NRC PERD 079 Project - Task 1 - Findings from the Carmacks Yukon survey

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Findings from the Carmacks Yukon Survey

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Canada

Carmacks Survey

- In March 2005 The Sheltair Group in Vancouver was contracted out to do the field survey in Yukon
- Yukon Housing Corporation provided support in finding the houses; Carmacks First Nations community was selected
- 8 houses/region
  - 4 with reported moisture troubles
  - 4 without reported moisture troubles
  - Carmacks survey was carried out from January 19 to February 21, 2006

Data Collection

- Hobo RH and T sensors
  - calibrated at IRC (up to about 60% RH)
  - 2 indoors per house
    - On wall of room with high moisture source or with identified moisture problem
    - One out of 16 indoor sensors did not work
  - one outdoors per survey region
  - Set to capture data every three minutes
- EnerGuide for Houses survey, fan depressurization test and Hot 2000 analysis
- IRC-made questionnaire on basic building characteristics

House Characteristics

- Manually-operated exhaust fans in kitchen and/or bathroom
- Moisture problems:
  - Mould growth on exterior walls, behind furniture, at wall-floor and wall-ceiling junctions, at window sills
  - Frost on glazing
- Two non-moisture troubled houses experienced mould growth as well but occupants regularly wash the walls to remove mould growth
- Several household have/plan to remove the drywall and replace it with wood panelling

- 8 single detached houses (I is a mobile home)
- Wood-frame 2X6
- 6 houses built 10 years ago or less
- Very leaky (between 5-19 ACH @ 50 Pa)
- 2 houses built in 1975 and 1978
- Occupancy varied between 1 to 6 persons
- Double glazed PVC windows
- 7 houses are heated with a wood-stove & no heat distribution system
- MT households have fewer or zero occupants during the day

House Characteristics

House	ACH @ 50 Pa	EGH rating (Age of construction)	Min and Max indoor RH recorded	Occupancy load (day/night)
MT- #1	7.8	49 (1978)	7-52%	6 occupants (0/6)
MT #2	19.0	34 (1975)	7-98 %	1 occupant (1/1)
MT #5	8.9	57 (2002)	10-67 %	5 occupants (0/5)
MT #6	12.0	61 (2002)	9-79 %	4 occupants (0/4)
NMT #3	9.6	57 (2002)	13-92 %	3 occupants (2/3)
NMT #4	13.6	57 (1996)	4-91 %	2 occupants (0/2)
NMT #7	7.9	61 (2002)	17-60 %	2 occupants (1/1)
NMT #8 (mobile home)	5.0	70 (1998)	20-66 %	6 occupants (5/6)

Characteristics of Non moisture troubled Sample

Non-Moisture Troubled Sample										
House No.	**Hobo sensors & location**	**No. of occupants (day/night)**	**Windows**	**Humidifier**	**House-general**	**Heating system**	**Ventilation**	**EGH rating / ACH @50 Pa/ELA (cm2)**	**Problems**	**Comments**
3 (250)	839964: bedroom closet 839971: kitchen	3 (2/3)	Double glazed PVC, fixed and casement Curtains closed during visit Plastic in place to reduce draughts	Drying of clothes indoors	Built 2002 807 sq ft Bungalow	Wood stove. No heat distribution	Manually-operated exhaust fan in bathroom	57/9.6/178cm^2		
4 (251)	839977: kitchen 839975: bedroom closet	2 (0/2)	Double glazed PVC, fixed and sliders Curtains closed during visit		Built 1996 851 sq ft	Wood stove. No heat distribution	Manually-operated exhaust fan in bathroom	57/13.6/ 184 cm^2		
7 (254)	839979:kitchen 839973: living room	2 (1/1)	Double glazed PVC, fixed and sliders Curtains open during visit	Pot on stove	Built 2002 860sq ft Bungalow	Wood stove. No heat distribution	Manually-operated exhaust fans in kitchen and bathroom	61/ 7.9/ 166cm^2	No moulds observed. Occupant cleans walls bi-weekly to control mould growth	
8 (255)	839982: kitchen 839967: living room	6 (5/6)	Double glazed PVC, fixed and sliders Curtains open during visit		Built 1998 863 sq ft Mobile home	Oil furnace with forced air system	Manually-operated exhaust fans in kitchen and bathroom	70/ 5.0/ 64 cm^2	Occupant cleans walls bi-weekly to control mould growth	Interior finish is wood panels

Characteristics of Moisture trouble Sample

Moisture-Troubled Sample										
House No.	Hobo sensors & location	No. of occupants (day/night)	Windows	Source of humidification	House-general	Heating system	Ventilation	EGH rating / ACH @50 Pa/ELA (cm^2)	Problems	Comments
1 (248)	839968:bedroom 839980: hall in storage cupboard	6 (0/6)	Double glazed PVC, fixed and sliders Curtains open during visit	No	Built 1978; 1517 sq ft, Bungalow	Wood stove is stocked AM and evening only; no heat distribution	Manually-operated exhaust fans in kitchen and bathroom	49/ 7.8/ 220 cm^2	*Frost on glass and frame *Mould on ext. walls, bathroom, behind furniture *Water damage under window sill and on bathroom ceiling	Drywall is replaced with wood panelling
2 (249)	839965: bathroom 839981: living room	1 (1/1)	Double glazed PVC, fixed and casement Curtains closed during visit	Pot of water boils all day Dryer is vented into bathroom	Built 1975 1052 sq ft Bungalow	Wood stove No heat distribution	Manually-operated exhaust fans in kitchen and bathroom	34/ 19/ 308 cm^2	*Frost on glass and frame *Mould on ext. walls, bathroom, behind furniture	Some drywall was removed. Plans are to replace it with wood panelling
5 (252)	839972: kitchen (above stove?) 839966:living room	5 (0/5)	Double glazed PVC, fixed and sliders Curtains close during visit	Exposed earth in crawl space Fresh air intake for stove in crawl space	Built 2002 902sq ft Bungalow	Wood stove No heat distribution	Manually-operated exhaust fans in kitchen and bathroom	57/ 8.9/ 188cm^2	Mould and frost on windows, in corners at floor and ceiling and on interior finish below window sill	Plans are to replace drywall with wood panelling
6 (253)	839976: kitchen 839978: hall	4 (0/4)	Double glazed PVC, fixed and sliders Curtains open during visit	Pot on stove	Built 2002 694 sq ft Log home	Wood stove No heat distribution	Manually-operated exhaust fans in kitchen and bathroom	61/12/ 178 cm^2	Mould and frost on windows	Occupant cleans walls bi-weekly to control mould growth

Moisture Troubled (MT) Houses

248(#1)MT
EGH: 49

249 (#2) MT
EGH: 34

253 (#6) MT
EGH: 61

252 (#5) MT
EGH:57

Non Moisture Troubled (NMT) Houses

250 (#3) NMT
EGH: 57

251 (#4) NMT
EGH: 57

255 (#8) NMT
EGH: 70

254 (#7) NMT
EGH: 61

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Types of Moisture Troubles

Mould growth in exterior walls, particularly behind furniture and at lower portion of floor. Mould noted in bathroom

Windows have frost on them and are frozen open

Stained drywall removed at time of site visit. It was noted that the air barrier was incomplete around penetrations. There was approximately 1cm thick of ice on the inside face of the exterior sheathing at these locations

Mould on walls, at corners of floor and ceilings

Sensor Locations

839968 (#1a)
Bedroom close to exterior wall

839980 (#1b)
in hall in storage cupboard

839981 (#2b)
Living room

839965 (#2a)
Bathroom

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Sensor Locations

839971 (#3b)
Kitchen

839964 (#3a)
Bedroom closet

839977 (#4b)
Kitchen

839975 (#4a)
Bedroom closet

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Sensor Locations

839972 (#5b)
Kitchen (above stove or fridge?)

839966 (#5a)
Living room

839972 (#6a)
Kitchen

839978 (#6b)
Hall in open closet

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Sensor Locations

839979 (#7a)
Kitchen

839982 (#8a)
Kitchen

839967 (#8b)
Living room

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Data Analysis

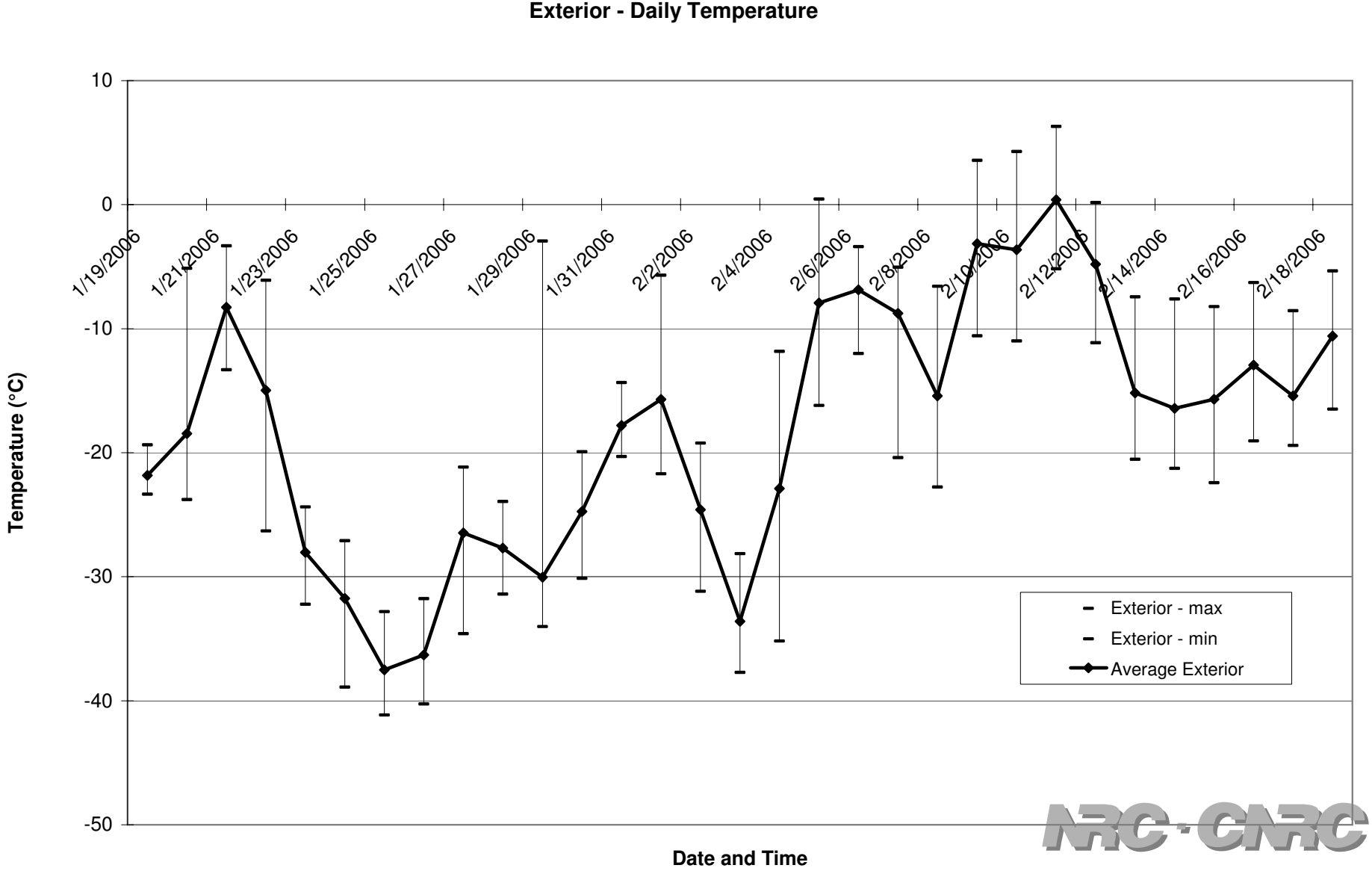
- Average outdoor RH and T in Carmacks during the survey period
- Average daily Temperature in NMT and MT relative to outdoors
- Average indoor RH in NMT and MT relative to outdoor and type of room
- Characteristics and duration of high humidity events

Very cold: T_{ext} rarely above 0C

Average outdoor T for the survey period:–18C

Min T_{ext} reached -40C

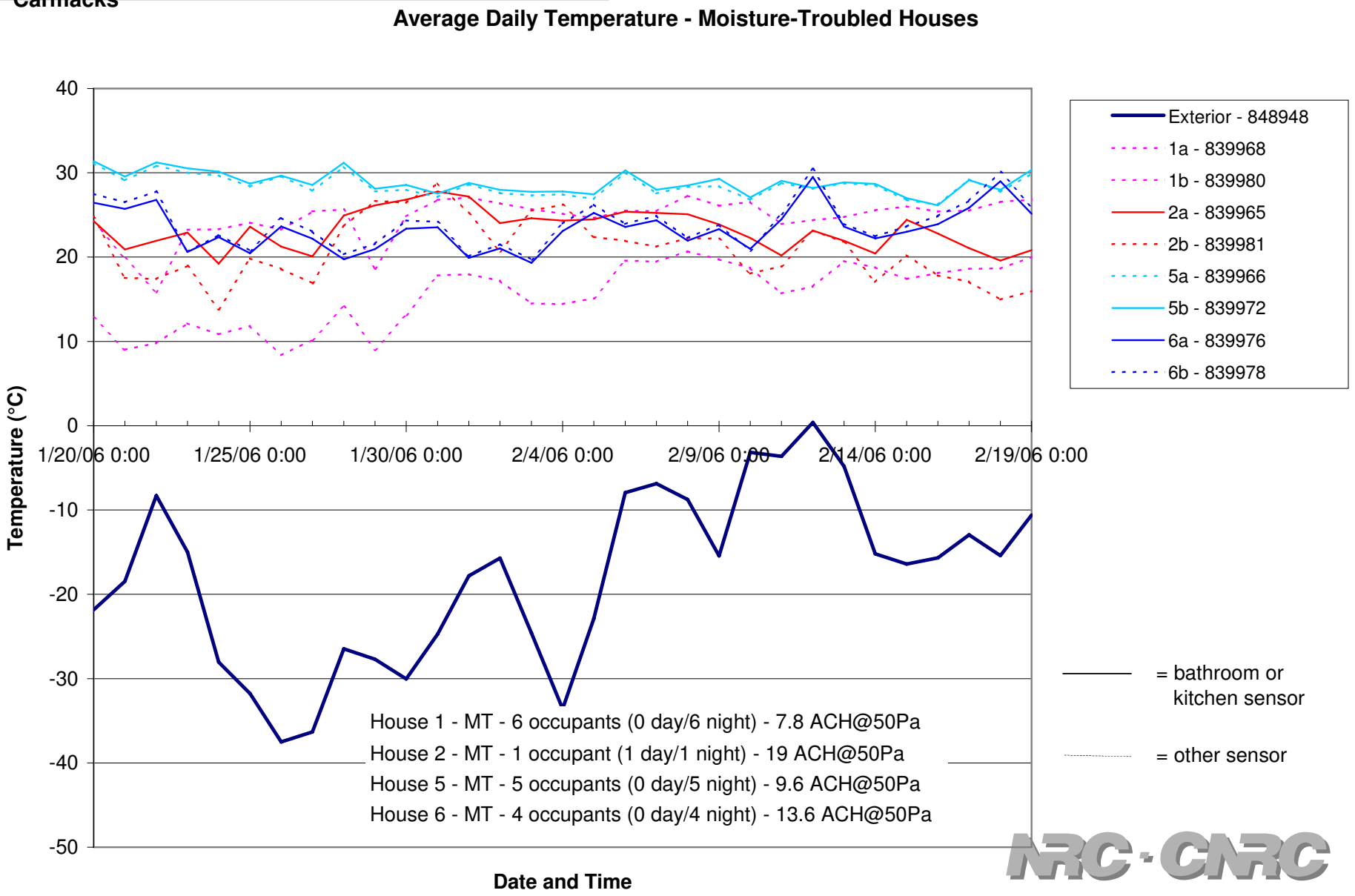
Exterior Average Daily Temperature



- **House 5 is warmer (28-31C) (kitchen-LR)**
- **House 1 is cooler (10-20C) (storage shelf- Closed off?)**

Average Daily Temperature Moisture Troubled Houses

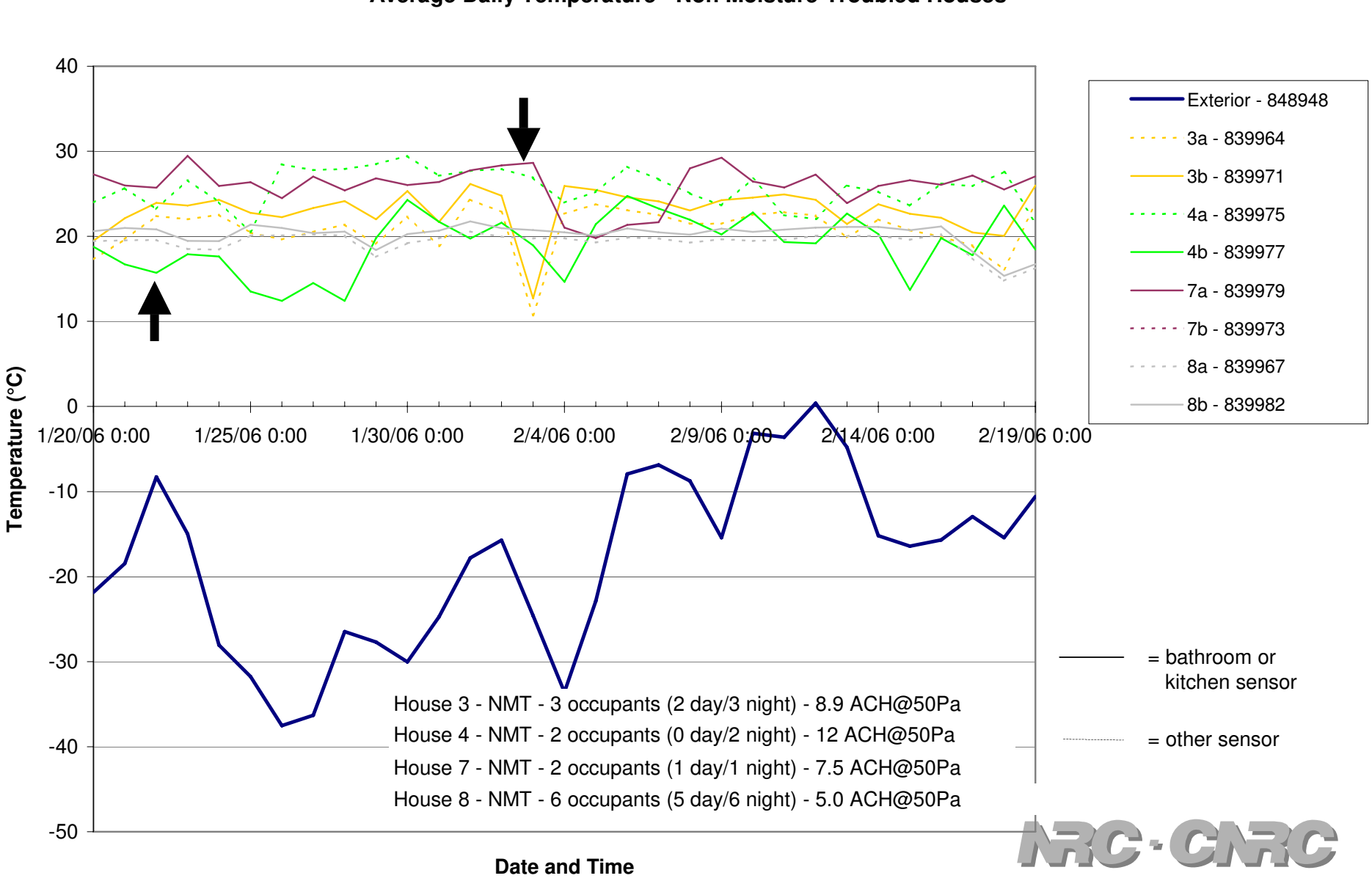
Carmacks



•House 4B (kitchen) was cool (followed outdoor T)
House 7A (kitchen) ran warmer

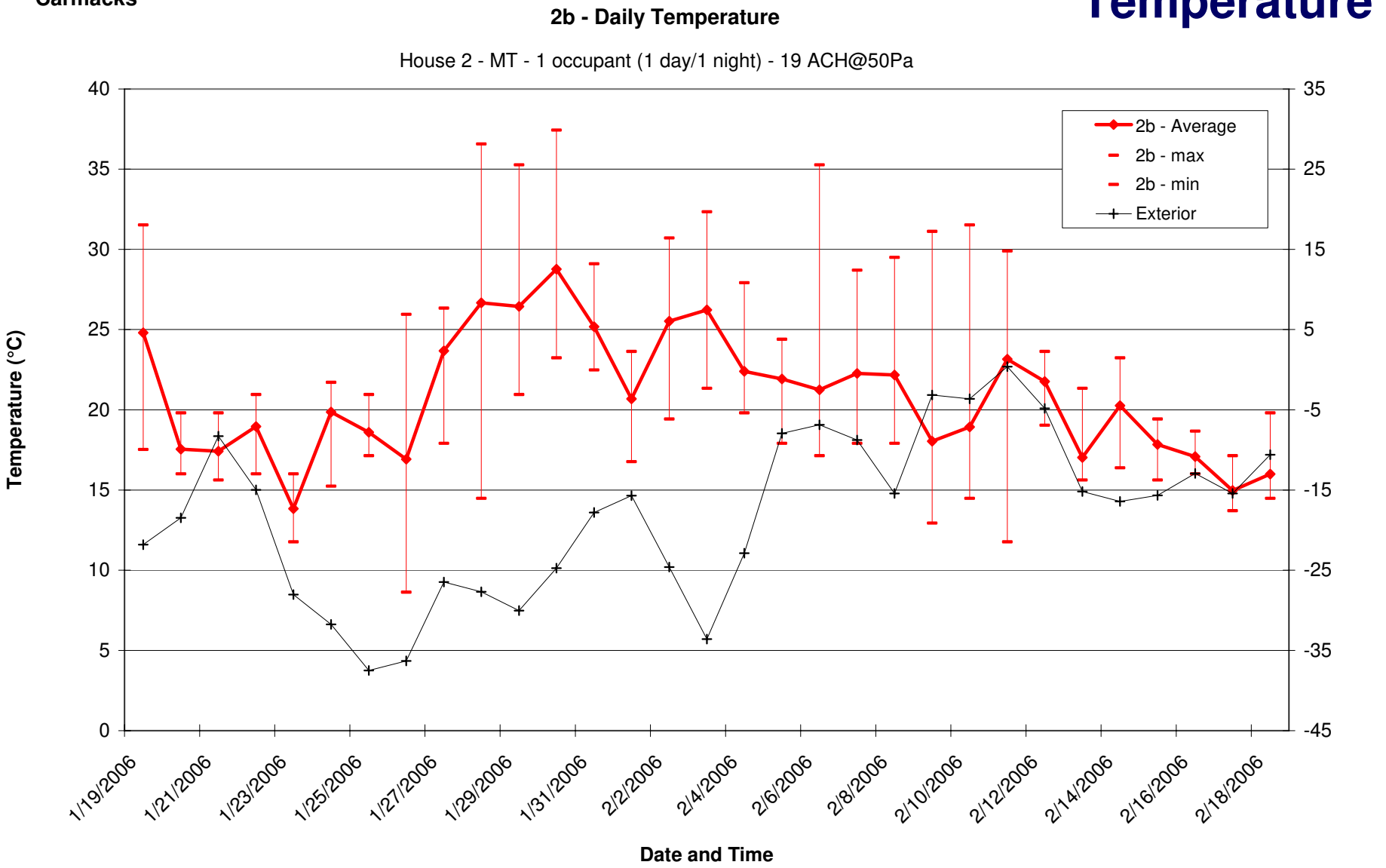
Temperature
Non Moisture Troubled Houses

Carmacks



Large Daily Fluctuations of Temperature

Carmacks



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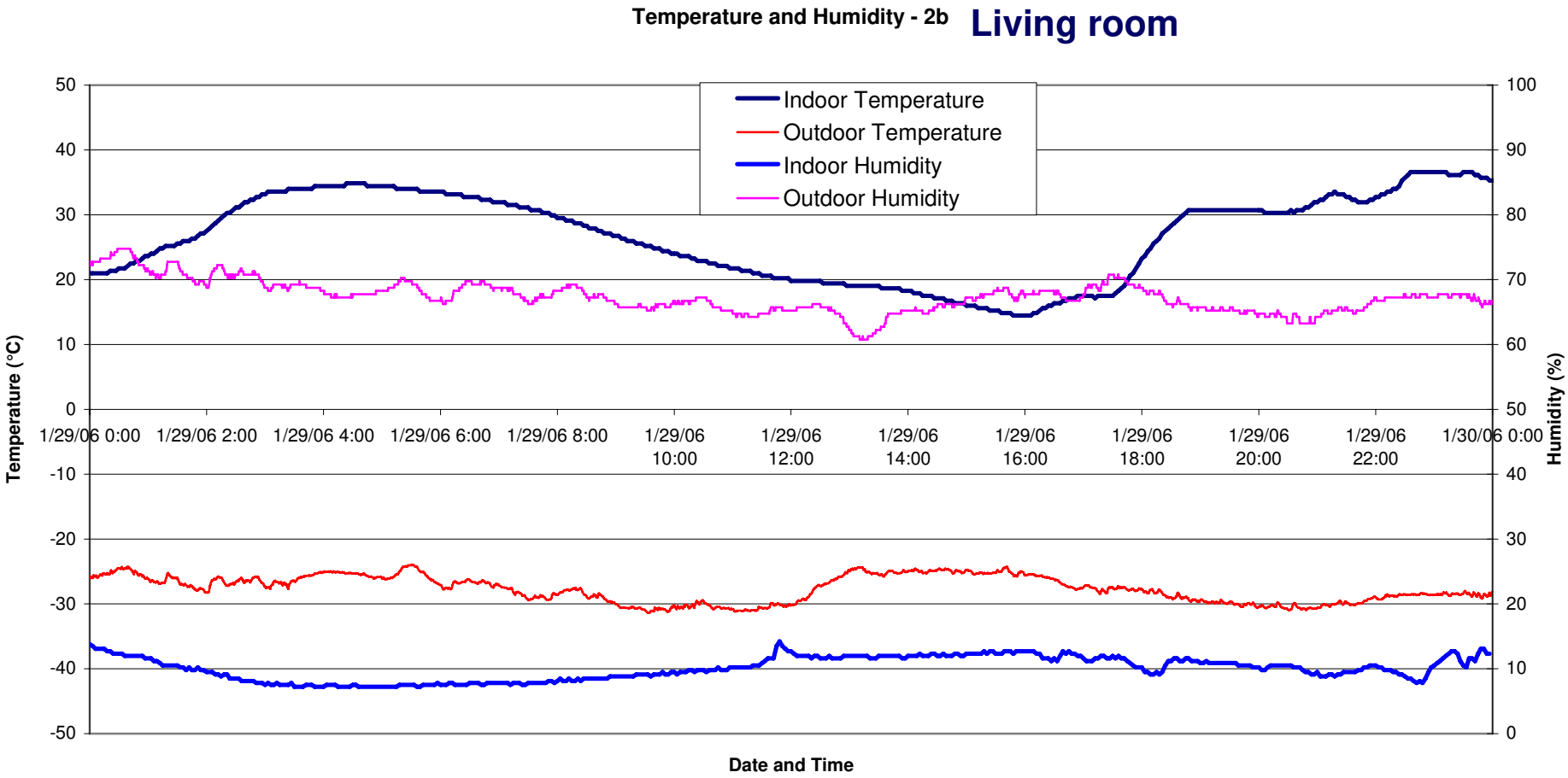
24-hour indoor T and RH fluctuations for 2B sensor



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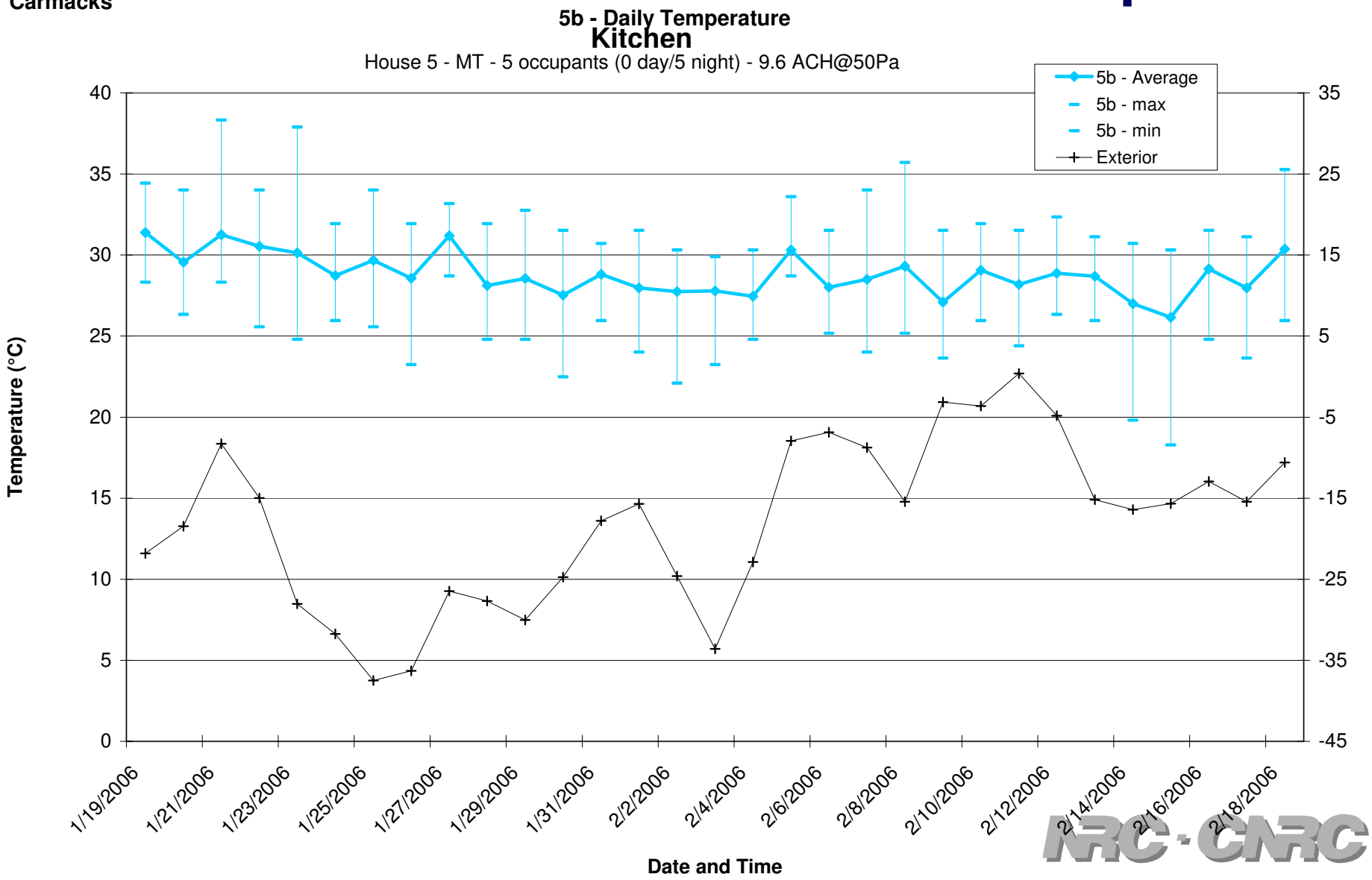
No one at home during the day (?)

Wood stove operation

High Indoor Temperature

Carmacks



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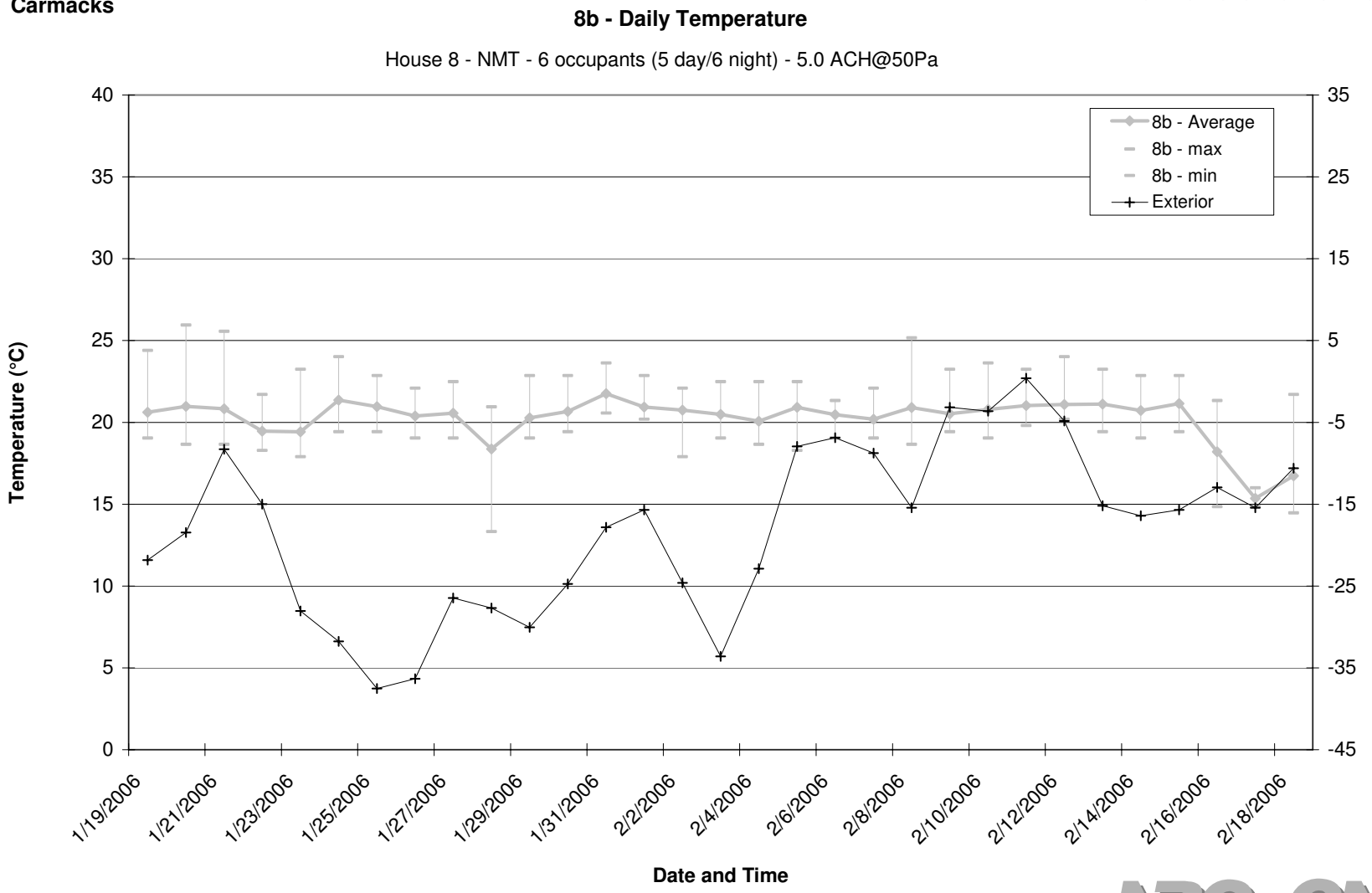
Only household with a oil furnace with forced air heat distribution, more airtight & several occupants during the day

Narrower band of Daily Temperature Fluctuations

Carmacks



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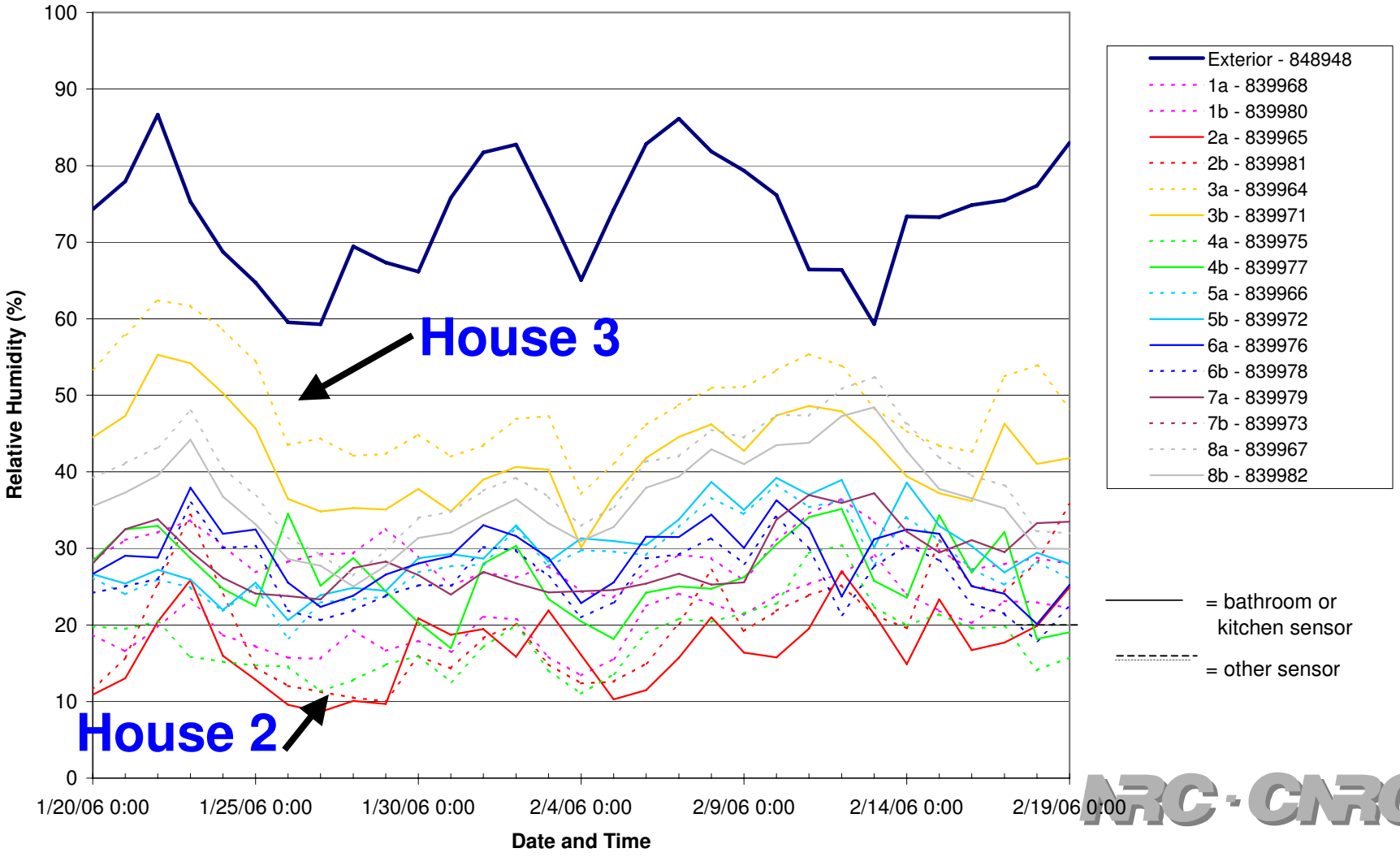
Daily Average Relative Humidity in All Houses

- Daily averages of Indoor RH data follow trends in outdoor RH
- House 3 (NMT) has highest daily average RH (kitchen and bedroom closet)
- House 2 (MT) has lowest daily average RH (bathroom and LR) BUT…



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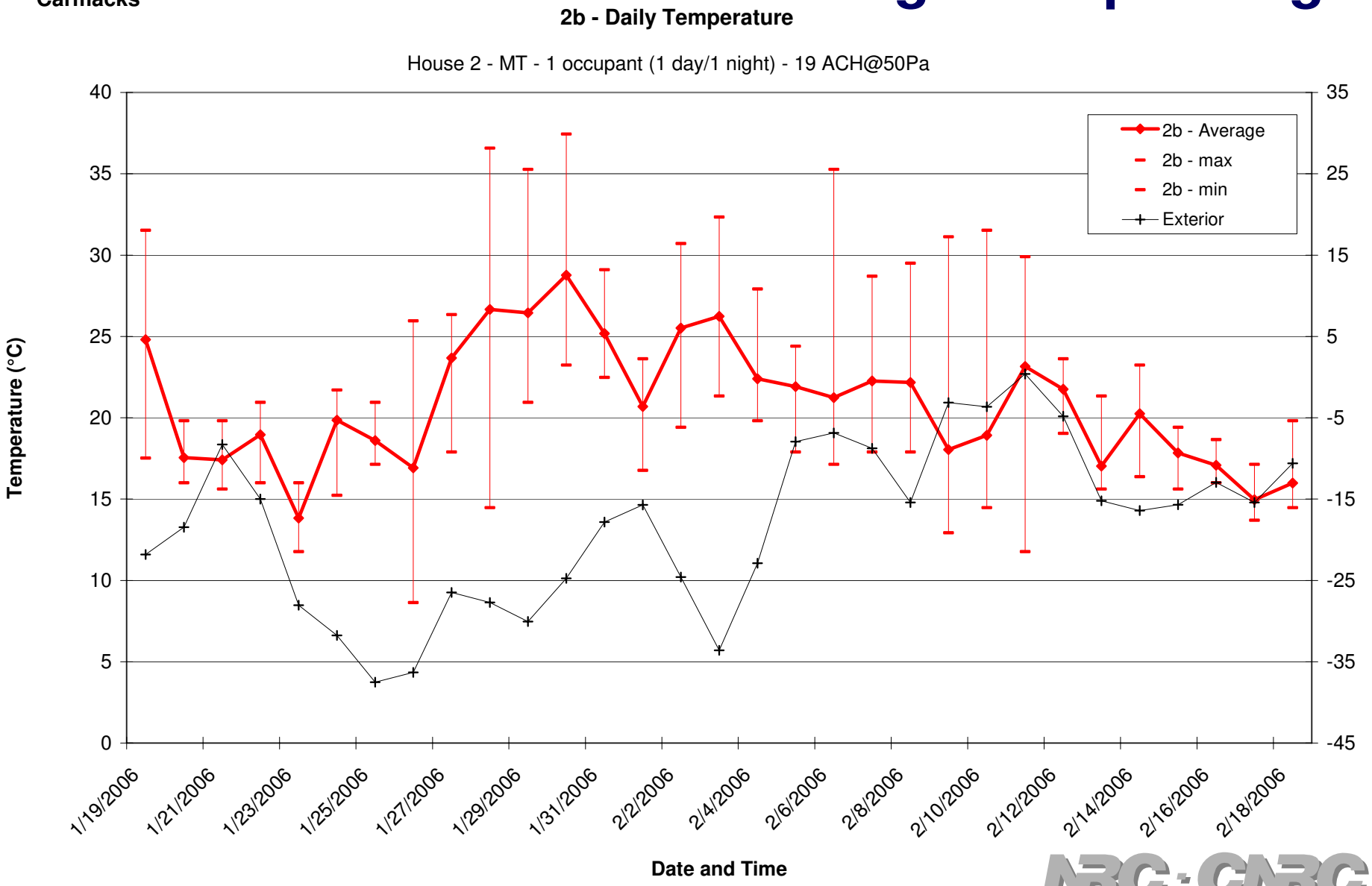
The case of House 2 (MT)
1st: large Temp swings

Carmacks



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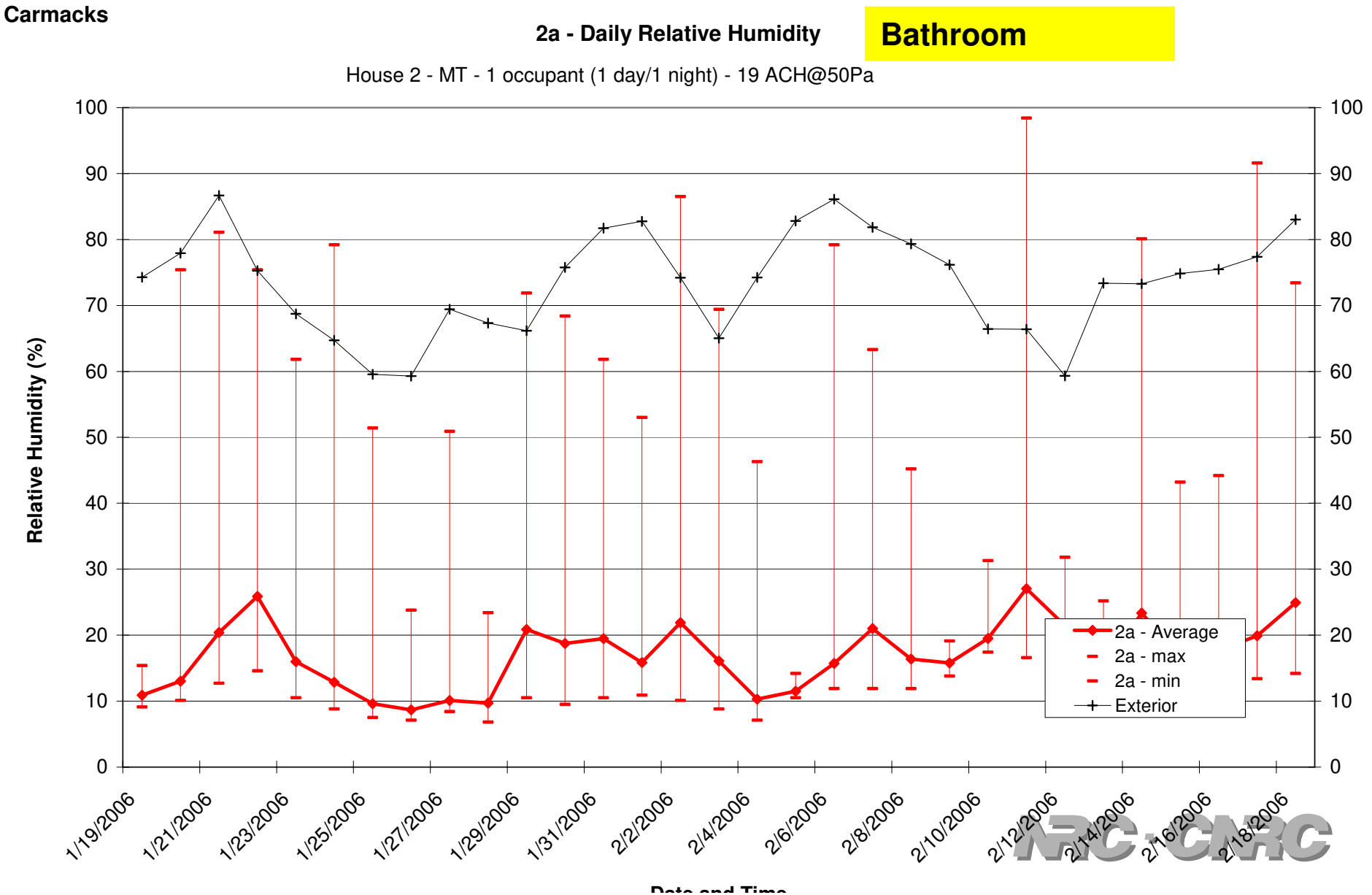
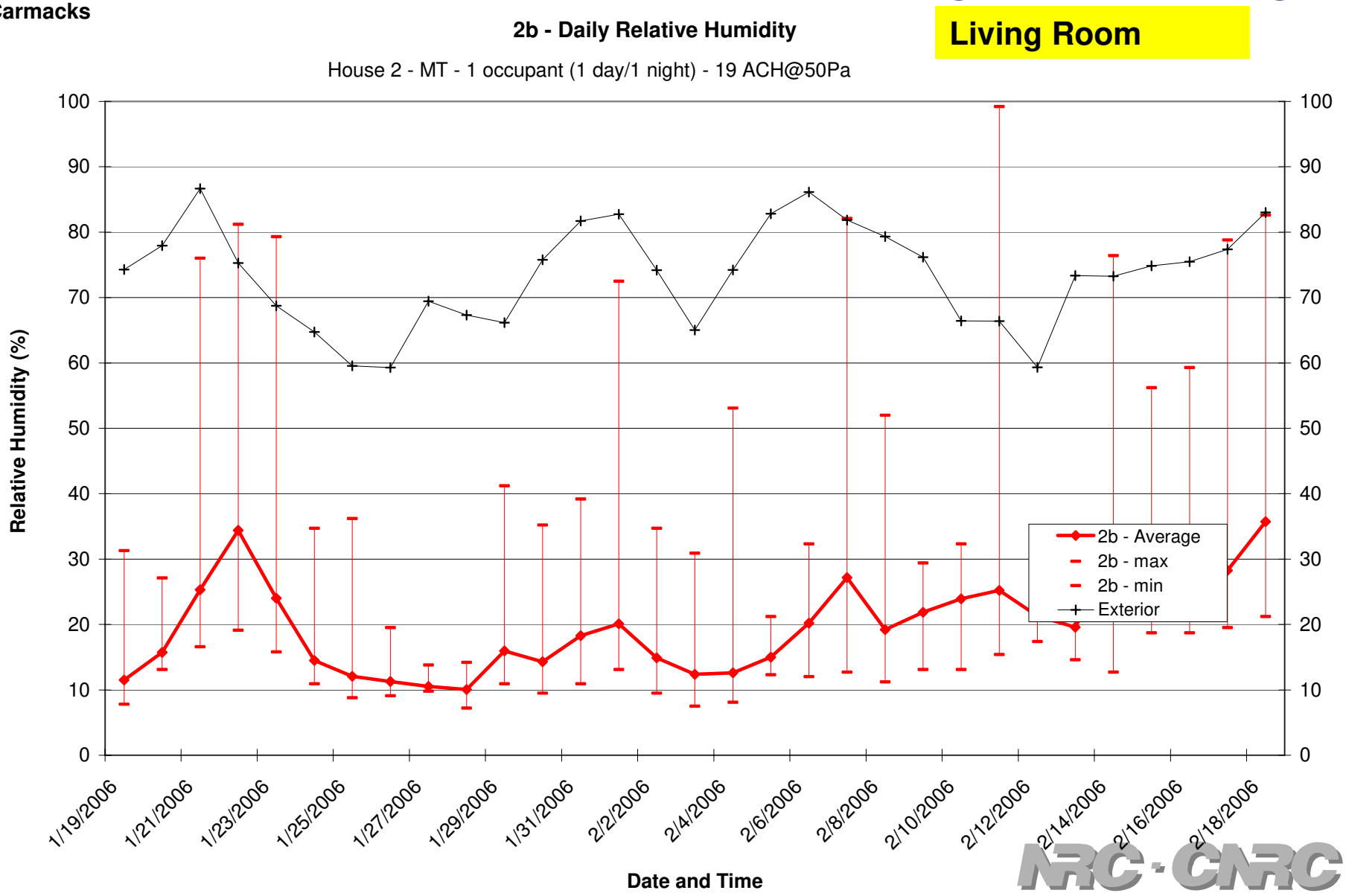
The case of House 2 (MT)
2nd: large RH swings



The case of House 2 (MT) large RH swings

Carmacks

Living Room



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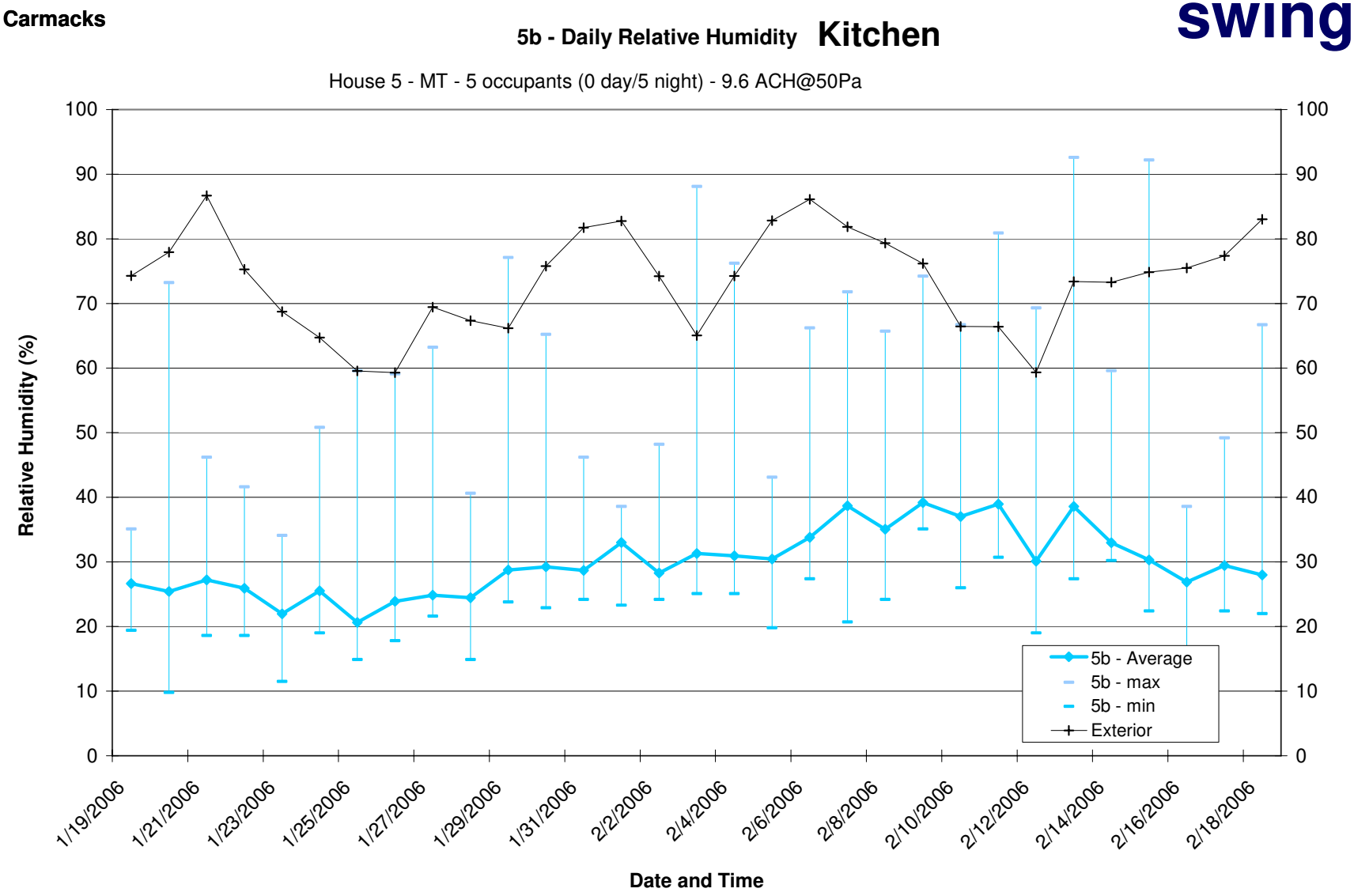
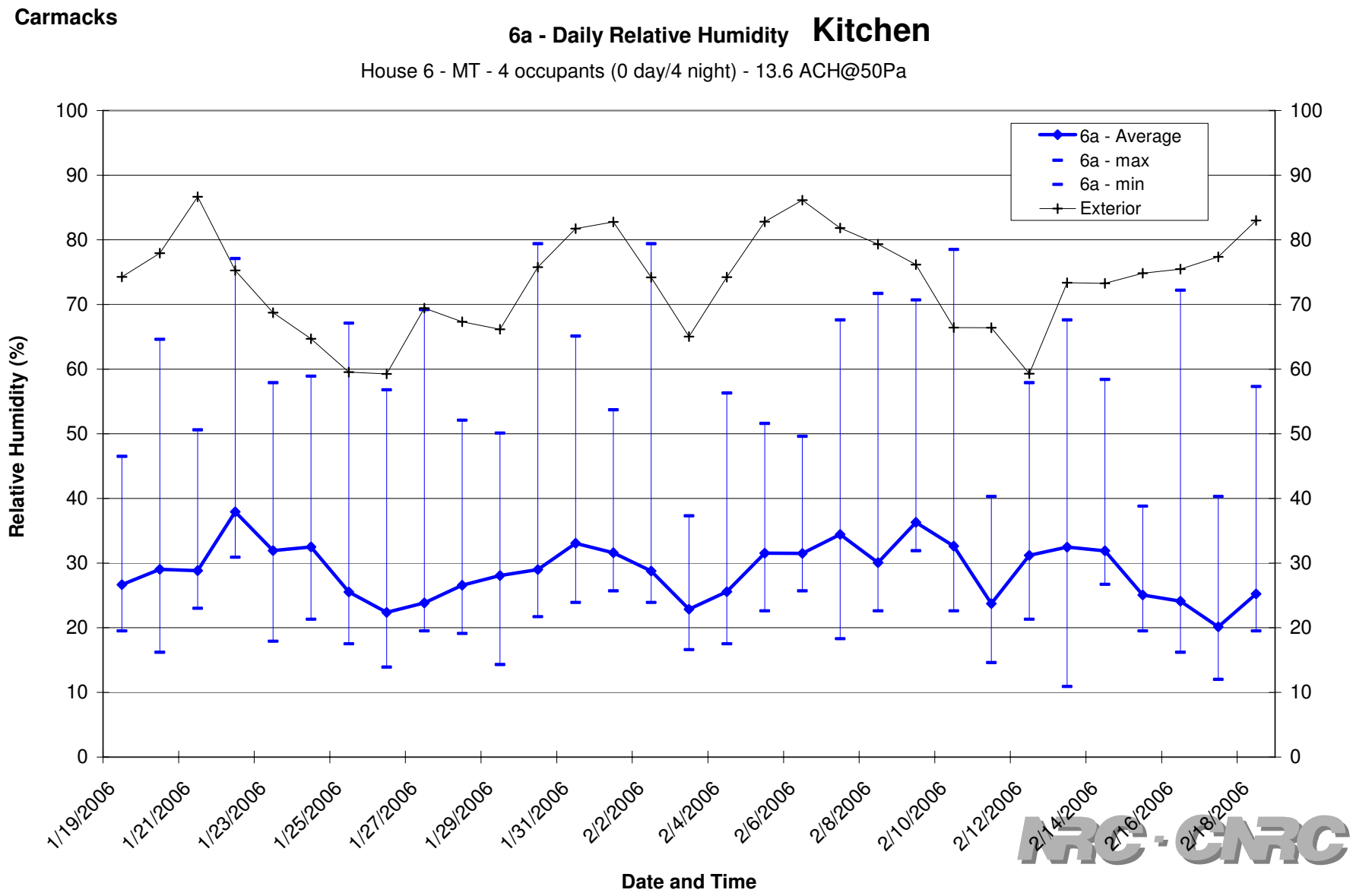
MT Houses; RH swings

Carmacks



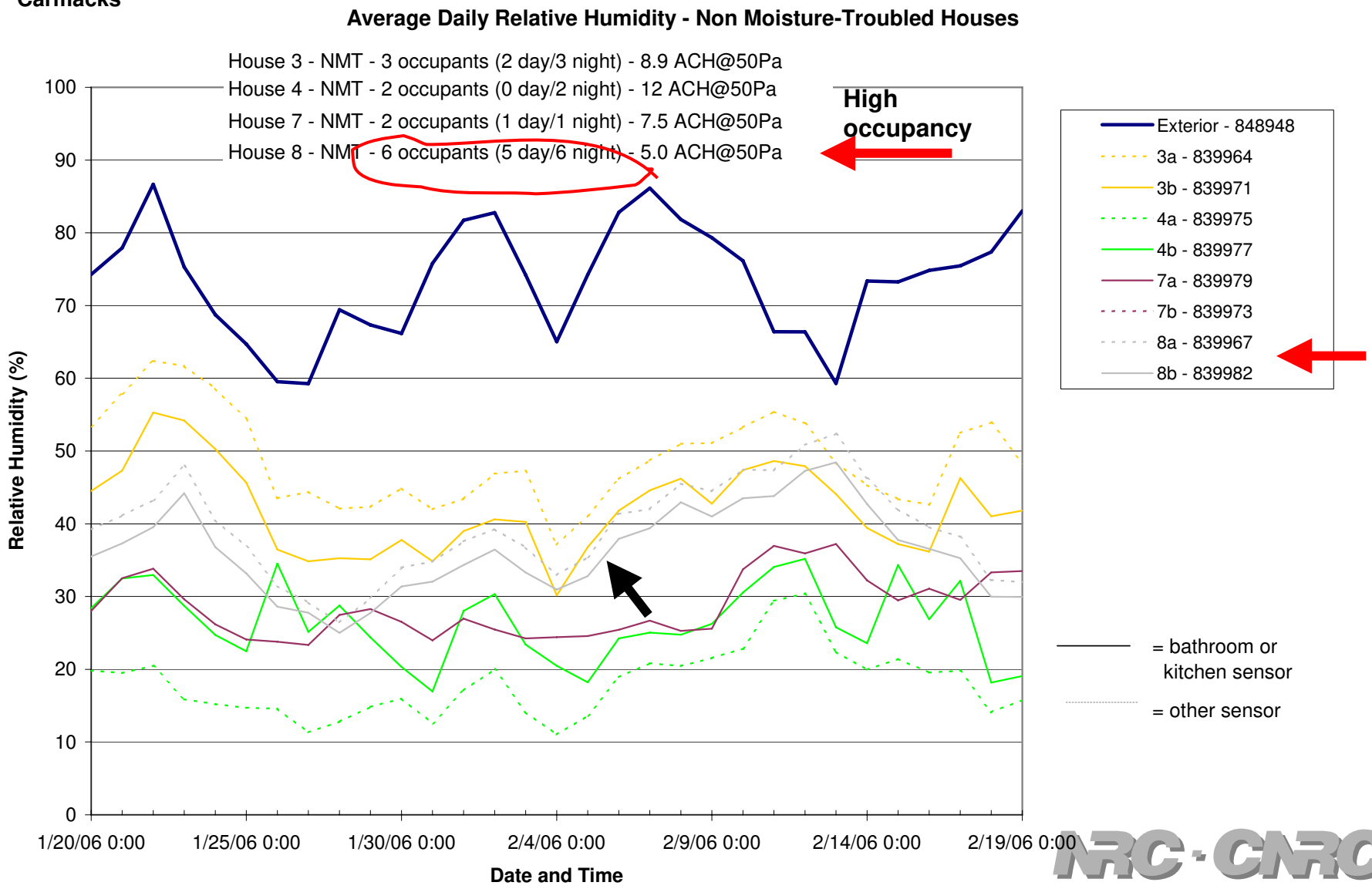
MT Houses; RH swings



House 8 is high occupancy BUT a mobile home (prefab), more airtight, more insulated, with oil furnace and forced air distribution

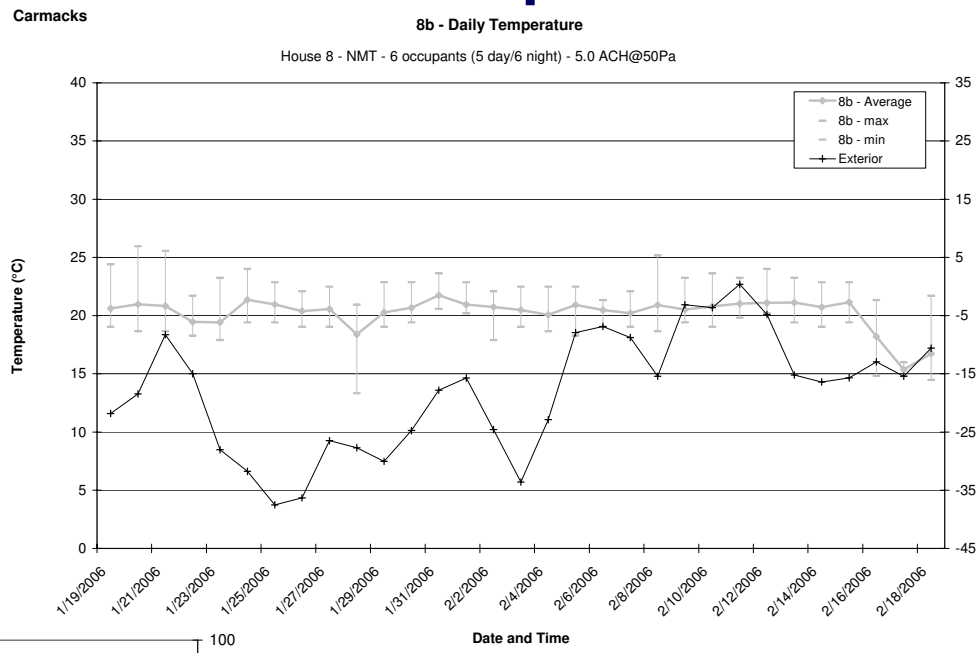
Indoor RH in Non Moisture Troubled Houses

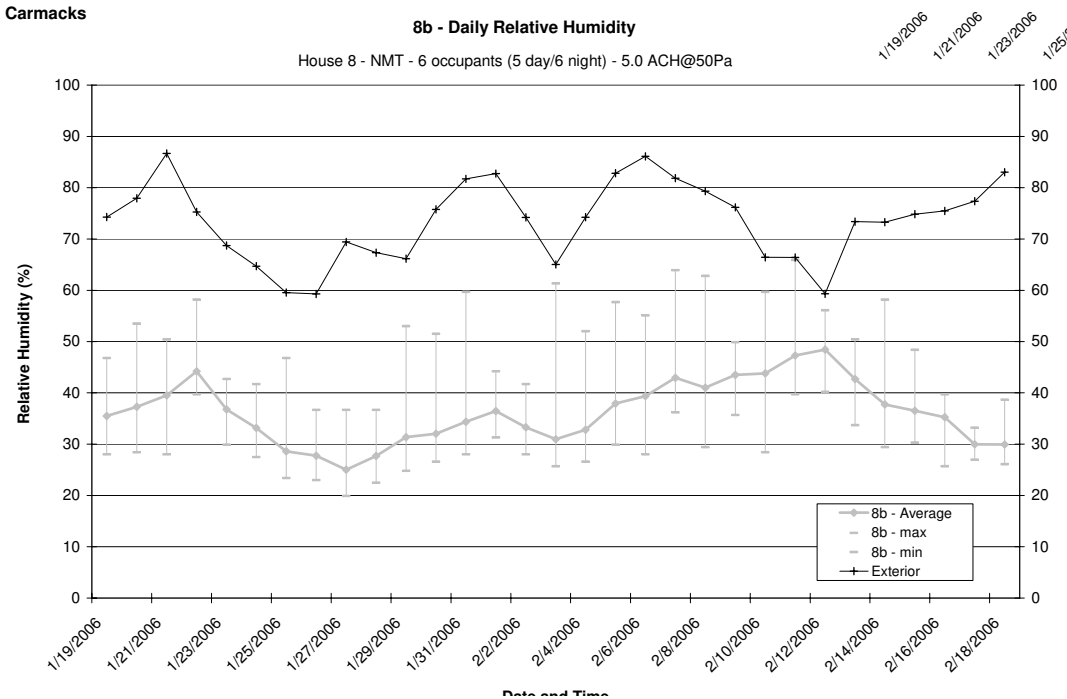
Carmacks



House 8 (NMT): Narrower band of RH and Temp. fluctuations

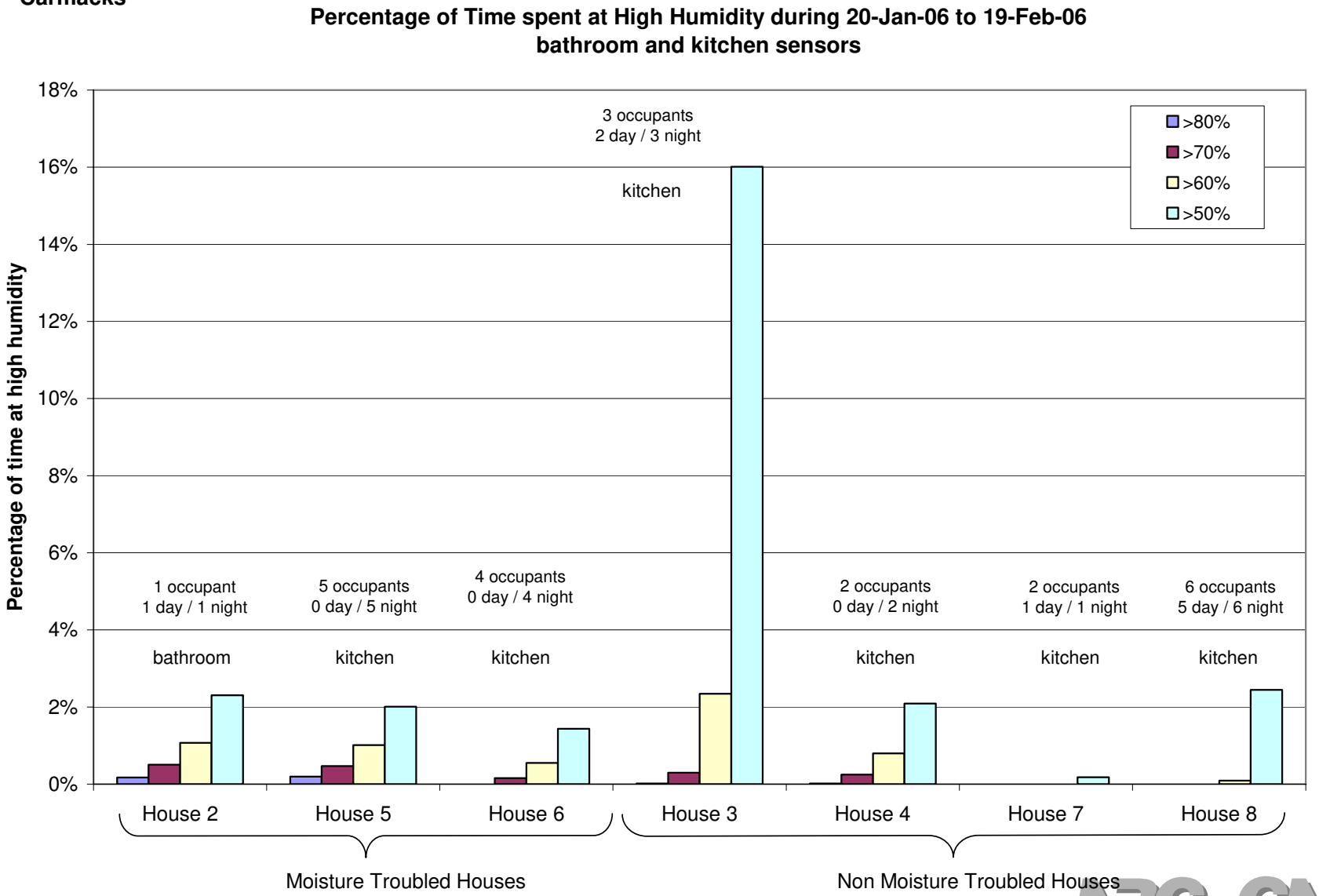
8b= kitchen



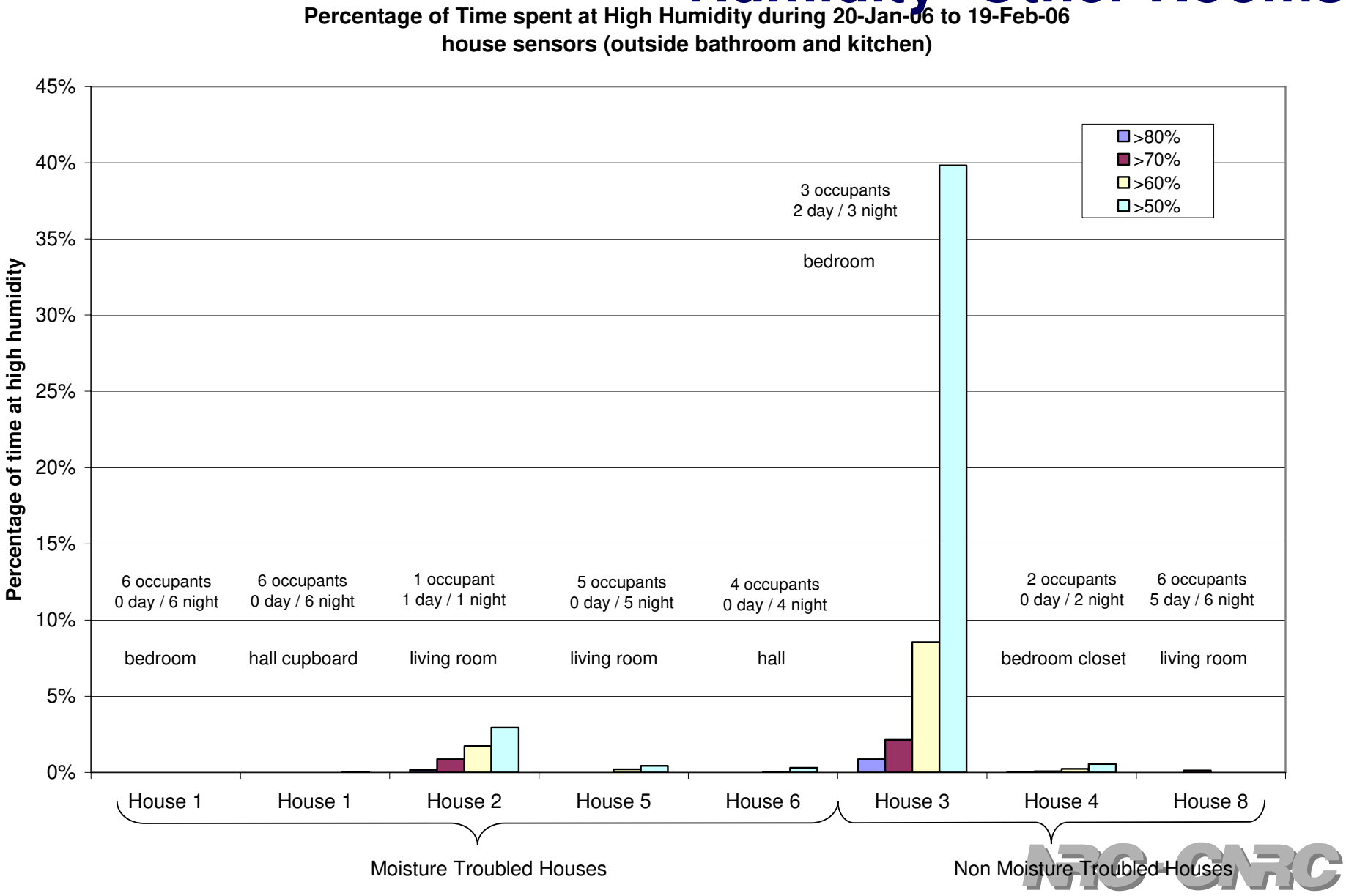


Time spent at High Humidity- Wet Rooms

Carmacks



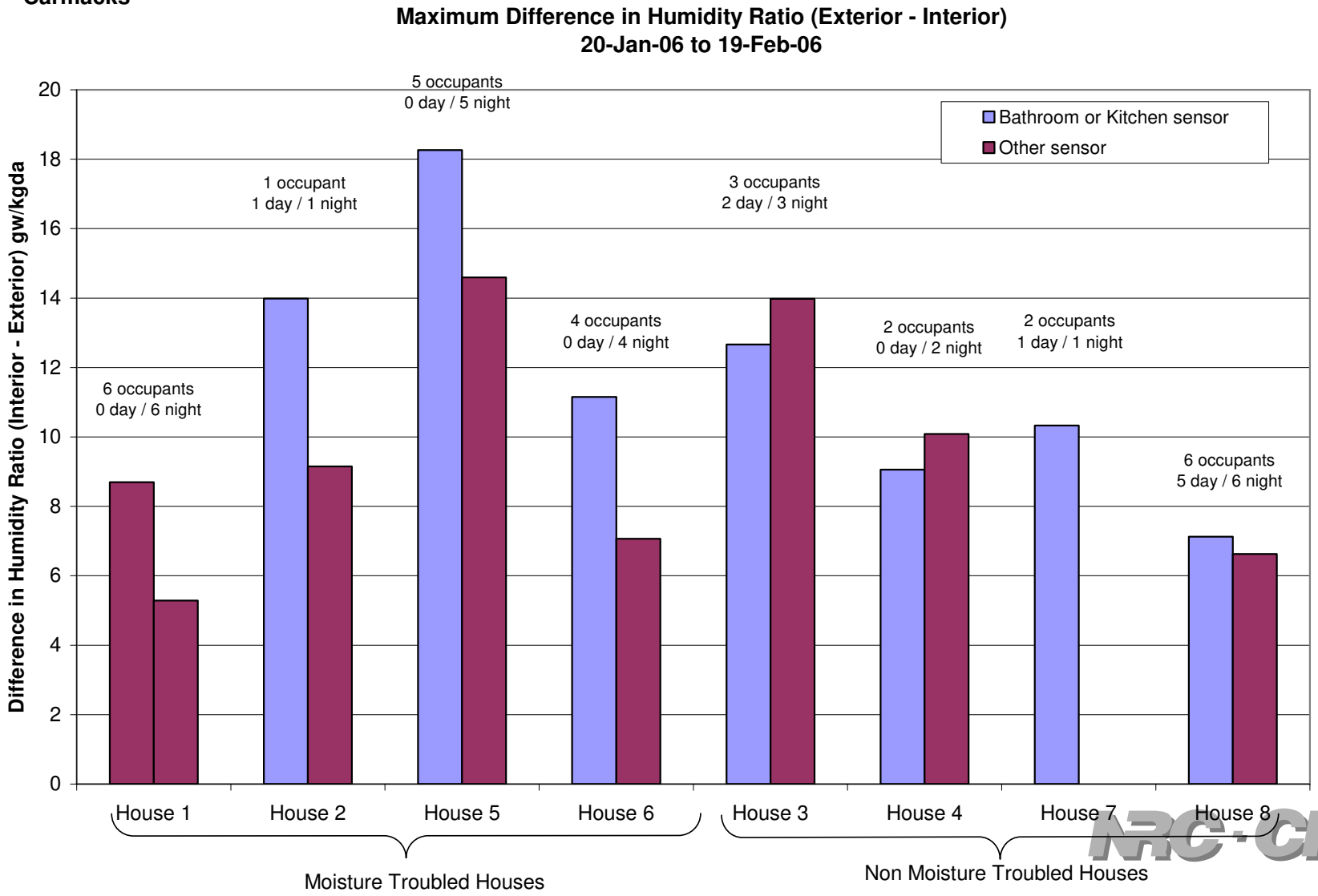
Time Spent at High Humidity- Other Rooms



Difference in Humidity Ratio (Exterior – Interior)

- Range of indoor moisture loads – from 5g/kg_{da} to 18 g_w/kg_{da}
- No obvious relationship to moisture problems

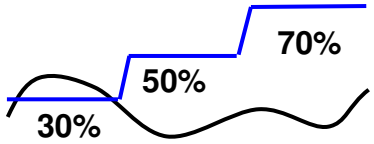
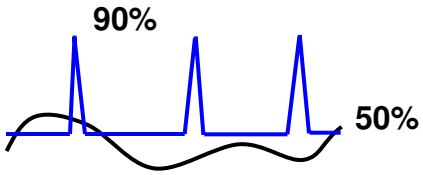
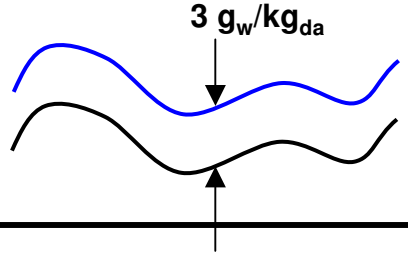
Carmacks



Carmacks Yukon (Jan-Feb 2006)

- Cold monitoring month with ext. temperature down to -40C and rarely above 0C.
- Bldg envelopes were subjected to large daily average indoor temperature swings between max 37C and min 7C. Bldg envelopes act as condensing plates.
- Peaks 3 min. indoor temperature: as low as 10C and as high as 37C
- Heating system was typically central wood stove and no heat distribution system. House with oil furnace and forced air experienced more stable RH and T indoors.
- Bathroom and kitchen experienced an extra moisture load of 6 to 18 g_w/kg_{da} relative to outdoors
- Moisture troubles may have a link with absence of occupancy during the day. No one at home during the day means the house temperature drops down considerably (no manual feeding of the stove) and exterior wall surfaces are allowed to cold down.
- Solutions used included to wash wall surfaces regularly, put plastic on window glazing, change drywall for wood panelling.

Input for Experimental Studies

Scenarios	Indoor Conditions Outdoor Conditions	Comments
Constant RH and T		Max. monthly average measured indoors
Ramping RH levels, constant T		3 Levels: low, average, high e.g. 30%, 50%, 70%
Constant combined with short-lived peaks		Max. monthly average and extreme 20 minutes peaks (e.g. 90% RH)
Dynamic offset of moisture over outdoor absolute moisture level		Additional 1-3 grams water/kg of dry air into indoor air over outdoor level