MOUNTAIN WAVES and WAVE TURBULENCE.

Wave Turbulence Overview.

This is an optional program module.

The RAOB program is the only commercially available sounding analyses program that produces mountain (lee) wave turbulence analyses. Even though RAOB also produces standard CAT and High Altitude CAT analyses, these forms of turbulence only use wind shear and lapse rates (respectively) as determining factors. Wave turbulence, however, is dependent on both wind speed and lapse rate in addition to terrain. In fact, results show that just the slightest variations in surface terrain can produce wave turbulence when the necessary wind shear and stability conditions are present – and the RAOB program has algorithms that objectively measure their combined effect upon the atmosphere.

There are literally hundreds of published articles on various mathematical solutions for wave turbulence, many of which have specific boundary conditions such as limited atmospheric layers or require explicit atmospheric lapse rates, wind shears, and terrain shapes. RAOB, on the other hand, consistently produces reasonable wave turbulence analyses using everyday soundings with user-definable mountain parameters, and without restriction to pre-defined lapse rates or wind shear. Even though RAOB has a default mountain range parameter algorithm that will always produce a maximum wave scenario, it is absolutely essential that the user provide RAOB with actual mountain parameters in order to produce the best possible wave turbulence results for any individual sounding. This necessity is discussed in more detail in the following pages of this section.

All mathematics used by RAOB to produce wave turbulence are taken from widely acknowledged and quoted sources of wave turbulence theory (which are detailed in the following pages). These theories were developed before the age of computers and no applications algorithms existed until Richard E. Cale (an internationally recognized Certified Consulting Meteorologist) converted these equations into a standard set of automated procedures for use on programmable calculators. Using these procedures, Mr. Cale has had repeated success in analyzing mountain wave turbulence over the Rocky Mountains and other worldwide locations during many years of research on numerous aviation incidents and related atmospheric phenomena.

The author of RAOB has obtained Mr. Cale's wave turbulence algorithms and incorporated them into the RAOB program in an interactive format. These algorithms were independently validated and tested before acceptance into the RAOB program. Test results were remarkable. Very good correlations were noted between soundings and reported wave activity. The author even found good correlation of observed low-level wave induced clouds over the mid-western United States, where a large hill was the only significant terrain feature. The source literature used by Mr. Cale and used to develop RAOB's wave algorithms similarly reflect the sensitivity of this methodology to analyze waves produced by even the slightest variations in terrain. The author cannot over-emphasize the need for the user to provide the RAOB program accurate mountain parameters for each sounding location in order to obtain the best possible mountain wave and related turbulence results.

It is important to note that even though RAOB consistently produces reasonable wave turbulence results, nearly all mountain and lee wave source documents indicate that there is no single set of equations that can accurately explain all wave phenomena. Furthermore, even though RAOB uses three parameters to define terrain (height, half-width, and ridge axis orientation), mountain shapes are much more complex than these simple definitions may suggest. In the meantime, improved and new methods are being sought for use in RAOB.

For those that require a *complete* analysis of atmospheric turbulence (with or without local terrain influences), RAOB's Turbulence & Mountain-Wave module is a must have tool.