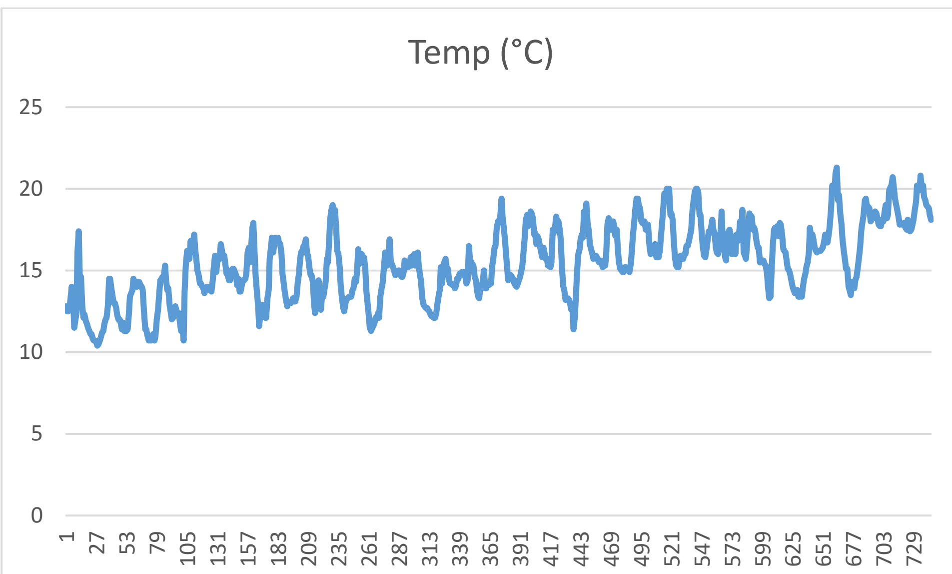
Internal Boundary Layer Effects on Sable Island

Peter Taylor, 9 June 2021

Chapter 4 of Kaimal and Finnigan (1994) deals with "Flow over Changing Terrain" and "Local Advection" in both Convective and stable IBLs. Both can occur (afternoons or early mornings) as air blows in from the ocean to the Sable Island A weather station at WSA, or the 17m mast, both around 400 m from the S shoreline of the island. Note that typical night to day 2-m temperature differences at YSA in July are 4-5 °C. Plot below is July 2019. Surface water temperature is unlikely to vary by more than 1 °C.



Going back a few years see modelling papers

Taylor, P.A., 1970: A model of airflow above changes in surface heat flux, temperature and roughness for neutral and unstable conditions. Boundary-Layer Met., 1, 18 39.

and

Taylor, P.A., 1971: Airflow above changes in surface heat flux, temperature and roughness: an extension to include the stable case. Boundary-Layer Met., 1, 474 497.

More recently

Weng, W., Taylor, P.A. and Salmon, J.R., 2010, A 2-D numerical model of boundary-layer flow over single and multiple surface condition changes, J. Wind Eng & Industrial Aerodynamics, 98, 121-132

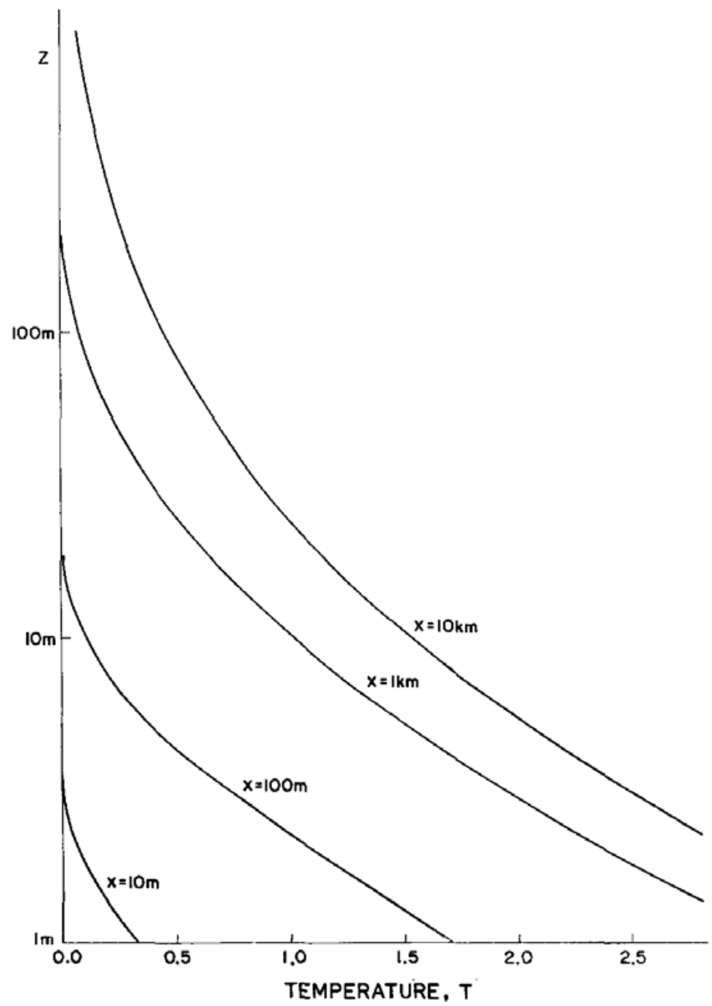


Fig. 16. Temperature profiles for lake breeze with $z_1 = 10$ cm.

A Lake Breeze case from Taylor (1970) is more or less appropriate for Sable Island, In this case the water z_0 was 0.001m, and land 0.1m. The upstream, over water wind speed was 6.5 ms^{-1} at 2m and the land - sea **surface** temperature difference was 9 °C. Upstream flow was neutral.

On the plot Temperature, T represents difference from upstream temperature, in °C.

So at 2m, 400 m inland a 2°C change is in accord with day-night differences, and smaller temperature changes would extend up to heights of order 30 m.

If the air temperatures increased from 15 °C to 17 °C then the difference in saturated mixing ratio would be 10.78 - 12.27 g/kg so about 1.5 g/kg of over water fog could evaporate.

The reverse night time situation would be different but it would be possible for 1 g/kg of water vapour to condense and produce advective radiation fog.

Kaimal, J.C. and Finnigan, J.J.,1994. Atmospheric Boundary Layer Flows, Oxford University Press, NewYork, 289 pp