SAR Phenomena World Championship
Labeling S-1 WV images

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Objective

esa

Label the atmosphere and ocean phenomena in S-1 WV images

Contact:

stopa@hawaii.edu
to compete!

Label 50 images
Estimated time: 30-60 m

Bragging rights for life

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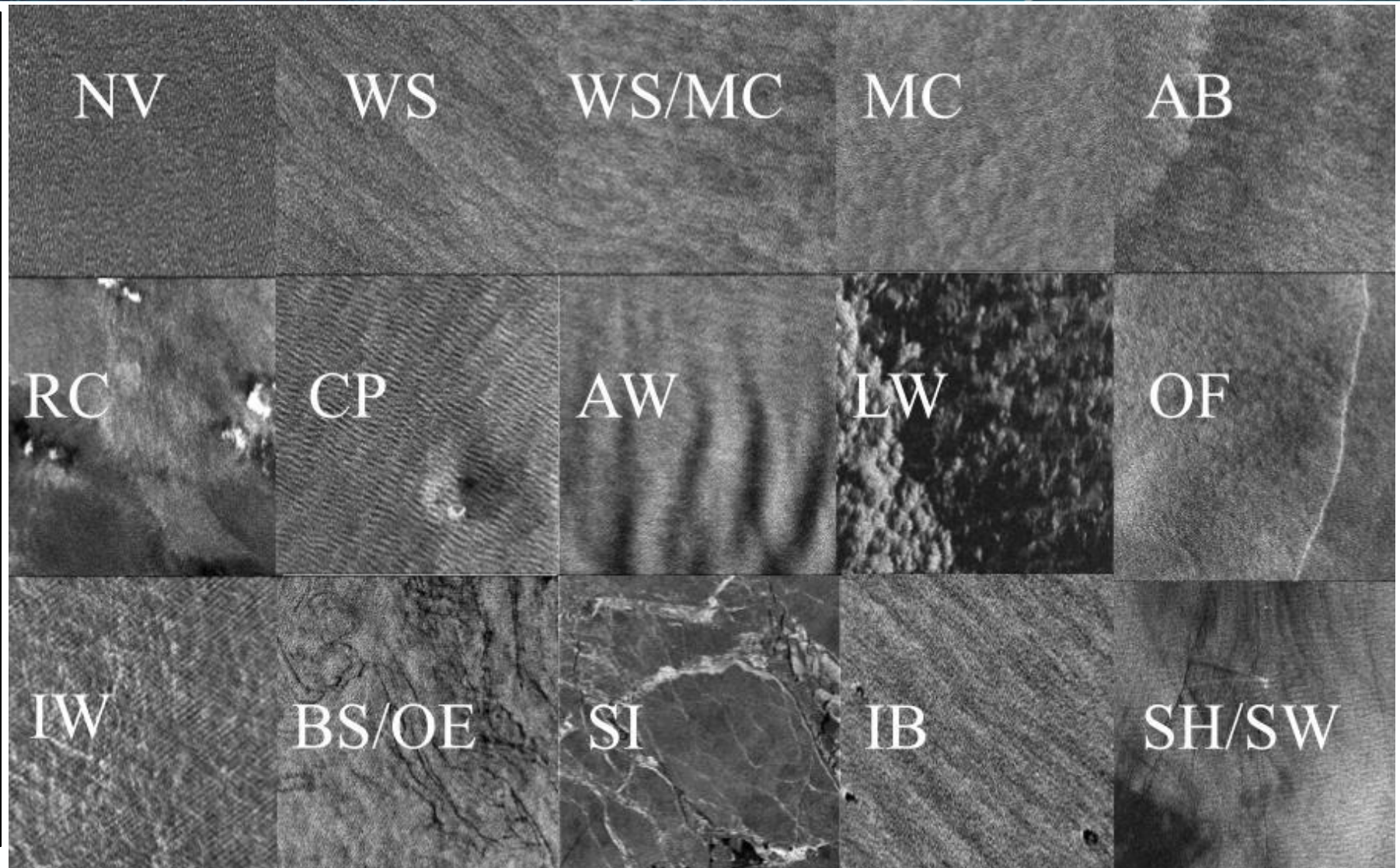
Objective

Objective: Label all phenomena in S-1 WV images

- Atmospheric or oceanic phenomena leave their imprints on the ocean surface that SAR can see → it is your task to identify the phenomena!

Guidelines and Recommendations:

- Contact me by email and give your (google email address) and your "nickname" to hide your identity
- Take 5-10 minutes to review these slides and familiarize yourself with the SAR classes
- Login into labelbox with a google login
- Label all images by selecting the phenomena in the drop down menu on the left-hand side
- Do not click "Skip" on the right-hand side - this means that you cannot label the image
- Use the zoom or contrast slider (top left controls) help highlight features
  - We recommend practicing on 10 images to get comfortable with the controls
- **Label the 50 images accurately and as fast as possible**
  - Complete labeling by 10 pm on Thursday evening
  - Awards will be given on Friday evening during the dinner

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- All image are Wave Mode (WM) images of S-1 sea surface roughness (SSR)
- These images are 20x20 km footprints available globally with pixel resolution of ~50 m

Creation of images
- We start with the normalized radar cross section (NRCS) to estimate the SSR
- Create SSR: The measured NRCS is divided by the NRCS predicted by CMOD5N (10 m/s at 45 degrees relative angle for the incidence) to create the SSR - reducing the incidence angle effect for both incidence angles of WV1~23° and WV2~37°
- Smoothing - a 2D running mean (block averaging) of 10x10 pixels is run through the entire image - to help reduce the speckle and reduce small-scale ocean roughness
- Downsampling (data reduction) – every 10th pixel is selected creating (450-500) pixel images
- Scaling –1 and 99th percentile values are the minimum and maximum values of the gray scale - meaning we removed the NRCS information to highlight ocean textures

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Ocean and Atmosphere Classes

Atmosphere
1) **NV** - Negligible atmospheric Variability
2) **WS** - Wind Streaks
3) **MC** - Microscale Convection
4) **RC** - Rain Cell
5) **CP** - Cold Pool
6) **LW** - Low Wind
7) **AB** - Air-mass Boundary or Gust Front
8) **AW** - Atmospheric gravity Wave
9) **UA** - Undefined Atmosphere

Other
1) **SH** - SHip
2) **SW** - Ship Wake
3) **LA** - LAnd
4) **NO** - NOne of these

Ocean
1) **BS** - Biological Slick
2) **SI** - Sea Ice
3) **IB** - Iceberg
4) **OF** - Ocean Front
5) **OE** - Ocean Eddy
6) **IW** - Internal ocean gravity Wave
7) **UO** - Undefined Ocean

This document is meant to guide labeling of the SAR imagery. It is not a comprehensive summary of the phenomena or the SAR textures!

Comments, suggestions, or questions are welcome!

NV - Negligible atmospheric Variability

- A portion of the image (>33%~1/3), or the entire image, is dominated only by ocean waves and <u>lacks</u> atmospheric features with scales of 0.8-5 km
- If an image contains a AB (or gust front), then it is possible to select NV along with turbulent features like WS or MC

<u>Examples</u>

- (a), (b), and (c) are typical S-1 NV images
- (d) NV with a gust front or AB; the bottom portion lacks atmospheric signatures and is more than the estimated 33% of the image

WS - Wind Streaks

- Bright/dark linear features that scale with the boundary layer height of 0.8-5 km
- There is one prevalent direction - the annotated lines show the orientation of the WS
- No indication of cells or circular structures
- WS can be varicose or very regular (like a corrugated roof)
- One of the most ubiquitous classes

Examples
- (a) shows shorter-scale WS of ~800 m
- (b) and (c) show classic WS; note that (c) is an example show less pronounced WS
- (d) shows an AB along with WS

WS/MC - Wind Streaks and Micro-scale Convection
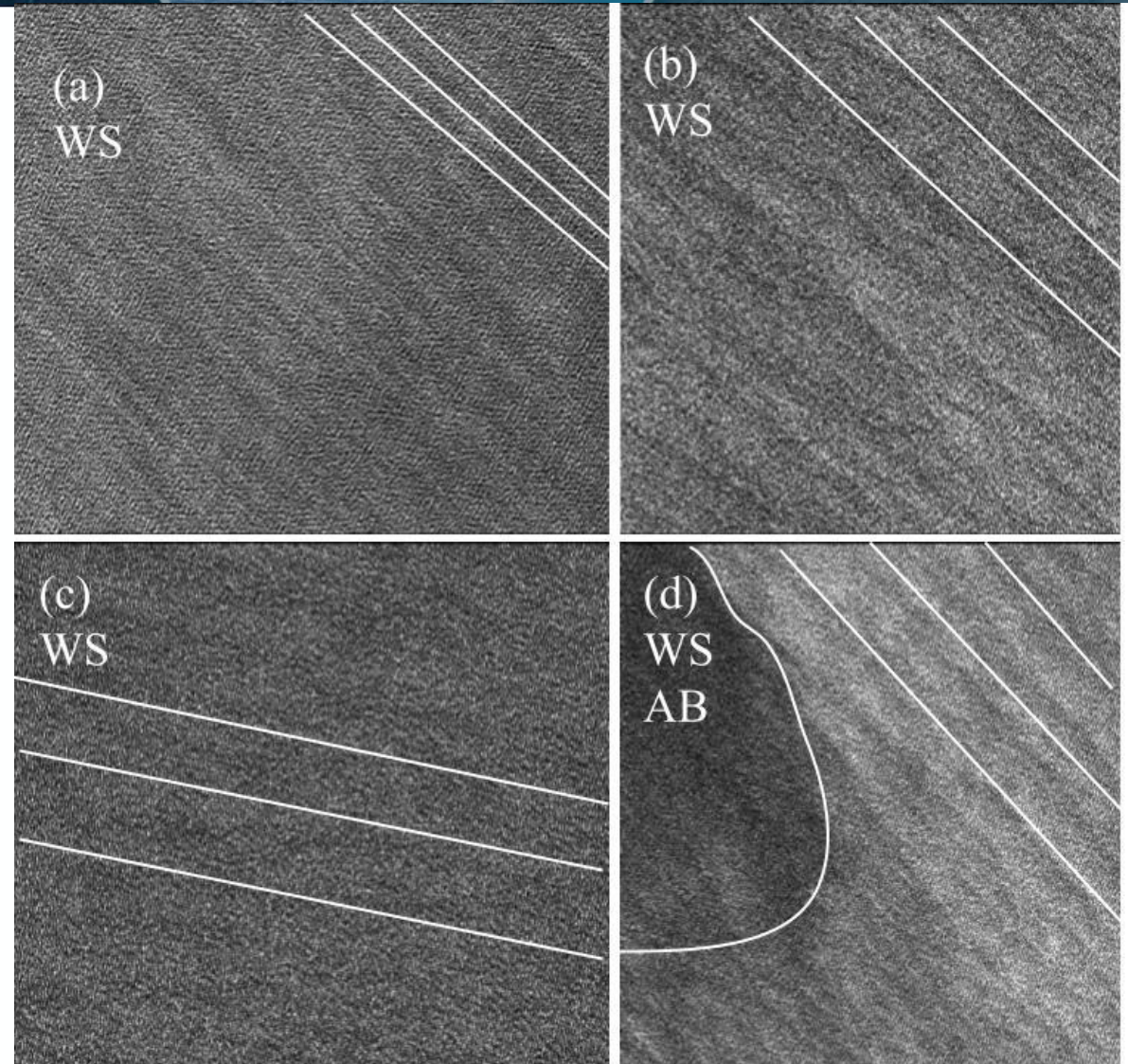
- Both WS and MC features are observable meaning there is a dominant direction of the linear-like features and there are 2D cellular features
- Use the tag if a region (>30%) or the entire image contains features of by WS and MC
- One of the most ubiquitous classes

Examples
- (a), (b), (d) show typical examples of WS/MC
- (c) shows a cold pool and an AB and WS/MC
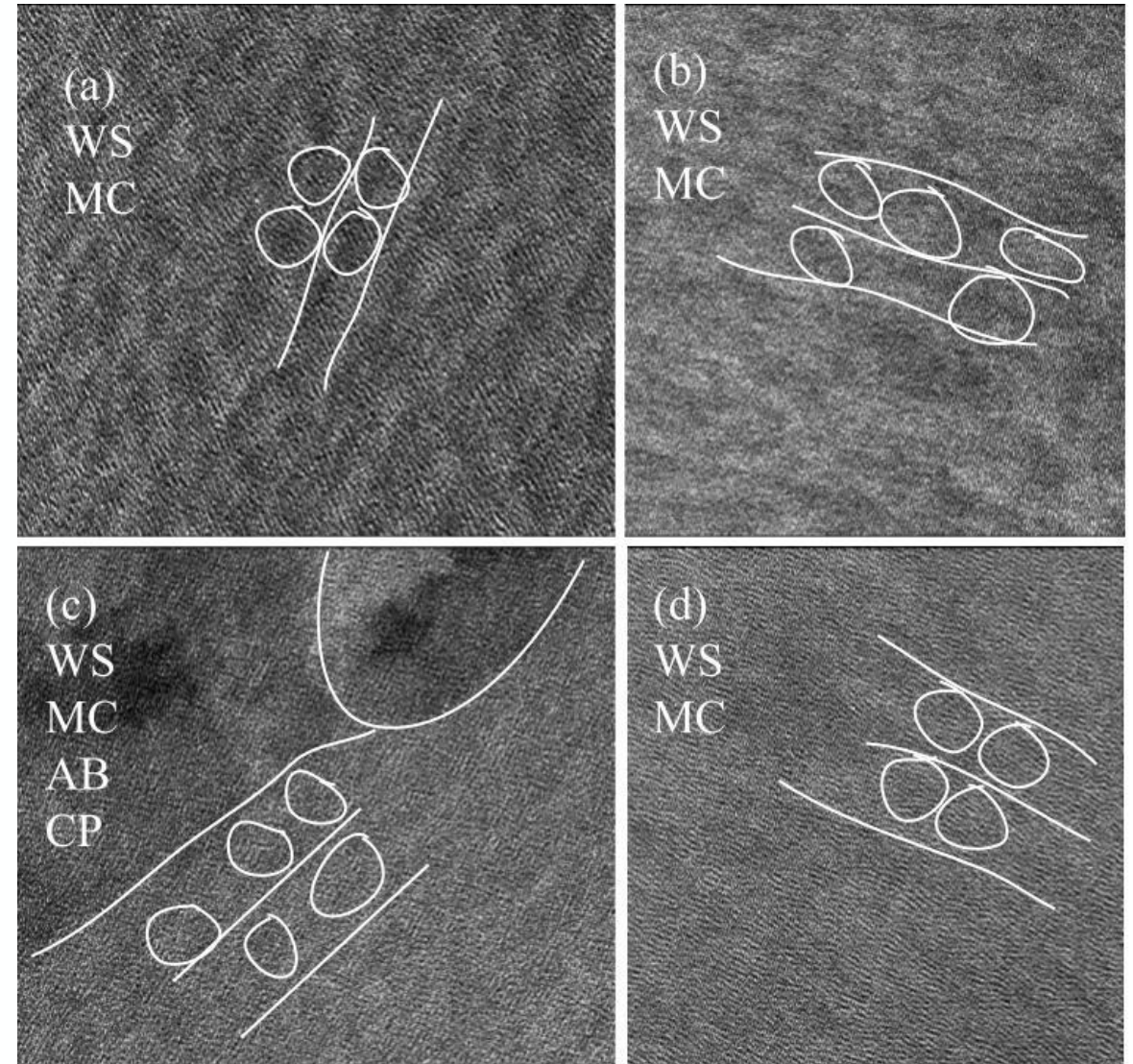
MC - Micro-scale Convection

- Honey-comb-like or popcorn-like patterns of circular patches
- Scales are similar to WS: 0.8-3 km with typical scales of 2 km
- No indication of streaks or linear patterns
- Use the tag if a region (>33%) of the image
- One of the most ubiquitous classes

Examples
- (a), (b) show typical examples of MC and they are consistent through the image
- (c) shows MC with more variations
- (d) show MC and BS

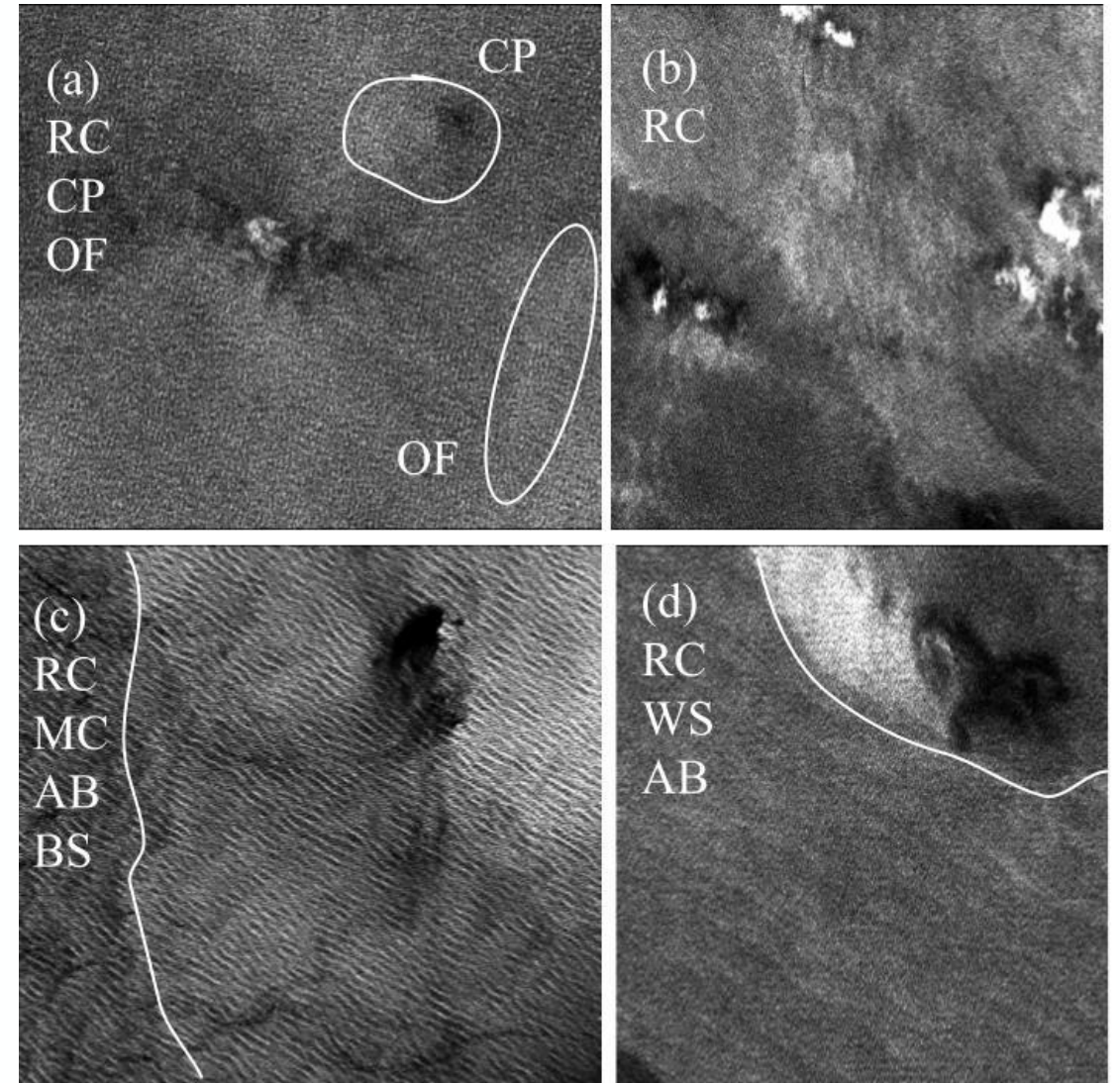(a) MC

(b) MC

(c) MC

(d) MC BS
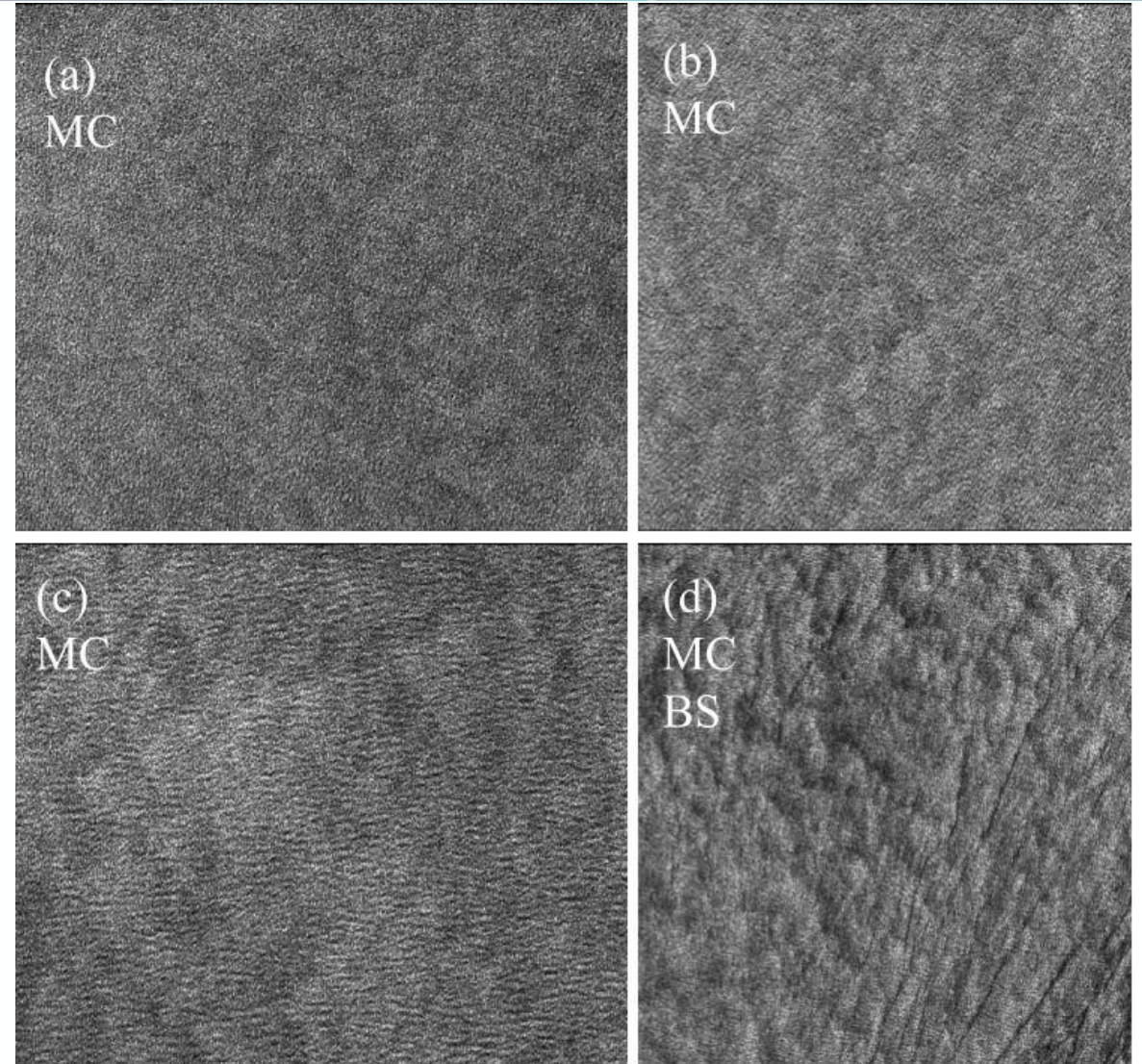
RC - Rain Cells

- Bright and dark patches with irregular shapes at the scales ~100 m to 5 km
- The bright patches are sometime more isolated relative to the dark patches
- It is common to see other features like AB, CP, WS, or MC

Examples

- (a) and (b) show common examples of RC
- (a) shows a CP and subtle OF
- (c) shows RC along with AB, BS, MC
- show typical examples of MC and they are consistent through the image
- (d) shows RC along with WS, AB and most likely a CP (but we would not tag the CP)

CP - Cold Pool

- Nearly circular areas with distinct bright (gust front) & dark regions (i.e. convergence/divergence)
- The bright/dark regions sometimes resemblance a tennis ball pattern
- Bright regions are gust fronts associated
- At least 75% of the CP must be contained within the image to use the tag; CP ~ 1-10 km
- Common to see RC and WS, WS/MC, and MC

Examples
- (a) & (b) classics CP
- (c) CP on the right has at least 75% the one on the right does not
- (d) multiple CP

LW - Low Wind

- The local winds are weak: so anything and everything will dominate the sea surface
- Small cm-scale roughness from the ocean waves is sometimes lacking resulting in dark areas
- Do not use AB tag with LW!
- Common to see MC and BS along with LW

Examples
- (a) & (d) classic LW
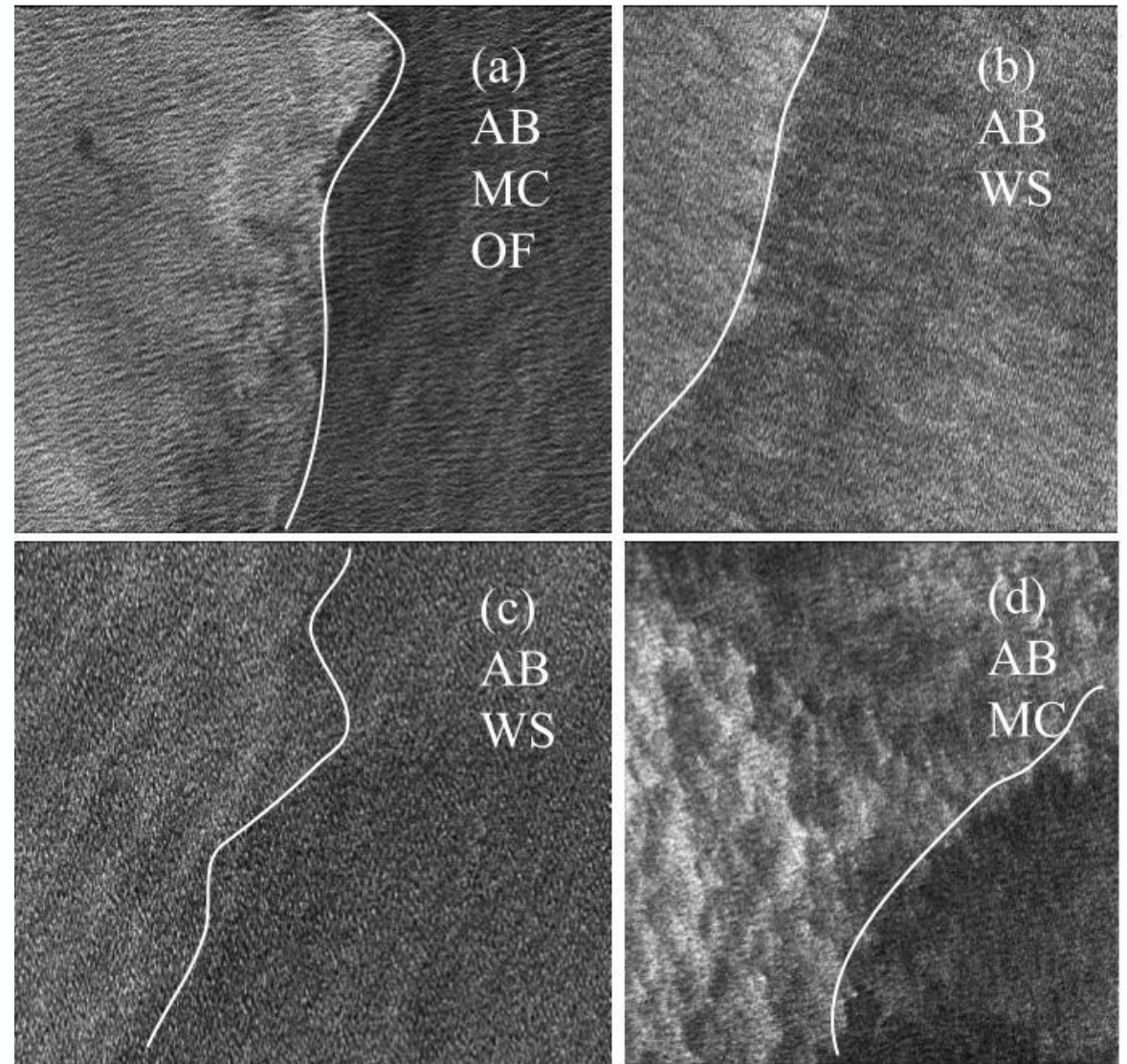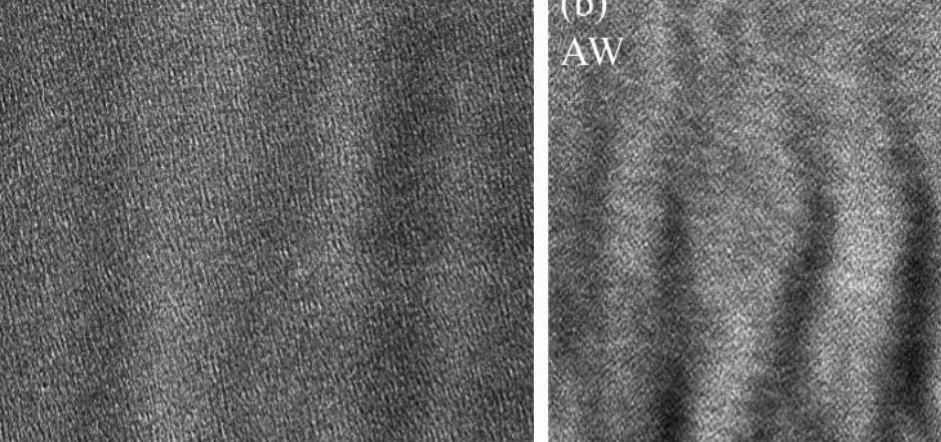- (b) LW with MC
- (c) LW with BS
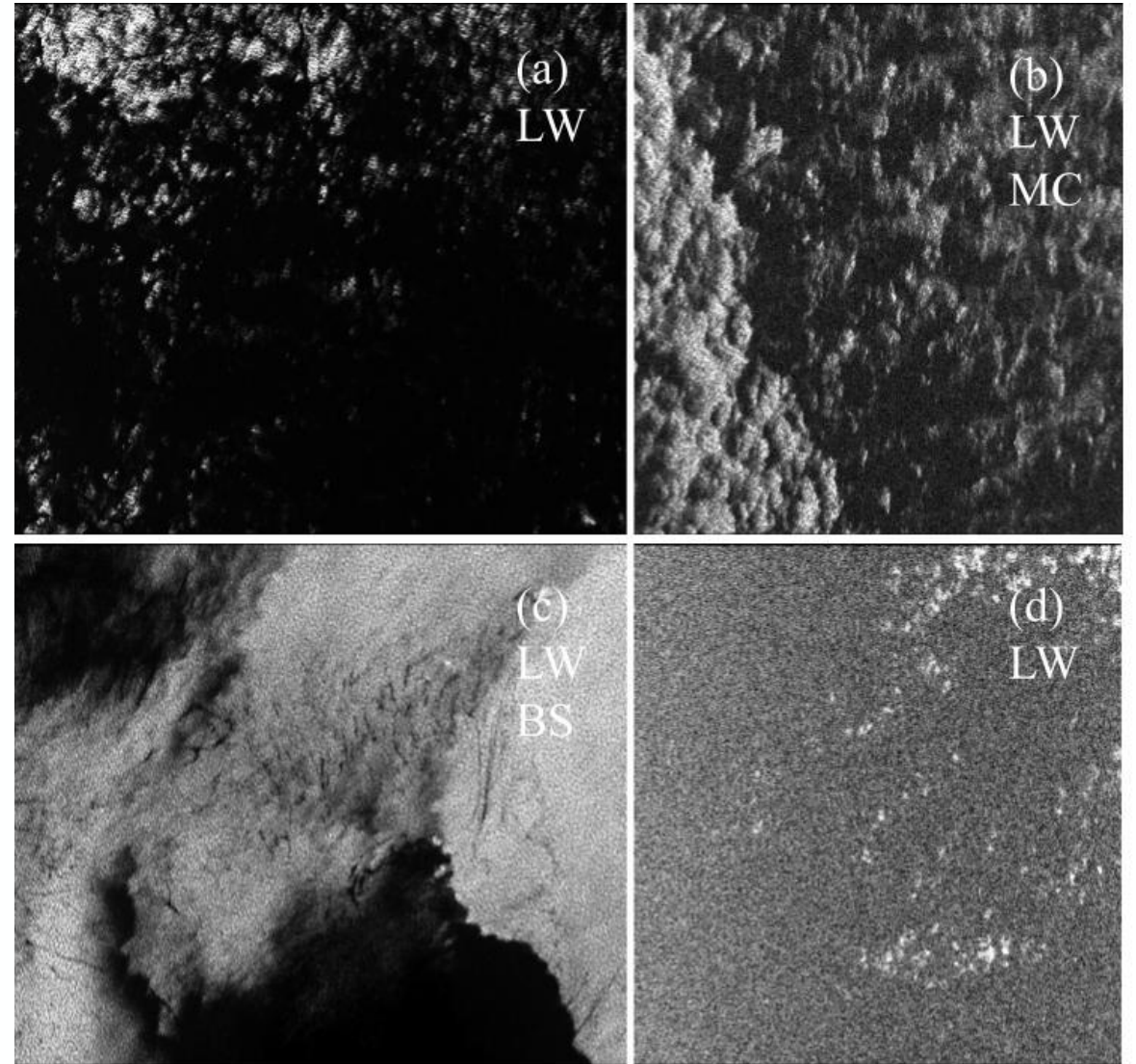
AB - Air-mass Boundary

- Observed as a linear or curved feature of brighter and darker features (the wind speeds changes) or represents the boundary b/t NV, WS, WS/MC, MC
- Locations of strong near‑surface horizontal gradients of wind, temperature and/or humidity
- These come in a variety of shapes and sizes…
- AB are common and occur with NV, WS, WS/MC, MC, RC, CP

Examples
- (a) AB and MC with OF
- (b) AB with WS
- (c) AB with WS
- (d) AB with MC

(a) AB MC OF

(b) AB WS

(c) AB WS

(d) AB MC

AB - Air-mass Boundary

- Vertical oscillations of the atmosphere that imprint bright (updraft) and dark (downdraft) regions on the sea surface
- The wave fronts are perpendicular to the wind direction; without knowledge of the wind direction they might look similar to WS
- The atmosphere has stable stratification (so it looks like NV and lacks WS or MC)
- Are expected to be rare (with random global sample) and isolated to specific geographic regions

Examples
- (a) classic AW
- (b) classic AW

UA - Unidentified Atmosphere

- Images that are difficult to identify the any of the other classes
- Use the tag when you expect the backscatter is dominated by the atmosphere but you cannot decipher exactly what it is!
- It is expected that the scales are larger than the 20x20 km footprints… with this zoomed in view is is near impossible to decipher

Examples
- (a) might be WS or MC but it is not clear… no consistent direction of the linear features
- (b) might be WS or MC
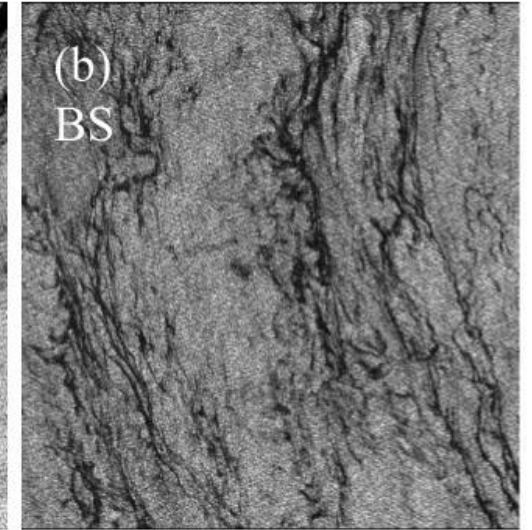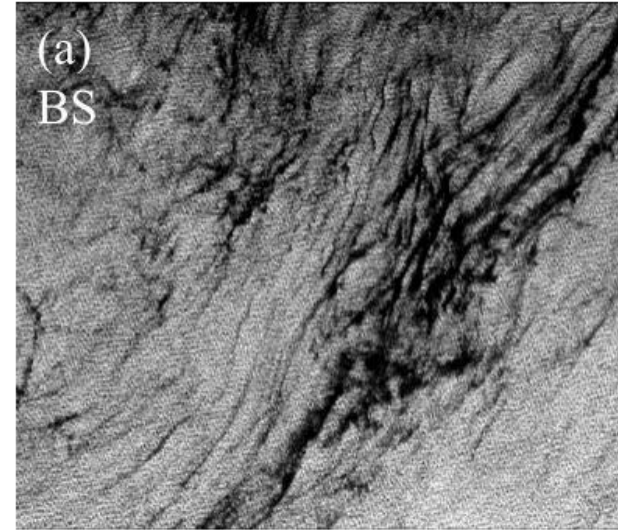- (c) might be MC but the scales are large
- (d) no idea

BS - "Biological" Slick

- Convergence of surface surfactants that are often identified by dark (sometimes bright) features
- Slicks can reveal small eddies or internal waves
- Slicks usually coincide with calm winds 2-7 m/s; however, slicks can be observed at higher wind speeds
- Slicks can be anthropogenic (e.g. oil) or natural (biologic) in nature - it is not our intent to distinguish them here
- It is common to see BS coupled with LW or MC

Examples
- (a) & (b) classic BS
- (c) BS with WS and MC
- (d) BS with LW - a classic examples
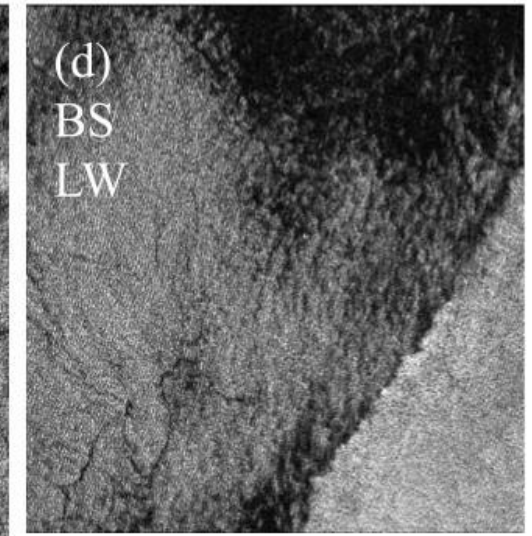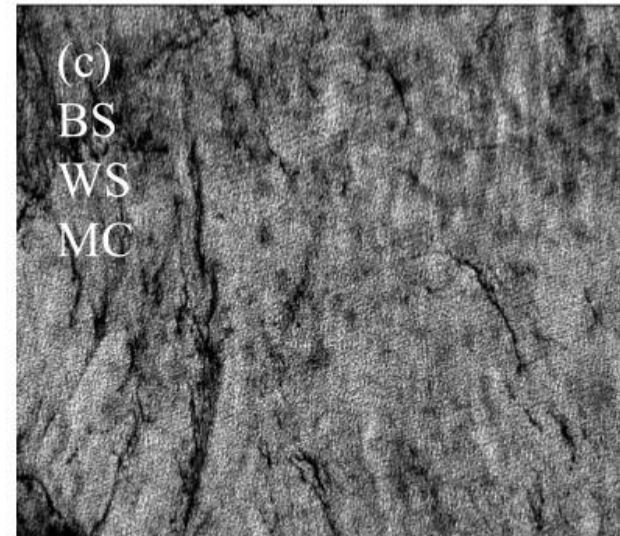
SI - Sea Ice
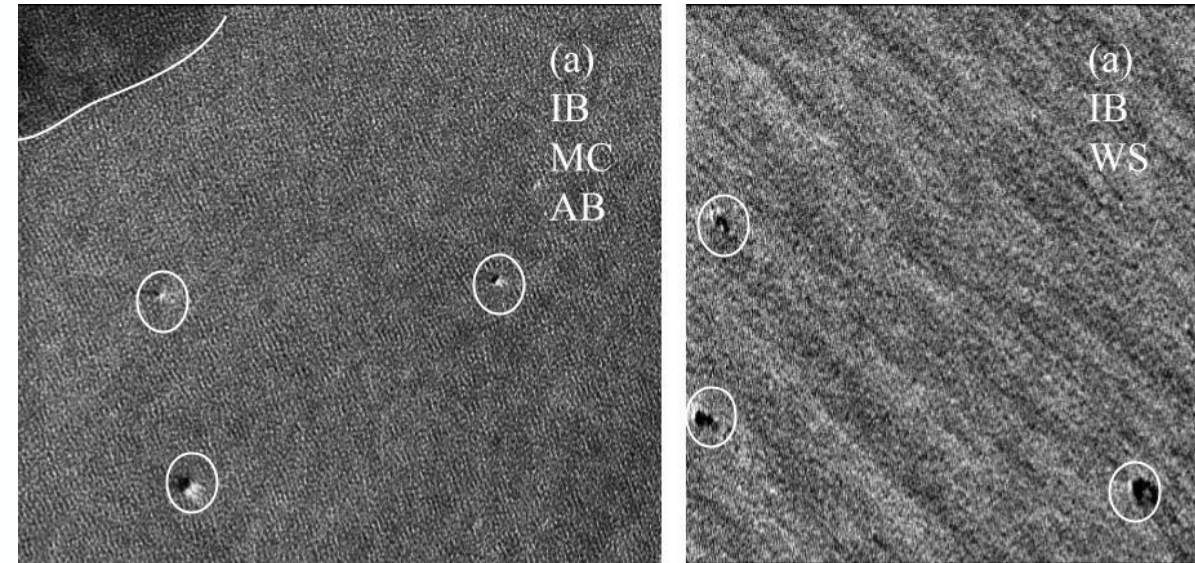
- Partial or full ice coverage
- S-1 WV only covers the Southern Ocean
- Images near the marginal ice zone (MIZ) will likely contain ocean wave features
- SI can have floes various sizes, or contain icebergs

Examples
- (a) & (b) classic SI with ice floes
- (c) & (d) images near the ice edge, in the MIZ, that have partial sea ice coverage

IB - IceBergs

- Isolated white or dark features of 200-500 m targets
- S-1 WV only covers the Southern Ocean
- IB can be in sea ice or in the open ocean
- If the images are in the open ocean it is common to see atmospheric signatures

Examples
- (a) IB with MC and a AB
- (b) IB with prominent WS

OF - Ocean Fronts

- Boundaries between water masses that can be caused by a differences in temperature, salinity, or density
- Ocean moves in different directions along the front creating up/downwelling and sea surface roughness anomaly - showing as a bright (sometimes dark) linear feature
- OF are observed when the wind speeds are moderate to calm and/or the atmosphere features are less pronounced
- Commonly occur with other phenomena!

Examples
- (a) OF with WS/MC
- (b) OF with MC and a CP
- (c) OF with WS
- (d) OF with NV

OE - Ocean Eddies

- Small-scale clockwise or counterclockwise rotation centers of surface convergence
- OE are only visible when surfactants (BS) are present so calm wind speeds typically <5 m/s (or LW)
- Are only visible when there are
- Extremely rare!

Examples
- (a) OE with BS clockwise rotation
- (b) OE with BS - counterclockwise rotation
- (c) OE with OF - expected strong counterclockwise rotation
- (d) OE with LW, BS, MC clockwise rotation
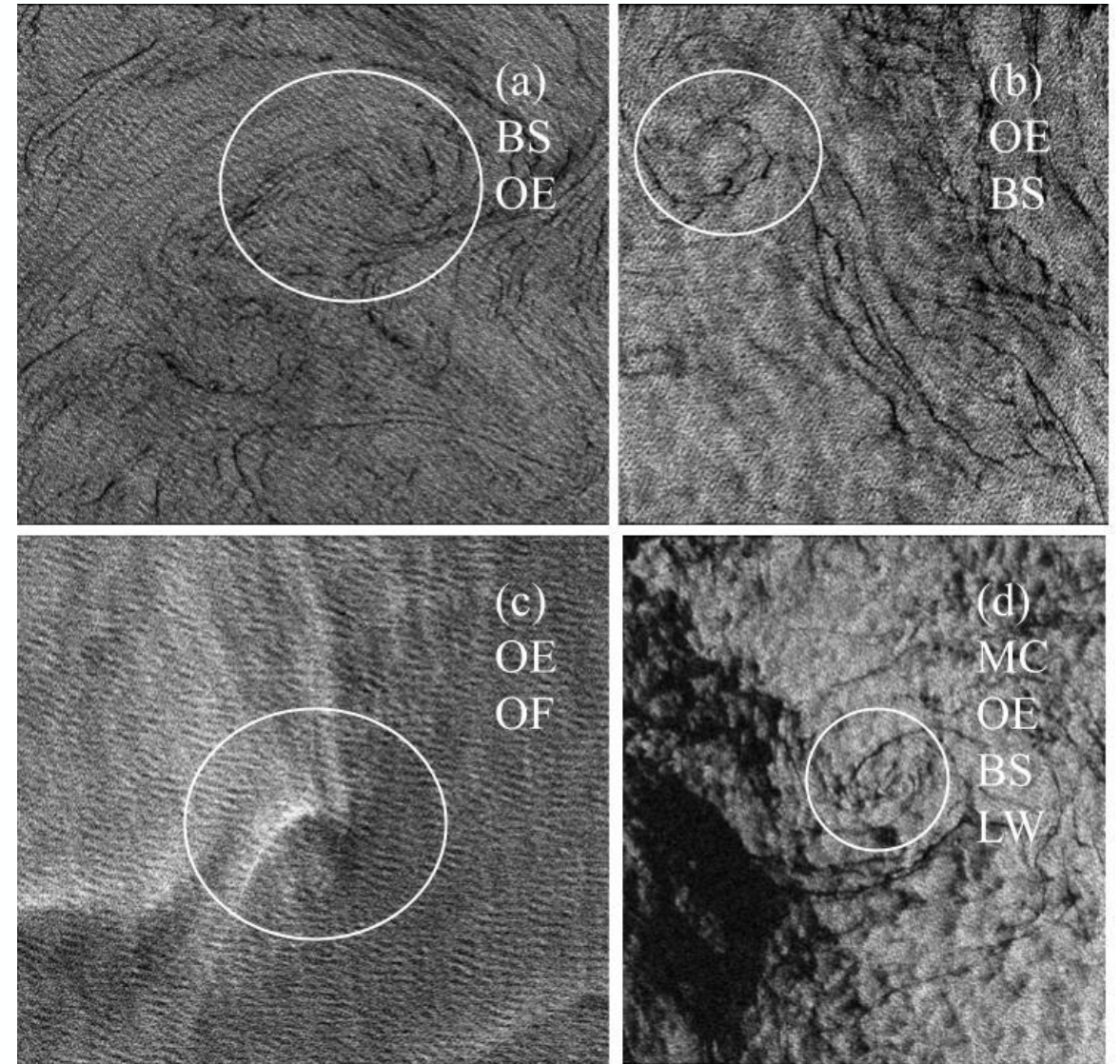
IW - Internal ocean gravity Waves

- Surface signatures of internal ocean waves with alternating bands of rough and smooth patches
- Wavelengths of 0.3 to 3 km
- Typically observed w/ moderate wind speeds (2-9 m/s)
- Often contain well-defined linear features
- Only occur in geographically isolated to regions of large bathymetric changes and strong tidal oscillations (e.g. Red China Sea) - uncommon to observe IW
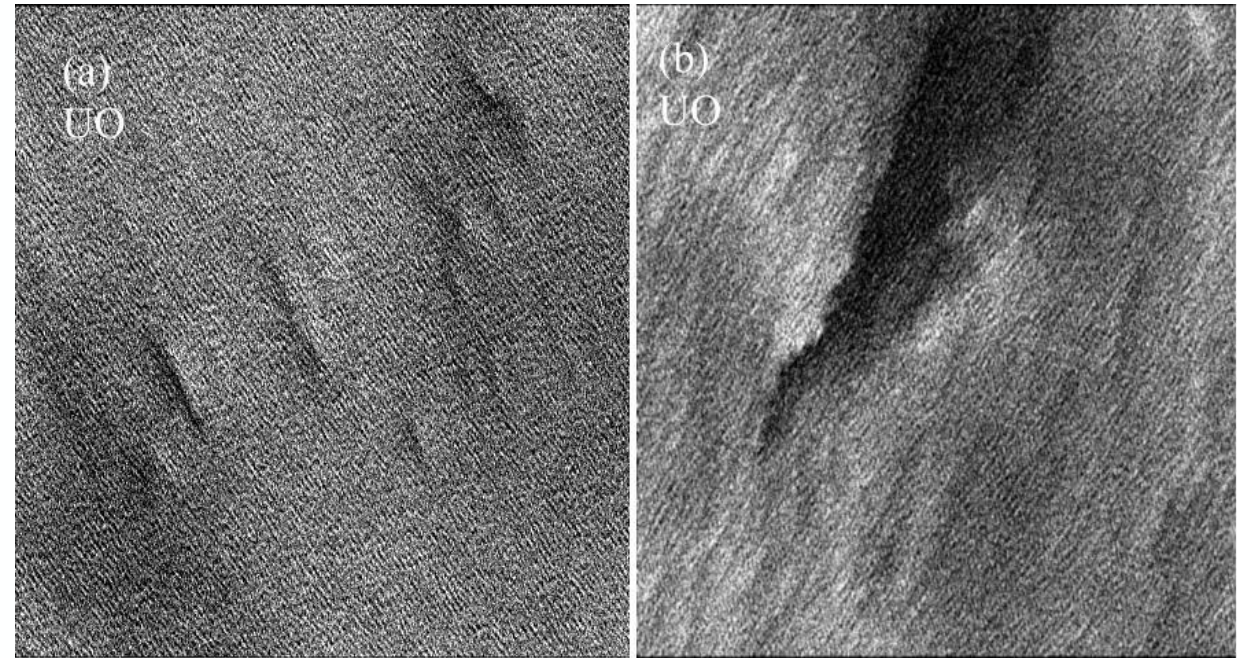
Examples
- (a) and (b) classic IW
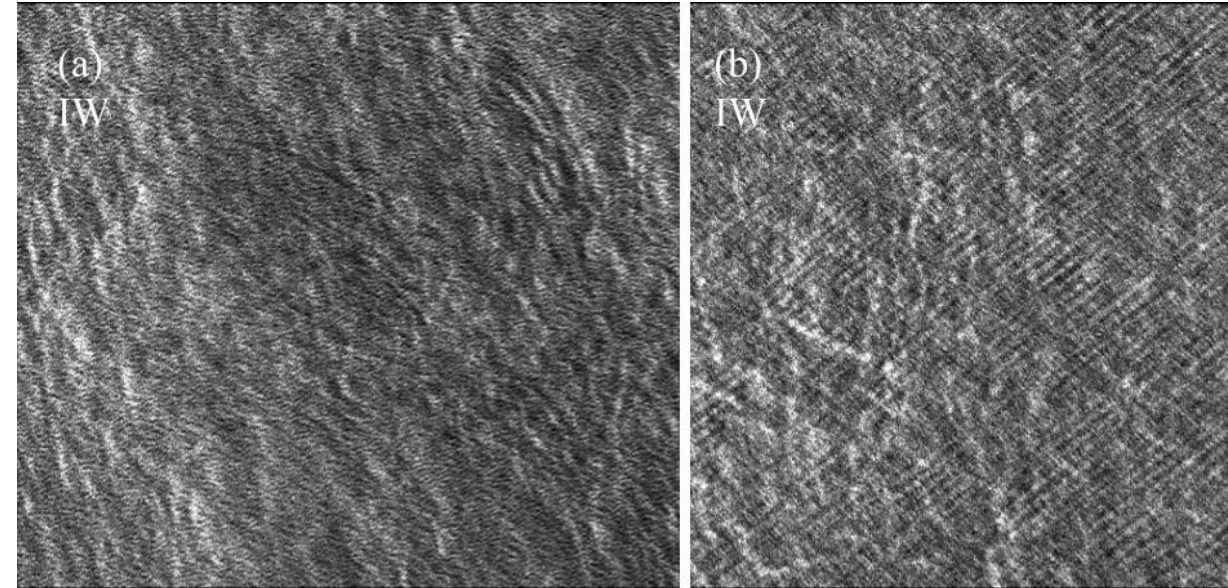
UO - Undefined Ocean

- Images that are difficult to identify the any of the other classes
- Use the tag when you expect the backscatter is dominated by the ocean or ocean phenomena but you cannot decipher exactly what it is!
- Unlikely to use this tag

<u>Examples</u>
- (a) anthropogenic slicks? Also tag UA?
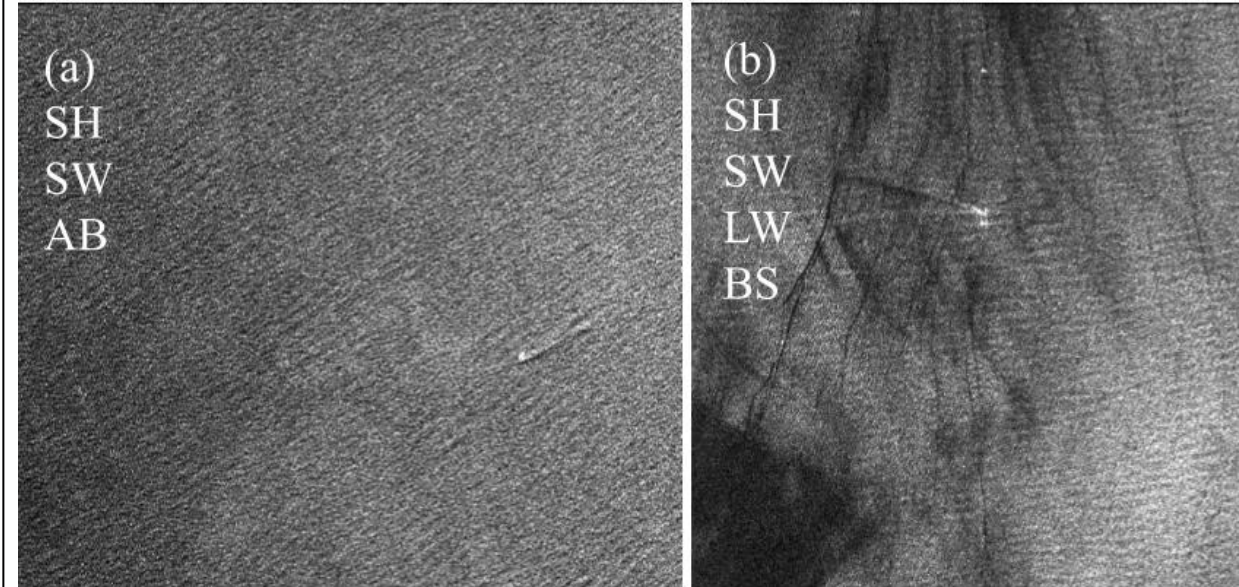- (b) upwelling? and WS

SH/SW - SHips or Ship Wakes

- Bright targets are the ships
- Linear features are the ship wakes
- It is possible to tag SH without SW
- It is possible to tag SW without SH
- The background images should also be classified as normal with all of other classes
- It might be difficult to decipher IB from SH without knowledge of the latitude

<u>Examples</u>
- (a) SH/SW with AB
- (b) SH/SW with LW and BS

SH/SW - SHips or Ship Wakes

- S-1 WV near near islands or atolls
- Rare since we remove S-1 images over land
- If near an island then it is common to see all of the other classes over the ocean

Examples
- (a) LA with WS
- (b) LA with MC

NO - None

- Unlikely to ever use this tag
- Use this tag if you discover something new in S-1 or the phenomena does not fit into any of the other categories!