From the earth to the sky: How biofuels and other renewable energy sources may impact global climate change and alter the course of history

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PHM Conference 2019
A tale of two planets
How They Formed

Magnesium isotope evidence that accretional vapour loss shapes planetary compositions

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It has long been recognized that Earth and other differentiated planetary bodies are chemically fractionated compared to primitive, chondritic meteorites and, by inference, the primordial disk from which they formed. However, it is not known whether the notable volatile depletions of planetary bodies are a consequence of accretion or inherited from prior nebular fractionation. The isotopic compositions of the main constituents of planetary bodies can contribute to this debate. Here we develop an analytical approach that corrects a major cause of measurement inaccuracy inherent in conventional methods, and shows that all differentiated bodies have isotopically heavier magnesium compositions than chondritic meteorites. We argue that possible magnesium isotope fractionation during condensation of the solar nebula, core formation and silicate differentiation cannot explain these observations. However, isotopic fractionation between liquid and vapour, followed by vapour escape during accretionary growth of planetesimals, generates appropriate residual compositions. Our modelling implies that the isotopic compositions of magnesium, silicon and iron, and the relative abundances of the major elements of Earth and other planetary bodies, are a natural consequence of substantial (about 40 per cent by mass) vapour loss from growing planetesimals by this mechanism.

Nature paper, September 28, 2017
How They Evolved

Artist’s rendering of a solar storm hitting Mars and stripping ions, carbon dioxide, and oxygen from the planet's upper atmosphere.

Illustration showing the Earth's internal structure.
The external layer shows the Earth’s surface topography and atmosphere, including land, water and clouds. The mantle (red) is a viscous layer of rocks under high pressures and temperatures. The outer core (yellow) is a liquid layer of iron and nickel. The inner core (centre) is a liquid sphere of a iron-nickel alloy. Image: Illustrator Gary Hincks
What will happen to them?

The sun, as it appeared on April 13, 2016. Though it's been burning for some 4.5 billion years, the sun is only about halfway through its life. Credit: NASA/SDO

Expanding red giant stars will swallow too-close planets. In the solar system, the sun will engulf Mercury and Venus, and may devour Earth, as well. (Image: © James Gitlin/STScI AVL)

Scorched Earth
Source: Digital Commons
What will happen to us?

Star Trek: USS Enterprise
Gene Roddenberry

Dead Poet Society
Robin Williams

The Blessed Hope
Nathan Anderson
The human race could live forever — if we can make it through the next 100 years

By: Georgia Frontiere King | January 30, 2019
Global risk of deadly heat
How to survive for the next 100 years?
And how to leave earth?

Humanity has only 100 years left to leave Earth or perish, Stephen Hawking believed

Best get Elon Musk and pals working on Mars rockets

Earth will be a “ball of fire” within 600 years - Stephen Hawking
Survival Initiatives

Breakthrough StarShot

SpaceX Has a Bold Timeline for Getting to Mars and Starting a Colony
Oh, and one other minor player...
DOE Laboratories

- Uncle SAM has 17 National Laboratories
- GOCO entities
- Average annual funding: $13 billion/year
- Multipurpose Science, technology and security labs

[Map of DOE Laboratories]
NASA Facilities

- Uncle SAM has 18 NASA research centers on earth
- And one in space
- Annual budget of $21.5 billion
About ORNL

DOE’s national missions:
- Scientific Discovery
- Clean Energy
- Security

Major areas of science and technology:
- Neutrons
- Computing
- Materials
- Nuclear
About Biosciences

Understanding Biological Systems:
- Biological and Environmental Research Information Systems
- Biological and Nanoscale systems.
- Metabolomics and Bioconversion
- Systems Genetics
- Molecular Biophysics

Biosciences
The Biosciences Division at Oak Ridge National Laboratory (ORNL) is focused on advancing science and technology to better understand complex biological systems and their relationship with the environment. The division has expertise and special facilities in genomics, computational biology, microbiology, microbial ecology, biophysics and structural biology, and plant sciences. This collective expertise includes collaborations within and outside ORNL and focuses on scientific challenges in biology for Department of Energy (DOE) missions in energy and the environment.
Episode IV: A New Hope

WiC’s second “Introduce Your Daughter to AI” workshop was the largest event it’s hosted thus far. Image Credit: Carlos Jones, ORNL
A 200-petaflop machine, Summit can perform 200 quadrillion (peta-) floating point operations per second (flops).

For AI, we can use less precise calculations, so we can quadruple Summit’s performance to exascale levels.

Summit’s file system can store 250 petabytes of data.
**GPU Brawn:** Summit links more than 27,000 deep-learning optimized NVIDIA GPUs with the potential to deliver exascale-level performance (a billion billion calculations per second) for AI applications.

**High-speed Data Movement:** NVLink high-bandwidth technology built into all of Summit’s processors supplies the next-generation “information superhighways” needed to train deep learning algorithms for challenging science problems quickly.

**Memory Where It Matters:** Summit’s sizable local memory allows for data-intensive tasks, which enables faster AI training and greater algorithmic accuracy.
Current Use Cases:
- Cancer
- Fusion Energy
- Materials Science
- High Energy Physics
About NREL

National Centers:
- National Bioenergy Center
- National Center for Photovoltaics
- National Wind Technology Center

Leading Research And Development in:
- Advanced Manufacturing
- Bioenergy
- Buildings
- Chemistry and Nanoscience

Energy Systems Integration Facility
Golden, Colorado
About CBI

Moving Toward Bioproducts from Biomass:

- **Developing** sustainable biomass feedstock crops using plant genomics and bioengineering.
- **Improving** processes to simultaneously break down and convert plants into advanced biofuels.
- **Creating** valuable products from the lignin residue remaining after bioprocessing.

Research And Development Focus Areas:

- Sustainability
- Feedstock Development
- Deconstruction and Separation
- Conversion to Specialty Biofuels and Bioproducts
Our Partners
What we need to do

In 2018 80% of US total energy consumption came from fossil fuels.
New partnerships wanted!
What do we need to do in the next 10 years to survive to 100 years?
1. Stop Fighting

War planning leads to war...

Which has huge environmental impacts

and impoverishes the participants
Stop war at the ballet box
And through travel for business, for fun, and for service
2. Switch to renewables

The most effective clean energy policy gets the least love

In defense of renewable energy mandates.

By David Roberts | @dvox | david@vox.com | Updated Oct 21, 2017, 9:31am EDT

(Shutterstock)

Global Greenhouse Gas Emissions by Economic Sector

- Electricity and Heat Production: 25%
- Agriculture, Forestry and Other Land Use: 24%
- Buildings: 6%
- Transportation: 14%
- Industry: 21%
- Other Energy: 10%
Renewables at home
Activism: Must change laws

Homeowners could see easier access to solar energy under new bill

N.C. law is murky on HOA regulation of solar power

NC House Bill 750 may change this
Renewables at work
Precision on the farm
And in the forest

What to plant, when to plant, how to manage

Surveillance, seeding, spraying
Current capability: 300 pods, 2.4 acres, 18 minutes
Precision requires accurate sensors and data processing.
The most powerful sensor of all

1. Accelerometer
2. Gyroscope
3. Magnetometer
4. GNSS (GPS)
5. Proximity Sensor
6. Ambient Light Sensor

And many more…
Sensor Demo:
Observing the space time continuum
How this is useful
3. Plant Trees

- Earth could support 4.4 billion hectares of canopy cover
- Which could store 205 gigatonnes of carbon
- Which could reverse the climate change trajectory

The global tree restoration potential
Bastin, et. al. Science, 05 July 2019
Thank you

Stanton Martin
Data Management Lead

Bio
Welcome to the data management group for the BioSciences Division at Oak Ridge National Laboratory. We focus on utilizing cutting edge sensor and data management technologies to standardize and streamline the acquisition, management, and curation of data on scales ranging from individual genomes to entire ecosystems. Our strategy is to leverage the ongoing work of colleagues who are developing existing bioinformatics tools and pipelines and expand on these to accommodate larger and more diverse data types. We have a strong interest in developing packages to manage data streams from sensors mounted on both proximal and remote sensing platforms. These data streams can then be merged and curated to create holistic and FAIR data repositories that lend themselves to rapid and automated extraction of information for analysis, research, publications, and public dissemination. We utilize both specialized equipment (such as hyperspectral imagers mounted on UAV's) and commodity equipment (cell phone GPS and cameras) to rapidly acquire field and greenhouse image data that can be translated into phenology measurements of interest to researchers.

One significant focus for our group is managing the data streams coming from experiments associated with the Center for Bioenergy Innovation (CBI). These data streams derive from individual genotypes of Poplar and Switchgrass that have been sequenced and cultivated in common gardens and green house facilities across the United States. Data types from these experiments can include tissue assays, soil assays, microbial assays, and environmental assays. We collaborate with researchers to develop new methods and new tools to help with standardizing and homogenizing the data streams coming from the experiments. Data is curated, manipulated, and FAIRified on our internal data platforms before being released as production data sets.