

# IODP Proposal Cover Sheet

915 - Pre

North Atlantic Fjord Sediment Archives

Received for: 2017-04-03

Title	Fjord sediment archives: assessing the recent (post LGM) millennial to sub-decadal scale variability of marine and continental climates in the northeastern North Atlantic.		
Proponents	Jacques Giraudeau, Jochen Knies, Katrine Husum, Seung-II Nam, Berit Oline Hjelstuen, James David Scourse, Matthias Forwick, Jan Sverre Laberg, Simon T. Belt		
Keywords	Marine-and-continental-paleoclimates, Holocene, Deglaciation, fjords, geo-hazards.	Area	Coastal Norway and Svalbard

## Proponent Information

Proponent	Jacques Giraudeau
Affiliation	CNRS-University of Bordeaux
Country	France

Permission is granted to post the coversheet/site table on [www.iodp.org](http://www.iodp.org)

## Abstract

The northeastern North Atlantic is a key area for unraveling oceanographic and atmospheric processes implied into millennial to decadal-scale climate changes of the present interglacial as well as the mechanisms involved into the last dismiss of northern European ice sheets. As the seat of the northward transport of Atlantic water to the Arctic and of the formation of oceanic deep water, the eastern sector of the Nordic Seas has a direct control over the climate of northwestern Europe. The impact of the major mode of atmospheric circulation in the northern hemisphere (North Atlantic/Arctic Oscillations) is particularly strengthened in this region: NAO/AO explains much of the present strength of the poleward flow of the surface and sub-surface waters over the NW European continental margin as well as recent changes in the mass balance of the maritime Scandinavian glaciers.

The general paucity of high resolution, continuous, coupled marine and continental records of Holocene environmental changes in the northeastern North Atlantic region since the initial dismiss of the NW European ice-sheets so far precludes any firm assumption on (1) the behavior and impact in this region of internal modes of the climate system variability (alike NAO and the Atlantic Multidecadal Oscillation), (2) their interactions with external climate forcing acting over short (volcanic and solar forcing) and long time-scales (orbital forcing), (3) the coupled ocean/cryosphere/atmosphere dynamics and the connections between marine and continental climates.

Tackling these three important scientific issues is the main motivation behind the FANA initiative. A fourth incentive and co-benefit of FANA's researches derives from the occurrence of frequent mass transport events in coastal systems of Norway and Svalbard. Hence, the climate-related records obtained as part of FANA will incidentally help moving forward on the questions of (4) the synchronicity and trigger mechanisms of past mass movements in high latitude coastal environments of Northwestern Europe.

A major step towards understanding natural climate changes in the northeastern North Atlantic region during the Holocene and the last glacial Termination, as well as their relation to the occurrence and frequency of mass failures, can be achieved by applying multi-proxy approaches to paleoceanographic, paleoclimatic, and age-model reconstructions from ultra-high-resolution sedimentary records retrieved in Norwegian and Svalbard fjords. FANA targets 8 fjord systems distributed along a latitudinal gradient from Southern Norway to Svalbard spanning the spread of the western sector of the last Scandinavian and Svalbard ice sheets.

## Scientific Objectives

Scientific objectives essentially refer to a research theme on Holocene millennial to sub-centennial climate changes and post-glacial dynamics of ice-sheets and tidewater glaciers.

As part of this research theme FANA aims at addressing the following questions:

- What are the main controls of sedimentation in glaciated and non-glaciated fjords? Did long and short-term changes in Holocene climate state impact the hierarchy of controls of sedimentation in fjords?
- What can decadal to millennial scale cycles of climate changes preserved in fjord sediments tell us about modes of North Atlantic climate variability?
- Were the flow strength and temperature of Atlantic water in the northeastern North Atlantic affected by high amplitude changes since the early Holocene initiation of modern circulation?
- Were the Holocene dynamics of marine and continental climates synchronous or time-transgressive across the Norwegian and Svalbard margins?
- Is the climate of the Anthropocene anomalous compared to previous Holocene warm periods?

Paleoclimate investigations will incidentally contribute to tackle a second set of questions related to the chronology and triggering mechanisms of mass transport deposits in coastal settings:

- How did relative sea-level changes and deglacial history explain contrasts in the post-glacial occurrence of mass movement events within and between fjords?
- Were Norwegian fjords widely impacted by mass transport deposits related to the main offshore megaslide events? Did these events occur during episodes of strengthened circulation of the poleward warm Atlantic water over the shelf?

## Non-standard measurements technology needed to achieve the proposed scientific objectives

## Proposed Sites (Total proposed sites: 24; pri: 23; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
<u>HAR-01A</u> (Primary)	60.4458 6.5497	792	75	0	75	Recover a post-glacial sediment sequence in inner Hardanger fjord (upstream of Younger Dryas end moraine) crossing upper slide units and acoustically laminated lower units: Chronological framework of acoustically laminated sedimentary unit; relating the dynamics of the post-glacial retreat of the western sector of the Fennoscandian ice sheet to marine and continental climates of western Norway during the last deglaciation. Chronology and frequencies of Holocene mass wasting events; inferring local or regional trigger mechanisms (comparison with nearby fjord systems – Fensfjorden, Byfjorden -).
<u>HAR-02A</u> (Primary)	59.9258 5.7507	509	75	0	75	Recover a post-glacial sediment sequence in inner Hardanger fjord - western sector - (upstream of Younger Dryas end moraine) crossing upper slide units and acoustically laminated lower units: Chronology and frequencies of Holocene mass wasting events; inferring local or regional trigger mechanisms (comparison with nearby fjord systems – Fensfjorden, Byfjorden -). Chronological framework of acoustically laminated sedimentary unit; relating the dynamics of the post-glacial retreat of the western sector of the Fennoscandian ice sheet to marine and continental climates of western Norway during the last deglaciation.
<u>HAR-03A</u> (Primary)	59.7640 5.5534	353	50	0	50	Recover a post-glacial sediment sequence in outer Hardanger fjord - western sector - (downstream of Younger Dryas end moraine) crossing a thin upper slide unit and thick acoustically laminated lower units: Chronological framework of acoustically laminated sedimentary unit; relating the dynamics of the post-glacial retreat of the western sector of the Fennoscandian ice sheet to marine and continental climates of south-western Norway during the last deglaciation and Holocene. Chronology and frequencies of Holocene mass wasting events; inferring local or regional trigger mechanisms (comparison with nearby fjord systems – Fensfjorden, Byfjorden -).
<u>HAR-04A</u> (Primary)	59.7320 5.5490	376	75	0	75	Recover a post-glacial sediment sequence in outer Hardanger fjord - western sector - (downstream of Younger Dryas end moraine) crossing an upper slide unit and a thick acoustically laminated lower units: Chronological framework of acoustically laminated sedimentary unit; relating the dynamics of the post-glacial retreat of the western sector of the Fennoscandian ice sheet to marine and continental climates of south-western Norway during the last deglaciation and Holocene. Chronology and frequencies of Holocene mass wasting events; inferring local or regional trigger mechanisms (comparison with nearby fjord systems – Fensfjorden, Byfjorden -).
<u>NOR-01A</u> (Primary)	61.8764 6.6826	325	75	0	75	Recover a post-glacial sediment sequence in inner Nordfjord (upstream of Younger Dryas end moraine) penetrating into laminated pre-Younger Dryas glacial marine sediments: Paleoenvironmental and paleoclimatological conditions at times (Bölling-Allerød) of initial retreat of the western sector of the Fennoscandian ice-sheet. Chronology of post-YD mass failure events and trigger mechanisms.
<u>NOR-02A</u> (Primary)	61.8454 6.3408	438	75	0	75	Recover a post-glacial sediment sequence in inner Nordfjord (upstream of Younger Dryas end moraine) penetrating into laminated pre-Younger Dryas glacial marine sediments: Paleoenvironmental and paleoclimatological conditions at times (Bölling-Allerød) of initial retreat of the western sector of the Fennoscandian ice-sheet. Chronology of post-YD mass failure events and trigger mechanisms.
<u>NOR-03A</u> (Primary)	61.9155 5.5433	582	75	0	75	Recover a post-glacial sediment sequence in outer Nordfjord (downstream of Younger Dryas end moraine) within dominantly acoustically laminated sediments. High resolution paleocirculation of the Norwegian Coastal Current and Norwegian Atlantic Current off south-western Norway and relation with the initial melting of the western sector of the Fennoscandian ice sheet and with the Modern and Holocene climate changes in the NE Atlantic region. Chronology of post-YD mass failure events and trigger mechanisms.

## Proposed Sites (Continued; total proposed sites: 24; pri: 23; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
<u>NOR-04A</u> (Primary)	61.9001 5.1361	315	45	0	45	Recover a post-glacial sediment sequence in outer Nordfjord (downstream of Younger Dryas end moraine) within dominantly acoustically laminated sediments: High resolution paleocirculation of the Norwegian Coastal Current and Norwegian Atlantic Current off south-western Norway and relation with the initial melting of the western sector of the Fennoscandian ice sheet and with the Modern and Holocene climate changes in the NE Atlantic region. Chronology of post-YD mass failure events and trigger mechanisms.
<u>TRO-01A</u> (Primary)	63.7264 10.9825	422	75	0	75	Recover a complete, extremely high-resolution pre-Boreal to Modern sediment sequence in the inner Trondheimsfjorden, with limited impact of mass wasting events: Sub-decadal scale variations of the marine and continental climates of western Norway with special reference to oceanic (Norwegian Atlantic Current and Norwegian Coastal Current) and atmospheric circulation changes. Modern (Anthropocene) changes in environmental conditions and sedimentary budget with regard to present global climate change and local human activity. Comparing proxy-records with instrumental time-series.
<u>TRO-02A</u> (Primary)	63.4947 10.1936	497	75	0	75	Recover a complete, extremely high-resolution pre-Boreal to Modern sediment sequence in the central Trondheimsfjorden, with limited impact of mass wasting events: Sub-decadal scale variations of the marine and continental climates of western Norway with special reference to oceanic (Norwegian Atlantic Current and Norwegian Coastal Current) and atmospheric circulation changes. Modern (Anthropocene) changes in environmental conditions and sedimentary budget with regard to present global climate change and local human activity. Comparing proxy-records with instrumental time-series.
<u>TRO-03A</u> (Primary)	63.7080 9.8545	255	75	0	75	Recover a complete, high-resolution post glacial sediment sequence in the outer Trondheimsfjorden (Stornfjorden), with occasional impact of mass wasting events: Decadal scale variations of the marine and continental climates of western Norway with special reference to oceanic (Norwegian Atlantic Current and Norwegian Coastal Current) and atmospheric circulation changes. Chronology and trigger mechanisms of mass failures events. Impacts of Holocene offshore megaslide-triggered tsunamis on local debris-flow deposits.
<u>RAN-01A</u> (Primary)	66.2286 13.2741	335	35	0	35	Recover a complete high resolution last deglaciation to Modern sediment sequence in inner Ranafjorden (upstream of Younger Dryas end moraine): Sediment infilling of Ranafjorden basins: relation to post glacial receding and advance of the ice sheet and marginal glaciers and to glacial changes in the NE Atlantic. Chronology and trigger mechanisms of mass failures events. Impacts of Holocene offshore megaslide-triggered tsunamis on local debris-flow deposits.
<u>RAN-02A</u> (Primary)	66.1547 12.6605	308	75	0	75	Recover a complete high resolution last deglaciation to Modern sediment sequence in outer Ranafjorden (upstream of Younger Dryas end moraine): Sediment infilling of Ranafjorden basins and relation to post glacial receding and advance of the ice sheet and marginal glaciers. Chronology and trigger mechanisms of mass failures events. Impacts of Holocene offshore megaslide-triggered tsunamis on local debris-flow deposits. High resolution paleocirculation of the Norwegian Coastal Current and Norwegian Atlantic Current off western Norway and relation with the final melting of the northern sector of the Fennoscandian ice sheet and the Holocene climate changes in the NE Atlantic region.
<u>LYN-01A</u> (Primary)	69.6463 20.4124	260	75	0	75	Recover the first complete high-resolution pre-Boreal to Modern sediment sequence in the inner Lyngenfjord with limited disturbance by gravitational processes: Dynamics of the retreating northern Norwegian ice margin at the confluence zone of the Fennoscandian and Southern Barents Sea ice sheets. Erosion rates of the Lyngenfjord catchment area during the last deglaciation based on sediment flux estimates. High resolution Holocene to Modern paleoclimatological history of the northern Norwegian region.

## Proposed Sites (Continued; total proposed sites: 24; pri: 23; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
<u>LYN-02A</u> (Primary)	69.9398 20.3980	285	75	0	75	Recover a complete high-resolution late Glacial to Modern sediment sequence in the outer Lyngenfjord: Dynamics of the retreating northern Norwegian ice margin at the confluence zone of the Fennoscandian and Southern Barents Sea ice sheets. Erosion rates of the Lyngenfjord catchment area during the late Glacial and last Deglaciation based on sediment flux estimates. Paleocirculation of the Norwegian Coastal Current and North Cape Current in the southern Barents Sea and relation with the final melting of the northern Fennoscandian ice sheet and the Holocene paleoclimatological history of northern Norway. Chronology of mass wasting events and trigger mechanisms.
<u>LYN-03A</u> (Alternate)	69.9465 20.4007	280	75	0	75	Alternate to LYN-02A. Recover a complete high-resolution late Glacial to Modern sediment sequence in the outer Lyngenfjord: Dynamics of the retreating northern Norwegian ice margin at the confluence zone of the Fennoscandian and Southern Barents Sea ice sheets. Erosion rates of the Lyngenfjord catchment area during the late Glacial and last Deglaciation based on sediment flux estimates. Paleocirculation of the Norwegian Coastal Current and North Cape Current in the southern Barents Sea and relation with the final melting of the northern Fennoscandian ice sheet and the Holocene paleoclimatology of northern Norway. Chronology of mass wasting events and trigger mechanisms.
<u>LYN-04A</u> (Primary)	70.4091 20.1263	200	75	0	75	Recover a complete high-resolution late Glacial to Modern sediment sequence in the outer Lyngenfjord: Dynamics of the retreating northern Norwegian ice margin at the confluence zone of the Fennoscandian and Southern Barents Sea ice sheets. Erosion rates of the Lyngenfjord catchment area during the late Glacial and last Deglaciation based on sediment flux estimates. Paleocirculation of the Norwegian Coastal Current and North Cape Current in the southern Barents Sea and relation with the final melting of the northern Fennoscandian ice sheet and the Holocene paleoclimatological history of northern Norway. Chronology of mass wasting events and trigger mechanisms.
<u>KEU-01A</u> (Primary)	77.5547 15.5331	90	25	0	25	Recover a complete post-glacial sediment sequence in outer basin (inner part) of Van Keulenfjorden: Holocene chronology of tidewater glacier (Nathrosbreen) surges and retreats. Late Glacial to late Holocene paleocirculation changes (East Svalbard Current, West Svalbard Current) over the west Svalbard shelf and impact on the deglacial history of the west Svalbard ice-sheet and on the Holocene dynamics of tidewater glaciers. Holocene changes in fjord sea-ice distribution and impact on brine water production and export to the western Svalbard shelf and slope.
<u>KEU-02A</u> (Primary)	77.5678 15.3083	97	25	0	25	Recover a complete post-glacial sediment sequence in outer basin (outer part) of Van Keulenfjorden: Holocene chronology of tidal glacier (Nathrosbreen) surges and retreats. Late Glacial to late Holocene paleocirculation changes (East Svalbard Current, West Svalbard Current) over the west Svalbard shelf and impact on the deglacial history of the west Svalbard ice-sheet and on the Holocene dynamics of tidal glaciers. Holocene changes in fjord sea-ice distribution and impact on brine water production and export to the western Svalbard shelf and slope.
<u>KON-01A</u> (Primary)	78.9576 11.9091	355	25	0	25	Recover a complete post-glacial sequence in central basin of Kongsfjorden: Holocene chronology of tidal glacier (Kronebreen) surges and retreats. Late Glacial to late Holocene paleocirculation changes (East Svalbard Current, West Svalbard Current) and impact on the deglacial history of the west Svalbard ice-sheet and on the Holocene dynamics of tidewater glaciers. Holocene changes in fjord sea-ice distribution and impact on brine water production and export to the west Svalbard shelf and slope. Modern (Anthropocene) changes in environmental conditions with regard to present global climate change. Comparing proxy-records with instrumental time-series (Ny-Alesund time-series).

## Proposed Sites (Continued; total proposed sites: 24; pri: 23; alt: 1; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
<u>KON-02A</u> (Primary)	79.0176 10.7316	318	30	0	30	Recover a complete post-glacial sequence in the outer Kongsfjorden: High resolution late Glacial to late Holocene paleocirculation of Atlantic (WSC) and Polar waters (ESC) over the west Svalbard shelf. Impact on the deglacial history of the west Svalbard ice-sheet and on the Holocene dynamics of tidewater glaciers. Holocene changes in sea-ice distribution, brine water production and export to the west Svalbard shelf and slope.
<u>KON-03A</u> (Primary)	79.0513 11.0900	327	25	0	25	Recover a complete post-glacial sequence in the outer Kongsfjorden: High resolution late Glacial to late Holocene paleocirculation of Atlantic (WSC) and Polar waters (ESC) over the west Svalbard shelf. Impact on the deglacial history of the west Svalbard ice-sheet and on the Holocene dynamics of tidewater glaciers. Holocene changes in sea-ice distribution, brine water production and export to the west Svalbard shelf and slope.
<u>HIN-01A</u> (Primary)	80.3566 16.2916	388	20	0	20	Recover a complete late Glacial to late Holocene sequence in Hinlopen trough (mid-shelf): Late Glacial to late Holocene changes in Atlantic Water inflow to the Arctic via the Fram Strait gateway. Comparing this flow history with conditions in the Barents Sea gateway (LYN-02A, LYN-04A). Deglacial history of the Northern Svalbard ice-sheet.
<u>HIN-02A</u> (Primary)	80.5000 15.9166	343	12	0	12	Recover a complete late Glacial to late Holocene sequence in Hinlopen trough (mid-shelf): Late Glacial to late Holocene changes in Atlantic Water inflow to the Arctic via the Fram Strait gateway. Comparing this flow history with conditions in the Barents Sea gateway (LYN-02A, LYN-04A). Deglacial history of the Northern Svalbard ice-sheet.