

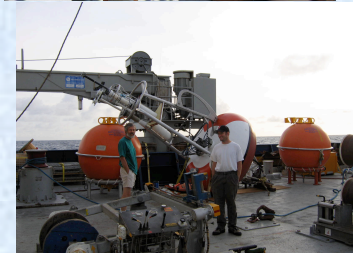
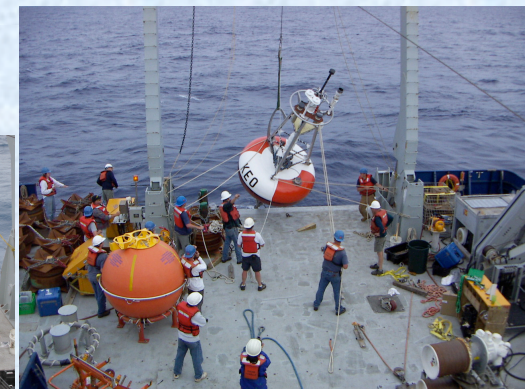
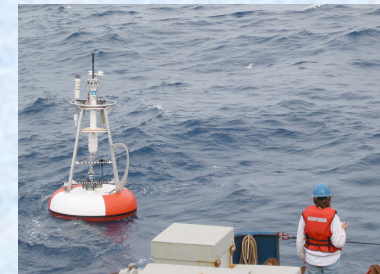
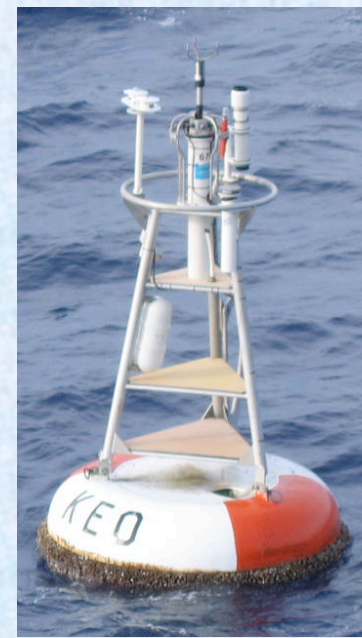
The KEO Story – Past, Present, Future

Meghan Cronin
NOAA PMEL

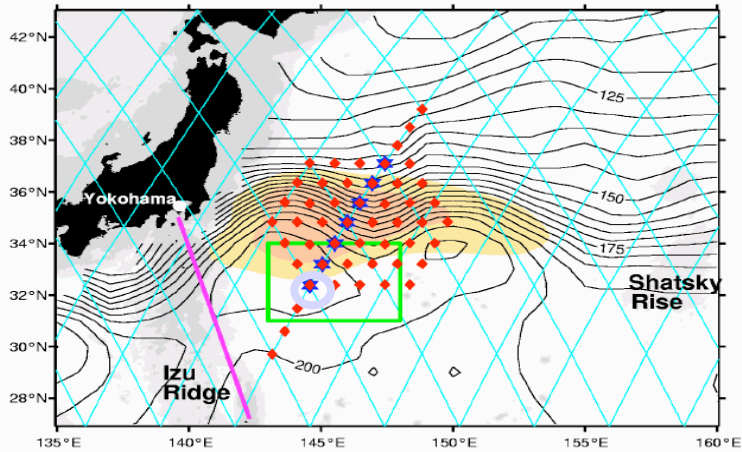
PMEL seminar June 23, 2005

Adapted from presentations at:

**“KESS and Beyond” Meetings, JAMSTEC,
Japan, 4 June 2004 & 15 June 2005**



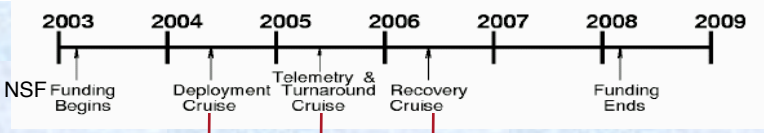
KESS Observational Plan



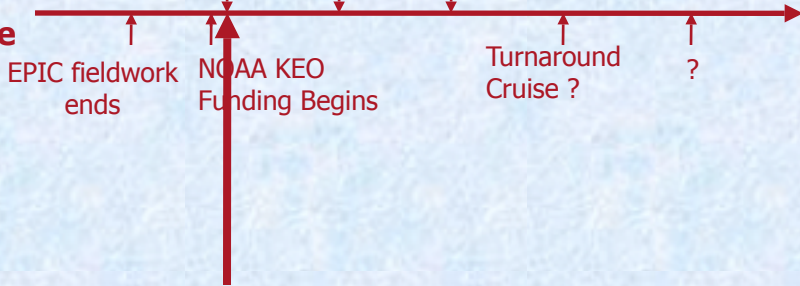
- ◆ C-PIES
- ◆ Profiler/ADCP/CM
- KEO Surface flux buoy
- Ferry XBT/ADCP
- Profiling Float Deployments

The Kuroshio Extension Observatory (KEO) is an element of the Kuroshio Extension System Study (KESS)...

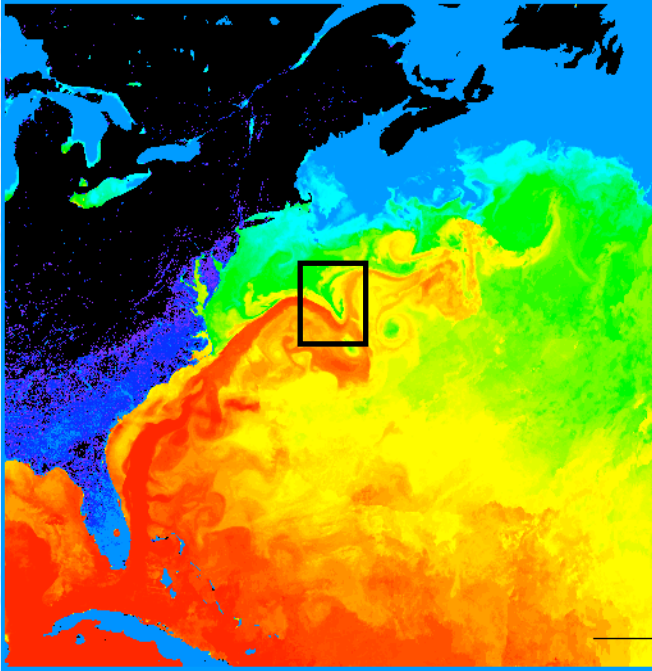
KESS Timeline



KEO Timeline



First "KESS and Beyond" meeting

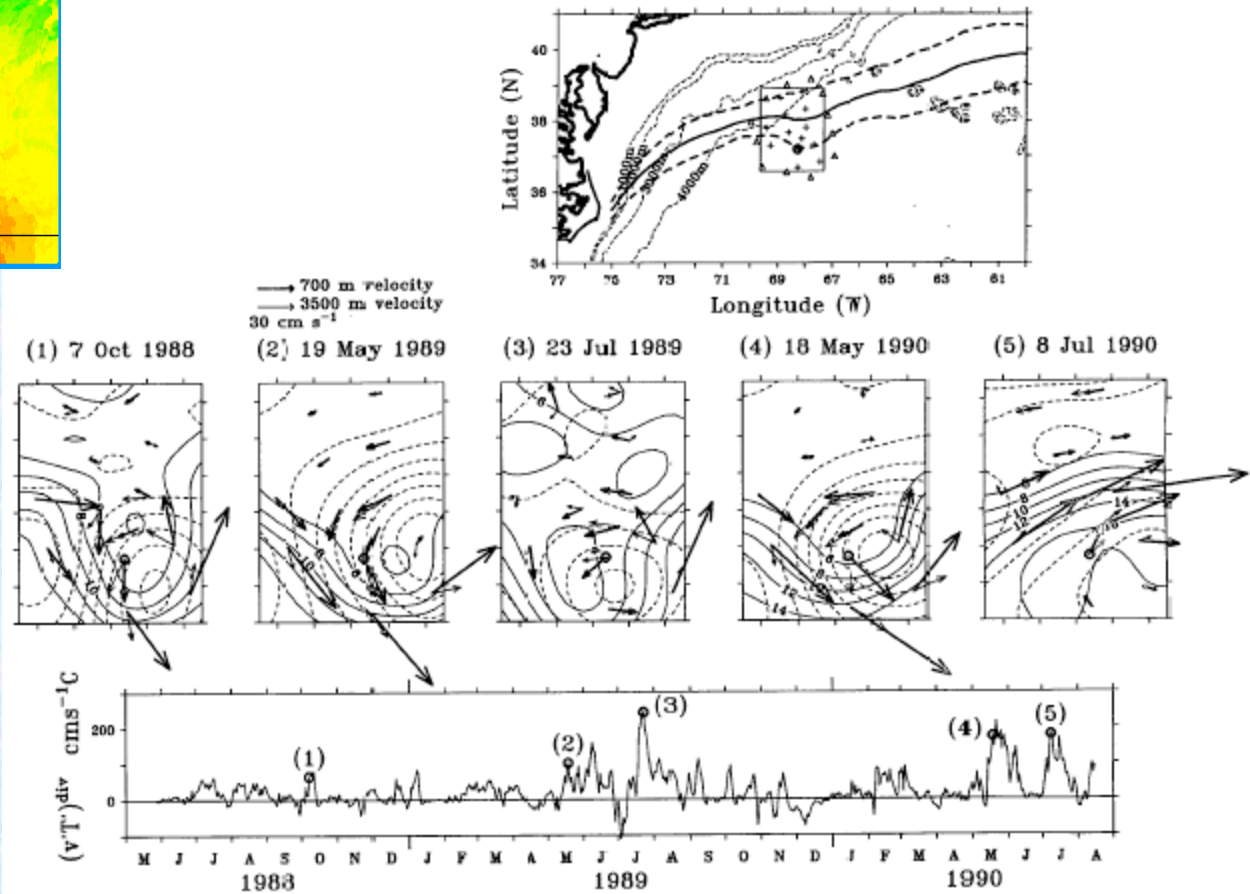


Cronin (1993): Eddy-mean flow interaction in the Gulf Stream

How are eddies formed? How do they feedback onto steady-state?

Meander life cycle similar to mid-latitude storms

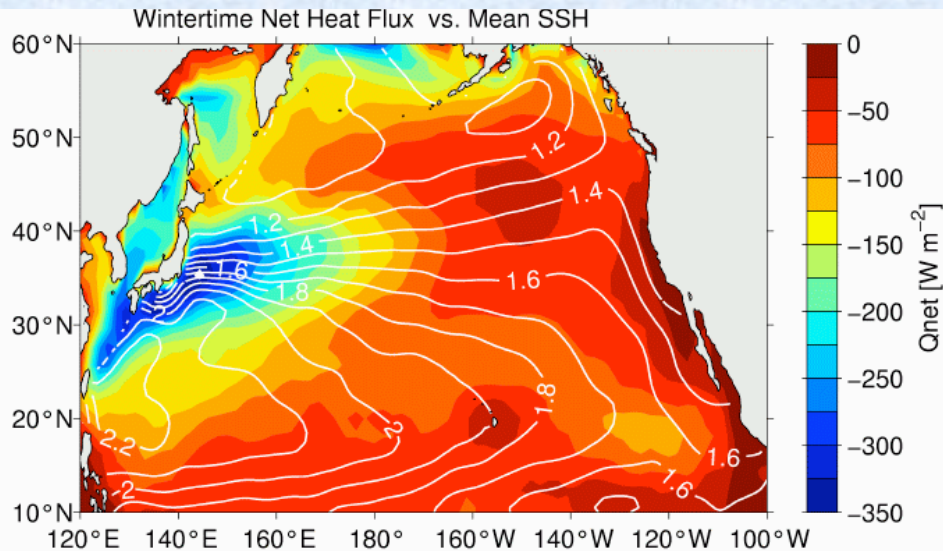
Heat is transported across front by eddies



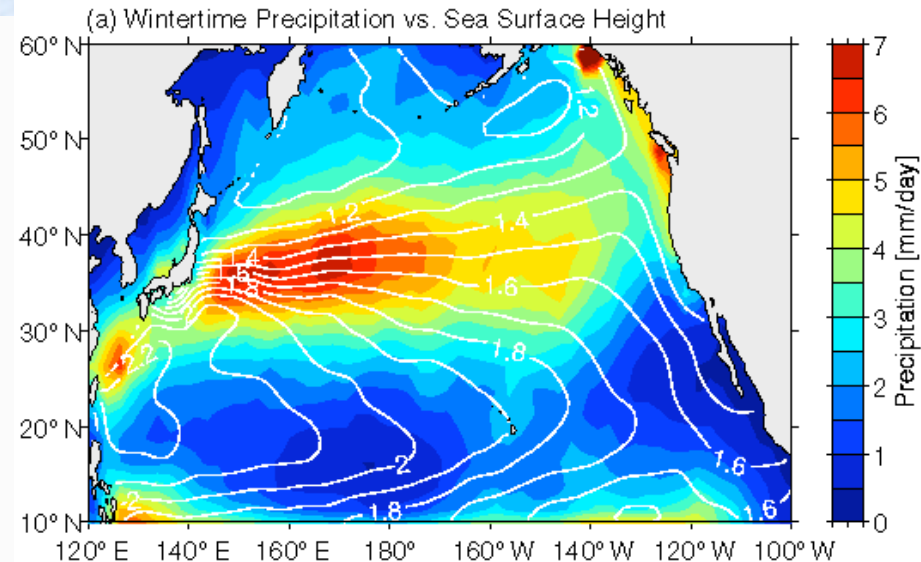
From: Cronin and Watts (1996)

Cold dry air blowing over warm Kuroshio Extension water causes large sensible and latent heat loss

Moisture flux leads to convective rainfall



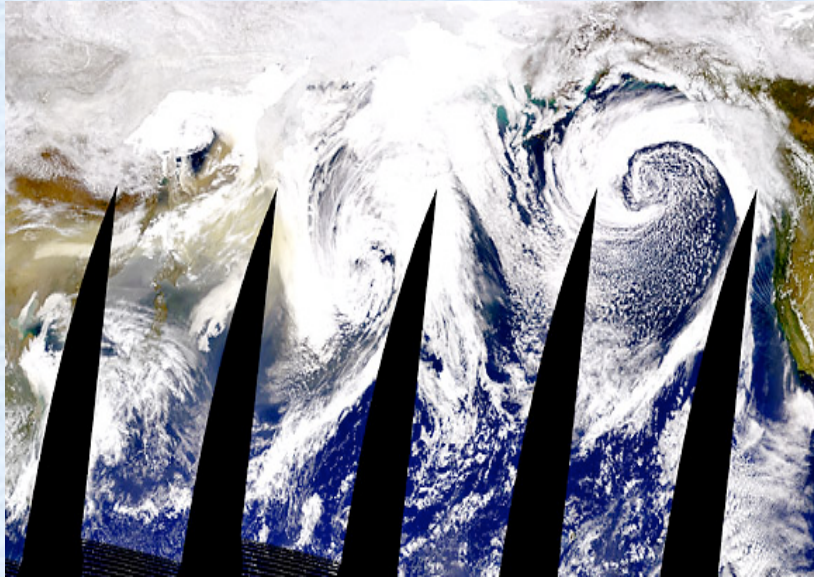
Adapted from Qiu, 2002.



• What is heat flux Q ? What is its affect on ocean and atmosphere?

• Do SST (and Kuroshio Extension) variations affect convection? Winds? Storm track?

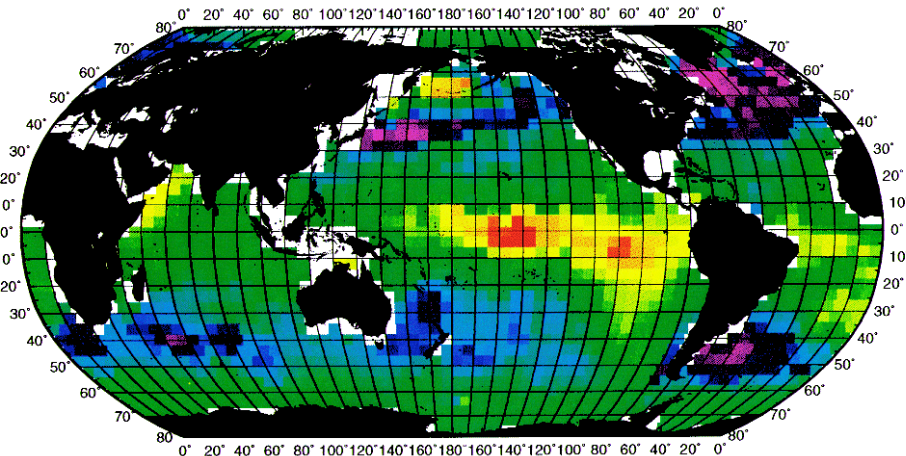
Asian dust storms
are rich in iron and
other micro-nutrients



*How do dust clouds affect the ocean
biological pump and carbon cycle?*

The largest sink of
carbon in the North
Pacific is in the Kuroshio
Extension

Annual Flux (Wanninkhof Gas Exchange)



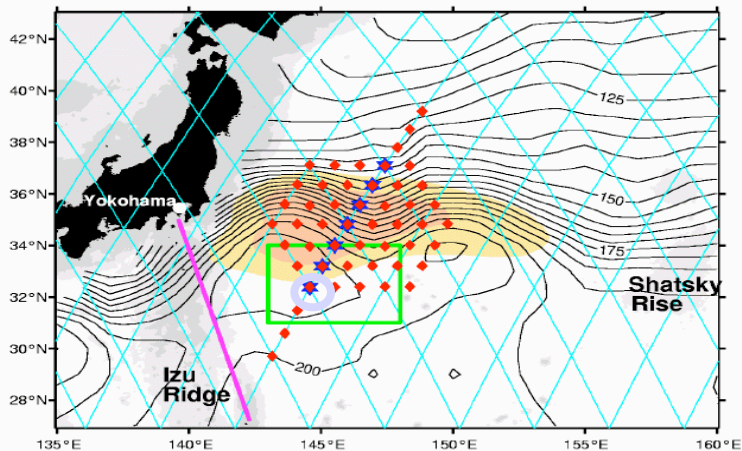
Takahashi et al. 1997



Net Flux (10^{12} grams C yr⁻¹ in each 4° x 5° area)

*...and the largest source is in the
equatorial cold tongue upwelling region.
These source and sink regions are
expressions of the subtropical meridional
overturning cell.*

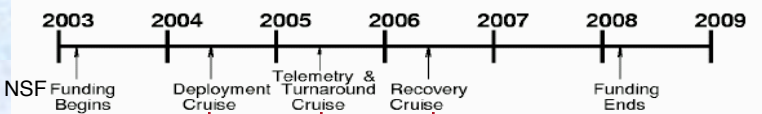
KESS Observational Plan



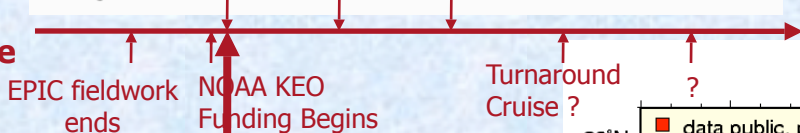
- ◆ C-PIES
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KEO is both an element of the Kuroshio Extension System Study (KESS)...

KESS Timeline

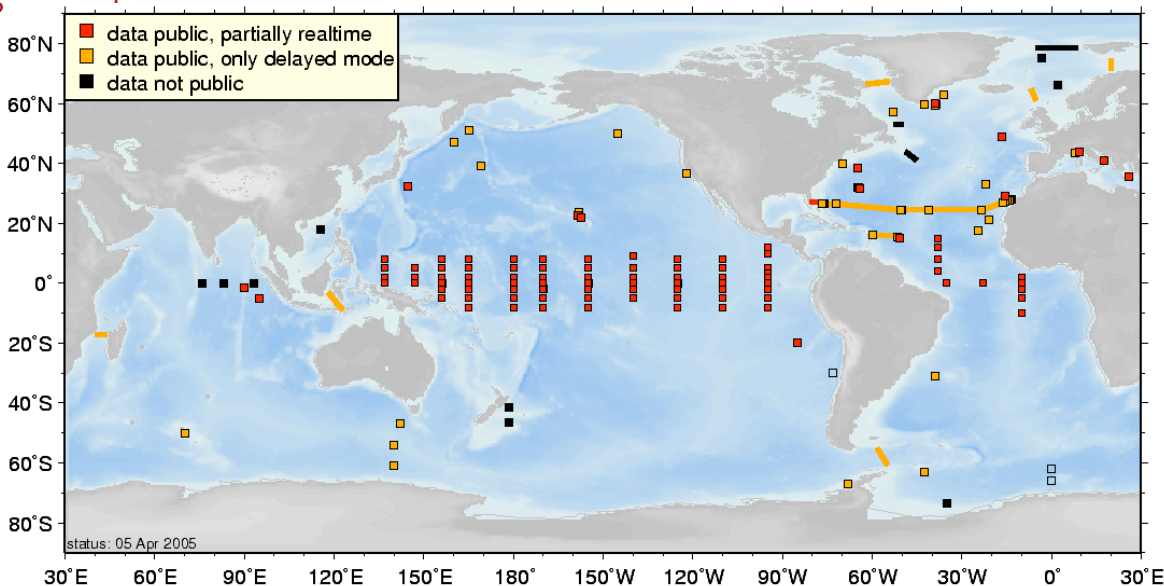


KEO Timeline



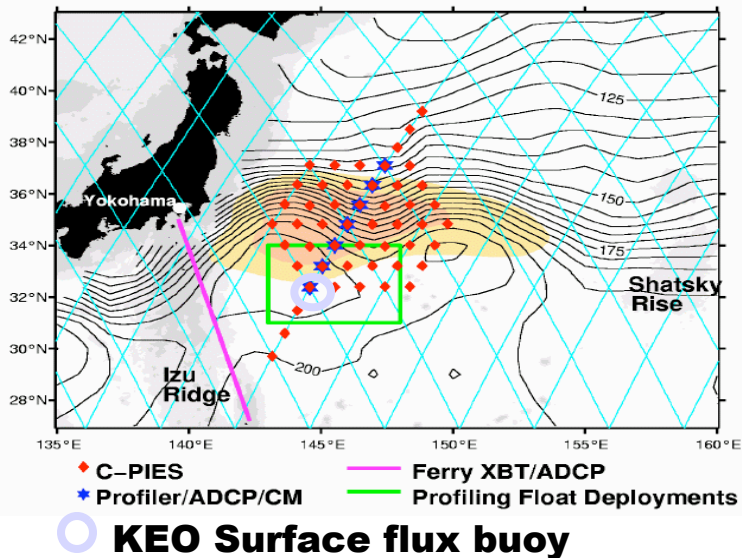
First "KESS and Beyond" meeting

OceanSITES - near-term



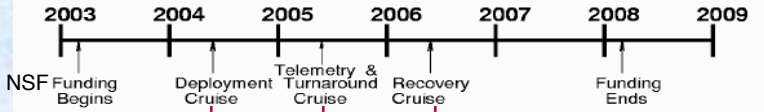
... and an element of the global network of OceanSITES time series reference sites.

KESS Observational Plan



KEO is both an element of the Kuroshio Extension System Study (KESS)...

KESS Timeline



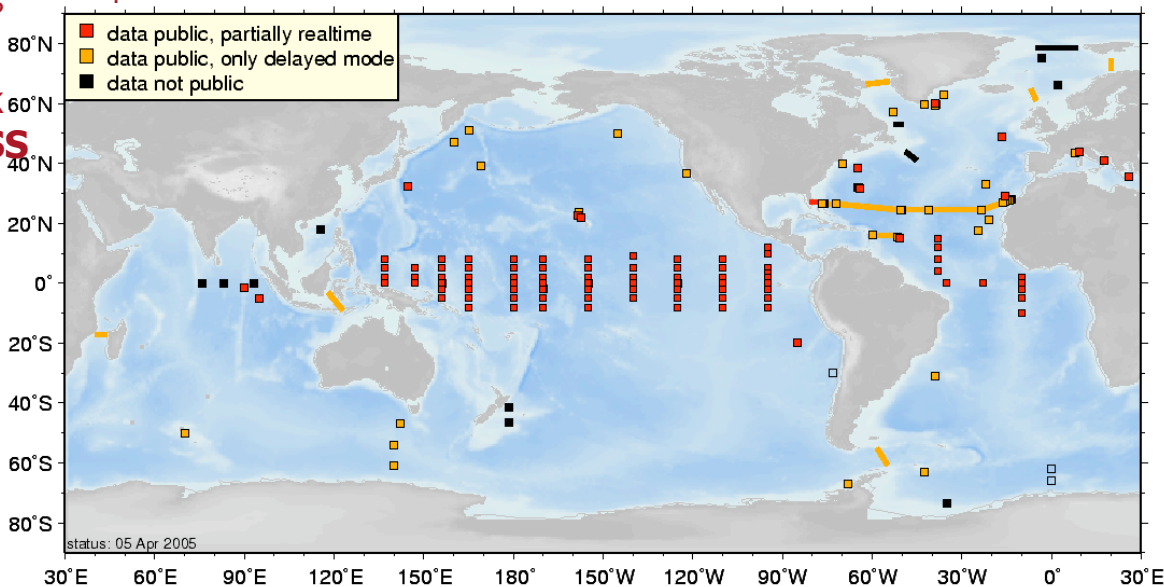
KEO Timeline



TODAY, one week after second "KES and Beyond" meeting

First "KES and Beyond" meeting

OceanSITES - near-term



... and an element of the global network of OceanSITES time series reference sites.

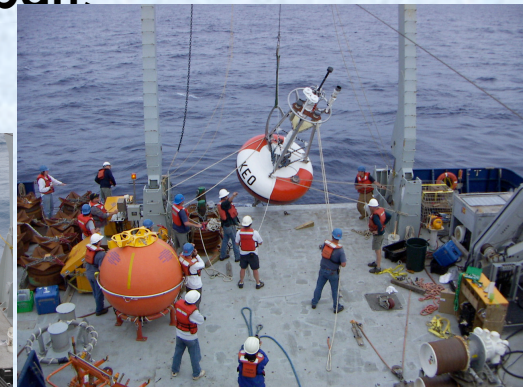
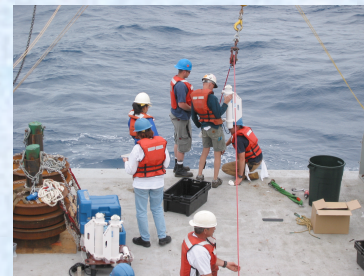
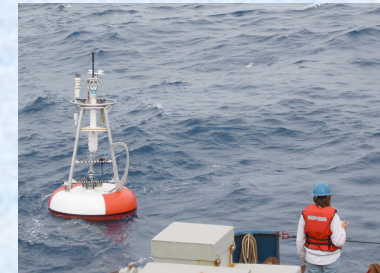
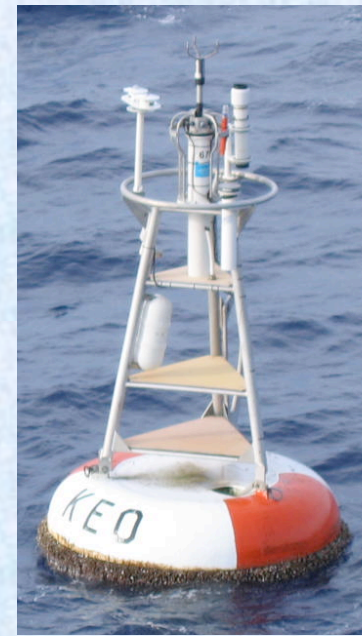
The KEO Story – Past, Present, Future

Meghan Cronin
NOAA PMEL

PMEL seminar June 23, 2005

Adapted from presentation at:

**“KESS and Beyond” Meeting, JAMSTEC, Japan.
15 June 2005**



The Buoy...

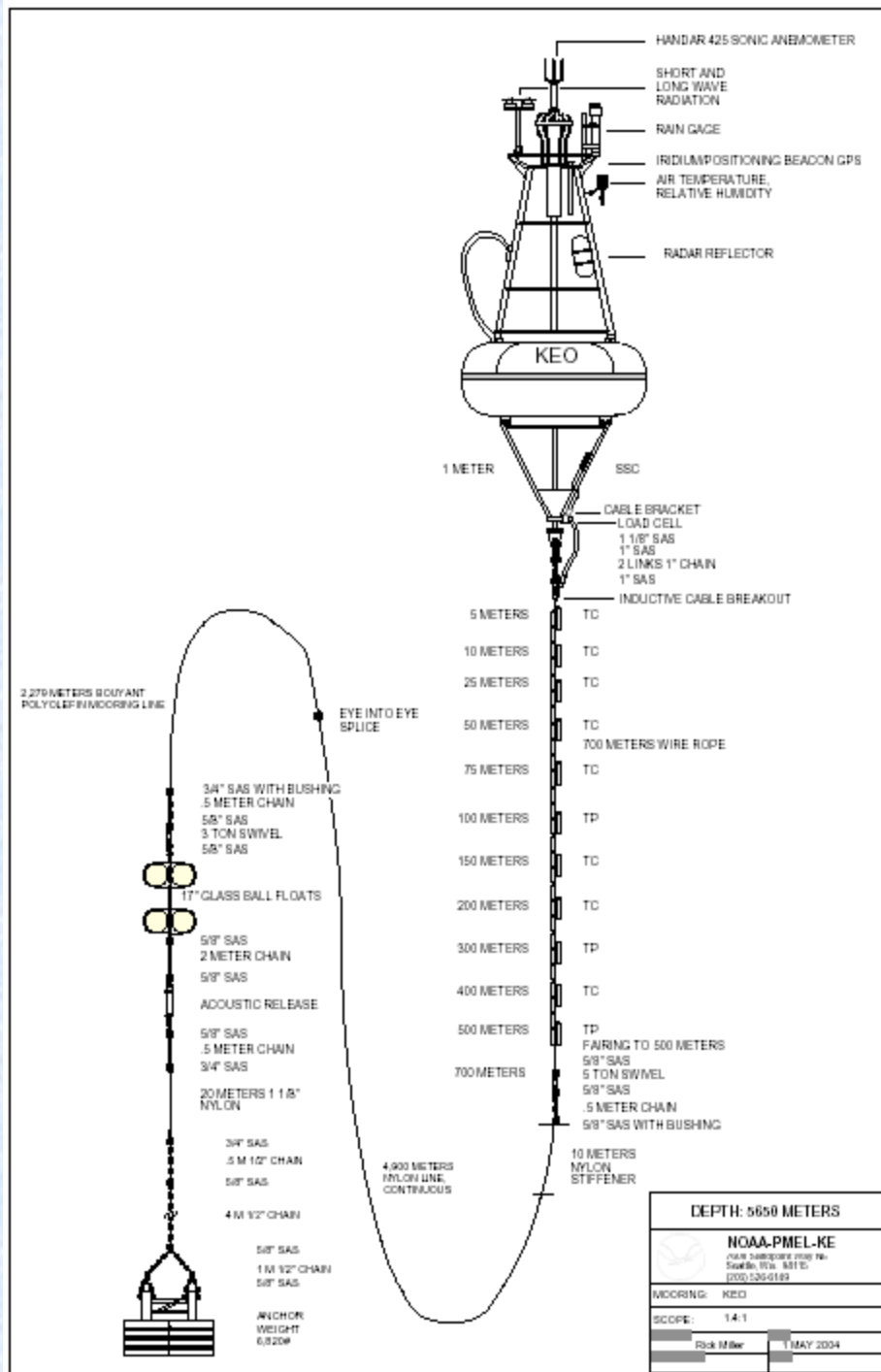
- **Past** (TAO-EPIC)
- **Present** (KEO1-04, KEO1-05)
- **Future Modifications**

For tropics ...



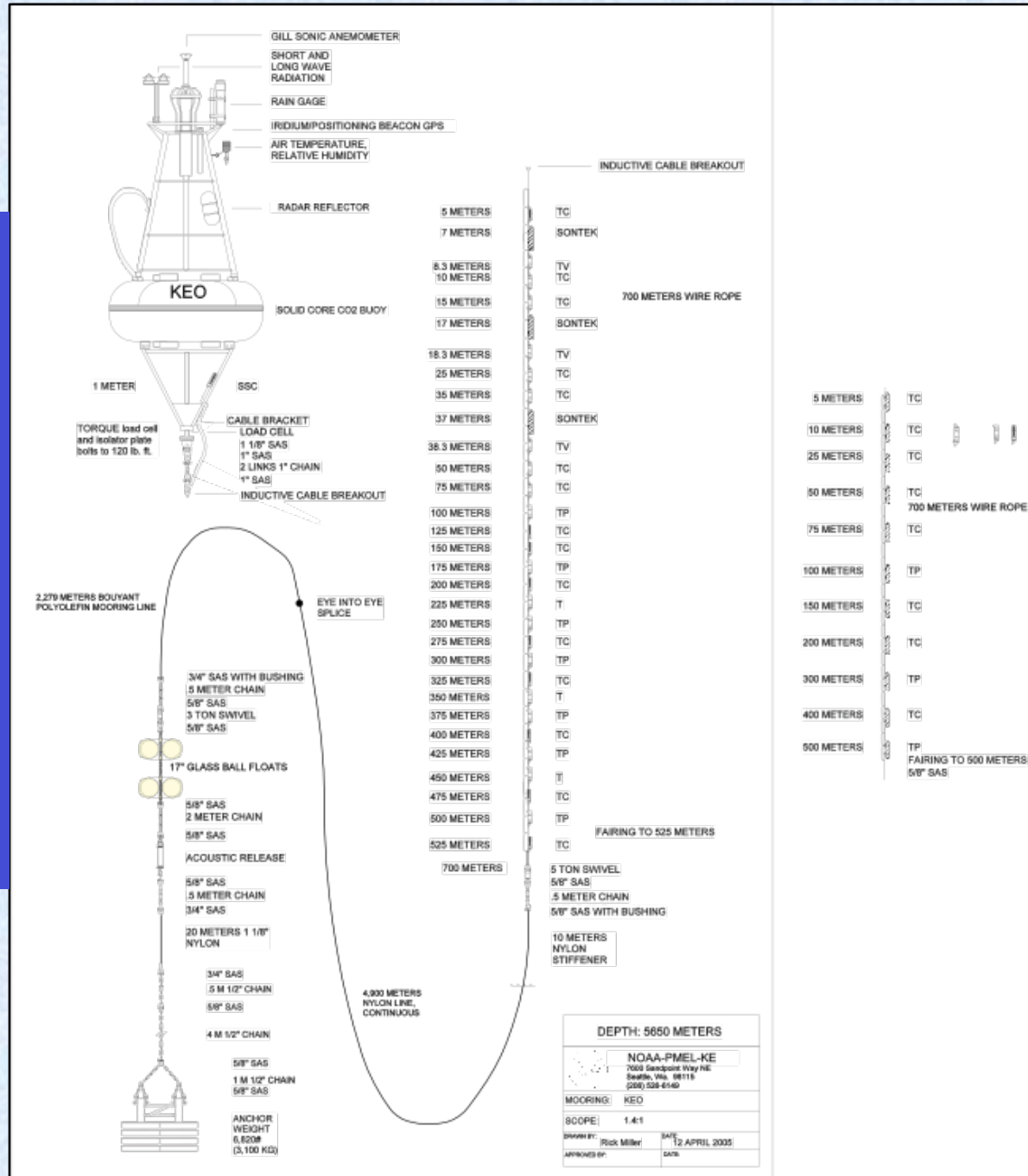
For Kuroshio Extension (145E, 32.3N) ...

- decked over toroid
- slack-line scope 1.4:1
- heavy anchor
- sonic anemometer



Modifications for KEO1-05 (year 2) deployment:

- Add CO₂ system
- Add 3 current meters
- Increase number of TP and TC modules



Possible Future Modifications

- Telemeter high resolution data
- Telemeter more subsurface data
- Nearby moorings (e.g. subsurface ADCP-profiler mooring, Tsunami mooring, ...)
- Biophysical sensors
- Optimize hull design

For more information:


Kuroshio Extension Observatory (KEO) – Mozilla Firefox

File Edit View Go Bookmarks Tools Help

http://www.pmel.noaa.gov/keo/


Getting Started Latest Headlines

National Oceanic and Atmospheric Administration / Pacific Marine Environmental Laboratory



Kuroshio Extension Observatory (KEO)

a contribution to the global network of time series reference sites




[Home](#) | [Overview](#) | [Technical](#) | [Data](#) | [Related Programs](#) | [Site Map](#)

As a contribution to the global network of [OceanSITES](#) time series reference sites, in June 2004, a surface buoy was deployed in the Kuroshio Extension recirculation gyre, at 144.5°E, 32.3°N. The buoy carries a suite of sensors to monitor heat, moisture and momentum fluxes, and upper ocean temperature and salinity. In June 2005, the buoy will carry air and sea surface pCO₂ sensors to monitor the CO₂ exchange between the atmosphere and ocean.

Lead: [Dr. Meghan Cronin](#) NOAA / PMEL
Lead Engineer: [Mr. Christian Meinig](#) NOAA / PMEL
Lead Carbon Scientist: [Dr. Christopher Sabine](#) NOAA / PMEL

The KEO time series reference site is sponsored by the National Oceanic and Atmospheric Administration (NOAA) Office of Climate Observations (OCO).



The KEO buoy

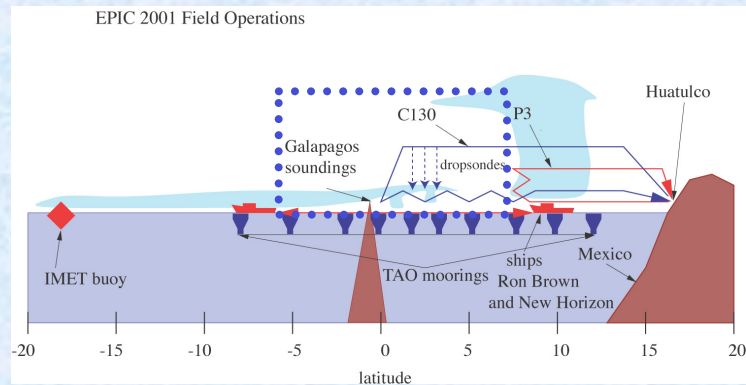
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Pacific Marine Environmental Laboratory
7600 Sand Point Way NE
Seattle, WA 98115

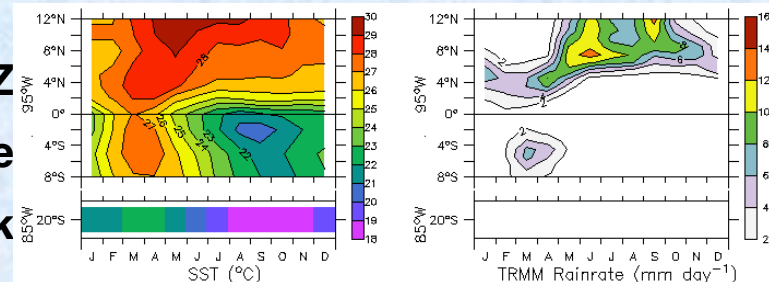
[KEO webmaster](#)
[DOC](#) | [NOAA](#) | [OAR](#) | [PMEL](#)
[Privacy Policy](#) | [Disclaimer](#)

The Science...

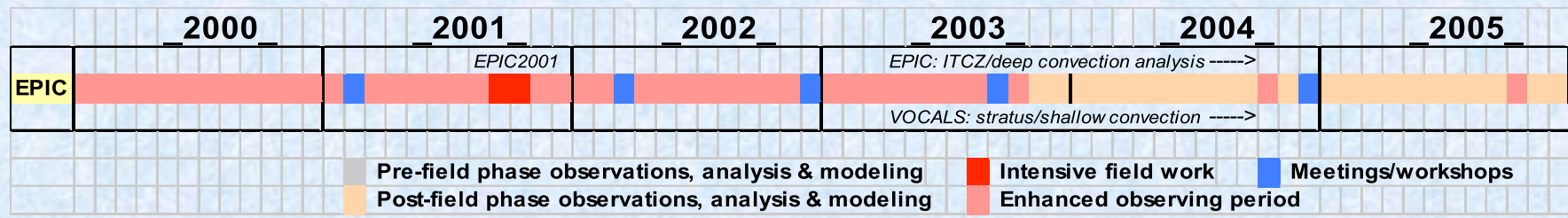
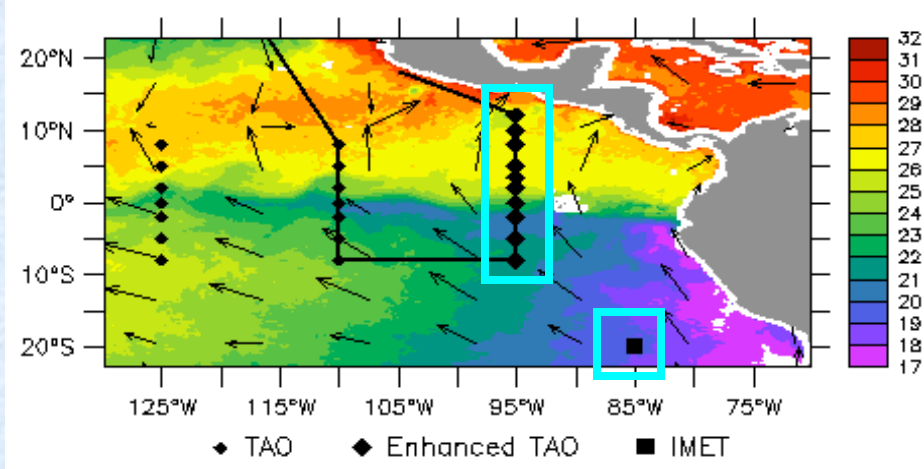
- **Past** (TAO-EPIC)
- **Present** (KEO-KESS)
- **Future**



ITCZ
cold tongue
stratus deck



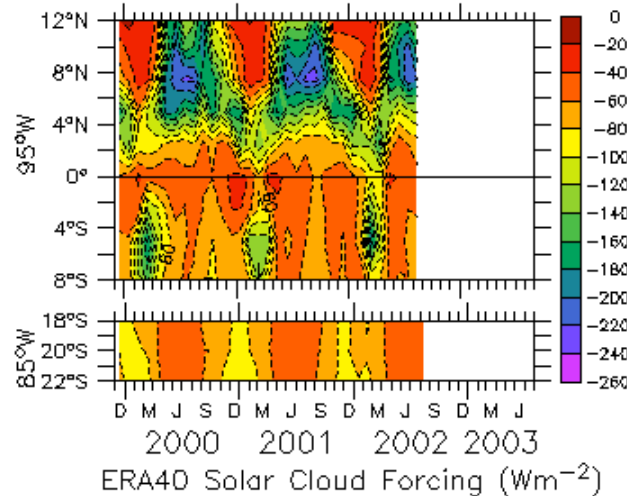
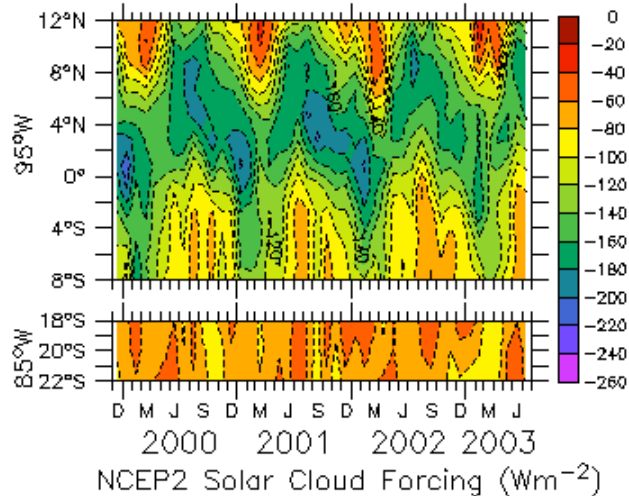
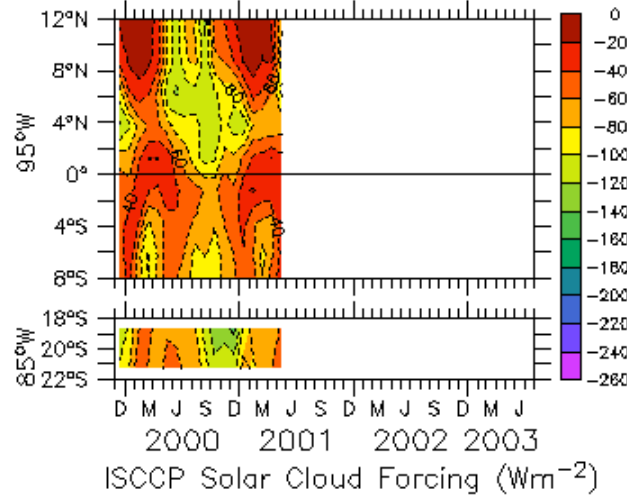
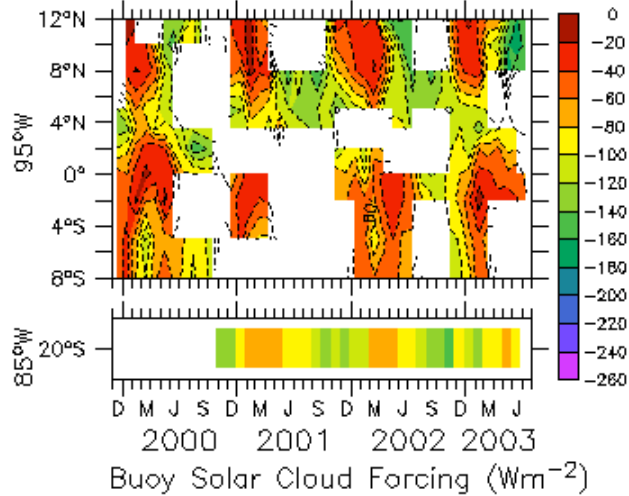
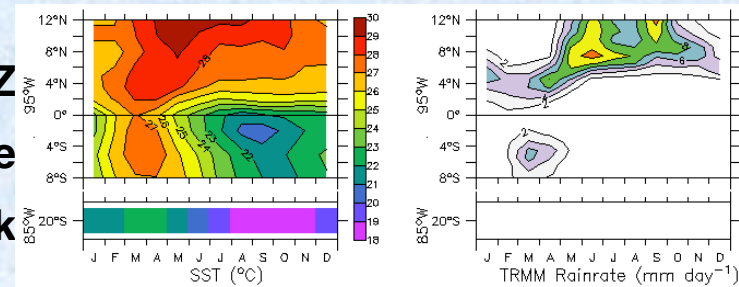
Eastern Pacific Investigation of Climate (EPIC)



How much sunlight is blocked by clouds? (How large is solar cloud forcing?)

$$CFRS = R_s - R_{s_0}$$

ITCZ
cold tongue
stratus deck



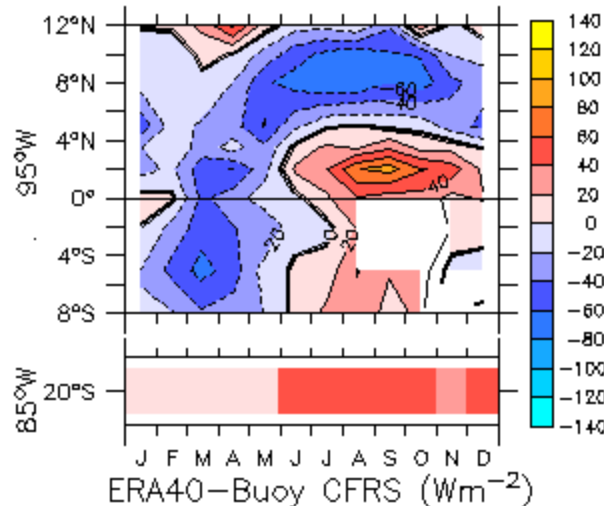
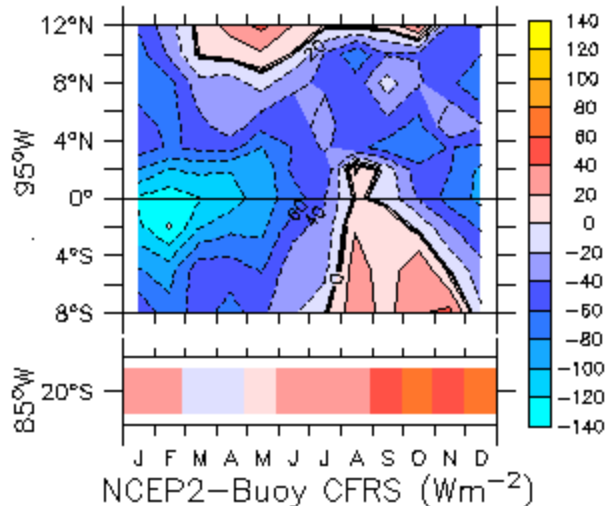
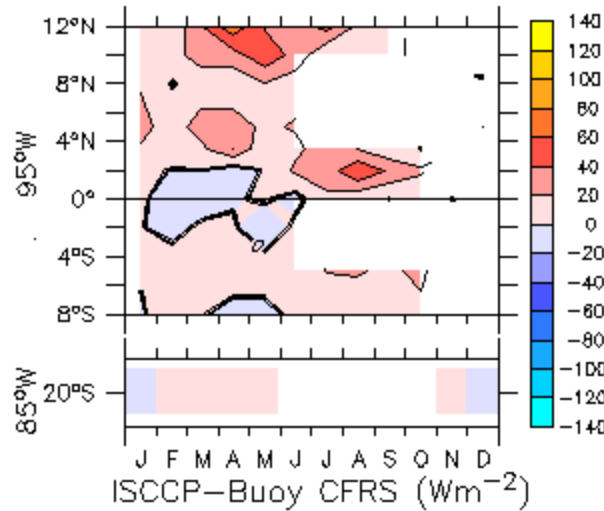
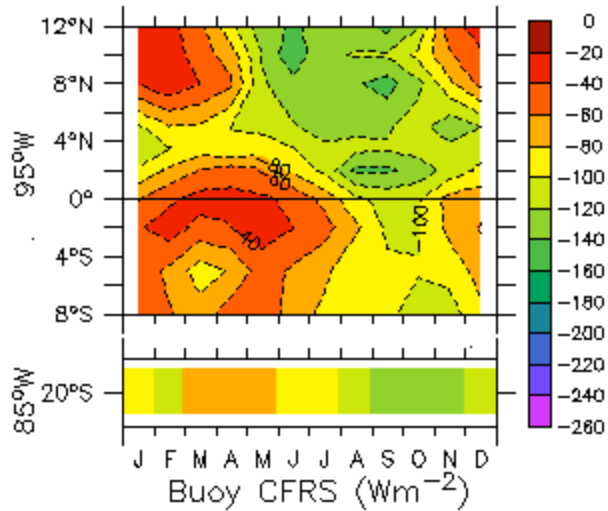
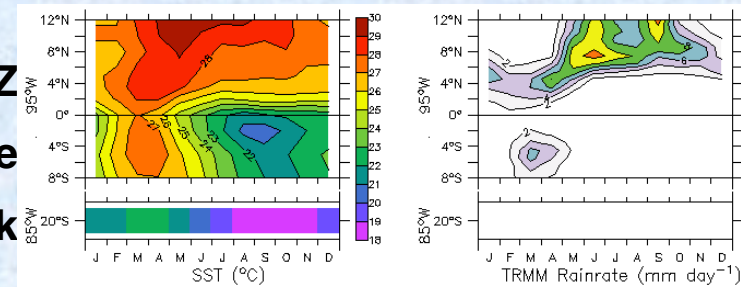
- Buoys suffered losses due to fishing related vandalism.
- Real-time data ensures data return.
- Are these all supposed to be the same? Yes!

From: Cronin, Bond, Fairall, Weller
(submitted to JClimate 2005)

Solar Cloud Forcing is reduction in surface radiation caused by clouds

$$CFRS = R_s - R_{s0}$$

ITCZ
cold tongue
stratus deck

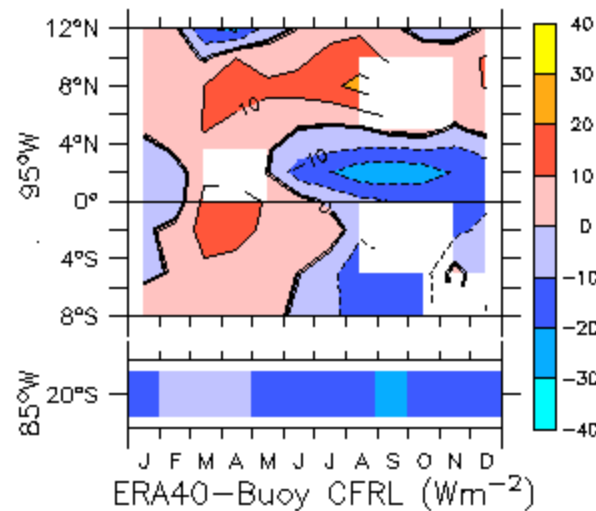
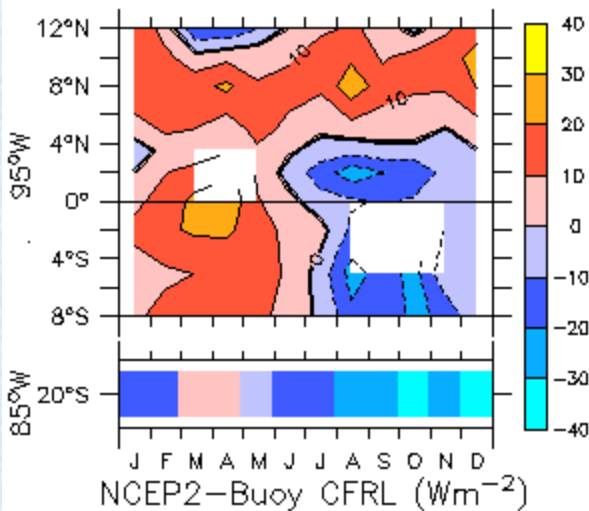
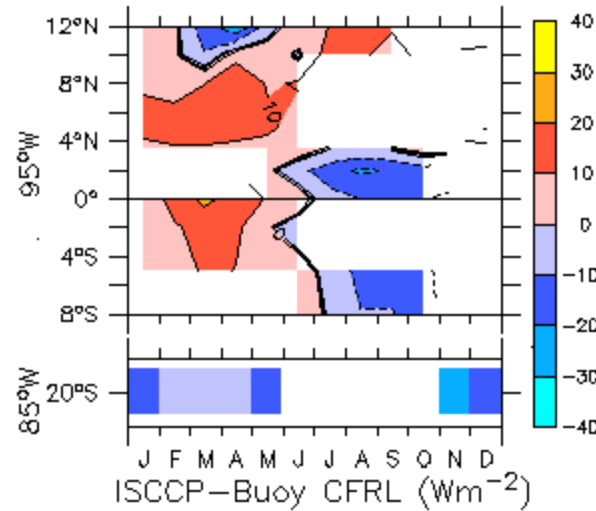
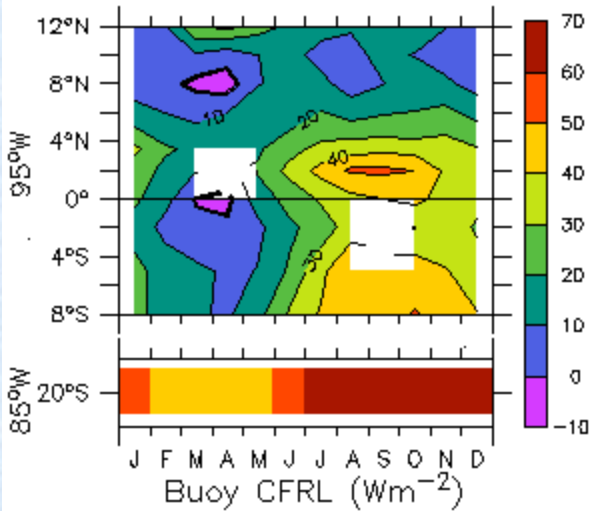
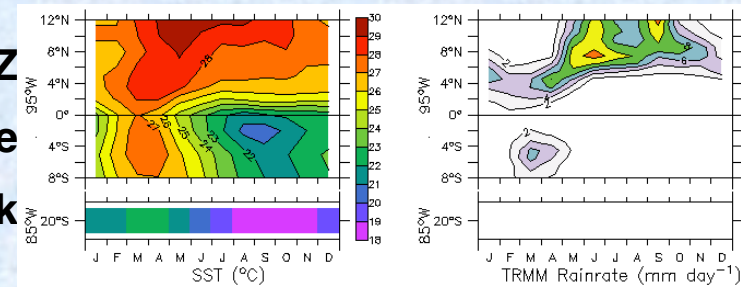


- East Pacific clouds have an annual cycle.
- NCEP2 clouds block too much SWR over the cold tongue. This would produce a cold SST bias.
- In stratus region, both NCEP2 and ERA40 have too little reduction in SWR. This would produce a warm SST bias.

How much infrared radiation is emitted from clouds? (How large is longwave cloud forcing?)

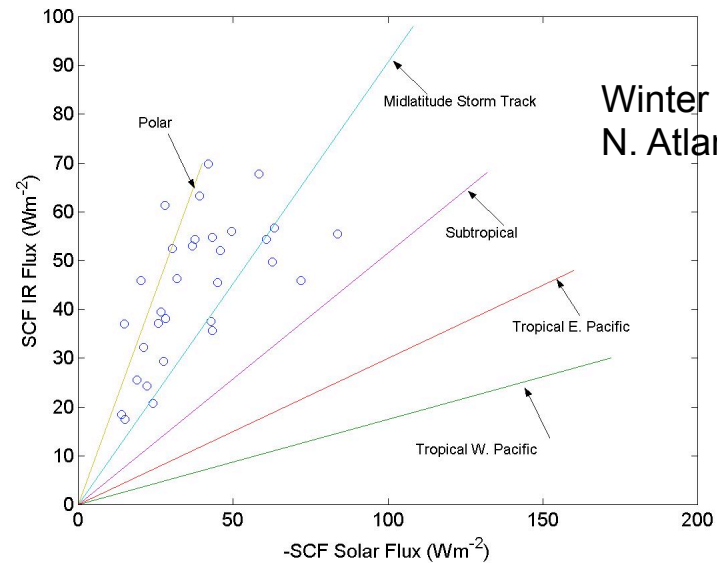
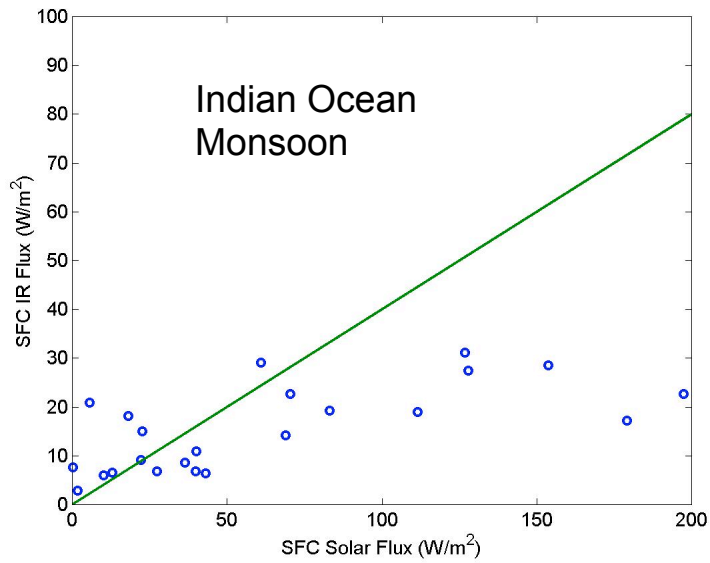
$$CFRL = RI - RI_0$$

ITCZ
cold tongue
stratus deck

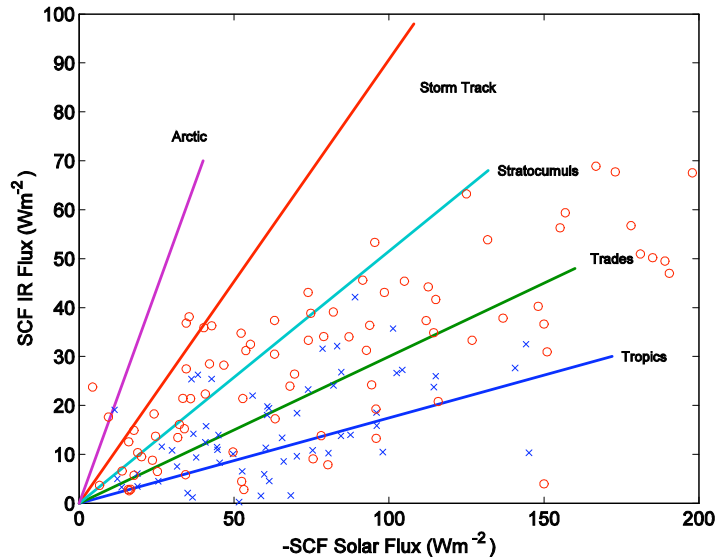


- NWP clouds emit too much longwave in NH & SH ITCZ.

- NWP clouds do not emit enough longwave radiation in stratus deck region.



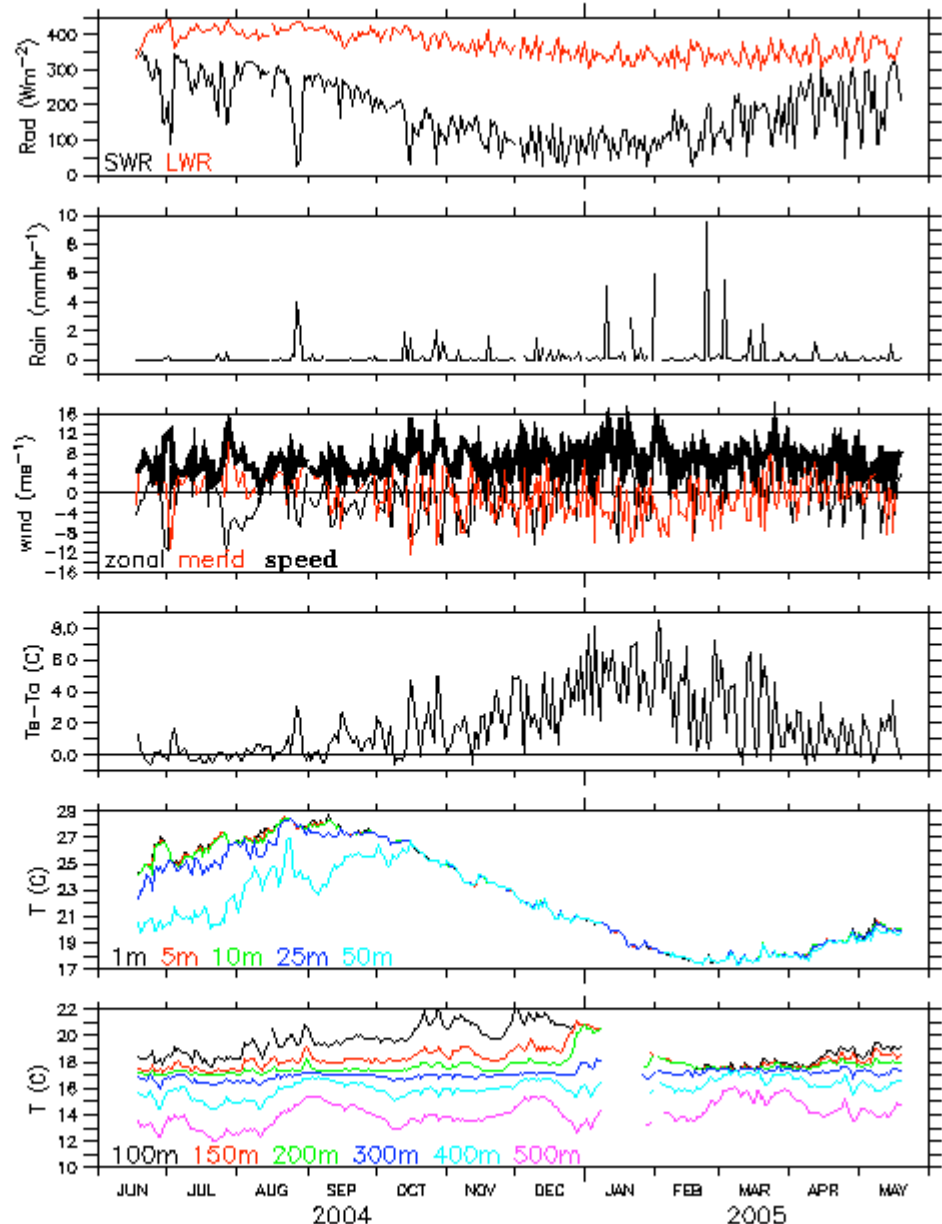
Equatorial EPac



KEO had 100% data return

With these data we will...

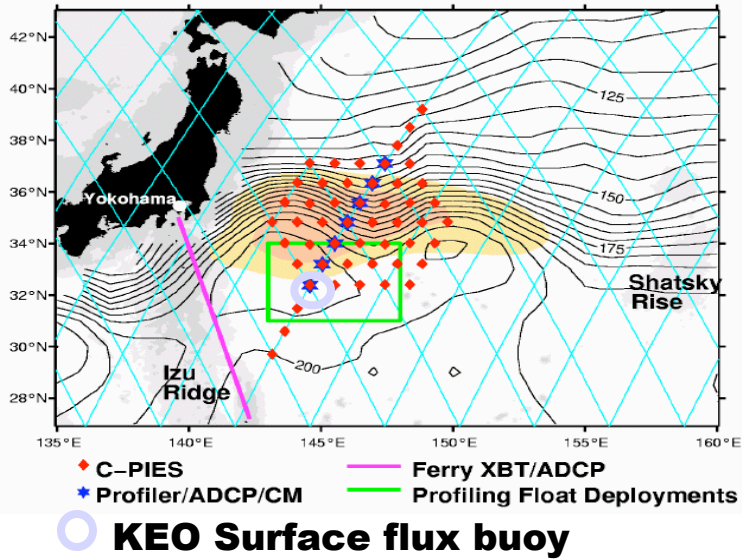
- Assess satellite and numerical weather prediction products,
- Study ocean response to typhoons and winter storms, and influence of ocean on storm development and track,
- Analyze the diurnal cycle, seasonal cycle, and other modes of variability,
- Analyze role of air-sea interaction in mode water formation.



The Program...

- **Past** (EPIC – a process study, embedded within enhanced monitoring, built upon the ENSO observing system)
- **Present**
- **Future**

KESS Observational Plan

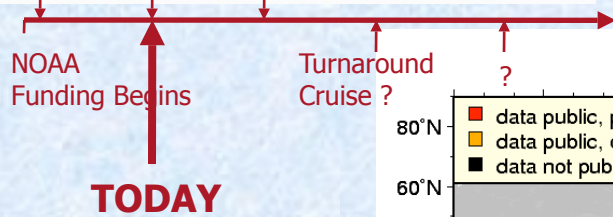


KEO is both an element of the Kuroshio Extension System Study (KESS)...

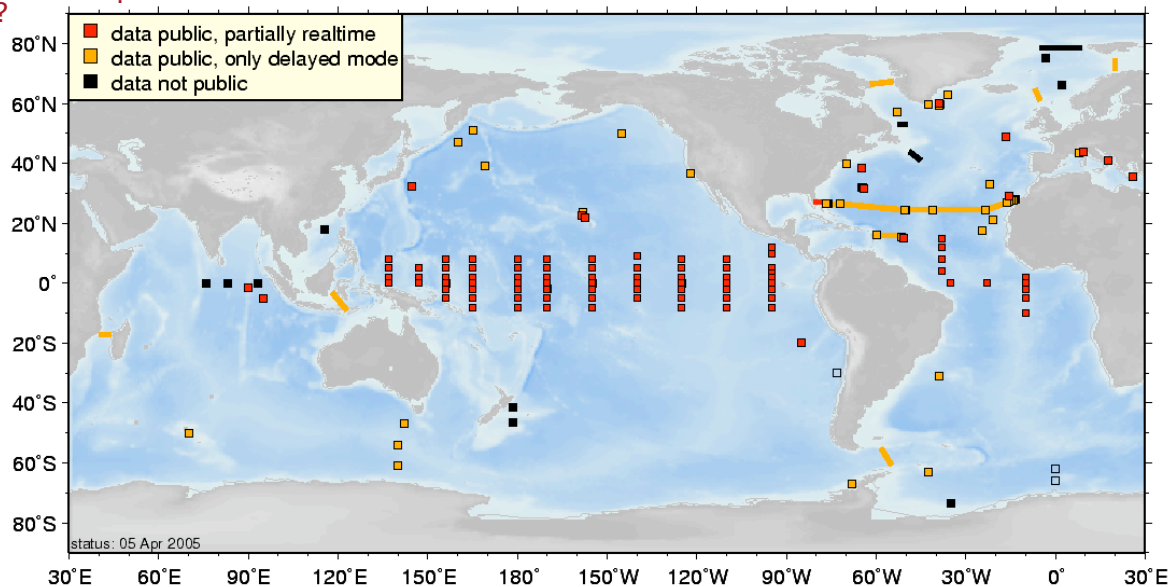
KESS Timeline



KEO Timeline

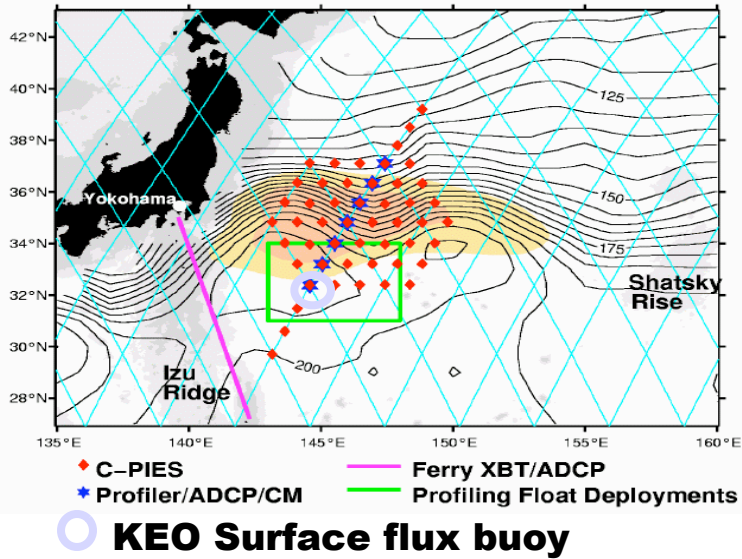


OceanSITES - near-term



... and an element of the global network of OceanSITES time series reference sites.

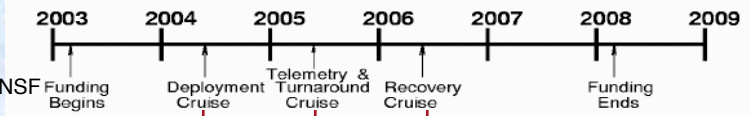
KESS Observational Plan



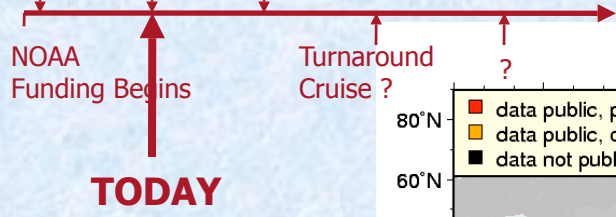
KEO is both an element of the Kuroshio Extension System Study (KESS)...

- KEO has longterm funding from NOAA Office of Climate Observations
- KEO has no ship time

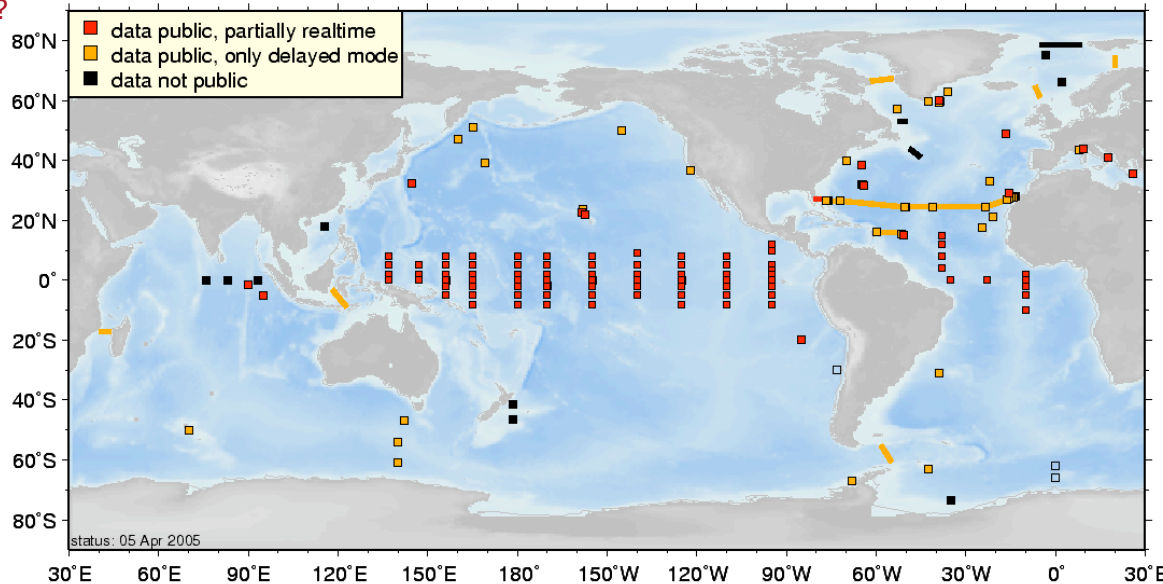
KESS Timeline



KEO Timeline



OceanSITES - near-term



... and an element of the global network of OceanSITES time series reference sites.

What will be the nature of our partnership?

- Scientific collaboration
- Technical collaboration (array design, implementation, ship time)
- KEO array elements (surface / subsurface, across / along front, sensor enhancements, ...)



The KEO buoy

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