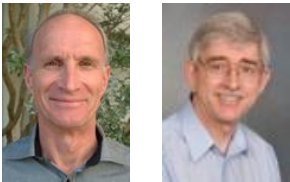




# MAINTAINING QUALITY DURING SHIPPING

Jim Thompson & David Reid | UC Davis



# HIGH FUEL COST

Q - Can we mix products with differing temperature requirements?

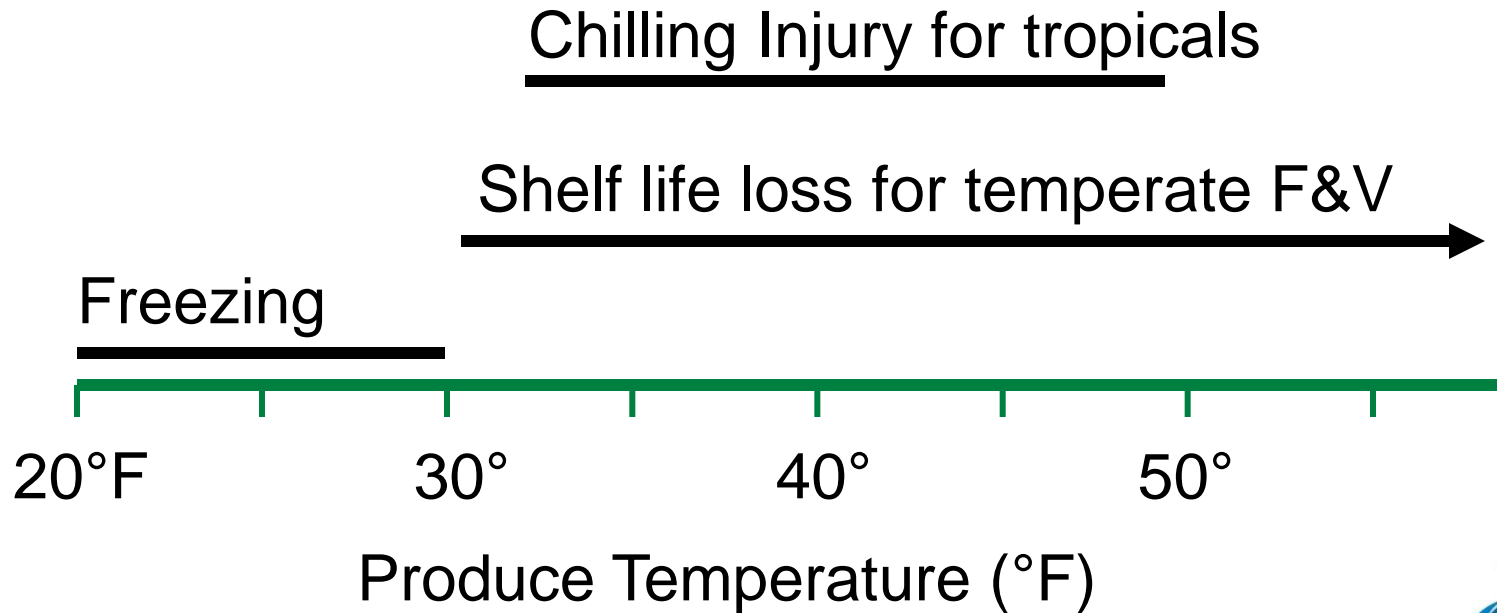
# HIGH FUEL COST

Q - Can we mix products with differing temperature requirements?

A - Sometimes, but it requires more management and more cost than straight loads.

# QUALITY

- Temperature and Time control the rate of quality loss for chilled produce.



# CHILLED PRODUCTS

- Quality loss is described by  $q_{10}$
- Rate of quality loss increases by a factor of 2 to 4 for every  $10^{\circ}\text{C}$  ( $18^{\circ}\text{F}$ ) increase in temperature

# CHERRY LIFE

Temperature (°F)	Respiration Rate	Life (days)
32	5	20
40	15	8
60	35	3
70	35	3

# SHELF LIFE OF FROZEN FOODS DEPENDS ON TEMPERATURE & TIME



Beef freezer burn



Off flavor, off odor, color change

# INFLUENCE OF TEMPERATURE ON STORAGE LIFE OF FROZEN FOODS

	Typical % loss in storage life in 1 week								
Temp. (°F)	Fatty fish Pork	Asparagus Beans	Lean fish	Shrimp Shellfish	Lamb	Broccoli Peas	Beef	Tree fruits	Soft fruits
<b>-10</b>	2.2	1.4	1.6	1.4	1.3	1	1.1	0.9	0.9
<b>-5</b>	2.9	2	2	1.8	1.7	1.3	1.4	1.2	1.2
<b>0</b>	3.7	2.7	2.5	2.4	2.2	1.8	1.9	1.6	1.6
<b>5</b>	4.8	3.6	3.2	3	2.8	2.5	2.4	2.2	2
<b>10</b>	6.1	4.8	3.9	3.9	3.6	3.4	3.2	3	2.6
<b>15</b>	7.8	6.5	4.9	5	4.6	4.6	4.1	4.1	3.3
<b>20</b>	9.8	8.6	6.1	6.4	5.9	6.2	5.3	5.5	4.2

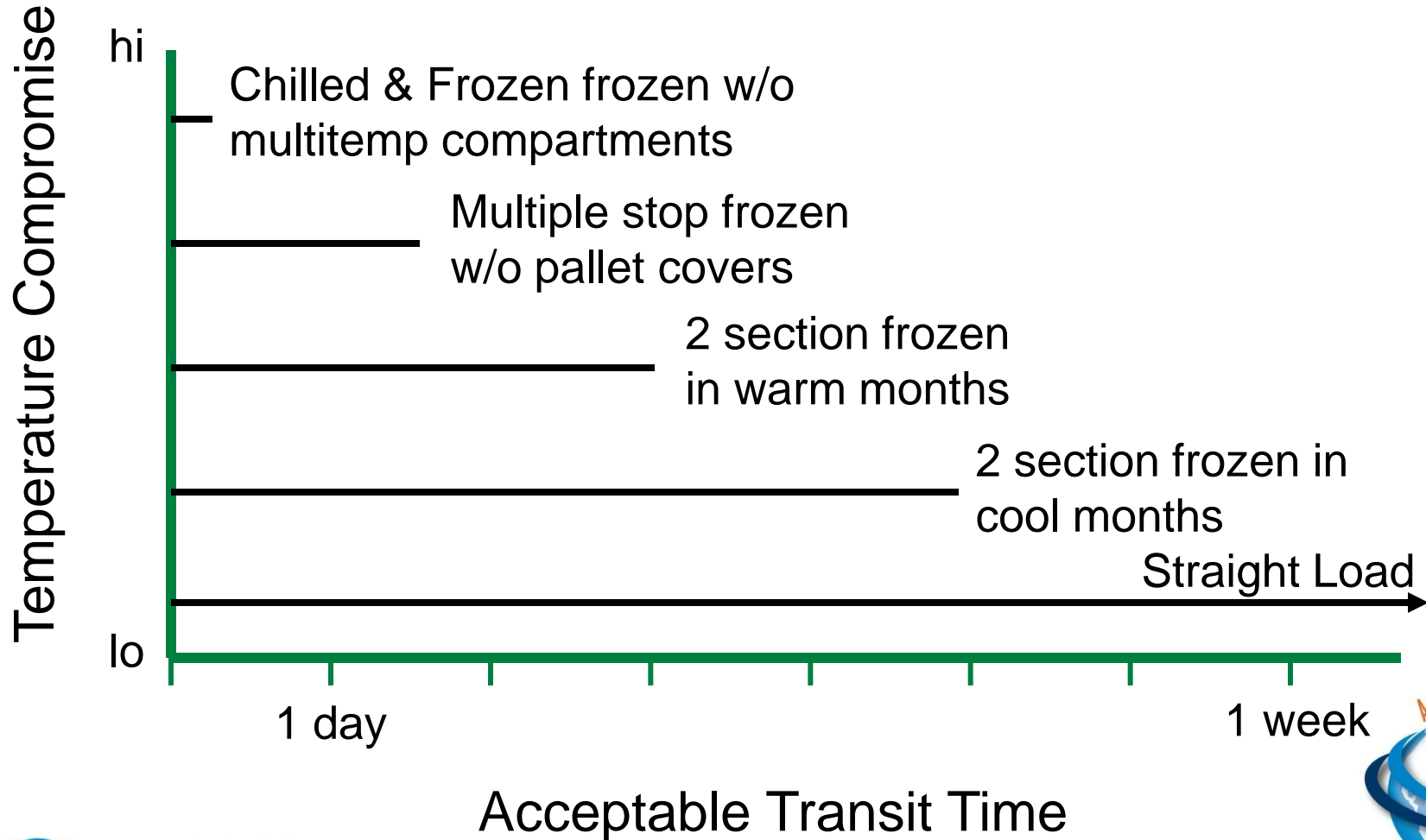
# Q<sub>10</sub> FOR FROZEN FOODS

	Approximate shelf life in frozen storage	
Temp (°F)	q <sub>10</sub> = 2	q <sub>10</sub> = 3
0	1 year	1 year
5	8 months	7 months
10	6 months	4 months
15	4 months	2 $\frac{1}{3}$ months

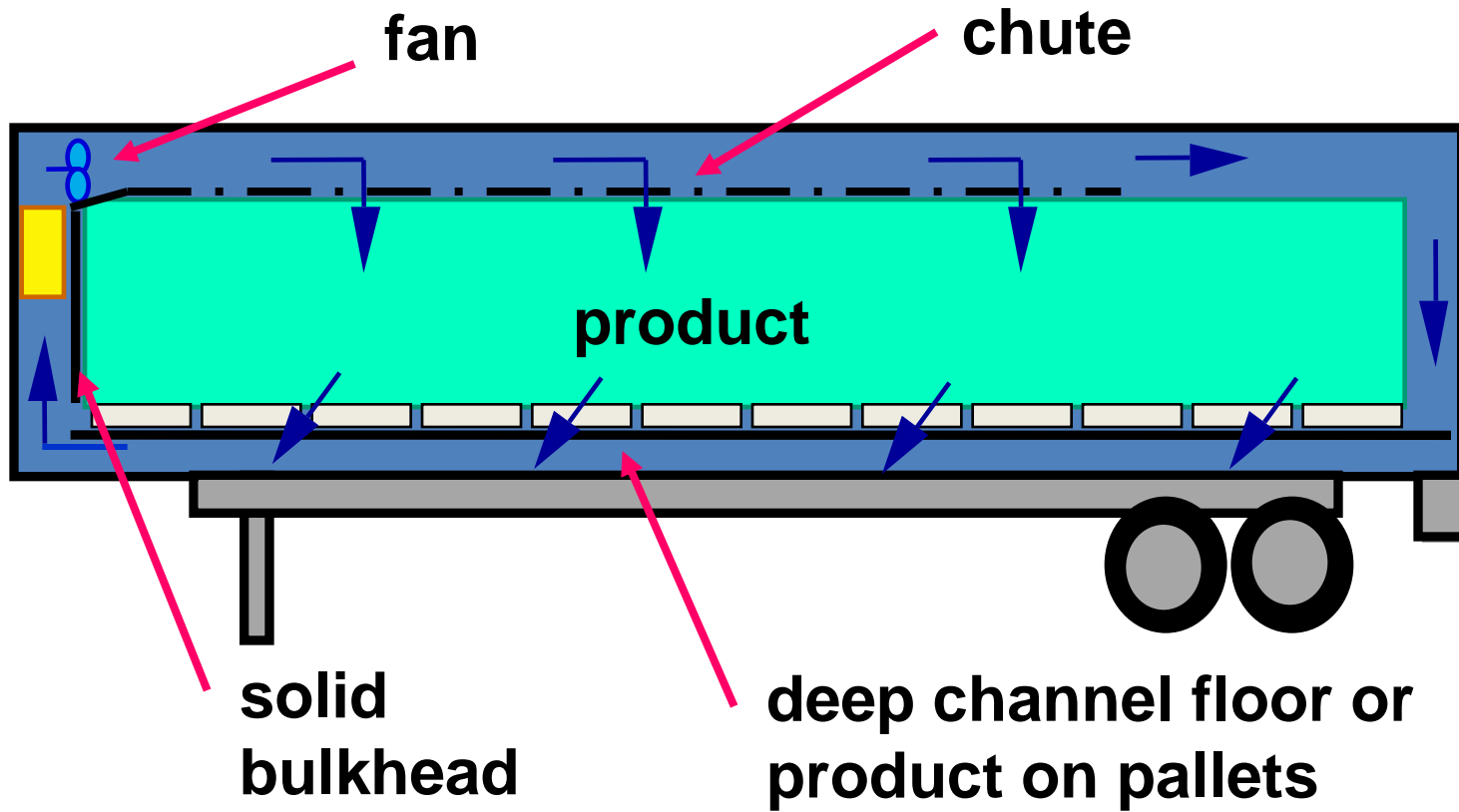
# TEMPERATURE FLUCTUATION

- Time-averaged storage temperature is main factor controlling shelf life for most products.
- Size of temperature fluctuation also matters for ice cream and for moisture migration (e.g. freezer burn)

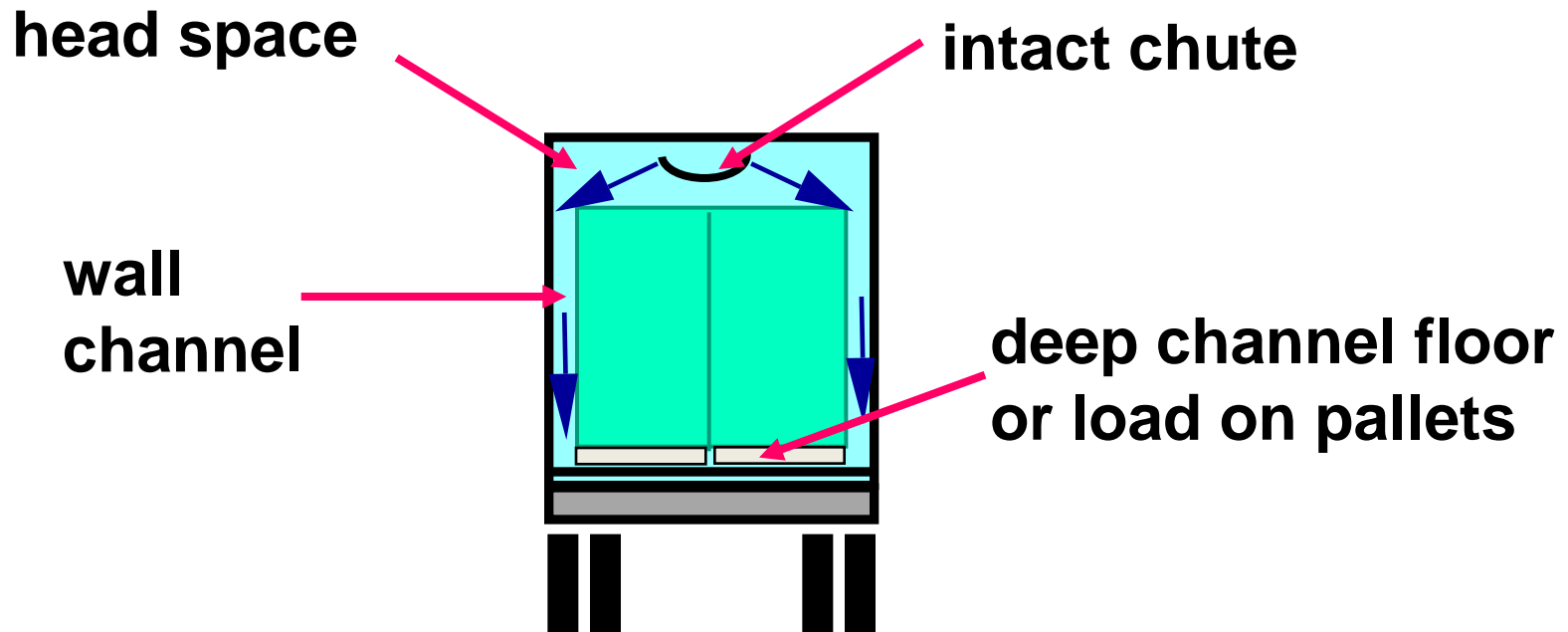
# MIXED LOADS



# AIRFLOW IN TRAILERS

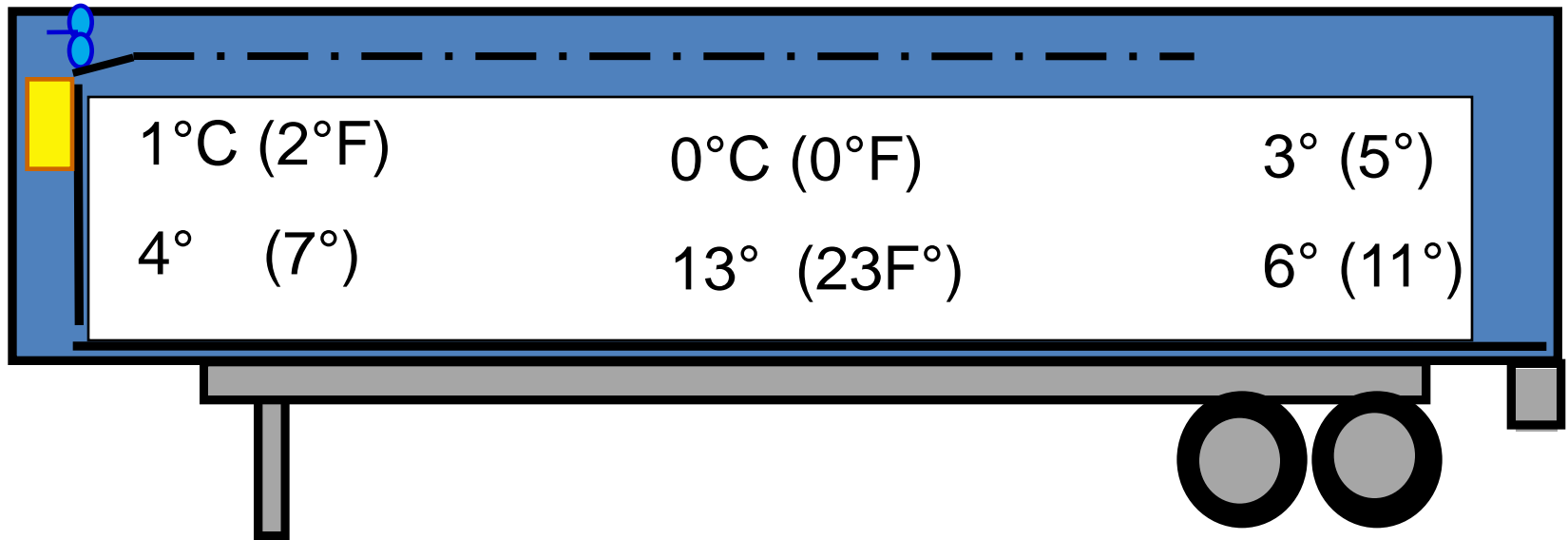


# AIRFLOW IN TRAILERS



# FROZEN PRODUCTS

Temperature increase in a 3 - 4 day trip



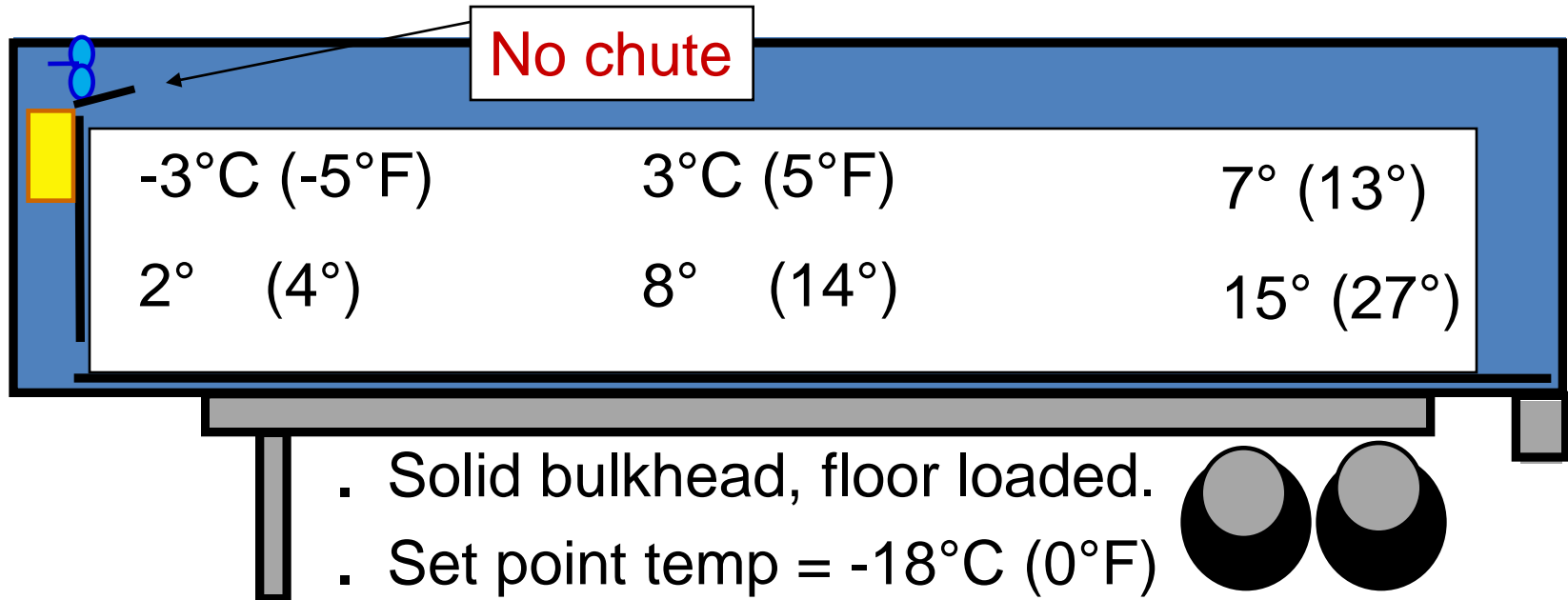
- . Solid bulkhead, full air chute, floor loaded.
- . Set point temp = -18°C (0°F)

LeBlanc, et al., 1994

# FROZEN PRODUCTS

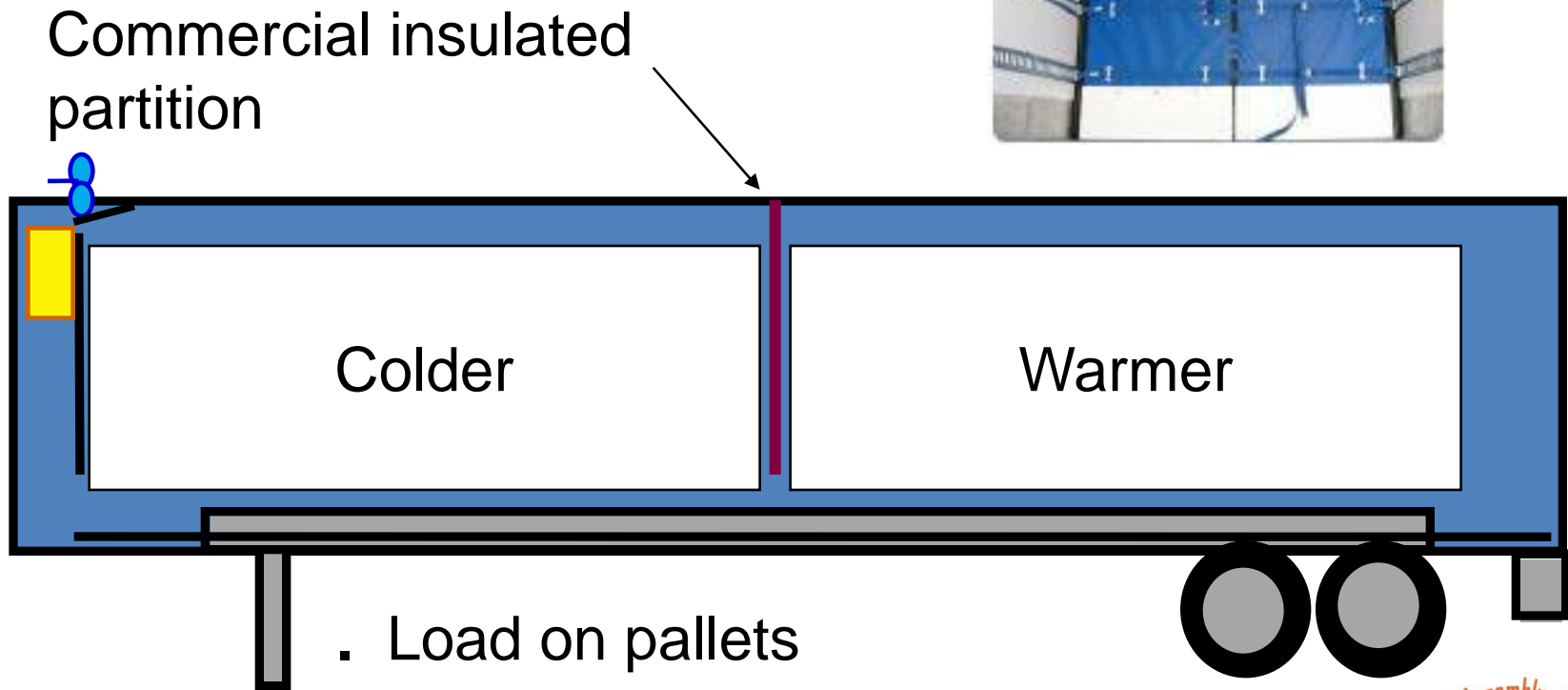
Temperature increase in a 3 - 4 day trip

Equipment and proper loading affect temperature



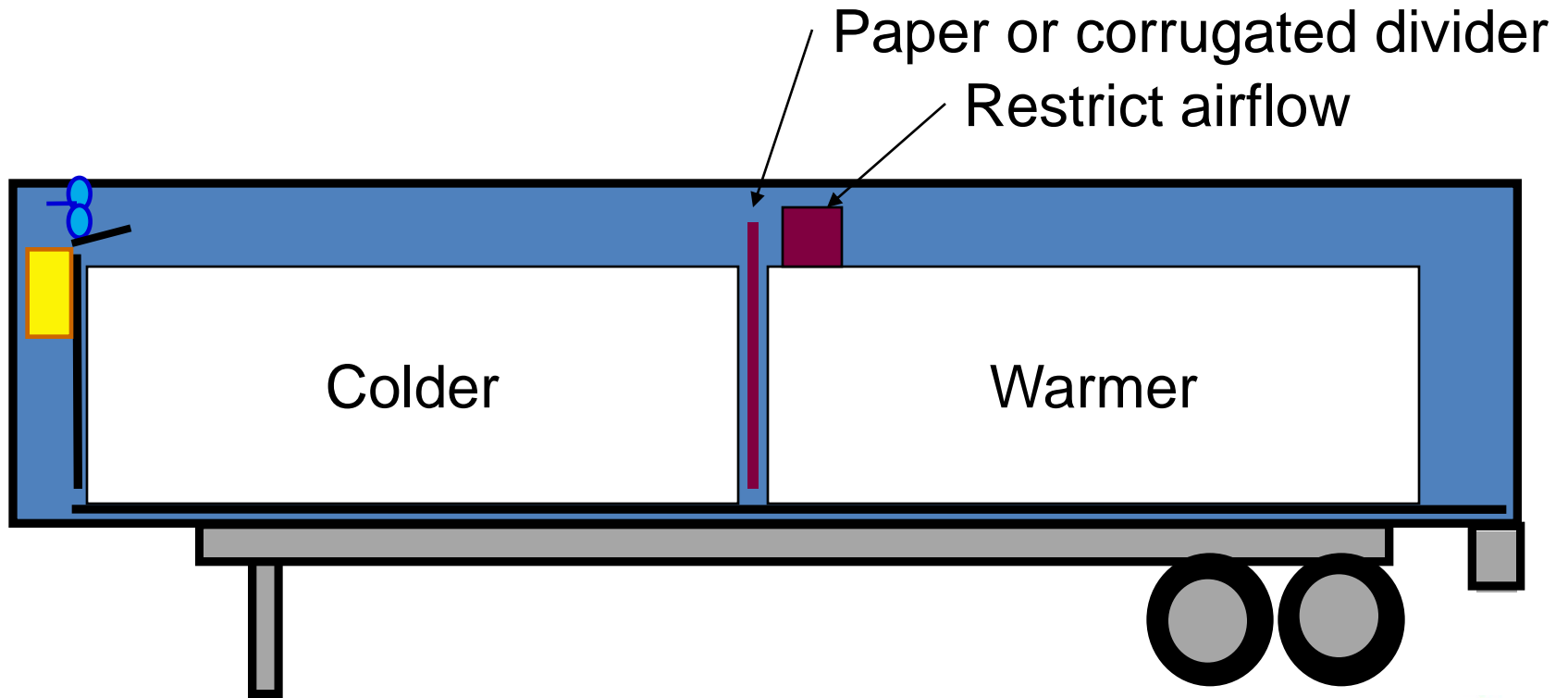
LeBlanc, et al., 1994

# TWO SECTION FROZEN

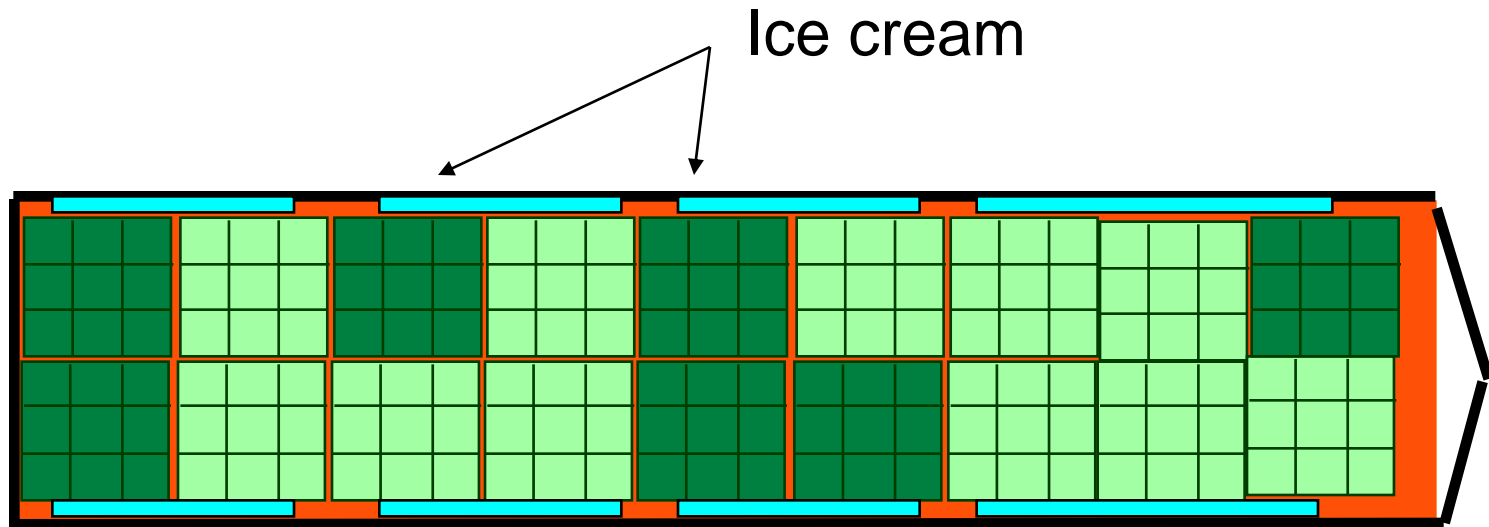


- . Load on pallets
- . Set thermostat for colder product

# MAKE YOUR OWN PARTITION?



# MULTIPLE STOPS



# MULTIPLE STOPS

- Pallets with different temperature requirements are mixed in the load.



Pallet covers



# TEST THE METHOD

- RF monitors can develop temperature history profile in trucks.



# RF MONITORING COMPANIES

- Alien Technologies  
[www.alientechnology.com](http://www.alientechnology.com)
- Sensitech [www.sensitech.com](http://www.sensitech.com)
- Infratab [www.infratab.com](http://www.infratab.com)

# ERDA/WFLO TEST PROJECT

1. Monitor loads with RF temperature monitors - one per pallet.
2. Measure temperature distribution with various loading patterns.
3. Evaluate shelf life loss based on published time/temperature data.
4. Recommend procedures for mixed loading based on test results.