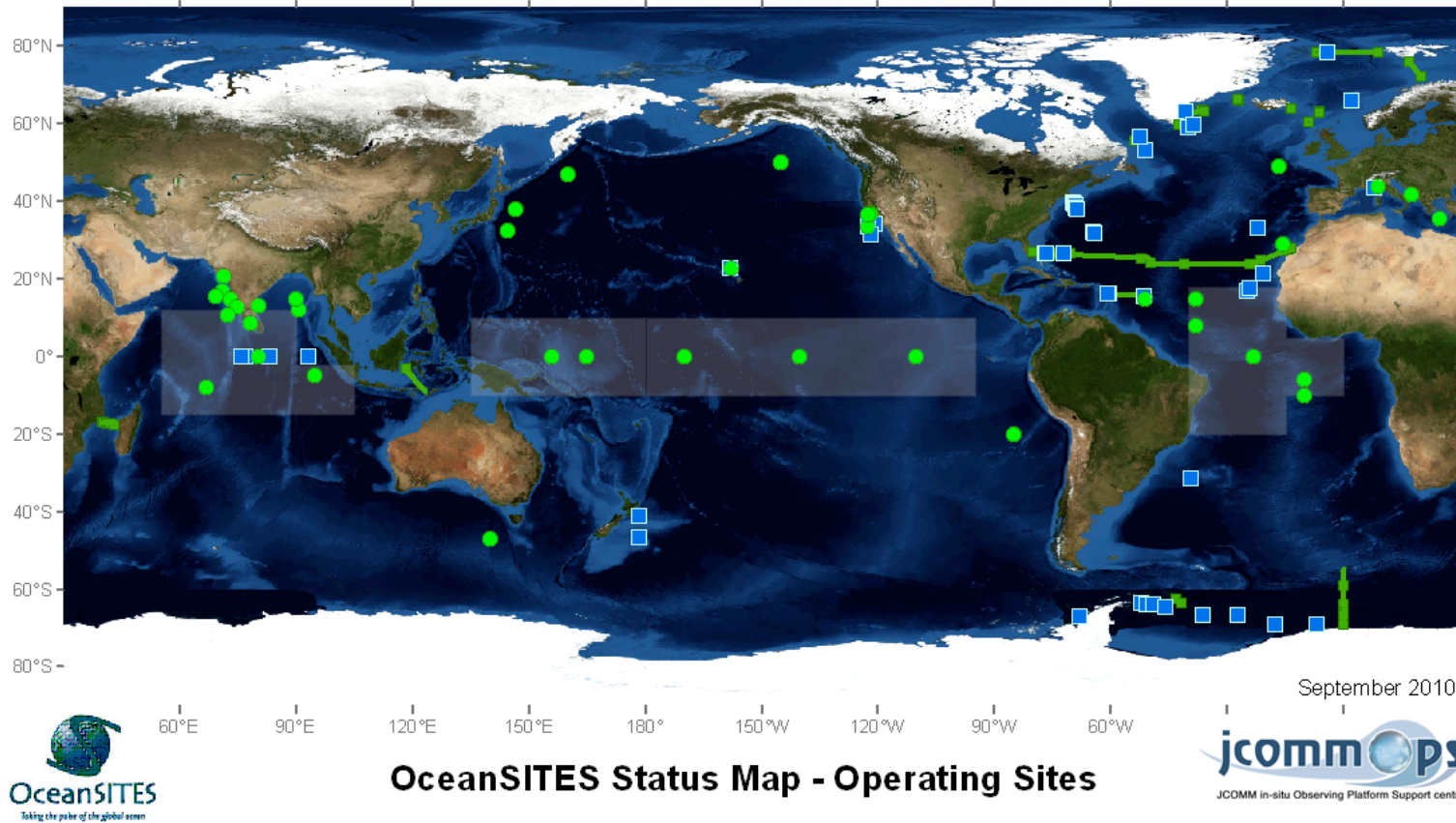
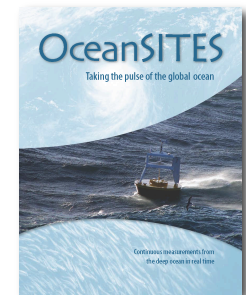


Ocean Reference Stations

<http://www.oceansites.org/>



OceanSITES Moorings and Observatories (89) Transport sites (16)

● OPERATING Real Time Data (42)

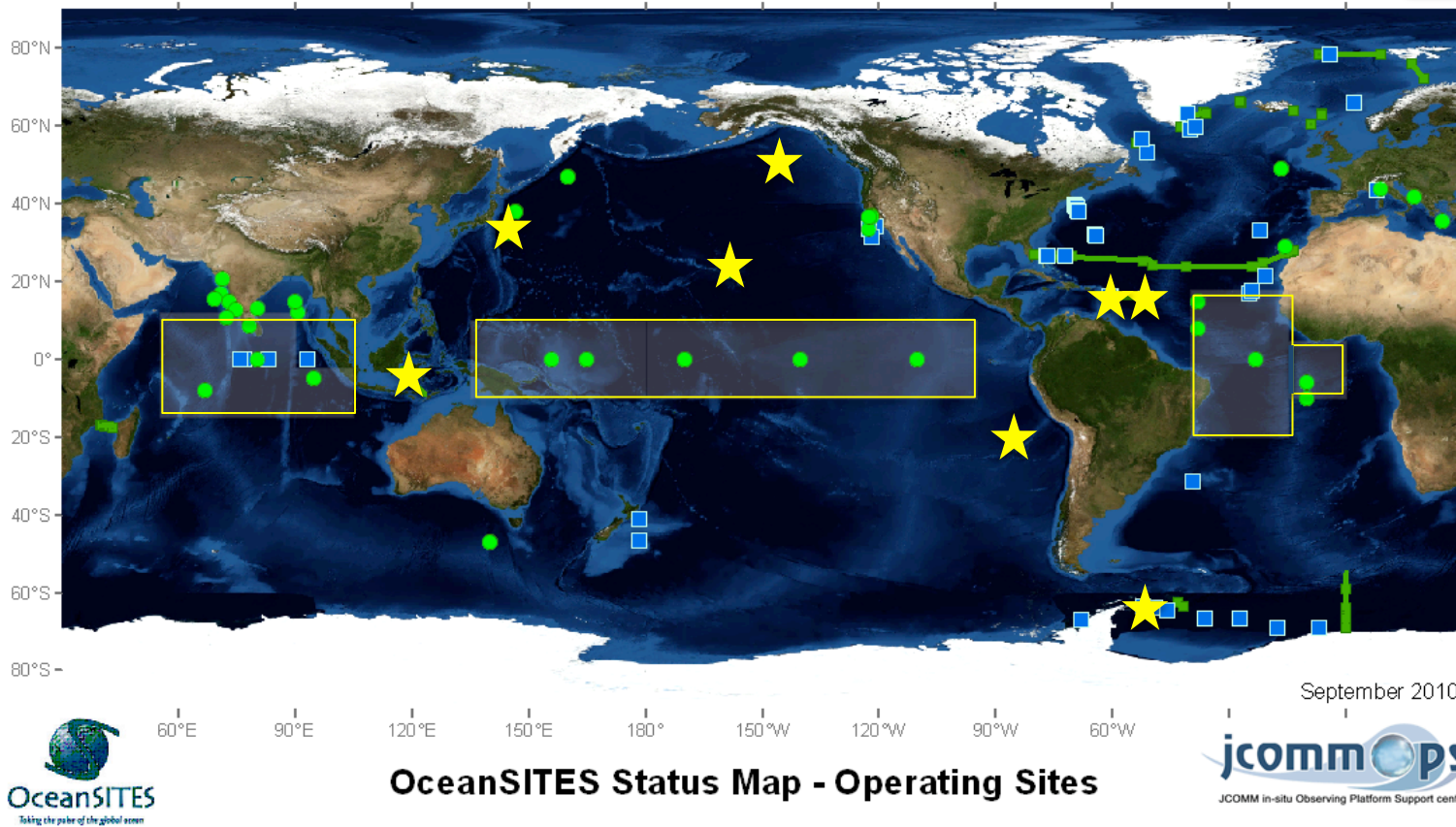
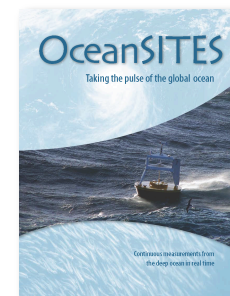
■ OPERATING Delayed Mode Data (47)

— OPERATING

■ Transport Stations

★ NOAA funded Ocean Reference Stations

<http://www.oceansites.org/>



OceanSITES Moorings and Observatories (89) Transport sites (16)

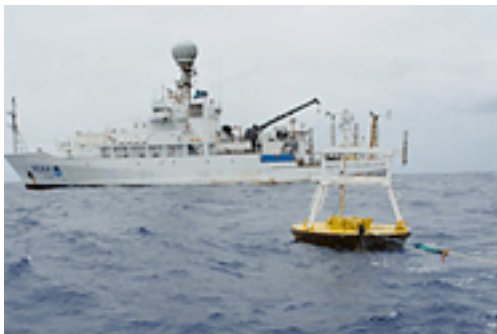
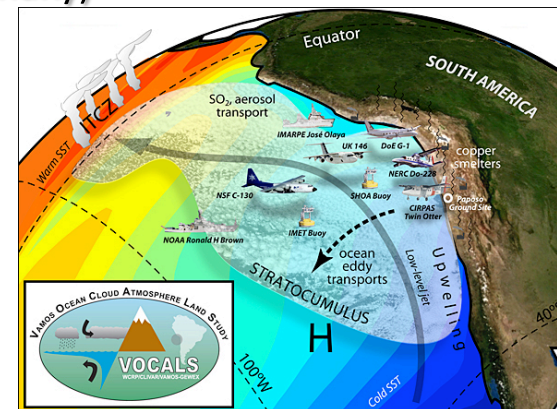
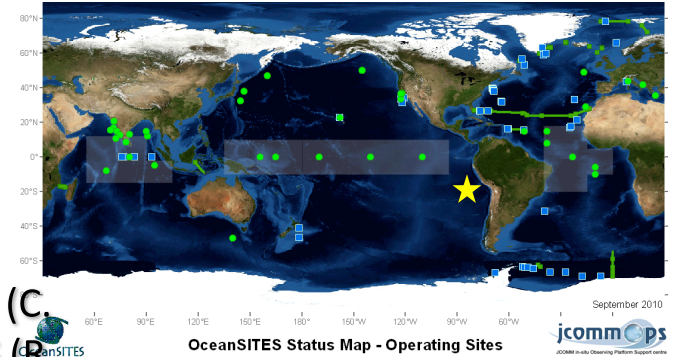
- OPERATING Real Time Data (42)
- OPERATING Delayed Mode Data (47)
- OPERATING
- Transport Stations

Stratus Ocean Reference Station

Bob Weller

Woods Hole Oceanographic Institution

Partners: Fluxes (C. Fairall); Carbon (Sabine), waves (NDBC); EPIC2001 (C. Bretherton, M. Cronin); Chile (SHOA, U. Chile, U. Concepcion); VOCALS (R. Wood, F. Straneo, T. Farrar...); Oxygen (L. Stramma, Germany)

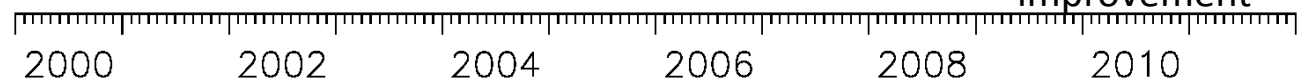


EPIC-2001: show uniqueness and climate impact of Chilean Stratus deck region

Stratus ORS: first accurate fluxes, identify model biases, ocean budget points to cooling and freshening processes

VOCALS: CLIVAR process study, model improvement, role of eddies

Stratus ORS: multi-disciplinary climate site; model validation and improvement



Stratus

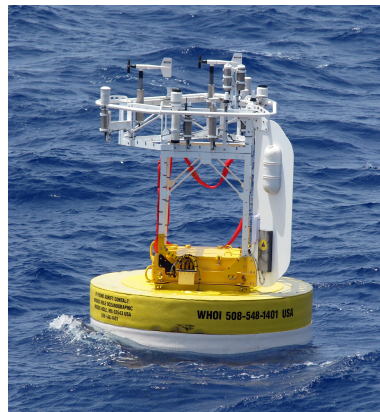
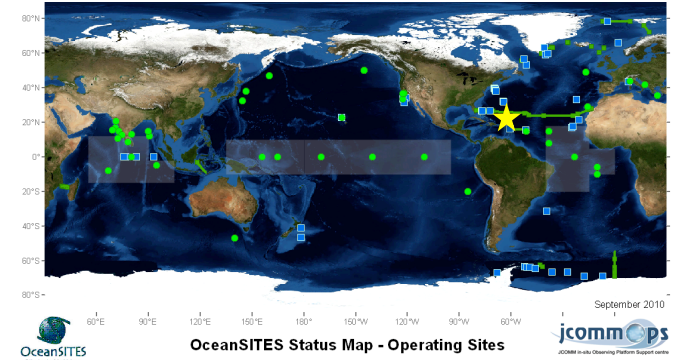


Northwest Tropical Atlantic ORS

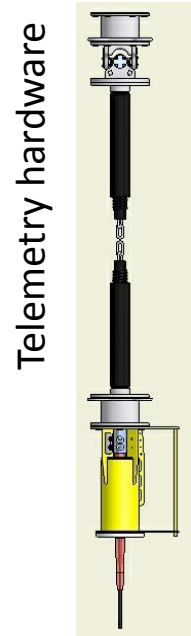
Al Plueddemann

Woods Hole Oceanographic Institution

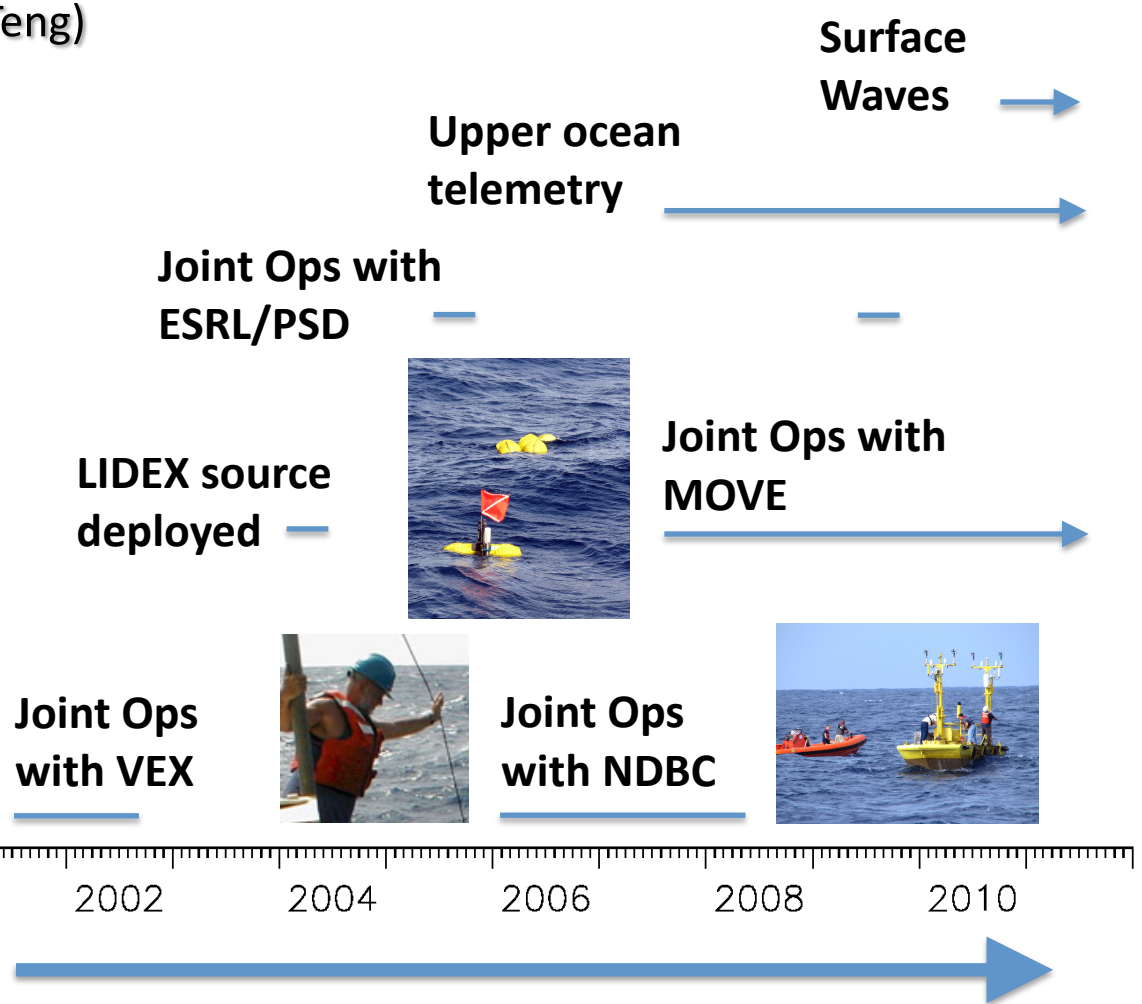
Partners: **MOVE** (U. Send), **ESRL/PSD** (C. Fairall, J. Hare),
NDBC (Chung-Chu Teng)



NTAS



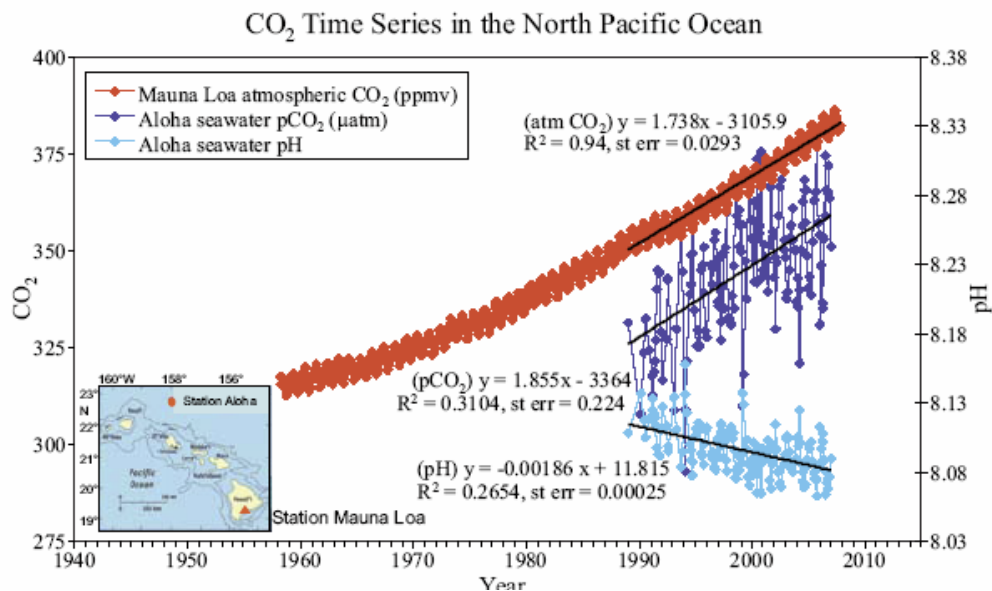
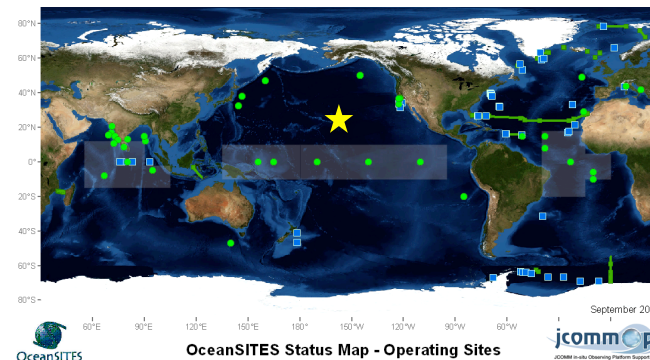
Telemetry hardware



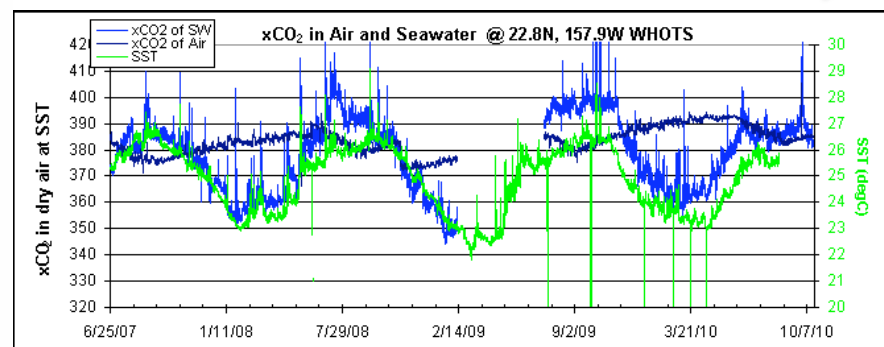
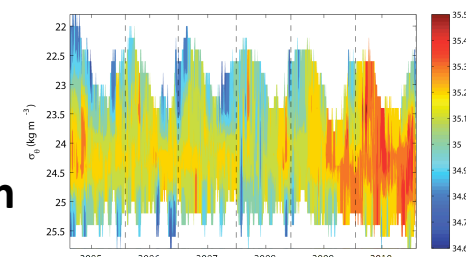
WHOI Hawaii Ocean Time-series ORS

Bob Weller, Al Plueddemann
Woods Hole Oceanographic Institution

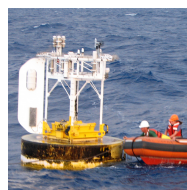
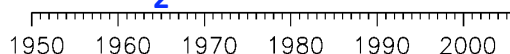
Partners: Hawaii Ocean Time-series (R. Lukas, M. Church, D.Karl, J. Dore, M. Landry, R. Letelier, R. Bidigare)
PMEL Carbon Group (C. Sabine)



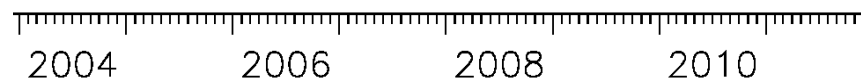
Upper ocean T/S trends



Mauna Loa context: CO₂ since 1958



CO₂ Time-series: Mauna Loa, HOT and WHOTS

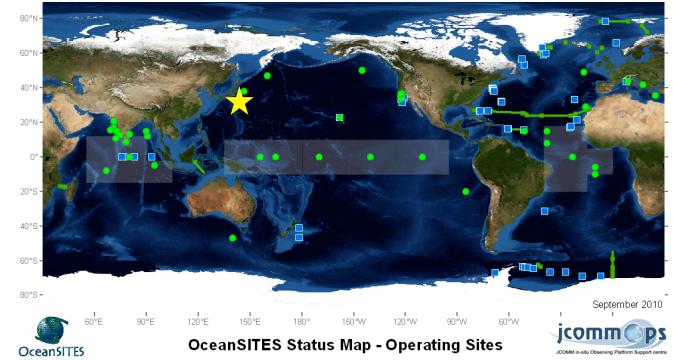


WHOTS

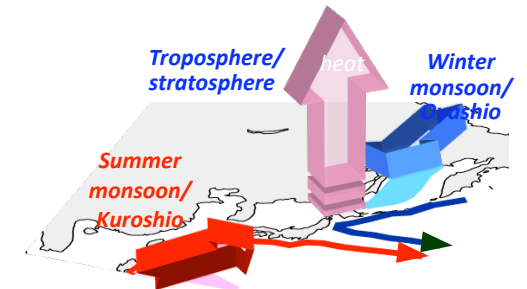
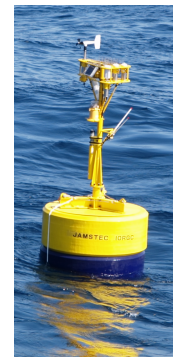
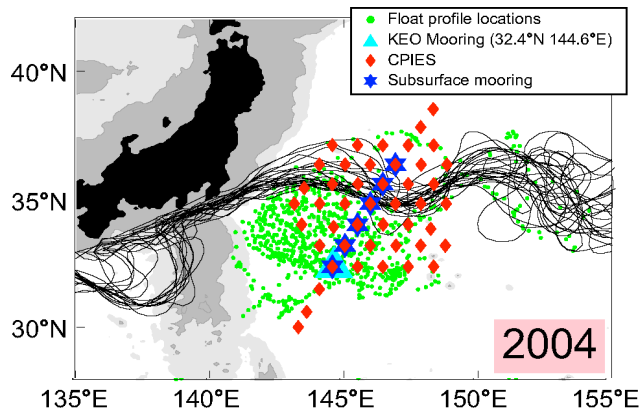


Kuroshio Extension Observatory (KEO)

Meghan Cronin, Chris Meinig & Chris Sabine
NOAA Pacific Marine Environmental Laboratory



Partners: JKEO (Y. Kawai, H. Ichikawa, M. Konda, H. Tomita),
KESS (N. Bond, L. Rainville, S. Jayne, T. Farrar, S.-P Xie...),
Hotspot (H. Nakamura,...)

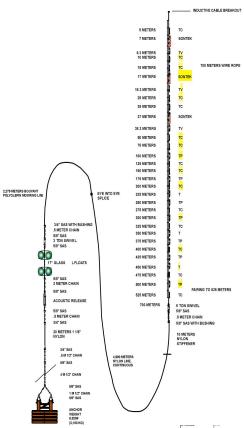
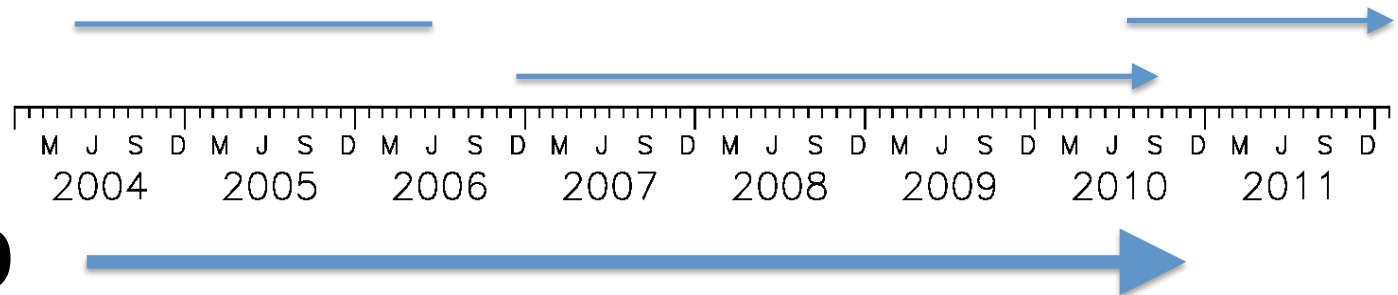


Hot-Spot: A new Japanese Air-Sea Interaction Exp't

Kuroshio Extension System Study (KESS)

JAMSTEC-KEO

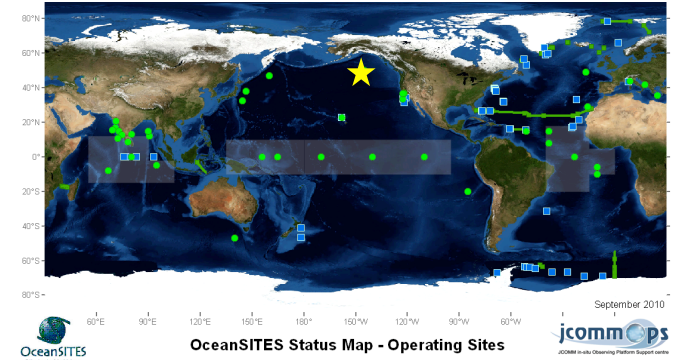
KEO



Ocean Climate Station Papa

Meghan Cronin, Chris Meinig & Chris Sabine
NOAA Pacific Marine Environmental Laboratory

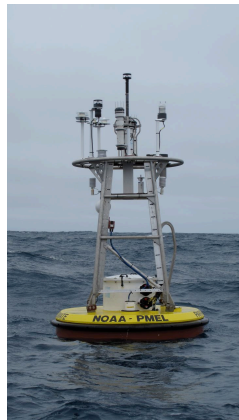
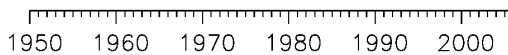
Partners: P-Line Program (M. Robert), **Carbon Cycle, pH** (S. Emerson), **glider** (C. Erickson), **Waves** (E. D'Asaro, J. Thomson, R. Harcourt), **ADCP** (M. Alford, J. Klymak), **NSF OOI** (U. Send)



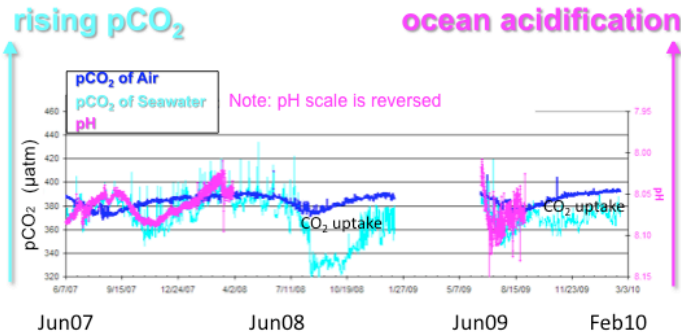
Canadian DFO P-Line Program



Ocean Weather Ship P

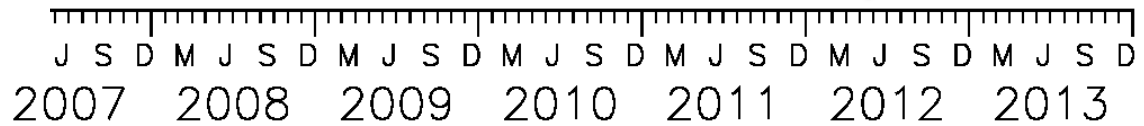


Papa



NSF Carbon Cycle

NSF Wave Mooring



NSF OOI Global Node

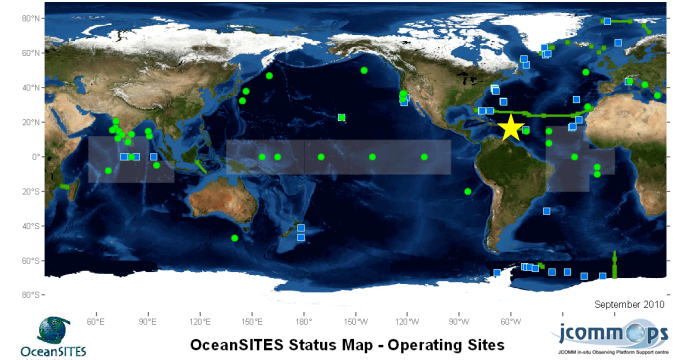
MOVE ORS

(Meridional Overturning Variability Experiment)

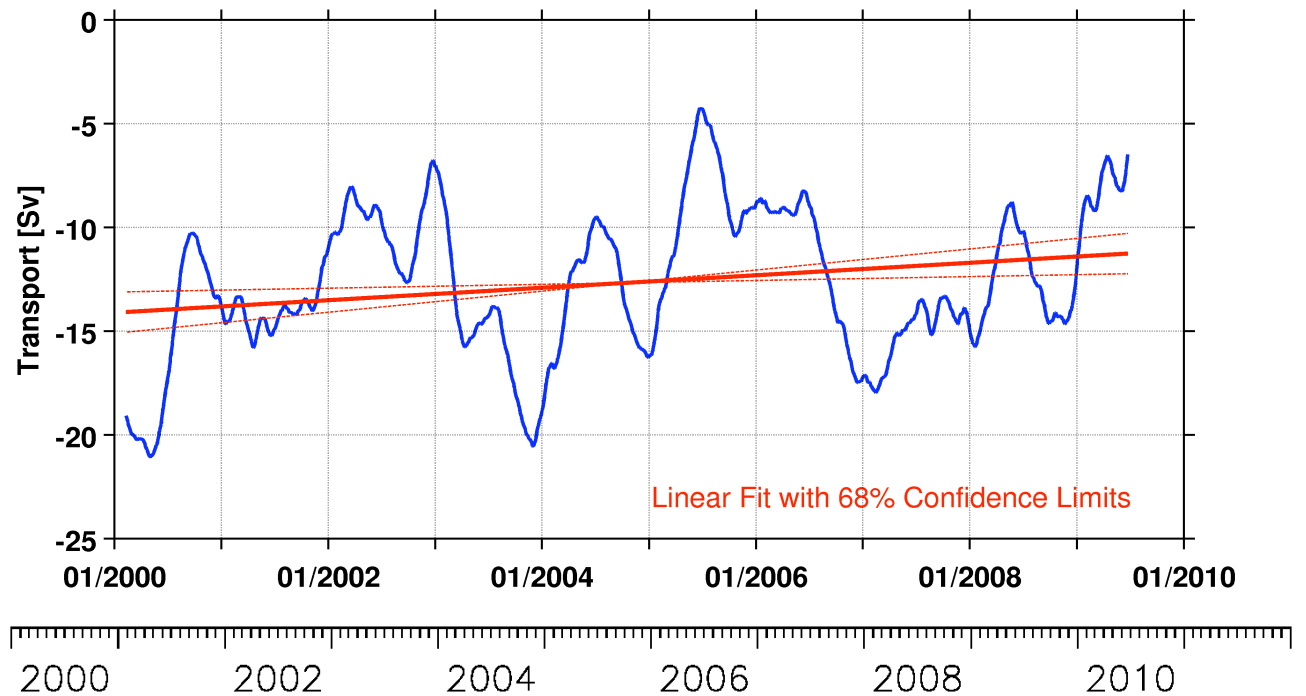
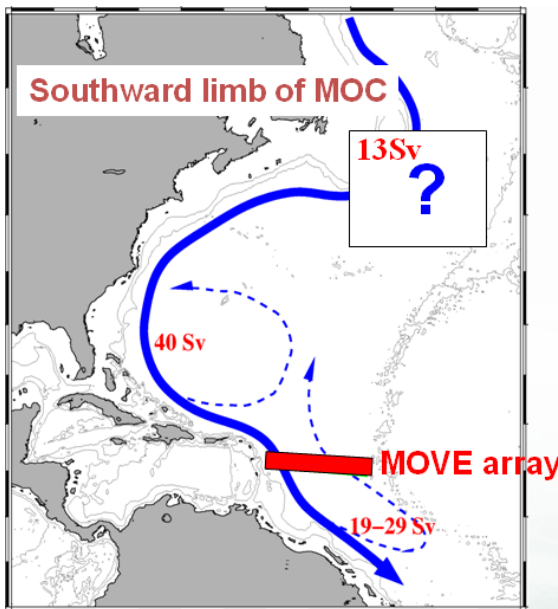
Uwe Send

Scripps Institution of Oceanography

Partners: NTAS (A.Plueddemann), IfM-Geomar



Captures transport of the southward branch of the AMOC, i.e. the NADW.
3Sv weakening observed over 10 years, 87% significant.



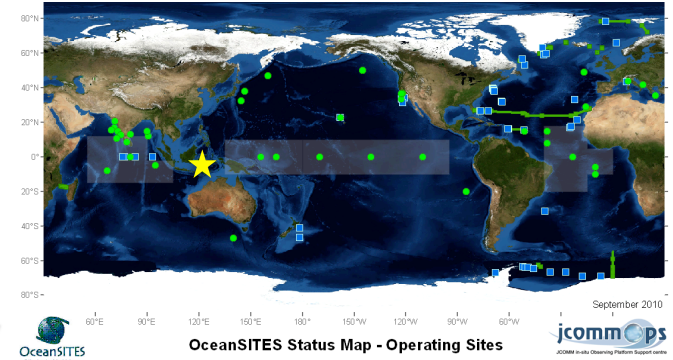
MOVE



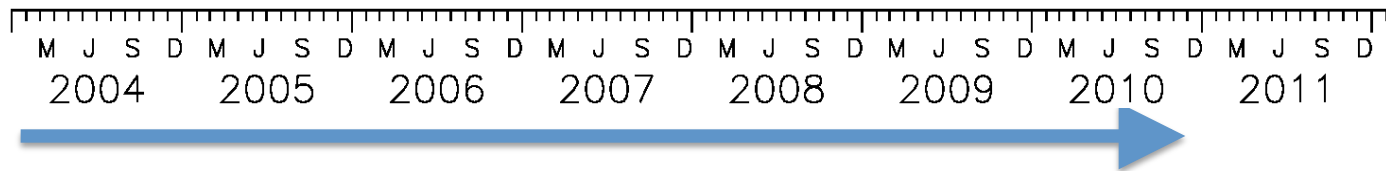
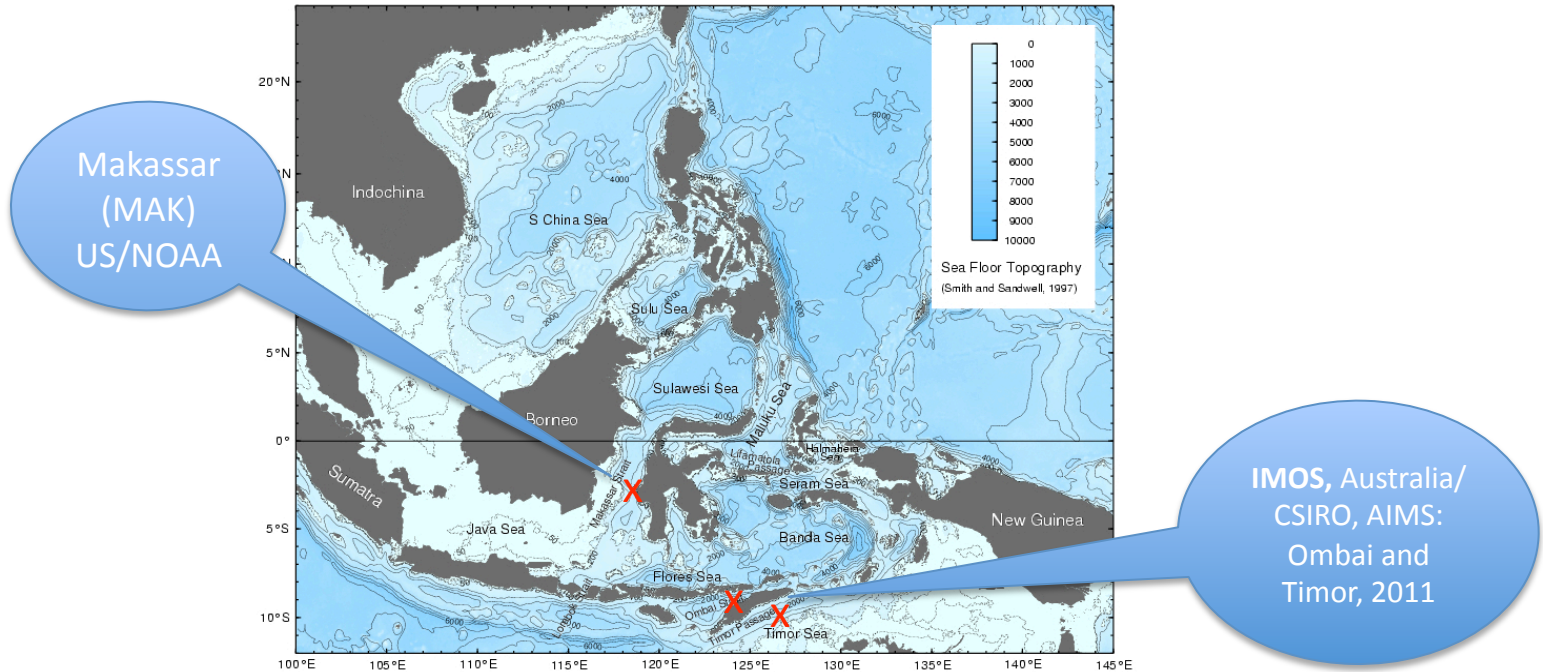
Makassar Strait Throughflow (MAK) Transport Station

Arnold L. Gordon

Lamont-Doherty Earth Observatory of Columbia University



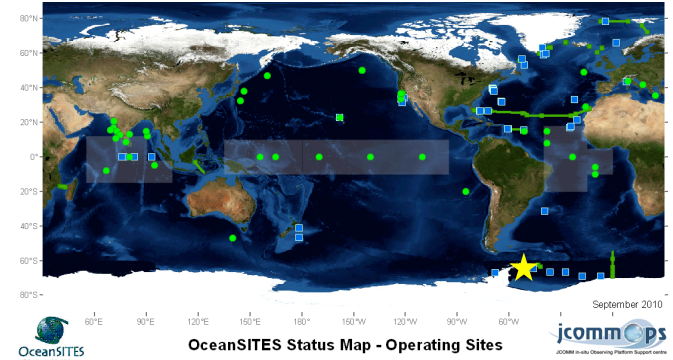
Partners: Agency for Marine and Fisheries Research (BRKP),
Indonesia; IMOS (CSIRO; AIMS) Australia



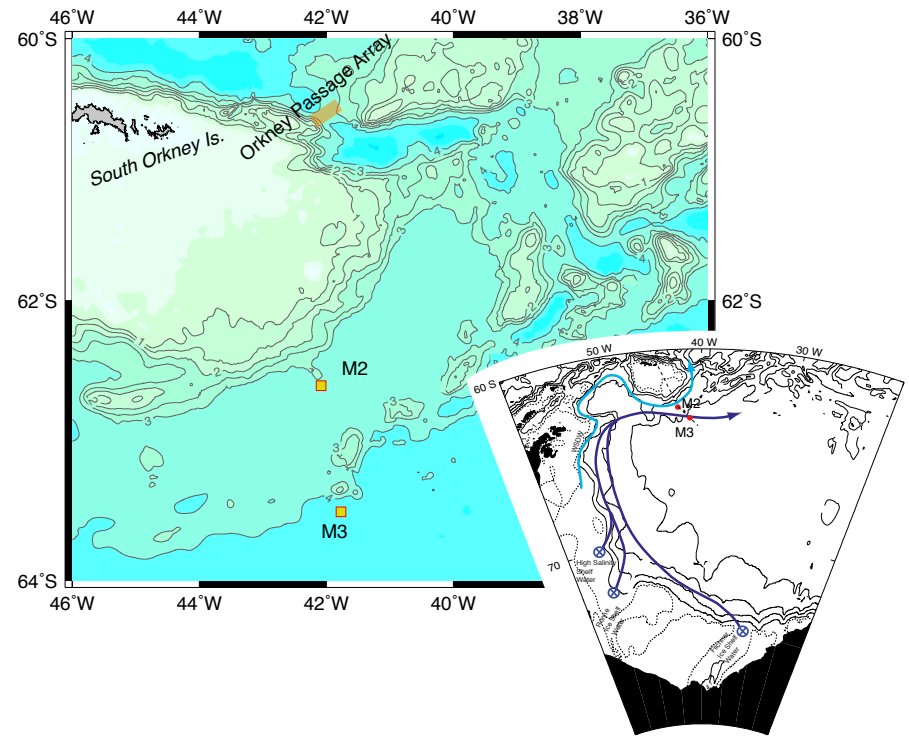
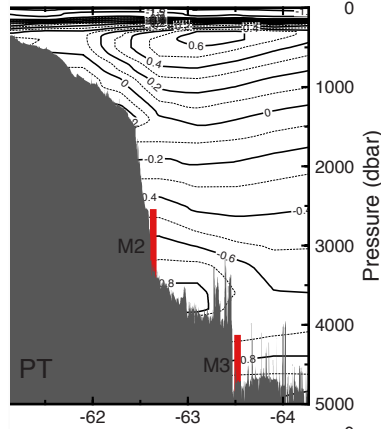
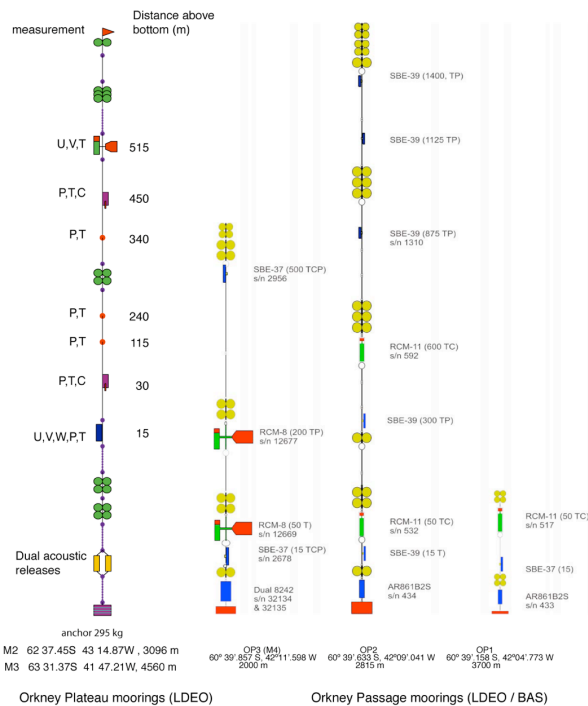
Weddell Sea Transport Station

Bruce Huber & Arnold Gordon

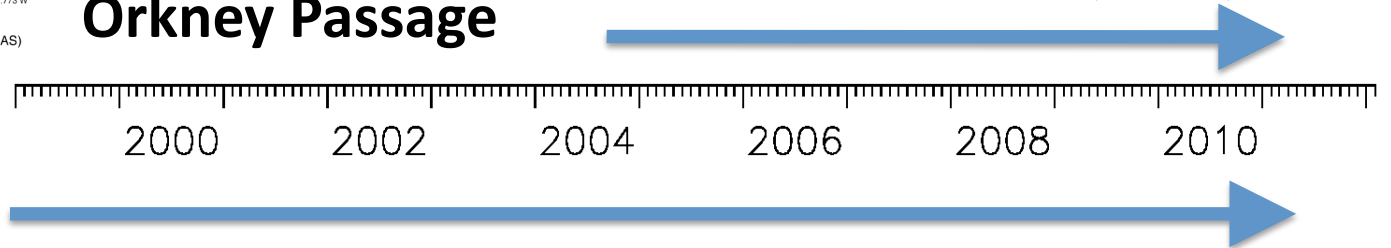
Lamont Doherty Earth Observatory of Columbia University



Partners: British Antarctic Survey, Orkney Passage mooring array (M. Meredith, K. Nicholls)

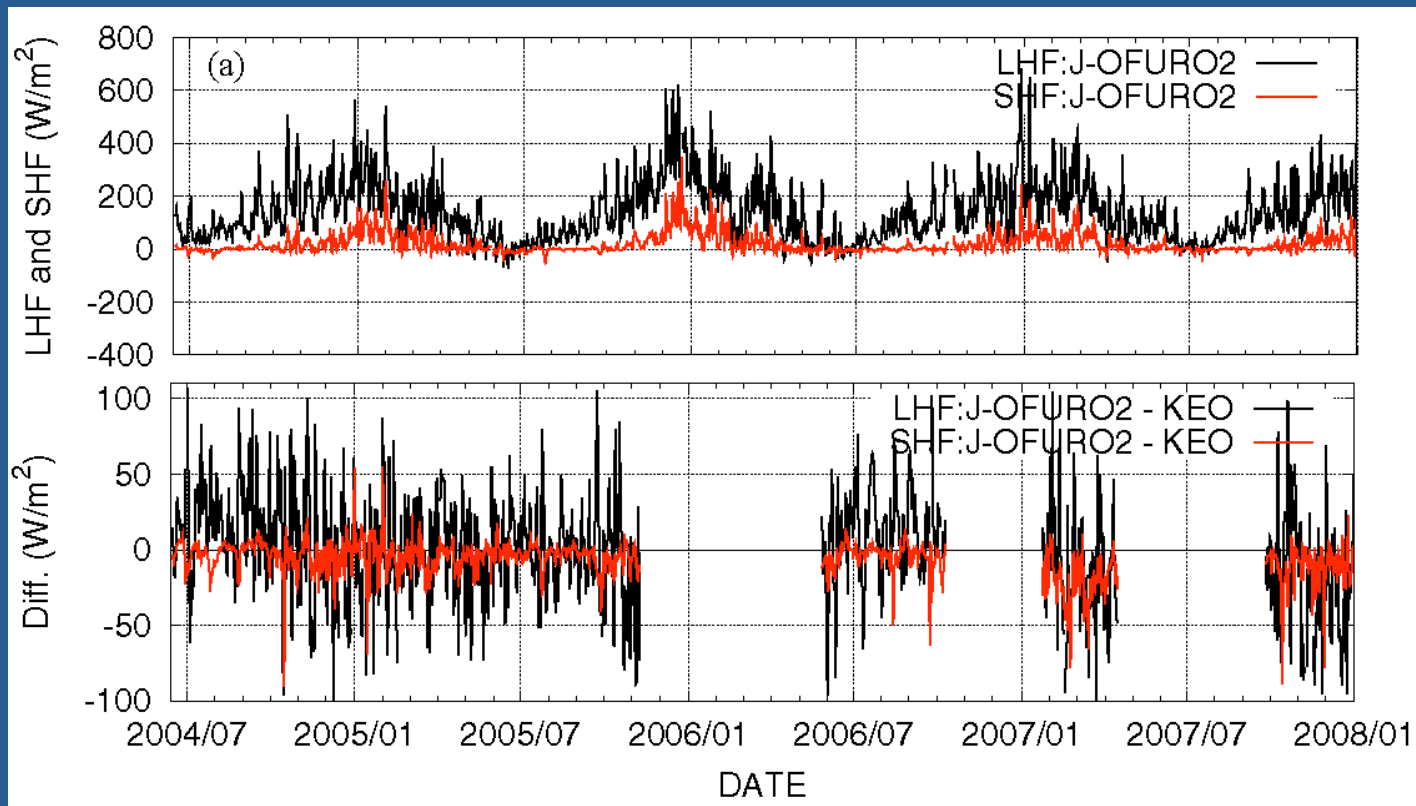


LDEO/BAS
Orkney Passage



KEO, a Time Series Reference Site (example)

Tomita et al. (JGR 2010): An assessment of surface heat fluxes from J-OFURO2 at the KEO/JKEO sites



Mean bias in J-OFURO2 Latent Heat Flux is ~ 0 W/m², RMSerr ~ 40 W/m²

*Mean bias in NCEP2 Reanalysis Latent Heat Flux was 44 W/m² -- **yikes!** (Kubota et al. JGR2008).*

Recommendations

- Reference station data are most useful for assessing products if they are not assimilated. Data sources for assimilation products should be clearly identified.
- Still a research topic how to constrain or initialize models with transport reference time series (through a section).
- Tariff agreement for Iridium is needed to lower cost of realtime data transmission.

Recommendations (cont.)

- Continue building network. These stations are hubs within GOOS network.
- OceanObs09 recommends that OceanSITES stations monitor not only fluxes, physical environment, and carbon cycle, but also ecosystem. The ORS network should be part of the Ocean Acidification Network.
- OceanObs09 recommends that the deep ocean be monitored. ORS flux moorings should be enhanced with deep sensors.
- Adequate charter time and shiptime scheduling are critical for maintaining stations.