Sergej Zilitinkevich

EGU Alfred Wegener Medal & Honorary Membership 2015

The 2015 Alfred Wegener Medal & Honorary Membership is awarded to Sergej Zilitinkevich for creating the fundamentals of the theory of stratified planetary boundary layers.

Sergej Zilitinkevich is a world leader in environmental turbulence and planetary boundary layers (PBLs). He deserves credit for the creation of the fundamentals of the theory of stratified PBLs in the 60s and 70s. In particular, for his rotation-stratification depth-scale for stable PBLs, now referred to as the Zilitinkevich scale, and the PBL bulk resistance and heat-mass-transfer laws expressing the near-surface turbulent fluxes through external parameters: wind speed at the outer boundary of PBL and the temperature-humidity increments across a PBL. In 2005–2006 he extended these laws to extreme stratifications accounting for the newly recognised non-local features of stable PBLs and organised structures in convective PBLs. Another important contribution is the prognostic equation for the depth of evolving boundary layers, accounting for the turbulent energy spin-up. Many of Zilitinkevich's discoveries and laws are included in textbooks and cited as classical without references.

In the seventies, Zilitinkevich developed a novel method for analysing turbulent motions driven by the inertia and buoyancy forces, and employed it to discover a puzzling 'sheared convection' regime involving two types of chaotic motions: usual shear-generated Kolmogorov turbulence, and unusual convective turbulence consisted of merging plumes rather than breaking eddies. This theory has received undoubted experimental confirmation; however, it was much ahead of contemporary views and did not initially attract attention. In 2010, Zilitinkevich has revealed that the merging-plume turbulence performs the inverse energy transfer (from smaller to larger scales), which is precisely the mechanism converting potential energy of unstable stratification into kinetic energy of large-scale convective structures.

In the last decade, Zilitinkevich has been leading international efforts aimed at developing energetically consistent turbulence-closure theory applicable to the strongly stratified, very-high-Reynolds-number flows in the free atmosphere and hydrosphere. Zilitinkevich and collaborators have discovered the key mechanisms of the self-control of stably stratified turbulence and self-organisation of convective turbulence, obtaining ground-breaking results. Until present, supercritically stratified turbulence dominating the free atmosphere and hydrosphere has been parameterised only heuristically and very uncertainly, without serious theoretical and experimental basis. Convective PBLs are still parameterised only heuristically.

Practical applications of the work of Zilitinkevich include modelling and forecasting of climate, weather, wind-energy potential, and air and water quality. His basic results, formulated in geophysical terms, are equally applicable to astrophysical problems, such as turbulence in accretion discs and convection in the Sun.

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