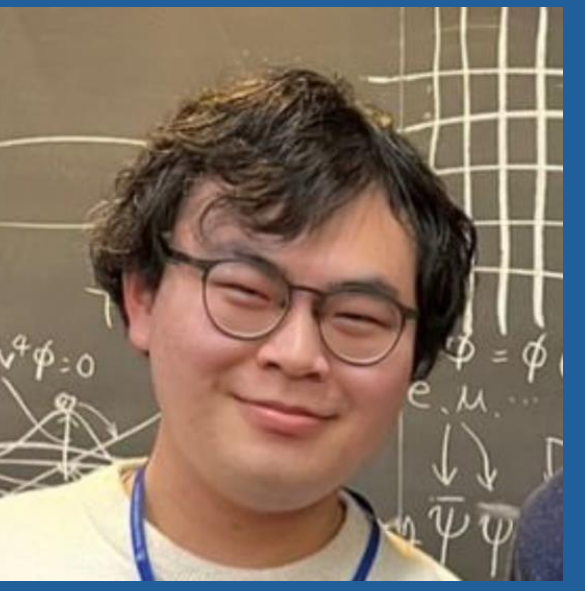




Towards revealing mantle heterogeneities with future directional geoneutrino detection

#43

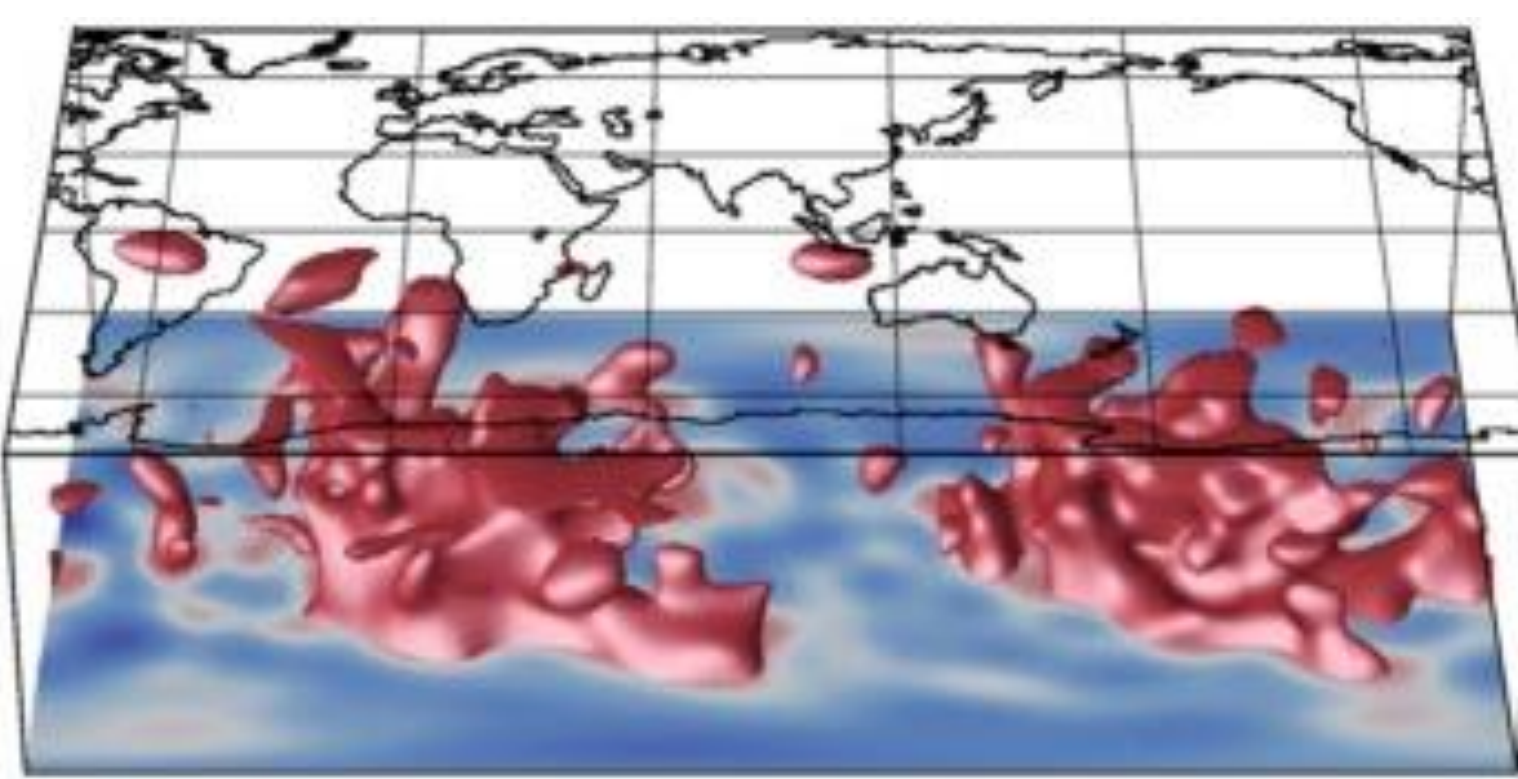
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for OBD Consortium



1. Introduction

Debate: What causes Earth's mantle physical heterogeneity?

LLVP imaged by seismology
(LLVP: Large Low-Velocity Province)



(McNamara, 2019, *Tectonophysics*)

Hypotheses

Thermal Plumes
(temperature-driven)

Moon-Forming Matter
(collision-driven)

Thermochemical Piles
(U, Th-rich)
(composition-driven)

Solution: Directional geoneutrino detection with an Ocean Bottom Detector (OBD) !!

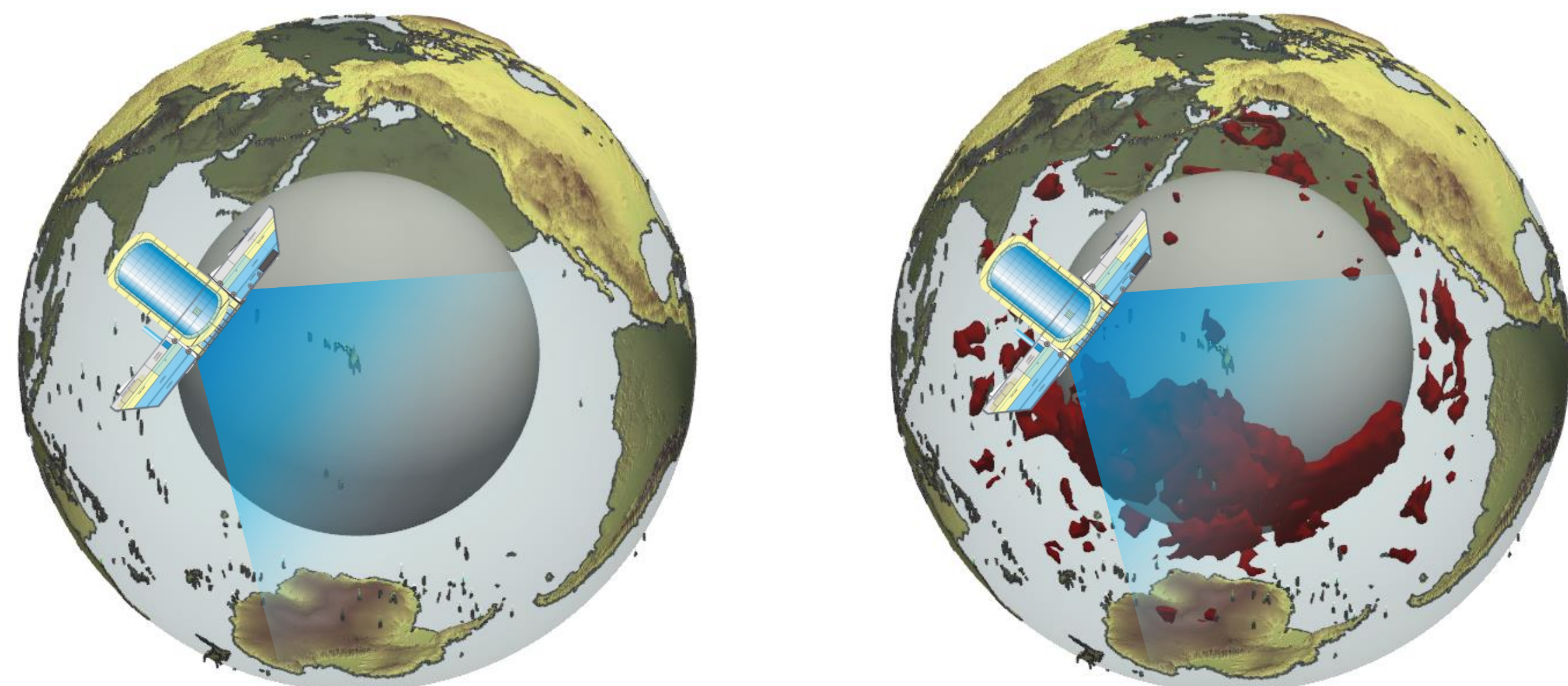
2. Method

Evaluate the angle distribution of geoneutrino flux

$$S(\mathbf{r}) = \epsilon n_p \sum_{X \in \text{HPE}} \frac{N_A \lambda_X}{\mu_X} \int_{E_\nu} \sigma_{\text{IBD}}(E_\nu) \frac{dn_X(E_\nu)}{dE_\nu} dE_\nu \int_{V_\oplus} \frac{\rho(\mathbf{r}') a_X(\mathbf{r}') P_{\text{cc}}(E_\nu, |\mathbf{r} - \mathbf{r}'|)}{4\pi |\mathbf{r} - \mathbf{r}'|^2} d\mathbf{r}'$$

under two chemically distinct cases

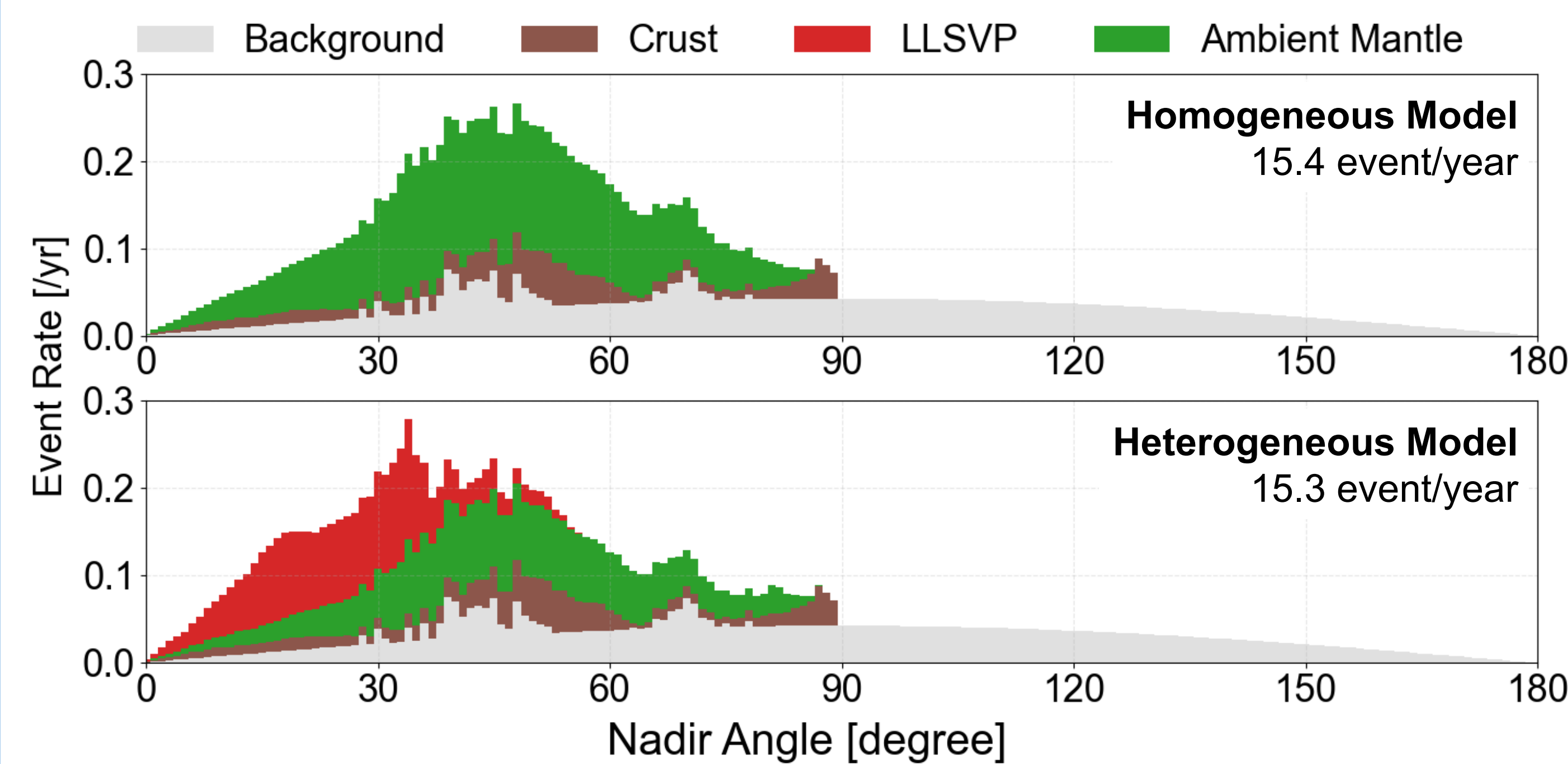
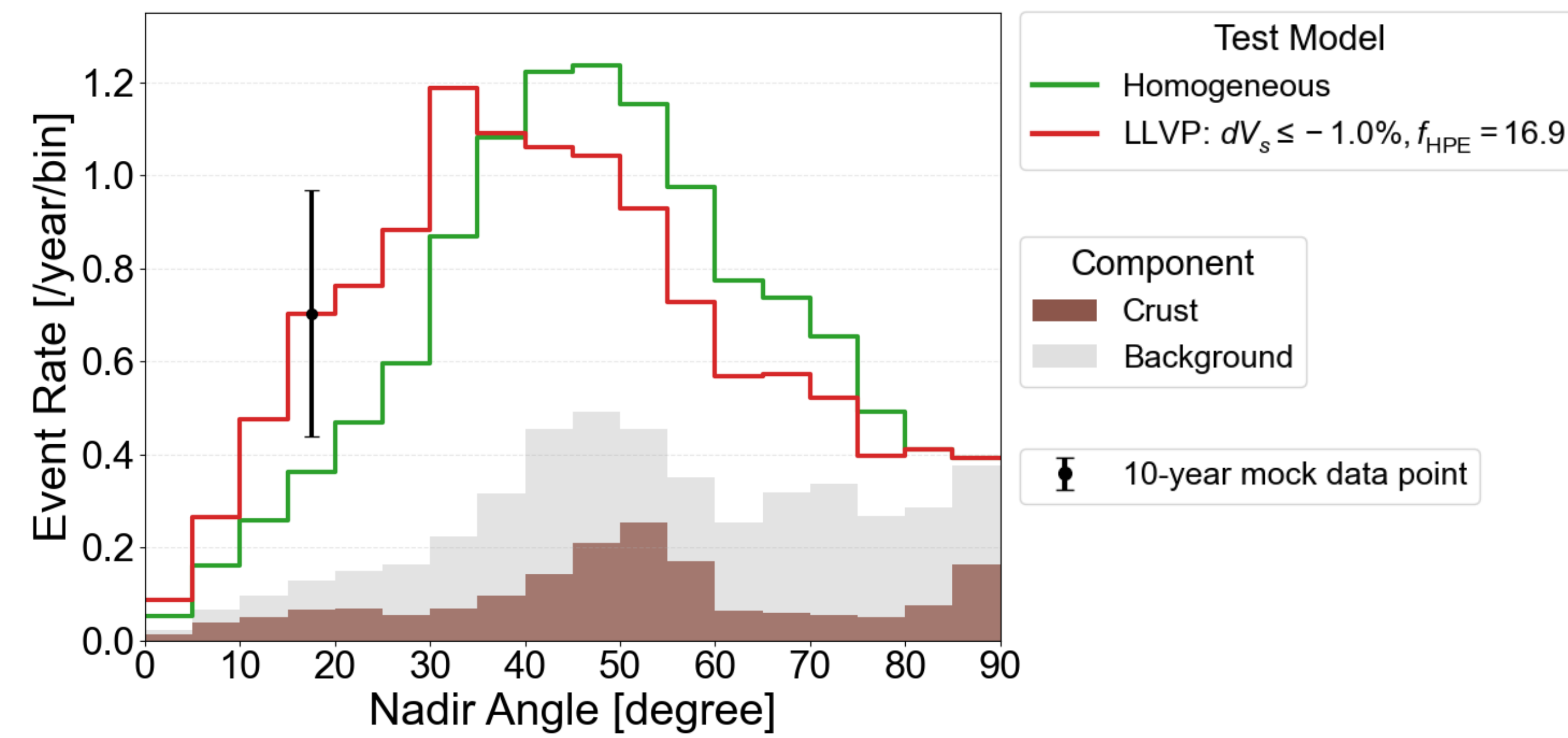
(a) homogeneous mantle (b) heterogeneous mantle



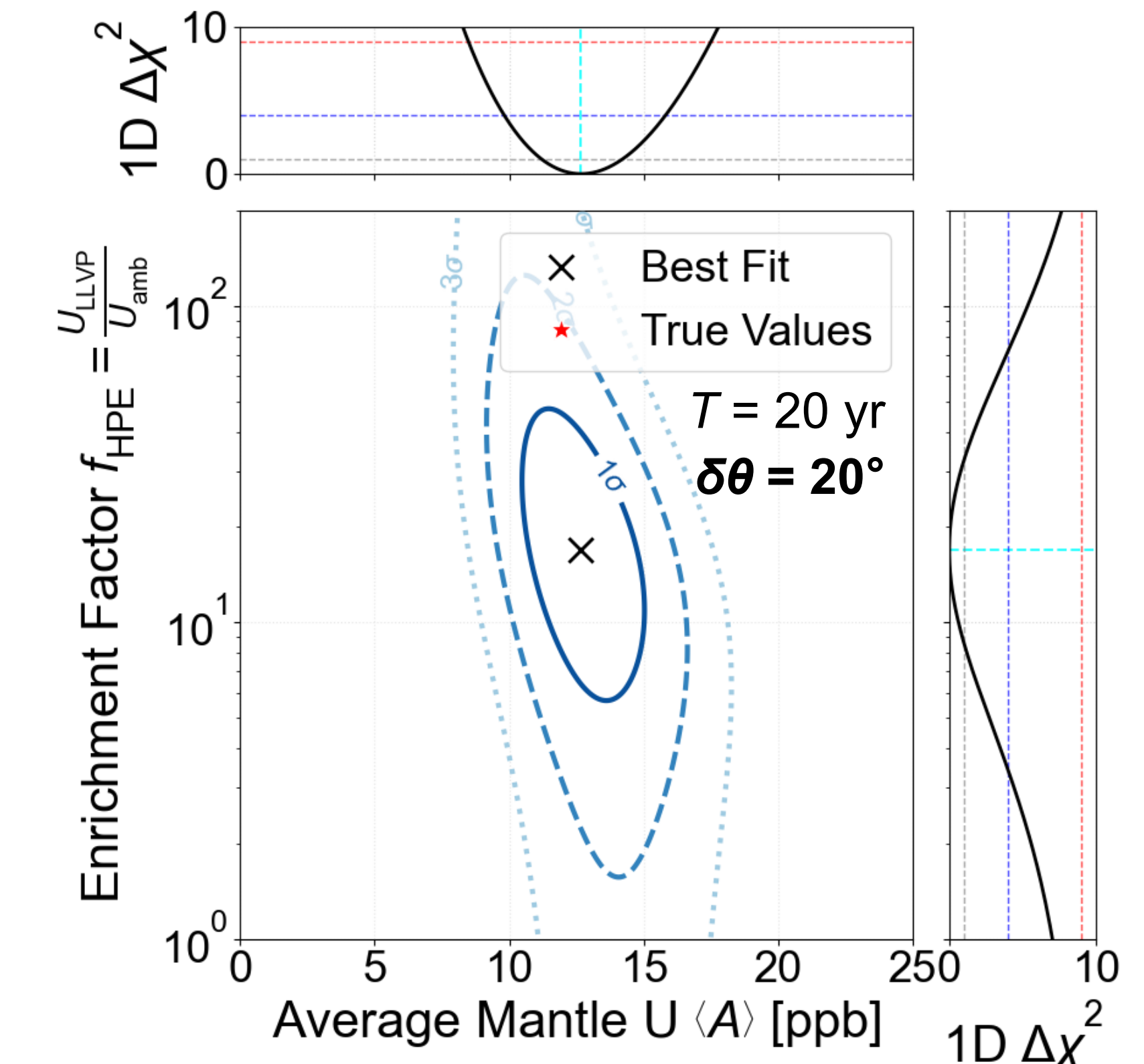
Assess the detectability via (1) result comparisons, (2) likelihood analyses, and (3) sensitivity studies

3. Results

(1) Angle distribution of geoneutrino flux

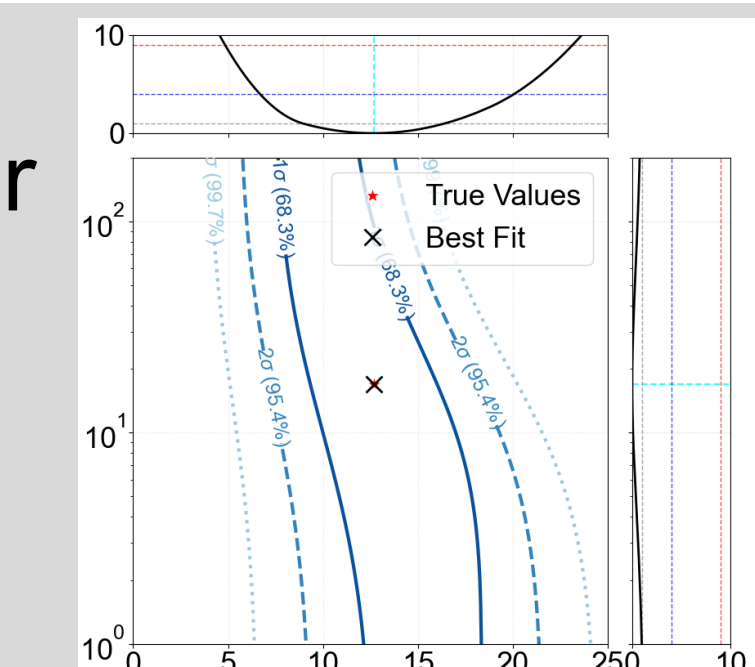


(2) Signal extraction

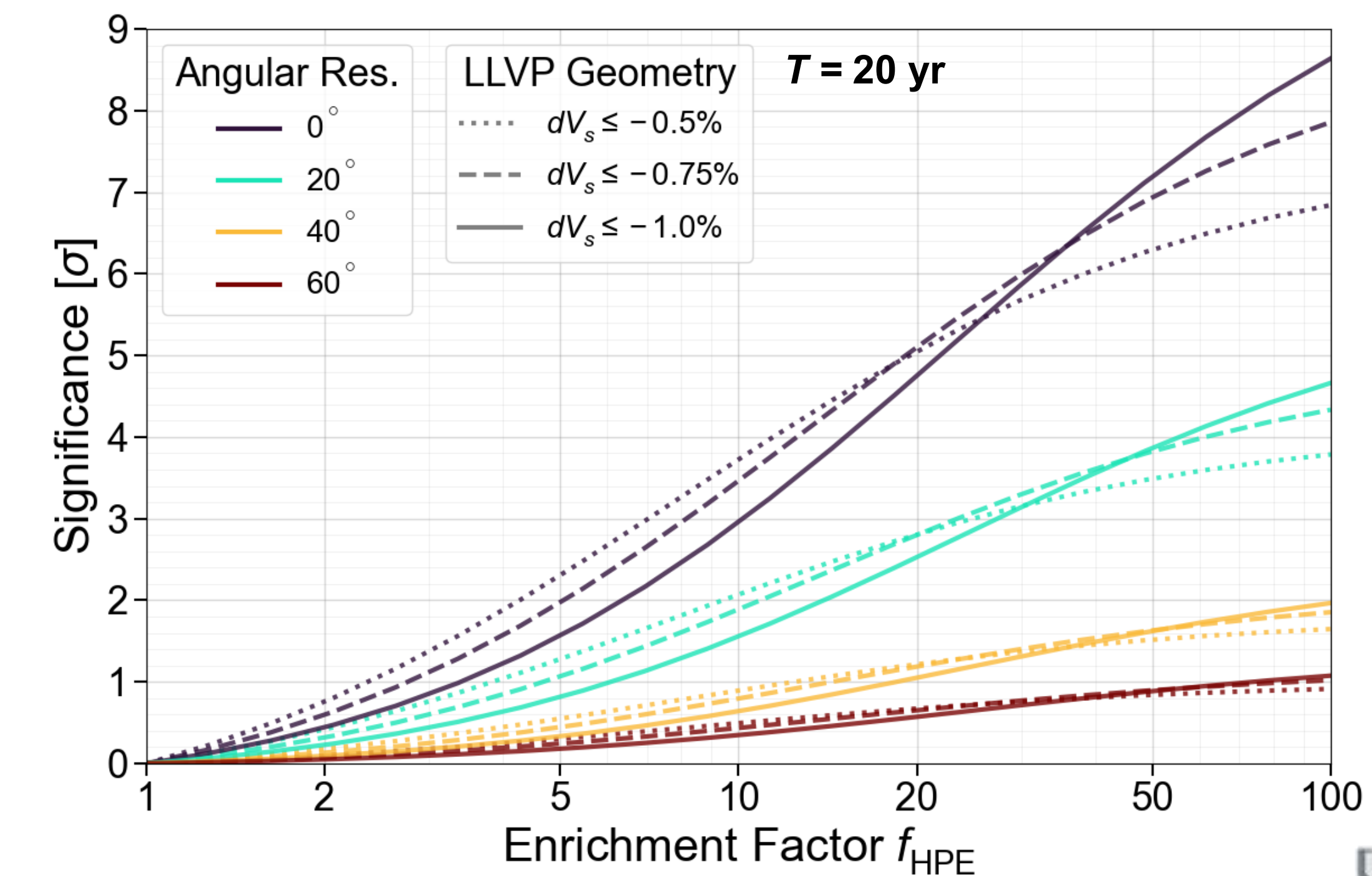
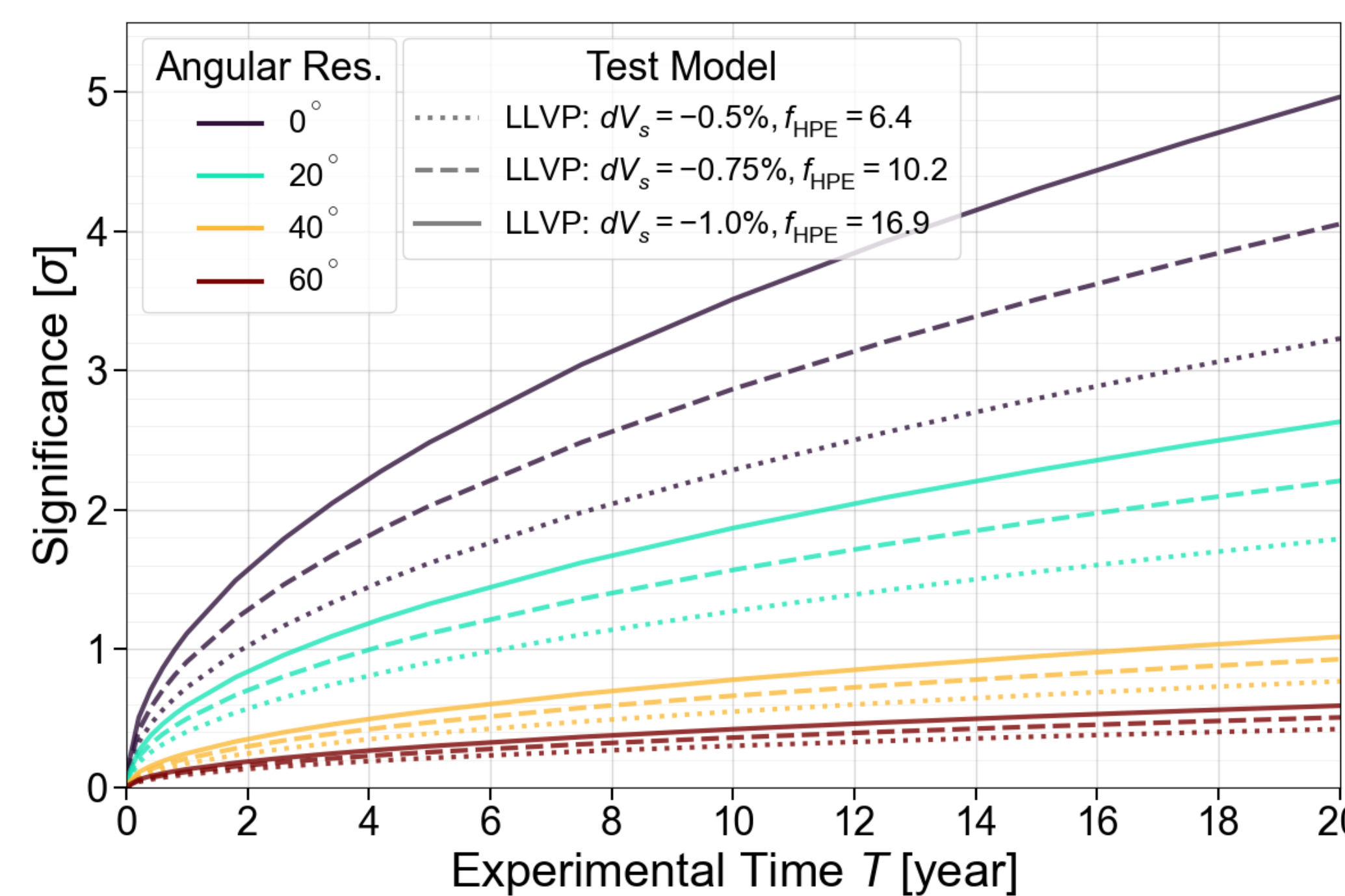


Mantle chemical heterogeneities can be resolved !!

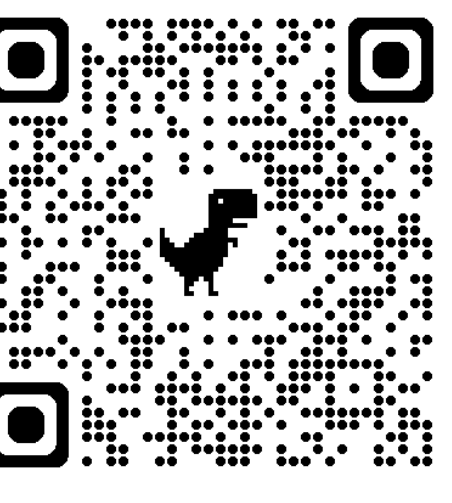
cf. Idealized 10-detector global network using conventional rate-only measurement



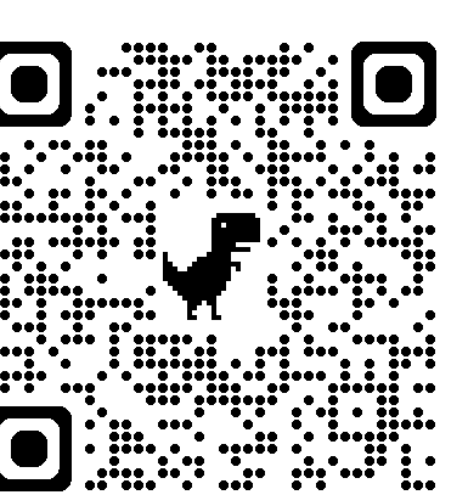
(3) Statistical significance for rejecting a homogeneous mantle hypothesis



Zhihao's homepage



This study (full paper)
arXiv: 2606.15680



This study (short paper)
arXiv: 2606.13273

