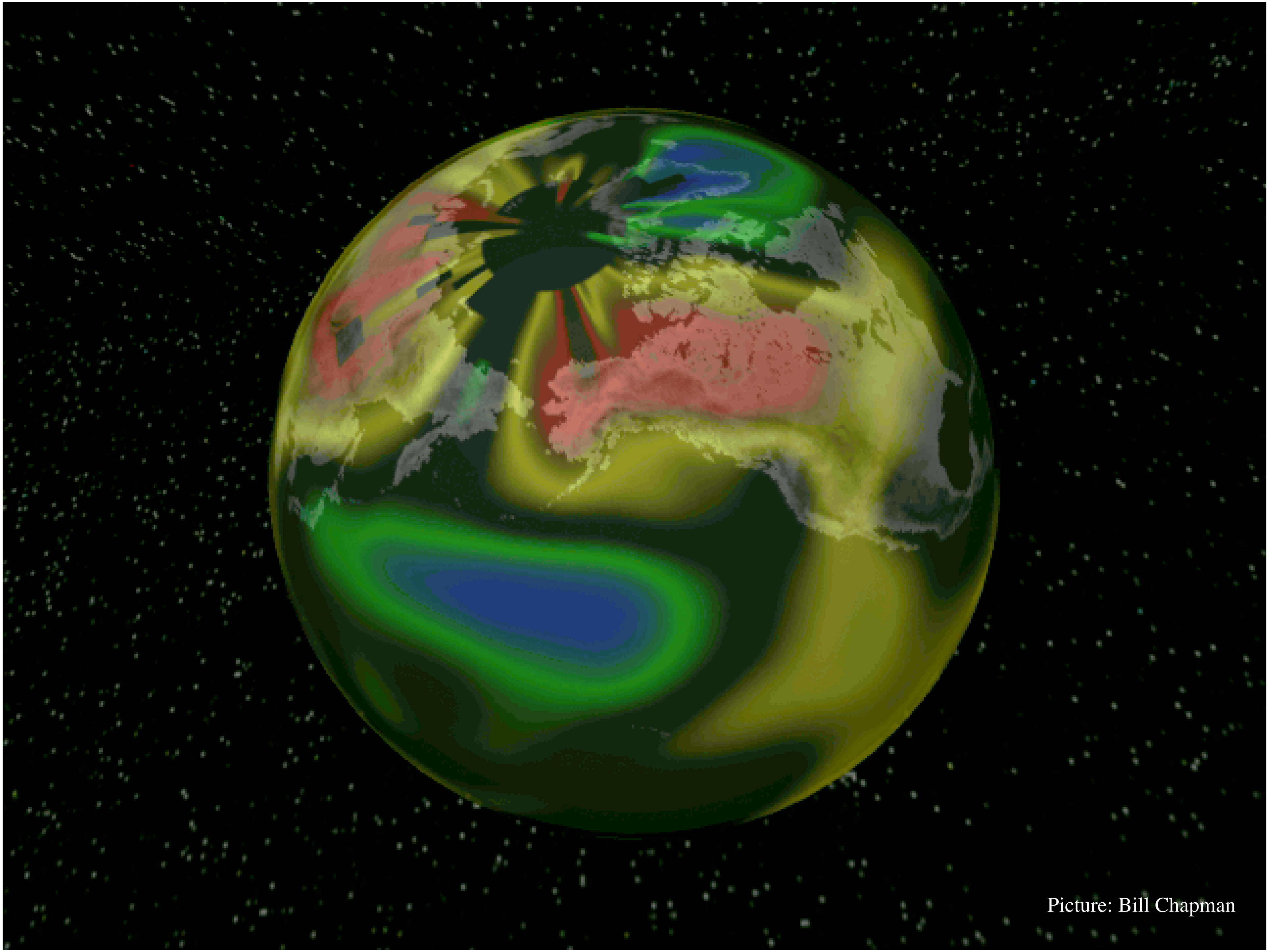
Picture: Bill Chapman

From the 1998 ARCSS Science Plan, the first theme was identified as follows:

1. How will the Arctic climate change over the next 10-100 years?

A primary goal of ARCSS research is the integration of contemporary and paleo-environmental observational, process and modeling studies to assess future near term change in the Arctic.

The importance of paleoenvironmental studies is highlighted when studies of Arctic change are placed in the context of multi-decadal modes of variability in the Arctic system.

Change in the Arctic climate system

Climate change in the next 100 years will be forced by a combination of radiative and “inherent” variability in the atmosphere-ocean-land-cryosphere global system.

- Preliminary assessments of paleodata suggest that, *neglecting the influence of feedbacks*, radiative forcing can account for a larger proportion of Arctic-wide average variability (Overpeck et al. 1997).
- The influence of feedbacks on Arctic climate change is large and highly uncertain.
- The interactions between radiative forcing and feedbacks on the one hand and “inherent” modes of variability on the other is highly uncertain.

Radiative forcing

From a physical point of view, external radiative forcing is relatively predictable, since we can measure trace gases and solar variability, and monitor volcanic activity.

BUT

Choice of emissions scenario has been shown to account for 50% of the spread in global model scenarios of the next 100 years (IPCC 2000).

Feedbacks

Feedbacks within the Arctic system and between the Arctic and global systems are innumerable.

However, key uncertainties with very large potential signals include -

- ice extent and ice properties - albedo feedback
- cloud feedbacks
- thermohaline circulation feedbacks
- Permafrost-atmospheric carbon dioxide/methane feedbacks

Natural variability

The “internal” forcing from ocean-atmosphere oscillations has greater uncertainties associated with it, and will likely be harder to predict.

Key uncertainties are:

- **What is the long-term natural variability of key systems (AO/NAO, ENSO, PDO)?**
- **Are these internal climate oscillations being influenced by trace gas forcing?**
- **Is the AO a real physical mode? Is it stationary through time?**

“The single largest problem with current Arctic models has to do with interpretation. We don't know enough about the dynamics of the Arctic system as a whole … to really know what the model output is telling us... If a paradigm (or multiple paradigms) for the Arctic climate system could be better elucidated at a theoretical level, I think it would be greatly improve the usefulness of our models.”

John Weatherly

Predictive goals

A further issue is the level of uncertainty acceptable to the "consumers" of Arctic climate predictions on the decadal to century time scale.

Less accurate but more regionally specific predictions may be appropriate.

Are scenarios, "what if" experiments and examinations of extreme events (the tails of the distribution) more important than "predictions"?

To answer these questions, what do we need?

A strawman list of requirements:

Data and process issues:

1. additional high-quality, high resolution paleoclimate records from throughout the Arctic, with increased spatial coverage, increased co-coverage, and increased record length;
2. better observations of arctic clouds and sea ice thickness;
3. additional observations of the relationships between key arctic variables;
4. further understanding of the key, large-signal, high-uncertainty feedbacks (can we narrow down a list?);

To answer these questions, what do we need?

A strawman list of requirements:

Dynamics and model issues:

1. **better integration between Arctic models and the Arctic in global models;**
2. **development of a better theoretical understanding of the Arctic dynamical systems and natural models of variability in that system;**
3. **better interactions with potential users of arctic climate projections to determine requirements.**