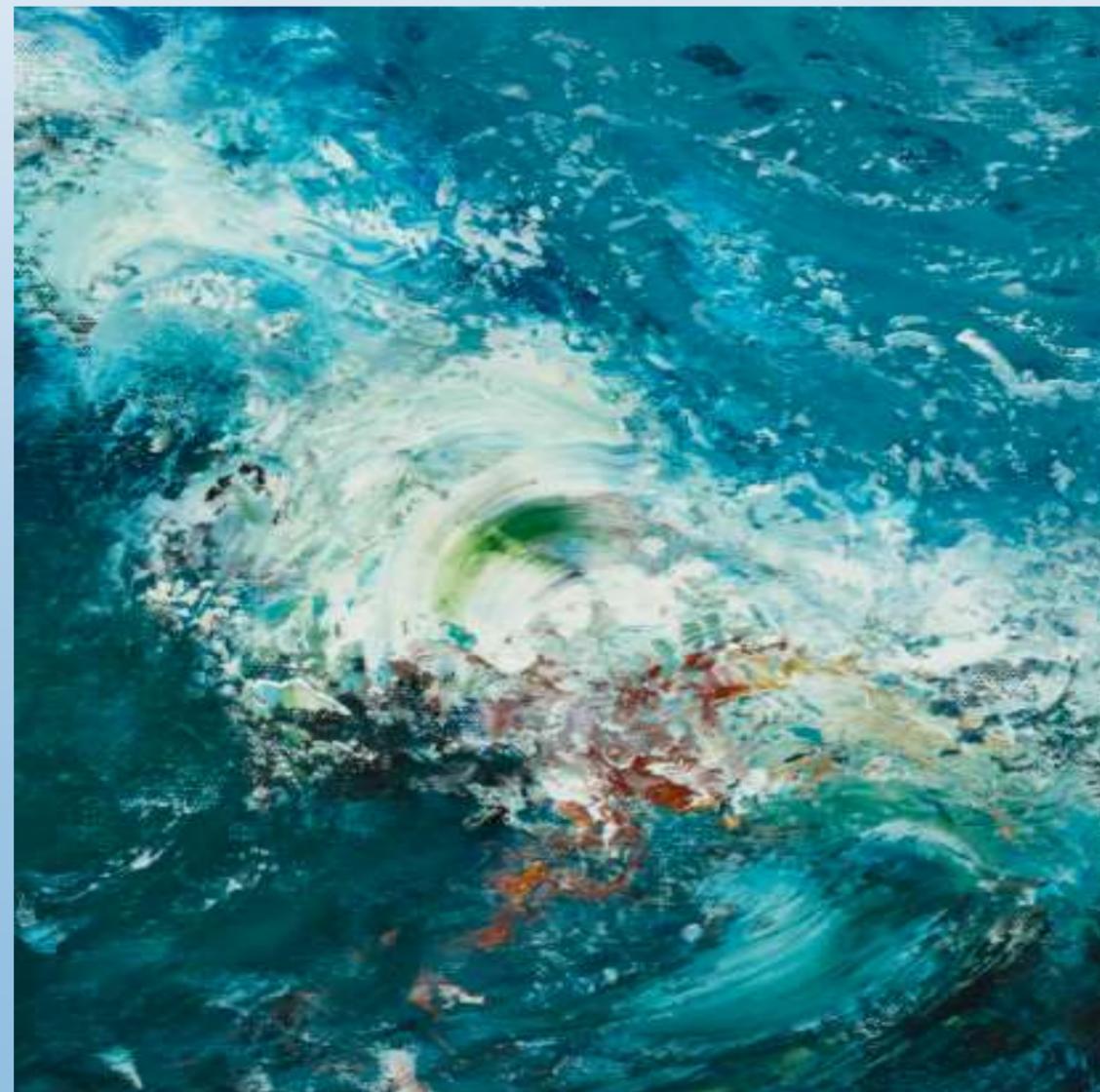


Harvesting Energy from Ocean Circulation Currents

Aliki Koemtzopoulou

Independent Researcher / Environmental Engineer MSc



W Overview of Ocean or Hydro Energy Sources & Technologies

- **Ocean Circulation Currents:** generated by a combination of factors: the rotation of the earth, salinity, density, bathymetry, temperature, wind
- **Waves:** generated by wind passing over the ocean surface
- **Tides** (tidal rise and fall) generated by the gravitational forces of the Earth-Moon-Sun system, predictable, reverse flow
- **Ocean Thermal Energy Conversion: (OTEC)** derived from temperature differences between the sun-warmed surface water and cold water in the deep ocean, generally below 1000m. (closed cycle/ open cycle/ hybrid)



Overview of Ocean or Hydro Energy Sources & Technologies

- **Salinity Gradients:** derived from salinity differences between fresh and ocean water at river mouths (Osmotic potential is being used to generate electricity by Reverse Electro Dialysis (RED) or Pressure Retarded Osmosis (PRO))
- **Sea-Water Air Conditioning (SWAC)** pumped seawater is used to cool or heat nearby urban areas

Hydrokinetic Energy: Riverine, Conventional (impoundment) hydro plants, Run-of-river (diversion), Pumped Hydro Storage Plants

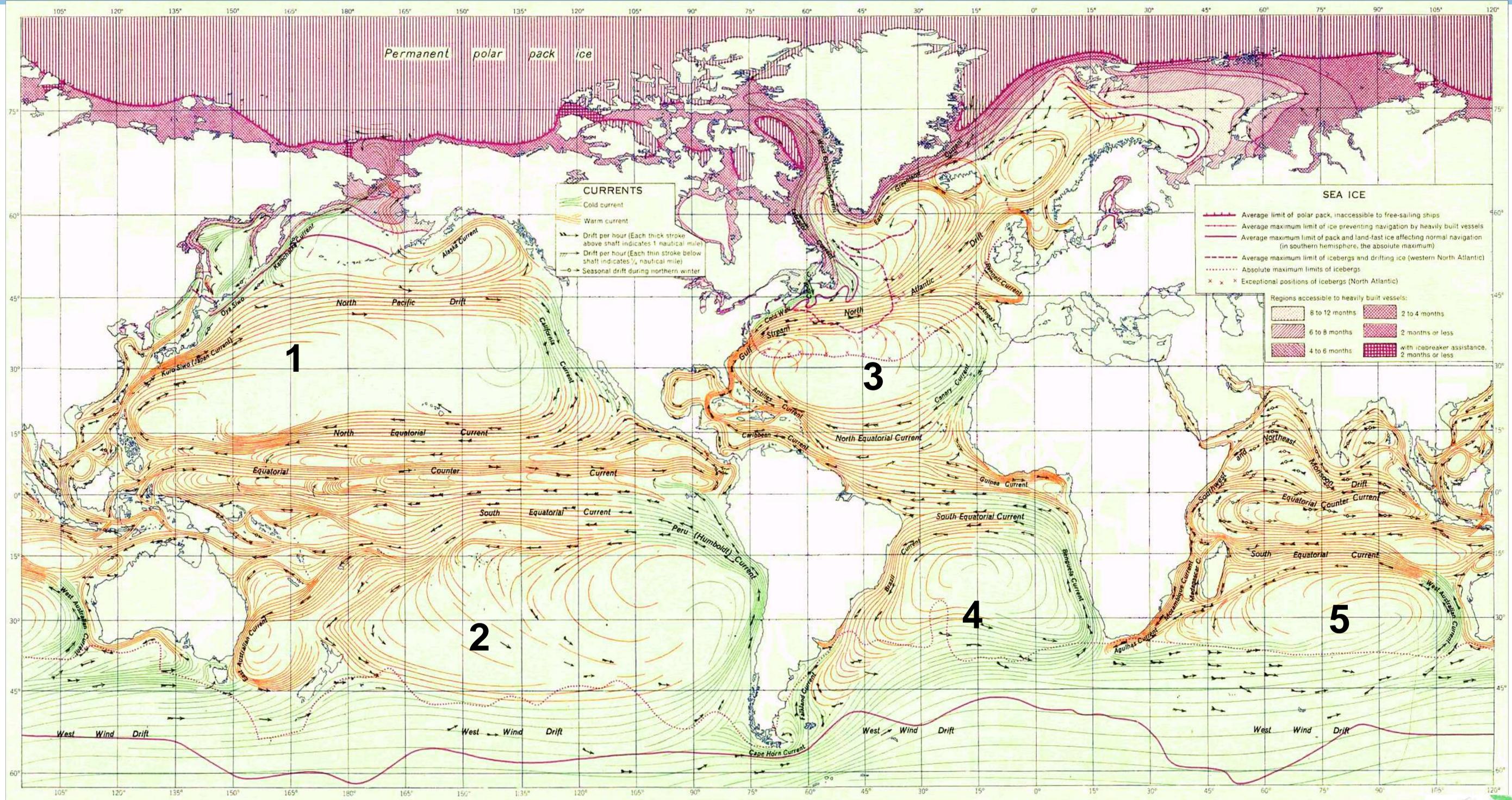
Other ocean-related energy sources (yet not directly utilising seawater properties):

- Off-shore Wind Farms, Marine Biomass, Submarine Geothermal



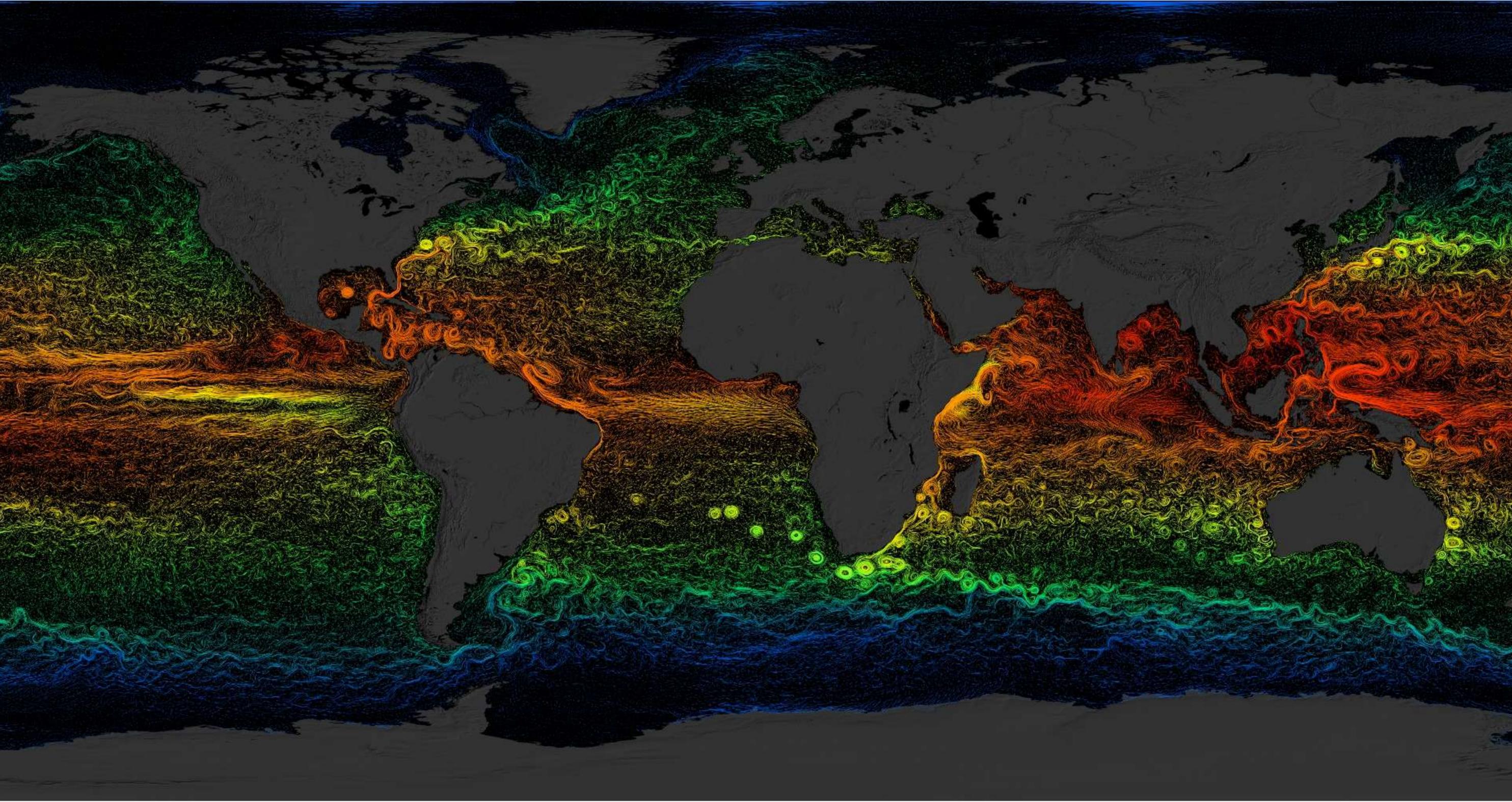
The Five Oceanic Gyres

A gyre is a large system of rotating ocean currents.



NASA Visualisation Currents

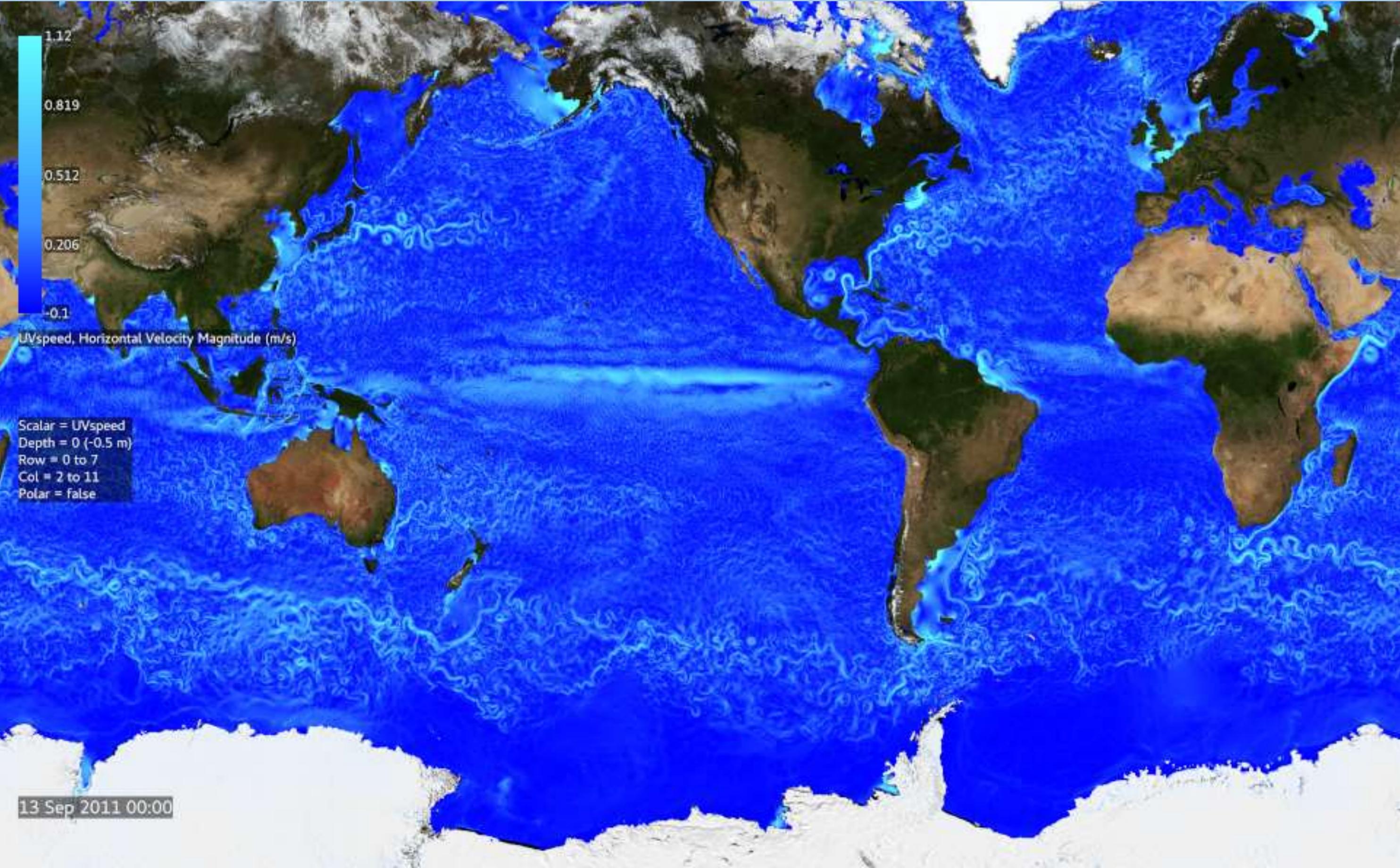
satellite and in-situ data



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NASA Visualisation Currents

satellite and in-situ data



North Atlantic Gyre – Gulf Stream



Scientific Visualization Studio

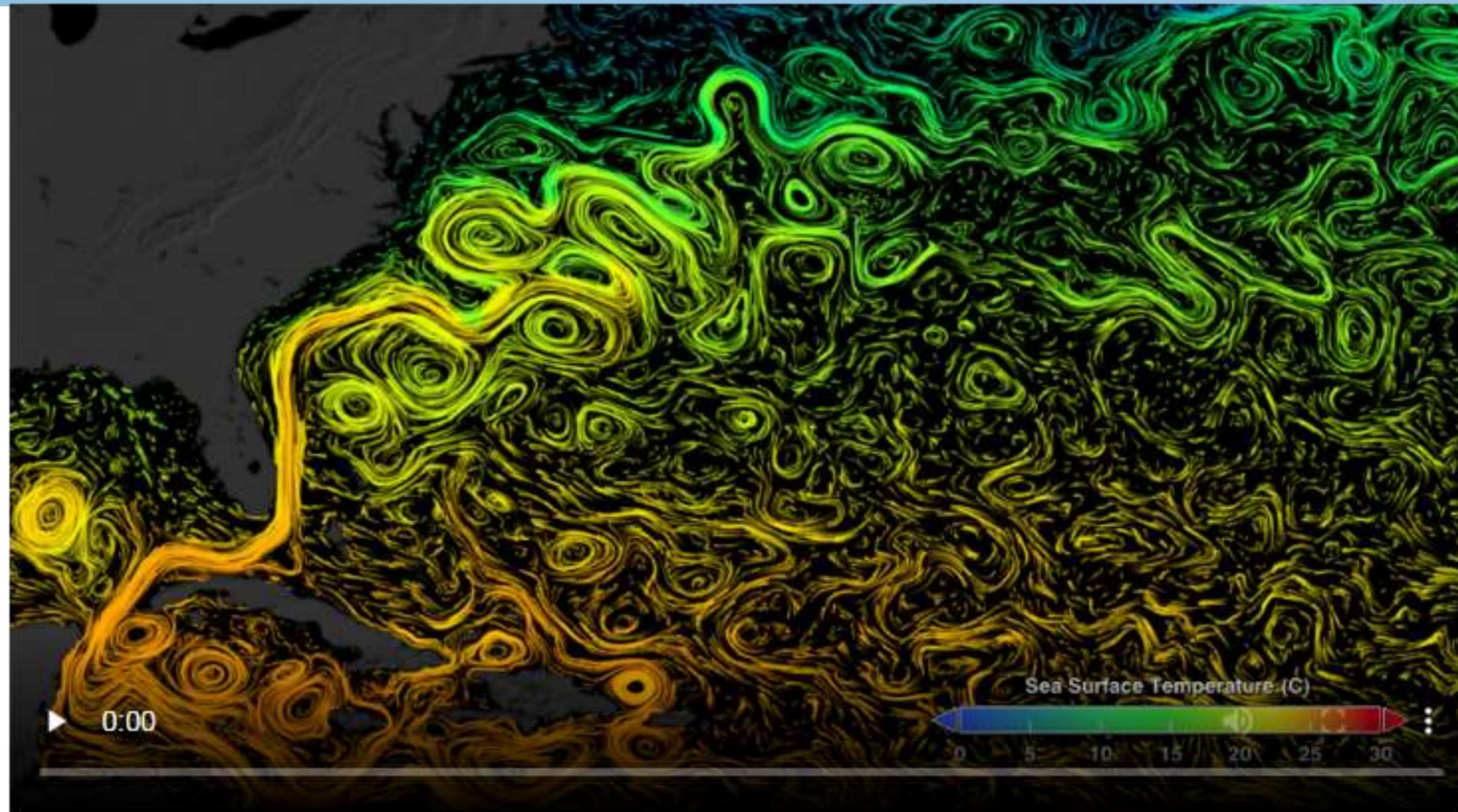


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North Atlantic Gyre – Gulf Stream



North Atlantic Gyre – Gulf Stream



Strong westward flows in the Atlantic help create the Gulf Stream. Watch for a slow-forming loop current off the western tip of Cuba.

[Download](#) ▾



North Atlantic Gyre – Gulf Stream

East Coast^a

Technical
Resource
(TWh/yr)^b

Potential Number
of Homes Powered^c

Resource as a Percent
of Regional Electricity
Generation (%)^d

Resource as a Percent
of U.S. Electricity
Generation (%)^e

 Ocean Current

49

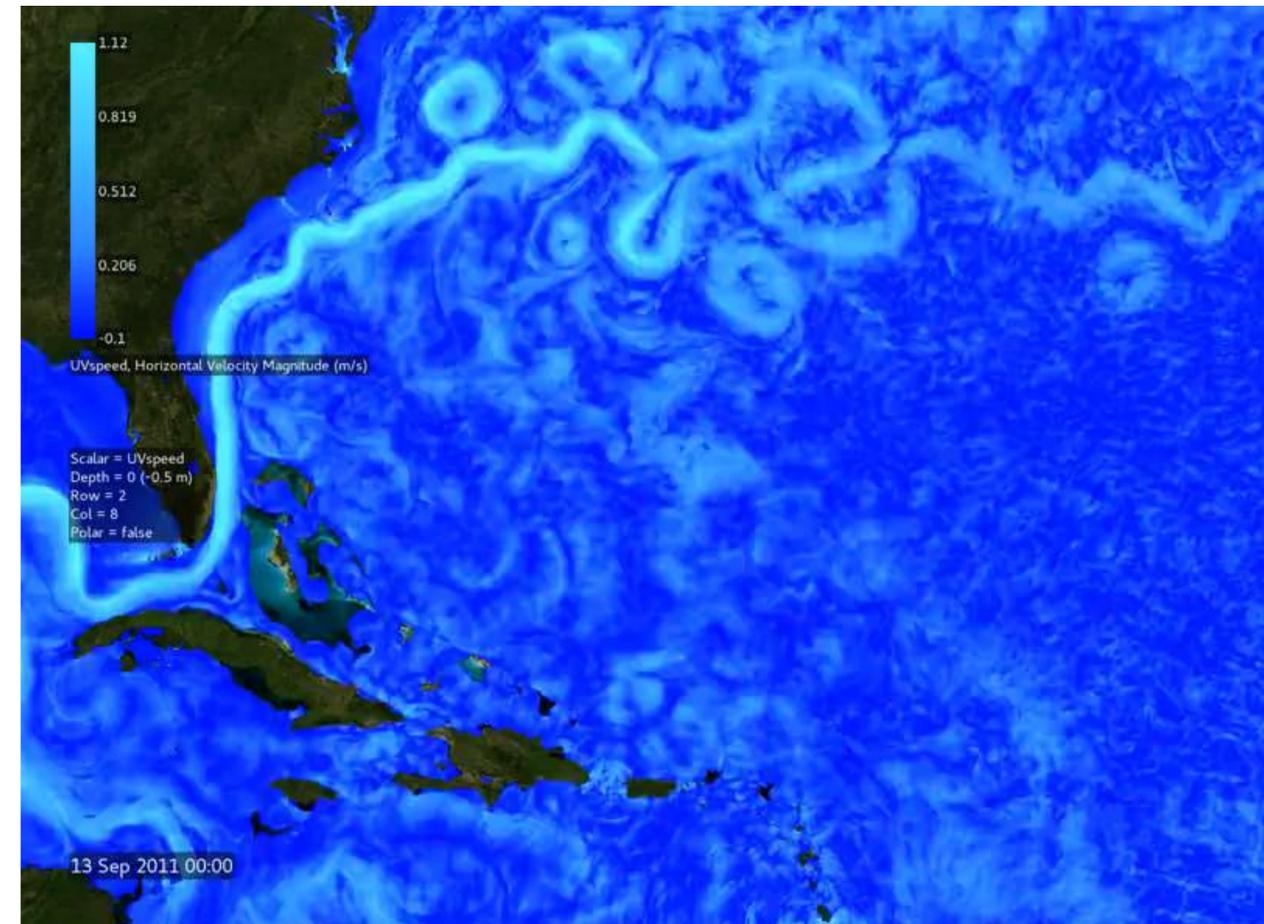
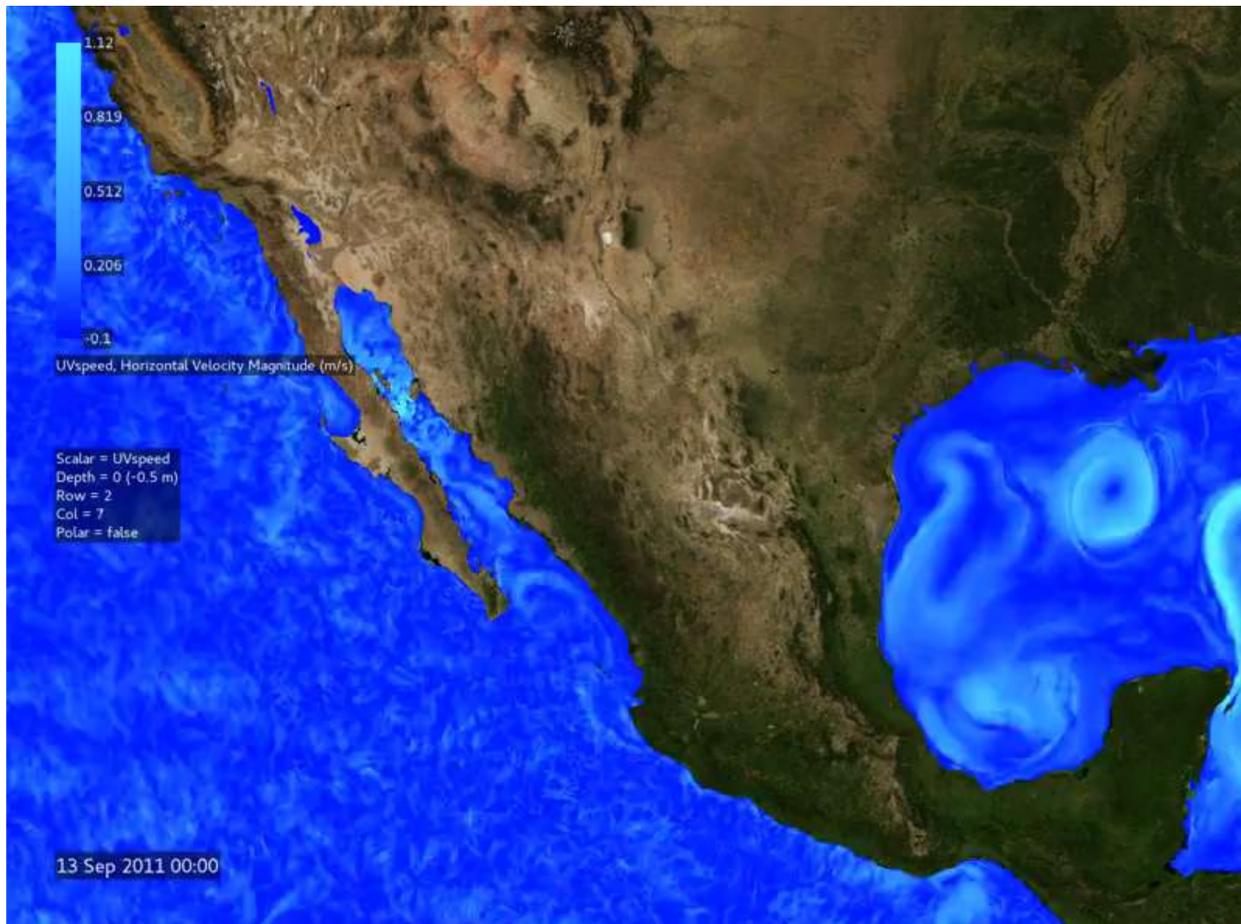
4,600,000

5.3

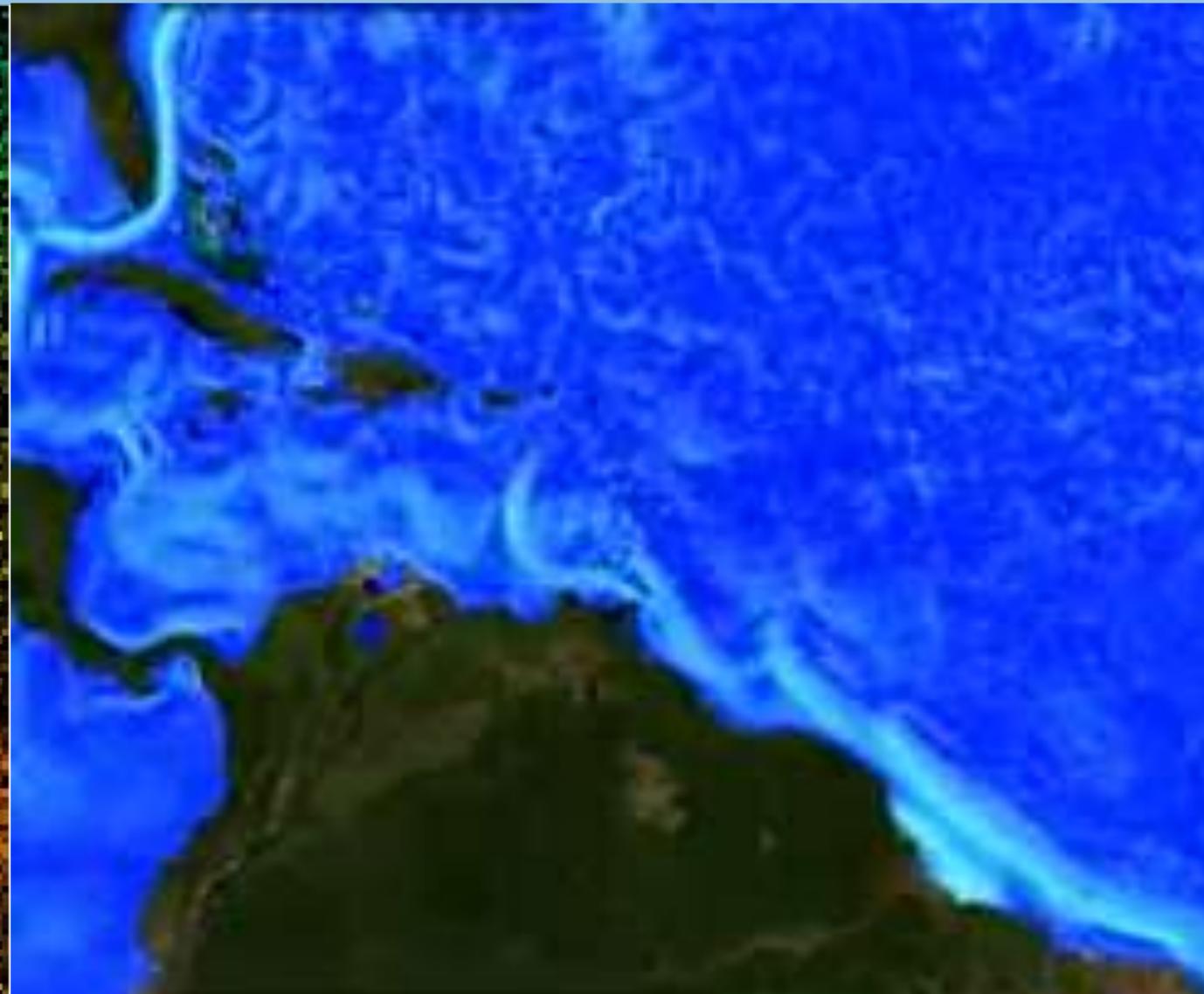
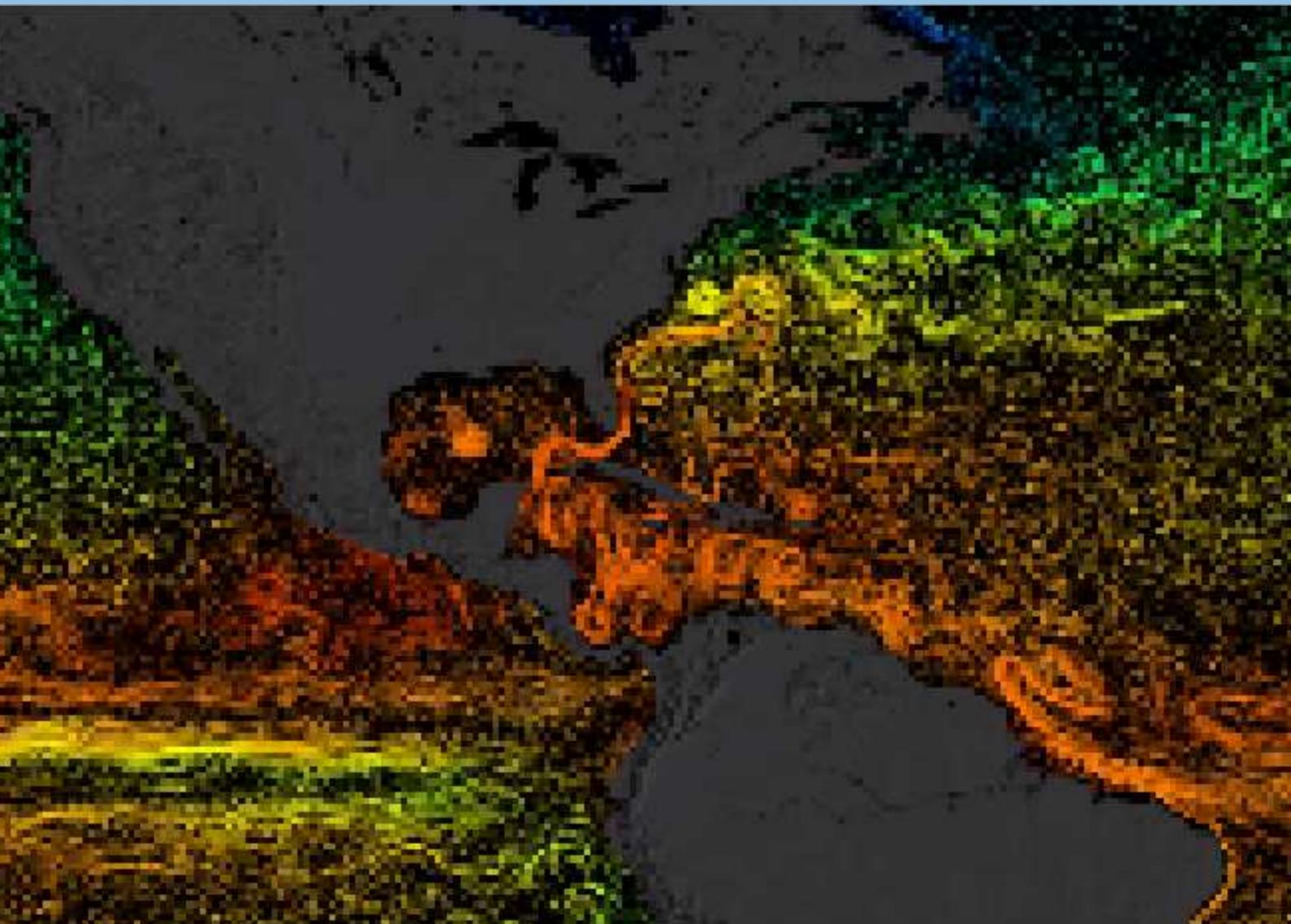
1.2

^dPercent based on 924.5 TWh of the East Coast's electricity generation produced in 2019. (ME to FL with 1/2 of FL's generation.)

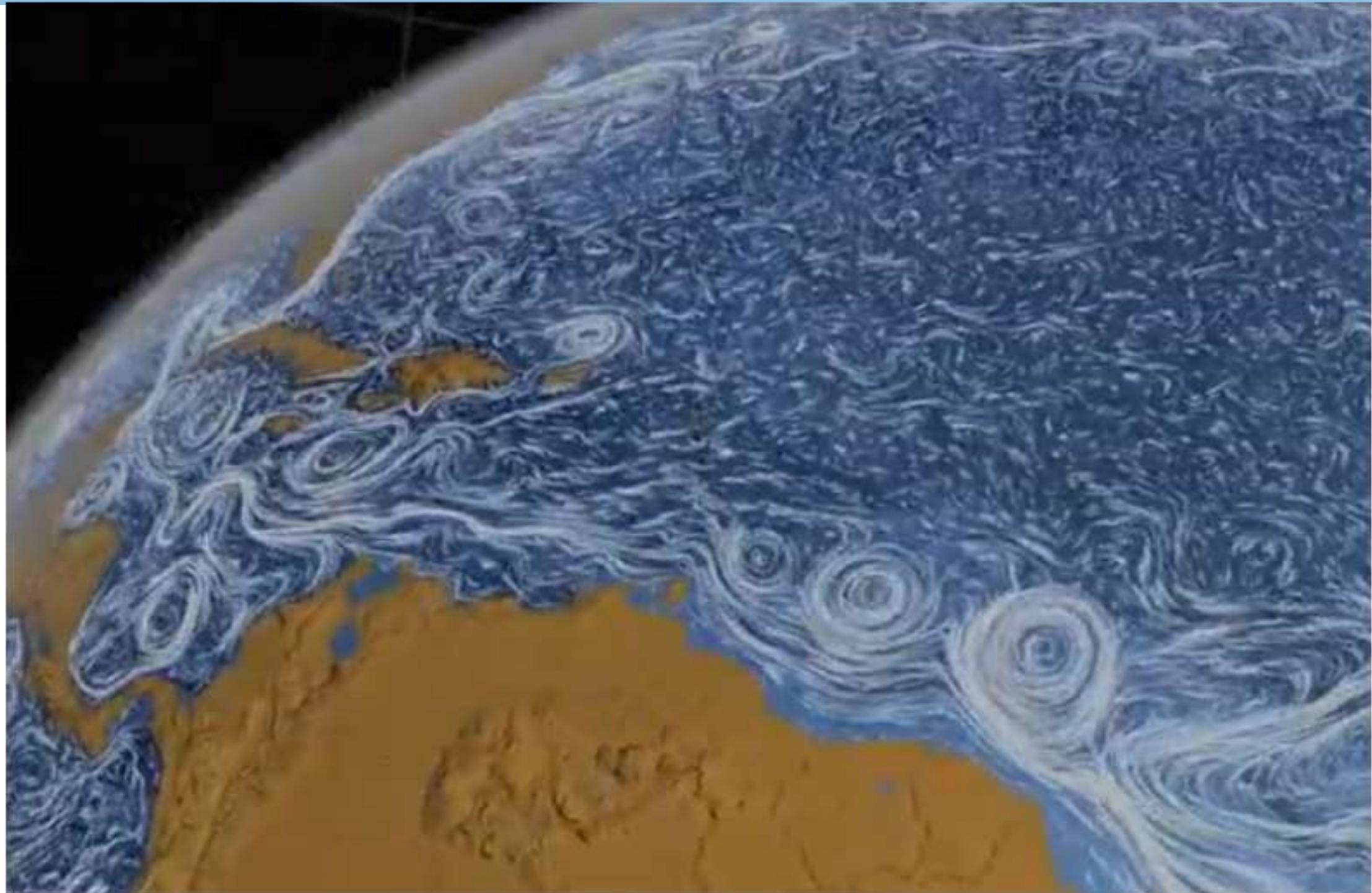
Marine Energy in the United States: An Overview of Opportunities, NREL, 02/2021



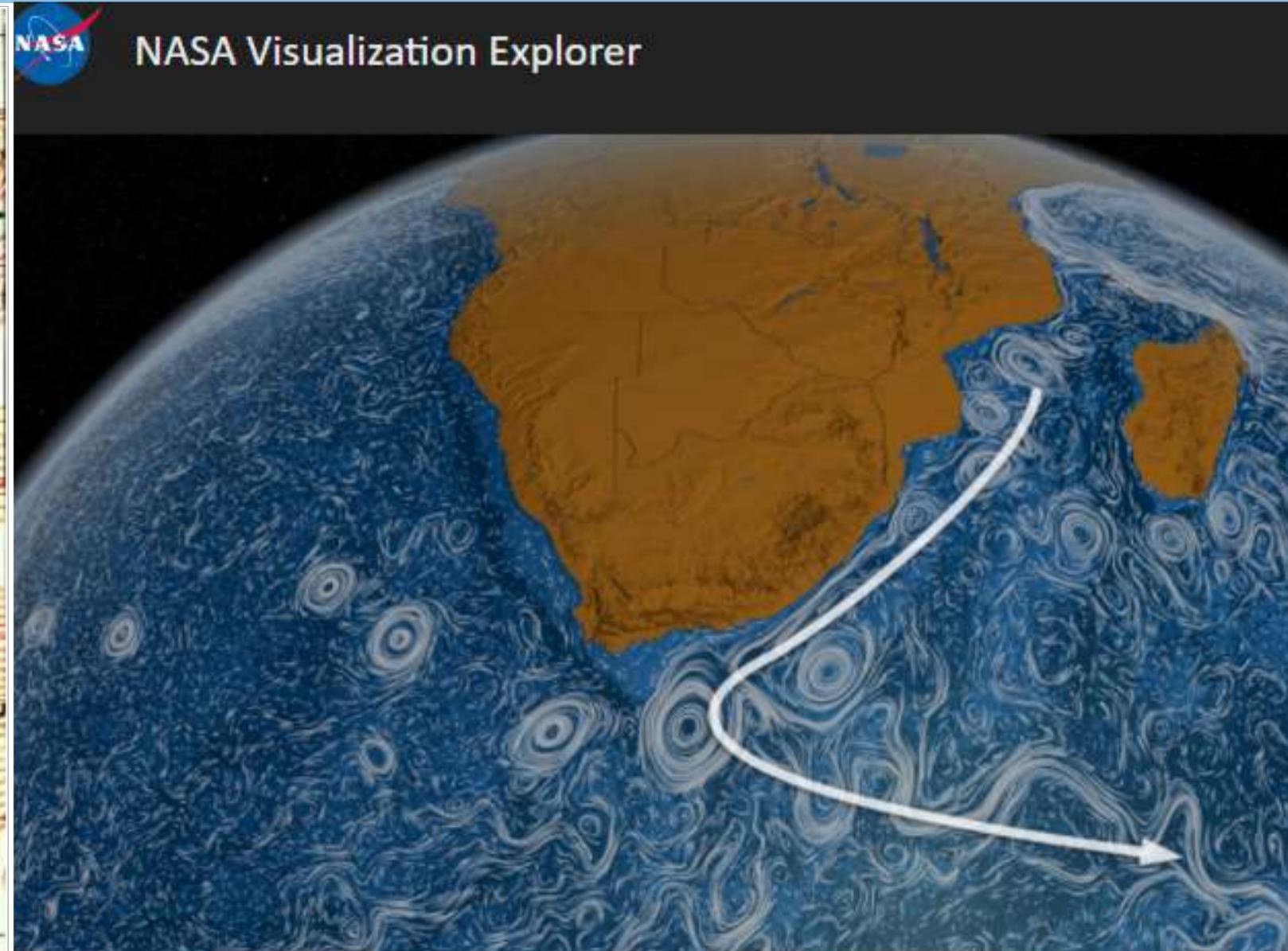
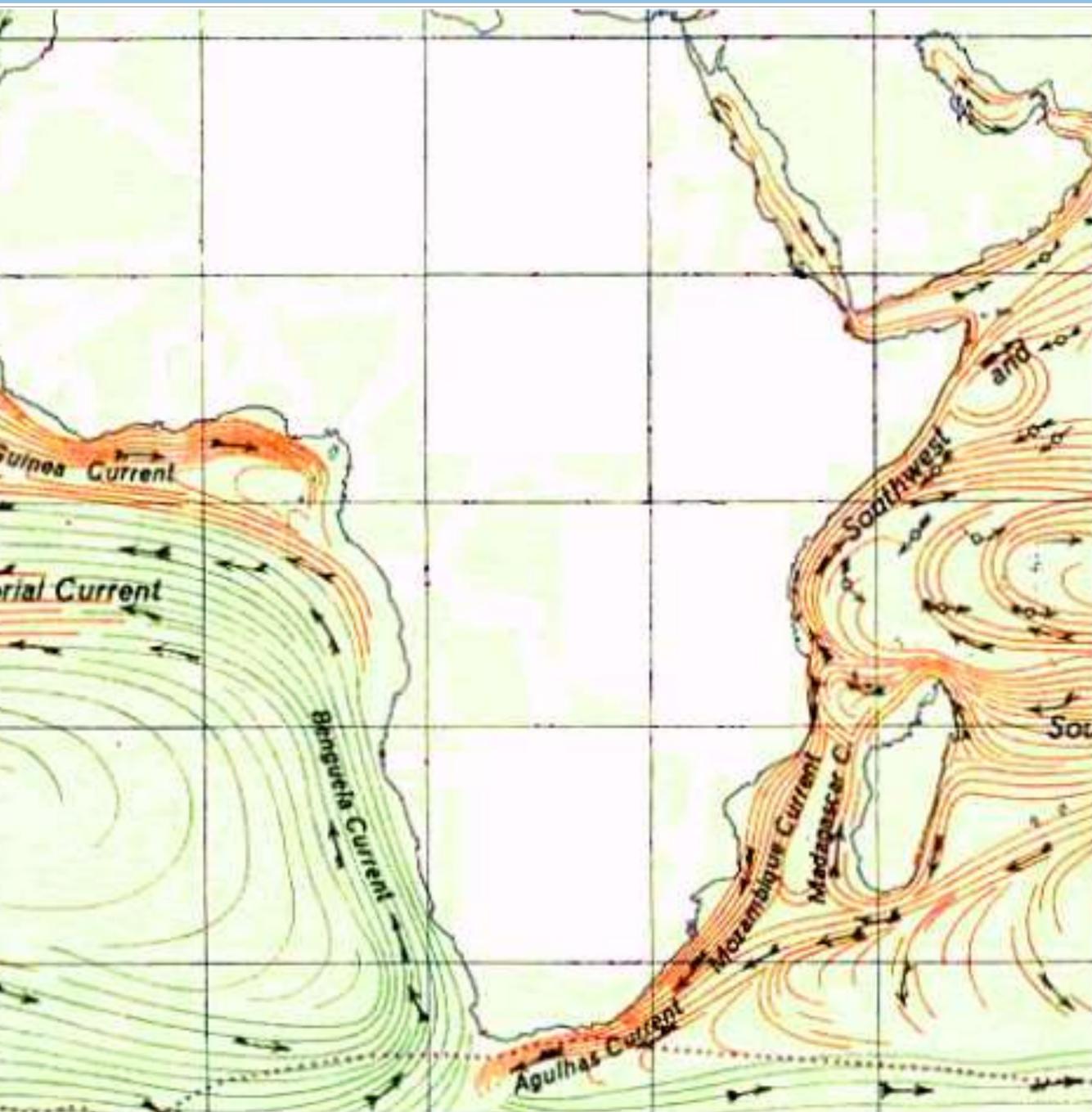
Latin America East Coast



Latin America East Coast



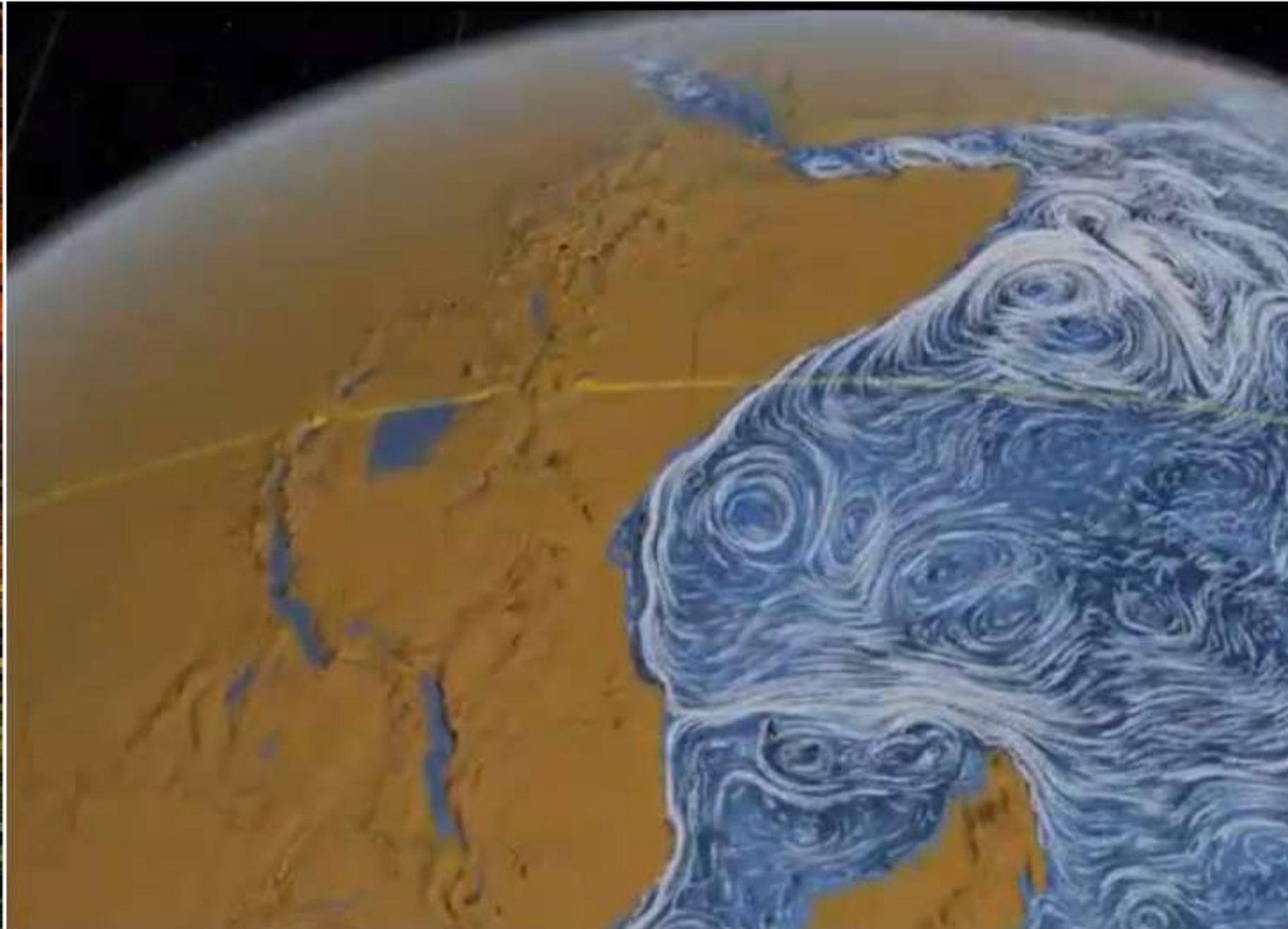
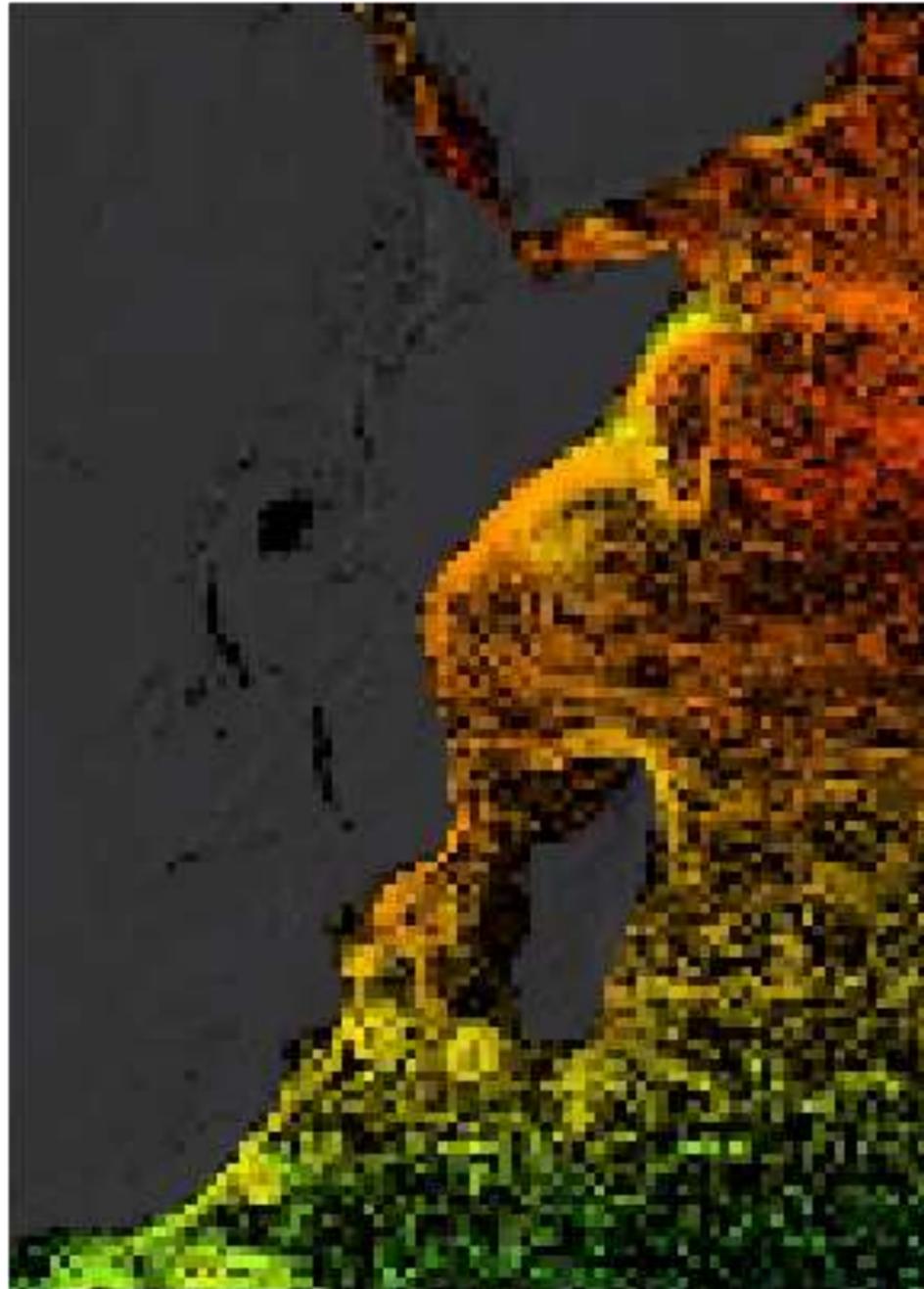
Africa East Coast, Agulhas current, Mozambique current



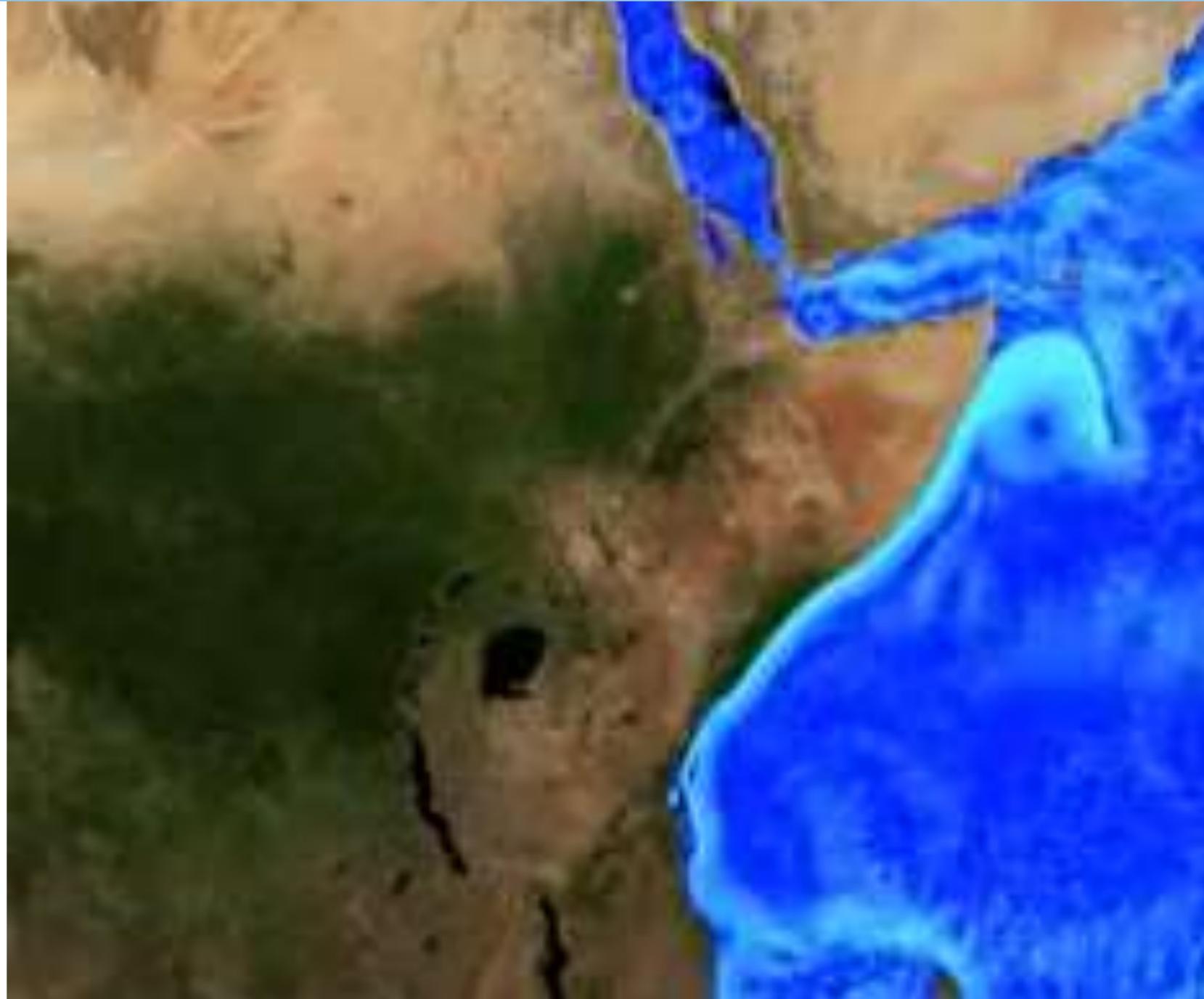
The Agulhas Current travels along the coastline of Mozambique and South Africa and then loops eastward.



Africa East Coast, South equatorial current



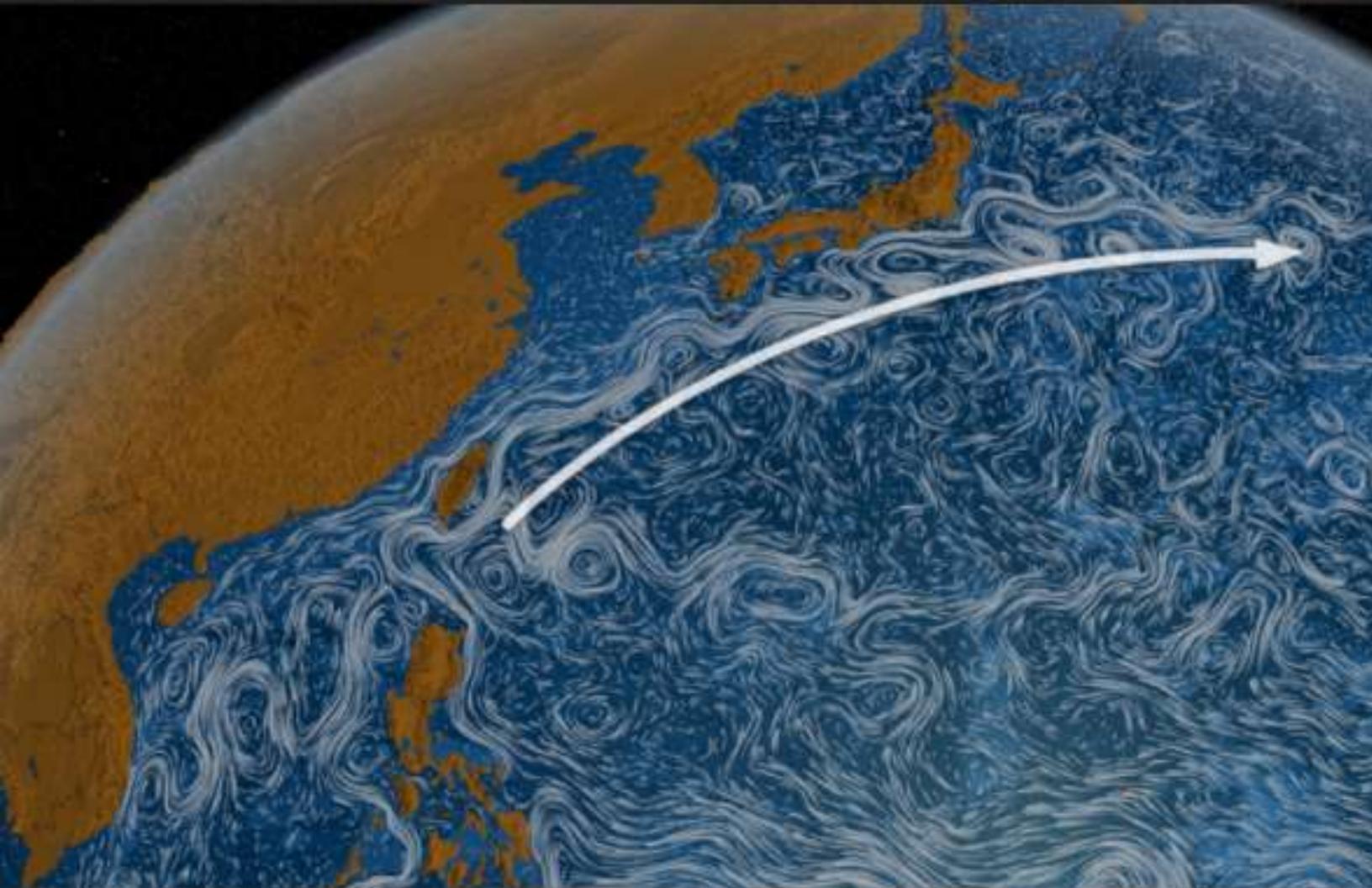
Africa East Coast, South equatorial current



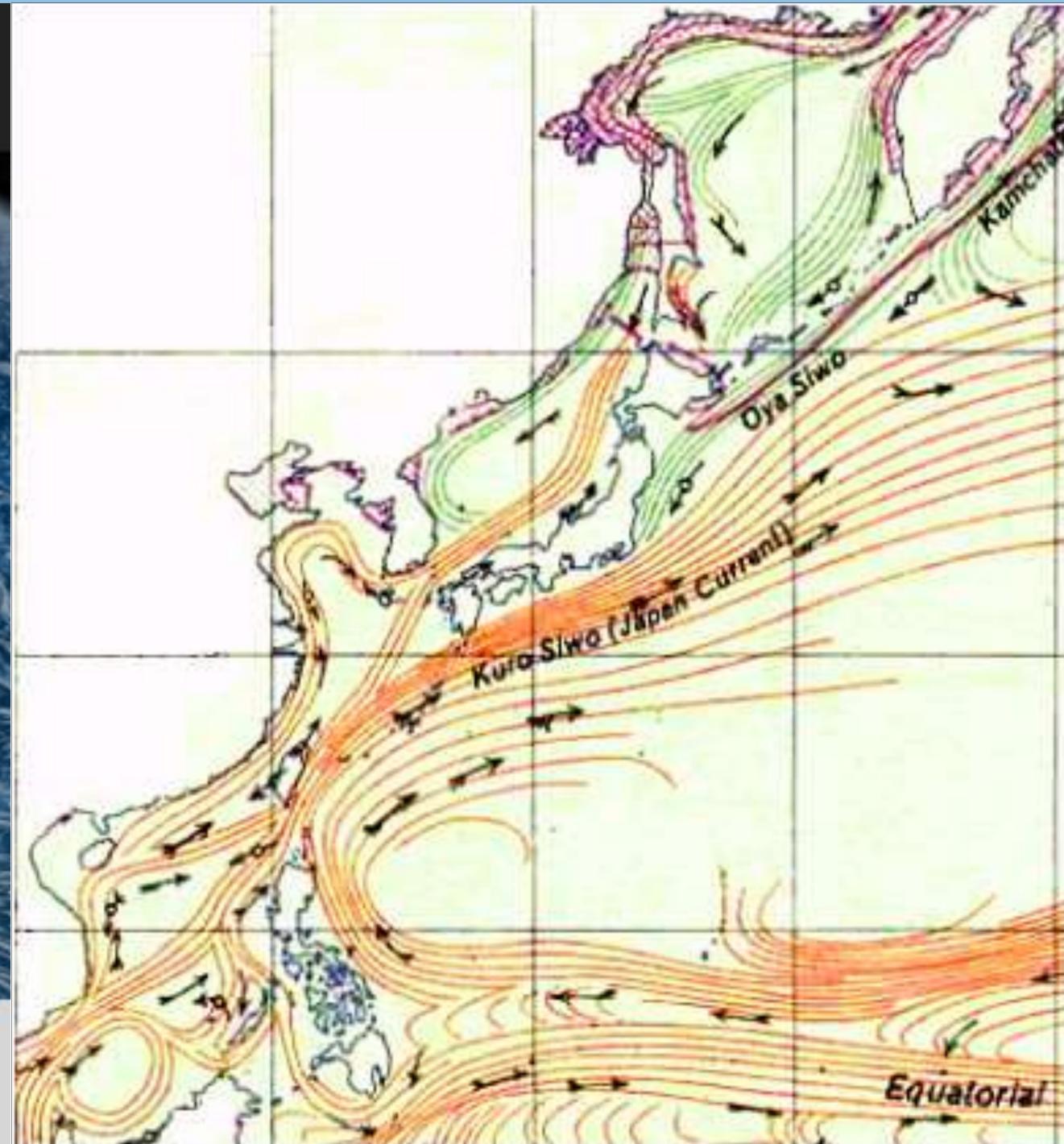
Asia: Japan, Taiwan, Kuroshio current



NASA Visualization Explorer



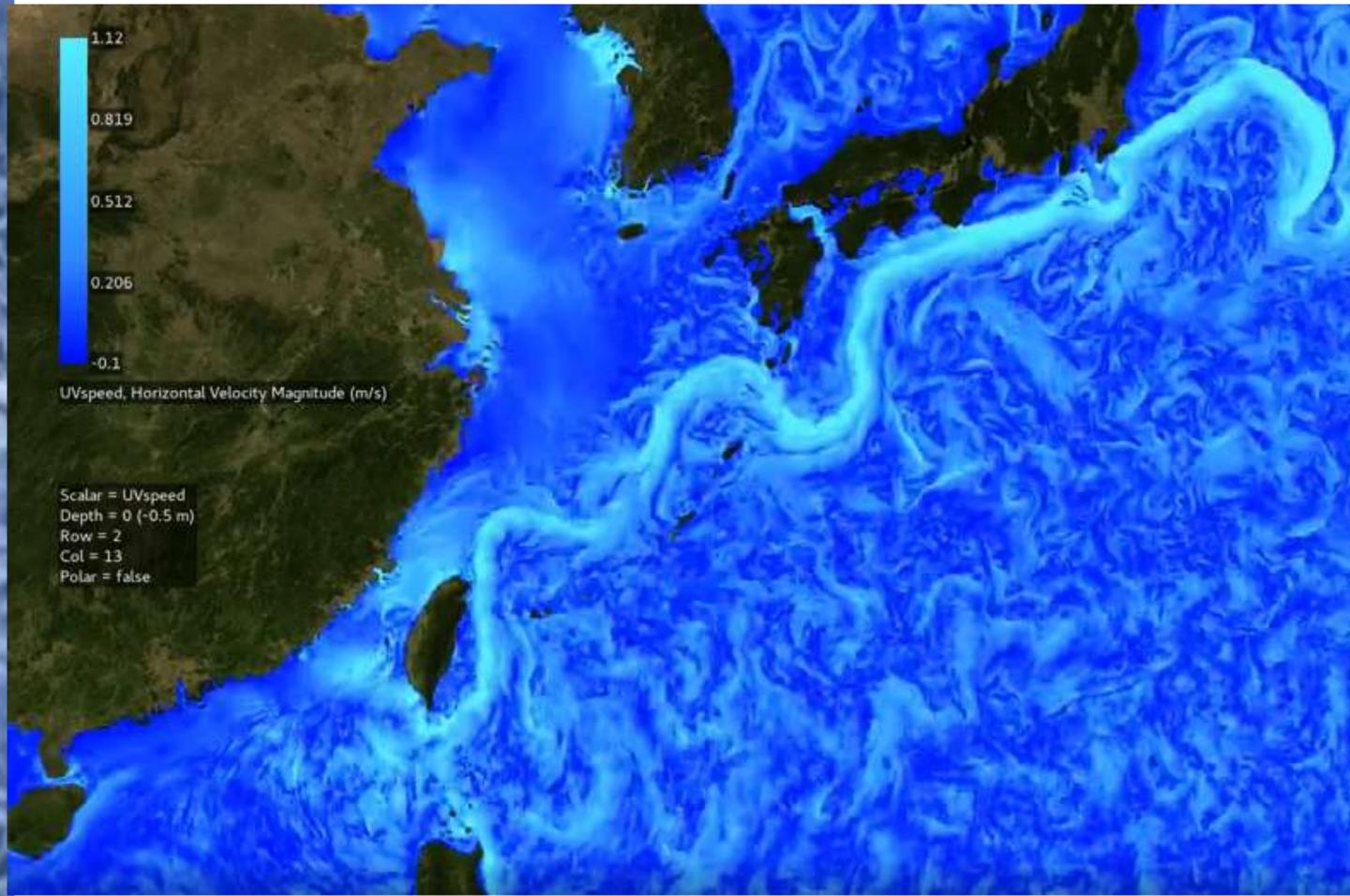
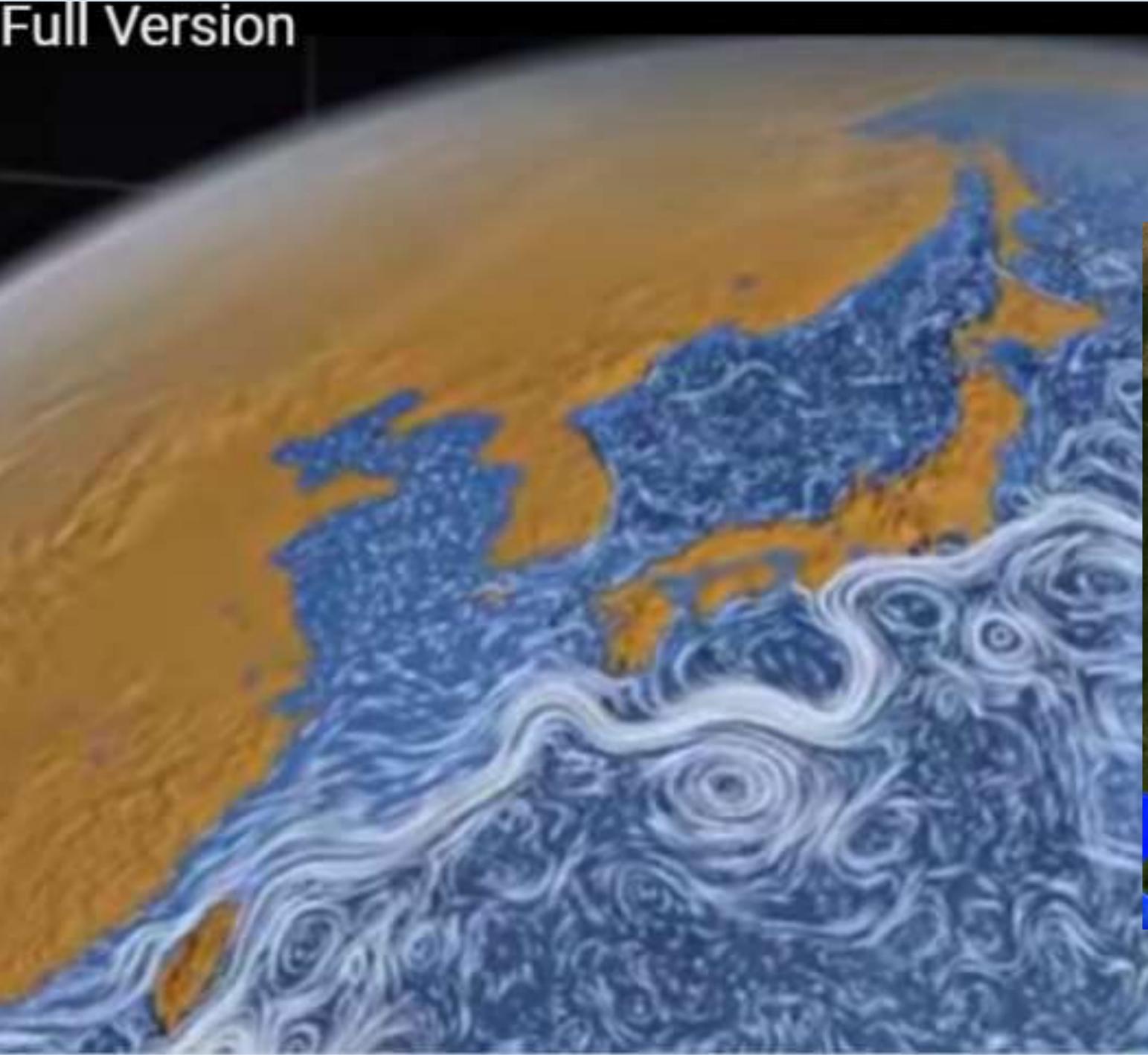
The Kuroshio Current flows northeast off the coast of Japan transporting warm ocean water circulating east of Taiwan.



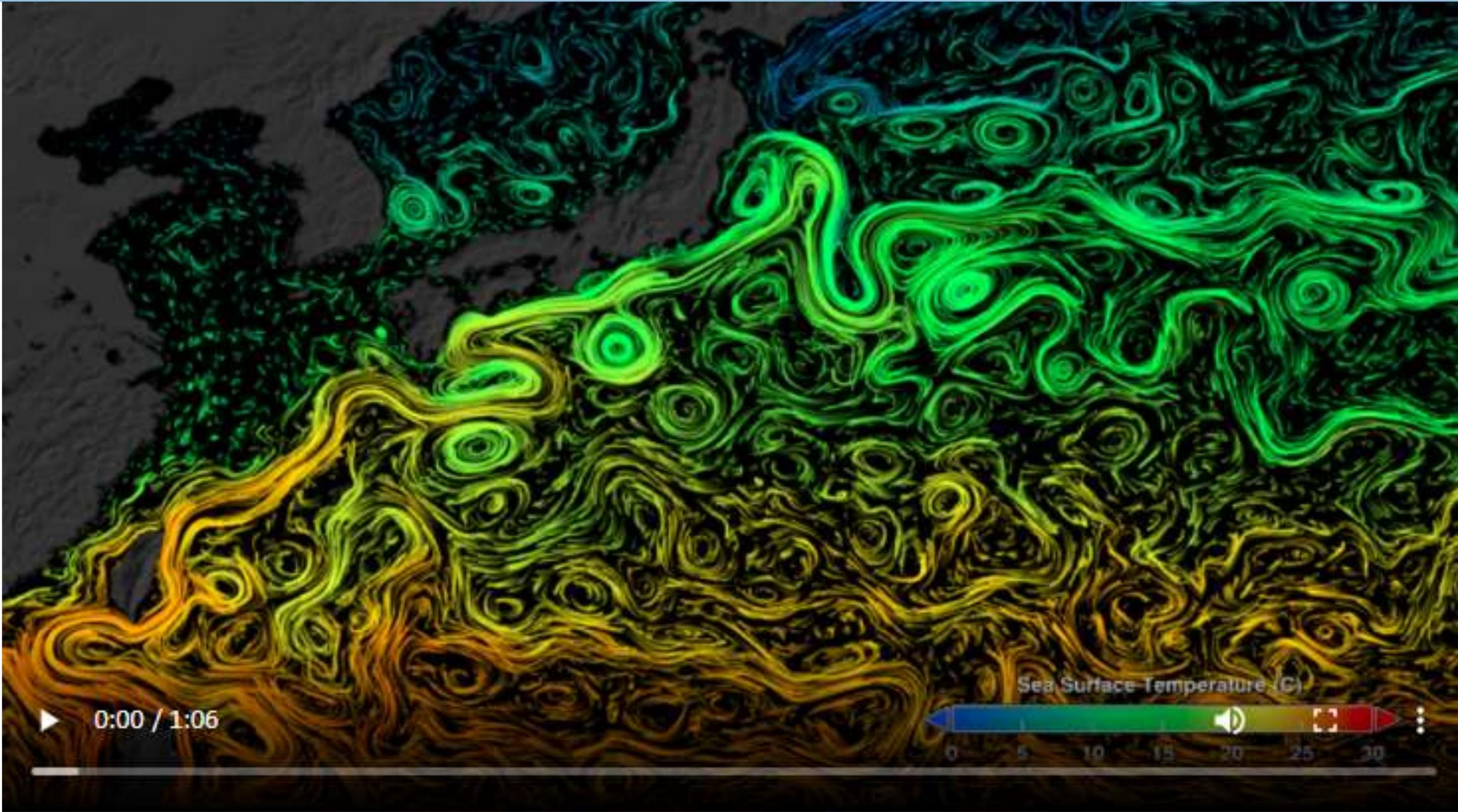
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Asia: Japan, Taiwan: Kuroshio current

Full Version



Asia: Japan, Taiwan: Kuroshio current

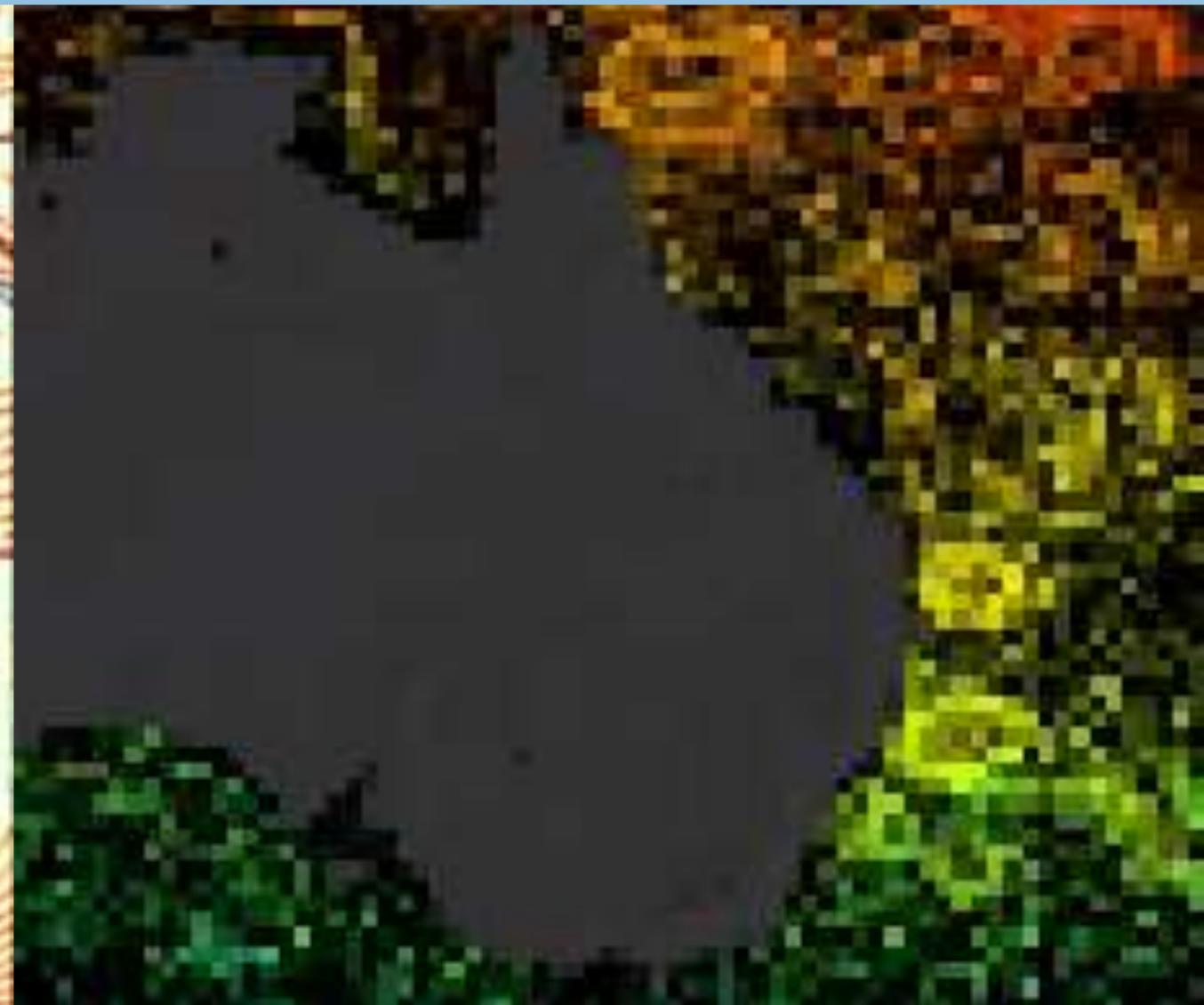
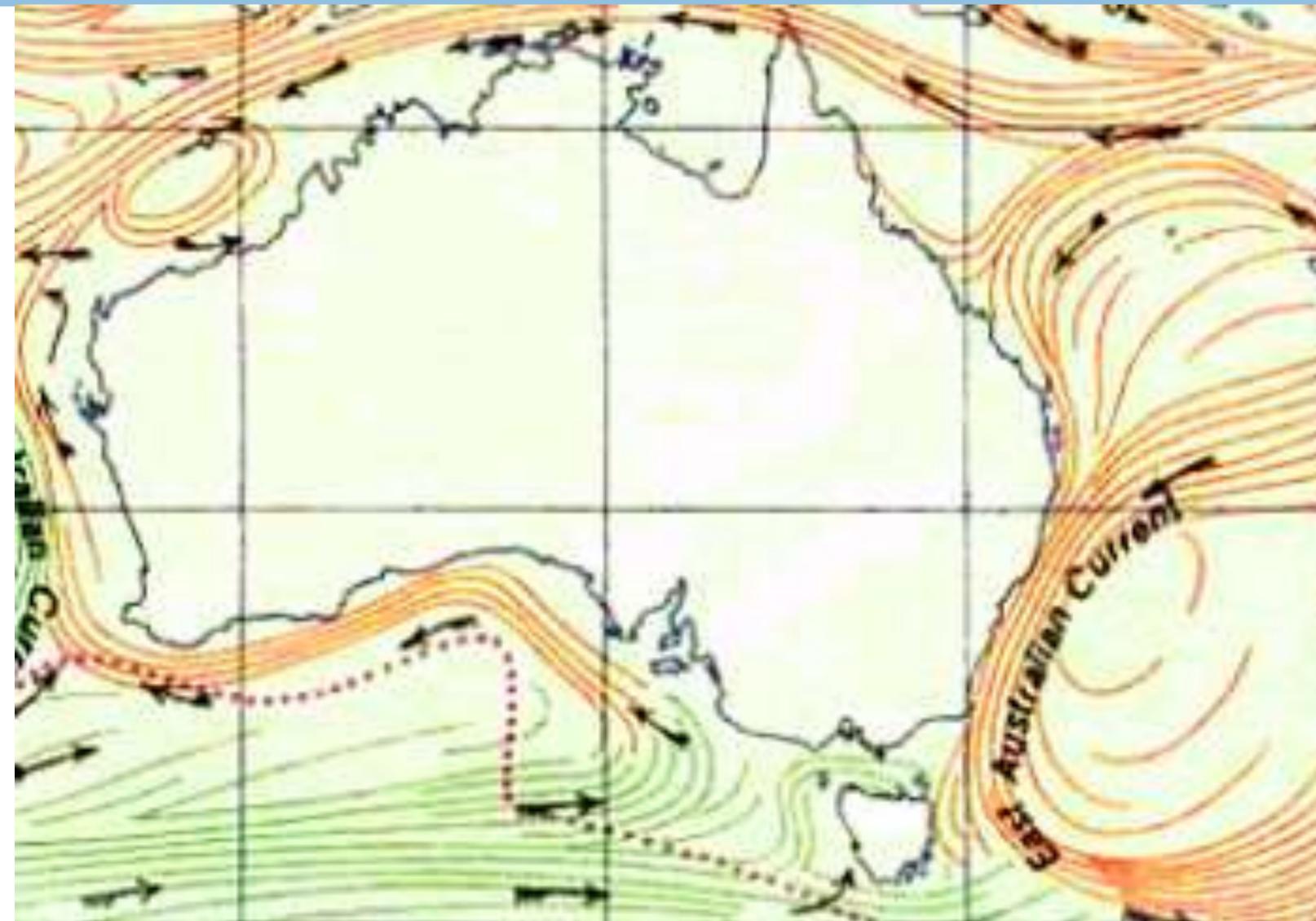


Longer streams represent faster currents. Here, fast Pacific flows rush toward Asia before turning to the northeast.

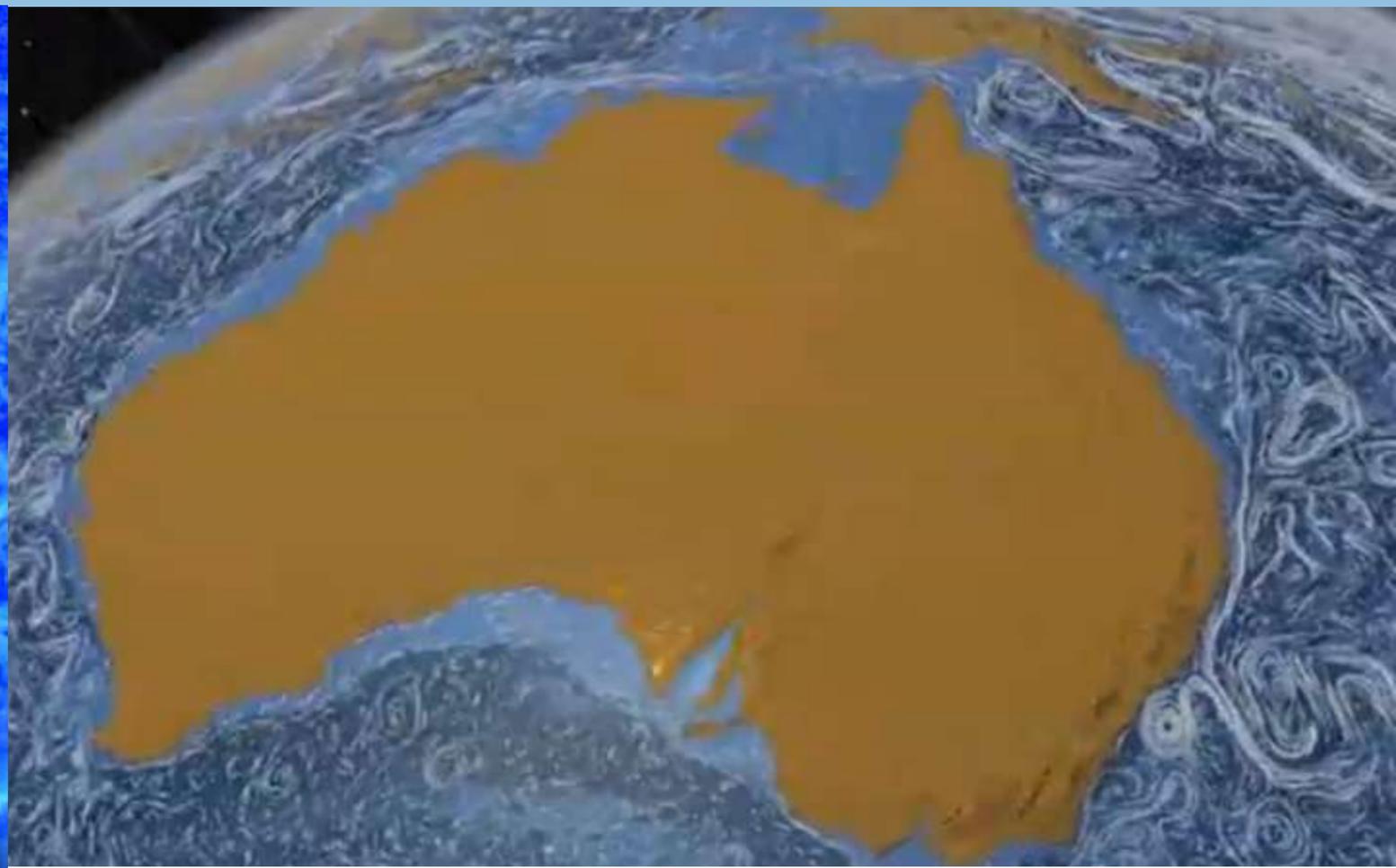
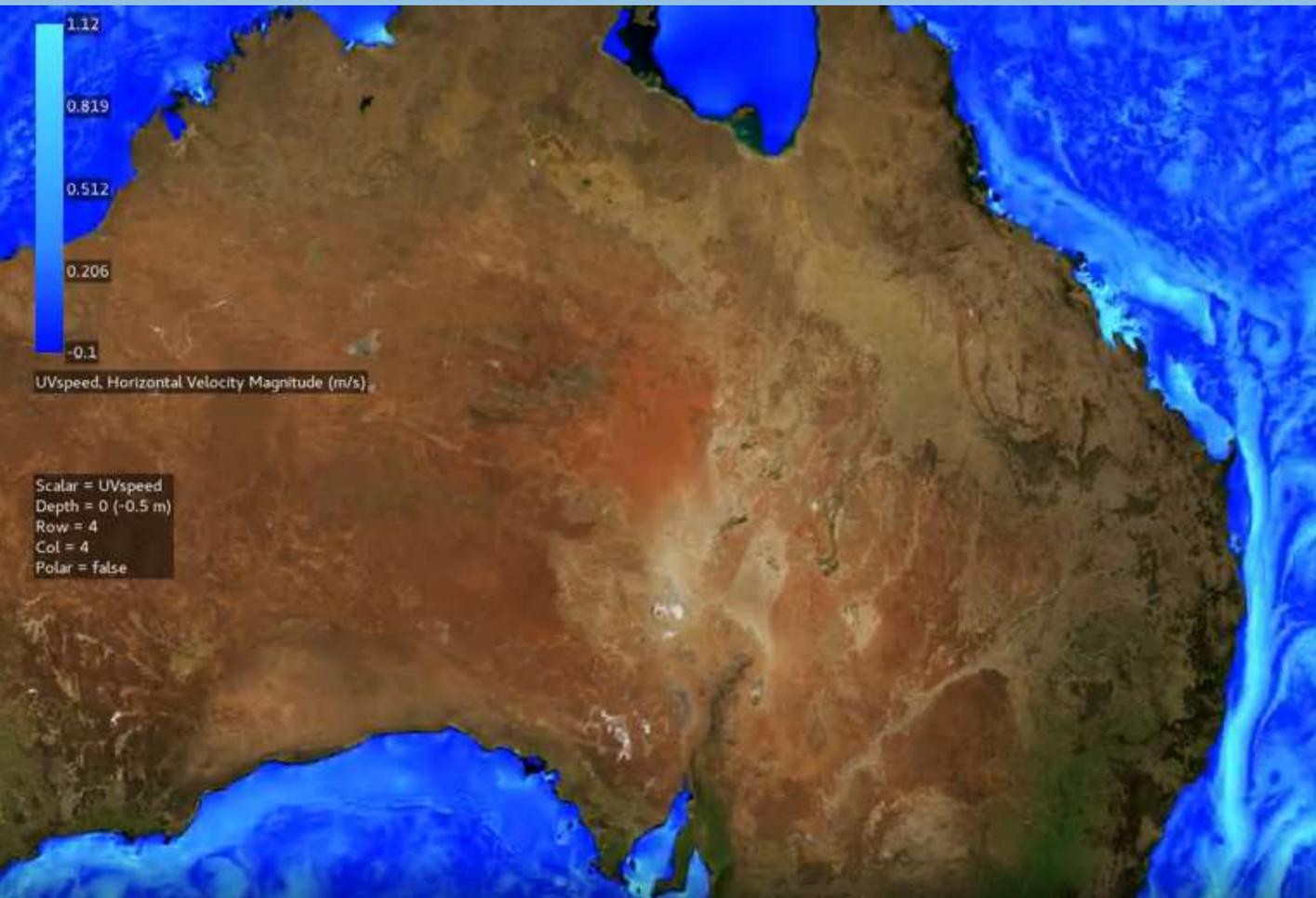
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Australia, East Australian Current



Australia, East Australian Current



What About Europe?

- SET-Plan (The European Strategic Energy Technology Plan)
- Blue Growth Strategy
- Horizon 2020

Wave energy



Tidal current



SWAC



OTEC



Salinity gradient



2021 OCEAN ENERGY EUROPE



POWERED BY THE OCEAN

Date : 6 December, 2021 - 7 December, 2021
Location : The Egg, Brussels
The annual Ocean Energy Europe Conference & Exhibition is the meeting point for the whole ocean energy sector.



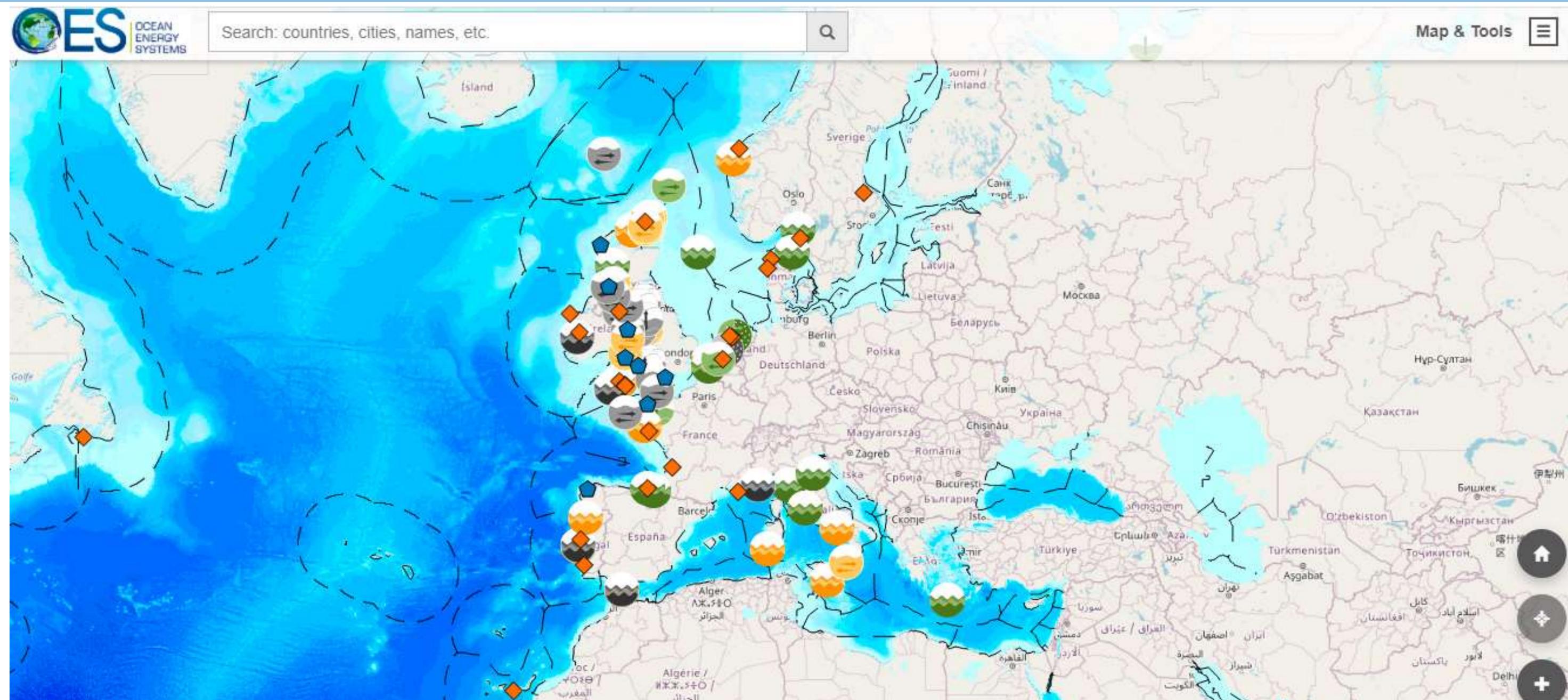
Useful GIS Interactive Tools

Marine & Hydrokinetic Atlas (MHK Atlas)



Useful GIS Interactive Tools

Worldwide GIS Database for Ocean Energy



PRIMRE Marine & Hydro Energy Databases

PRIMRE Knowledge Hubs

 MHK Data Repository The Marine Hydrokinetic Data Repository (MHKDR) is the repository for data collected using funds from the Water Power Technologies Office of the U.S. Department of Energy (DOE). It contains data on MHK devices, testing, resource and environmental impact assessments, cost analyses, and more. View MHKDR	 Tethys Tethys facilitates the exchange of information and data on the environmental effects of wind and marine renewable energy technologies and serves as a commons for wind and marine renewable energy practitioners and therefore enhance the connectedness of the renewable energy community. View Tethys	 Tethys Engineering Tethys Engineering stores documents from around the world about the technical and engineering aspects of marine renewable energy. View Tethys Engineering	 MRE Technology Database Provides up-to-date information on marine and hydrokinetic renewable energy. The database includes wave, tidal, current, and ocean thermal energy, and contains information on the various energy conversion technologies, companies active in the field, and development of projects in the water. View Tech Database	 Telesto Telesto is home to open source Wikis and Databases which provide a comprehensive explanation of and guidance for MRE testing, measurement, and data processing based on experience, lessons learned from prior laboratory and field testing, industry standards, and best practices. Visit Telesto	MRE Software A collection of MRE relevant software, including the code hub and code catalog. The code hub is a collection of open source MRE software for simulating devices, and processing and analyzing data. The code catalog is a searchable online software discovery platform with a faceted search to identify software tools, codes and other software products. View MRE Software
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Collection Methods

- Field Data
- Lab Data
- Modeling
- Test Center

Reference Models

- RM1: Tidal Current Turbine
- RM2: River Current Turbine
- RM3: Wave Point Absorber
- RM4: Ocean Current Turbine
- RM5: Oscillating Surge Flap
- RM6: Oscillating Water Column

Technologies

- Current
 - Axial Flow Turbine
 - Cross Flow Turbine
 - Oscillating Hydrofoil
 - Tidal Kite
 - Archimedes Screw

Documents

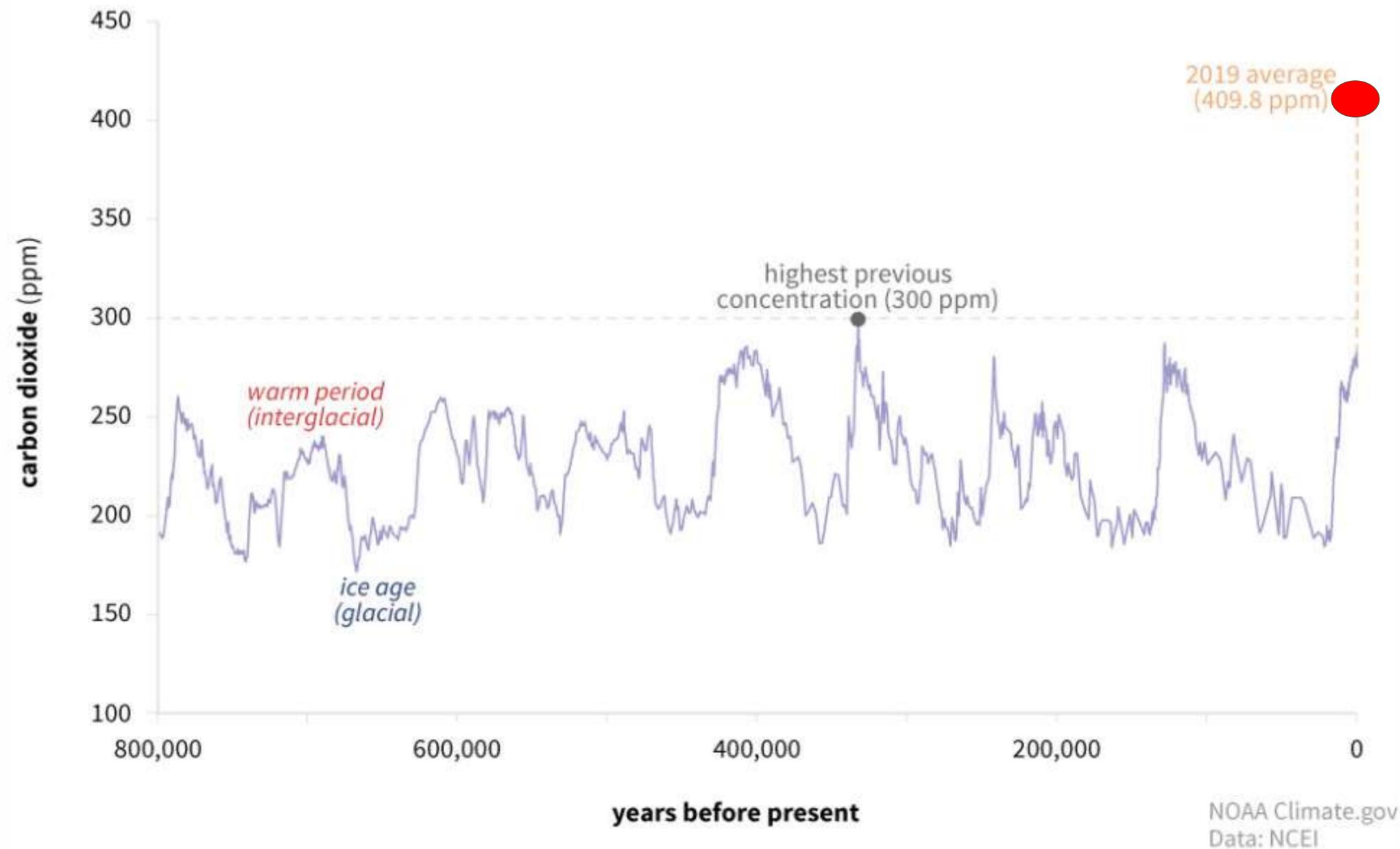
- Journal Article
- Report
- Presentation
- Conference Paper
- Book
- Book Chapter
- Thesis



Where We Stand Today

410 ppm CO₂ concentration in the global atmosphere

CARBON DIOXIDE OVER 800,000 YEARS



Graph by
National
Oceanic and
Atmospheric
Administration



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Slide 1: [Painting](#) by Maggi Hambling

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Slide 11:

- <https://svs.gsfc.nasa.gov/10841>

Slide 12:

- <https://svs.gsfc.nasa.gov/10841>

Slide 13:

- <https://svs.gsfc.nasa.gov/10841>
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Slide 14:

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Slide 16:

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Slide 18:

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Slide 19:

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