Satellite observations of stratospheric gravity waves from AIRS and IASI: Mountain waves and storm sources

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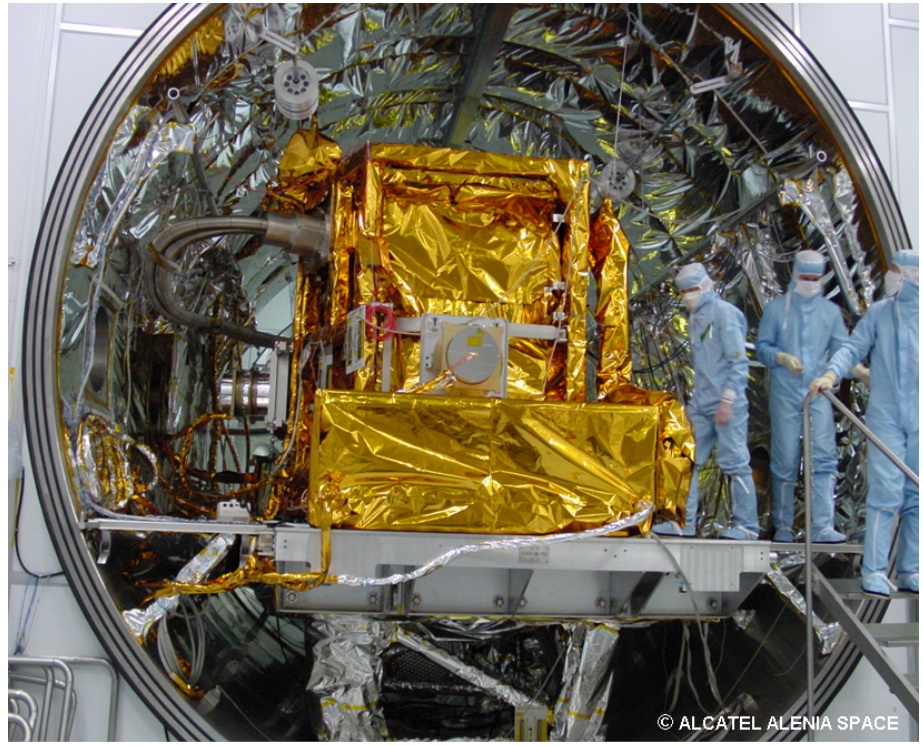
Topics

- Measurement characteristics of AIRS and IASI
- Case studies of orographic and convective waves
- Comparison of 5-year records of GW activity

Why combine AIRS and IASI?

- Both are hyperspectral infrared sounders, performing rather similar measurements...

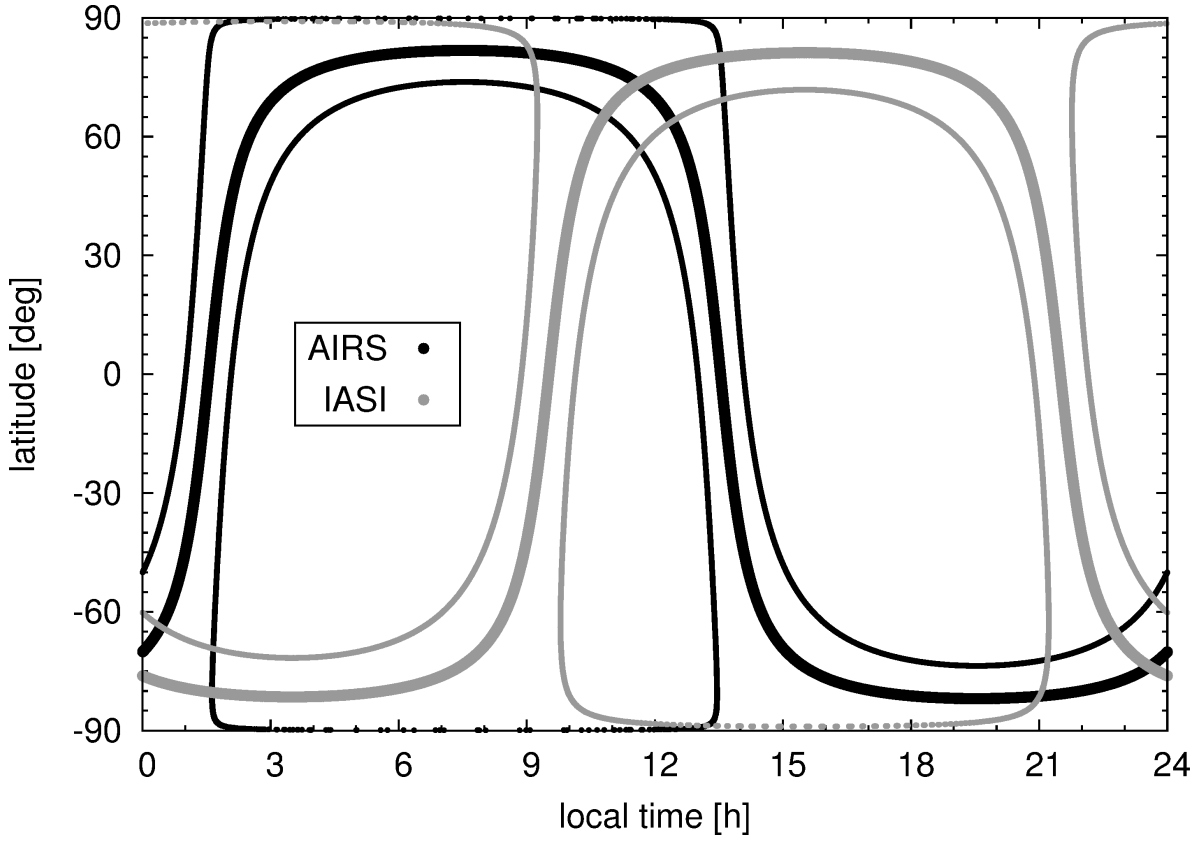
AIRS/Aqua,
launched 2002



IASI-A/MetOp-A,
launched 2006

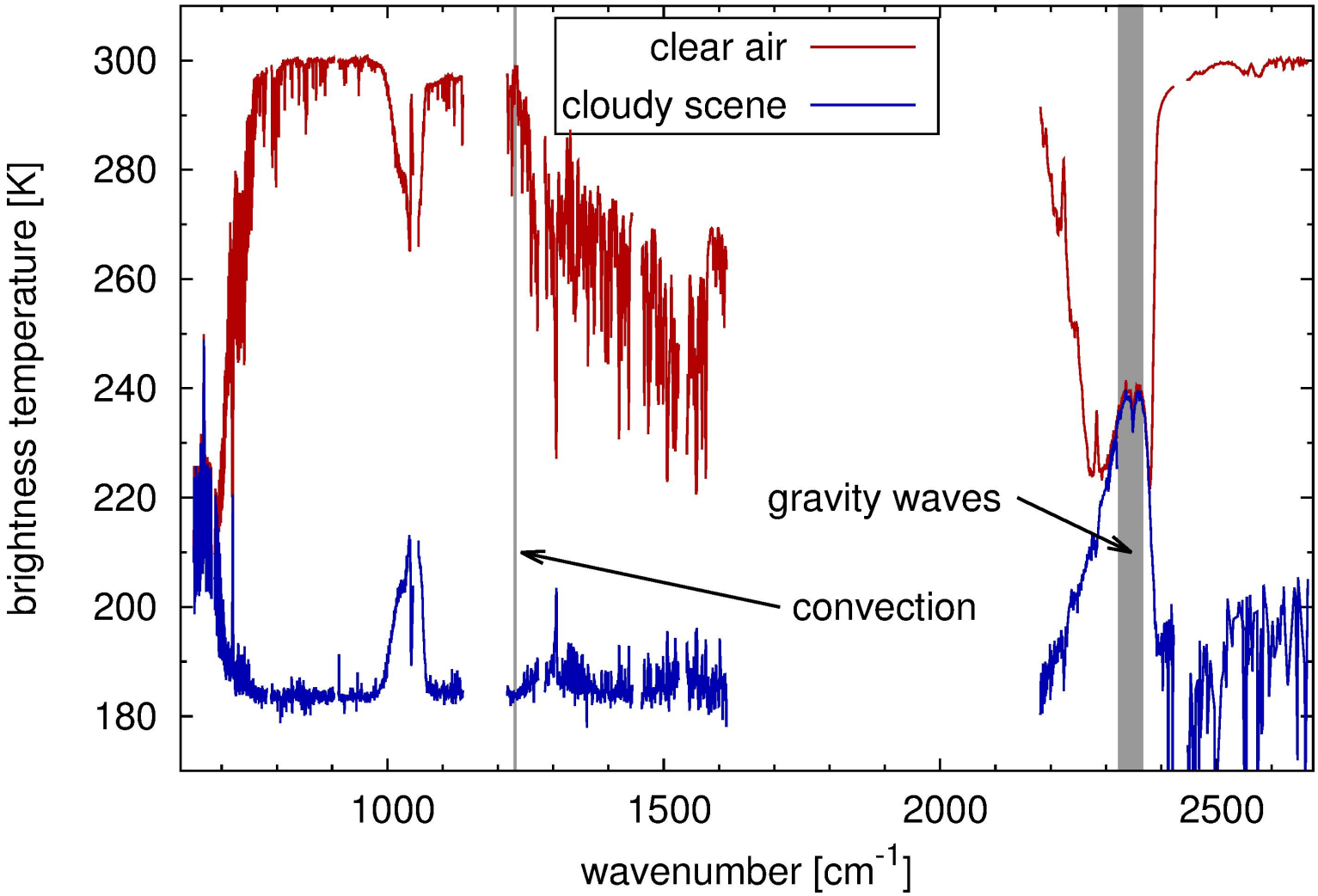
Why combine AIRS and IASI?

- AIRS used in many GW studies, IASI not exploited at all.
- AIRS and IASI measure at different local time. Combined data may yield information on diurnal cycle of GW activity.



How to get information on GW activity?

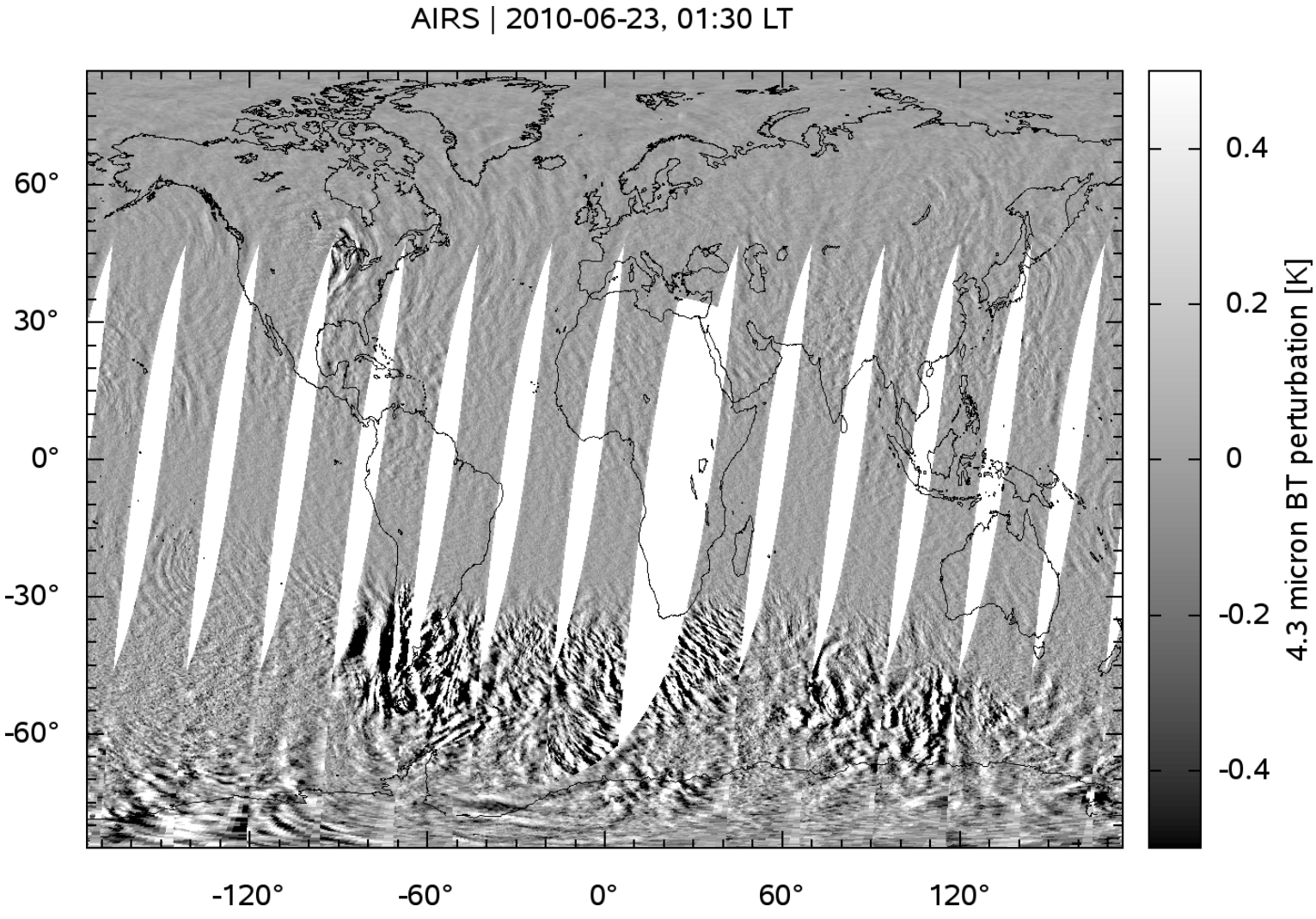
- GW signals are extracted from 4.3 μm CO_2 waveband:



- Spectral averaging provides noise reduction and similar vertical coverage and sensitivity of AIRS and IASI.

How to get information on GW activity?

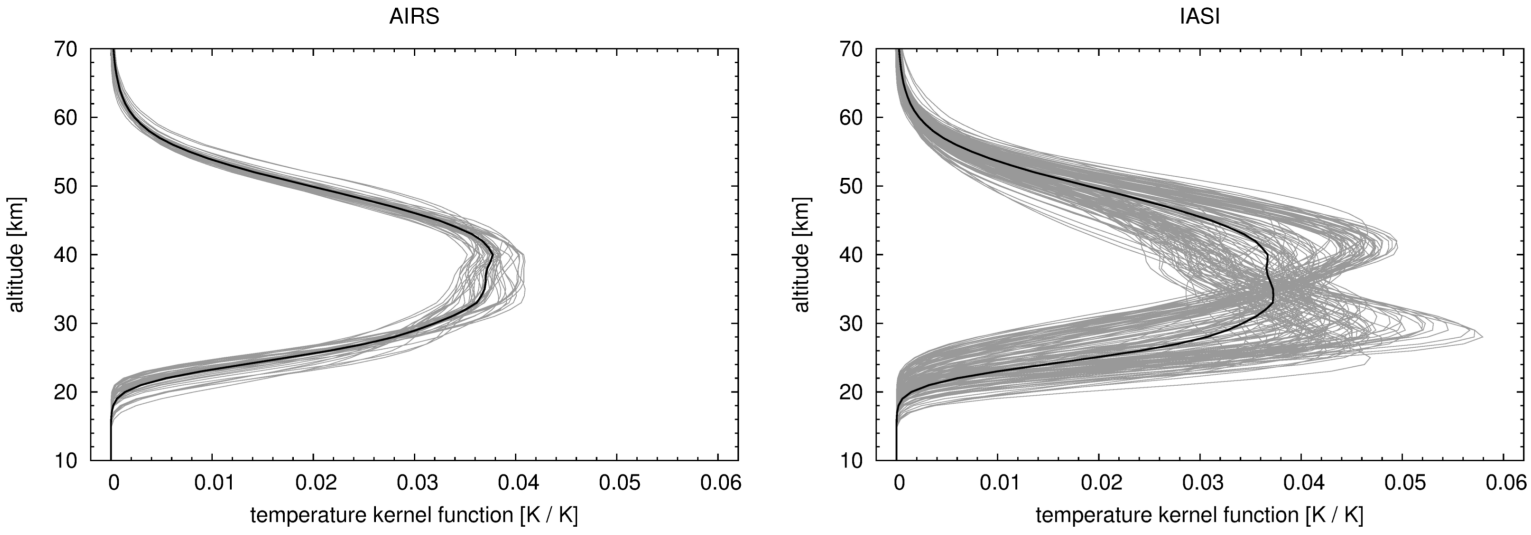
- AIRS 4.3 μm brightness temperature perturbation map:



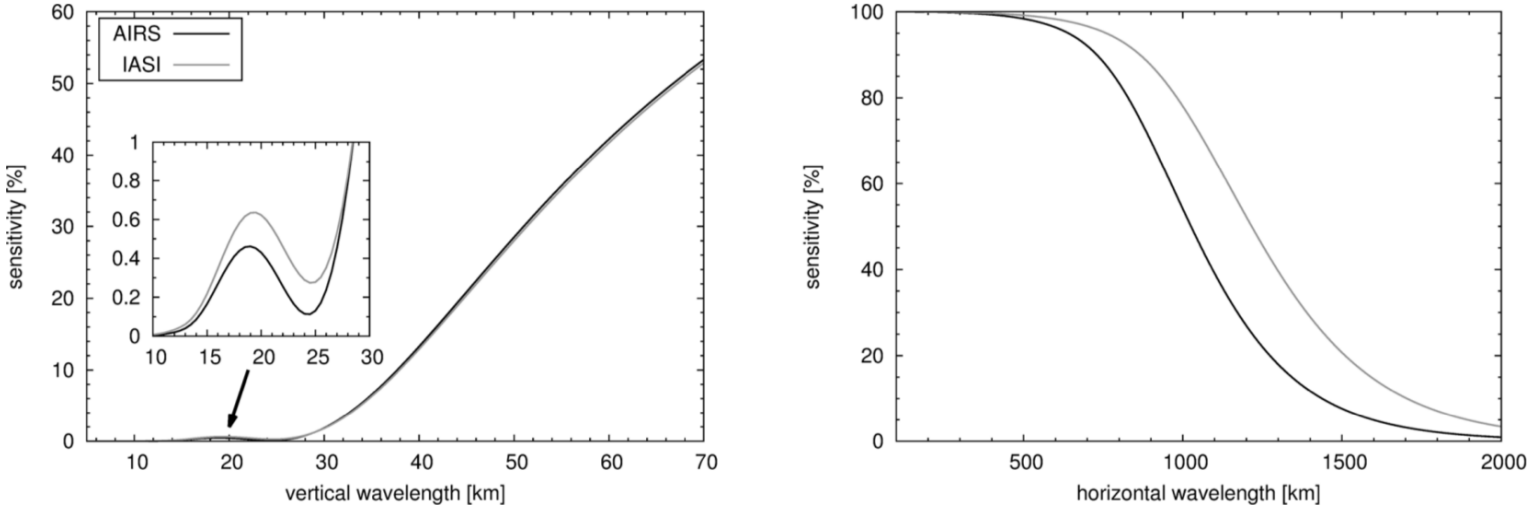
- Detrended with a 4th-order polynomial fit for each scan.

Coverage and sensitivity of 4.3 μm channels

- Temperature weighting functions:

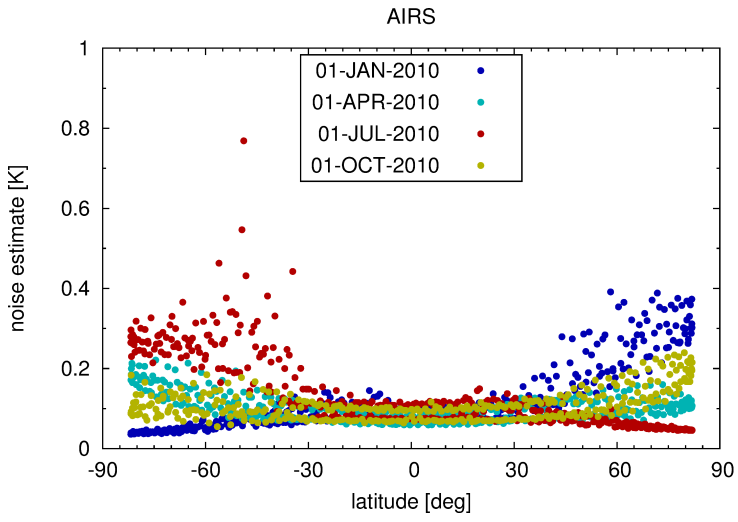


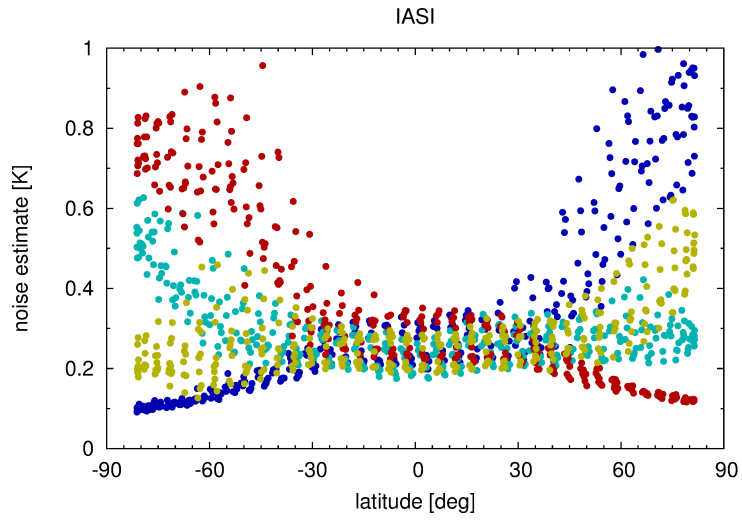
- Response curves of brightness temperature variances:

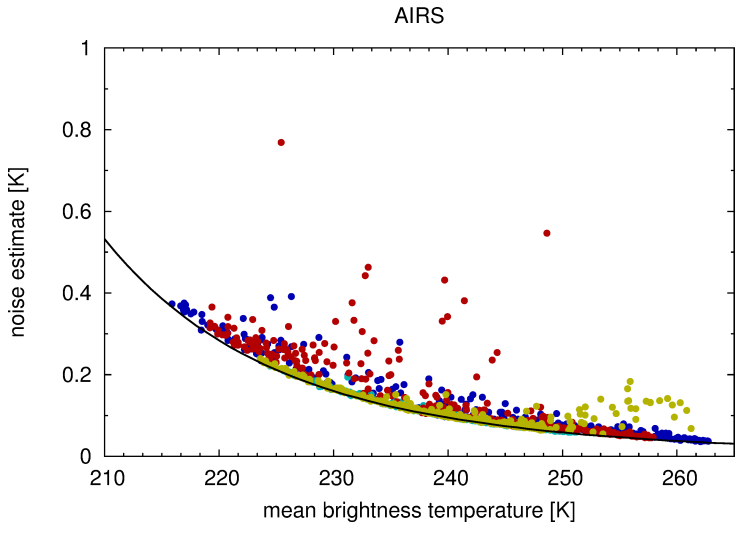


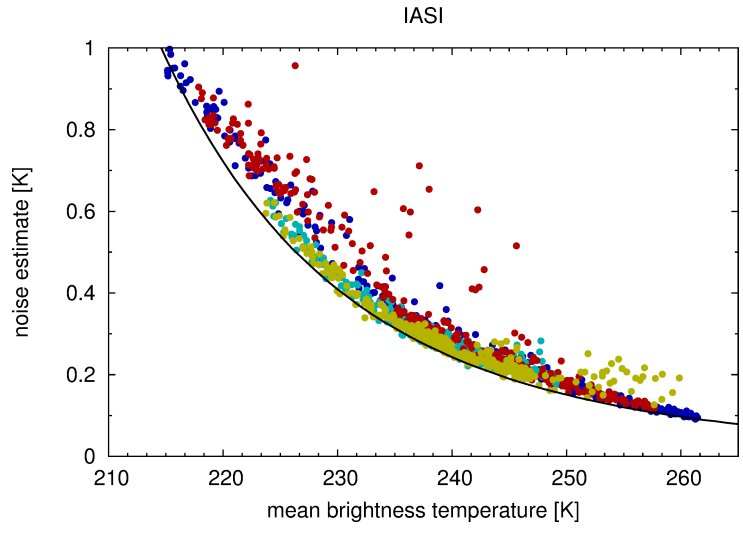
Measurement noise

- Comparison of noise estimates:

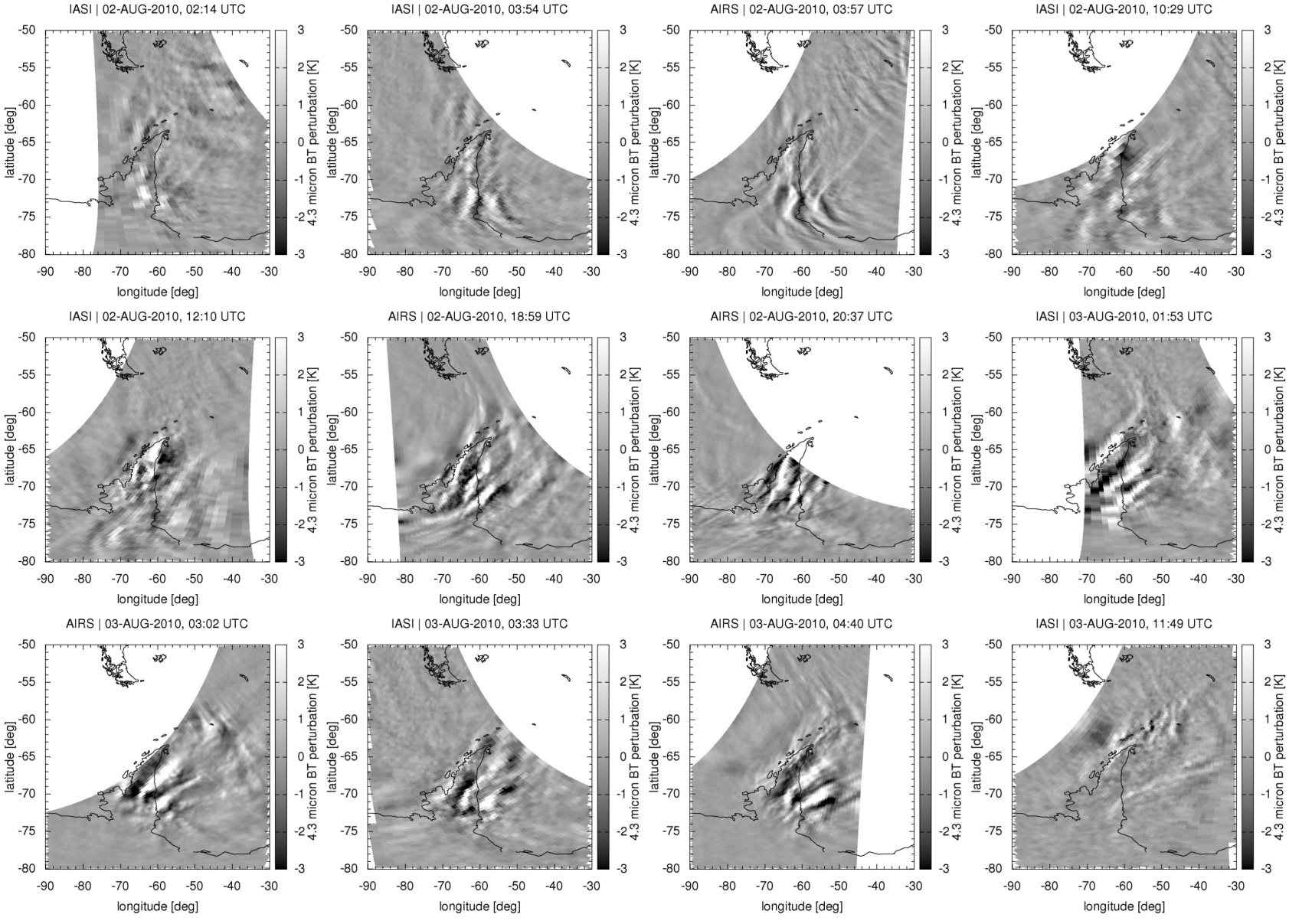






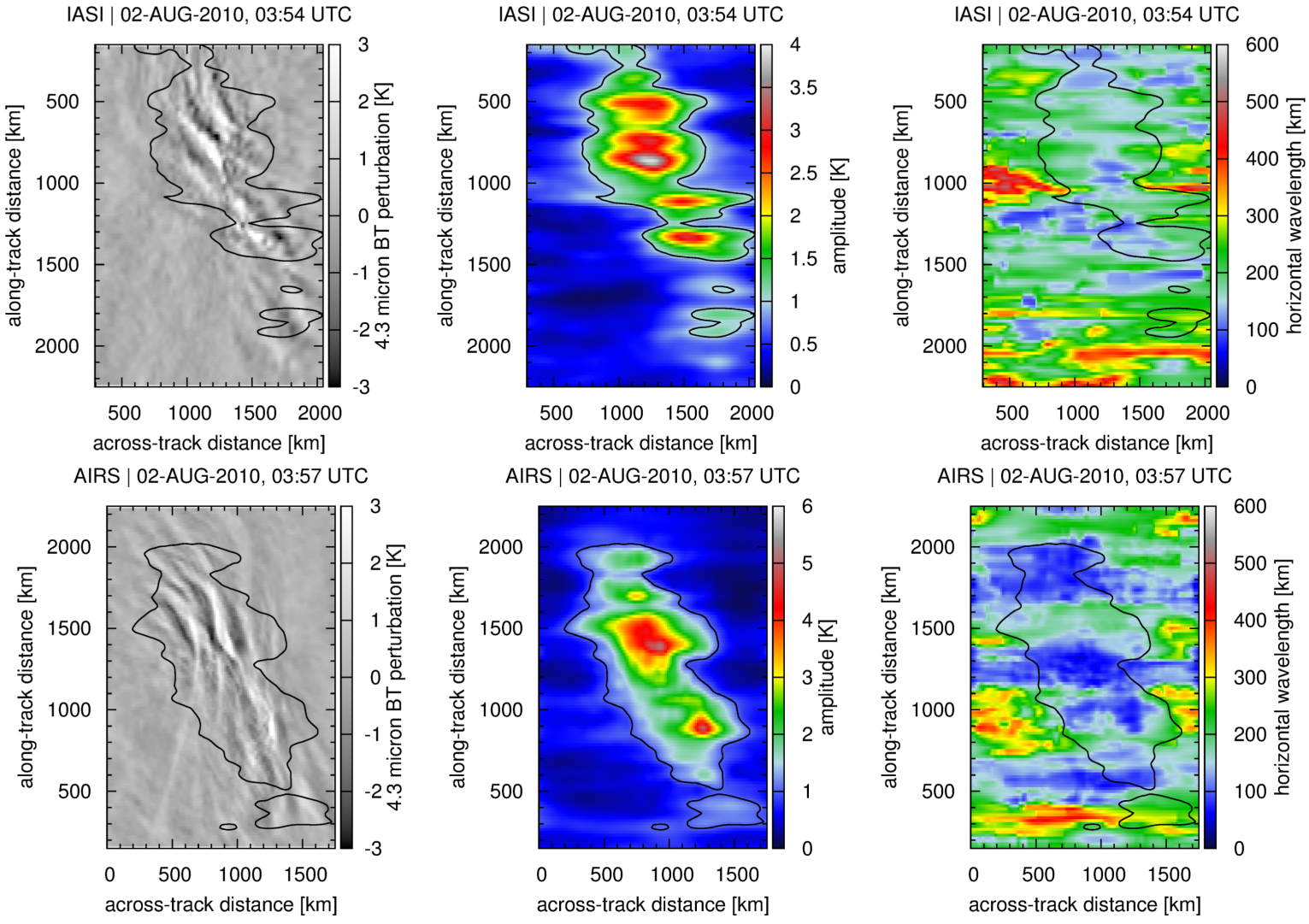


Mountain Waves at Antarctic Peninsula

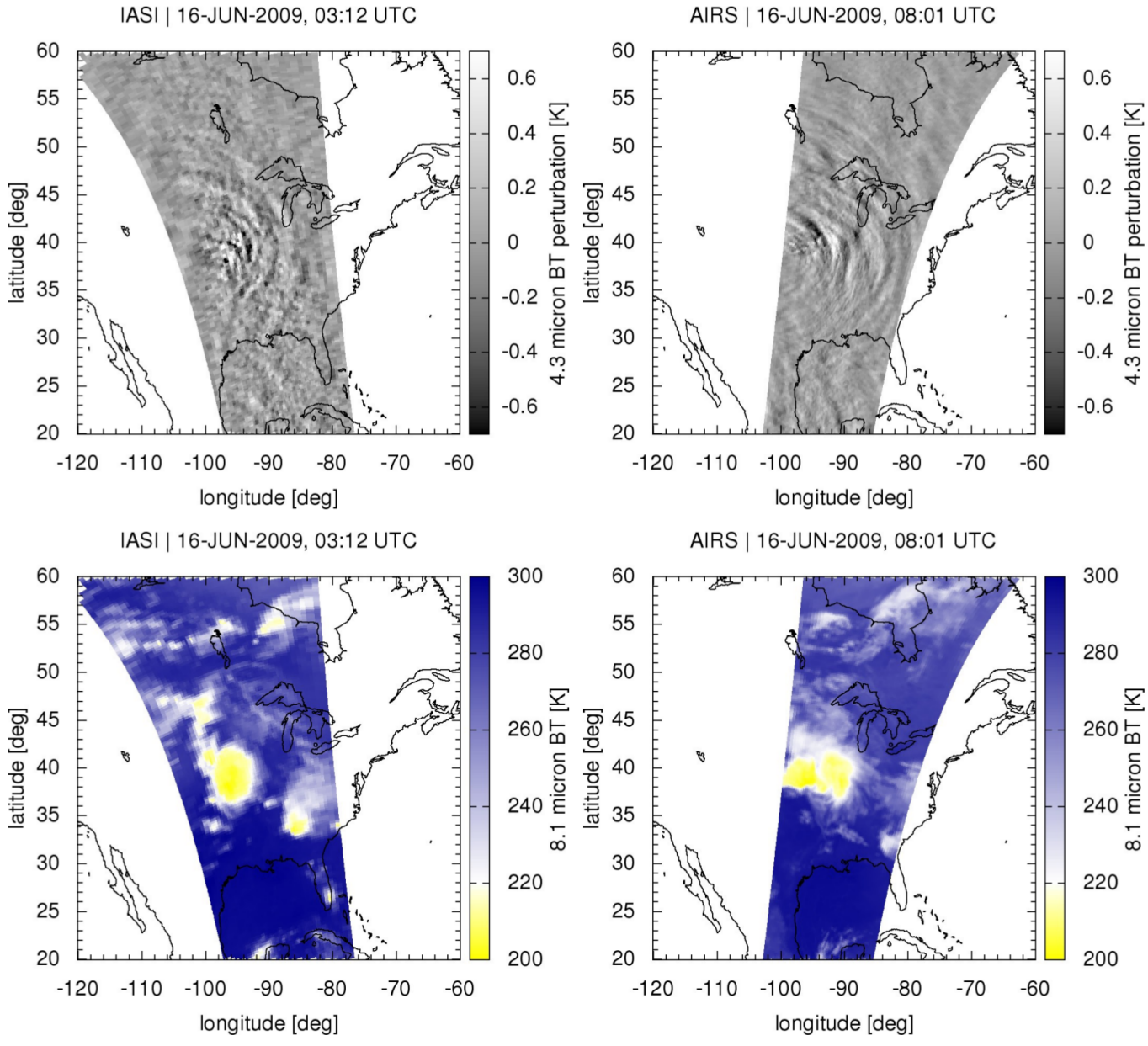


Mountain Waves at Antarctic Peninsula

- Spectral analysis of coincident AIRS and IASI overpasses:

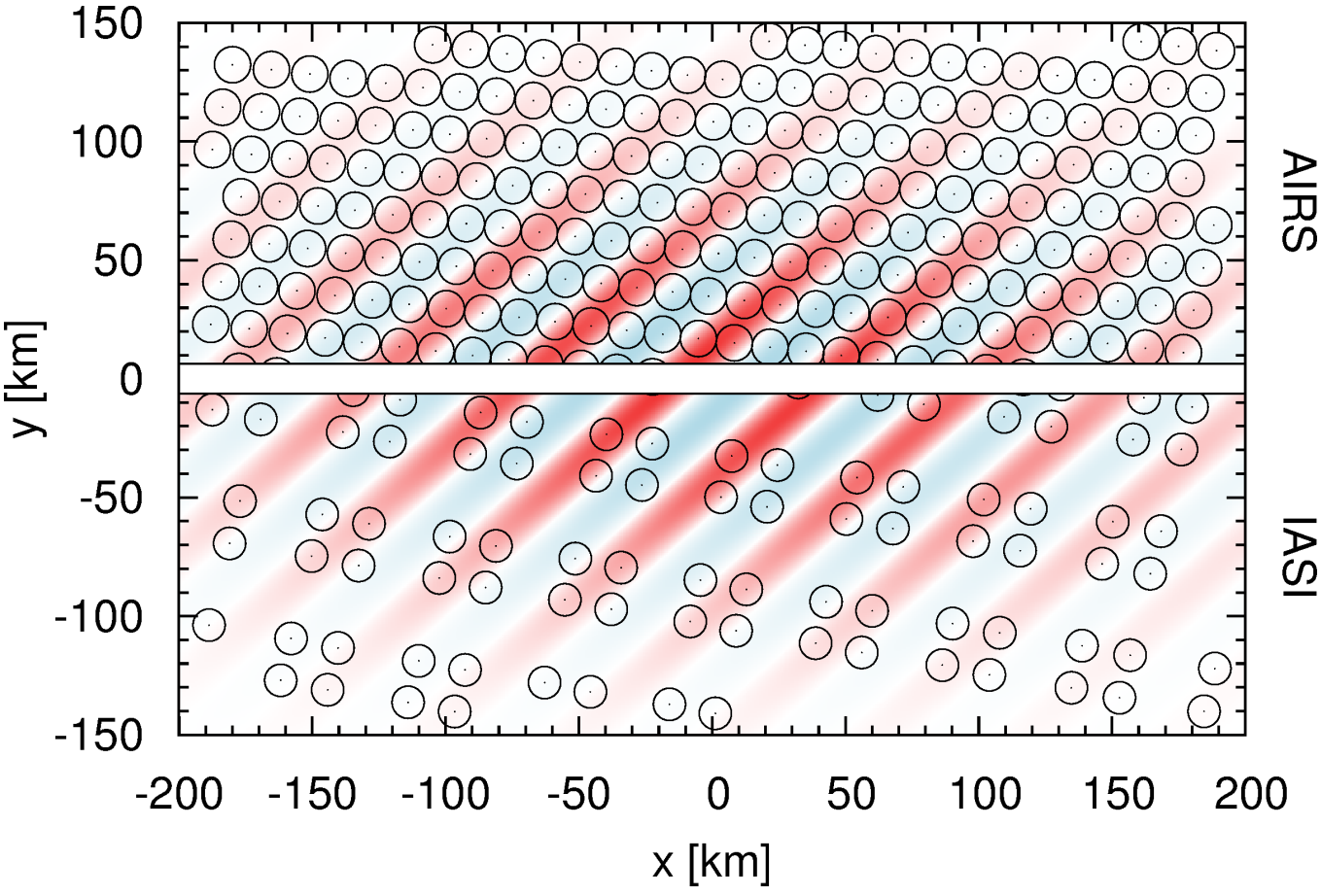


Convective Waves over North America



Why does AIRS look more “clear” than IASI?

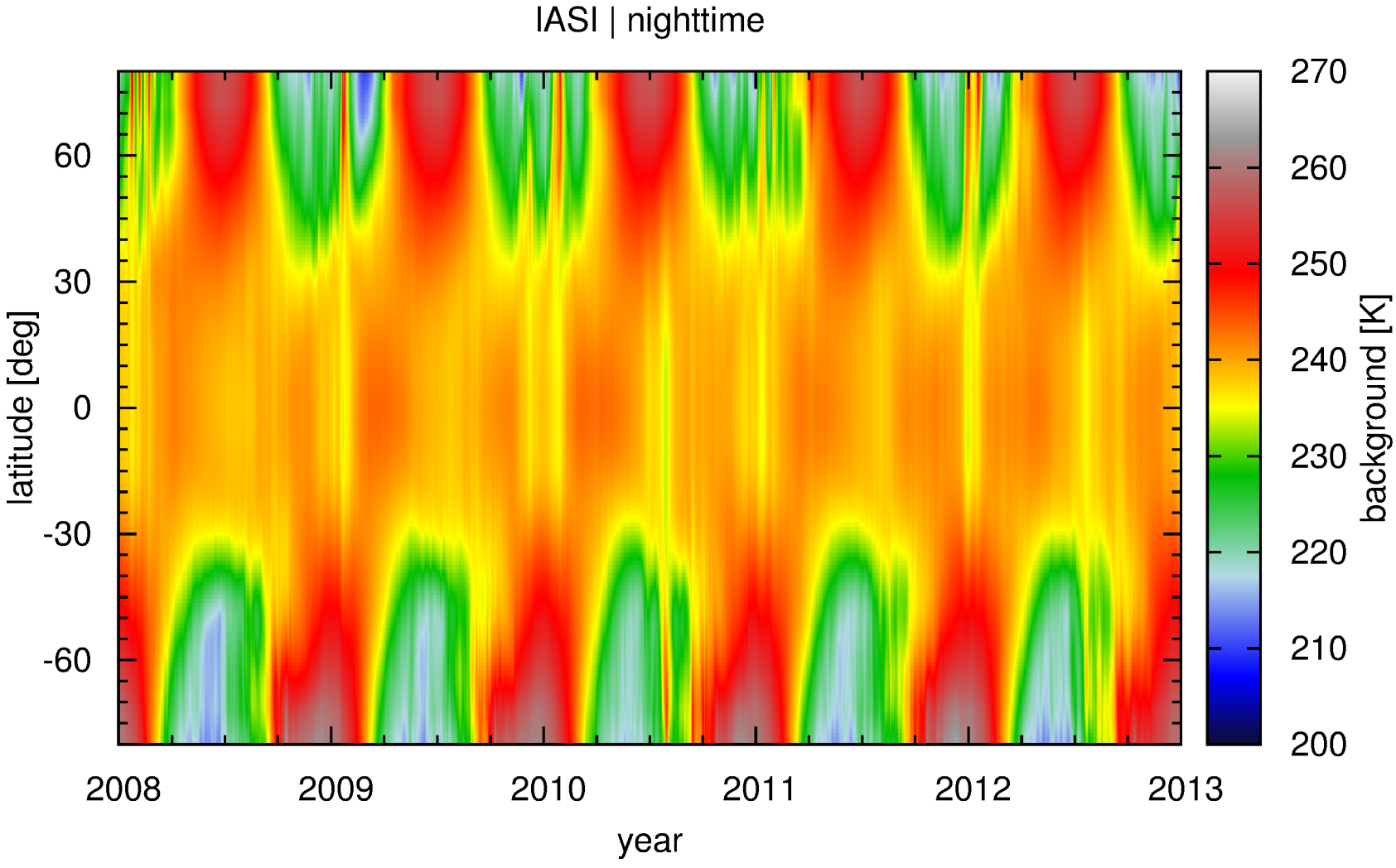
- AIRS has a more dense and regular footprint pattern:



- IASI has smaller footprints, yielding sensitivity to large-amplitude short-scale waves.

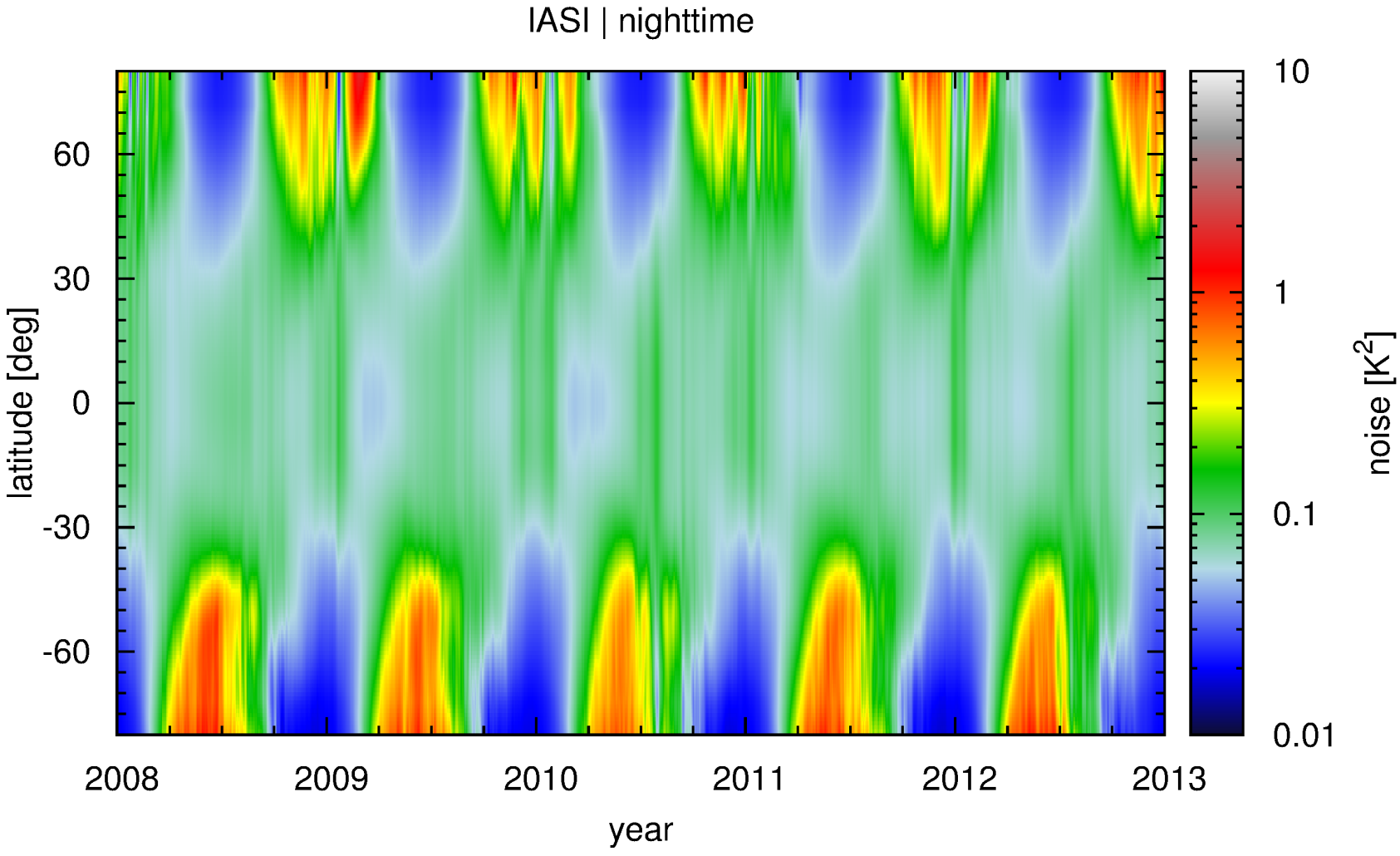
2008 – 2012 time series of IASI observations

- Background temperatures at 30 – 40 km altitude:



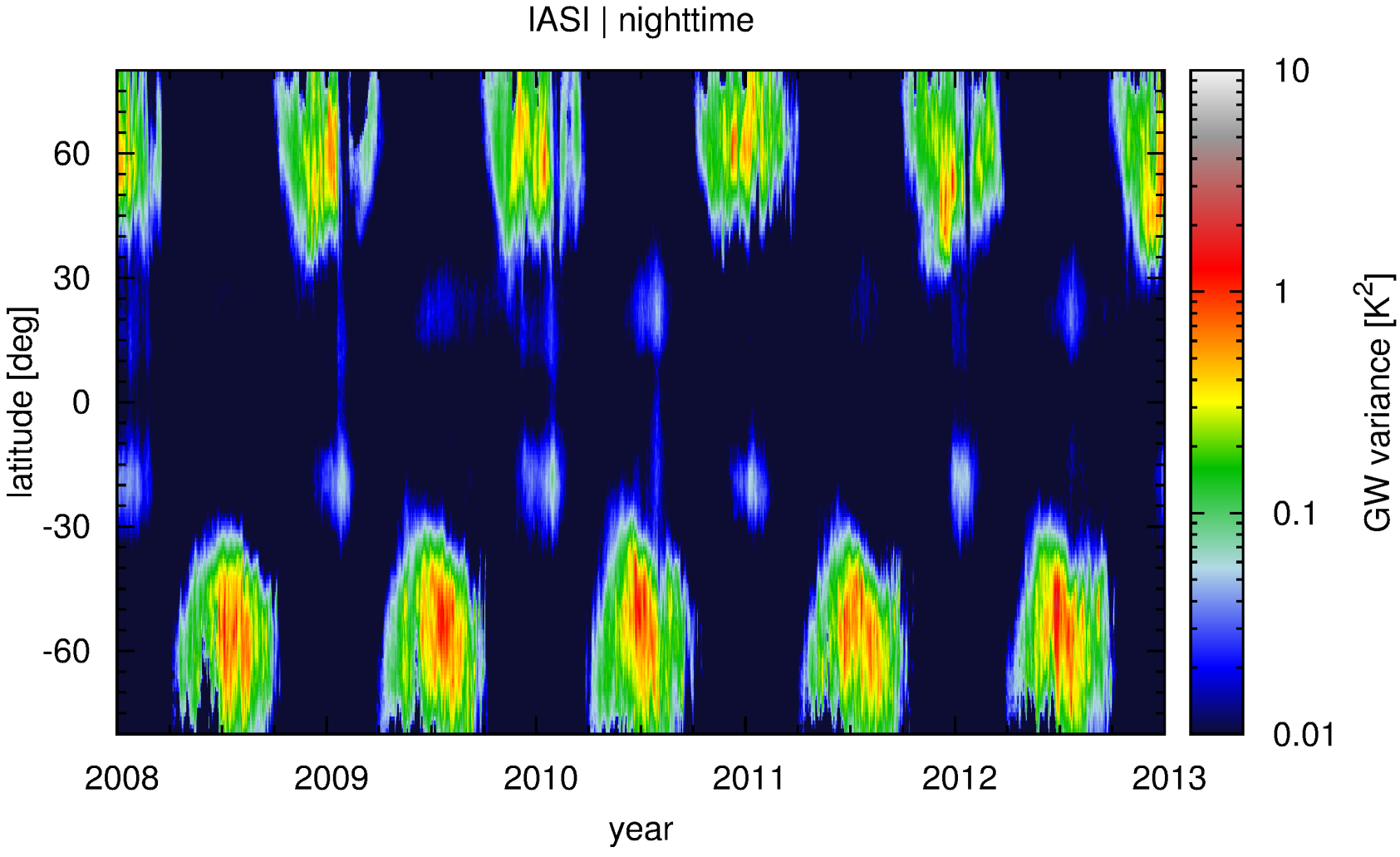
2008 – 2012 time series of IASI observations

- Corresponding noise variances:



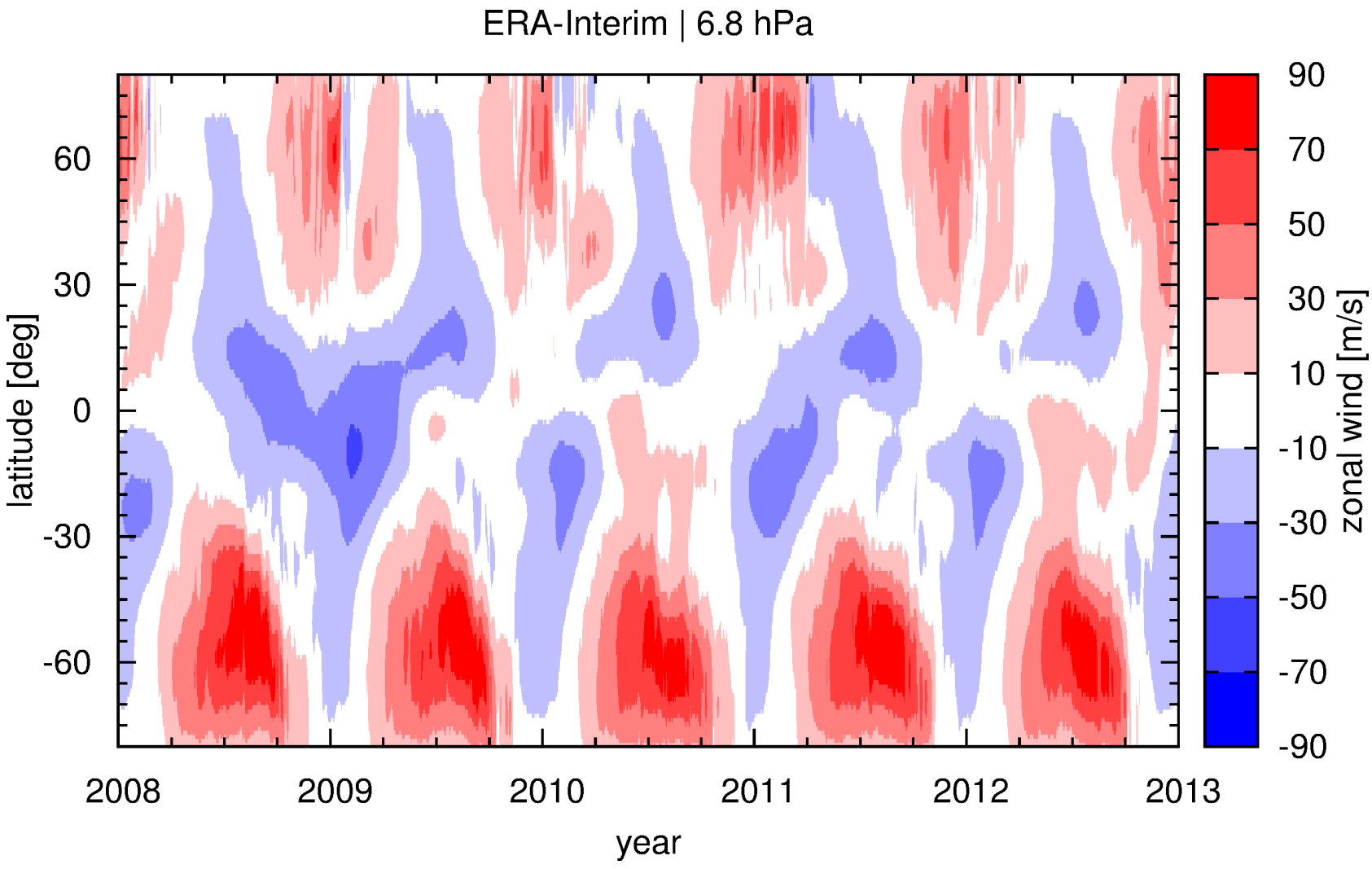
2008 – 2012 time series of IASI observations

- Detrended and noise-corrected GW variances:



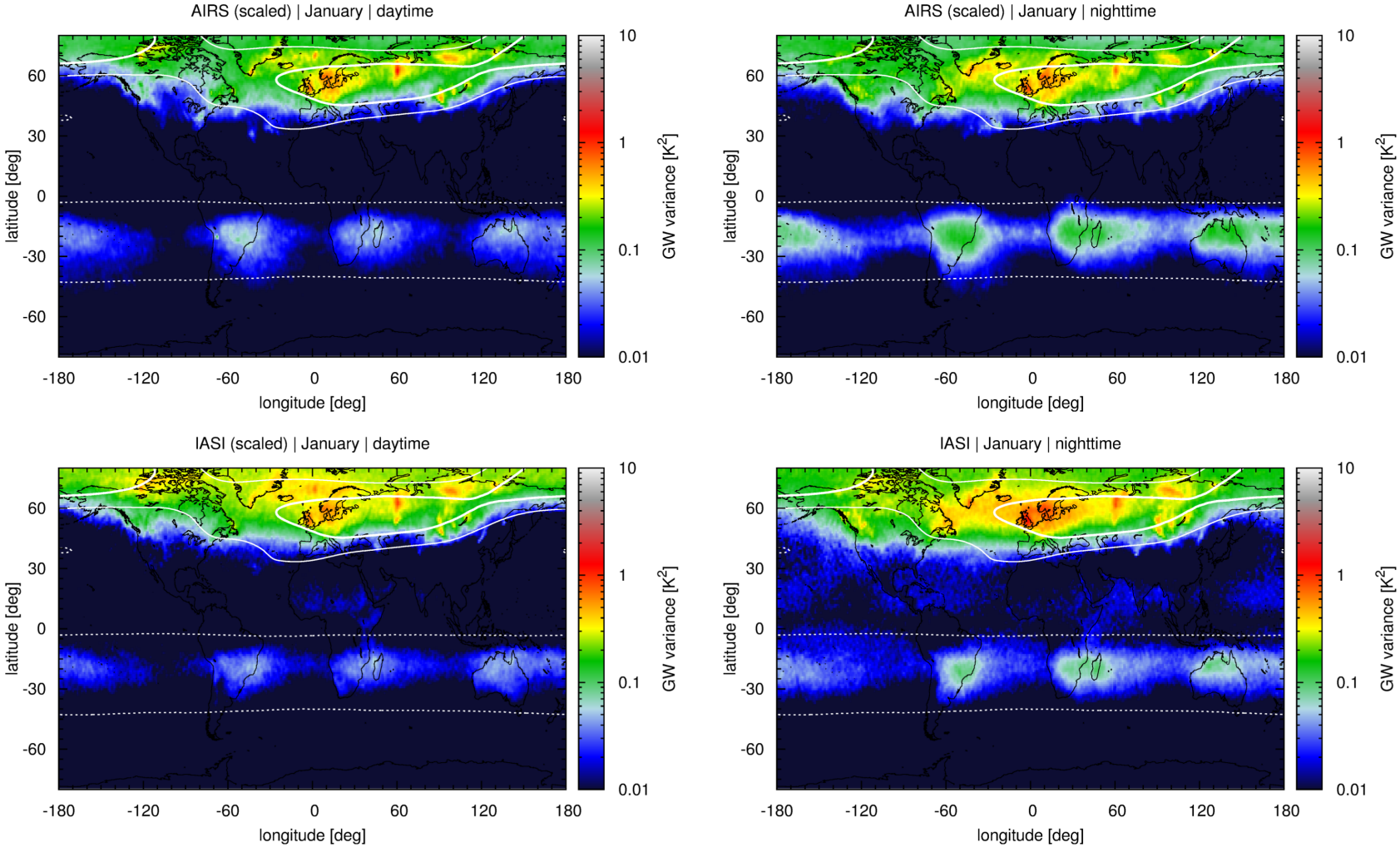
2008 – 2012 time series of IASI observations

- Correlation with ERA-Interim 6.8 hPa zonal winds:



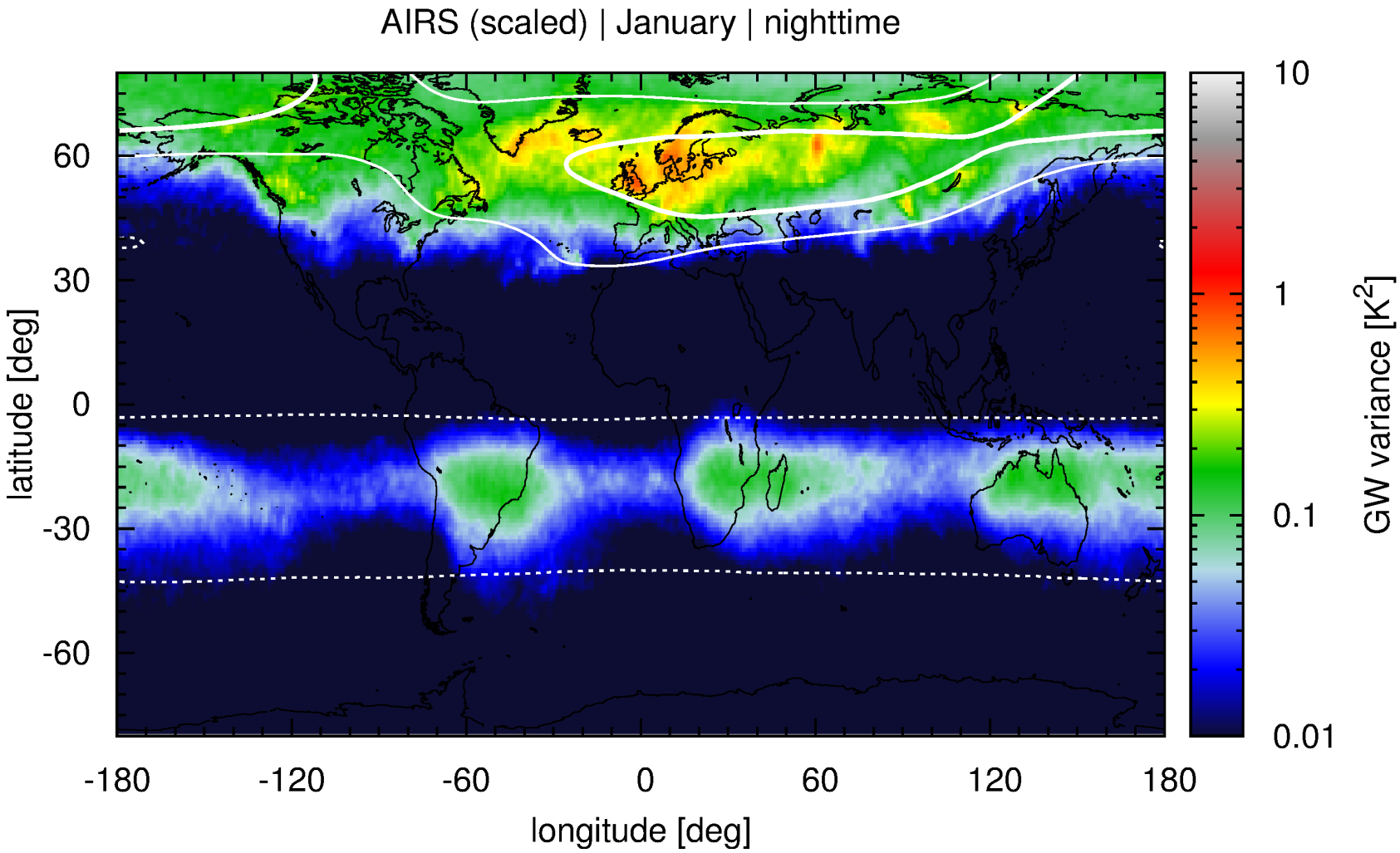
GW activity in January

- Comparison of AIRS and IASI:



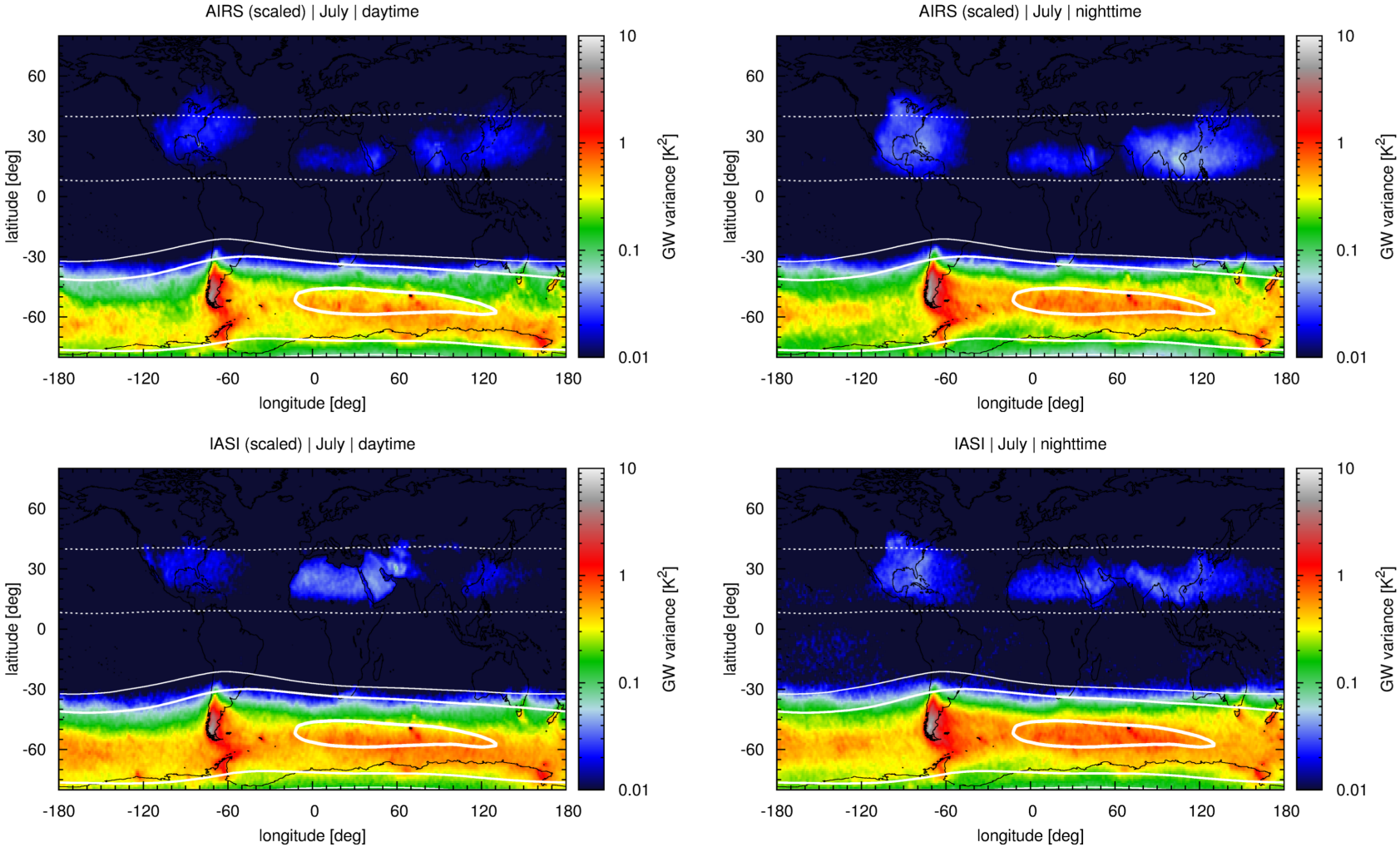
GW activity in January

- AIRS patterns of GW activity at nighttime:



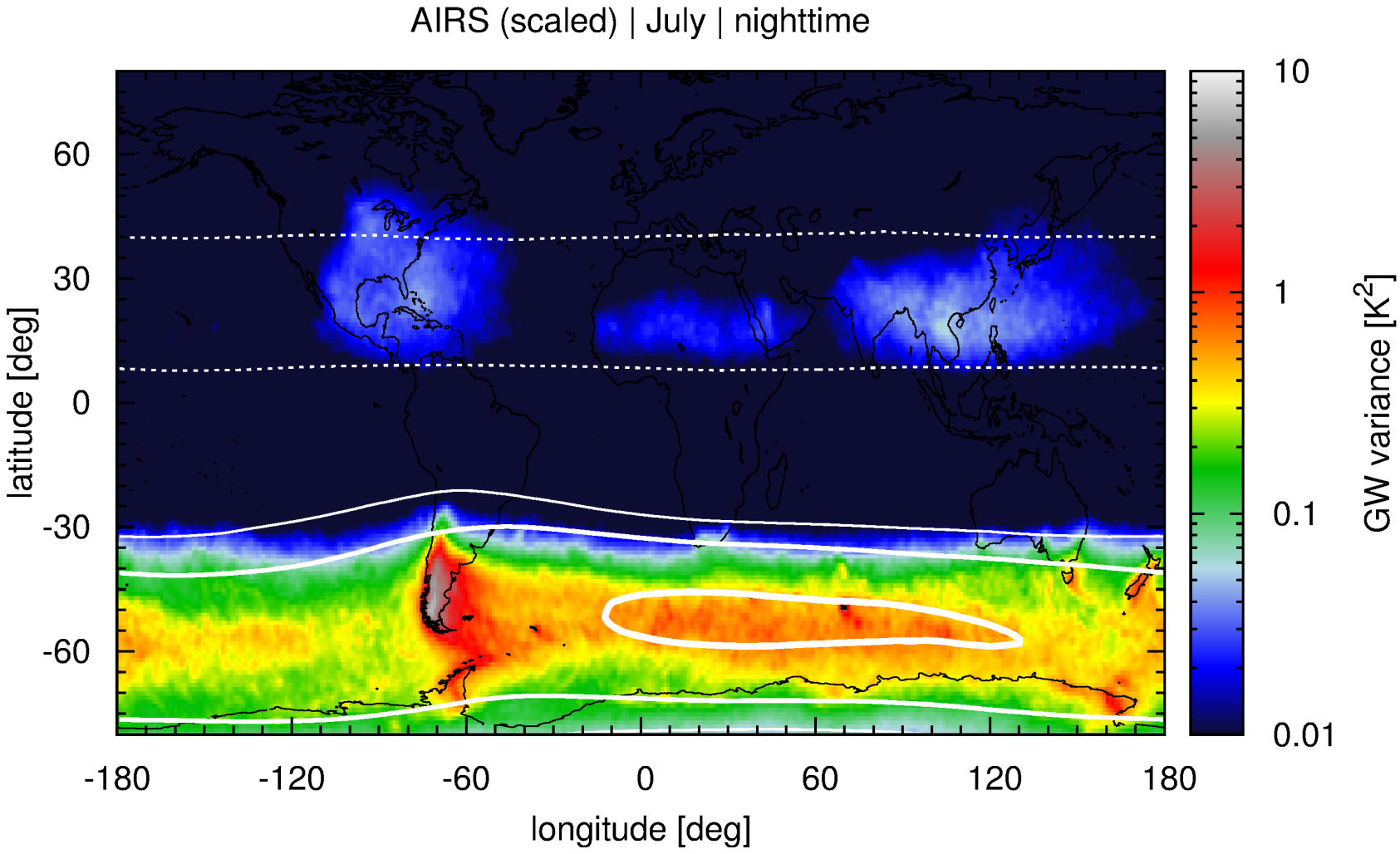
GW activity in July

- Comparison of AIRS and IASI:



GW activity in July

- AIRS patterns of GW activity at nighttime:



Conclusions

- IASI data used here for the first time for GW research.
- AIRS and IASI provide a consistent picture of the temporal development of individual GW events.
- AIRS and IASI show similar spatial and temporal patterns of GW activity, but IASI variances 40 – 50% larger.
- Instrument characteristics need to be considered:
  - IASI is more sensitive to long horizontal wavelengths.
  - IASI is a bit more sensitive to short vertical wavelengths.
  - IASI has better horizontal resolution.
  - AIRS has better horizontal sampling.
  - AIRS has lower noise at 4.3 μm.

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Intercomparison of stratospheric gravity wave observations with AIRS and IASI

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Abstract. Gravity waves are an important driver for the atmospheric circulation and have substantial impact on weather and climate. Satellite instruments offer excellent opportunities to study gravity waves on a global scale. This study focuses on observations from the Atmospheric Infrared Sounder (AIRS) onboard the National Aeronautics and Space Administration Aqua satellite and the Infrared Atmospheric Sounding Interferometer (IASI) onboard the European MetOp satellites. The main aim of this study is an

sampling are carefully considered. The ability to combine observations from different satellites provides an opportunity to create a long-term record, which is an exciting prospect for future climatological studies of stratospheric gravity wave activity.

1 Introduction