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Argo – Opportunity and Challenge

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References

- Chu, P.C., L.M. Ivanov, T.P. Korzhova, T.M. Margolina, and O.M. Melnichenko, 2003a: Analysis of sparse and noisy ocean current data using flow decomposition. Part 1: Theory. Journal of Atmospheric and Oceanic Technology, 20 (4), 478-491.
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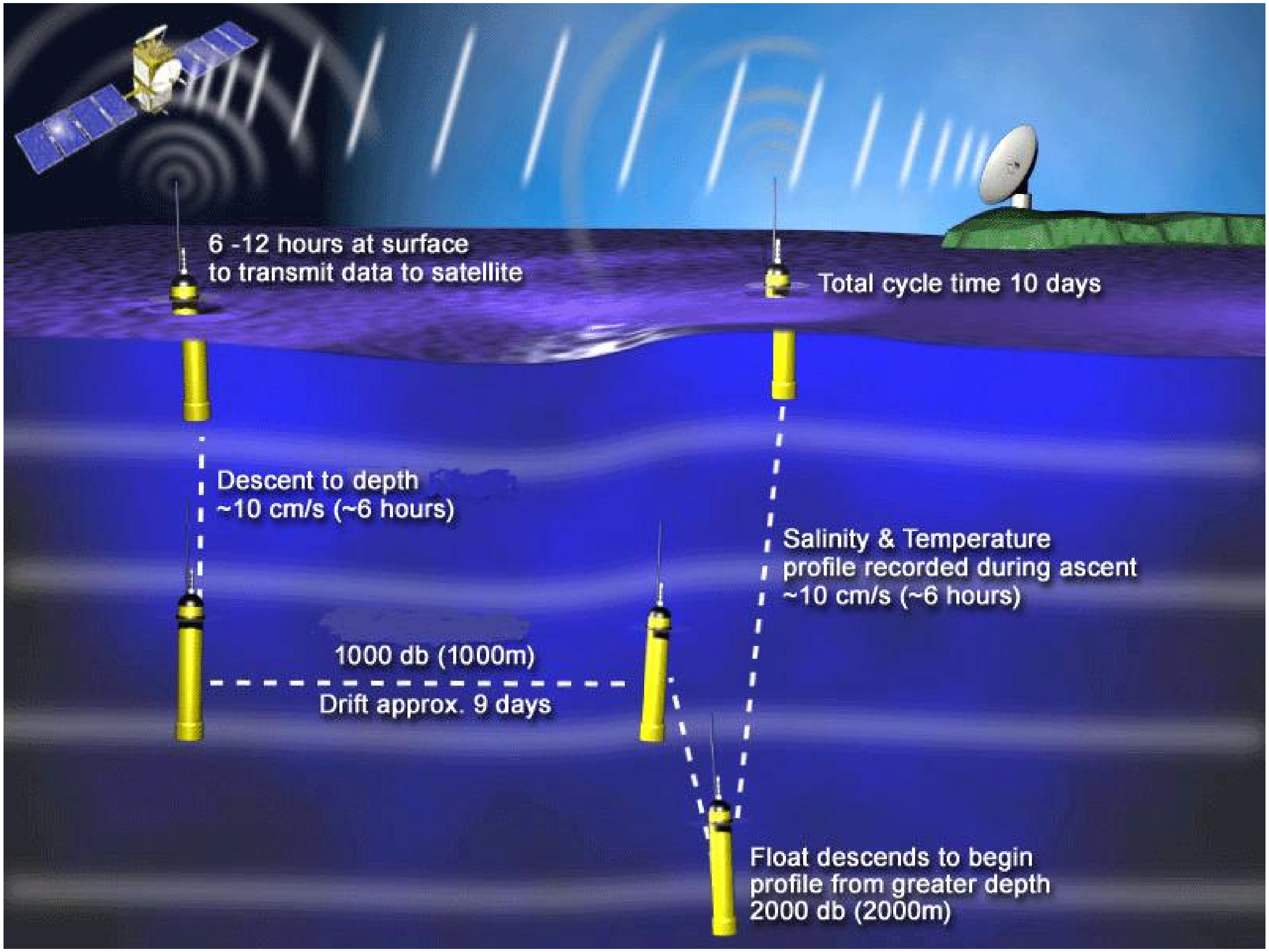
- Chu, P.C., L.M. Ivanov, and T.M. Margolina, 2004: Rotation method for reconstructing process and field from imperfect data. International Journal of Bifurcation and Chaos, 14(8), 2991-2997.
- Chu, P.C., L.M. Ivanov, and O.M. Melnichenko, 2005: Fall-winter current reversals on the Texas-Lousiana continental shelf. Journal of Physical Oceanography, 35, 902-910
- Chu, P.C., L.M. Ivanov, O.M. Melnichenko, and N.C. Wells, 2007: On long baroclinic Rossby Waves in the tropical North Atlantic observed from profiling floats. Journal of Geophysical Research – Oceans, 112, C05032, doi:10.1029/2006JC003698

- These papers can be downloaded from:
- http://faculty.nps.edu/pcchu

- http://www.argo.net/index_flash.html
- 3000 Argo drifters → Sampling the Global Ocean



Opportunities

- (1) 4D (T, S) fields
- (2) Deep ocean currents
- (3) Physical phenomena → Rossby wave propagation in mid-depth, …

Challenges

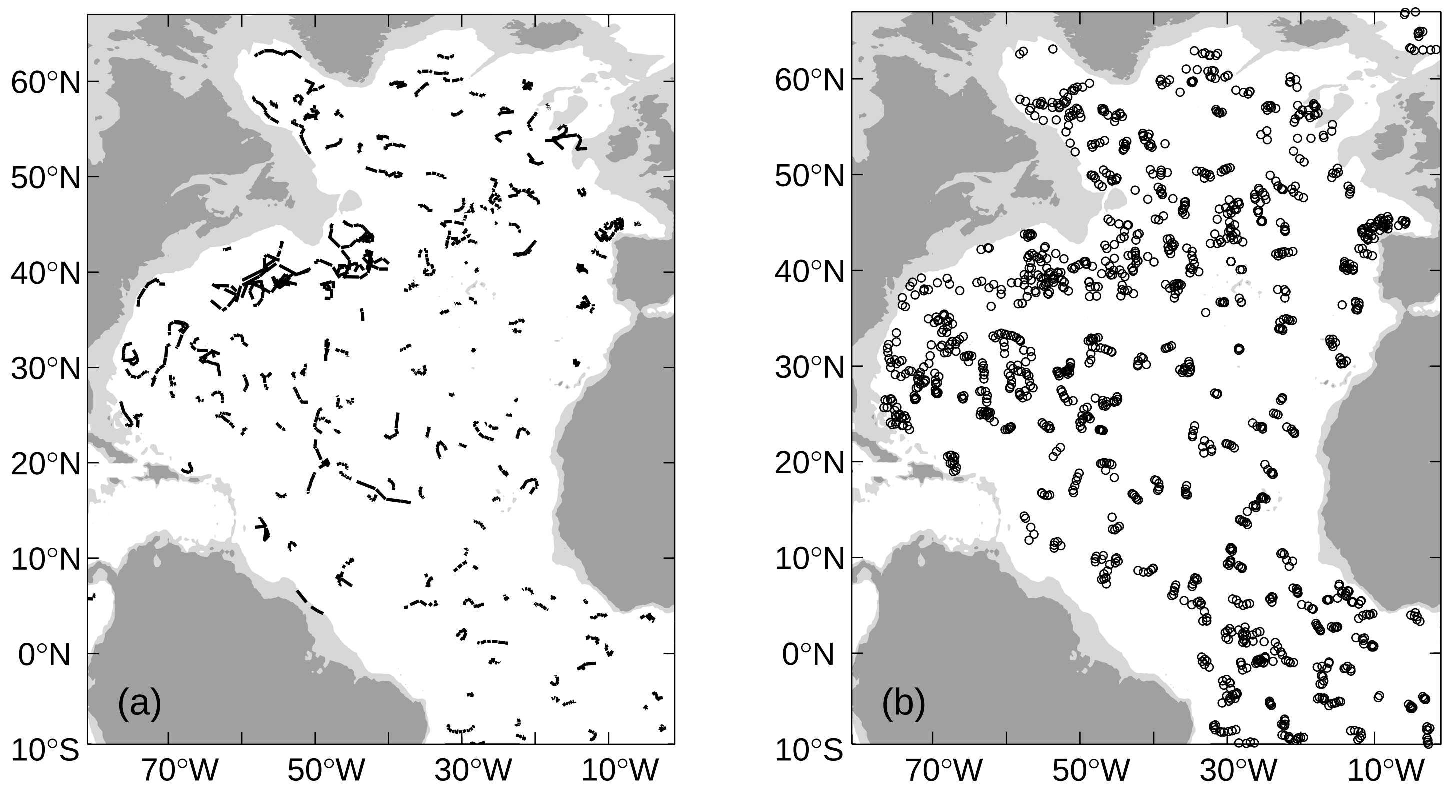
- Argo (T, S) profile and drift data

→ Noisy and inhomogeneously distributed

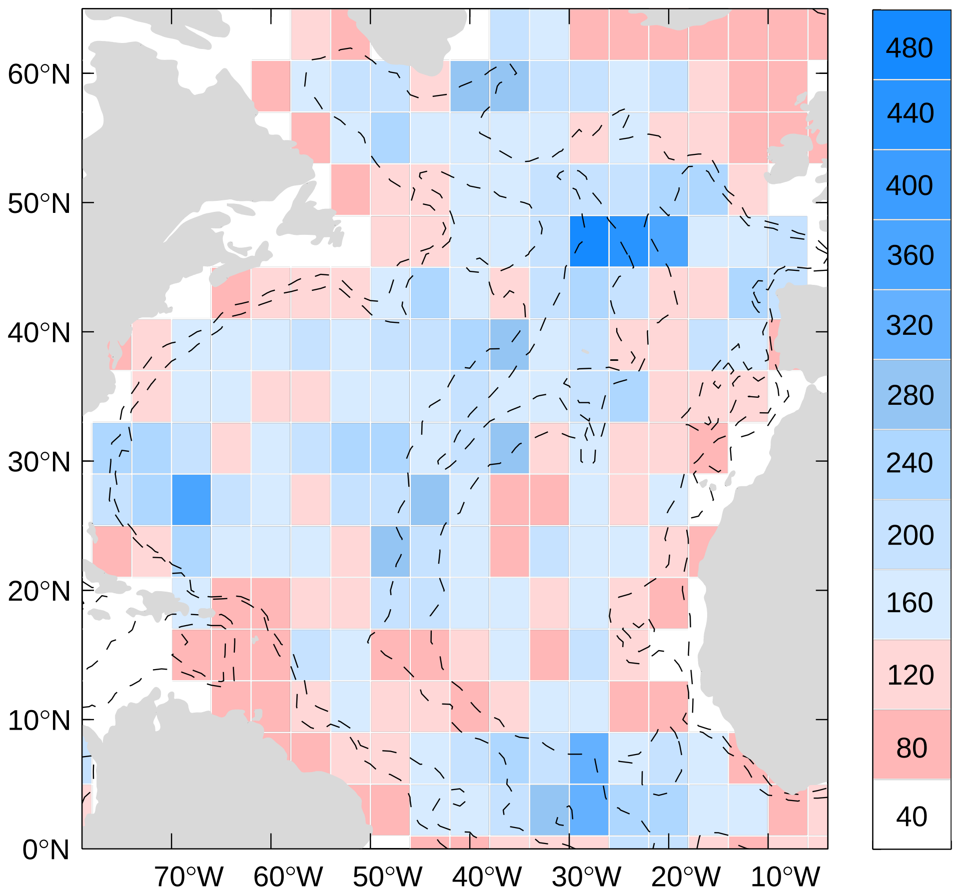
ARGO Observations (Oct-Nov 2004)

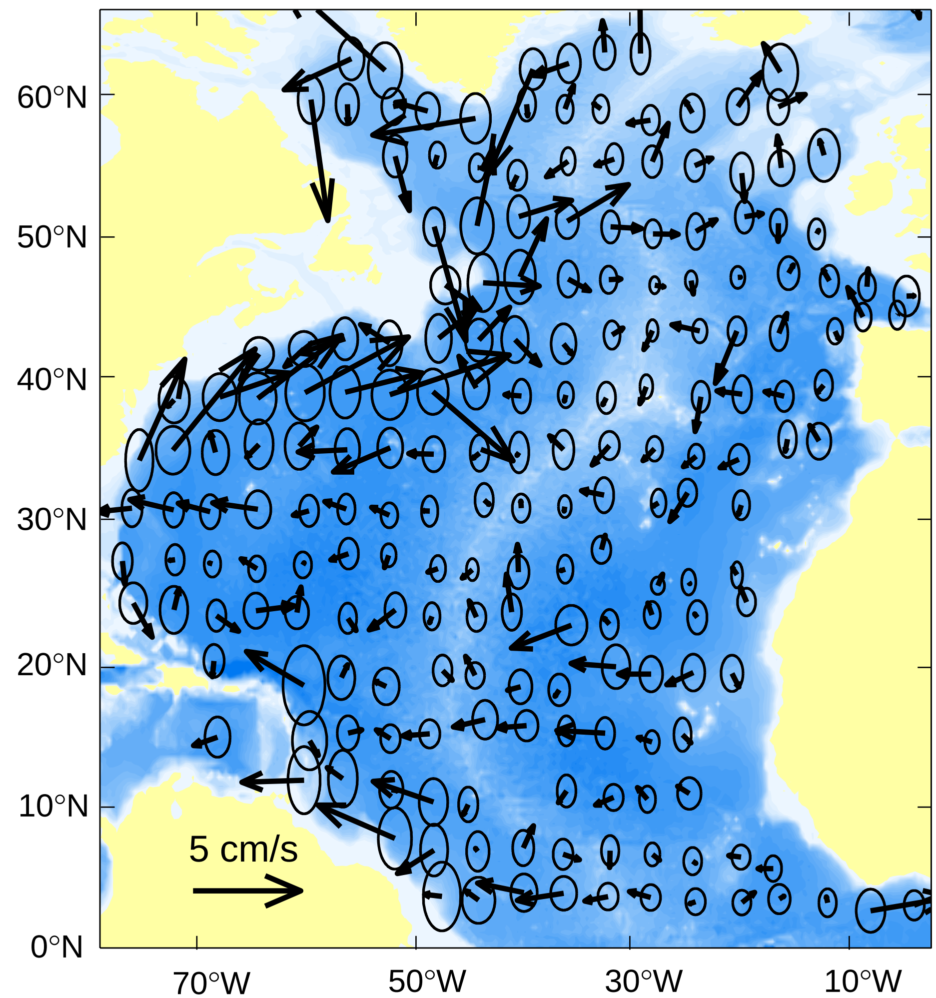
(a) Subsurface tracks

(b) Float positions where (T,S) were measured



Circulations at 1000 m estimated from the original ARGO float tracks (bin method)
April 2004 – April 2005





It is difficult to use such noisy data into ocean numerical models.

OSD
Spectral Representation

$$c(\mathbf{x}, z_k, t) = A_0(z_k, t) + \sum_{m=1}^{M} A_m\left(z_k, t\right)\ \Psi_m\left(\mathbf{x}, z_k\right),$$

Spatial Variability is represented by the basis functions

→ Vertical structure is preserved

Basis Functions (Closed Basin)

$$\triangle\Psi_k = -\lambda_k\Psi_k, \quad \Psi_k|_\Gamma = 0, \qquad k = 1, ..., \infty$$

$$\triangle\Phi_m = -\mu_m\Phi_m, \quad \frac{\partial\Phi_m}{\partial n}|_\Gamma = 0, \qquad m = 1, ..., \infty.$$

Basis Functions (Open Boundaries)

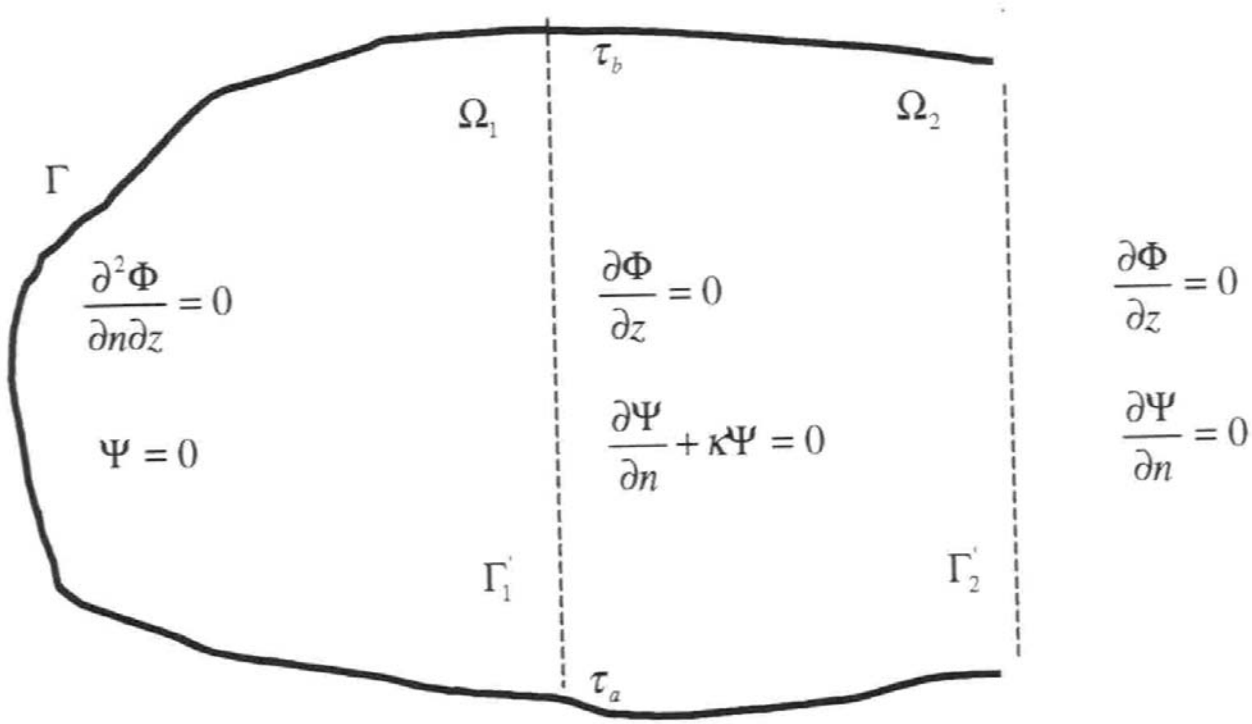
$$\triangle \Psi_k = -\lambda_k \Psi_k,$$

$$\triangle \Phi_m = -\mu_m \Phi_m,$$

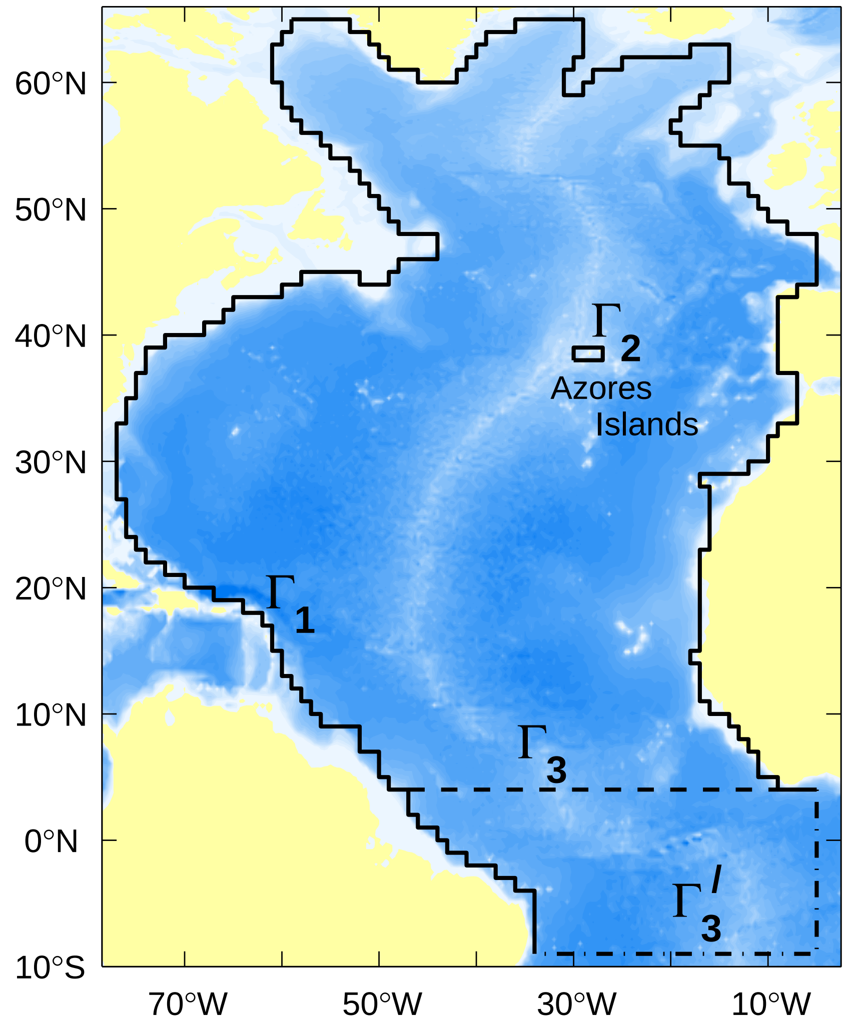
$$\Psi_k|_\Gamma = 0, \quad \frac{\partial \Phi_m}{\partial n}|_\Gamma = 0,$$

$$\left[\frac{\partial \Psi_k}{\partial n} + \kappa(\tau)\Psi_k\right]|_{\Gamma_1'} = 0, \quad \Phi_m|_{\Gamma_1'} = 0,$$

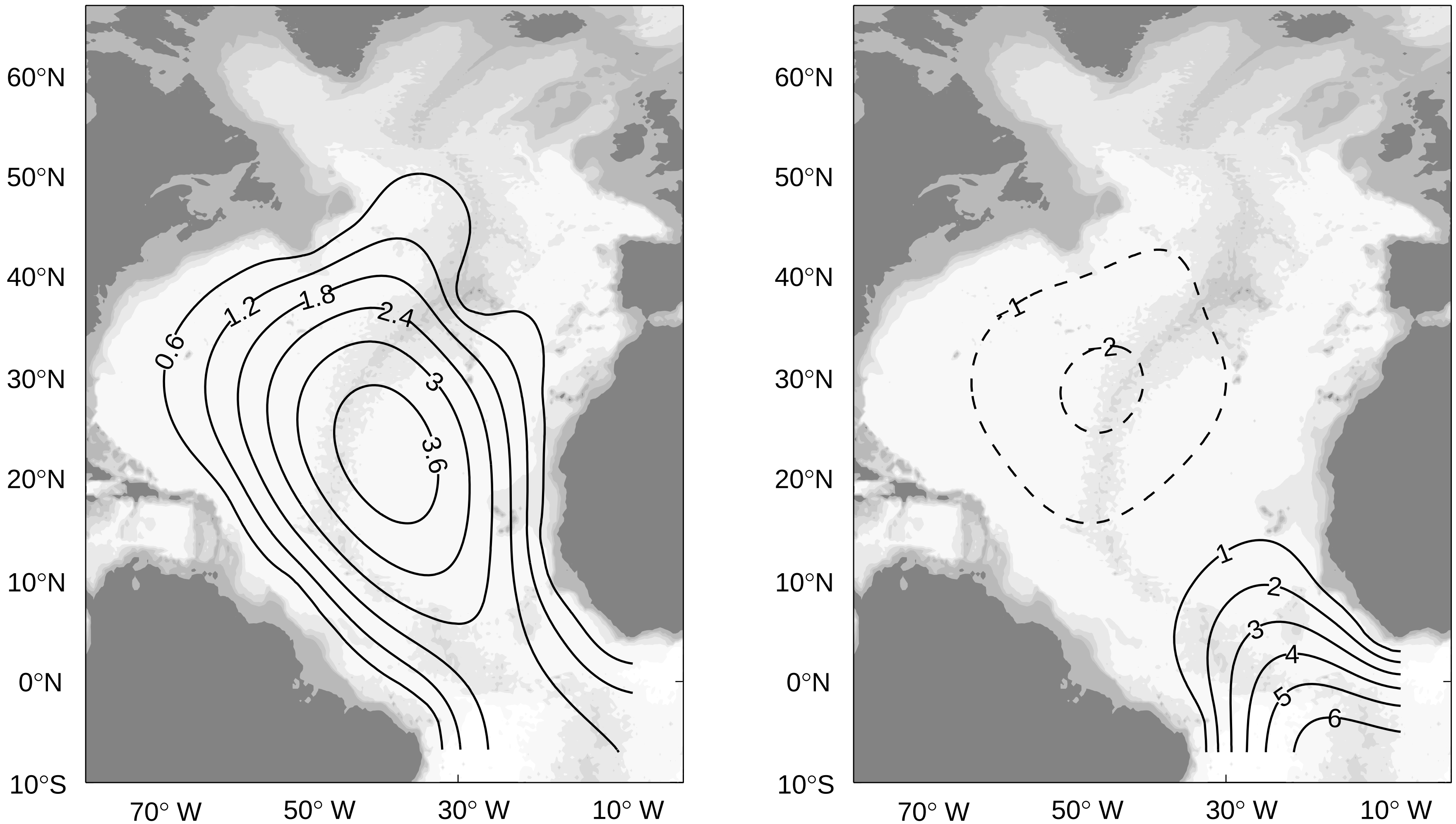
Boundary Conditions



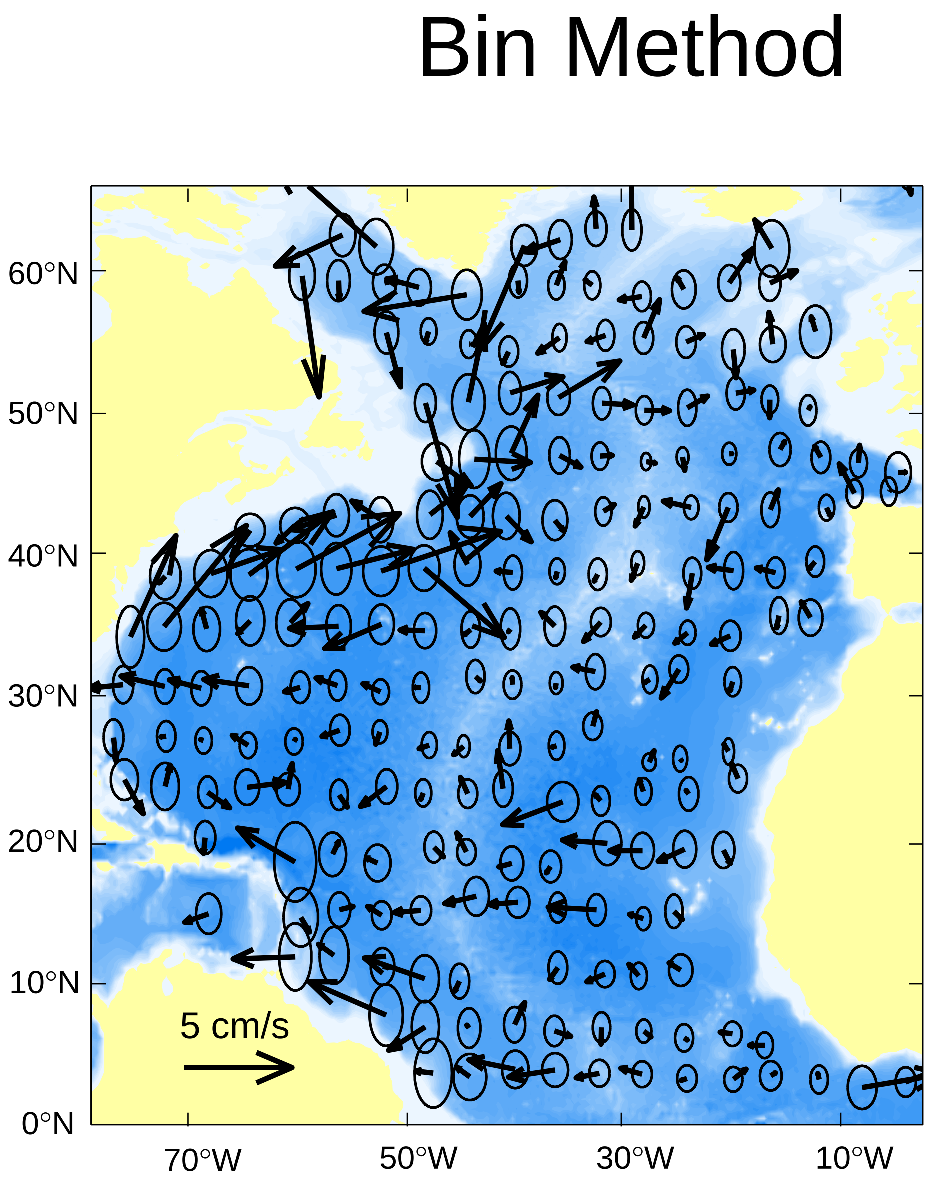
Boundary Configuration → Basis Functions for OSD

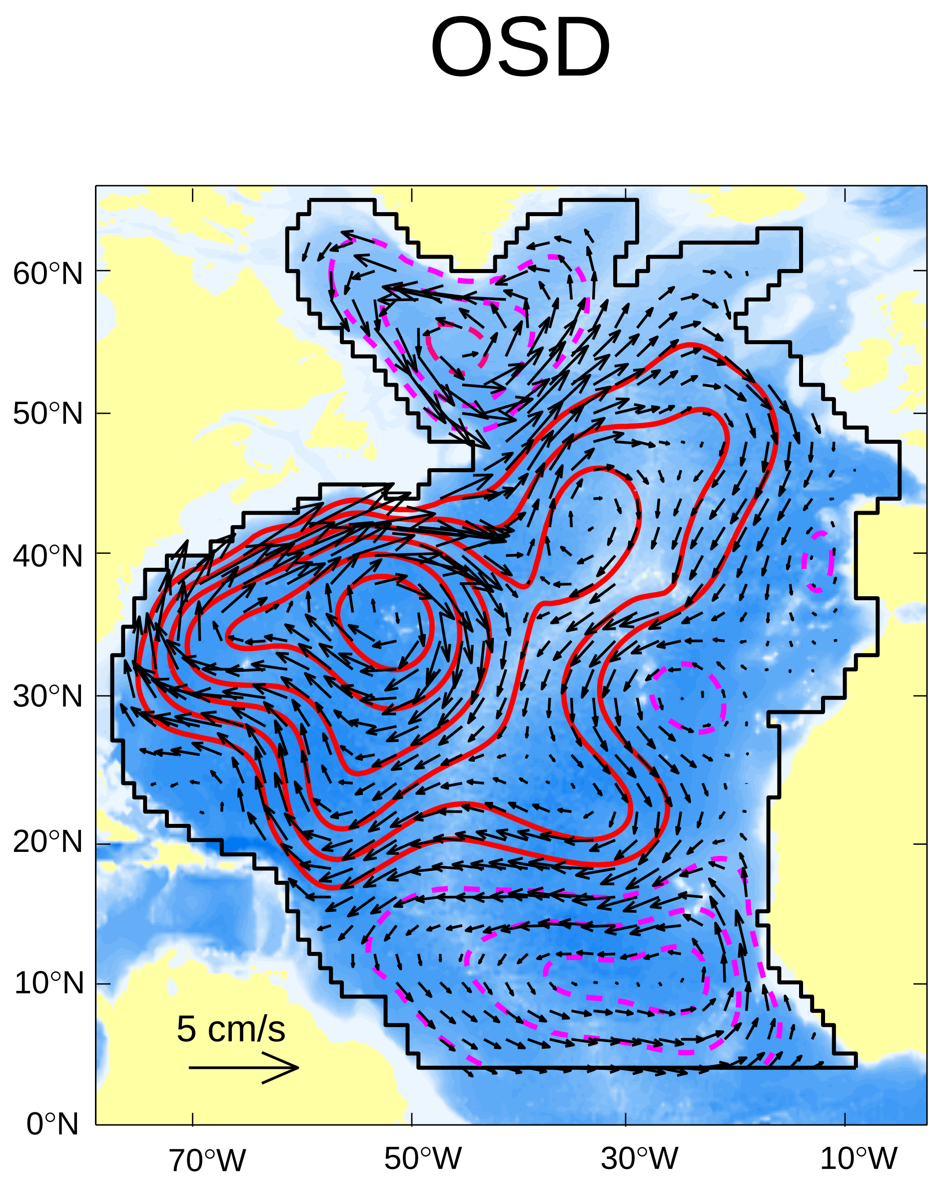


Basis Functions for Streamfunction Mode-1 and Mode-2



Circulations at 1000 m (March 04 to May 05)





Monthly Temperature (10 m) in the Pacific Ocean since 1990 (analyzed from GTSPP)

Monthly Temperature (200 m) in the Pacific Ocean since 1990

Monthly Temperature (500 m) in the Pacific Ocean since 1990

Monthly Temperature (1000 m) in the Pacific Ocean since 1990

Monthly Temperature (10 m) in the Atlantic Ocean since 1990

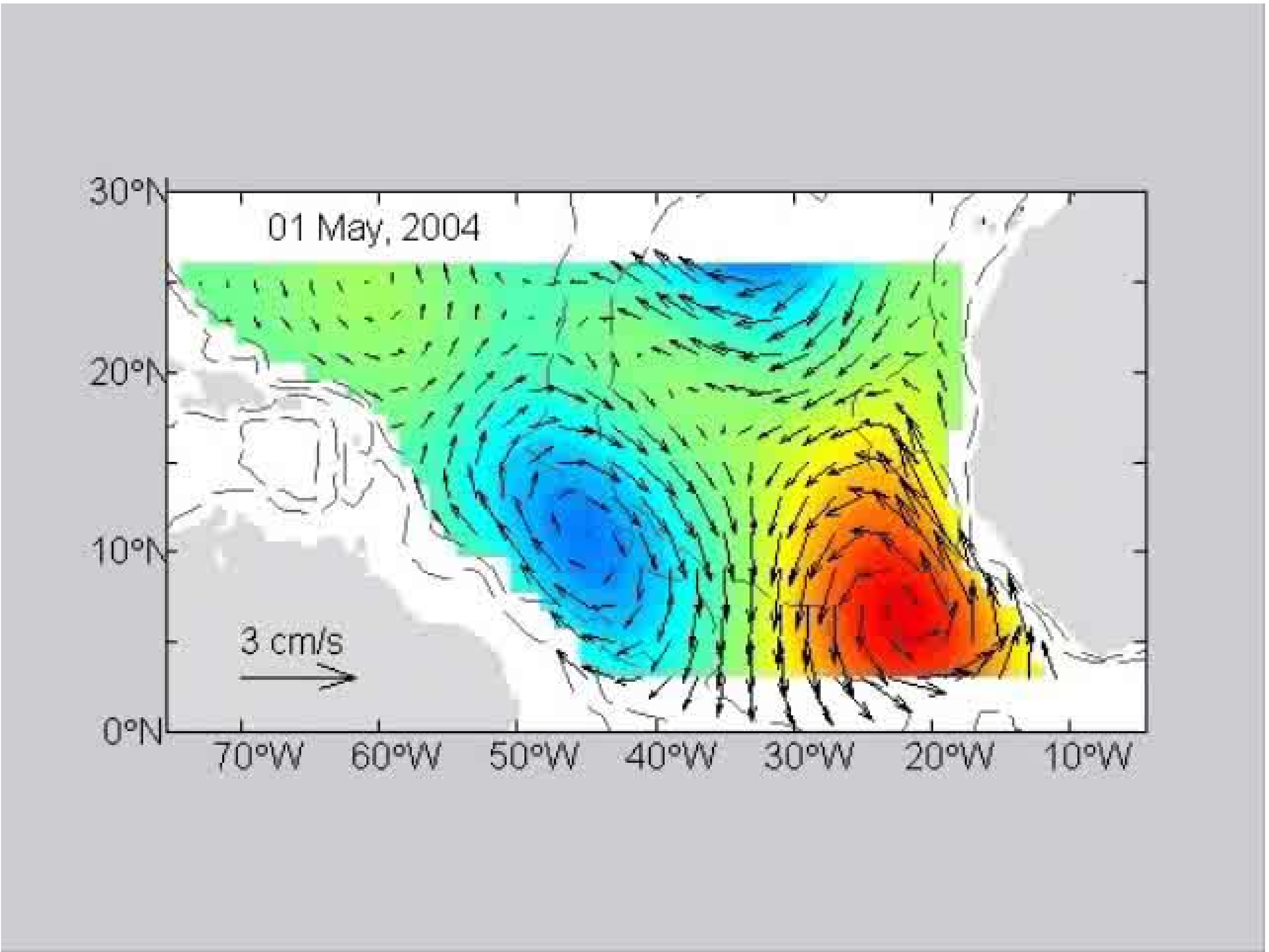
Monthly Temperature (200 m) in the Atlantic Ocean since 1990

Monthly Temperature (500 m) in the Atlantic Ocean since 1990

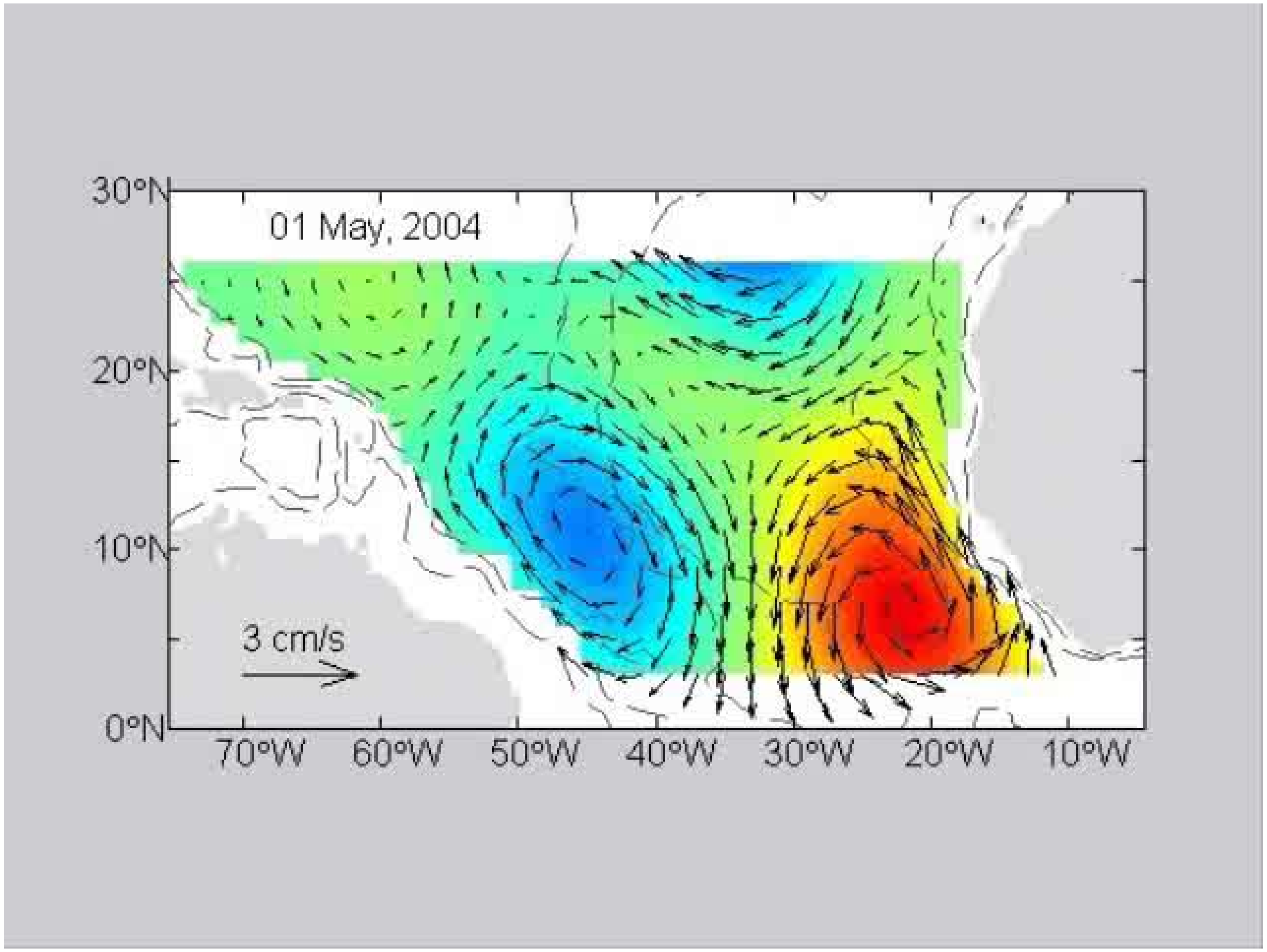
Monthly Temperature (1000 m) in the Atlantic Ocean since 1990

Baroclinic Rossby Waves in Tropical North Atlantic

Annual Component



Semi-annual Component



Characteristics of Annual Rossby Waves

	March, 04 – May, 05 float data			March, 04 – May, 06 float data		
Latitude	c_p (cm/s)	L_1 (km)	L_2 (km)	c_p (cm/s)	L_1 (km)	L_2 (km)
5^0N	12	1200	1100	12	1300	900
8^0N	16	2500	1400	12	2100	1100
11^0N	14	2200	1400	11	1900	1100
13^0N	11	2100	1500	10	2300	1500

Western Basin Eastern Basin Western Basin Eastern Basin

Conclusions

- (1) Argo provides wonderful opportunities for ocean research.
- (2) Many issues should be taken care of in Argo data analysis/assimilation.
- (3) The existing methods for (T, S) data assimilation (OI, 3D-Var, Kalman Filter) create false static instability.
- (4) Assimilation of (T, S) data should keep the vertical structure such as the treatments in building GDEM and the OSD method.
- (5) GDEM does not have any false unstable profile, which indicates feasibility of ocean (T, S) data analysis in the parameter space than in the physical space.
- (6) We may need to consider ocean (T, S) data assimilation in the parameter space.