A new conceptual model of global ocean heat uptake and transient climate response

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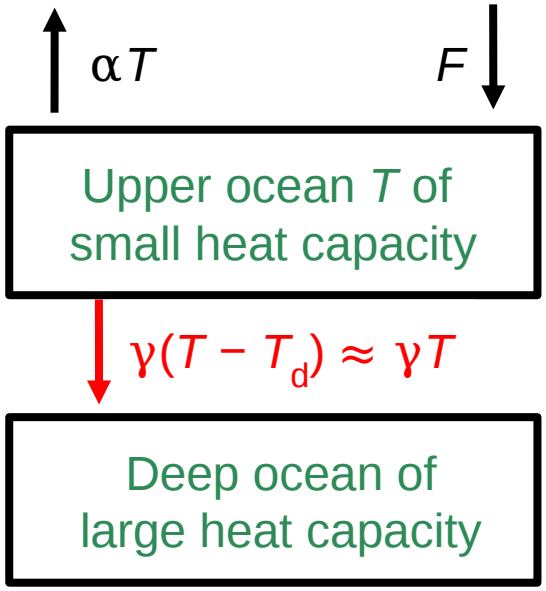
See end of poster for list of authors

Two-layer model



γ is AOGCM-specific.

Net downward TOA flux
$= N = F - \alpha T$
= Heat flux into ocean

Ocean heat uptake efficiency
OHUE ≡ $N \div T$

⬅ $N = \gamma T$

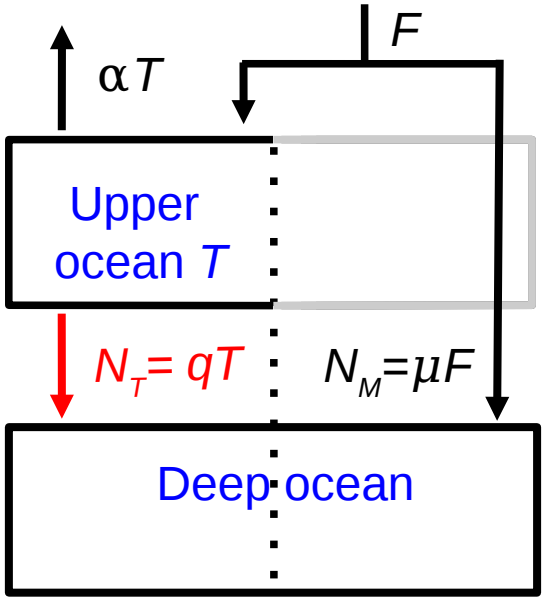
⇒ N is small if T is small, and N correlates with γ

Neither is true in CMIP.

$N = qT + \mu F$ ➡

CMIP T anticorrelates with μ, so OHUE = $q + \mu F / T$ is larger with stronger AMOC.

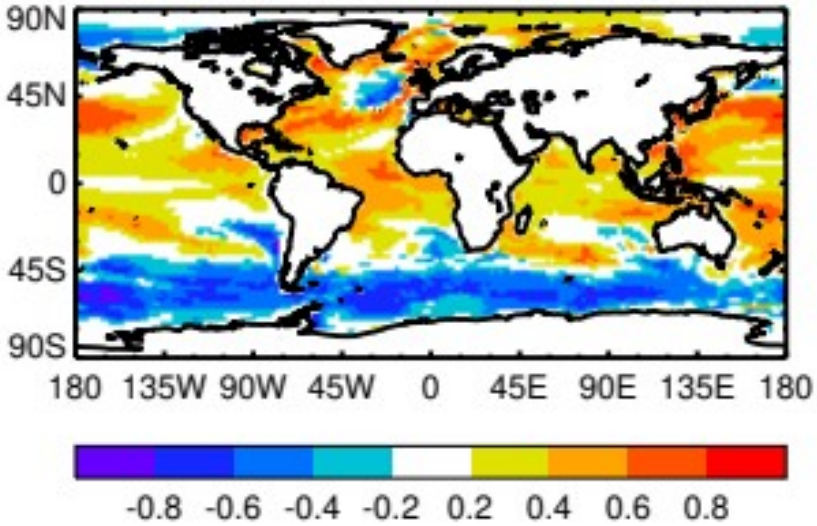
*MT*2 model



$q(t)$ is AOGCM-independent, μ correlates with AMOC.

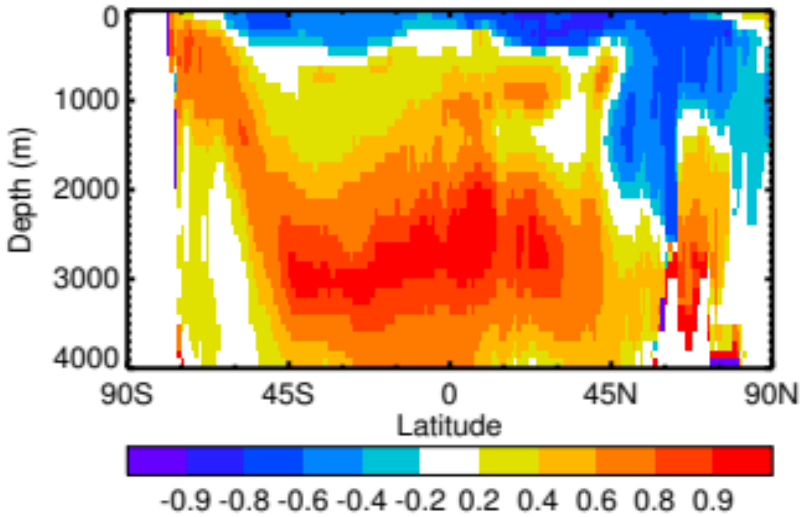
Interpretation and implications of the *MT*2 model

Correlation of ΔSST with global-mean N_T



N_T occurs at low latitude

Correlation of passive heat with AMOC



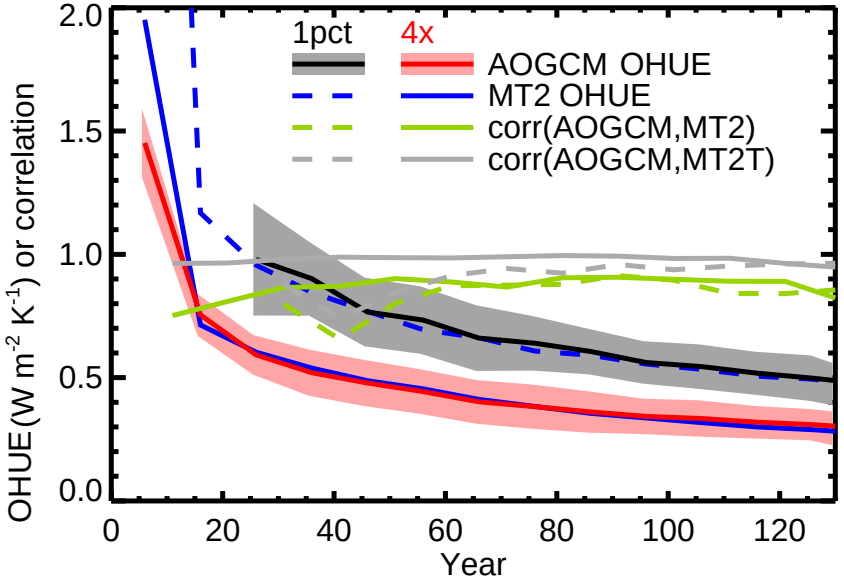
N_M occurs at high latitude

AOGCMs with stronger AMOC have smaller *T* because α is larger (EffCS smaller) and heat is removed more efficiently from the surface (but **not by** the AMOC).

$$F - \alpha T = N = qT + \mu F \Rightarrow T = F(1 - \mu)/(\alpha + q)$$

⇒ *T* determined almost entirely by α ⇒ *T* correlates with EffCS (Grose *et al*.)

MT2 model for time-dependent ocean heat uptake efficiency



$N_M(t) = \mu F(t)$, where μ is constant in time and AOGCM-specific, $\mu = s_0(M - M_0)$, $s_0 = 0.5\%$ Sv^{-1}, $M_0 = -10.2$ Sv.

$N_T(t) = q(t)\ T(t)$ is described by the two-layer model, with AOGCM-independent heat capacities and $\gamma = 0.47$ W m^{-2} K^{-1}.

OHUE $N/T = (\mu\alpha + q)/(1 - \mu)$ decreases in time because α and q do.

MT2 reproduces OHUE well in AOGCM mean (black, red and blue) and individual AOGCMs (green); MT2T is better (grey, AOGCM-specific deep-layer thickness).

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