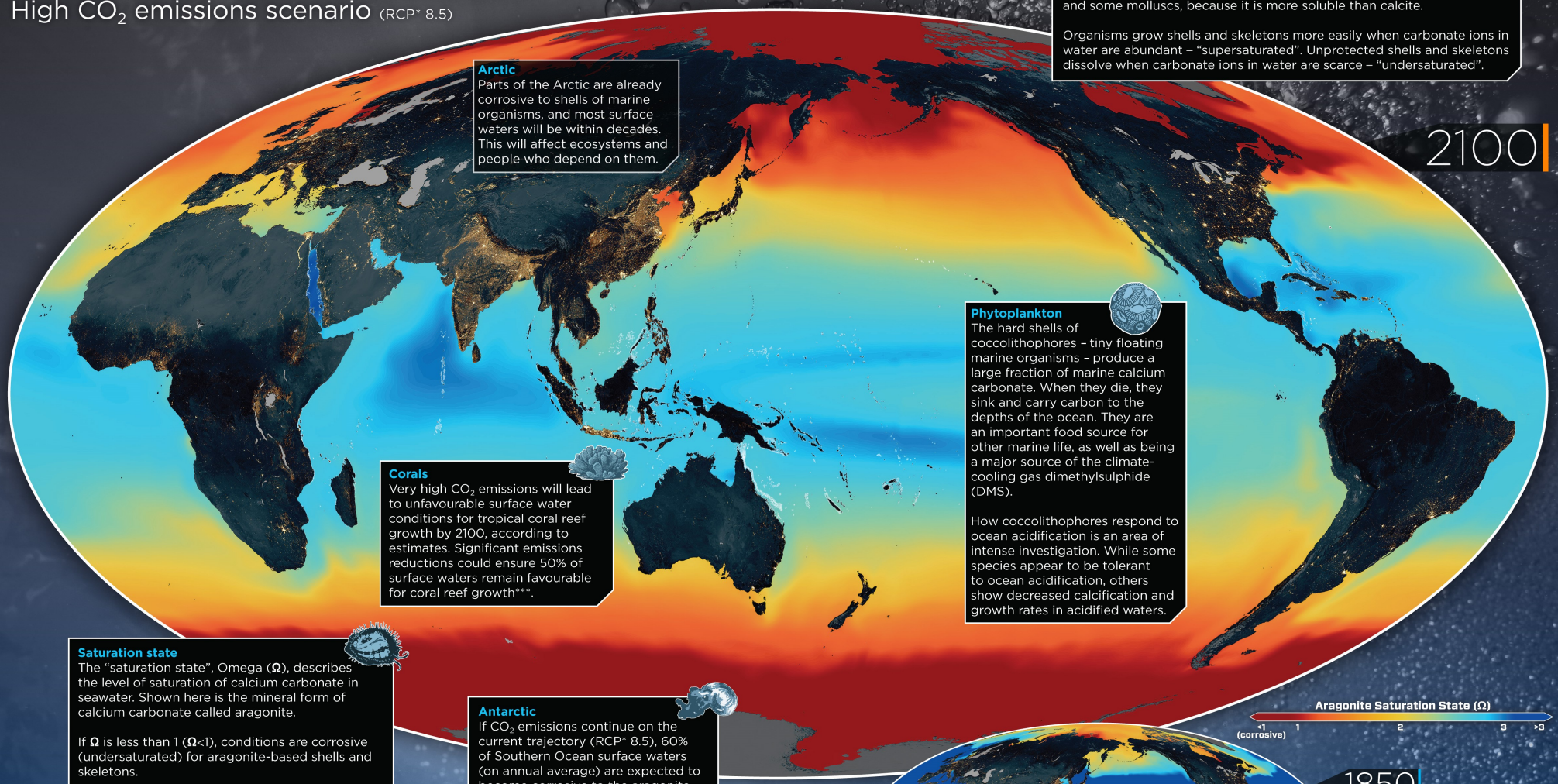
OCEAN ACIDIFICATION

Aragonite saturation in 2100

High CO_2 emissions scenario (RCP* 8.5)



Shells and skeletons
The shells and skeletons of many marine organisms are made from either calcite or aragonite; both are forms of calcium carbonate. Scientists are particularly interested in aragonite, which is produced by many corals and some molluscs, because it is more soluble than calcite.

Organisms grow shells and skeletons more easily when carbonate ions in water are abundant – "supersaturated". Unprotected shells and skeletons dissolve when carbonate ions in water are scarce – "undersaturated".

Arctic
Parts of the Arctic are already corrosive to shells of marine organisms, and most surface waters will be within decades. This will affect ecosystems and people who depend on them.

2100

Phytoplankton
The hard shells of coccolithophores – tiny floating marine organisms – produce a large fraction of marine calcium carbonate. When they die, they sink and carry carbon to the depths of the ocean. They are an important food source for other marine life, as well as being a major source of the climate-cooling gas dimethylsulphide (DMS).

How coccolithophores respond to ocean acidification is an area of intense investigation. While some species appear to be tolerant to ocean acidification, others show decreased calcification and growth rates in acidified waters.

Corals
Very high CO_2 emissions will lead to unfavourable surface water conditions for tropical coral reef growth by 2100, according to estimates. Significant emissions reductions could ensure 50% of surface waters remain favourable for coral reef growth***.

Saturation state
The "saturation state", Omega (**Ω**), describes the level of saturation of calcium carbonate in seawater. Shown here is the mineral form of calcium carbonate called aragonite.

If **Ω** is less than 1 (**Ω**<1), conditions are corrosive (undersaturated) for aragonite-based shells and skeletons.

When **Ω**>1, waters are supersaturated with respect to calcium carbonate and conditions are favourable for shell formation. Coral growth benefits from **Ω**≥3.

By 2100, computer model projections show that **Ω** will be less than 3 in surface waters around tropical reefs if CO_2 emissions continue on the current trajectory***.

Antarctic
If CO_2 emissions continue on the current trajectory (RCP* 8.5), 60% of Southern Ocean surface waters (on annual average) are expected to become corrosive to the aragonite-shelled organisms, for example pteropods, which are part of the marine food web. Substantial emissions reductions (RCP* 2.6) could prevent most of the Southern Ocean surface waters from becoming corrosive to the shells of aragonitic organisms**.

Aragonite Saturation State (Ω)

<1 (corrosive) | 1 | 2 | 3 | >3

1850

* Intergovernmental Panel on Climate Change emissions scenarios — Representative Concentration Pathways (reference 1).
** Personal communication: Joos & Steinacher, after Steinacher *et al.*, 2013 (reference 10).
*** Ricke *et al.*, 2013 (reference 11).

Ocean acidification maps: model data provided by Tatiana Ilyina from Ocean Biogeochemistry Group, Max Planck Institute for Meteorology.
Design: Félix Pharand-Deschênes, Globaia.

This infographic is part of the *Ocean Acidification Summary for Policymakers – Third Symposium on the Ocean in a High-CO_2 World*, sponsored by IGBP, IOC-UNESCO and SCOR.
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