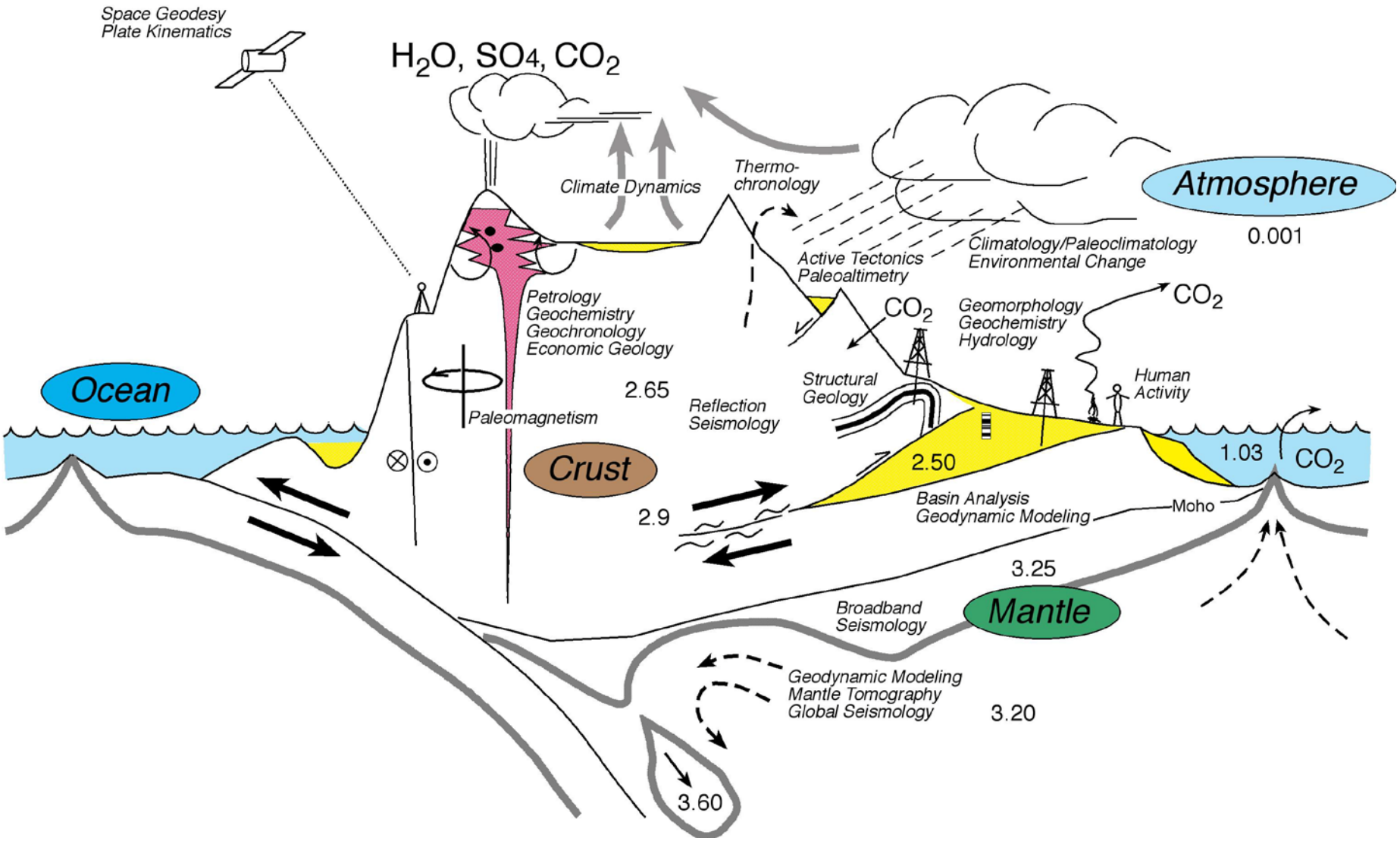
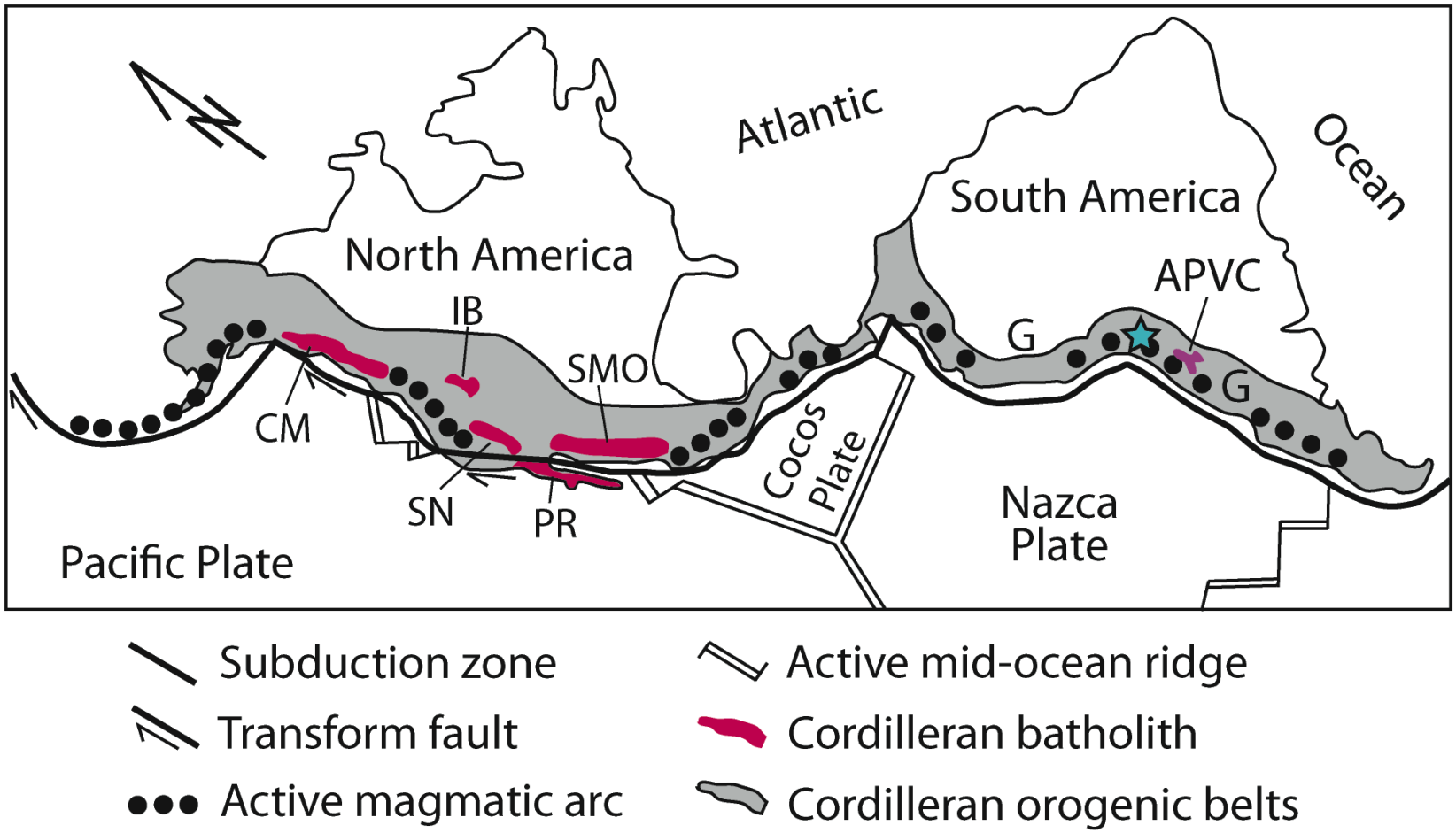

Space Geodesy
Plate Kinematics
H_2O, SO_4, CO_2
Climate Dynamics
Thermo-
chronology
Atmosphere
0.001
Active Tectonics
Paleoaltimetry
Climatology/Paleoclimatology
Environmental Change
Petrology
Geochemistry
Geochronology
Economic Geology
CO_2
Geomorphology
Geochemistry
Hydrology
CO_2
Ocean
2.65
Structural
Geology
Human
Activity
Paleomagnetism
Reflection
Seismology
Crust
2.50
1.03
CO_2
2.9
Basin Analysis
Geodynamic Modeling
Moho
3.25
Broadband
Seismology
Mantle
Geodynamic Modeling
Mantle Tomography
Global Seismology
3.20
3.60

Complementary Cordilleras

The middle crustal to lithospheric (post-orogenic) view

The upper crustal to atmospheric view, synorogenic lithospheric view



Modified after Dickinson, 2004

Personnel:

UA Faculty

Beck
Bennett
Carrapa
Chase
Cohen
Davis
DeCelles
Ducea
Gehrels
Goodman
J. Kapp
P. Kapp
Pelletier
Quade
Reineers
Ruiz
Russell
Zandt

38 total

UA Postdocs & Students

Cartwright
Einhorn
Engelder
Fan
Fuentes
Gans
Girardi
Guenther
Manthei
McBride
McGlue
McNabb
Murray
Ojha
Pearson
Peyton
Safipour
Stair
Umlauf
Vernon

Other collaborators

Horton (UTA)
Starck (Tecpetrol)
Alonso (UNSA)
Hernandez (Tecpetrol)
Schoenbohm (UToronto)
Clementz (UWyo)
Otamendi (UCordoba)
Boyd (UWyo)
Bywater-Reyes (UWyo)

Main EM collaborators (~35)

Kendall
Rudolph
Schafer
Fraticelli
Shipman
May
Kalbas
McGroder
Saltzer
Darby
Reistroffer
Brami
O'Grady

Cordilleran Cyclicity

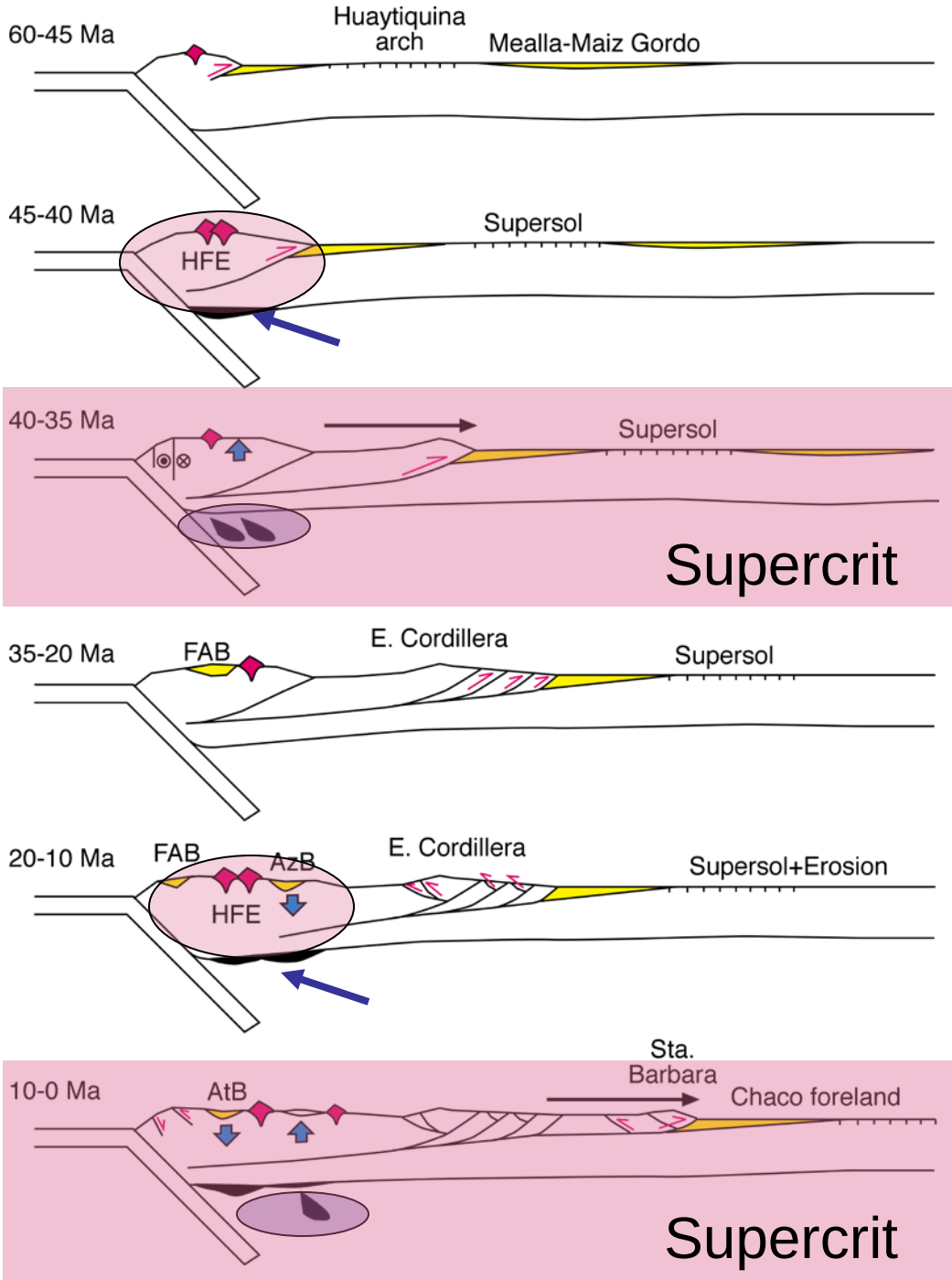
Arc magmatism is periodic in flux and composition, dominated by continental sources during HFE's & returning to more typical OIA-like behavior during lulls

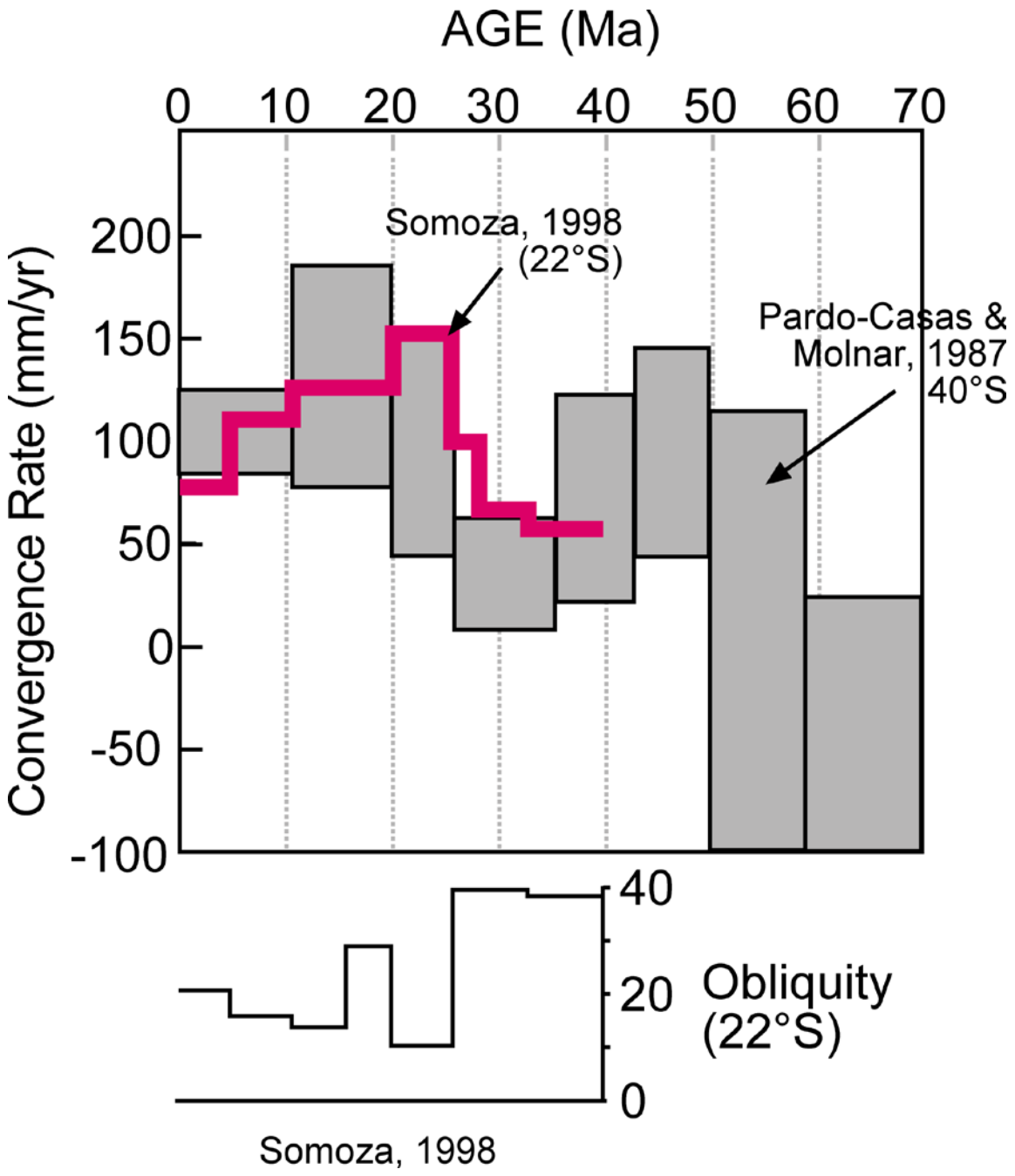
During HFE's restitic eclogite forms beneath the arc and hinterland, eventually reaching critical mass and dropping off

Shortening and propagation in retroarc and forearc wedges responds to the resulting isostatic changes in surface elevations (supercritical vs. critical/subcritical)

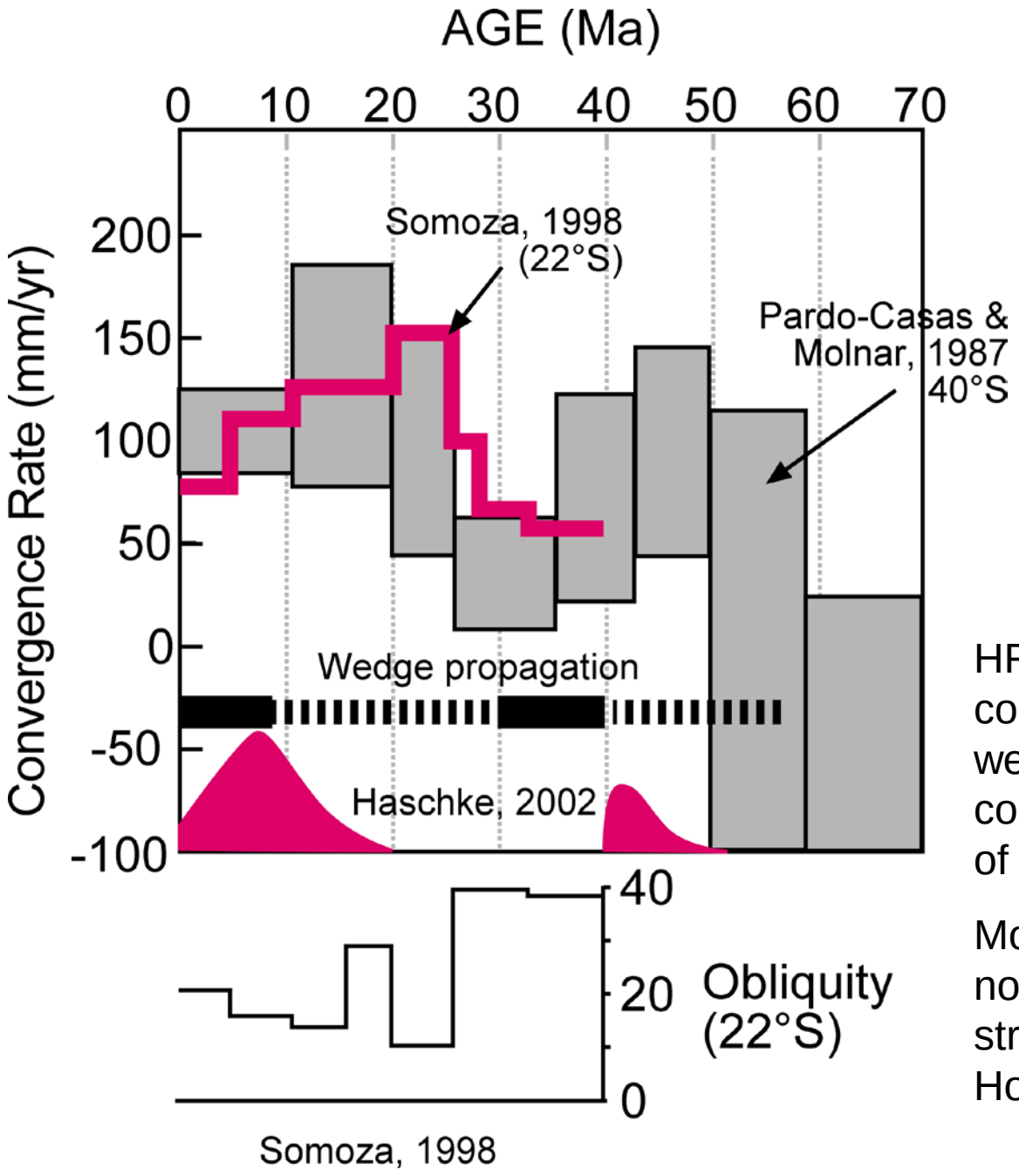
Cyclical:

Shortening feeds the arc feeds the eclogite feeds the mantle allows shortening to feed the arc to feed the eclogite….





Could it just be plate rates?

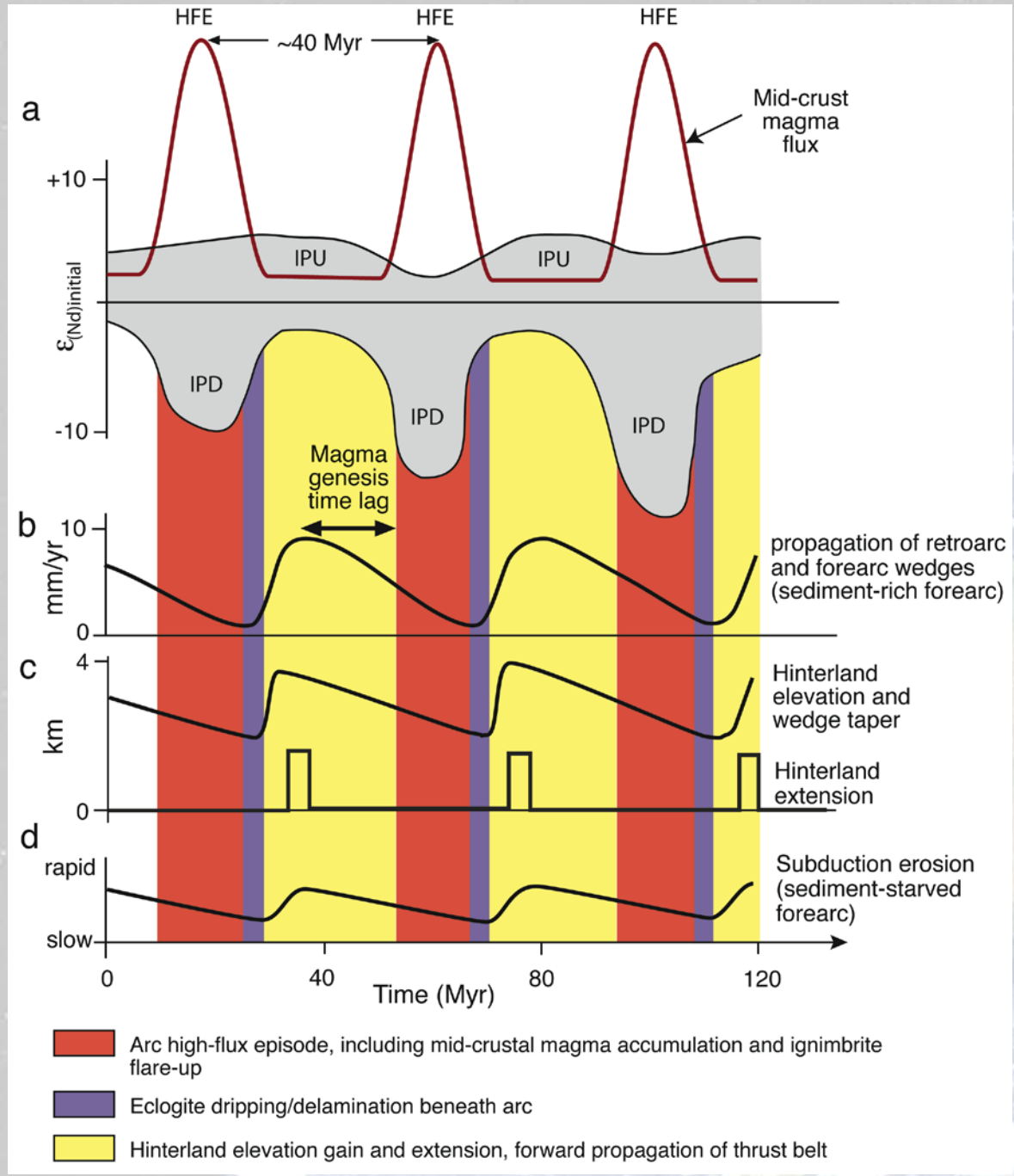


NO.

HFE's post-date peak convergence rates, and wedge prop events are coincident with lowest rates of convergence.

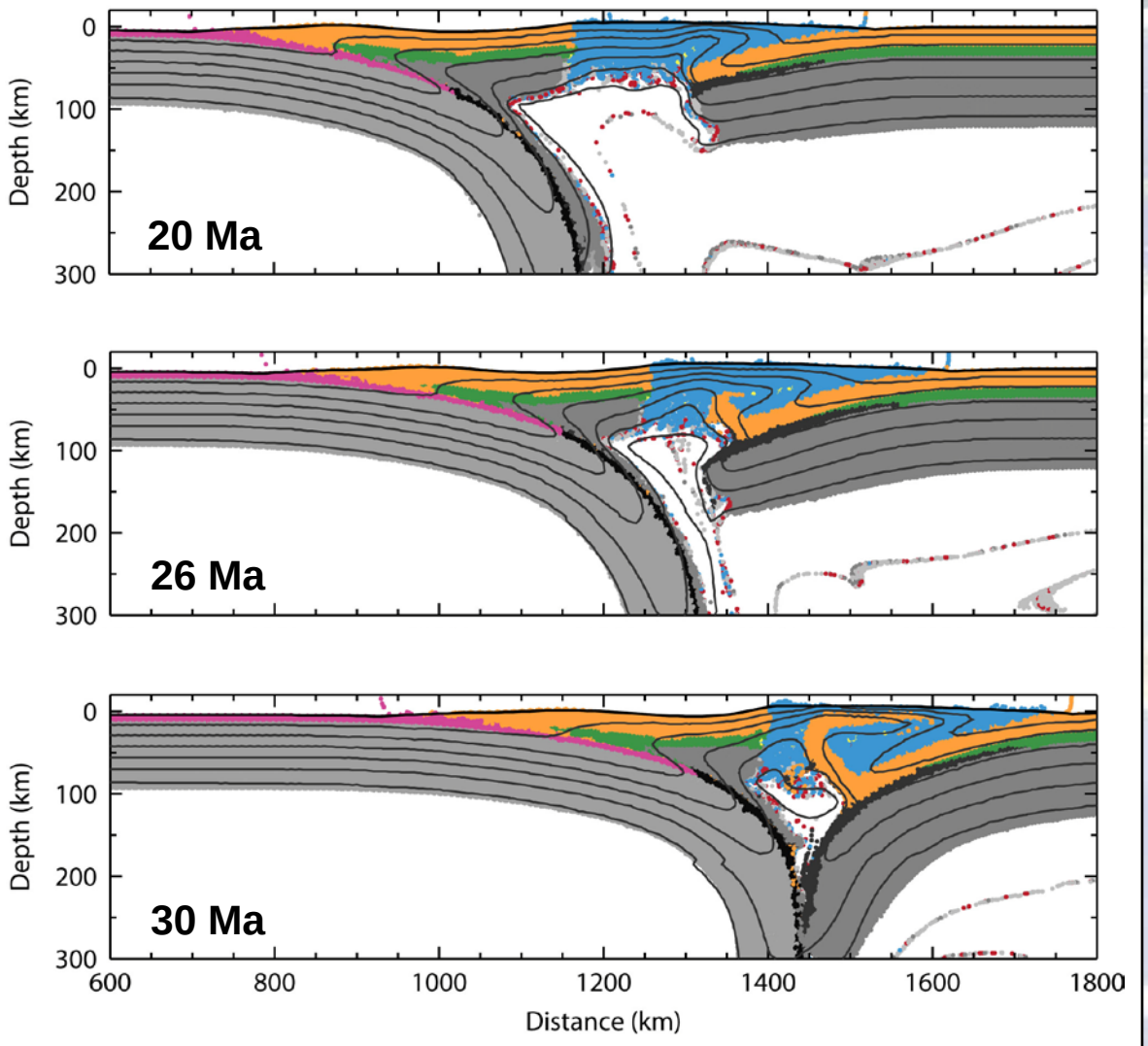
Moreover, the Andes are not the same all along strike. (Cf also '09 CSI Houston, Umlauf & Kleist)

Some Predictions

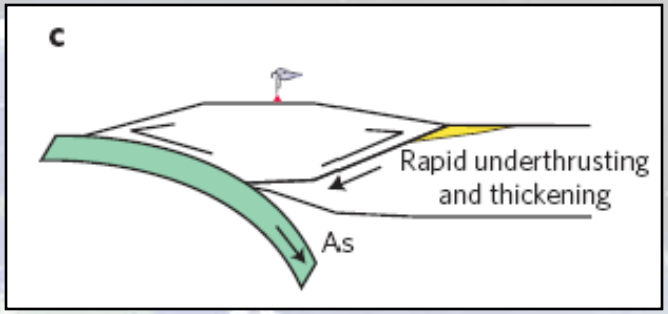


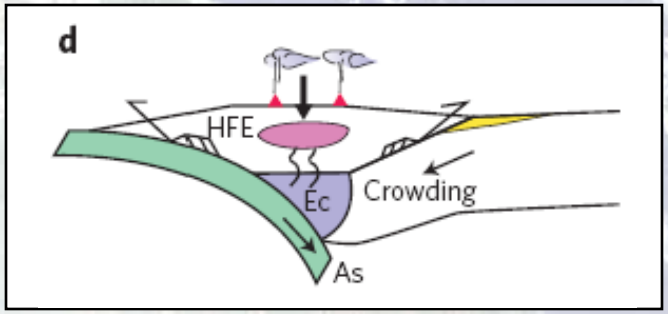
Geodynamic Models

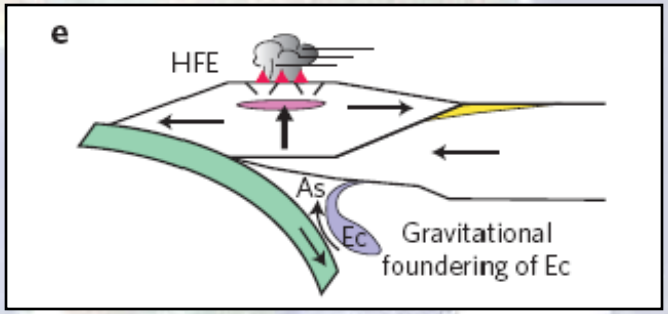
Claire Currie



(200°C contours)



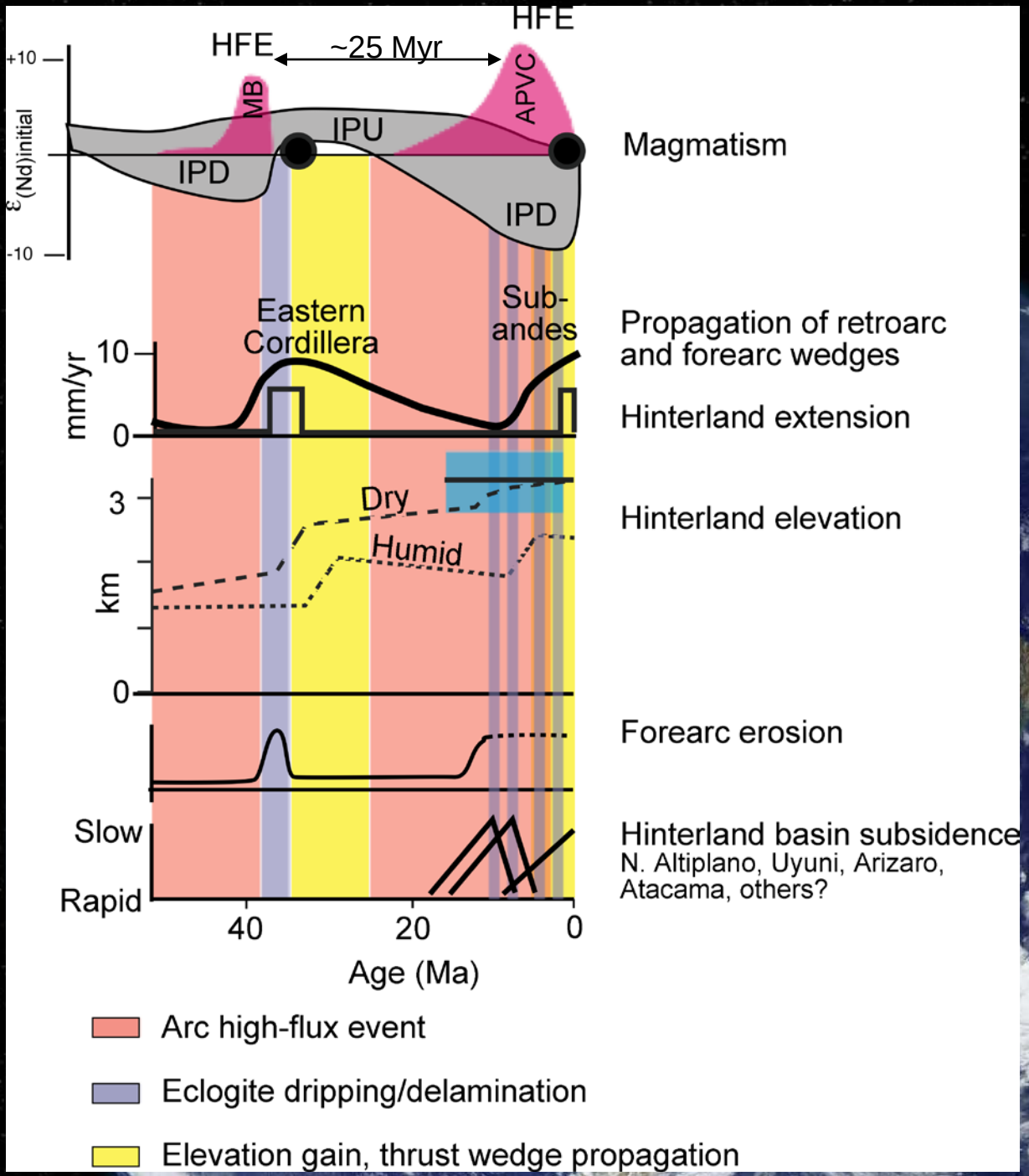




(DeCelles et al., 2009)

What have we learned in the Andes?

1. Seismology indicates that the upper mantle is dynamic and complex in 3-D -->removal of lithosphere ± lower crust. *Not a wholesale removal process*!
2. Magmatism exhibits the *expected cyclical patterns*. However, thus far, mafic magmatism shows *no evidence* of complete removal of lithosphere.
3. Forearc and retroarc orogenic wedges are *in phase,* and presently supercritical.
4. Basins include the regional scale *flexural wave* signal and *local hinterland response* to growth and removal of dense roots. Timing is right on schedule. 100 km scale may be diagnostic of drip scale.
5. Modern foreland basin 'maps' onto the Paleocene-late Miocene foreland system.
6. Modeling: climate/erosion are important for eclogite; system is *strongly coupled*. It's *easy to make an instability*, but need to get it right in time and space.
7. Climate modeling suggests *2 km minimum elev* to drive Andean aridity; stratigraphic record points to *15-20 Ma for onset of aridity* in Puna and forearc.


HFE
~25 Myr
HFE
+10
-10
εNd(initial)
MB
IPU
APVC
IPD
IPD
Magmatism
Eastern Cordillera
Sub-andes
Propagation of retroarc and forearc wedges
mm/yr
10
0
Hinterland extension
3
km
0
Dry
Humid
Hinterland elevation
Forearc erosion
Slow
Rapid
Hinterland basin subsidence
N. Altiplano, Uyuni, Arizaro, Atacama, others?
40
20
0
Age (Ma)
Arc high-flux event
Eclogite dripping/delamination
Elevation gain, thrust wedge propagation

Research Experiences for Undergraduates (REU) Program

$400k for 3 yrs of programs – NSF Division of Earth Sciences

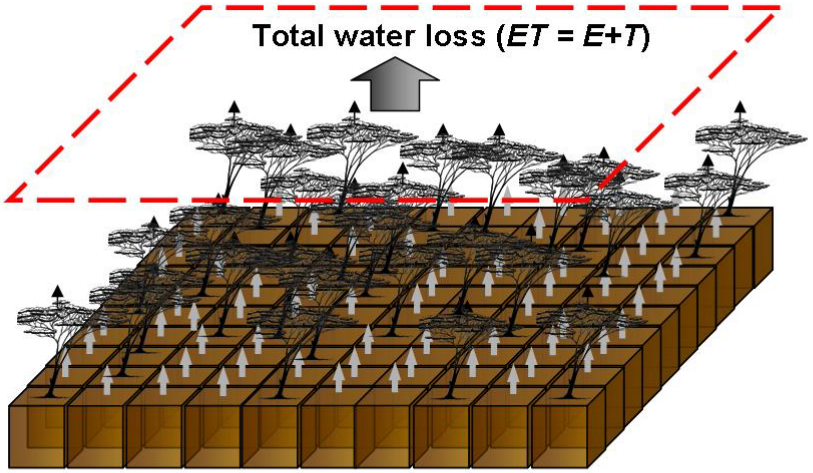
10-student cohort each summer from across the USA

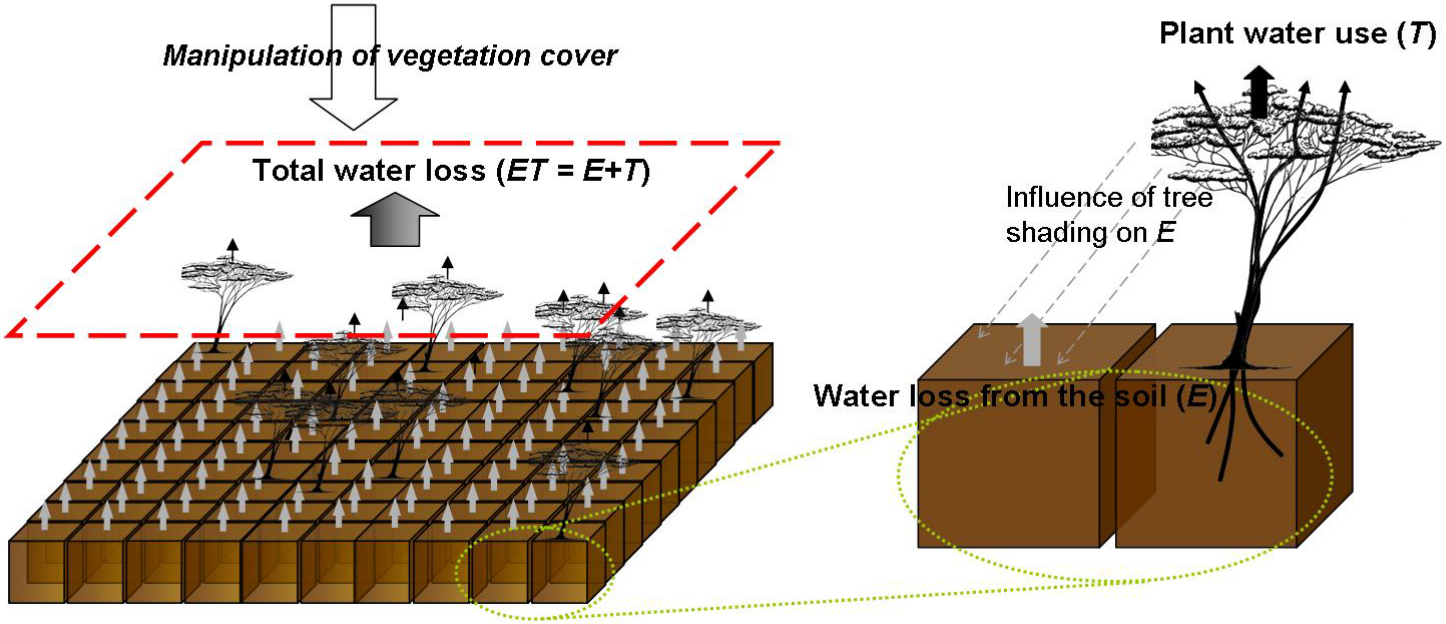
10-week residential program

Projects span lab and field

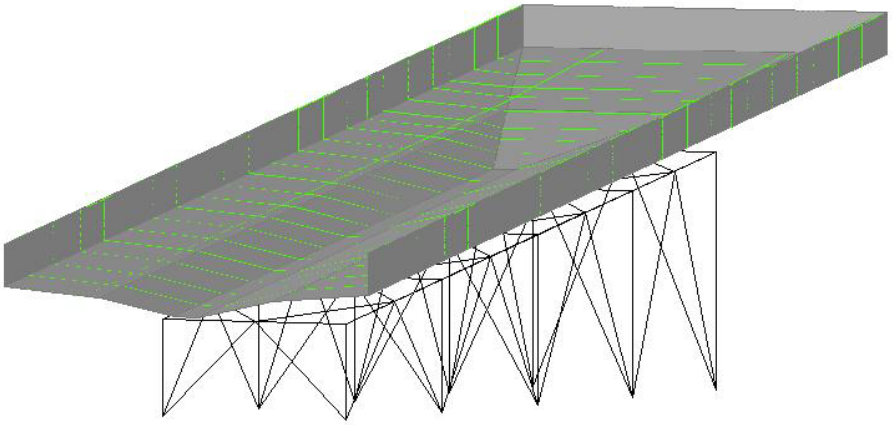
Science theme: understanding how physical, chemical, and biological processes interact across spatial and temporal scales

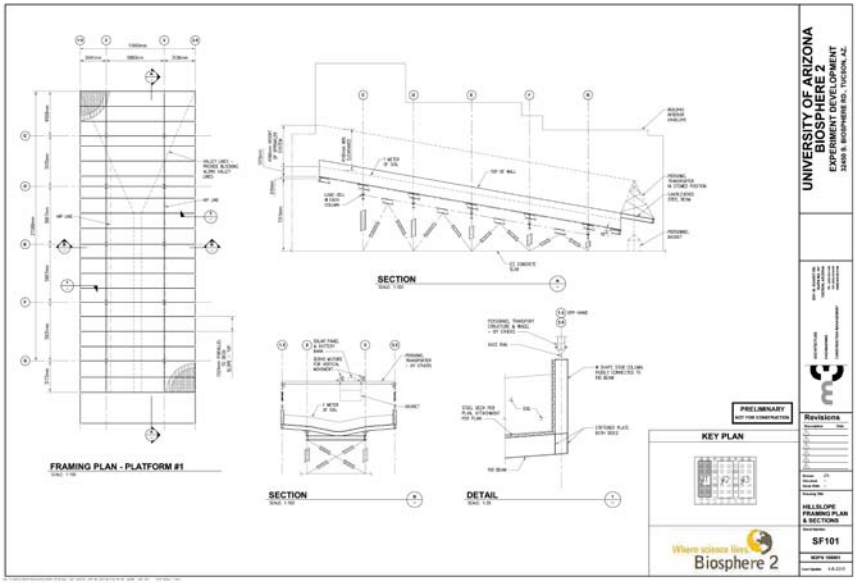
- How do plants modify their environment?
- (and what does that mean for the water cycle?)





B2 **L**andscape **E**volution **O**bservatory





M3 Engineering design:

- Still 10º average slope, with increased slopes towards axis
- Form now set of 7 planes instead of smooth contours
- Max slope ~17º

The way forward: Phase 2 major objectives
(besides trying to apply the model to North American Cordillera)

•Increased basinal focus- expansion of study to include orogen-wide transect (feasible because of abundance of data in foreland and hinterland)
- North America provides more common ground.

•Enhanced exportability- establish ‘global truths’
- expansion of Andes study area along-strike to include flat-slab and other regions
- compare and contrast with Laramide Rockies

•Expanded opportunities for direct collaboration