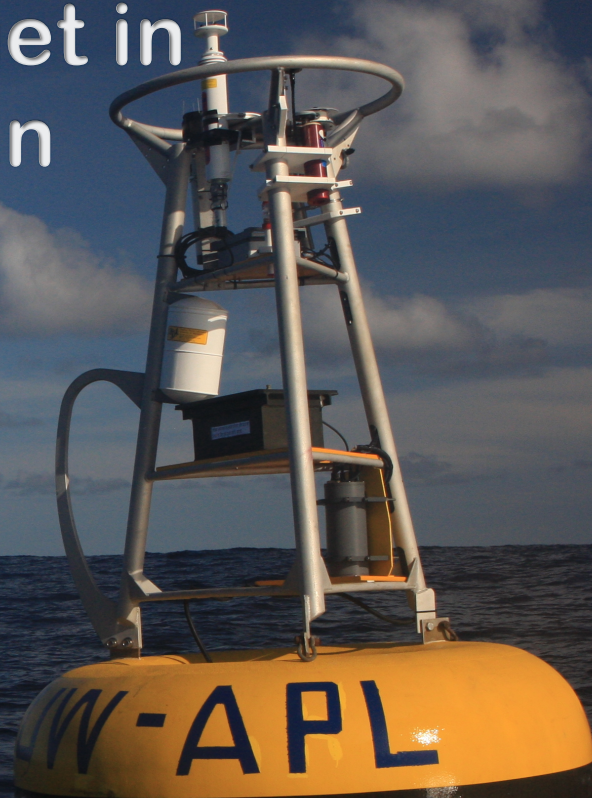




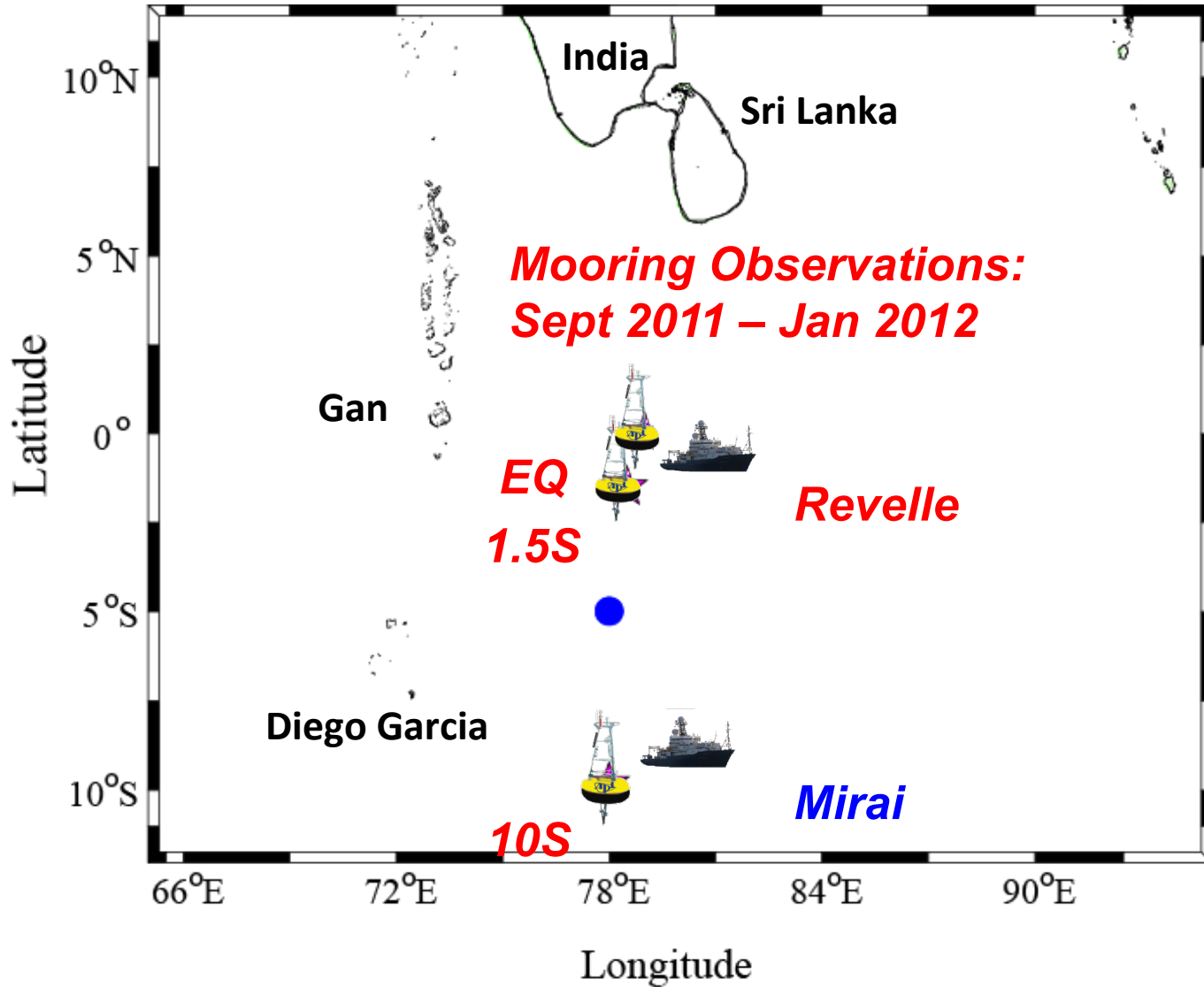
Variations of Surface Mixed Layer Heat Budget in Central Indian Ocean during DYNAMO



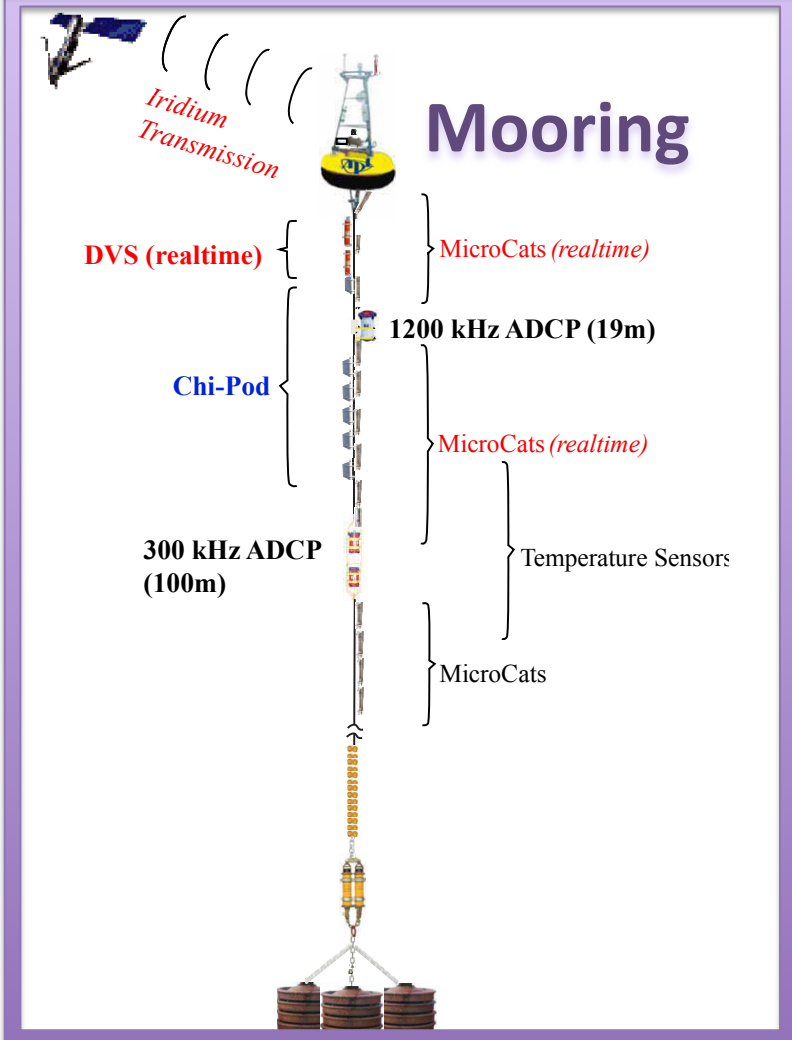
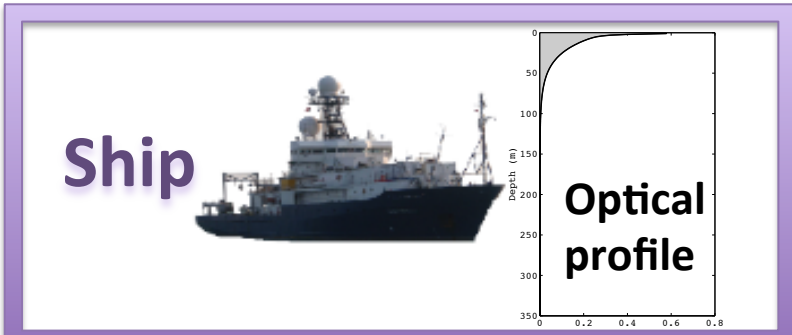
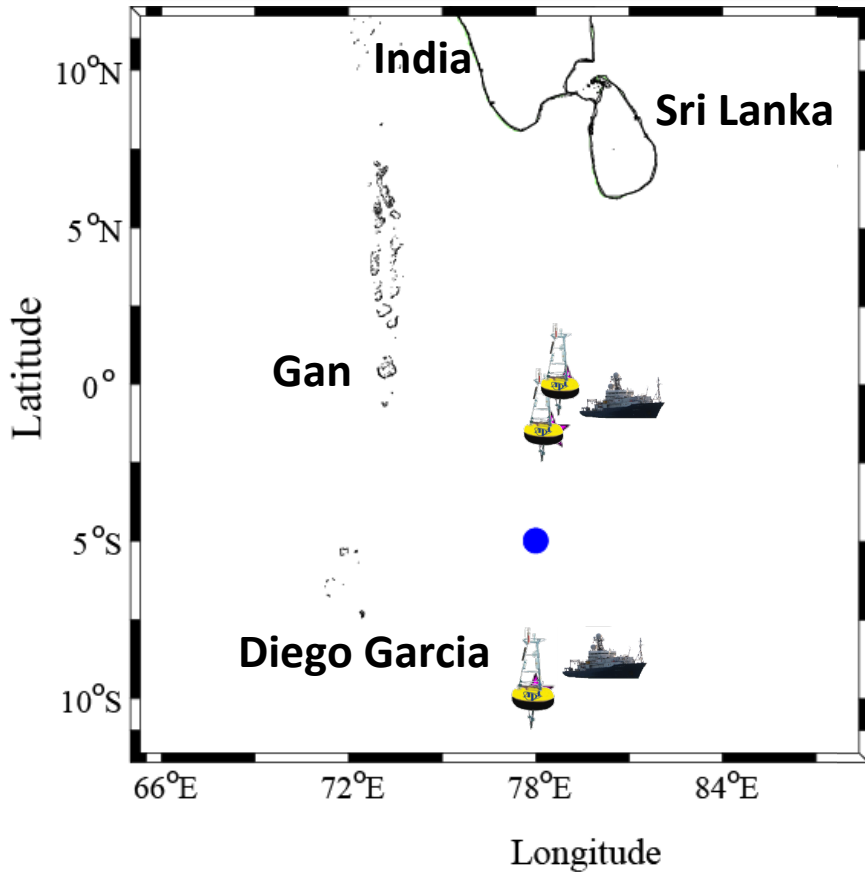
Nan-Hsun Chi, Ren-Chieh Lien, Eric D'Asaro

Acknowledgement: Michael McPhaden, LuAnne Thompson, Jim Moun, Jim Edson, Chris Fairall, KG Fairbarn, Carter Ohlmann

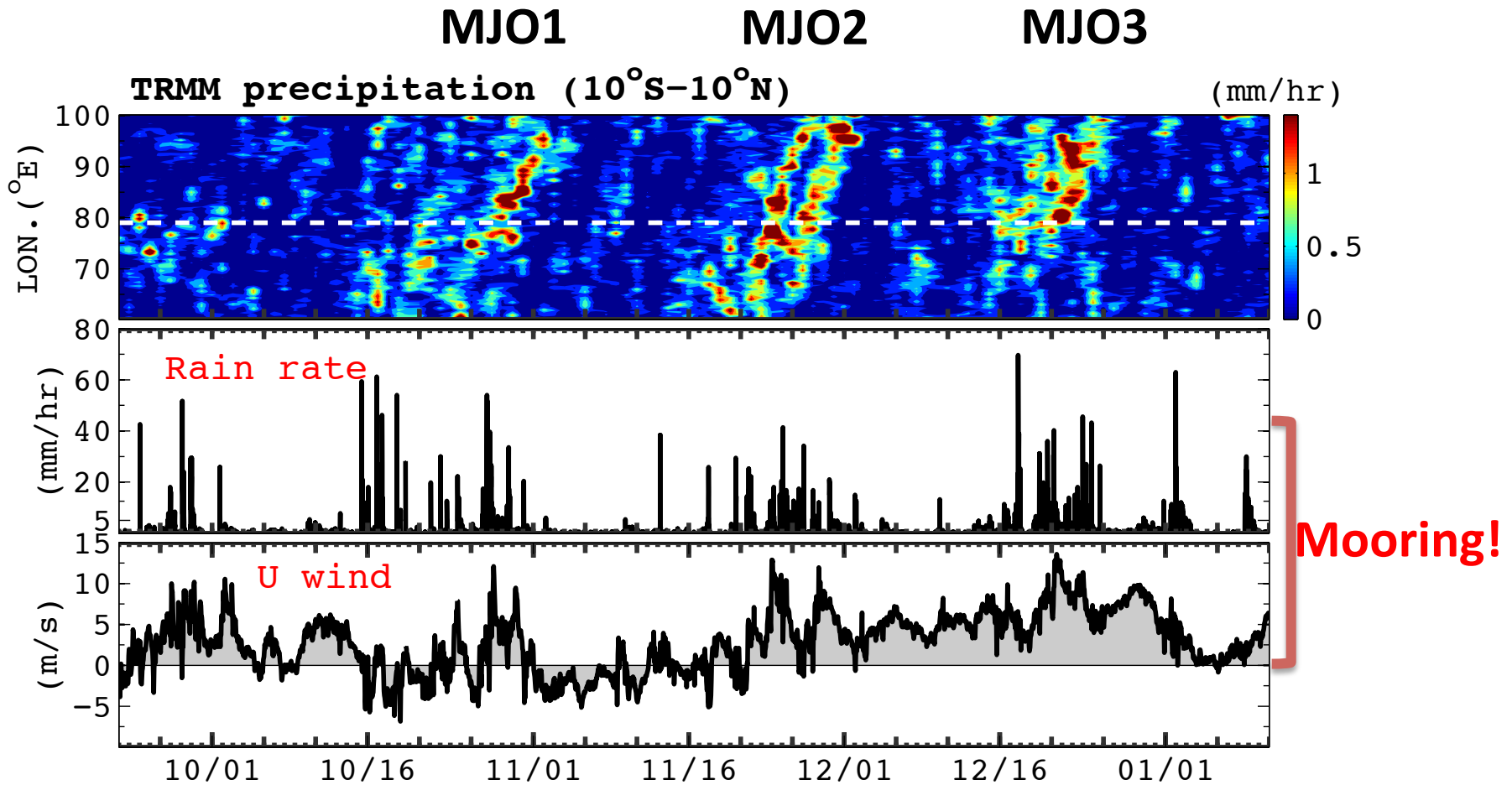
DYNAMO Mooring



Instruments!!



MJOs captured during DYNAMO!



Vertically Integrated Heat Budget

Moisan & Niiler 1998,
Foltz et al. 2010

Surface
heat flux

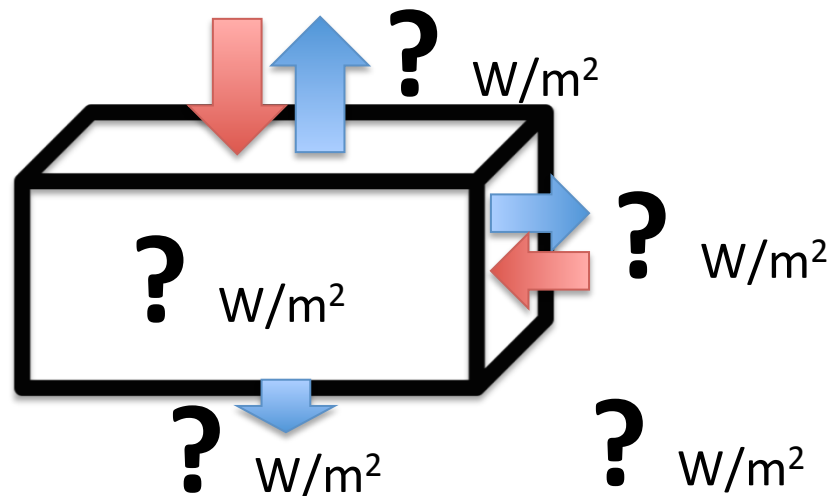
Horizontal heat
advection

$$\rho c_p h \frac{\partial \bar{T}}{\partial t} = q_0 - q_{-h} - \rho c_p h \bar{\mathbf{U}} \cdot \nabla \bar{T} + R$$

Mixed layer heat
storage rate

Penetrative
short-wave

Residual

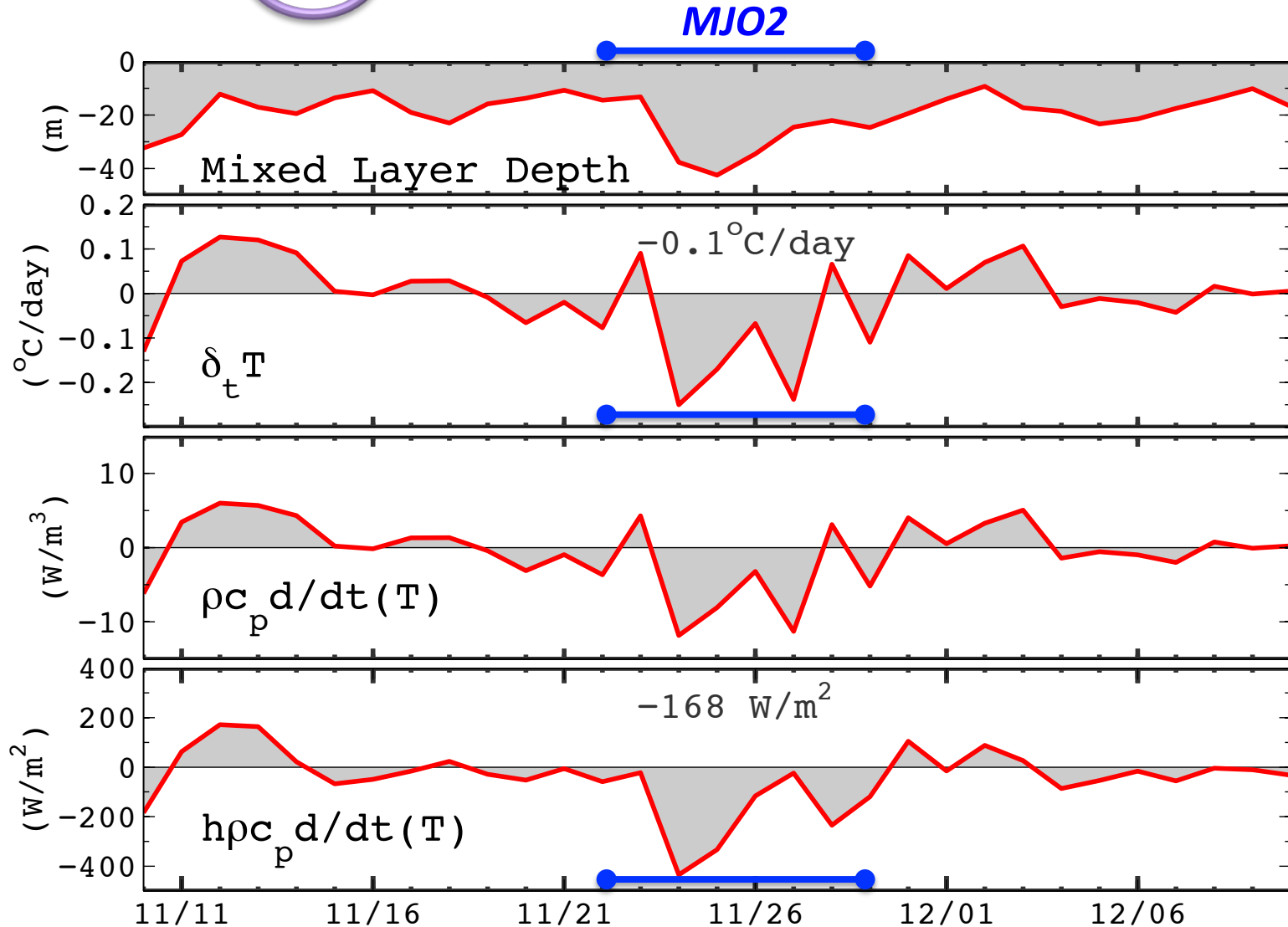


- * Residual: horizontal divergence of eddy heat flux + turbulent flux at -h
- ** h: mixed layer depth = 0.1 kg/m^3 increase in density from 1.5m CTD
- *** $\bar{\mathbf{U}}$ and \bar{T} : vertically averaged from 1.5m (shallowest CTD) to h

What is changed in the Mixed Layer?

Looking at:

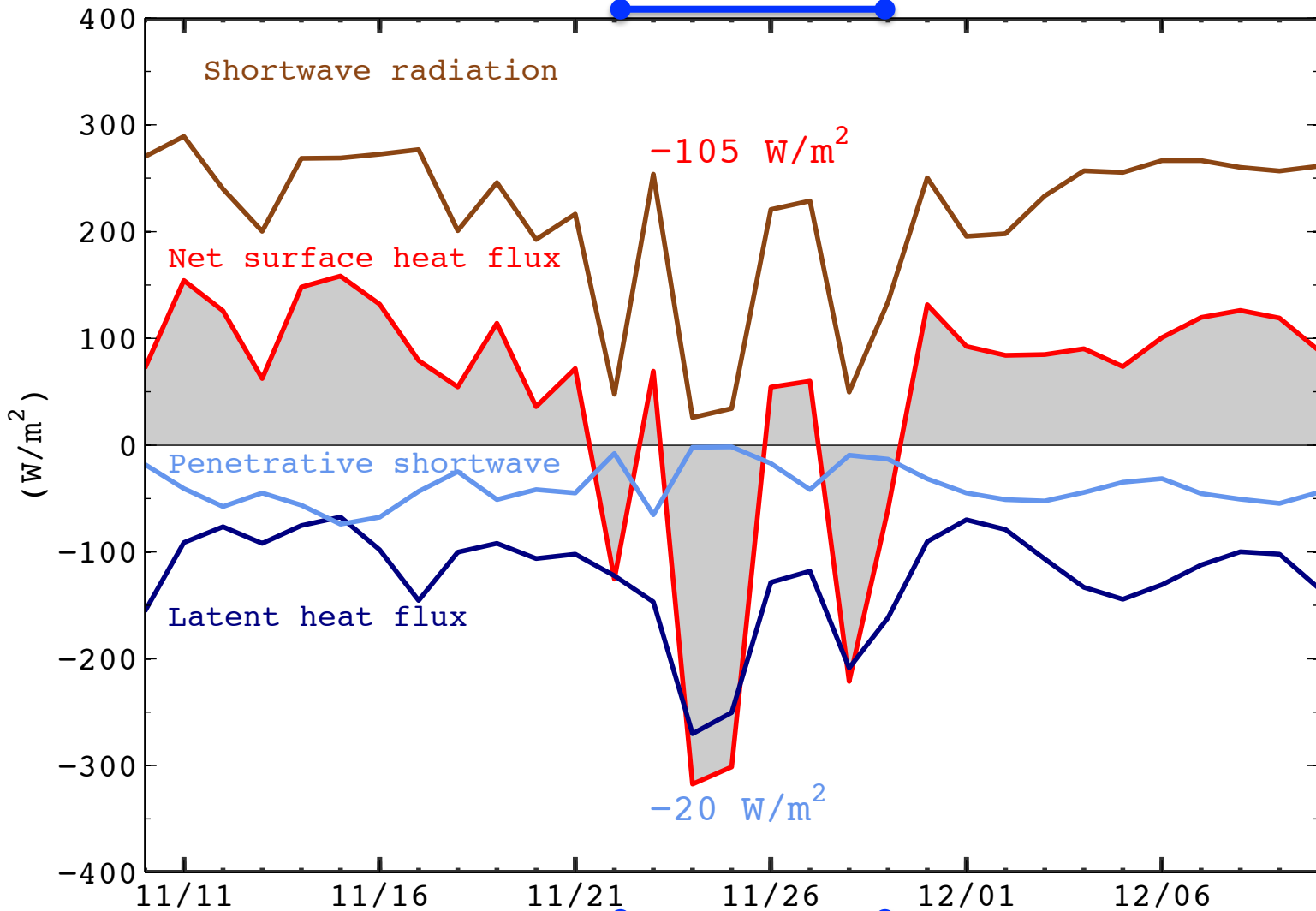
$$\rho c_p h \frac{\partial \bar{T}}{\partial t} = q_0 - q_{-h} - \rho c_p h \bar{U} \cdot \nabla \bar{T} + \text{Residual}$$



Fluxes at surface & base of ML

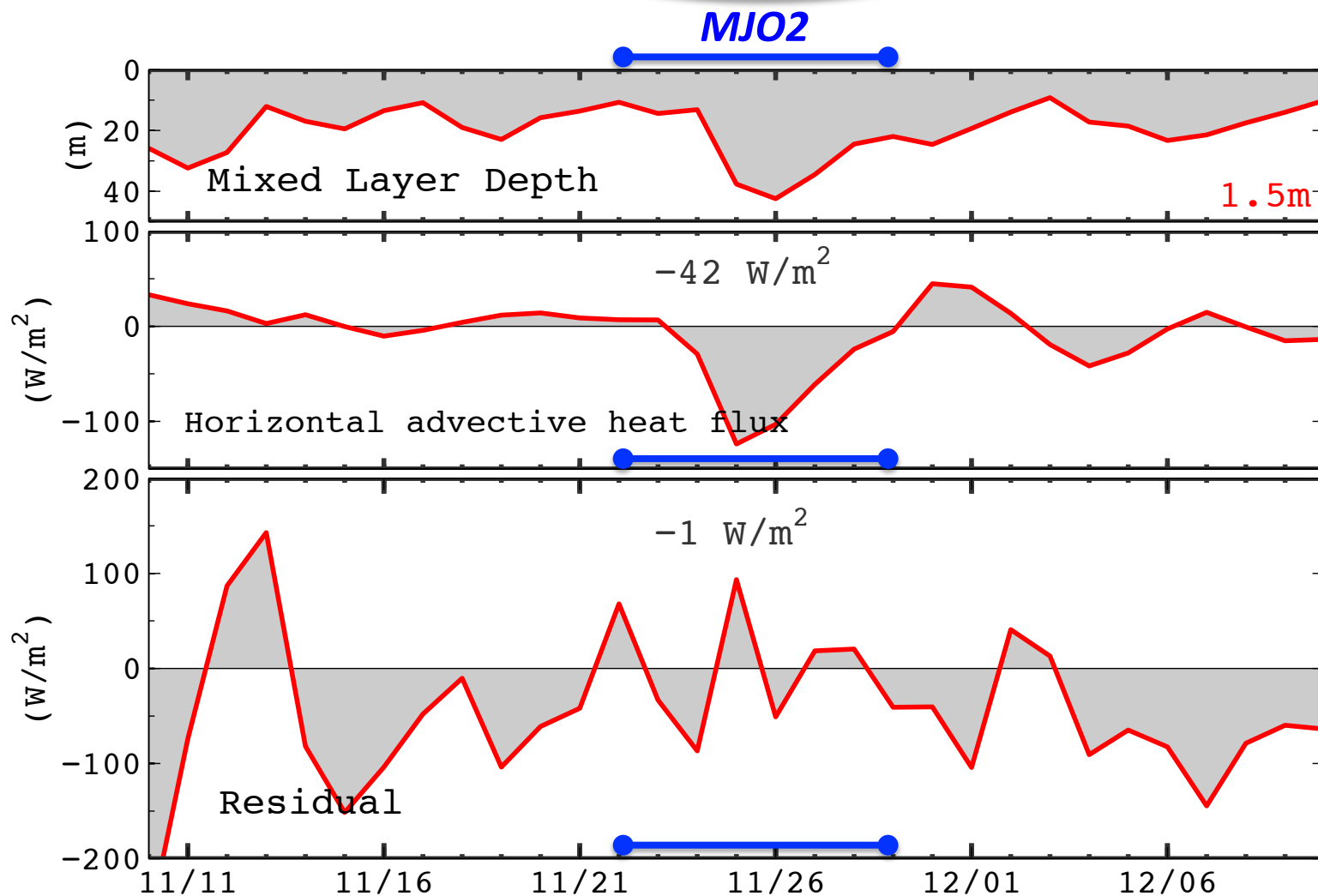
Looking at: $\rho c_p h \frac{\partial \bar{T}}{\partial t} = q_0 - q_{-h} - \rho c_p h \bar{U} \cdot \nabla \bar{T} + \text{Residual}$

MJO2



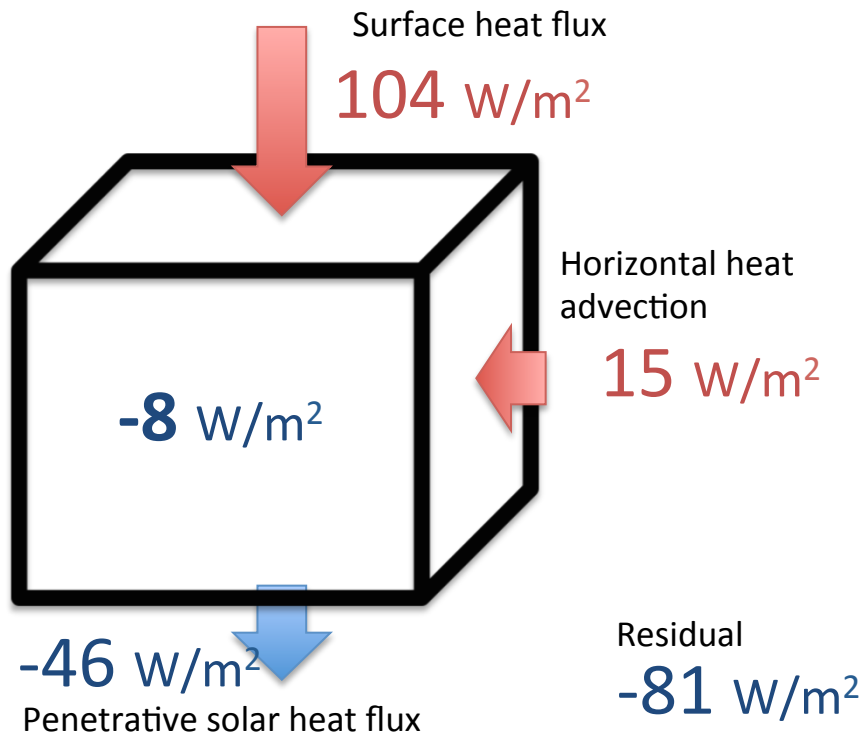
Advective heat & Residual of ML

Looking at: $\rho c_p h \frac{\partial \bar{T}}{\partial t} = q_0 - q_{-h} - \rho c_p h \bar{U} \cdot \nabla \bar{T} + \text{Residual}$

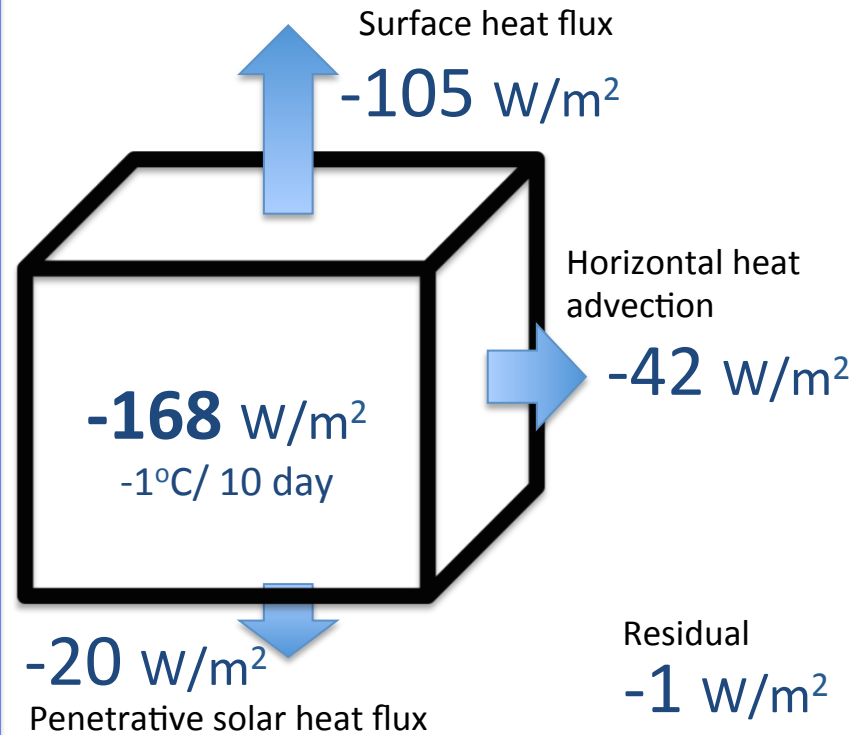


Summary of Heat Budget Balance

Before MJO2

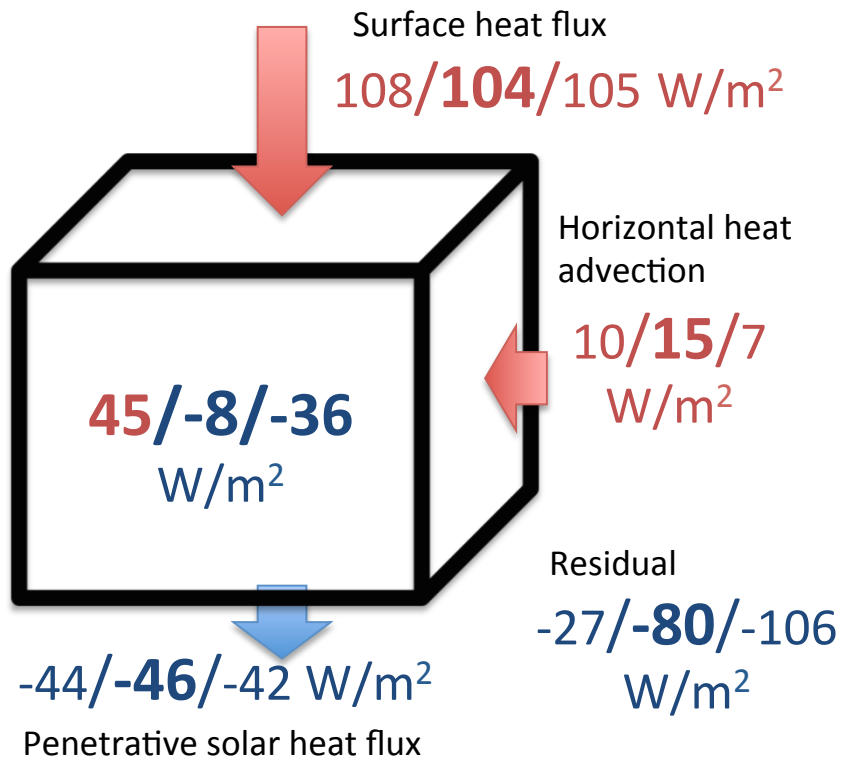


During MJO2

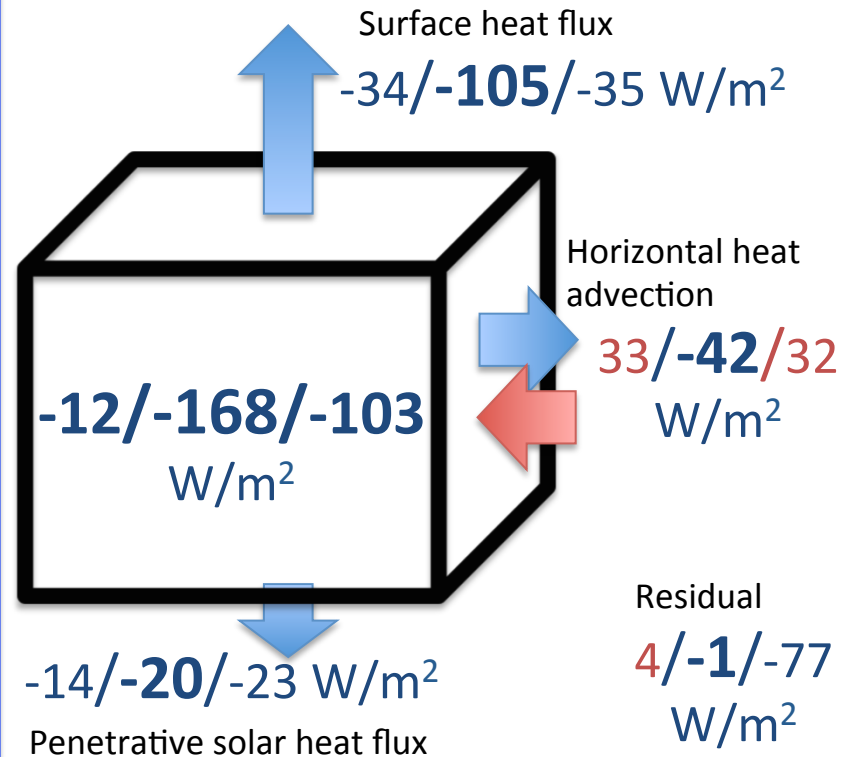


Summary of Heat Budget Balance during 3 MJOs

Before MJOs



During MJOs



MJO1/MJO2/MJO3

Summary

- 3 (2.5) MJOs events were captured by moorings!
- **Prior MJOs: *Net surface heat flux & Residual*** dominates
 - Shortwave radiation
 - Latent heat flux
- **During MJOs:** all are modulated. Esp. ***Net surface heat flux & Mixed layer heat storage rate***
 - Advective heat flux is ***NOT*** negligible
 - Penetrative shortwave becomes smaller
- **Ongoing work:** error estimates...

A full-page background image of a sunset over the ocean. The sky is filled with dense, textured clouds in shades of orange, red, and dark brown. The sun is partially obscured by a layer of clouds near the horizon, creating a bright glow. The water in the foreground is dark and reflects the colors of the sky.

Thank you