



# **Road Temperature Model**

**Cold Regions Research and Engineering Laboratory**

**CRREL**

# **SNTHERM**

**1-D mass and energy balance model for snow and soil**

## **Military:**

**Tank tracks -- 1989 Army R & D Achievement Award**

**Smart Weapons Operability Enhancement (SWOE)**

**Pre-mission briefing tool for AF, Navy pilots**

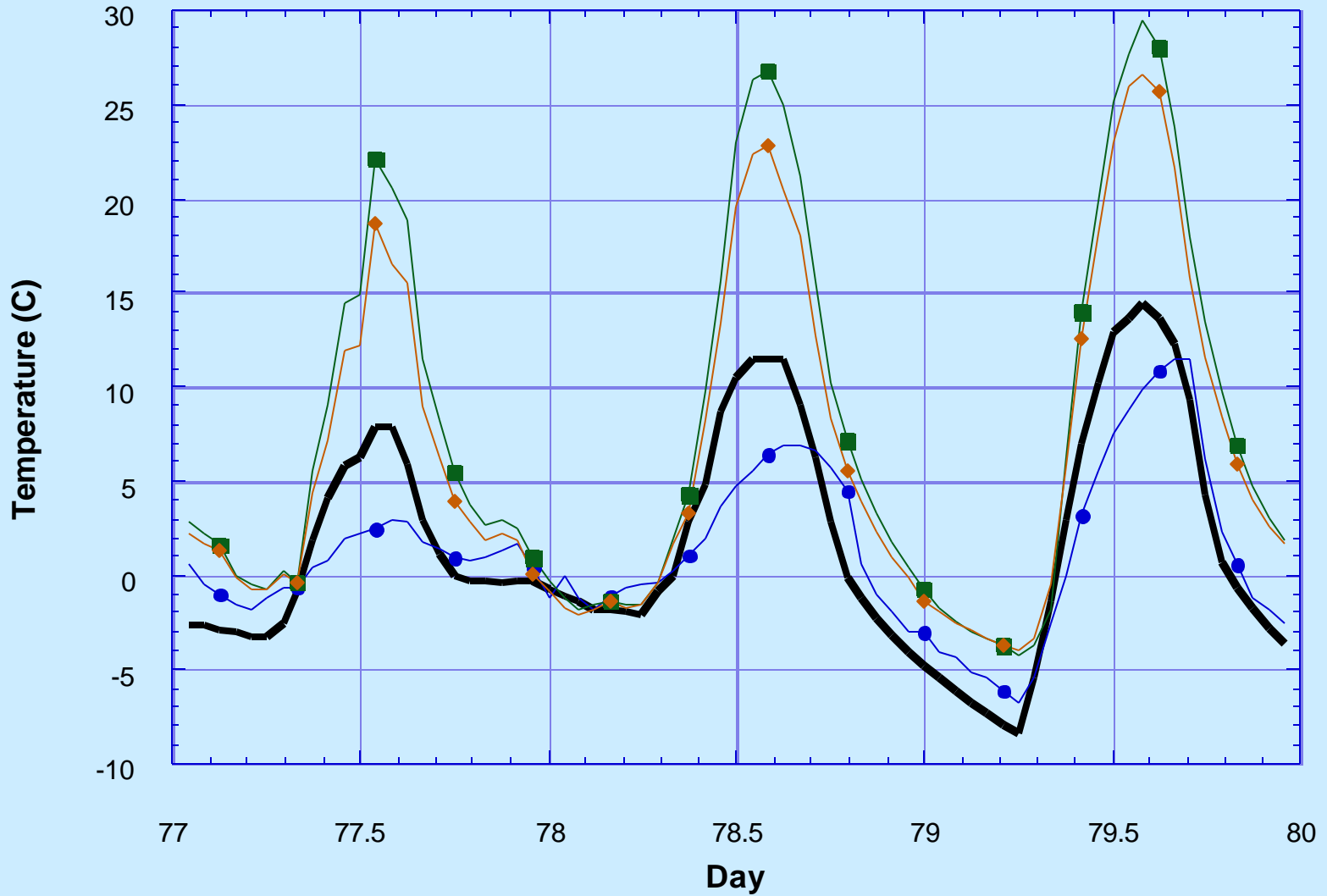
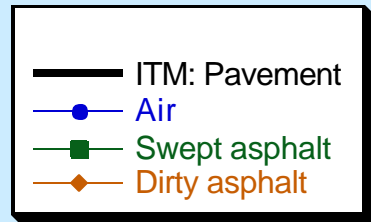
**Snowcover and frozen ground occurrence**

**Universities: >30 worldwide; 4 Ph.D. dissertations**

**2000 USACRREL Technology Transfer Achievement Award**

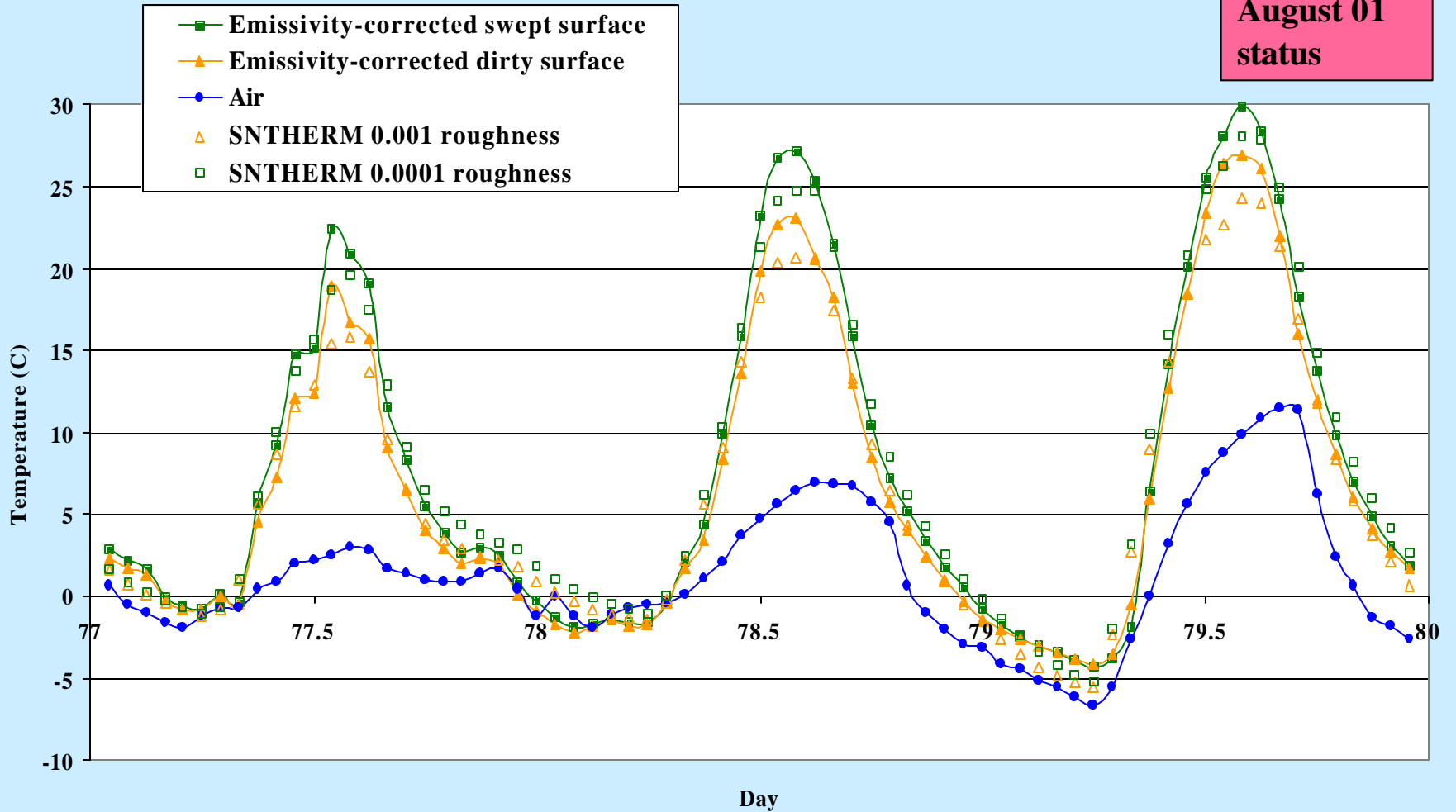
June 01  
status

### CRREL Asphalt Test Plot, Winter 2001



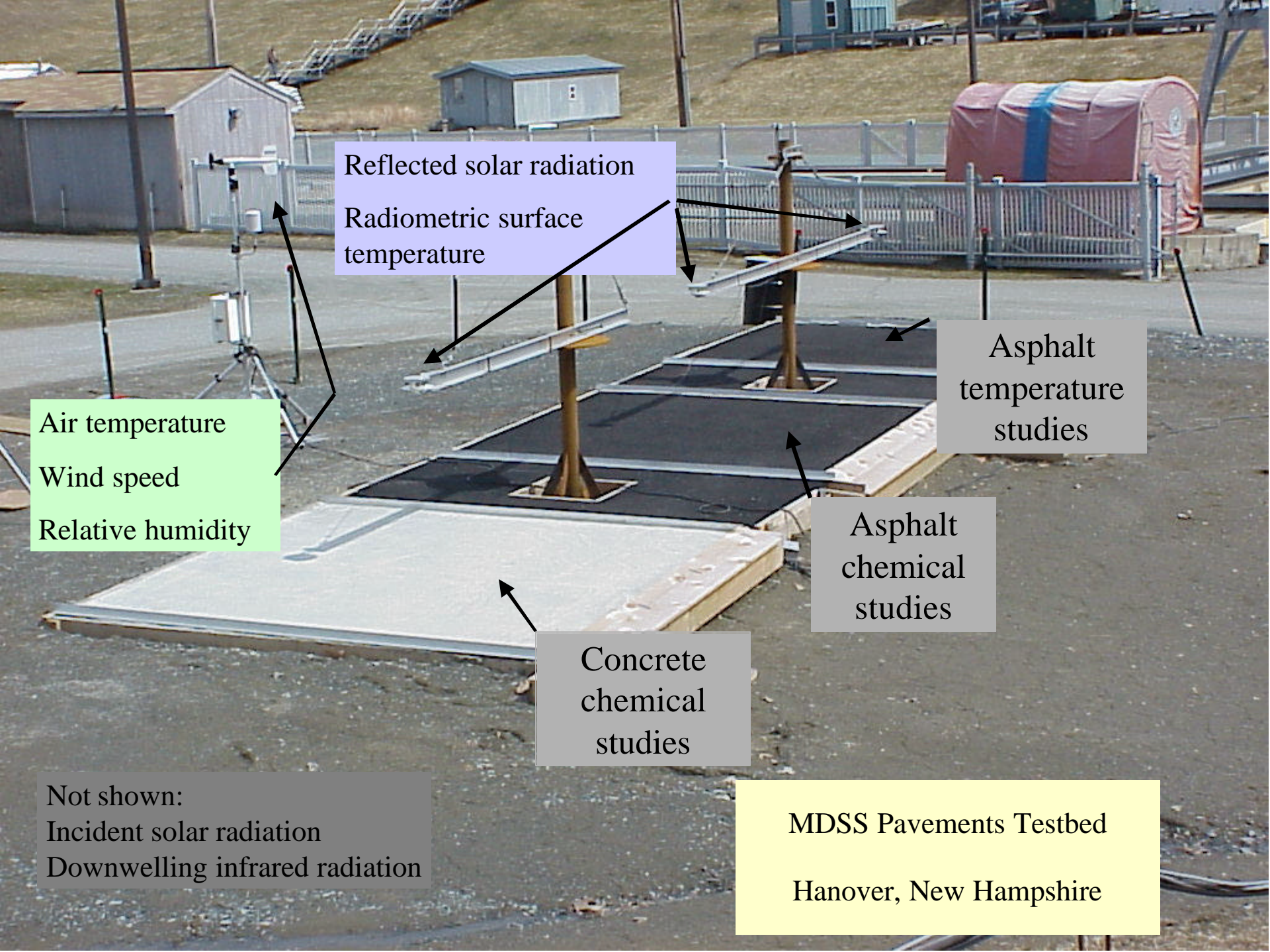
# SNTHERM Asphalt Temperatures 18 - 20 March 01

**August 01  
status**



# Asphalt Material Properties

<b>Solar albedo</b>	<b>0.10</b>
<b>Emissivity</b>	<b>0.94</b>
<b>Surface roughness (m)</b>	<b>0.001, 0.0001</b>
<b>Thermal conductivity (W/m-C)</b>	<b>2.00</b>
<b>Specific heat (J/kg-C)</b>	<b>920</b>
<b>Density of dry material constituents (kg/m<sup>3</sup>)</b>	<b>2100</b>
<b>Bulk density of dry material (kg/m<sup>3</sup>)</b>	<b>2000</b>
<b>[Bulk water density (kg/m<sup>3</sup>)]</b>	<b>[1]</b>



Reflected solar radiation  
Radiometric surface temperature

Air temperature  
Wind speed  
Relative humidity

Asphalt temperature studies

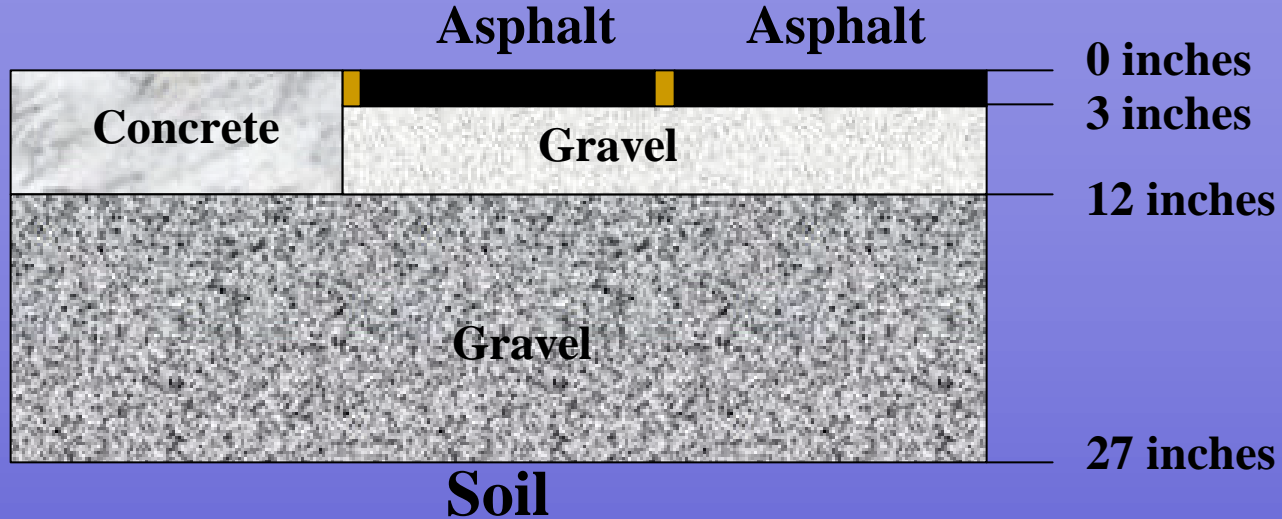
Asphalt chemical studies

Concrete chemical studies

Not shown:  
Incident solar radiation  
Downwelling infrared radiation

MDSS Pavements Testbed  
Hanover, New Hampshire

# MDSS Pavements Testbed



## Thermocouples

(distance below surface, inches)

Concrete: 0

Asphalt: 0

1.5

2.5

3

4

6

7

12

13

15

16

27

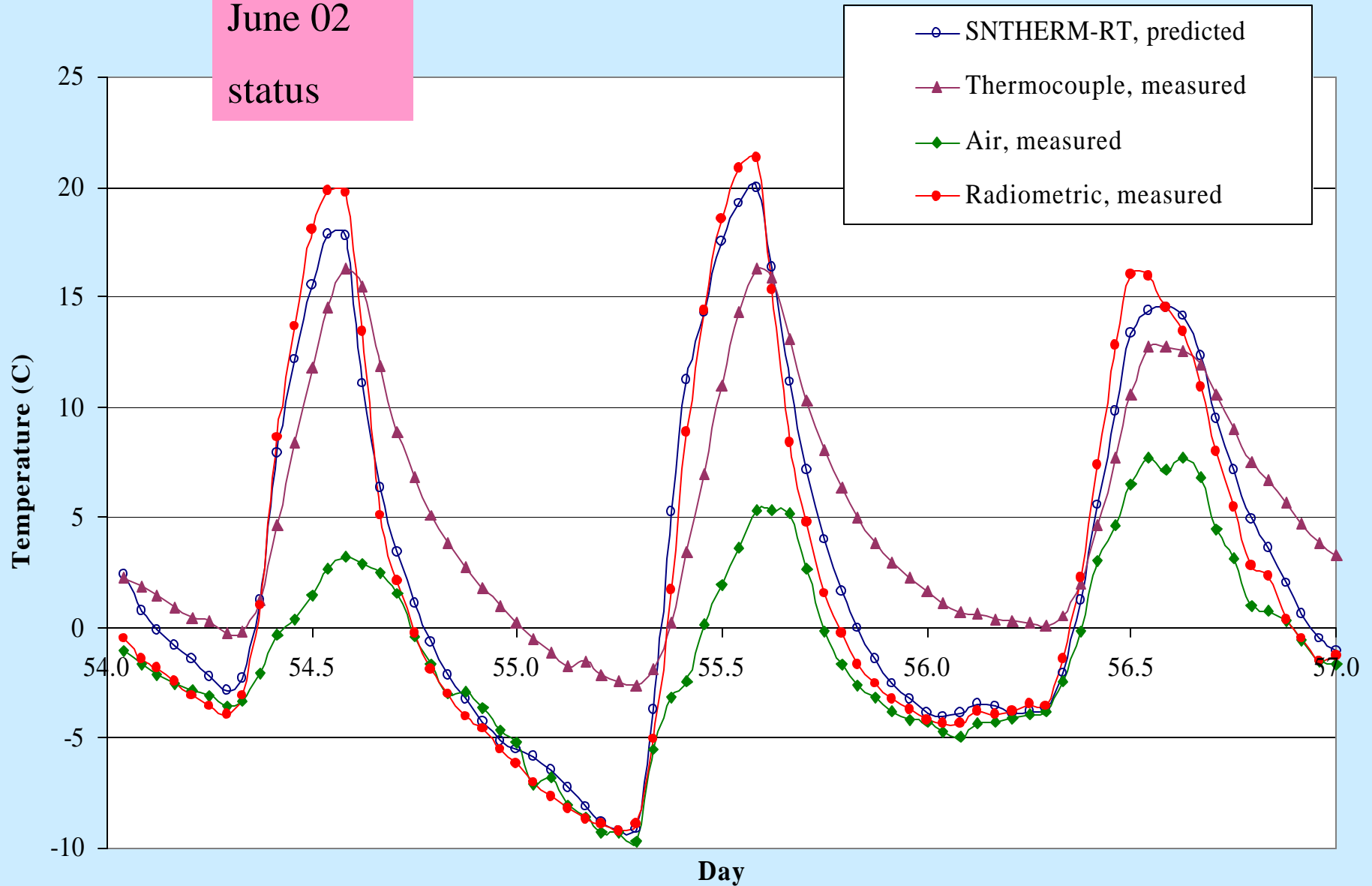
28

40

41

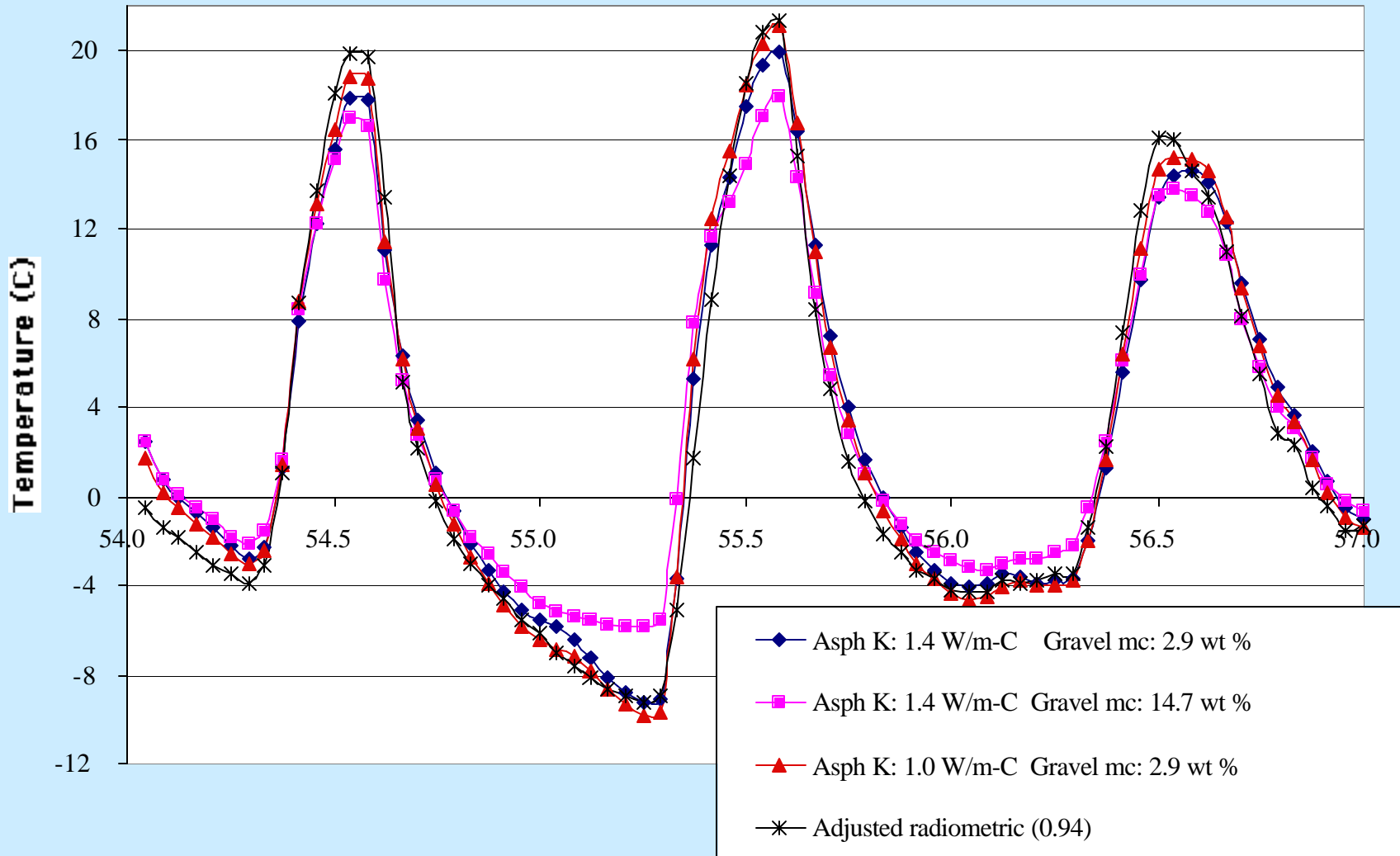
# Asphalt Surface Temperature, MDSS Testbed, February 2002

June 02  
status



June 02  
status

## Variation in Predicted Asphalt Surface Temperature



# Measured and Predicted Pavement Temperature Profiles (C)

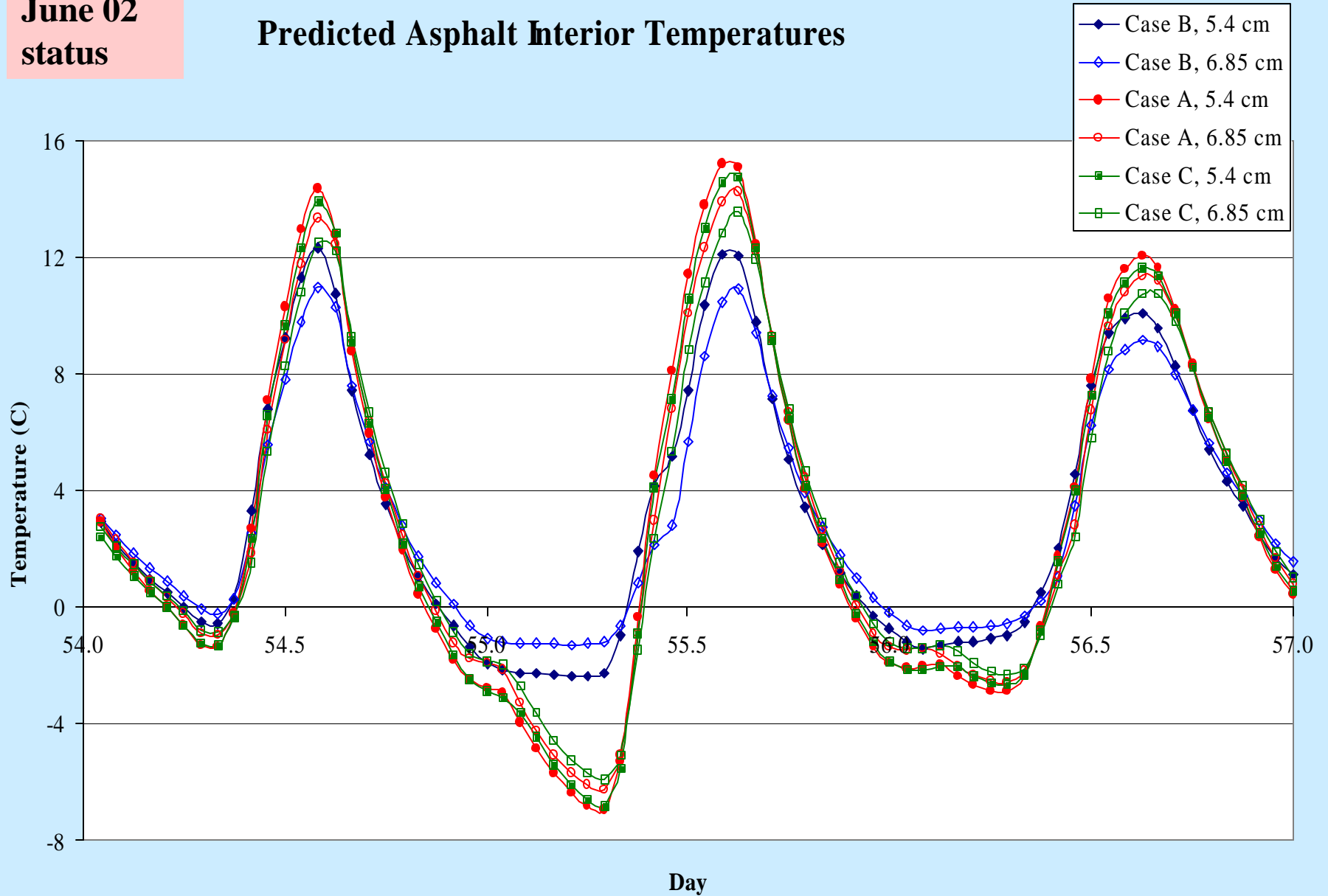
Day 55: temperature range over 24 hours

<u>Depth, cm</u>	<u>Material</u>	<u>Radiometer</u>	<u>Thermocouple</u>	<u>A</u>	<u>B</u>	<u>C</u>
0	Asphalt	(-9.4) – 21.1	(-2.6) – 16.9	(-9.2) – 20.0	(-5.9) – 17.9	(-9.8) – 21.1
6.25	Asphalt		(-0.8) – 13.7	(-6.6) – 14.7	(-1.8) – 11.4	(-6.3) – 14.2
10	Gravel		0.2 – 10.5	(-3.4) – 10.2	(-0.2) – 8.4	(-3.4) – 9.4
20	Gravel		1.3 – 7.0	0.6 – 4.4	1.1 – 4.8	0.7 – 4.3
30	Gravel		2.2 – 5.2	1.6 – 3.3	1.8 – 3.8	1.6 – 3.1
40	Gravel		2.7 – 4.3	2.2 – 3.3	2.4 – 3.2	2.2 – 3.1

	Asphalt layer thermal conductivity <u>W/m-C</u>	Gravel (dry) thermal conductivity <u>W/m-C</u>	Gravel layer moisture content <u>wt %</u>
Case A	1.4	0.4	2.9
Case B	1.4	0.4	14.7
Case C	1.0	0.4	2.9

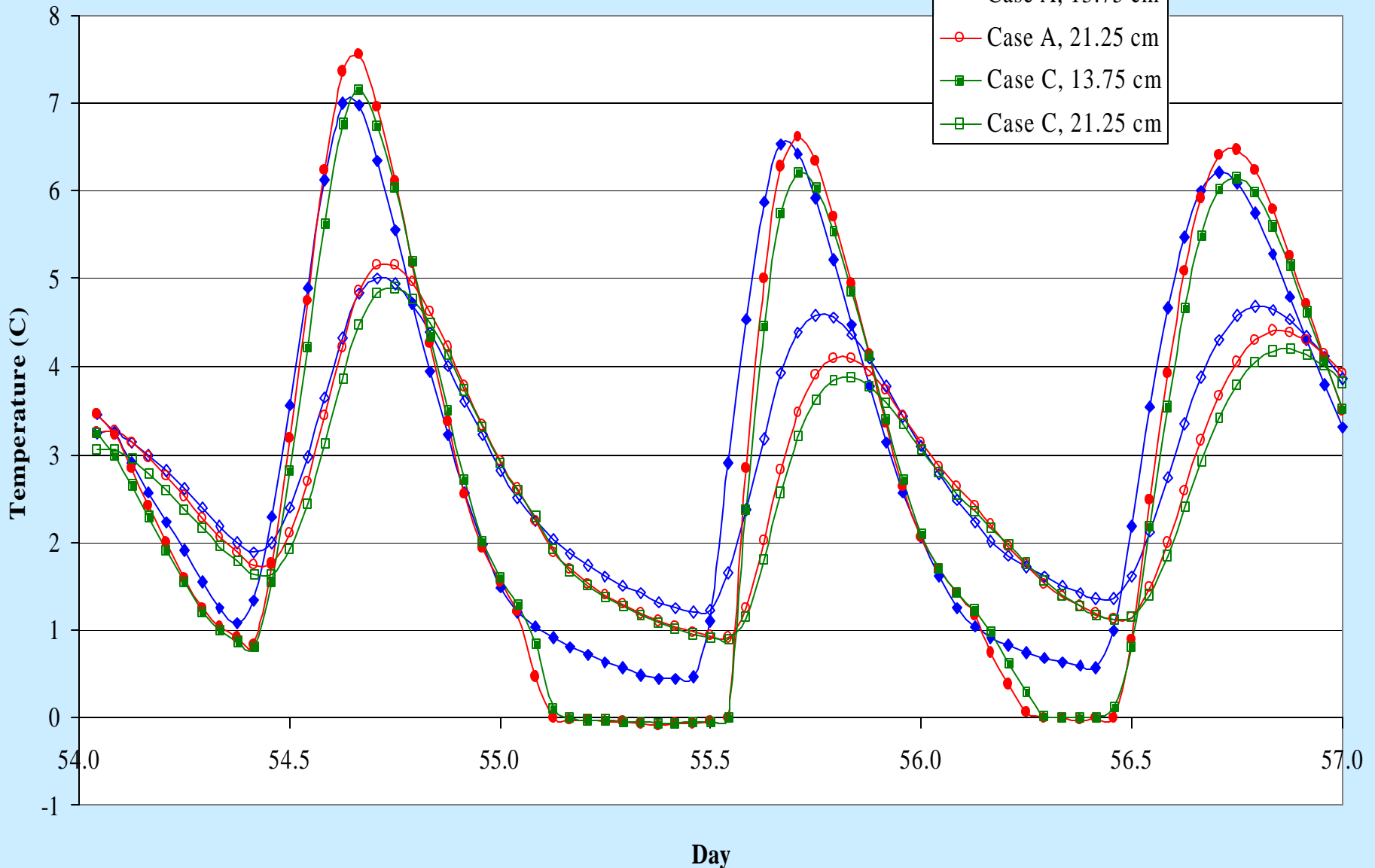
**June 02**  
status

# Predicted Asphalt Interior Temperatures



# Predicted Gravel Interior Temperatures

**June 02**  
**status**



# Road Temperature Model Summary

## **SN THERM-RT:**

**Tested against measured surface and interior pavement temperatures**

**Requires accurate representation of entire pavement system: material properties, moisture content**

## **Other models:**

**CRREL weather data and pavement temperature profiles, and SN THERM-RT predictions, available for comparison ([lpeck@crrel.usace.army.mil](mailto:lpeck@crrel.usace.army.mil))**