EO science strategy workshop

7-8 May 2024, ESRIIN

Splinter session 2

Advancing EO Science Priorities during the next 6 years

Summary

Session chair: Diego Fernandez, Susanne Mecklenburg
Rapporteurs: Anna Maria Trofaier, Gunther March, Edward Malina, Thorsten Fehr, Michael Eisinger, Marie-Helene Rio, Roberto Sabia, Stephen Plummer, Espen Volden

Subgroup on ATMOSPHERE

Splinter session 2 – Atmosphere subgroup

CSQs felt relevant to the Atmosphere:

- CSQ-1
- CSQ-2
- CSQ-3
- CSQ-7
- CSQ-24
- CSQ-43
- CSQ-44
- CSQ-45
- CSQ-46
- CSQ-48
- CSQ-51

Splinter session 2 – Atmosphere subgroup – Summary 1

- Do the selected 22 science questions covers the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?

  Policy areas missing
  - UN Convention on Long-Range Transboundary Air Pollution (LRTAP)
  - UN Ozone depletion: Montreal protocol, Kigali Amendment
  - EU directives on air quality and Public Health
  - Environmental issues on top of climate issues

  Science questions missing
  - Dynamics, including troposphere-stratosphere exchange, and stratosphere-mesosphere coupling
  - Air pollution, including its long-term trends and health effects
  - Nitrogen cycle

- What are the main scientific opportunities and need considering the EO missions that will be flying and launched in that time frame?
  - Air pollution: Sentinel-4, diurnal cycle! Sentinel-5/p, satellites synergy for transboundary pollution,
  - Tropospheric pollution and GHGs: Sentinel-5/p and many others, use of satellite data to quantify anthropogenic emissions
  - Carbon Cycle: CO2M
  - Clouds, Aerosols Radiation Budget: EarthCARE, FORUM, combination with IASI-NG and international partners
  - Profiles of Ozone: Altius coming up
  - Supported by Diurnal Cycles
  - Perceived lack of preparation for data exploitation
  - Use of emerging technologies - make AI part of it, but not to the detriment of physical models/retrievals
  - Assimilation of satellite data into models, including AI models
  - Long-term monitoring of atmospheric constituents, including pollutants
  - Focus on urban pollution and environmental change

Splinter session 2 – Atmosphere subgroup – Summary 2

- * Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years?
  - CSQ-1** key atmosphere topic, CO2M, Sentinel 5
  - CSQ-24: FORUM (20 years of IASI data)
  - CSQ-43,44,46: Clear assessment for EarthCare!
  - CSQ-2,3,7,48: Progress possible in some sub-areas
- * What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?
  - Publication based assessments (peer review process)
  - Need to be individually defined per science question
  - Predictability skills for weather, climate, and atm. composition models
  - Socio-economic impact studies

Splinter session 2 – Atmosphere subgroup – Seed Question 1

- Do the selected 22 science questions covers the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?

It was felt that the 22 questions could have included a more clear route for atmospheric science, this was captured through from the following discussion

Policy areas missing

- UN long-range transport of pollution protocol (transboundary pollution)
- Ozone recovery (UN Ozone depletion, montreal protocol, Kigali amendment)
- EU directives

Science areas missing

- Dynamics completely missing (gravity waves, Brewer-Dobson circulations)
  - Relevant for both pollution transport and climate exchange
- Preparing for next generation of missions and data
- Nitrogen cycle needs to be mentioned, including challenges surrounding ammonia.
- CO2 emissions, not just the carbon cycle
- Ozone, both stratospheric (long-term dynamics and recover), and tropospheric (health and GHGs).
- Not well-mixed greenhouse gases
- Air quality (NO2, SO2, VOCs, others), including their long-term trends and health effects
- Precursors in all aspects of atmospheric composition (e.g. NMVOCs)
- Diurnal cycles of clouds combining GEO and EarthCARE
- Direct mention of exploitation of S4, S5, EarthCARE missing, but understood that CSQs were trying to avoid explicit mentions of this

Synergisms missing

- Wording of questions might be too specific, so not cover everything
- Stratospheric-tropospheric exchange - limb-sounding capabilities
- Stratosphere-higher atmospheric coupling
- Science preparation for the future
- Synergistic use of missions

Splinter session 2 – Atmosphere subgroup – Seed Question 2

- What are the main scientific opportunities and need considering the EO missions that will be flying and launched in that time frame?

Missions

Sentinel 4 AQ diurnal cycles, CO2M carbon cycle, Sentinel 5 carbon cycle, tropospheric solution, EarthCare - Aerosol Cloud interaction, radiation balance, FORUM (Earth's radiation budget), ALTIUS (long term stratospheric ozone)

Tools and data

Preparation for the data exploitation was felt to be missing

New and upcoming tools, ML, cloud computing e.g. question CSQ-45, the question can be reworded to imply use of techniques

Coupling data, assimilation of data, multiple data sources, synergisms to better quantify natural and anthropogenic emissions. How can we better include models?

Scientific Questions

Combination of space-based and in-situ data and air pollution

Combine S4 data with land use or traffic information -> urban pollution

Assimilation of satellite data into models, including AI models

Use of satellite data to quantify anthropogenic emissions

Long-term monitoring of atmospheric constituents, including pollutants

Focus on urban pollution, environmental change

Long term time series, we need these, homogeneous datasets for ease of long term series and trend analysis.

What is missing from the CCI? We have GCOS, but we don't have environmental change and how they related to climate change.

Splinter session 2 – Atmosphere subgroup – Seed Question 4

- Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years?

- CSQ-1 is an immediate opportunity Sentinel 5, CO2M, Key CSQ for atmosphere
- CSQ-2 – not immediate some opportunities for wetlands
- CSQ-3 - contribution, aerosol-ocean interactions, making use of new instruments such as EarthCARE.
- CSQ-7 - Question on temporal and spatial resolution, opportunities if the appropriate resolutions are possible. Challenge of spectral regions as well. Emphasised that spatial resolution is key, possibly challenging over multiple spectral regions. Possibly S2&S3 could be used to investigate future opportunities
- CSQ-24 - Missing is stratospheric ozone, change in energy throughput through ozone is unknown. We will have 20 years of IASI data to have a look at, this is an obvious question that can be achieved. Atmospheric dynamics are also a topic that can be looked at.
- CSQ-43 - FORUM and EarthCare can answer these questions, and therefore can be quickly addressed, assuming successful launches.
- CSQ-44 - Potentially addressed through EarthCARE, IASI-NG. Atmospheric rivers are still a topic that need to be investigated.
- CSQ-45 - Radiation balance, EarthCARE and FORUM have these capabilities, difficult to make a link to the atmosphere
- CSQ-46 - Big progress expected from EarthCARE, and new GEO sensors which allow understanding of diurnal cycles
- CSQ-48 - FORUM, IASI MTG, METOP-SG, these can, Sentinel 3 there are numerous instruments that could contribute to these, but requires refinement
- CSQ-51 - Not felt easily achievable with existing data, possibly with NASA satellite, but not a big ESA opportunity.

Splinter session 2 – Atmosphere subgroup – Seed Question 3

- What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?
- Regular assessments, there are no obvious single metrics, needs to be individually defined for each question
- The questions are cross-cutting and general, making this difficult. However an assessment of predictability could be useful indicator, e.g. Weather, composition and climate models
- NASA set up a series of mission targets/efforts, and report back on how they performed, something similar could be achieved in this case.
- How close are GCOS requirements achieved?
- In science key metrics are references and acceptance into the IPCC
- Relationship to the sustainability goals
- Predictability skills - Weather, composition and climate models
- Define science mission objectives and related key indicators
- Socio-economic impact studies
- Growth of downstream services
- Publication based assessments - peer review process

Subgroup on OCEAN

Splinter #2 – received Seed Questions

- 1) Do the selected 22 science questions covers the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?
- 2) What are the main scientific opportunities and need considering the EO missions that will be flying and launched in that time frame?
- 3) Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years?
- 4) What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?
- 5) What are the types of ESA implementation actions that you consider best support this effort?
- 6) How do we ensure short term gains contribute to longer term objectives and advances?

CSQ	Short Title	Atmosphere	Land	Ocean	Solid Earth	Cryosphere
CSQ-1	Anthropogenic influences on the carbon cycle	x	x			
CSQ-2	Land biosphere response to CC	x	x			
CSQ-3	Ocean carbon cycle responses to climate	x		x		
CSQ-5	Sea level change in the coastal ocean		x	x		
CSQ-7	Coastal interfaces with land atmosphere and	x	x	x		
CSQ-8	Coastal climate change feedbacks		x	x		
CSQ-20	Ice mass balance			x	x	x
CSQ-21	Sea Ice thermodynamics					x
CSQ-24	Polar change and climate variability	x		x		x
CSQ-25	Cryosphere and Polar ecosystems		x	x		x
CSQ-33	Ice sheets and rheology				x	x
CSQ-35	Erosion and sedimentation		x	x	x	
CSQ-36	Plate boundary deformation dynamics				x	
CSQ-39	Crust and internal dynamics interactions				x	
CSQ-43	Coupling between energy water and carbon	x	x	x		
CSQ-44	Anthropogenic influences on the water cycle	x	x			
CSQ-45	internal energy flux estimates	x	x	x		x
CSQ-46	Earth energy imbalance	x	x	x		x
CSQ-48	Regional planetary heat exchange	x	x	x		
CSQ-51	Lithosphere-atmosphere-ionosphere coupling	x			x	
CSQ-55	State of Land ecosystems		x			
CSQ-56	Land ecosystem critical transitions		x			

Table 3: Summary of 22 CSQs selected for detailed analysis

Splinter #2 - Ocean

Discussion considerations

1. Several Ocean-related gaps have been identified in the existing 22 CSQs; other ocean elements are somehow “buried” in the 22 CSQs
    I. Some gaps will just need some rephrasing of the existing 22 CSQs and related KAOs
    II. Other gaps will call for rescuing/rephrasing 2 CSQs out of the original 59 CSQs list
    III. A brand-new CSQ was identified and put forward
2. In the (slide-2) provided cross-domains mapping, some of the 12 ocean-labelled CSQs did not really have big emphasis on ocean
3. Gaps have been identified at all spatial, temporal and CSQ timing (short/long-term) scales
4. “open ocean” is not thoroughly represented anywhere
5. Connection between coastal and open ocean need to be emphasized. Besides, unclear “how-coastal” is “coastal” (continental shelf/pixel-based/EEZ)?
6. Need to emphasize quantification of accuracy and uncertainty (incl. uncertainty propagation)

Splinter #2 - Ocean

Seed Question #1: Do the selected 22 science questions covers the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?

Ocean-related gaps have been identified in the existing 22 CSQs

1. **Need for rephrasing some of the exisiting 22 CSQs:**
   a) Relevance of “coastal” CSQ(7/8) would still hold if enlarged to “ocean” (eg, air-sea interaction)
   b) CSQ-55/56 (Terrestrial Biodiversity/Ecosystem) need to be enlarged to the marine/coastal/freshwater ecosystems, with emphasis on Ocean Health
   c) CSQ-3 (Ocean Carbon Cycle) need to include Ocean Acidification
   d) CSQ-44 (Water cycle) need to be extended to the oceanic branch of water cycle
2. **Need for rescuing/rephrasing 2 CSQ put of the original 59 CSQ**
   a) Ocean Extremes (marine heatwaves, storms, sea level rise, pollution, flash floods, salt intrusion, etc) –> by merging CSQ-6 and CSQ-11, adding impact on ocean physics and biota
   b) Tipping Points (with emphasis on thresholds and trends) -> by merging CSQ-29/30/31/32
3. **Identified one brand-new CSQ:**
   a) What are the main drivers and impacts of the Ocean Circulation across different spatio-temporal scales (from sub-mesoscale to climate)?

Splinter #2 - Ocean

- **Seed question #2: What are the main scientific opportunities and need considering the EO missions that will be flying and launched in that time frame?**

➢ Take the opportunity of the synergy between all missions including SWOT, Sentinels, Harmony and define with the scientific community a number of supersites (instrumented with a wealth of in-situ measurements) to tackle the upper ocean dynamics knowledge gaps (new proposed CSQ).
➢ Need of sustained and continuous in-situ measurements for the optimal exploitation of the satellite missions.
➢ Get prepared for the exploitation and processing of upcoming missions with unprecedented capabilities (high resolution, hyperspectral)
➢ Fully-exploit the information provided by EarthCare, transversal to all the cycles (water, energy and carbon)

- **Seed question #3: Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years?**

➢ CSQ-20 on Ice-mass balance – [eg, via CIMR] -> estimates of Freshwater Fluxes and water cycle, circulation.
➢ CSQ-46 on Earth Energy Imbalance – [eg, via Earthcare, GRACE_FO, NGGM] -> Emphasis on OHC
➢ CSQ-5 on SL and new-CSQ on Ocean Circulation – [eg, via SWOT, S6, S3C, Harmony] -> Closer-to-the-coast, HR, better coverage, 2D
➢ CSQ-7 on coastal processes – [eg, via LSTM, Trishna, S2]. -> HR coastal processes
➢ CSQ7A on Exchanges land/atm/ocean – [eg, via Harmony, S1, ROSE-L, CIMR] -> air-sea interactions
➢ CSQ-55/56 on Ecosystem – [CHIME, S2, FLEX] -> Hyperspectral, new bands and Coastal Fluorescence

Splinter #2 - Ocean

- **Seed question #4: What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?**
  - High-impact peer reviewed scientific papers
  - Uptake of products generated by ESA projects into Copernicus.

- **Seed question #5: What are the types of ESA implementation actions that you consider best support this effort?**
  - Assess impact through long-term time-series reprocessing
  - Workshops/Conferences
  - Digital Twins

- **Seed question #6: How do we ensure short term gains contribute to longer term objectives and advances?**
  - (Not discussed)

Subgroup on LAND

Land

Do the selected 22 science questions cover the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?

- Focus on the land CSQs (CSQ1, CSQ2, CSQ5, CSQ7, CSQ8, CSQ25, CSQ35, CSQ43-CSQ48, CSQ55, CSQ56) but mainly on CSQ1 and CSQ44.
- There is nothing missing from the CSQs in terms of missions for the given 6 year view but very different levels of specificity (e.g. CSQ33 v CSQ1/44). Broad themes allow more room for a range of studies over 6 years.
- Continuity of the Strategy is important – no distinct split from the previous strategy
- No conflict between the CSQs and upcoming missions. Missions considered FLEX, BIOMASS, HydroGNSS, Sentinel Expansion (long view)
- Need for greater emphasis/clarity within the CSQ and their sub-questions. Especially on the **'human footprint'** on the land (urban, land management (AFOLU)), **extreme events** (no explicit CSQ), **humans and water** (quality, availability, hazards, critical loads on ecosystems)
- Spatial and temporal scale, continuity, data access, availability (especially of long-time series) and latency should be emphasised across all CSQs (including drawing from the reserve list of CSQs).

Land

What are the main scientific opportunities and need considering the EO missions that will be flying and launched in that time frame?

- How do we combine what we have and are planned to ensure we respond to needs – scales, observation types, processes within the CSQs.
- Consider what data are used where, why and how (not necessarily reflected in CEOS/OSCAR databases) for communities associated to the CSQ.
- Ensure preparation of Analysis Ready Data for each CSQ (includes latency, continuity, long term understanding).
- Use AI/ML to help combine both multiple EO and other data types (especially e.g, human/social/cultural)

Land

Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years??

- All 22 CSQs need reframing to identify priority targets
- Very important to bring cycles (carbon, water, energy, nitrogen etc) and domains together (e.g. land-ocean continuum).
- This includes community engagement, cross-sensor activities but also aspects of sub-questions e.g. agriculture in both carbon and water cycles.
- The CSQs are linked and effort is needed on this
- ESA could proactively bridge and link across CSQs as an opportunity NOW.

Land

What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?

- Measure success in terms of outputs
- Uptake and use of the data/products by communities addressed by CSQ including:
    - Major scientific papers with use of ESA data/products (per mission, per project, per domain, cycle, CSQ etc)
    - Appropriate use/understanding of what EO offers (are data used ‘correctly’)
    - Engagement with communities as ESA (not at individual project level)
    - Connection and visibility across projects (ESA, EC and beyond) and programmes (EC, Other Space Agencies)
- Ensure the ‘next’ mission addresses a given question or set of questions.
- Engagement/bridge building at the country level on specific aspects of CSQs e.g. uptake and use of satellite data in AFOLU.

Land

What are the types of ESA implementation actions that you consider best support this effort?

- Clear indication for community of where and how to engage with ESA and engagement with other funders/agencies for the CSQs.
- Regular updating of strategy (not every 5 years).
- Demonstrate how the Science Strategy influences the selection of new missions in next 6 years
- Demonstrate impact of ESA activities on scientific understanding/policy/country reporting etc.
- Be proactive in capacity building – the next generation of communities - targeted workshops and fellowship schemes e.g. on process understanding not quantification of variables linked to CSQs.
- Products are visible, easy to access, available (full time series) and there is continuity beyond '2-year projects'.
- Appropriate and consistent formats, in places where the community accesses data habitually.

Land

How do we ensure short term gains contribute to longer term objectives and advances??

- Clarity in ESA activities on CSQs
  - Structure ESA activities in a connected manner (clear connection from mission development, operation to exploitation) towards the answers to questions, sub-questions, sub-sub questions.
  - Ensure availability of products from current and upcoming satellites (long term, access, continuity, latency, rapid response).
- Ensure community preparation for the upcoming satellite observations
  - Rapid engagement with the community to bring them to use the data that is coming before it is available (campaigns, workshops, etc) and provide the data as quickly as possible to the community (beta testing etc).
  - Focus on engagement beyond the EO community.
- Shape activities/sub-questions to scale of processes and where the processes are important (region/local)
  - Processes are important at region and especially local level so the focus should be first there then scaling up rather than starting at global level.

Subgroup on SOLID EARTH

Priorities for the next 6 years: Solid Earth & Geomagnetism

Sustain current scientific activities based on **current missions** to maximise scientific return

- Core dynamics / deep interior is completely missing in the current strategy draft;
- Include “thermosphere”!
- More measurements for models, more near-real time for space weather (Swarm FAST data is the way to go!)
- Enhance synergies between different observations (e.g., thermal imager observations)

Enable (new) **synergies**!

- Several groups are working on “thermosphere/ionosphere/magnetosphere”, which is the region where Earth meets space. This is also the conduit of space weather to our system. “*Heliophysics in Europe”* is a great opportunity to bring people together. Enhancing these synergies is crucial to better utilise our European strengths! Solid Earth is part of this system!
- Improve science & industry connections & create opportunities to foster such activities (hardware availability can be a stopping point for universities).
- Synergy between big and small satellites.

Prepare for the future (do not miss continuity & go **beyond**!)

- It takes time to have new missions… prepare & consolidate next gen missions!
- Diversification of EO portfolio can help covering upcoming gaps.

CSQs update:
Reshape & extend current CSQs.
Add details to guide implementation/decisions.
Push for multidisciplinary methods/observations.
NEW/Modified CSQs: #35, #36, #38, #51
(see next slides!)

Actions for the EO Strategy document:

Reshape & extend current CSQs. Add details to guide implementation/decisions.

Push for multidisciplinary methods/observations.

Propositions (original/updated CSQs):

CSQ#36: “Can we observe, model and forecast the deformation processes during the seismic cycle at plate boundaries, from pre- to post-seismic phases and during the inter-seismic phase?”
CSQ#36: “Can we observe, model and forecast the deformation processes, emissions and surface temperature due to vulcanism and during all phases of the seismic cycle?”

CSQ#51: “What are the mechanisms that couple the lithosphere, atmopshere and ionosphere, and can they be modelled and monitored with adequate to support hazard risk management?”
CSQ#51: “What are the mechanisms that couple the lithosphere, thermosphere, ionosphere and magnetosphere, and can they be modelled and monitored to advance understanding in area of geohazard and space weather related science?”

Actions for the EO Strategy document:

CSQ#35: “Can we quantify erosional processes of drainage basins and the resulting sediments discharge to the oceans?”
CSQ#35: “Can we quantify mass movement and erosional processes of drainage basins and the resulting sediments discharge to the oceans?”

CSQ#38: “How does Earth’s crust evolve interaction with internal geodynamic processes and how does this reshape the Earth’s surface over the long-term?”
CSQ#38: “How do geodynamic processes in the core and mantle evolve and interact with Earth’s surface and how do they influence Earth’s surface and internal structure?”

Subgroup on CRYOSPHERE

Splinter-2 (Cryosphere) - Objectives:

To establish whether all cryosphere aspects are covered by the candidate science questions (CSQs).

To comment on any missing elements; so that the CSQs and their associated Knowledge Advancement Objectives (KAOs) are comprehensive and complete for the cryosphere.

To address the initial seed questions from the EO Science Strategy Workshop in Bruges 2023:

- Do the selected 22 science questions cover the main scientific priorities and opportunities for advancing Earth system and climate science in the time frame of the next 6 years?
- What are the main scientific opportunities and needs considering the EO missions that will be flying and launched in that time frame?
- Which of the 22 science questions provide the best opportunity for R&D to progress quickly in the time frame of the next 6 years?
- What is best way to measure progress in these science questions and are there any metrics that we could use in reporting progress to the community and member states?
- What are the types of ESA implementation actions that you consider best support this effort?
- How do we ensure short term gains contribute to longer term objectives and advances?

Splinter-2 (Cryosphere) - Key Issues raised:

- **CSQ-44** Cryosphere in context of global water cycle: We need to ensure that the world water towers are correctly captured and include seasonal snow in mountains and all complex terrain.
- **CSQ-10** Cryosphere in terms of climate-induced geo-hazards in mountain areas: GLOFs, Permafrost and other hazards need to explicitly be addressed.
- **CSQ-21** Cryosphere in terms of sea ice: Basically complete observables but high-level description of science questions could be reformulated to avoid misinterpretation. Disentanglement of sea ice thermodynamics and dynamics is important. Perhaps: What are the dominant physical process that drive the changes in sea ice thermodynamic and dynamic state of variability?
- **CSQ-24** Cryosphere in terms of polar climate relationship. Add seasonal snow to KAO for CSQ-24. Snow as an insulator for permafrost not considered.
- Quick wins in terms of advances on the science questions for cryosphere for societal relevance. How do we use the upcoming mission data, the synergy of those missions, in relation to advances in water cycle science. In particular Sentinel Expansion missions with current Sentinels and Next Generation, which will deliver unique new data sets
- Metrics and how to measure impact (indexing ITTs and new mission calls, then linking them to CSQs ? Linking to progress on maturing algorithms for cryosphere parameters? Progress in linking R&D of prototypes to transfer to operational services (CLMS, EMS, C3S ...)?
- How to support the implementation: New EO mission ideas (NEOMI) to develop new observational capabilities recognised as needed for e.g. SWE retrieval, Sentinel User Preparation (SUP) -like activities for developing use of expansion of sentinels to support the cryosphere-related services and integration in CLIMATE-SPACE activities.
- Short term gains contributing to long-term objectives: Sustainable transfer of knowledge from CSQ advancement into CLIMATE-SPACE activities.

Splinter-2 (Cryosphere) - Recommended actions:

1. Snow needs to explicitly appear in CSQ-44a. Make sure there are the right words in all KAO for 44 (a,b and c). We need to augment the document and append the final strategy with the links.
    a) Foresee a sub-question: CSQ-44d about **Quantifying variability and trends of snow in mountains and all complex terrain/topography as a contributor to regional and continental water cycle**.
    b) Derive the traceability for the observable.
    c) CSQ-44 PAGE A-89: Make some additional revision to the word file and incorporate this.
    d) Proposed follow up, is a brief discussion in ACEO about the logic, including a review of the paragraph for entry in the bullets and accompanying additions to the requirements table with a proposal for additional KAO d relevant seasonal variability of mountain snow and complex topography.
2. Reconsider CSQ-10 in the context of climate-induced risks in mountain regions.
3. Change the wording for CSQ-21 to ensure this is not misleading and both sea ice thermodynamics and dynamics are being considered.
4. Add seasonal snow to KAO for CSQ-24. In the observable column add snow variability. Make sure that the variables are same terminology as OSCAR and use MIM reference numbers.
5. Given the focus on science questions, there needs to be a way to provide sustainability through the programmes to be able to allow R&D to blossom, and provide opportunity for operational development. Ensuring that there are programmes that take up short-term R&D developments for sustained development.