12.708: Topics in Paleoceanography

Climate of the Common Era

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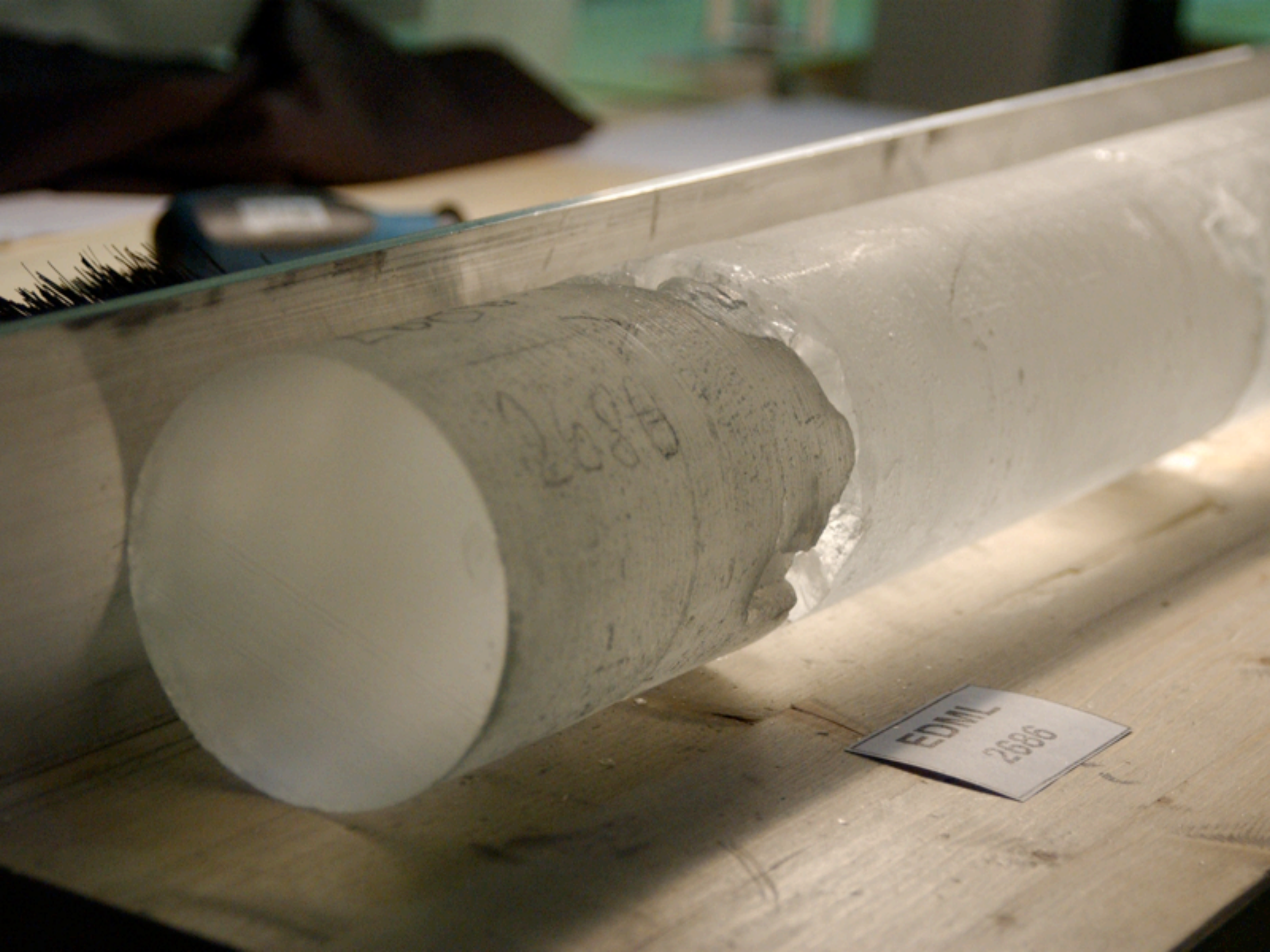
http://www.whoi.edu/sbl/liteSite.do?litesiteid=11318&articleId=16067

Why the last 2000 years?


EDML
2686

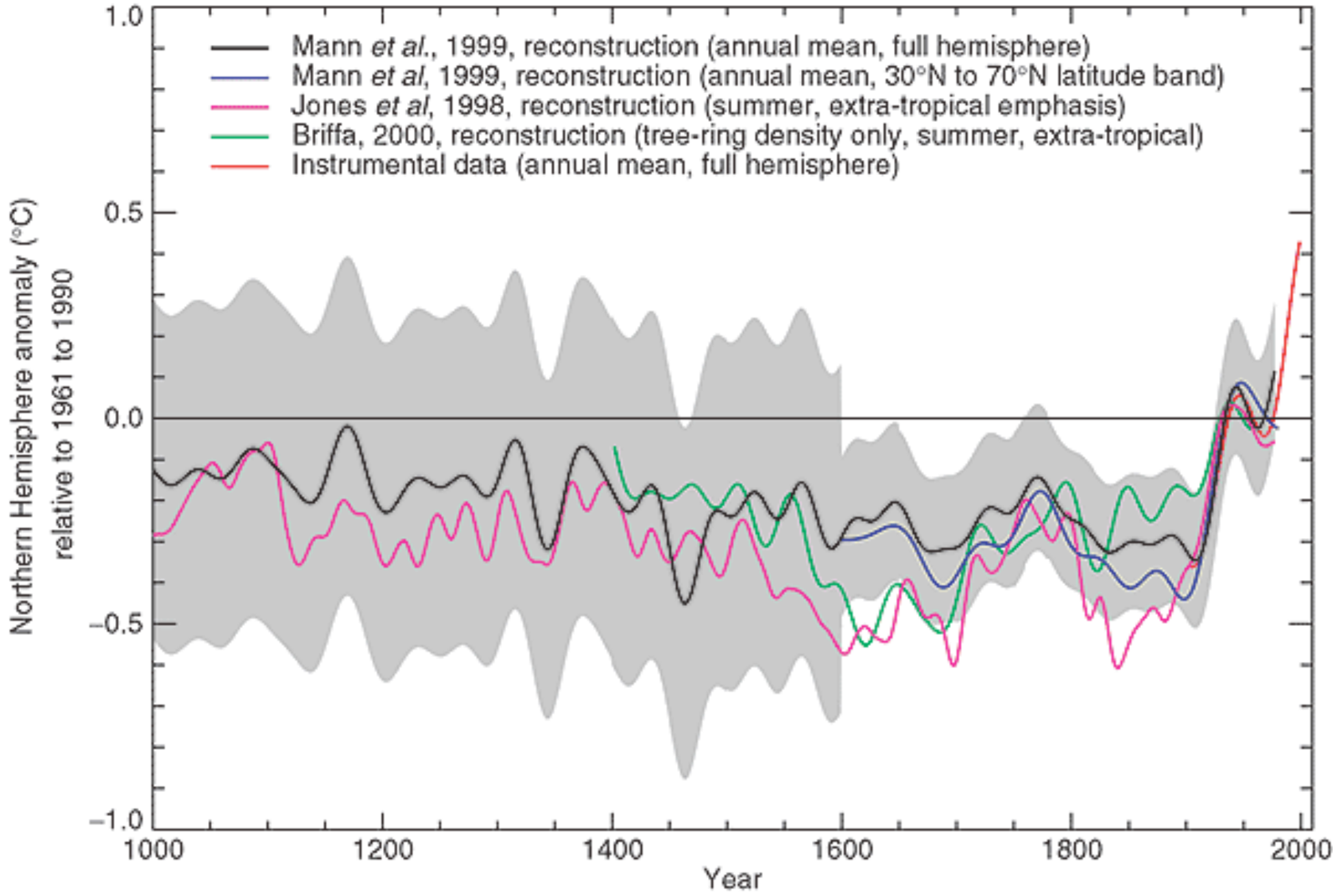

Univ. of Georgia Dept. of Geology
centimeters

Photograph: Scott St. George

1826

2000

IPCC Third Assessment Report (TAR 2001)
Millennial climate change subsumed within Chapter 2



http://www.ipcc.ch/ipccreports/tar/wg1/067.htm

TAR IPCC 2001

Summary for Policymakers

'It is likely that the **rate and duration** of the warming of the 20th century is **larger than any other time during the last 1,000 years.** The 1990s are likely to have been the warmest decade of the millennium in the Northern Hemisphere, and 1998 is likely to have been the warmest year'

Mastrandrea et al. 2010
'Guidance Note...Consistent Treatment of Uncertainties'

Table 1. Likelihood Scale	
Term*	**Likelihood of the Outcome**
Virtually certain	99-100% probability
Very likely	90-100% probability
Likely	66-100% probability
About as likely as not	33 to 66% probability
Unlikely	0-33% probability
Very unlikely	0-10% probability
Exceptionally unlikely	0-1% probability

* Additional terms that were used in limited circumstances in the AR4 (*extremely likely* – 95-100% probability, *more likely than not* – >50-100% probability, and *extremely unlikely* – 0-5% probability) may also be used in the AR5 when appropriate.

http://www.ipcc.ch/pdf/supporting-material/uncertainty-guidance-note.pdf

Why is this interesting?

[1] In theory, surface temperature should tell us something about planetary energy balance (+ natural variability)

[2] Planetary energy balance should respond to things like atmospheric composition (well-mixed greenhouse gases), solar irradiance, albedo, etc.

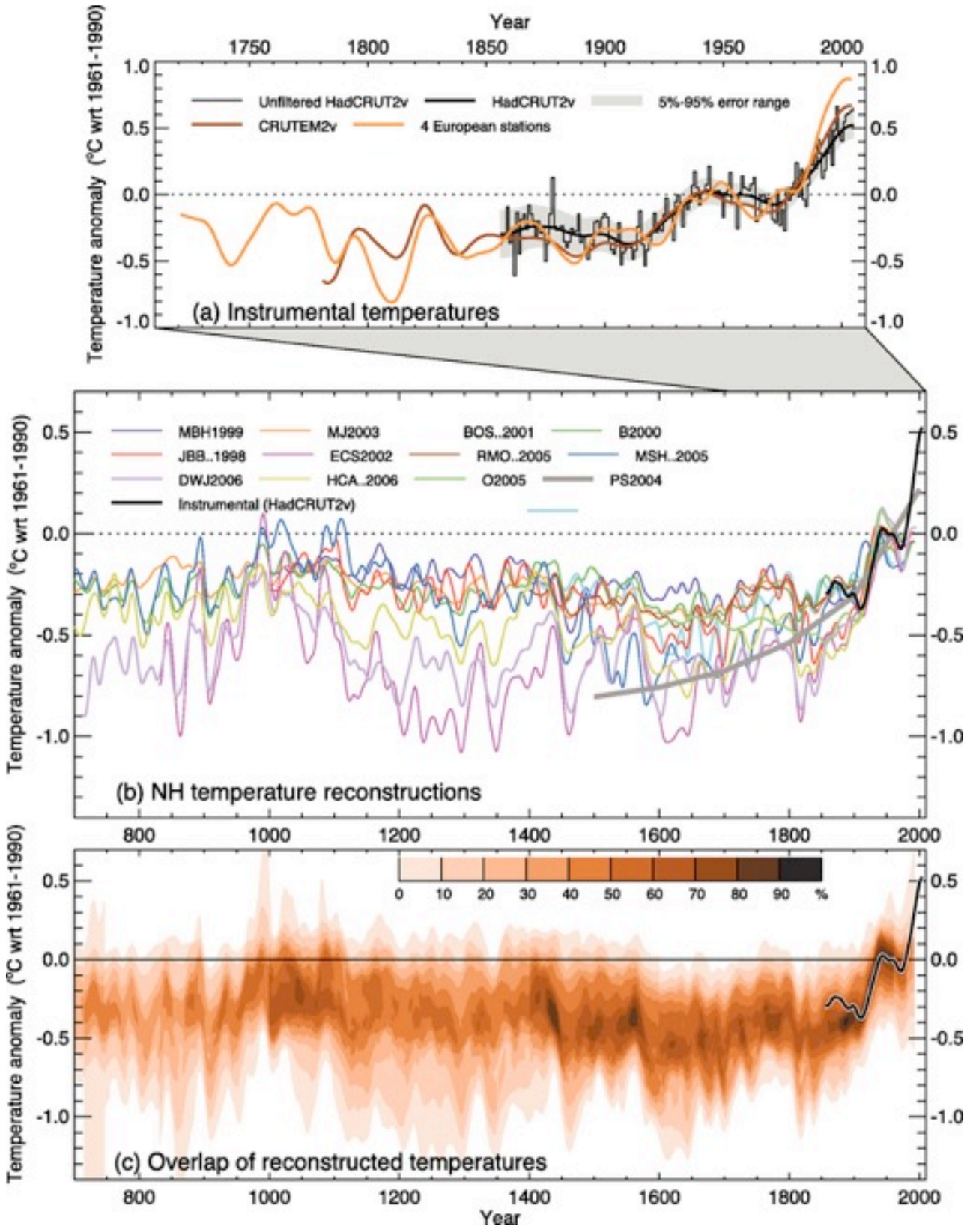
[3] Such reconstructions also tell us something about natural variability in the climate system, implication for detection and attribution of different forcings, role of internal variability, >decadal scale variability

[4] Spatial 'fingerprint' may reflect type of forcing and influence of internal modes of climate variability

SURFACE TEMPERATURE RECONSTRUCTIONS FOR THE LAST 2,000 YEARS

'Large-scale surface temperature reconstructions have the potential to further improve our knowledge of temperature variations over the last 2,000 years, particularly if **additional proxy evidence** can be identified and obtained from areas where the coverage is relatively sparse and for time periods before A.D. 1600 and especially before A.D. 900. Furthermore, it would be helpful to **update proxy records** that were collected decades ago, in order to develop more reliable calibrations with the instrumental record. **Improving access to data** used in publications would also increase confidence in the results of large-scale surface temperature reconstructions both inside and outside the scientific community. **New analytical methods, or more careful use of existing ones**, may also help circumvent some of the existing limitations associated with surface temperature reconstructions based on multiple proxies. Finally, because some of the most important potential consequences of climate change are linked to changes in regional circulation patterns, hurricane activity, and the frequency and intensity of droughts and floods, **regional and large-scale reconstructions of changes in other climatic variables**, such as precipitation, over the last 2,000 years would provide a valuable complement to those made for temperature.'

IPCC Assessment Report 4 (AR4 2007)
Entire Paleoclimate Chapter 6



http://www.ipcc.ch/publications_and_data/ar4/wg1/en/figure-6-10.html

AR4 IPCC 2007, Chapter 6

Executive Summary

'How does the 20th-century climate change compare with the climate of the past 2,000 years?'

'It is **very likely that average Northern Hemisphere temperatures during the second half of the 20th century were higher than for any other 50-year period in the last 500 years.** It is also **likely** that this 50-year period was the warmest Northern Hemisphere period in the last **1.3 kyr,** and that this warmth was more widespread than during any other 50-year period in the last 1.3 kyr. These conclusions are most robust for summer in extratropical land areas, and for more recent periods because of poor early data coverage.'

AR4 IPCC 2007, Chapter 6

Executive Summary

'How does the 20th-century climate change compare with the climate of the past 2,000 years?'

'Some of the studies conducted since the Third Assessment Report (TAR) indicate greater multi-centennial Northern Hemisphere temperature variability over the last 1 kyr than was shown in the TAR, demonstrating **a sensitivity to the particular proxies used, and the specific statistical methods of processing and/or scaling them to represent past temperatures.** The additional variability shown in some new studies implies mainly cooler temperatures (predominantly in the 12th to 14th, 17th and 19th centuries), and only one new reconstruction suggests slightly warmer conditions (in the 11th century, but well within the uncertainty range indicated in the TAR).'

AR4 IPCC 2007, Chapter 6

Executive Summary

'How does the 20th-century climate change compare with the climate of the past 2,000 years?'

'Knowledge of climate variability over the last 1 kyr in the **Southern Hemisphere and tropics** is very limited by the low density of palaeoclimatic records.'

'The palaeoclimate records of northern and eastern Africa, as well as the Americas, indicate with high confidence that **droughts lasting decades or longer were a recurrent feature of climate in these regions** over the last 2 kyr.'

Jones et al. 2009, High-resolution palaeoclimatology of the last millennium: a review of current status and future prospects

28 recommendations:

Tree rings: more subfossil chronologies, more tropical research, improved statistical methods, enhanced replication, time-dependent confidence limits, improved assessment of uncertainty, the 'divergence problem'

Corals: replication, longer records, in situ monitoring, calibration and validation, more Sr/Ca, screening for diagenesis

Ice cores: crossdating/reduce dating uncertainties, process-based understanding of isotope 'thermometer', calibration on >interannual not annual cycle, non-climatic biases, multiple proxies

Documentary data: unexploited archives, recovery of weather data, careful use in reconstructions, assessment of biases

Sediments and speleothems: 'quantitative documentation of chronological accuracy and climate sensitivity'

Jones et al. 2009, High-resolution palaeoclimatology of the last millennium: a review of current status and future prospects

28 recommendations:

Models: models as testbed for evaluating statistical techniques (~pseudoproxy studies)

Statistical techniques: preservation of low-frequency variability? field vs mean skill, better and more realistic assessment of uncertainty

Forcing: address uncertainties, ensembles of models with different forcings and perturbed physics

Model/Data comparisons: take uncertainties in both models and reconstruction into account when assessing either or making comparisons

Climatic Change (2009) 94:247–259
DOI 10.1007/s10584-009-9588-0

The future of the past—an earth system framework for high resolution paleoclimatology: editorial essay

M. K. Hughes · C. M. Ammann

'We propose a new direction, in which emerging tools are used to formalize the combination of process knowledge and proxy climate records to better illuminate past climate variability on these time scales of great relevance to human concerns.'

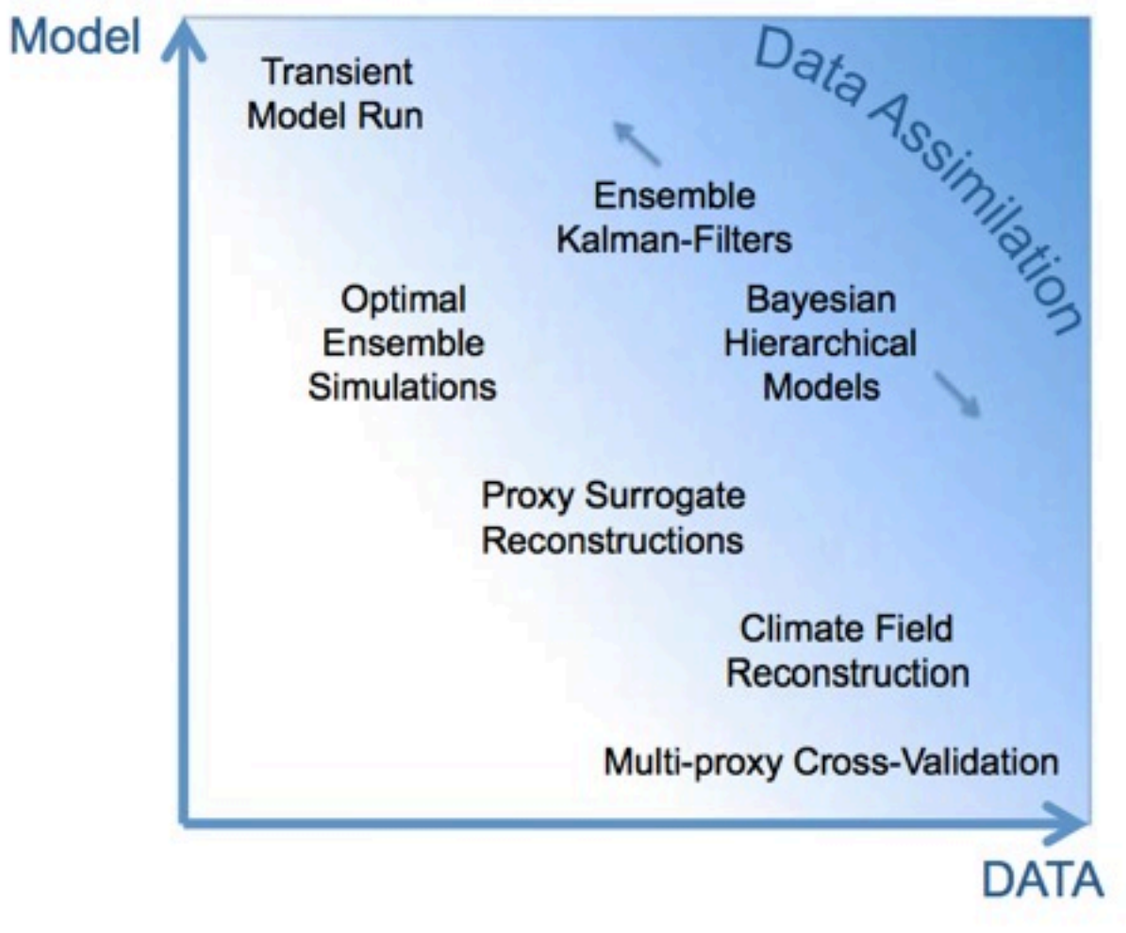
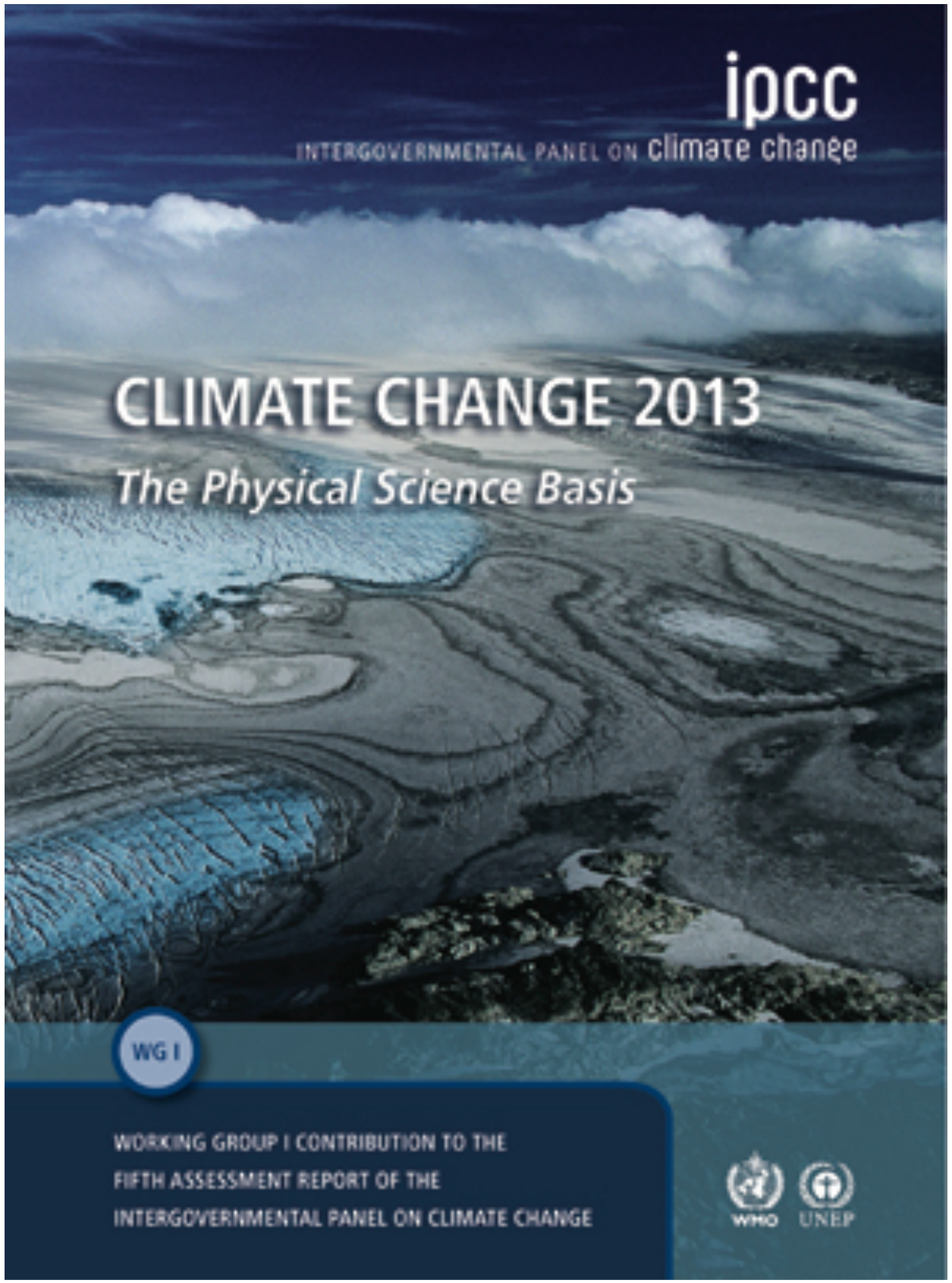


Fig. 1 A schematic illustration of the relationships between methods requiring detailed process understanding (lesser to greater on vertical axis *bottom* to *top*) and those depending on data (lesser to greater on horizontal axis *left* to *right*)



http://www.climatechange2013.org/

http://www.climatechange2013.org/contributors/chapter/chapter-5

When doing the reading and preparing your discussion, try to think about and incorporate the following:

1. How does the paper under discussion expand on/counter/provide context for/change our understanding of the climate of the last 2000 years compared to TAR and AR4?

2. How well do new proxies, new syntheses, new methods meet the suggestions in the NAS 2006 report and Jones et al. 2009 and Hughes and Amman 2009?

3. When AR5 is released, how well does AR5 synthesize the primary literature? What are the changes in TAR and AR4? How justified are the AR5 conclusions, in light of the primary literature?

Guidelines for Presentations:

1. One presenter per week should develop a synthesis presentation (30-45 minutes) to review the paper, elaborate on methods, bring in additional information from papers, and stimulate discussion

2. Try to put the paper under discussion in the context of previous work, assessments, and touchstones like Jones et al. 2009