Of Rainforests and Rain, Land Titles, Bosons (the Higgs), Albatross Deaths, and More

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Higgs boson discovery: 'It was an extraordinarily tense time, but exciting'

Physicist Fabiola Gianotti reflects on the culmination of decades of work on the elusive particle

Chris Jordan, Photographer

My Over-all Line of Pursuit Aims At These Questions:

A: According to three broadly-configured bodies of scientific research:

1—Is the water cycle/system—the movement of water from earth to sky and back again-- significantly influenced by land-atmospheric feedbacks (interactive processes involving land, its subsurface, and the lower atmosphere, where precipitation forms and is released)? [YES, there is strong agreement about this, sub nom., e.g., “feedbacks”, “interactions”, “teleconnections”, a variant of “ecosystem services”]

2—If so, do some types of land masses make particular contributions to this cycle? [There is considerable agreement about this, though not complete consensus.]

3—If so, what specific contributions to the water cycle do they make? [a—through unusually large contributions to evapotranspiration (ET) or water storage and/or release; (b)—through the provision of environmental niches for biological ice nucleation]

4—Do rainforests make any such contributions; if so, what?

5—Do human-induced rainforest changes affect these contributions? If so, how?

6—What knowledge of these processes, contributions, and alterations do the three bodies of research offer? What questions do they invite?

[Note: Q’s 4, 5,and 6 are the focus of my current study. Provisional responses follow.]

B. Does current research into water cycle-related land-atmospheric feedbacks yield [good and sufficient] reasons to protect rainforests from further human-caused development—i.e., loss-- using available public policy tools (i.e., protective regulatory policies--PRP?):

1. My ongoing research investigation suggests reasons for PRP. But I'll test-drive here both a stronger and a weaker version of that claim. The research I am studying lies within: (a) Earth Sciences/Environmental Engineering/Forest Ecology; (b) Multi-disciplinary research into Biological Ice Nucleation ("BIN's"); (c) the Microphysics of Clouds ("cloud physics").
2. Here is a sampling of current findings and active research questions from these fields:

C. From the Earth Science Research:

1. Consistent with Christopher Columbus's observations in 1494, there is general agreement within the earth sciences today that vegetation influences climate and, as Columbus observed, that forested areas positively influence the formation of mists and rain. What Columbus observed was a feedback process.
2. Today, the proven understandings are that forested regions are implicated in a complexity of feedback processes and that locally, regionally, and even globally, these processes influence and are influenced by climate and ecosystem functions in highly specific ways.
3. At stake are factors that include temperatures at, above, and below the earth's surface; the moisture profile of land at the surface and below; the emission or storage of chemical species, including atmospheric and terrestrial carbon and nitrogen; propensity toward ignition (fire); the partition of rainfall into runoff and evaporative components; influence over precipitation patterns; and much else. These factors have been consistently shown to be highly dynamic, variable, and interdependent, though heterodox experimental methods common to this research produces outcomes that remain inconsistent in a variety of details.
4. Forested regions have proven both adaptive and maladaptive to land cover change (LCC). This is especially so as to major rainforests that have been altered substantially by LCC's such as intentional deforestation in favor of agricultural uses , logging, and precipitous rises in the extent of human habitation.

[C. Earth Science Research, continued:]

5. The essential finding regarding rain is that evapotranspiration is essential to the water cycle, as it stores water in the structure of plants and, through root activity, mediates water retention below the ground, providing also a significant means of achieving the surface roughness that incite energy fluxes needed for moisture to rise into the atmosphere, where it converts to water vapor for transport into the clouds. There, it freezes into crystals that condense to fall as rain.

[C. Earth Sciences, continued:]

6. Despite unanimity within the allied earth sciences fields over the crucial role of evapotranspiration within the water cycle and the powerful effects of rainforests on local and regional rainfall patterns, there are divergences within recent experimental findings, causing epistemic perturbations within the field, e.g.:

(a)There is a net impact offset in negative local rainfall effects based on findings that deforestation somewhat increases rain within those areas. The positive effect may be unstable but remains undertheorized.

(b) There is conflict over whether deforestation for hydropower within the Amazon basin has a positive or a negative effect on power generation from a vast new hydropower plant under construction there. The most recent modeling displays negative effects.

(c) Effects of tropical deforestation on global hydroclimate due to effects on remote regions ("teleconnectivity") are in dispute.

(d) Methodological diversity, which is great, may generate experimental biases, thus, noisy conflicts that are costly and slow to settle.

(e) In general, earth science experimental data does not attempt to account for the microbial and other nuclear properties of precipitation, even though the propagation of ice nuclei may be favored by "environmental niches" (Morris et al, 2008) on the forest floor (debris) and/or in the tree canopy, thus enhancing the "value" of ecosystem services.

D. From the Multi-disciplinary (agronomy, bacteriology, botany, cloud physics, genetics, meteorology, and more) Biological Ice Nucleation (BIN) Research:

- 1. The conventional hypothesis—that the composition of ice nucleii is a matter of scientific indifference because of the great heterogeneity of capable atmospheric particles (dust, minerals, bacteria, etc.)—has been somewhat overtaken by experimental interest in BIN's, which exhibit the ability to perform better than inorganic particles at warm tropospheric temperatures. A warming climate contributes to this interest.
- 2. The increasing validation of an hypothesis from the early 1980's exhibits support for a single bacterium, Pseudomonas syringae (P. syringae), as a prolific contemporary BIN. A major prehistoric (and possibly, therefore, continuous) role for this bacterium finds support in recently-excavated glacial ice cores. (Note: Of the 600-odd strains of P.syringae, fewer than a half-dozen have been found to exhibit the relevant property: a lattice-like structure on the outer portion of the cell that can stimulate water droplets to crystalize into a structure the lattice supports.
- 3. P. syringae has begun to migrate from being viewed exclusively as a perceived enemy of agriculture, subject to bactericidal campaigns because it produces (otherwise harmless) stem- and leaf-rot through its ice-productive manipulations of certain crops, to being celebrated as a hero of the water cycle for its generative capacity to make rain. This new form of positive notoriety has helped to galvanize multi-disciplinary interest in IN- active biota (INA's). So has a dearth of snow for the purposes of the ski industry, which has begun employing BIN's to make snow.
- 4. A very recent testable hypothesis is that BIN's including P. syringae could be propagated to service the water cycle, being grown on host plants (crops, for example), which could be genetically modified to accept the BIN's as their guests. The over-all effects of BIN production—a new agronomy!—on the drought-ridden water cycle within increasingly prominent regions, including agricultural regions, remains altogether unknown. But the subject could light a spark of interest over the theorized potential for positive effects on water scarcity through precipitation enhancement via biological means.

E. From the cloud microphysics research:

[Note: This section is a placeholder for more factually- embroidered work.]

1. From a position of apparently total disinterest on the part of cloud physicists just a few years ago (see Clouds in the Perturbed Climate System, which mentions ice nucleation but once, glancingly) to a two-day conference this year devoted to the microphysics of clouds—a field foundational to BIN research—it is clear that physicists—young ones, in particular—are finding experimental interest in the role of circulating biota in the water cycle.
2. The true correlative amounts to a burgeoning of interest in all of the organic families of known IN's. These include both identified and unidentified types of bacteria, fungae, lichen, spores, and more. As might be expected, the new research is attaching itself to the study of different types of clouds and differing behaviors, including the "scavenging" of ice-nucleating microorganisms under heterogeneous atmospheric conditions (Schmalle 2015).
3. The need to understand not only nucleating properties but aggregative phenomena such as sheer numbers and mass in respect to IN's of each type (inorganic IN's, too)within each possible atmospheric locale now is beginning to yawn.
4. The effort to understand ice nucleation, in full effect, should propel a new thrust to integrate forest ecology with bacteriology and microbiology and these with physical chemistry and microphysics. Like the search for the Higgs boson, the work of understanding will need to be shared by theorists and data-gatherers, who may, as in physics, represent differing tribes or, given the differences between and among these fields and their historical development, it may be that the theorizers will also be wont to explore forest floors, hands-on.

F. (Still-)Evolving Thoughts on Protective Regulatory Policy (PRP) for Rainforests:

1. The prior recapitulation of three groups of scientific efforts to comprehend, as of now, significant facets of the water cycle should make it clear that very little is fully understood about water as a moving (non-static) system at the level of practical effect and that, unlike the Standard Model in physics (or any that compete with it), there is no comprehensive, or even integrated, theoretical model of how the water cycle works.
2. A business-as-usual orientation toward the earth's ever-transient water supply would be framed by a sense that it will always self-renew, so that boredom rather than watchfulness is the order of the day. Or, that the costs of meaningful intervention to prevent its continued alteration and perturbation are just too high. Or, that the collective action problems attendant on who would need to pay whom for what are impossibly complex.

F. (Still-)Evolving Thoughts on Protective Regulatory Policy (PRP) for Rainforests, Continued:

3. Recent estimates of deforestation in the Brazilian Amazon alone put the land mass loss to human habitation and private enterprise at 20% or more of the total forested area. A common extrapolation is that at familiar (recent historic) rates of deforestation, though the Brazilian government worked to slow it in for a few brief years, well over half of the forest will have been destroyed within the next three decades (Soares- Filho 2006). Similar rates of destruction are projected for most of the rainforests in the world, some of which have already seen destruction at rates faster than that in Brazil.

4. Major efforts have been and are being undertaken to work the alchemy necessary to treat rainforest as the sum of its "ecosystem services", hence, as a monetizable capital asset. In fact, there is no realistic way to avoid the subject of money in relation to land and its use or non-use. Land was the chief form of capital when our property system began and it remains a major source of private and public wealth today. Major, sophisticated effort has gone into the development of a variety of scenarios by which value can be extrapolated for rainforest services, then pricing schemes announced. (The latest of these may be the attempt to "Make Forests Pay" by placing a value on their total carbon storage capacity, then selling these carbon reserves as offsets to greenhouse gas emitters subject to imposed emissions limits…or to those who want to voluntarily reduce their carbon footprints through a payment device such as this. Melnick et al, NYT 1/20/15.) It should be noted that part of the arbitrariness of these valuation schemes involves the fact that carbon storage in forests is still better theorized than understood and that a region in the process of deforestation can become a net carbon-emitter in that area, which can, if the loss of forest is aggressive enough, reduce greatly what there is to value and preserve. It may be, too, that greatly reduced forests can no longer do this work. Carbon storage is more like a beautiful smile than a timeless work of art: it can fade or disappear into a frown or suffer a mortal blow. What is significant about these schemes beyond their arbitrariness and impracticality is that they always fail to value the most essential "service" that we have seen forests to provide: Their integral function within the water cycle. It is that, above all else, that we should worry after how to preserve. At least is that the case until we can understand and build a reliable alternative of our own—meaning, made by our hands.

[F. PRP, Continued]
To explore non-monetized frames of protection, I want to consider that most basic, conservative element of property theory: ownership. Is my stronger claim that of public ownership of the rainforest commons?

(a) Res Communes and the Public Trust Doctrine: One Method (but requires the naming of guardians who then may get targeted for extinction, as in Peru (see NYT editorial 11/28/14 and National Geographic 2013))
(b) The Brazilian constitution and government ownership of mineral rights: Does this work without endangerment or corruption?
(c) The concept of Res Nullius—ownership by no one, as opposed to res communes: Is this worth a try?
(d) But what can we learn from the Ecuadorian constitution? Are poetic claims of state obligation worth having even if they aren't well-enforced?
(e) Tribes as "forest guardians", with title to the land.

The weaker claim is to enhanced funding for water cycle research that could subsume research into rainforests. Should it include research into producing critical masses of BIN's?