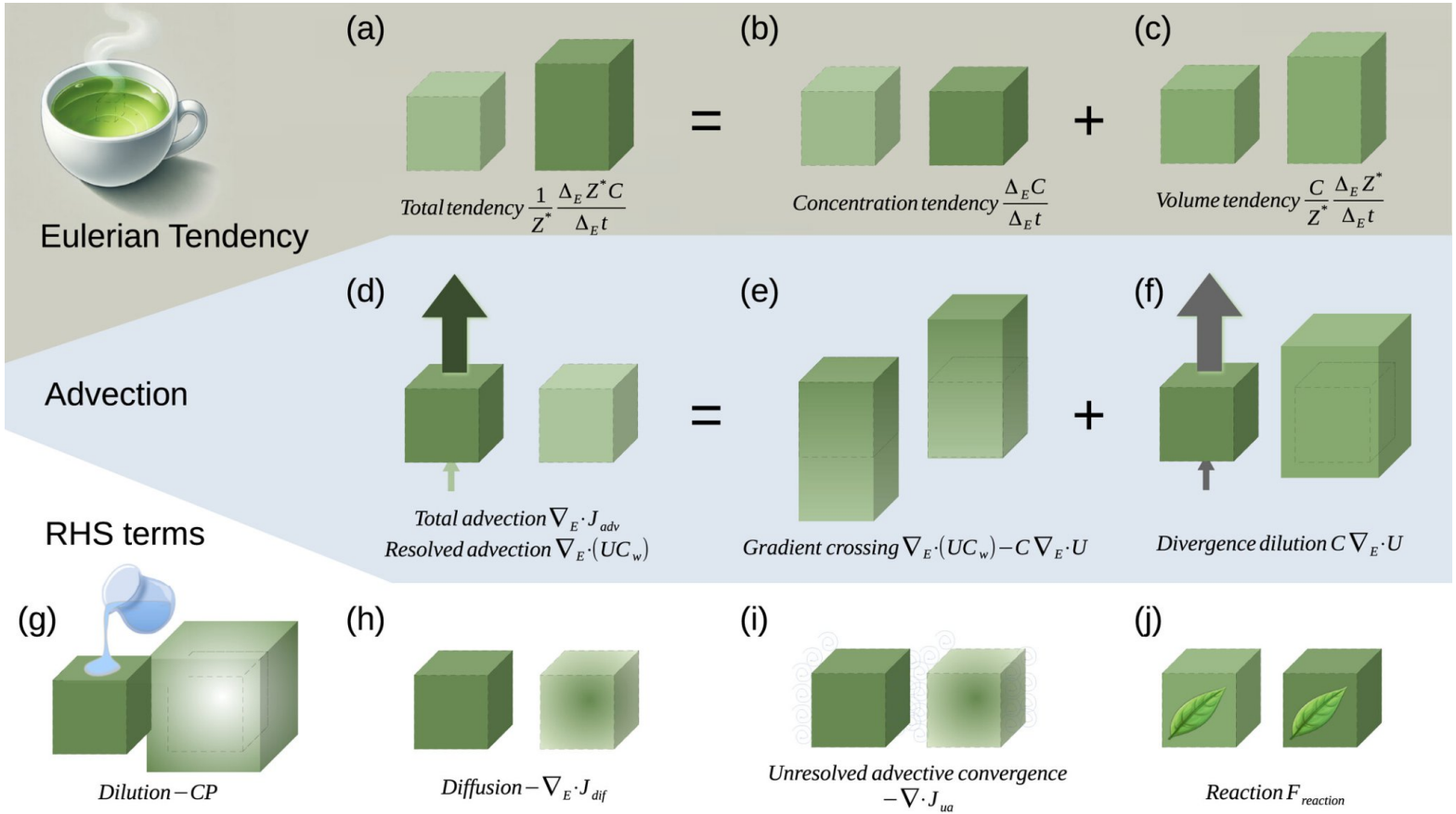
# Lagrangian Tracer Budget Based on ECCO

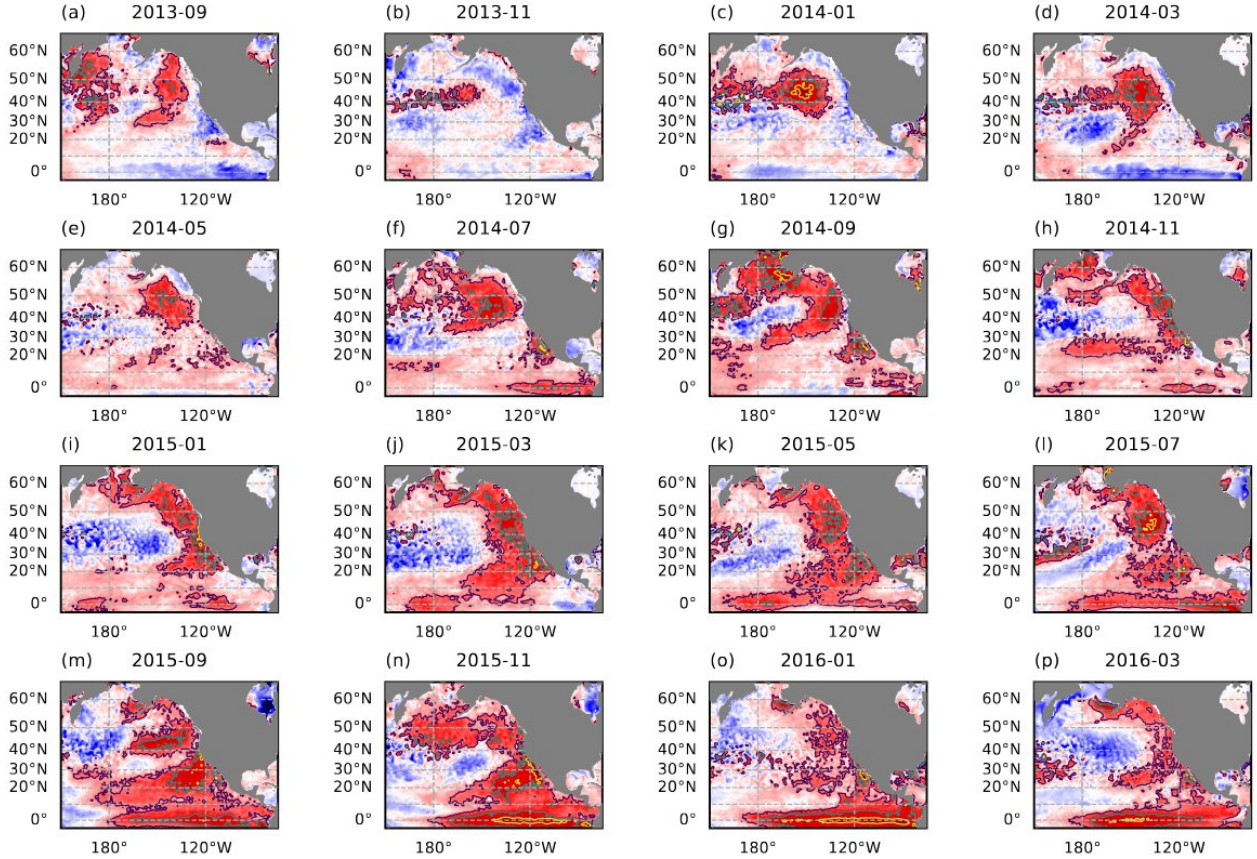
2026 ECCO Annual Project Meeting

# Table of Content

$$\frac{\partial c}{\partial t} = -u \cdot \nabla c + \cdots$$

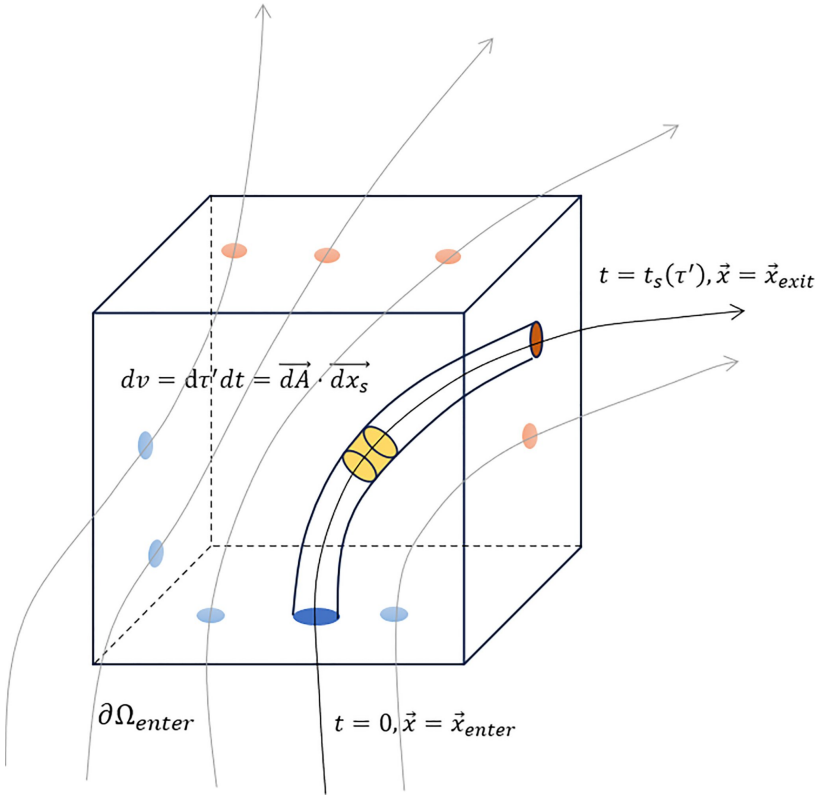


# Surface temperature anomaly



$$\frac{\partial c}{\partial t} + u \cdot \nabla c = \cdots$$

- The grid cell integral of RHS terms matches that in the budget.
- The temporal integral of RHS terms along trajectories explains the tracer concentration change felt by a particle.



$$\frac{\partial c}{\partial t} + u \cdot \nabla c = \cdots$$

- The grid cell integral of RHS terms matches that in the budget.
- The temporal integral of RHS terms along trajectories explains the tracer concentration change felt by a particle.

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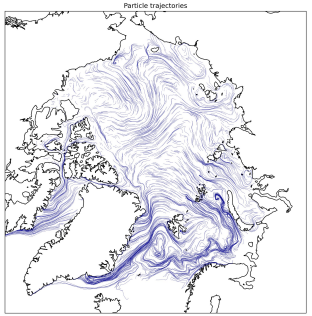
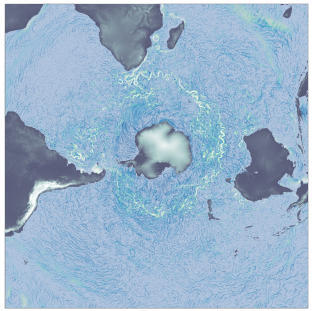
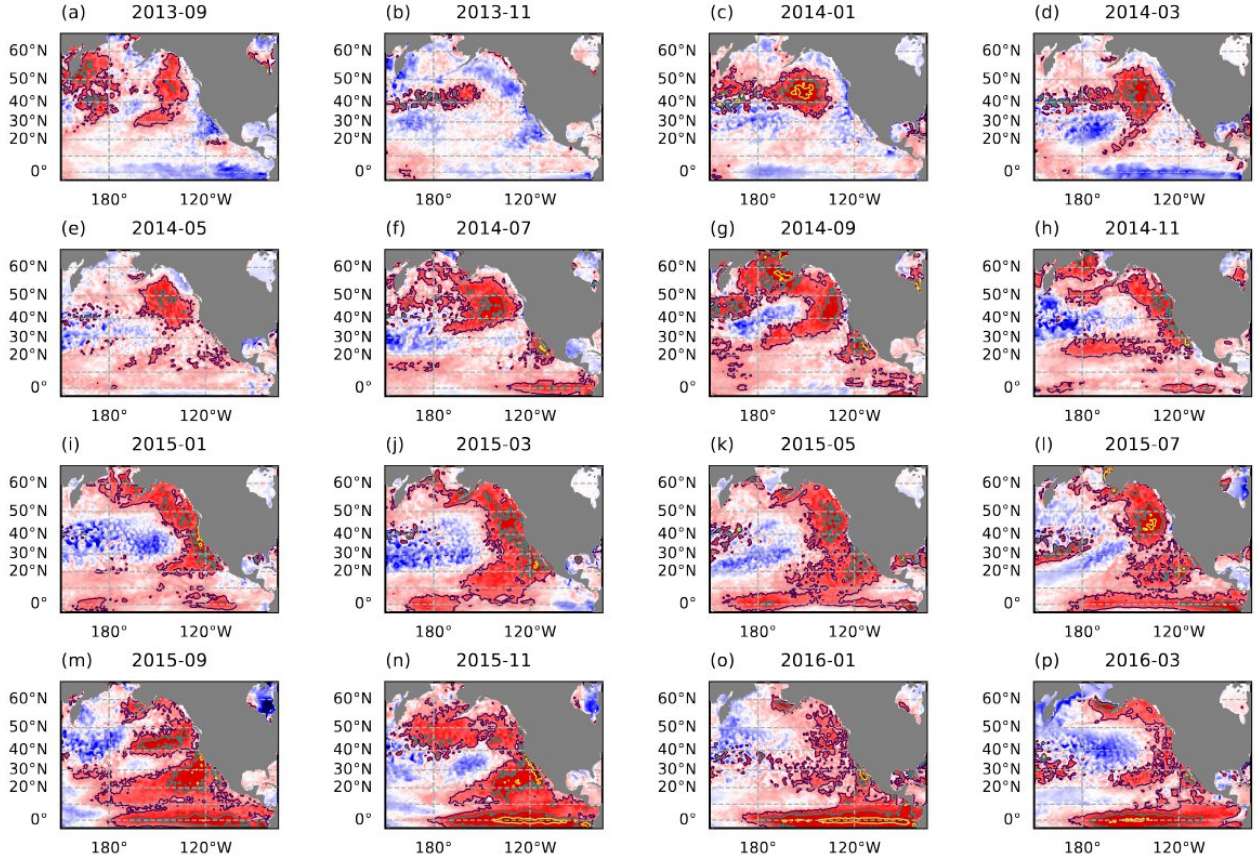
# Implementation in Seaduck

https://macekuailv.github.io/seaduck/bud_tut.html

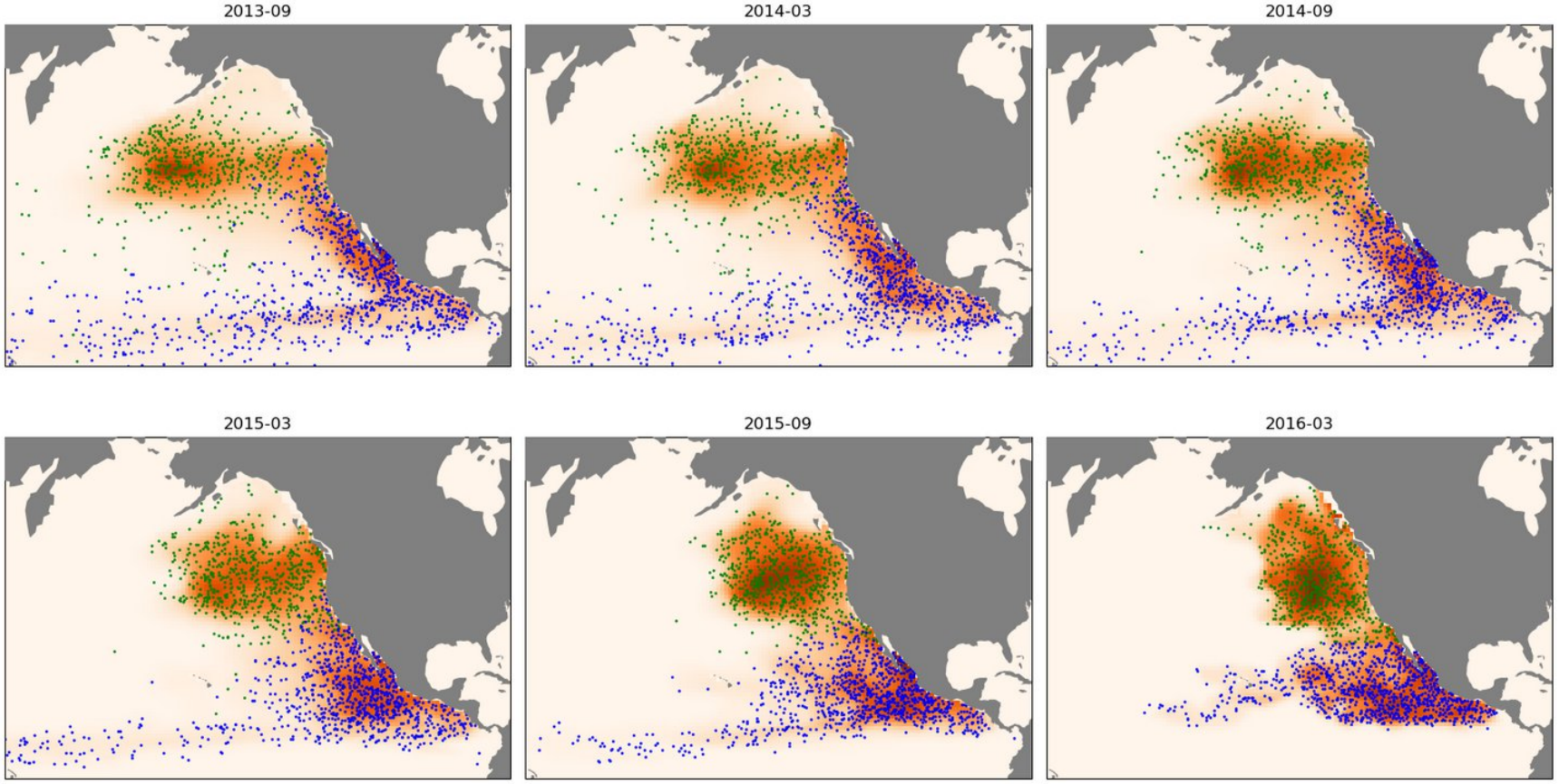


# Surface temperature anomaly



# Follow the anomaly with particles

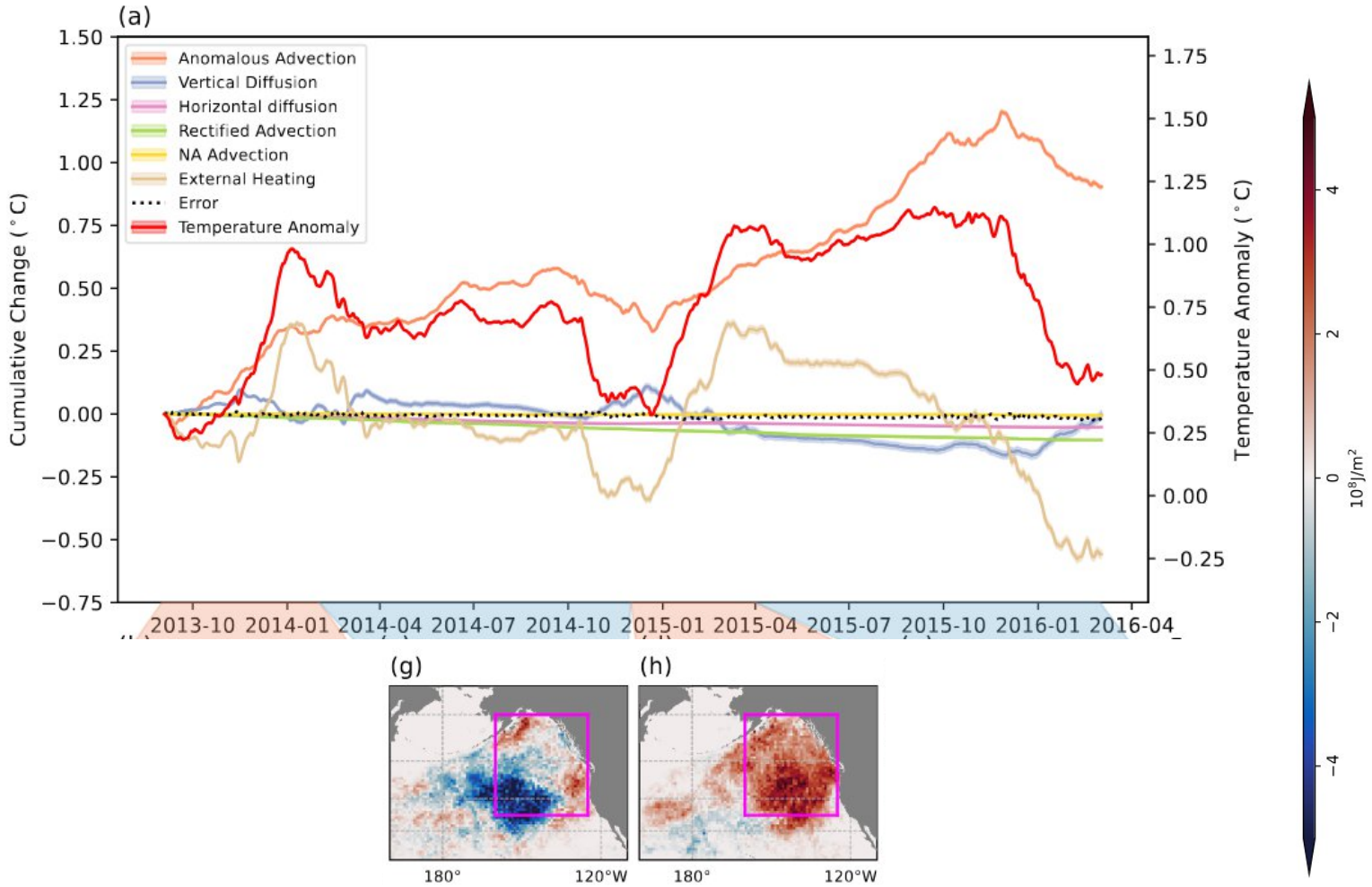


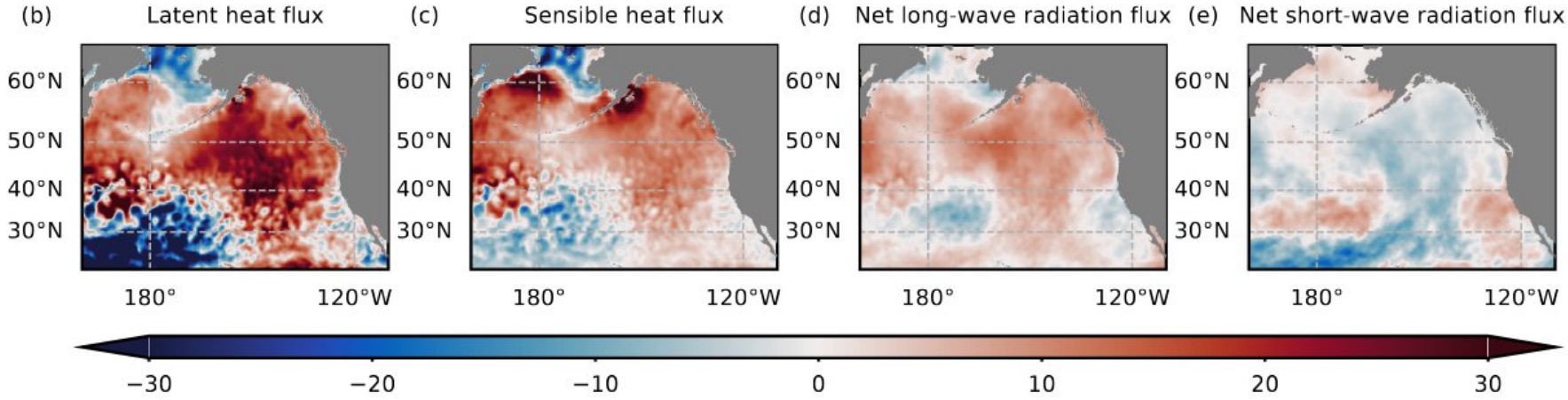
# Salinity Anomaly Equations

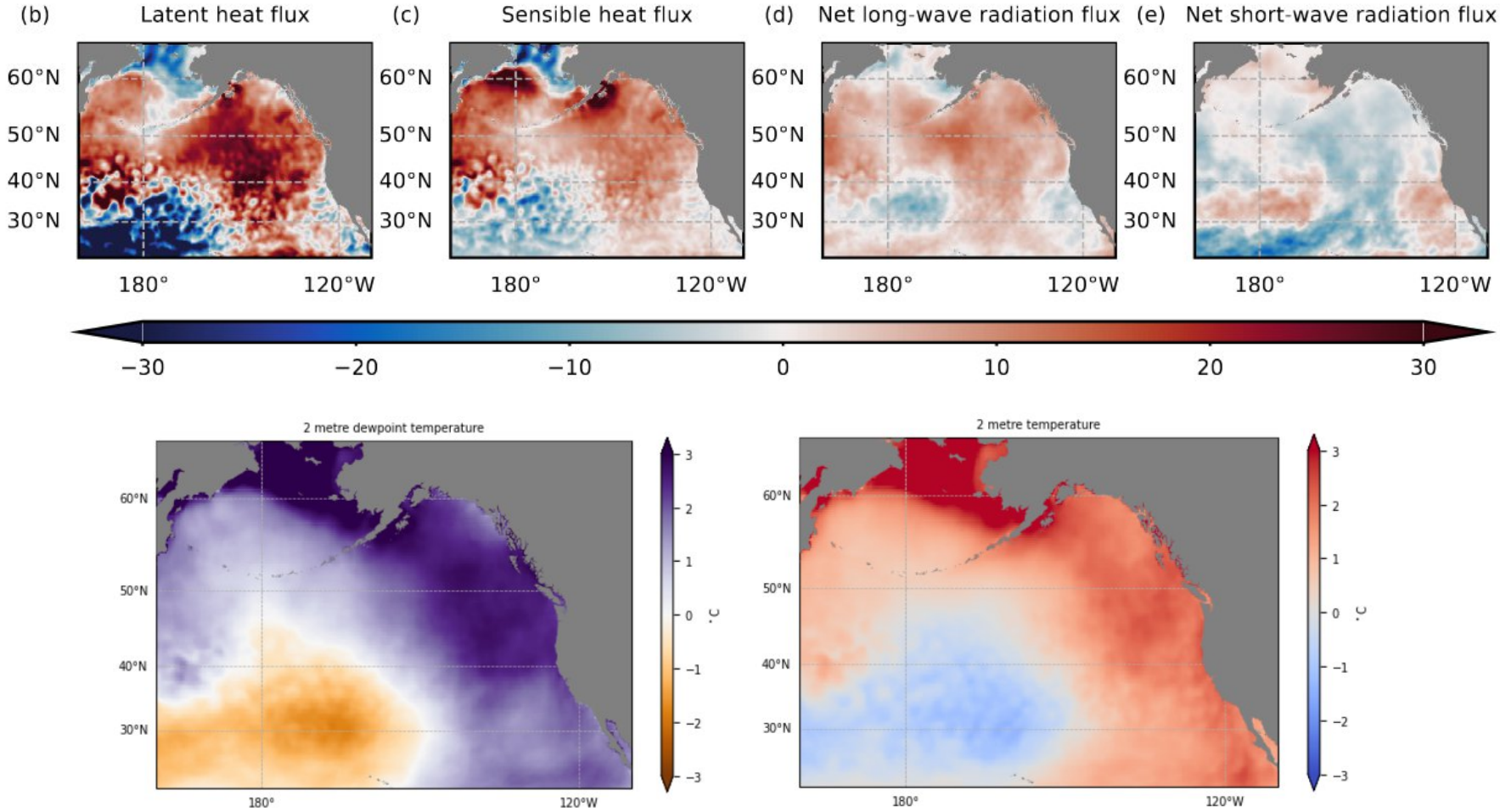
$$\frac{\partial \Theta}{\partial t} + \mathbb{A}(U,\Theta) = \mathcal{D}_h(K,\Theta) + \mathcal{D}_v(K,\Theta) + \mathcal{Q}(\Theta) + \delta_{NA}, \tag{1}$$

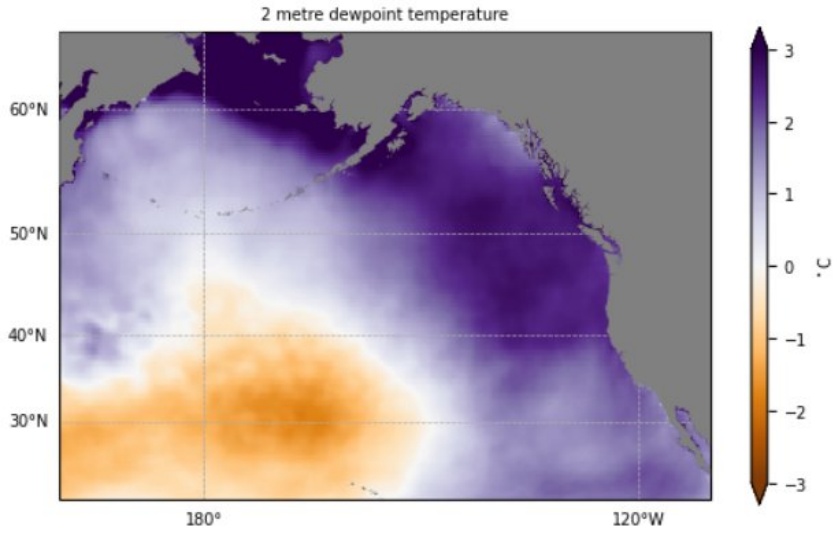
$$\frac{\partial \overline{\Theta}}{\partial t} + \mathbb{A}(U,\overline{\Theta}) = \overline{\mathcal{D}_h(K,\Theta)} + \overline{\mathcal{D}_v(K,\Theta)} + \overline{\mathcal{Q}(\Theta)} + \overline{\delta_{NA}} - \overline{\mathbb{A}(U',\Theta')} + \mathbb{A}(U',\overline{\Theta}), \tag{2}$$

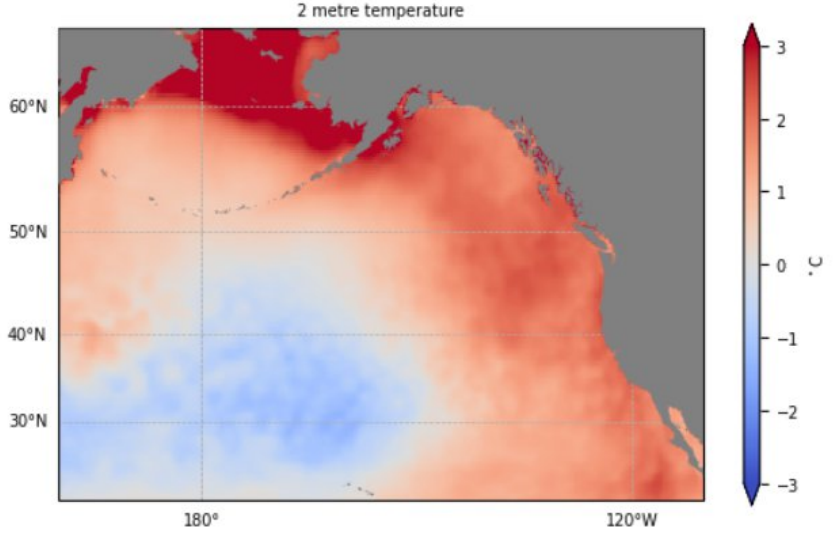
$$\frac{\partial \Theta'}{\partial t} + \mathbb{A}(U,\Theta') = \underbrace{\mathcal{D}_h(K,\Theta)'}_{\text{Horizontal diffusion}} + \underbrace{\mathcal{D}_v(K,\Theta)'}_{\text{Vertical diffusion}} + \underbrace{\mathcal{Q}(\Theta)'}_{\text{Surface Heating}} + \underbrace{\delta'_{NA}}_{\text{NA advection}} + \underbrace{\overline{\mathbb{A}(U',\Theta')}}_{\text{Rectified advection}} + \underbrace{\left(-\mathbb{A}(U',\overline{\Theta})\right)}_{\text{Anomalous advection}}, \tag{3}$$

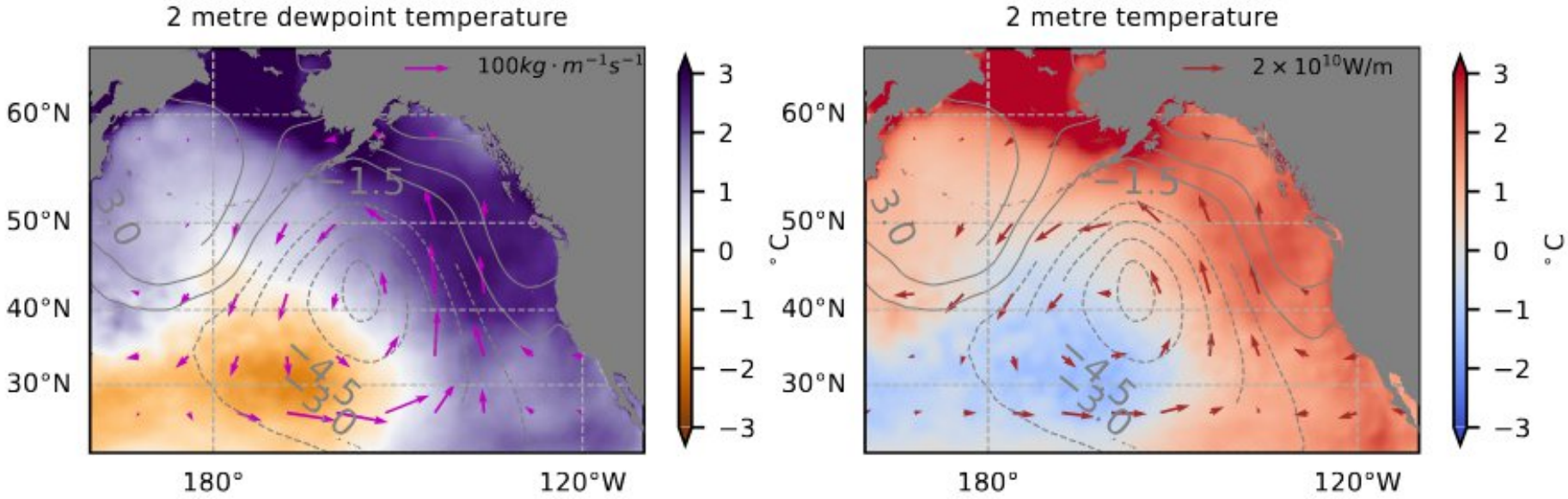

(a)
Anomalous Advection
Vertical Diffusion
Horizontal diffusion
Rectified Advection
NA Advection
External Heating
Error
Temperature Anomaly
Cumulative Change (°C)
Temperature Anomaly (°C)
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
−0.25
2013-10 2014-01 2014-04 2014-07 2014-10 2015-01 2015-04 2015-07 2015-10 2016-01 2016-04
(g)
(h)
180°
120°W
180°
120°W
4
2
0
−2
−4
$10^8$J/m$^2$

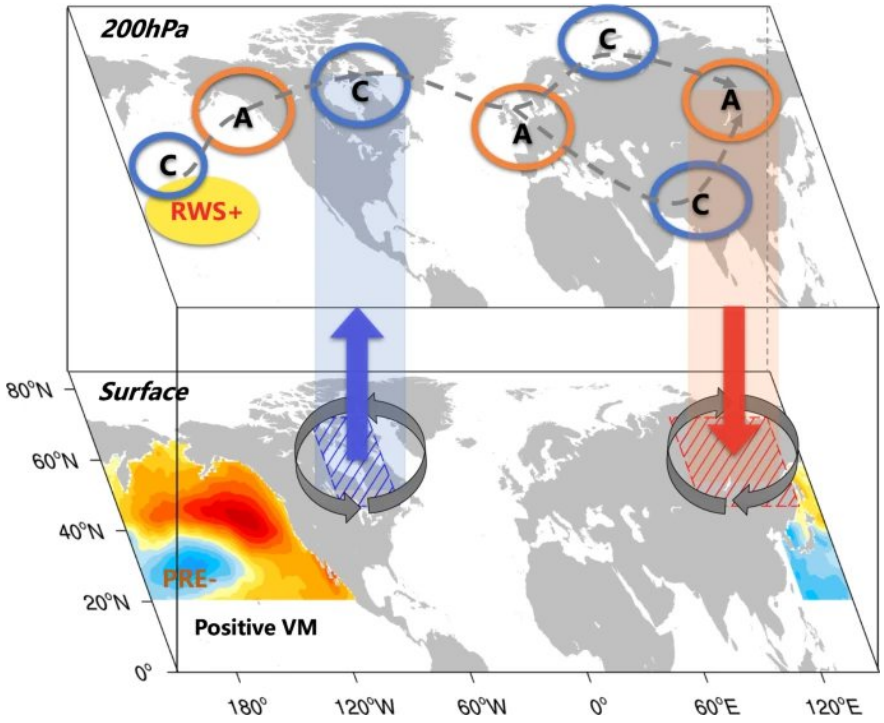

(b)
Latent heat flux
(c)
Sensible heat flux
(d)
Net long-wave radiation flux
(e)
Net short-wave radiation flux
60°N
50°N
40°N
30°N
180°
120°W
−30
−20
−10
0
10
20
30


(b) Latent heat flux
(c) Sensible heat flux
(d) Net long-wave radiation flux
(e) Net short-wave radiation flux
60°N
50°N
40°N
30°N
180°
120°W
−30
−20
−10
0
10
20
30
2 metre dewpoint temperature
2 metre temperature
°C

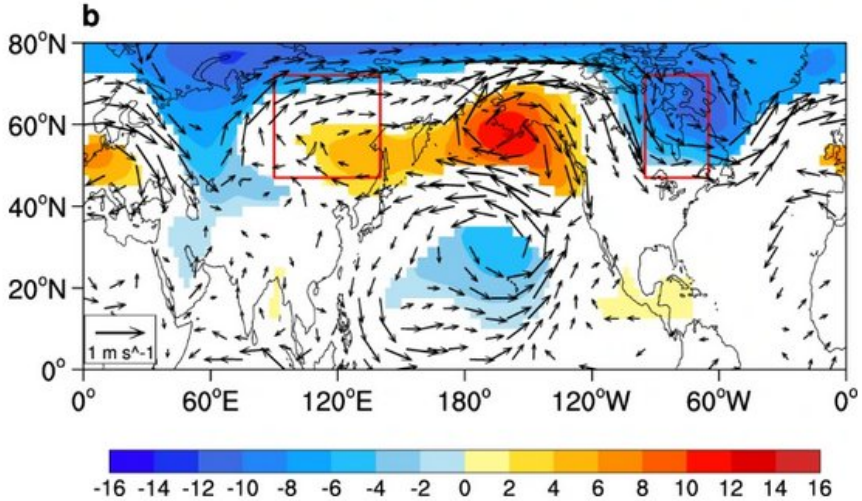

2 metre dewpoint temperature
60°N
50°N
40°N
30°N
180°
120°W
3
2
1
0
−1
−2
−3
°C


2 metre temperature
60°N
50°N
40°N
30°N
180°
120°W
3
2
1
0
−1
−2
−3
°C


2 metre dewpoint temperature
100kg · m⁻¹s⁻¹
60°N
50°N
40°N
30°N
180°
120°W
−1.5
3.0
1.5
3.0
°C
3
2
1
0
−1
−2
−3
2 metre temperature
2 × 10¹⁰W/m
60°N
50°N
40°N
30°N
180°
120°W
−1.5
3.0
1.5
3.0
°C
3
2
1
0
−1
−2
−3




Regressed 850hpa Geopotential Height

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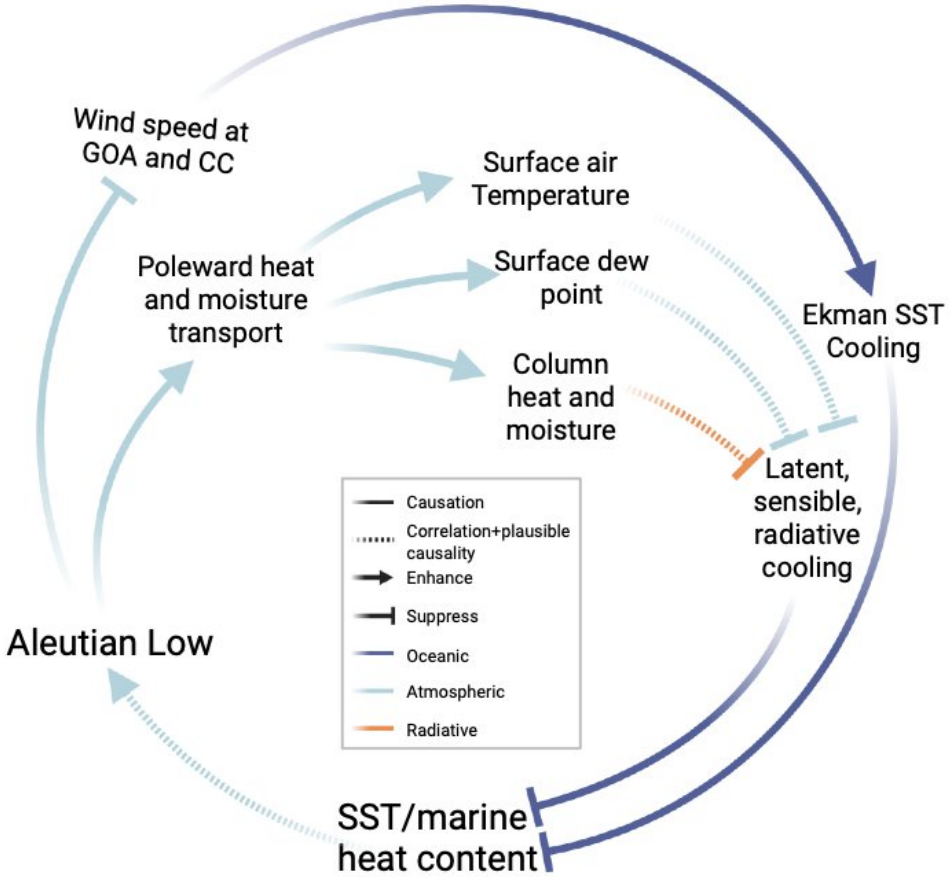
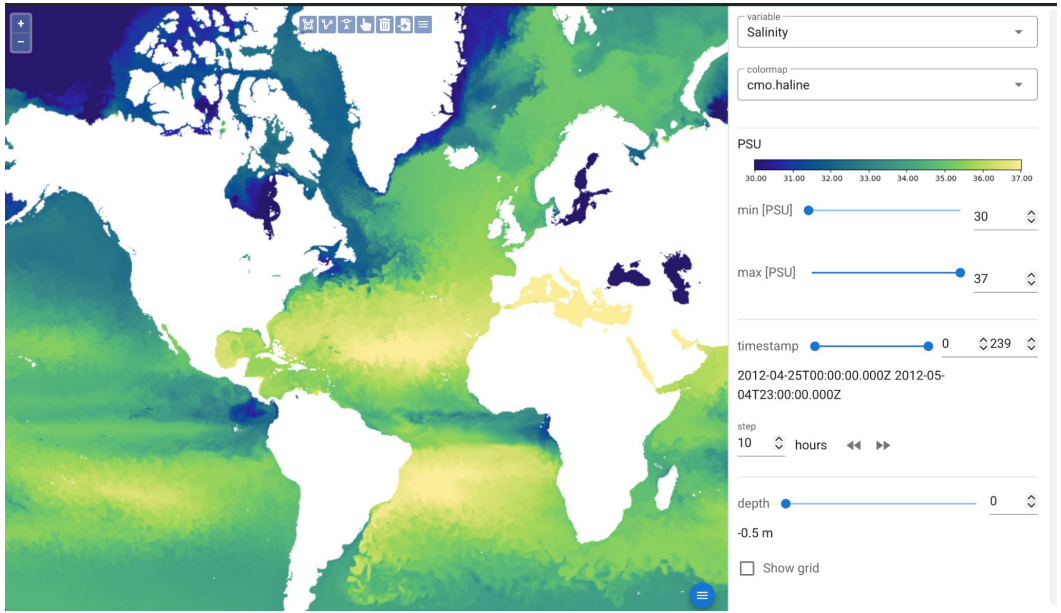

Wind speed at GOA and CC
Surface air Temperature
Poleward heat and moisture transport
Surface dew point
Ekman SST Cooling
Column heat and moisture
Latent, sensible, radiative cooling
Causation
Correlation+plausible causality
Enhance
Suppress
Oceanic
Atmospheric
Radiative
Aleutian Low
SST/marine heat content

# Plug: Poseidon Viewer




Thank You