Localization of Structure on Extended RO Propagation Geometries

By

Charles Rino, Charles Carrano, and Keith Grove

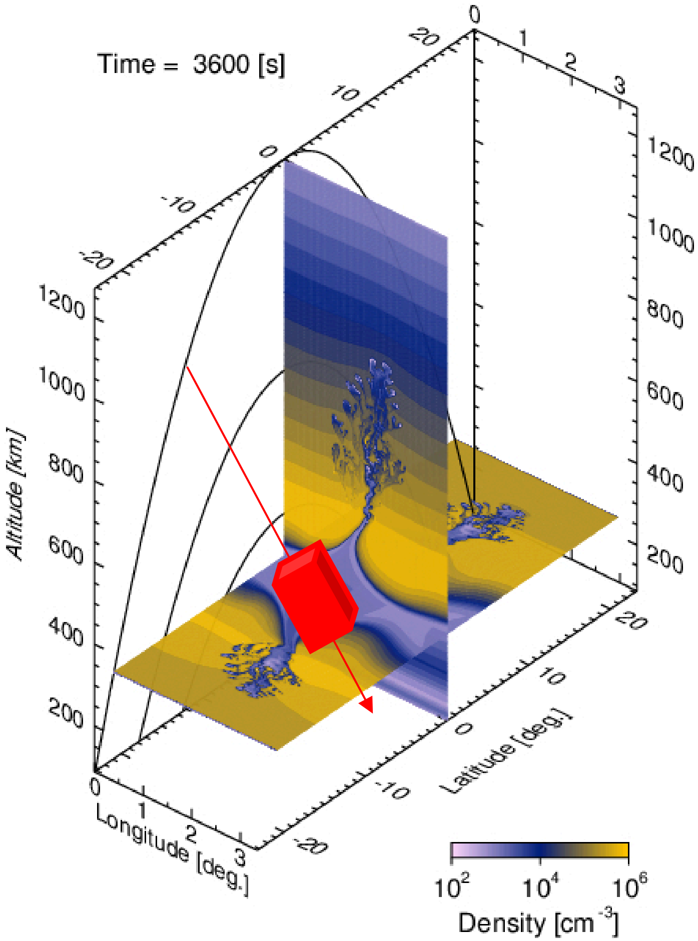
BOSTON COLLEGE ISR INSTITUTE FOR SCIENTIFIC RESEARCH

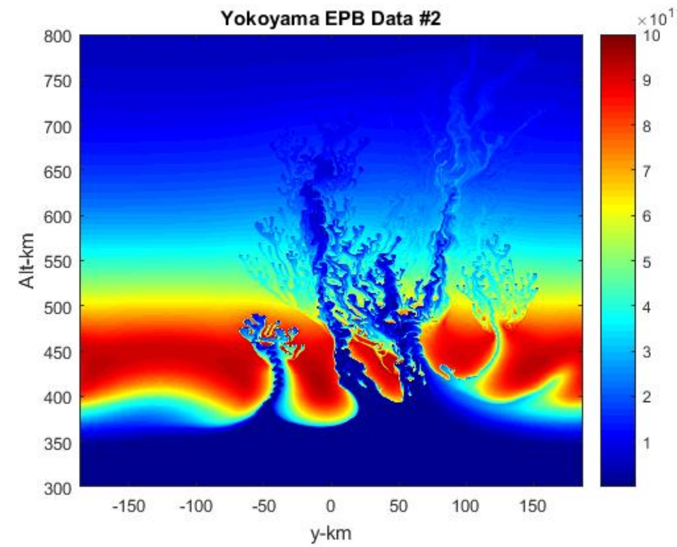
Ionospheric Effects Symposium

Alexandria, Virginia

May 2017

Configuration Space Models





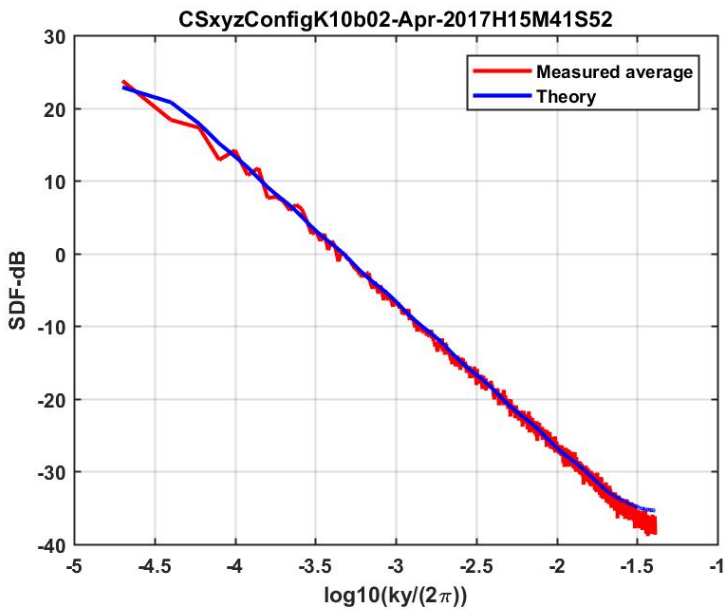
- Configuration-space models populate rectangular data space region with randomly located field-aligned striation
- Size, number density, and fractional strength can be chosen to support two-component inverse power law spectral density functions

A Configuration Space Model for Stochastic Ionospheric Structure

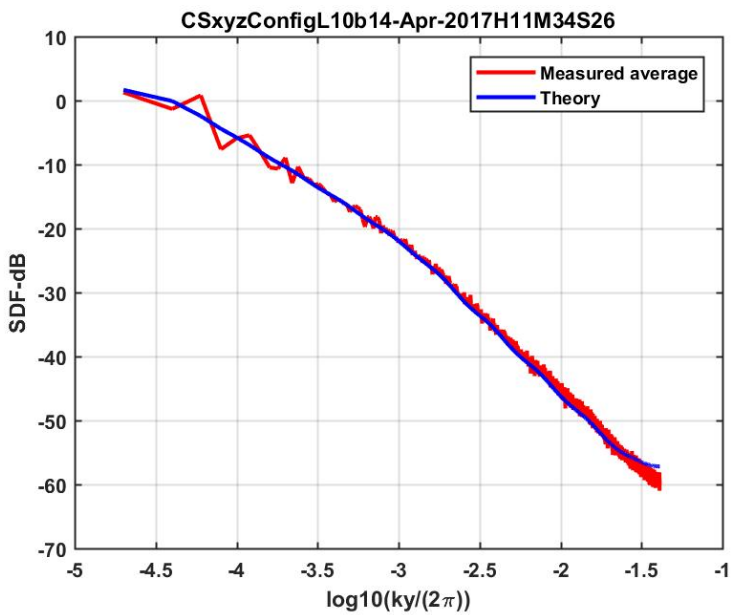
http://chuckrino.com/wordpress/wpcontent/uploads/2015/04/ConfigurationSpaceModelSubmissionRev-3.pdf

Intermediate Scale
Striation Size Distributions

Single-Component Power Law



Two-Component Power Law

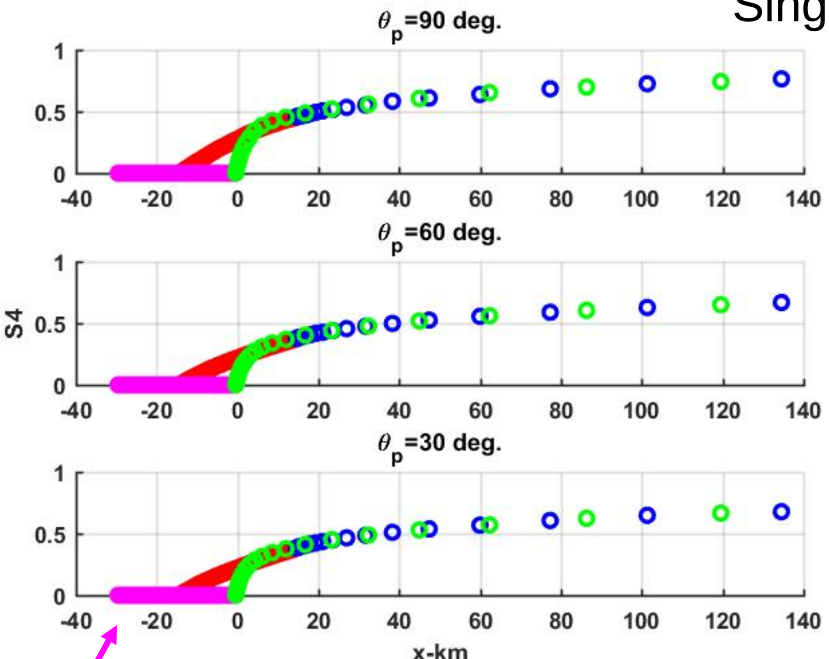


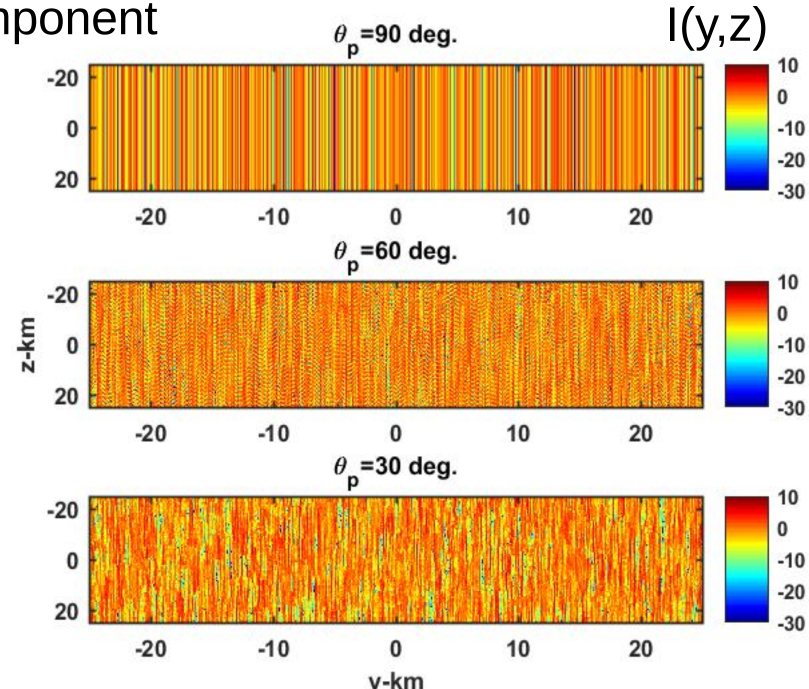
8188 Striations
19.53 m to 20 km
11 bifurcations

Data Volume
50 km by 50 km by 30 km
4096x4096x64
Propagation x-interval =468.75 m

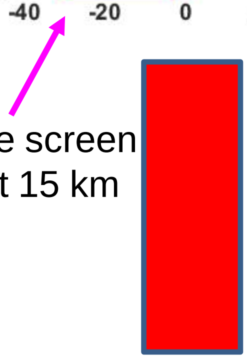
Phase-Screen Equivalence 3D

Single-Component



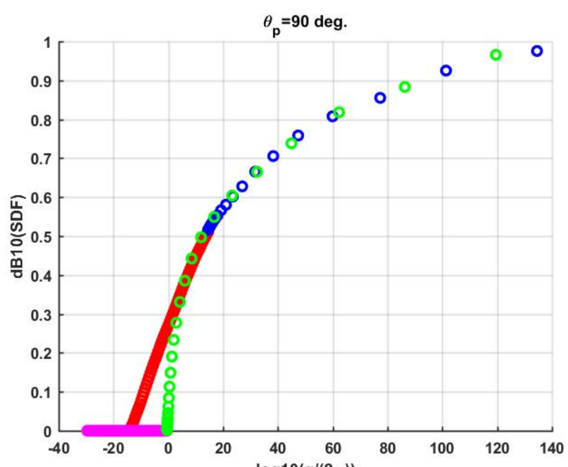


Phase screen offset 15 km



30 km structured region -15 km to 15 km

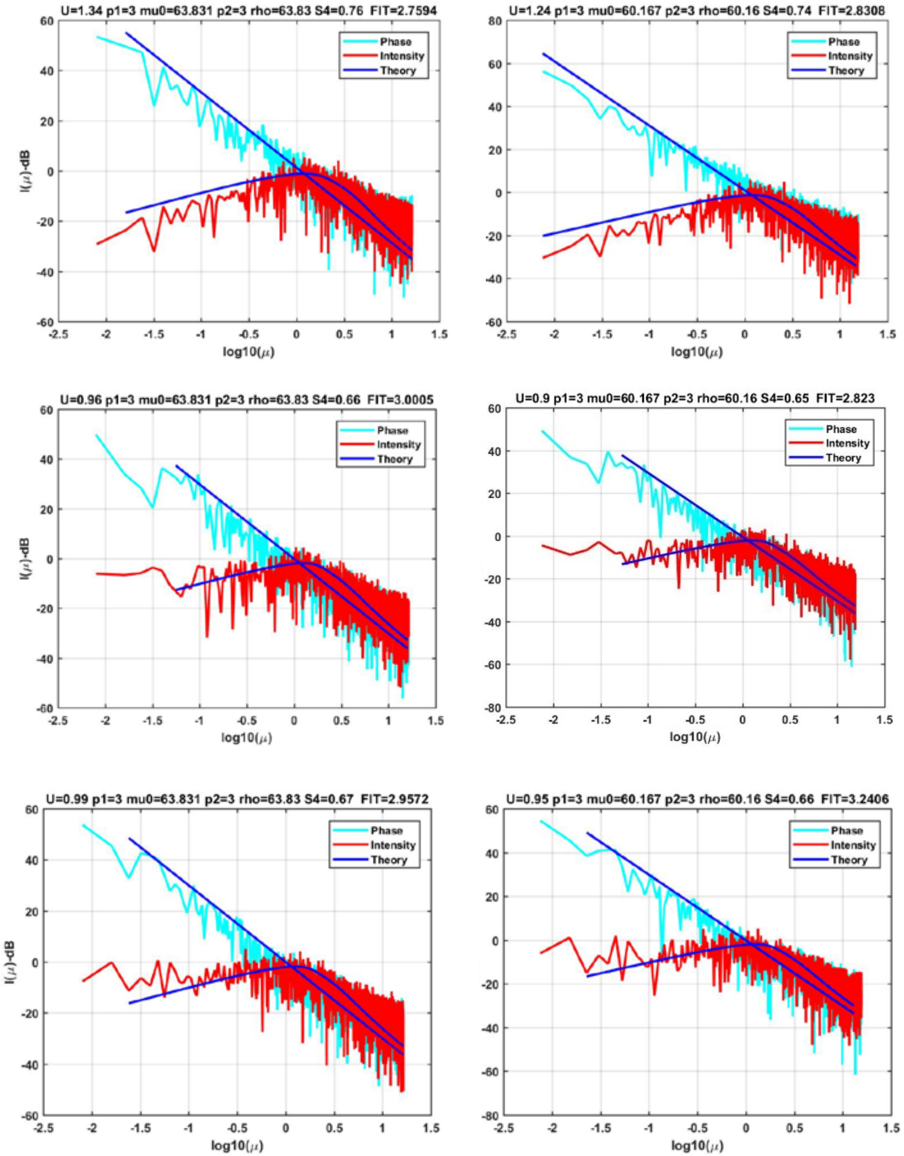
Two-Component



Empirical Rule

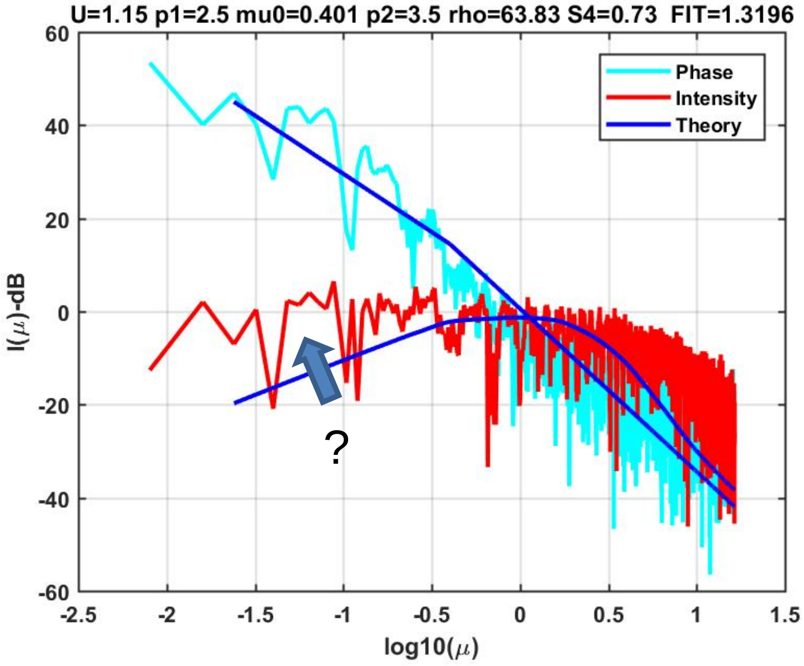
Phase-screen offset by -½ structure extent aligns with full diffraction at ½ structure extent

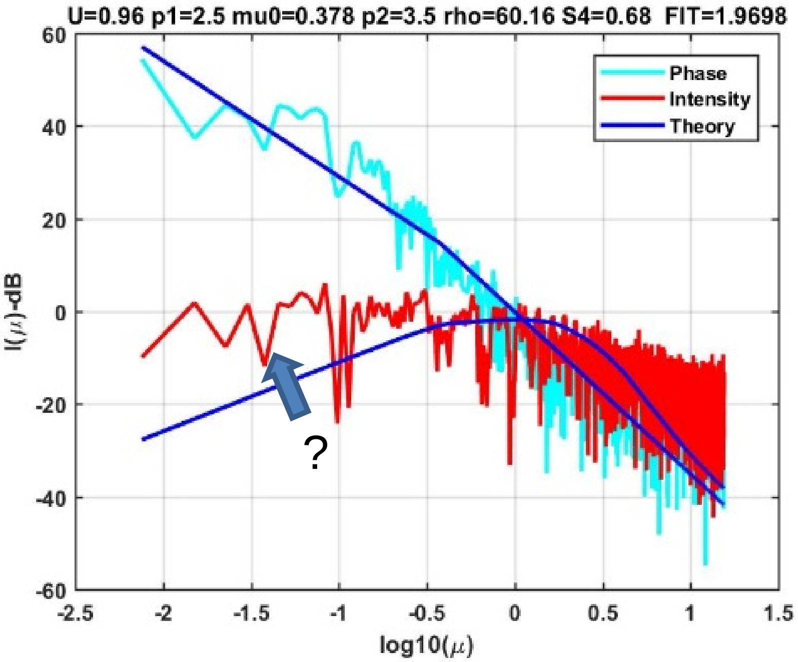
Phase-Screen Equivalence 2D Single Power Law



- To model data a one-dimensional scan is extracted at z=0 from each complex signal realization
- To the extend that the 2D to 1D mapping of in-situ structure to path-integrated structure holds, the only unknown propagation parameter is universal strength
- Interpretative parameter estimation is applied to each realization to estimate the U parameter
- The results are summarized in the following 2 slides:
    1. The left-hand columns show 90, 60, and 30 degree propagation angles first for full diffraction and then for the phase-screen approximation. The second column shows a 90 degree stronger scatter result
    2. The two slides show the 90 degree full diffraction and phase-screen approximation results

Phase-Screen Equivalence 2D Two-Component





The *standard* translation of the defining striation structure model overestimates the large-scale index in the two-dimensional phase screen model.

This is possibly attributable to correlation of structure along the propagation path.

Summary & Conclusions

- Fully three-dimensional propagation through configuration-space realizations verify *first-order* phase screen equivalence for cross-field geometries
  - The equivalence holds for both single and two-component inverse power-law structures
- The two-dimensional phase-screen theory reproduces measured intensity SDFs for the single-power-law structures with standard parameter translation
  - Theoretic SDF fits for two-component inverse power-law structures require a power-law index closer to the in-situ index
  - This may be due to correlation along the propagation direction
- Strictly field-aligned propagation (now shown) is a special case under study
  - The isotropic field structure, particularly phase, is strongly influenced by the striation shape

THANK YOU FOR YOUR ATTENTION