The importance of ocean mesoscale variability for air-sea interactions and upper ocean temperature flux in the Gulf of Mexico

Dian Putrasahan
Igor Kamenkovich and Ben Kirtman

UNIVERSITY OF MIAMI
ROSENSTIEL
SCHOOL of MARINE &
ATMOSPHERIC SCIENCE

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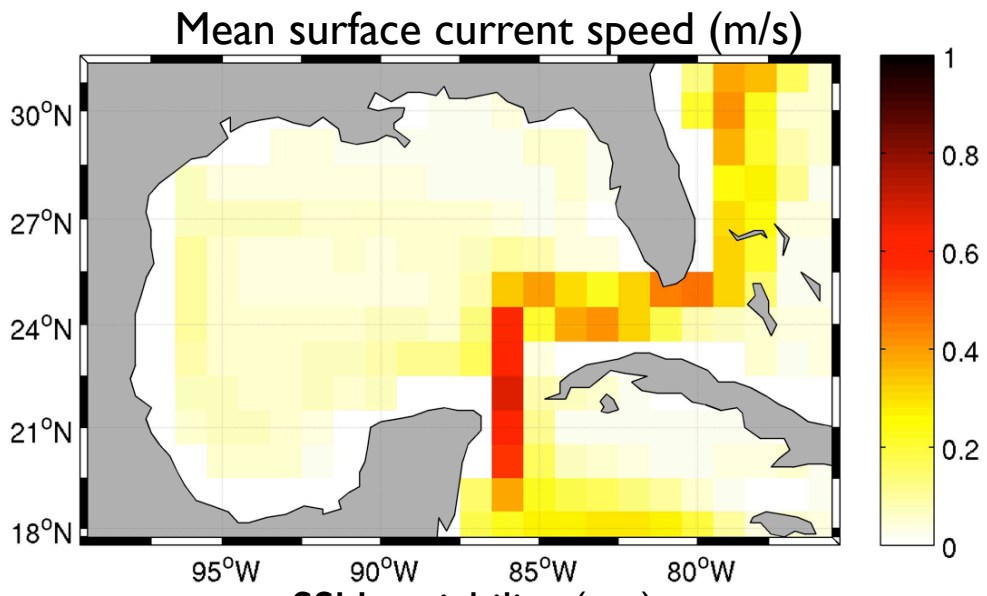
Community Climate Systems Model (CCSM3.5)

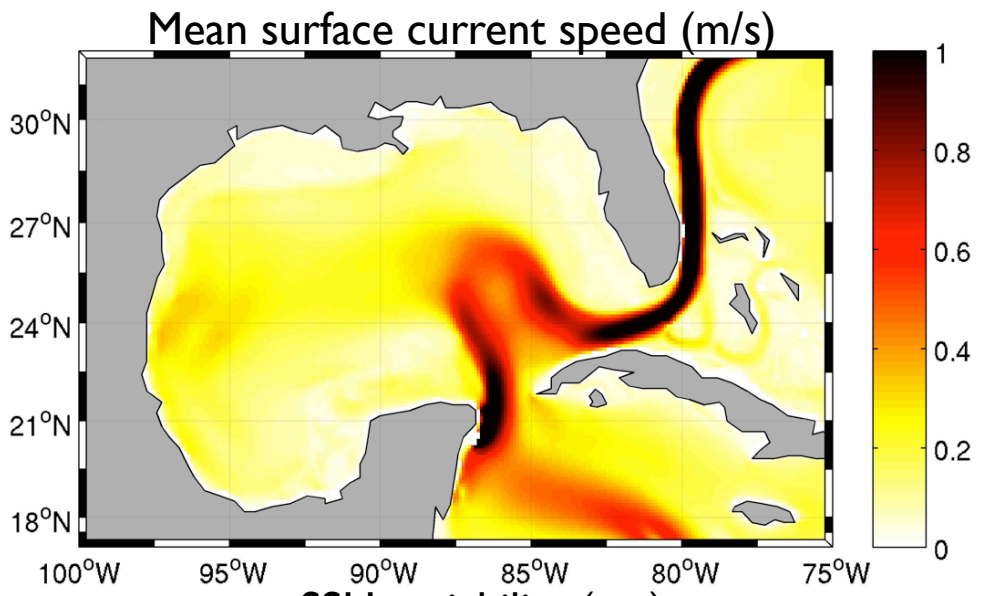
Low resolution (LRC):

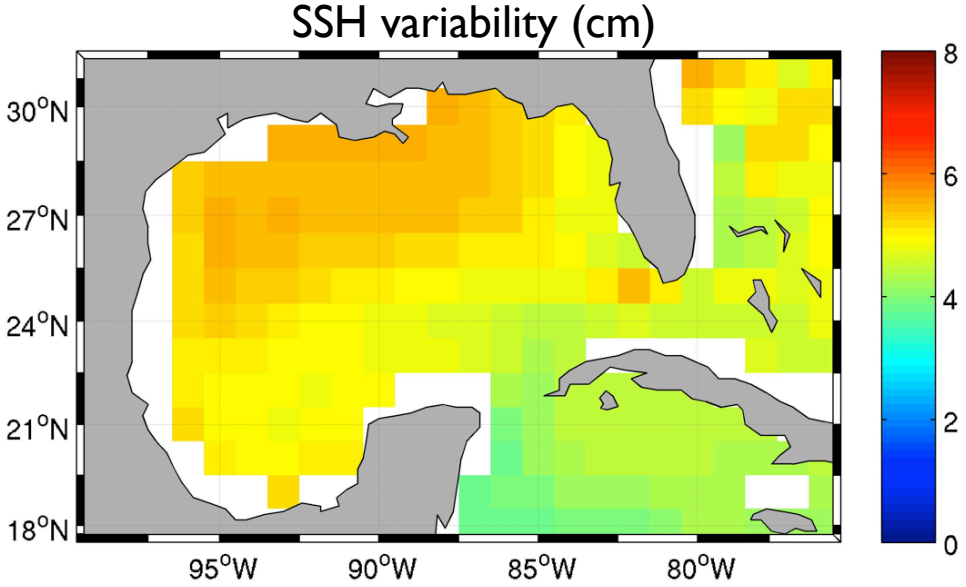
- 1º ocean, 0.5º atm
- Model years: 35-88
- Fixed forcing (1990)

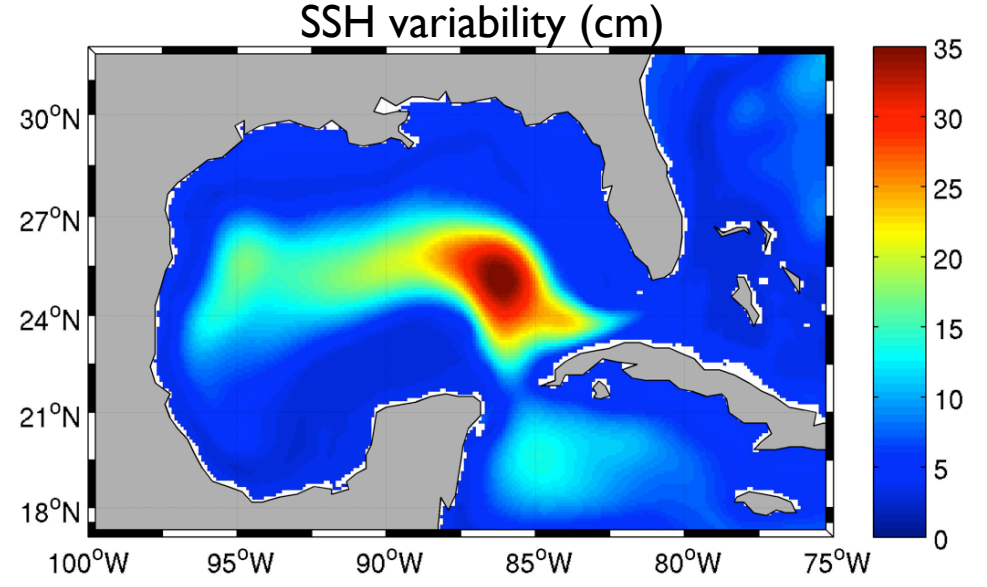
High resolution (HRC):

- 0.1º ocean, 0.5º atm
- Model years: 102-155
- Fixed forcing (1990)









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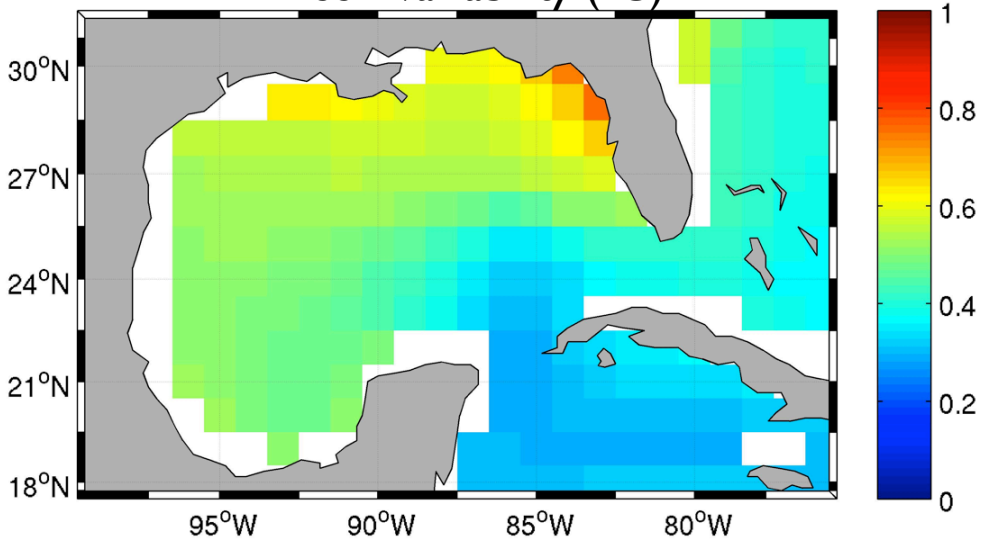
SST variability (°C)



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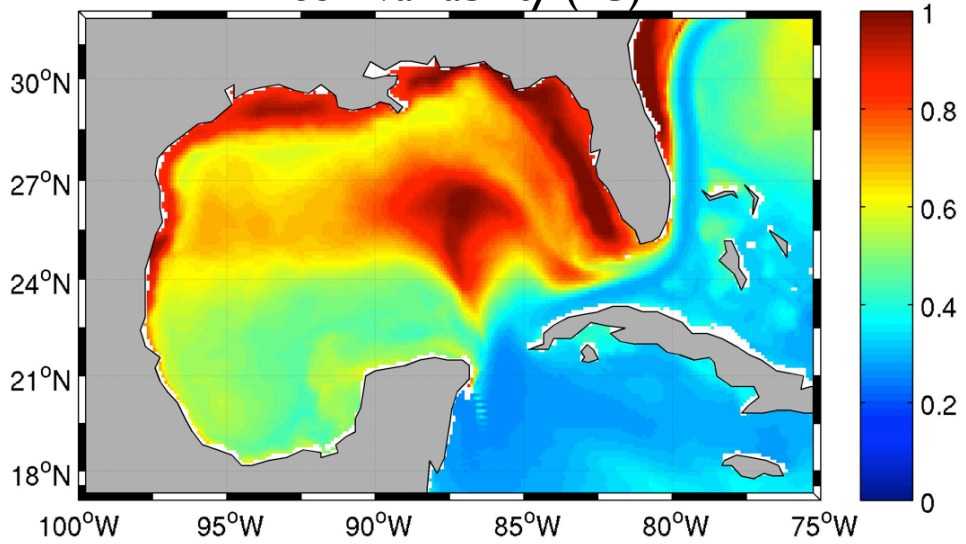
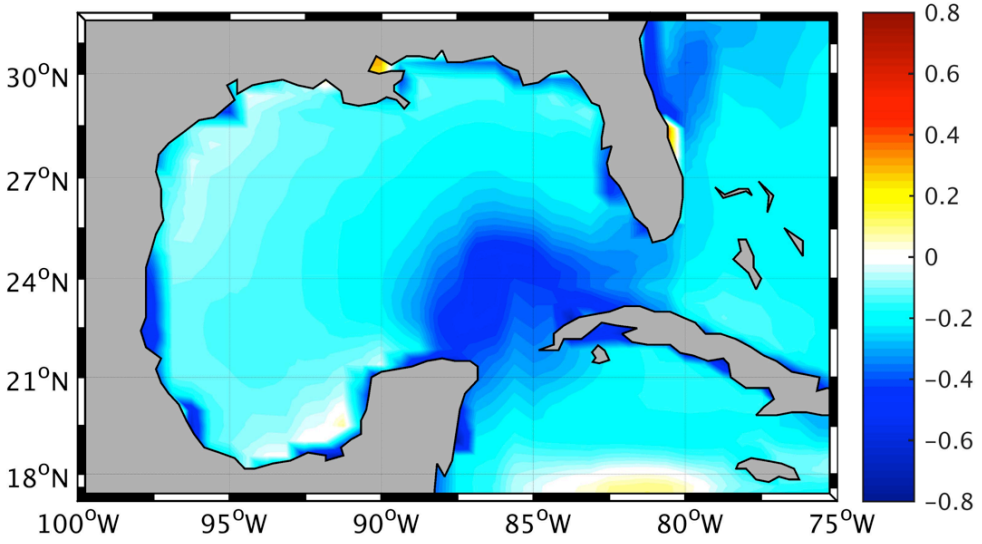
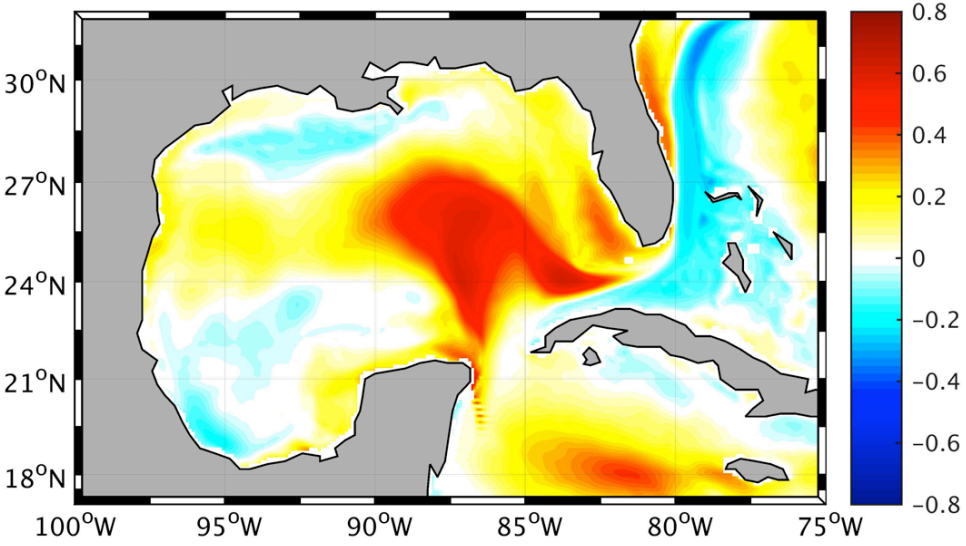


Correlation of LHF and SST for LRC



Correlation of LHF and SST for HRC

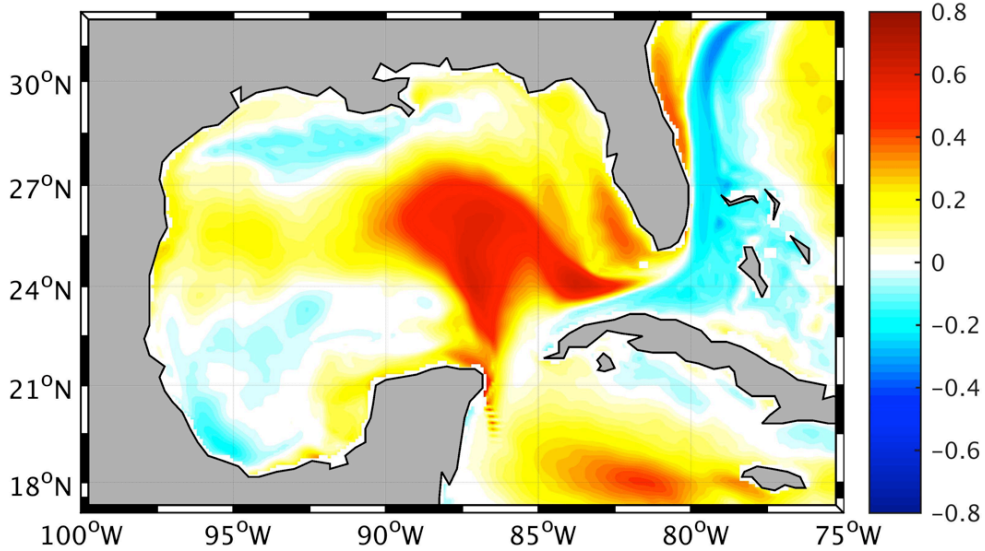


Correlation between LHF and ocean variables (HRC)

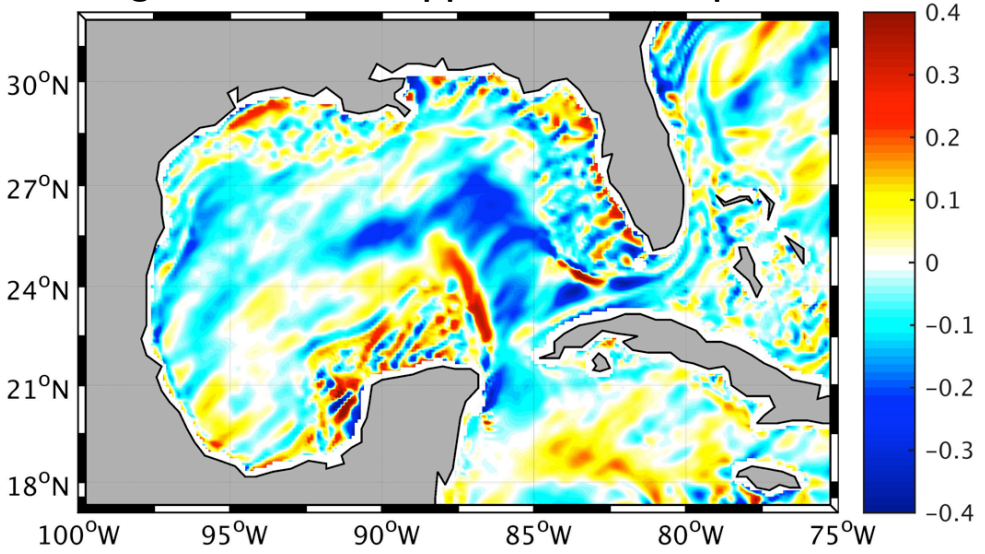
$$\nabla \cdot (\overline{\mathbf{u}T}) = \nabla \cdot (\overline{\mathbf{u}}\,\overline{T}) + \nabla \cdot (\overline{\mathbf{u}'T'})$$

total mean submonthly

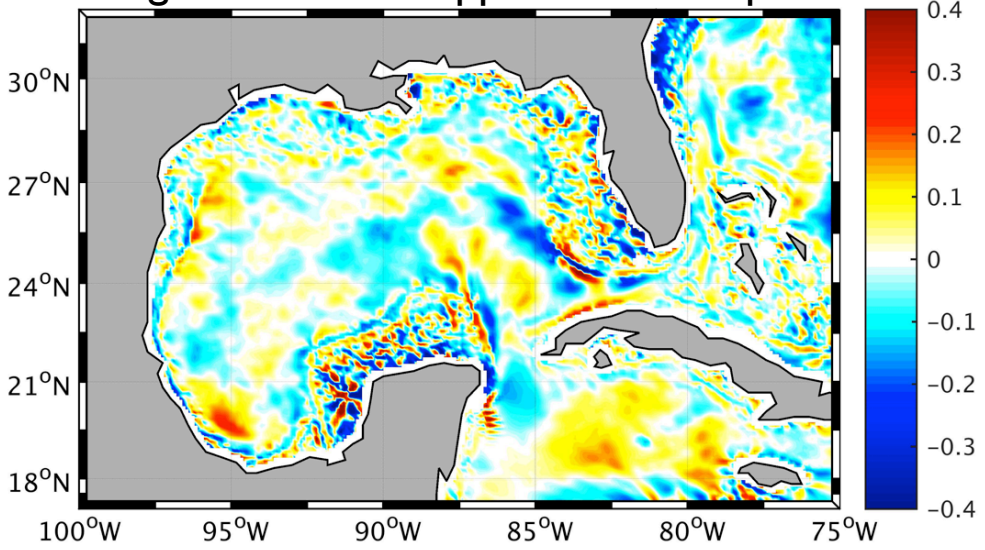
Sea surface temperature



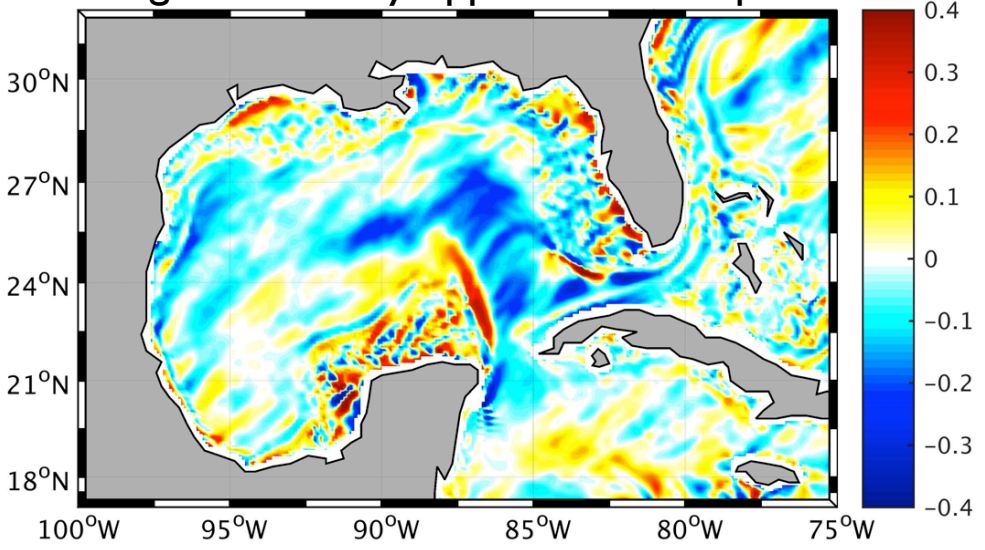
Divergence of total upper 200m temperature flux



Divergence of mean upper 200m temperature flux



Divergence of eddy upper 200m temperature flux



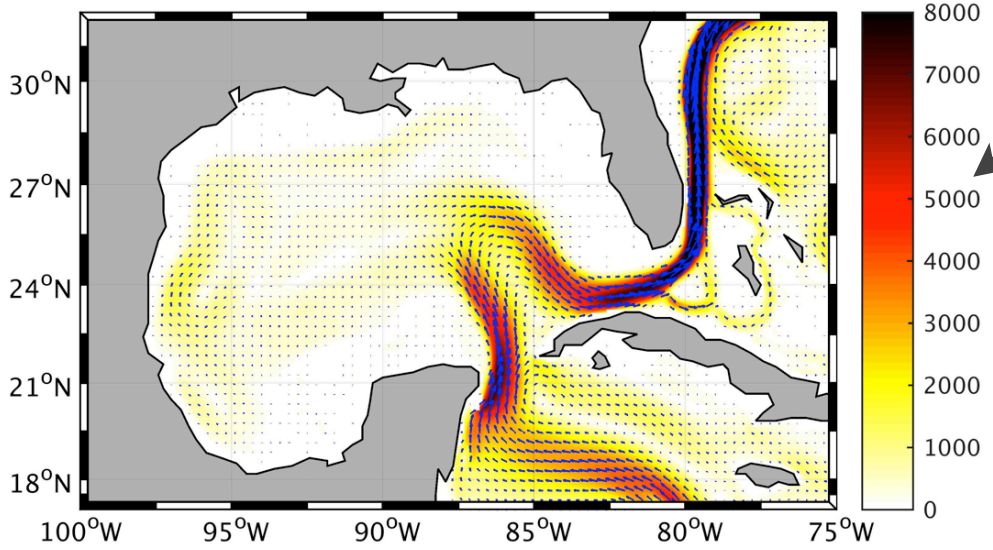
Magnitude of upper 200m temperature flux <climatological 54-year mean>

$$< (\overline{\mathbf{u}T}) >=< (\overline{\mathbf{u}}\,\overline{T}) > + < (\overline{\mathbf{u}'T'}) >$$

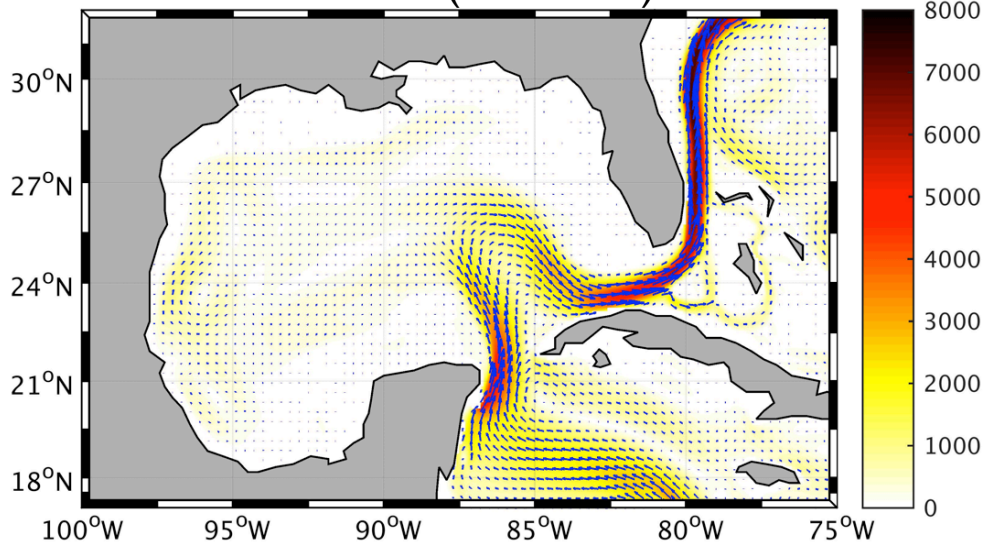
total — mean — submonthly

$$< (\overline{\mathbf{u}}\,\overline{T}) >=< \overline{\mathbf{u}} >< \overline{T} > + < \overline{\tilde{\mathbf{u}}\tilde{T}} >$$

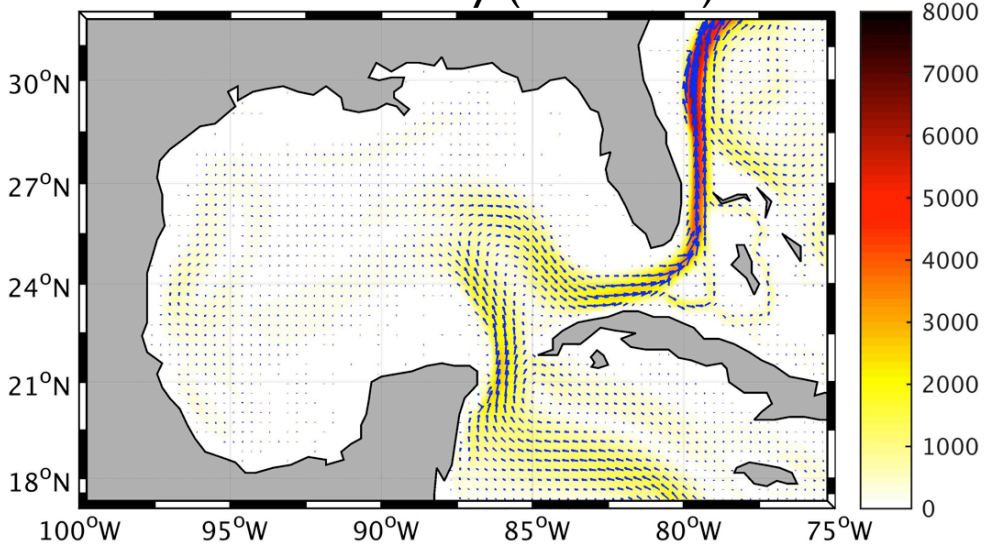
Total (m-°C-m/s)



Mean (m-°C-m/s)



Submonthly (m-°C-m/s)

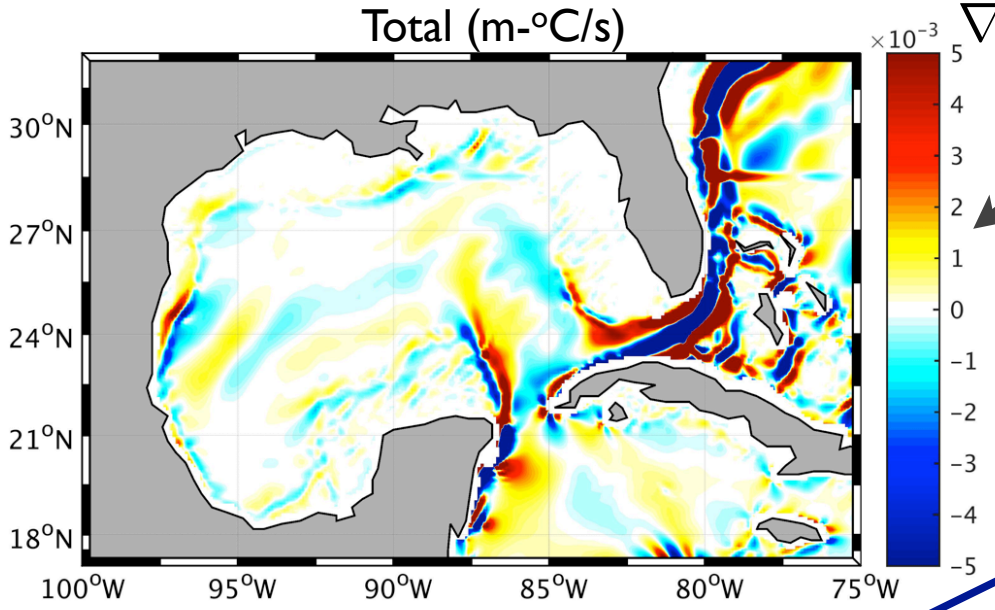


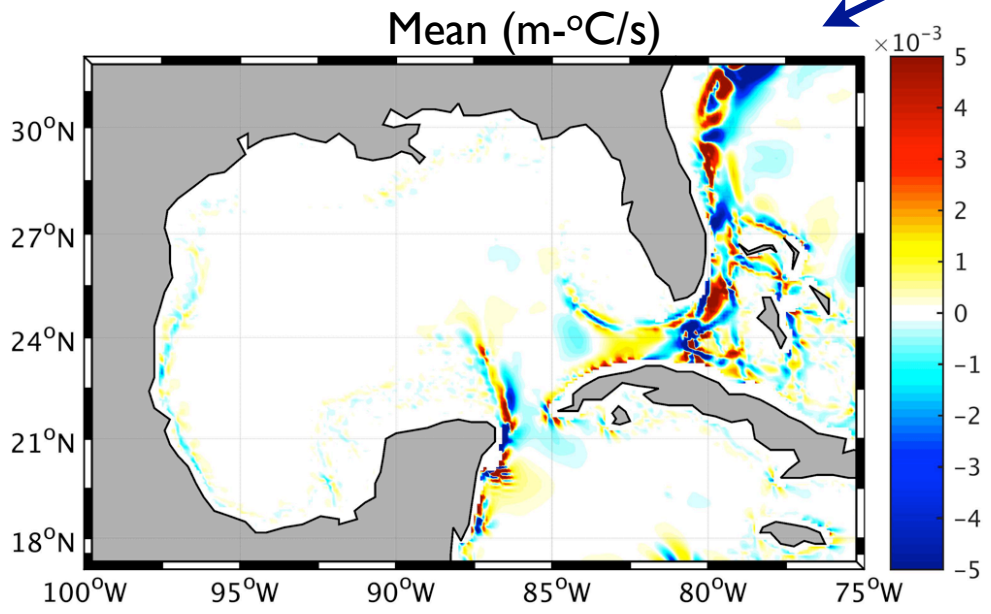
Divergence of upper 200m temperature flux <climatological 54-year mean>

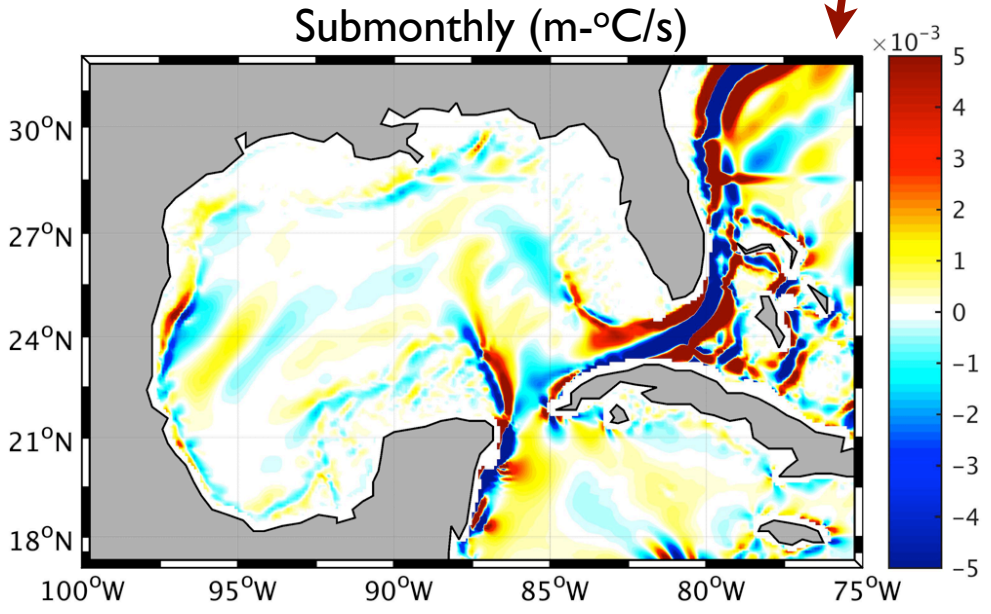
$$\nabla\cdot<(\overline{\mathbf{u}T})>=\nabla\cdot<(\overline{\mathbf{u}}\overline{T})>+\nabla\cdot<(\overline{\mathbf{u}'T'})>$$

total = mean + submonthly

$$<(\overline{\mathbf{u}T})>=<\overline{\mathbf{u}}><\overline{T}>+<\overline{\tilde{\mathbf{u}}\tilde{T}}>$$



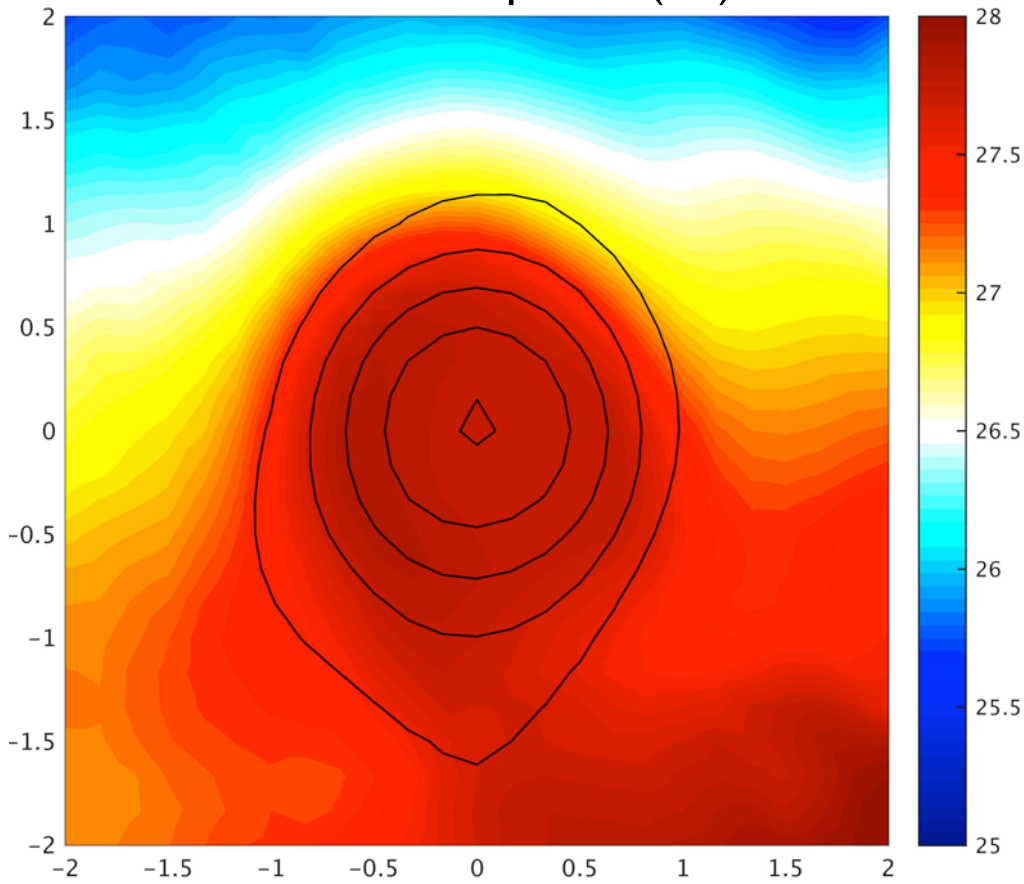




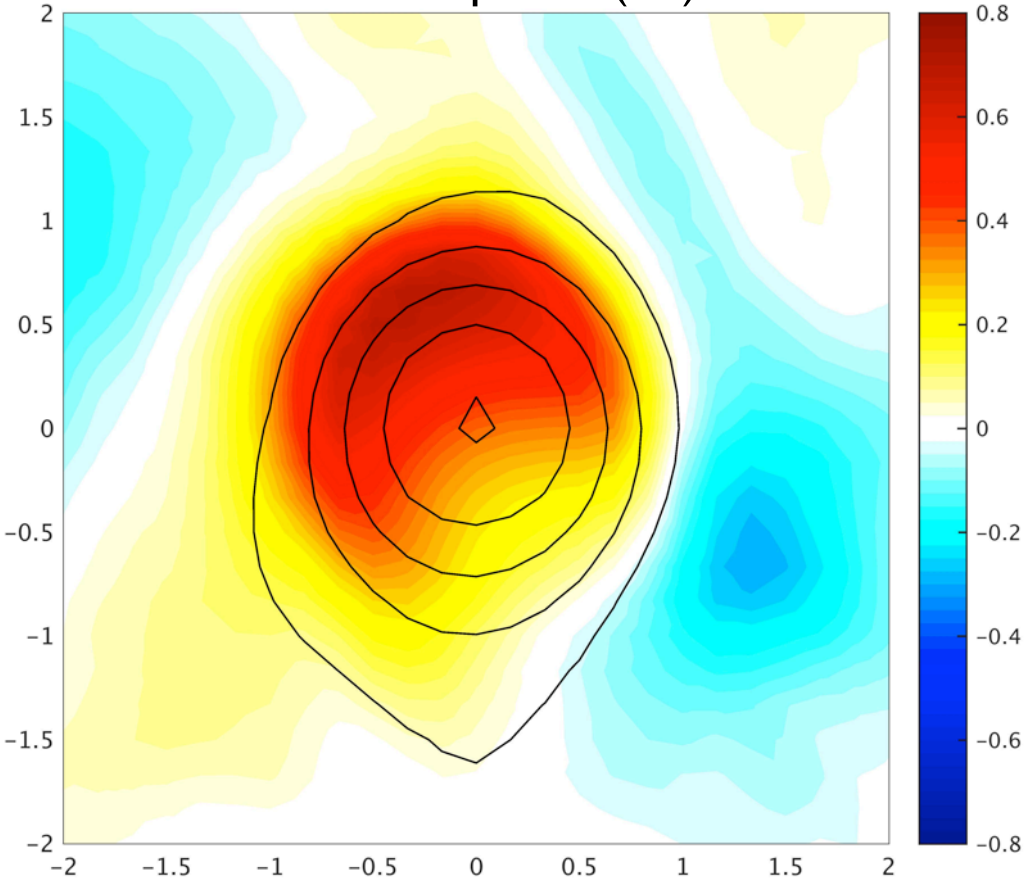
Anticyclonic eddies in the Gulf of Mexico

- ✦ 1111 anticyclonic eddies based on SLA
- ✦ Average diameter: ~348km

Full SST composite (°C)

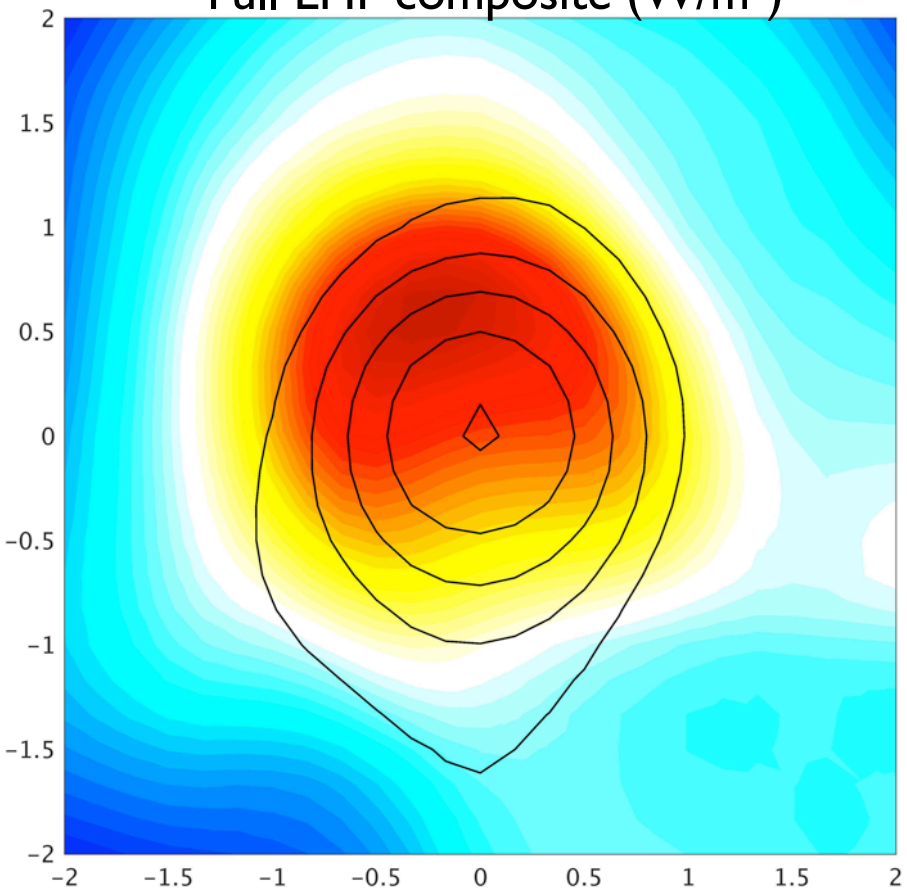


SSTA composite (°C)

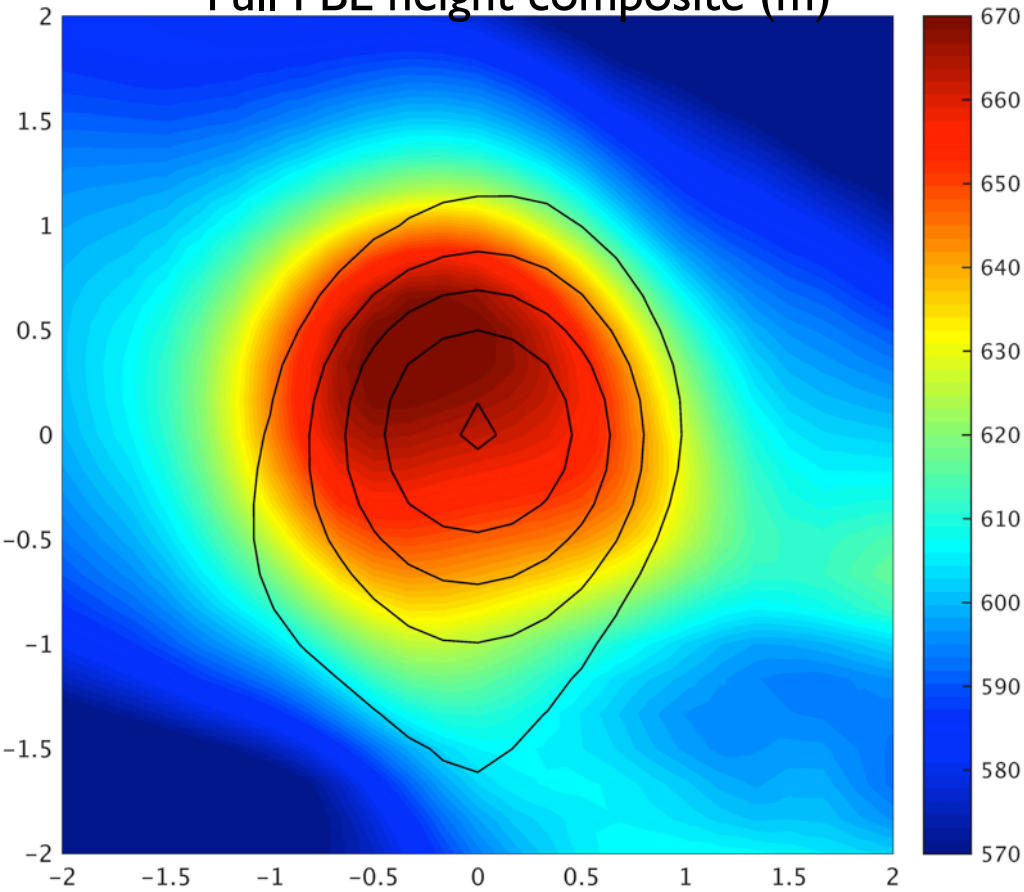


Anticyclonic eddies in the Gulf of Mexico
(Atmospheric imprint)

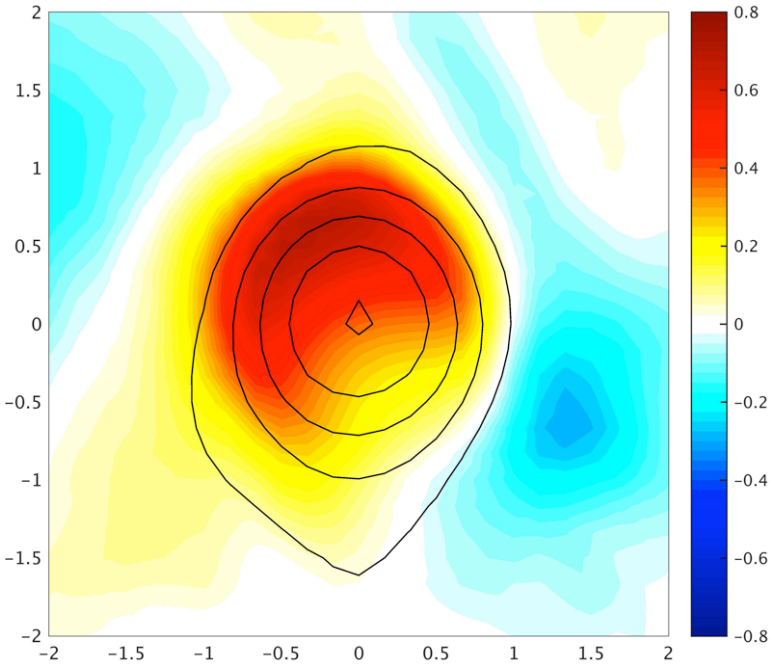
Full LHF composite (W/m^2)



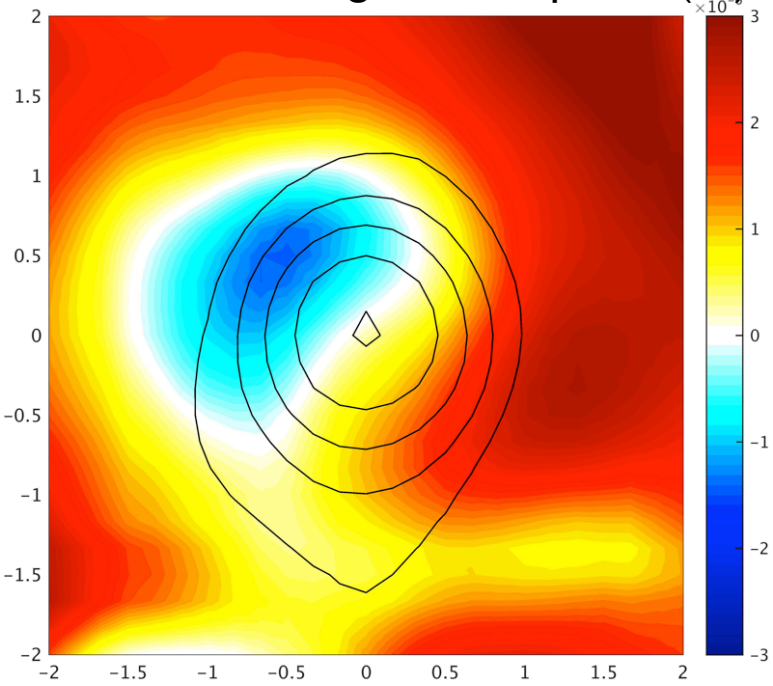
Full PBL height composite (m)



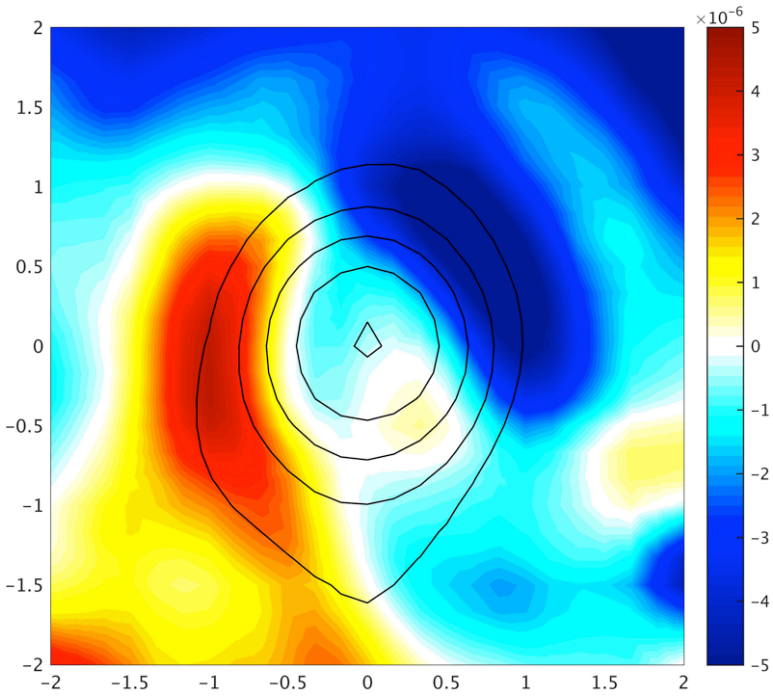
SSTA composite (°C)



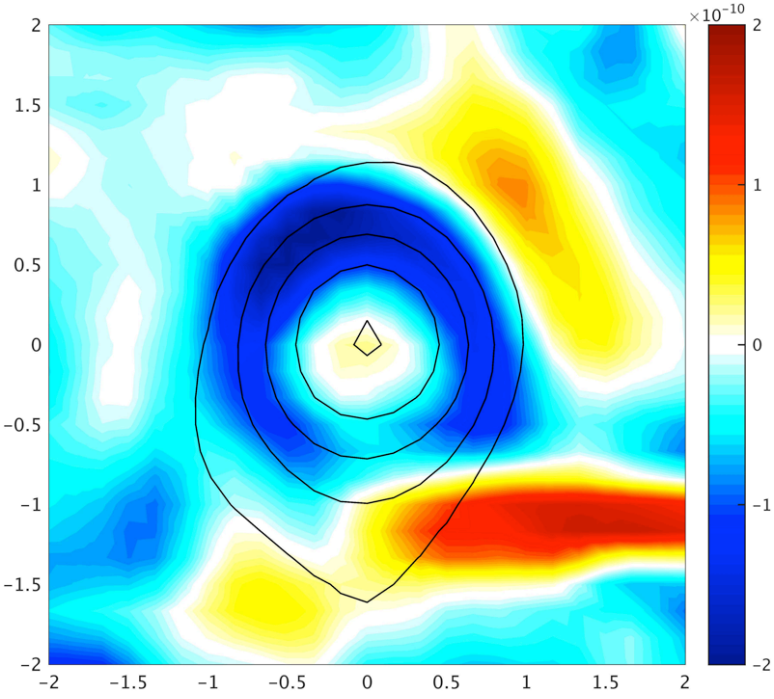
Full wind divergence composite (s^{-1})



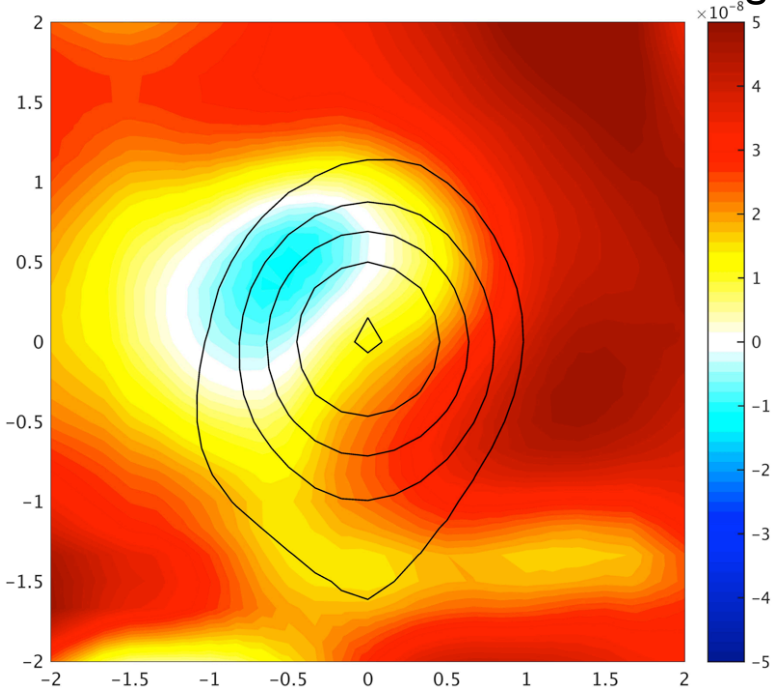
Full downwind SST gradient composite (°C/m)

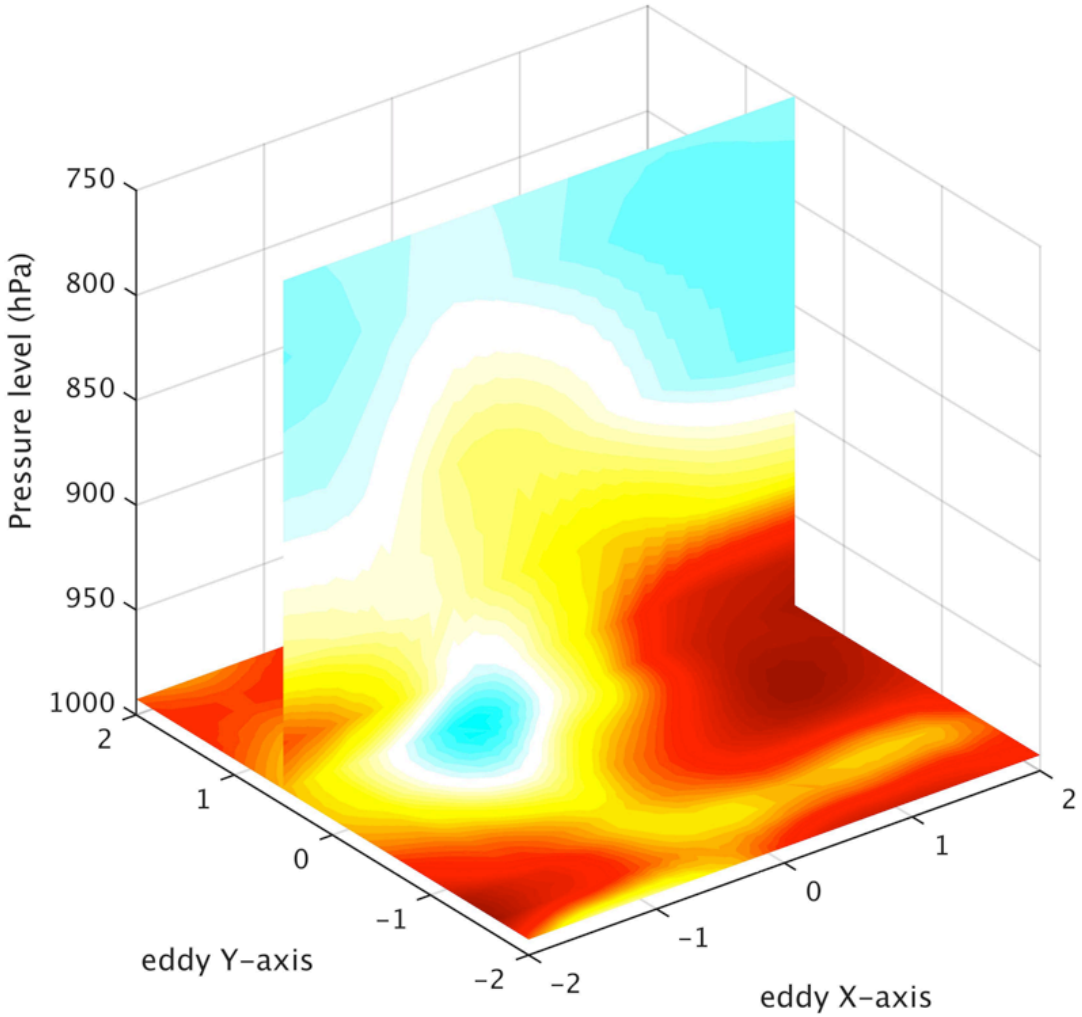


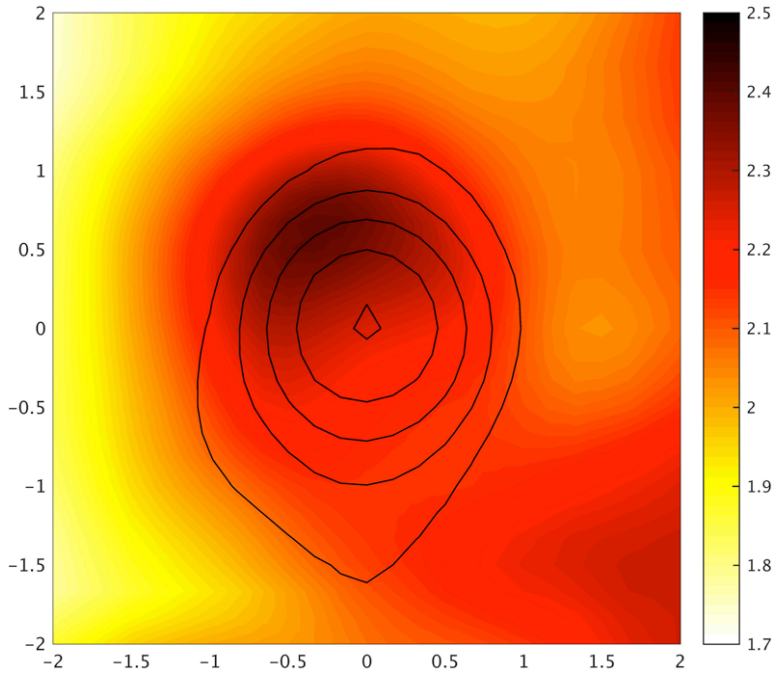
Full Laplacian of SST composite (°C/m^2)



Full moisture divergence composite (kg/kg/s)

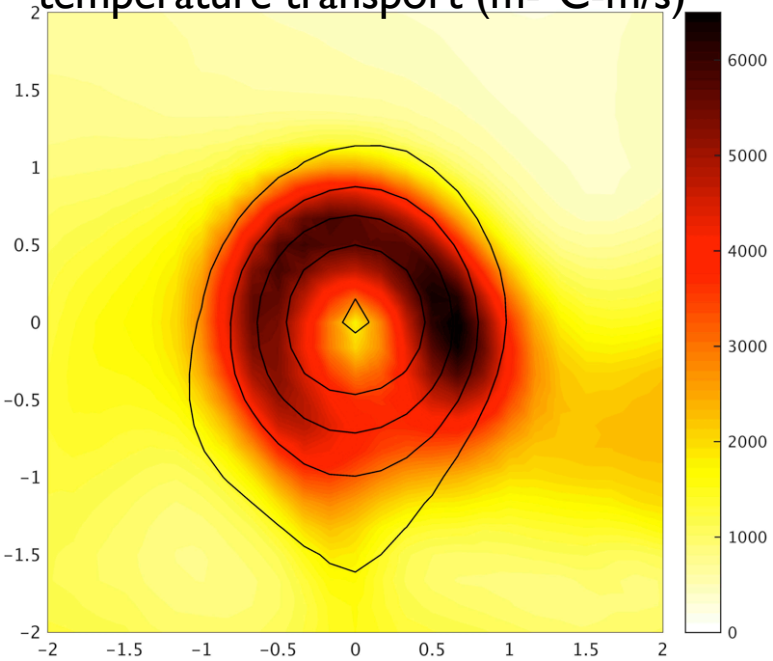






Full convective precipitation composite (mm/day)

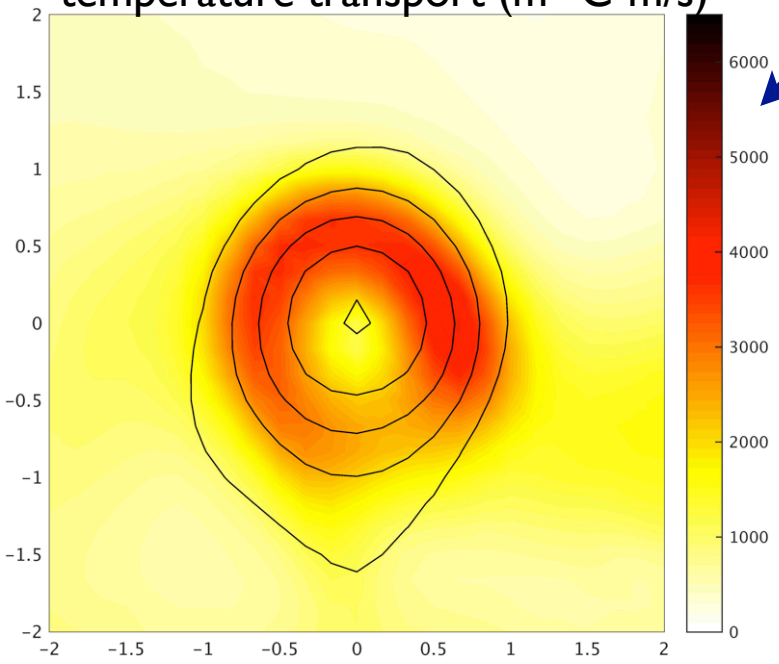
Magnitude of total upper 200m temperature transport (m-°C-m/s)



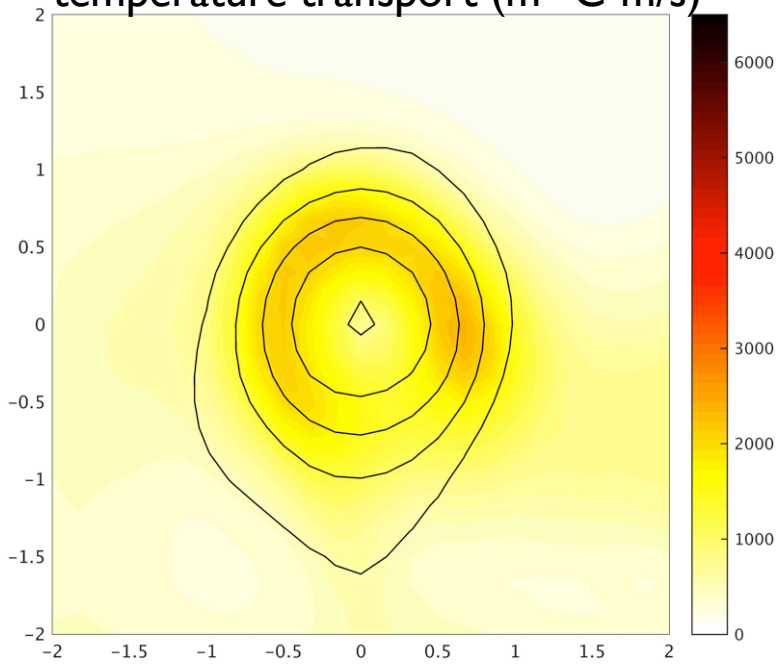
$$\overline{\mathbf{u}T} = \overline{\mathbf{u}}\,\overline{T} + \overline{\mathbf{u}'T'}$$

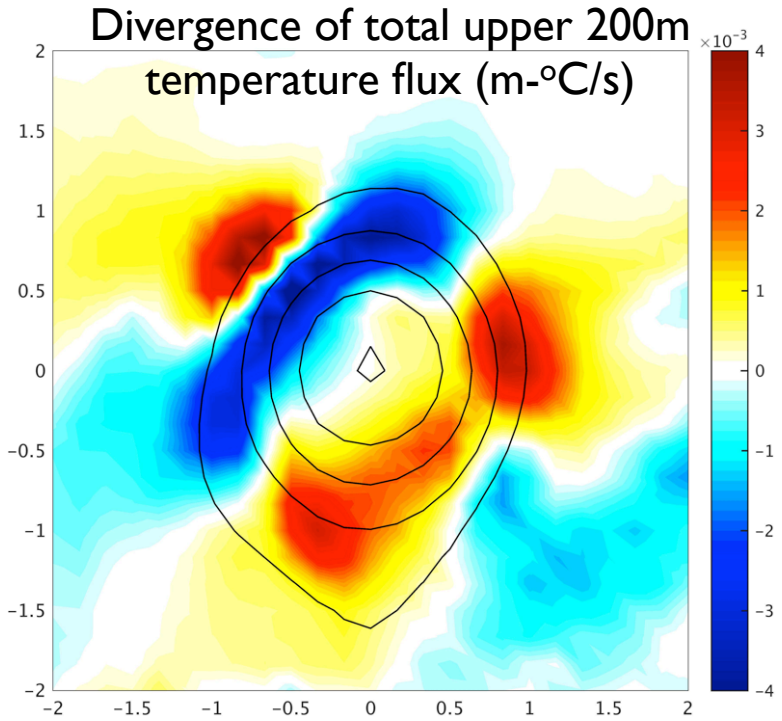
total mean submonthly

Magnitude of mean upper 200m temperature transport (m-°C-m/s)



Magnitude of submonthly upper 200m temperature transport (m-°C-m/s)





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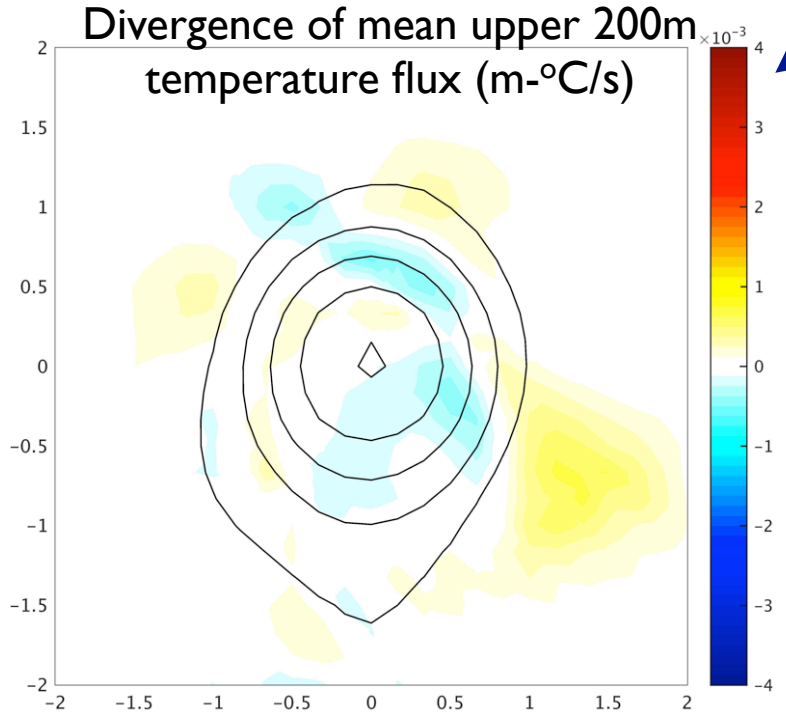

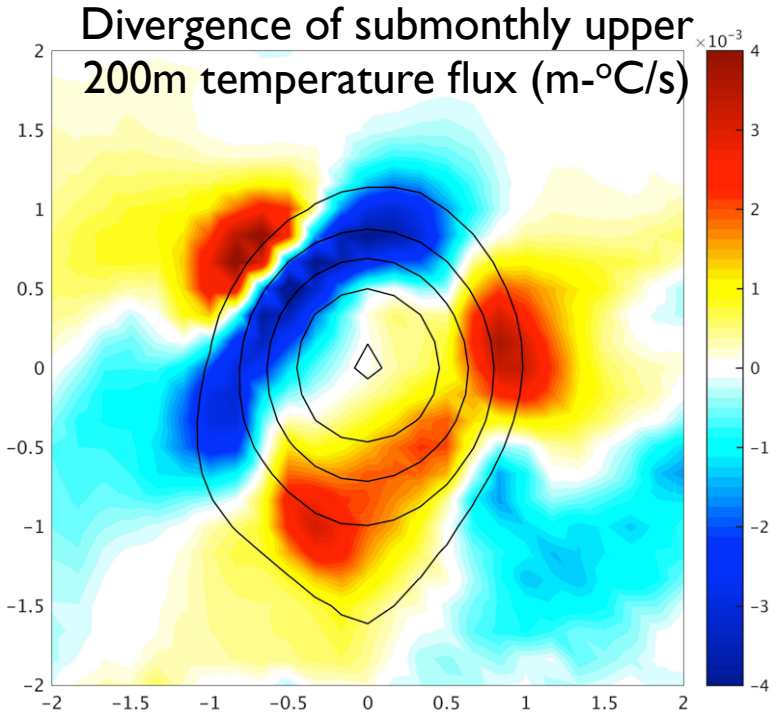

Summary

- Positive correlation of latent heat flux with SST that indicates ocean forcing to the atmosphere (high ocean resolution case)
- This is supported by temperature flux divergence on a submonthly scale, even though magnitude of temperature flux vectors are larger in the mean
- Anticyclonic eddies from Loop current and rings have an imprint on the atmosphere in the northwest quadrant where warm anomalies reside
    - more LHF out of the ocean, deeper PBL, wind and moisture convergence, and more convective precipitation
    - warm SST anomalies are supported by submonthly divergence of temperature flux

Thank You!!!