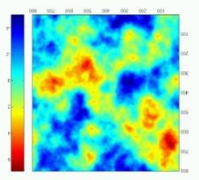




Geostatistics Research Unit



Department of Mineral Resources Engineering
Technical University of Crete, Chania – Greece

Director: Prof. Dionisis Hristopulos

Diploma in Electrical Engineering, NTUA, 1985

PhD Physics, Princeton University, 1991

Dept. of Environmental Sciences & Engin., UNC, Chapel Hill (1993-2000)

Pulp and Paper Research Institute of Canada (2000-2002)

Technical University of Crete (2002 – Present)

Interdisciplinary Research Team

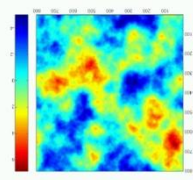
1 Teaching associate

1-2 Post-docs

2-3 M.Sc. & **1-3** PhD students



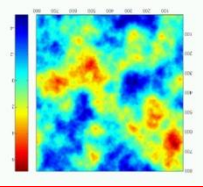
Recent Funded Research Projects



- **BRIDGSEISMTIME** : *Bridging the timescales in fault-slip accumulation: from the earthquake record to the geological record.* (FP7, European Commission). Budget: 202.163€. Duration: 2009-2011.
- **INTAMAP** : *Interoperability and Mapping.* Specific Targeted Research Project (FP6, European Commission). Total Budget: 1.856.000€ - Duration: 2006-2009.
- **SPATSTAT** : *Development of Spartan Spatial Random Field Models for Geostatistical Applications* : Marie Curie Transfer of Knowledge (FP6, European Commission): Budget: 304.806€. Duration: 2005-2008.
- **ACTIVATION**: *Super high Energy Milling in the Production of Hard Alloys, Ceramic and Composite Materials.* Specific Targeted Research Project (FP6, European Commission). Duration 2004-2007. Budget 1.999.999 €
- **PYTHAGORAS II**: *Development of Novel Geostatistical Methods in Environmental Pollutant Mapping and Environmental Risk Assessment.* (National Project). Budget 50.000 €. Duration 2005-2006.



Recent Research Highlights



Scientific Interests

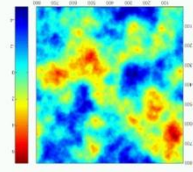
- ❖ Development of novel Geostatistical methods
- ❖ Fast algorithms for reconstruction of missing data
- ❖ Kinetic models of sintering – wealth exchange?
- ❖ Numerical and theoretical models for random media
- ❖ Scale dependence and interevent times of earthquakes

Applications

- ❖ Reconstructions based on incomplete data (environmental mapping)
- ❖ Upscaling of hydraulic properties in heterogeneous media
- ❖ Kinetics of sintering process
- ❖ Estimates of natural resources reserves and risks
- ❖ Statistical models of seismic risk assessment
- ❖ Analysis of GPS time series

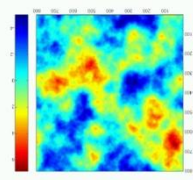


GRU and FuturICT





Langevin Equations, Random Fields and Spatial Data Processing



- The joint SRF pdf is: $f_X(\mathbf{X}; \{s_i\}) = \frac{1}{Z} \exp[-H(\mathbf{X}; \{s_i\})]$
- The **energy functional** involves the squares of the following quantities:

Fluctuation (F) - Gradient (G) - Curvature (C)

$$H[X_\lambda] = \frac{1}{2\eta_0\xi^d} \int ds \left\{ [X_\lambda(s) - E[X_\lambda(s)]]^2 + \eta_1\xi^2 [\nabla X_\lambda(s)]^2 + \xi^4 [\nabla^2 X_\lambda(s)]^2 \right\}$$

FGC-SSRF Properties: *Gaussian, stationary, isotropic SRF*

FGC – SSRF Model Parameters

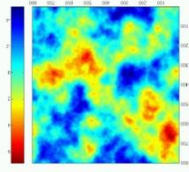
- η_0 : Scale parameter
- ξ : Characteristic length
- η_1 : Covariance shape factor
- k_c : Cutoff wavevector (band limit)

Hristopulos, SIAM J. Scientific Computation, 2003;

Hristopulos & Elogne, IEEE Trans. Infor. Theory 2007; IEEE Trans. Signal Proc., 2009



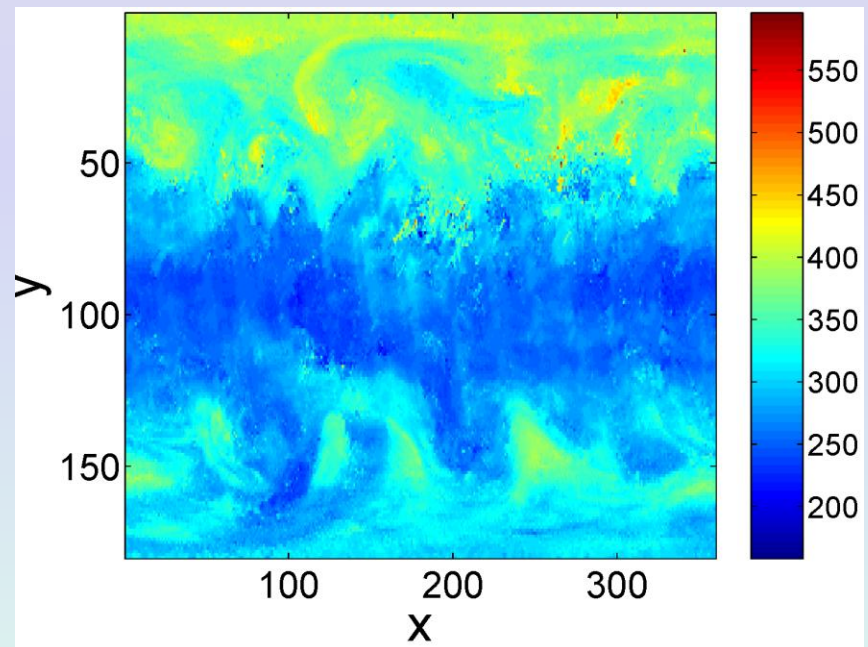
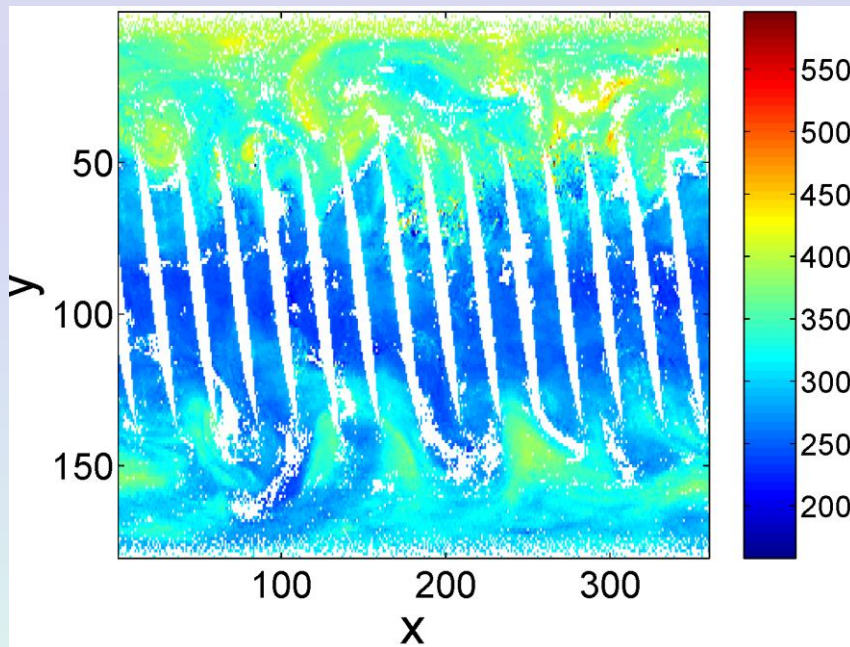
Example: Interpolation of Satellite data



Žukovič and Hristopulos, In preparation

Daily column ozone map with missing data due to limited coverage. Source: NASA, Giovanni online data system

Reconstructed ozone map with *Directional Gradient – Curvature* method

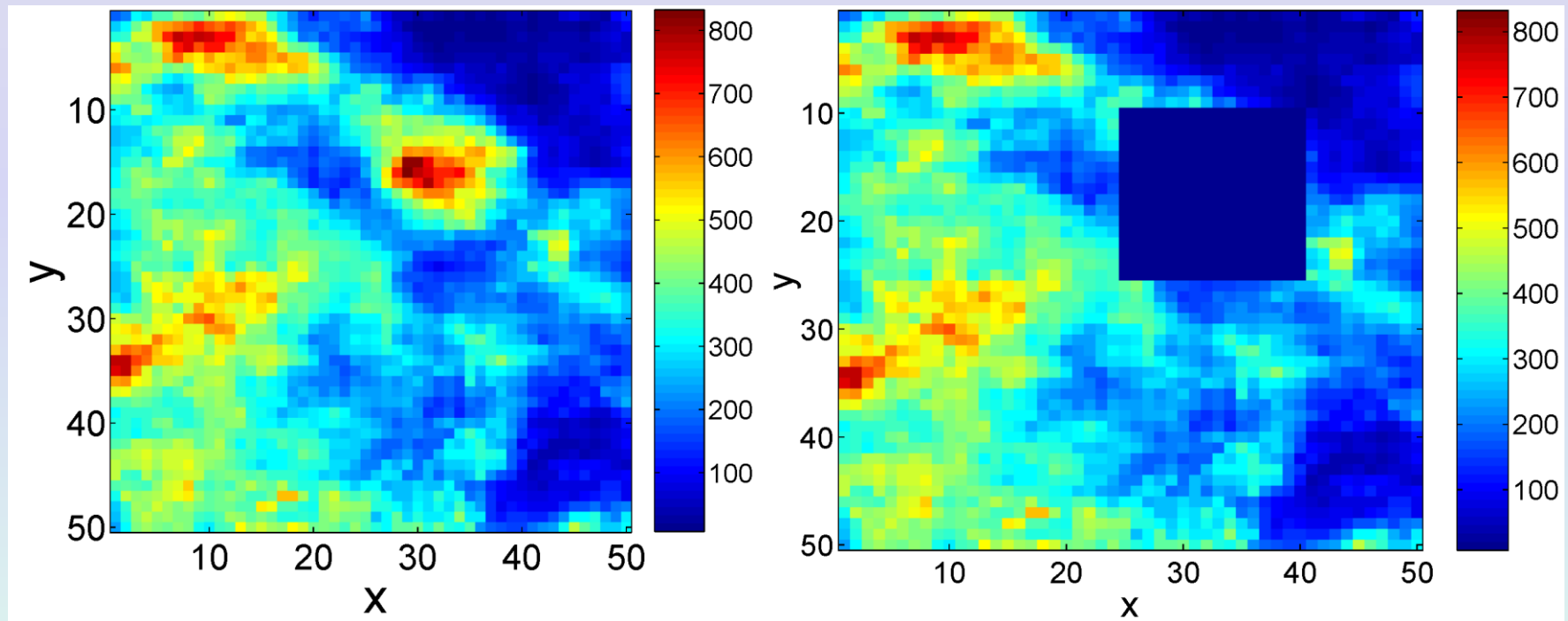


Example: Interpolation of rainfall data

Žukovič and Hristopulos, *Phys. Rev., E*, 2009

Rainfall data from Indonesia, January 2007. *Source*: NASA, Giovanni online data system

Block of data artificially removed to create a gap over a hot-spot area

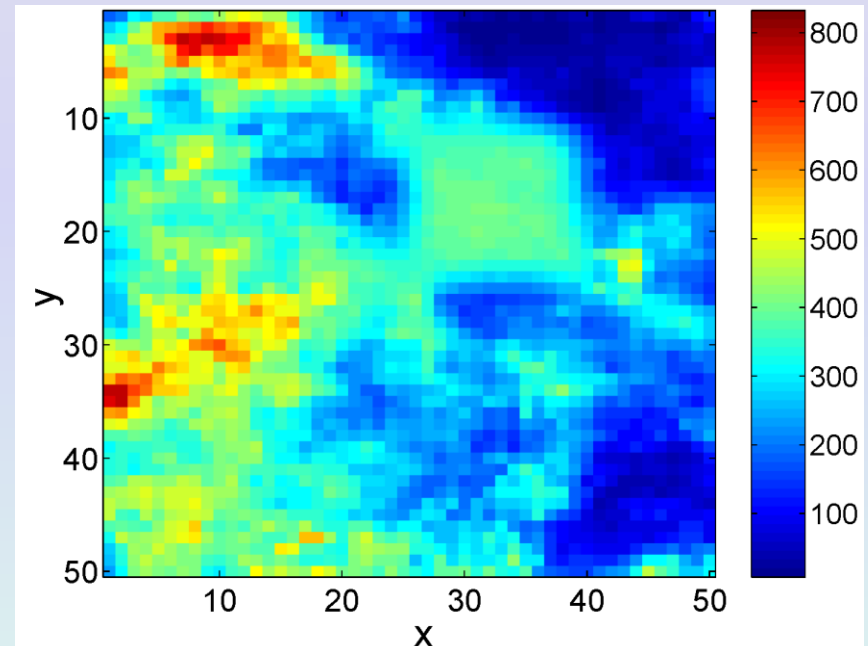
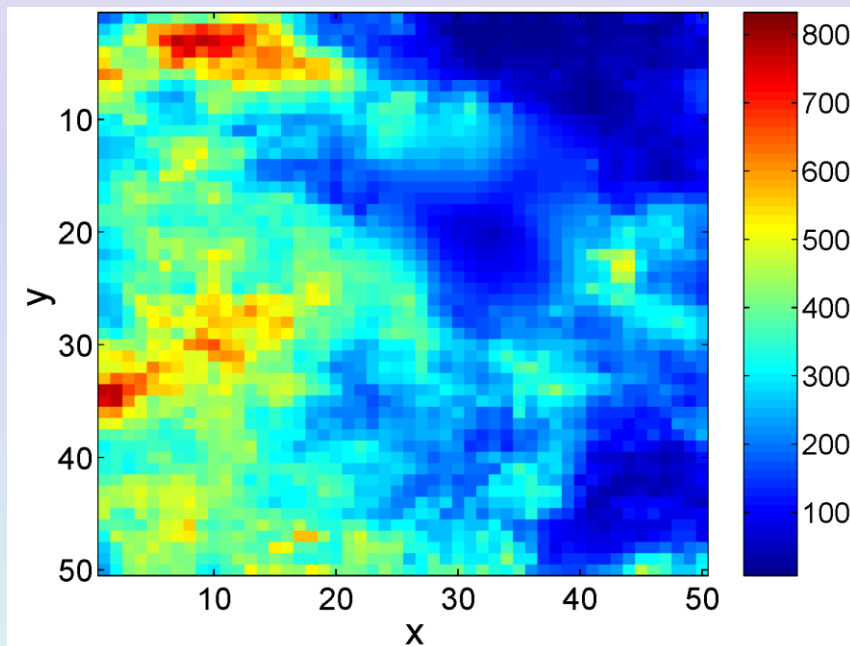


Example: Interpolation of rainfall data

Žukovič and Hristopulos, *Phys. Rev., E*, 2009

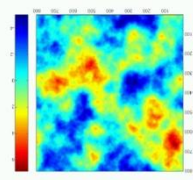
Data reconstruction using *Universal Kriging*

Data reconstruction using *our Gradient – Curvature Monte Carlo* algorithm

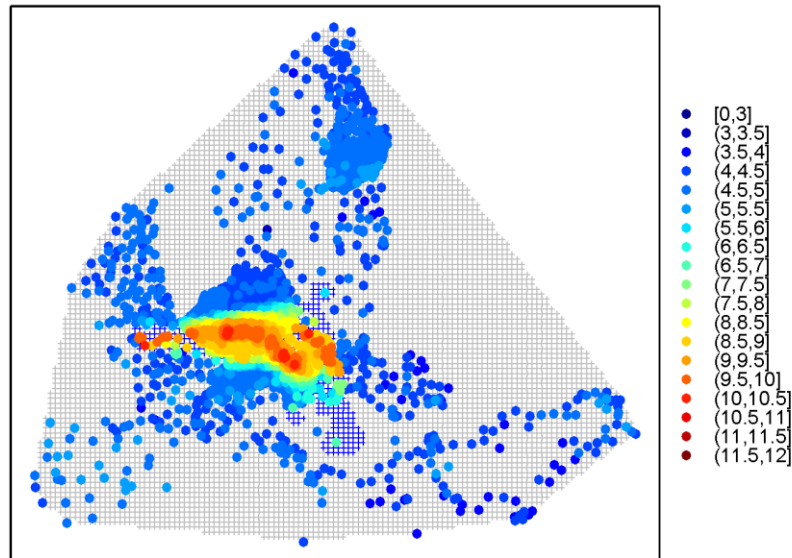




Example: Emergency Mapping

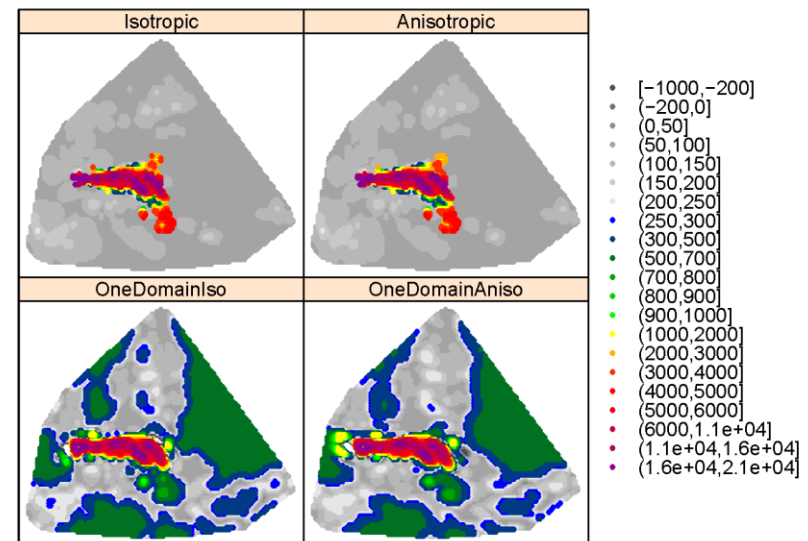


Log-values of gamma ground dose rates over Europe with a simulated accidental release of a radioactive plume. *Source: BfS, Germany*



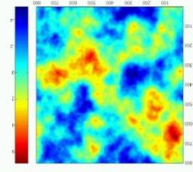
Hristopulos et al., *Computers & Geosciences*, 2011

Reconstructed maps of background and radioactive plume using stochastic optimal linear filter with anisotropy estimation



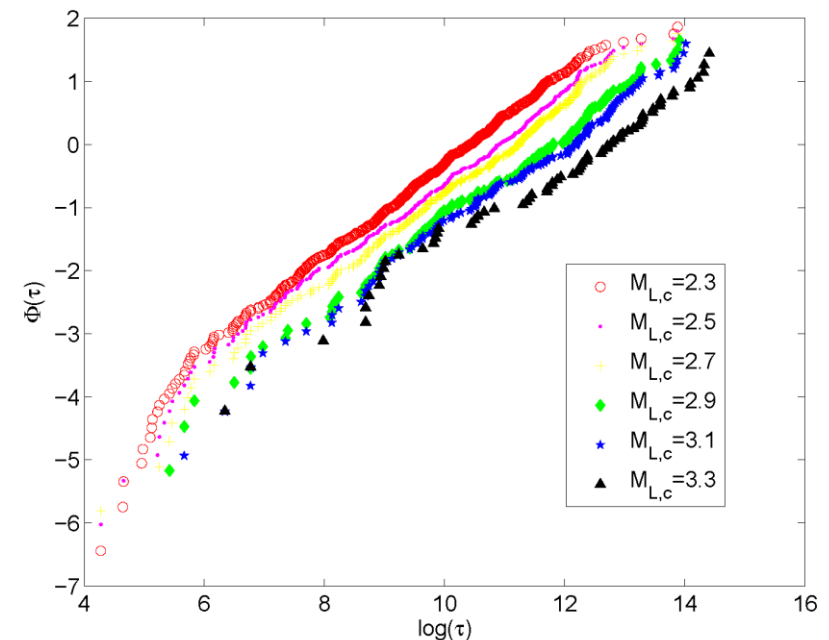
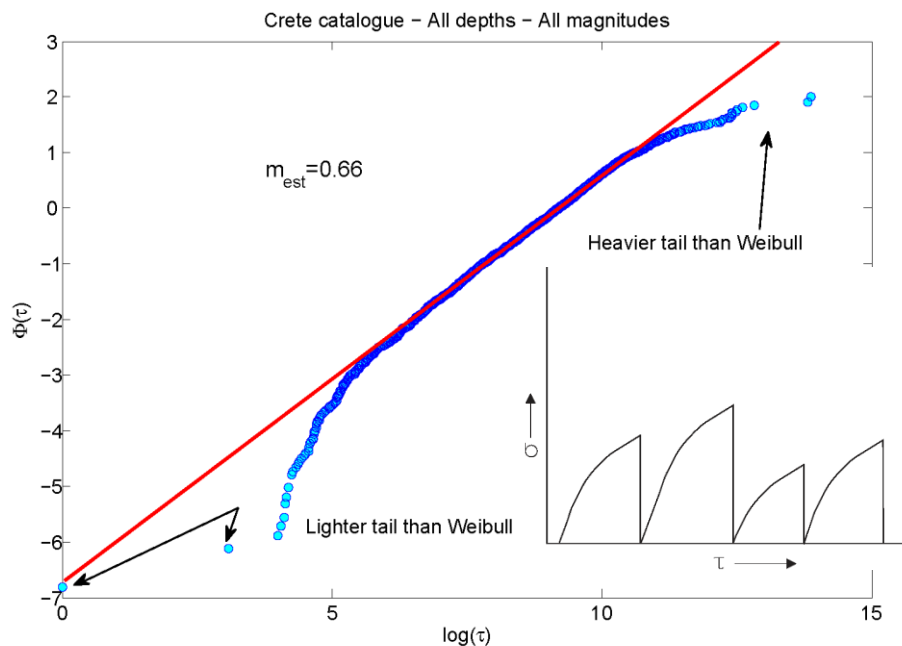


Earthquakes



Earthquakes are nonlinear, stochastic, non-stationary, spatially distributed phenomena

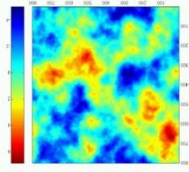
Stick – slip stochastic model provides justification for Weibull interevent times distribution



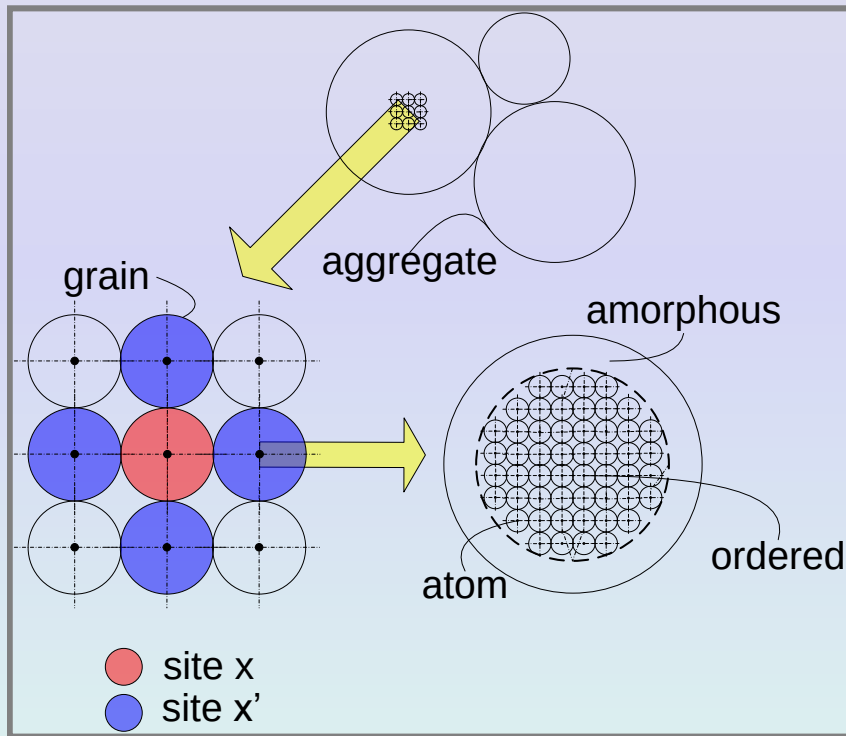
Mouslopoulou & Hristopulos, *J. Geophys. Res. B*, 2011; Hristopulos & Mouslopoulou, in preparation



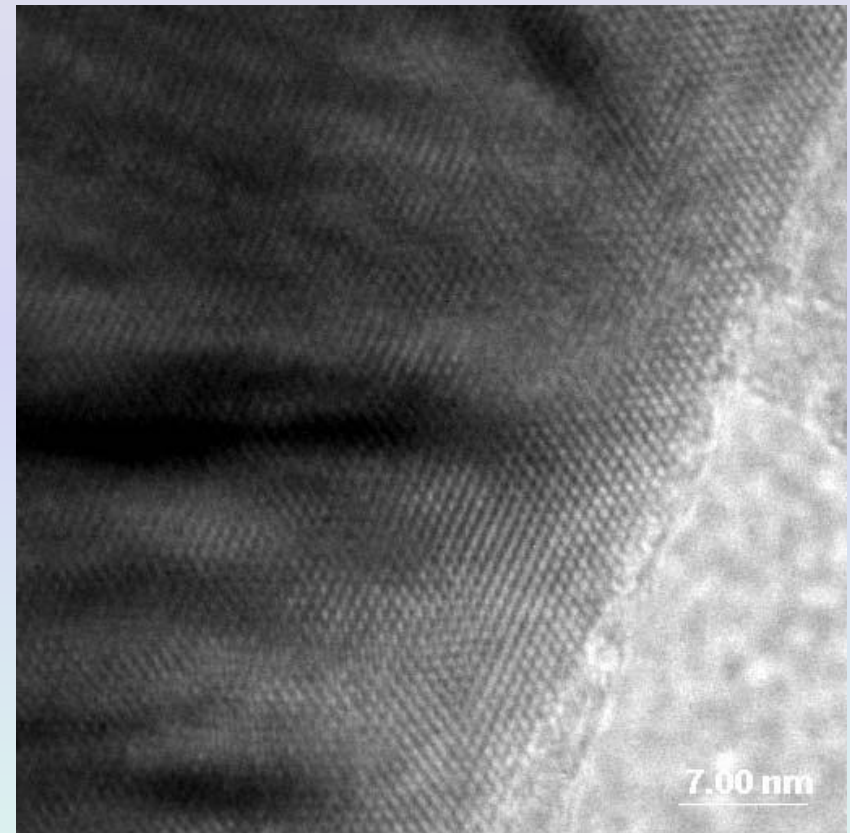
Kinetic models of sintering



Schematic of grain structure displaying ordered (bulk) and amorphous (boundary) phases

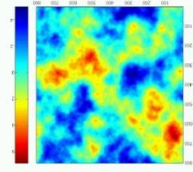


High-resolution TEM image of β -sialon grain after mechanical activation by ball milling





Kinetic models of sintering

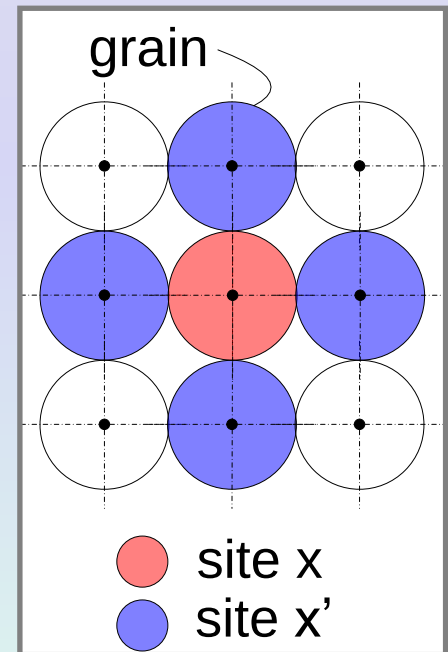
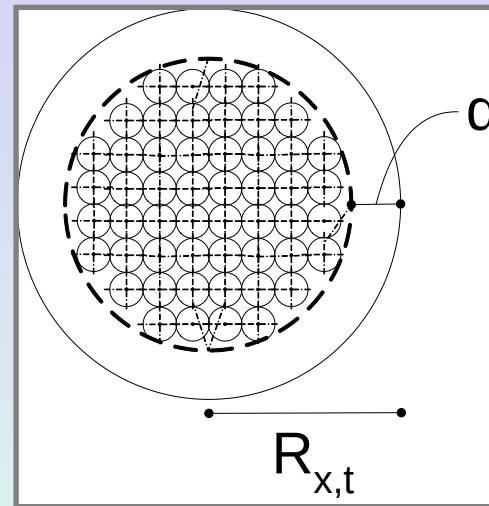


$$\partial_t m(\mathbf{x}, t) = \sum_{\mathbf{x}'} e^{-u m(\mathbf{x}', \tilde{t})} m(\mathbf{x}', t) - \sum_{\mathbf{x}'} e^{-u m(\mathbf{x}, t)} m(\mathbf{x}, t)$$

$$u \propto \alpha Q / T$$

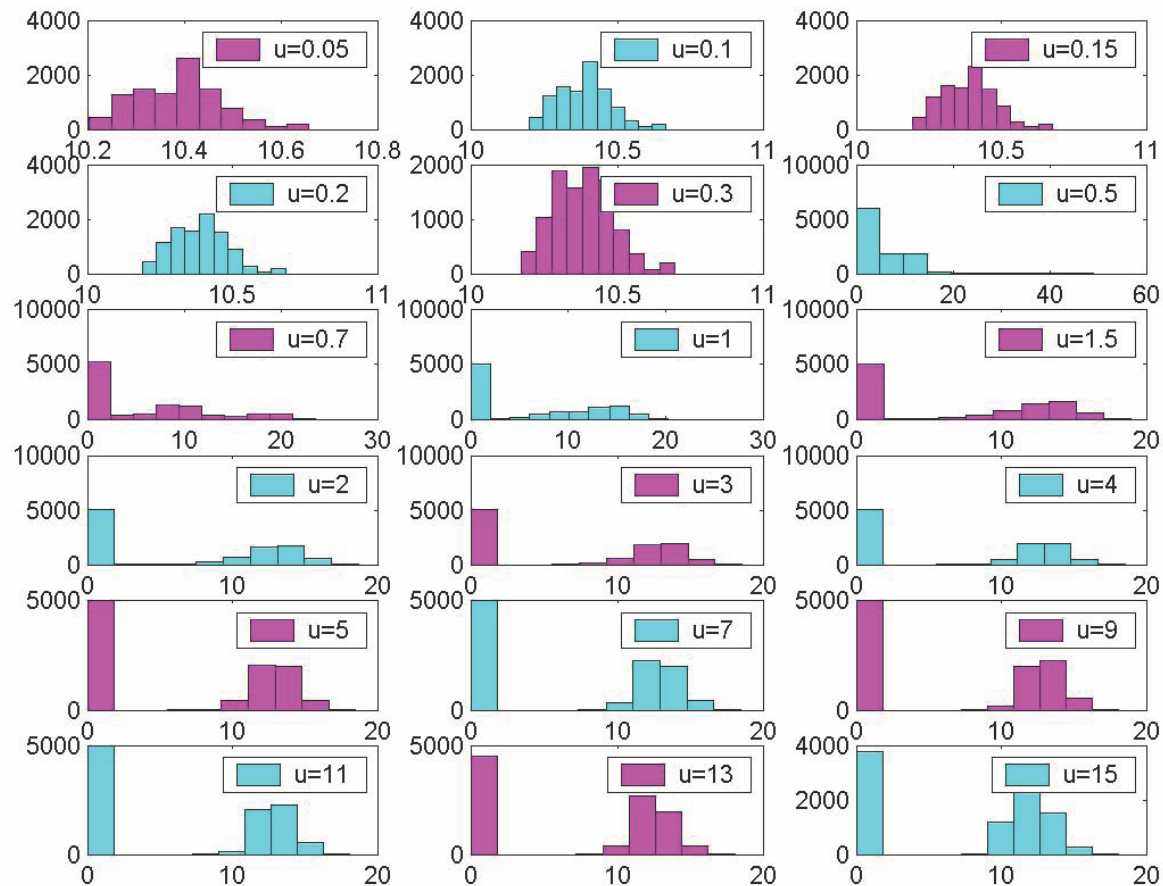
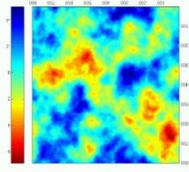
The model conserves mass

Transition between diffusion
and bimodal regimes





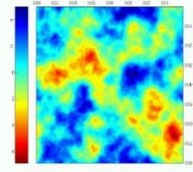
Kinetic models of sintering



Hristopulos, Leonidakis, Tsetsekou, *Eur. Phys. Jour. B*, 2006



SELECTED RECENT PUBLICATIONS



- **V. Mouslopoulou and D. T. Hristopulos**, "Patterns of tectonic fault interactions captured through geostatistical analysis of microearthquakes" *Journal of Geophysical Research - Solid Earth*, in 116, B07305, doi:10.1029/2010JB007804.
- **D. T. Hristopulos, S. Elogne**, "Computationally efficient spatial interpolators based on Spartan spatial random fields" *IEEE Transactions on Signal Processing*, 57(9), 3475-3487 (2009).
- **M. Žukovič and D.T. Hristopulos**, "The method of normalized correlations: a fast parameter estimation method for random processes and isotropic random fields that focuses on short-range dependence," *Technometrics*, 15(2), 173-185 (2009a).
- **M. Žukovič and D.T. Hristopulos**, "Classification of missing values in spatial data using spin models," *Physical Review E, Statistical Mechanics and its Applications*, 80(1), 011116 (2009b).
- **A. Chorti and D. T. Hristopulos**, "Non-parametric Identification of Anisotropic (Elliptic) Correlations in Spatially Distributed Data Sets" *IEEE Transactions on Signal Processing*, 56(10), 4738-4751 (2008).
- **D. T. Hristopulos and S. Elogne**, "Analytic properties and covariance functions for a new class of generalized Gibbs random fields," *IEEE Transactions on Information Theory*, 53(12), 4467-4679 (2007).
- **D. T. Hristopulos, Leonidakis, L., Tsetsekou, A.** "A discrete nonlinear mass transfer equation with applications in solid-state sintering of ceramic materials," *European Physical Journal B* 50 (1-2), pp. 83-87 (2006).
- **D. T. Hristopulos and T. Uesaka**. "Structural disorder effects on the tensile strength distribution of heterogeneous brittle materials with emphasis on fiber networks," *Physical Review B*, 70(6), art. no. 064108 (2004).