

## Impact Assessment of Climate Change on the Hygrothermal Performance of Buildings

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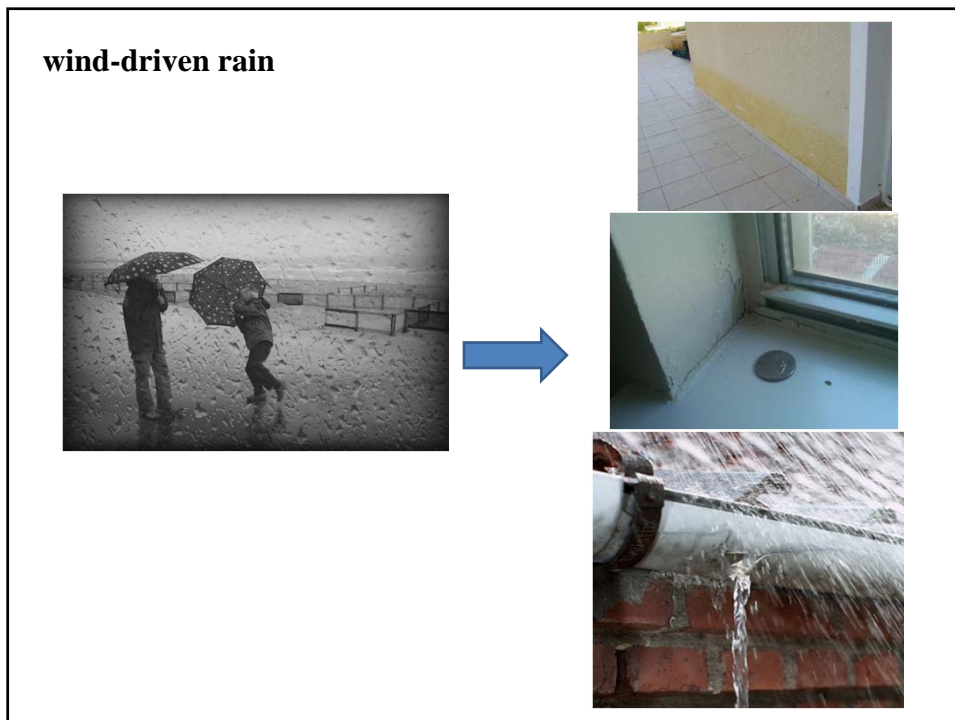
5<sup>th</sup> assessment report of the state of the global climate by the Intergovernmental Panel on Climate Change (IPCC) climate change will accelerate.

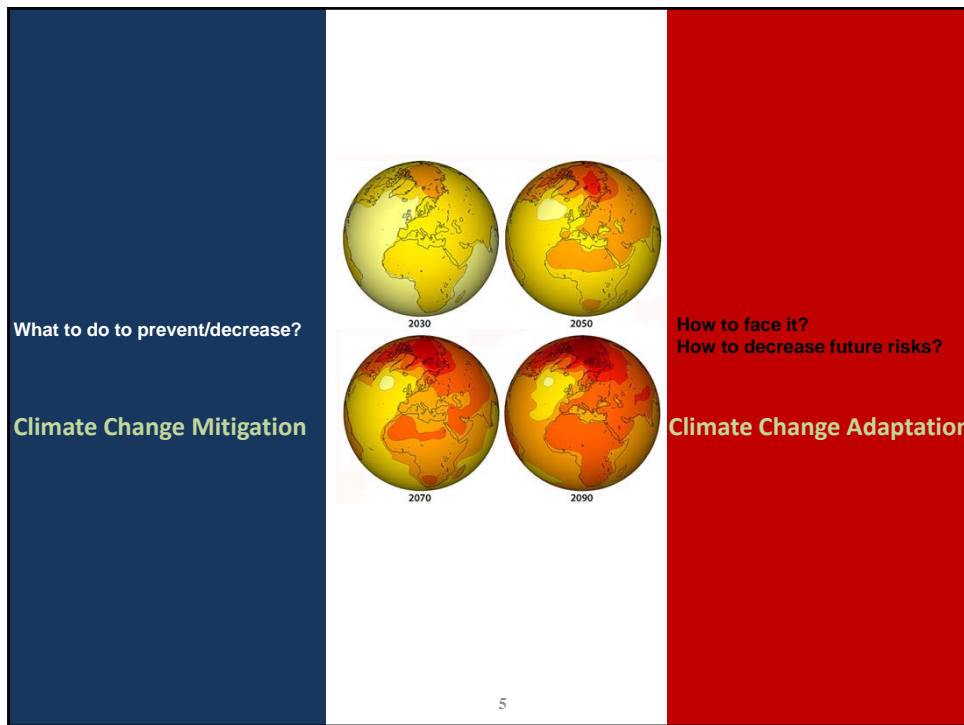
Depending on greenhouse gas emissions an increase of 0.8 to 2.4°C by 2050 is expected in the global temperature compared to 1990.

- Increase in climate variability
- Increase in extreme events



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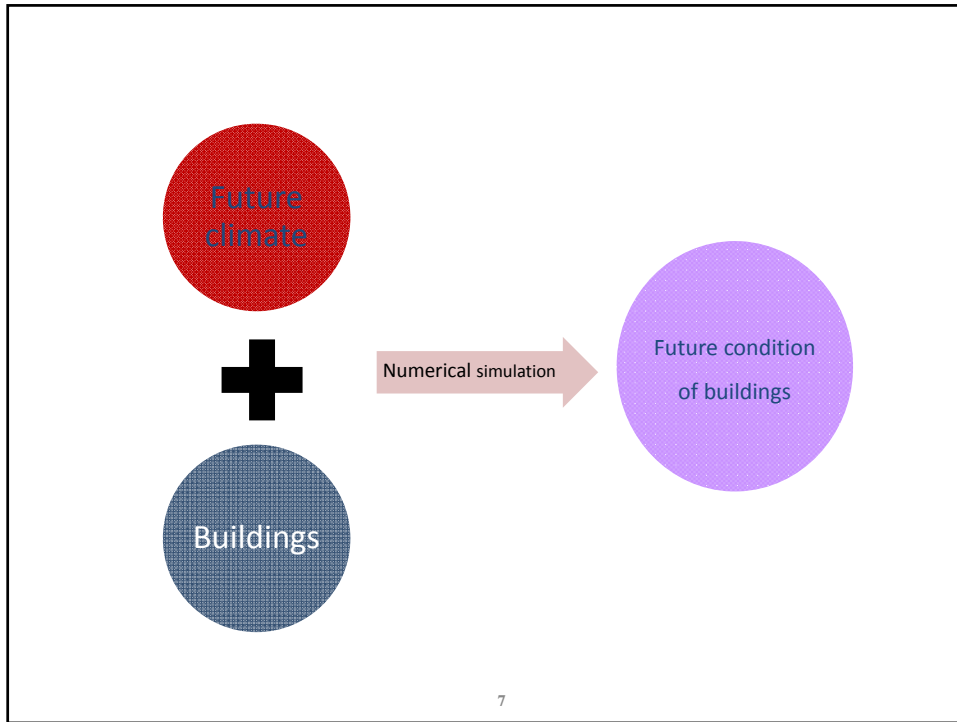




**What are the future conditions for buildings in Sweden?**

**Impact Assessment of Climate Change**

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**SMHI**

**Swedish Meteorological and Hydrological Institute**

**Rosby Centre**

Norwegian Sea

Norway

Finland

Sweden

Östersund

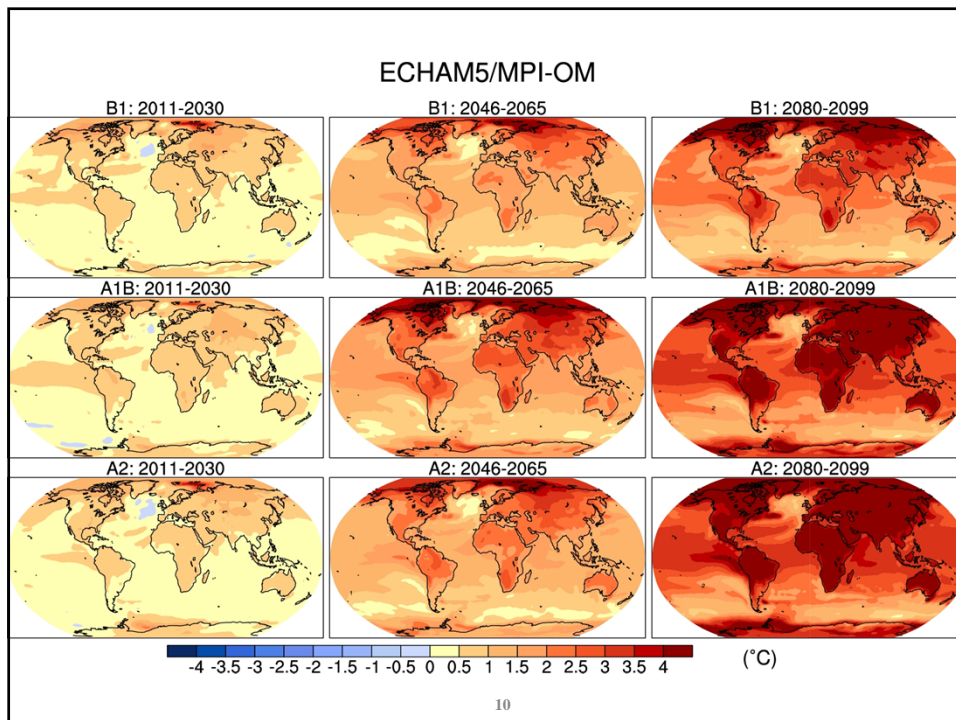
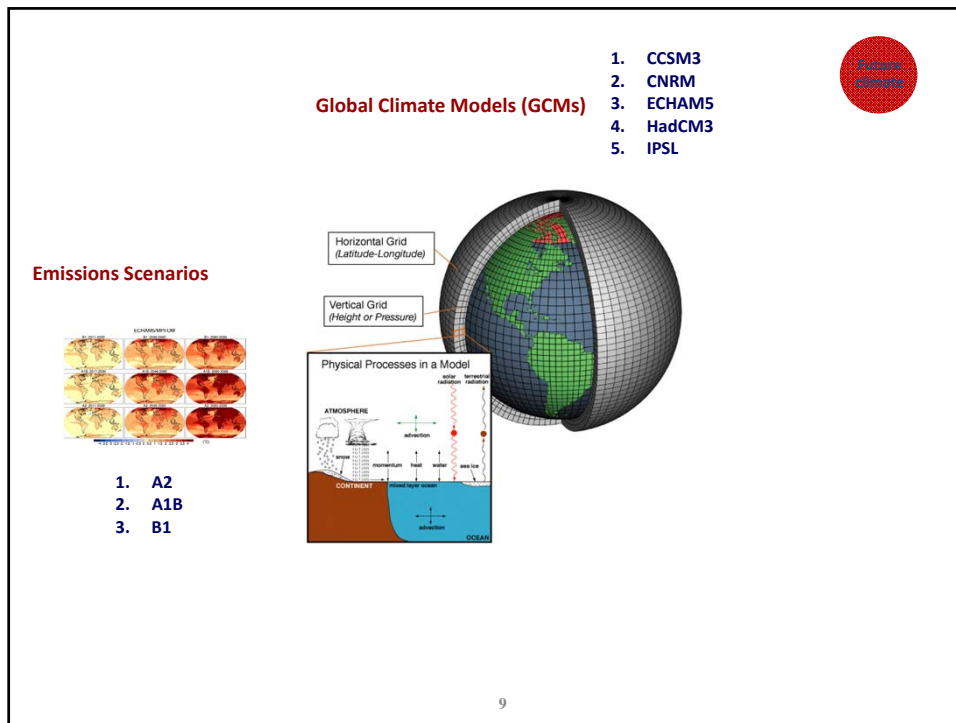
Stockholm


Baltic Sea

Gothenburg

Lund

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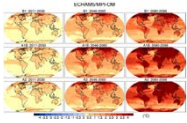




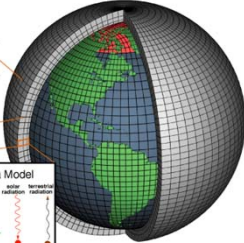
**Global Climate Models (GCMs)**

1. CCSM3
2. CNRM
3. ECHAM5
4. HadCM3
5. IPSL

**Emissions Scenarios**

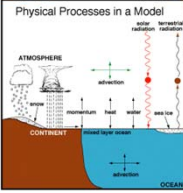


1. A2
2. A1B
3. B1



Horizontal Grid (Latitude-Longitude)

Vertical Grid (Height or Pressure)



Physical Processes in a Model

ATMOSPHERE: solar, terrestrial, atmospheric radiation; convection; advection; diffusion; evaporation; condensation; cloud; rain; snow; ice; sea ice


CONTINENT: vegetation; soil; land use change

OCEAN: mixed layer ocean; ocean circulation

**Initial Conditions**

- 1
- 2
- 3

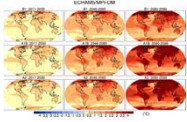
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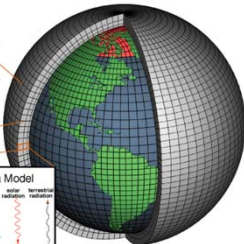
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**Emissions Scenario**

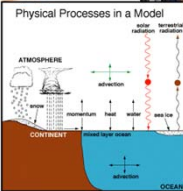


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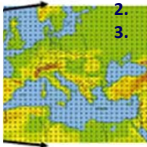
CONTINENT: vegetation; soil; land use change

OCEAN: mixed layer ocean; ocean circulation

**Regional Climate Model**

**RCM**

1. RCA3
2. KNMI-RACMO2
3. DMI-HIRHAM5



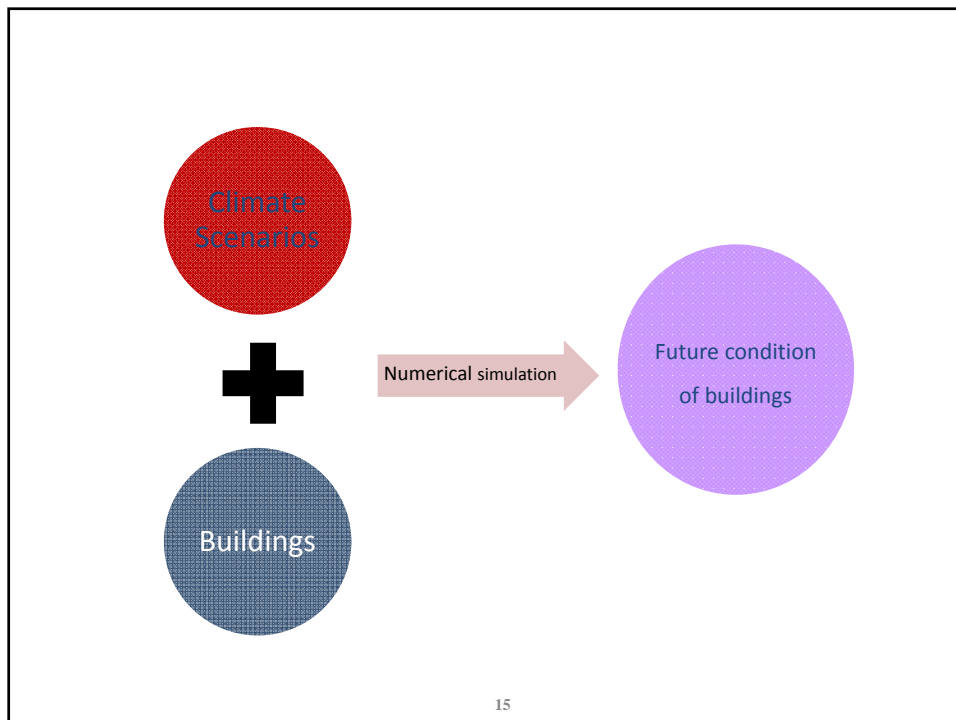
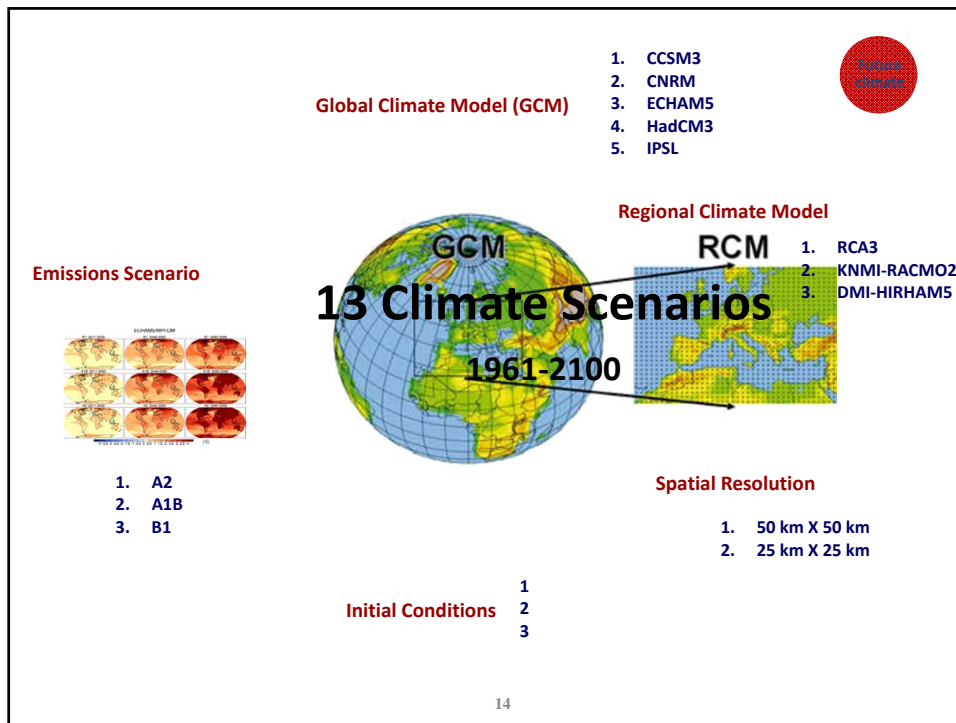
**Initial Resolution**

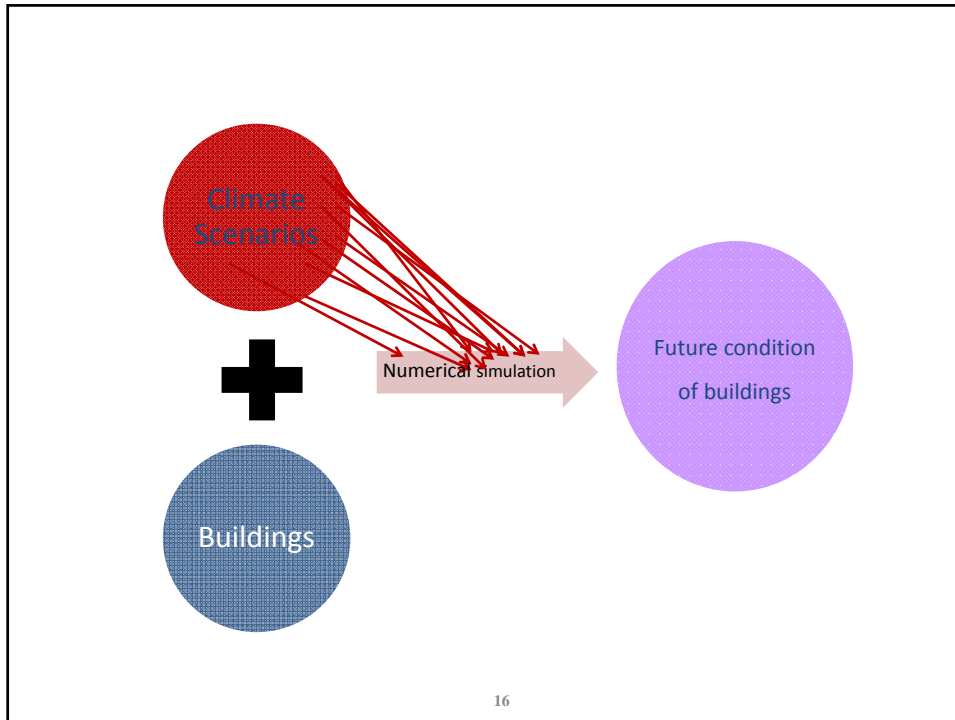
1. 50 km X 50 km
2. 25 km X 25 km

**Initial Conditions**

- 1
- 2
- 3

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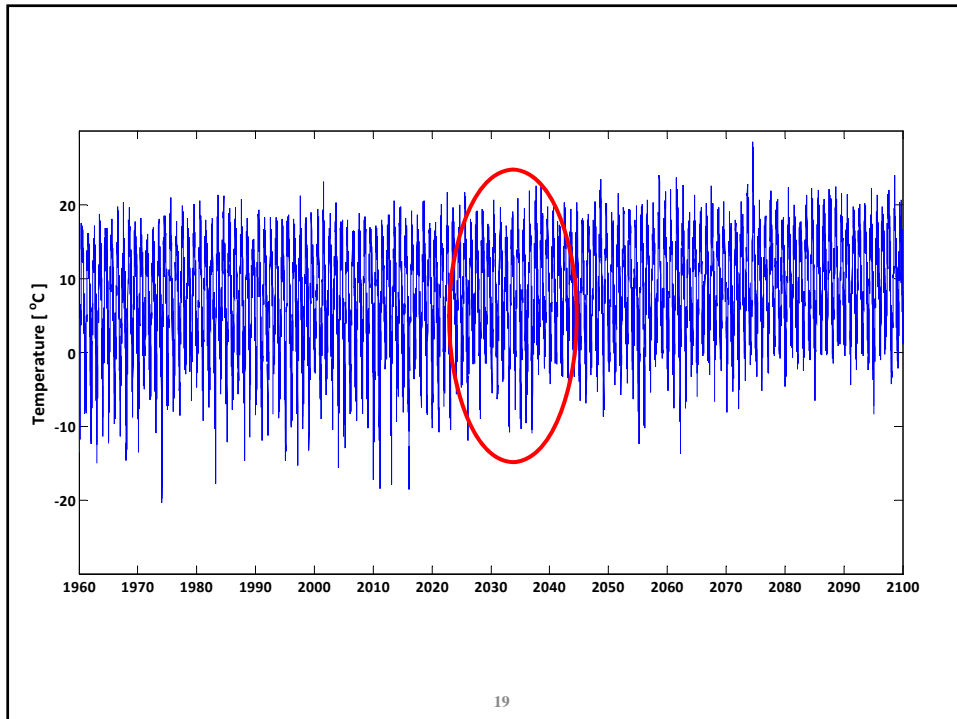
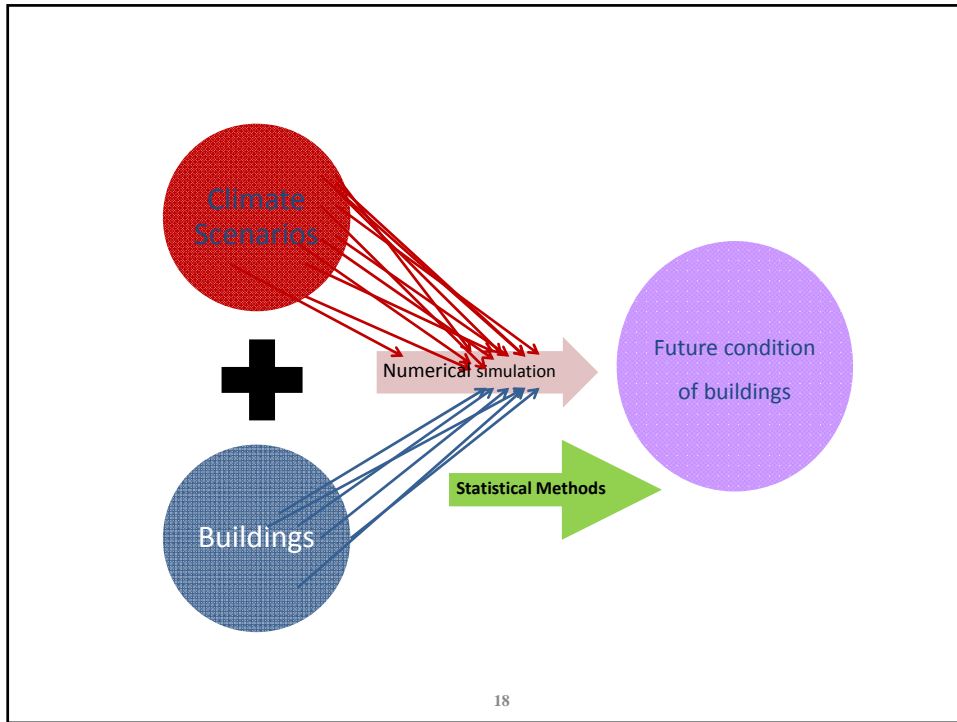
**Buildings**

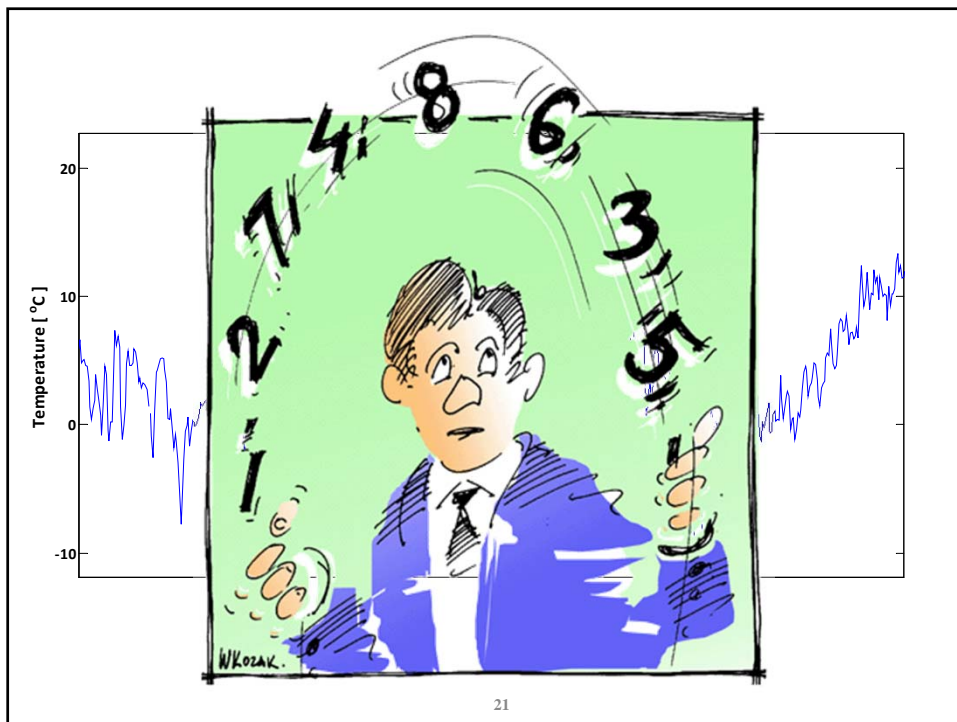
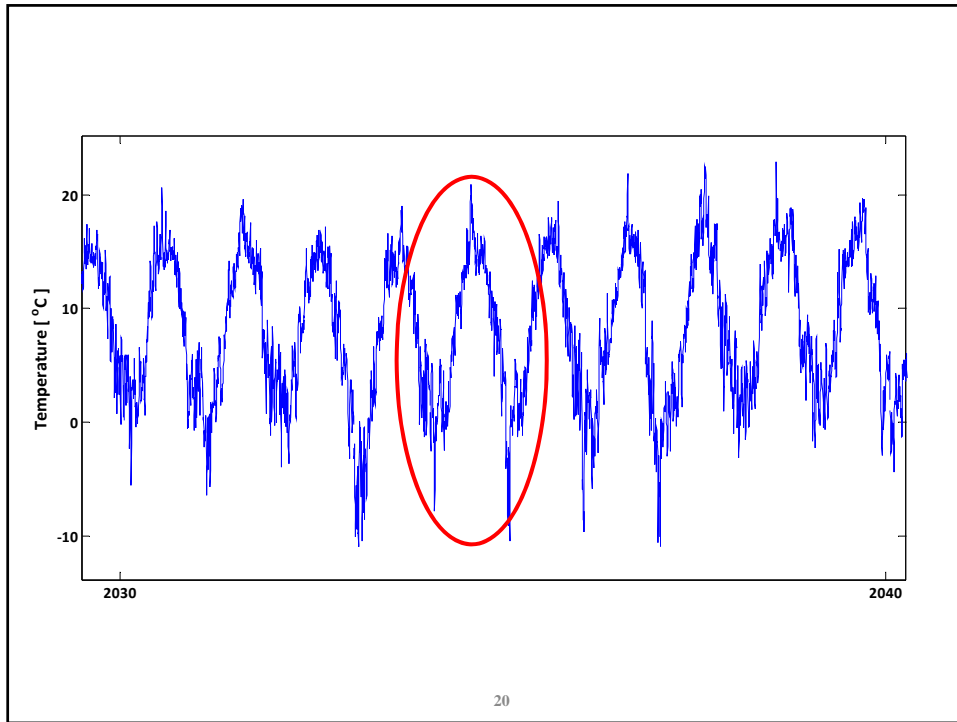
**Moisture Safety & Energy Demand of the Swedish Residential Buildings**

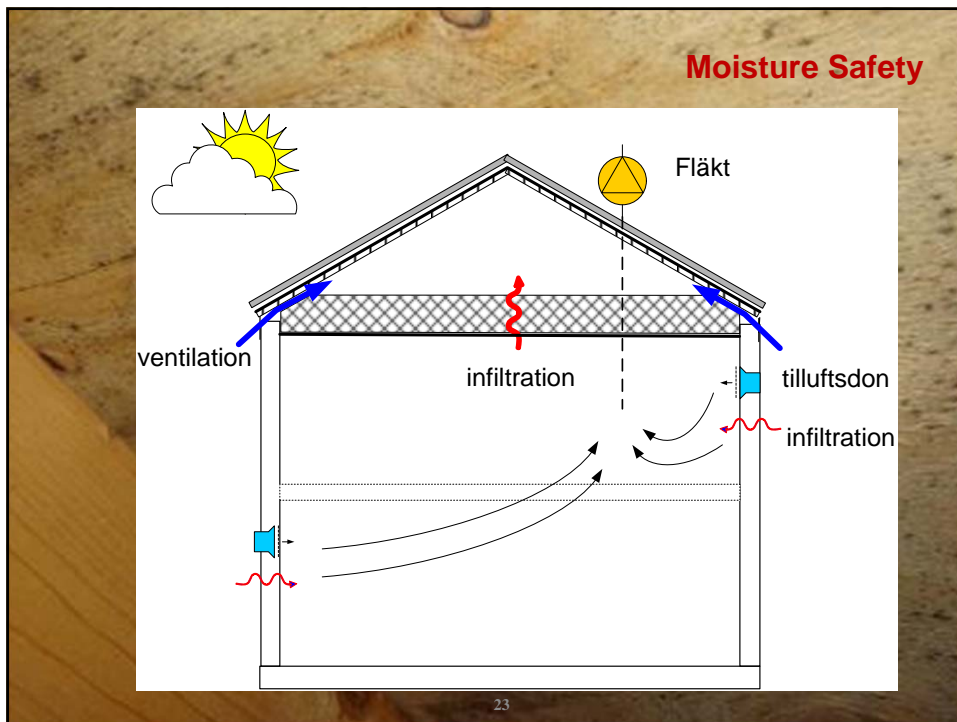
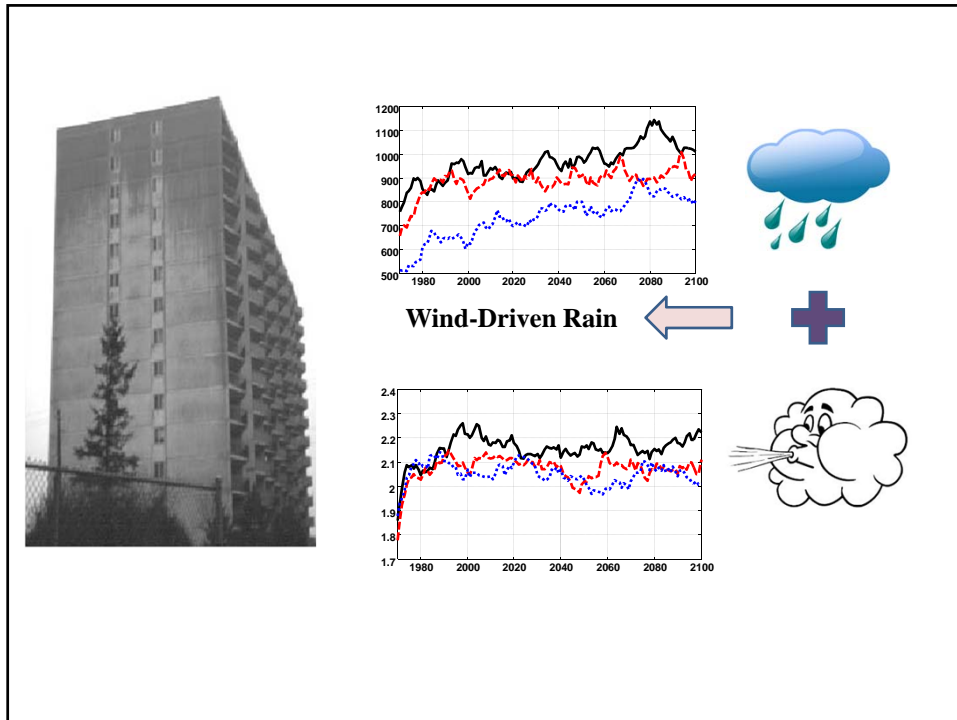
4 Attic Constructions	Gothenburg	184	buildings
	Lund	52	buildings
	Stockholm	153	buildings
	Östersund	63	buildings

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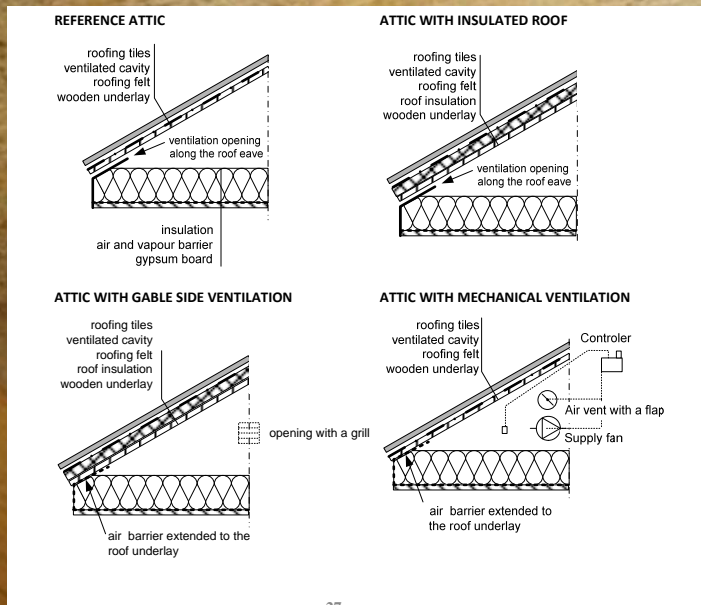


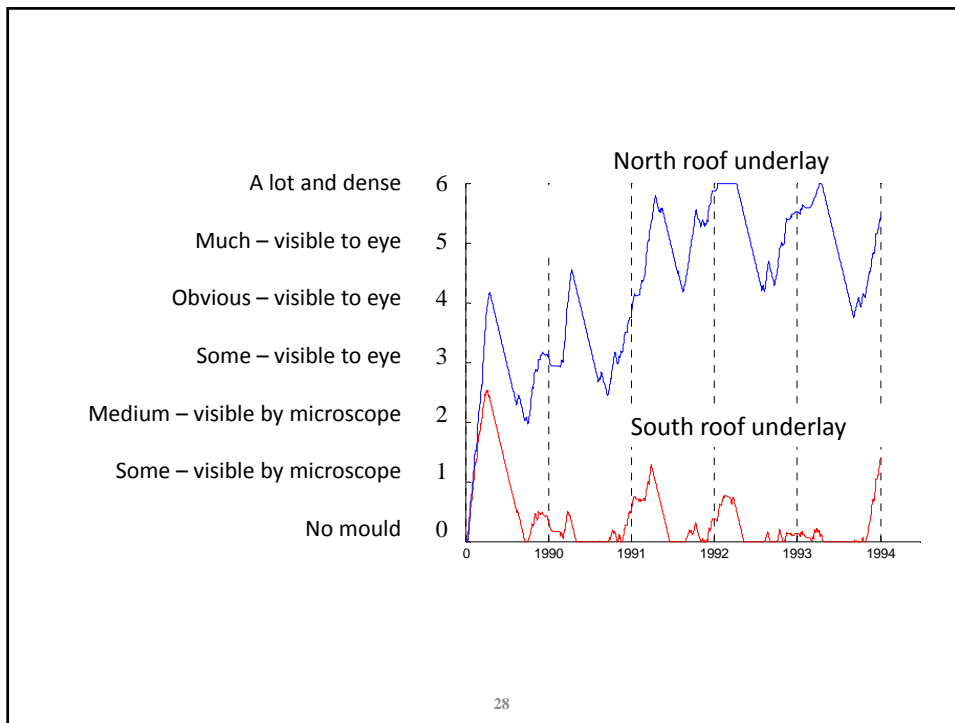


mean values – GCMs – outdoor climate

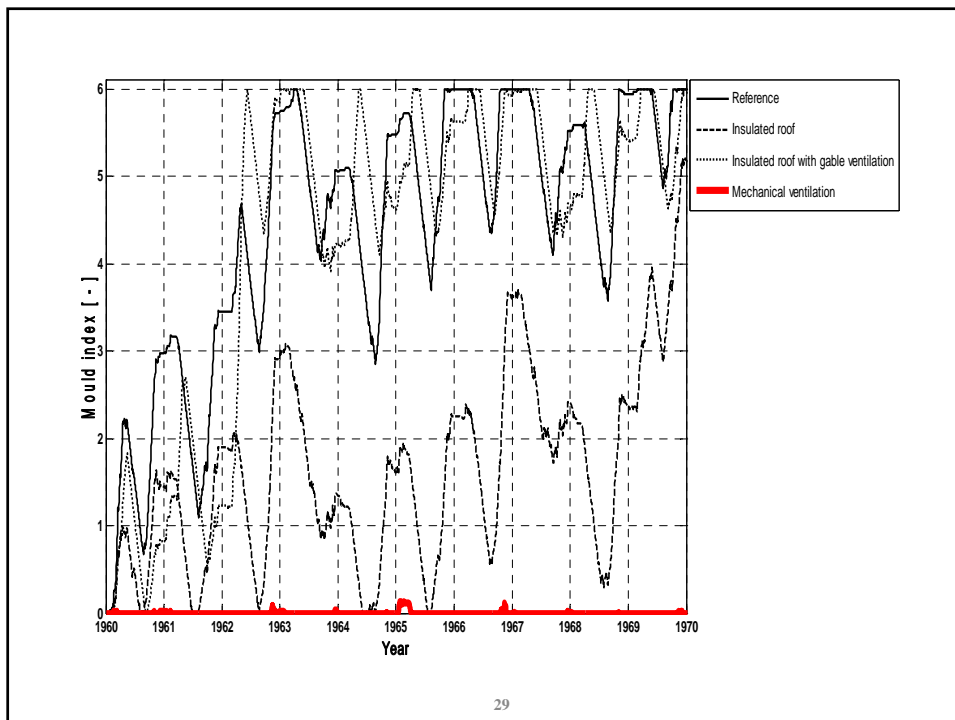
	CTL period (1961-1990)					SCN period (2071-2100)			
	ERA40	CCSM3	CNRM	ECHAM5	HADCM3	CCSM3	CNRM	ECHAM5	HADCM3
30-year mean (Summer)									
$\bar{T}$	11.96	10	12.3	11.47	12.08	11.9	13.82	13.5	14.7
$\overline{RH}$	0.83	0.83	0.84	0.85	0.85	0.86	0.87	0.88	0.89
$\overline{GR}$	169	165	163	157	161	149	146	137	137
Seasonal mean (Summer)									
$\bar{T} + T'_y$	11.46	10.2	13.45	12.57	11.3	11.76	14.3	12.65	14.5
$\overline{RH} + RH'_y$	0.82	0.84	0.83	0.82	0.85	0.88	0.89	0.87	0.91
$\overline{GR} + GR'_y$	177	155	175	174	158	141	137	142	119

Moisture Safety

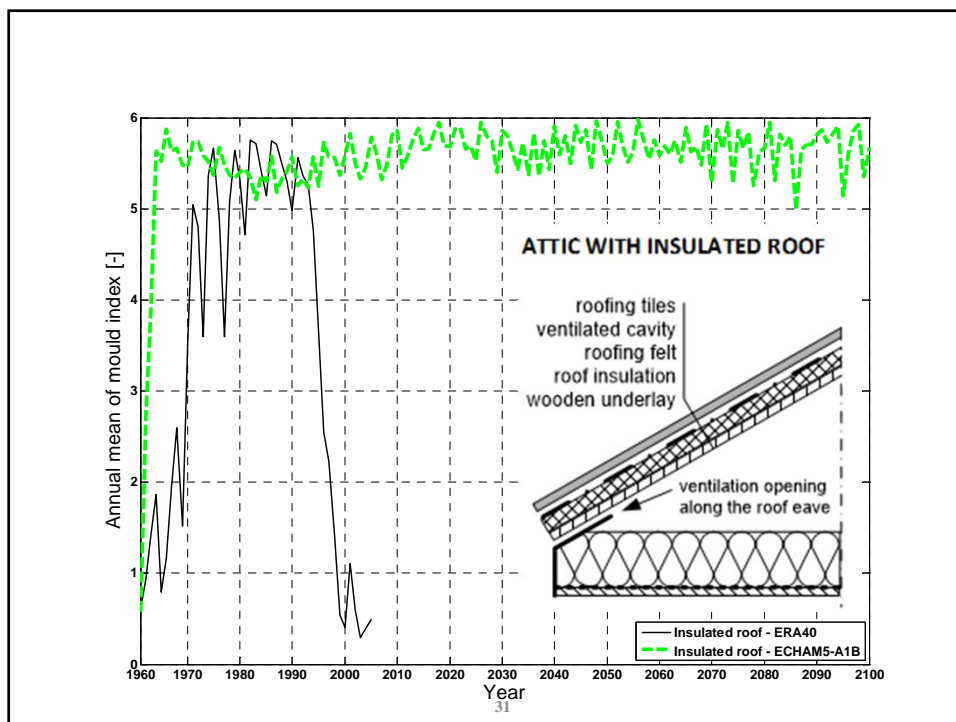
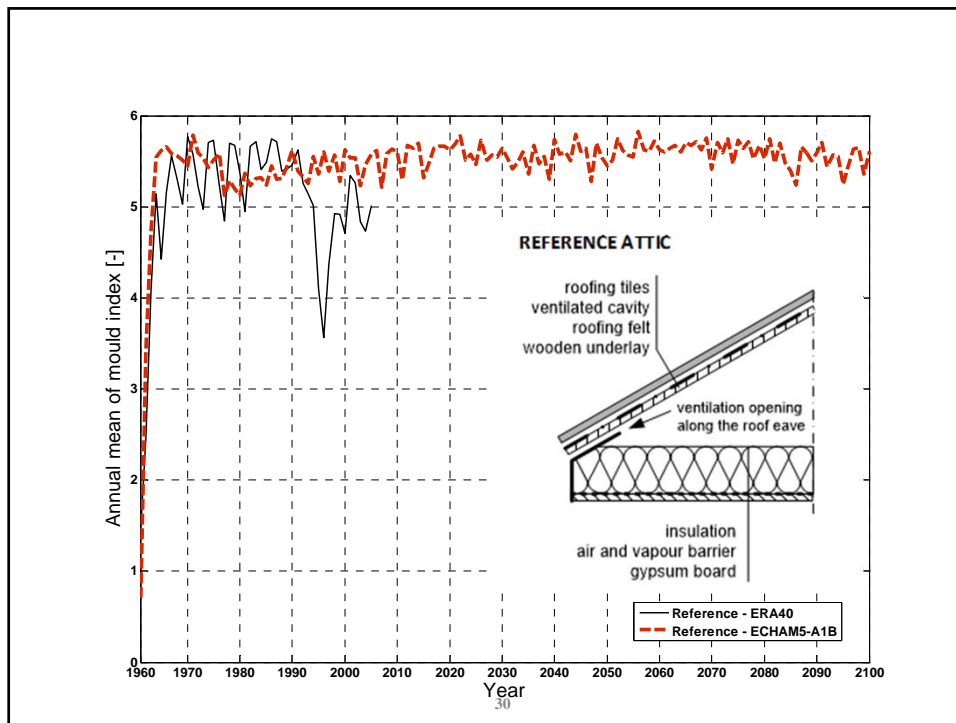


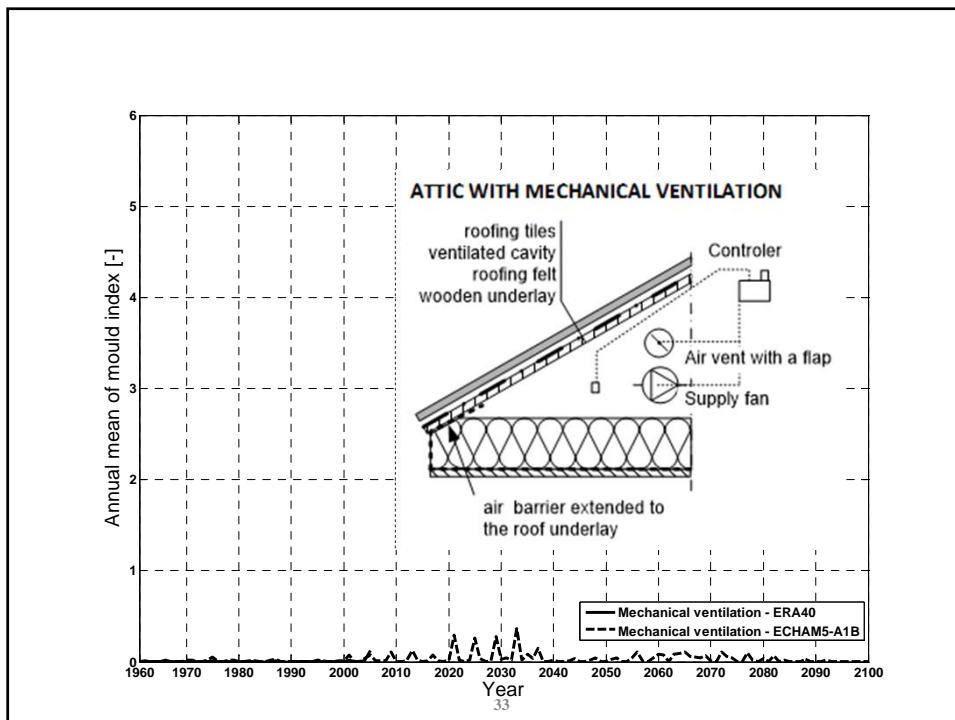
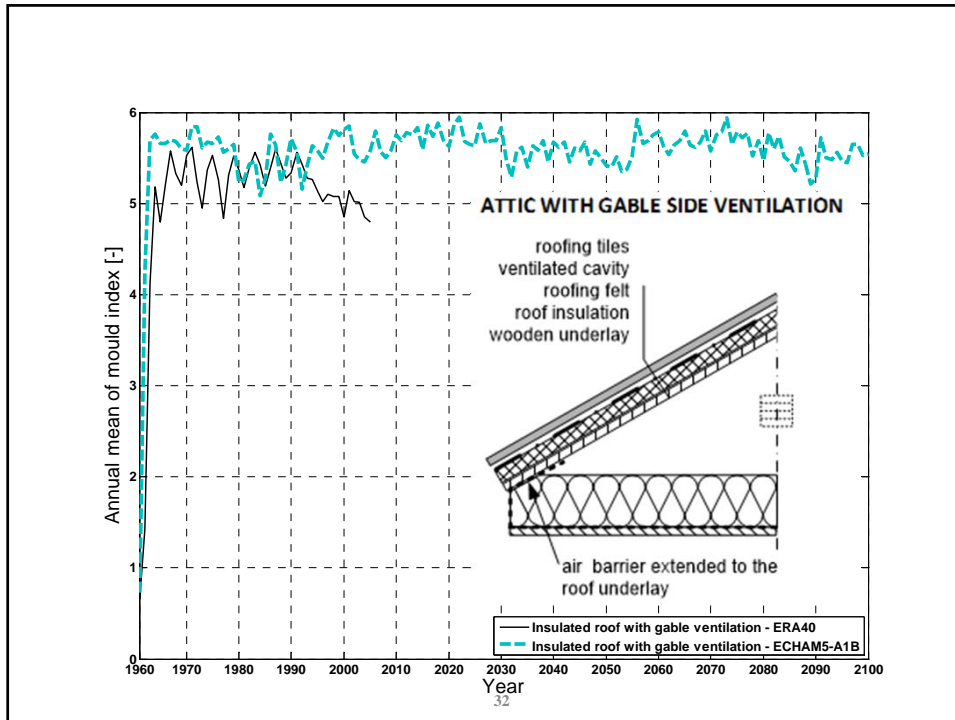


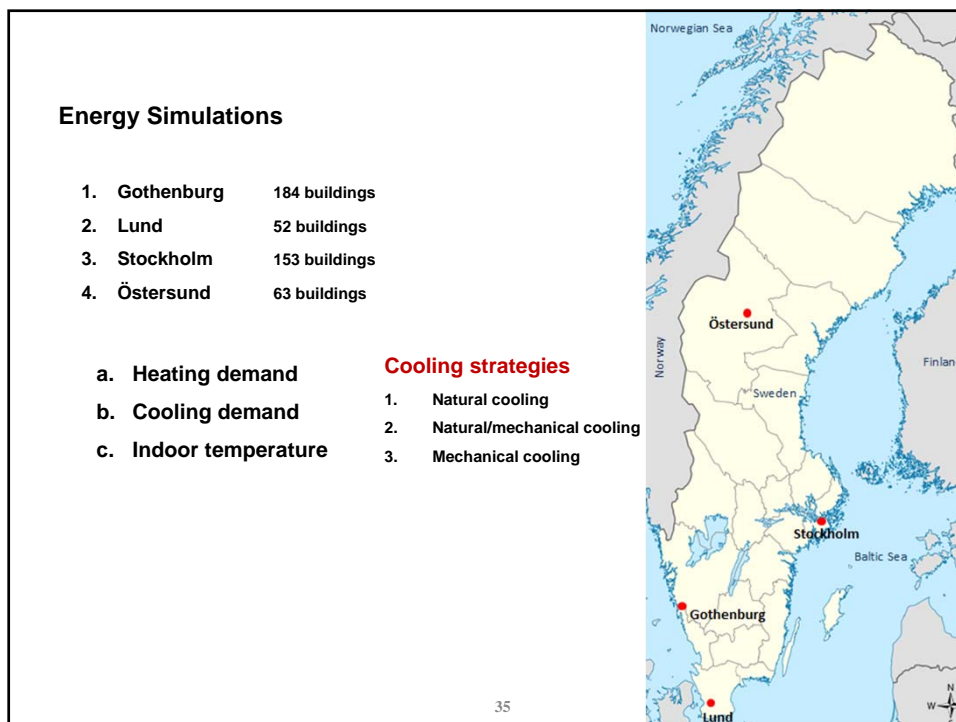
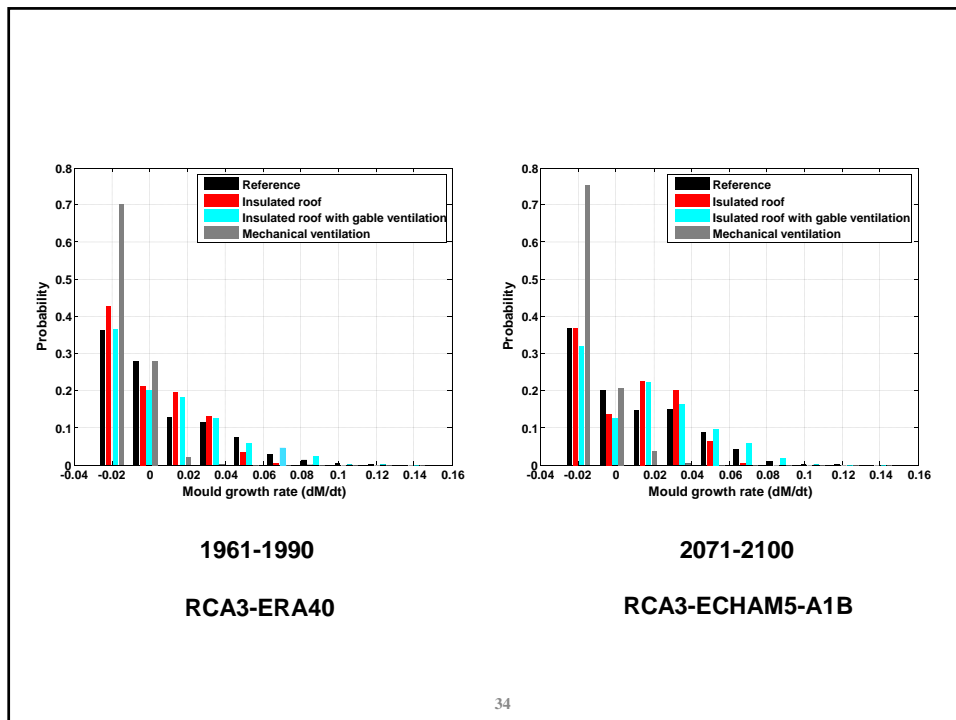
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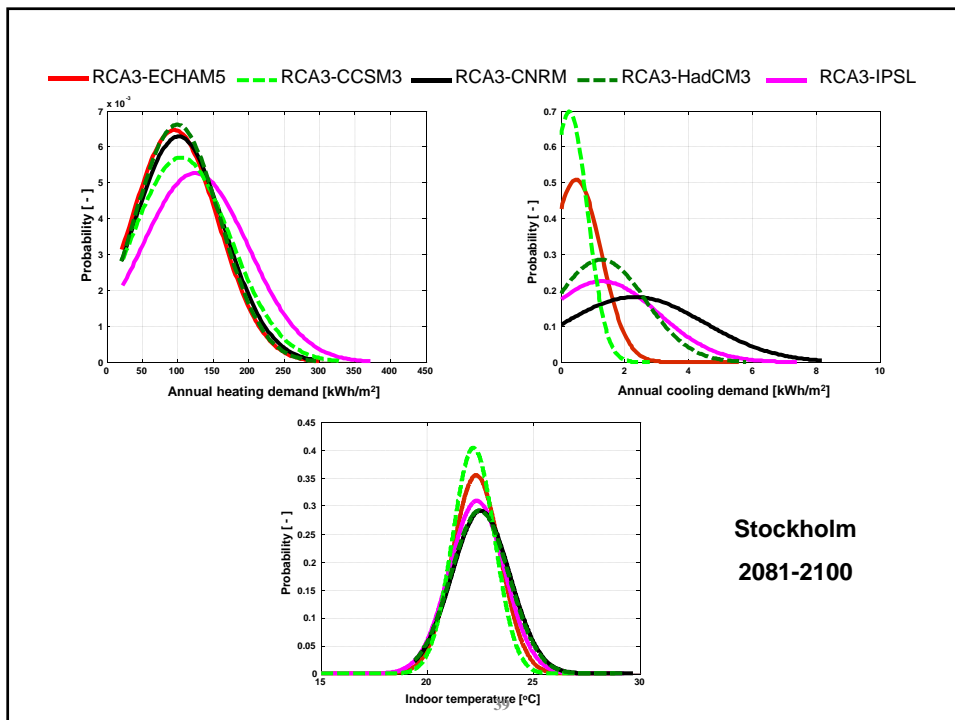
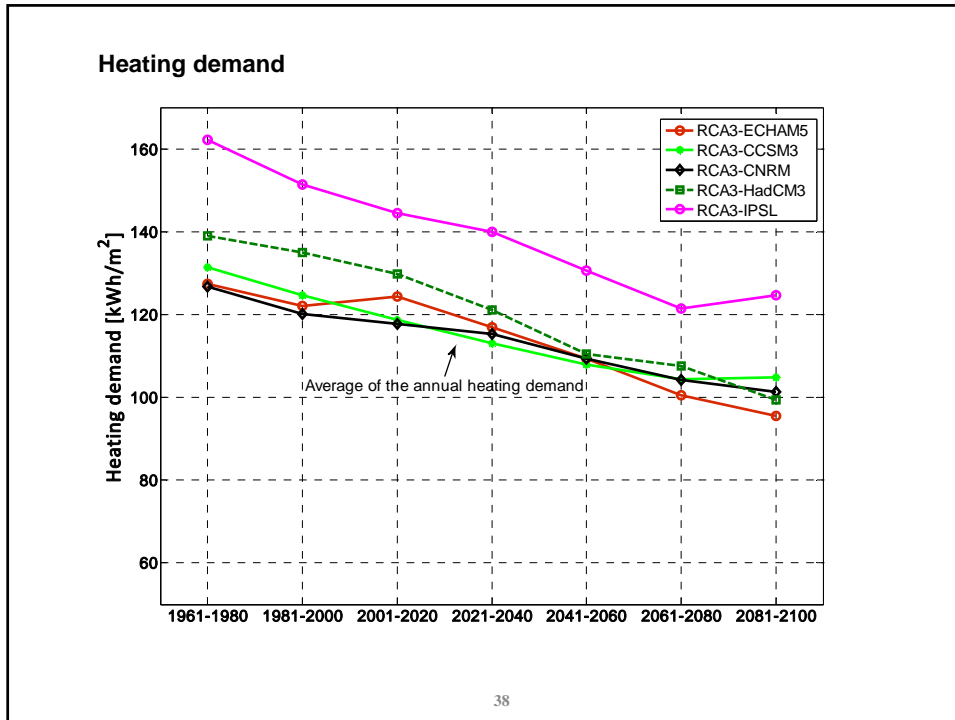
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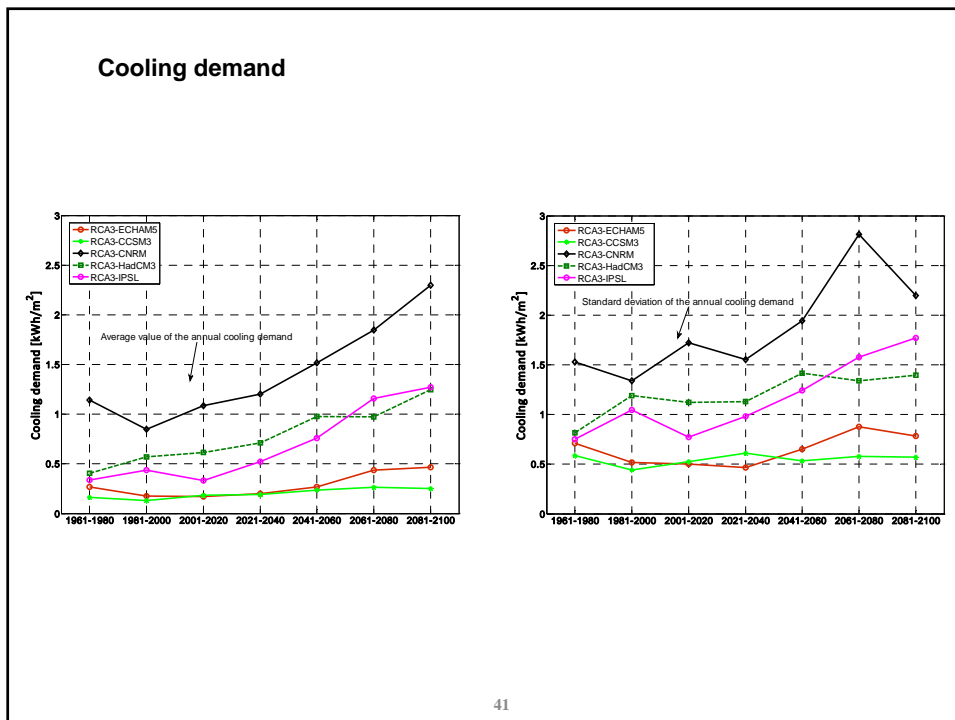
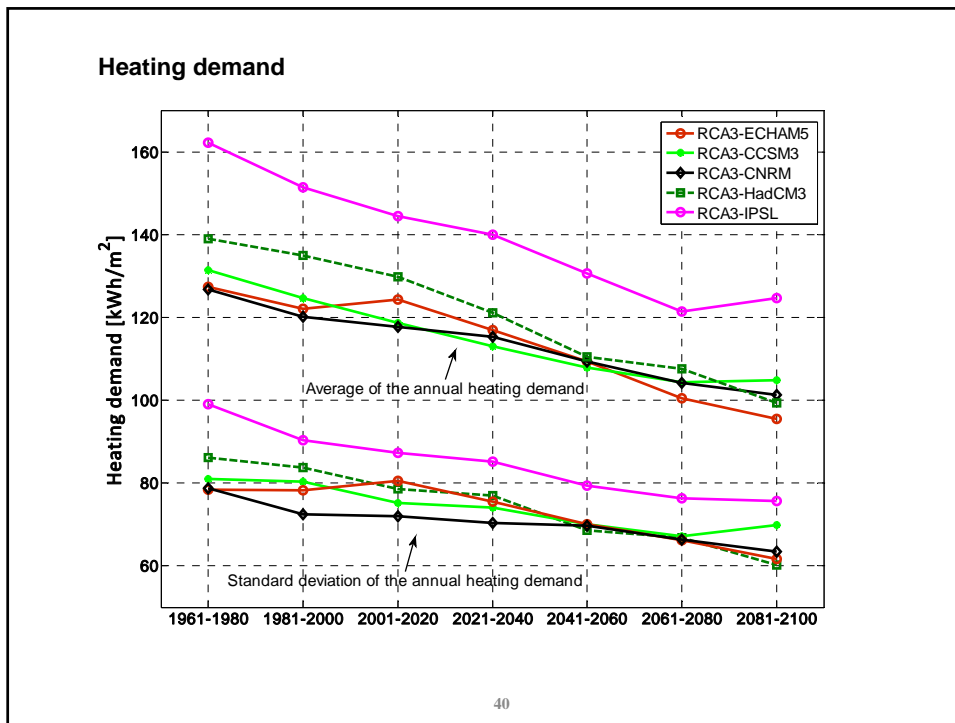


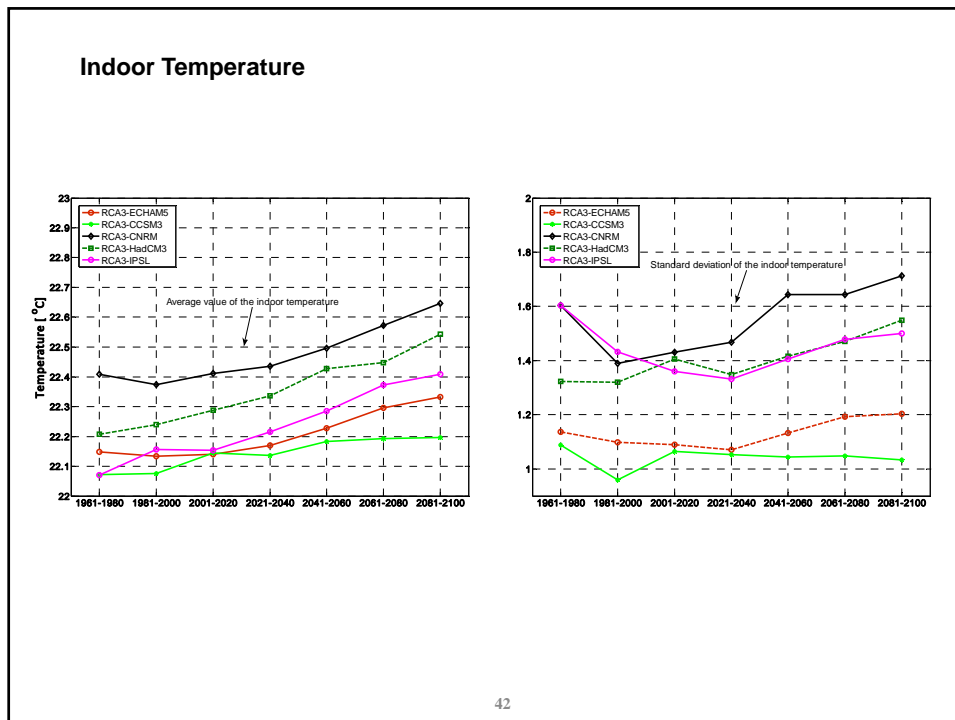












Formas project – started in 2013

**Evaluating the energy retrofitting strategies of the Swedish building stock for the uncertain future climate**

**Utvärdering av energistrategier vid upprustning av det svenska byggnadsbeståndet inför ett osäkert framtida klimat**

### Some points

- Impact analysis of the climate change cannot be based on a few number of climate scenarios.
- Temperature and humidity levels will increase in attics which can increase the risk of mould growth, specifically in attic. Most of the passive strategies won't work in future.
- Heating demand and its variations will decrease in the future. Decrement does not happen with the same rate among the cities and the climate scenarios.

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