UNDERWATER COLORIMETRY

COLORS IN THE OCEAN

Dr. Derya Akkaynak | dakkaynak@univ.haifa.ac.il

LAB: Basic Colorimetry
POSTMORTEM

- ~~Read the instructions to save yourself time!~~
- Well done! You finished before sunset!
- Most problems I witnessed were about setting the paths of files/folders.
- What went well for you?
- What could have been better?

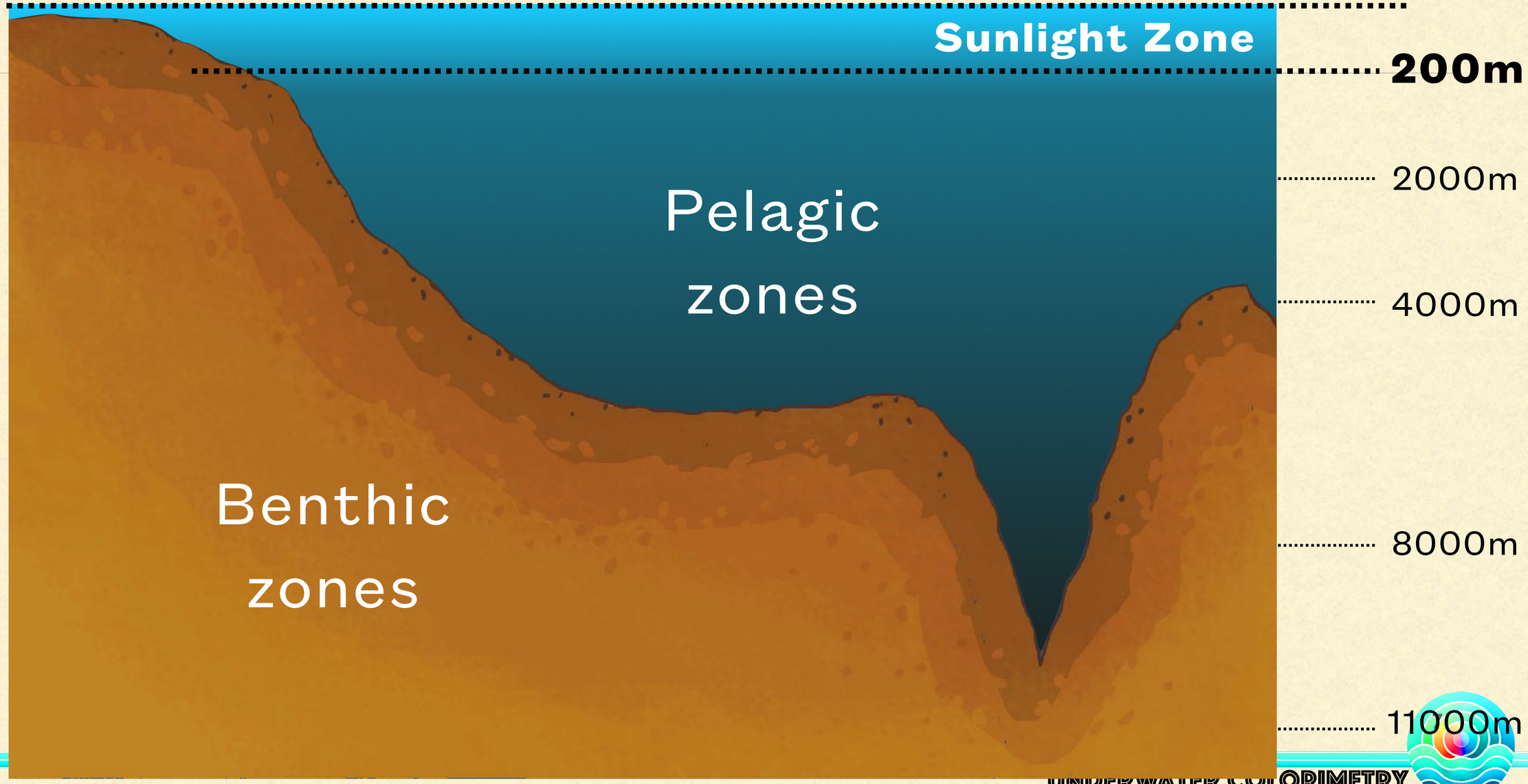
What Will I Learn in This Lecture?

- Does the color of the ocean mean anything?
- Physics of light propagation in the ocean:
  - Absorption
  - Scattering
  - Attenuation
  - Path radiance
  - Backscatter
- Image formation in a scattering medium

Why Are There Colors in the Benthic Ocean ?

The benthic ocean

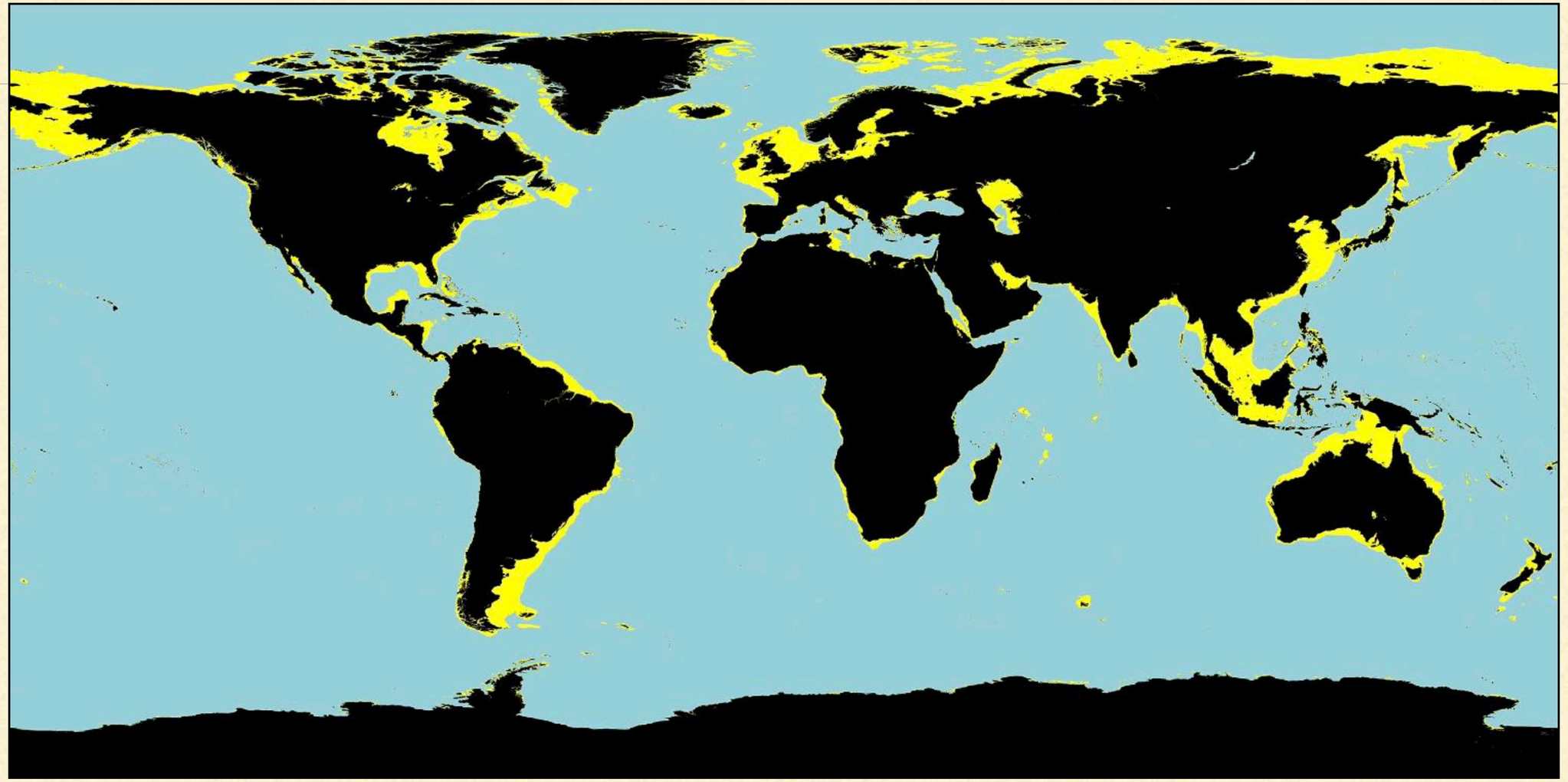
Defies comprehensive exploration



The benthic ocean

Defies comprehensive exploration

GEBCO 2022 grid
https://www.gebco.net/



Shallow benthic ocean

Why Are There Colors?

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Lomáscolo, Silvia B., et al. "Dispersers shape fruit diversity in Ficus (Moraceae)." PNAS (2010)

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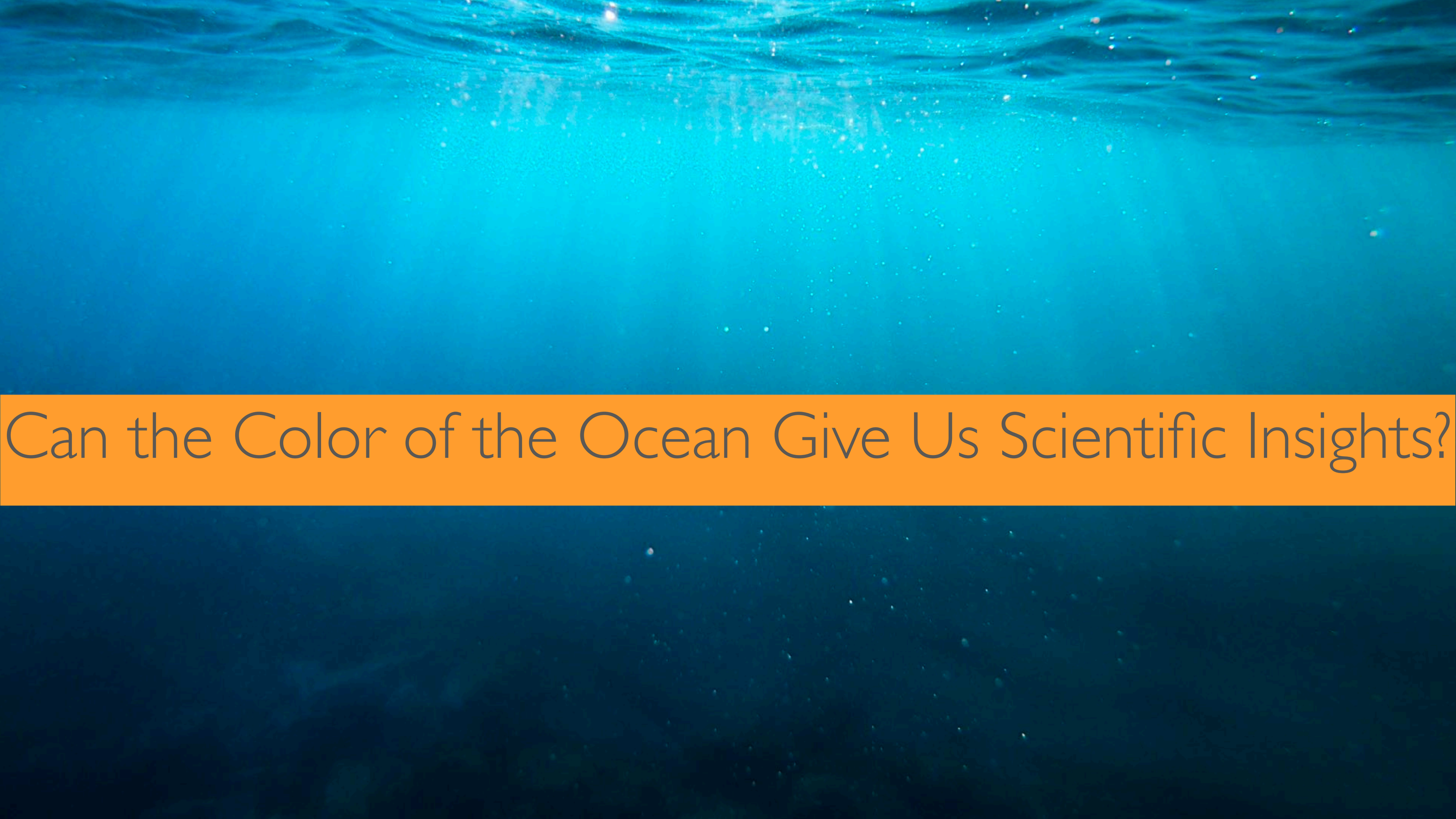
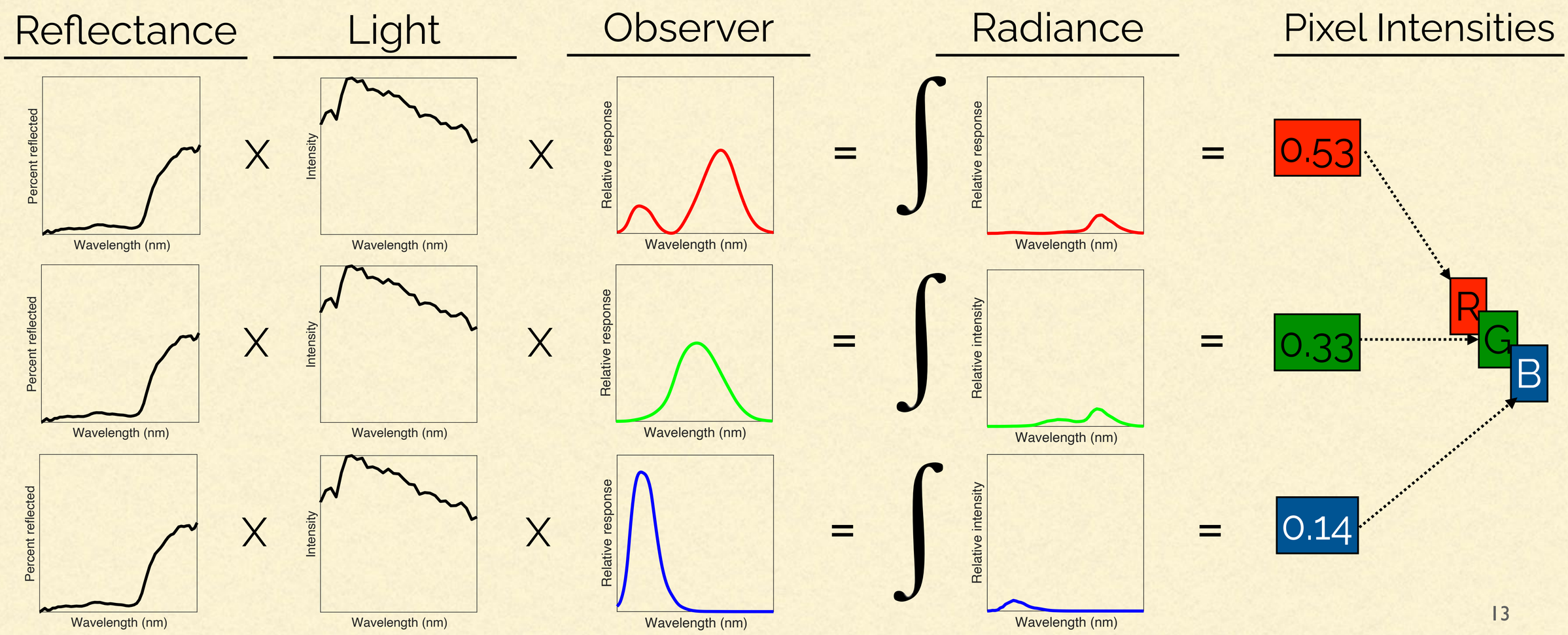


Can the Color of the Ocean Give Us Scientific Insights?

Image Formation

$$Color = \frac{1}{\kappa}\int_{\lambda_1}^{\lambda_2} \rho(\lambda)E(\lambda)S(\lambda)d\lambda$$

κ: exposure-related constant



Can Ocean Color Give Us Scientific Insights?

Photos: Tom Shlesinger & Solomon David

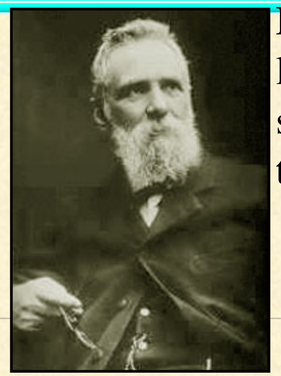
UNDERWATER COLORIMETRY

1865 - Secchi Disk

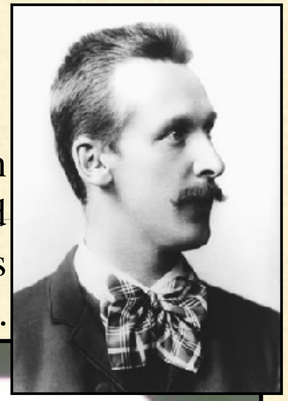
Angelo Secchi (1818–1878), an Italian Jesuit priest, astronomer, and scientist.

COLORIMETRY

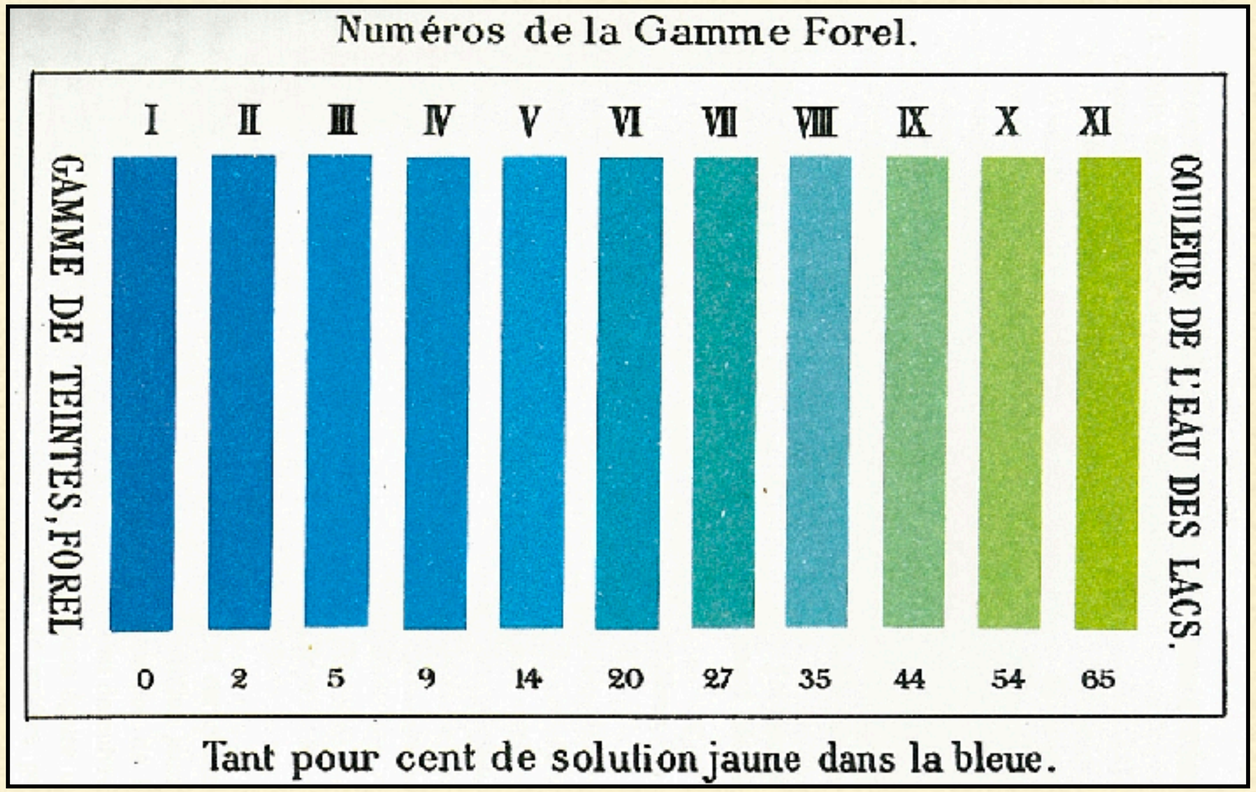
1890s - Forel Ule Scale



François-Alphonse Forel (1841–1912): A Swiss limnologist often regarded as the "father of limnology" (the study of inland waters). He developed the initial concept of the scale for assessing the color of lake water.



Wilhelm Ule (1861–1940): A German limnologist who later refined and expanded Forel's work on the scale, contributing to its application and standardization.



Measuring Water Color and Visibility

https://www.youtube.com/watch?v=xuH_xLTjmOQ

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1960s - Crazy Ideas

What if the color of the ocean tells us something meaningful?

What if we could see the color of the global ocean from space?

1970 - Ocean Color —> Chlorophyll

Science, 20 February 1970

Reports

Spectra of Backscattered Light from the Sea Obtained from Aircraft as a Measure of Chlorophyll Concentration

GEORGE L. CLARKE
GIFFORD C. EWING
CARL J. LORENZEN

Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 20543

1978 - Nimbus 7 Launched

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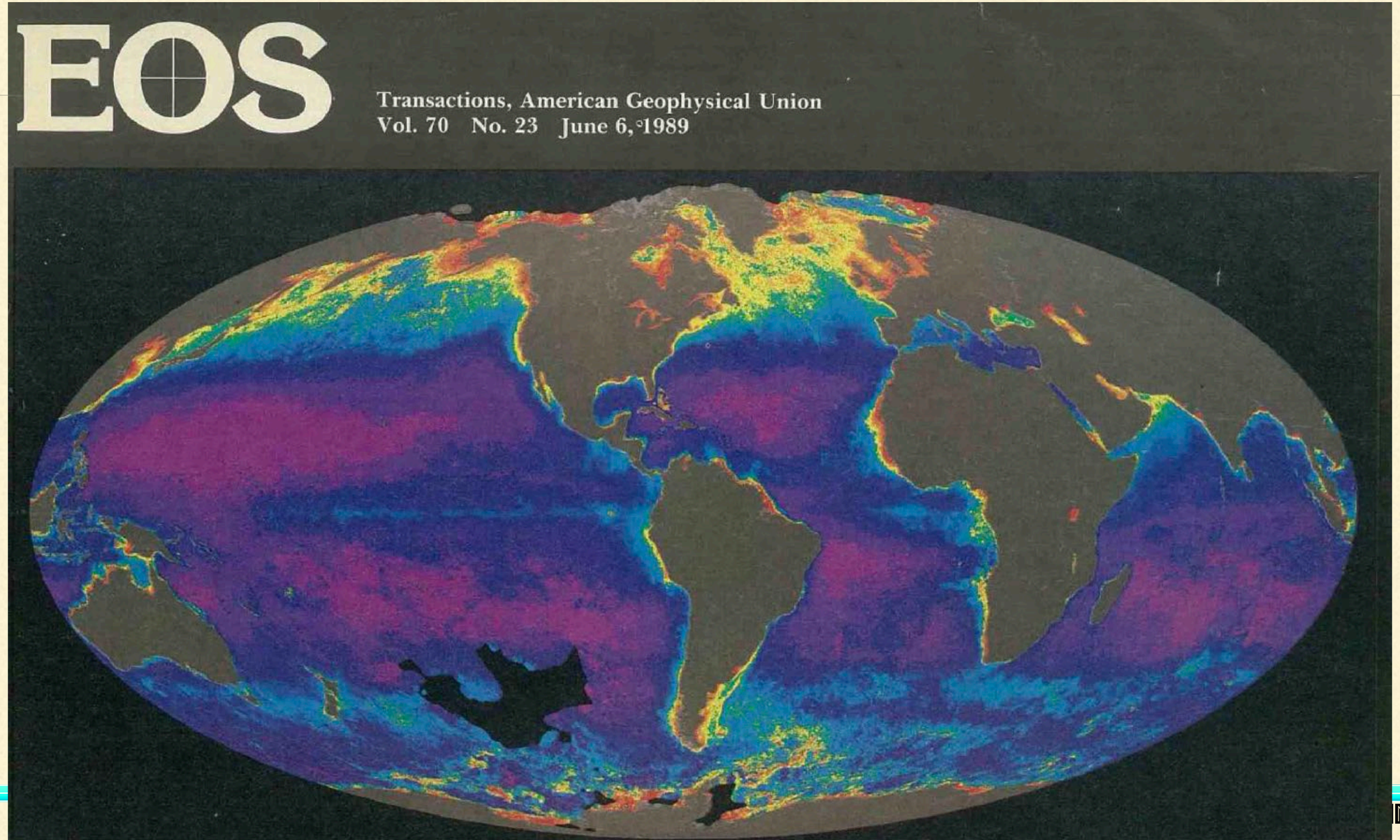
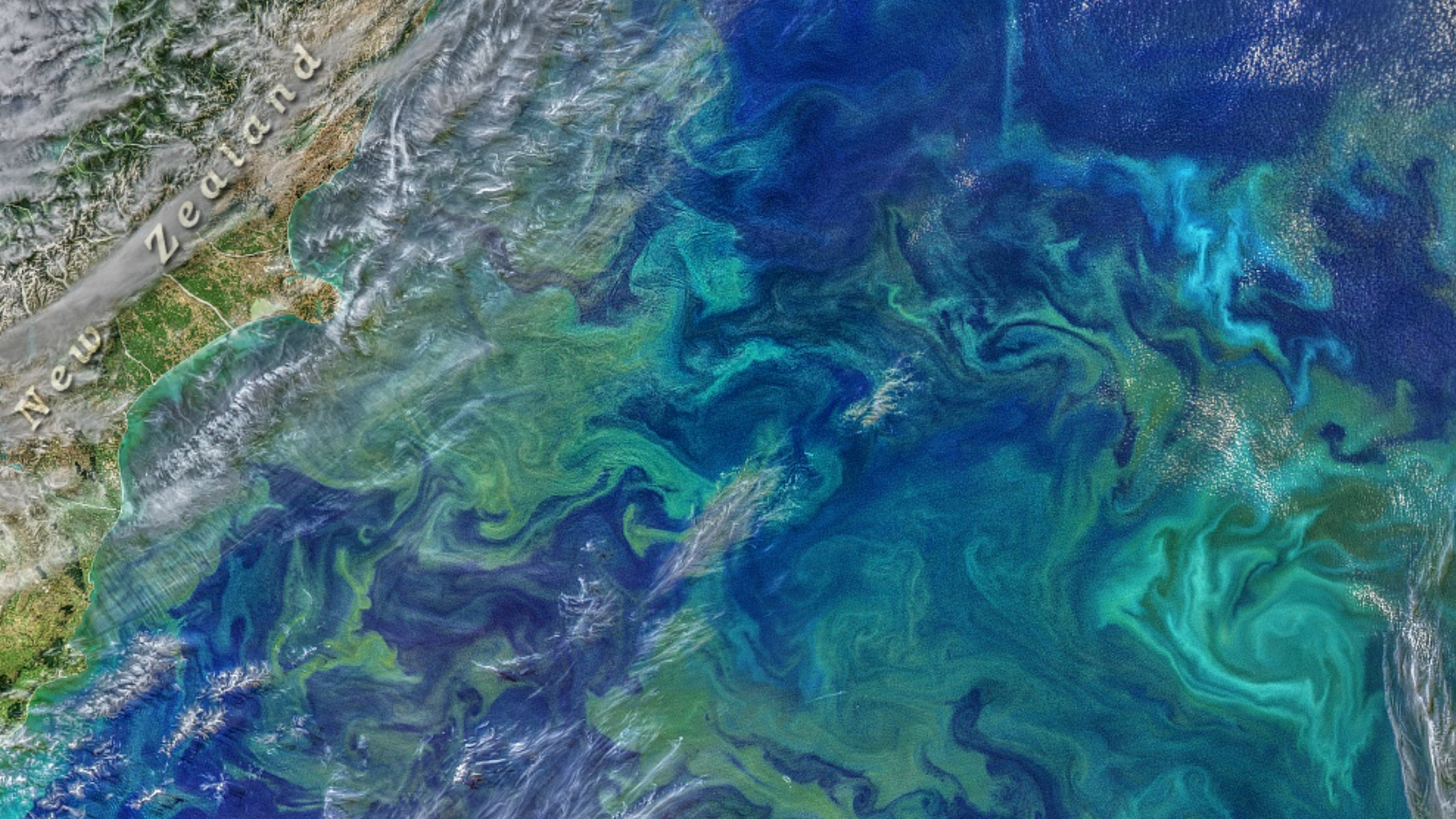
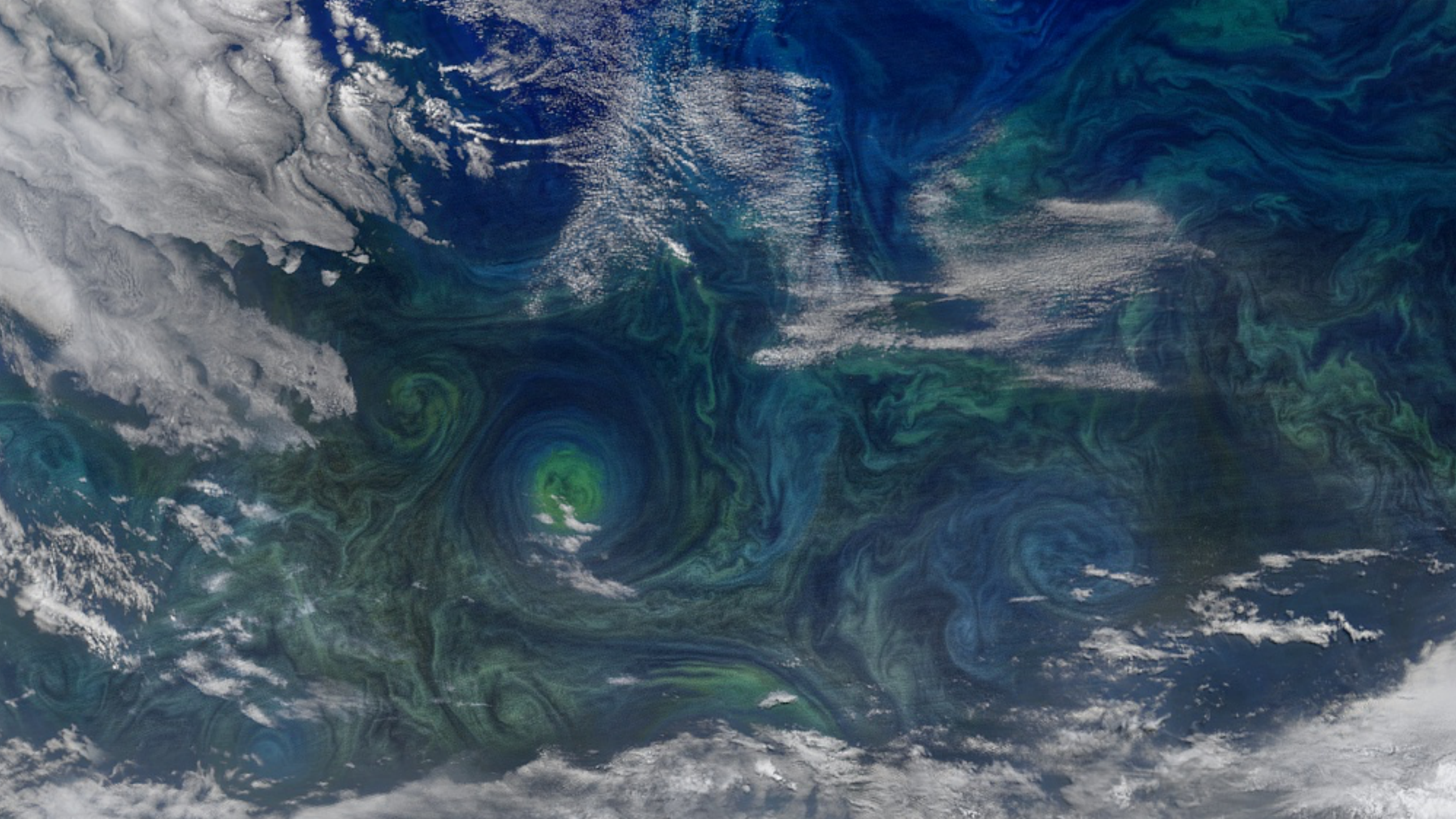
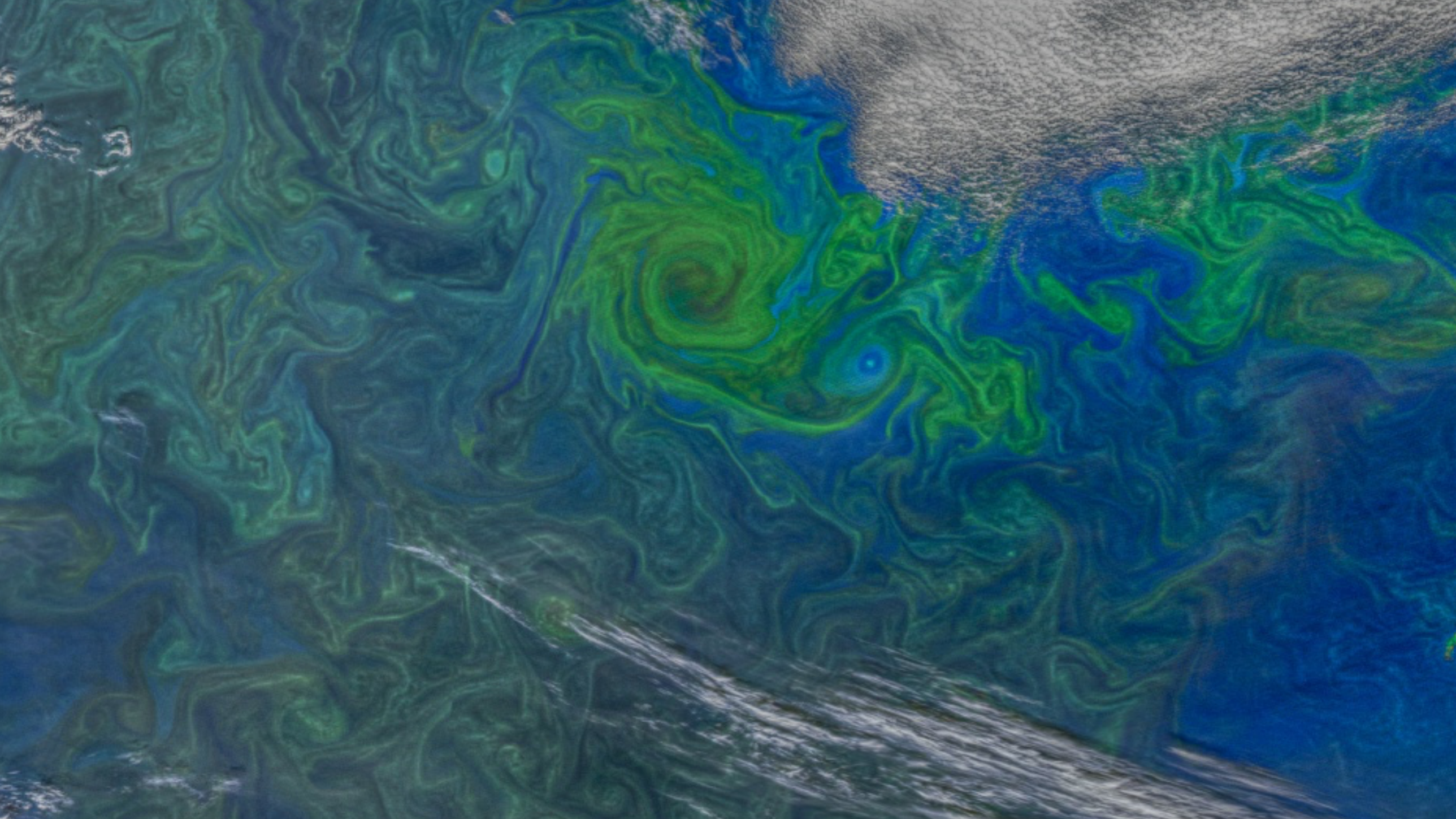
1989 - Ocean Color —> Productivity




New Zealand





Break

- Thank you for not using your cell phones during the lectures.
- Phantom vibration syndrome: the perception that one's mobile phone is vibrating or ringing when it is not.

Nearly 90 percent of college undergrads in a 2012 study said they felt phantom vibrations. The number was just as high for a survey of hospital workers, who reported feeling phantom vibrations on either a weekly or monthly basis.

"Something in your brain is being triggered that's different than what was triggered just a few short years ago," says Dr. Larry Rosen, a research psychologist who studies how technology affects our minds.

"If you'd ask me 10 years ago, or maybe even five years ago if I felt an itch beneath where my pocket of my jeans were, and asked me what I would do, I'd reach down and scratch it because it was probably a little itch caused by the neurons firing," he says.

https://www.npr.org/sections/alltechconsidered/2013/09/30/226820044/phantom-phone-vibrations-so-common-they-ve-changed-our-brains