GC51A-14 Energy Diagnostics in Coupled Ice-Ocean Arctic Models

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http://fish.cims.nyu.edu/project_aomip/overview.html

1 INTRODUCTION

The *Arctic Ocean Model Intercomparison Project* (AOMIP) is an international collaborative effort that has been established to perform a detailed analysis of the performance of state-of-the-art coupled ice-ocean models of the Arctic.

One important diagnostic of model performance is the total energy content within a model domain and the manner in which that energy is distributed in its various forms, such as kinetic, potential, and internal. The kinetic and potential forms can be further subdivided and analyzed in terms of their mean and eddying components. Quantifying the sources and sinks of energy is also an important aspect of obtaining an overall energy budget for the model domain. In addition temporal and seasonal variability of energy between the models can be studied. Energy intercomparisons provide high level information of the model parameterizations of e.g. mixing processes, currents and river freshwater input. The energy transport between the Arctic and mid-latitudes is especially crucial parameter. Eventually the knowledge of the Arctic Ocean energy balance links the region to the global climate system.

In this poster, the first steps towards a comprehensive accounting and intercomparison of the energy budgets for the various AOMIP models is reported.

2 METHODS AND DATA

The kinetic energy (*KE*) is defined as

$$KE = \frac{1}{2}\iint \rho(z,A)\,\mathbf{u}\cdot\mathbf{u}\,dz\,dA\ ,$$

total potential energy (PE) as

$$PE = g\iint_{-D}^{0} \rho(z,A)(z-D)\,dz\,dA\ ,$$

and internal heat content (IH)

$$IH = c_o\iint \rho(z,A)\,T\,dz\,dA\ .$$

We calculated the available potential energy following a definition

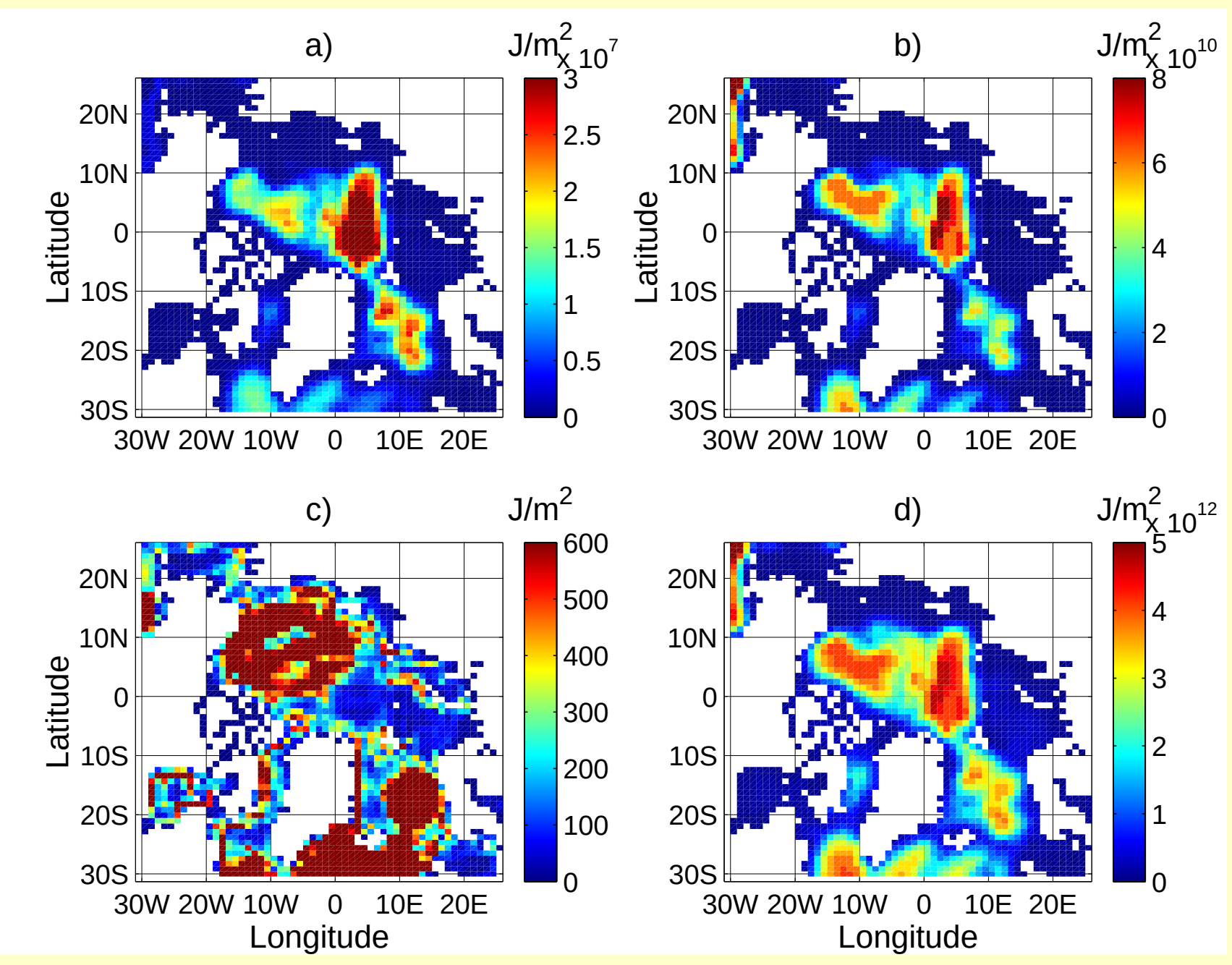
$$APE = PE - RPE = PE - g\iint \rho(Z_r)\,Z_r\,dZ_r\,dA\ ,$$

where the reference potential energy is subtracted from the total potential energy. The reference level was defined to correspond the minimum potential energy state.

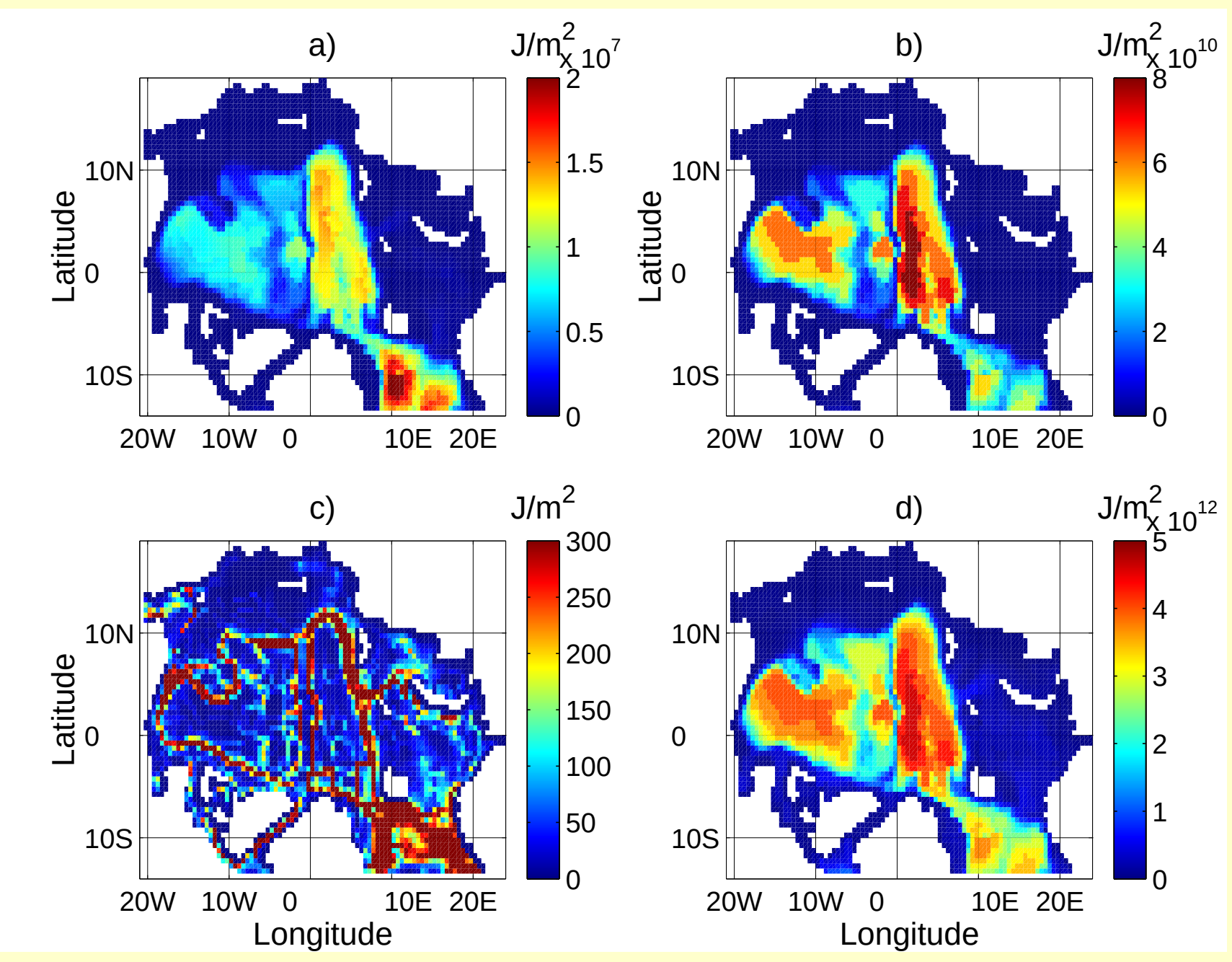
AOMIP models were forced in general with different data and physical and numerical parameters varied as well. For example atmospheric forcing was constructed either from NCEP or ECMWF (ERA-40) reanalysis or from observed data.

Three models (IOS, UW and NYU models) were compared in this particular study. IOS model originates in the Institute of Ocean Science, Sidney, Canada, UW model is from the University of Washington, Seattle, USA, and the reference institution of NYU model is the same as the authors of this presentation. Most remarkable differences between the results were that the IOS model utilized NCEP reanalysis, NYU model applied ECMWF reanalysis forcing, and UW model was forced with IPAB/POLES observations from 1999. Additionally IOS and UW models took the river discharge into consideration, which was parameterized in the NYU model as an artificial climate restoring term. The NYU and UW models covered larger area than the IOS model. The UW model had horizontal resolution of 40 km, IOS model 1/2°, and NYU model 1° in both longitudinal and latitudinal directions.

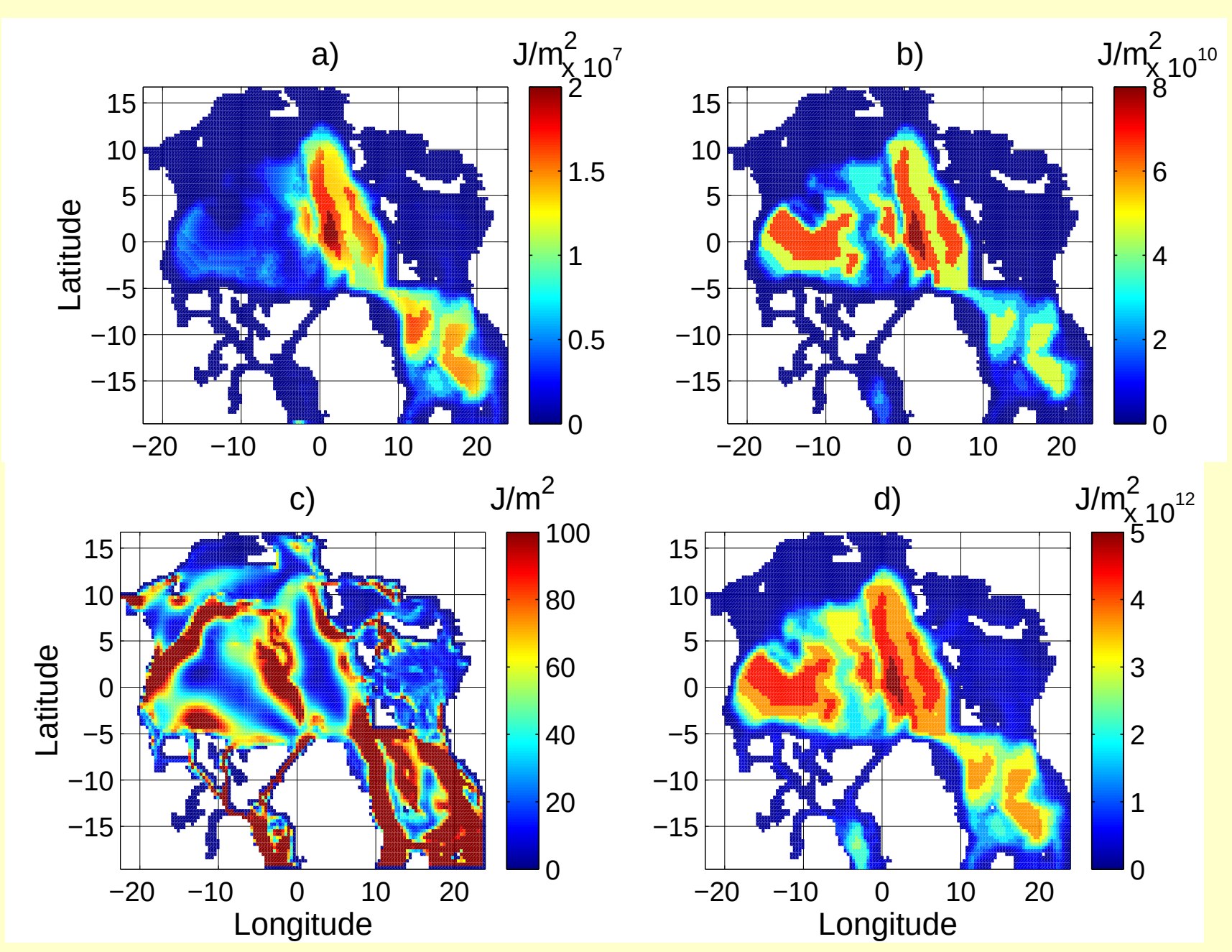
3 PRELIMINARY RESULTS



NYU model



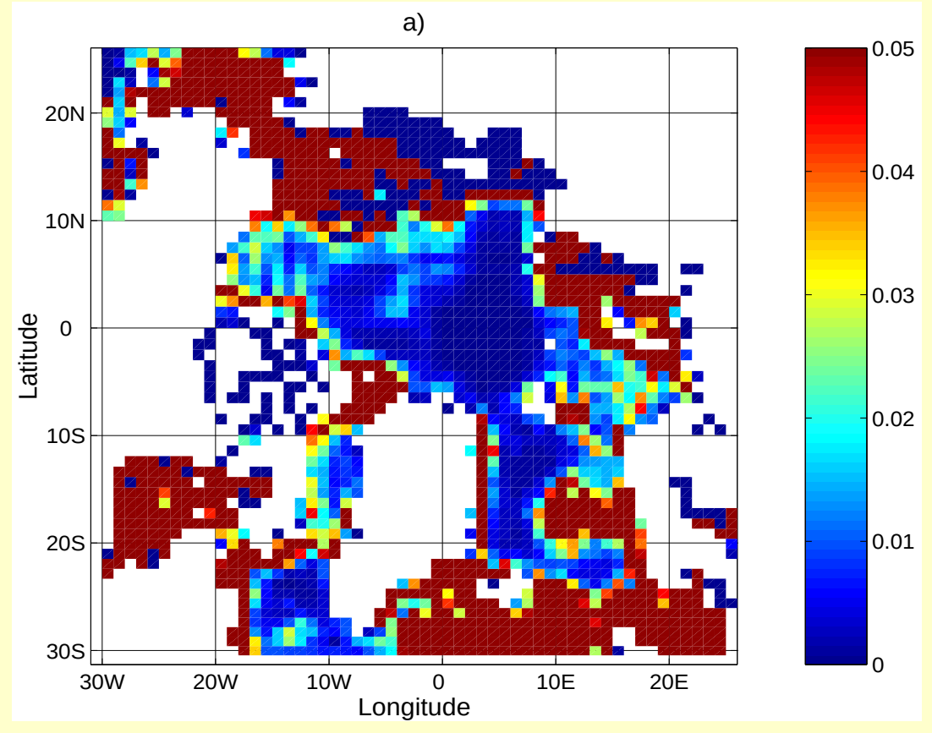
IOS model



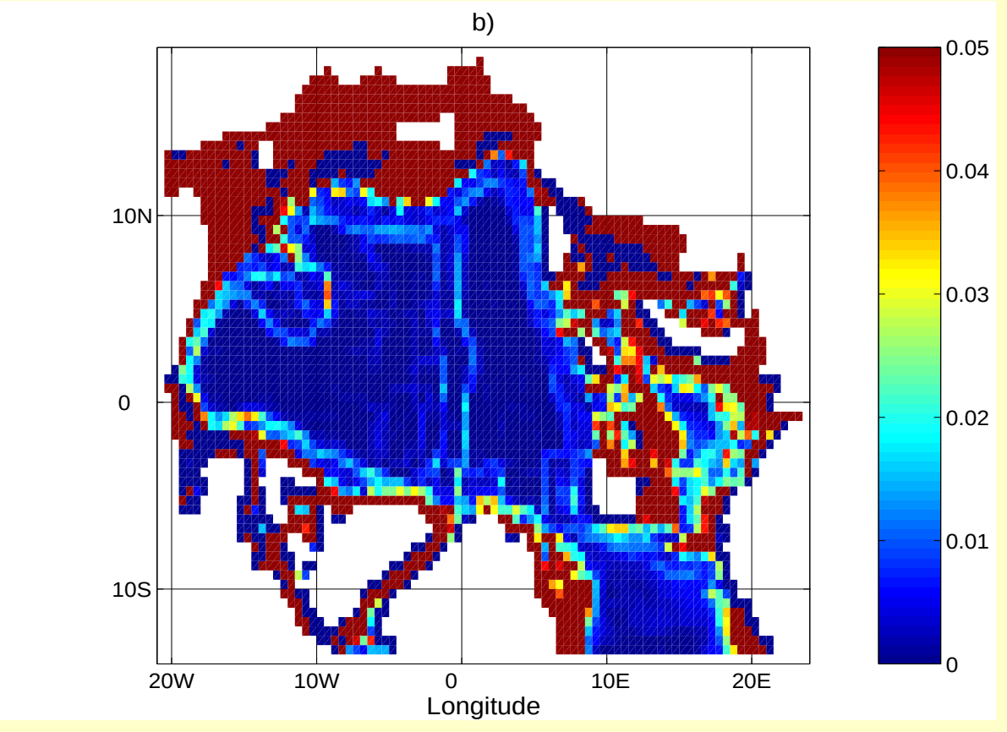
UW model

Plates 1-3: Annual average fields of a) available potential energy b) total potential energy, c) kinetic energy and d) internal thermal energy. The model results vary especially with the kinetic energy.

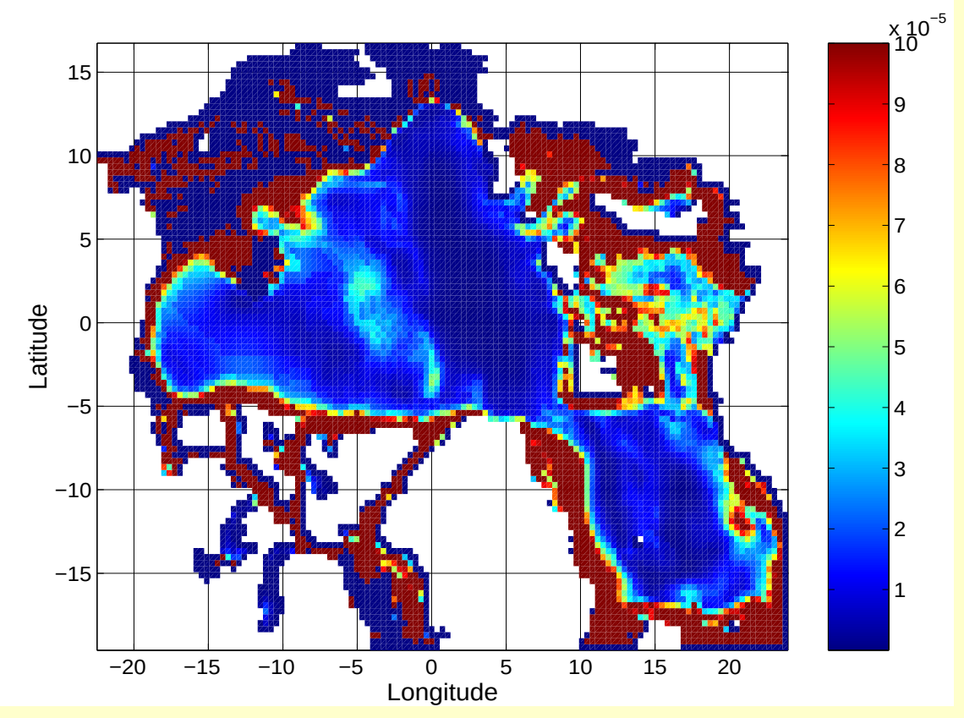
Energy / area fields



NYU model



IOS model



UW model

Kinetic / Potential energy

Plates 4-6. Kinetic to available potential energy ratio. Note the different scales of colorbars. At the shallow areas the ratio varies much because the relative accuracy of the energy components is low.

Table 1. Annual averages and standard deviations of the energy components from the three numerical models.

	Mean (J)				*Std (J)*			
	NYU	IOS	UW		NYU	IOS	UW	
IH	1.613	1.624	1.713	$\times10^{25}$	6.14	9.80	11.5	$\times10^{20}$
PE	1.769	1.915	1.885	$\times10^{23}$	8.53	12.6	13.4	$\times10^{17}$
APE	7.579	4.208	3.789	$\times10^{19}$	66.7	44.3	11.8	$\times10^{17}$
KE	5.559	1.558	0.601	$\times10^{15}$	21.7	0.52	0.49	$\times10^{14}$

Seasonal variability

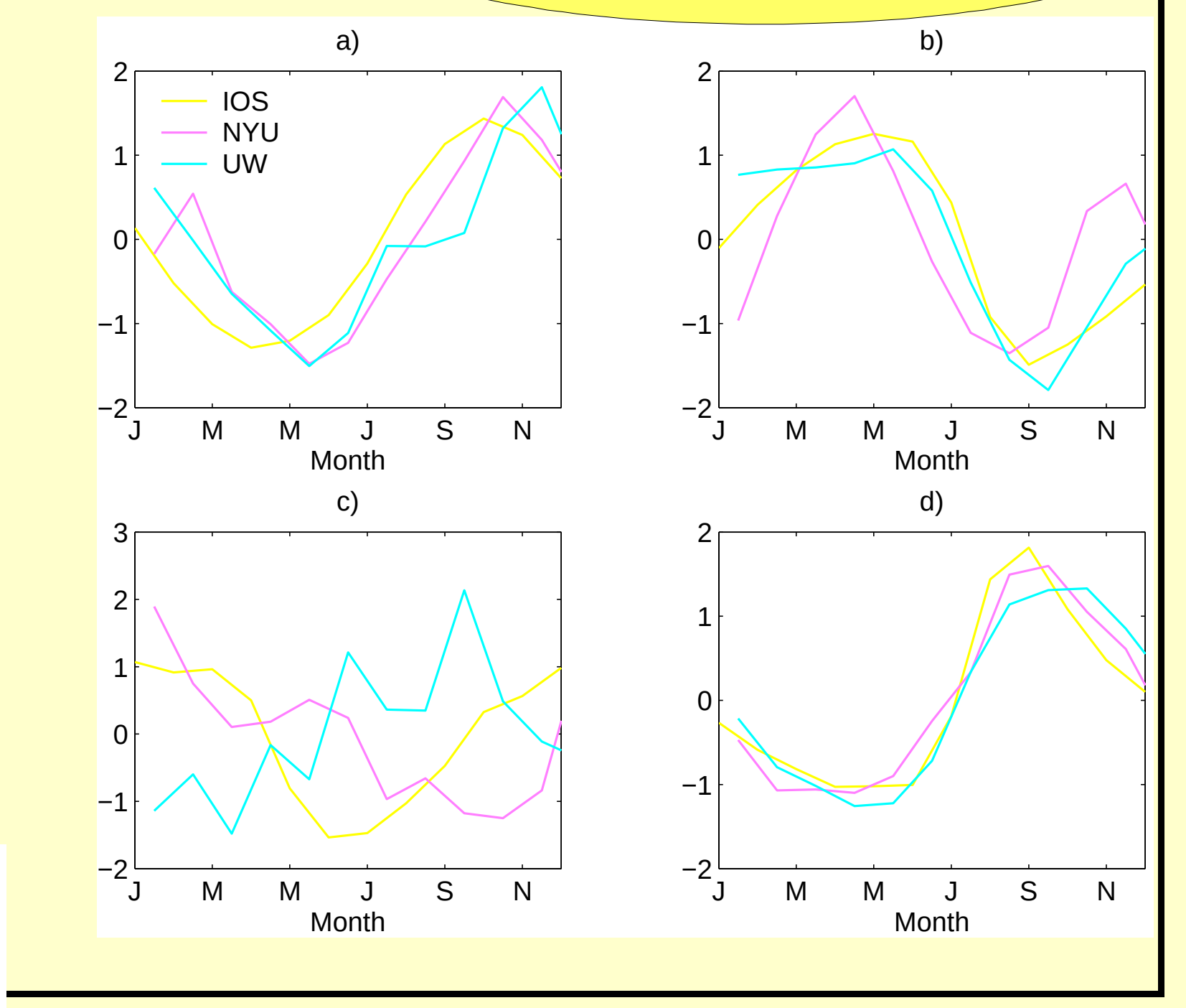


Plate 7: Normalized monthly values of a) Internal thermal heat, b) potential energy, c) kinetic energy, and d) available potential energy. The mutual correspondence of the annual cycles is apparent in a), b), and d).

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