Southern Ocean Sustained Observations Status

OOPC Sept. 2003

Status of all Southern Ocean CLIVAR-relevant projects maintained by CLIVAR office:

http://www.clivar.org/organization/southern/CLIVAR_CliC_Obs.html

Basic message here: in-situ (ARGO, XBT, etc) data are far from adequately sampling the ocean, e.g. daily or seasonal bias, regional bias. Better sampling is needed to correct biases for data-based analyses and to aid the interpretation and calibration of satellite data.

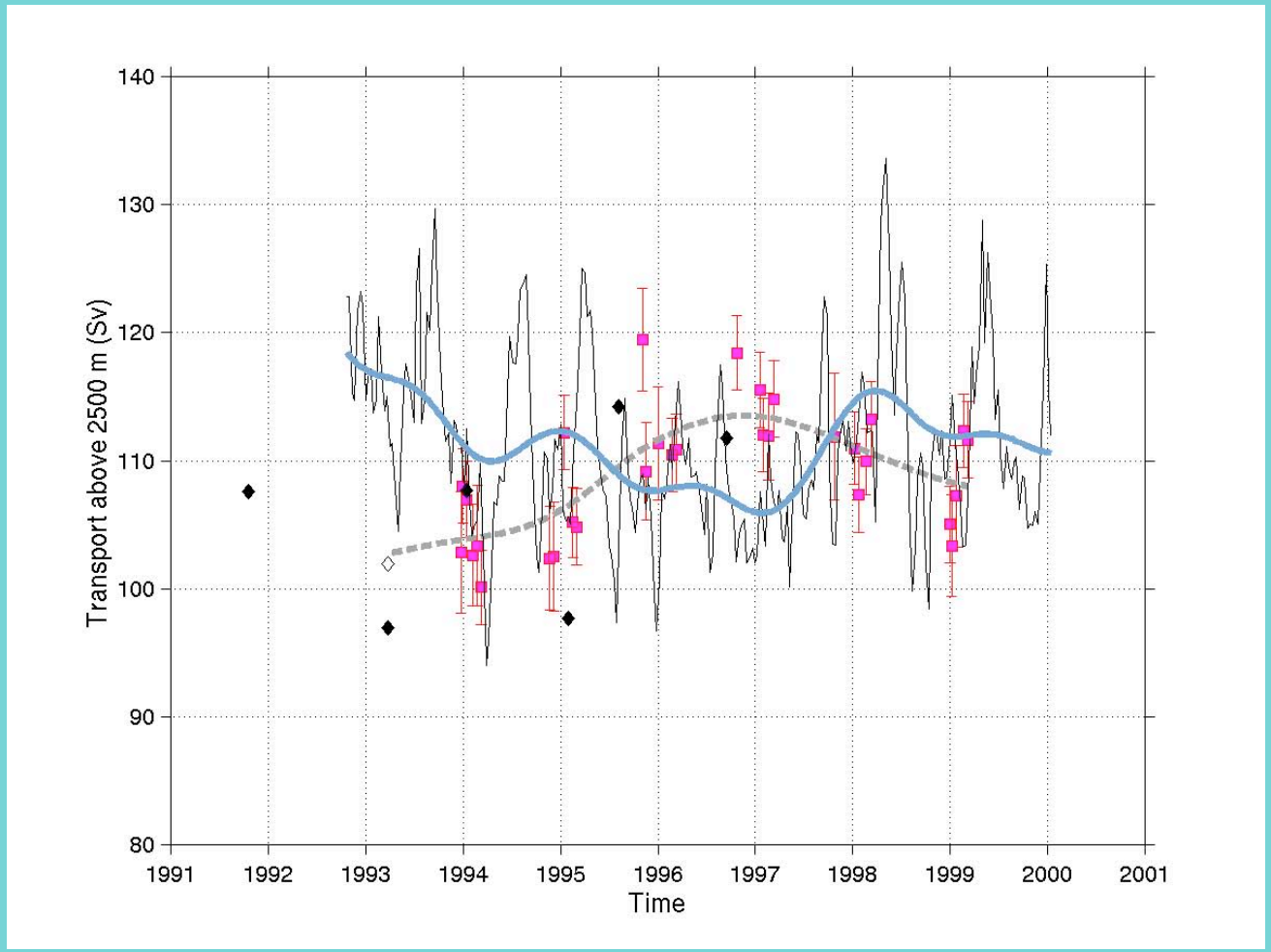
Time series of net baroclinic transport south of Australia

Baroclinic transport estimated from XBTs using an empirical relationship between temperature and transport streamfunction

CTD (diamond), XBT (square), low-passed XBT record (dashed line)

Rintoul and Sokolov, 2001

Time series of net baroclinic transport south of Australia



Transport estimated from altimeter (thin line), low-passed (thick blue line).

Empirical relationship between surface height and transport fn used to estimate transport.

Continuous record from altimeter shows XBT time series is badly aliased.

Sustained measurements

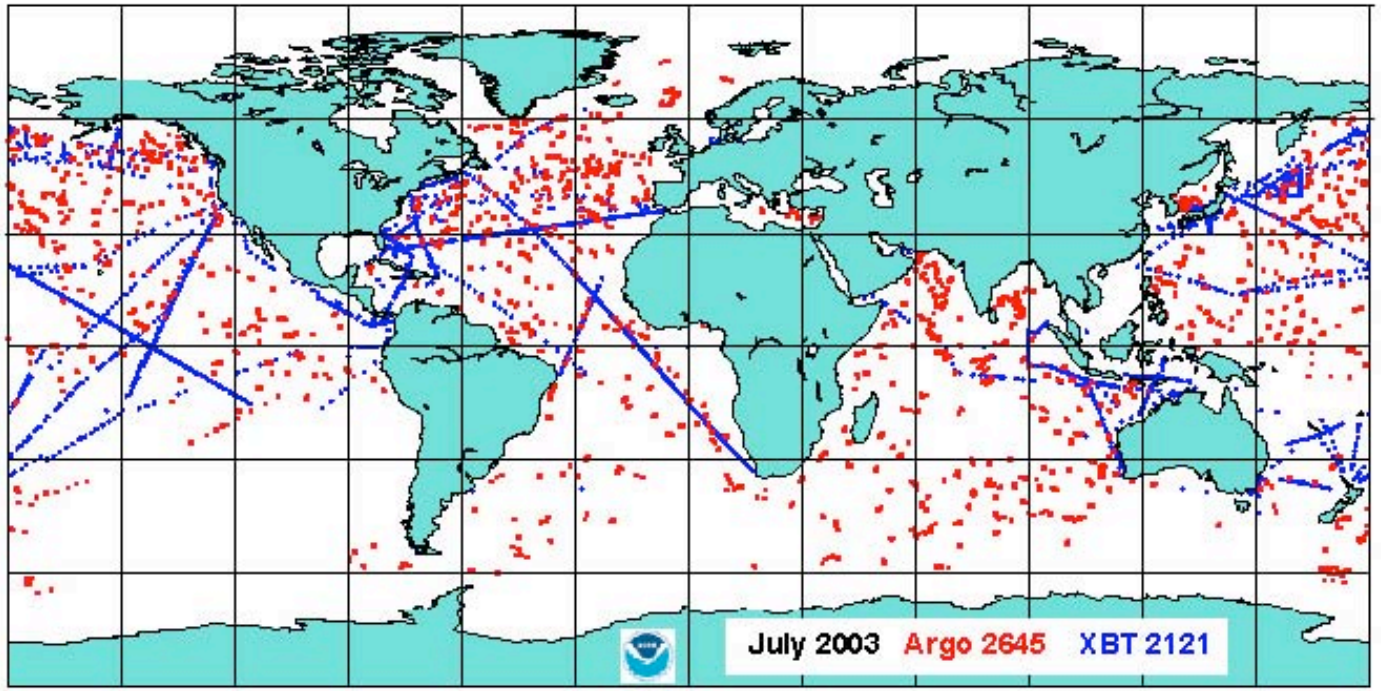
In-situ data

- HR XBT
- Tide gauges
- Argo
- Repeat sections
- Time series stations, moorings
- Surface drifter array

Satellite data

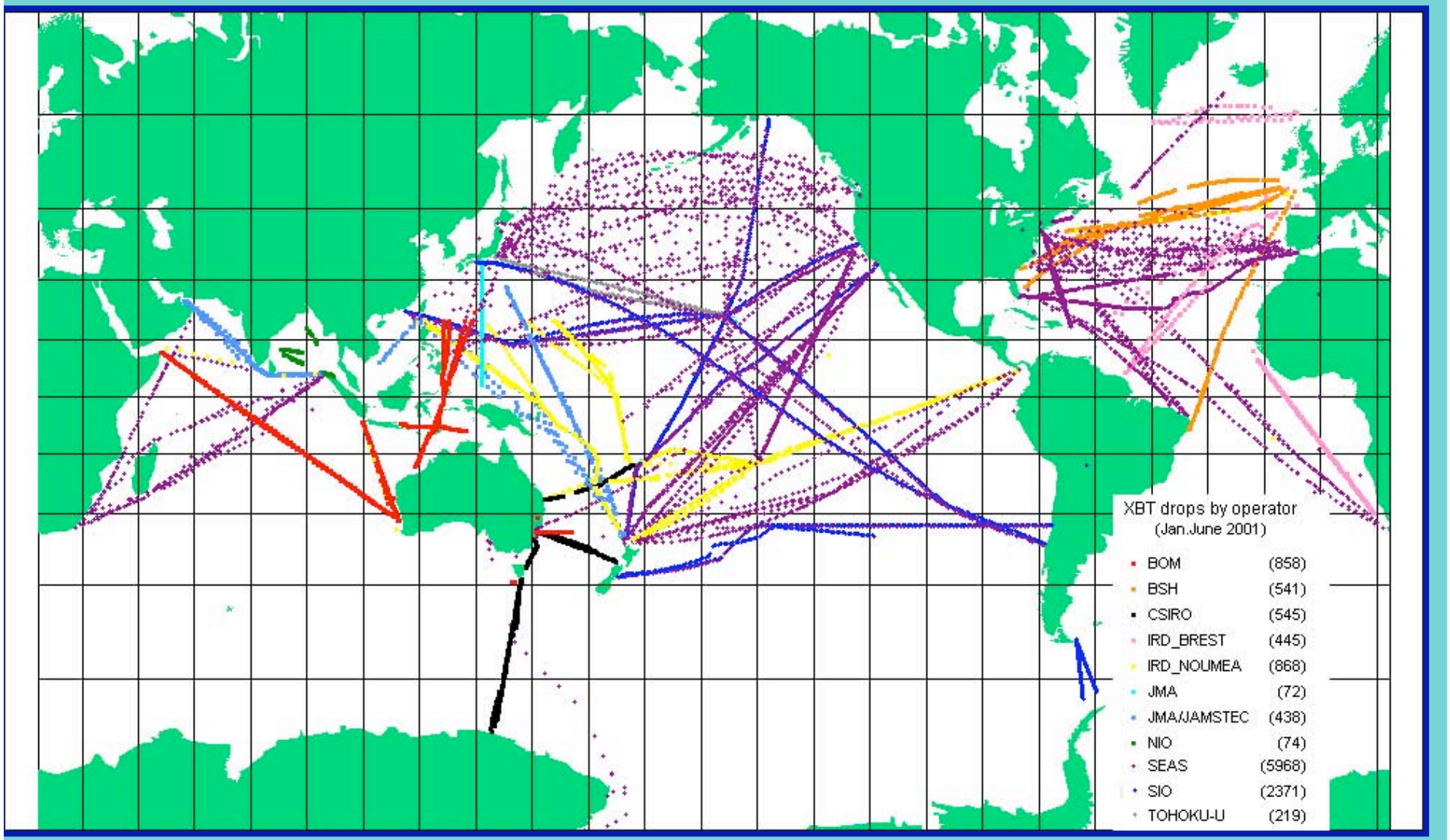
- TP class altimetry
- Vector winds a là QuikScat
- SST (IR+Microwave)

XBT and ARGO July 2003



Austral winter sampling poor.

XBT Jan-June 2001

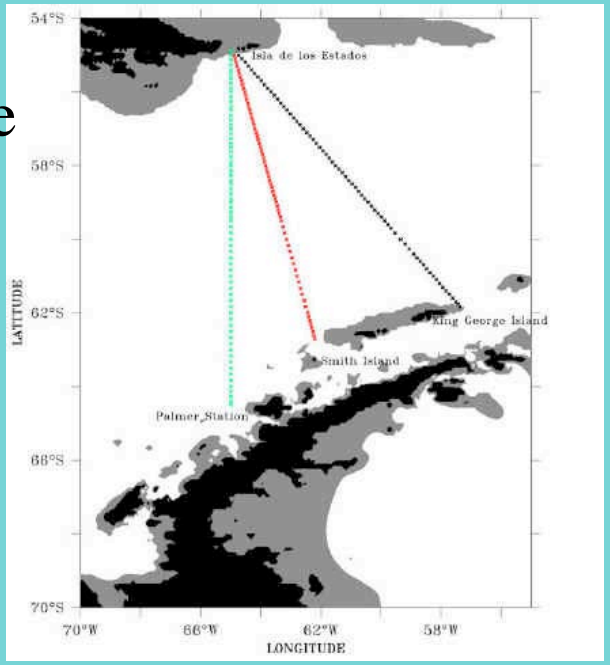


6 month period shows transpacific, Drake Passage and Tasman lines

Southern Ocean HD XBT Lines

Drake Passage

(6-8x per year; SIO)



Only Drake Passage approaches needed sampling rate…

Upgrade ADCP to deeper profile

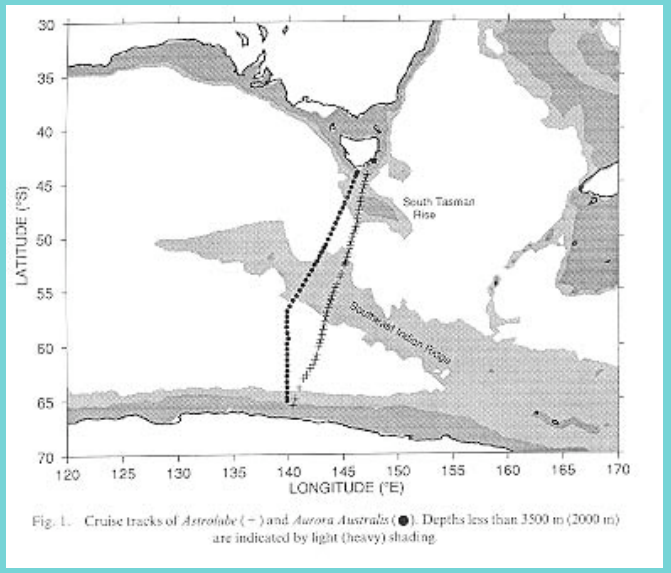
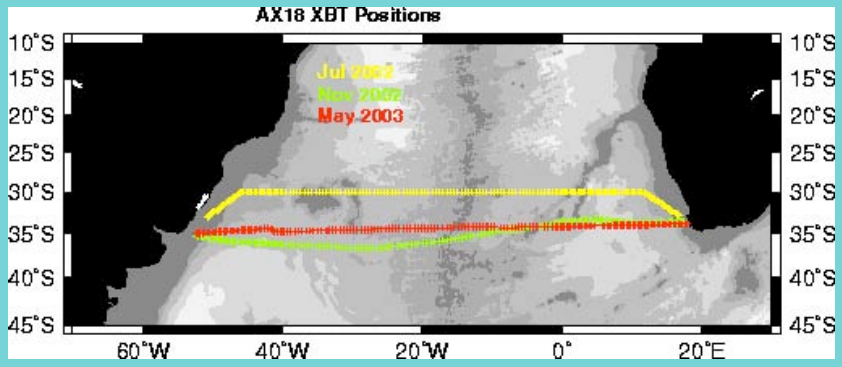


Fig. 1. Cruise tracks of *Astrolabe* (+) and *Aurora Australis* (●). Depths less than 3500 m (2000 m) are indicated by light (heavy) shading.

Tasmania-AA (6x/summer - n.b. aliasing; SURVOSTRAL)

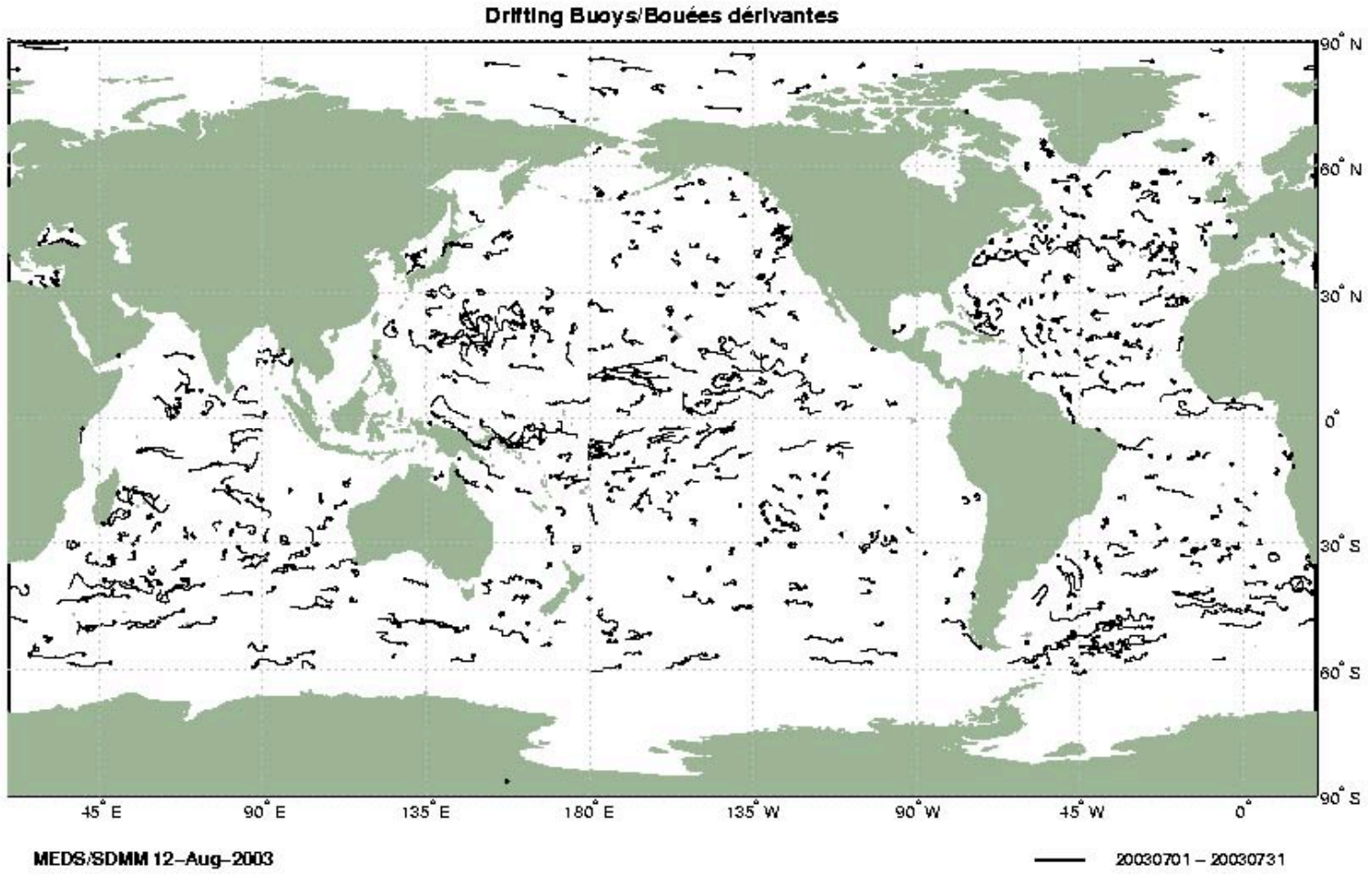
Transatlantic (0-2x/yr; NOAA AOML)



New lines proposed south of Africa (Goodhope)

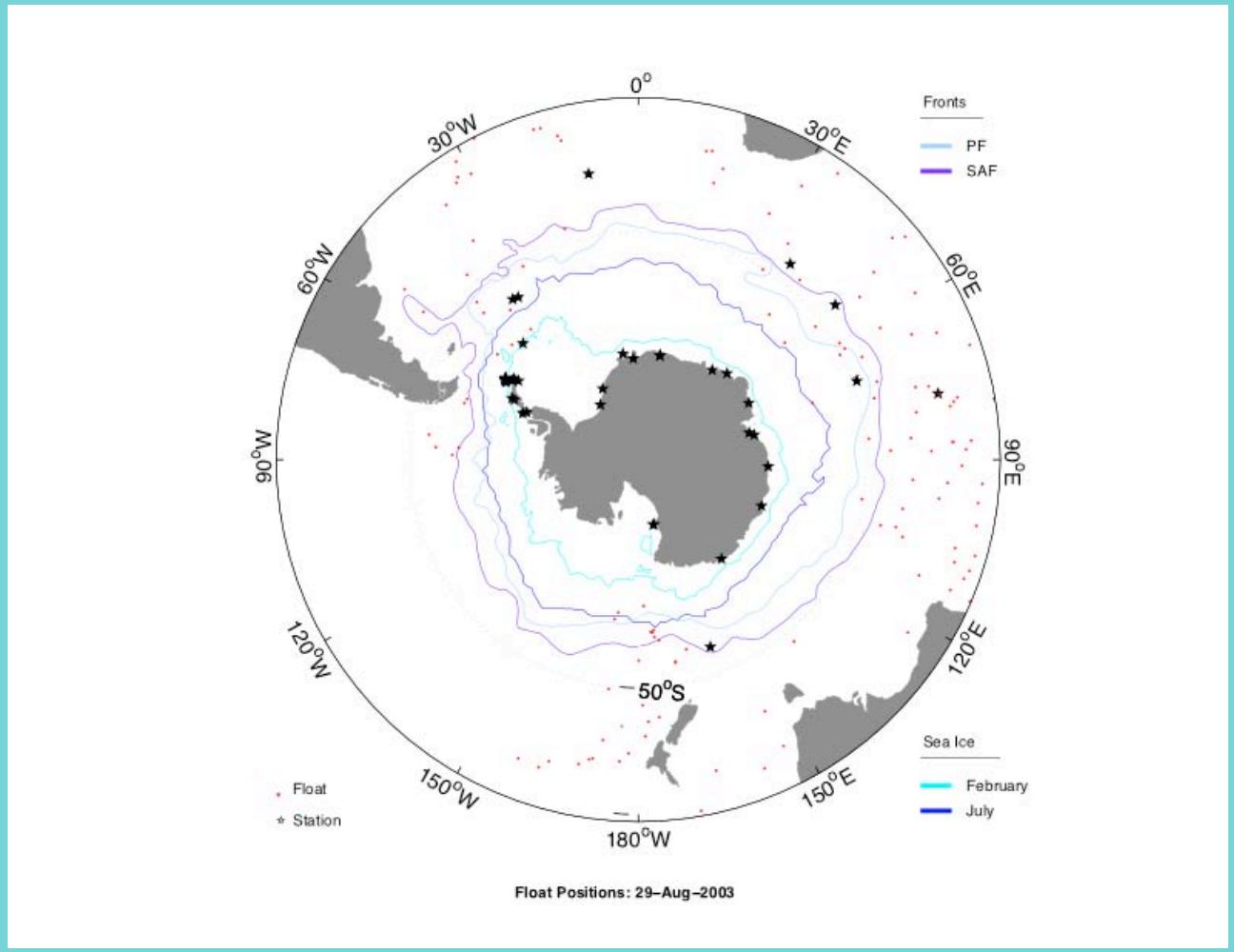
Retain Pacific 32 S (?)

Drifters



5 x 5, Are data actually used?

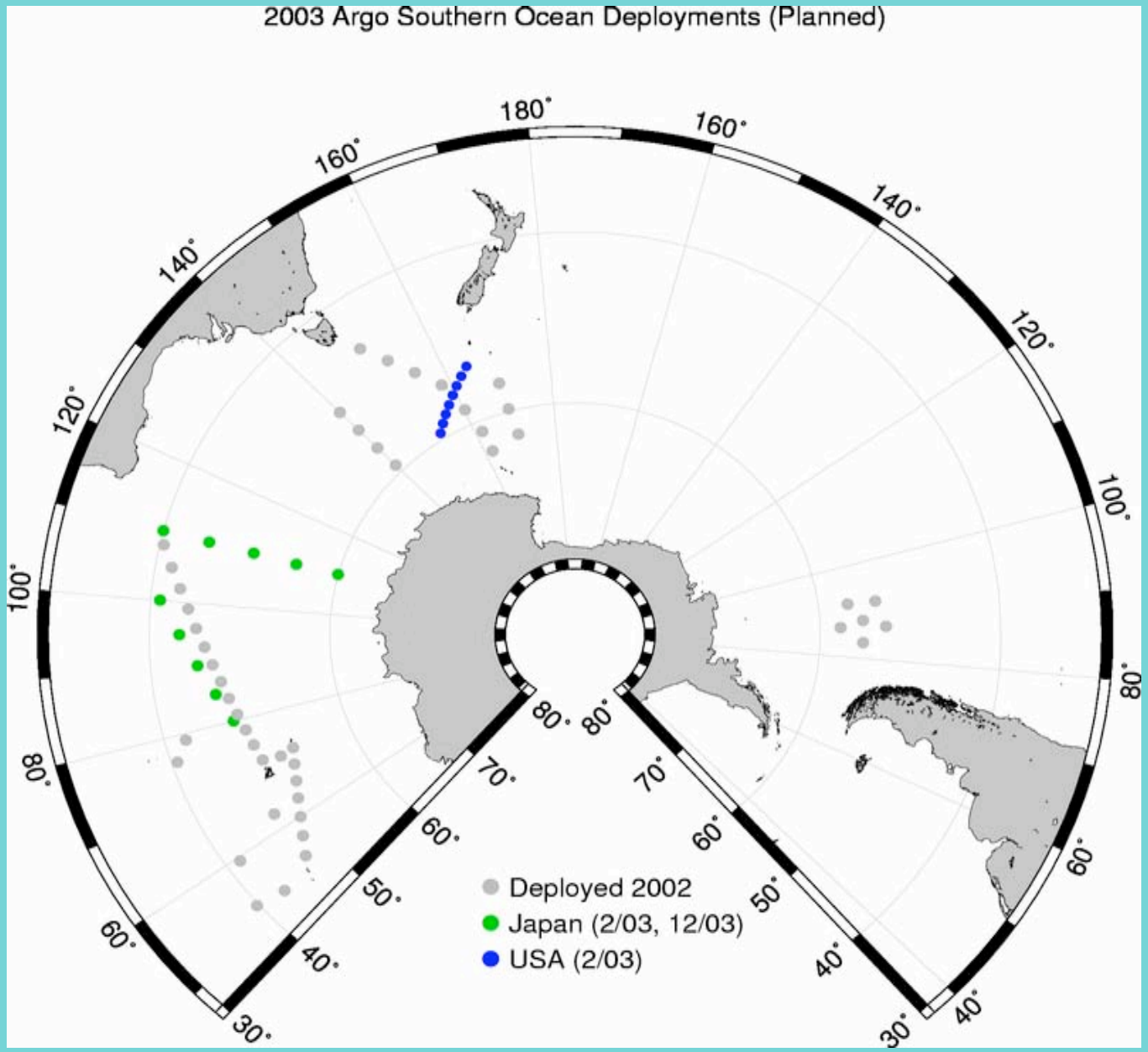
ARGO Southern Ocean



Pacific sector coverage ~nil, Atlantic poor.

N/900 << 1

No long-term sampling in sea-ice zone



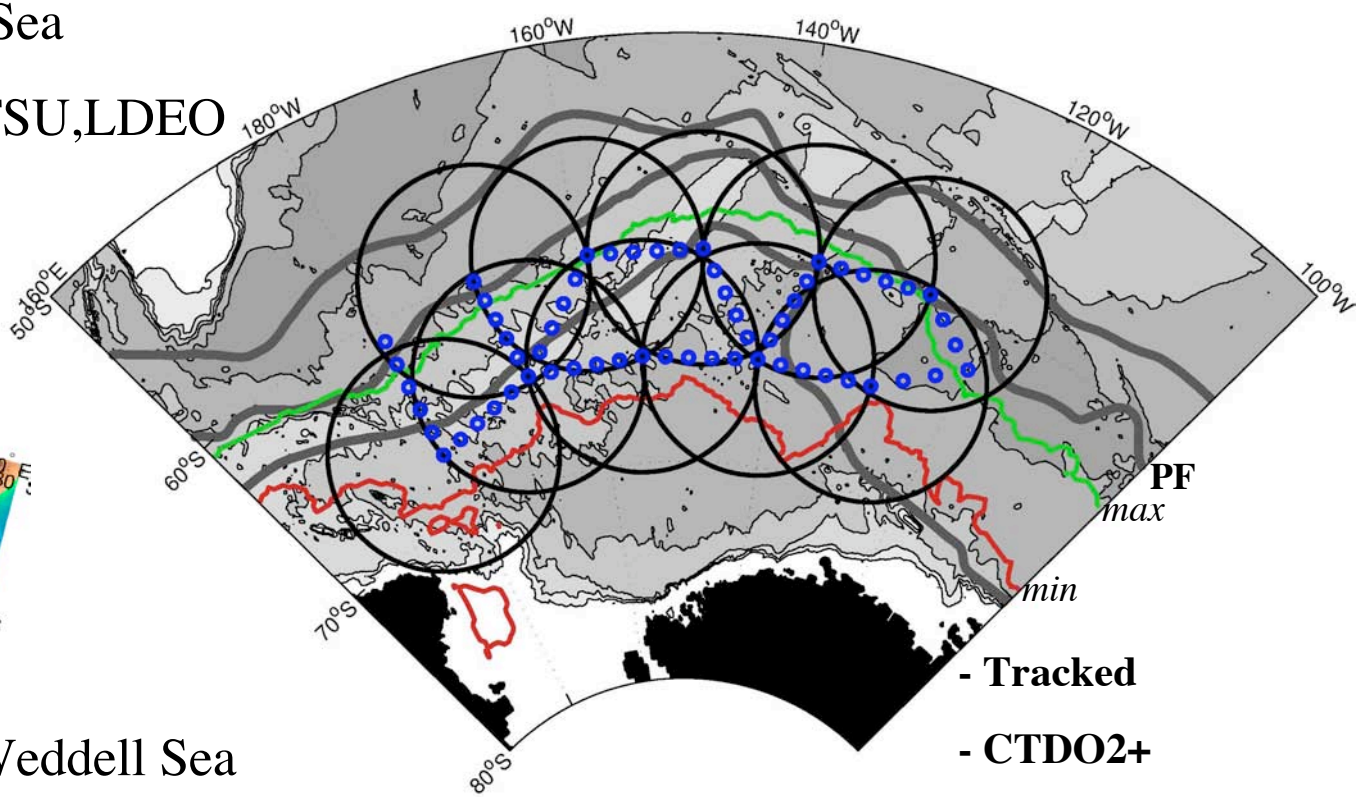
Deployment gap in the South Pacific sector

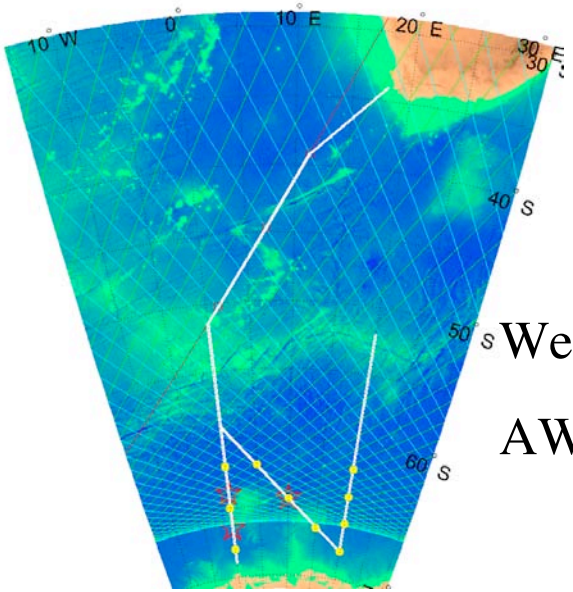
Plans to charter vessels to fill gap…

Profiling floats in the seasonal sea-ice zone: a new sustainable measurement

Ross Sea

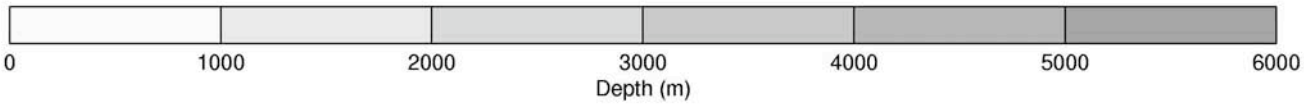
UW,FSU,LDEO



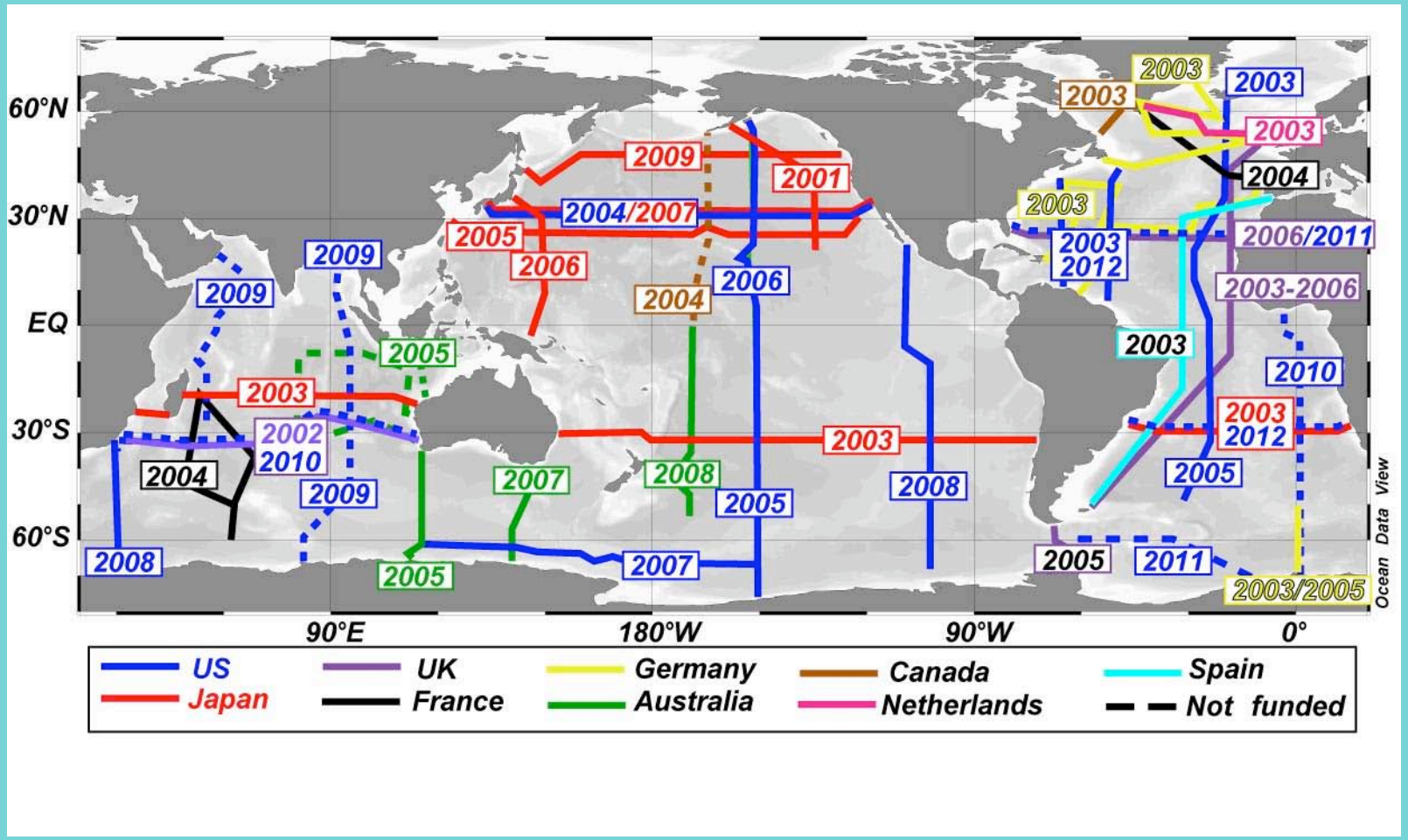


Weddell Sea

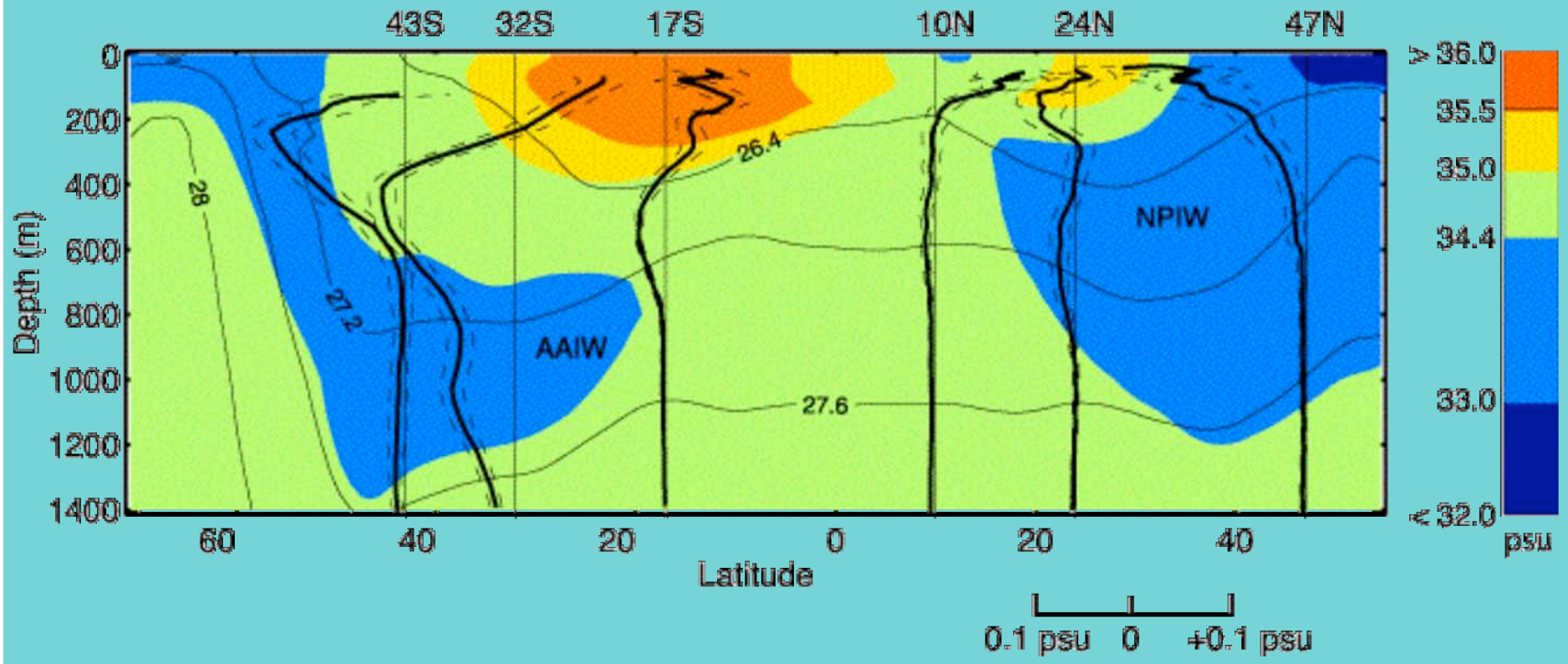
AWI, LDEO



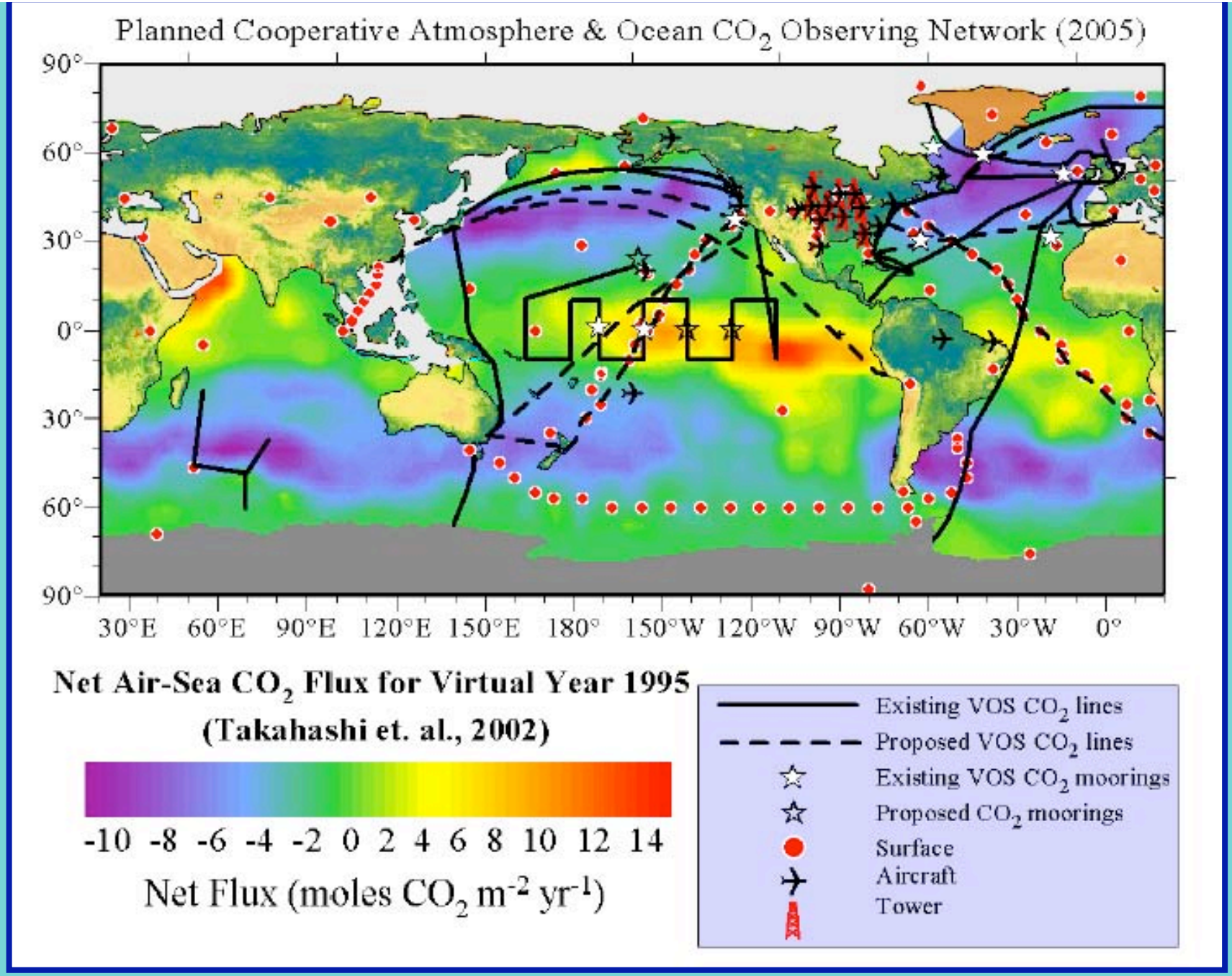
Repeat hydrography - decadal time scale (Climate signal and Carbon inventory)



Freshening of Subantarctic Mode Water



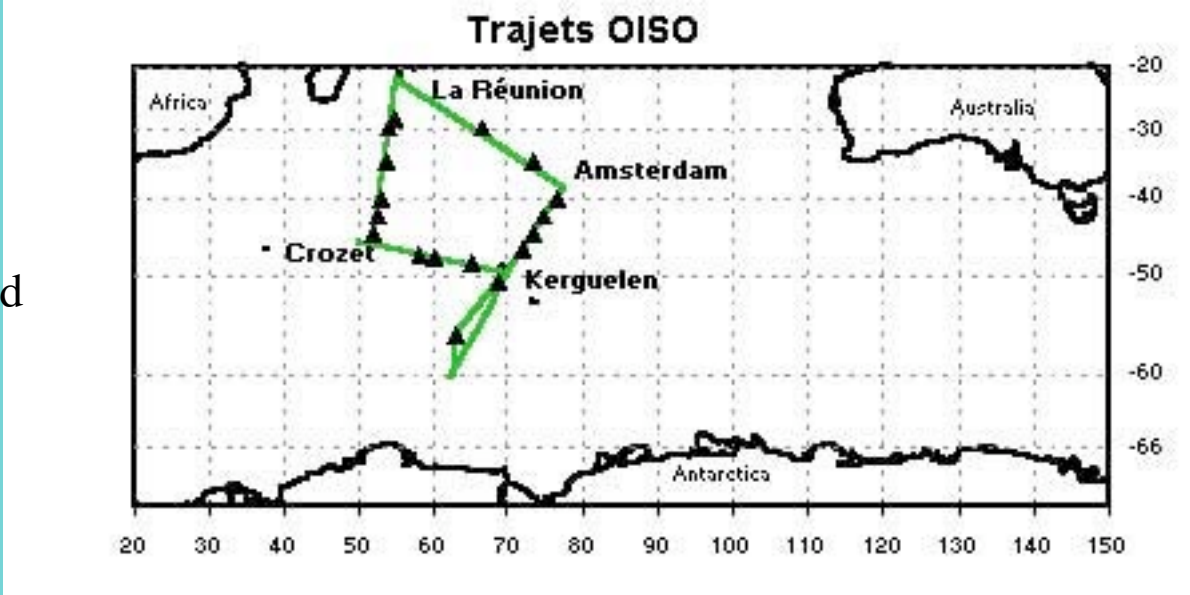
Wong et al. 1999



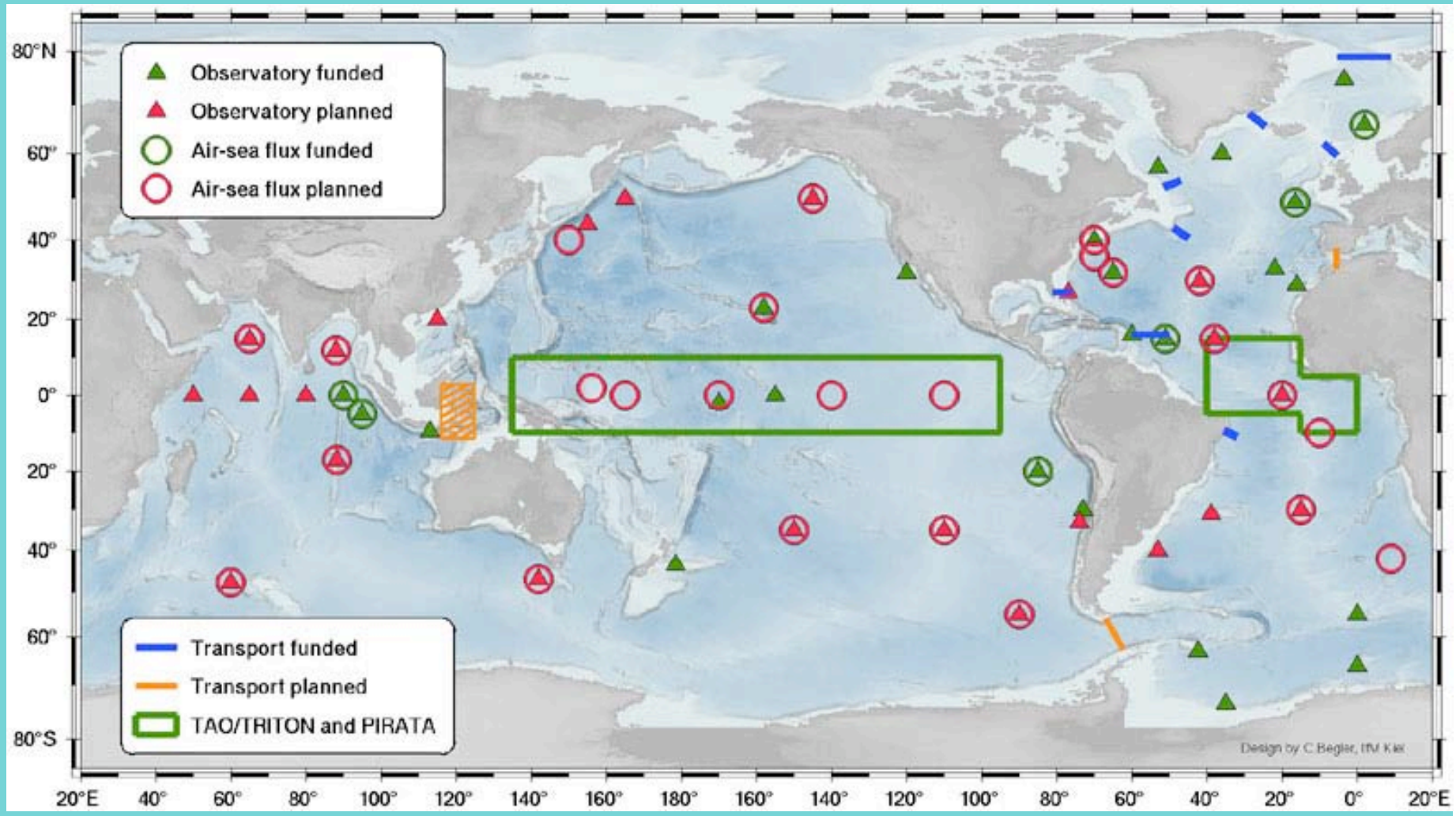
Sustained CO2 measurements

OISO: Indian Ocean repeat surface measurements

Surface CO2 chemistry, meteorology, and ADCP, 2 occupations/yr

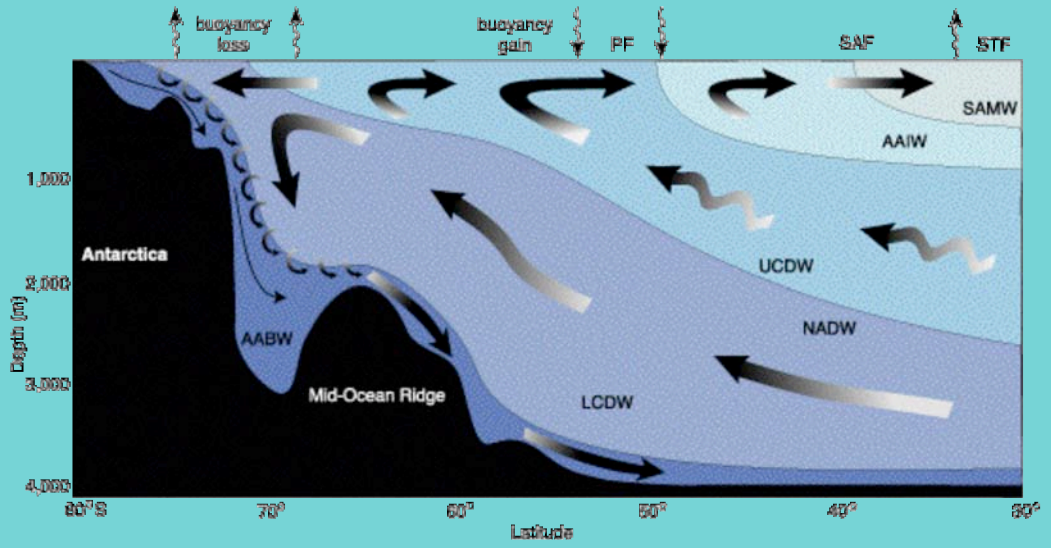


Time-series reference stations



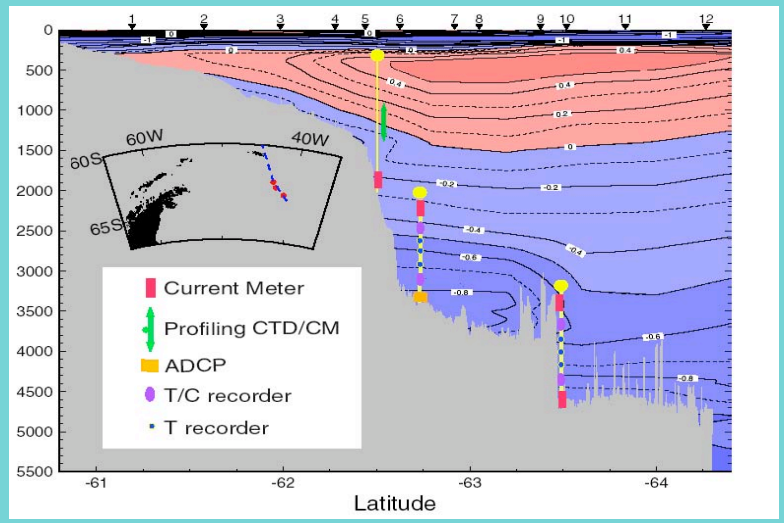
Southern Ocean: Crozet, SE Pacific; missing Ross Sea and Indian sector subsurface stations

Subsurface time-series



Meridional overturning circulation

Weddell Sea western boundary current "outflow". Similar arrays in other locations.



Sustained Transport Measurements

- Measurements from fixed points required to monitor transport.
- Repeat sections are necessary, but not sufficient: sampling in time too coarse to avoid aliasing.
- Learning how to incorporate altimetry.
- Fixed point time series have a key role
  - boundary current signals
  - end-point monitoring
  - absolute velocity

Where?

- Antarctic Circumpolar Current
  - how to monitor net transport through wide passages?
  - baroclinic from T,S moorings, XBT
  - barotropic variability from pressure gauges
  - mean barotropic? (leveling pressure gauges? jumps?)

- Deep boundary currents (need in-situ monitoring since sea-ice zone boundary conditions so poorly known)
  - German, US arrays in northwest Weddell
  - Ross Sea and Princess Elizabeth Trough sites?

- Subtropical - Southern Ocean exchange
  - can end-point monitoring do the job? (for transport? for heat flux? arrays? altimetry? Need design study…

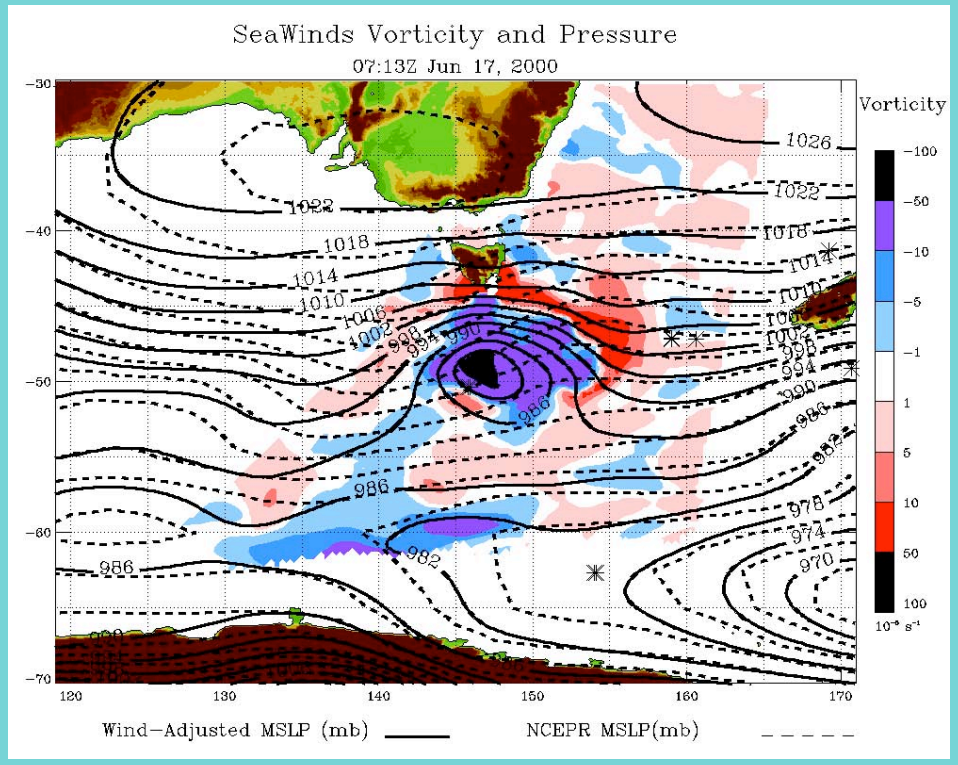
Satellite Observations

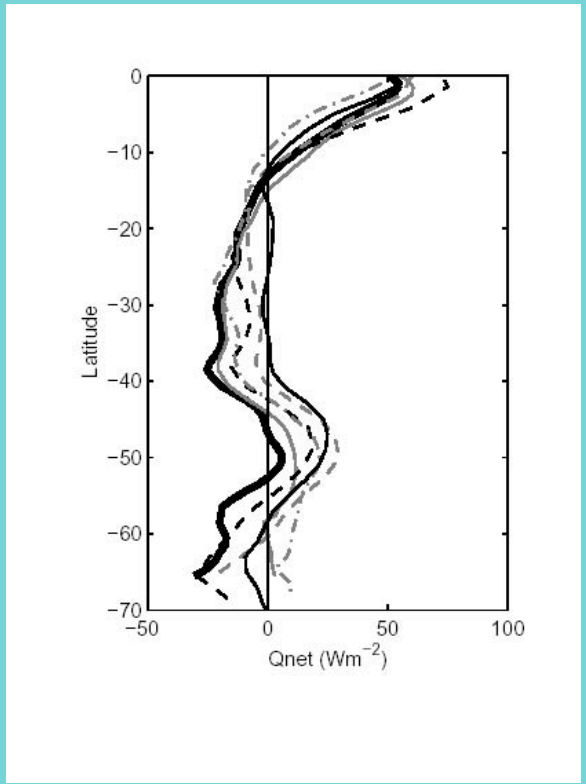
Have problems too…

- TOPEX/Poseidon
- Winds QuikSCAT (6 am and 6 pm) coverage is nearly global. (US)-SeaWinds on ADEOS-II (10:30 am and 10:30 pm)
- SST Infrared difficult to interpret in the Southern Ocean, except perhaps on monthly scales because of clouds and diurnal cycle aliasing..

Tandem scatterometer mission and probably a tandem microwave temperature mission, plus in-situ high-frequency variability obs to improve bias due to gaps, clouds.

Winds and air-sea fluxes

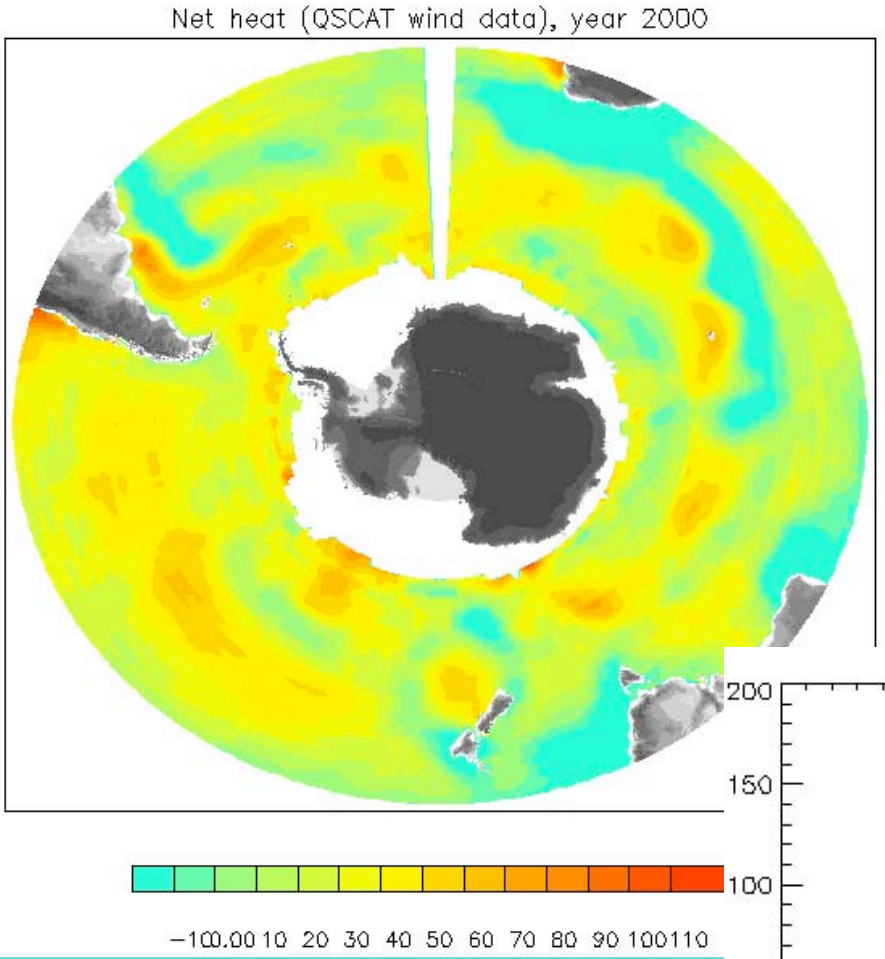


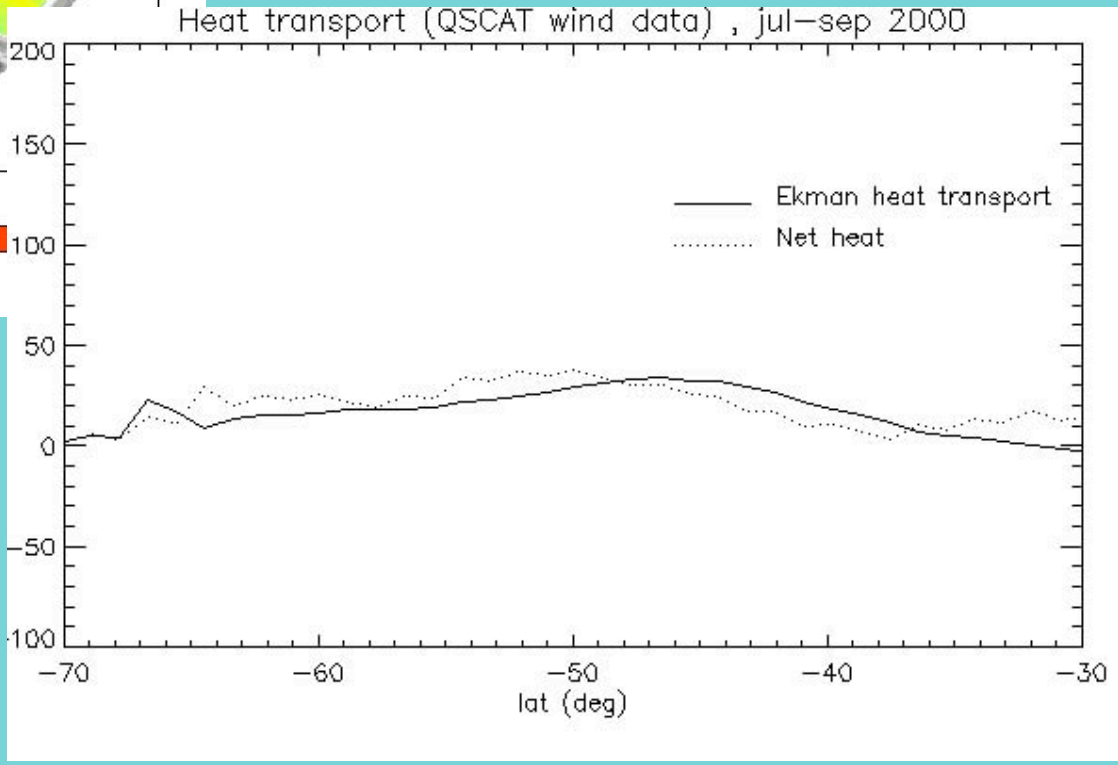


Preliminary QSCAT Results

(Bourassa and Wacongne)

Biases remain…but role of synoptic scales important - more structure in mean fields





Enhancements:

Calibration: IMET, Buoys, AWS, get good data into NWP system…

Enhancements *(with help from S. Gille et al.)*

DRIFTERS

- ARGO spatial coverage, esp. SE Pacific sector; also extension to the seasonal sea-ice zone (can't be global w/o ice zone).
- Surface drifters - wind slip calibrations, high wind conditions - extend these tests to the Southern Ocean.

SURFACE METEOROLOGY

- Enhance IMET coverage. In situ sampling of the diurnal cycle of SST and wind will help with interpretation of sun synchronous satellite observations.
- Meteorological buoys in the seasonal sea-ice zone (Tair, wind…).
- AWS on subantarctic islands.
- Surface Time-series stations in SE Indian (high mean wind conditions - *some technological buoy development required*) and Pacific-AA (synoptic variability) sectors.

SUBSURFACE OCEANOGRAPHY

- Subsurface Time-series stations/arrays in the Ross Sea, Weddell Seas, and Princess E. Trough. Need in-situ monitoring since sea-ice zone boundary conditions so poorly known.
- XBT (sampling on Drake, Tasman, African, 32 S)

SEA-ICE

- Sea-ice thickness important for climate models (echo sounders) and Met buoys in the sea-ice zone for sea-ice dynamics.