

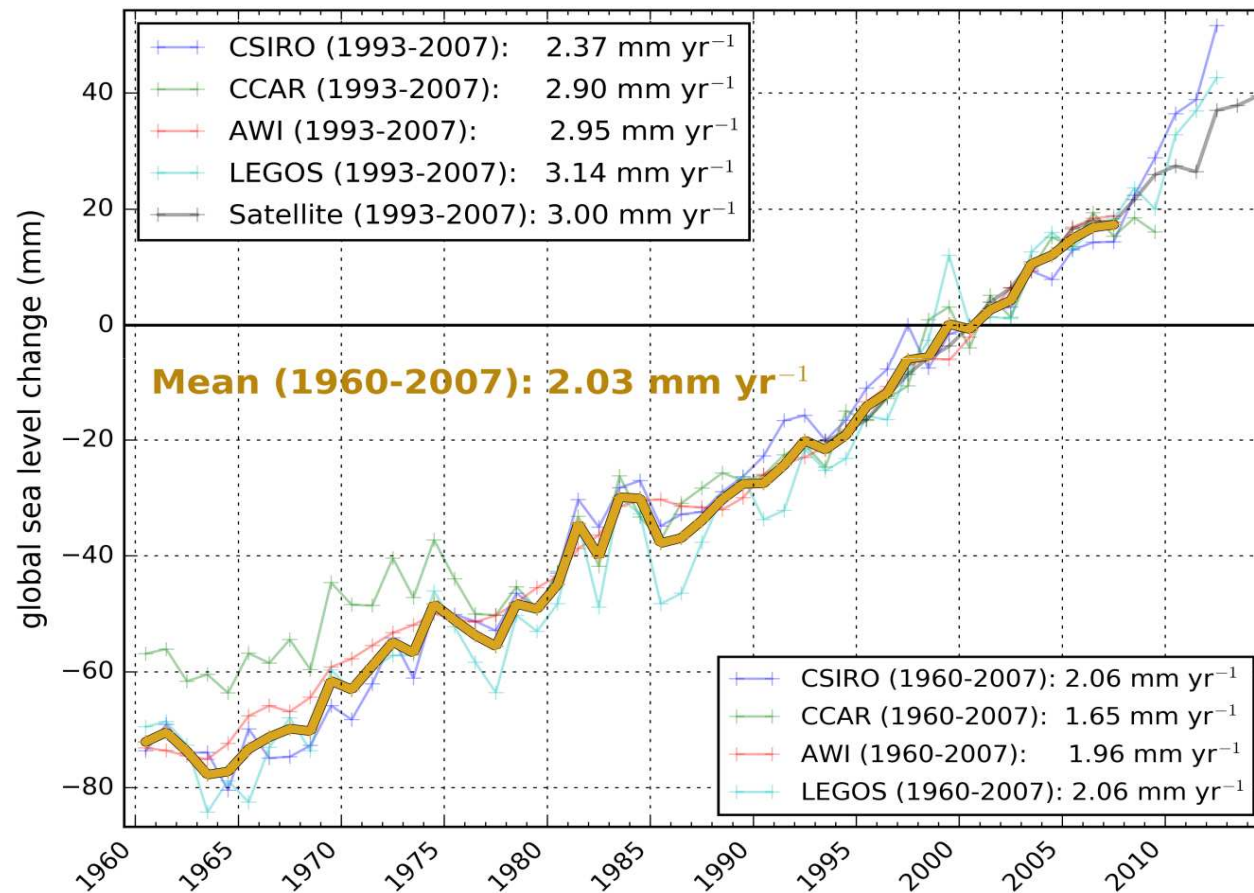
Tide Gauge Reconstructions

- Tide gauges (TG) are the only sea level data which are available for most of the time prior to satellite altimetry. Coastal, irregular, NH
- Tide gauge reconstructions (TGRs) attempt to fill in the open ocean by extending TG using open-ocean variability patterns from modern satellite data. The primary purpose of these reconstructions is usually to obtain improved estimates of the global mean sea level (GMSL).
- Reconstructions:
 - LEGOS, variability patterns in EOFs from altimetry and data assimilation products (Meyssignac et al. 2012)
 - CSIRO, variability patterns from altimetry in EOFs (Church et al. 2004)
 - CCAR, variability patterns from altimetry in cyclostationary EOFs (Hamlington et al. 2011)
 - AWI, neural networks trained from altimetric data for filling data; fitting tide gauges to altimetric patterns (reverse fit) (Wenzel & Schröter 2010, 2014)

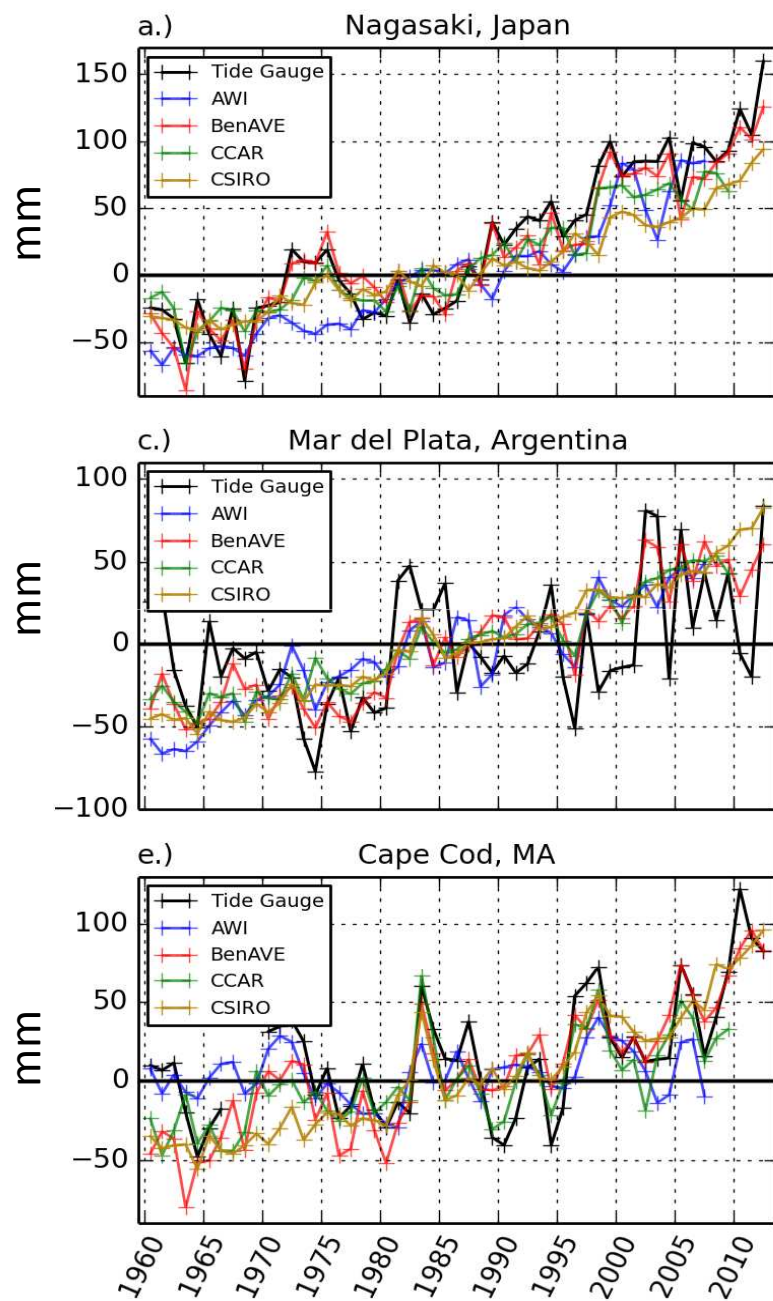
Tide gauge processing

- Minimal; aim to have a neutral set wrt TGR
- IB correction was made
- Annually averaged, GIA (2004 Peltier ice history) removed
- Gaps less than two years' long were filled with climatology + simple linear interpolation
- Gauges were only kept which had 32+ yrs of data between 1960–2007

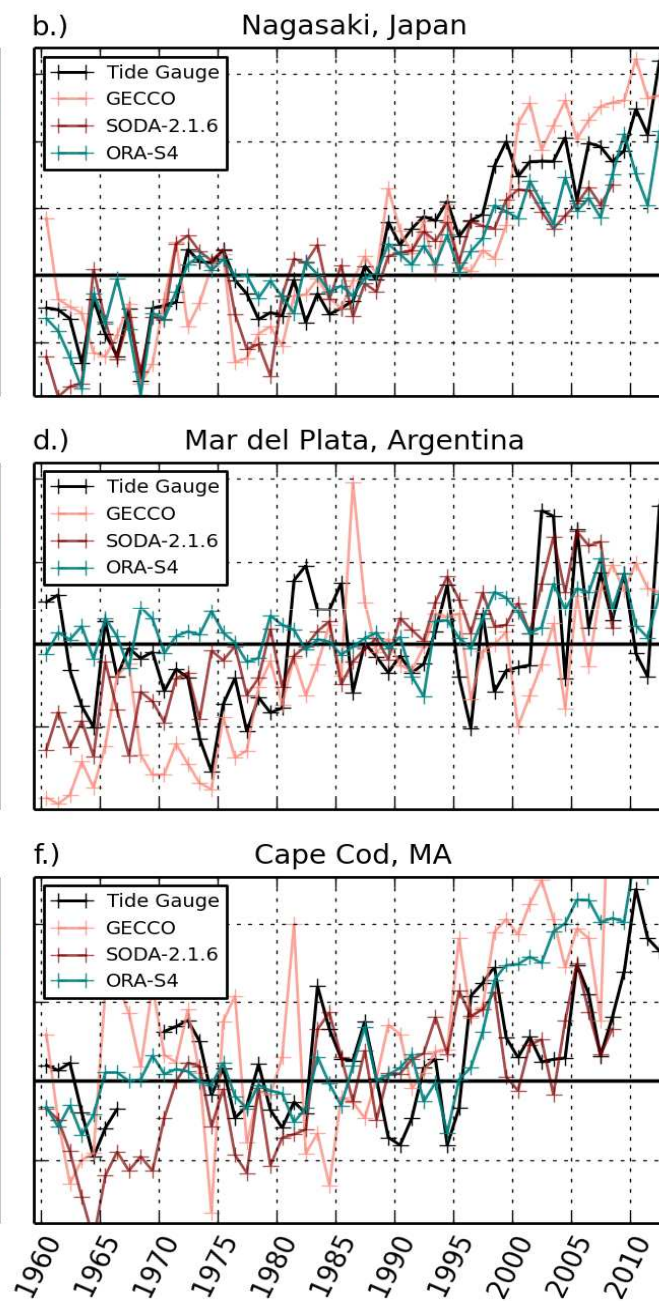
Global mean sea level from tide gauge reconstructions



Tide gauge reconstructions

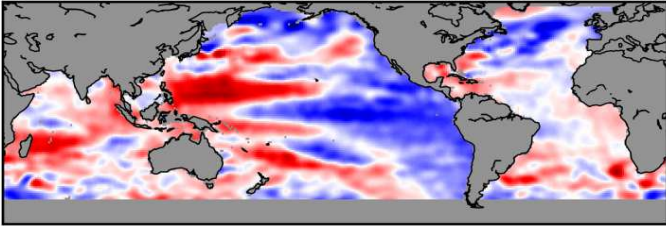


Ocean data assimilations

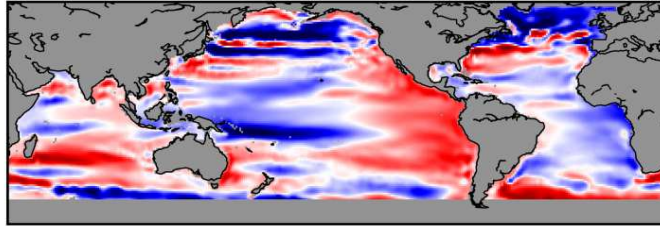


Trends, 1960-1992

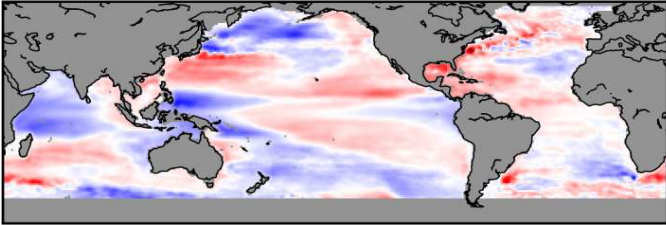
a.) AWI



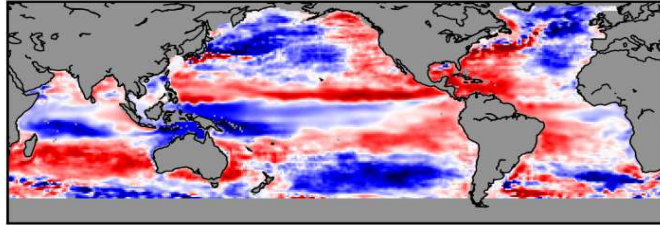
e.) GECCO2



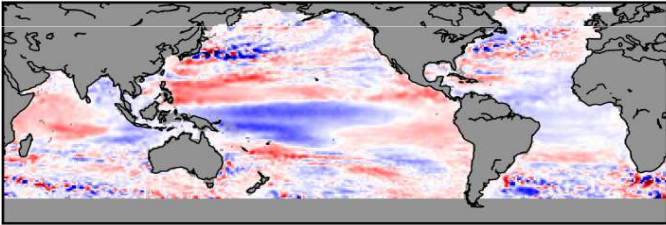
b.) LEGOS



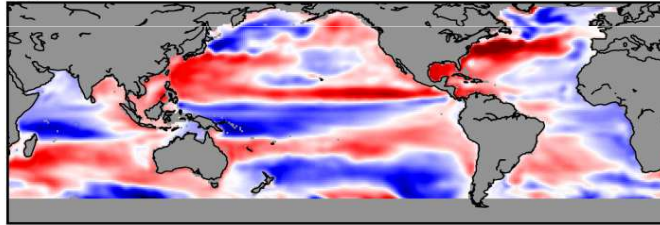
f.) SODA-2.1.6



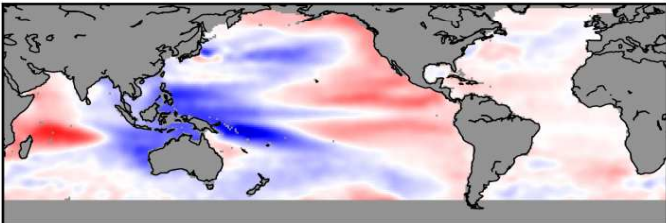
c.) CCAR



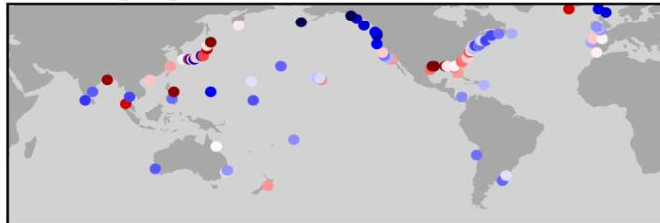
g.) ORA-S4



d.) CSIRO



h.) Tide gauges



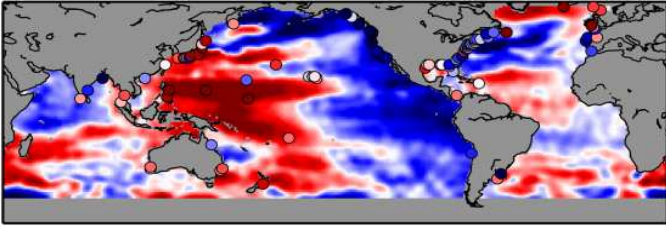
Annual data; the global mean of each product has been removed from each grid box

Removed mean GMSL from each station

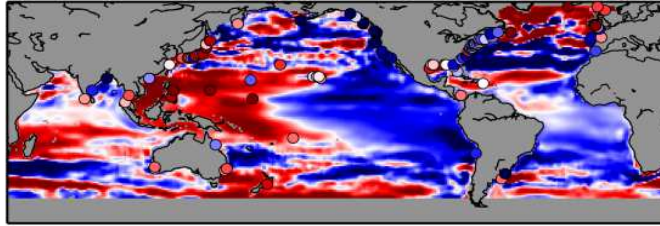


Trends, 1993-2007

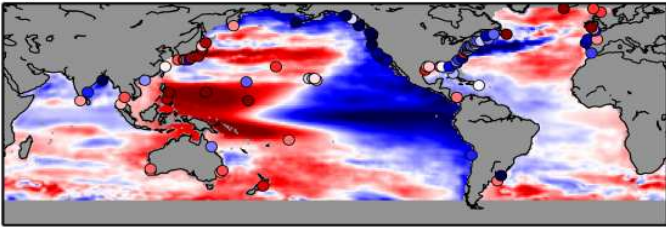
a.) AWI-SSH



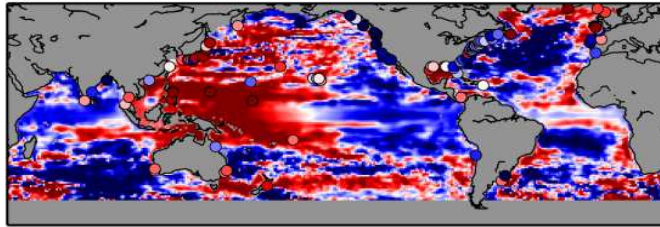
e.) GECCO2



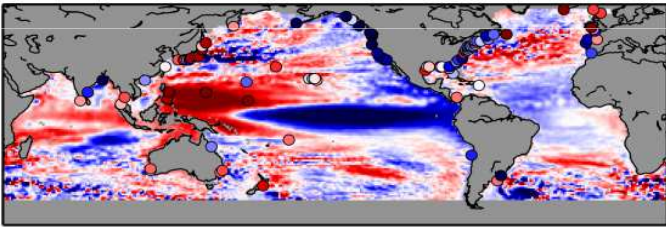
b.) LEGOS



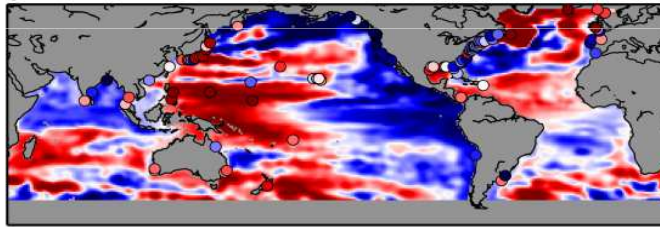
f.) SODA216



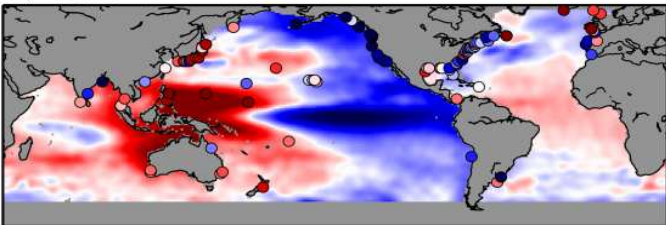
c.) CCAR



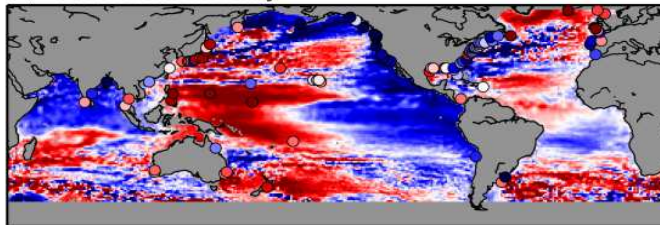
g.) ORA-S4



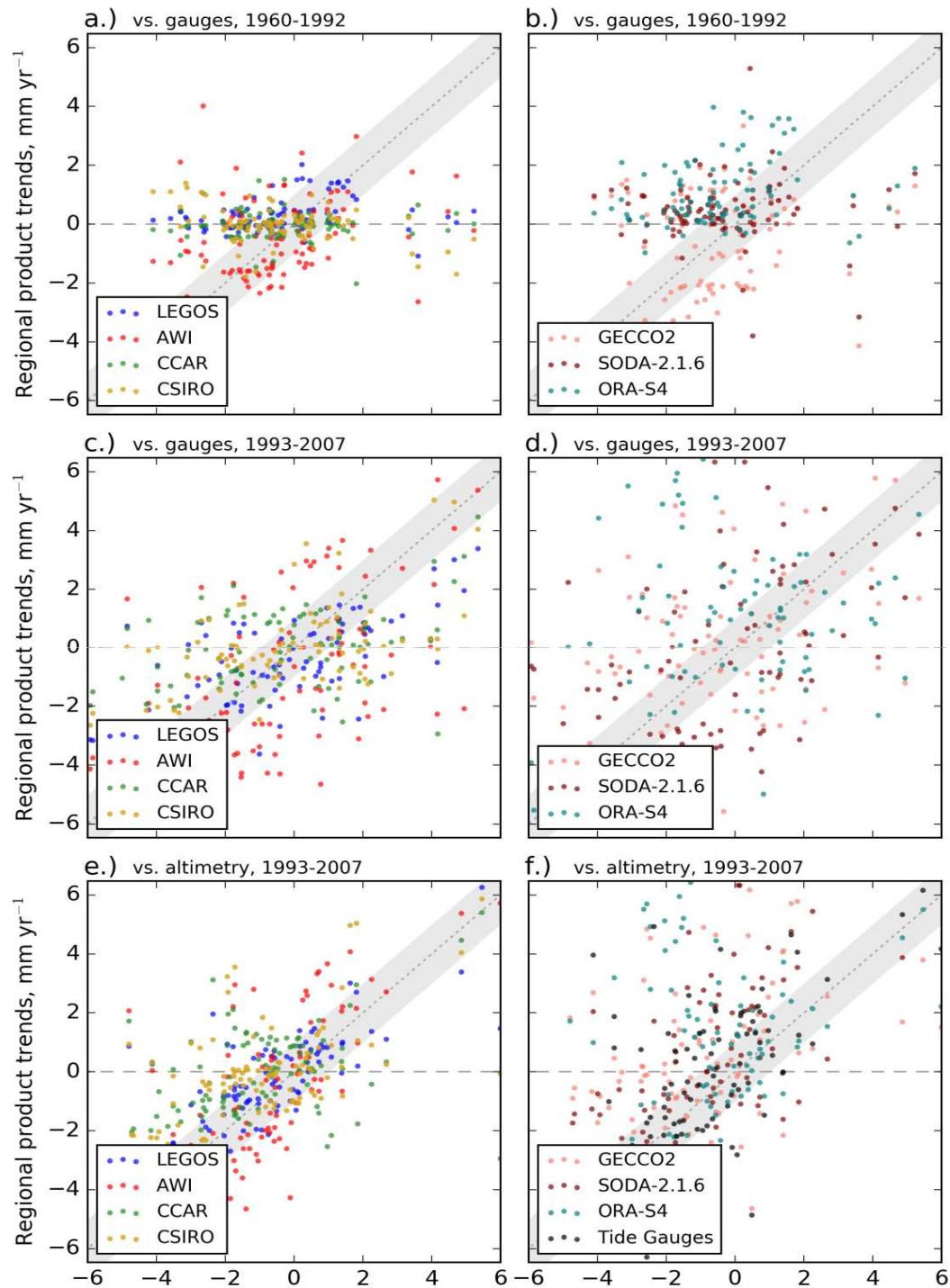
d.) CSIRO



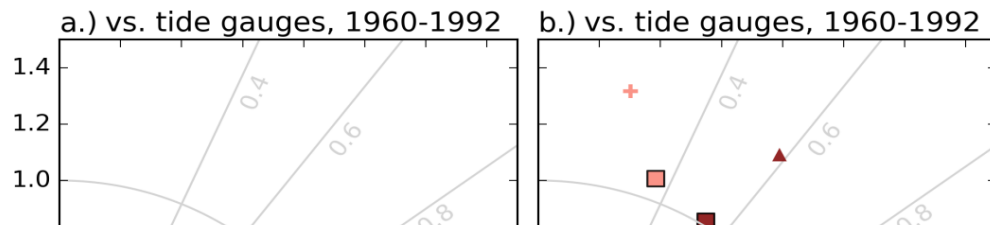
h.) Satellite altimetry



Annual data; the global mean of each product has been removed from each grid box

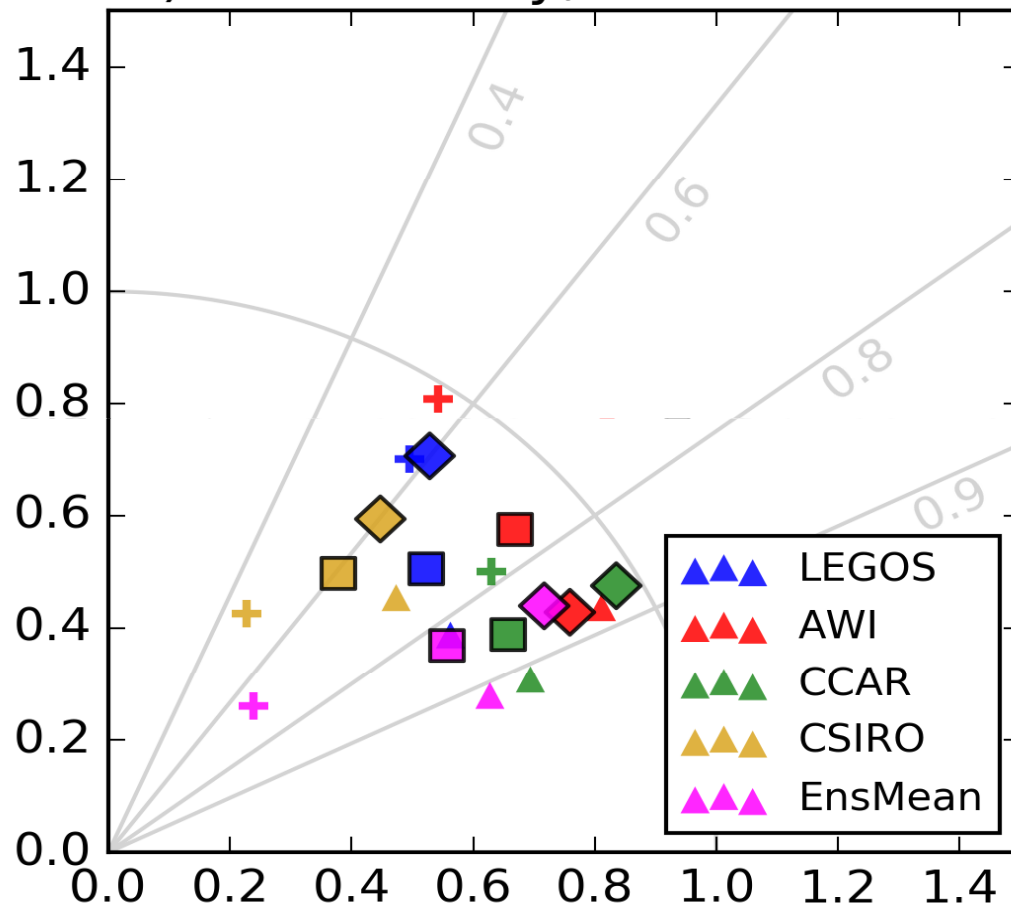


Product regional trend on the y-axis;
the tide gauge trend magnitude on the
x-axis

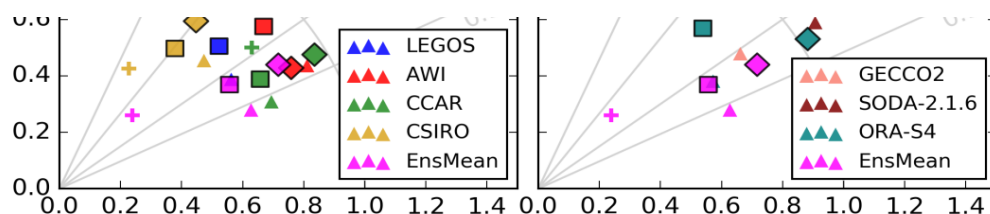
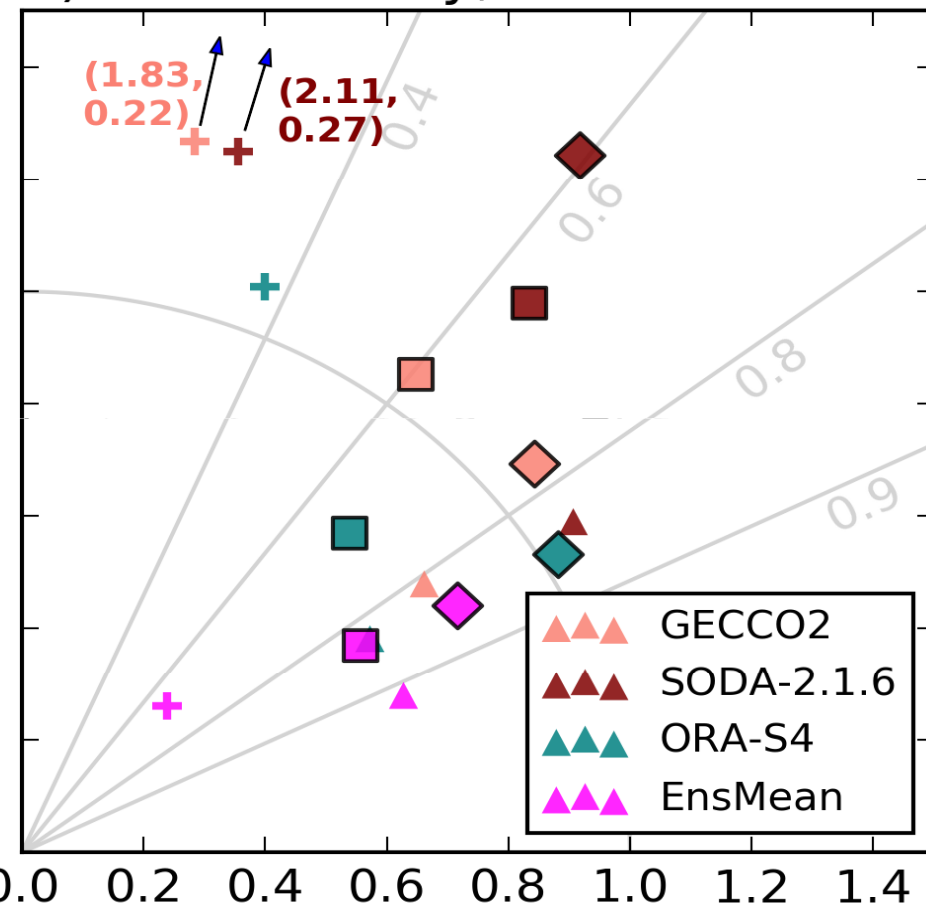


- Locally detrended, and a running 5-yr mean calculated with a Hanning window to beat

e.) vs. altimetry, 1993-2007



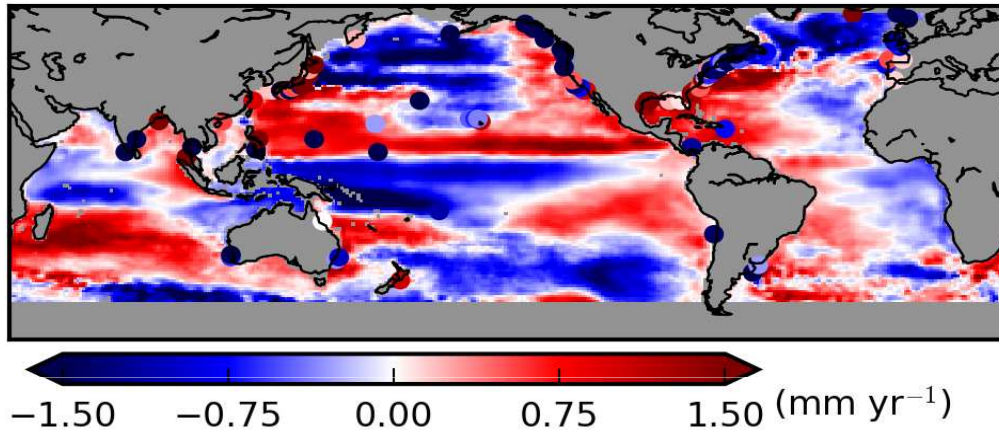
f.) vs. altimetry, 1993-2007



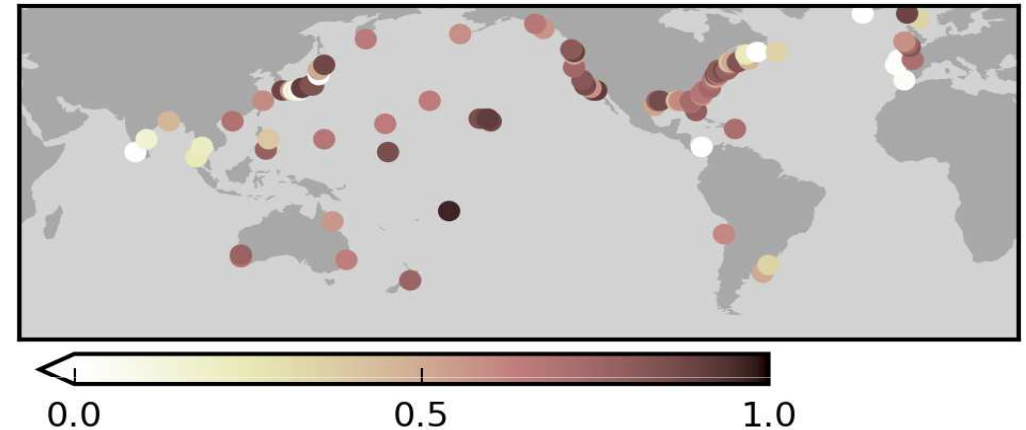
(diamonds) than to just TG locations.

Ensemble mean trends and correlation

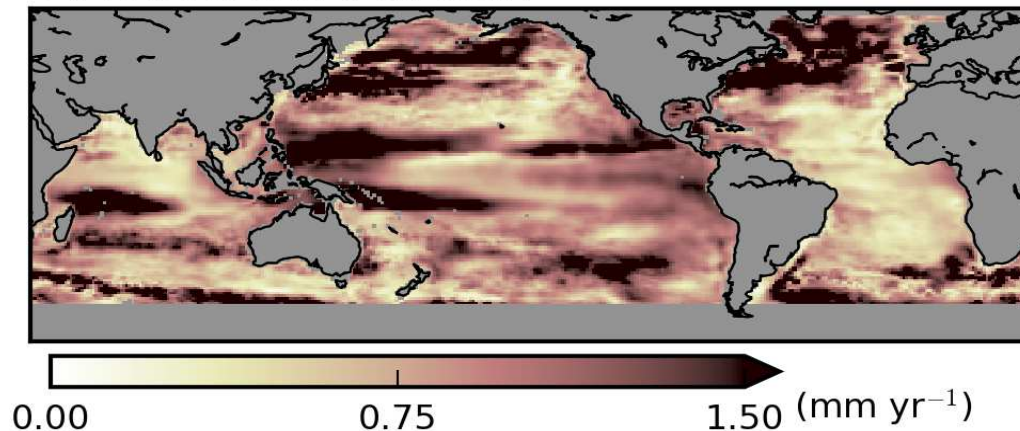
a.) Ens. mean trends, 1960-1992



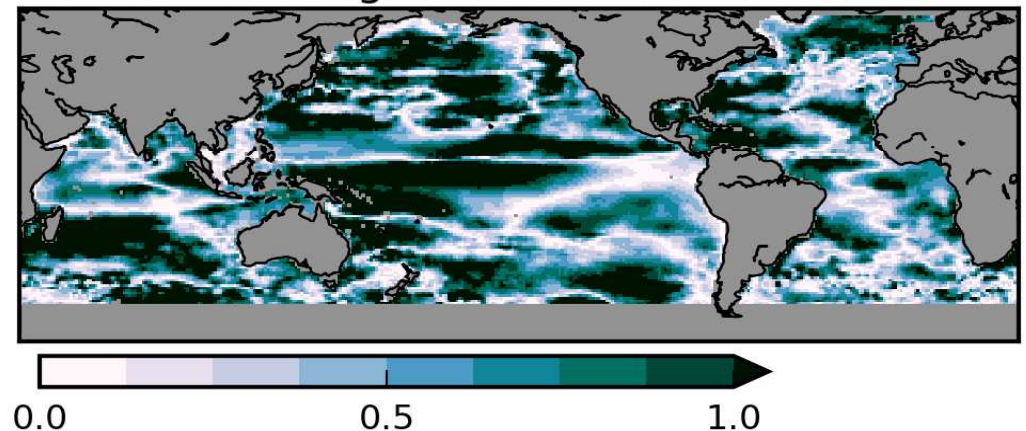
c.) Ens. mean correl. with TG (1960-1992)



b.) Ens. trend std. dev.



d.) Ensemble signal-to-noise (90% CL)

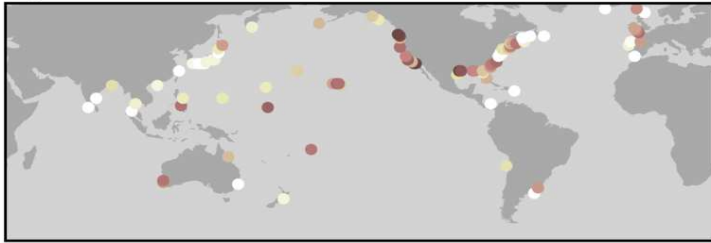


Discussion

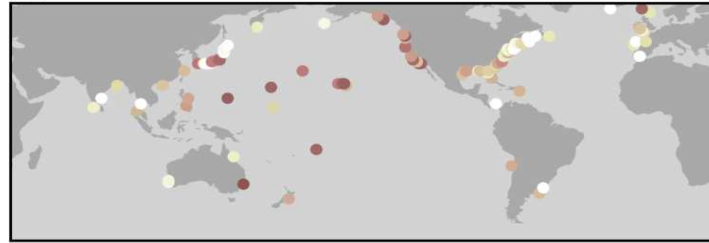
- TGR regional trends over the period 1960-1992 do not match tide gauges particularly well, nor each other.
- Low-frequency variability in the Atlantic is poorly reproduced over the long period (1960-92)
- Improvements in vertical land motion estimates may help trends
- Ensemble mean of all products performs okay in these metrics, but there's no good way to verify it in the pre-altimetry open ocean

Correlation with tide gauges

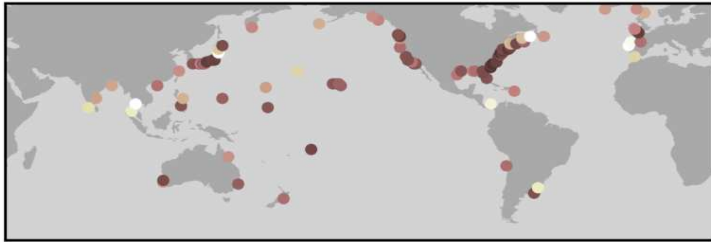
a.) AWI



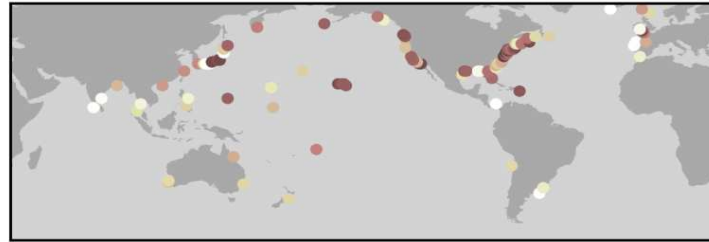
e.) GECCO2



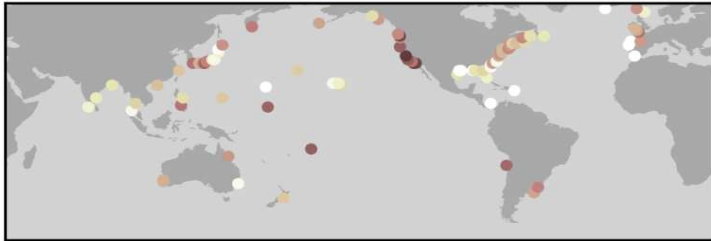
b.) LEGOS



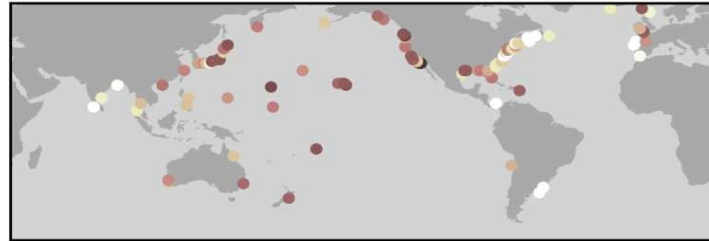
f.) SODA-2.1.6



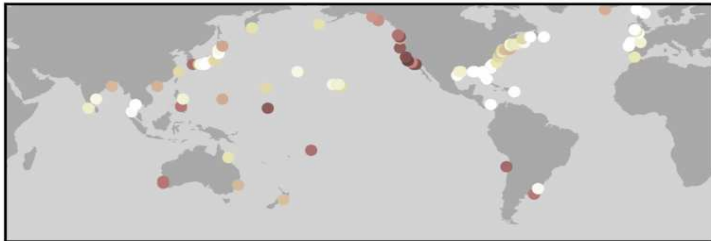
c.) CCAR



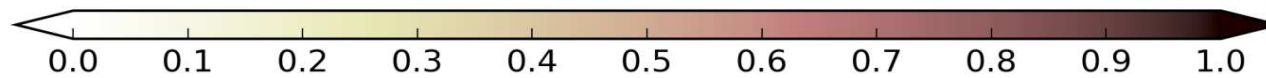
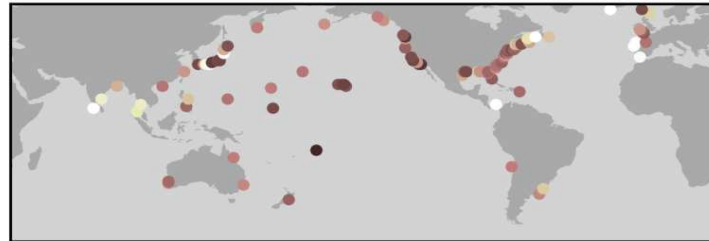
g.) ORA-S4



d.) CSIRO



h.) Ensemble mean



Mean correlations between products, global

	GECCO2	SODA	ORA	AWI	LEGOS	CCAR
GECCO2						
SODA	0,47					
ORA	0,59	0,61				
AWI	0,36	0,30	0,38			
LEGOS	0,45	0,46	0,53	0,35		
CCAR	0,38	0,35	0,43	0,43	0,48	
CSIRO	0,36	0,33	0,41	0,43	0,55	0,54

Mean correlations between products, N. Pac.

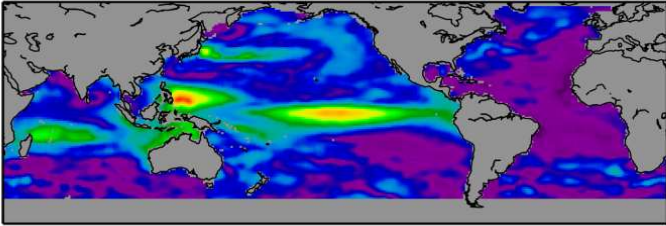
	GECCO2	SODA	ORA	AWI	LEGOS	CCAR
GECCO2						
SODA	0,61					
ORA	0,69	0,75				
AWI	0,44	0,43	0,49			
LEGOS	0,60	0,57	0,65	0,52		
CCAR	0,53	0,50	0,58	0,54	0,63	
CSIRO	0,52	0,51	0,58	0,57	0,71	0,67

Mean correlations between products, N. Atl.

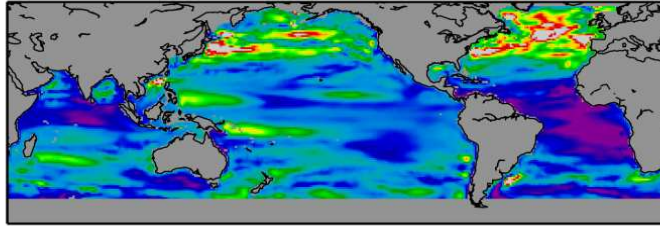
	GECCO2	SODA	ORA	AWI	LEGOS	CCAR
GECCO2						
SODA	0,32					
ORA	0,40	0,45				
AWI	0,28	0,22	0,29			
LEGOS	0,22	0,32	0,36	0,12		
CCAR	0,10	0,17	0,17	0,29	0,12	
CSIRO	0,02	0,05	0,00	0,09	0,09	0,12

Interdecadal variability

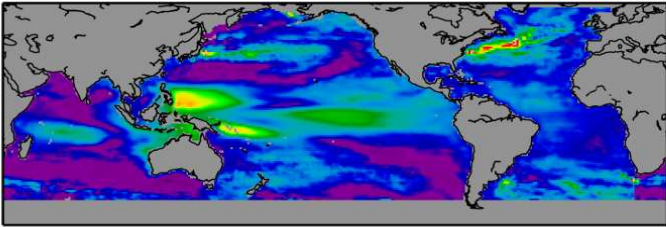
a.) AWI-SSH



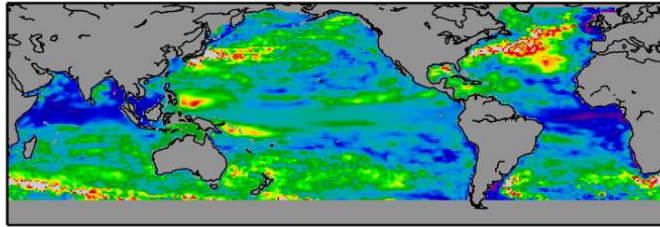
e.) GECCO2



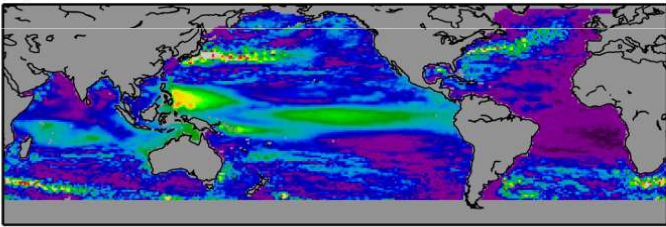
b.) LEGOS



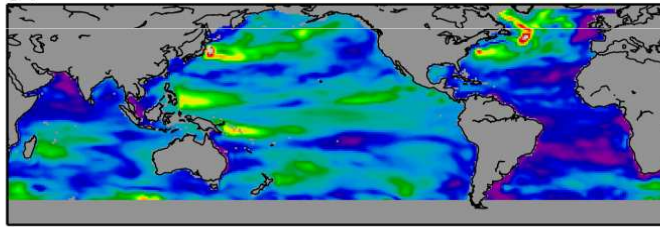
f.) SODA216



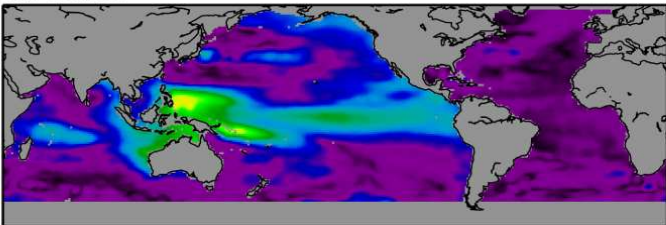
c.) CCAR



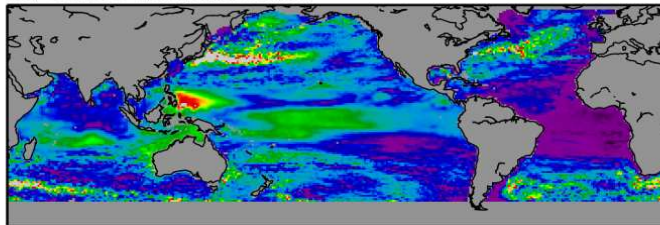
g.) ORA-S4



d.) CSIRO



h.) AVISO (Satellite obs)



Running 7-yr mean,
calculated with a Hanning
window to beat down
interannual variability

Satellite data limited to
only 22 years of obs

