

PROSPECTS FOR UNPRECEDENTED SEEING IN ANTARCTICA

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Seeing degradation is almost entirely the result of thermal inhomogeneity in the atmosphere and at most observatory sites, a major contributor to this inhomogeneity is the diurnal variation in temperature. In addition to its effects on the free atmosphere, the daily temperature variation leads to local seeing degradation, especially with large telescopes, because the temperatures of massive components tend to lag behind the temperature of the surrounding air and give rise to convective disturbances.

For much of Antarctica, at least during the dark months, the systematic diurnal variation is negligible, so seeing will not suffer on this account. Furthermore, the upper atmosphere, especially over the highest part of the Eastern Plateau, is generally very stable, with extremely low circulation velocities. Near the centre of this circulation, the predominant airflow is a slow settling from the stratosphere, which must be very conducive to good seeing. So there is reason to suggest that better seeing might be attainable from an Antarctic site than from any other earth-bound observatory. In the near infrared, which is, in any case, favoured in Antarctica by the very low temperature of the atmosphere and telescope and for which the diffraction-limited resolution of a telescope of a few metres diameter is a small fraction of an arcsecond, great advantage could be taken of exquisite seeing. Even at visible wavelengths, gains in resolution might, for many observations, outweigh the disadvantages due to increased auroral activity.

However, the air temperature near ground level in Antarctica does vary considerably over a period of a few hours, particularly in winter. This variation is due to the air in the lowest few to many tens of metres, in which there is typically a steep negative temperature gradient (coldest next the ground), being stirred by wind. Unfortunately, this effect must be accompanied by microthermal fluctuations which will degrade seeing. The depth of the disturbed layer is expected to be least at the highest part of the plateau, where the wind speeds are lowest, but at any Antarctic plateau site, it may be much more profitable to mount a telescope high above the local terrain than at conventional (mountain top) observatories. The economics of doing this will depend critically on the amount of the advantage to be gained, i.e. on just how good the seeing would be from such an elevated mounting, and on the height required.

In testing prospective Antarctic sites, the potential for achieving unprecedented seeing should be fully recognised and seeing test techniques devised which will quantify the performance attainable and the special efforts needed, e.g. in elevating telescopes, to approach it. Insofar as sites at the very highest part of the plateau (or nearest the centre of the atmospheric circulation, if these locations differ) may offer great advantages in seeing over lower altitude sites, critical seeing tests should be applied there as soon as the techniques are proven to be reliable at existing sites like the South Pole and Vostok.