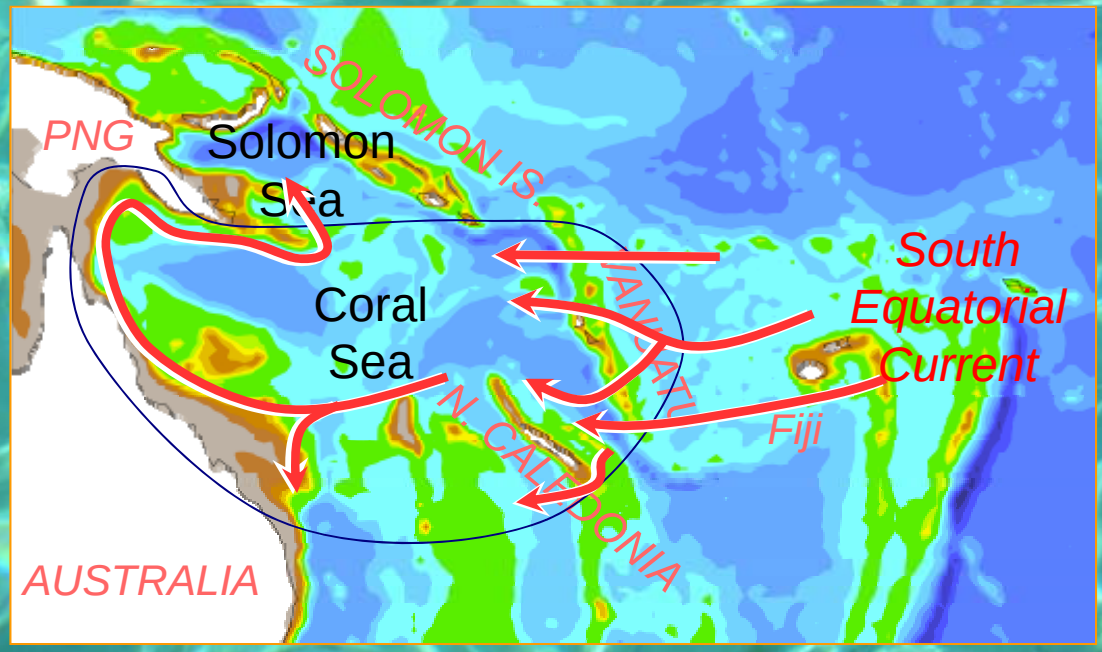
Monitoring the northern limb of the subtropical gyre with high-resolution XBT surveys in the South Pacific Ocean

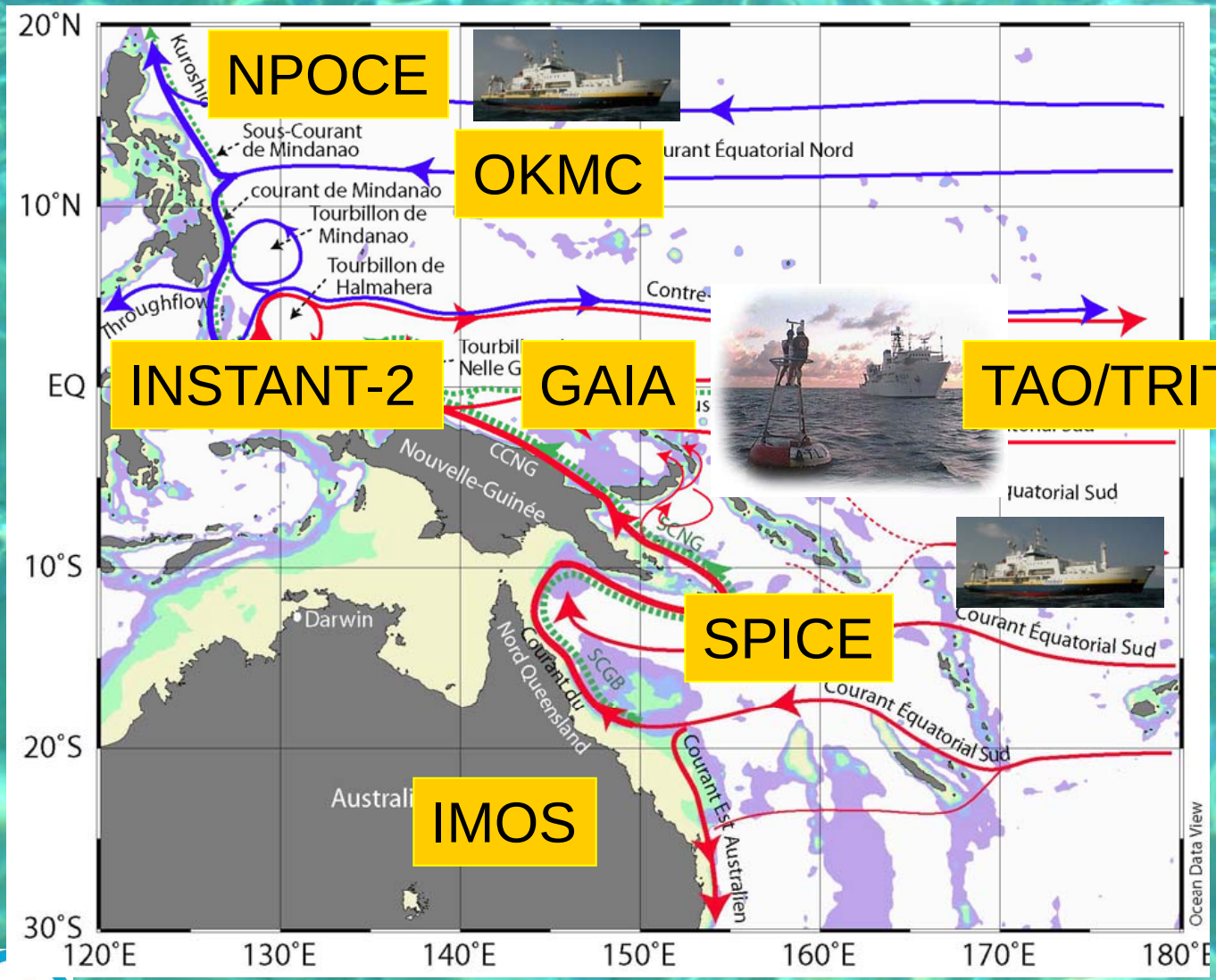
C. Maes, A. Ganachaud, D. Varillon, F. Durand

Institut de Recherche pour le Développement, Nouméa

New Caledonia

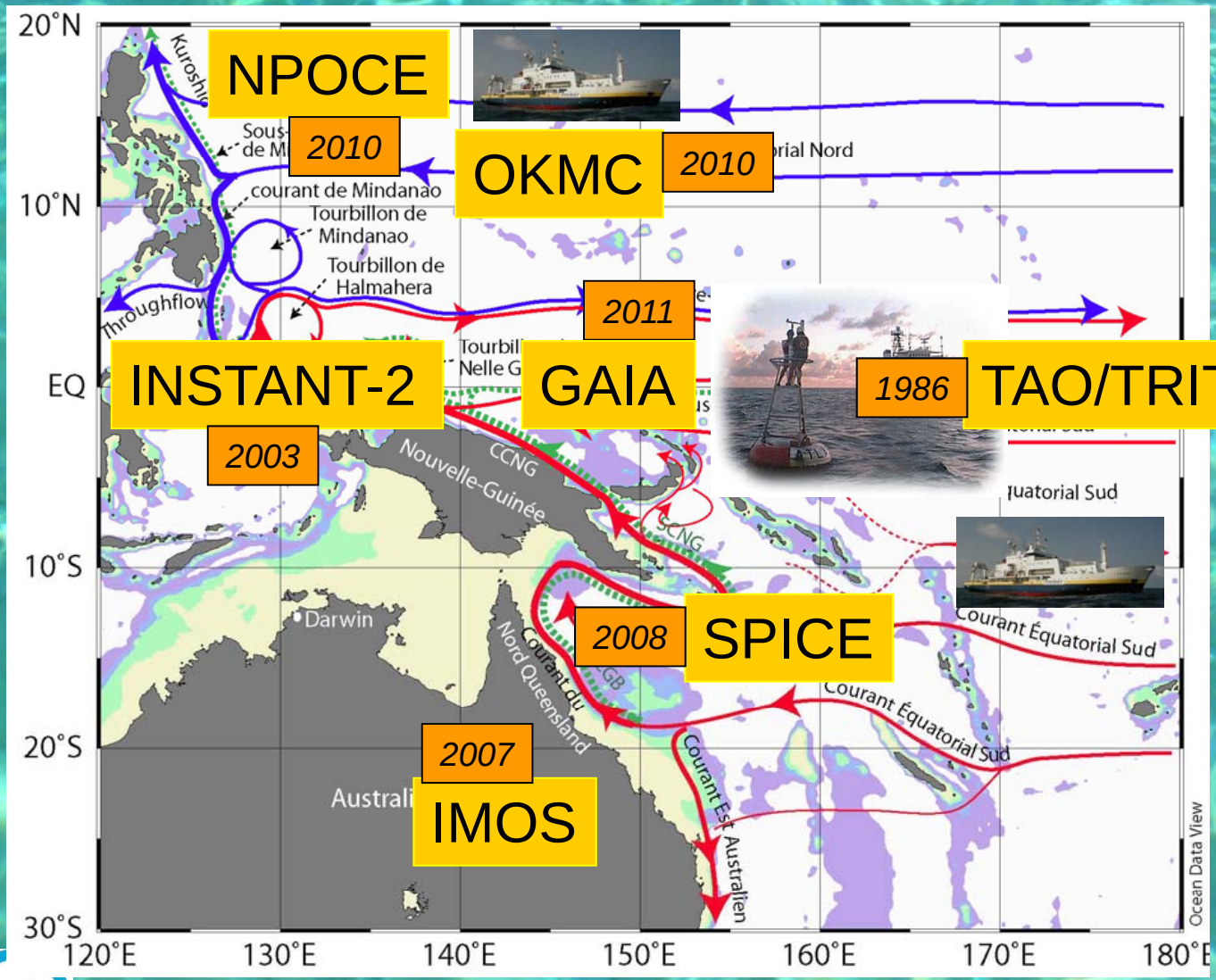


A West Pacific coordination



CLIVAR Newsletter, 2010
M. Fieux, 2010

A West Pacific coordination



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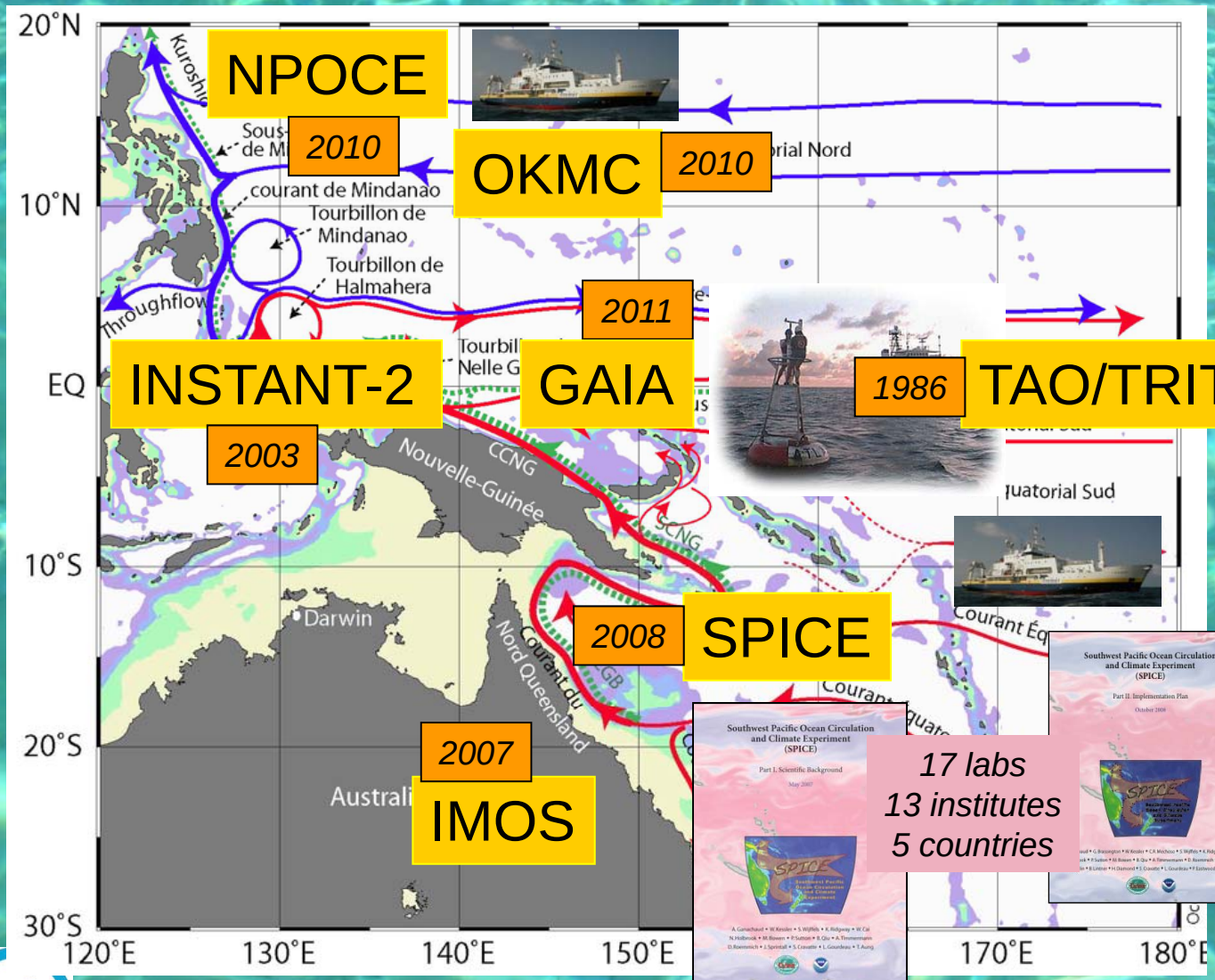
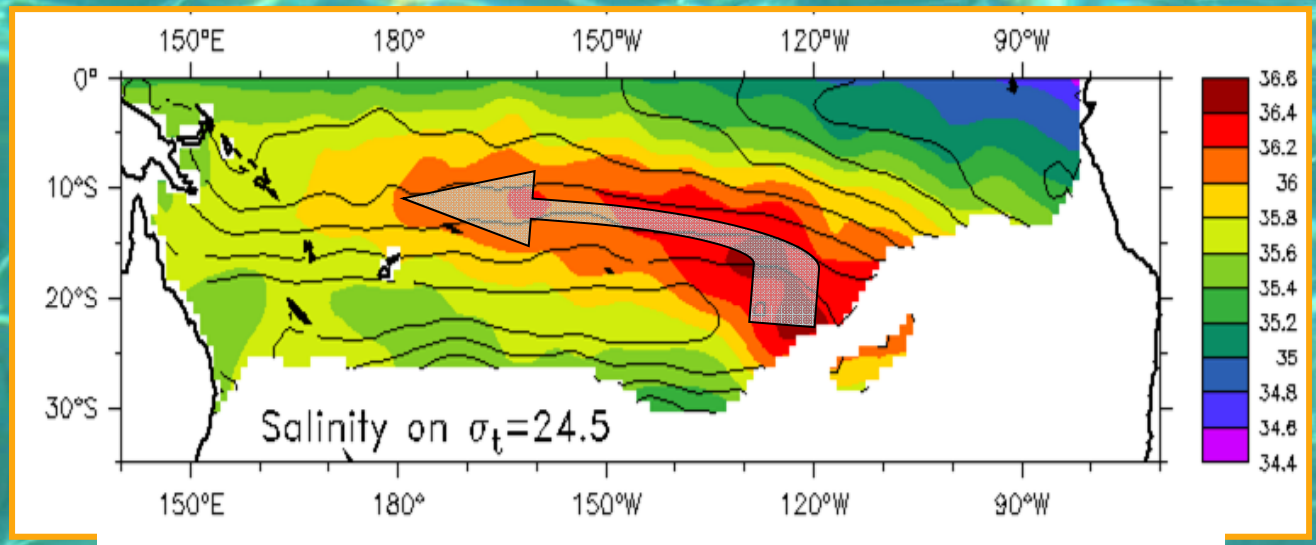
A West Pacific coordination

www.clivar.org



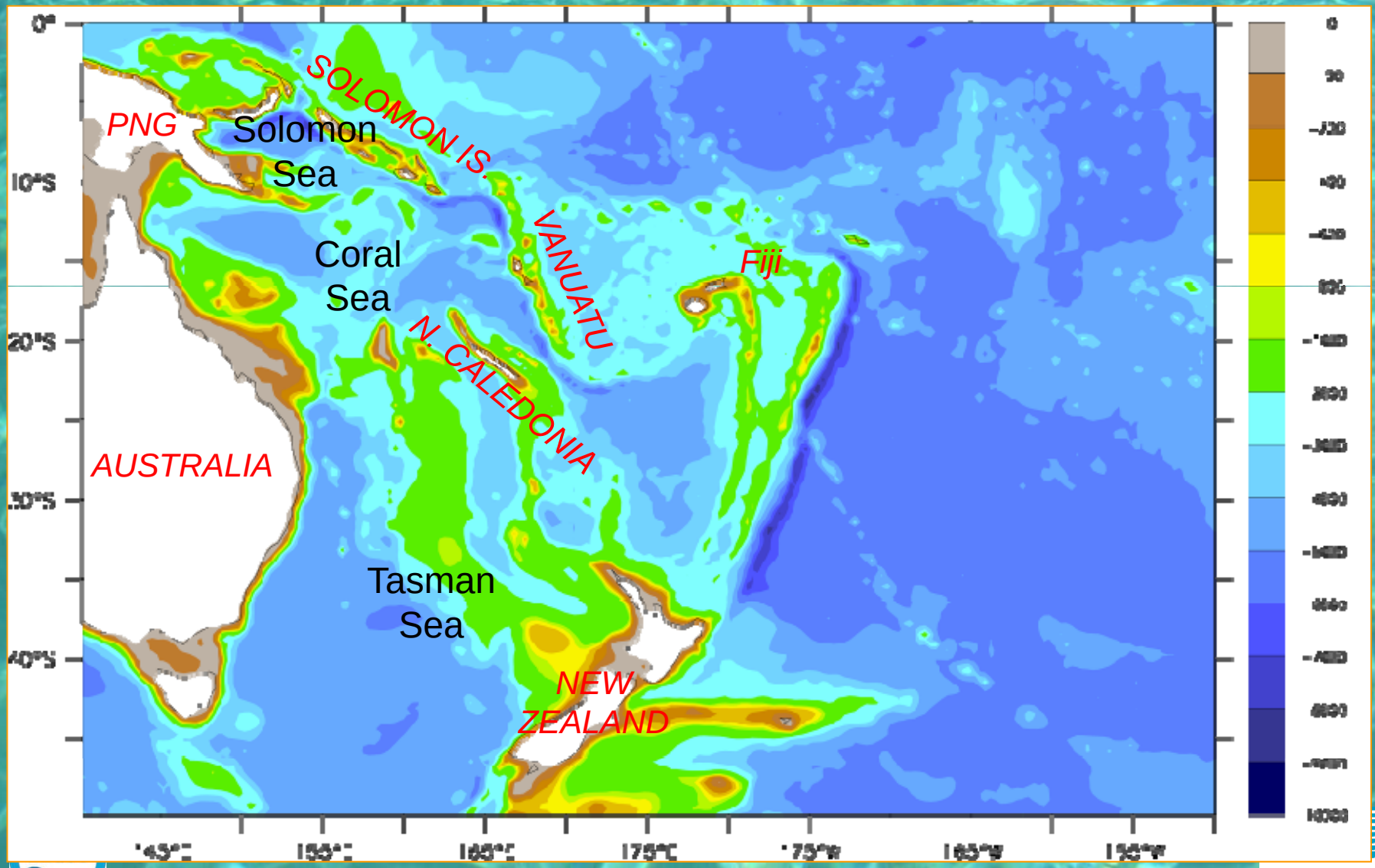
Why SPICE ?

Decadal climate variability
Connection subtropics to equator
and Tasman Sea **through WBCs**

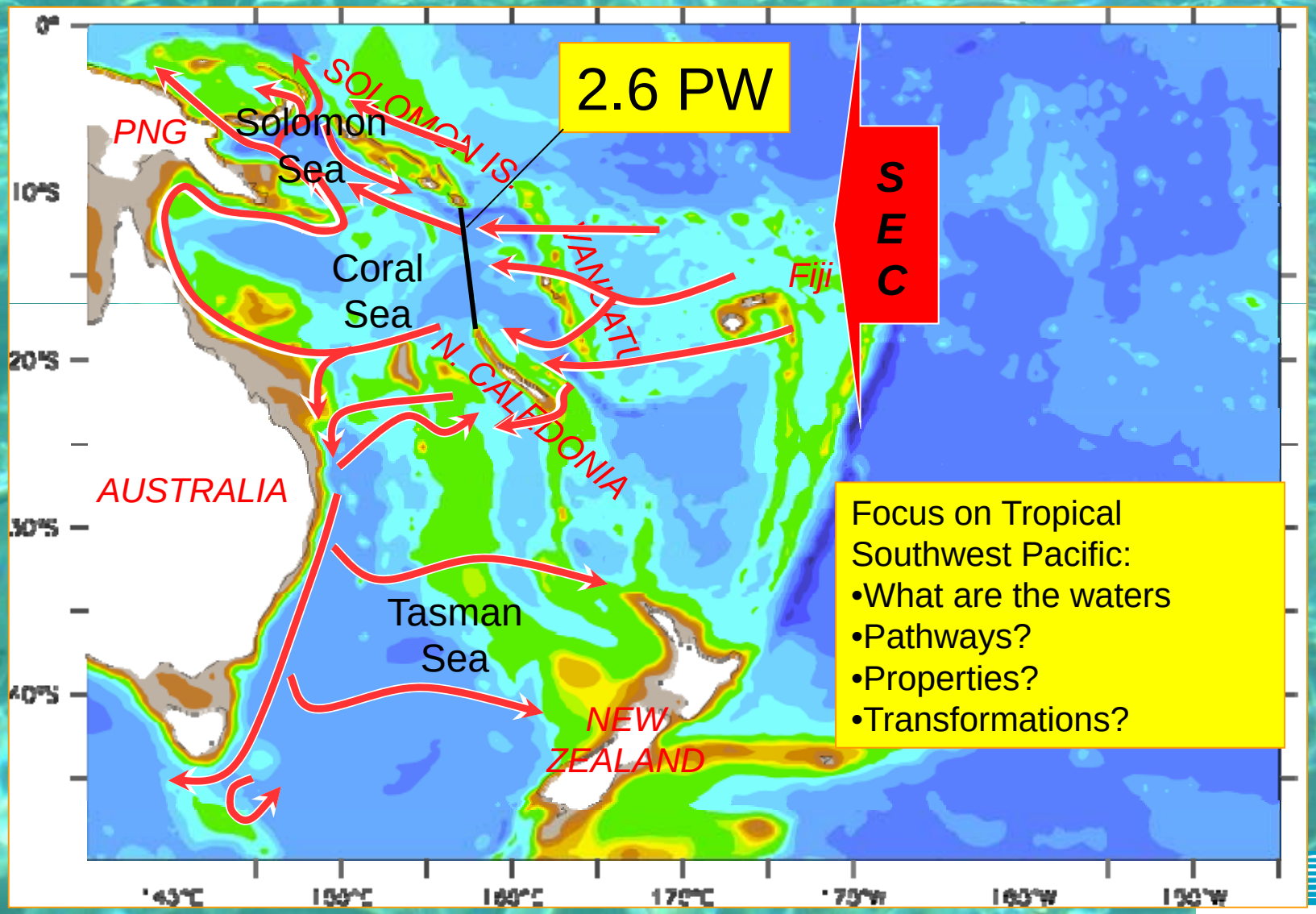


Salinity and geostrophic streamlines on 24.5 (courtesy B. Kessler)

Southwest Pacific topography

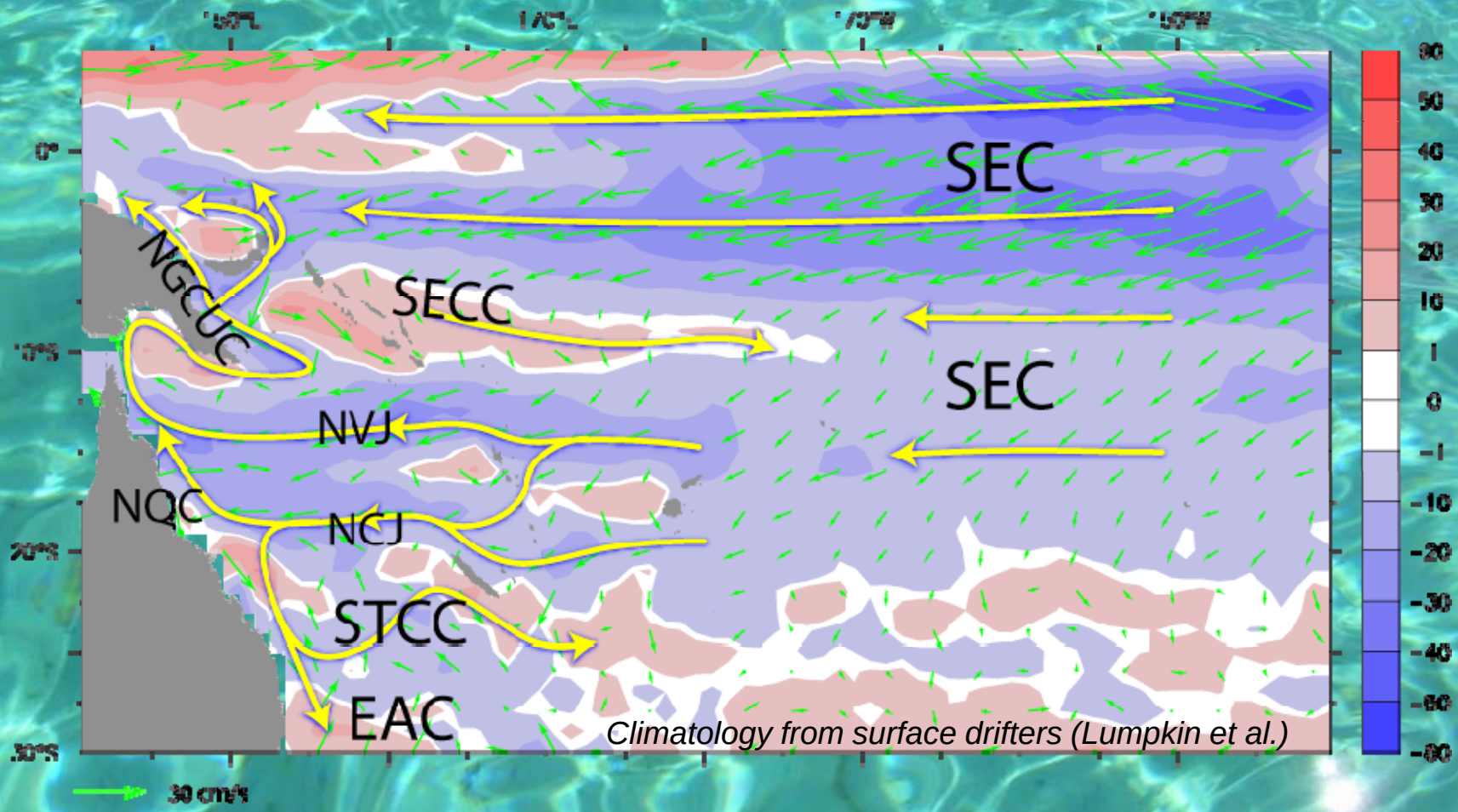


Fate of the incoming warm water

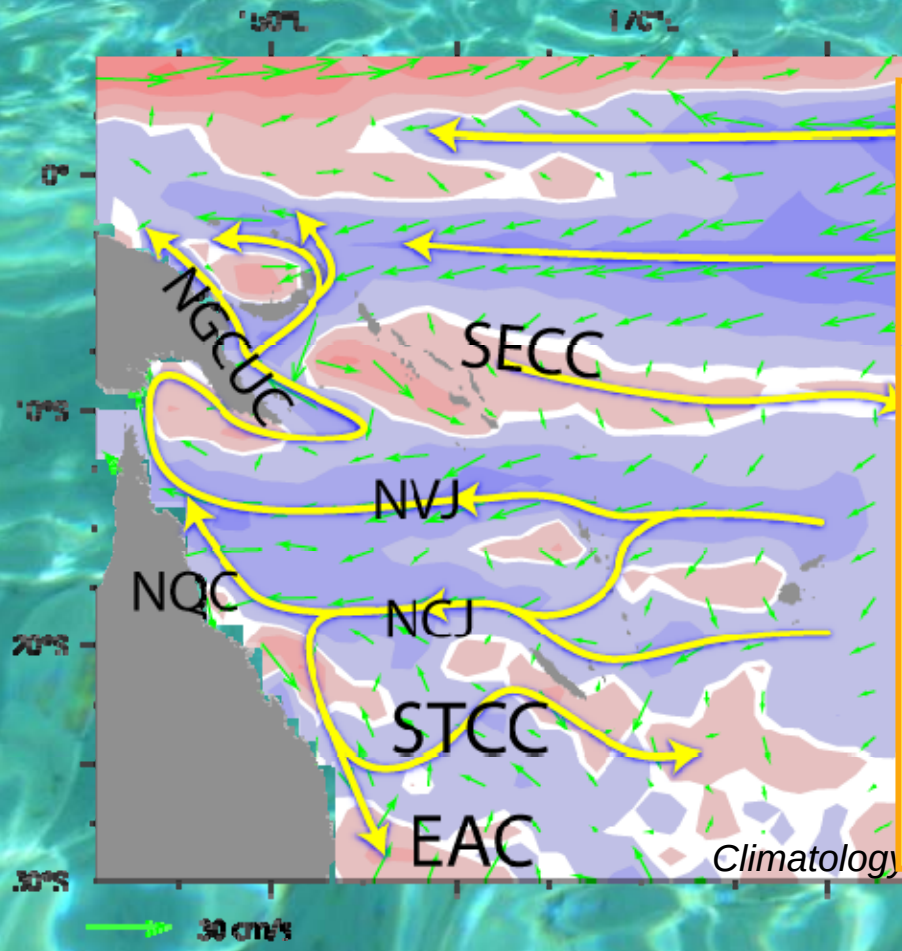


Focus on Tropical Southwest Pacific:
- What are the waters
- Pathways?
- Properties?
- Transformations?

Ongoing experiments, Coral Sea



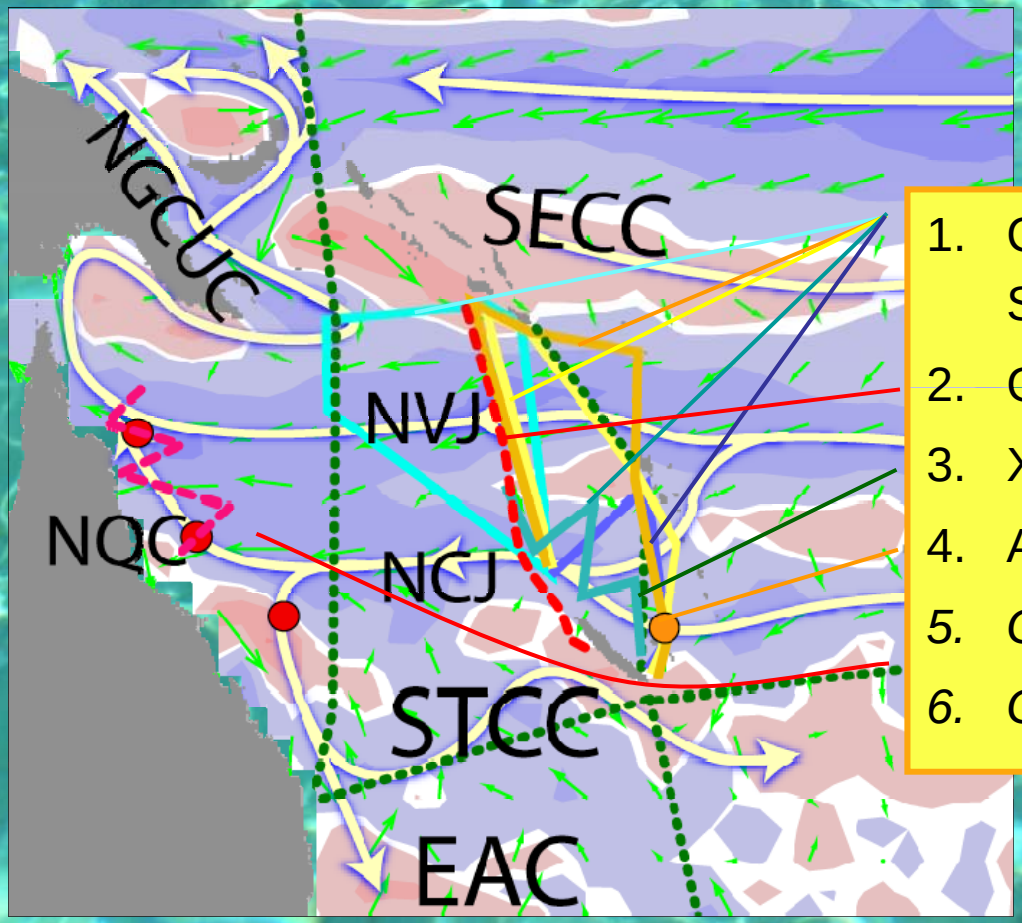
Ongoing experiments, Coral Sea



The South Equatorial Current (SEC) feeds:

- NVJ: North Vanuatu Jet
- NCJ: North Caledonian Jet
- WBC system:
  - EAC: East Australian Current
  - STCC
  - NQC: North Queensland Current
  - NGCUC: New Guinea Coastal Undercurrent

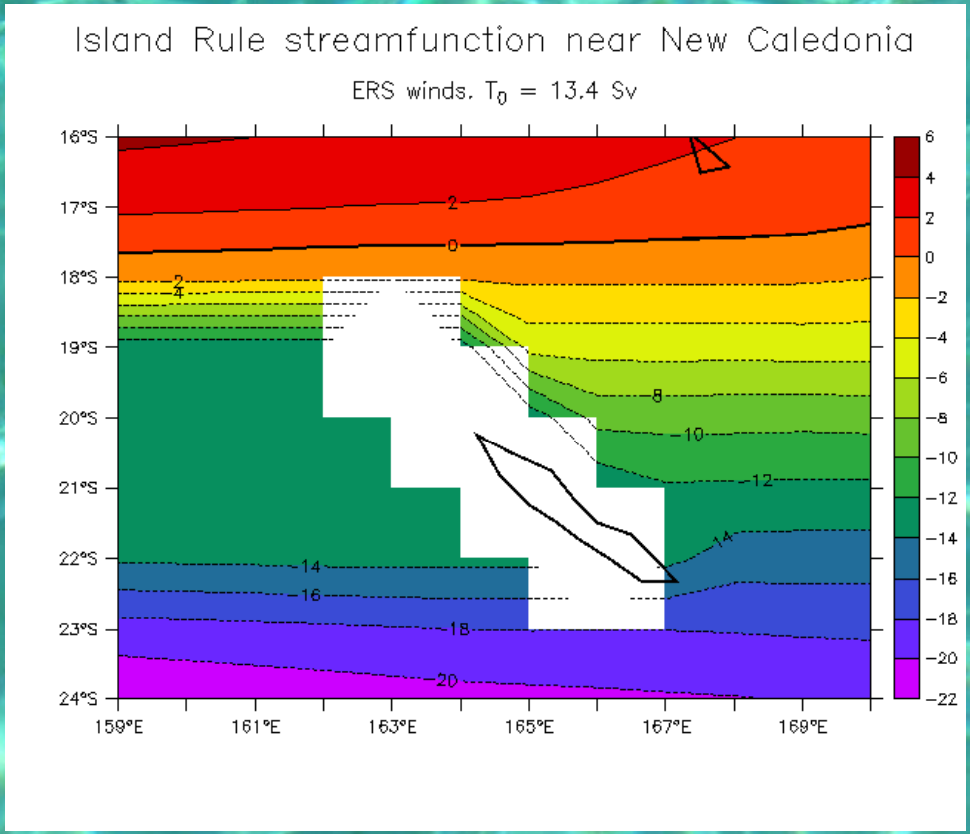
Ongoing experiments, Coral Sea



1. Cruises 2003-2010: SECALIS/FLUSEC/SECARGO
2. Gliders: SIO / IRD
3. XBT/Argo on Voluntary OS
4. Altiglidex Mooring/Satellite
5. *GBROOS Moorings NQC*
6. *GBROOS Gliders NQC*

Funding: LEFE/ANR (Solwara project); CNES (SECARGO); Coriolis; IRD; NOAA

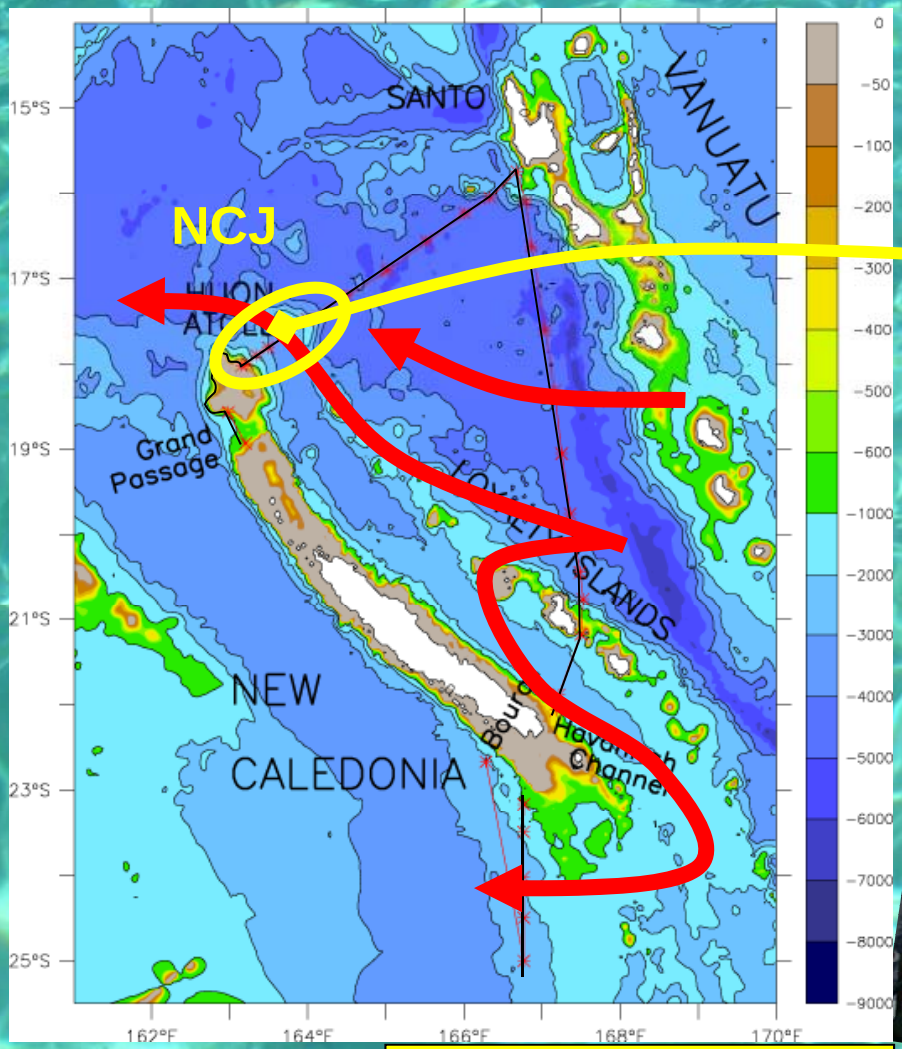
What did we learn on water mass pathways ?

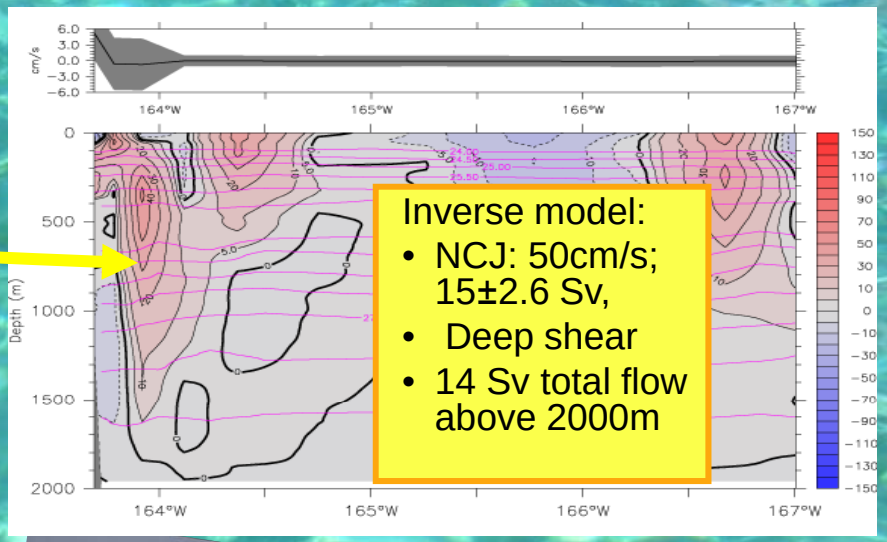


B. Kessler, August 2002:

"According to these linear dynamics, there should be a 10 Sv western boundary current along the NE coast of the island. Is that observed?"

Mean jet structures in the Coral Sea

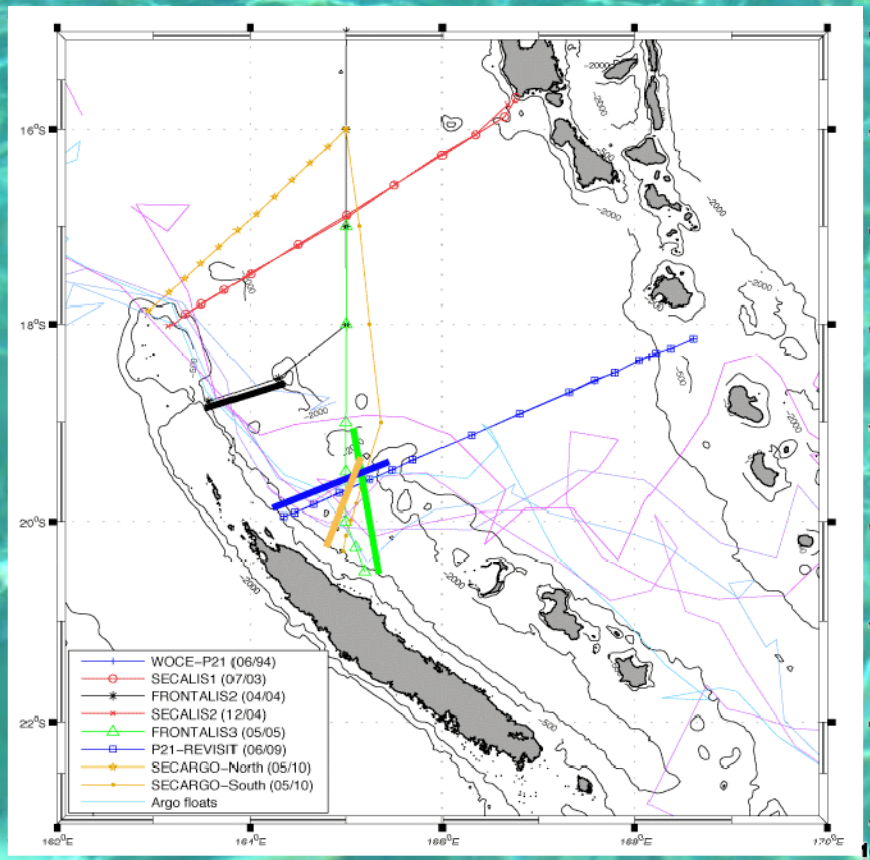


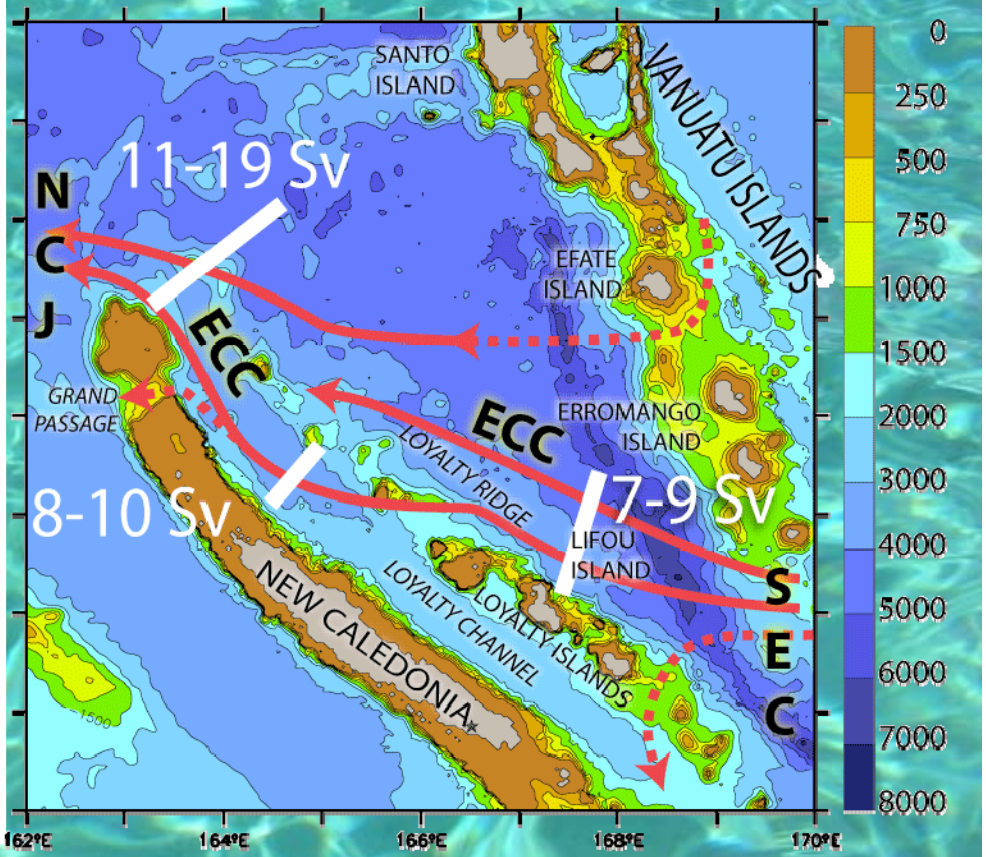


Inverse model:
- NCJ: 50cm/s; 15±2.6 Sv,
- Deep shear
- 14 Sv total flow above 2000m

Ganachaud, Gourdeau, Kessler, JPO, 2008

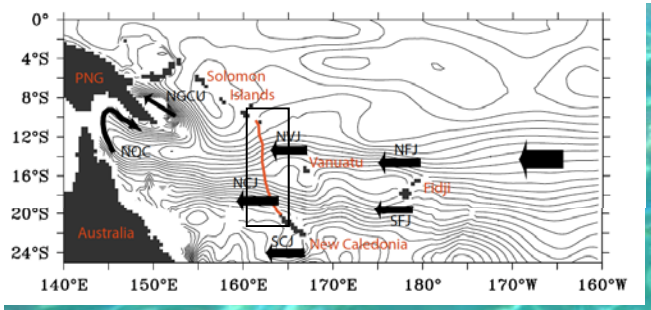
Mean jet structures in the Coral Sea

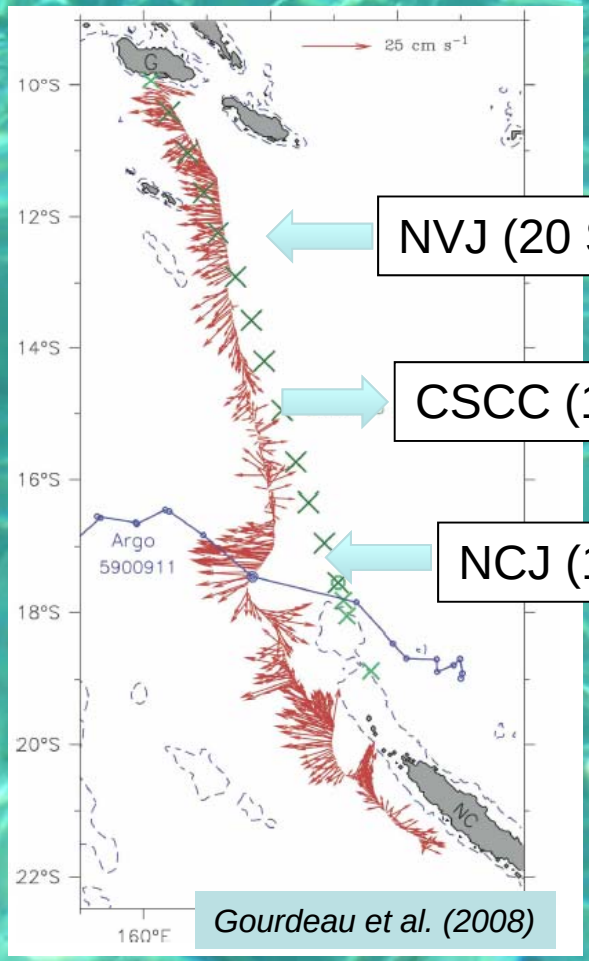




Gasparin et al. DSR, 2011

Mean jet structures in the Coral Sea





NVJ (20 Sv)

CSCC (1 Sv)

NCJ (12 Sv)

Gourdeau et al. (2008)

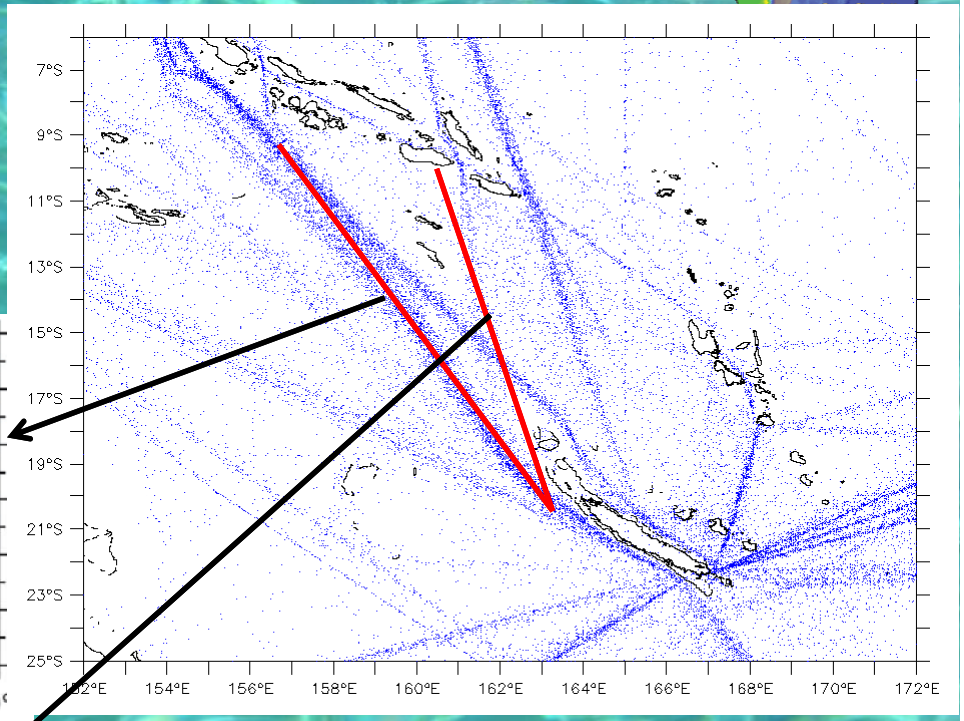
NCJ: very deep, narrow
NVJ: broader, above thermocline
About 2.6 PW enthalpy westward

PhD. Thesis, Gasparin

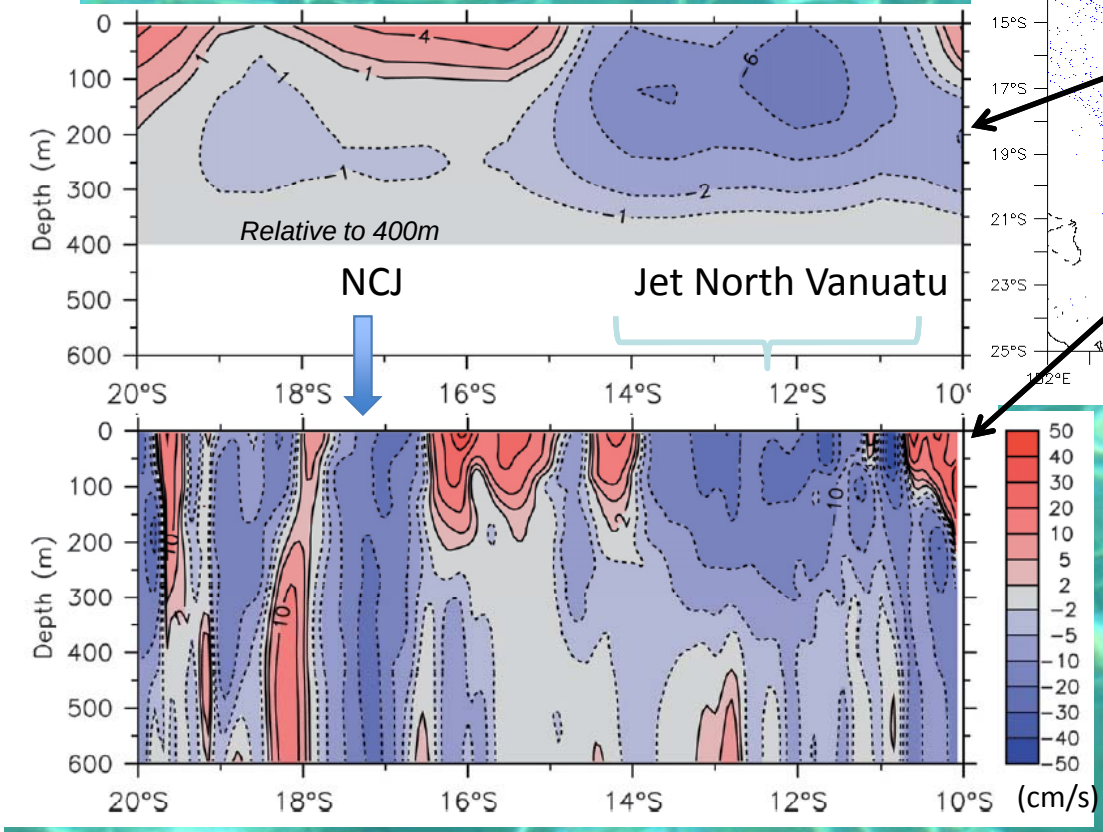
0-600m glider velocity

Monitoring the SEC variability in the Coral Sea

Historical XBT data set from Nouméa



Geostrophic near zonal current from XBT 1985-2002 (Qiu et al., 2009)



Need to monitor the jets entering the Coral Sea:
deep and HR XBT casts.

SECARGO project from Nouméa to Solomon Islands started in 2008

Cross track zonal current from a glider in Jul-Oct 2005 (Gourdeau et al., 2008)

Monitoring the SEC variability in the Coral Sea

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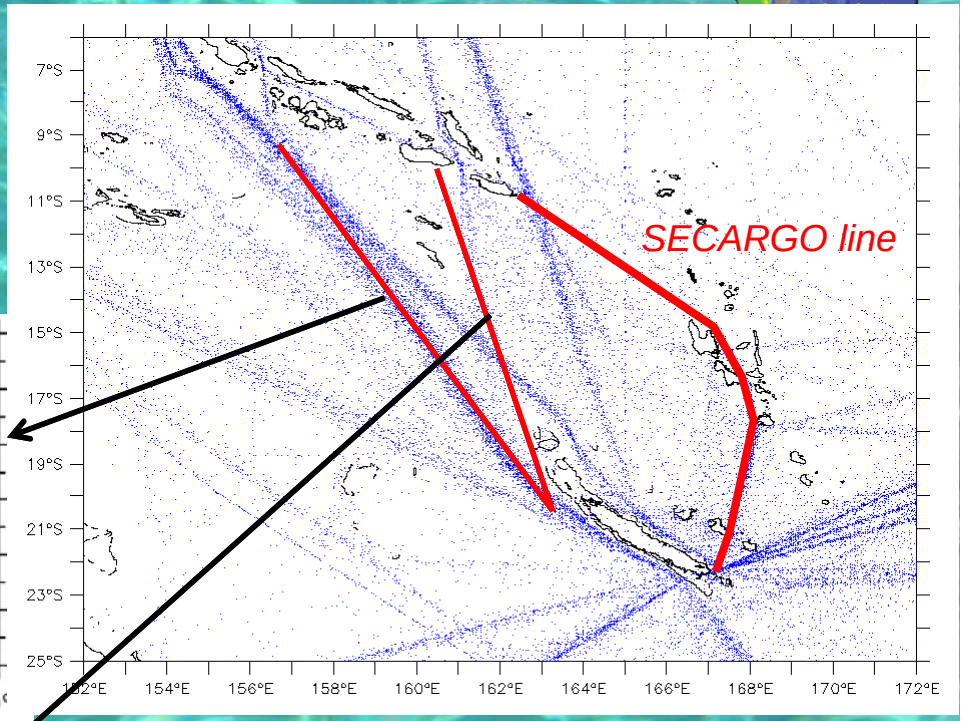

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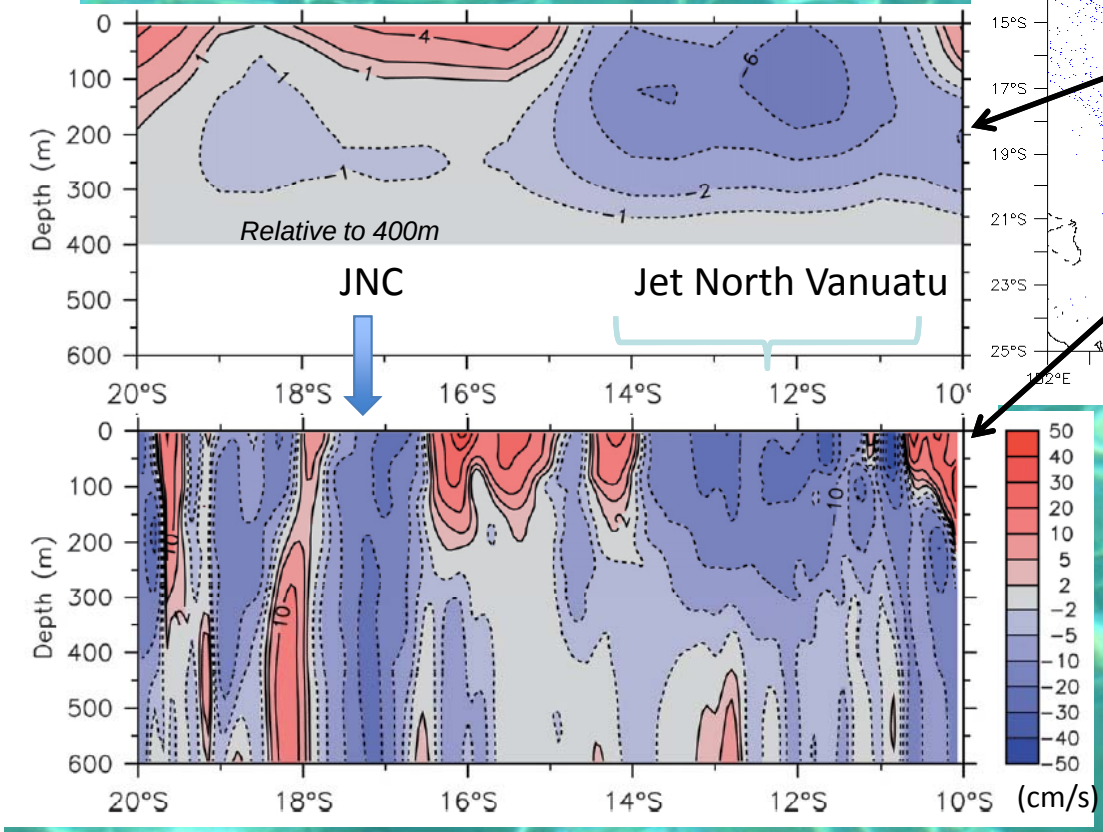

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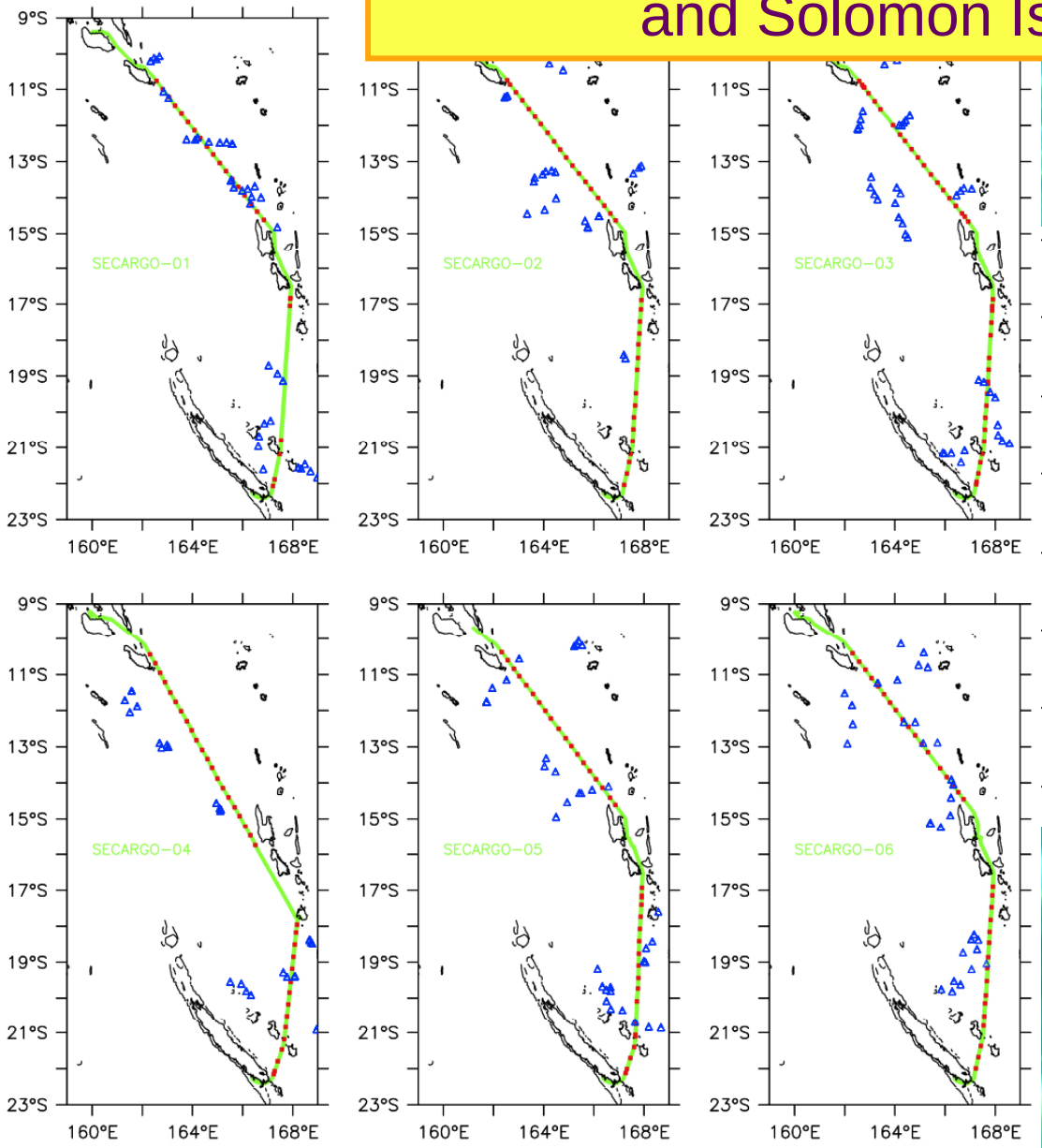
HR XBT line between New Caledonia and Solomon Islands



1st line in mid-2008; Seven repeats until now

Dates	Type of probes (nominal depth, in m)	Nb of profile (nb of used probes)
27 June – 01 July 2008	DeepBlue (760)	25 (26)
31 Oct. – 03 Nov. 2008	DeepBlue	35 (41)
27 Feb. – 03 March 2009	T5 (1830) and T7 (760)	40 (57)
18 Aug. – 20 Aug. 2009	T5, T7 and FastDeep (1000)	36 (43)
17 Feb. – 20 Feb. 2010	T5, T7 and FastDeep	39 (46)
22 Nov. – 25 Nov. 2010	T7	34 (44)

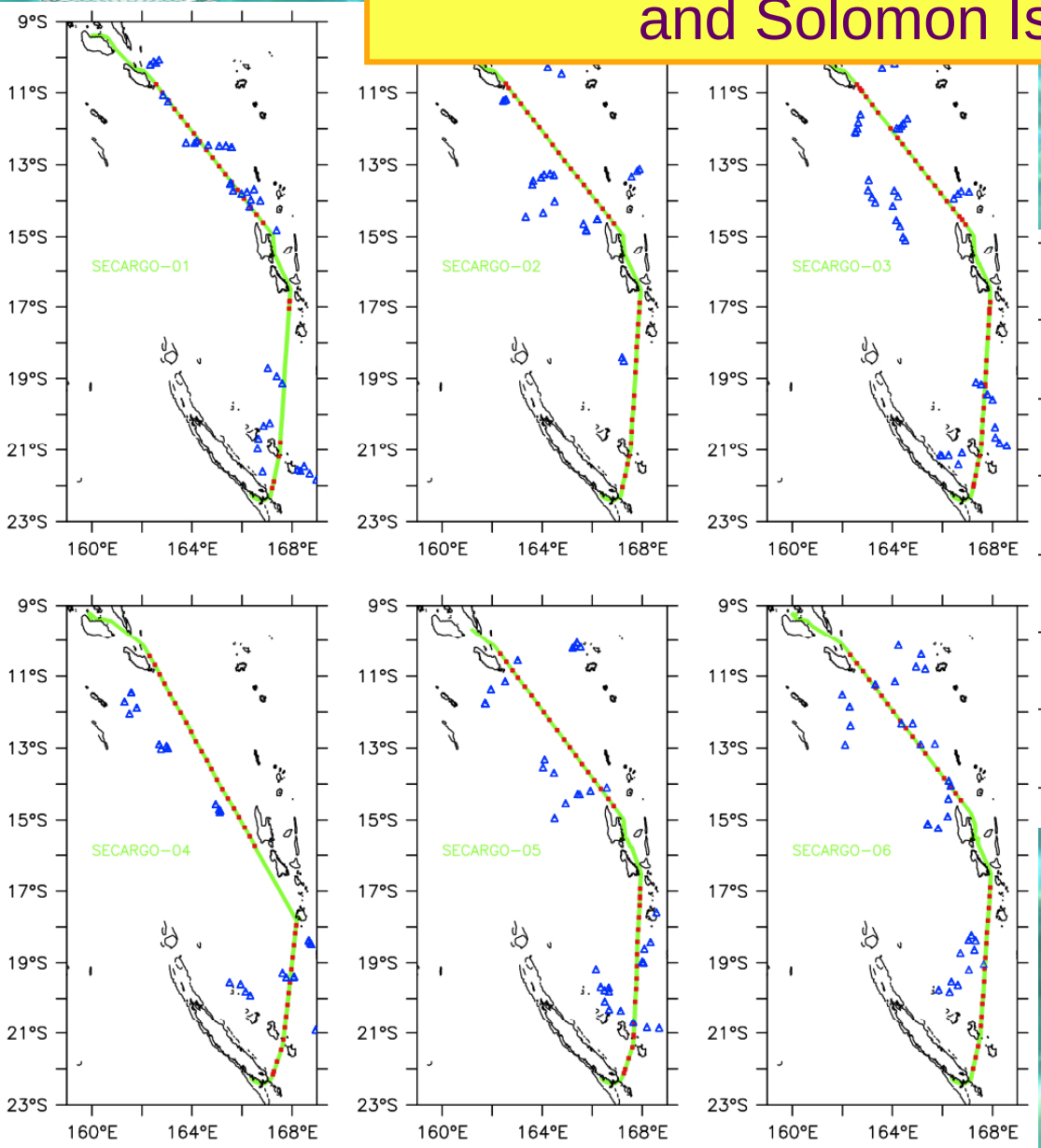
Table 1: Characteristics of the SECARGO surveys.

(Maes et al., 2011, CORIOLIS newsletter)

One observer onboard VOS

ARGO & SVP floats deployment

HR XBT line between New Caledonia and Solomon Islands



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Resolution at 1/6th ° (40 probes) Different types of probes (NOAA; Coriolis Center; Solwara)

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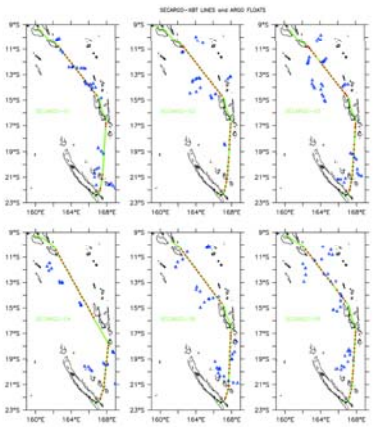
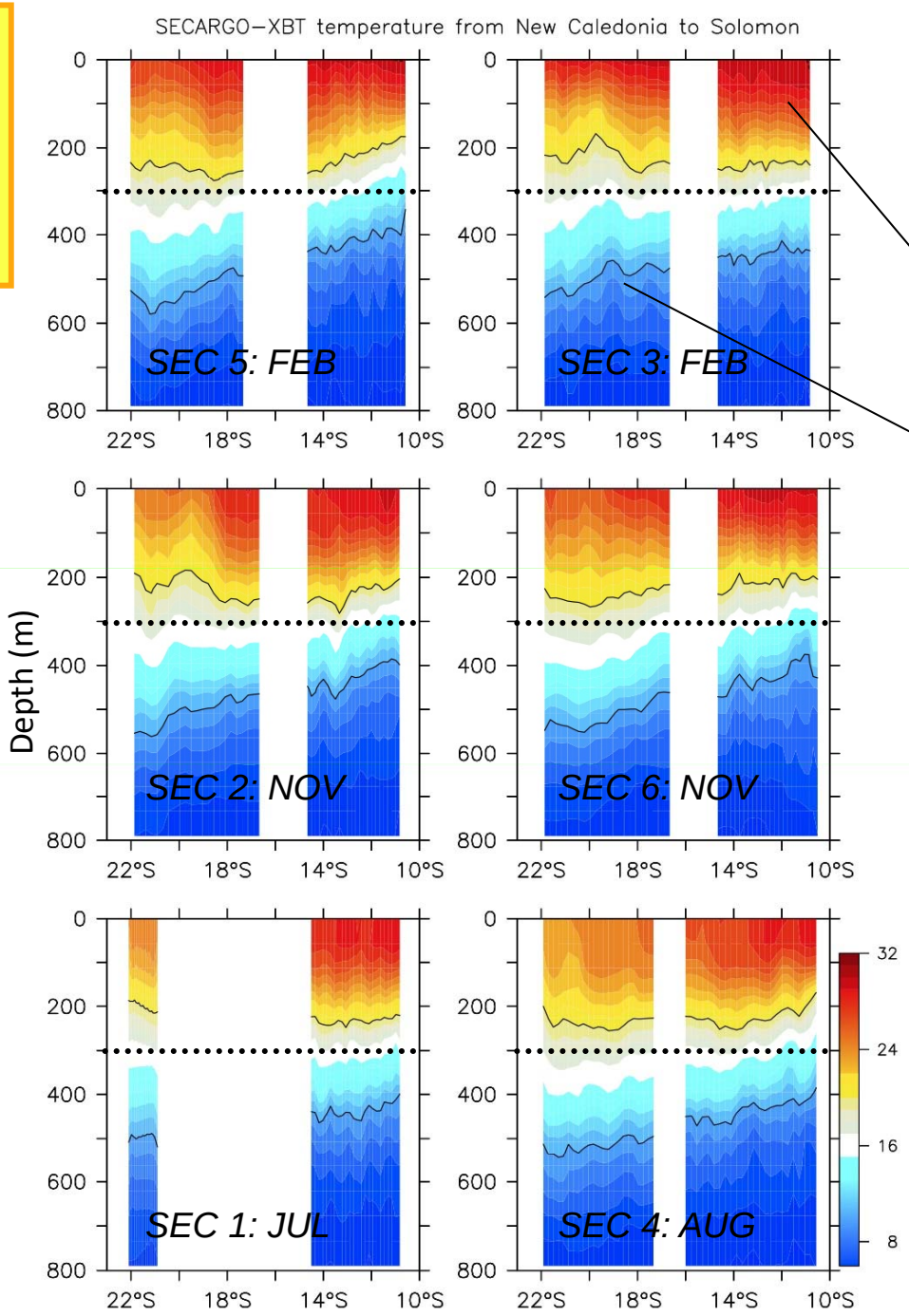
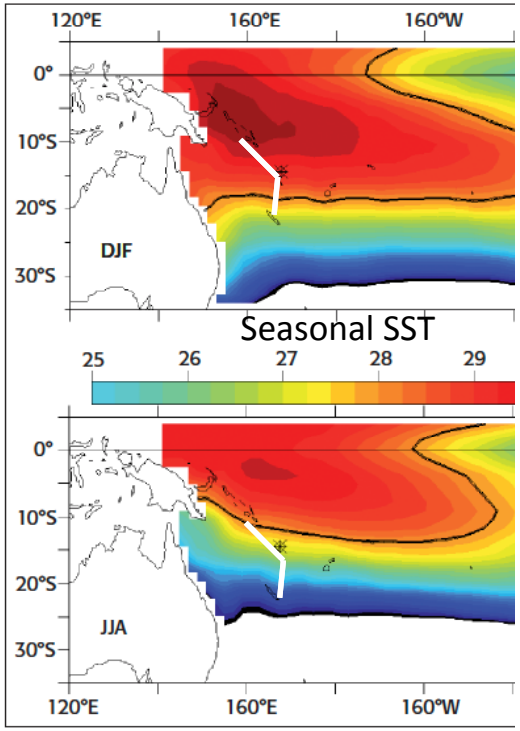
Temperature section from New Caledonia to Solomon Isl.

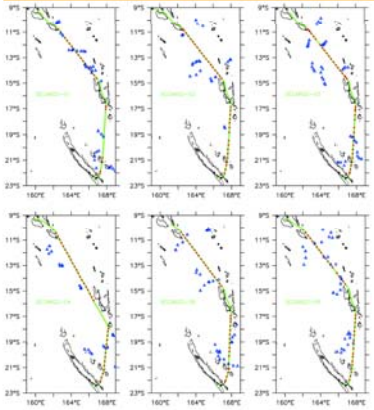


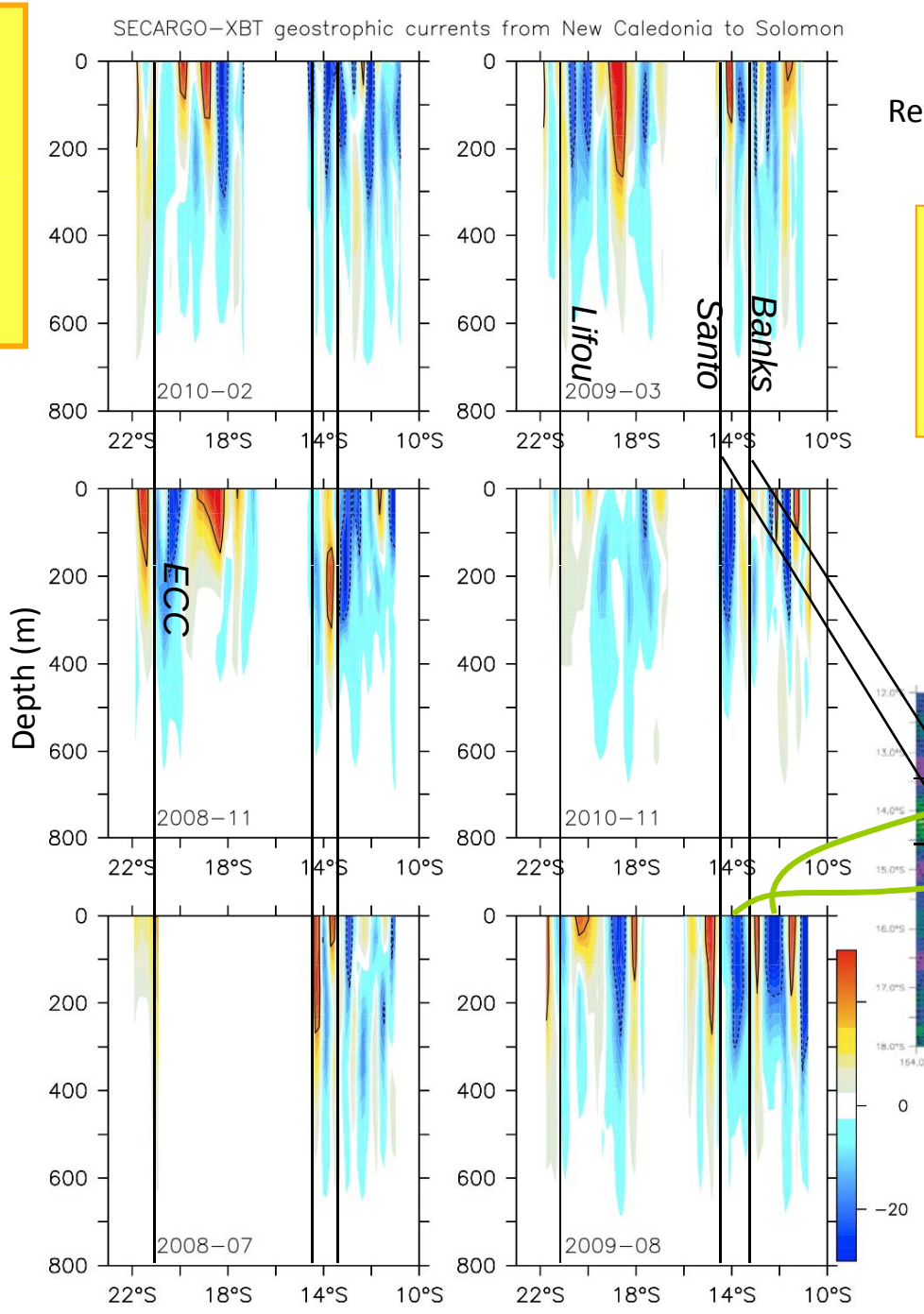


- Upper temperatures follow the seasonal variations of the warm pool in the northern part
- The thermocline is deep and tilted in the southern part



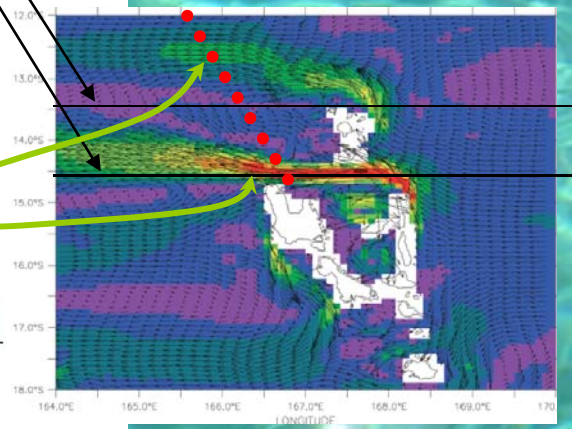
Near zonal current from New Caledonia to Solomon Isl





Ref. level 800 m

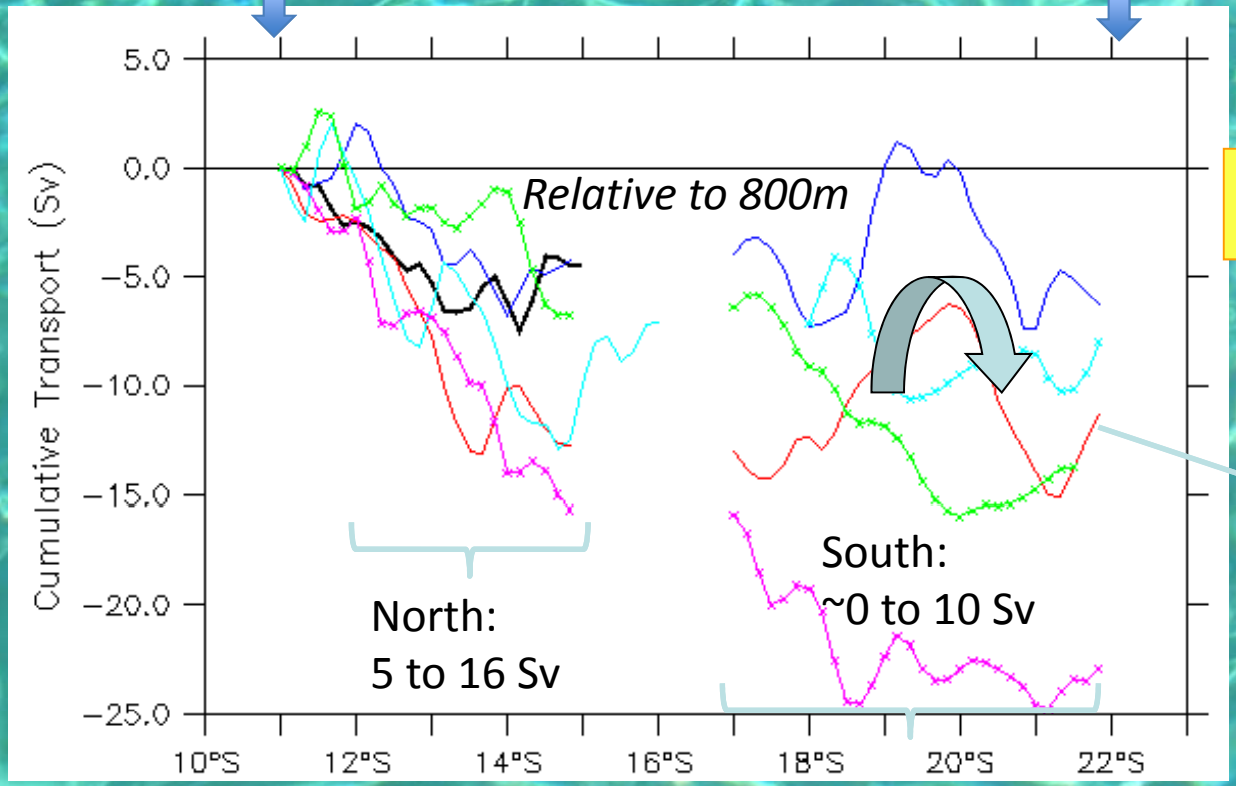
- HR XBTs reveal stable fine structures in the jets: multiple jets for the NVJ
- South part shows ECC but less stable



July 19, 2011

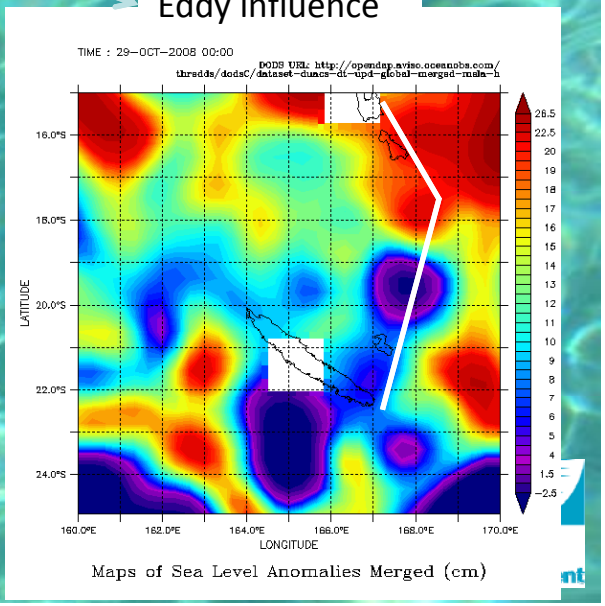
Cumulative mass transport from Solomon Islands to New Caledonia

Solomon Isl. Vanuatu New Caledonia



Total flow entering the Coral Sea:
7 to 22 Sv relative to 800m

Eddy influence

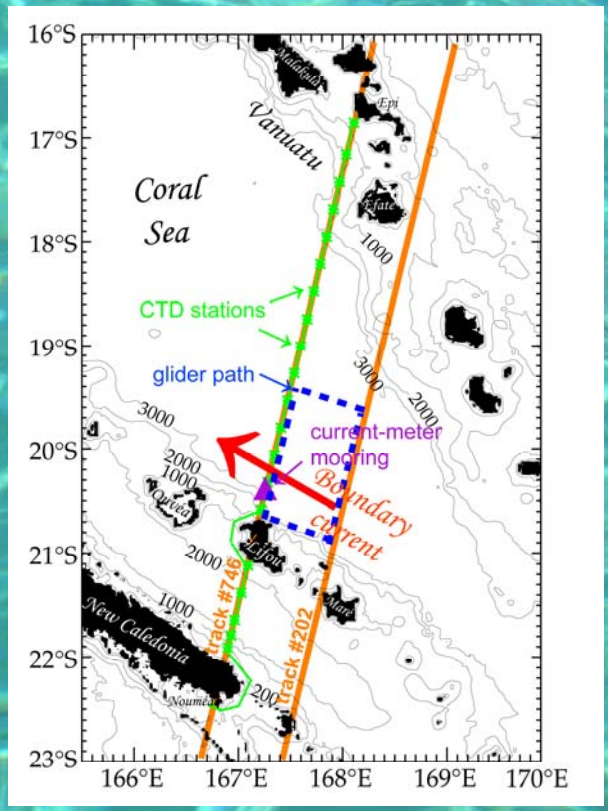


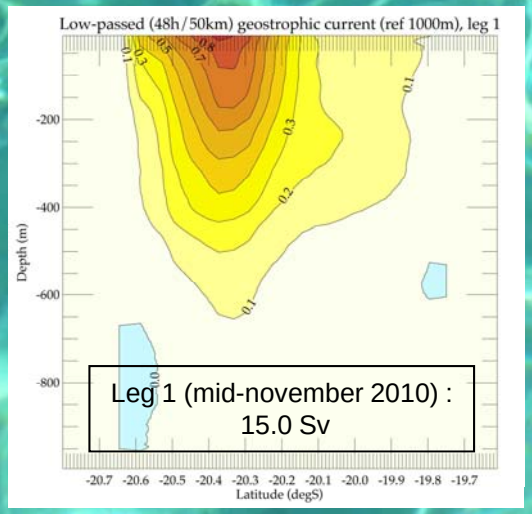
Gourdeau et al. 2008:
20 Sv 0-600m glider

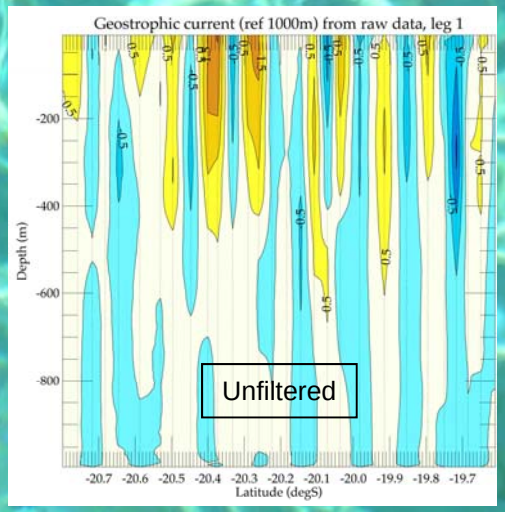
Ganachaud et al. 2008
14 Sv 0-2000m

Variability in the Coral Sea: Altika, Mooring and XBT

Synergy between AltiKa and 3 *in situ* observing systems:
1-gliders
2-mooring
3-XBT/CTD sections
to monitor the whole spectrum of the boundary current.



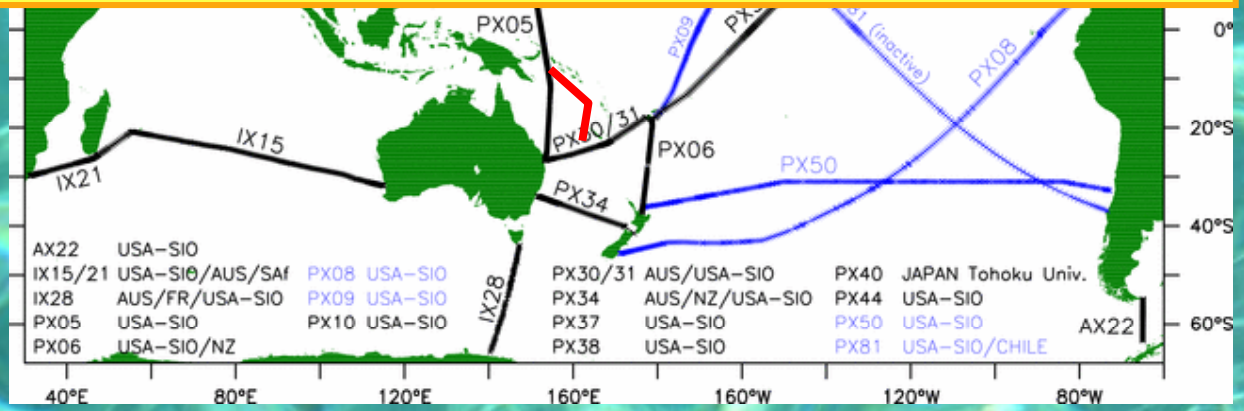




SECARGO and Altika projects (PIs C. Maes & F. Durand)

Conclusions:
Monitoring Coral Sea inflow with XBTs

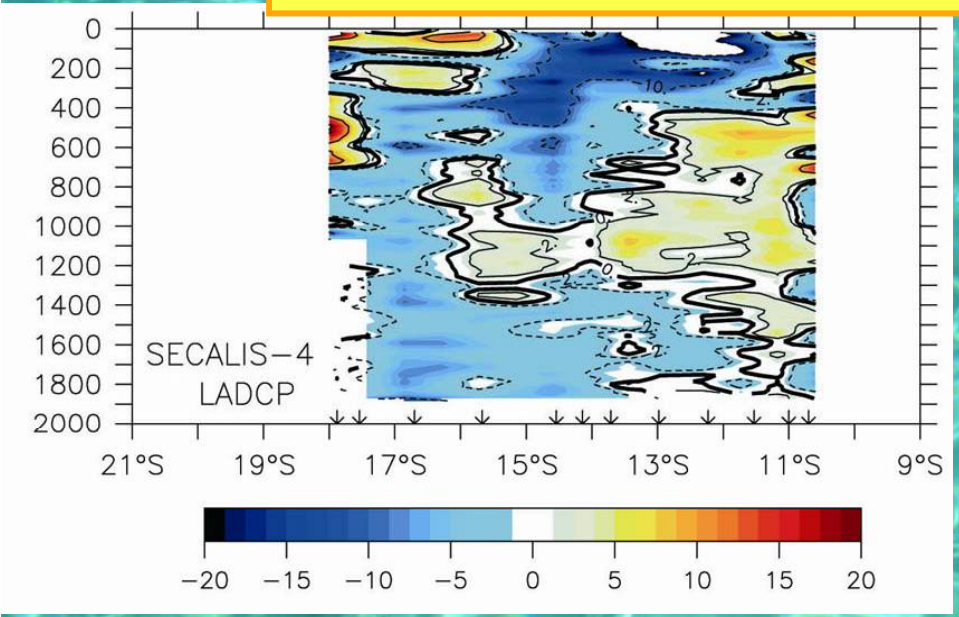
- **A key measurement to the tropical climate system**
- **Transport of 20 to 35 Sv and ~2.6 PW into the Coral Sea (0-2000m)**
- Large variability; 15 Sv occur in the boundary current near New Caledonia; deep, variable shear that is missed by 0-800m XBTs.
- Need deep probes (1500-2000m) at high resolution, at least near the slopes (does this exist?)
- **Need probes and recurrent funding to reach 4 rotations/year**

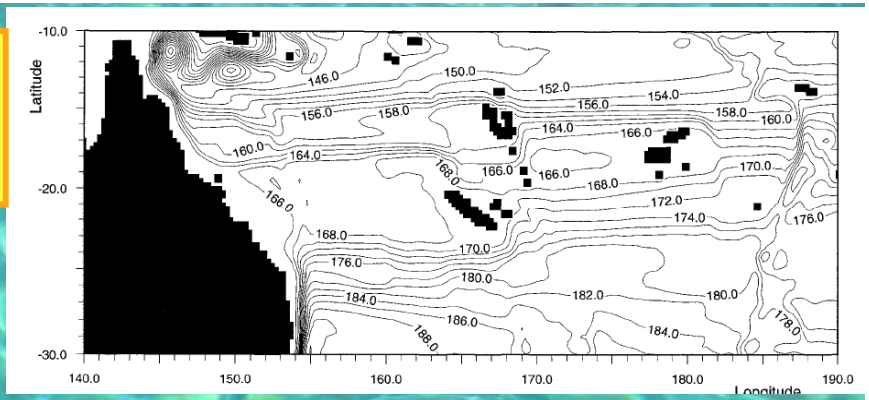


SIO high resolution XBT http://www-hrx.ucsd.edu/

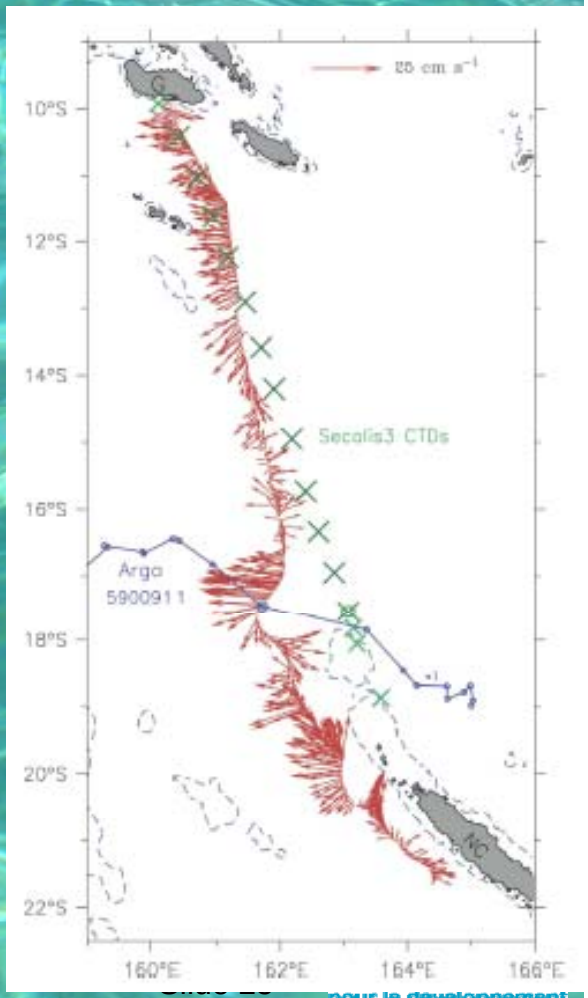
Thank you !!

XBT: Deep jets





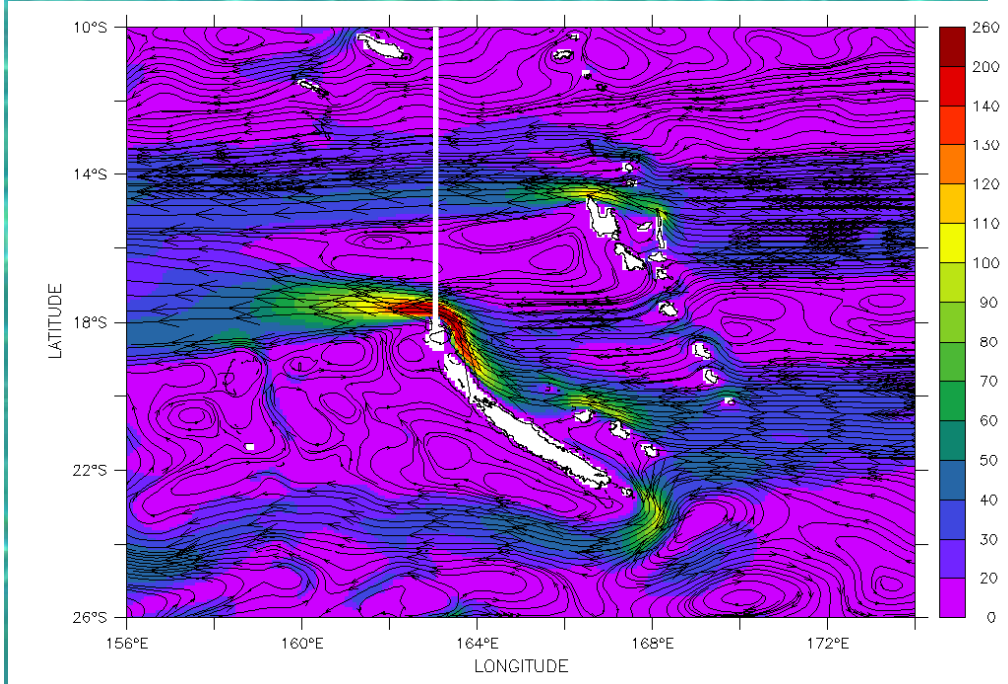
LADCP
Argo floats
Secalis-3



QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

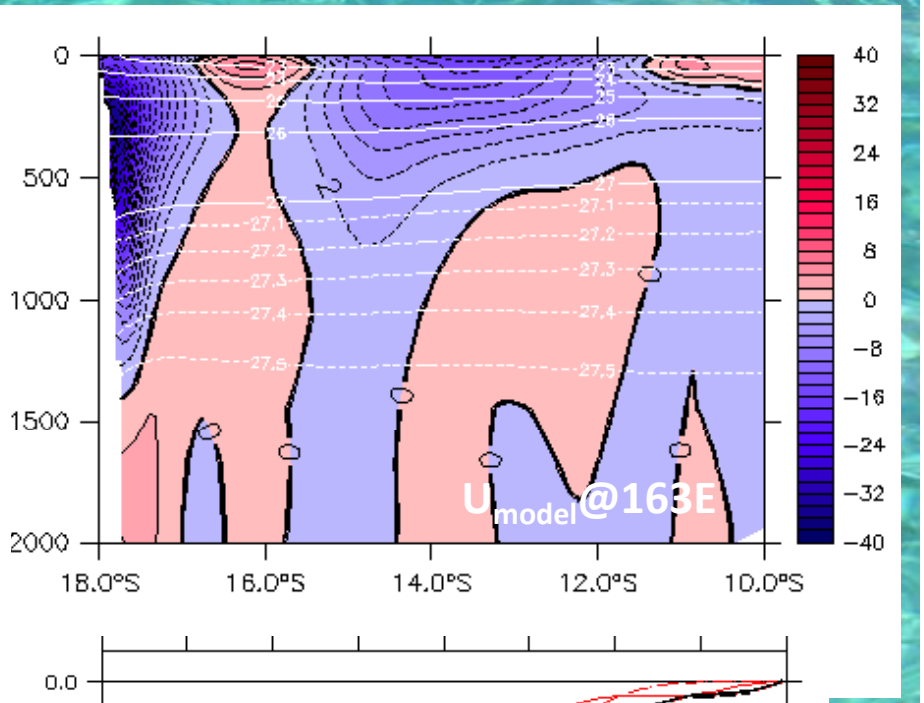
XBT: Missing part due to the deep currents?

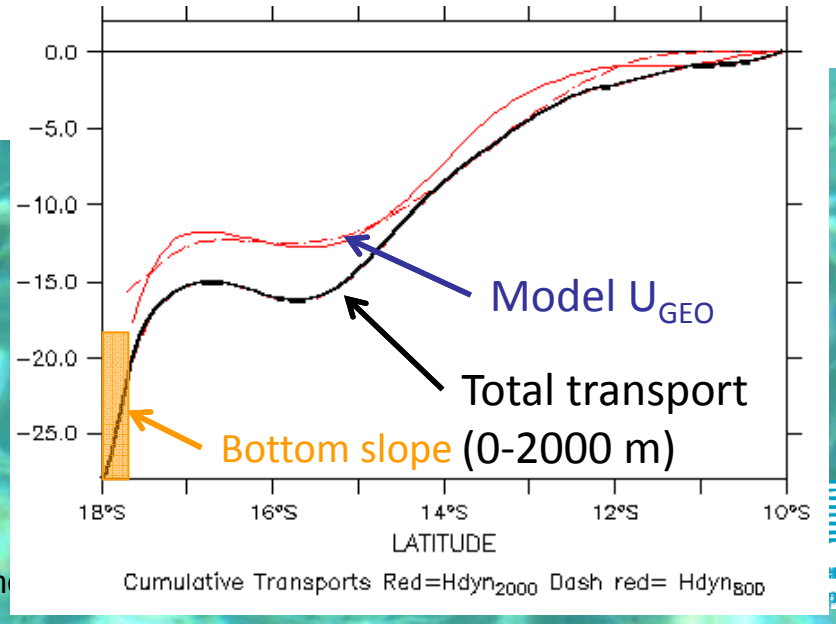
Estimates from high-resolution OGCM



Integrated mean circulation (0-1000 m)

ORCA 1/12 from MERCATOR
(operational oceanography; no assimilation)





Geostrophy in a GCM: high loss near topography

Comparisons of Glider sections between 2005 and 2006

NCJ

NVJ

New Cal

Guadalcanal

Depth

July to Oct. 2005

Geostrophic currents
@ref = 600 m
Horizontal 1/8°

QuickTime™ et un
décompresseur
sont requis pour visionner cette image.

Nov. To March 2007

Fine structures of the jets require high resolution data