

APPENDIX 1

Supporting Information for CARP Model Update Methods - Computational Grid Resolution Increase

Slides previously presented to the CARP Management Committee

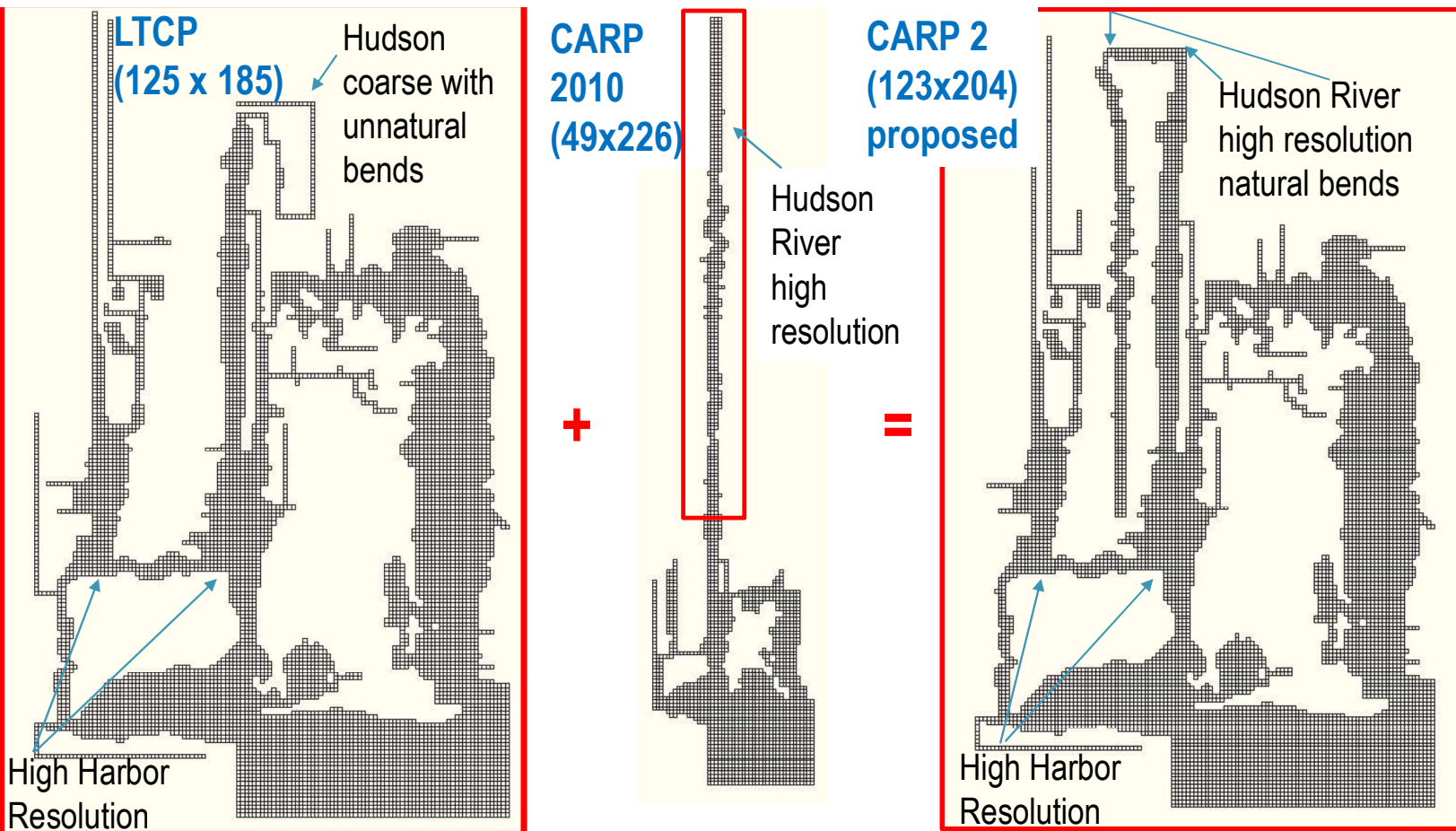
Why a New Grid for CARP 2?

The post-audit demonstrated that CARP 1 model predictions of PCB and dioxin levels were reliable within the variations of measurements, and CARP 2 In-Channel and Off-channel measurements are still under review, however:

- CARP 2 model will be a tool for the next 20 years
- Computer speed has increased since CARP 1, computational limitations have decreased
- CARP 2 model grid generation can be informed by other modeling efforts
 - CSO LTCP, Lower Passaic River/Newark Bay Superfund, CARP 2010 HRF Research
- CARP 1 model results compare well to high frequency salinity measurements at some but not all HRECOS stations. Work with other models indicates this can be fixed with model grid resolution
- Some Harbor areas were not properly resolved for CARP 1, e.g., Shooter's Island vicinity
- Extreme events, deepening projects and benthic mapping have occurred since CARP 1. CARP 1 model bathymetry requires updating

Model Grids Informing CARP 2 Model Grid Design

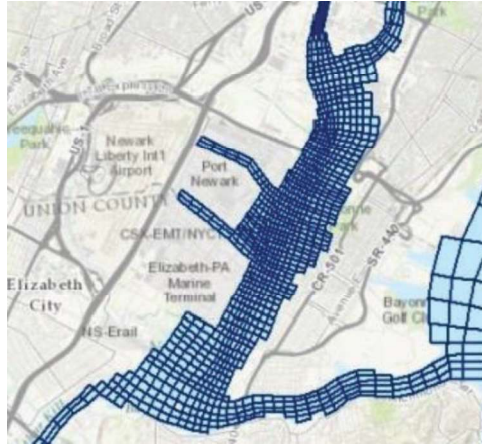
Model	Grid Size	Increased Resolution as Compared to CARP 1	Comments
CARP 1	49 x 84		
CARP 2010	49 x 226	Above Haverstraw Bay	Computationally inefficient, restricted gain
Lower Passaic/Newark Bay Superfund	74 x 268	Lower Passaic River Hackensack River Newark Bay Kills	No gain beyond Newark Bay complex Does not improve Upper NY Bay transport
CSO Long Term Control Plan (LTCP)	125 x 185	All Harbor areas except above Haverstraw Bay	Known to reproduce HRECOS temperature and salinity, all Harbor locations Widespread gains compared to Superfund
Simple CARP2010 LTCP merge	125 x 325	All areas	Computationally inefficient
CARP 2 (proposed)	123 x 204	All areas	CARP 2010 and LTCP merge optimized for resolution and computational burden



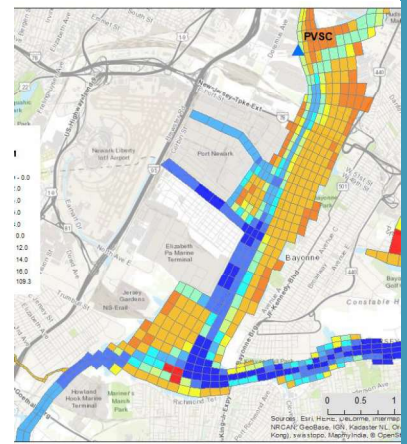
Model Grids in Newark Bay



CARP 1



Superfund

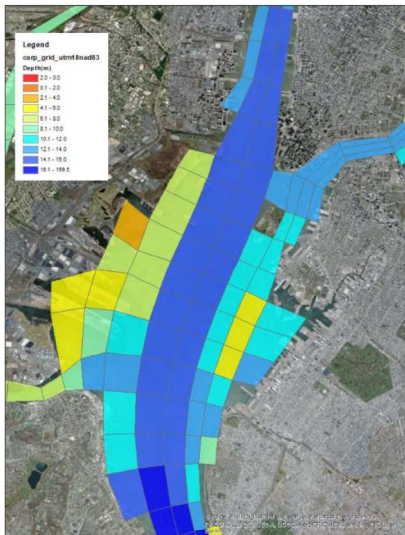


LTCP and
Proposed CARP 2

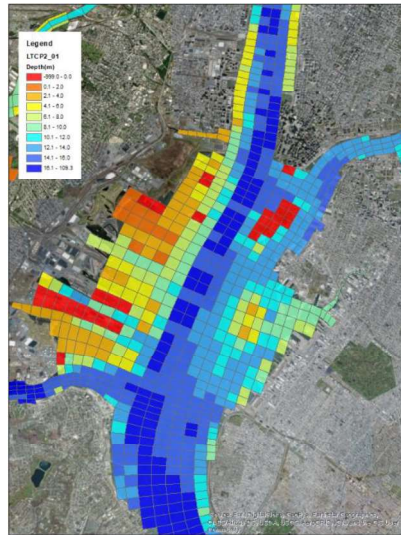
Proposed CARP 2 model grid resolution in Newark Bay falls in between resolution used for CARP 1 and Superfund

Model Grids in Upper NY Bay

Superfund
and
CARP 1



LTCP and
Proposed
CARP 2



Proposed CARP 2 model grid resolution in Upper NY Bay exceeds resolution used for CARP 1 and Superfund

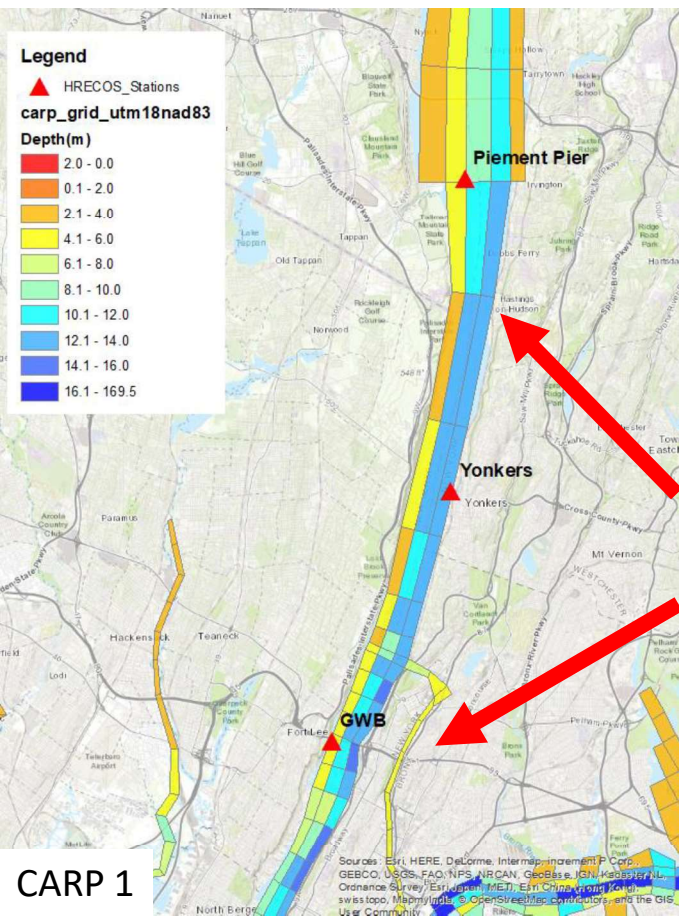
CARP 1 Model Salinity Calibration Problem (1 of 2)

HRECOS Piermont Pier and Yonkers stations

- CARP 1 model computed salinity is lower than observations at both stations
- LTCP model computed salinity matches observations at both stations

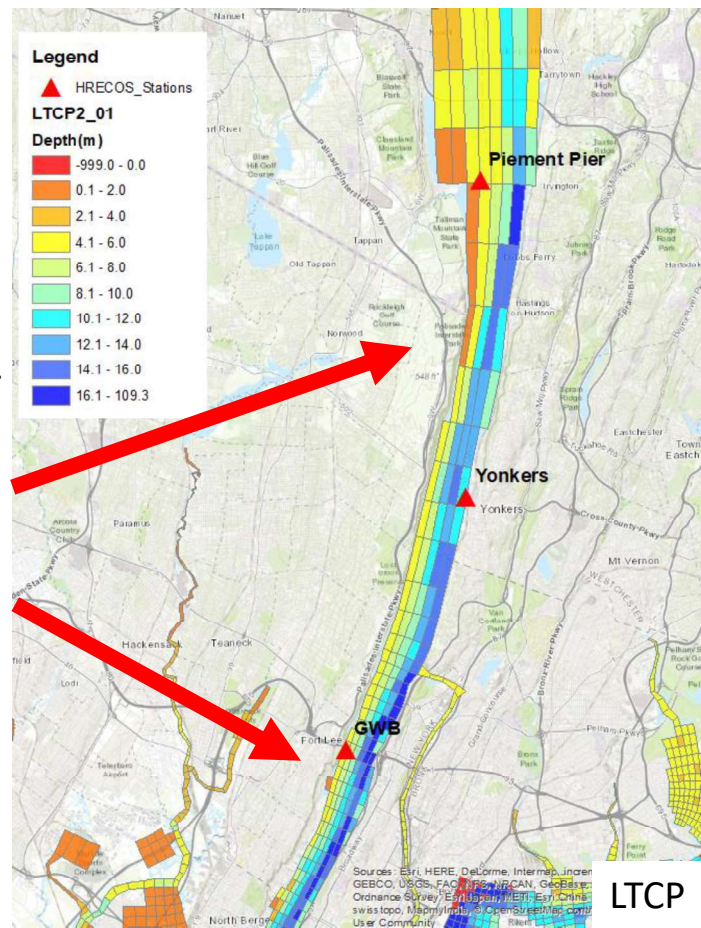
Why?

- CARP 1 model grid lacks the resolution needed for higher salinity water from the Hudson River near the George Washington Bridge to migrate further upstream
 - 3 lateral grid cells in lower Hudson in CARP 1 model
 - 5 lateral grid cells in Lower Hudson in LTCP model
 - Enhanced longitudinal grid resolution in Lower Hudson in LTCP model vs CARP 1 model
 - Deep channel depth better represented in LTCP model vs CARP 1 model



Agreement with HRECOS data near Piermont and Yonkers better for LTCP than CARP 1

Good agreement with HRECOS data near George Washington Bridge



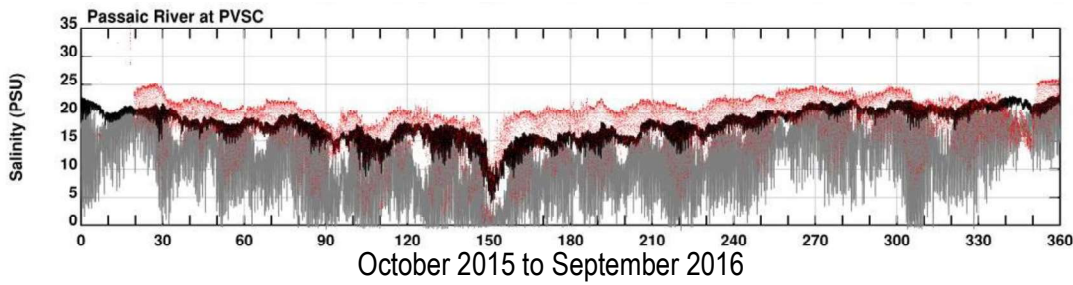
CARP 1 Model Salinity Calibration Problem (2 of 2)

HRECOS PVSC station (analogous to Piermont Pier and Yonkers stations)

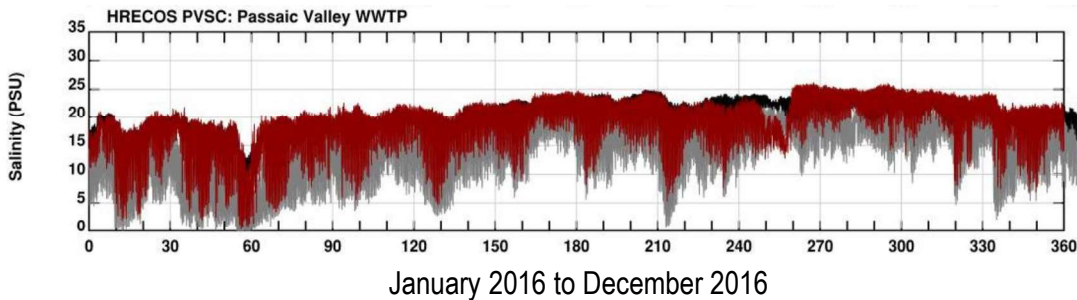
- CARP 1 model computed salinity is lower than observations
- LTCP model computed salinity matches observations

Why?

- CARP 1 model grid lacks the resolution needed for higher salinity water to migrate further upstream in Newark Bay
 - 1 lateral grid cell and few longitudinal cells in Newark Bay in CARP 1 model
 - Enhanced lateral and longitudinal grid resolution in Newark Bay in LTCP model vs CARP 1 model
 - Depth gradients between the narrow deep channel and the shallow flats better represented in LTCP model vs CARP 1 model



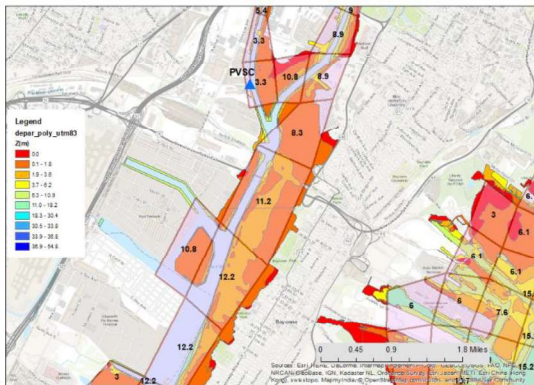
CARP 1 model calculations (black and grey) lower than HRECOS measured salinity (red)



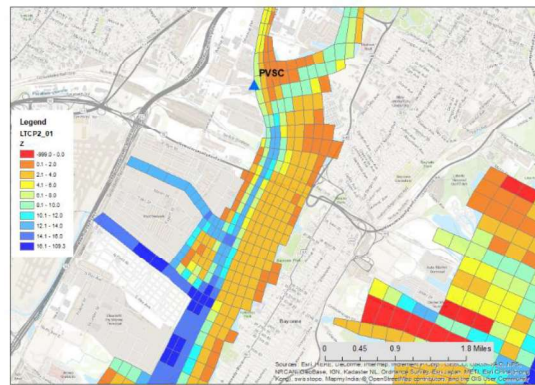
LTCP model calculations (black and grey) agree with HRECOS measured salinity (red)

Higher LTCP model grid resolution in Newark Bay improves salinity calibration as compared to the CARP 1 model. Proposed CARP 2 grid based on LTCP grid

Model Grids In Newark Bay Near PVSC HRECOS station

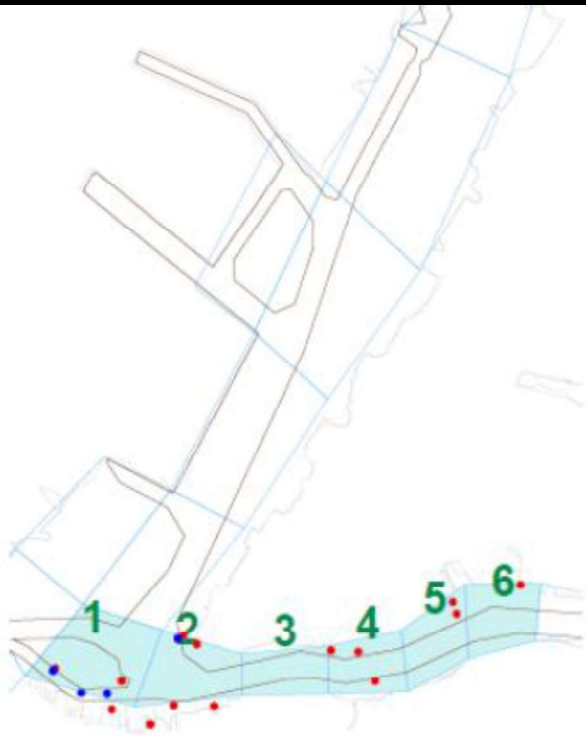


CARP 1



LTCP
and proposed CARP 2

Higher LTCP model grid resolution in Newark Bay improves representation of depth gradients and salinity calibration as compared to the CARP 1 model



CARP 1 model grid in the vicinity of the confluence of Newark Bay and the Kill van Kull. Highlighted model grid cell 1 covers Shooter's Island as well as the channels north and south of the Island. Model results for model grid cell 1 are calculated as average concentrations over the entire surface area and volume. Inconsistent with the model segmentation, in-channel (blue symbols) and off-channel (red symbols) measurements are all located south of Shooter's Island. Highlighted model grid cells 2 through 5 illustrate the spatial relationship between the channel in the Kill van Kull and off-channel (red symbols) historical measurements.

Proposed CARP 2 grid will address CARP 1 grid concern near Shooters Island