SAND2011-2244C

YUCCA MOUNTAIN 2008 PERFORMANCE ASSESSMENT: INCORPORATION OF SEISMIC HAZARD CURVE UNCERTAINTY

Jon C. Helton, SNL
Cédric J. Sallaberry, SNL

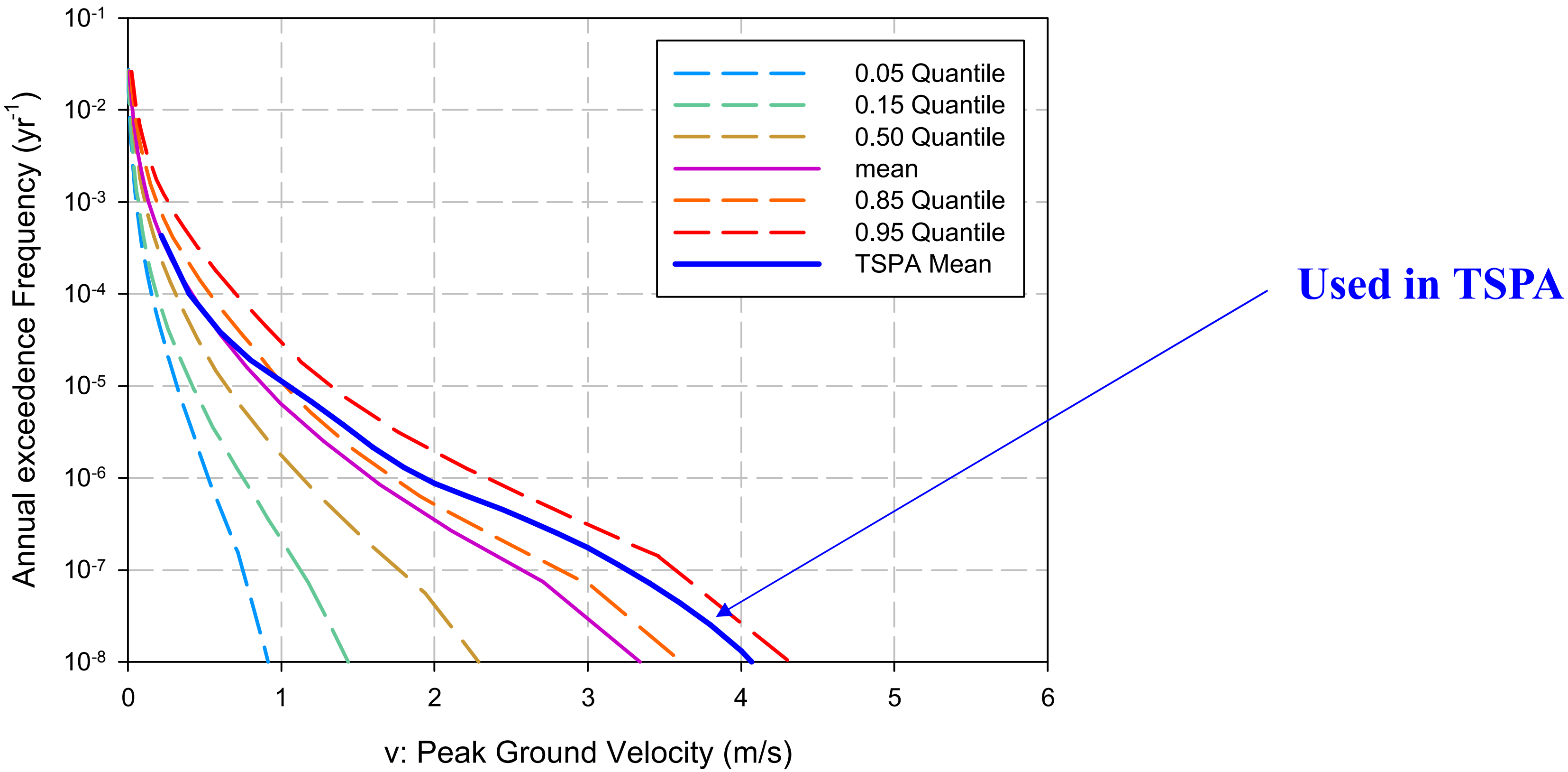
International High-Level Radioactive Waste Management Conference
Albuquerque, NM
April 10-14,2011

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

Uncertainty on seismic hazard curve

A "mean" value was used to represent Seismic Hazard Curve in the 2008 TSPA analysis.

Q: What are the consequences of using a single value instead of a distribution ?



Equation of expected dose for Seismic GMD scenario class [0 – 20,000 yr]

$\lambda_1(\mathbf{e})$ = occurrence rate (yr^{-1}) for seismic ground motion events that cause damage to CDSP WPs with intact internals, (Eq. J.8.3-3)

$d_{A1}(A|\mathbf{e})$ = density function (m^{-2}) defined on set $\mathcal{A}1$ for damaged (i.e., diffusive) area on a CDSP WP with intact internals conditional on the occurrence of a damaging seismic ground motion event, (Eq. J.8.3-4)

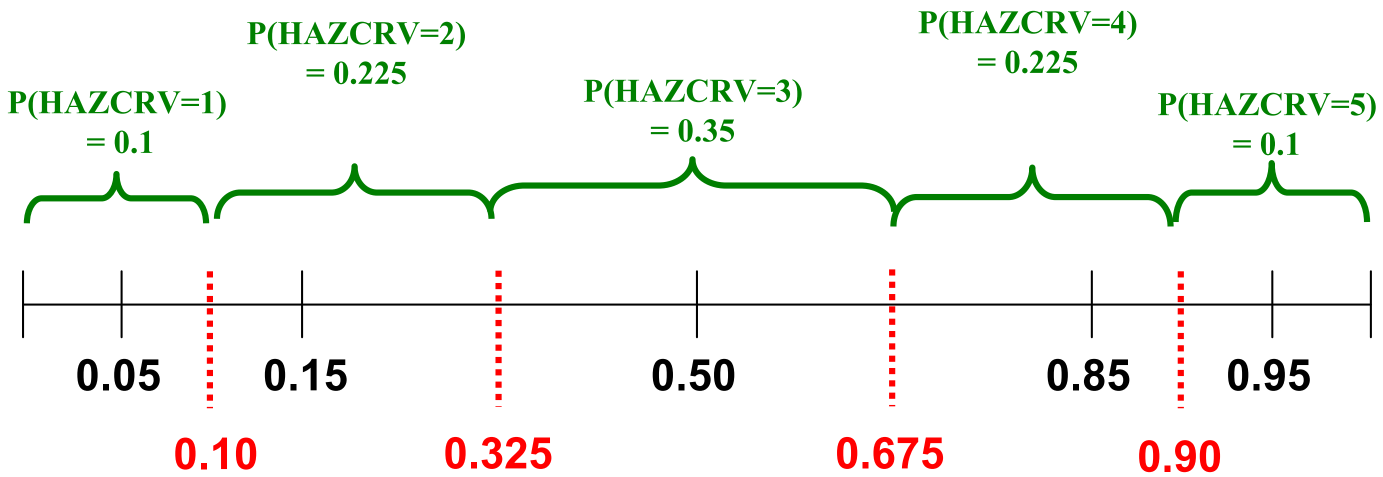
$\lambda_2(\mathbf{e})$ = occurrence rate (yr^{-1}) for seismic ground motion events that cause damage to CDSP WPs with degraded internals, (Eq. J.8.3-5)

$d_{A2}(A|\mathbf{e})$ = density function (m^{-2}) defined on set $\mathcal{A}2$ for damaged (i.e., diffusive) area on a CDSP WP with degraded internals conditional on the occurrence of a damaging seismic ground motion event. (Eq. J.8.3-6)

$$\bar{D}_{SG}(\tau|\mathbf{e}) = \int_0^\tau \left(\lambda_1(\mathbf{e})\exp\left[-\lambda_1(\mathbf{e})t\right]\right)\left(\int_{\mathcal{A}1} D_{SG}(\tau|[1,t,A],\mathbf{e}_M)\, d_{A1}(A|\mathbf{e})\,\mathrm{d}A\right.$$
$$\left. + \int_t^\tau \left[\int_{\mathcal{A}2} D_{SG}(\tau|[1,\tilde{t},A],\mathbf{e}_M)\, d_{A2}(A|\mathbf{e})\,\mathrm{d}A\right] \lambda_2(\mathbf{e})\,\mathrm{d}\tilde{t}\right)\mathrm{d}t$$

Changing the hazard curve from a single value to a distribution will affect the distributions of λ_1 and λ_2

Construction of Discrete Distribution for Seismic Hazard Curve



Weighting

0.05 Quantile ~ HAZCRV1: 0.10

0.15 Quantile ~ HAZCRV2: 0.225

0.50 Quantile ~ HAZCRV3: 0.35

0.85 Quantile ~ HAZCRV4: 0.225

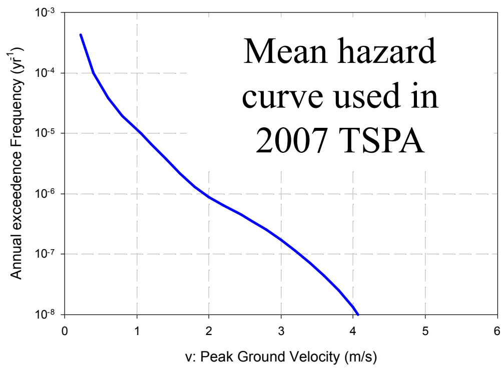
0.95 Quantile ~ HAZCRV5 : 0.10

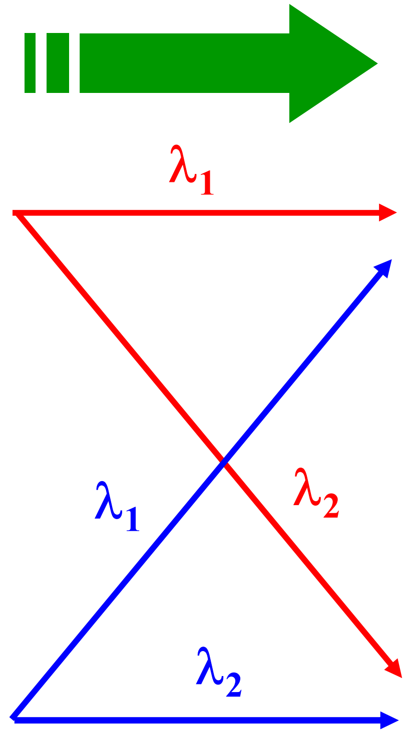
Why using a discrete distribution ?

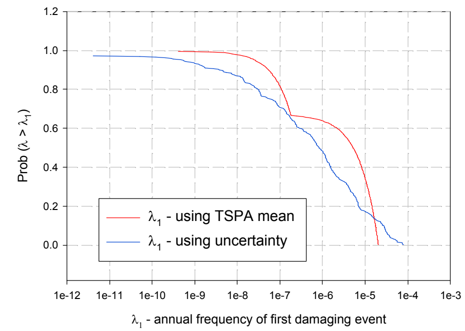
- no control on the work that determine seismic hazard curve : only quantiles were available once this study has been done.
- No information w/ respect to the shape of individual distributions used to construct these quantiles.

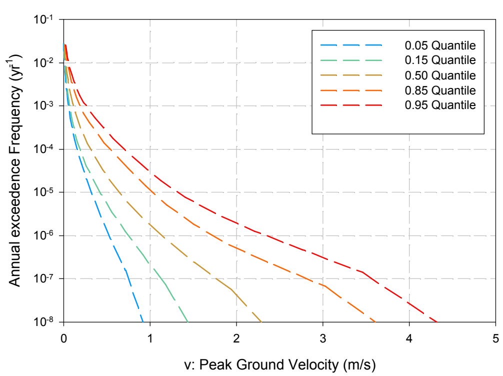
Uncertainty on annual frequency of damaging event

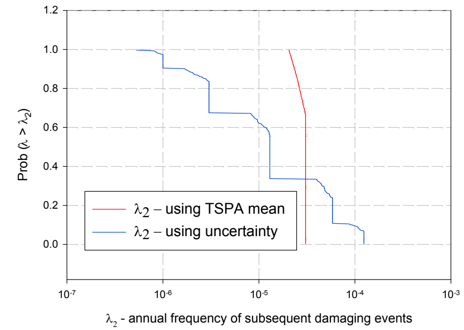
Uncertainty in RST











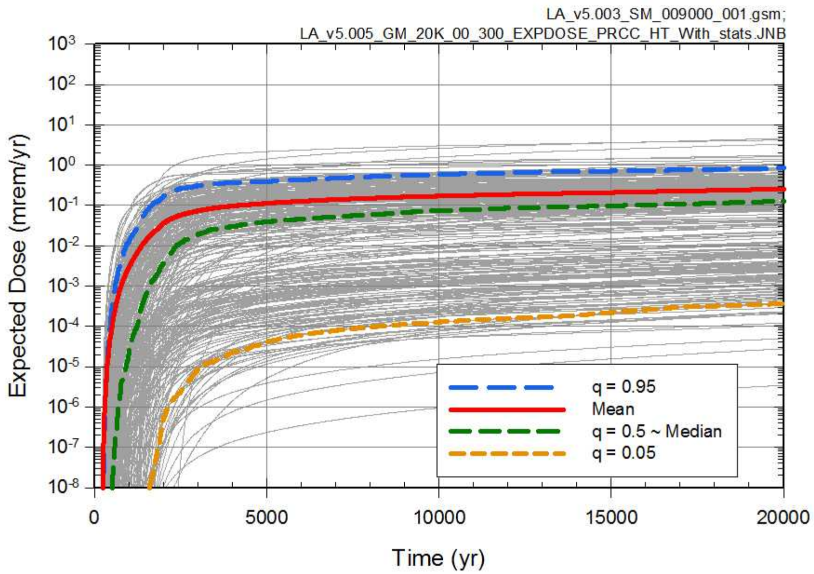
Hazard Curves for PGV

HAZCRV={HAZCRV1,…,HAZCRV5}

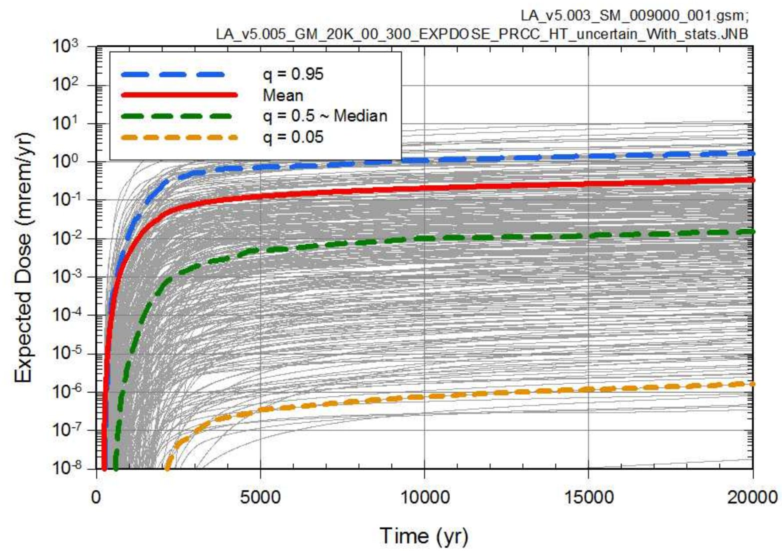
Distribution of Annual frequency of damaging seismic event

Influence of adding uncertainty on lambda (1/5)

Without uncertainty

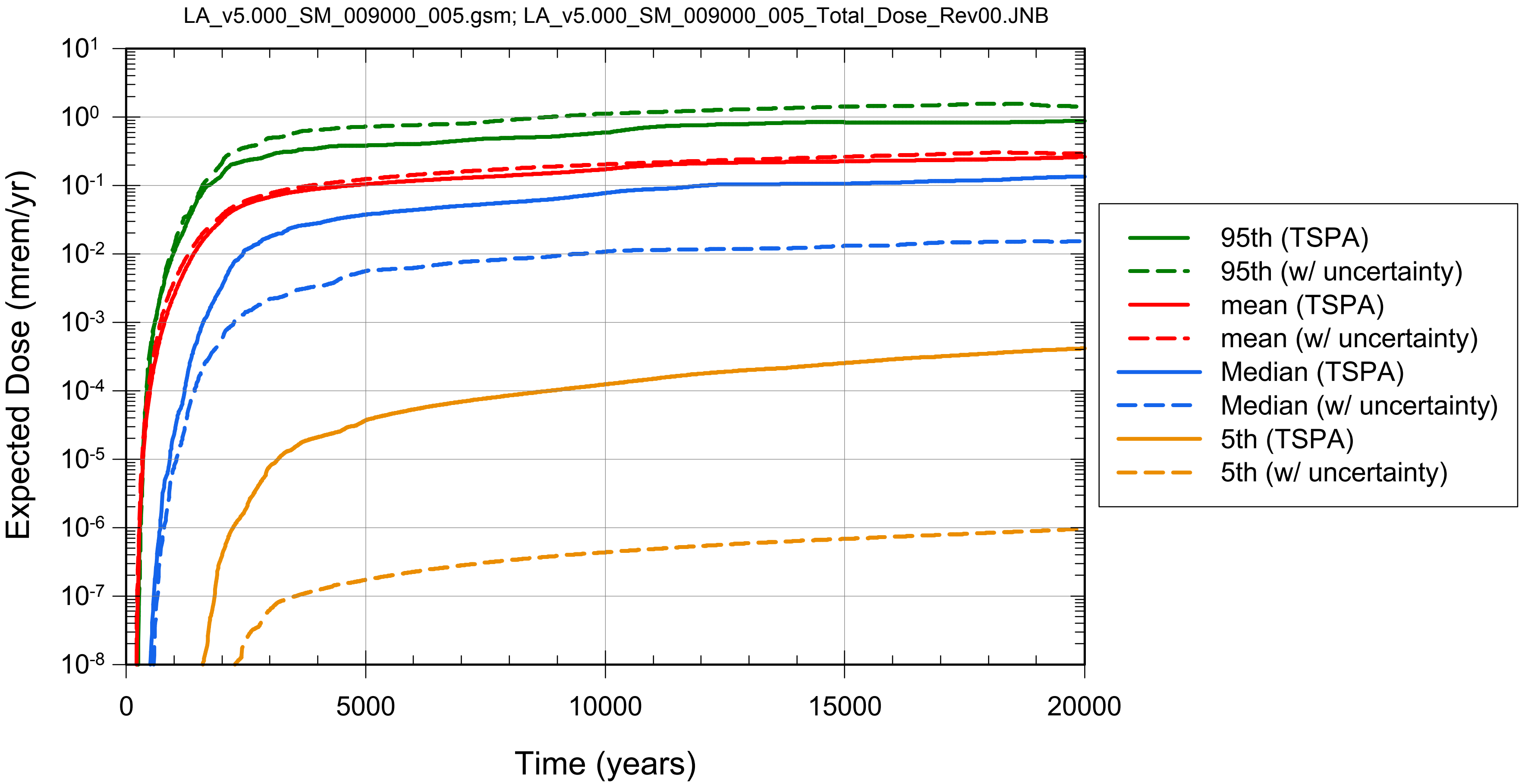


With uncertainty



The spread of the distribution is a lot more important, especially toward the lowest values.

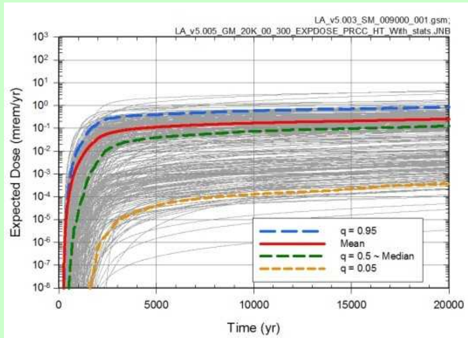
Influence of adding uncertainty on lambda (2/5)

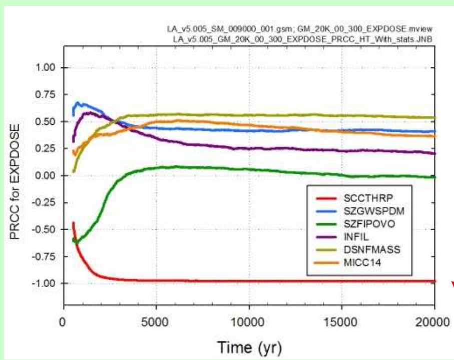


The effect of uncertainty in seismic hazard curve on the mean value (used for regulatory purposes) is negligible. The choice of the "mean" distribution for the hazard curve was appropriate.

Influence of adding uncertainty on lambda (3/5)

Without uncertainty

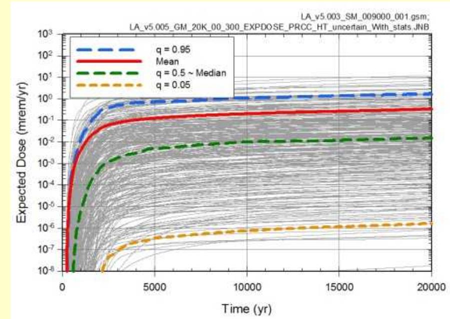


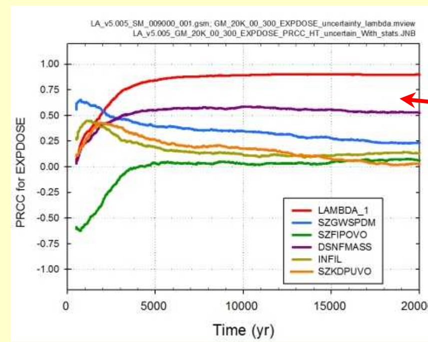


Most important parameter:
SCCTHRP

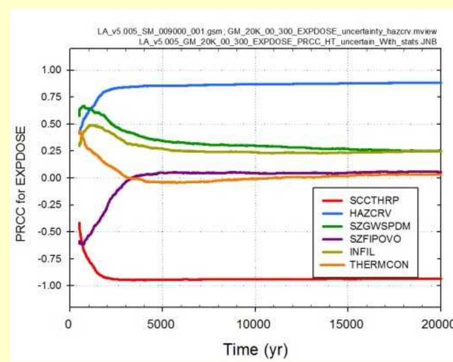
All others parameters with
|PRCC|< 0.5

With uncertainty





Lambda1: most important parameter



A new important parameter: HAZCRV

Influence of adding uncertainty on lambda (4/5)

Without uncertainty

	3000 yr			5000 yr			10,000 yr		
Step	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**
1	**SCCTHRP**	**0.81**	**-0.87**	**SCCTHRP**	**0.86**	**-0.91**	**SCCTHRP**	**0.88**	**-0.93**
2	SZGWSPDM	0.83	0.16	MICTC99	0.88	0.10	MICTC99	0.90	0.12
3	INFIL	0.85	0.13	DSNFMASS	0.89	0.14	DSNFMASS	0.91	0.14
4	MICTC99	0.87	0.10	SZGWSPDM	0.90	0.11	HLWDRACD	0.91	0.08
5	DSNFMASS	0.88	0.14	MICC14	0.90	0.10	MICC14	0.92	0.08

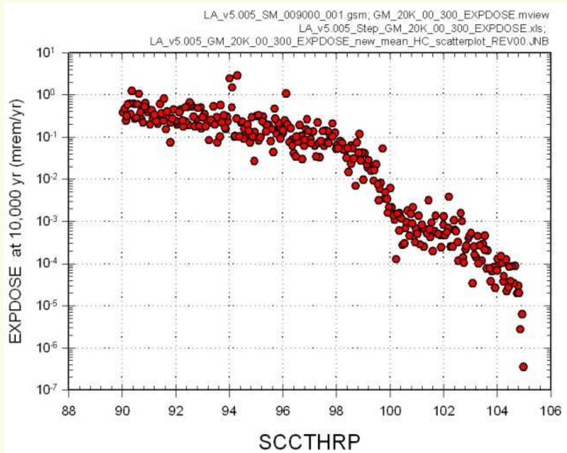
With uncertainty

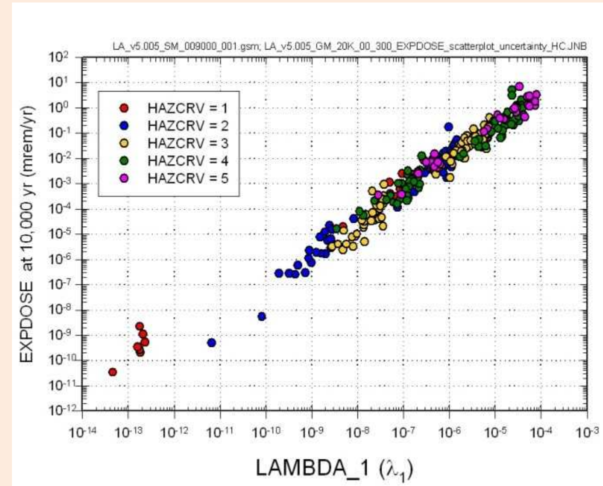
	3000 yr			5000 yr			10,000 yr		
Step	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**
1	**LAMBDA_1**	**0.89**	**0.81**	**LAMBDA_1**	**0.94**	**0.88**	**LAMBDA_1**	**0.96**	**0.95**
2	SZGWSPDM	0.91	0.11	MICTC99	0.95	0.07	MICTC99	0.97	0.07
3	INFIL	0.92	0.09	SZGWSPDM	0.96	0.06	SZGWSPDM	0.97	0.04
4	**SCCTHRP**	**0.92**	**-0.16**	**SCCTHRP**	**0.96**	**-0.10**	**DSNFMASS**	**0.98**	**0.06**
5	MICTC99	0.93	0.07	DSNFMASS	0.96	0.07	HLWDRACD	0.98	0.04

	3000 yr			5000 yr			10,000 yr		
Step	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**	**Variable**	**R^2**	**SRRC**
1	**SCCTHRP**	**0.64**	**-0.81**	**SCCTHRP**	**0.64**	**-0.82**	**SCCTHRP**	**0.61**	**-0.81**
2	**HAZCRV**	**0.85**	**0.46**	**HAZCRV**	**0.88**	**0.49**	**HAZCRV**	**0.89**	**0.53**
3	SZGWSPDM	0.86	0.11	MICTC99	0.89	0.07	MICTC99	0.90	0.07
4	INFIL	0.87	0.09	SZGWSPDM	0.89	0.07	DSNFMASS	0.90	0.07
5	MICTC99	0.88	0.07	WDGCUA22	0.89	-0.06	WDGCUA22	0.90	-0.06

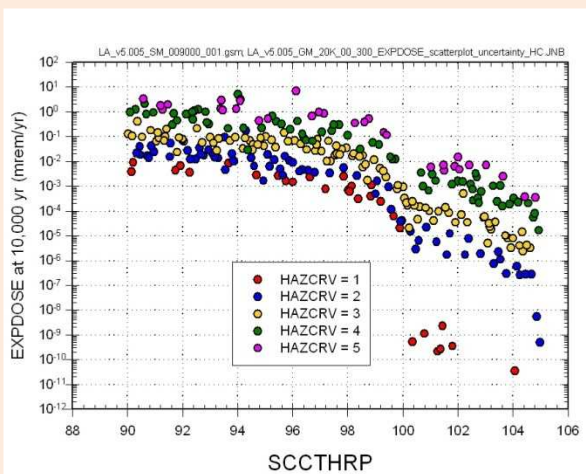
Influence of adding uncertainty on lambda (5/5)

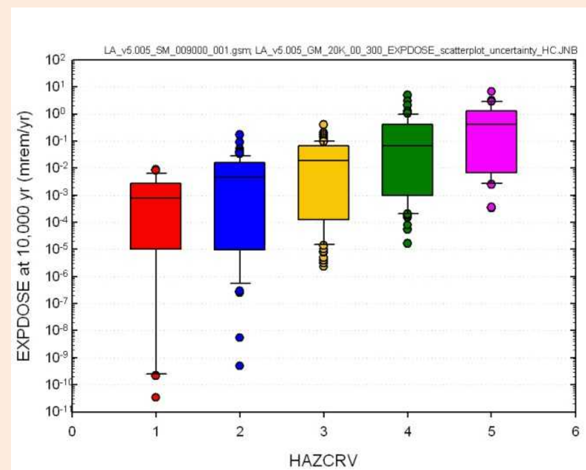
Without uncertainty





With uncertainty





Backup slide – Relation between λ_1, λ_2 and SCCTHRP