Planetary Vital Signs, Planetary Decisions, Planetary Intelligence

Public Mistrust of Global Temperature

Ocean Heat

Vital Signs and Risk Indicators

Global Knowledge Action Network

Planetary Intelligence

Based on
Charles F Kennel & Stephen Briggs, Seminar presentation to Centre for Study of Existential Risk, University of Cambridge, February 26, 2016, in collaboration with David Victor, School of Global Policy and Strategies, UCSD

Global Temperature

Our naïve attempt to communicate haunts us all.

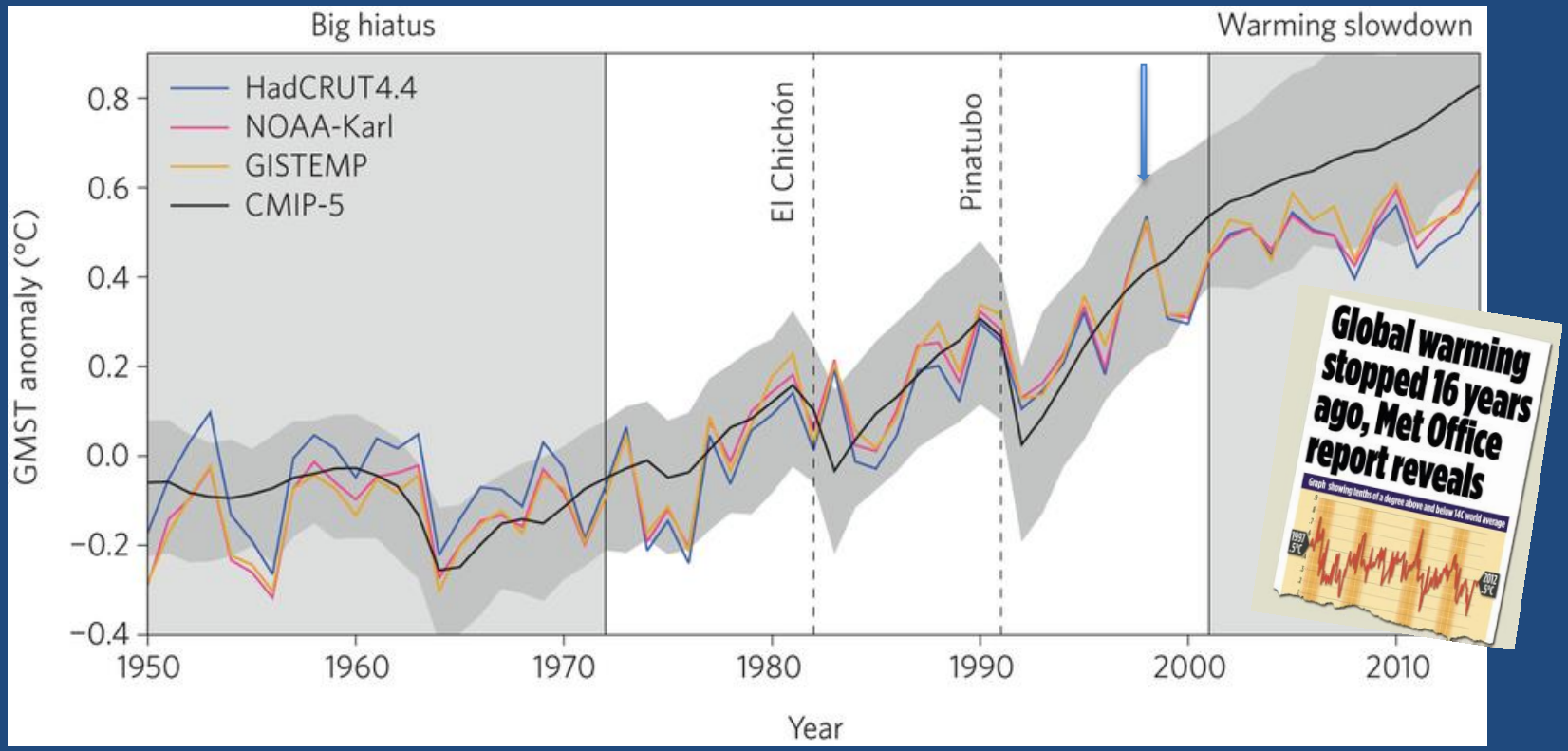
We measure and compute a vast range of variables yet focus publicly on one number that conveys the misleading impression that the world warms up uniformly, or that increased temperature is the primary manifestation of climate change. We then use this highly imperfect index of the rate humans are adding energy to the climate system as our primary criterion for whether we are making progress.

Hiatus

Greenhouse warming not showing up in surface temperature

Models work before 2000 but not after

Interdecadal Pacific Oscillation ?



Anomalies are from three updated observational datasets and the ensemble mean (black curve) and 10–90% range (darker grey shading) GMST of 124 simulations from 41 CMIP-5 models using RCP4.5 extensions from 2005.

Fyfe, J.C. *et al*, Making Sense of the early 2000s warming slowdown, Nature Climate Change 6, 224–228 (2016) doi:10.1038/nclimate2938 Published online 24 February 2016 .

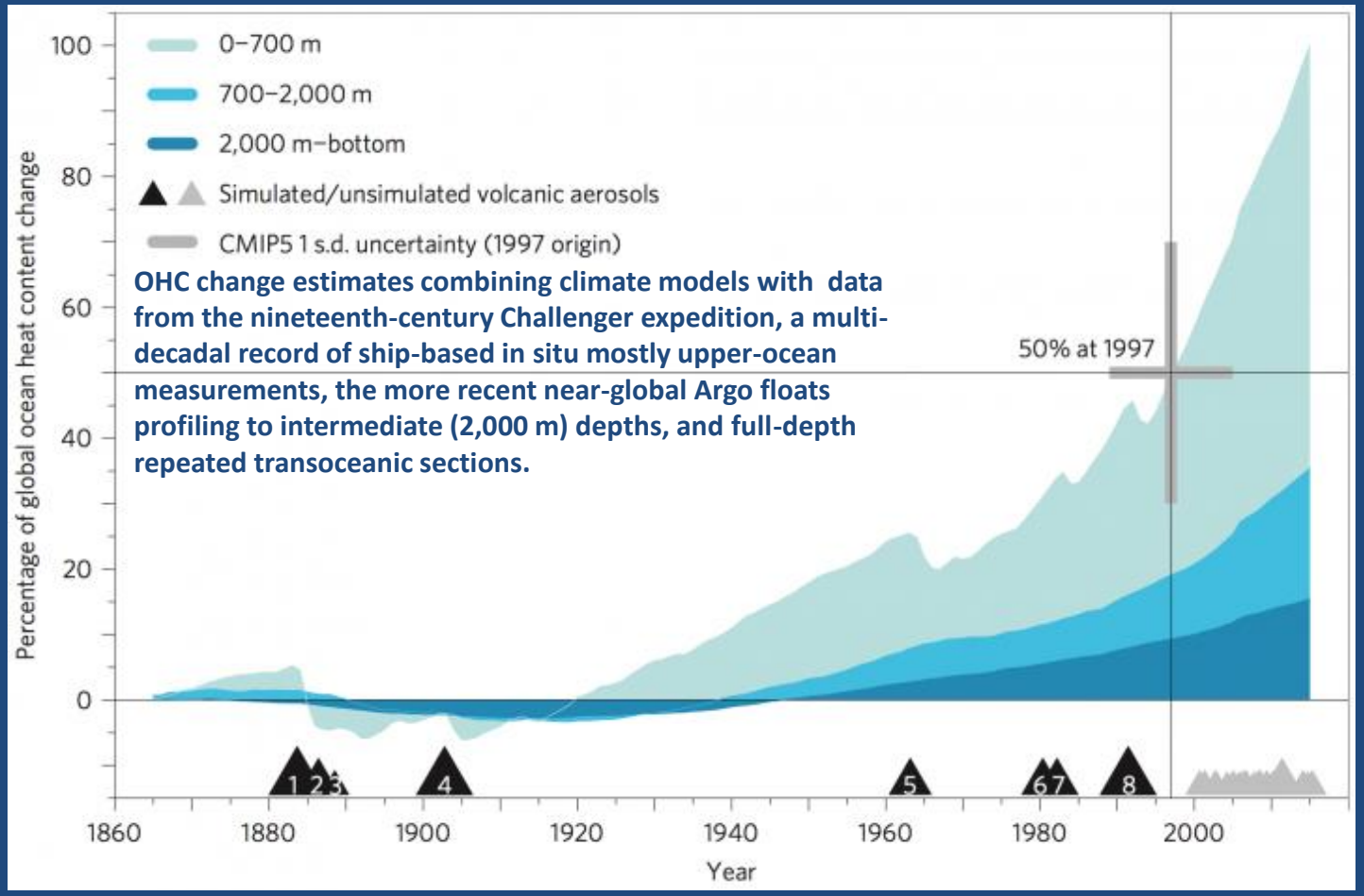
Why do we let the world rely on temperature?

The oceans take up more than 90% of the energy added to the climate system by humans. The atmosphere, 2%.

The heat content of the ocean is our best measure of humanity's impact on the climate. Its time history and geographical distribution help us understand whether the changes we are seeing are incidental or fundamental. It tells us how much climate risk we are storing up for the future. Fortunately, we can now measure it.

Ocean Heat, 1865-2015

Half of all ocean warming since 1865 was during hiatus



Gleckler, Peter J., et al. "Industrial-era global ocean heat uptake doubles in recent decades, "Nature Climate Change" (2016). Also, Wijffels, Susan, et al. "Ocean temperatures chronicle the ongoing warming of Earth." *Nature Climate Change* 6.2 (2016): 116-118.

This whole episode is troubling

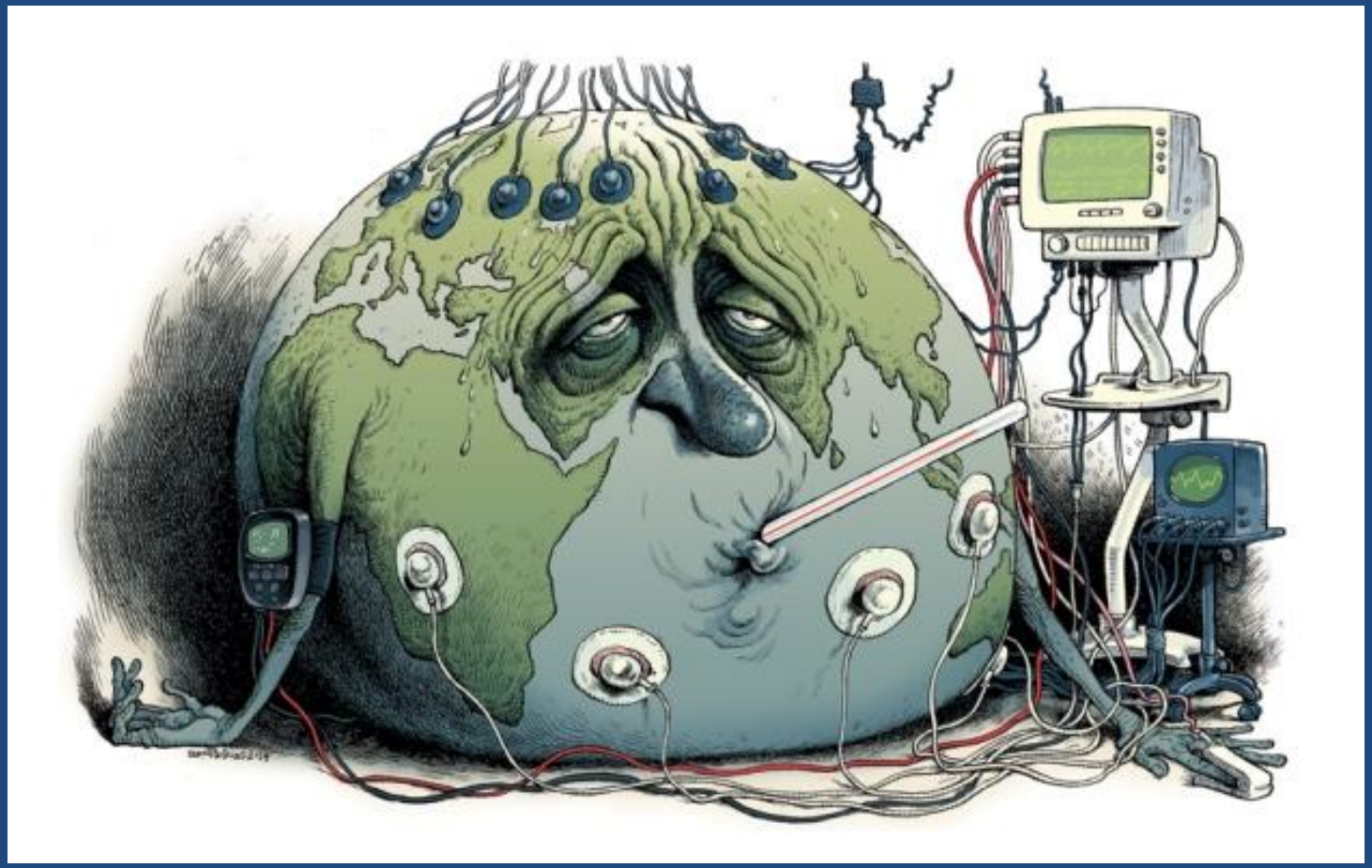
That an important policy debate has been hostage to delicate aspects of reanalysis shows how tricky reliance on a single indicator can be.

Of course, ocean heat content data, indeed all climate time series data, are fragile in the same way as temperature has proven to be.

But that is the point. When all indicators are fragile, you should not rely on one; you risk over-focusing policy on it. You look at a number of different ones and ask whether they all point in the same general direction. You look at the balance of evidence.

Ditch the 2-degree warming goal

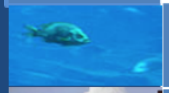
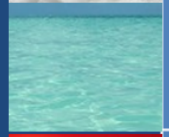
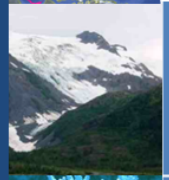
David G. Victor and Charles F. Kennel, *Nature, 514*, 30–31 (02 October 2014) doi:10.1038/514030a



A basket of indicators is needed, just as in central banking, trade policy, and medicine, indeed wherever there are nonlinear systems of systems.

Planetary Vital Signs

Understandable measures that tell a richer story of climate change

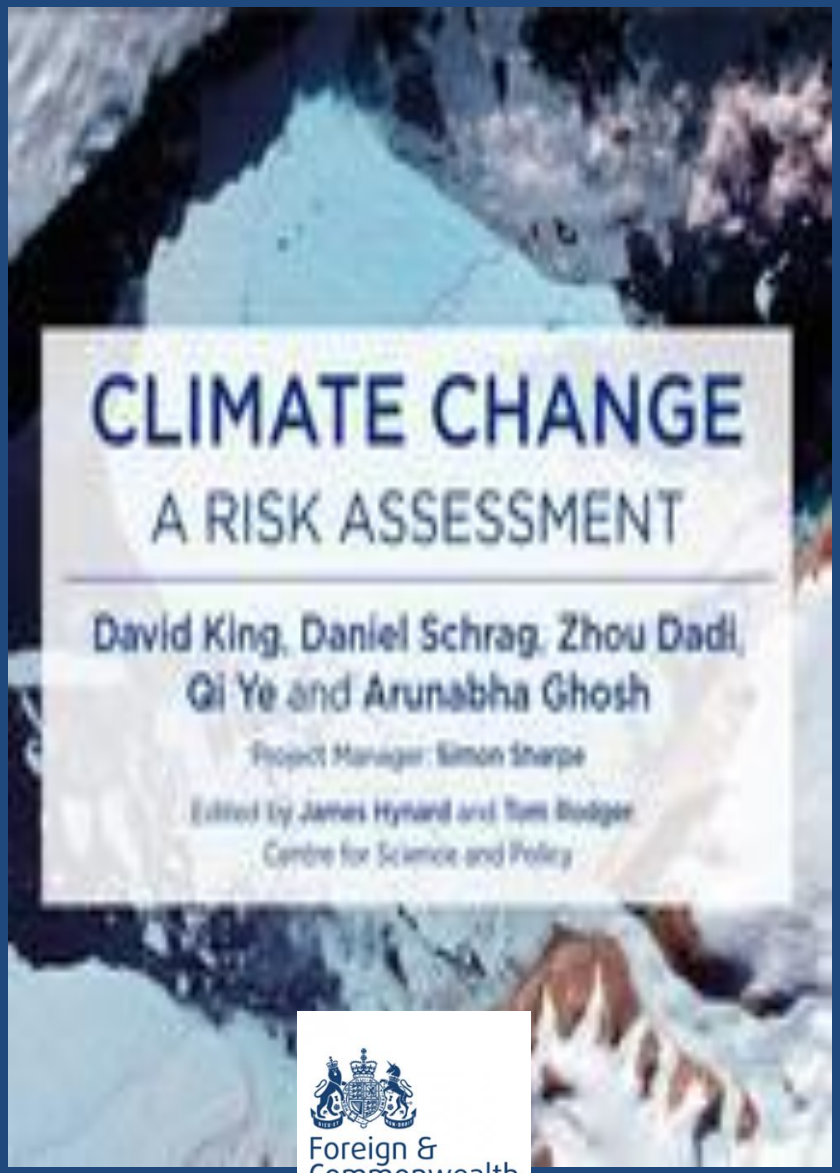
	Global Indicator	Period of Record	Long-term Trend	Trend Since 2000
	Ocean Heat Content	1955-2012	↑	↑
	Global Sea Level Rise	1880-2011	↑	↑
	Global Sea Surface Temperature	1880-2012	↑	↑
	Global Surface Temperature	1901-2012	↑	↑
	Arctic Minimum Sea Ice Extent	1979-2012	↓	↓
	Reference Glaciers Cumulative Mass	1945-2010	↓	↓
	Ocean Acidity	1983-2011	↑	↑

Brenda Ekwurzel, Union of Concerned Scientists

Vital signs are only the beginning. Scientists do not make the decisions on climate, politicians and business leaders do. They respond to the risks to things the public care about, not abstract threats of climate change.

Briggs, Stephen, Charles F. Kennel, and David G. Victor. "Planetary vital signs, "*Nature Climate Change* 5.11 (2015): 969-970.

What kinds of indices make people care?



Vital Signs

Empirical indicators of ongoing change in key climate systems

Direct Risk

"Objective" calculations of ecological and/or societal risk

Systemic Risk

Value-based queries about extreme outcome likelihood

We risk a false start if we do not confront the issues of scale and scope upfront

Scope

Can we create a methodological framework to deal with the huge variety of issues associated with climate change management?

Scale

Can we create a knowledge management infrastructure that meets the needs of millions of decision makers in thousands of culturally distinct communities in hundreds of ecological regions?

ADAPTATION KNOWLEDGE CASCADE

Climate Systems

Ocean state-Temperature, salinity, heat & CO2 content…
Atmospheric state-radiation balance, greenhouse gases, clouds, precipitation,
Ocean dynamics-Great Conveyor Belt (heat transport, heat & CO2 sequestration)…
Atmospheric dynamics-Hadley, Ferrel cells; meridional heat transport, jet streams…

Vital Signs

Regional Geophysical Systems

Cycles-ENSO, Pacific Decadal Oscillation; Monsoons, Indian Ocean Dipole; Arctic Oscillation…
Polar-Sea ice, ice shelves, permafrost, glaciers…
Watersheds-Mountain snows & glaciers, rivers, aquifers, deltas, …
Coasts and Islands-Sea level rise and storm surges; beach erosion, salt-water intrusion…

Regional Ecological Systems

Biomes-Aquatic, alpine, riverine, desert, forest, savanna, grassland, tundra …
Marine-Food chain and biological pump, coral reefs, seamounts, continental shelves
Biodiversity-hotspots, habitats, species abundances, migration, invasive species, …

Direct Risk

Regional Technical Systems

Managed ecosystems-Agriculture, forestry, fisheries…
Managed water-Irrigation, dams, canals, reservoirs,…
Energy-wind, solar, wave, & hydroelectric power…
Urban-infrastructure, transport, built environment…

Human Security

Health-Pandemics, vector-borne disease, pollution, heat mortality and survivability…
Resources-Food, water, energy…
Economics and finance-Prices, trade, markets, regulations, insurance…
Resilience-natural disasters, emergency services, defensive infrastructure
Societal stability-failed states, environmental conflict, migration, social justice…

Systemic Risk

Common Challenge

Trustable, traceable pathways connecting independent knowledge domains and ontologies

Direct Risk Indicators

Quantitative statistical relationships among climate, ecological, and/or societal changes

Systemic Risk Indicators

Query-based outcome probabilities
Low probability, high impact events

Bayesian Methods

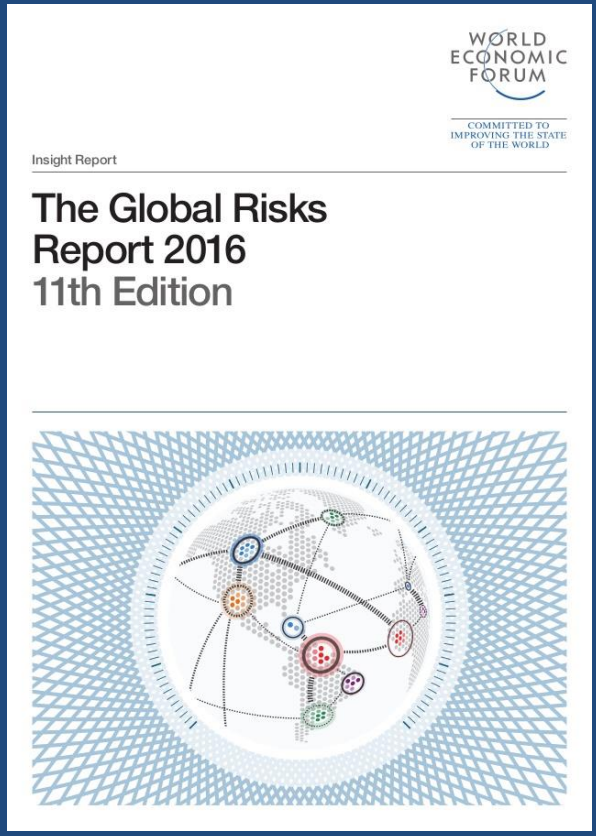
Knowledge gaps; sparse, Inhomogeneous, incommensurate data; arbitrary formats; long tails

Data Analytics

Machine learning, Artificial Intelligence

World Economic Forum

Failure to mitigate or adapt to climate change is largest single threat to the global economy



"One of the innovations that emerged from Paris was the official recognition of the role played by business, investors, cities and provinces in driving and delivering climate action. Effective mobilization of these constituencies – alongside civil society and faith-based groups –has indeed contributed to this successful outcome".

Post-Paris Needs for Decision Support

- **The US and the EU are developing climate services that support *specialized* decisions in the civil sector**
  - **Regional and local decision makers will ask targeted practical questions related to their particular responsibilities**

- **Cities and provinces will need to update their regulations frequently**
  - **Japan's building regulations require resilience to a 200-year earthquake. But what is a 200-year flood, or heat wave, when we know the climate will be different 200 years from now? How do the so-called 200-year floods of today compare with the 200-year floods of 2050?**

- **Public corporations may be required by financial markets to assess the risks to their climate-exposed infrastructure, operations, and markets**
  - **Highly specific risk assessments that the corporations can only make themselves; *Viz,* Multi-national companies have facilities in many different climatic regions; they will have to calculate their risks on a region-by-region basis and aggregate them.**
  - **Corporations will want to do their own risk assessments to avoid revealing competitively sensitive information. Yet, their accounting must also use reliable climate data and generally accepted analytic algorithms or it will not satisfy investors.**
  -

- **Far-seeing policies are required to assure that reliable climate data and generic versions of analytic tools are freely available to companies, their insurers, and their financial consultants**

Embed Knowledge Management Tools in Smart Cyber-Infrastructure

Turn climate change assessment from a periodically appearing document into an always-on knowledge management service that communities, industries, and individuals everywhere can access at any time.

Guides to the Information Jungle

Scientific Networks

Disciplinary Maps

Expert Rankings

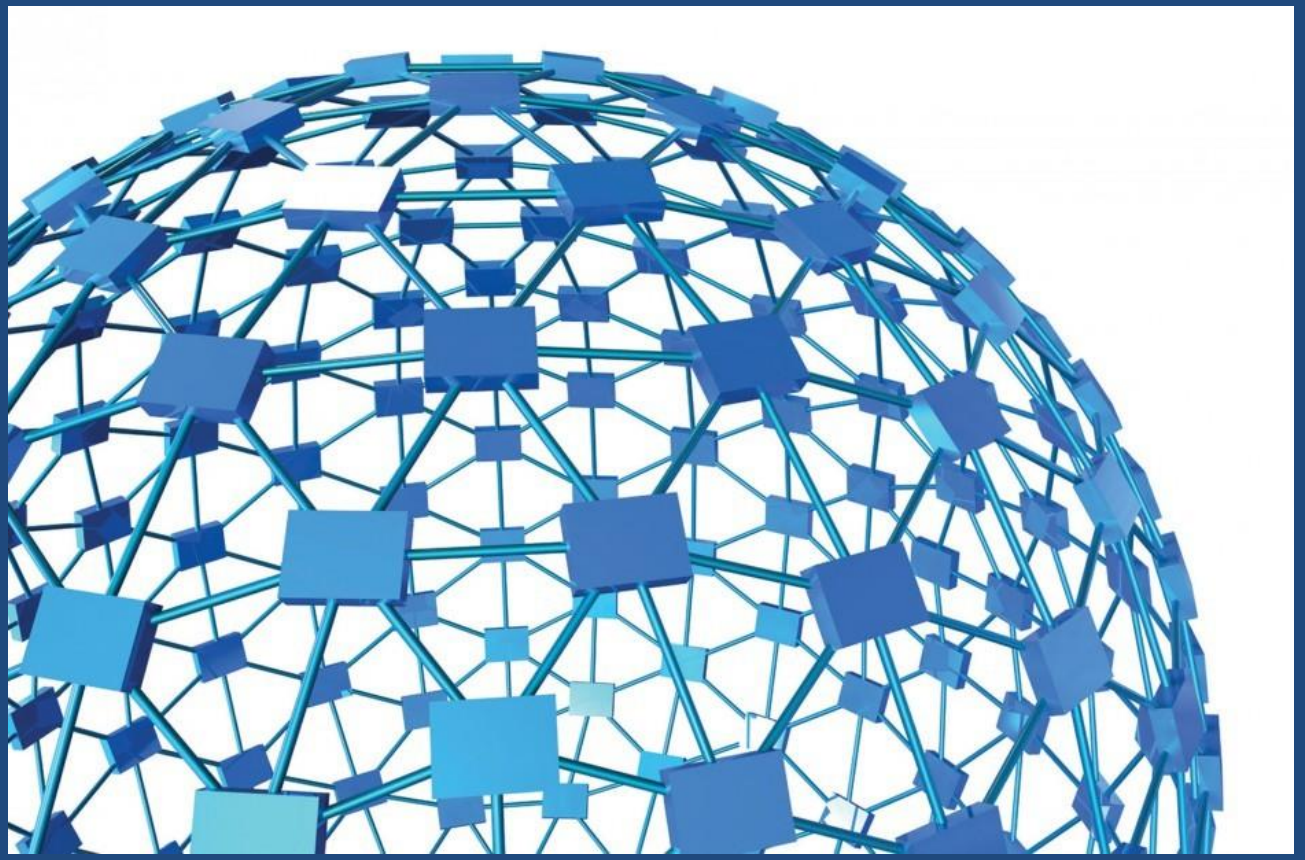
Meta-Languages

Machine Learning

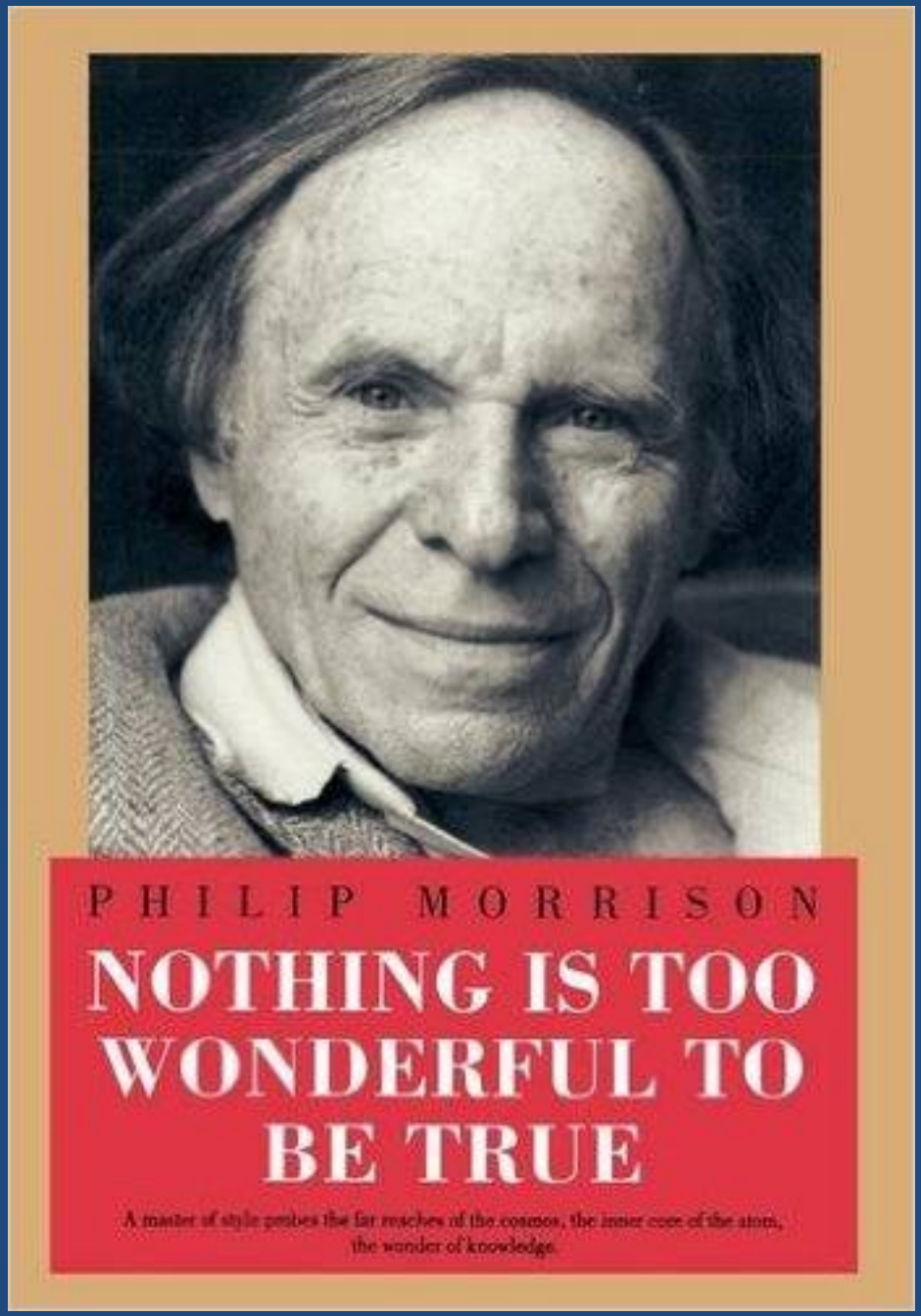
Artificial Intelligence

Global Knowledge Action Network

Knowledge needs to be connected to action "horizontally" among experts and decision makers at each level, and "vertically", both up and down, connecting the global, regional, and local levels.



C.F. Kennel, "Knowledge Action Networks" in Sustainable Humanity, Sustainable Nature, Our Responsibility, Proceedings of the Joint Workshop, Pontifical Academies of Science and Social Science, Extra series 41, Vatican City 2015



My dear lady, here at UCLA they first interconnected computers. Soon there will be a world-wide network. It will first be used to manage global finance, but the expansion of economic activity it induces will create so much pollution that it will be asked to manage our economy and environment in harmony with one another. People will want day-by-day, minute-by-minute adaptive management, for which they neither have the patience or quickness of mind. So they will connect their environmental sensors directly to their computer network. At that point, they will have created a planet aware of its own internal processes, a planetary consciousness. And that, dear lady, is what will communicate with similar entities across the galaxy.

Dinner table conversation in the 1970s,
paraphrased by Charles Kennel in 2016

We are on the way to building Morrison's planetary consciousness. We will think we are asking it to diagnose the planet's ills, but it may conclude that we are the problem….