Geophysical Research Abstracts
Vol. 18, EGU2016-2852, 2016
EGU General Assembly 2016

Gravity Waves characteristics and their impact on turbulent transport above an Antarctic Ice Sheet

Daniela Cava (1), Umberto Giostra (2,3), and Gabriel Katul ()

(1) Istituto di Scienze dell'Atmosfera e del Clima, ISAC-CNR, strada. prov. Lecce-Monteroni km 1.2, Lecce 73100, Italy (d.cava@isac.cnr.it), (2) Department of Pure and Applied Sciences (DiSPeA), Università degli Studi di Urbino "Carlo Bo", Scientific Campus "E. Mattei", Urbino 61029, Italy; (umberto.giostra@uniurb.it), (3) CINFAI (National Inter-University Consortium for Physics of the Atmosphere and Hydrosphere), Tolentino, 62029, Italy
, (4) Nicholas School of the Environment, Duke University, Box 90328, Durham, NC 27708, USA, (gaby@duke.edu)

Turbulence within the stable boundary layer (SBL) remains a ubiquitous feature of many geophysical flows, especially over glaciers and ice-sheets. Although numerous studies have investigated various aspects of the boundary layer motion during stable atmospheric conditions, a unified picture of turbulent transport within the SBL remains elusive. In a strongly stratified SBL, turbulence generation is frequently associated with interactions with sub-meso scale motions that are often a combination of gravity waves (GWs) and horizontal modes. While some progress has been made in the inclusion of GW parameterisation within global models, description and parameterisation of the turbulence-wave interaction remain an open question. The discrimination between waves and turbulence is a focal point needed to make progress as these two motions have different properties with regards to heat, moisture and pollutant transport. In fact, the occurrence of GWs can cause significant differences and ambiguities in the interpretation of turbulence statistics and fluxes if not a priori filtered from the analysis.
In this work, the characteristics of GW and their impact on turbulent statistics were investigated using wind velocity components and scalars collected above an Antarctic Ice sheet during an Austral Summer. Antarctica is an ideal location for exploring the characteristics of GW because of persistent conditions of strongly stable atmospheric stability in the lower troposphere. Periods dominated by wavy motions have been identified by analysing time series measured by fast response instrumentation. The GWs nature and features have been investigated using Fourier cross-spectral indicators. The detected waves were frequently characterised by variable amplitude and period; moreover, they often produced non-stationarity and large intermittency in turbulent fluctuations that can significantly alter the estimation of turbulence statistics in general and fluxes in particular. A multi-resolution decomposition based on the Haar wavelet has been applied to separate gravity waves from turbulent fluctuations in case of a sufficiently defined spectral gap. Statistics computed after removing wavy disturbances highlight the large impact of gravity waves on second order turbulent quantities. One of the most impacted parameters is turbulent kinetic energy, in particular in the longitudinal and lateral components. The effect of wave activity on momentum and scalar fluxes is more complex because waves can produce large errors in sign and magnitude of computed turbulent fluxes or they themselves can contribute to intermittent turbulent mixing. The proposed filtering procedure based on the multi-resolution decomposition restored the correct sign in the turbulent sensible heat flux values. These findings highlight the significance of a correct evaluation of the impact of wave components when the goal is determining the turbulent transport component of mass and energy in the SBL.