Splinter Session Outcomes
EO Candidate Science Questions Review

Room Ambassadeur – Red Badge

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Approach to science strategy taken

- Where are benefits to society inhibited by lack of scientific understanding of Earth system processes?
- Where is understanding of these science processes inhibited by lack of appropriate Earth observations?
- What should ESA set as priorities to respond to the barriers set out under (2) above?

And:

- What are the system-level actions needed by ESA to underpin the above specific Earth observation actions?
- How can we ensure that 'discovery science' in Earth Observation is still enabled by ESA?

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CSQ11. How can we improve early warning of extreme events and climate hazards?

CSQ15. Which specific observations are needed: polar / tropical regions, new measurement techniques vs long-term series of observation, large-scale field experiments?

CSQ14. What are the main issues with calibration-validation, absolute calibration, long-term monitoring?

CSQ01. What anthropogenic and natural processes are driving the global carbon cycle?

CSQ02. How has the land biosphere responded to human activity and climate change?

CSQ09. What are the characteristics of the processes related to climate extremes and the hazards related to them?

CSQ10. How can we improve the characterization and preparedness for risks related to compound climate extremes?

CSQ20. What is the mass balance of the cryosphere and how is it changing over time?

CSQ29. Can we better quantify the temperature thresholds, time scales, and impacts of identified tipping points?

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Seed questions - EO Candidate Science Questions Review

1. How complete are the Candidate Science Questions (CSQs): description & justification ?

- Within the scope of the current CSQs being discussed, is there anything important missing?
- Are there additional knowledge advancement objectives within a CSQ that need to be added or other existing elements to be refined ?
- Are there any important CSQs you think are missing and can be documented and justified to the same level of detail as the current CSQs?

2. What is the expected Science Impact of the current CSQs ?

- Which are the CSQs that you consider will have the biggest impact on Earth system science and how is this impact expressed (e.g. improved understanding, reduced uncertainty, societal needs) ?

3. What are the timescales associated with CSQs and knowledge advancement objectives ?

- Which CSQs can be advanced significantly in medium term 5-6 year timescale (typically supported by data from existing or soon-to-be available EO missions) ?
- Which CSQs will take much longer and might require new observations not available in the near future?
- How can progress be measured for both medium and longer-term time scales ?

4. Overall prioritization

- What factors in addition to science impact should be most important in ranking CSQs for consideration in a future EO science Strategy ?
- How can these factors be quantified ?

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CSQ09. What are the characteristics of the processes related to climate extremes and the hazards related to them?

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CSQ11. How can we improve early warning of extreme events and climate hazards?

- Representation of extremes in models still not very good
  - Particularly for compound events
- Need for more frequent observations, e.g. hours (floods) to 1-3 days (vegetation)
- How to make NRT data consistent with Climate Data Records
- Missing from Extremes: snow, ocean vertical profiles, air-sea coupling (El Nino), compound events (e.g. marine heat waves)
- Other observations from EUMETSAT, NASA, New Space, Copernicus – science need to integrate across all space assets
- Use of AI to make sense of complex data streams across disciplines
- What is “Early warning"? – how early and for whom ?
- Adaptability – capacity to respond to early warning and adapt
- Impact of large scale variability on short-term extremes
  - Long-term datasets as basis for extreme detection and prediction
- Facilitate access and use to CDR, expand CDR portfolio to more variables

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CSQ14. What are the main issues with calibration-validation, absolute calibration, long-term monitoring?

CSQ15. Which specific observations are needed: polar / tropical regions, new measurement techniques vs long-term series of observation, large-scale field experiments?

- Need for simultaneous measurements for in situ (forcing and fluxes), but also for satellites (same orbits, tandem, convoys)
- Missing: Arid regions need more in situ observations (arid regions will increase in time)
- Merging datasets to gain additional insights
- Polar and tropics characterised by cloud cover – develop new technique to measure properties in cloud (and nighttime)
- Focus on climate change hotspots, rather than 'polar' or 'tropics'
- Continuity mission-to-mission, continuity of measurement while technology and methods evolve.
- Need for long-term reference targets (validation sites, vicarious, ensure validation capacity within Europe)
- Uncertainty estimation for propagation of error is essential
- Collocate observations with atmospheric corrections

CSQ01. What anthropogenic and natural processes are driving the global carbon cycle?

CSQ02. How has the land biosphere responded to human activity and climate change?

- Coupling water cycle and carbon cycle
- Uncertainties to be addressed include:
  - terrestrial carbon sink,
  - land use/management choices,
  - impact of disturbances and extremes (fire, diseases, insect outbreaks, droughts/floods)
- Large disagreement on estimates of land use change
- Ocean carbon cycle – missing ?
- How to accurately account for carbon fluxes from wetlands (double-counting) - is it a lake, a pond…?
- Connect and coordinate better with in situ networks and operators

CSQ20. What is the mass balance of the cryosphere and how is it changing over time?

- Global know relatively well but regional more problematic
- Need better regional climate models for better precision in mass balance estimates
- Ask the modellers what observations they need ?
- Missing?
  - snow mass at high resolution
  - snow on sea ice

CSQ29. Can we better quantify the temperature thresholds, time scales, and impacts of identified tipping points?

- Long-term variability v abrupt change
- No consensus on what constitutes a tipping point
- Tipping point identified from Earth System Models that miss important processes
  - Use of EO for further definition and quantification of processes in tipping points
- Missing?
  - marine ecosystem response as tipping point ?
  - Land erosion accelerated by extremes ?

- Rephrase the question: replace ‘temperature thresholds” with “environmental thresholds”

- ESA Tipping Point workshop: check these questions are consistent with outcome of workshop

General comments/Common themes

- Need for improved temporal sampling
- Need for improved in situ observations for all questions
- Anthropogenic and Natural: vulnerability, resilience, adaptation
- How to convert science results into actionable information for policy makers and general public
  - Priority on societal impact on land
  - Communication through media

What next ?

- Community want opportunity to comment more on CSQs
- Community can submit new CSQs for aspects not covered by existing questions (not enough time)
  - Check existing CSQs (57) and Objectives (100+)
- Prioritisation on the basis of: science relevance, feasibility in 5-6 years timeframe, societal benefits