Modeling the Fate and Transport of Ammonia and Temperature Using DSM2-QUAL

Marianne Guerin

Resource Management Associates

Richard Rachiele, Eu Gene Chung, Don Smith

RMA Resource Management Associates

SWC Project Objectives

(1) Calibration and validation of the DSM2-QUAL water quality module to simulate:

- temperature
- nitrogen dynamics
- Time span: 1990 - 2008

(2) Development of a prioritized water quality monitoring program with the intent of improving the understanding of ammonia and temperature dynamics

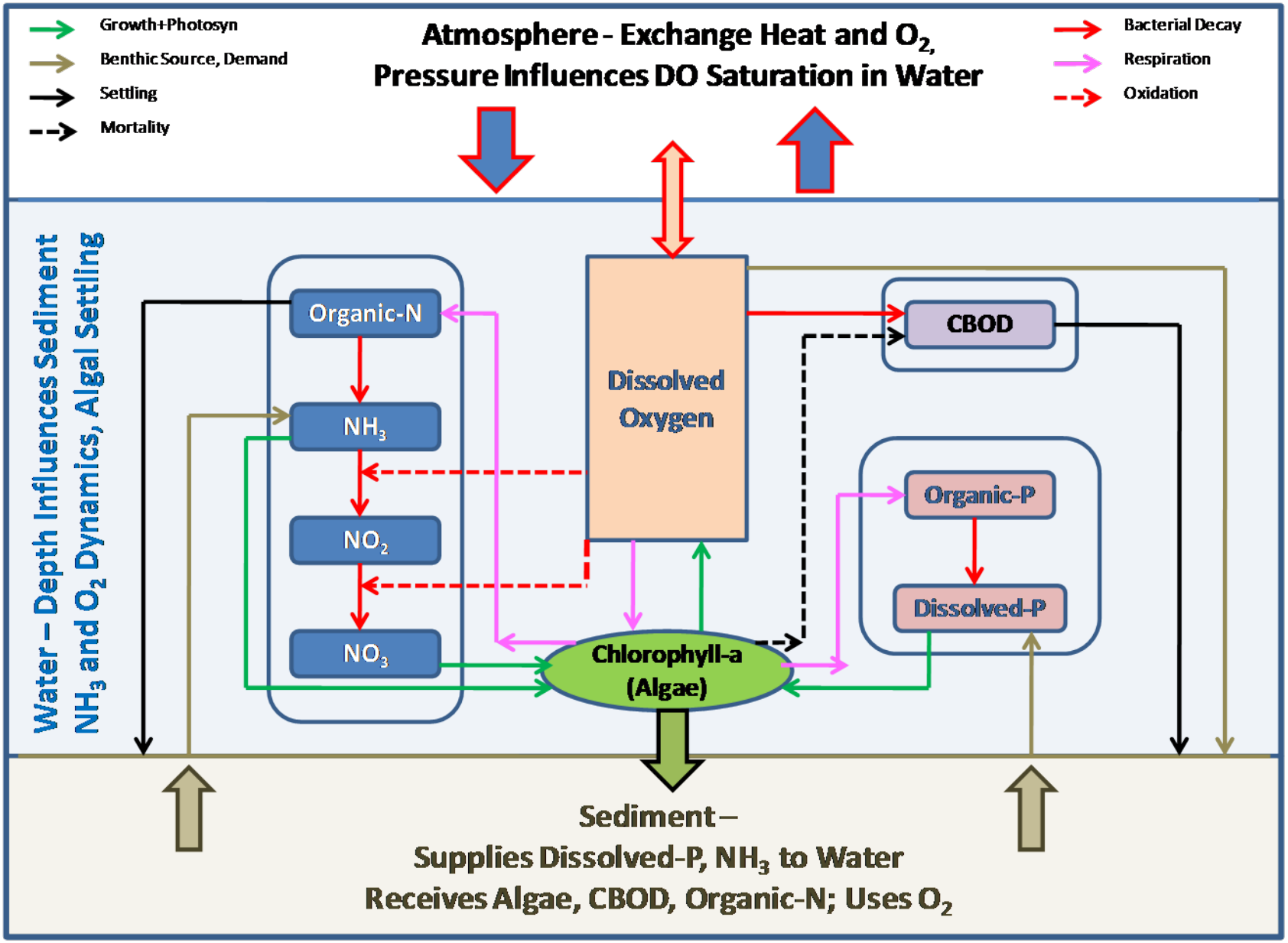
Motivation:

- Models help elucidate complex linkages:
  - Ecosystem decline in the Delta
  - POD
- Nitrogen constituents:
  - Ammonium (NH4) known to be toxic - concentration, pH, temperature dependence
  - Stockton and Sacramento waste water treatment plants are known contributors of nitrogen-containing compounds
  - Recent work indicate problems with ammonia/nitrate dynamics in/around Suisun Bay (Dugdale et al.) – high NH4 may disrupt NO3 use by phytoplankton & perhaps contribute to POD
- Water temperature may reach lethal levels for some species residing in-Delta
- Current QUAL water quality model has not yet been developed for ammonia/nitrogen (Hari ~ DO/Stockton)

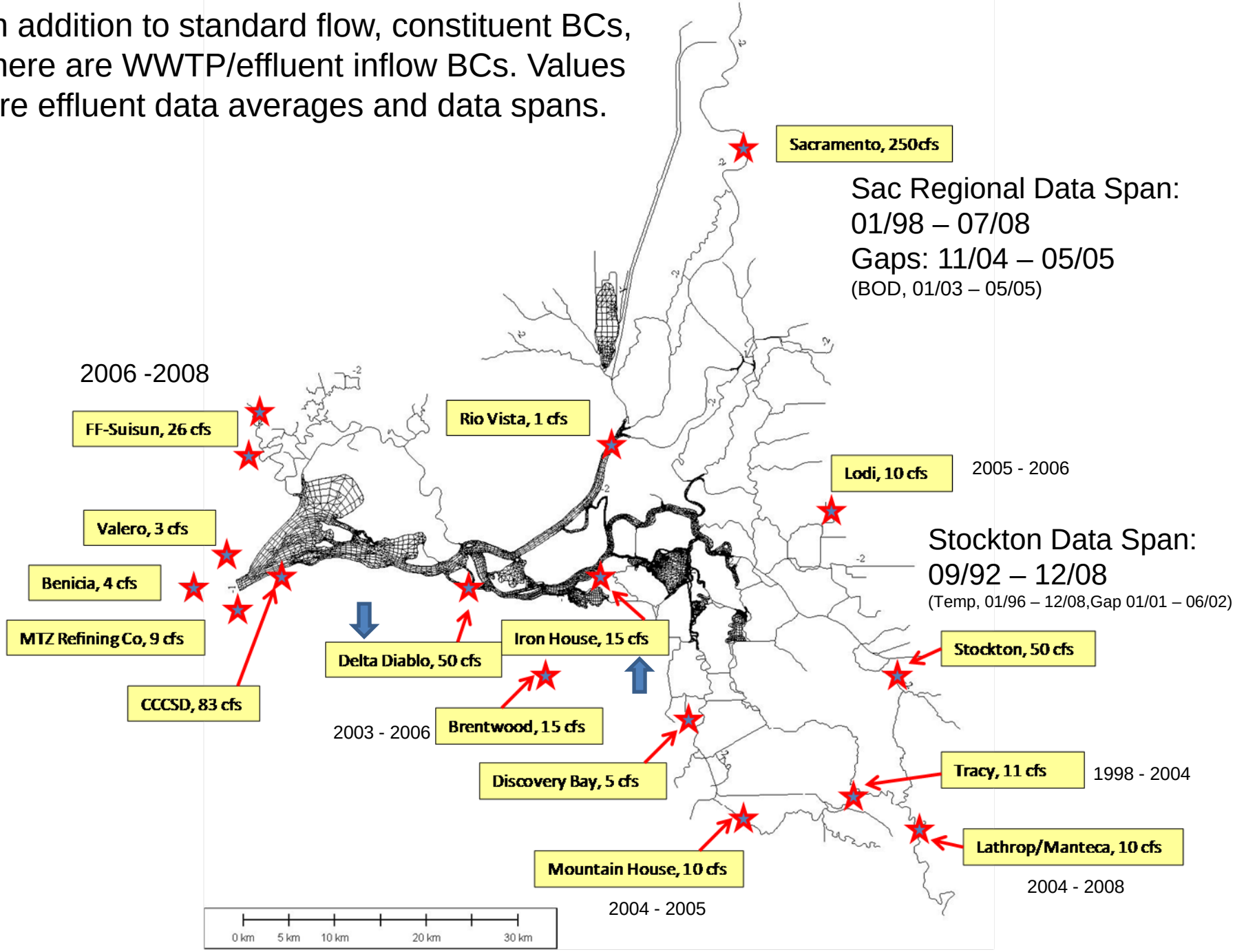
Issues = Opportunities

- Data quality and availability
  - Filling missing data
  - Calibration data
- Point source vs. NPS BCs:
  - Regionalizing meteorological input
  - Working w/DWR-DMS
- Other potential issues:
  - DICU: low flow example
  - Water temperature: model instability at some locations

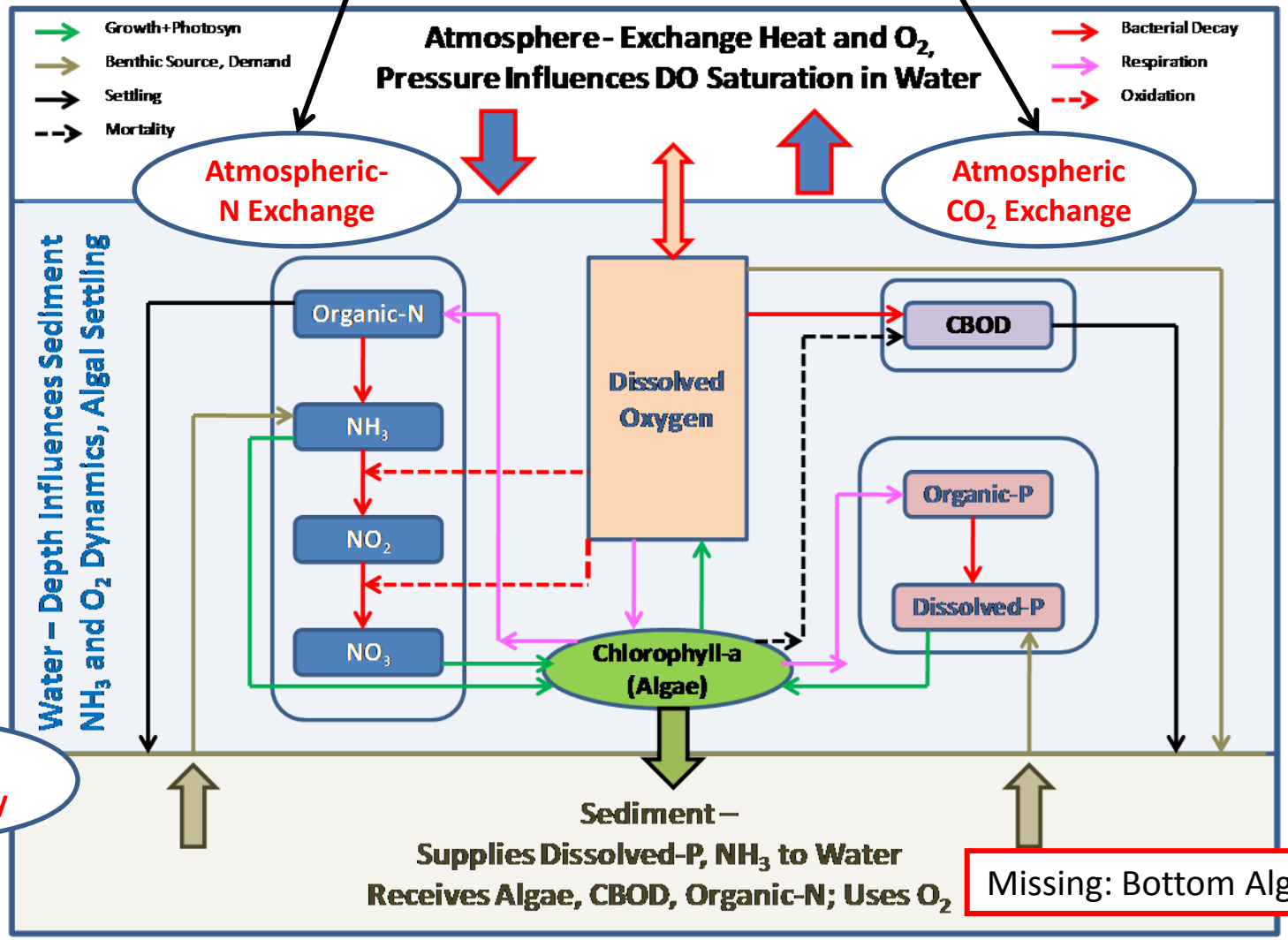
DSM2/QUAL Conceptual Model – Boxes ~ Model Input



In addition to standard flow, constituent BCs, there are WWTP/effluent inflow BCs. Values are effluent data averages and data spans.



Missing Atmospheric Sources/Interactions:



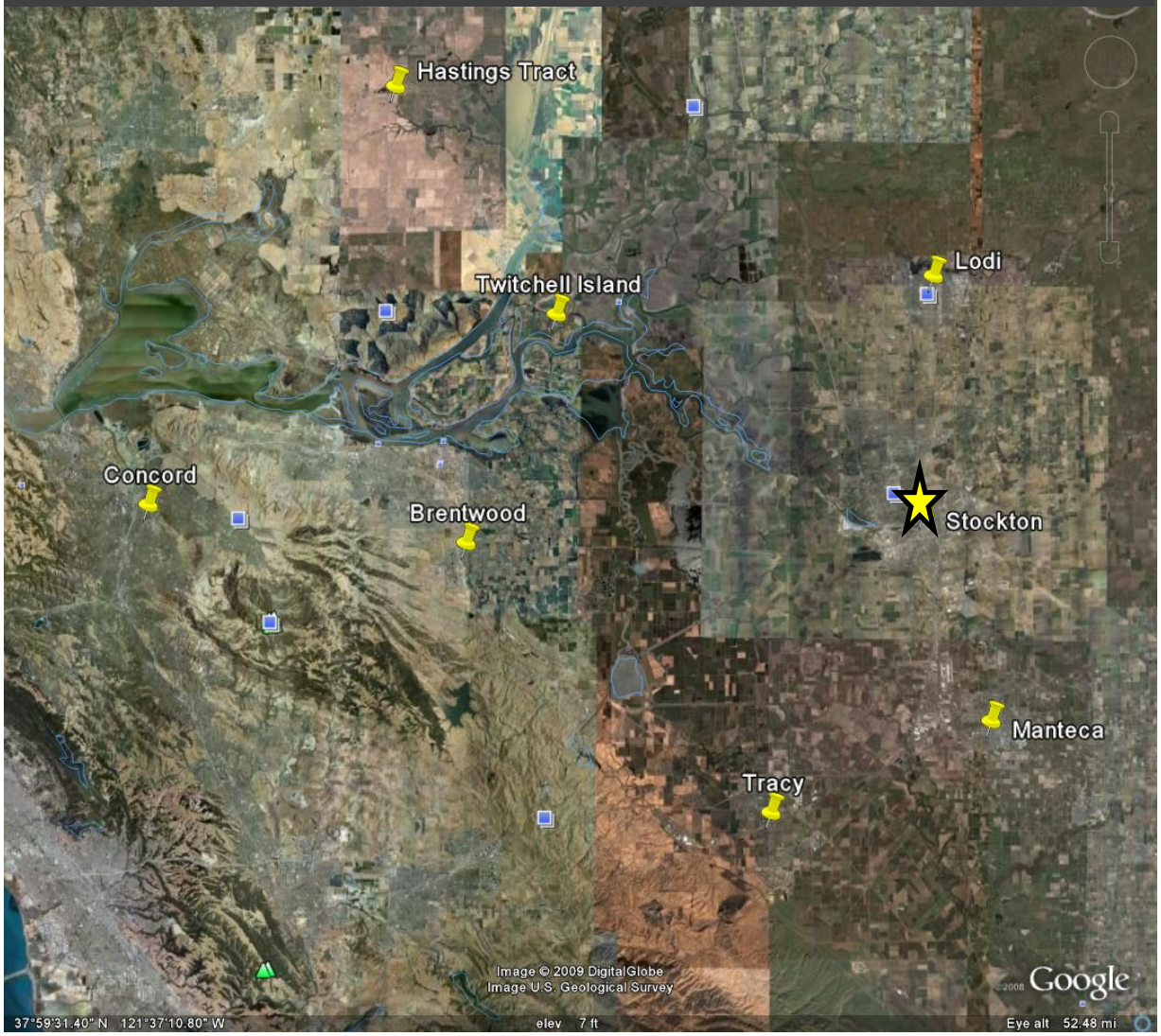
pH and
Alkalinity

Missing: Bottom Algae Reactions

Missing Water Parameters

Measured Rate Constants: Each arrow is a temperature-dependent reaction

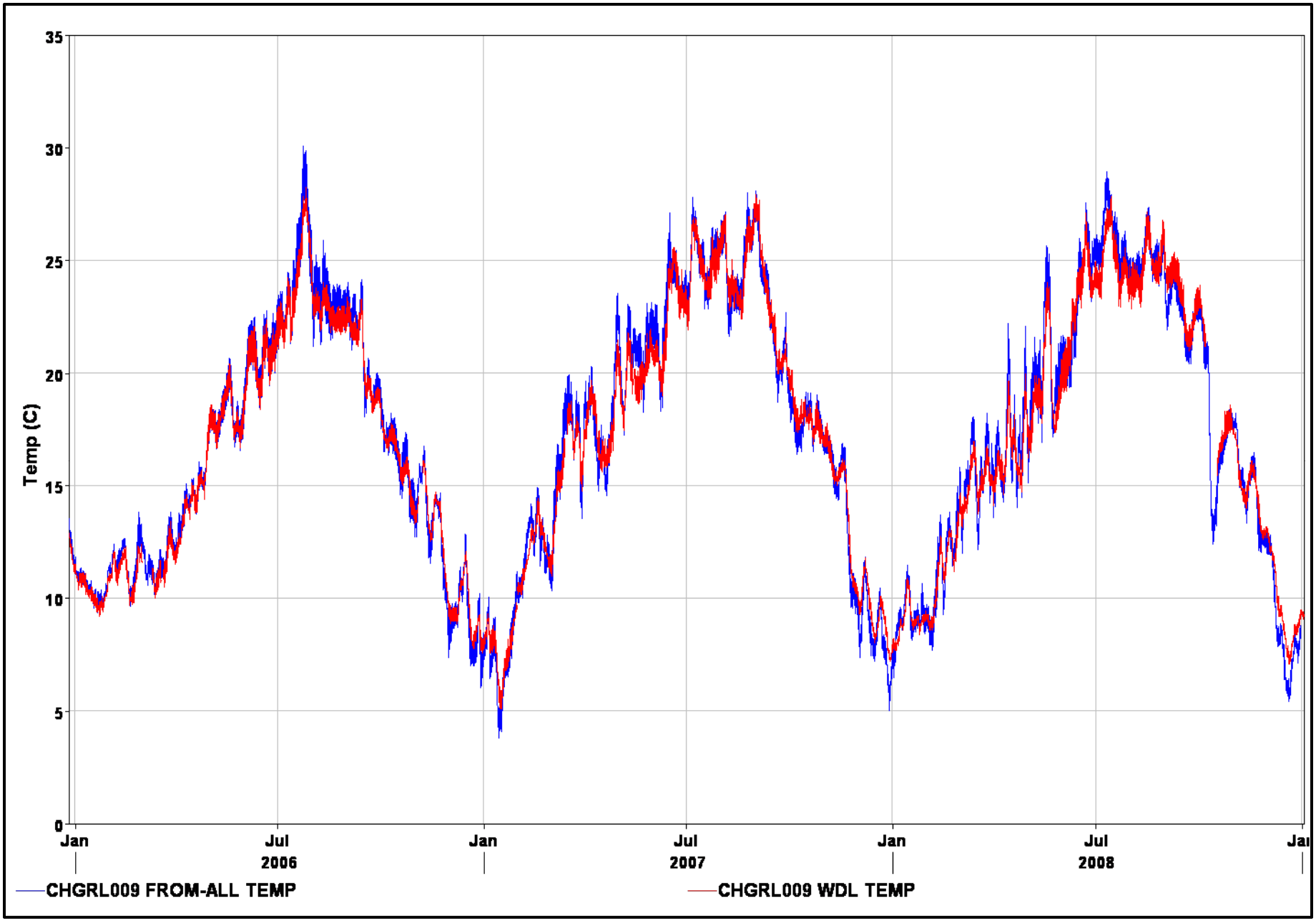
Meteorology – CIMIS + NOAA



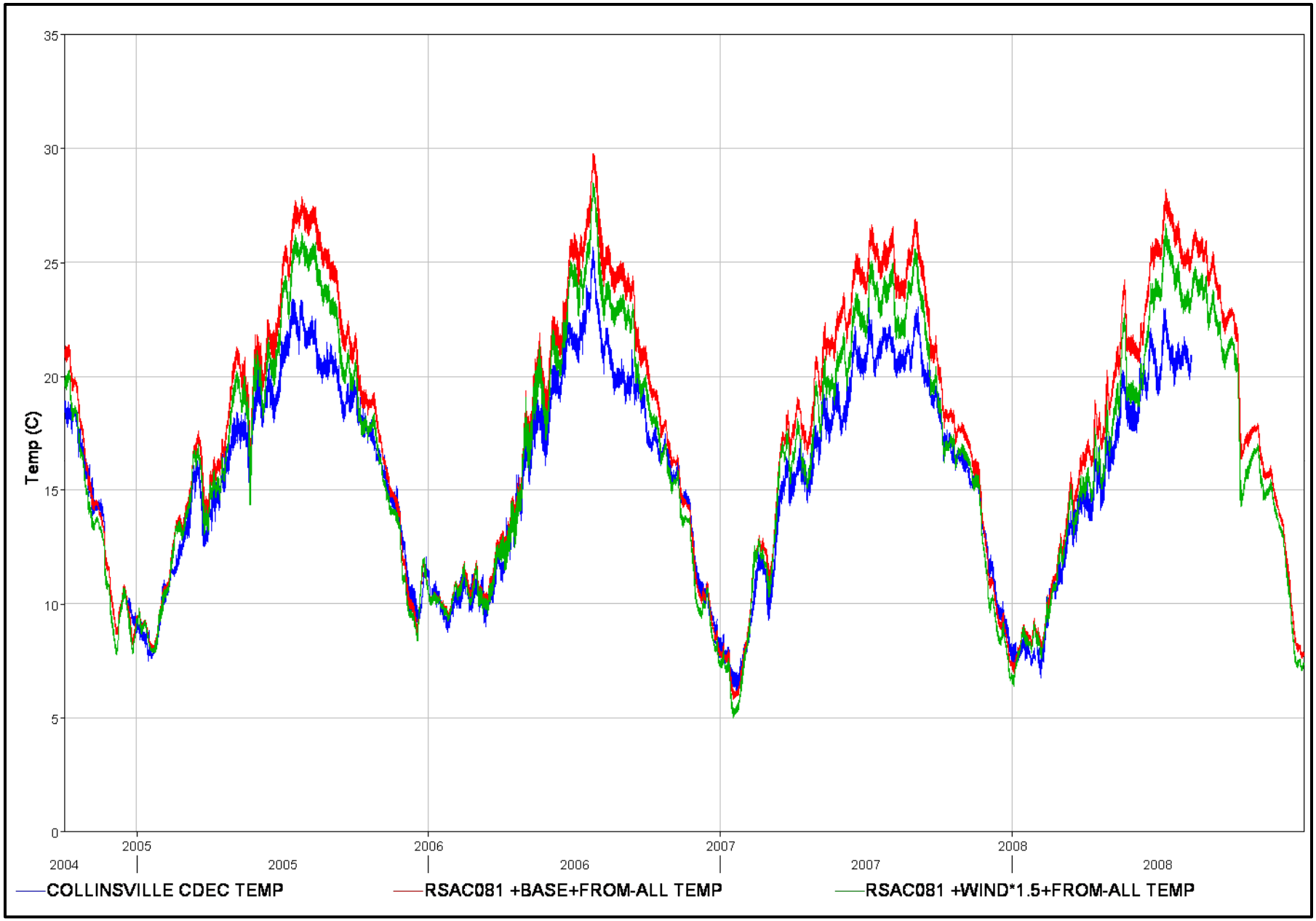
NOAA/Stockton:
Complete BC
1997 – 2008

For 1990 - 1996
need to calculate
Atm. Pres (Altimeter),
Wet bulb (Dew Pt.)

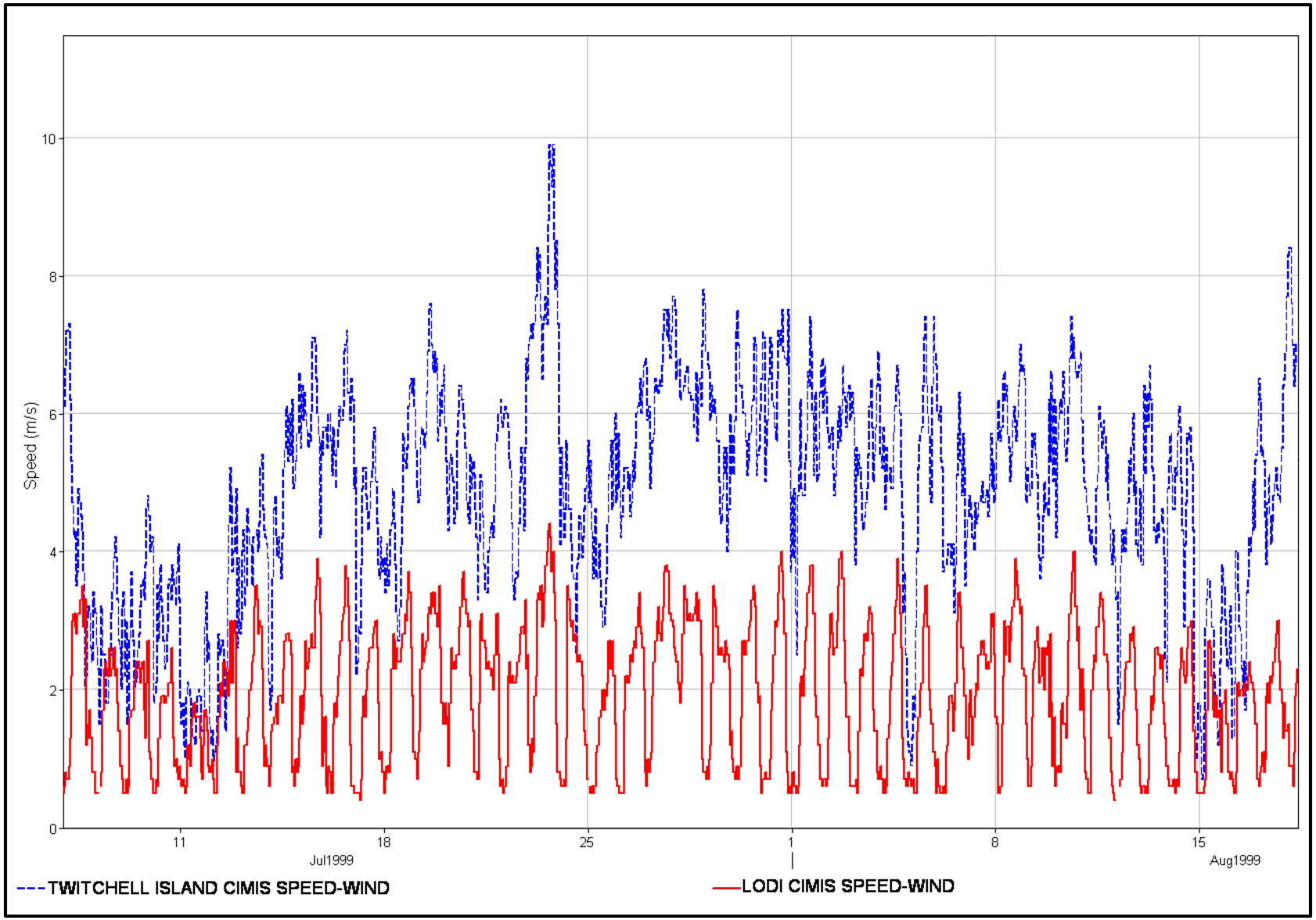
★ NOAA – Stockton airport
Central District of CIMIS stations (California Irrigation Management System)
(Source: http://www.cimis.water.ca.gov/cimis/infoStnMapCentral.jsp)



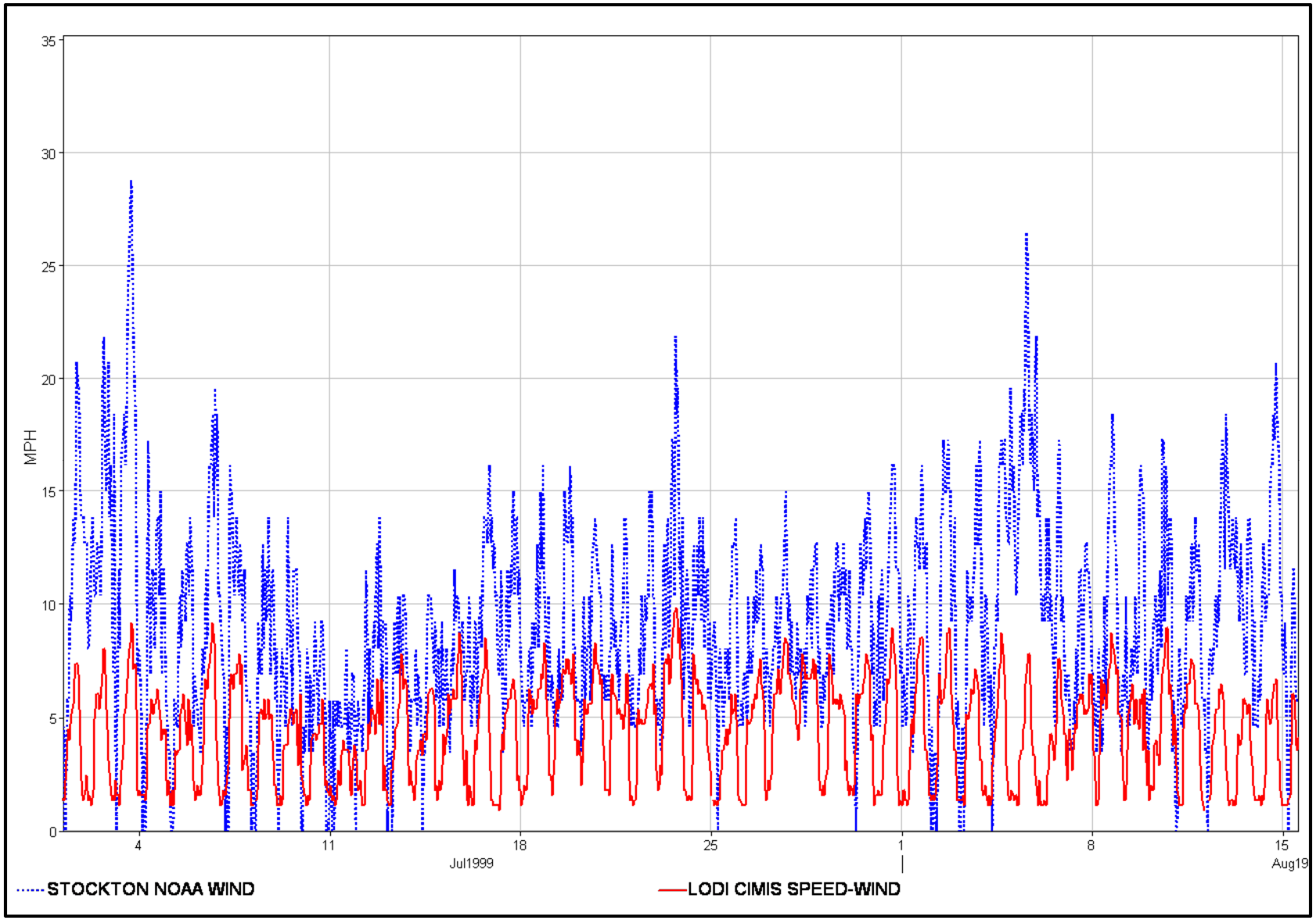
Temperature Data (blue) and Model Output in Grant Line Canal



Temperature Data (blue) and Model Output at Collinsville

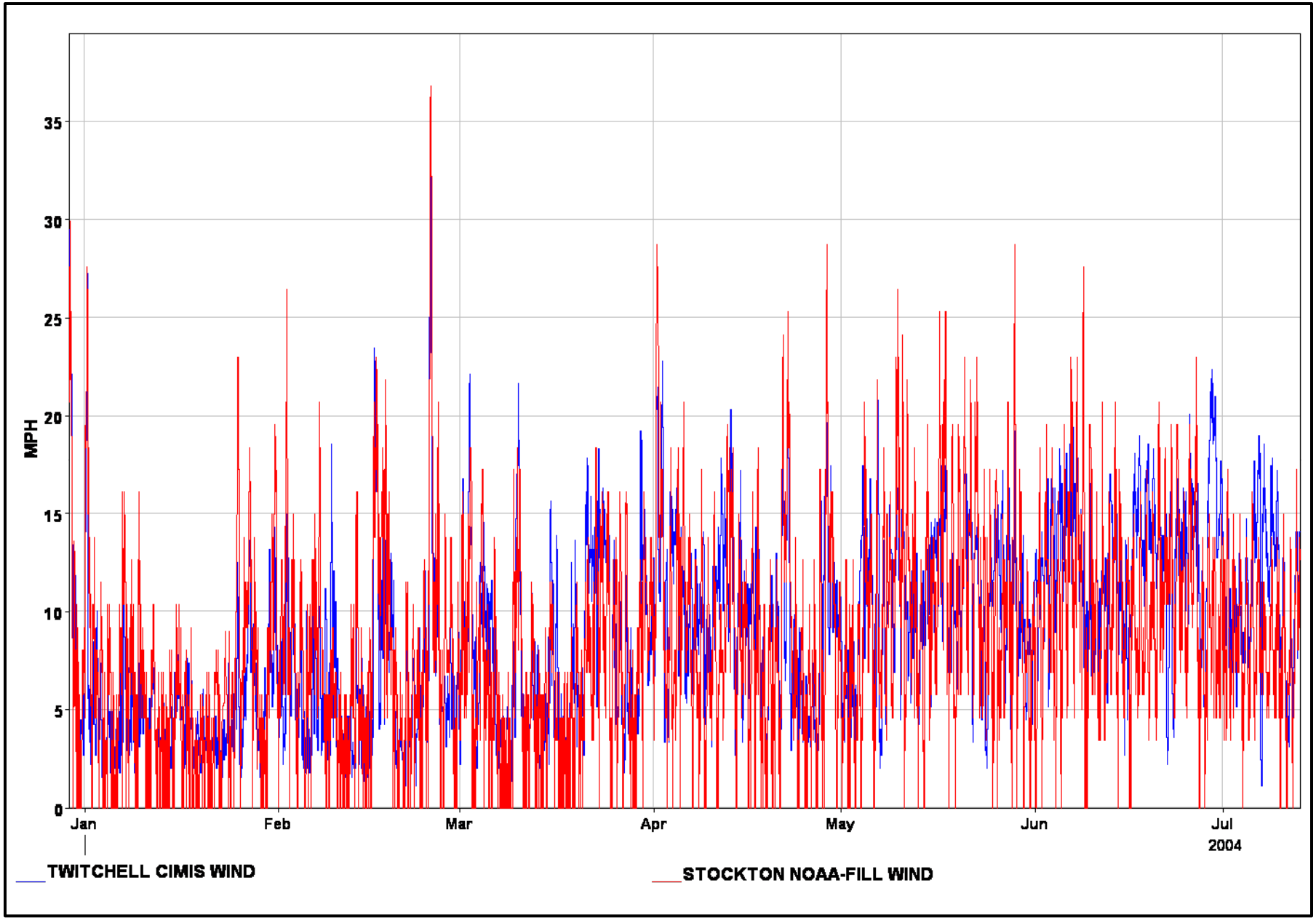


Wind speeds for the CIMIS station at Lodi and at Twitchell Island

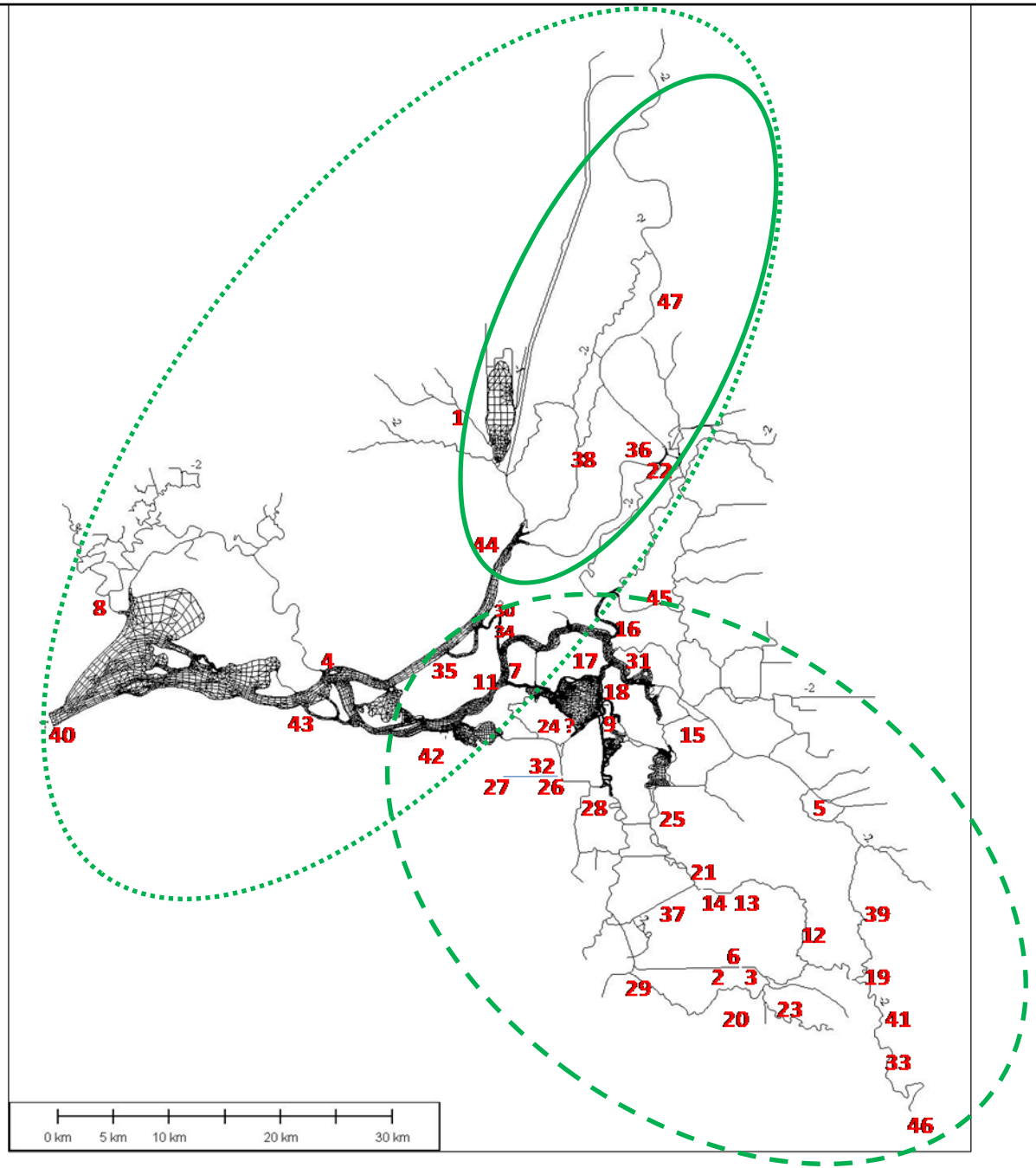


Wind speeds for the CIMIS station at Lodi and the NOAA station at Stockton

Temperature Data (blue) and Model Output – Both Twitchell and NOAA WIND*2 – at Collinsville

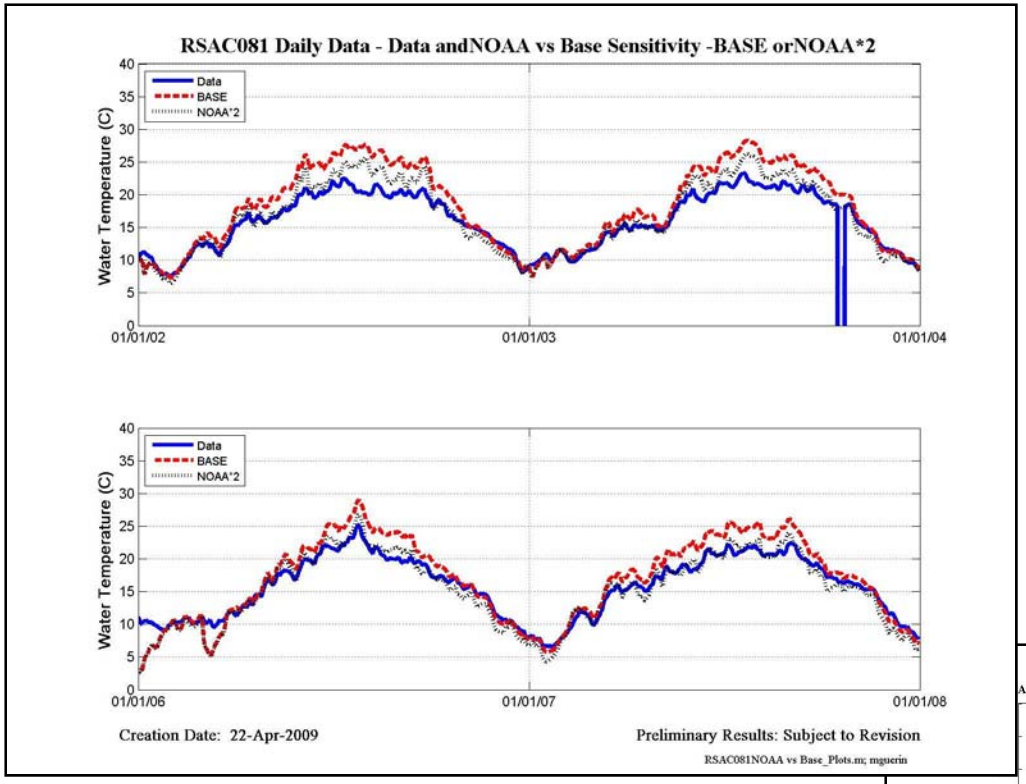

MPH
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Apr
May
Jun
Jul
2004
TWITCHELL CIMIS WIND
STOCKTON NOAA-FILL WIND

Water Temperature Regions & Data Locations – Data has Variable Quality & Time Span



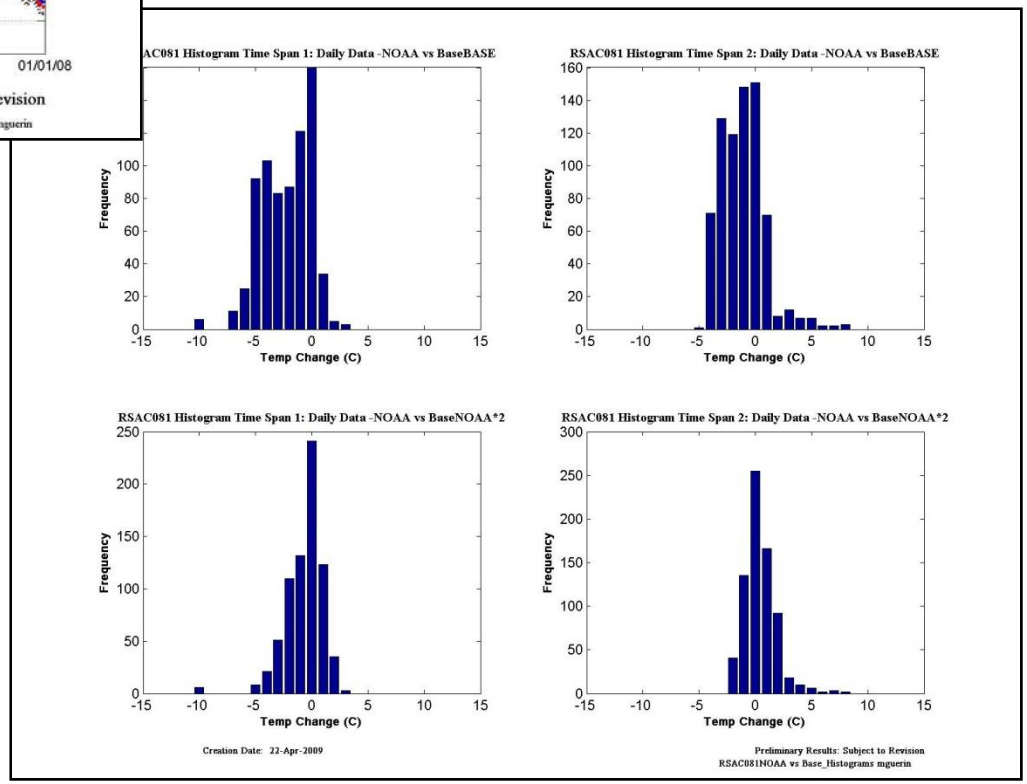
Meteorological BC Sensitivity Analysis – Water Temperature

- Wind –
  - Location, NOAA vs. CIMIS
  - Variation in evaporation parameters
    - Evap ~ (a+B*W)*(Sat. Vapor Pres. at water temp - Vapor Pres. at 6 ft)
- Air temperature (+/- 2°C)
- Wet bulb temp (+/- 5°F)



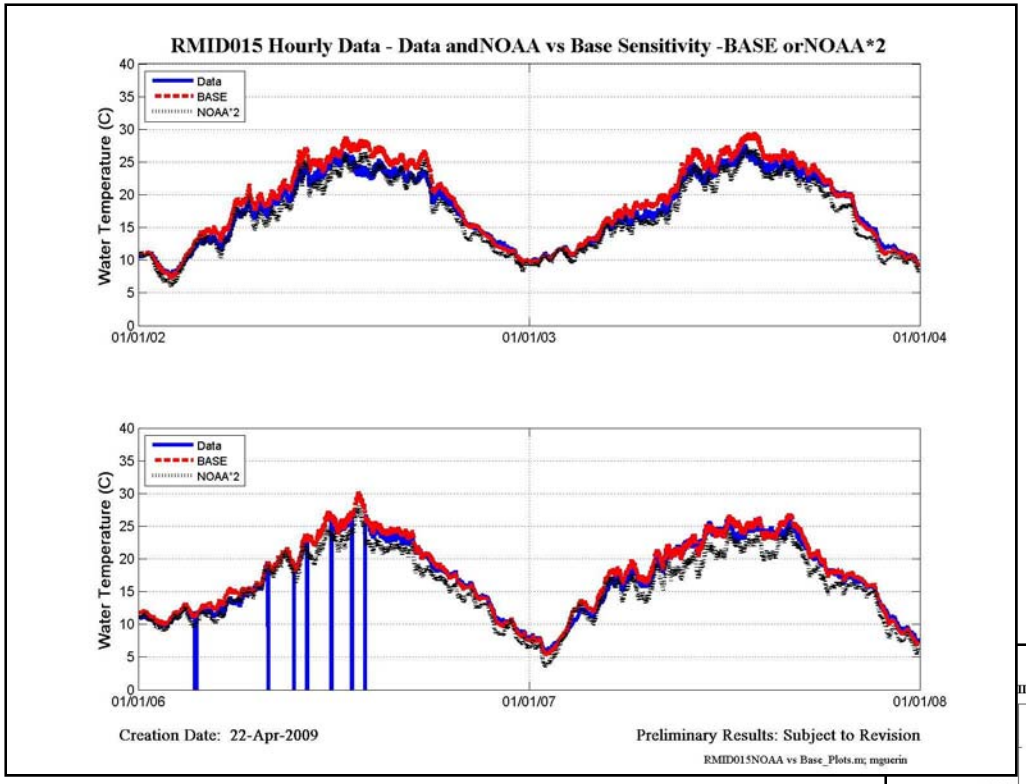
Variation in Wind Parameter b:

- Base Case (NOAA wind unchanged)
- b*2 (double wind)



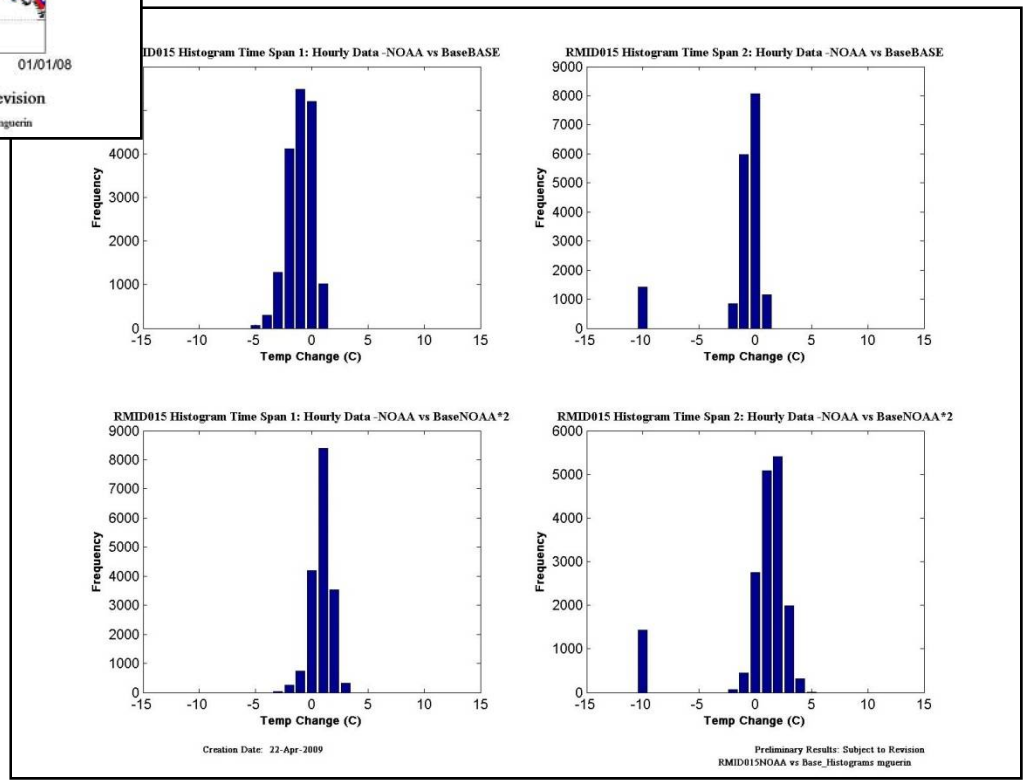
Results at Collinsville:

- Doubling NOAA wind gave better fit
- Residual (Data – Model) show decreased variation, centered closer to zero



Variation in Wind Parameter b:

- Base Case (NOAA wind unchanged)
- b*2 (double wind)



Results at RMID015:

- Doubling NOAA wind gave worse fit
- Residual (Data – Model) show better fit at Hari's original values

Status

- Water temperature – ready to start calibration
- Refining nutrient model BC data
  - BDAT problems – missing some data
- Estimate aerial deposition of N (dry, wet)
- Hoping to collaborate w/C. Kendall (USGS)
- Waste water – BC mostly complete:
  - Organizing “Receiving Water” measurements
  - Need two more stations
- SAV and clams – to do