Environment Canada Environnement Canada

Canada

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

L. Garand, S. K. Dutta, S. Heilliette, and S. Macpherson

19th Intl. TOVS Study Conference
Jeju Island, South Korea
March 26- April 1, 2014

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

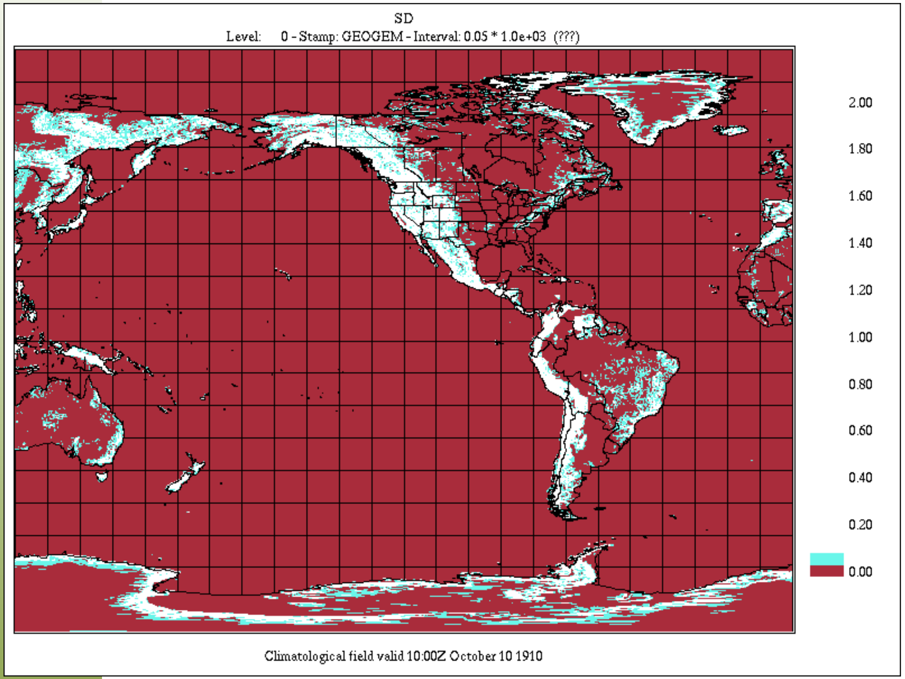
Assimilate under these restrictive conditions over land and sea ice:

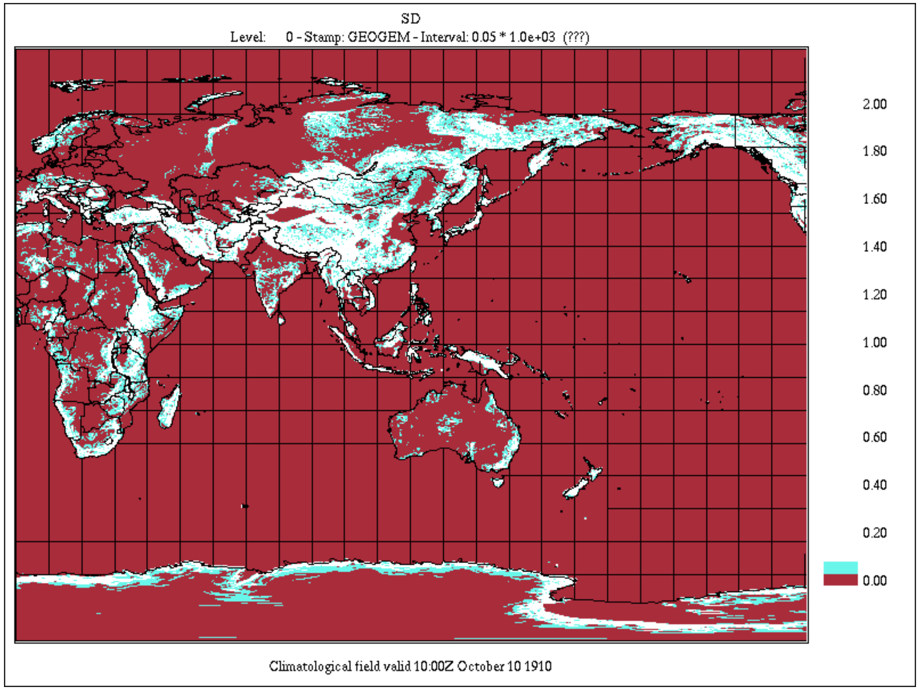
- Estimate of cloud fraction < 0.01
- High surface emissivity (> 0.97)
- Relatively flat terrain (local height STD < 100 m)
- Diff between background Ts and rough retrieval based on inverting RTE limited to 4K

Radiance bias correction approach:

- For channels flagged as being surface sensitive, use only ocean data to update bias coefficients

Limitation linked to topography

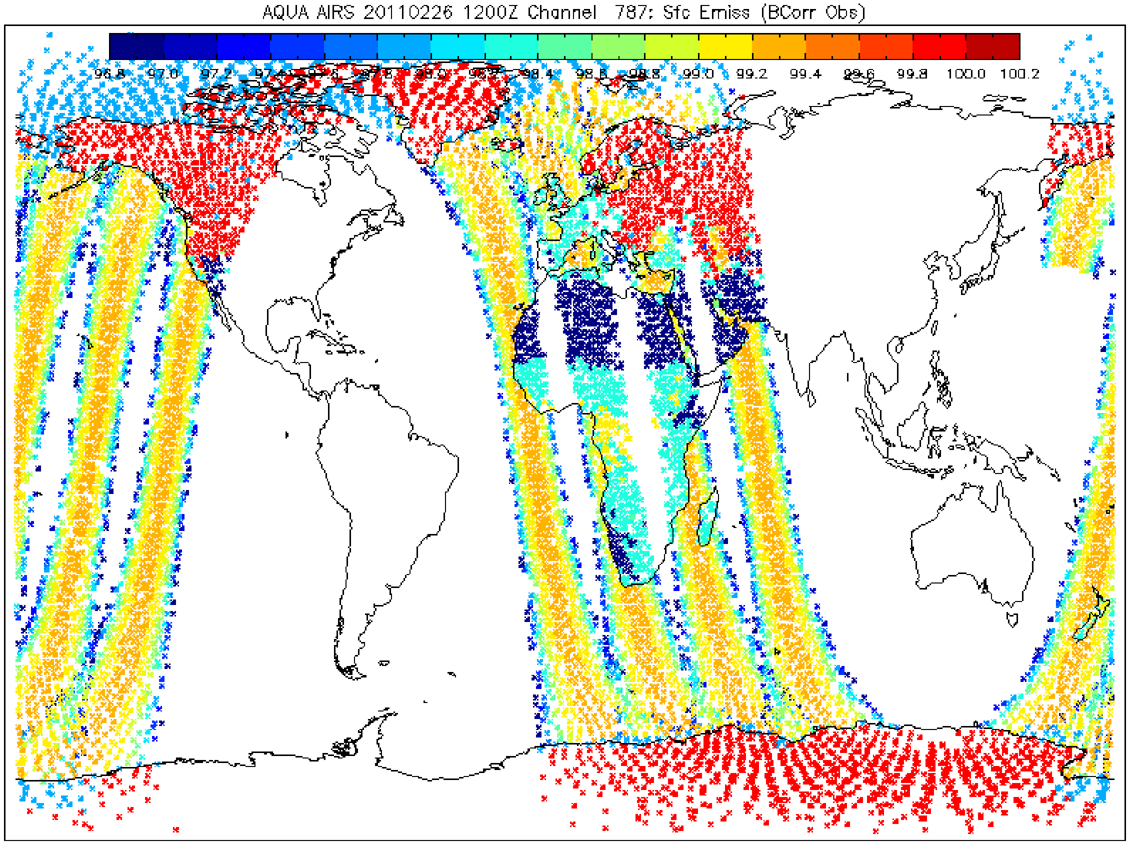




Criterion used: local STD of topography < 50 m (on 3X3 ~50 km areas)

RED: accepted, white std > 100 m, blue 100>std>50 m

Limitation linked to surface emissivity

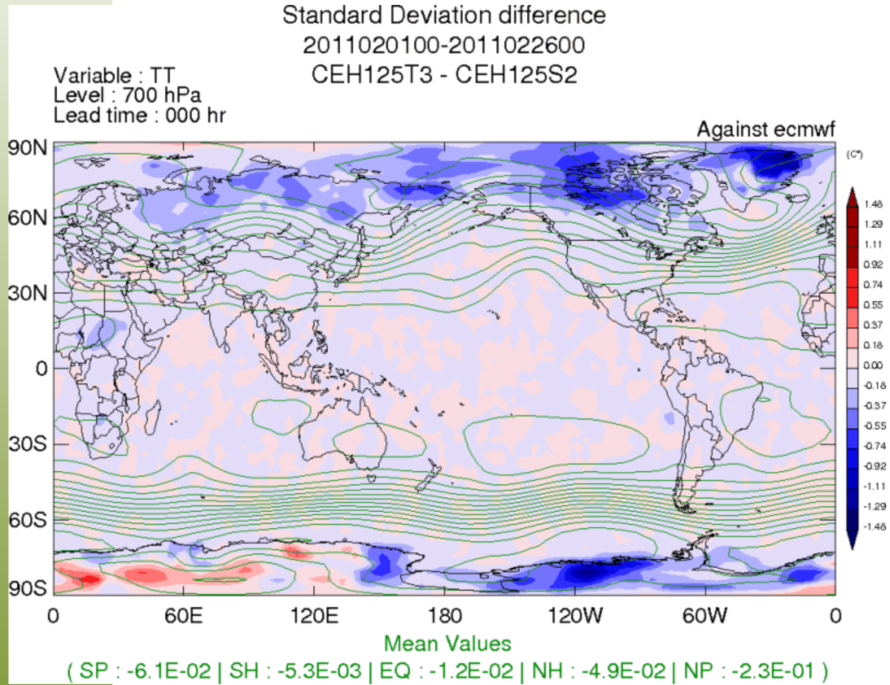


Surface emissivity
AIRS ch 787

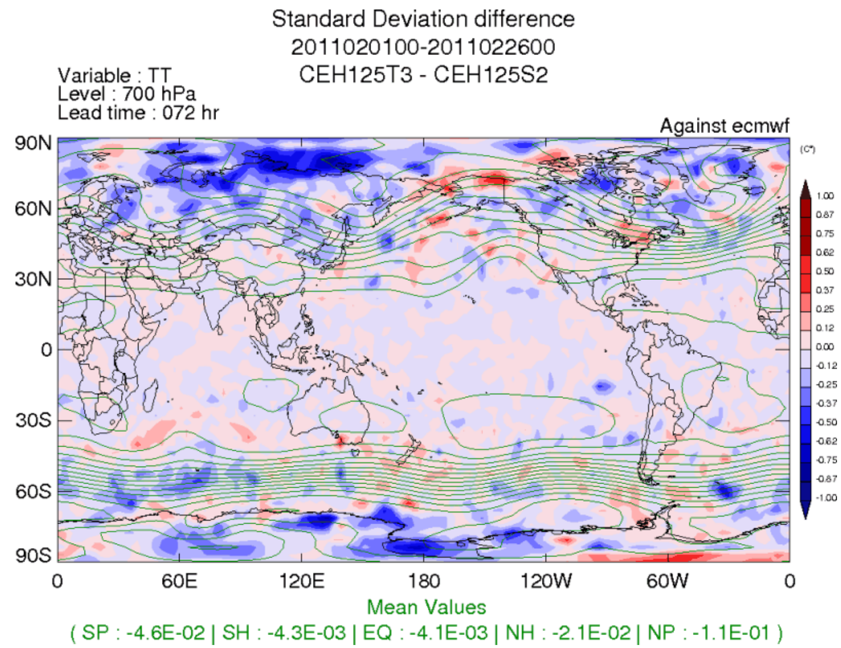
Accept only emissivity > 0.97 ; Bare soil, open shrub regions excluded.

First attempt: negative impact in region 60-90 N/S

00 hr



72hr



Possible cause: cloud contamination

Risk reduction: no assimilation at latitudes > 60 deg.

Second attempt

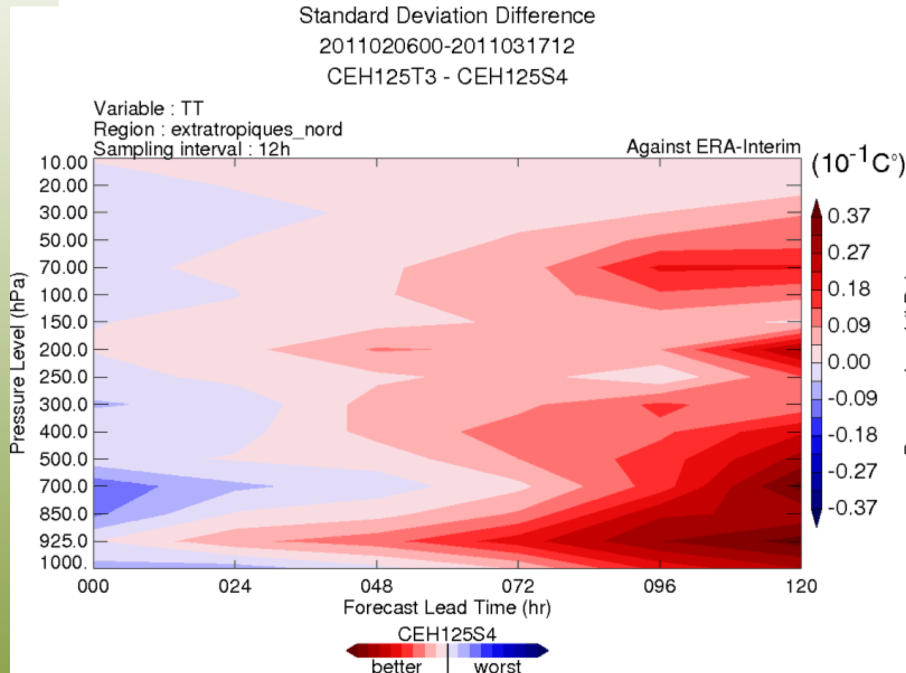
- Cut latitudes > 60 deg
- Local gradient of topography < 50 m

- Cycle: 6 Feb-17 March 2011

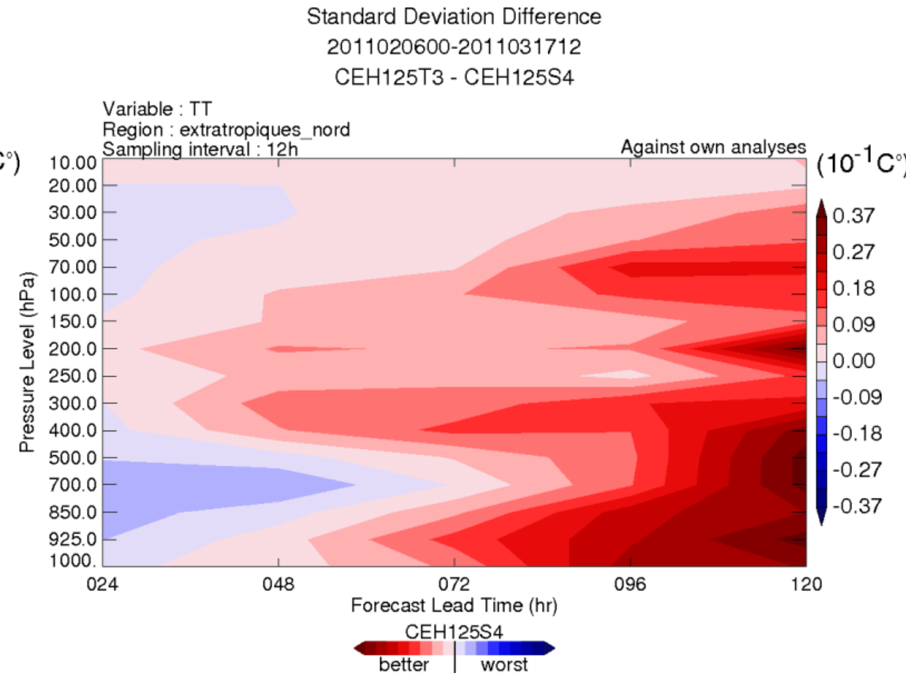
T STD difference vs lead time

NH-Extra_trop

vs ERA Interim



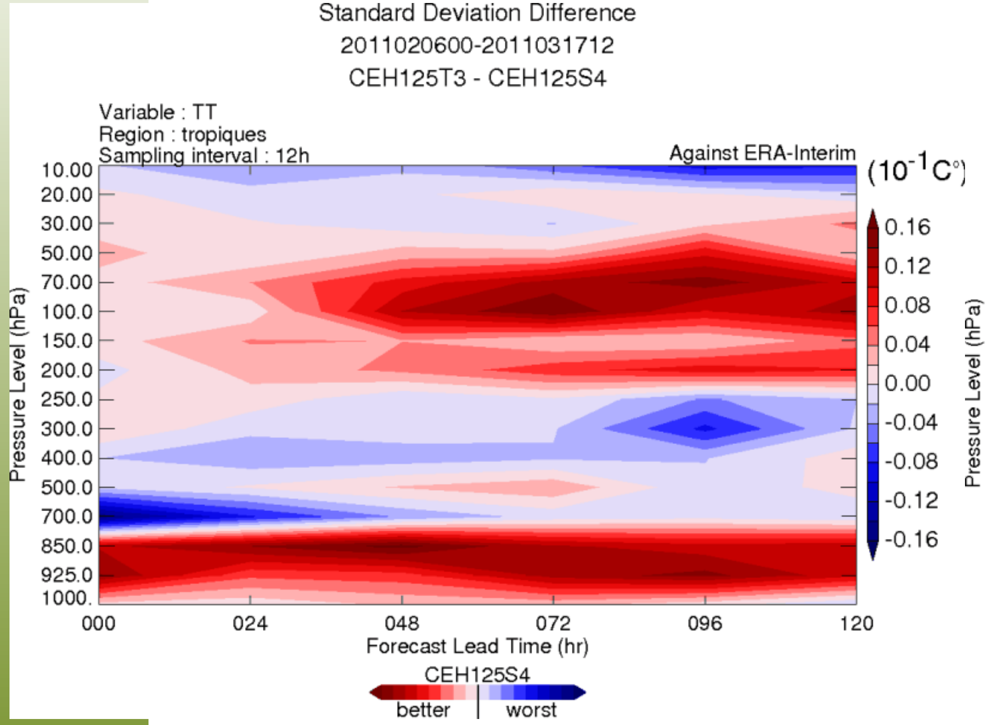
vs own analysis



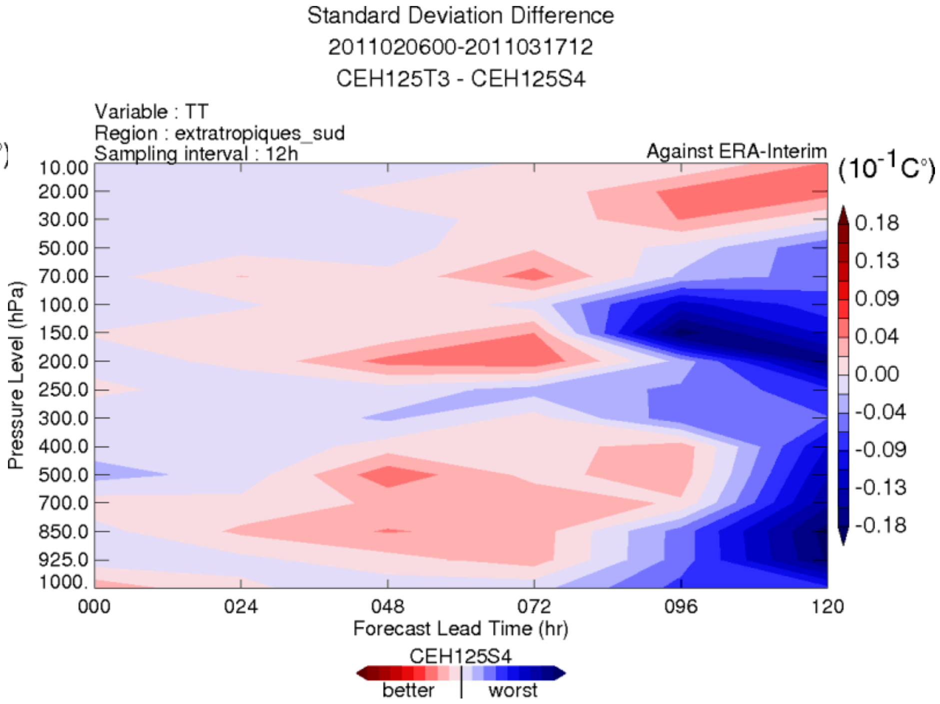
Consistent positive impact vs ERA Interim and own

T std diff (CNTL-EXP) vs ERA-Interim

Tropics

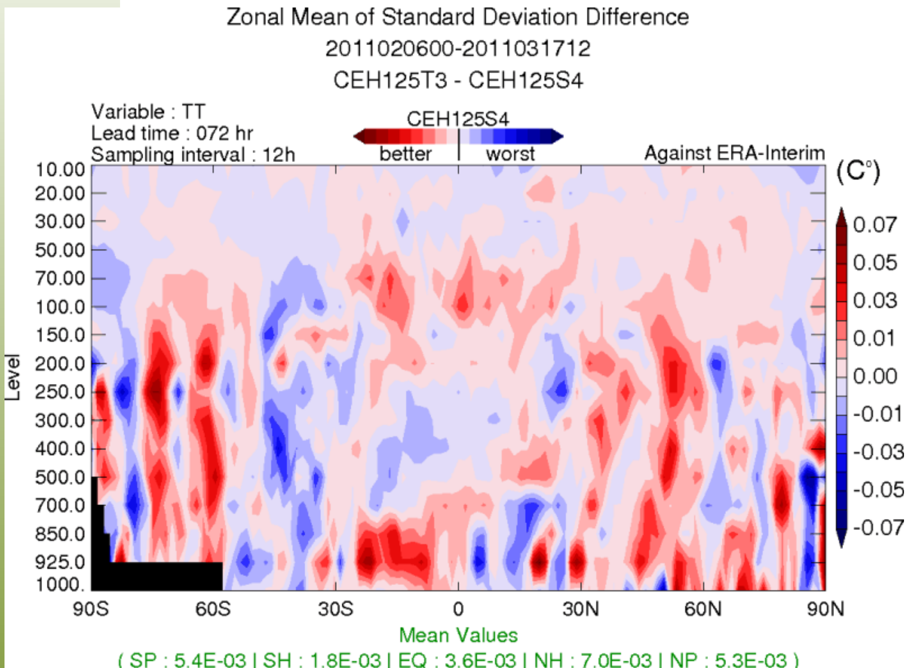


SH Extratropics

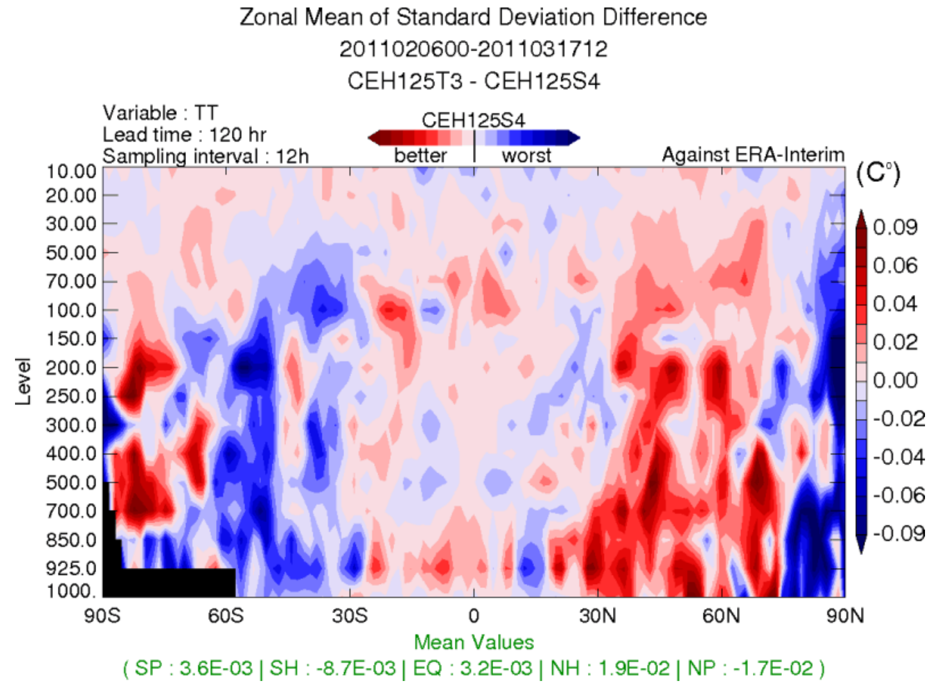


Zonal T STD difference (CNTL-EXP)

72-h



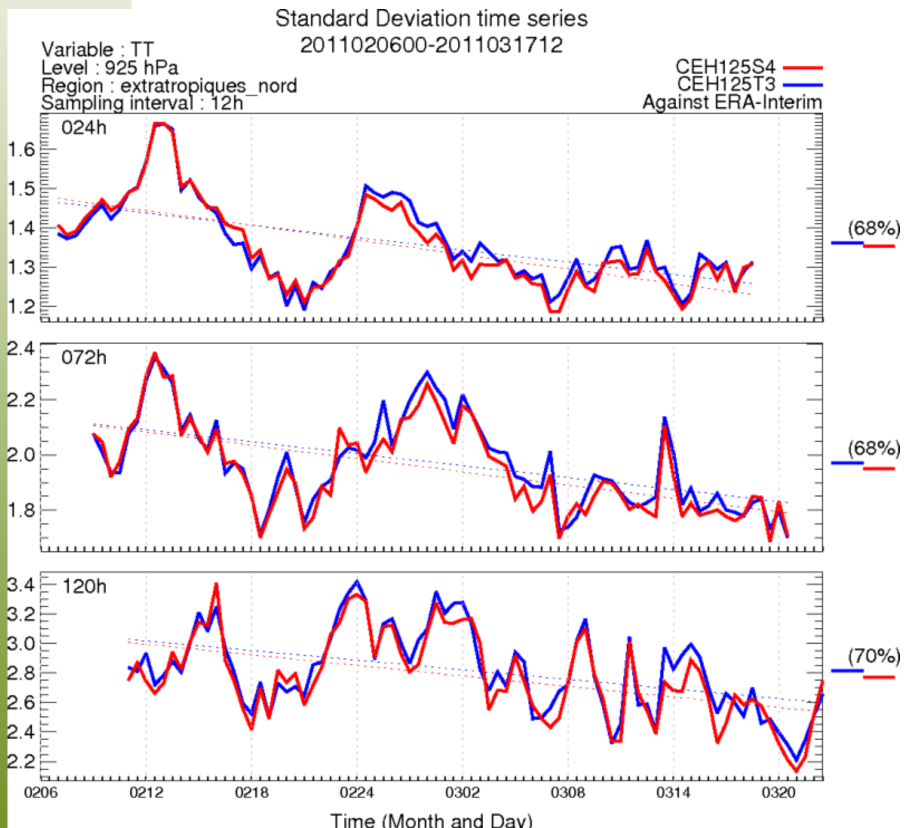
120-h



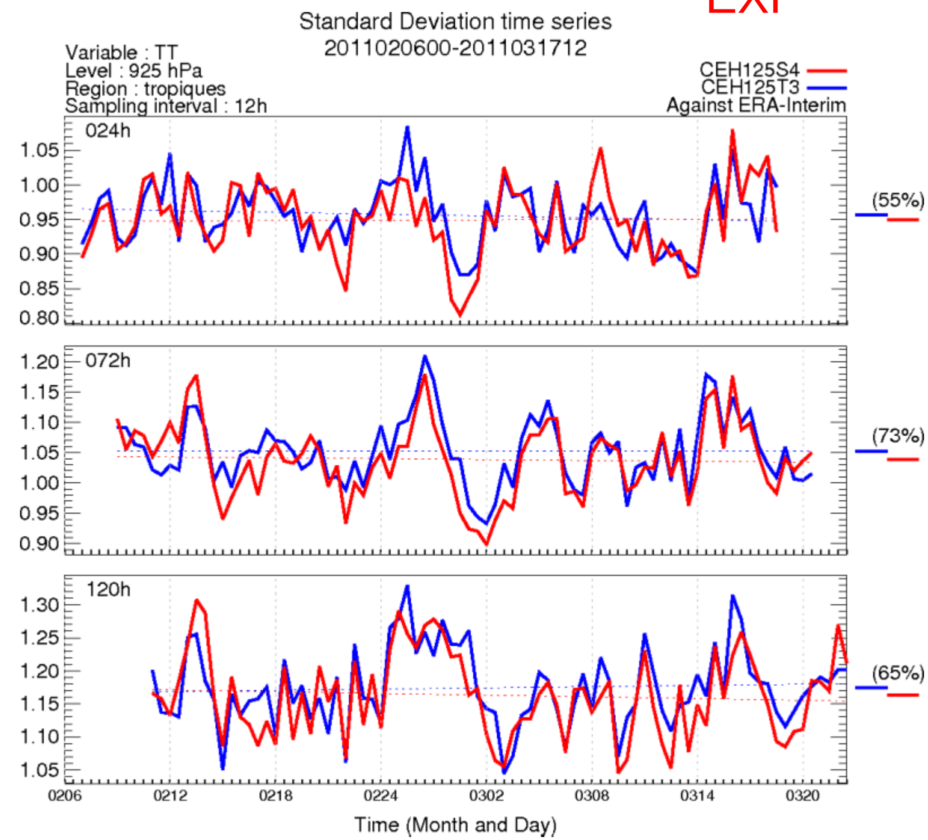
Time series of T std diff at 925 hPa

CNTL
EXP

NH extratropics



Tropics



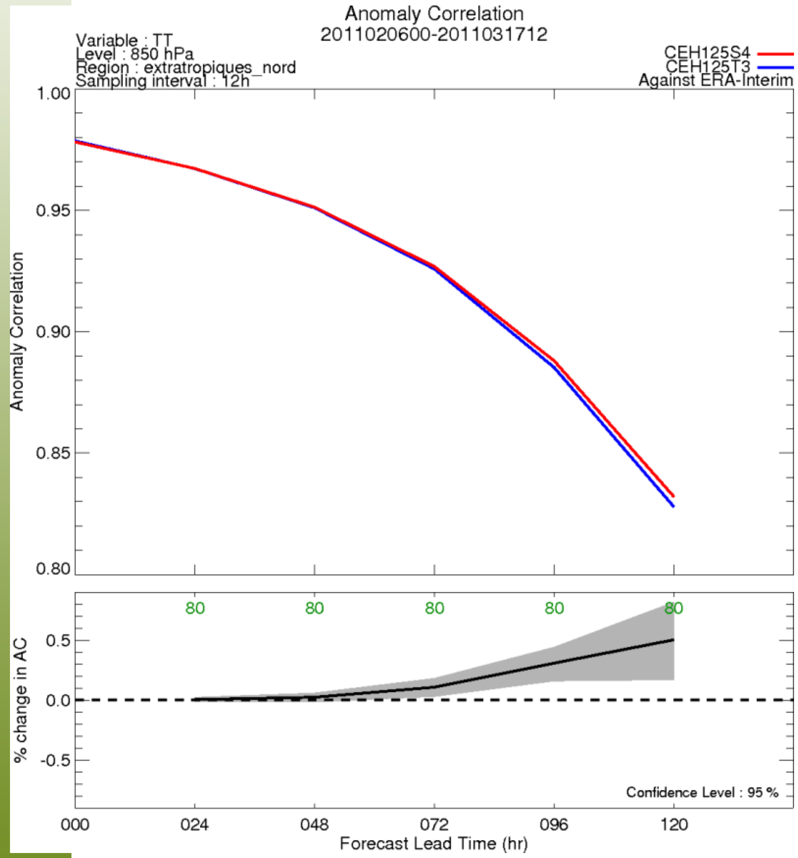
Environment Canada Environnement Canada

Canada

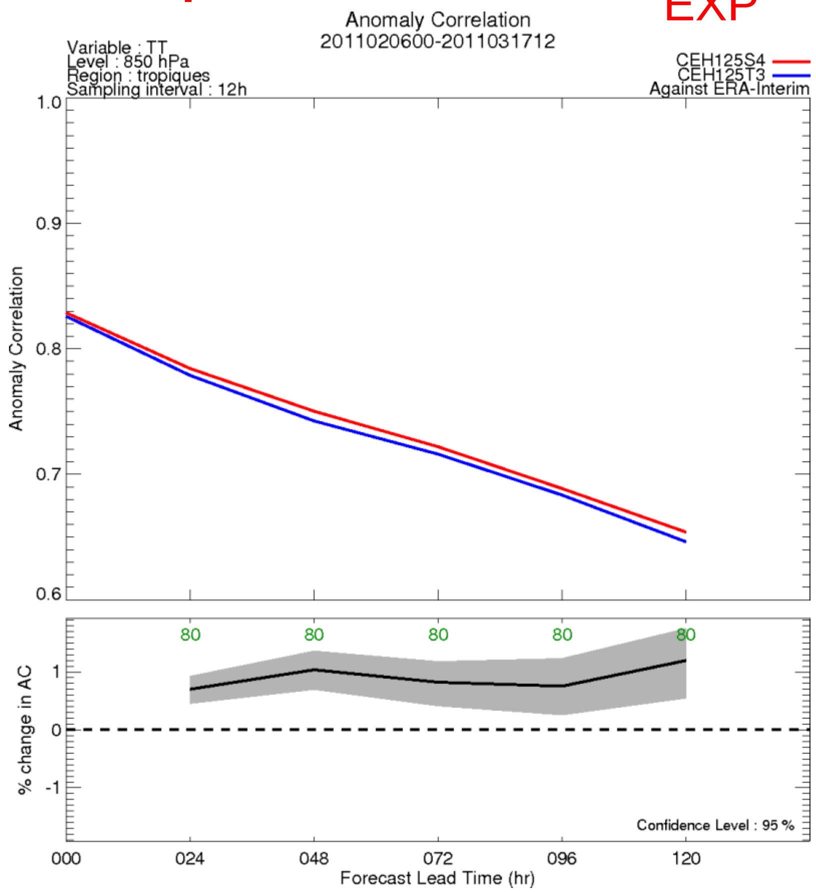
850 hPa TT anomaly cor.

CNTL
EXP

NH extratropics



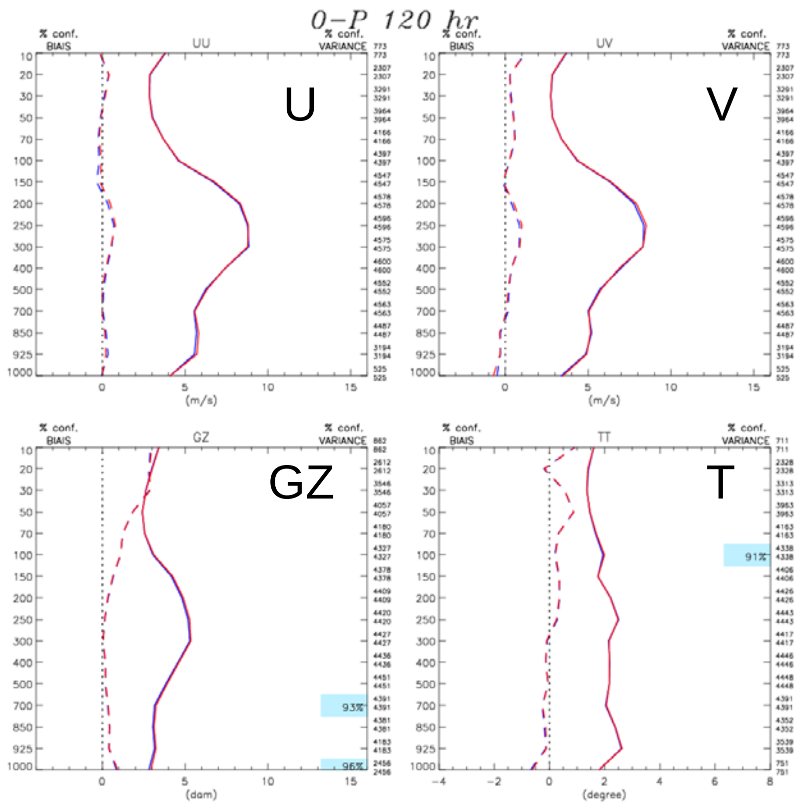
Tropics



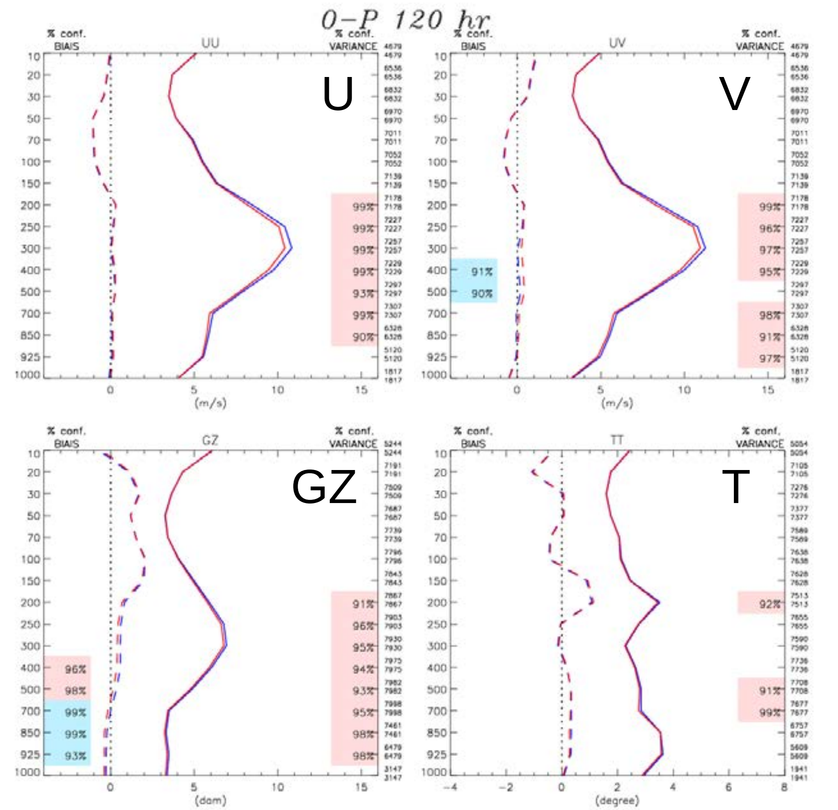
Validation vs raobs 120-h

CNTL
EXP

SH-extratropics

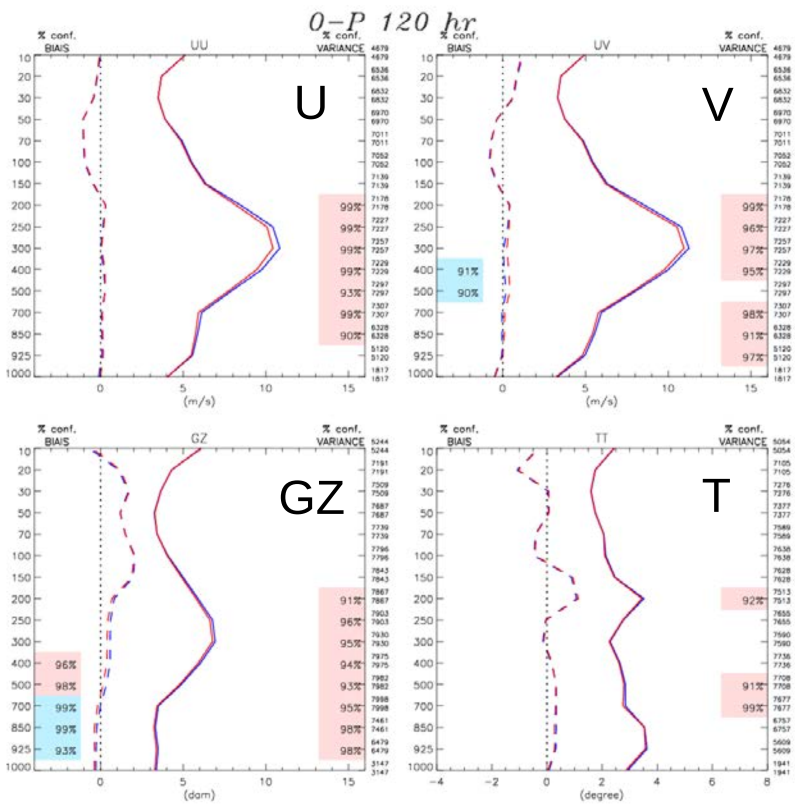


NH-extratropics

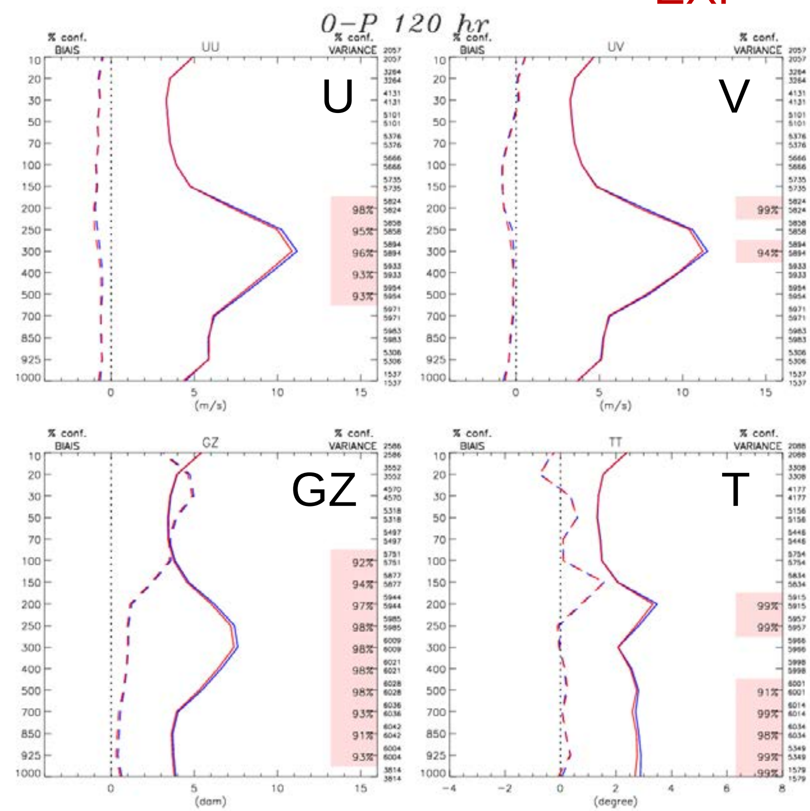


Validation vs raobs 120-h

North America



Europe



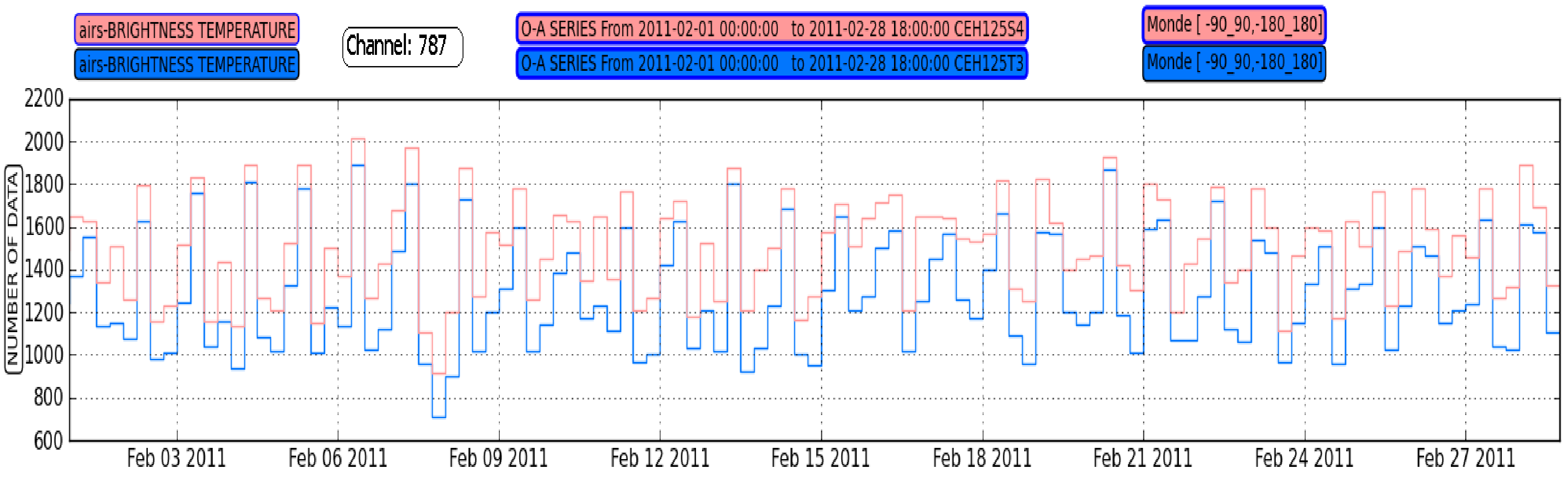
CNTL
EXP

Added yield: about 15%

(for surface sensitive channels)

CNTL
EXP

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

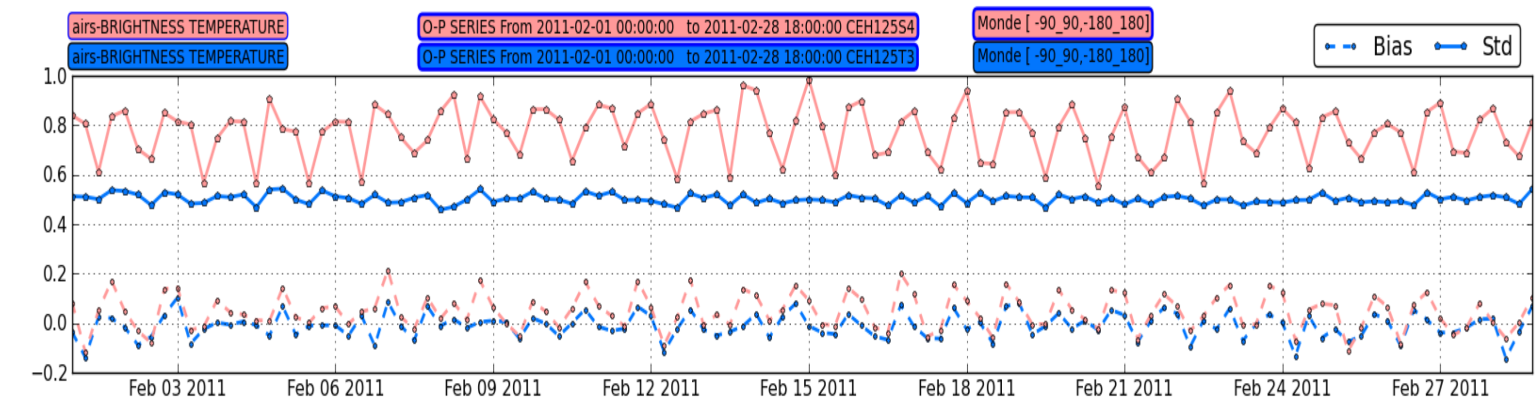


Region: world, EXP excludes surface-sensitive channels at latitudes > 60
Radiance thinning is at 150 km

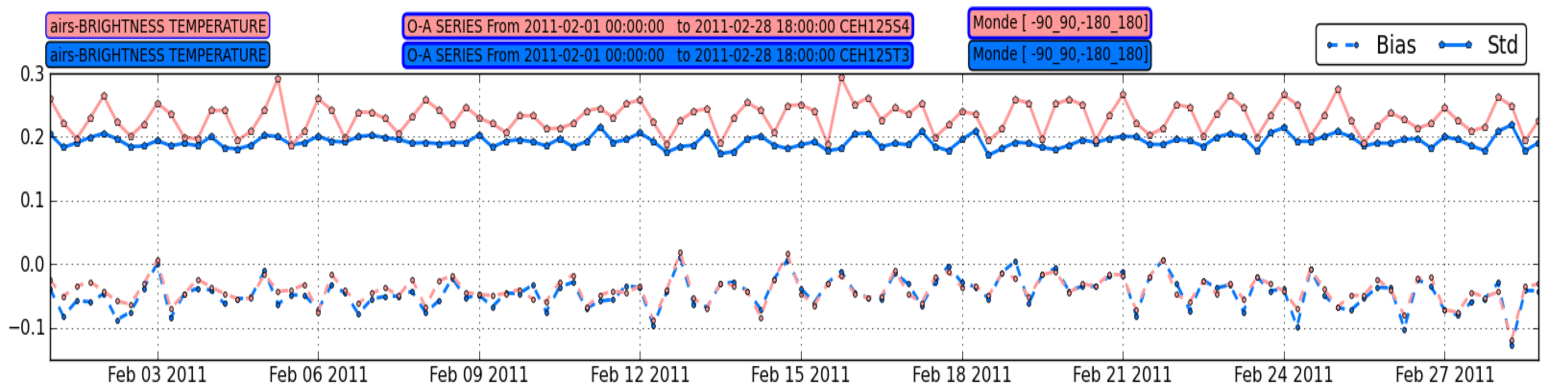
Std/bias of (O-P) and (O-A), AIRS 787

CNTL EXP

O-P



O-A



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