Introduction to Inverse Problem Diagnostics

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Getting Started

A suite of diagnostic programs is available in Matlab and in IDL. They can be found at `ftp.atm.ox.ac.uk/pub/user/rodgers/SpringSchool2003`. Documentation is available in the files MatlabDiagDoc.pdf and IDLDiagDoc.pdf.

The main program is in Matlab/diagtools/diagnose.m (Matlab) and in IDL/programs/diag.pro, and in each of the subdirectories (IDL). (In IDL the program copies in subdirectories were intended to be symbolic links, but somehow the actual files have been copied there). There are data sets in the remaining subdirectories. These are described in detail in the documentation.

Your current directory should be the case you are interested in examining. When you run the diagnostic code, it will ask you for the name of the case you wish to run. Type e.g: `example`. The program will compute a range of diagnostics, as described in the lectures, and leave them in meaningfully named variables in the data space. The will mostly not be printed. You can the print or plot whichever of the diagnostics you wish to examine, using the tools of the language you are using.

Example

Run the case 'Example' first. This is the standard example used in the lectures. Examine the data files, to ensure that you understand the case being run.

• Examine the basic diagnostics for the case as given:

– Plot the weighting functions (`K`).
  - In Matlab, use the system plot command: `plot(K')` or `surface(K)`
  - In IDL you will find that diag.pro includes a very simple routine, `zplot`. Using `zplot,K,xlabel` will plot the weighting functions against the labels of the state vector elements. If you know IDL well, you might like to write your own plotting code.

– Plot the gain matrix (`G`). (`plot(G)` or `zplot,transpose(G),xlabel)` Think about what it means.

– Plot the averaging kernels (A). Think about what they mean.

– Examine the diagonals of `Shat`, `Sn` and `Ss`.

– Look at the singular values of Ktilde (i.e. `lambda`). Check qualitatively that this is consistent with the information content and dfs computed.

• Look at the effect of improving the instrument's measurement error by a factor of e.g. 10: Change the contents of the file example.noise from 0.25 (i.e. 0.5^2) to 0.0025 (i.e. 0.05^2). Is improvement in the performance as you expect?

• Replace the instrument noise by its original value, and look at the effect of using a different a priori covariance of your choice.

• If you have time, try other data sets in the same way.