| WG1 | WG2 | WG3 |
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| Chair: Mark Buehner<br>Secretary: Steffen Tietsche | Chair: Anne O'Carroll<br>Secretary: Tony Mc Nally | Chair: Chris Merchant<br>Secretary: Phil Browne |
| Large Committee Room (We, Thu) | Meeting Room 1 (Wed, Thu) | Mezzanine Room (Wednesday)<br>Council Chamber (Thursday) |
| Observations and Methods processing chains | Downstream Applications of SST and sea ice | Observations and Method processing chains |
| Frozen (Sea ice) | | Unfrozen (SST) |

- What are the possible visions (10 years) for SST and sea ice information at ECMWF?
- What recommendations would you make to space/observations agencies ?
- Which observations (& what level) should drive the evolution of our systems?
- What should be the next steps to improve SST and sea ice in NWP and reanalysis?
- What are the current gaps future barriers (observations, forward models, DA, etc)?

# WG1: Observations and Methods. Sea-Ice

## Participants

Chair: Mark Buehner  Rapporteur: Steffen Tietsche

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# What are the current gaps future barriers (observations, forward models, DA, etc)?

Current challenges/deficiencies at ECMWF:

- Difficulties with sea ice concentration (SIC) at coastlines, Baltic, lots of complaints from our users; also proper use of passive microwave (PM) retrievals in summer due to melt ponds
- Timeliness of data and products is sometimes not sufficient
- Possible difficulties with SIC long-term temporal consistency and missing data in L4 products used for atmospheric reanalysis (ERA5)
- Discussion highlighted differences in requirements for real-time analysis vs. reanalysis (L3 vs. L4) and also atmosphere-only vs. ocean or coupled systems with an ice-ocean model component
- What is the best product to use currently? Impossible to deliver a “perfect” L4 for SIC in all cases (what to do along coasts, for sensor outages etc.)
- Some issues related to lack of uncertainty information (esp. in L4 products) or not making better use of uncertainty when it is available
- Only SIC information used currently, not thickness
- Underutilization of in situ information – made difficult by different file formats

# What are the possible visions (10 years) for sea ice information at ECMWF?

- In the future, all systems will be fully coupled, including DA
- In that context, direct assimilation of radiance observations allows accounting for contributions from atm., ice surface, ocean surface, etc.
- No longer think about “ice” analysis, but complete A-I-O-L-… analysis
- Make better use of observations to simultaneously improve all components
- Also, makes system more robust, since possible to include all available satellite sensor data
- Requires good forward models (observation operator), including surface emissivity model that accounts for ice type, snow properties, etc.
- Forward models should be shared by community and provided/supported by central facility
- Also requires good coupled model including all components needed for forward models (e.g. snow, melt ponds)

# What should be the next steps to improve sea ice in NWP and reanalysis?

- Work towards using SIC retrieval algorithms in house (code supplied and supported by OSI-SAF) – initially, implementations would be compared with existing products
- Analogous to NWP using in-house retrieval of T-Q profiles, as a step towards full radiance assimilation – learn from difficulties encountered in NWP context, e.g. error correlation between retrieval and background state
- Initially use OSI-SAF L3 and then L2 products (requires consistent reprocessing for reanalyses)
- This will improve timeliness, allow using latest NWP input data and enable using QC information
- Work on improving sea ice model and transitioning all systems towards coupled models (already happening)
- Start using CryoSat-2 (and Sentinel-3) thickness data, first for validation (already done for SMOS), in near-real-time
- Seek collaboration for advancing thickness assimilation (e.g. NEMOVAR consortium)
- Assess availability/accessibility and start using existing in situ data for verification
- Encourage in situ data providers to adopt standard formats and procedures/protocols

# What recommendations would you make to space/observations agencies?

Space Agencies:

- Continuity in PM data (AMSR-2 like), L-band (SMOS like), and Cryosat altimetry (high latitude coverage) is a priority demand
- Explore use of protected frequencies (2.6-2.7, 4.3, 4.9 GHz) as alternative to unprotected 6.9 GHz
- New mission for snow information

In-situ observation providers:

- In-situ observations (e.g. 2m temperature from ice buoys) are very valuable to operational centers, but need to be properly documented and archived, ideally in a central location (GTS, BUFR, ESA-CCI efforts, …)

OSI-SAF:

- Expand focus from only being data/product provider to a provider of retrieval algorithms and forward models (like NWP-SAF providing RTTOV)

National Ice Services:

- Provide digitized ice chart and other information (as shape files and gridded) including uncertainties in standard formats (Global Digital Sea Ice Data Bank)

# Which observations (& what level) should drive the evolution of our systems?

- Sea ice concentration, thickness, and drift, but also skin temperature, snow, melt ponds, albedo,… initially at L3, but transitioning towards L1
- New observation types initially used for verification and monitoring, with transition towards assimilation