Climate, Infiltration, and UZ Flow for TSPA-VA

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Climate

- Affects infiltration, UZ flow (w-t rise), SZ flow (flux), and biosphere components

- Three climate states are represented
  - DRY (similar to present)
  - LTA (long-term average; similar to Santa Fe)
  - SP (super-pluvial; similar to Los Alamos)

- Transition from one state to another is instantaneous

- Over 80% of the sampled time is LTA
Climate (contd.)

- Climate-change timing based on global paleoclimate record
- Climate magnitude based on local paleoclimate record
SPECMAP Seabed O-18 (Past Climate)
Climate Reconstructions

Yucca Mountain Project Precipitation estimates using Jaccard analog measure and applying anomaly regression to modern grid

Thompson and Anderson (August, 1997)
# Climate Definition

<table>
<thead>
<tr>
<th></th>
<th>DRY</th>
<th>LTA</th>
<th>SP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>average precip (mm/yr)</strong></td>
<td>150</td>
<td>300</td>
<td>450</td>
</tr>
<tr>
<td><strong>analog site</strong></td>
<td></td>
<td>Area 12</td>
<td>South Lake, CA</td>
</tr>
<tr>
<td><strong>average infil (mm/yr)</strong></td>
<td></td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td><strong>I/3 (mm/yr)</strong></td>
<td>2.3</td>
<td>13.3</td>
<td>40</td>
</tr>
<tr>
<td><strong>I*3 (mm/yr)</strong></td>
<td>21</td>
<td>120</td>
<td>360</td>
</tr>
<tr>
<td><strong>duration (ky)</strong></td>
<td>0-20</td>
<td>80-100</td>
<td>0-20</td>
</tr>
<tr>
<td><strong>water-table rise (m)</strong></td>
<td></td>
<td>80</td>
<td>120</td>
</tr>
<tr>
<td><strong>SZ-flux multiplier</strong></td>
<td>--</td>
<td>3.9</td>
<td>6.1</td>
</tr>
</tbody>
</table>
Summary

- TSPA-VA base case is primarily an LTA climate with excursions to more extreme states (DRY and SP)
  - DRY (150 mm/yr)
  - LTA (300 mm/yr – like Santa Fe)
  - SP (450 mm/yr – like Los Alamos)

- Uncertainty/variability limited to climate durations and UZ fluxes
  - no water-table-rise uncertainty
  - no SZ-flux uncertainty
  - no biosphere uncertainty
Sensitivity Analyses
1,000,000-yr Expected-Value Total Dose-Rate History

All Pathways, 20 km

Dose Rate (mrem/yr)

Time (years)
Climate Sensitivity
1,000,000-yr Expected-Value Dose-Rate History
All Pathways, 20 km

Dose Rate (mrem/yr)

Time (years)

Present Day Dry
Long Term Average
Super Pluvial
Infiltration

- Affects UZ flow and T-H components.

- Model calculates water balance in the soil profile based on precipitation, evapotranspiration, permeability, and storativity.

- Net infiltration (model output) is the water percolation rate at bedrock or a depth of 6 m in deep alluvium.
Infiltration Model Parameters

- Precipitation (*site and analog records*)
- Temperature (*site-present day*)
- Cloudiness (*site-present day*)
- Vegetation (*site-present day*)
- Slope (*site*)
- Surface properties (*estimated*)
- Runoff-infiltration fraction (*estimated*)
Present Day Infiltration (Flint et al., 1996)
Area of net infiltration modeling domain

Prominent mountain ranges

State boundaries

Yucca Mountain region boundary

Death Valley ground-water region boundary

Nevada Test Site boundary

- Precipitation stations.

1. 4JA (current climate analog)
2. Area 12 Mesa (wetter future climate analog)
3. Lake Valley - Steward (wetter future climate analog)
4. South Lake (wetter future climate analog)
Long Term Average (32.5 mm/yr: USGS, 10/97)
Super Pluvial (118 mm/yr: USGS, 10/97)
Super Pluvial x5 (284 mm/yr: USGS, 10/97)

Northing [m]

Easting [m]

MM/Year

1800
675
600
525
450
375
300
225
150
75
15
Sensitivity Analyses
DKM-\(X_{fm}\) Infiltration Sensitivity

100,000-yr Expected-Value Dose-Rate History

All Pathways, 20 km

![Graph showing dose rate over time for different scenarios with logarithmic scale on the y-axis and linear scale on the x-axis.](image)
UZ Flow

- Affects seepage and UZ transport components (also, UZ properties are used by the T-H component)
- Model is 3-D, steady-state DKM from LBNL (1997)
- Model is calibrated to $S_m$, $\psi_m$, pneumatic data, and perched water, using infiltration maps and site hydrologic-property data
- TSPA calculation samples among discrete flow fields produced by the model
Mountain-Scale UZ Flow Model
(Bodvarsson et al., 1997)
East-West Stratigraphy at SD-7

GFM DEVELOPED BY LBNL
EAST-WEST SECTION B-B' THROUGH SD-7

EAST NEVADA COORDINATES (m)
Base-Case UZ-Flow Simulations
(15 Simulations)

Uncertainty in Parameters

Min. $\alpha_f$
Fitted $X_{fm}$

Min. $\alpha_f$
Fitted $X_{fm}$

Mean $\alpha_f$
Fitted $X_{fm}$

Max. $\alpha_f$
Fitted $X_{fm}$

Uncertainty in present-day infiltration

mean/3
mean*3
mean
mean/3
mean*3

Uncertainty in Climate

P LTA/3 SP/3
P LTA*3 SP*3
P LTA SP
P LTA/3 SP/3
P LTA*3 SP*3

Climate Legend

P: Present
LTA: Long-Term Average
SP: Super Pluvial
Streamlines for 3-D UZ Flow Field
Total (fracture+matrix) Percolation Fluxes
Base-Case Long-Term Average Climate Scenario

Surface (Infiltration)

Repository Horizon

Water Table

Percolation Flux (mm/year)
1.0 pulse release 1 mole
0.9 mean alpha model
0.8 present inf.
0.7 long term average inf.
0.6 super pluvial inf.
Normalized accumulative breakthrough curves

Time (year)
SENSITIVITY ANALYSES
Pulse release 1 mole, no matrix adsorption, no matrix diffusion

Normalized accumulative breakthrough curves

- $E[\alpha]$, lta. inf.
- WEEPS, lta. inf.

Time (year)
DKM-weeps Infiltration Sensitivity
100,000-yr Expected-Value Dose-Rate History
All Pathways, 20 km

Dose Rate (mrem/yr)

Time (years)

IXfm Model
Weeps Model