Introduction to Geophysics

Prof. Reinhard Drews

Rebecca Schlegel

- Sign up in Alma and Ilias!

Grading Scheme

20%	Grade of field report.
80%	Written exam at the end of the term.

The report is graded and passing is pre-requiste for the exam. If your grade of the exam is better than the one from the report, *only* the exam will count. Grades will follow the standard scale, scaling is at my discretion.

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Class Schedule

Geophysics Tübingen

Smart science by friendly people.

Part 1: Seismics & Seismology

Ressources: Clauser (2018) Chapter 2; Telford, Chapter 4

Lecture 1	16.04 (Schlegel)	• Introduction lecture format & scope of applied geophysics • Introduction wave-based methods (GPR, Seismics)
Lecture 2	18.04 (Schlegel, flipped)	• Wave equation and wave types (body (p,s) & surface) • Rays, refraction & reflections (fermat & huygens & snell's law)
Lecture 3	23.04 (Drews)	• Principal of seismic data aquis. & interpret of shot gathers • Horizontal one layer case (refraction)
Lecture 4	25.04 (Drews)	• Multiple and dipped layers (refraction) • Application examples
Lecture 5	30.04 (Drews)	• Reflection seismics principles • Velocity analysis
Lecture 6	02.05 (Drews)	• Imaging & migration • Application examples
Lecture 7	07.05 (Drews)	• Seismology & Earthquake location • Fault plane solutions & Application examples

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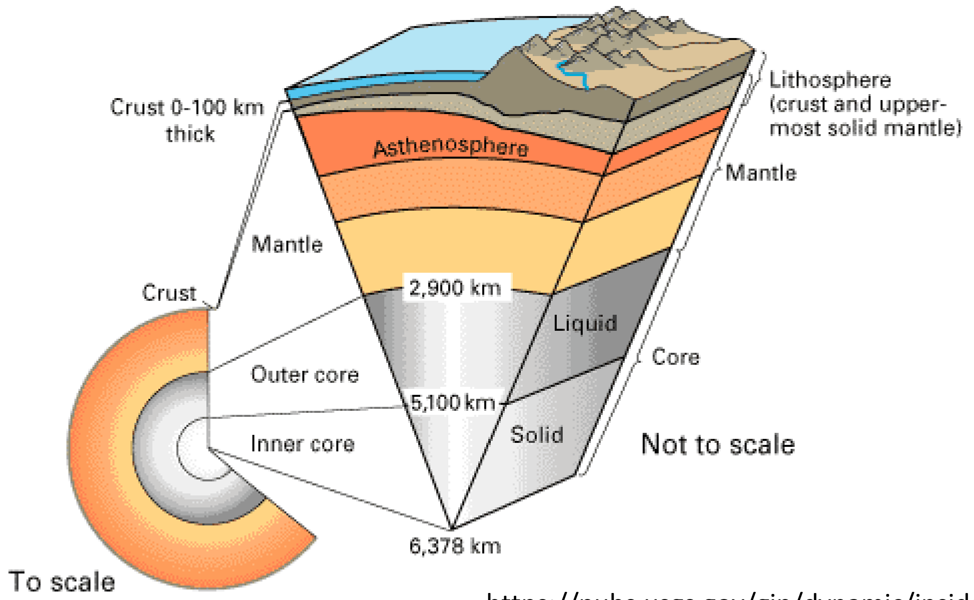
How can we study the inner earth?

How can we study the inner earth?

Deepest Borehole so far ~12km in Russia (not used anymore)

Deepest Borehole still used: ~9km in Bavaria

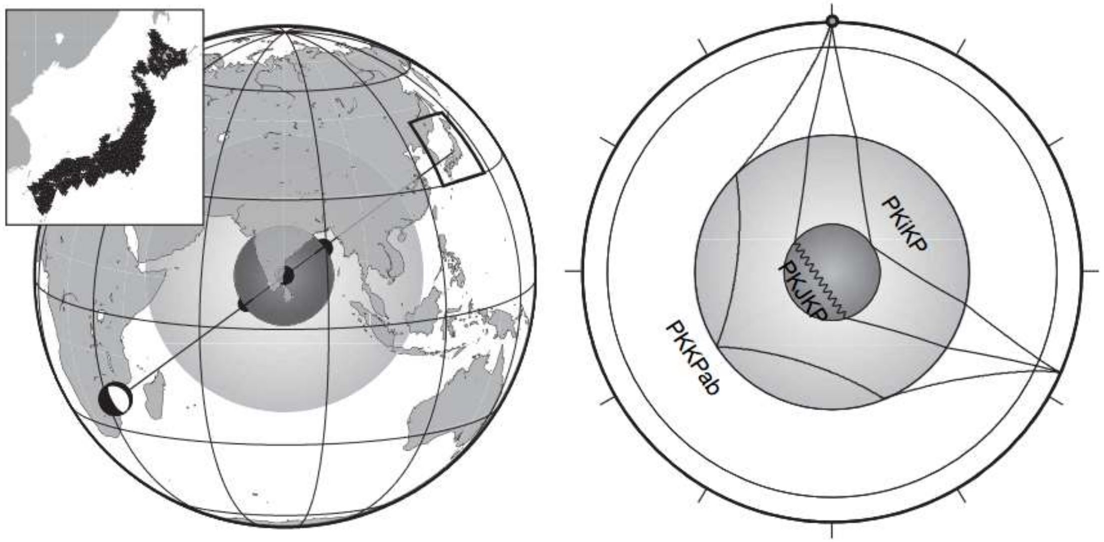
"Geophysics is a science that deals with the physical features of the earth's surface and its internal structure" From: Developments in Petroleum Science, 2013



https://pubs.usgs.gov/gip/dynamic/inside.html

How can we study the inner earth?

- Earthquake in Mosambik in 2006 with 7.5 strength
- Recorded in Japan with over 600 stations
- Clear sign of shear waves travelling through the core



doi:10.1038/nature07131

Many more applications in or outside of academia

- tunnel construction
- geologic structures, e.g. karst
  - ultimate disposal place for radioactive waste
  - natural stone requests (e.g. Marmor for buildings)
  - windfarms
- geothermy
- groundwater
- geoharzards, landslides
- weather and climate phonomen
- observations around vulcanos to predict eruptions

What could your future as a geophysicist look like?

Sarah Siebert,
Technical Data
Analyst, Rosen,
Germany

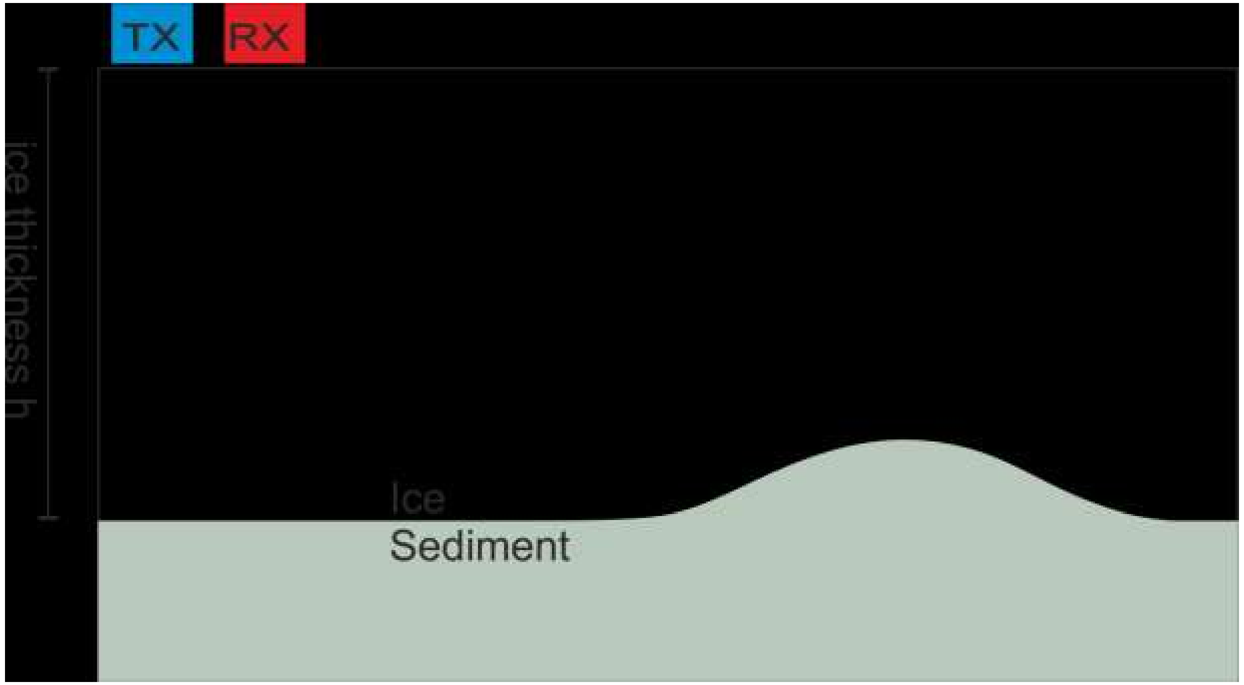
Michael Schwartz,
Head of Geophysics,
Germany

Emma Pearce,
Geophysicist,
Glaciologist, British
Antarctic Survey, UK

Examples of wave-based methods: Radar

Radar data include time it took the wave to travel from transmitter to the ice-sediment interface and back to the receiver so called **two-way traveltime**

Transmitter Receiver



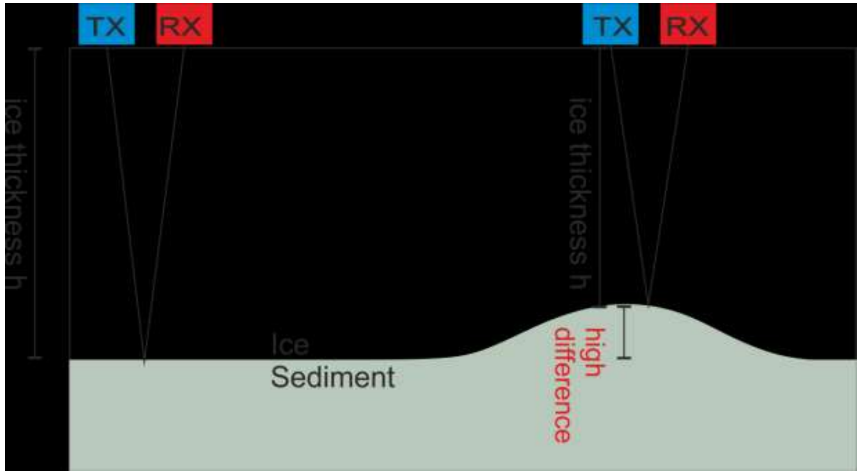
Principle or radar

- Transmission of high frequency pulse (10-1000 MHz) (Neal, 2004)
- Different electrical properties alter the EM velocity
- Abrupt changes in dielectric constants cause a reflection of part of the energy:
  - Density and porosity
  - Water-saturation/ water content
  - Electromagnetic conductivity of the sediment
  - Temperature
  - …

Material	Velocity [m\ns]	Dielectric constant	Attenuation [dB/m]
Air	0.3	1	0
Ice	0.168	3-4	0.01
Fresh water	0.033	80	0.1
Wet Sand	0.06	20-30	0.03-0.3
Dry Sand	0.13	5	0.01

Principle or radar

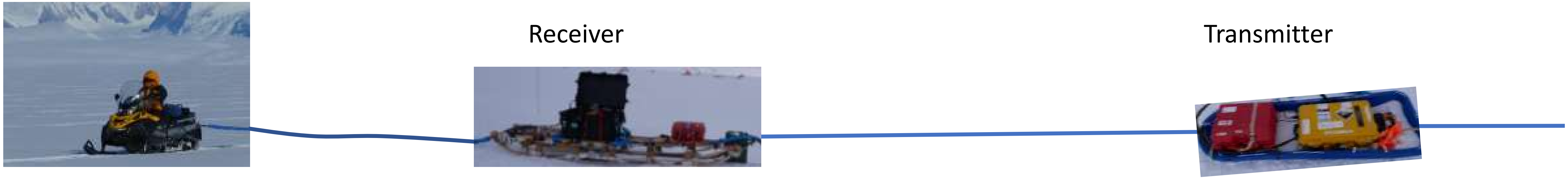
Radar data include time it took the wave to travel from transmitter to the ice-sediment interface and back to the receiver so called **two-way traveltime (twt)**



With knowledge of the velocity the depth (or ice thickness) can be calculated:

$$\mathrm{h} = v * \frac{twt}{2}$$

h= ice thickness
v= propagation velocity
twt= two-way traveltime (recorded time)


Receiver
Transmitter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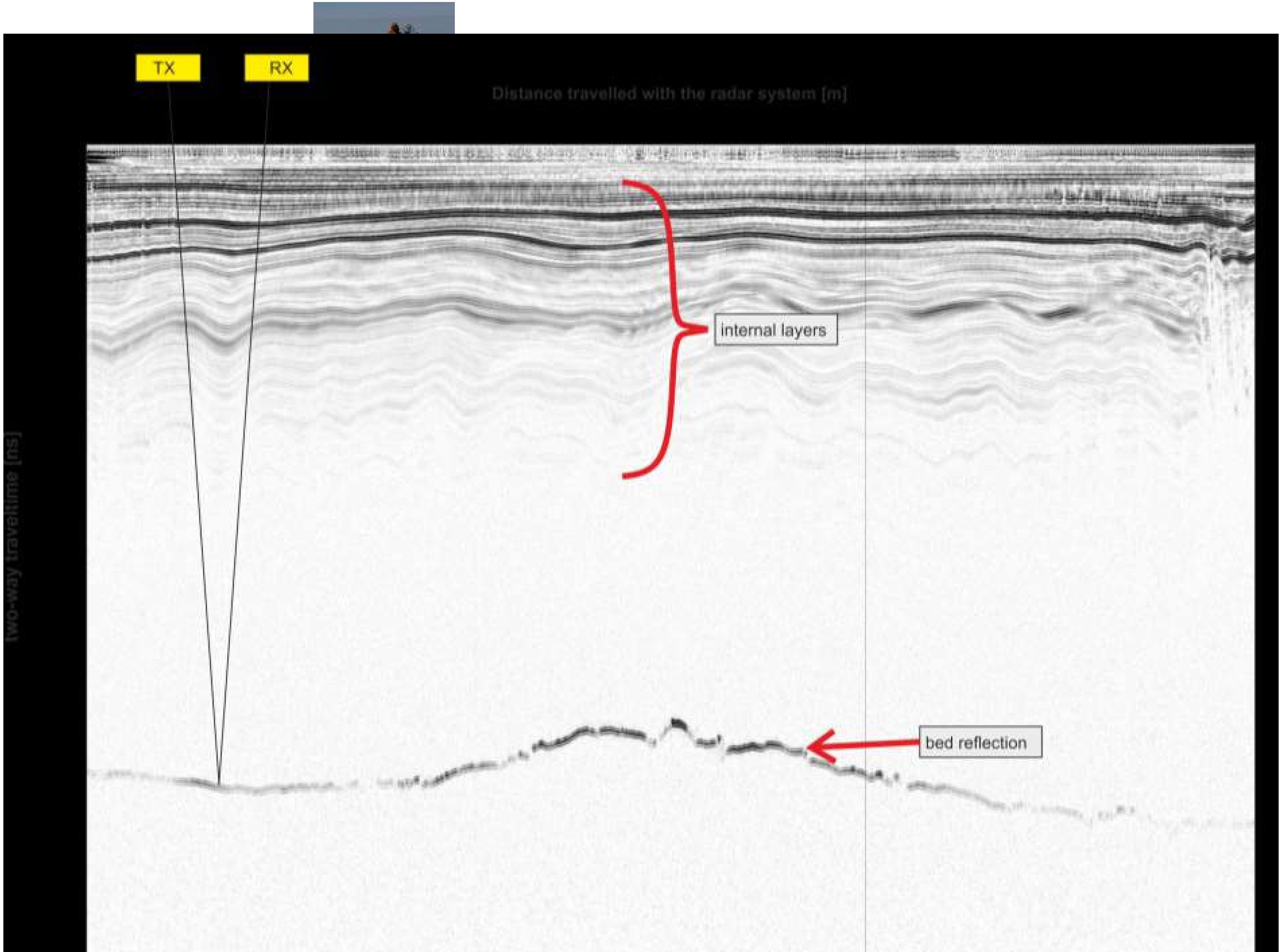
TX
RX
Distance travelled with the radar system [m]
two-way traveltime [ns]
internal layers
bed reflection


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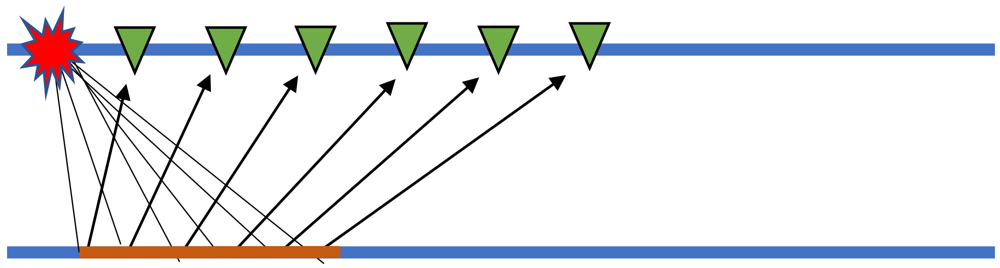
Reflection seismic data acquisition



Reflection seismics:

- **Acoustic waves**
- 1 source
- Several geophones for recording
- Coverage is limited

Reflection seismic data acquisition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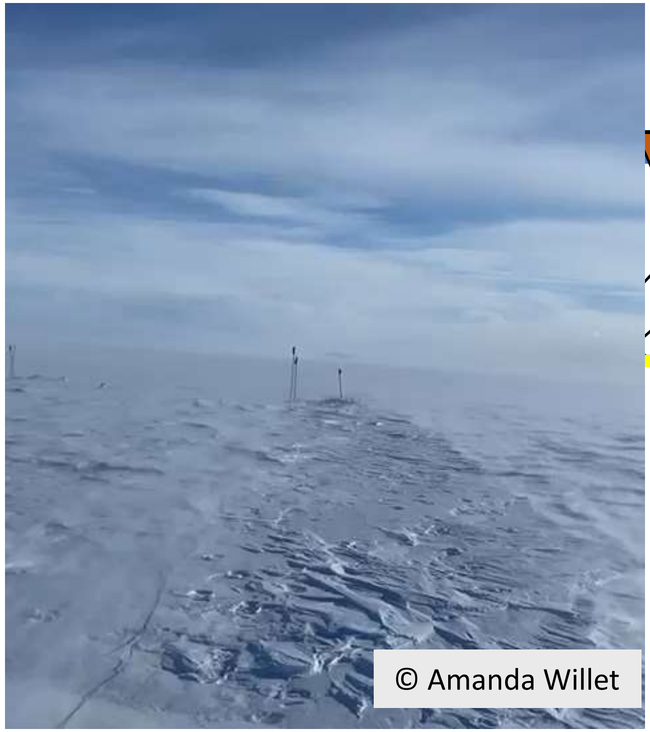
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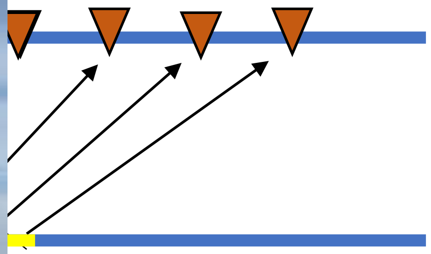

Any Questions?

To-do until Thursday:

- Flipped classroom: Watch video on Ilias