FY09 GOES-R3 Project Proposal Title Page

- Title: Winter Weather Studies with GOES-R
- Project Type: Product Development Proposal
- Status: Final Year
- Duration: 3 years
- Lead(s):
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- Other Participants:
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  - H. Gosden, CIRA
  - D. Bikos, CIRA
  - J. Braun, CIRA

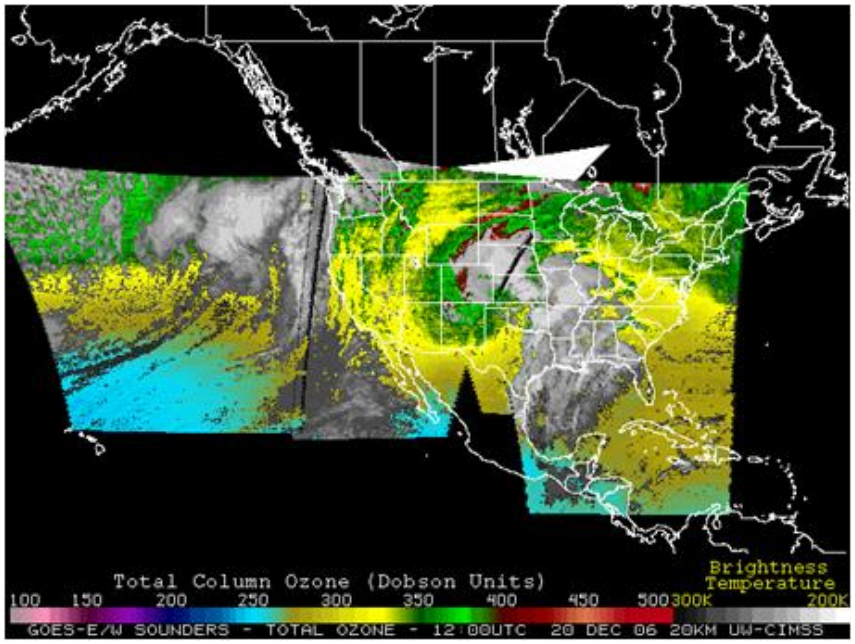
Motivation/Summary

- Virtually all wintertime, high-impact weather in the United States occurs in association with midlatitude cyclones.
  - » Heavy rain and snow
  - » High winds
  - » Turbulence

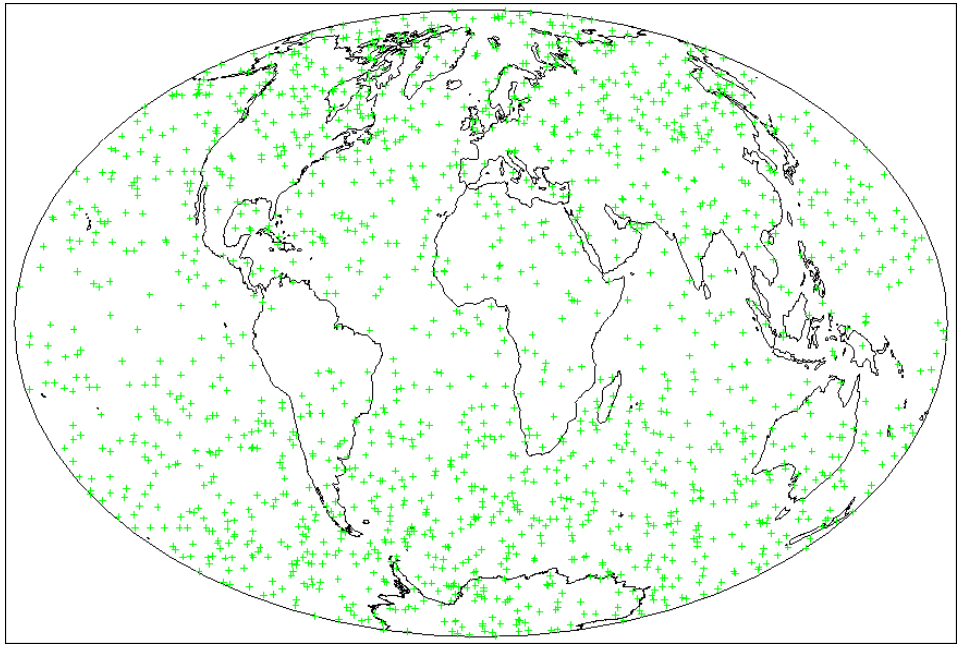
- Develop GOES-R applications for mid-latitude cyclone diagnosis
  - » Multiple-dataset upper-tropospheric jet stream analysis
    - – Use current GOES as proxy to GOES-R total ozone data
    - – COSMIC (Constellation Observing System for Meteorology, Ionosphere, and Climate)
    - – Radiosondes
    - – OMI (Ozone Monitoring Instrument)

FY08 – FY09 Milestones

- Collect necessary data
- Begin development of technique



GOES Total ozone



COSMIC soundings for one day

FY10 Milestones

Wind Field at the Tropopause from Satellite Measurements of Ozone

Procedure

1)Get tropopause pressure

- Radiosondes
- COSMIC Retrievals

2)Compute ozone in the lower stratosphere ($O_{3,LS}$)

- GOES Sounder
- OMI

3)$O_{3,LS}$ is related to the vorticity on the tropopause (Vaughn and Price, 1991)

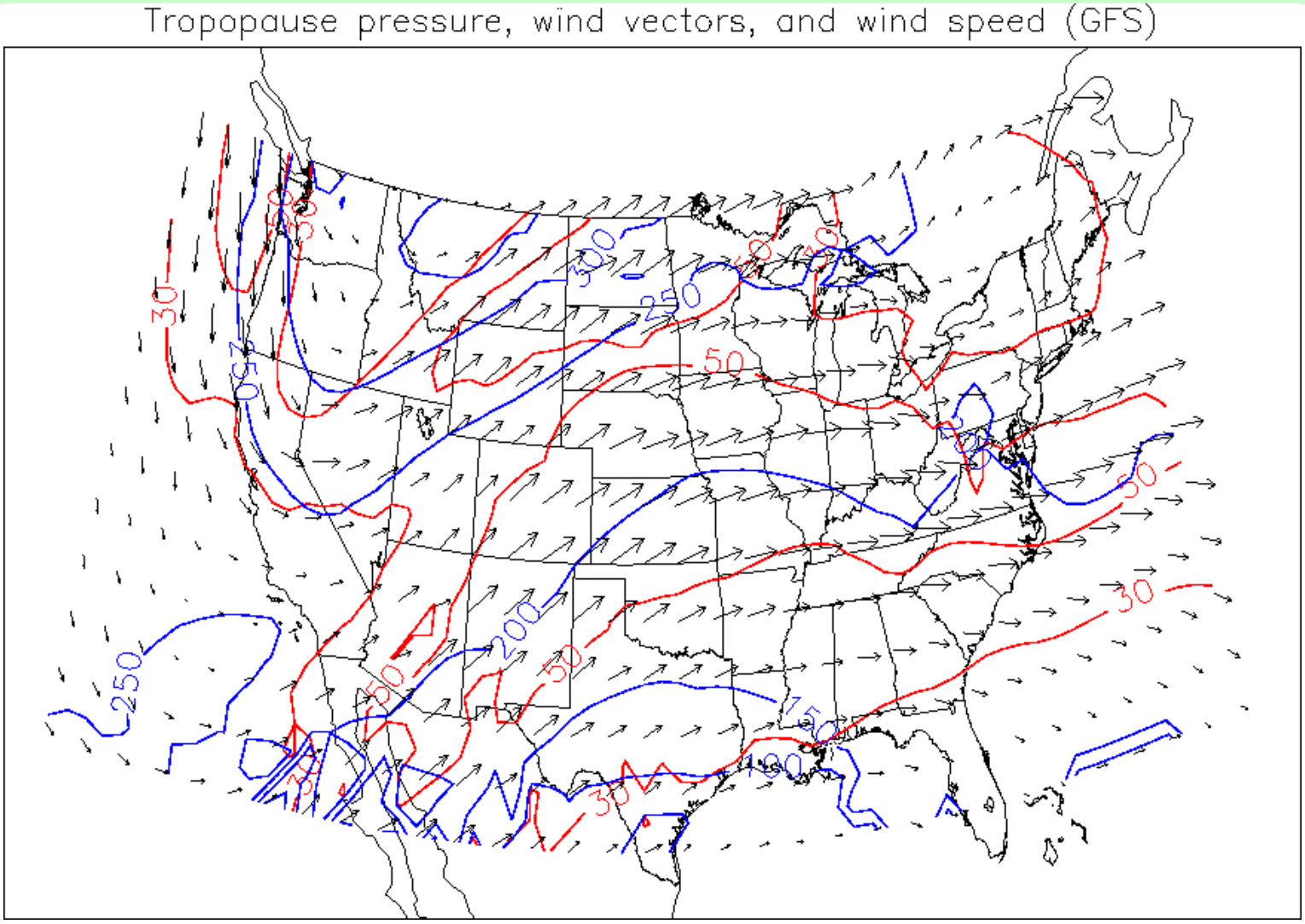
4)From the vorticity, compute the nondivergent wind field on the tropopause (i.e. jet-stream level)

Reference:

Vaughn, G. and J. D. Price, 1991: On the relation between total ozone and meteorology. *Quart. J. Roy. Meteor. Soc.,* **117,** 1281-1298.

FY10 Milestones

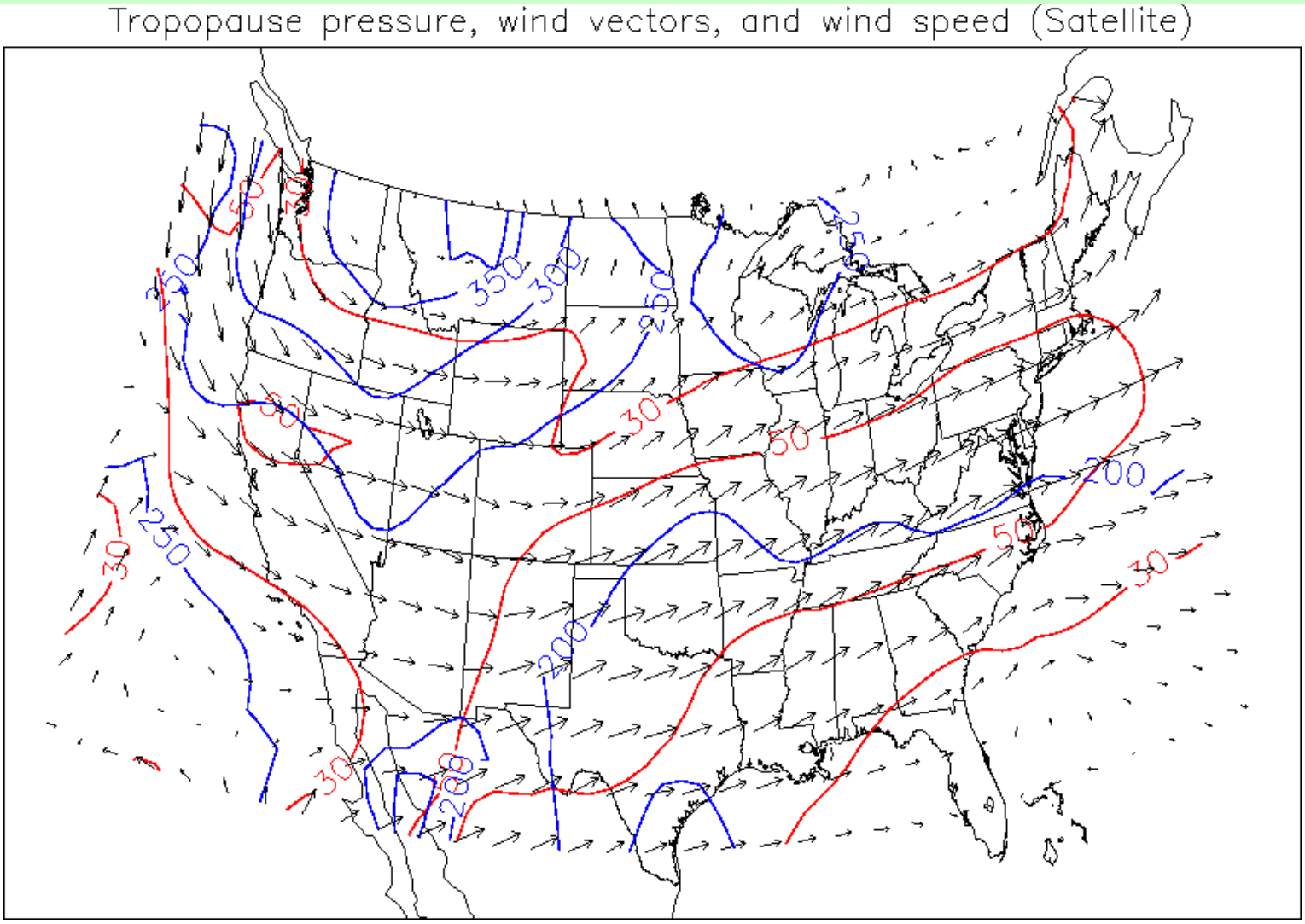
Wind Field at the Tropopause from Satellite Measurements of Ozone



Tropopause level pressure (hPa, blue), wind vectors, and wind speed (m s^{-1}, red) from the 1200 UTC 9 March 2009 GFS analysis.

FY10 Milestones

Wind Field at the Tropopause from Satellite Measurements of Ozone



Tropopause level pressure (hPa, blue), wind vectors, and wind speed (m s^{-1}, red) from satellite measurements of ozone.

Discussion of the Results

- Observation of winds at the tropopause (i.e. upper-level jet) which are independent of model except:
  - Model winds for boundary condition on streamfunction (could use radiosonde winds)
  - Model may be used in satellite retrievals
- Clouds are an issue.
- Hourly position of upper-level jet streams (more frequent for GOES-R)
- Year-round use.

Future Work

- Compute a series of wind fields over several hours.
- Optimize “constants” in equation relating lower-stratospheric ozone to vorticity at the tropopause.
- Verification.

Cloud Climatology

The Goal

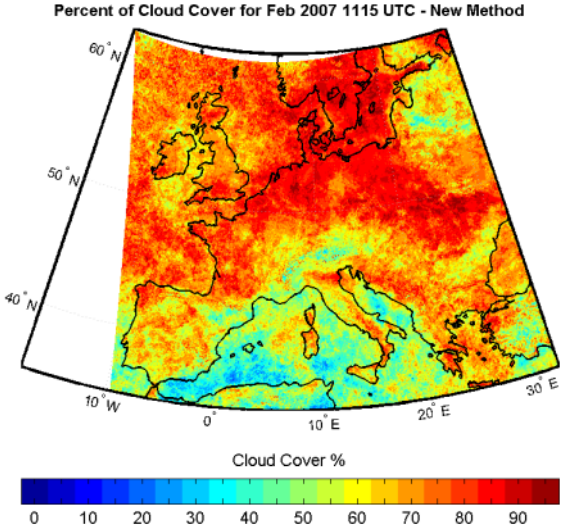
The main idea is to solve a problem with the current regional cloud climatologies – snow contamination – by leveraging one of the new channels that will be available on GOES-R.

In the literature, snow identification is usually the last step. For example, the MODIS snow product starts with the MODIS cloud mask. In this task, I am attempting to identify snow first, then identify clouds in the wintertime scene.

FY08 and FY09 Milestones

- *Pick test cases for cloud climatology and process data*
- *Design new cloud algorithm and test*
- *Produce cloud composites using current and new algorithms*
- *Process cloud climatology data for three winter season test cases*

The above milestones are completed.

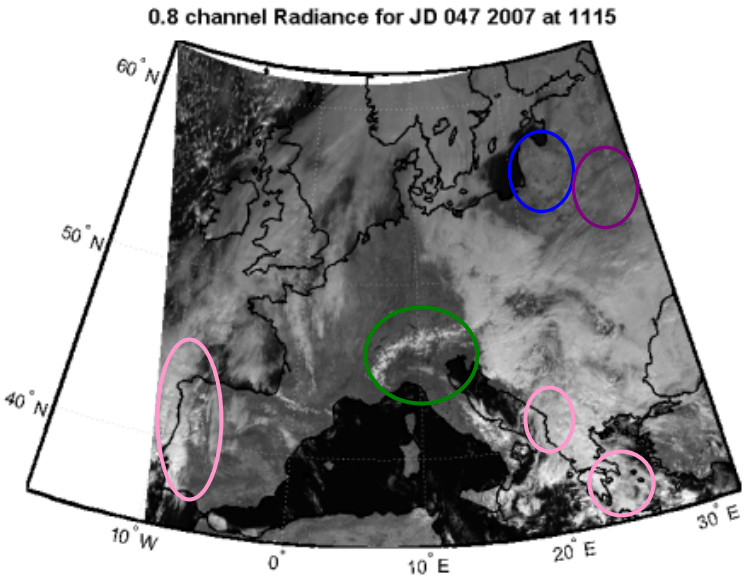


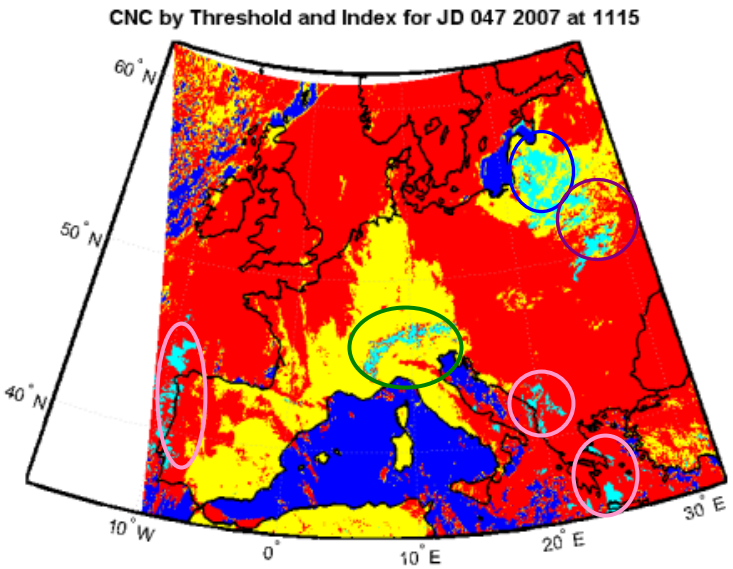
FY10 Milestones

Analyze 3-season cloud climatologies and prepare journal paper.

Preliminary results of the analysis are on the following slides.

Threshold Method Plus Snow Index





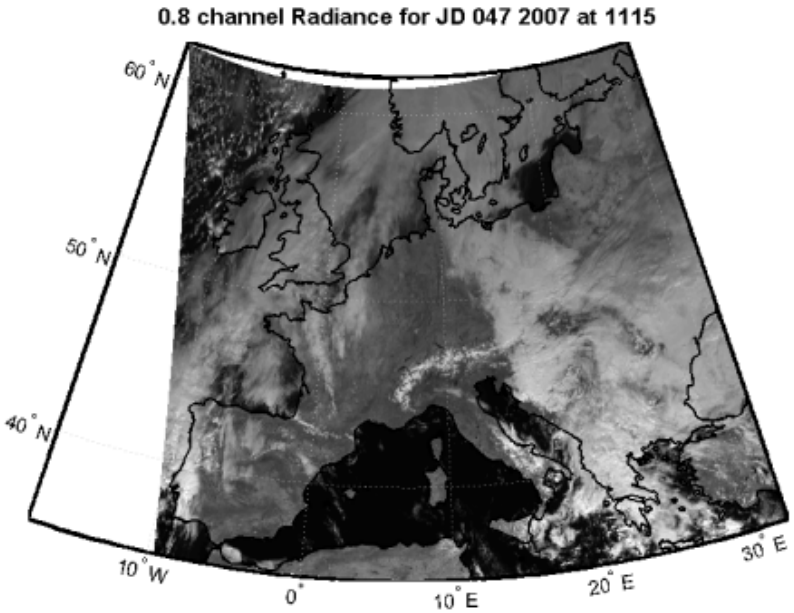
To detect snow, most methods use a snow index (NDSI) between either 0.6 µm or 0.8 µm and the 1.6 µm channels. The latter is not available on the current GOES series but will be on GOES-R.

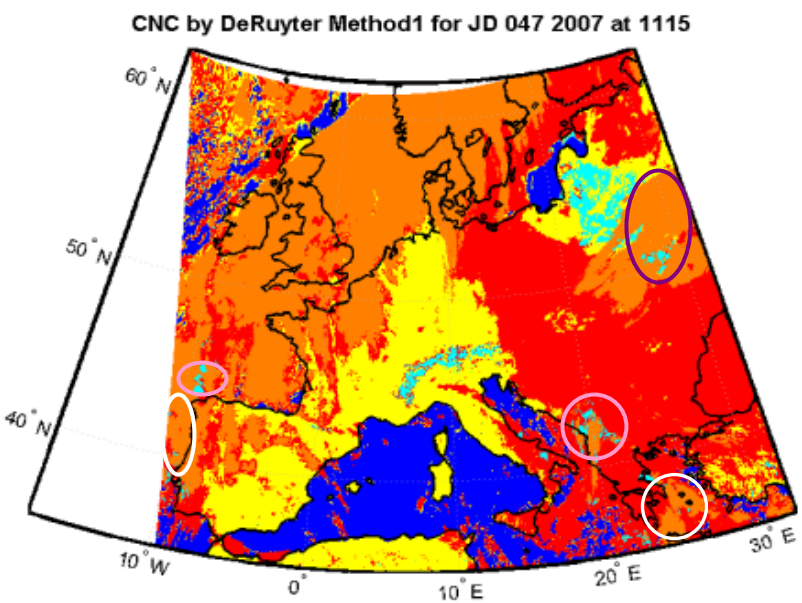
The lower left combines my current threshold method (each image compared to clear visible background plus a threshold) with the NDSI to produce a cloud/no cloud (CNC) image. Note:

- Improved detection of snow field in Latvia
- Snow detected over alps
- Thin cloud deck partially detected
- High, thick cloud classified as snow off Portugal, in Sea of Crete, Balkans

	Clear land		Snow
	Clear Water		Cloud

Additional Checks for High Clouds





De Ruyter et al. paper, which describes a method for determining snow fields using SEVIRI data, outlined three additional checks to remove high clouds. Two of the checks were employed with some success. Note:

- High cloud over Belarus now detected
- Some of the high cloud correctly identified (Portugal, Sea of Crete)
- Some high cloud still identified as snow.

Unfortunately, I was unable to reproduce the third high cloud check.

Clear land
Snow
High Cloud
Clear Water
Cloud

Future Work

- Find a new check to separate high, thick, cold clouds from snow. (threshold using 10.8 μm and/or 3.9 μm?)
- Check improved method for other months, especially during marginal seasons such as early spring (March).
- Rerun cloud composites for three seasons.
- Write paper.