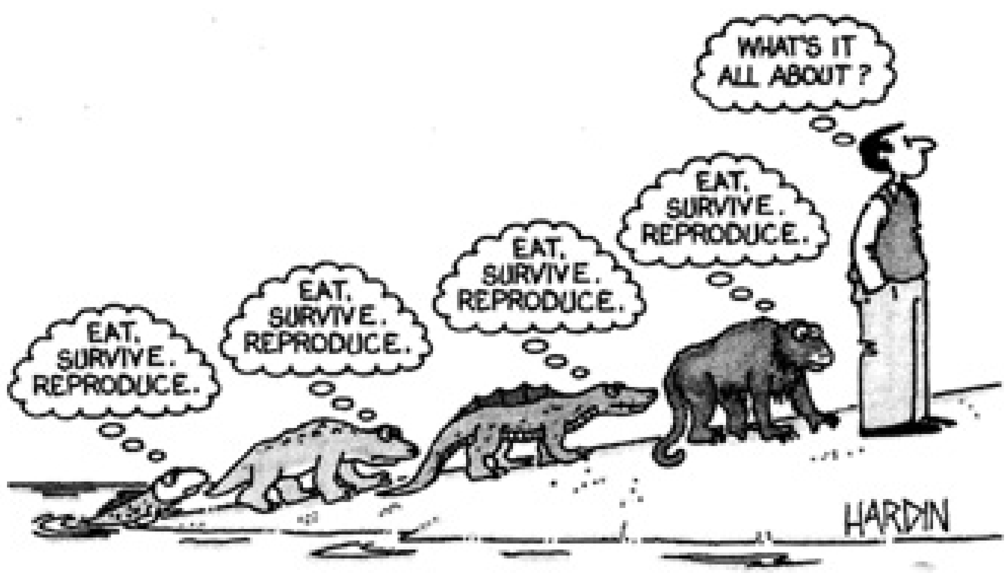
# Atividade Científica

*Renato Vicente*
*EACH-USP/2007*

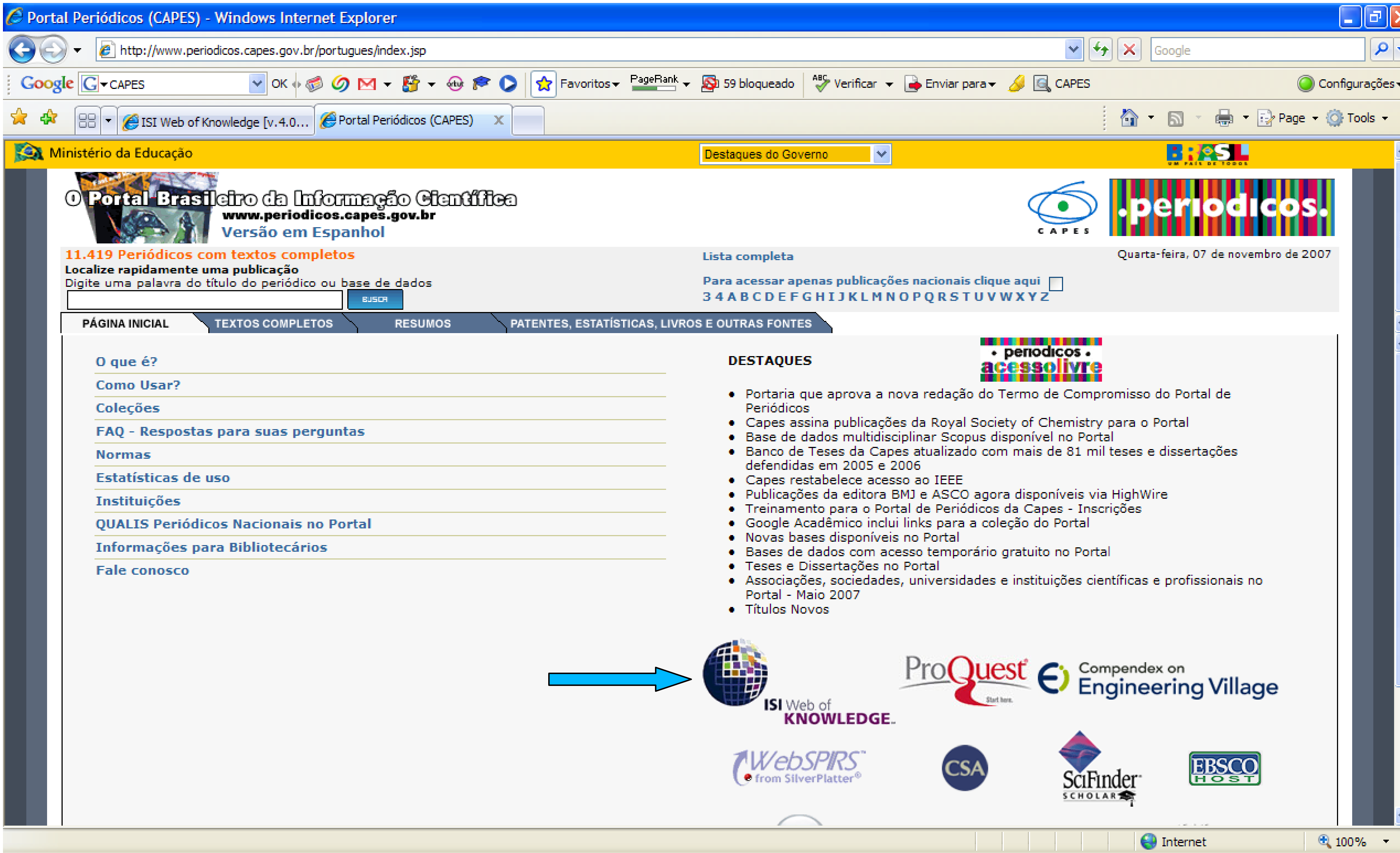
# Perguntas

1. Como sei o que já se sabe sobre um determinado assunto?
2. Como produzo conhecimento novo?
3. Onde as pesquisas são realizadas?
4. Como pesquisas são financiadas?
5. Como funciona a carreira acadêmica?
6. Como divulgo os resultados obtidos?
7. Resumindo

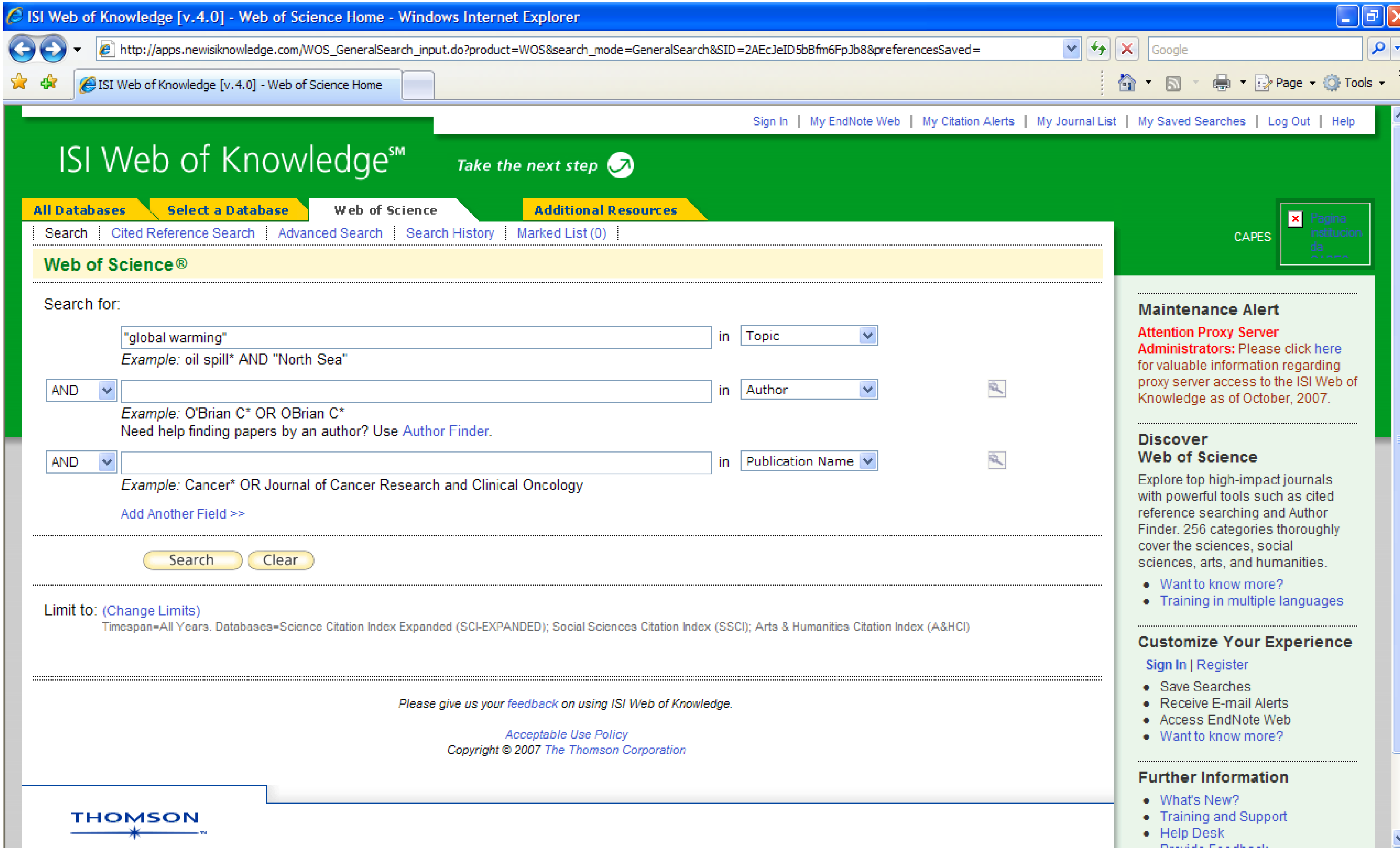


# O que já se sabe?

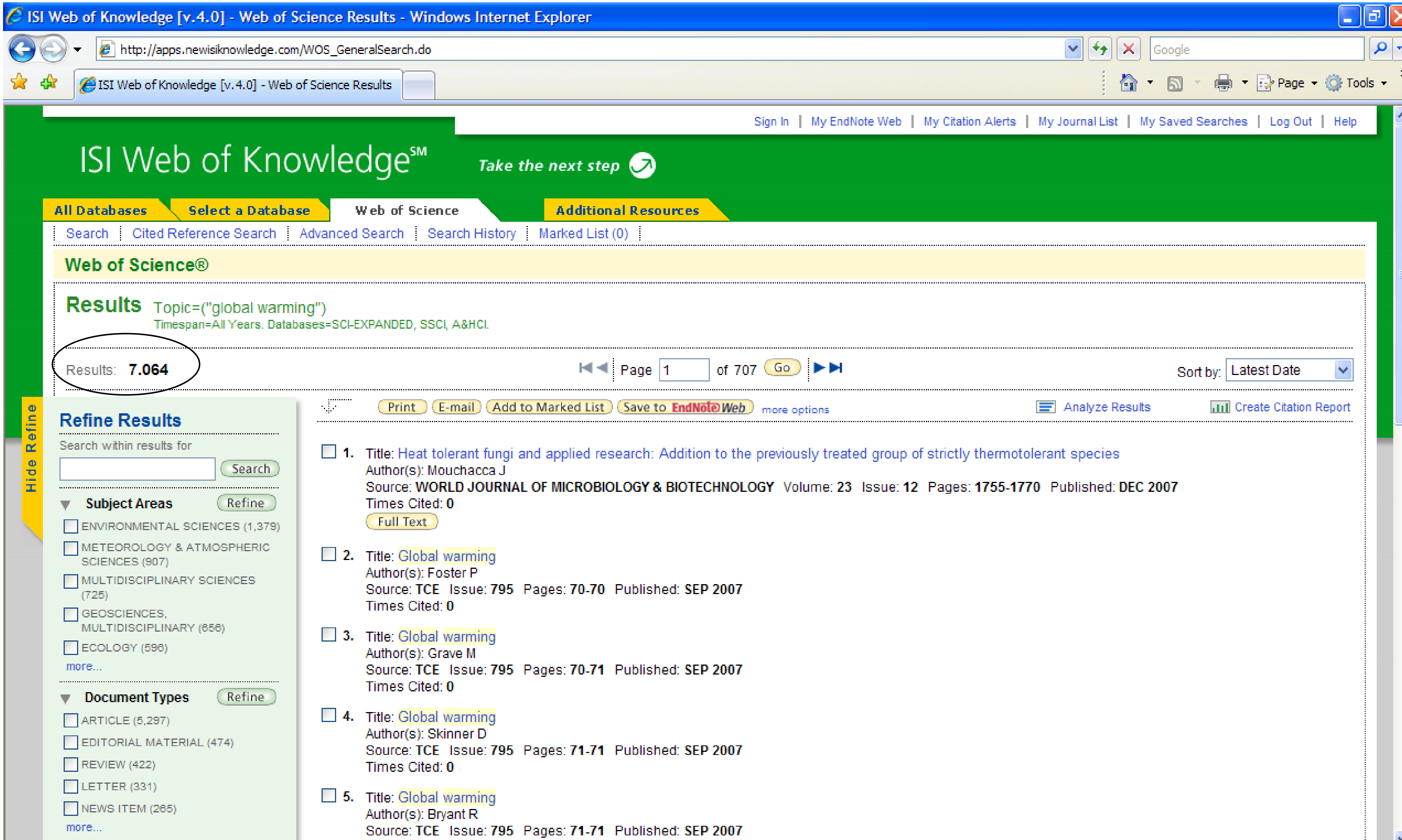
# Portal CAPES



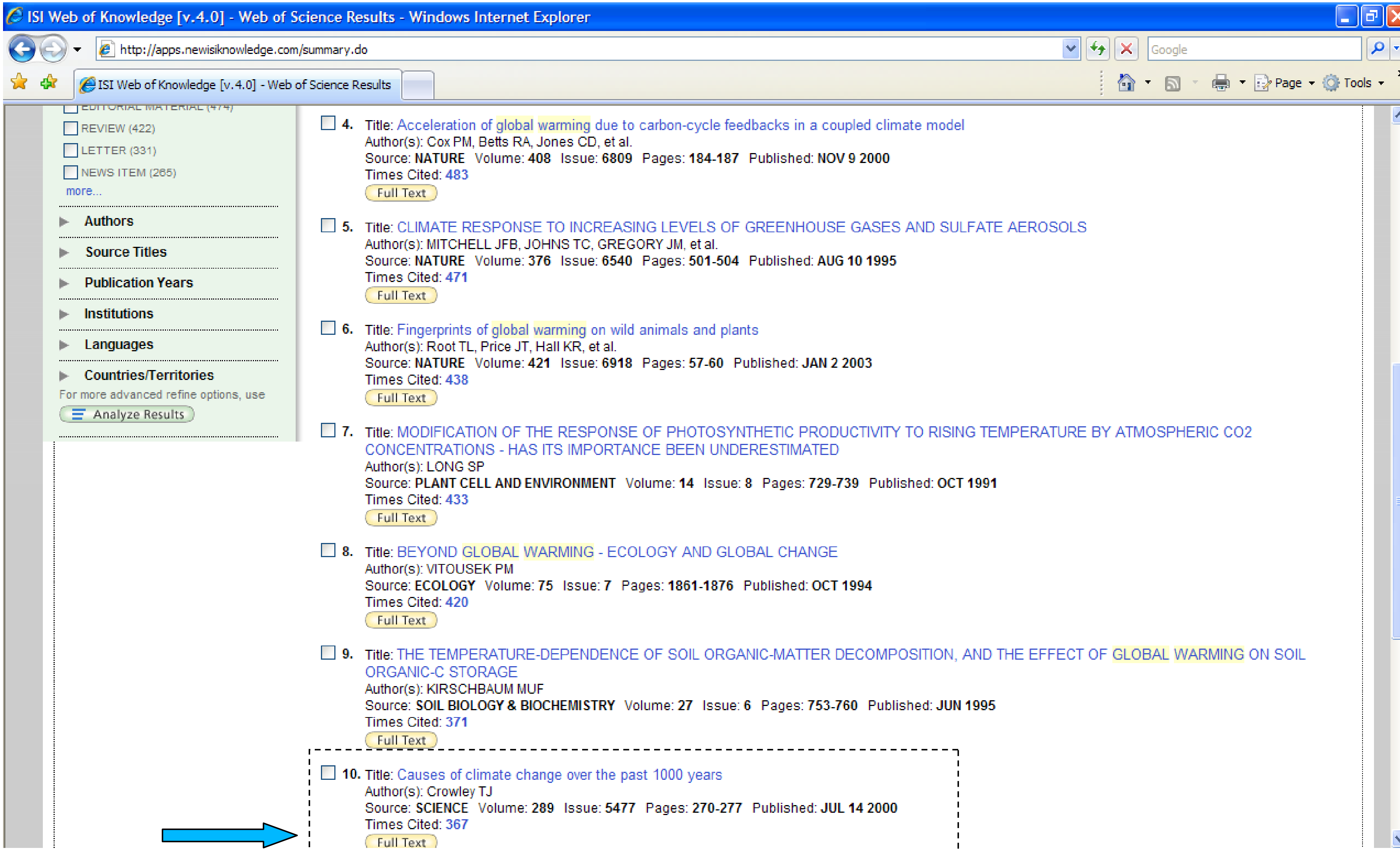
# Base de Dados: Web of Knowledge



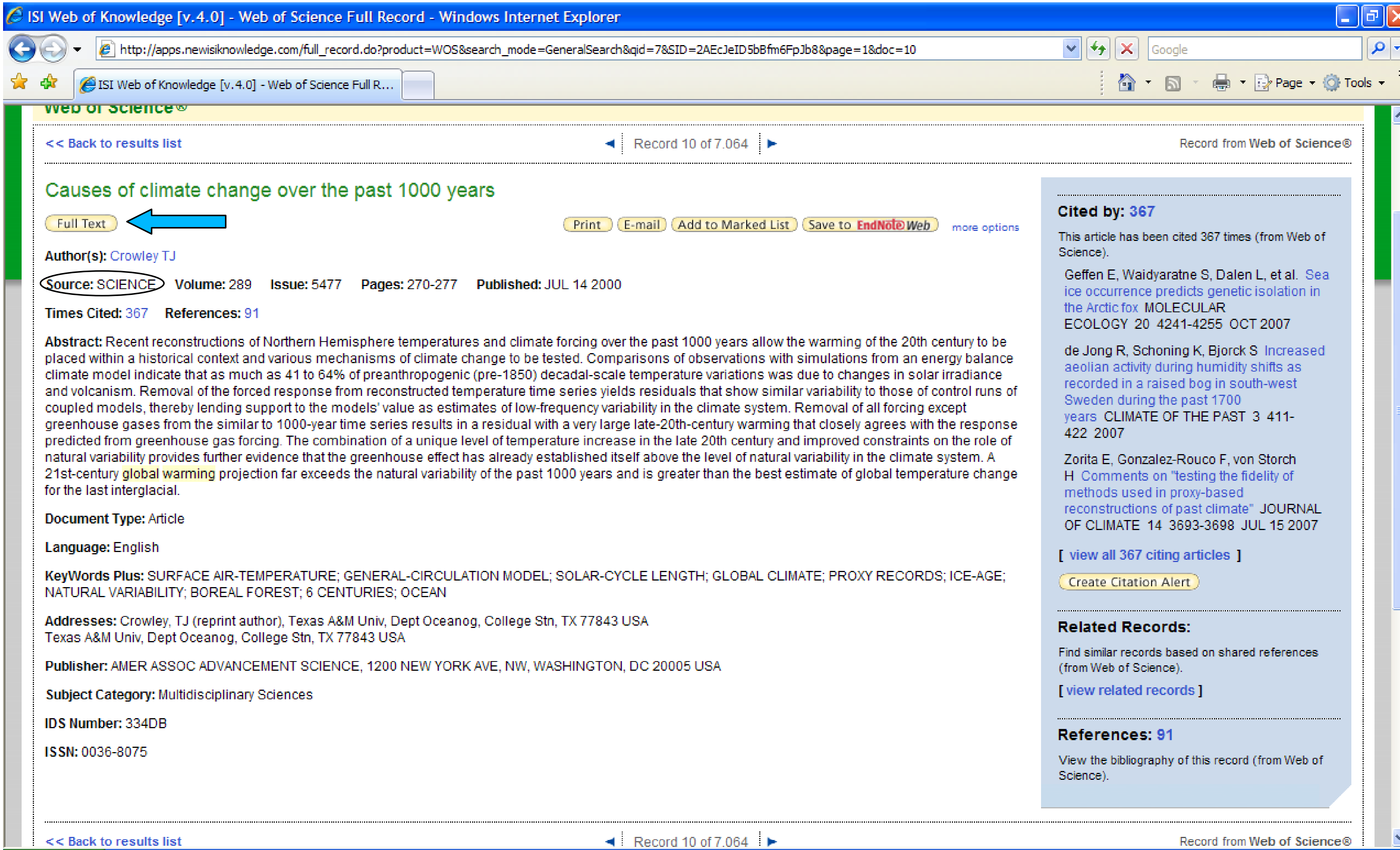
# “global warming” (aquecimento global)



# Ordenados por número de citações



# Abstract (Resumo)



ISI Web of Knowledge [v.4.0] - Web of Science Full Record - Windows Internet Explorer

http://apps.newisiknowledge.com/full_record.do?product=WOS&search_mode=GeneralSearch&qid=7&SID=2AEcJeID5bBfm6FpJb8&page=1&doc=10

Web of Science®

<< Back to results list | Record 10 of 7.064 | Record from Web of Science®

## Causes of climate change over the past 1000 years

Full Text | Print | E-mail | Add to Marked List | Save to EndNote Web | more options

**Author(s):** Crowley TJ

**Source:** SCIENCE **Volume:** 289 **Issue:** 5477 **Pages:** 270-277 **Published:** JUL 14 2000

**Times Cited:** 367 **References:** 91

**Abstract:** Recent reconstructions of Northern Hemisphere temperatures and climate forcing over the past 1000 years allow the warming of the 20th century to be placed within a historical context and various mechanisms of climate change to be tested. Comparisons of observations with simulations from an energy balance climate model indicate that as much as 41 to 64% of preanthropogenic (pre-1850) decadal-scale temperature variations was due to changes in solar irradiance and volcanism. Removal of the forced response from reconstructed temperature time series yields residuals that show similar variability to those of control runs of coupled models, thereby lending support to the models' value as estimates of low-frequency variability in the climate system. Removal of all forcing except greenhouse gases from the similar to 1000-year time series results in a residual with a very large late-20th-century warming that closely agrees with the response predicted from greenhouse gas forcing. The combination of a unique level of temperature increase in the late 20th century and improved constraints on the role of natural variability provides further evidence that the greenhouse effect has already established itself above the level of natural variability in the climate system. A 21st-century global warming projection far exceeds the natural variability of the past 1000 years and is greater than the best estimate of global temperature change for the last interglacial.

**Document Type:** Article

**Language:** English

**KeyWords Plus:** SURFACE AIR-TEMPERATURE; GENERAL-CIRCULATION MODEL; SOLAR-CYCLE LENGTH; GLOBAL CLIMATE; PROXY RECORDS; ICE-AGE; NATURAL VARIABILITY; BOREAL FOREST; 6 CENTURIES; OCEAN

**Addresses:** Crowley, TJ (reprint author), Texas A&M Univ, Dept Oceanog, College Stn, TX 77843 USA
Texas A&M Univ, Dept Oceanog, College Stn, TX 77843 USA

**Publisher:** AMER ASSOC ADVANCEMENT SCIENCE, 1200 NEW YORK AVE, NW, WASHINGTON, DC 20005 USA

**Subject Category:** Multidisciplinary Sciences

**IDS Number:** 334DB

**ISSN:** 0036-8075

**Cited by: 367**

This article has been cited 367 times (from Web of Science).

Geffen E, Waidyaratne S, Dalen L, et al. Sea ice occurrence predicts genetic isolation in the Arctic fox MOLECULAR ECOLOGY 20 4241-4255 OCT 2007

de Jong R, Schoning K, Bjorck S Increased aeolian activity during humidity shifts as recorded in a raised bog in south-west Sweden during the past 1700 years CLIMATE OF THE PAST 3 411-422 2007

Zorita E, Gonzalez-Rouco F, von Storch H Comments on "testing the fidelity of methods used in proxy-based reconstructions of past climate" JOURNAL OF CLIMATE 14 3693-3698 JUL 15 2007

[ view all 367 citing articles ]

Create Citation Alert

**Related Records:**

Find similar records based on shared references (from Web of Science).

[ view related records ]

**References: 91**

View the bibliography of this record (from Web of Science).

<< Back to results list | Record 10 of 7.064 | Record from Web of Science®

# Artigo





*Science* 14 July 2000:
Vol. 289. no. 5477, pp. 270 - 277
DOI: 10.1126/science.289.5477.270



RESEARCH ARTICLES

## Causes of Climate Change Over the Past 1000 Years

**Thomas J. Crowley**

Recent reconstructions of Northern Hemisphere temperatures and climate forcing over the past 1000 years allow the warming of the 20th century to be placed within a historical context and various mechanisms of climate change to be tested. Comparisons of observations with simulations from an energy balance climate model indicate that as much as 41 to 64% of preanthropogenic (pre-1850) decadal-scale temperature variations was due to changes in solar irradiance and volcanism. Removal of the forced response from reconstructed temperature time series yields residuals that show similar variability to those of control runs of coupled models, thereby lending support to the models' value as estimates of low-frequency variability in the climate system. Removal of all forcing except greenhouse gases from the ~1000-year time series results in a residual with a very large late-20th-century warming that closely agrees with the response predicted from greenhouse gas forcing. The combination of a unique level of temperature increase in the late 20th century and improved constraints on the role of natural variability provides further evidence that the greenhouse effect has already established itself above the level of natural variability in the climate system. A 21st-century global warming projection far exceeds the natural variability of the past 1000 years and is greater than the best estimate of global temperature change for the last interglacial.

Department of Oceanography, Texas A&M University, College Station, TX 77843, USA. E-mail: tcrowley@ocean.tamu.edu

Read the Full Text

Artigo

# Causes of Climate Change Over the Past 1000 Years

**Thomas J. Crowley**

Recent reconstructions of Northern Hemisphere temperatures and climate forcing over the past 1000 years allow the warming of the 20th century to be placed within a historical context and various mechanisms of climate change to be tested. Comparisons of observations with simulations from an energy balance climate model indicate that as much as 41 to 64% of preanthropogenic (pre-1850) decadal-scale temperature variations was due to changes in solar irradiance and volcanism. Removal of the forced response from reconstructed temperature time series yields residuals that show similar variability to those of control runs of coupled models, thereby lending support to the models' value as estimates of low-frequency variability in the climate system. Removal of all forcing except greenhouse gases from the ~1000-year time series results in a residual with a very large late-20th-century warming that closely agrees with the response predicted from greenhouse gas forcing. The combination of a unique level of temperature increase in the late 20th century and improved constraints on the role of natural variability provides further evidence that the greenhouse effect has already established itself above the level of natural variability in the climate system. A 21st-century global warming projection far exceeds the natural variability of the past 1000 years and is greater than the best estimate of global temperature change for the last interglacial.

The origin of the late-20th-century increase in global temperatures has prompted considerable discussion. Detailed comparisons of climate model results with observations (*1*) suggest that anthropogenic changes, particularly greenhouse gas (GHG) increases, are probably responsible for this climate change. However, there are a number of persistent questions with respect to these conclusions that involve uncertainties in the level of low-frequency unforced variability in the climate system (*2*) and whether factors such as an increase in solar irradiance or a reduction in volcanism might account for a substantial amount of the observed 20th-century warming (*1*, *3–10*). Although many studies have addressed this issue from the paleoclimate perspective of the past few centuries (*3–10*), robust conclusions have been hampered by inadequate lengths of the time series being evaluated. Here I show that the agreement between model results and observations for the past 1000 years is sufficiently compelling to allow one to conclude that natural variability plays only a subsidiary role in the 20th-century warming and that the most parsimonious explanation for most of the warming is that it is due to the anthropogenic increase in GHG.

Department of Oceanography, Texas A&M University, College Station, TX 77843, USA. E-mail: tcrowley@ocean.tamu.edu

## Data

The data used in this study include physically based reconstructions of Northern Hemisphere temperatures and indices of volcanism, solar variability, and changes in GHGs and tropospheric aerosols.

*Northern Hemisphere temperatures.* Four indices of millennial Northern Hemisphere temperature have been produced over the past 3 years (*11–14*). The analysis here uses the mean annual temperature reconstructions of Mann *et al.* (*11*) and of Crowley and Lowery (CL) (*12*), because the energy balance model used in this study calculates only this term [the other records (*13*, *14*) are estimates of warm-season temperature at mid-high latitudes]. The Mann *et al.* reconstruction was determined (*8*) by first regressing an empirical orthogonal function analysis of 20th-century mean annual temperatures against various proxy indices (such as tree rings, corals, and ice cores). Past changes in temperature are estimated from variations in the proxy data (*15*). The Mann *et al.* reconstruction has a varying number of records per unit of time (although the number in the earlier part of the record is still greater than in CL). The CL reconstruction is a more heterogeneous mix of data than the Mann *et al.* reconstruction, but the number of records is nearly constant in time. It is a simple composite of Northern Hemisphere climate records and was scaled (*12*) to temperature using the instrumental record (*16*) in the overlap interval 1860–1965. The instrumental record was substituted for the proxy record after 1860 for two reasons: (i) there were too few proxy data in the CL time series after 1965 to reconstruct temperatures for this interval, and (ii) the original CL reconstruction indicated a "warming" over the interval 1885–1925 that is at variance with the instrumental record. This difference has been attributed (*11*, *17*) to

# Artigo
## Resultados

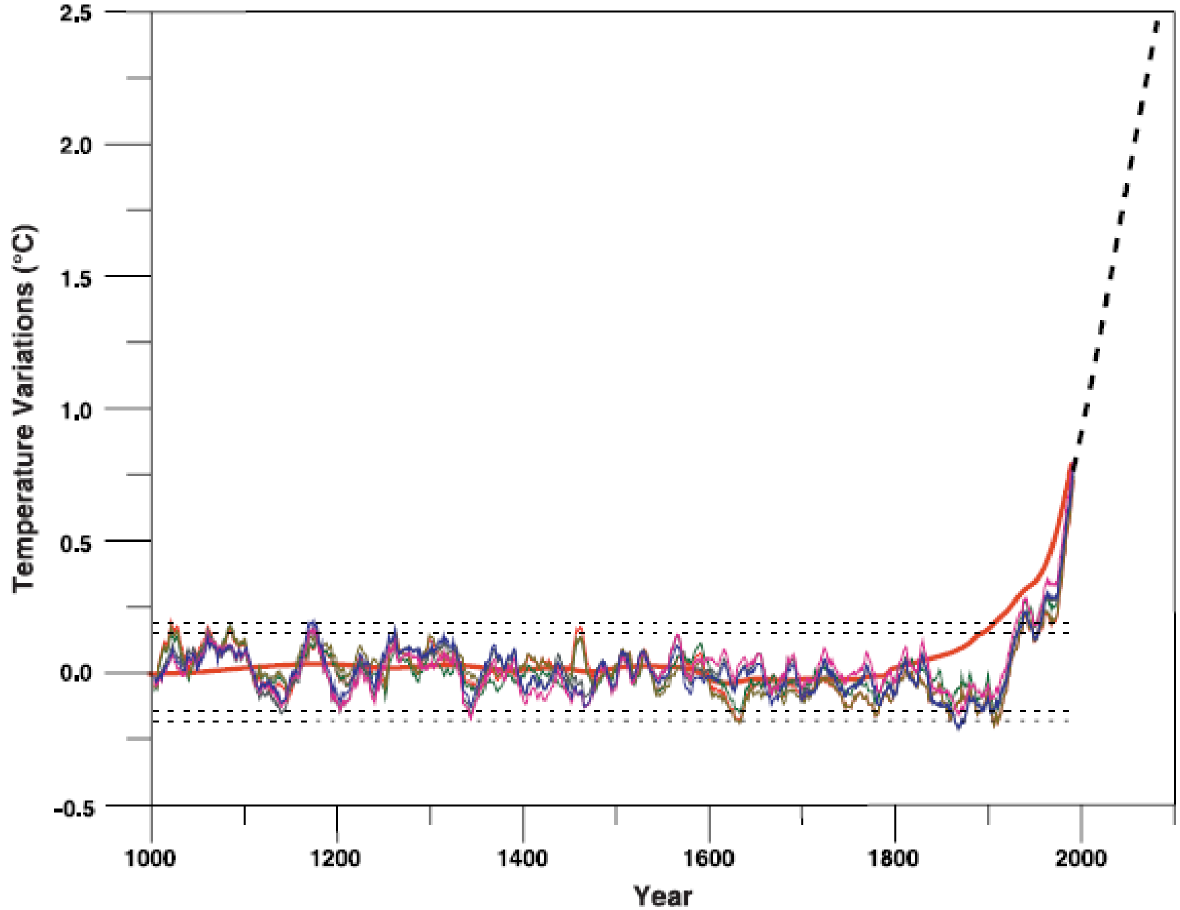



**Fig. 6.** Comparison of the GHG forcing response (from Fig. 3) with six residuals determined by removing all forcing except GHG from the two different temperature reconstructions in Fig. 1. As in Fig. 5, the three different estimates of solar variability were used to get one estimate of the uncertainty in the response. This figure illustrates that GHG changes can explain the 20th-century rise in the residuals; ±2 standard deviation lines (horizontal dashed lines) refer to maximum variability of residuals from Fig. 5A (inner dashes) and maximum variability (outer dashes) of the original pre-1850 time series (Fig. 1). The projected 21st-century temperature increase (heavy dashed line at right) uses the IPCC BAU scenario (the "so-called IS92a forcing") for both GHG and aerosols (sulfate and biomass burning, including indirect effects), and the model simulation was run at the same sensitivity (2.0°C for a doubling of $CO_2$) as other model simulations in this article. The IS92a scenario is from (59).

# Artigo
## Referências

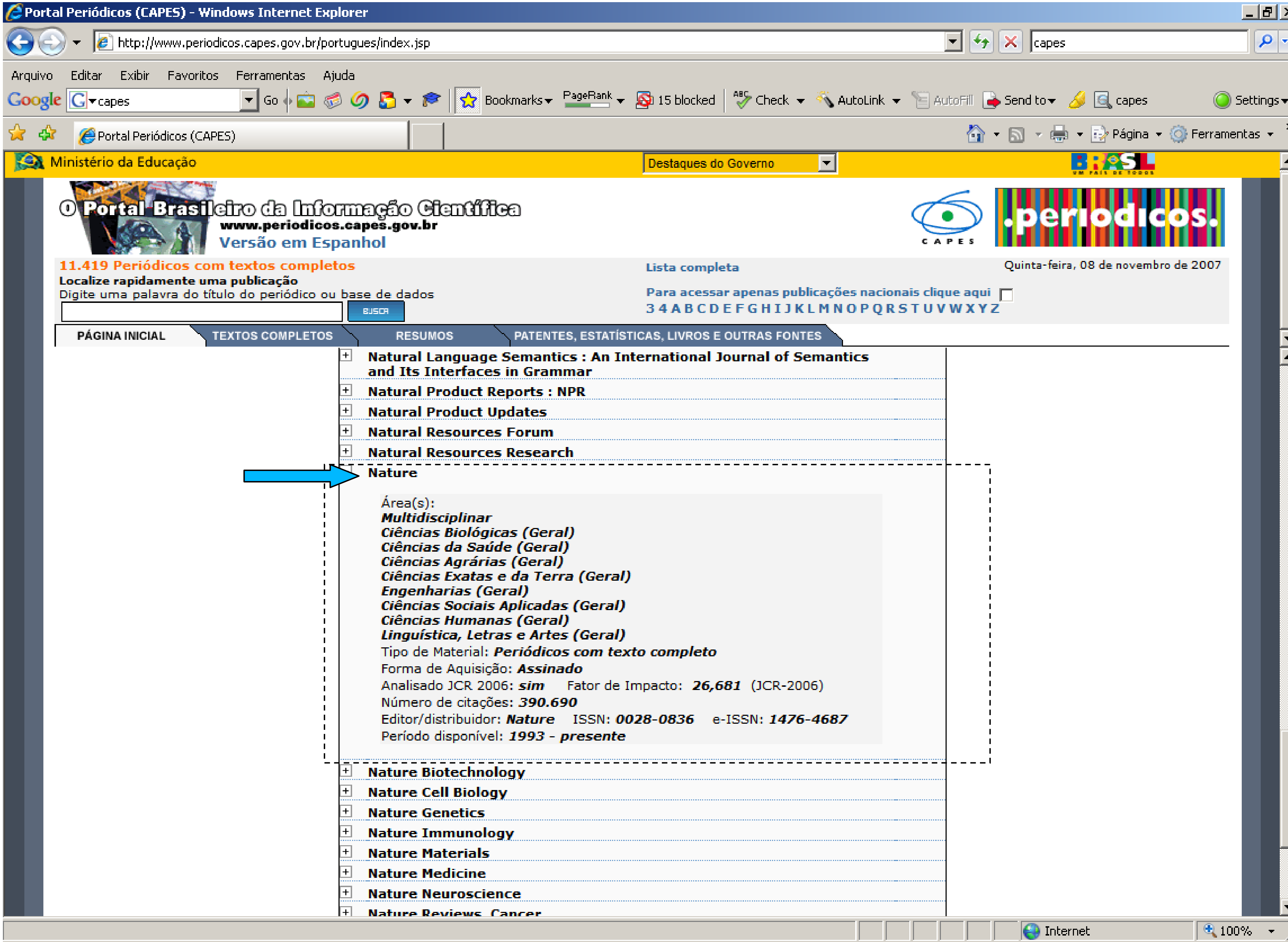

1365 (1999)].

**References and Notes**

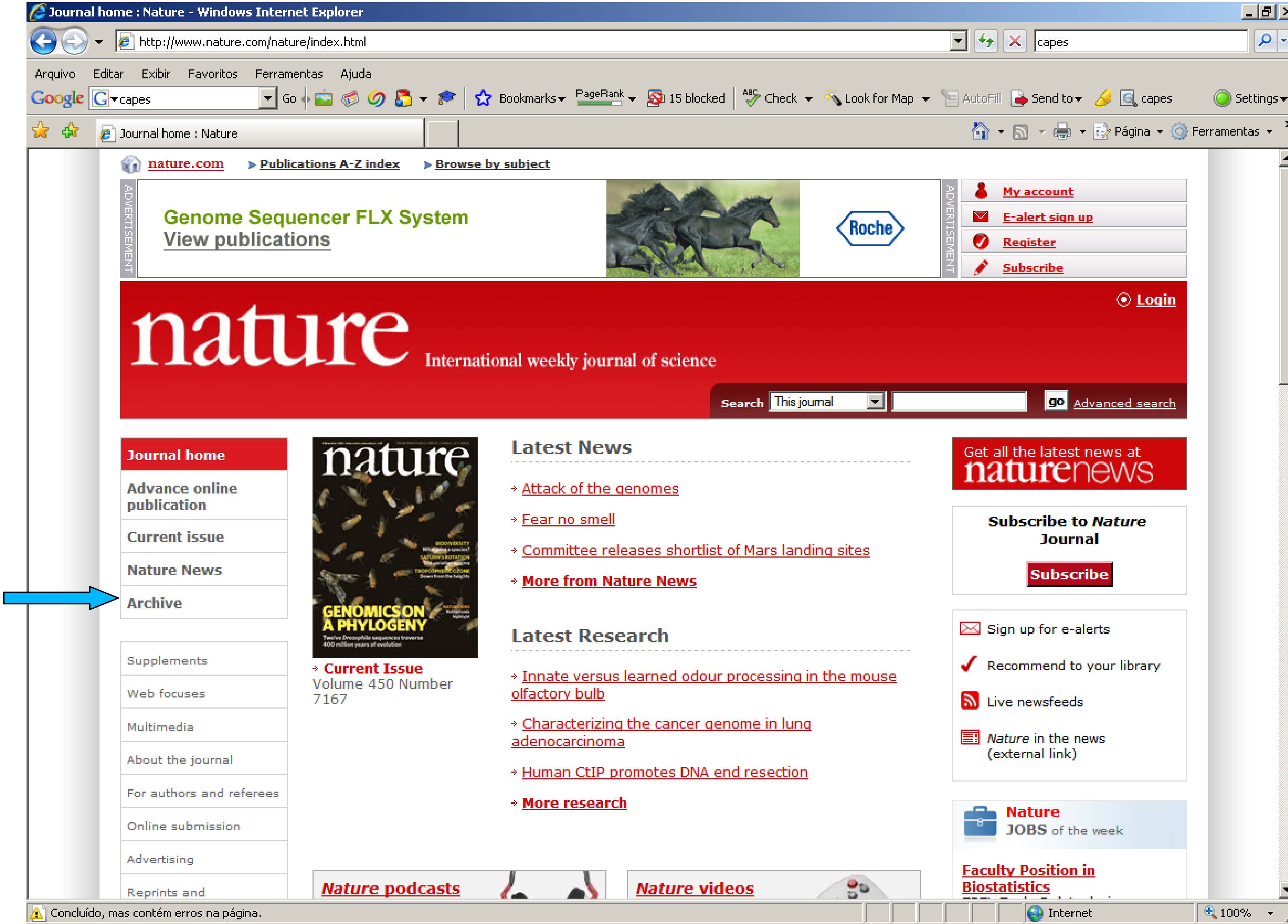
1. B. D. Santer *et al.*, *Nature* **382**, 39 (1996); G. C. Hegerl *et al.*, *Clim. Dyn.* **13**, 613 (1997); G. R. North and M. J. Stevens, *J. Clim.* **11**, 563 (1998); S. F. B. Tett *et al.*, *Nature* **399**, 569 (1999); T. P. Barnett *et al.*, *Bull. Am. Meteorol. Soc.* **80**, 2631 (1999); G. C. Hegerl *et al.*, *Clim. Dyn.*, in press.
2. T. P. Barnett, B. D. Santer, P. D. Jones, R. S. Bradley, K. R. Briffa, *Holocene* **6**, 255 (1996).
3. A. Robock, *Science* **206**, 1402 (1979); T. M. L. Wigley and S. C. B. Raper, *Nature* **344**, 324 (1990); P. M. Kelly and T. M. L. Wigley, *Nature* **360**, 328 (1992); E. Friis-Christensen and K. Lassen, *Science* **254**, 698 (1991); T. J. Crowley and K.-Y. Kim, *Quat. Sci. Rev.* **12**, 375 (1993); D. Rind and J. Overpeck, *Quat. Sci. Rev.* **12**, 357 (1993); U. Cubasch *et al.*, *Clim. Dyn.* **13**, 757 (1997); P. E. Damon and A. N. Peristykh, *Geophys. Res. Lett.* **26**, 2469 (1999); J. Lean and D. Rind, *J. Atmos. Sol. Terr. Phys.* **61**, 25 (1999).
4. D. V. Hoyt and K. H. Schatten, *J. Geophys. Res.* **98**, 18895 (1993).
5. J. Lean, J. Beer, R. Bradley, *Geophys. Res. Lett.* **22**, 3195 (1995).
6. J. Overpeck *et al.*, *Science* **278**, 1251 (1997).
7. K. R. Briffa, P. D. Jones, F. H. Schweingruber, T. J. Osborn, *Nature* **393**, 450 (1998).
8. M. E. Mann, R. S. Bradley, M. R. Hughes, *Nature* **392**, 779 (1998).
9. T. J. Crowley and K.-Y. Kim, *Geophys. Res. Lett.* **26**, 1901 (1999).

25. W. T. Hyde and T. J. Crowley, *J. Clim.* **13**, 1445 (2000).
26. An informal survey of published historical records also failed to yield any clear evidence for extremely severe agricultural disruptions at this time (as would be expected if linear scaling of the ice core sulphate concentration applies). The study by Langway *et al.* (*22*) clearly indicates that evidence of this eruption occurs in both Greenland and Antarctic ice cores.
27. J. P. Pinto, R. P. Turco, O. B. Toon, *J. Geophys. Res.* **94**, 11165 (1989).
28. M. Sato, J. E. Hansen, M. P. McCormick, J. B. Pollack, *J. Geophys. Res.* **98**, 22987 (1993).
29. Because of the noisy nature of the volcanic series, EBM runs were used to correlate the two long volcano time series illustrated in Fig. 2A. The 11-point smoothed correlation for the interval 1405–1960 is 0.78 ($P < 0.01$).
30. Beryllium-10 measurements are from E. Bard *et al.*, *Earth Planet. Sci. Lett.* **150**, 453 (1997); the irradiance estimates derived from the $^{10}$Be measurements are from E. Bard *et al.*, *Tellus B* **52**, 985 (2000).
31. M. Stuiver and T. F. Braziunas, *Radiocarbon* **35**, 137 (1993).
32. G. H. Denton and W. Karlén, *Quat. Res.* **3**, 155 (1973).
33. J. Lean, A. Skumanich, O. White, *Geophys. Res. Lett.* **19**, 1591 (1992).
34. M. Lockwood and R. Stamper, *Geophys. Res. Lett.* **26**, 2461 (1999).
35. D. M. Etheridge *et al.*, *J. Geophys. Res.* **101**, 4115 (1996).

# Consultando Referências



# Consultando Referências



Consultando
Referências



# Global-scale temperature patterns and climate forcing over the past six centuries

**Michael E. Mann**[*]**, Raymond S. Bradley**[*] **& Malcolm K. Hughes**[†]

[*] *Department of Geosciences, University of Massachusetts, Amherst, Massachusetts 01003-5820, USA*
[†] *Laboratory of Tree Ring Research, University of Arizona, Tucson, Arizona 85721, USA*

**Spatially resolved global reconstructions of annual surface temperature patterns over the past six centuries are based on the multivariate calibration of widely distributed high-resolution proxy climate indicators. Time-dependent correlations of the reconstructions with time-series records representing changes in greenhouse-gas concentrations, solar irradiance, and volcanic aerosols suggest that each of these factors has contributed to the climate variability of the past 400 years, with greenhouse gases emerging as the dominant forcing during the twentieth century. Northern Hemisphere mean annual temperatures for three of the past eight years are warmer than any other year since (at least) AD 1400.**

Knowing both the spatial and temporal patterns of climate change over the past several centuries remains a key to assessing a possible anthropogenic impact on post-industrial climate[1]. In addition to the possibility of warming due to increased concentrations of greenhouse gases during the past century, there is evidence that both solar irradiance and explosive volcanism have played an important part in forcing climate variations over the past several centuries[2,3]. The unforced 'natural variability' of the climate system may also be quite important on multidecadal and century timescales[4,5]. If a faithful empirical description of climate variability could be obtained for the past several centuries, a more confident estimation could be made of the roles of different external forcings and internal sources of variability on past and recent climate. Because widespread instrumental climate data are available for only about one century, we must use proxy climate indicators combined with any very long instrumental records that are available to obtain such an empirical description of large-scale climate variability during past centuries. A variety of studies have sought to use a 'multiproxy' approach to understand long-term climate variations, by analysing a widely distributed set of proxy and instrumental climate indicators[1,5–8] to yield insights into long-term global climate variations. Building on such past studies, we take a new statistical approach to reconstructing global patterns of annual temperature back to the beginning of the fifteenth century, based on the calibration of multiproxy data networks by the dominant patterns of temperature variability in the instrumental record.

Using these statistically verifiable yearly global temperature reconstructions, we analyse the spatiotemporal patterns of climate change over the past 500 years, and then take an empirical approach to estimating the relationship between global temperature changes, variations in volcanic aerosols, solar irradiance and greenhouse-gas concentrations during the same period.

## Data

We use a multiproxy network consisting of widely distributed high-quality annual-resolution proxy climate indicators, individually collected and formerly analysed by many palaeoclimate researchers (details and references are available: see Supplementary Information). The network includes (Fig. 1a) the collection of annual-resolution dendroclimatic, ice core, ice melt, and long historical records used by Bradley and Jones[6] combined with other coral, ice core, dendroclimatic, and long instrumental records. The long instrumental records have been formed into annual mean anomalies relative to the 1902–80 reference period, and gridded onto a $5° \times 5°$ grid (yielding 11 temperature grid-point series and 12 precipitation grid-point series dating back to 1820 or earlier) similar to that shown in Fig. 1b. Certain densely sampled regional dendroclimatic data sets have been represented in the network by a smaller number of leading principal components (typically 3–11 depending on the spatial extent and size of the data set). This form of representation ensures a reasonably homogeneous spatial sampling in the multiproxy network (112 indicators back to 1820).

Potential limitations specific to each type of proxy data series must be carefully taken into account in building an appropriate network. Dating errors in a given record (for example, incorrectly assigned annual layers or rings) are particularly detrimental if mutual information is sought to describe climate patterns on a year-by-year basis. Standardization of certain biological proxy records relative to estimated growth trends, and the limits of constituent chronology segment lengths (for example, in dendroclimatic reconstructions), can restrict the maximum timescale of climate variability that is recorded[9], and only a limited subset of the indicators in the multiproxy network may thus 'anchor in' the longest-term trends (for example, variations on timescales greater than 500 years). However, the dendroclimatic data used were carefully screened for conservative standardization and sizeable segment lengths. Moreover, the mutual information contained in a diverse and widely distributed set of independent climate indicators can more faithfully capture the consistent climate signal that is present, reducing the compromising effects of biases and weaknesses in the individual indicators.

Monthly instrumental land air and sea surface temperature[10] grid-point data (Fig. 1b) from the period 1902–95 are used to calibrate the proxy data set. Although there are notable spatial gaps, this network covers significant enough portions of the globe to form reliable estimates of Northern Hemisphere mean temperature, and certain regional indices of particular importance such as the 'NINO3' eastern tropical Pacific surface temperature index often used to describe the El Niño phenomenon. The NINO3 index is constructed from the eight grid-points available within the conventional NINO3 box (5° S to 5° N, 90–150° W).

## Multiproxy calibration

Although studies have shown that well chosen regional paleoclimate reconstructions can act as surprisingly representative surrogates for

# Como produzo conhecimento novo?

# Formas de Produção de Conhecimento

1. Dedução
2. Simulação
3. Observação
4. Experimentação
5. Pesquisa de Opinião

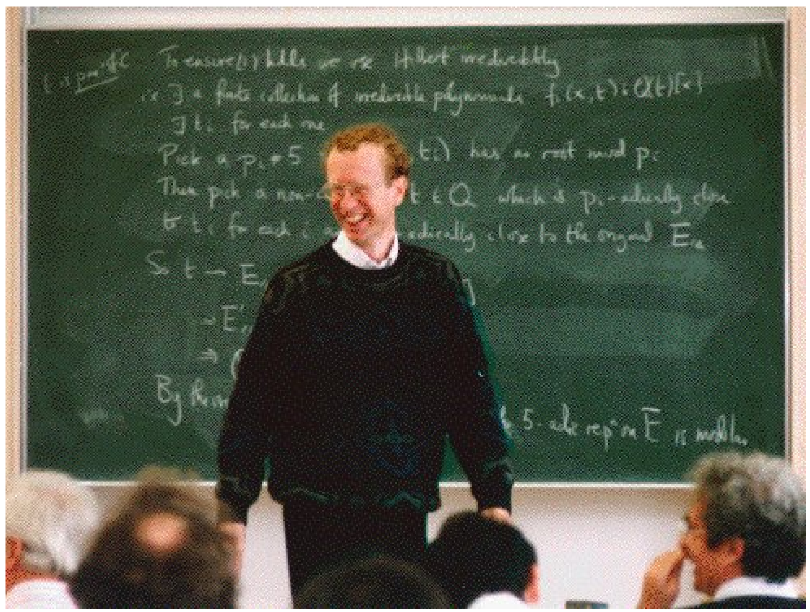
# Dedução

**Último teorema de Fermat** (ou **Teorema de Fermat-Wiles**)

Não existe nenhum conjunto de inteiros positivos $x$, $y$, $z$ e $n$ com $n$ maior que 2 que satisfaça

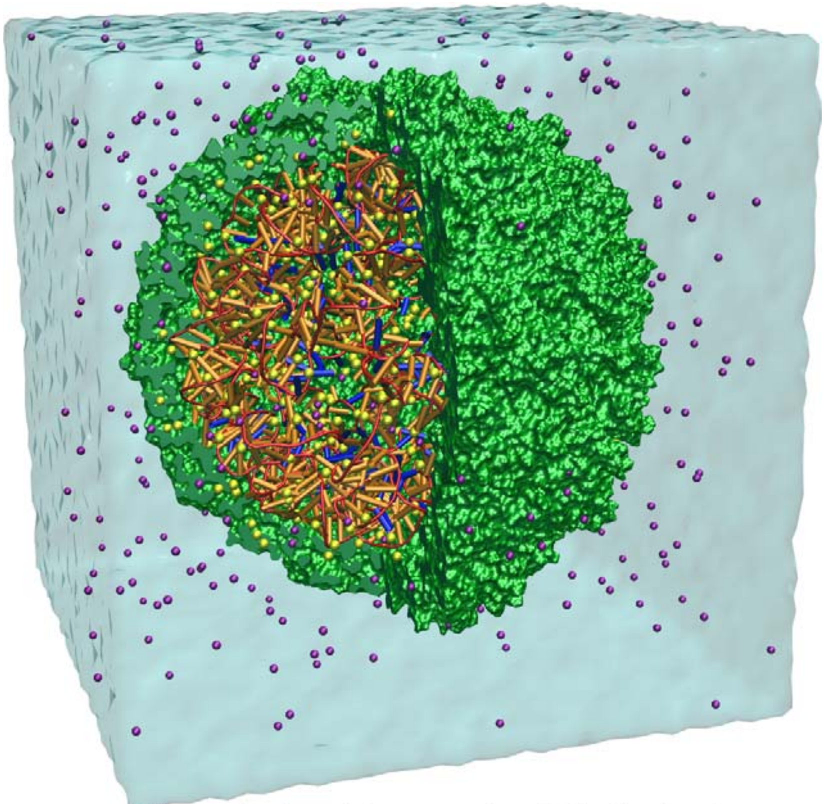
$$x^n + y^n = z^n$$

.

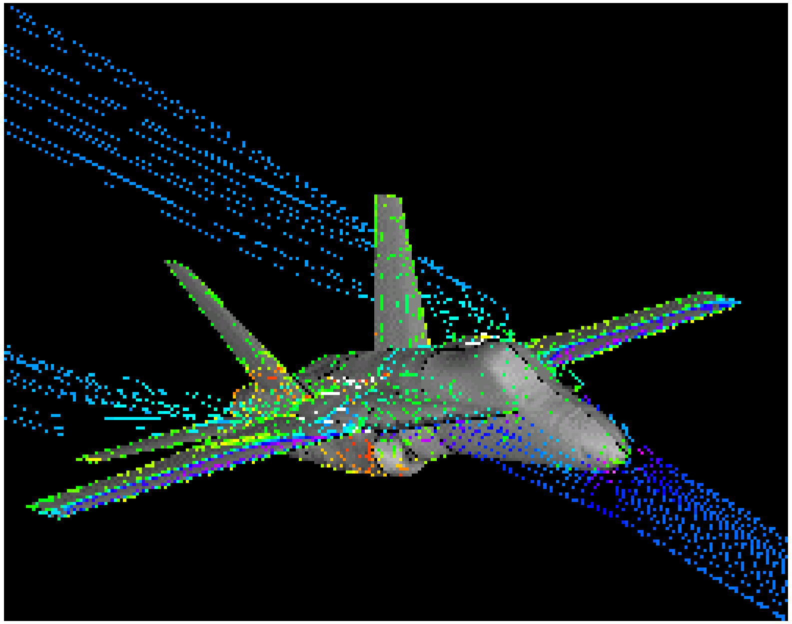


Demonstram-se certas asserções dadas premissas (axiomas) estabelecendo-as como Teoremas (afirmações verdadeiras demonstradas como verdadeiras).

# Simulação

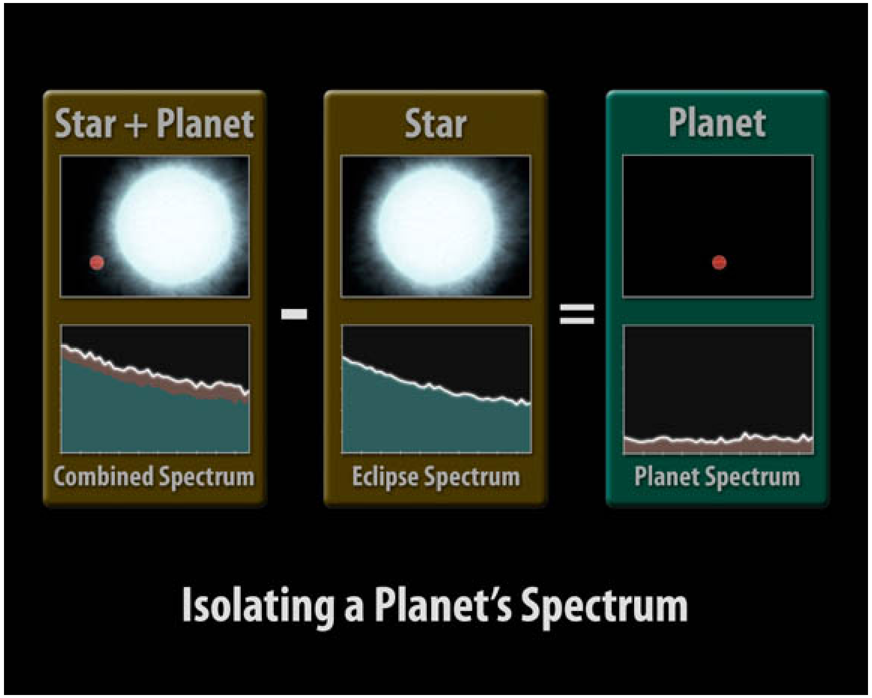


Theoretical and Computational Biophysics Group
Beckman Institute
University of Illinois at Urbana-Champaign



Dado o conhecimento dos mecanismos, calculam-se as consequências em cenários complexos demais para a dedução direta.

# Observação

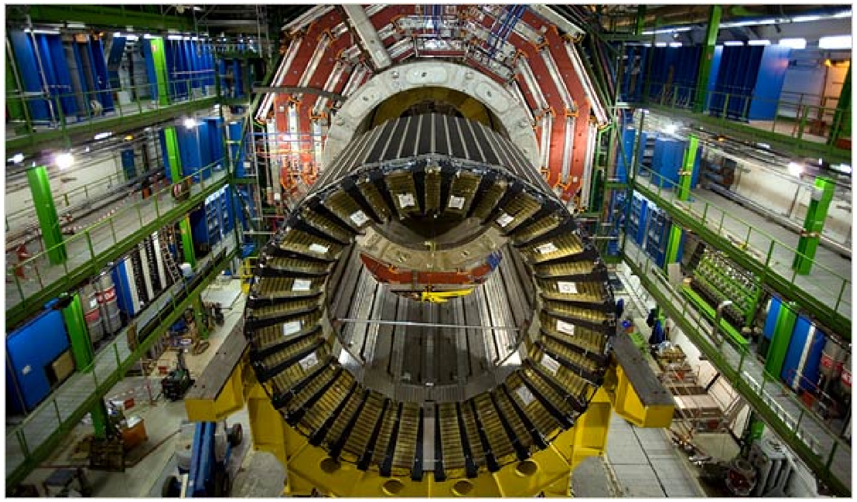



Planetas Extra-solares

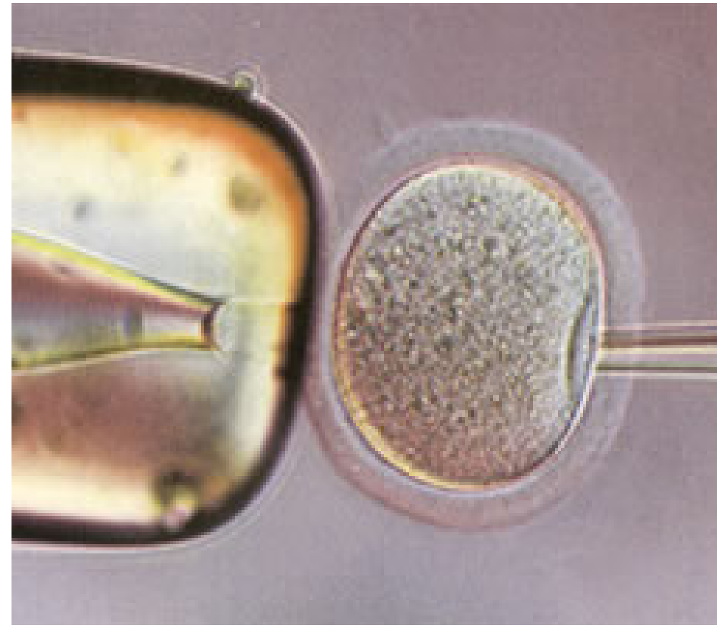
Culturas de Chipanzés

Observações revelam aspectos ainda desconhecidos da realidade, rejeitam ou sustentam teorias conhecidas.

# Experimentação



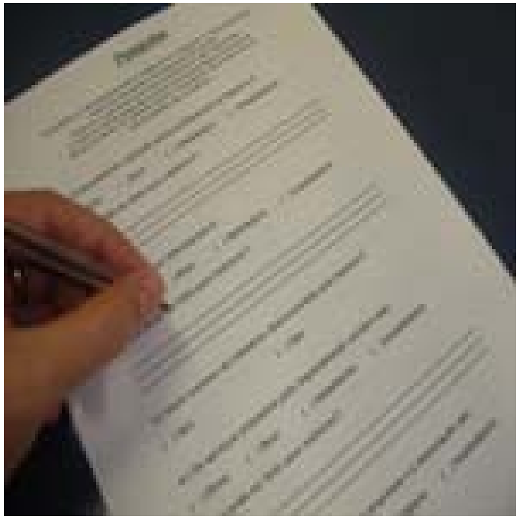
Larger Hadron Collider (LHC)



Clonagem

Experimentos são produzidos para testar teorias específicas

# Pesquisa de Opinião

Utilizando instrumentos que podem ser quantitativos ou qualitativos procura-se acessar a opinião de pessoas sobre Um determinado assunto.

# Onde a pesquisa é realizada?

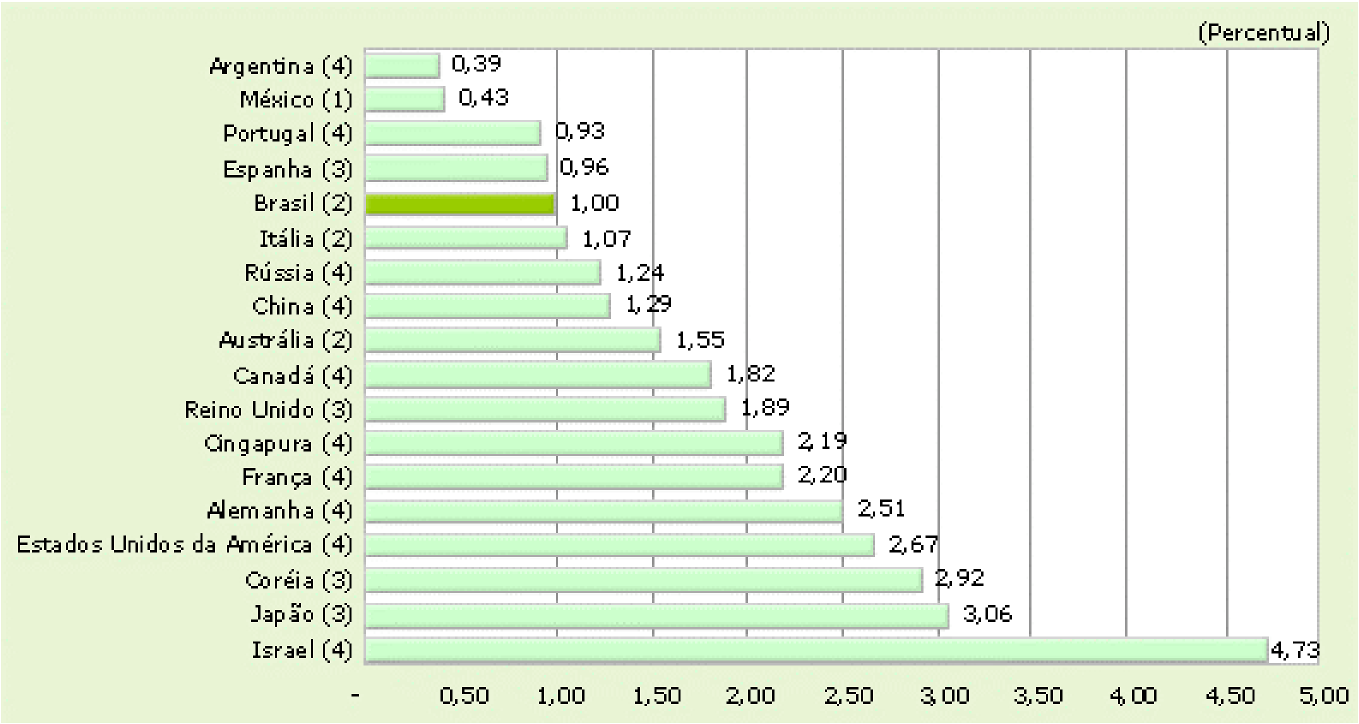
# Pesquisa no Brasil: Onde estão os pesquisadores

**Distribuição de pesquisadores em equivalência de tempo integral, por setores institucionais, de países selecionados, nos anos mais recentes disponíveis (em percentual)**

| Países | Anos | Setores | | |
|---|---|---|---|---|
| | | Governo | Empresas | Ensino superior |
| **Alemanha** | 2001 | 14,6 | 59,7 | 25,7 |
| **Argentina** | 2002 | 37,6 | 11,3 | 49,3 |
| **Austrália** | 2000 | 13,6 | 24,4 | 59,8 |
| **Brasil** | 2000 | 7,9 | 26,7 | 64,7 |
| **Canadá** | 1999 | 8,2 | 54,5 | 36,6 |
| **China** | 2002 | 23,3 | 54,7 | 22,0 |
| **Coréia** | 2001 | 8,8 | 73,5 | 16,9 |
| **Espanha** | 2001 | 16,7 | 23,7 | 58,6 |
| **Estados Unidos da América** | 1999 | 3,8 | 80,5 | 14,7 |
| **França** | 2001 | 12,9 | 49,9 | 35,2 |
| **Itália** | 2000 | 21,7 | 39,5 | 38,9 |
| **Japão** | 2001 | 5,0 | 63,7 | 29,6 |
| **México** | 1999 | 34,5 | 16,2 | 48,7 |
| **Portugal** | 2001 | 20,6 | 15,4 | 50,4 |
| **Reino Unido** | 1998 | 9,1 | 57,9 | 31,1 |
| **Cingapura** | 2002 | 7,2 | 50,8 | 42,0 |
| **Rússia** | 2002 | 29,6 | 56,0 | 14,1 |

Fonte: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators, November 2003 e Brasil: para empresas: Pesquisa Industrial de Inovação Tecnológica (Pintec) - 2000, do Instituto Brasileiro de Geografia e Estatística (IBGE); para estudantes de doutorado: Fundação Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Capes); e, para o restante: Diretório dos Grupos de Pesquisa no Brasil (DGP), Censo 2000, da Assessoria de Estatística e Informação (AEI), do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

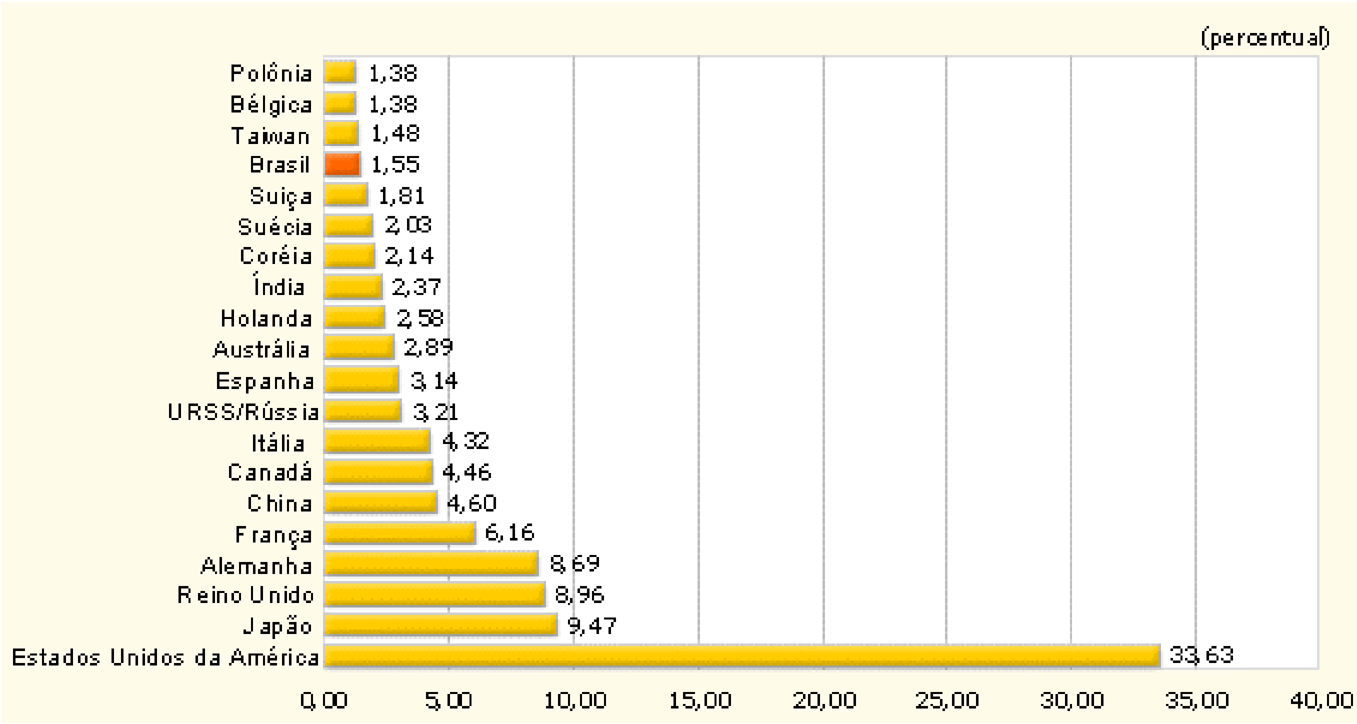
# Pesquisa no Brasil: Investimento/PIB




Investimento em % PIB

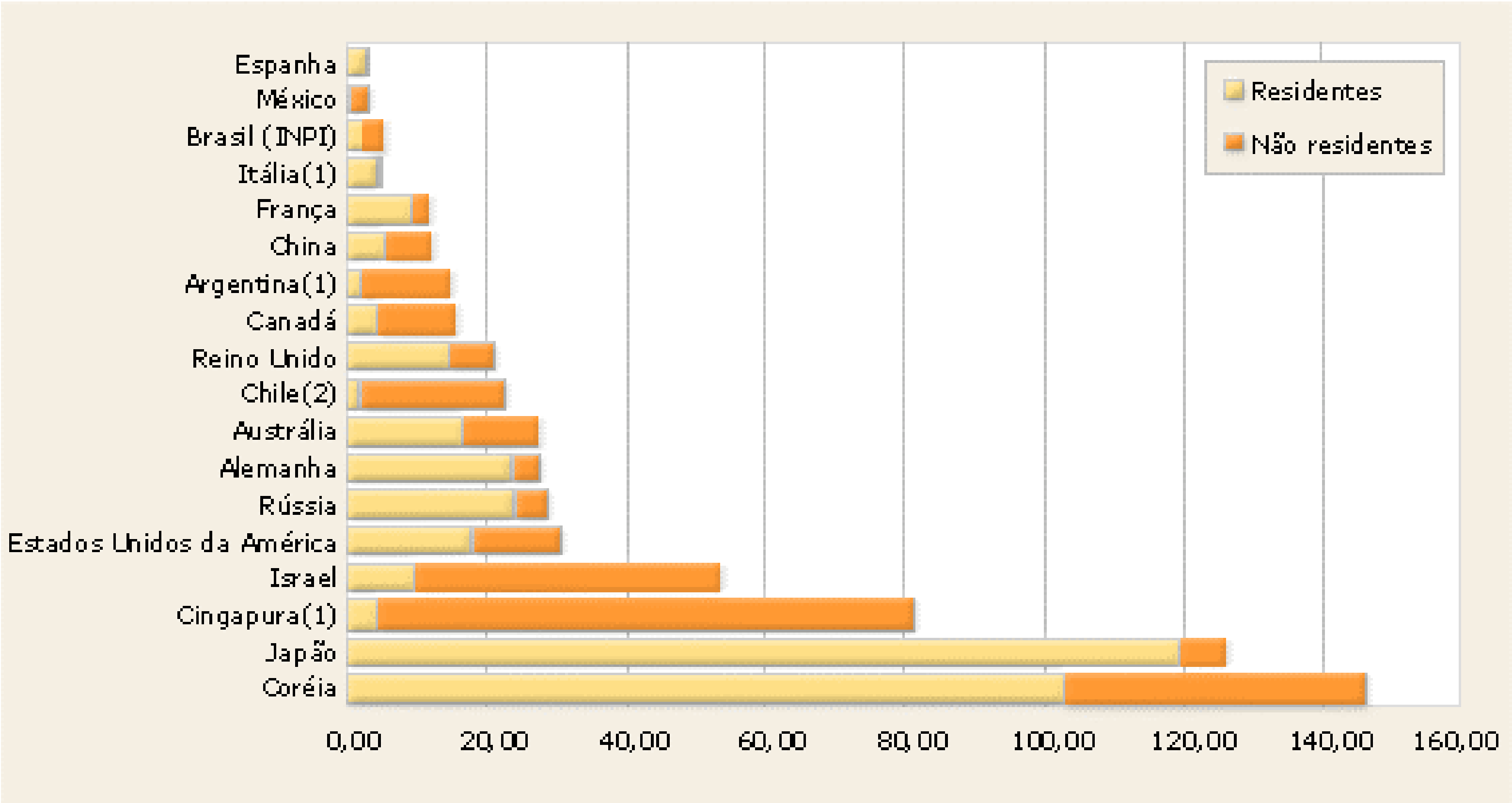
(Fonte: MCT 2001)

# Pesquisa no Brasil: Produção




Percentual da produção global
(Fonte: MCT 2001)

# Pesquisa no Brasil: Inovação




Patentes/bilhão do PIB

(Fonte: MCT 2001)

# Como as pesquisas são financiadas?

# Pesquisa no Brasil: Onde está o investimento?

**Dispêndios nacionais em pesquisa e desenvolvimento (P&D), públicos e privados, por setor de execução, países selecionados, em anos mais recentes disponíveis (em percentual)**

| Países | Anos | Governo | Empresas | Ensino superior | Privado sem fins lucrativos |
|---|---|---|---|---|---|
| **Alemanha** | 2003 | 13,4 | 69,8 | 16,8 | 0,6[(1)] |
| **Argentina** | 2003 | 41,1 | 29,0 | 27,4 | 2,5 |
| **Austrália** | 2002 | 20,3 | 48,8 | 28,0 | 2,9 |
| **Brasil** | 2000 | 18,4 | 37,4 | 43,6 | 0,6 |
| **Canadá** | 2004 | 10,5 | 51,2 | 38,1 | 0,3 |
| **China** | 2003 | 27,1 | 62,4 | 10,5 | ... |
| **Coréia** | 2003 | 12,6 | 76,1 | 10,1 | 1,2 |
| **Espanha** | 2003 | 15,4 | 54,1 | 30,3 | 0,2 |
| **Estados Unidos da América** | 2003 | 9,0 | 68,9 | 16,8 | 5,3 |
| **França** | 2003 | 17,1 | 62,3 | 19,3 | 1,4 |
| **Japão** | 2003 | 9,3 | 75,0 | 13,7 | 2,1 |
| **México** | 2001 | 39,1 | 30,3 | 30,4 | 0,2 |
| **Portugal** | 2002 | 20,7 | 31,8 | 36,7 | 10,8 |
| **Rússia** | 2003 | 25,3 | 68,4 | 6,1 | 0,2 |

Fonte: Organisation for Economic Co-operation and Development, Main Science and Technology Indicators, 2005/1 e Brasil: Sistema Integrado de Administração Financeira do Governo Federal (Siafi). Extração especial realizada pelo Serviço Federal de Processamento de Dados (Serpro) e Pesquisa Industrial de Inovação Tecnológica (Pintec) do Instituto Brasileiro de Geografia e Estatística (IBGE) - 2000 e 2003.

Elaboração: Coordenação-Geral de Indicadores - Ministério da Ciência e Tecnologia.

# Agências Públicas Financiadoras

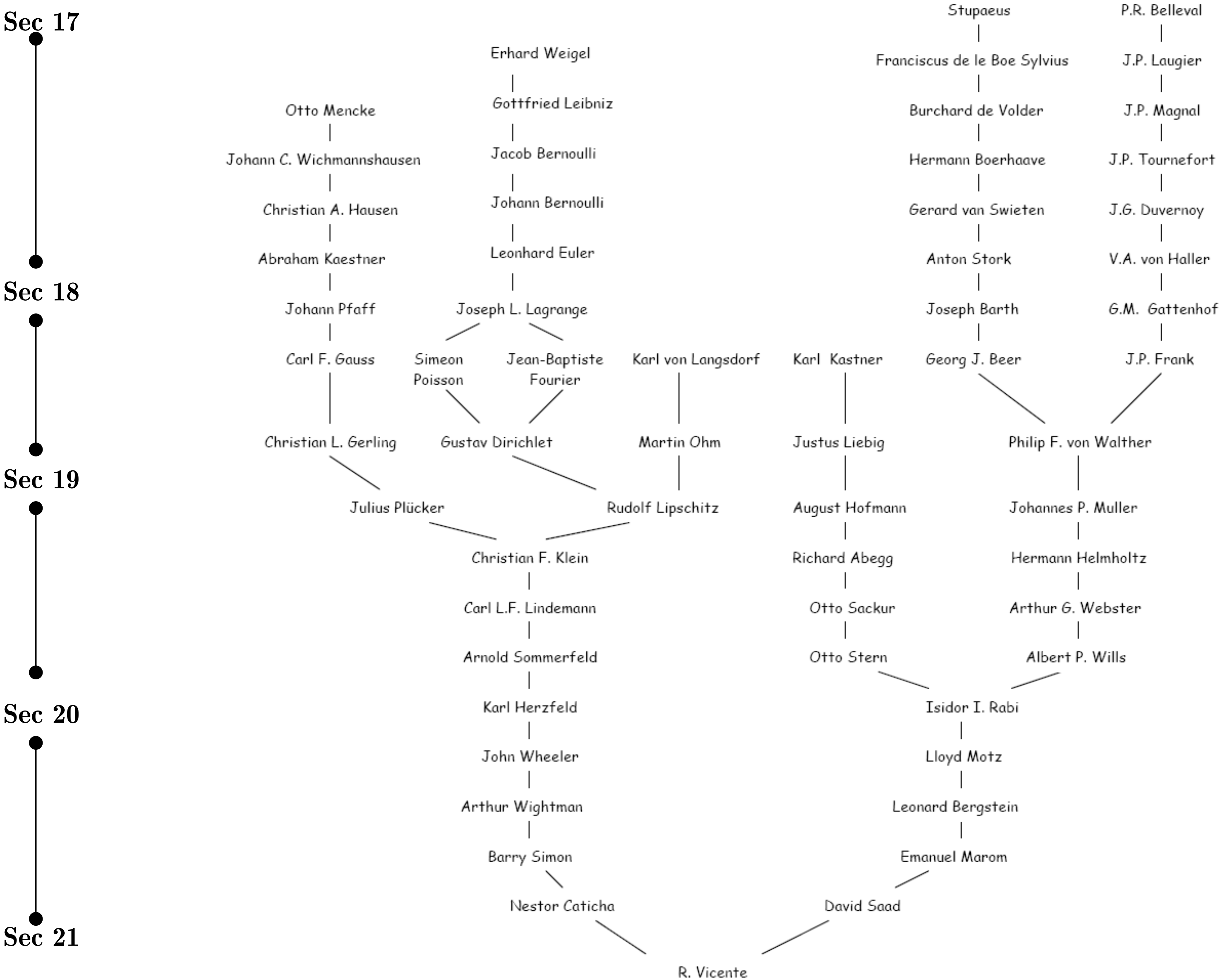
## Agências nacionais

Coordenadoria de Aperfeiçoamento de Pessoal de Nível Superior

## Agências estaduais

# Como funciona a carreira acadêmica?

# Genealogia de Orientação Acadêmica



# Etapas na Carreira Acadêmica

1. **Graduação**: Introdução às práticas acadêmicas e a conhecimentos específicos básicos.

2. **Especialização:** Tópicos avançados em um assunto restrito. Normalmente encerrada com uma monografia aprofundando ainda mais um tópico restrito, mas sem contribuições originais.

3. **Mestrado *Lato Sensu:*** Tópicos avançados em uma área mais geral (lato sensu= em sentido amplo). Encerrada com uma monografia em algum tópico mais restrito, mas sem contribuições originais.

4. **Mestrado *Strictu Sensu:*** Iniciação à produção de pesquisa original em um tópico específico (strictu sensu= em sentido restrito), fazendo a transição entre a graduação e o doutorado. Encerrada com uma dissertação que normalmente contem uma visão crítica e pequenas expansões sobre o conhecimento atual.

5. **Doutorado:** Trabalho de pesquisa envolvendo **necessariamente** a produção de conhecimento novo. Encerrada com uma tese que deve ser defendida frente a uma banca de pares.

*Etapas não-obrigatórias

# Etapas na Carreira Acadêmica

6. **Estágio Pós-Doutorado:** Etapa dedicada ao amadurecimento como pesquisador pelo desenvolvimento de linhas de pesquisa bem definidas. Não se trata de um título acadêmico

7. **Professor Doutor**: Primeira etapa na carreira de um pesquisador acadêmico. Nessa fase consolida-se uma linha de pesquisa própria divulgada através de publicações e da orientação de alunos.

8. **Professor Associado (Livre docência):** Atestado de amadurecimento na carreira acadêmica. O título pode ser pleiteado por detentores de um doutorado. Envolve uma tese que é julgada por pares que já detém o título de livre-docente. Geralmente os candidatos a este título já possuem a posição de Prof. Dr., mas isso não é uma exigência formal.

9. **Professor Titular:** Título proferido a livre-docentes que demonstraram ao longo de sua carreira alto grau de liderança científica. Envolve um concurso competitivo no qual são analisados os memoriais (documento biográfico) dos candidatos  e seu grau de erudição na área do concurso.

*Etapas não-obrigatórias