SLODAR: Profiling Atmospheric Turbulence at the WHT

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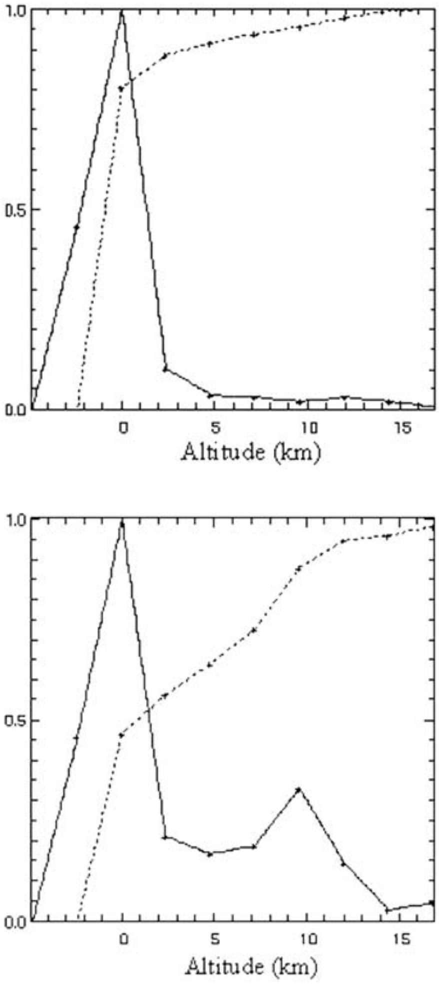

Figure 1. Normalised profiles of the strength of optical turbulence versus altitude for April 15 21:38 UT (top) and April 16 20:45 UT (bottom), 2003.

A new method for measuring the altitude and velocity of turbulent layers in the atmosphere —which cause the astronomical seeing and scintillation or 'twinkling' of the stars— has been demonstrated at the WHT. SLODAR (SLOpe Detection And Ranging) is a triangulation method, in which the turbulence profile is recovered from observations of bright binary stars using a Shack-Hartmann wavefront sensor.

In the past, astronomers have been concerned only with the overall effects of the turbulence, in terms of the resulting image spread or 'seeing angle' (FWHM for a point source) at the telescope focus. However with the advent of adaptive optical correction for astronomy, measurements of the changing atmospheric turbulence structure are of increasing importance.

The altitude distribution of the turbulence determines the corrected or 'isoplanatic' field of view for adaptive optics (AO). High altitude layers reduce the isoplanatic angle, since for these layers the wave-front aberrations measured in the direction of the AO guide star will not coincide perfectly with the aberrations at off-axis field-angles.

The velocities of the turbulent layers are also important, since these determine the rate of change of the seeing aberration at the telescope, and hence the temporal bandwidth of the AO control system required to achieve effective image correction.

SLODAR is a highly automated system which can provide real-time data for optimising and calibrating observations with AO. More details of the method and instrument can be found at the Durham astronomical instrumentation website: `http://aig-www.dur.ac.uk/ /fix/projects/slodar/res/wht.html`.

Figures 1 and 2 show SLODAR results for April 15th and 16th, both recorded in excellent seeing (0.45 arcsec), but with contrasting turbulence profiles. The conditions on April 15th were dominated by ground-level turbulence, whereas significant turbulence at higher altitudes was present on the 16th. Hence although the overall seeing was the same for the two nights the conditions for AO were different. The isoplanatic angle was very large on April 15th, but was reduced on the 16th by the presence of the high altitude turbulence.¤

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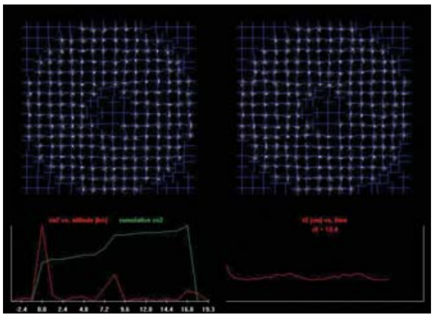

Figure 2. Snapshot of the WHT SLODAR system graphical user interface, showing the Shack-Hartmann spot patterns for a binary star, and real-time plots of the turbulence-altitude profile and the integrated turbulence strength versus time.

Amazing GRACE

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The profile of the William Herschel Telescope (WHT) has changed since the beginning of this year, with the addition of a new facility at one of the telescope's Nasmyth platforms. For many years the WHT has had the GHRIL building on the Nasmyth1 platform —now the ING has added GRACE to the opposite side of the telescope. GRACE (**GR**ound based **A**daptive optics **C**ontrolled **E**nvironment) is a dedicated structure designed to facilitate the routine use of adaptive optics (AO) at the WHT, using ING's AO instrument suite. The design of GRACE allows for the future use of laser guide stars.