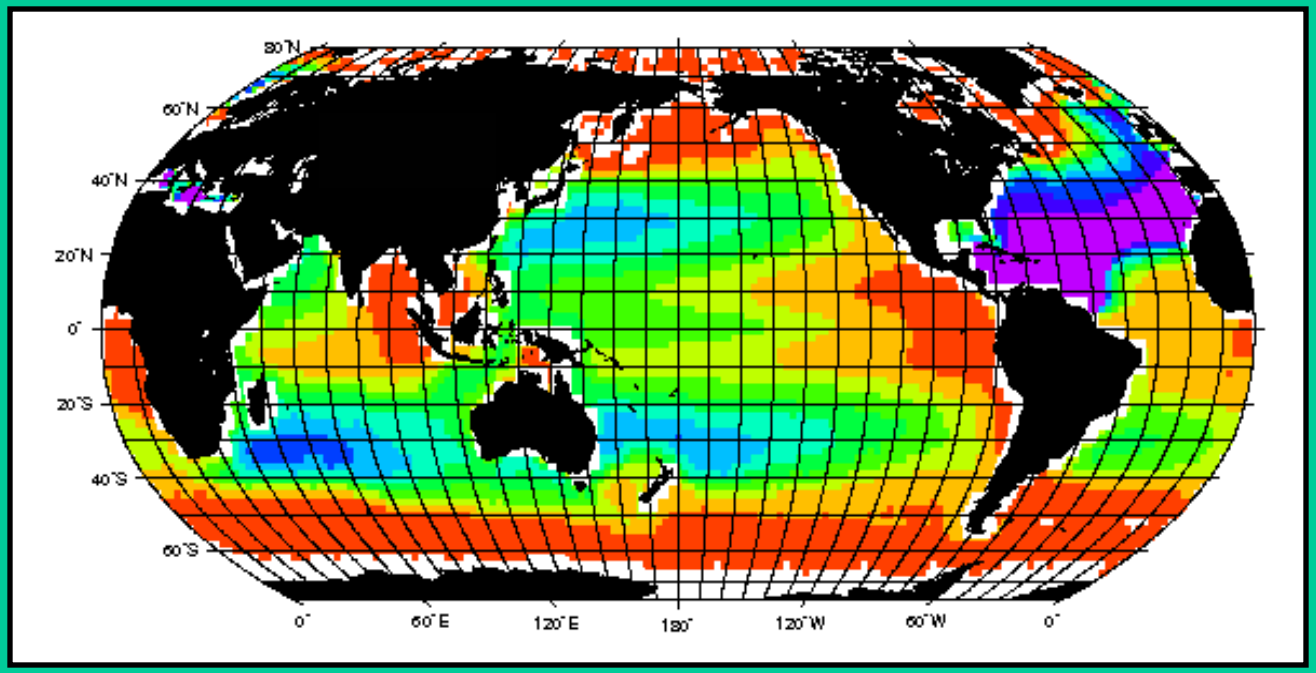
Trends in ocean $CaCO_3$ undersaturation in the CMIP5 suite of Earth System Models



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How well do climate models reproduce the observed distribution of calcite and aragonite saturation states?

What are the likely future changes in ocean calcite and aragonite saturation states?

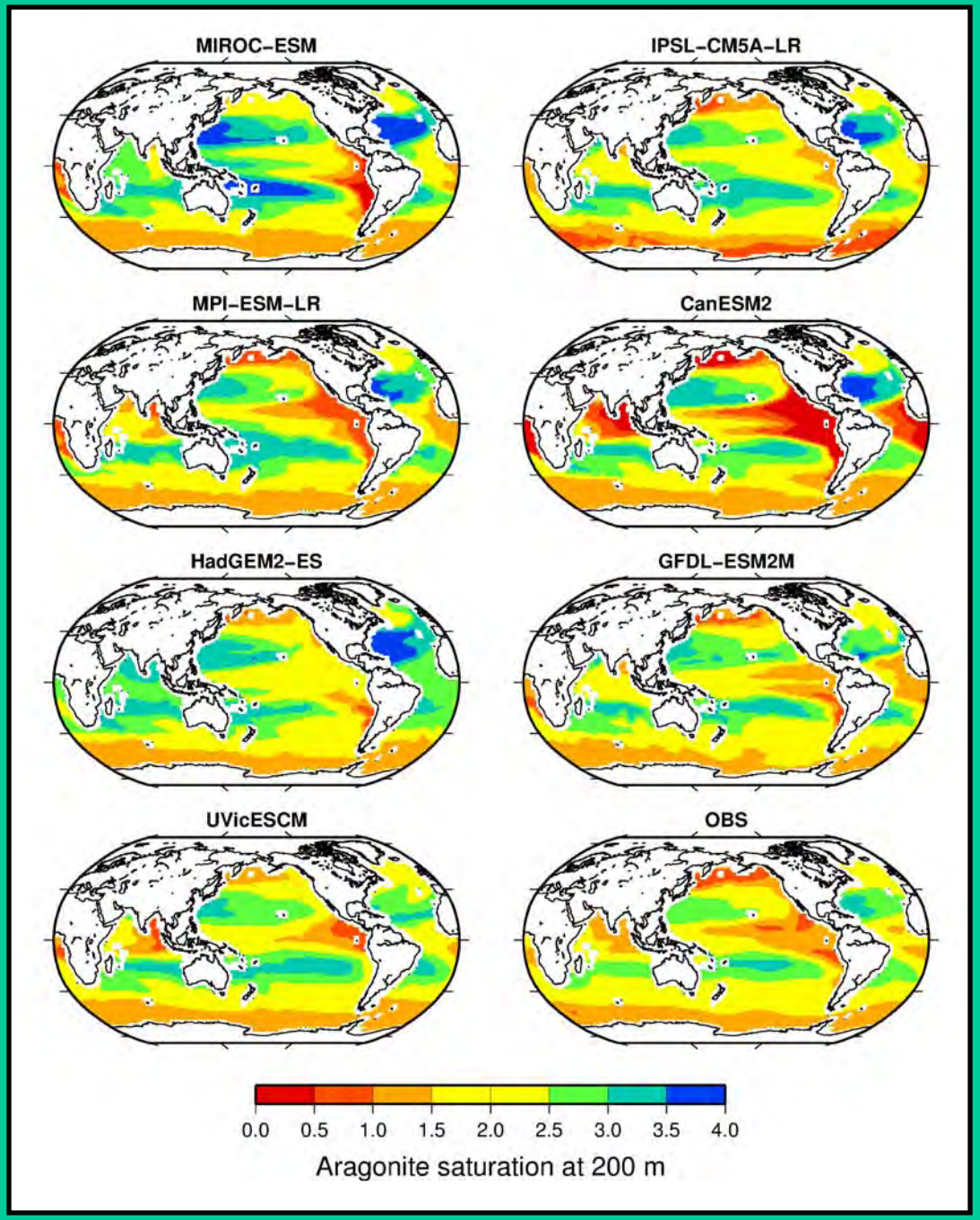
How do models differ in their regional responses?

Ω is the saturation state of seawater with respect to $CaCO_3$ minerals (calcite or aragonite)

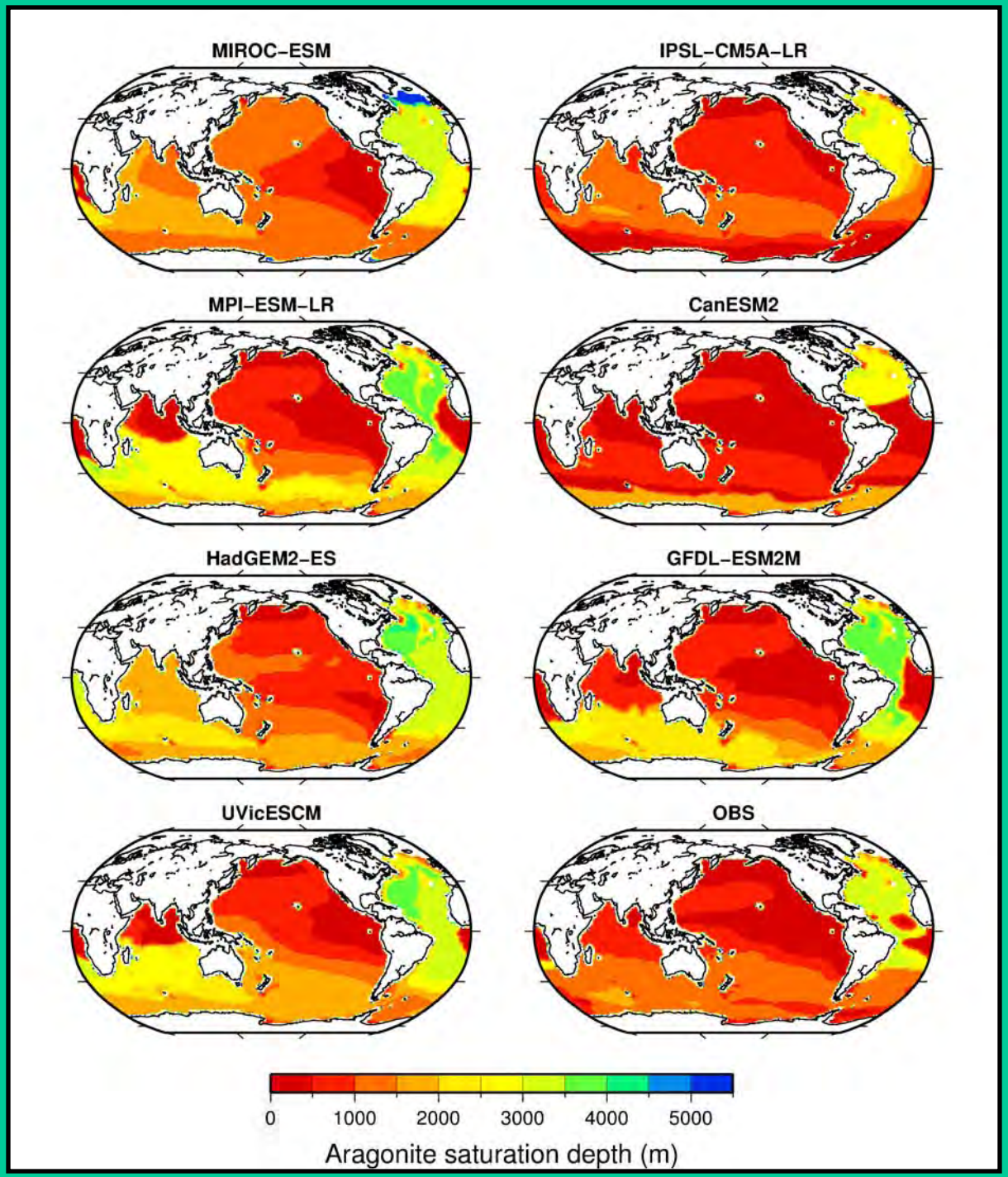
$$\Omega = \frac{[Ca^{2+}][CO_3^{2-}]}{\text{(saturation concentration)}}$$

$$[CO_3^{2-}] = f(T,S,DIC,alkalinity)$$

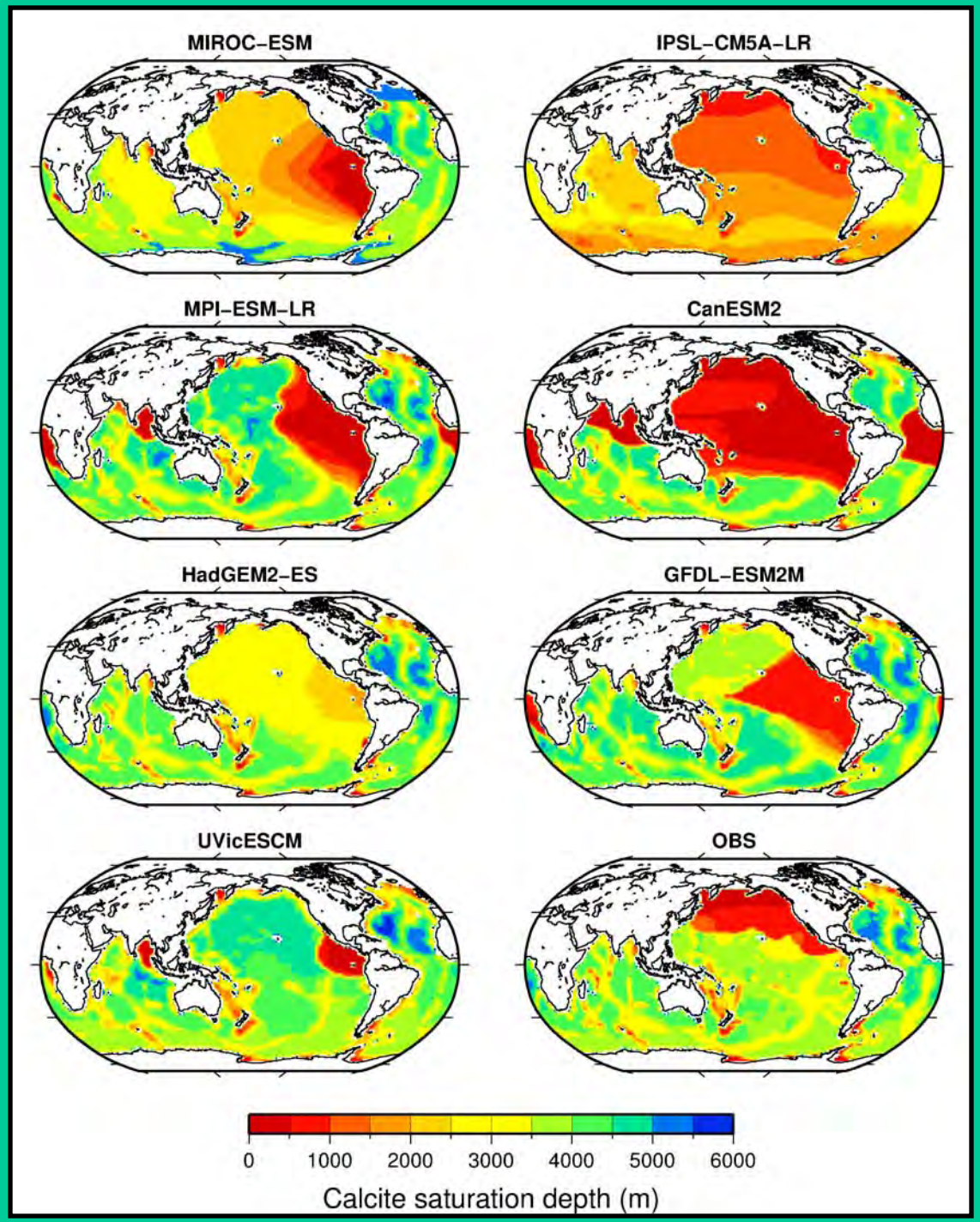
Aragonite saturation at 200 m depth gives an index of regions most vulnerable in terms of biological impacts.



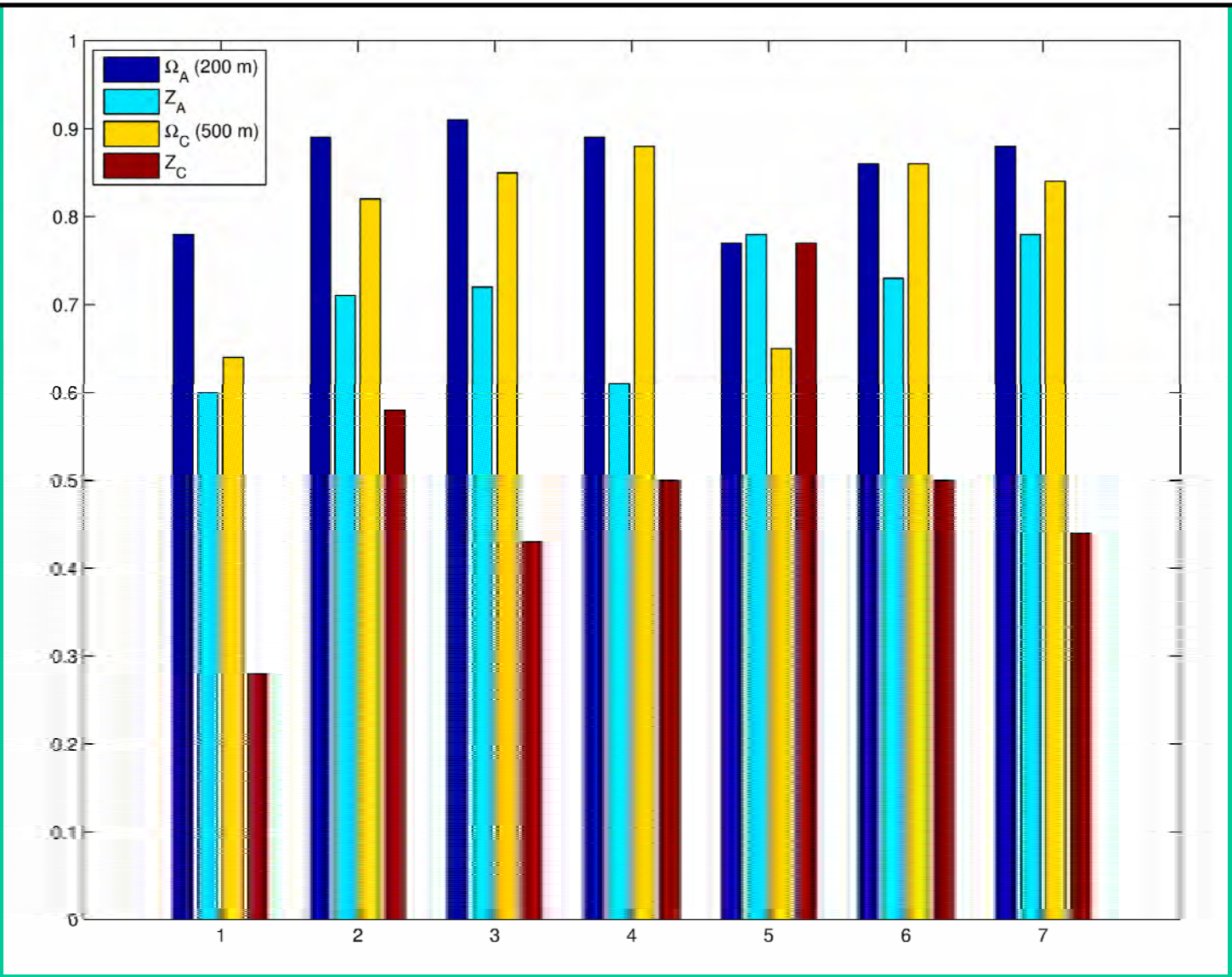
Aragonite saturation horizon depth (Ω=1)



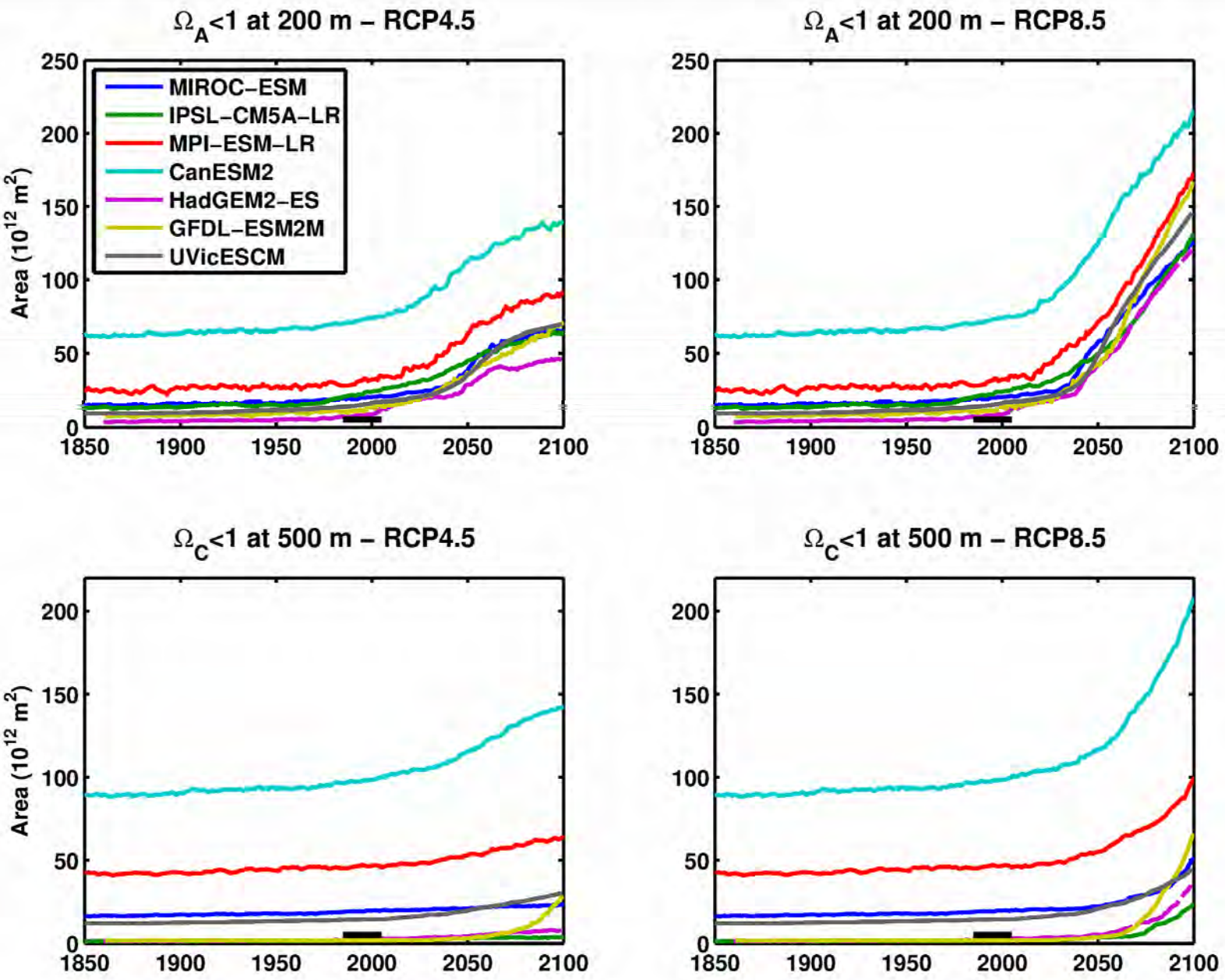
Calcite saturation horizon depth (Ω=1)



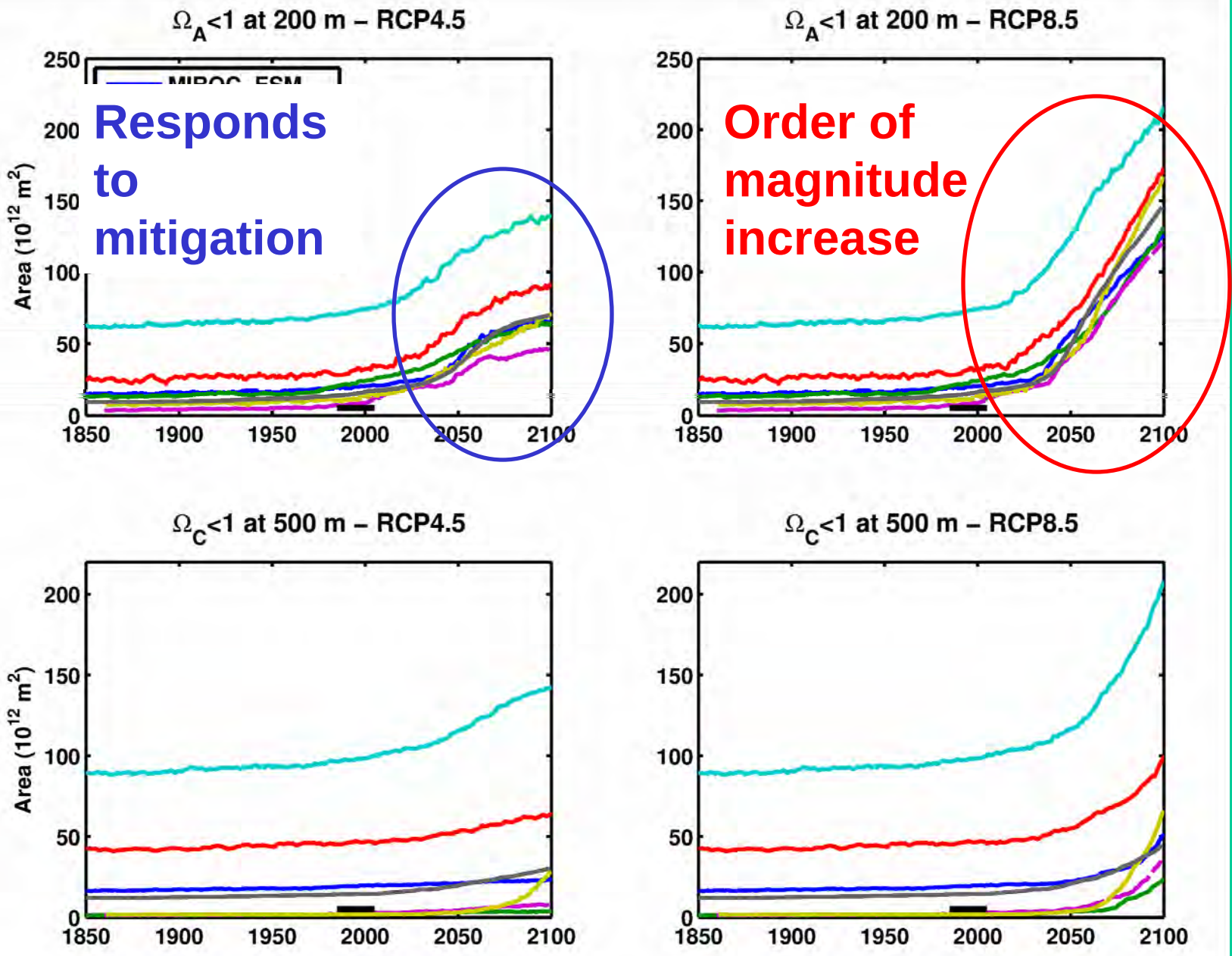
Global pattern correlation coefficients: models vs observations



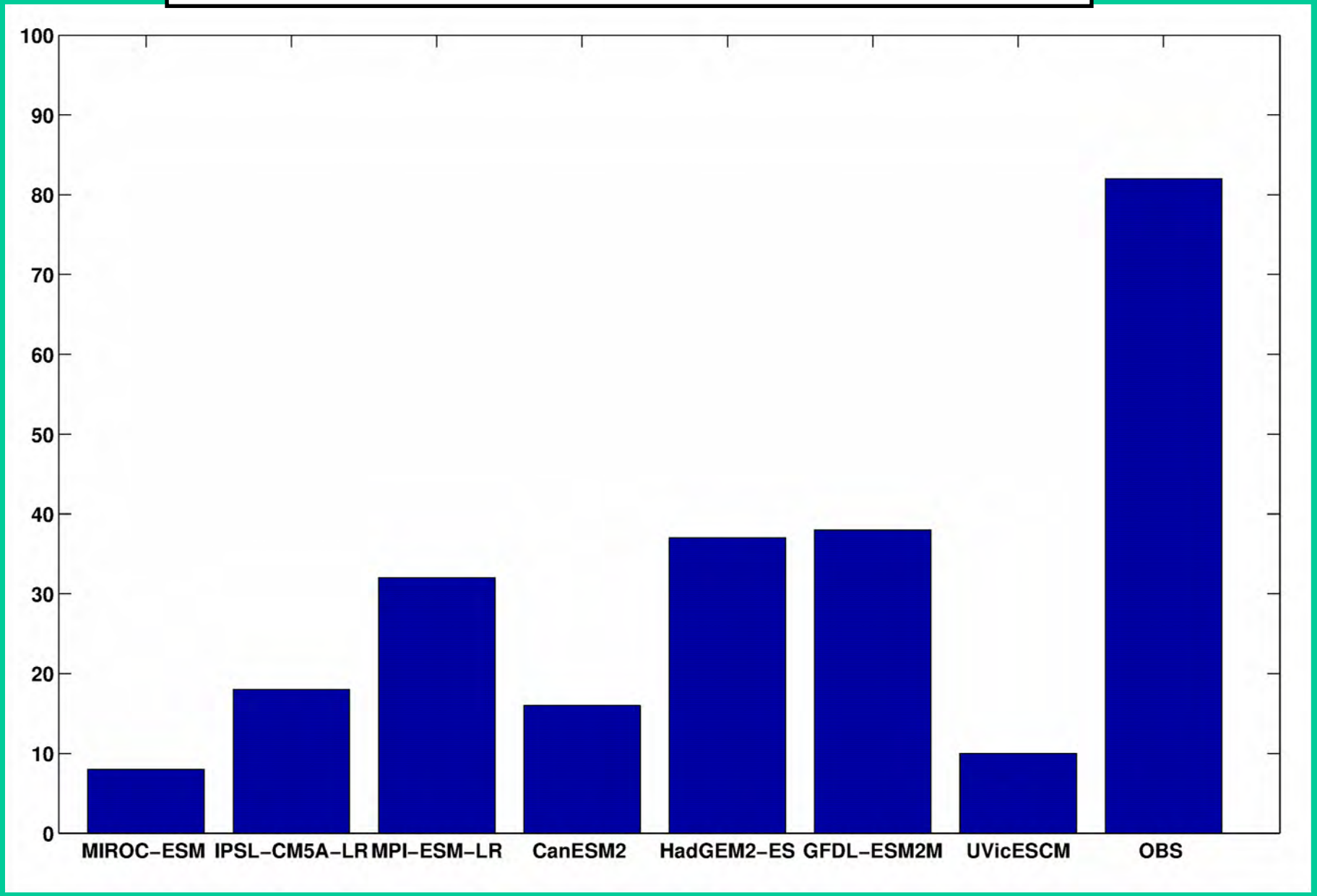
Global total area of shallow undersaturation



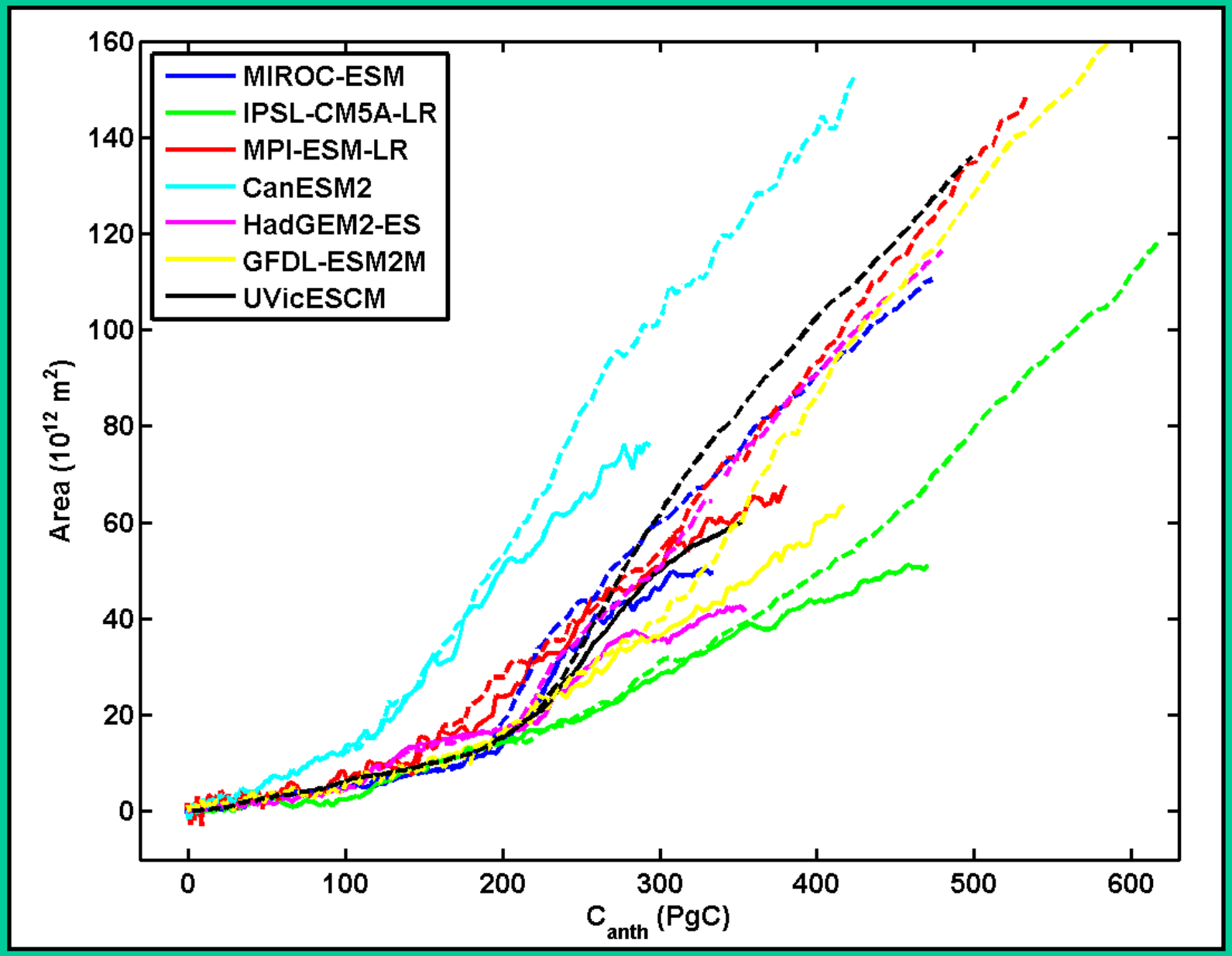
Global total area of shallow undersaturation



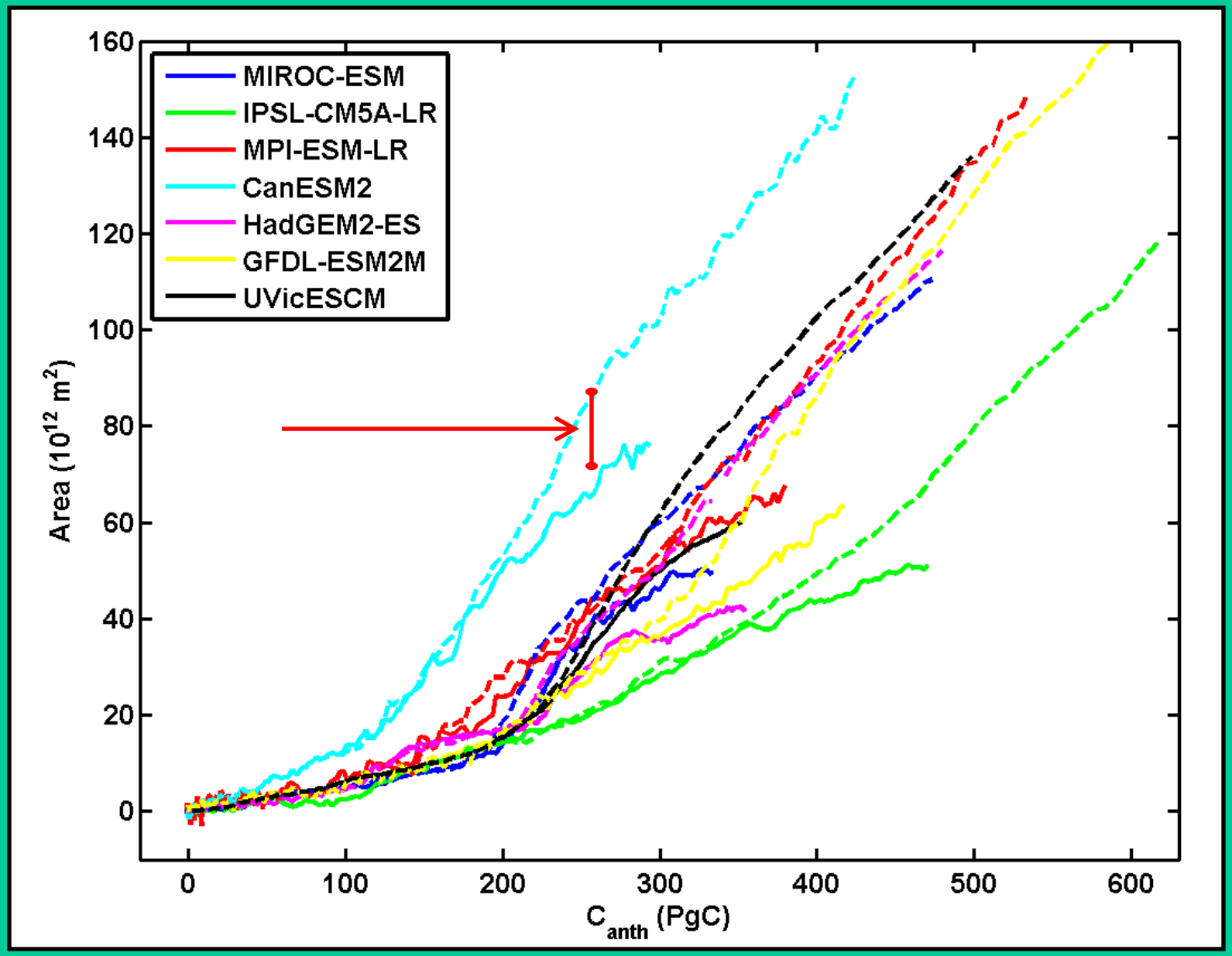
North Pacific fraction of total A_{200}



A_{200} as function of cumulative anth CO_2 uptake



A_{200} as function of cumulative anth CO_2 uptake



Take home messages

- no model performs best on all skill metrics

- growth of area with shallow undersaturation (A_{200})
  - consistent across models
  - depends on rate of atm CO_2 growth
  - up to an order of magnitude under RCP8.5
  - responds to mitigation

- all models underestimate North Pacific fraction of A_{200}

- no simple relationship between A_{200} and cumulative uptake