Augmented Reality Applications for Remote Sensing in Secondary Education using Radar, Lidar, and Imaging Spectrometer Data

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Existing app parts

Or search for “Columbus Eye” in the Google Play Store.

Sorry no iOS yet, I’m on it!

Worksheets with markers @
(EN) http://columbuseye.rub.de/english/
(DE) http://columbuseye.rub.de/unterricht/

Part	grade	subjects	English?
Algal Bloom	10-13	Geo+Bio+Phy	planned
Aralkum	7-9	Geo	yes
Mountains in the Solar System	5-7	Geo/Maths	planned
Image Processing	*10-13*	*CS*	*planned*
Earth By Night – Light pollution	7-9	Geo	yes
Earth By Night – Energy	7-9	Geo	yes
Earth Moon System	8-12	Phy+Geo	yes
Satellite Systems	*any*	*Phy/Maths/Geo*	*yes*
The Eye of the Cyclone	7-9	Geo	yes
Volcanoes on Mars?	*7-8*	*Geo*	*yes*
Volcanos under the Radar	7-10	Geo+Maths+Phy	planned

Teaching and Learning...

...about EO	...through EO	...with EO
Tools and methods	Spatial thinking	Technical skills
Research	Data literacy	Explorative learning
Disciplines	Critical thinking	Research-based learning
Professional development	Analytical thinking	Problem-oriented learning
	Citizenship formation	
What is possible with EO?	Which transferable skills are acquired when using EO?	How is EO used as a learning tool?

Modified according to Uwe Schulze (2021)

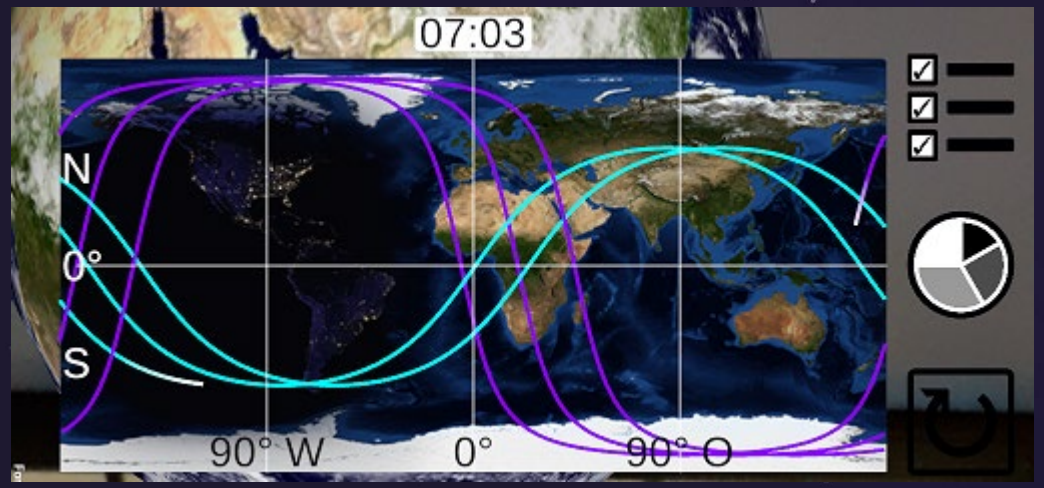
Teaching Earth Observation teaches more than Earth Observation!

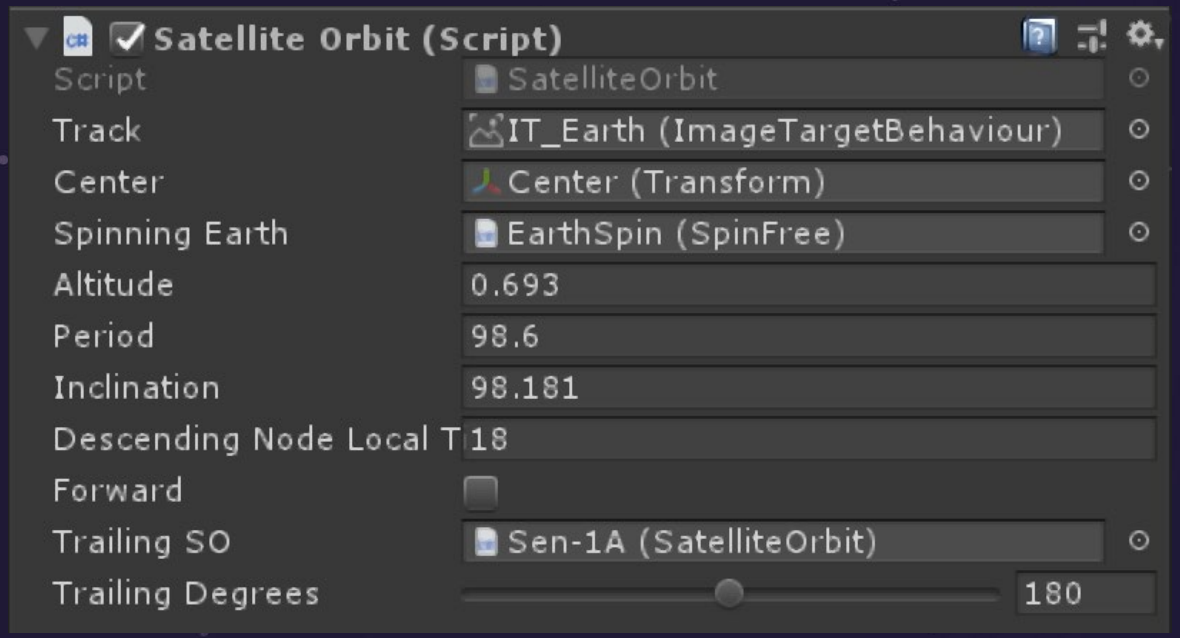
“Satellite Systems”

- Not bound to any specific topic
- General introduction into Earth Observation
- Teaching *about* and *through* EO

“Satellite Systems”

- All information within the app
- Accurate orbits
- Temporally “to scale”:
  1d = 1440 min » 288 s ≈ 6 min
  → 90 min sat orbits » 18 s
- Map & model day-night-cycle
- Expandable



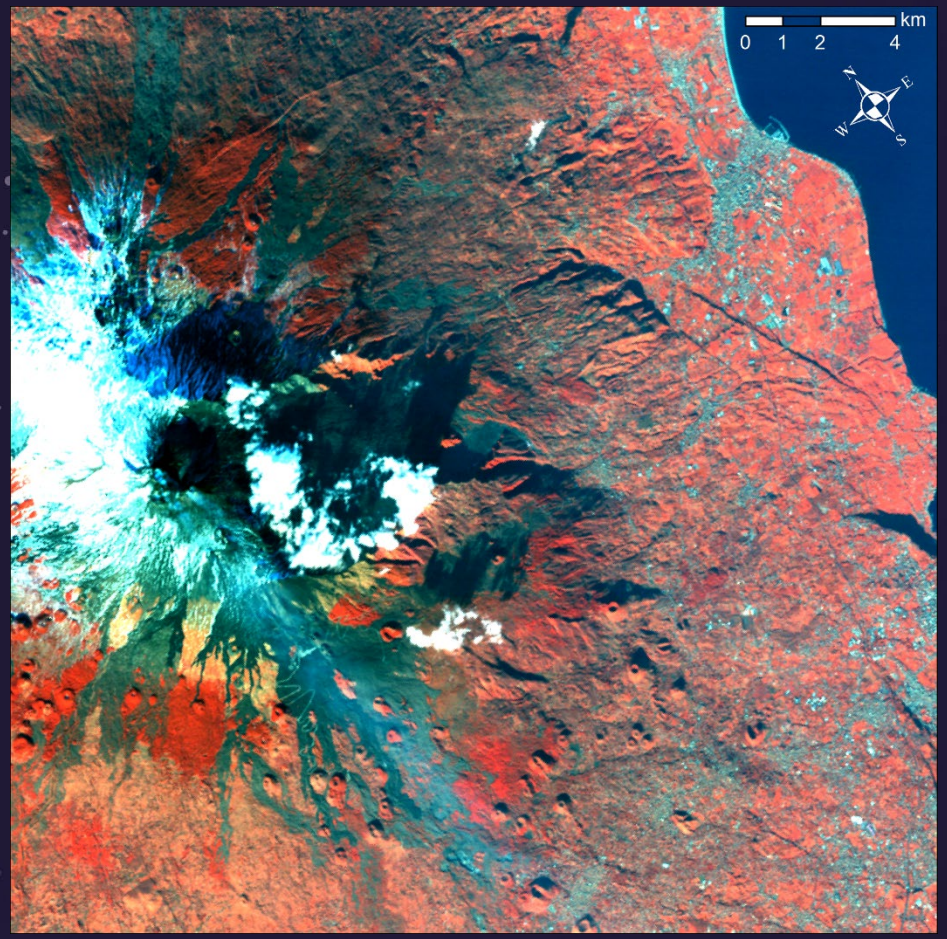


“Image Processing” using DESIS data

For Computer Science, grades 10-13

Students are to:

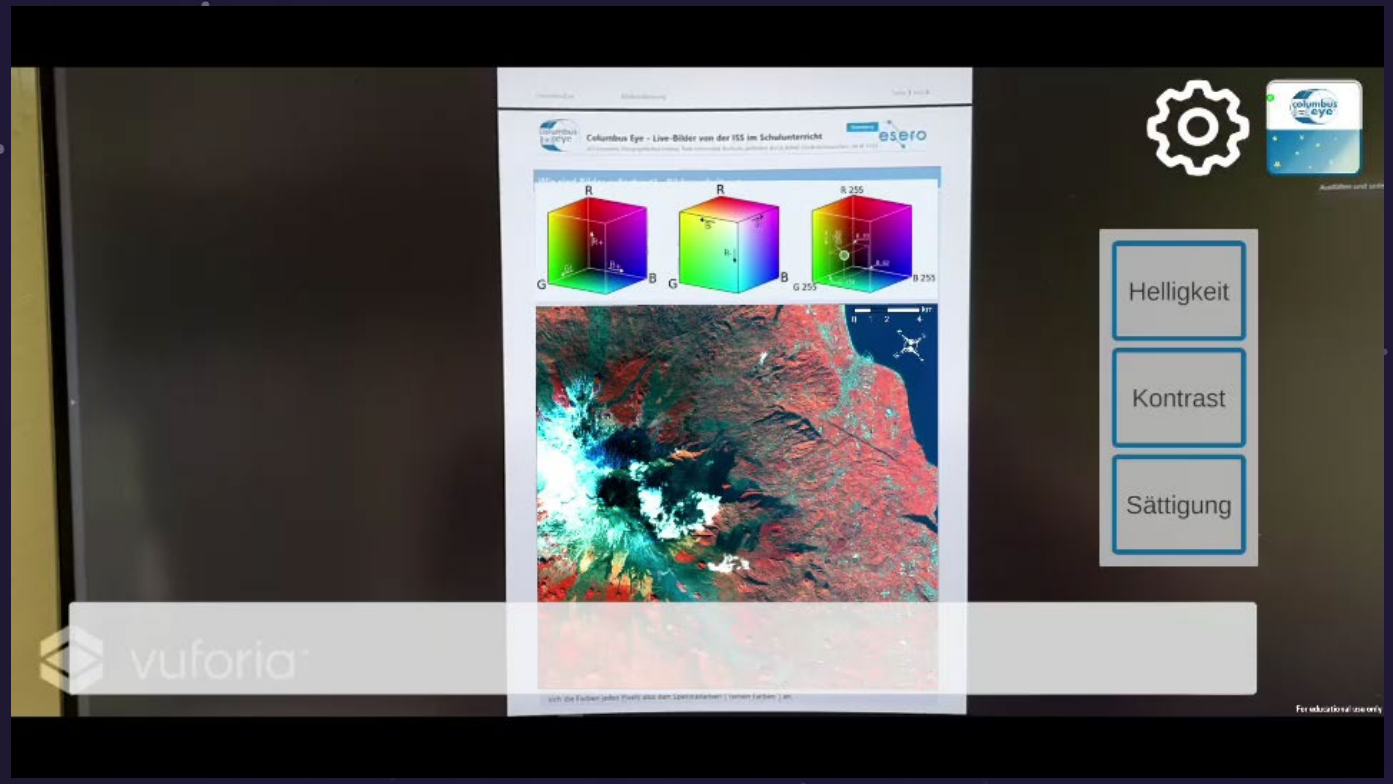
- Describe digital images in the RGB color space
- Explain and implement changes in contrast, saturation, and brightness
- Process hyperspectral imagery using the NDVI
- Teaching *with* EO



DESIS image (©DLR) – R: Infrared

“Image Processing” using DESIS data

- Play around with the sliders and describe what is happening
- Introduction to the RGB color space
- Discuss how the sliders affect R, G, and B



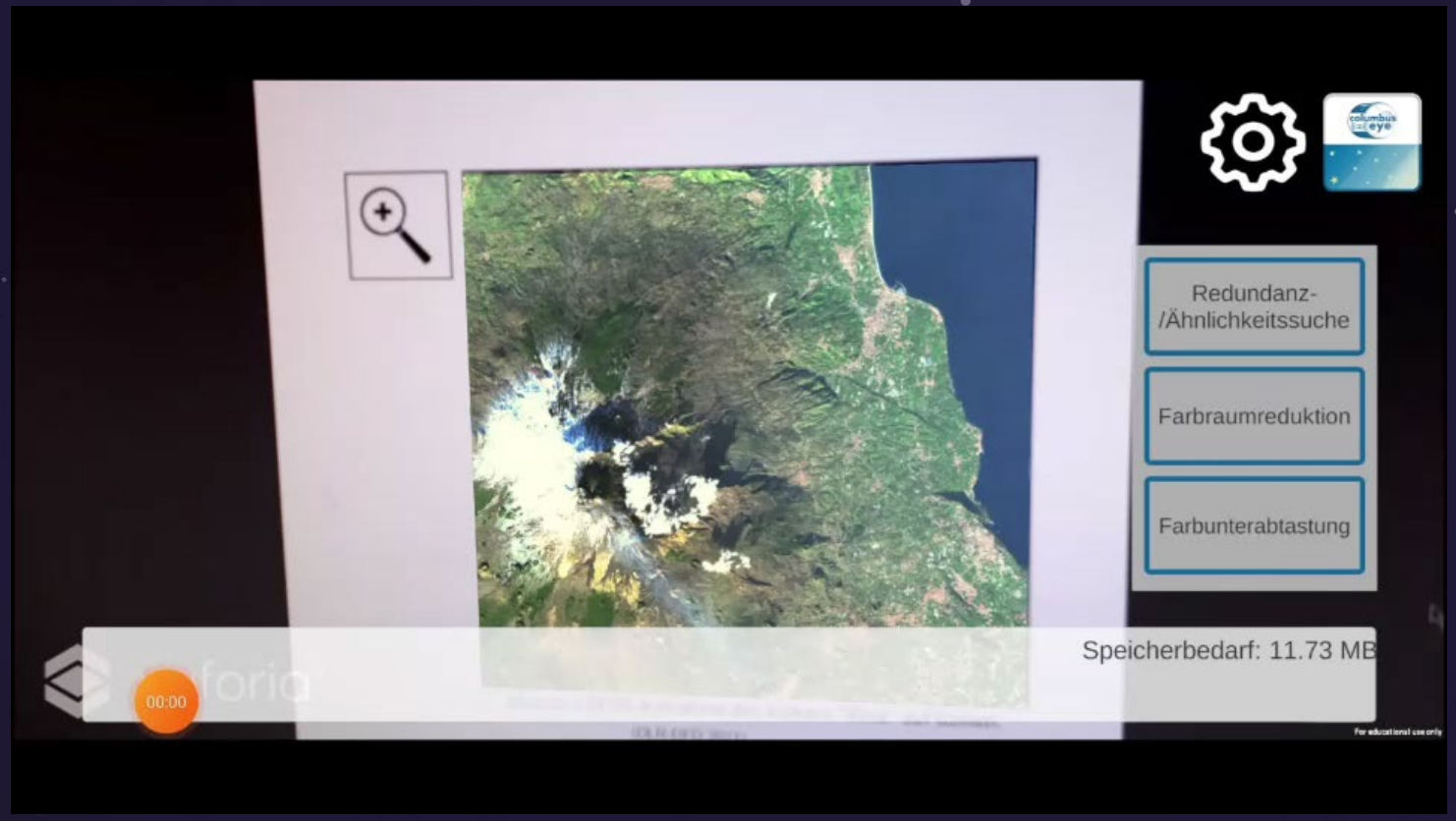
Brightness

Contrast

Saturation

“Data Compression” using DESIS data

- Divide in 3 groups, each analyse one compression algorithm
- Read some text, play with the app, and find out how the algorithm works
- Discuss how and why each algorithm is suitable for imagery
- Present findings to the other groups
- Discuss: “There is no perfect compression algorithm.”



Sorry for shaky cam ☹

Redundancy/ similarity

Color space reduction

Chroma Subsampling

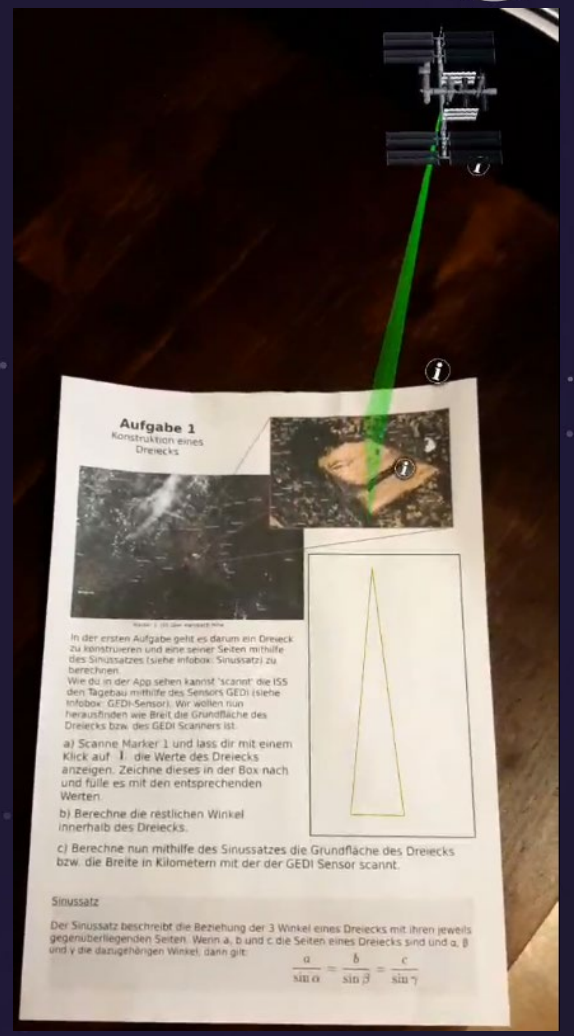
“Mining Data” using GEDI data

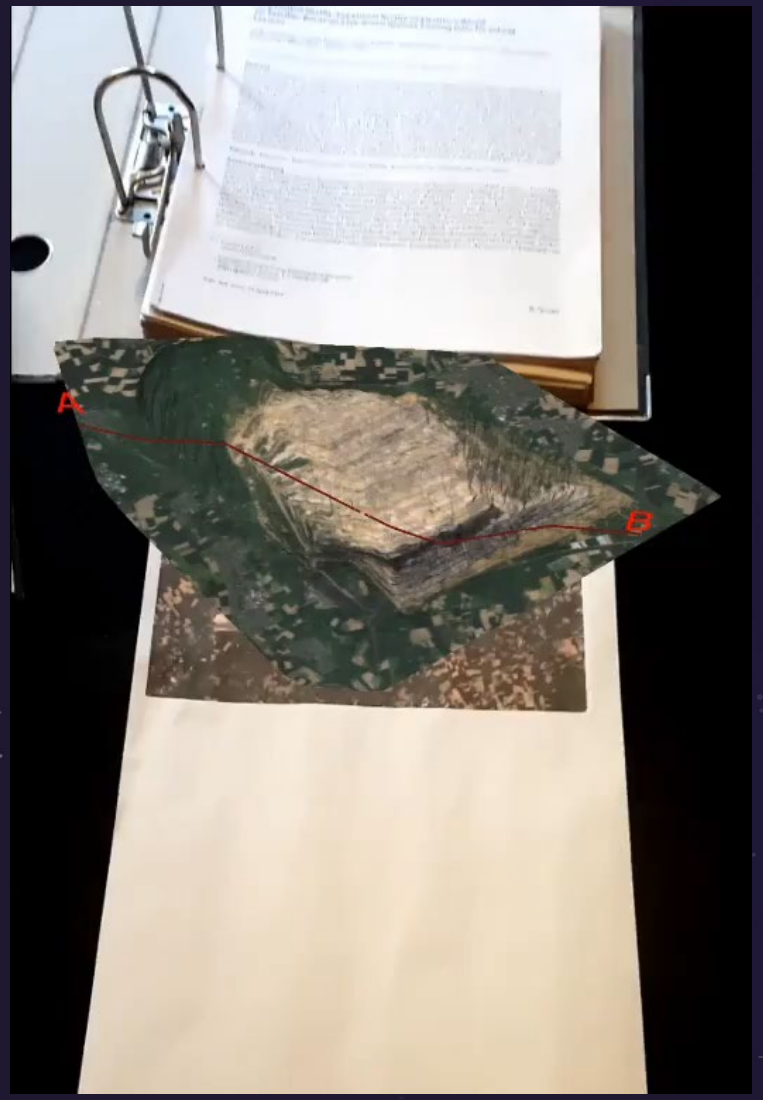
For Maths, grades 7-10

Teaching *about*, *through*, and *with* EO

Students are to:

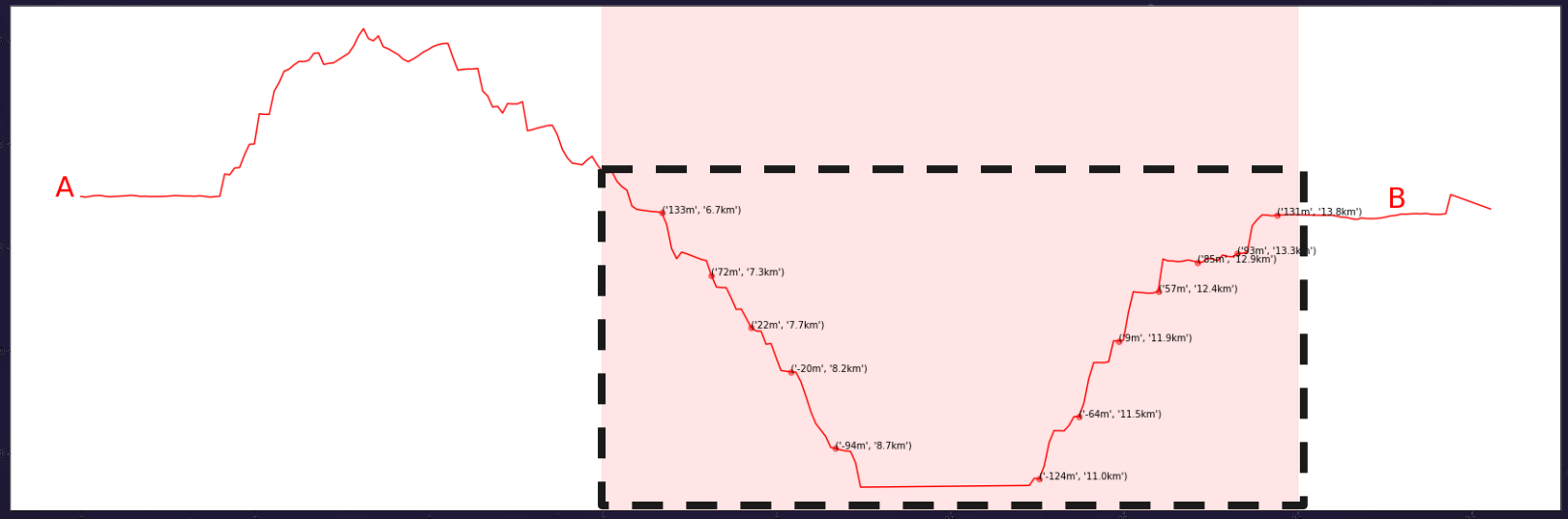
- Calculate the area of triangles, rectangles, and circles
- Use sin/cos/tan to calculate angles and side lengths within those
- Calculate volume and density of simple shapes
- Learn to mathematize environmental problems
- Learn to develop and explain their own approaches
- Develop awareness for a recent societal problem and base their opinion on calculatable facts
- Understand some basics of satellite remote sensing and its applications





“Mining Data” using GEDI data

- Calculate an average depth of the mine
- Calculate the volume of the mine
- Estimate the amount of coal being mined and how much energy came from it
- CO_2 calculations & discussion

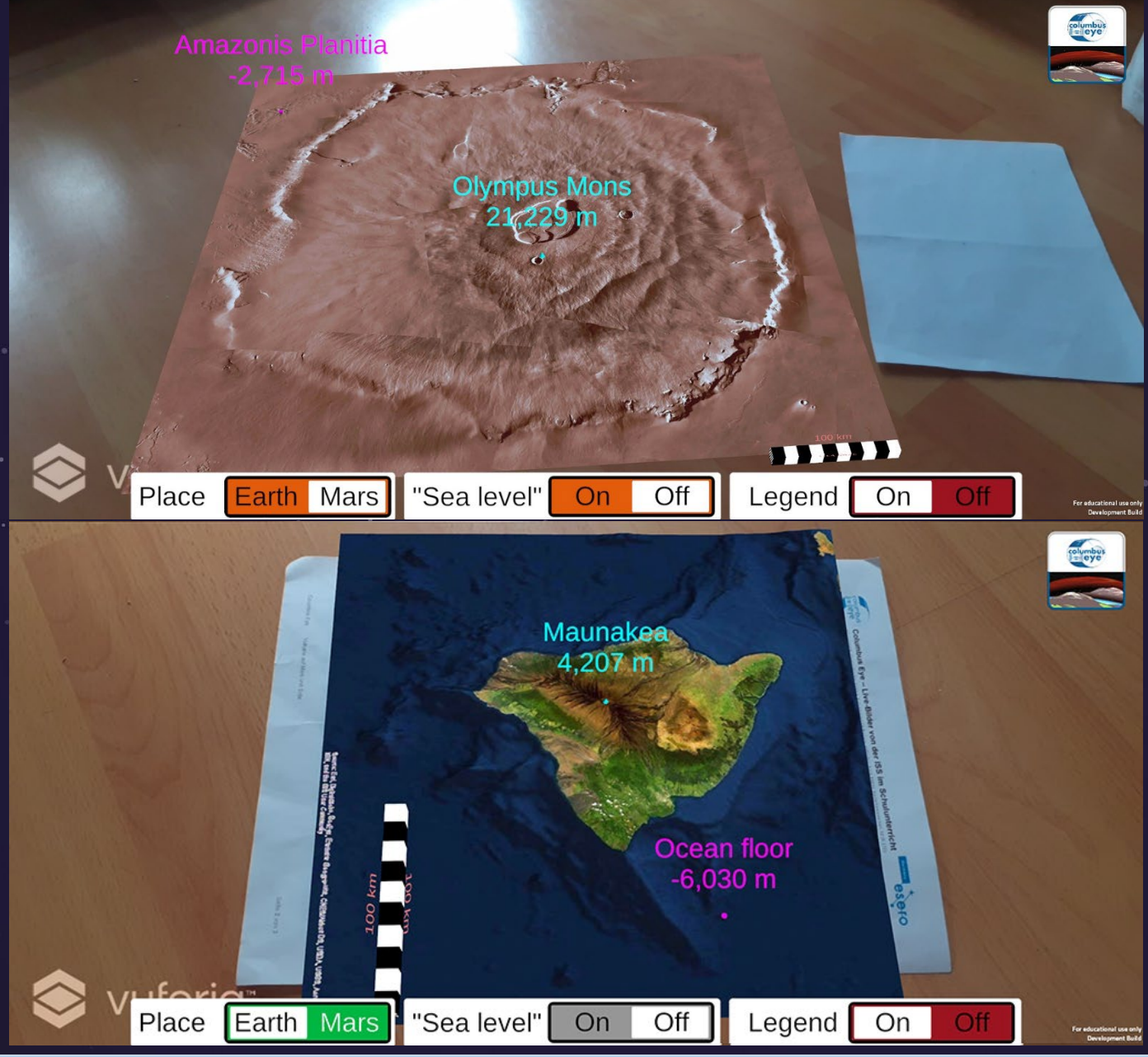


“Volcanos on Mars?”

- Simple 3D models to give pupils an idea of the scale of the mountains and the slope angles.

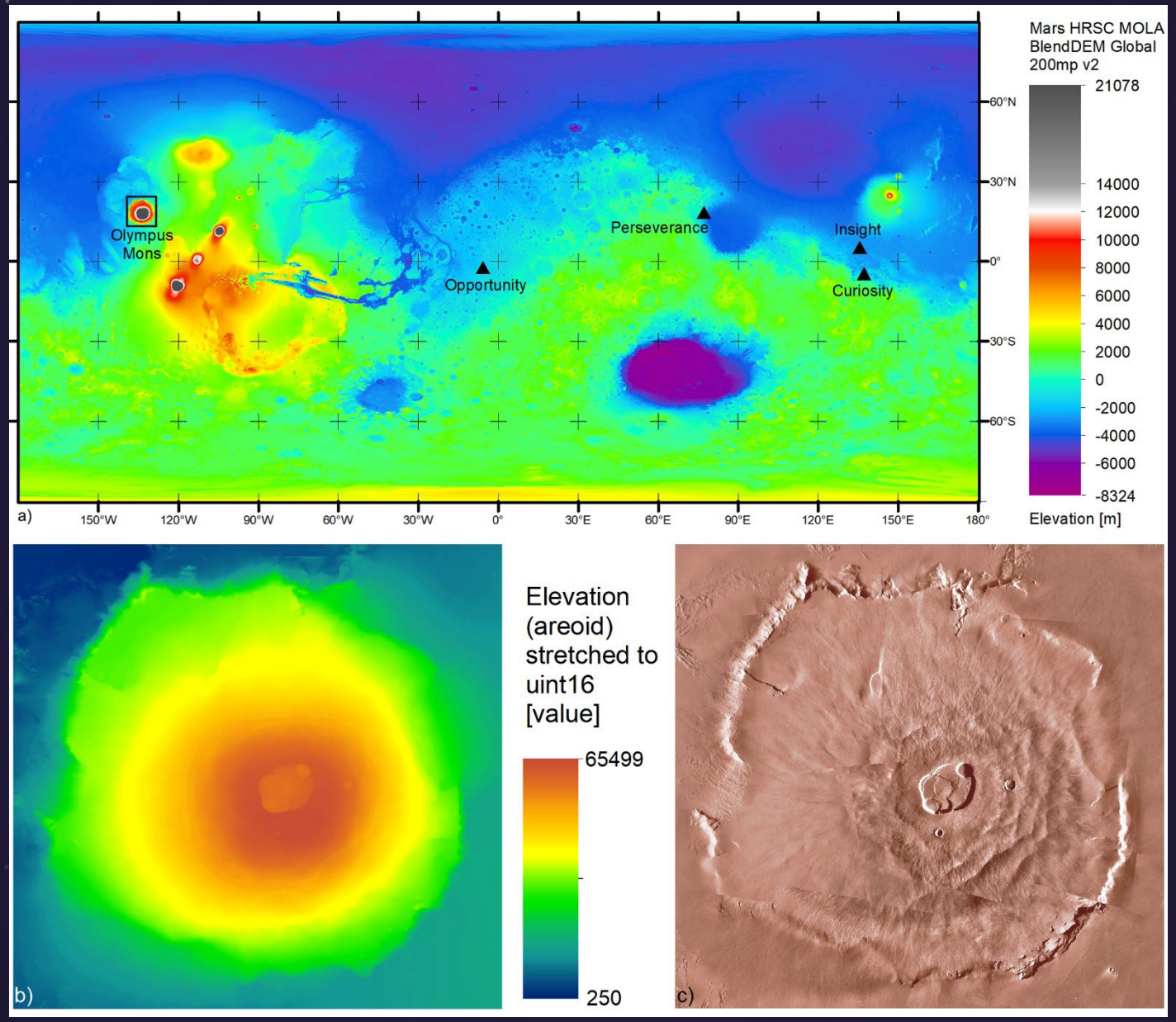
- Switch between Earth an Mars
- Real/calculated sea level
- Scale bar and highest/lowest spots marked

- Teaching *through* and *with* EO



“Volcanos on Mars?” & Mars VR

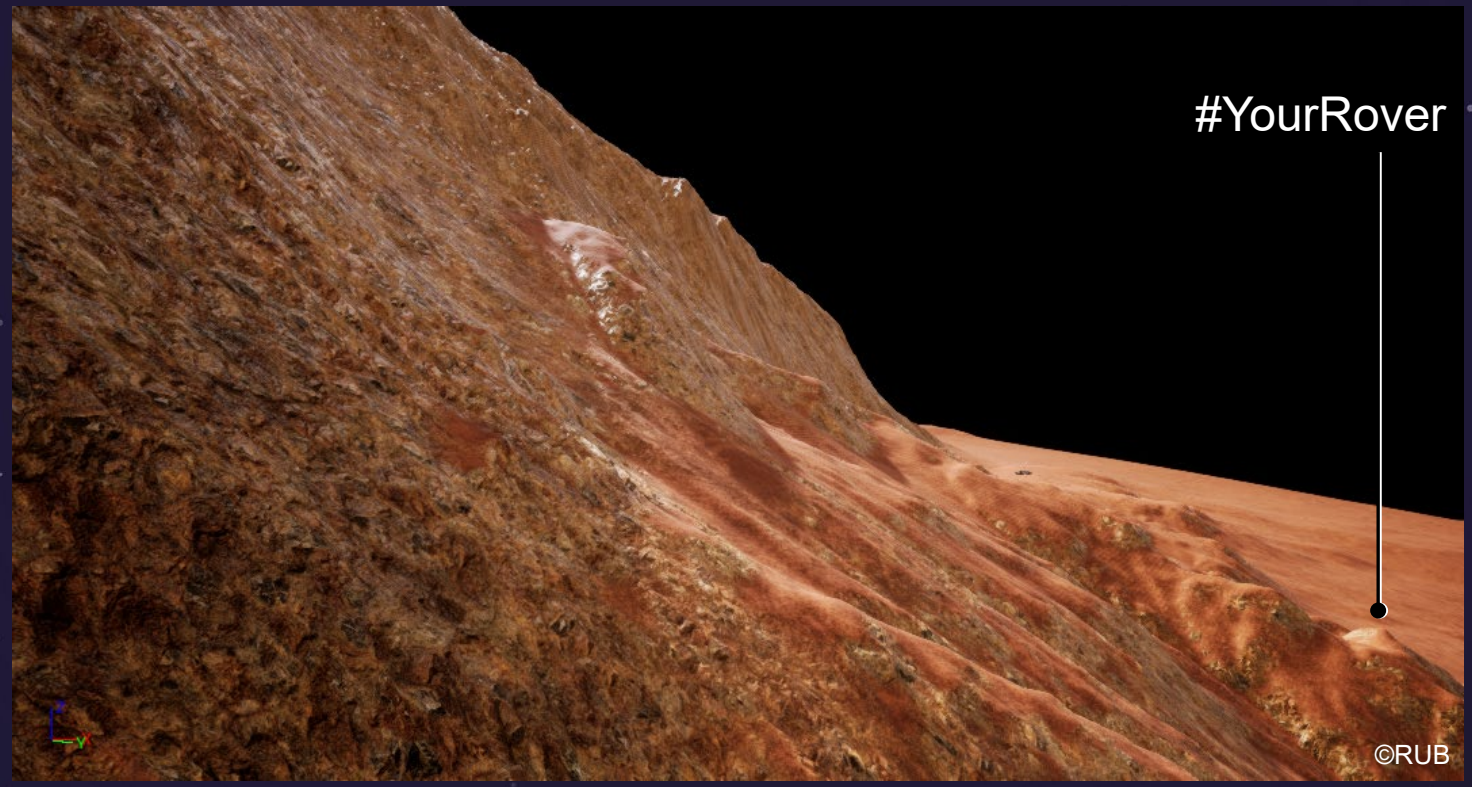
- Mars Viking Colorized Global Mosaic 232m v2,
- Mars MGS MOLA,
- MEX HRSC Blended DEM Global 200 m v2,



Lindner, C., Ortwein, A., Staar, K., Rienow, A. (2021): Different Levels of Complexity for Integrating Textured Extra-terrestrial Elevation Data in Game Engines for Educational Augmented and Virtual Reality Applications. *KN - Journal of Cartography and Geographic Information.*

“Mars VR”

- Virtual expedition to a dangerous/inaccessible place
- Analyse Rover landing sites in VR using EO methods
- Combination of 2D and 3D materials for better understanding of maps in the “real world”



Conclusion & Outlook

- Continually producing Augmented Reality apps using Earth and other planetary observation satellites, including the ISS
- More than geography, applications in various STEM subjects
- EO is an integral part, but on different levels of utilization, sometimes just an example (*with EO*), sometimes the subject (*about EO*), sometimes the method (*through EO*)
- Real EO data can be integrated into these apps for the benefits of students
- iOS planned (eventually!) (I promise!!)

Thank you! Any questions?