Introduction to the Development of a Dynamic Infrared Land Surface Emissivity Atlas based on IASI Retrievals

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Motivation

NRT atlas

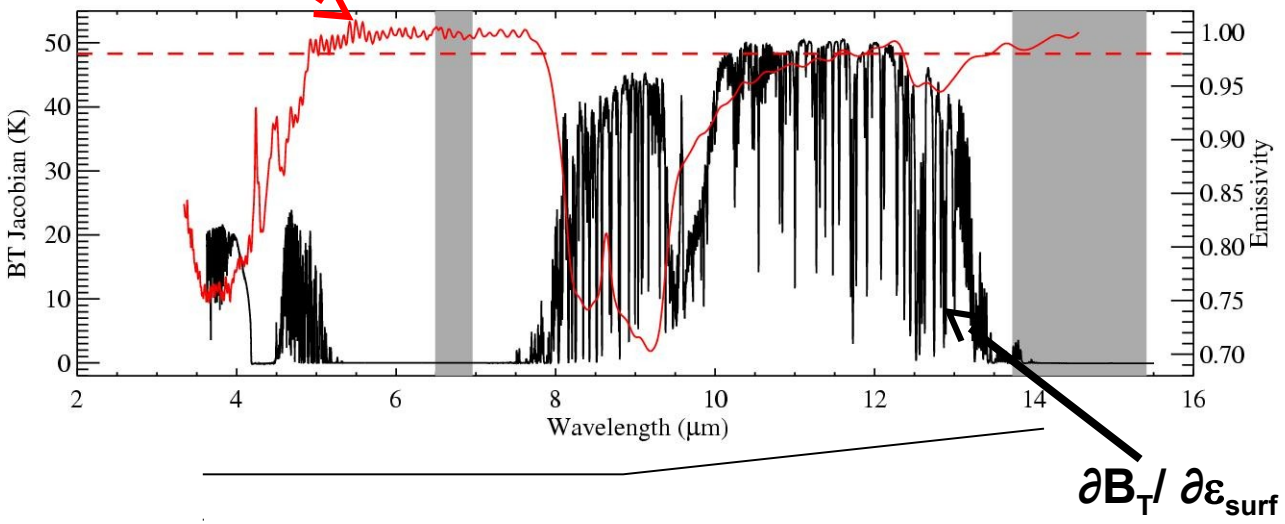
- up-to-date information
- short term variability

• assimilation surface sensitive IR channels over land for NWP (FG for 1dvar)

• apply to other IR instruments such as SEVIRI

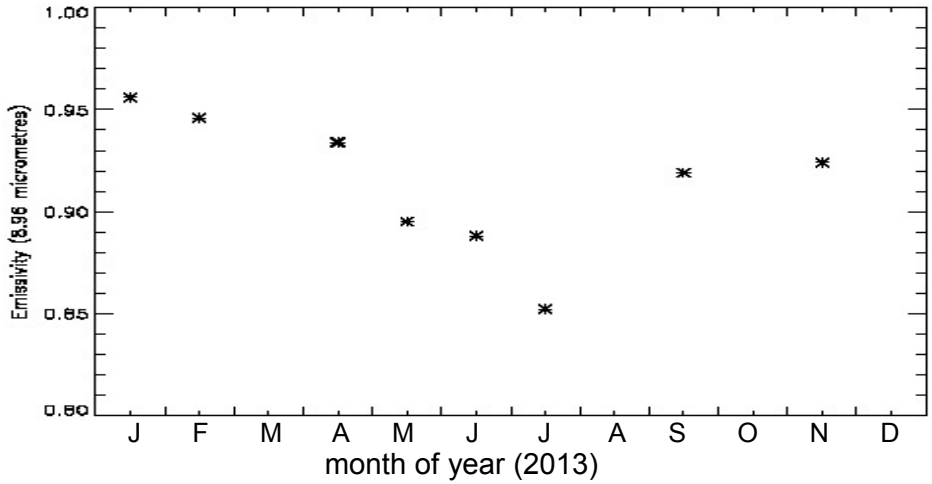
• improve Tskin accuracy

ε of sand (lab spectral analysis)



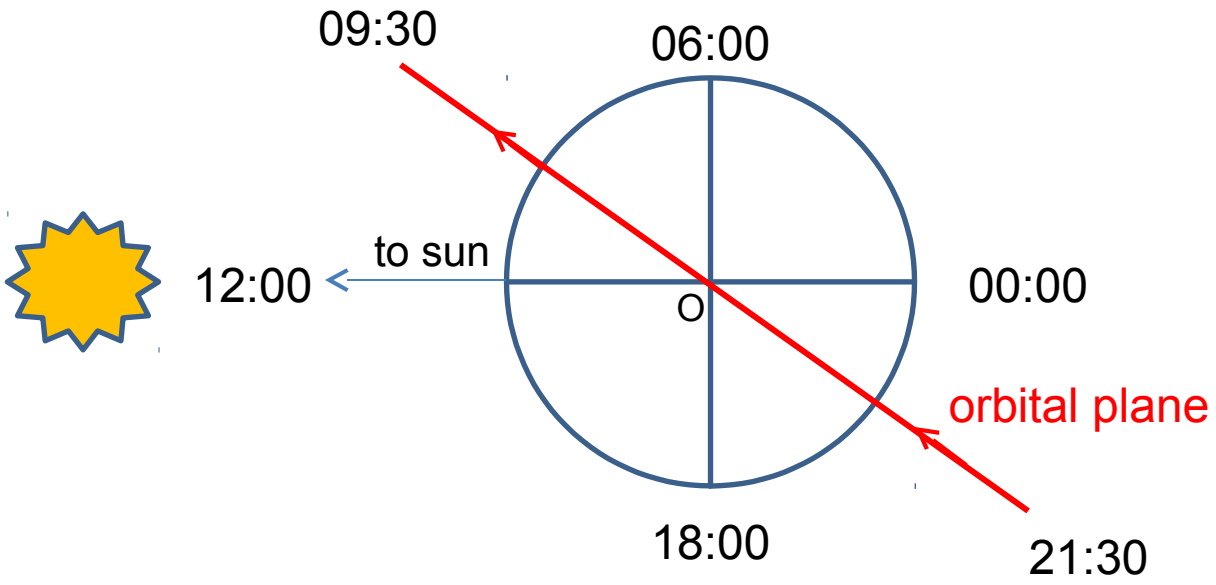
surface emissivity sensitive IR wavelengths

Retrieved Emissivity at [lon,lat]=[-0.50,12.50] at 8.96μm 2013



IASI (Infrared Atmospheric Sounder Interferometer)

- CNES/EUMETSAT
- MetOp-A (2006), MetOp-B (2013)
- Hyperspectral IR Sounder (8461 channels)
- Spectral Range 3.62 – 15.5 μm
- Mid-morning orbit 09:30 (desc) / 21:30 (asc)



1dvar Retrieval of Emissivity

- $\varepsilon(\lambda)$ retrievals from estimation of PC coefficients in 1dvar

- high dimensional data set reconstructed from PC set of reduced dimensionality

- skin temperature, cloud top pressure and cloud fraction also retrieved

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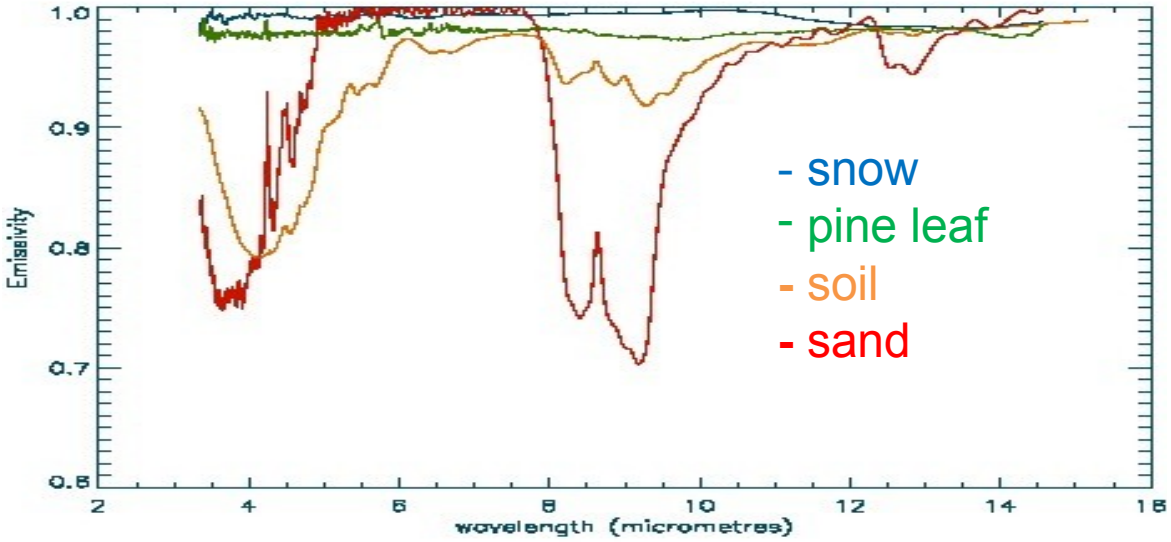
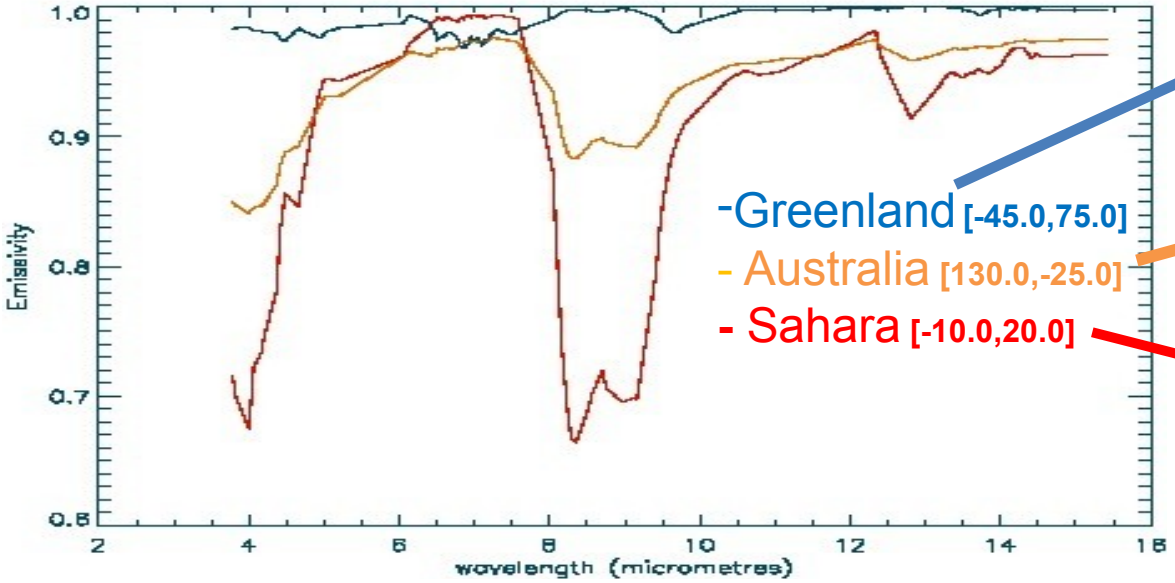
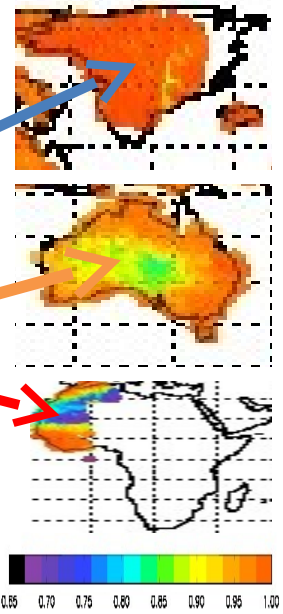
Lab Spectral Emissivities (UCSB Emissivity Library)



1dvar Retrieved Emissivities, 2013010100



8.96μm retrieved ε



Atlas Construction

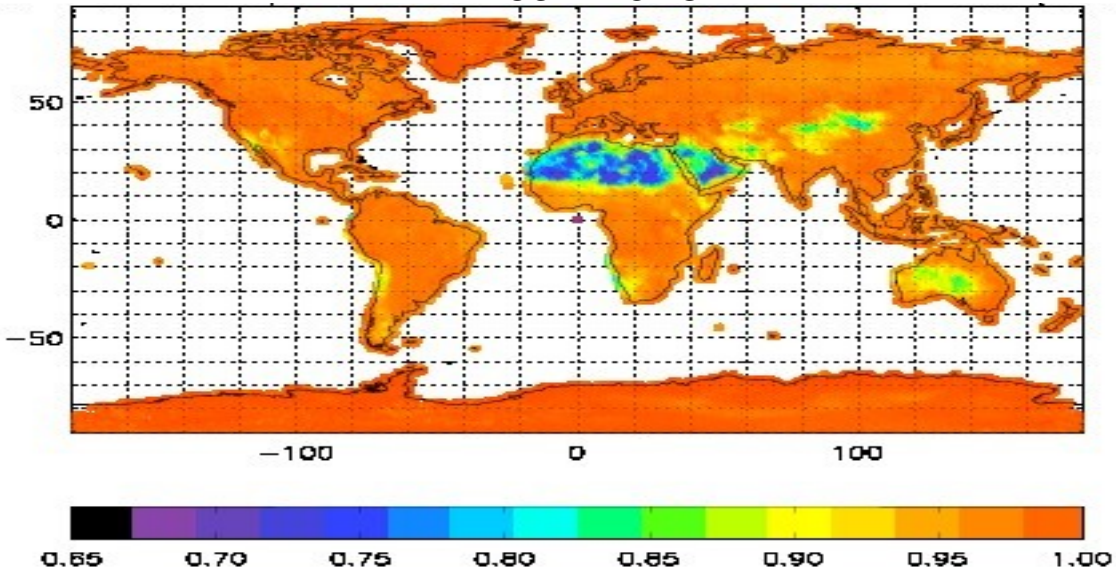
- Gridded dataset
- emissivity spectral estimate for each gridbox
- NRT updates from 1dvar IASI emissivity retrievals
  -> initially mean for each gridbox
  -> eventually data driven Kalman Filter

Kalman Filter Implementation

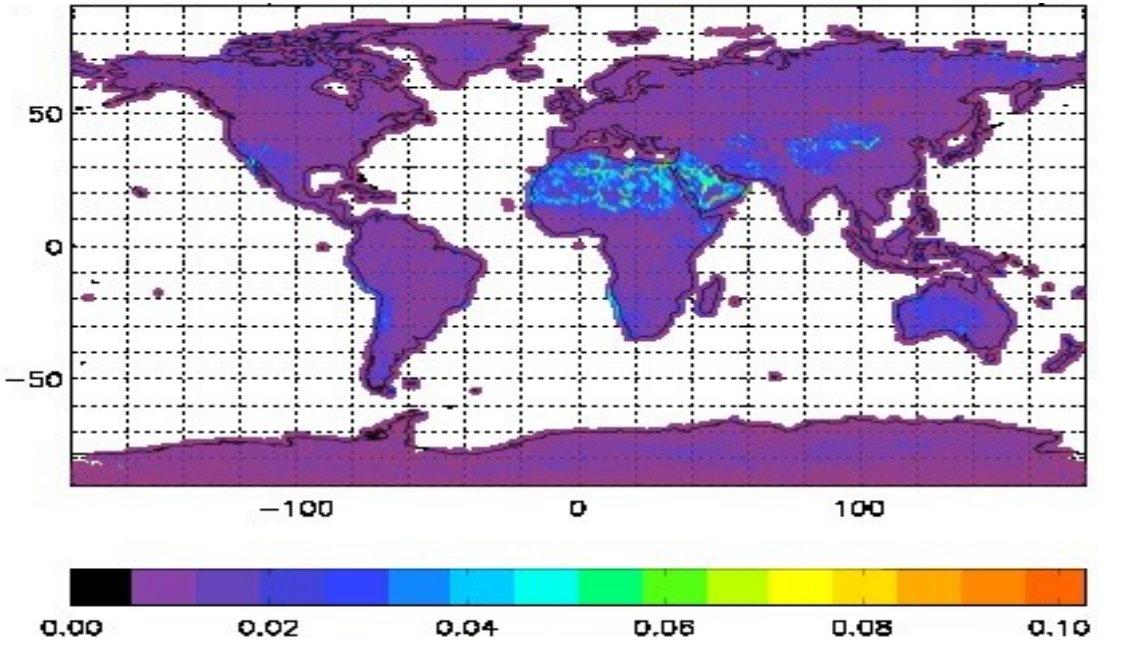
- Initial $\underline{\varepsilon}$ over each gridbox
- persistence model for each $\varepsilon(\lambda)$ in each gridbox
- 1dvar retrievals as measurement updates
- measurement noise from 1dvar analysis covariance matrix
- update $\underline{\varepsilon}$ for each relevant gridbox

Atlas construction IASI chan.1884 (8.96μm)

Jan 2013



Emissivity



$\sigma_{emissivity}$

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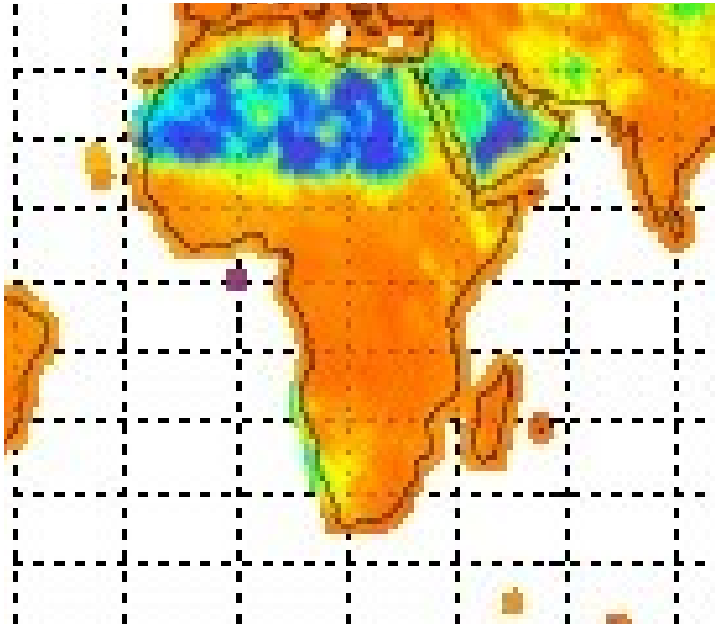
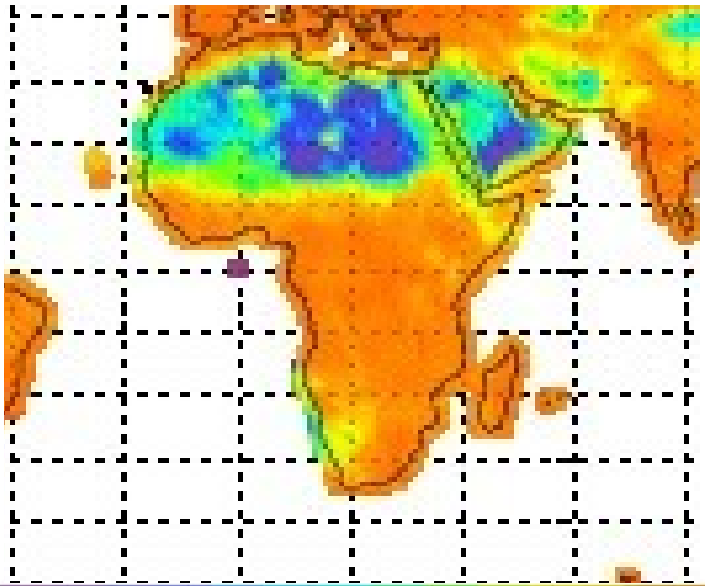
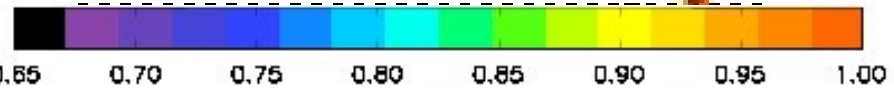
ε variation over seasons, latitude variation of low ε Sahara region



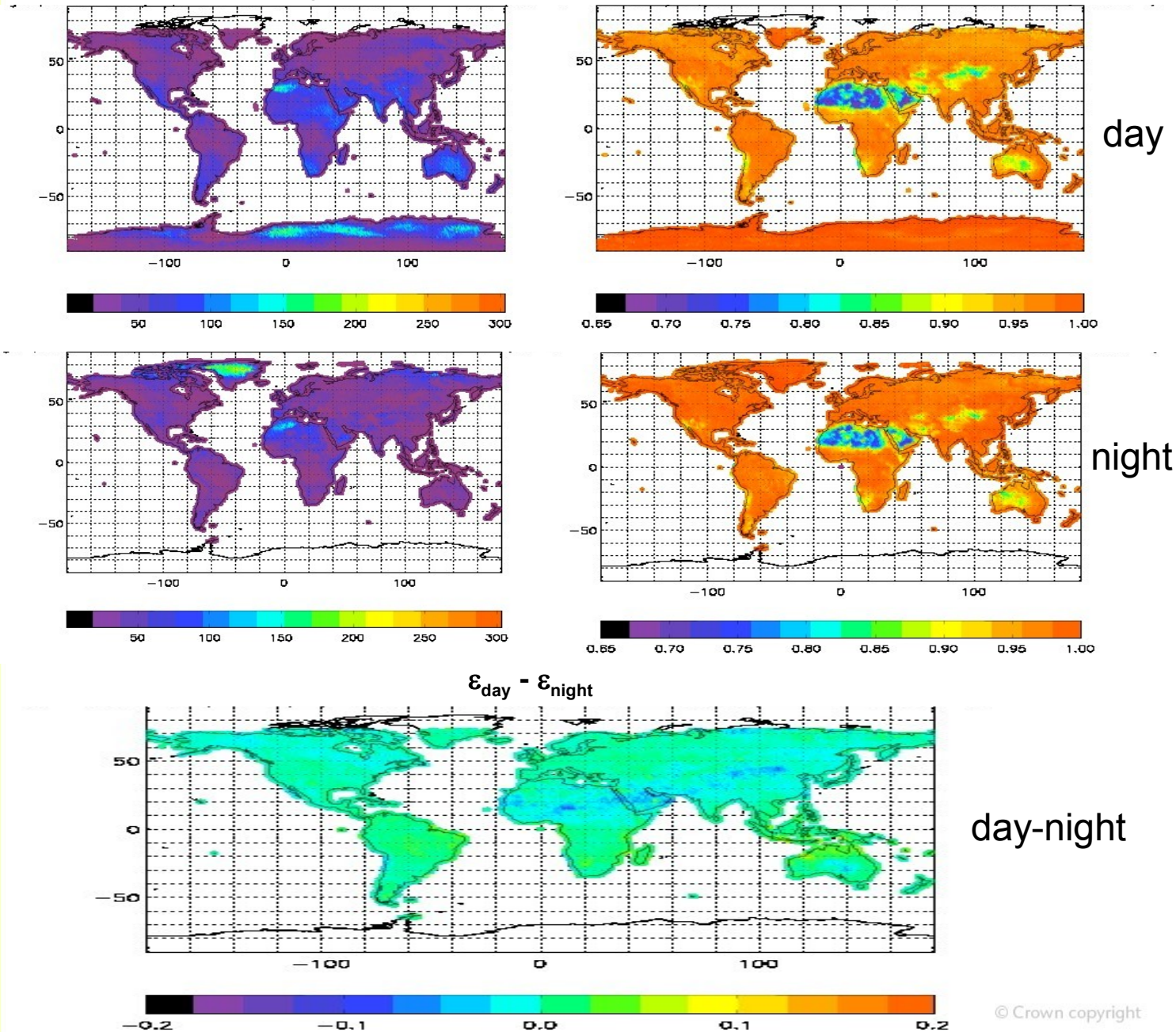
Jan 2013



Jul 2013



Jan 2013 day-night emissivity differences 8.96μm



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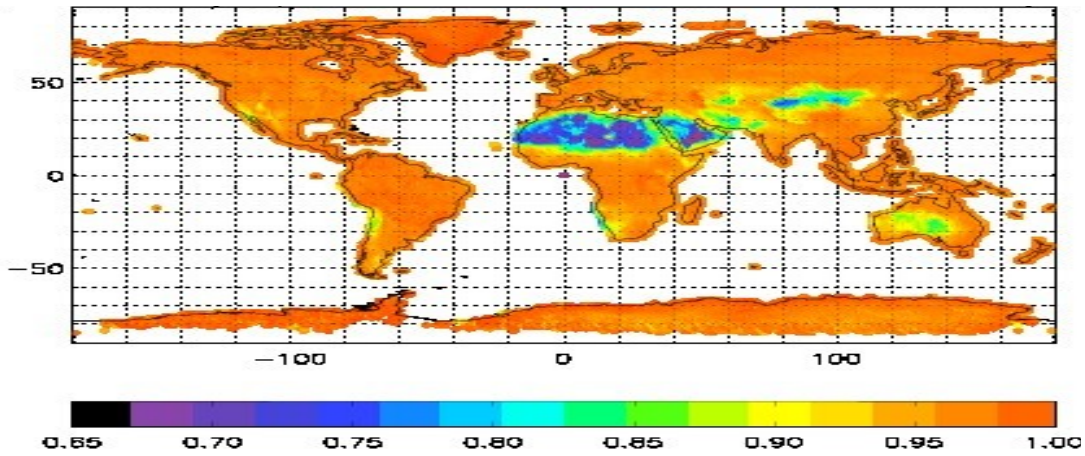
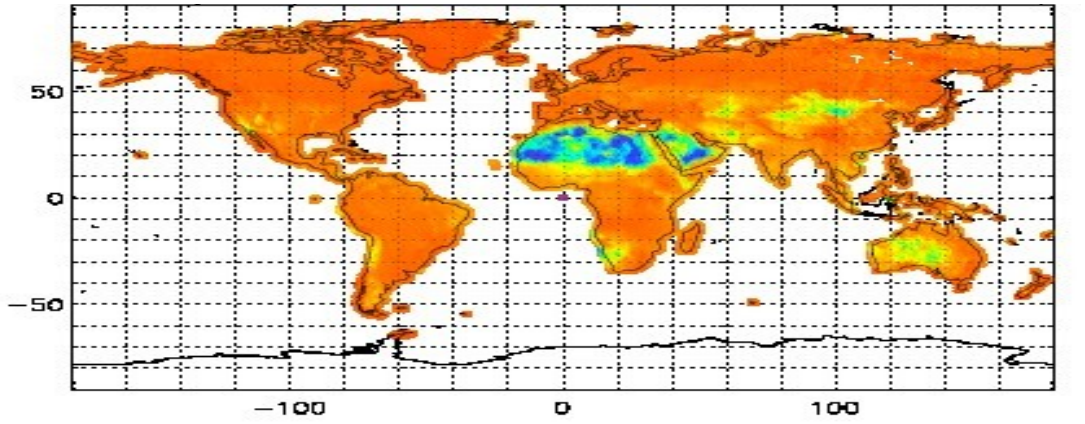
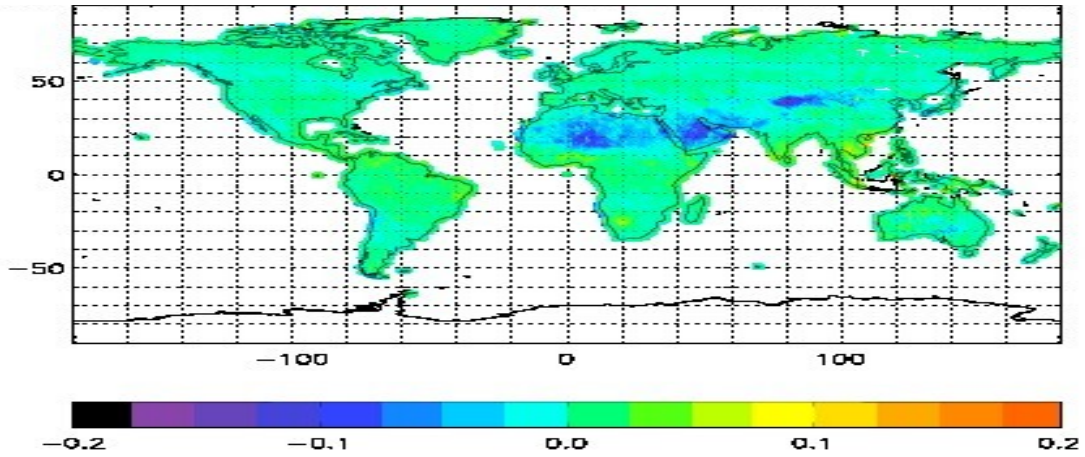
Apr 2013 day-night emissivity differences 8.96μm



day



night



day-night

Summary and Next Steps

- KF implementation
  - R-noise from 1dvar analysis error cov matrix
  - Q-noise from UWIREMIS (or derived variation)
  - P cov estimate

- Snow consideration

$$\varepsilon(\lambda) = (1\text{-sfc})*\varepsilon_{retrieved}(\lambda) + sfc*\varepsilon_{snow}(\lambda)$$

- Diurnal Variation

- Scan angle dependence

- Test and Validation against other sources and instruments

- 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

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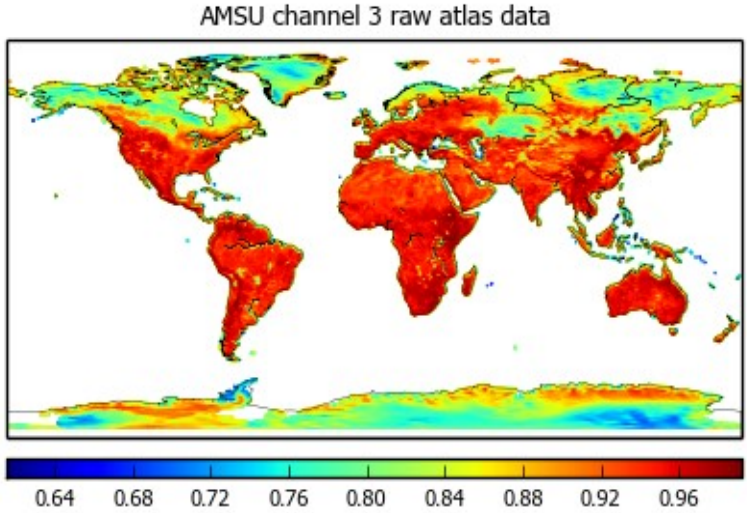
Extending our use of AMSU-A over land

(Stu Newman and Bill Bell)

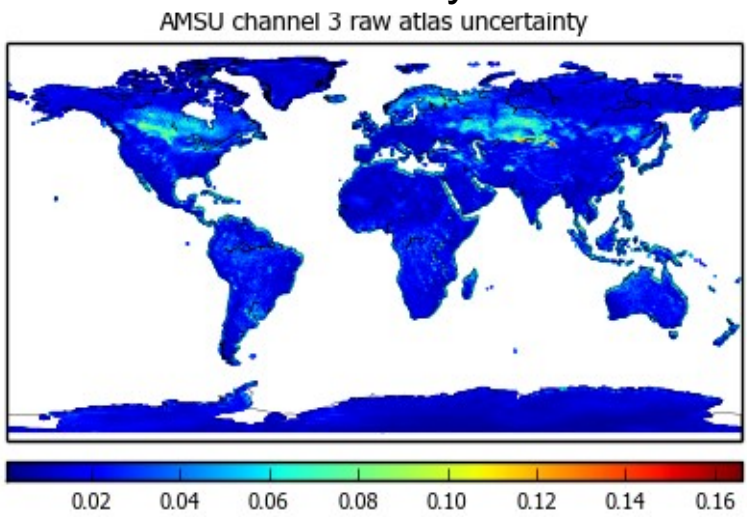
1D-Var retrieval of microwave emissivity and skin temperature

- Current operational usage at the Met Office: land surface emissivity fixed at 0.95 and lower-peaking channels AMSU 4 & 5 not assimilated over land
- Aim: use microwave emissivity atlas (Fatima Karbou / Météo France) as a first guess in a 1D-Var retrieval
- Atlas is tabulated for frequencies 23.8, 31.4, 50.3 & 89 GHz (AMSU channels 1, 2, 3 & 15) per calendar month
- Use atlas uncertainty estimate to derive observation-dependent errors
- 1D-Var retrieval of Tskin and microwave emissivity

AMSU ch 3 emissivity (March)

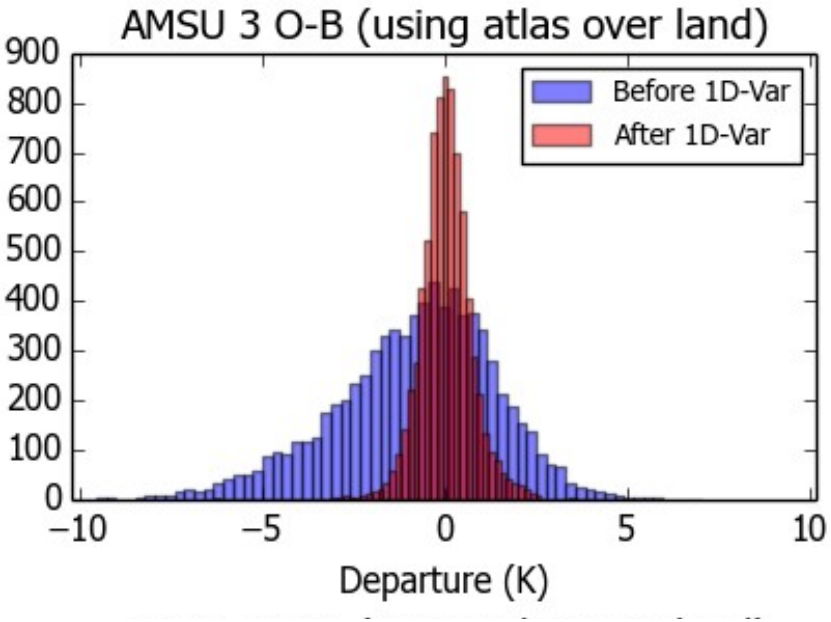


Atlas uncertainty estimate



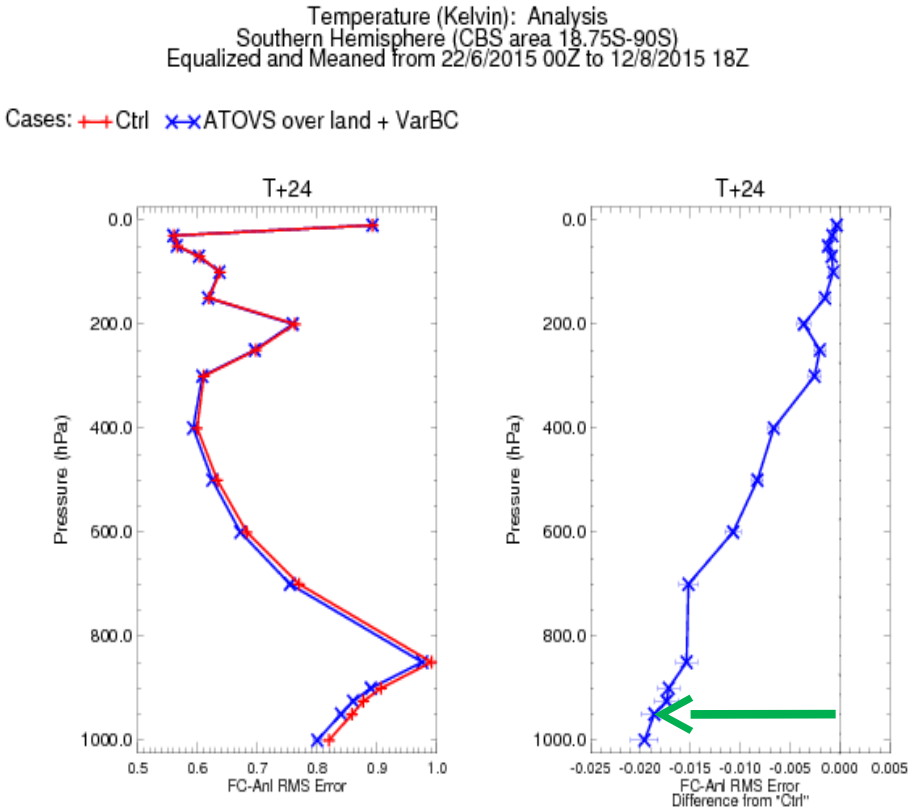
Improved modelling of surface sensitive channels

- Before 1D-Var the atlas provides a reasonable first guess
- Retrieved skin temperature and emissivity for AMSU-A channel 3 at 50.3 GHz is used as representative for channels 4 & 5 (52.8, 53.6 GHz)
- After 1D-Var retrieved skin temperature and emissivity are passed to 4D-Var where AMSU-A channels 4 and 5 are assimilated (as well as current channels 6-14)



NWP global experiments

- Assimilation of AMSU-A channels 4 & 5 over land tested in global experiments for summer and winter seasons (on top of full observing system)
- Improvements seen in RMS forecast-analysis error for tropospheric temperature at short range in Southern Hemisphere; results mixed in Northern Hemisphere
- Overall verification considered positive, assimilation of AMSU-A 4&5 over land to be included in next set of planned operational changes mid-2016



RMS error reduction ~2% for SH lower atmospheric temperature vs analysis