GLOBAL

PISCES Model & Evaluation

Model Description:

PISCES (Pelagic Interactive Scheme for Carbon and Ecosystem Studies) simulates the cycling of carbon, oxygen, and the major nutrients determining phytoplankton growth (PO_4^{3-}, NO_3^-, NH_4^+, Si, Fe). Phytoplankton growth is limited by the availability of nutrients, temperature, and light. The model has two phytoplankton size classes (small and large), representing nanophytoplankton and diatoms, as well as two zooplankton size classes (small and large), representing microzooplankton and mesozooplankton. For all species the C:N:P ratios are assumed constant (122:16:1), while the internal ratios of Fe:C, Chl:C, and Si:C of phytoplankton are predicted by the model. Iron is supplied to the ocean by aeolian dust deposition and from a sediment iron source. During biological production it is taken up by the plankton cells and released during remineralisation. Scavenging of iron onto particles is the sink for iron to balance external input. There are three non-living components of organic carbon in the model: semi-labile dissolved organic carbon (DOC), with a lifetime of several weeks to years, as well as large and small detrital particles, which are fuelled by mortality, aggregation, fecal pellet production and grazing. Small detrital particles sink through the water column with a constant sinking speed of 3mday−1, while for large particles the sinking speed increases with depth from a value of 50mday−1 at the depth of the mixed layer, increasing to a maximum sinking speed of 425mday−1 at 5000m depth. For a more detailed description of the PISCES model see Aumont and Bopp (2006) and Gehlen et al. (2006).

PISCES has been used in its offline configuration, i.e. forced by monthly output of the IPSL coupled climate model over 1860-2100 for several scenarios (A2, A1B, E1). IPSL-CM4 model consists of the Laboratoire de Météorologie Dynamique atmospheric model (LMDZ-4) with a horizontal resolution of about 2°x1x5° and 19 vertical levels (Hourdin et al., 2006), coupled to the OPA-ocean model with a horizontal resolution of 2°×2°·cos lat and 31 vertical levels and the LIM sea ice model (Madec et al., 1998).

References

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Gehlen, M., Bopp, L., Emprin, N., Aumont, O., Heinze, C., and Ragueneau, O.: Reconciling surface ocean productivity, export fluxes and sediment composition in a global biogeochemical ocean model, Biogeosciences, 3, 521–537, 2006,

Hourdin, F.,Musat, I., Bony, S., et al.: The LMDZ4 general circulation model: climate performance and sensitivity to parametrized physics with emphasis on tropical convection, Clim. Dynam., 19(15), 3445–3482, doi:10.1007/s00382-006-0158-0, 2006.

Madec, G., Delecluse, P., Imbard, M., and Lévy, M.: OPA 8.1 ocean general circulation model reference manual. Notes du Pôle de Mod´elisation 11, Tech. rep., IPSL, Paris, 1998.

Model Evaluation (from Schneider et al. 2008, Biogeosciences)

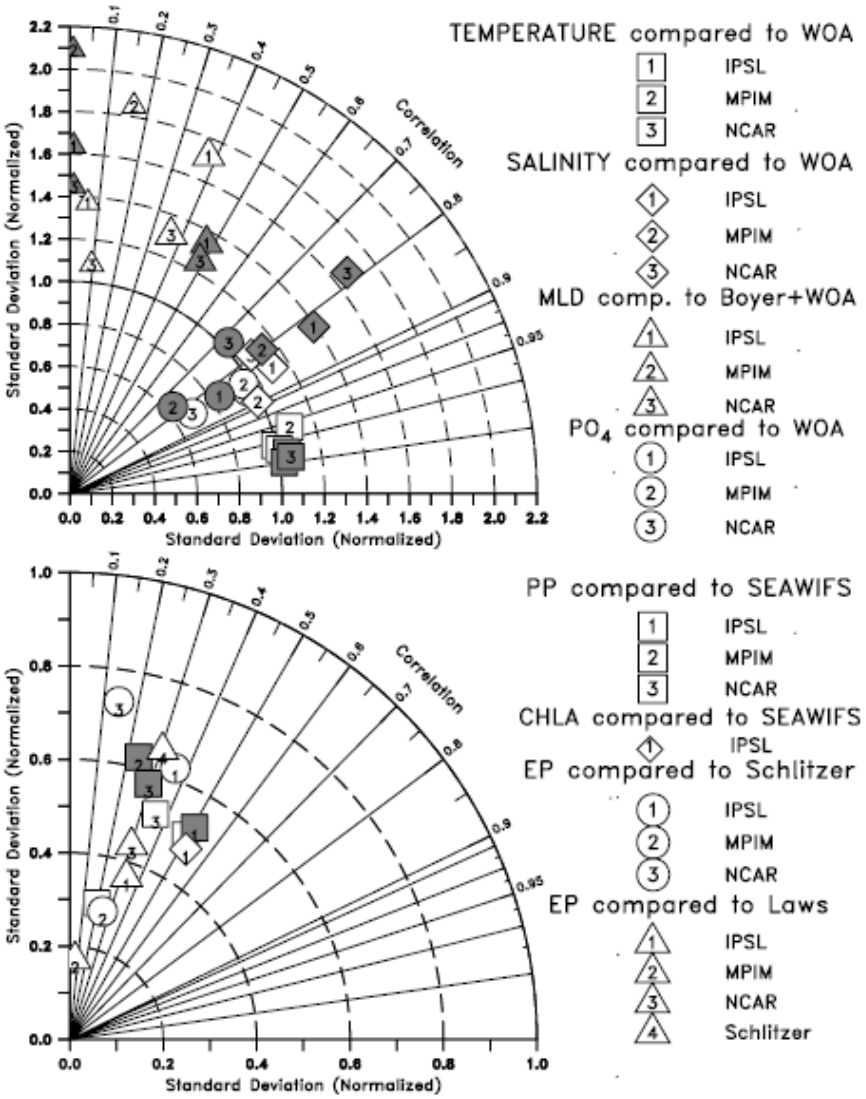

Figure: Top: Taylor diagram showing the correspondence between model results and observations for 3-D fields weighted by volume of annual mean temperature (squares) salinity (diamonds) and PO3− 4 concentration (circles), as well as 2-D fields of MLD (small and large triangles). White symbols indicate annual mean values, except for MLD where they represent the respective maximum (MLDmax). Grey symbols show spatial correlations including the seasonal cycle of sea surface temperature (SST), sea surface salinity (SSS), PO3− 4 (averaged over 0–100 m) and MLD. Modelled MLD is compared to data from de Boyer-Mont´egut et al., (2004) (large triangles) and based on a recalculation (small triangles) from T and S from the models and data from theWorld Ocean Atlas (WOA; Collier and Durack, 2006; Conkright et al., 2002). For MPIM the normalised standard deviation of MLD compared to de Boyer-Mont´egut et al., (2004) is 6.0 and 4.7 for MLDmax and seasonal MLD, respectively, and therefore not displayed in the diagram. Bottom: Taylor diagram showing the correspondence between model results and observation-based estimates for primary production (PP; squares), chlorophyll (CHLA; diamond) and particulate organic carbon (POC) export production (EP; circles and triangles). White symbols show results for annual mean 2-D fields, grey symbols include the seasonal cycle for PP. The angular coordinate indicates the correlation coefficient (R), the radial coordinate shows the normalised standard deviation (stdmodel/stdobs). A model perfectly matching the observations would reside in point (1,1).