Hydroterra
Background and scientific objectives

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25/06/2020

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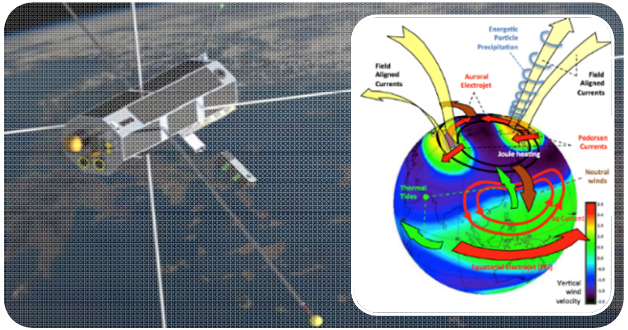
Earth Explorer 10 mission candidates (Phase 0)

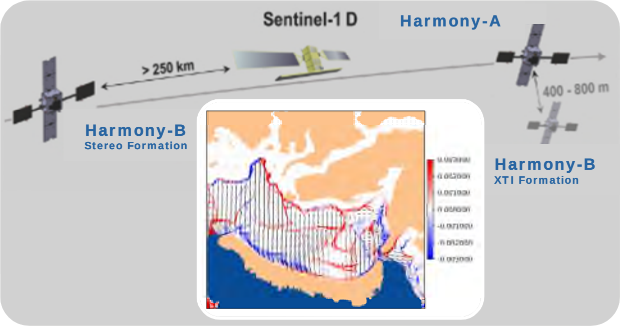
Daedalus
Exploring the thermosphere-ionosphere



Key science and mission objectives
- Measure previously inaccessible atmospheric structure and electrodynamics processes in the lowermost TI (between ~100 – 500 km)
- Improve understanding of Sun-Earth coupling, energy deposition, composition and dynamics

Proposed mission concept
- Full suite of *in situ* plasma, neutral atmosphere, particles, and electro-magnetic fields instruments
- Periodic micro-satellite release for probing lowermost layers and multi-point measurements
- Elliptical orbit with perigee ~150 km and deep dips

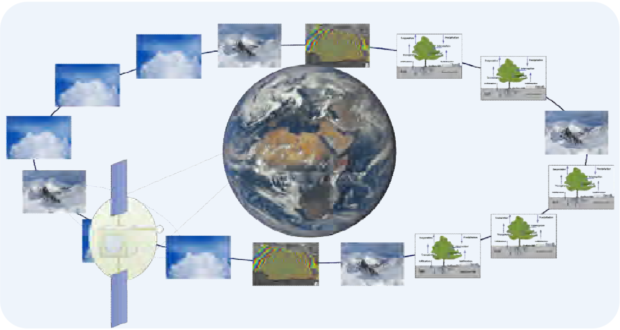
Harmony
Measuring surface deformation



Key science and mission objectives
- Measure small displacements in ocean surface, cryosphere, and solid Earth
- Improve understanding of ocean sub-mesoscale circulation patterns, ice dynamics/mass balance, and 3D deformation fields in land topography

Proposed mission concept
- Two passive receiving antenna satellites for bistatic SAR, flying in formation with Copernicus Sentinel-1
- 3D Doppler/backscatter measurements +TIR
- Baselines of ~250 km, configurable constellation for along- and cross-track interferometry

Hydroterra
Monitoring the diurnal water cycle



Key science and mission objectives
- Excellent temporal sampling (minutes to hours) for new understanding of the water cycle over land
- Improve prediction capability for intense rainfall and its impacts: flooding and landslides
- Observe daily cycles of surface moisture (soils, snow) for agriculture and water resources
- Enable near real-time monitoring of ground motion

Proposed mission concept
- C-band radar in geosynchronous orbit, with flexible imaging capability over Europe and Africa
- Excellent low to mid-latitude coverage

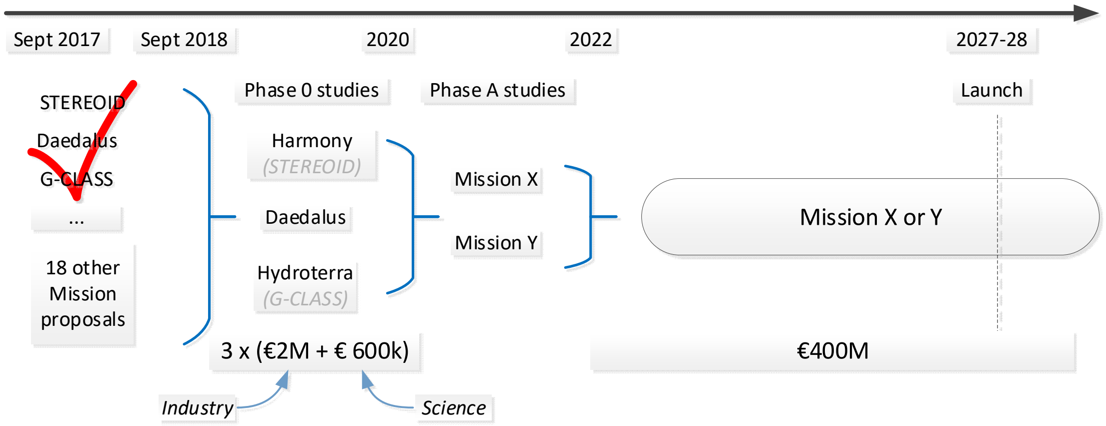
Status of the Phase 0 Review Process

For each of the three candidates there are science studies underway in parallel with two industry teams assessing the implementation feasibility

- A key document is the "MATER" (Mission Assumptions and Preliminary Technical Requirements) as interface between us and the industry teams

Review by ESA's ACEO committee on 30 Nov – 2 Dec 2020 will decide which missions progress to Phase A study

- Science studies will complete by end of October
- Each team is also preparing for Phase A to enable smooth continuation if chosen



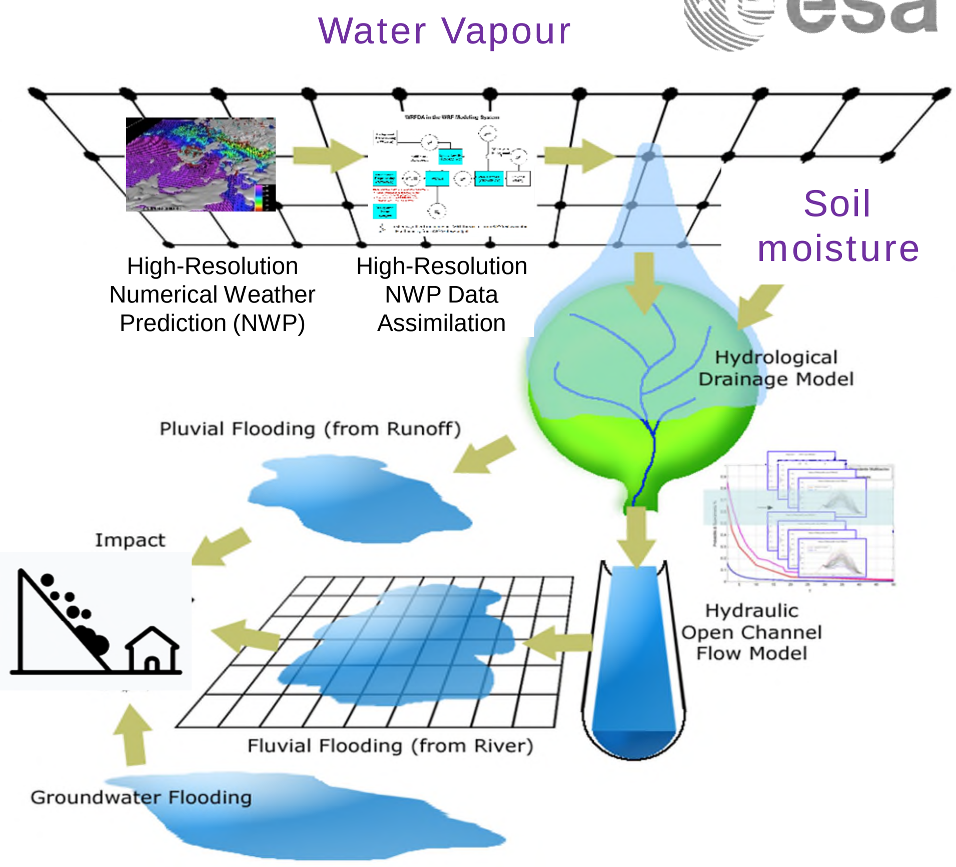
European Space Agency

Hydroterra: Mission Aim

The mission will measure key elements of the water cycle over land, providing observations every several hours or better and at regional scale (1 000 km or more).

These elements are

- Central to our <u>understanding</u> of hydro-meteorological processes and the surface energy balance
- They control <u>impacts</u> in terms of floods, landslides and water availability for agriculture and society in general.



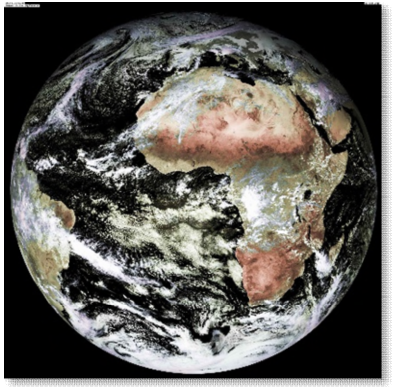
The Water Cycle

… is central to Earth system science

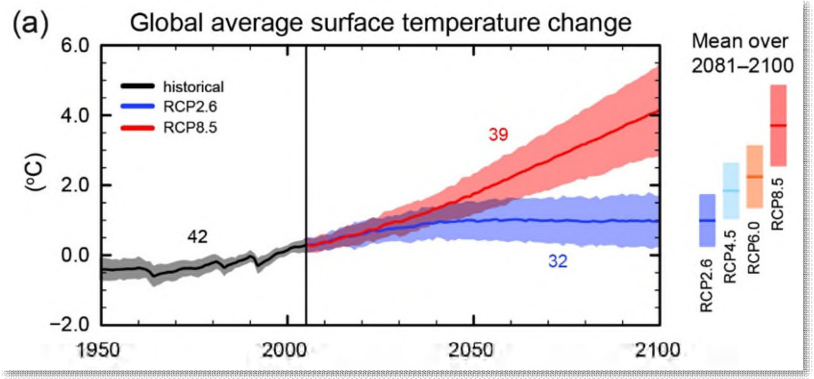
… and provides many ecosystem services for society

Drivers of current Earth system science are

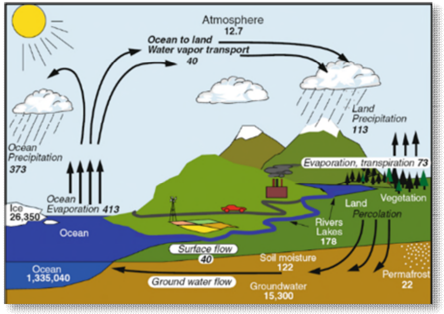
- Climate change – we need improved models which better capture fine-scale process physics
- Advances in modelling – higher spatial and temporal resolution
- Global change – rising population, more pressure on natural resources, etc.



Meteosat image



IPCC 5AR (2013)



Trenberth (2007)

Hydroterra Science Goals

Hydrometeorology

- Resolve fine-scale dynamic processes in weather systems
  - Coupling between land surface and the atmosphere
- Intense rainfall in Africa and around the Mediterranean

Emphasis on the ***atmosphere***

Surface Energy Balance

- Diurnal changes of surface moisture (soil, vegetation)
  - Soil drying, intercepted precipitation / evaporation, vegetation moisture content (μwave optical depth)
  - Irrigation (70% of fresh water use)
- Agriculture, water resource management

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Land Cryosphere

- Snow accumulation, snow-pack diurnal changes, snow-melt; glacier motion

Solid Earth (*opportunistic science*) – landslides, volcanoes, earthquakes

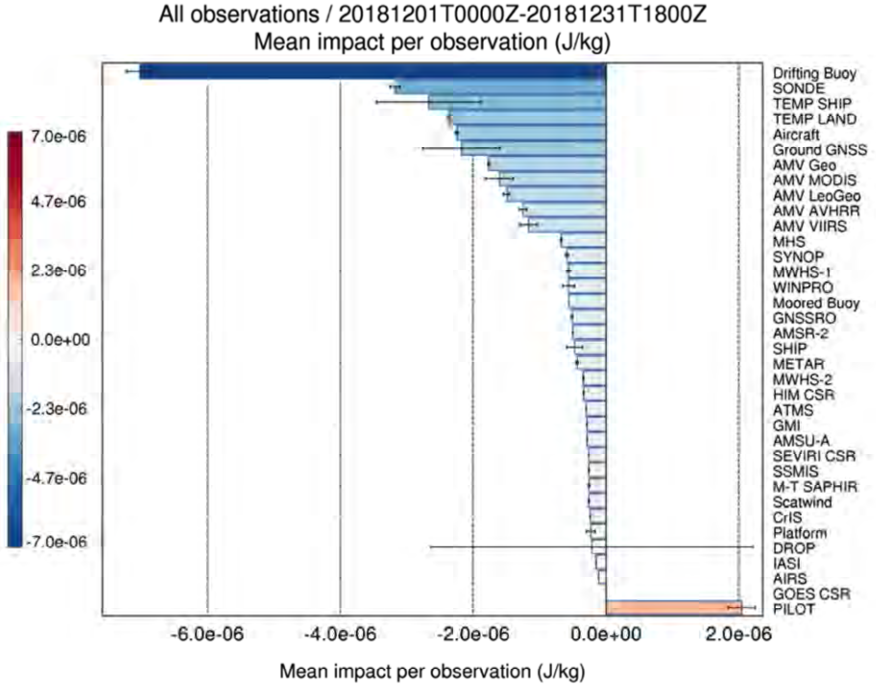
Science goal: Hydrometeorology

Dynamic processes involve water vapour (WV)

- GNSS is currently the most "valuable" space-based observation of IWV (Integrated WV)
- Significant value in improving geographical coverage and spatial resolution while maintaining temporal resolution

Current research gaps / drivers:

- Mismatch between resolved and required scales of weather and hydrology for hydrometeorological modelling
- Lack of model physics at fine scales
- Simplistic surface hydrology
- Extreme events becoming more frequent



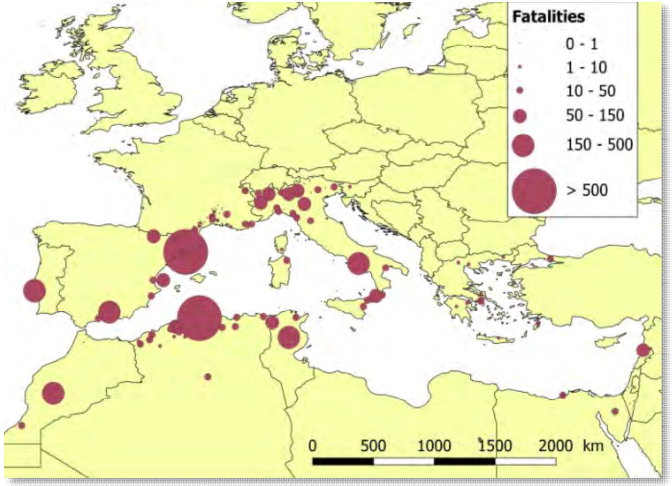
Hydrometeorology: Intense Rain

Location, timing, and intensity of intense rain are difficult to predict

- Current observations fail to capture these accurately

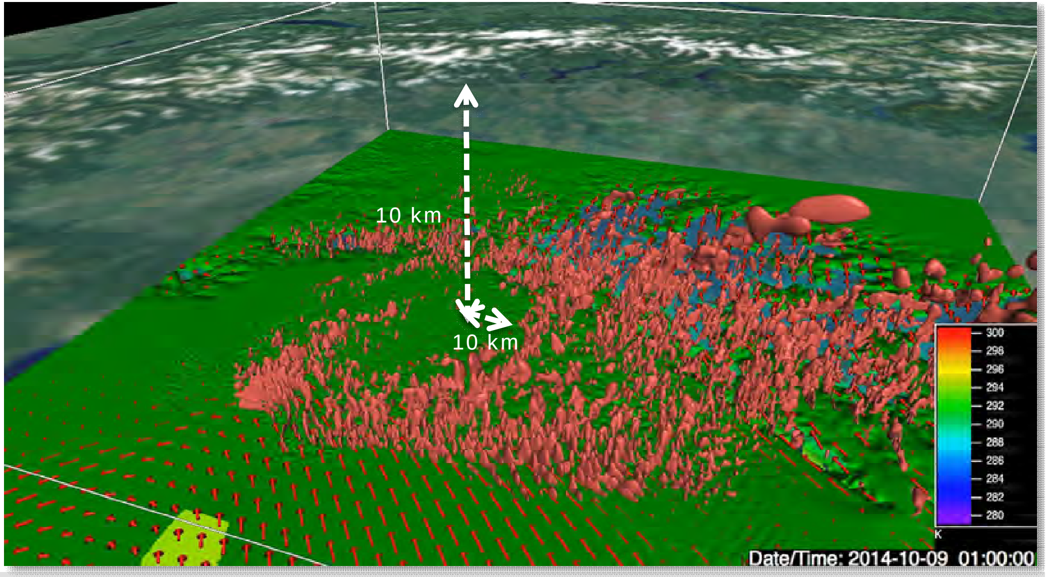
Civil authorities need actionable information to better respond to floods, especially flash-floods

Bingley (UK) floods (2015)

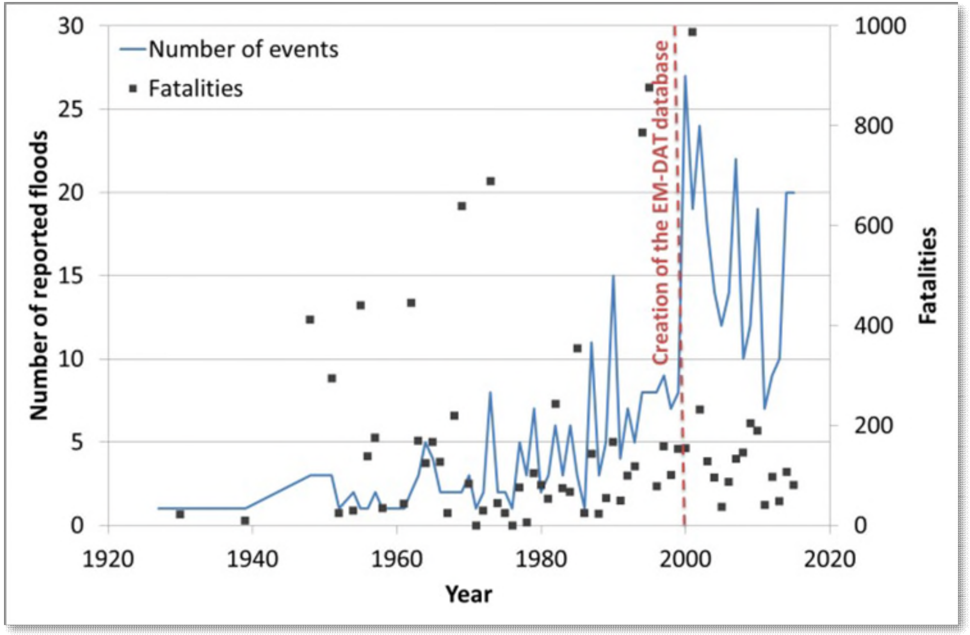


Distribution and impact of flash floods around the Mediterranean (1940-2015)

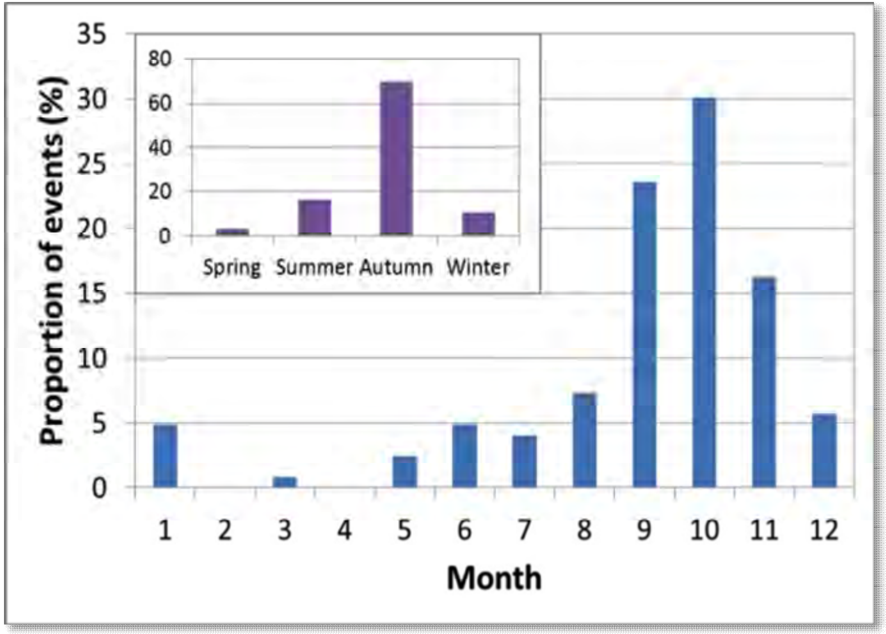
Fiori et al., QJRMetSoc (2016)



Flash-floods in the Mediterranean region



Changes in the number of damaging floods in the countries surrounding the Mediterranean Sea in the EM-DAT database.



Number of people reported killed each month in documented flood events over the period 1940-2015 (Gaume et al., Mediterranean extreme floods and flash floods, sec 1.3.4 of Med. Region under Climate Change, ed. Allenvi, IRD, 2016)