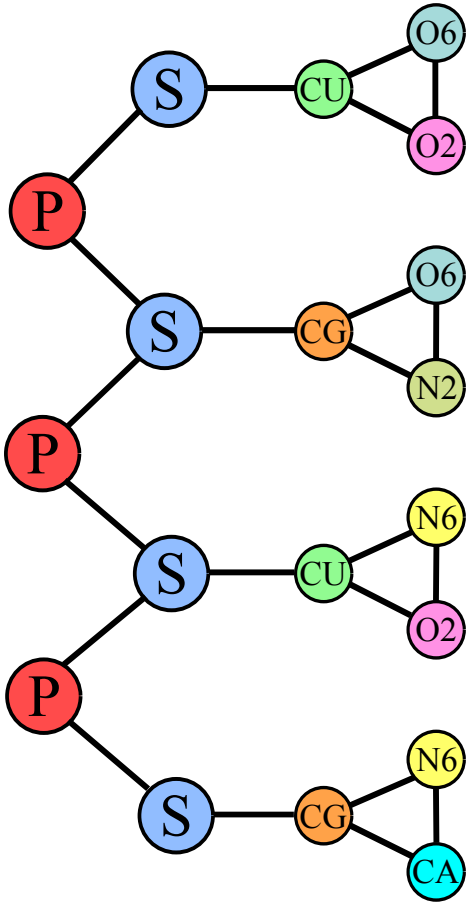
RNA Model Energy Optimization

11/14/14

Coarse-Grained Model



U

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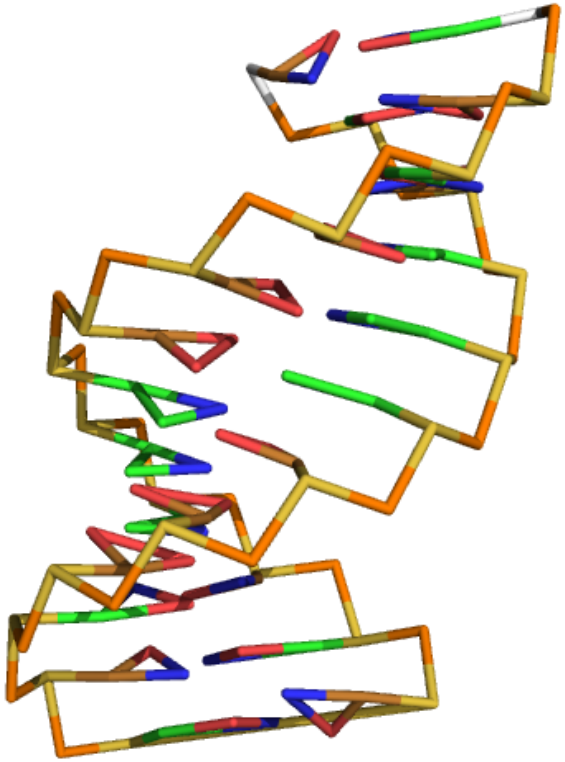
C

A



PDB ID: 1AL5

Force-Field

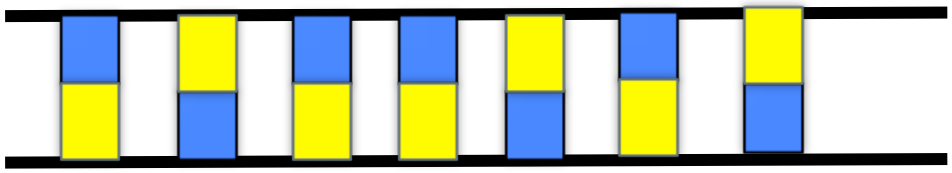
- Standard bond stretching, angle bending and torsion
- Debye-Hückel electrostatics and Buckingham vdW

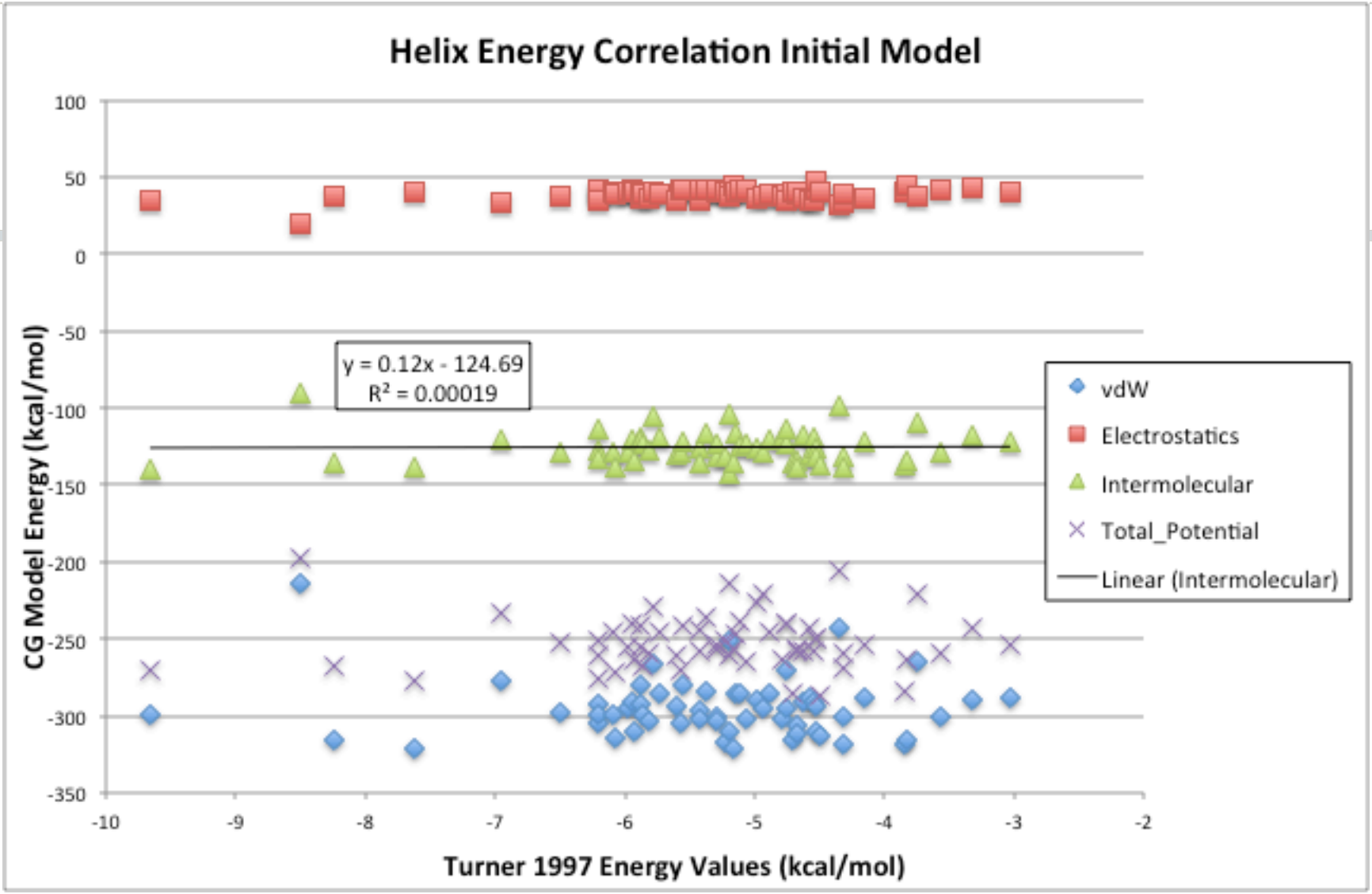
$$E_{ele} = \sum_{i>j} \frac{q_i q_j}{4\pi D r_{ij}} e^{-\frac{r_{ij}}{\xi}}$$

$$E_{vdW} = \sum_{i,j} \varepsilon_{ij} \left[-2.25 \left(\frac{\sigma_{ij}}{r_{ij}} \right)^6 + 1.84\, X10^5 e^{-\left(\frac{12 r_{ij}}{\sigma_{ij}} \right)} \right]$$

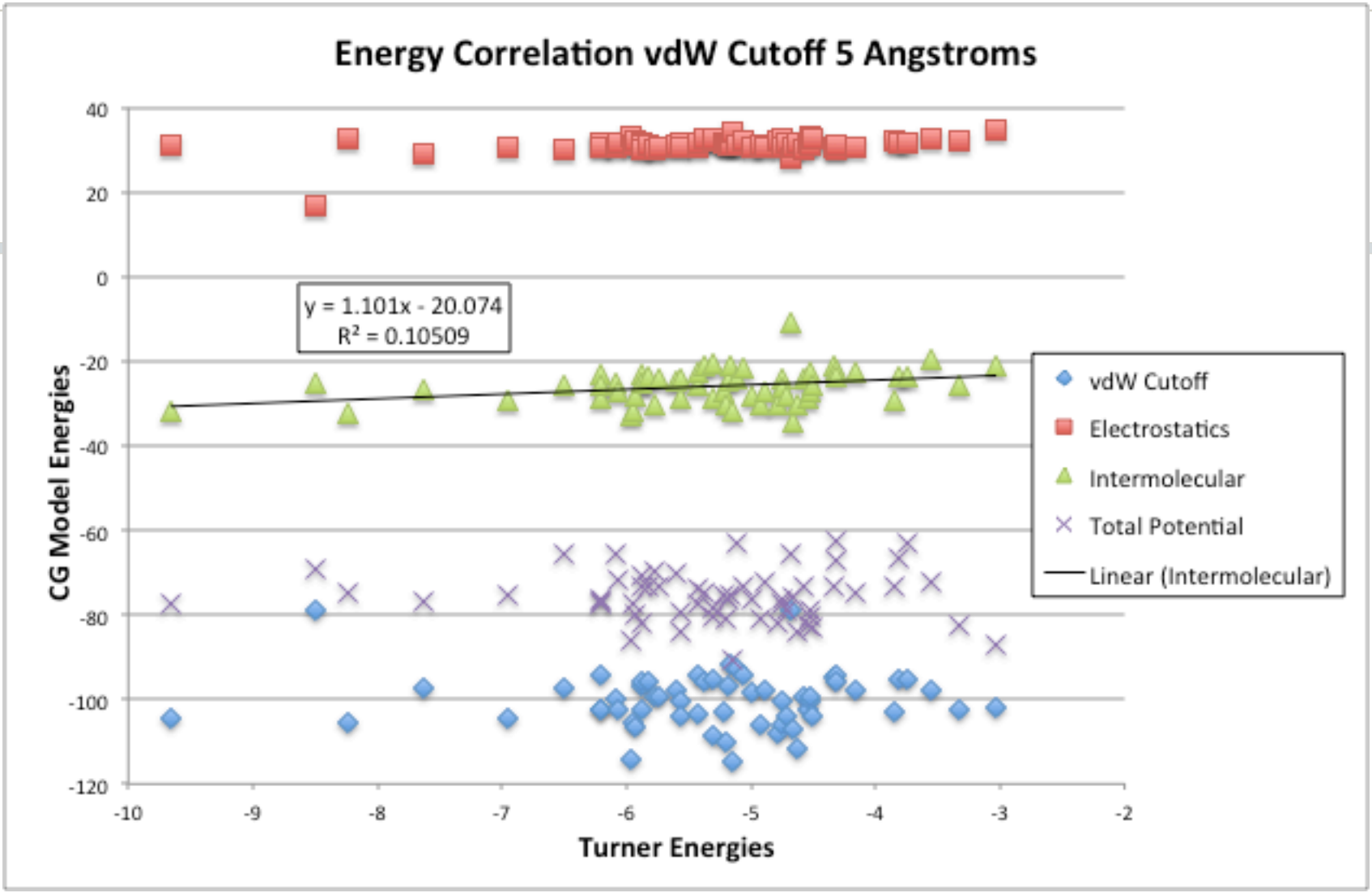
Optimization

- Original model parameterized to statistical potentials from 668 RNA structures (PDB, NDB, CRW)
- RNA secondary structure field optimizes to free energy
- Optimize our model to Turner's 1997 melting free energies for 60 duplexes





Interplay between vdW and electrostatics needs to be adjusted:
-Dielectric and vdW/vdWpr



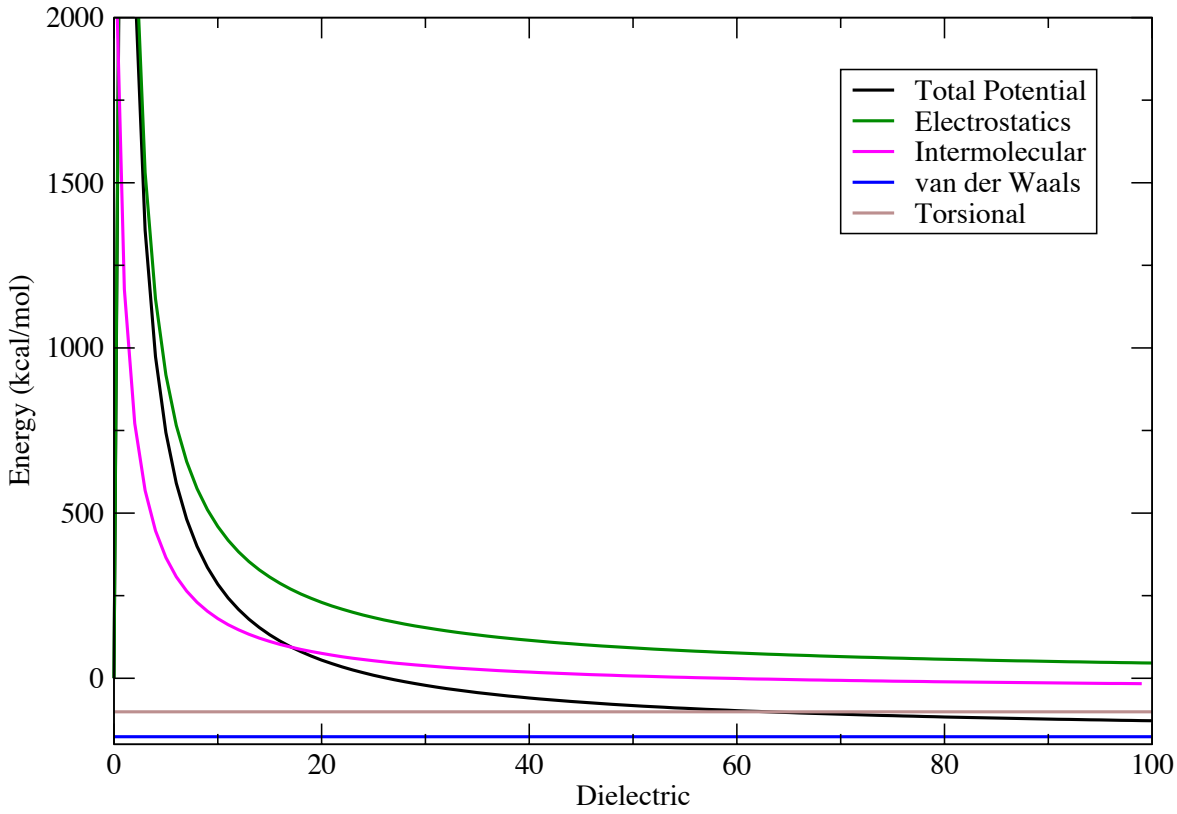
- Using modest vdW cutoff, vdW energy increases by 200 kcal/mol.
- Long-range interactions are captured from model
- Interplay between vdW and electrostatics needs to be adjusted: Dielectric and vdW/vdWpr

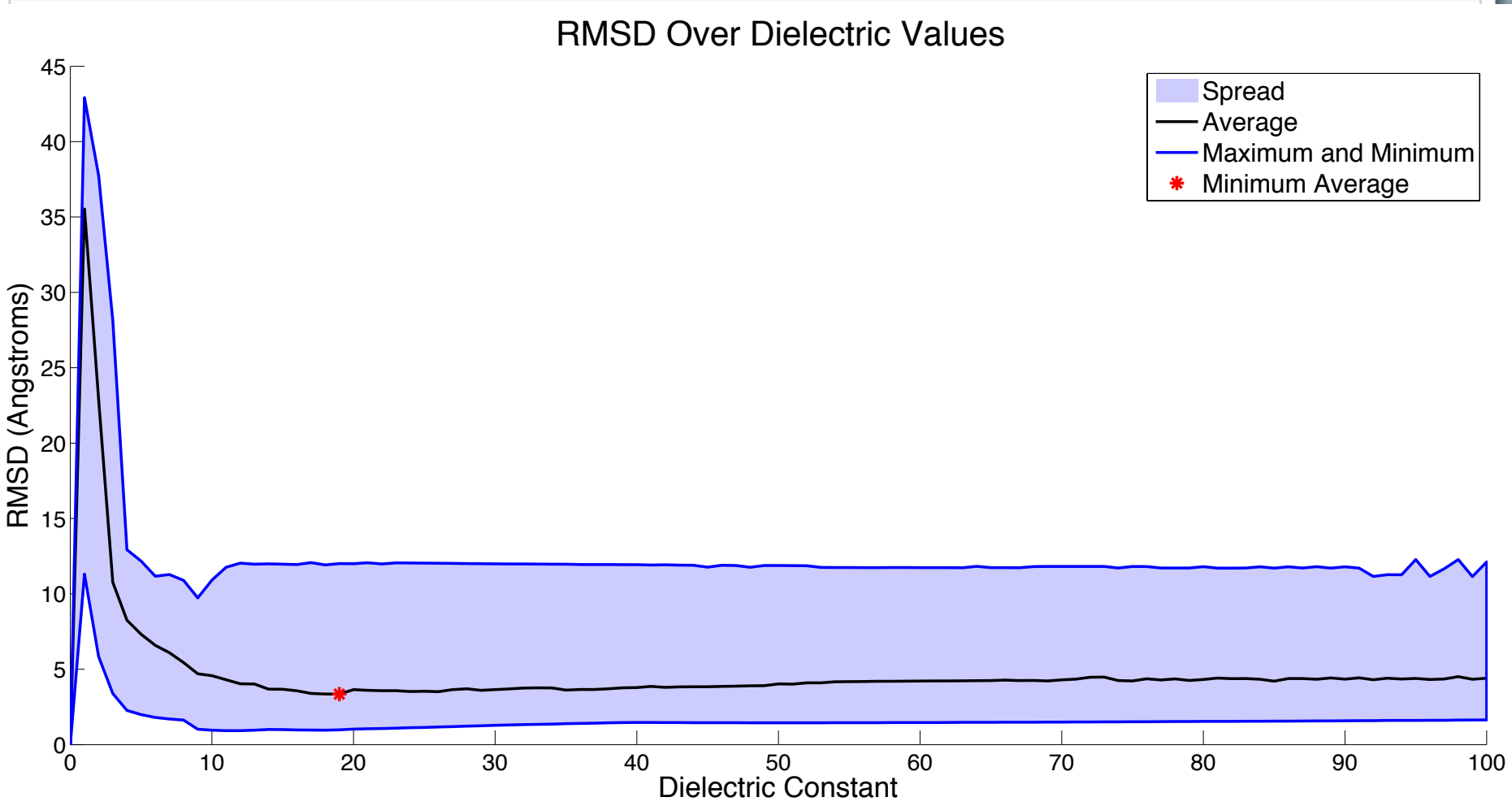
Dielectric Optimization

$$E_{ele} = \sum_{i>j} \frac{q_i q_j}{4\pi D r_{ij}} e^{-\frac{r_{ij}}{\xi}}$$

Previous Value: 78

Energy Composition as a function of Dielectric 10_23_14



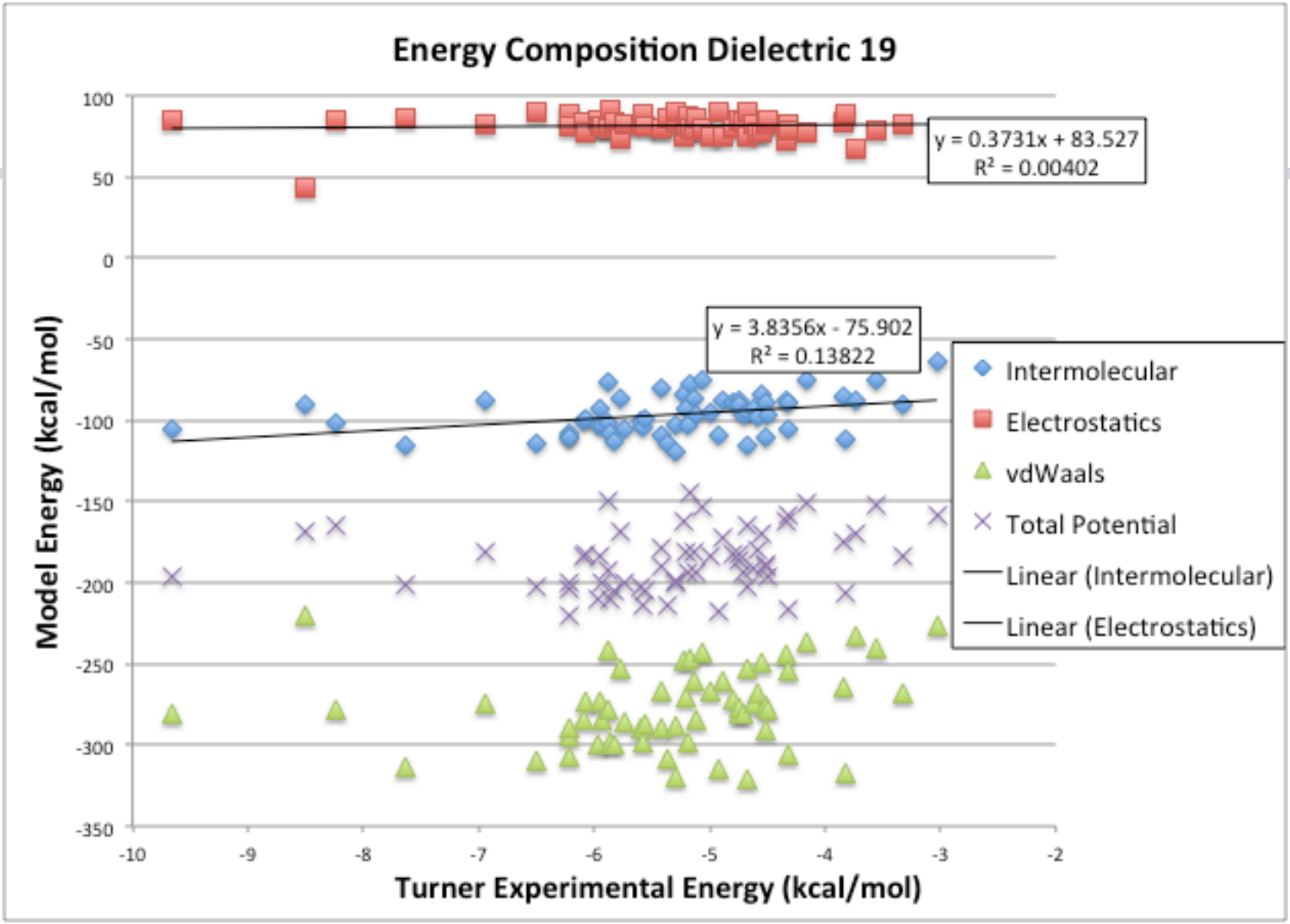


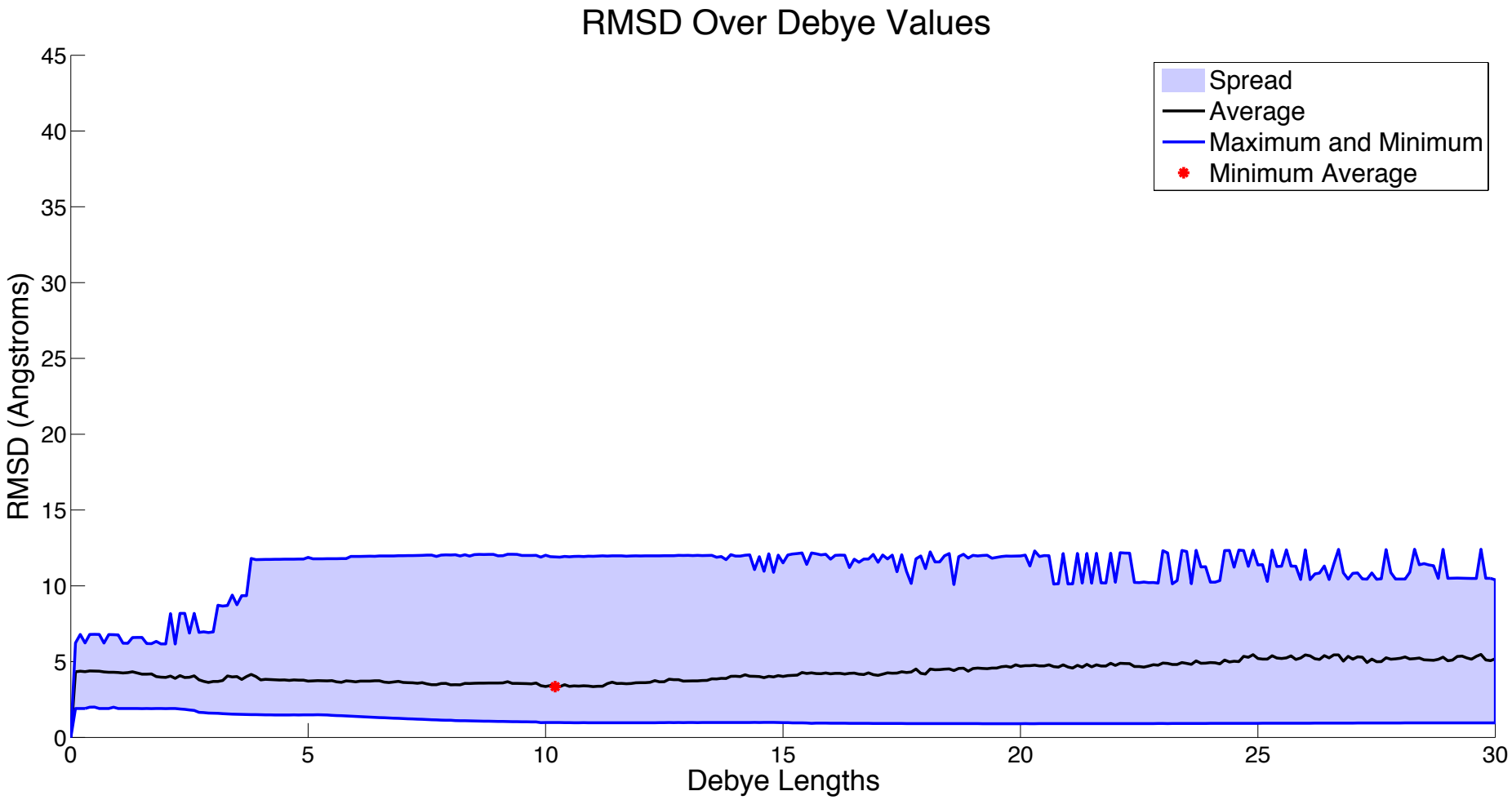
Electrostatics Interaction:

q = -1.0

Debye length = 10.0 Å (default)

Minimum Average: 19

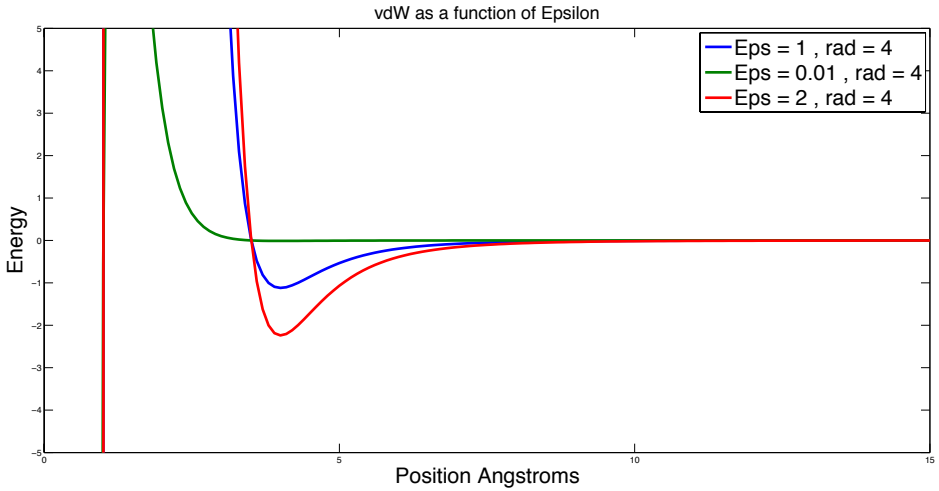

Energy Composition Dielectric 19
Model Energy (kcal/mol)
Turner Experimental Energy (kcal/mol)
y = 0.3731x + 83.527
R² = 0.00402
y = 3.8356x - 75.902
R² = 0.13822
Intermolecular
Electrostatics
vdWaals
Total Potential
Linear (Intermolecular)
Linear (Electrostatics)
100
50
0
-50
-100
-150
-200
-250
-300
-350
-10
-9
-8
-7
-6
-5
-4
-3
-2

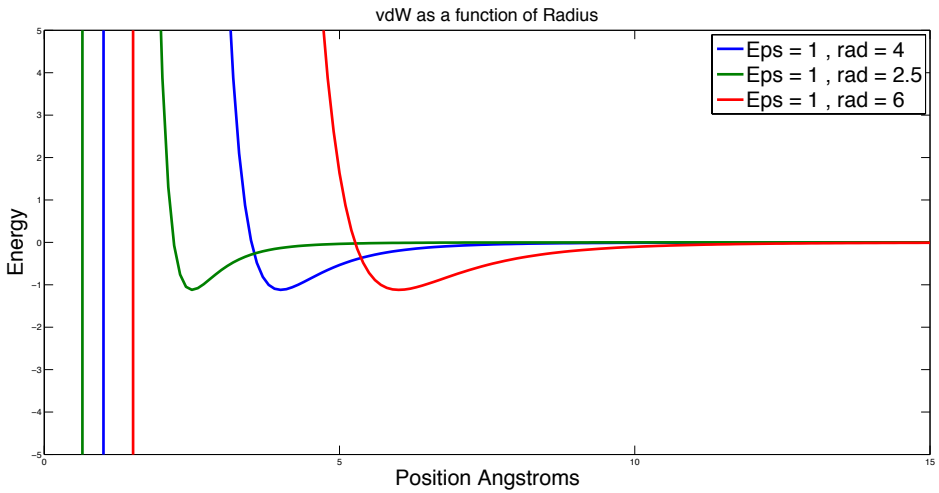


Electrostatic Interactions:
q = -1.0
Dielectric = 19

Minimum Debye: 10.2

$$E_{vdW} = \sum_{i,j} \varepsilon_{ij} \left[-2.25 \left(\frac{\sigma_{ij}}{r_{ij}} \right)^6 + 1.84\, X10^5 e^{-\left(\frac{12 r_{ij}}{\sigma_{ij}} \right)} \right]$$





Previous Parameters