Climatic Data for Energy Efficiency and Building Performance Evaluation

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Climatic Data for Energy Efficiency and Building Performance Evaluation

- Building design and performance modeling require weather data to represent climatic conditions of the building location. This may include:
- Building Design Conditions for peak heating and cooling calculations (temperature, humidity, solar and wind conditions for design calculations)
- Building Performance Simulation
  - Typical hourly weather data
  - Actual hourly weather data for calibration to utility bills
  - Future hourly weather data

ASHRAE

- Formerly known as American Society of Heating Refrigerating and Air-Conditioning Engineers
- >55,000 members
- Major products:
  - Handbooks (Fundamentals, Systems and Equipment, Refrigeration, Applications)
  - Standards
- More than 100 Technical Committees (TC) and Standards Committees composed of volunteers who write the handbooks, standards, and manage research projects.
- Climatic data for ASHRAE member's use is created in TC 4.2 and SSPC 169.

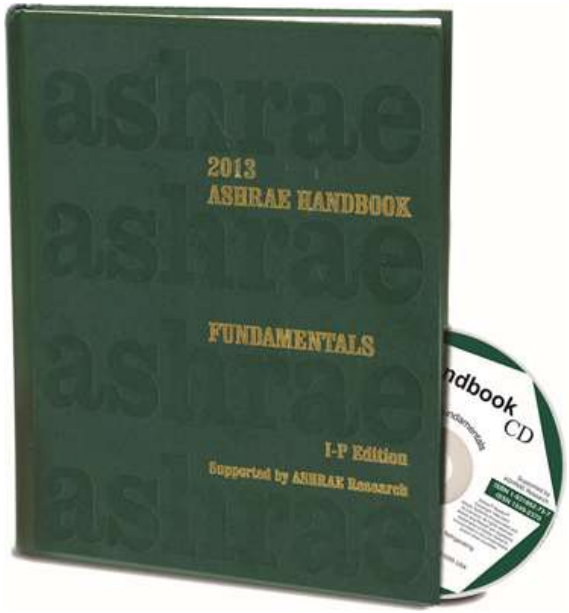
ASHRAE Technical Committee 4.2
Climatic Information

Scope:

TC 4.2 is concerned with identification, analysis and tabulation of climatic data for use in analysis and design of heating, refrigeration, ventilation and air-conditioning systems. Promotion of effective use of weather information in these applications is also included.

Committee members includes meteorologists, data suppliers and users (engineers, energy simulation)

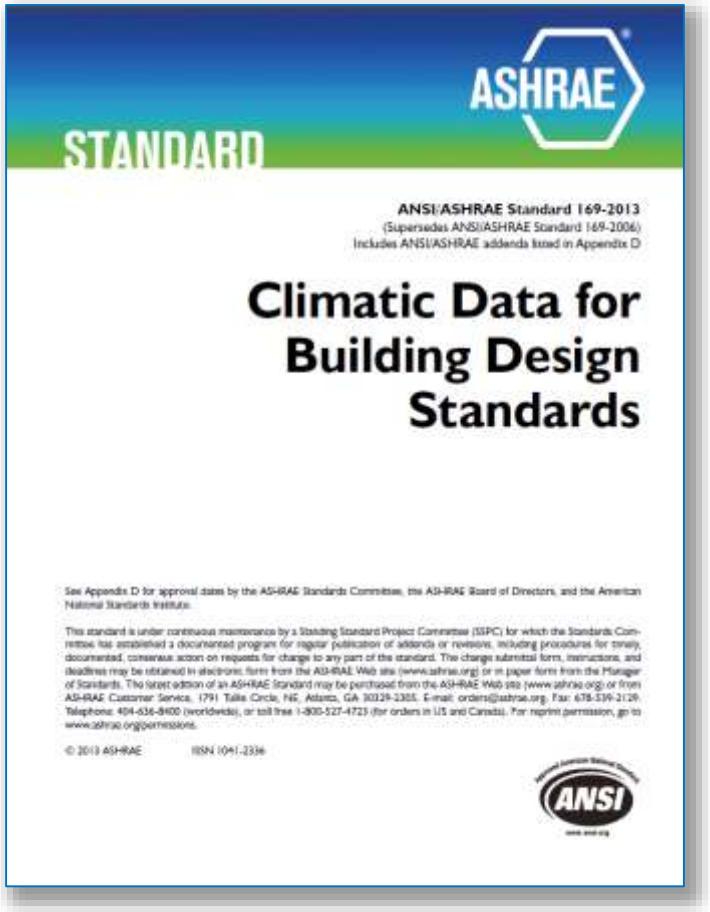
TC 4.2 Major Products



- Chapter 14 ASHRAE 2013 Handbook Fundamentals which contains Climatic Design Conditions for more than 6,443 locations throughout the world.
- Recent research projects (competitive solicitations):
  - New climatic design conditions for 2017 Handbook
  - International Weather data for Energy Calculations (more than 3200 'typical' hourly data files for use in energy simulation – all outside US and Canada)
  - Macroclimatic – regional models
  - Data filling for sparse data sets

Standing Standards Project Committee 169
Climatic Data for Building Design Standards

- **PURPOSE:** This standard provides recognized climatic data for use in building-design and related equipment standards.
- **SCOPE:**
  - This standard covers weather data used in ASHRAE standards, including dry-bulb, dew-point and wet-bulb temperatures, enthalpy, humidity ratio, wind conditions, solar irradiation, latitude, longitude, and elevation for locations worldwide.
  - This standard also includes statistical data such as mean temperatures, average temperatures, mean/median annual extremes, daily ranges, heating and cooling degree days and degree hours, and hours and seasonal percentages within ranges of temperatures as well as bins.



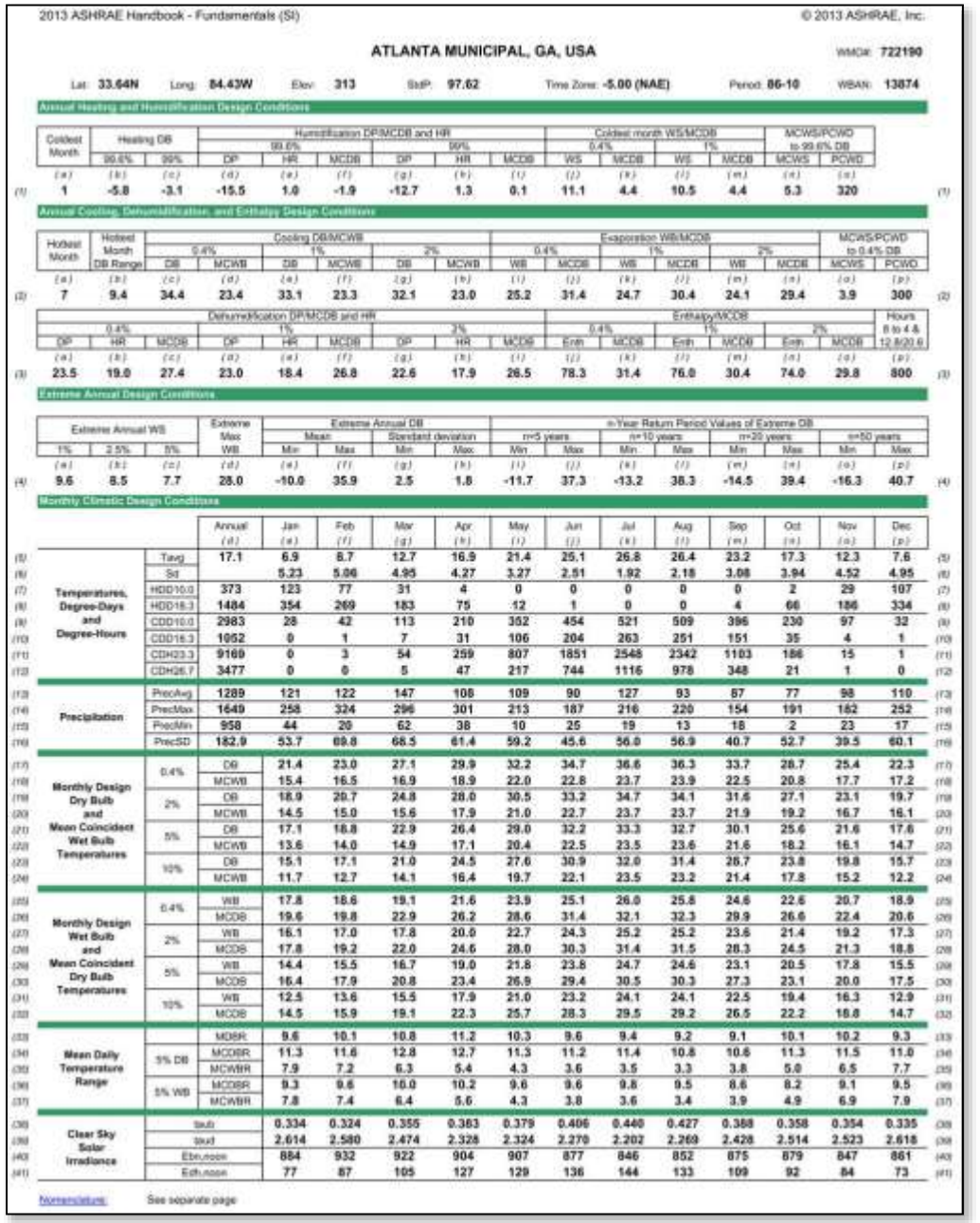
- **Publications:**
  - **ANSI/ASHRAE Standard 169-2006** - Published standard. **Weather Data for Building Design Standards**
  - Major update recently approved to incorporate new data: 169-2013.
  - Update begun for new update in 2017 incorporating 2017 Fundamentals Design Conditions

- Climatic Design Conditions are at the core of TC 4.2 and Standard 169

- These summary statistical data are calculated from 20-30 years of weather conditions

- Primary data source has been the National Center for Environmental Information (formerly NCDC), which houses the WMO data repository for the entire world
  - Integrated Surface Hourly 1986-2010
  - Stations in all countries (including Canada and USA)

- Stations in Canada: GRP118 Data Set 1986-2010



2013 ASHRAE Handbook - Fundamentals (SI) © 2013 ASHRAE, Inc.

ATLANTA MUNICIPAL, GA, USA WMO#: 722190

Lat: 33.64N Long: 84.43W Elev: 313 StdP: 97.62 Time Zone: -5.00 (NAE) Period: 86-10 WBAN: 13874

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB 99.6%	Heating DB 99%	Humidification DP/MCDB and HR 99.6% DP	99.6% HR	99.6% MCDB	99% DP	99% HR	99% MCDB	Coldest month WS/MCDB 0.4% WS	0.4% MCDB	1% WS	1% MCDB	MCWS/PCWD to 99.6% DB MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
1	-5.8	-3.1	-15.5	1.0	-1.9	-12.7	1.3	0.1	11.1	4.4	10.5	4.4	5.3	320

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB 0.4% DB	0.4% MCWB	1% DB	1% MCWB	2% DB	2% MCWB	Evaporation WB/MCDB 0.4% WB	0.4% MCDB	1% WB	1% MCDB	2% WB	2% MCDB	MCWS/PCWD to 0.4% DB MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
7	9.4	34.4	23.4	33.1	23.3	32.1	23.0	25.2	31.4	24.7	30.4	24.1	29.4	3.9	300

Dehumidification DP/MCDB and HR 0.4% DP	0.4% HR	0.4% MCDB	1% DP	1% HR	1% MCDB	2% DP	2% HR	2% MCDB	Enthalpy/MCDB 0.4% Enth	0.4% MCDB	1% Enth	1% MCDB	2% Enth	2% MCDB	Hours 8 to 4 & 12 &/20 &/0
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
23.5	19.0	27.4	23.0	18.4	26.8	22.6	17.9	26.5	78.3	31.4	76.0	30.4	74.0	29.8	800

Extreme Annual Design Conditions

Extreme Annual WS 1%	2.5%	5%	Extreme Max WB	Extreme Annual DB Mean Min	Mean Max	Standard deviation Min	Standard deviation Max	n-Year Return Period Values of Extreme DB n=5 years Min	n=5 years Max	n=10 years Min	n=10 years Max	n=20 years Min	n=20 years Max	n=50 years Min	n=50 years Max
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
9.6	8.5	7.7	28.0	-10.0	35.9	2.5	1.8	-11.7	37.3	-13.2	38.3	-14.5	39.4	-16.3	40.7

Monthly Climatic Design Conditions

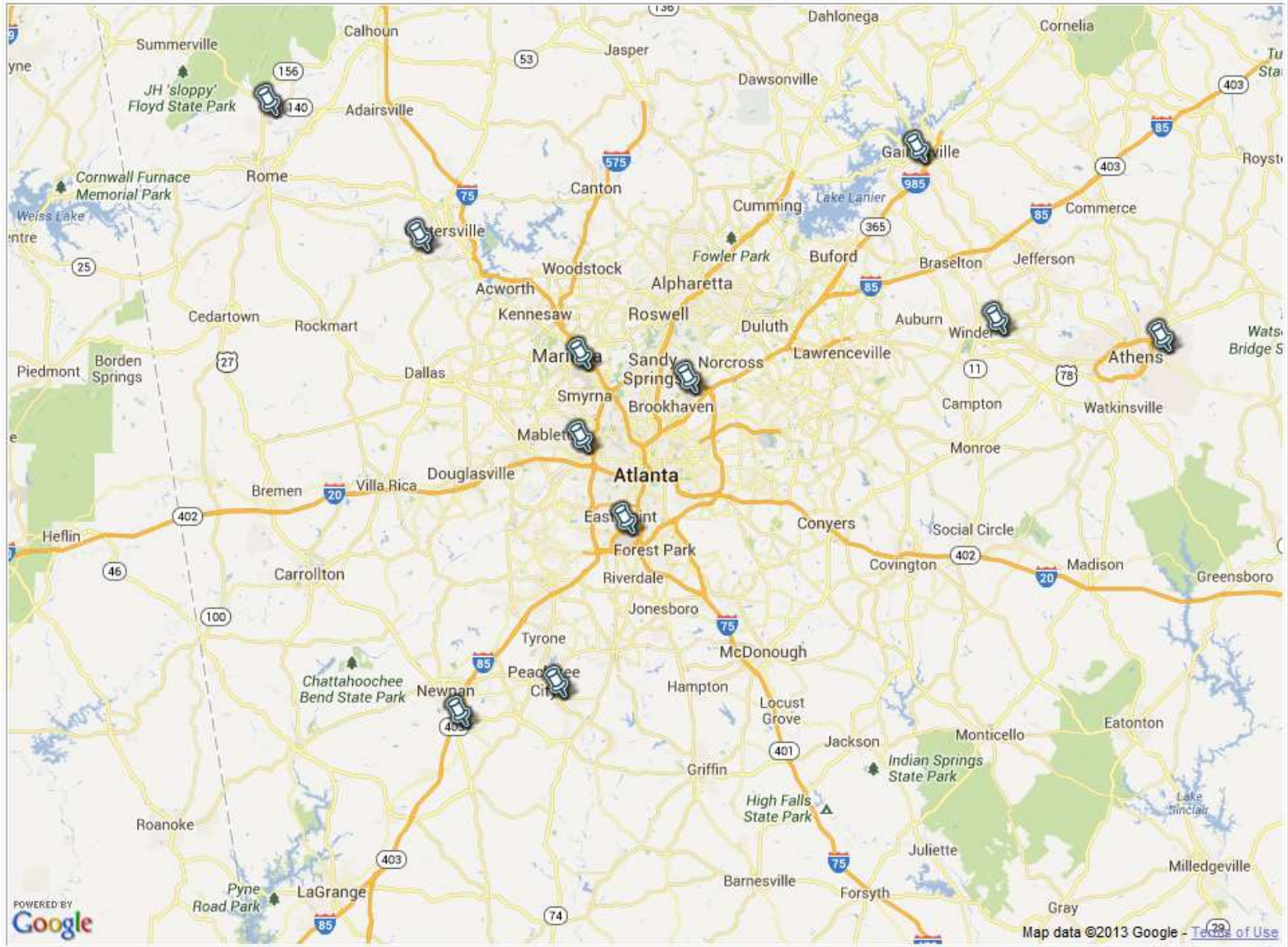
			Annual (d)	Jan (e)	Feb (f)	Mar (g)	Apr (h)	May (i)	Jun (j)	Jul (k)	Aug (l)	Sep (m)	Oct (n)	Nov (o)	Dec (p)
Temperatures, Degree-Days and Degree-Hours		Tavg	17.1	6.9	8.7	12.7	16.9	21.4	25.1	26.8	26.4	23.2	17.3	12.3	7.6
		Sd		5.23	5.06	4.95	4.27	3.27	2.51	1.92	2.18	3.08	3.94	4.52	4.95
		HDD10.0	373	123	77	31	4	0	0	0	0	0	2	29	107
		HDD18.3	1484	354	269	183	75	12	1	0	0	4	66	186	334
		CDD10.0	2983	28	42	113	210	352	454	521	509	396	230	97	32
		CDD18.3	1052	0	1	7	31	106	204	263	251	151	35	4	1
		CDH23.3	9169	0	3	54	259	807	1851	2548	2342	1103	186	15	1
		CDH26.7	3477	0	0	5	47	217	744	1116	978	348	21	1	0
Precipitation		PrecAvg	1289	121	122	147	108	109	90	127	93	87	77	98	110
		PrecMax	1649	258	324	296	301	213	187	216	220	154	191	162	252
		PrecMin	958	44	20	62	38	10	25	19	13	18	2	23	17
		PrecSD	182.9	53.7	69.8	68.5	61.4	59.2	45.6	56.0	56.9	40.7	52.7	39.5	60.1
Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures	0.4%	DB		21.4	23.0	27.1	29.9	32.2	34.7	36.6	36.3	33.7	28.7	25.4	22.3
		MCWB		15.4	16.5	16.9	18.9	22.0	22.8	23.7	23.9	22.5	20.8	17.7	17.2
	2%	DB		18.9	20.7	24.8	28.0	30.5	33.2	34.7	34.1	31.6	27.1	23.1	19.7
		MCWB		14.5	15.0	15.6	17.9	21.0	22.7	23.7	23.7	21.9	19.2	16.7	16.1
	5%	DB		17.1	18.8	22.9	26.4	29.0	32.2	33.3	32.7	30.1	25.6	21.6	17.6
		MCWB		13.6	14.0	14.9	17.1	20.4	22.5	23.5	23.6	21.6	18.2	16.1	14.7
	10%	DB		15.1	17.1	21.0	24.5	27.0	30.9	32.0	31.4	28.7	23.8	19.8	15.7
		MCWB		11.7	12.7	14.1	16.4	19.7	22.1	23.5	23.2	21.4	17.8	15.2	12.2
Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures	0.4%	WB		17.8	18.6	19.1	21.6	23.9	25.1	26.0	25.8	24.6	22.6	20.7	18.9
		MCDB		19.6	19.8	22.9	26.2	28.6	31.4	32.1	32.3	29.9	26.6	22.4	20.6
	2%	WB		16.1	17.0	17.8	20.0	22.7	24.3	25.2	25.2	23.6	21.4	19.2	17.3
		MCDB		17.8	19.2	22.0	24.6	28.0	30.3	31.4	31.5	28.3	24.5	21.3	18.8
	5%	WB		14.4	15.5	16.7	19.0	21.8	23.8	24.7	24.6	23.1	20.5	17.8	15.5
		MCDB		16.4	17.9	20.8	23.4	26.9	29.4	30.5	30.3	27.3	23.1	20.0	17.5
	10%	WB		12.5	13.6	15.5	17.9	21.0	23.2	24.1	24.1	22.5	19.4	16.3	12.9
		MCDB		14.5	15.9	19.1	22.3	25.7	28.3	29.5	29.2	26.5	22.2	18.8	14.7
Mean Daily Temperature Range		MDBR		9.6	10.1	10.8	11.2	10.3	9.6	9.4	9.2	9.1	10.1	10.2	9.3
	5% DB	MCDBR		11.3	11.6	12.8	12.7	11.3	11.2	11.4	10.8	10.6	11.3	11.5	11.0
		MCWBR		7.9	7.2	6.3	5.4	4.3	3.6	3.5	3.3	3.8	5.0	6.5	7.7
	5% WB	MCDBR		9.3	9.6	10.0	10.2	9.6	9.6	9.8	9.5	8.6	8.2	9.1	9.5
		MCWBR		7.8	7.4	6.4	5.6	4.3	3.8	3.6	3.4	3.9	4.9	6.9	7.9
Clear Sky Solar Irradiance		taub		0.334	0.324	0.355	0.363	0.379	0.406	0.440	0.427	0.388	0.358	0.354	0.335
		taud		2.614	2.580	2.474	2.328	2.324	2.270	2.202	2.269	2.428	2.514	2.523	2.618
		Ebn,noon		884	932	922	904	907	877	846	852	875	879	847	861
		Edh,noon		77	87	105	127	129	136	144	133	109	92	84	73

Nomenclature See separate page

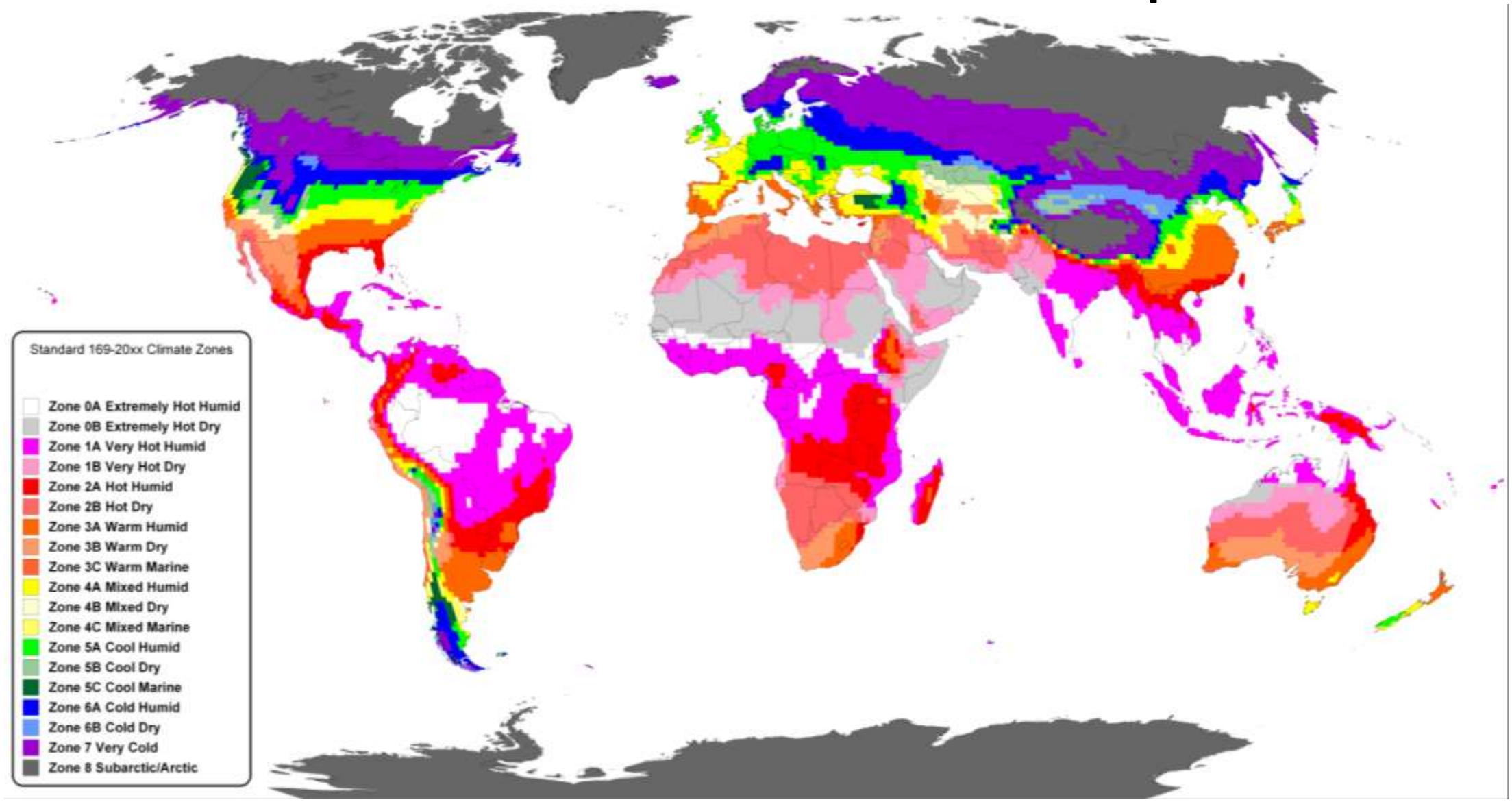
2013 ASHRAE Climatic Design Conditions - Station Finder

Zoom in to a particular area to make the markers corresponding to the stations appear, or type the name of the location in the Location box.
Browser suggestion: This page is best viewed in Firefox or Safari. It may be very slow under some versions of Internet Explorer - allow 20-30 seconds for the map to load, and 10-15 seconds for the markers to appear.

Location: Atlanta, GA Search



169-2013 Climate Zone Maps



Climate Data Needed for Building Performance Evaluation

Element	Model use(s)	Availability and issues
Dry-bulb air temperature	• Exterior surface convection • Infiltration/ventilation sensible heat transfer • Equipment (e.g. air-cooled condenser)	• Universally observed • Significant local effects (e.g. heat island)
Humidity (relative humidity, wet-bulb temperature, or dew-point temperature)	• Infiltration/ventilation latent heat transfer • Equipment (e.g. cooling tower)	• Commonly observed
Solar irradiance (direct and diffuse)	• Fenestration heat gain • Exterior surface heat balance • Solar thermal and photovoltaic systems	• Sparsely measured • If observed, often global only • Model sources widely used • Remote sensing opportunities
Solar illuminance (direct and diffuse)	• Daylight modeling	• Rarely measured (modeled from irradiance)
Sky temperature	• Exterior surface heat balance	• Rarely measured (modeled from temperature, humidity, and cloud cover)
Cloud cover / sky condition	• Sky models (e.g. for daylighting)	• Generally observed • Multiple data representation conventions • Evolution of automated instrumentation introduces uncertainties
Wind (velocity and direction)	• Exterior surface convection • Infiltration • Natural ventilation	• Generally observed • Local effects very significant for both velocity and direction • Low velocity observations unreliable
Ground temperature	• Below-grade heat transfer	• Measured for agricultural purposes, limited exploitation of observed values for building simulation
Ground surface albedo	• Reflected irradiance / illuminance	• Inferable from presence of snow
Weather conditions (e.g. rain)	• Exterior surface wetting	• Generally measured; inconsistent reporting formats

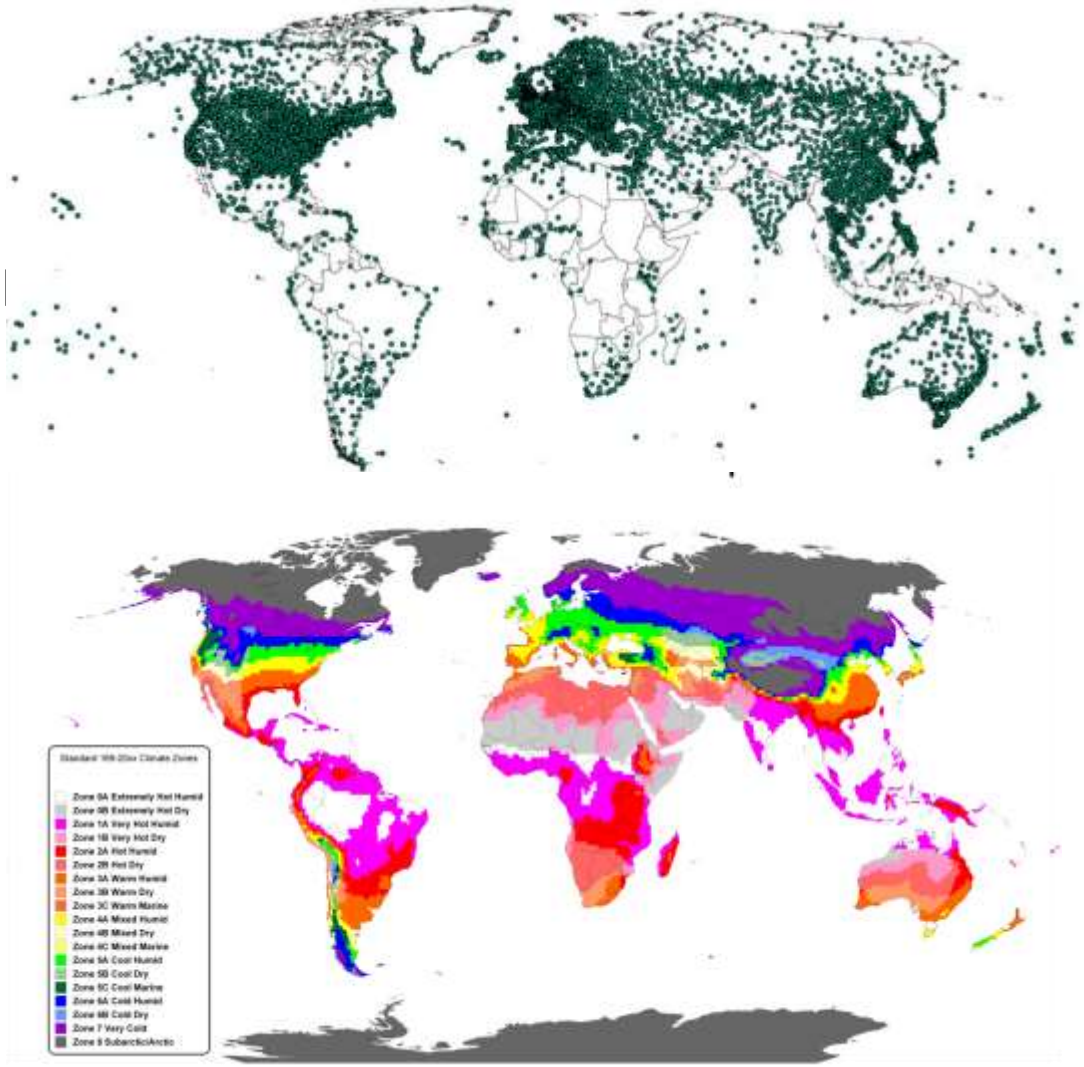
Chapter 3 Weather Data for Building Performance Simulation, *Building Performance Simulation for Design and Operation*, 2011 Hensen and Lamberts

Earth Observations

- Focus has been on available station data from NOAA/NCEI
  - Integrated Surface Dataset (ISD)
  - POR 1986 to 2010
- Data readily available (at low cost)
- WMO repository
- Most data needed are present: temperature, humidity, cloud cover, wind speed / direction!
- Supplemented by NASA Surface Meteorology and Solar Energy data (and other) for precipitation (NASA Langley)

Challenges in Earth Observations for Energy Efficiency and Building Performance

- Sparse data
- Microclimatic variability
- Keeping up with changing climate co
- Almost all solar radiation data
- Design conditions and near-real time data
- Typical year hourly data and actual year hourly data to match against utility bills



Thank you!

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