

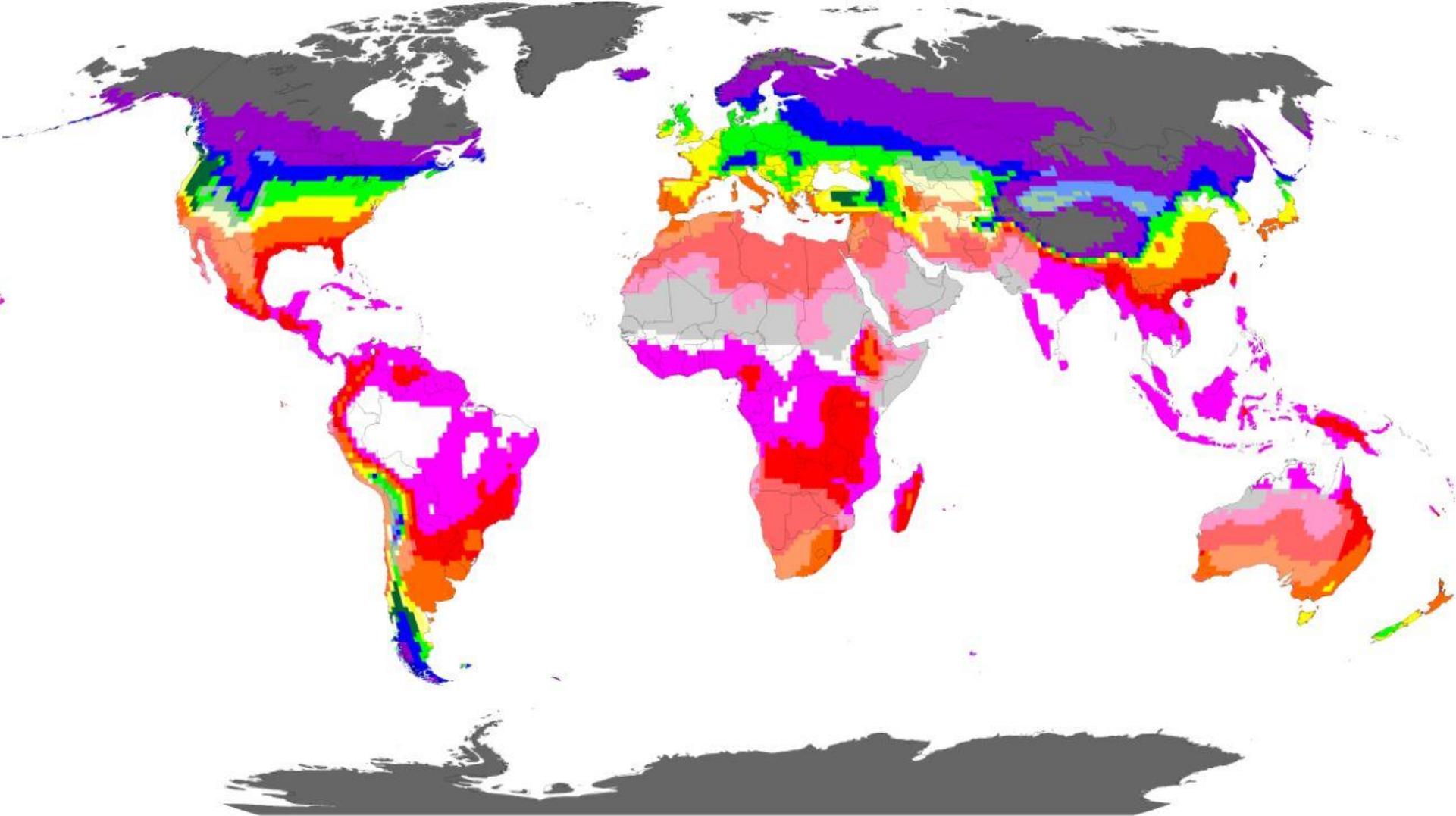
# VISUALIZING CLIMATES AND HUMIDIFICATION TO FIGHT PANDEMICS

RELATIVE HUMIDITY PROFILES FOR NOTABLE NORTHERN HEMISPHERE CITIES

1. CLIMATE ZONE MAP
2. VISUALIZING CLIMATE OVERVIEW
3. ZONE 3A – ROME, ITALY
4. ZONE 4A – MADRID, SPAIN
5. ZONE 4C – BARCELONA, SPAIN
6. ZONE 5A – BERLIN, GERMANY
7. ZONE 3A – WUHAN, CHINA
8. ZONE 4A – PARIS, FRANCE
9. ZONE 3B – TEHRAN, IRAN
10. ZONE 4C – LONDON, UNITED KINGDOM
11. ZONE 5A – GENEVA, SWITZERLAND
12. ZONE 1A – SINGAPORE

# ASHRAE CLIMATE ZONES AND ASHRAE STANDARD 169-2013

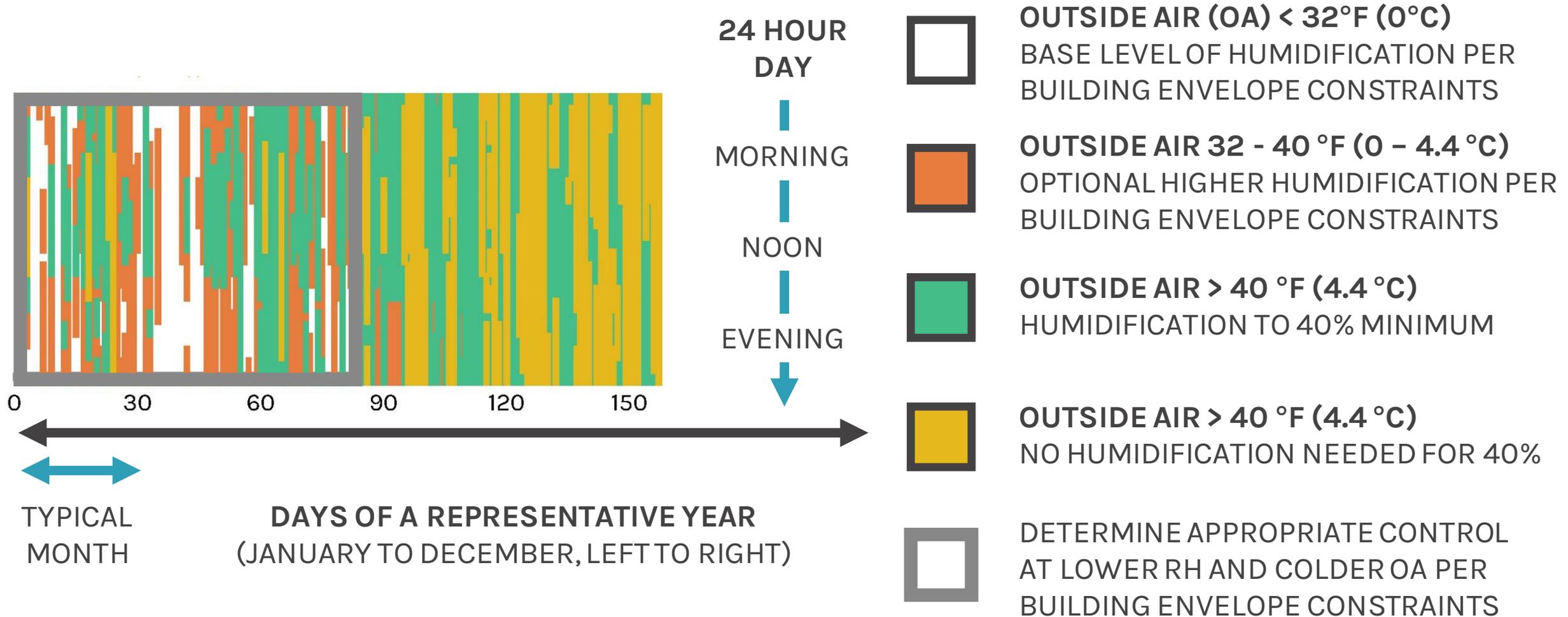
CLIMATE ZONE VARIATION BY LOCATION IN THE WORLD



- Zone 0A Extremely Hot Humid
- Zone 0B Extremely Hot Dry
- Zone 1A Very Hot Humid
- Zone 1B Very Hot Dry
- Zone 2A Hot Humid
- Zone 2B Hot Dry
- Zone 3A Warm Humid
- Zone 3B Warm Dry
- Zone 3C Warm Marine
- Zone 4A Mixed Humid
- Zone 4B Mixed Dry
- Zone 4C Mixed Marine
- Zone 5A Cool Humid
- Zone 5B Cool Dry
- Zone 5C Cool Marine
- Zone 6A Cold Humid
- Zone 6B Cold Dry
- Zone 7 Very Cold
- Zone 8 Subarctic/Arctic

# VISUALIZING RELATIVE HUMIDITY OPERATION BY LOCATION

RELATIVE HUMIDITY NEEDS VARY GREATLY BY LOCATION AND ELEVATION



# ASHRAE CLIMATE ZONE 3A

WARM - HUMID

## ROME, ITA

□ OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 1% OF DAYS PER YEAR

■ OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 5% OF DAYS PER YEAR

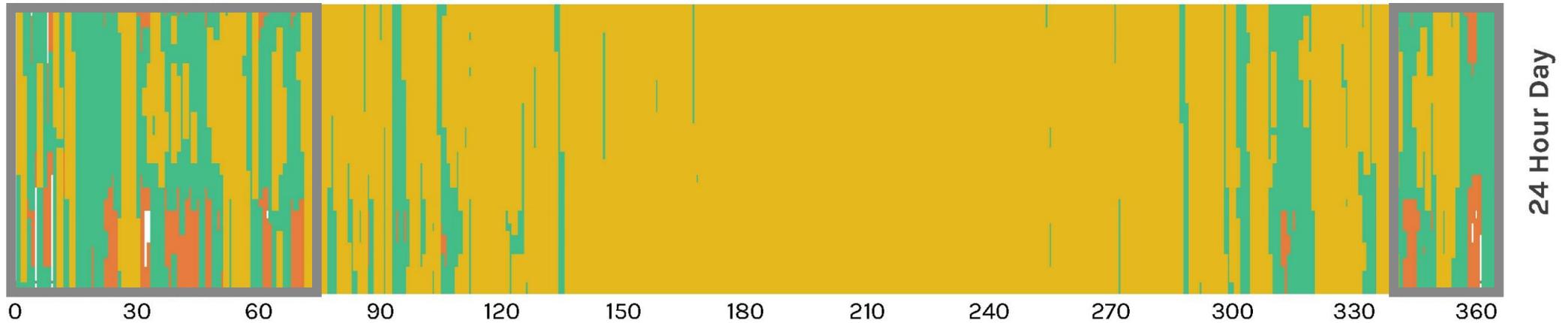
■ OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 25% OF DAYS PER YEAR

■ OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 69% OF DAYS PER YEAR

ROME, ITA

10 FEET ABOVE SEA LEVEL

LATITUDE: 41.8 / LONGITUDE: 12.23



DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

□ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY ELEVATED OUTDOOR HUMIDITY REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- LIMITED POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

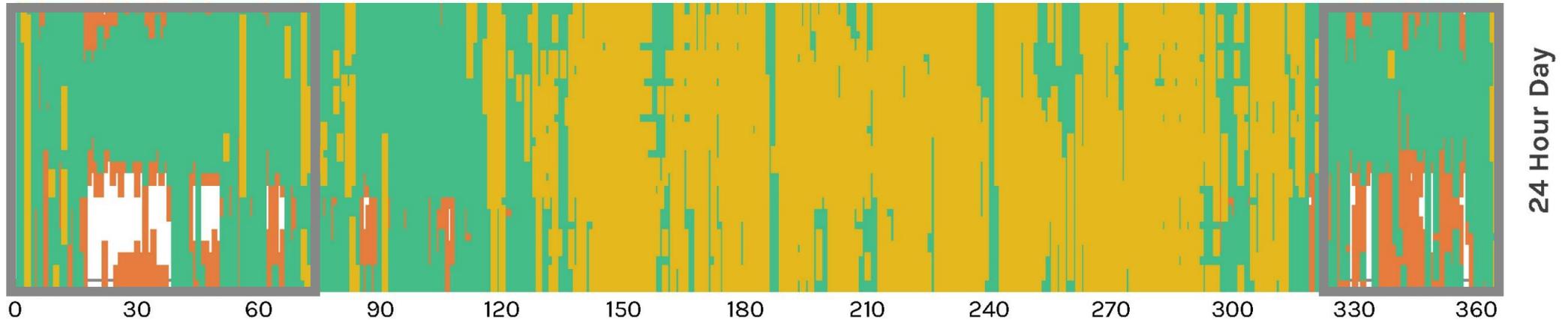
# ASHRAE CLIMATE ZONE 4A

MIXED - HUMID

## MADRID, ESP

- OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 3% OF DAYS PER YEAR
- OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 9% OF DAYS PER YEAR
- OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 48% OF DAYS PER YEAR
- OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 40% OF DAYS PER YEAR

MADRID, ESP  
1909 FEET ABOVE SEA LEVEL  
LATITUDE: 40.45 / LONGITUDE: -3.55



24 Hour Day

DETERMINE APPROPRIATE CONTROL AT LOWER RH\* **DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)**

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- ELEVATED OUTDOOR HUMIDITY IN SUMMER/FALL REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

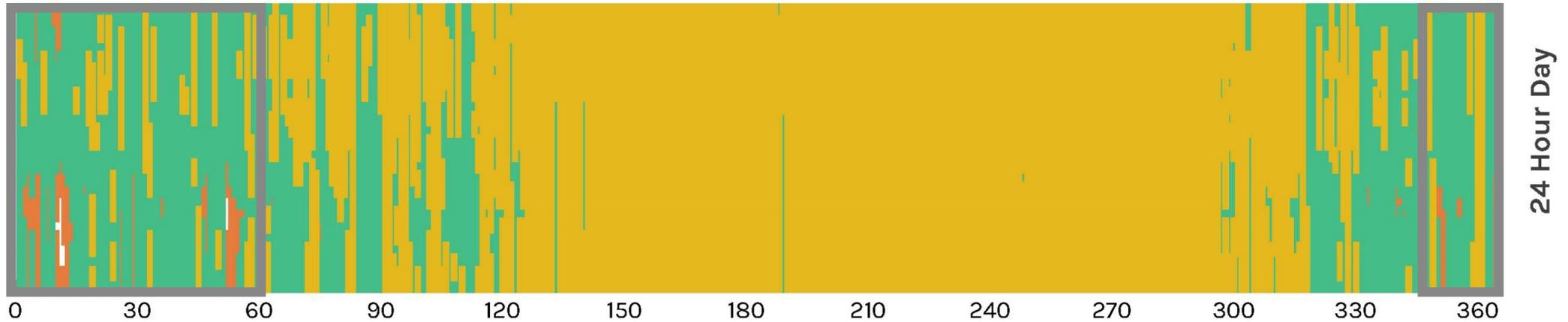
# ASHRAE CLIMATE ZONE 4C

MIXED - MARINE

## BARCELONA, ESP

- OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 0% OF DAYS PER YEAR
- OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 3% OF DAYS PER YEAR
- OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 34% OF DAYS PER YEAR
- OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 63% OF DAYS PER YEAR

BARCELONA, ESP  
20 FEET ABOVE SEA LEVEL  
LATITUDE: 41.28 / LONGITUDE: 2.07



DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY ELEVATED OUTDOOR HUMIDITY REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO LATE FALL THROUGH EARLY SPRING
- MINIMAL POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM FOR LATE FALL TO EARLY SPRING

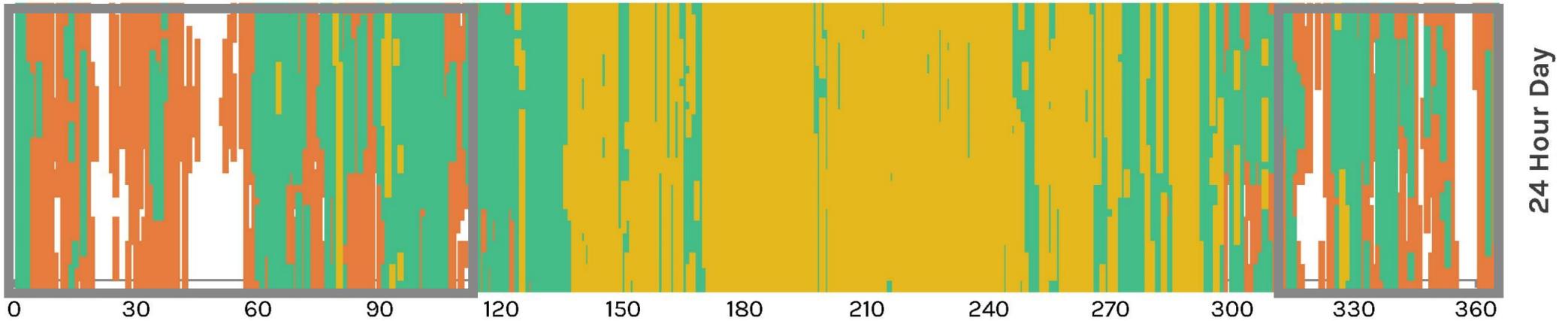
# ASHRAE CLIMATE ZONE 5A

COOL - HUMID

## BERLIN, DEU

- OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 10% OF DAYS PER YEAR
- | OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 21% OF DAYS PER YEAR
- | OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 34% OF DAYS PER YEAR
- | OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 35% OF DAYS PER YEAR

BERLIN, DEU  
161 FEET ABOVE SEA LEVEL  
LATITUDE: 52.47 / LONGITUDE: 13.4



DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

□ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- ELEVATED OUTDOOR HUMIDITY IN SUMMER REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

# ASHRAE CLIMATE ZONE 3A

WARM – HUMID

## WUHAN, CHN

□ OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 2% OF DAYS PER YEAR

I OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 10% OF DAYS PER YEAR

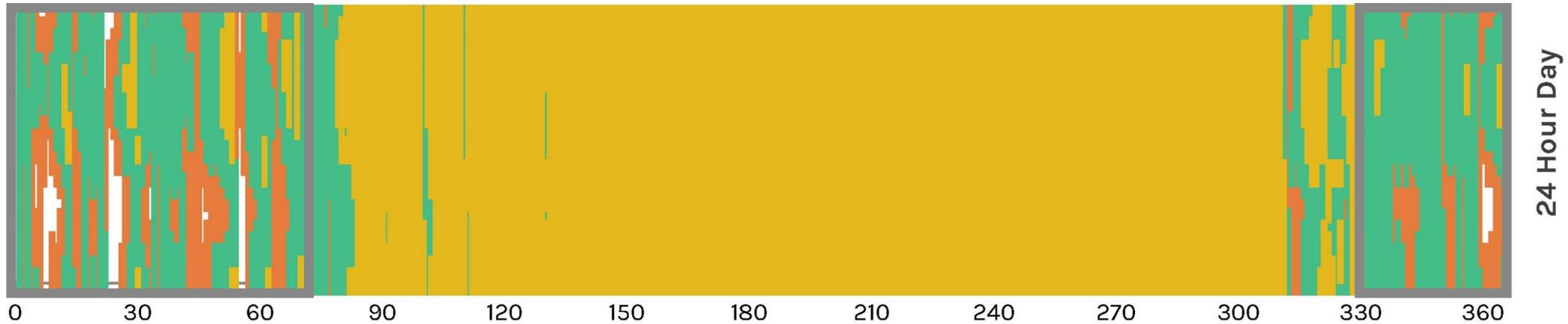
I OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 23% OF DAYS PER YEAR

I OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 65% OF DAYS PER YEAR

Wuhan, CHN

76 FEET ABOVE SEA LEVEL

LATTITUDE: 30.61667 / LONGITUDE: 114.1333



□ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY ELEVATED OUTDOOR HUMIDITY REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- SOME POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

# ASHRAE CLIMATE ZONE 4A

MIXED - HUMID

## PARIS\_ORLY, FRA

□ OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 5% OF DAYS PER YEAR

▮ OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 14% OF DAYS PER YEAR

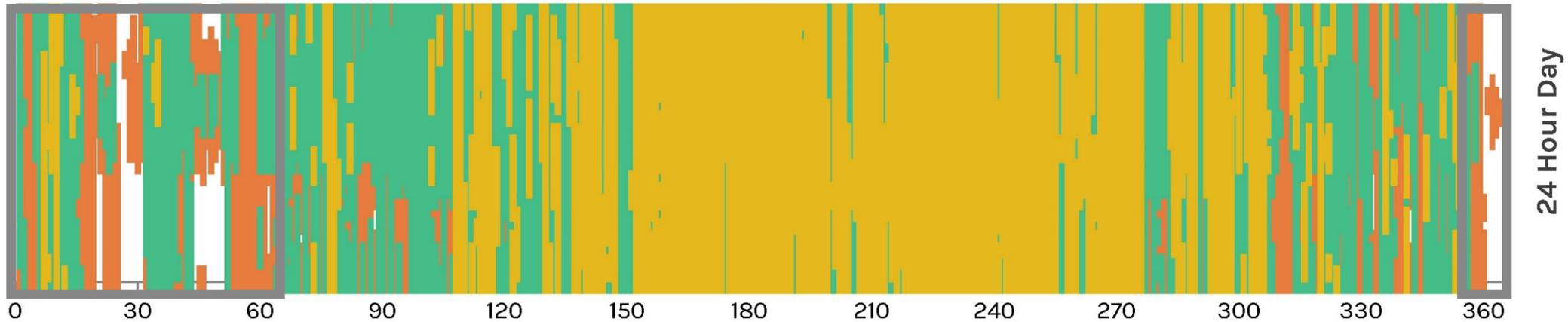
▮ OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 36% OF DAYS PER YEAR

▮ OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 45% OF DAYS PER YEAR

PARIS\_ORLY, FRA

315 FEET ABOVE SEA LEVEL

LATITUDE: 48.73 / LONGITUDE: 2.4



DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

□ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- ELEVATED OUTDOOR HUMIDITY IN SUMMER/FALL REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

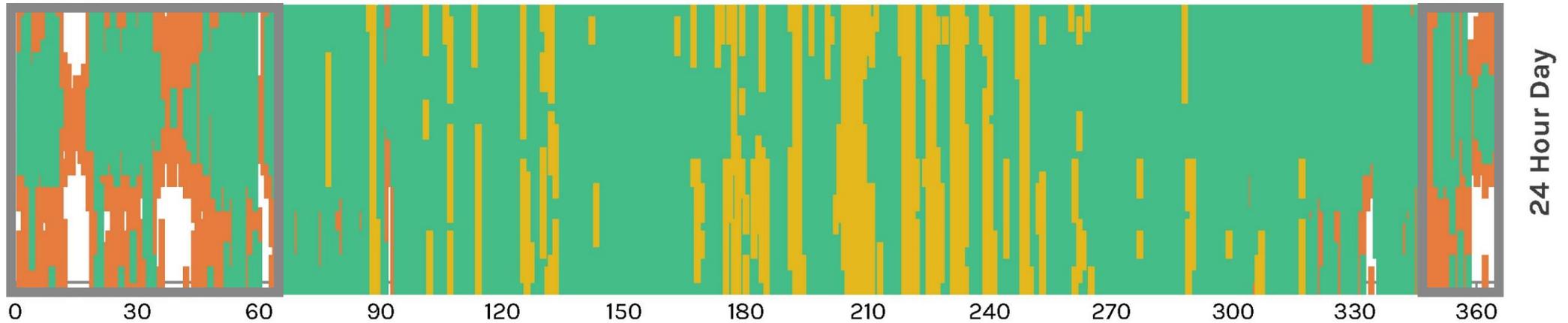
# ASHRAE CLIMATE ZONE 3B

WARM – DRY

## TEHRAN MEHRABAD INTL AP, IRN

- OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 4% OF DAYS PER YEAR
- | OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 12% OF DAYS PER YEAR
- | OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 73% OF DAYS PER YEAR
- | OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 11% OF DAYS PER YEAR

Tehran Mehrabad Intl AP, IRN  
3903 FEET ABOVE SEA LEVEL  
LATITUDE: 35.68333 / LONGITUDE: 51.31667



□ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY DRY CONDITIONS WITH SHORTENED PERIODS OF ELEVATED HUMIDITY PRIMARILY IN SUMMER
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM THROUGHOUT THE YEAR
- SOME POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

# ASHRAE CLIMATE ZONE 4C

MIXED – MARINE

## LONDON CITY AP, GBR

□ OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 1% OF DAYS PER YEAR

| OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 8% OF DAYS PER YEAR

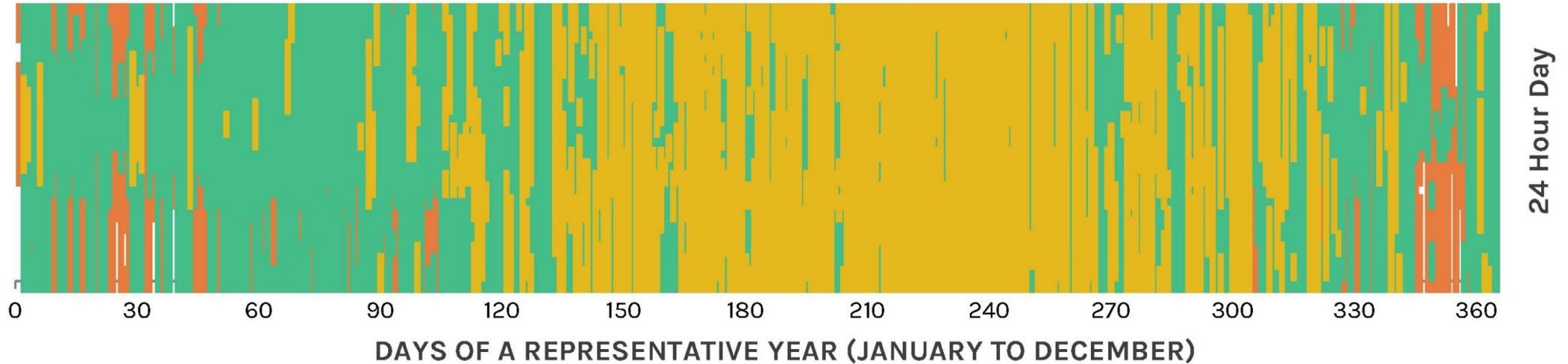
| OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 49% OF DAYS PER YEAR

| OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 42% OF DAYS PER YEAR

London City AP, GBR

19 FEET ABOVE SEA LEVEL

LATITUDE: 51.505 / LONGITUDE: 0.055



\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY ELEVATED OUTDOOR HUMIDITY REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO LATE FALL THROUGH EARLY SPRING
- MINIMAL POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM FOR LATE FALL TO EARLY SPRING

# ASHRAE CLIMATE ZONE 5A

COOL - HUMID

## GENEVA, CHE

☐ OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 7% OF DAYS PER YEAR

I OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 22% OF DAYS PER YEAR

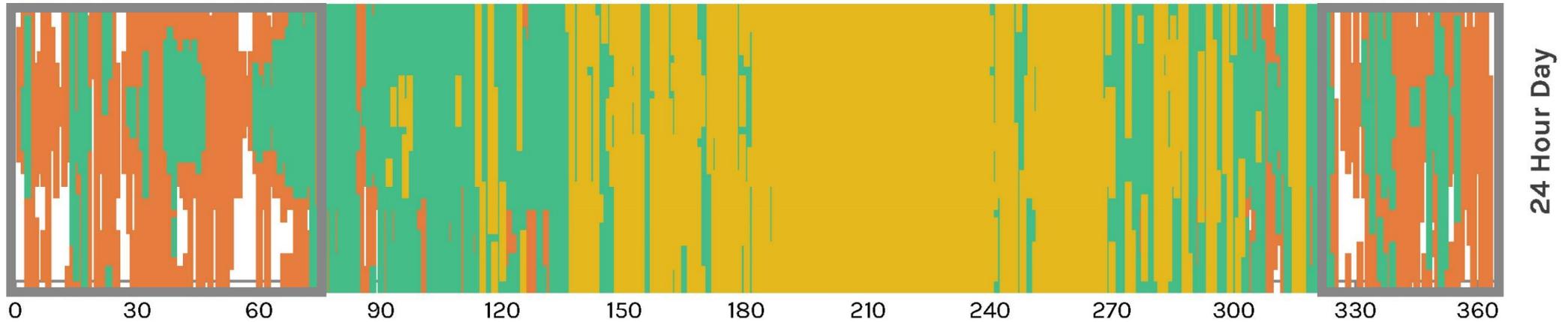
I OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 34% OF DAYS PER YEAR

I OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 37% OF DAYS PER YEAR

GENEVA, CHE

1364 FEET ABOVE SEA LEVEL

LATITUDE: 46.25 / LONGITUDE: 6.13



24 Hour Day

### DAYS OF A REPRESENTATIVE YEAR (JANUARY TO DECEMBER)

☐ DETERMINE APPROPRIATE CONTROL AT LOWER RH\*

\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- ELEVATED OUTDOOR HUMIDITY IN SUMMER REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- NEED FOR SUPPLEMENTAL HUMIDIFICATION TO 40% RH MINIMUM IS LIMITED TO FALL THROUGH SPRING
- POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS
- PROVIDE SUPPLEMENTAL HUMIDIFICATION TO 40% MINIMUM TOGETHER WITH ABILITY TO REDUCE WITH OA TEMPERATURES BELOW 40 °F (4.4 °C)

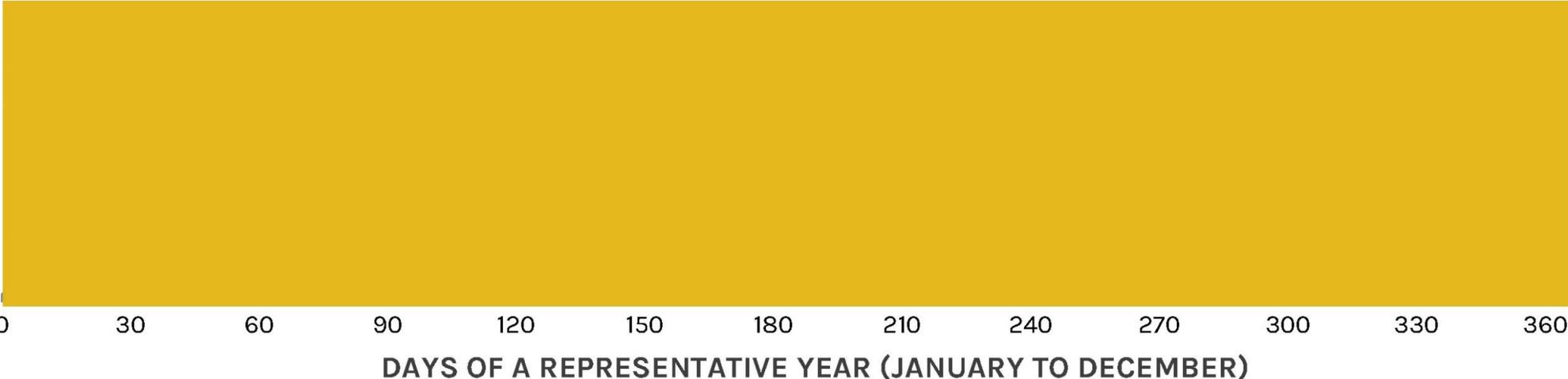
# ASHRAE CLIMATE ZONE 1A

VERY HOT - HUMID

## SINGAPORE, SGP

- OUTSIDE AIR (OA) < 32F (0C), BASE LEVEL OF HUMIDIFICATION\* - 0% OF DAYS PER YEAR
- | OA = 32F-40F (0C-4.4C), OPTIONAL HIGHER LEVEL OF HUMIDIFICATION\* - 0% OF DAYS PER YEAR
- | OA > 40F (4.4C), HUMIDIFICATION TO 40% MINIMUM - 0% OF DAYS PER YEAR
- | OA > 40F (4.4C), NO HUMIDIFICATION NEEDED FOR 40% MIN - 100% OF DAYS PER YEAR

SINGAPORE, SGP  
52 FEET ABOVE SEA LEVEL  
LATITUDE: 1.37 / LONGITUDE: 103.98



\* PER BUILDING ENVELOPE CONSTRAINTS

### OBSERVATIONS

- CONSISTENTLY ELEVATED OUTDOOR HUMIDITY REQUIRES DEHUMIDIFICATION TO LOWER INDOOR RELATIVE HUMIDITY
- SUPPLEMENTAL HUMIDIFICATION TO MINIMUM 40% IS NOT REQUIRED
- NO POTENTIAL FOR FREEZING IN THIS CLIMATE

### RECOMMENDATIONS

- PROVIDE HVAC SYSTEMS THAT MAINTAIN UPPER LIMIT RELATIVE HUMIDITY OF 60% OR LESS

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