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Building Energy Codes

The 2006 IECC—Will it Change Your Life for the Better?

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Building Energy Codes Program

U.S. Department of Energy

Summary

- The 2006 IECC is much simpler and easier to understand, comply with, and enforce
- But its many differences with respect to the 2003 IECC may lead to some confusion



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PART 1

How the 2006 IECC Makes Life Easier

(a brief review)

Making life easier

- Homogeneity across building types
- Homogeneity across construction types
- Homogeneity across building designs
- Homogeneity within jurisdictions
- Simplicity and memorizability

Making life easier—homogeneity across building types

- Single family and multifamily buildings use exactly the same requirements

Making life easier—homogeneity across construction types

- New construction and addition/remodel use the same requirements

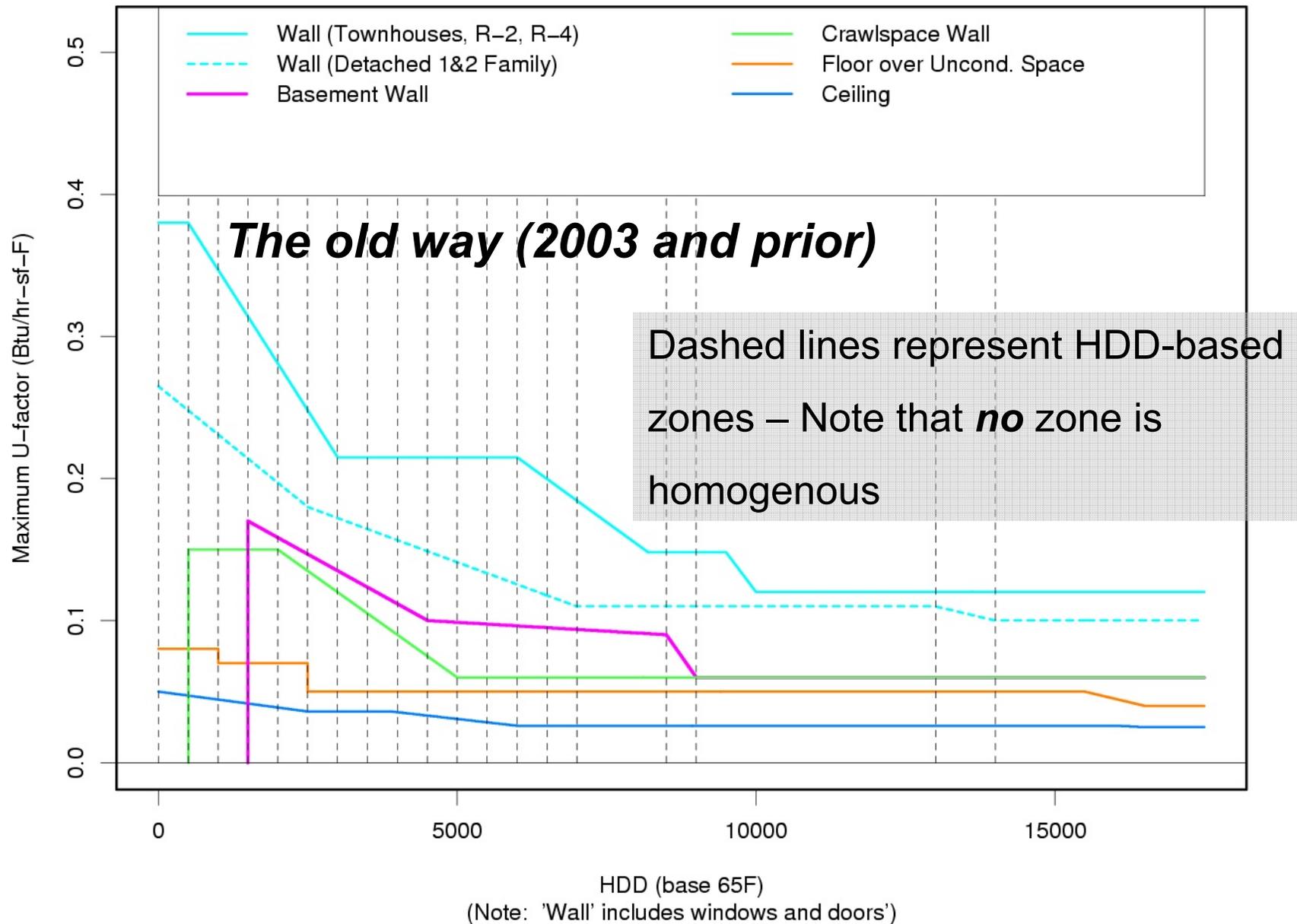
Making life easier—homogeneity across building designs

- All sizes, shapes, and glazing areas use the same requirements
 - No dependency on window-wall ratio
 - No dependency on window-floor ratio
 - (Exception: performance path)
- Enforcement easier
 - Plan review frequently unnecessary
 - Inspections require no measurements
- Fewer irrational behaviors
 - Large buildings no longer comply with less insulation
 - High ceilings (10-ft walls) no longer comply with less insulation
 - Starter homes (small window areas) and apartments no longer have unreasonably inefficient envelopes

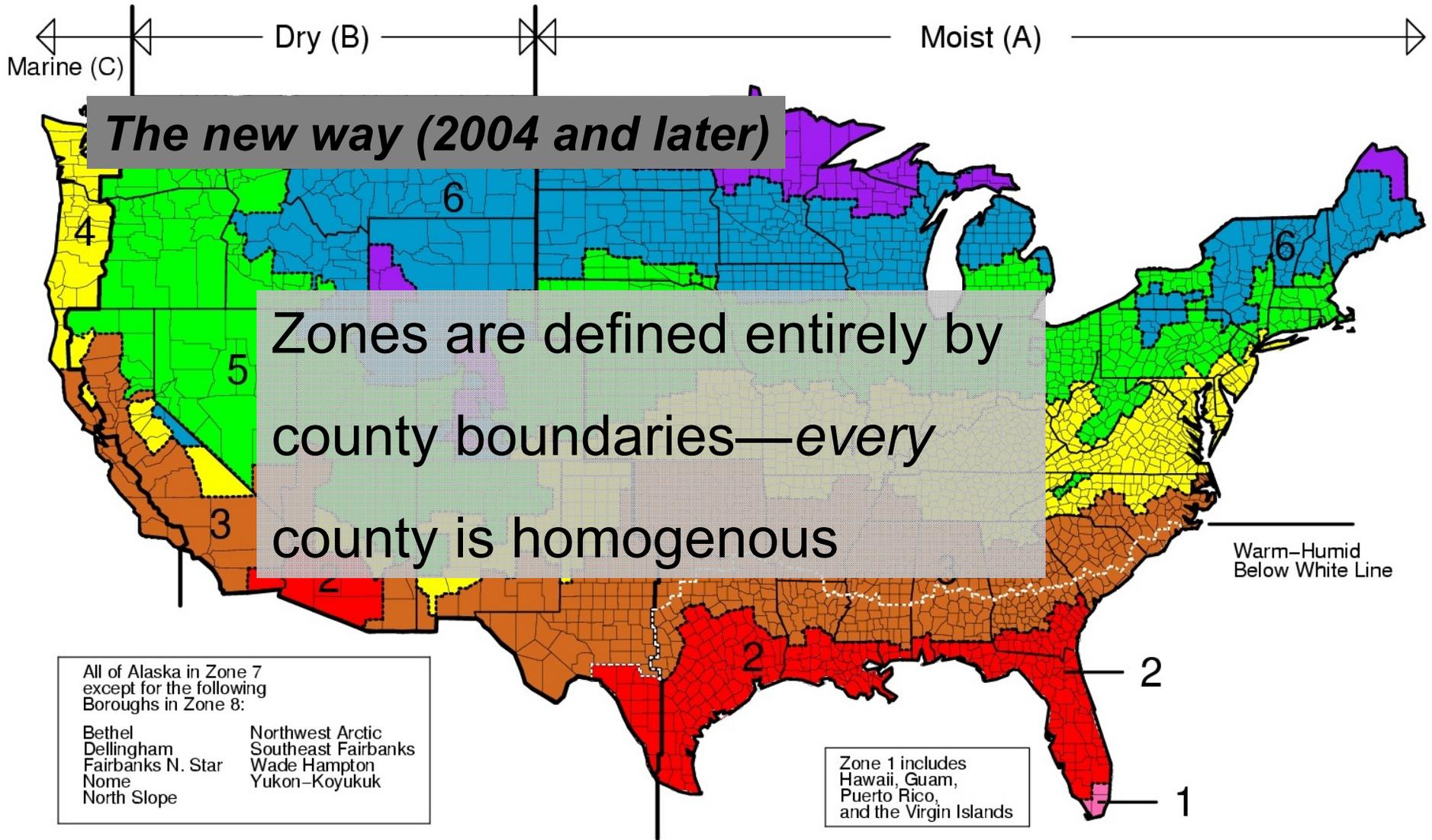
Making life easier—homogeneity within jurisdictions

- Requirements never vary within county boundaries

Making life easier—homogeneity within jurisdictions



Making life easier—homogeneity within jurisdictions



Making life easier—homogeneity within jurisdictions

**Table 402.1.1
Insulation and Fenestration Requirements by Component**

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40	30	13	5	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5	13	30	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

Making life easier—simplicity and memorizability

- Primary requirements expressed as R-values, not U-factors
 - Rules of thumb are meaningful and easy to remember
 - Last-minute construction changes don't torpedo those rules of thumb
 - REScheck can always be made to hit exactly “0% better” 😊
- Performance path greatly improved



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PART 2

Threats to the Easy Life

or

What questions or problems might you
or your users encounter when you adopt
the 2006 IECC?

Threats to the easy life--overview

- Compliance paths
- Hard limits
- IECC/IRC differences
- Climate zones
- Opaque doors
- Duct insulation
- U-factors
- Below-grade walls
- Heated slabs
- Prescriptive exemptions/allowances
- Certificate
- Mass walls
- Performance path

Mark your code books!

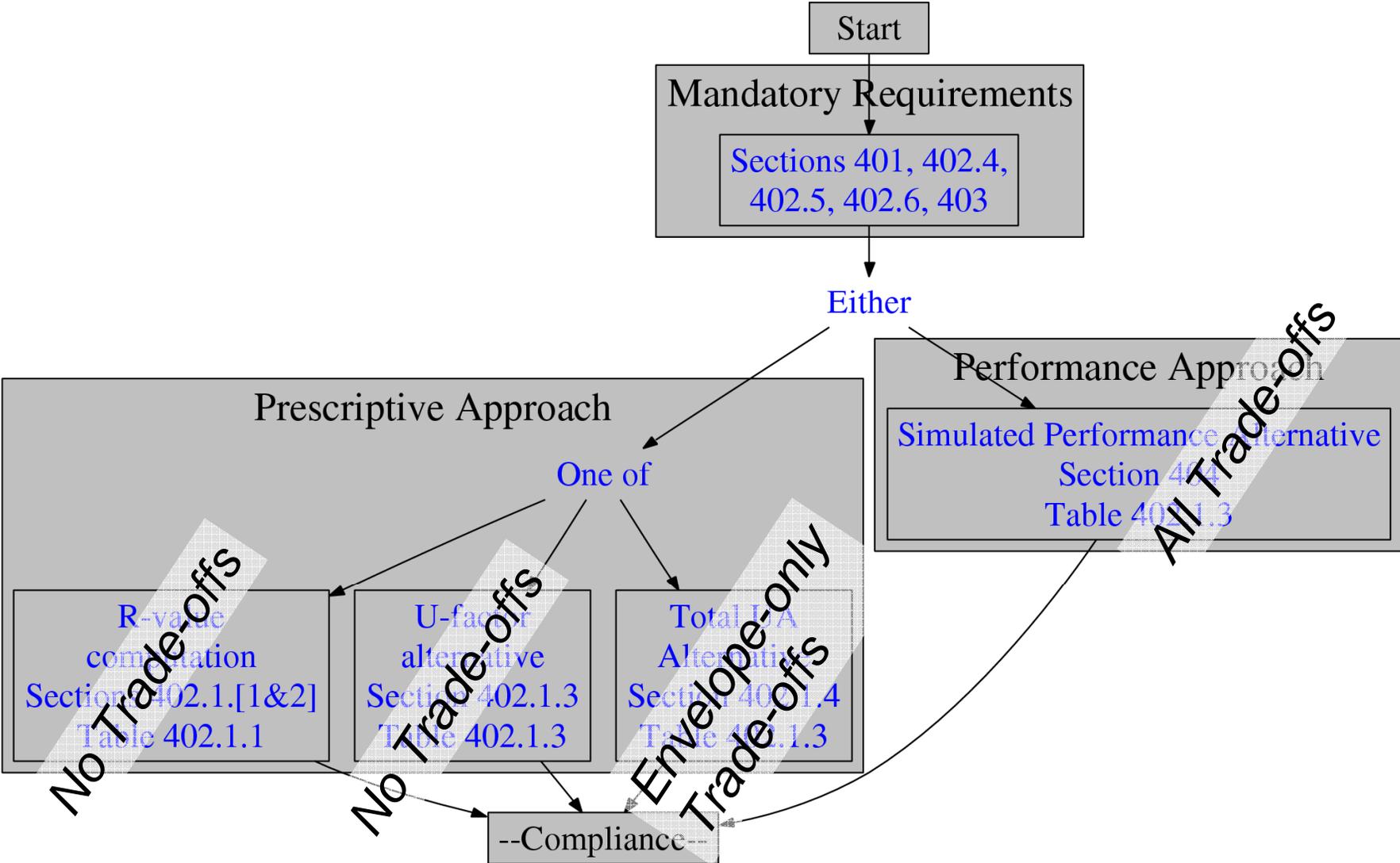
Potential issue—compliance paths

- How many are there?
 - Two
 - Prescriptive
 - Performance
 - Three
 - Prescriptive
 - UA
 - Performance
 - Four
 - Prescriptive R-value
 - Prescriptive U-factor
 - UA
 - Performance

Potential issue—compliance paths

- How many are there?
- Two
 1. Prescriptive
 - a) R-value
 - b) U-factor
 - c) UA
 2. Performance

Potential issue—compliance paths



Potential issue—hard limits

- Formally, these are “mandatory” minimums (or maximums)
- AKA, “trade-off limits”
- Section 402.6
 - Fenestration U-factor ≤ 0.48 (zones 4-5)
 - Fenestration U-factor ≤ 0.40 (zones 6-8)
 - Skylight U-factor ≤ 0.75 (zones 4-8)
 - Fenestration SHGC ≤ 0.5 (zones 1-3)

NOTE: These are all area-weighted averages

Potential issue—hard limits

Zone	Prescriptive	Mandatory (hard limits)
1	$SHGC \leq 0.4$	$SHGC \leq 0.5$
2	$SHGC \leq 0.4$	$SHGC \leq 0.5$
3 (except Marine)	$SHGC \leq 0.4$	$SHGC \leq 0.5$
4 except Marine	$U_{\text{vert}} \leq 0.40$ $U_{\text{skylight}} \leq 0.60$	$U_{\text{vert}} \leq 0.48$ $U_{\text{skylight}} \leq 0.75$
5 and Marine 4	$U_{\text{vert}} \leq 0.35$ $U_{\text{skylight}} \leq 0.60$	$U_{\text{vert}} \leq 0.48$ $U_{\text{skylight}} \leq 0.75$
6	$U_{\text{vert}} \leq 0.35$ $U_{\text{skylight}} \leq 0.60$	$U_{\text{vert}} \leq 0.40$ $U_{\text{skylight}} \leq 0.75$
7 & 8	$U_{\text{vert}} \leq 0.35$ $U_{\text{skylight}} \leq 0.60$	$U_{\text{vert}} \leq 0.40$ $U_{\text{skylight}} \leq 0.75$

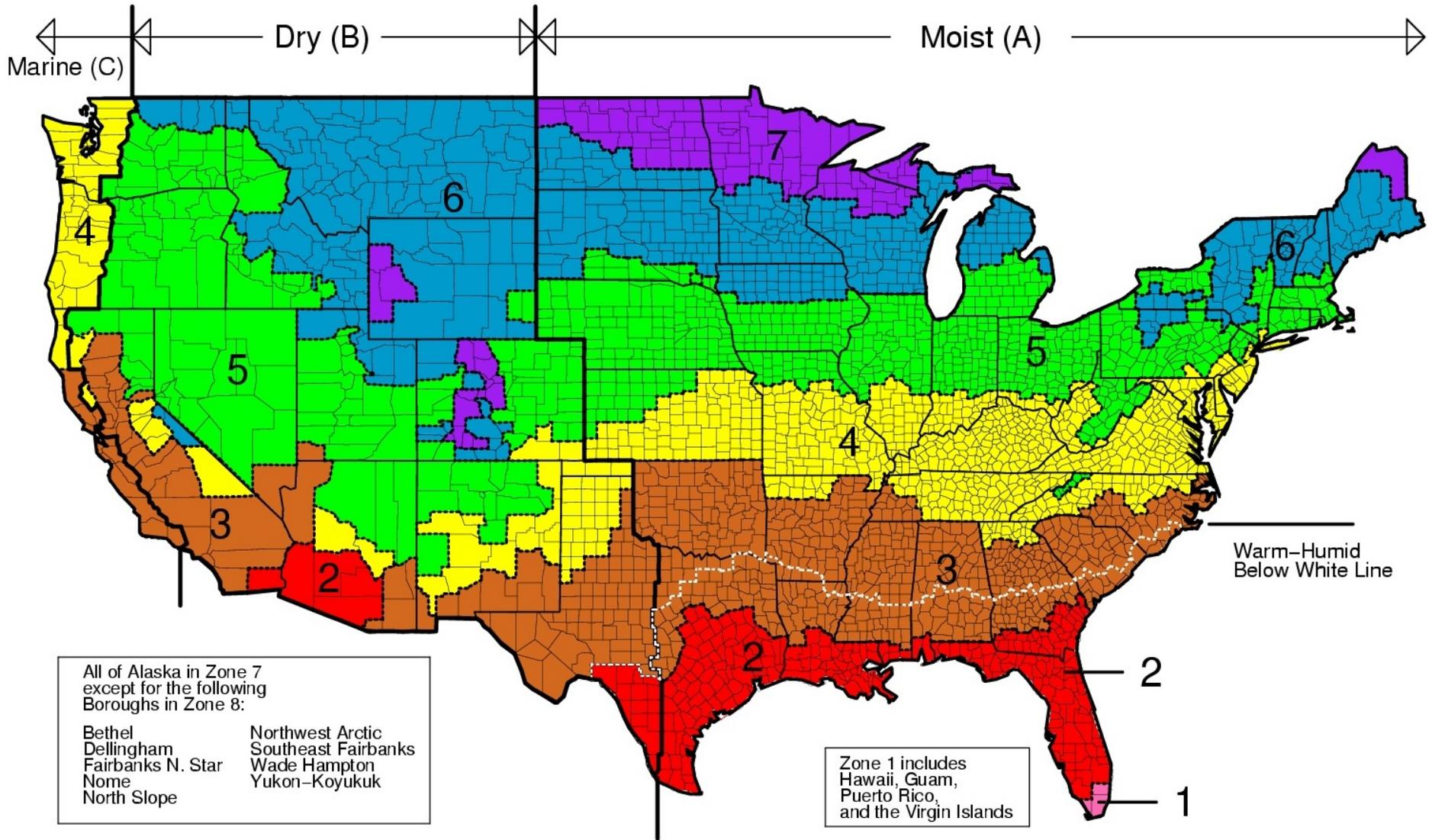
Potential issue—IRC differences

- Hard limits are different for U-factors, nonexistent for SHGC
- Minor mass wall differences
- Covers residential only, excludes most apartments
- Has no performance path
- (References IECC)

Potential issue—climate zones

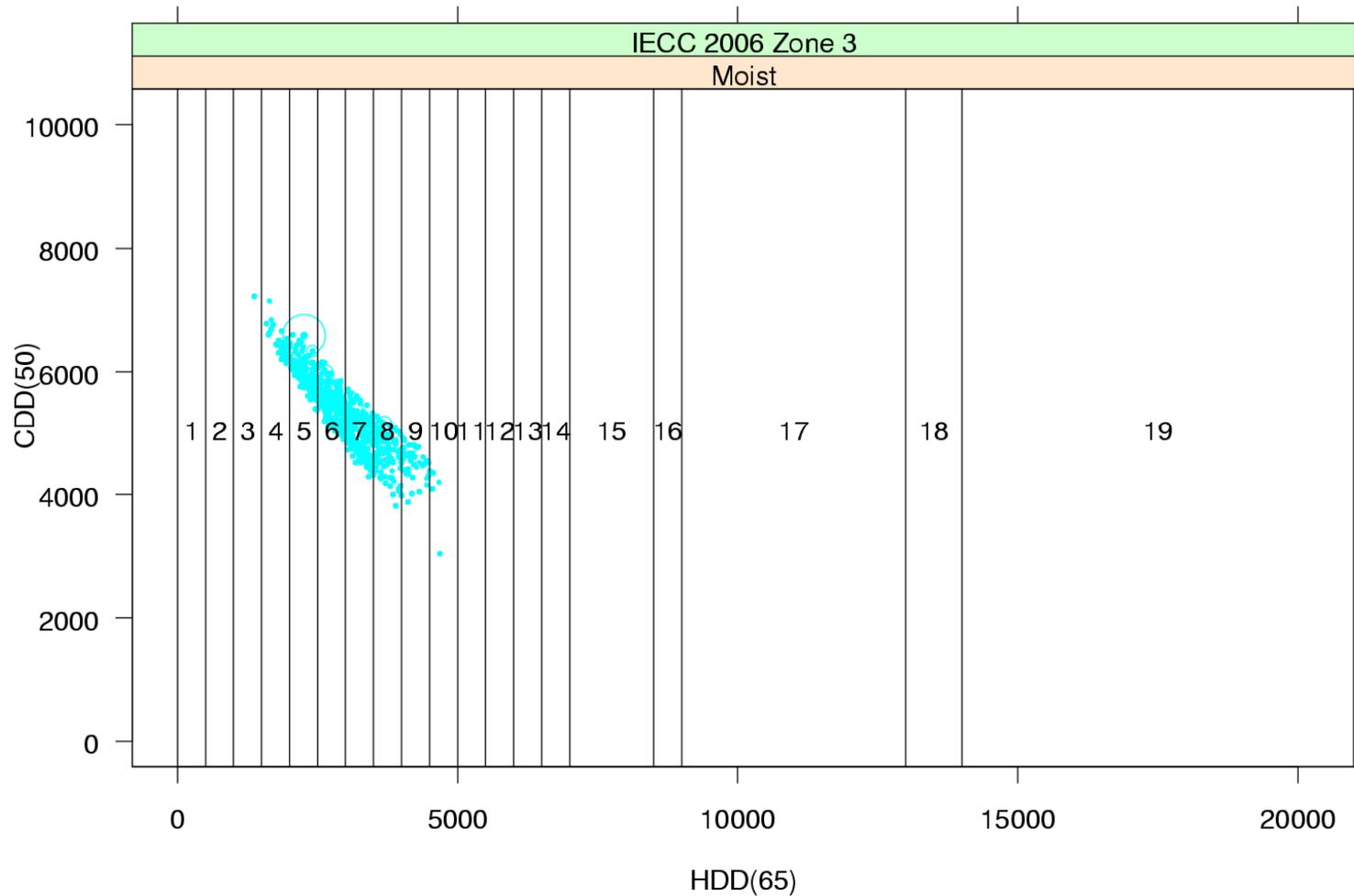
- New zones are better at capturing cooling drivers
- But...

Climate zones



Climate zones represent multiple climate drivers

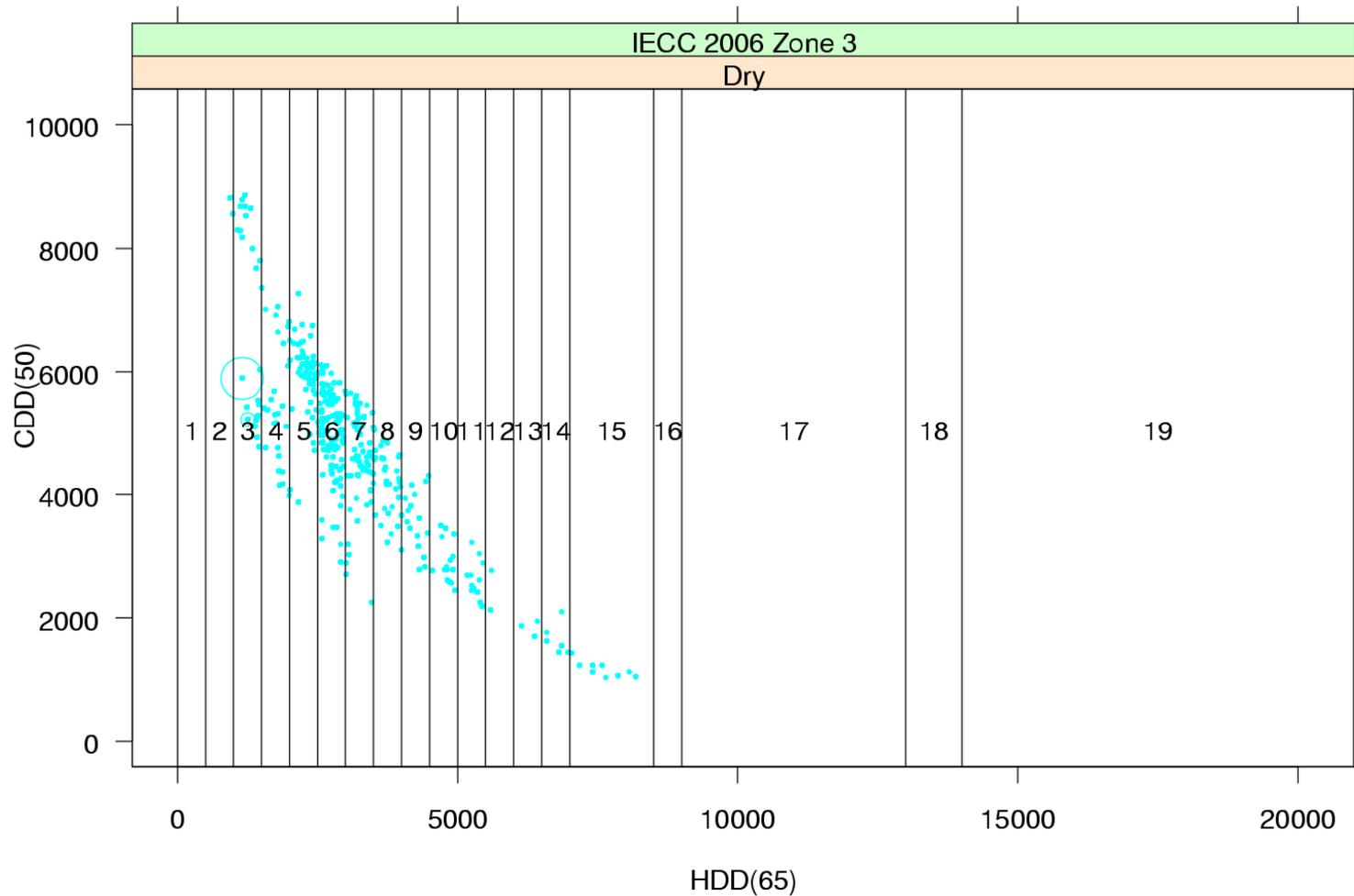
IECC 2006 Zones Mapped Onto EC30's Zone Definitions



Each point is one U.S. city; circle radii are proportional to population

Climate zones represent multiple climate drivers

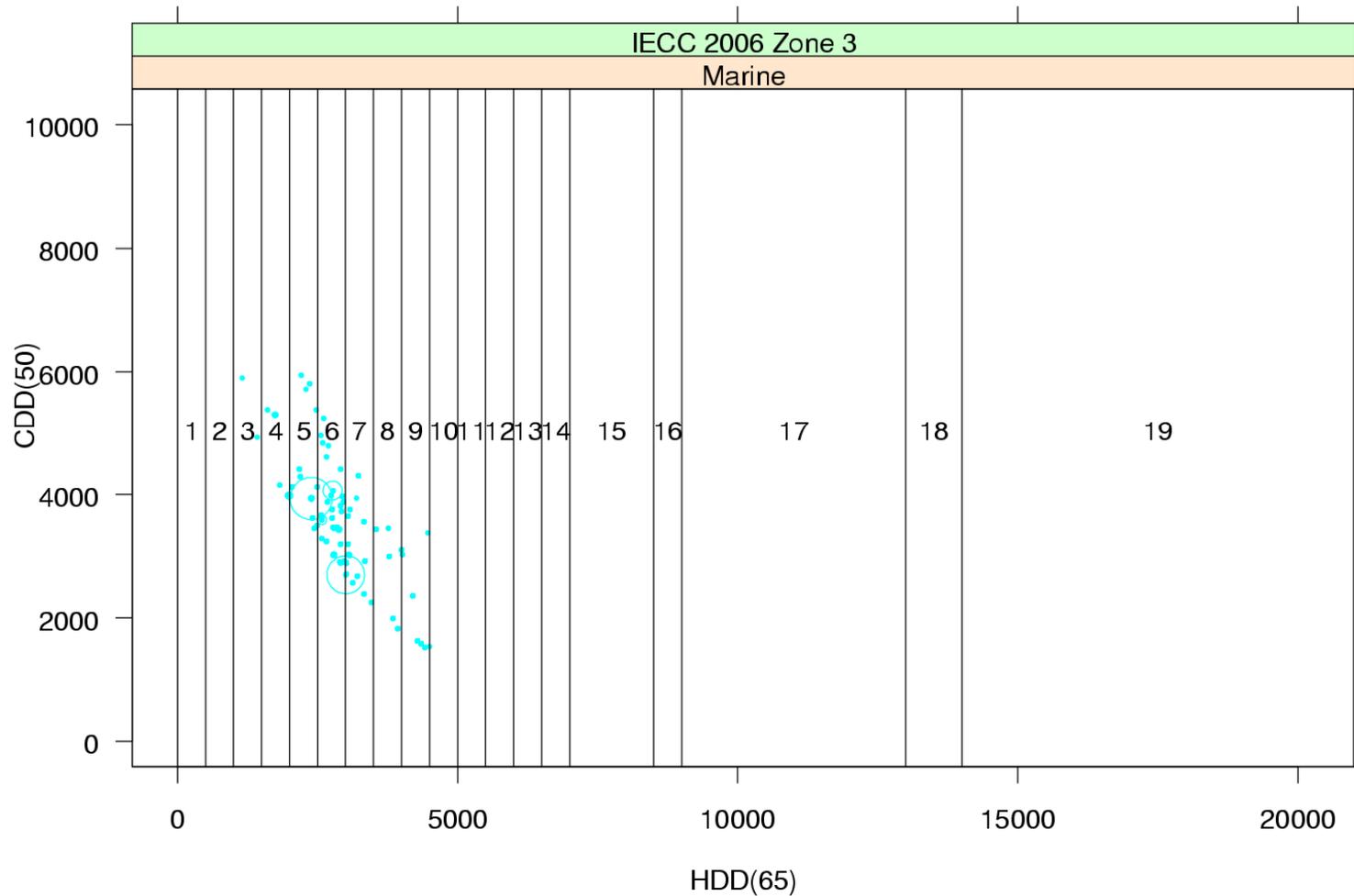
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Climate zones represent multiple climate drivers

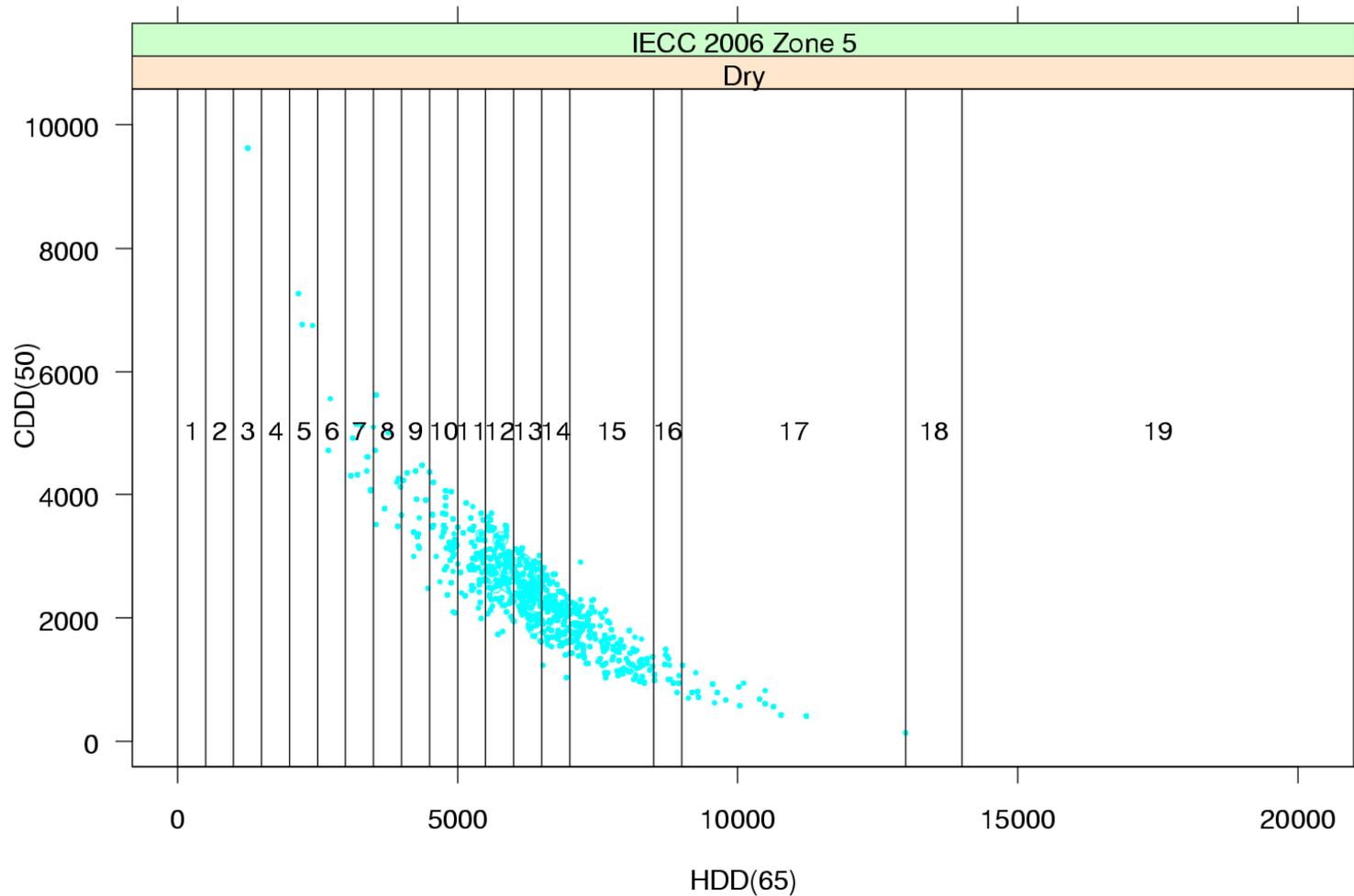
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Climate zones represent multiple climate drivers

IECC 2006 Zones Mapped Onto EC30's Zone Definitions



Each point is one U.S. city; circle radii are proportional to population

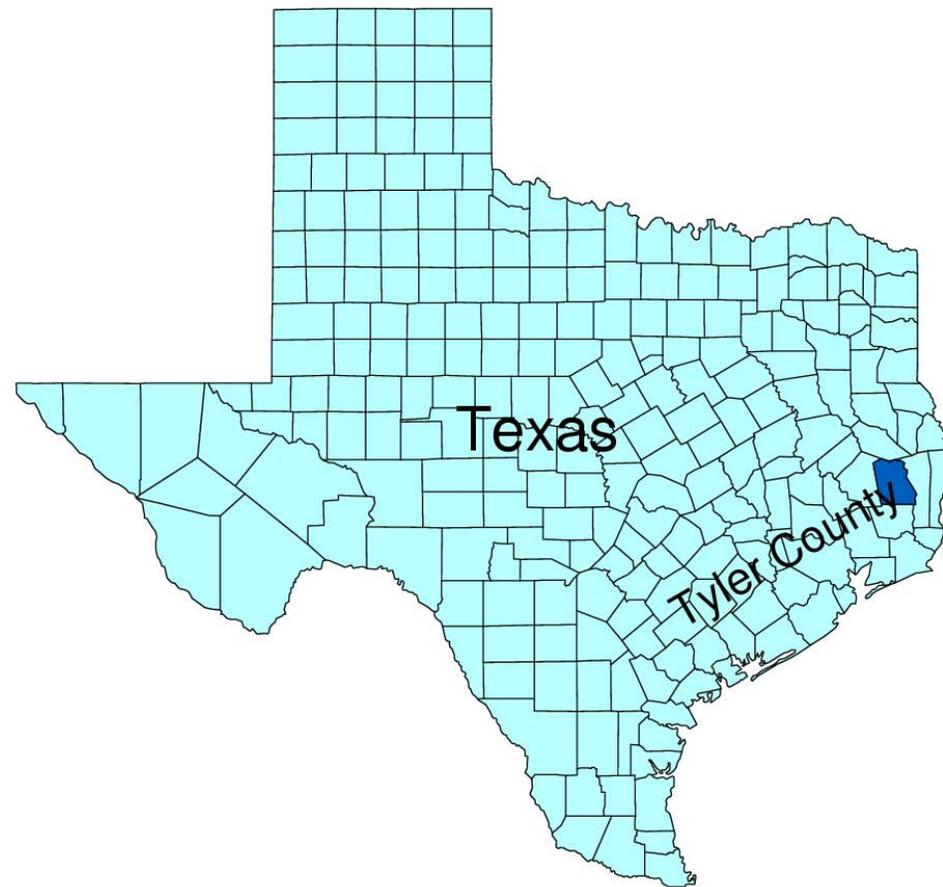
Potential issue—climate zones

- New zones are better at capturing climate drivers
- But...
 - Cities and towns have new zones

Potential issue—climate zones

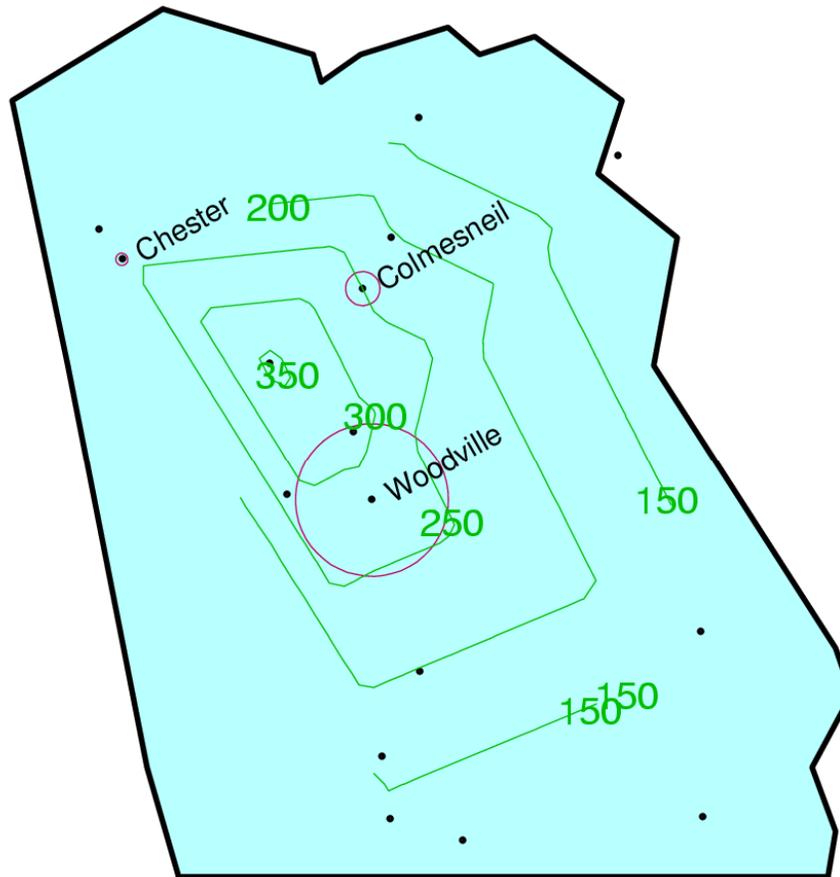
- New zones are better at capturing climate drivers
- But...
 - Cities and towns have new zones
 - Within-county homogeneity can misrepresent extreme microclimates

Potential issue—within-county homogeneity and elevation



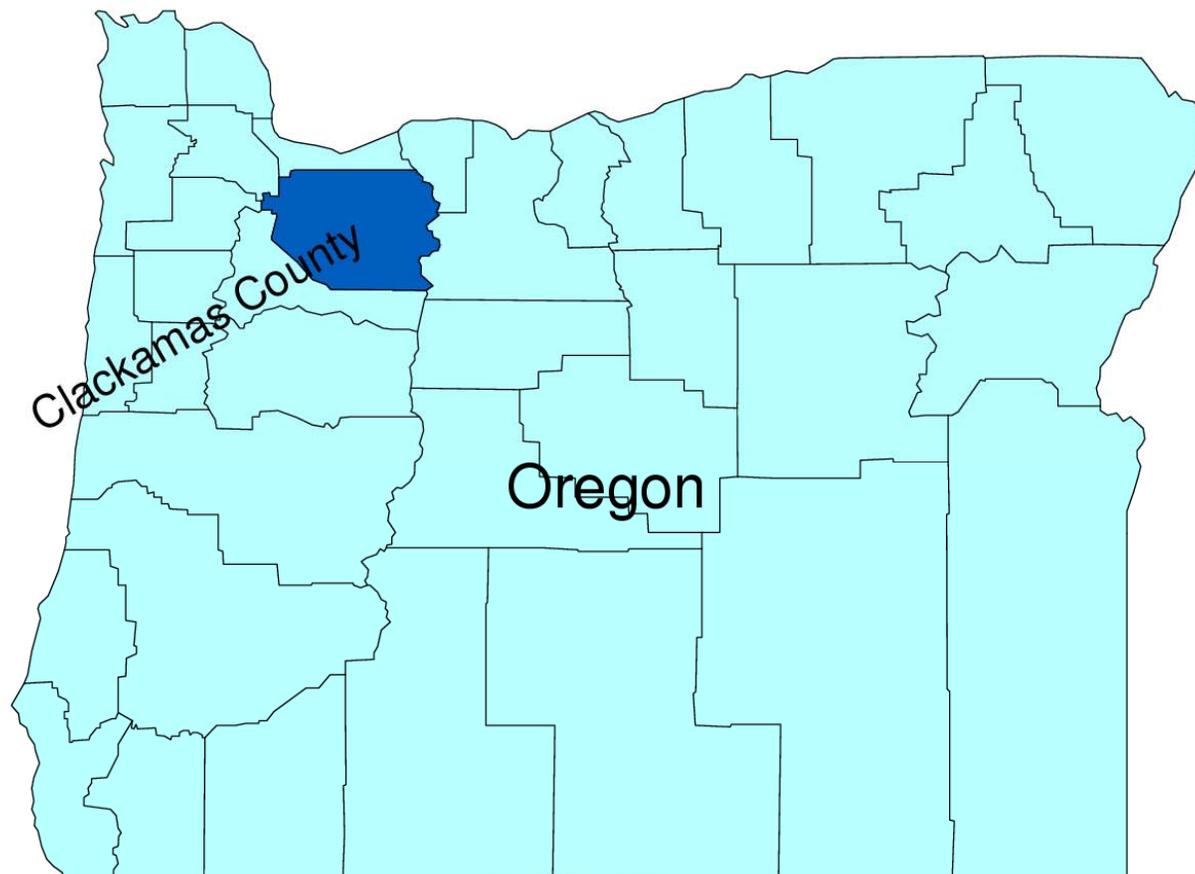
Potential issue—within-county homogeneity and elevation

Tyler County, TX



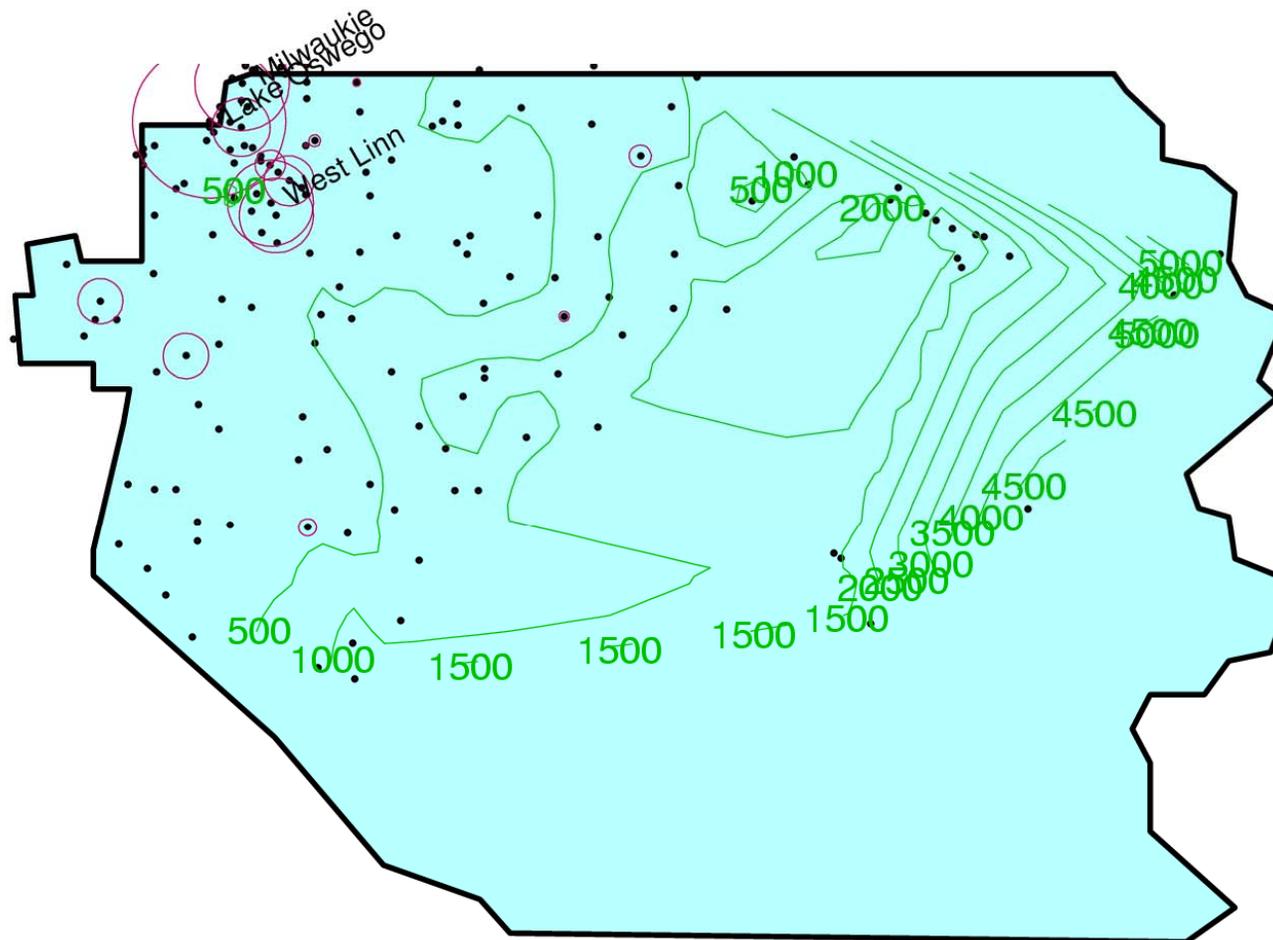
Points are cities; Circles are proportional to population; Contours are elevation

Potential issue—within-county homogeneity and elevation



Potential issue—within-county homogeneity and elevation

Clackamas County, OR



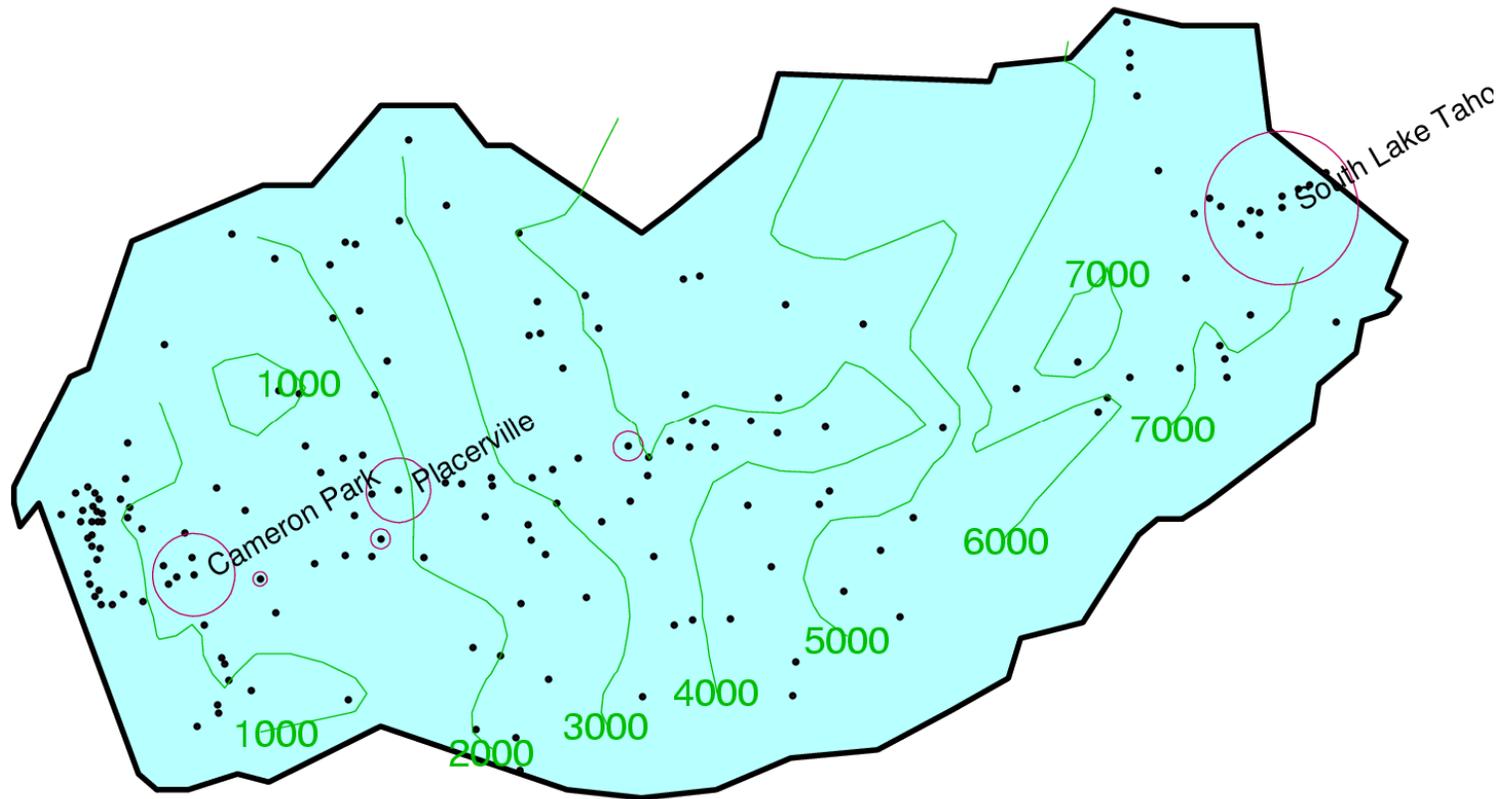
Points are cities; Circles are proportional to population; Contours are elevation

Potential issue—within-county homogeneity and elevation



Potential issue—within-county homogeneity and elevation

El Dorado County, CA



Points are cities; Circles are proportional to population; Contours are elevation

Potential issue—opaque doors

- Are opaque doors regulated?
- Where are the requirements?

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Insulation and Fenestration Requirements by Component**

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
1	1.20	0.75	0.40	30	13	3	13	0	0	0
2	0.75	0.75	0.40	30	13	4	13	0	0	0
3	0.65	0.65	0.40	30	13	5	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5	13	30	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

Potential issue—opaque doors

- Are opaque doors regulated?
- Where are the requirements?

“Fenestration” includes all doors, whether glazed, opaque, or combination

Potential issue—duct insulation

- How can the R-8 duct insulation requirement be traded off?

It can't.

(Duct insulation is a *mandatory* requirement.)

Potential issue—U-factors

Overheard: “The U-factors in Table 402.1.3 don’t match the R-values in Table 402.1.1”

Potential issue—U-factors

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	GLAZED FENESTRATION SHGC	CEILING R-VALUE	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
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3	0.65	0.65	0.40	30	13	5	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5	19	10 / 13	10, 2ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	19 or 13+5	13	30	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

CLIMATE ZONE	FENESTRATION U-FACTOR	SKYLIGHT U-FACTOR	CEILING U-FACTOR	FRAME WALL U-FACTOR	MASS WALL U-FACTOR	FLOOR U-FACTOR	BASEMENT WALL U-FACTOR	CRAWL SPACE WALL U-FACTOR
1	1.20	0.75	0.035	0.082	0.197	0.064	0.360	0.477
2	0.75	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.65	0.65	0.035	0.082	0.141	0.047	0.360	0.136
4 except Marine	0.40	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.060	0.082	0.033	0.059	0.065
6	0.35	0.60	0.026	0.060	0.06	0.033	0.059	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.033	0.059	0.065

Potential issue—U-factors

Overheard: “The U-factors in Table 402.1.3 don’t match the R-values in Table 402.1.1”

Response:

1. Oh, yes they do!
 2. That’s not surprising and it doesn’t matter
- The U-factor table uses conservative assumptions (e.g., eave compression)
 - Your building probably really is different from the code’s assumptions

Potential issue—below-grade walls

- The Zone-3 loophole:
 - A floor over an *unheated* basement requires R-19
 - Walls of a *heated* basement require R-0

So...

- Declare the basement heated (or really heat it)
- And you can eliminate the insulation!

U-FLOOR	WOOD FRAME WALL R-VALUE	MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH
0	13	3	13	0	0
0	13	4	13	0	0
0	13	5	19	0	0
3	13	5	19	10 / 13	10, 2ft
3	19 or 13+5	13	30	10 / 13	10, 2 ft
0	19 or 13+5	15	30	10 / 13	10, 4 ft
0	21	19	30	10 / 13	10, 4 ft

Potential issue—heated slabs

- The R-0 conundrum in Zones 1-3:
 - Unheated slabs require 0 feet of R-0 insulation
 - Heated slabs require that R-5 be added to the unheated requirement

So...

- The requirement is 0 feet of R-5 insulation?

MASS WALL R-VALUE	FLOOR R-VALUE	BASEMENT WALL R-VALUE	SLAB R-VALUE & DEPTH	CRAWL SPACE WALL R-VALUE
3	13	0	0	0
4	13	0	0	0
5	19	0	0	5 / 13
5	19	10 / 13	10, 2ft	10 / 13
13	30	10 / 13	10, 2 ft	10 / 13
15	30	10 / 13	10, 4 ft	10 / 13
19	30	10 / 13	10, 4 ft	10 / 13

Potential issue—prescriptive exemptions and special allowances

- Exemptions & allowances:
 - Where R-38 ceilings required, R-30 with raised trusses will suffice (ditto for R-49/38)
 - Where $>R-30$ ceilings required, R-30 will suffice if the higher value would require larger structural members (500-ft² limit)
 - Up to 15 ft² of glazing may be exempted from U-factor and SHGC requirements
 - One opaque door is exempted from the U-factor requirement

Potential issue—prescriptive exemptions and allowances

- Intent of R-value allowances was to give a little flexibility to the otherwise static R-value table (402.1.1)
- Not needed when using the U-factor table
- However...
 - ICC has interpreted these to apply to the U-factor table as well
 - Which leads to logic issues and lesser efficiency
- Opaque door language (“is exempted” rather than “shall be permitted to be exempted”)—one could infer that taking the exemption is mandatory

Potential issue—certificate

- Code says put certificate “on or in the electrical distribution panel”
- Some worry about violating electrical codes (Section 408.4 of the 2002 NEC)
- Code-change proposals in the works:
 - EC32 clarifies that the certificate should not cover or obstruct other required labels or signs
 - EC33 eliminates the certificate altogether

Potential issue—mass walls

ISSUE:

- Mass wall R-value can be lower than frame wall R-value *if $\geq 50\%$ of the “required R-value is on the exterior of, or integral to, the wall”*
- Exceptions in zones 1-3 provide a mid-way “**added R-value**” for walls that don’t meet the mass placement requirement

QUESTIONS:

- What “required R-value”? (Should read “proposed R-value”?)
- What does “added” mean?

Potential issue—mass walls

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6	0.35	0.60	NR	49	19 or 13+5	15	30	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19	30	10 / 13	10, 4 ft	10 / 13

Section 402.2.3 adds:

Can't use mass-wall R-value unless the mass is inside (or integral with) the insulation.

Except that, for zones 1-3:

If mass is outside, may use R4, R6, and R8 instead of R13. ⁴⁸

Potential issue—mass walls

What it really means:

Zone	Frame wall R-value	Mass wall R-value (mass <u>inside/outside</u> insulation)
1	13	3 / 4
2	13	4 / 6
3	13	5 / 8
4	13	5 / Frame-R
5	19 or 13+5	13 / Frame-R
...

Potential issue—performance path

- The only way to do HVAC trade-offs (so it's likely to get used more often)
- Baseline is U-factor (Table 402.1.3), not R-value (Table 402.1.1)
- Mandatory requirements still apply
 - Duct insulation R-value ≥ 8
 - Hard limits on glazing U/SHGC
 - Taping/caulking for air tightness
- Metric of comparison is **energy cost** (unless local jurisdiction requires **site energy**)

Potential issue—performance path

- Calculation procedure must be software
 - Comparing each “proposed design” against a “standard reference design”
 - Conforming to the code’s specific rules for comparing the two designs
 - Documented as to its accuracy and correctness
 - Having at least a specified minimum set of capabilities
 - Producing a specified suite of output reports
 - Other tools permitted if approved by official (e.g., limited scope or locally-relevant application)

Potential issue—performance path

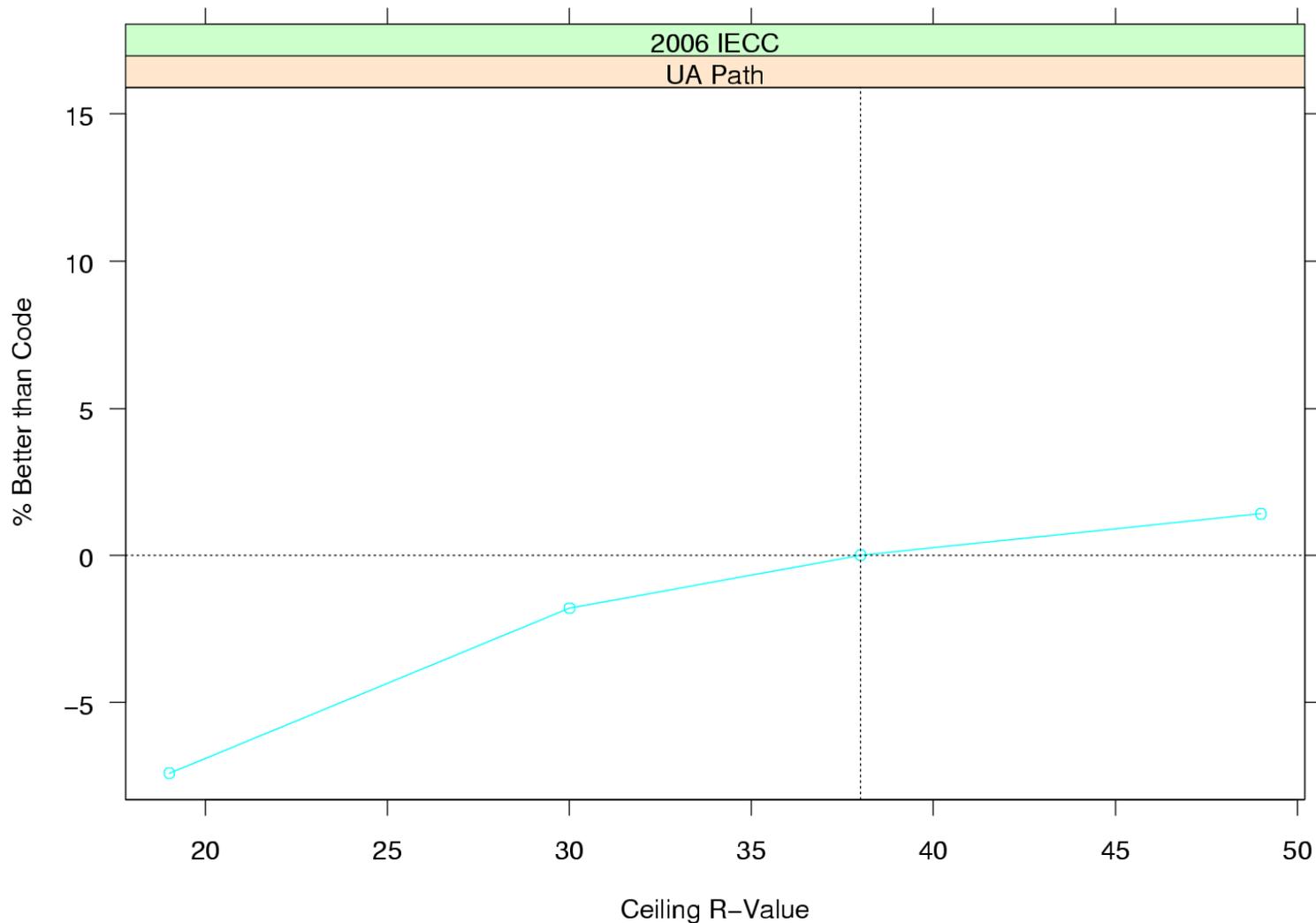
- Differences w.r.t. prescriptive path
 - Outside scope of prescriptive path
 - Glazing area (above 18% CFA)
 - Glazing orientation
 - Credit/penalty for tested air-tightness
 - Mechanical ventilation

Might appear to be built-in free-riders for some homes
 - Features never in standard reference design
 - Skylights
 - Electric Furnace
 - Sunrooms

Might appear to be built-in penalties for some homes
- The “value” of an envelope change is different (usually less)

Things that might confuse—performance path vs UA path

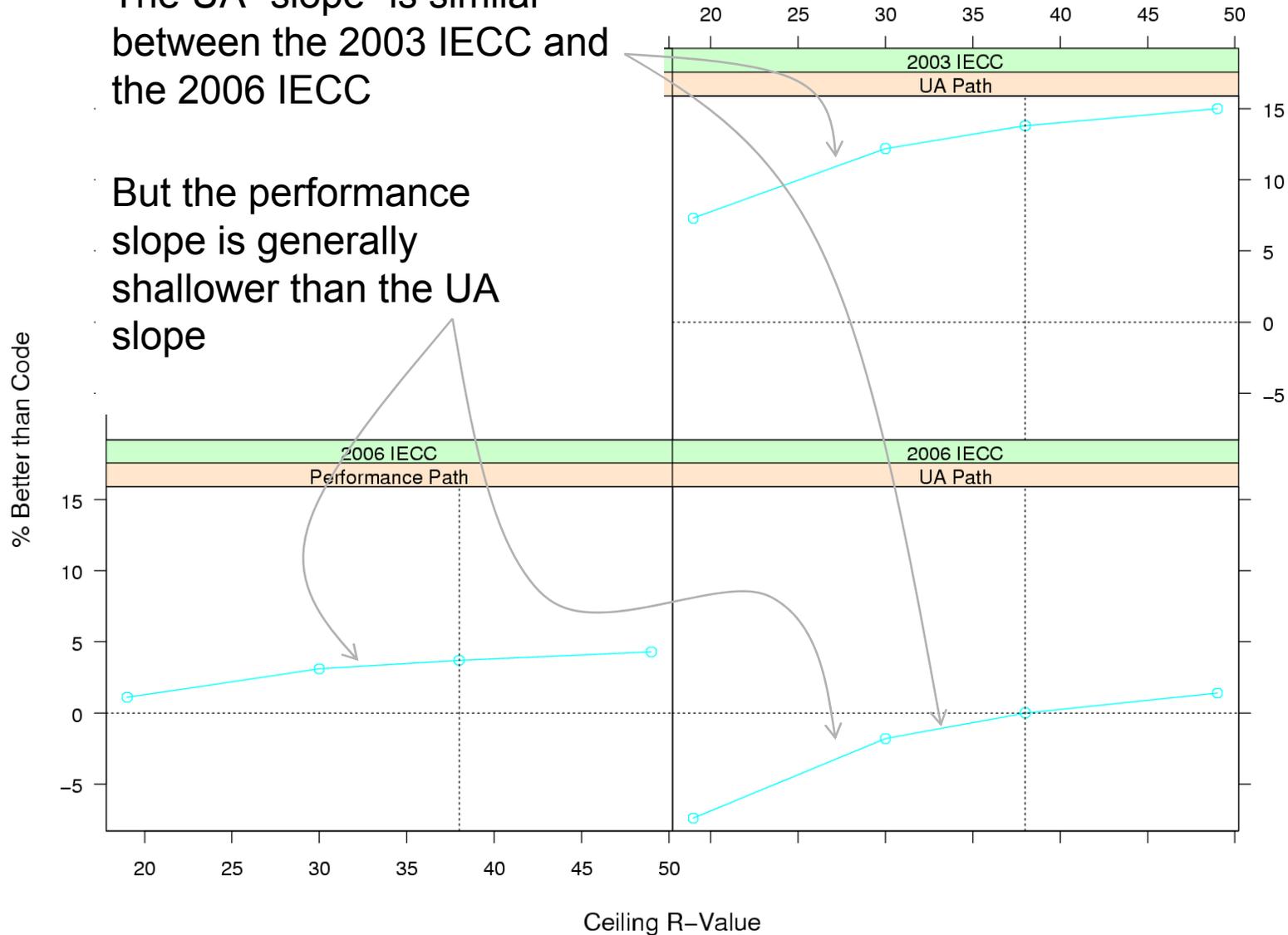
Compliance in Denver (Zone 5)



Potential issue—performance path vs UA path

The UA “slope” is similar between the 2003 IECC and the 2006 IECC

But the performance slope is generally shallower than the UA slope





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PART 3

What About Energy Efficiency?

What about energy efficiency?

- 2006 IECC efficiency increases
 - Multifamily homes
 - Homes with average to below-average glazing percentages
 - Duct insulation (always R8)
 - Air handler must be sealed
- 2006 IECC efficiency reductions
 - Homes with above-average glazing percentages
 - Homes in rural, high-elevation locations

Questions and Discussion
