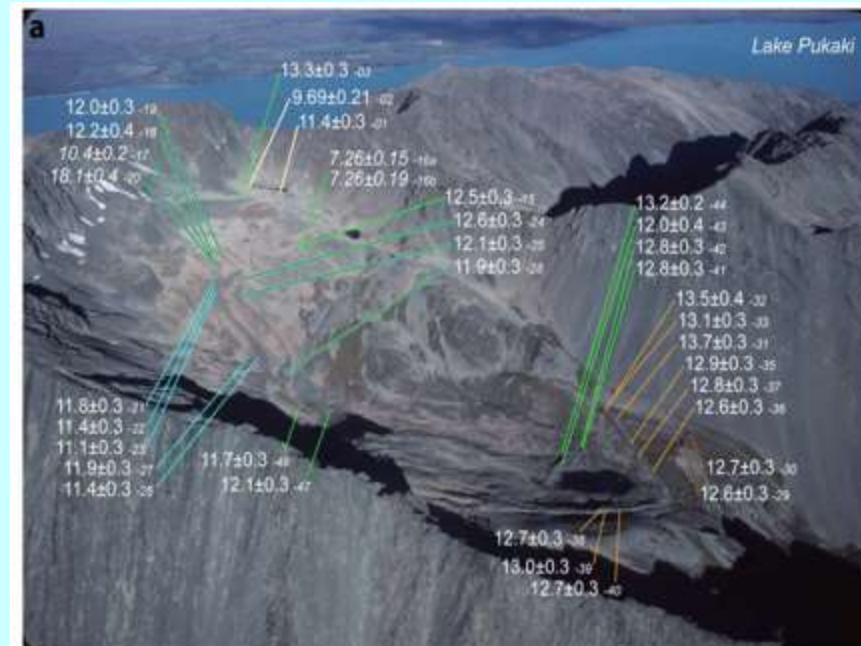


What I do

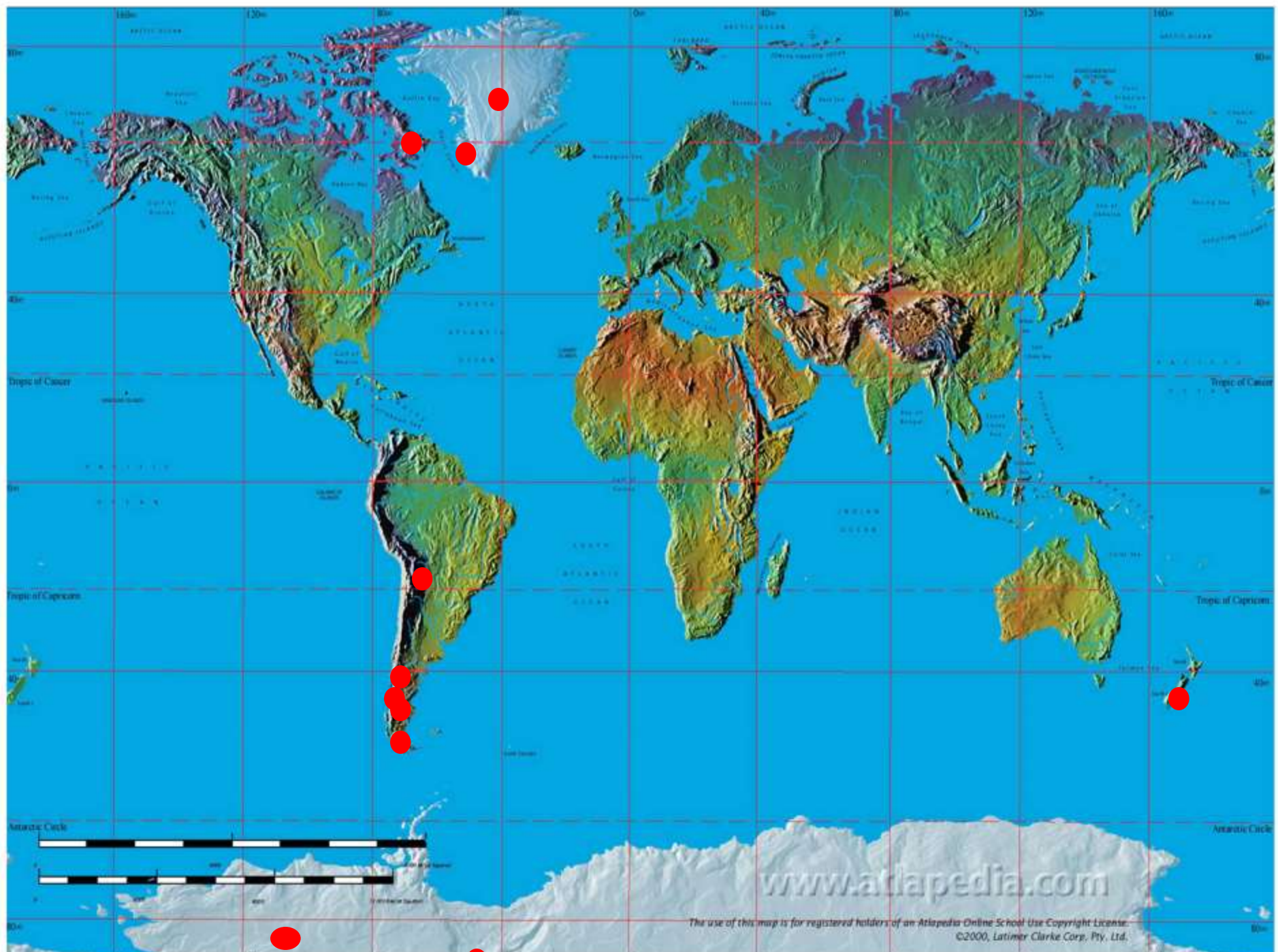
- I am mainly an observation-based researcher.
- I study geologic records to find out how glaciers and climate have changed in the past. For comparison, someone who 'does modeling'
- 'Field work' - Go to various localities around the world to gather observations and to collect samples
- 'Laboratory work' - Many of us use chemical tools to gather our observations
- Provide evidence or observations to construct and test hypotheses

From Kaplan et al., 2010



- A hallmark of the geosciences is that theoretical advances are usually grounded in direct observations of the Earth, oceans, atmosphere or planets.
- Observations play a central role in geoscientists' formulation and testing of new ideas and theories.

From Kastens et al., 2009



Why do we care?

- Use the Earth as a natural laboratory to learn how glaciers and climate work

That is, study 'natural experiments' that have been carried out in the past.

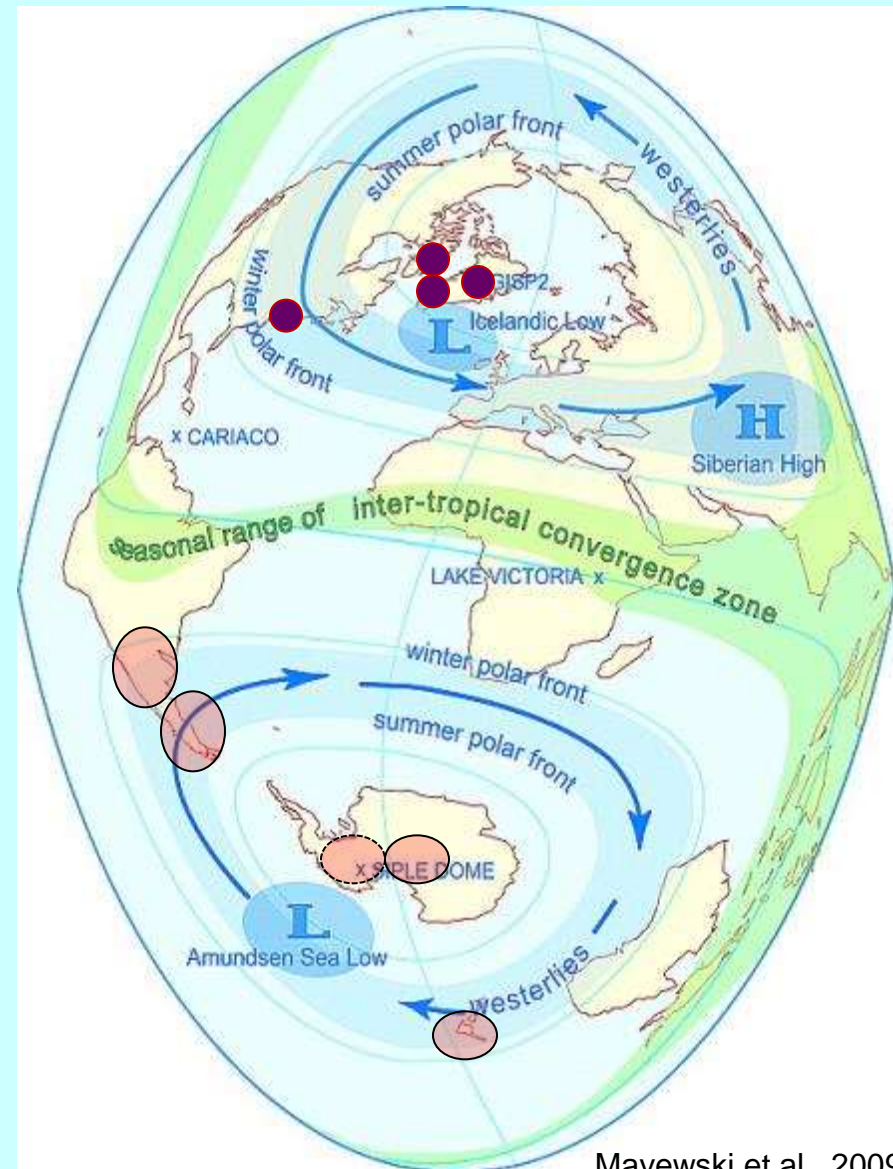
- Learn how the climate system has behaved in the past

For example, the end of the ice age when LDEO – NYC (most) were covered with an ice sheet) is the largest climate change Earth has experienced in the last 100,000 years – we still do not know entirely what caused it.

- We can give that information to modelers to constrain their boundary conditions and understand their experiments.

In this talk, I will give examples of research in different areas.

Research sites and past climate



Significance

- Well dated records on land
- Proxy records for past climate and ocean climate regimes

Field work



From Kaplan et al., 2010



From Putnam et al., 2013

moraine



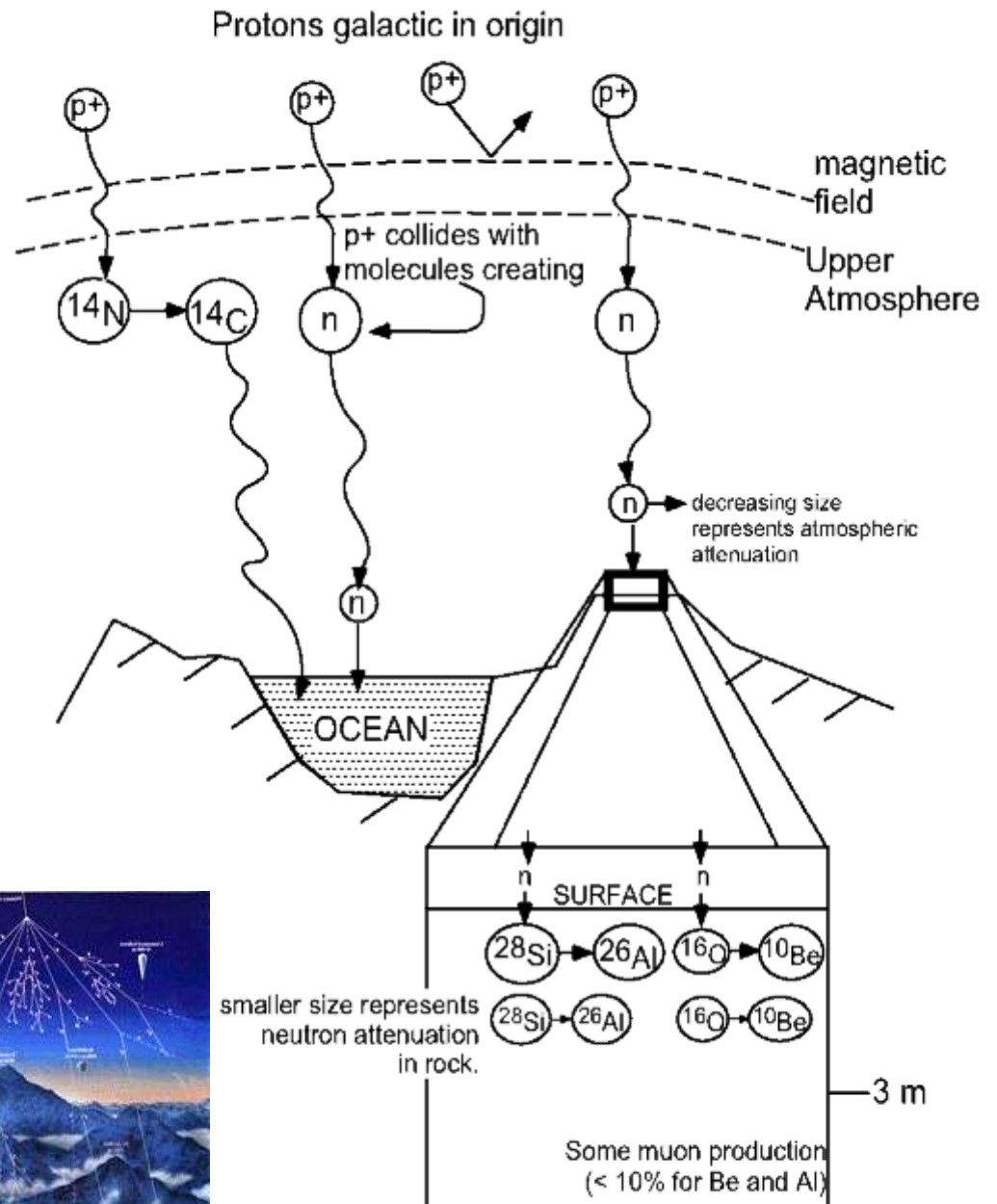
Glacier
outwash

Lava flow, 760,000 years old

1990s (?) Ford Falcon

From Singer et al., 2004

Cosmogenic or surface exposure dating

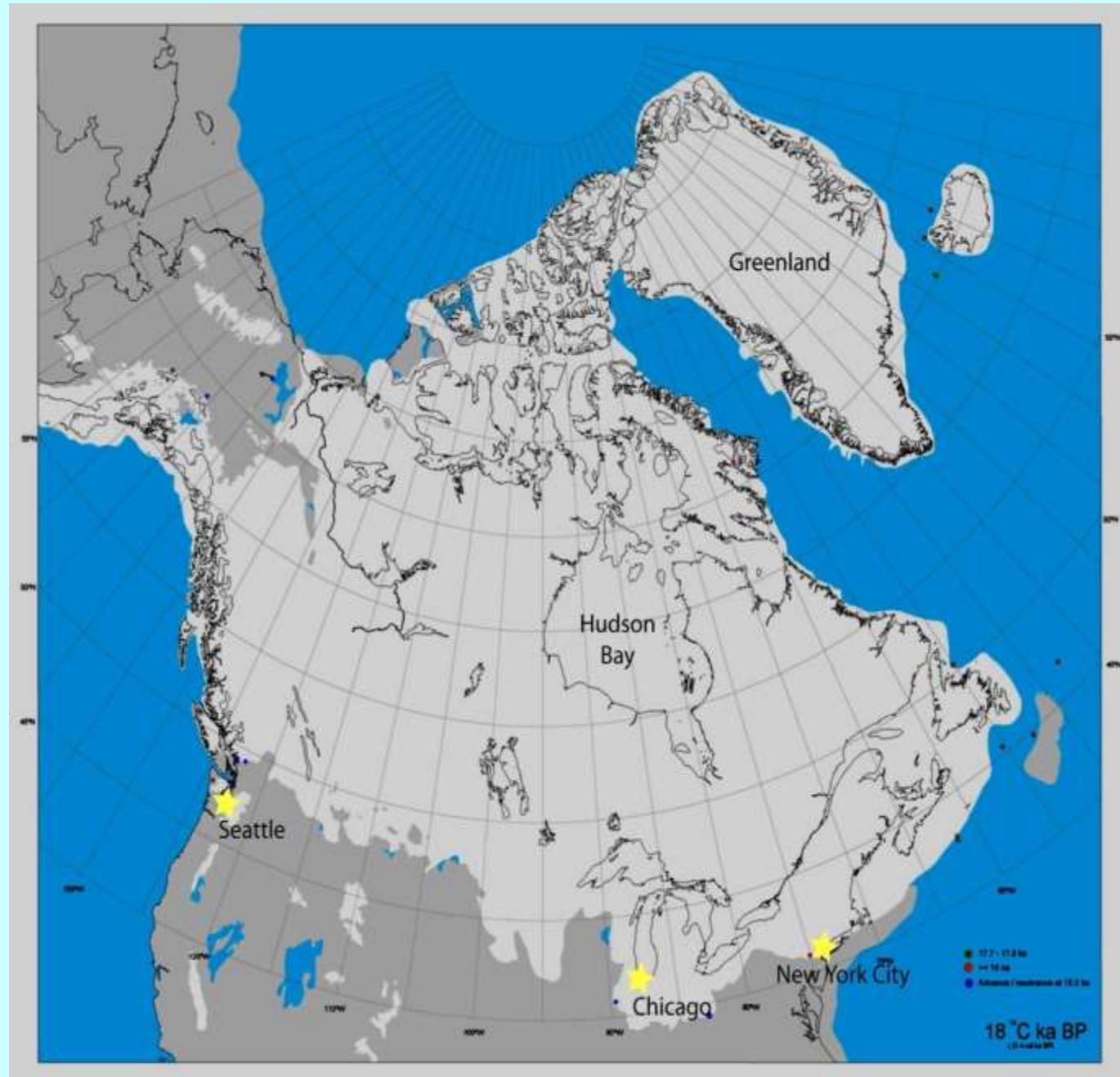


So, this is one of the ways we find out the timing and rates of geologic processes

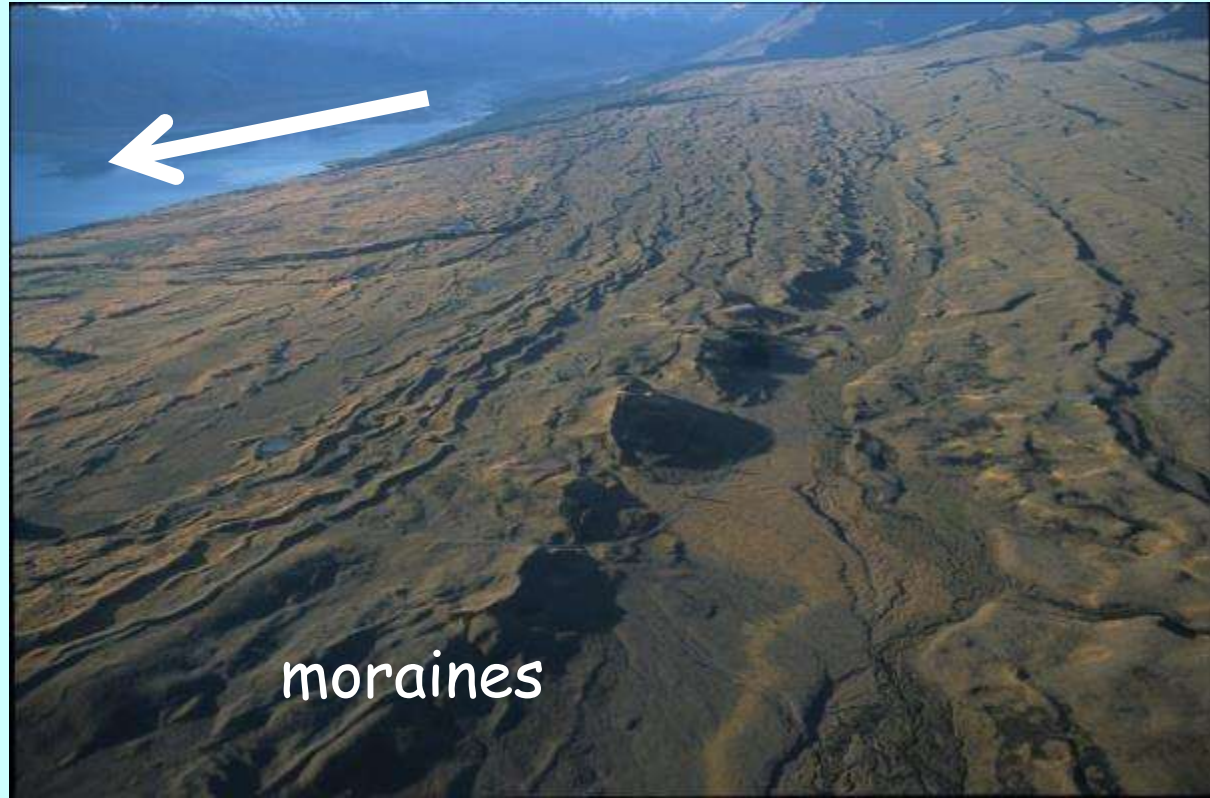
Earth scientists are 'trained' take a long view of time
(Kastens et al., 2009)

The Laurentide Ice Sheet during the last glacial period

From Dyke et al.



New Zealand – the last ice age



From Barrell et al., 2011
Photo: G. Denton

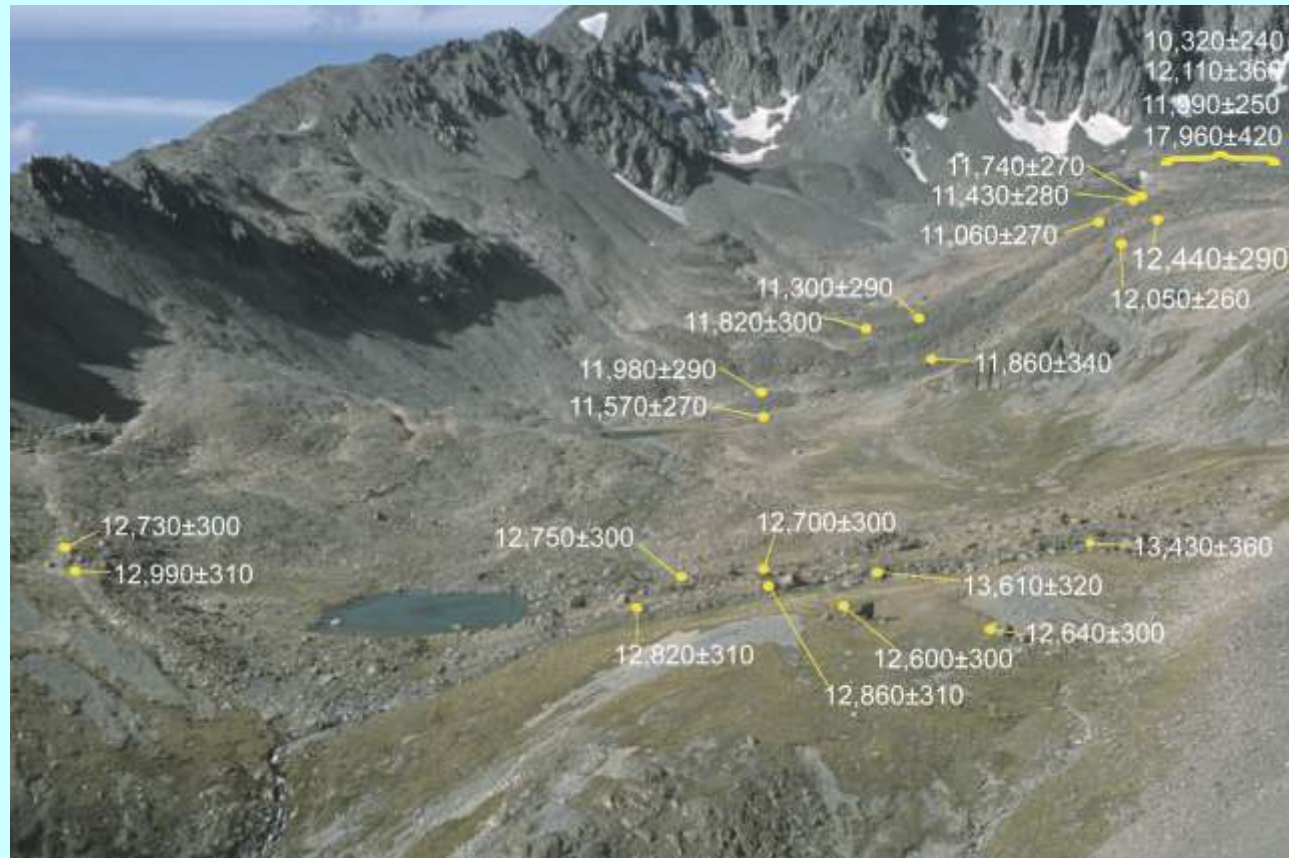
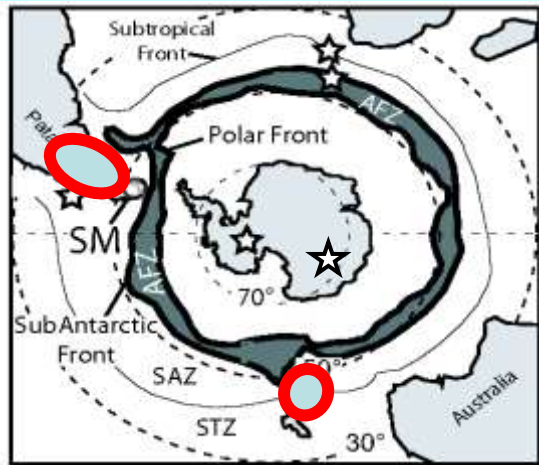
~30,000 to 18,000 years ago (Putnam et al., 2010, 2013;
Schaefer et al., 2006)

How to understand the end of an ice age in New Zealand



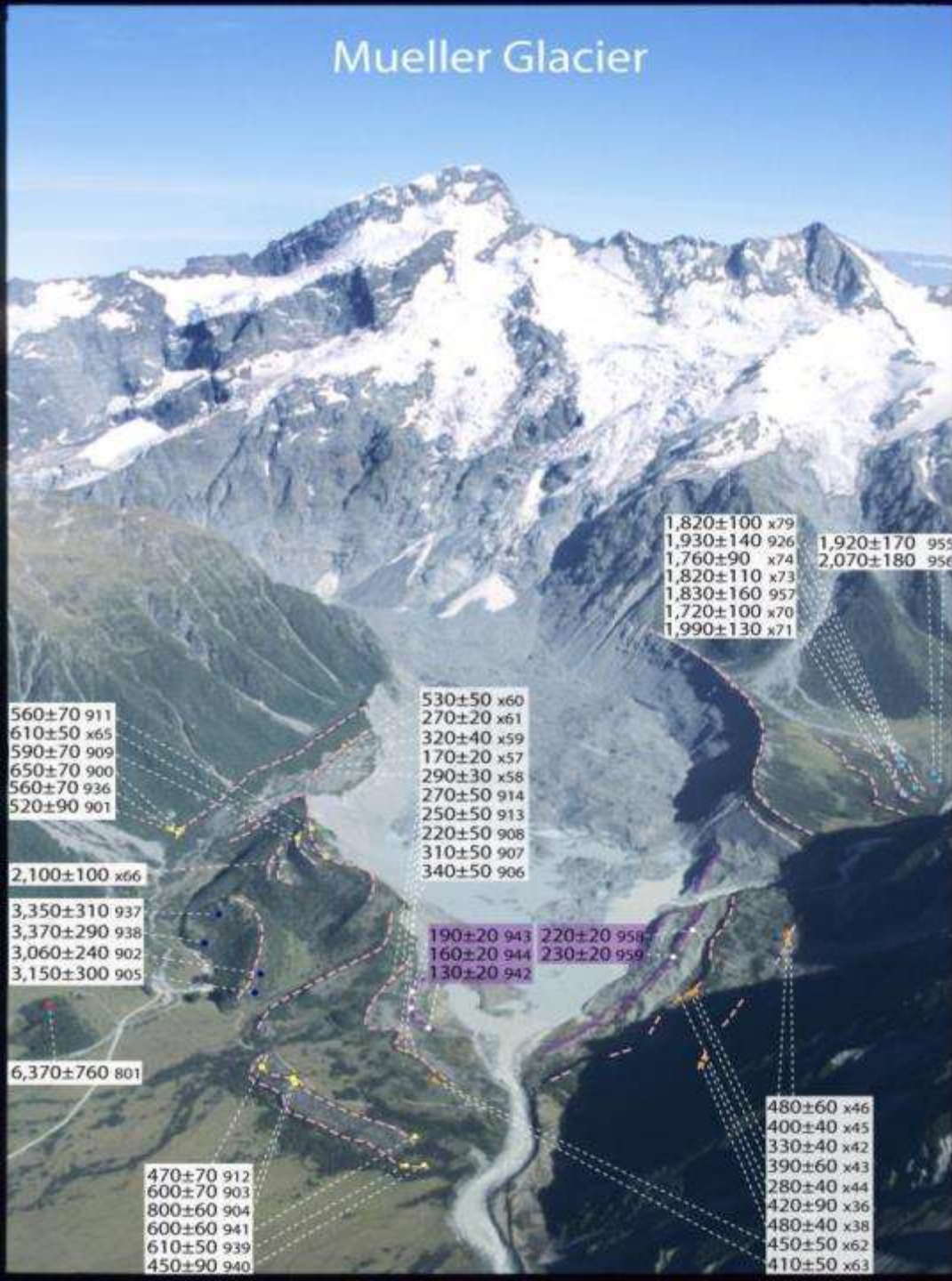
Study retreat of glaciers into the headwaters of valleys

Testing a hypothesis



Moraines document pauses in warming during transition from ice age climate to present Holocene interglacial climate (Kaplan et al., 2010; Putnam et al., 2010). Did these pauses occur at same time as in the Northern Hemisphere (“Younger Dryas problem”).

Mueller Glacier



New Zealand

The last 10,000 years



From Schaefer et al., 2009

South America -- The Problem

- Are past climate changes different between the Northern and Southern hemispheres?

Different past context compared with that in Northern Hemisphere? Glacial events at same time as Little Ice Age?

- 20th/21st century changes in glaciers are cited evidence for global warming, both in the scientific literature and in the popular press



South and North Patagonian Icefields

UPSALA GLACIER, ANDES, ARGENTINA

1928

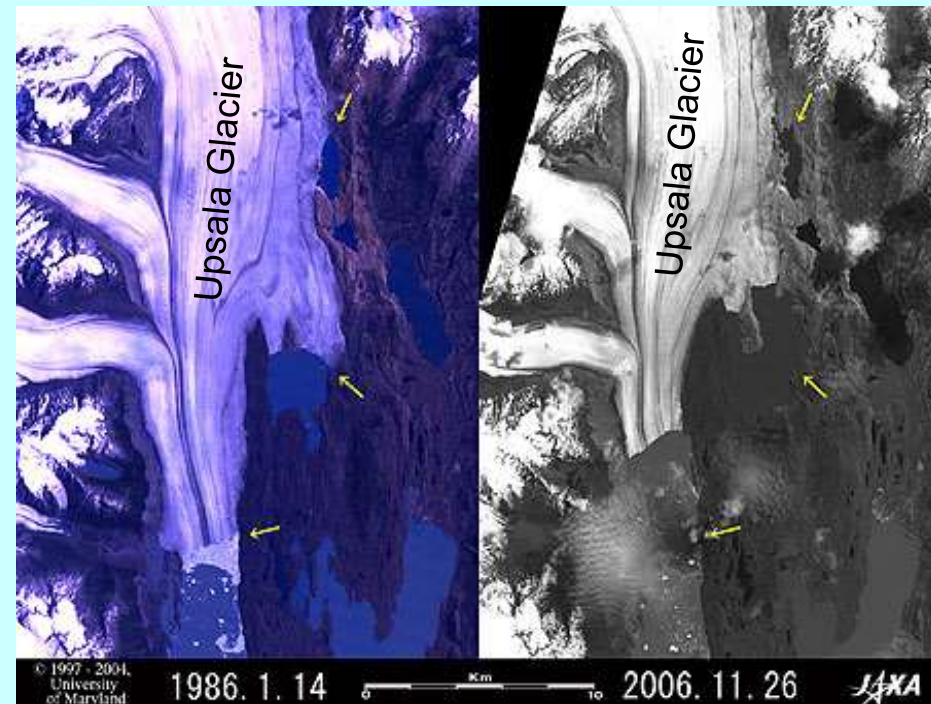


2004



www.time.com

Time magazine



Contribution of the Patagonia Icefields of South America to Sea Level Rise

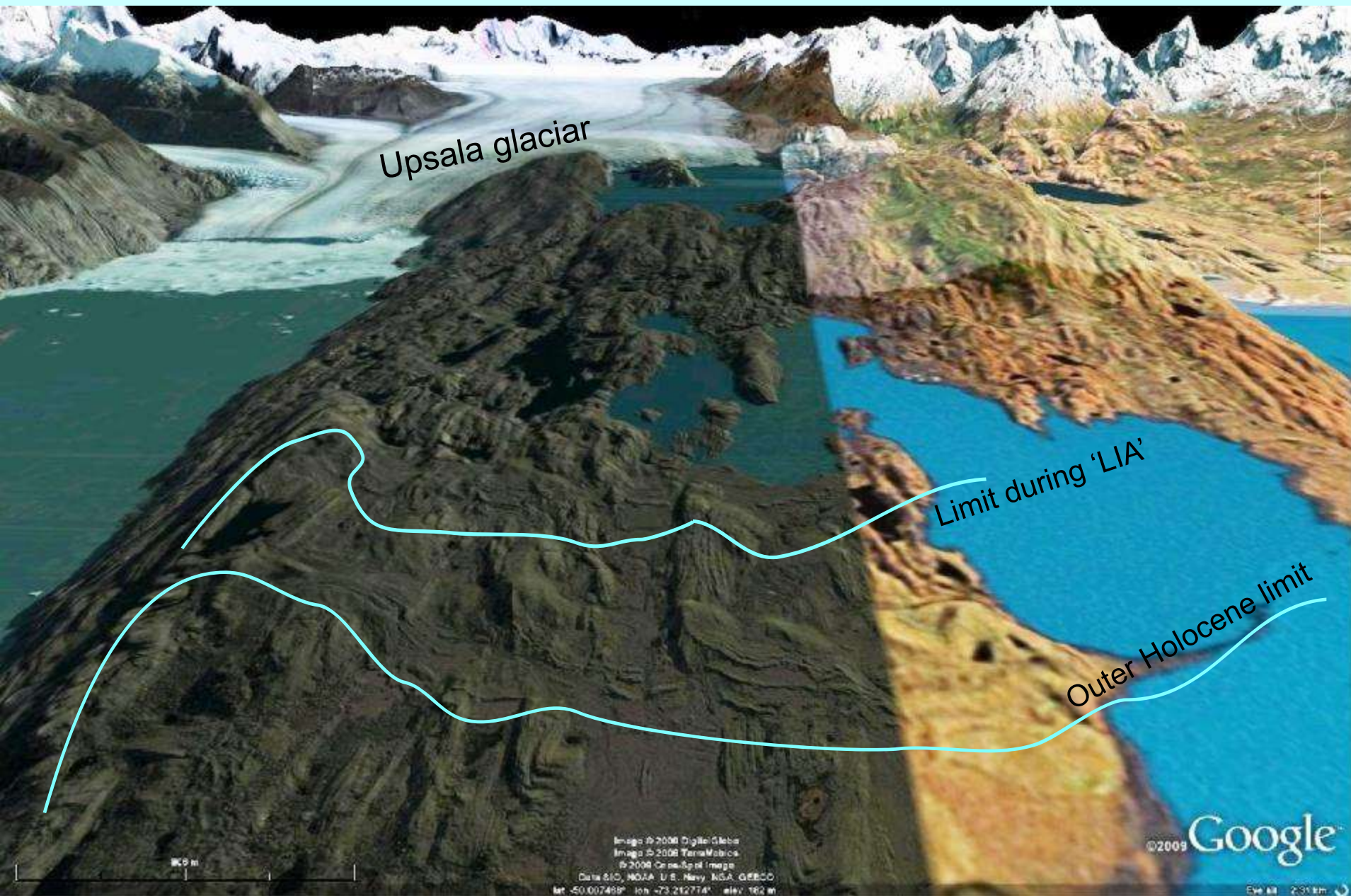
Eric Rignot,^{1*} Andrés Rivera,^{2,3*} Gino Casassa^{3*}

Digital elevation models of the Northern and Southern Patagonia Icefields of South America generated from the 2000 Shuttle Radar Topography Mission were compared with earlier cartography to estimate the volume change of the largest 63 glaciers. During the period 1968/1975–2000, these glaciers lost ice at a rate equivalent to a sea level rise of 0.042 ± 0.002 millimeters per year. In the more recent years 1995–2000, average ice thinning rates have more than doubled to an equivalent sea level rise of 0.105 ± 0.011 millimeters per year. The glaciers are thinning more quickly than can be explained by warmer air temperatures and decreased precipitation, and their contribution to sea level per unit area is larger than that of Alaska glaciers.

Science, 2003

- Patagonian glaciers are some of the fastest disappearing glaciers on Earth.
- We want to provide a context for 20th/21st century changes

Using glacial geology and cosmogenic dating to address these problems



From Mercer, 1968 and Kaplan et al. unpublished

To sum up:

Problems oriented (usually) – center around hypotheses testing

Observations

Field-based problems

Geochronology – timing of earth surface processes (for example, how glaciers have changed)

Involves laboratory work

I will just end on the note that we can give these observations to modelers. For example, glacial changes – temperature or precipitation. GCM modelers