

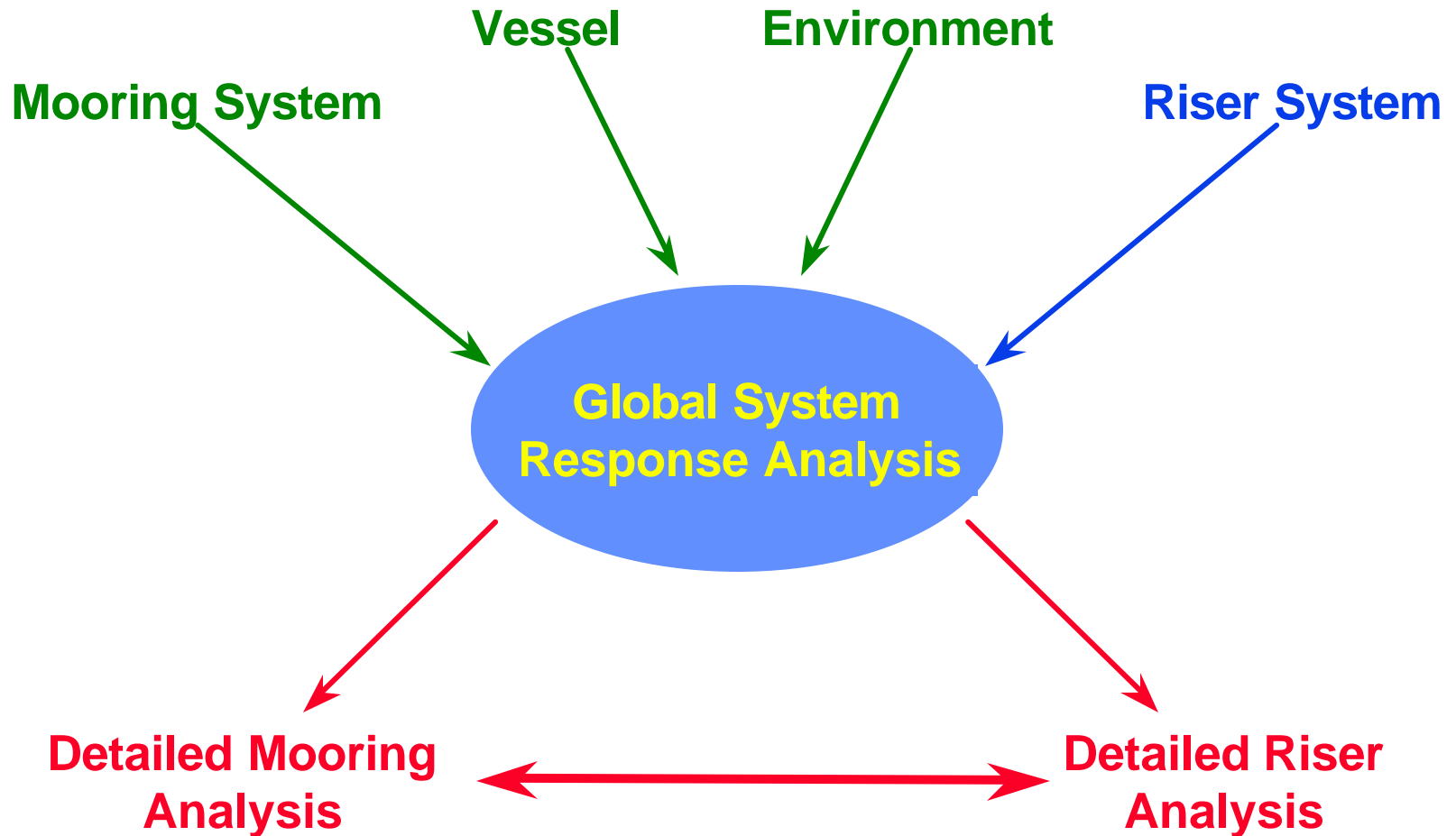
Coupled Analysis of Mooring and Riser Systems

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Coupled Analysis



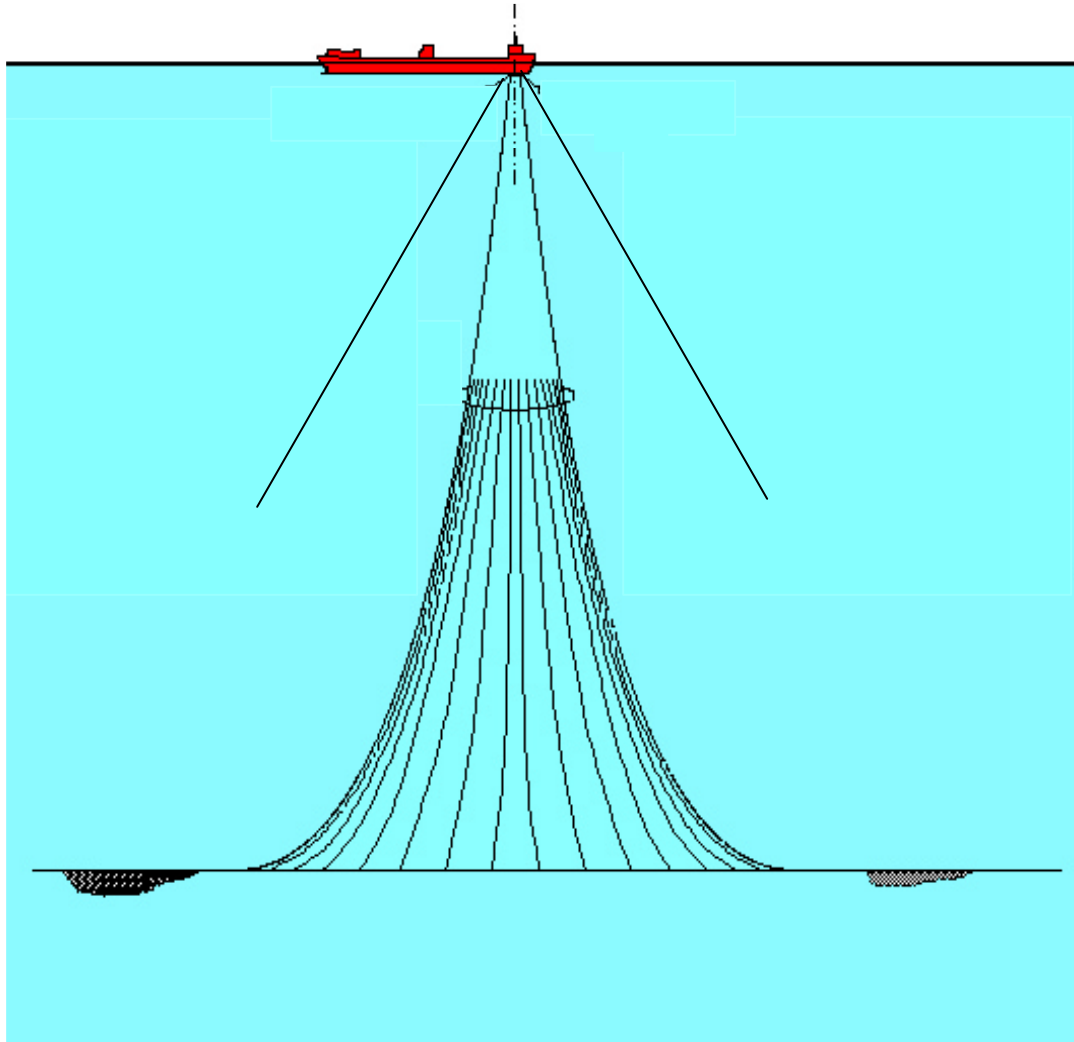
Benefits of a Coupled Analysis



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- **Determine Impact on Global System Response**
 - **Location of turret**
 - **Mooring stiffness**
 - **Current load**
 - **Vessel LF surge damping**
 - **Turret and Riser Interface Loads**
 - **Global and local turret loads**
 - **Mooring and riser arrangement**
 - **Basis for Independent Detailed Riser Analysis**
 - **Critical vessel LF offsets and associated vessel WF motions**

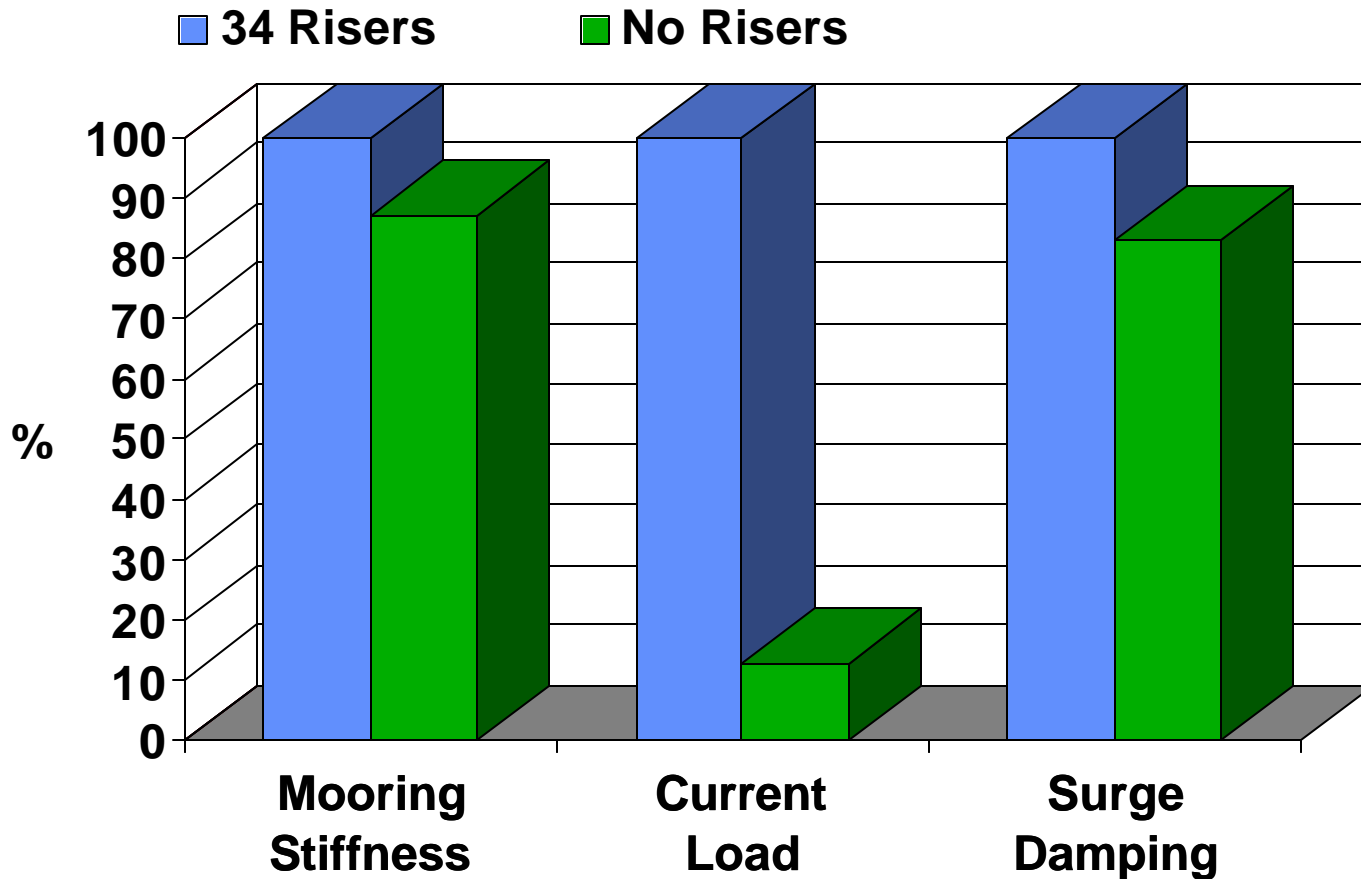
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- **Barracuda FPSO, Campos Basin, 835 m**
 - **6 anchor legs**
 - **34 risers and umbilicals**
 - **Terra Nova FPSO, Grand Banks, 95 m**
 - **9 anchor legs**
 - **19 risers and umbilicals**
 - **Generic FPSO, Gulf of Mexico, 1500-2000 m**
 - **9 anchor legs**
 - **10 risers**

Barracuda FPSO, Campos Basin

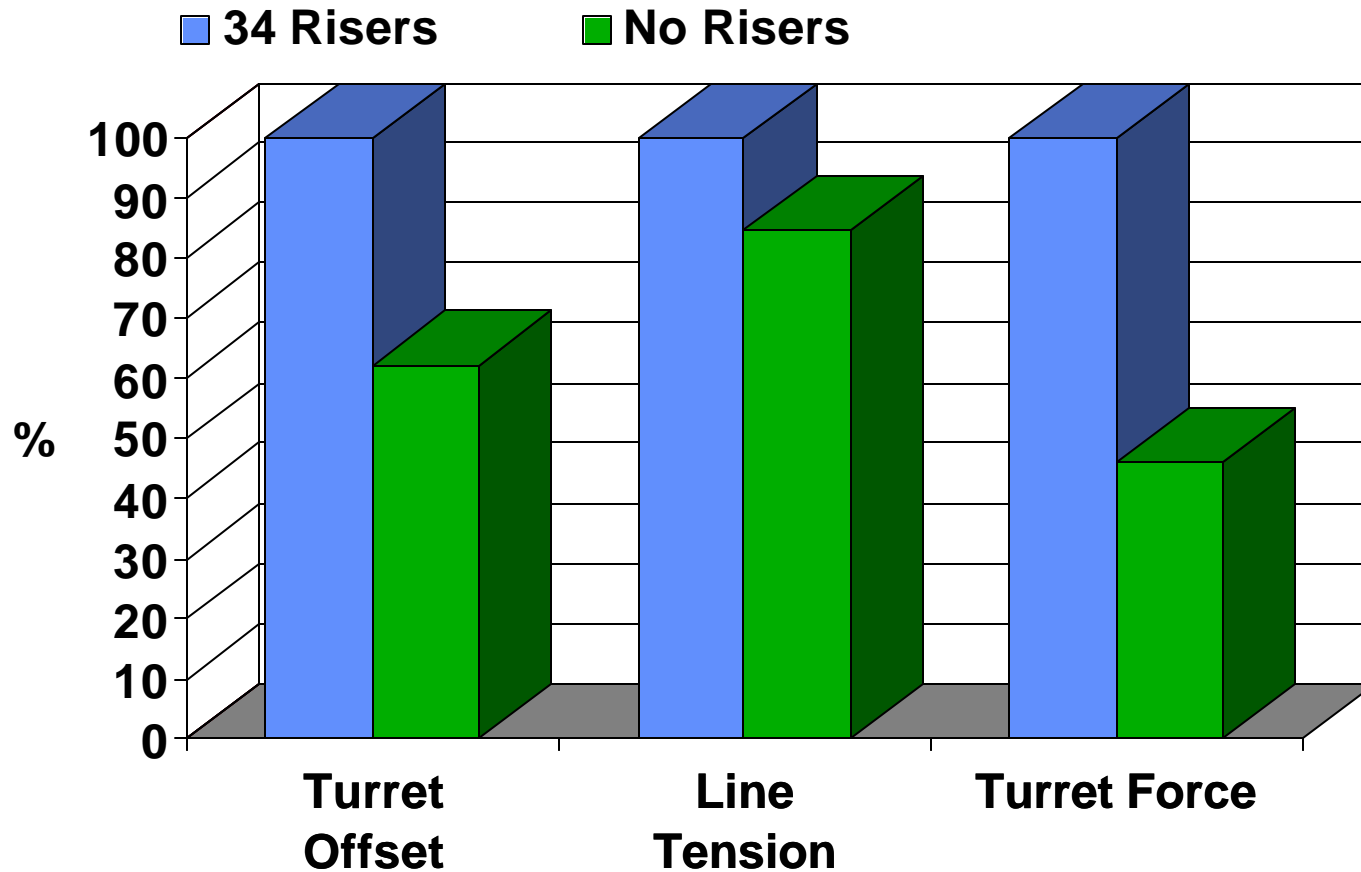


- Vessel: 64,000 MT
- Mooring: 6 chain/wire
- Risers: 34 *flexible catenary*
- Waves: $H_s = 7.2$ m
- Current: 1.8 m/s surface *deep profile*
- Wind: 68 knots

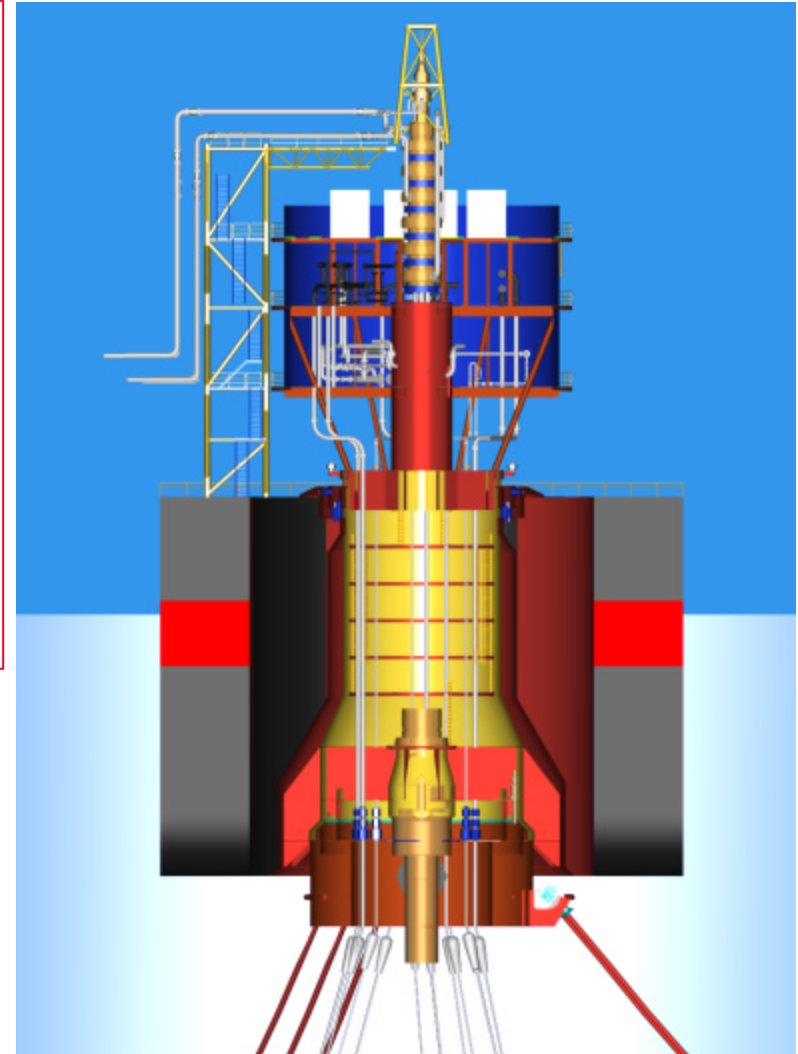
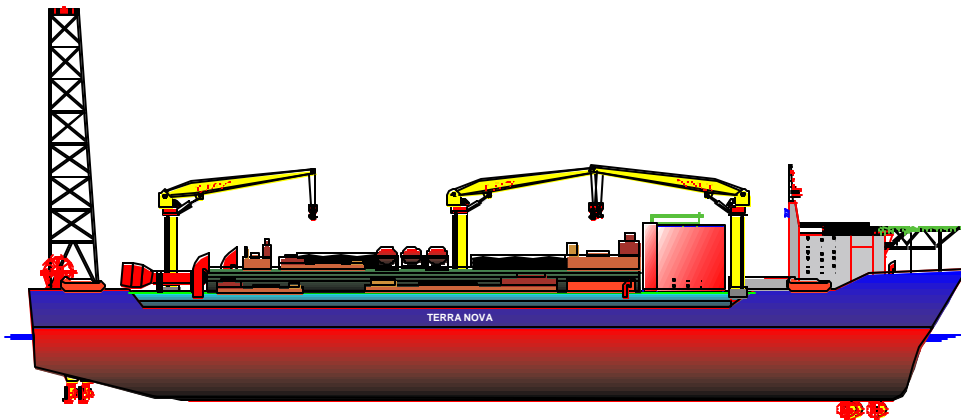
Global Response Parameters



Coupled Analysis Results



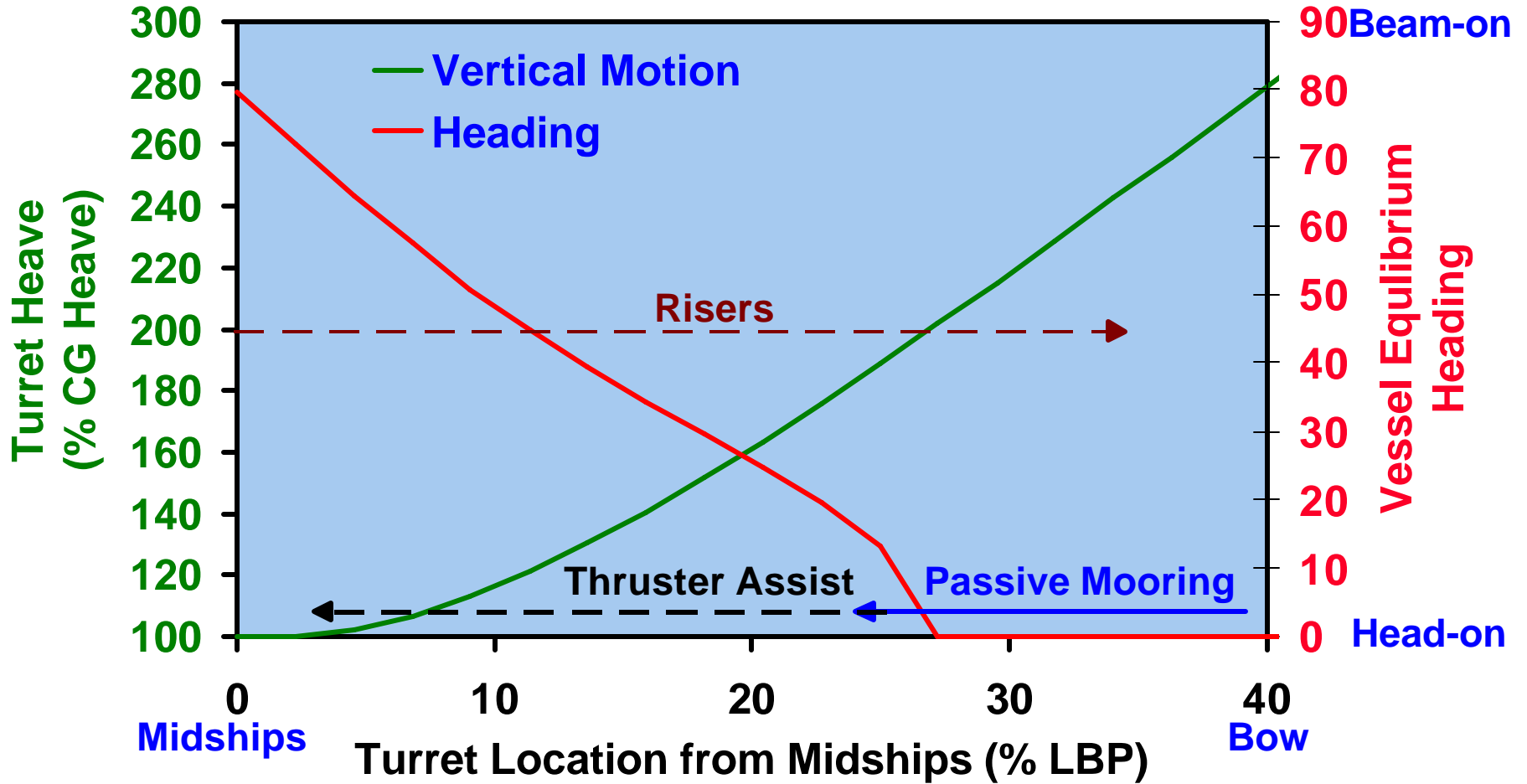
Terra Nova FPSO, Grand Banks



Mooring and Riser Design Basis

- Connected (FPSO): 100-year storm
- Disconnected (Buoy): 1-year storm

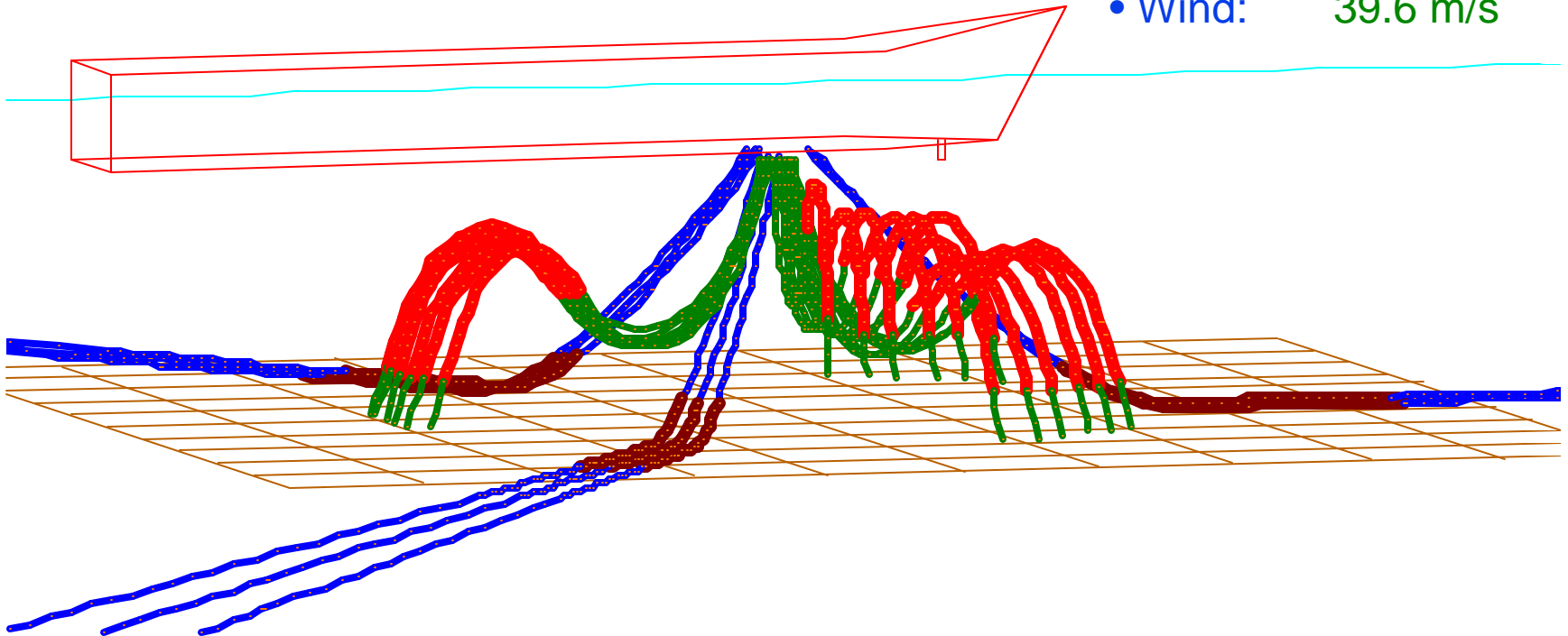
Turret Location



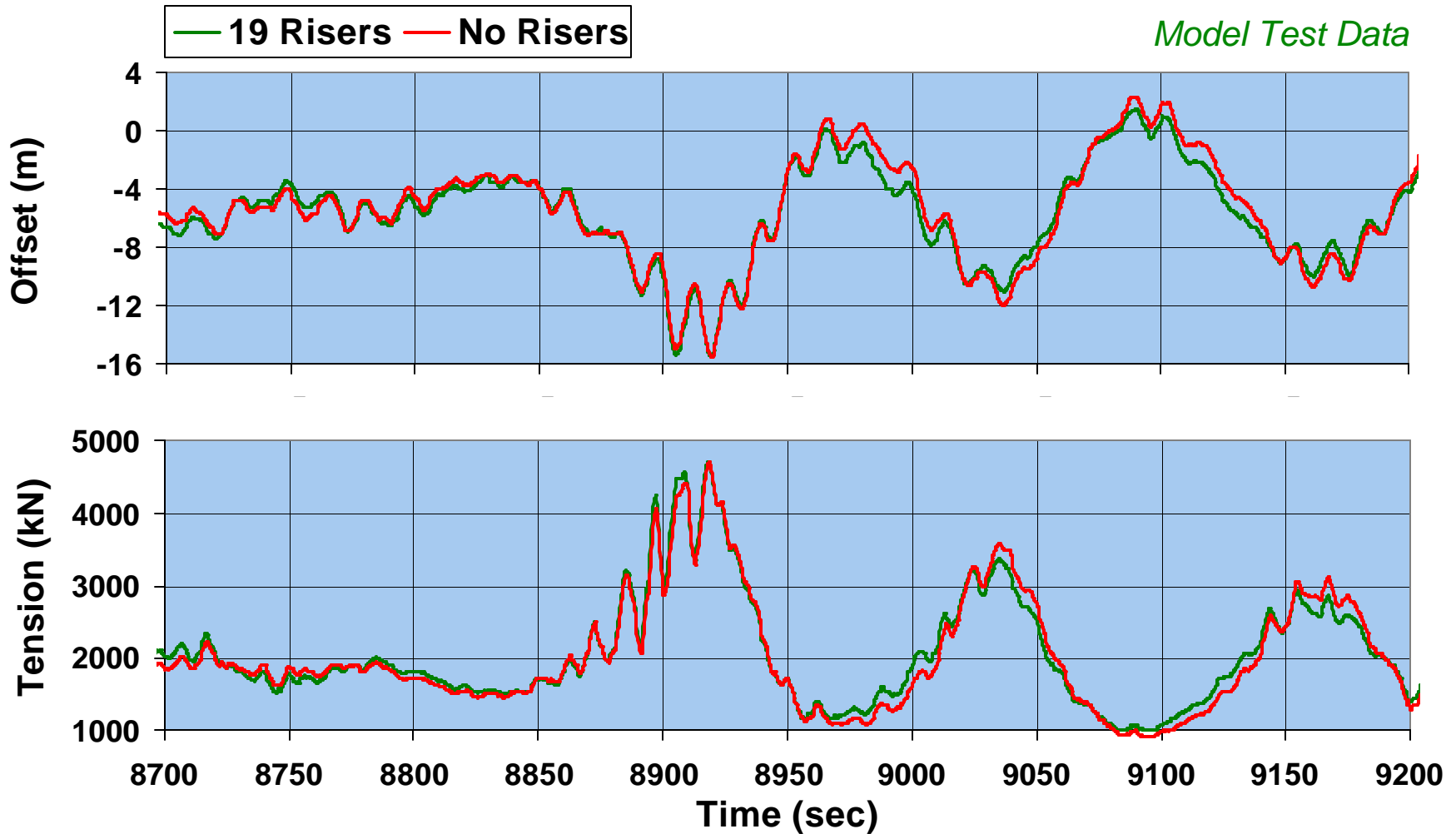
Terra Nova FPSO



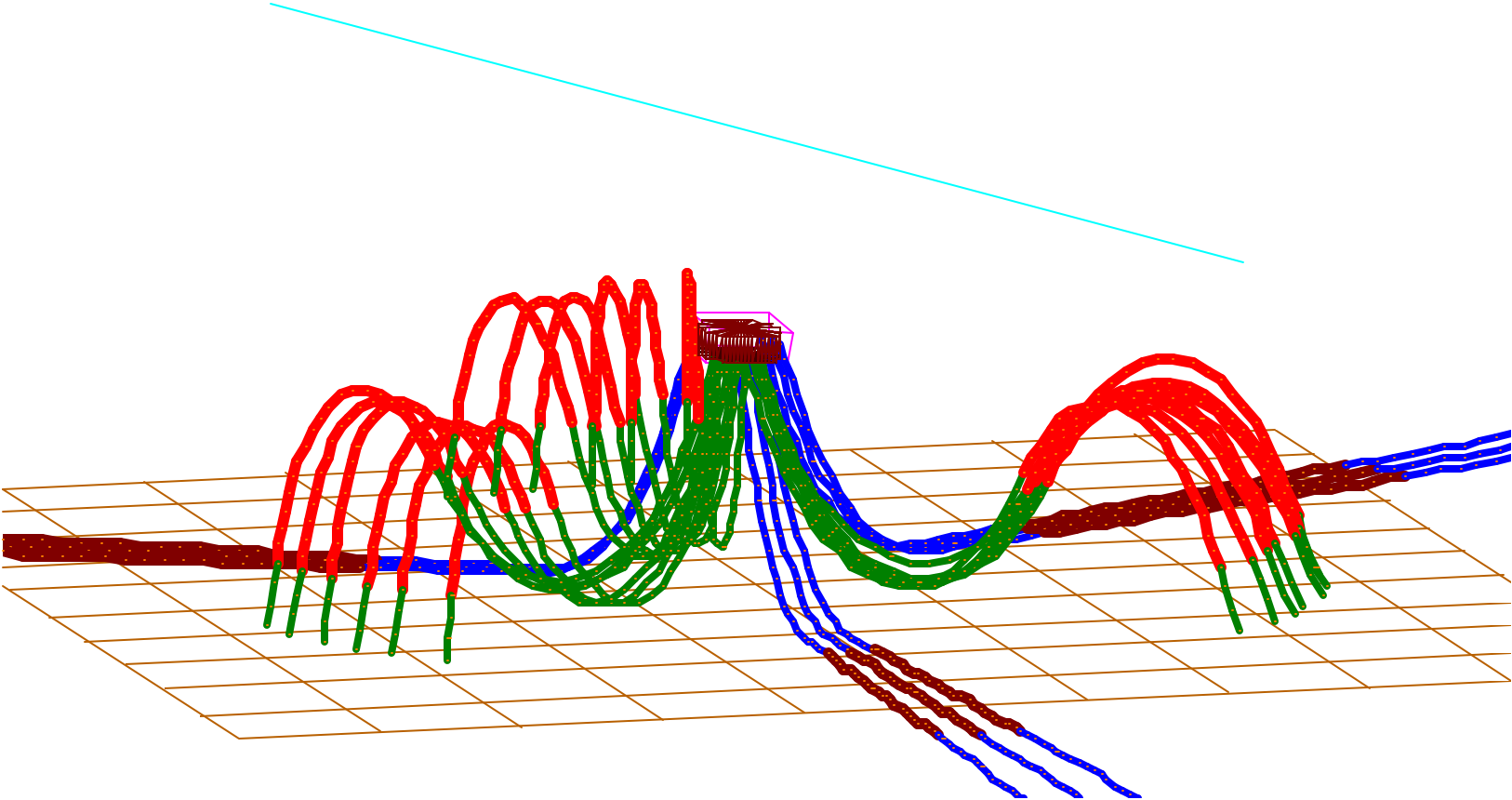
- Vessel: 190,000 MT
- Mooring: 9 chain
- Risers: 19 *flexible pliant wave*
- Waves: $H_s = 16.0$ m
- Current: 1.3 m/s surface
- Wind: 39.6 m/s



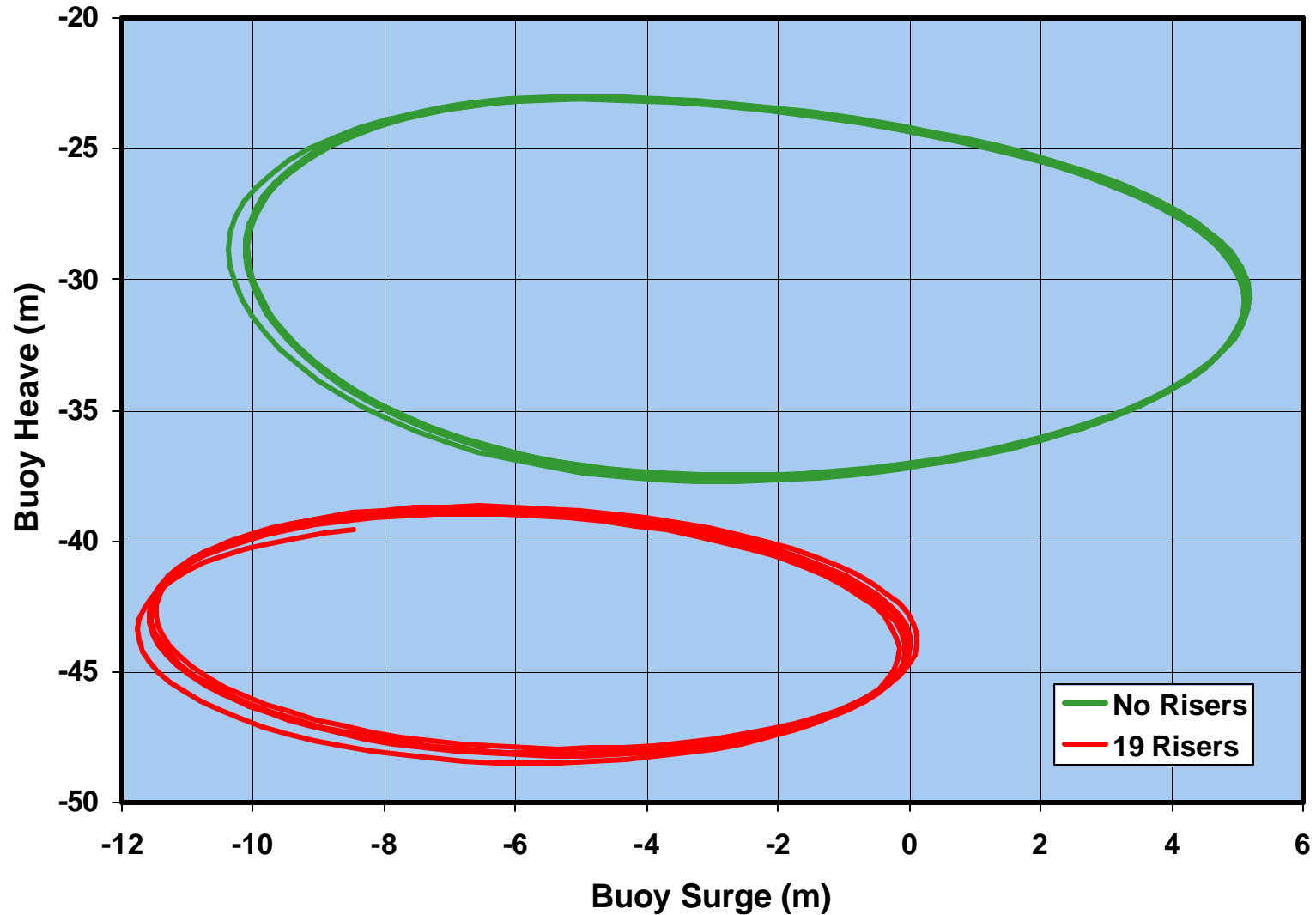
Riser Influence on FPSO Motions



Terra Nova Spider Buoy



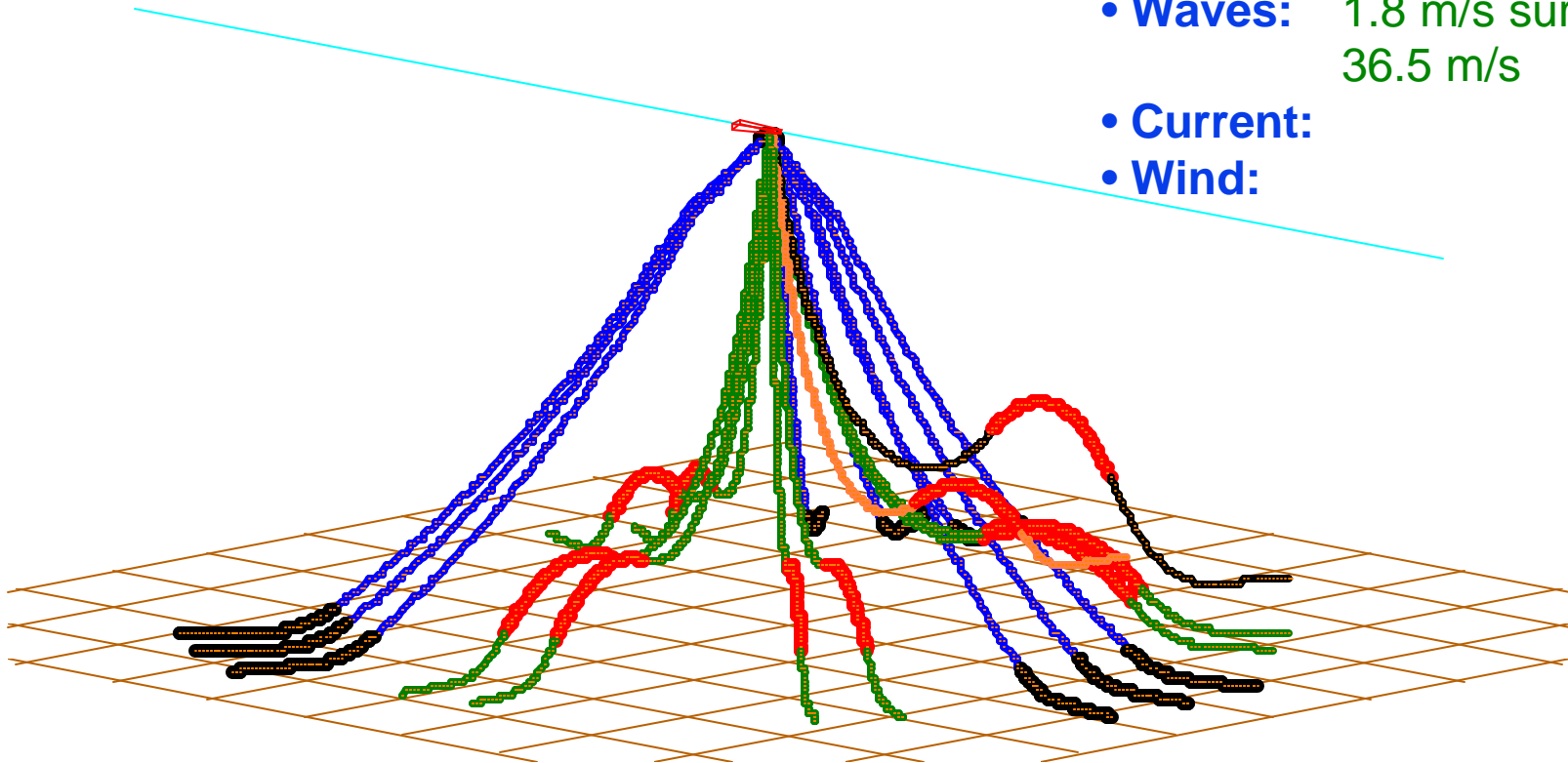
Riser Influence on Buoy Motions



Generic FPSO, Gulf of Mexico



- Vessel: 140,000 MT
- Mooring: 9 chain/wire/buoy
- Risers: 10 *steel lazy wave*
Hs = 12.2 m
- Waves: 1.8 m/s surface
36.5 m/s
- Current:
- Wind:

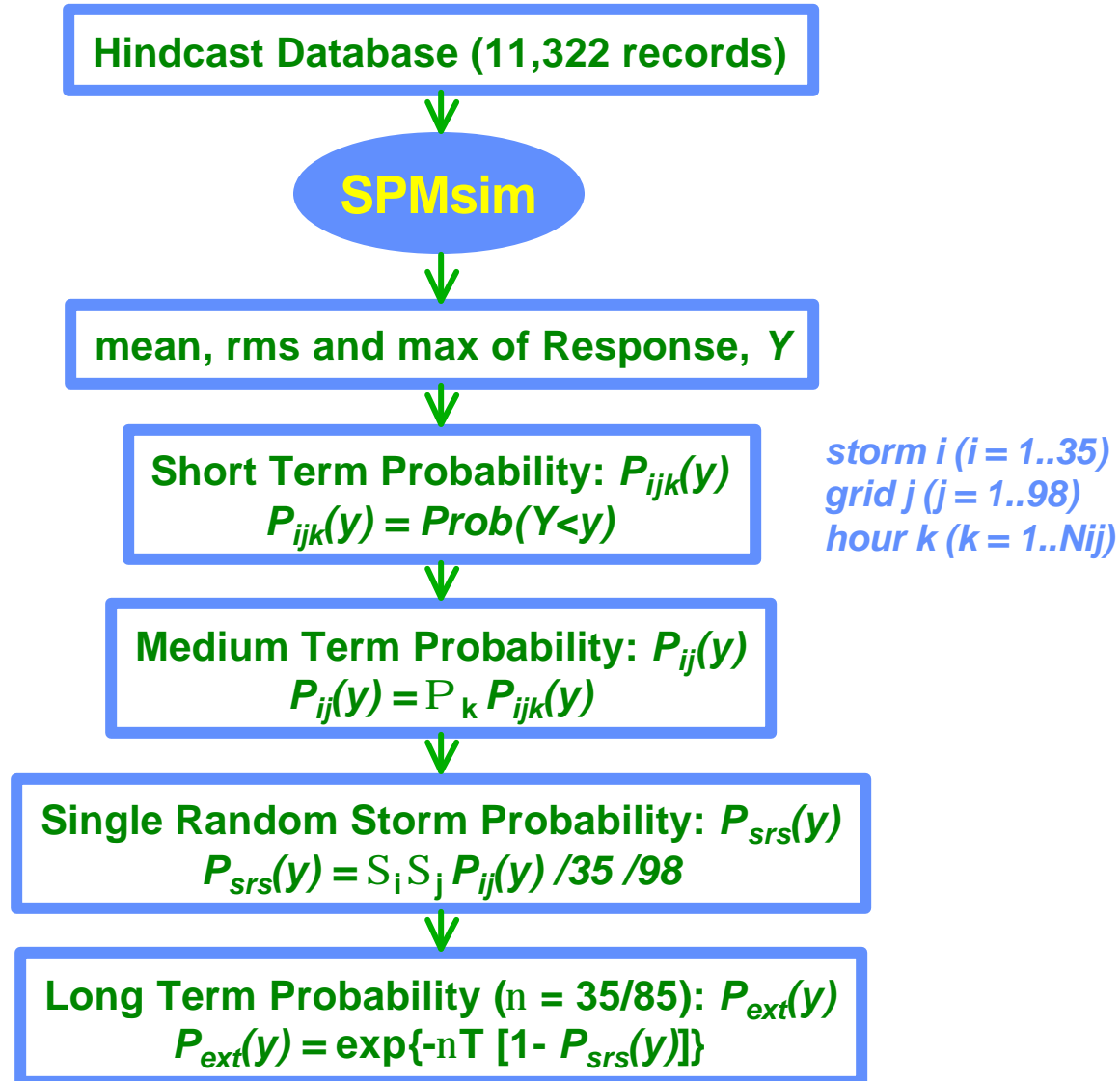


Long-Term Response Analysis

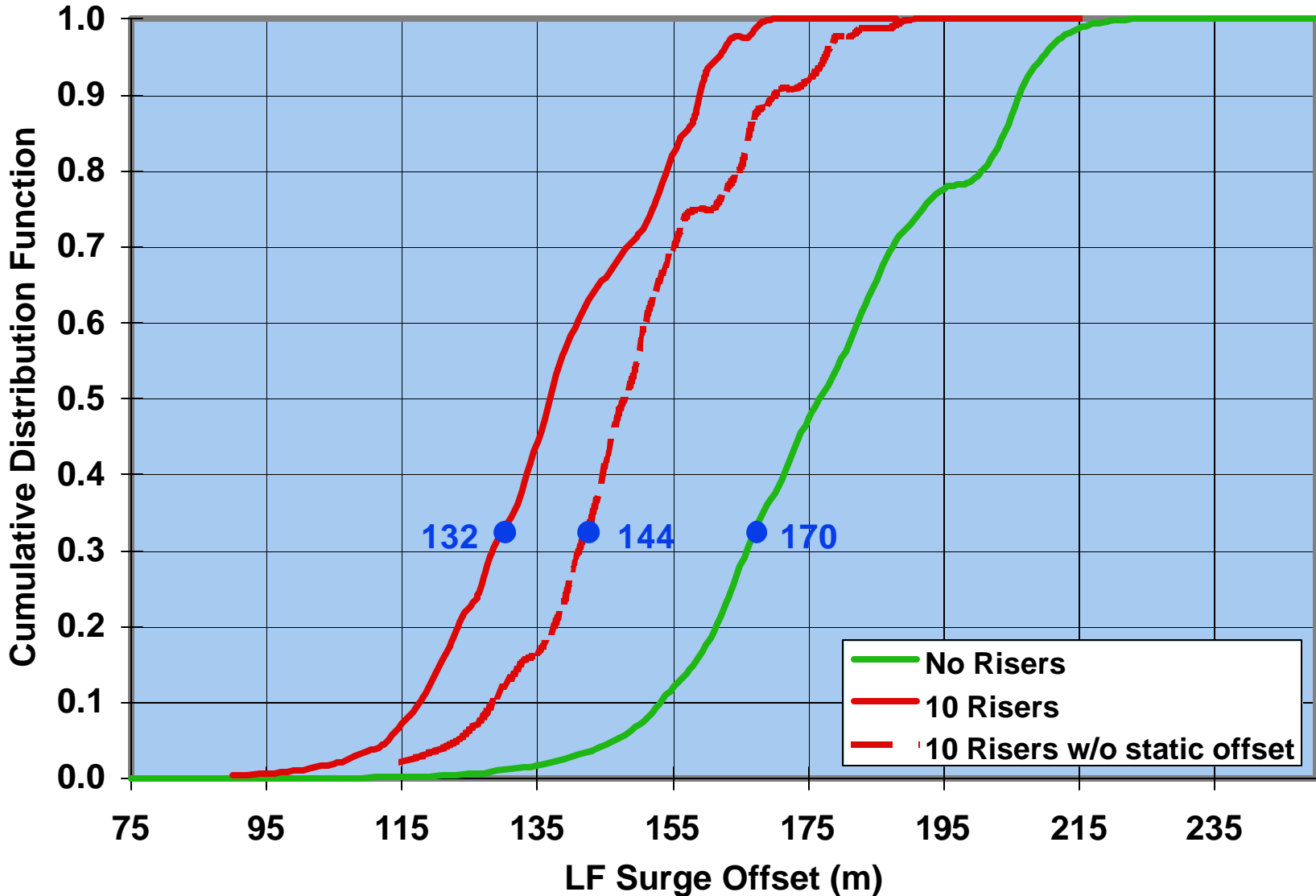


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- **Hindcast Hurricane Database (11,322 records)**
 - **85 year database**
 - wind height and period
 - wind and current speed
 - wave, wind and current direction
 - **35 storms over 98 grid-points**
 - **Dynamic Global Analysis Model of FPSO System**
 - **FPSO and mooring**
 - **FPSO, mooring and risers**
 - **Develop Long-Term Response Statistics:**
 - **Anchor leg and riser tensions**
 - **Turret loads and moments**
 - **Vessel offsets and motions**

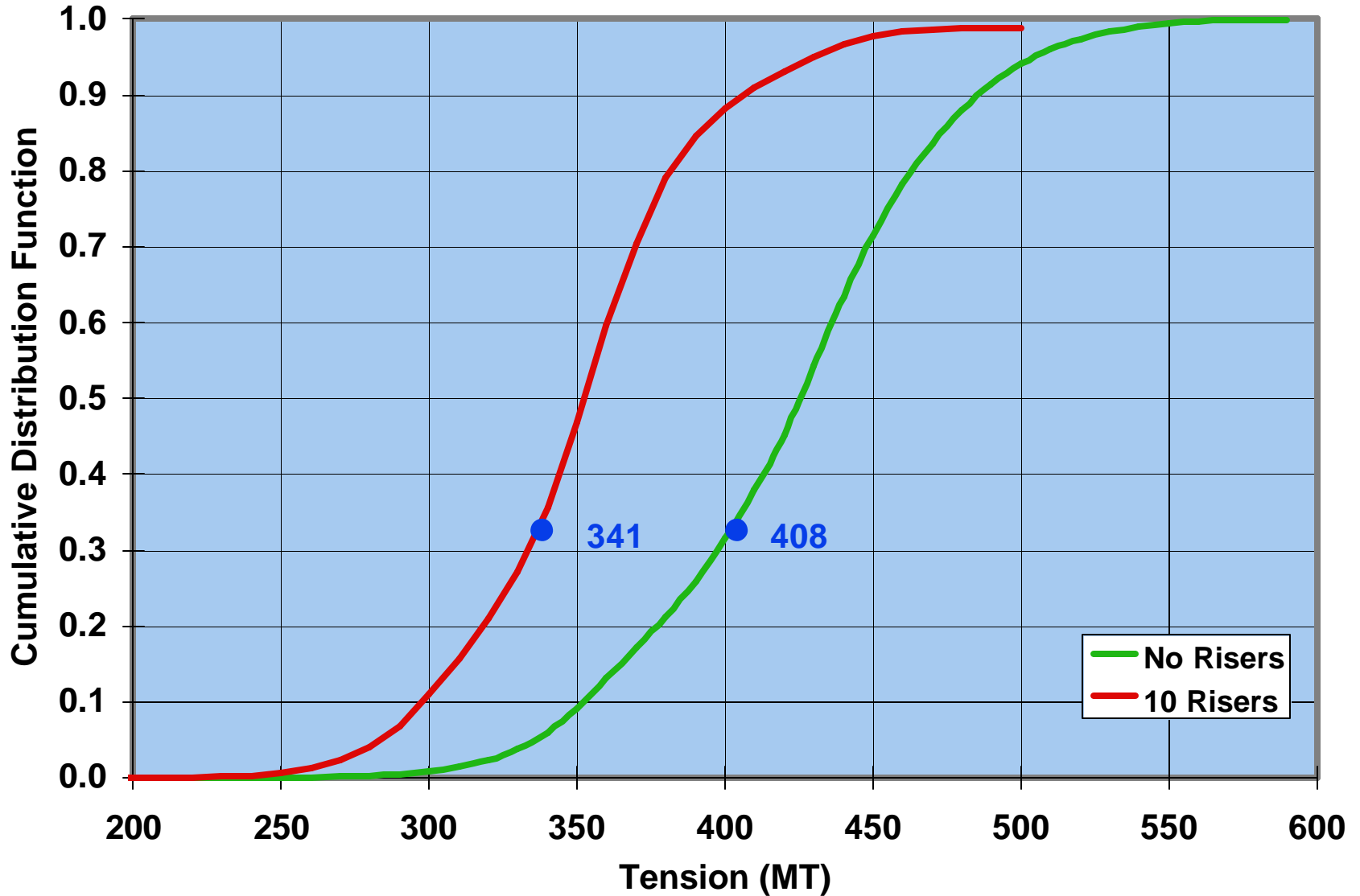
Long Term Response Analysis Methodology



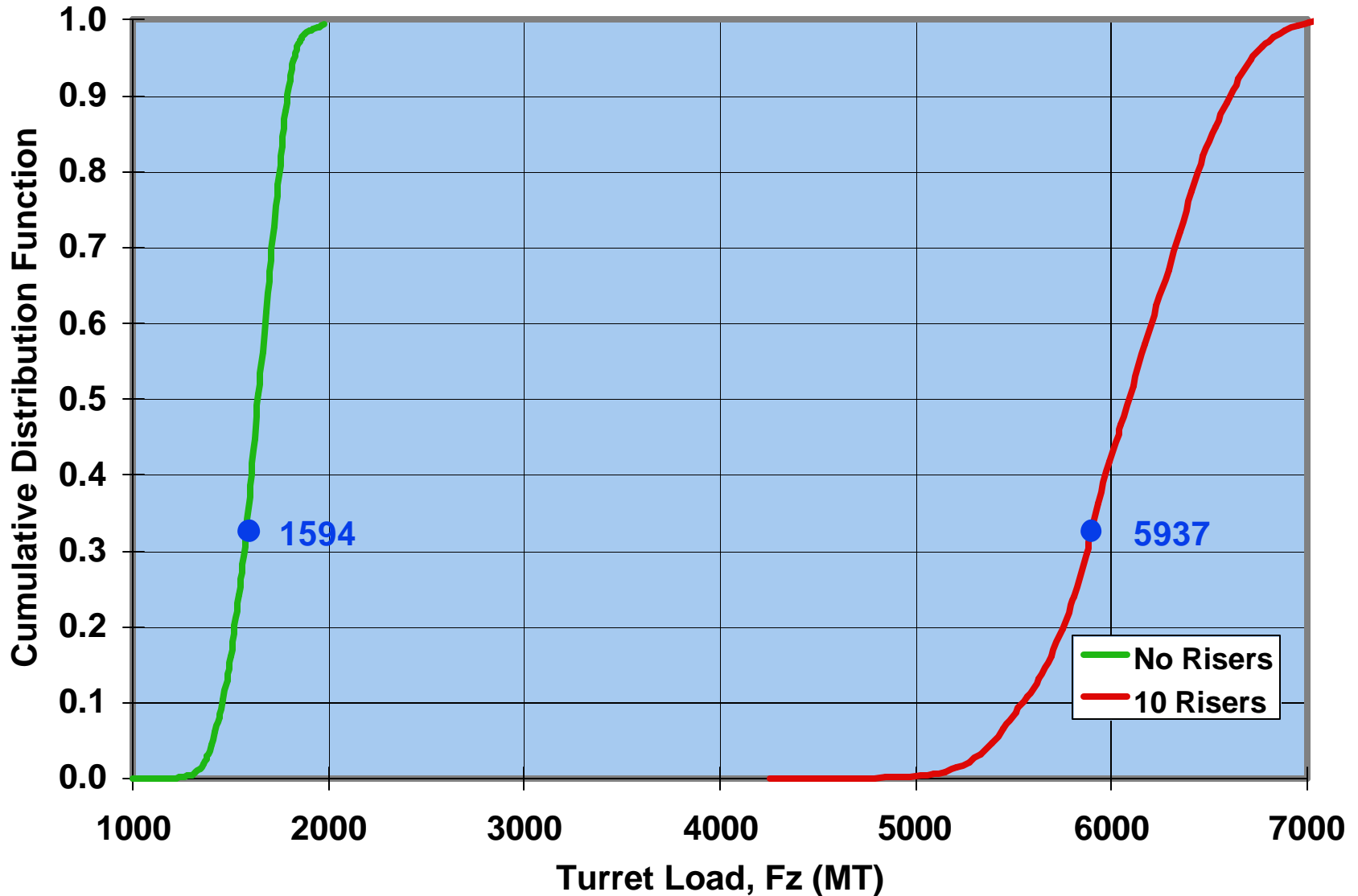
CDF of LF Surge Offset



CDF of Anchor Leg Tension



CDF of Turret Load, Fz



Coupled Analysis of Mooring and Riser Systems:

- **Accurate Estimate of the Global System Response**
 - **Vessel motions**
 - **Mooring and turret loads**
 - **Riser dynamics and loads**
- **Optimization of the Turret Mooring System**
 - **Turret location**
 - **Mooring and riser arrangement**
 - **Turret sizing and layout**