

*Project proposal to the European Space Agency, Directorate of Earth Observation Programmes,
Support to Science Element (STSE)*

Sea Surface Temperature and Altimeter Synergy for Improved Forecasting of Polar Lows

FINANCIAL, MANAGEMENT AND ADMINISTRATIVE PROPOSAL

Bidder: Norwegian Meteorological Institute (met.no)

Project Leader: Øyvind Saetra (met.no)

Reference: EOP-SM/1900/CD-cd

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The Research Department, Remote Sensing Section is working with R&D on satellite data in two main areas: 1) Analysis and monitoring of sea and land surface variables, and 2) Use of satellite data in numerical ocean and weather prediction. met.no is responsible for the high latitude part of the OSI SAF (<http://saf.met.no>) with emphasize on sea ice, high latitude SST and radiative fluxes. On ocean model assimilation focus has been on use these data as well as on ERS and Envisat SAR and Altimeter wave data in ocean wave modelling. In numerical weather prediction the group has been responsible for assimilation of atmospheric satellite sounding data and ocean surface wind data (ERS and ASCAT scatterometer).

All sections have been heavily involved in national project for regional climate modelling. The first national effort to investigate impact of climate change on the regional climate in Scandinavia was the RegClim project, initiated in 1997, where the Research and Development Department played a major role. An important part of this activity relates to coupling of ocean, atmosphere and sea-ice models. Currently, the department is a partner in the national climate research centre Norsk klimasenter which coordinates climate research in Norway.

Norway is a member of the World Meteorological Organization (WMO), the European Centre for Medium Range Weather Forecasts (ECMWF), and the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT). The institute is actively involved in the work of these organisations.

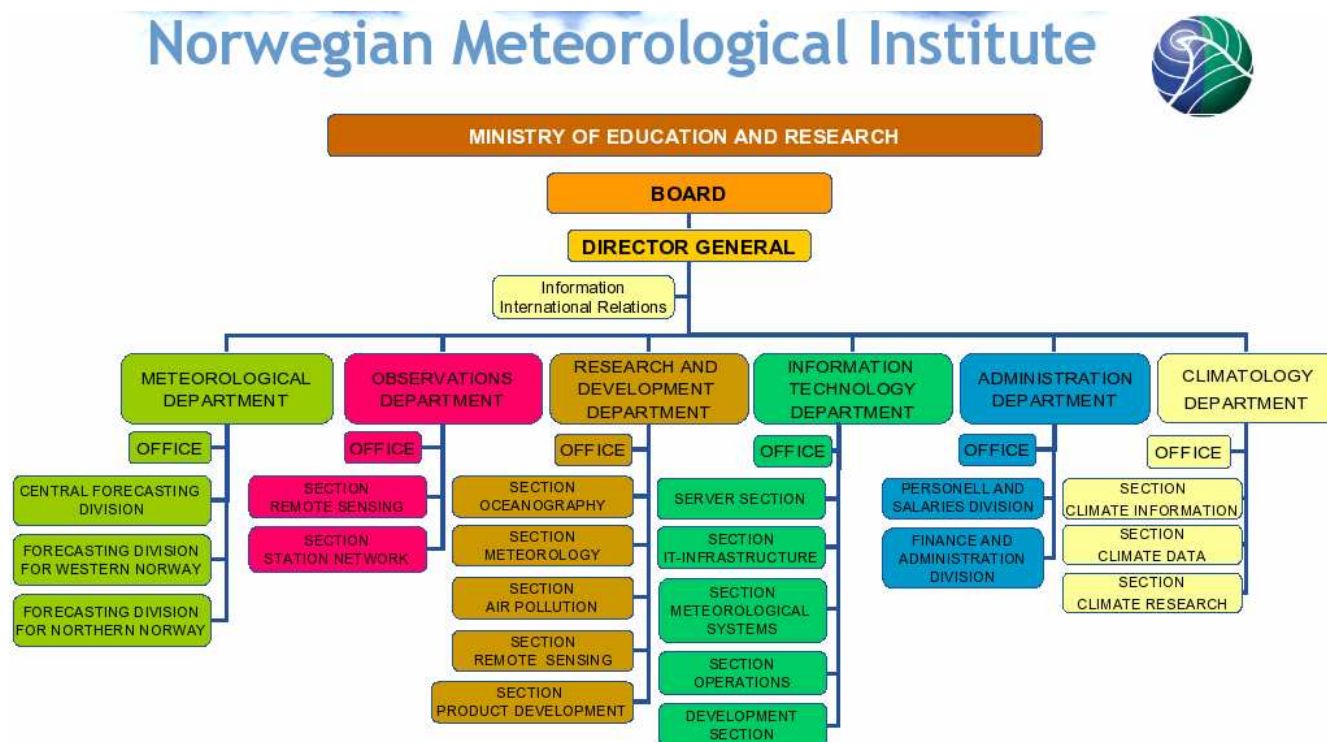


Figure 1: Organization map for Norwegian Meteorological Institute.

The Norwegian Meteorological Institute is the representative institution for the Norwegian Membership to ECMWF and elects the national representatives to the council, which is the governing body of ECMWF. As a member state institution the Norwegian Meteorological Institute have unlimited access to all ECMWF products.

3 FACILITIES

For the STARS project, all of the necessary facilities are available within the existing facilities at the Research Department at met.no. The organisation has access to high performance through computer facilities shared with the University of Oslo and of the national high-computational facility in Trondheim (NOTUR).

Resolution SST (GHRSSST), taking part in the SST validation and diurnal variability working groups.

Dr. Pål Erik Isachsen

Pål Erik Isachsen holds a M.Sc. from the University of British Columbia, Canada, and a Ph.D. from the University of Bergen, Norway. His M.Sc. work involved observations and theory of tidally-induced mixing in fjord while his Ph.D. work focused on analytical models of the large-scale circulation in the Nordic Seas and Arctic Ocean and on inverse models of the high-latitude oceanic overturning circulation. During post doctoral studies at the University of Oslo he worked with analytical and numerical models of baroclinic Rossby wave break-up from baroclinic instability.

At the Norwegian Meteorological Institute Dr. Isachsen is primarily working on the diagnosis of oceanic eddy activity and its representation in models---with a particular focus on topographic effects on eddy growth and propagation. Under a current IPY project he also works, with collaborators at the University of Oslo, on models of the large-scale circulation and eddy dispersion in the Southern Ocean. Dr. Isachsen also works on data assimilation methods in ROMS, an ocean model with which he has worked for more than five years.

Dr. Jens Debernard

Jens Debernard took his Ph.D. on the turbulent oceanic boundary layer beneath deformed sea ice at the University of Oslo in 2000. In 2001 he started as a senior scientist at met.no R&D Department where he now has a special focus on polar climate, regional climate modelling, and on the development and maintenance of sea ice models used for in climate and forecast applications. He has been the main developer behind the sea ice model used for coupled ice-ocean forecasts at met.no, and has also been responsible for coupling this model to several ocean circulation models. Also, he is the main developer behind the Oslo Regional Climate Model (ORCM). This model has been developed and used in several Norwegian- (RegClim) and EU-funded projects (GLIMPSE and IP-DAMOCLES). With an expert competence on physical and technical aspects of atmosphere-ice-ocean coupling, he is one out of three core members of the main development theme behind the new Norwegian Earth System Model called NorESM, with a special responsibility for maintaining and developing the sea ice component and its interaction with atmosphere and ocean. The NorESM should be ready to deliver results to the next IPCC assessment report (AR5). Also he is strongly involved in the IPY project iAOOS-Norway, with a special focus on improving the sea ice component used in the met.no sea-ice forecast system.

Mr Morten Ødegaard Køltzow

Morten Køltzow took his Master of Science on anthropogenic aerosols impact on the atmospheric circulation in 1997. Since 1999 he has been working as scientist in the section for Meteorology in the R&D division at the Norwegian Meteorological Institute.

He has been working in several climate projects and with the development of models for numerical weather prediction. He has especially acquired expertise on regional modelling (choice of domain, resolution and lateral and surface forcing). In addition he has been doing research on surface processes (e.g. fluxes at the ocean-atmosphere interface and description of snow and sea ice albedo) and how they influence weather and climate. In several projects he has been involved in the coupling of atmosphere and ocean/wave models (such as, RegClim and Thorpex).

5 LIST OF DELIVERABLE ITEMS

The list below shows the deliverable items. The items are in compliance with the SoW, only the milestones have been changed a bit.

| ID | Deliverable title | Short name | Milestone | Number of hard copies | Electronic delivery for final version |
|-------------|---|---|------------------|------------------------------|--|
| D-1 | STARS web page and project management services. | WEB | KO+1 month | 0 | Web page |
| D-2 | Scientific and technical review of polar lows in the Nordic Seas. | REP-1 | KO+4 months | 6 | Web page |
| D-3 | Scientific Analysis Plan. | SAP | KO+4 months | 6 | Web page |
| D-4 | Version 1 of the STARS-DAT data set | STARS-DAT v1.0 | KO+8 months | 0 | Web page |
| D-5 | Version 1 of the STARS-DAT metadata database. | STARS-DAT-DB v1.0 | KO+8 months | 0 | Web page |
| D-6 | Version 1 of the STARS-DAT user manual. | STARS-DAT-UM v1.0 | KO+8 months | 6 | Web page |
| D-7 | Scientific and technical report of the character of polar low events in the Nordic Seas using the STARS-DAT data set. | REP-2 | KO+11 months | 6 | Web page |
| D-8 | ATBD for a PLI field for the Nordic Seas. | ATBD-1 | KO+15 months | 6 | Web page |
| D-9 | Polar Low Indicator (PLI) development, implementation and validation report. | REP-3 | KO+15 months | 6 | Web page |
| D-10 | Updated STARS-DAT database: D-10a: STARS-DAT v2.0 D-10b: STARS-DAT-DB v2.0 D-10c: STARS-DAT-UM v2.0 | STARS-DAT v2.0, STARS-DAT-DB v2.0 and STARS-DAT-UM v2.0 | KO+15 months | 6 (STARS-DAT-UM) | Web page |
| D-11 | Nordic Seas coupled model Description Document | NS-MODEL-DD | KO+16 months | 6 | Web page |
| D-12 | Nordic Seas coupled model Sensitivity Analysis Document | NS-MODEL-SAD | KO+26.5 months | 0 | Web page |
| D-13 | Nordic Seas coupled model Operational Manual | NS-MODEL-OM | KO+26.5 months | 6 | Web page |
| D-14 | Test data set used in Task 7 | TDS-1 | KO+26.5 | 0 | Web page |

6 WORK BREAKDOWN STRUCTURE

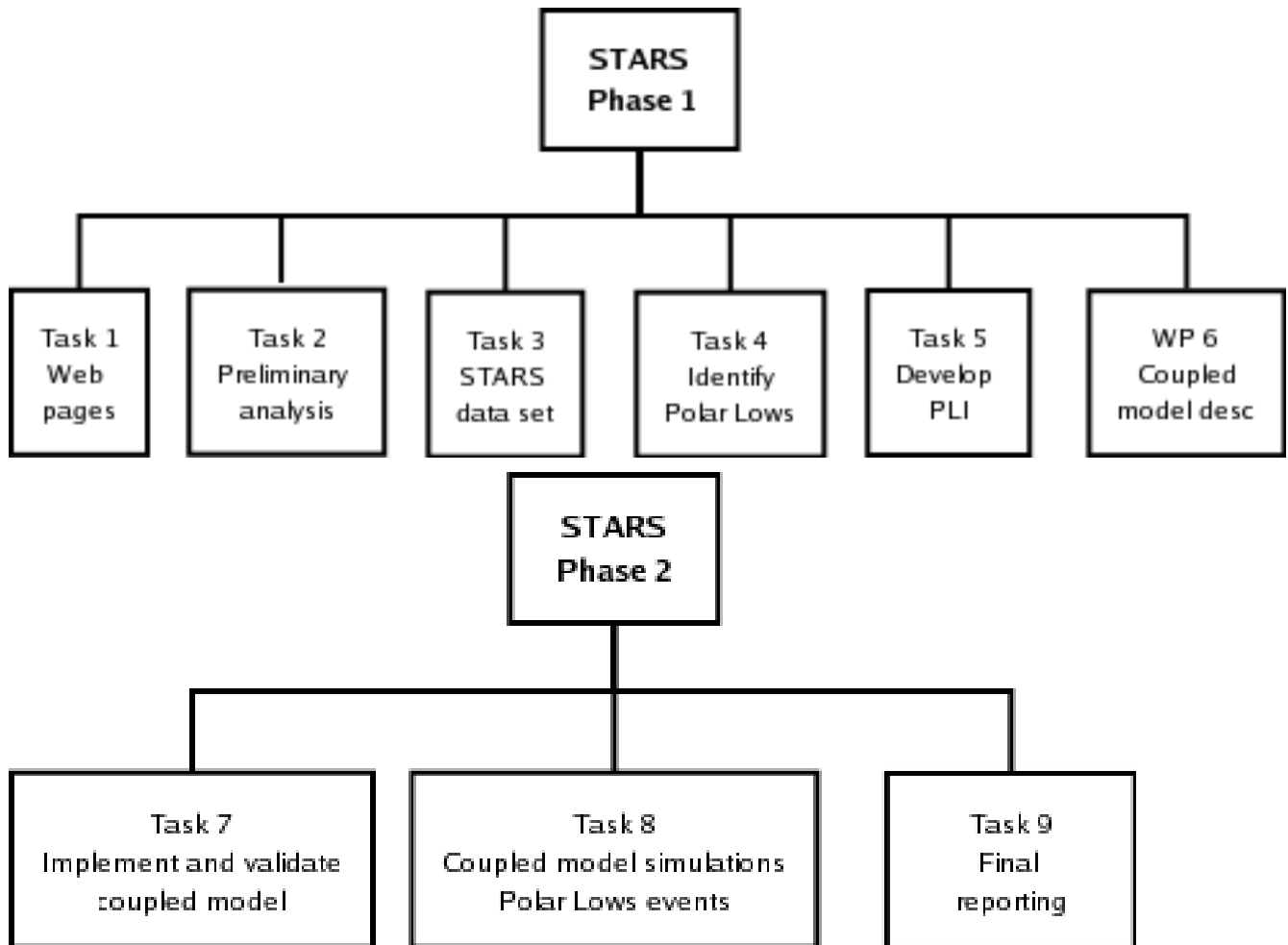


Figure 2: Work Breakdown Structure for the STARS project down to major Task level, divided in the two phases.

| WBS | Name | Start | Finish | Work | Duration | Slack |
|------------|-------------------------------|--------------|---------------|-------------|-----------------|--------------|
| 1 | Task 1 | Sep 3 | May 14 | 703d | 703d | 1d |
| 2 | D-1: STARS web page | Oct 15 | Oct 15 | N/A | N/A | 674d |
| 3 | Task 2 | Oct 19 | Jan 1 | 55d | 55d | 617d |
| 4 | D-2: REP-1 | Jan 1 | Jan 1 | N/A | N/A | 617d |
| 5 | D-3: SAP | Jan 1 | Jan 1 | N/A | N/A | 617d |
| 6 | Task 3 | Jan 1 | Apr 30 | 86d | 86d | 379d |
| 7 | D-4: STARS-DAT V.1.0 | Apr 30 | Apr 30 | N/A | N/A | 532d |
| 8 | D-5: STARS-DAT-DB V.1.0 | Apr 30 | Apr 30 | N/A | N/A | 532d |
| 9 | D-6: STARS-DAT-UM V1.0 | Apr 30 | Apr 30 | N/A | N/A | 532d |
| 10 | Task 4 | May 3 | Jul 30 | 65d | 65d | 379d |
| 11 | D-7: REP-2 | Jul 30 | Jul 30 | N/A | N/A | 467d |
| 12 | Task 5 | Aug 2 | Dec 1 | 88d | 88d | 379d |
| 13 | D-8: ATBD-1 | Dec 1 | Dec 1 | N/A | N/A | 379d |
| 14 | D-9: REP-3 | Dec 1 | Dec 1 | N/A | N/A | 379d |
| 15 | D-10: STARS-DAT V.2.0 | Dec 1 | Dec 1 | N/A | N/A | 379d |
| 16 | Task 6 | Sep 1 | Dec 22 | 81d | 81d | 7d |
| 17 | D-11: NS-MODEL-DD | Dec 22 | Dec 22 | N/A | N/A | 364d |
| 18 | MID-TERM REVIEW | Jan 3 | Jan 14 | 10d | 10d | |
| 19 | Task 7 | Jan 17 | Oct 14 | 195d | 195d | |
| 20 | D-12: NS-MODEL-SAD | Oct 14 | Oct 14 | N/A | N/A | 152d |
| 21 | D-13: NS-MODEL-OM | Oct 14 | Oct 14 | N/A | N/A | 152d |
| 22 | D-14: Test data set Task 7 | Oct 14 | Oct 14 | N/A | N/A | 152d |
| 23 | Task 8 | Oct 17 | Apr 13 | 130d | 130d | |
| 24 | D-15: REP-4 | Apr 13 | Apr 13 | N/A | N/A | 22d |
| 25 | Task 9 | Apr 16 | May 15 | 22d | 22d | |
| 26 | D-16: Final Report (FR) | May 15 | May 15 | N/A | N/A | |
| 27 | D-17: Summary Report (SR) | May 15 | May 15 | N/A | N/A | |
| 28 | D-18: Power Point of SR | May 15 | May 15 | N/A | N/A | |
| 29 | D-20: Final Presentation (FP) | May 15 | May 15 | N/A | N/A | |
| 30 | D-20: Technical Data Package | May 15 | May 15 | N/A | N/A | |

Figure 4: Start and end dates for all tasks and dates for all deliverables..

9 TRAVEL PLAN

The following table briefly describes the envisaged travels during the STARS project period.

| Meeting | Place | Time | Title + deliverables | Participants |
|--------------------------|--------|----------|--|-----------------------|
| Kick Off (KO) | ESA | 03.09.09 | Kick off meeting (PMP) | ØS, SE, JD, ESA |
| Progress Meeting 1 (PM1) | met.no | 02.02.10 | Web site and literature review (WEB, REP-1) | ØS, SE, ESA |
| Progress Meeting 2 (PM2) | met.no | 03.05.10 | STARS-DAT (STARS-DAT-v1, STARS-DAT-DB-v1, STARS-DAT-UM-v1, TR-2) | ØS, SE, ESA |
| Progress Meeting 3 (PM3) | met.no | 30.08.10 | Investigate each polar low event within the STARS-DAT (REP-2) | ØS, SE, ESA |
| Progress Meeting 4 (PM4) | met.no | 01.12.10 | PLI development and monitoring (ATBD-1, REP-3) | ØS, SE, ESA |
| Progress Meeting 5 (PM5) | ESA | 03.01.11 | Nordic Seas coupled model (NS-MODEL-DD) | ØS, JD, ESA |
| Mid-Term Review (MTR) | ESA | 04.01.11 | Review of project | ØS, SE, JD, ESA |
| Progress Meeting 6 (PM6) | met.no | 16.10.11 | Nordic Seas coupled model Sensitivity Analysis (NS-MODEL-SAD, NS-MODEL-OM) | ØS, JD, PEI, MØK, ESA |
| Progress Meeting 7 (PM7) | met.no | 16.04.12 | First application of NS-model (draft of REP-4) | ØS, JD, PEI, MØK, ESA |
| Progress Meeting 8 (PM8) | met.no | 16.04.12 | Final application of NS-model (REP-4) | ØS, JD, PEI, MØK, ESA |
| Final Meeting (FM) | ESA | 16.05.12 | Final presentation (FR, SR, FP, TDP) | ØS, JD, SE, ESA |

ØS - Øyvind Saetra

SE - Steinar Eastwood

PEI - Pål Erik Isachsen

JD - Jens Debernard

MØK - Morten Ødegaard Køltzow

10 WORK PACKAGE DESCRIPTIONS

In the following schemes the work package descriptions for all the work packages are given.

| | | | |
|--|--------------|----------|------------------------|
| PROJECT: | STARS | Phase: 1 | WP REF: Task 1 |
| WP Title | Management | | Sheet 1 of 1 |
| Contractor | met.no | | |
| Major Constituent (eg Subsystem) | | | Issue Ref: 1.1 |
| Start date | KO | | Issue Date: 12.06.2009 |
| End date | KO + 30 | | |
| WP Manager | Øyvind Sætra | | |
| <p>Main tasks:</p> <ol style="list-style-type: none"> 1. Design web portal for STARS project based on WIKI technology. 2. Make all project documents available on web portal at least one week before reviews. 3. Maintain web portal through the whole project period. 4. Project management through the whole project period. <p>Required input from other WPs:</p> <ol style="list-style-type: none"> 1. SoW 2. Contract <p>Deliverables:</p> <ol style="list-style-type: none"> 1. D-1 : STARS web portal (KO + 1) 2. D-21: Project Management Plan (KO) <p>Persons involved:</p> <ol style="list-style-type: none"> 1. Øyvind Sætra (50%) 2. Steinar Eastwood (50%) | | | |

| | | | |
|---|------------------|----------|------------------------|
| PROJECT: | STARS | Phase: 1 | WP REF: Task 3 |
| WP Title | STARS data set | | Sheet 1 of 1 |
| Contractor | met.no | | |
| Major Constituent (eg Subsystem) | | | Issue Ref: 1.1 |
| Start date | 01.01.2010 | | Issue Date: 01.10.2009 |
| End date | 30.04.2010 | | |
| WP Manager | Steinar Eastwood | | |
| <p>Main tasks:</p> <p>Task 3.1</p> <ul style="list-style-type: none"> • Build STARS-DAT data set with multiple satellites, in situ, NWP and other relevant data sets in the Nordic Seas region during the winter seasons from 2005-2008. • Make STARS available through a FTP server connected to the STARS web page. <p>Task 3.2</p> <ul style="list-style-type: none"> • Build STARS-DAT-DB electronic metadata database. • Design a web-based PHP5 interface to STARS-DAT-DB with basic search capabilities. <p>Task 3.3</p> <ul style="list-style-type: none"> • Make a user manual to document the STARS-DAT and STARS-DAT-DB. <p>More details are given in the STARS technical proposal.</p> <p>Required input from other Tasks:</p> <ol style="list-style-type: none"> 1. SAP from Task 2 <p>Deliverables:</p> <ol style="list-style-type: none"> 1. STARS-DAT v1 2. STARS-DAT-DB v1 3. STARS-DAT-UM v1 <p>Persons involved:</p> <ol style="list-style-type: none"> 1. Steinar Eastwood (100%) | | | |

| | | | |
|---|---------------------------|----------|------------------------|
| PROJECT: | STARS | Phase: 1 | WP REF: Task 5 |
| WP Title | Polar Low Indicator (PLI) | | Sheet 1 of 1 |
| Contractor | met.no | | |
| Major Constituent (eg Subsystem) | | | Issue Ref: 1.1 |
| Start date | KO + 7 | | Issue Date: 12.06.2009 |
| End date | KO + 11 | | |
| WP Manager | Øyvind Sætra | | |
| <p>Main tasks:</p> <ol style="list-style-type: none"> 1. Develop the Polar Low Indicator 2. Documentation of the Polar Low Indicator 3. Implement the PLI field data according to ATBD-1 4. Validate and verify the PLI fields 5. Demonstrate the use of the PLI field to monitor the potential intensification of polar lows 6. Prepare a PLI development, implementation and validation report (REP-3) <p>Required input from other WPs:</p> <ol style="list-style-type: none"> 1. SAP 2. REP-1 3. REP-2 4. STARS-DAT v1 <p>Deliverables:</p> <ol style="list-style-type: none"> 1. D-8 ATBD-1 2. D-9 PLI 3. D-10 STARS-DAT v2, STARS-DAT-DB v2, STARS-DAT-UM v2 <p>Persons involved:</p> <ol style="list-style-type: none"> 1. Øyvind Sætra (50%) 2. Steinar Eastwood (50%) | | | |

| | | | |
|--|--|----------|------------------------|
| PROJECT: | STARS | Phase: 2 | WP REF: Task 7 |
| WP Title | Implement and validate a coupled model of ocean-atmosphere system for investigation of polar lows in the Nordic Seas | | Sheet 1 of 1 |
| Contractor | met.no | | |
| Major Constituent (eg Subsystem) | | | Issue Ref: 1.1 |
| Start date | KO+14.5 | | Issue Date: 12.06.2009 |
| End date | KO+23.5 | | |
| WP Manager | Jens Debernard | | |
| <p>Main tasks:</p> <ul style="list-style-type: none"> 3. Implement and validate the NS-MODEL system. 4. Preparation of data assimilation system for NS-MODEL <p>Required input from other WPs:</p> <ul style="list-style-type: none"> 3. REP-1 4. REP-2 5. RSAP 6. EP-3 7. NS-MODEL-DD 8. STARS-DAT <p>Deliverables:</p> <ul style="list-style-type: none"> 3. D-12 NS-MODEL-SAD 4. D-13 NS-MODEL-OM 5. D-14 TEST DATA SET <p>Persons involved:</p> <ul style="list-style-type: none"> 2. Jens Debernard (34%) 3. Pål Erik Isachsen (33%) 4. Morten Ødegaard Køltzow (33%) | | | |

| PROJECT: | STARS | Phase: 2 | WP REF: Task 9 |
|--|---|----------|------------------------|
| WP Title | Prepare utility report, final report, data pack and a final presentation of results | | Sheet 1 of 1 |
| Contractor | Met.no | | |
| Major Constituent (eg Subsystem) | | | Issue Ref: 1.1 |
| Start date | KO+29 | | Issue Date: 12.06.2009 |
| End date | KO+30 | | |
| WP Manager | Øyvind Saetra | | |
| <p>Main tasks:</p> <ol style="list-style-type: none"> 1. Provide a final report (FR) 2. Provide a summary report based on FR 3. Provide power point presentation based on final report and present this at final meeting <p>Required input from other WPs:</p> <ol style="list-style-type: none"> 1. All previous deliverables <p>Deliverables:</p> <ol style="list-style-type: none"> 1. D-16: Final Report 2. D-17: Summary Report 3. D-18: Power Point presentation 4. D-19: Final presentation 5. D-20: Technical Data Package <p>Persons involved:</p> <ol style="list-style-type: none"> 1. Øyvind Saetra (38%) 2. Steinar Eastwood (25%) 3. Pål Erik Isachsen (12%) 4. Jens Debernard (12%) 5. Morten Ødegaard Køtzow (12%) | | | |