A DATA ASSIMILATION SYSTEM FOR THE CARIBBEAN SEA AND GULF OF MEXICO

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INTRODUCTION:

Since 1996 a comprehensive observational program has been carried out in the Mexican Caribbean and the Gulf of Mexico (CANEK group, Badan, Candela, Ochoa, Sheinbaum). The first 5 years, measurements concentrated in the Yucatan Channel including CTD-LADCP surveys, pressure sensors and a mooring array that was deployed during 1999-2001 (fig 1a,b). The purpose of the array was to continuously monitor the exchange between the Caribbean Sea and the Gulf of Mexico and to provide boundary conditions for numerical ocean models with the hope that better forecasts of Loop-Current eddy-shedding events (fig. 2) could be obtained.

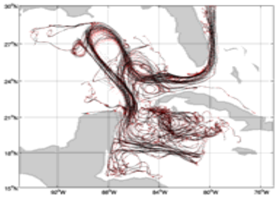


Fig 2 Float trajectories tracked for six months showing the Loop Current the Cayman Current. and the large eddy variability

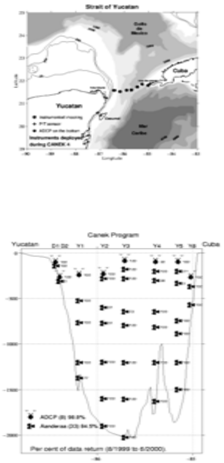


Fig. 1 (a) Mooring array across Yucatan Channel and (b) Instrumentation

OBSERVATIONAL RESULTS:

The flow in Yucatan Channel turned out to be highly structured and variable (fig. 3) with a mean transport of 23 Sv (5 Sv less than previously thought), and mean currents smaller than the standard deviation, except for the Yucatan Current on the western side. Much of the variability is believed to originate in the central and eastern Caribbean in the form of eddies that propagate all the way to Yucatan (fig. 4). The EOFs that explain most of the velocity variability can be associated with the passage of eddies through the Channel (fig. 5a,b) .

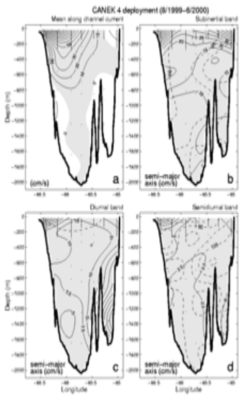


Fig. 3 Mean structure and variability of the flow in Yucatan Channel. The jet on the western side (Yucatan) is the Yucatan Current. Shading indicates northward flow. Southward currents can be seen close to Cuba, both at surface and depth, and also below the Yucatan Current.

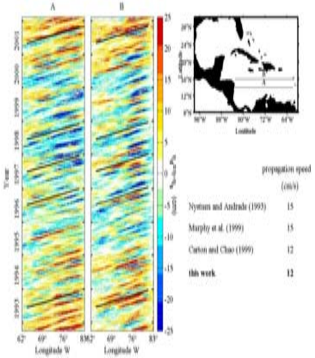


Fig. 4 Havmoller diagrams of ssh anomalies from the gridded AVISO data set showing eddies propagating along the Caribbean

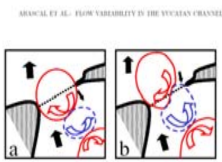
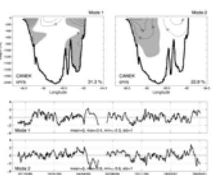


Fig. 5 The passage of eddies through the Yucatan Channel may explain the basic modes of variability (Abascal et al 2003)



MODELLING THE MBRS

Since 2002, the morring array of ADCPS shown in fig. 6a was deployed along the Mexican Caribbean coast which is home of the second largest barrier-reef system in the world. Besides this array, 4 acoustic current meters were deployed inside Puerto Morelos reef lagoon. The ROMS data assimilation system including its TLM and adjoint are being implemented in the region (fig. 7) with a resolution of 10 km horizontal resolution and 30 sigma levels. Open boundary conditions are obtained from the North Atlantic ROMS simulation and COADS climatology provides the surface forcing. The forward model simulates the basic features of the circulation in the region. Optimal perturbation and stochastic optimals are currently underway using this model.

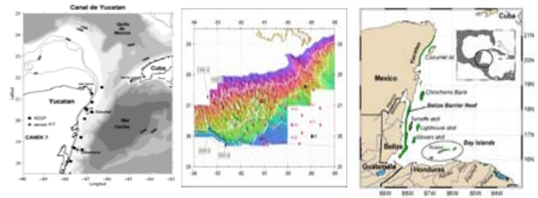


Fig. 6 (a) Mooring array along the Mexican Caribbean
(b) MMS mooring array in the Gulf of Mexico
(c) The Measoamerican Barrier_Reef System (MBRS)

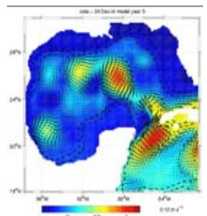


Fig. 7 Snapshot of the model ssh which shows an eddy detached from the Loop-Current and another anticyclone going through Yucatan.

DATA CONSTRAINTS ON THE CARIBBEAN CIRCULATION USING ROMS

A coarser resolution (1/6 of a degree, 20 sigma levels) ROMS has also been implemented for the Caribbean and Gulf of Mexico. The objective is to assimilate available data for the last 5-10 years, including those from the canek group and test hypotheses regarding circulation pathways and transports through the passages. Two configurations are used (fig 8). Using configuration OBC2 forced by climatology at the open boundaries figs 9a,b show the optimal perturbation for an optimal growth period of 1 day at t=0 and t=1day that maximizes variability in the Yucatan barotropic transport. Fig. 9c shows the t=0 OP sst.

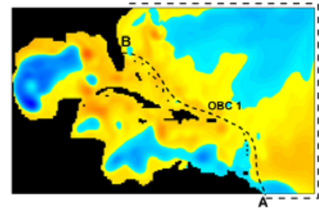
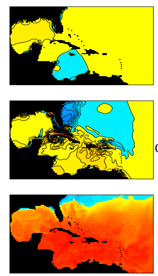


Fig 8 ROMS Caribbean configurations

The stochastic optimals that generate the largest variability in Yucatan transport are shown in fig 10. Their local and off Yucatan location suggest forced waves within the GoM may be resposnible for large transport variations in agreement with findings by Abascal et al. 2003, that Yucatan wind-stresses are not correlated with transport variations and neither are the eddies.



OP ssh t=0

OP ssh t=1day

OP sst t=0