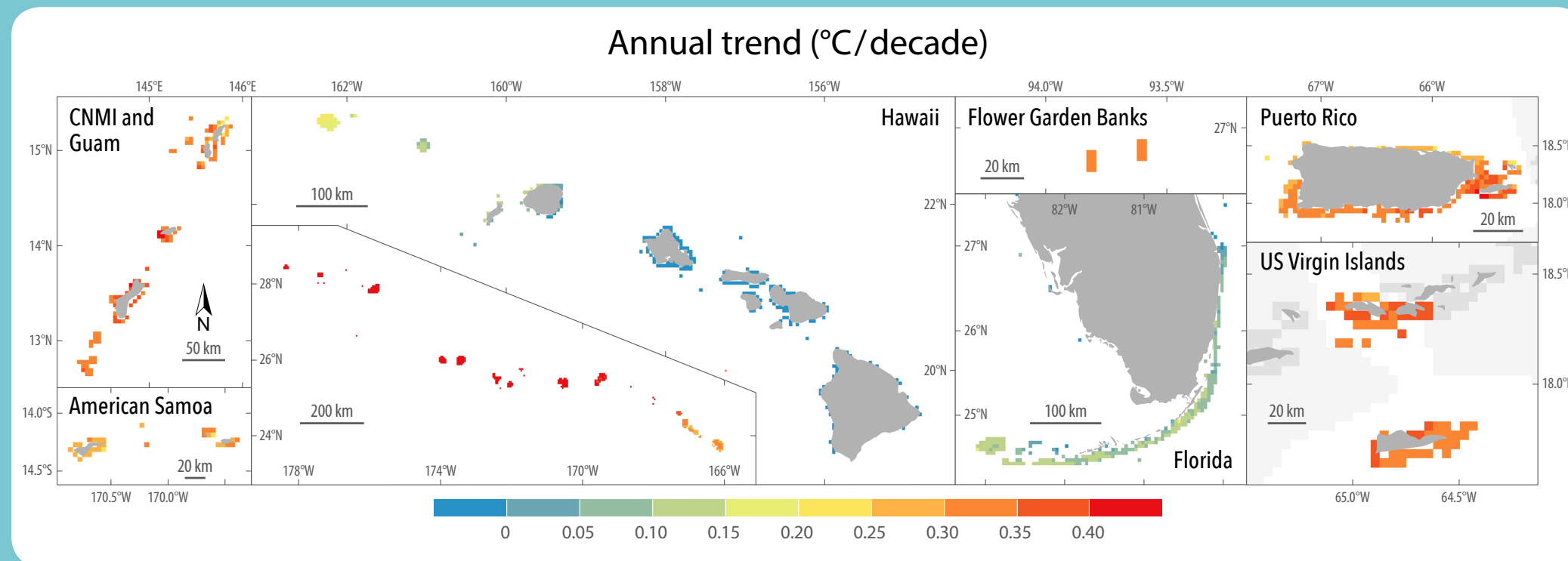
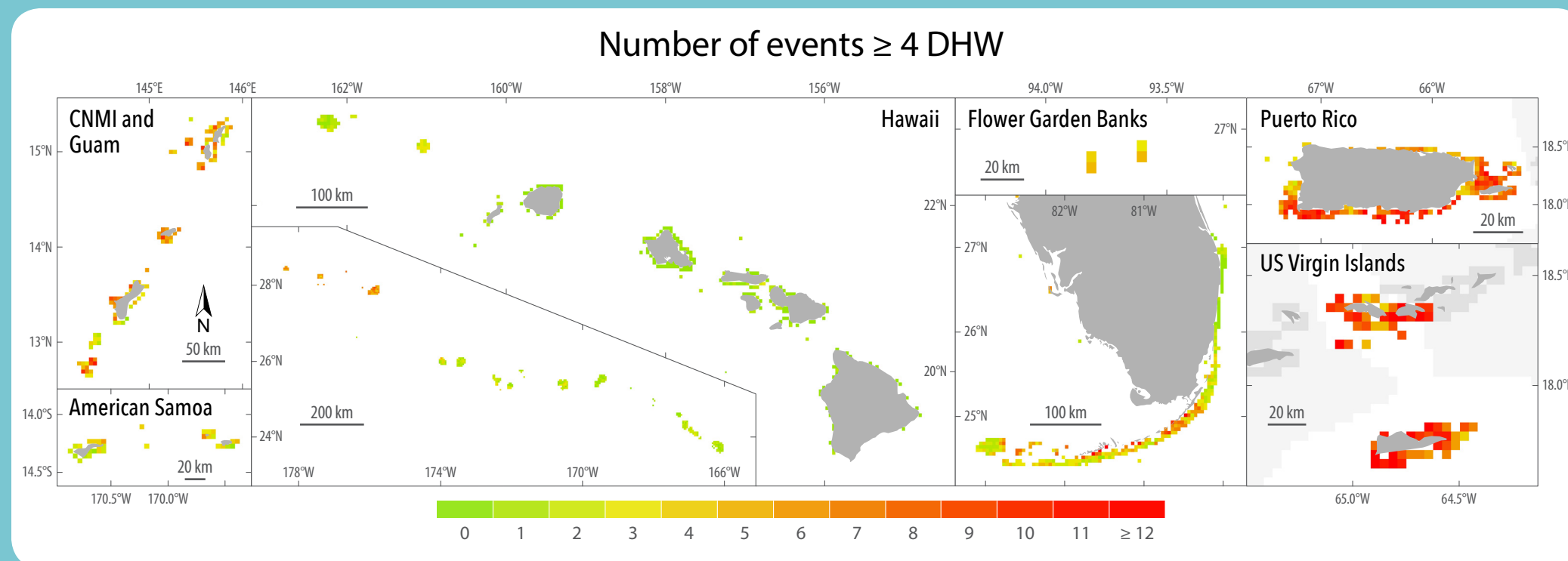


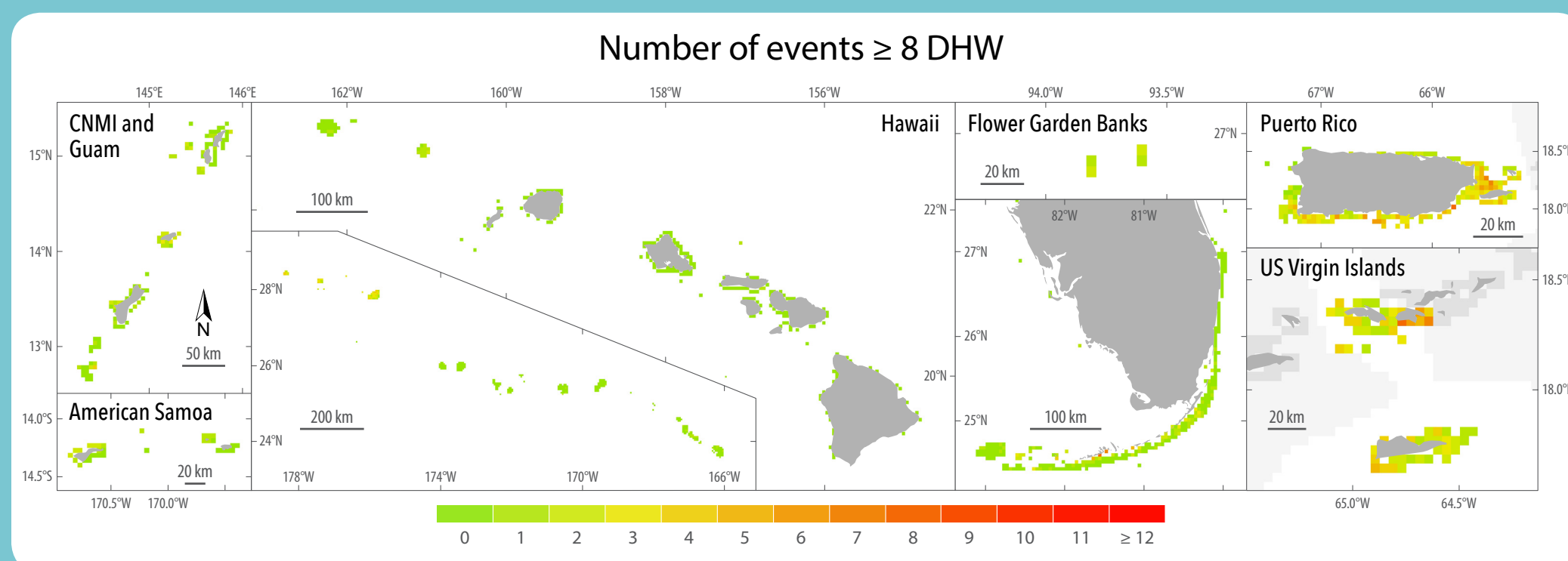
Past and projected future climate impacts to coral reefs in the the United States



Rate at which temperatures increased between 1982 and 2012; this is the trend in annual temperatures, or the change in temperatures when expressed as annual averages.



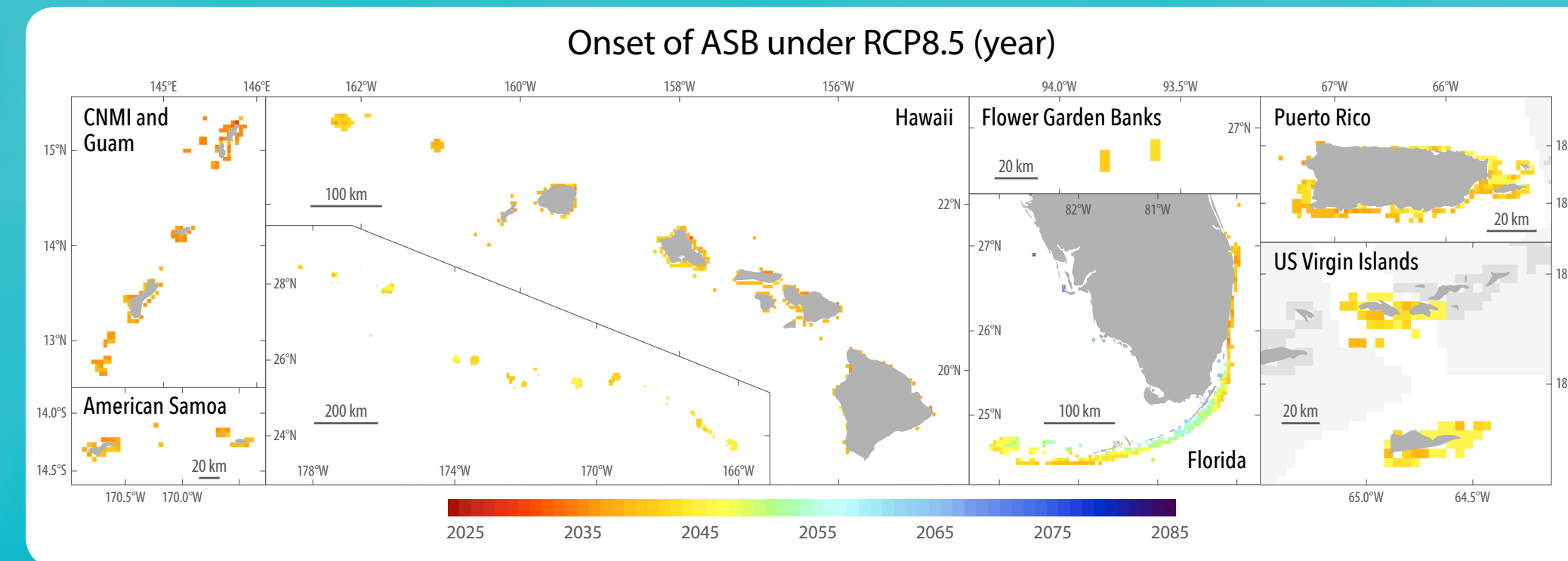
Frequency of thermal stress events >4 Degree Heating Weeks (DHWs) between 1982 and 2012. Thermal stress meeting and exceeding 4 DHWs is associated with moderate bleaching.



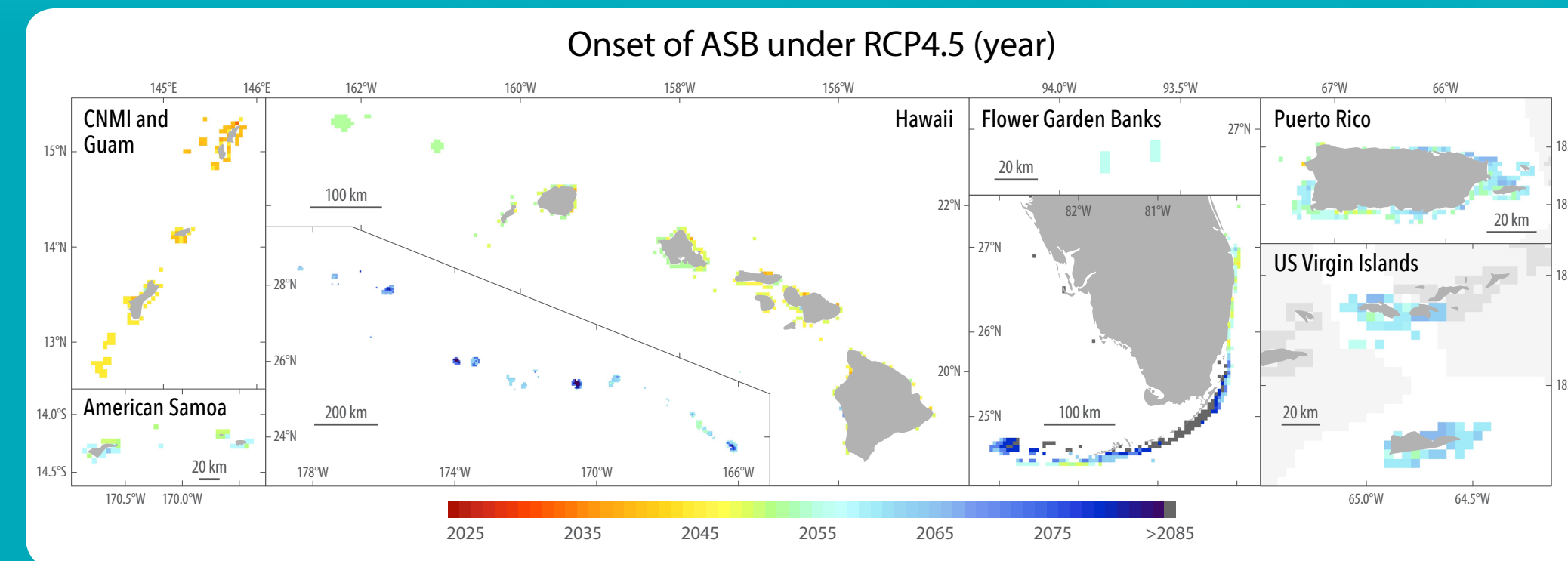
Frequency of thermal stress events >8 Degree Heating Weeks (DHWs) between 1982 and 2012. Thermal stress meeting and exceeding 8 DHWs is associated with severe bleaching.

These data and maps are adapted from this publication:

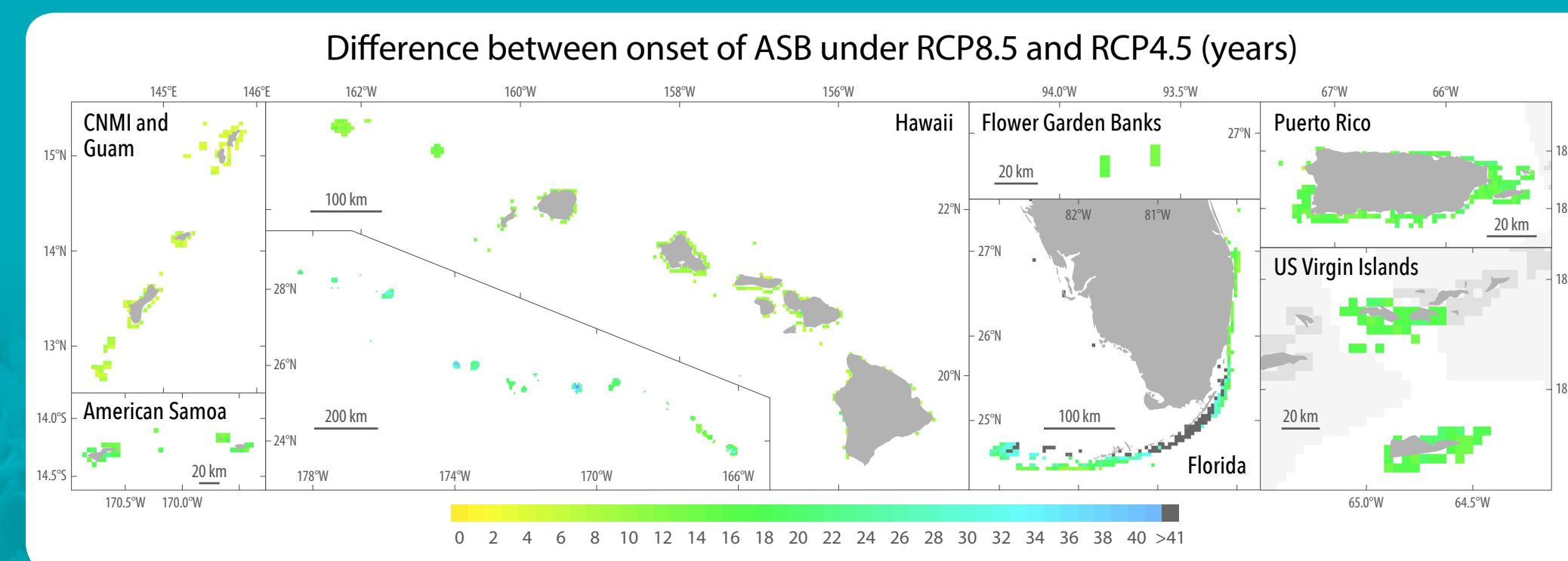
Heron, S. F., Maynard, J. A., & Ruben van Hooidonk, C. (2016). Warming Trends and Bleaching Stress of the World's Coral Reefs 1985–2012. *Scientific Reports*, 6.



Projected timing of the onset of annual severe bleaching under RCP8.5. At this point in time, the current generation of climate models suggest that thermal stress severe enough to cause bleaching will occur every year.



Projected timing of the onset of annual severe bleaching under RCP4.5.



Difference in years between RCP8.5 and RCP4.5 in the timing of annual severe bleaching.

These data and maps are adapted from these publications:

van Hooidonk, R., Maynard, J., Tamelander, J., Gove, J., Ahmadi, G., Raymundo, L., ... & Planes, S. (2016). Local-scale projections of coral reef futures and implications of the Paris Agreement. *Scientific Reports*, 6.

van Hooidonk, R., Maynard, J. A., Manzello, D., & Planes, S. (2014). Opposite latitudinal gradients in projected ocean acidification and bleaching impacts on coral reefs. *Global Change Biology*, 20(1), 103–112.

References cited:

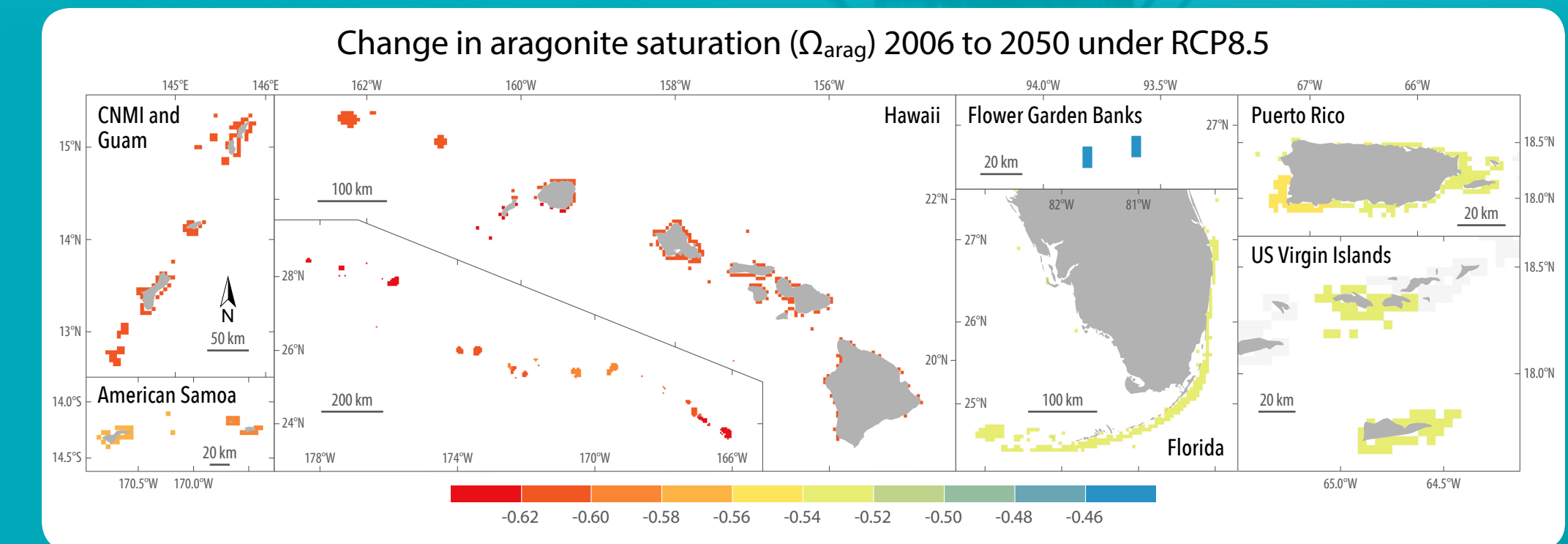
Chan NCS, Connolly SR (2013) Sensitivity of coral calcification to ocean acidification: a meta-analysis. *Global Change Biology*, 19, 282–290.
Glynn PW (1997) Bioerosion and Coral Reef Growth: A Dynamic Balance. In: *Life and death of coral reefs* (ed Birkeland C), pp. 69–98. Springer.

Note on emissions scenarios:

The emissions scenarios used by the Intergovernmental Panel on Climate Change (IPCC) are called Representative Concentration Pathways. RCP8.5 reflects 'business-as-usual', i.e. that climate policy will have little to no effect on the growth of greenhouse gas concentrations in the atmosphere between now and 2100. We are currently tracking above what

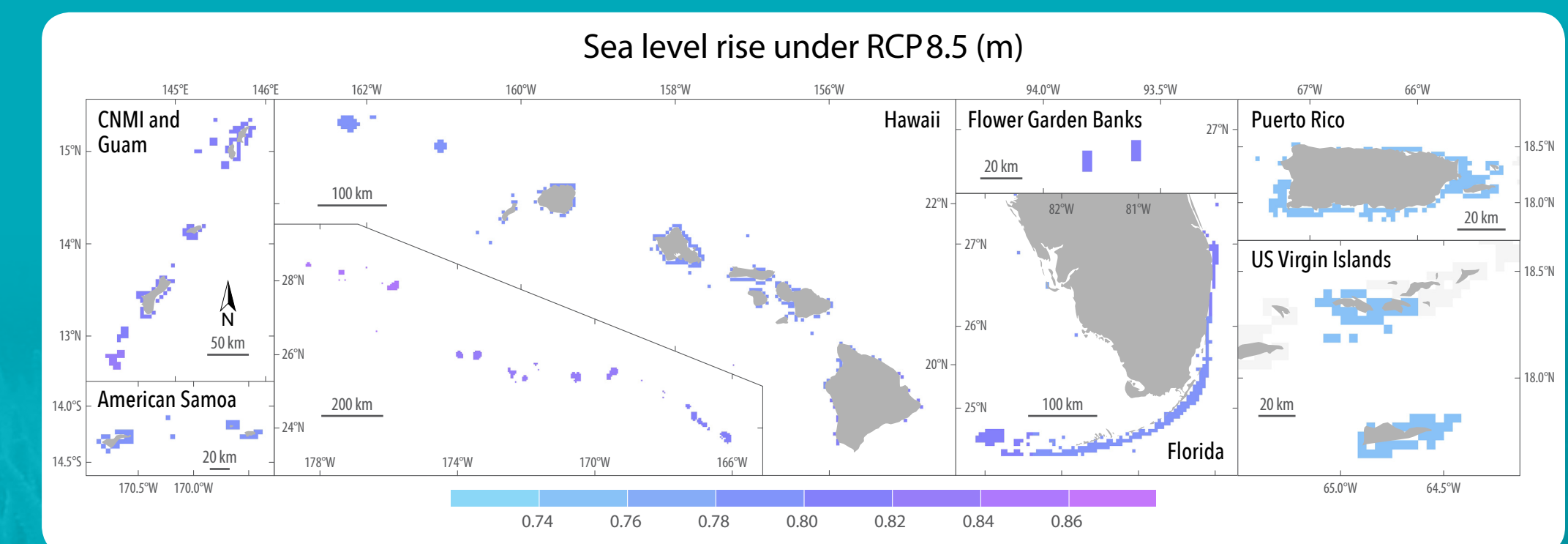
RCP8.5 suggested would be the CO₂ concentration (at the Mauna Loa observatory in Hawai'i) in 2017. RCP4.5 is a stabilization scenario that assumes emissions outputs will reduce in the coming decades and stabilize later in the century. Greenhouse gas concentrations in 2050 under RCP4.5 represent 1.5 times the reductions in emissions pledged

under the recently ratified Paris Agreement. Recent emissions reductions pledges are not enough for RCP4.5 to represent our future; however, these recent pledges may result in great momentum in our efforts to reduce emissions. We can compare RCP8.5 and RCP4.5 to examine the effects of our efforts to reduce emissions on coral reef futures.



Coral calcification could decline 15% for each unit of Ω_{arag} declined.

This number is an estimate from a meta-analysis of 25 studies presented in Chan & Connolly (2013). Small changes in calcification could mean that a reef switches from net accretion to net dissolution because reefs are dynamic ecosystems where rates of CaCO₃ production only slightly outpace the loss of CaCO₃ due to physical and biological erosion (Glynn, 1997). Numerous local factors determine how acidification affects calcification rates. Changes in aragonite saturation state are projected to be lower in the Caribbean than the Pacific and lower in Guam than other parts of the Pacific.



Projected sea level rise (a mean of all of the current generation of climate models (CMIP5)) under RCP8.5 between 2006 and 2100.

PAST

Coral bleaching in American Samoa. Images © XL Catlin Seaview Survey.

PROJECTED FUTURE

