Diurnal Sampling Utilizing Formosat-3/COSMIC Data

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• Satellite orbits

• Local time sampling
  – Sun-synchronous orbits
  – Non Sun-synchronous orbits

• Temperature diurnal cycle in July and December

• Local time component of the sampling error in Formosat-3/COSMIC temperature climatologies

• Summary
Satellite Orbits

- Mean motion of the Earth
  \[ \Omega = \frac{360°}{365.24 \text{ d}} = 0.9856°/\text{d} \]

- Satellite's drifting rate:
  \[ \dot{\Omega} = -\frac{3}{2} J_2 \left( \frac{a_e}{a} \right)^2 n \cos i \]

- Drifting rate with respect to the sun:
  \[ \Omega_{\text{sun}} = \frac{360°}{365.24 \text{ d}} \cdot \dot{\Omega} \]
Satellite's drifting rate:

\[ \dot{\Omega} = -\frac{3}{2} J_2 \left( \frac{a_e}{a} \right)^2 n \cos i \]

Inclination (May 2006 - September 2007)

Altitude (May 2006 - September 2007)

Drifting Rate (May 2006 - September 2007)

Equator Crossing Time (May 2006 - September 2007)
Local Time Sampling

- Sun-synchronous orbit (e.g., MetOp):
  - $\Omega = 0.9856^\circ / d$
  - $\Omega_{\text{Sun}} = 0^\circ / d$

- Non Sun-synchronous orbit (e.g., COSMIC in final orbit)
  - $\Omega = -2.0361^\circ / d$
  - $\Omega_{\text{Sun}} = 3.0218^\circ / d$
Local Time Sampling

COSMIC, December 2006 – July 2007

Dec2006

COSMIC

Dec 2006

December 2006

RO Events Between 60°N and 90°N

NHP

No Of Events: 4607

NHSM

No Of Events: 13899

TRO

No Of Events: 7691

SHSM

No Of Events: 13285

SHP

No Of Events: 5124

Local Time Sampling

Altitude (May 2006 - September 2007)

Equator Crossing Time (May 2006 - September 2007)
Local Time Sampling

COSMIC, December 2006 – July 2007

July 2007

- RO Events Between 60°N and 90°N
  - NHP
  - No Of Events: 4973

- RO Events Between 20°N and 60°N
  - NHSM
  - No Of Events: 13233

- RO Events Between 20°S and 20°N
  - TRO
  - No Of Events: 8538

- RO Events Between 20°S and 60°S
  - SHSM
  - No Of Events: 15266

- RO Events Between 60°S and 90°S
  - SHP
  - No Of Events: 4943
Local Time Sampling

COSMIC, December 2006 – July 2007

Final Constellation (Simulation)

No Of Events: 7857
No Of Events: 23477
No Of Events: 13086
No Of Events: 23477
No Of Events: 7964
Diurnal Cycle

December 2006, July 2007

December 2006

NHP

NHSM

TRO

SHSM

SHP

July 2007

NHP

NHSM

TRO

SHSM

SHP
Diurnal Cycle

COSMIC - ECMWF, July 2007

Mean profiles

COSMIC: July 2007

ECMWF: July 2007
Diurnal Cycle

July 2005 - July 2007

mean profiles

COSMIC: July 2007

ECMWF: July 2007

(Simulation)

ECMWF: July 2005

Mean NHP Temperature (July 2007)

Mean NHSM Temperature (July 2007)

Mean TRO Temperature (July 2007)

Mean SHSM Temperature (July 2007)

COSMIC NHP Dry Temperature (July 2007)

COSMIC NHSM Dry Temperature (July 2007)

COSMIC TRO Dry Temperature (July 2007)

COSMIC SHSM Dry Temperature (July 2007)

co-located ECMWF NHP Dry Temperature (July 2007)

co-located ECMWF NHSM Dry Temperature (July 2007)

co-located ECMWF TRO Dry Temperature (July 2007)

co-located ECMWF SHSM Dry Temperature (July 2007)

COSMIC NHP Physical Temperature (July 2005)

COSMIC NHSM Physical Temperature (July 2005)

COSMIC TRO Physical Temperature (July 2005)

COSMIC SHSM Physical Temperature (July 2005)
Diurnal Cycle

Formosat-3/COSMIC Simulations: July, December

ECMWF: July 2005

ECMWF: December 2004
Local Time Component

Temperature Climatologies: Sampling Error

- Results from spatio-temporal undersampling of the “true” atmospheric variability
- Spatial and temporal component
- Local time component is part of the sampling error
Local Time Sampling

Sampling Error

- (a) NHSM
- (b) TRO
- (c) NHSM
- (d) SHSM

Local Time Component

- (a) NHSM
- (b) TRO
- (c) NHSM
- (d) SHSM
Diurnal cycle:

- Formosat-3/COSMIC is able to detect the diurnal cycle of atmospheric parameters in different geographical regions within one month
- Tropical results are in good agreement with
  - Alexander and Tsuda (2007)
  - Zeng et al. (2007)

Climatological point of view:

- Uneven local time sampling at higher latitudes
- Alternating small positive and negative deviations in the local time component of the sampling error
- Local time component of monthly-mean zonal-mean climatologies amounts to ±0.03 K
THANK YOU!!