When it Rains it Pours:

Atmospheric Rivers,
rivers in the sky
2016-2017 Water Year-Drought to Flood

Science of Teaching Atmospheric Rivers

Intervention: Real-time videos & simulations to optimize outcomes achievement

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Science of Teaching Atmospheric Rivers

Incorporating real-time video or simulation events: Keep the videos short and frequent (Weller, 1996; Smetana et al, 2012; Lang, 2016) effectively involve students in authentic scientific practices

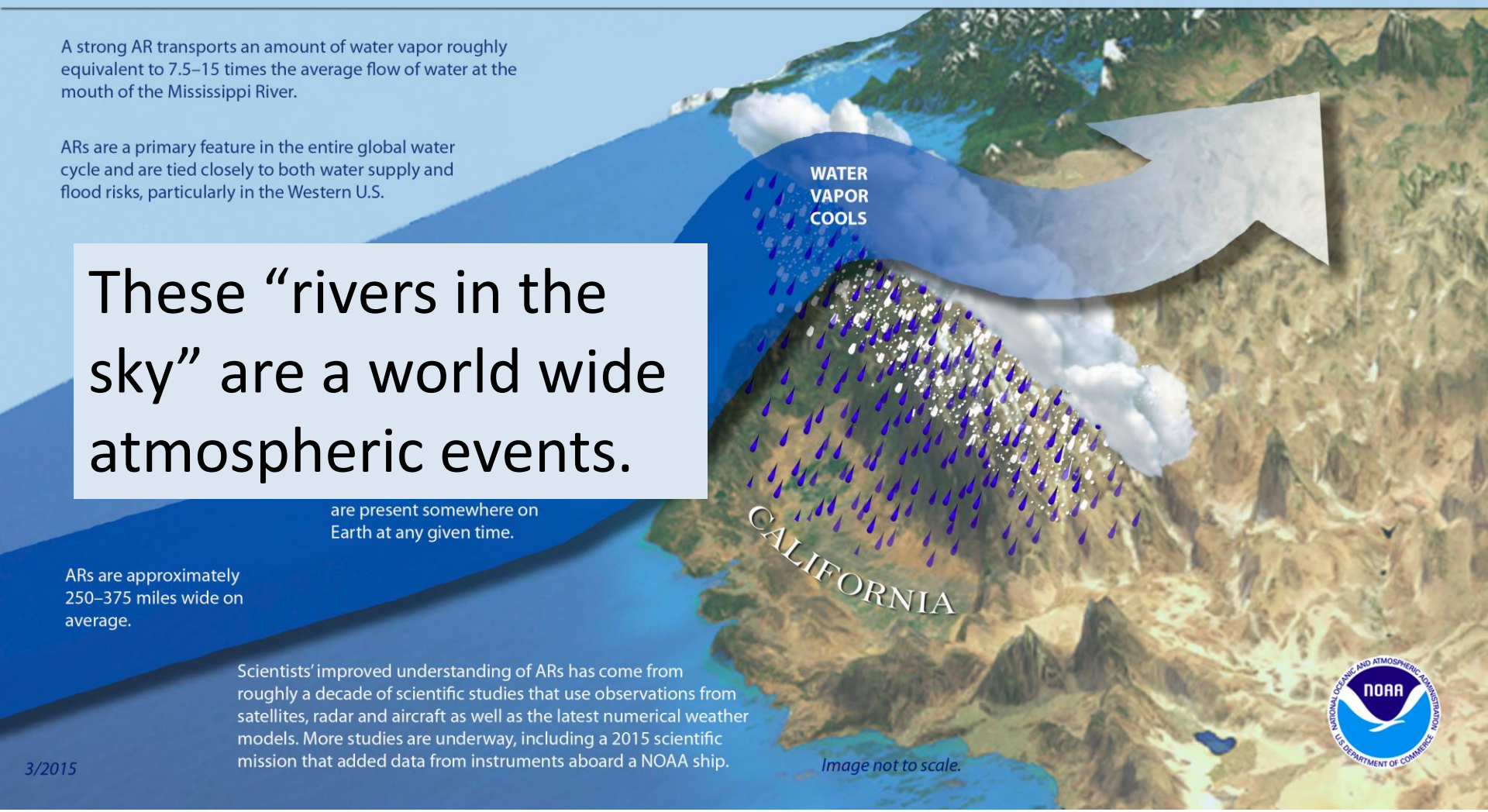
The understanding the basis of these events incorporates connections between several chapters of understanding. (Perry, 1983; Lang, 2016)

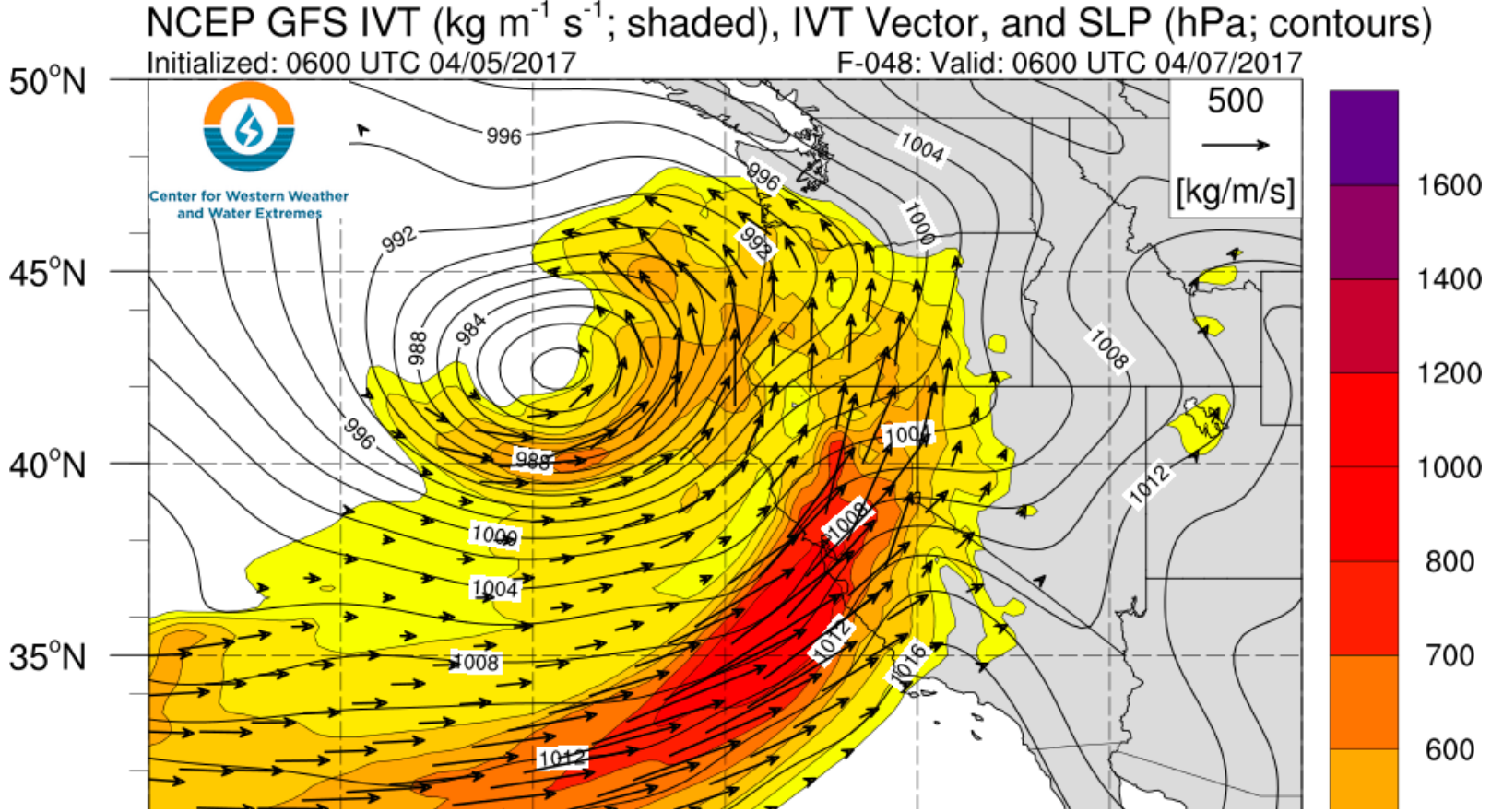
Instruction of the tasks of understanding concepts requires practice activities. (Tomlinson, 2014; Lang, 2016)

My *raison d'etre* is that I wish that the student understand the events as they unfold to them. So that they might embrace them for future decision making

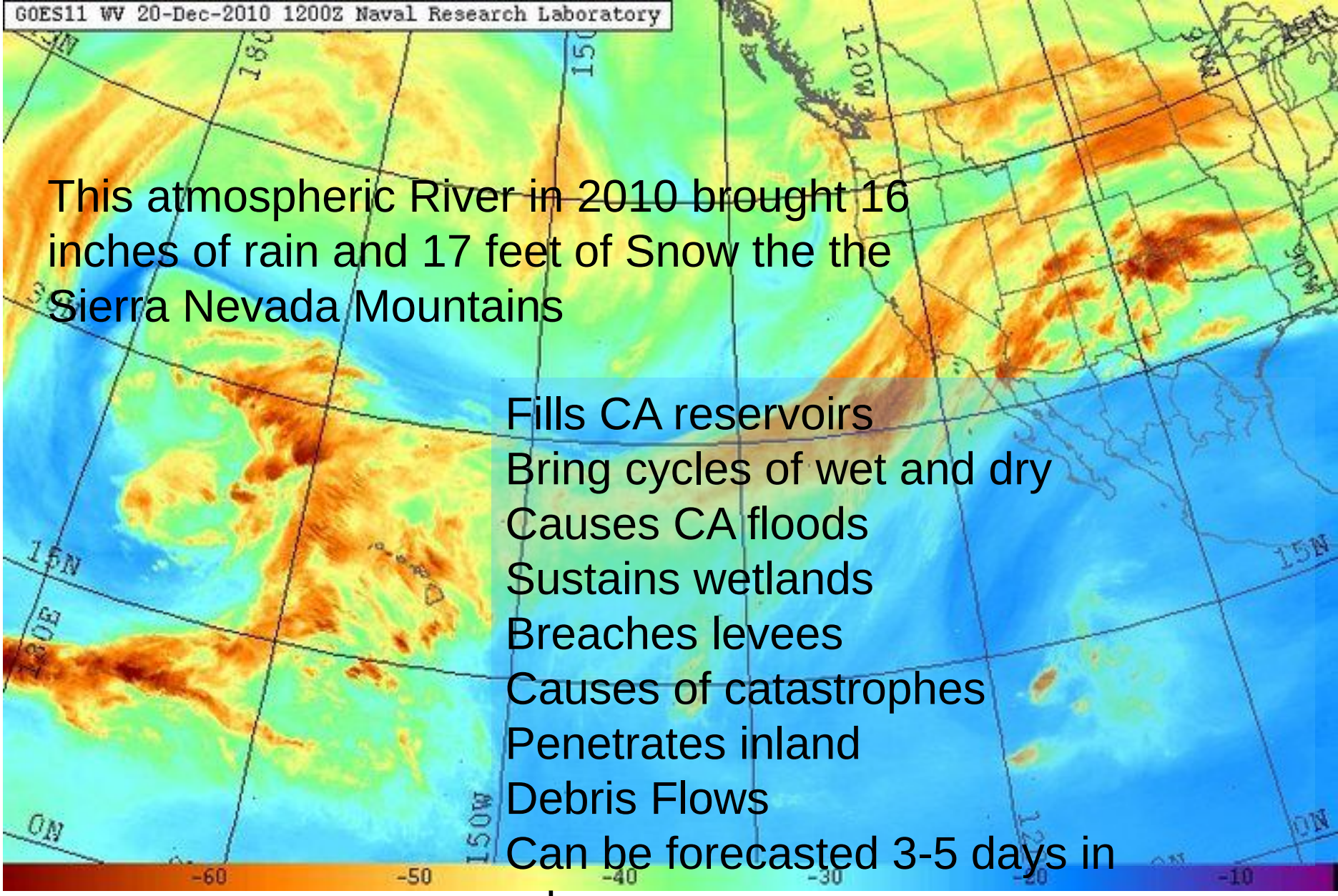
The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.





Hypothesis: Introduction of real-time short videos and in-class exercises that focus on practice activities increases scores on exams and communication between students.



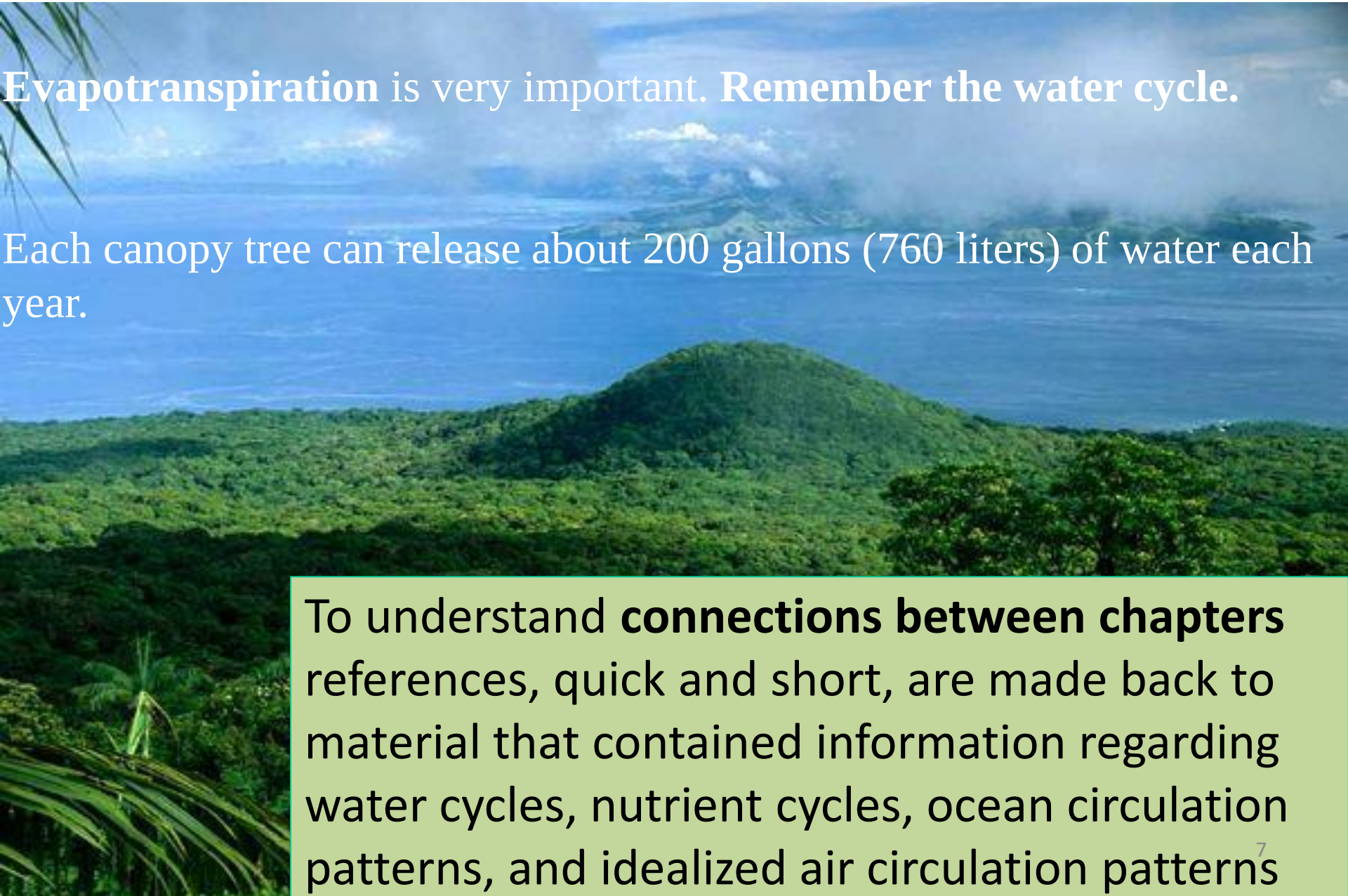
Why are Atmospheric Rivers important to California? How do they effect you? What lifestyle changes should you make for us all to achieve sustainably in our society?

Intervention

Real-Time Videos and Practice Activities

- Delivery of short real-time videos during the course of the semester to optimize the outcome achievement
- In-class exercises to compliment topic, in this case the water cycle, ocean currents, air circulation patterns on Earth and the Coriolis Effect
- Group-to-group discussions regarding Atmospheric Rivers implications and importance to California water supply and to the student. Are there any solutions?

Tropical Rainforests at the equator



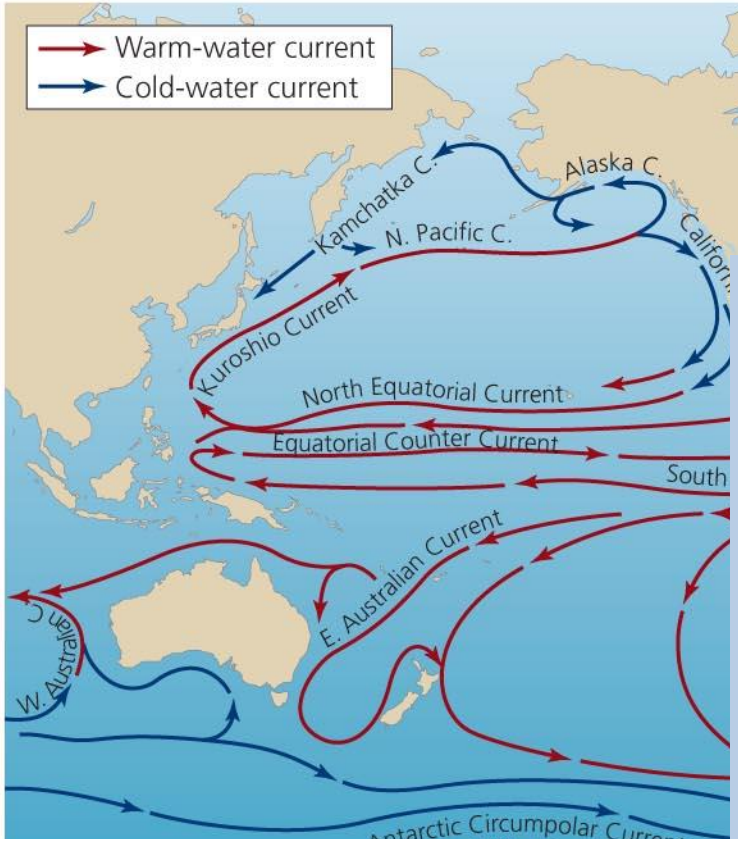
Evapotranspiration is very important. **Remember the water cycle.**

Each canopy tree can release about 200 gallons (760 liters) of water each year.

To understand **connections between chapters** references, quick and short, are made back to material that contained information regarding water cycles, nutrient cycles, ocean circulation patterns, and idealized air circulation patterns

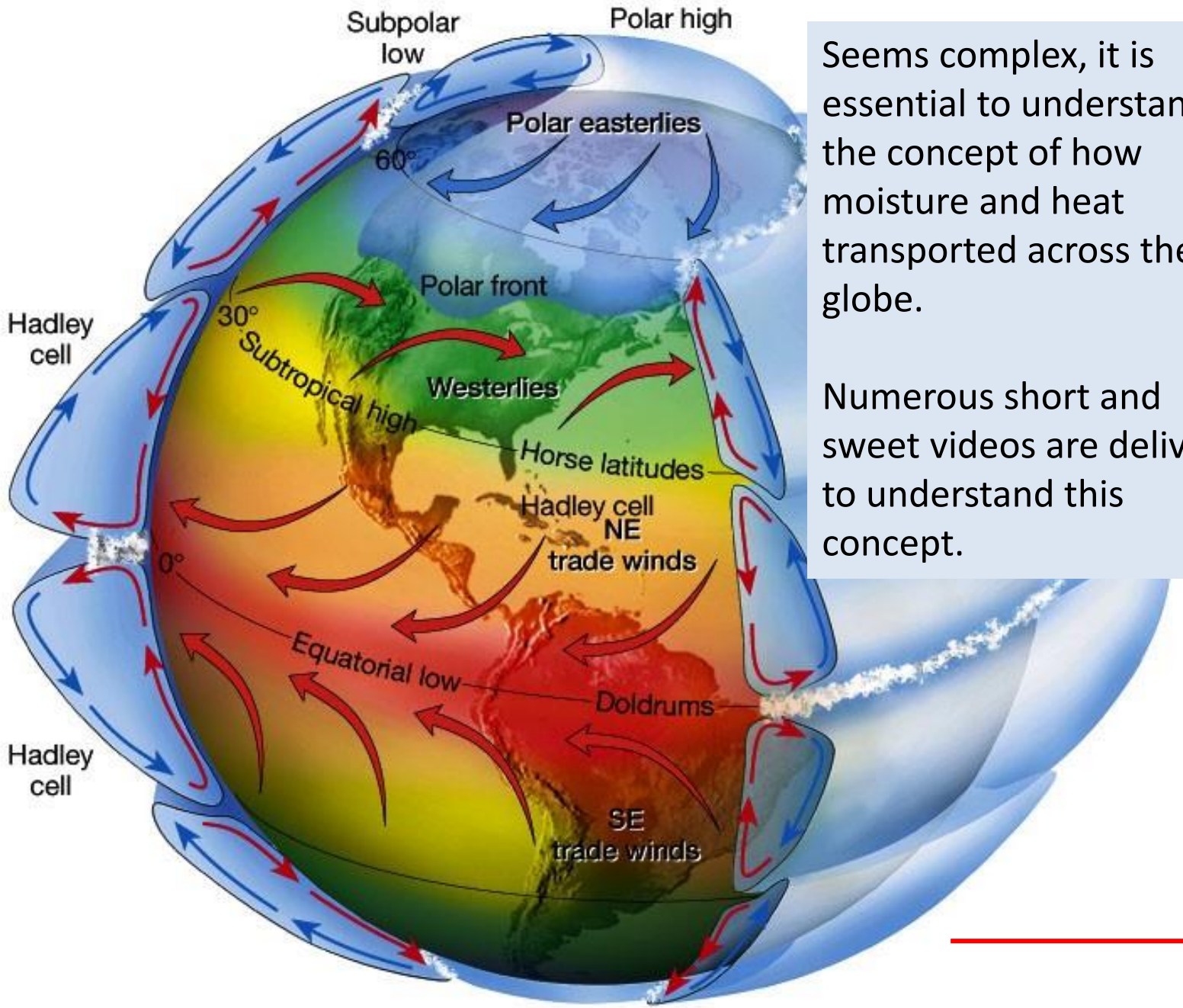

Water Cycle
Atmosphere
Evaporation
Precipitation
Oceans
Infiltration
Water Table
Water

Ocean currents form patterns across the globe



An in-class exercise on ocean circulation compliments the understanding Atmospheric Rivers source and circulation of convectional energy on Earth. **(Connections, repeating information and practice Lang, 2016)**

- Driven by density differences, heating and cooling, gravity, and wind
- Influence global climate and El Niño and La Niña

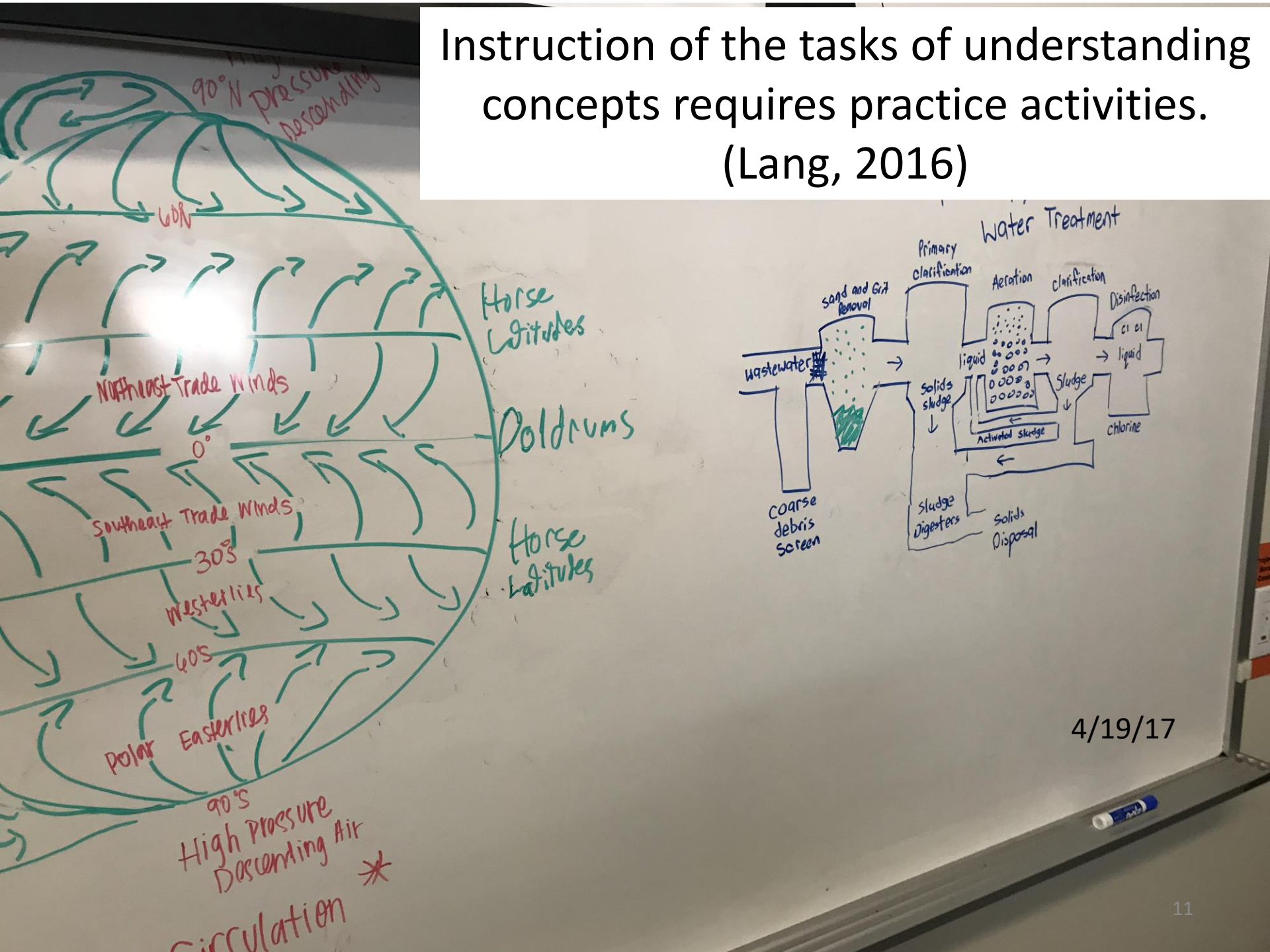


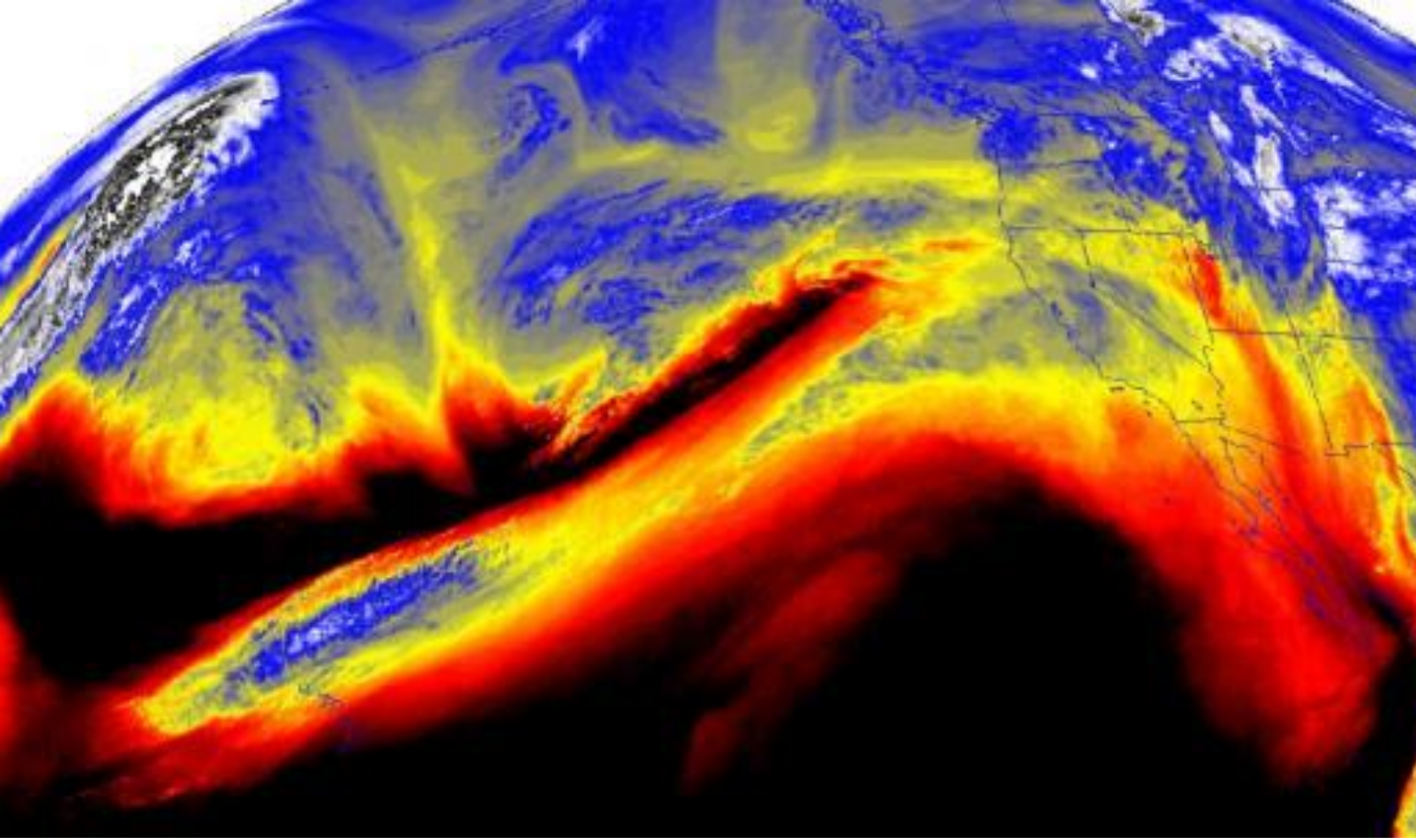
Seems complex, it is essential to understanding the concept of how moisture and heat transported across the globe.

Numerous short and sweet videos are delivered to understand this concept.

The Earth rotates west to the east (counter clockwise).

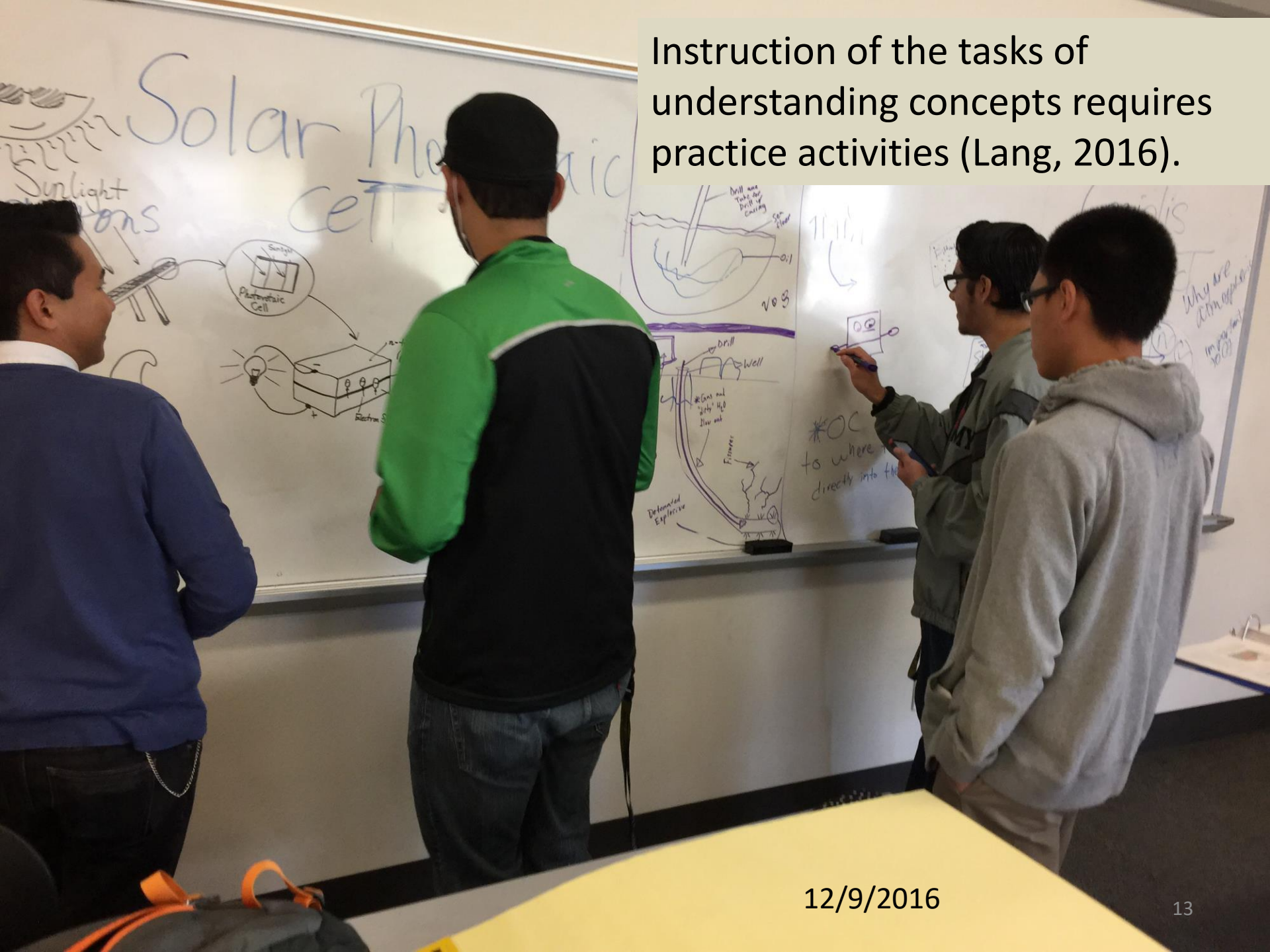
Instruction of the tasks of understanding concepts requires practice activities. (Lang, 2016)





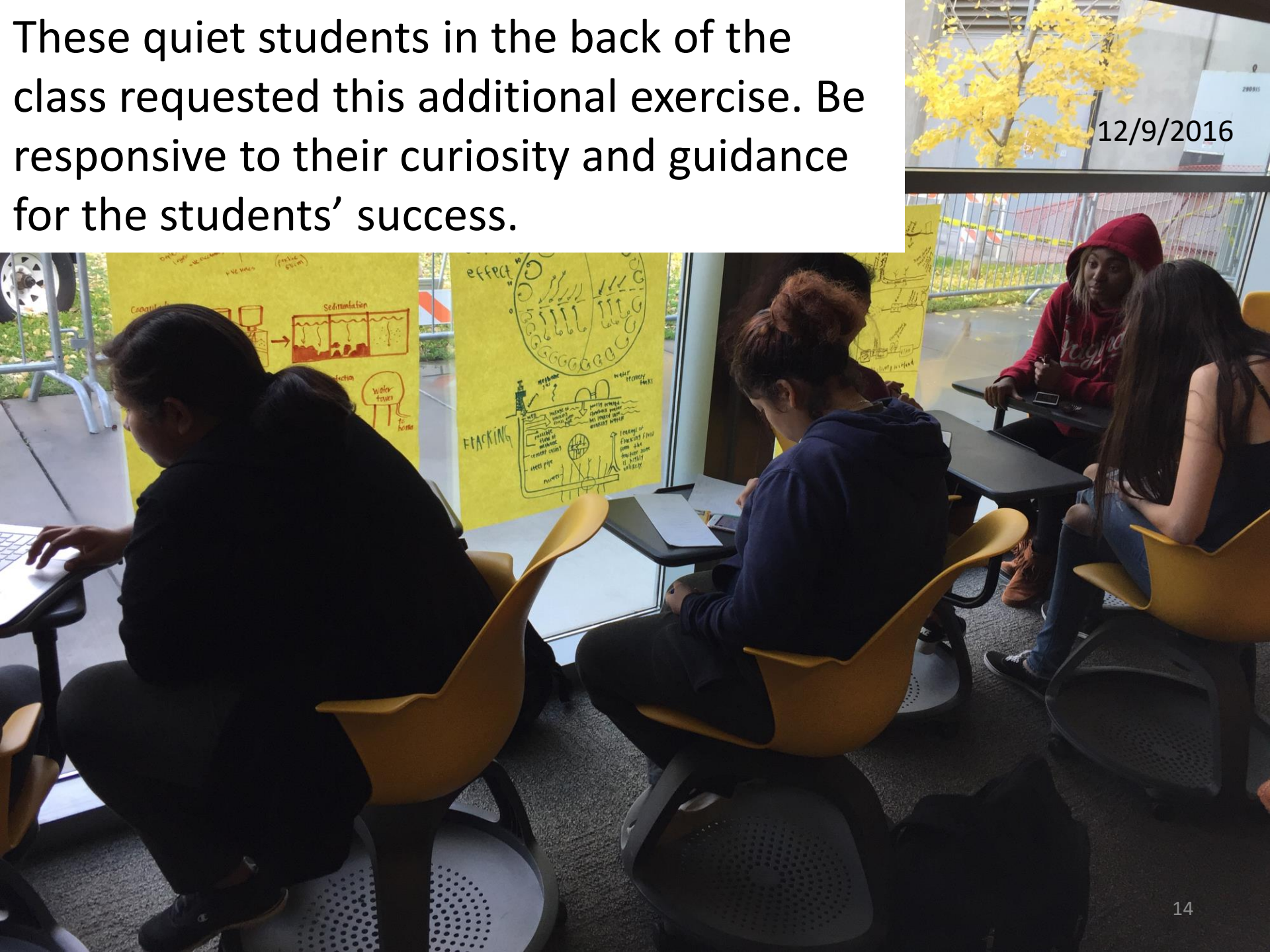
Moisture plume of late Jan early Feb 2017. Water is carried in winds aloft for thousands of miles, this is a global event. (Daniel Swain, 2017)

CIMMS morphed composite 2/17 NOAA



Instruction of the tasks of understanding concepts requires practice activities (Lang, 2016).

These quiet students in the back of the class requested this additional exercise. Be responsive to their curiosity and guidance for the students' success.



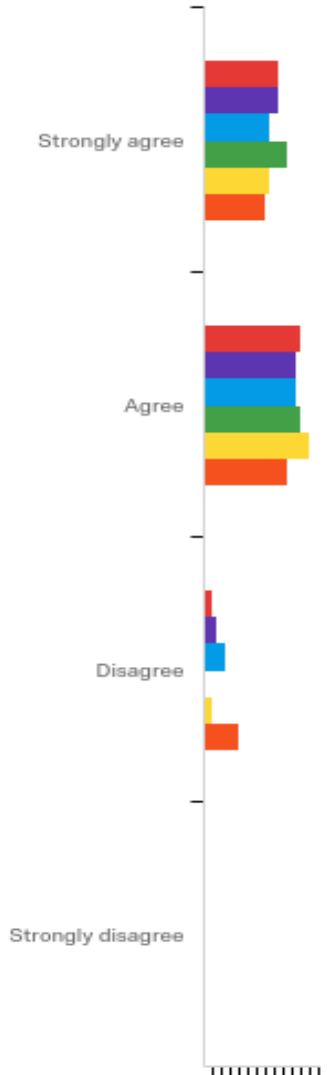
Methods

- Qualitative Data:
  - Online Survey (SATAL)
    outcomes & activities

- Quantitative Data:
  - Exam Scores on specific question for two AYs. (re-grading a specific final exam question)

Results

How well do you agree with the following statements regarding the ENVE 10 course outcomes? "My skills to ... have become much stronger"

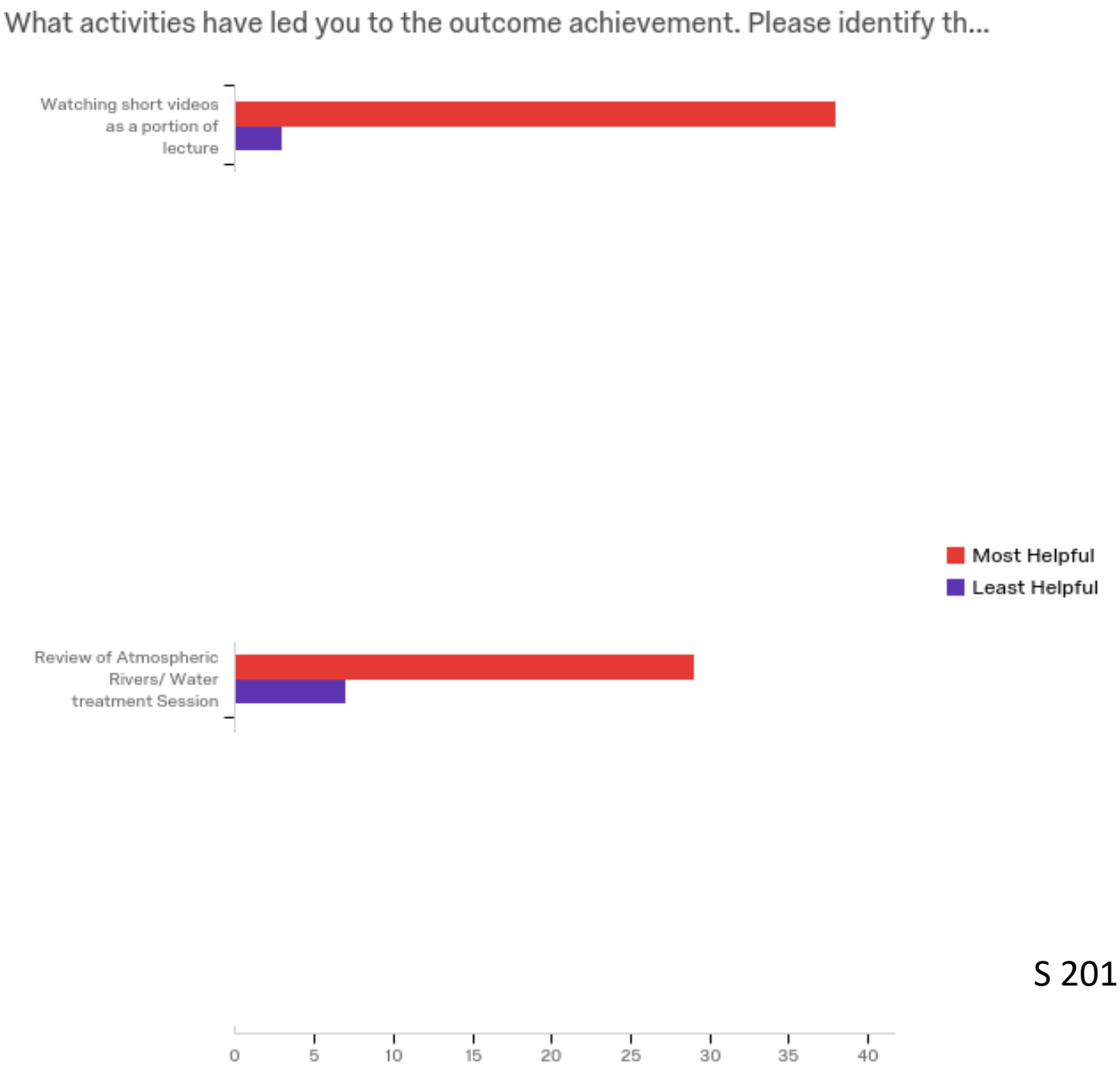


These questions are duplicated from the syllabus.

1. Synthesize current and emerging issues concerning global environmental s...
2. Explain and apply complex, multiple objectives related to environmental ...
3. Learn to speak and write about environmental issues individually and as ...
4. Learn how their lives, in the context of society, have an environmental ...
5. Critically analyze environmental issues, in particular responsibilities ...
6. Perform scientific investigations including environmental data collectio...

Reinforcement of outcomes during the process of delivery of projects is essential.

S 2017


What activities have led you to the outcome achievement. Please identify th...
Watching short videos as a portion of lecture
Review of Atmospheric Rivers/ Water treatment Session
Most Helpful
Least Helpful
0
5
10
15
20
25
30
35
40

S 2017

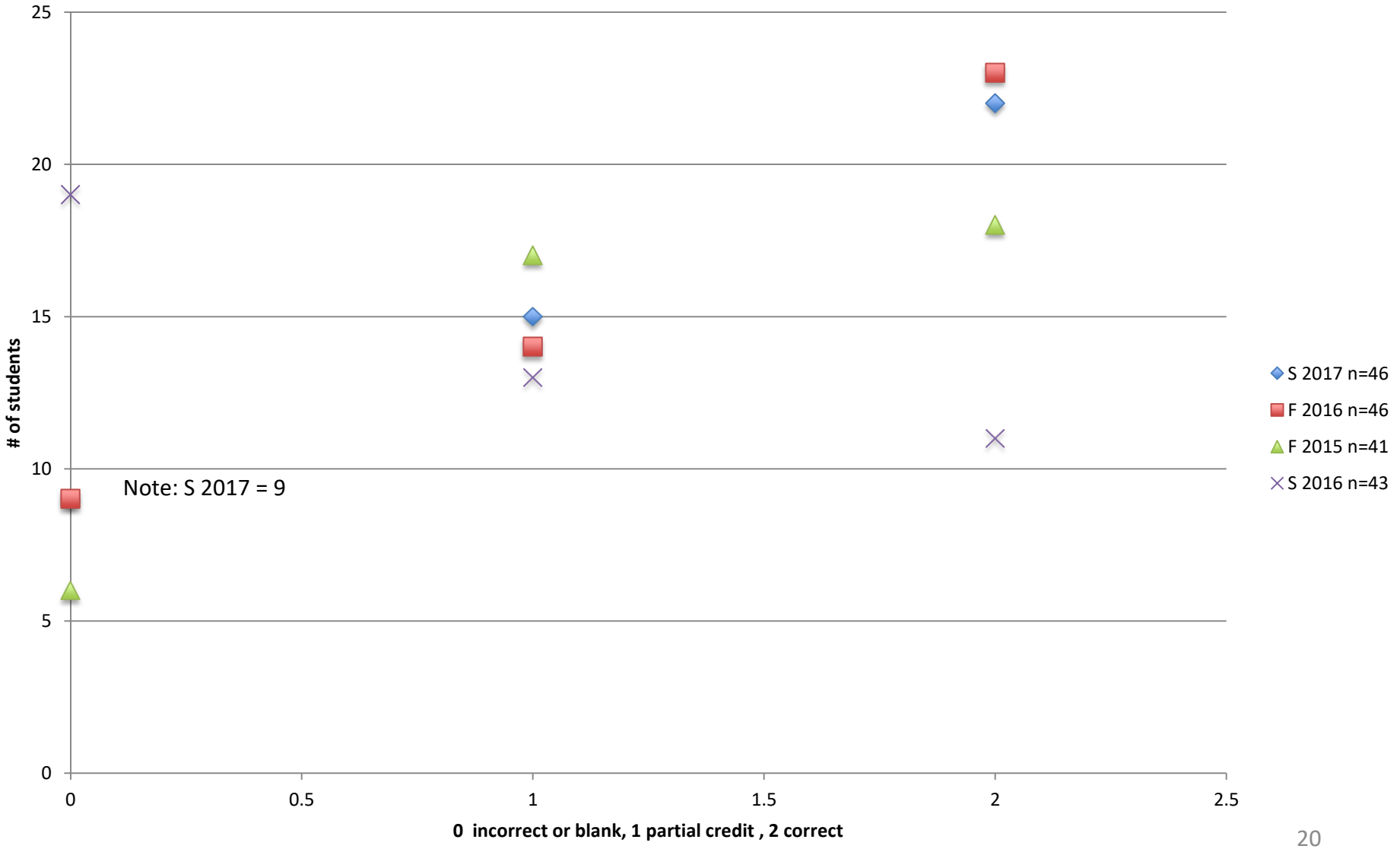
Students' comments on short videos

- I am visual learner, I can see tangible effects of what we are learning impacted my learning experience
- The videos were the most helpful to my learning because I heard about topics in different perspectives
- Videos … offer breaks in the lecture … visuals help me remember the topics. (x3)
- I am a very visual learner and videos and diagrams help me understand the content better. (x2)
- Really interesting and fun to watch.
- The videos multiple explanations, so if not understood in the lecture, it could be reviewed in a video

Students' comments on in-class diagrams

- diagrams help me understand
- helped me understand instead of just reading from the book
- I learn best when I get to learn by interacting with the lesson.
- They helped me learn the content best by visualizing diagrams
- I am able to work with other classmates and receive their input on the topic.
- Hands on activities usually help me a lot with learning. (x2)

Examination of students scores regarding understanding of Atmospheric Rivers
S 2017, F2016 with and F 2015, S2016 without in-class exercises
wrong - partial credit - correct



Discussion

- 1st statistical analysis p=0.064 ambiguous. note: p value smaller than 0.05 is significant

- 2nd evaluation evaluated incorrect vs correct and accounted for a continuity correction p=0.029 which indicated that the in-class activity was beneficial to student's success

- 3rd analysis was a proportional test 49% p=0.075 14% incorrect vs 35% correct which offered a practicality significance perhaps as a consequence of the sample size

Moreover,

Based on the students' responses on the questionnaire, students found the activities engaging.

The diagram activities seemed to relieve anxiety of understanding materials that might be on the exam.

Students had a chance to discuss materials with their peers. The instructor had additional one-to-one time to review and check students' work for errors.

The students displayed more sophisticated reasoning

Conclusions

- Although the statistical difference in scores appeared ambiguous, students' success was evidenced by their grades and engagement with activities.
- Students developed understanding of the subject and weather models during the course of the semester. It was evident by their insight questions during activities and their applications to exam questions.
- Students would request real times videos since they helped their understanding of complex subjects.

Observations

- Students asked more questions during delivery of the in-class exercise than in the past during the lecture covering the same material.
- Students stepped outside the class and applied information to other courses. Students that stayed after class and further explored subject matter later thanked me. Reporting scores of 97% on their class essay in Core with bright smiles.
- Students have long lasting memories of their experiences when material is delivered in this manner. Students from previous years have returned to refresh their memory for their master's thesis.

Changes to the implementation of the intervention

- Develop homework assignment prior to the in-class exercise
- Should an advanced review be developed to connect the variables of Atmospheric Rivers and indicate specific chapters covered that influence Atmospheric Rivers
- A question remains should I present the material again as I would for the public for this specific question? Or allow the student to synthesize the material on their own.
- In parting-How many Atmospheric Rivers does it take to break the drought of the last 5 years?

Distribution of Landfalling Atmospheric Rivers on the U.S. West Coast
(From 1 Oct 2016 to 31 March 2017)

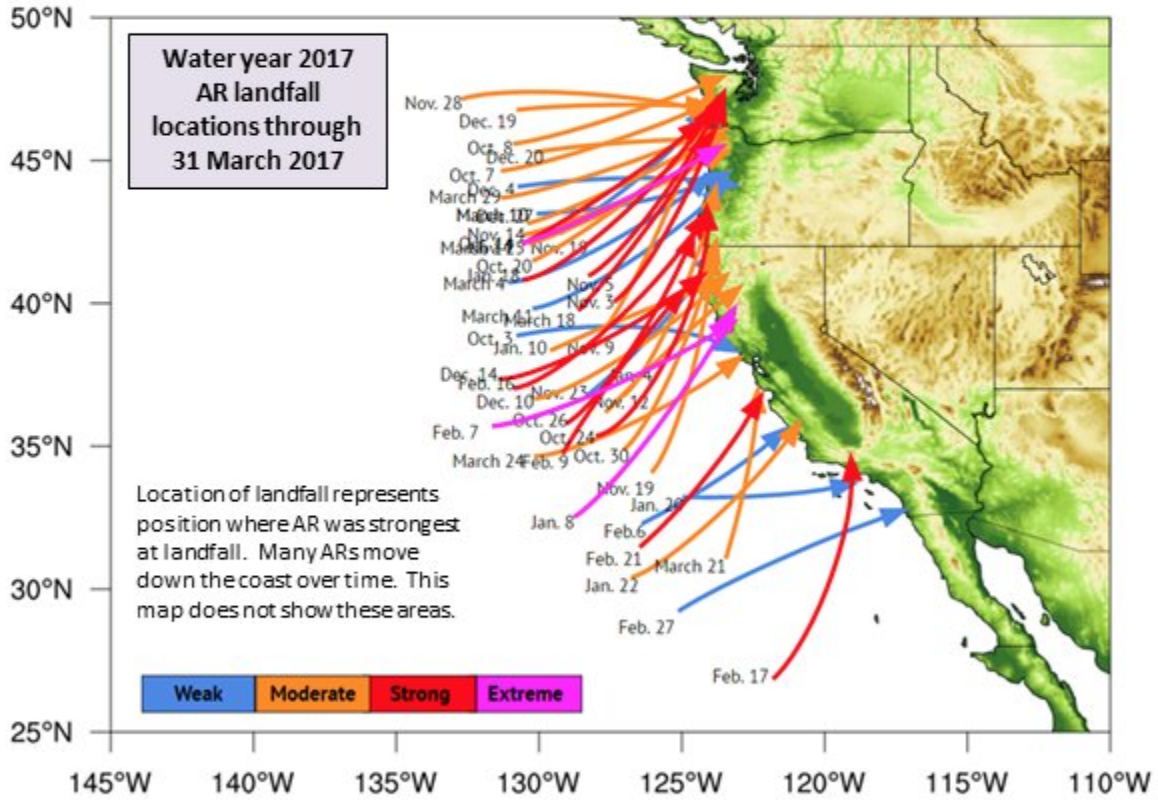
AR Strength	AR Count*
Weak	11
Moderate	20
Strong	12
Extreme	3

Ralph/CW3E AR Strength Scale

- Weak: IVT=250–500 kg m^{-1} s^{-1}
- Moderate: IVT=500–750 kg m^{-1} s^{-1}
- Strong: IVT=750–1000 kg m^{-1} s^{-1}
- Extreme: IVT>1000 kg m^{-1} s^{-1}

*Radiosondes at Bodega Bay, CA indicated the 10–11 Jan AR was strong (noted as moderate based on GFS analysis data) and 7–8 Feb AR was extreme (noted as strong)

- 45 Atmospheric Rivers have made landfall on the West Coast thus far during the 2017 water year (1 Oct. – 31 March 2017)
- This is much greater than normal
- 1/3 of the landfalling ARs have been "strong" or "extreme"



Center for Western Weather and Water Extremes
SCRIPPS INSTITUTION OF OCEANOGRAPHY AT UC SAN DIEGO

By F.M. Ralph, B. Kawzenuk, C. Hecht, J. Kalansky

Experimental

Don’t forget the groundwater aquifers? What is their recharge rate?

Are our human activities sustainable for future generations?

Questions?

References

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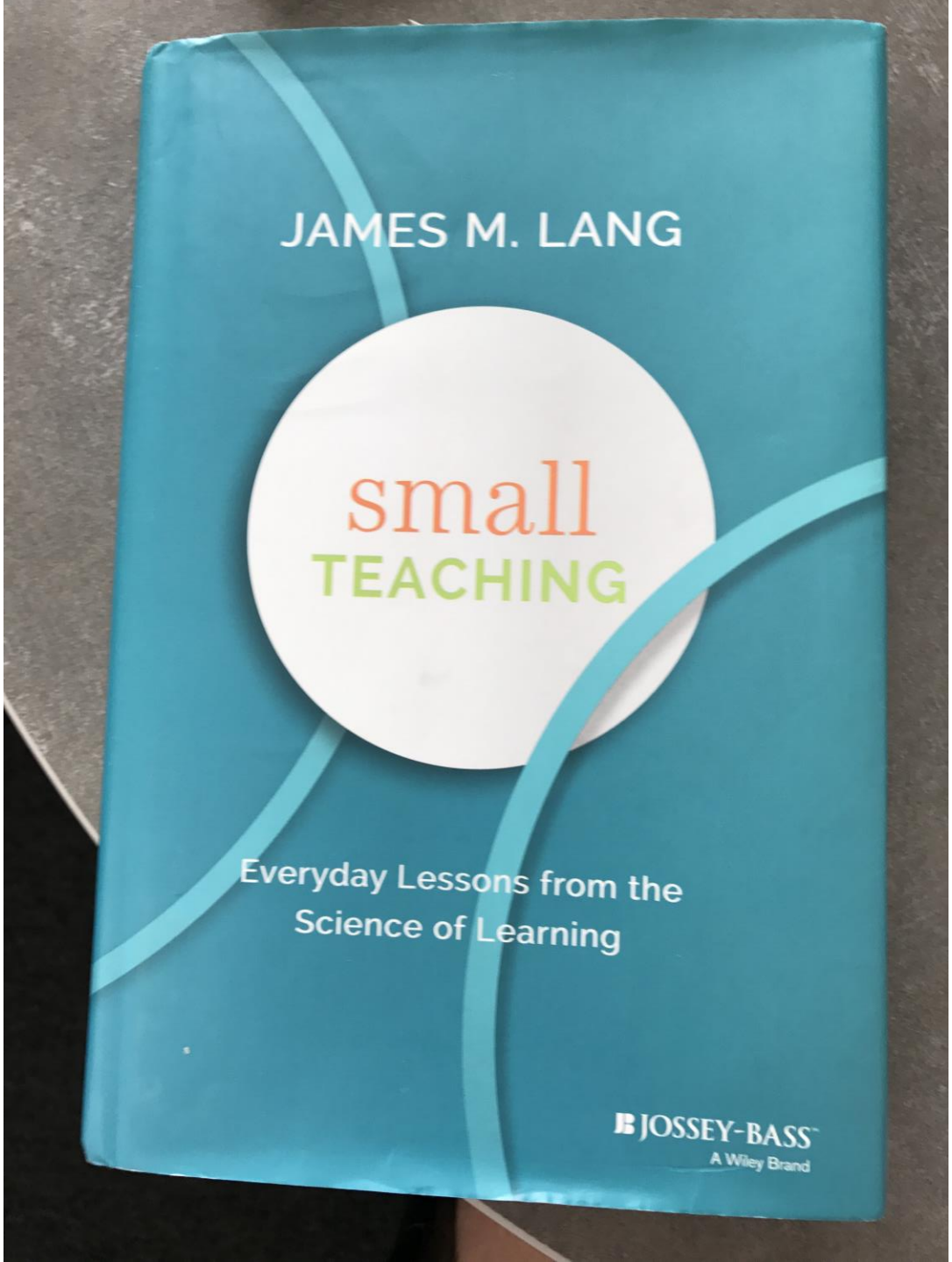
What's next on the agenda?

1) Get trained to deliver a project that Students are human subjects
2) Start out the year with all releases signed by the students
3) Develop additional in-class activities
4) Add additional data – ratio testing between semesters could be done
5) Find more references
6) Present a poster to the American Geophysical Union Dec 2018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