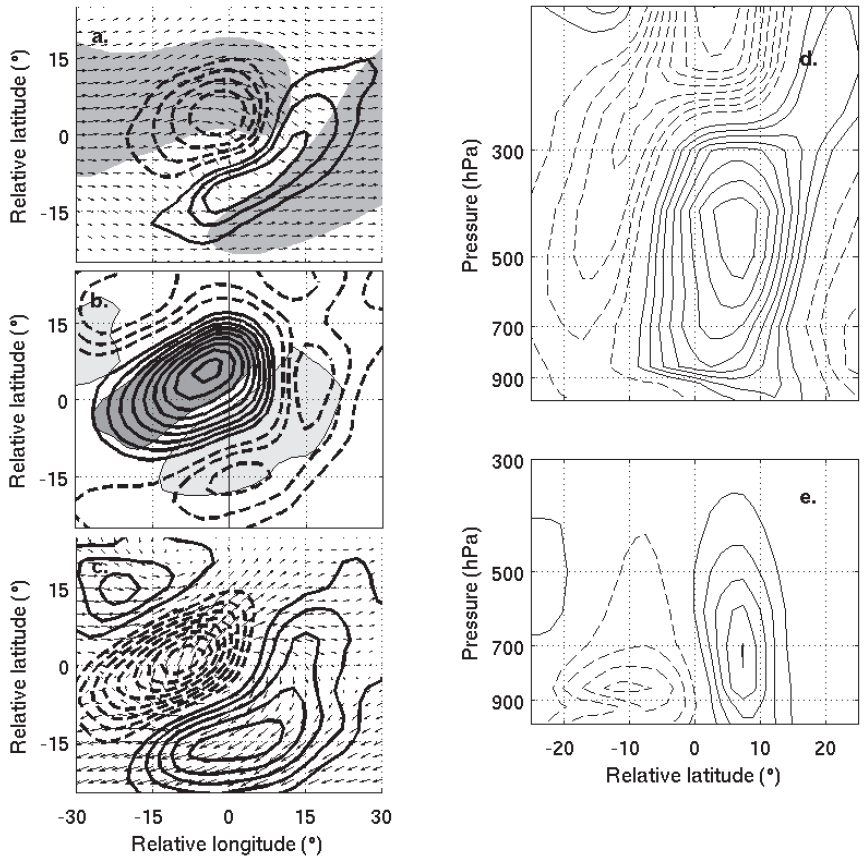
US CLIVAR High Latitude Surface Flux Working Group

Telecon 2: Surface Flux User Requirements

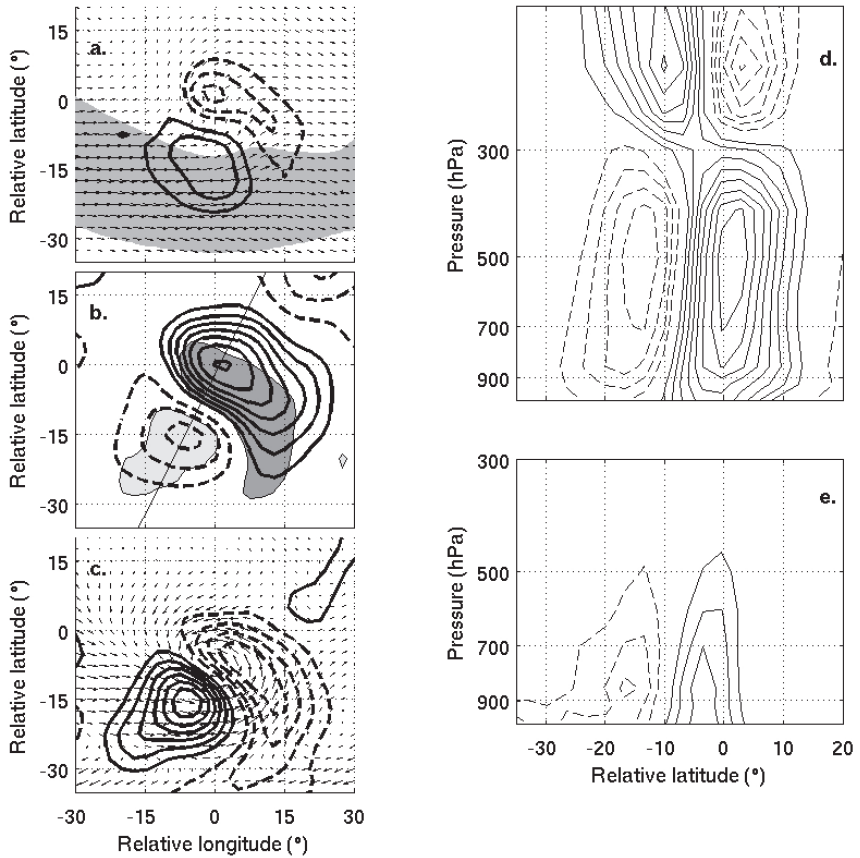
- What are the applications for flux products?
- How accurate do flux estimates need to be? What resolution is needed?
- Do applications provide a means to validate fluxes?

Gudrun Magnusdottir: Rossby Wave Breaking



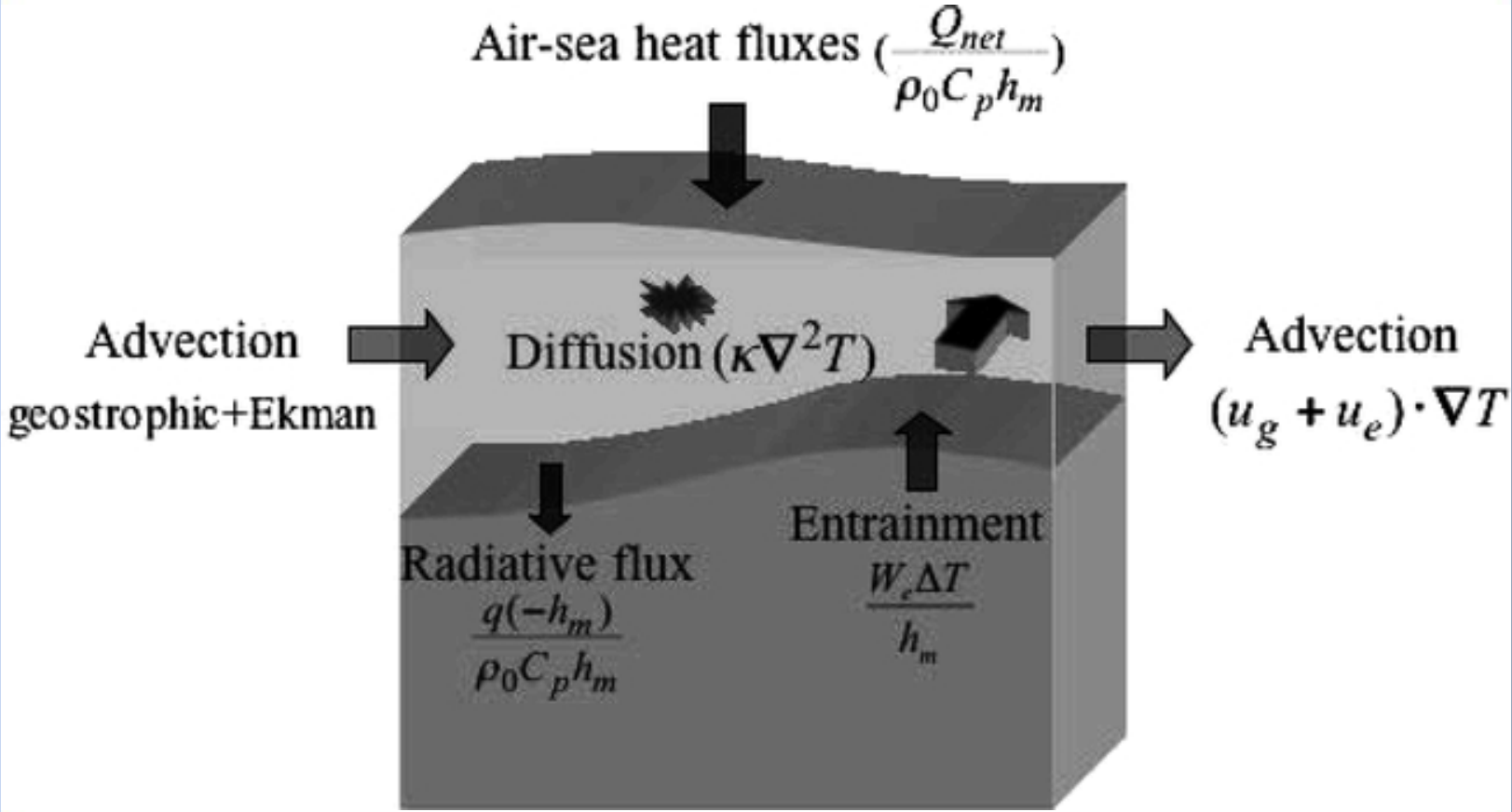
J. Climate, submitted

Gudrun Magnusdottir: Rossby Wave Breaking



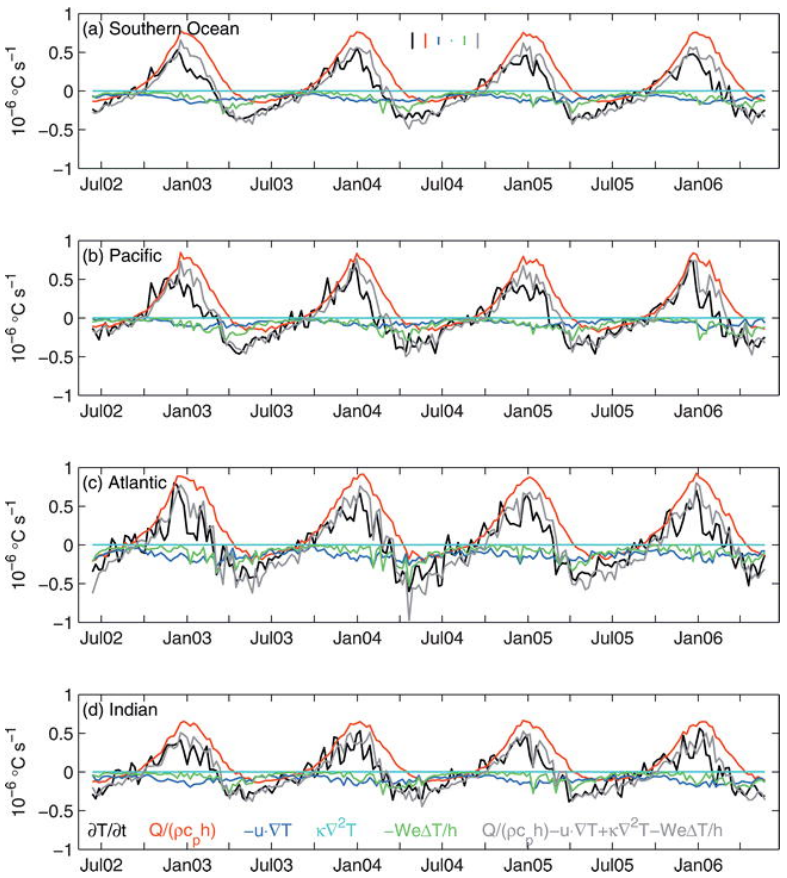
J. Climate, submitted

Sarah Gille: Defining the Upper Ocean Heat Budget



Dong et al., *J. Climate*, 2007

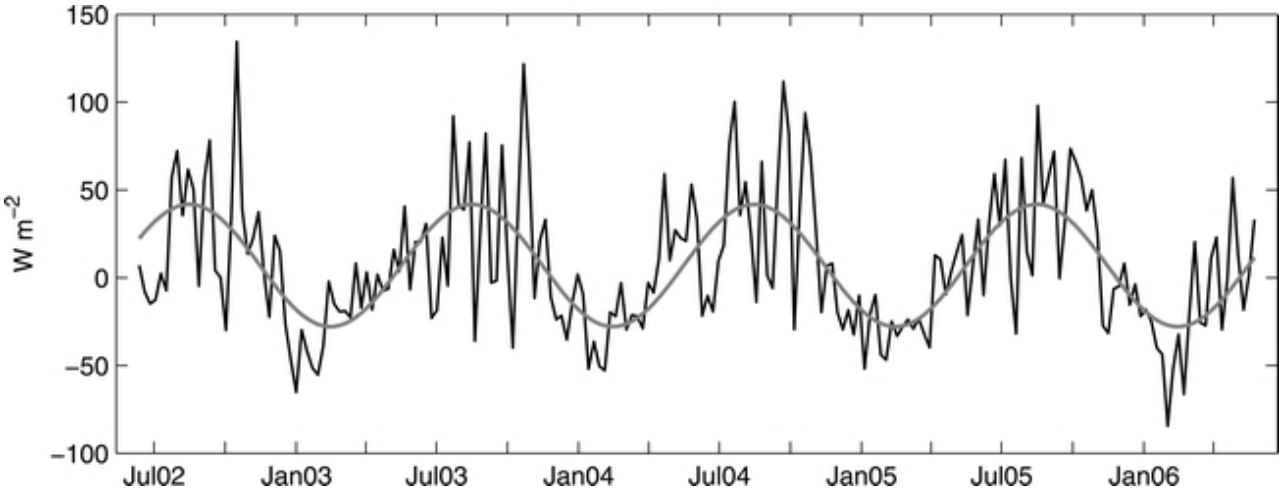
Sarah Gille: Southern Ocean Mean Budgets



- 40-60°S
- Heat flux is NCEP variables with COARE 3.0 algorithm
- Other heat fluxes tested—this is best option
- Globally, gray and black lines match within 2σ uncertainties

Dong et al., *J. Climate*, 2007

Sarah Gille: Domain-averaged imbalance



- With fitted annual cycle
- Implies improvements in domain-averaged heat flux of O(50 W m^{-2}) needed, especially for winter.

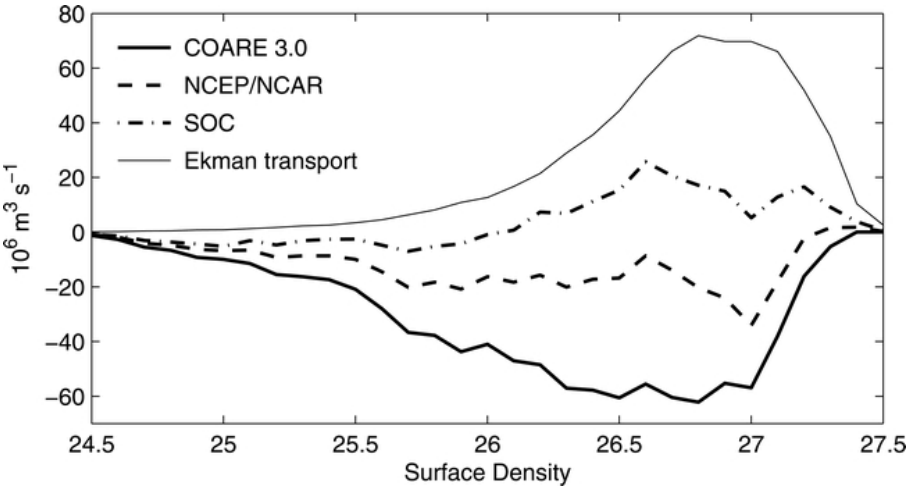
Dong et al., *J. Climate*, 2007

Sarah Gille: RMS Imbalances

rms(δ) ± 2 standard error	ΔT from Argo	
	10^{-7} °C s^{-1}	W m^{-2}
Base case	3.26 ± 0.12	127.8 ± 4.9
h_m from Argo (T)	3.37 ± 0.13	129.3 ± 4.9
De Boyer Montegut et al. (2004) h_m (T)	3.58 ± 0.14	118.5 ± 4.5
h_m of *WOA94* (ρ)	66.92 ± 2.55	216.5 ± 8.3
	6.78 ± 0.23*	207.2 ± 7.1*
h_m of *WOA94* (T)	377.28 ± 14.39	293.7 ± 11.2
	7.12 ± 0.24*	208.5 ± 7.2*
h_m from *WOA01* (ρ)	3.86 ± 0.15	220.3 ± 8.4
h_m from *WOA01* (T)	5.24 ± 0.20	186.8 ± 7.1
GRACE mean SSH	3.37 ± 0.12	131.1 ± 4.8
Rio05 mean SSH	3.36 ± 0.12	130.4 ± 4.8
κ = 2000 m^2 s^{-1}	3.27 ± 0.12	128.6 ± 4.9
NCEP–NCAR fluxes	3.76 ± 0.14	139.6 ± 5.2
	Flux climatologies defined as multiyear (10+) averages f	
SOC climatology	3.67 ± 0.13	142.0 ± 5.1
NCEP–NCAR climatology	3.35 ± 0.13	133.0 ± 5.0
NCEP II climatology	3.54 ± 0.14	133.6 ± 5.1
ECMWF climatology	3.47 ± 0.13	134.8 ± 5.1
COARE3.0 climatology	3.22 ± 0.12	126.8 ± 4.8

Dong et al., *J. Climate*, 2007; Base Case: NCEP COARE3, mixed-layer depth from Argo density

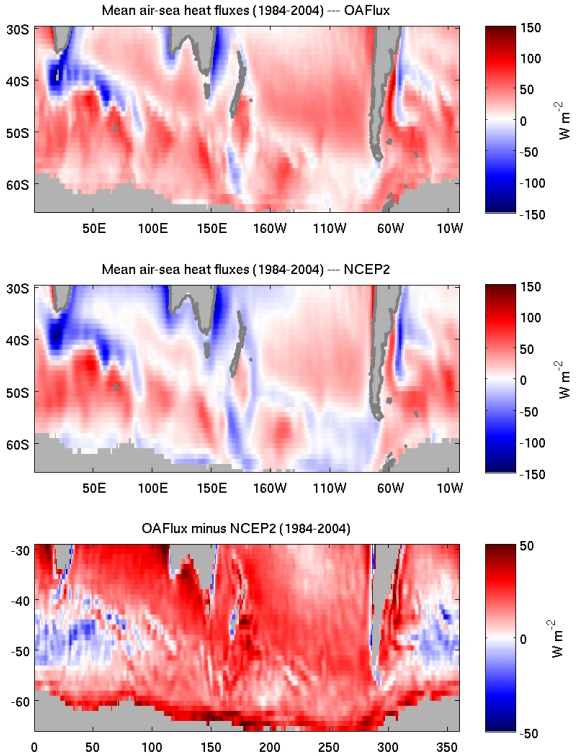
Sarah Gille: Water-mass transformation for Southern Ocean



- Simple concept suggests that upper ocean advection (Ekman transport) should balance heat flux.
- Closest match with NCEP variables and COARE 3.0 algorithm, but not perfect ....

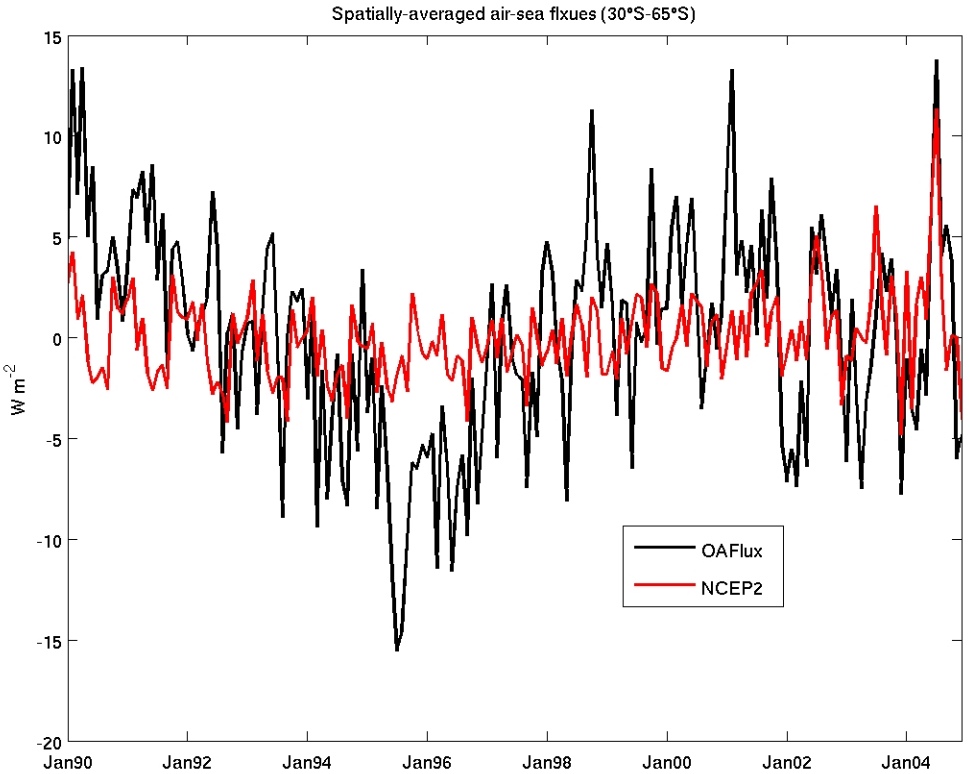
Dong et al., *J. Climate*, 2007

Sarah Gille: NCEP vs NOAA OAFlux (1990-2004)



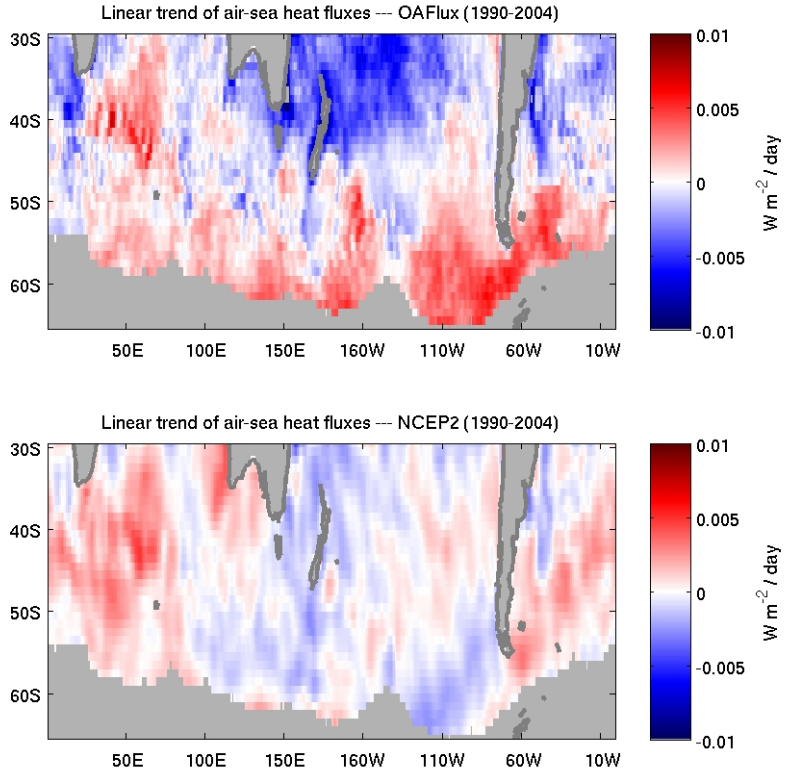
courtesy of Shenfu Dong

Sarah Gille: Interannual Variability



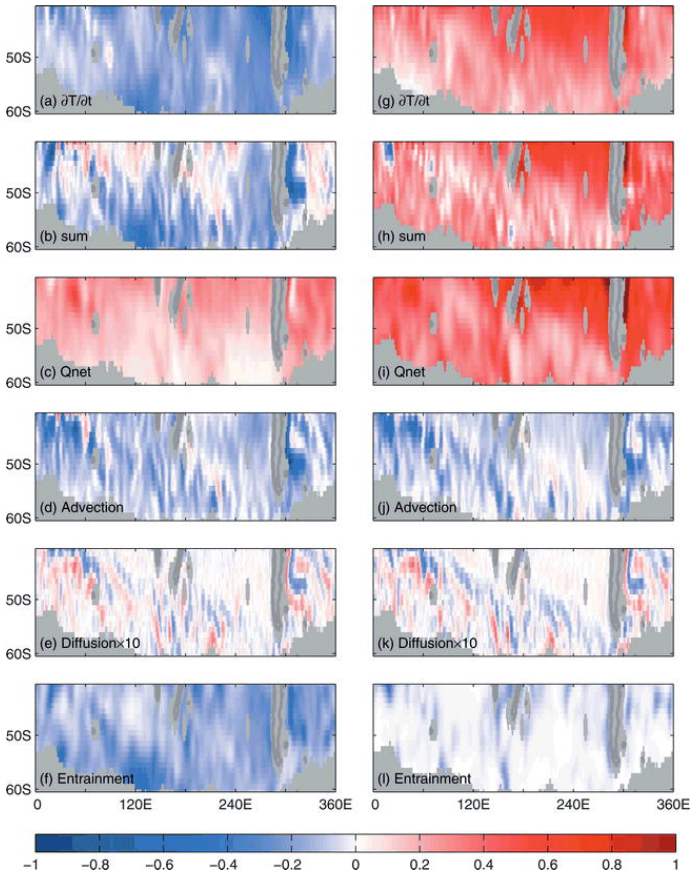
courtesy of Shenfu Dong

Sarah Gille: NCEP vs NOAA OAFlux: Trends



courtesy of Shenfu Dong

Sarah Gille: Regional Balance (March and Nov)



Dong et al., *J. Climate*, 2007

- Units: 10^{-6} °C s^{-1}
- Small-scale structure in T and advection not reflected in Q_{net}

Summary

- Problems largest in winter
- Accuracy requirements: at present there are questions about sign. Is O(10 W m^{-2}) a reasonable goal?
- Resolution: SST and advection features on scale of Rossby radius (i.e. 60 km or less); so ideally 0.25 to 0.5° resolution
- Temporal resolution: For heat budget, monthly is OK at moment; if spatial resolution improved, then weekly (or better) would be useful to match eddy feature propagation.
- Diurnal cycle smaller than tropics but detectable: upper ocean temperature amplitude O(0.02 to 0.04°C).