ADAC Year 5 Annual Meeting
ADAC Project Briefing
“High Resolution Modeling of Arctic Sea Ice and Currents”

A presentation by

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HIOMAS (2 km resolution) sea ice thickness for Sept 2018
ADAC Project (HIOMAS): (High Resolution Modeling of Arctic Sea and Currents)

- Project Principal Investigator(s)
  Jinlun Zhang
- Lead Institution
  University of Washington/APL
- Supporting Team
  Kay Runciman, programmer
- Project Champion
  Dr. Jonathan Berkson, CG-WWM

HIOMAS (2 km) sea ice velocity (Oct 31, 2018); one out of 400 vectors plotted (1 vector represents 400 vectors)
ADAC Project (HIOMAS): Description and Baseline

• Project Description
To support USCG Arctic operators and planners by developing High-resolution Ice-Ocean Modeling and Assimilation System (HIOMAS) to realistically predict Arctic sea ice and ocean currents on daily to seasonal time scales

• Baseline
We have developed 3 versions of HIOMAS with 6, 4, and 2 km horizontal resolutions for the whole Arctic Ocean. We found that these 3 versions all create realistic sea ice thickness fields that better match observations than some other modeling approaches. They are also able to create narrow leads or cracks seen by satellites. We have newly developed a 4th version of HIOMAS that has 1 km resolution for the Alaska waters (i.e., U.S. EEZ).
Project (HIOMAS): Relevance and Method

• Relevance to DHS and USCG:

Accurate, high-resolution forecast of Arctic sea ice and currents days to months in advance would help the USCG to conduct search and rescue missions more safely and reliably and to prepare for and respond to potential disasters such as oil spills.

• Research Method:

HIOMAS is developed based on the Pan-arctic Ice–Ocean Modeling and Assimilation System (PIOMAS). PIOMAS is a well-established system whose sea ice output is widely used by scientists and the general public. HIOMAS is designed to have much higher resolution than PIOMAS and therefore can better serve the needs of the USCG, NOAA, and other Arctic stakeholders
Project (HIOMAS): Progress in meeting research objectives

- Developed 3 versions of HIOMAS with 6, 4 and 2 km horizontal resolutions for the whole Arctic Ocean.
- Developed a version of HIOMAS with 1 km horizontal resolutions for the Alaska waters (US EEZ).
- Assimilate satellite sea ice concentration in HIOMAS hindcast to improve initial conditions for forecast.
- Calibrated and validated HIOMAS hindcast using sea ice observations (ice thickness and velocity etc).
- Conducted (near) real-time hindcast and daily to seasonal forecast of Arctic sea ice and currents.
- HIOMAS forecast data distributed on NOAA's Arctic Environmental Response Management Application (ERMA) for wide access in support of the CG and other customers.
- Working to transition the 2 km resolution HIOMAS to the company of Axiom Data Science.
Project (HIOMAS): Ice thickness comparison with IceBridge & CryoSat2

- HIOMAS ice thickness is also compared with CryoSat2 ice thickness observations over the period 2013-2017, with 590K data points. Compared to CryoSat2 observations, the model mean bias is 0.23 m and the model-observation correlation is 0.66, capturing 44% of the variance of the observations.

Comparison with IceBridge data over 2013-2015
**Project (HIOMAS):** Ice thickness comparison with GOFS3.1 & CryoSat2, 4/30/18

HIOMAS is able to create narrow ice leads/cracks often seen by satellites. CryoSat2 data area available from www.cpom.ucl.sc.uk.

From 4 km resolution HIOMAS

From CryoSat2
25 km resolution
4/24-5/21/2018

From Navy’s model GOFS3.1
4 km resolution for the Arctic
Project (HIOMAS): Ice thickness comparison with GOFS3.1 & CryoSat2, 10/22/18

From 4 km resolution HIOMAS

From CryoSat2
25 km resolution
10/9-11/5/2018

From Navy’s model GOFS3.1
4 km resolution for the Arctic
Project (HIOMAS): Ice thickness: 2 HIOMAS versions vs. GOFS3.1 (1/21/18)

Higher resolution HIOMAS (2 km) tends to create more ice leads/cracks
**Project (HIOMAS):** Rough ice deformation comparison: HIOMAS vs. SAR image

SAR derived sea ice shear deformation during 5/17-23/2007
(SAR = Synthetic Aperture Radar)

2 km resolution HIOMAS sea ice deformation on 5/15/2017
Project (HIOMAS): Ice thickness (May 27, 16) & photo off Barrow in late May 16

From 1 km resolution HIOMAS for Alaska waters

Sea ice off Barrow in late May 2016
Project (HIOMAS): Ice thickness, velocity and currents on NOAA Arctic ERMA

Example: HIOMAS sea ice thickness field
Predicted on March 1, 2019 is on Arctic ERMA (Environmental Response Management Application)
Project (HIOMAS): Schedule and Metrics

• Current year research schedule and milestones:

⇒ 6/2018 – 6/2019: continue to improve the 1 km resolution HIOMAS and conduct model validation
⇒ 6/2018 – 6/2019: continue to conduct hindcast and forecast, distribute prediction data, and assess forecast skills to identify areas for further improvement
⇒ 12/2018 – 6/2019: working on transition of the 2 km resolution HIOMAS to Axiom Data Science

• Current year metrics:

⇒ Mean model error in ice concentration: < 10%
⇒ Mean model error in ice thickness < 0.4 m
⇒ Mean model error in ice drift: < 0.02 m/s
HIOMAS: Planned Research Outcomes

- A knowledge product: e.g., scientific papers and presentations.
- Continue to distribute HIOMAS forecast data to NOAA Arctic Environmental Response Management Application (ERMA) for wide access.
- Potential to be integrated into new research: e.g., tracking oil spills or icebergs.
- Software transition to Axiom Data Science to provide continued support to USCG, NOAA, and other Arctic stakeholders.
- Potential integration of HIOMAS data into NIC sea ice products for wider distribution: e.g., sea ice thickness, velocity, and leads or cracks information.
HIOMAS: Key Accomplishments

• Developed 4 high-resolution versions of HIOMAS that are able to realistically model Arctic sea ice and ocean currents to support USCG, NOAA, and other Arctic stakeholders; data are distributed to NOAA Arctic ERMA for wide access.

• One paper published on Journal of Geophysical Research, one presentation given at Alaska Marine Science Symposium, and one paper in revision, which are aimed to inform the sea ice research community and general public about changes in sea ice and behavior of sea ice models.
HIOMAS: Transition Plans

• We are transitioning HIOMAS to Axiom company so Axiom will continue to provide HIOMAS support to the CG, NOAA, and other stakeholders.
• Main focus is to transition the 2 km resolution HIOMAS to Axiom.
• Once the 1 km resolution HIOMAS is mature, it will be transitioned to Axiom as well.
• The 2-km resolution HIOMAS has been installed on an Axiom computer and hindcast test runs are being conducted, before testing forecast.
• After transition, ADAC will coordinate with project champion Dr. Berkson and end-users to maximize the use of HIOMAS data.
Ready for questions

- Feedback...
- What are we missing?
- What can we improve?
- Who should we connect with to improve odds of research success?

HIOMAS (2 km) ocean surface velocity (May 2018); one out of 400 vectors plotted (1 vector represents 400 vectors)