

Climate Data Case Study

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NSF/DOE IPCC Project

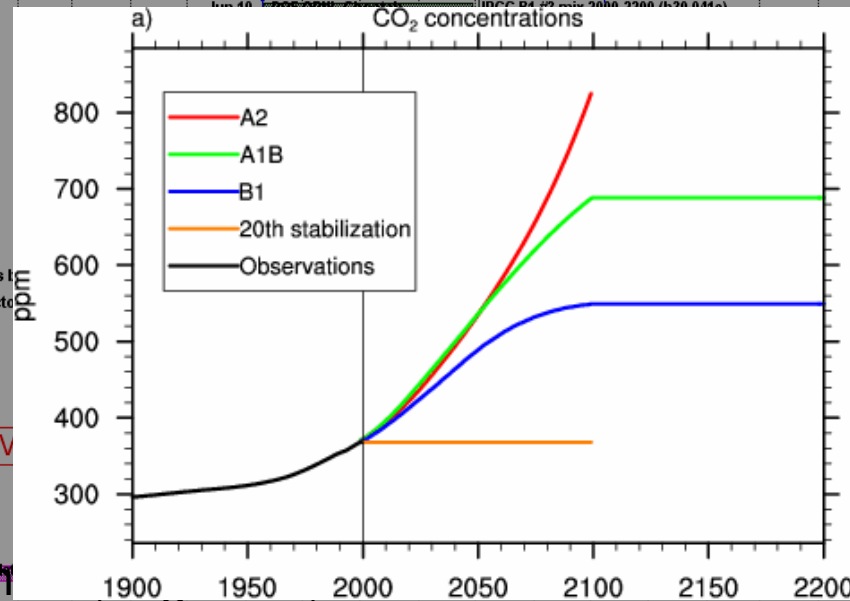
NCAR, ORNL, NERSC, ES

Observations
of the
Earth's Climate System

Simulations
Past, Present
Future Climate States

6-Year Timeline

- 2002: Climate Model/Data-systems development
- 2003: Climate Model Control Simulations
- 2004: IPCC Historical and Future Simulations
- 2005: Data Postprocessing & Analysis
- 2006: Scientific Synthesis
- 2007: Publication



CDP/ESG has transformed **CCSM data services**

“Lets our Scientists do Science”

- **CCSM3.0 Release (2004)**
 - **Source Code, Input data and Documentation**
 - **So easy that it was almost an afterthought.**
- **IPCC AR4 (2005-present)**
 - **Distributed data services through PCMDI and NCAR**
 - **Delivered the model data for the IPCC AR 4 (WG 1)**
 - **Changed the World**
- **Ongoing CCWG Research**

ESG data services have been a huge win for us...

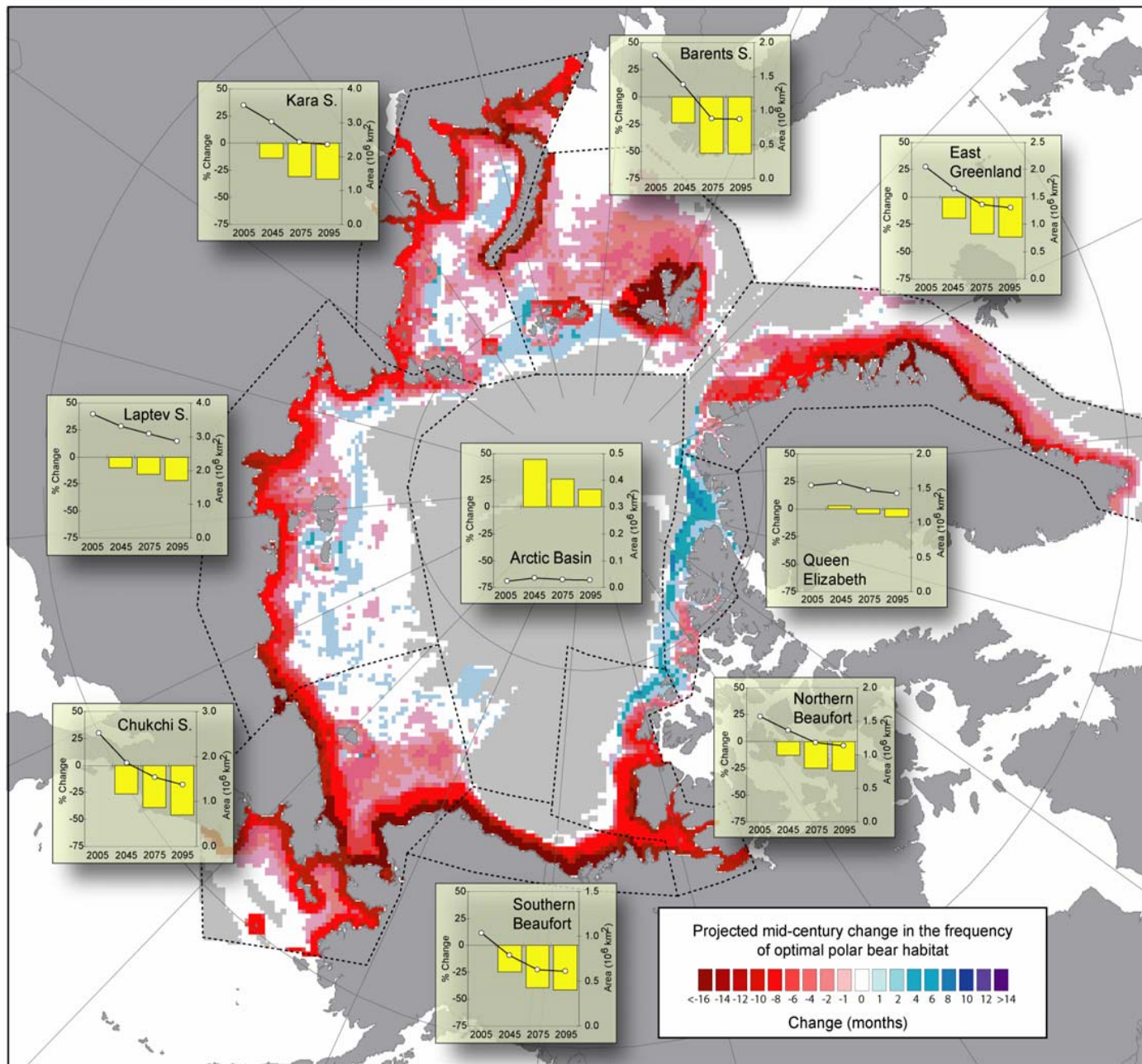
- **Promoted use of data/metadata standards & richer metadata**
- **Much cheaper, easier and effective**
- **Allows us to reach huge new research/app communities (GIS)**



Briefing on Results:

USGS Science Strategy to Support U.S. Fish & Wildlife Service Polar Bear Listing Decision: *a 6 month effort*

Habitat Change Projection: 2001-2010 to 2041-2050

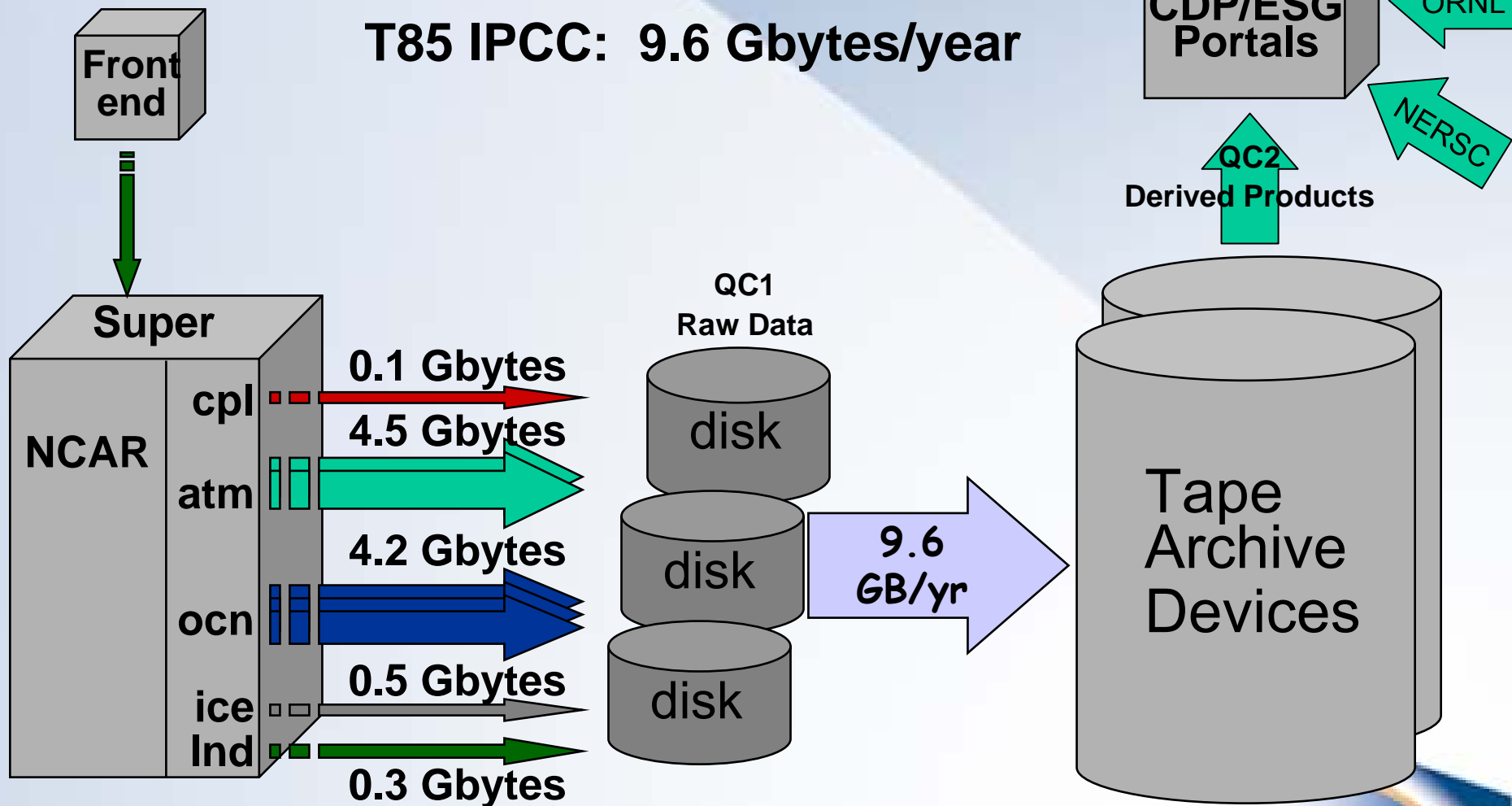


IPCC/CMIP4 Models

- 1 bccr_bcm2_0
- 2 cccma_cgcm3_1
- 3 cccma_cgcm3_1_t63
- 4 cnrm_cm3
- 5 csiro_mk3_0
- 6 gfdl_cm2_0
- 7 gfdl_cm2_1
- 8 giss_aom
- 9 giss_model_e_r
- 10 iap_fgoals1_0_g
- 11 inmcm3_0
- 12 ipsl_cm4
- 13 miroc3_2_hires
- 14 miroc3_2_medres
- 15 miub_echo_g
- 16 mpi_echam5
- 17 mri_cgcm2_3_2a
- 18 near_ccsm3_0
- 19 ukmo_hadcm3
- 20 ukmo_hadgem1

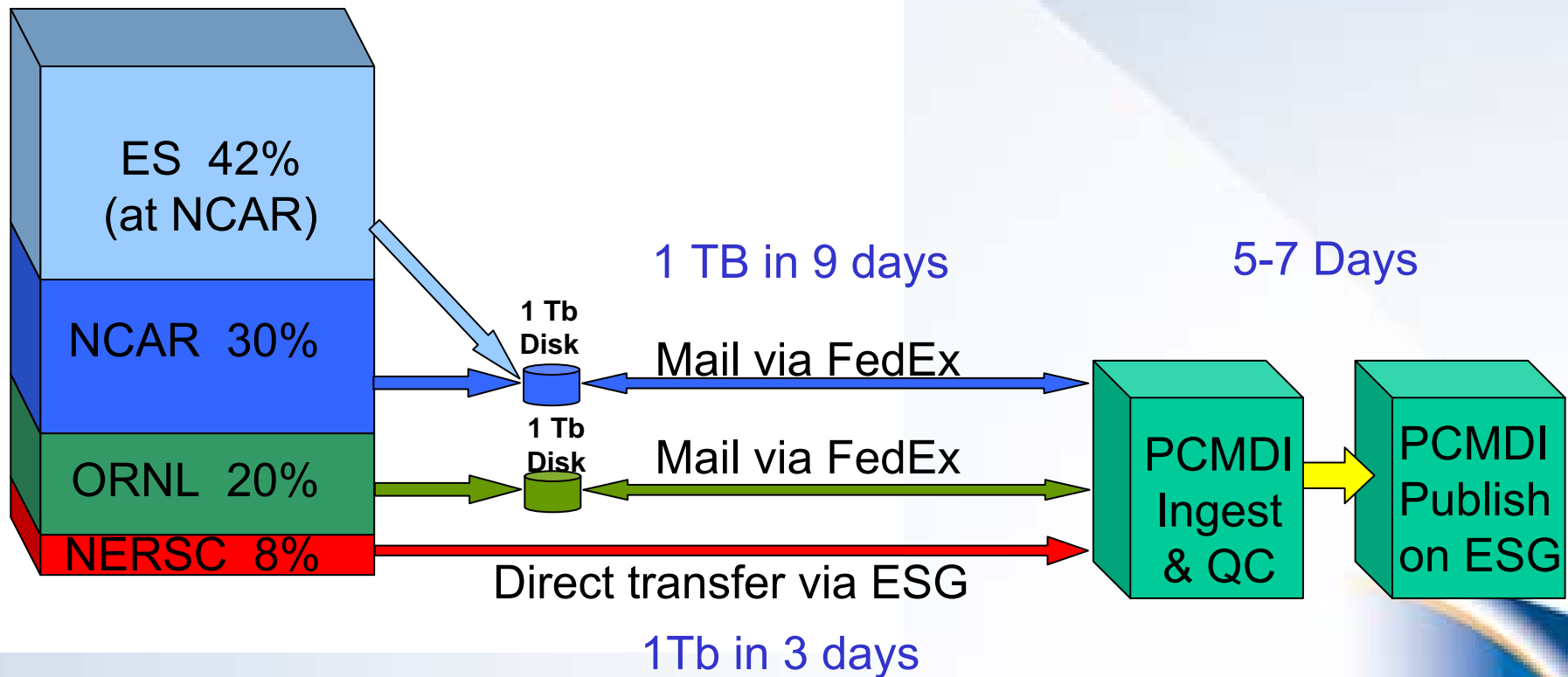
CCSM IPCC Run Process

T85 IPCC: 9.6 Gbytes/year



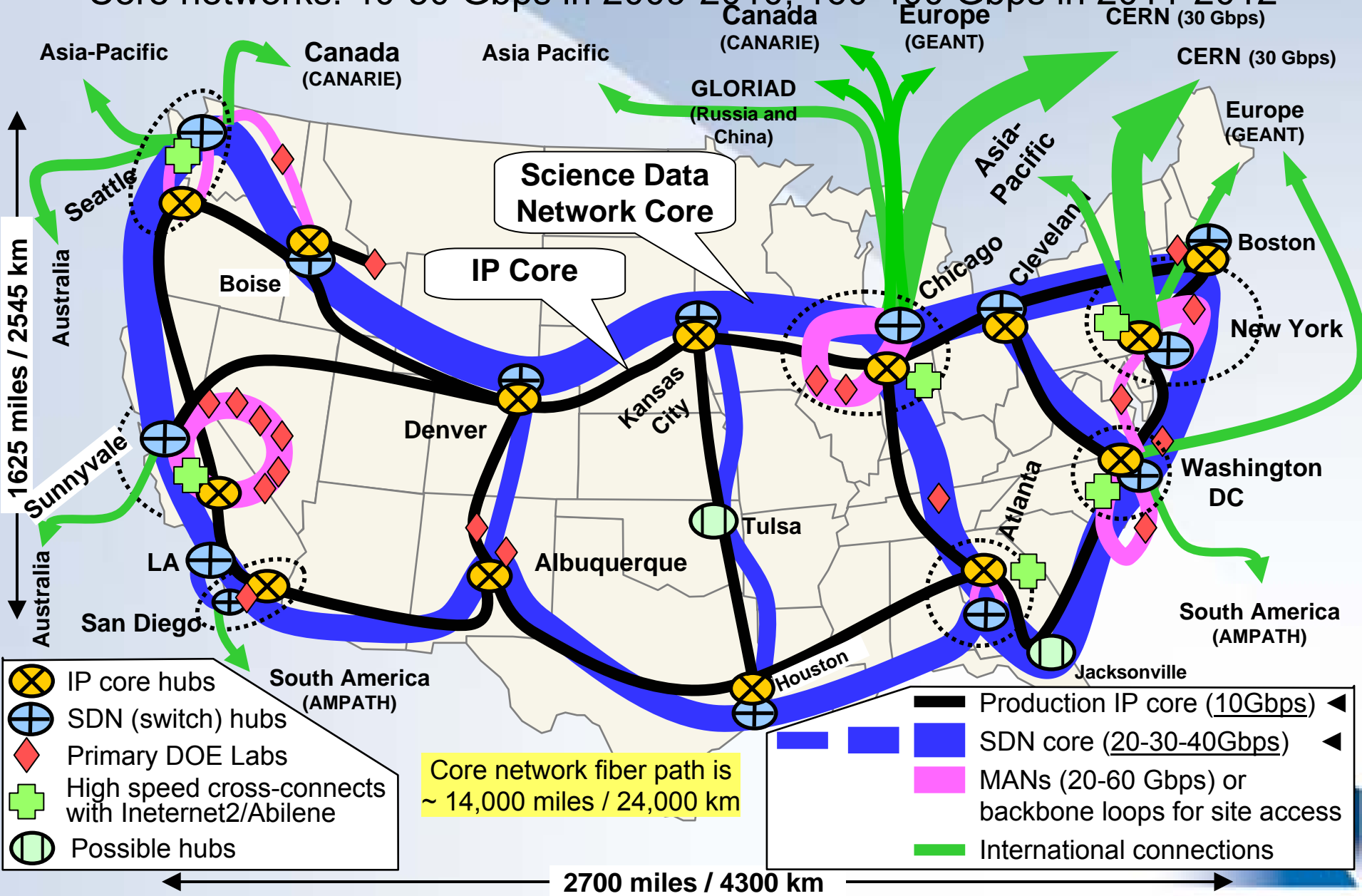
IPCC Data Transfer Process

- 100+ Tb total data volume
- 25-30 Tb to IPCC data archives at LLNL/PCMDI

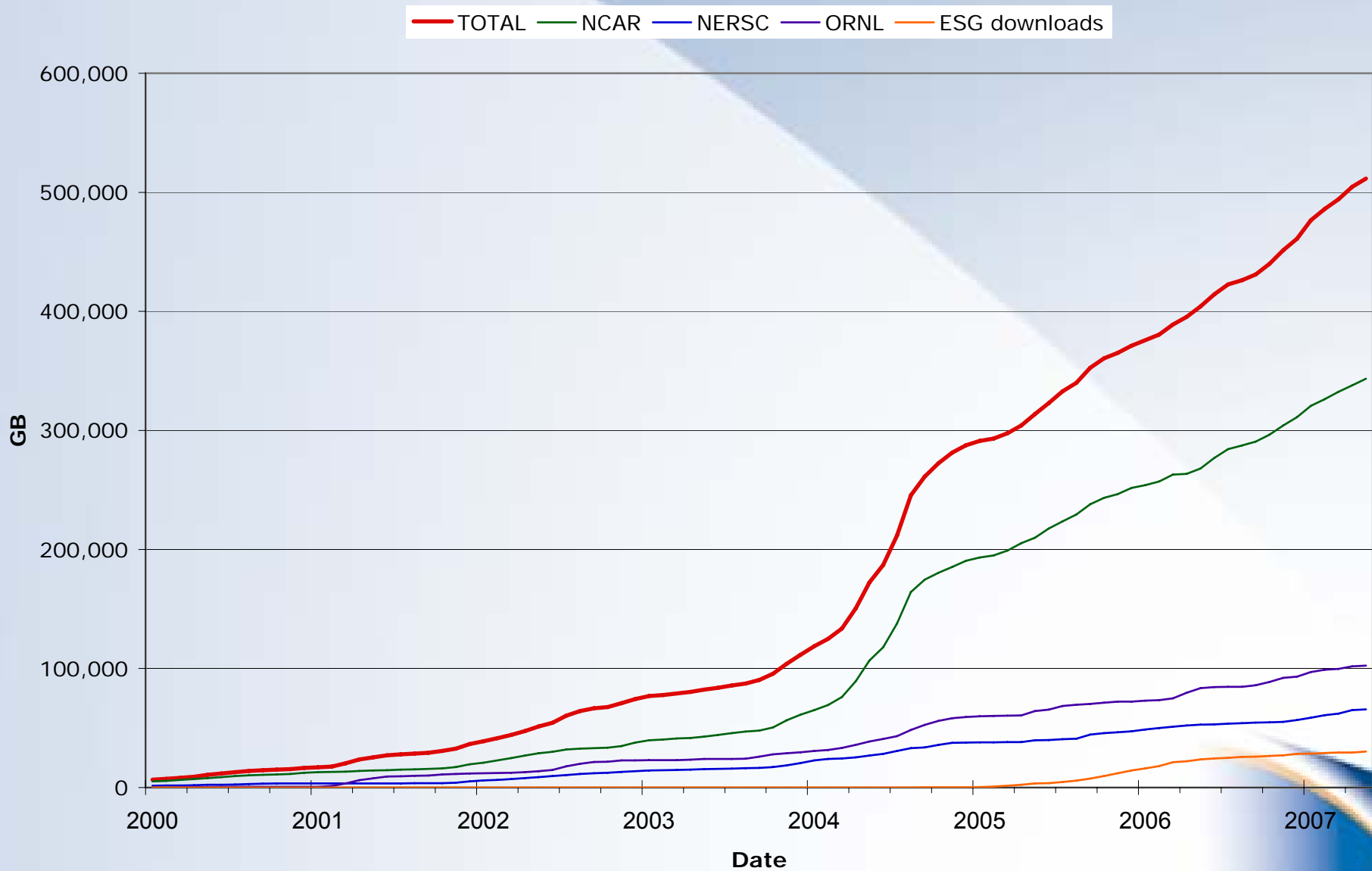


DOE ESnet4 Configuration

Core networks: 40-50 Gbps in 2009-2010, 160-400 Gbps in 2011-2012



Archival Holdings and ESG Downloads



Climate Change Epochs

Before

IPCC AR4

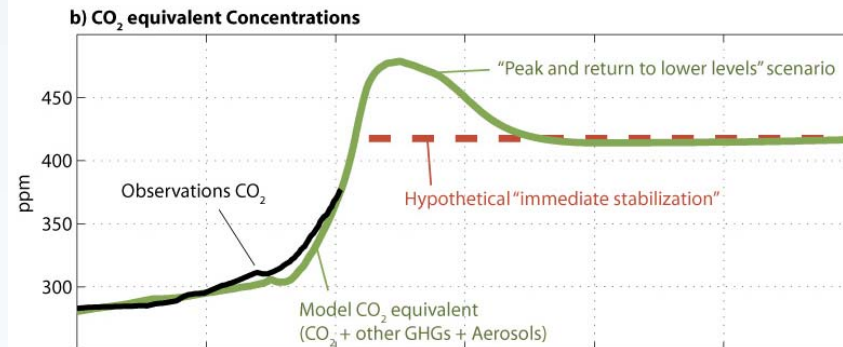
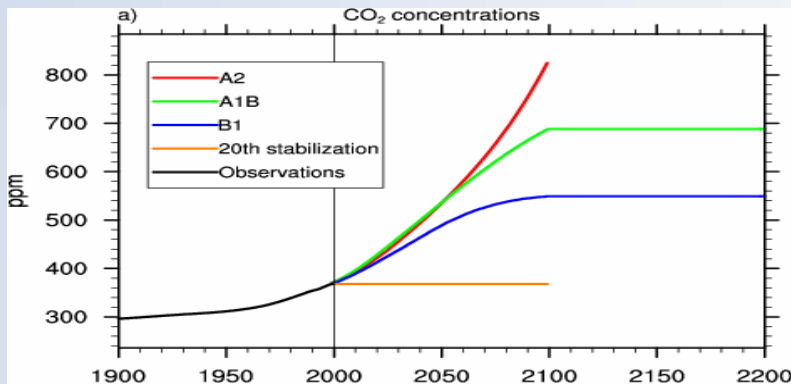
After

Attribute sources of historical warming

Project range of possible non-mitigated future warming from SRES scenarios

Quantify Climate Change Commitment

- Project adaptation needs under various mitigation scenarios
- Time-evolving regional climate change on short and long-term timeframes
- Quantify carbon cycle feedbacks



Conclusion: With the wide public acceptance of the IPCC AR4 findings, the climate science community is now facing the new challenge of quantifying time evolving regional climate change that human societies will have to adapt to under several possible mitigation scenarios, as well as addressing the size of carbon cycle feedbacks with more comprehensive Earth System Models



DOE CCRD Directions

- Less emphasis on climate change detection and attribution
- More emphasis on decision support for policy makers
 - provide decision-makers with scientific information on "acceptable" target levels for stabilizing atmospheric CO₂
 - possible adaptation and mitigation strategies for the resulting climates before or after stabilization.

“Long Term Measure” for DOE Climate Change Research

Deliver improved scientific data and models about the potential response of the Earth’s climate and terrestrial biosphere to increased greenhouse gas levels for policy makers to determine safe levels of greenhouse gases in the atmosphere.

Imperative post IPCC: Improved climate/earth system models for regional prediction.

What does a 2° C rise imply in terms of regional change and impacts?

Where to place century-scale hydroelectric investments in an evolving climate?

Future Plans

CCWG/CCP Research 2008-2012

Aug 14 2007

2008

- 1000 year CCSM4
- BGC Control Run

NCAR: Analysis of climate variability: Forced vs unforced decadal variability, extremes, water cycle, Arctic & North Atlantic Oscillation, Large Ensembles

NCAR: Analysis of specified hurricane simulations

NERSC: 1000 Year CCSM4 Biogeochemistry Control Run: C & N cycles + dynamic vegetation w/ BGCWG 2x2

NERSC: Low emissions scenarios T85 CCSM3.0

NERSC: Aerosol indirect forcing FV? CCSM3.5+

ORNL: Climate Change 2100 & beyond

ORNL: High Resolution Historical (1870-2000)

ORNL: Prognostic carbon aerosol forcing

ORNL: Fully coupled ice sheet runs

ORNL: Near-term climate predictions (1980-2030)

ORNL: Special DOE US energy strategy scenarios

2009

- CCSM4 Release
- AR5 preparation

NCAR: Analysis of climate variability:

NSF Climate change detection/attribution

NCAR: Signal-to-noise detection in forced simulations

NCAR: Analysis of specified hurricane simulations

NERSC: CCSM4 AR5 sensitivity/test runs: Equilibrium climate sensitivity

ORNL: Ultrahigh-res 1870 control: 0.2'Atm x 0.1'Ocn

ORNL: High-resolution near-term climate predictions (1980-2030)

ORNL: Special DOE Scenarios for US energy strategies

ALL: IPCC AR5 Simulations

NCAR: Analysis of climate variability: Monsoons & monsoon breakdown threshold: Role of aerosols

NCAR: Analysis of climate variability: Climate change detection and attribution including regional effects of urbanization.

NCAR: IPCC AR5: Adaptation and Mitigation Scenarios

NERSC: IPCC AR5: Long-term stabilization Scenarios

NERSC: Geographic representations of probabilistic climate change

ORNL: IPCC

ORNL: Ultra

ORNL: Speci

NCAR: Clim

and

NERSC: Very

ORNL: Very

near-

2010

- IPCC AR5 runs

2011-2012

- Very high Resolution

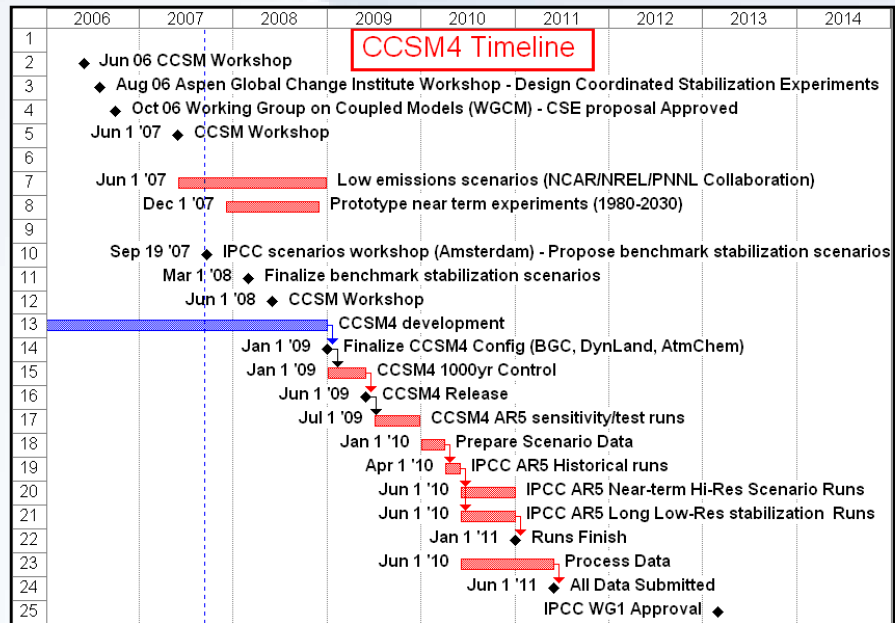


The current model development timeline anticipates CCSM4 in 2009 in time to participate in the next set of internationally coordinated mitigation scenario experiments in 2010-2011

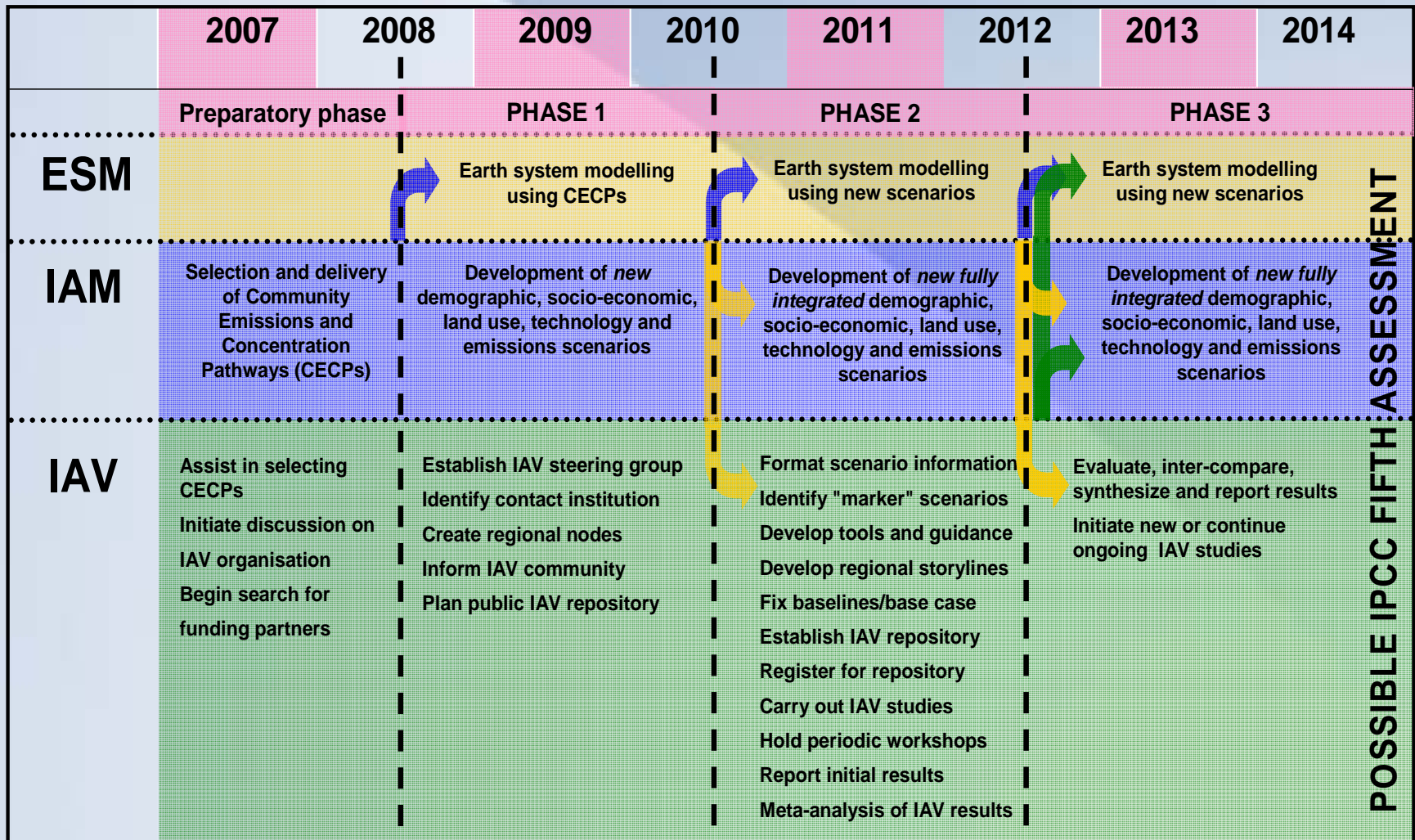
short term climate change: 30-year climate predictions at higher resolution and a single scenario

long term climate change: 300-year climate change simulations at medium resolution and carbon cycle for benchmark mitigation scenarios

A next-generation Earth System Model will also be under development during this time period.



The overarching goal is to ensure that CCSM plays a substantial and credible leadership role in climate change science, and makes substantial contributions to national and international coordinated climate change experiments and assessments



Lessons Learned

4. Effective Data Distribution Systems Require Sustained Investment

Home Grown Data Systems



- Initially Cheap
- \$\$\$ in long term
- Limited Scale

Institutional Data Portal



- Modest Investment
- Agile and Right-sized for Many Projects
- Institutional Scale

Earth System Grid



- Large Investment
- Infrastructure for Large Projects
- Spans Institutions