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The atmosphere and ocean as two-time-scale systems

The dynamics of the atmosphere and ocean is dominated by large-scale, slow motion with time scales of a few days or more. Faster motion in the form of gravity waves with periods of a few hours is also present, but its amplitude is typically much smaller. Nevertheless this fast motion has a determining influence on the large-scale circulation of both the atmosphere and the ocean. Because of the large time-scale separation between the two types of motion, they interact only weakly. They are not completely separated, however; in particular, slow motion continuously excites fast gravity waves through a process known as spontaneous waves generation. I will discuss how this relates to the concepts of slow manifold and balanced approximations to the dynamics, and show how exponential asymptotics provides methods to capture spontaneous wave generation in simple models.