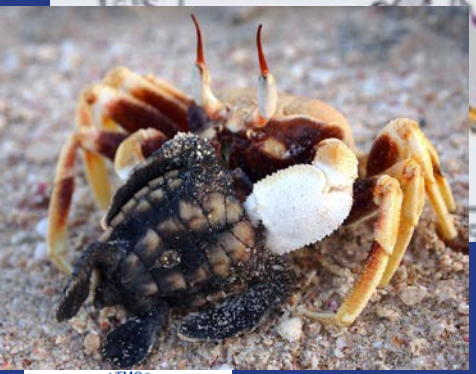

Project Sim Turtle

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NCAR/CGD/Ocean Section

Matthew Long, Nathan Putman, Jessica Luo, Qingfeng Li

Project Sim Turtle: Motivation

Sea turtles are:

- Endangered
- Have a “cryptic” juvenile phase of oceanic dispersal
- Understanding where they spend these “lost years” helps us:
  - Find and sample them
  - Understand what features/regions are critical for their survival
  - Assess their sensitivity to climate change

Questions:

- What are the optimal migration pathways?
- Do the modeled pathways look like observed turtle tracks?
- How do these optimal pathways utilize the ocean? (e.g., interiors vs. exteriors of eddies, jets, regions etc?)
- Can we back out optimal behavior?
- Can we identify critical ocean habitats and how these may be affected by climate change?

Models and Methods

Ocean Model: Global CESM-BEC, x0.1, CORE normal year, 5 year run

- 5-day output
- Full biogeochemistry

Particle Tracking Model: CMS (Paris et al. 2013)

- Modified to output ecosystem variables along trajectories
- Added directed swimming

Experiment Design:

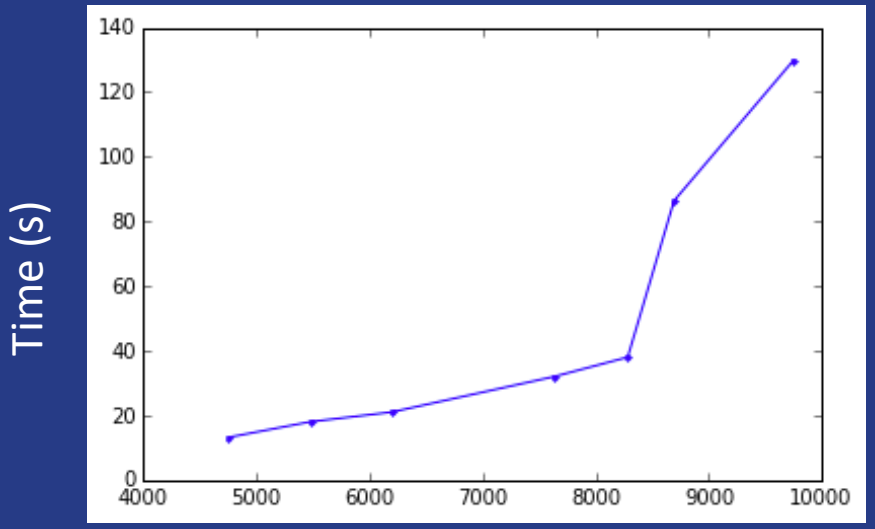
- Simulate Loggerheads (*Caretta caretta*)
- Release at all global nesting sites, track for 1-4 years
- Calculate temperature and food availably along trajectories
- Food:
  - NPP
  - bioC = sum of plankton biomass

A Plug for Particle Pushing

Particle Tracking is Useful!

- Dispersal and connectivity
- Effects of circulation features
- Transport boundaries
- Pathways for nutrients
- Thermohaline circulation

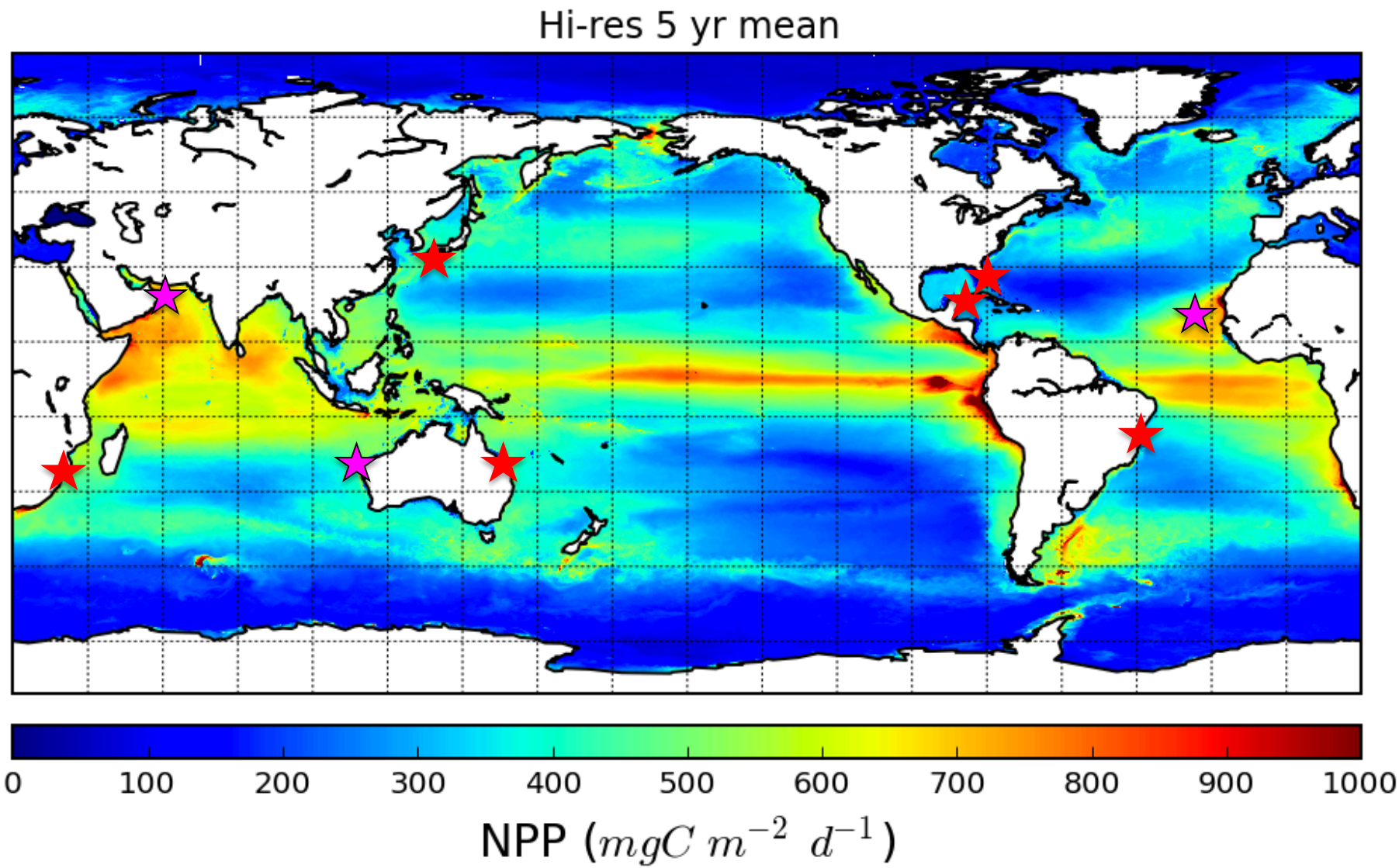
Computational cost per day integration



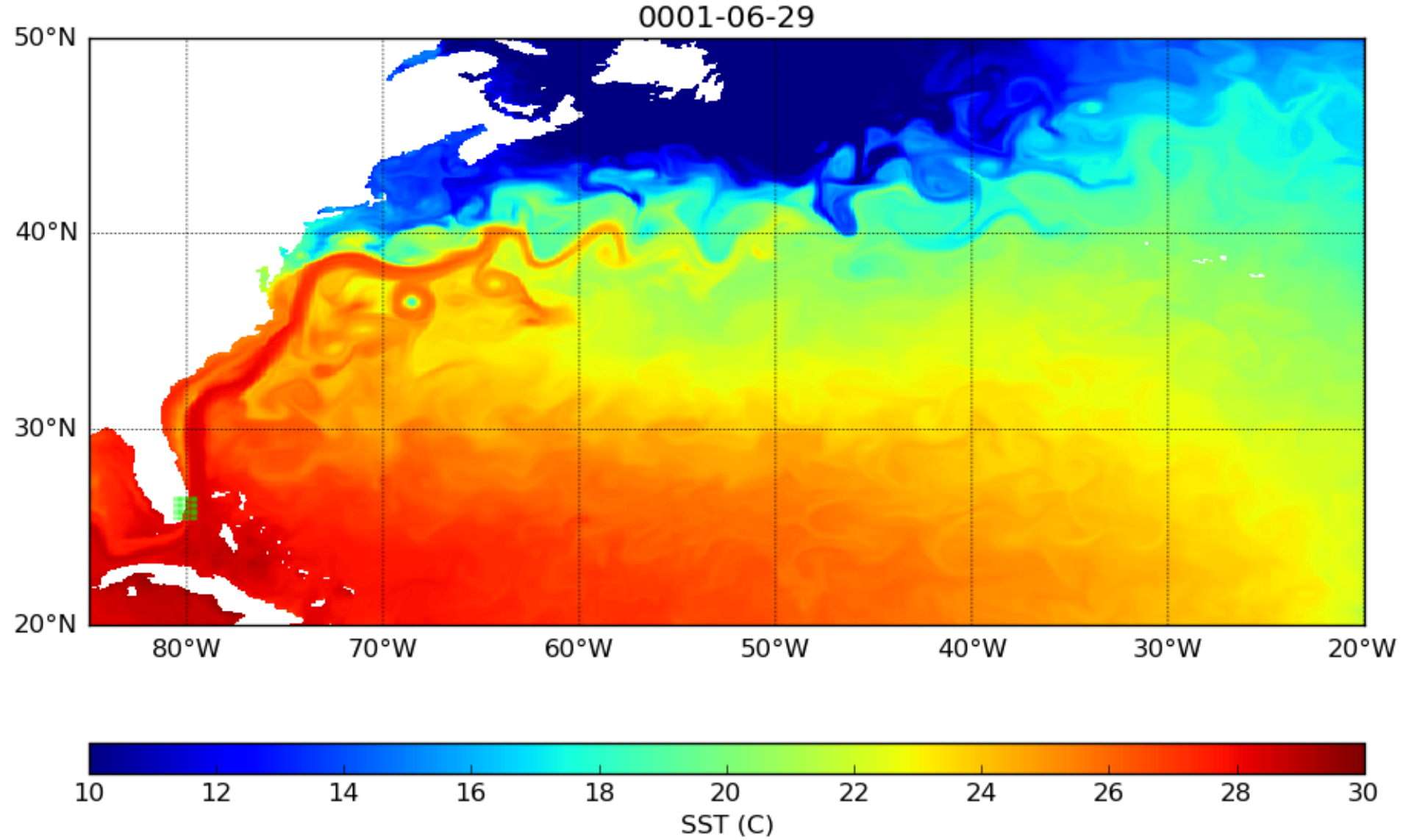
CMS is a Good Code Package!

- MPI enabled
- 2D or 3D
- Scales well with number of particles
- Simulation of subgridscale processes

Hacks: “swimming”, variables output along trajectories



Global Release sites



Methods:

Showing 5-day trajectories, green is last day

Released every 5 days in hatching season

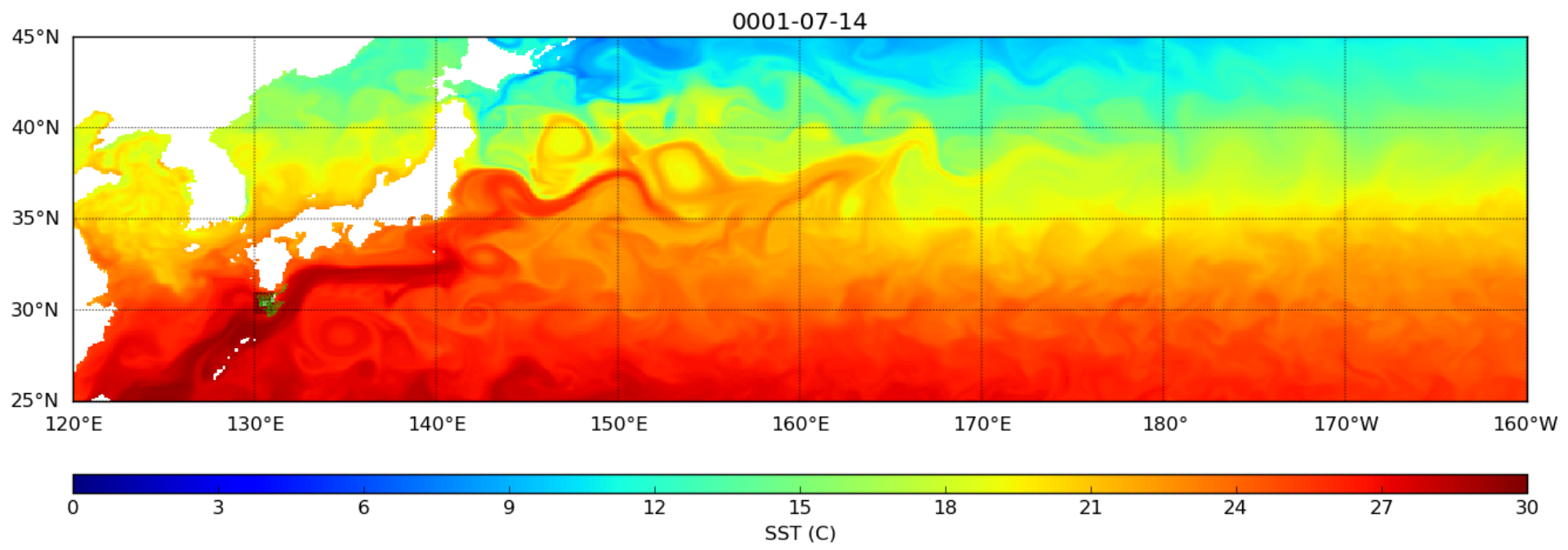
CESM BEC x0.1 CORE normal year

Results:

Concentrated on north flank of Gulf Stream

Most productive region in North Atlantic

North Pacific: Yakashima Island



Methods:

Showing 5-day trajectories, green is last day

Released every 5 days in hatching season

CESM BEC x0.1 CORE normal year

Results:

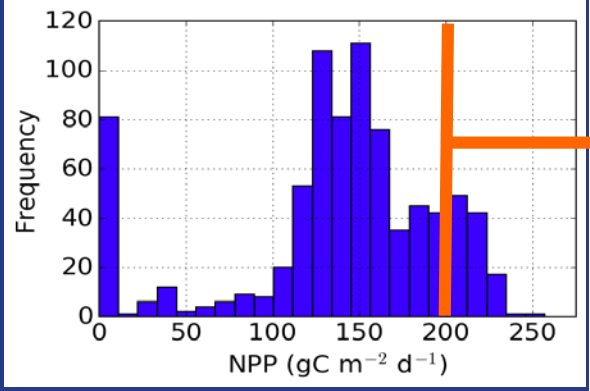
Concentrated on north flank of Kuroshio

Most productive region in North Pacific

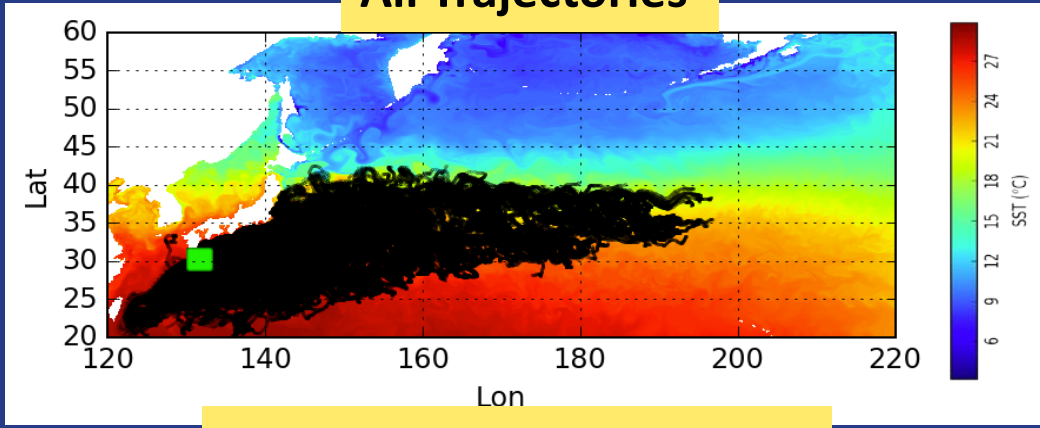
North Pacific

Yakashima Island

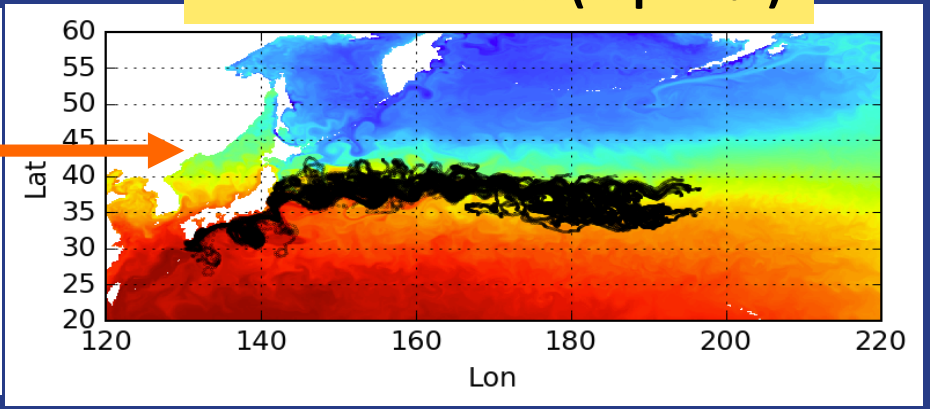
Summed food availability over the first year:

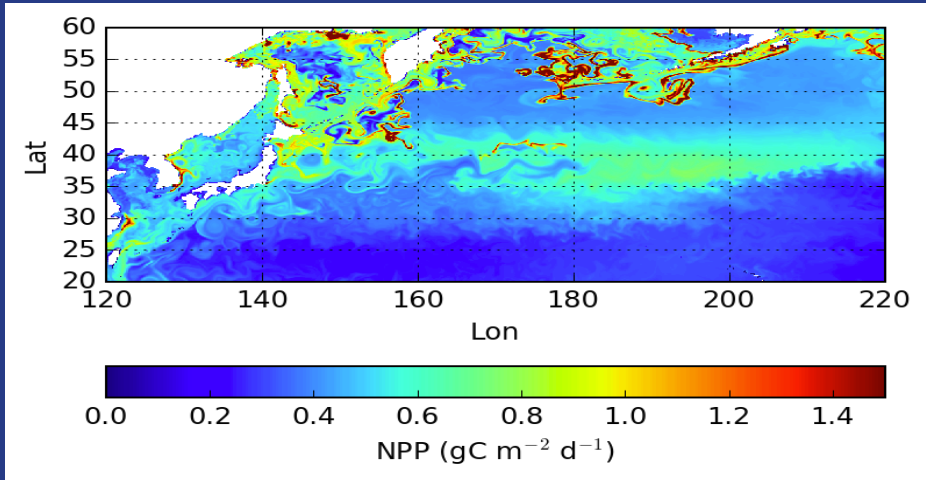


All Trajectories



Well Fed Turtles (top 15%)





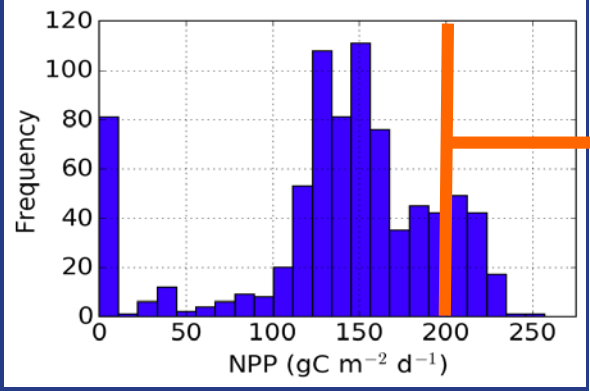
Well fed turtles are associated with northern flank of the Kuroshio Extension:

- **High production**
- **Moderate temperatures**
- **Passive transport**

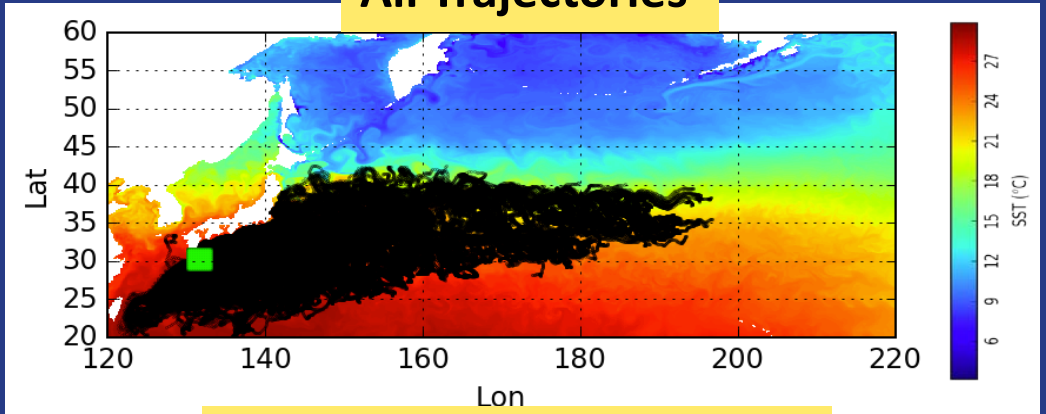
North Pacific

Yakashima Island

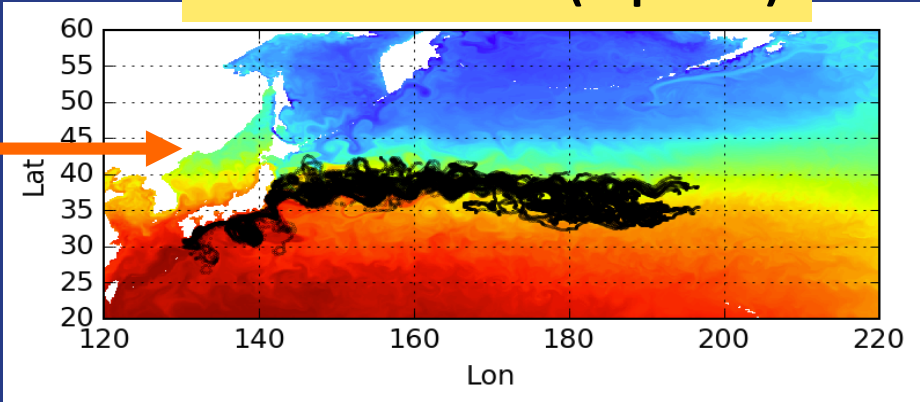
Summed food availability over the first year:



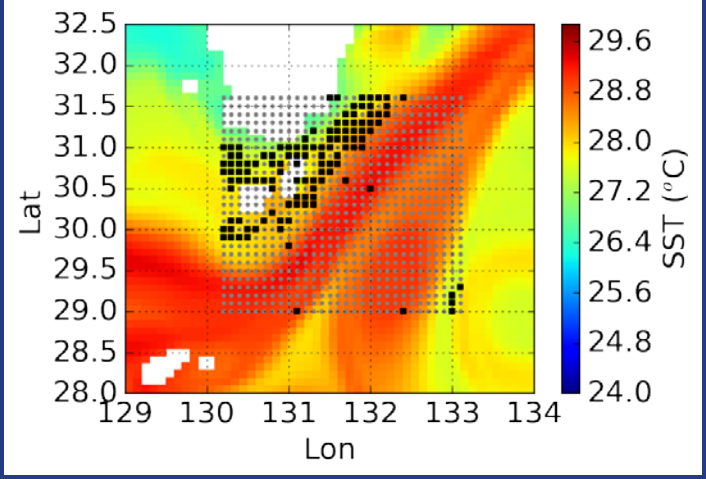
All Trajectories

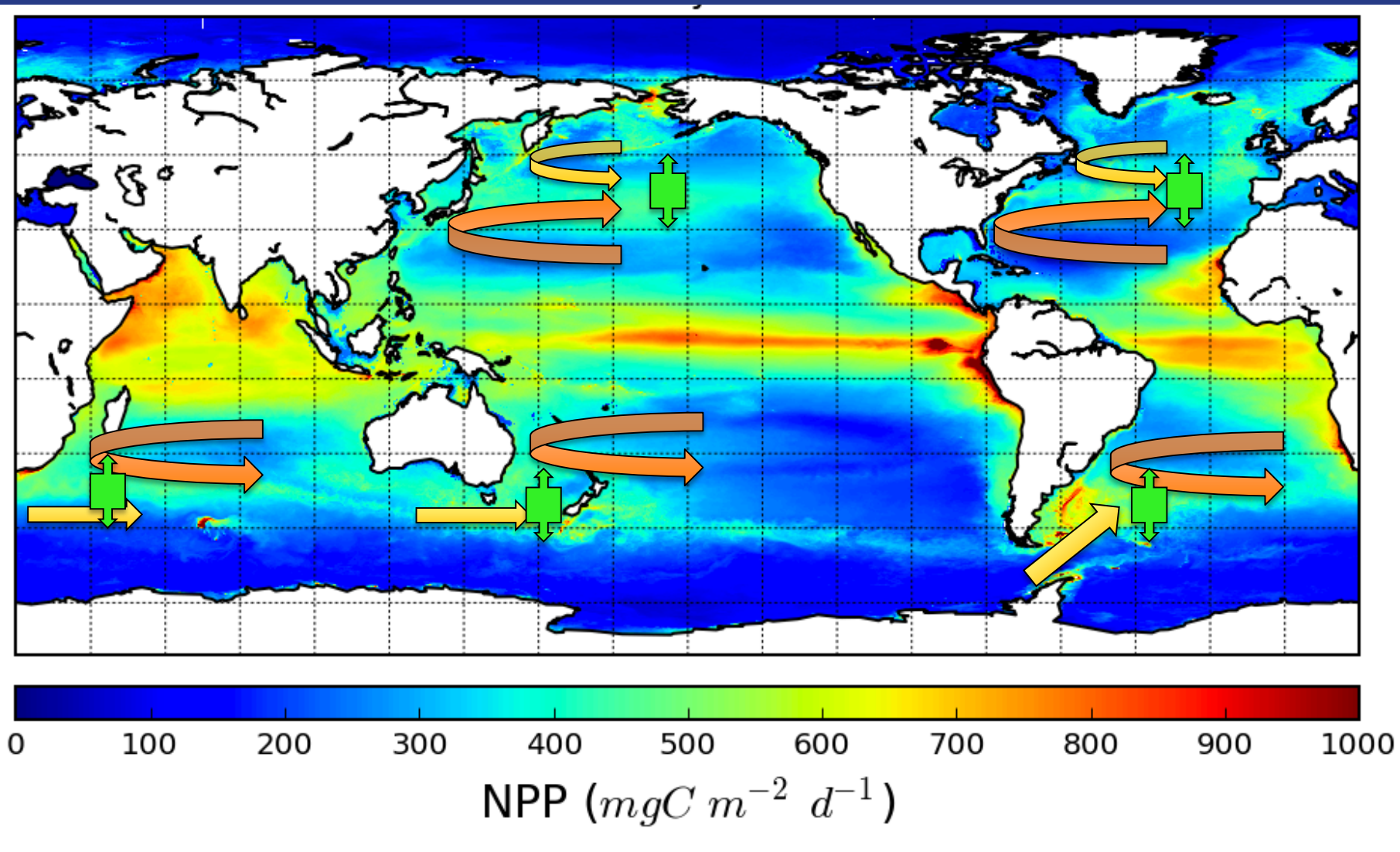


Well Fed Turtles (top 15%)



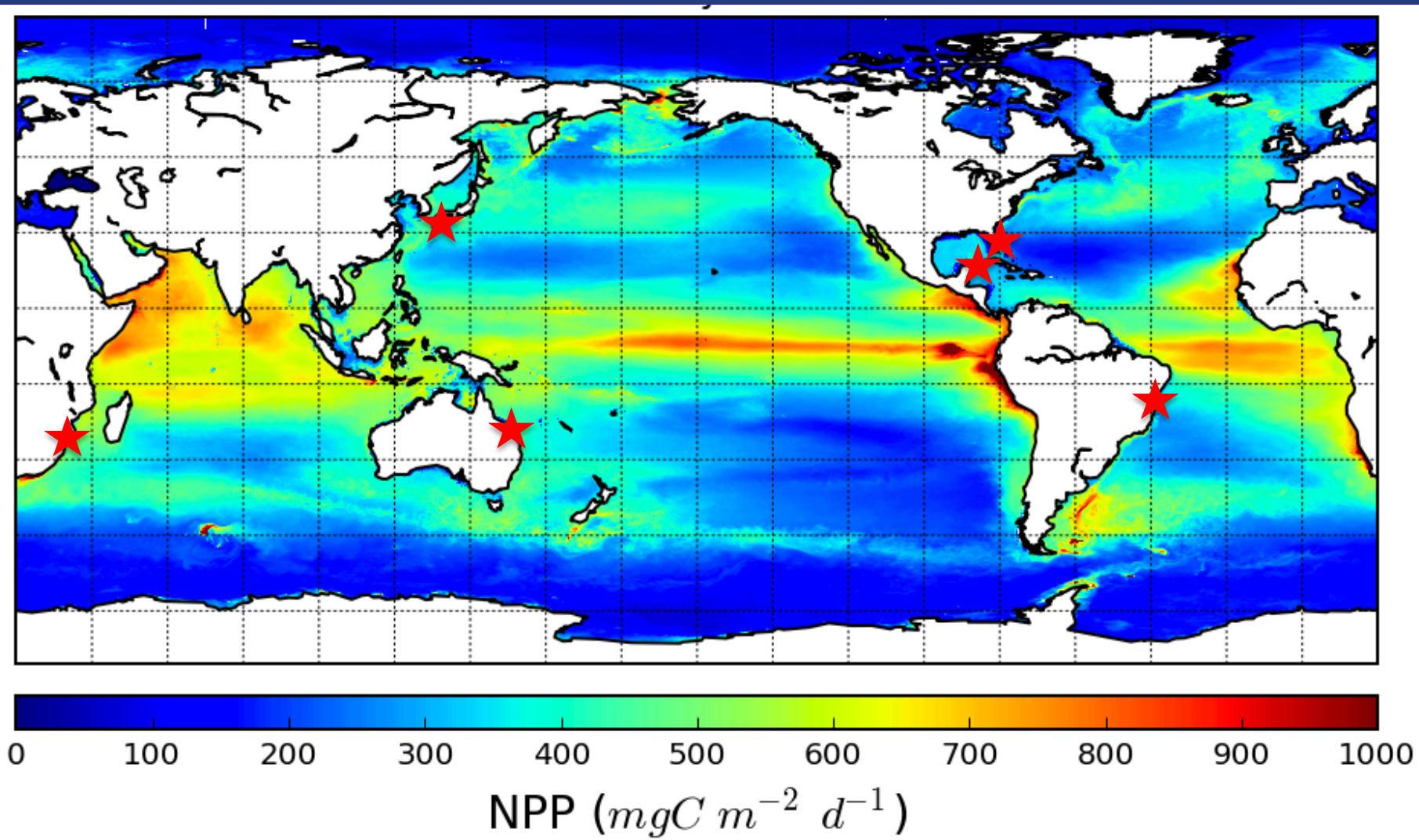
Well fed, non-swimming turtles are largely released north of the Kurioshio jet (red), near Yakashima Is.
=> Nesting at optimal location





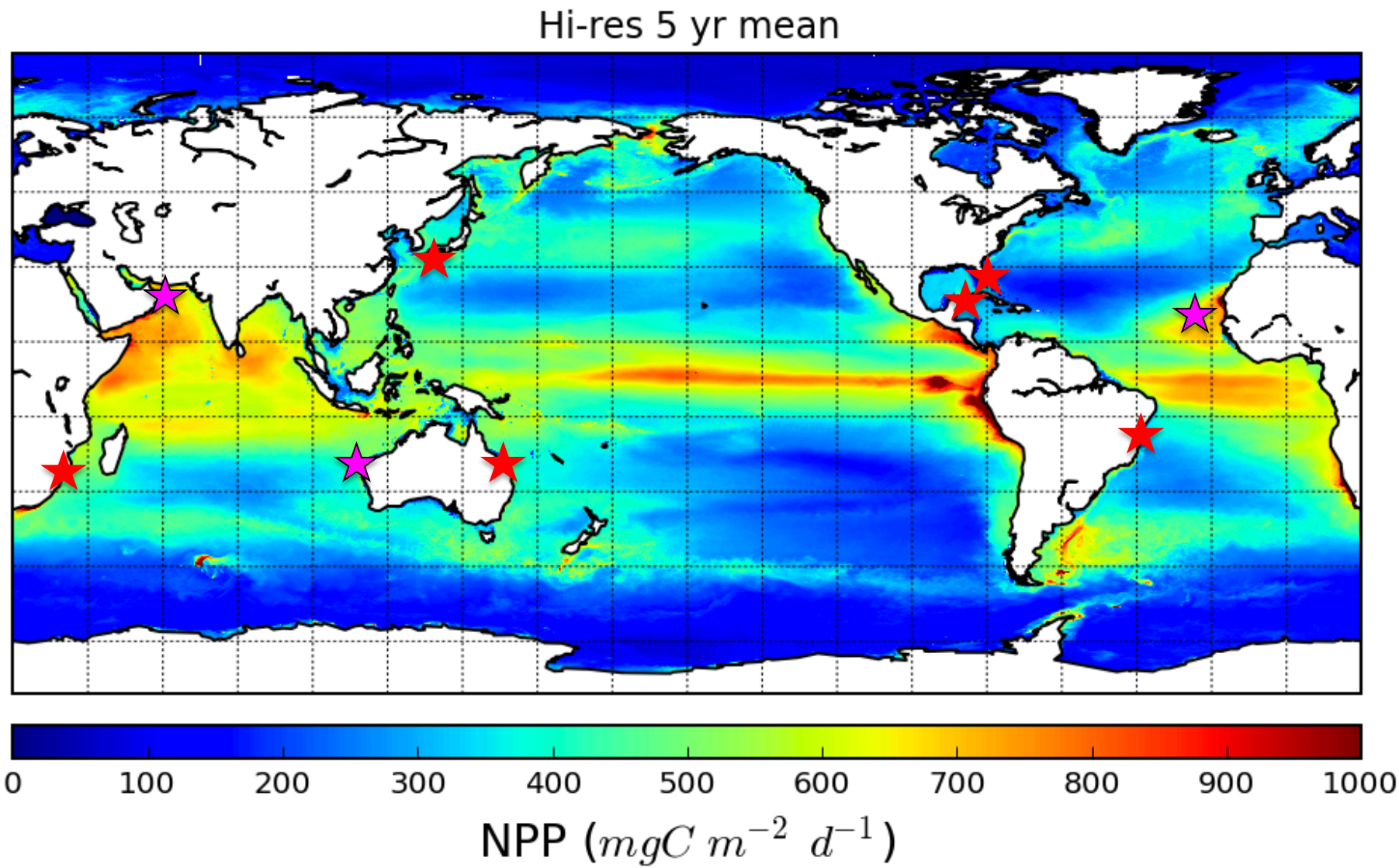
Western boundary current extensions are associated with high production

= high-iron low-nutrient + low-iron high-nutrient + horizontal and vertical mixing



Western boundary current extensions are associated with high production

All have loggerhead nesting populations



Global Release sites

Conclusions and Questions

Turtles are nesting at "optimal" locations

- Warm
- Freeway to productive waters (WBC)
- Or in low dispersal/high food regions (Arabian Sea)

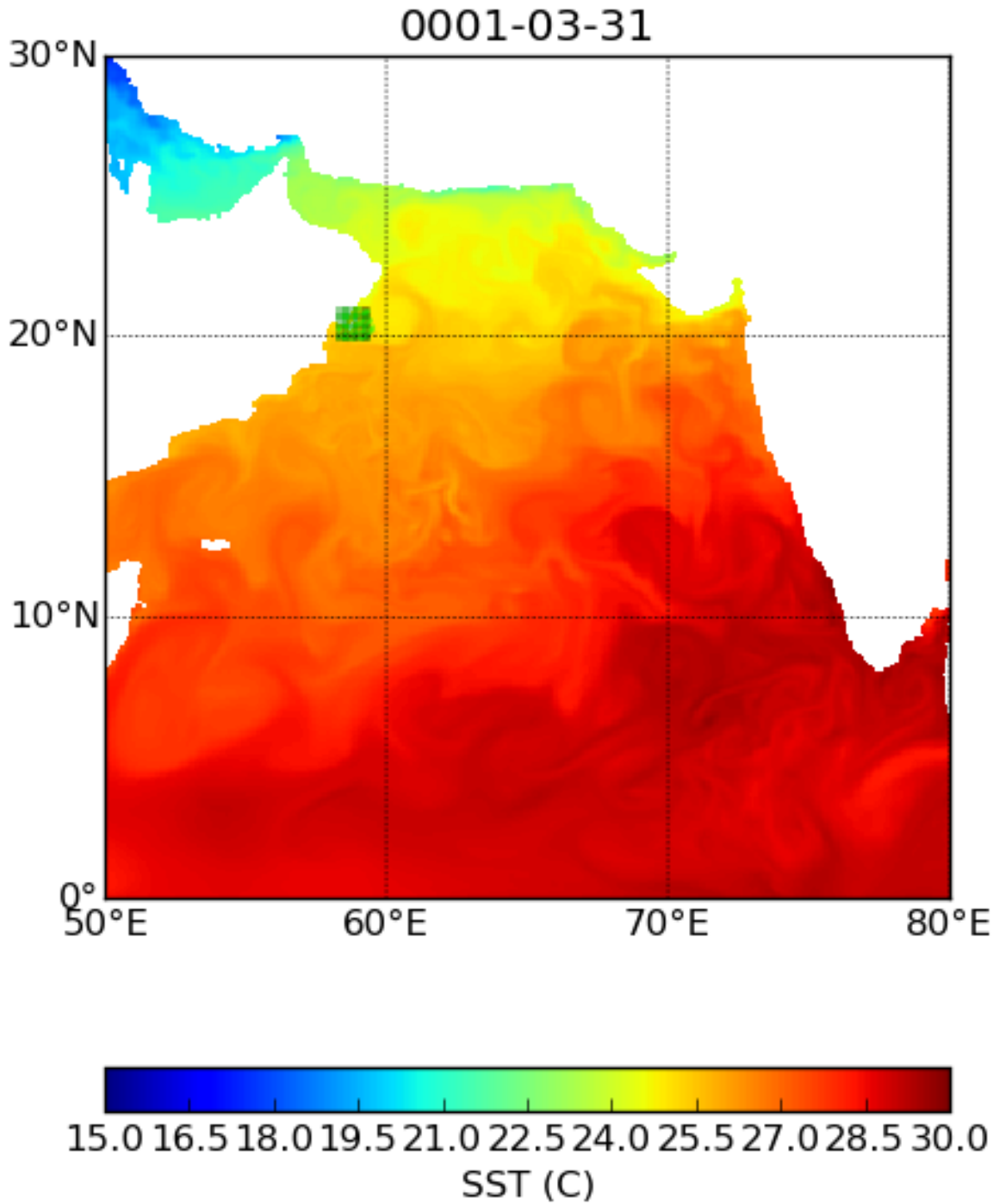
What determines relative success of sites?

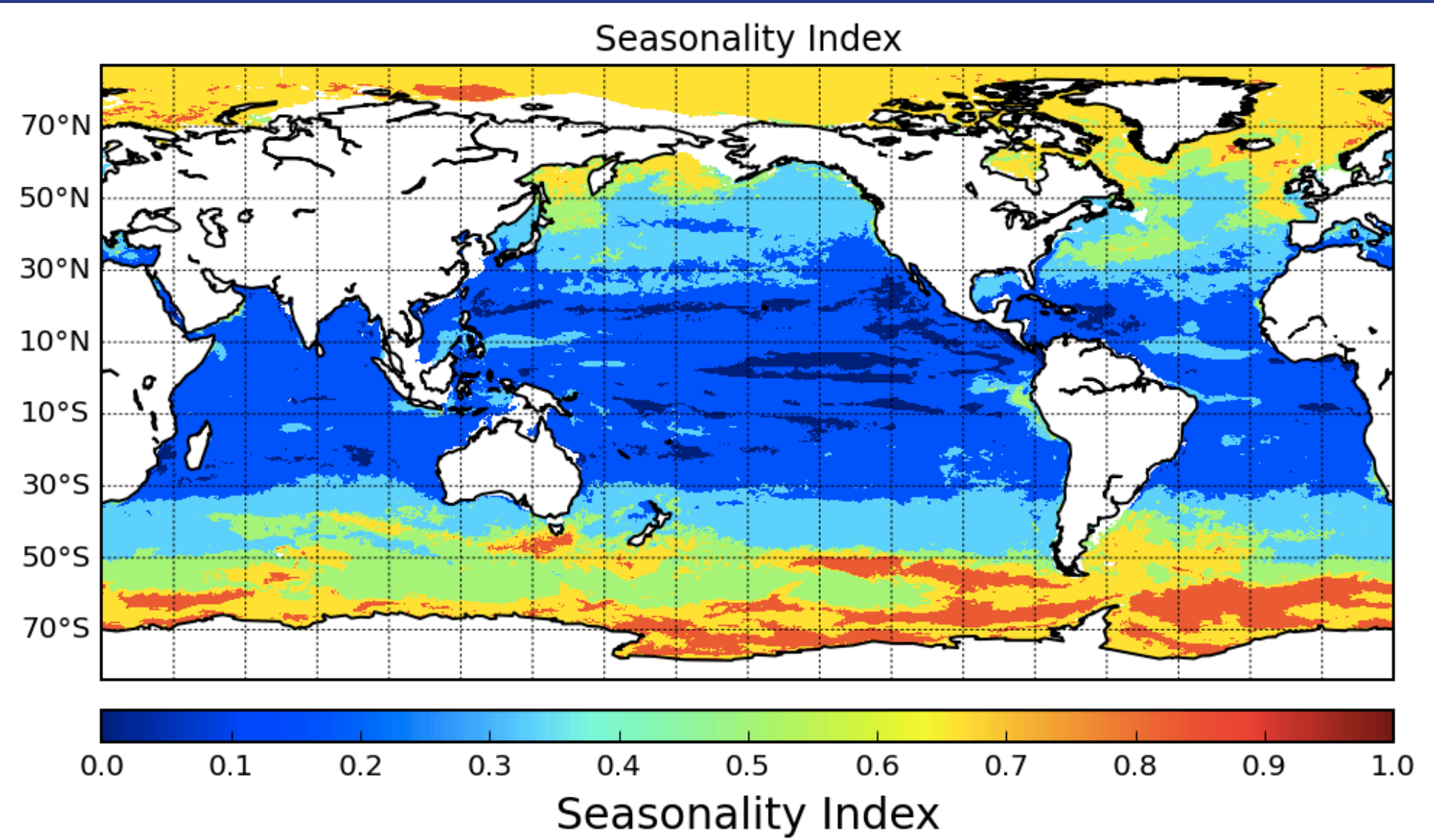
- H1: Easy return route, low energetic cost relative to food intake
  - North Atlantic
  - Arabian Sea
- H2: Having good habitat along the way
  - Sargassum in earliest months (North Atlantic)
  - Good, reliable feeding pit stops (Azores, Bahamas)

What happens to these regions under climate change?

Thank you

Extra Slides


0001-03-31
30°N
20°N
10°N
0°
50°E
60°E
70°E
80°E
15.0 16.5 18.0 19.5 21.0 22.5 24.0 25.5 27.0 28.5 30.0
SST (C)



SI = (6-HT)/6, where HT is the export half-time