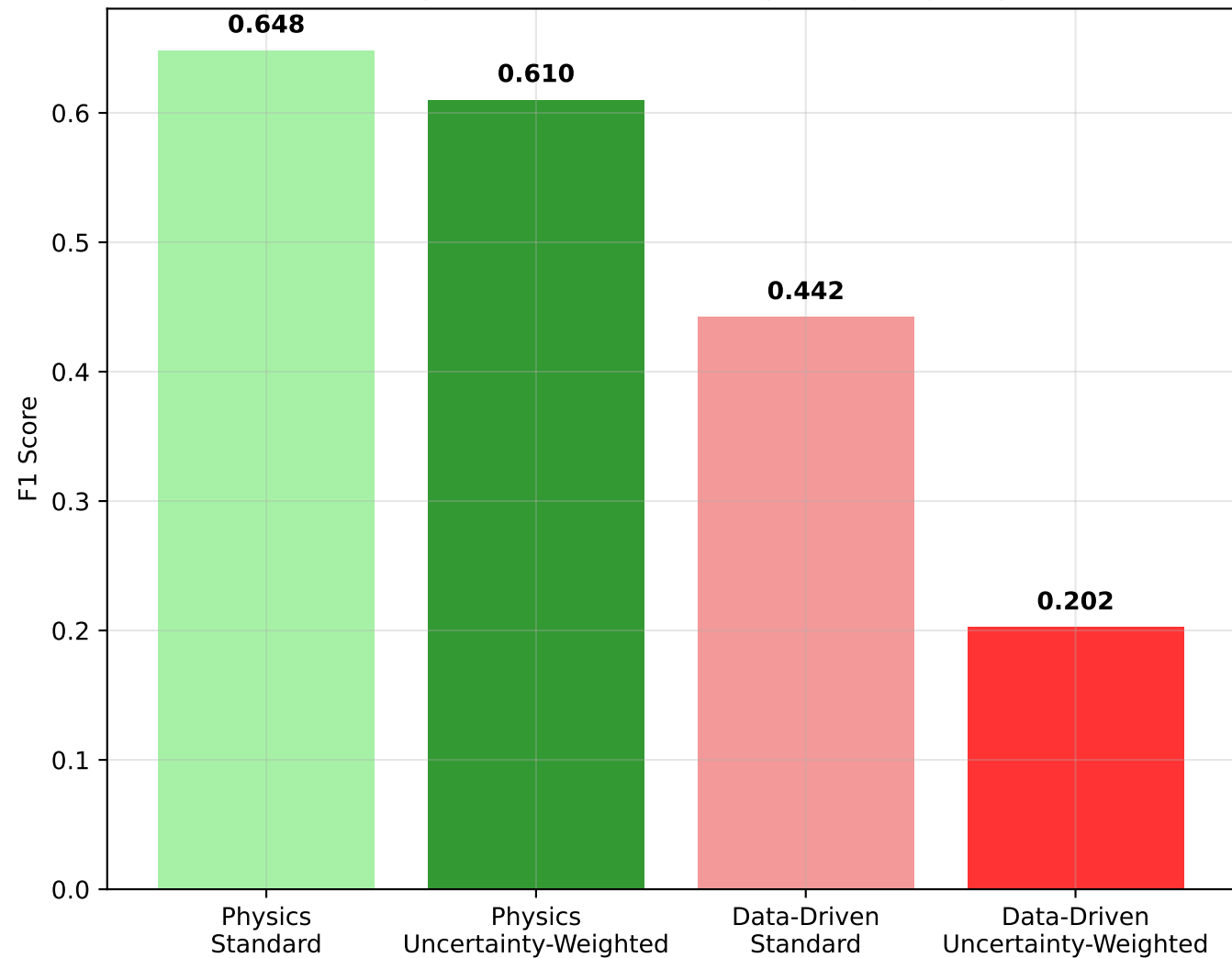
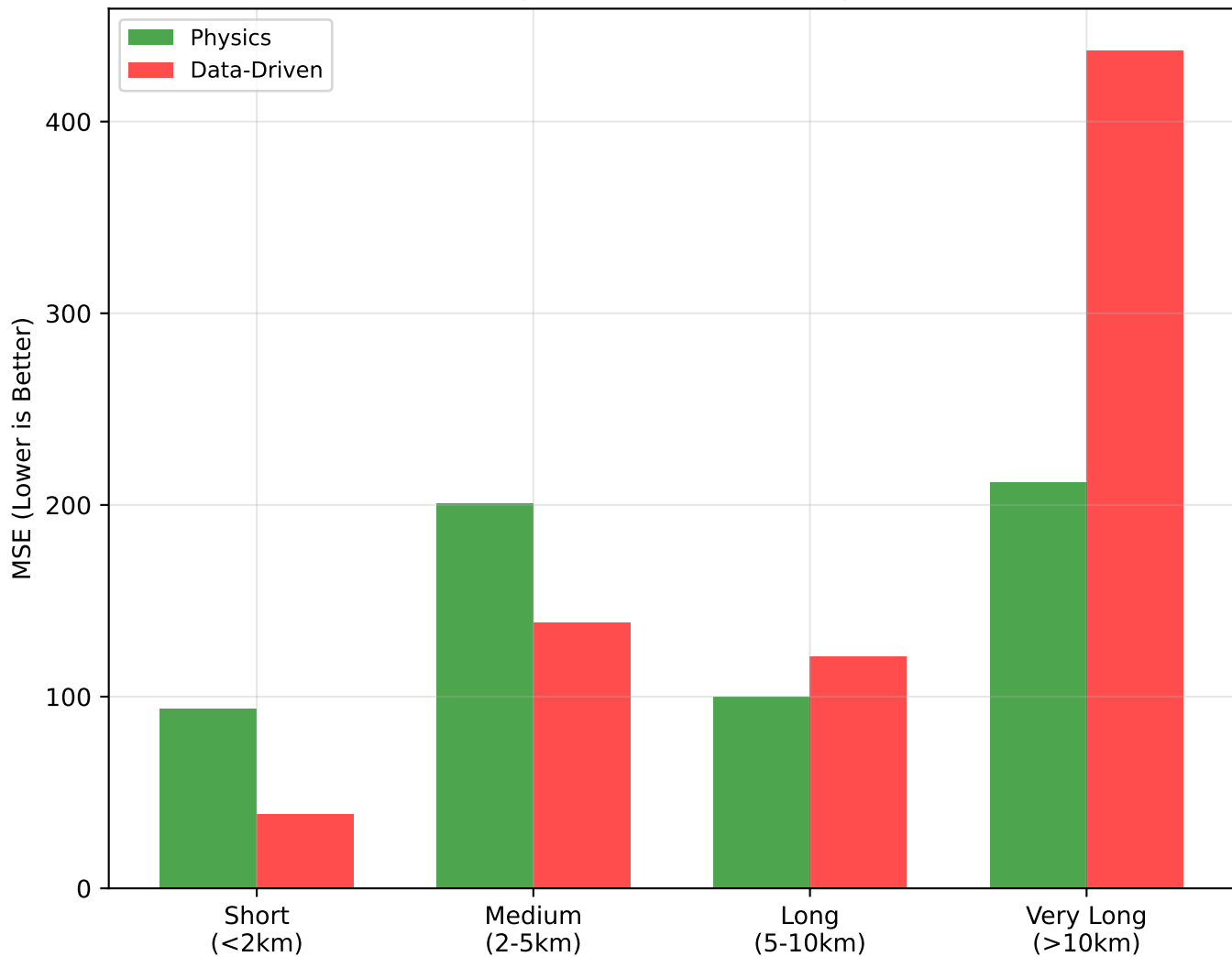


Anomaly Detection: Uncertainty Weighting Helps



Performance Degradation by Distance  
(Physics Maintains Quality)



DEMONSTRATION SUMMARY: PHYSICS SUPERIORITY UNDER EXTRAPOLATION

✓ TRAINING BIAS DEMONSTRATED:

- Data-driven learned slope: 0.003952 ms/km
- True physics slope: 0.005000 ms/km
- Bias error: 21.0%

✓ UNCERTAINTY QUALITY COMPARISON:

- Physics coverage: 89.2% (BEST - closest to 95%)
- Data-driven coverage: 76.9% (biased baseline)
- Conformal coverage: 43.2% (assumption violated)

✓ PRACTICAL IMPLICATIONS:

- Physics uncertainty remains reliable under distribution shift
- Data-driven methods fail when training assumptions violated
- Uncertainty-weighted anomaly detection improves performance

✓ RISK ASSESSMENT: HIGH\_RISK

- Extrapolation factor: 12.9x
- Multiple risk factors present
- Physics constraints provide robustness

Method Recommendation Matrix  
(Green=Recommended)

