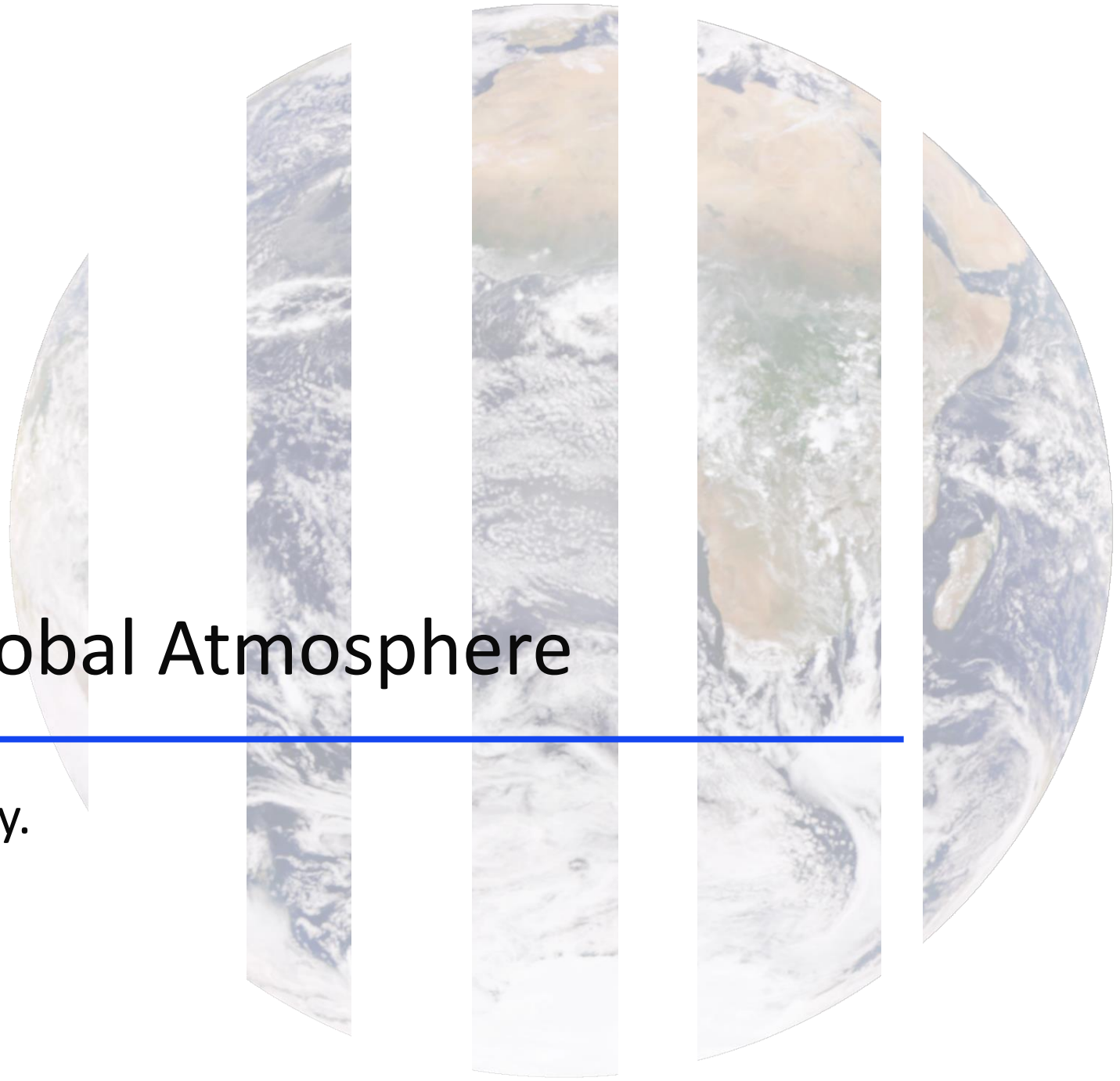
cloudflight



Global Insights for a Global Atmosphere

And how to handle data responsibly.

World Space Forum 2021
Michael Aspetsberger

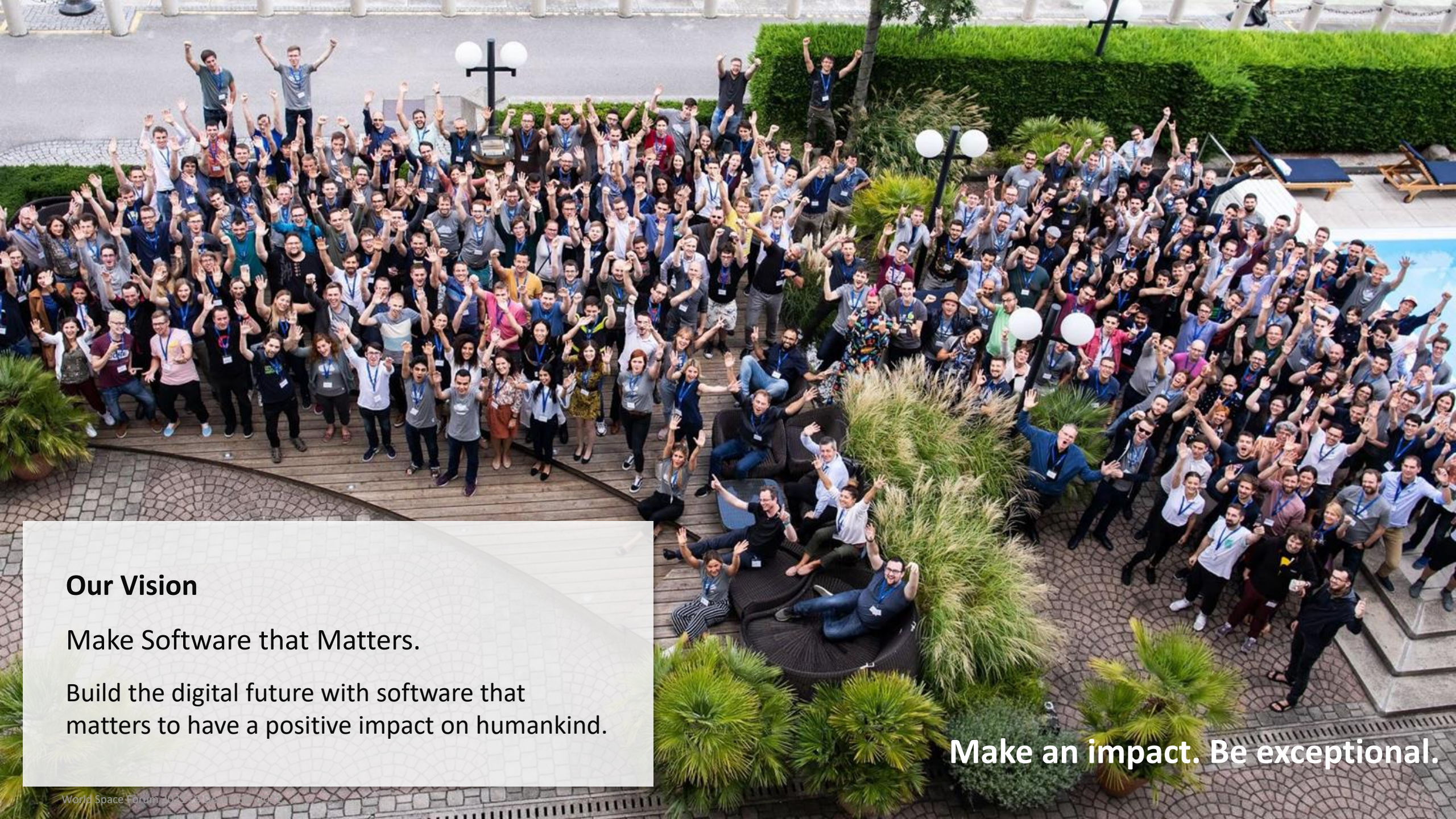
Earth Observation is more accessible than ever.

Whether from LEO, GEO, or as far out as L1, Earth Observation satellites keep a watchful eye – 24x7, 365 days a year.

The number of satellites is at an all-time high, thanks to public contributions and private investments. Space Data as a Service is on the doorstep.

Long term archives, cloud resources, data science and artificial intelligence have all extended significantly the capabilities that existed only a decade ago.

DISCOVR/EPIC Visual Image, 7 December 2021, 11:24, NASA



Our Vision

Make Software that Matters.

Build the digital future with software that matters to have a positive impact on humankind.

Make an impact. Be exceptional.

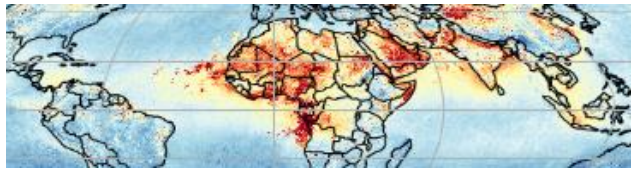
At Cloudflight we have realized a variety of satellite data products.

For the natural Environment, and for artificial structures.

These products were jointly implemented with top science teams across the world.

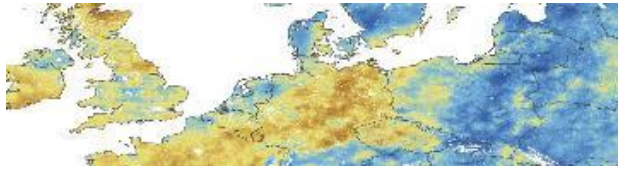
From raw data processing up to integration in decision support platforms.

Atmosphere
Aerosols
Air Quality

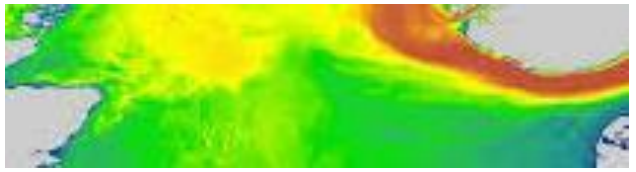


Cryosphere
Snow Cover

Hydrosphere
Soil Moisture
Water Index

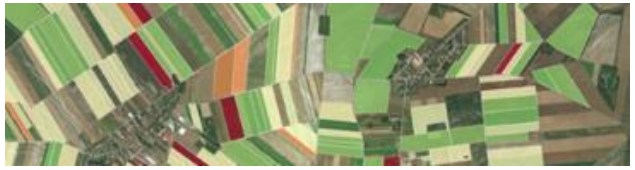


Coastal
Bathymetry
Coastal Erosion

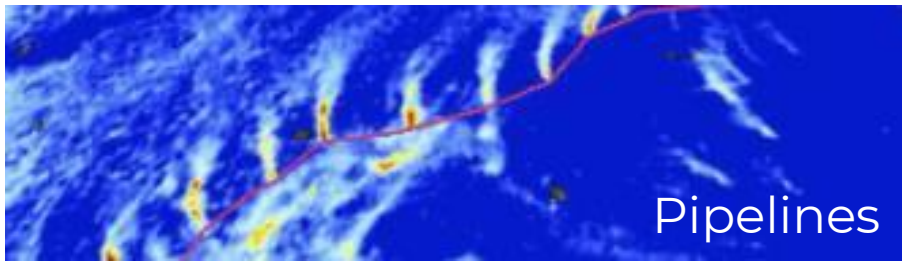


Forestry
Wood Capacity
Storm Damage

Agriculture
Crop Status
Crop Freezing

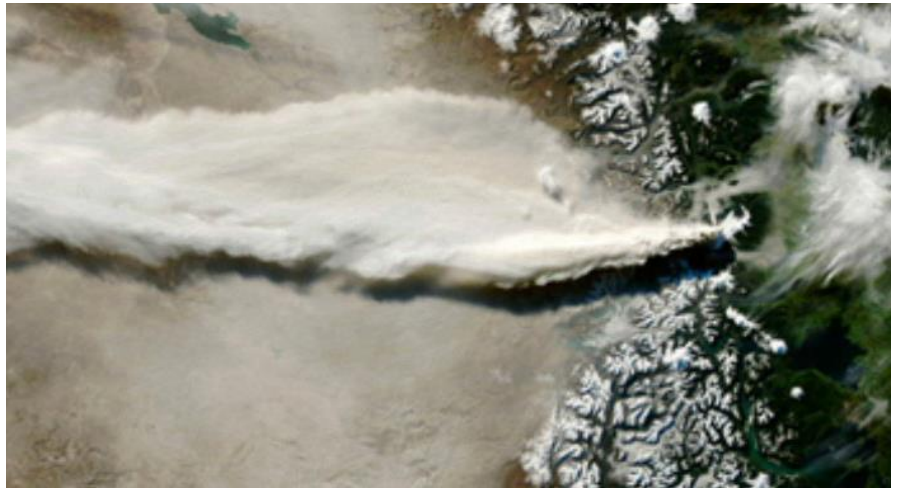


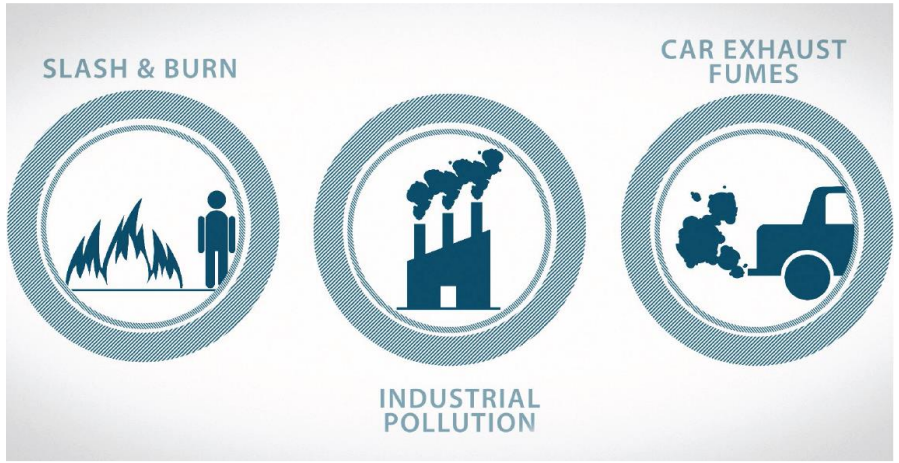
Monitoring assets from anywhere. Construction progress, pipeline status...



Some of the aerosols in our atmosphere have natural sources…

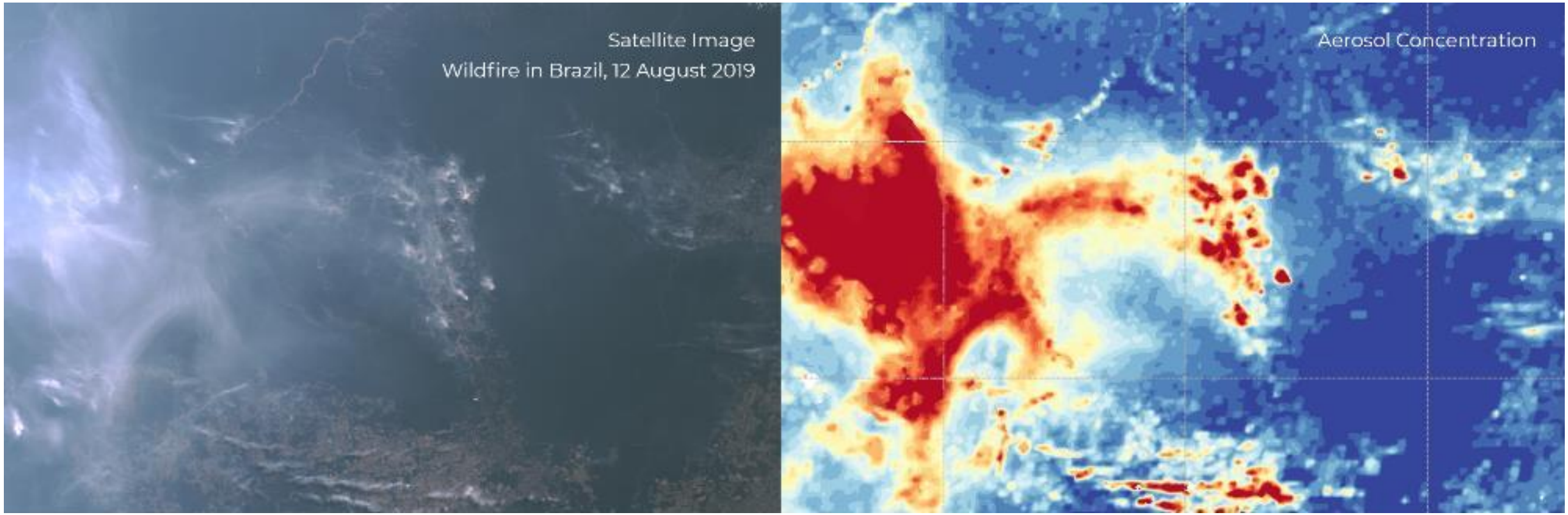
… others are man-made.





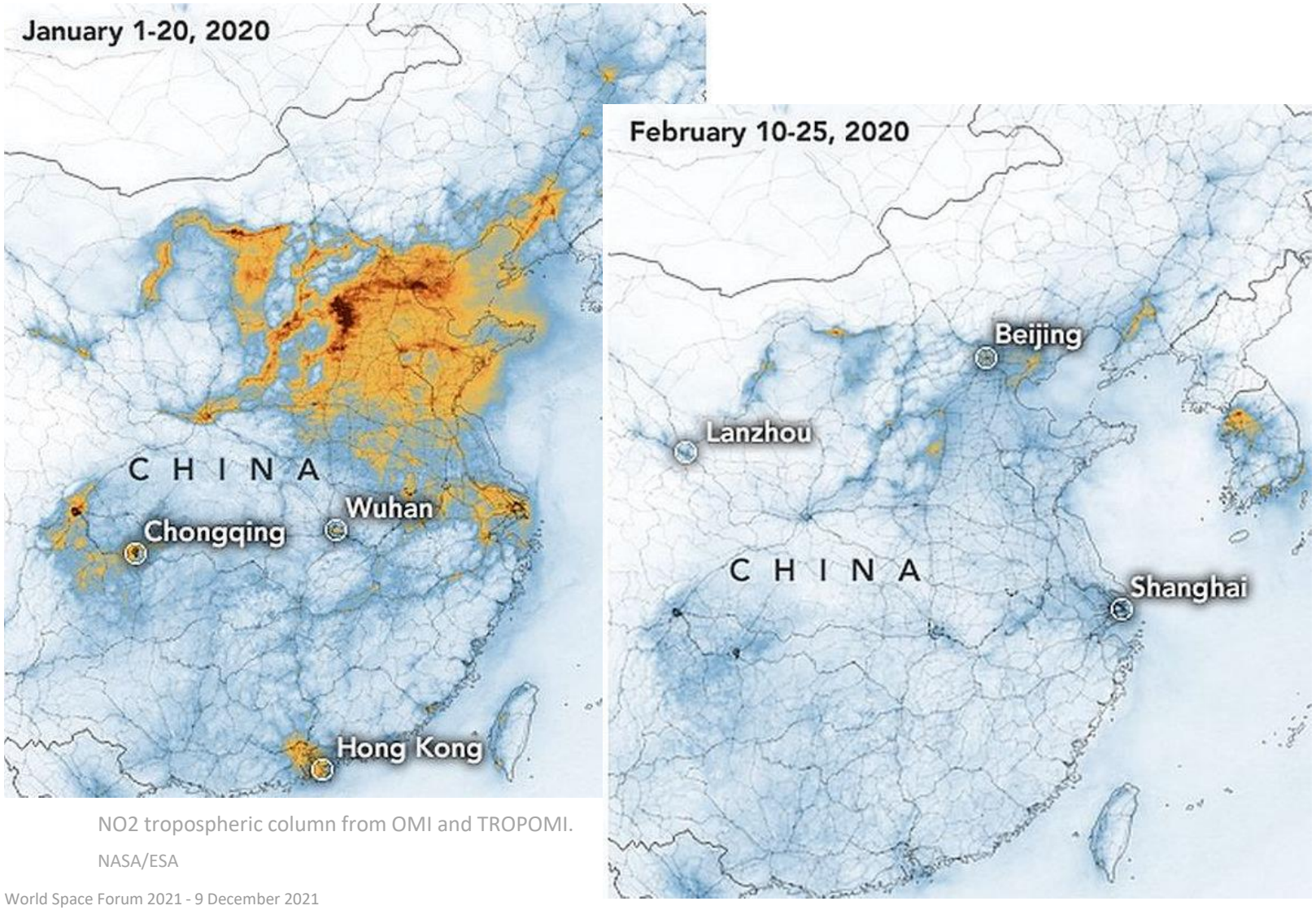
The wide variety of aerosols makes characterization a challenge.

Their impact is felt often regionally but can also get carried over continental distances.



Visual image and Aerosol Concentration from Sentinel-3 OLCI, GRASP/Cloudflight

COVID-19 shutdown and its impact on Air Quality

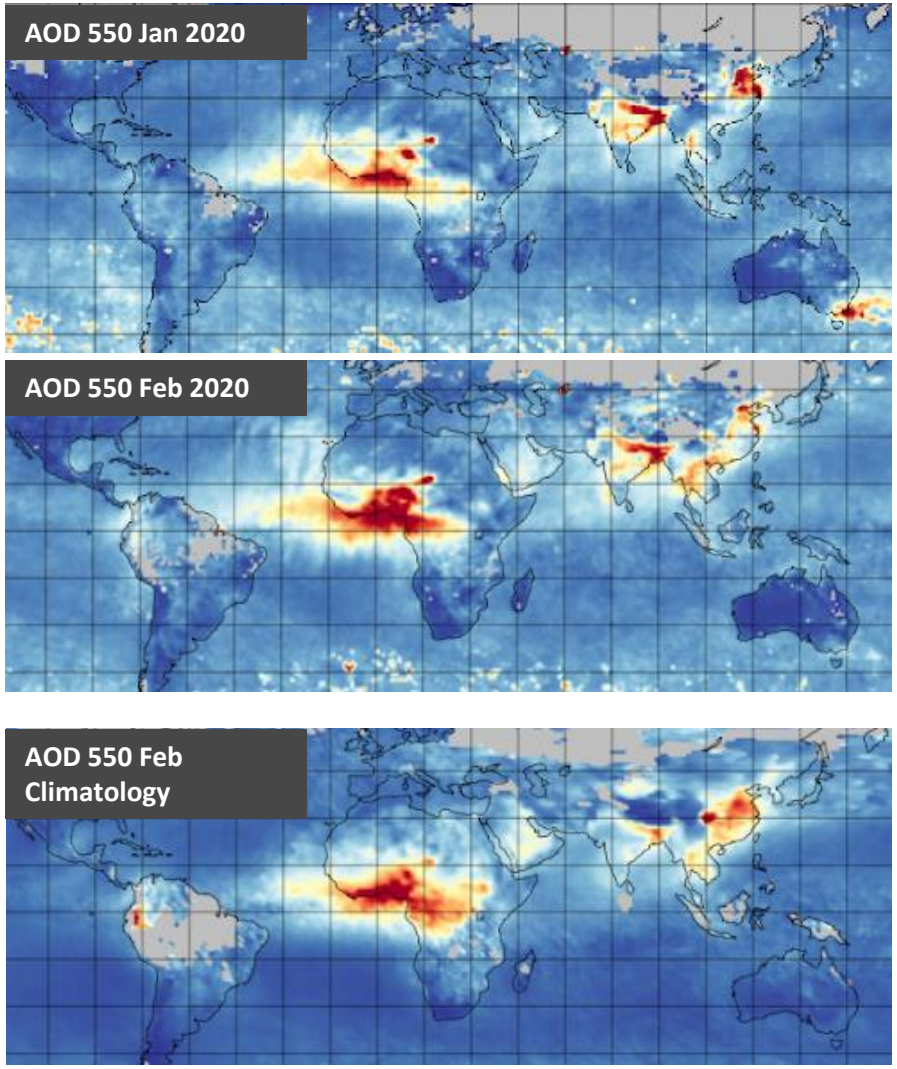


NO2 tropospheric column from OMI and TROPOMI.

NASA/ESA

Satellite measurements have observed a drastic reduction in NO2 over China and Europe, immediatly after restrictions were put in place.

The situation for aerosols was more subtle.



The strong decline visible with NO2 is not that evident in other atmospheric measurements.

While there are little natural sources for NO2, aerosols are often a complex mixture of anthropogenic and natural sources.

Satellite aerosol observations over China in February show a reduction compared to the 10 year climatology derived from GRASP/PARASOL retrievals.

Total Column Aerosol Optical Depth from MODIS/TERRA (top and middle) and GRASP/PARASOL (bottom).

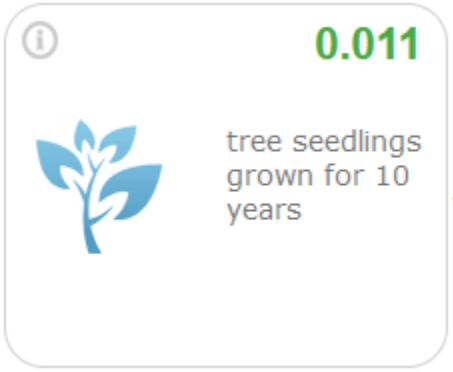
NASA/Cloudflight/GRASP/CNRS

Earth Observation provides a global, objective assessment on footprint of humankind.

Disregardless of the situation down on earth.

But what is the impact of processing all this EO data?

Viewing one single product for a day

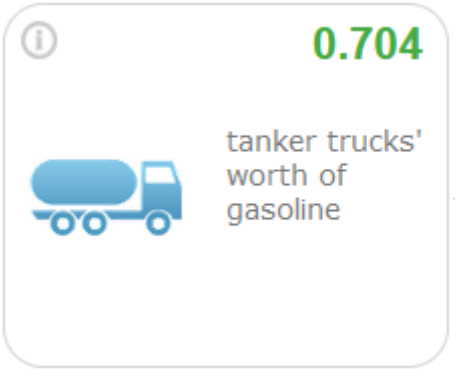


Approx. 0.9 kWh

Storing 100 TB data per year

Approx. 9 MWh

Processing 1PB with 400 CPUs for a month



Approx. 75 MWh

https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Delivering accurate results is not an easy feat

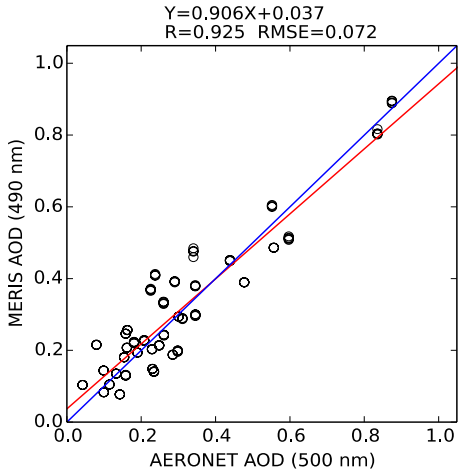
The challenge of providing an accurate aerosol assessment required a rigorous scientific model for GRASP.

$$\mathbf{I}(\mu_0;\mu;\varphi_0;\varphi;\lambda) = \mathbf{L}\left[\mathbf{M}_{scat}(\Theta;\lambda) + \mathbf{M}_{reflec}(\mu_0;\mu;\varphi_0;\varphi;\lambda)\right]\mathbf{E}_0 + mult.\ scat.$$

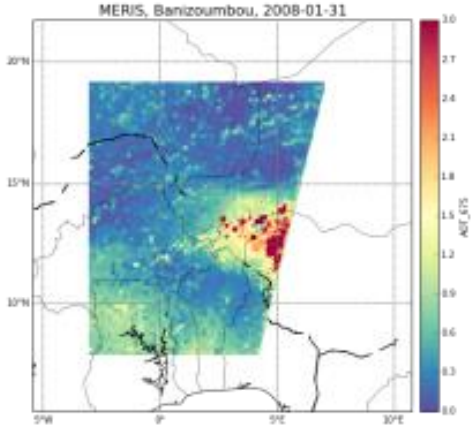
$$\mathbf{M}_{scat}(\Theta;\lambda) = \frac{\mu_0}{\mu_0+\mu}\sum_{i=1,..,N}\left(e^{-\tau_{i-1}}(1-e^{-\Delta\tau_i})\frac{\omega_0^i}{4\pi}\mathbf{P}_i(\Theta;\lambda)\right) \qquad \mathbf{M}_{reflec}(\mu_0;\mu;\varphi_0;\varphi;\lambda) = \frac{\mu_0}{\pi}e^{-\tau^*}\mathbf{R}(\mu_0;\mu;\varphi_0;\varphi;\lambda)$$

...

Computation speed was not the priority.

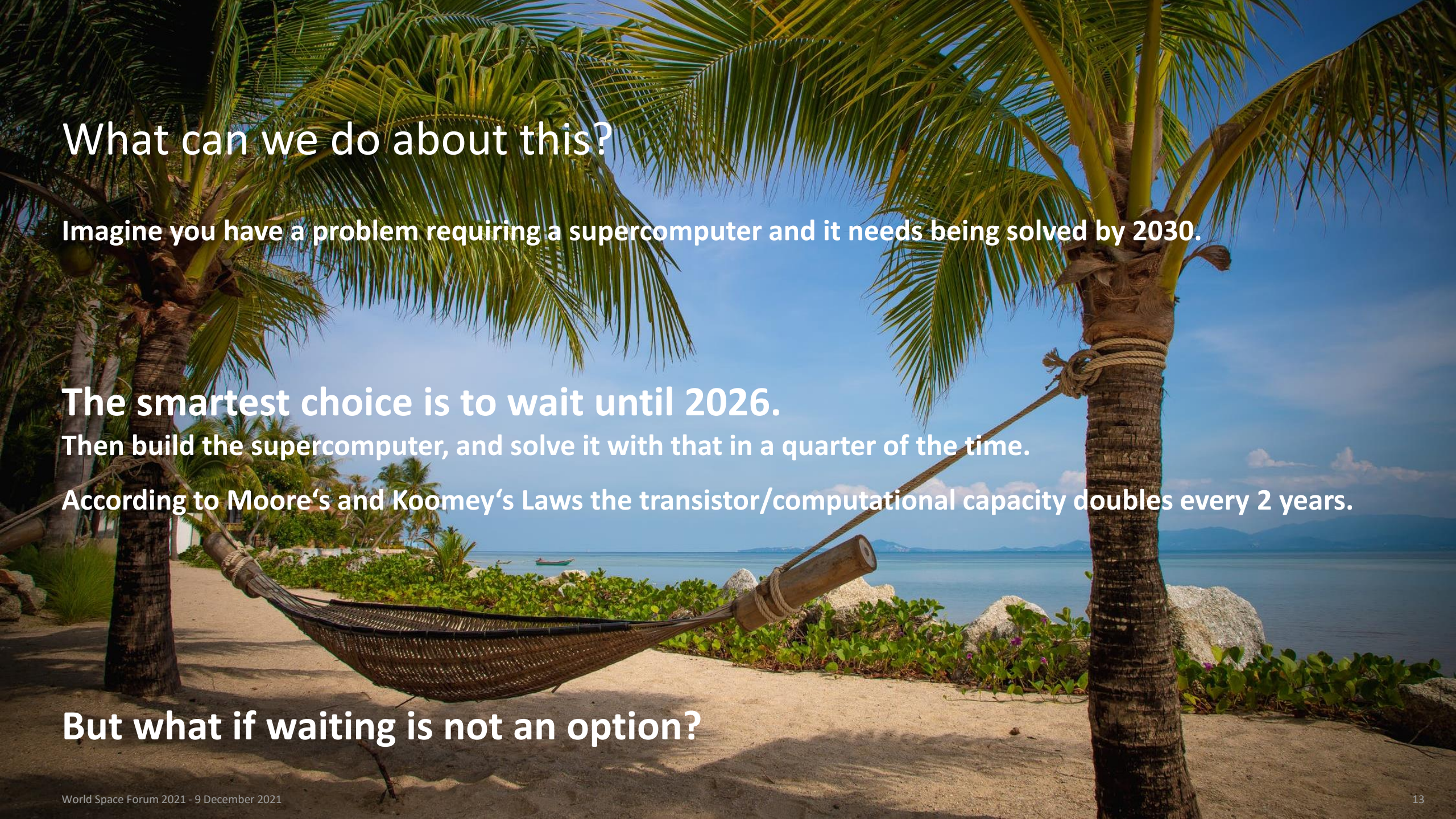


Individual Location



Region

Full Global, Full Mission



What can we do about this?

Imagine you have a problem requiring a supercomputer and it needs being solved by 2030.

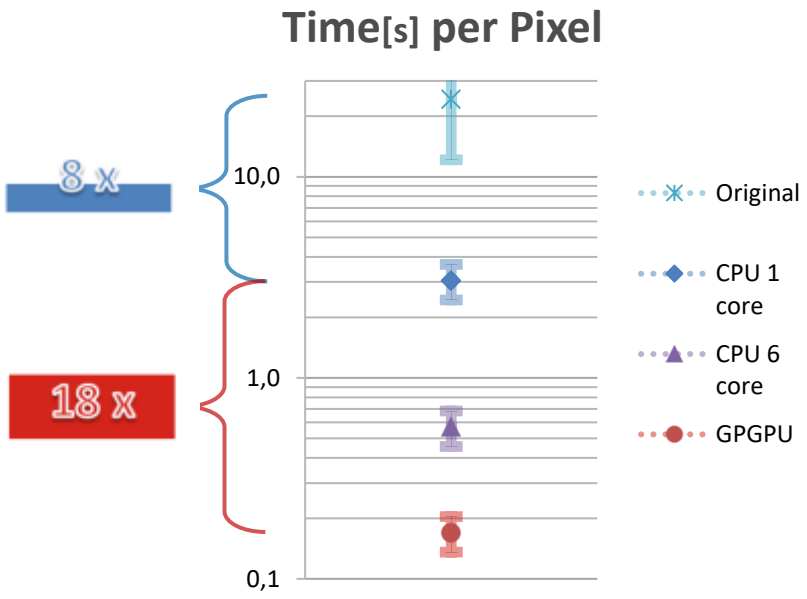
The smartest choice is to wait until 2026.

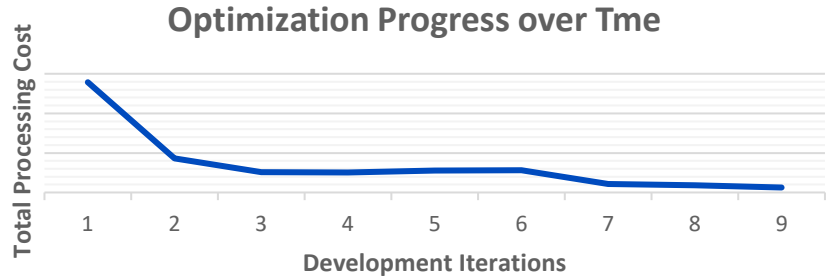
Then build the supercomputer, and solve it with that in a quarter of the time.

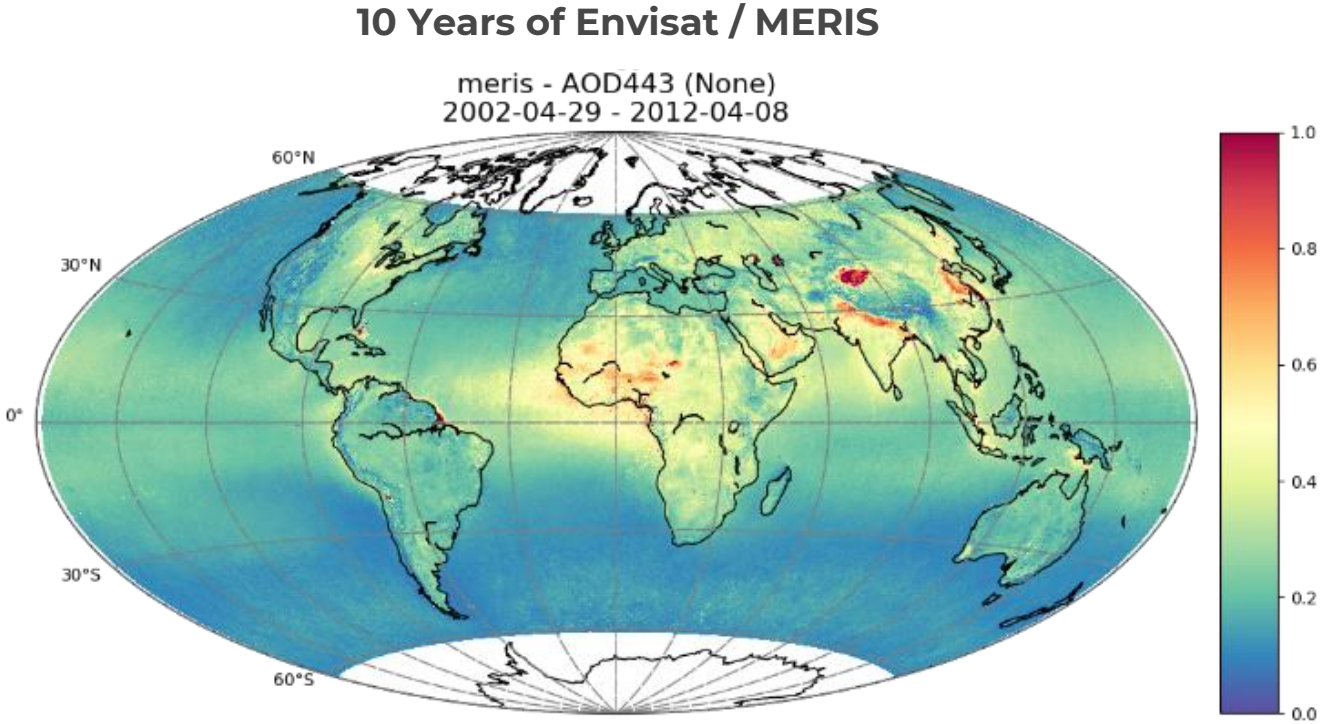
According to Moore‘s and Koomey‘s Laws the transistor/computational capacity doubles every 2 years.

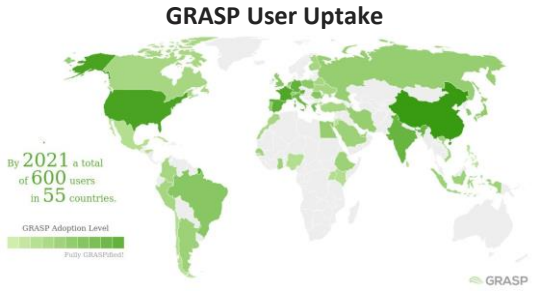
But what if waiting is not an option?

Optimizing made global results possible and justifiable.

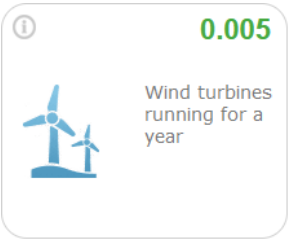








Production required the equivalent of:



or 1 turbine for 2 days

cloudflight

Optimizing algorithms will be essential to manage environmental impact and costs.

After all, monitoring should make the world better, not worse!

Michael Aspetsberger

Algorithm Acceleration Service is available via the Network of Resources

esa NoR