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## The Case Against Severe Cold Eddies

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### Abstract

Beginning in 1990, seven rigs operating in the deepwater Gulf of Mexico reported instances of strong subsurface currents characterized by weak near-surface currents. Unfortunately there were few high quality measurements so the source of the currents remained uncertain though the most likely generation source was cold eddies. In 2001, an ADCP (Acoustic Doppler Current Profiler) measured 1.7 m/s (3.3 kt) subsurface currents at Shell's Brutus site. These measurements were subjected to expert review and while several suspicious characteristics were noted, the measurements were eventually judged to be valid. The Brutus measurements convinced most Oil Industry metocean experts to add a "cold eddy" case and in 2005, ISO [1] included a consensus load case in their Gulf regional annex. Given the onerous load imposed by the cold eddy case on risers and the limited observational evidence, we initiated further investigations. This paper briefly describes the basis for the original load case and summarizes our investigations. We conclude that the original observations were flawed for various reasons and that there is no solid evidence that severe cold eddies exists.

### Introduction

In 1990, a BP drilling rig operating on the inner continental slope reported strong subsurface currents. Over the next 12 years, half a dozen more rigs reported similar incidents. The events were characterized by weak near-surface currents, strong subsurface currents peaking at roughly 250 m beneath the surface and lasting for the order of one day. Unfortunately, there were few direct current measurements and no temperature information so the process causing the strong currents was open to conjecture. The most likely source appeared to be cold eddies. Weak cold eddies were known to be prolific in the Gulf., e.g. [2, 3]. During almost any week, the Horizon Marine EddyWatch shows many cold eddies ranging in size from 20-100 km with peak speeds sometimes reaching 0.8 m/s (at a nominal depth of 50 m where the buoys are drogued). Fig. 1 shows an example. Note the numerous annotations, "CE", which denote cyclonic (cold) eddies.

In 2001, an ADCP (Acoustic Doppler Current Profiler) on Shell's Brutus reported subsurface currents of nearly 1.8 m/s. At that point most metocean experts started including a "cold eddy" case in their design basis. In 2005, ISO [1] published a consensus cold eddy case in their Gulf of Mexico metocean guidelines. Fig. 2 compares the 100-yr ISO profiles from various processes. The "cold eddy" profile is clearly much stronger in the 200-300 m depth range so it can dominate riser design for many deepwater facilities, especially classical spars. It can also induce VIV in TLP tendons. The bottom line: it was found that the cold eddy case could add many millions of dollars to the capital cost of certain new deepwater designs.

Given the poor observational basis and the cost implications of the cold eddy case, the CASE-EJIP JIP embarked on a major research initiative to investigate the phenomena. The major tasks included:

1. Set up of a vessel that could be quickly dispatched to the scene of a reported cold eddy in order to make a detailed survey of the 3-D velocity and temperature fields.
2. Development of a satellite-tracked drifting buoy with a deep drogue. These buoys were expendable and could be rapidly deployed by aircraft or ship.
3. Initiation of a three-year numerical modeling study to investigate the possible generation mechanisms, maximum velocities, and longevity of cold eddies.
4. Initiation of a network of rig-mounted ADCP's that would report currents in real time to a central website. Most of these measurements were scanned to identify possible cold eddies.
5. Examination of the ADCP quality channels during cold eddy measurements.