ACCESS WOMBAT OM2 NPP Validation

Tyler Rohr

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1 Methods

- All analysis is on climatologies averaged from 2012-2017, the overlap between the VIIRS satellite record and ACCESS OM2 output
- Model Surface Carbon (oceanbgc-2d-surface_phy-1-daily-mean-3-sigfig-ym_*) and Depth Integrated NPP (oceanbgc-2d-pprod_gross_2d-1-daily-mean-3-sigfig-ym_*) are converted from mmolN to mg Carbon using a Redfield ratio of 106/16 and the molar mass of carbon (12).
- Even though the macro nutrient is described as more like P, I've converted using C:N (rather than C:P) because a) converting from P would lead to very unreasonable NPP (Roughly 300 Pg C/yr) and b) it is labeled as N in the meta data
- NPP is compared to both the Carbon-based Productivity Model (CbPM) and Standard Vertically Generalized Productivity Model (VGPM). the difference is detailed here http://sites.science.oregonstate.edu/ocean.productivity/vgpm.model.php. But briefly, CbPM, uses backscatter to estimate carbon biomass and the observed C:CHL and irradiance (a function of PAR and MLD estimates) to estimate divisions rates. Then NPP=biomass*division rate*volume function. In VgPM there is no estimate of biomass and NPP is calculated by multiply CHL by temperature dependent function that expresses the rate of carbon fixed per unit CHL.

2 Key Points

- Globally integrated, column integrated, annual NPP in WOMBAT is 18.6 Pg/C/yr (Fig 1A), compared to 52.1 (Fig 1B) and 44.8 (Fig 1B) in the CbPM and VGPM, respectively (Fig 1C)
- Globally averaged mean surface carbon in WOMBAT is 9.06 mg/m^3 (Fig 1D), compared to 16.69 (Fig 1B) in CbPM.
- NPP is disproportionately lower than carbon, suggesting that division rates are also low.

- NPP co varies very much with biomass, which is not so in CbPM. If we believe CbPM this suggest there is not enough variability in phytoplankton growth rates globally, which would be unsurprising with one phytoplankton group.
- The model performs much better at high latitude (¿40N, ¡40S) than mid/low latitudes (Fig 2).
- **In particular model skill for replicating NPP (relative to CbPM) in the Southern Ocean is excellent (Fig 2)**. It does a pretty good job with Southern Ocean surface carbon too, but generally overestimates the size of the bloom (Fig 3I) and standard deviation of the seasonal cyclce (Fig 3H)
- It does much worse in other regions though, with low and even strong negative correlations in the lower latitudes.
- There is large regional variability in the NPP and biomass bias (which largely covary in space) (Fig 3).
- WOMBAT does good job recreating the shape of the seaaonal cycle and timing of the annual peak at high latitudes but a very poor job at lower latitudes.

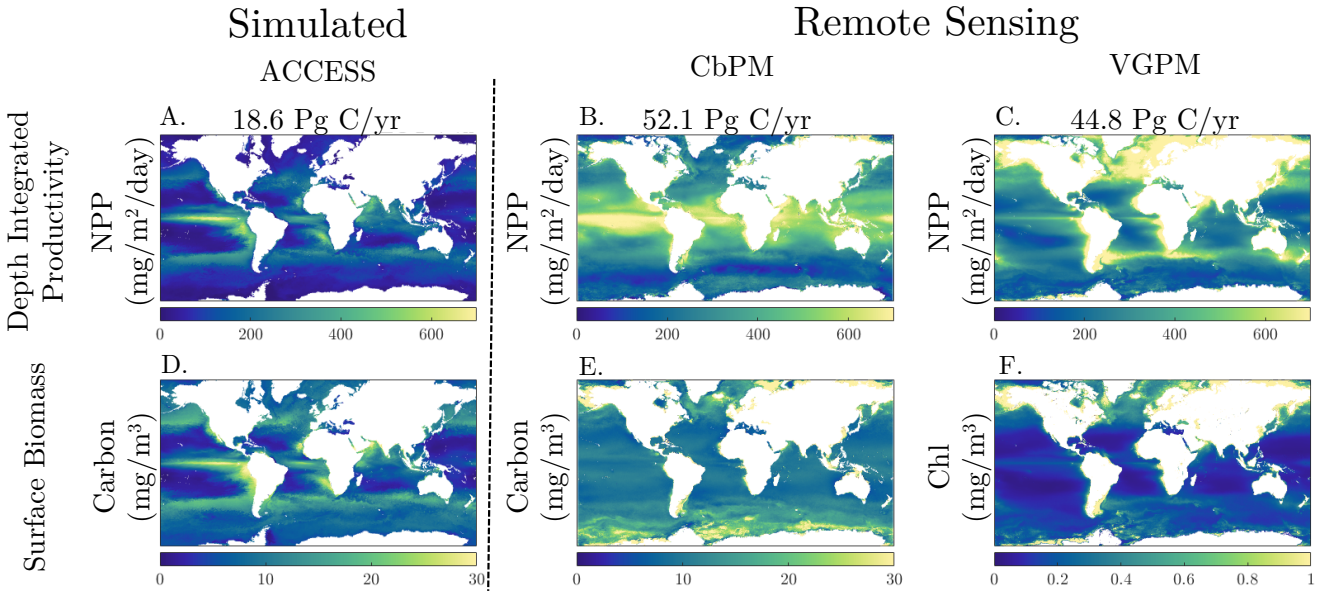

Figure 1: Annually averaged simulated and observed depth integrated NPP, surface carbon, and Chl (only observed)

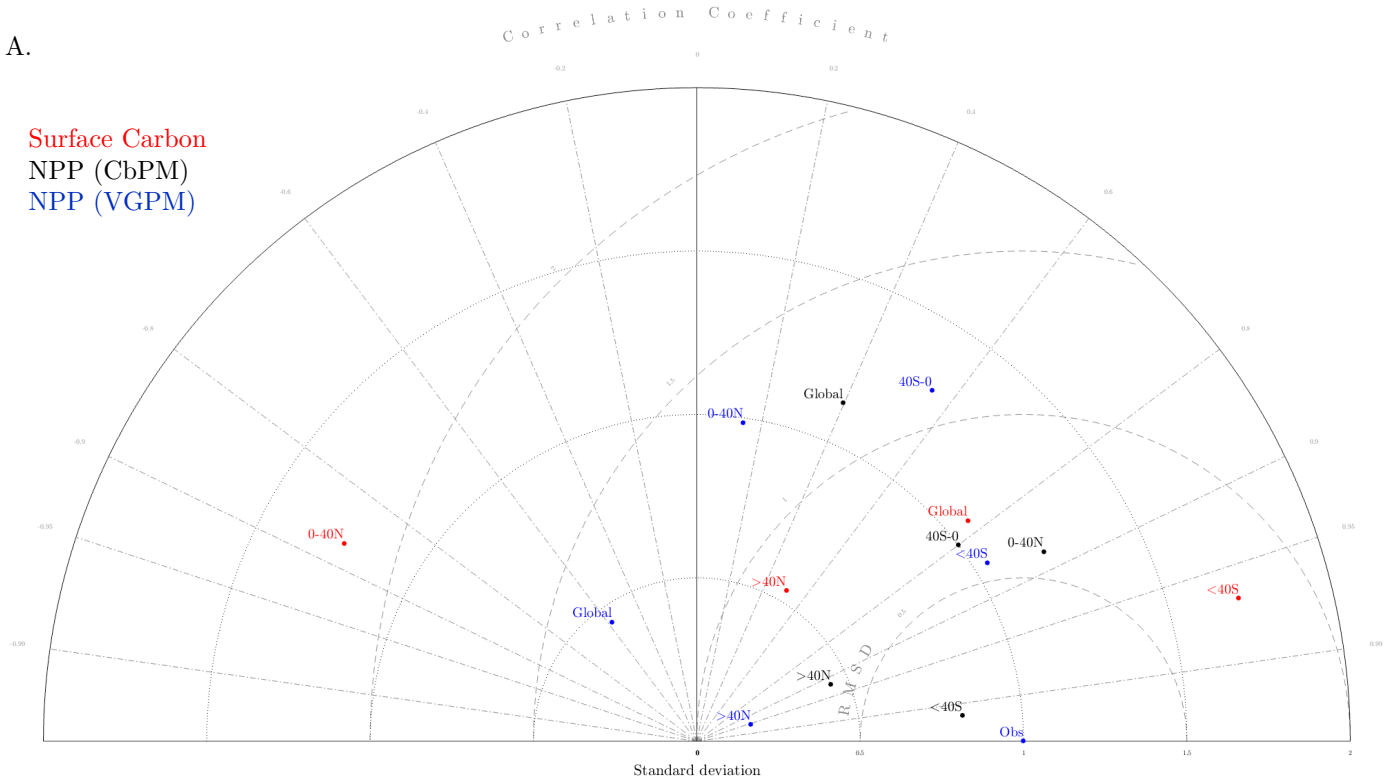

Figure 2: Taylor Diagram of regionally averaged climatologic seasonal cycles for surface carbon (red), NPP (compared to CbPM), and NPP (compared to VGPM). All time series were normalized by the standard deviation of the reference (observed) time series before computing Taylor statistic. Note, the region of 40S-0 for Surface Carbon is left off the chart as the STD and RMSE are much higher (very poor skill) than any other

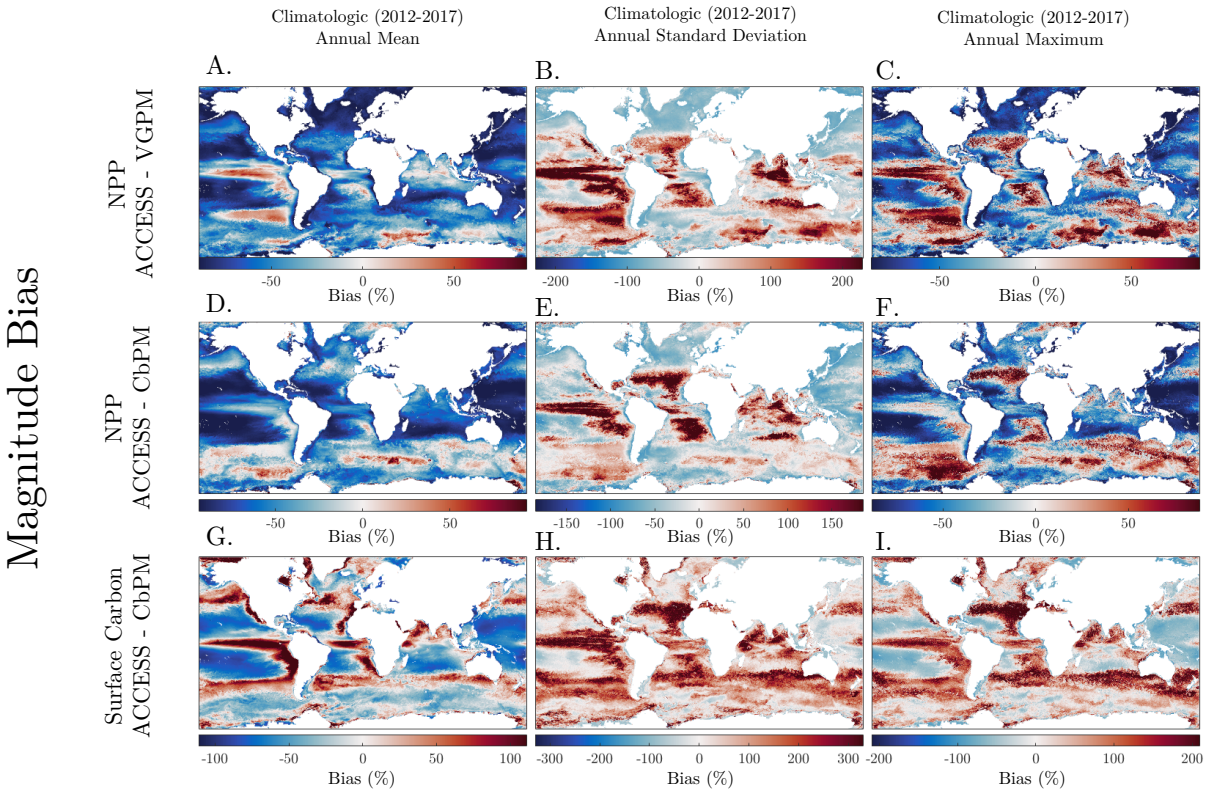

Figure 3: Percent difference in mean annual model attributes relative to observations

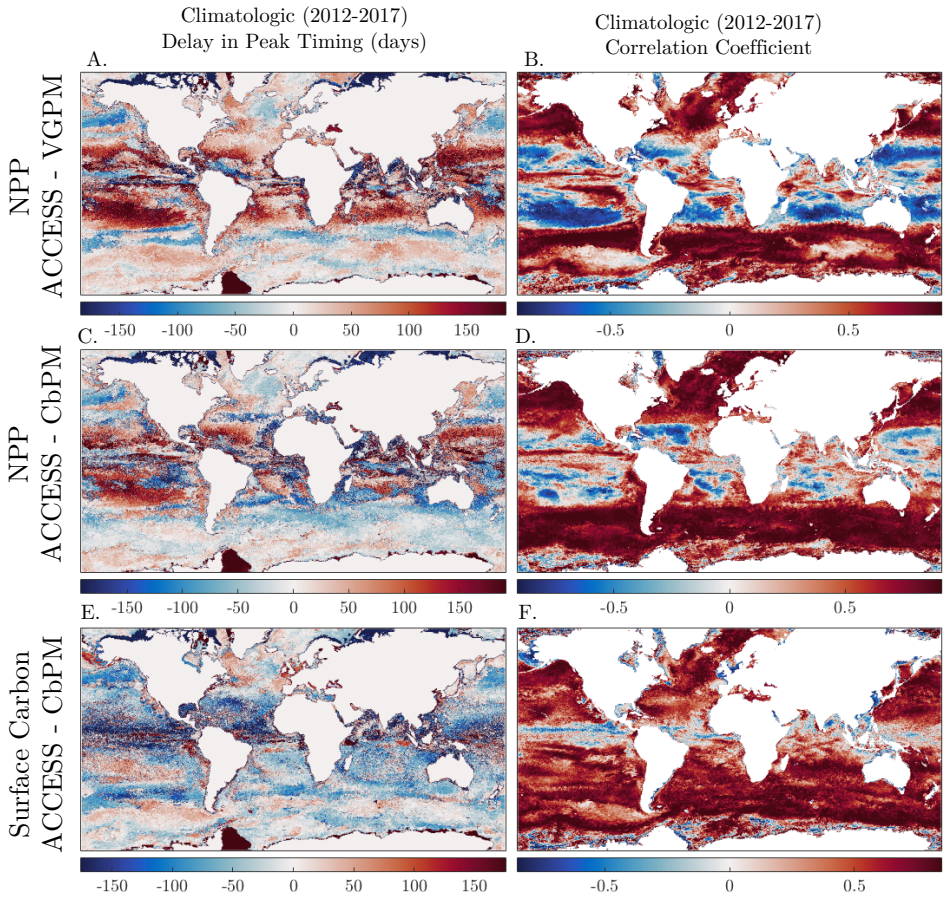

Figure 4: Temporal offset in peak bloom timing (measure by surface biomass or NPP) and the coerelation coeficient between simulated and observed seaosnal cycles