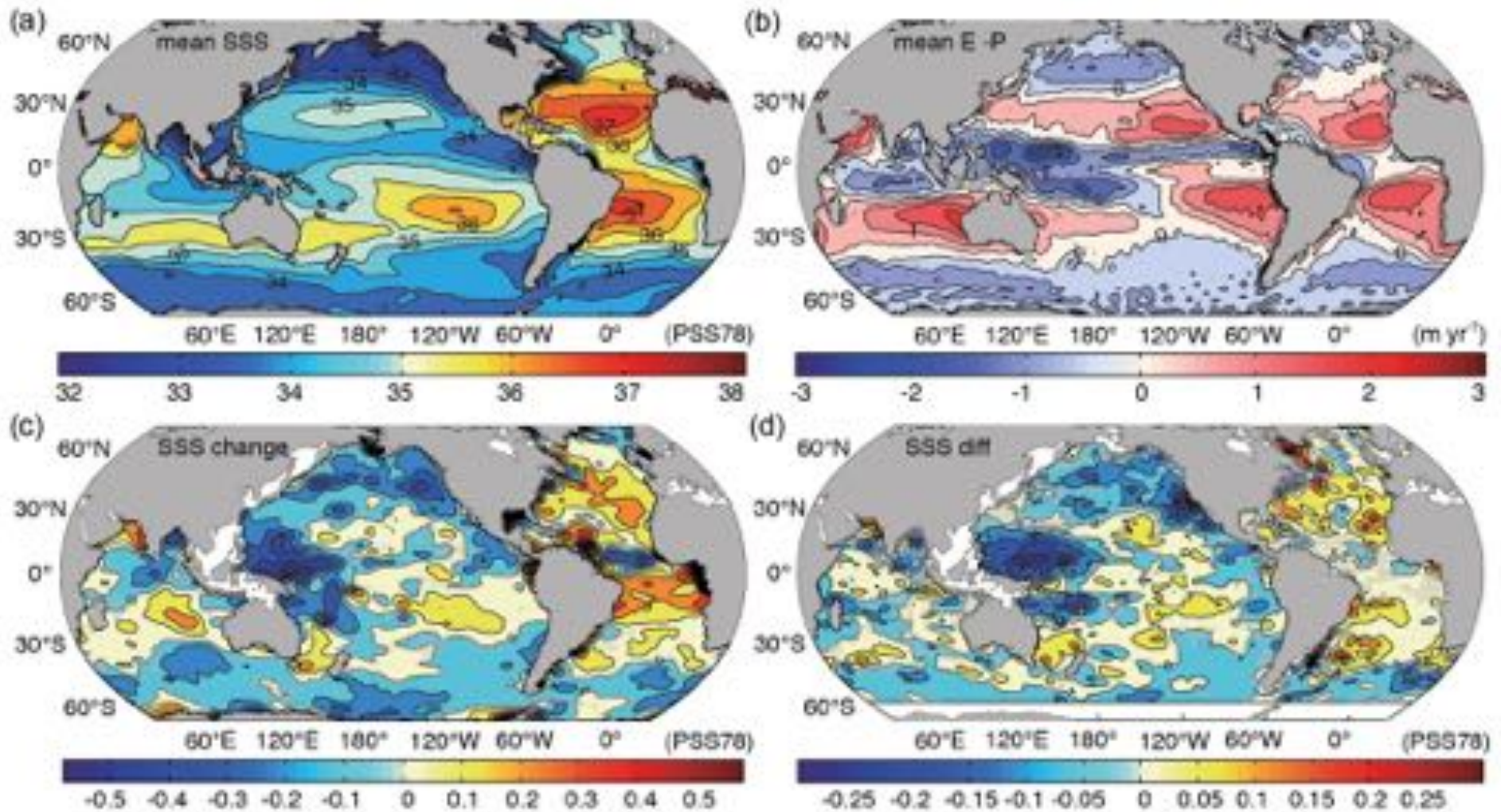
40 PSS

2. Ocean salinity

Sea Surface salinity

1955-2005

1950-2000



2008 minus 1950

(2003-2007) minus (1960-1989)

Contrast increased by 0.13 PSS78

Fig. 3. 4

3. Sea level

Measurement history

1700, Intermittent records of sea level at four sites in northern Europe

Late 1800, More tide gauges in northern Europe, North American coasts,
Australia and New Zealand

Early 1900, Tide gauges began to be placed on islands far from continental coasts

1970s, Tide gauges in deep-ocean islands

Satellite radar altimeters for global observations

For gauge measurements: Ocean volume change and vertical land motion (VLM)

Glacial isostatic adjustment (GSA) is the ongoing movement of land once burdened by ice-age glaciers.

Tectonic activity

Groundwater mining induced land subsidence

For satellite measurements: no need to account for VLM

3. Sea level

Reference Period
1900-1905

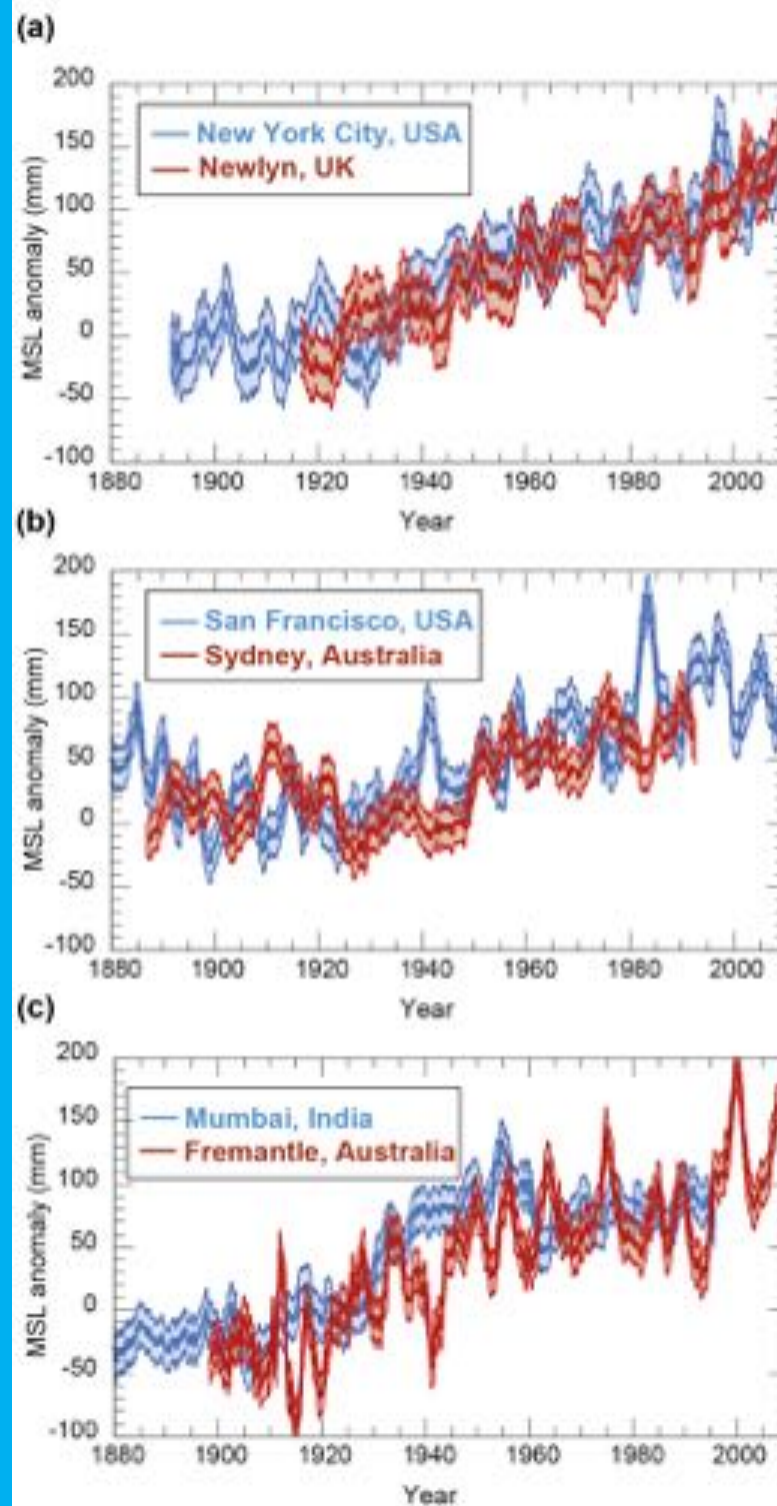
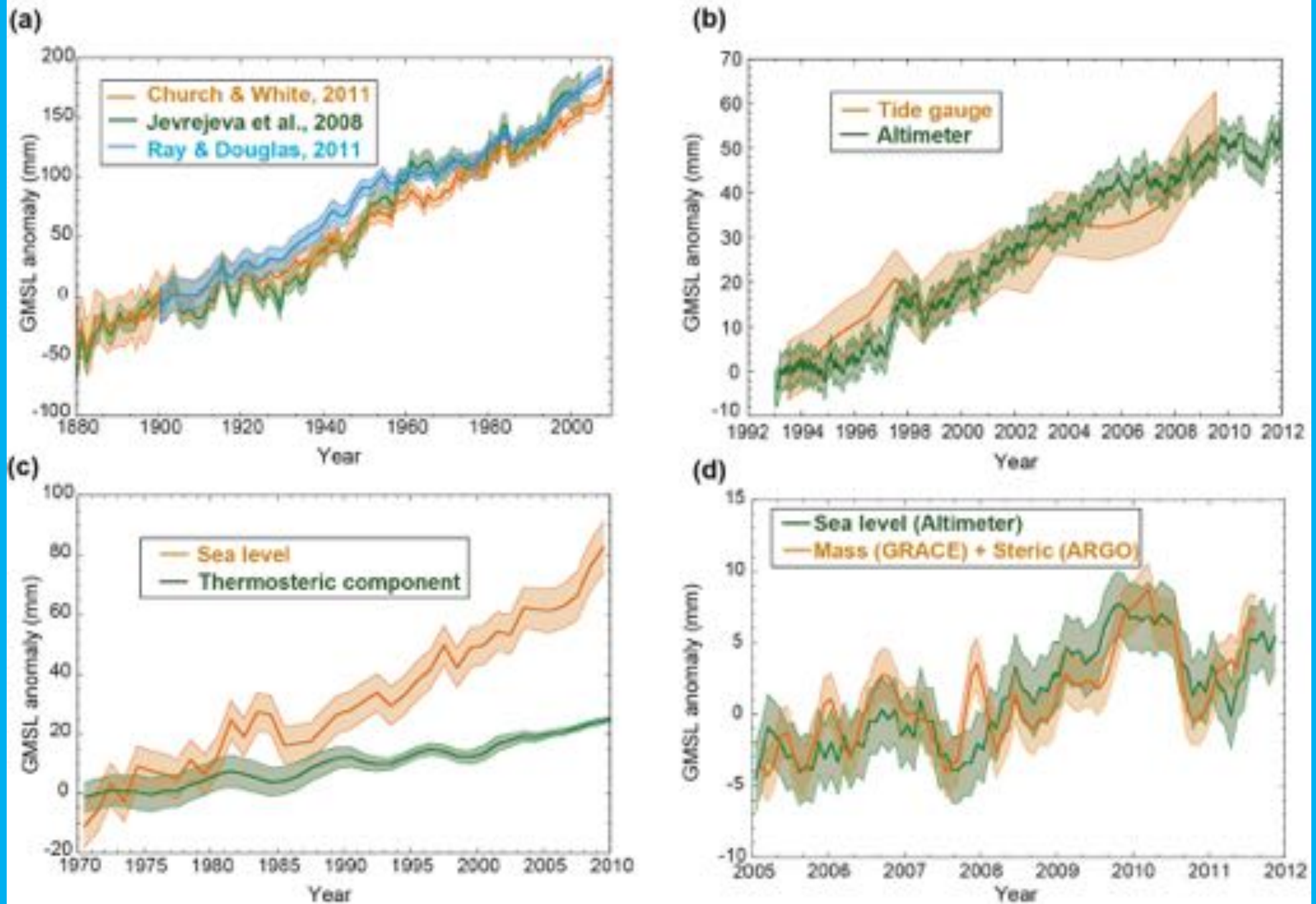


Fig. 3. 13

3. Sea level

Fig. 3. 14



3. Sea level

It is *virtually certain* that globally averaged sea level has risen over the 20th century, with a *very likely* mean rate between 1900 and 2010 of 1.7 [1.5 to 1.9] mm yr⁻¹ and 3.2 [2.8 and 3.6] mm yr⁻¹ between 1993 and 2010.

Warming of the upper 700 m of the ocean has *very likely* contributed an average of 0.6 [0.4 to 0.8] mm yr⁻¹ of sea level change since 1971.

It is *very likely* that the rate of mean sea level rise along Northern European coastlines has accelerated since the early 1800s.

It is *likely* that sea level rise throughout the NH has also accelerated since 1850, as this is also observed in a smaller number of gauges along the coast of North America

4. Ocean Biogeochemical Changes

Ocean uptake of carbon

$p\text{CO}_2$

$\Delta p\text{CO}_2$

C_{ant}

Global uptake rate 1.0 - 3.2 PgC yr⁻¹

4. Ocean Biogeochemical Changes

Ocean uptake of carbon

2010 C_{ant} inventories

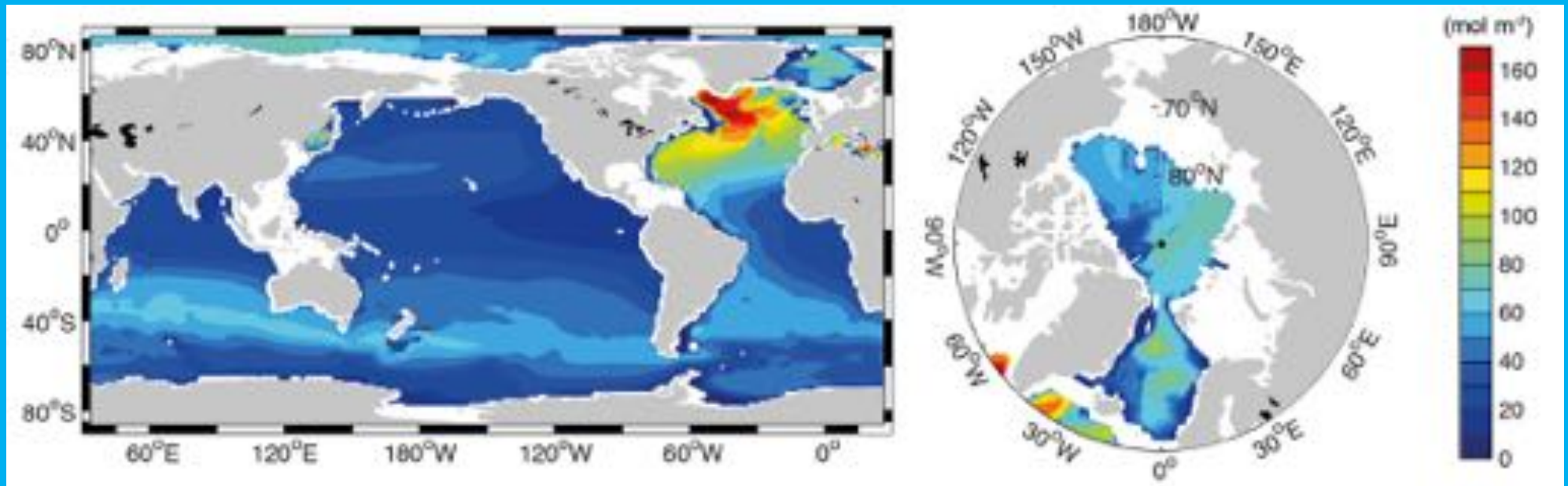
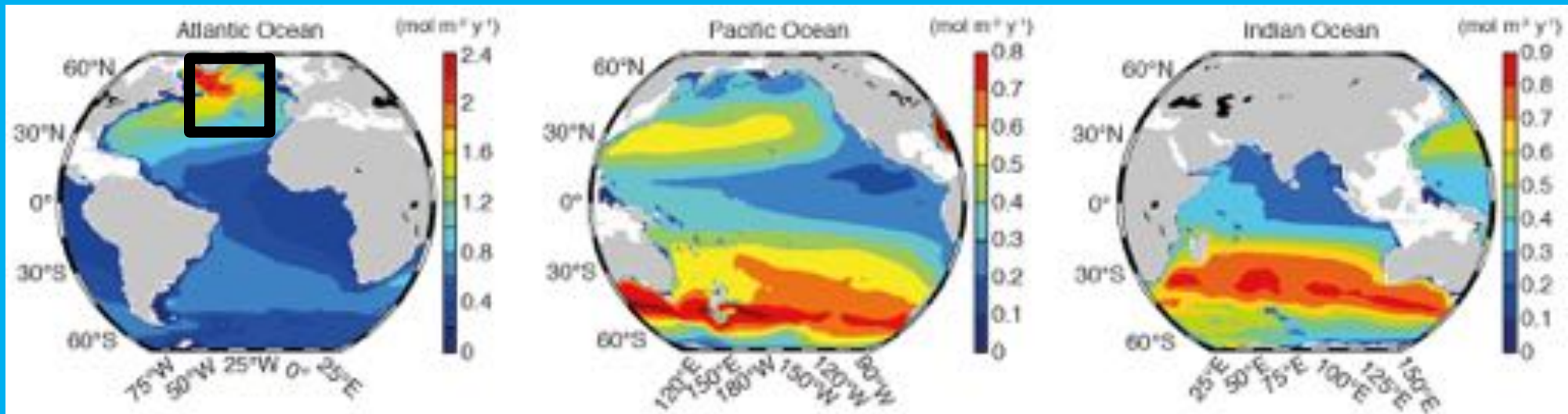


Fig. 3. 16

4. Ocean Biogeochemical Changes

Ocean uptake of carbon

Fig. 3. 17



How much carbon stored in the “squared” area per year?

Assume the area approximately covers 30 to 60 N, 50 to 10 W, and 1 degree is approximately equal to 100 km, let's use $1.6 \text{ mol m}^{-2} \text{yr}^{-1}$

$$30 \times 100 \times 40 \times 100 \times 10^6 \times 1.6 \times 44 = 0.84 \times 10^{15} \text{ g per year} = 0.84 \text{ Pg per year}$$

8.4 Pg of carbon is emitted in 2009

4. Ocean Biogeochemical Changes

Anthropogenic Ocean acidification

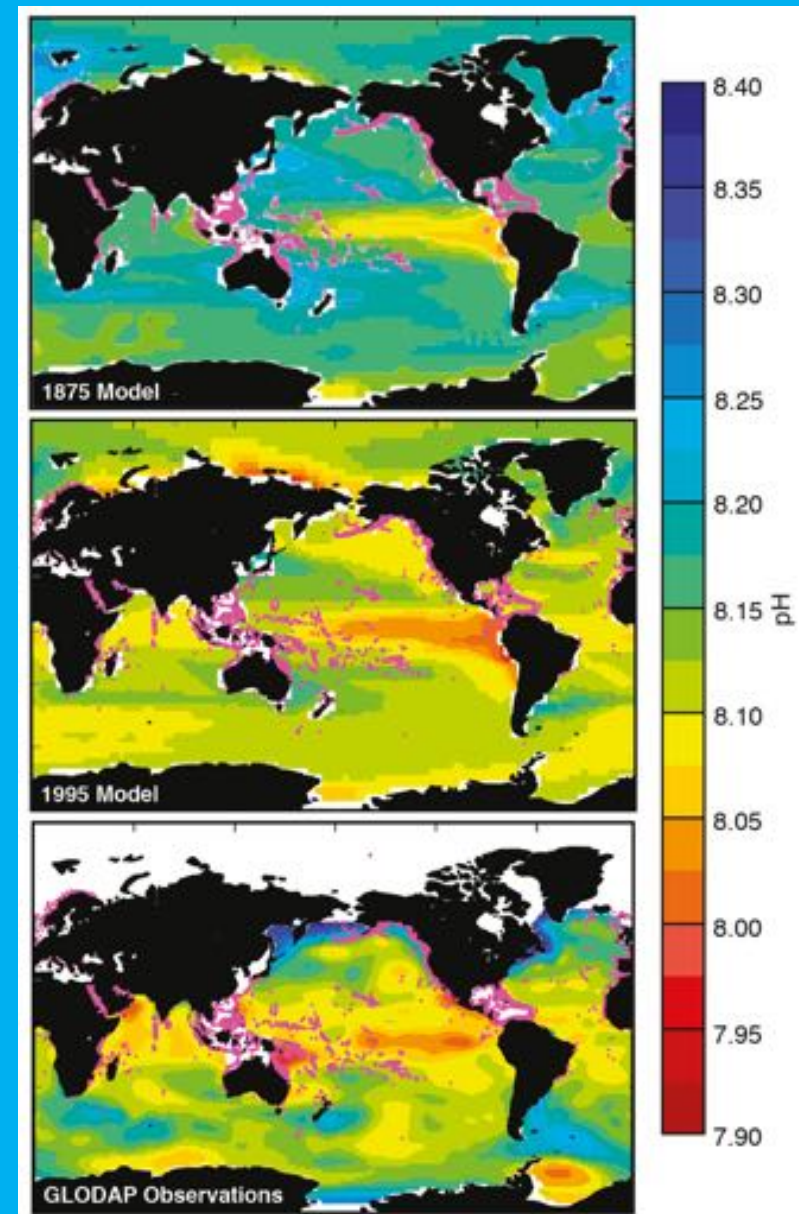
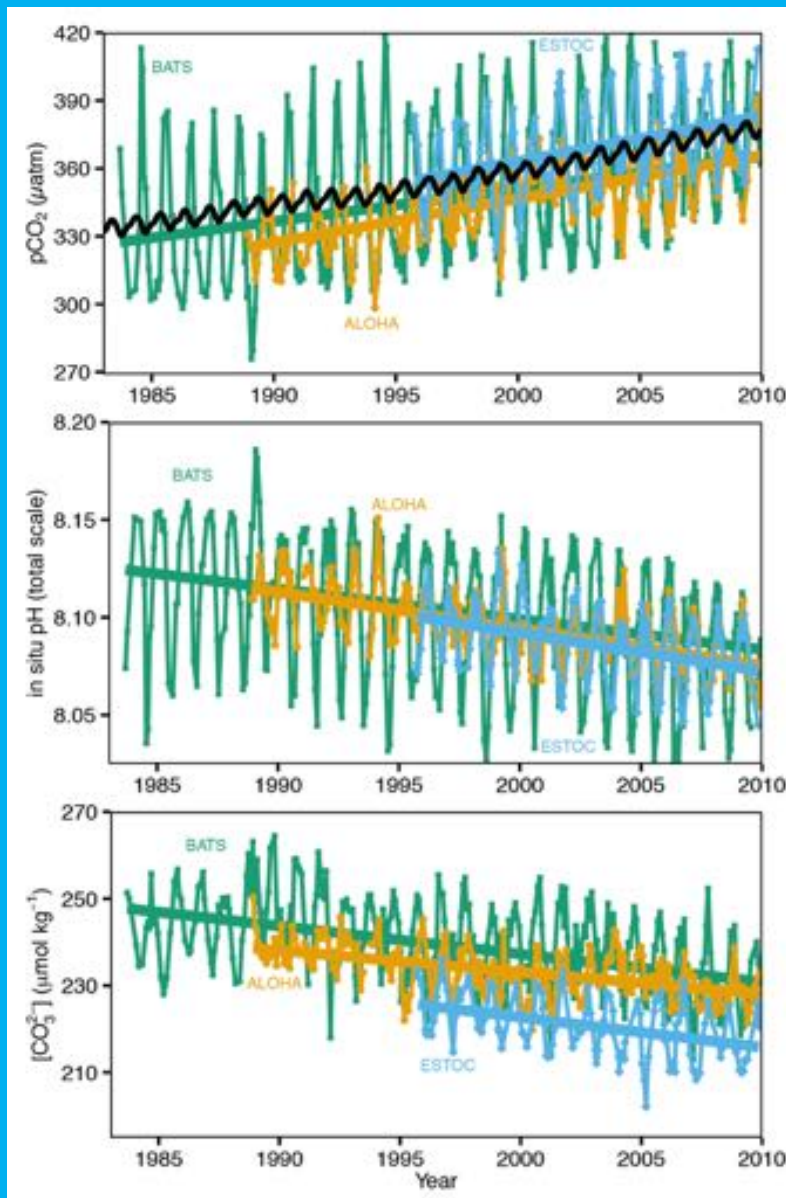


Fig. 3. 18 pH decreased 0.1 since industrial era

Box 3.2 Fig. 1

4. Ocean Biogeochemical Changes

Solubility effect
Stratification effect

Dissolved oxygen

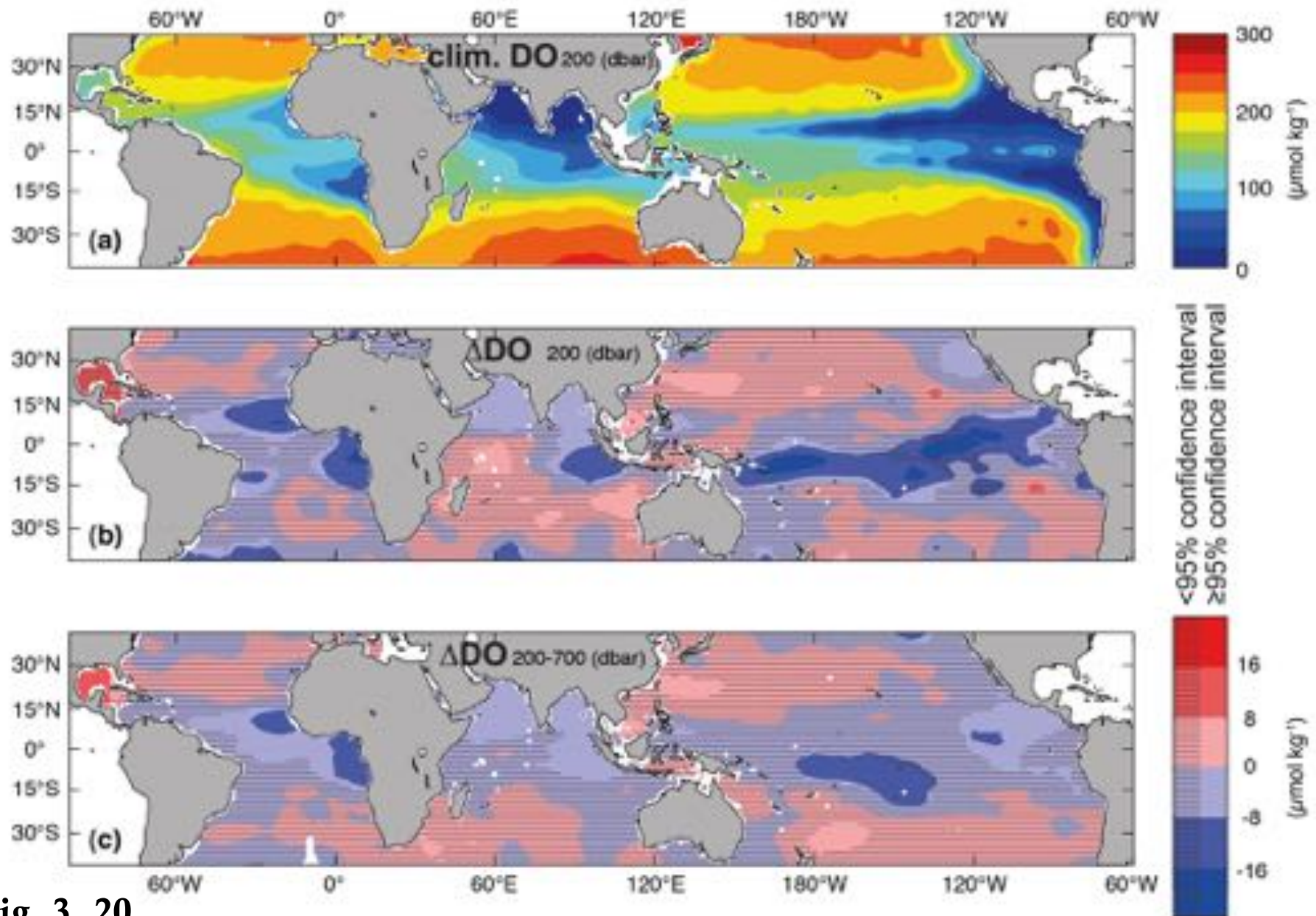


Fig. 3. 20

4. Ocean Biogeochemical Changes

Synthesis

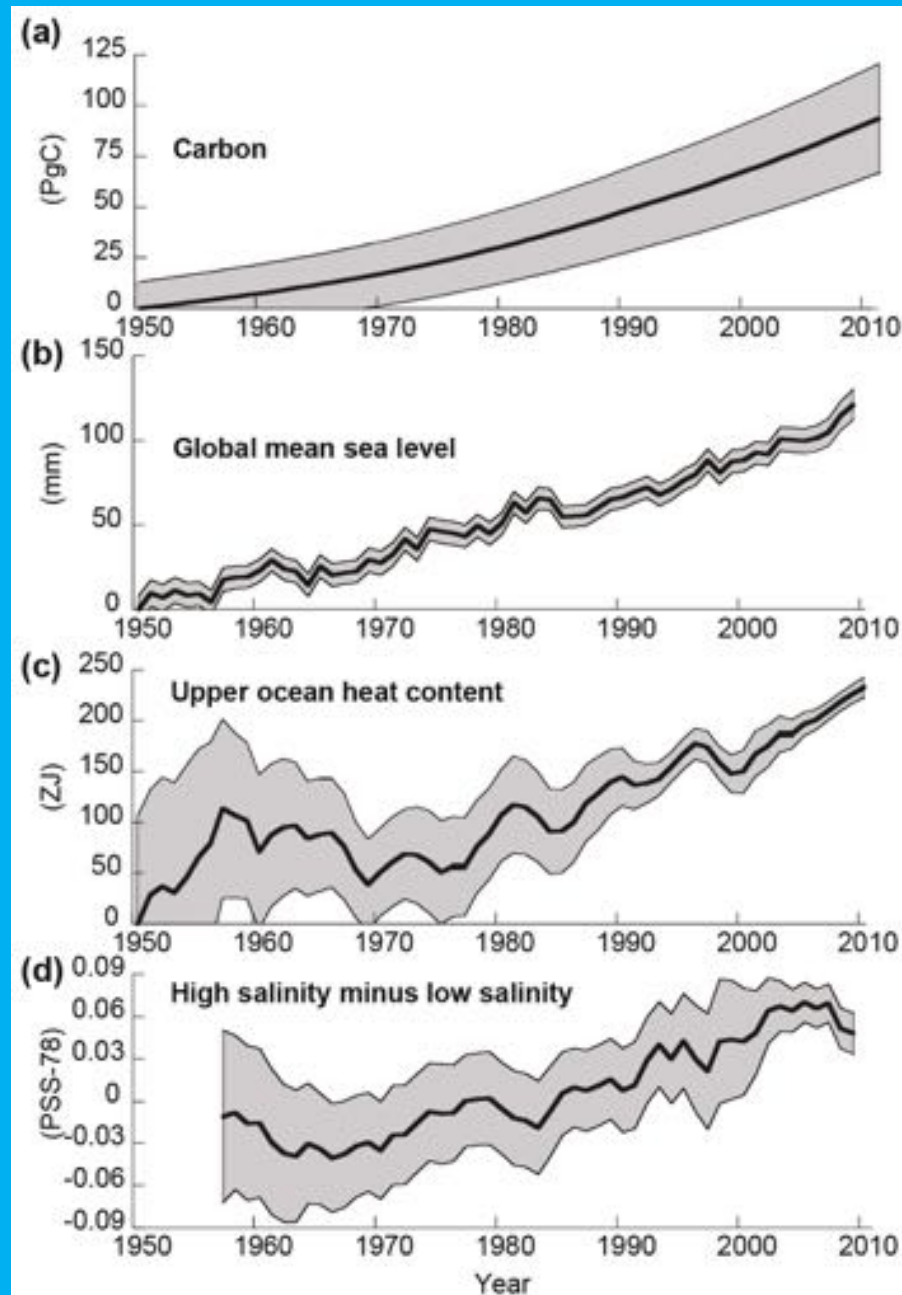


Fig. 3. 21

4. Ocean Biogeochemical Changes

Synthesis

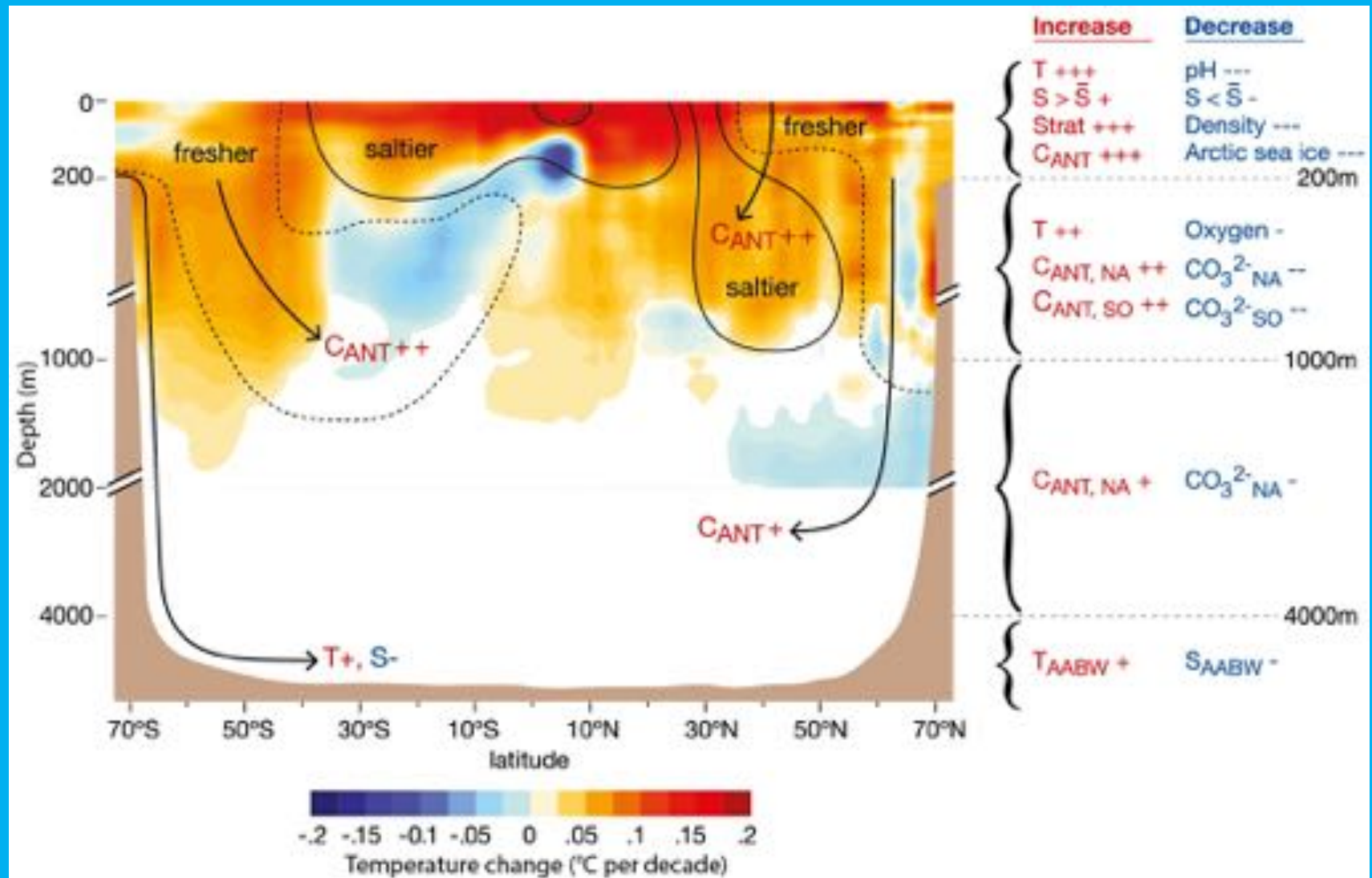


Fig. 3. 22

Reading Assignment

WG1AR5_Chapter03_FINAL

