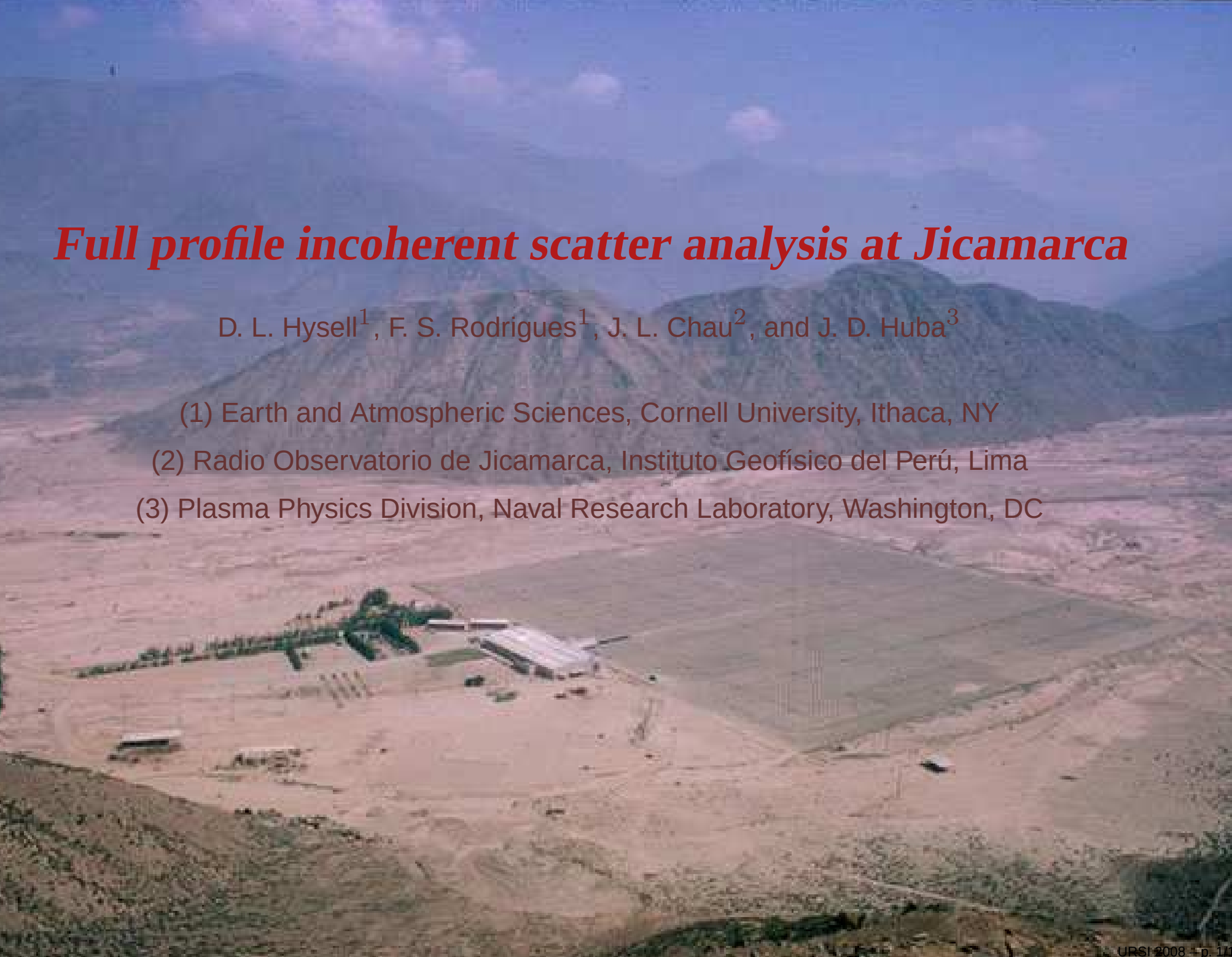




Full profile incoherent scatter analysis at Jicamarca

D. L. Hysell¹, F. S. Rodrigues¹, J. L. Chau², and J. D. Huba³

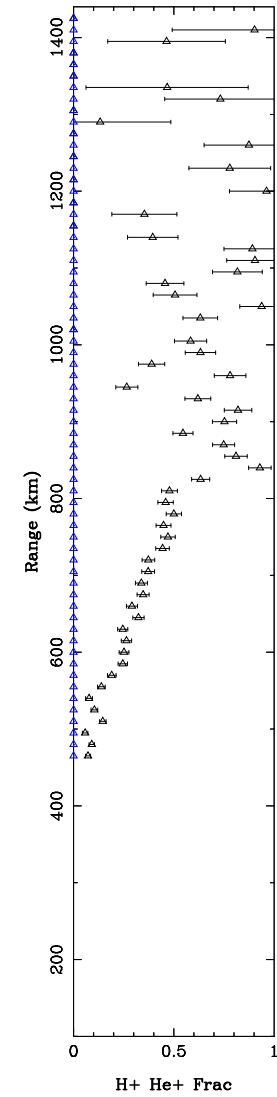
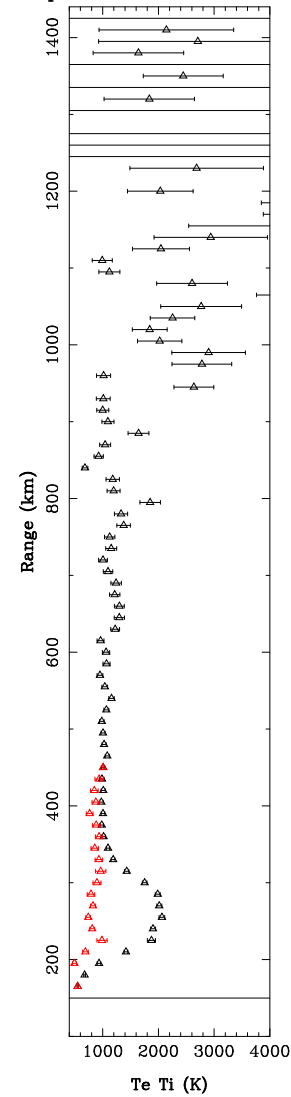
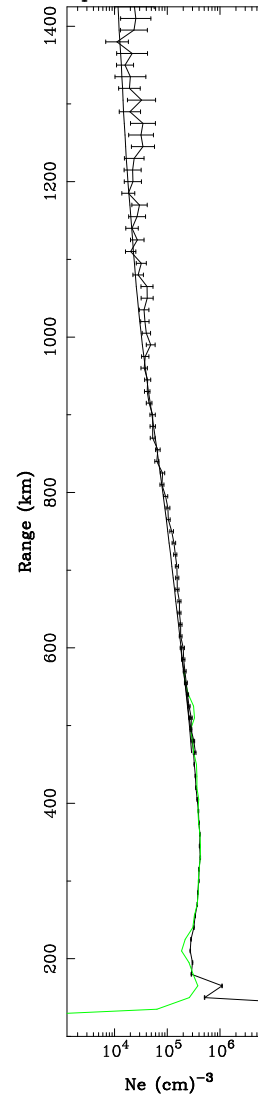
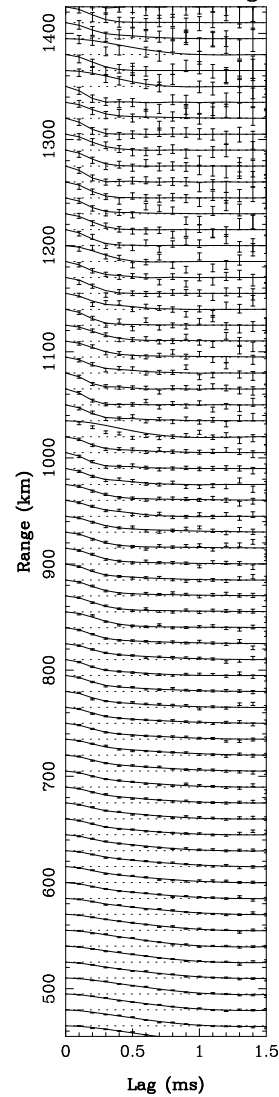
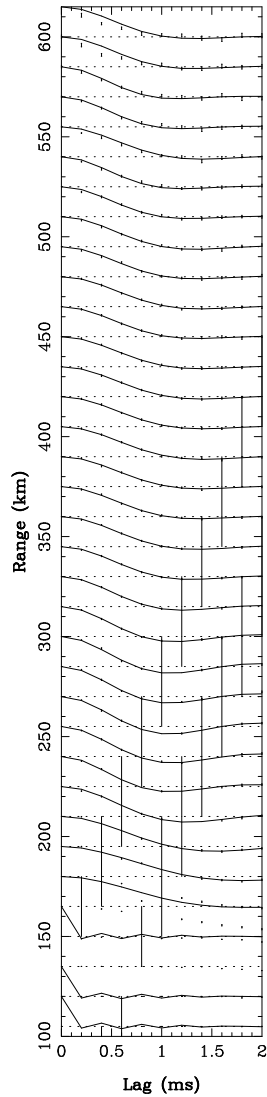
(1) Earth and Atmospheric Sciences, Cornell University, Ithaca, NY

(2) Radio Observatorio de Jicamarca, Instituto Geofísico del Perú, Lima

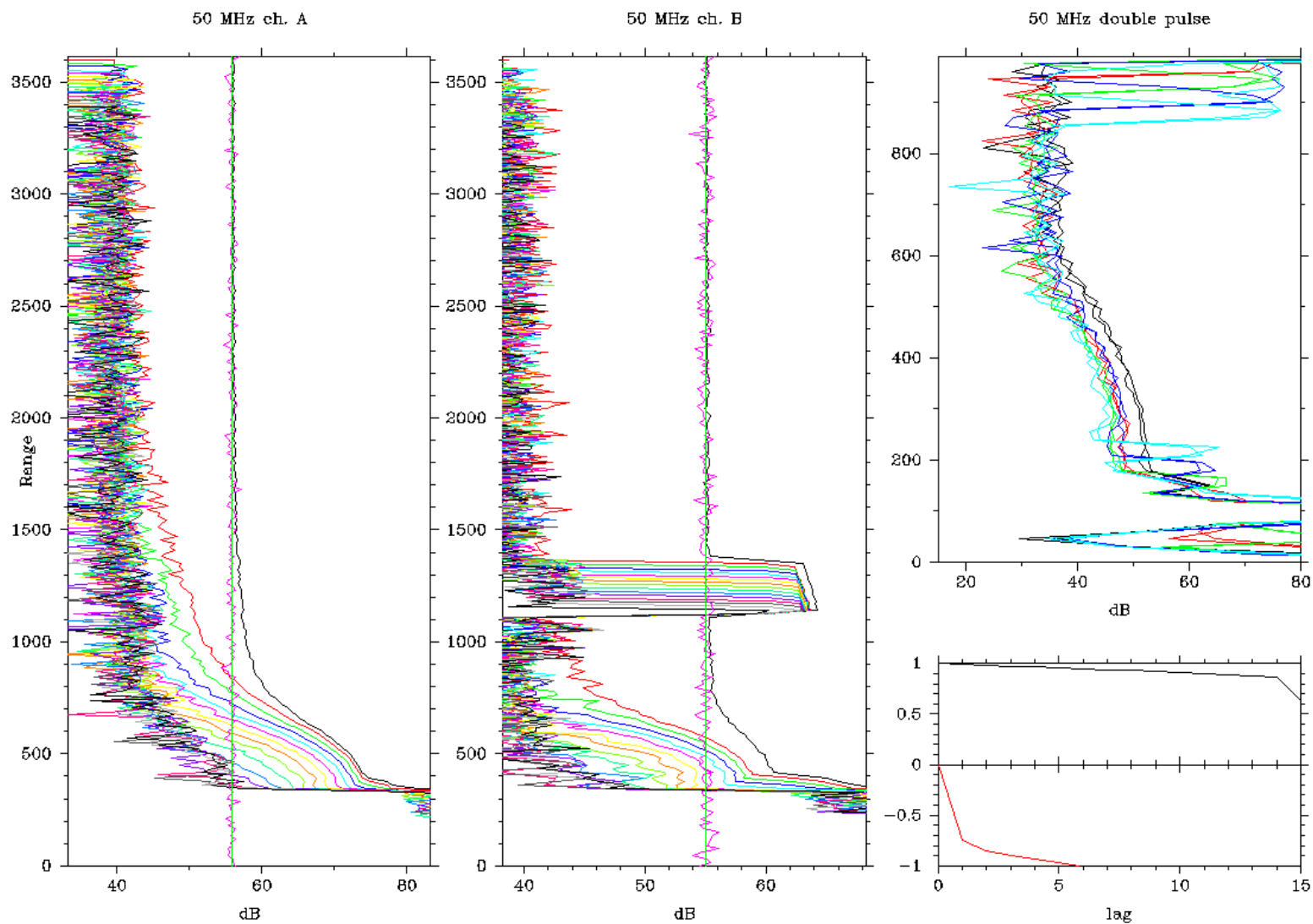
(3) Plasma Physics Division, Naval Research Laboratory, Washington, DC

coded pulse data

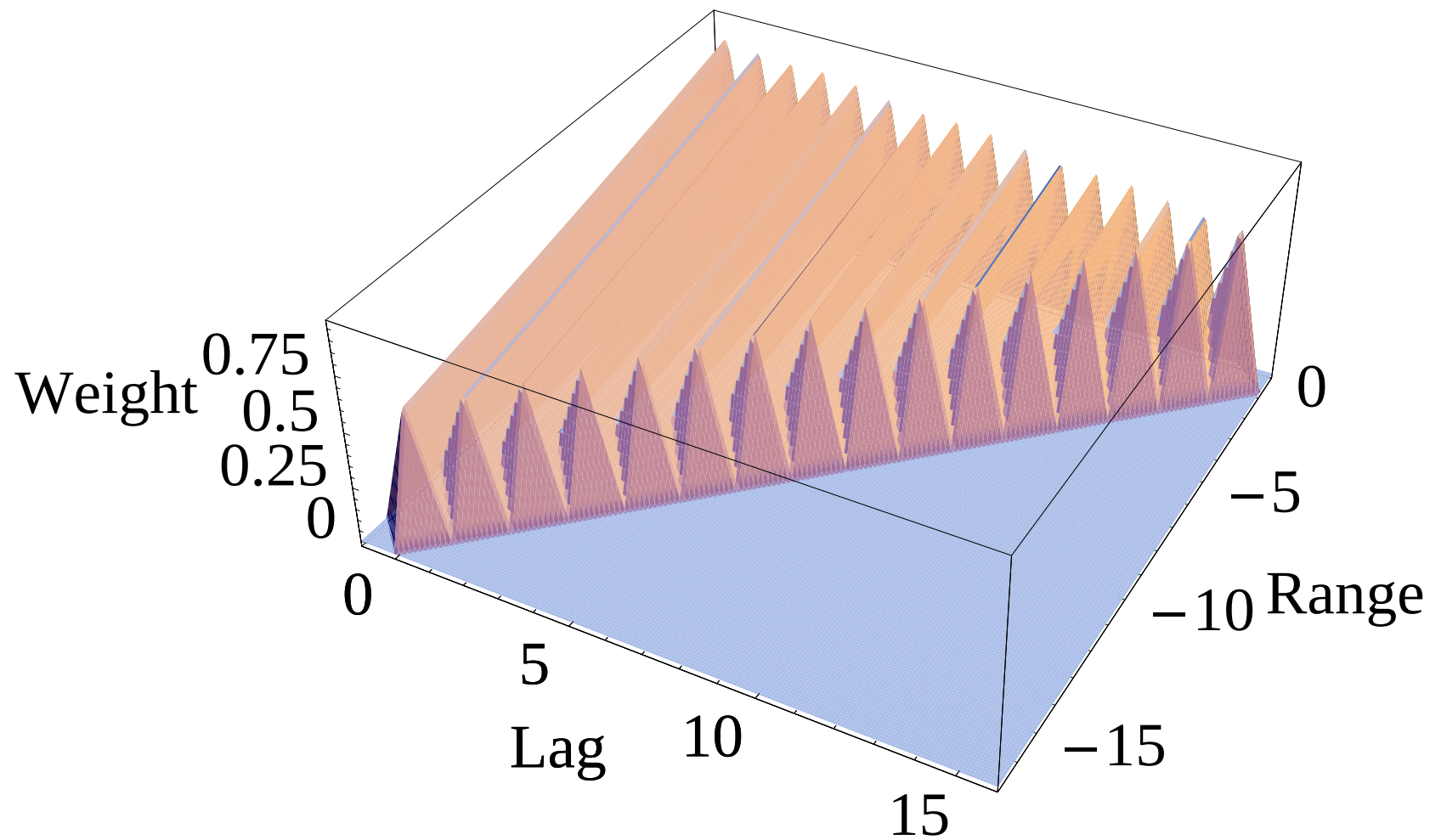
ROJ Alternating Code: Wed Sep 20 11:36:37 2006 Wed Sep 20 11:48:24 2006



long-pulse data



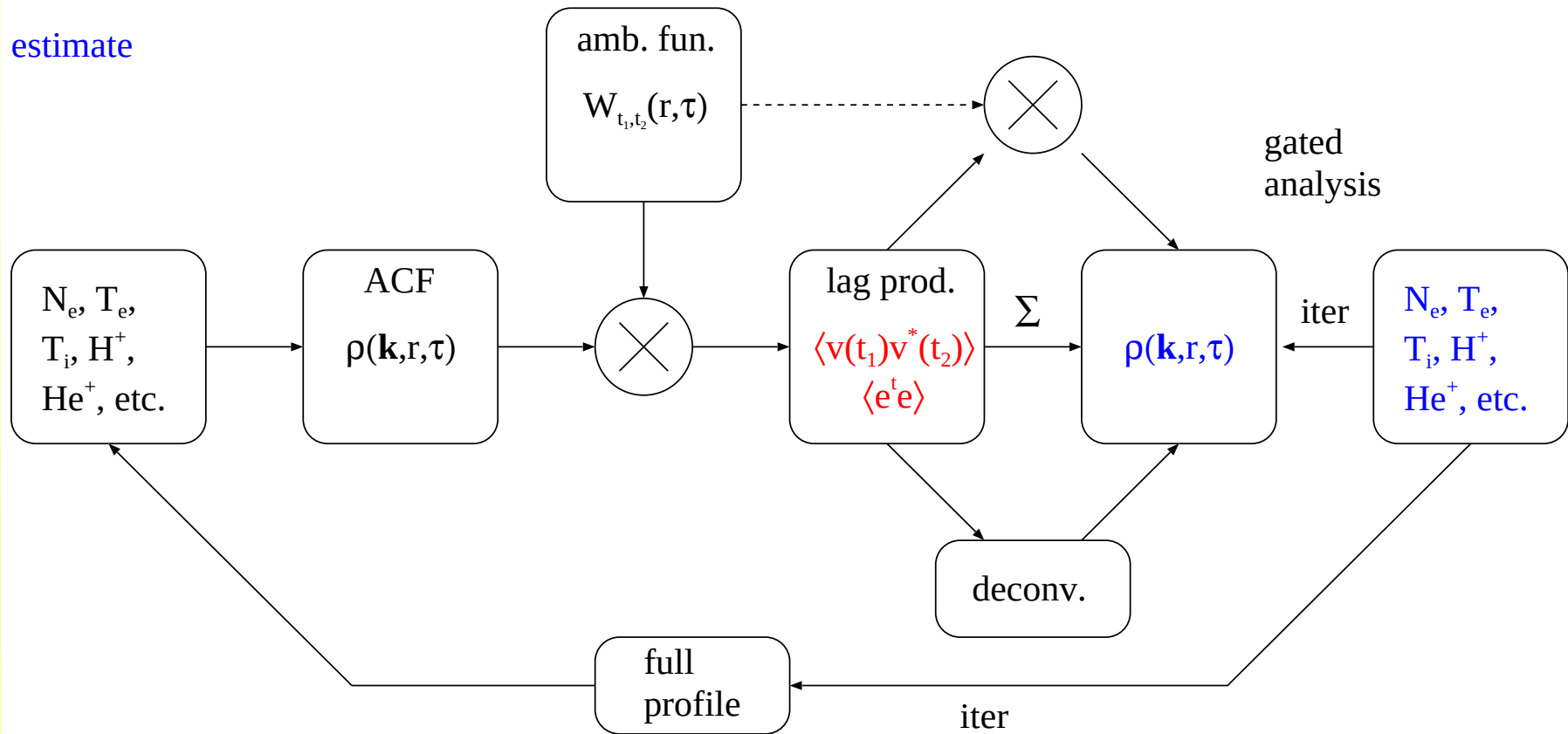
ambiguity functions



full profile analysis

data

estimate



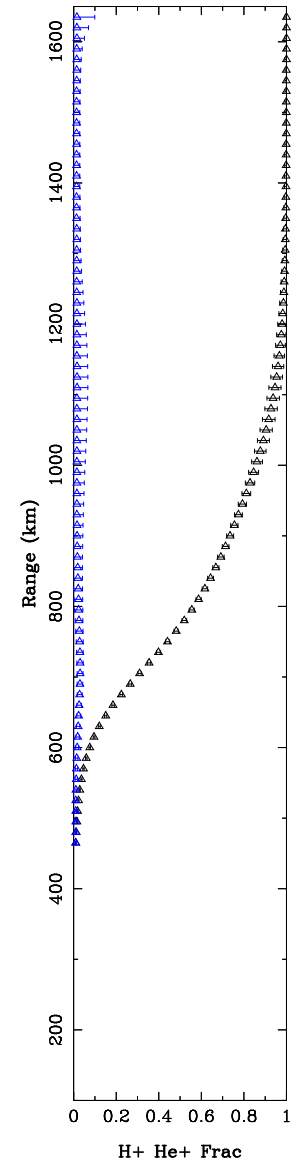
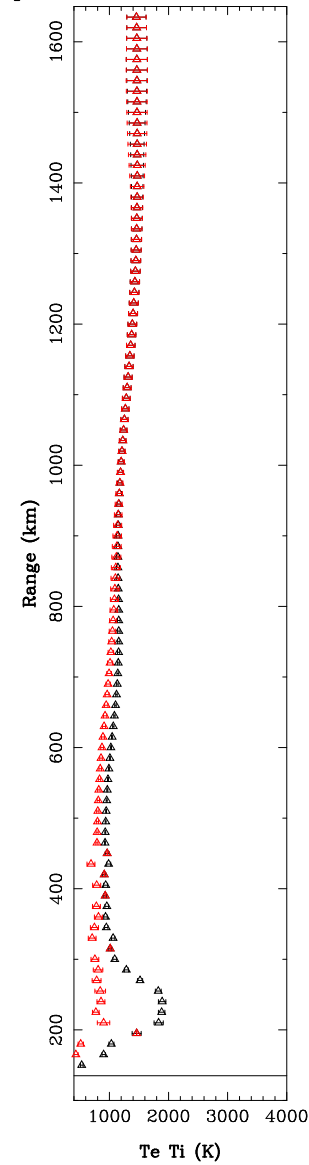
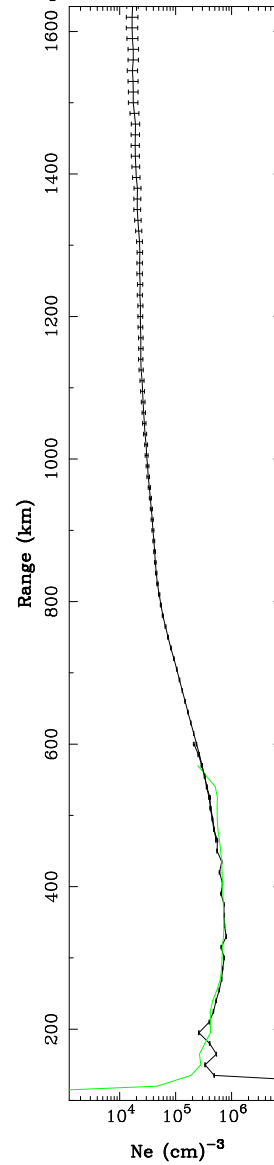
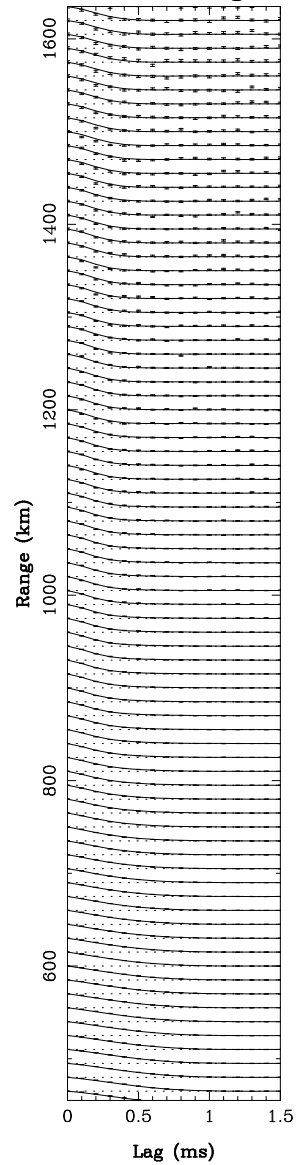
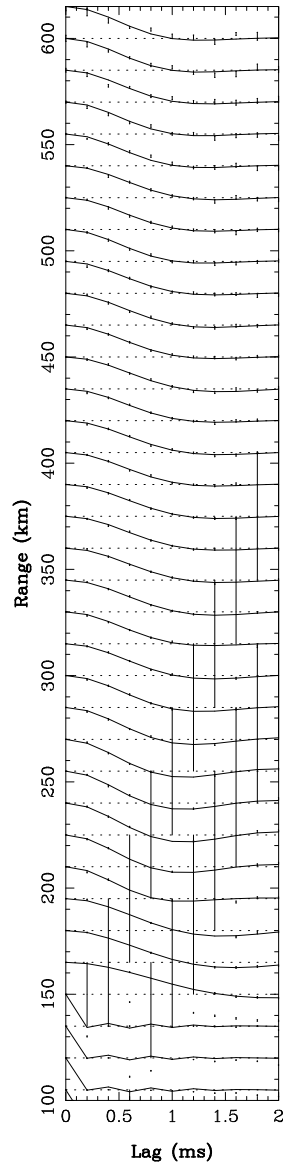
inverse methodology

- Problem is to find density, temperature, and composition of ionosphere consistent with lag-product measurements (1600) within confidence limits (determining bandwidth, pulse width, integration time). Must begin with sufficiently accurate lag products, error estimates.
- Strategy is to solve the forward problem, iterate using nonlinear damped/augmented least squares methodology (regularization).
- Discretization: parameterize temperature, composition curves by finite number of points (20) and fill in using cubic B-spline interpolation.
- Problem is mixed determined (no exact solution, many statistically indistinguishable solutions) and poorly conditioned (solutions to noisy data problem typically very oscillatory).
- Regularize by introducing prior information to cost function.

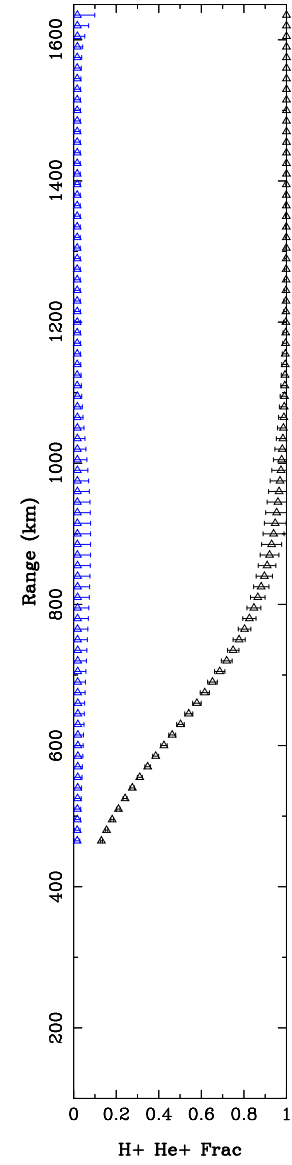
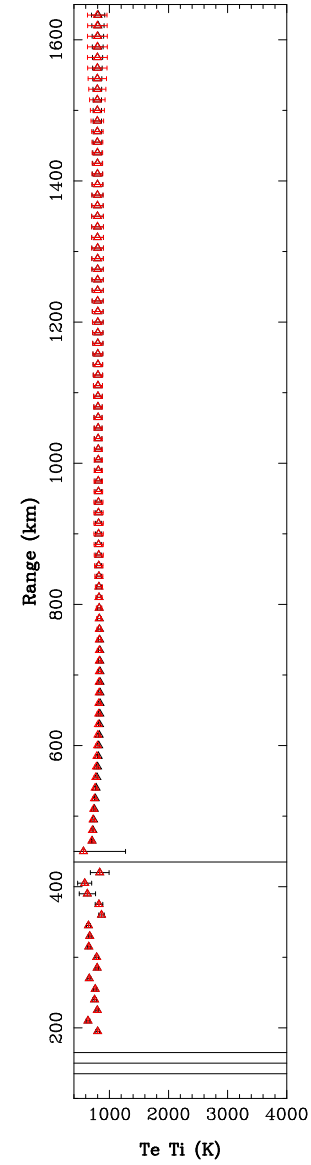
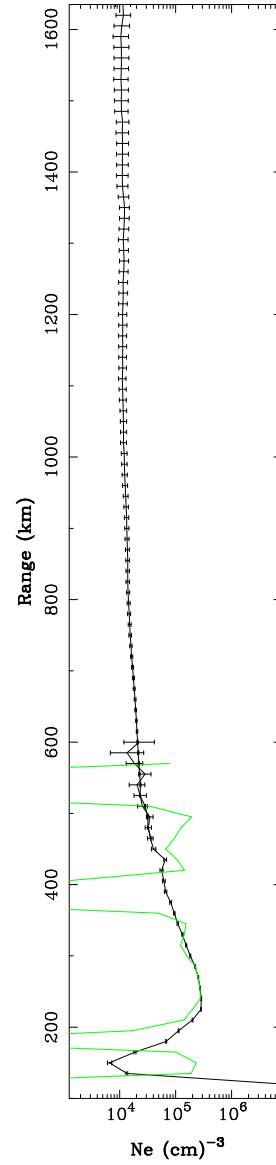
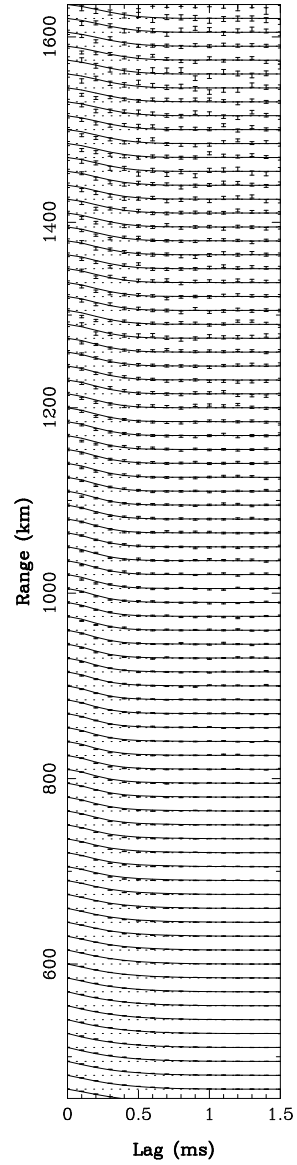
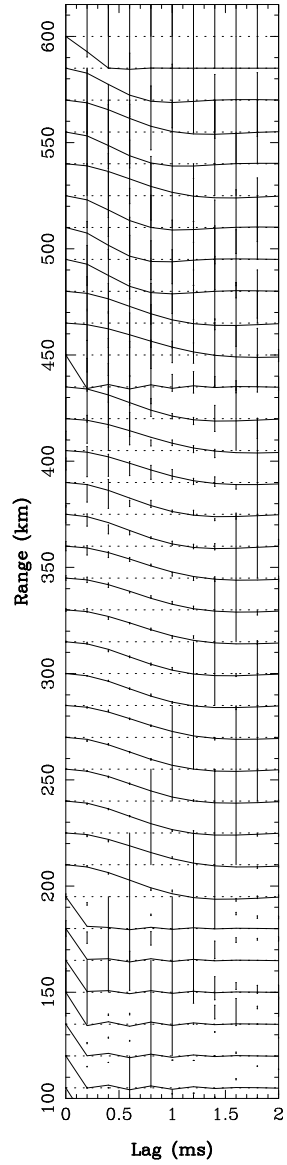
Minimize penalty composed of the following elements

- prediction error norm $e^t C_d^{-1} e$
- $\|T_e''\|_2^2 \|T_i''\|_2^2$ temperature roughness
- $T_i/T_e \leq 1$ temperature ratio
- $\|H^{+''}\|_2^2$ hydrogen ion roughness
- composition fractions $[0,1]$

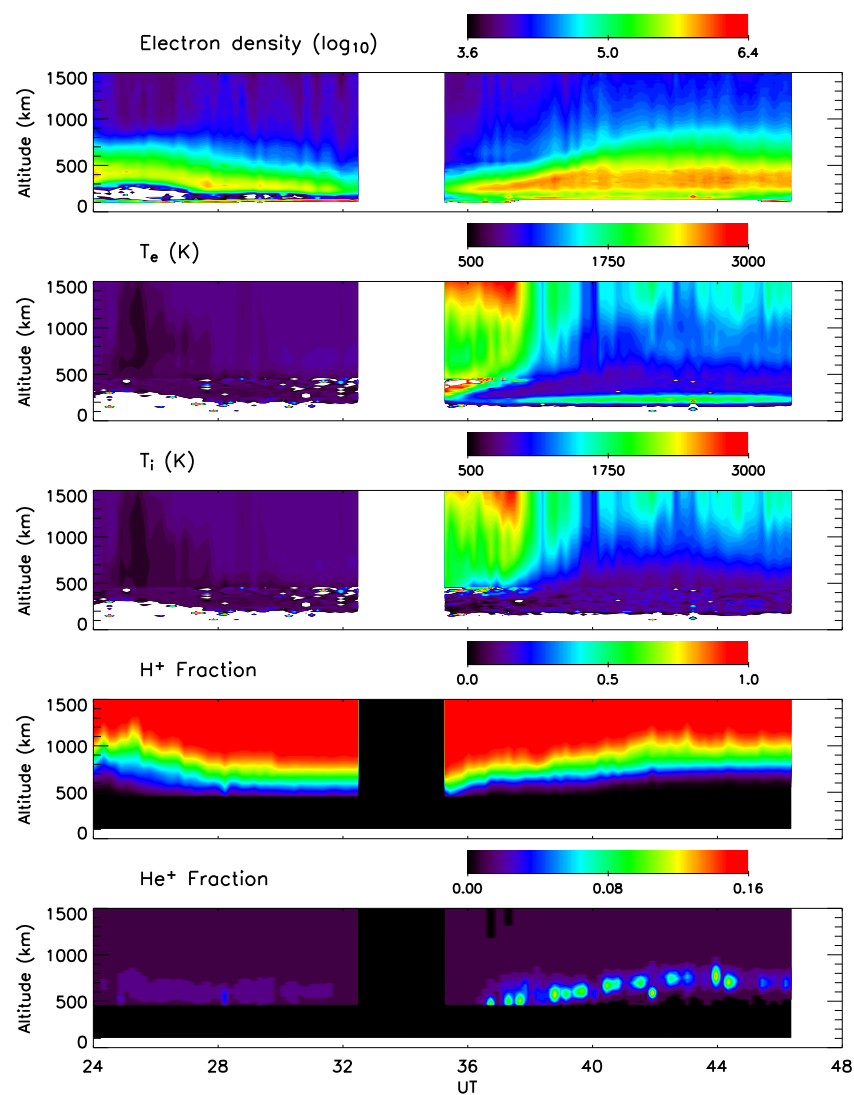
R0J Long Pulse: Thu Apr 20 12:00:18 2006 Thu Apr 20 12:10:01 2006



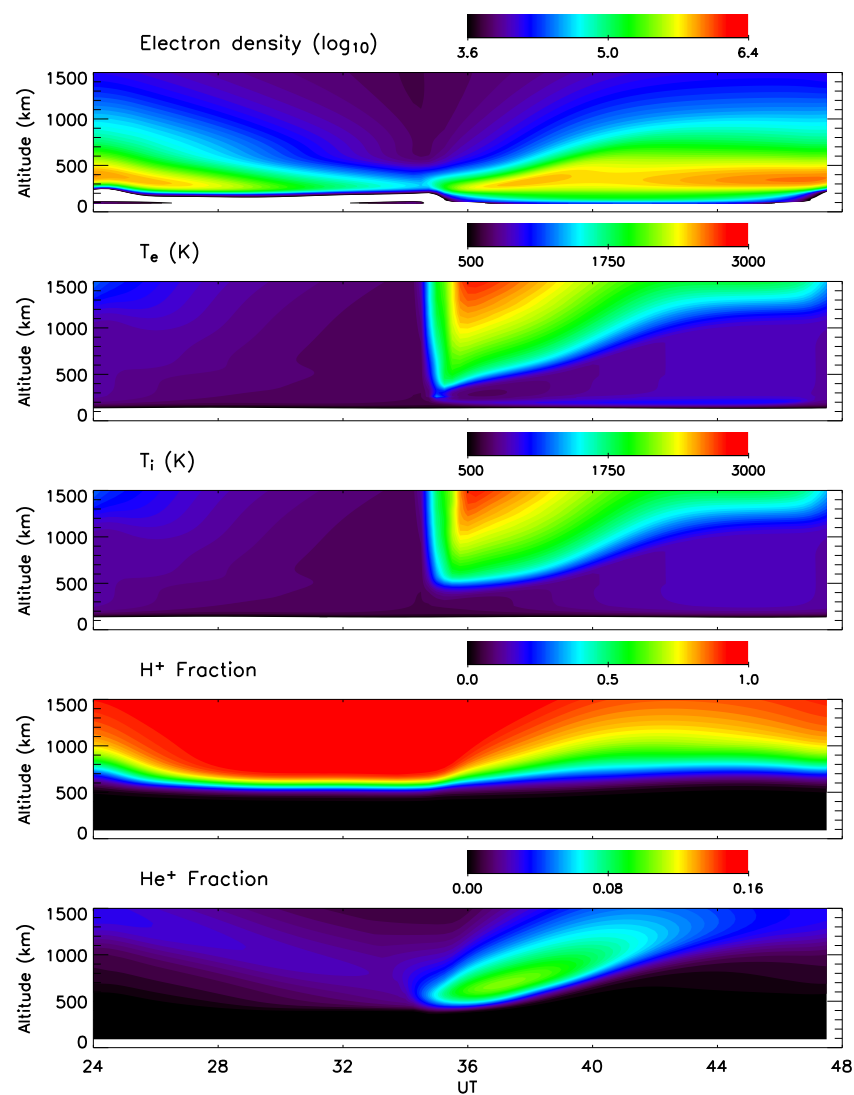
R0J Long Pulse: Thu Apr 20 02:45:07 2006 Thu Apr 20 02:54:50 2006



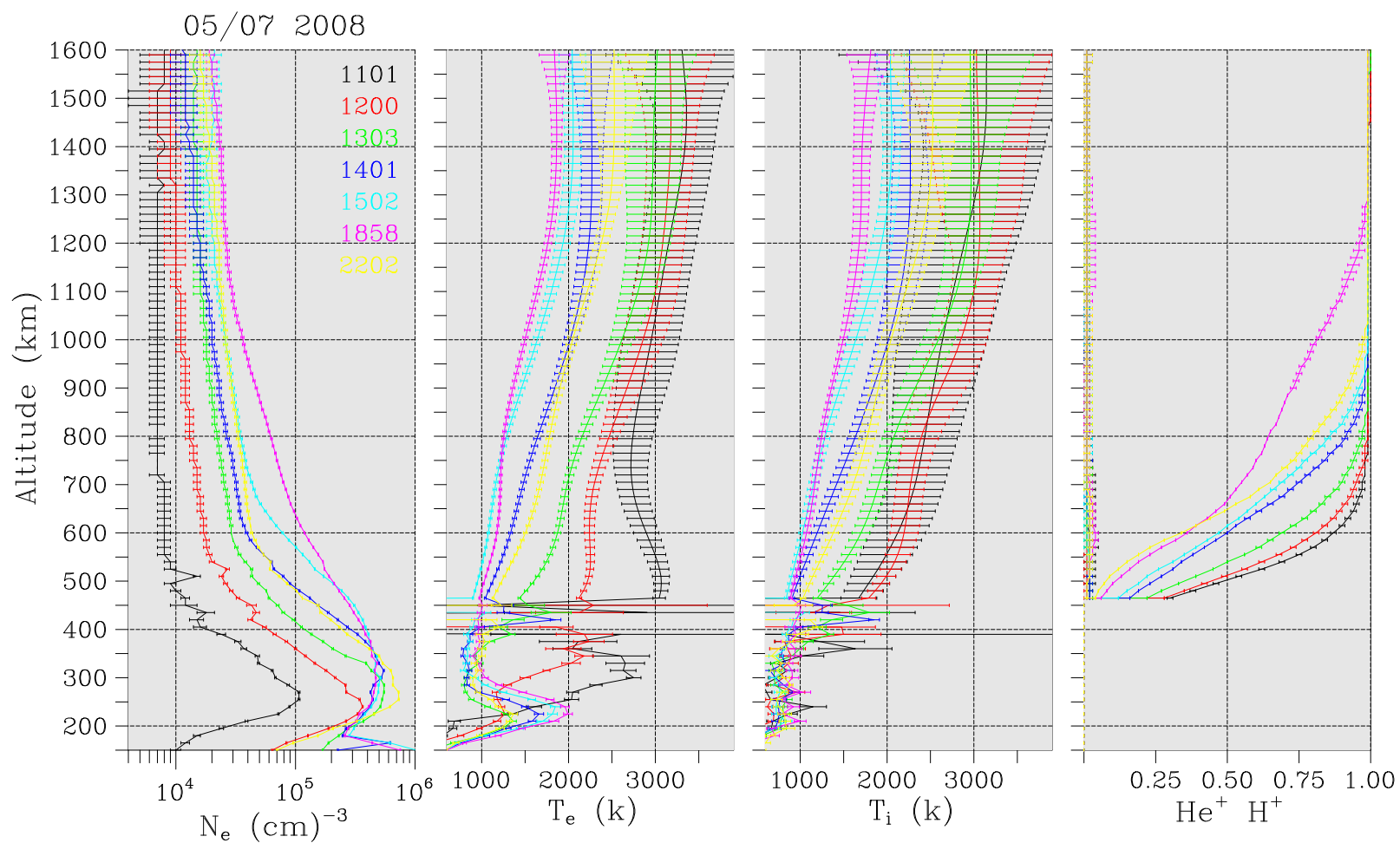
24 hours

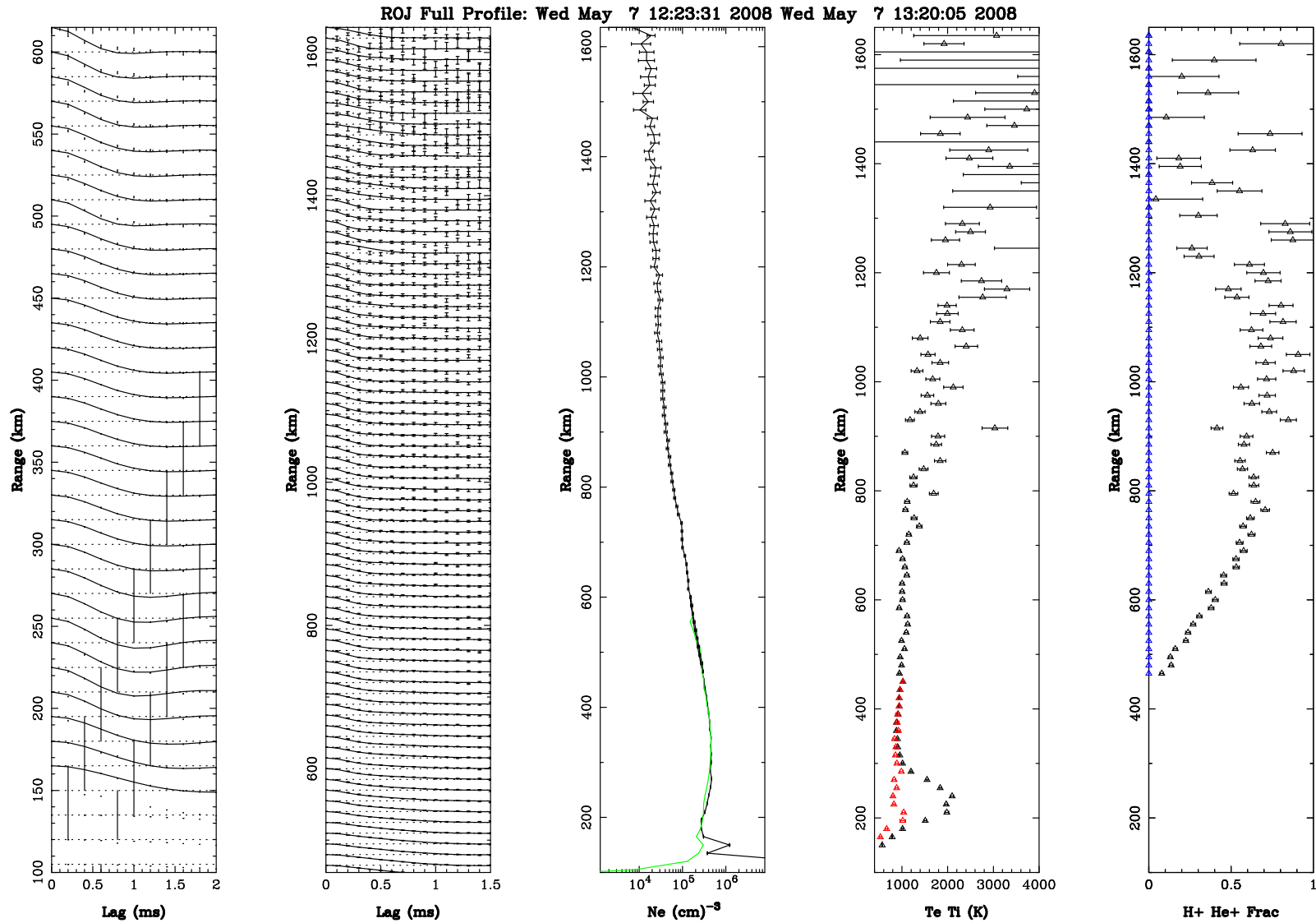


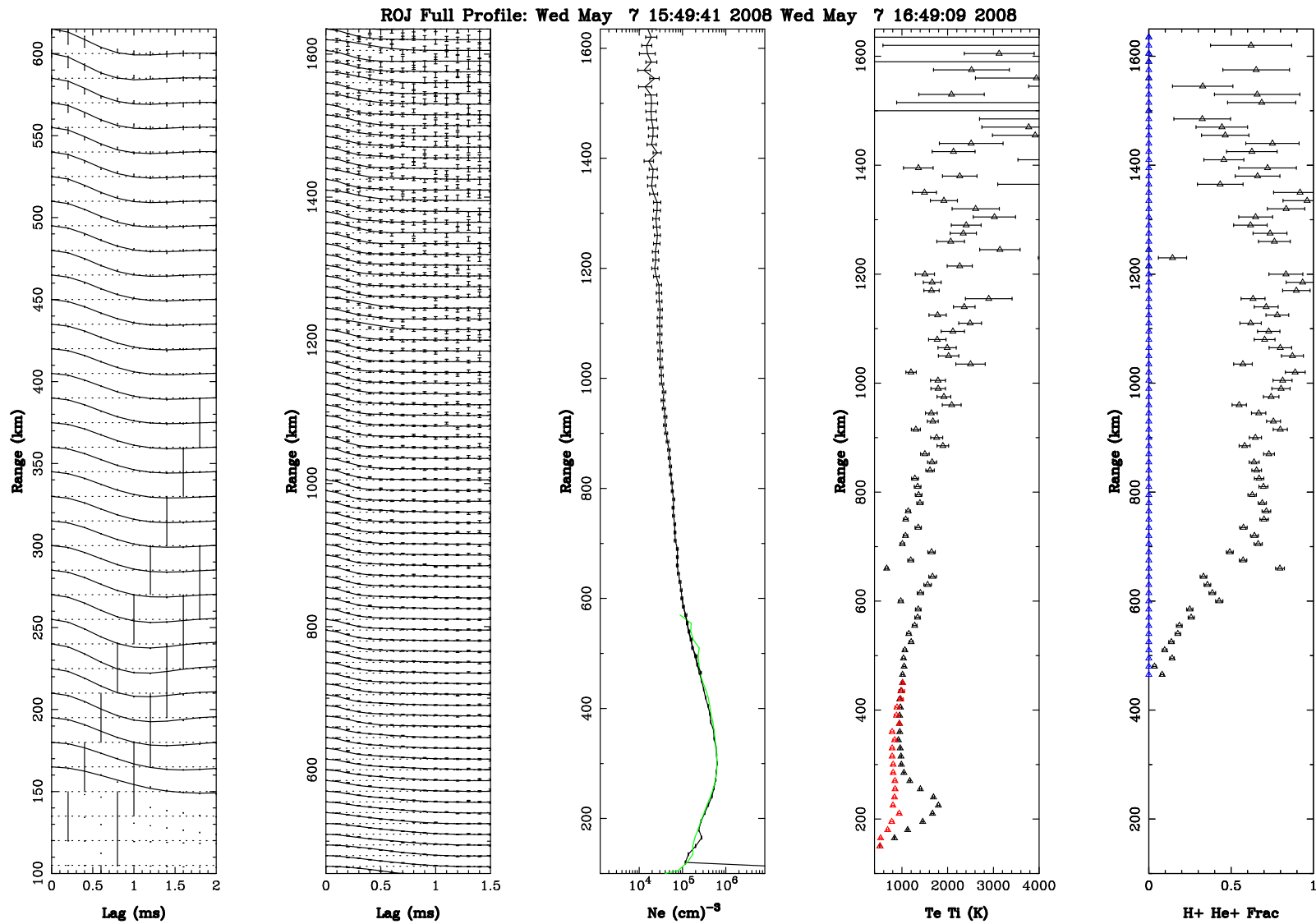
SAMI2 comparison



May '08







- Full-profile analysis will permit the first comprehensive, time-resolved measurements of plasma density, temperature, and composition profiles with drifts at Jicamarca.
- Validation — compare other modes?
- More meaningful comparisons with *in situ* (RPA) and radio propagation (TEC, occultation) measurements from space now possible.
- Thermal balance, ion composition, and photoelectron transport studies getting underway.
- Substantial improvement in noise estimation, debris removal and transmit pulse characterization should facilitate new analyses, including conventional drift measurements.