

HEAT AND MOMENTUM FLUXES FOR HYCOM
AN EXAMPLE APPLICATION : 3.2 km BLACK SEA MODEL

By

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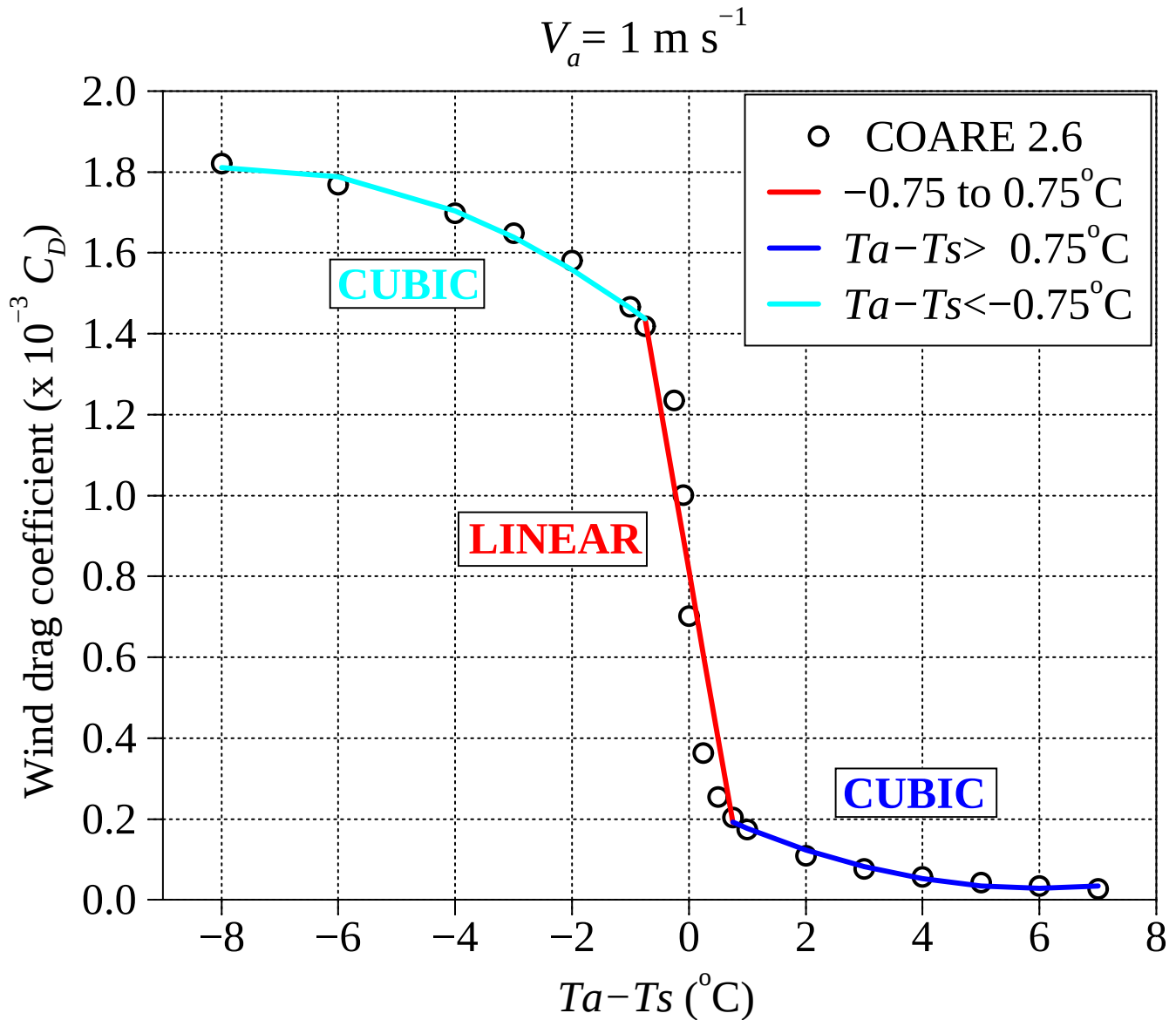
Contents

- Wind Stress
- Thermal Forcing
 - latent and sensible heat fluxes
 - shortwave and longwave fluxes
- The Black Sea Simulation
- Impact of Water Turbidity
- Summary and Conclusions

Atmospheric Forcing

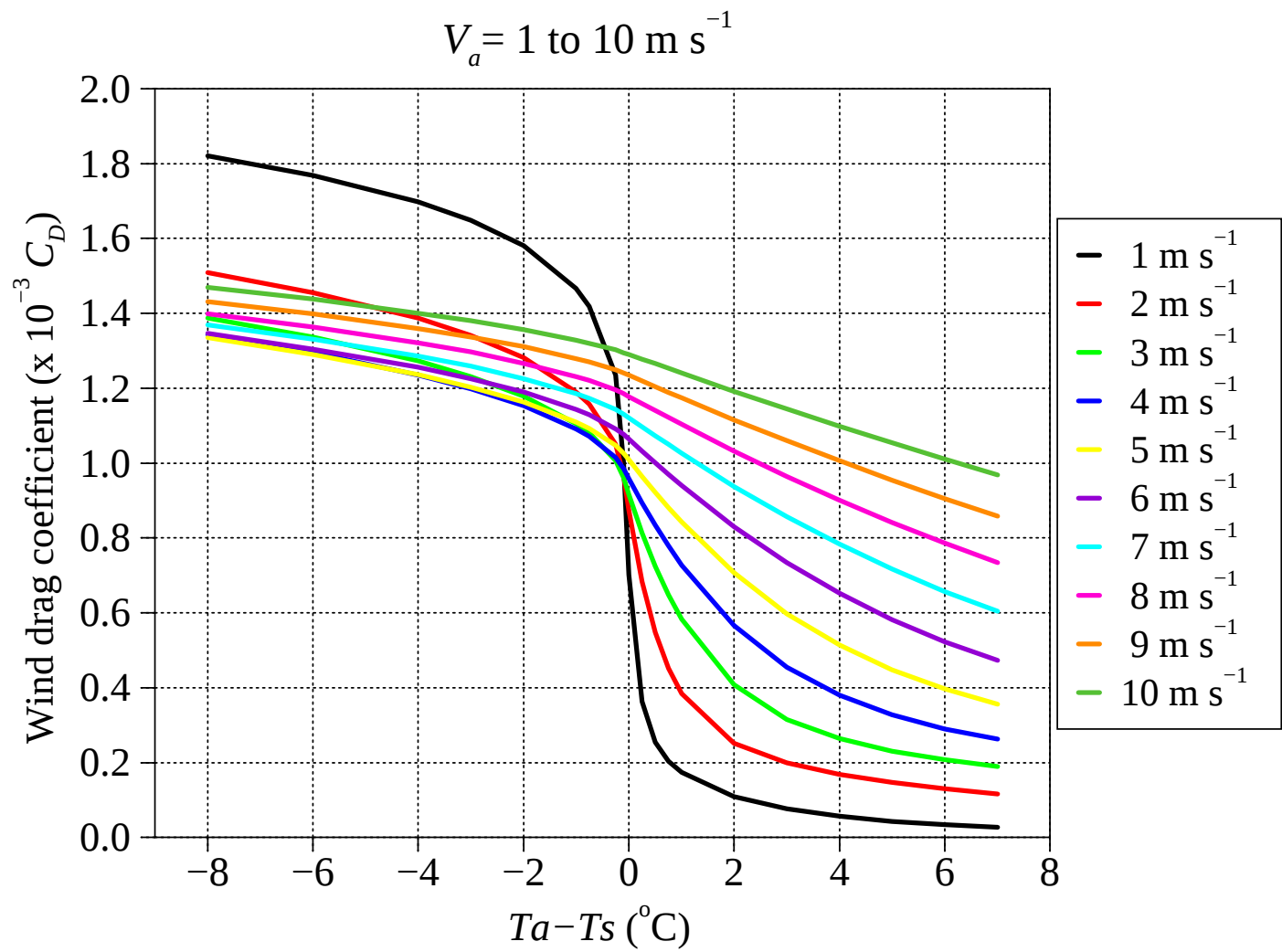
- Wind stress:
 - a bulk formula
 - air/sea stability on drag coefficient
- Latent and sensible heat fluxes:
 - bulk formulae
 - air/sea stability on exchange coefficients
 - calculated using HYCOM SST at each time step
 - realistic tendency towards the “correct” SST
 - keep the HYCOM SST on track
- Shortwave radiation at the sea surface
- Longwave radiation at the sea surface

WIND DRAG COEFFICIENT



- The methodology includes
 - stable case, unstable case, neutral case

WIND DRAG COEFFICIENT FOR DIFFERENT WIND SPEEDS



Shortwave Radiation Penetration

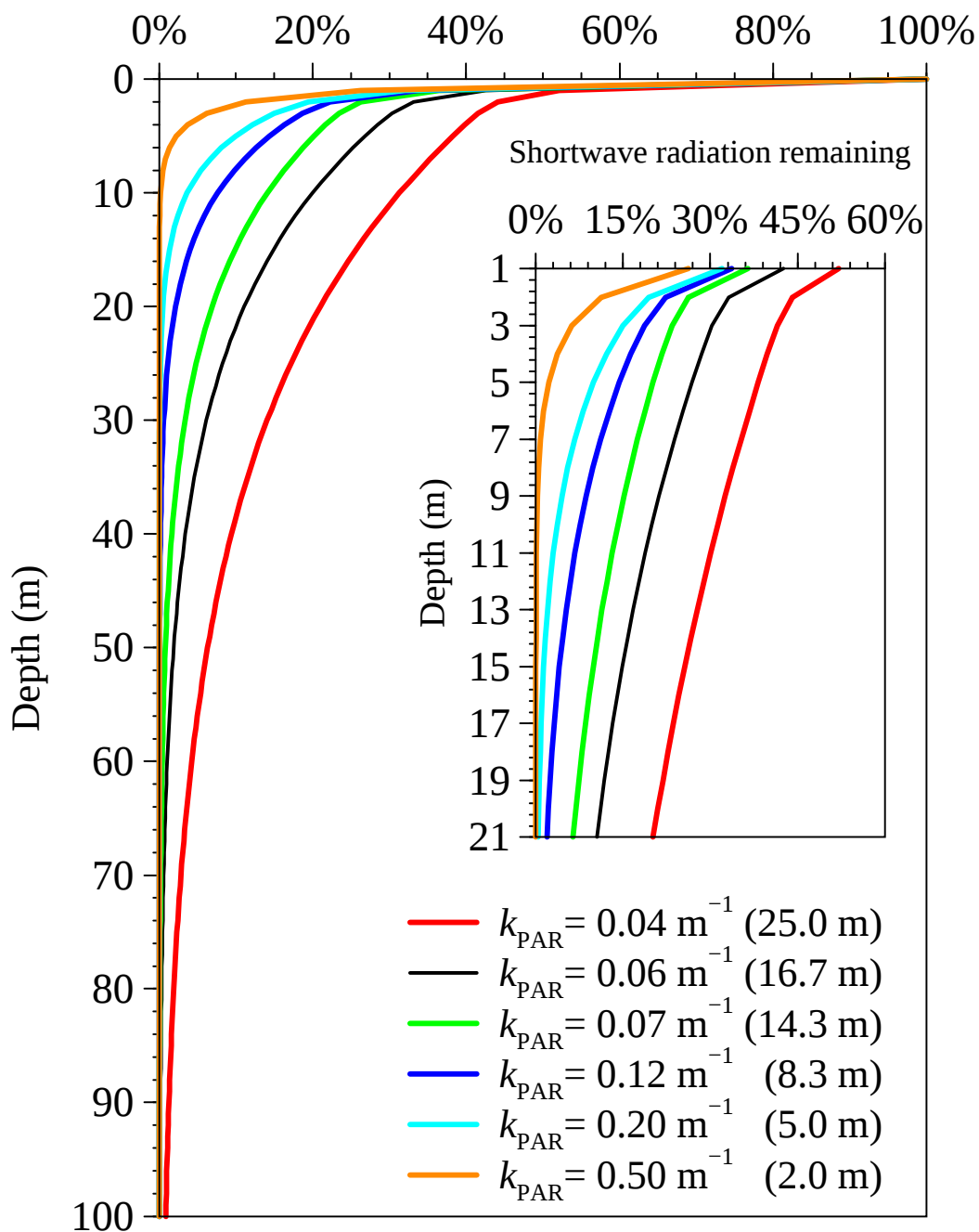
- Previous Subsurface Heating Parameterization in HYCOM
 - few discrete attenuation profiles

	Type	Red (%)	Blue (%)
1	I	58	42
2	IA	62	38
3	IB	67	33
4	II	77	23
5	III	78	22

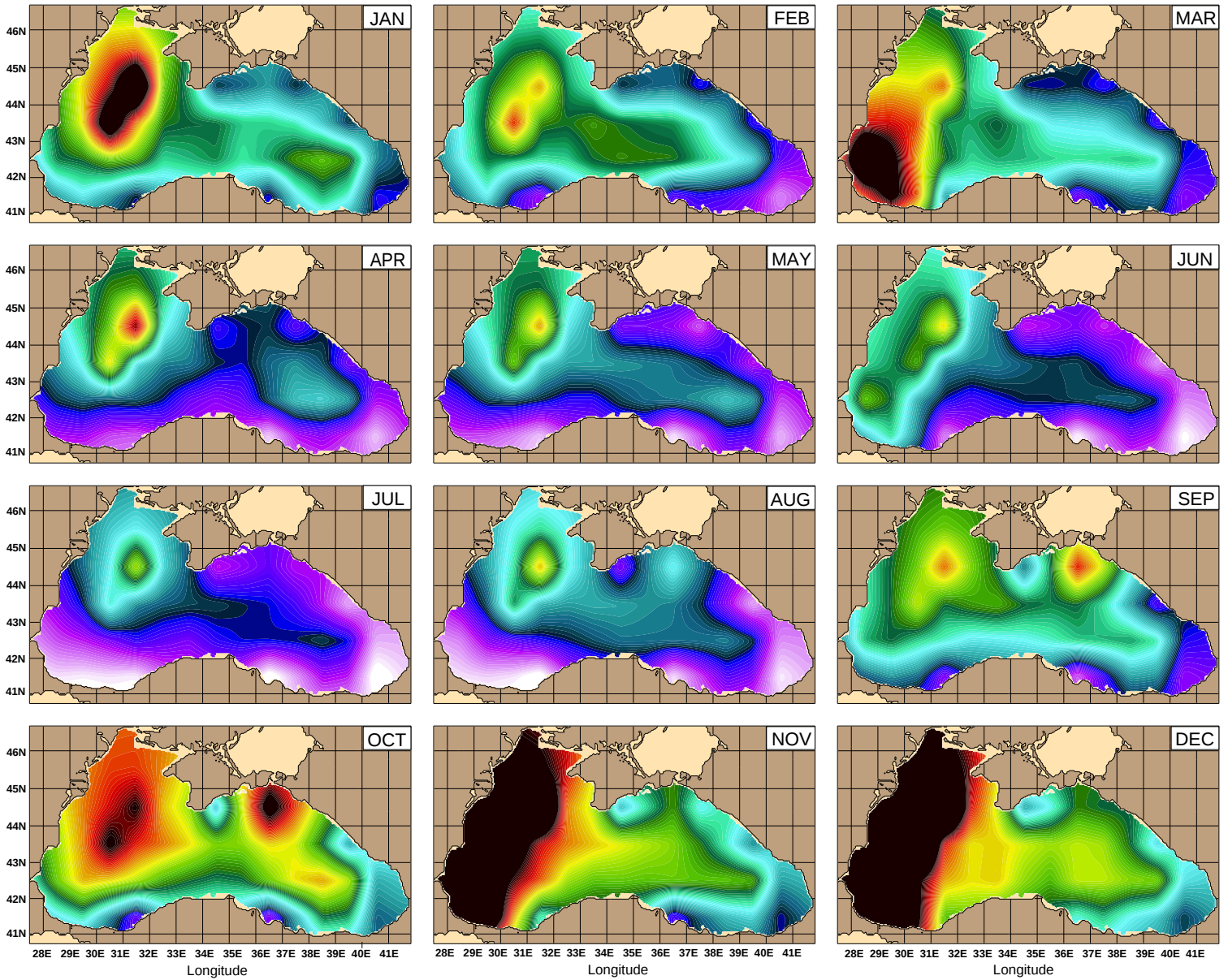
- A new shortwave radiation penetration scheme for HYCOM
- Different than “bulk type” mixed layer models
 - spatial and temporal water turbidity from SeaWiFS
 - 2–band scheme:
 - red spectrum: absorbed near surface
 - blue spectrum: more deeply penetrating

SHORTWAVE RADIATION ABSORPTION

Shortwave radiation remaining below the sea surface



ATTENUATION COEFFICIENT CLIMATOLOGY

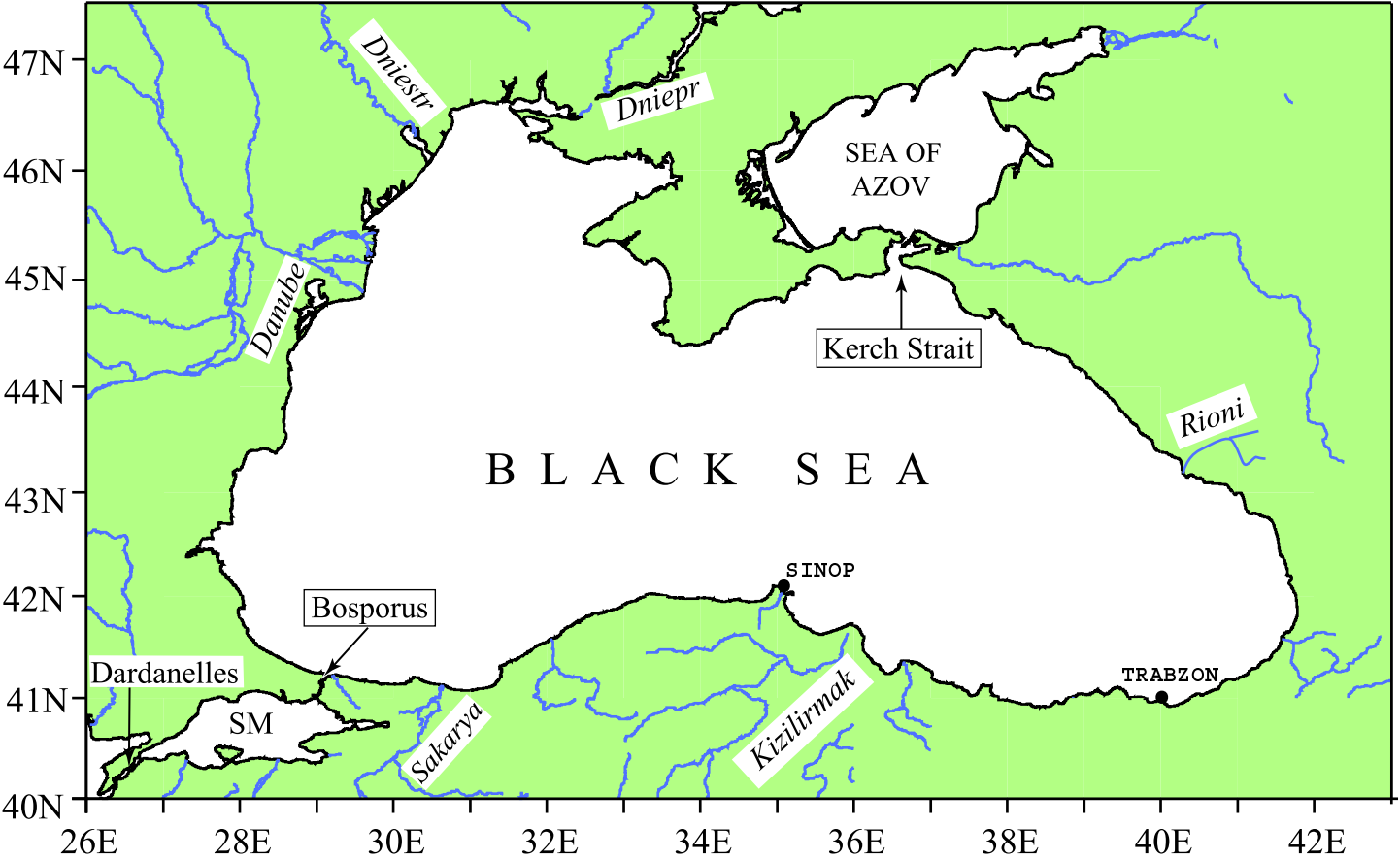


k_{PAR} (m^{-1})

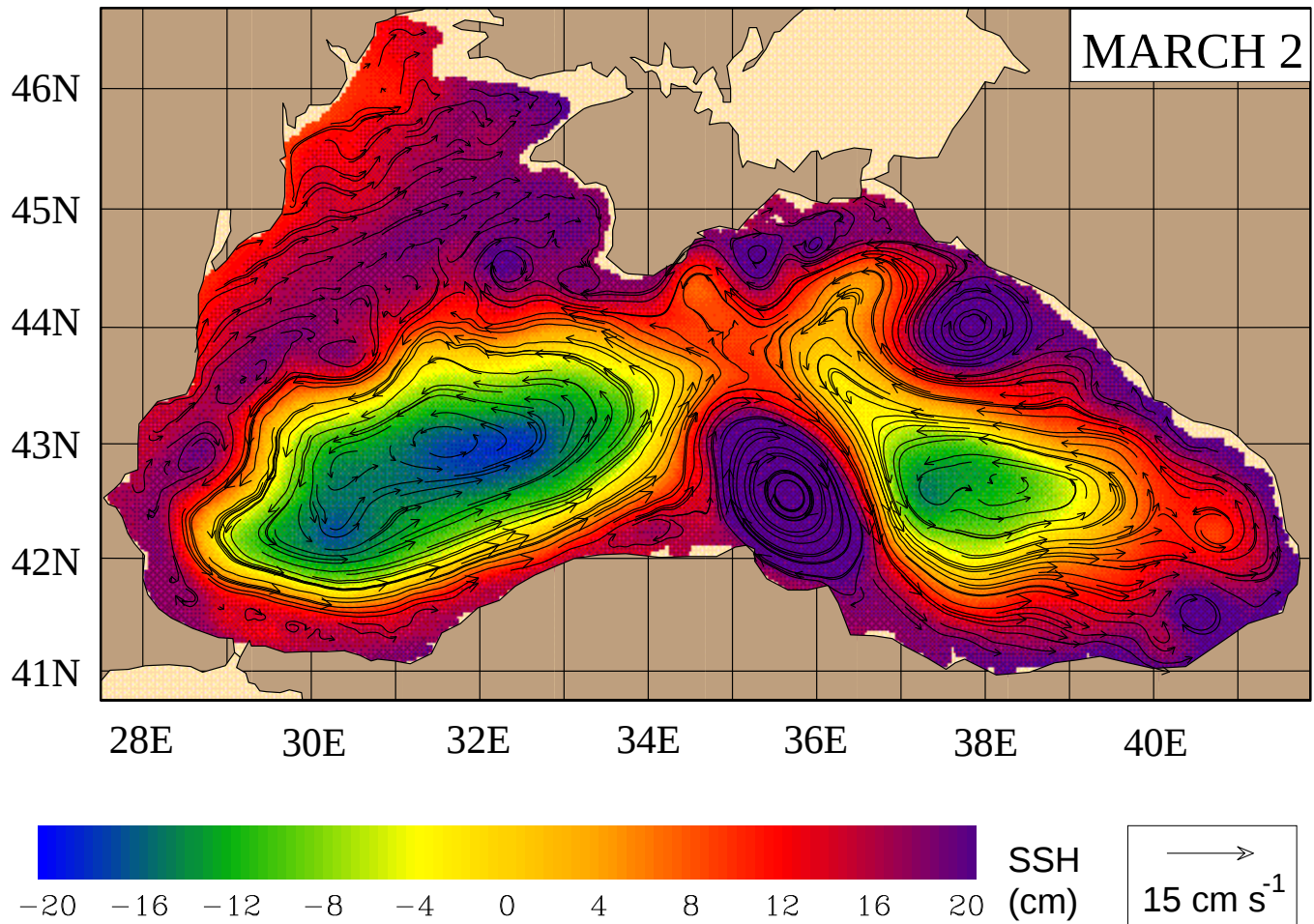
Longwave Radiation

- A correction is needed. Why ?
 - Longwave radiation from ECMWF or NOGAPS
 - Calculated using their model SST
- HYCOM now uses
$$Q_{\text{LW}}(\mathbf{T}_s) = Q_{\text{LW}}(\mathbf{T}_c) - 5.3 (\mathbf{T}_s - \mathbf{T}_c).$$
 - $\mathbf{T}_s$: HYCOM SST
 - $\mathbf{T}_c$: Climatological SST
- A constant value: $-5.3 \text{ W m}^{-2} \text{ C}^{-1}$ (relaxation term)

GEOGRAPHY OF THE BLACK SEA



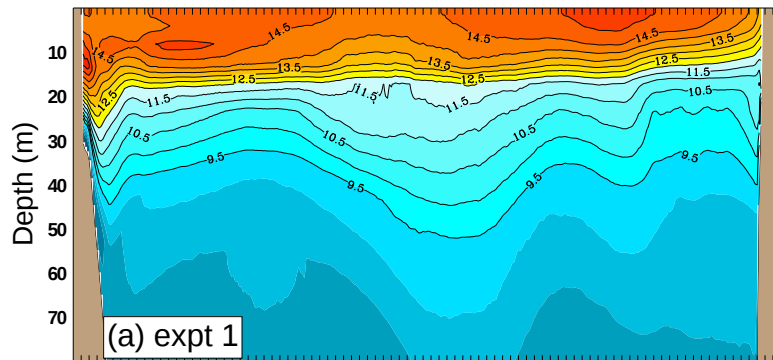
SNAPSHOTS OF SSH and SURFACE CURRENTS



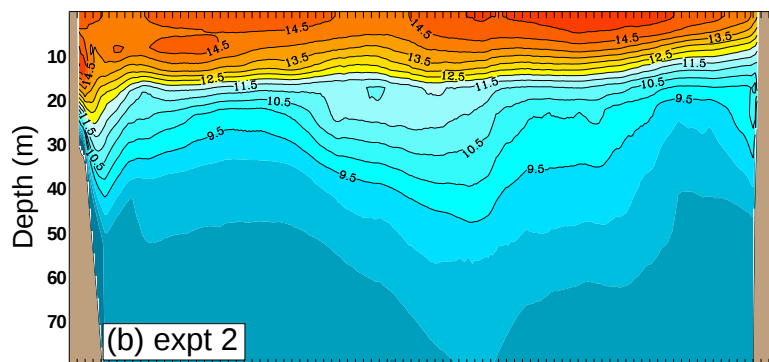
- Climatologically forced HYCOM simulation:
- Wind and thermal forcing from NOGAPS

NOGAPS: Navy Operational Global Atmospheric Prediction System

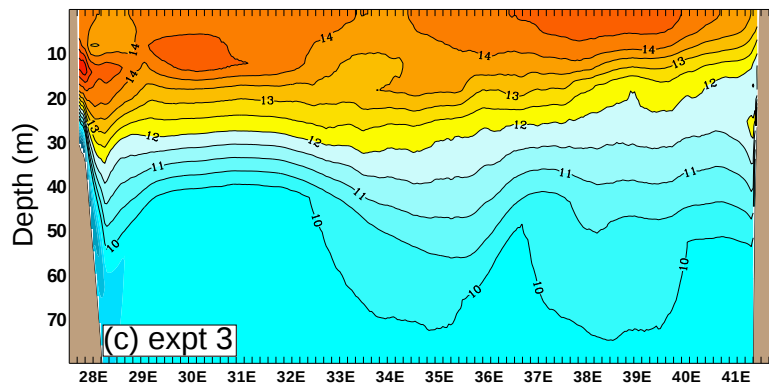
ANNUAL MEAN SUBSURFACE TEMPS. ALONG 42.6°N



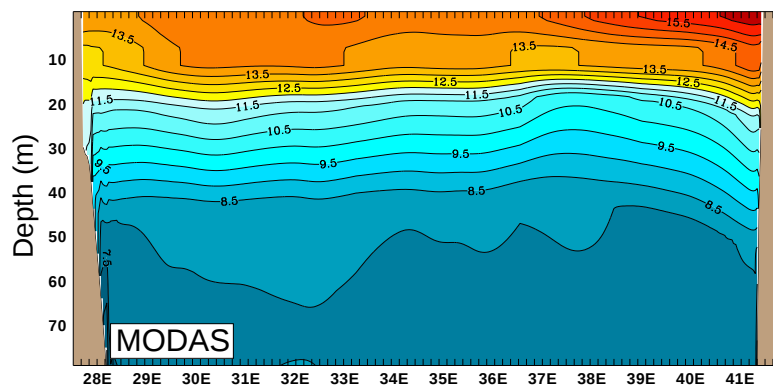
SeaWiFS BASED
TURBIDITY



ALL RADIATION
AT THE SURFACE



CLEAR WATER
ASSUMPTION



MODAS TEMP.
CLIMATOLOGY

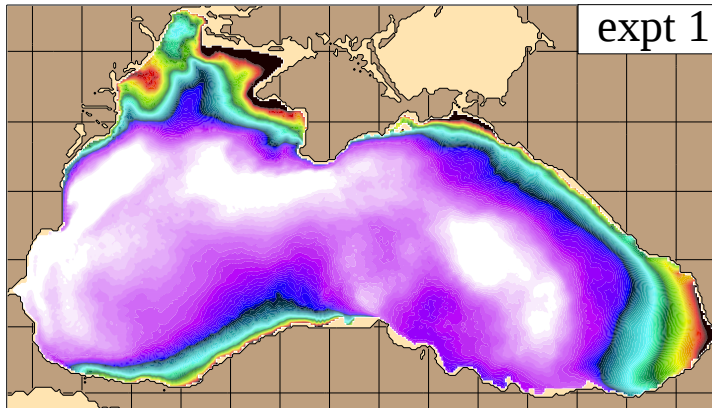


Temp. (°C)

SST VALIDATION

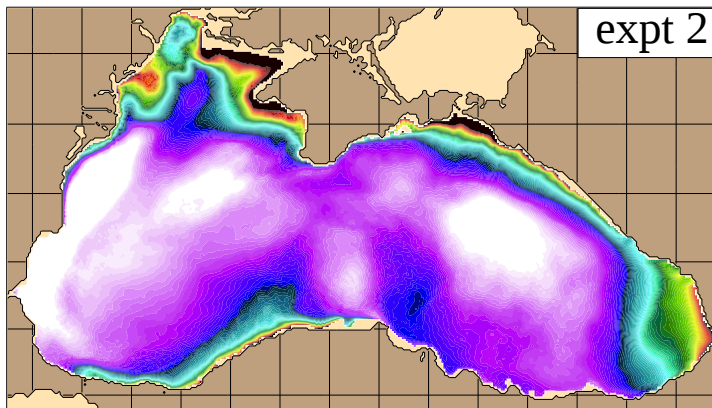
SST RMS difference with respect to the $1/8^\circ$ Pathfinder SST clim.

12 monthly HYCOM SST versus 12 monthly Pathfinder SST



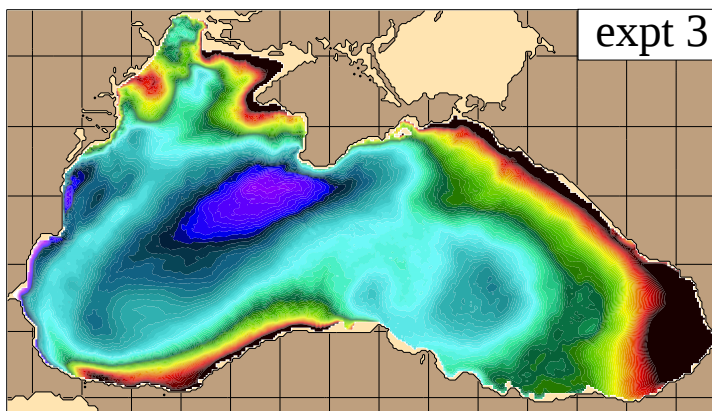
**SeaWiFS BASED
TURBIDITY**

(RMS = 1.41°C)



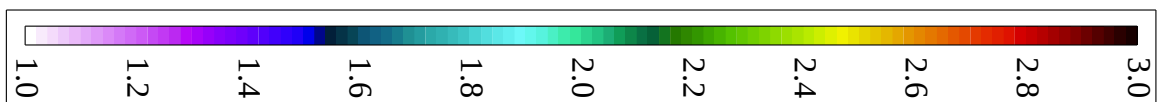
**ALL RADIATION
AT THE SURFACE**

(RMS = 1.42°C)



**CLEAR WATER
ASSUMPTION**

(RMS = 2.06°C)



RMS
($^\circ\text{C}$)

SST SKILL SCORE and LAND/SEA MASK

LAND/SEA MASK FROM ECMWF

