

令和 7 年度（2025 年度）
東北大学大学院理学研究科 地学専攻
博士課程前期 2 年の課程 入試問題

英語

令和 6 年 8 月 8 日 10 : 00 ～ 11 : 20 実施

注 意 事 項

1. 机の上には受験票、筆記用具、時計以外は置かないこと。
2. 携帯電話や音の出る機器などは、電源を切ってかばんの中に入れること。
3. 試験開始の合図があるまで、問題冊子を開かないこと。
4. 試験時間は 10:00 から 11:20 までである。
5. 試験中大きな地震が発生した場合、試験監督の指示に従うこと。
6. 問題は、英語 1、英語 2 の大問 2 問からなる。解答は解答用紙の指定されたところに記入すること。

英語1 次の文章を読み、以下の問1～問5に答えよ。

Earth's rotation is an imperfect timekeeper. This imperfection is imperceptible to humans, but the exquisite accuracy of atomic clocks makes it clear that the time taken for the planet to make one full turn varies from day to day.

On a millennial timescale, changes in Earth's rotation reflect the combined effect of (a)three geophysical processes. First, friction between ocean water and the sea floor — both in shallow seas and in the deep ocean — has progressively slowed Earth's rotation. This effect is known as tidal dissipation. Second, since the last ice age ended, Earth has undergone shape adjustments that have increased its rotation rate. These ongoing changes have brought the planet back to a shape that is more spherical than the flattened form it took when massive ice sheets existed in its polar regions. Finally, the coupling between Earth's iron core and its outer rocky mantle and crust means that any change in the angular momentum of the core must be balanced by a change of equal magnitude and opposite sign in the mantle and crust.

Although the individual contribution of each process is somewhat uncertain, their sum is known precisely: it has led to an increase in Earth's rotation period of 6 millionths of a second per year. This slowing might seem trivially small, but its effect is responsible for a phenomenon known as clock error. (b)This error describes a discrepancy in the timing of eclipses: events recorded by ancient astronomers seem to have occurred at times that differ from those predicted by assuming that Earth's rotation rate has remained unchanged since ancient times. Clock error increases with the age of the eclipse and reaches around 4 hours for eclipses that were observed 2,500 years ago.

The effects of tidal dissipation and shape adjustments have not changed appreciably since the advent of modern atomic timekeeping, but the impact of core–mantle coupling on Earth's rotation varies on multiple timescales as a result of the fluid nature of the outer core. And herein lies the probable cause of timekeeping's most recent dilemma: leap seconds have been required with much lower frequency since 2000 than in the previous 30 years, which indicates that Earth's rotation rate is accelerating. Given the stability of tidal dissipation and shape-adjustment effects over this period, the main culprit must be core–mantle coupling. However, Agnew's findings suggest that there is another factor at play.

Agnew analysed changes in Earth's rotation and in its gravity field — changes in the latter arising through the redistribution of mass on Earth's surface. His analysis demonstrates persuasively that core–mantle coupling has led to accelerated rotation, but that there has also been a pronounced deceleration owing to the onset of major melting of polar ice sheets that began near the end of the twentieth century. (c)This human-induced process is slowing rotation by moving melted ice mass from the poles to lower latitudes.

(d)Core–mantle coupling alone could have necessitated a negative leap second in about two years' time. According to Agnew's calculations, changes in polar ice mass have delayed this eventuality by another three years, to 2029. But no realistic projection of

future ice-mass changes will thwart the need for a negative leap second beyond the next decade. Unless international timekeeping guidelines change soon, the myriad technological foundations of human society must be updated in preparation for ^(e)this unprecedented event, and for the disappearance of 23:59:59 on a single day in the not-too-distant future.

出典: Tavella P, Mitrovica JX (2024) Nature 628, 273–274.

問1 下線部(a)の3つのプロセスとは何か、また、それらは地球の自転をどのように変化させるのか。3行以内の和文で説明せよ。

問2 下線部(b)を和訳せよ。

問3 下線部(c)について、なぜ人為的なプロセスによって地球の自転速度が遅くなるのか、その仕組みを6行以内の英文で具体的に説明せよ。

問4 下線部(d)を和訳せよ。

問5 下線部(e)について、なぜこのイベントは前代未聞と考えられるのか、2行以内の和文で説明せよ。

英語2 次の Fig. 1 は植生分布の決定要因に関する論文からの抜粋である。この図を用いて短い英語のプレゼンテーションを行う場合の台本を10行以内で記述せよ。口語的な表現を用いてもよい。

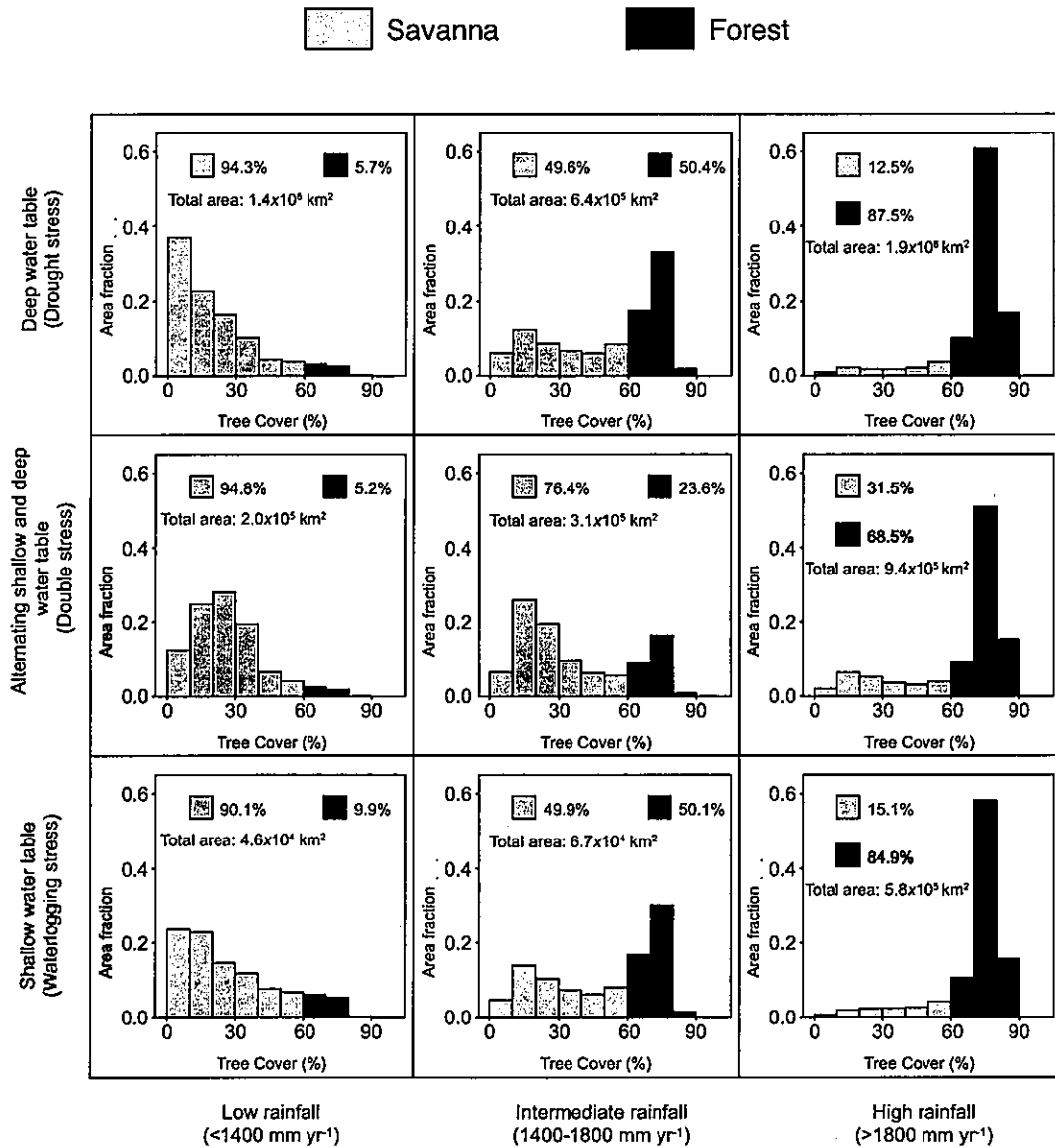


Fig 1. Histograms showing tree cover distribution in each rainfall-drainage class, with relative abundance of forest and savanna.

出典： Mattos, CRC et al. (2023) PNAS 120(33) e2301255020.