greater transparency. This raises the possibility that quantum cryptography could be incorporated into future networks to provide cybersecurity at the physical layer for new application areas such as the SmartGrid and data centers. Deployment of transparent network infrastructure is most advanced in the Asia-Pacific region, where the potential value of quantum cryptography has been recently demonstrated. For example, Japan's quantum cryptography testbed is a component of a national optical communications program and involves the research arms of several major Japanese corporations, which provide the commercial "heft" for successful future deployment (see the figure). Japan also plans to draw on its satellite optical communications capability to overcome the current metro-area range limitation of optical fiber quantum cryptography. With one or more space-based quantum communications nodes, geographically separated ground-based domains could be linked, even on a global scale. Japan has announced plans for a combined quantum and optical communications demonstration satellite for launch in 2013 (*7*), and China will launch its own experimental quantum communications satellite in 2016 (*8*).

Quantum cryptography research has been reinvigorated by quantum hackers. The fundamental connection between security and quantum mechanics is now more clearly defined. And with new clarity brought to its value proposition, quantum cryptography has a bright future within applied communications research as a physical-layer security technology for protecting the networks of the future.

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GEOCHEMISTRY

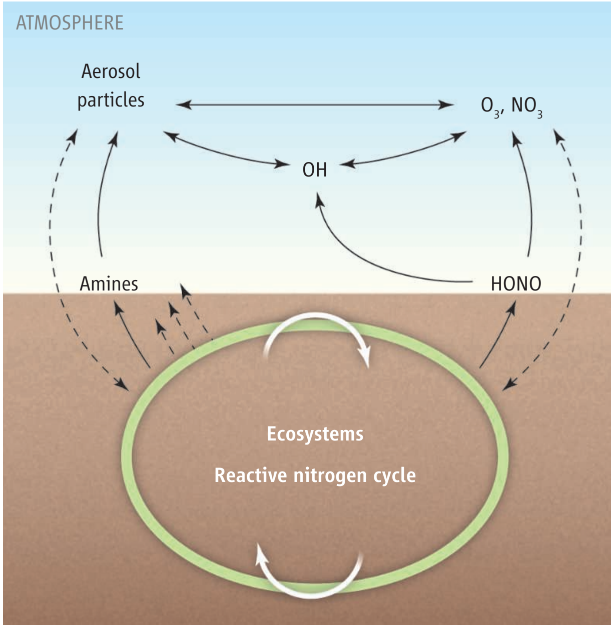
Soil Nitrites Influence Atmospheric Chemistry

Soil nitrite is a source of nitrous acid emissions that contribute to hydroxyl radical production.

Markku Kulmala and Tuukka Petäjä

Public discussion of climate change typically revolves around greenhouse gases, aerosol particles, and the role of human actions (*1*–*3*), but it is just beginning to reflect an awareness of the important role played by the global nitrogen cycle (*4*). It has been difficult, however, to disentangle the nitrogen cycle's role in climate change owing to its complex interactions with other biogeochemical cycles, including the carbon and sulfur cycles (*5*), and with factors such as soil, vegetation, and water. These interactions can lead to unexpected, nonlinear responses in the Earth system as a whole. On page 1616 of this issue, Su *et al.* (*6*) illuminate one poorly understood set of interactions, showing that nitrite in soil can produce nitrous acid (HONO) emissions that are a source of hydroxyl (OH) radicals in the atmosphere. The finding helps identify one source of "missing" atmospheric HONO, and highlights how HONO emissions could rise with increasing temperatures and nitrogen fertilizer use.

Reactive nitrogen compounds, including synthetic fertilizers, are key to sustaining soil fertility and global food production. During the last century, humans have increased the amount of reactive nitrogen involved in the global nitrogen cycle (*4*). In ecosystems, nitrogen compounds circulate within an almost closed loop (*7*). Studies have suggested that the photolysis of HONO, one component of the nitrogen cycle, is a major source of OH in the lower atmosphere. OH, in turn, plays a role in creating and removing atmospheric gases (*8*) and acting as a precursor for aerosols, particles that contribute to pollution and climate change. Known sources of HONO, however, were poorly understood and did not account for observed levels in the atmosphere (*6*, *9*). For example, measurements taken on a mountain top in Hohenpeissenberg, Germany, suggested that ~30% of OH formation was attributable to unknown HONO sources (*10*). Recently, researchers have suggested that microbe-produced nitrite in soil (*6*) and on leaf surfaces (*9*) could be the missing sources.



Soil-atmosphere connections. Microbial activity in the soil and processes in the ecosystem (bottom) connect the nitrogen cycle (green) to atmospheric reactions (blue) involved in atmospheric chemistry and aerosol dynamics. Microbe-produced nitrite in soil feeds HONO emissions, which contribute to the creation of atmospheric OH. Amines contribute to aerosol formation. HONO and amine emissions from soil could increase as global temperatures rise and nitrogen fertilizer use increases, in turn affecting global climate. White arrows indicate reactive nitrogen cycle in the soil ecosystem.

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Su *et al*. confirm that idea and demonstrate how soil sources of HONO operate. In laboratory experiments involving a closed chamber and models of atmosphere-soil exchange of trace gases, they show that the amount of HONO released by nitrite in soil can vary by time of day, and can depend on the soil's physical, chemical, and biological properties, including temperature, moisture, and levels of reactive nitrogen and microbial activity. Their data suggest that, in the future, enhanced nitrogen deposition and the increased use of fertilizer, together with increasing temperatures and changes in soil acidity, could increase HONO emissions from soil.

What would happen if global HONO emissions from soil doubled within the next 25 years? OH concentrations would increase by ~30%. This could increase the atmosphere's ability to cleanse itself of volatile compounds such as methane and sulfur dioxide. At the same time, the OH increase could increase aerosol formation; sulfuric acid and low-volatile organic compounds, formed in the atmosphere from precursors via atmospheric oxidation by OH, are responsible for new particle formation and the growth of the recently formed particles (*11*, *12*). This process is nonlinear and depends on the production rate of condensable vapors and is affected by changes in ambient OH concentrations (*13*). Reducing HONO emissions, in contrast, could reduce the cooling effects of aerosols.

HONO is not the only reactive nitrogen compound relevant to aerosol formation; trace compounds known as amines also contribute. With rising HONO emissions, amines will further enhance aerosol nucleation, growth (*11*, *14*) and concentrations. This suggests that nitrites and amines can have a crucial effect on atmospheric chemistry and aerosol dynamics, even though they are present only in trace concentrations, compared with nitrates, ammonia, and other reactive nitrogen compounds (*4*).

HONO is a good example of how soil processes are linked with atmospheric chemistry. It is also an excellent example of how trace amounts of reactive nitrogen link the nitrogen and sulfur cycles and with the water and carbon cycles. It is well known that the carbon and nitrogen cycles are coupled (*5*), but we need to document all the cycles and their links and feedback loops to fully understand how the biosphere affects the atmosphere and global climate (*1*–*5*, *15*). Besides extensive global modeling, we need continuous, comprehensive field measurements (*16*); these should include monitoring of soil, ecosystem, and atmospheric processes, fluxes, and storage, and of greenhouse gases, trace gases, and aerosols. Su *et al*. provide a good starting point for future investigations, including studies of reactive nitrogen compounds other than HONO.

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DEVELOPMENT

Electrically Driven Insulation in the Central Nervous System

Electrically active axons drive local myelination.

Alfonso Araque and Marta Navarrete

In the central nervous system, cells called oligodendrocytes create myelin, the electrical insulation that sheathes the axons of neurons. The formation of myelin dramatically increases the speed of nerve signals and is critical to nervous system development and physiology, and demyelination can play a central role in disease (*1*–*4*). Many of the mechanisms underlying myelination, however, remain unclear. On page 1647 of this issue, Wake *et al*. (*5*) expand our understanding. They demonstrate that electrically active axons can induce myelin formation by vesicular release of glutamate that signals nearby oligodendrocytes to start local production of a myelin-building protein. The finding provides novel insights into how experience can influence brain development and physiology.

Neurons transmit information through fast electrical signals (action potentials) that are conducted along axons, specialized enlargements that can extend long distances from the cell body. The evolution of faster information processing has had important implications for animal performance and survival. Many invertebrates have evolved faster action potential propagation by increasing axonal diameter. In contrast, vertebrates evolved more sophisticated mechanisms that abide by volume restrictions and allow the development of more complex nervous systems. Vertebrate axons can be wrapped in a multilayered myelin sheath that increases conduction velocity by up to two orders of magnitude (*1*). Myelin sheaths are formed by specialized glial cells (Schwann cells in the peripheral nervous system; oligodendrocytes in the central nervous system).

Myelination is a complex process. It requires oligodendrocyte maturation and differentiation, as well as regulatory mechanisms that ensure that myelination occurs at the right time and place on the correct axon. Many axon-glia signals control myelination, including membrane surface and diffusible signals (*1*, *3*, *4*). In addition, axonal electrical activity regulates the proliferation and differentiation of oligodendrocytes, which results in myelin formation (*6*, *7*).

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