Seasonality of the Mesoscale Inverse Cascade

as Inferred from Global Scale-Dependent Eddy Energy Observations

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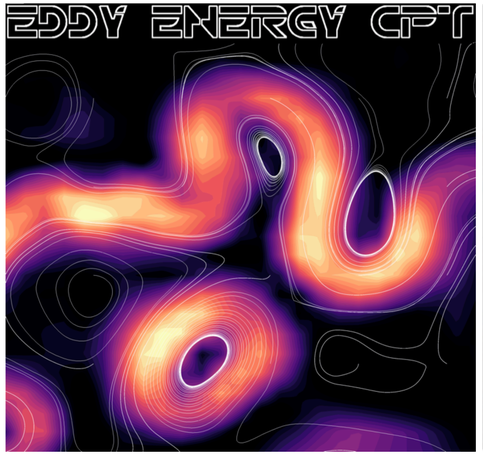
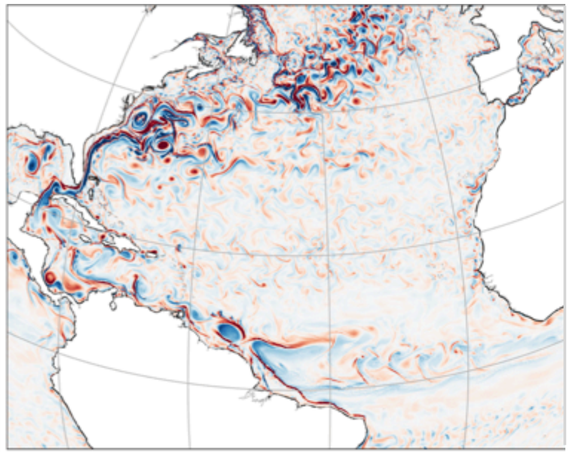
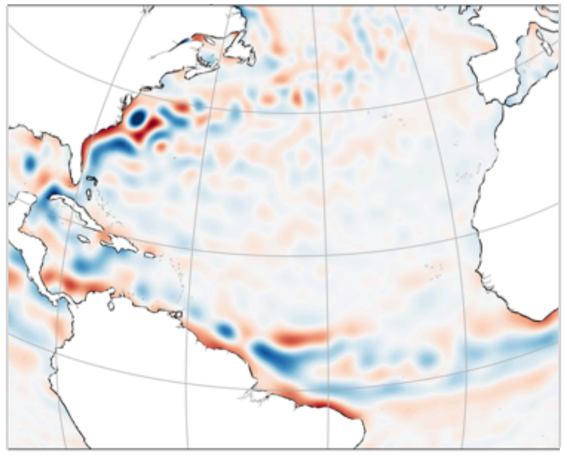
https://jakesteinberg.github.io



https://ocean-eddy-cpt.github.io





@Nora Loose: https://gcm-filters.readthedocs.io/en/latest/

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Context and Motivation

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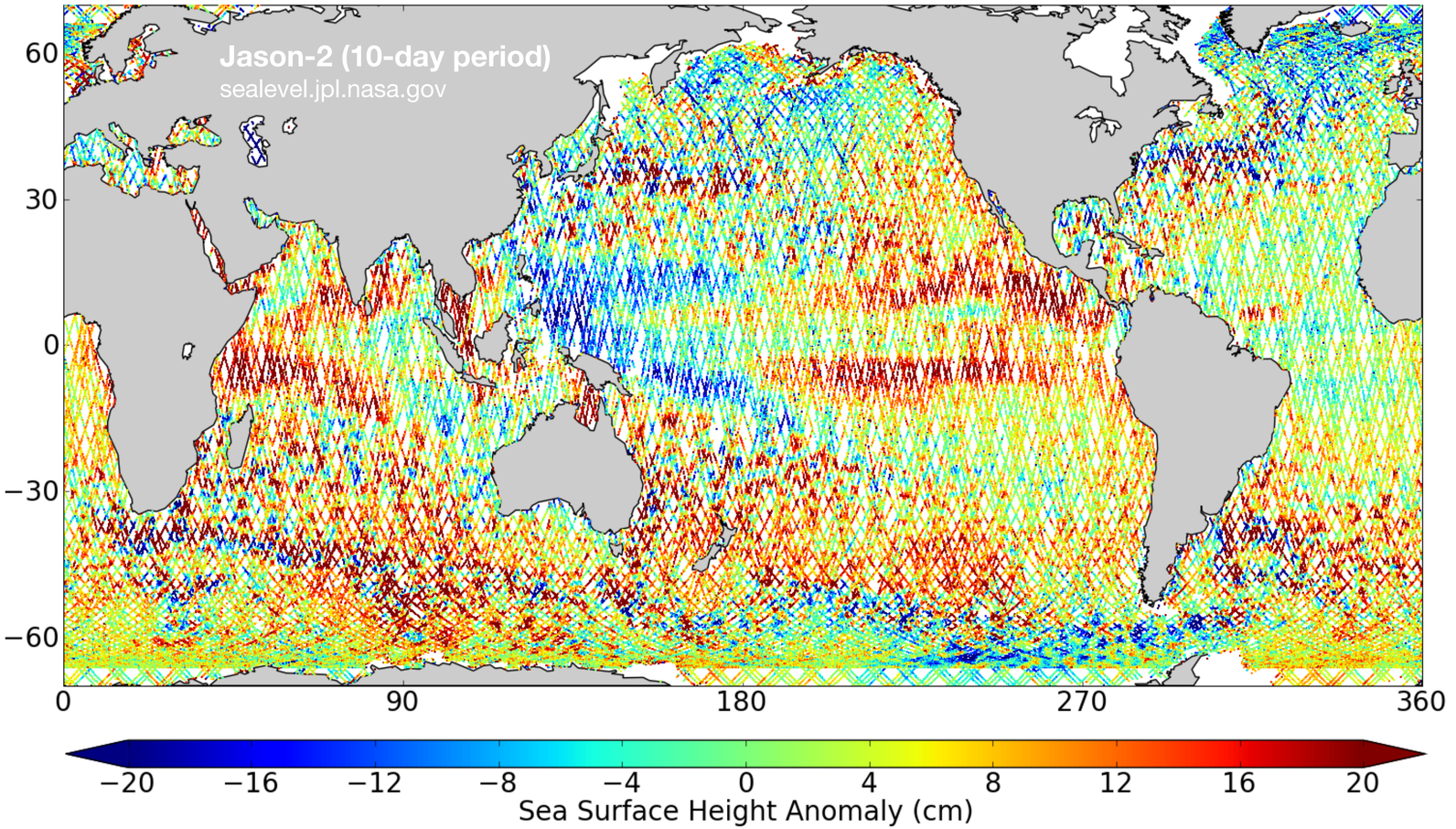
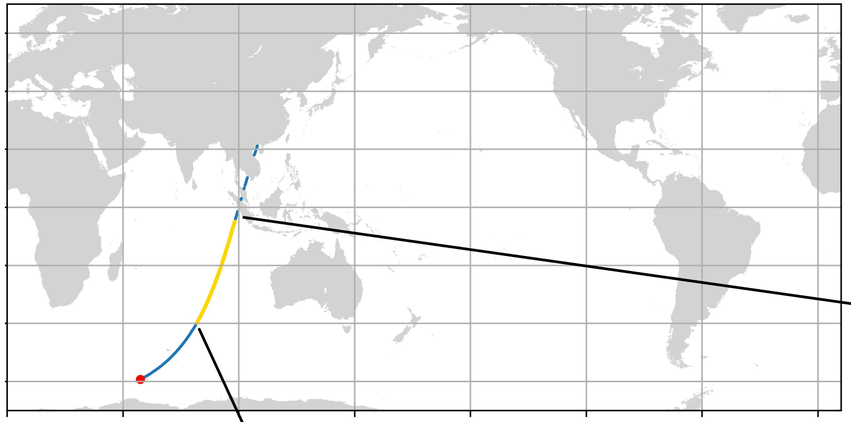
Approach (using observations to help)

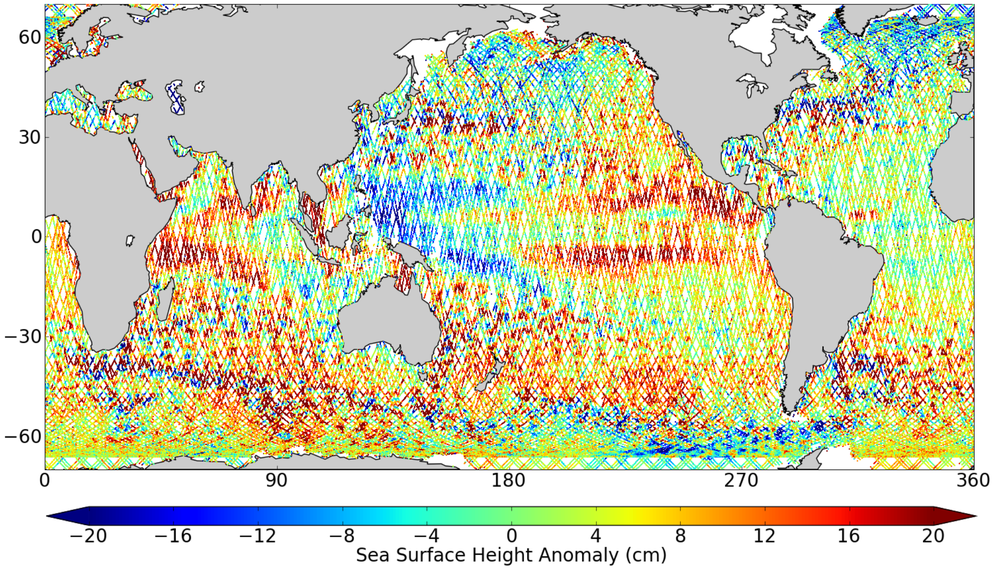
- decompose satellite altimeter-derived estimates of surface KE into contributions per horizontal scale [KE —> mean + eddy = MKE + EKE]

$$EKE_l = \langle u^2 \rangle_l - \langle u \rangle_l^2$$

- detail temporal variability


Jason-2 (10-day period)
sealevel.jpl.nasa.gov
60
30
0
−30
−60
0
90
180
270
360
−20
−16
−12
−8
−4
0
4
8
12
16
20
Sea Surface Height Anomaly (cm)




60
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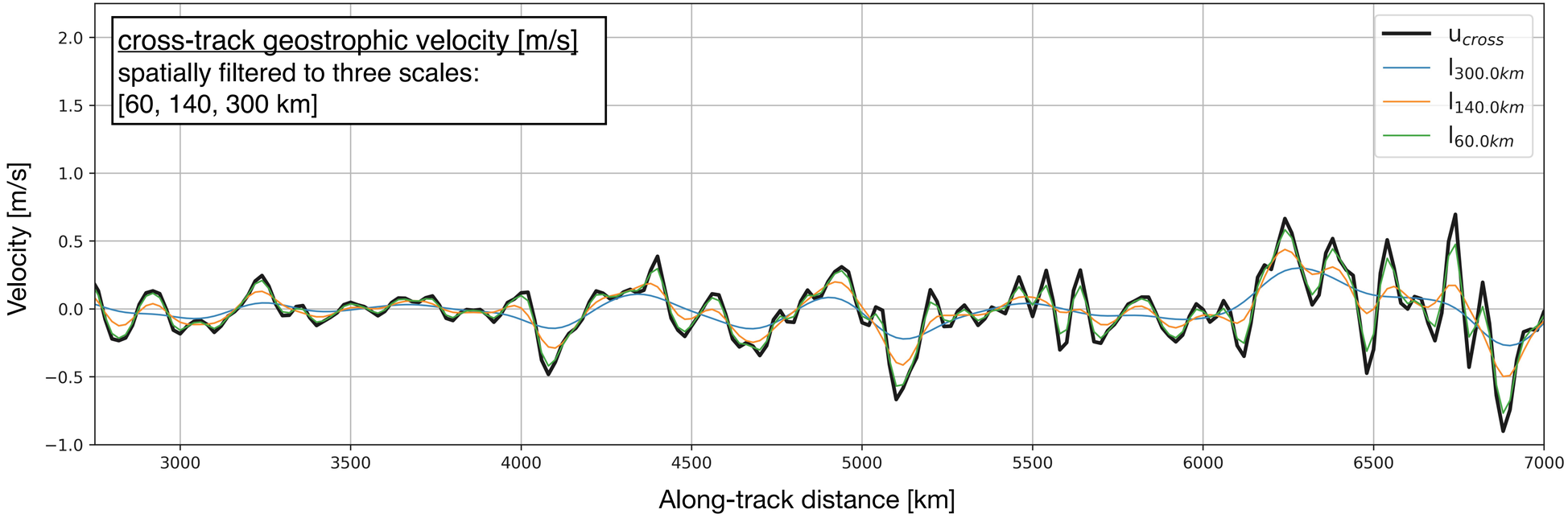
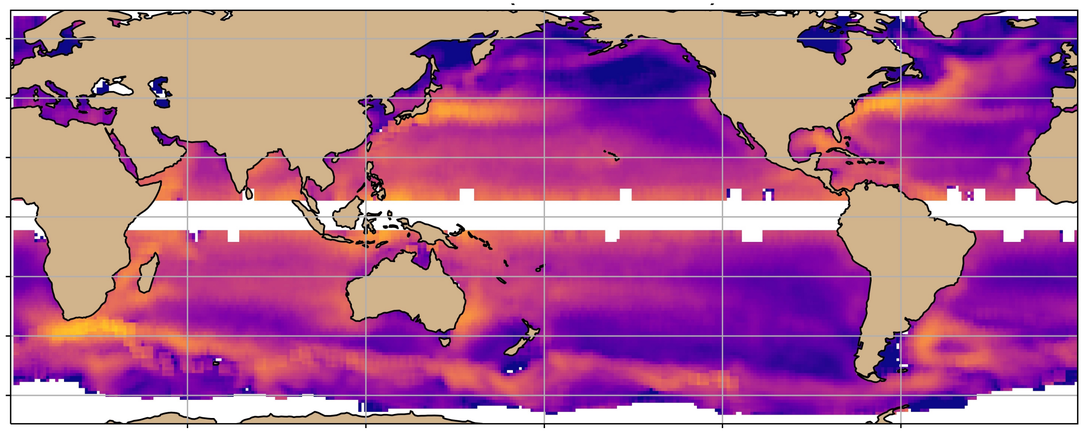

cross-track geostrophic velocity [m/s]
spatially filtered to three scales:
[60, 140, 300 km]
u_{cross}
$l_{300.0km}$
$l_{140.0km}$
$l_{60.0km}$
Velocity [m/s]
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
3000
3500
4000
4500
5000
5500
6000
6500
7000
Along-track distance [km]

$$EKE_l = \langle u^2 \rangle_l - \langle u \rangle_l^2$$

$\langle\,\rangle$ = spatial filter

l = 60 km, 140 km, 300 km

mean mesoscale EKE (60-300 km)



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spatial filtering as a tool

mean mesoscale EKE (60-300 km)

$$EKE_l = \langle u^2 \rangle_l - \langle u \rangle_l^2$$

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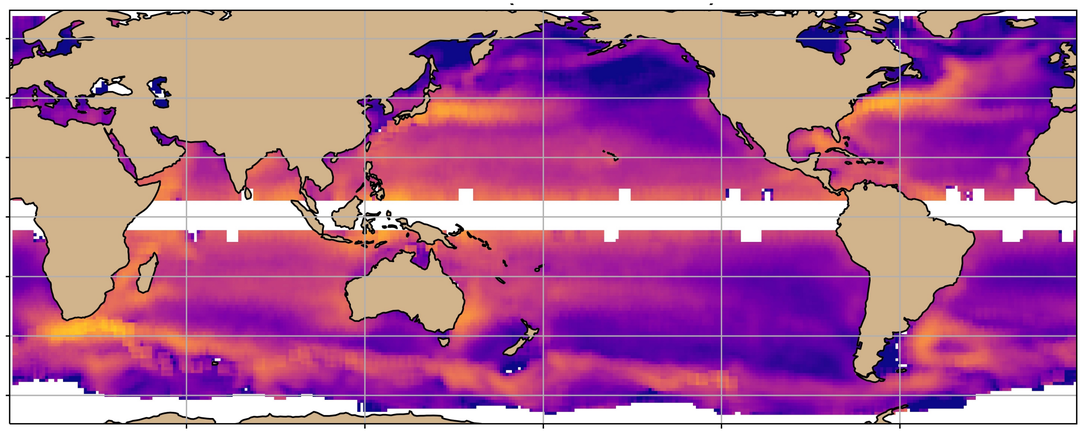

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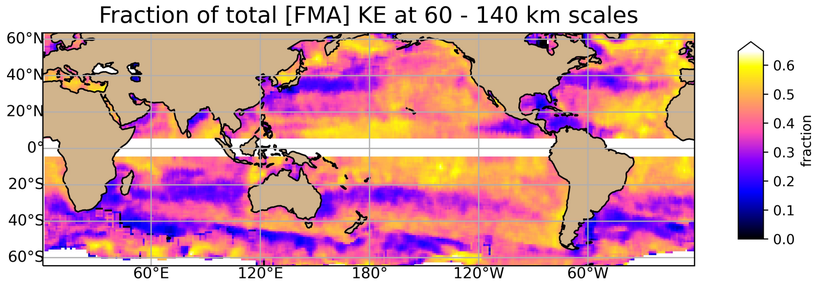
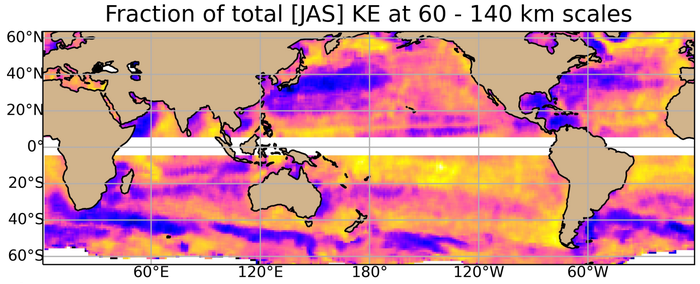
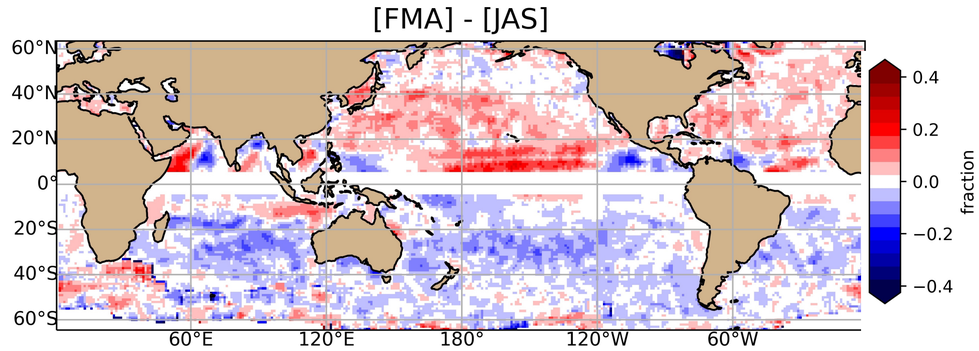
seasonal variations
@ 60 - 140 km scales

N. Hem. winter

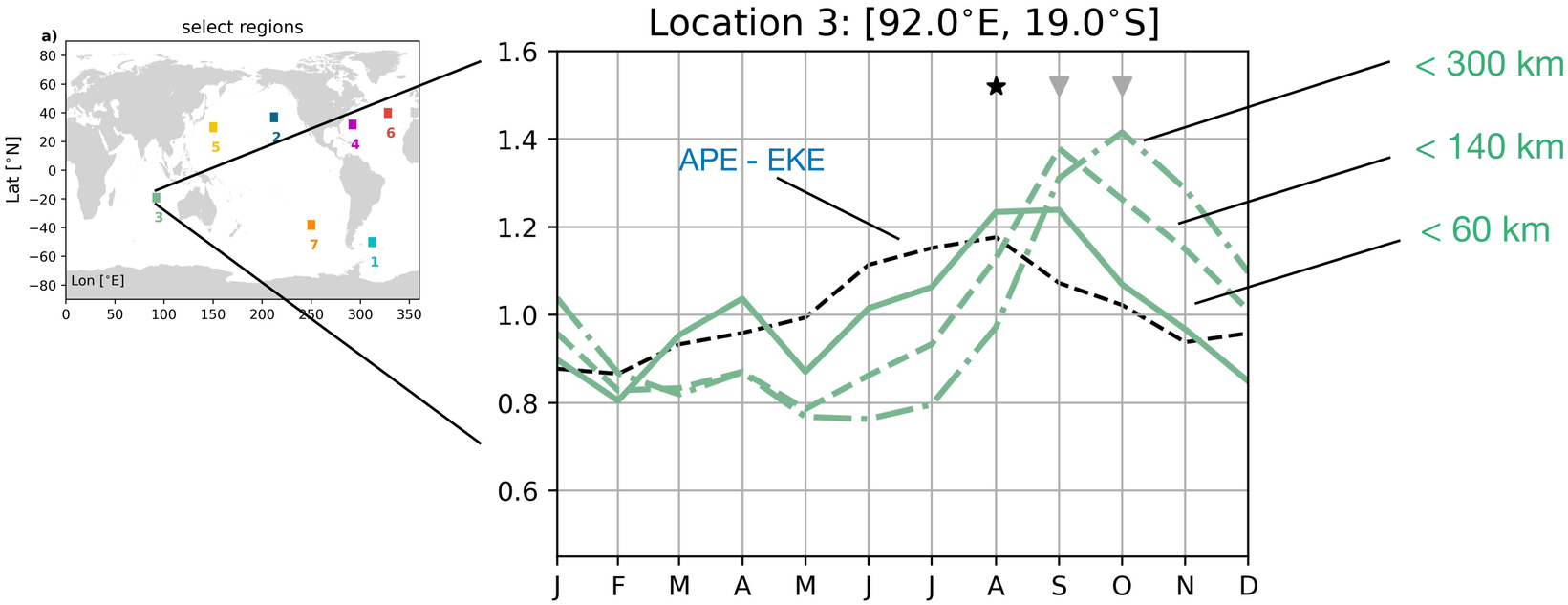


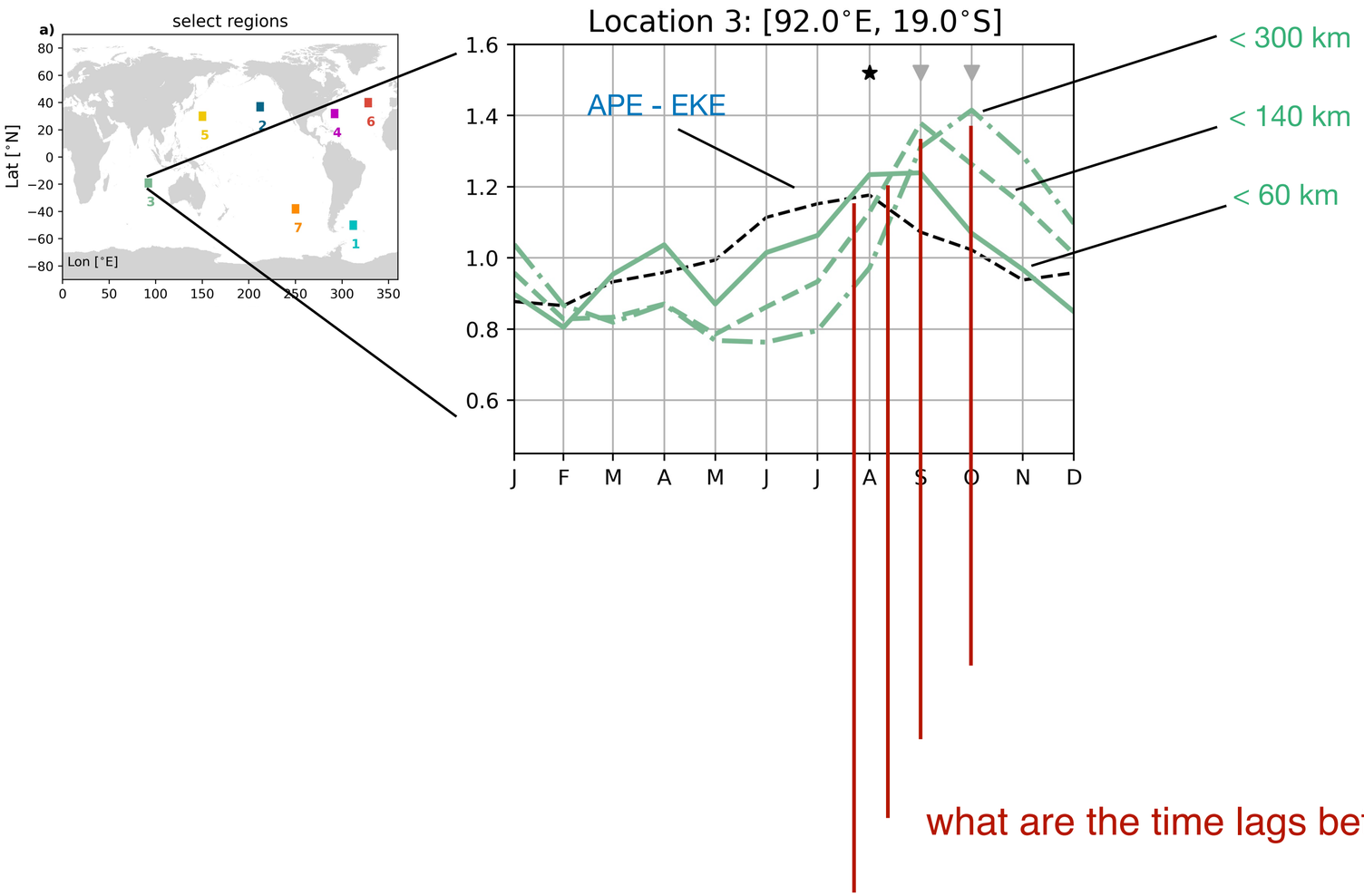
N. Hem. summer



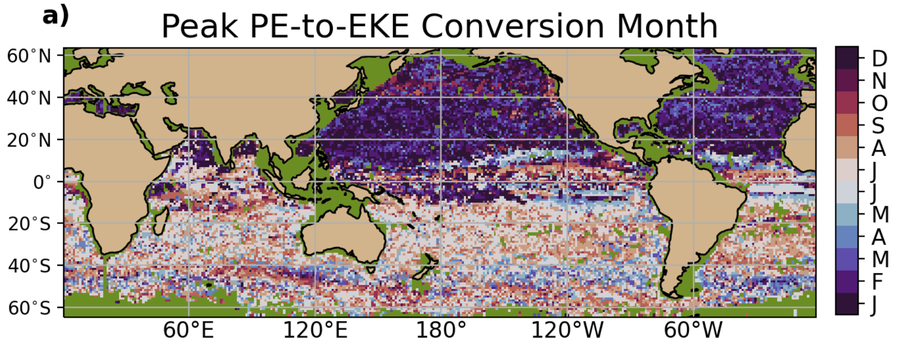


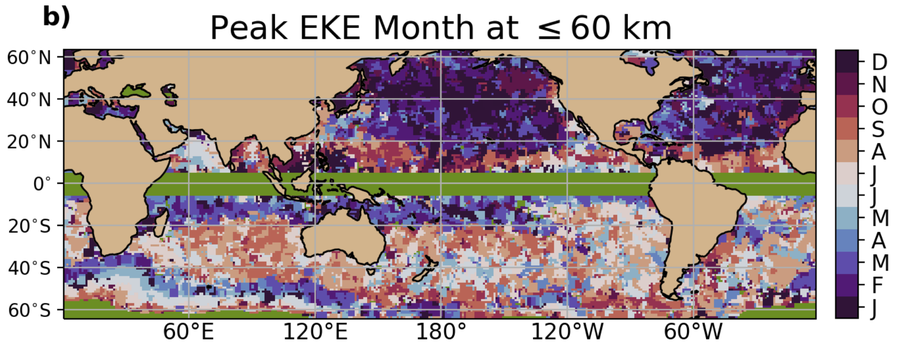
seasonal cycle in EKE

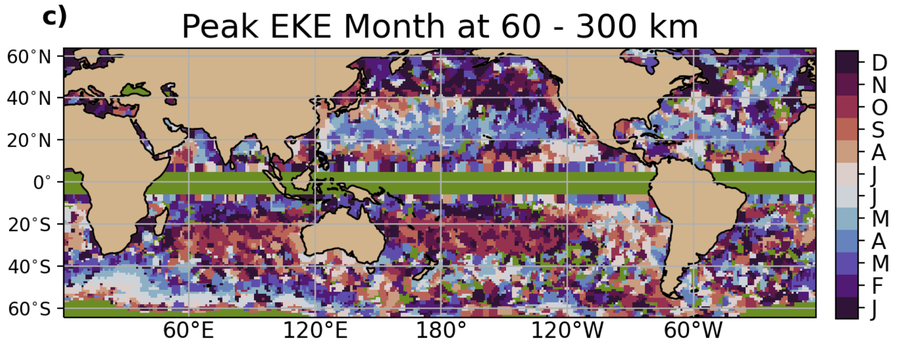




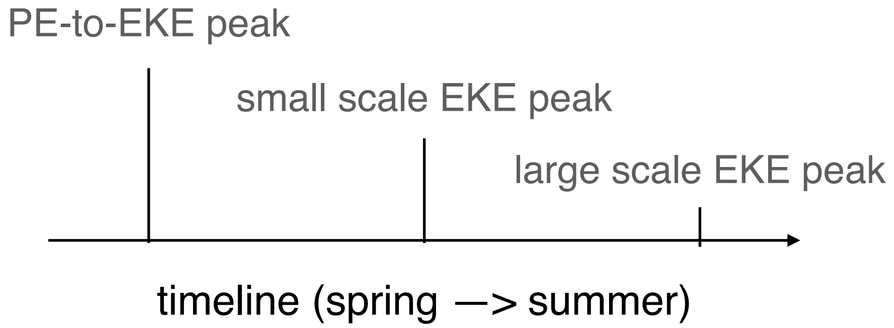
what are the time lags between these peaks?

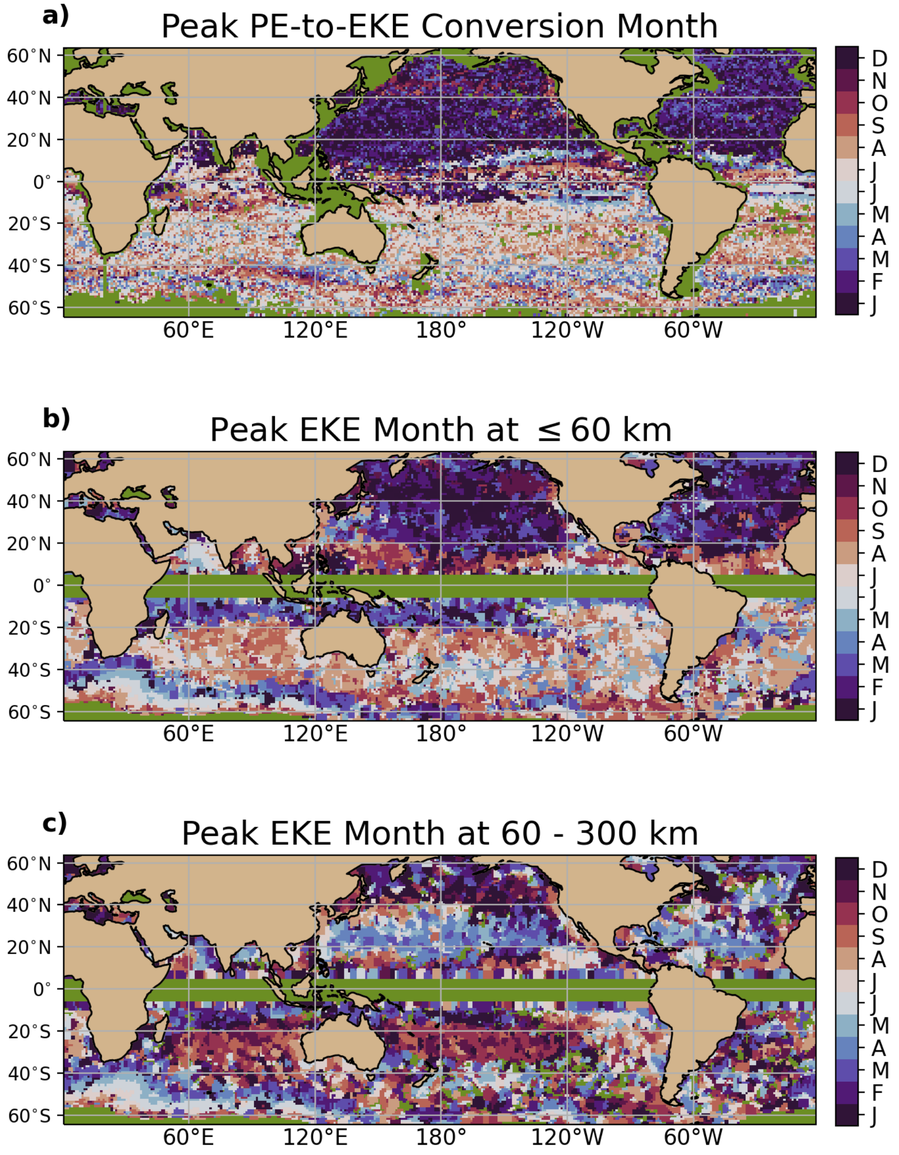


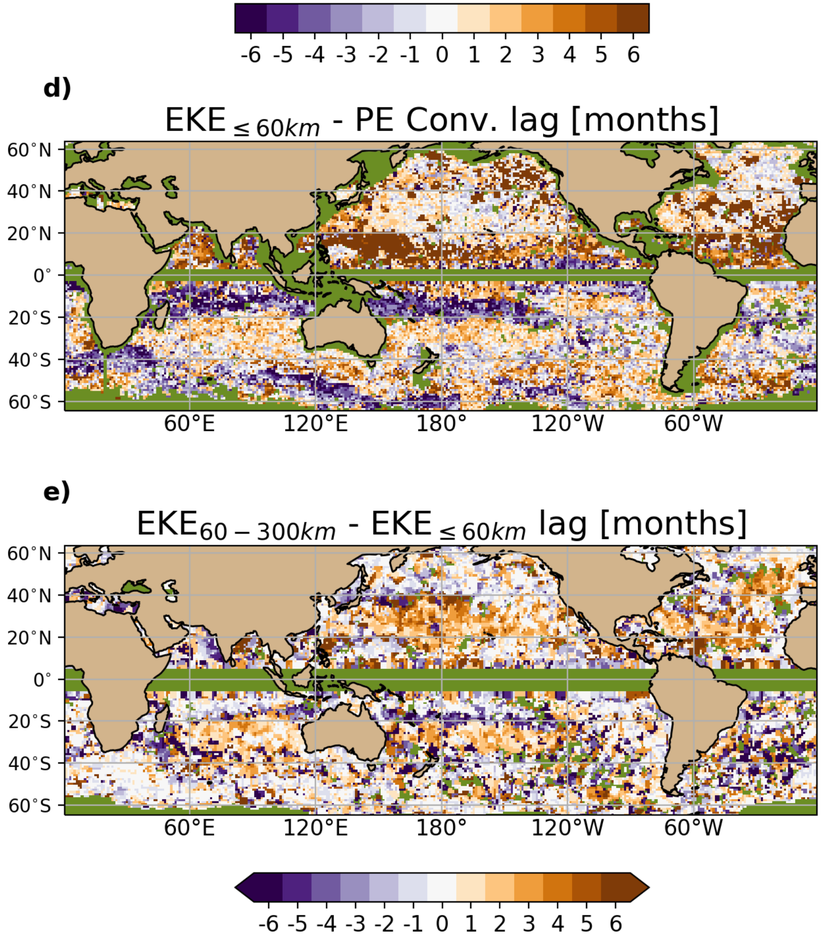




<u>the progression in this timing suggests KE to move upscale</u>



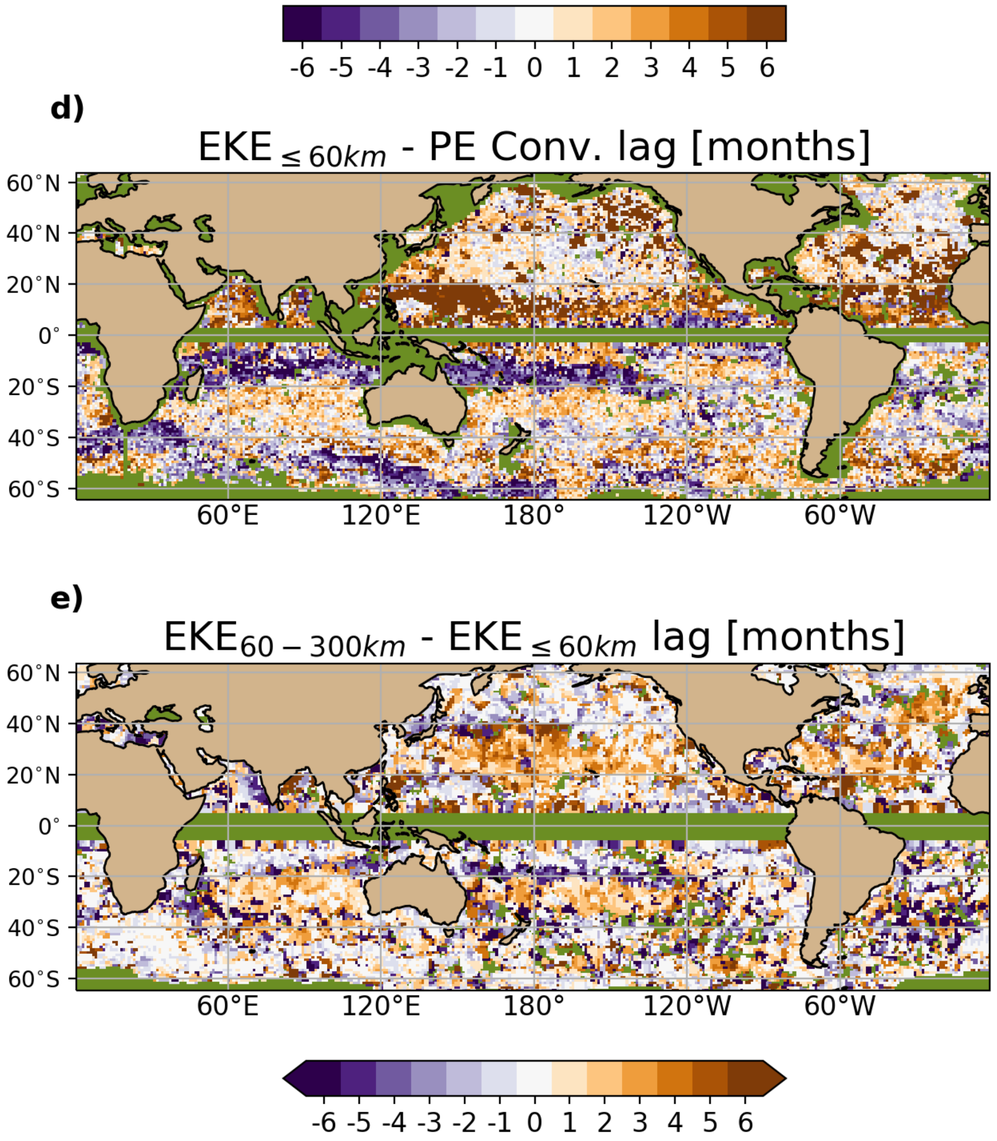




differing timing of peaks quantified as a lag

white/orange = conversion peak ‘just’ precedes small-scale EKE peak

orange = small-scale EKE peak ‘just’ precedes large-scale EKE peak



white/orange = conversion peak ‘just’ precedes small-scale EKE peak

orange = small-scale EKE peak ‘just’ precedes large-scale EKE peak

Conclusion:

progression in the timing of peaks identifies a source of mesoscale EKE to be submesoscale EKE.

this energy moves upscale in late winter resulting in a scale dependent season cycle in mesoscale eddy kinetic energy.

reveals the spatial dependence of upscale energy transfer (a backscatter/ source term in the mesoscale KE budget)