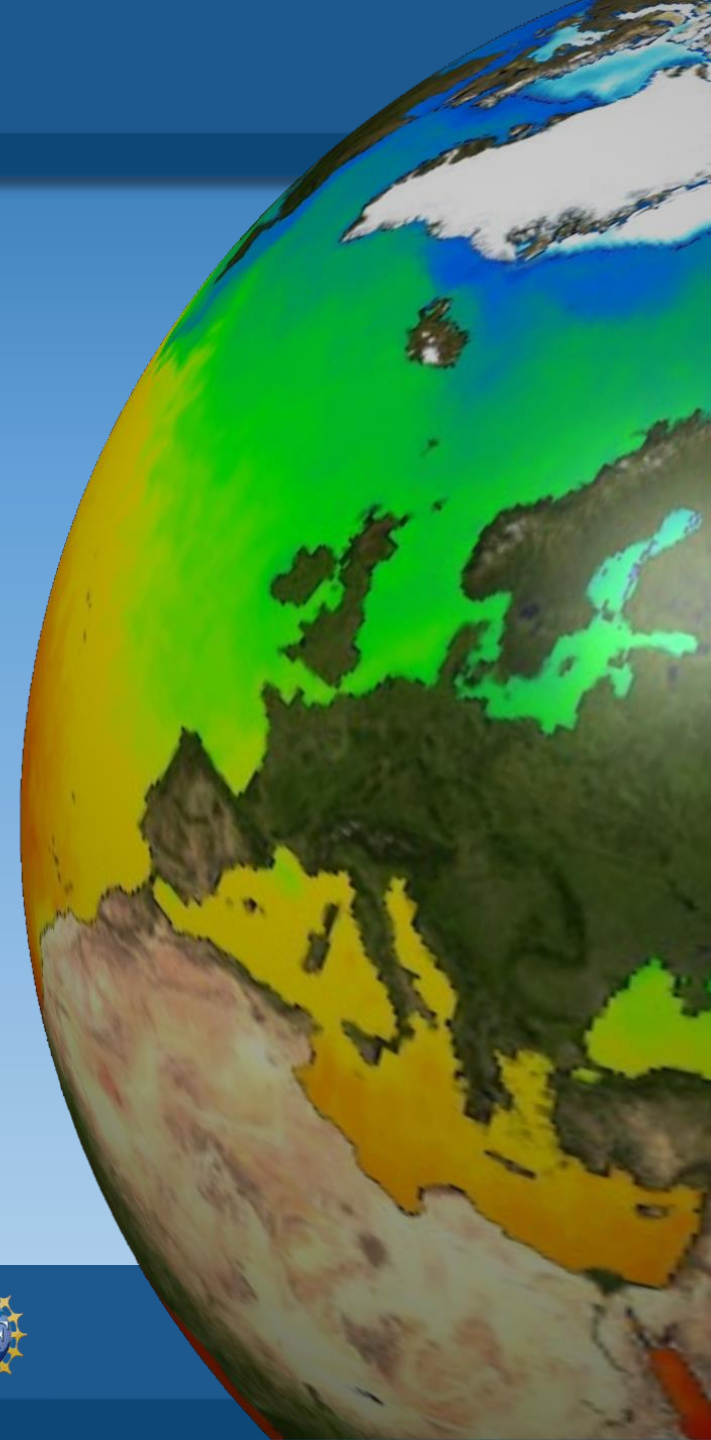# Exploring Geoscience with AR/VR Technologies

Tim Scheitlin

*Computational & Information Systems Laboratory (CISL),
National Center for Atmospheric Research (NCAR),
Boulder, Colorado, USA*

Using ECMWF's Forecasts (UEF2018)
Reading, UK
5-8 June 2018

Presentation Overview

Meteo AR

Meteo VR

- Brief Introduction to NCAR

- Project Motivation

- Summer SIParCS Program

- Meteo AR/VR Apps

- Adding ECMWF Data to the Apps

- Future Directions and Interests

- Try it for yourself!

Brief Introduction to NCAR

• National Center for Atmospheric Research, Boulder, CO

• Mission: Understand…atmosphere and geospace systems…and to **foster the transfer of knowledge and technology** for the betterment of life on Earth.
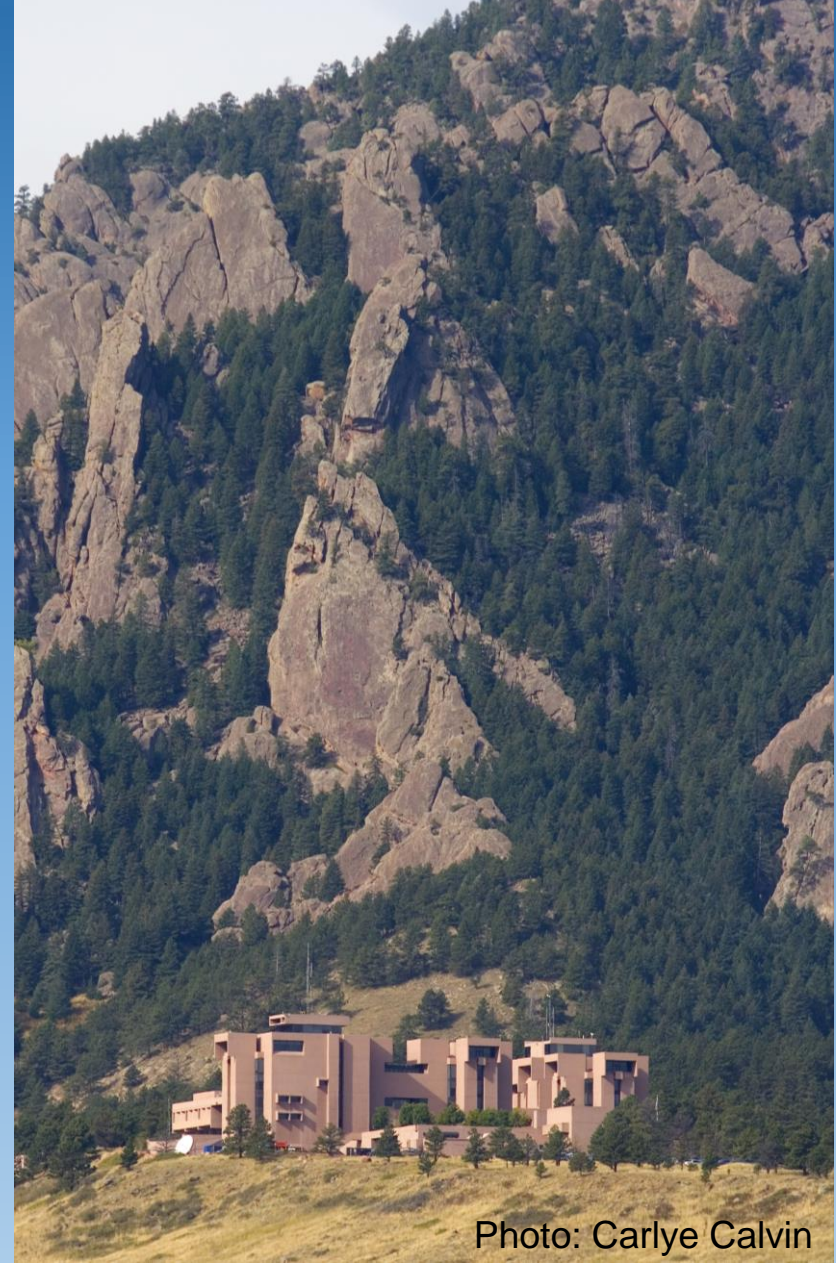
Photo: Carlye Calvin

# Data center and computing resources

Computational and Information Systems Laboratory (CISL) supports the computing resources for NCAR.

- Yellowstone (retired) – 1.54 petaflops
- Cheyenne: 5.34 petaflops
- Glade: 53 PB rotating disk
- HPSS: 320 PB tape archive

Visualization Lab

• Organizational resource for collaborative meetings, 3D presentations, and classroom instruction.

• Used for Training, Education, and Outreach to diverse audiences including K-12, post-secondary, adult students, and the general public, as well as scientific, governmental, and corporate visitors.

• Provides support to scientists for developing compelling visualizations suitable for presentation, communication, and publication.

• Supports 3D rendering of large datasets to foster awareness and understanding of NCAR science and research.

NCAR

Exploring Geoscience with AR/VR
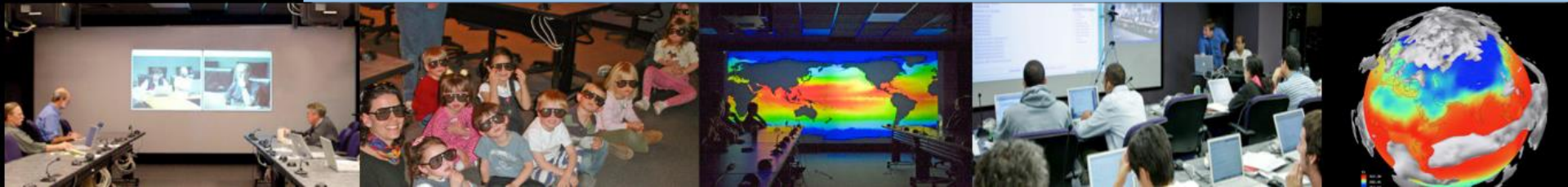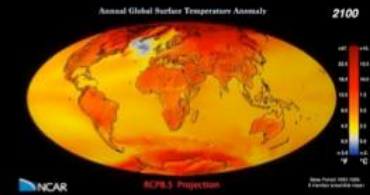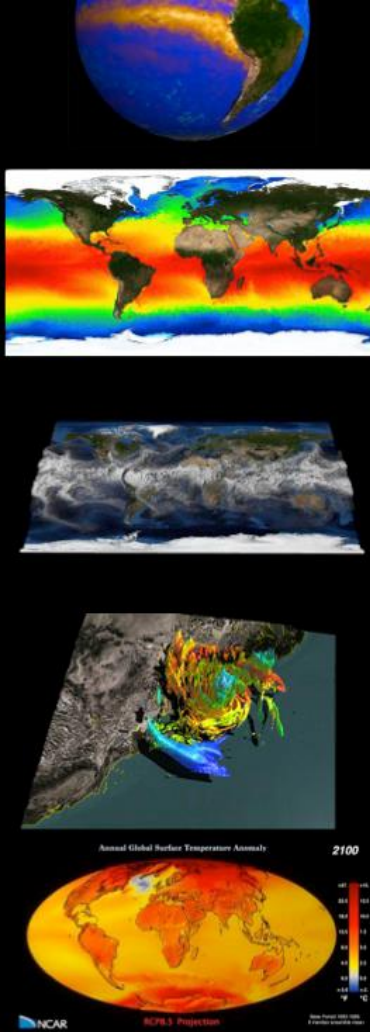
Project Motivation

How can we educate, engage, and make our data and visualizations more accessible to a wider and more diverse audience?

- In the V   a large flat
  screen
- We wan   e's
  smartph
- Users s   alization.

https://blog.davemdavis.net/2015/01/23/virtual-reality-vs-augmented-reality-vs-holograms/

What is Virtual Reality (VR) ?

- VR is an environment in which the user is fully immersed in a virtual/ synthesized environment

- Can be achieved with a smartphone and Google Cardboard or head mounted displays (HMDs) (E.g. Oculus rift, OSVR …)

- The phone displays a split screen image/video

OSVR headset

Google Cardboard

Split screen view

NCAR *Exploring Geoscience with AR/VR*

What is Augmented Reality (AR) ?

- Augmented reality allows the user to see the real world with virtual objects superimposed on it

Pokémon Go

- Can be achieved with smartphones, tablet computer or head mounted displays (HMD)

* Microsoft's HoloLens

NCAR

Exploring Geoscience with AR/VR
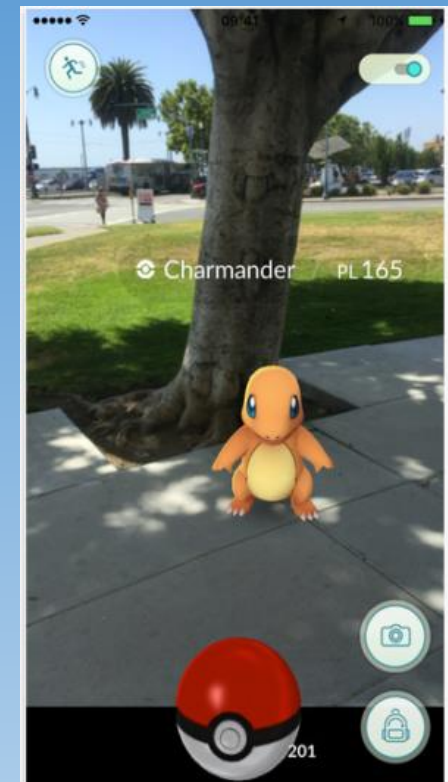
2016 SIParCS Interns
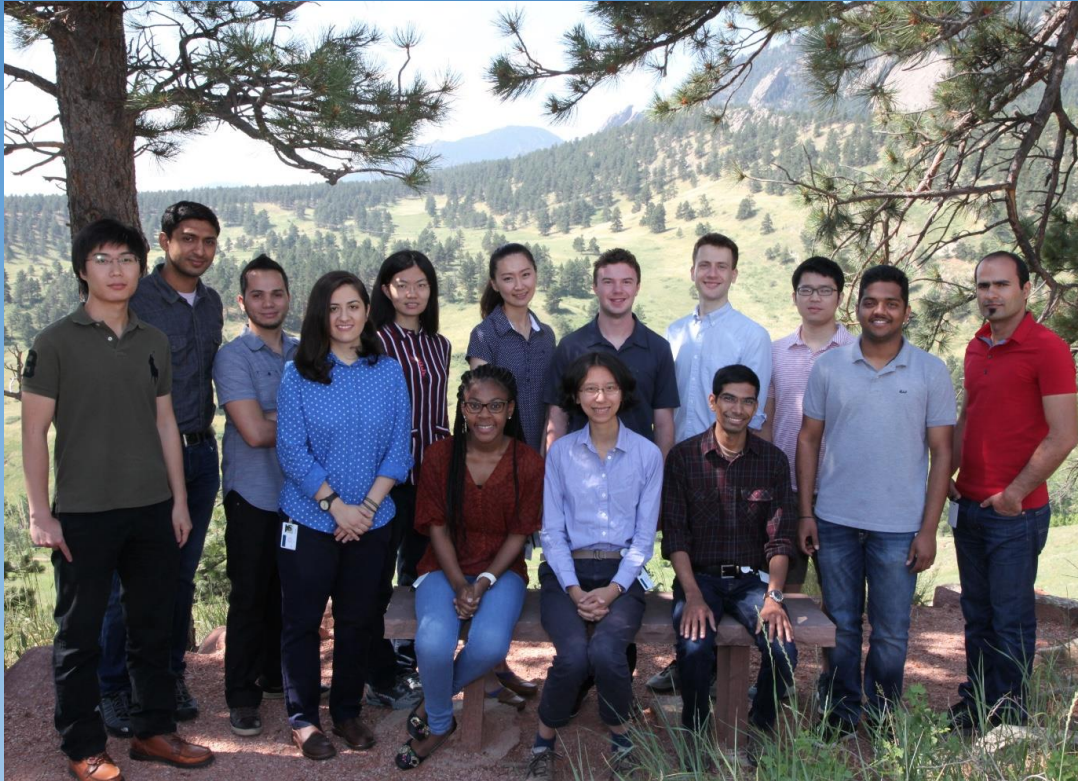
- Makes a long-term, positive impact on the quality and diversity of the workforce needed to use and operate 21st century supercomputers.

- Offers undergraduate and graduate students hands-on R&D opportunities in High performance computing (HPC).

- Embeds students as interns in CISL for an 11-week session.

SIParCS Summer Project in Virtual Reality

Summer Project Proposal: Develop a Google Cardboard VR app for exploring and manipulating Earth science data by displaying 3D scenes on a smart phone.

Nihanth Cherukuru: Lead Developer and AR/VR expert

Matt Rehme: Content Developer and viz expert

backgroundcheckall.com

CESM

https://dzone.com/

NCAR   *Exploring Geoscience with AR/VR*

Meteo VR and Meteo AR
Interactive, Educational, & Free

Meteo VR   Meteo AR

Downloads in the last 12 months

Application	iOS	Android
Meteo AR	1235	764
Meteo VR	148	41
Total = 2188	1383	805

NCAR

Exploring Geoscience with AR/VR

Meteo VR (Virtual Reality)
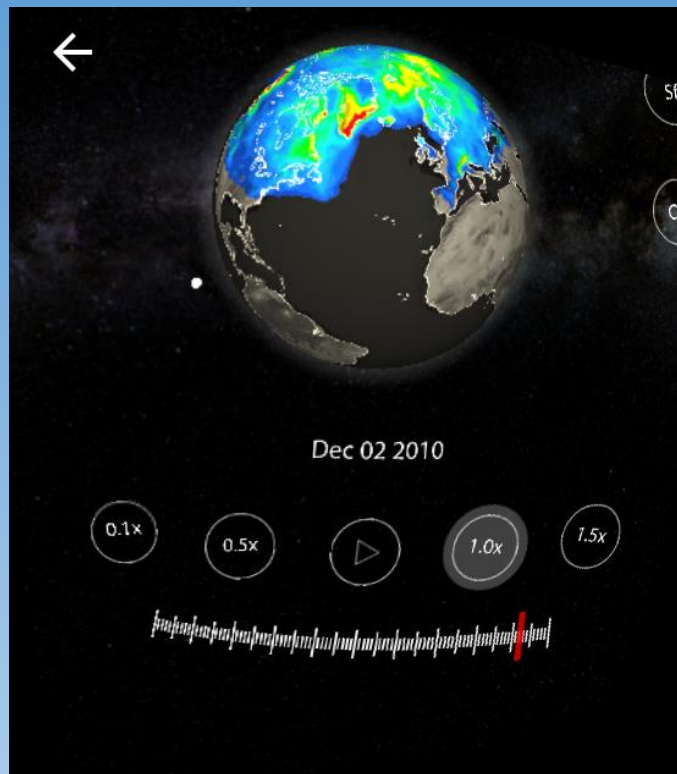
Meteo VR user interface

Choose a dataset
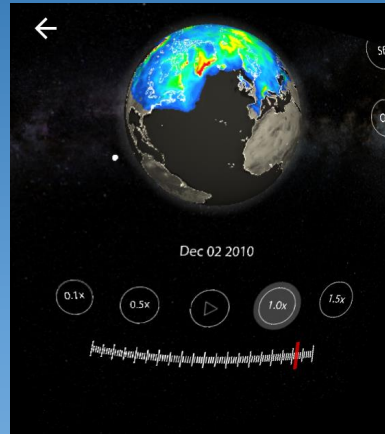
Animate
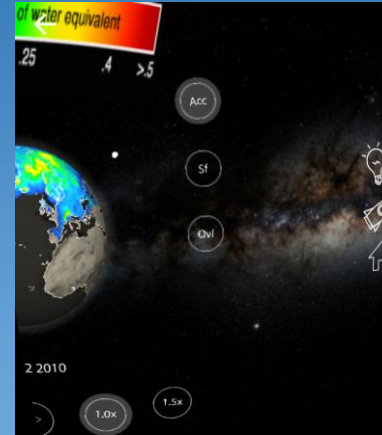
Choose a variable
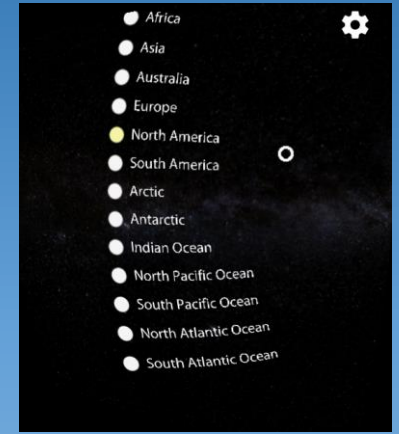
Choose a view
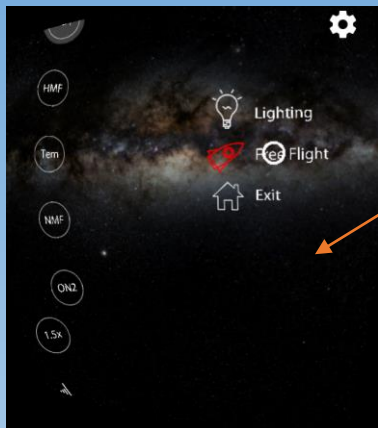
Navigate

Double-click to get out

Interactive Click Button

Meteo AR (Augmented Reality)

Exploring Geoscience with AR/VR

Meteo AR

An Augmented Reality interface for exploring 3D earth science datasets

Meteo AR Cube

NCAR

Exploring Geoscience with AR/VR
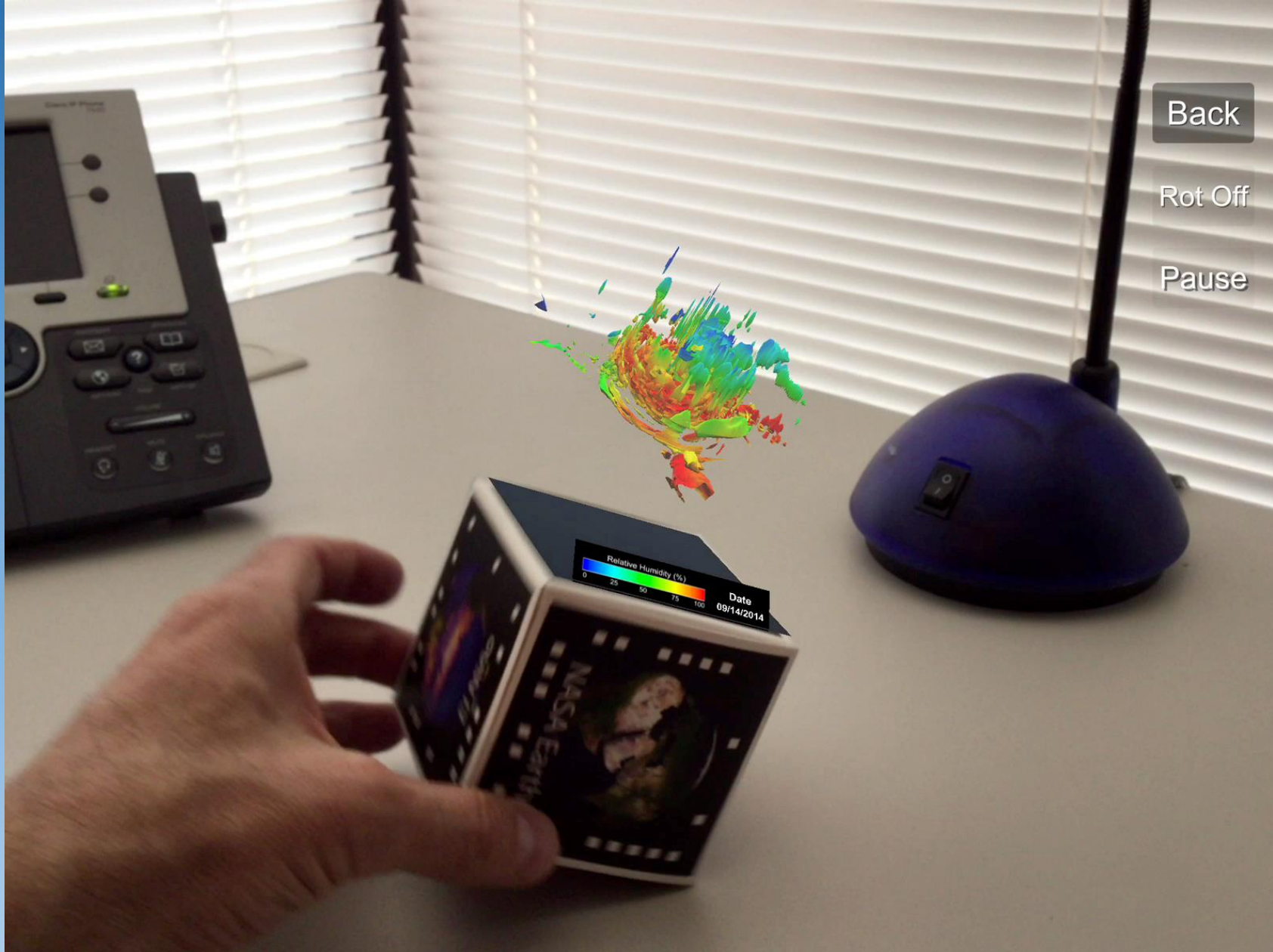
Game development platforms

- They are tools to create computer games

- E.g. Unity, Unreal, Cryengine …

- Unity was chosen based on its popularity and extensive documentation

- Typical workflow:

    a) Create or import computer models

    b) Attach scripts (computer code) to specify mechanics and the logic

   c) Package and create an executable version of the game

Game development platform

(3D Modeling software)   Attach scripts/code   Build project

C#   Exe.

NCAR
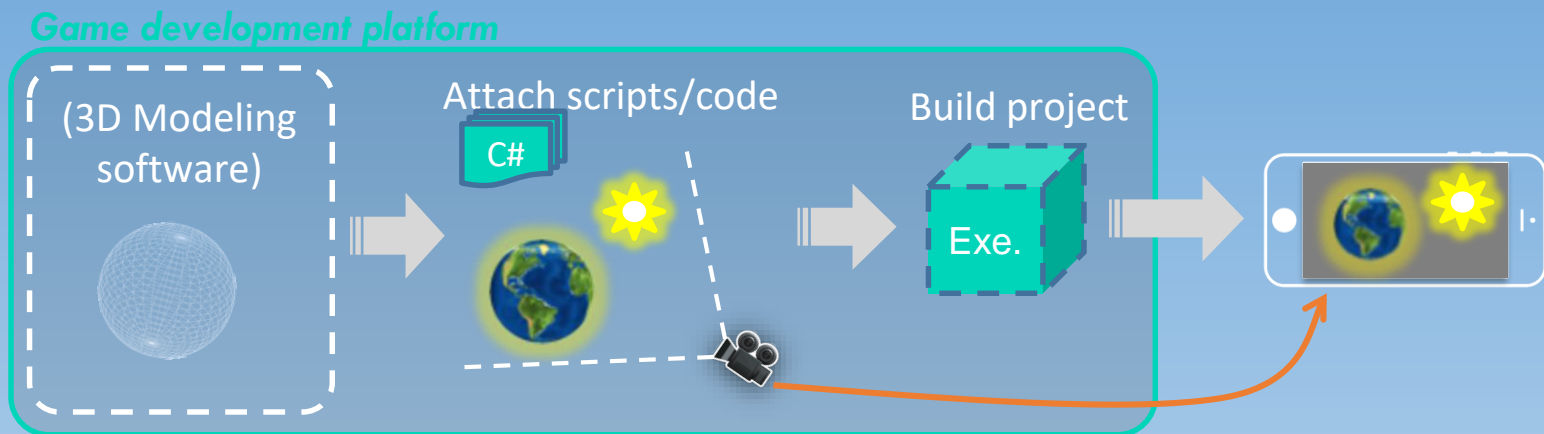
Computer Vision Techniques (AR Version)

Marker on the science sheet is used to:

1) Identify the dataset

2) Track the device in 3D space

Exploring Geoscience with AR/VR

Slide courtesy Nihanth Cherukuru
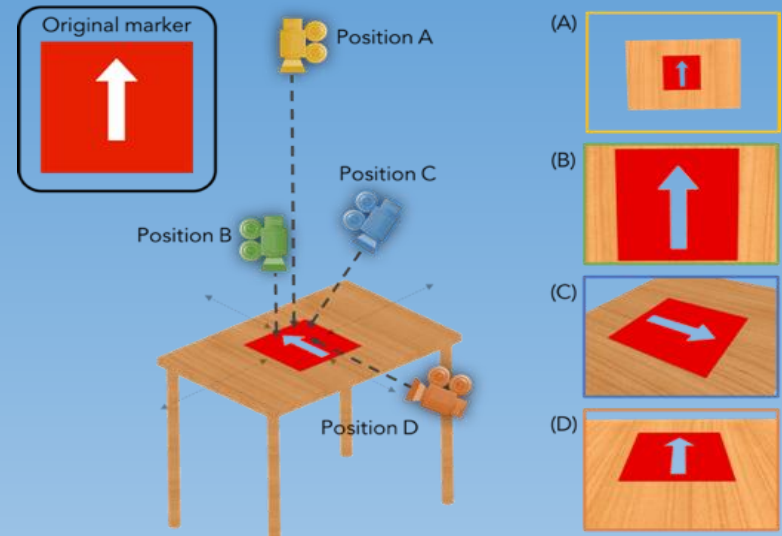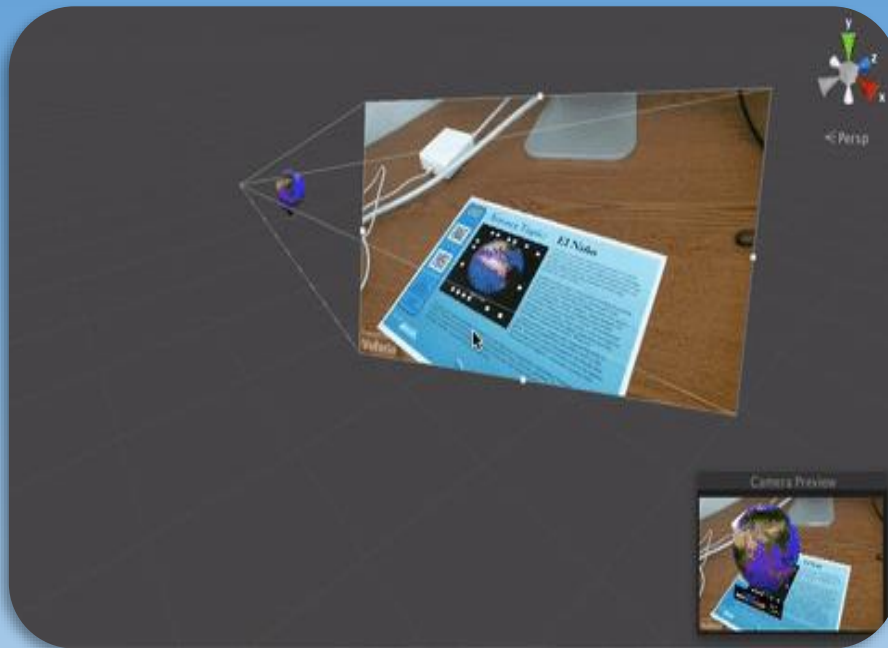
VR version

- One image per eye is captured by two virtual cameras to obtain the image to be displayed on the screen

- The virtual cameras mimic the orientation of the device by obtaining the attitude information of the physical device
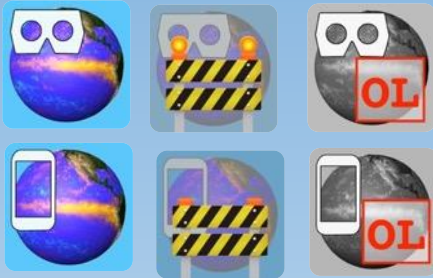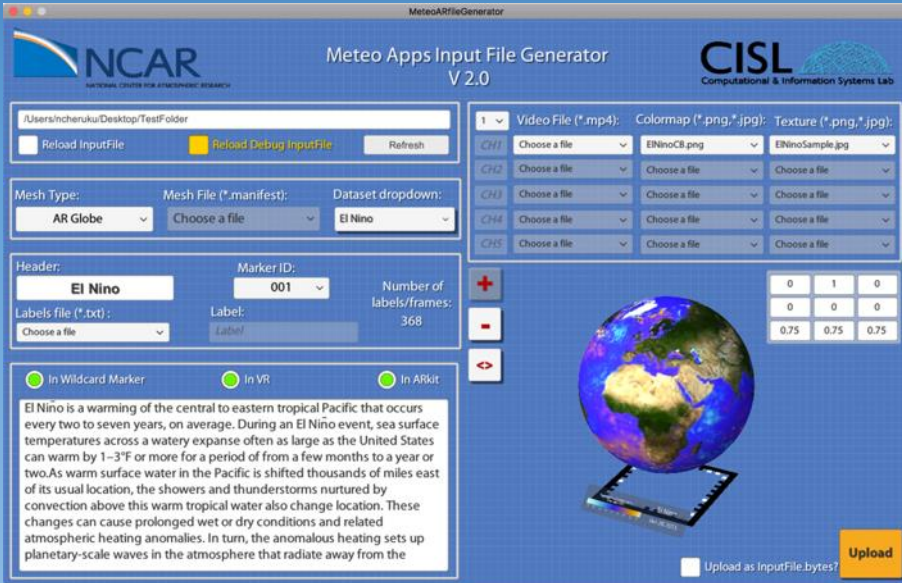
Right eye

Left eye

Roll,pitch,yaw

NCAR
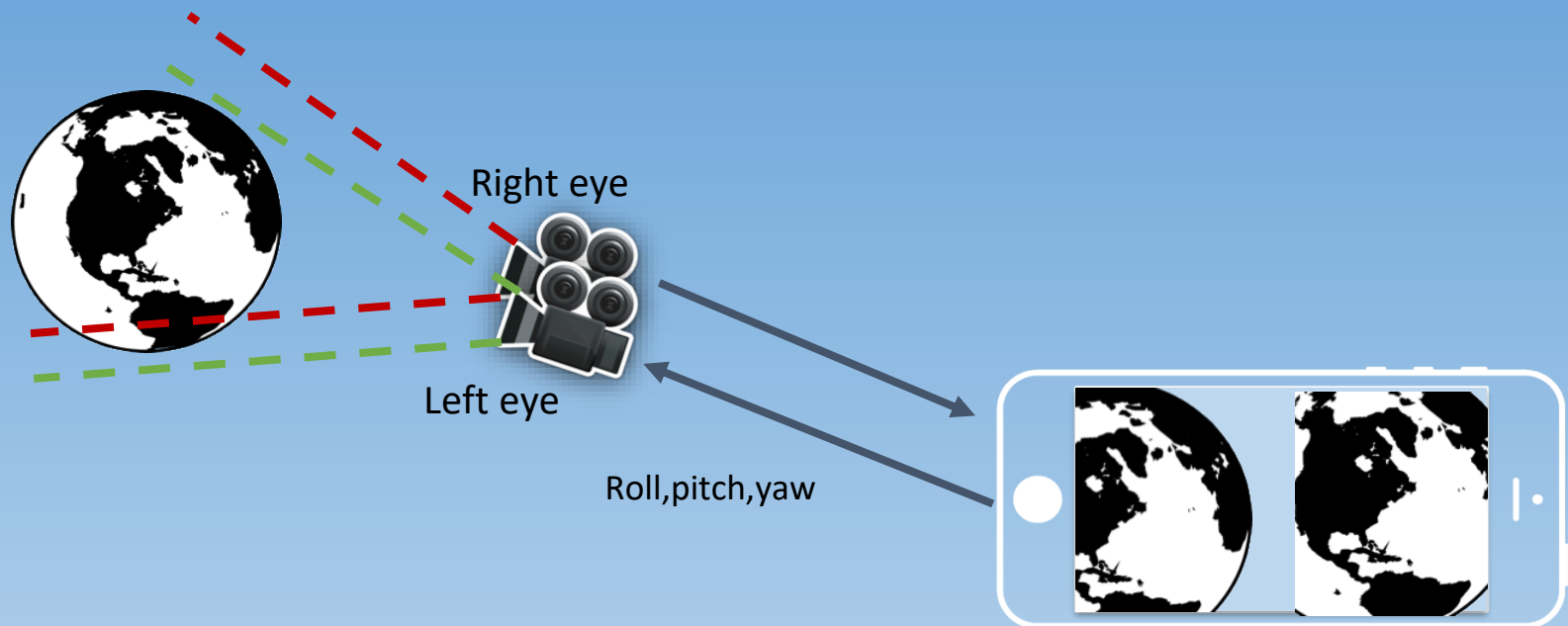
Server Side
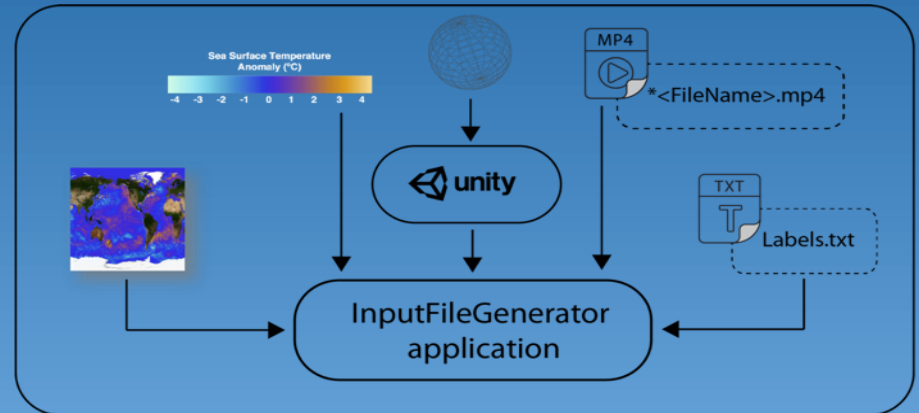
Stores dependencies

Texture atlas to display startup image

Texture atlas of colormaps

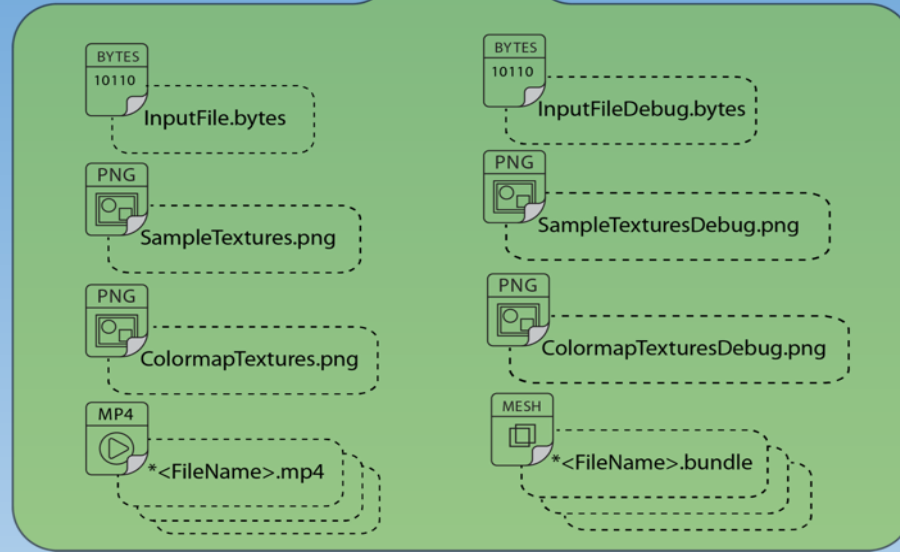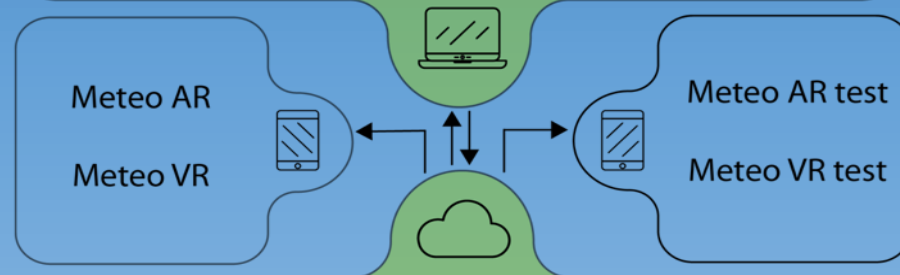Video file for each dataset

Mesh file for generic datasets
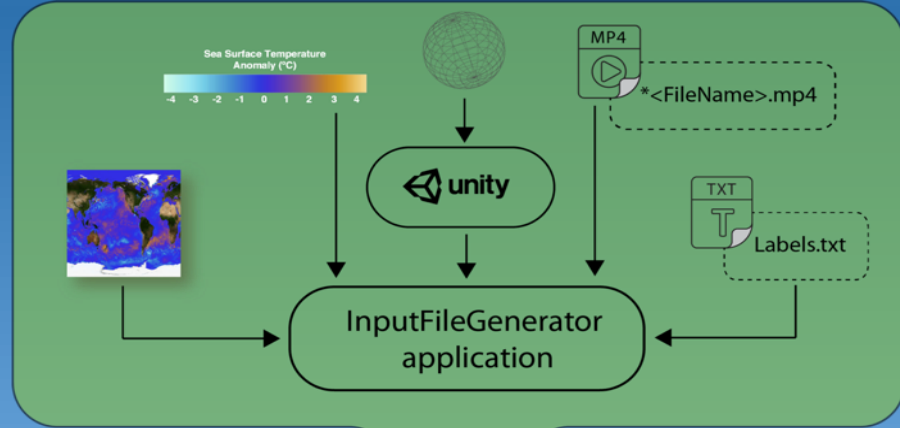
Exploring Geoscience with AR/VR
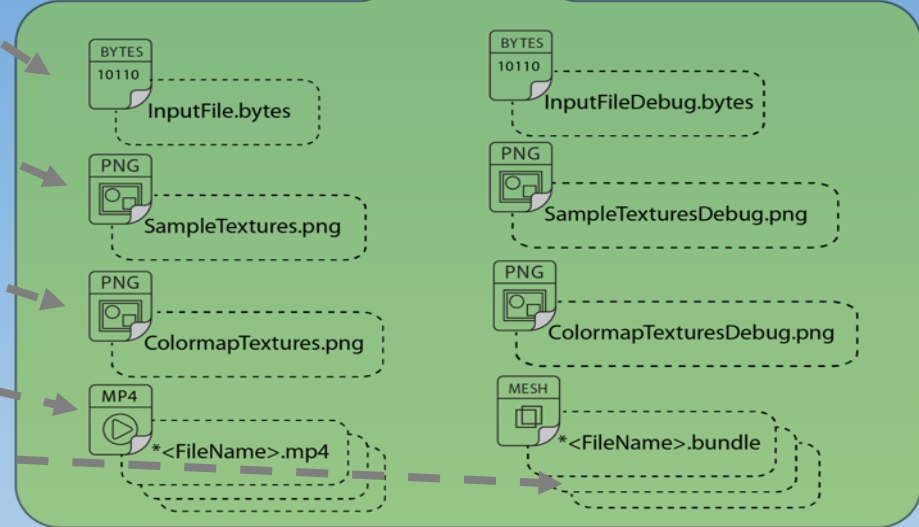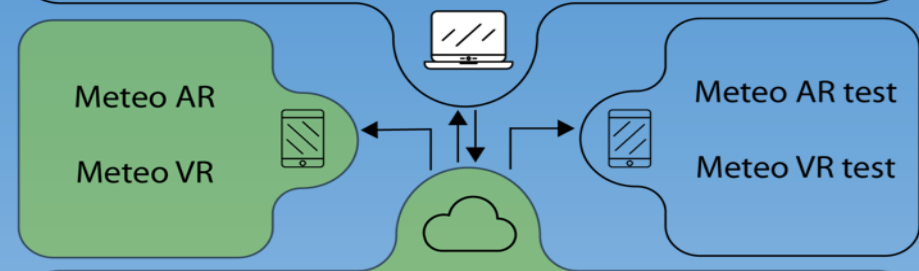
Data Providers

- Desktop app built in Unity and seamlessly integrates with AWS


Production, Test, and Offline Versions
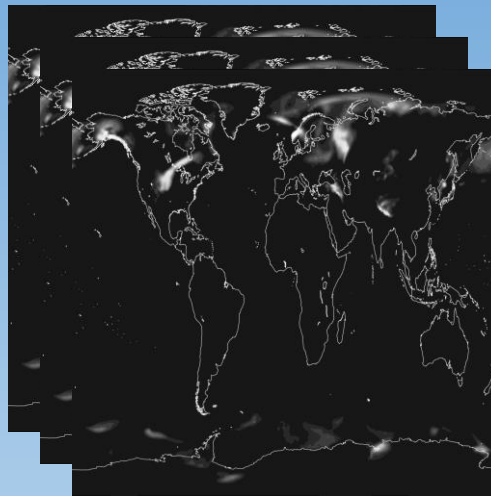
Adding ECMWF Data to Meteo Apps

- Downloaded snowfall data from MARS System
  - ERA-Interim/LAND Global Climate Reanalysis
  - Variable: 2010 Snowfall, 480x241, netCDF, ~500 MB
- NCAR Command Language (NCL) generates CE contour plots:
  - ~200 LOC in the NCL script
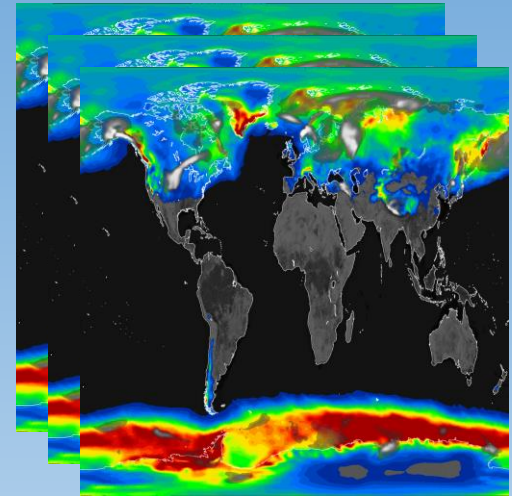 - Daily Snowfall
  - Accumulated Snowfall

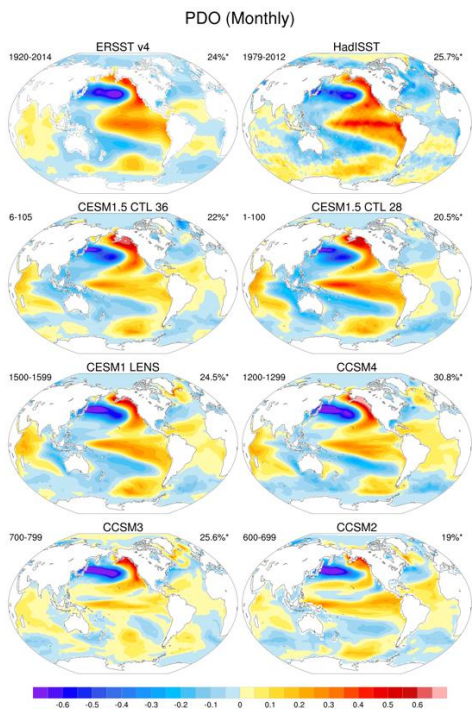Snowfall Accumulation   Snowfall   Overlay

NCAR

Exploring Geoscience with AR/VR
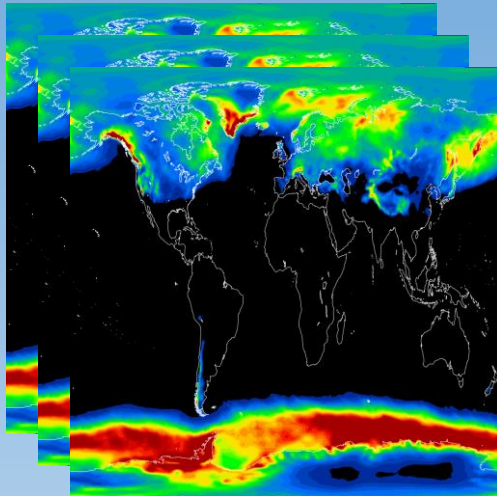
NCAR Command Language
https://www.ncl.ucar.edu/

Scripting language tailored for the analysis of geoscientific data

robust file I/O • specialized computational routines • publication-quality visualizations • intensive training workshops • well-supported • hundreds of examples
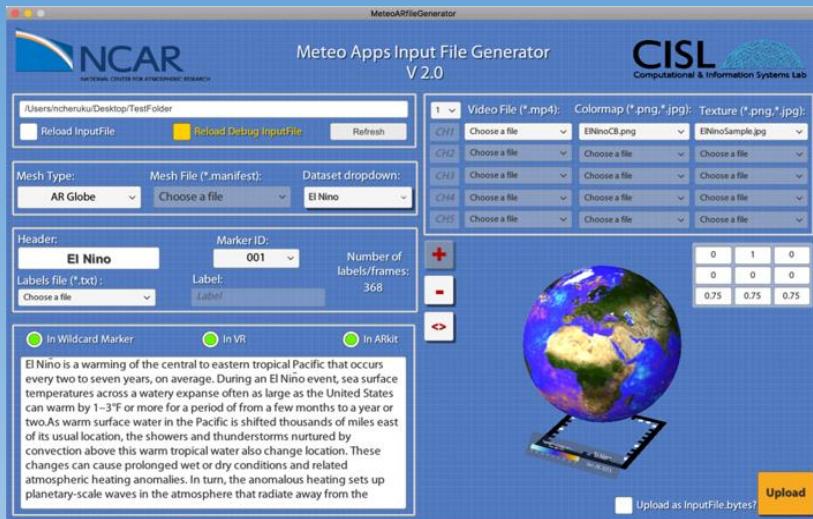
Location and number of NCL downloads : March 2010 to May 2018

Exploring Geoscience with AR/VR
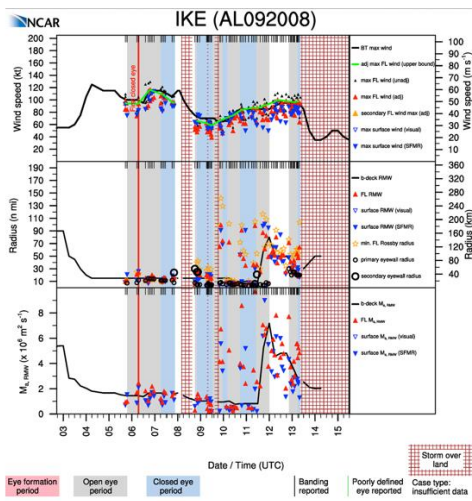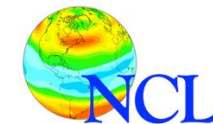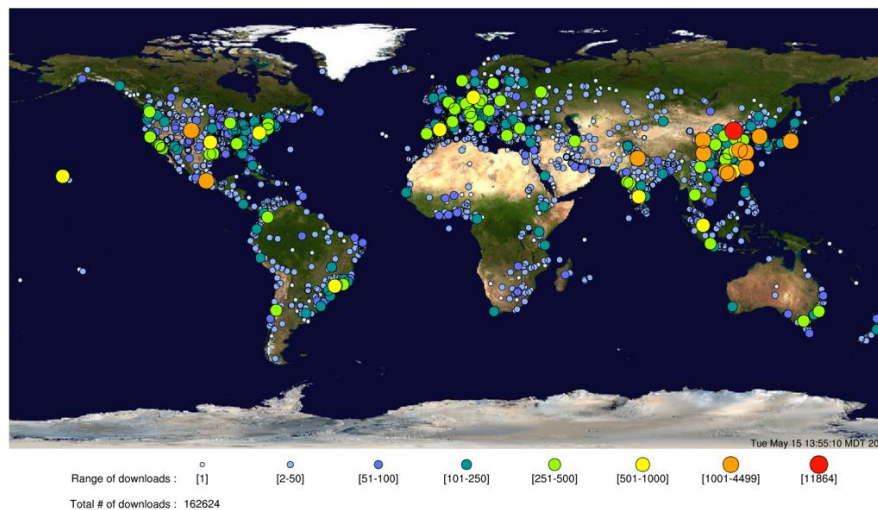
Adding ECMWF Data to Meteo Apps

- MP4 files generated with Quicktime Pro
- Meteo Apps InputFileGenerator application used to ingest imagery
- Tested and published to AWS.
- Science sheet added

iPad Demo

Photo courtesy Jenna Preston and Eliott Foust

Future Directions and Interests

- Markerless AR (ARkit)
- Adding real time weather forecasts
- Work with a partner to develop a curriculum around AR/VR
- Release a version for content developers (to host on their own site)
- 3D printed models with AR overlays

Future Directions: 3D printing with AR overlay

3D Hurricane courtesy
Scott Pearse (NCAR)
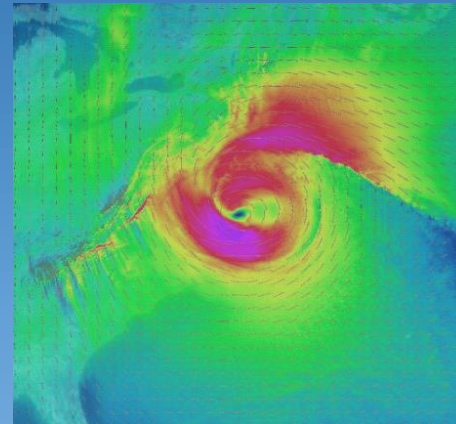
Hurricane windspeed
visualization

Thank you!
&
Questions?

Download the Meteo Apps to your device.

Meteo VR   Meteo AR

NCAR

Exploring Geoscience with AR/VR

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Extra Slides

Meteo AR
Exploring Geoscience with Augmented Reality

Meteo AR (bit.ly/NcarMeteoApp case sensitive) is a free Augmented Reality (AR) application that runs on iOS and Android devices. It displays interactive virtual objects, like an animated globe or a hurricane, over real world imagery that is captured by your mobile device's camera. The app works with downloadable "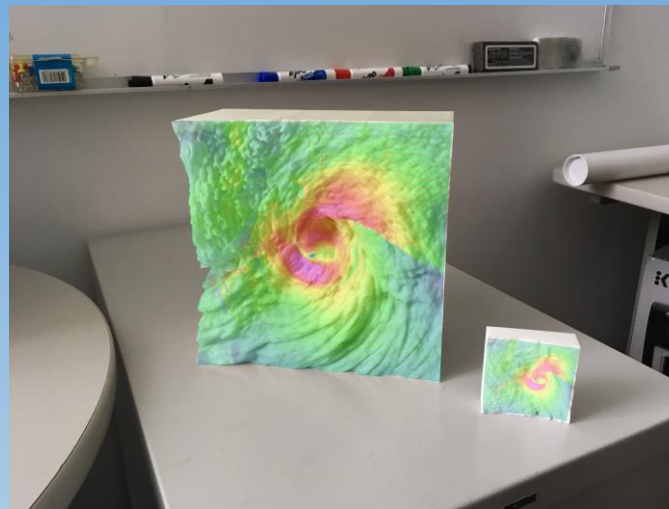science sheets" that include background information about science topics like El Niño, Hurricanes, Climate Change, and more.
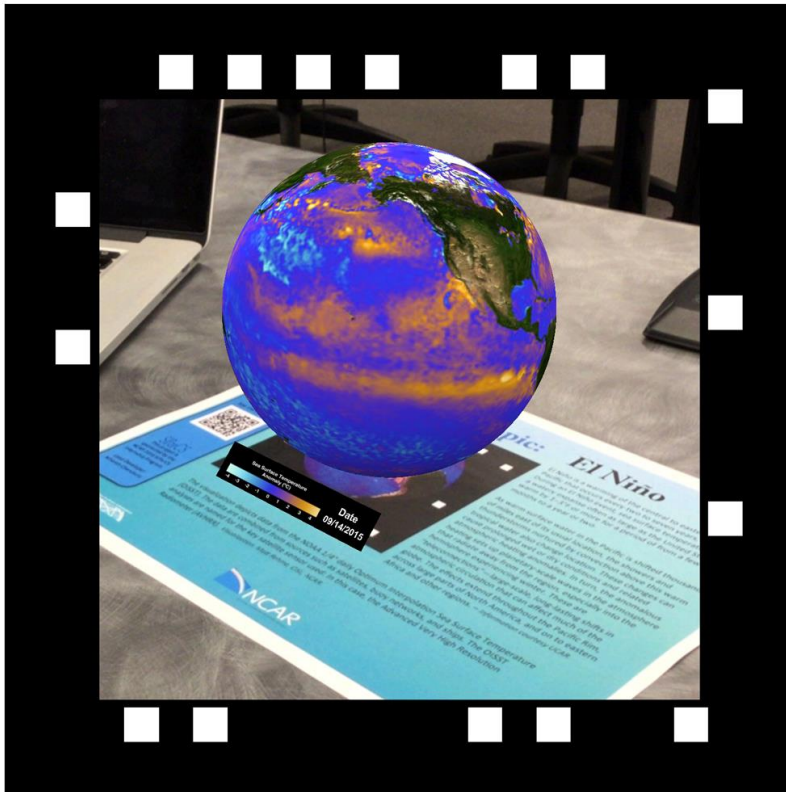
Two Simple Steps

1. Download the Meteo AR app from the Google Play (Android Devices) or the Apple App Store (iOS devices).

2. Run the app and point your mobile device's camera at the image to the left. A virtual object will soon appear!

The image is interactive. Rotate the object with a finger swipe across the screen or explore many other science topics like those shown here!
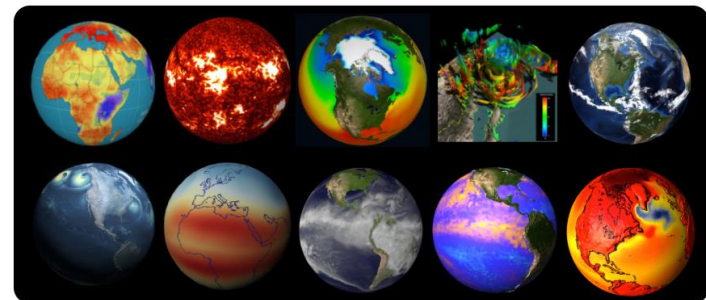
Print out (in color or black and white) a collection of science sheets to explore more topics:

http://bit.ly/NcarMeteoApp-ScienceSheets
(Case Sensitive)

AR

Mobile devices ($200-1000)

http://www.augmentedrealitytrends.com/ar-app/top-augmented-reality-apps-for-ipad.html

Vuzix Smart Glass ($1500 est.) + phone

https://www.vuzix.com/Products/m3000-smart-glasses

Microsoft Hololens ($4000) + PC

https://www.microsoft.com/en-us/hololens/hardware

VR

Google   Cardboard ($15) + phone

https://store.google.com/product/google_cardboard

Samsung Gear VR ($99) + phone

https://consumermediallc.files.wordpress.com/2015/01/samsungvr.jpg

HTC Vive ($500) + PC

http://heavy.com/tech/2016/11/top-best-vr-headset-virtual-reality-oculus-rift-htc-vive-christmas-gifts-gaming-guide-review