



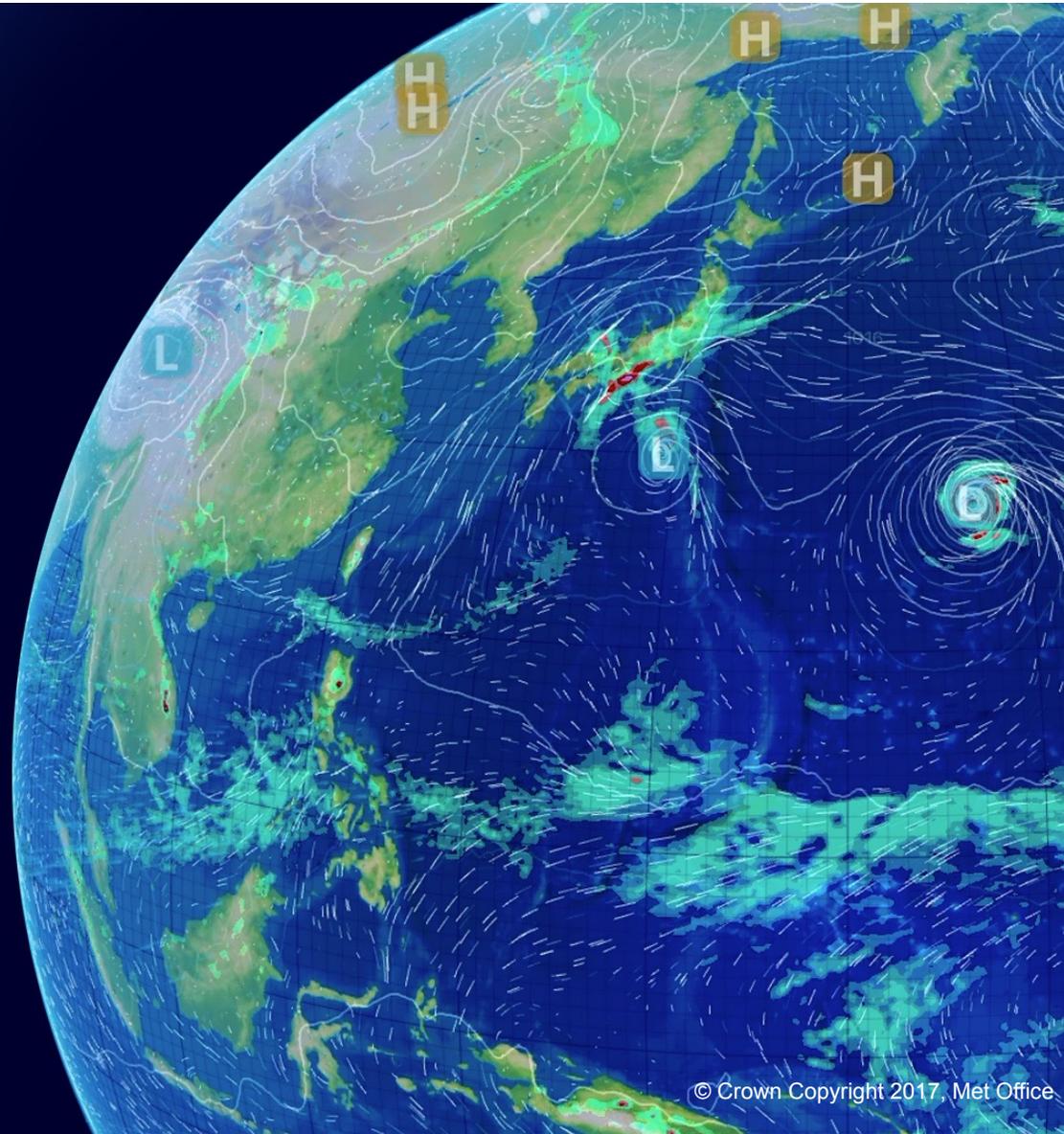
Dynamic Infrared Land Surface Emissivity Atlas based on IASI Retrievals

EUMETSAT Fellowship 2015-2018

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Thanks to: Ed Pavelin, Bill Bell, Chawn Harlow



Contents

- Background and Motivation
- Atlas Construction
- Preliminary Runs
- Comparison with UWIREMIS atlas
- Status

IR Emissivity

- TOA radiance from surface depends on surface emissivity
- varies temporally and geographically
- improved estimate beneficial for near surface retrievals, atmospheric DA, atmos-surface heat energy balance estimates

NRT atlas

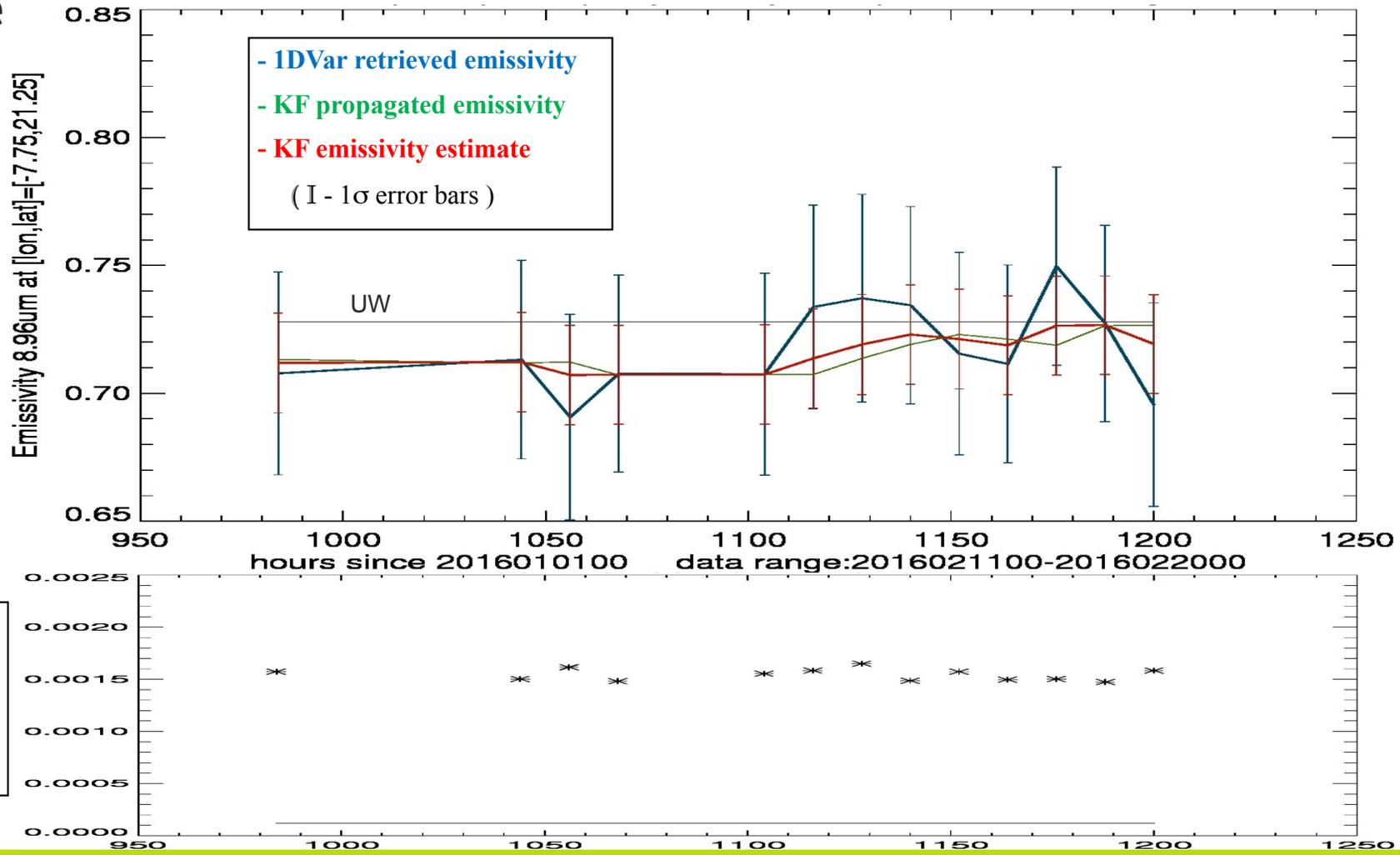
- up-to-date information
 - short term variability
- assimilation surface sensitive IR channels over land for NWP (FG for 1dvar)
 - apply to other IR instruments such as SEVIRI
 - improve Tskin accuracy

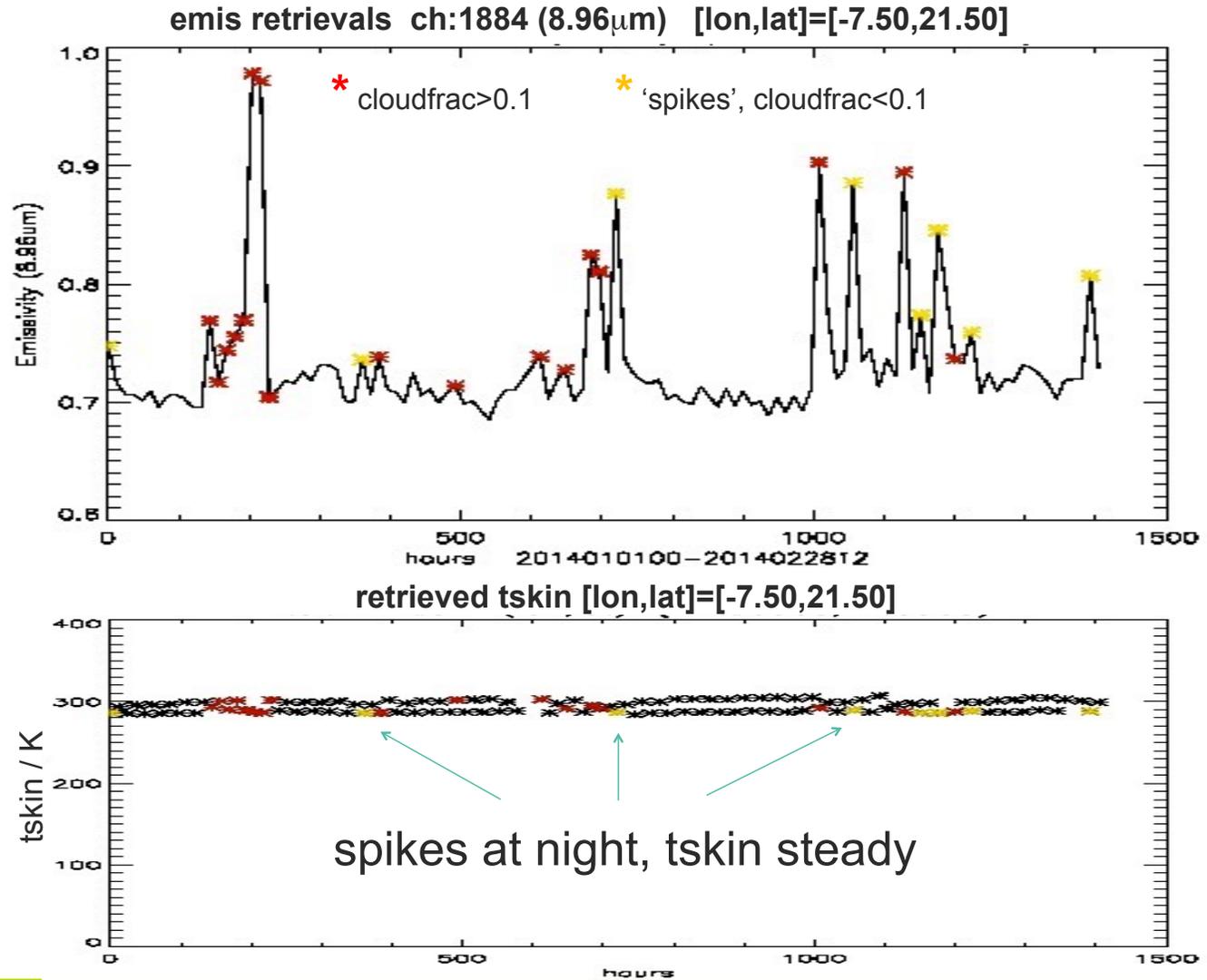
Atlas Construction

- Atlas derived from ϵ retrievals from 1DVar pre-processor of IASI observations
- IR LSE reconstructed at 314 IR NWP wavelengths from 1DVar retrieval of 12 PC scores
- Gridded dataset 0.2 deg x 0.2 deg
- emissivity spectral estimate for each gridbox
- 1dvar IASI emissivity retrievals fed into data driven Kalman Filter to update existing estimates

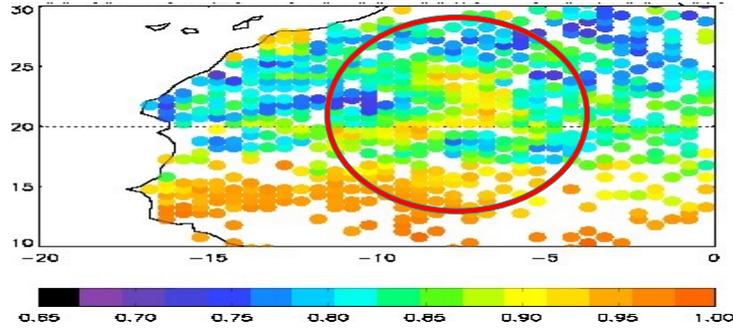
- Initial $\underline{\varepsilon}$ over each gridbox
- persistence model for each $\varepsilon(\lambda)$ in each gridbox
- 1dvar retrievals as measurement updates
- measurement noise from 1dvar analysis covariance matrix
$$A = [B^{-1} + H^T R^{-1} H]^{-1}$$
- system noise from UWIREMIS atlas
- update $\underline{\varepsilon}$ for each relevant gridbox
- covariance matrix estimate

8.96 μ m emissivity evolution [lon,lat] = [-7.75,21.25]

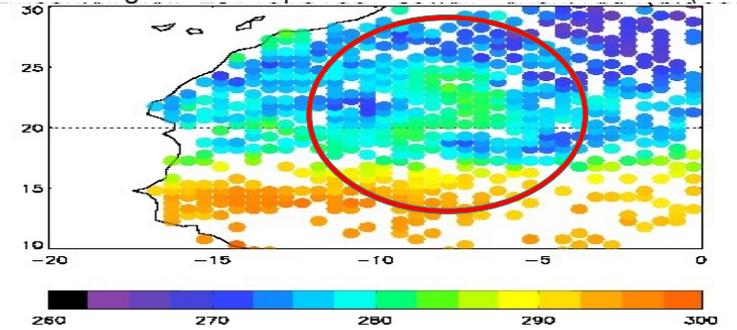




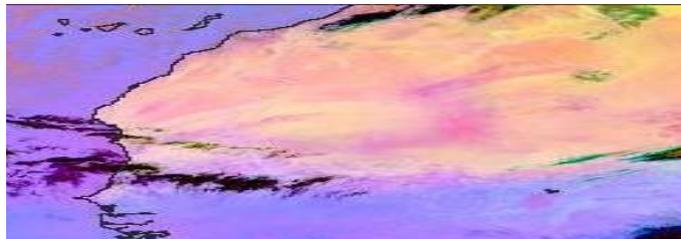
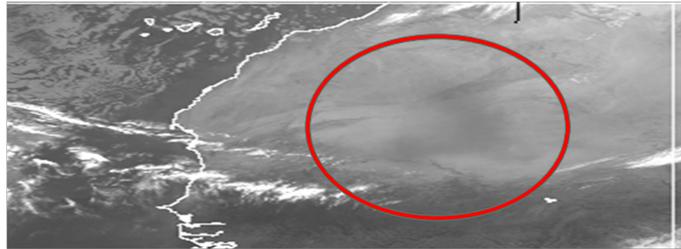
emis retrievals, 20140131 0000hrs, ch.1884 (8.96 μ m)



observed brightness temp 20140131 0000hrs ch:1884 (8.96 μ m)

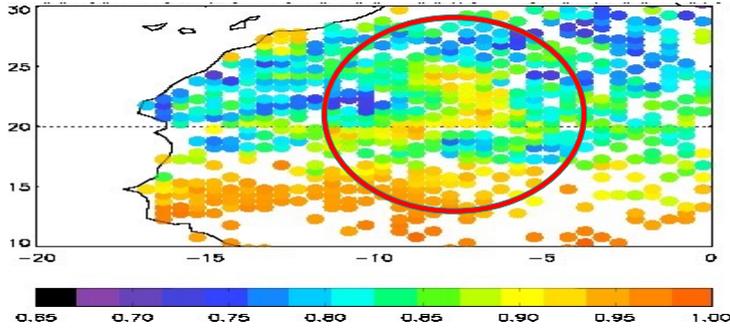


MSG 8.7 μ m 20140131 0000hrs

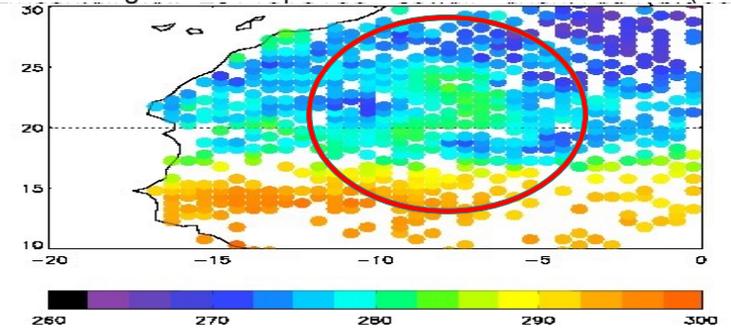


MSG DUST RGB (12.0 μ m, 10.8 μ m, 8.7 μ m),
20140131 0000hrs

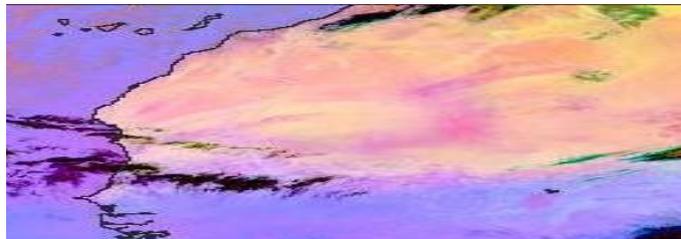
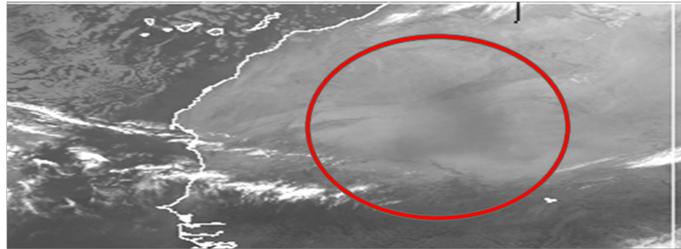
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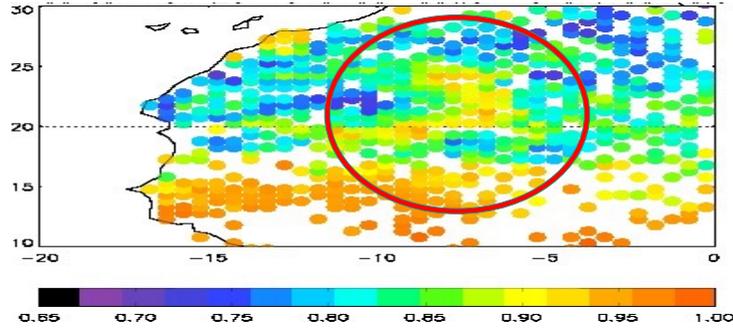
MSG 8.7 μ m 20140131 0000hrs



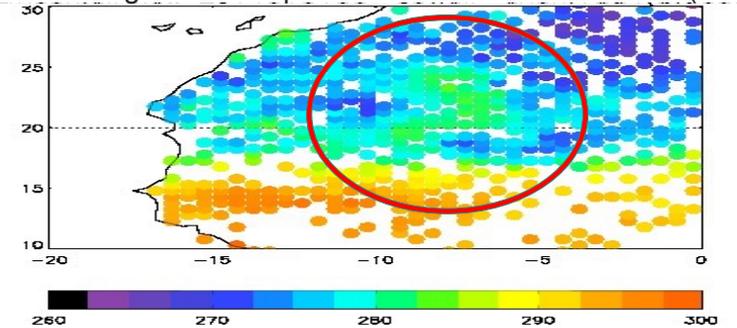
MSG DUST RGB (12.0 μ m, 10.8 μ m, 8.7 μ m),
20140131 0000hrs

QC check
 $BT_{dep} > 4.0K$ & $|Ts_{inc}| < 2.5K \Rightarrow$
discard

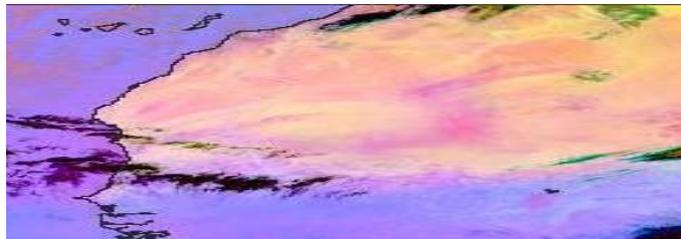
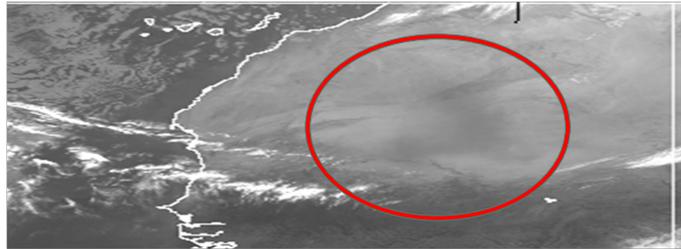
emis retrievals, 20140131 0000hrs, ch.1884 (8.96 μ m)



observed brightness temp 20140131 0000hrs ch:1884 (8.96 μ m)

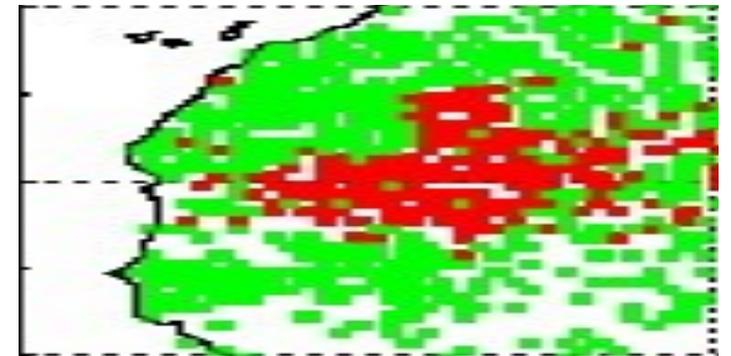


MSG 8.7 μ m 20140131 0000hrs



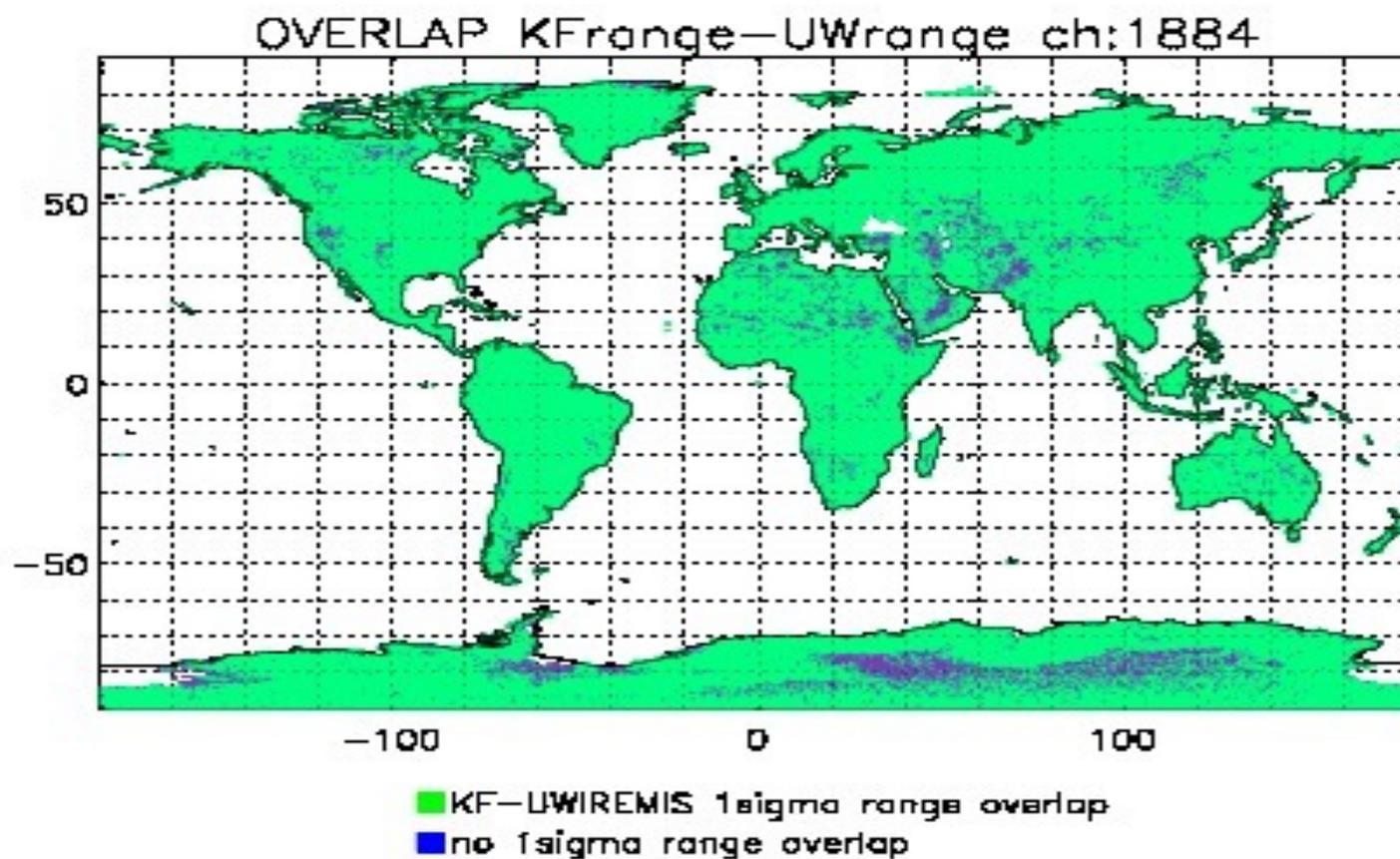
MSG DUST RGB (12.0 μ m, 10.8 μ m, 8.7 μ m),
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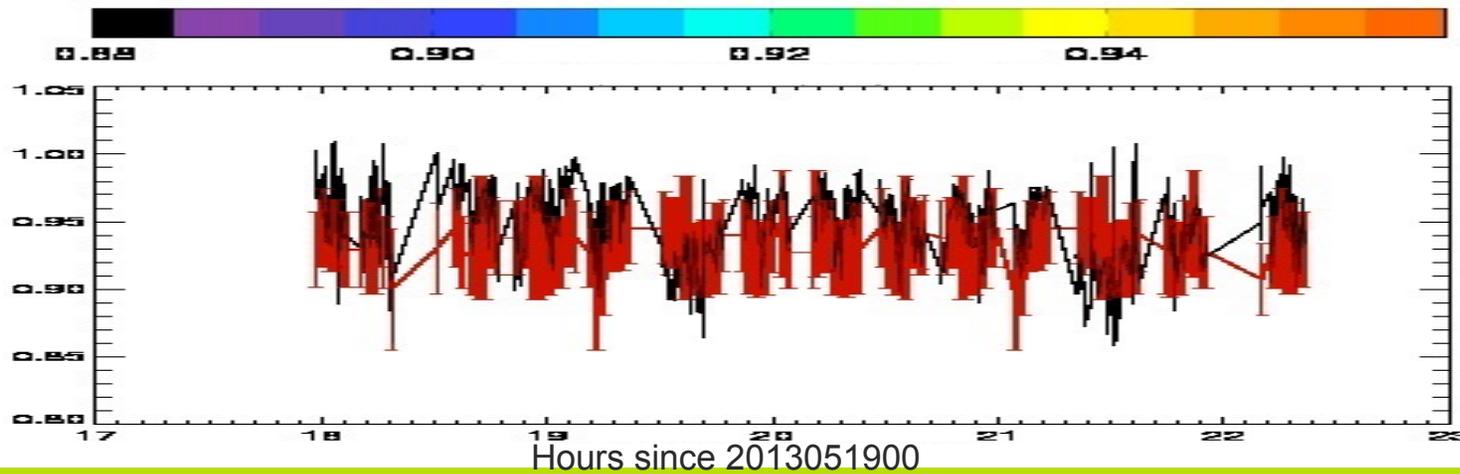
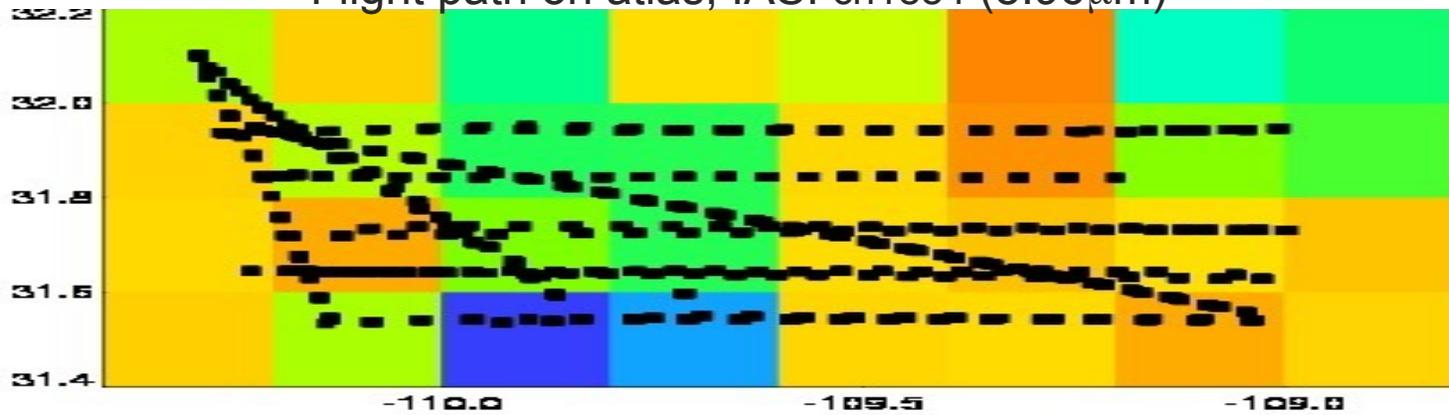
 discarded

 retained



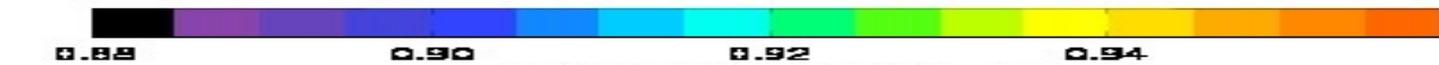
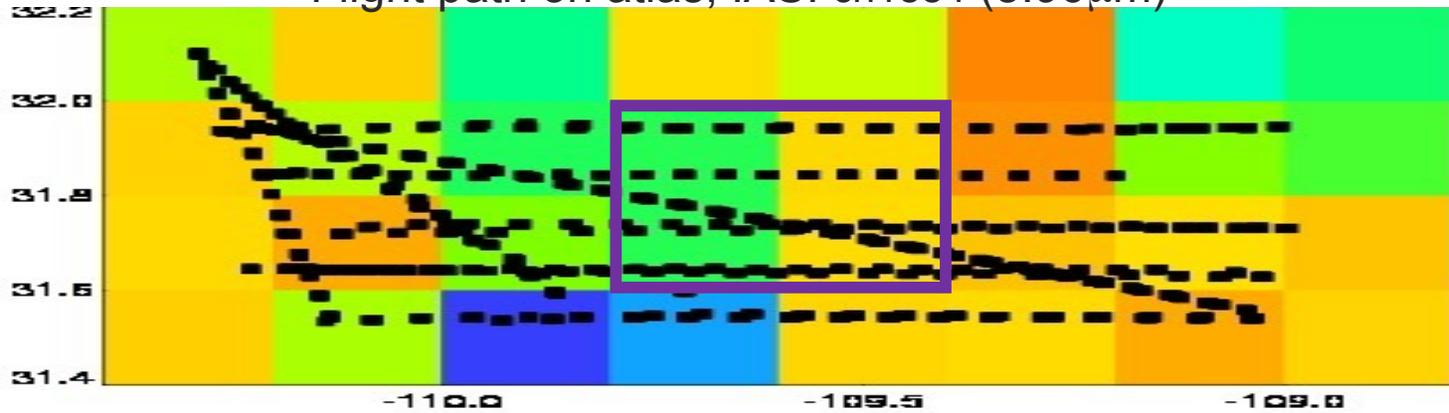
atlas_data_upd_2014073118.nc-UWIREMIS_07 82373/89595(91.9393%) range overlaps

ARIES Retrieval Comparison
SALSTICE campaign, Arizona, 2013051918
Flight path on atlas, IASI ch1884 ($8.96\mu\text{m}$)

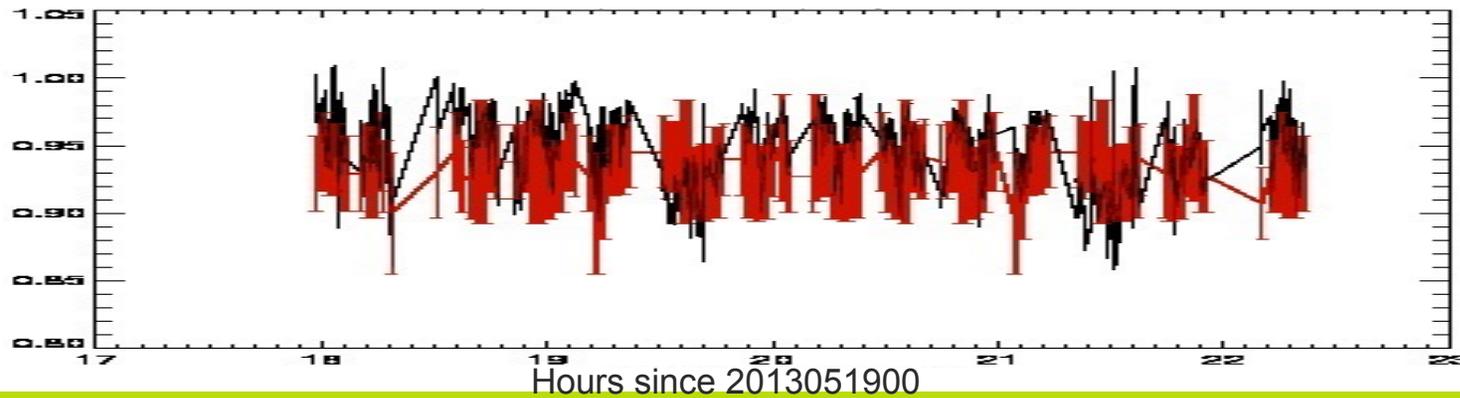


atlas
ARIES

ARIES Retrieval Comparison
SALSTICE campaign, Arizona, 2013051918
Flight path on atlas, IASI ch1884 ($8.96\mu\text{m}$)



8.96μm emissivity

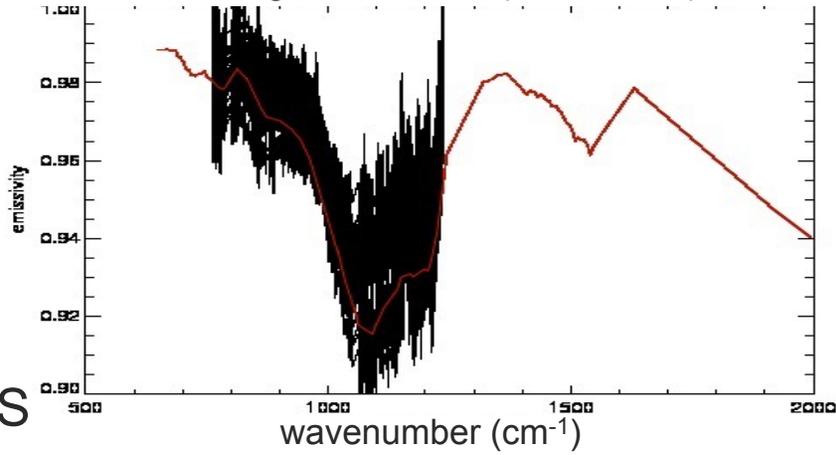


atlas
ARIES

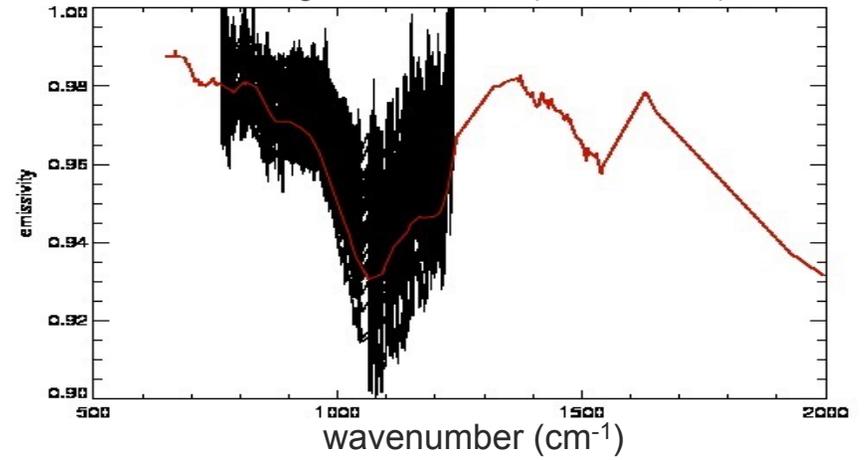


ARIES Retrieval Comparison Emissivity Spectra

gridbox centre (-109.7,31.9)

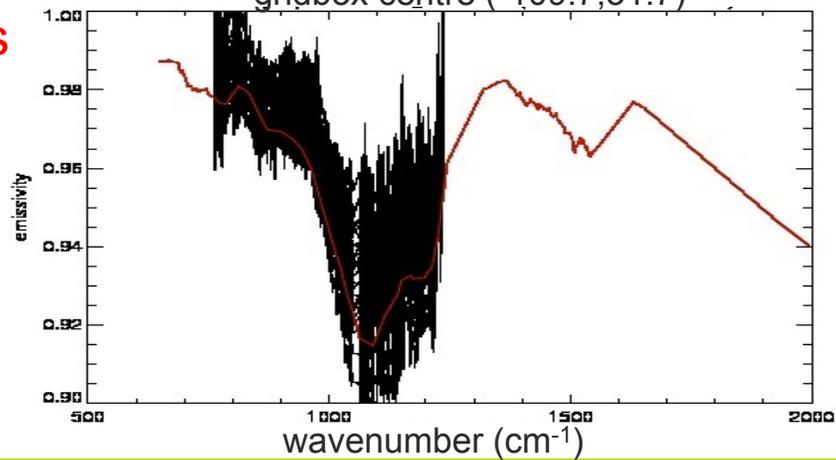


gridbox centre (-109.5,31.9)



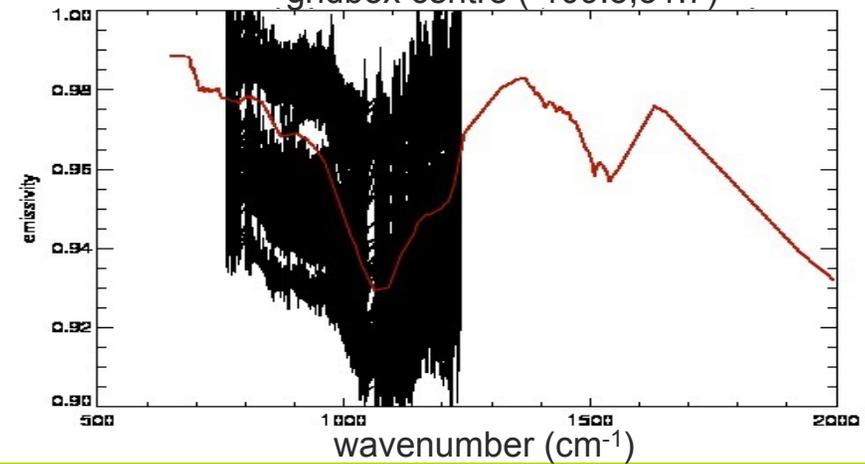
- ARIES

gridbox centre (-109.7,31.7)



- atlas

gridbox centre (-109.5,31.7)



SEVIRI

- 8 IR chans Ch.5-Ch.12
- WV chans 4,5 assimilated over land and sea. IR land emissivity=0.98 assumed
- 3 window chans currently assimilated over sea only:
ch7 (8.7 μ m), ch9(10.8 μ m), ch10 (12.0 μ m)

Method

- 1.Update IASI derived atlas at cycle time t
- 2.Run SEVIRI 1DVar at cycle time t+1, using emissivities derived from IASI atlas convolved onto SEVIRI channels using SEVIRI SRFs

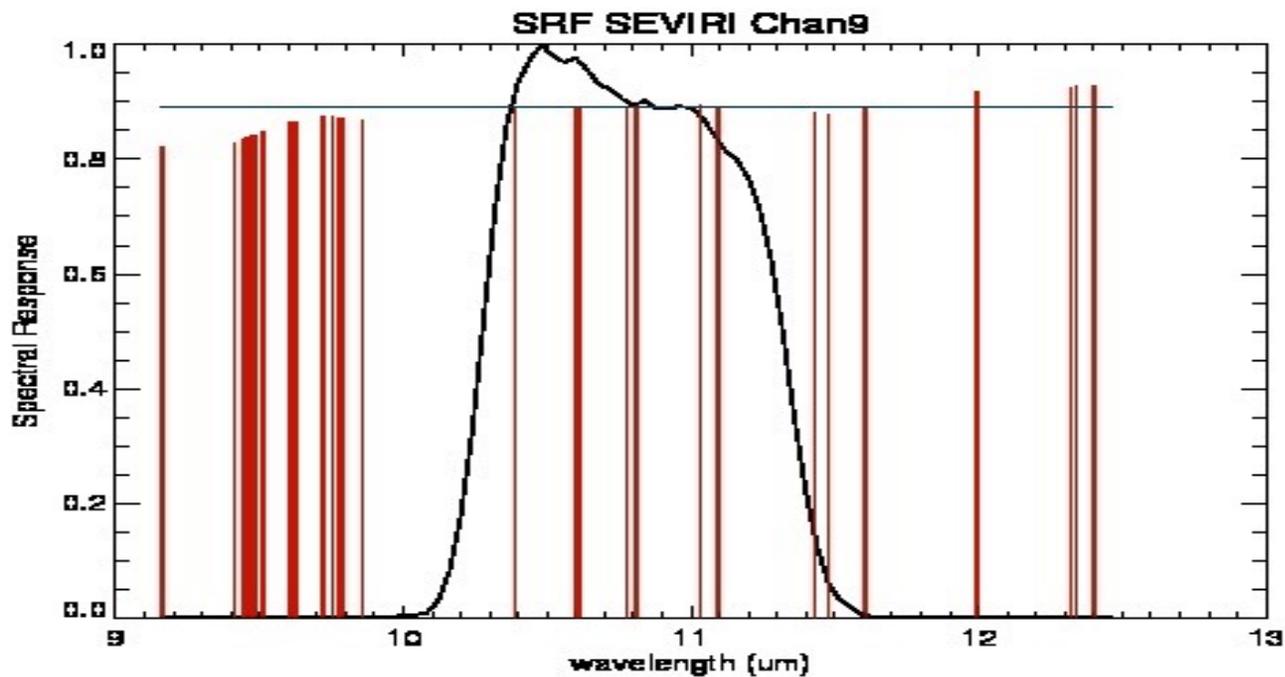
Repeat Steps 1 and 2 over desired time range

Compare BT stats from dynamic atlas with:

- i) stats from using $\varepsilon=0.98$
- ii) stats from using UW monthly mean atlas

Application to SEVIRI

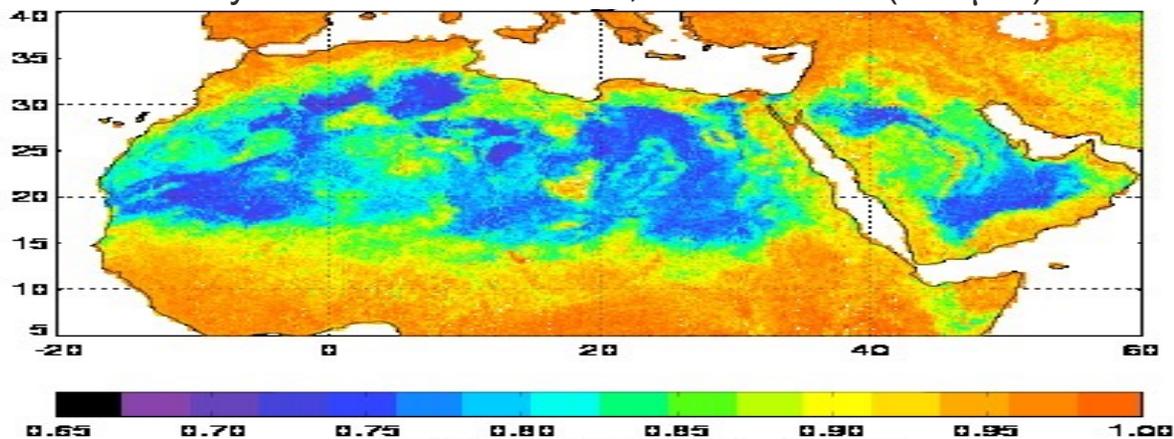
SEVIRI ε from IASI derived atlas



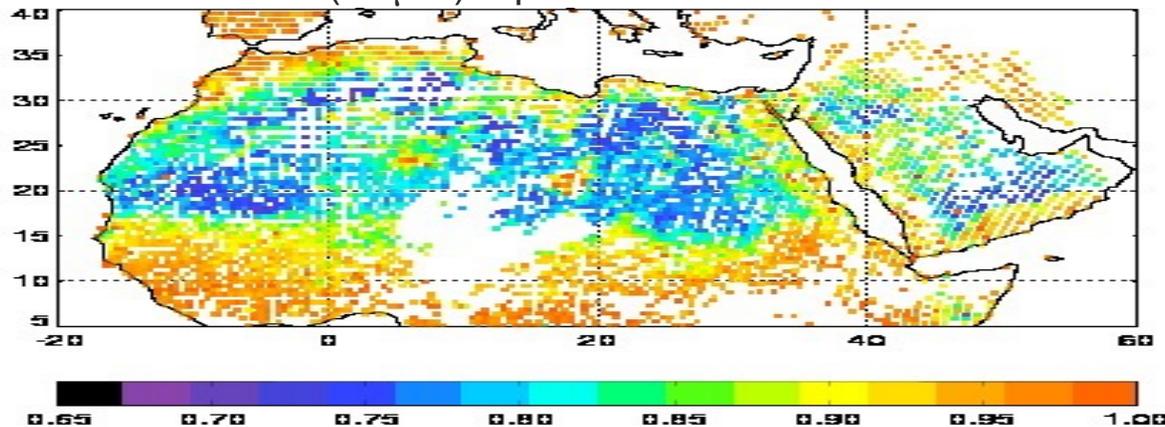
- IASI ε
- SEVIRI SRF
- SEVIRI equivalent ε

Application to SEVIRI

emissivity atlas at 2013042112, IASI ch1991 ($8.75\mu\text{m}$)



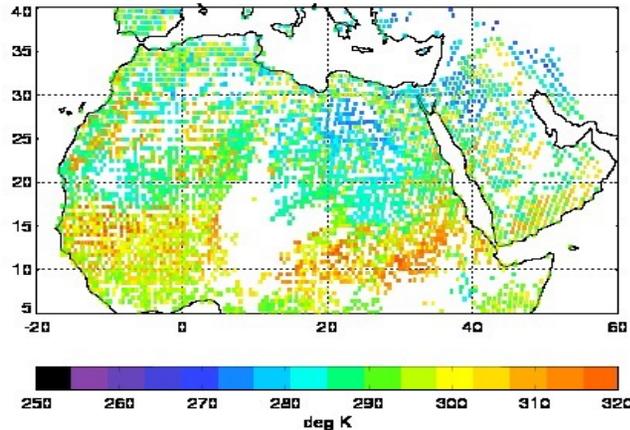
SEVIRI ch7($8.7\mu\text{m}$) equivalent emis at 2013042118



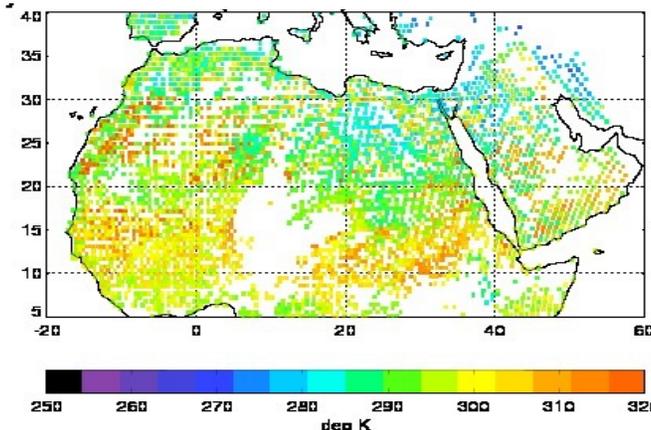
Application to SEVIRI

Ch7 (8.7 μ m) SEVIRI brightness temps 2013042000-2013042118

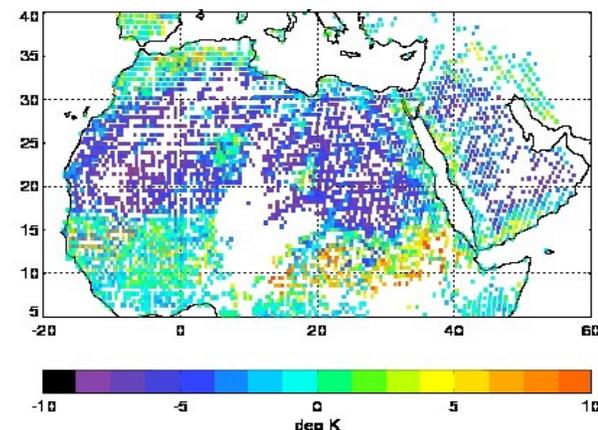
$\epsilon=0.98$



OBS (O)

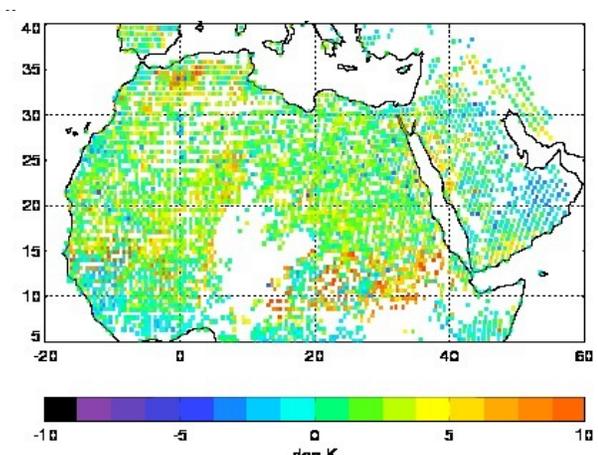
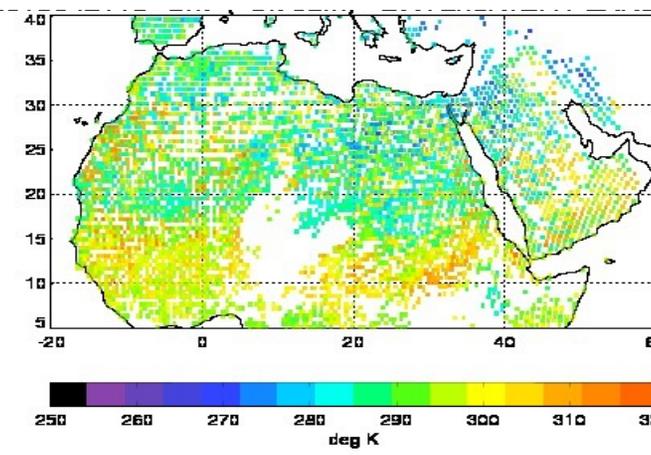
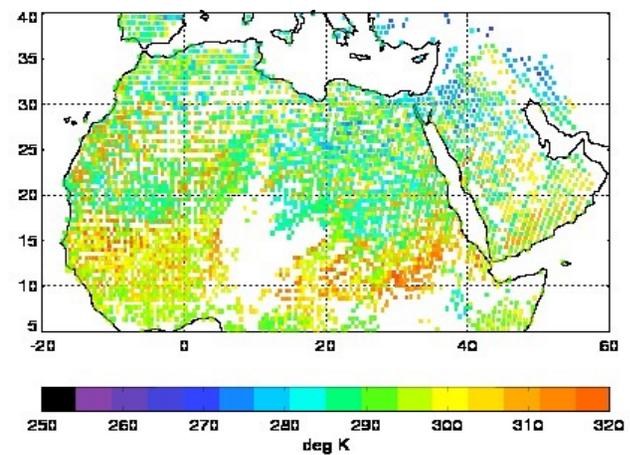


BG (B)



O-B

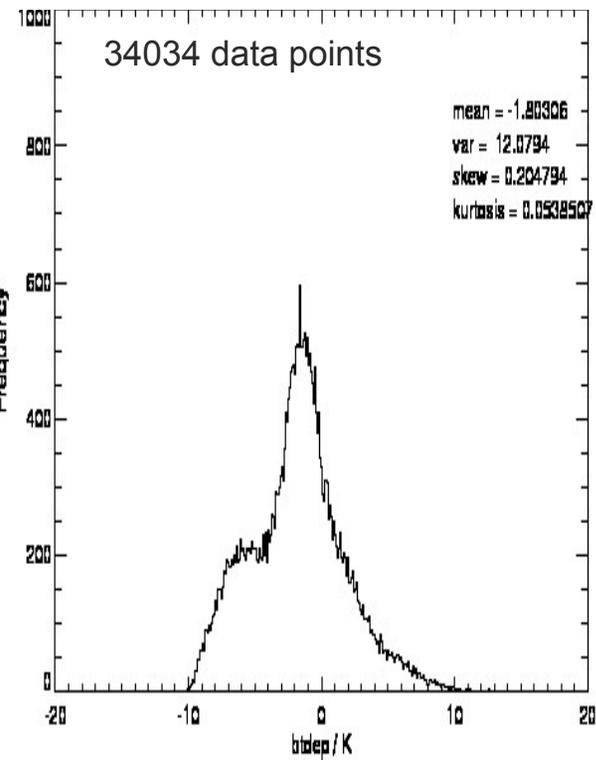
ϵ
from atlas



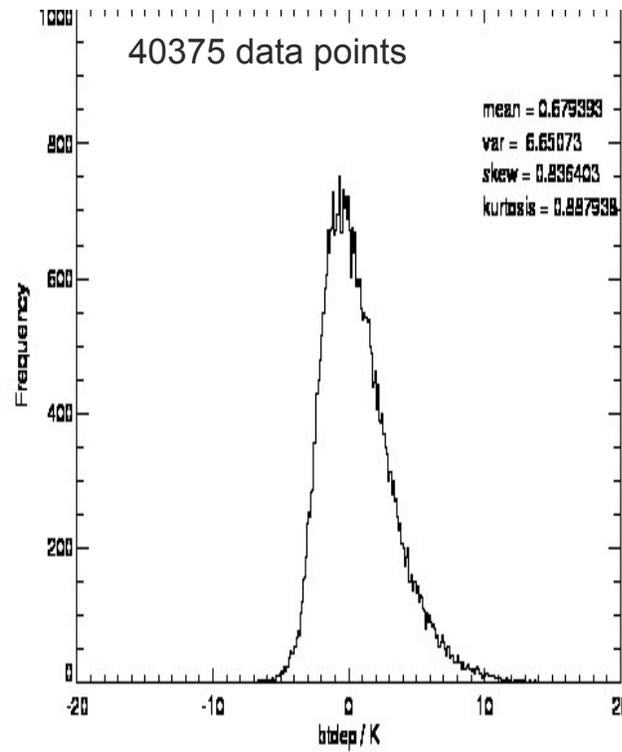
Application to SEVIRI

SEVIRI BT departures (O-B)

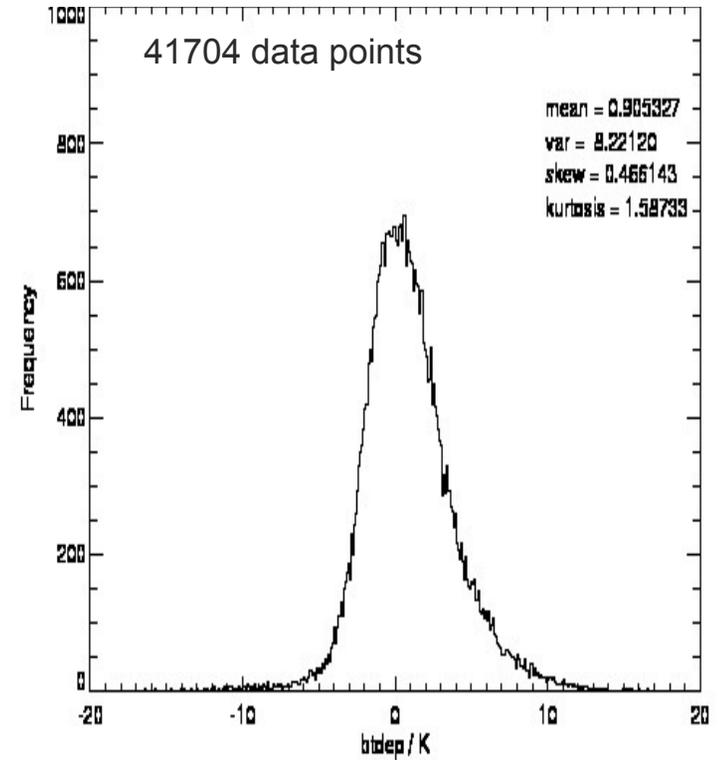
Ch7(8.7 μ m) 2013042000-2013042118



$\epsilon = 0.98$

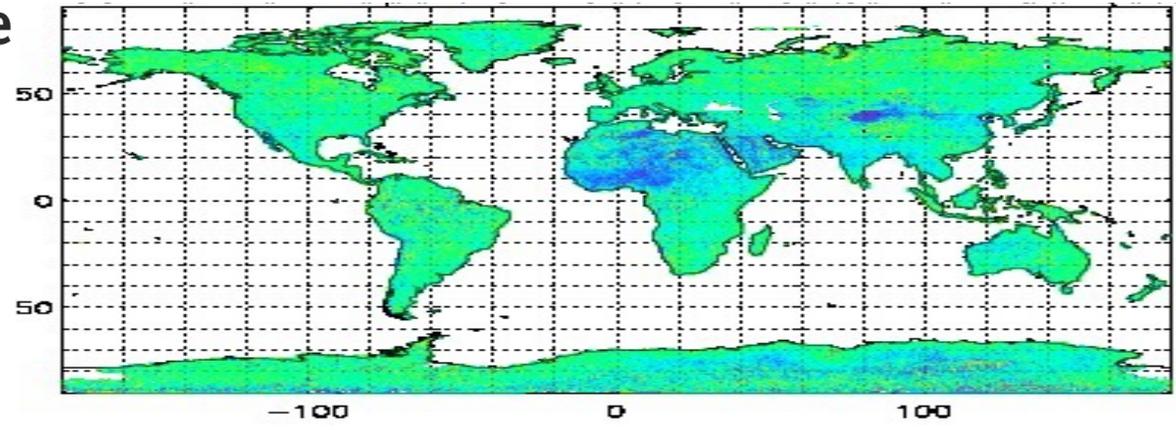


ϵ from UW atlas

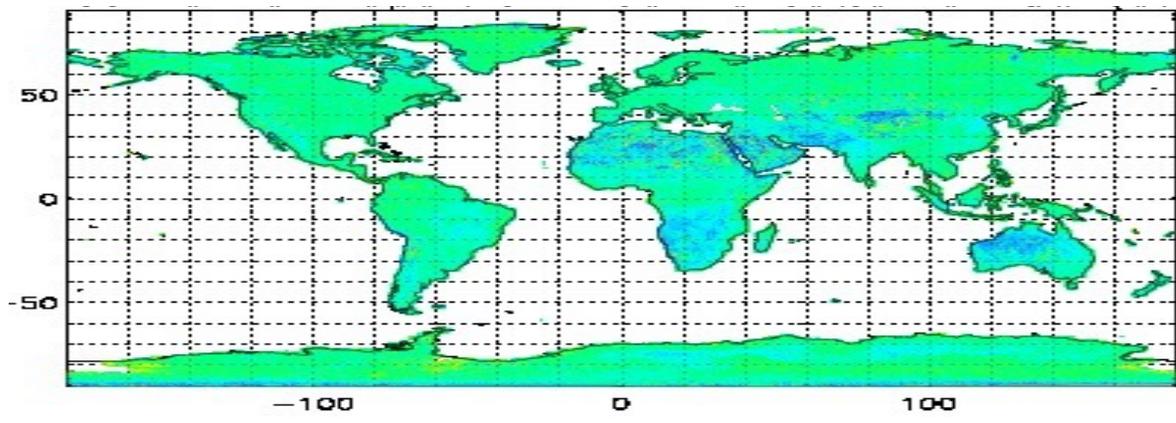


ϵ from dyn atlas

KF emis day-night differences ch:1884 (8.96 μ m)



Mar 2014



Oct 2014



Summary

- Kalman Filter Atlas version developed
- Dust aerosol issue detected
- Initial comparisons against UW monthly atlas
> 90% '1-sigma overlap'
- Consistency with ARIES flight
- Initial application to SEVIRI encouraging but positive BT departure bias detected

Next Steps

- Test and Validation against other sources and instruments
 - UW atlas
 - EUMETSAT IASI LSE operational/experimental products
- Investigate positive BT departure bias
- QC flag for dust aerosol
- Diurnal variation
- Snow consideration
- Use UW-NASA CAMEL atlas error estimates
- Scan angle dependence
- Application to other current and future IR instruments
 - SEVIRI, HIRS, MTG-IRS, IASI-NG
- Use in Met Office Data Assimilation system
- Available to all centres with full documentation