



Calhoun: The NPS Institutional Archive
DSpace Repository

Faculty and Researchers

Faculty and Researchers' Publications

2020-01-16

An Evaluation of MoninObukhov Similarity Theory within the Marine Atmospheric Surface Layer: The Prevalence of the Constant Stress Layer

Ortiz-Suslow, David G.; Alappattu, Denny P.; Kalogiros, John; Yamaguchi, Ryan; Wauer, Benjamin; Franklin, Kyle; Wang, Qing

AMS

Ortiz-Suslow, David G., et al. "An Evaluation of MoninObukhov Similarity Theory within the Marine Atmospheric Surface Layer: The Prevalence of the Constant Stress Layer." 100th American Meteorological Society Annual Meeting. AMS, 2020.
<http://hdl.handle.net/10945/66916>

This publication is a work of the U.S. Government as defined in Title 17. United



Downloaded from NPS Archive: Calhoun

Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

Dudley Knox Library / Naval Postgraduate School
411 Dyer Road / 1 University Circle
Monterey, California USA 93943

<http://www.nps.edu/library>



13.2: An Evaluation of Monin–Obukhov Similarity Theory within the Marine Atmospheric Surface Layer: The Prevalence of the Constant Stress Layer

Thursday, January 16, 2020

01:45 PM - 02:00 PM

📍 Boston Convention and Exhibition Center - 158

Monin-Obukhov Similarity Theory (MOST) forms the backbone for many studies of the atmospheric surface layer (ASL), whether over land or ocean, and is critical to predicting the electromagnetic (EM) propagation in the marine environment. Fundamentally, MOST extends the Richardson-Prandtl flux-gradient relationship to the general case of non-neutral conditions using dimensionless, empirical functions for momentum, temperature, moisture, and turbulent energy dissipation. These empirical functions provide a means to represent surface fluxes from mean quantities such as those from gridded numerical simulations. A critical component to the underlying basis for MOST, and the flux-gradient relationship, is the constant flux layer assumption. In the neutral conditions, the absence of stress divergence implies that only one relevant turbulent velocity scale is needed to close the surface flux problem (e.g., the friction velocity). However, in the marine environment, flux profile measurements are rarely collected and the overwhelming majority of data sets cannot confirm the presence of this critical assumption over typical averaging windows. Using a complete (momentum and total heat), high-resolution flux profile (ranging 2–16 m above the surface) collected during the CASPER-West field campaign, we have conducted a study that systematically evaluates the prevalence of the constant flux layer model over the marine ASL (MASL). These measurements were taken from the Research Platform (R/P) *FLIP*, which is an ideal ocean-going platform for making near-surface measurements free from the contaminations endemic to typical ship-based measurements. We utilize a novel approach to empirically test each observed profile of momentum, sensible, and latent heat flux against a sufficiently constant profile. This enabled us to analyze the dependence of whether or not an individual profile was “constant” against the mean environmental state, e.g., wind speed, stability, and air-sea temperature difference. For the momentum flux, we found that only 33% of profiles could be considered non-divergent, which drops to 10% if only considering the profiles below 6 m. If only considering statistically stationary profiles (~20% of the total data set), we found that 43% of profiles were sufficient constant stress. Similar findings were observed for sensible heat flux, with a dramatic increase in the prevalence of non-divergence for the latent heat flux. An analysis into the environmental dependence of these general results will be presented. These results question the generally held assumption that the MASL is typically a constant stress layer; this holds significant implications for how surface fluxes are parameterized and/or derived over the ocean, as well as the widespread reliance on MOST to accurately describe the vertical structure of the MASL.

Authors

David G. Ortiz-Suslow

NPS
Monterey, CA, USA

Denny P. Alappattu

San Jose State Univ.
Moss Landing, CA, USA

John Kalogiros

NPS
Monterey, CA, USA

Ryan Yamaguchi

NPS
Monterey, CA, USA

Benjamin Wauer

Naval Postgraduate School
Monterey, CA, USA

Kyle Franklin

Naval Postgraduate School
Monterey, CA, USA

Qing Wang
NPS
Monterey, CA, USA



 **Recorded Presentation**
Recording.

[Find Similar](#)

View Related Events

Day: [Thursday, January 16, 2020](#)