

## HOBE – the Danish Hydrological Observatory

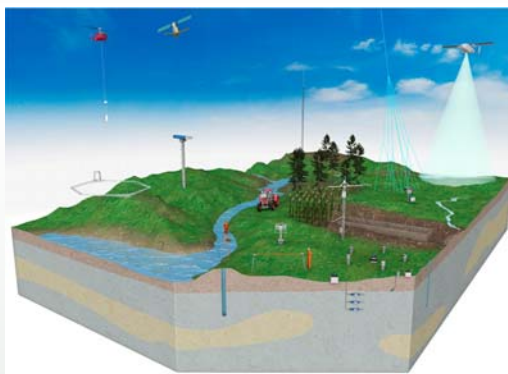
Karsten H. Jensen  
University of Copenhagen



### Key objectives of HOBE – the Danish hydrological observatory



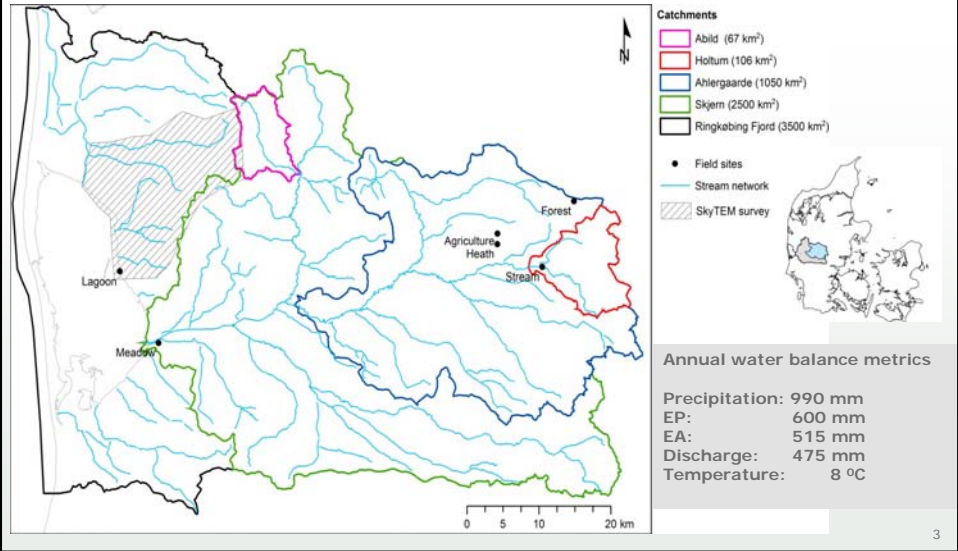
- ▶ To establish an observational and experimental inter-disciplinary outdoor laboratory
- ▶ Test new innovative field instrumentation and observation techniques
- ▶ Establish scientific datasets to support fundamental research of hydrological processes
- ▶ Integrate monitoring, measurements, experiments, modeling and scaling
- ▶ Integrate knowledge across hydrological disciplines to help closing water balance at catchment scale



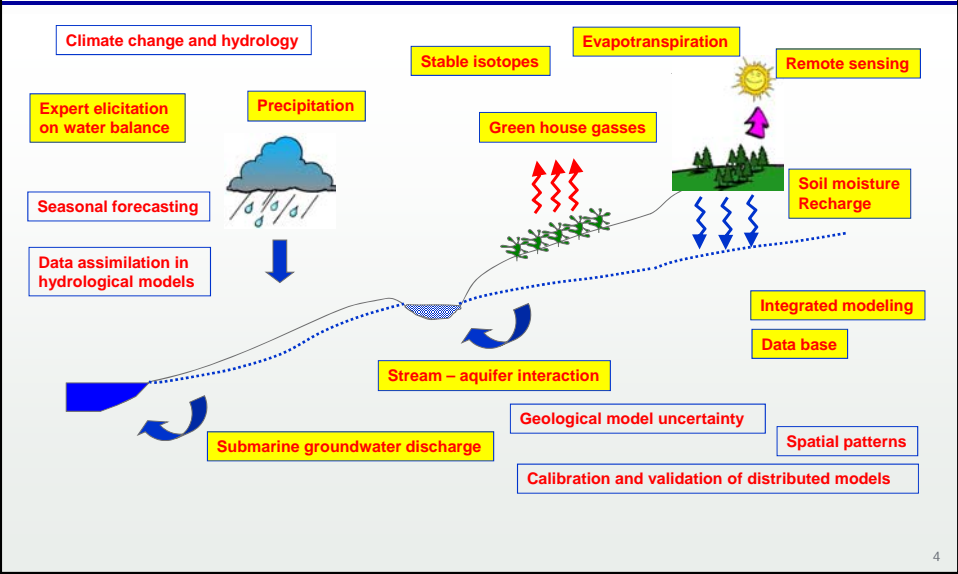
- ▶ Provide a basis for international research collaboration



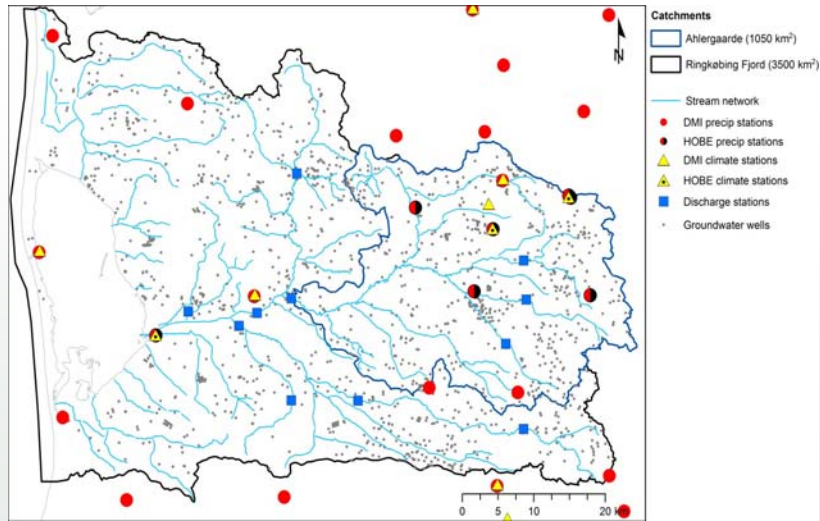
# Study area - Skjern catchment and associated subcatchments – nested approach



# Project components



## Basic monitoring



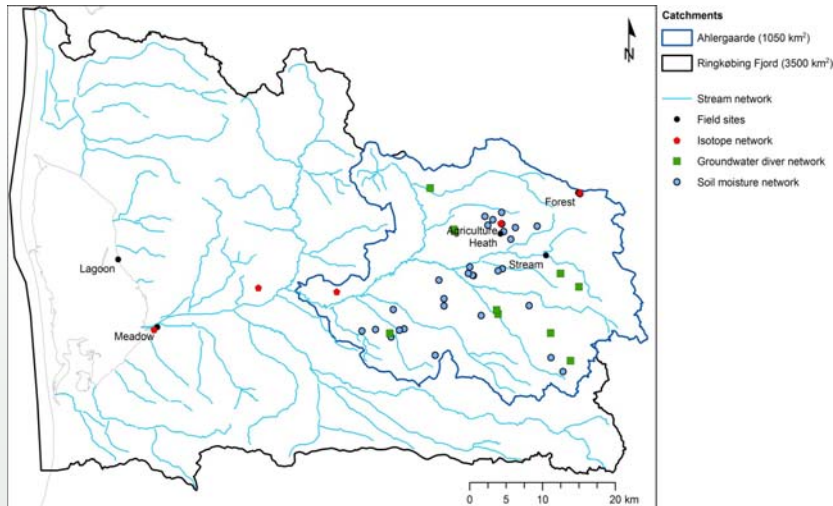
5

## Basic monitoring

- ▶ Discharge: 11
- ▶ Precipitation: 22+3
- ▶ Climate: 7+3
- ▶ Groundwater wells: 3000

6

## Special monitoring



7

## Agricultural site

1. Precipitation
  - a. Seven precipitation gauges of which one is placed at ground level as reference for liquid precipitation and one is shielded with a double fence as reference for solid precipitation
2. Weather type
  - a. Two distrometers for measuring drop size distribution
3. Climatic variables
  - a. Radiation (net radiation, in- and outgoing short- and long wave radiation)
  - b. Wind speed and direction
  - c. Air temperature
  - d. Relative humidity
  - e. Soil temperature at three depths
  - f. Soil heat flux at 5 cm depth
4. Energy and greenhouse gas fluxes (12 m covariance flux tower)
  - a. Latent heat
  - b. Sensible heat
  - c. CO<sub>2</sub> gas
  - d. N<sub>2</sub>O gas
5. Recharge
  - a. Outflow from four underground lysimeters (3.2 x 3.9 x 1.5 m) each holding nine probes for soil moisture measurements
6. Groundwater
  - a. One deep well (36 m) with screens at 5-7 m, 7-9 m, 13-15 m, and 33-35 m depths
  - b. Three shallow wells for measuring water table using pressure transducer
7. Cosmic ray
  - a. Moderated cosmic ray sensor and an associated network of soil moisture probes (30 Decagon STE) and suction probes (5)

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## Agricultural site

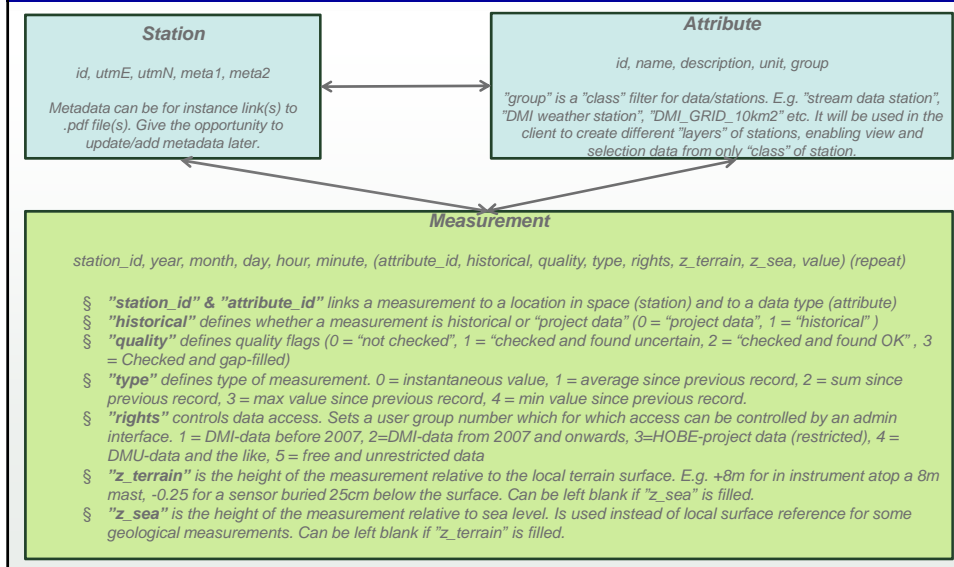
8. Soil moisture
  - a. 70 soil moisture probes (TDR and Decagon STE) installed at depths 0.1, 0.2, 0.3, 0.4, 0.5, 1.0, 2.0, 3.0 and 4.0 m
9. Soil water pressure
  - a. 15 probes installed at depths 0.1, 0.2, 0.3, 0.4 and 0.5 m
10. Suction cups for water sampling
  - a. 4 cups at depths 1.0, 2.0, 3.0 and 4.0 m
11. Hydrogeophysics array
  - a. Cross-borehole georadar array (4 x 6 m access tubes)
  - b. Cross-borehole electrical resistivity array (5 x 6 m tubes with 24 electrodes in each tube placed every 25 cm)
  - c. Temperature sensors placed every 25 cm
  - d. 17 Decagon STE soil moisture sensors installed to a maximum depth of 3 meter
  - e. 6 Decagon MPS soil suction sensors installed to a maximum depth of 3 meter
  - f. 6 suction cups installed at depths 1, 2, 2.4, 3.4, 4.5 and 5.5 m
  - g. 15 unpolarizable electrodes for self-potential measurements

## Remote sensing and campaigns

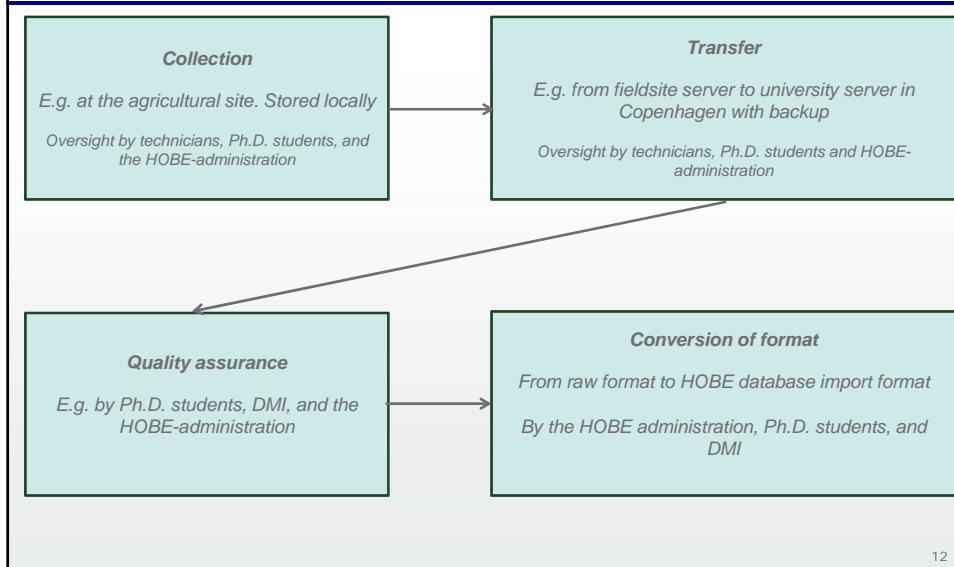
- ▶ Remote sensing products
  - MODIS
  - SMOS
- ▶ Campaigns
  - Helicopter borne geophysical measurements over and near Ringkøbing lagoon
  - Airborne measurements with the L-band radiometer EMIRAD-2 for measurement of brightness temperature
  - UAV flight campaigns for measuring land surface characteristics
  - Point and distributed temperature sensing of groundwater-surface water interactions and sediment mobility
  - Areal measurements of cosmic rays intensity on different land use types
  - Measurements of hydraulic properties
  - Hydrogeophysical measurements at the agricultural field observatory
  - Measurements of migration of tracers at the agricultural field observatory



## Datamodel

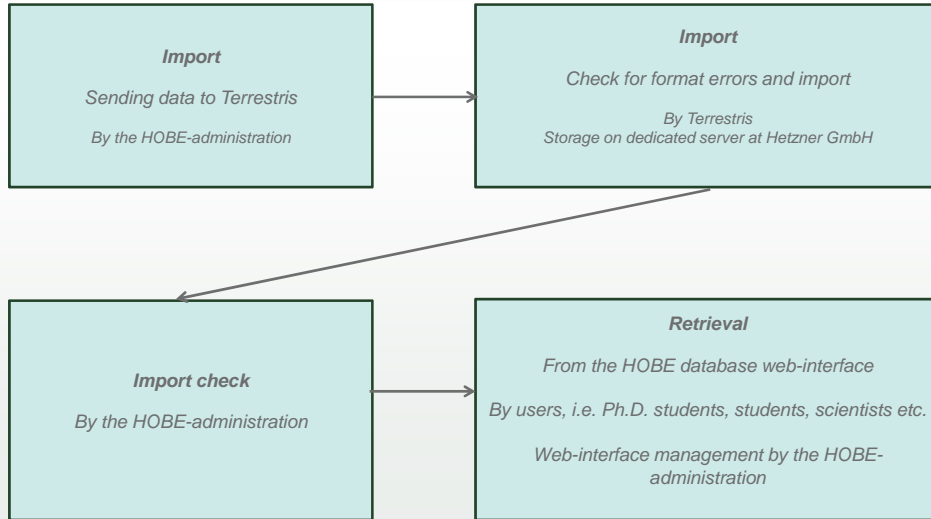


## Dataflow





## Dataflow



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Date: \_\_\_\_\_

**User name:** \_\_\_\_\_

**Address:** \_\_\_\_\_

**Name:** \_\_\_\_\_

**E-mail:** \_\_\_\_\_

**Service address:** \_\_\_\_\_

**Url site:** \_\_\_\_\_

**Date received:** \_\_\_\_\_

**Date delivery time:**  email  cd-rom

Selections value sent to terrestrial DME contribution to the project:  (DME and Y 3.1)

Agree: delivery cost will be invoiced by paid by the user:  (DME and Y 3.1)

**Research structure project title program:** \_\_\_\_\_

*Please submit project description and information on the expected form and time of publication (max. one A4 page) must be returned to DME attached this statement before data can be delivered*

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## Web-interface

The screenshot displays the HOBE Center for Hydrology web interface. It features a map of a region with several stations marked. A data table is open, showing the following columns: ID, Name, Description, Unit, Startdate\_start, Created\_at, Group\_name, and Request\_date. The table contains 18 rows of data.

ID	Name	Description	Unit	Startdate_start	Created_at	Group_name	Request_date
E14	discharge	m <sup>3</sup> /s		2009-07-10 08:00:00	2009-07-10 08:00:00	discharge	4
E15	water_level	cm above DMS0		2009-07-10 08:00:00	2009-07-10 08:00:00	water_level	5
E16	water_level	cm above DMS		2009-07-10 08:00:00	2009-07-10 08:00:00	water_level	6
E17	dir	wind direction	degrees	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	100
E18	WS	wind speed	3.3 m/sec	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	101
E19	WS	humidity	percent	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	102
E20	PS	air pressure at station 0.1 MPa		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	103
E21	TS	air temperature	0.1 degC	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	104
E22	TS	soil temperature 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	105
E23	TS	soil temperature 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	106
E24	TS	relative humidity	percentage	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	107
E25	TS	soil depth	cm	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	108
E26	TS	soil temperature + 10 cm 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Automatic_DMS123	109
E27	TS	soil temperature + 50 cm 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Automatic_DMS124	110



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E14	discharge	m <sup>3</sup> /s		2009-07-10 08:00:00	2009-07-10 08:00:00	discharge	4
E15	water_level	cm above DMS0		2009-07-10 08:00:00	2009-07-10 08:00:00	water_level	5
E16	water_level	cm above DMS		2009-07-10 08:00:00	2009-07-10 08:00:00	water_level	6
E17	dir	wind direction	degrees	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	100
E18	WS	wind speed	3.3 m/sec	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	101
E19	WS	humidity	percent	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	102
E20	PS	air pressure at 0.1 MPa		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	103
E21	TS	air temperature	0.1 degC	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	104
E22	TS	soil temperature 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	105
E23	TS	soil temperature 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	106
E24	TS	relative humidity	percentage	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	107
E25	TS	soil depth	cm	2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Sunsp	108
E26	TS	soil temperature + 10 cm 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Automatic_DMS123	109
E27	TS	soil temperature + 50 cm 0.1 degC		2009-11-13 14:45:15	2009-11-13 14:45:15	DMS_Automatic_DMS124	110





Output from HOBE's database

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	station_name	station_latitude	station_longitude	measurements_id	measurements_unit	measurements_value	measurements_measured	measurements_updated	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at	measurements_measured_at
2	250734	524440	4197619	5th/10th	A	0.0085	5/1/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
3	250734	524440	4197619	5th/10th	A	0.0086	5/2/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
4	250734	524440	4197619	5th/10th	A	0.0087	5/3/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
5	250734	524440	4197619	5th/10th	A	0.0088	5/4/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
6	250734	524440	4197619	5th/10th	A	0.0089	5/5/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
7	250734	524440	4197619	5th/10th	A	0.0090	5/6/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
8	250734	524440	4197619	5th/10th	A	0.0091	5/7/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
9	250734	524440	4197619	5th/10th	A	0.0092	5/8/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
10	250734	524440	4197619	5th/10th	A	0.0093	5/9/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
11	250734	524440	4197619	5th/10th	A	0.0094	5/10/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
12	250734	524440	4197619	5th/10th	A	0.0095	5/11/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
13	250734	524440	4197619	5th/10th	A	0.0096	5/12/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
14	250734	524440	4197619	5th/10th	A	0.0097	5/13/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
15	250734	524440	4197619	5th/10th	A	0.0098	5/14/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
16	250734	524440	4197619	5th/10th	A	0.0099	5/15/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
17	250734	524440	4197619	5th/10th	A	0.0100	5/16/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
18	250734	524440	4197619	5th/10th	A	0.0101	5/17/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
19	250734	524440	4197619	5th/10th	A	0.0102	5/18/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
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22	250734	524440	4197619	5th/10th	A	0.0105	5/21/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
23	250734	524440	4197619	5th/10th	A	0.0106	5/22/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
24	250734	524440	4197619	5th/10th	A	0.0107	5/23/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
25	250734	524440	4197619	5th/10th	A	0.0108	5/24/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
26	250734	524440	4197619	5th/10th	A	0.0109	5/25/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
27	250734	524440	4197619	5th/10th	A	0.0110	5/26/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
28	250734	524440	4197619	5th/10th	A	0.0111	5/27/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
29	250734	524440	4197619	5th/10th	A	0.0112	5/28/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
30	250734	524440	4197619	5th/10th	A	0.0113	5/29/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
31	250734	524440	4197619	5th/10th	A	0.0114	5/30/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
32	250734	524440	4197619	5th/10th	A	0.0115	5/31/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
33	250734	524440	4197619	5th/10th	A	0.0116	6/1/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
34	250734	524440	4197619	5th/10th	A	0.0117	6/2/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
35	250734	524440	4197619	5th/10th	A	0.0118	6/3/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
36	250734	524440	4197619	5th/10th	A	0.0119	6/4/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
37	250734	524440	4197619	5th/10th	A	0.0120	6/5/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
38	250734	524440	4197619	5th/10th	A	0.0121	6/6/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
39	250734	524440	4197619	5th/10th	A	0.0122	6/7/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
40	250734	524440	4197619	5th/10th	A	0.0123	6/8/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
41	250734	524440	4197619	5th/10th	A	0.0124	6/9/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0
42	250734	524440	4197619	5th/10th	A	0.0125	6/10/2013 0:00	6/30/2018 18:39	6/30/2018 18:39	2	0	4	0	0	0	0	0	0	0