Toward predicting the spatial pattern of mid-latitude marine heat waves based on the imprinting of regional wind anomalies

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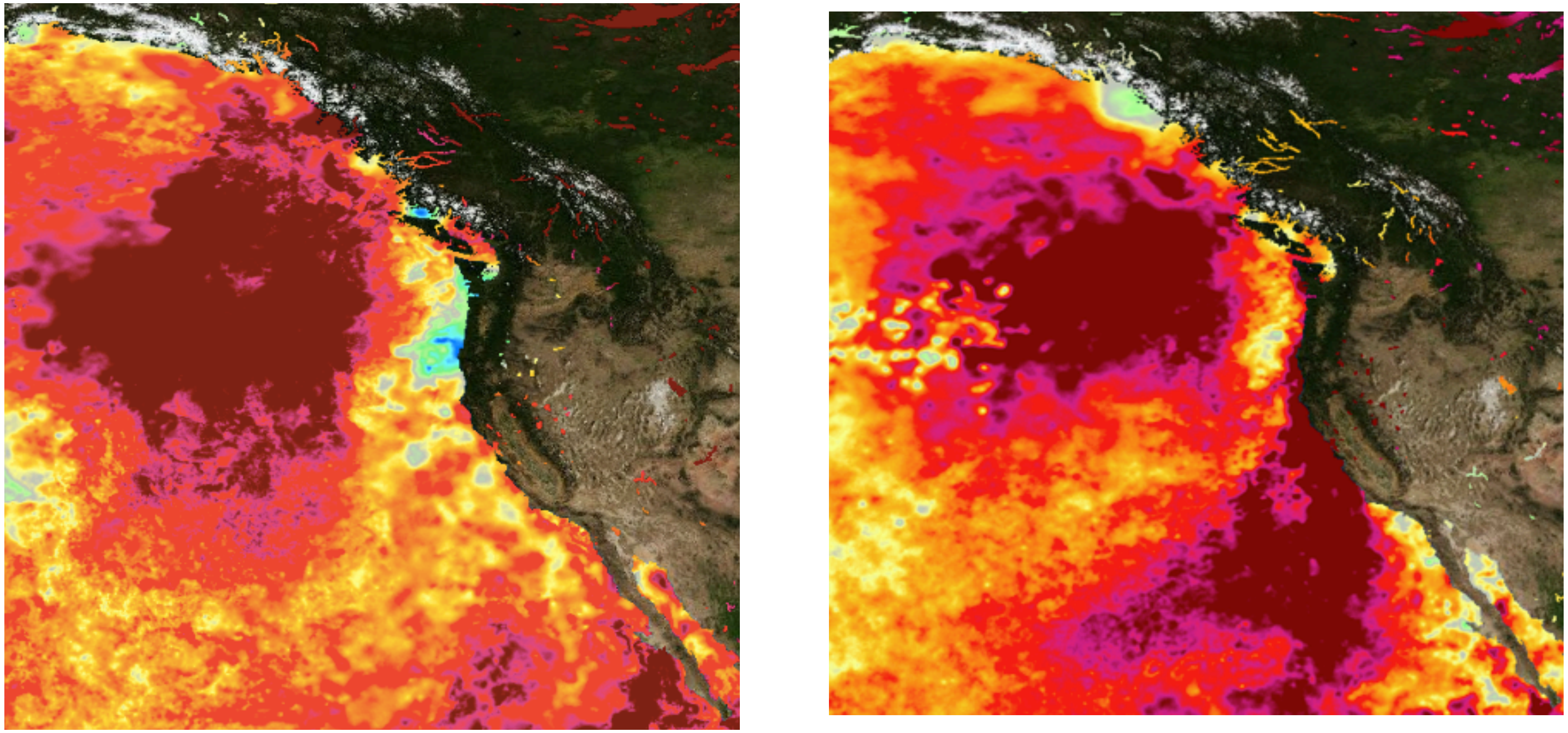
SST anomaly July 1, 2015

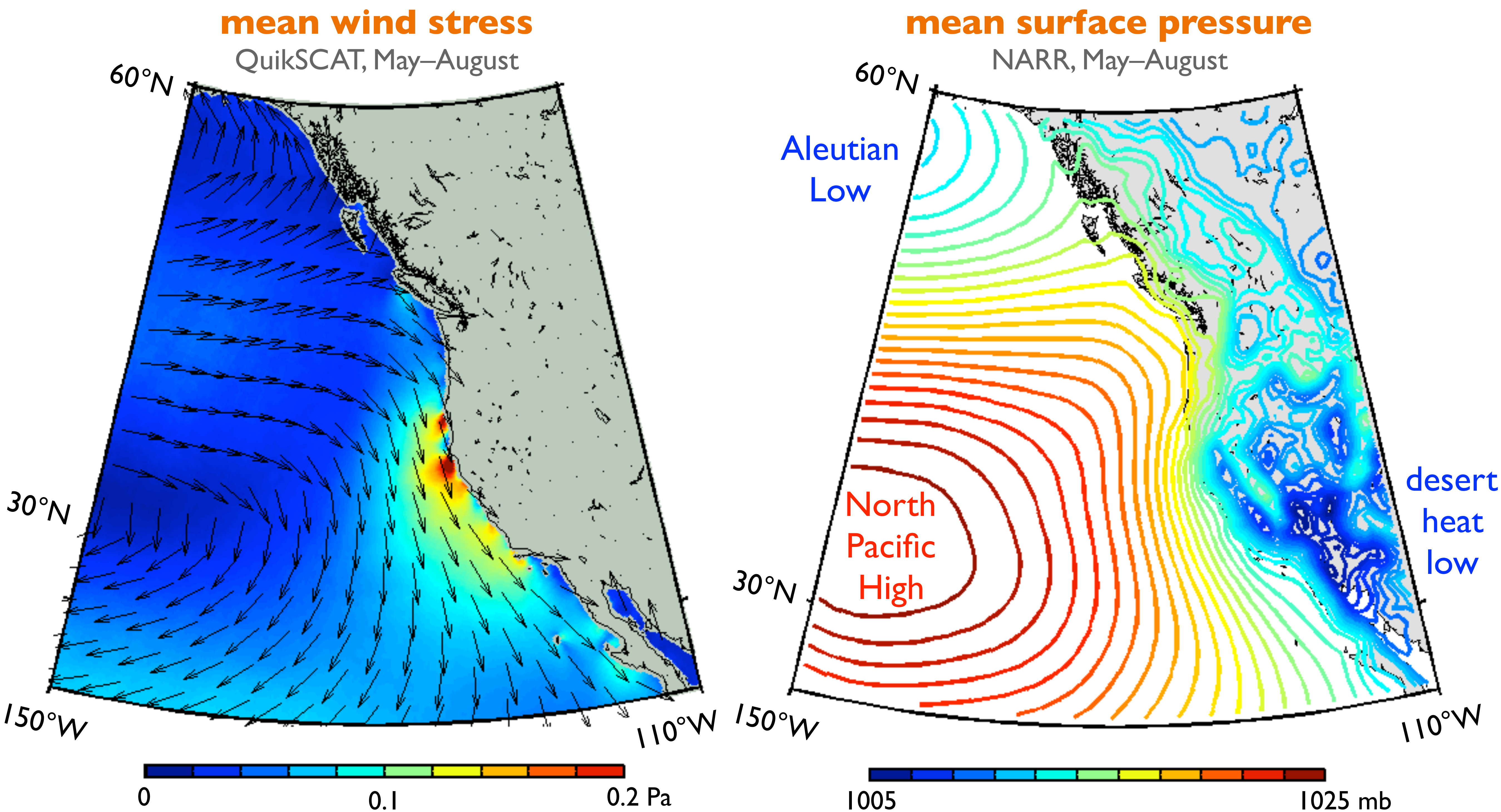
SST anomaly July 14, 2015



GHRSST L4 MUR

−3 0 3°C

The prevailing winds in summer are driven by the North Pacific High and Aleutian Low pressure systems

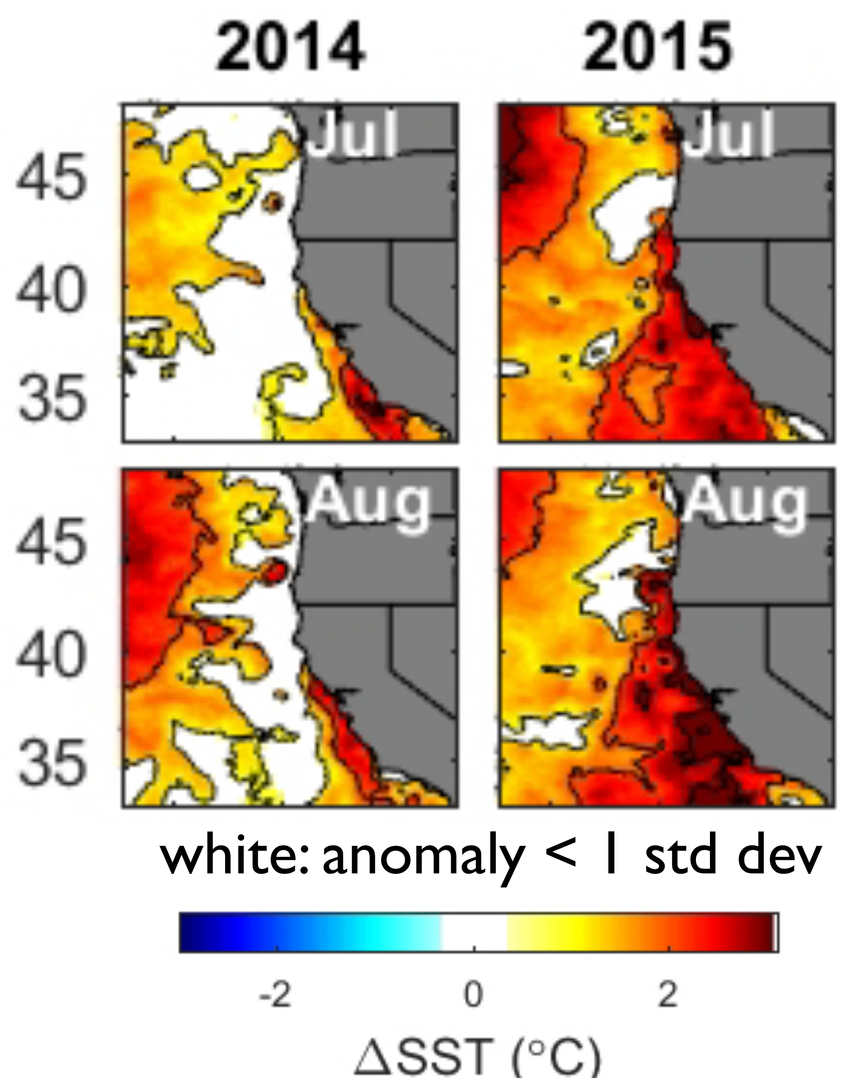


Halliwell and Allen, JGR 1987; Figures from Fewings et al., JGR 2016

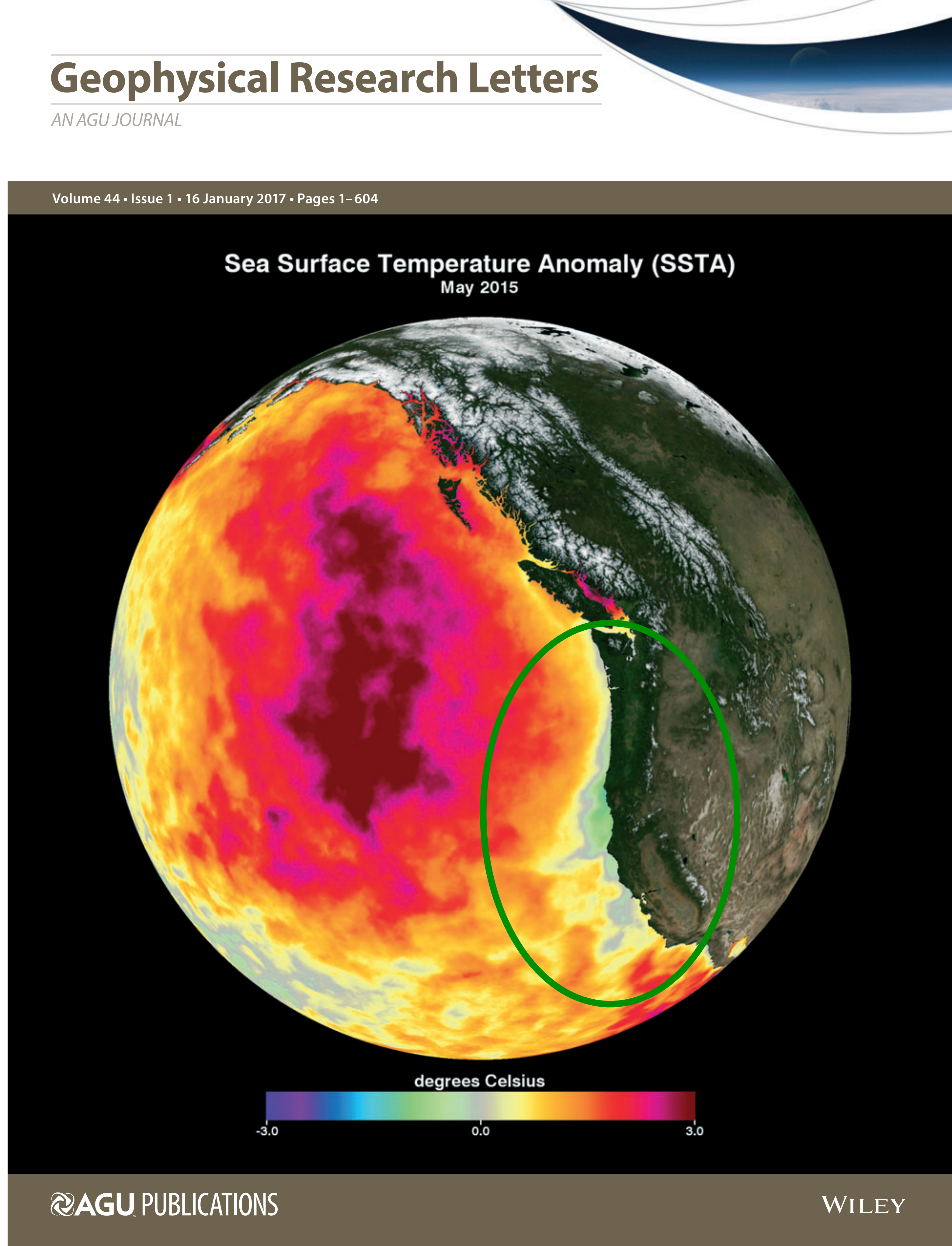
In 2014-2016, persistent ridging caused a large-scale marine heat wave

(Bond et al., 2015 and others)

The heat wave was worse in the southern half of the California Current System.



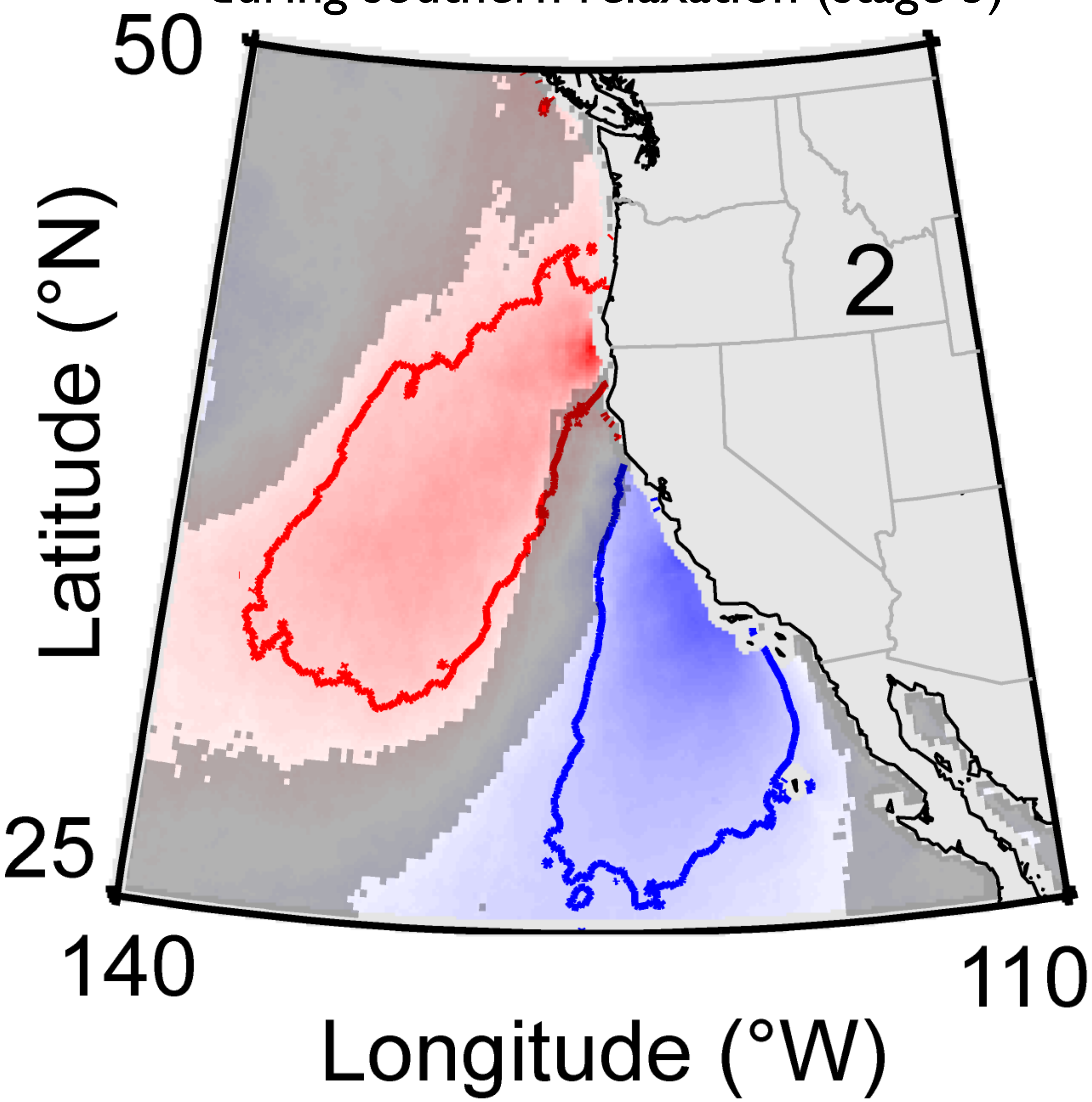
Gentemann, Fewings, and García-Reyes
Geophysical Research Letters, 2017



The dominant wind variability along the coast in summer is a dipole

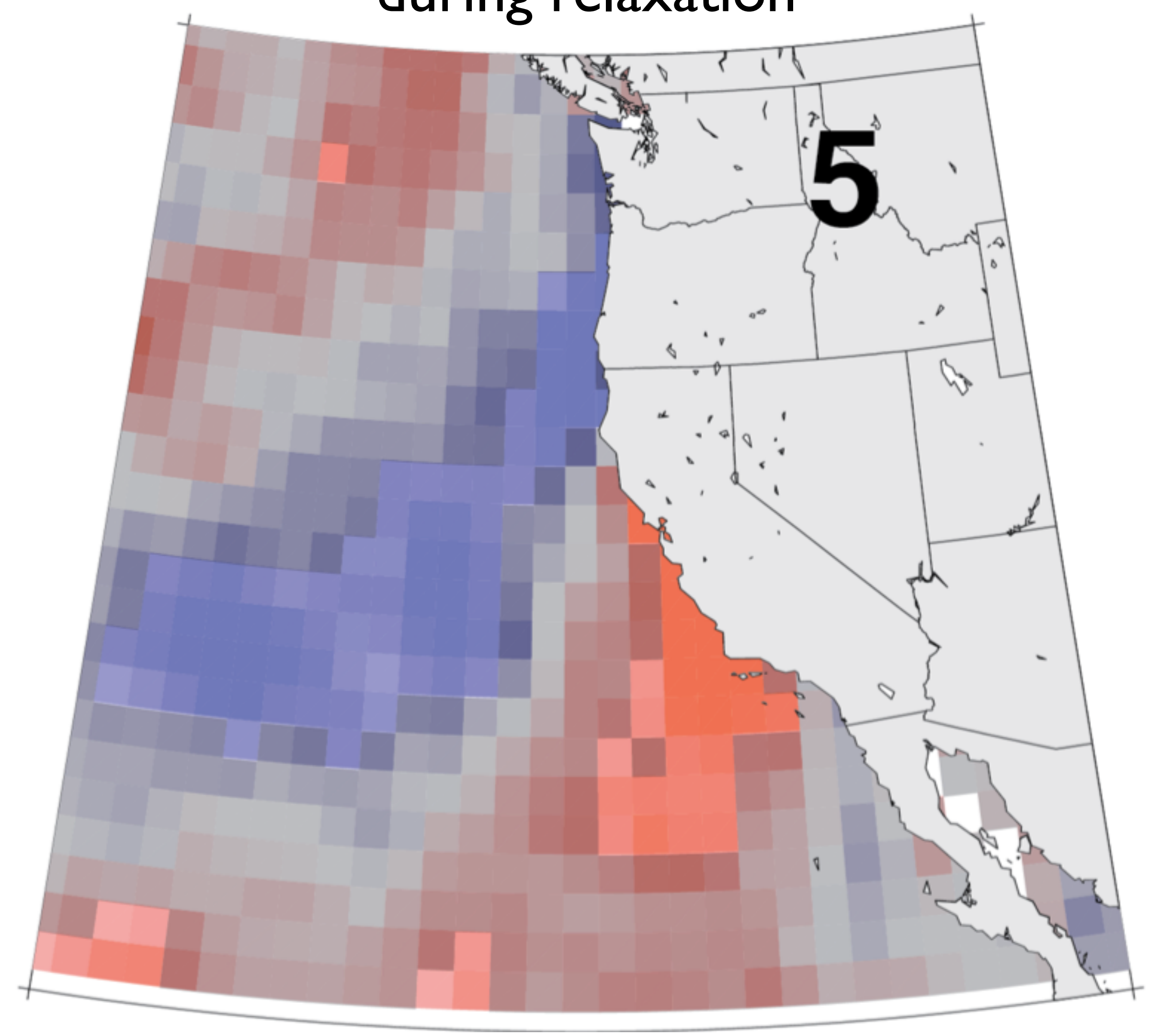
wind and SST anomalies in "southern relaxation" phase
have similar spatial structure to southern half of split Blob

wind stress anomaly
during southern relaxation (stage 3)



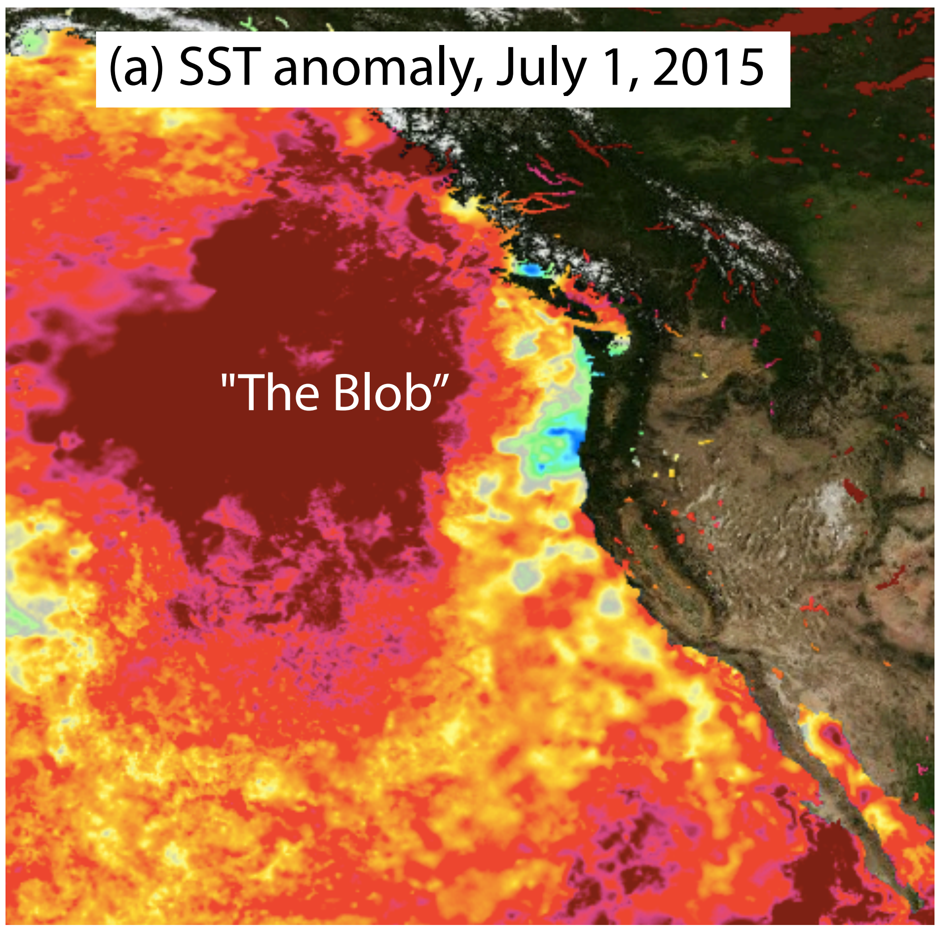
Fewings et al., JGR 2016, Fewings MWR 2017

change in SST
during relaxation

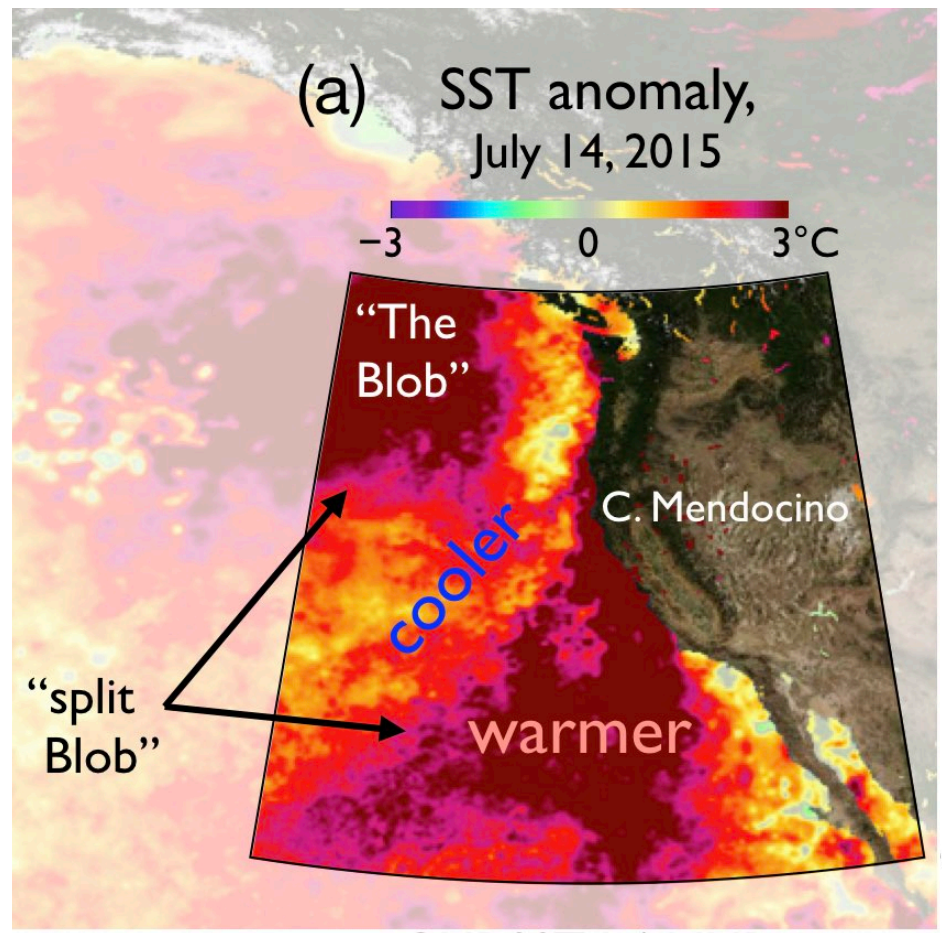


Flynn, 2016
Flynn et al., JGR 2017

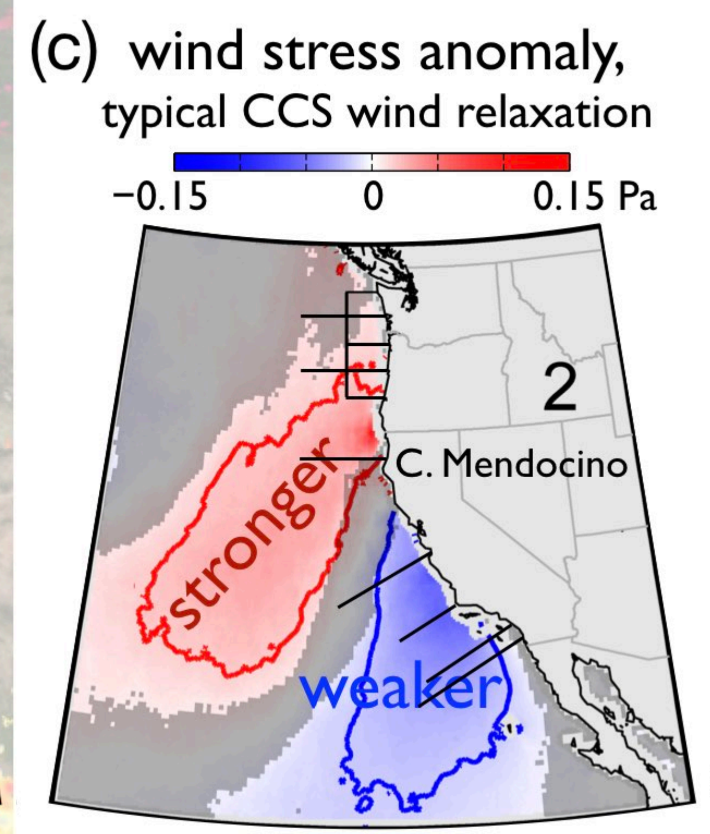
Could unusual persistence of the southern relaxation phase of the dipole explain the "Split Blob"?



GHRSST L4 MUR



GHRSST L4 MUR



Fewings et al., JGR 2016

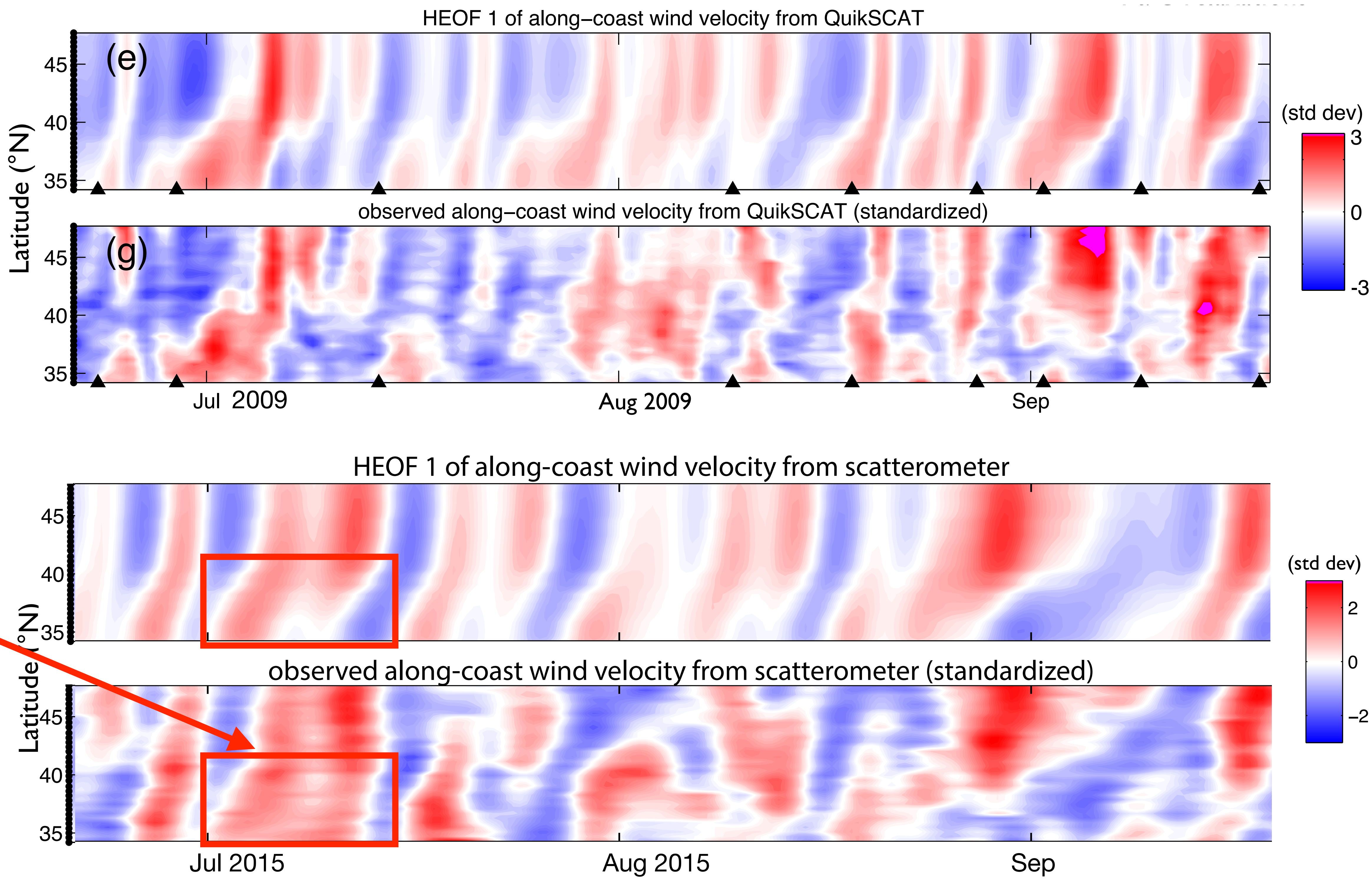
In July 2015, winds in the southern California Current System WERE in a persistent relaxation state

We extended Hilbert EOF 1 of along-coast wind velocity to 2015 using OceanSAT, RapidSCAT, and ASCAT-A satellite winds.

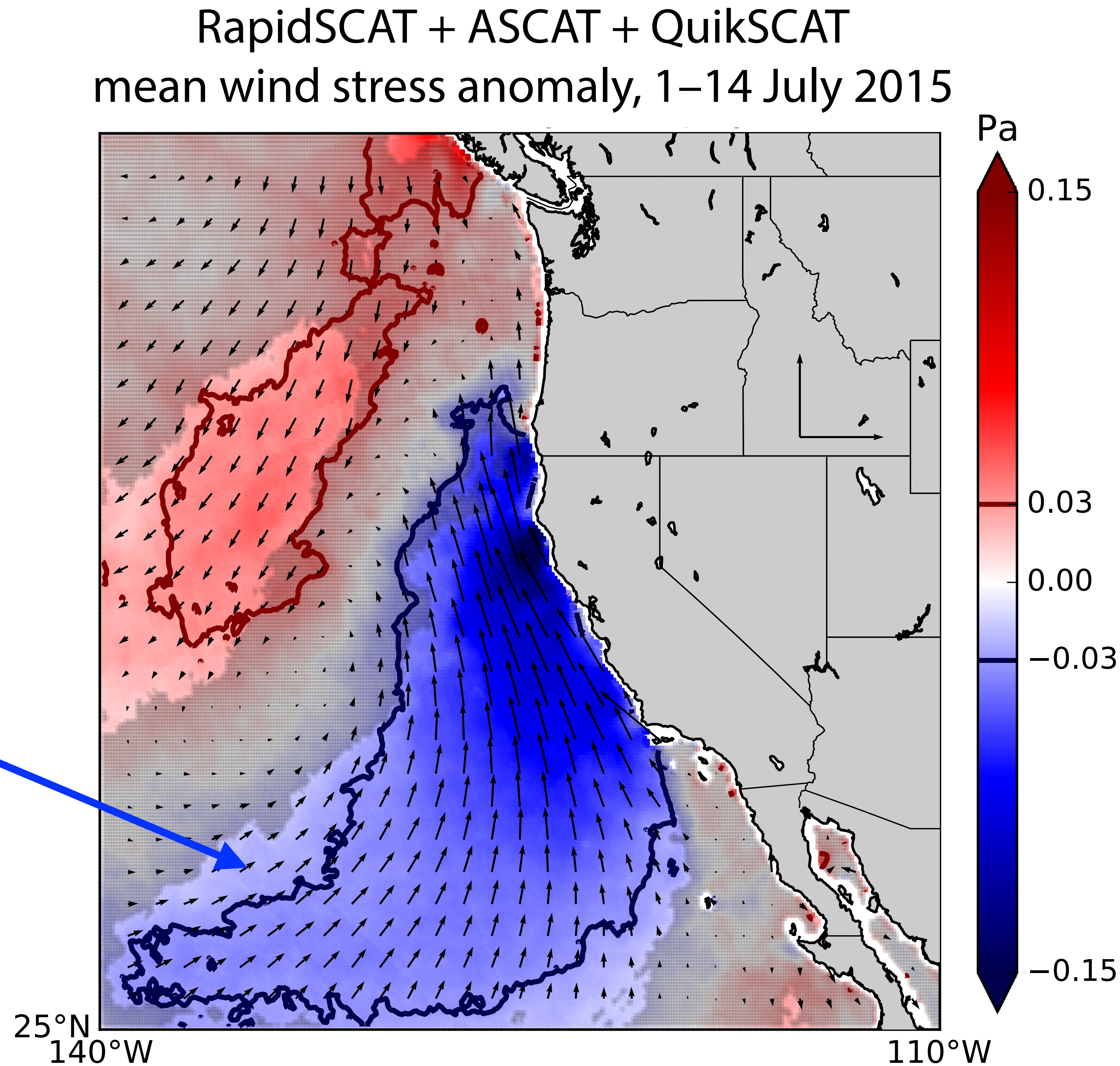
2009

(Fewings, *MWR* 2017)

2015: more persistent relaxations (red)



The anomaly in wind stress during July 1-14, 2015 does show a large-scale wind relaxation

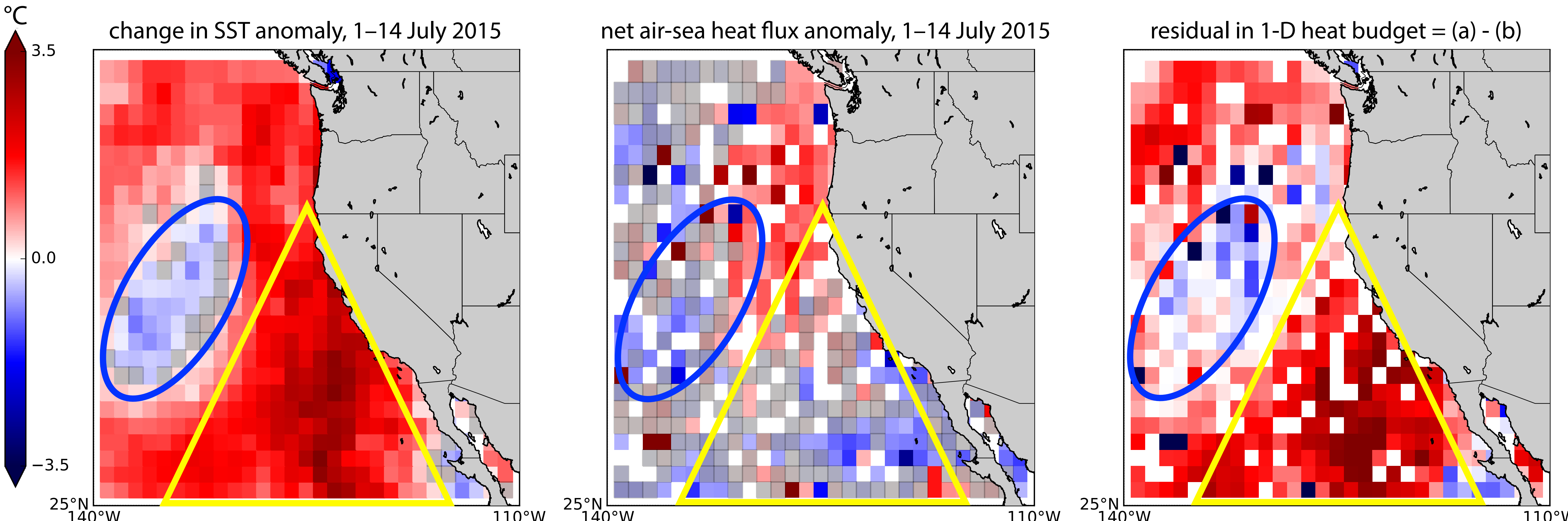


relaxation (blue)

The air-sea heat flux anomaly does NOT explain the SST anomaly during the split Blob of 2015 (or typical wind relaxations; Flynn et al., JGR 2017)

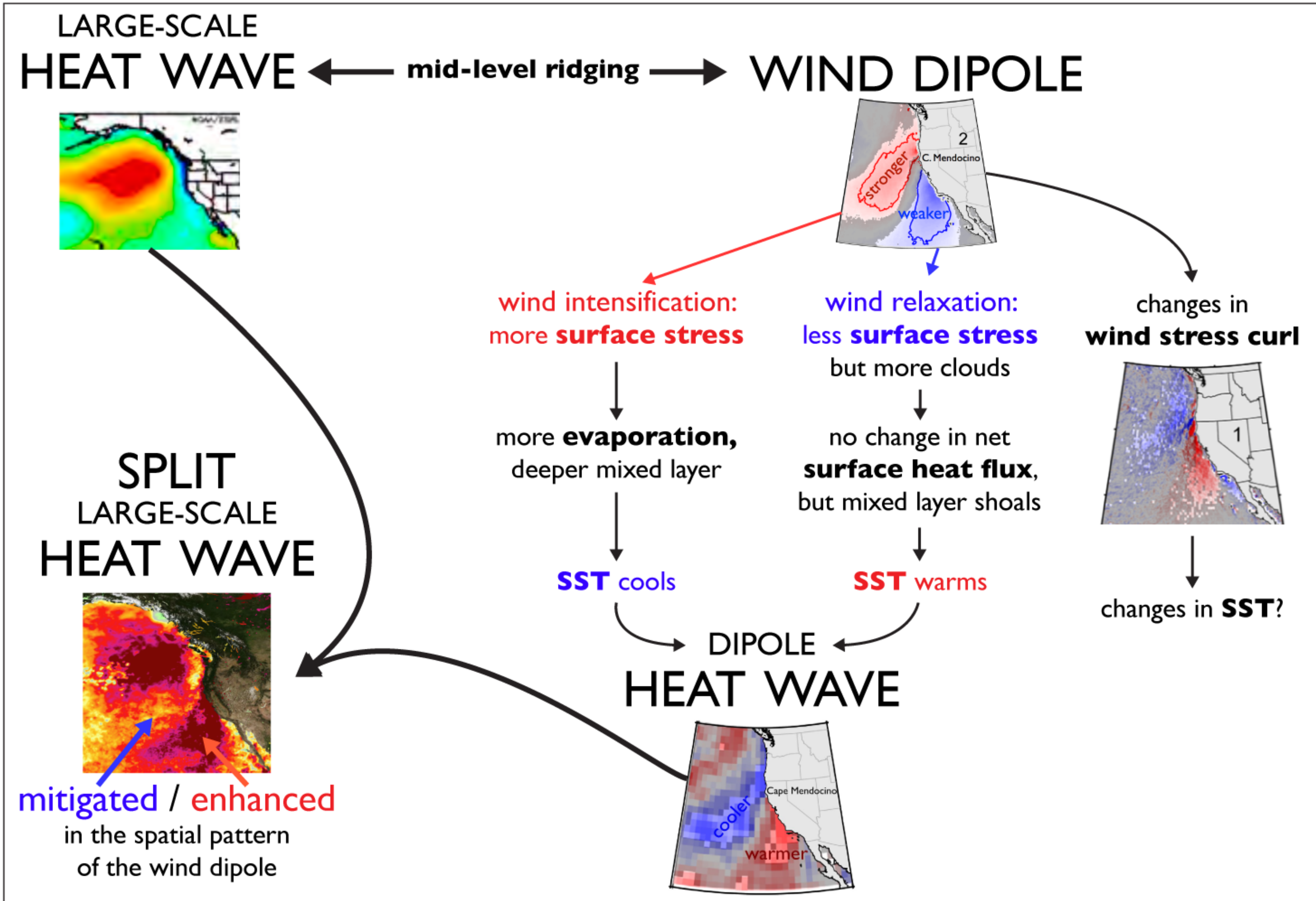
surface mixed layer anomaly heat budget:

$$\int_{\mathrm{Jul}\ 1}^{\mathrm{Jul}\ 14} R\,dt = (SST'|_{\mathrm{Jul}\ 14} - SST'|_{\mathrm{Jul}\ 1}) - \int_{\mathrm{Jul}\ 1}^{\mathrm{Jul}\ 14} \frac{Q_{net}}{\rho c_p h} dt$$



OAFlux **air-sea heat flux anomaly is near zero or the wrong sign** to explain observed increase in SST.
We hypothesize changes in vertical mixing and entrainment cause the SST anomalies

We suggest the spatial structure of NE Pacific marine heat waves will be predictable even if the timing is not: a split Blob



Conclusions

- The “split Blob” spatial structure of the MHW
  = large-scale MHW + regional dipole SST anomaly
  from persistent “southern” wind relaxation

- Persistent ridging causes large-scale MHW
- Persistent ridging causes regional “southern" wind relaxation
- Southern wind relaxation causes dipole SST anomaly
- The sum of SST anomalies is a split Blob.

- Wind stress (and curl) anomalies,
  but NOT surface heat flux anomalies,
  explain the stronger SST anomalies
  in the southern CCS.

- This implies mixed layer depth changes and entrainment
  cause the dipole SST anomaly

- This suggests the “split Blob" spatial structure
  will also occur in future MHW in the NE Pacific