Rate: A quantity measured with respect to another measured quantity (e.g. velocity, carbon fixation/t)

To put better constraints on the carbon cycles we need better estimates of rates e.g.

- Primary production rates
- Surface velocity
- Sinking rates
- Various community production rates
- Export production rates

Satellite rate estimates are presently modeled using static (single image) data.

… largely because of temporal limitations

A conventional NPP model

Behrenfeld,M.J; Falkowski,P.G.; 1997. Photosynthetic Rates Derived from Satellite-Based Chlorophyll Concentration. Limnology and Oceanography, Volume 42, Number 1

```
/* Calculate euphotic depth (z_eu) with Morel's Case I model.
/* Calculate chl_tot from Satellite Surface Chlorophyll Data.
/* Calculate the Pb_opt from satellite sea surface temperature
/* calculate the irradiance function (satellite PAR as an imput)
/* Return the primary production calculation.

npp = pb_opt * chl * dayL * irrFunc * z_eu;
```

Potential problems:

1. Recall ZhongPing's discussion on Monday (PAR, chl change over the day; averages do not capture enough info)
2. Cannot not account for water mass movement (e.g. regional studies w/ monthly data are problematic).
3. Carbon cycle science needs more; we need P-R.

For example: If we can keep track of the evolution of OC inventories in space and time, then new methods for retrieving NCP are at hand

$$\mathrm{NCP_{O_2}} = \frac{\partial}{\partial t}\left(\underbrace{\int_1^{z_{eu}} \Delta[O_2]_{bio}\, \partial z}_{\Delta \mathrm{O_2\ Stock}} + \underbrace{\int_{t_1}^{t_2} F_s\, \partial t}_{\mathrm{Air-Sea\ Flux}} + \underbrace{\int_{t_1}^{t_2} F_d\, \partial t}_{\mathrm{Diffusion}} + \underbrace{\int_{t_1}^{t_2} \Gamma\, \partial t}_{\mathrm{Advection}} \right)$$

$$\mathrm{NCP_{OC}} = \frac{\partial}{\partial t}\left(\underbrace{\int_1^{z_{eu}} \Delta POC\, \partial z}_{\Delta \mathrm{Particle\ Stock}} + \underbrace{\int_1^{z_{eu}} \Delta DOC\, \partial z}_{\mathrm{Extracellular\ Production}} + \underbrace{\int_{t_1}^{t_2} F_g\, \partial t}_{\mathrm{Gravitational\ Flux}} \right)$$

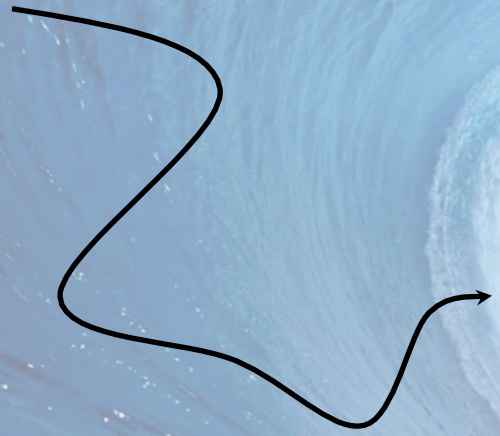
We assume these are equivalent (within the context of a homogenous water mass)

Constraining net community productivity via tracking particle inventories in a Lagrangian context.

NCP = Gross primary production – community respiration

Premise:

PC_{t1}



PC_{t2}

$$\frac{(PC_{t2} - PC_{t1})}{(t2 - t1)} \approx NCP\ (mg\ m^2\ d^{-2})$$

Jonsson, Salisbury, Mahadevan, Campbell (2009)
Jonsson, Salisbury, Mahadevan (2011)
Jonsson et al, in prep.

$PC = satChl * Q * z_e$

$z_e = \log_e(0.01) = K490$

Q (C:Chl) modified from Behrenfeld et al., 2005

Full-resolution satellite time series of the California Current area

Mati Kahru, mkahru@ucsd.edu

Updated on: 5-April-2011

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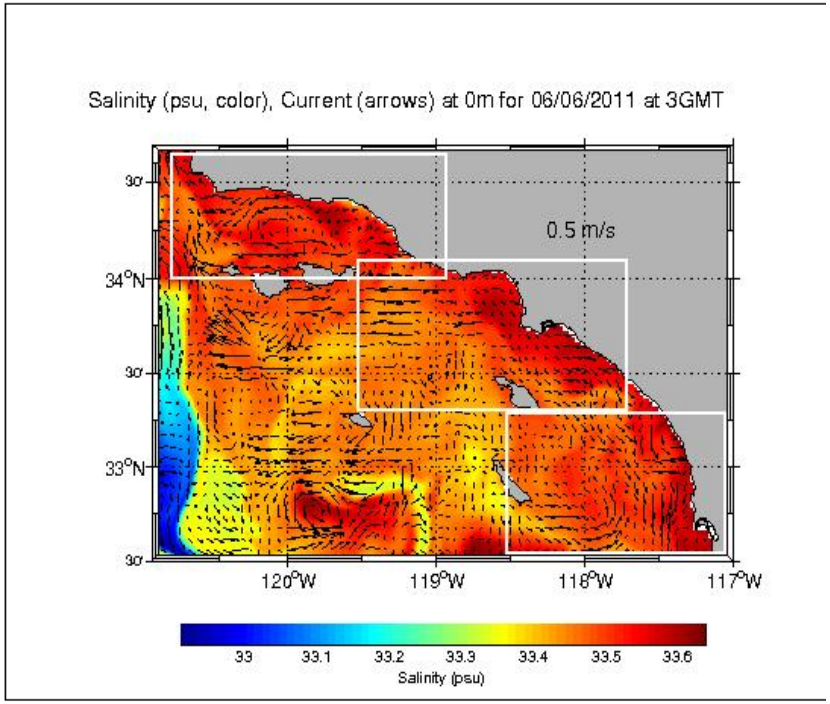
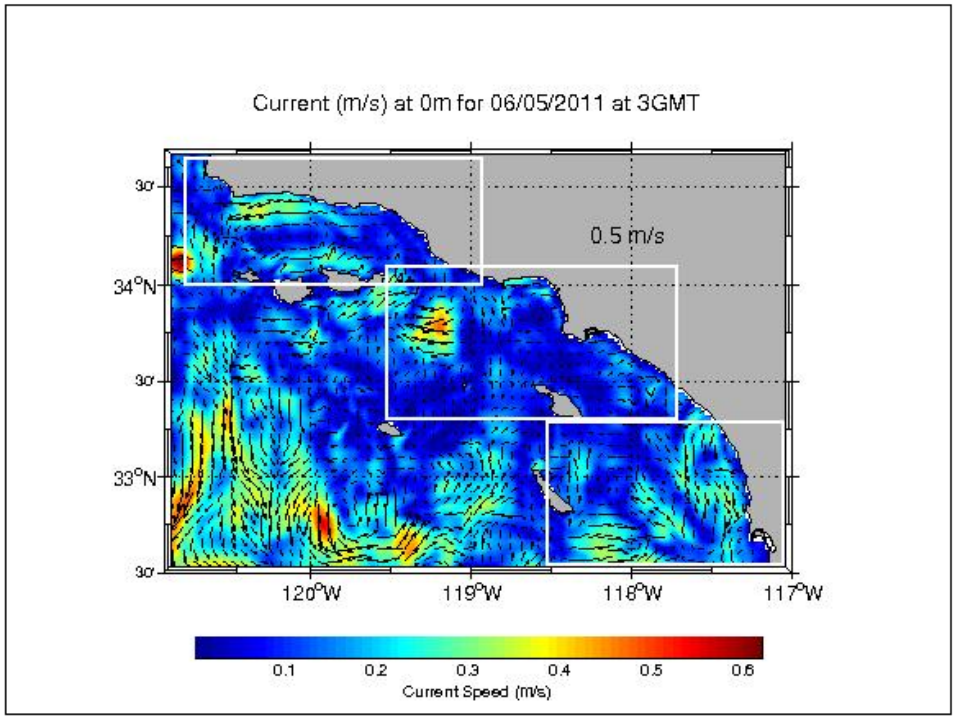
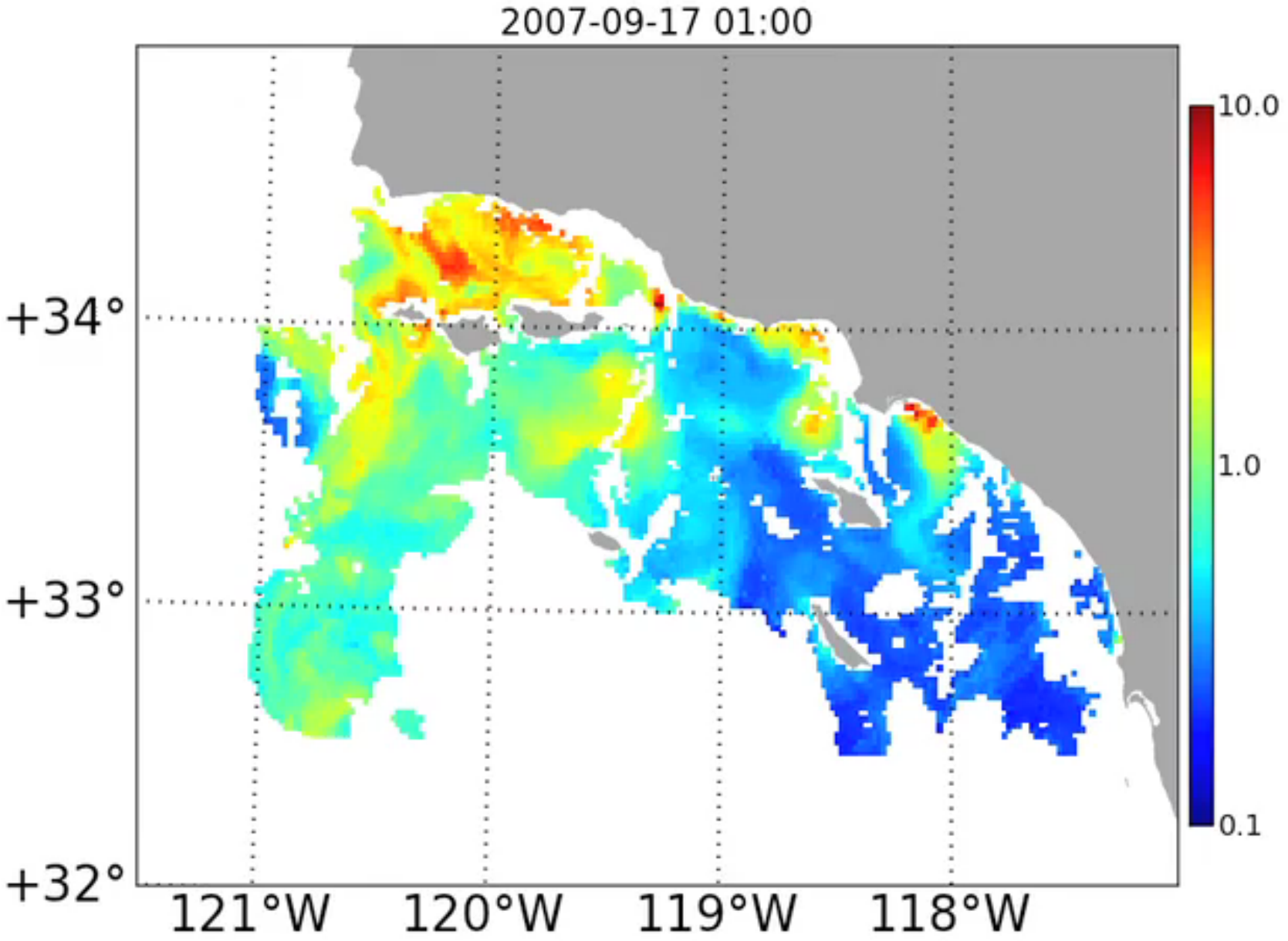
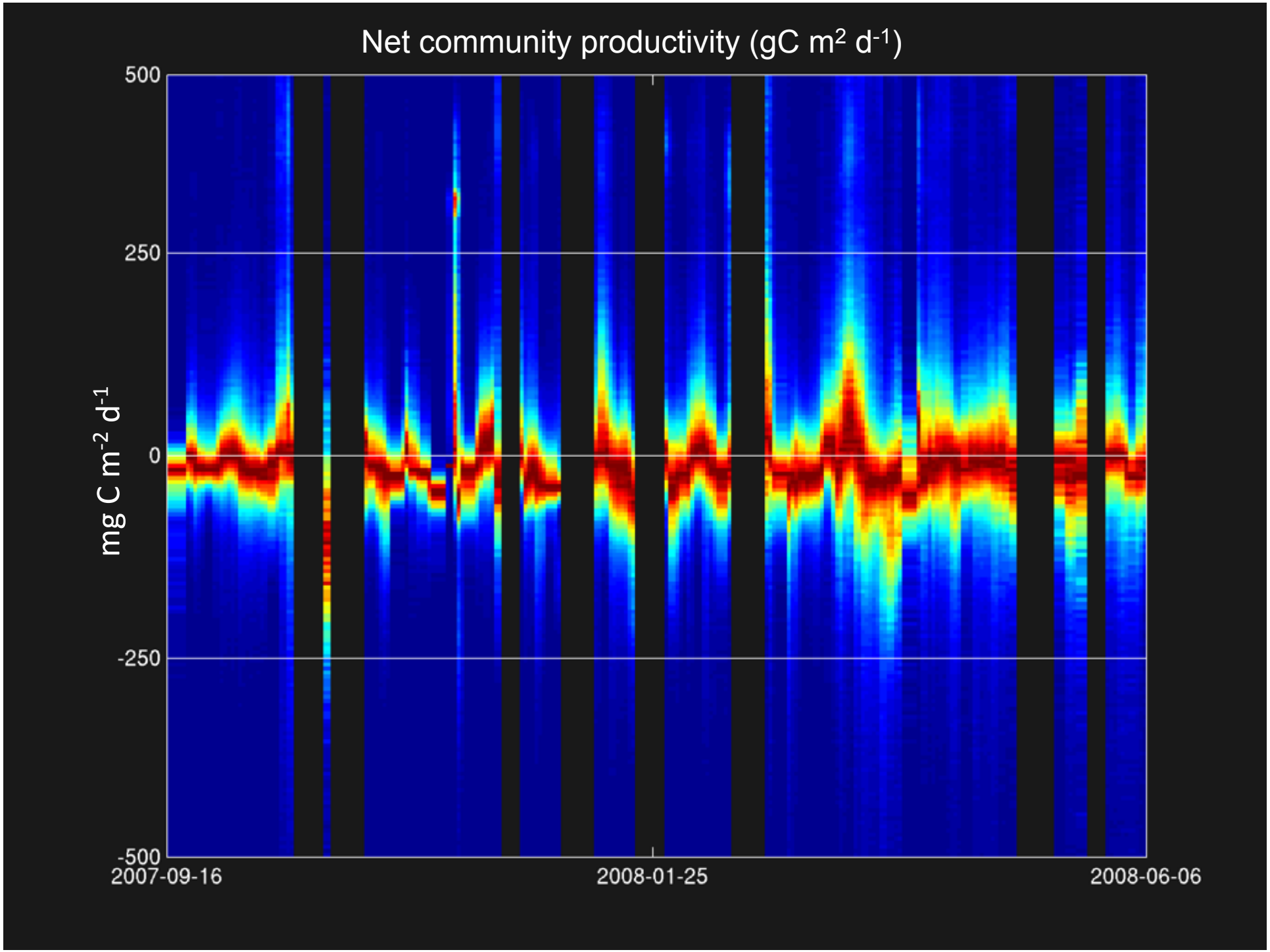


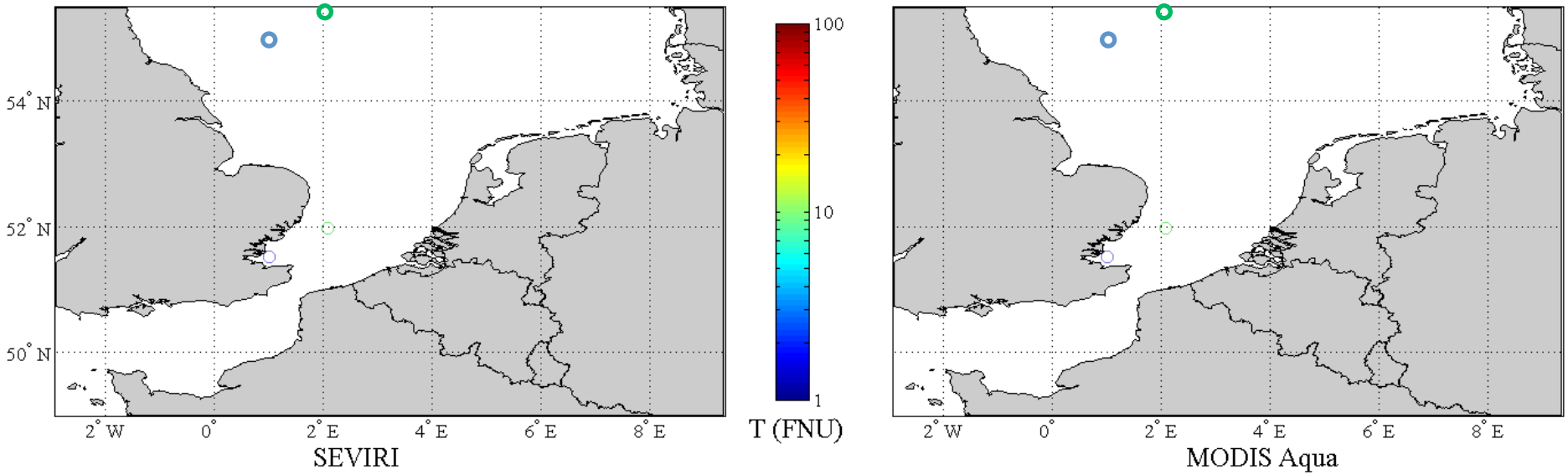


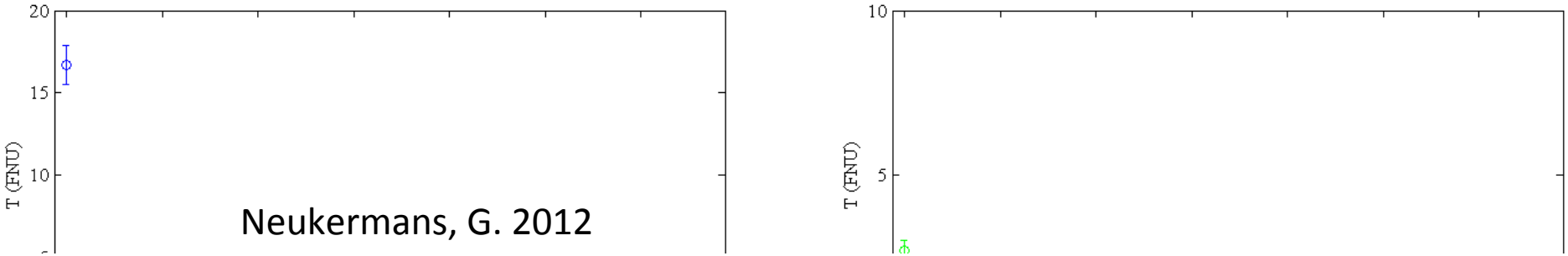

2007-09-17 01:00
+34°
+33°
+32°
121°W
120°W
119°W
118°W
10.0
1.0
0.1


Net community productivity (gC m2 d-1)
500
250
0
-250
-500
mg C m-2 d-1
2007-09-16
2008-01-25
2008-06-06

Other examples: Sinking rates from space?

Net disappearance of TSS likely has gravitational, advective and net biogeochemical components





Discussion on rates using Geostationary Data

1. More advantages?

2. Other novel strategies?

3. Necessary ancillary info from other satellites of ground?

4. Research needed to promote better rate estimates?