The Second JIMAR/PIFSC Symposium
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A Regional Ocean Model System for the Coral Triangle to study coral bleaching and connectivity

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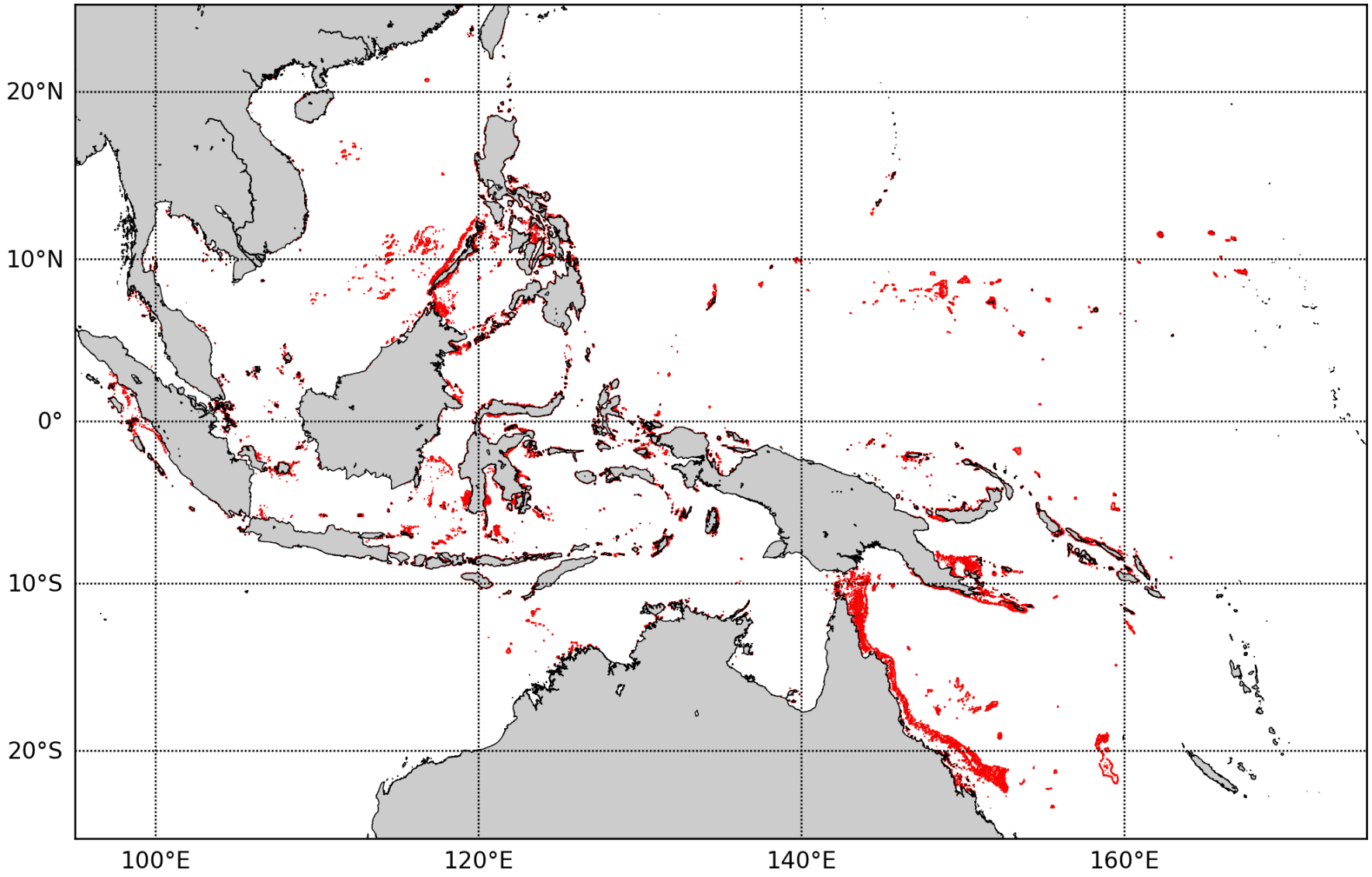
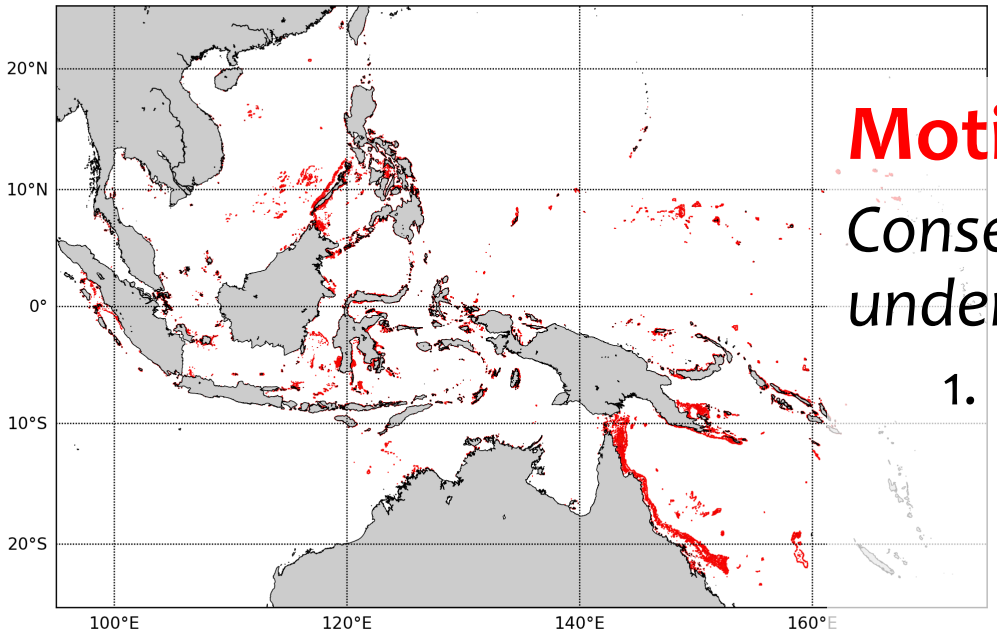
Current focus: The Coral Triangle



Current focus: The Coral Triangle



Motivation:

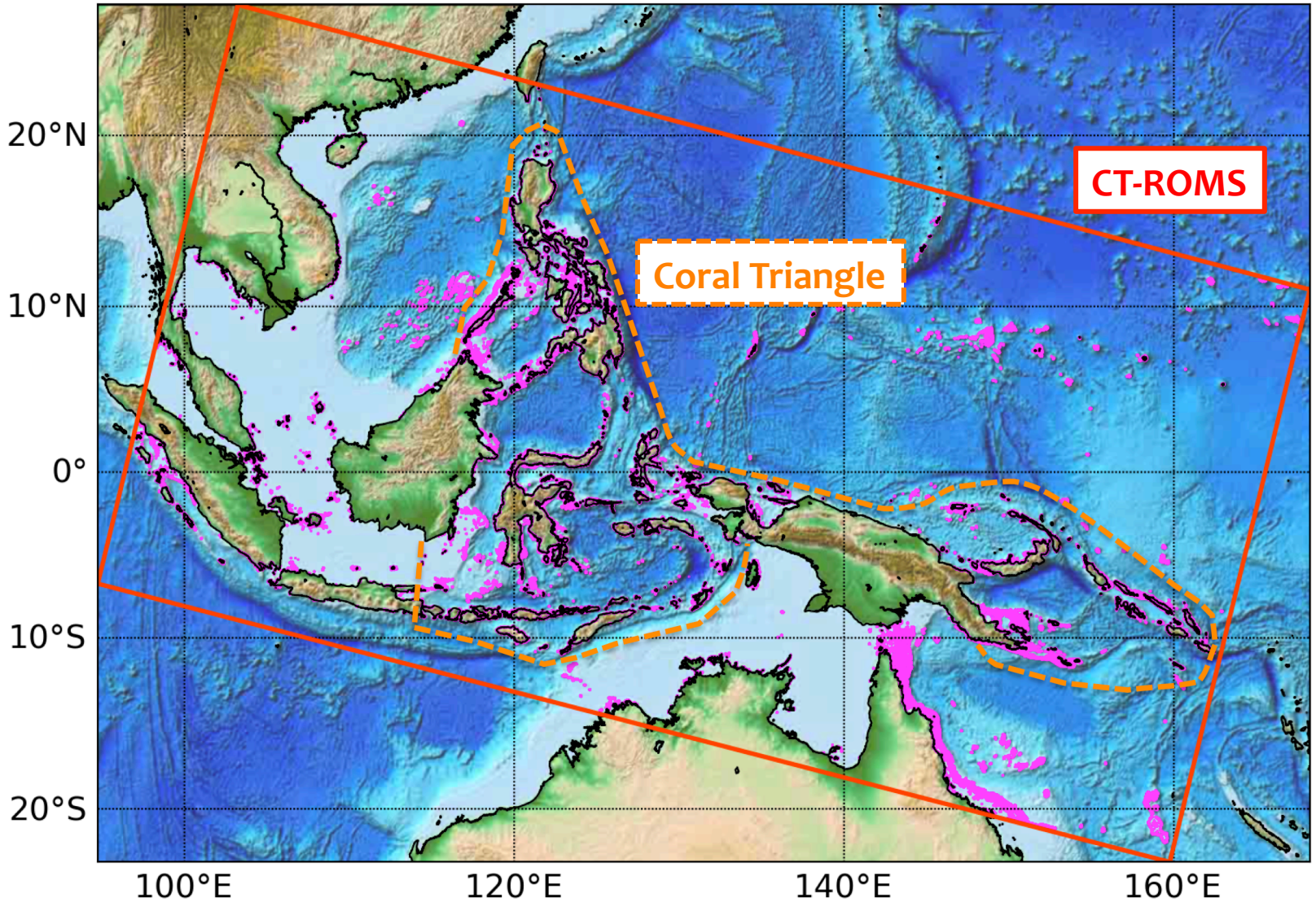
Conservation efforts require understanding of:

1. How oceanographic circulation influences the susceptibility of coral reefs to bleaching
2. Ability of reefs to recolonize via larval-dispersal following a bleaching event

Solution:

Apply high-resolution modeling to examine current and future state of coral reef ecosystems

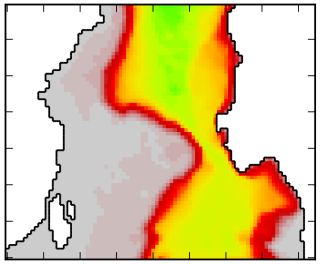
The Coral Triangle



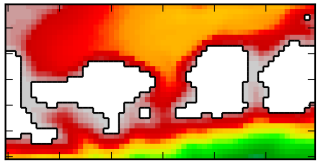
Castruccio et al. (in review) *JGR*

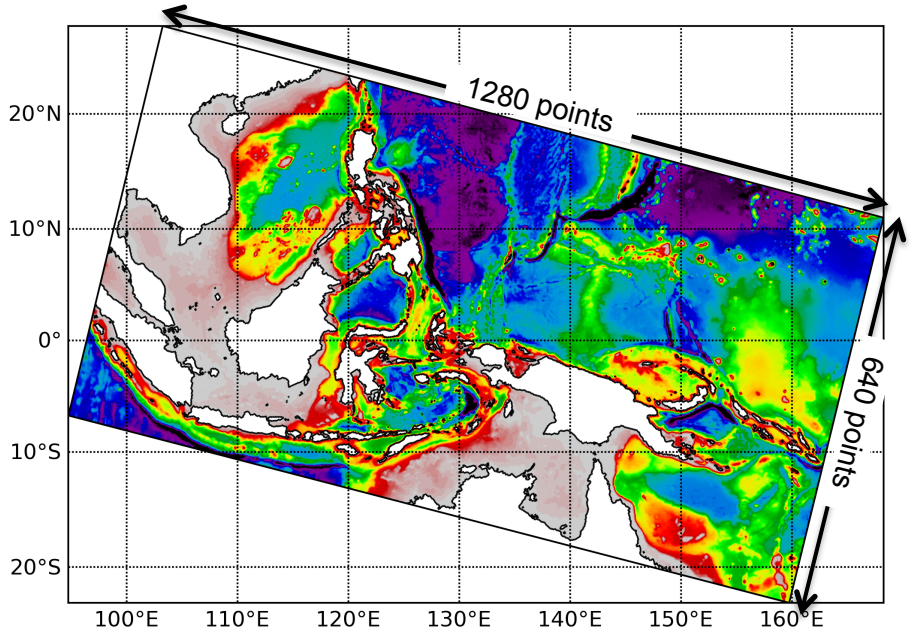
CT-ROMS

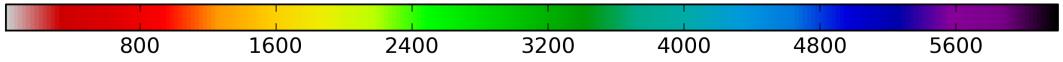
Makassar Strait - Labani Chanel



Lombok Strait

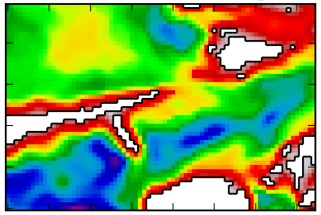




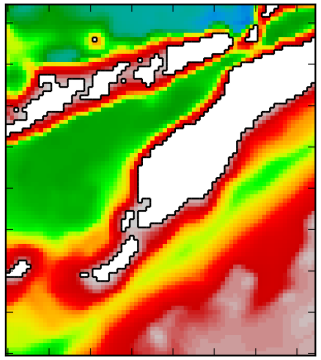


CT-ROMS Bathymetry (in meter). [Castruccio et al., 2013]

Lifamatola Passage



Ombai Strait & Timor Passage



CT-ROMS configuration: ~5-km horizontal resolution with 50 terrain-following levels

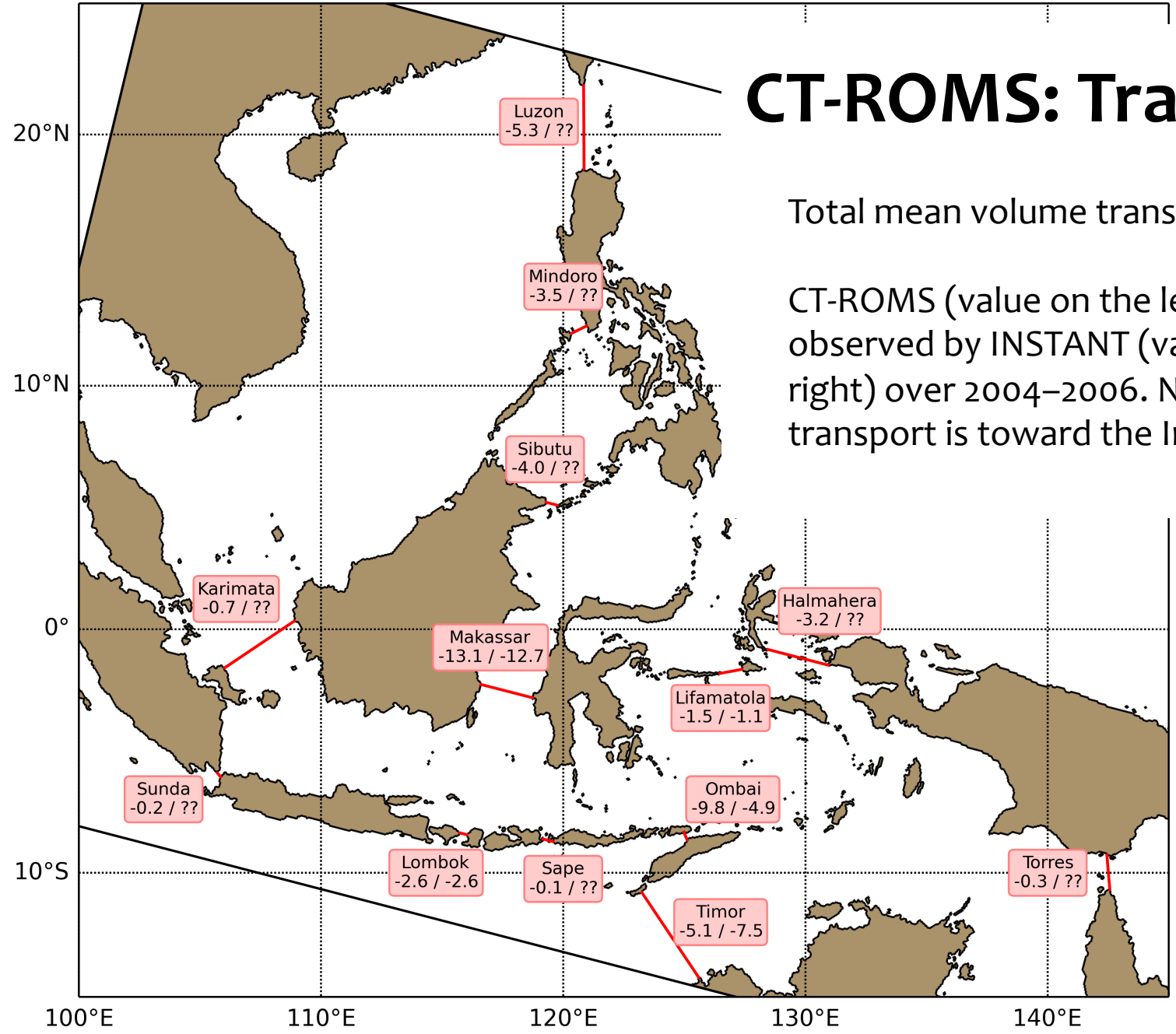
Bathymetry: global SRTM30_PLUS product with 30-sec resolution [Becker et al., 2009]

Atmospheric forcing: Common Ocean-ice Reference Experiments (CORE2) [Large and Yeager 2004]

Boundaries and initial conditions: Simple Ocean Data Assimilation (SODA) [Carton et al., 2000]

Tidal boundary conditions: global model of ocean tides TPXO 7.2 [Egbert and Erofeeva, 2002]

CT-ROMS: Transports



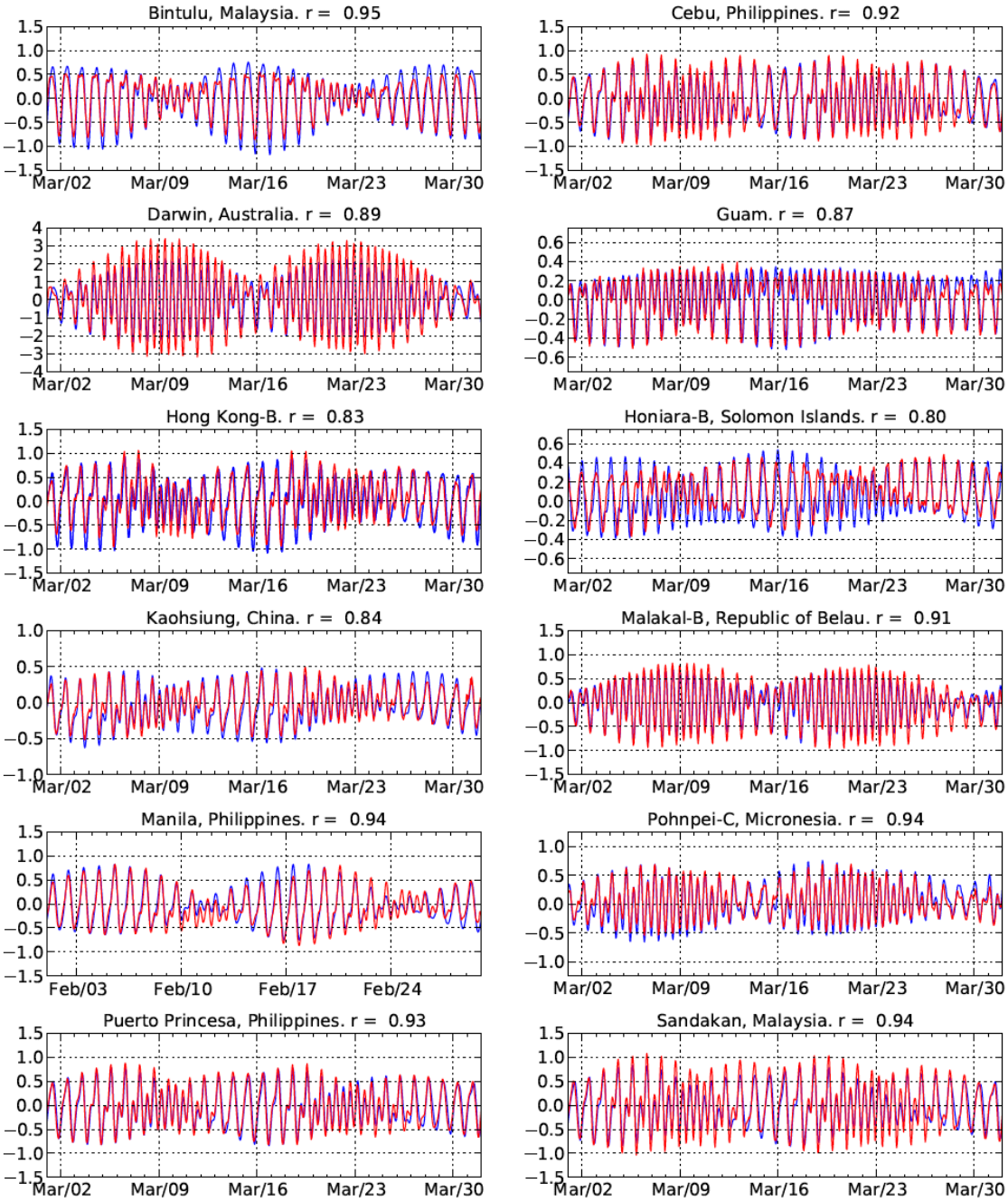
Total mean volume transport (in Sv)

CT-ROMS (value on the left) and observed by INSTANT (value on the right) over 2004–2006. Negative transport is toward the Indian Ocean.

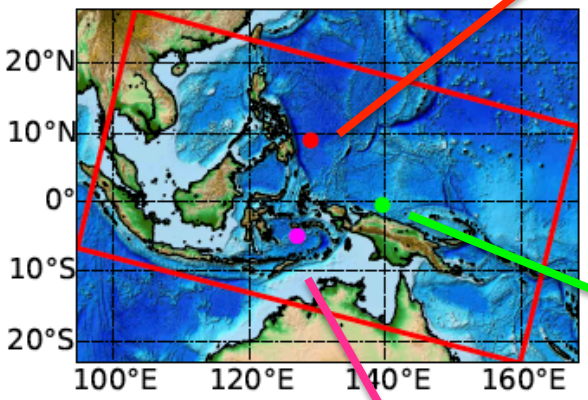
CT-ROMS: Tides

Tide Station Data

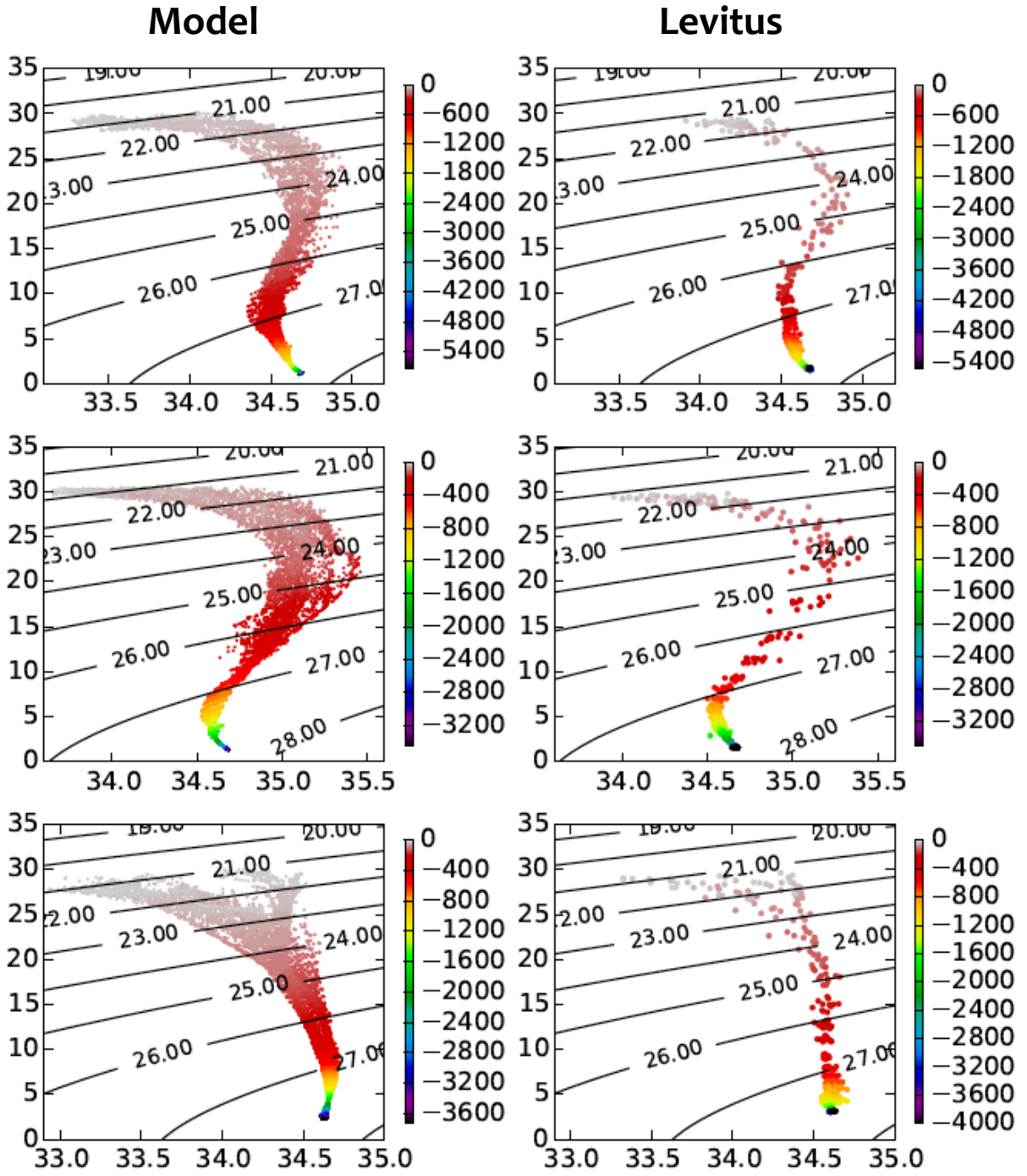
CT-ROMS



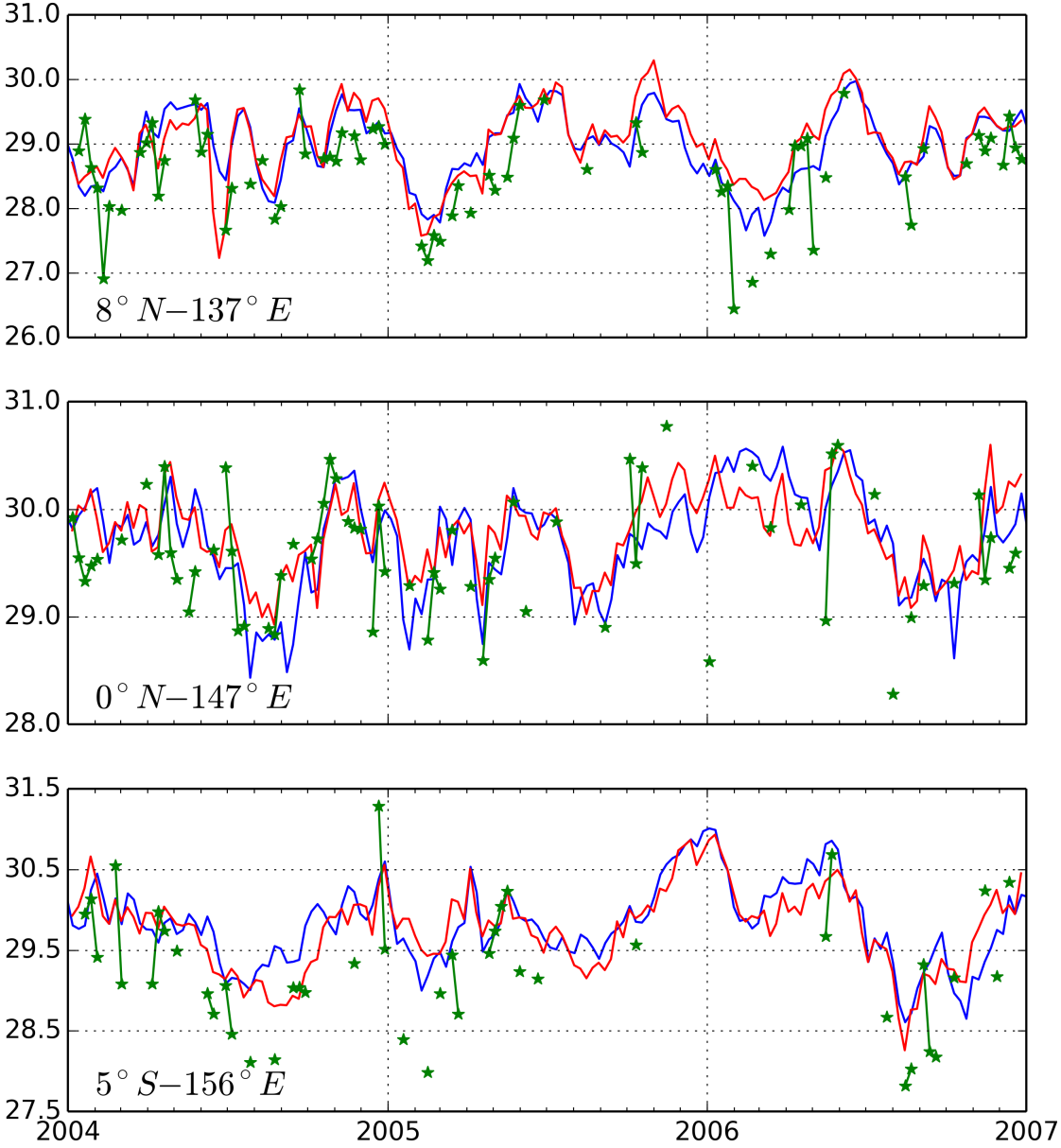
CT-ROMS: TS diagrams

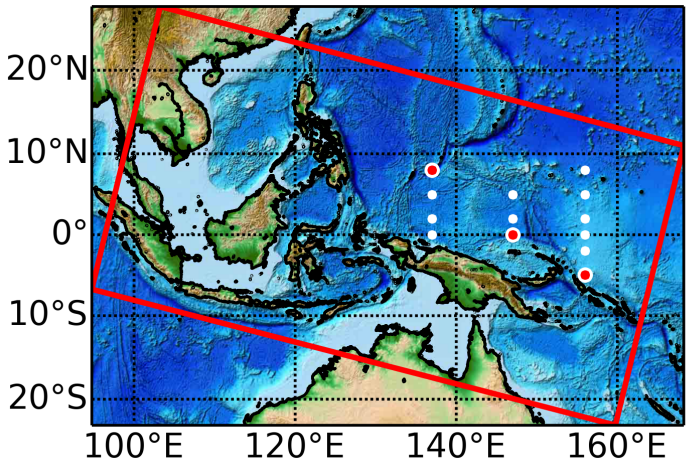


TS diagrams for CT-ROMS (left) and Levitus climatology (right), in the Indonesian Seas entrances (red, North Pacific, and green, South Pacific) and in the Banda Sea (magenta).



CT-ROMS: SST



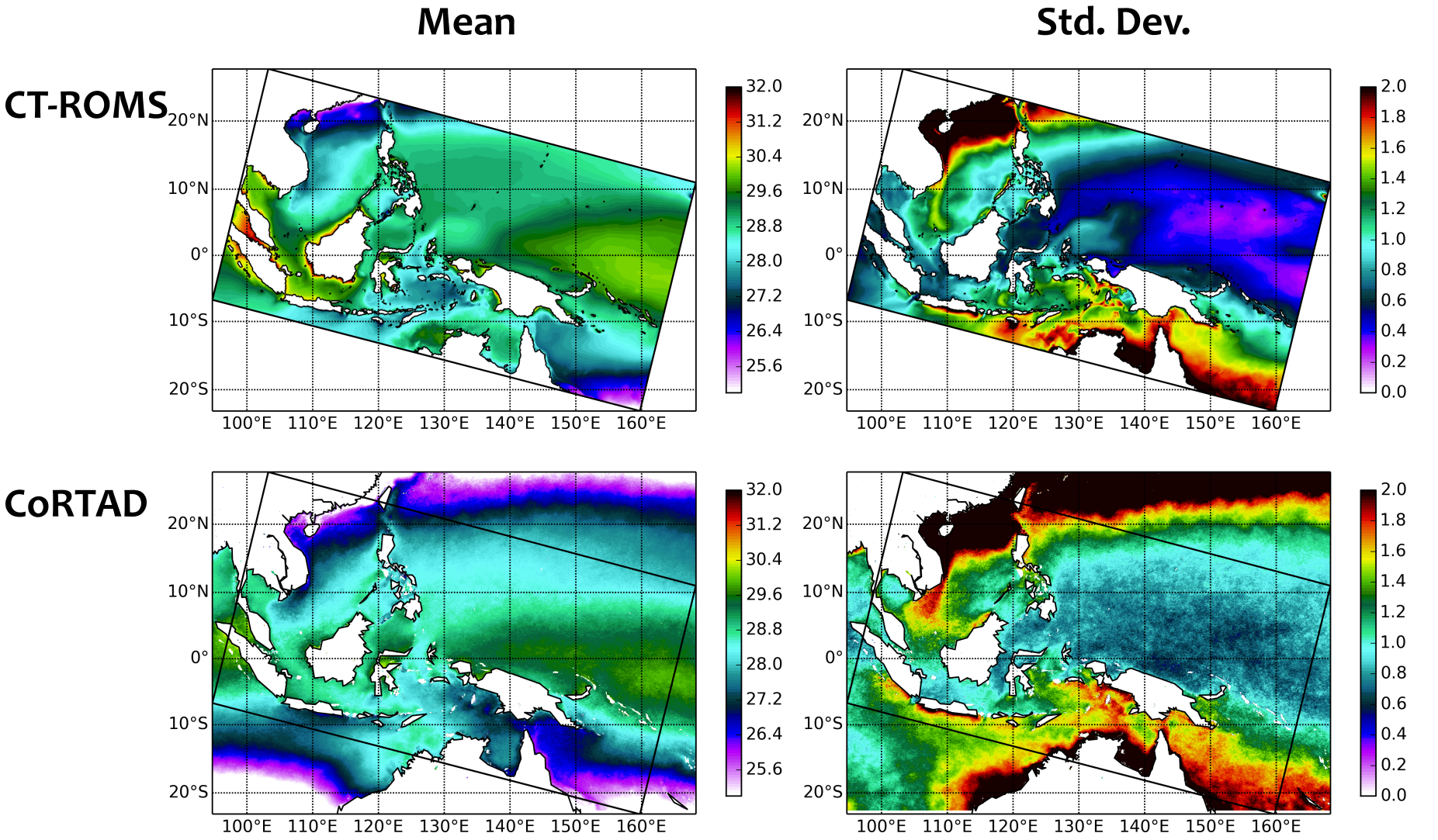


TAO-TRITON

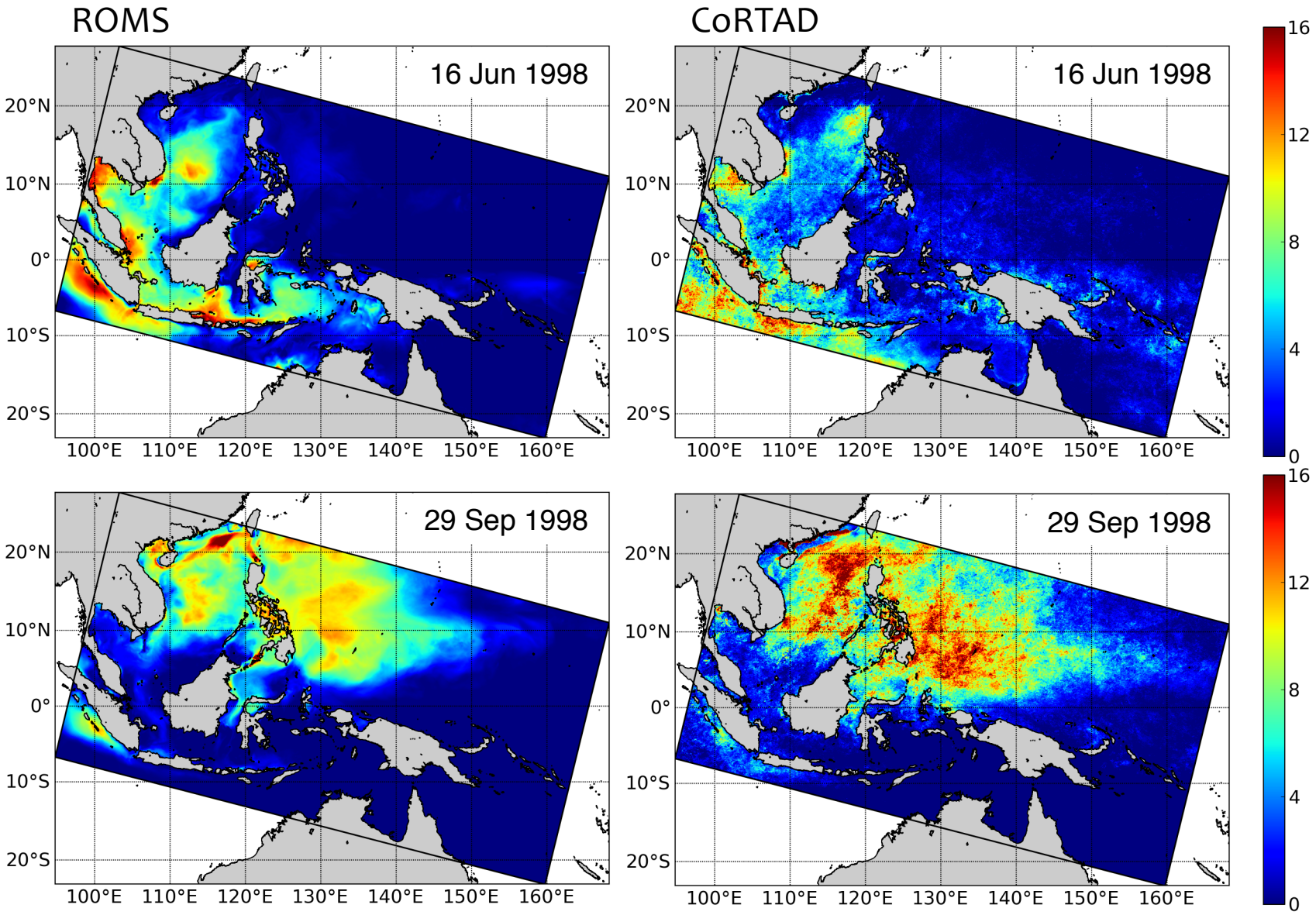
CT-ROMS

CoRTAD

SST: CT-ROMS versus CoRTAD



CT-ROMS: Degree-Heating-Weeks (DHW)



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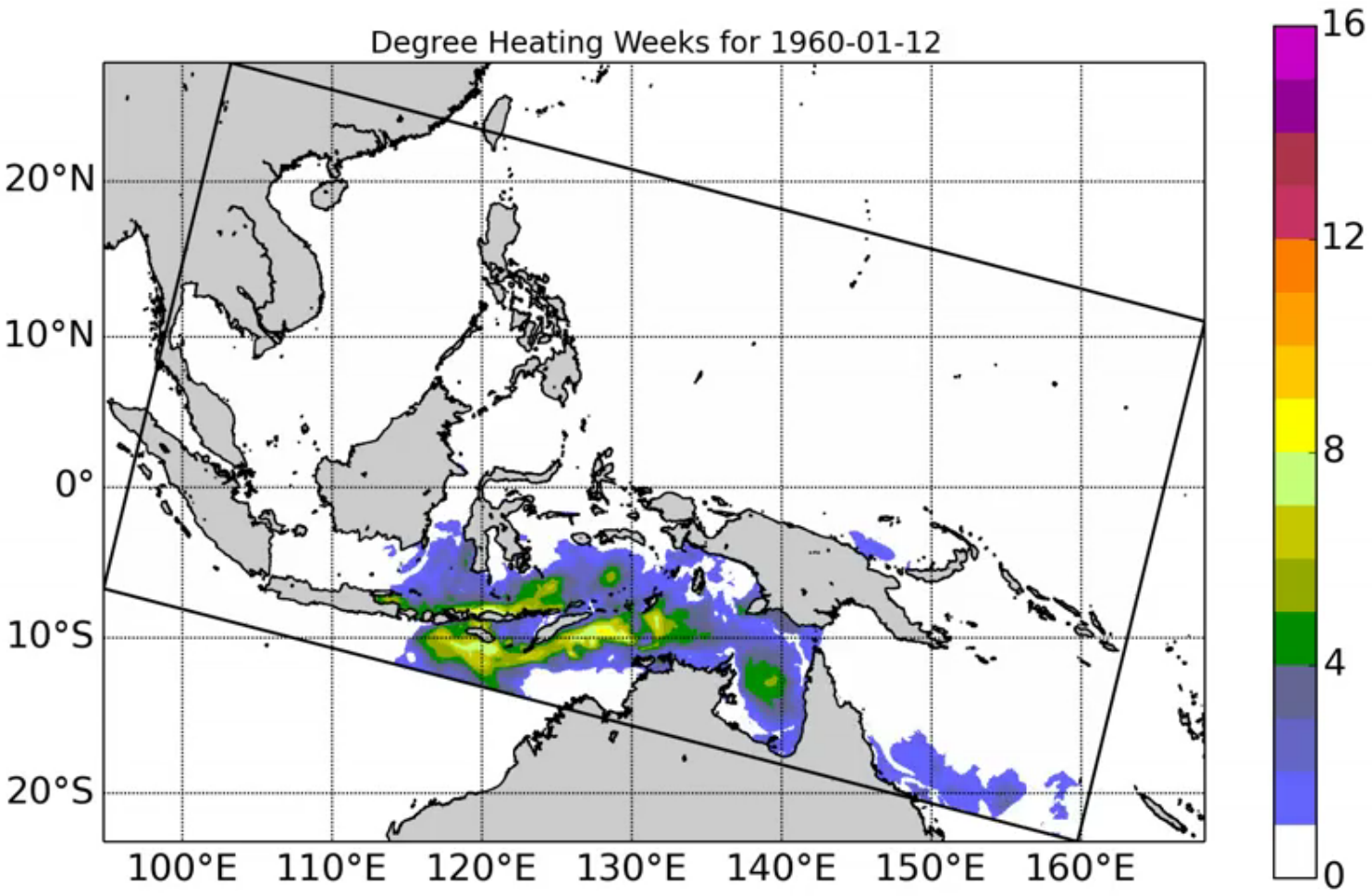
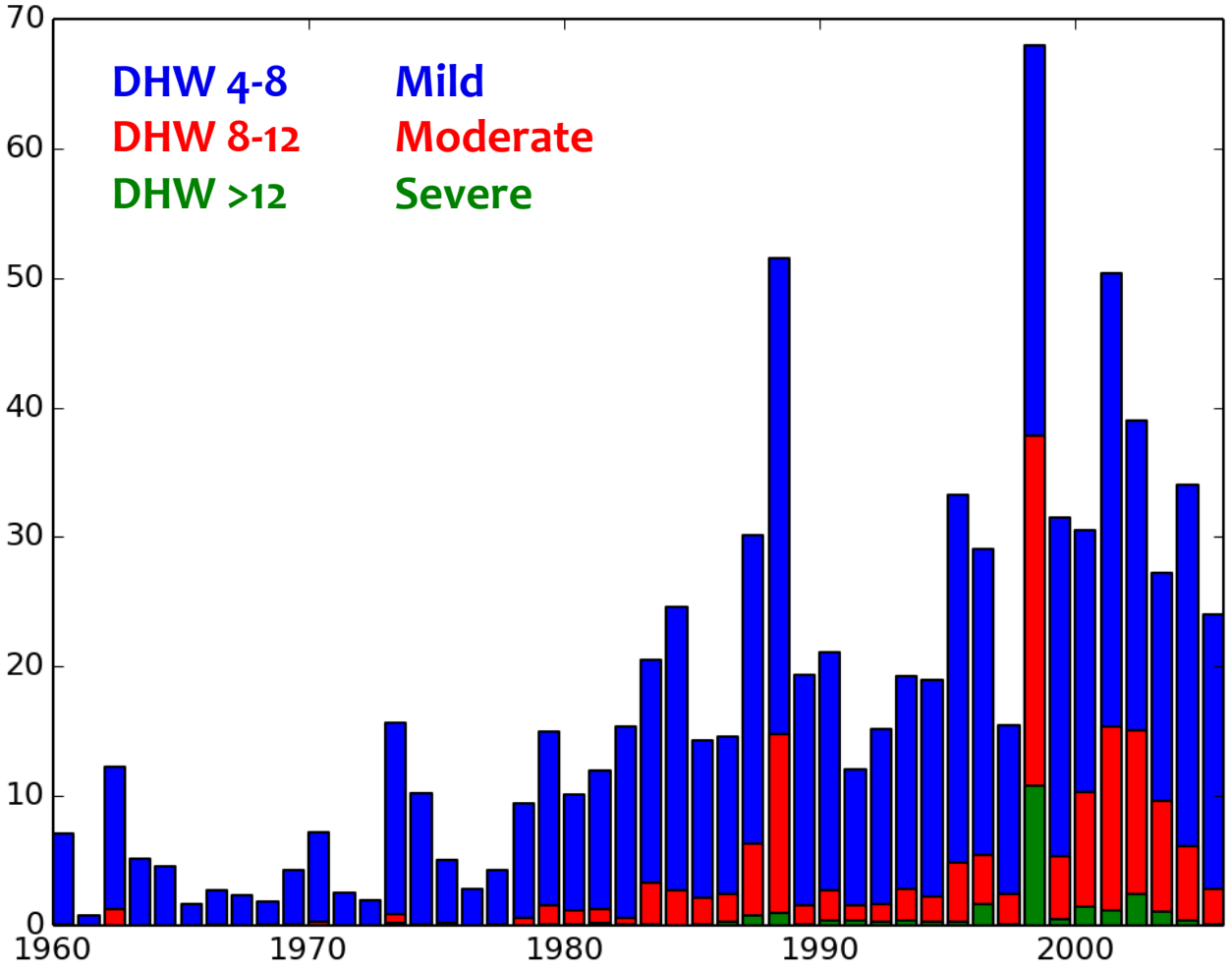


(see DHW animations under www.ctroms.ucar.edu/results.html)

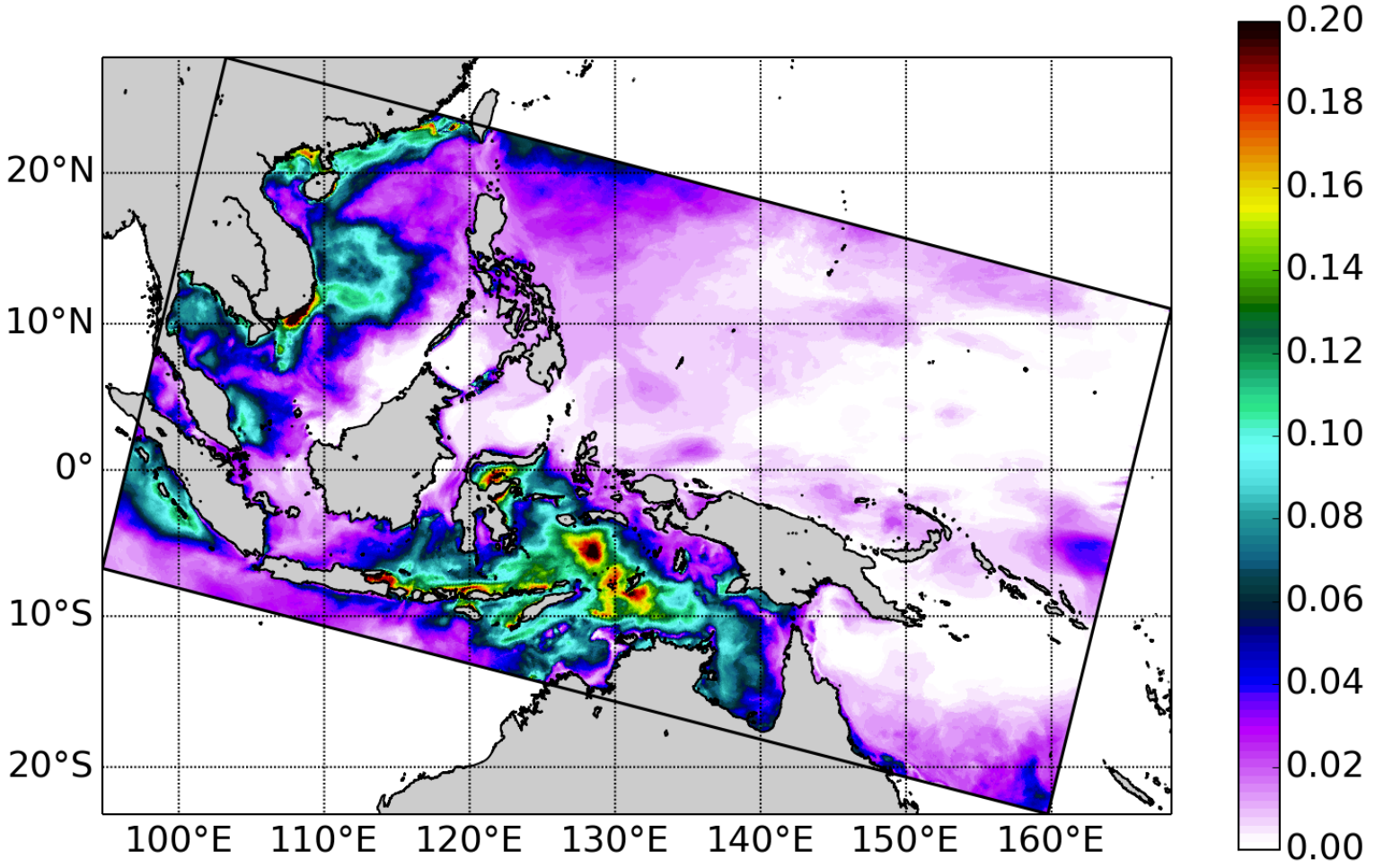
CT-ROMS: Degree-Heating-Weeks (DHW)

Annual percentages of reef-containing grid cells reaching DHW stress thresholds



CT-ROMS: Degree-Heating-Weeks (DHW)

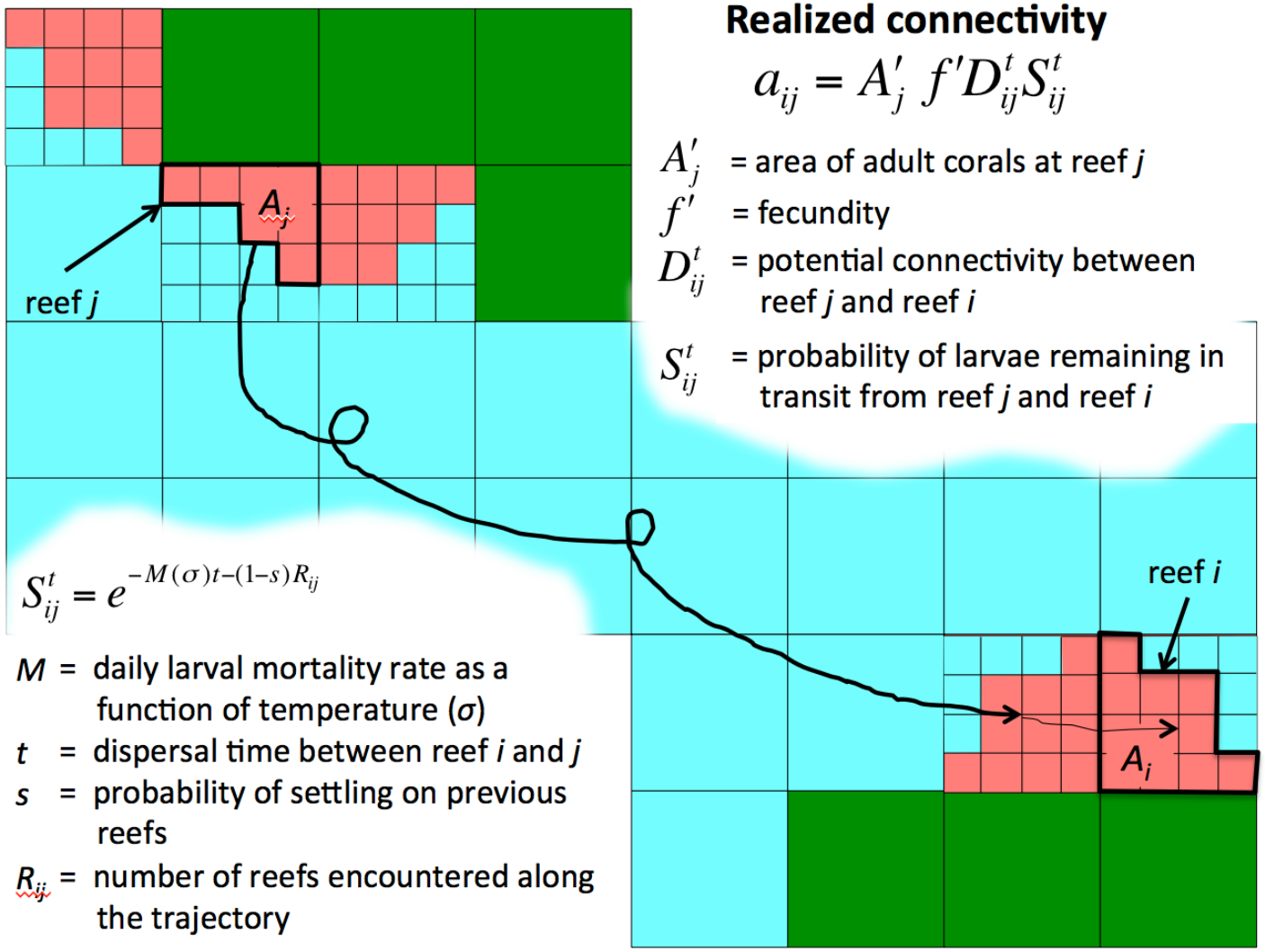
Return frequency of thermal stress events reaching a stress thresholds of DHW > 4.



CT-ROMS: Connectivity

Potential versus *Realized* connectivity

Watson et al. 2012



Realized connectivity

$$a_{ij} = A'_j \; f' D^t_{ij} S^t_{ij}$$

A'_j = area of adult corals at reef *j*

f' = fecundity

D^t_{ij} = potential connectivity between reef *j* and reef *i*

S^t_{ij} = probability of larvae remaining in transit from reef *j* and reef *i*

$$S^t_{ij} = e^{-M(\sigma)t-(1-s)R_{ij}}$$

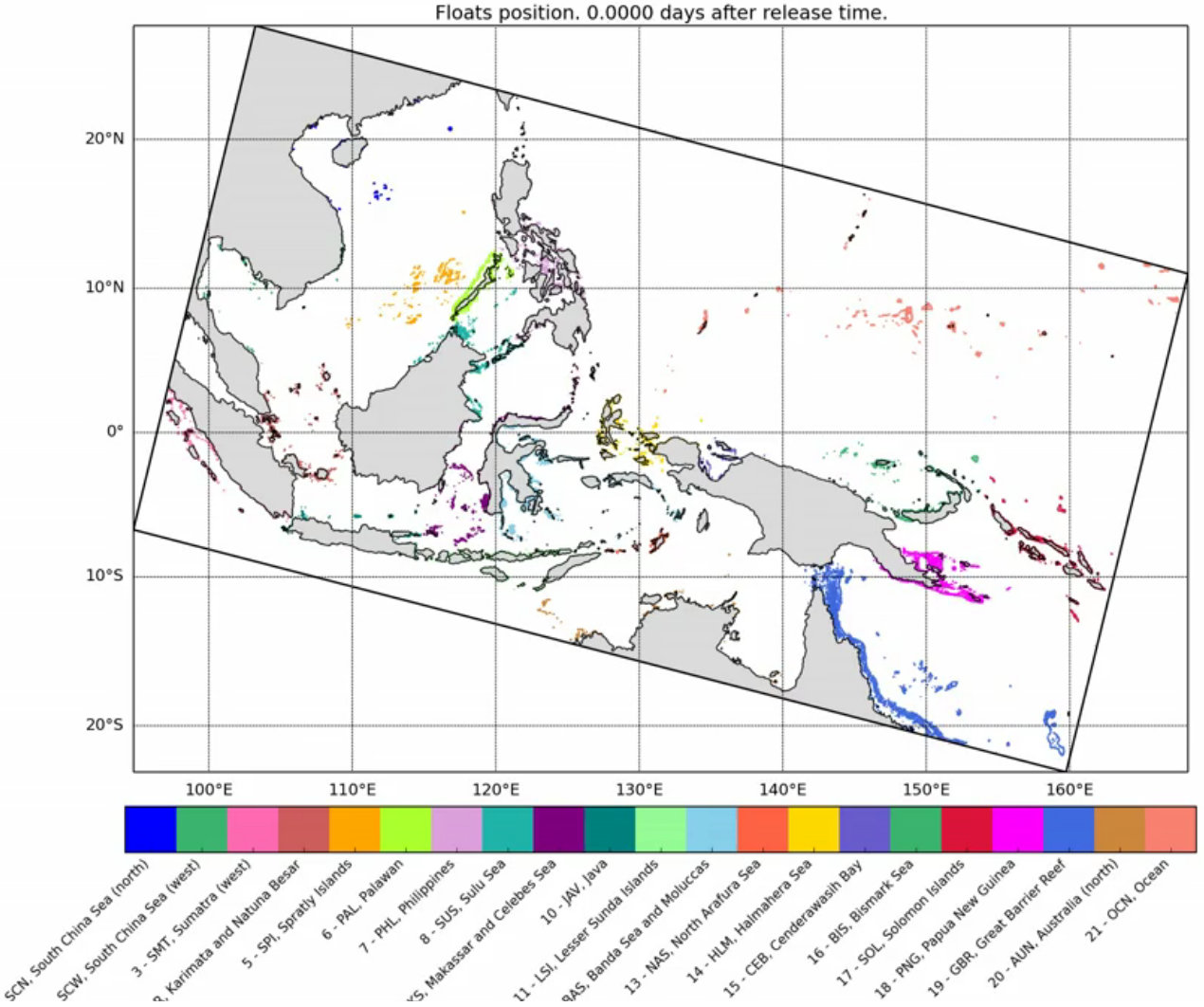
M = daily larval mortality rate as a function of temperature (σ)

t = dispersal time between reef *i* and *j*

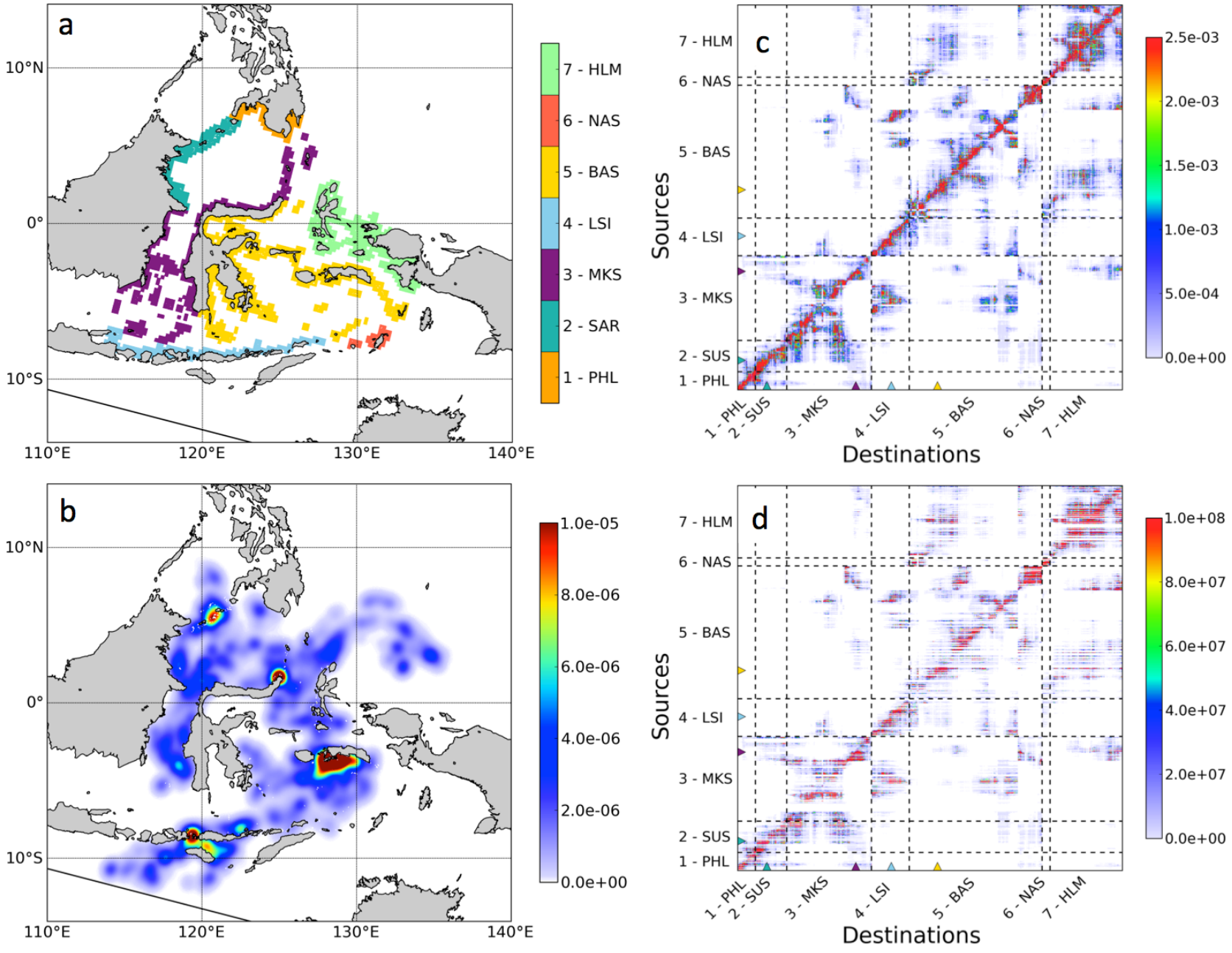
s = probability of settling on previous reefs

R_{ij} = number of reefs encountered along the trajectory

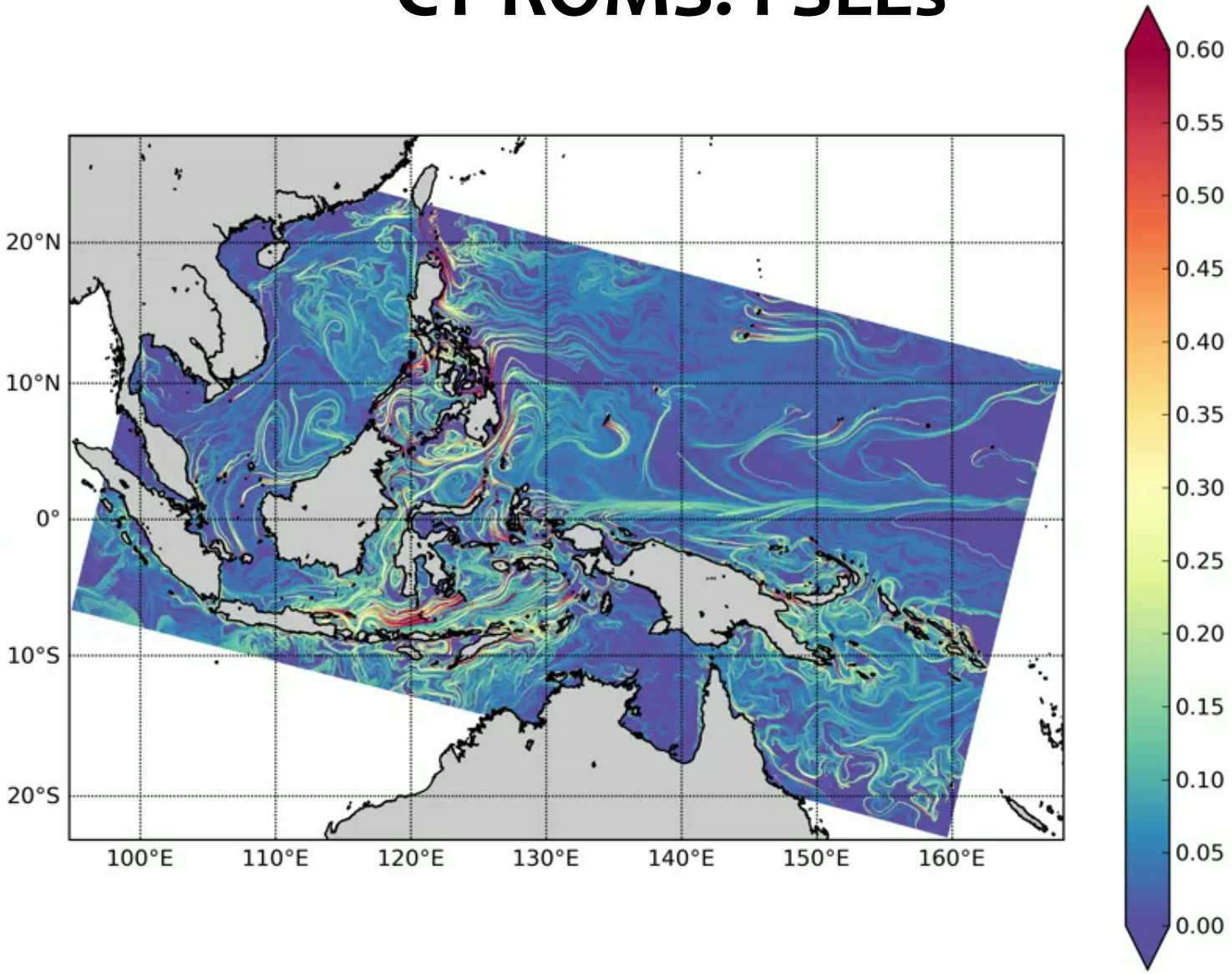
CT-ROMS: Connectivity



(see Lagrangian particle tracking animation under www.ctroms.ucar.edu/results.html)

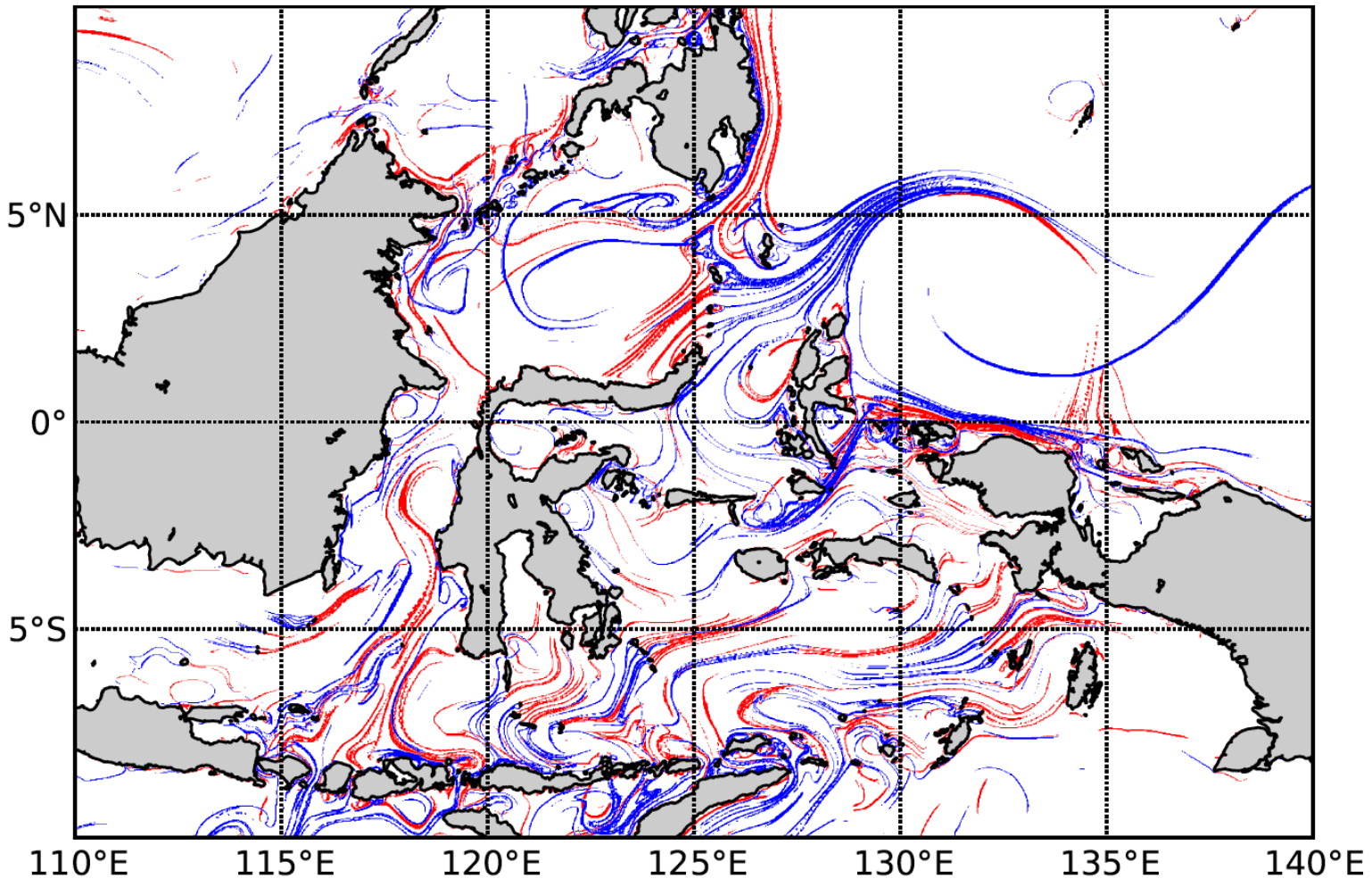

a
10°N
0°
10°S
110°E
120°E
130°E
140°E
7 - HLM
6 - NAS
5 - BAS
4 - LSI
3 - MKS
2 - SAR
1 - PHL
b
1.0e-05
8.0e-06
6.0e-06
4.0e-06
2.0e-06
0.0e+00
c
Potential
Sources
Destinations
7 - HLM
6 - NAS
5 - BAS
4 - LSI
3 - MKS
2 - SUS
1 - PHL
2.5e-03
2.0e-03
1.5e-03
1.0e-03
5.0e-04
0.0e+00
d
Realized
1.0e+08
8.0e+07
6.0e+07
4.0e+07
2.0e+07
0.0e+00

CT-ROMS: FSLEs



FSLE (day^{-1})spatial distribution computed forward in time. $d_x = d_o = 0.02°$, $d_f = 0.6°$.
(see FSLE animation under www.ctroms.ucar.edu/results.html)

CT-ROMS: LCSs



Lagrangian coherent structures (LCSs) [sensu Harrisson et al., 2013]
Blue and red lines represent attracting and repelling LCSs, respectively.

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Thank you