

1 ☐ Applications – 2

2 ☐ Urban heat island effects

- Temperature differences develop between cities & surrounding rural regions
- Urbanization has greatest influence on minimum temperature records
- Increases cloudiness & precipitation in the city – sets up thermal circulation between city & surrounding region

3 ☐ Satellite-derived temperatures

- Satellite-derived temperature data
 - AVHRR thermal data (10.5-12.5 μm) at night to determine urban & rural surface temperature differences
 - HCMM (10.5-12.5 μm) to assess the extent & intensity of urban surface heating

4 ☐ Satellite-derived VIs

- Greatest differences in surface radiant temperature observed at midday
- Measure difference in density of urban & rural vegetation – indicator of magnitude of differences observed in the minimum air temperatures of urban & rural areas
- VIs – useful estimators of amount of leaf area & related variables associated with agriculture

5 ☐ Satellite-derived VIs

- Urban-rural differences in min, max, & ave air temperatures at met stations related to AVHRR estimates of NDVI & surface radiant temps

6 ☐ Other studies

- Use remote sensing (multitemporal TM) & GIS to detect urban growth – assess its impact on surface temperature
- Measure UHI in magnitude & spatial extent – UHI magnitude inversely correlated with rural temp, while spatial extent independent of heat island magnitude & rural temp

7 ☐ Carbon cycle studies

- Human activities – fossil fuel burning & changing land use – have caused an increase (>28%) in atmospheric carbon concentration over past 150 yrs
- As atmospheric CO_2 increases, earth's climate will change
- To prevent further increase of carbon & other greenhouse gases – need to understand global carbon cycle

8 ☐ Approach – terrestrial carbon

- 2 approaches to determine change of terrestrial carbon distribution in 3 pools – atmosphere, plants, soils
 - “Bottom-up approach” – start with parcel of land to account for various pathways of carbon exchange between ecosystem & atmosphere; scale up to larger regions
 - “Top-down approach” – measured changes in atmospheric gas concentrations; attempt to infer spatial distribution & magnitude of net exchange

9 ☐ “Bottom-up” approach

- Relies on ecosystem process models & spatial datasets
 - Develop at local scale, validate using conventional measurements

- Satellite observations provide spatial distribution & up-to-date information
 - Figure 13.8
 - Use optical & thermal remote sensing to get information
- 10 ☐ Global carbon cycle info from RS
- Land cover & land use – present & historical – satellite mapping
 - Aboveground & belowground biomass – size & changes of terrestrial carbon pool
 - Future LiDAR satellite programs – VCL & ICESat GLAS
 - Multi-angle remote sensing – MISR, POLDER
- 11 ☐ Global carbon cycle info from RS
- Seasonal growth cycle
 - Leaf area (LAI), growing season duration, timing of growth – constraints on carbon sequestration
 - Multispectral (Landsat, MODIS) & multiangle (MISR, POLDER, EPIC) RS data
 - Fire
 - Strongest disturbance of vegetation – detect burned areas
 - Need to calculate net carbon sinks; causes interannual variations in carbon emissions, influences ecosystem succession & land
 - TM/ETM+, SPOT, AVHRR, MODIS
- 12 ☐ Global carbon cycle info from RS
- Solar radiation
 - Global solar radiation (shortwave) & photosynthetically active radiation (PAR) – drives photosynthesis & evapotranspiration
 - Satellite radiance measurements – ERBE, GOES
 - Ecosystem productivity
 - Ecosystem productivity quantities determined using satellite-derived products, soil & meteorological databases & bio/geochemical models
 - AVHRR
 - Case demonstrations – GloPEM, BEPS & InTEC
- 13 ☐ Land-atmosphere interaction
- What is role of land surface in modulating the global climate?
 - Basic elements of land-atmosphere interaction – exchange of moisture and energy between the 2 systems
 - Ocean – sea surface temperature (SST) plays a major role in forcing the atmosphere
 - Land – major element of the climate system
 - More variable & exchangeable than oceans
 - Land surface processes contribute to the variance of annual precipitation over continents
- 14 ☐ Land surface models
- System of parameterized equations to include surface radiation budget & surface energy budget
 - Surface radiation budget – influenced by solar diurnal cycle & cloud field
 - Surface energy budget – major interaction point between land surface model & GCMs
 - Variety of land surface models developed, incorporating varying levels of complexity of land-atmosphere interaction
- 15 ☐ Land surface models
- Late 1960s & 1970s – 1st generation
 - Simple aerodynamic bulk transfer formulas
 - Uniform surface parameters (albedo, aerodynamic roughness, soil moisture availability)
 - Early 1980s – 2nd generation

- Recognized the effects of vegetation in calculating the surface energy balance
- 1990s – 3rd generation
 - Use modern theories relating photosynthesis & plant water relations – provides description of energy exchange, evapotranspiration & carbon exchange by plants

16 ☐ Land surface model development

- One of major causes of uncertainties in current climate change predictions
- Constrained by availability of data acquired to initialize, parameterize, & test the models
 - Promising approach to obtaining these data is by developing algorithms to predict the state of the land surface & atmosphere from RS data
- Land-atmosphere research – models, satellite data algorithms, field experiments
 - See Figure 13.11

17 ☐ Summary

- Benefits of quantitative remote sensing
- Understanding remote sensing data (1st part)
- Land surface information extraction (2nd part)
- Applications (3rd part)
- New requirements of applications motivate the development of new sensor systems, new models for understanding the data acquired by new sensors, and new algorithms for estimating surface variables – leads to next cycle