Assimilation of infrared surface sensitive channels over land and sea ice at Environment Canada


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Outline

• Context & motivation
• Approach
• Results
Context & motivation

Env. Can. moving to ensemble-variational system with:

- Flow-dependent background errors including surface skin temperature correlations with other variables
- Analysis grid at 50 km, increments interpolated to model 15 km grid
- ~140 AIRS and IASI channels assimilated: many sensitive to low level T, q, and Ts. RTM is RTTOV-10.

Favorable context to attempt assimilating surface-sensitive IR channels over land and sea-ice vs earlier work with GOES (Garand et al. JAM, 2004) with analysis grid at 150 km and no hyperspectral IR.
Numerous challenges

- Reliable cloud mask
- Spectral emissivity
- Highly variable topography
- Background may present non-gaussian error statistics
- Radiance bias correction

- Also improving over available in-situ data, notably regions of
  - dense network of surface stations
  - dense aircraft data (e.g. US, Europe)
Approach guided by prudence

Assimilate under these restrictive conditions over land and sea ice:

- Estimate of cloud fraction < 0.01
- High surface emissivity (> 0.97)
- Relatively flat terrain (local height STD < 100 m)
- Diff between background Ts and rough retrieval based on inverting RTE limited to 4K

Radiance bias correction approach:
- For channels flagged as being surface sensitive, use only ocean data to update bias coefficients
Limitation linked to topography

Criterion used: local STD of topography < 50 m (on 3X3 ~50 km areas)

RED: accepted, white std > 100 m, blue 100>std>50 m
Limitation linked to surface emissivity

Accept only emissivity > 0.97; Bare soil, open shrub regions excluded.
First attempt: negative impact in region 60-90 N/S

Possible cause: cloud contamination
Risk reduction: no assimilation at latitudes > 60 deg.
Second attempt

- Cut latitudes > 60 deg
- Local gradient of topography < 50 m

- Cycle: 6 Feb-17 March 2011
T STD difference vs lead time
NH-Extra_trop

vs ERA Interim

vs own analysis

Consistent positive impact vs ERA Interim and own analysis
T std diff (CNTL-EXP) vs ERA-Interim

**Tropics**

Standard Deviation Difference
2011020600-2011031712
CEH125T3 - CEH125S4

**SH Extratropics**

Standard Deviation Difference
2011020600-2011031712
CEH125T3 - CEH125S4
Zonal T STD difference (CNTL-EXP)

72-h

120-h
Time series of T std diff at 925 hPa

NH extratropics

Tropics

CNTL

EXP
850 hPa TT anomaly cor.

NH extratropics

Tropics

CNTL EXP
Validation vs raobs 120-h

SH-extratropics

NH-extratropics
Validation vs raobs 120-h

North America

Europe

CNTL

EXP
Added yield: about 15%
(for surface sensitive channels)

Number of radiances assimilated for surface channel AIRS 787
CNTL: ~1400/6h  EXP: ~1600/6h

Region: world, EXP excludes surface-sensitive channels at latitudes > 60
Radiance thinning is at 150 km
No major impact on bias. Strong assimilation over land, with std (O-P) of ~1.7 K, std (O-A) of 0.40 K
Conclusion

- Very encouraging results, especially in NH where most of new data are assimilated

Next steps:

- Study sensitivity to topography and emissivity constraints
- Optimize configuration for 60 N/S domain
- Run a summer cycle
- Operational implementation

Longer term
- Evaluate problems specific to high latitudes