Climate Change in the Pacific Northwest: Do Global Models Tell the Whole Story?

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IPCC Scenarios for Pacific Northwest Climate Change

![Graph showing climate change projections for the Pacific Northwest, with observed 20th-century variability and projected temperature changes. The graph includes multiple models and future time periods.]

- Observed 20th-century variability
- Projected temperature changes: 0.4-1.0°C, 0.9-2.4°C, 1.2-5.5°C
- Models: IPSL, MIROC, CCSM, HadCM3, CGCM, Echam5, CNRM, CSIRO, PCM, GISS
- Change in temperature
IPCC Scenarios for Pacific Northwest Climate Change

Change in precipitation

Observed 20th century variability

Pacific Northwest
Downscaling Methods Used in CIG Impacts studies

Empirical Downscaling
• Assumes climate model captures temperature and precipitation trends

Regional Climate Model
• Represents regional weather processes
• May produce local trends not depicted by global models
Mesoscale Climate Model -- MM5

- Based on **MM5 Weather Model**
- ECHAM5 Climate Model used to force Mesoscale Simulation
- Nested grids 135-45-**15** km
- **Nudging** on outermost grid by forcing **global model**
- Advanced land-surface model (NOAH) with interactive deep soil temperature
Model Topography and Resolution

MM5 Topo (15 km)  

ECHAM5 Topo (150 km)
More Rain
Shift in Pacific Storm Track

1950-2000 to 2050-2100 Nov-Dec-Jan
Composite of 10 Global Models

“Observed” Climate
NCEP-NCAR Reanalysis

20th Century Model Composite

21st Century Model Composite

Salathé, Geophys Res Lett, 2006
MM5 Result for November

Change 1990s to 2050s NOV Total Precip (mm/day)
MM5 vs Statistical Downscaling

Statistical Downscaling
Precip only

Precip & Winds

MM5

Change in November Precip (mm/day)
1990s to 2050s
More Warming
Winter Warming in MM5

1990s to 2050s
Temperature Change

Difference between
MM5 and ECHAM5

Change in Winter Temperature (degrees C)

Less warming In MM5

More warming In MM5
Loss of Snow cover and Warming

Temperature Change

Snow Cover Change
January to April in MM5

April–Jan MM5 1990s T2M (°C)

April–Jan MM5 1990s Snow Fraction (%)
Comparison of MM5 and HCN Observations

April minus January Air Temperature

1990-1999

Correlation Coef: 0.82

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<tr>
<th>MM5 Model (°C)</th>
<th>HCN Observations (°C)</th>
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The scatter plot shows a strong correlation between MM5 model predictions and HCN observations, with a correlation coefficient of 0.82. The data points are well aligned with the 1:1 line, indicating good agreement between the two datasets.
Consistent trend over 21st Century

2020s

2050s

2090s

![Map showing change in winter temperature (degrees C)]
Regional Model Compared to Global Model

2020s 2050s 2090s

Change in Winter Temperature (degrees C)
Overestimate in global model

ECHAM5
1990s to 2050s
Temperature Change

MM5 Topo

ECHAM5 Topo
Winter Trends at Various Stations

MM5 - ECHAM5

Temperature Change (°C)

- Cascade Crest
- Cascade Upwind
- Columbia Basin
- Snake Plain
- WA Coast

Year:
- 1980
- 2000
- 2020
- 2040
- 2060
- 2080
- 2100
Winter Trends at Various Stations

MM5 - ECHAM5

Temperature Change (°C)

Cascade Crest
Cascade Upwind
Columbia Basin
Snake Plain
WA Coast

10 IPCC Models

Temperature Change (°F)

Temperature Change (°C)
Summary

Do Global Models Tell the Whole Story?

NO

• Circulation changes alter the orographic influences on precipitation

• Snow-albedo feedback works at very fine scales and produces large regional variations in warming